SECOND ANNUAL REPORT

NASA Cooperative Agreement Goddard Earth Sciences Technology and Research II (GESTAR II)
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by
The University of Maryland, Baltimore County
Consortium

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Message from the Director

I am delighted to present the second annual report of the NASA Goddard Earth Sciences, Technology and Research II (GESTAR II) cooperative agreement for the period of October 1, 2022 to September 30, 2023. I joined GESTAR II as Director effective February 1, 2023. I am highly impressed by the exceptional standards set and followed by both the NASA Goddard Earth Science Division (ESD) leadership and the consortium partnership in the implementation of this cooperative agreement. This has resulted in the competent, friendly, and efficient performance of the GESTAR II administrative personnel who have provided effective and virtually seamless support to our faculty and scientists, thereby allowing them to devote their attention to the scientific work for which this partnership was established.

This report provides a summary of the research activities and accomplishments by GESTAR II scientists during the 2022-2023 reporting period. GESTAR II employs more than 160 scientists who are distributed across almost all laboratories of the ESD (*i.e.*, Codes 610.1, 612, 613, 614, 615, 616, 617, 618, 61A) and one branch (*i.e.*, Code 555) of the Instrument Systems & Technology Division. These scientists are involved in a wide spectrum of scientific research activities that support NASA's strategic goals and Earth Science Mission objectives. Indeed, GESTAR II scientists actively participate (some with leadership roles) in the implementation of various existing and upcoming space missions (*e.g.*, TERRA, AQUA, AURA, CALIPSO, GPM, JPSS, SMAP, DSCOVR, PACE, AOS, TSIS-2, GLIMR) and major field campaigns (*e.g.*, EXPORTS, IMPACTS, AEROMMA, PACE-PAX, Asia-AQ), as well as major Earth-system models or data systems (*e.g.*, GEOS, JEDI, EIS) and ground-based networks (*e.g.*, AERONET, MPLNET, PANDONIA).

In partnership with their respective NASA sponsors, GESTAR II scientists are engaged in cutting-edge research on important topics that result in innovative algorithms and numerical models, transformative datasets, and analysis results. They are also engaged in developing and operating scientific instrumentation that support ground-based, suborbital, and space missions. Our scientists have been remarkably productive, publishing in high-ranking refereed journals, giving invited and contributed presentations at a wide variety of international conferences, workshops, and seminars, and leading and participating in science team meetings and working groups. During the reporting period, many of our scientists won competitive proposals and served on proposal review panels for NASA and other funding agencies. Our scientists also participated in student and peer mentoring and training, media communication, and other public outreach activities. A significant number of GESTAR II scientists received NASA individual and group achievement awards, attesting to their remarkable dedication to NASA's mission and their outstanding performance.

I applaud the wonderful efforts and accomplishments of all GESTAR II scientists and research associates, the leadership and administrative personnel at all GESTAR II member institutions and organizations, the NASA civil service sponsors of the GESTAR II faculty, and the leadership and management of the cooperative agreement at NASA Goddard ESD. This is a tremendous team that I have been privileged to work with over the last several months to fulfill our common purpose of advancing NASA's Earth Science strategic goals and priorities. It is a great honor for me to be a part of this team, and I look forward to continued synergy and accomplishments in the coming months and years.

I would like to take this opportunity to specifically call out the tremendous leadership of the

GESTAR II proposing PI and interim Director, Belay Demoz, for his leadership in transitioning our scientists into GESTAR II.

Charles Ichoku, Director

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I. Technical Volume: Tasks

CODE 555: MICROWAVE INSTRUMENT TECHNOLOGY BRANCH

Name: Priscilla Mohammed-Tano
Sponsor: Jeffrey Peipmeier
Code: 555
Task: 020

NASA's Soil Moisture Active and Passive (SMAP) Mission is the first of a series of Earth Science Decadal Survey missions which was launched January 31, 2015. The mission is providing global measurements of soil moisture and freeze/thaw state using L-band radiometry. Dr. Mohammed has worked with a collaborative team at GSFC to develop the L1B TB algorithm, which converts radiometer data into calibrated estimates of brightness temperature.

As part of the continued mission work, Dr. Mohammed was responsible for monitoring SMAP radiometer data by processing and observing instrument data from the L1A and L1B_TB products. Automated reports were generated to ensure normal instrument performance. Radio frequency interference (RFI) monitoring tools were run weekly to monitor RFI and algorithm performance.

Although SMAP operates within the protected Earth Exploration Satellite Service passive frequency allocation of 1400-1427 MHz, unauthorized in-band transmitters and out of band emissions have been causing interference to the SMAP microwave data. To reduce the impact, sources are identified and reported to the necessary administrations for enforcement of shutting down the sources. Reports were created for a different country each month and submitted to NASA, which then submitted them to the relevant authorities for action. Follow-up responses were also provided to the spectrum office relating to any feedback received from administrations. Dr. Mohammed also worked closely with OfCom from the United Kingdom by providing weekly data updates to aid in identifying interference sources.

Dr. Mohammed serves as the point of contact and is the expert for RFI related activities for the SMAP mission. Over the past year, her activities included liaising with the SMOS team for the coordination of reporting activities by both missions, providing updated SMAP data to the spectrum office to be presented at various meetings, such as the International Space Radio Monitoring Meeting, as well as providing updated RFI algorithm tables for the ground processing software.

Dr. Mohammed is also part of a team for the IIP project “Hyperspectral Microwave Photonic Instrument (HyMPI)” to advance toward the first in-space demonstration of an integrated microwave photonic system for future microwave radiometers. She is tasked with developing and writing the calibration and radio frequency and interference detection algorithms. During this reporting period, Dr. Mohammed has been working on system modeling as well as data analysis of the ASIC to be used in the digital back end of the instrument. She has completed system modeling for the radio frequency (RF) front end and the optical link for the system. The model was used to determine requirements for the RF front end, and was used for various trade studies to reduce calibration error. Work continues with system modeling to include the digital back end and system non-idealities.

In the coming months, Dr. Mohammed will continue to monitor the SMAP radiometer and provide

monthly RFI reports for SMAP. Also, Hyperspectral Microwave Photonic Instrument (HyMPI) modeling efforts will continue. The model will be used to determine optical system requirements and RFI detection algorithms will be written as part of the calibration algorithm.

Name: Jinzheng Peng
Sponsor: Jeffrey Peipmeier
Code: 555
Task: 020

The Soil Moisture Active and Passive Mission (SMAP) is one of four first-tier missions recommended by the U.S. National Research Council's Committee on Earth Science and Applications from Space, and the fully polarized L-band radiometer is one of two spaceborne instruments to make global measurements of land surface soil moisture and freeze/thaw state. While measuring the input signal strength, unwanted emissions in the antenna sidelobe from the Sun, the Moon, the galaxy, the atmosphere, the ionosphere, and Earth are also received. The input signal strength needs to be calibrated by internal calibration sources, which also needs to be calibrated (or validated) by external well-known targets; further, the unwanted emissions needs to be removed from the calibrated and Radio Frequency Interference (RFI)-free input signal.

The SMAP radar (active) and radiometer (passive) share a single feedhorn and mesh reflector. The antenna pointing has been calibrated by the radar and the result is applied to the radiometer. Because the two instruments work at different frequencies, the antenna pointing for the two instruments are slightly different. Validation shows that the antenna pointing accuracy for the SMAP radiometer is 2.7 km. In the past year, Dr. Peng worked on the antenna pointing cal/val for the SMAP radiometer, with the result showing that the antenna pointing accuracy can be improved by about 40%. This will help to improve the water-body correction used in the soil moisture retrieval and to improve the ocean surface incidence accuracy needed in the retrieval of sea surface salinity (SSS).

The SMAP radiometer TAs are calibrated by using two internal calibration sources. Dr. Peng developed an alternative method to perform the internal calibration by using only one internal calibration source. The radiometer's receiver noise temperature has been modeled and the performance of this one-point calibration (using one calibration source) was validated by comparing to the results of the conventional two-point calibration (using two calibration sources) over various aspects (e.g. NEDT, long-term calibration drift over ocean and the Cold Sky). Results show that one-point calibration has comparable performance to the conventional two-point calibration with additional advantages (e.g., higher reliability, cost reduction, etc.) The results were presented in SMAP science team meetings and IGARSS 2023.

Dr. Peng also supported the SMAP mission by monitoring/reporting the SMAP radiometer status and the L1B_TB data quality weekly; he also works with Science Data System (SDS) and operation teams to address any problems. Further, as Co-I, Dr. Peng continued working on improving the SMAP radiometer L1B_TB data quality by submitting a proposal to cross-calibrate the radiometer sub-band and full-band brightness temperatures to enable improved soil moisture and salinity retrievals under varying conditions.

For another activity, Dr. Peng works on COWVR, a conically scanning, fully polarimetric radiometer with three frequency bands between 18-34 GHz designed to provide measurements of ocean wind vector, and its performance is expected to meet or exceed WindSat in all non-

precipitating conditions. Launched in December 2021, the radiometer was mounted onto the International Space Station (ISS). As with other radiometers, the COWVR radiometer will be calibrated, including the antenna pointing (or geolocation) after launch. Dr. Peng focused on the COWVR radiometer antenna pointing cal/val in the past year. By using the various coastlines over the world, the antenna pointing accuracy can be improved from 4.0 km to 1.6 km; results were presented at IGARSS2023. He also monitored the COWVR data quality and provided an operational approach to flag abnormal data (possibly due to RFI).

For the upcoming months, Dr. Peng will continue working on the SMAP radiometer project by supporting operation and SDS activities, and submitting a manuscript for journal publication. Work will continue on the COWVR radiometer project by validating the result of antenna pointing calibration/validation at the calibrated TB level.

CODE 610: EARTH SCIENCE DIVISION

Name: Christopher Shuman
Sponsor: Compton Tucker
Code: 610
Task: 089

For part of this task, Dr. Shuman evaluates the utility for cryospheric targets afforded by the 14-bit radiometry of Landsat 9 versus 12-bit Landsat 8 data as well as 8-bit Landsat 7 data (https://www.usgs.gov/centers/eros/news/underfly-positions-landsat-9-below-landsat-8-simultaneous-scenes). This effort was conducted with assistance from Dr. Ted Scambos (U. Colorado, Boulder) and Dr. Mark Fahnestock (U. Alaska, Fairbanks). Because of the close temporal coverage of the early Landsat 9 and Landsat 8 overflight period as well as from the subsequent 8-day offset (the nominal, operations), multiple overlapping scenes in Antarctica were evaluated due to converging orbits. Scenes with small temporal offsets (<1 hour) were selected as unlikely to be impacted by weather events, even blowing snow. They focused on sub-areas across West Antarctica's Siple Dome and other areas in East Antarctica. Their comparisons indicate that 'detector-level' variations are the source of apparent noise between the two 'Operational Land Imager' sensors (OLI and OLI-2). While contemporaneous Landsat 7 Enhanced Thematic Mapper Plus (ETM+) data was not available from this location in January 2022, a similarly cloud-free image from January 2000 with Scan Line Corrector on (SLC) confirmed that both of the OLI 12 and 14 bit data (Landsat 8 and 9 respectively) had a much greater digital number (DN) range.

Another part of this research is to implement the Landsat Extended Acquisitions of the Poles (LEAP) acquisition plan that was developed, presented, and approved last year by the Landsat Science Team. Along with colleagues Drs. Scambos and Fahnestock, Dr. Shuman selected an additional 306 cryospheric Path/Row locations for acquisition by both L8 and L9's sensors as part of the Long-Term Acquisition Plan. These scenes will support improved monitoring and research of outlet glaciers; interior ice sheet regions; sea ice, landfast ice, and coastal ocean sites; and icebergs. Multiple LEAP scenes were processed and evaluated, anticipating that a Landsat Science Team meeting would happen in Reno, NV, but that did not come to pass in 2022.

Figure S (below) illustrates such an acquisition very close to the north end of the Antarctic Peninsula shown only in Thermal Infrared (TIRS-2 Band 10). It is noteworthy that the temperature contrast is so marked not just between open water (brightest tones in where sea is missing or thin when in the Band 10 data) but also for the very bright tones at some locations across the area's rugged topography. The full implementation of all Arctic and Antarctic LEAP scenes in early 2023 marks the culmination of their experimental or 'special' Landsat acquisitions begun in the boreal fall of 2019. The standard illumination limit for Landsat has long been 5° solar elevation so LEAP greatly expands cryospheric temporal coverage.

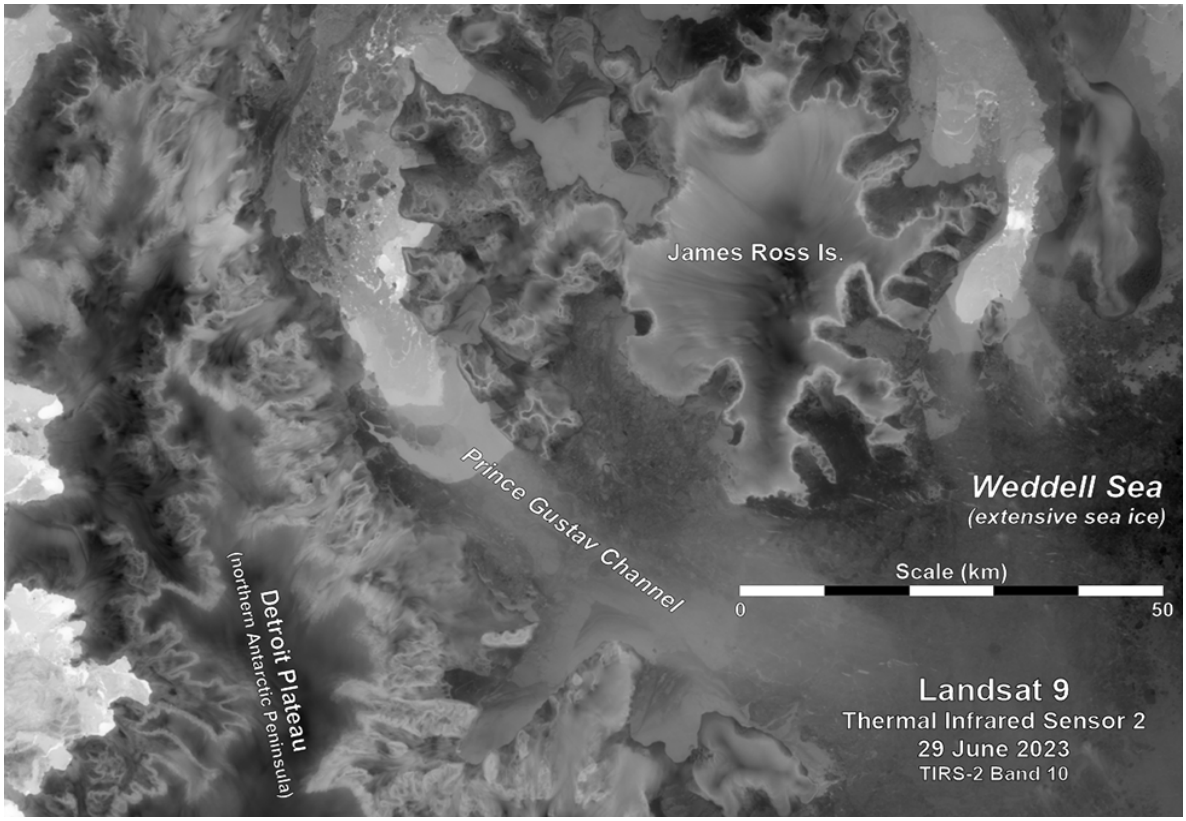


Figure 'S' – A ~140x100 km portion of a Landsat 9 Thermal Infrared Sensor 2 scene from late June 2023. These data from near the northern end of the Antarctic Peninsula were acquired as part of the Landsat Extended Acquisitions of the Poles (LEAP) activity that became fully enabled by the USGS early in 2023. These thermal infrared data from TIRS-2 varies from quite dark on the highest, coldest parts of the Peninsula to nearly white where there were open leads in the adjacent sea ice. Further, although the reflected light bands were also acquired, they were impacted by 'block banding'. This is because the Operational Land Imager 2 sensor, while still able to acquire useful data, it was not designed to work in such low light. The solar angle was about minus 4.2°, so well below the horizon in this winter acquisition. (USGS figure, provided by C. Shuman.)

Dr. Shuman also evaluated lower altitude, shifting time of acquisition Landsat 7 scenes for the potential to enhance tropical glacier information (https://www.usgs.gov/landsat-missions/landsat-7-extended-science-mission). A number of these extended science mission scenes were compared to nearly contemporaneous observations from Landsat 8 and 9 (OLI/2) for selected tropical glacier sites. In all areas studied, the lower altitude, earlier overpass scenes suffered from the expected SLC-off problem when the ETM+ sensor malfunctioned in late May 2003 (https://www.usgs.gov/landsat-missions/landsat-7) and because of difficult shadowing due to those same earlier, drifting overpass times. However, this analysis series also led to the difficult awareness of detectable spatial differences between Collection 1 and Collection 2 processing of Landsat data. These changes to "Geometric Accuracy Improvements" (see https://www.usgs.gov/landsat-missions/landsat-collection-2-level-1-data) led to the knowledge that all of the existing Collection 1 analyses of tropical glacier areas (dozens of areas from Mexico to New Guinea, and especially Peru) could not be combined with Collection 2 data. This has made a long-running project even more challenging to complete.

A further assessment in the past year used BlackSky (https://www.blacksky.com/company/) 'small

sat' panchromatic and multispectral imagery over selected tropical glaciers. The ~1m resolution data from BlackSky was impressive and revealed detailed features of the targeted ice remnants. BlackSky imagery was not impacted by any apparent sensor banding and was very consistent in quality across these small coverage areas in both multispectral (RGB) and panchromatic. Ice areas included variable albedo ice and adjacent windblown snow except near Pico de Humboldt (Venezuela); that actually looked to be snow-free. Larger cordillera such as Santa Marta would require multiple BlackSky scenes and this is not a large cordillera by tropical standards. Lastly, comparisons to Landsat 8/9 data indicated probable orthorectification issues for BlackSky data over these rugged mountain areas.

In the coming months, Dr. Shuman plans to continue to track changes around the margins of Greenland and Antarctica using the combined imagery acquisitions of Landsat 8 and Landsat 9. For broader portions of the cryosphere, he will utilize Terra & Aqua MODIS and Suomi NPP VIIRS imagery via NASA Worldview. For example, this early August 2023 view of the front of West Antarctica's Pine Island Glacier shows the relatively warm (lightest tones) waters of the ice front polynya that are contributing to further ice losses for this major outlet glacier: https://go.nasa.gov/3YuPF1L Such images also provide clues as to when to search USGS archives for valuable austral polar winter Landsat acquisitions (see LEAP). Additionally, Pine Island Glacier (PIG) is an area of particular interest, given an evolving Landsat imagery series that shows a transition from large tabular icebergs being calved as the ice front has retreated inland to much smaller bergs breaking from the now jagged glacial terminus. A further post for the Greenland Ice Sheet Today (see Media section of this report) is anticipated in early September due to the late August heat wave that impacted all of Greenland, especially the northern part of the ice sheet. This will likely be followed by a late September post that will summarize the boreal summer's melt events around and across Greenland. A continuing collaboration with NOAA Global Monitoring Laboratory will enable a detailed look at multiple early summer melt events at Summit Station, Greenland. Contributions to similar 'Antarctica Today' posts is anticipated.

Further, the three principal investigators that were involved in the initial proposal and ongoing program called LEAP: Landsat Extended Acquisitions of the Poles (Dr. Shuman, Ted Scambos, and Mark Fahnestock) will publish an EOS article advertising these low-, no-light acquisitions with the a USGS collaborator. In addition, Dr. Shuman has been requested to support a soon-to-be-released documentary film on Dr. Lonnie Thompson (Ohio State), whose work on a small tropical ice area is entitled 'Canary'. The film will be premiered on September 20 in New York City, NY.

CODE 610.1: GLOBAL MODELING AND ASSIMILATION OFFICE (GMAO)

Name: Bryan Karpowicz
Sponsor: Steven Pawson
Code: 610.1
Task: 006

Previously, the NASA Earth Science and Technology Office (ESTO) asked the Global Modeling Assimilation Office (GMAO) to perform a series of Observation System Simulation Experiments (OSSEs) on three proposed wind instrument concepts: a midwave-shortwave infrared hyperspectral instrument, a shortwave infrared imaging instrument, and a coherent doppler wind LiDAR. As part of a team at GMAO, Dr. Karpowicz was responsible for simulating measurements from the shortwave imaging instrument, along with the coherent doppler LiDAR. He worked with Dr. Nikki Privé to expand upon this work to explore different aspects of the OSSE, and results have been submitted for publication in the Journal of Geophysical Research Atmospheres. In addition to the LiDAR OSSE work, Dr. Karpowicz has worked with Dr. Erica McGrath-Spangler and Dr. Privé on analyzing an OSSE for hyperspectral infrared sounder for the Geostationary Extended Observations (GeoXO) Program; initial work has been published in the Journal of Oceanic and Atmospheric Technology. Follow-on work is ongoing, including an OSSE using an updated version of the GEOS-ADAS to reflect a more modern global observing system with an additional publication planned for submission to the Journal of Oceanic and Atmospheric Technology. Additionally, a validation paper of the updated OSSE framework has been submitted to Tellus with Dr. Privé as first author.

In addition to OSSE work, Dr. Karpowicz has led or contributed to several Observation System Experiments (OSE). First, he led an effort to improve the use of hyperspectral sounders in the GEOS-ADAS. This involved a small change to quality control to lower stratospheric and upper tropospheric channels on several hyperspectral sensors, including CrIS, IASI, and AIRS. The change helped to reduce the number of cases where misclassification of cloudy pixels would result in a degradation in the forecast skill of the GEOS-ADAS. The change is scheduled to be released in the next version of the GEOS-ADAS, and the GEOS Forward Processing (GEOS-FP) system. Dr. Karpowicz also worked with Ms. Erin Jones of NOAA STAR on the publication of recent OSE work using the shortwave infrared 4.0 micron band on CrIS. Two papers will be submitted to the Bulletin of the American Meteorological Society (BAMS), with Ms. Jones as first author. Dr. Karpowicz also worked with Dr. Christoph Keller, and Dr. Makoto Kelp of Harvard University by including the 9.6 micron band to the Constituent Data Assimilation (CoDAS), along with submission of a paper to Environmental Research Letters with Dr. Kelp as first author.

The Joint Center for Satellite Data Assimilation (JCSDA) is an organization created by NOAA, NASA, the US Navy, and the US Air Force to advance the state of satellite data assimilation. Dr. Karpowicz has been involved in several aspects of this effort including contributions to the CRTM, and the next-generation data assimilation system known as the Joint Effort in Data Integration (JEDI). Dr. Karpowicz recently contributed pyCRTM to the JCSDA, a Python package that he developed, which acts as a wrapper to CRTM. The package allows for quick and easy simulation of various satellite instruments. The package is widely used in the community, including researchers at NASA and the Naval Research Laboratory. Dr Karpowicz has continued to make updates and address bug fixes. In addition to the development of pyCRTM, he has been working with Dr. Krzysztof Wargan to migrate ozone assimilation capabilities from the current GEOS-ADAS to a JEDI-based system. In addition to sensors added in 2022-2023, Drs. Karpowicz and Wargan

included the Ozone Mapping Profiler Suite – Limb Profiler (OMPS-LP) to the suite of ozone instruments available in JEDI.

In the coming months, Dr. Karpowicz, along with Drs. McGrath-Spangler and Privé, will develop a series of OSSEs highlighting the importance of polar orbiting satellites in combination with future geostationary satellites in support of the JPSS program office. Also, Dr. Karpowicz will work with Dr. Wargan to update the JEDI-enabled GEOS-ADAS to use an updated forward operator provided by the JCSDA, and validate its performance. They also will work towards implementing hyperspectral ozone sensitive radiances into the retrospective analysis for the 21st century chemistry reanalysis.

Name: Nikki Prive'
Sponsor: Ron Gelaro
Code: 610.1
Task: 007

Dr. Privé supported the Microwave Barometric Radar and Sounder (MBARS) instrument by performing Observing System Simulation Experiments (OSSE) to explore different orbital configurations of a spaceborne instrument for marine surface pressure observations. Rain contamination and 50 km footprints were implemented in the simulated surface pressure observations. Dr. Privé presented the results of some initial experiments in a virtual oral presentation at the AMS Annual Meeting in January. OSSE tests were performed to evaluate the performance of the instrument with varying levels of observation error. A manuscript describing results from preliminary experiments was published with JTECH. Dr. Privé was co-author on a second manuscript describing the radar instrument.

Dr. Privé supported the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) mission by testing observational data from the Pathfinder mission in a recent version of the GEOS/GSI numerical weather prediction (NWP) system. Dr. Privé worked with Drs. Bryan Karpowicz (UMBC) and Min-Jeong Kim (NASA) to update the GSI code to ingest the Pathfinder data. Three weeks of data were run in the modified system to produce observation statistics and observation impact estimates with forecast sensitivity observation impact metrics. Experiment results were provided to the TROPICS instrument team.

Dr. Privé performed preliminary experiments extending the OSSE Control into October. A paper describing the behavior of the previous OSSE framework was published in Monthly Weather Review with Dr. Privé as a co-author. She also performed experiments evaluating the performance of radio occultation and atmospheric wind vector (AMV) observations in the updated OSSE framework compared with the previous one and prepared a manuscript on this topic to be submitted this fall.

Dr. Privé provided support to the GeoXO OSSE project. Expected work over the next few months includes possible OSSE investigating the interplay between a ring of geostationary hyperspectral infrared sounders and LEO hyperspectral infrared instruments. This work will be performed in conjunction with Drs. Bryan Karpowicz (UMBC) and Erica McGrath-Spangler (MSU) with possible support from JPSS. Additionally, Dr. Privé will continue MBARS OSSE comparing different nadir smallsat configurations for the proposed instrument.

Name: Erica McGrath-Spangler
Sponsor: Ron Gelaro
Code: 610.1
Task: 008

Dr. McGrath-Spangler's work on this task has focused on assessing the impact of the proposed NOAA/NASA GeoXO Sounder (GXS), scheduled to launch in the mid-2030s using the GMAO's Observing System Simulation Experiment (OSSE) framework. Dr. McGrath-Spangler has designed and executed experiments to evaluate the impact of GXS from a global numerical weather prediction (NWP) perspective, both as a single geostationary infrared sounder and as part of an international global ring of such instruments. She has presented this work in international meetings and worked with NASA's Scientific Visualization Studio (SVS) to generate an animation demonstrating instrument impact on hurricane forecasts.

Additionally, Dr. McGrath-Spangler made the necessary modifications to the GEOS ADAS to allow assimilation of cloud-cleared AIRS hyperspectral infrared radiances, allowing the incorporation of cloud-affected IR data into the system. This has previously been shown to improve representation of tropical cyclones, mid-latitude waves, and polar lows.

In the upcoming three months, Dr. McGrath-Spangler intends to submit a lead author publication to J. Atmos. Ocean. Tech detailing her work on the expected impact of the proposed NOAA/NASA GeoXO Sounder in the GMAO OSSE framework. She is also a contributing author on an article being led by Dr. Nikki Privé that is expected to be submitted in this timeframe. Dr. McGrath-Spangler will attend the 2023 EUMETSAT meeting being held in Malmö, Sweden in September 2023. Her oral presentation "Assessment of Future Geostationary Hyperspectral Infrared Sounders from the Perspective of Global NWP" will be given on September 13.

Additionally, Dr. McGrath-Spangler intends to make the necessary modifications to the GEOS ADAS to allow for assimilation of CrIS hyperspectral infrared radiances that have been cloud-cleared. This will allow cloud-affected data from this instrument to constrain model analyses and forecasts in the GEOS model.

Name: Pamela Wales
Sponsor: Lesley Ott
Code: 610.1
Task: 022

Dr. Wales contributes to the development and evaluation of the GEOS Composition Forecast (GEOS-CF) system. During preliminary testing of a version update to this system, she has assessed the representation of stratospheric constituents and provided recommendations that have been incorporated into GEOS-CF (version 2). Developments implemented within the GEOS-CF system also will be leveraged for an upcoming GEOS composition reanalysis. Dr. Wales is conducting preliminary testing of nitrogen oxide tracers, tagged based on an emission source within GEOS. The development of these tagged tracers is ongoing and will be included in GEOS-CF forecasts for the upcoming Asia-AQ aircraft campaign. She has a first-author publication accepted by the Journal of Advances in Modeling Earth Systems on the detection of Arctic bromine explosion events using NASA satellite retrievals and a GEOS-coupled chemical model. Dr. Wales has also supported the Earth Information System (EIS) – Fire project by evaluating the impact of increased nighttime wildfire emissions in GEOS on atmospheric composition.

In the upcoming months, Dr. Wales will continue to develop tagged nitrogen oxide tracers for the Asia-AQ campaign. She will continue to monitor the representation of stratospheric constituents within GEOS-CF as the new version is brought into production, and she will expand the observation datasets being used to include additional satellite and ground-based observations. Dr. Wales is preparing a proposal to submit to the NASA ROSES (A.30) SAGE III/ISS Science Team call as a principal investigator.

Name: Lionel Arteaga
Sponsor: Lesley Ott
Code: 610.1
Task: 023

Dr. Arteaga has been working on the estimation of carbon fluxes in the NASA Ocean Biogeochemical Model (NOBM) in support of NASA's EXPORTS program and PACE mission. He focused on the biogeochemical effects of marine heatwaves on planktonic ecosystems and identified changes in community composition due to alterations in nutrient supply derived from the oceanic heat anomalies. He published these findings as a first author in Nature's Communication Biology. To expand on this work, Dr. Arteaga wrote a proposal as PI to NASA's Carbon Monitoring System to investigate uncertainties in the air-sea flux of carbon in the Southern Ocean. This proposal was selected for funding in spring of 2023. Currently, Dr. Arteaga is working on the validation of vertical profiles in chlorophyll and carbon biomass to support the computation of deep carbon fluxes from the surface to the deep ocean.

Dr. Arteaga utilized "CbPM for BGC-Argo floats", a Python code to compute oceanic primary productivity from BGC-Argo floats (https://biogeochemical-argo.org), in his 2022 Global Biogeochemical Cycles (GBC) publication "Vertical Structure in Phyto- plankton Growth and Productivity Inferred from Biogeochemical-Argo Floats and the Carbon-Based Productivity Model." Dr. Arteaga developed and published this software in May 2022, and it can be downloaded by anyone (doi:10.5281/zenodo.6599224). (Note, this GBC publication was corrected in March 2023.)

Dr. Arteaga is currently writing a first-author manuscript describing the depth-structure of chlorophyll profiles predicted by the NOBM and comparing them with in situ data from BGC-Argo floats. This manuscript is expected to be submitted for publication in Fall 2023. A large portion of the work planned for the next year includes the coupling of the NOBM to the Goddard Earth Observing System (GEOS) infrastructure of the GMAO, to be able to estimate biogeochemical fluxes at a higher spatial resolution and implement the assimilation of ocean color data from PACE.

Name: K. Emma Knowland
Sponsor: Lesley Ott
Code: 610.1
Task: 024

Dr. Knowland is working in collaboration with Dr. Christoph Keller and other members of the GMAO to validate and further develop the GEOS Composition Forecast system (GEOS CF). This year, the focus was on producing a version 2 of the GEOS-CF system for public release, which includes bringing together many advances since the version 1 system was rolled out in 2019, such as multi-constituent data assimilation, updated GEOS model, updated GEOS-Chem chemistry

module, and updated anthropogenic emissions. Dr. Knowland continues to lead the transition of GEOS-CF model development to the GMAO production team, especially any needs from the TEMPO retrieval team regarding the TEMPO-specific GEOS-CF files, forecasting test runs prior to launch and the start of support following the April 2023 launch with first light in summer 2023 and the start of retrievals. Dr. Knowland is the point-of-contact for the TEMPO retrieval team, who use GEOS-CF as the model prior for the trace gas retrievals, and the point-of-contact for SPIEGEL reporters and several other stakeholders. She maintains the File Specification for GEOS-CF Products document (now version 1.3), which was updated at the time of the release of the emissions collection to the public in December 2022.

Drs. Knowland and Keller jointly lead the GEOS-CF system team, which involved several individual and sub-group meetings. They met weekly with Dr. Viral Shah (SSAI/GMAO), who is tasked with monitoring the GEOS-CF near-real time system and current events. Drs. Knowland and Keller met twice monthly with the GMAO FLUID visualization website developers (Mr. Callum Wayman (SSAI/GMAO) and Mr. Joe Ardizzone (SSAI/GMAO)) to discuss visualization capabilities and model download on FLUID for the GEOS-CF and the NASA-Google Partnership project to ingest GEOS-CF into Google Earth Engine (GEE) platform and to explore downscaling techniques using GEE tools, on which Mr. Wayman is tasked half time (https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/new-generation-gmao-apps.php).

Dr. Knowland and sponsor Dr. Lesley Ott continue to lead a group of GMAO and Code 614 scientists on transport evaluation specific diagnostics, which can be used during the testing of GEOS Earth System model and how changes in model physics may impact the transport and chemistry in GEOS chemistry simulations. This work has expanded into a separate group of GMAO and GEOS-Chem model developers meeting every 4 to 8 weeks, led by Dr. Knowland, to prepare model experiments for an intercomparison study specific for GEOS transport evaluation and the impacts on GEOS-Chem chemistry in the three different flavors of model setup. She also attends the weekly Model Development meeting led by Dr. Bill Putman to learn about upcoming changes in the GEOS model.

Dr. Knowland is a member of the GEOS Chemistry-Climate Model (CCM) leadership committee, which meets monthly and with the CCM developers bimonthly. As part of the CCM leadership committee, she supports the development of visualization tools and platforms specific for the analysis of the long-term chemistry model output, meeting twice monthly with the “Eviz” development team led by Dr. Carlos Cruz (Code 606). She is also the Compute PI for the CCM group, and is in charge of the group’s users, High-End Computing Program requests, and Data Management Plans.

In late September 2022, Dr. Knowland attended the first Global Air Quality Forecasting and Information System (GAFIS) GAW Key Initiative Steering Committee physical meeting held at the WMO in Geneva, Switzerland. On the first day of the GAFIS meeting, Dr. Knowland, along with her co-lead Stephan Nordmann (Federal Environment Agency, Germany), led the discussion on the second thematic group "Good practices and evaluation of air quality forecasting and information systems" portion of the GAFIS Implementation Plan.

In the upcoming three months, Dr. Knowland will continue to lead the GEOS-CF Monitoring & Validation efforts as the GEOS-CF v2 spins up, with a focus on the evaluation of the stratospheric composition and any necessary updates that may be required. This activity aligns with the GMAO’s Composition Reanalysis development efforts that will use similar model framework to GEOS-CF

v2 but with additional stratospheric constituent assimilation; Dr. Knowland is a Composition Reanalysis group member, and the group expects that at least a sweeper version for the composition reanalysis may start in Fall 2023 and the group will validate and monitor the sweeper and the development of this system. Additionally, Dr. Knowland is a co-Lead Chair of the Technical Program Committee organizing this year's Meteorology and Climate – Modeling Air Quality Conference, to be held in Davis, CA, in September.

Name: Brad Weir
Sponsor: Lesley Ott
Code: 610.1
Task: 025

Dr. Weir continued to deliver gridded fields of column CO_2 (XCO_2) at daily and monthly resolutions to NASA's Goddard Earth Science Data and Information Services Center (GES DISC) and the trilateral NASA/ESA/JAXA Earth Observing (EO) dashboard (https://eodashboard.org). These are official products of NASA's Orbiting Carbon Observatory 2 (OCO-2) satellite mission and will be a part of NASA's upcoming Greenhouse Gas Center.

Among other activities in the coming months, Dr. Weir will continue to develop constituent reanalyses based on satellite observations and to investigate what these data can tell us about the processes governing the surface exchange of greenhouse gases.

Name: Natalie Thomas
Sponsor: Michael Bosilovich
Code: 610.1
Task: 027

Over the past year, Dr. Thomas worked on a study of MERRA-2 extreme climate indices, and how they change with an updated baseline climatology period. This work was accepted to Geophysical Research Letters in August 2023. She also contributed to a study on the extreme flooding in California in early 2023 by examining the sub-seasonal forecast of this event in GEOS-S2S-v2; the paper including these results was submitted to Journal of Climate. Finally, Dr. Thomas started looking at seasonal forecasts of temperature extremes in GEOS-S2S-v2 by computing an extreme temperature index.

In the upcoming months, Dr. Thomas will continue work on the extreme temperature index in the seasonal forecasts, including using the forthcoming GEOS-S2S-v3. This work has been submitted to be presented at the Climate Diagnostics and Prediction Workshop in October 2023.

Name: Christoph Keller
Sponsor: Steven Pawson
Code: 610.1
Task: 045

Dr. Keller has been working on the next-generation version of the NASA GEOS Composition Forecast system (GEOS-CF). This involves continuous integration of scientific updates into the GEOS Earth System Model (ESM), the coupling of disjoint model components, and the transition from the legacy GSI data assimilation system to the Joint Effort for Data assimilation Integration (JEDI) framework. Dr. Keller has also been leading the development of a chemistry emulator

model using deep learning, with the goal to use deep learning emulators for uncertainty characterization. These efforts are ongoing.

For the upcoming three months, Dr. Keller will continue working with Dr. Emma Knowland towards the next version of GEOS-CF, including the transition to the JEDI data assimilation framework and the development of AI model emulators. He will also work on evaluating trace gas observations from the NASA TEMPO mission.

Name: Niama Boukachaba
Sponsor: Yanqiu Zhu
Code: 610.1
Task: 046

Dr. Boukachaba is working on enhancing the use of the hyperspectral infrared sounders, such as the infrared Atmospheric Sounding Interferometer (IASI) and the Cross Track Infrared Sounder (CrIS), radiances over land in the NASA Goddard Earth Observing System (GEOS) data assimilation system through enhanced data selection techniques, error modeling, and data sampling. Dr. Boukachaba, along with sponsor Dr. Yanqiu Zhu, modified and corrected the code to retrieve Land Surface Temperature (LST) from selected IASI and CrIS surface-sensitive channels. Dr. Boukachaba then used these LST retrievals in the assimilation of other IASI and CrIS surface-sensitive channels. She also ran several stand-alone experiments by taking one GEOS forward processing (FP) experiment as a reference (CTRL experiment). Dr. Boukachaba looked at the quality control for LST retrieval along with the bias correction and tuned the existing cloud-detection algorithm over land and ocean. She ran several data assimilation (DA) experiments to test the code and readjust it, if needed. Some examples of the DA experiments included the following: 1) LST retrieval code and the bias correction changes, to study the impact of IASI over land and LST retrievals compared to the control experiment; 2) tuning the cloud detection to study the impact of IASI land and ocean data along with cloud detection changes; and, 3) tuning the Ts for CrIS only, to study the impact of CrIS land data and LST retrieval compared with the first experiment as well as the control one.

Dr. Boukachaba will continue updating the implementation of IASI, CrIS and other JPSS measurements in GEOS systems and examine their impacts on analysis quality and long-term stability using the GMAO's present hybrid 4D-ensemble-variational data assimilation framework

In the coming months, she will continue to work on a first-author manuscript, currently titled "Assimilation of IASI and CrIS Radiances Over Land into the NASA GEOS Earth System Model, Part I: LST Inversion and Validation." This paper will describe the methodology applied to retrieve LST from IASI and CrIS land-surface sensitive channels to improve the assimilation of IASI and CrIS radiances over land in the GEOS model.

Name: Virginie Buchard
Sponsor: Arlindo da Silva
Code: 610.1
Task: 050

Dr. Buchard has been actively involved in the development of the aerosol data assimilation (DA) system in GEOS. As part of this work, she has been working on incorporating and testing several model export fields in the aerosol module GOCART-2G (GOCART 2nd Generation). The objective

of this work is to ensure the availability of the required fields for aerosol data assimilation and to facilitate model validation. Additionally, efforts are being made to ensure the readiness of a version for integration into GMAO operational systems. She made contributions to the GOCART-2G evaluation paper submitted recently to the journal GMD by conducting model vertical profile comparisons against CALIOP. She also had the opportunity to contribute to a paper in collaboration with colleagues from CPTEC in Brazil on The South American Tropopause Aerosol Layer (SATAL) over the Amazon Basin. Regarding the transition of the aerosol DA system to a JCSDA/JEDI system, she is currently improving the observation operator to assimilate multi-wavelength Aerosol Optical Depth (AOD) she developed in JEDI/UFO. This improvement aims to provide more flexibility in the process.

Dr. Buchard plans to focus on developing the future structure for the aerosol assimilation in GEOS based on the JCSDA/JEDI system. This encompasses the ongoing development of essential codes for a working system, as well as scientific testing involving the assimilation of multi-wavelength AOD within GEOS.

Name: Allison Collow
Sponsor: Arlindo da Silva
Code: 610.1
Task: 051

Dr. Collow has been working to evaluate aerosols in GEOS, particularly with respect to the science updates and code refactoring that were included in GOCART-2G. She completed her analysis of a benchmark simulation, evaluating modeled aerosol optical depth and surface particulate matter against satellite and surface-based observations. A manuscript has been submitted for publication detailing the changes that were incorporated into GOCART-2G and documenting the performance of the benchmark simulation. Additionally, Dr. Collow has been assisting with the evaluation of aerosols in experimental model simulations included in GMAO's protocol for incorporating model updates into the quasi-operational forecasting system, GEOS-FP. A recent focus of Dr. Collow's evaluation of aerosols in GEOS has been the poor air quality event in the northeastern United States in early June because of Canadian wildfire smoke.

During the fall of 2023, it is anticipated that Dr. Collow will continue her work on the Canadian wildfire event, documenting the challenges in observing and forecasting such events. Dr. Collow will quantify the impact of persisting stale emissions throughout the forecast period.

Name: Manisha Ganeshan
Sponsor: Rolf Reichle
Code: 613/610.1
Task: 052

The research performed under this task involves investigating the impact of assimilating SMAP soil moisture observations on the prediction of landfalling Tropical Cyclones (TCs). Dr. Ganeshan's contribution included running Observing System Experiments (OSEs) using a weakly coupled version of the GEOS ADAS and LDAS systems, to explore the sensitivity of TCs and TC-related precipitation to soil moisture. Dr. Ganeshan further helped develop diagnostic metrics to quantify the land influence on TC structure and intensity by helping to isolate the land areas that influence the TC. A manuscript describing this research has been submitted to the journal Monthly Weather Review. To perform a more systematic evaluation of the soil moisture influence on TC prediction,

Dr. Ganeshan has participated in a new proposal that has recently been submitted to the ROSES 2023 solicitation "Soil Moisture Active-Passive Mission Science Team" (PI: Dr. Jana Kolassa).

Dr. Ganeshan will continue working on this project, and will contribute to any revisions of the submitted manuscript that are requested during the peer-review process.

Name: Erica McGrath-Spangler
Sponsor: Rolf Reichle
Code: 610.1
Task: 052

Dr. McGrath-Spangler has been working to evaluate the impact of SMAP data assimilation into the weakly coupled land-atmosphere GEOS data assimilation system with an emphasis on the consequences for tropical cyclones in the vicinity of land. This includes designing and executing data assimilation experiments for observing system experiments (OSEs). A particular storm that has been investigated is Idai (2019), a South Indian Ocean tropical cyclone that primarily affected southeastern Africa (Mozambique) and Madagascar. The incorporation of SMAP data resulted in a more compact storm and an improvement in the along-track forecast error. Results have been detailed in a recently submitted Monthly Weather Review journal article, led by Dr. Jana Kolassa. Additionally, a new proposal was submitted to the Soil Moisture Active Passive Mission Science Team ROSES call, also led by Dr. Kolassa.

It is expected that in the following three months, the Monthly Weather Review journal editor will return reviews and that Dr. McGrath-Spangler will help address comments and concerns. Additional OSE experiment results will be evaluated for SMAP impacts on additional tropical cyclones.

Name: Yehui Chang
Sponsor: Randal Koster
Code: 610.1
Task: 058

Dr. Chang has been working to test and to produce NASA/GMAO MERRA-2 Ocean data assimilation from 1981-2023 and NASA/GMAO GEOS-IT Ocean data assimilation from 1998-2023. The systems assimilate all available sea level and in situ temperature and salinity observations, Aquarius, SMAP, SMOS, and other satellite data sets combined. The assimilated ocean statistics have been used to initiate the GEOS-S2S forecast system. This research has been presented at conferences and published in journals. The long productions of assimilated atmosphere/ocean data will be released to the public.

Dr. Chang has been generating the 45-member ensemble 43-year-long NASA/GMAO/GEOS-AGCM regional relay runs for 4 different replay regions that were initialized on January 1, 1980 and are forced with observed daily mean SST. The large numbers of simulations have been used in many climate extreme studies, and the results have been used in multiple publications.

Dr. Chang will continue to work on the NASA/GMAO ocean data assimilation productions from 1998 to present. He will develop, test and implement the new ocean replay capability in the NASA/GMAO GEOS coupled GCM in simulation and ocean data assimilation. He will also develop, test and implement the tendency bias correction techniques in the NASA/GMAO GEOS

coupled GCM to improve subseasonal-to-seasonal predictions skills.

Name: Eunjee Lee
Sponsor: Randal Koster
Code: 610.1
Task: 059

Dr. Lee evaluated subseasonal-to-seasonal (S2S) predictions of land's carbon and water fluxes and investigated underlying mechanisms of the forecast skills. She conducted over 1,000 offline ensemble simulations using NASA GMAO's land model and seasonal forecast system, and she has been analyzing the carbon forecast skills related to terrestrial productivity and wildfire. Dr. Lee investigated subseasonal river water forecast skills in Southeast Asia and presented a result of potential improvement of the forecast skill at the workshop supported by NASA SERVIR.

In the coming months, a manuscript (currently in preparation) is expected to be submitted to a peer-reviewed journal in September. From October 1, 2023 to December 31, 2023, Dr. Lee will visit the Department of Civil and Environmental Engineering in Yonsei University in South Korea as an invited visiting scientist, supported by a visiting scientist fellowship of the National Research Foundation of Korea.

Name: Young-Kwon Lim
Sponsor: Andrea Molod
Code: 610.1
Task: 061

Dr. Lim has been involved in various projects encompassing 1) enhancement and assessment of the GEOS subseasonal to seasonal (S2S) forecast model, 2) study on climate variability and extremes, 3) the impact of surface salinity assimilation on the simulation of the Madden-Julian Oscillation (MJO), 4) evaluation of the GEOS S2S system's efficacy in predicting tropical cyclone features, and 5) non-hydrostatic high-resolution GEOS model for better representing tropical intraseasonal oscillation and tropical cyclone. For the first project, he has been working on the GEOS S2S forecast system's ability to represent the MJO and prominent climate modes. This includes assessing the representation of vital processes like moistening and heat-induced tropical circulation in both the current and new GEOS S2S forecast system. He presented his findings at an international conference. Regarding the second project, he has delved into the causes and dynamic mechanisms behind the 2020 Siberian heatwave and the 2023 California flood. He conducted GEOS model experiments and analyses, with resultant papers published or submitted to the Journal of Climate as a coauthor. For the subsequent projects (third through fifth), he has presented at different meetings, either as a lead or coauthor. A paper as an outcome for the fourth project is in press with Weather and Forecasting.

Dr. Lim plans to work on the validation of the recently developed GEOS S2S forecast system's capabilities. This involves assessing its effectiveness in predicting the Madden-Julian Oscillation (MJO), significant climate patterns, tropical cyclones, and other climate fluctuations. This evaluation will be accomplished by analyzing the retrospective forecast outputs that are currently being produced. Also, he will continue to work on the other ongoing projects to advance understanding of earth's climate system, improve simulation of the MJO through surface salinity assimilation, and improve representation of tropical cyclones in the GEOS model system. Expected outcomes include both publications and presentations, consistent with the activity observed in the

current annual report period. Additionally, he will be submitting a paper on the role of global modes of variability to climate in High Mountain Asia.

Name: Peter Norris
Sponsor: William Putman
Code: 610.1
Task: 080

Dr. Norris has continued his role as Radiative Transfer lead in the Global Modeling and Assimilation Office (GMAO) Modeling Group. Throughout the reporting period, Dr. Norris helped to activate the new GEOS-5 Orbital system (which Dr. Norris earlier developed) in the operational GEOS-5 version, and added new features in support of Dr. Anton Darmenov (GMAO/GSFC).

Dr. Norris continued research and development (in support of GMAO's Dr. Andrea Molod) to eliminate an energy leak in the surface energy balance that is caused by the intermittent nature of the full solar radiation refresh and its interaction with faster changing surface albedo features (snowfall, etc.). This has proved to be a challenging problem to solve at GMAO. Initial attempts had centered on replacement of the very approximate heartbeat solar update with a more physically realistic (but still approximate) model. Although a useful approach, it was abandoned due to its failure to maintain the necessary vertical resolution in absorption and scattering effects. The second approach, continuing until the present, removes the energy leak by running a full RRTMG solar radiation refresh every timestep. Since this is computationally too expensive (an eight-fold slowdown), success depends on speeding up the refresh by various efficiency measures, in particular, by updating slowly varying optical properties less frequently, while still running the radiative transfer kernel every timestep. This efficiency work was very thorough and reduced the eight-fold slowdown to only three-fold. Further progress awaits GPU work being done by a team working at the NCCS (NASA Center for Climate Simulation).

Dr. Norris worked extensively with Dr. Michael Mehari (GMAO/GSFC) to couple the GEOS-5 radiation codes with the Ocean Biology (OBIO) package that he is preparing to be operational. This involved interpolating the surface radiation wavelength spectrums of the Chou-Suarez, RRTMG, and RRTMGP versions of the GEOS-5 solar radiation code to the wavelength bands required by OBIO.

Also, Dr. Norris was involved in the research and development of a new high-fidelity Monte Carlo test code specifically designed to address the following: topographic influences on radiation; upper atmosphere only (limb) illumination / photolysis / absorption; and, 3D cloud effects. Extensive work was done on how to accurately represent surface topography for the radiation code. He worked on numerous smaller tasks, such as radiation adaptations to the new refactored GEOS-5 Moist physics; numerous investigations of problems within GEOS-5 that initially manifested within the radiation codes but were (on investigation) caused by failures in other parts of the code; keeping up-to-date the solar input data.

Dr. Norris provided guidance and outreach both within and external to GMAO to early career researchers to answer various questions as to how the radiation transfer works in GEOS-5 and to explain the various diagnostics that the codes produce.

During the upcoming months, Dr. Norris will continue with RRTMGP integration and testing, general radiation code maintenance, adding diagnostics, and user / Modeling Team / Office

assistance. He will continue developing a high-fidelity Monte Carlo test code specifically designed to address topographic influence on radiation, upper atmosphere only (limb) illumination / photolysis / absorption, and 3D cloud effects.

Name: Andrew Fox
Sponsor: Rolf Reichle
Code: 610.1
Task: 094

Dr. Fox has been working with other members of the land data assimilation system (LDAS) team in the GMAO to develop additional capabilities in the GEOSldas with the medium-term goal of enabling a reliable and beneficial land reanalysis in upcoming coupled atmosphere-land-ocean reanalysis efforts. Specifically, this has entailed: (i) identifying and obtaining a novel source of soil moisture retrievals from ESA's ACAT sensor; (ii) adding a capability to ingest these new BUFR-formatted observations into the GEOSldas; (iii) developing and applying an offline bias correction scheme to produce a time varying, global suite of scaling parameters in netCDF format (a first for this system); (iv) development of a new "update-type" in the GEOSldas that will allow for the assimilation of multiple types of observations simultaneously; and, (v) testing this new capability with the joint assimilation of ASCAT soil moisture retrievals and SMAP brightness temperatures.

During Fall 2023, Dr. Fox and his colleagues anticipate continuing to test the new multivariate assimilation capability in the GEOSldas and conducting experiments to assess the impact this has on improving model estimates of global soil moisture. One particular goal is to present the results of this work at the American Meteorological Society annual meeting in January 2024. The results also will provide the basis for a journal article on this topic. In addition, the new code will be rigorously reviewed, and the final version will be incorporated into the GEOSldas public release.

Name: Yujin Zeng
Sponsor: Randal Koster
Code: 610.1
Task: 124

In the existing GEOS land modeling and data assimilation system (GEOSldas), runoff water is directly sent to its final destination, typically the ocean. This approach does not account for the intricate routing of runoff through streams, thereby preventing the model from producing accurate daily-scale river discharge. To rectify this, Dr. Zeng has been working on developing a river routing module to integrate into GEOSldas. This module is constructed on the foundations of the catchment's shape and topology as defined by GEOSldas, and it calculates river discharge using principles from the theory of hydraulic geometry. The model has been calibrated using approximately 3 million field measurements of flow velocity and discharge from around 7,000 USGS gauging stations. Upon validation with USGS discharge measurements from 21 hydrologic units across the US, the model has demonstrated a commendable performance.

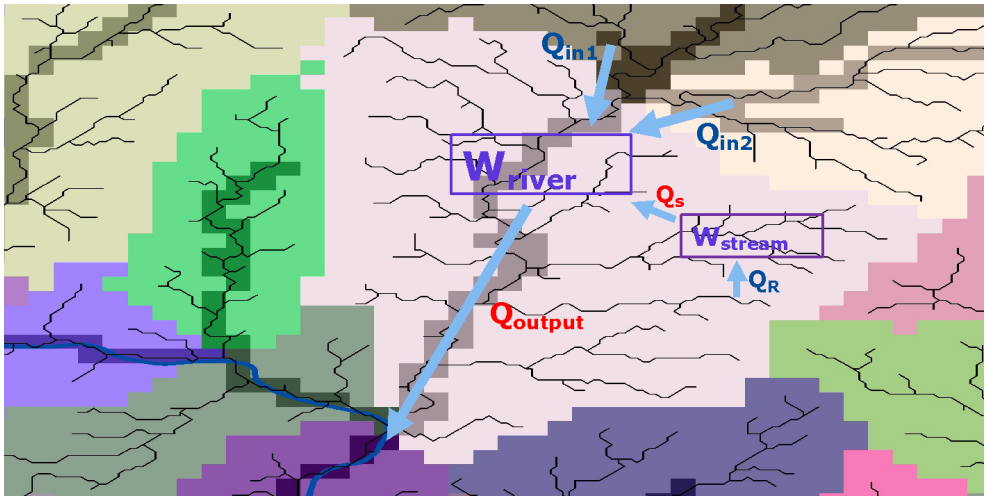


Figure: Structure of the river routing model. (Provided by Y. Zeng.)

Among other upcoming plans, Dr. Zeng will submit a manuscript for publication. This paper will detail the newly developed river routing model, present simulated results alongside comparisons to gauging measurements, and discuss the benefits of the velocity-based model, as well as its potential applications in GEOSldas.

Name: William Olson
Sponsor: Michael Bosilovich
Code: 612/610.1
Task: 125

The overarching goal of this task is to produce a budget-consistent description of the Earth's water and energy cycles. This means that for any region of the globe over a given time period, the amount of water or energy being horizontally transported into (out of) a region either leads to increases (decreases) of water/energy storage in that region or vertical fluxes of water/energy out of (into) the region. For example, water vapor carried by the atmosphere into a region must lead to an increase of total water vapor storage in the atmosphere of that region or increased precipitation or decreased evaporation at the surface in that region. In the current project, the globe has been divided into 25 continental/ocean basin regions and monthly water and energy flux/storage data have been collected for each region; however, due to errors in those data, the budgets of water and energy data are not balanced.

The balancing method, previously developed, for calculating budget-consistent water and energy fluxes/storages closest to the collected (and unbalanced) monthly regional observations is an application of constrained optimization, which (a) assumes that the collected observations are unbiased and Gaussian-distributed, and (b) requires estimates of the uncertainties of those observations. During the reporting period, different approaches for estimating the bias and uncertainties of the collected data using the general framework of the balancing procedure were studied at both theoretical and computational levels. Dr. Olson and colleagues concluded that the success of these estimation methods depends upon plausible “initial guess” constraints on the estimates; otherwise, the water/energy budget relationships themselves can have a deleterious impact on the bias/uncertainty estimation.

Also during the reporting period, the method for balancing the Earth’s water and energy cycle components was extended from balancing water and energy components of the atmosphere to

components of the Earth's surface and subsurface. Namely, water fluxes/storages in terrestrial regions were constrained to be balanced, while energy fluxes/storages in oceans and large lakes were similarly constrained. This action completed the balancing of the Earth's water/energy components where it was practical, satisfying a major goal of the overall investigation. Specific sources of collected water and energy data were then scrutinized to find those sources that were *a priori* in better balance with other collected water/energy data. For example, streamflow data from NASA's 1.0°-resolution Catchment Land Surface Model were found to be in better consistency with precipitation, evaporation, and storage observations, relative to other sources of streamflow data. The choice of more consistent *a priori* datasets in conjunction with better *a priori* estimates of dataset biases and uncertainties will ultimately lead to more budget-consistent products. Beta-test versions of the collected and budget-consistent water and energy budget component datasets were output to netCDF4-format files and distributed to in-house users to obtain their feedback on the utility of the datasets.

In the September 1, 2023 – November 30, 2023 period, Dr. Olson expects the water and energy cycle component data will be used to evaluate biases and uncertainties using the methods developed during the reporting period. These biases and uncertainties will feed back into the budget balancing procedures. Also, interactions with users of the collected and budget-consistent water/energy component data will continue, as a means to identify ways of modifying or improving those data for science applications.

Name: Genevieve Elsworth
Sponsor: Lesley Ott
Code: 610.1
Task: 126

Dr. Elsworth has been working to integrate the NASA Ocean Biogeochemical Model (NOBM) in the Goddard Earth Observing System (GEOSv3) Earth System Model as a member of the Carbon Monitoring System (CMS). Her analysis has focused on the use of various ocean carbon and biogeochemistry observational records to validate the performance of the GEOSv3 NOBM. Dr. Elsworth has assembled a database of various ocean carbon and biogeochemistry observations and observational products and has used this database to validate simulations of the Poseidon NOBM, a data assimilative model. Dr. Elsworth is in the process of revising a first author manuscript which was submitted to the journal Biogeosciences regarding changes in variability in ocean carbon and biogeochemistry with anthropogenic climate change. She has presented her work internally at NASA Goddard in several seminars and poster sessions.

In the coming months, Dr. Elsworth will use the assembled database of ocean carbon and biogeochemistry observations and observational products to validate simulations of the GEOSv3 NOBM under different atmospheric carbon dioxide conditions. She will prepare a manuscript of the results of this validation analysis to be published in a scientific journal and will present the results of the study at the 2024 Ocean Sciences Meeting. She will publish an online repository of the assembled ocean carbon and biogeochemistry database and the GEOSv3 NOBM simulations in accordance with NASA's open science efforts.

Name: Carl Malings
Sponsor: Stephen Cohn
Code: 610.1
Task: 129

Dr. Malings is working on a ROSES-funded project in Earth Science Applications: Health and Air Quality to combine model, satellite, and in-situ monitor data to improve air quality forecasting. Since September 2022, he has worked to develop, test, and refine data fusion algorithms as well as implement them on the Google Earth Engine platform. He has attended numerous project team meetings and meetings with end-users and stakeholders to discuss developments in the project and future needs.

Dr. Malings also is working on a ROSES-funded project supporting the Asia-AQ field campaign by providing high spatial and temporal resolution air quality forecasts. Since July 2022, he has been gathering necessary surface, model, and satellite datasets to support forecasting, and has tested the basic forecasting methodology for a case study covering Seoul, Korea.

Dr. Malings has contributed to the NASA Applied Remote Sensing Training (ARSET) capacity-building program in the Health and Air Quality topic. He has helped to deliver one training that supported US EPA applications in March 2023. He is preparing to deliver a training on the use of satellite data in environmental justice applications, scheduled for August and September 2023.

Going forward, from September to November 2023, Dr. Malings will continue to work on his ROSES-funded Earth Science Applications: Health and Air Quality project, focusing on refining methods for uncertainty quantification in data fusion. He anticipates presenting preliminary results for these methods at the MAC-MAQ scientific conference in September 2023. He also will continue to work on his ROSES-funded project supporting Asia-AQ. He will continue to gather relevant input datasets and develop algorithms to integrate them in support of air quality forecasting. He will be focusing next on trace gas data from the geostationary GEMS satellite. Additionally, Dr. Malings will continue to support the ARSET program, including attending an annual retreat during which next year's training activities will be planned. In September 2023, Dr. Malings will serve as a session chair at the Meteorology and Climate Modeling for Air Quality (MAC-MAQ) conference; also, he will serve on the technical planning committee for the Air Sensors International Conference planned for 2024.

Name: Manisha Ganeshan
Sponsor: Yanqiu Zhu
Code: 613/610.1
Task: 152

Under this task, Dr. Ganeshan contributes to the research of optimal utilization of satellite hyperspectral infrared radiances by allowing their assimilation in areas affected by clouds with a goal of improving Tropical Cyclone representation and related processes in the GEOS. Dr. Ganeshan has set up and is currently running the Northern Hemisphere control experiment for 2020, using the GEOSadas-5.29.4-p3 version, which involves running the ensemble 4D variational (4DEnVar) hybrid data assimilation system and daily 10-day forecasts for a 3.5-month-long experiment covering the Atlantic Hurricane season of 2020. Dr. Ganeshan's research published under this task was selected as her laboratory's Monthly Science Highlight to be featured in the Earth Science Division's Earth Science Research Results Portal (ESRRP). Dr. Ganeshan participated as co-author in submitting responses to two Request For Information (RFIs) issued by NASA (lead author/PI: Dr. Oreste Reale). As part of this task, Dr. Ganeshan also contributes to exploring strategies for assimilating PBL height observations in the GEOS, specifically GNSS RO-derived PBL height. She has submitted an abstract to present this work at the 2023 AGU meeting.

Looking ahead, Dr. Ganeshan will continue running the 2020 GEOS control experiment, and contribute towards evaluating the experiment's performance in terms of global statistics (such as anomaly correlation of geopotential height), as well as the representation of Tropical Cyclones (TCs) and Polar Lows (PLs). She will perform frequency analysis using the 2D Hilbert Huang Transform (HHT) for studying tropical waves, and she will prepare a manuscript detailing the results to be submitted to a suitable peer-reviewed journal. Dr. Ganeshan will prepare to deliver an AGU presentation detailing the strategies for PBLH assimilation in the GEOS.

Name: Seunghee Lee
Sponsor: Patricia Castellanos
Code: 610.1
Task: 157

Since joining GESTAR II in July 2023, Dr. Lee has been working to retrieve Aerosol Layer Height from satellite and aerosol data assimilation. She conducted background research on aerosol layer height retrieval from TROPOMI satellite observations. There are several space-based aerosol layer height products from TROPOMI, GOME-2, EPIC/DSCOVR, MISR/Terra, and GEMS. TROPOMI is the first passive remote sensing mission to provide an operational stream of retrieved aerosol layer height to the public. A scattering aerosol layer can scatter sunlight back to space, shortening the path length of light traveling in the atmosphere and reducing the chance of that light being absorbed by O_2 molecules. As a result, an elevated scattering layer enhances the top-of-atmosphere (TOA) reflectance within the O_2 absorption bands as detected by a satellite.

Looking ahead, Dr. Lee will develop the forward model based on a neural network (NN) trained to estimate the aerosol layer height in the O2-A band wavelength window. The newly developed forward model would have some advantages, such as global data and faster computation speed. Then, the retrieved aerosol layer height based NN will be assimilated to the GEOS model. Aerosol vertical distribution has a significant impact on the estimation of the global budget of aerosols on climate and planetary boundary layer (PBL) stability. Currently, there is no research on assimilating spatiotemporally continuous data of aerosol vertical profiles. Assimilating aerosol layer height can significantly improve the aerosol vertical profile simulations and has a large potential to allow further studies of the impact of aerosol vertical distribution

Name: Amin Dezfuli
Sponsor: Michael Bosilovich
Code: 610.1
Task: 162

Dr. Dezfuli has been contributing to the Framework for Live User-Invoked Data (FLUID), which is an online platform for climate/weather visualization developed at GMAO. In this task, he writes and runs computer programs that produce NetCDF files for MERRA-2-based climate statistics, which are then plotted in FLUID. The files are also transferred to GES-DISC to be available to the broader community. Their team has recently generated MERRA-2 climate files for the new climatology period (1991-2020), similar to other centers like NOAA.

Dr. Dezfuli is a member of GMAO's Science Snapshot Committee that solicits and reviews brief reports from GMAO members on their recent publications or high-impact ongoing climatic events. He also writes about his own scientific findings. The snapshots are posted online on GMAO's website: https://gmao.gsfc.nasa.gov/research/science_snapshots/. Additionally, he is a team

member of the GMAO National Climate Assessment (NCA) enabling tools group funded by NASA, working on various climate applications using NASA products. Using various NASA products, Dr. Dezfuli has analyzed the climatic drivers of biomass burning in Africa and their impacts on other regions. He is currently working on the draft of a paper to present the results.

In the coming months, Dr. Dezfuli is planning to lead a number of interdisciplinary projects in the next few years focusing on public health and ecological aspects of climate extremes. One will be a follow-up to his recent study regarding climate impacts on bird migration. He will further explore the continental patterns of bird migration in North America and their large-scale climatic drivers, and he will examine the impacts of weather extremes on migraine headaches in the United States. He has already initiated this effort and formed a team including neurologists from The Johns Hopkins University School of Medicine and the Medical University of South Carolina. In addition, in collaboration with a team of neonatologists, Dr. Dezfuli is planning to investigate the impacts of extreme weather events on pre-term birth in the United States.

Name: Eun-Gyeong Yang
Sponsor: Yanqui Zhu
Code: 610.1
Task: 163

Dr. Yang has been working on developing optimal global data assimilation (DA) capabilities in GEOS, especially for planetary boundary layer height (PBLH) derived from multiple observing systems, to support the assessment and the use of future PBL observations. While she developed DA methodologies for PBLH from GNSS-RO, space-, and ground-based Lidar (CALIPSO, CATS, and MPLNET), and implemented corresponding thinning and quality control procedures, she also generated PBLH derived from radiosonde observations. Dr. Yang has been evaluating departures of model PBLH from a wide range of PBLH observations.

For Sept 1 – Nov 30, 2023, Dr. Yang will continue working on improving PBLH DA strategies and ingesting PBLH from radar wind profiler to compare this with model PBLH. She will also compare backscatter-based model PBLH with PBLH from CALIPSO, CATS, and MPLNET. In addition, she will develop methods to improve background error covariances in the lower troposphere. In October, Dr. Yang will give a poster presentation on PBLH DA at the PBL community meeting.

Name: Jie Gong
Sponsor: Yanqui Zhu
Code: 610.1
Task: 164

During the reporting period, Dr. Gong generated the machine learning-based radiance simulator and ice water path (IWP) retrieval models and compared with the current CRTM model performance in the GEOS system.
Dr. Gong became a NASA Civil Servant in early December 2022.

Name: Michael Murphy
Sponsor: Steven Pawson
Code: 610.1
Task: 168

Dr. Murphy has been working on the use of Global Navigation Satellite System (GNSS) Radio Occultation (RO) observations in the Goddard Earth Observing System (GEOS) numerical weather prediction (NWP) modeling and data assimilation systems. Since he joined GESTAR II in May 2023, his focus has been on assessing the massive dataset of commercial RO from Spire in NASA's Commercial Smallsat Data Acquisition (CSDA) archive. This has included comparing the quality of the Spire RO dataset in the CSDA archive to the much smaller real-time Spire RO dataset acquired by NOAA and the state-of-the-science COSMIC-2 RO mission. The CSDA Spire RO dataset will be assimilated into the R21C reanalysis that is currently in development and his assessment is supporting this effort. Preliminary design and analysis of data denial experiments comparing the Spire RO from the CSDA and NOAA archives as well as the COSMIC-2 have recently begun. This evaluation is ongoing and an abstract for the AMS Annual Meeting 2024 will be submitted in August 2023 for presentation in January 2024.

In the coming months, Dr. Murphy will continue his work on assessing the CSDA Spire RO and the impact of assimilating it into the GEOS system. This will include contributing to the effort to deliver the R21C reanalysis product by assisting with the assimilation and evaluation of the CSDA Spire RO as well as documenting the use of GNSS RO within the R21C. He will also present on the status of GNSS RO research at GMAO and potential use of polarimetric RO observations at the "2nd PAZ Polarimetric Radio Occultations User Workshop" at Caltech, in Pasadena, CA in November 2023.

Name: Retha Mecikalski
Sponsor: Steven Pawson
Code: 610.1
Task: 169

Dr. Mecikalski joined GESTAR II in early August 2023. The main goals for the next several months, including the beginning of 2024, are to become familiar with both the Goddard Earth Observing System (GEOS) family of models as well as the Joint Effort for Data assimilation Integration (JEDI) framework.

More specifically, the work will begin with a study of the relationship between lightning observed with the lightning sensor on the International Space Station (ISS) and the cloud systems represented in the GEOS analyses, and examining how the cloud structure and microphysical properties impact the lightning field. The outcome from these studies will then be used to develop lightning parameterization schemes that will be incorporated into the GEOS model and possibly the JEDI framework as well. The model outputs from GEOS (and JEDI) will then be statistically compared to the output from numerical experiments in order to obtain the accuracy of these lightning parameterizations. These statistical comparisons will also be used to update and improve the lightning parameterizations as needed. These parameterization schemes could include both lightning parameterization schemes as a function of hydrometeor type, as well as the parameterization of the production of nitrogen oxides (NOx) via lightning.

Future work of the project could encompass one or more foci, including the development of new lightning parametrizations using modern analysis techniques, the development of lightning assimilation techniques in the JEDI framework, the development of lightning assimilation techniques for the ISS and geostationary data, or the investigation of convection-composition budgets in global high-resolution models.

Name: Janak Joshi
Sponsor: Arlindo da Silva
Code: 610.1
Task: 176

Since joining GESTAR II in June 2023, Dr. Joshi has been working toward examining and evaluating several dust-emission schemes in the GEOS model. As a first step, he has been developing familiarity with the structure/architecture of the GEOS modeling system.

In the coming months, he will continue to work on the evaluation of dust schemes, which is expected to lead to material worthy of a scientific publication.

Name: Fei Liu
Sponsor: Arlindo da Silva
Code: 614/610.1
Task: 186

Work began on this task in May 2023. Dr. Liu has begun to develop a framework for tracking and analyzing individual aerosol plumes in different types of datasets, such as model simulations and geostationary satellite retrievals. Her work will focus on GOES observations and future AOS missions. The developed framework will provide a flexible new way to understand the evolution of the characteristics of individual aerosol plumes in model intercomparison studies or model assessment based on observational data.

For the upcoming months, Dr. Liu plans to develop the framework to track aerosol plumes based on Tracking and Object-Based Analysis of Clouds (TOBAC). She will demonstrate the framework using a pyrocumulonimbus (pyroCb) firestorm event known as the Pacific Northwest Event (PNE), which occurred on August 12, 2017, as the case study.

CODE 612: MESOSCALE ATMOSPHERIC PROCESSES LABORATORY

Name: Jackson Tan
Sponsor: George Huffman
Code: 612
Task: 018

A key focus for Dr. Tan is on the Integrated Multi-satellitE Retrievals for GPM (IMERG) V07 product development. He has contributed to its development and the submission of the code, with the processing of the record currently ongoing. He was involved in the testing and worked closely with the production team to ensure a seamless release. He also helped with preparing the documentation. Dr. Tan completed a NASA MEaSUREs project on Unified Weather States, in which he played a key role in producing a range of MODIS and VIIRS Cloud Regimes datasets as well as several reports on unsuccessful efforts in unifying them with ISCCP Weather States. This past year, Dr. Tan presented his work at the AGU Fall Meeting, the International Precipitation Conference, the Asia Oceania Geosciences Society Annual Meeting, and the NASA PMM Science Team Meeting; and he is the co-author on two papers published in the Journal of Hydrometeorology.

In the upcoming months, with the anticipated completion of the IMERG Final V07 record, Dr. Tan will analyze the data for possible science application and other aspects for further improvement. Concurrently, he will assist the production team with upgrading the IMERG Early and Late Runs to V07, and will investigate the feasibility of a planned extension of the IMERG record to 1998. He also expects to begin a new funded MEaSUREs project on producing convective/stratiform type estimates. Dr. Tan will attend and present at the NASA PMM Science Team Meeting.

Name: Liang Liao
Sponsor: Robert Meneghini
Code: 612
Task: 053

Dr. Liao's work on this task is three-fold. First, it involves studying DPR attenuation by radar mirror image. The GPM Dual-frequency Precipitation Radar (DPR) operating at Ku- and Ka-band undergoes signal losses due to attenuation by precipitating hydrometeors as it propagates in storms. Such attenuation needs to be corrected so that the precipitation profiles can be properly estimated. Current DPR attenuation algorithm is to use the surface returns under an assumption that differences in the measurements of the normalized radar cross section of the surface (NRCS) between the rain and no-rain areas are attributed to the path integral attenuation (PIA). Because of the variability in the NRCS measurements caused by changes in wind speed and direction over the ocean and rapidly changing surface condition over the land, accuracy of the PIA estimates depends on the variance of the rain-free NRCS. An independent estimate of the attenuation is highly desirable in order to check the consistency and accuracy of the PR algorithm. The Mirror Image (MI) returns, through the double reflections of the ocean surface from the rain medium, are collected by the DPR. When combined with the direct return, they can be used for deriving the path attenuation. This is based on the fact that the difference between the direct and MI returns at equal distances from the surface is directly associated with the rain path attenuation. However, the accuracy of the MI method for inferring the attenuation relies strongly on the radar geometry such as the antenna beam width and the radar altitude.

To compare estimates of path attenuations obtained from the MI and DPR standard algorithms over a large database, a number of the DPR orbit measurements are used. The applications of the MI algorithms are confined to the measurements that are made for stratiform storms over the ocean at nadir or near nadir (±1 angle bins off nadir). As a result of the PR limited sensitivity, the MI algorithms are suitable only for moderate rain rates for which the MI signals are usually measurable over the full path. Given the uncertainties resulting from the possible mismatches of the scattering volumes between the direct and MI returns, the path attenuations derived from the MI algorithms are generally in reasonable agreement with those from the DPR standard algorithm with good correlation.

Second, Dr. Liao studies the hydrometeor phase identification using a multi-frequency airborne radar system. Knowledge of hydrometeor phase (liquid, frozen and melting hydrometeors) in precipitation profiles within storm systems is important not only for active/passive remote sensing retrieval of cloud and precipitation microphysical properties but also for climate and weather prediction models that require an accurate representation of the phase state in time and space. Although hydrometeor identification methods have been studied for full-polarimetric radar, such research has not yet been well established using non-polarimetric (co-polarization) radars such as most airborne and spaceborne weather radars. Accurate identification of phase state from air/spaceborne radar has been a challenging task despite some recent progress made primarily in classifying storm type (stratiform and convective storms) and in determining bright-band height. Separating liquid and frozen hydrometeors in convective storms in clouds and precipitation are important goals in studying the rain/snow transition. Achieving this goal, however, has been difficult with non-polarimetric radars because a clearly defined bright band is often absent. Dual- and multi-frequency Doppler radar measurements may help with this characterization, but they are currently only available with airborne measurements.

Dr. Liao and colleagues carried out a comprehensive study involving theoretical simulations of dual-frequency radar (e.g., Ku-Ka band, Ka-W band, and Ku-W band), and multi-frequency radar (e.g., X-, Ku-, Ka- and W-band) to explore the capability of dual- and multi-frequency Doppler radar for the identification of snow, rain and mixed-phase hydrometeors. Their simulations show clear separation of the radar signatures in snow and rain in the spaces of the single frequency reflectivity (Z) and either the differential frequency ratio (DFR, defined as difference of radar reflectivities between two frequencies) or the differential Doppler velocity (DDV, defined as difference of the Doppler velocities between two frequencies). These promising results demonstrate great potential to develop effective airborne and spaceborne radar techniques to distinguish hydrometeor phases. They will apply these approaches to NASA aircraft field campaign data in a variety of weather systems for improvements both in understanding the storm structure and in the algorithms themselves.

Third, Dr. Liao compares the DPR Ku-band reflectivity with the WSR-88D measurements. The NOAA ground-based radars – WSR-88D network – underpin nationwide precipitation observations with advanced polarimetric capability providing a good reference to evaluate the DPR measurements and estimates. In this study, systematic comparisons between WSR-88D network and DPR have been performed at 136 WSR-88D radar sites from 2014 to 2020. It is found that there are systematic differences in reflectivity, around 2.4 dBZ, across most of the ground radars when the DPR Version 6 product is used. This probably arises from the different calibration standards, signal attenuation correction, and different scattering geometries between WSR-88D and DPR. A few tests are also made using the recently updated DPR Version 7 product, showing reduction of the overall differences to ~1.0 dBZ. The objective of this study is to examine the

systematic differences of radar reflectivity between the WSR-88D network and the DPR. Further investigation into understanding and alleviating the systematic bias between the two platforms will be their next task.

Dr. Liao will continue and complete his current studies and explore new fields that can improve and enhance the space/air-borne radar algorithms for detection and estimates of precipitation microphysical properties.

Name: Hyokyung Kim
Sponsor: Robert Meneghini
Code: 612
Task: 054

Dr. Kim has been working as a member of the science team developing algorithms for estimating global precipitation using Dual frequency Precipitation Radar (DPR) onboard the GPM satellite. The main objectives of her task are as follows: 1) contributing to more accurate precipitation estimation by enhancing and improving algorithms that estimate the radar surface return signals attenuated by precipitation, and 2) developing, improving, and providing operational support for Level 3 algorithms that offer daily and monthly statistics of Level 2 products estimated by each radar.

In this year's research, Dr. Kim mainly focused on improving the radar attenuation correction algorithm over snow-covered land. Information about whether the land is covered with snow or if the sea is frozen is obtained from NOAA's AutoSNOW data. AutoSNOW has been recently upgraded to a new version by NOAA. She analyzed the surface return signal(σ^0) from snow-covered land using GPM radar data from April 2023 to evaluate how the new version of AutoSNOW data impacts the attenuation correction algorithm. The new AutoSNOW product (ITE793) appeared to be more accurate compared to the previous version (V07A), particularly in terms of reduced artificial transitions between surface types (snow-covered land and open land) and a stronger correlation with σ^0. She also found that at the boundary between snow-covered land and open land, using surface temperature as supplementary information for snow presence improved the attenuation correction algorithm’s performance.

After the launch of the GPM satellite in 2014, four years later in 2018, the Ka-band radar’s observation coverage was expanded to align with that of the Ku-band radar by extending the existing scanning pattern. Consequently, the operational scan angle, which was originally 9 degrees, was expanded to 18 degrees. Dr. Kim has provided two databases, one for the temporal reference of the existing scan pattern and the other for the temporal reference of the new scan pattern, to accommodate this change. This year, she has created a set of hybrid databases that satisfies both the previous and current requirements, which will be utilized in Version 8, scheduled for release in 2024. The advantage of this approach lies in the provision of two tables, each 5 GB in size, resulting in a total of 10 GB. The hybrid table, sized at 5 GB, contributes to reducing the file size of the public version.

	Pre(2014-2018)	Post(2018-2020)	Hybrid (2014-2022)
Ku	4Y Full Swath	2Y Full Swath	8Y Full Swath (2014 ~)
Ka/DPR	4Y Inner Swath	2Y Full Swath	8Y Inner Swath (2014 ~) 4Y Outer Swath (2018 ~)
KaHS	4Y Inner Swath	Empty	4Y Inner Swath (2014-2018)

Table 1. *Table describing the structure of each database and the years of observational data used for generating the databases.* (Provided by H. Kim.)

The algorithm for correcting the surface return signals (σ^0) attenuated by precipitation is divided into temporal reference and spatial reference methods. The temporal reference method compares the σ^0 from raining FOV with the statistical mean of σ^0 during the past rain-free period to estimate attenuation. The temporal reference database provides information for the six surface types at 0.5-degree latitude and longitude resolution across all four seasons and has been continuously updated to provide the reliable statistics of rain-free σ^0 since its launch. In coastal or shoreline areas where finding spatial references is difficult, temporal references have a dependency close to 100%.

Dr. Kim has been conducting research to provide a more reliable (statistically low standard deviation) temporal reference database. She has investigated methods to increase resolution by reducing the standard deviation of rain-free references and spatially averaging low-standard-deviation surrounding areas. As shown in Figure 1, the standard deviation of rain-free references decreases as the resolution increases (black line), and the spatial averaging method in the direction of reducing standard deviation has been investigated as a more effective approach in decreasing standard deviation compared to the method of reducing resolution (red line).

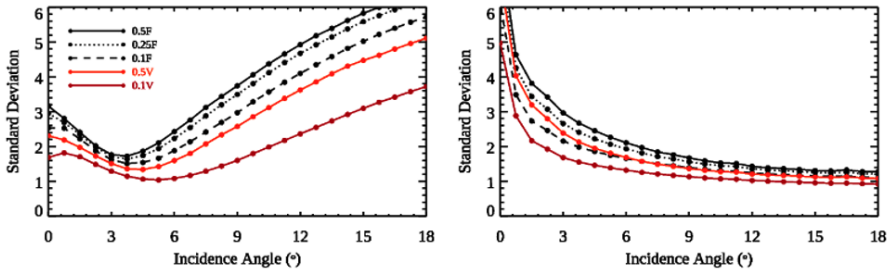


Figure 1*. The black lines show how the standard deviation of reference data changes with the incidence angle as the resolution of the data is increased. The red lines represent the same, but for the spatial averaging method. Left is for Ocean and Right for Land.* (Provided by H. Kim.)

Among other activities in the coming months, Dr. Kim will be attending the bi-monthly radar algorithm team meetings between the United States and Japan and presenting status on the progress of attenuation correction algorithm improvement and the development status of radar Level 3 algorithms.

Name: Mircea Grecu
Sponsor: Robert Meneghini
Code: 612
Task: 055

Dr. Grecu worked on the development and evaluation of methodologies for the mitigation of ground clutter in the GPM Dual Precipitation Radar (DPR) observations. Ground clutter echoes, which originate in power emitted by the radar and reflected by the ground, are a major source of uncertainty in the GPM DPR observations as they can contaminate and obscure precipitation echoes. A ground clutter correction methodology already has been developed and implemented in the GPM combined radar-radiometer algorithm. During the reporting period, Dr. Grecu worked on refining and improving this methodology. One improvement involved the implementation of a machine learning (ML) methodology to further stratify the observed radar reflectivity profiles by automatically detected features. The automatic stratification of profiles reduces the random error in the ground clutter correction and improves the accuracy of precipitation estimates in the presence of ground clutter. A second improvement involved the development of a methodology to extrapolate into clutter regions the precipitation estimates derived from the GPM DPR observations in near-nadir profiles that are minimally affected by ground clutter. Such profiles are the basis of ground-clutter mitigation and correction in off-nadir profiles that are significantly affected by ground clutter.

From September 1 to November 30, 2023, Dr. Grecu will continue the work on the ground-clutter mitigation and correction in the GPM DPR observations. Specifically, he will work on the evaluation of the mitigation methodology using cross-validation and document the entire work in a peer-reviewed article to be submitted to the Journal of Atmospheric and Oceanic Technology.

Name: Mei Han
Sponsor: Scott Braun
Code: 612
Task: 068

Dr. Han has been working on the projects of Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Storms (IMPACTS) field campaign and the Global Precipitation Measurement (GPM) mission. IMPACTS is an Earth Venture Suborbital-3 (EVS-3) field campaign that takes place from 2020 to 2023. She was involved in the IMPACTS field operations in January and February of 2023, during which she worked as a forecaster and a scientist on P-3 aircraft for two weeks. Dr. Han's current focus is to understand the supercooled liquid water in clouds and precipitation systems of snowstorms that have been well sampled during the IMPACTS campaign. She is working on reporting her findings in the AMS radar conference and the IMPACTS and PMM science team meetings. Dr. Han was also working on the planning for the IMPACTS aircraft under flight of the GPM satellite and conducting the evaluation of the coincident satellite and aircraft data for several GPM under flight cases.

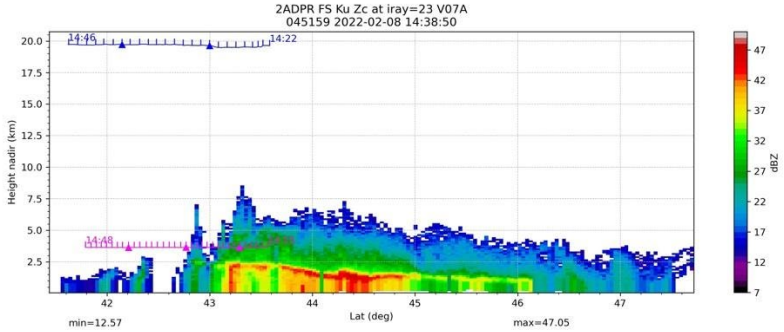


Figure above: NASA GPM satellite DPR Ku band reflectivity (color shade) of a winter cyclone on Feb. 8, 2022, during IMPACTS, in the Gulf of Maine. Magenta line shows the P-3 flight leg penetrating the storm. Blue line shows the ER-2 flight leg at ~20km above the ground. (Provided by M. Han.)

In the coming months, Dr. Han will attend the AMS radar conference that ends on September 1, 2023 and the PMM science team meeting from September 18 - 22, 2023. She will attend the IMPACTS science team meeting from Oct 24 - 26, 2023. She will write a manuscript to report her research findings to scientific journals.

Name: Amita Mehta
Sponsor: Stephanie Uz
Code: 612/610
Task: 096

Dr. Mehta is a lead instructor in NASA Applied Remote Sensing Training (ARSET) program, conducting online webinars and in-person trainings for applications of NASA earth observations for water resources and disasters management.

During 2022-23, Mehta participated in planning trainings on the following four topics. First, she participated in the training on Monitoring Water Quality of Inland Lakes using Remote Sensing. This advanced webinar with three sessions was conducted on July 18, 20, and 25, 2023. Dr. Mehta provided an overview of remote sensing observations with to assess water quality in lakes and reservoirs, and outlined algorithm procedure to derive water quality parameters, chlorophyll-a concentration and suspended sediments. Using Google Earth Engine (GEE), Dr. Mehta demonstrated how to access Landsat and Sentinel-2 optical images using a case study of Lake Erie. Dr. Mehta also introduced GLORIA, The GLObal Reflectance community dataset for imaging and optical sensing of Aquatic environment, in situ measurement data. She helped in developing statistical regression algorithm to derive chlorophyll-a concentration and suspended sediments from Landsat-8 blue, green, red, and near-infrared bands and GLORIA in situ data using GEE. Also, D.r Mehta designed an exercise for monitoring cyanobacteria in lakes using Cyanobacteria Assessment network (CyAN) web application. This training was attended by 1055 participants from 108 countries, 32 US states, and close to 500 organizations.

Second, she participated in the training on Assessing Impacts of Fires on Watershed Health. This advance training webinar had three sessions on July 6, 11, and 13, 2023. Dr. Mehta contributed a session on satellite observations and tools for fire risk. She developed and presented information about monitoring pre-fire watershed conditions, including precipitation, soil moisture, and

Normalized Difference Vegetation index (NDVI). She presented two fire case studies using Goggle Earth Engine and QGIS: the Woolsey fire in California (November 2018) and the June 2023 fires in eastern Canada that impacted air quality in the eastern US. Using NASA earth observations from GPM, SMAP, and MODIS, she showed how anomalous dry and hot conditions led to the fires. This training was attended by 804 participants from 102 countries, 39 US states, and about 400 organizations.

Third, Dr. Mehta participated in the training on Earth Observations for Informing Disaster Risk and Response to Drought, Wildfire, and Flooding in Mexico. This in-person training was offered in Monterrey, Mexico from May 8-11, 2023 and was hosted by the Civil Protection Agency of Mexico (State of Nuevo Leon). Dr. Mehta, together with two ARSET colleagues, provided in-depth information on applications of NASA earth observations to assess risk of droughts, fires, and flood in Mexico. She presented multiple sessions about accessing precipitation from GPM, Population data from SEDAC, Weather data from MERRA-2, hydrology data from Land Data Assimilation Systems, and VIIRS nighttime light imagery. Also, she provided presentations about flood modeling tools, different types of droughts and calculation of indices to detect flood/drought conditions, and detection of pre-fire conditions. Dr. Mehta demonstrated how to monitor conditions conducive to floods, droughts and wildfires by assessing anomalies in precipitation, surface temperature, soil moisture, and vegetation using Google Earth Engine.

The fourth training she participated in was titled Monitoring and Modeling Floods using Earth Observations, and this introductory training with two sessions was conducted on September 14 and 21, 2022. Dr. Mehta provided detailed information on flood monitoring tools based on NASA remote sensing observations, and an overview of hydrological and hydrodynamic flood models. This training was attended by 1193 participants from 122 countries, 34 US States and approximately 600 organizations. Additionally, Dr. Mehta helped to organize the training titled Application of NASA SPoRT-Land Information System (SPoRT-LIS).

In September and October, Dr. Mehta will support the following trainings: 1) Building Climate Risk Assessments from Local Vulnerability Exposure, and 2) Synthetic Aperture Radar (SAR) Applications for Disasters. She will also attend the ARSET Retreat during 26-29 September 2023. Dr. Mehta will prepare proposals for trainings to be conducted between Oct 2023 and Sept 2024.

Name: Jasper Lewis
Sponsor: Judd Welton
Code: 612
Task: 101

Dr. Lewis has continued efforts to evaluate aerosol and cloud observations from the CALIPSO satellite using level 3 MPLNET products. His analysis uses five years of collocated satellite-surface measurements from several diverse sites within the lidar network. These results will be used as a basis for a similar study expected to begin with the launch of the joint European Space Agency – Japanese Aerospace Exploration Agency EarthCARE mission, which is expected to launch in 2024.

Furthermore, Dr. Lewis has collaborated in a study intended to develop PBL data assimilation capabilities in the NASA Global Earth Observing System, focusing on planetary boundary layer height retrievals from multiple observing systems.

In the coming months, Dr. Lewis will present results of the CALIPSO-MPLNET comparison study

at the Pre-launch EarthCARE Science and Validation Workshop in Frascati, Italy and submit a first-author manuscript for publication.

Name: Stephen Guimond
Sponsor: Gerald Heymsfield
Code: 612
Task: 107

Dr. Guimond has been working to understand the fundamental physical processes underlying multi-bands in extratropical cyclones (ETCs), provide three-dimensional (3D) wind retrievals for NASA scanning airborne radars, and participate in a NASA field experiment called IMPACTS. Dr. Guimond participated as a mission scientist in the IMPACTS field operations during the reporting interval, providing science and flight design duties. He delivered 3D wind fields from EXRAD to the IMPACTS science team and published this work through the NASA GHRC. The biggest contribution has been the development of new understanding of multi-bands in ETCs. Dr. Guimond has discovered that these multi-bands are not gravity waves and fit more completely within the theory of vortex Rossby waves. Several presentations detailing these findings were given to NASA personnel and a paper is being written that will be submitted in the near future.
Note: Dr. Guimond accepted a new position with Hampton University in late August 2023.

Name: William Olson
Sponsor: Scott Braun
Code: 612
Task: 108

This task has two focus areas. The first focus area is the development and testing of software for operational estimation of precipitation rates based on a combination of spaceborne radar and passive microwave observations from the Tropical Rainfall Measuring Mission (TRMM) and Global Precipitation Measuring (GPM) mission core satellites. During the reporting period, a collaboration with Prof. Claire Pettersen of University of Michigan, along with Dr. Ali Tokay, David Wolff, and Jason Pippitt of the GPM Ground Validation team, has resulted in the production of a validation dataset for snow rates based on National Weather Service radar data from the Marquette, Michigan site over the 2017-2023 period. The important value of this validation dataset is that beam-obstructed data have been filtered, and appropriate radar reflectivity-snow rate relations for the Marquette radar have been used to infer snow rates from low-altitude reflectivity observations. Also during the reporting period, the current Version 7 combined radar-radiometer estimation method was updated to work with the new RedHat8 compiler as required by NASA/GSFC.

The second focus area of the task is the development and testing of snow and mixed-phase precipitation particle models for use in satellite combined radar-radiometer estimation methods, such as those used operationally in the TRMM and GPM missions. During the reporting period, a physically-based computational method (SnowMeLT) for simulating the melting of snow particles with realistic geometries was applied to a distribution of snow particles that represent particle sizes over an observed range (i.e., 0.2 mm to 3.5 mm liquid equivalent diameter). Due to the computational burden of the SnowMeLT calculations, a strategy for selecting a small set of particles (30) that represent both the size range and geometrical variations of the snow particles was developed. The melting of this small set of particles, and the calculation of their single-scattering properties which is critical for TRMM/GPM precipitation estimation applications, will continue

over the next year.

It is expected that in the September 1, 2023 – November 30, 2023 period, GPM core satellite combined radar-radiometer estimates of snow rates will be evaluated using the Marquette, Michigan ground validation snow data. Dr. Olson and colleagues also will begin collecting and analyzing GPM core data from the satellite, after its expected boost to 435 km altitude, to look for potential biases in the Version 7 combined radar-radiometer estimates of precipitation. Also, they will continue performing melting simulations of snow particles using the SnowMeLT code and extend those to larger particle simulations using Graphics Processing Unit hardware.

Name: Ali Tokay
Sponsor: David Wolff
Code: 612/610.W
Task: 123

Dr. Tokay participated in NASA's Investigation of Microphysics and Precipitation for Atlantic Coast Threatening Snowstorms (IMPACTS) 2022-23 field campaign in conjunction with the NASA Global Precipitation Measurement (GPM) mission ground validation activities. The field study covered a nearly five-month period starting in December 2022. The ground-based precipitation measuring devices have been deployed to two sites in Storrs, Connecticut. The sites, approximately 3 km apart, were suited with weighing and tipping bucket gauges, Particle Imaging Package (PIP) and Particle Size Velocity (PARSIVEL) disdrometers, vertically pointing K-band micro rain radar (MRR), and an All-In-One weather station. One of the sites also had NASA's Ka- and Ku-band radar and W-band radar ensemble. Dr. Tokay examined the performance of in-situ precipitation measuring devices throughout the field study.

Dr. Tokay has been investigating the a) precipitation phase identification and b) radar snowfall estimate utilizing the IMPACTS 2021-22 field campaign data, which had the same sets of ground instrumentation but in a single site. The presence of mixed-phase precipitation is common in southern New England; therefore, the transition between the rain and snow can be substantially different depending on the reference instrument. Southern New England is subject to frontal precipitation, but the position of low pressure center and flow patterns could be drastically different between and within storms. This feature complicates the appropriate use of radar reflectivity versus snow rate relationships. Dr. Tokay and his summer intern have been trying to resolve the synoptic features during Summer 2023.

Dr. Tokay was one of the mentors of the NASA GPM capstone project. The mentee, a graduate student in University of Sao Paulo, Brazil, evaluated NASA's global precipitation mapping product (IMERG) over a dense gauge grid in metropolitan Sao Paulo. The comparative study has been conducted on an hourly basis and the database extended over a year's period. The ordinary kriging was used to construct the gauge-based reference rainfall and the accuracy of the reference product has been tested through several simulations. The project included statistics of probability of detection, false alarm ratio and related statistics. For the periods where both IMERG and gauge reported rainfall, the bias was calculated to determine the potential under- and over-estimate of IMERG for the 9-pixels centering over the gauge grid.

For the expected activities and research during the upcoming three months, Dr. Tokay and his visiting scholar will focus on IMPACTS 2022-23 data analysis. The focus will be on the two PIP disdrometers. The cross checking of snowfall density, snow water equivalent, particle-size

distribution parameters, and radar observables will provide new insights on the spatial variability of falling snow. The cross check will also be done for the other instruments. Since there is a slight elevation difference between the two sites, the preliminary analysis revealed that temperature differences as low as half-degree Celsius could result in different phases of precipitation between the two sites.

Name: Yuli Liu
Sponsor: Ian Stuart Adams
Code: 612
Task: 149
Dr. Liu has been working on developing the tomography algorithm for the submillimeter-wave radiometer, specifically focusing on CoSMIR and CoSSIR. The objective is to combine the strength of the radiometer operating at different scanning modes with the nadir-pointing radar sensor to construct three-dimensional cloud microphysics. The tomography algorithm is formulated within the framework of Bayesian optimization, and the radar and radiometer retrievals are both performed based on the Optimal Estimation Method. The ray-tracing technique is employed to provide geolocation information for the entire cloud reconstruction process. One first author manuscript has been completed, which Dr. Liu will submit to "Remote Sensing of Environment" in August 2023 to present the innovative development of the tomography algorithm.

Additionally, Dr. Liu has been working on a proposal focusing on the detection of supercooled liquid water and the constraint of their microphysics using synergistic active radar, lidar, and passive radiometer remote sensing observations. Supercooled liquid water plays significant roles in weather, climate, and the energy and water cycle; leveraging a synergistic combination of radiometer and active sensors that directly probe the structure of clouds and precipitation is an effective approach for cloud and precipitation studies. In November 2022, Dr. Liu submitted a proposal on this topic as the Principal Investigator (PI) for the "A.22 Weather and Atmospheric Dynamics" program, which initially did not receive funding. Following subsequent changes, Dr. Liu resubmitted the proposal as PI for the "A.39 Early Career Investigator Program in Earth Science" in August 2023.

For the Sept 1 – Nov 30, 2023 period, Dr. Liu will extend the developed tomography algorithm to the along-track radiometer for two-dimensional cloud reconstruction. The goal is to investigate the concept of relying solely on the along-track scanning radiometer observations to obtain high-resolution vertical profiles that are typically attained by active sensors. The completion of a simulated experiment aimed at validating the feasibility is expected during this period.

Name: Mircea Grecu
Sponsor: Scott Braun
Code: 612
Task: 181

For this task, Dr. Grecu worked on the development and evaluation of precipitation algorithms for the NASA Atmosphere Observing System (AOS) mission (https://aos.gsfc.nasa.gov/AOS). Specifically, he developed algorithms to evaluate possible space-borne radars considered in the AOS design. The possible radars include a Ku-band precipitation radar in the inclined orbit, and a Ka-band (or W-band) radar for the polar orbit. The polar orbit may also feature a dual-frequency Ka-W band radar. As such, Dr. Grecu developed single and multi-frequency retrieval algorithms for multiple instruments characterized by various resolutions and

sensitivities. The algorithms were tested using a combination of real and synthetic observations. Results are presented and discussed during the biweekly AOS algorithm development meetings.

From September 1 to November 30, 2023, Dr. Grecu will continue the work on the development and evaluation of precipitation algorithms for the NASA Atmosphere Observing System (AOS) and start work on the transition from development to production. That is, he will upgrade the algorithms to make them run in the operational environment being developed for the AOS mission.

Name: Sean Foley
Sponsor: Scott Braun
Code: 612
Task: 181

Mr. Foley was hired in April 2023, with in-person work starting in July. He has been finalizing his internship project, which involves the use of deep learning to predict a narrow-swath vertical cloud product (derived from the CloudSat radar) from wide-swath multi-angle polarimetry (from POLDER-3). This work is directly applicable to AOS, as it will carry both a multi-angle polarimeter and a radar. Mr. Foley also submitted an abstract to the upcoming American Geophysical Union meeting, involving the use of advanced techniques from the computer vision literature for the derivation of 3D cloud structure in wide-swath, multi-angle satellite imagery.

From September 1, 2023 to November 30, 2023, Mr. Foley will submit the paper discussed above to Atmospheric Measurement Techniques. He will also continue working on the AGU abstract, applying the method to both POLDER-3 and HARP CubeSat data with the intention of eventually applying it to HARP2 after PACE's launch.

Name: Sergey Korkin
Sponsor: Scott Braun
Code: 613/612
Task: 182

Since February 2023, Dr. Korkin has been supporting activities relevant to the Atmospheric Observing System (AOS) as a local GSFC expert in numerical simulation of solar light multiple scattering and absorption in Earth's atmosphere, commonly referred to as radiative transfer (RT) modeling. He participates in bi-weekly meetings of the AOS Aerosol Working Group (AWG) led by Dr. Reed Espinosa (613). Dr. Korkin gave a talk to the AWG group and submitted a proposal in collaboration with Dr. Espinosa and others.

Dr. Korkin will continue to participate in the AWG meetings and support the AOS mission planning as an RT expert. However, details of expected activities and research for September 1 – November 30, 2023 will depend on the outcome of the submitted proposal (expected in September).

Name: Chenxi Wang
Sponsor: Scott Braun
Code: 612
Task: 182

Dr. Wang has been working to develop and evaluate algorithms to retrieve ice cloud properties (including cloud ice water path, and cloud-top height) using joint passive instruments. His analysis

has focused on 1) how to merge fine passive infrared observations into coarse passive microwave observations and 2) how to design a feasible yet accurate RT model for both instruments.

From Sept. 1 – Nov. 30, 2023, Dr. Wang will focus on the following: 1) developing cloud synergy retrieval algorithm using joint passive Infrared (IR) and Microwave (MW) observations for the Atmosphere Observing System (AOS) mission; 2) evaluating cloud synergy retrieval algorithm with coincident active sensor observations (e.g., CloudSat and CALIOP).

CODE 613: CLIMATE AND RADIATION LABORATORY

Name: Sergey Korkin
Sponsor: Alexei Lyapustin
Code: 613
Task: 001

As an expert in numerical simulation of multiple scattering and absorption of sunlight in Earth's environment (radiative transfer - RT), Dr. Korkin collaborates with colleagues from GSFC Codes 613, 614, 616, and 618. Specifically, he supports algorithm MAIAC (PI: Dr. Lyapustin, 613) by generating look-up tables for retrievals; OMPS (limb profiler) RT modeling in spherical-shell atmosphere (PI: Drs. Kramarova and Krotkov, both 614); development of a new, well documented, clean, and updated code for simulation of line-by-line atmospheric absorption spectroscopy (with 616); and supports his RT code used by the GSFC AERONET team (618).

Over the span of the past year, Dr. Korkin's efforts resulted in six submitted proposals (in 4 Dr. Korkin is a PI, one of these was deemed "selectable" – further decision is currently pending), three published peer-reviewed papers (including one as first author), and a White Paper to NASA GSFC ESD management. One of Dr. Korkin's proposals, which he submitted in August 2022 as Institutional PI (not included in the aforementioned six), was declined. Details for these activities are provided in other sections of this annual report.

Plans for September 1 – November 30, 2023 depend on the outcome of the submitted proposals (expected in September). If certain proposals are selected, Dr. Korkin will focus on refactoring, documentation, and publication of two codes – one for RT in a spherical-shell atmosphere and the other for light scattering by spheroidal particles. Both have been used in GSFC for decades mostly as "black boxes" due to lack of support. If not selected, Dr. Korkin will focus on finalizing an open access paper and a new open-source code for atmospheric absorption by trace gases and will be exploring opportunities to integrate neural network algorithms into MAIAC. As always, he will be providing continuous support in RT numerical simulation to the aforementioned groups.

Name: Manisha Ganeshan
Sponsor: Yukeui Yang
Code: 613
Task: 012

Dr. Ganeshan's research is aimed at improving our understanding and representation of the polar planetary boundary layer (PBL), an atmospheric feature that is crucial for correctly predicting the earth's surface radiation budget and climate. She uses satellite and in-situ measurements to study the Antarctic PBL structure, factors affecting it, and to compare its representation in reanalysis data. Recently, Dr. Ganeshan published a first-author paper in the Journal of Geophysical Research-Atmospheres describing the impact of clouds and blowing snow on the PBL structure over Dome C, Antarctica, and their feedback to the surface radiation budget (Fig. 1), and she is preparing a new manuscript comparing the representation of clouds and PBL in NASA's MERRA-2 reanalysis against CALIPSO satellite observations. Dr. Ganeshan is also investigating the potential of GNSS RO satellite observations for polar PBL studies. She presented a talk at the fall 2022 AGU meeting describing the lower atmospheric sounding capability over the Arctic Ocean from new commercial and several existing GNSS RO products, and she is currently preparing a manuscript describing her results for submission to the OPAC-IROWG 2022 Special Issue in Atmospheric Measurement

Techniques. Dr. Ganeshan has recently been awarded a ROSES research grant by NASA to continue her work of evaluating GNSS RO commercial products. She is also part of NASA HQ's Satellite Needs Working Group to help assess the GNSS RO satellite needs of federal agencies such as NOAA, and to provide solutions for the same.

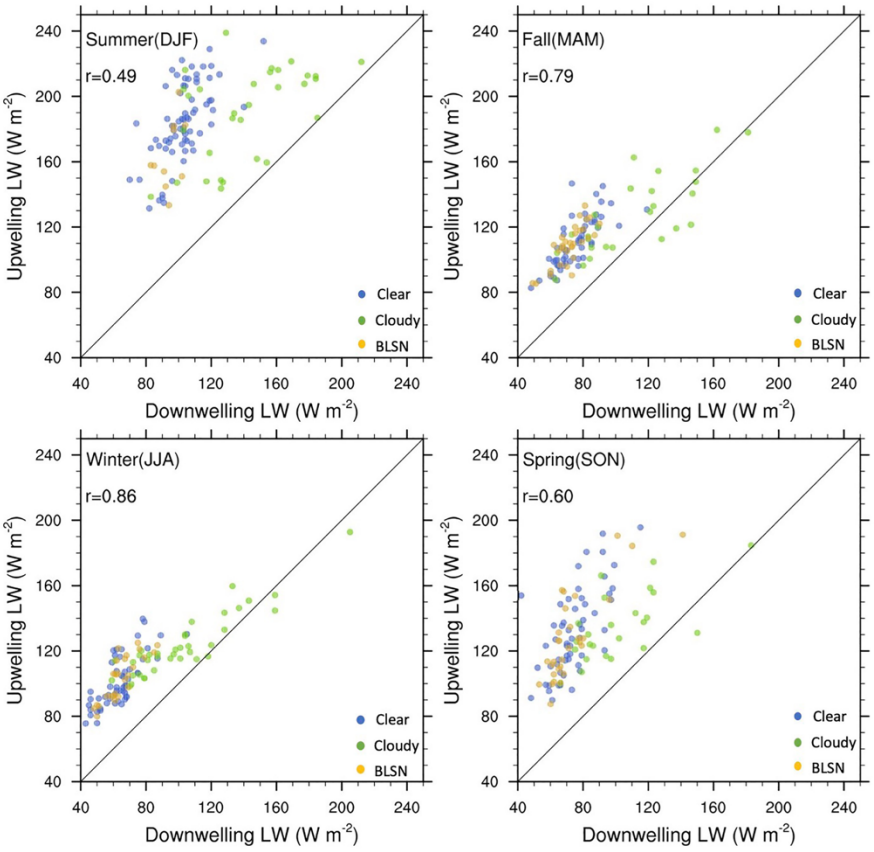


Fig.1 *Scatter plot showing the relation between estimated upwelling longwave (LW) radiation and measured downwelling LW radiation at Dome C, Antarctica, for different sky conditions (clear, cloudy, blowing snow) and different seasons. Points falling on the black line, representing 1:1 correspondence, indicate radiative equilibrium, which is typically only observed during cloudy conditions.* Figure source: Ganeshan et al. 2022.

In the coming months, Dr. Ganeshan will work on two manuscripts describing the research performed under this task. The first article will seek to compare the representation of clouds in NASA's MERRA-2 and ERA-5 reanalyses against CALIPSO satellite observations, and will be submitted to *JGR-Atmospheres*. The second article is being prepared for submission to the OPAC-IROWG 2022 Special Issue in *Atmospheric Measurement Techniques*, describing the lower atmospheric sounding capability of commercial GNSS RO products in the Arctic region and their potential for PBL monitoring. Dr. Ganeshan will also contribute to an AGU presentation as lead author titled "Evaluating the Potential of NASA GeoOptics Refractivity Profiles for Planetary Boundary Layer Studies: Comparison with Spire, MetOp and COSMIC-2", and one as co-author, titled "Antarctic Boundary Layer Study with CALIPSO and In-situ Measurements."

Name: Jie Gong
Sponsor: Dong Wu
Code: 613
Task: 034

During the reporting period, Dr. Gong implemented the dropout method for quantification of water vapor uncertainty. She also carried out a grid search for the optimal dropout threshold.
Dr. Gong became a NASA Civil Servant in early December 2022.

Name: Jude Salinas
Sponsor: Dong Wu
Code: 613
Task: 035

Dr. Salinas has been working to analyze ionospheric electron density as well as middle atmosphere temperature, carbon monoxide, water vapor and ozone. He primarily uses satellite-based measurements, first-principles Physics-based models, and empirical models.

For his work centered on ionospheric electron density, Dr. Salinas has been developing the first empirical E-region electron density model that accounts for variabilities due to photoionization and solar cycle. The model is called E-region Prompt Radio Occultation Based Electron Density (E-PROBED) model. Dr. Salinas submitted a proposal as Principal Investigator to the Space Weather Research to Operations to Research (SWR2O2R) ROSES solicitation that proposes to take E-PROBED and integrate it with the International Reference Ionosphere (IRI) empirical model. The integrated E-PROBED and IRI model will then be tested for radar operational use by the Air Force Institute of Technology and the Air Force Research Laboratory. Dr. Salinas has co-authored two manuscripts on ionospheric electron density in the past 6 months. One was published in the Remote Sensing journal and is on an optimal estimation inversion of F-region electron density retrieved from Global Navigation Satellite System Precise Orbit Determination measurements. Another one was published in Advances in Space Research and is on the variability and distribution of nighttime equatorial to mid latitude ionospheric irregularities and vertical plasma drift as observed by Formosat-5 Advanced Ionospheric Probe.

For his work centered on middle atmospheric dynamics and composition, Dr. Salinas is currently working on determining a way to infer middle atmospheric daily-mean zonal-mean zonal wind interannual variabilities from quasi-2-day wave phase speeds. Dr. Salinas submitted a proposal as Co-Investigator to the Heliophysics Supporting Research ROSES solicitation that proposes to understand the role of middle atmospheric dynamics and composition on Polar Mesospheric Cloud variability. Dr. Salinas was lead author of two manuscripts on middle atmosphere dynamics and composition: one was published in Atmospheric Chemistry and Physics journal and is about the migrating diurnal tide component of upper mesospheric carbon monoxide, and the other was published in the Journal of Geophysical Research: Space Physics and is about the seasonality of the migrating semidiurnal tide and its thermodynamic and momentum budget. Dr. Salinas co-authored a manuscript on the response of mesospheric ozone to energetic particle precipitation that will be submitted to Nature Communications.

For the period Sept – Nov 2023, for his work centered on ionospheric electron density, Dr. Salinas is currently preparing a peer-reviewed manuscript and software package on the E-PROBED model that accounts for variabilities due to photoionization and solar cycle. Dr. Salinas is also preparing to

submit a NASA Living With A Star Proposal under the specific Focused Science Topic of ionospheric conductivity. Apart from this proposal, Dr. Salinas is also preparing to submit a manuscript about his work on quasi-6-day wave variability in the nighttime top-side ionosphere.

For his work centered on middle atmospheric dynamics and composition, Dr. Salinas is currently preparing a manuscript on determining a way to infer middle atmospheric daily-mean zonal-mean zonal wind interannual variabilities from quasi-2-day wave phase speeds.

Name: Young-Kwon Lim
Sponsor: Dong Wu
Code: 610.1/613
Task: 036

Dr. Lim has been working on the sea ice variation in both the Arctic and Antarctic regions, with a notable focus on how they are substantially influenced by large-scale climate modes. Throughout the reporting period, he has placed particular emphasis on investigating the variations in Antarctic sea ice modulated by decadal change in the Antarctic Dipole (AD) pattern and the Pacific South American (PSA) mode over the last four decades. The changing nature and strength of ENSO events, including a higher occurrence of central Pacific-type ENSO and a relatively milder intensity in the early 21st century, have impacted the AD and PSA patterns, leading to the weakening of these patterns and diminished strength of the sea ice anomaly dipole between the Ross/Amundsen Sea and Weddell Sea. A paper is in progress for submission to a journal.

Dr. Lim remains committed to exploring the Antarctic sea ice variation, which is impacted by the decadal-scale changes in the AD, PSA, and ENSO. He is actively working on a manuscript to submit to a journal.

Name: Lipi Mukherjee
Sponsor: Dong Wu
Code: 613
Task: 037

Dr. Mukherjee has been working on developing a twilight model, which has simulated spectra corresponding to different realistic atmospheric conditions using the Monte Carlo-based radiative transfer of the Libradtran package. She is also comparing the Pandora instrument's data from the Lauder site in New Zealand with modeled spectra having various aerosol loading at different altitudes. She is preparing a manuscript to publish her findings.

Upcoming plans include Dr. Mukherjee's preparation of a proposal to SAGE III. The SAGE III Instrument is on the International Space Station and studies stratospheric aerosols.

Name: Dongmin Lee
Sponsor: Lazaros Oreopoulos
Code: 613
Task: 038

Dr. Lee has been working to evaluate cloud and radiation in GEOS with passive (MODIS) and active (CloudSat-CALIPSO) cloud measurements. Dr. Lee published a paper in Frontiers in Remote Sensing titled "Revisiting cloud overlap with a merged dataset of liquid and ice cloud

extinction from CloudSat and CALIPSO." Dr. Lee also presented his work at the AGU Fall Meeting in December 2022. His presentation was titled "Viewing large-scale Diabatic Heating through Cloud Vertical Structure regimes."

Name: Nayeong Cho
Sponsor: Lazaros Oreopoulos
Code: 613
Task: 039

Dr. Cho has performed data transformation and configuration by combining two products describing the two-dimensional extinction properties of liquid and ice phase clouds (and their mixtures) according to active cloud observations by the CloudSat and CALIPSO satellites as a part of CloudSat/CALIPSO project tasks ("Using CloudSat and CALIPSO observations to assess and inform Global Climate Model hydrometeor generators about the horizontal and vertical subgrid variability of clouds and precipitation"). She and colleagues published a paper with the results titled "Revisiting cloud overlap with a merged dataset of liquid and ice cloud extinction from CloudSat and CALIPSO".

The MODIS cloud regime framework is a great tool to dissect and sort global cloud types. Based on this global cloud type distinction, she explored radiative flux anomalies in the last two decades seen by CERES, which could be interpreted as the result of changes in particular cloud types. She sought to obtain the relative contributions to the anomalies of binned all-sky fluxes of changes in cloud fraction within cloud types and of changes in their overcast fluxes modulated by other cloud properties. She presented her findings at the 2022 AGU Fall Meeting.

In the coming months, to capture the climatological essence of MODIS Cloud Regimes (CRs), she and her colleagues will make further organization by clustering frequency of occurrence over a period (seasonal or annual), creating MODIS "regimes of regimes" (RORs) containing similar mixtures of MODIS CRs. She will examine how the variability (spatial, seasonal, interannual) of the planetary radiation budget as seen by CERES EBAF radiative fluxes relates to RORs and will conduct additional related research.

Name: Daeho Jin
Sponsor: Lazaros Oreopoulos
Code: 613
Task: 040

With the previous project, ROSES PMM 2018, Dr. Jin developed cloud-precipitation hybrid regimes, which provide pre-clustered states of cloud and precipitation at 1-degree and daily scale. By utilizing this product, Dr. Jin has continued to investigate large-scale climate phenomena.

First, Dr. Jin examined the relationship between the Madden-Julian Oscillation (MJO) and the Quasi-biannual oscillation (QBO). Previously, other researchers had hypothesized that lower temperature anomalies in the upper troposphere/lower stratosphere (UTLS) associated with the easterly phase of QBO may promote stronger and larger MJO convections. Using the aforementioned cloud-precipitation regimes, Dr. Jin provided observational evidence to support this hypothesis. This result was published as "QBO deepens MJO convections" in Nature Communications (https://doi.org/10.1038/s41467-023-39465-7).

Second, Dr. Jin examined the change of clouds and related radiation properties by global mean surface temperature (Ts), also known as cloud radiative effect (CRE) feedback. Based on MODIS cloud regimes and reanalysis data, and a comparison of feedbacks between boreal winter and summer seasons, he showed that stronger ENSO activity in the boreal winter season disrupts the pattern of CRE feedback. By removing the effect of ENSO through linear regression, Dr. Jin found that CRE feedbacks in boreal winter become similar to those in boreal summer. These results have been organized and submitted to the Journal of Climate, and are currently under revision.

Lastly, Dr. Jin performs the cloud evaluation work as an internal project given by GMAO in NASA GSFC. As an example, Dr. Jin adopted known low-cloud-cover (LCC) indices, and is evaluating their performance against MODIS observations. He also examines the possibility of machine learning to predict cloud properties from physical variables like radiation, temperature, and humidity.

Dr. Jin will continue the cloud evaluation work. He will compare the performance of LCC indices at various temporal and spatial scales. Dr. Jin will also tune the machine learning models to produce reliable prediction results of cloud properties from physical variables.

Name: Guoyong Wen
Sponsor: Alexander Marshak
Code: 613
Task: 043

Dr. Wen has been studying radiative transfer of solar radiation in the atmosphere, specifically to study the 3D cloud radiative effects on aerosol retrieval in the vicinity of clouds for MODIS/VIIRS aerosol retrievals, characterize near-cloud properties from MODIS and CALIPSO, analyze EPIC-observed reflectance changes due to clouds and satellite orbit, and perform radiative transfer simulations to understand the associated physical processes. Dr. Wen has reported his results in national conferences and science meetings.

In the upcoming period of Sept 1 – Nov 30, 2023, Dr. Wen will be focusing on correction for 3D cloud radiative effects on MODIS-observed top-of-atmosphere (TOA) reflectance and associated aerosol retrievals. He will compare MODIS retrieved aerosol properties with collocated CALIPSO retrievals for better understanding of the impact of clouds on nearby aerosol properties.

Name: Alfonso Delgado Bonal
Sponsor: Alexander Marshak
Code: 613
Task: 044

Dr. Delgado-Bonal has been working on analyzing data from the EPIC instrument onboard the DSCOVR spacecraft. His analysis has focused on investigating the diurnal variability of cloud properties. To that end, Dr. Delgado-Bonal has developed a set of statistical tools and algorithms specifically for the EPIC datasets to exploit the vantage point of the spacecraft. After validating the methodology with different cloud properties (e.g., cloud fraction and height), his research is now focused on cloud optical thickness variability and its correlation to albedo diurnal changes. The findings are being summarized in two manuscripts. This research will allow future testing of General Circulation Model outputs that was not possible with data derived from polar or geostationary satellites.

Among other activities, Dr. Delgado-Bonal expects to submit one of the manuscripts in the coming months, and plans to present these findings to the EPIC mission directorate meeting and to the public in the DSCOVR science meeting in October.

Name: Surrendra Bhatta
Sponsor: Yuekui Yang
Code: 613
Task: 098

Dr. Bhatta has been deeply involved in the development and design of cutting-edge artificial intelligence tools aimed at studying the Earth's atmosphere, with a specific focus on the intricate phenomenon of Antarctic blowing snow. Working alongside his dedicated team, he has achieved a remarkable feat – the creation of a specialized machine learning model engineered to accurately predict the classification of blowing snow events. This groundbreaking model serves a novel purpose, facilitating the generation of extensive blowing snow data exclusively for integration into the MERRA2 official data product. Noteworthy is the expansive temporal scope of this achievement, spanning from 1980 to the present. In the year 2023 alone, Dr. Bhatta has authored two peer-reviewed articles as the first author and contributed as a co-author to another. These articles delve into the study of diverse topics such as clouds, aerosols, and blowing snow. Furthermore, Dr. Bhatta has also presented several abstracts, contributing to the discourse on these subjects.

At present, Dr. Bhatta is actively involved in employing Machine Learning models to estimate surface mass balance over Antarctica, thereby contributing to the generation of the official MERRA2 data product. Simultaneously, he is in the process of developing an additional model that amalgamates various satellite data sources. This new model aims to comprehensively investigate polar clouds, showcasing his ongoing commitment to innovative research in the field.

Name: Tamás Várnai
Sponsor: Lazaros Oreopoulos
Code: 613
Task: 102

Dr. Várnai and his colleagues examined the impact of sun glint off ice clouds on the operational sun glint product of the Earth Polychromatic Camera (EPIC) onboard the Deep Space Climate Observatory (DSCOVR) spacecraft. They found that the glints (due to the intense reflection of sunlight by ice crystals that maintain a steady horizontal orientation) have a significant impact on several parameters included in the EPIC cloud product. For example, glints help the detection of thin or small ice clouds, but they also cause overestimations of cloud optical thickness and cloud altitude. As first author, Dr. Várnai submitted a journal manuscript on the findings; this manuscript is currently under review. He also contributed to the publishing of a machine learning algorithm the team developed last year for satellite measurements of aerosol optical depth in regions of broken cloudiness. Finally, Dr. Várnai continued expanding the user community of the first publicly available online simulator of atmospheric three-dimensional radiative processes, which the team developed and released earlier.

In the coming months, Dr. Várnai plans to explore statistical relationships between spectral variations in satellite-observed radiances and cloud properties, with the goal of improving our

ability to characterize the observed clouds. He also plans to start expanding the analysis of spaceborne sun glint observations by considering data from additional satellite instruments such as MODIS.

Name: Zhibo Zhang and Jianyu "Kevin" Zheng
Sponsor: Lazaros Oreopoulos
Code: 613
Task: 103

As one of the research directions supported by this task, Dr. Zhang has been evaluating the performance and uncertainties of several widely used warm-rain parameterizations in Earth-System-Model (ESM) application scenarios. To achieve this goal, in situ measured droplet size distributions (DSDs) from the ACE-ENA field campaign are used to drive a numerical stochastic collection equation (SCE) solver, which is used as a benchmark for uncertainty evaluation. In the comparison of local and instantaneous autoconversion rates, the two parameterization schemes based on numerical fitting to SCE results (KK2000 and Chiu 2021) perform best. However, because of Jessen's inequality, their performance deteriorates when grid-mean, instead of locally-resolved, cloud properties are used in their simulations. In contrast, the effect of Jessen's inequality partly cancels the overestimation problem of two semi-analytical schemes (SB2001 and Liu 2007), leading to an improvement in the ESM-like comparison. In the assessment of uncertainty due to the large time step of ESMs, it is found that the rain water tendency simulated by the SCE is roughly linear for time steps smaller than 10 minutes, but the nonlinearity effect becomes significant for larger time steps, leading to errors up to a factor of 4 for a time step of 20 minutes. After considering all uncertainties, the grid-mean and time-averaged rain water tendency based on the parameterization schemes are mostly within a factor of 4 of the local benchmark results simulated by SCE. A journal paper is being prepared based on the results from this study.

Regarding another research task, Dr. Zhang and his student Jianyu ("Kevin") Zheng, have been developing a novel remote sensing method based on the combination of active lidar observations from CALIOP and passive radiometric observations from MODIS to retrieve the infrared optical thickness and coarse mode particle size of dust aerosols. Dust is one of the most abundant types of atmospheric aerosols. It plays a vital and multi-faceted role in the Earth Systems. To understand the impacts of dust on the climate, environments and human health, researchers need to monitor the origin, transport and distribution of dust aerosols on regional to global scales. In this study, they developed a novel algorithm based on the collocated Moderate Resolution Imaging Spectroradiometer (MODIS) thermal infrared (TIR) observations and dust vertical profiles from the Cloud–Aerosol Lidar with Orthogonal Polarization (CALIOP) to simultaneously retrieve dust aerosol optical depth at 10 μm (DAOD10 μm) and the coarse-mode dust effective diameter (Deff) over global oceans.

Using the new retrievals from 2013 to 2017, they performed a climatological analysis of coarse-mode dust Deff over global oceans. They found that dust Deff over the Indian Ocean (IO) and North Pacific (NP) is up to 20 % smaller than that over the North Atlantic (NA). Over NA in summer, they found a ∼50 % reduction in the number of retrievals with Deff >5 μm from 15 to 35◦ W and a stable trend of Deff average at 4.4 μm from 35◦ W throughout the Caribbean Sea (90◦ W). Over NP in spring, only ∼5 % of retrieved pixels with Deff>5 μm are found from 150 to 180◦ E, while the mean Deff remains stable at 4.0 μm throughout eastern NP. To the best of their knowledge, this study is the first to retrieve both DAOD and coarse-mode dust particle size over global oceans for multiple years. This retrieval dataset provides insightful information for

evaluating dust longwave radiative effects and coarse-mode dust particle size in models.

In the coming months, work will continue on the developing and testing the novel remote sensing method as well as work on preparing a manuscript for publication.

Name: Ryan Kramer
Sponsor: Lazaros Oreopoulos
Code: 613
Task: 104

Dr. Kramer pursued multiple activities towards using the multi-decade EOS record to diagnose changes in Earth's energy budget and decompose them into contributions from radiative forcings and feedbacks. This includes using estimates of observed aerosol forcings to demonstrate in a publication the different warming response patterns to aerosol emissions over Eastern China versus over India. Additionally, Dr. Kramer used observations of Earth's energy imbalance (EEI) to highlight how anomalous changes in ocean dynamics, driven by wind forcing, likely have contributed to the unprecedented recent changes in EEI. Both of these results were published. During this reporting period, Dr. Kramer also continued to pursue performing first-of-its-kind observationally-based estimates of greenhouse gas radiative forcing in a manner that fully accounts for the effects of cloudy conditions. Through this work, he has collaborated on efforts to define how the underlying climate state influences CO2 radiative forcing more generally. This led to a manuscript that is under review at Science and also led to multiple invited talks over the past year.
Note: Dr. Kramer accepted a position with NOAA in June 2023.

Name: Chamara Rajapakshe
Sponsor: Hongbin Yu
Code: 613
Task: 105

Dr. Rajapakshe was investigating aerosol-cloud-radiation interactions. His research was focused on the long-range transport of aerosol and pollution from Asia to North America over the North Pacific Ocean by the Mid-latitude Cyclones (MC). He performed a comprehensive analysis of the 3D distribution of aerosol (dust and pollution) around MCs along their trans-Pacific journey by combining the information from multiple satellites complemented by the model simulations. Dr. Rajapakshe also investigated the spatial distribution of aerosol and pollution around MCs in the context of removal caused by the clouds and precipitation associated with the MCs.
Dr. Rajapakshe accepted a new position in late February 2023.

Name: Yaping Zhou
Sponsor: Yuekui Yang
Code: 613
Task: 106

Under this task, Dr. Zhou is working on several projects. Two projects are related to remote sensing of cloud and aerosol; the third project is a science-driven investigation into the interaction of cloud-radiation-convection aggregation-precipitation in the tropics.

As a Co-I of EPIC's cloud team, Dr. Zhou has been working on algorithm validation and improvements of cloud products from the Earth Polychromatic Imaging Camera (EPIC) onboard

the Deep Space Climate Observatory (DSCOVR). During the reporting period, Dr. Zhou conducted RTM simulations for EPIC observations at the South Pole using in-situ radiosonde measurements to examine the instrument calibration and stability of the oxygen bands. They found the model-simulated oxygen band reflectances are much higher than the observations. The high bias could not be explained by uncertainties in input atmosphere or surface albedo, but can be explained by small shifts in instrument response function, which currently EPIC's moon-view calibration is not capable of detecting. This finding will affect many EPIC retrieval algorithms using the oxygen bands. The results of the study were published in the Journal of Quantitative Spectroscopy and Radiative Transfer. As a member of the Dark Target aerosol retrieval algorithm team, Dr. Zhou contributes to product validation and improvement. In particular, she has evaluated LUTs derived from potential new radiative transfer models (RTM) to replace current RTMs and works with other team members to improve cloud masking for the DT algorithm.

As a Co-I of a TASNPP project, "Investigating the Relationships of Cloud and Radiative Properties and Extreme Precipitation with Convective Clustering in the Tropics with Observations," Dr. Zhou generated dynamic and thermodynamic convective aggregation indices from MERRA-2 products and assisted the PI in the analysis of cloud and radiation properties according to the convective aggregation indices. A journal article that was submitted to the Journal of Geophysical Research is in revision. In addition, Dr. Zhou created a database of 5 years of extreme precipitation events (EPE) in the tropics and analyzed EPE characteristics and their relationship with large-scale environment and convective aggregation. The results have been reported in AOGS2023 and a journal article is in preparation.

In the coming months, for the EPIC project, Dr. Zhou will examine the impact of improved LUT with corrected oxygen response function on cloud retrieval products. She will also examine the impact of spherical radiative transfer on all EPIC bands and retrieval impact. Dr. Zhou will continue to examine the relationships between large-scale environment, convective aggregation, and extreme precipitation.

Name: Anin Puthukkudy
Sponsor: Reed Espinosa
Code: 613
Task: 110

The retrieval-simulation setup for CAMP2Ex observations has been developed for the multi-angular polarimeter (MAP), specifically a polarimeter based on the HARP family of MAPs. Dr. Puthukkudy was involved in exploring the impact of assumptions on the measured size distribution compared to the modeled distribution. Additionally, the completed task examined the effects of using simplified modeling approximations on aerosol and surface properties and their influence on the retrieved products from MAP. The framework developed here is highly versatile and can be easily applied to future MAP instruments. The findings of this study were presented at the 2022 AGU fall meeting, and a draft manuscript has been prepared and shared with sponsor Reed Espinosa.

In the coming months, they will conclude this project by submitting the manuscript and making the code and data utilized in this study publicly accessible.

Name: Tianle Yuan
Sponsor: Lazaros Oreopoulos
Code: 613
Task: 112

Dr. Yuan's research pioneered methods to automatically detect ship-tracks with deep learning and utilized the powerful sampling capability offered by said methods to study aerosol-cloud interactions, effect of societal regulations on our natural world and climate change, and air quality. He is leading an effort to combine the power of NASA-GEOS GOCART model and observations from satellite and ground sensors to retrieve particular matter at the surface. His work uses the largest known dataset in this research area. His research has had large public outreach. He has given several talks at the AGU, AMS, and other international conferences. He published four peer reviewed papers and got three proposals funded during the period. He was interviewed by large media outlets like Science Magazine, Washington Post, and the Associated Press for his work on ship-tracks.

Dr. Yuan will continue to work on his projects in the coming year. Specifically, Dr. Yuan will work on using DOE ARM observations to study aerosol-cloud interactions. He is also trying to quantify the climatic impact of fuel regulations in terms of radiative forcing.

Name: Jae Lee
Sponsor: Dong Wu
Code: 613
Task: 114

For more than 49 years, NASA has been measuring how much solar irradiance is arriving on Earth's top of the atmosphere. In December 2017, NASA launched the Total and Spectral solar Irradiance Sensor (TSIS-1) with two instruments to the International Space Station to continue monitoring the Sun's energy input to Earth, as a follow-up to the SORCE (SOlar Radiation and Climate Experiment) mission. The Total Irradiance Monitor (TIM) onboard TSIS-1 is measuring the total amount of radiant energy emitted from the Sun coming to the Earth called total solar irradiance, whereas the Spectral Irradiance Monitor (SIM) is measuring the solar spectrum and spectral solar irradiance.

Dr. Lee's major task is to provide the theoretical and physical bases for the TSIS-1 mission operation and TSIS-2 mission development. The TSIS-2 mission, which will be flown in 2025 on a free flyer, will continue to measure solar irradiance toward a continuous climate data record as recommended by the last decadal survey, as a follow-up to TSIS-1. Throughout mission activities, Dr. Lee is managing science data quality and engaging in validations and calibration status so that the mission can fulfill all levels of requirements and science objectives. During the reporting period, Dr. Lee provided support to complete the Instrument Pre-Environmental Review (I-PER) and Mission Operations Review (MOR) for TSIS-2. Dr. Lee's science investigation involves rotational and solar cycle variations in Total and Spectral Solar Irradiance. Besides the Sun, her major scientific research area is the Sun-Climate connection, which is a complex combination of multiple nonlinear processes involving Earth's ozone layer, atmospheric circulation, clouds, and the ecosystem.

For the Sept. 1 – Nov. 30, 2023 period, Dr. Lee will continue to investigate the polar mesospheric clouds (PMCs) and their potential relations with solar and volcanic forcings.

Name: Chenxi Wang
Sponsor: Steven Platnick
Code: 613
Task: 116

Dr. Wang has been working to develop and evaluate algorithms to retrieve cloud properties (including cloud optical thickness, effective radius, and cloud-top height) for passive imagers such as MODIS, VIIRS, and ABI. His analysis has focused on the impacts from surface emissivity database, ancillary atmospheric profiles, and infrared absorption bands on cloud property retrievals. Dr. Wang has been working to develop machine learning algorithms for cloud-aerosol detection using polar orbiting and geostationary instruments and gravity wave pattern detection from nighttime VIIRS DNB images. Dr. Wang is working together with research groups of the Department of Information System at UMBC on multiple machine learning algorithms in remote sensing applications.

From September 1, 2023, to November 30, 2023, Dr. Wang will be focusing on developing several algorithms: 1) developing and improving infrared optimal estimation (IROE) retrieval algorithm for ice cloud property retrievals using passive spectrometers (MODIS/VIIRS/ABI); 2) developing machine learning-based cloud mask/phase detection algorithms for passive spectrometers; 3) developing machine learning-based cloud and aerosol masking and typing algorithms using Geostationary imagers; 4) developing machine learning algorithms for detecting Atmospheric Gravity Waves using VIIRS Day Night Band; and, 5) developing a cloud synergy retrieval algorithm using joint passive Infrared (IR) and Microwave (MW) observations for the Atmosphere Observing System (AOS) mission. Also, Dr. Wang will be working on providing a flexible platform for satellite data collocation systems and providing ready-to-use collocation datasets for users. In addition to that, he will be working on developing multiple end-to-end ML-based algorithms (Domain Adaptation, VAE etc.) for cloud/aerosol detection.
Note, Dr. Wang transitioned to a new position in mid-September 2023.

Name: Kathleen McKee
Sponsor: Ralph Khan
Code: 613
Task: 117

Dr. McKee worked on examining volcanic plumes with the Multi-angle Imaging SpectroRadiometer (MISR) onboard the satellite Terra and geostationary satellite observations from GOES and Himawari-8. Her analysis focused on the plume from the 15 January 2022 eruptive episode of Hunga volcano, Tonga, and shows the presence of ash in the plume. Dr. McKee has drafted a first author manuscript for publication to the Journal of Volcanology and Geochemical Research. In addition to this research, she revised and resubmitted a ROSES proposal for continued research in plume characterization.
Note, Dr. McKee accepted a new position in April 2023.

Name: Yujie Wang
Sponsor: Alexei Lyapustin
Code: 613
Task: 118

Dr. Wang has been continuously working on the improvement and extension of the Multi-Angle

Implementation of Atmospheric Correction (MAIAC) algorithm. First, Dr. Wang finished the cross-calibration analysis of Aqua MODIS, SNPP VIIRS and JPSS-1 VIIRS sensors. He derived the cross-calibration coefficients for the VIIRS sensors using MODIS Aqua as the benchmark, and these results agree with independent vicarious calibration results of both the MODIS/VIIRS Characterization Support Team as well as the CERES Imager and Geostationary Calibration Group within an estimated uncertainty of 1–2%. Applying these coefficients to the MAIAC algorithm showed a high level of agreement of MAIAC aerosol, surface reflectance, and NDVI records between MODIS and VIIRS. This work has been published in the journal Remote Sensing of Environment. Second, Dr. Wang has updated the MAIAC VIIRS algorithm to reflect these improvements and submitted a new version of the MAIAC VIIRS operational code. Third, Dr. Wang also worked on the DSCOVR EPIC MAIAC algorithm; a new version of the EPIC MAIAC algorithm is under development. Lastly, Dr. Wang worked on the development of the PACE OCI MAIAC algorithm and developed a new gridding algorithm based on simulated PACE OCI data.

Upcoming plans include finishing the VIIRS MAIAC CMG code development, completing PACE OCI MAIAC code development, and starting new research on northern latitude wildfire-emitted aerosol temporal trend and spatial transportation analysis. In addition, Dr. Wang will work on NASA Earth surface Mineral dust source InvesTigation (EMIT) project, will develop a new atmospheric correction algorithm for EMIT, and will support the EMIT dust Direct Radiative Effects (DRE) analysis.

Name: Myungje Choi
Sponsor: Alexei Lyapustin
Code: 613
Task: 120

Dr. Choi has been investigating how to improve the smoke retrieval accuracy from the multiangle implementation of atmospheric correction (MAIAC) EPIC algorithm. He has improved this algorithm for retrieving multi-variable smoke properties by introducing delicate constraints in inversion processing and different cost functions for aerosol layer height and other optical properties. He has conducted a global validation of smoke retrievals by using AERONET and CALIOP measurements. Furthermore, Dr. Choi characterizes spatiotemporal changes in smoke optical properties and has specifically inferred BC and BrC (Black Carbon and Brown Carbon) over regional-to-continental scales. A statistical assessment of EPIC smoke properties shows regional differences based on different source types in smoke-dominant regions. These results were presented at the 2022 AGU fall meeting and the 2023 IGARSS meeting.

Dr. Choi evaluated the radiative calibration of BlackSky satellites, which are very-high-resolution commercial satellites. Dr. Choi conducted vicarious calibrations to convert BlackSky digital numbers to TOA radiance by using MAIAC processing with MODIS and DESIS datasets. Scene-specific calibration factors were extracted and analyzed.

From September 1, 2023, to November 30, 2023, Dr. Choi will submit a paper about EPIC smoke properties analysis to a peer-reviewed journal (e.g., Atmospheric Chemistry and Physics). He will also submit another paper about the vicarious radiometric calibration of Maxar commercial satellites using MAIAC.

Name: Lorraine Remer
Sponsor: Robert Levy
Code: 613
Task: 131

Dr. Remer supports the Dark Target aerosol retrieval group (0.17 FTE). She mentors group members and encourages submission of publications by reviewing analysis, co-authoring papers and presentations, and editing early drafts of manuscripts. She is contributing to the revision of the Algorithm Theoretical Basis Document (ATBD) that is being revamped to be a more general discussion of the generic Dark Target algorithm and less MODIS-centric. Dr. Remer also was invited to submit an Opinion to the journal Atmospheric Chemistry and Physics (ACP) in celebration of the journal's 20th anniversary. Along with her co-authors (including Dr. Levy), she submitted the piece, which is now in review.

She links the Dark Target group to activities happening with the PACE mission, the Unified Algorithm that she is leading for the PACE mission, and UMBC's Earth Space Institute (ESI) activities. Dr. Remer kept the Dark Target group informed on the results and progress of her work towards the publication of the Science paper on atmospheric nourishment of global ecosystems.

For September 1, 2023, to November 30, 2023, Dr. Remer will continue to work on the ATBD during the final three months of this reporting period, as well as supporting lead authors in responses to reviewer comments and revising two papers currently in review. She will also revise and resubmit the Opinion to ACP, while keeping the Dark Target group abreast of her other activities with PACE and ESI.

Name: Yingxi Shi
Sponsor: Robert Levy
Code: 613
Task: 132

Dr. Shi executed a thorough and careful validation work on various versions of DT products that are created under MEASURES projects, including DT on MODIS Aqua and Terra, VIIRS, NOAA20, ABI-16, ABI-17, and AHI. All level2 products were validated against ground-based measurements as well as intercompared with DT on MODIS Aqua to illustrate the similarity/differences between the products. The large impact of sampling differences among all sensors are also demonstrated. Dr. Shi also managed the process of generating a new version of ATBD regarding the DT product generated by DT package with inputs from the entire team. She participated in the atmosphere-ocean interaction project that involves atmospheric dust deposition and ocean biological response and the results of this study was published in Science. Dr. Shi created a Machine Learning (Random Forest) model to extrapolate aerosol optical depth (AOD) from visible to UV and implemented it into the operational algorithm of PACE unified aerosol algorithm (PI: Dr. Lorraine Remer). Various tests and validation of the model results were performed to ensure the quality of the model output. She also transformed the PACE unified algorithm research code into an operational environment and delivered it to the PACE team via GitHub.

Dr. Shi submitted her work regarding the FIREX-AQ campaign for consideration as a journal publication. The ability of operational and modified DT products on various sensors (MODIS, ABI-16/17) capturing the spatial and temporal variation of smoke plumes that are just emitted from fire

sources were analyzed. The representative of plume optical characteristics in retrieved products due to product spatial resolution is extensively studied. Dr. Shi is investigating several cases of severe smoke emissions from the 2020 California fires to develop and test regions where current operational codes fail to retrieve aerosols. Several new cloud masks were tested. Additionally, Dr. Shi worked on developing a machine learning based dust detection model using MODIS and CALIOP collocated dataset.

For the rest of the calendar year of 2023, Dr. Shi expects to continue working on thorough validation of MEASURES project-related DT products quality and quantifying the uncertainties within the products. Dr. Shi plans to submit a paper regarding her work on the validation efforts towards these DT aerosol products. She will work on developing a Machine Learning based dust detection system.

Name: Pengwang Zhai
Sponsor: Yuekui Yang
Code: 613
Task: 135

Dr. Zhai is responsible for the development and implementation of the improved pseudospherical shell approximation for better look-up tables closer to the edge of the EPIC images. Dr. Zhai previously developed an improved pseudo spherical shell (IPSS) approximation for simulating the polarized radiance field in the Earth system, which was based on an assumption that the ratio of multiple to single scattering contributions is the same for spherical shell and plane-parallel atmospheres. In addition, the exact single scattering contribution in the spherical shell atmosphere can be solved. By combining the first assumption, Dr. Zhai can solve the multiple contributions corrected for spherical shell effects in the Earth system. Originally this algorithm was written based on a ground sensor. In the past year, he has generalized it to a TOA sensor, which makes it easier to simulate satellite sensor observations.

In addition, the original code was based on a Lambertian reflectance for land surface. In order to apply this code to the polar region, Dr. Zhai has further implemented the snow bidirectional reflectance distribution function into the code. Using the new code, their GSFC collaborators have simulated a series of TOA responses based on in-situ measured atmosphere profile. Dr. Zhai and colleagues have found that the match between the EPIC measurements and RT simulations is within 1%, except in strong oxygen absorption bands. They found that shifting the instrument response function by ~0.2 nm could result in a much better fit for the measurements. This research led to a better calibration of the EPIC sensor.

Looking ahead, Dr. Zhai will continue to work closely with Dr. Yuekui Yang to simulate the EPIC responses of a series of cloudy scenes in order to update the lookup table for the EPIC cloud algorithm. The sensitivity experiment carried out in the past will be used to guide future algorithm development.

Name: Seoyoung Lee
Sponsors: Christina Hsu
Code: 613
Task: 156

Since joining GESTAR II in February 2023, Dr. Lee has been working on aerosol remote sensing

using the Deep Blue (DB) algorithm. Her analysis has focused on applying the DB algorithm to AVIRIS-NG data. She also has been involved in the assessment of MODIS C6 and C7 data, along with the implementation of the DB algorithm to MODIS C7 data.

In the coming months, Dr. Lee will be working on validating the VIIRS DB V2 aerosol products that were released in April 2023.

Name: Mijin Kim
Sponsor: Robert Levy
Code: 613
Task: 165

Dr. Kim joined GESTAR II in January 2023 and has been working on evaluating and improving the Dark Target (DT) aerosol retrieval algorithms operating on the geostationary (GEO) orbit sensors. Her primary research focus centers on the evaluation of surface reflectance parameterization. Dr. Kim submitted a first author manuscript for publication to Atmospheric Measurement Techniques, analyzing biases in DT aerosol retrieval from ABI, GOES-16 observation. Through a modification of surface reflectance parameterization, notable improvements have been achieved in the aerosol optical depth retrieval, particularly in capturing diurnal variations.

The focus of Dr. Kim's upcoming research will be on GEO-LEO consistency of DT retrieval. The DT algorithm is being ported to VIIRS and other GEO sensors including ABI and AHI, which will relay the 20-year legacy of DT aerosol dataset. In her pursuit of continuing the high performance of DT aerosol retrieval, Dr. Kim is working on enhancing the surface reflectance assumption on the DT algorithm by considering the sensor geometry differences between GEO and LEO sensors to maintain high-performance DT aerosol retrieval across various platforms. The synergistic use of GEO-LEO DT retrieval is also a plan for her future research. She also has submitted an abstract to AGU fall meeting to present her recent study.

Name: Colten Peterson
Sponsor: Kerry Meyer
Code: 613
Task: 170

Dr. Peterson, who joined GESTAR II in June 2023, has been working to develop and evaluate the MODIS/VIIRS Cloud Team's pixel-level and aggregated SW and LW radiative flux datasets that are to be released as a part of Collection 7 Cloud Products (MYD06/MOD06) and Version 2 of the CLDPROP MODIS/VIIRS Cloud Continuity Products. He has worked on more extensive evaluations of the MODIS (standard and continuity) surface pixel-level fluxes using globally distributed surface radiation measurements. Dr. Peterson also has performed extensive evaluations of MODIS TOA pixel-level radiative fluxes using two CERES radiative flux products (SSF and CRS). Dr. Peterson presented this work at the July 2023 Gordon Climate and Radiation Conference, and he is working towards the publication of the MODIS/VIIRS flux work. Additionally, he is participating in the 2024 NASA ARCSIX field campaign, where his role will involve AVIRIS-NG imagery algorithms and cloud products. He participated in the first ARCSIX science team meeting in August 2023, which involved key preparatory work for the upcoming campaign.

In the coming months, Dr. Peterson will help incorporate multiple updates to the science codes used to operationally produce the MODIS/VIIRS radiative flux datasets. These include modifications of

ocean albedo and cloud base determination for the surface downwelling longwave flux calculations. Dr. Peterson will perform more extensive global scale evaluations of the MODIS/VIIRS TOA fluxes against the CERES SSF and CRS products. A main goal of such evaluations is to determine if TOA flux biases exist (and, if so, why?). He will also continue to work on developing the global level-3 monthly MODIS/VIIRS surface and TOA radiative flux datasets.

Name: Alexander Kotsakis
Sponsor: Antonia Gambacorta
Code: 613
Task: 180

This task is a follow-on task to #095, sponsor: Glenn Wolfe (614), which ended 3/31/23. This task began on 04/01/23 under Dr. Gambacorta. The nature of his report is the same. Dr. Kotsakis has been working on the development of an artificial intelligence deep learning model that utilizes passive (microwave, infrared) and active (LIDAR) satellite measurements to determine the planetary boundary layer height. This model development also serves the purpose of aiding in the development of a NASA Instrument Incubator Program funded hyperspectral microwave instrument, HyMPI. This instrument has shown the capability of significantly advancing currently available technology and retrievals, allowing for higher resolution temperature and water vapor sounding. A prototype of this instrument is being flown on the NASA ER-2 next year through the funding received in his selected NOAA BAA proposal. Dr. Kotsakis has been active in the early preparation stages of the field campaign planning. In addition to model development and field campaign preparation, multiple manuscripts have been in development and are anticipated to be submitted later this year.
Note, Dr. Kotsakis began a new position at a different institution on July 31, 2023.

Name: Roshan Mishra and Yingxi Shi
Sponsor: Kerry Meyer
Code: 613
Task: 184

This year, Dr. Yingxi Shi and her PhD student Dr. Roshan Mishra, who recently joined GESTAR II, made great progress in the project of "Resolving Spectral Aerosol Absorption and Optical Depth of Rapidly-Evolving Smoke with Geostationary Observations." They found very exciting results of smoke single-scattering albedo (SSA) retrievals that match well with ground-based measurements with bias less than 0.02 on all selected case studies. This year they focused on generalizing their success to the entire domain of study. They did encounter difficulties in accurately finding cloud regimes (CRs) values as well as creating representative smoke models; thus, they adjusted their tasks in order to fully understand and resolve these issues.

In the coming months and year, they will try to expand the infrastructure spatially and study the smoke absorption change following one signature smoke plume.

Name: Yaping Zhou
Sponsor: Antonia Gambacorta
Code: 613
Task: 191

For this new task, Dr. Zhou will perform physical and statistical retrieval research applicable to

hyperspectral passive and active remote sensing instruments. She will conduct Earth PBL research using data from the current and future program of record. Dr. Zhou will publish results and research findings in peer review journals and present in science conferences as well as contribute to proposal writing.

CODE 614: ATMOSPHERIC CHEMISTRY AND DYNAMICS LABORATORY

Name: Daniel Anderson
Sponsor: Bryan Duncan
Code: 614
Task: 013

Dr. Anderson developed a methodology to indirectly constrain the hydroxyl radical (OH) in the tropical atmosphere using machine learning, chemical transport models, and satellite observations of its drivers. Hydroxyl is the dominant atmospheric oxidant and is responsible for removing many other chemicals from the atmosphere. He published a paper outlining the feasibility of the methodology and highlighting the suitability of observations from the Terra and Aura satellites for the hydroxyl product in the journal Atmospheric Chemistry and Physics. In addition, he has developed a parameterization of ozone to be incorporated into the NASA GEOS model that will allow for computationally efficient studies of the interactions between ozone and other atmospheric trace gases, such as methane.

Dr. Anderson will continue the evaluation of the satellite hydroxyl product, with an aim to understand recent trends and variability in OH and to understand differences between the satellite product and the GEOS model output. He will also complete the creation of ozone parameterization for GEOS and begin to develop an analogous parameterization for hydrogen peroxide. Finally, he will begin work on quantifying CO_2 emissions from hundreds of power plants around the world using observations from TROPOMI and OCO3.

Name: Junhua Liu
Sponsor: Bryan Duncan
Code: 614
Task: 014

Dr. Liu has worked on the evaluation and trend analysis of ozone and its related species (including NO_2, CH_2O and CO) for the RefD1 simulation performed by the GEOS CCM group based on various satellite measurements and in-situ observations. She uses a model-data combined analysis to quantify tropospheric ozone changes and its contribution to total column ozone change. The results show that the global total column ozone increased a few Dobson Units during the recent two decades, and a significant part of this increase is attributed to the increase in the tropospheric column ozone (Figure 1). Dr. Liu published a first author paper on this work in Journal of Geophysical Research: Atmospheres. She continues to work on model evaluations of new simulations conducted by the GEOS-CCM group.

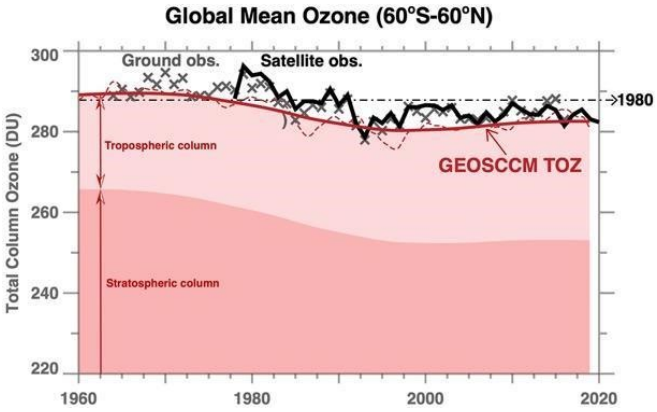


Figure 1: Temporal variations of simulated annual mean total column ozone (red dashed line) with the tropospheric column ozone stacked on top of the stratospheric column ozone from the RefD1 simulation between 1960 and 2018, superimposed on the annual mean of total column ozone from ground-based observations (gray cross symbol) and merged satellite observations (black thick line) (Weber et al., 2018). A 5-year low pass filter has been applied to the simulated ozone fields to highlight the long-term variations (red solid line). Figure 5 in Liu et al., 2022.

Dr. Liu has conducted sensitivity simulations using the 2-D F0AM box model and various aircraft measurements to identify the main drivers for tropical OH changes. The results from this work supports UMBC's Dr. Daniel Anderson's ACCDAM project on developing a machine learning algorithm to infer tropospheric column OH (TCOH). Dr. Liu also supports the Computationally-Efficient CH4-CO-OH (ECCOH) and Quick-Chem simulations and evaluation processes. She participates in the development of the NASA eViz (Easy Visualization) applications of Earth System Models.

In the coming months, Dr. Liu will continue work on the model evaluations of new simulations conducted by the GEOS-CCM group including the RefD2 simulation and any new benchmark runs. Work also will continue on the ECCOH model simulations and evaluations, and she will support the development of eViz applications of Earth System Models. Additionally, Dr. Liu will continue work with Dr. Lok Lamsal (UMBC) on his ACCDAM project on analyzing the O3-NOx-VOCs Sensitivity and assessing O3 response to NOx and VOCs using box model and aircraft campaign measurements.

Name: Sarah Strode
Sponsor: Bryan Duncan
Code: 614
Task: 015

Dr. Strode supported an effort to evaluate the climate sensitivity of the GEOS model. She conducted two sensitivity simulations, one related to sea salt and the other to nitrates, to help interpret differences in aerosols that occurred when carbon dioxide concentrations in the GEOS model were quadrupled.

Dr. Strode is contributing to the GEOS Chemistry Climate (GEOSCCM) effort for the Chemistry Climate Model Initiative (CCMI), a multi-model effort to increase understanding of how climate and chemistry interact. She prepared input files for the GEOSCCM following the CCMI specifications and set up the RefD2 multi-decade simulation. She is helping to evaluate the output of the simulation.

Dr. Strode is contributing to the development of quick chemistry within the GEOSCCM. She conducted and evaluated several simulations to test the performance of a new machine learning-based OH parameterization that allows efficient simulation of feedback mechanisms between methane, OH, and carbon monoxide. She evaluated the simulations with surface observations. She is also working on implementation of a quick chemistry approach to tropospheric ozone within the GEOSCCM.

As part of the NASA ARSET program, Dr. Strode worked to develop and deliver an in-person training on "NASA Air Quality-Focused Remote Sensing for EPA Applications". This 3-day training was presented at the U.S. Environmental Protection Agency (EPA) in Research Triangle Park, NC.

Dr. Strode helped develop a use case for NOx observations with the Intelligent Long Endurance Observing System (ILEOS). She helped identify useful datasets and develop methodology for quantifying pixels of interest.

In the coming months, Dr. Strode plans to continue implementing and testing the quick chemistry ozone implementation, evaluating its performance compared to simulations with "full chemistry" simulations that have a mechanistic representation of ozone chemistry. She will contribute to an online ARSET training on "Satellite Data for Air Quality Environmental Justice and Equity Applications".

Name: Fei Liu
Sponsor: Joanna Joiner
Code: 614
Task: 019

Dr. Liu has been working to estimate anthropogenic emissions of air pollutants and greenhouse gases based on satellite and model data. Her work has focused on Aura OMI and sentinel 5p TROPOMI NO2 observations. The new emission estimates will help to improve the performances of climate and air quality models. Dr. Liu submitted a first-author manuscript for publication to Atmospheric Chemistry and Physics, developing a catalog of NOx emissions from TROPOMI observations for major US cities. The development of a global NOx emission database for cities is ongoing.

For Sept – Nov 2023, Dr Liu plans to extend the catalog of urban NOx emissions and lifetimes inferred from the TROPOMI tropospheric NO2 observations from domestic to global. The catalog is derived using the CTM-Independent SATellite-derived Emission estimation Algorithm for Mixed-sources (MISATEAM) developed under the same task. Dr Liu is going to investigate the application of MISATEAM to geostationary satellite NO2 observations. The investigation will shed light on the diurnal cycle of urban NOx lifetimes and emissions. She will present the work about the satellite-derived urban NOx emissions at the AMS annual meeting in Baltimore.

Name: Lok Lamsal
Sponsor: Nickolay Krotkov
Code: 614
Task: 021

Dr. Lamsal leads the development, improvement, and maintenance of the Ozone Monitoring

Instrument (OMI) operational nitrogen dioxide (NO_2) Standard Product (OMNO2) algorithms and products. He ensures uninterrupted data processing and release, and provides user support. Over the past several months, he has been working on multiple algorithm updates for the next version, V5, of the OMNO2 Level 2 (L2)-L3 products. Major updates include the use of 1) OMI collection 4 Level 1B (L1B) data, 2) high-resolution a-priori NO_2 vertical profiles from an improved GEOS-GMI simulation, 3) improved geometry-dependent surface reflectivity data, and 4) updated cloud products. Several test retrievals and data evaluation have been performed. Under a separate activity, Dr. Lamsal manages a MEaSUREs (Making Earth System Data Records for Use in Research Environments) NO_2 project, titled, "Multi-Decadal Nitrogen Dioxide and Derived Products from Satellites (MINDS)". The goal of the project is to develop a consistent, long-term (1995-present), multi-satellite global trend-quality NO_2 data record.

Dr. Lamsal conducts studies focusing on atmospheric composition and trends. He has analyzed OMI tropospheric NO_2 data for over 300 cities and power plants from all over the world, and archived trend maps, time-series plots, and data in the NASA Air Quality website (https://airquality.gsfc.nasa.gov/no2). Additionally, an analysis focusing on NO_2 reductions during COVID-19 lockdowns are maintained separately at https://so2.gsfc.nasa.gov/no2/no2_index.html. He has also been working on other projects involving analysis and interpretation of satellite observations using models, development of trace-gas products from airborne sensors, and participation in a mission proposal.

Dr. Lamsal's expected activities and research for September 1, 2023, to November 30, 2023 include continuing working on the V5 OMNO2 product and its evaluation.

Name: Stephen Steenrod
Sponsor: Luke Oman
Code: 614
Task: 041

Mr. Steenrod made many important improvements to the GMI chemistry package in the GEOS Chemistry Climate Model (GEOSCCM). The most important improvement added was probably the capability to have many different GMI mechanisms in place in the GEOSCCM and allowing the user to choose which one is used with a compile-time option. Previously the mechanism could only be changed by a painstaking procedure of manually swapping files in and then making detailed mechanism specific changes to several other files. Mr. Steenrod also formulated two new mechanisms by adding new reactions and species. This includes a new stratospheric/tropospheric mechanism that adds some HFCs, short-lived bromine species and a sulfur mechanism. With the sulfur mechanism, he and his colleagues are going to do the gas phase chemistry consistent with the rest of the oxidant chemistry. Previously this chemistry was parameterized within GOCART. The other new GMI mechanism is designed to simplify the original mechanism to speed the runtime for stratospheric climate studies. Mr. Steenrod also updated the kinetics generating software (KMG) to fully support the GEOSCCM model structure. The KMG package automatically creates the Fortran files needed for the GEOSCCM model. This package had not previously been updated to create all of the files that are now needed for the later releases of the GEOSCCM model. KMG now creates all mechanism-related files automatically.

Mr. Steenrod also added new capabilities to the GEOSCCM, such as point emissions for any and all GMI species. This facilitates several new types of studies, including the Hunga Tonga-Hunga Ha'apai volcanic eruption simulations or chemical injections from forest fires. This will be used to

study the chemical effects from the many extremely large forest fires that have been happening worldwide lately. Mr. Steenrod ran many simulations that were used in AGU and AMS presentations by other principal investigators on their projects. Mr. Steenrod also worked on a detailed chemical coupling of the GMI sulfur chemistry with the GOCART and CARMA sulfate aerosol packages. This coupling is bidirectional with the GMI gas phase sulfur being fed to the respective sulfate aerosol calculations. The aerosols are then fed back into the calculations for the GMI heterogeneous and photolytic reactions.

Mr. Steenrod will continue to develop the new aqueous SO2 reaction rate calculation. He will also continue working on the simplified stratospheric mechanism. When these are complete several simulations will be run. He also plans to begin work on the new ACMAP proposal looking at the atmospheric chemical effects of the Australian forest fires (PI: Das).

Name: Hiren Jethva
Sponsor: Omar Torres
Code: 614
Task: 047

Dr. Jethva worked extensively on developing and testing Collection 4 of the OMAERUV aerosol product. His analysis was focused on validating the aerosol retrievals against ground-based measurements and checking the long-term stability. Additionally, he suggested novel approaches to improve the accuracy of aerosol retrievals for partially cloudy pixels by introducing a concept of mixing the aerosol and cloud look-up tables.

He took the lead in developing, testing, and integrating the Oxygen-B band-related retrieval algorithm for deriving the product of the optical centroid of the absorbing aerosol layer (or aerosol layer height) from the DSCOVR-EPIC and S5p-TROPOMI sensors.

He closely followed the unusual Canadian wildfire smoke transport over North America using NASA TROPOMAER and EPICAERUV algorithms applied to TROPOMI and EPIC sensors, respectively. Figure 1 shows the spatial distribution of the maximum UV Aerosol Index values observed from TROPOMI during May and June. Figure 2 displays the multiple panels of daily all-sky aerosol absorption optical depth at 388 nm for June 02-09, 2023, derived from the NASA TROPOMAER algorithm.

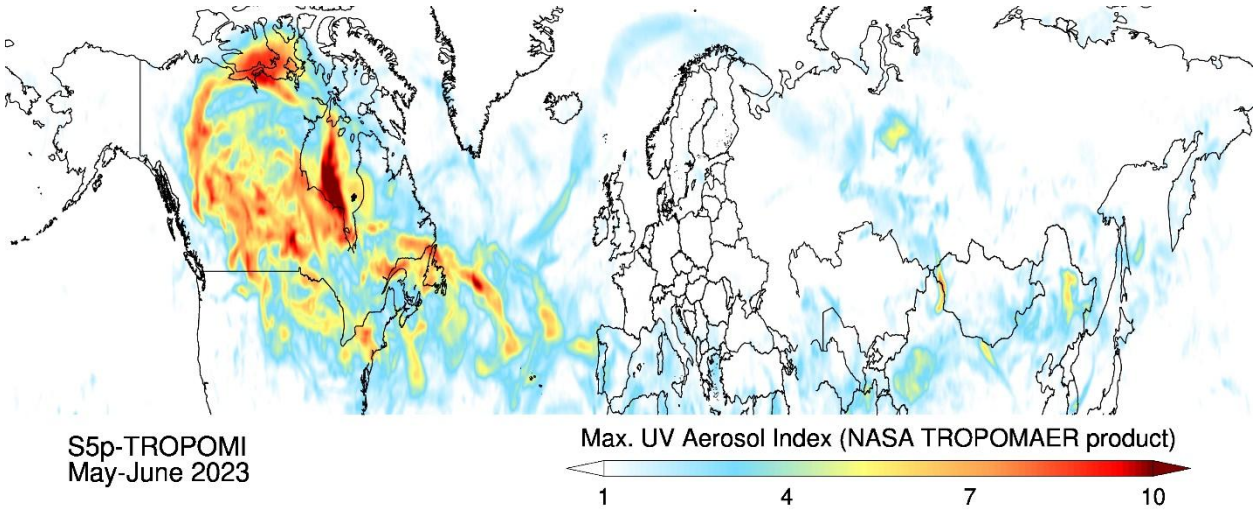


Figure 1 *Spatial distribution of maximum UV Aerosol Index observed from S5p-TROPOMI sensor during two months of May-June 2023. The unusual wildfires in Canada early in May, which continued through June, transported massive amounts of smoke across the breadth and width of Canada and the northern/eastern United States, resulting in poor air quality in the region. The smoke plume further traveled across the Atlantic Ocean and reached Eastern Europe.* (Provided by H. Jethva.)

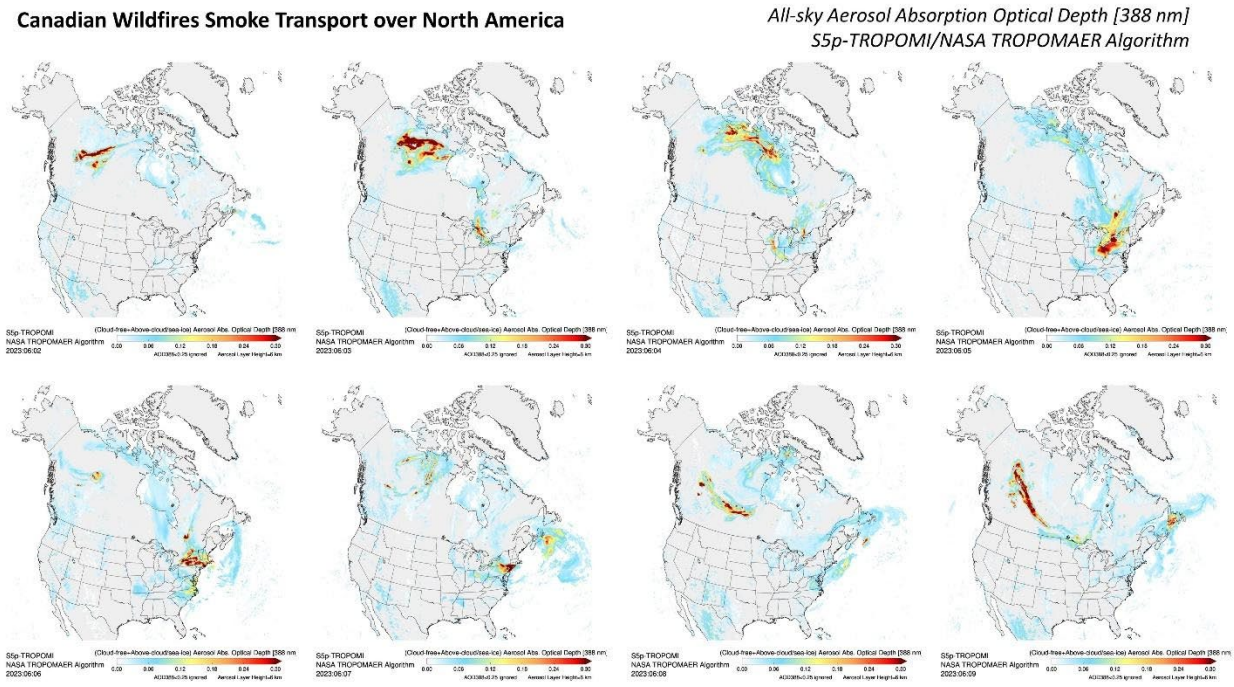


Figure 2 *Daily maps of all-sky aerosol absorption optical depth of Canadian wildfires smoke transport derived from NASA TROPOMAER algorithm applied to S5p-TROPOMI sensor.* (Provided by H. Jethva.)

Dr. Jethva has planned the following activities from September 1, 2023, to November 30, 2023. He will complete the evaluation of the OMI Collection 4 OMAERUV aerosol product and recommend necessary changes for the final processing and delivery of the product. Dr. Jethva will implement important changes in the TROPOMAER UV-VIS aerosol algorithm and EPICAERUV near-UV aerosol algorithm related to 1) the aerosol layer height retrievals from the Oxygen-B band observations and 2) aerosols above clouds product. He also will develop a manuscript describing the above-cloud aerosol absorption algorithm and product results derived from the synergy of CALIOP-OMI-MODIS (Aura Science Team grant).

Name: Feng Li
Sponsor: Paul Newman
Code: 614/610
Task: 064

Dr. Li has participated in the assessment of the coupled atmosphere-ocean GEOS model for climate research. A 100-year preindustrial control simulation and a 150-year abrupt CO_2 quadrupling simulation were performed by the GSFC Chemistry-Climate Model (CCM) group. Dr. Li has evaluated model atmospheric and oceanic climatology in the preindustrial simulation and their changes in the abrupt CO_2 quadrupling simulation. An important goal of this project is to determine the equilibrium climate sensitivity (ECS) of the GEOS. GEOS simulates well the atmosphere and ocean responses to $4\times CO_2$, e.g., the Arctic amplification of the surface warming, the narrowing of the Intertropical Convergence Zone (ITCZ), the poleward shift of the SH midlatitude jet, the shift of the Southern Annular Mode (SAM) and North Atlantic Oscillation (NAO) toward positive phase, the delayed warming of the Southern Ocean, and the weakening of the Atlantic Meridional Overturning Circulation. These analyses indicate that the coupled GEOS model is suited for long-term climate change research. Dr. Li is preparing a manuscript to document the ECS and climate response to $4\times CO_2$ in GEOS.

In the coming months, a first-author paper by Dr. Li entitled “Impacts of stratospheric ozone recovery on Southern Ocean temperature and heat budget” is expected to be published by Geophysical Research Letters. Also, as PI, Dr. Li will submit a proposal to NASA ROSES Cryospheric Science.

Name: Susan Strahan
Sponsor: Paul Newman
Code: 614/610
Task: 065

Dr. Strahan continued to direct chemistry transport model simulations that are used in her research and by measurement scientists who are part of the Network for the Detection of Atmospheric Composition Change (NDACC). She participated in her final NDACC Steering Committee meeting in September, giving a presentation on the impact of faster tropical stratospheric circulation on ozone chemistry. She continued to provide model simulations and NASA satellite ozone data to support the polar ozone working group in Code 614.

Dr. Strahan gave an in-person oral presentation at the American Meteorological Society annual meeting, January 10, 2023. The title was “Faster Upper Stratospheric Upwelling Drives Changes in Ozone Chemistry”.
Note, Dr. Strahan retired in late March 2023.

Name: Andrew Swanson
Sponsor: Thomas Hanisco
Code: 614
Task: 069

In Fall 2022 and early 2023, Mr. Swanson worked on instrument production of an identical Rapid OZone Experiment (ROZE) to be utilized by the GSFC In Situ Observation Laboratory on atmospheric research field campaigns. He oversaw and directed the fabrication and assembly of custom machine parts into a new aircraft-worthy, research-grade instrument, capable of tropospheric flux measurements. His engineering work included chassis components, a honeycomb optical table, and a custom broadband cavity enhanced absorption spectroscopy cell. ROZE is a semi-autonomous, state-of-the-art air-worthy research instrument that Mr. Swanson helped to design and develop in 2018-2019. This past year, he built a duplicate instrument for the lab so that its technique can be employed simultaneously in multiple field campaigns or laboratory operations. In addition to mechanical components, Mr. Swanson played a vital role in electronics development and assembly for the new ROZE instrument, overseeing and directing circuit board production, instrument wiring, and testing.

Mr. Swanson also worked on the design and development of aircraft flight hardware for integrating the In Situ Lab's research instruments into the NSF's C-130 Research Aircraft as part of the NASA/University of Maryland Greater NY Oxidant, Trace gas, Halogen and Aerosol Airborne Mission (GOTHAAM) field campaign. He created the design for an aircraft instrument rack layout to be integrated into the C-130, which included provisions for the GSFC Code 614 In Situ Laboratory's Compact Airborne Formaldehyde Experiment (CAFE) instrument, the Compact Airborne Nitrogen diOxide Experiment (CANOE) instrument, and ROZE. He is responsible for the mechanical design and development of CAFE and CANOE in 2015 and 2017, respectively. During the current reporting period, Mr. Swanson's work on GOTHAAM consisted of engineering, design, and overseeing the fabrication, assembly, and certification of mechanical components for integrating the lab's instruments into the C-130 for the GOTHAAM campaign.

In addition, Mr. Swanson coordinated with other GSFC engineers and scientists on an additional balloon launch of the Code 614 In Situ Laboratory's nitrogen dioxide (NO2) balloon instrument. This was their third launch and test flight for evaluating the instrument's autonomous operation while simultaneously gathering useful tropospheric NO2 concentration data. The instrument was launched at the Howard University Beltsville Campus and was recovered several days later in Gambrills, MD.

Finally, Mr. Swanson worked on the design of a rack layout for the Code 614 In Situ Lab's Compact Airborne Formaldehyde (ISAF) instrument into the NASA DC-8 Flying Laboratory aircraft for the NASA/NOAA Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) field campaign. The layout consisted of reutilizing old aircraft rack hardware that Mr. Swanson had developed for previous campaigns; therefore, no fabrication was required for new parts, only design and the structural analysis thereof. (Mr. Swanson is responsible for the mechanical design and development of ISAF in 2011-2012.)
Note, in March 2023, Mr. Swanson accepted a new position.

Name: Jin Liao
Sponsor: Thomas Hanisco
Code: 614
Task: 070

Dr. Liao was in charge of the PANDORA instruments lab, where she conducted radiometric, wavelength and straylight calibration regularly. She helped simplify the Pandora lab measurement routines and trained a colleague to perform lab calibrations.

Dr. Liao has been working on comparing three satellite HCHO retrievals to the NASA Atmospheric Tomography Mission (ATom) four seasons of HCHO measurements. NASA ATom was a suborbital campaign that performed frequent vertical profiling over remote oceans around the world during 2016-2018. Dr. Liao wrote codes to re-grid satellite HCHO parameters (e.g. vertical columns, a priori profiles) from the three retrievals to start investigating the reasons for the differences between satellite retrievals and the ATom in situ integrated columns. The comparison between HCHO satellite retrievals and in situ column-integrated measurements showed that the in situ column products are consistently higher than satellite retrievals in mid and high latitudes, especially in the Northern Hemisphere. This comparison may benefit the improvement of satellite HCHO retrievals. Dr. Liao submitted an abstract about this study to the coming 2023 Fall AGU meeting. She is also preparing a first author manuscript, with an expected submission date at the end of this year or early next year.

During Sept -Nov 2023, Dr. Liao will continue to write the manuscript currently titled "Validation of formaldehyde products from three satellite retrievals (OMI SAO, OMPS-NPP SAO, and OMI BIRA-IASB) in the remote atmosphere with four seasons ATom aircraft observations".

Name: Jerry Ziemke
Sponsor: Richard McPeters
Code: 614
Task: 074

Dr. Ziemke works to develop tropospheric ozone data products from satellite instruments and provides them to the scientific community. He has been doing this for NASA Goddard Space Flight Center Code 614 since the late 1990s. The NASA/NOAA Earth Polychromatic Imaging Camera (EPIC), Ozone Monitoring Instrument (OMI), Ozone Mapping and Profiler Suite (OMPS), and Microwave Limb Sounder (MLS) satellite instruments are operational at the current time, producing continuously updated ozone measurements that Dr. Ziemke includes together for deriving satellite tropospheric ozone products. These tropospheric ozone products are available from either the NASA Aura Validation Data Center (AVDC) (https://avdc.gsfc.nasa.gov/) or the NASA Goddard tropospheric ozone website (https://acd-ext.gsfc.nasa.gov/Data_services/cloud_slice/). The newest EPIC tropospheric ozone product provides maps of tropospheric ozone every 1-2 hours and is also available from the NASA Langley Atmospheric Science Data Center (ASDC).

The activities of Dr. Ziemke include his participation in the international Tropospheric Ozone Assessment Report (TOAR) II. The TOAR II includes the satellite tropospheric ozone data products from EPIC, OMPS, OMI, and TOMS that Dr. Ziemke produces to provide monitoring and long-record analyses of global tropospheric ozone. He also contributes to the Bulletin of the American Meteorological Society (BAMS) annual State of the Climate Report to provide updates

every year for global tropospheric ozone. His involvement in these reports has been largely online rather than in person for the last several years following the Covid-19 pandemic.

Dr. Ziemke has also been active with contributing to journal publications, paper reviews, and national and international meetings including weekly-to-monthly onsite ozone production team meetings at NASA Goddard Space Flight Center.

The plan for upcoming activities for Dr. Ziemke is to continue development of tropospheric ozone products with drift corrections and added improvements including boundary-layer ozone, cloud, and aerosol adjustments. Also, he will keep active with attending and contributing to processing team meetings on the development of SBUV, EPIC, OMI, and OMPS ozone products. Dr. Ziemke will attend upcoming meetings (in person or virtual) for DSCOVR, AGU, AMS, EGU, and the international Quadrennial Ozone Symposium.

Name: Ghassan Taha
Sponsor: Glen Jaross
Code: 614
Task: 084
Dr. Taha has been leading the SNPP OMPS LP aerosol algorithm development, enhancing the aerosol retrieval in the upper troposphere/lower stratosphere through improved cloud detection and removal methods. The newly developed aerosol product is scheduled for release in the coming months. He has also been working on improving the calibration of the recently launched N21 OMPS LP instrument. His efforts have centered on refining its wavelength registration and ensuring the accuracy in its tangent height registration. In addition, Dr. Taha led the development and release of the OMPS-NPP L3 LP Aerosol Extinction Vertical Profile 5 x 15 deg lat-lon grid multi-wavelength monthly V1 product to GES DISC:
https://disc.gsfc.nasa.gov/datasets/OMPS_NPP_LP_L3_AER_MONTHLY_1/summary
Dr. Taha has been studying the record-breaking Hunga-Tonga volcanic eruption using OMPS LP aerosol measurements. His work resulted in four published papers, one as a first author, and four presentations at various meetings.

In the coming months, Dr. Taha plans to release a new version of the OMPS-NPP LP L2 aerosol products v2.4. In addition, he plans to release the first version on the newly launched OMPS-N1 L2 aerosol products.

Name: Tom Kucsera
Sponsor: Mian Chin
Code: 614
Task: 086

Mr. Kucsera worked on atmospheric aerosol numerical modeling and analysis. He worked on various multi-year simulations and numerous aerosol post-analyses, which included post-processing modeling results for the international AEROCOM inter-comparison project. Completed products and results were regularly uploaded to the AEROCOM project's archive facility for further analyses and ongoing collaboration purposes. All results were processed to abide by the project's agreed-upon and strict format structure to increase collaboration by enabling analyses to be more easily carried out by all involved researchers.

In addition to his scientific research activity, Mr. Kucsera maintained and provided system

administration for multiple Linux workstations, local storage devices, and redundant backup systems for two research groups at the NASA GSFC facility, and he resolved software and hardware issues in an expedient manner. He kept all equipment operational with no serious stoppage or down time, and all equipment were maintained to meet strict NASA guidelines to keep them secure and operational. New storage equipment was installed, which increased the amount of disk space available to all his supported members by more than a factor of four.

Mr. Kucsera, in preparation for his retirement, transferred and trained colleagues in his aerosol research group on the algorithms and products that they would need to continue to use to provide ongoing service to his research projects.
Note, Mr. Kucsera retired as of Dec 31, 2022.

Name: Zhining Tao
Sponsor: Mian Chin
Code: 614
Task: 087

Dr. Tao continues to work on multiple projects where he serves as PI or co-I. Specifically, he led the effort to complete the update of the aerosol scheme in NU-WRF. He oversees the work of the coupling of aerosols with cloud/radiation schemes and the development of burnt LULC based on satellite observations to better understand the impact of wildfires. He used observations and modeling to explore the impact of urbanization on local to regional precipitation – its onset and intensity. In addition, Dr. Tao contributed to the development and submission of several research proposals including one selected for funding.

In the next three months, Dr. Tao will focus on designing and carrying out NU-WRF simulations related to wildfires and air pollution tied to two funded projects. He will also assist in the modeling experiment on cloud and precipitation in urban areas.

Name: Dongchul Kim
Sponsor: Mian Chin
Code: 614
Task: 088

Dr. Kim's research is on aerosol modeling using GEOS/GOCART and NU-WRF. His main focus is to improve the understanding of the global and regional dust processes and distribution. He has been contributing to a NASA/MAP project (PI: Chin) in the area of NU-WRF model development. Dr. Kim is conducting a long-term dust simulation with multiple tagged sources for the GAC project, which aims to improve the estimate of lidar ratio for CALIOP (PI: Schuster).

From Sept – Nov 2023, Dr. Kim will continue working on the current tasks that include AeroCom/DUSA and GAC experiments. Preliminary results from the AeroCom/DUSA experiment will be presented at the (1) AeroCom meeting (Oct 16-20, 2023), Richland, WA and (2) AGU Fall meeting (Dec 11-15, 2023), San Francisco, CA. The research is also reported in manuscripts that are currently under preparation for journal publications. He will continue other research activities that are expected to offer new insights about Alaskan dust, dust mineralogy, and dust settling velocity.

Name: Alexander Kotsakis

Sponsor: Glenn Wolfe
Code: 614
Task: 095

Dr. Kotsakis worked on developing an artificial intelligence deep learning model that utilizes passive (microwave, infrared) and active (LIDAR) satellite measurements to determine the planetary boundary layer height. This model development also serves the purpose of aiding in the development of a NASA Instrument Incubator Program funded hyperspectral microwave instrument, HyMPI. This instrument has shown the capability of significantly advancing currently available technology and retrievals, allowing for higher resolution temperature and water vapor sounding. A prototype of this instrument is being flown on the NASA ER-2 next year through the funding received in his selected NOAA BAA proposal. Dr. Kotsakis has been active in the early preparation stages of the field campaign planning. In addition to model development and field campaign preparation, multiple manuscripts have been in development and are anticipated to be submitted later this year.
Note, this task ended 03/31/23; a follow-on task was created under task #180, code 613.

Name: Amir Souri
Sponsor: Bryan Duncan
Code: 614
Task: 111

Dr. Souri has actively contributed to the development of ECCOH (Efficient CH4–CO–OH), an efficient chemistry module tool utilized for parameterizing OH concentration, which holds significant implications for methane modeling. He strongly advocated for the creation of an open-source object-oriented Python package, capable of automatically retrieving and processing satellite observations. This software package has played a pivotal role in enhancing the capabilities of NASA's GEOS-quickchem model by effectively minimizing discrepancies between model simulations and satellite observations. Comprehensive testing has demonstrated its efficacy in mitigating substantial biases in OH that stem from the misrepresentation of NO2 and HCHO. Dr. Souri has designed a series of compelling experiments utilizing the model, constrained by satellite observations, to assess the added valuable information derived from the satellite data in improving OH representation. Furthermore, numerous experiments have been devised with the aim of understanding the driving factors behind OH variability and trends. Furthermore, Dr. Souri made notable contributions to the forthcoming TEMPO, the pioneering geostationary satellite designed to monitor air pollution in North America. Leveraging high-resolution chemical transport model simulations and radiative transfer calculations, he conducted a comprehensive study that revealed the substantial errors in satellite retrievals arising from the misrepresentation of the vertical profile of HCHO during sea/land breezes in coastal regions.

From Sept – Nov 2023, Dr. Souri will continue running the ECCOH-related experiments to unravel the convoluted relationship between various OH drivers and methane lifetime.

With two proposals funded by NASA ACMAP, Dr. Souri will be responsible for coordinating different subtasks, managing the data preparation and archive, ensuring that the state-of-the-art developments and analyses are considered in his project. He will set up, tailor, validate NASA’s box model constrained by numerous aircraft measurements. He will devise an empirical framework to determine the ozone production rates using the information derived from the two metrics

proposed in this proposal. He will validate the ozone production rate estimators from the empirical method as well as the machine-learning one against independent observations.

Name: Huisheng Bian
Sponsor: Mian Chin
Code: 614
Task: 127

Dr. Bian has been working on the study of atmospheric aerosols and their impact on air quality and climate. She led a study of the sulfur cycle in the marine atmosphere using NASA ATom measurements and AeroCom model simulations. ATom was a suborbital campaign focused on remote ocean regions around the globe, collecting in situ remote sensing observations of aerosol mass and extinction. She also conducted a series of GEOS experiments to support studies of utilizing satellite AOD data for surface air quality, reducing ship emissions on aerosol direct and indirect radiative, and interpolating aircraft ACCLIP measurements to understand the influence of the Asian monsoon on the UT/LS aerosol species that originated from pollution and biomass burning in Asia. Other work she was involved in include understanding pollution changes during the COVID-19 pandemic from the perspective of emission reduction and meteorological changes, and applying ORACLES aircraft measurements to study biomass burning aerosols in fire sources and outflow regions in Southern Africa.

From Sept. 1 to Nov. 30, 2023, Dr. Bian will wrap up the ATom-Aerocom sulfur cycle study and submit a first author manuscript for publication. She will give an invited overview talk at the AeroCom/AeroSat meeting on evaluating and improving model aerosol simulations using ORACLES measurements.

Name: Larrabee Strow
Sponsor: James Gleason
Code: 614
Task: 136

Dr. Strow's team, which includes Howard Motteler, Christopher Hepplewhite, and Steven Buckowski (all of UMBC), supported the commissioning of the CrIS sounder on NOAA-21 (JPSS-2) this year. They successfully performed the spectral calibration updates for operational and research products and showed that the performance of the NOAA-21 CrIS sensor is similar to CrIS on SNPP and NOAA-20. Absolute calibration differences between these sensors are being evaluated now.

Additionally, they have been supporting work by NASA to define a new high-spectral resolution infrared sounding sensor for geosynchronous orbit.

The team's climate-quality radiance product (the Climate Hyperspectral Infrared Radiance Product, or CHIRP) is now being produced by GES-DISC and is migrated operationally to AWS Cloud storage in netcdf format in granule format. This product converts both AIRS and CrIS radiances to a common spectral response and radiometric calibration; however, this form of the L1b radiance data is unsuited for time-series studies of the earth's outgoing infrared radiation for climate applications. The team was recently awarded a NASA ADVANCE program grant of 100 TB of storage on the Amazon AWS Open Registry site, which, unlike NASA data from EOSDIS, does not require hourly authentication, allowing serious analysis studies (such as batch processing). Working

with the NASA Sounder SIPS at NASA JPL, they have developed the algorithm to produce CHIRP in time-series format (called Tiles) that holds 16-days' worth of data for 3x5 latitude/longitude grid points in zarr format, which is compatible for direct reading from AWS S3 buckets. These are technical issues, but they are absolutely key to providing the climate community with the ability to do real climate analysis with these data in-place. They will be providing open-source codes to help the outside community to use data in this format.

Looking ahead, thermal vacuum ground testing of the last CrIS sensor (for launch on JPSS_4) is scheduled for September 2023. Dr. Strow's group will perform the spectral calibration using data from these tests in order to properly locate the Michaelson interferometers focal plane positions for the three bands and in order to calibrate the sensor's Neon lamp that provides absolute spectral calibration.

Name: Reem Hannun
Sponsor: Glenn Wolfe
Code: 614
Task: 137

For this task, Dr. Hannun is currently working on quantifying trace exchange between the atmosphere and biosphere. She has participated in the NASA BLUEFLUX field project collecting aircraft measurements of carbon dioxide (CO2) and methane (CH4) over mangrove ecosystems in the Florida Everglades to assess the relative strength of CO2 sequestration and CH4 emissions. In collaboration with the USDA, she is also deploying an ozone (O3) sensor to measure O3 deposition to soybean and maize crops. Dr. Hannun is working to understand the vegetation sink of O3, an important loss pathway in the tropospheric O3 budget, as well as the impacts of O3 pollution on crop productivity by identifying how much O3 the plant stomata (tiny pores through which plants breathe) absorb.

Finally, Dr. Hannun has been mentoring a student using field data from the NASA Carbon Airborne Flux Experiment (CARAFE) and remote sensing vegetation imagery to build a machine learning model that can predict forest carbon exchange for the State of Maryland. These projects are all ongoing.

Dr. Hannun expects to continue analyses on the above projects and her student will submit a manuscript on the CARAFE project within the next few months.

Name: Anne Thompson
Sponsor: John Sullivan
Code: 614
Task: 138

Dr. Thompson's task covers three areas: (1) development and promulgation of ozonesonde Standard Operating Procedures (SOP); (2) collection and analysis of trace gas data from sondes, aircraft and satellites, including calculation of trends; (3) analysis of in-situ and remotely sensed pollution constituents and related validation pertaining to emissions from offshore oil and natural gas (ONG) operations. In area 1, Dr. Thompson gave six papers and presentations at international meetings and submitted one journal article. Dr. Thompson also launched ozonesondes in the inaugural SARP-East NASA field demonstration-deployment at the Rice Rivers Center in Charles City, Virginia, in June 2023 as well as participated in instrument testing with the Code 614 and

Wallops ozonesonde teams at Wallops in July 2023. In area 2, she published 4 journal articles, one of which refuted an erroneous report of a so-called "tropical ozone hole" that received great attention. She gave two invited seminars in Europe on trace gas analysis. In area 3, on ONG pollution, Dr. Thompson's *ESS* article showed that NO2 pollution from offshore activity has a lower pollution impact than urban and industrial emissions along the Louisiana coast. Furthermore, the Pandora spectrometer was used to evaluate satellite NO2 over the Gulf of Mexico from OMI and TROPOMI; the satellites mostly under-detected NO2. The *ESS* paper was selected as an AGU Editors' Highlight. Follow-on work from the *ESS* paper, examining satellite NO2 time-series over the Gulf, showed relatively modest trends from 2005 to 2022 but clear signatures of the largest oil platform emitters; a new article based on that work was submitted to *ESS* in July 2023.

For the Sept – Nov 2023 period, there are four anticipated activities. First, she plans to complete two tropical trends articles, both with comparisons to Dr. Thompson's 2021 SHADOZ trends article (*JGR).* The second article will be based on SHADOZ and related satellite data over Southeast Asia that show changes in convection, not only pollution, have led to a seasonal increase (Feb.-April) in tropospheric ozone over the past 25 years. Second, Dr. Thompson will present on tropical ozone trends at the 12-13 Sept. SAGE III/ISS Science Team meeting in Atlanta. On 14 Sept. she will give an invited Georgia Tech Seminar on "Satellite & In-situ Pollution Measurements over the Gulf of Mexico during the 2019 SCOAPE Cruise." Third, she expects to co-propose with Georgia Tech for the ROSES call for a new SAGE III Science Team. And, fourth, from 6-22 November, Dr. Thompson will join Dr. Ryan Stauffer on a Technical Site Visit to the SHADOZ Ascension Island station.

Name: Nigel Richards
Sponsor: Natalya Kramarova
Code: 614
Task: 143

Since joining GESTAR II in February 2023, Dr. Richards has been working on the validation of OMPS LP ozone profile measurements processed with the new NASA GSFC version 2.6 retrieval algorithm. The OMPS Limb Profiler (OMPS LP) satellite instrument, launched in October 2011, performs limb measurements of scattered solar radiation in the ultraviolet and visible wavelengths, which allow for the retrieval of ozone profiles from the top of clouds up to 55km. Previous versions of OMPS LP retrievals were evaluated using MLS observations; however, since MLS is due to be decommissioned in the near future, other sources of observations are needed to validate future stratospheric ozone profile retrievals. Therefore, in this work, Dr. Richards has focused on utilizing ozone retrievals from two solar occultation satellite instruments, SAGE III/ISS and ACE-FTS for this validation. OMPS LP started operational observations in April 2012, whereas ACE-FTS observations started in February 2004; therefore, there are currently 12 years of data overlap to exploit for validation. SAGE III/ISS observations started in June 2017, which provides 7 years of data overlap with OMPS LP. This work is ongoing.

Looking ahead, Dr. Richards will continue his work on OMPS LP validation using SAGE III/ISS and ACE-FTS, and this work will be expanded to include ozonesonde and ground-based lidar data. Dr. Richards will present this work at the 2023 SCISAT 20th anniversary meeting, to be held in October at the Canadian Space Agency in Montreal.

Name: Diego Loyola
Sponsor: Omar Torres
Code: 614
Task: 145

Dr. Loyola has been providing advice on the adaptation of the NASA aerosol retrieval algorithm (TROPOMAER) to the TROPOMI instrument, including recommendations on the usage of TROPOMI L1 products, in particular the measurements of the oxygen B-band used for the retrieval of the aerosol layer height.

Among other activities, for September – November 2023, Dr. Loyola expects to participate in the regular aerosol group meetings.

Name: Nader Abuhassan
Sponsor: Thomas Hanisco
Code: 614
Task: 146

Dr. Abuhassan significantly contributed to various operational aspects of NASA's Pandonia Global Network (PGN), including repairs, upgrades, quality assurances, and remote monitoring of the instruments in the field. Throughout this period, Dr. Abuhassan actively participated in all the PGN operations and progress meetings with NASA/HQ and ESA leadership. Dr. Abuhassan also made considerable efforts in training new technical staff and young scientists joining the Network. Dr. Abuhassan provided valuable support in the deployment of new instruments both nationally and internationally. One of the most significant achievements during this reporting period was Dr. Abuhassan's direct involvement in the worldwide deployment of new instruments. More than 27 new instruments were deployed globally. These instruments were strategically placed to support multiple NASA field campaigns in the USA or key locations within the satellite validation field for TEMPO, OMI, and GEMS.

Image: PGN has more than 160 operational sites worldwide, contributing to the advancements of the atmospheric sciences. (Provided by N. Abuhassan.)

Among other activities in the coming months, Dr. Abuhassan will continue to support the Network and remotely monitor the instruments. He also will support the next Pandonia International User Group Workshop to be held in October 2023

Name: Jason St. Clair
Sponsor: Thomas Hanisco
Code: 614
Task: 147

Dr. St. Clair worked on several field campaigns during the reporting period. He led the preparation of the GSFC CAFE (formaldehyde), CANOE (NO2), and ROZE (O3) instruments for the NSF-funded GOTHAAM study of the NY City metro area. Unfortunately, issues with the aircraft and pilots resulted in postponing the project to 2025. He led the effort to measure formaldehyde as part of the in situ payload for NASA's SARP-East project, which successfully flew 26 students over the Newport News/James River, Virginia region and obtained ~20 spiral profiles over Pandora instruments for the intercomparison of formaldehyde and NO_2 data. He also supported the installation and deployment of the GSFC ISAF (formaldehyde) instrument aboard the NASA DC-8 aircraft for the NOAA AEROMMA field campaign, which is studying urban air quality at multiple large North American cities, with flights out of Palmdale, CA and Dayton, OH.

In the laboratory, Dr. St. Clair has provided oversight to an engineer and a technician as they design and build new instruments, including a duplicate ROZE O3 instrument, a duplicate CANOE (NO2) instrument, and a next-generation ISAF (formaldehyde) instrument. The ROZE instrument is completed, ordering parts for the CANOE instrument has begun, and the new ISAF instrument is in the final stages of design. Dr. St. Clair personally designed and fabricated new electronic boards for the new ISAF and for coordinated control of the three instruments on the GOTHAAM payload.

During the Sept - Nov period, Dr. St. Clair will continue his analysis comparing in situ formaldehyde data with Pandora data from the NASA SARP-East campaign, with the goal of evaluating the data quality of the Pandora profiling data products. The chassis of the duplicate CANOE NO2 instrument should be assembled by the Code 614 lab technician, with Dr. St. Clair's oversight. The laser for the new ISAF will be transferred to the in situ lab from Code 554 and set up for operation. Lastly, Dr. St. Clair will submit a proposal to NOAA's AC4 call, proposing to make measurements during an upcoming NOAA field campaign.

Name: Joseph Robinson
Sponsor: Thomas Hanisco
Code: 614
Task: 148

Mr. Robinson has continued to engage with Pandora users and groups from around the world for the purpose of adding their instruments to the Pandonia Global Network (PGN). These efforts include coordinating, completing, and reviewing PGN site information forms as well as registering stations within the PGN framework. In addition, Mr. Robinson has worked with team members from LuftBlick (Austria) to communicate data processing, availability, and publishing timelines with PGN end users. Beyond this, Mr. Robinson has also been responsible for producing and communicating global PGN distribution images and databases, as needed by end users. For example, in July 2023 Mr. Robinson worked with end users from the US EPA to produce a database of official PGN instruments that fall within the field of view of the recently launched

NASA Tropospheric Emissions: Monitoring of Pollution (TEMPO) satellite.

Since the beginning of September 2022, Mr. Robinson's efforts have resulted in the addition of 32 new Pandora instruments to the PGN. As of mid-August 2023, there are 166 total instrument members in the PGN globally; Mr. Robinson has been responsible for coordinating membership for all of these. As part of his role in communicating data availability, Mr. Robinson also provided resources and answered questions for end users in Edwards, California as they planned observing efforts for the summer 2023 Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) campaign.

In October 2023, Mr. Robinson will attend the PGN User group meeting being held at Howard University. During this meeting, Mr. Robinson will discuss how PGN data are being used as well as PGN application and data distribution processes with end users. This will allow for refinements to the PGN application process that address end user ideas and concerns. Over the September – November 2023 period, Mr. Robinson expects to facilitate addition of 5-10 Pandora instruments to the PGN, consistent with his efforts in previous years.

Name: Jay Herman
Sponsor: Adam Szabo
Code: 614
Task: 155

Dr. Herman serves as the EPIC instrument scientist for the DSCOVR satellite mission orbiting the Earth's Lagrange-1 point. He recently wrote significant parts of the DSCOVR NASA Senior Review and the follow-on response to NASA-HQ questions. As part of his DSCOVR duties, Dr. Herman makes mission decisions related to science and instrument in-flight calibration. He analyzes satellite data from several missions and specializes in estimating long-term changes in ozone and cloud cover and their response to climate change. At present, Dr. Herman has three publications under review; two are first author articles with AMT and the other is a co-authored article with ACP.

Starting in September 2023, Dr. Herman will continue his role as EPIC instrument scientist and will extend the cloud cover reflectivity study back to 1979 by joining data from several satellites.

Name: Keith Evans
Sponsor: Nickolay Krotkov
Code: 614
Task: 159

Mr. Evans worked on developing ways to use machine learning for data analysis, creating weekly reports and maps of (mostly) volcanic SO_2 outgassing from OMI, OMPS and TROPOMI data as needed (ESDSWG) and comparing those maps for validation. Trying to answer the question of how natural and anthropogenic sources of trace gases (SO_2 and NO_2) impact the local people and their environment.

The website http://so2.gsfc.nasa.gov/ currently includes generation of daily OMI and OMPS SO_2 images for volcanic regions and daily images NO_2 in 317 cities around the world. Automatic data/image upload is no longer possible due to security concerns; rather, this has to be done manually every day now using the RSA Tokens. Mr. Evans also updated the web site to display

weekly SO_2 outflows and/or eruptions.

During September 1, 2023 to November 30, 2023, he will analyze NO_2 data of selected cities from around the world by comparing the last 4 years of data. He will also prepare an AGU presentation and continue the maintenance of the SO_2 and NO_2 web sites.

Name: Caterina Mogno
Sponsor: Peter Colarco
Code: 614
Task: 172

Since joining GESTAR II in May 2023, Dr. Mogno has been working to evaluate the aerosols component of the GEOS chemistry climate model (CCM), benchmarking decadal hindcast simulation with in-situ observations of particulate matter concentrations and optical properties. She also used the GEOSCCM to analyze global and regional distribution and long-term trends of surface particulate matter and of aerosols. This evaluation is ongoing. Dr. Mogno submitted two abstracts as a first author to present her work and results to international conferences this fall at AeroCom (https://aerocom.mpimet.mpg.de/program) and at the 2023 AGU Fall Meeting.

Dr. Mogno will continue to work on the GEOSCCM aerosols evaluation, extending the benchmark to additional in-situ observations and satellite aerosols observations. She will present her work at the Aerocom Workshop (October 2023).

Name: Apoorva Pandey
Sponsor: Thomas Hanisco
Code: 614
Task: 177

Since joining GESTAR II in May 2023, Dr. Pandey has been supporting calibration and instrument improvement efforts for the Pandora instrument, which provides ground-based retrievals of ozone, nitrogen dioxide and formaldehyde. She also conducts data quality checks and performance validation for field instruments that are part of the Pandonia Global Network. She characterizes the radiometric and spectral performance of Pandora instruments through laboratory measurements and subsequently monitors the instruments at the Goddard rooftop testing stations before they are deployed to their final locations. She has also been involved in field calibration and dataset preparation for deployed instruments, with a focus on validating Pandora data products against in-situ and ground-based instruments.

Dr. Pandey will continue to work on operational calibration and data analysis tasks. She is planning experiments for identifying sources of optical noise in the Pandora spectrometers, with the goal of modifying instrument design for improved optical performance. She then plans on characterizing the influence of instrument optical characteristics on retrieval accuracy for the various data products. She will also use data from validation campaigns to assess the quality of the newer generation of Pandora retrievals: formaldehyde and nitrogen dioxide vertical profiles.

Name: Doyeon Ahn
Sponsor: Bryan Duncan
Code: 614
Task: 179

Dr. Ahn started working with GESTAR II on August 9, 2023. His first research project focuses on investigating the role of Hydroxyl radical (OH) on estimating atmospheric Carbon monoxide (CO) and Methane (CH_4). Early on, Dr. Ahn conducted literature reviews on the topic of CH4-CO-OH cycle in the Earth's Atmosphere. Also, Dr. Ahn has been collaborating with Dr. Anderson and Dr. Liu on the topic of estimating power plants' CO_2 emissions using satellite data. He investigated the U.S. power plants and selected three specific facilities that could potentially be used for the case study of this project.

From September to November 2023, Dr. Ahn will learn how to use the computationally Efficient CH_4-CO-OH (ECCOH) chemistry module, which is an essential component to conduct the methane research project. He will reproduce the model output of CH4-CO-OH cycle presented in Elshorbany et al. (2016). Also, Dr. Ahn will continue collaborating with Dr. Liu on the power plant CO_2 project. He will estimate power facility-specific NOx-to-CO2 emission ratios using the TROPOMI and OCO-3 satellite observations. The estimated results will be compared to estimates from EPA's stack monitoring system.

CODE 615: CRYOSPHERIC SCIENCES LABORATORY

Name: Paolo de Matthaeis
Sponsor: David de Le Vine
Code: 615
Task: 016

Dr. de Matthaeis' work falls in the framework of estimating sea surface salinity from space, for study of large-scale ocean processes and climate change, using measurements from the SMAP radiometer and the Aquarius instruments. Activities focus on minimizing the various errors in the brightness temperature measurements acquired over the ocean to perform a reliable retrieval of sea surface salinity. In particular, during the period from September 1, 2022, to August 31, 2023, Dr. de Matthaeis has contributed to a study on the use of the Fourth Stokes Parameter for geolocation of SMAP data published in a journal. He also part of the RFI (Radio Frequency Interference) SMAP team, and regularly presents his work in its bi-weekly online meetings. Among the aspects that he has been focusing on is the analysis of observed interference and reporting to the competent authorities so the sources can be identified and removed. His work was included in the RFI SMAP team presentation given at the SMAP 17th Science Team meeting on February 15-17, 2023, and was the basis for two conference papers (IGARSS 2023 and URSI GASS 2023) and a journal article for the IEEE Transactions on Geoscience and Remote Sensing currently under review.

Dr. de Matthaeis will keep working on issues related to the calibration and validation of the SSS retrievals using SMAP data, with particular focus on the problem of RFI. He also is participating in planning the MicroRad 2024 Symposium, IGARSS 2024 and the RFI Workshop 2024.

Name: Denis Felikson
Sponsor: Brooke Medley
Code: 615
Task: 077

Dr. Felikson has been helping to lead the Earth Information System (EIS) project as Deputy Project Scientist, working on developing new projections of the Greenland Ice Sheet, and serving as data product lead for the ICESat-2 Land Ice Height Level-3 product (ATL06). Dr. Felikson has also been serving as co-lead for the Sea-Level Change and Coastal Risk thematic area for the EIS project. His focus has been on leading the implementation of numerical process-based models on the cloud, overseeing the development of open-source datasets and analysis tools, and designing best practices for open-source science on the project. As part of research being done with NASA's Sea-Level Change Team, Dr. Felikson developed a novel ensemble of model projections for the Greenland Ice Sheet and is investigating how to use different types of satellite observations to calibrate the projections.

In the upcoming months, Dr. Felikson will continue leading the Earth Information System project, helping to on-ramp a new task dedicated to investigating the impacts of El Niño on the interconnected Earth System, including impacts on Fire, Agriculture, Freshwater, and Sea-Level Change. He also will continue working with the NASA Sea-Level Change Team, advancing his work on calibration of sea-level projections from ice sheet numerical model ensembles by quantifying the spread in sea-level projections that arises due to uncertainties in model parameters, physics, and modeling choices.
Note, Dr. Felikson became a Civil Servant in mid-September 2023.

CODE 616: OCEAN ECOLOGY LABORATORY

Name: Susanne Craig
Sponsor: Jeremy Werdell
Code: 616
Task: 004

Dr. Craig is the science lead for PACE (Plankton, Aerosol, Cloud, and ocean Ecosystem) system vicarious calibration (SVC) activities. This year, these activities have included a demonstration of capabilities exercise dubbed a 'Day in the Life' (DITL). This involved generating match ups in space and time between simulated PACE data (PyTOAST – Python Top of Atmosphere Simulation Tool) and an SVC *in situ* data set based on data from the legacy SVC platform, MOBY (Marine Optical Buoy). Processing of the data was performed to calculate water leaving radiance for 365 simulated days. These were then pushed to the Ocean Data Processing System (ODPS), which calculated system vicarious gain factors. This demonstrated that SVC can be achieved for the hyperspectral measurements that PACE will make.

In addition to the DITL SVC activities, Dr. Craig has been developing processing pipelines for two new SVC platforms that are funded as part of the PACE mission. These activities involve close collaboration with the two science teams that have built and deployed these new systems. She has worked with the SVC teams and GESTAR II data scientist, Dr. Ian Carroll, to ensure that data files meet the community Climate and Forecast (CF) standards. Dr. Craig is working closely with PACE software developers to build entirely new processing systems that will ingest SVC data central to ensuring that PACE's Ocean Color Instrument OCI retains its calibration on orbit.

During the last two years, Dr. Craig has been working on establishing a radiometric calibration facility within the Ocean Ecology Laboratory. She has worked with subject matter experts on designing this and has completed procurement of the core optical and electronic components required. This summer, she met with visiting scientist and world leading expert, Dr. Giuseppe Zibordi, to develop a scope of work that will facilitate collaboration with him over the coming months to realize the calibration laboratory build out. This facility will be central to the OEL's capability to calibrate its radiometric instruments and ensure that it remains a leader in the field.

Dr. Craig has continued working on the development of autonomous measurement systems. Pre-pandemic, she led a NASA IRAD with Lab Chief, Dr. Carlos Del Castillo (CSs must submit the proposal), to build an autonomously positionable, ocean-viewing, hyperspectral polarimeter in collaboration with a Naval Research Laboratory colleague. This system was dubbed RoboHypo (Robotic Hyperspectral Polarimeter for the Ocean). The pandemic severely impeded completion of this project and an extension was granted. The instrument is nearing completion and will be deployed in the late summer/early fall on the research pier at Horn Point Laboratory, University of Maryland Center for Environmental Science. This is part of a new collaboration with Horn Point scientist, Dr. Greg Silsbe, that will yield simultaneous measurements of polarized ocean color and phytoplankton community composition (PCC). In addition to acting as a demonstration deployment of RoboHypo, the resulting dataset will be used in Dr. Craig's NASA funded project to use machine learning to predict PCC from ocean color. Additionally, Dr. Craig was awarded an IRAD during GESTAR/USRA to build an uncrewed aerial vehicle (drone) that makes simultaneous measurements of ocean color and atmospheric chemistry in order to investigate the role of phytoplankton in the formation of secondary organic aerosols and cloud condensation nuclei. She has been investigating further development of this platform via various mechanisms as detailed

below.

As part of Dr. Craig's long-term plans to answer pressing Earth System Science questions, she responded to an Earth Science Division Strategic Science call for proposals issued by Code 610 leadership. Per the regulations, these must be submitted by a civil servant and Dr. Del Castillo once again fulfilled this role. Two proposals were submitted: one to miniaturize RoboHypo with a view to deploy on global observation platforms such as Bio-GO-SHIP (https://biogoship.org), and a second to further develop the UAV concept detailed above. Both proposals are directly responsive to priority Decadal Survey Science Questions.

During September 1, 2023, to November 30, 2023, it is anticipated that PACE SVC activities will take up much of Dr. Craig's time as the countdown to launch readiness date fast approaches. It is hoped that the RoboHypo instrument will be ready for its test deployment at Horn Point Laboratory in early fall. In November, she will attend the International Ocean Colour Science Meeting https://iocs.ioccg.org), which is a space agency-centric conference and an important opportunity to promote the PACE mission internationally. Calibration lab build out, in collaboration with Dr. Giuseppe Zibordi, will commence shortly afterwards.

Name: Violeta Sanjuan Calzado
Sponsor: Bryan Franz
Code: 616
Task: 005

Dr. Sanjuan Calzado has been working on the NASA bio-Optical Marine Algorithm Dataset (NOMAD) database structure and organization. The new database is a relational database to accommodate the large amount of hyperspectral data. Data requirements and specifications have also been established. Metadata and file formatting compatible with the SeaWiFS Bio-optical Archive and Storage System (SeaBASS) database has also been established. Wavelength definition was set up considering data availability in SeaBASS and the historical requirements of NOMAD and previous ocean color missions as well as meeting new data requirements supporting the PACE mission.

During this year, all available AOP data in SeaBASS from 2015 going forward was processed to generate NOMAD stations. Additionally, CDOM data from specific cruises and backscattering data were also processed. Currently, data streams for POC and pigment data are being incorporated with other validation leads and scripts have been developed to generate product specific .env files.

Together with the validation leads, Dr. Sanjuan Calzado also established the data requirements for all validation products as well as file formatting and specifications and metadata, including flagging system for quick data classification and labeling. Uncertainty reporting for each validation product was also established and documented as well as uncertainty metrics for each product following uncertainty requirements for PACE validation. Data interpolation scheme was also set up both for multispectral and hyperspectral data.

Visual Seabass is an AOP processing software for in situ radiometry to generale water leaving radiances for validation activities of ocean color missions, including PACE. This past year, Dr. Sanjuan Calzado engaged in continued software development and debugging of VSB3. During this time a new module in the software was developed to perform multiple data processing functions from similar acquisitions in time and space, increasing data density and therefore providing more

robust statistics for calculation of derived parameters. The software was also optimized for different types of file formats and data loading for large hyperspectral datasets. Software graphics were also debugged and improved to accommodate the different types of data streams. Software is currently under new development to process AOP data from other platforms such as Hypernav, an autonomous platform for collection of validation data. Note, Visual Seabass is also in the process of an NTR invention for public software release.

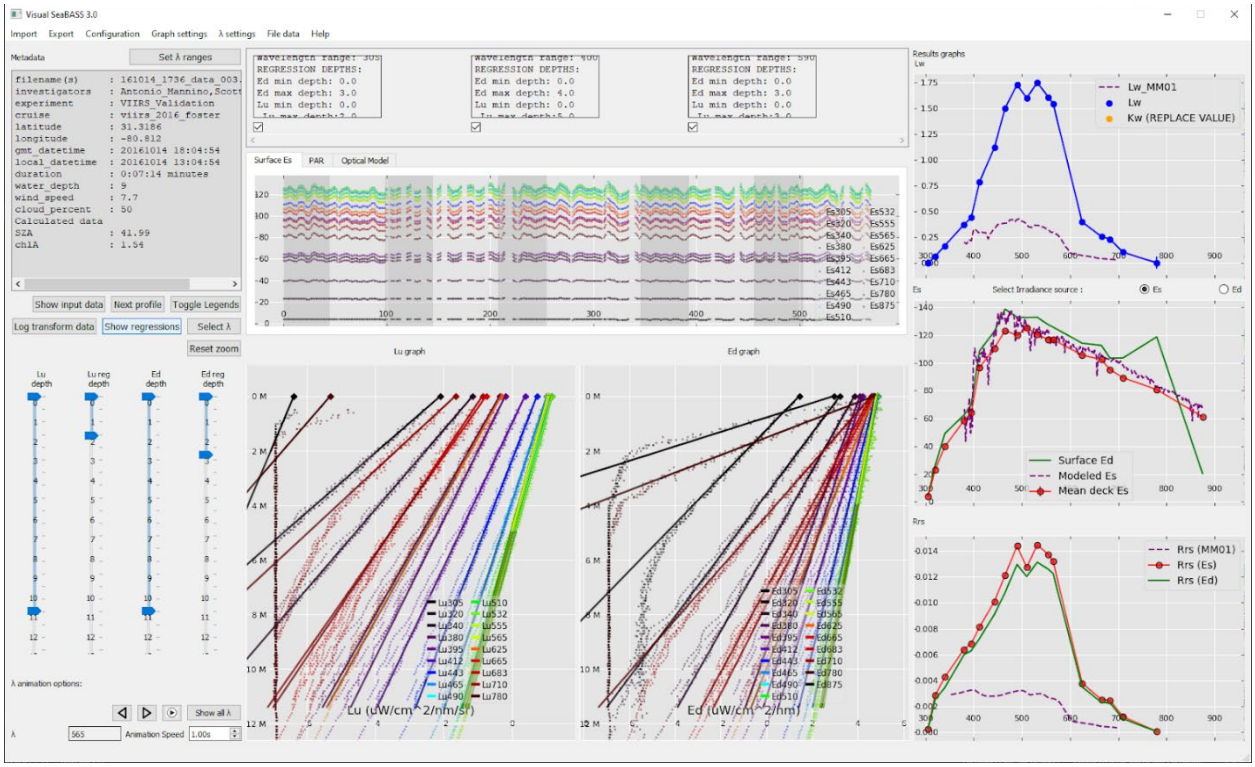


Fig 1. Visual SeaBASS 3 AOP processing software. (Provided by V. Sanjuan Calzado.)

For the upcoming year Dr. Sanjuan Calzado will continue processing data for NOMAD and generating NOMAD stations as she receives validation data from other validation leads. New data streams for other validation products will be added as data becomes available. She is also part of the organizing committee of Ocean Optics 2024 meeting and will perform various activities as required for the meeting. Additionally, she will give an invited talk titled "Visual Seabass 3, a radiometric data processing software" at the 8th Sentinel 3 Validation Team meeting Eumetsat in Darmstadt, 5-7 December 2023. She will also give a presentation of the NOMAD database, at the International Ocean color Science Meeting, St Petersburg, Florida, in November 2023.

Name: Dirk Aurin
Sponsor: Antonio Mannino
Code: 616
Task: 009

Dr. Aurin has continued to provide support to the PACE mission through the development and advancement of the open source HyperInSPACE community processor (HyperCP; https://github.com/nasa/HyperCP) for the processing and submission of validation-quality in situ hyperspectral radiometry. As lead scientist on this effort, he formalized a collaboration with the European FRM4SOC-2 consortium, including the Copernicus Programme, EUMETSAT, National

Physical Laboratory (UK), ACRI-ST, University of Tartu, and others, as well as outside academic and commercial collaborators including University of Victoria, University of Maine, and Gybe Inc. Through these collaborative efforts, HyperCP has been advanced in v1.2.0 (August 2023) to incorporate new radiometric instrument platforms and sampling strategies as well as adding fiducial reference measurement (FRM) compliant, end-to-end uncertainty analysis including radiometric characterizations as detailed in the International Ocean Colour Coordinating Group (IOCCG) Protocols (2019). HyperCP was selected by the FRM4SOC-2 consortium for the FRM4SOC Intercomparison Experiment (FICE-22) in July 2022 (with Dr. Aurin's participation) to improve the quality and protocol compliance of in situ radiometry for satellite sensor validation of ocean color products, such as the hyperspectral water-leaving reflectance. Data analysis and manuscript preparation (with Dr. Aurin as co-author) associated with that experiment were ongoing throughout FY23. The HyperCP project will also support validation for European missions, including Sentinel-3, and upcoming NASA missions including GLIMR and SBG. In addition to advancing the capabilities of HyperCP, Dr. Aurin supports end-users in the ocean color community directly by providing technical support for the software.

Dr. Aurin has provided guidance and support to PACE validation-related science teams within Ocean Ecology Laboratory, including SeaBASS and the nascent PACE Validation Science Team by contributing community guidelines for the submission of above-water radiometry, as well as participating in a team of experts who will screen incoming data submissions for validation-quality data. He also participated in August 2023 as a panelist in the review of proposals for the NASA ROSES A.30 PACE Validation call.

In addition, Dr. Aurin frequently supported the Field Support Group within OEL with the acquisition and processing of in-water and above-water radiometry during various field campaigns during FY23 including multiple Arctic campaigns in Alaska, and the 2023 Atlantic Meriodonal Transect (AMT) cruise.

As the manager (or PI) of the Chesapeake Bay node of the AERONET-OC network, Dr. Aurin monitors the in situ radiometry telemetered from the SeaPRISM instrument located on a tower in the Bay and leads multiple boat trips to the tower each year (two so far in FY23 with another expected very soon) in coordination with NOAA, Maryland Department of the Environment (MDE), the US Coast Guard, and colleagues in codes 610 and 618 to maintain and service the instrumentation. This effort includes staying current in training related to tower climbing and maintaining up-to-date hazard analysis and avoidance strategies. In FY23, this role also led to Dr. Aurin participating in the initiative by NASA colleagues and the Royal Belgium Institute for Natural Sciences to install a hyperspectral PANTHYR radiometer on the tower in association with the WATERHYPERNET network (a network of hyperspectral radiometers for multi-satellite water reflectance validation). He advised project leads on the power systems and design logistics, tested systems in the lab prior to deployment, and led the field work on the Bay to install the PANTHYR system.

During 2023, Dr. Aurin was invited to participate in the Geosynchronous Littoral Imaging and Monitoring Radiometer (GLIMR) mission Science Team under the direction of his NASA sponsor and GLIMR Deputy PI Antonio Mannino. He participated in weekly GLIMR Science Team meetings as well as the GLIMR Critical Design Review in June, and the follow-up to address requests for action from the science review board.

Between September 1, 2023 and November 30, 2023, Dr. Aurin's role in the GLIMR Science Team

will grow significantly as he takes on the responsibility for running radiative transfer models designed by OEL's Ocean Biology Processing Group (OBPG) to deliver, e.g., radiometric uncertainties for GLIMR primary data products including water-leaving reflectance. His role will also include providing GLIMR targeting and scheduling support to help optimize ocean color imagery acquisition and vicarious calibration efforts.

During this timeframe, Dr. Aurin will finalize the public release of HyperCP v1.2.0 and host a half-day tutorial session on the software at the International Ocean Colour Science Meeting in San Franciso, where he will also present the project. He will begin reprocessing historic NASA FSG field radiometry using v1.2.0 for SeaBASS revised submission and incorporate those data in the analysis contained in a lead-author manuscript under preparation.

Dr. Aurin will lead a trip during this period to the AERONET-OC node in the Chesapeake Bay to swap out the SeaPRISM radiometer for calibration.

Name: John Blake Clark
Sponsor: Antonio Mannino
Code: 616
Task: 010

Dr. Clark has led the modeling efforts on two projects focused on the coastal Arctic Ocean in Alaska. His main work has been to finish the initial development and application of the Coastal Beaufort Sea Finite Volume Community Ocean Model (CBS-FVCOM) that is now running on an interannual basis spanning 2018-2022. The main research accomplishment has been to implement, test, and validate a new landfast ice and sea ice modeling component that is crucial for representing physical oceanographic processes in the coastal Arctic. The model is now running in an iterative fashion and is nearly ready for public dissemination via a peer reviewed manuscript (in prep) and online data portal. This is a first of its kind system that will be coupled to a biogeochemical modeling system in the coming months to understand how changing river flow, sea ice, and climate affect carbon cycling in the coastal Arctic. The model is applicable to both Alaskan Arctic projects that Dr. Clark is leading the modeling work on: 1) the Yukon River and Northern Bering Sea project, "Arctic Deltas and Coastal Margins as Buffers and Transformers of Carbon Along a Rapidly Changing Land-Ocean Continuum" (PI: Dr. Maria Tzortziou, CCNY), and 2) the Coastal Beaufort Sea project, "Remote Sensing of Environmental Change in Arctic Coastal Aquatic Ecosystems" (PI: Dr. Wesley Moses, NRL).

Dr. Clark also was able to finish a first-author manuscript on long term trends in large Arctic River flow and dissolved organic carbon fluxes that will be an impactful paper. This paper describes how changing river flow – increasing discharge volume and earlier spring flow – leads to an increase in the total amount of dissolved organic carbon and the chemical composition of that carbon at the outflow of the rivers into the ocean. It was a multi-institutional collaborative effort that leveraged the Arctic Great Rivers Observatory data set and included multiple established and Arctic researchers as co-authors and collaborators.

For September 1, 2023, to November 30, 2023, Dr. Clark will use the CBS-FVCOM model results to finish a draft manuscript for submission to Ocean Modelling detailing the new system and the dominant physical processes of the region. This work also will coincide with continued data analysis and new model development to represent key ecological and biogeochemical processes, such as alternate plankton metabolic strategies, in the region. He has also begun implementing new

modeling components for use in both Arctic studies that represent the inorganic carbon cycle components. In the next few months, these will be tested in an idealized modeling framework for parameter optimization and sensitivity analysis with the following goals: 1) understanding how processes unique to the Arctic affect the overall carbon cycle, especially the carbon dioxide flux between the atmosphere and the ocean, and 2) quantifying how interannual variability in river flow changes the oceanic carbon cycle and net ecosystem production to infer how the near future Arctic carbon cycle may shift as river hydrology and sea ice continues to rapidly change.

Name: Ivona Cetnić
Sponsor: Jeremy Werdell
Code: 616
Task: 017

Dr. Cetinić has been serving as a PACE Science lead for Ocean Biogeochemistry, and in that role, she has been working on different science aspects of the mission. She is overseeing the implementation of the new PACE-targeted algorithms and is curating the existing suite of ocean biogeochemical products on current and past missions. She has been working closely with the SeaBASS team on updating the validation pipeline, and curating and producing validation files. She collaborates closely with the PACE Science and Application team and provides support to the PACE Application component (through community of practice as well as with government collaborators), as well as to the outreach for the mission. As part of her role as EXPORTS Project Scientist, she continues to facilitate the science of EXPORTS, through organizing the meetings, assisting with data analysis and paper writing, and supporting the data management section of the project. She is also serving as a PACE-PAX Deputy Mission Scientist, helping with planning the post-launch experiment, which will take place in September 2024. In this role, she has been facilitating documentation, as well as building upon the ocean component through collaborations with NOAA and university partners.

Dr. Cetinić has participated in national and international meetings. Her science production was mostly focused on publications in the field of biogeochemical remote sensing, and the role of phytoplankton in the global carbon cycle. She has co-authored 8 peer-reviewed publications in this period (see Figure 2), and currently has 6 papers and one chapter (of the State of the Climate) in review, one of which (shared first authorship) is a comprehensive review of the observation of phytoplankton from space, from the perspective of future hyperspectral missions (see Figure 1).

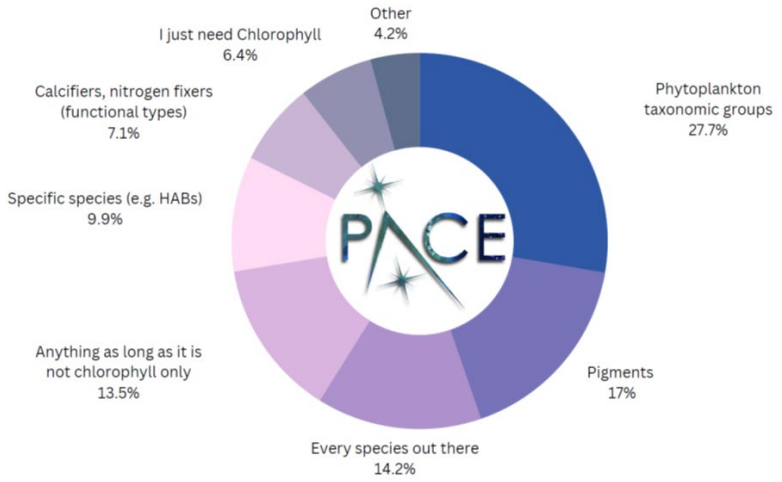


Figure 1. Needs of the PACE Community of Practice, based on the responses collected from a questionnaire with predetermined answers or other (optionally including a write-in answer). From Cetinić, Rousseaux et al, submitted. (Credit: I. Cetinić.)

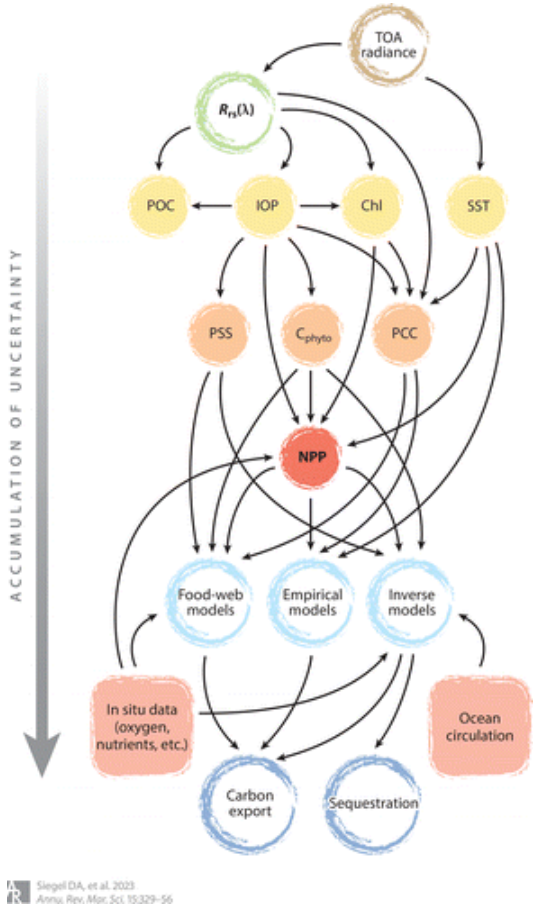


Figure 2. The flow of information from top of the atmosphere radiance to satellite data products used for assessing the state of the biological carbon pump. TOA information collected by satellites is converted into Rrs(λ) (green circle) and then into the primary products (yellow circles). The primary products are used in models to calculate secondary products (orange circles) that are then used as inputs in different models (light blue circles). From Siegel, DeVries, Cetinić, Bisson 2023. (Credit: I. Cetinić.)

For future plans in Sept – Nov 2023, Dr. Cetinić will continue to support PACE ocean biogeochemistry as they head towards the launch through implementation, validation, and communication with all stakeholders in the mission. In September, she will participate in a dry run for the PACE-PAX mission and continue to support the general mission, as well as build upon the ocean component. In September, she will participate in the meeting at Woods Hole supporting the science of the biological carbon pump, and in an online meeting on the topic of global marine observing network, organized by G7 FSOI members. In November, she will participate in an International Ocean Color Science meeting in Florida. During this time, she also will serve as a reviewer on a NASA panel.

Name: Bridget Seegers
Sponsor: Jeremy Werdell
Code: 616
Task: 029

Dr. Seegers has been working as the NASA lead on the Cyanobacteria Assessment Network

(CyAN). She has been continuing analysis of algorithm performance and working to engage and inform end-users with trainings, webinars, and website updates. She was Co-I on a funded proposal to expand the application of satellites for inland water quality monitoring using the Sentinel-2 satellites, which would greatly expand the number of water bodies that could be monitored.

Among other activities in the coming months, Dr. Seegers will attend the International Ocean Colour Science (IOCS) meeting, St. Petersburg, FL, Nov 14-17, 2023.

Name: Andrew Sayer
Sponsor: Jeremy Werdell
Code: 616
Task: 048

Over the past year, Dr. Sayer's main efforts continued to be supporting the forthcoming NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission (https://pace.gsfc.nasa.gov) as its Project Science Lead for Atmospheres. With the launch coming in January 2024, the main accomplishments are related to continued testing and refinement of scientific algorithms to monitor aerosols and clouds from PACE, in order to ensure that the project will be able to provide scientifically useful data sets rapidly after the instrument is functioning on-orbit.

One key achievement over the past year is the publication of a paper detailing an algorithm to determine cloud altitude from the PACE OCI instrument based on measurements in the oxygen A-band spectral region. This first-author publication in Atmospheric Measurement Techniques represents an original line of research as NASA's main heritage cloud algorithms (relying on thermal bands, which OCI lacks) are not applicable to PACE. Existing A-band-based techniques have largely been applied to sensors with coarser spatial resolution and different spectral sampling (either much finer or much coarser), such that they are also not directly applicable. The algorithm is being implemented in the PACE operational processing system; Dr. Sayer is assisting with verification and testing, and has increased the realism of the treatment of clouds in the "PyTOAST" simulated data stream being used to test the PACE OCI processing chain prior to launch. Using the European instrument OLCI as a proxy for OCI (while OLCI is more limited, it shares some A-band sampling similarities), he also has performed an evaluation of the approach against ground-based reference data. This not only provides a practical demonstration of the algorithm, but also of the validation system, which will be used to evaluate and monitor PACE post-launch.

Dr. Sayer (along with Dr. Ian Carroll) also continued mentoring two students through GESTAR II Fellowships. Both are developing machine learning techniques to monitor the atmosphere – one graduate student, Xingyan Li at UMBC, is working on cloud identification and optical thickness prediction from PACE OCI and other instruments (MODIS and VIIRS), while undergraduate student Micah Wallace at MSU is working on dust aerosol quantification. Both of these represent excellent opportunities for the students, as self-contained projects working on an important problem, as well as being able to contribute to Dr. Sayer's own ongoing research areas and help him to develop and refine new skills.
Within and external to the PACE mission, he has continued to collaborate with others on radiative transfer simulations, sensor calibration, aerosol/cloud remote sensing development and validation, and outreach efforts for the PACE mission. This has led to several papers and presentations, as well as successful proposals to NASA and NOAA. He is also assisting external PACE Science and Applications Team members in their use of PyTOAST simulated data and with their submissions of code for review and implementation in the PACE system.

During the upcoming months, Dr. Sayer anticipates almost total focus on ensuring that all PACE OCI atmospheres algorithms necessary early in the launch of the mission are implemented and working correctly, and that validation analysis systems are in place. He will also co-convene the annual AeroCom/AeroSat workshop focusing on aerosol modeling and observation to be held in Pasco, WA this year (although attending remotely).

Name: Inia Soto Ramos
Sponsor: Jeremy Werdell
Code: 616
Task: 049

As part of the Ocean Ecology Lab, Dr. Soto Ramos supports three NASA Projects: SeaBASS, EXPORTS, and PACE. As part of SeaBASS, Dr. Soto Ramos is responsible for overseeing all the data archival which exceeded 5,800 datasets from September 2022 to August 2023. She was responsible for data archival, all communication with data submitters, and the creation of new data collections, DOI's, and user accounts. Dr. Soto Ramos assisted with the development of protocols and guidelines for newer types of data submission and data standardization. In March 2023, SeaBASS hired a new data manager, who she trained to assist with all data management-related activities. Dr. Soto Ramos is still overseeing the data archival; however, she is actively training to assist with PACE validation and confirm data submitted to SeaBASS flows into the validation system. As part of EXPORTS, Dr. Soto Ramos continues to archive the data from the second field campaign (EXPORTSNA) and assists with manuscript development and data submission. During this time frame, she archived over 2,600 EXPORTS data files. As part of PACE, Dr. Soto Ramos assisted with communications, outreach events, data organization, and PACE validation.

In collaboration with scientists from the University of Southern Mississippi and GESTAR II, she published a science manuscript about cyanobacteria blooms in the Mississippi Sound and the relationship between these blooms and the opening of the Bonnet Carre Spillway. This was the first time that NASA's ocean-color CyAN product was used to study coastal cyanobacteria blooms. The publication was presented at the State of the Coast meeting in New Orleans, LA. She also participated in several events geared towards increasing diversity in STEM fields, such as the NSF Louis Stokes Alliances for Minority Participation (LSAMP) program and she was featured in the NSF LSAMP "Bridge to the Doctorate" 20-year anniversary video.

Looking ahead, as the PACE launch date approaches, Dr. Soto Ramos will be preparing for PACE validation. She will be organizing and confirming data is flowing from the initial steps when the data gets to SeaBASS, is archived and reviewed, QA/QC is implemented, PACE science leads filter out bad data, and match-ups are created.

Name: Dirk Aurin
Sponsor: Stephanie Uz
Code: 616
Task: 075

For this second task, Dr. Aurin has continued to validate the radiometric quality and atmospheric corrections for commercial DESIS hyperspectral ocean color imagery collected from the International Space Station for the purpose of application to satellite water quality retrievals in the Chesapeake Bay. He has developed an extensive database of hyperspectral L1C (radiometrically

calibrated; 583 GB) and L2A (provisionally atmospherically corrected; 297 GB) DESIS imagery and he continues to acquire targeted scenes as they are collected on orbit and become available in the DESIS data portal. As of July 2023, these include 209 targeted images at 10 globally distributed AERONET-OC ground stations, 152 images in Chesapeake Bay, and 10 images of Lake Tahoe. Ground truth radiometry data from the AERONET-OC SeaPRISM instrumentation (L1.5 and L2.0) was downloaded and matched in the Matlab database to satellite imagery for the purpose of validation. Imagery from all locations (371 tiles) was processed using ACOLITE software for atmospheric correction to L2R imagery and added to the database. These were validated against matchup in situ radiometry from AERONET and DESIS-provided, standard L2A atmospherically corrected imagery with relatively poor results (~100% - 150% error in normalized water leaving radiance from 400 nm to 700 nm). Multiple adaptations to the atmospheric correction were developed with sensitivity analyses in collaboration with the author of ACOLITE – each requiring reprocessing of all imagery – in the hopes of improving validation results. Atmospherically corrected imagery for the Chesapeake Bay was delivered to project collaborators using the GSFC ADAPT server after each reprocessing to provide them with hyperspectral water-leaving reflectance for use in water quality product algorithm development. Imagery from Lake Tahoe was used to derive estimates of the hyperspectral signal-to-noise ratio of DESIS water-leaving reflectance over dark (i.e., low signal), aquatic targets (~100 from 400 – 550 nm, declining to ~50 at 700 nm). In 2023, validation analyses were extended to top-of-atmosphere vicarious validation against MODIS Aqua imagery with mostly disappointing results (~20% error from 412 nm to 676 nm). Sensitivity analysis and validation results were shared with the project team and collaborators in regular meetings.

Between September 1 and November 30, 2023, Dr. Aurin will finalize his validation analysis and compile his findings in a manuscript for lead-author peer review publication.

Name: John Blake Clark
Sponsor: Stephanie Uz
Code: 616
Task: 076

Dr. Clark has been working with Troy Ames (NASA GSFC Code 500) and Dr. Stephanie Schollaert Uz (NASA GSFC Code 600 Applied Sciences) on the NASA Earth Science Technology Office (ESTO) Advanced Information Systems Technology (AIST) project, “Integration of Observations and Models into Machine Learning for Coastal Water Quality.” The technology the team is developing is called Deep learning for Environmental and Ecological Prediction-eValuation and Insight with Ensembles of Water quality (DEEP-VIEW), and the team has made significant progress in building machine learning capability for water quality observations in the Chesapeake Bay. Dr. Clark has led the efforts to process MODIS-Aqua remote sensing reflectance imagery for the Chesapeake Bay using a specific atmospheric correction, and the files are now being used as the input for the machine learning segment of the system being developed by Troy Ames. Dr. Clark has also successfully built a new methodology for increasing “labeled” data from relatively sparse *in-situ* observations called Water-Distance-Based Kriging. This takes the relatively common geospatial interpolation technique of kriging and uses the distance over water within the Chesapeake Bay (rather than geographical distance, or “as the crow flies”) to estimate water quality properties (e.g., clarity and constituent concentrations between observations) in space. The team, represented by Mr. Ames, presented the work at the annual review meeting in Pasadena, California to the AIST program management and received overall positive feedback.

For the months and year ahead, the water-distance-based kriging and machine learning will be further integrated into both the training and validation ends of the machine learning tool. This will likely improve model predictive performance and applicability to other satellite sensors. The team will meet with stakeholders from the Virginia Institute of Marine Science and the Maryland Department of the Environment to begin the framework to move the tool beyond a prototype towards what it could be as an operational system. Additionally, Dr. Clark is the lead convener on an AGU 2023 session that is framed around technology development in the coastal ocean.

Name: Xiaoguang Xu
Sponsor: Bryan Franz
Code: 616
Task: 115

Dr. Xu has been working on developing a validated, robust, and computationally efficient Level-1 processing system for UMBC's Hyper-Angular Rainbow Polarimeter 2 (HARP2) onboard NASA's PACE satellite. The PACE mission satellite, to be launched in early 2024, will make extended observation records for ocean color, aerosols, and clouds. Dr. Xu has delivered several versions of HARP2 Level 1A and Level 1B/C processing software to the NASA PACE Science Data Segment, which are being integrated and tested for operation. The software has been used to promptly process HARP2 measurements during various pre-launch (i.e., calibration and thermal-vacuum) tests. He also generated and provided simulated and proxy HARP2 Level-1 data products for the PACE Project Science team for evaluating and testing HARP2 data processing flow and for HARP2 Level-2 science data production. The testing and further improvement of the HARP2 Level-1 data processing system is ongoing, which will be ready for producing HARP2 Level-1 data products after the launch of PACE satellite.

For September 1, 2023, to November 30, 2023, Dr. Xu will continue to support the development of HARP2 Level-1 data processing system. He will assist with evaluating HARP2 data collected during PACE's pre-launch testing activities.

Name: Ian Carroll
Sponsor: Amir Ibrahim
Code: 616
Task: 161

Dr. Carroll's work is advancing capability within the Ocean Ecology Laboratory (OEL) to perform atmospheric correction (AC) as applied to radiometry and polarimetry from spaceborne sensors. Working with UMBC colleague Dr. Pengwang Zhai, author of a novel radiative transfer numerical model, Dr. Carroll implemented the flexible production of AC tables for arbitrary sensors, including the PACE mission's Ocean Color Instrument (OCI). Dr. Carroll is using Dr. Zhai's model to produce datasets for machine learning (ML) approaches that will improve on legacy AC algorithms. A collaboration with GESTAR II colleague Dr. Andrew Sayer resulted in three intern projects developing improvements to atmospheric data products produced by the OEL. Two projects are using radiative transfer models and neural networks to estimate cloud masks and cloud optical thickness using OCI bands, while the third and most recently initiated project will target the same approach on estimating dust aerosol optical thickness using VIIRS thermal bands. Two interns are currently preparing abstracts and conference papers for the IEEE Big Data meeting in Dec. 2023 and the American Meteorological Society meeting in Jan. 2024.

Activities through November 2023 are focused on 1) researching the application of neural networks for AC correction using the recently produced training datasets, and 2) developing a production implementation of the cloud mask product for OCI that resulted from one intern's project.

Name: Seohui Park
Sponsor: Pawan Gupta
Code: 616
Task: 173

Since joining GESTAR II in early July 2023, Dr. Park has been working on checking the effect of the Canada wildfires on the U.S. air quality using GOES-R AOD and AERONET AOD. This research is ongoing. Also, Dr. Park will be working to evaluate hourly $PM_{2.5}$ forecasting results at U.S. embassy locations. NASA HAQAST team in partnership with the U.S. State Department is developing the City Air quality foREcasting and analysis System (CARES). The innovation of CARES is the application of a Machine Learning Model Output Statistics (ML-MOS) framework to statistically calibrate on a point-by-point basis, thus significantly improving the NASA Goddard Earth Observing System Model global outputs for individual US Department of State post locations.

In the coming months, Dr. Park will be participating in the CARES project for validating the developed model output with ground in-situ measurement for improving the model's performance.

Name: Sean Foley
Sponsor: Kirk Knobelspiesse
Code: 616
Task: 175

Mr. Foley joined GESTAR II in April 2023, with in-person work starting in July. He has been finalizing his internship project, which involves the use of deep learning to predict a narrow-swath vertical cloud product (derived from the CloudSat radar) from wide-swath multi-angle polarimetry (from POLDER-3). Although PACE will not carry a radar, this method could be applied to HARP2 with the use of ground-based radar stations or other sources of vertical cloud profiles. Mr. Foley also submitted an abstract to the upcoming American Geophysical Union meeting, involving the use of advanced techniques from the computer vision literature for the derivation of 3D cloud structure in wide-swath, multi-angle satellite imagery.

From September 1, 2023 to November 30, 2023, Mr. Foley will submit the paper discussed above to Atmospheric Measurement Techniques. He will also continue working on the AGU abstract, applying the method to both POLDER-3 and HARP CubeSat data. This method will be applied to HARP2, once data is available after PACE's launch.
Name: Vanderlei Martins and team members
Sponsor: Jeremy Werdell
Code: 616
Task: 178

Dr. Martins leads a team to pursue innovative science associated with the HARP2 multi-angle polarimeter delivered to NASA for the PACE mission. At present, his team consists of Lorraine Remer, Rachel Smith, Yomiyu Fekadu, Joseph Shields, Ian Decker, Daniel Nelson, Roberto Borda, and Dominik Cieslak. The overarching accomplishment since the establishment of this task in

February 2023 has been to develop the hardware and software necessary to prove the calibration of this unique instrument, to implement this infrastructure and to apply it during the environmental testing of the PACE observatory with HARP2 fully integrated. The point is that HARP2's wide FOV optics present a scientific challenge for characterization, and while there was a successful initial calibration campaign at Goddard in the Fall, that calibration was not done under space-relevant conditions. Transferring the laboratory calibration to space conditions for this type of instrument has never been done and is the focus of the research under this task. Success in this work will provide Earth science with high quality multi-angle polarimetric data from HARP2 and for generations of Earth science missions in the future.

Specific accomplishments to date include the following. Dr. Martins and team completed the final design and fabrication of Optical Ground Support Equipment (OGSE) that provide three light sources and a rotating stage to filter one of the light sources through different angles of polarization. The different light sources address the different needs for characterizing the radiometric, polarimetric, alignment and flat field across the wide FOV. This is unique experimental equipment.

Also, the team developed and implemented the controlling software for the OGSE to coordinate the timing of the rotating stage with the timing of the data collection of the HARP2 instrument. They also developed processing software to input the experimental data and output scientific results including Malus curves for fast analysis during experimental runs.

The team was completed implementation of the system, hardware and software, at Goddard during the PACE Environmental testing. They ran the OGSE and monitored telemetry from HARP2 and the OGSE at the console in the PACE control room in Bldg 7, around the clock for weeks of testing. Further, they provided quick analysis and advice concerning the scientific performance of HARP2 to PACE during testing.

Finally, the team prepared for HARP2 commissioning in conjunction with PACE commissioning during the first months of the PACE mission. This will be an adaptation of the work they have done during testing, but without the OGSE. They will be running HARP2 through all of its commands including multiple checks of scientific performance while in orbit.

Expected activities and research for September 1, 2023, to November 30, 2023 will include the culmination of the experimental campaign occurring during PACE environmental testing, the continuation of the analysis of the data collected, and participation in Commissioning Simulations to prepare for launch and on-orbit activities.

Name: Vanderlei Martins
Sponsor: Jeremy Werdell
Code: 616
Task: 183

This new task will support the collection of airborne science measurements for the post-launch calibration and validation of retrievals from the PACE observatory, namely HARP2 and SPEXone. It includes preparation of aircraft instrument(s) - including airHARP - and their pre- and post-campaign calibration(s), deployment, and data processing, as well as science analysis of the measurements. This task will support participation in the PACE-PAX aircraft field campaign (https://pace.oceansciences.org/campaigns.htm) to be conducted in September 2024, where the airHARP instrument is to be deployed. After PACE-PAX, the team will not only perform data processing, but also publish and present results in science team meetings and conferences.

Name: J. Blake Clark
Sponsor: Cecile Rousseaux
Code: 616
Task: 192

Under this new task, Dr. Clark will work on improving the transport and transformation of carbon and nutrients from land to the ocean using in situ, satellite and earth system models. An existing terrestrial biosphere model (Ecosystem Demography model, ED) combined with the Land-Use Harmonization (LUH) dataset provide fluxes of carbon and nutrients from land to rivers under varying land use and land cover change scenarios. The River-Estuary model transports and transforms aqueous forms of carbon and nutrients to represent the lateral fluxes of carbon and nutrients from rivers to the NASA Ocean Biogeochemical Model (NOBM). Dr. Clark will perform research on the transport and transformation of the organic and inorganic matter in the rivers. He will run various sensitivity analysis to assess the effects that the various land use/management and climate variability have on the transfer of this matter to the rivers. Additionally, a postdoctoral researcher will perform research related to river model development as well as a related in-situ database. Research under this task will be conducted as part of the NASA Ocean Ecology Laboratory and in collaboration with the Global Modeling and Assimilation Office.

CODE 617: HYDROLOGICAL SCIENCES LABORATORY

Name: Robert Emberson
Sponsor: Dalia Kirschbaum
Code: 617
Task: 030

Dr. Emberson has been involved in several different activities in 2022-2023, both research and programmatic. On the research side, he leads two funded projects. The first project under the New Investigator Program focuses on soil erosion by intense rainfall and has led to the first publication to use NASA satellite rainfall data to estimate global hotspots of rainfall erosivity; further results have already progressed to exploring connections between erosion estimates and the impacts on agricultural and hydrological systems around the world. His second project, which began in 2023, tests whether seasonal-to-subseasonal estimates of extreme rainfall from NASA's GEOS S2S forecasts can be used to predict intense rainfall with lead times of months or more. After months of testing code to analyze the S2S data, the project has begun to yield initial results and likely will provide exciting avenues forward.

Dr. Emberson also carries out extensive work on behalf of NASA's Disasters Program, for which he is one of the Associate Program Managers. In this role, he helps draft solicitation text and programmatic documentation, represents the program at various meetings domestically and abroad, and assesses both the research progress and funding status of projects funded by the Disasters Program. He also serves as the de facto lead for Disaster response activities at NASA – personnel from the program provide data and products from NASA to inform decisions by stakeholders around the world before, during and after disasters, and Dr. Emberson is the lead coordinator of all of those activities. Reflecting on this role, he has also played a key part in developing the Disaster Response Coordination System (DRCS), which will be led by a programmatic office at NASA Langley Research Center – this office will take over much of the response activity that Dr. Emberson currently leads.

For Sept – Nov 2023, Dr. Emberson will attend the Global Flood Partnership meeting in Singapore in September and the launch of the DRCS in November on behalf of the Disasters program. He also will draft the next ROSES solicitation for the program in conjunction with the program manager.

On the research side, Dr. Emberson anticipates beginning to draft the first paper detailing the results of the Seasonal-to-Subseasonal rainfall analysis project, as well as an additional paper focused on the connection between soil erosion model estimates from satellites and connections with hydrological and agricultural impacts. He will serve as a panel reviewer for the Earth Surface and Interior call from NASA ROSES at the end of August and beginning of September. He also anticipates receiving final reviews on two research papers of which he is a co-author before the end of October.

Name: Elijah Orland
Sponsor: Dalia Kirschbaum
Code: 617
Task: 031

Mr. Orland has been working on applications of remote sensing data for active fire tracking and post-fire hazard assessments. This includes putting two sets of scientific software into production:

the LHASA Post Fire Debris Flow (PFDF) Model and the Fire Events Data Suite (FEDS) algorithm, both of which are now running routinely to provide near-real-time information related to active fire properties and their subsequent impacts on landscapes. The LHASA software he contributes to recently received the NASA Software of the Year award for 2023; his work with the FEDS algorithm is now utilized by multiple US agencies to track active fires in the United States, in addition to drawing interest from non-governmental organizations, such as the Wall Street Journal and World Central Kitchen.

Mr. Orland leads and contributes to a variety of research projects. This includes the research he leads linking active fire properties to the post-fire burn severity data. His contributions to the work of others includes advising on multiple fire-related research projects within the Hydrological Sciences Laboratory (617) and on one project funded by the Precipitation Measurement Mission (PMM). He is a subject matter expert and point of contact for these ongoing research and software efforts.

For his upcoming plans, Mr. Orland will continue much of the work that is already in progress, in addition to working directly with his colleagues at the United States Geologic Survey and United States Forest Service for an in-depth analysis of the impacts of the Hermit's Peak/Calf Canyon Wildfire in California on local watershed hydrology and debris flow response.

Name: Thomas Stanley
Sponsor: Dalia Kirschbaum
Code: 617
Task: 032

Mr. Stanley projected the future of landslide hazard in High Mountain Asia over coming decades, based on downscaled temperature and precipitation estimates from the GFDL SPEAR model. The projections are based on a landslide hazard indicator (LHI) that combines information from several risk factors at a 5-kilometre resolution. Aggregated over time and/or space, the LHI reveals patterns of hazard that may grow or shift with rising temperatures throughout the twenty-first century. Initial results suggest that hazard will rise across High Mountain Asia, but with significantly different outcomes depending on the future path of human development.

He also developed a prototype landslide forecast for the Karnali Basin of western Nepal. The forecast was built upon the High-Impact Weather Assessment Toolkit, an ensemble of models that predict extreme events in a region that includes Nepal and Bangladesh. This data was combined with static information on topography, geology, and seismicity through machine learning to produce a gridded probability of landslide occurrence for the years 2018-2022. The prototype has been running at the International Centre for Integrated Mountain Development since the start of the 2023 monsoon, with the goal of gaining preliminary feedback from interested parties. The prototype was presented to stakeholders during a one-week workshop in Kathmandu. Future work could include extension of the forecast across the whole of Nepal.

In the fall of 2023, Mr. Stanley will work on the seasonal forecasting of landslides in High Mountain Asia. This project is expected to rely on hindcast from the GEOS-S2S and a series of regional landslide inventories to establish a relationship between ensemble predictions and conditions on the ground.

Name: Nishan Biswas
Sponsor: Dalia Kirschbaum
Code: 617
Task: 033

Dr. Biswas led the development of Google Cloud Platform-based Landslide Hazard Assessment model for Situational Awareness (LHASA-Mekong) and LHASA-Mekong forecast for the Lower Mekong Region of South-East Asia. The LHASA-Mekong incorporates Earth Observation (EO)-based products and artificial intelligence (AI) models in a flexible decision support system to quantify landslide hazard and exposure over the Lower Mekong Region. The application incorporates landslide inventories within a machine-learning framework to estimate the relative probability of occurrence. The decision-support tool relies on the following variables: slope, relief, distance to rivers and distance to roads, lithological strength, precipitation, and soil moisture. Precipitation is estimated from the Integrated Multi-Satellite Retrievals for Global Precipitation Measurement (GPM-IMERG). The modeling framework also estimates the potential exposure of local communities to landslide hazards. LHASA has been validated with reference to new inventories of rainfall-triggered landslide events. LHASA-Mekong is open-source and produces landslide probability at a 1-kilometer resolution.

Dr. Biswas worked with the EIS Freshwater team on quantifying the impact of climate change and human impacts on mega deltas. As a part of this effort, the team investigated the intensive and unplanned groundwater abstraction in Bangladesh and its impact on water availability throughout the country.

For the upcoming three months, Dr. Biswas will continue to work with the EIS Freshwater team on quantifying the impact of climate change and human impacts on mega deltas on the Bengal delta. He will focus on the quantification of compound impact from irrigation, sea level rise, groundwater depletion and surface water declination.

Name: Goutam Konapala
Sponsor: Sujay Kumar
Code: 617
Task: 056

Dr. Konapala has been working to evaluate snow retrieval algorithms for AMSR2, particularly with respect to the algorithm upgrades, machine learning and code refactoring to be included in the recently funded MEASURES proposal. His analysis has focused on the CONUS region as well as on a 20-year global retrieval.

For research related to EIS Freshwater, Dr. Konapala is contributing to the global land surface model runs for evaluating the propagation of droughts from meteorological to hydrologic phase. In particular, this is a global analysis based on the years from 2000 to 2022.

For September 1, 2023, to November 30, 2023, Dr. Konapala will continue working on the global land surface model runs for EIS and plans to further contribute to the journal, which evaluates the impact of droughts on vegetation productivity.

Name: Fadji Z. Maina
Sponsor: Sujay Kumar
Code: 617
Task: 057

Dr. Maina has been working on NASA's High Mountain Asia project under which she has led the development of a land reanalysis over the region. The High Mountain Asia land reanalysis leverages an unprecedented set of available satellites (optical, thermal, passive microwave, laser, gravity, and altimetry) and ground measurements and provides spatially and temporally consistent estimates of storages, fluxes, and meteorological conditions that are relevant for a range of model applications in hydrology. Over the past year, Dr. Maina has led the publication (first-author) of two articles on this work. Two other papers have also been submitted on the topic with Dr. Maina as a first author.

Dr. Maina also works on developing a fine-scale North American precipitation analysis and surface meteorology dataset for retrospective and operational applications by leveraging high-quality gauge, satellite, and model datasets through advanced data assimilation methods. Additionally, she is leading the integration of the hydrologic model ParFlow into the NASA Land Information System (LIS) to better improve the representation of groundwater flow in NASA LIS and therefore the better interpretation of NASA's GRACE and GRACE FO satellite data.

For the Sept 1 – Nov 30, 2023 period, Dr. Maina will continue working on the three projects mentioned above. She plans to submit a paper on the High Mountain Asia project and another one on the ParFlow-LIS coupling in the upcoming months. She also will address any comments on two papers that are currently under review. Additionally, she will be working on upcoming presentations (all invited) at World Water Week, Euro-Africa Montpellier Water Days, and the African Conference of Mathematics and Applications.

Name: Pukar Amatya
Sponsor: Dalia Kirschbaum
Code: 617
Task: 063

Dr. Amatya is a Co-I on a project studying landslide changes in the Hindu Kush Himalayan region. The team received a one-year augmentation grant to develop a prototype landslide mapping and forecasting system for Nepal. In November 2022, Dr. Amatya visited the International Centre for Integrated Mountain Development (ICIMOD) in Nepal and took part in the stakeholder consultation workshop. Dr. Amatya is leading an effort to transfer the landslide mapping system developed at GSFC to the cloud for ease of access. In August 2023, he visited ICIMOD again to close out the project and train regional stakeholders on the landslide mapping and forecasting system.

Dr. Amatya was involved in a rapid response effort providing information on landslide locations using automated mapping systems during the August 2021 earthquake and tropical storm event in Haiti. Dr. Amatya led a multi-agency effort to summarize and document the landslide rapid response products released by several organizations with disaster response capabilities or programs, describe the detection methods, quantify the accuracy, and provide guidelines on how some of the shortcomings encountered in this effort might be addressed in the future. The result of this effort was published in Natural Hazards journal (https://doi.org/10.1007/s11069-023-06096-6).

Looking ahead, a proposal titled “Evaluation of ICEYE data for landslide disaster response product generation” was selected by the Commercial Smallsat Data Acquisition New Vendor Onramp Evaluation (CNVOE) program with Dr. Amatya as PI. The main objective of this work is to evaluate the quality and usefulness of ICEYE data for SAR change detection and image classification, with particular focus on landslide detection for rapid response. Dr. Amatya will spend a significant amount of time working with ICEYE data in preparation for the mid-term reporting timeline of mid-November 2023.

Name: Armaghan Abed-Elmdoust
Sponsor: Sujay Kumar
Code: 617
Task: 072

Dr. Abed-Elmdoust has been actively contributing to multiple funded earth science proposals, including the Land Information System (LIS) Mobility Support Development Tasks. Her efforts have been centered on leveraging various Earth science remote sensing data sources to gain insights into the intricate interactions within the components of the Earth system. She has developed a computational and stochastic framework for uncertainty estimation modules within the LIS model to assess uncertainty levels associated with Earth Observation Systems (EOS) forecasts. Along different lines, she has led a project on enhancing Land Data Assimilation (LDA) techniques evaluating and extending the LDA capabilities of the NASA LIS to enable the effective utilization of Soil Moisture, Snow Water Equivalent (SWE), and Snow Depth derived from the Weather Satellite Follow-on-Microwave (WSF-M). She provided a science plan for integration into the ongoing contract with the United States Air Force (USAF) and led a technical project on enhancing the operational Land Information System and exploring alternative algorithms to improve the management of radiative forcings.

From September 1, 2023, to November 30, 2023, Dr. Abed-Elmdoust will concentrate on enhancing Data Assimilation (DA) capabilities. She will be extending the DA functionality of LIS to support the assimilation of the 9-km resolution enhanced SMAP soil moisture product, also known as SMAP Enhanced. This product is being considered for inclusion in either LISFV7.5.1x or LISFV7.6. In addition to this, Dr. Abed-Elmdoust will contribute to improvements in operational LIS by exploring alternative algorithms for better handling of radiative forcings, such as the hybrid-WWMCA-MPAS approach. Lastly, she will focus on assimilation enhancements by leveraging WSF-M satellite data.

Name: Cheng-Hsuan “Joseph” Lyu
Sponsor: Edward Kim
Code: 617
Task: 073

Dr. Lyu supported both ground and on-orbit calibration and validation of the sensor performance for a series of ATMS (Advance Technology Microwave Sounder) instruments. The sequentially built ATMS sensors are part of JPSS spacecraft missions. They include EDU (Quick Sounder to be launched, tentatively in 2025), S-NPP (launched in 2011), JPSS-1 (NOAA-20, launched in 2017), JPSS-2 (NOAA-21, launched on Nov. 10, 2022), JPSS-3 (currently performing satellite observatory TVAC testing) and JPSS-4 (currently at the instrument-level testing). Dr. Lyu performed data evaluation and review of ATMS performance prediction, and all test reviews and the Performance Review Document (PRD). Dr. Lyu has reviewed the related Calibration Data Book, ATBD (ATMS

Theoretical Background Document), and CDRL (Critical Design Requirement), etc. He will publish, either as a journal paper or a science report, on all the subsequent JPSS ATMS sensor performance. He also helped to develop algorithms to characterize, monitor and/or evaluate the on-orbit sensor performance. He is collaborating with other science teams from MIT-LL, NOAA, NG to support ATMS SDR and other related calibration and validation activities.

During this reporting period, since JPSS-2 (J2, N21) was launched on Nov. 10, 2022, Dr. Lyu supported all the pre-launched planning, pre-launched spacecraft observatory level testing, data evaluation and sensor performance, and post-launch 90-day test planning, and compiled ATMS-related Post-Launch Test (PLT) procedure and requirement documents. During the J2 post-launch 90-day test phase, because of one major data downlink Ka-band transmitter loss, Dr. Lyu had to modify the test plan accordingly. He implemented all ATMS-related test data analyses and assembled J2 post-launch test reports, including the following: J2-ATMS-6105 Active Geolocation Verification PLT Report; J2-ATMS-6111 Lunar Intrusion Mitigation PLT Report; J2-ATMS-6113 Scan Sync Offset PLT Report; and, J2-ATMS-6106 Cold Calibration Position Selection PLT Report. (For the last two reports, Dr. Lyu provided major analysis results and partial reporting.)

Dr. Lyu will continue supporting S-NPP, JPSS-1, and JPSS-2 on-orbit data analysis and he will continue to monitor the sensor performance from EDU (QuickSounder), JPSS-3 & JPSS-4 ground tests & in collaboration with MIT-LL, NOAA, NG and other instrument teams for the reviews and the planning of future pre-launch and post-launch calibration and validation activities.

Name: Jessica Sutton
Sponsor: Dalia Kirschbaum
Code: 617
Task: 160

Dr. Sutton has been working to evaluate precipitation during storm events using the GPM IMERG early run product. Her analysis has focused on when, where, and why GPM IMERG missed or falsely detected storm events. She is preparing her manuscript for publication in the Journal of Hydrometeorology.

Over the upcoming year, Dr. Sutton plans to 1) publish her current research, 2) present current research at the Precipitation Measurement Missions Science Team Meeting (September 2023) and the AMS Annual Meeting (January 2024), 3) evaluate extreme storm events using GPM IMERG V07, and 4) evaluate sub seasonal and seasonal precipitation forecasts for landslide modeling.

Name: Jeff Walker
Sponsor: Edward Kim
Code: 617
Task: 167

During his ten weeks with GESTAR II, Dr. Walker was involved with preparations for the SARP-East mission, including calibrations and check flight of SLAP on the NASA Langley King Air. Additionally, he researched drone-based soil moisture remote sensing including the Blackswift and Prosensing concepts.

Dr. Walker gave a presentation on “Towards Smart Irrigation” at the University of Virginia; attended the SMAPVEx Workshop in Boston, MA; and, presented “Towards a next generation soil

moisture mapping technology" at ESSIC (see https://www.youtube.com/watch?v=rHTF45OkYRs).

He participated in discussions relating to a potential HAP mission for disaster prediction and monitoring. With Fritz Policelli, he discussed an idea of using smartphones for rainfall mapping and an Expression of Interest has been submitted. Additionally, he discussed opportunities to use the Australian OzNet site for validation of SNOOPI and NISAR missions.
Note, Dr. Walker's short-term appointment concluded on June 30, 2023.

CODE 618: BIOSPHERIC SCIENCES LABORATORY

Name: Celio Resende de Sousa
Sponsor: Lola Fatoyinbo
Code: 618
Task: 060

Dr. De Sousa has been working on the development of mapping and monitoring approaches using remote sensing in order to evaluate the potential to put together Blue Carbon projects on marine protected areas (MPAs) in West Africa. Dr. De Sousa is using a Landsat-based compositing approach (LandTrendr) and machine learning classifiers to develop annual land cover (eight key land cover classes, including mangrove forests, from 2000 to 2022) for approximately 275,000 Km^2 along the coast from Mauritania to the Democratic Republic of Congo, covering more than 235 MPAs. Dr. De Sousa submitted a first author manuscript for publication to Conservation Science and Practice, analyzing 20 years of forest cover change and fragmentation in Liberia, West Africa.

For the period of September 1, 2023, to November 30, 2023, Dr. De Sousa will be working on a project called "Earth Observation-based restoration and monitoring in Coastal and Forested Protected Areas of West Africa" that was submitted in response to NNH22ZDA001N-ECON: A.40 Earth Science Applications: Ecological Conservation and was approved recently.

Name: Amanda Armstrong
Sponsor: Batuhan Osmanoglu
Code: 618
Task: 081

Dr. Armstrong has been working to evaluate the rates and drivers of treeline advancement in the boreal region of North America. Her analysis has focused on developing and utilizing a high-resolution, spatially explicit individual-based gap model, SIBBORK-TTE, to simulate the changes to forest at the warm and cold edges of the treeline. As part of her ABoVE Phase 2 research project, permafrost, litterfall-decomposition, moss growth and fire modules were added to the existing SIBBORK modeling framework. CMIP-6 climate scenarios were also added for future-casting response to changing climatic conditions. Environmental inputs are in many cases satellite product-derived (MERRA-2 climate, Arctic DEM, Worldview-2 site selection and landcover run stratification, Landsat derived treeline abruptness map) and underpin the site-specific gap model parameterizations. Results of model runs at over 60 test sites across the ABoVE extended domain depict an uncertain future for North American forests, with northern forest densities increasing and successional dynamics shifting, and warmer forests in the Aspen Parklands of central Canada drying out and declining. The rates and occurrence of these shifts are non-uniform and dependent on site-specific environmental demography.

During the upcoming quarter (September 1, 2023 - November 30, 2023), Dr. Armstrong expects to complete the final testing/debugging of the model additions. She will then apply the model along a treeline transect in the Brooks Mountain Range. She will also lead finishing and submitting of two manuscripts and assist on a third. Finally, she will continue preparing a proceedings paper from the Applied Earth Observations Innovation Partnership from the March 2022 Workshop that she co-organized and co-lead. Dr. Armstrong expects to submit two first author manuscripts to ERL ABoVE Special Issue and Ecological Modelling; she will submit as a co-author a manuscript to Global Ecology and Biogeography.

Name: Min Jeong Jo
Sponsor: Batuhan Osmanoglu
Code: 618
Task: 082

Dr. Jo has been working on evaluating commercial small-satellite data on NASA's Commercial Smallsat Data Acquisition program (CSDA). The CSDA program was established by NASA's Earth Science Division (ESD) to identify, evaluate, and acquire commercial small-satellite data. Her analysis has focused on the feasibility of measuring three-dimensional (3D) surface displacements derived from volcanic activities using the synthetic aperture radar interferometry (InSAR) technique.

The main research site on this project is Kīlauea volcano, Hawai'i. Kīlauea, which is one of the most active volcanoes in the world, and will serve as the evaluation site, since there are significant stacks of SAR images acquired from different satellites and GPS observations from permanent stations. She has been collecting archived and new data acquisitions over the Kīlauea volcano and analyzing the data.

Dr. Jo has been working on developing a change detection module for wildfire burned areas using SAR imagery. Since SAR data is capable of penetrating clouds and smoke, and observing the Earth's surface day and night, it has been playing a critical role in wildfire monitoring. A wildfire alters the physical properties of the ground, such as vegetation and soil moisture, leading to distinctive changes in the radar backscatter signals. By analyzing the amplitude changes between pre- and post-fire images, the burned area can be detected. Figure 1 shows a time-series of burned area detection maps derived from Sentinel-1 SAR data. The burn severity and progression of the wildfires can be assessed through this analysis.

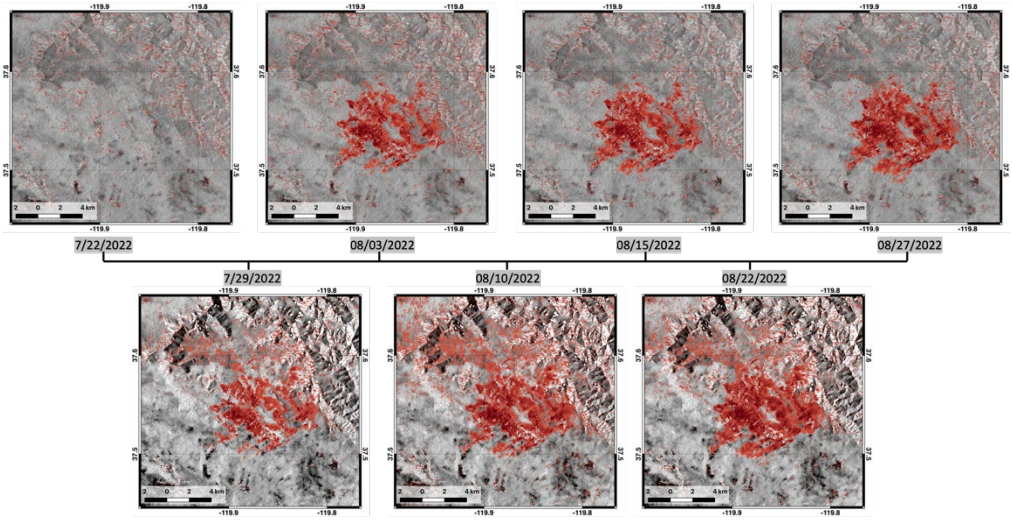


Figure 1. Time-series of change detection maps for the California Oak fire that happened in 2022. The detected pixels in red show burned areas. (Provided by M.-J. Jo.)

Among other activities in the coming months, Dr. Jo will continue to work on the CSDA project to evaluate the capability of the InSAR method with ICEYE imagery. She will assess the quality of the surface deformation maps generated from ICEYE data by comparison with the maps from other satellite imagery and the GPS/GNSS data.

Name: Akiko Elders
Sponsor: Christopher Neigh
Code: 618
Task: 083

Dr. Elders has been working to evaluate the biosphere and cryosphere to understand the Earth's vegetative and ice-covered surfaces. Dr. Elders is part of an interagency collaboration using remote sensing and machine learning to estimate crop type and yield of small holder fields and develop new approaches to increase prediction skill. Dr. Elders published a first author paper on her work in August 2022. Since August 2022, she has been evaluating the utility of Very High Resolution satellite imagery as well as more complex machine learning algorithms to increase skill in regions with dense cultivation. In addition, Dr. Elders has been working with the NASA GISS global climate models to understand Earth's ice covered surfaces. This work includes running ModelE with observations, and submitting two new proposals based on preliminary results identified through her work.

Dr. Elders was invited to give several presentations over the last year, including serving as the keynote speaker for the Prince George's Area Science Fair Awards ceremony in March 2023. *Note, Dr. Elders began a new role with the D.O.D. in mid-September 2023.*

Name: Thomas Eck
Sponsors: Pawan Gupta
Code: 618
Task: 085

Mr. Eck performed direct sun channel calibrations utilized for the measurement of aerosol optical depth (AOD) for the NASA/GSFC portion of the global Aerosol Robotic Network (AERONET). Additionally, he participated in the analysis of various techniques for the calibration of sky radiance measurements, including the vicarious technique, sky radiance transfer technique, and comparisons to the laboratory measurements made at the World Radiation Center in Davos, Switzerland. He has also analyzed AERONET observations of desert dust spectral single-scattering albedo, size distributions, and spectral AOD.

In the coming months, Mr. Eck will continue the investigation of dust optical properties from AERONET data and comparison of spectral single-scattering albedo to laboratory global soil samples. He will prepare a presentation for the AGU Fall Meeting titled "Desert Dust Optical Properties from AERONET Observations: Spectral AOD, Size Distributions, Spectral Absorption and Seasonal Dynamics."

Name: Dhruva Kathuria
Sponsor: Alexey Shiklomanov
Code: 618
Task: 093

Dr. Kathuria has been working on developing novel Bayesian statistical algorithms for predicting plant functional traits (such as chlorophyll, nitrogen, etc.) from hyperspectral data at leaf and canopy scales. He has successfully developed a statistical algorithm which is (a) interpretable, (b) computationally efficient, (c) accounts for uncertainties in input reflectance, and (d) provides parameter and prediction uncertainties. The proposed algorithm is an improvement over commonly

used algorithms such as Partial Least Squares Regression. The algorithm is relevant to developing trait retrieval algorithms for upcoming hyperspectral satellite missions such as Surface Biology and Geology (SBG). Dr. Kathuria is currently finishing a manuscript on this work.

Dr. Kathuria is also working on improving the land surface temperature (LST) product of The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) reanalysis product produced by NASA Global Modeling and Assimilation Office (GMAO) at approximately 50 km spatial resolution by characterizing its spatio-temporal variability using 2 km hourly LST data Geostationary Operational Environmental Satellites (GOES)-R satellites. This analysis will help us better understand how much information we lose when we go from 2 km GOES resolution to 50 km Merra resolution and how this information loss varies between land use/land cover types. This analysis is ongoing.

Additionally, Dr. Kathuria is working on developing novel unmixing algorithms to generate flowering maps using airborne and satellite hyperspectral data. A manuscript was submitted based on this work which successfully maps yellow flowering areas using airborne data collected as part of the SBG High-Frequency Time Series (SHIFT) campaign in Santa Barbara, California. A NASA ROSES proposal was also submitted proposing to extend this work to other study sites.

From September 1, 2023 to November 30, 2023, Dr. Kathuria will submit the manuscript based on the Bayesian trait estimation algorithm and continue research on land surface temperature project.

Name: Anthony Campbell
Sponsor: Lola Fatoyinbo
Code: 618
Task: 109

Dr. Campbell has been working on coastal mapping change, focusing on nearshore bathymetry and coastal wetland change. He has worked on planning and pre-analysis for his BioSCape field campaign participation, including multitemporal mapping of estuarine vegetation in South Africa with Worldview-2/3 very high-resolution data. This work is ongoing with the field campaign happening in October-November 2023.

Dr. Campbell participated in coastal mapping of nearshore ecosystem classes for the NASA-Conservation International partnership. This work included mapping the Bathymetry of Liberia, Senegal, and Mozambique with an ICESat-2 and optical data fusion approach. The resulting work was shared at the ASLO conference in Spain. He additionally worked on analyzing Worldview-2/3 data for mapping nearshore LCLU in Mozambique.

Dr. Campbell participated as a named CO-I, PI, and Postdoc on four grants. Two grants have been funded. One was submitted to the ECIPES call on 8/11/2023, and the final grant was not funded. Dr. Campbell mentored two interns for the summer of 2023, one through the NASA internship program and one through NASA Neurodiversity Network (N3). Both participated in activities related to the task elements.

In the coming months, Dr. Campbell will participate in GEOBON (Group on Earth Observation Biodiversity Observation Networks) conference in Montreal, Canada (Oct 10-13). He is presenting work related to BioSCape and meeting with collaborators. He will also conduct fieldwork in the Greater Cape Floristic Region of South Africa from the end of October to Mid-November as part of

the BioSCape field campaign.

Name: Petya Campbell
Sponsor: Christopher Neigh
Code: 618
Task: 122

Dr. Campbell's task involves five different elements of research and activity. First, throughout the past decade, Dr. Campbell has been coordinating the work of the "GOFC-GOLD, South Central and Eastern European Regional Information Network (SCERIN)" as the USA Coordinator, working closely with the SCERIN Coordinators in the EU. In 2023, she organized and led the 10th SCERIN Workshop and Anniversary, which was held June 26-29, 2023, in Brno, Czech Republic, and was attended by 35 members from 10 countries. The next SCERIN-11 workshop will likely be held jointly with MedRIN in Burgas, Bulgaria the last week of June 2024, in coordination with the Trans-Atlantic training (TAT).

Second, in 2023, Dr. Campbell joined the Raising Stella (Science and Outreach) (STELLA) team, contributing to the scientific and outreach use of the instruments and data, and for advising the development of the instrument and software. She participated in field measurement efforts using STELLA during the winter, spring, and summer months in Maryland and Alaska, USA. She introduced STELLA to the SCERIN network members during the SCERIN-10 Workshop.

Third, Dr. Campbell participated in NASA's Satellite Needs Working Group (SNWG) 2022 assessment as a subject matter expert (SME) in the Land Cover/Land Use team, conducting interviews and assessments for seven SNWG tasks. Further, she will participate in the retrospective discussion on the Satellite Needs Working Group (SNWG) 2022 assessment planned by NASA/HQ to discuss what went well and what should be changed in preparation for the 2024 assessment. She will also contribute to the lessons learned survey to help identify common issues.

Fourth, Dr. Campbell has contributed her expertise continuously for the advancement of hyperspectral remote sensing. She has been and will continue to be contributing scientific support for the advancement of the NASA Surface Biology and Geology (SBG) mission study as a member of the GSFC Team and Algorithm WG Member. During 2022, she participated in the SBG/SHIFT campaign in California, USA, working with Dr. Fred Huemmrich and a summer student intern, Sara McKnight, to analyze the data. Results were presented in the SBG session at the Second Workshop on International Cooperation in Spaceborne Imaging Spectroscopy, 10-21 October 2022, Frascati, Italy, as an oral virtual talk titled "Evaluation of the Seasonal Change in Canopy Function for Q. agrifolia, by combining AVIRIS-NG and Field Data from the SBG Spring 2022 Campaign (SHIFT) in California."

During the past several years, Dr. Campbell has installed automated field spectrometers at multiple flux sites (e.g., agricultural, forested and grassland ecosystems) to measure reflectance and solar induced fluorescence and observe the changes in the spectral responses with vegetation function. She conducted analysis of the data collection for the deciduous forest at SERC, MD and presented the results at the NASA Carbon Cycle & Ecosystems (CCE) Joint Science Workshop (JSW), May 8-12, 2023, in College Park, MD. Her presentation was titled "Combining Field Proximal and Space-borne Reflectance Time Series for Evaluation of Canopy Function and Productivity."
Fifth, Dr. Campbell has worked with and evaluated the Commercial Small Sat DESIS (CSS_DESIS). She has extensive experience working with imaging spectrometer data, including

aircraft, satellite, and ISS images. She has completed the processing and analysis of the DESIS imagery planned for the project, and, to enrich the collection, she will further expand the processing and augment the DESIS collection with additional images coinciding with flux observations.

Among other activities, during September 1, 2023 - November 30, 2023, Dr. Campbell will meet with GOFC-GOLD, MedRIN and TAT leads and coordinators to discuss the dates and activities to conduct in 2023-2024 to prepare for the next SCERIN-11 workshop. She also will meet with the STELLA team to report on the data collection and processing completed during the spring and summer of 2023 and to plan the efforts and developments for 2023-2024. She will continue to work as needed with NASA's Satellite Needs Working Group (SNWG), and her work with SBG is ongoing.

Name: Arif Albayrak
Sponsor: Batuhan Osmanoglu
Code: 618
Task: 133

Mr. Albayrak participated in InSAR Scientific Computing Environment (ISCE3) reader development, and SAR simulation activities Internal Research & Development Program (IRAD). In addition to these activities, Mr. Albayrak is also a member of the NASA Disasters group and joined these activities. First, he joined the Committee on Earth Observation Satellites (CEOS). He contributed to the White Paper for the CEOS Working Group on Information Systems and Services on ML/DL, including but not limited to machine learning operational workflow capabilities. Furthermore, he participated remotely on the first and second days of the CEOS "The 55th Meeting of the Working Group on Information Systems and Services" meeting (Argentina Cordoba). Secondly, he joined the International Telecommunication Union (UN). He has been leading the activities on AI/ML and data as a Co-Chair for the ITU/WMO Data Working Group. He is also a member of the Focus Group on AI for Natural Disaster Management (FG-AI4NDM) (ITU/UN). Also, he participated in the International Union of Geodesy and Geophysics (IUGG), where he gave an oral presentation titled "NASA'S Earth Applied Sciences Disaster Program: From disaster response to AI/ML technologies." Furthermore, he was a panelist at Fraunhofer HHI on the subject of "Digital Technologies for Advancing the Geosciences". He also joined WMO/ITU Early Warning for Disasters meeting with the ITU group.

Mr. Albayrak will continue with the above activities and groups. He also will continue work on two manuscripts, currently in progress.

Name: K. Fred Huemmrich
Sponsor: Kenneth Ranson
Code: 618
Task: 134

This task supports work on remote sensing of the Structure and Function of Ecosystems (SAFE) from Commercial Data Sources. Dr. Huemmrich leads an effort funded by the NASA Commercial Smallsat program to combine commercial spectral imaging from the DLR (German Aerospace Center) Earth Sensing Imaging Spectrometer (DESIS) on the International Space Station (ISS) to inform the retrievals and interpretation of photosynthetic and photoprotective leaf pigment contents that describe plant productivity and stress responses with forest canopy structure derived from stereo pairs of Maxar WorldView satellite images to improve retrievals of forest gross primary

production derived from eddy covariance flux towers. He extracted flux data from National Ecological Observatory Network (NEON) eddy covariance flux towers, working with NEON user support to get R code to extract flux data directly from the NEON database from 17 different forested NEON sites. He calculated gross primary productivity (GPP) from the measured net ecosystem exchange (NEE), matched the 30-minute flux data with the time of the DESIS overpasses, and calculated daily totals and midday averages of the flux variables. Using the merged DESIS reflectance and NEON flux dataset, he examined a number of approaches to relate spectral reflectance with GPP across different sites and through the seasons. Approaches included spectral vegetation indices (SVI), spectral derivatives, spectral feature analysis (SFA) which uses continuum removal techniques to quantify the characteristics of absorption features in the spectrum, and partial least squares regression (PLSR).

In a second effort for this task, Dr. Huemmrich is a member of the Science and Applications Team (SAT) for NASA's Plankton, Aerosol, Cloud, and ocean Ecosystem (PACE) mission. Although the primary objectives for PACE are directed toward the study of atmospheric and oceanic processes, by providing frequent global moderate-resolution hyperspectral observations, PACE has the potential to produce a new generation of remotely sensed products addressing key science questions on terrestrial ecosystem productivity, function, and biodiversity. He represents the remote sensing land community in the SAT and is working to define potential terrestrial products from PACE. A key challenge for the development of PACE terrestrial products is that there is little existing data that have important PACE OCI qualities of hyperspectral global observations with nearly daily temporal repeat. Therefore, this requires the development of datasets using available existing data that have aspects of the PACE data to examine the function and performance of potential product algorithm approaches. Dr. Huemmrich works with available satellite (DESIS), aircraft (Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)), and ground (Fluorescence Box (FLoX) and ASD spectrometers) measurements. He has examined seasonal patterns of foliar pigments based on SVI and related them to ecosystem productivity and stress responses for crops and forests.

In the coming months, work will continue on a paper describing the use of DESIS spectral reflectance to describe GPP of forested sites. Also, Dr. Huemmrich is presently working on an Algorithm Theoretical Basis Document (ATBD) for terrestrial ecosystem products derived from PACE.

Name: Giuseppe Zibordi
Sponsor: Brent Holben
Code: 618
Task: 151

The collaborative work performed by Dr. Giuseppe Zibordi at the Goddard Space Flight Center within the Consultancy Agreement set with SURA for the period October 2022 – July 2023 largely focused on the implementation and verification of an Automated Quality Control procedure for data products from the Ocean Color component of the Aerosol Robotic Network (AERONET-OC). The activities were centered on supporting AERONET personnel in coding the processing elements, streamlining quality control details, verifying the processing steps, and assessing results for a number of measurement sites across various marine regions. The automated quality control procedure was definitively released and made operational during late July 2023.

In view of future work centered on the generation and application of state-of-the-art sea-surface reflectance factors for the removal of sky-glint contributions in AERONET-OC measurements, a

number of meetings were held to coordinate efforts among contributing parties (i.e., the Joint Research Centre of the European Commission in Italy, and AEQUORA LDA in Portugal). Efforts were also made in creating a reference data set for the experimental assessment of AERONET-OC data products. These reference data, based on in-water radiometric profiles collected simultaneously with AERONET-OC data at the Acqua Alta Oceanographic Tower in the Adriatic Sea, will support future investigations on the performance of spectrally dependent sea surface reflectance factors.

Further activities regularly carried out during the consultancy period included i) the verification of instrument performance at the AERONET-OC sites including the effort to help establish new sites; ii) the regular verification of calibration coefficients for the AERONET-OC instruments calibrated both at the Marine Optical Laboratory of the Joint Research Centre and at Goddard Space Flight Centre; iii) multiple planning discussions with NASA personnel contributing to the forthcoming PACE mission expected to extensively leverage AERONET-OC data for validation purposes.

Name: Norm O'Neill
Sponsor: Brent Holben
Code: 618
Task: 153

As part of the GESTAR II / AERONET project, Dr. O'Neill worked as a consultant with the AERONET team (notably Brent Holben, Thomas Eck, Ilya Slutsker, David Gilles, Alexander Sinyuk and Alexander Smirnov) to characterize the precision and accuracy errors of the SDA (Spectral Deconvolution Algorithm) and the SDA/FMC (SDA / Fine Mode curvature algorithm). Part of this process involves comparisons with the partially parallel AERONET inversion algorithm. During this time, investigations were carried out with the objective of implementing the SDA+ algorithm in the AERONET processing chain (the SDA+ being an extension of the SDA from the visible to near-IR spectral region to the shortwave IR region now from the UV to NIR to the SWIR spectral regions).

An article that elaborated on the relationship between the SDA and the AERONET parameters and was informed by the GESTAR II / AERONET project was submitted to AMT in 2022 and published in March of 2023. Dr. O'Neill was first author of "Relationship between the sub-micron Fraction (SMF) and fine mode fraction (FMF): case of AERONET retrievals," which reported on a systematic AERONET-wide theoretical relationship between the (SMF) sub-micron fraction derived from the AERONET inversion and the FMF (fine mode fraction) was verified using the AERONET inversion and SDA retrievals.

Two articles that were informed by the GESTAR II activity and which employed the SDA products of fine and coarse mode aerosol optical depth as a means of verifying reanalysis simulations over the Arctic were published in ACP. Dr. O'Neill was a co-author on both publications: "Arctic spring and summertime aerosol optical depth baseline from long-term observations and model reanalyses–Part 1: Climatology and trend" and "Arctic spring and summertime aerosol optical depth baseline from long-term observations and model reanalyses–Part 2: Statistics of extreme AOD events, and implications for the impact of regional biomass burning processes."

A meeting will be held at GSFC on Sept. 5, 2023 to (i) review the status of the SDA and FMC error analysis (including plans for future papers) and (ii) plan the way forward for the VIS to SWIR version of the FMC and implementation of the SDA+ code.

Name: K. Fred Huemmrich
Sponsor: Ben Poulter
Code: 618
Task: 154

For his second task, Dr. Huemmrich has been working to develop and evaluate algorithms using spectral reflectance to describe terrestrial vegetation physiological condition, productivity, and biodiversity in support of the NASA SBG (Surface Biology and Geology) mission. He uses a variety of available existing data types that provide continuous high spectral resolution reflectances including: DLR Earth Sensing Imaging Spectrometer (DESIS) on the International Space Station (ISS), Airborne Visible/Infrared Imaging Spectrometer Next Generation (AVIRIS-NG) imagery from aircraft, and ground measuring Fluorescence Box (FLoX) and ASD spectrometers. In addition, he works with data from existing networks of eddy covariance flux towers to describe spatial and temporal patterns of ecosystem productivity. He also measures leaf level spectral reflectance and transmittance using an integrating sphere and FluoWat leaf clip.

Dr. Huemmrich collected leaf level and ground canopy level measurements in Fairbanks, AK in April 2023 in conjunction with AVIRIS-NG flights that were part of the SnowEx campaign. The goal of this work is to describe spectral changes in evergreen spruce associated with the springtime onset of photosynthetic activity in these trees and to develop approaches to detect these changes in the presence of a snow background.

For the upcoming months, Dr. Huemmrich will work with the reprocessed AVIRIS-NG imagery collected in the spring at the National Ecological Observatory Network (NEON) eddy covariance flux towers at Delta Junction and Caribou Creek, Alaska to examine approaches for detecting the onset of photosynthesis in the boreal conifers.

Name: K. Fred Huemmrich
Sponsor: James Mackinnon
Code: 618
Task: 158

Dr. Huemmrich works on a third task as well. The Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System (CASALS) project is combining lidar descriptions of topography and vegetation structure with visible to shortwave-infrared spectral imaging of foliar biochemistry to improve descriptions of forest function, productivity, and stress responses. Machine learning (ML) approaches are being applied to merge these diverse data types and evaluate the significance of different inputs. For the development of datasets for training and testing the ML approaches, Dr. Huemmrich has worked with eddy covariance flux tower observations, advised on the use of spectral vegetation indices, and helped in choosing the array of input variables. He has also aided in the interpretation of the modeling results. Dr. Huemmrich has also examined diurnal change in spectral vegetation indices, canopy light environment, and productivity for corn and soybean crops at different times in the growing season.

Looking ahead, Dr. Huemmrich is working with the National Ecological Observatory Network (NEON) Assignable Assets group to attempt to get the NEON Airborne Observation Platform (AOP), which flies lidar, high resolution digital camera, and imaging spectrometer, to collect observations over flux towers at multiple times of the day to provide inputs for the CASALS ML models.

Name: Ameni Mkaouar Chaaben
Sponsor: Christopher Neigh
Code: 618
Task: 166

Dr. Mkaouar has been assessing the geo-localization accuracy of the Global Ecosystems Dynamics Investigator (GEDI). Her analysis primarily revolves around employing the discrete anisotropic radiative transfer (DART) model to comprehensively evaluate and rectify geolocation errors in the GEDI LiDAR system. This holds significant implications for potential future LiDAR instruments considered for the Surface Topography and Vegetation (STV) targeted observation.

Dr. Mkaouar visited the DART team at the CESBIO laboratory in Toulouse, France, fostering collaboration and discussions on project priorities. The DART model is employed with GEDI parameters, incorporating the corresponding pointing vector and sensor position to simulate full waveforms. This effectively captures the interactions between LiDAR signals and the 3D vegetation structure. Through full-waveform comparison, the simulated and observed GEDI waveforms are juxtaposed within a local search area surrounding each footprint. This approach facilitates precise quantification of the geolocation error for nearly all GEDI footprints within the study area. Dr. Mkaouar has submitted an abstract to the American Geophysical Union (AGU) for a presentation at the 2023 AGU Fall Meeting.

Looking ahead, her intended activities encompass testing this method on a broader scene as well as other sites, and subsequently leveraging the findings to write a journal paper. As part of her future research endeavors, she plans to advance investigations by merging LIDAR data with high-resolution images to enhance the estimation of vegetation structure. This integration of complementary data sources holds the potential to provide a more comprehensive and accurate understanding of the characteristics of vegetation within various environments.

Name: Seohui Park
Sponsor: Pawan Gupta
Code: 618
Task: 173

Since joining GESTAR II in early July 2023, Dr. Park has been working on studying the effects of the Canada wildfires on the U.S. air quality using GOES-R AOD and AERONET AOD. This research is ongoing. Also, Dr. Park will be working to evaluate hourly $PM_{2.5}$ forecasting results at U.S. embassy locations. The NASA HAQAST team in partnership with the U.S. State Department is developing the City Air quality foREcasting and analysis System (CARES). The innovation of CARES is the application of a Machine Learning Model Output Statistics (ML-MOS) framework to statistically calibrate on a point-by-point basis, thus significantly improving the NASA Goddard Earth Observing System Model global outputs for individual US Department of State post locations.

In the coming months, Dr. Park will be participating in the CARES project for validating the developed model output with ground in-situ measurement for improving the model's performance.

CODE 698: PLANETARY GEODYNAMICS LABORATORY

Name: Robert Tyler
Sponsor: Erwan Mazarico
Code: 698
Task: 121

Dr. Tyler's tidal research was three-fold. He documented and distributed orbital integration software he previously developed and used for calculating the Earth-Moon tidal evolution. He also served as an external reviewer for a Ph.D. examination on a similar subject at U. Paris/Paris Observatory.

For his work with NSF, under "Ocean tidal generated magnetic fields" (PI: R. Tyler), he has led work on extracting ocean variability from historical geomagnetic records. His colleague Dr. Trossman has led work on estimating the utility of assimilating magnetic data in ocean models. Two talks on these subjects were given by Dr. Tyler at IUGG, Berlin, July 2023.

Dr. Tyler also conducted the estimation of the mass/gravity anomalies due to tides on Jupiter (part of a GSFC ISFM grant, PI: R. Tyler).
Dr. Tyler became a NASA Civil Servant in early August 2023.

CODE 61A: GEODESY AND GEOPHYSICS LABORATORY

Name: Erricos Pavlis
Sponsor: Stephen Merkowitz
Code: 61A
Task: 128

Dr. Pavlis and his colleagues, Dr. Magda Kuzmicz-Cieslak and Mr. Keith Evans, carried out the daily and weekly analysis of sea-level rise (SLR) data and the combination of products from the International Laser Ranging Service (ILRS) network throughout the reporting period, and they delivered analysis and combination products to the ILRS archives at CDDIS and EDC. They additionally supported the ILRS Central Bureau operations and the ILRS Network of stations, performing the required validation and qualification tests for systems in quarantine or newly installed systems. They attended the ILRS Central Bureau (CB) and Quality Control Board (QCB) telecoms monthly and bimonthly, respectively. Dr. Pavlis attended in person the international meetings REFAG2022 and the Unified Analysis Workshop (UAW2022) in Thessaloniki, GR (October 17-23), presenting "The ILRS Analysis Standing Committee Contribution to ITRF2020" and organizing and co-chairing two sessions of UAW2022. He also attended (virtually) the 2022 ILRS Workshop, Guadalajara, Spain, November 6-11, presenting "Enhanced ILRS analysis for ITRF2020" and "The LARES 2 satellite for testing general relativity successfully placed in orbit with VEGA C". On November 6, 2022, they attended the annual ILRS Governing Board meeting that was held virtually as a teleconference. They attended virtually the Fall AGU meeting (Chicago, IL, Dec. 10-16) and presented (oral) "ITRF2020: The ILRS Contribution and Operational Implementation" and the poster "An Addition to the Suite of Geodetic Satellites Supporting the ITRF: LARES-2". They also attended virtually the sessions of EGU2023 (Vienna, Austria, April 22-28, 2022), and presented "Implementation of ITRF2020 in the ILRS Operational Products" and the poster "Incorporating LARES-2 SLR Data in ILRS Products for ITRF Development". On April 26, 2023, the group participated in a virtual online meeting of the ILRS ASC. This meeting reviewed the implementation plans for the ITRF2020 model in all ILRS products.

Their international collaboration since 1996 with the Italian groups at the Rome University "La Sapienza" and the University of Salento (which led to the launch of the LARES mission in 2012) continued after the successful launch of the LARES-2 follow-on mission on July 13, 2022, with ESA's latest rocket, VEGA-C. They have now moved into the full analysis of the ranging data since the launch, with the intention to support the ITRF development as well as the project on relativistic experiments and fundamental physics in general.

The upcoming plans for their SLR work are to begin the implementation of the new ITRF2020 for all ILRS products that will ensure the extension and maintenance of the a priori error model based on the results of the "Station Systematic Error Model Pilot Project—SSEM PP" and the establishment of the new product series (SSEM-X), its implementation in ITRF2020 and the transition to a routine service-like process. In the coming year, they also will include LARES-2 and LARES data in the operational ILRS products and establish a new series that will deliver weekly averaged low degree and order spherical harmonics based exclusively on SLR data.

II. Student Programs

GESTAR II MSU Undergraduate Fellowship

The GESTAR II Undergraduate Fellowship provides Morgan State University (MSU) students with the opportunity to explore and apply their skills in projects alongside GESTAR II mentors. It provides financial support, including a stipend and conference costs. This year, Erica McGrath-Spangler, Nikki Privé, Ian Carroll, Andrew Sayer, and Dhruva Kathuria supported Morgan State's new Climate Science Division by providing lectures to demonstrate applied technical skills utilized in earth sciences. This provided students with an opportunity to not only learn more about earth sciences, but also allowed them to gain a deeper knowledge of how their specialized skills can be utilized in the field.

This year, selected undergraduate students from Morgan State University are working with research scientists on the following projects:

Student	Major	Research Mentor(s)	Research Title
Ajan Coleman	Computer Science	Dhruva Kathuria (618/MSU)	Surface Biology and Geology (SBG) mission related research
Ahsan Fludd (through 8/11/23)	Biology	Erica McGrath-Spangler and Nikki Privé (both 610.1/MSU)	Connecting Observation Impact Studies with the Real World
Olamilekan Sulaiman	Computer Science	Thomas Stanley (617/UMBC)	Landslide Research
Micah Wallace	Computer Science	Ian Carroll and Andy Sayer (both 616/UMBC)	Can neural networks learn to see airborne dust and sand in thermal satellite imagery?

GESTAR II Graduate Fellowship

GESTAR II has a strong commitment to supporting education and outreach and fostering collaboration between GESTAR II scientists and students at partner universities. The GESTAR II graduate fellowship is one of the most important components of GESTAR II's education/outreach program. It provides financial support, including student stipend, health insurance and tuition, to a graduate student for a full academic year to work on a research project who is co-advised by a GESTAR II scientist and an academic advisor. From 2022 to present, GESTAR II has funded three graduate students at UMBC and Colorado State University (CSU) through the GESTAR II graduate fellowship.

Student	Major/University	GESTAR II Scientist(s) and Academic Advisor(s)	Research Title
Chhaya Kulkarni (7/30/23 – 7/27/24)	Information Systems/University of Maryland, Baltimore County	Nikki Prive' (610.1/MSU), Vandana Janeja (UMBC Advisor)	Estimating Radiance Observation Uncertainties from Spatial Footprints
Yu-An Chen (7/30/23 – 7/27/24)	Atmospheric Sciences/Colorado State University	Stephen Guimond, Peter Jan van Leeuwen (CSU Advisor), Chris Slocum, and Steven Miller	Hurricane Dynamics and Predictability: Coupling boundary-layer to cloud observations in a Nonlinear Data Assimilation Framework
Xingyan Li (7/31/22 – 7/29/23)	Information Systems/University of Maryland, Baltimore County	Andy Sayer (616/UMBC), Jianwu Wang (UMBC Advisor)	Towards a neural network cloud mask for the future NASA PACE OCI

III. Supplemental Information

Awards & Recognition

Nishan Biswas was a recipient of a NASA HBG Annual Peer Award for Science/Technical Support (2022), NASA GSFC.

Anthony Campbell received a Code 618 Award for Best Publication – First Author Non-Civil Servant, for the November 2022 publication "Global hotspots of salt marsh change and carbon emissions."

Ian Carroll received a 2023 Hydrosphere, Biosphere, and Geophysics (HBG) Annual Peer Award: Outreach in August 2023.

On Feb 10, 2023, **Myungje Choi** received Outstanding Scientific Support Award – "*For his sustained high-quality work on the calibration of high-resolution commercial sensors*" from NASA Goddard Space Flight Center (GSFC) Climate and Radiation Laboratory.

In February 2023, **Susanne Craig** received a Robert H. Goddard Award, which NASA awarded to the NASA EXPORTS Science Team on which Susanne Craig acted as Data Manager from 2018-2020. This international mission investigated the export of carbon to the deep ocean.

In September 2022, **Susanne Craig** received a NASA Robert H. Goddard Award for Exceptional Achievement for Science, which was awarded to The PACE project Science Team, for outstanding efforts that contributed to the PACE mission reaching Phase C.

In October 2022, **Denis Felikson** received a NASA GSFC 610 HBG Award for Scientific Achievement Award for Being a Champion of Open Sea Level Science.

Reem Hannun received a 2022 NASA Goddard Atmospheres Distinguished Contribution Group Award.

Christoph Keller received the 2021 ACP Paul Crutzen Publication Award for the outstanding paper "Global Impact of COVID-19 restrictions on the surface concentrations of nitrogen dioxide and ozone" (9/26/22): https://www.atmospheric-chemistry-and-physics.net/about/news_and_press/2022-09-29_the-inaugural-acp-paul-crutzen-publication-award.html

Christoph Keller was recognized for the Top Cited Article 2021-2022 in Journal of Advances in Modeling Earth Systems for the paper "Description of the NASA GEOS Composition Forecast Modeling System GEOS-CF v1.0" (Dr. Keller was informed of this on 02/21/23.)

K. Emma Knowland was recognized in Sept 2022 with the 2021 ACP Paul Crutzen Publication Award for the outstanding paper "Global Impact of COVID-19 restrictions on the surface concentrations of nitrogen dioxide and ozone" led by **Christoph Keller**:

Keller, C. A., M. J. Evans**, K. E. Knowland**, C. A. Hasenkopf, S. Modekurty, R. A. Lucchesi, T. Oda, B. B. Franca, F. C. Mandarino, M. V. Díaz Suárez, R. G. Ryan, L. H. Fakes, and S. Pawson. 2021. "Global impact of COVID-19 restrictions on the surface concentrations of nitrogen dioxide

and ozone." Atmospheric Chemistry and Physics, 21 (5): 3555-3592 [10.5194/acp-21-3555-2021]

Goutam Konapala received an HBG Peer Award, Greenbelt, Maryland, in August 2023.

Alexander Kotsakis received a Certificate of Appreciation for contributions to the NASA Student Airborne Research Program, Newport News, VA on 07/28/23.

Jae N. Lee received a "Certificate of Recognition for 2023 Senior Review Completion" by NASA ESD, 05/30/2023.

Cheng-Hsuan Lyu was a co-recipient of a 2023 NASA Robert H. Goddard team award for the team's hard work and dedication in helping to launch and successfully commission JPSS-2, involving the JPSS-2 Instrument and Imagery Calibration and Validation Teams.

Fadji Zaouna Maina will be receiving a NASA GSFC Hydrosphere, Biosphere, Geophysics (HBG) Peer Award for Scientific Achievement, August 2023.

Norm O'Neill was awarded the status of Emeritus professor at his home university, Universite' de Sherbrooke, Canada, in late September of 2022. The development and testing of the SDA over the years with the AERONET group (including the GESTAR II – AERONET project) was an important distinction in the case for the emeritus professor status.

Elijah Orland is a recipient of the 2023 HBG Peer Award for Scientific Achievement, August 2023.

Nikki Privé received a 2022 Global Modeling and Assimilation Office Peer Award for Business Support.

Thomas Stanley received an HBG 2023 Peer Award for Scientific Achievement, Greenbelt, Maryland.

L. Larrabee Strow was named 2022-2023 Research Professor of the Year by UMBC: https://facultystaffawards.umbc.edu/2022-2023-umbc-research-faculty-excellence-award/

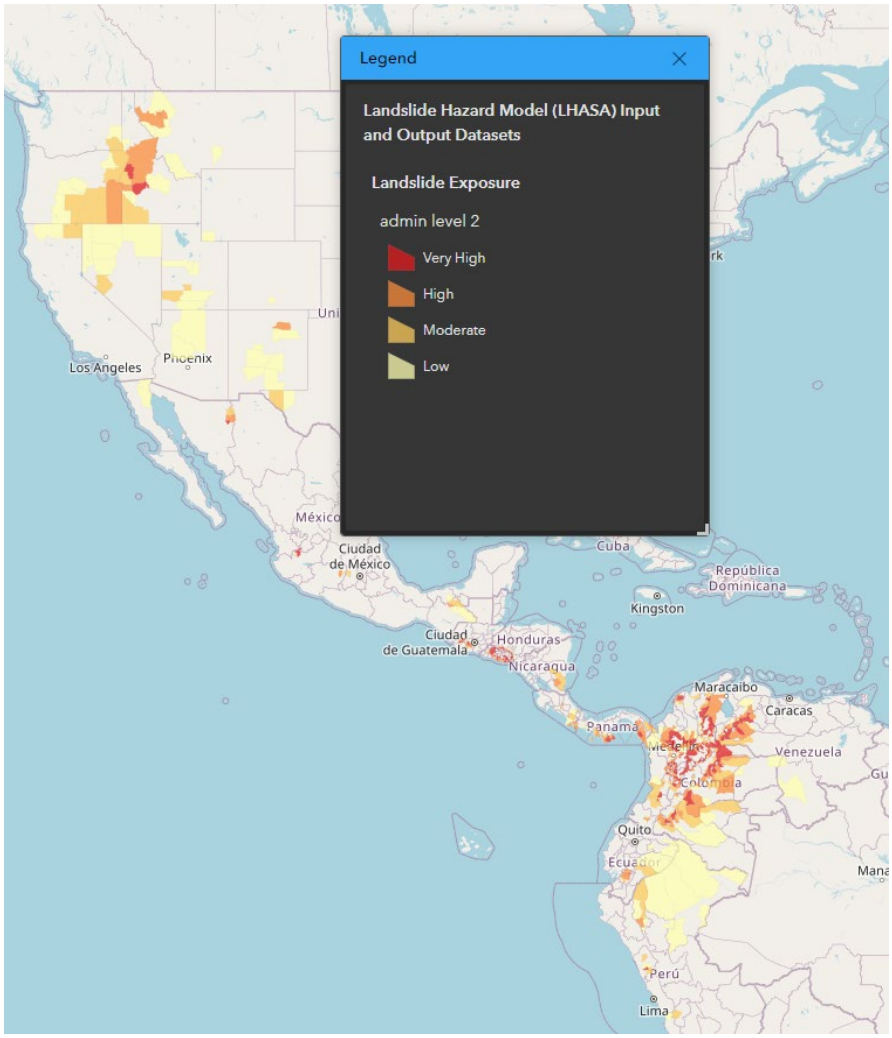
Andrew Swanson received a NASA GSFC Earth Sciences Division, Atmospheres, Distinguished Contribution Award for his contributions to the design, development, and first successful flight of the GSFC Code 614 In Situ Lab's NO2 Sonde Instrument in December 2022. For the same project, for which NASA is currently pursuing a patent, Mr. Swanson was listed as an innovator on the agency's Disclosure of Invention and New Technology in 2020.

In December 2022, **Ghassan Taha** received the NASA GSFC 610AT Peer award for Best Science Highlight or Nugget.

Ghassan Taha received a Morgan State University award in recognition of his role as a principal investigator and contribution to advancing research at MSU.

Jerald Ziemke was recognized for best senior paper of 2022 at the NASA GSFC Code 610AT Peer Awards in December 2022.

This year, the Landslide Hazard Assessment for Situational Awareness system (LHASA) was recognized with the NASA 2023 Software of the Year Award. Among the team awardees are **Thomas Stanley**, **Pukar Amatya,** and **Robert Emberson**. (Note, this award is derived from a previous software release for LHASA 2.0.) This award was announced the week of August 14, 2023; a NASA press release was very recently posted online: https://www.nasa.gov/feature/goddard/2023/goddard-team-wins-nasa-2023-software-of-the-year-award.



From the Landslide Viewer website, August 22, 2023 (https://landslides.nasa.gov/viewer).

This map shows the proportion of the human population exposed to landslide hazard in each county. To do so, LHASA generates a map of landslide hazard with a one-kilometer grid resolution. Then it determines what locations may be exposed at a "Moderate" level (p>50%) and totals the potentially affected population and road length. These estimates are available for most of the world within hours of a given rainfall event. Users of the Landslide Viewer web app can see other statistics, such as road exposure, by clicking on the county (2nd level administrative district) of interest. (Text and graphic provided by T. Stanley.)

Outreach

Arif Albayrak and Batuhan Osmanoglu (GSFC) are mentoring Cesar Rojas (PhD student at Florida International University) on subjects such as Combining Remote and In-situ Sensing for Autonomous Underwater Vehicle Localization and Navigation.

In October 2022, **Amanda Armstrong** visited 4 and 5th grade elementary classes and gave a lecture on what satellites measure and how different types make measurements. This was an age-appropriate lecture and activity. In the corresponding activity that Dr. Armstrong led, students worked in small groups to research their satellite measurement interests, then they used legos to build their own satellite and presented to the class what their satellites measured.

In May 2023, **Amanda Armstrong** visited three Burley Middle School 8th grade science classes, lecturing on the electromagnetic spectrum and how it forms the basis for what we measure with satellite and airborne sensors. The term remote sensing was also defined and explored. During the 90-minute class block, students then accomplished online research and worked in small groups to draw their own satellite and discuss with classmates about what they would use their satellite to measure and why.

Amanda Armstrong mentored one third-year University of Virginia (UVA) undergraduate student during the fall semester of the 2022-2023 academic year. The student worked to build a new parameterization for the SIBBORK model for Virginia forests under Dr. Armstrong's direction.

Amanda Armstrong mentored another third-year UVA undergraduate student during the spring semester of the 2022-2023 academic year. The student worked to finish building the Virginia forest parameterization for the SIBBORK model and then tested the model under Dr. Armstrong's direction.

Amanda Armstrong mentored a first-year UVA Undergraduate student during the spring semester of the 2022-2023 academic year. In this mentorship, Dr. Armstrong met with the student weekly to discuss assigned readings to learn about ecological modeling and individual based gap models. The student then worked to build a database of model parameters for existing gap models.

As part of her ABoVE Phase 2 project, **Amanda Armstrong** co-advises a PhD candidate at the UVA. The ABD doctoral candidate is progressing in her dissertation research and is expected to defend her dissertation and graduate during the coming 2023-2024 academic year.

Amanda Armstrong also advised a PhD candidate at George Mason University. Dr. Bradley Gay joined Dr. Armstrong's team during the Covid pandemic, as part of the first remote summer interns at NASA (summer 2020). Dr. Gay then remained a team member, using the SIBBORK model in his dissertation research, with Dr. Armstrong taking an active role in his mentorship as a committee member. Dr. Gay defended his dissertation in March 2023, graduated in May 2023 and then moved to a postdoctoral position at NASA's Jet Propulsion Laboratory in June 2023.

Anthony Campbell mentored two students in Summer 2023.

Petya Campbell (618/UMBC) contributed to the Graduate Advising Committee of the following graduate students: Mumin Abdulahi (Ph.D., UMBC, USA; Supervisor: Dr. B. Demoz); Paul

William Hacker (Ph.D., UBC, Canada; Supervisor: Dr. N. Coops) and Paulina Anna Rajewicz (Ph.D., UH, Finland; Supervisor: Dr. A. Porcar-Castell).

Petya Campbell (618/UMBC) mentored one NASA/GSFC Summer Student Intern in 2022 and 2023: Sara McNight (UNL, Lincoln, NE, USA). She hosted one visiting scholar in November 2022: Dr. Petr Lukes (Global Change Research Institute of the Czech Academy of Sciences (GCRI), Brno, CZ)

Ian Carroll was a Co-mentor to Xingyan Li, GESTAR II Graduate Fellow for 2022-2023 and a Co-mentor to Micah Wallace, GESTAR II MSU Undergraduate Fellow for 2023-2024, with **Andrew Sayer**.

Ian Carroll was a Coding mentor for the inaugural Student Airborne Research Program (SARP-East) 2023 Summer Program in Newport News, VA.

Ivona Cetinić gave a presentation regarding PACE, "Observing the Invisible Ocean Life from Space" as part of NASA STEM - An Evening with NASA Scientists and Engineers, October 20, 2022.

Ivona Cetinić participated in 3G Ready with NASA, NASA outreach event for Girls, Gigabyte and Gadgets, National Harbor, MD, October 6, 2022.

Ivona Cetinić participated in "Meet at Scientist" – "Djevojčice u STEM-u: Upoznaj znanstvenicu!", Girls in STEM, February 13, 2023.

Ivona Cetinić participated in NASA Earth Day at Union Station, Washington, DC, April 20, 2023.

Ivona Cetinić was on the Ph.D. committee - *Examinatrice*, for Louis Terrats, Sorbonne Universite, December 2, 2022.

Ivona Cetinić was on the Ph.D. committee - *Examinatrice*, for Fabian Ricour, Sorbonne Universite & Liege Universite, May 23, 2023.

J. Blake Clark presented as an invited speaker to the University of California - Davis Agricultural and Environmental Chemistry Graduate Group Fall 2022 Seminar Series with a talk titled "Organic Carbon Transport and Transformation in the Changing Coastal Arctic" on November 14, 2022.

J. Blake Clark is a co-author/mentor and will serve, if selected, on two NASA FINESST Proposals for Tina Geller (U Colorado, Boulder; Advisor Dr. Julia Moriarty) and Alyssa Burns (UC-Davis, Advisor Dr. Peter Hernes) that are being reviewed.

J. Blake Clark attended the Ocean Carbon Biogeochemistry (OCB) C-Saw workshop in Raleigh, NC to share his and his colleagues' work on understanding storm driven fluxes on coastal water quality and carbon.

Susanne Craig served as a Faculty Mentor for the inaugural year of the Student Airborne Research Program East (SARP East, https://baeri.org/sarp/). SARP West has been running for the last 14-years and NASA HQ and leadership at GSFC are developing its sister program here in the Chesapeake Bay area. SARP recruited rising seniors from diverse backgrounds to participate in a 2-month long residential summer school during June-July 2023. The students participated in research flights out of NASA Langley, and terrestrial and aquatic studies around the Chesapeake Bay area, centered at Virginia Commonwealth University's Rice Rivers Center. Dr. Craig was the science

lead for the aquatic studies and, along with other faculty mentors, developed a program of student research projects that investigated various biogeochemical and optical properties of the water bodies from the James River down to the Chesapeake Bay. The overall focus of SARP is on the coupled human natural system of the Surf, Turf, Above the Earth and how they fit together, with a strong interdisciplinary slant that involves surface to space, nose height to satellite, ground to geostationary. The summer school culminated with the students presenting their individual research projects as a poster presentation and then forming small groups that developed a NASA Interdisciplinary Science (IDS)-style research proposal. Dr. Craig closely supervised these groups and was part of a team of Faculty Mentors that helped the students prepare the research proposals for their final presentations on graduation day. She has continued to mentor her students, with many of them presenting their work at the upcoming AGU 2023 Meeting in San Francisco, CA.

Akiko Elders virtually presented "Estimating crop type and yield using multi day sentinel 2," during Earth Science Week at GSFC, October 11 2022.

Akiko Elders gave the Keynote speech at Prince George's Area Science Fair, March 18, 2023, Flower High School, Springdale, MD.

Denis Felikson served as external Ph.D. advisor to the following students: Ana Luzardi, Univ. at Buffalo; Mikayla Pascual, Univ. of Texas at Austin; and, Christian Taubenberger, The Johns Hopkins University.

Andrew Fox co-supervised post-doctoral research assistant Xueli Luo (University of Arizona) until she began a new position at University of Utah.

Mircea Grecu participated in the GPM mentorship program (https://www.watersheds.online/gpm-mentorship-2023/). He delivered two lectures and participated in the group mentorship of six participants.

Steve Guimond gave a lecture at "The Jemicy School" on 9/27/2022 to 8th graders interested in STEM. The title was "What Can You Do with The Material You Learn in School? A Case Study from An Atmospheric Physicist".

Mei Han mentored a graduate student in the GPM mentorship program in 2023.

Reem Hannun mentored four undergraduate students and one graduate student during the reporting period.

K. Fred Huemmrich was a Committee Member of a Ph.D. Dissertation by Gillian Simpson, titled "Drivers of peatland CO2 balance: a fusion of UAV remote sensing and micrometeorology," date of thesis defense: October 25, 2022.

K. Fred Huemmrich was a Committee Member of a M.S. Thesis by Rebeca Campos Valverde, titled "Observations of Sun-Induced Chlorophyll fluorescence (SIF), Photochemical Reflectance Index (PRI) and Chlorophyll:Carotenoid Index (CCI) during spring recovery in two evergreen conifers from the Boreal Forest," date of thesis defense: August 31, 2022.

K. Fred Huemmrich gave a virtual talk titled "Remote Sensing of Ecosystems from the International Space Station", as a Joint Center for Earth Systems Technology presentation to UMBC Geography and Environmental Science Students, Dec. 7, 2022.

K. Fred Huemmrich (618/UMBC) is mentoring two PhD students from Virginia Tech.

At the Goddard Visitor Center, Greenbelt, MD, **Daeho Jin** presented "Introduction of NASA GSFC and the life of a NASA earth scientist" to students from South Korea who were on an international field trip to the U.S.: 1) Jeonbuk Science High School, 05/02/2023; 2) Chungbuk Science High School, 05/16/2023; 3) Kyoungsan Science High School, 05/22/2023; and 4) Incheon Science High School, 06/02/2023.

Dhruva Kathuria is mentoring undergraduate student Ajan Coleman from Morgan State University as part of the GESTAR II undergraduate fellowship program. This student will work on retrieving and compiling leaf hyperspectral reflectance data along with the associated insitu measurements of multiple plant functional traits associated with chemical, physiological and structural properties of leaves from publicly available data repositories.

Christoph Keller mentored three graduate students: Makoto Kelp (Harvard University), Obin Sturm (University of Southern California), Noussair Lazrak (New York University).

K. Emma Knowland participated in GMAO's ocean-salinity demonstration at STEM event as part of Girls, Gigabytes, & Gadgets, National Organization of Black Elected Legislative Women's (N.O.B.E.L. Women), https://www.nobel-women.org, Annual Legislative Conference (ALC), MGM Hotel, Washington, DC, October 5, 2022

K. Emma Knowland led a discussion on climate and creation care at her church, St. Monica and St. James Episcopal Church, Washington, DC, February 25, 2023.

K. Emma Knowland was a panel member at the seventh annual University of Maryland Baltimore County (UMBC) Earth Day Symposium, held on April 21, 2023 at UMBC (https://eds.umbc.edu/eds-2023/).

Alexander Kotsakis was invited to the National Weather Service office in Indianapolis, IN to give an overview talk on air quality and how to better forecast poor air quality events on July 13, 2023.

Young-Kwon Lim has been serving as a dissertation committee member for mentoring a doctoral student from the University of Colorado. The student's dissertation is tentatively titled "Examination of the impact of ocean subsurface data assimilation on MJO propagation across the Maritime Continent in ECMWF subseasonal forecasts."

Young-Kwon Lim is also mentoring a post-doctoral scientist working at Oak Ridge National Laboratory to help conduct research on the role of global modes of variability to climate in high mountain Asia.

Eunjee Lee hosted a short visit of a graduate student (Hocheol Seo) from Yonsei University in South Korea to UMBC and GSFC in March 2023. She arranged the student's presentation at the land group meeting at NASA GMAO and organized several meetings that discussed an ongoing collaboration (wildfire modeling).

Jae N. Lee hosted a TSIS-2 (Total and Spectral Solar Irradiance Sensor -2) booth at the NASA exhibition, handed out new mission information and promoted NASA Sun-Climate Symposium 2023, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023

Jae N. Lee served as an organizing committee of the Sun-Climate Symposium 2023, which will be held in Flagstaff, AZ during 10/15-20, 2023.

Fadji Zaouna Maina serves as a Jury Member of the UNESCO-AI Fozan Prize for the Promotion of Young Scientists in STEM. She was appointed by the UNESCO Director-General (2022-present) https://www.unesco.org/en/articles/unesco-and-al-fozan-foundation-create-new-prize-support-young-scientists.

On January 12, 2023, **Fadji Zaouna Maina** attended "Eye on the Future," an event organized by UNESCO to promote STEM careers in Riyadh, Saudi Arabia. She was a panelist alongside Nobel laureate Didier Queloz and Canadian scientist Edna Matta-Camacho. More information about the event can be found here: World's great science minds inspire Saudi students at Mawhiba event.

On September 8, 2022, **Fadji Zaouna Maina** was a panelist at an event organized by AGU H3S on academic and non-academic careers: AGU Panel: Navigating Academic Waters Panel with AGU H3S: Navigating Non-Academic Waters

Carl Malings served as a volunteer judge for the 2022 NASA TechRise Student Challenge, November 2022.

Carl Malings served as a Volunteer Coordinator for AGU 2022 Outstanding Student Presentation Awards (OSPA) for Atmospheric Chemistry section, December 2022.

Carl Malings served as a Volunteer judge for the Meteorology and Climate Modeling for Air Quality Conference early-career poster awards, September 2023.

J. Vanderlei Martins's task involves mentoring and experiential learning of two graduate students: Noah Sienkiewiscz and Rachel Smith, both Ph.D. students in Atmospheric Physics at UMBC. These students are placed in professional environments and function as peers with established instrument scientists stationed at UMBC and at Goddard, picking up knowledge, skills and experience along the way. The students are responsible for data collection, development of software infrastructure, analysis and interpreting results. Noah Sienkiewiscz and Rachel Smith also provided leadership for UMBC's Earth Day symposium, while Dr. Martins and other professionals participated in Earth Day with tours, demonstrations and sitting on the panel discussion.

Erica McGrath-Spangler co-mentored a Morgan State University intern with **Nikki Privé** through the GESTAR II undergraduate internship over the summer session 2023.

Norm O'Neill's PhD student Keyvan Ranjbar was directly involved in the coding and analysis of the SDA algorithm that was delivered to AERONET and was a key part of the GESTAR II – AERONET project.

Erricos Pavlis served as a PhD dissertation committee member for Mr. V. Massinas, Nat. Tech. Univ. of Athens, Greece.

Nikki Privé attended Morgan State University Career Fair on April 12, 2023, to discuss GESTAR II internship opportunities with students.

Nikki Privé presented a virtual seminar for undergraduate and graduate students at University of California - Berkeley on government career paths, April 4, 2023.

Nikki Privé gave a presentation for the Morgan Climate Science/GESTAR II Internships seminar series with **Erica McGrath-Spangler** on April 24, 2023.

Lorraine Remer served as a Panelist at the UMBC Earth Day Symposium, which was held on the UMBC campus, April 2023. This is an annual student-led all-day activity.

Andrew Sayer is mentoring two students, Micah Wallace (an undergraduate at MSU) and Xingyan Li (a doctoral student at UMBC), jointly with **Ian Carroll**, on GESTAR II Fellowships.

Andrew Sayer also (remotely) presented about NASA and space to children at James Allen's Girls' School in London, UK.

Bridget Seegers along with Dr. Blake Schaeffer at US EPA led an Applied Remote Sensing Training (ARSET) titled "Monitoring Water Quality of Inland Lakes using Remote Sensing with a focus on the Cyanobacteria Assessment Network (CyAN)" on July 20, 2023. The training included how to access the satellite data and extended Q&A sessions. The training across two sessions had 688 total participants representing 91 countries and 27 U.S. states.
https://www.youtube.com/watch?v=eFQz6qmbsok

Bridget Seegers was a science advisor for NASA DEVELOP, co-advising students on a project titled "PACE Water Resources." DEVELOP is part of NASA's Applied Sciences' Capacity Building Program (June-August 2023).

Bridget Seegers participated in a short remote interview for Elkhorn Area High School in Elkhorn, Wisconsin on April 11, 2023. She originally attended this high school, and the conversation focused on how she became a research scientist.
https://www.youtube.com/watch?v=vtDMC32yRKA&feature=youtu.be&themeRefresh=1

Bridget Seegers provided an Audio Recording to be the 'voice' for the opening of the Ocean Mural of Street Art for Mankind in Houston titled "THE OCEAN / OUR TEACHER / OUR HEALER / OUR LIFE" that was held on December 10, 2022.

Bridget Seegers is serving as a science advisor to an American University student earning a Masters in Environment Filmmaking developing a documentary focused on harmful algal blooms. (January 2023 - present).

Bridget Seegers will be co-leading a webinar for The Association of State Drinking Water Administrators on September 19, 2023. The webinar, which will focus on harmful algal blooms, is titled "CyAN Potential Satellite Monitoring of Drinking Water Sources."

Yingxi Shi mentored one PhD student in 2022-2023 and two summer NASA interns.

Christopher A. Shuman (615/UMBC) gave a virtual presentation to Code 615 titled "Landsat Tracks Iceberg B-22A, Amundsen Sea Embayment, 2017 to 2023" on July 28, 2023.

Christopher A. Shuman (615/UMBC) was a guest lecturer on "50+ Years of Landsat Highlighting the Joint NASA/USGS Program For Earth Imaging", University of Maryland, College Park, Geography 172, July 25, 2023.

Christopher A. Shuman (615/UMBC) contributed to "Earth Day 2023: Explore Your World with NASA's Worldview," https://www.earthdata.nasa.gov/news/earth-day-2023-campaign, April 24, 2023.

On April 21, 2023, **Inia Soto Ramos** volunteered at the PACE table for Earth Day.

Inia Soto Ramos guided PACE tours during the President's One Marine Band PACE fanfare performance.

Inia Soto Ramos gave a short presentation about PACE to a cohort of graduate students (science writing) from The Johns Hopkins University on July 11th, 2023.

Inia Soto Ramos was a guest speaker at Mote's Marine Lab Career Virtual Panel on July 11th, 2023.

Inia Soto Ramos met with SARP-East students on July 11, 2023.

Inia Soto Ramos was invited to the NSF LSAMP Principal Investigator and Project Director Meeting and NSF LSAMP Bridge to the Doctorate 20th Anniversary Day of Recognition, June 1-4, 2023, at the Capital Hilton in Washington DC, and served as mentor for the current BD doctoral students via roundtable discussions on Saturday, June 3, from 3p-4p ET.

Jason St. Clair interacted continuously with SARP East undergraduate students during the in situ aircraft measurement period (~ 1 week), as well as gave a lab tour when they visited GSFC. The interaction ranged from career and graduate school advice to field campaign stories to coding and data processing instruction.

Jason St. Clair mentored two graduate students who are working with our group during the NOAA AEROMMA project, one from University of Maryland, College Park and one from Georgia Tech.

Thomas Stanley advised a midshipman from the US Naval Academy for a one-month-long internship.

Thomas Stanley also advised an undergraduate student from Morgan State University for a summer fellowship 2023.

Sarah Strode recorded a virtual presentation on "Using the NASA Chemistry Climate Model for Future Climate Simulations" for the NASA exhibit at the International Conference for High Performance Computing, Networking, Storage, and Analysis (SC22) in Dallas, TX Nov. 14-17, 2022 (https://www.nas.nasa.gov/SC22/).

On May 31, 2023, **Anne Thompson** visited the 100-year old Lerwick (Scotland) meteorological Observatory on the Shetland Islands, the northernmost weather station in the UK, and participated in the weekly ozonesonde launch. She also gave UK Meteo. Office station staff a presentation on "Ozonesondes: What, Where and the Latest Quality Assurance Research."

Anne Thompson participated in NASA Goddard 610 Mentoring Circle from October 2022 to July 2023.

Since February 2023, **Anne Thompson** and Ryan Stauffer have been co-mentoring the UMBC senior Joshua Richards on the analysis of the 2004-2022 Beltsville ozonesonde record. This mentoring will continue with Mr. Richards starting the Atmospheric Physics graduate program at UMBC in August 2023.

Ali Tokay was a mentor for the GPM Capstone project in Spring 2023.

Ali Tokay was a mentor for NASA Summer internship program in Summer 2023.

Chenxi Wang mentored graduate student Mrs. Yihan Fang at University of Maryland, College Park on the research project "Cloud-Aerosol detection using spectral, spatial, and temporal observations of Geostationary instruments".

Chenxi Wang served as a committee member and mentored UMBC doctoral student Dr. Xin Huang for his research "Deep Learning based Cloud Retrieval Techniques using Multiple Satellite Remote Sensing Data".

Chenxi Wang served as a committee member and mentored UMBC doctoral student Mr. Seraj Mostafa for his research "Detection of gravity wave from VIIRS DNB night images using machine learning algorithms".

Chenxi Wang served as a collaborative mentor of UMBC NSF Funded Big Data Research Experience for Undergraduates (REU) program "Exploring Machine Learning based Atmospheric Gravity Wave Detection".

Yujie Wang presented to students at River Hill High School (Maryland) to introduce Earth Science and the NASA MODIS mission.

Brad Weir coordinated presentations by **Katherine Breen** (MSU) and Kristan Morgan (ADNET) at the H-B Woodlawn High School science fair, Woodlawn, MD.

Xiaoguang Xu mentored UMBC PhD student (Ms. Rachel Smith) for her thesis research on polarimetric remote sensing of cloud microphysics.

GESTAR II Seminar Series

The GESTAR II Seminar Series presentations are held virtually on Tuesdays or Thursdays on a mostly monthly basis. Carol Kuehn (SURA) organizes and facilitates the presentations. Speakers come from universities, research facilities, within GESTAR II, etc. Since this series began, speakers have included the following:

Name(s)	Affiliation	Date	Title of Presentation
Dr. Emily Fischer and Dr. Jeff Pierce	Colorado State University, Dept. of Atmospheric Science	Oct 13, 2022	"Fires to Farms: Collaborations using In-Situ and Satellite Observations to Understand Non-Traditional Air Pollution Sources and Impacts"
Dr. Jose Fuentes	Pennsylvania State University, Meteorology and Atmospheric Sciences Assoc. Director, GESTAR II	Nov 10, 2022	"Arctic Climate Change and Cycles of Trace Gases"
Dr. Susan Anenberg	George Washington University Climate and Health Institute	Jan 24, 2023	"Climate change, air pollution, and public health: Bridging science to policy"
Dr. Clement Guilloteau	University of California-Irvine	Mar 9, 2023	“The representation of extremes in global precipitation records: a scale issue"
Dr. David Turner	NOAA	Mar 31, 2023	“Retrieving geophysical parameters from passive remote sensors: What we all should know”
Dr. Joe Turk	Jet Propulsion Laboratory, California Institute of Technology	Apr 13, 2023	“Moisture in the Lower Free Troposphere and Observational Strategies for Obtaining Vertical Profiles In and Near Convection”
Dr. Chuntao Liu	Texas A&M University-Corpus Christi	April 25, 2023	“Connections between convection and the stratosphere in tropics”
Dr. Efi Foufoula-Georgiou	University of California-Irvine	May 11, 2023	“Preserving space-time patterns and extremes in satellite precipitation retrievals: from spectral error analysis and diagnostics to Machine Learning”
Dr. Christine Chiu	Colorado State University	May 23, 2023	“Clouds and aerosols laid bare-A 3D view from synergistic satellite observations for improved

			process-level understanding”
Dr. Xianglei Huang	University of Michigan	June 8, 2023	“Including two missing longwave physics into the earth system model”
Dr. Anne Thompson	Senior Scientist (Emeritus), NASA GSFC Senior Research Faculty, UMBC/GESTAR II	August 29, 2023	“The SHADOZ Tropical Network at 25 years: Tropical Ozone Variability and Trends”

Media/Communication

Pukar Amatya was featured in Early Career Scientist Spotlights (September 1, 2022) (https://science.gsfc.nasa.gov/600/ECSS/Pukar-Amatya.html).

Pukar Amatya was featured in Satellite data to aid the development of a landslide monitoring and forecasting system for Nepal. (https://servir.icimod.org/news/satellite-data-to-aid-the-development-of-a-landslide-monitoring-and-forecasting-system-for-nepal/, January 19, 2023)

In April 2023, **Amanda Armstrong** was among others who organized, hosted and presented at the Applied Earth Observation Innovation Partnership (AEOIP)'s "2023 USFS-NASA Joint Applications Workshop: Addressing Land & Water Monitoring Needs Using Remote Sensing" held in Salt Lake City, UT. The goals of the workshop were to: 1) increase awareness at NASA of USFS (and other land management agencies) operational needs, and 2) increase awareness among USFS resource managers of NASA data products that will inform their decisions. More information can be found out about the event here: https://www.aeoip.com/2023-usfs-nasa-workshop.

Lionel Arteaga contributed to a GMAO science snapshot on the current low sea ice detected in Antarctica: *A New Minimum in Southern Hemisphere Sea Ice Extent*. Richard Cullather and **Lionel Arteaga**: https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/southern_hemisphere.php

Lionel Arteaga contributed to NCCS story: *NCCS-Enabled Data Assimilation Probes Impact of Pacific Ocean Heatwaves on Phytoplankton Populations*: https://www.nccs.nasa.gov/news-events/nccs-highlights/Impact-of-Pacific-Ocean-Heatwaves-on-Phytoplankton-Populations

Nishan Biswas wrote an Op-Ed on tracking Bangladesh's climate change and human intervention in water resources using satellite information, and it was published by the leading daily newspaper of Bangladesh (January 30, 2023): https://www.thedailystar.net/opinion/views/news/what-nasa-satellites-say-about-bangladeshs-climate-3234491

During two VIP visits from the French Embassy on November 29, 2022 and February 2, 2023, **Niama Boukachaba** attended and helped translate as needed, and she helped to convey the amazing science happening at NASA Goddard Space Flight Center.

From left to right, Dr. Boukachaba (610.1) with Dr. Elodi Macorps (618.0), Dr. Dalia Kirschbaum (Director, Earth Sciences Division) and Mr. Mehdi Trabelsi (France Elysee representative). Photo provided by N. Boukachaba.

From May 22-26, 2023, **Niama Boukachaba** was one of many NASA researchers interviewed for "Climate Change and Me", a middle school education project with the Chicago Adler Planetarium

and the NASA Office of Communications (Code 130).

On March 29, 2023, **Niama Boukachaba** appeared in the GMAO News item "The GMAO Stays Warm at ITSC in the Arctic Circle" https://gmao.gsfc.nasa.gov/news/2023/itsc.php

Anthony Campbell contributed to NASA's Earth Science News Team article: https://www.nasa.gov/feature/esnt/2022/nasa-scientists-map-global-salt-marsh-losses-and-their-carbon-impact on December 7, 2022.

Anthony Campbell contributed to the Monga Bay article, Global study reveals widespread salt marsh decline: https://news.mongabay.com/2022/12/global-study-reveals-widespread-salt-marsh-decline/ on December 19, 2022.

Anthony Campbell was interviewed about BioREaCH project for BioSCape documentary with Fishwater films (this film is in production).

Petya Campbell contributed to three articles about the ABoVE project *Clarifying linkages between canopy SIF and physiological function for high latitude vegetation,* sponsor: NASA/ROSES Terrestrial Ecology, Co-Investigator (PI. F. Huemmrich, 2019-2023). The articles were written by **K. F. Huemmrich**, and appeared in the Earth Observatory's Notes from the Field: https://earthobservatory.nasa.gov/blogs/fromthefield/2022/07/14/spring-greening-in-the-arctic-tundra/

https://earthobservatory.nasa.gov/blogs/fromthefield/2022/08/31/return-to-utqiagvik/

https://earthobservatory.nasa.gov/blogs/fromthefield/2023/05/18/illuminating-a-boreal-forests-spring-wake-up/

Ivona Cetinić contributed to an article about climate change changing the ocean's color (21 July 2023): https://www.washingtonpost.com/nation/2023/07/21/ocean-color-changing-climate-change/

Ivona Cetinić contributed to an article about climate trends in ocean satellite color" (12 July 2023) https://www.nature.com/articles/d41586-023-02262-9

Ivona Cetinić contributed to an article about phytoplankton from space (22 June 2023): https://www.nasa.gov/feature/goddard/2023/nasa-wants-to-identify-phytoplankton-species-from-space-heres-why , which also included a video about phytoplankton: https://www.youtube.com/watch?v=1xl5Z1d3wcQ.

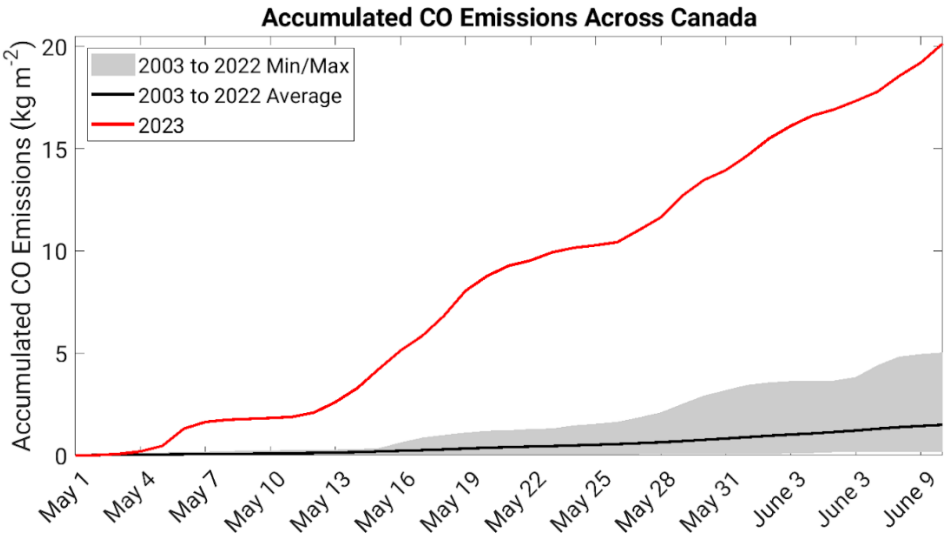
Ivona Cetinić contributed to an article about phytoplankton (3 December 2023) (https://earthobservatory.nasa.gov/images/150656/breathing-life-into-the-ocean

Ivona Cetinić contributed to Global temperature update live shots (12 and 13 January 2023) - https://svs.gsfc.nasa.gov/14268

Ivona Cetinić participated in CTD Appreciation Day , a social media campaign for rising awareness about oceanography (23 January 2023)

Allison Collow provided guidance on the usage of fine particulate matter from the GEOS FP model in an animation included in the Washington Post article, "Find out just how bad wildfire smoke has been in your area" (June 8, 2023): https://www.washingtonpost.com/climate-environment/interactive/2023/smoke-map-air-quality-wildfires/

Allison Collow contributed the science snapshot, "Exceptional Wildfire Smoke Across Canada Inundates the Northeastern United States," for the GMAO website (image below): https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/wildfire_smoke.php



Accumulated emissions of carbon monoxide (CO) across all of Canada during May and early June of 2023 from the Quick Fire Emissions Database (QFED; Darmenov and da Silva, 2015) compared to the range of accumulated emissions of CO for all prior years in the QFED data record beginning in 2003. (Provided by A. Collow.)

Susanne Craig was featured in a myUMBC article on her participation in the inaugural year of NASA's Student Airborne Research Program, East (SARP East). The article was published on June 1st 2023: https://my3.my.umbc.edu/groups/gestar2/posts/133822

Susanne Craig was also featured in an article published on the nasa.gov main reporting on SARP East. The article was published on August 16th 2023: https://www.nasa.gov/feature/goddard/2023/surf-turf-above-earth-students-participate-in-nasa-field-research

Alfonso Delgado Bonal contributed to the NASA campaign for the Earth Day in Spanish with six interviews with Telemundo, La Noticia, Telemundo Network, Grupo Imagen, NTN24. Interviews were centered around the Earth Day topic and included sections about his research.

Amin Dezfuli's work appeared in the Earth Day feature, provided by NASA's Transform to Open Science (TOPS). "Climate Patterns Thousands of Miles Away Affect U.S. bird Migration." April 2023. https://www.nasa.gov/centers/marshall/feature/5-ways-open-science-is-transforming-nasa-research-and-protecting-our-planet

Amin Dezfuli was invited to a podcast on the "Influence of Atmospheric Rivers in the Middle East and North Africa", hosted by the Middle East Institute in Washington D.C., February 2023. https://www.mei.edu/multimedia/podcast/influence-atmospheric-rivers-mena

Amin Dezfuli was featured as one of the two "People of Climate Science" in the 2022 Annual Report of NASA Goddard Space Flight Center (Page 7), December 2022: https://issuu.com/nasagsfc/docs/digital_2022_gsfcannualreport_121222_pages

Amin Dezfuli was interviewed by BBC Persian 60 Minutes, talking about climate change and extremes in the Middle East and over the globe. July 2023: https://www.youtube.com/watch?v=dGk-7rFpL3w&list=PLmdEvtplre60hSntPFIRKugLrCbj9imvE&index=14&t=465s

Denis Felikson's research was featured in a News Brief on NASA's Sea-Level Change Team Portal (October 2022): *Tracking 'Wiggles' Could Help Improve Glacier Models.* https://sealevel.nasa.gov/news/243/tracking-wiggles-could-help-improve-glacier-models/.

Manisha Ganeshan had a Monthly Science Highlight detailing her lead author publication's results published in ESD's ESRRP. The highlight that assimilating adaptively thinned cloud-cleared hyperspectral IR radiances in the GEOS has a positive impact on the representation of Polar Lows, which are elusive, short-lived extratropical convective storms. https://esdresearch.nasa.gov/result/impact-assimilating-adaptively-thinned-airs-cloud-cleared-radiances-analysis-polar-lows-and

Jie Gong was part of an NCCS news article published online at the end of Nov. 2022, titled "Spandan Das: A Self-Taught Machine Learning Intern, NCCS User, College Student, and Published Author", featuring an intern student who she mentored during summer 2020 and 2021 and who published a first-author paper with her.

Steve Guimond's paper on megafire smoke plumes was featured by AGU and UMBC. He helped edit the news stories and provided figures for: (1) https://umbc.edu/stories/research-megafire-smoke-plumes/ and (2) https://www.eurekalert.org/news-releases/986865.

Hiren Jethva was interviewed and asked for his scientific inputs for the NASA Earth Observatory article dated November 3, 2022, " Smoky Skies in Northern India". https://earthobservatory.nasa.gov/images/150555/smoky-skies-in-northern-india.

Hiren Jethva was also interviewed by a prominent news media Hindustan Times and referred to his analysis and comments on the post-monsoon crop residue burning in northwestern India in the new article dated Nov 03, 2022. https://www.hindustantimes.com/india-news/wind-speed-brings-down-aqi-but-farm-fires-double-101667413420121.html.

Christoph Keller was featured in a NASA article highlighting the NASA – Google partnership (Sep 15, 2022): https://www.nasa.gov/feature/nasa-and-google-team-up-to-better-track-local-air-pollution

Christoph Keller was the lead author of a GMAO Science Snapshot about the 2022 Mauna Loa volcanic eruption (December 2022): https://gmao.gsfc.nasa.gov/research/science_snapshots/2022/mauna-loa.php

Christoph Keller contributed to a GMAO Science Snapshot about stratospheric ozone forecasts (January 2023): https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/stratospheric-ozone.php

Christoph Keller provided scientific input to an article about air pollution published by Der Spiegel (April 23, 2023): https://www.spiegel.de/ausland/luftverschmutzung-wo-die-luft-weltweit-am-schlechtesten-ist-und-was-dagegen-getan-werden-kann-a-1e542a7c-a46b-496f-901d-2fd0d85f3939

Christoph Keller contributed to a GMAO Science Snapshot highlighting the incorporation of GEOS-CF data into Google Earth Engine (May 2023): https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/new-generation-gmao-apps.php

Christoph Keller contributed to a GMAO Science Snapshot analyzing ozone anomalies over the U.S. (July 2023): https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/ozone-2023.php

K. Emma Knowland was the lead author on two GMAO Science Snapshots for the GMAO webpage and is a co-author on four more. The first led by Dr. Knowland was published in January 2023, "Stratospheric Ozone Forecasts are Realistic when using the Chemical Mechanism in the GEOS-CF System" highlighting the result published in the Dr. Knowland's first-author paper benchmarking the GEOS-CF stratospheric composition. (https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/stratospheric-ozone.php)

Based on their published article in early 2022, Dr. Knowland worked with Dr. Kevin Cromar (NYU) and Laura Gladson (Ph.D. candidate, NYU) to use the jointly-developed global health-based air quality index for children with respiratory illnesses, with the GEOS-CF pollutant concentrations as inputs, in analysis for the WMO Air Quality and Climate Bulletin No. 2, published in September 2022. **K. Emma Knowland,** with Dr. Cromar and Ms. Gladson, presented the full analysis on "Health Impacts from Wildfires in 2021 over North America" in a GMAO Science Snapshot publish on the GMAO website in April 2023. (https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/health-impacts-over-north-america.php).

In Spring 2023, **K. Emma Knowland, Christoph Keller,** and Dr. Steven Pawson provided guidance to SPIEGEL reporters on a story which features a 3D-globe on which GEOS-CF data were mapped to illustrate problems with fine particulate matter (PM2.5) in India, China, Chad and Italy. The article below the globe visits places where people are particularly suffering from air pollution, but also locations where progress has been made in recent years to address the problem. https://www.spiegel.de/ausland/luftverschmutzung-wo-die-luft-weltweit-am-schlechtesten-ist-und-was-dagegen-getan-werden-kann-a-1e542a7c-a46b-496f-901d-2fd0d85f3939

Ryan Kramer was interviewed by San Francisco Examiner for a story about co-authored paper "Surface warming and wetting due to methane's long-wave radiative effects muted by short-wave absorption" (April 2023) https://www.sfexaminer.com/news/climate_change/methane-is-less-harmful-than-previously-thought/article_51cd59c2-d406-11ed-84cb-bb0888e29884.html.

Eunjee Lee contributed to an article about the global carbon cycle and climate change. She made comments about the subject at an online interview with a science reporter from the Korean Broadcasting System, who is currently a science journalism fellow at the University of North Carolina at Chapel Hill. The article was archived in the Korea Science Journalists Associations webpage (https://naver.me/FfW5x7mm; article written in Korean).

Young-Kwon Lim was interviewed twice by a weather reporter from the Korean Broadcasting System (KBS), South Korea. The interviews covered a variety of climate/weather phenomena that include ENSO, climate change, heat waves, tropical cyclones, atmospheric rivers, and their forecasts. Trends of their impact in recent years due to climate change and current research activity on climate in NASA were also discussed. One of the articles in Korean is available here: https://m.post.naver.com/viewer/postView.naver?volumeNo=35843325&memberNo=36405506

Fadji Zaouna Maina was invited to the Washington Forum on Voice of America to talk about climate change (Sept 2022): Washington Forum: Faire face au changement climatique

In October 2022, **Fadji Zaouna Maina's** work and scientific journey was featured on NASA GSFC NGAPS (NASA Goddard Association of Postdoctoral Scholars) site: Early Career Spotlight NASA GSFC, Dr. Fadji Maina.

On November 12, 2022, **Fadji Zaouna Maina** was invited to discuss the use of satellite data to better understand the impacts of climate change on Radio France International: Explorer l'espace aux côtés de Fadji Maina.

In March 2023, **Fadji Zaouna Maina** was invited to Voice of America to talk about her scientific journey and research on the International Women's Day. The two interviews can be found here: Fadji Maïna, hydrologue à la NASA : il faut la parité hommes-femmes dans les sciences

Niger-Born NASA Scientist Shares Her Story

In April 2023, **Fadji Zaouna Maina's** research on High Mountain Asia was featured in NASA's Earth data: Data from NASA's NSIDC DAAC help scientists like Dr. Fadji Z. Maina research hydrological change in High Mountain Asia

Elijah Orland contributed informal communication with the Wall Street Journal and New York Times related to FEDS active fire tracking data. He also was featured regarding the coordination with the NASA Disasters Program for rapid response to the wildfires in Maui.

Elijah Orland was part of a feature on the NASA Earth Observatory Image of the Day; he also contributed to a Hyperwall feature at 2022 AGU Fall Meeting.

Lorraine Remer was quoted in UMBC and Oregon State University press releases and interviewed by NASA's Earth Observatory that was requoted across multiple platforms and organizations concerning the publication of "Atmospheric nourishment of global ocean ecosystems" in Science magazine. A few examples are given below, but it went much wider than this.

https://umbc.edu/stories/atmospheric-dust-and-ocean-health/

https://my3.my.umbc.edu/groups/gestar2/posts/133370

https://www.nasa.gov/feature/esnt/2023/how-desert-dust-nourishes-the-growth-of-phytoplankton-at-sea

https://today.oregonstate.edu/news/scientists-begin-unravel-global-role-atmospheric-dust-nourishing-oceans

https://spacenews.com/society-and-technology-the-space-observing-imperative/

Andrew Sayer contributed to a NASA blog feature on carbon and how PACE will track cycles of carbon through the atmosphere and ocean (March 22, 2023): https://blogs.nasa.gov/pace/2023/03/22/the-journey-of-a-carbon-atom-from-space-nasas-pace-mission-detects-carbon-in-the-sky-land-and-sea/

Bridget Seegers' TEDx talk from May 2022, "*Plankton, Space, Earth, and Us,"* was released by TEDx to their 36 million subscribers on December 2, 2022. The talk focused on the importance of plankton and why scientists study them with satellites. Additionally, the talk reminds listeners that all of us are global influencers with big impacts. https://www.youtube.com/watch?v=cgSm_TtTfiw

Bridget Seegers contributed to an article for Ocean Day about satellite remote sensing of phytoplankton (June 2023). https://www.nasa.gov/feature/goddard/2023/nasa-wants-to-identify-phytoplankton-species-from-space-heres-why

Bridget Seegers participated in a NASA Earth outreach event focused on the global ocean on June 20, 2023. The outreach was an 'Ask an Expert' Question and Answer session on social media platforms Instagram, Twitter, and Facebook.

Christopher Shuman contributed to a NASA Earth Observatory story about nearly four decades of changes to Mendenhall Glacier in coastal Alaska (10 August 2023): Alaska's Mendenhall Glacier

https://earthobservatory.nasa.gov/images/151682/alaskas-mendenhall-glacier

Christopher Shuman contributed to a NASA Earth Observatory story about seasonal changes in northeastern Greenland (8 August 2023): Summer Breakout in Northeast Greenland
https://earthobservatory.nasa.gov/images/151673/summer-breakout-in-northeast-greenland

Christopher Shuman contributed to a Greenland Ice Sheet Today report published by the National Snow and Ice Data Center (19 July 2023): Sudden shift to southern heat
https://nsidc.org/greenland-today/2023/07/sudden-shift-to-southern-heat/

Christopher Shuman created a new hyperwall for the NASA Scientific Visualization Studio (11 July 2023): Landsat Tracks Brunt Ice Shelf Evolution 1986-2023 https://svs.gsfc.nasa.gov/31228

Christopher Shuman contributed to a NASA Earth Observatory story about the long anticipated departure of the last 'big berg' from Thwaites Glacier (13 April 2023): Long-Lived Iceberg Sails Away
https://earthobservatory.nasa.gov/images/151202/long-lived-iceberg-sails-away

Christopher Shuman contributed to a NASA Earth Observatory story on the Brunt Ice Shelf calving of Iceberg A-81 using Landsat (28 January 2023): Antarctic Iceberg on the Move
https://earthobservatory.nasa.gov/images/150884/antarctic-iceberg-on-the-move

Christopher Shuman contributed to an Antarctica Ice Sheet Today report published by the National Snow and Ice Data Center (12 Jan. 2023): Extensive melting in West Antarctica and the Peninsula
https://nsidc.org/greenland-today/2023/01/extensive-melting-in-west-antarctica-and-the-peninsula/

Christopher Shuman created a new hyperwall for the NASA Scientific Visualization Studio (9 Nov. 2022): Changes in Zachariæ Isstrøm, North East Greenland, from Landsat – 1999-2022
https://svs.gsfc.nasa.gov/31207

Christopher Shuman contributed to a Washington Post story on late summer warmth in Greenland (6 September 2022): Ice usually stops melting in Greenland by September. Not this year.
https://www.washingtonpost.com/climate-environment/2022/09/06/greenland-ice-melt-heat-wave-summer/

Christopher Shuman contributed to a NASA Earth Observatory story celebration “Landsat At 50” (30 August 2022) A Half-Century of Loss in Northwest Greenland https://earthobservatory.nasa.gov/images/150267/a-half-century-of-loss-in-northwest-greenland

Inia M. Soto Ramos was featured on the NSF LSAMP Bridge to the Doctorate 20-year anniversary video, available at https://www.youtube.com/watch?v=FzCdhhxTr8o.

Inia Soto Ramos and **Ivona Cetinic** were featured in a NASA Earthdata article, "Deep Data: Analyzing Carbon in the Ocean” (https://www.earthdata.nasa.gov/learn/articles/exports-deep-data-carbon-cycle) that discussed the preparation, planning, and data archiving for the NASA EXPORTS field mission.

Pamela Wales contributed to two GMAO snapshots: "Exceptional Wildfire Smoke Across Canada Inundates the Northeastern United States", A. Collow (UMBC), J. Ardizzone, K.E. Knowland (MSU), and P. Wales (MSU); https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/wildfire_smoke.php and “Stratospheric Ozone Forecasts are Realistic when using the Chemical Mechanism in the GEOS-CF System”, K. E. Knowland (MSU), L. Coy, K. Wargan, P. Wales (MSU), C. Keller (MSU), S. Pawson; https://gmao.gsfc.nasa.gov/research/science_snapshots/2023/stratospheric-ozone.php

Tianle Yuan was interviewed by the Associated Press, Washington Post, and Science Magazine as well as several other media outlets for his work. The Associated Press piece was widely distributed by many media outlets. https://www.science.org/content/article/changing-clouds-unforeseen-test-geoengineering-fueling-record-ocean-warmth, https://www.washingtonpost.com/weather/2023/06/14/record-warm-ocean-temperatures/, https://apnews.com/article/hot-summer-climate-change-el-nino-9c5151f2fca2cd77d92a1c7bc61a0035, https://eos.org/articles/tracking-climate-through-ship-exhaust

Reviewer Activities

Armaghan Abed-Elmdoust served as a reviewer for Journal of Hydrology.

Doyeon Ahn served as a reviewer for the journal Climatic Change.

Pukar Amatya served on an Earth Surface and Interior ROSES Panel Review, and he served as a reviewer for Journal of the Indian Society of Remote Sensing.

Daniel Anderson reviewed articles for Atmospheric Chemistry and Physics (5), Environmental Science and Technology (1), and Earth and Space Chemistry (1). He also served on a review committee for a NASA ROSES proposal call.

Amanda Armstrong continues to serve as Subject Editor for the Elsevier Journal Ecological Modelling. Dr. Armstrong also serves as a guest editor for a Special Issue of the MDPI Journal: Remote Sensing of the Environment (1/2022 to present). Dr. Armstrong served on a NASA ROSES review panel in 2023.

Lionel Arteaga reviewed five scientific manuscripts, one each for the following journals: ELEMENTA, Nature Communications, Biogeosciences, Journal of Geophysical Research – Oceans, and Global Biogeochemical Cycles. He also participated in a NOAA mCDR panel in April 2023. Dr. Arteaga will participate in NASA's PACE Validation panel at the end of August, 2023.

Surendra Bhatta served as a reviewer for IEEE Transactions on Geoscience and Remote Sensing.

Huisheng Bian reviewed two articles for JGR.

Nishan Biswas served as a reviewer for an NSF proposal, and he served a reviewer for the following journals: Journal of Geomorphology, Water Resources Research, MDPI Water, Journal of Hydrology, and IEEE Transaction on Geoscience and Remote Sensing.

Niama Boukachaba was a reviewer for the Remote Sensing of Environment journal and for the Quarterly Journal of the Royal Meteorological Society.

Virginie Buchard was a reviewer for both the Journal of Advances in Modeling Earth Systems and Atmospheric Chemistry and Physics.

Anthony Campbell reviewed articles for Biological Invasions, All Earth, and Estuaries and Coasts.

Petya Campbell contributed as a reviewer for peer reviewed publications in the AGU JGR Biogeosciences, Canadian Journal of Remote Sensing, Ecological Applications, Journal of Applied Meteorology and Climatology, and Remote Sensing of Environment. She also served in 2022 and 2023 as a reviewer on NASA's FINNEST and LCLUC proposal review panels.

Ian Carroll served as a reviewer for Regional Studies in Marine Science and Frontiers in Remote Sensing.

Ivona Cetinić served as Associate Editor for Limnology and Oceanography Methods (stepped down in January 2023) and Editor for a Special Edition of Elementa Science of the Anthropocene (EXPORTS). She also served as a reviewer for the following journals: Nature, JGR-Oceans, Ocean Optics, among others. She served as a reviewer on an NOAA panel, for NSF, and for NASA.

Myungje Choi served as a reviewer for three journals: Journal of Quantitative Spectroscopy and Radiative Transfer, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, and Frontiers in Remote Sensing.

J. Blake Clark served as a reviewer on NSF proposals on an ad-hoc basis, on Department of Energy proposals, and on a panel review for Delaware sea grant proposals. Dr. Clark also served as a reviewer for JGR-Oceans, Ocean Modelling, Journal of Marine Systems, Progress in Oceanography, and Frontiers in Marine Science.

Allison Collow served as a reviewer for the journals Weather and Forecasting, Journal of Hydrometeorology, Journal of Geophysical Research: Atmospheres, and Nature Communications. She was also involved with the GESTAR II Graduate Fellowship.

Susanne Craig served on two NASA review panels as an expert reviewer: Interdisciplinary Science review panel (April) and PACE Validation Science Team review panel (August). Dr. Craig served as a reviewer and Editor for Frontiers in Remote Sensing.

Paolo de Matthaeis served as a reviewer for IEEE Transactions on Geoscience and Remote Sensing (2), IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (1) and MDPI Remote Sensing (1).

Amin Dezfuli served on a panel review for FINESST22 Weather and Atmospheric Dynamics in 2023.

Thomas Eck continued to serve as an Associate Editor for the journal Atmospheric Measurement Techniques. Mr. Eck performed peer review for publications in the following scientific journals: Atmospheric Chemistry and Physics, Journal of Geophysical Research, Atmospheric Environment, and Atmospheric Measurement Techniques.

Akiko Elders served as a MUREP proposal reviewer in fall 2022.

Robert Emberson served as a proposal reviewer for SMDSS (NASA Science Mission Directorate Single Source), for RRNES proposals (NASA Rapid Response and Novel research in the Earth Sciences), and FINESST proposals (NASA Future Investigators in NASA Earth and Space Science and Technology). He also reviewed papers for ESPL, GCA, Landslides, and Natural Hazards.

Denis Felikson served as a reviewer for Journal of Geophysical Research and The Cryosphere as well as a reviewer on an NSF proposal.

Manisha Ganeshan served as reviewer for Journal of Geophysical Research: Atmospheres.

Jie Gong served as a reviewer for IEEE TGRS, International Journal of Remote Sensing and Remote Sensing Letters, MDPI Earth, and Quarterly Journal of the Royal Meteorological Society.

Mircea Grecu served as a reviewer for several AGU journals and served as a reviewer for the NASA MUREP PBI/HBCU Data Science Equity, Access and Priority for Research and Education (DEAP) program.

Steve Guimond reviewed several articles for Journal of the Atmospheric Sciences and Journal of Advances in Modeling Earth Systems.

Reem Hannun served as a reviewer for Atmospheric Measurement Techniques; Atmospheric

Chemistry and Physics; Agriculture and Forest Meteorology; and Journal of Geophysical Research: Atmospheres. She also served as Associate Editor for Environmental Research Letters CMS Focus Issue; Atmospheric Measurement Techniques.

K. Fred Huemmrich served as a reviewer for two papers from Remote Sensing of Environment and one paper from Ecosphere.

Hiren Jethva reviewed several research articles submitted to different international journals, including Atmospheric Chemistry and Physics, Environmental Science and Pollution Research, Atmospheric Research, and Remote Sensing of Environment.

Daeho Jin reviewed papers for Int. Journal of Climatology (3), Atmosphere (3), and Remote Sensing (2).

Bryan Karpowicz served as a reviewer for Journal of Geophysical Research, Atmospheres.

Dhruva Kathuria served as a reviewer for the following journals: Hydrological Processes, Journal of Hydrology, and Frontiers in Water.

Christoph Keller reviewed papers for Atmospheric Environment and Journal of Geophysical Research.

Dongchul Kim was a reviewer on a NOAA Earth's Radiation Budget (ERB) proposal. He also served as a reviewer for Bulletin of the American Meteorological Society (2), Nature Communications, and Journal of Geophysical Research.

Mijin Kim reviewed two manuscripts submitted to IEEE Trans. on Geoscience and Remote Sensing.

K. Emma Knowland served as a reviewer on two NASA ROSES review panels and one Red Panel review. Dr. Knowland also served as a reviewer for five articles in various journals.

Goutam Konapala served a reviewer for the journals Water Resources Research, Nature Communications, Nature Water, and Journal of Hydrology. He also served on FINNEST review panel.

Sergey Korkin served as a reviewer for one paper submitted to each of the following journals: Optics Express, Environmental Monitoring and Assessment, Journal of the Atmospheric Sciences, and Journal of Quantitative Spectroscopy and Radiative Transfer.

Alexander Kotsakis served as a reviewer for American Meteorological Society: Weather and Forecasting Journal.

Ryan Kramer reviewed journal articles for ESSD, Elementa and AGU Advances, and he also served as panel reviewer for NASA FINESST proposal.

Lok Lamsal served on a NASA ROSES Review Panel. Dr. Lamsal continued to serve as an Associate Editor for the Atmospheric Measurement Technique Journal.

Eunjee Lee served as a reviewer for two peer-reviewed journals (Journal of Climate, and Climate Dynamics).

Jasper Lewis served as a peer reviewer for multiple articles in the journals Atmospheric Research,

Journal of Geophysical Research – Atmospheres, and Remote Sensing of the Environment.

Feng Li reviewed 4 manuscripts for Journal of Geophysical Research, 1 manuscript for Geophysical Research Letters, 1 manuscript for Remote Sensing of Environment, and 1 proposal for National Science Foundation.

Liang Liao served as reviewer for two articles submitted to IEEE Transaction on Geoscience and Remote Sensing.

Young-Kwon Lim served as a reviewer for Journal of Climate, Journal of Geophysical Research, International Journal of Climatology and Atmosphere (MDPI). Also, he served on NASA FINESST proposal review panel in 2023.

Fei Liu reviewed two publications for ACP, three for AMT, three for Remote Sensing of Environment, and one for Environmental Science and Technology.

Junhua Liu served as a reviewer for articles in both Atmospheric Chemistry and Physics and Remote Sensing of Environment.

Yuli Liu served as a reviewer for Atmospheric Measurement Techniques (3 articles); Monthly Weather Review (1 article); and, Journal of Quantitative Spectroscopy and Radiative Transfer (2 articles).

Fadji Zaouna Maina served as Editor for HESS and Editor for PloS Water. She also served as reviewer for Nature Sustainability, Nature Communications, the Journal of Hydrology, Water Resources Research, Hydrology Earth and System Sciences, and Geophysical Research Letters. Dr. Maina served as NASA ROSES panelist for grant reviews.

Carl Malings served as a reviewer for the following journals: ACS Earth and Space Chemistry, Environmental Science & Technology, Atmospheric Environment, Toxics, Environmental Science and Technology, Computation, Remote Sensing, Climate, Atmosphere, Sustainability, Sensors, Environmental Pollution, and Heliyon.

Erica McGrath-Spangler served on a NASA proposal review panel in May 2023.

Priscilla Mohammed-Tano reviewed papers for the International Geoscience and Remote Sensing Symposium (IGARSS) 2023; reviewed one journal article for the Journal of Selected Topics in Applied Earth Observations and Remote Sensing; and, reviewed one journal article for the Transactions on Geoscience and Remote Sensing.

Norm O'Neill served on one PhD jury and two MSc juries during the GESTAR II – AERONET project.

Elijah Orland served as a reviewer for Geophysical Research Letters.

Erricos Pavlis continues to serve as Associate Editor for Celestial Mechanics & Dynamical Astronomy and as Editor for The European Physical Journal Plus. He reviewed articles for JGR amd IAG Proceedings.

Jinzheng Peng served as a reviewer for TGRS (IEEE Trans. Geosci. Remote Sens) and for JSTARS (IEEE J. Sel. Topics Appl. Earth Obs. Remote Sens).

Nikki Privé served on a NASA FINESST review panel, and she served as a reviewer for a paper in

both J. Atmos. and Ocean. Tech and Ocean Modelling.

Anin Puthukkudy reviewed multiple articles in Remote Sensing of Environment, Remote Sensing, Atmospheric Environment, and Frontiers in Remote Sensing,

Chamara Rajapakshe served as a reviewer for the journals MDPI Remote Sensing, ACP, and JQSRT.

Lorraine Remer served as Editor of the Journal of the Atmospheric Sciences. In addition, she reviewed one manuscript for Remote Sensing of Environment, one for the Bull. Of the American Meteorological Society, and one proposal for the European Research Council.

Joseph Robinson served as reviewer for the journal Atmospheric Research.

Andrew Sayer served on two NASA review panels, and one GESTAR II review panel. He acted as a peer-reviewer for over a dozen journal articles for journals including Atmospheric Chemistry and Physics, Atmospheric Environment, Atmospheric Measurement Techniques, Atmospheric Research, and Geo-Spatial Information Science. He continues to serve as an Associate Editor for Atmospheric Measurement Techniques, handling seven papers so far this year.

Bridget Seegers served as a reviewer for Water Research and for Journal of Great Lakes Research. Dr. Seegers was a member of a NASA proposal review panel (Spring 2023).

Yingxi Shi reviewed 10 manuscripts for various journals.

Christopher Shuman served as a reviewer on a NASA proposal in Spring 2023.

Inia M. Soto Ramos served as a reviewer for two journals and participated in one tenure-track review for New College Florida.

Amir Souri served as a reviewer for Atmospheric Chemistry and Physics (two papers) and Geophysical Research Letters (one paper) as well as on a NASA IDS Proposal Review Panel.

Thomas Stanley served as reviewer for Remote Sensing and Environmental Earth Sciences.

Jason St. Clair reviewed an article for Atmospheric Measurement Techniques.

Sarah Strode reviewed journal articles for Atmospheric Environment, ACP, and Chemosphere.

Larrabee Strow was a reviewer for Earth and Space Science, Atmospheric Chemistry and Physics, and Remote Sensing of Environment.

Ghassan Taha reviewed two manuscripts, one for Geophysical Research Letters and a second for EGUsphere. He also reviewed a proposal submitted to the Leverhulme Trust in London, UK.

Zhining Tao served as a reviewer for the journals Atmosphere and Smart Cities.

Natalie Thomas served as a reviewer for Journal of Climate, Geophysical Research Letters, Nature Reviews, Weather and Climate Extremes, Journal of Hydrometeorology, and Climate Dynamics. She also served as a reviewer for a NOAA proposal review panel and a NASA review panel.

Ali Tokay continued to serve as associate editor of AMS Journal of Hydrometeorology. He reviewed articles for the following journals: Journal of Hydrometeorology, Journal of Atmospheric and Oceanic Technology, Journal of Atmospheric Sciences, and Atmospheric Research. He also

reviewed a book chapter.

Tamás Várnai reviewed 3 manuscripts for the journal Remote Sensing, and one each for Atmosphere, Atmospheric Measurement Technology, and the ISPRS Journal of Photogrammetry and Remote Sensing. He also made editorial decisions for 5 manuscripts submitted to the journal Remote Sensing.

Pamela Wales served as a reviewer for an Atmospheric Chemistry and Physics article.

Chenxi Wang served as a reviewer for the following journals: Nature, Remote Sensing, Remote Sensing of Environment, Journal of Geophysical Research, and Journal of Applied Meteorology and Climatology.

Yujie Wang served as reviewer for the following journals: Frontiers in Earth Science, Remote Sensing, Atmospheric Research, Atmospheric Environment, and Environmental Pollution.

Brad Weir served as a reviewer for both Environmental Science & Technology and Geophysical Research Letters.

Guoyong Wen served as a reviewer for the journals Remote Sensing and Atmospheric Research.

Xiaoguang Xu served as a reviewer for several journals including Frontiers in Remote Sensing, Remote Sensing of Environment, and Atmospheric Measurement Techniques. He also serves as Associate Editor of Frontiers in Remote Sensing.

Tianle Yuan served as a reviewer for Nature, Remote Sensing of Environment, GRL, JGR-Atmosphere, and ACP.

Yujin Zeng served as a reviewer for Journal of Hydrometeorology, Journal of Oceanology and Limnology, and Journal of Hydrology.

Yaping Zhou reviewed articles for Advances in Space Research and Advances in Atmospheric Sciences. Dr. Zhou reviewed proposals for NASA MUREP program and a Banff International Research Station workshop proposal, as well as an NSF New Frontiers graduate fellowship.

Jerald Ziemke reviewed three refereed journal papers.

Miscellaneous

Dirk Aurin participated in Hiring Panels for OEL postdoctoral scientist through the GESTAR-II cooperative agreement, May and August, 2023.

Niama Boukachaba co-chaired Session 6 "Retrieval and Software" with Dr. Marc Crapeau (EUMETSAT) during the 24th International TOVS Study Conferences (ITSC-24). March 17th, 2023, Tromsø, Norway.

Niama Boukachaba is a member of the International TOVS Data Assimilation and Numerical Weather Prediction Working Group (https://itwg.ssec.wisc.edu/working-groups/).

Anthony Campbell created a poster and communicated science to the public, at the Blueflux open house, Homestead, FL, October 16, 2022.

Ian Carroll is a contributor for open source software packages "XArray" (pull requests 7393 and 8034) and "rioxarray" (pull request 636).

Ivona Cetinić is a member of National Academies of Sciences, Engineering Committee on Earth Sciences and Applications from Space (CESAS). She is also a Member of National Academies of Sciences, Lessons-Learned in the Implementation of the EV-M and EV-I Strands of NASA's Earth Venture Class committee.

J. Blake Clark was appointed as a member of the Arctic- COastal Land Ocean inteRaction (Arctic-COLORs) Science Definition Team. Dr. Clark also was appointed as a member of the NASA Carbon Monitoring System Science Team.

Allison Collow is a member of the NASA Code 600 Goal Team on Recruitment.

Allison Collow contributed to the hyperwall animation, "Column CO from Canada Wildfires", on display in the lobby of GSFC Building 33: https://portal.nccs.nasa.gov/datashare/gmao/geos-fp/.internal/Wildfires/5760x3240/final/geos-fp.cobbna.nam.jun2023.log_scale.mp4.

Susanne Craig acted as a search committee member for a GESTAR II postdoctoral fellow.

Susanne Craig has agreed to serve as the subject matter expert on a GESTAR II Promotions Committee.

Susanne Craig is a member of the Scientific Steering Committee for Ocean Carbon and Biogeochemistry (OCB, https://www.us-ocb.org/), a NASA and NSF funded scientific organization. This role includes organizing the annual summer workshop (~200 participants), reviewing requests for various funding opportunities, interacting with other national/international research organizations, and participating in monthly meetings. DEIA is high on OCB's list of priorities. Each year, we strive to improve equity and access in our field by ensuring funding requests are only met if satisfactory and demonstrable DEIA plans are in place. A strict code of conduct is enforced at all OCB workshops and related activities. April 2022-present.

Susanne Craig is the Chairperson for The Oceanography Society's (TOS) Justice, Equity, Diversity, and Inclusivity (JEDI) Committee (https://tos.org/diversity). Her role includes guiding and facilitating committee activities, attending TOS Executive and JEDI committee meetings, and authoring JEDI content in society's bi-monthly publication. The JEDI committee strives to

dismantle barriers to participation in the ocean sciences and related disciplines through challenging and updating our parent organization's codes of conduct, bylaws, and practices. Achievements to date include organizing a DEIA Town Hall Meeting at the 2022 Ocean Sciences Meeting, planning another Town Hall for the 2023 Ocean Sciences Meeting, establishing a regular DEIA column in Oceanography Magazine, and fundamentally re-writing the elgibility criteria for TOS Awards and Honors. The re-thinking of how Awards and Honors are given is something that many professional societies are now recognizing as a systemic barrier to the inclusivity in our disciplines. The TOS JEDI committee hopes to set an example by dismantling long-standing, biased, and privilege-based award eligibility criteria. June 1, 2020 - December 31, 2026.

Susanne Craig was a co-chair for the OCB 2023 Summer Workshop plenary session on 'Sustained observations of global ocean biology'. Along with her co-chairs, she recruited subject matter experts to deliver presentations, organized the scheduling, and facilitated a panel discussion during the session.

Susanne Craig is a co-chair for a session at the Ocean Sciences Meeting 2024 on 'Phytoplankton Ecology at Large Scales'. This role will include reviewing session poster and oral submissions and overall organization.

Genevieve Elsworth is a member of the NASA GMAO Future of Work Committee – Defining, formalizing, and expanding NASA's flexible work model.

Andrew Fox is organizer and chair of "Land Data Assimilation for Earth System Prediction" sessions at 37th Conference on Hydrology at 103rd American Meteorological Society Annual Meeting, Denver, CO, January 2023.

Andrew Fox is organizer of AIMES Land Data Assimilation Working Group "Town Hall on Ensemble Methods for Land Data Assimilation", Virtual, 28 February 2023.

Andrew Fox co-hosted the "3rd Annual Land Data Assimilation (DA) Community Workshop – Recent Technical Developments in Land Data Assimilation", Virtual, June 20 – 21, 2023. The workshop was organized by the Land Data Assimilation Working Group of the Analysis, Integration and Modeling of the Earth System (AIMES) project (https://aimesproject.org/ldawg/) and had 111 participants from around the globe.

Reem Hannun is the Lead of the NASA CMS Atmospheric Flux working group. Additionally, she is Session Co-chair: "Agriculture-Atmosphere Interactions" at American Meteorological Society Conference on Atmospheric Chemistry.

Dhruva Kathuria served as Co-convener of an oral session in American Geophysical Union (AGU) fall meeting 2022: Remote Sensing of Soil Processes.

K. Emma Knowland was a Session Chair, "Advances in the Integrated Global Observing System for Air Quality: Science and Societal Benefit" Session, AGU Fall Meeting 2022, Chicago, December 16, 2022.

K. Emma Knowland was one of several co-authors on the Committee on Earth Observation Satellites (CEOS) White Paper titled "Monitoring Surface PM2.5: An International Constellation Approach to Enhancing the Role of Satellite Observations" (https://repository.library.noaa.gov/view/noaa/49032), published in Sept 2022. Dr. Knowland

contributed text to Section 4 (Estimating Surface PM2.5) and overall editing of the document.

K. Emma Knowland was one of several co-authors of the WMO Air Quality and Climate Bulletin No. 2, published Sept 2022. She contributed analysis to the "Growing air pollution hazards from wildfires" section and overall editing (https://public.wmo.int/en/our-mandate/focus-areas/environment/air_quality/wmo-air-quality-and-climate-bulletin-no.2)

K. Emma Knowland is a co-author on the WMO GAW Report, Global Air Quality Forecasting and Information System (GAFIS) Implementation Plan: 2022-2026. As co-lead of Topical Area 2, Dr. Knowland contributed original text for Section 4.2 to Nicolas Huneeus, the consult to bring together the plans from each area into one report document. Dr. Knowland contributed to other Topical areas, as a GAFIS Steering Committee member, and provided editorial feedback on report draft. See Global Air Quality Forecasting and Information System (GAFIS) Implementation Plan: 2022-2026. GAW Report No. 277 (https://library.wmo.int/doc_num.php?explnum_id=11358), led by Nicolas Huneeus, Johannes Flemming, and Jessica Seddon.

In collaboration with 616, **Sergey Korkin** has compiled a 2-page white paper with co-authors A. M. Sayer, A. Ibrahim, and C.E. Del Castillo (616), titled "*Development of NASA GSFC Radiative Transfer Capabilities to keep us competitive in Earth Science*". The document argues that NASA Earth Science is losing expertise in one of its key components – numerical simulation of propagation of light in the atmosphere-surface system, commonly referred to as radiative transfer (RT). The document offers some actionable steps for GSFC and NASA HQ managers to consider. Dr. Del Castillo, 616 Lab Chief, has presented the document to GSFC ES management (e.g., Drs. Robert Swap, Associate Division Director for Mission Planning, and Julia Breed, Earth Science Opportunity Development Manager, among others).

Alexander Kotsakis was the primary forecaster and flight planning coordinator for the NASA Student Airborne Research Program East Coast (SARP-East) based out of NASA Langley. Forecasting and flight planning was done for three different aircraft with vastly different payloads, which required complex coordination and communication.

Lok Lamsal submitted a response, entitled "Continuity Data Products for NASA Earth Observing System Aura/OMI Nitrogen Dioxide (NO2) Level-2 and Higher-level Products" to NASA's "Request for Information for NASA's Terra, Aqua, and Aura Data Continuity Workshop (NNH23ZDA010L)". The purpose of this document was to provide information on continuity data for the Aura/OMI NO2 products.

Fadji Zaouna Maina continued to serve as a User Working Group Member of NSIDC, and as a Member of AMS hydrology committee, 2021 – present.

Carl Malings volunteers with Community Scientist for the AGU Thriving Earth Exchange (since 2021).

Carl Malings is a Co-lead, NASA Goddard Space Flight Center Health and Air Quality Working Group (since 2021), and also a Co-lead for the Air Quality Working Group of the GEO Health Community of Practice (since January 2023).

Carl Malings is a Program Committee Member, Meteorology and Climate Modeling for Air Quality Conference (2023), Jan.-Sep. 2023.

Carl Malings is also a Conference Planning Committee Member, Air Sensors International Conference (2024), Apr. 2023-May 2024.

Carl Malings is coordinating lead author, World Meteorological Organization report on best practices for the use of low-cost sensors to support air quality applications, Aug. 2023-Feb. 2024.

Priscilla Mohammed-Tano serves as Frequency Allocations in Remote Sensing (FARS) Technical Committee Secretary providing support for documents related to radio frequency interference. https://www.grss-ieee.org/technical-committees/frequency-allocations-in-remote-sensing/

Nikki Privé and **Erica McGrath-Spangler** co-hosted a Morgan State University undergraduate student for summer 2023 involving research into societal benefits of improved weather forecasts.

Nikki Privé will begin working with a GESTAR II Graduate Fellow this fall on a project to perform proof of concept studies using machine learning techniques to calculate radiance uncertainties within satellite footprints.

Nikki Privé is a Convener, Observation Impact session, International Symposium on Data Assimilation-Online, virtual, 4 November 2022.

Nikki Privé attended the American Meteorological Society Summer Policy Colloquium, Washington D.C., 4-9 June 2023.

Nikki Privé is the chief organizer of the 12th Workshop on Meteorological Sensitivity Analysis and Data Assimilation. Planning for the May 2024 workshop began this spring with venue selection and submission of proposals to NSF and NASA for student participant costs.

Nikki Privé was a GESTAR II Team Lead for code 610.1.

In 2023 **Violeta Sanjuan Calzado** submitted a proposal to host Ocean Optics 2024 meeting. This meeting is most remarkable for the community, with an attendance ranging from 350-500 attendees, and held every 2 years in different locations across the globe. Her proposal to host the meeting in Las Palmas de Gran Canaria, Spain was successful. Local research and educational institutions such as PLOCAN and the University of Las Palmas de Gran Canaria supported this proposal. Also, the local government represented by SPGEC, Sociedad de Propocion EConomica de Gran Canaria participated in the preparation of the proposal. The meeting will be held in October 2024 at the Congress Palace Auditorium Alfredo Kraus.

Larrabee Strow served on the NASA Sounder Science Leadership Team, and he was very involved in the TERRA/AQUA/AURA Continuity Workshop in May 2023.

Zhining Tao volunteered at the event Taste of Asia and the Pacific Islands (TAPI) during the Asian American and Pacific Islander Heritage Month, 2023.

Natalie Thomas is Co-chair of the Impactful Extremes working group of the US Regional Hydroclimate Project Affinity Group.

Ali Tokay is a topical chair of the AMS radar meteorology conference that will be held in August 2023.

Ali Tokay organized a GESTAR II presentation session as part of UMBC Department of Geography and Environmental Systems (GES) seminar series (December 2022).

Ali Tokay is the Team lead for Code 612.0 in GESTAR II. He is one of the committee members of GESTAR II fellowship evaluations. Also, he participated in the 50th anniversary of GES reception.

Pamela Wales is a co-organizer for the GMAO Seminar Series on Earth system science (August 2022 – present).

Brad Weir was elected as Secretary for AGU's Nonlinear Geophysics section.

Courses Taught

Amanda Armstrong taught two semesters of a course titled Remote Sensing Foundations at the University of Vermont. The asynchronous online course was a dual-enrollment online course that allowed for both credit-bearing and geospatial certificate-based student enrollment.

Dirk Aurin is the lead author (with N. Haentjens, lead instructor) of the HyperCP Tutorial, Training demonstration and tutorial, as part of NASA's Sponsored Workshop on Calibration and Validation of Ocean Color Remote Sensing, June 12 – July 7, 2023, Orr's Island, ME.

Nishan Biswas developed course material on situational landslide hazard monitoring and forecasting using machine learning and cloud computing for the capacity development of the end-users on satellite data use. The course material will be disseminated through the Asian Disaster Preparedness Center, Thailand (https://courses.adpc.net/)

Petya Campbell provided training in "Hyperspectral remote sensing applications for vegetation assessments" as part of the joint NASA/ESA Trans-Atlantic Training initiative for students and young professionals, in September 2022 and in June 2023.

Ivona Cetinić taught Calibration & Validation for Ocean Color Remote Sensing, University of Maine/Bowdoin College, Brunswick Maine, 12 – 16 June 2023.

Denis Felikson was a Guest Lecturer for a course titled Introduction to Computational Earth Science (GLY579), Univ. at Buffalo, NY, Nov. 1 and 3, 2022. He gave a 75-minute lecture on Monte Carlo methods and a 75-minute coding practicum (Matlab) on Monte Carlo error propagation.

Reem Hannun taught a course titled Environmental Science at University of Pittsburgh, Pittsburgh, PA (Spring 2023). In Fall 2023, she will be teaching the following two courses at the same university: Exploring Issues in Climate Change and Introduction to Atmospheric Chemistry.

K. Fred Huemmrich taught Special topics in Geography: Arctic Geography (GES302) at University of Maryland, Baltimore County, Fall 2022.

J. Vanderlei Martins taught a course titled Atmospheric Remote Sensing at University of Maryland, Baltimore County, Jan-June, 2023.

Amita Mehta taught a class titled "Weather and Climate" (GES311) in the Department of Geography and Environmental Systems at University of Maryland, Baltimore County, Fall 2022.

Lorraine Remer taught Digital Image Processing for Environmental Applications (GES 481) in the Geography and Environmental Systems department at University of Maryland, Baltimore County, Spring 2023.

Thomas Stanley gave a lecture titled "Introduction to LHASA 2.0", University of North Carolina Wilmington, October 31, 2022.

Ali Tokay taught Weather and Climate (GES 311) at University of Maryland, Baltimore County, Fall 2023.

Xiaoguang Xu taught Physics and Chemistry of Atmosphere (PHYS335) at University of Maryland, Baltimore County, Fall 2022, and will again in Fall 2023.

IV. Appendices

Publications

Ackerman, A., Yarincik, K., Murphy, S., **Cetinić, I**., Fundis, A., Miller, A., et al. (2023). Know before you go: A community-derived approach to planning for and preventing sexual harassment at oceanographic field sites. *Oceanography*, 36(1), 38-43. https://doi.org/10.5670/oceanog.2023.112

Allen, R.J., Zhao, X., Randles, C.A., **Kramer, R.J.,** Samset, B.H, Smith, C.J. (2023): Surface warming and wetting due to methane's long-wave radiative effects muted by short-wave absorption. *Nature Geosci.,* **16**(4), 314-440. https://doi.org/10.1038/s41561-023-01144-z

Amatya, P. M., C. Scheip, A. Déprez, J.-P. Malet, S. L. Slaughter, A. L. Handwerger, **R. Emberson,** D. Kirschbaum, J. Jean-Baptiste, M.-H. Huang, M. K. Clark, D. Zekkos, J.-R. Huang, F. Pacini, and E. Boissier. 2023. "Learnings from rapid response efforts to remotely detect landslides triggered by the August 2021 Nippes earthquake and Tropical Storm Grace in Haiti." *Natural Hazards*, https://doi.org/10.1007/s11069-023-06096-6.

Anderson, D. C., B. N. Duncan, J. M. Nicely, **J. Liu**, **S. A. Strode**, and M. B. Follette-Cook. 2023. "Technical note: Constraining the hydroxyl (OH) radical in the tropics with satellite observations of its drivers – first steps toward assessing the feasibility of a global observation strategy." *Atmospheric Chemistry and Physics*, 23 (11): 6319-6338, https://doi.org/10.5194/acp-23-6319-2023.

Anderson, D. C., M. B. Follette-Cook, **S. A. Strode**, J. M. Nicely, **J. Liu**, P. D. Ivatt, and B. N. Duncan. 2022. "A machine learning methodology for the generation of a parameterization of the hydroxyl radical." *Geoscientific Model Development*, 15 (16), [10.5194/gmd-15-6341-2022].

Arteaga, L. A., and C. S. Rousseeaux (2023), Impact of Pacific Ocean heatwaves on phytoplankton community composition, *Communications Biology*, 6(263), doi:10.1038/s42003-023-04645-0.

Arteaga, L. A., M. J. Behrenfeld, E. Boss, and T. K. Westberry (2022), Vertical Structure in Phyto-plankton Growth and Productivity Inferred From Biogeochemical-Argo Floats and the Carbon-Based Productivity Model, *Global Biogeochemical Cycles*, 36(8), e2022GB007,389, https://doi.org/10.1029/2022GB007389. (Note, published in Aug 2022, corrected Mar 2023.)

Aryal, K., **Zhai, P.**, Gao, M., Franz, B. A. (2022). Instantaneous photosynthetically available radiation models for ocean waters using neural networks. *Applied Optics, 61*(33), 9985--9995. https://opg.optica.org/ao/abstract.cfm?URI=ao-61-33-9985.

Barenblitt, A., Fatoyinbo, L., Thomas, N., Stovall, A., **De Sousa, C.**, Nwobi, C., Duncanson, L. (2023). Invasion in the Niger Delta: remote sensing of mangrove conversion to invasive Nypa fruticans from 2015 to 2020. *Remote Sensing in Ecology and Conservation*, https://doi.org/10.1002/rse2.353.

Baublitz, C.B, Fiore, A.M., Ludwig, S.M., Nicely, J.M., Wolfe, G.M., Murray, L.T., Commane, R., Prather, M.J., **Anderson, D.C.**, et al. (2023). An observation-based, reduced-form model for oxidation in the remote marine troposphere. *Proc. Nat. Acad. Sci*., https://doi.org/10.1073/pnas.2209735120.

Bernier, C., Y. Wang, G. Gronoff, T. Berkoff, **K. E. Knowland**, J. T. Sullivan, R. Delgado, V. Caicedo, and B. Carroll. 2022. "Cluster-based characterization of multi-dimensional tropospheric ozone variability in coastal regions: an analysis of lidar measurements and model results." *Atmospheric Chemistry and Physics*, 22 (23): 15313-15331 [10.5194/acp-22-15313-2022]

Bhatta, S., A. K. Pandit, R. P. Loughman, and J.-P. Vernier (2023), Three-wavelength approach for aerosol-cloud discrimination in the SAGE III/ISS aerosol extinction dataset, *Appl. Opt*., 62, 3454-3466.

Bhatta, S., Yang, Y. Reconstructing $PM_{2.5}$ Data Record for the Kathmandu Valley Using a Machine Learning Model (2023). *Atmosphere*. 14(7):1073. https://doi.org/10.3390/atmos14071073

Biswas, N. K., **Stanley, T. A.,** Kirschbaum, D. B., **Amatya, P. M.**, Meechaiya, C., Poortinga, A., & Towashiraporn, P. (2022). A dynamic landslide hazard monitoring framework for the Lower Mekong Region. *Frontiers in Earth Science*, 10. https://doi.org/10.3389/feart.2022.1057796.

Borges, D. E., S. Ramage, D. Green, C. Justice, C. Nakalembe, A. Whitcraft, B. Barker, I. Becker-Reshef, C. Balagizi, S. Salvi, V. Ambrosia, J. San-Miguel-Ayanz, L. Boschetti, R. Field, L. Giglio, L. Kuhle, F. Low, A. Kettner, G. Schumann, G. R. Brakenridge, R. Adler, H. Kontoes, H. De Boissezon, A. Eddy, D. Kirschbaum, **R. Emberson**, et al. (2023). Earth observations into action: the systemic integration of earth observation applications into national risk reduction decision structures, *Disaster Prevention and Management: An International Journal*, [10.1108/dpm-09-2022-0186].

Bourgeois, I., Peischl, J., Neuman, J. A., Brown, S. S., Allen, H. M., Campuzano-Jost, P., Coggon, M. M., DiGangi, J. P., Diskin, G. S., Gilman, J. B., Gkatzelis, Georgios, I, Guo, H., Halliday, H. A., Hanisco, T. F., Holmes, C. D., Huey, L. G., Jimenez, J. L., Lamplugh, A. D., Lee, Y. R., Lindaas, J., Moore, R. H., Nault, B. A., Nowak, J. B., Pagonis, D., Rickly, P. S., Robinson, M. A., Rollins, A. W., Selimovic, V., **St. Clair, J. M.**, et al. (2022). Comparison of airborne measurements of NO, NO2, HONO, NOy, and CO during FIREX-AQ. *Atmospheric Measurement Techniques*, https://doi.org/10.5194/amt-15-4901-2022.

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Presentations

Abed-Elmdoust, A., (lead), Harnessing Probabilistic Machine Learning for Large-Scale Hydrological Uncertainty Quantification, U.S. Army Corps of Engineers, May 2023 (invited).

Amatya, P., "Landslide mapping and forecasting system for Nepal," Stakeholder consultation on development of a landslide monitoring and forecasting system for Nepal, ICIMOD, Nepal, November 10, 2022.

Amatya, P., "Landslide susceptibility and runout assessment for the Arun hydropower cascade in Nepal based on multitemporal landslide inventory developed using Planet imagery," 2022 AGU Fall Meeting, Chicago, IL, December 15, 2022.

Anderson, D.C. (lead), Constraining Tropical OH with Satellite Observations of its Drivers. AGU Fall Meeting, Chicago, IL, Dec. 15, 2023.

Anderson, D.C. (lead), Understanding OH variability and trends with satellite observations and chemical transport models. FETCH4 Seminar Series. Aug. 24, 2023.

Armstrong, A. (lead), Results & Lessons Learned from the AEOIP 4-Year Effort. Applied Earth Observations Innovation Partnership (AEOIP) Joint Applications Workshop. Salt Lake City, Utah. April 25-27, 2023.

Arteaga L. (lead), Impact of Pacific Ocean heatwaves on phytoplankton community composition. Invited remote oral presentation. Ocean Ecology Lab. Seminar (NASA GSFC), Virtual, March 2023.

Arteaga L., (lead), Impact of Pacific Ocean heatwaves on phytoplankton community composition. Poster presentation. ASLO 2023, Mallorca, Spain. June 2023.

Aurin, D. (lead), HyperInSPACE; Transitioning from a community processor in name to in practice, 2nd Future of Above-water Radiometry (FAR-2), Oral presentation, Brussels, Belgium, October 12-13, 2022 (invited).

Aurin, D. (lead), NASA pySAS FICE-22 Radiometric Intercomparison; Timeline, Radiometric Convolution, Matchups, (QWIP/AVW), Oral presentation, FICE-22 Campaign Data Meeting, Virtual, November 3, 2022.

Aurin, D. (lead), Validating Commercial Imagery, Oral presentation and session chair, Chesapeake Bay Working Group Workshop, July 20, 2023, Greenbelt, MD (invited).

Bian, H., (lead), Investigation of aerosol hygroscopicity from aircraft measurement and GEOS simulation, AeroCom Workshop, virtual, Oct 10-14, 2022.

Bian, H., (lead), Observationally constrained analysis of sulfur species in the marine troposphere, EGU23, Vienna, Austria, Apr 23-28, 2023.

Biswas, N. K., (lead) “Understanding the stress on water resources due to climate change and human activities in Bangladesh using satellite observations,” AGU Fall Meeting, Chicago, IL, Dec

11-15, 2022.

Biswas, N. K., (lead), “A dynamic Landslide hazard forecasting Framework for the Lower Mekong Region,” AGU Fall Meeting, Dec 11-15, 2022.

Biswas, N. K., (lead), “Understanding the stress on water resources due to climate change and human activities in Bangladesh using satellite observations,” 11th conference on International Perspective on Water Resources and the Environment, jointly organized by Environmental & Water Resources Institute, American Society of Civil Engineers, and Institute of Water and Flood Management, Bangladesh University of Engineering and Technology, Dhaka, Bangladesh, January 4-6, 2023.

Biswas, N. K., “Understanding the stresses on freshwater resources in Ganges Delta due to climate change and human impact using satellite observations,” Early Career Scientist Forum 2022 (Hybrid), NASA Goddard Space Flight Center.

Boukachaba, N. (lead), "Toward improving the assimilation of IASI and CrIS radiances over land into the NASA GEOS: LST Inversion and Validation", The 24th International TOVS Study Conferences (ITSC-24). Session: Surface, Tromsø, Norway, March 20, 2023.

Campbell, A. et al. "BioREaCH: Biodiversity-Remote sensing for Estuarine and Coastal Habitat research", NASA Joint Science Workshop. College Park MD. 5/11/2023. Invited

Campbell, A. et al. "Engaging stakeholders in Biodiversity-Remote sensing for Estuarine and Coastal Habitat research", BioSCapes Application Workshop. South Africa. 5/23/2023 Invited

Campbell, A., Fatoyinbo T. de Sousa, C., Honzák, M., Larsen, T., Mapping aquatic classes in coastal regions of Mozambique, Senegal, and Liberia. EO 4 Ecosystem Accounting Workshop 2022, Virtual.

Campbell, A., Fatoyinbo, T. et al., "Wet carbon monitoring with remote sensing: a review of the knowledge and needs, AGU 2022, Chicago, USA. (Virtual)

Carroll, I. T. (lead), Code Delivery, Co-development, and the Year of Open Science @NASA, PACE Team Meeting, San Diego, CA, March 1, 2023 (invited).

Cetinić, I., “Chasing Ocean carbon from sky to sea and below” Earth Day Symposium, University of Maryland, Baltimore County, 21 April 2023 (invited).

Cetinić, I., “Environment of the Ocean,” University of Virginia, 3 January 2023.

Cetinić, I., “NASA Plankton, Aerosol, Cloud, ocean Ecosystem: NASA’s jump to hyperspectral,” Gussenhoven Graduate Students lecture, University of North Carolina – Chapel Hill, 31 March 2023 (invited).

Cetinić, I., “Operational Highlights of the EXport Processes in the Ocean from RemoTe Sensing (EXPORTS) North Atlantic 2021 Field Campaign”, NASA Carbon Cycle & Ecosystems Joint Science Workshop, 8–12 May, 2023.

Cho, N., Examining the feasibility of detailed decomposition of radiative flux anomalies to cloud changes, 2022 AGU, Chicago, IL, Dec 12 -16 2022.

Cho, N., Examining the feasibility of detailed decomposition of radiative flux anomalies to cloud changes, SED Poster Party, NASA Goddard Space Flight Center, Building 28 Atrium, Jan 26, 2023.

Choi, M. (lead), Absorbing Aerosol Composition Analysis from DSCOVR EPIC MAIAC Algorithm, AGU Fall Meeting, Chicago, IL, in person, Dec 12-16, 2022.

Choi, M. (lead), BC and BrC light-absorbing smoke aerosol components inferred from DSCOVR EPIC measurements, AGU Fall Meeting, Chicago, IL, in person, Dec 12-16, 2022.

Choi, M. (lead), Calibration analysis of BlackSky using MAIAC, CSDA BlackSky Evaluation Team Midterm Review Workshop, NASA GSFC, in person, Jan 19-20, 2023.

Choi, M. (lead), Estimation of black carbon and brown carbon light-absorbing smoke aerosols using DSCOVR EPIC MAIAC processing, IEEE International Geoscience and Remote Sensing Symposium (IGARSS) 2023, Pasadena, CA, in person, Jul 16-21, 2023.

Clark, J. B. (lead), "A New Observing System for Estimating Coastal Aquatic Carbon During Transient Events," Ocean Carbon Biogeochemistry C-Saw Workshop, Raleigh, NC, October 26-28, 2022.

Clark, J.B. (lead), "Assessing Carbon Properties in Coastal Waters with a New Observing System Testbed," OCEANS 2022, Virginia Beach, VA, October 17-20, 2022.

Collow A. (lead), Benchmarking GOCART-2G in the Goddard Earth Observing System (GEOS), 2023 AeroCenter-CPC Meeting, Greenbelt, MD, May 31, 2023.

Collow, A. (lead), An Overview of ARTMIP's Tier 2 Reanalysis Intercomparison: Uncertainty in the Detection of Atmospheric Rivers and Their Associated Precipitation, AGU Fall Meeting, Chicago, IL, December 16, 2022 (invited).

Collow, A. (lead), Excessive Subsidence of the Southeast Atlantic Biomass Burning Aerosol Plume in the NASA Goddard Earth Observing System (GEOS) Model, AGU Fall Meeting, Chicago, IL, December 13, 2022.

Collow, A., Atmospheric River Detection and Associated Precipitation Climate and Radiation Lab Seminar Series, Seminar, NASA GSFC, Greenbelt, MD., September 28, 2022.

Craig, S.E. "Remote Sensing of Ocean Color in the Coastal Zone: Challenges and Solutions," Daily to Decadal Ecological Forecasting along North American Coastlines Workshop, US CLIVAR, Oral Presentation, Woods Hole Oceanographic Institution, Woods Hole, 12th April 2023 (invited).

Craig, S.E., "Advanced topics: PACE Radiometry and Atmospheric Correction", PACE Applications Workshop, virtual, 14th September 2022 (invited).

Craig, S.E., "Keeping PACE with the NASA Plankton, Aerosol, Cloud, ocean Ecosystem mission", Student Airborne Research Program East (SARP East), 9th June 2023, Christopher Newport University, Newport News, VA, (invited).

Craig, S.E., "NASA SARP East 2023: Surf - An Overview", Student Airborne Research Program East (SARP East), 5th June 2023, Christopher Newport University, Newport News, VA, (invited).

Craig, S.E., Carroll, I., Graff, J., Menden-Deuer, S., Karaköylü, E., Rousseaux, C. Machine Learning for Predicting Phytoplankton Community Composition from Ocean Color. AGU Ocean Sciences Meeting, Oral Presentation, virtual, 3rd March 2023.

de Matthaeis, P., Update on the Activities of the Frequency Allocations in Remote Sensing Technical Committee, Spring Meeting of the US National Academies Committee on Radio Frequencies, Washington, DC, May 10-11, 2023 (invited).

Delgado-Bonal, A. (lead), Cloud Height Daytime Variability From DSCOVR/EPIC and GOES-R/ABI Observations. DSCOVR Science Meeting, NASA Goddard, Greenbelt, MD, Sep 17-21, 2022.

Dezfuli, A. (lead), Continental patterns of bird migration linked to climate variability, an invited talk to a group of ~25 visitors from the USGS Bird Banding Laboratory, GSFC, Greenbelt, MD, in-person, May 9, 2023.

Dezfuli, A., (lead), Potential Impacts of Climate Change on Future Transboundary Water Conflicts in the Middle East. AGU Annual Meeting, Chicago, IL, in-person, December 2022.

Eck, T., "The extreme forest fires in California/Oregon in 2020: Aerosol optical and physical properties and comparisons of aged versus fresh smoke", The Remote Sensing/GRASP Workshop, University of Lille, Lillle, France, May 22-25, 2023 (invited).

Elders, A. (Lead) Estimating crop type and yield using multi day sentinel 2, Millennium Challenge Corporation, Oct 2022, virtual (invited).

Elders, A. (lead) Local and Remote Response to Arctic Sea Ice Decline and Sea Ice Representation in Climate Models, May 12, 2022, NASA GISS, virtual (invited).

Elsworth, G.W., Anthropogenic climate change drives non-stationary phytoplankton variance, NASA Ocean Ecology Seminar – NASA Goddard Space Flight Center, October 2022 (invited)

Emberson, R., Connecting ENSO to Landslide Impacts. Presented to Quad Space Working Group Technical Workshop on Extreme Precipitation, Feb 8, 2023.

Emberson, R., Extreme Rainfall and Soil Erosion. Presented as a NASA Terrestrial Water Cycle Seminar, Feb 2, 2023

Emberson, R., Improving Soil Erosion Monitoring using Earth Observations for Food Security, ASABE conference on Soil Erosion, Puerto Rico, Jan 9, 2023.

Emberson, R., NASA Disasters Program: Recovery & Resilience from Space. Presented at Global

Flood Partnership Conference, Leeds, UK, Sept 2022.

Emberson, R., NASA Disasters: Hazard Decision Support Tools. Presented at White House Subcommittee on Science for Disaster Reduction, Feb 2, 2023.

Emberson, R., What Characterizes Rainfall Triggered Landslides and the Places they Impact? USGS Landslides Hazards Seminar, 21st June 2023 (Invited).

Evans, K. (lead) "Comparing satellite measurements of volcanic SO_2 mass from OMI, OMPS, and TROPOMI," 2022 Fall Meeting, AGU, Chicago, IL, 12-16 Dec 2022.

Felikson, D. (lead), NASA's Earth Information System: Sea-Level Change, the IEEE Oceans Conference and Exposition (Virtual), Hampton Roads, VA, 17 Oct 2022.

Felikson, D. (lead), Revealing the processes controlling outlet glacier seasonality with ICESat-2, the ICESat-2 Science Team Meeting, Austin, TX, 16 Oct 2022.

Felikson, D. (lead). The Earth Information System: Sea-Level Change, the NASA Sea-Level Change Team Meeting, Savannah, GA, 19 Sep 2022.

Felikson, D., ICESat-2 Mission Updates, the Future of Greenland Ice Sheet Science Meeting, Atlanta, GA, 22 Mar 2023.

Felikson, D., NASA's Earth Information System, the ECCO Annual Meeting, Pasadena, CA, 25 Jan 2023.

Felikson, D., NASA's Earth Information System: A New Paradigm for Earth System Science, iHARP All Hands Meeting, Pasadena, CA, 8 Jan 2023.

Ganeshan, M. (lead), Lower atmospheric sounding capability from Spire and operational GNSS RO products for Arctic PBL studies, AGU Fall Meeting, Chicago, IL, Dec 12 – 16, 2022.

Gong, J., et al. (talk, 2022), A GCM-Oriented Passive Microwave Diurnal Ice/Snow Cloud Retrieval Product using CloudSat/CALIPSO as the Baseline, CloudSat-CALIPSO science team meeting, Fort Collins, CO, September 2022.

Gong, J., Special seminar for the UMBC Physics335 class students, titled "Cloud, Precipitation, and how we see them through polarized lenses", UMBC, Baltimore, MD, 11/18/2022.

Grecu, M. (lead), GPM Blind Zone Research Activities Review and Updates, NASA PMM Science Team Meeting, Denver, CO, October 4-6, 2022.

Grecu, M. (lead), GPM Blind Zone Research Status, NASA PMM GV Workshop, Wallops, VA, May 23-24, 2023.

Grecu, M. (lead), Investigation of uncertainties in the cold season precipitation estimates by the GPM combined algorithm, AGU Fall Meeting, Chicago, IL, December 14, 2022.

Grecu, M. (lead), Measurement synergies: CCP more broadly, PMM Ku with US cloud profiling for single-orbit considerations, NASA AOS planning meeting, Greenbelt, MD, March 14, 2023.

Guimond, S., Research and Development in the Geophysical Fluid Dynamics Group, UMBC ATPH seminar to graduate students, in person, Jan 2, 2023.

Guimond, S., The Dynamics of Banded Structures in Extra-Tropical Cyclones: A Combined Remote Sensing and Modeling Perspective from NASA IMPACTS, AMS annual meeting, Denver, CO, in person, Jan 10, 2023.

Guimond, S., The Dynamics of Megafire Smoke Plumes in Climate Models: Why a Converged Solution Matters for Physical Interpretations, NASA GMAO seminar, in person, Oct 18, 2022 (invited).

Han, M. (lead), An investigation of airborne data obtained during the IMPACTS campaign with coincident GPM overpasses. NASA Precipitation Measurement Missions Science Team Meeting, October 3-7, hybrid, Denver, CO.

Hannun, R., "Eddy covariance observations of ozone deposition over a soybean field." AMS 25th Conference in Atmospheric Chemistry, Denver, CO. Jan. 2023.

Hannun, R., "From the Canopy to Space and Back: Investigating the Biosphere-Atmosphere Exchange of Carbon and Ozone." NASA Ames Earth Science Division Seminar; Mountain View, CA, May 2023 (invited).

Hannun, R., "Linking Forest Biomass and Carbon Exchange Using Airborne Flux Observations and LiDAR Forest Canopy Structure." NASA Carbon Monitoring Systems Science Team Meeting, Washington, DC. Sep 2022.

Huemmrich, K.F. (lead), Monitoring Terrestrial Foliar Pigments with PACE, Poster, PACE Applications Workshop, virtual, September 14-15, 2022.

Jethva, H. (Lead), Estimating instantaneous direct radiative effects of absorbing aerosols above clouds from OMI and EPIC, *EPIC Science Team Meeting*, NASA Goddard, In-person, Sep 27-29, 2022.

Jethva, H. (Lead), Toward a global retrieval dataset of UV-VIS spectral single-scattering albedo of absorbing aerosols above clouds from CALIOP-OMI-MODIS synergy, *2022 AGU Fall Meeting*, Virtual, 12-16 December 2022.

Jin, D., (lead), Cloud feedback decomposition with 19-year satellite observations, AGU Fall Meeting 2022, A54H-01, Chicago, IL, Dec 2022.

Jo, M., (lead), Assessment of tropospheric signal mitigation techniques for synthetic aperture radar interferometry, IGARSS 2023.

Jo, M., (lead), Automatic Flood Depth Estimation Based on the HAND-based Approach for Bangladesh Floodplains, 2022 AGU Fall Meeting, Chicago, IL, Dec 2022.

Karpowicz, B.M. Improving CrIS Infrared Assimilation in the GEOS Atmospheric Data Assimilation System, 24th International TOVS Study Conference, Tromsø, Norway, March 16-22, 2023.

Kathuria, D. (lead), Enhancing soil moisture predictions across CONUS using Big Data fusion, AGU Fall Meeting, Chicago, IL, Dec 2022.

Kathuria, D. (lead), Sensitivity analysis on inputs to the DisALEXI algorithm using a Machine Learning interpretability method, AGU Fall Meeting, Chicago, IL, Dec 2022.

Kathuria, D. (lead), Advancing Hyperspectral Remote Sensing of Foliar Plant Functional Traits: A Bayesian Hierarchical Regression Approach, Carbon Cycle and Ecosystems Joint Science Workshop, Baltimore, MD, May 2023.

Keller, C. (2022), Leveraging the Science Managed Cloud Environment to deliver on-demand air quality forecasts to stakeholders using a combination of NASA model simulations and surface observations, SMCE Cloud Forum, virtual, November 17, 2022 (invited).

Kim, D., "Assessment of Dust Source Attribution to the Global Land and Ocean Regions", AGU Fall meeting 2022, Chicago, IL (virtual), 12/16/2022.

Kim, D., "Assessment of Dust Source Attribution to the Global Land and Ocean Regions", for the GESTAR-2 special seminar series at the University of Maryland, Baltimore County, April 28, 2023 (invited).

Kim, D., "Assessment of Dust Source Attribution to the Global Land and Ocean Regions", Aerocenter seminar, NASA/GSFC. April 11, 2023.

Kim, D., Assessment of dust source attribution to the global land and ocean regions, Aerocom meeting, Oslo, Norway, October 10, 2022.

Kim, D., Multi-model comparison of dust optical depth at 10 um over the Northern Atlantic Ocean, Aerocom meeting, Oslo, Norway, October 13, 2022.

Kim, H. (lead), Effects of AutoSNOW changes on Path Integrated Attenuation Estimates for GPM-DPR, NASA Precipitation Measurement Mission (PMM) Science Team Meeting, Minneapolis, MN, September 17-22, 2023.

Knowland, K. E. (lead), Air Quality Space Based Observations and GEOS Model and Data Assimilation Products, NASA exhibition booth hyperwall presentation, 2023 American Thoracic Society conference, Washington, D.C., May 23, 2023

Knowland, K. E. (lead), Keynote presentation "NASA GEOS Forecasting Capabilities for Air Quality" at the Air Quality Community of Practice of Latin-American and African Cities workshop coordinated by World Resource Institute (WRI) Mexico and WRI Africa. April 27, 2023 (virtual)

Knowland, K. E. (lead), NASA GEOS Composition Forecast System, GEOS-CF: Overview, Applications, and Future Directions, Joint International Atmospheric Chemistry Conference 2022 (iCACGP-IGAC2022), Manchester, England, September 14, 2022

Knowland, K. E. (lead), NASA GEOS Composition Forecast system: GEOS-CF, presentation and panelist in the Air Quality Modeling Session, Joint Science Meeting for TEMPO, GeoXO ACX, &

TOLNet, Huntsville, AL, May 3, 2023

Knowland, K. E. (lead), NASA GEOS model and DA System for AQ, "Looking toward the 2027 Decadal Survey: Considerations for a coordinated national air quality architecture" Workshop, Pasadena, February 6, 2023 (invited)

Knowland, K. E. (lead), NASA's High-Resolution GEOS Forecasting and Reanalysis Products: A unified Tool from Local to Global Scales, Global Change Seminar series, School of Geosciences, University of Edinburgh, Edinburgh, Scotland, September 16, 2022 (Invited)

Knowland, K. E. (lead), Near real-time air quality forecasts using the NASA GEOS model, NW-AIRQUEST 2023 annual meeting, June 21, 2023 (invited, virtual)

Knowland, K. E. (lead), Near real-time air quality forecasts using the NASA GEOS model, 1st Greater D.C. Area Atmospheric Composition and Modeling Workshop, George Mason University, Fairfax, Virginia, June 22, 2023 (invited)

Knowland, K. E. (lead), Predicting more than just weather: New high-resolution forecasts of composition from GEOS, NASA exhibition booth hyperwall presentation, 2023 American Thoracic Society conference, Washington, D.C., May 22, 2023

Knowland, K. E. (lead), Supporting NASA missions with the GEOS Composition Forecast System, AGES (AEROMMA+CUPiDS, GOTHAAM, EPCAPE, and STAQS) Workshop, September 29, 2022 (virtual)

Kotsakis, A. (lead), "Characterization of the Planetary Boundary Layer (PBL) in Houston, TX Using Trace Gas Profiles and Traditional Measurement Techniques," 2023 AMS Annual Meeting, Denver, CO, January 8-12, 2023.

Kotsakis, A., (lead) "Hyperspectral Microwave Measurement Demonstrations of Improved Thermodynamic Sounding From Space," the International Geoscience and Remote Sensing Symposium, Pasadena, CA, July 16-20, 2023.

Kotsakis, A., Viewing Air Quality and Meteorology from the Ground and From Space, the 2023 Great Lakes Meteorology Conference, Valparaiso, IN, April 22, 2023.

Kramer, R., Observing and interpreting Earth's energy imbalance in a warming world. Penn State University's Climate Dynamics Seminar, March 22, 2023 (invited).

Kramer, R., Observing and modeling Earth's energy imbalance in a warming world. NC State University Marine, Earth and Atmospheric Science Seminar, March 6, 2023 (invited).

Kramer, R., Radiative forcing from observations: A powerful tool for monitoring the climate. 2023 Gordon Research Conference on Radiation and Climate, Lewiston, ME, July 26, 2023 (invited).

Kramer, R., The opposing roles of radiative feedbacks and radiative forcing in driving observed precipitation change, 2023 AMS Annual Meeting, Denver, CO, January 12, 2023.

Kuzmicz-Cieslak, M., (lead) "An Addition to the Suite of Geodetic Satellites Supporting the ITRF:

LARES-2", AGU Fall 2022 Meeting, Virtual, Dec 2022.

Lamsal, L. (lead), Multi-Decadal Nitrogen Dioxide and Derived Products from Satellites (MINDS): Application to GOME-2 on MetOp-A and -B, AGU Fall Meeting, Chicago, IL, virtual, Dec 14, 2022.

Lee, D., Viewing large-scale Diabatic Heating through Cloud Vertical Structure regimes, AGU Fall Meeting, Chicago, IL, virtual, Dec 12-16, 2022.

Lee, E. (lead), Applications of model forecasts to water resources management and carbon dynamics research, Seminar at Graduate School of Environmental Studies, Seoul National University, Seoul, Korea, Jun 29, 2023

Lee, E. (lead), Decoding the Science of Climate Change and the Carbon Cycle, Seminar at Department of Civil and Environmental Engineering, Seoul National University, virtual, March 10, 2023.

Lee, E. (lead), Exploring coupled land-atmosphere carbon dynamics and seasonal carbon forecast skill, Seminar at Division of Environmental Science and Engineering, Pohang University of Science and Technology, Pohang, Korea, Jan 26, 2023.

Lee, E. (lead), Investigation of coupled land-atmosphere carbon dynamics and seasonal carbon forecast skill, Seminar at Department of Urban and Environmental Engineering, Ulsan National Institute of Science and Technology, Ulsan, Korea. Jan 5, 2023.

Lee, E. (lead), Investigation of coupled land-atmosphere carbon dynamics and carbon forecast for a better understanding of the Earth system predictability, Seminar at School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea, Dec 22, 2022.

Lee, E. (lead), Modeling carbon and water dynamics on land and its application, Seminar at Graduate School of Energy and Environment, Korea University, Seoul, Korea, Dec 13, 2022.

Lee, E. (lead), Modeling terrestrial carbon and water dynamics and its applications, Seminar at Korea Institute of Energy Technology, Naju, Korea, Jan 10, 2023.

Lee, E. (lead), Seasonal forecast of the carbon and water dynamics on land, Guest speaker at the Resilient Infrastructure Technology Seminar Class, Department of Civil and Environmental Engineering, Yonsei University, Seoul, Korea, Sep 20, 2022.

Lee, E. (lead), Seasonal forecast skill of land's carbon uptake, Oral presentation at the Korean Society of Climate Change Research Winter Meeting, Jeju Island, Korea, Dec 2, 2022.

Lee, E. (lead), Subseasonal river water forecasts for southeast Asia using NASA's S2S forecast system, Oral presentation at NASA SERVIR workshop, Bangkok, Thailand, Jun 21, 2023

Lee, J. N. (lead), "Cool and wet mesosphere: precursor or spinoff?", AGU Fall meeting, Chicago, IL, Dec. 12-16, 2022.

Lee, J. N. (lead), "The sensitivity of PMC to mesospheric water vapor and temperature", EGU

meeting, Vienna, Apr. 23-28, 2023.

Lewis, J., "A Scheme for Cloud-Aerosol Discrimination Using Polarized MPL Measurements", American Meteorological Society Annual meeting, January 2023.

Li, F. (lead), Impacts of Stratospheric Ozone Recovery on Southern Ocean Heat Content, Heat Uptake, and Meridional Ocean Heat Transport, SPARC 2022 General Assembly, Boulder, CO, Oct 24-28, 2022.

Li, F. (lead), Stratospheric Water Vapor under Global Warming: Climate Feedback and Impact on Temperature and Circulation, ECS & Cloud Feedback Symposium, virtual, Nov 19, 2022 (invited).

Liao, L., "GPM DPR Version-6 and 7 Snow Estimates", NASA PMM Science Meeting, Denver, CO, October 2022.

Liao, L., "Microphysical Properties of Precipitating Hydrometeors inferred from Multi-Frequency Airborne Radar", in AMS Radar Conference in Minneapolis of Minnesota, August 2023.

Liao, L., "Phase Transition Study Activities", NASA GPM Ground Validation Workshop, Wallops, VA, May 2023.

Lim, Y.-K. (lead), Impact of the Arctic Oscillation from March on summertime sea ice, NOAA's Climate Diagnostics and Prediction Workshop, Logan, UT, October 25-27, 2022.

Lim, Y.-K. (lead), MJO propagation and associated moist dynamics in NASA's new GEOS S2S forecast system, The WWRP/WCRP S2S Summit, Reading, UK, July 3-7, 2023.

Lim, Y.-K. (lead), Prediction of the Eurasia/Siberian warm extreme events in 2020 in Version 2 of NASA's GEOS-S2S forecast system and the mechanism for their development and maintenance associated with Rossby-wave propagation, Weather and Climate Extremes and their Predictability conference, Barcelona, Spain, September 27-29, 2022.

Lim, Y.-K. (lead), Subseasonal to seasonal time-scale modes of climate variability represented in the coupled NASA GEOS model and their predictions, The 9th U.S. Climate Modeling Workshop/Summit, Princeton, NJ, April 24-26, 2023.

Lim, Y.-K. (lead), Tropical cyclones in GEOS-ECCO high-resolution simulations (presentation virtually). NASA – NOAA QOSAP meeting, JPL, CA, virtual, April 19-20, 2023.

Liu, F. (lead), Catalog of City Emissions and Lifetimes of Nitrogen Oxides Inferred from Tropomi Nitrogen Dioxide Observations, AMS Annual Meeting, Denver, CO, January 8-12, 2023.

Liu, F. (lead), High-resolution mapping of nitrogen oxides emissions in US large cities from TROPOMI retrievals of tropospheric nitrogen dioxide columns, EGU General Assembly, Vienna, Austria, April 23-28, 2023.

Liu, Y., (Sub)millimeter-wave radiometer retrieval algorithms, CCP algorithms meeting, virtual, Nov 17, 2022.

Liu, Y., Three-dimensional ice cloud tomography algorithm for the (sub)millimeter-wave

radiometer, IMPACTS monthly meeting, virtual, July 17, 2023.

Lyu, C.-H., "On-Orbit Performance of the NOAA-21 Advanced Technology Microwave Sounder (ATMS), IEEE IGARSS 2023, Los Angeles, California.

Lyu, C.-H., "Pre-Launch Performance Trending of Joint Polar Satellite System (JPSS) Advance Technology Microwave Sounder (ATMS)", IEEE IGARSS 2023, Los Angeles, California.

Maina F.Z., "On the use of space technology to tackle water scarcity issues", The Africa Aerospace and Defense Exhibition, Pretoria, South Africa, Sept 23, 2022, (invited).

Maina, F.Z. (lead), "Disentangling the impacts of anthropogenic activities and changing climate on the land surface processes in High Mountain Asia", December 13th, 2022, AGU Fall Meeting, Chicago, IL, Dec 13, 2022 (invited).

Maina, F.Z. (lead), "Rain-on-snow events over High Mountain Asia", AGU Fall Meeting, Chicago, IL, Dec 15, 2022 (invited).

Maina, F.Z., "Etudier l'eau de l'espace", Université Abdou Moumouni, Niamey, Niger, April 25, 2023, (invited).

Maina, F.Z., "Satellite observations reveal the responses of Asian water towers to a changing climate and agricultural activities", Stanford University, Stanford, CA, April 15, 2023, (invited).

Maina, F.Z., "The impacts of a changing climate and human activities on the hydrology of High Mountain Asia", Montclair State University, Montclair, NJ, Feb 6, 2023 (invited).

Maina, F.Z. (lead), "Development of a multidecadal land reanalysis over High Mountain Asia", AMS Annual Meeting, Denver, CO, Jan 11, 2023.

Malings, C. (co-lead), "Air quality forecasting at sub-city-scale by combining models, satellites, and surface measures". 6th AfriGEO Symposium (virtual). October 31, 2022 (invited).

Malings, C. (co-lead), "NASA Air Quality-Focused Remote Sensing for EPA Applications" Training provided by NASA ARSET and hosted by US EPA. Research Triangle Park, NC, USA, March 21-23, 2023 (invited).

Malings, C. (lead), "Creating & Using Open Global and Local Air Quality Data at NASA GMAO". ESIP Meeting January 2023 (virtual). January 26, 2023 (invited).

Malings, C. (lead), "Data fusion with uncertainty quantification for sub-city-scale air quality assessment and forecasting (poster)". Meteorology and Climate Modeling for Air Quality Conference 2023. Davis, CA. September 13, 2023.

Malings, C. (lead), "Forecasting with the GEOS-CF System and Other NASA Resources to Support Air Quality Management". International Conference on Air Quality in Africa (virtual). October 11-14, 2022.

Malings, C. (lead), "Supporting Local Government Public Health and Air Quality Decision-Making with a Sub-City Scale Air Quality Forecasting System from Data Fusion of Models,

Satellite, In Situ Measurements, and Low-Cost Sensors" at the NASA Health and Air Quality Applied Sciences Program Annual Meeting. Asheville, NC, March 29-30, 2023 (invited).

Malings, C. (lead), "Towards a Flexible Data Fusion Tool for Air Quality Estimation and Forecasting with a Global Scope in Google Earth Engine". Google exhibition booth, American Geophysical Union Annual Meeting. Chicago, IL, December 13, 2022 (invited).

Malings, C. (lead), "Towards a Flexible Data Fusion Tool for Air Quality Estimation and Forecasting with a Global Scope in Google Earth Engine". American Geophysical Union Annual Meeting. Chicago, IL, December 16, 2022.

Malings, C. (lead), "Towards a Flexible Data Fusion Tool for Air Quality Estimations & Forecasting with a Global Scope in Google Earth Engine". American Thoracic Society 2023 Conference, the NASA Exhibition Booth, Washington, DC, May 23, 2023 (invited).

Malings, C. (lead), "Towards a flexible data fusion tool incorporating model, satellite, regulatory monitor and low-cost sensor data for air quality estimation and forecasting". American Meteorological Society 103rd Annual Meeting (virtual). Denver, CO, January 12, 2023 (invited).

Malings, C. (lead). "Air Quality Analysis with Sensors, Satellites, and Models". American University Fall Colloquium Series. Washington, DC, USA. September 23, 2022 (invited).

Malings, C. (lead). "Air Quality Analysis with Sensors, Satellites, and Models". Montclair State University Sustainability Seminar Series of the Doctoral Program in Environmental Science & Management (virtual). April 3, 2023 (invited).

Malings, C. (lead). "Air Quality Analysis with Sensors, Satellites, and Models (virtual)". University of Arkansas Little Rock, Donaghey College of Science, Technology, Engineering, and Mathematics Colloquium Series. October 13, 2023 (invited).

Malings, C. (lead). "Air quality forecasting at sub-city-scale by combining models, satellites, and surface measures". Air Sensors International Conference Fall Webinar Series (virtual). November 21, 2022 (invited).

Malings, C. (lead). "Air Sensors as Input to an Air Quality Data Fusion System". US Environmental Protection Agency Air Sensors Quality Assurance Workshop 2023. Durham, NC, July 26, 2023 (invited).

Malings, C. (lead). "NASA Data for Air Quality". CanAIRy Alert training: Tools for AQ management and capacity building (virtual). June 29, 2023 (invited).

Malings, C. (lead). "NASA Resources to Support Air Quality Monitoring and Forecasting". Training Course for Jakarta City: Air Quality Monitoring Best Practices: Data Collection, Management, and Use (virtual). May 3, 2023 (invited).

Malings, C. (lead). "Satellites and Low-Cost Sensors: Advantages, Limitations, and Opportunities for Integration". African Centre for Clean Air Webinar on Understanding the Use of Satellite Data for Air Quality Management (virtual). July 13, 2023 (invited).

Martins, J. V., "Aerosol and Cloud Measurements with the HARP Family of HyperAngular Imaging Polarimeters," International Radiation Symposium / International Radiation Committee, Thessaloniki, Greece, December 2022.

Martins, J. V., "The use of atmospheric Inversion on Multi Angle polarization data from Ground, Aircraft and Satellite," AGU Fall Meeting 2022, December 2022.

McGrath-Spangler, E. (lead), Impacts of Assimilating Infrared Sounders from Geostationary Orbit, International Symposium on Data Assimilation - Online Topic: Observation impact, Online 4 Nov 2022.

McGrath-Spangler, E., "Global NWP Impacts of Infrared Sounders from Geostationary Orbit", International TOVS Study Conferences-24, Tromso, Norway, 16-22 March 2023

McGrath-Spangler, E., Assessing the Impact of SMAP Soil Moisture Data Assimilation on the Simulation and Prediction of Tropical Cyclone Idai, 2022 AGU Fall Meeting, Chicago, IL, 12 Dec 2022.

McKee, K.F. (lead),"Insights into the 15 January 2022 Hunga volcano, Tonga eruption using infrasound, lightning, and particle properties." Oral presentation at: International Association of Volcanology and Chemistry of Earth's Interior (IAVCEI) Scientific Assembly. Rotorua, New Zealand, 2023.

O'Neill, N. T., Recent results on the ground- and satellite-based remote sensing of Arctic aerosols & clouds over Eureka (SACIA-2 project), AeroCenter presentation, GSFC/NASA, Greenbelt, MD, Oct 4, 2022.

Olson, W. S. (lead), PMM Combined Radar-Radiometer Algorithm (CORRA) V07+, NASA 2022 Precipitation Measurement Missions Science Team Meeting, Denver, CO, October 6, 2022 (invited).

Orland, E. (lead), "Remote Sensing Applications for Post-Fire Hazard Assessments", GSA Connects 2022, Geological Society of America, October 12, 2022.

Orland, E., "NASA EIS - Integrated and actionable information across the fire life cycle", NASA-USFS Joint Applications Workshop Applied Earth Observations Innovation Partnership, Salt Lake City, UT, April 27, 2023 (invited).

Pavlis, E. C. (2022) "Low Degree Gravity SH from SLR and GRACE/GRACE-FO Mission Models", Unified Analysis Workshop 2022 (UAW 2022), Thessaloniki, Greece, 21-23 October 2022.

Pavlis, E. C., (lead) "Incorporating LARES-2 SLR Data in ILRS Products for ITRF Development", EGU General Assembly 2023 Meeting, Vienna, Austria, 23–28 April 2023.

Pavlis, E. C., (lead), "The ILRS Analysis Standing Committee Contribution to ITRF2020", Reference Frames for Applications in Geosciences (REFAG 2022), Thessaloniki, Greece, 17-20 October 2022.

Pavlis, E. C., (lead), "ITRF2020: The ILRS Contribution and Operational Implementation", AGU Fall 2022 Meeting, Virtual, Dec 2022.

Peng, J. (lead), One-Point Calibration for Soil Moisture Active/Passive (SMAP) L-band Microwave Radiometer, IGARSS 2023, Pasadena, CA, Jul 16-21, 2023.

Peng, J. (lead), The Geolocation Validation and Calibration for the Compact Ocean Wind Vector Radiometer, IGARSS 2023, Pasadena, CA, Jul 16-21, 2023.

Peterson, C., (lead), The MODIS/VIIRS Cloud Team's Pixel-Level Radiative Flux Datasets. Gordon Climate and Radiation Research Conference, Lewiston, ME, in-person, July 23-28, 2023.

Privé, N. "Introduction to OSSEs", online seminar for the department of Atmospheric and Oceanic Science, University of Maryland, College Park, 31 October 2022 (invited).

Privé, N.C., M. Walker McLinden, B. Lin, G. Heymsfield, I. Moradi, S. Harrah, M. Sienkiewicz, K. Horgan, and L. Li. "Potential Use of Spaceborne Differential Absorption Radar Measurements of Marine Surface Pressure to Improve Weather and Tropical Cyclone Forecasting ", virtual speaker, 103rd American Meteorological Society Annual Meeting, Denver, CO, 8-12 January 2023.

Puthukkudy, A. (lead), "An assessment of the effectiveness of multi-angle polarimeter aerosol retrievals based on data from the CAMP2Ex field campaign," 2022 AGU Fall Meeting, Dec 2022.

Puthukkudy, A., "Aerosol and Cloud Observations from Space with HARP CubeSat", Workshop on Recent advancements in remote sensing and modeling of aerosols, clouds and surfaces, Univ. of Lille, France, May 2023 (invited).

Puthukkudy, A., "HARP: A 3U CubeSat for aerosol and cloud observations", 73rd IAC22, Paris, France, Sept 18-22, 2022.

Rajapakshe, C. (lead), "Aerosol 3-D Distributions around North Pacific Cyclones Observed by CALIOP and MODIS", AGU Fall meeting, December 13, 2022.

Remer, L. (lead), Unified broad spectrum aerosol algorithm for OCI, NASA PACESAT Meeting, San Diego, CA, 27 Feb. to 01 Mar., 2023 (invited).

Remer, L., Nourishment of the global oceans from deposition of atmospheric dust aerosols. NASA MODIS-VIIRS Meeting, College Park MD, 02 May 2023.

Salinas, C.C.J. (lead), Development of the E-region Prompt Radio Occultation Based Electron Density (E-PROBED) Model: Progress on the Background Ionosphere Component, CEDAR Workshop 2023, San Diego, California, June 25 – 30, 2023

Sayer, A. M. (co-lead), User Driven Air Quality Management using Future NASA PACE Mission Data, GeoHealth Community of Practice Webinar Series, virtual, Jul 7-12 2023 (oral, invited).

Sayer, A. M. (lead), ARM data as a resource for validation of NASA PACE cloud retrievals, 2023 ARM/ASR Joint User Facility and PI Meeting, Rockville, MD, Aug 7-10 2023 (poster).

Sayer, A. M. (lead), NASA's PACE mission launches in January 2024 and will provide data

relevant to the air quality community, HAQAST meeting, St. Louis, MO, Apr 17-19 2023 (poster, plus invited panelist).

Sayer, A. M. (lead), PACE Uncertainties Working Group summary, PACE Science Team meeting, San Diego, CA, Feb 27-Mar 2 2023 (oral, invited).

Sayer, A. M. (lead), Validation of MODIS cloud liquid water path to prepare for PACE evaluation efforts, MODIS/VIIRS Science Team meeting, College Park, MD, May 1-4 2023 (poster).

Shi, Y. (lead), Investigating the spatial and temporal limitations of satellite characterization of wildfire smoke using satellite and airborne imagers during FIREX-AQ, the 21th AeroCom / 10th AeroSAT meeting, Oslo, Norway, Oct 2022

Shi, Y. (lead), Investigating the spatial and temporal limitations of satellite characterization of wildfire smoke using satellite and airborne imagers during FIREX-AQ, AGU, Chicago, IL, Dec 2022

Shi, Y. (lead), Retrieving Rapid-evolving Smoke Absorption Using Critical Reflectance Methods with Geostationary Observations, AOGS 2023, Singapore, July 2022

Shi, Y. (lead), Retrieving Rapid-evolving Smoke Absorption Using Critical Reflectance Methods with Geostationary Observations, 9th COAA International Conference on Atmosphere, Ocean and Climate Change (ICAOCC23), Singapore, July 2022

Shi, Y. (lead), Working Towards Dark Target Aerosol Product Synergy Among Geo and Leo Sensors, AOGS 2023, Singapore, July 2022

Shuman, C., "Big Bergs No More" A Landsat Study of the Thwaites Ice Tongue and Glacier Front Utilizing Imagery from 1972 to 2022," in-person iHARP All Hands meeting, the Interdisciplinary Life Sciences Building, UMBC, Jan 9-10, 2023.

Shuman, C., "Earth's Glacial Ice: Changing Now", NASA Climate Summit Breakout: Developing the Climate-Savvy Workforce of the Future, virtual, 9 December 2022.

Shuman, C., Landsat Tracks Brunt Ice Shelf Evolution 1986-2023, virtual presentation to Code 615, March 8, 2023 (now an SVS hyperwall, https://svs.gsfc.nasa.gov/31228/, 11 July 2023)

Soto Ramos, I., (lead) 2023. Spatial and temporal characterization of cyanobacteria blooms in the Mississippi Sound and their relationship to the Bonnet Carré Spillway openings. State of the Coast (SOC) 2023 meeting. New Orleans, LA. May 31-June 2, 2023.

Souri A., A decoupled relationship between HCHO surface and columns during a sea breeze event, Seminar for NASA GSFC (614), 2023, Greenbelt, MD.

Souri A., Characterization of errors in Satellite-based HCHO/NO2 ratios, Seminar for NASA GSFC (614), Greenbelt, MD, 2022.

Souri, A., (lead), A Complete Picture of Errors Precluding the Precise Diagnosis of Ozone Chemical Regimes Using Satellite-Based HCHO/NO2 Ratios, 103rd AMS Annual Meeting,

2023.

Souri, A.H. (lead), MethaneSAT OSSE Simulation to Assess Errors in XCH4 Derived From the CO2 and O2 Proxy Methods. Presented at the 103rd AMS Annual Meeting, AMS.

St. Clair, J. M. (lead), Formaldehyde as a Short-Lived Convective Tracer, ACCLIP Science Team Meeting, NCAR, Boulder, CO, 2022.

St. Clair, J. M., Formaldehyde in the Earth's Atmosphere, Chemistry Department Seminar, Rochester Institute of Technology, Rochester, NY, virtual, Nov. 15, 2022 (invited).

Stanley, T., "Applying Earth Observation Data for Research and Applications in Sustainable Development," 2022 AGU Fall Meeting, Chicago, IL, Dec 2022.

Taha, G., Monitoring the 2022 Hunga Tonga-Hunga Ha'apai Aerosol Cloud Using Space-Based Observations, AGU Fall meeting, December 2022.

Taha, G., Evolution of the 2022 Hunga Tonga-Hunga Ha'apai Aerosol Cloud Using Space-Based Observations, SPARC Hunga-Tonga Hunga-Ha'apai impacts open science workshop, online event, May 2023.

Taha, G., Measurements of the 2022 Hunga Tonga-Hunga Ha'apai Aerosol Cloud Using Space-Based Observations, 12th Atmospheric Limb Workshop, Brussels, Belgium, May 2023.

Taha, G., Monitoring the 2022 Hunga Tonga-Hunga Ha'apai Aerosol Cloud Using Space-Based Observations, AMS annual meeting, Denver Co., 8-12 January 2023, Invited.

Tao, Z., "NASA Unified Weather Research & Forecasting Model (NU-WRF): Development and Applications to Air Quality Study", GSFC's Chemistry and Dynamic Laboratory (code 614), 11/10/2022.

Tao, Z., "Improving aerosol representation in NU-WRF in support of the emerging GEO-LEO satellite observation of air quality", AMS 103rd annual meeting, Denver, CO, 8-12 January 2023.

Tao, Z., "Improving aerosol representation in NU-WRF in support of MICS-Asia and ACAM activities," the 5th ACAM Workshop, Dhaka, Bangladesh, 8-10 June 2023.

Tao, Z., "Urban effect on precipitation – A case study over Houston," the 2023 Goldschmidt Annual Conference, Lyon, France, 9-14 July 2023.

Thomas, N. (lead), Defining Extremes in a Present and Changing Climate: Examples using MERRA-2, US Regional Hydroclimate Project (RHP) Affinity Group meeting, virtual, May 11, 2023.

Thomas, N. (lead), Effect of Baseline Period on Quantification of Climate Extremes over the United States, GES DISC UWG meeting; Greenbelt, MD, Sep 29, 2022.

Thomas, N. (lead), Variability in SMAP Soil Moisture Patterns and Vector-Borne Disease Outbreaks: Some Recent Observations, SMAP Science Team Meeting #17, virtual, Feb 15, 2023

Thomas, N., (lead), Effect of Baseline Period on Quantification of Climate Extremes over the United States, AGU fall meeting, Chicago, IL, Dec 16, 2022.

Thompson, A. M. (Lead) "Quality Assurance in Ozonesonde Profiles for Satellite and Trends Studies: JOSIE and the 2021 ASOPOS 2.0 (Assessment for Standard Operating Procedures [SOP] for OzoneSondes) WMO/GAW Report 268," SPARC-General Assembly, Boulder, CO, 24 October 2022.

Thompson, A. M. (Lead) "The 2021 ASOPOS (Assessment of Standard Operating Procedures [SOP] for OzoneSondes) 2.0 WMO/GAW 268 Report: Global Ozonesonde Best Practices," Virtual**,** WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observations – TECO-2022, Paris, 12 October 2022.

Thompson, A. M. (Lead) "The SHADOZ Ozonesonde Network at 25 Years: Accomplishments and Recent Innovations," AGU Annual Meeting, Chicago, 16 December 2023.

Thompson, A. M. (Lead) "The Stability of the Global Ozonesonde Network," NASA/LaRC, Hampton, VA, SAGE III/ISS Science Team Meeting, 13 October 2022.

Thompson, A. M. (Lead) "Thirty Years of the Network for Detection of Atmospheric Composition Change (NDACC): Contributions to Metrology," Virtual, BIPM (Intl Bureau of Weights & Measures), Paris, 28 September 2022.

Thompson, A. M. (Lead) "Tropical Tropospheric Ozone Trends (1990-2020): An Integrated Satellite, Soundings and Aircraft View." Virtual, NOAA Global Monitoring Annual Conference, Boulder, CO); 23 May 2023.

Thompson, A. M. (Lead) "Use of Profile and Satellite Data for OPT Trends: Insights from SHADOZ," TOAR II Workshop, Cologne, Germany, 8 March 2023.

Thompson, A. M., "SHADOZ (Southern Hemisphere Additional Ozonesondes) Project & Indonesian (Watukosek) Science," Virtual International Conference on Radioscience, Equatorial Atmospheric Science & Environment (INCREASE), sponsored by Indonesian Agency for Space & Innovation, 22 November 2022 (invited).

Thompson, A. M., "SHADOZ Ozonesonde Network Operations and Data Quality Assurance Activities Update," Research Center-Juelich, Germany, 15 March 2023 (invited).

Thompson, A. M., Celebrating 25 Years of the SHADOZ (Southern Hemisphere Additional Ozonesondes) Network: Scientific Accomplishments, Academy of Athens, Greece, 24 April 2023 (invited).

Tokay, A. (lead), Ground-based precipitation measurements in New England during IMPACTS: An Overview. 14th International Precipitation Conference, oral presentation, Norman, OK, 2023.

Tokay, A., (lead), Precipitation Forecasting: Three simple questions. Earth Day Symposium, oral presentation, UMBC, 2023.

Tokay, A., (lead), Radar snowfall relationships during IMPACTS, 40th AMS Radar Meteorology

Conference, poster presentation, Minneapolis, MN, 2023.

Várnai, T. (lead), EPIC observations of sun glint caused by horizontal ice crystals in clouds. 2022 AGU Fall Meeting, Chicago, IL, December 16, 2022.

Wales, P., (lead), Satellite-Based Emission Estimates of Tropospheric Bromine during Arctic Spring and Application within the GEOS-Chem, AGU Fall Meeting, Virtual, Dec 2022.

Wang, C. (lead), A Convenient and Flexible Satellite Data Spatial-temporal Collocation System, ESDSWG 2022 Poster Session, April 20, 2023

Wang, C. (lead), A flexible satellite data spatial-temporal collocation system and applications, 2023 ESDSWG Technology Spotlight, May 15, 2023 (invited).

Wang, C. (lead), Cloud and Aerosol Detection using Spectral, Spatial and Temporal Information from Passive Satellite Instruments, AGU Fall Meeting, A52D-03, Chicago, IL, virtual, Dec 12-16, 2022.

Wang, C. (lead), Cloud and Aerosol Detection Using Spectral, Spatial and Temporal Information from Passive Satellite Instruments, AOGS2023, Singapore Jul 30 – Aug 4, 2023.

Wang, C. (lead), Cloud and Aerosol Detection with Spectral, Spatial and Temporal Observations of GOES-R ABI, AMS 22nd Conference on AI for Environmental Science, Poster #891, Denver, CO, Jan 8-12, 2023.

Wang, C. (lead), Ice Cloud Synergy Retrieval Using Joint Passive Infrared and Microwave Instruments, AOGS2023, Singapore, Jul 30 – Aug 4, 2023.

Wang, Y. (lead), Addressing MODIS TERRA L1B High Latitude Striping Issue with Empirical Adjustment of MODIS Polarization Correction Parameters, AGU Fall Meeting, Chicago, IL, poster, Dec. 11-15, 2022.

Weir, B. (lead), "Constituent data assimilation plans of the GMAO at NASA Goddard", Mathematical Approaches of Atmospheric Constituents Data Assimilation and Inverse Modeling, Banff International Research Station, Banff, Alberta, Canada, 20 March 2023 (invited).

Wen, G. (lead), Spectral Reflectance Relations from EPIC Observations, DSCOVR EPIC and NISTAR Science Team Meeting, Goddard Visitor Center, Greenbelt, MD, 27-29 September 2022.

Wen, G. (lead), Spectral Relations of Global Reflectance Observed from DSCOVR/EPIC, AGU Fall Meeting, Chicago, IL, 12-16 December 2022.

Xu, X. (lead), First Peek of the Cloud Thermodynamic Phase from the Hyper-Angular Rainbow Polarimeter (HARP) CubeSat Observations, A12K-1247, AGU Fall Meeting, Chicago, IL, Dec 12-16, 2022.

Xu, X. (lead), Recent Updates and Applications of the UNL-VRTM Remote Sensing Testbed, AOGS2023 Meeting, Singapore, Jul 30 – Aug 04, 2023.

Xu, X. (lead), The "A" as in PACE: Applications of Polarimetric Aerosol Data to Climate &

Health, PACE workshop, AOGS2023 Meeting, Singapore, Jul 30 – Aug 04, 2023 (invited).

Zeng, Y. (lead), Enhancement of Sahel Precipitation by Remote Irrigation, Virtual Symposium Honoring Chris Milly's Contributions to GFDL and Beyond, Princeton, NJ, Virtual, Jan 20, 2023 (invited).

Zhou, Y (lead),"Event-Based Extreme precipitation Characteristics in the Tropics", AOGS, Singapore, July 31-Aug 5, 2023.

Zhou, Y. (lead), "Evaluation of EPIC Oxygen Band Stability and Calibration with Radiative Transfer Simulations Over South Pole", AGU fall meeting, Chicago, IL, Dec 12-16, 2022.

Zhou, Y. (lead), "Evaluation of the stability of EPIC Oxygen channels with observations and Radiative Transfer Simulations Over South Pole", DSCOVR EPIC and NISTAR STM. GSFC, Sep 27-29, 2022.

Ziemke, J. R., "Global-scale reductions in free tropospheric ozone in 2020-2022 associated with decreased pollution due to COVID-19 and impact on trends", EGU session highlight talk, virtual, April 28, 2023.

Ziemke, J. R., "NASA satellite measurements show global-scale reductions in tropospheric ozone in 2020 and again in 2021 during COVID-19", the DSCOVR EPIC and NISTAR Science Team Meeting, NASA GSFC, 27-29 September 2022.

Proposals Awarded

Proposal Title	Funding Agency	PI (GESTAR II)	CO-I(s) GESTAR II)	Period of Performance
Assessing the dependence of aerosol-cloud interactions on low-cloud mesoscale morphology with ARM observations	DOE ASR	Yuan, T. (UMBC)		09/01/2023 – 02/28/2025
Cooperation and AgReements enhancing Global interOperability for Aerosol, Cloud and Trace gas research infrastructures (CARGO-ACT	European Commission funded		Lewis, J. (UMBC)	11/01/2023 – 10/31/2026
The evaluation of clouds in R21C data via a ML-based MODIS simulator	Internal NASA/GSFC/GMAO Call	Jin, D. (UMBC)		01/01/2023 – 12/31/2023
Unified Ceilometer Network: Remote Sensing Depository of Aerosol Profiles	MD DOE	Demoz, B. (UMBC)	Xu, X. (UMBC)	04/01/2023 – 03/31/2024
Augmentation grant for High Mountain Asia	NASA		Amatya, P. (UMBC), Stanley, T. (UMBC)	09/01/2022-08/31/2023
Coseismic landslides and cascading hazards of the Feb 6, 2023 Turkiye earthquake: Preliminary database development and modeling analysis	NASA		Amatya, P. (UMBC), Stanley, T. (UMBC)	07/01/2023 – 06/30/2024
Evaluation of ICEYE data for landslide disaster response product generation	NASA	Amatya, P. (UMBC)		01/01/2023-12/31/2023
Integrating lateral carbon fluxes into CMS ocean carbon estimates	NASA		Clark, J. B. (UMBC)	08/01/2023 – 07/31/2026
NASA Earth Information System (EIS) Fire	NASA		Orland, E. (UMBC)	02/01/2022-02/28/2023
Polarized Submillimeter Ice-cloud Radiometer, Co-I, Science Enhancement Opportunity entitled “Direct Assimilation of PolSIR radiances in GEOS	NASA	Karpowicz, B. (UMBC)		At present, 2024-2028
Revealing the processes controlling outlet glacier seasonality with ICESat-2	NASA	Felikson, D. (MSU)		12/15/2022 – 07/31/2025
Understanding Hurricane Dynamics Using Field Campaign Datasets and Large Eddy Numerical Simulations for Interpretation of NASA Satellite Data	NASA	Guimond, S. (UMBC)		05/01/2023-04/30/2026
Using NASA Earth Observations for Rapid Wildfire Severity Mapping and Extended Recovery Assessments	NASA		Orland, E. (UMBC)	08/01/2022 – 07/31/2023
Investigating the Role of Wildfire Smoke on Stratospheric Chemistry and Composition using an Aerosol-Chemistry Coupled Global Model	NASA ACMAP		Steenrod, S. (UMBC)	10/01/2023 – 09/30/2026
Improved assessment of recent trends in NOx and VOC emissions and ozone production sensitivity regimes using satellite data, 2023-2025	NASA ACMAP-AURA		Souri, A. (MSU)	08/01/2023 – 07/31/2023

Long-term Maps of Satellite-Based Ozone Production Rates using OMI, OMPS, and TROPOMI HCHO and NO2 Observations via Empirical and Machine Learning Methods: Insights from NASA's Air Quality Campaign	NASA ACMAP-AURA	Souri, A. (MSU)		08/01/2023 – 07/31-2026
GEOS Visualization And Lagrangian dynamics Immersive eXtended Reality Tool (VALIXR) for Scientific Discovery	NASA AIST		Guimond, S. (UMBC)	08/01/2022 – 07/31/2024
Cloud composition from the analysis of sun glints off horizontally oriented ice crystals	NASA AURA/ACMCAP	Várnai, T. (UMBC)		04/21/2023 – 04/20/2026
Earth Observation-based restoration and monitoring in Coastal and Forested Protected Areas of West Africa	NASA ECON		Resende de Sousa, C. (UMBC)	Awarded
Modeling of SAR observations of snow under forest canopy	NASA GSFC IRAD		Armstrong, A. (UMBC), Albayrak, A. (UMBC)	Awarded
Robotic Hyperspectral Polarimeter for the Ocean (RoboHyPO)	NASA GSFC IRAD		Craig, S. (UMBC)	01/01/2023 – 12/31/2023 (extension)
ISFM work package for GPM ground validation research and analysis at NASA Wallops Flight Facility	NASA HQ		Tokay, A. (UMBC)	Awarded
Atmospheric nourishment of global ocean ecosystems on a changing planet	NASA IDS	Remer, L. (UMBC)	Shi, Y. (UMBC)	Originally 06/01/2023 – 05/31/2026
Making a Long-term Data Records of Opportunistic Experiments for Studying Aerosol-Cloud Interactions	NASA MEASURES	Yuan, T. (UMBC)		Awarded
Growth of the Earth and Space Institute at University of Maryland, Baltimore County	NASA RFP	Martins, J. V. (UMBC)	Borda, R. F. (UMBC), Remer, L. A. (UMBC)	07/01/2023 – 06/30/2024
Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ	NASA ROSES		Bian, H. (UMBC)	04/01/2023 – 03/31/2026
Coastal resilience over time - feedbacks between coastal ecosystems, cyclone activity, and coastal protection benefits	NASA ROSES		Campbell, A. (UMBC)	01/01/2023 – 12/31/2023
Coseismic landslides and cascading hazards of the Feb 6, 2023 Turkiye earthquake: Preliminary database development and modeling analysis	NASA ROSES		Amatya, P. (UMBC), Stanley, T. (UMBC)	09/01/2023 – 08/31/2024
Developing a Comprehensive and Augmented Multi-decadal Remote-sensing Observations of Dust (CAMRO-Dust) Data Record for Earth Science Research and Applications	NASA ROSES		Zhang, Z. (UMBC), Rajapakshe, C. (UMBC), Shi, Y.	08/01/2023 – 07/31/2028

			(UMBC), Zhou, Y. (UMBC)	
Feasibility study on 3-D surface deformation mapping for volcanic unrest and eruptions using ICEYE imagery	NASA ROSES	Jo, M.-J. (UMBC)		03/09/2023 – 03/08/2024
Forecasting, Modeling Support and Analysis with GEOS Systems for Asia-AQ	NASA ROSES		Collow, A. (UMBC), Bian, H. (UMBC), Malings, C. (MSU), Wales, P. (MSU) Knowland, K.E. (MSU, Collaborator), Keller, C. (MSU, Collaborator)	10/01/2024 – 09/30/2026
Improving sub-seasonal temperature, precipitation, and hydrological forecasts over North America through online bias correction	NASA ROSES		Chang, Y. (MSU, Collaborator)	01/01/2023 – 12/31/2025
Improving the Parameterization of Lightning Flashes in the GEOS Models Using GOES Geostationary Lightning Mapper Data and Machine Learning	NASA ROSES		Keller, C. (MSU, Collaborator)	07/01/2023 – 06/30/2026
Over Four Decades of Consistent Aerosol Data Records: Fusing AVHRR with EOS Sensors for Climate Studies	NASA ROSES	Lee, J. (UMBC)	Sayer, A. (UMBC)	Originally 01/01/2023 – 12/31/2027
The Future Recovery of Stratospheric Ozone: Influence of ODSs, VSLS Cl, and GHGs	NASA ROSES		Wales, P. (MSU, Collaborator)	02/01/2023-01/31/2026
Advancing satellite-constrained modeled air-sea CO2 fluxes with a focus on the strength of the Southern Ocean carbon sink	NASA ROSES 2022 A.6 CMS	Arteaga, L. (UMBC)	Weir, B. (MSU)	07/01/2023-06/30/25
A Framework for Global Cloud Resolving OSSEs	NASA ROSES AIST		Buchard, V. (UMBC)	08/01/2022 – 07/30/2025
Linking Inter-Model Differences in Simulated Hydroxyl Radical (OH) and its Interannual Variability to Transport Processes	NASA ROSES AURA AND ACMAP	Strode, S. (MSU)	Anderson, D. (UMBC, Collaboratoor)	04/21/2023 – 04/20/2026
Recent decadal trend of the Pacific westerly jet in response to anthropogenic aerosol emissions and its impact on trans-Pacific aerosol transport	NASA ROSES AURA AND ACMAP	Bian, H. (UMBC)	Strode, S. (MSU), Li, F. (UMBC)	05/11/2023-05/10/2026
Evaluating the Planetary Boundary Layer Height Derived from GeoOptics GNSS RO Measurements	NASA ROSES	Ganeshan, M. (MSU)		05/01/2023 – 04/30/2024

	Commercial Smallsat Data Acquisition			
Making a Long-term Data Record of Opportunistic Experiments for Studying Aerosol-Cloud Interactions	NASA ROSES MEASURE	Yuan, T. (UMBC)	Wang, C. (UMBC)	12/10/2022 – 12/09/2027
Assessment of life cycle of snow using data assimilation and machine learning	NASA ROSES MEASURES		Konapala, G. (UMBC)	01/01/2023 – 12/31/2027
Developing a Comprehensive and Augmented Multi-decadal Remote-sensing Observations of Dust (CAMRO-Dust) Data Record for Earth Science Research and Applications	NASA ROSES MEASURES		Zhang, Z. (UMBC), Rajapakshe, C. (UMBC), Shi, Y. (UMBC), Zhou, Y. (UMBC)	Awarded
Multi-Instrument Record of Radiative Forcing and Feedback Responses for Climate Monitoring and Global Change Studies	NASA ROSES MEASURES	Kramer, R. (UMBC)	Strow, L. (UMBC, Collaborator), DeSouza-Machado, S. (UMBC, Collaborator)	2023-2028
Long-Term, High-Resolution Urban Aerosol Database for Research, Education and Outreach	NASA ROSES MUREP DEAP		Mehta, A. (UMBC)	Awarded
Characterizing extreme precipitation events to better inform hydrological hazard assessment	NASA SMD		Orland, E. (UMBC), Sutton, J. (UMBC), Stanley, T. (UMBC)	10/01/2022 – 12/31/2024
SNWG Air Quality Forecasts and Distributed Pandora Sensors: GMAO Forecasts	NASA SNWG	Keller, C. (MSU)		07/01/2023 – 06/30/2028
Developing the NOAA Next Generation Hyperspectral Microwave Sensor (HyMS): Instrument Concept and Demonstration of Benefits for the NOAA Mission	NOAA		Kotsakis, A. (ERT), Mohammed, P. (MSU)	04/01/2023 – 03/31/2025
Improving Aerosol Representation in NOAA's UFS-Aerosols Model through Assimilation of Advanced Aerosol Retrievals from NASA's PACE Mission	NOAA Climate Program Office		Remer, L. (UMBC), Sayer, A. (UMBC), Xu, X. (UMBC)	09/01/2023 – 08/31/2026

Generalizability of ship tracks to historical aerosol-cloud interactions and marine cloud brightening: Are there differences between sulfur, soot, and salt tracks?	NOAA ERB	Yuan, T. (UMBC)		
Machine-enabled modeling of terminus ablation for Greenland's outlet glaciers	NSF		Felikson, D. (MSU)	08/15/2022 – 08/14/2025
12th Workshop on Meteorological Sensitivity Analysis and Data Assimilation	NSF unsolicited		Privé, N. (MSU, Collaborator)	01/01/2024 – 012/31/2024
Model Development for Polarimetric Remote Sensing of Clouds in the Thermal Infrared	UMBC CIDER Program	Xu. X. (UMBC)		01/01/2023 – 06/30/2024
Cyanobacteria Assessment Network: Inclusion of Sentinel-2 derived chlorophyll Year 1	US Army Corps of Engineers		Seegers, B. (MSU)	05/01/2023 – 04/30/2024
Near Real-Time Fire Behavior And Progression To Predict Hydrologic Burn Severity And Post-Fire Recovery	USGS		Orland, E. (UMBC)	08/01/2023 – 09/30/2024

Proposals Submitted - Pending

Proposal Title	Funding Agency	PI (GESTAR II)	CO-I(s) (GESTAR II)	Status
A deep learning-based landslide mapping framework using PlanetScope and EarthDEM data	NASA	Amatya, P. (UMBC)	Stanley, T. (UMBC), Orland, E. (UMBC)	Pending
Across scales: understanding the dynamic interactions between ice sheets, ocean, and sea ice	NASA	Felikson, D. (MSU)		Pending
Carbon cycling along the terrestrial-aquatic continuum: Extreme hydrology and agricultural activity as drivers of coastal change	NASA		Blake, J. B. (UMBC)	Pending
Comparing the function and resilience of protected and cultivated vegetation land covers by integrating thermal, reflectance, lidar and field observations	NASA	Campbell, P. (UMBC)	Huemmrich, K. F. (UMBC)	Pending
Cyanobacteria Assessment Network: Inclusion of Sentinel-2 derived chlorophyll-A	NASA		Seegers, B. (MSU)	Pending
Disentangling the surface optical properties and chemical composition from the suspended dust signal by combining in situ and laboratory measurements	NASA		Puthukkudy, A. (UMBC)	Pending
Eyes on ecosystem demography and post-disturbance forest recovery using OCO (XCO2, SIF) with support from ISS sensors	NASA		Tao, Z. (MSU)	Pending
Landslide mapping and forecasting in Nepal	NASA	Stanley, T. (UMBC)	Amatya, P. (UMBC)	Pending
NOAA-Passive Radiometer Interference Management for Earth-Observing Systems (N-Prime): A Study to Examine Approaches and Methodologies for the Detection, Characterizing and Mitigation of Passive Sensor Data Corrupting Emissions (DMiPS)	NASA		Mohammed, P. (MSU), Peng, J. (MSU)	Pending
Spatio-Temporal Connections of Integrated Energy, Water and Biogeochemical Processes Across Alaska's Land and Ocean Ecosystems	NASA	Clark, J. B. (UMBC)		Pending
Leveraging GISS and GEOSCCM strengths for building predictability of atmospheric composition	NASA Code 610 Strategic Science		Mogno, C. (UMBC, collaborator)	Pending
Carbon Flux Orbiting Explorer (CarbonFOX)	NASA Earth System Explorers		Lamsal, L. (UMBC)	Pending
WindMapper: Breakthrough Wind Observations Revealing the Mechanisms Driving Atmospheric Rivers and Monsoon Disturbances	NASA Earth System Explorers		Prive', N. (MSU)	Pending
Constraining Three-dimensional Microphysical Properties of Supercooled Liquid Water in Winter Storms Using Synergistic Active and Passive Remote Sensing Observations in NASA Field Campaigns	NASA ECIPES	Liu, Y. (UMBC)		Pending

Marine stratocumulus clouds: a new polarized interband calibration target for upcoming multi-angle polarimeter missions	NASA ECIPES		Puthukkudy, A. (UMBC, Collaborator)	Pending
Impacts of weather extremes on frequency of preterm birth in the U.S.	NASA ESD Strategic Science Call	Dezfuli, A. (UMBC)		Pending
Improving, Miniaturizing, and Refining RoboHypo, a robotic hyperspectral polarimeter for the ocean	NASA ESD Strategic Science Call		Craig, S. E. (UMBC)	Pending
Investigating the relationship between ocean biology and the production of biogenic aerosols: Developing capabilities for a Goddard EVS and future collaboration with the Naval Research Laboratory	NASA ESD Strategic Science Call	Craig, S. E. (UMBC)		Pending
Towards an Integrated Data Record for Antarctic Climate Studies	NASA ESD Strategic Science Call		Ganeshan, M. (MSU)	Pending
FORTE: Arctic Coastlines –Frontlines Of Rapidly Transforming Ecosystems	NASA EV-Suborbital		Clark, J. B. (UMBC)	Pending
Quantifying sources of chromophoric dissolved organic matter in the Yukon River delta and near-coastal region	NASA FINNEST		Clark, J. B. (UMBC)	Pending
Seasonal Variations in Arctic Lagoons: Physical and Biogeochemical Dynamics	NASA FINNEST		Clark, J. B. (UMBC)	Pending
Boosting Inversion Research and Data Processing at GSFC with AI	NASA GSFC ESD Strategic Science Call		Korkin, S. (UMBC), Choi, M. (UMBC, Collaborator), Go, S. (UMBC, Collaborator)	Pending
Filling a Gap in GSFC Radiative Transfer Capabilities to Keep the Center Competitive in Earth Science	NASA GSFC ESD Strategic Science Call	Korkin, S. (UMBC)	Sayer, A. (UMBC), Jethva, H. (MSU, Collaborator)	Pending
Towards Better Scientific Software at GSFC Earth Science: A Paper to Document New AERONET Code for Light Scattering by Spheroids	NASA GSFC ESD Strategic Science Call	Korkin, S. (UMBC)		Pending
Atmospheric nourishment of global ocean ecosystems on a changing planet	NASA IDS	Remer, L. (UMBC)	Shi, Y. (UMBC)	Pending

Atmosphere Observing System - Polar (AOS-P) Polarimeter Instrument Phase A Study	NASA RFQ	Martins, J. V. (UMBC)		Pending
12th Workshop on Meteorological Sensitivity Analysis and Data Assimilation	NASA ROSES	Prive', N. (MSU)	McGrath-Spangler, E. (MSU)	Pending
Addressing Parallax Challenges in Aerosol Retrieval from Multi-Angle Polarimeter Observations: Cloud Screening and Horizontal Inhomogeneity	NASA ROSES ECIPES	Puthukkudy, A. (UMBC)		Pending
Characterizing the Urban Carbon Metabolism and its Drivers Synergistically Using OCO-3 and A Suite of Earth Observation Data	NASA ROSES		Weir, B. (MSU)	Pending
Climate-induced Hazards Impacting Pastures and People (CHIPP): Mapping the spectral colors of blooming deserts with EMIT	NASA ROSES		Kathuria, D. (MSU)	Pending
Climate-induced Hazards Impacting Pastures and People (CHIPP): Transdisciplinary NASA product applications in a Northern Mongolian participatory environmental justice study	NASA ROSES		Kathuria, D. (MSU)	Pending
Commercial smallsat data analysis for advancing the HLS products for agricultural and forest monitoring at mid-resolution	NASA ROSES	Campbell, P. (UMBC)	Huemmrich, K.F. (UMBC)	Pending
Connecting UV-VIS-NIR Spectral Absorption of Dust with Surface Mineralogy from Synergy of EMIT-AERONET-TROPOMI	NASA ROSES	Jethva, H. (UMBC)		Pending
Development of a multidecadal land reanalysis over South America	NASA ROSES	Maina, F. Z. (UMBC)		Pending
Earth Observation for Coastal Wetland Resilience and Carbon Monitoring: Algorithm development and Uncertainty analysis with Satellite Imaging Spectrometers and Very High-Resolution imagery	NASA ROSES	Campbell, A. (UMBC)		Pending
Enhanced retrievals of smoke aerosols from combined ABI and EPIC measurements	NASA ROSES	Choi, M. (UMBC)	Wang, Y. (UMBC), Go, S. (UMBC) Korkin, S. (UMBC), Zhang, Z. (UMBC) – collaborators	Pending
Enhancing the Data Quality and Science Value of OCO-2/-3 SIF and XCO_2 Products Using Innovative Machine Learning Techniques	NASA ROSES		Lamsal, L. (UMBC)	Pending
E-region Prompt Radio Occultation Based Electron Density (E-PROBED) Model	NASA ROSES	Salinas, C. C. J. H. (UMBC)		Pending
Improving SMAP Radio Frequency Interference Detection and Geolocation and Consolidating SMAP Calibration	NASA ROSES		Mohammed, P. (MSU), Peng, J. (MSU)	Pending
Integrating commercial satellite data to characterize biodiversity across forest biomes	NASA ROSES	Huemmrich, K.F. (UMBC)	Campbell, P. (UMBC)	Pending
Interannual Variations of Polar Mesospheric Cloud and their impacts on the lower thermosphere	NASA ROSES	Lee, J. (UMBC)	Salinas, C. C. J. H. (UMBC)	Pending

Investigating urban anthropogenic CO2 emissions from C40 Cities using the synergy of the OCO-2/3 and NO2-observing missions	NASA ROSES		Ahn, D. (MSU)	Pending
Investigation of Diurnal-to-Interannual Variations of PBL Height from Long-Term Multi-Constellation GNSS-RO	NASA ROSES		Ganeshan, M. (MSU)	Pending
Monitoring of dryland vegetation function and detection of stress using spectroscopy	NASA ROSES	Campbell, P. (UMBC)	Huemmrich, K.F. (UMBC)	Pending
OSCARS: Open Science Capacity-building for Applied Remote Sensing	NASA ROSES	Malings, C. (MSU)		Pending
Retrieval of spectrally-resolved dust aerosol direct radiative effect from EMIT hyperspectral observations	NASA ROSES	Zhang, Z. (UMBC)	Wang, Y. (UMBC)	Pending
Satellite remote sensing based reservoir monitoring at the global scale for hydrologic applications	NASA ROSES	Biswas, N. (UMBC)		Pending
Technical and Science Analysis of EMIT Data	NASA ROSES		Choi, M. (UMBC), Wang, Y. (UMBC), Go, S. (UMBC), Korkin, S. (UMBC)	Pending
The Paper-and-Code Bundle as a New Paradigm Supporting the TOPS Initiative in Earth Science	NASA ROSES	Korkin, S. (UMBC)	Sayer, A. (UMBC)	Pending
Using DoE/ARM and other ground-based and in-situ observations to compile a dataset for the validation of PACE aerosol and cloud products	NASA ROSES PACE	Varnai, T. (UMBC)	Wen, G. (MSU)	Pending
Variability and Sub-seasonal to Seasonal Predictability of Turbine-Height Wind Speed over the United States	NASA ROSES	Thomas, N. (UMBC)		Pending
Volcanology from Space: Combining NASA's Earth Observing System (EOS) with traditional lightning and infrasound observations to investigate active volcanism	NASA ROSES ESI	McKee, K. (UMBC/Vanderbilt Univ.)		Pending
A Machine Learning approach for improving sea ice and climate in Earth System Models	NASA ROSES MAP	Elders, A. (MSU)		Pending
Use of the Enhanced AirHARP-2 suite for airborne validation of the PACE algorithms for aerosol, cloud, and surface properties	NASA ROSES PACE	Martins, J. V. (UMBC)	Borda, R. F. (UMBC), Remer, L. (UMBC), Xu, X. (UMBC), Puthukkudy, A. (UMBC)	Pending
A systematic investigation of the potential of SMAP soil moisture assimilation for improving the simulation and prediction of tropical cyclones	NASA ROSES SMAP		McGrath-Spangler, E. (MSU), Ganeshan, M. (MSU)	Pending
Enhancing soil erosion risk assessments with SMAP soil moisture	NASA ROSES SMAP	Emberson, R. (UMBC)		Pending
Soil Moisture and Carbon Flux in Grasslands and Shrublands	NASA ROSES		Weir, B. (MSU)	Pending

	SMAP			
Interactions between North Atlantic climate and realistic future Greenland ice loss	NSF		Felikson, D. (MSU)	Pending
Supplement to Collaborative Research: Greater New York (NY) Oxidant, Trace gas, Halogen, and Aerosol Airborne Mission (GOTHAAM)	NSF	St. Clair, J. (UMBC)		Pending

Proposals Submitted - Not Funded

Proposal Title	Funding Agency	PI (GESTAR II)	CO-I(s) GESTAR II)	Status
Development of a fine-scale North American precipitation analysis and surface meteorology dataset for retrospective and operational application	Climate Program Office	Maina, F. Z. (UMBC)		Not Funded
Improving understanding of aerosol-cloud interactions in the cloud-clear transition zone using ARM shortwave spectrometer data	DOE ASR		Várnai, T. (UMBC), Wen, G. (MSU)	Not Funded
Ghost forests and the future of blue carbon	Google Blue Carbon Grants		Campbell, A. (UMBC)	Not Funded
Atmospheric formaldehyde in the recent decades: Its sources, long-term change, and contribution to tropospheric ozone change	NASA	Liu, J. (MSU)	Strode, S. (MSU)	Not Funded
Comprehensive Digital Time Series of Tropical Glacier Loss	NASA	Shuman, C. (UMBC)		08/01/2023 – 07/31/2025 Not Funded
Deployment of the Modular AirHARP-II System in the ASIA-AQ Campaign to Measure Aerosol and Cloud Properties	NASA	Martins, J. V. (UMBC)	Xu, X. (UMBC)	Not Funded
Global Daily Tropospheric Ozone Maps from Multiple NASA Missions from 1980 to Present for Use in Research Environments	NASA	Ziemke, J. (MSU)	Strode, S. (MSU)	Not Funded
Improving NU-WRF-Chem Air Quality Forecasts with Assimilation of Geostationary Observations to Constraint Fast-Changing Processes: Lightning Nitrogen Dioxide and Wildfire Emissions with WRF-Chem/DART	NASA		Tao, Z. (MSU)	Not Funded
Improving smoke and dust aerosol simulation capability in NU-WRF and GEOS models using the high frequency geostationary satellite products	NASA	Kim, D. (UMBC)	Tao, Z. (MSU), Lee, J. (UMBC)	Not Funded
In-situ measurements of the angular light scattering pattern of aerosol during the ASIA-AQ campaign in order to gain a better understanding of aerosol optical and microphysical properties	NASA	Puthukuddy, A. (UMBC)		Not Funded
Understanding Ice-Phase Microphysical Processes by Combining NASA Satellite and Field Campaign data with Cloud-Resolving Modeling	NASA		Liao, L. (MSU, Collaborator)	Not Funded
Understanding Supercooled Liquid in Winter Storms using Field Campaign Observations and Data Assimilation	NASA – WEATHER	Liu, Y. (UMBC)		Not Funded
Linking LEO to GEO: Long-term and diurnal nitrogen dioxide trends based on consistent multi-satellite observations and global chemistry simulations	NASA ACMAP	Lamsal, L. (UMBC)	Liu, J. (MSU)	Not Funded
Intraseasonal to interannual variabilities of aerosols in the upper troposphere-lower stratosphere and their connections to multiple timescale oscillations	NASA AURA and ACMAP		Bian, H. (UMBC), Taha, G. (MSU)	Not Funded
A deep learning-based landslide mapping framework using PlanetScope and EarthDEM data	NASA CSDA	Amatya, P. (UMBC)	Orland, E. (UMBC), Stanley, T. (UMBC)	10/01/2023-09/30/2025 Not Funded

Advanced Trace Gas, Aerosol and Value-Added Research Products in Support of Copernicus Sentinel-4 and Sentinel-5 Algorithm Validation and Optimization	NASA ROSES		Lamsal, L. (UMBC)	Not Funded
Aerosol effects on evolution of cloud development and organization on fine temporal scales	NASA ROSES	Remer, L. (UMBC)	Martins, J. V. (UMBC)	Not Funded
Application of NASA Airborne Radar for Hydrometeor Phase Identification	NASA ROSES	Liao, L. (MSU)		Not Funded
Coastal land use adaptation- the multifaceted response of tidal marsh and mangroves to climate change with implication for future coastal zone resilience	NASA ROSES		Campbell, A. (UMBC)	Not Funded
Exploring the Full Potentials of Single FOV-Resolution Hyperspectral Sounding Data for Mesoscale Weather and Atmospheric Dynamics Research	NASA ROSES		Knowland, K. E. (MSU)	Not Funded
Fast cloud-related variations in aerosol properties and aerosol radiative forcing	NASA ROSES	Várnai, T. (UMBC)		Not Funded
Identifying fingerprints of changing anthropogenic sources and natural variability on observed regional and seasonal trends in tropospheric ozone and precursors	NASA ROSES		Lamsal, L. (Collaborator)	Not Funded
Impact of Lightning-NOx on free-troposphere NOx trends and atmospheric composition	NASA ROSES		Anderson, D. (UMBC), Lamsal, L. (Collaborator)	Not Funded
Improving Air Quality Smoke Forecasting using Geostationary Satellite Observations of Fire Radiative Power to Illuminate a Process Based Understanding of a Fire's Diurnal Cycle	NASA ROSES		Wales, P. (UMBC)	Not Funded
Integrating satellite observations, in situ measurements, and a global model to improve quantification of the trans-Atlantic transport of African biomass burning smoke on a decadal time scale	NASA ROSES ACMAP		Bian, H. (UMBC)	Not Funded
Monitoring CO2 Enhancements from Wildfires and Improving Fire Emissions Inventories in Boreal North America: Combining Passive with Active Remote Sensing Data	NASA ROSES		Tao, Z. (MSU), Weir, B. (MSU, Collaborator)	Not Funded
Observing System Simulation Experiments to explore the role of observation uncertainty in numerical weather prediction	NASA ROSES	Privé, N. (MSU)		Not Funded
Spatiotemporal Fusion of Satellite-Inferred Estimates and Bottom Up Inventory Data for Global Anthropogenic Emissions	NASA ROSES	Liu, F. (MSU)	Lamsal, L. (Collaborator)	Not Funded
The Paper-and-Code Bundle as a New Paradigm Supporting the TOPS Initiative in Earth Science	NASA ROSES	Korkin, S. (UMBC)	Sayer, A. M. (UMBC)	Not Funded
Understanding Microphysics and Vertical Motion in Clouds and Precipitation Using Airborne Data with Implications for Future Spaceborne Observations	NASA ROSES	Han, M. (MSU)		Not Funded
Investigating the Climate Impacts of Hunga Tonga – Hunga Ha'apai Volcanic Eruption	NASA ROSES ACMAP	Li, F. (UMBC)		Not Funded
Volcanology from Space: Combining NASA's Earth Observing System (EOS) with traditional lightning and infrasound	NASA ROSES ESI	McKee, K. (UMBC)		Not Funded

observations to investigate active volcanism				
Quantifying the role of fires in the socio-ecological dynamics of tropical dry forests: a framework for community-based fire management and climate change adaptation	NASA ROSES IDS	Armstrong, A. (UMBC)		Not Funded
An Air Quality Reanalysis: Integration of surface, satellite, and model outputs to generate a level 4 PM2.5 dataset	NASA ROSES MEASURES		Lamsal, L. (Collaborator)	Not Funded
A Biosphere-Scale Cuvette: Leveraging the Geostationary Perspective to Advance Simulation of Photosynthesis in Earth System Models	Schmidt Future Fdtn.		Korkin, S. (UMBC), Wang, Y. (UMBC)	Not Funded
An AI-driven approach for retrieving aerosol and surface properties from HARP family of multi-angle polarimeter measurements	UMBC CIDER	Puthukuddy, A. (UMBC)		Not Funded
Developing a Global Extreme Precipitation Monitoring System from Satellite Precipitation Estimates	UMBC CIDER	Zhou, Y. (UMBC)		Not Funded
An AI-driven approach for retrieving aerosol and surface properties from HARP family of multi-angle polarimeter measurements	UMBC START	Puthukuddy, A. (UMBC)		Not Funded

Acronyms

ACCDAM	Atmospheric Composition Campaign Data Analysis and Modeling
ACCLIP	Asian Summer Monsoon Chemical & CLimate Impact Project
AEROMMA	Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas
AERONET	Aerosol Robotic Network
AIRS	Atmospheric Infrared Sounder
AOD	Aerosol Optical Depth
ARCSIX	Arctic Radiation-Cloud-Aerosol-Surface Interaction Experiment
Arctic COLORs	Arctic-COastal Land Ocean interaction
ASIC	Application Specific Integrated Circuit
ATBD	Algorithm Theoretical Basis Document
AVDC	Aura Validation Data Center
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer
AVIRIS-NG	Airborne Visible/Infrared Imaging Spectrometer Next Generation
BioSCape	Biodiversity Survey of the Cape
BLUEFLUX Fluxes	Blue Carbon Prototype Products for Mangrove Methane and Carbon Dioxide
BOEM	Bureau of Ocean Energy Management
CAMP2Ex	Cloud, Aerosol and Monsoon Processes Philippines Experiment
CASALS	Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System
CBS-FVCOM	Coastal Beaufort Sea Finite Volume Community Ocean Model
CCS	Carbon Cycle Science project
CESAS	Committee on Earth Science and Applications from Space
CHIRP	Climate Hyperspectral Infrared Radiance Product
CMIS	Compact Midwave Imaging System
CoDAS	Constituent Data Assimilation
COSMIC-2 RO	Constellation Observing System for Meteorology Ionosphere and Climate-2 Radio Occultation

COWVR	Compact Ocean Wind Vector Radiometer
CrIS	Cross Track Infrared Sounder
CRTM	Community Radiative Transfer Model
CSDA	Commercial Smallsat Data Acquisition
CSS-DESIS	Commercial Small Sat DESIS evalutation
CyAN	Cyanobacteria Assessment Network
DCOTSS	Dynamics and Chemistry of the Summer Stratosphere
DEEP-VIEW	Deep learning for Environmental and Ecological Prediction-eValuation and Insight with Ensembles of Water quality
DESIS	DLR Earth Sensing Imaging Spectrometer
DRCS	Disaster Response Coordination System
DSCOVR	Deep Space Climate Observatory
DT	Dark Target
DUSA	Dust Source Attribution
EarthCARE	Earth Cloud Aerosol and Radiation Explorer satellite mission
ECCOH	Efficient CH4-CO-OH chemistry module
ECS	Equilibrium Climate Sensitivity
EMIT	NASA Earth surface Mineral dust source InvesTigation
EPE	Extreme Precipitation Events
EPIC	Earth Polychromatic Imaging Camera
E-PROBED	E-region Prompt Radio Occulation Based Electron Density model
ESTO	Earth Science and Technology Office
EXRAD	ER-2 X-band Doppler Radar
FG-AI4NDIM	Focus Group on AI for Natural Disaster Management
FLUID	Framework for Live User-Invoked Data
G7 FSOI	G7 Future of the Seas and Oceans Initiative
GAFIS	Global Air Quality Forecasting and Information System
GEOBON	Group on Earth Observation Biodiversity Observation Networks
GEOS	Goddard Earth Observing System

GEOS-ADAS	Global Earth Observing System-Atmospheric Data Assimilation System
GEOS-LDAS	Global Earth Observing System-Land Modeling and Data Assimilation System
GEOS-CF	GEOS Composition Forecast system
GEOS-FP	GEOS Forward Processing system
Geo-XO	Geostationary Extended Observations Program
GES DISC	Goddard Earth Science Data and Information Services Center
GFDL SPEAR	Geophysical Fluid Dynamics Laboratory's Seamless system for Prediction and EArth system Research
GHRC	Global Hydrometeorology Resource Center
GIS	Geographic Information Systems
GLIMR	Geosynchronous Littoral Imaging and Monitoring Radiometer
GLOWS	Global L-Band Active/Passive Observatory for Water Cycle Studies
GNSS-RO	Global Navigation Satellite System Radio Occultation
GOCART	Goddard Chemistry Aerosol Radiation and Transport
GOCART-2G	Goddard Chemistry Aerosol Radiation and Transport 2nd generation
GOTHAAM	Greater New York Oxidant Trace gas Halogen and Aerosol Airborne Mission
HARP2	Hyper-Angular Rainbow Polarimeter-2
HIPP	Hyper-angle Image Processing Pipeline
HMA	High Mountain Asia
HyMPI	Hyperspectral Microwave Instrument
HyperCP	HyperInSPACE community processor
IAGOS	In-service Aircraft for a Global Observing System
IASI	Infrared Atmospheric Sounding Interferometer
ICESat-2	Ice, Cloud and land Elevation Satellite 2
ICIMOD	International Centre for Integrated Mountain Development (Nepal)
ILEOS	Intelligent Long Endurance Observing System
ILRS	International Laser Ranging Service
IMERG	Integrated Multi-SatellitE Retrievals for GPM

IMPACTS	Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms
ISCCP	International Satellite Cloud Climatology Project
ITRF	International Terrestrial Reference Frame
JCSDA	Joint Center for Satellite Data Assimilation
JEDI	Joint Effort in Data Integration
KMG	Kinetics Generating Software
LADAS	Land-Atmosphere Data Assimilation System
LARES-2	Laser Relativity Satellite 2
LHASA	Landslide Hazard Assessment for Situational Awareness
LST	Land Surface Temperature
MAIAC	Multi-Angle Implementation of Atmospheric Correction
MAP	Multi-Angular polarimeter
MBARS	Microwave Barometric Radar and Sounder instrument
MC	Mid-latitude Cyclones
MCSSA	Monte Carlo code for Spherical Shell Atmosphere
MISATEAM	CTM-Independent SATellite-derived Emission estimation Algorithm for Mixed-sources
MLS	Microwave Limb Sounder
MOBY	Marine Optical Buoy
MODIS	Moderate Resolution Imaging Spectroradiometer
MPA	Marine Protected Areas
NCCS	NASA Center for Climate Simulation
NDACC	Network for the Detection of Atmospheric Composition Change
NEON	National Ecological Observatory Network
NSF LSAMP	NSF Louis Stokes Alliances for Minority Participation program
NSIDC	National Snow and Ice Data Center
NOMAD	NASA bio-Optical Marine Algorithm Dataset
OCI	Ocean Color Instrument

OCO-2	Orbiting Carbon Observatory 2
OMI	Ozone Monitoring Instrument
OMPS-NM	Ozone Mapping Profiler Suite – Nadir Mapper
OSE	Observing System Experiments
OSSEs	Observation System Simulation Experiments
PACE	Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission
PACE-PAX	Plankton, Aerosol, Cloud, ocean Ecosystem Post-launch Airborne eXperiment
PARSIVEL	Particle Size Velocity
PBLH	Planetary Boundary Layer Height
PCC	Phytoplankton Community Composition
PIP	Particle Imaging Package
PMCs	Polar Mesospheric Clouds
PyTOAST	Python Top of Atmosphere Simulation Tool
RoboHypo	Robotic Hyperspectral Polarimeter for the Ocean
ROZE	Rapid OZone Experiment
RRTMG	Rapid Radiative Transfer Model Global
SAFE	Structure and Function of Ecosystems
SALaD	Semi-automated Landslide Detection (SALaD) system
SARP-East	Student Airborne Research Program-East
SATAL	South American Tropopause Aerosol Layer
SCERIN	South Central and Eastern European Regional Information Network
SeaBASS	SeaWiFS Bio-optical Archive and Storage System
SeaPRISM	Sea Photometer Revision for Incident Surface Measurements,
SLR	Sea-Level Rise
SMAP	Soil Moisture Active and Passive Mission
SMOS	Soil Moisture and Ocean Salinity
SNPP	Suomi National Polar-orbiting Partnership
SNWG	Satellite Needs Working Group
SSS	Sea Surface Salinity

SSEM PP	Station Systematic Error Model Pilot Project
SVC	System Vicarious Calibration
TEMPO	Tropospheric Emissions: Monitoring of Pollution spectrometer
TIM	Total Irradiance Monitor
TOAR	Tropospheric Ozone Assessment Report
TOBAC	Tracking and Object-Based Analysis of Clouds
TROPICS	Time-Resolved Observation of Precipitation structure and storm Intensity with a Constellation of Smallsats mission
TROPOMI	TROPOspheric Monitoring Instrument (TROPOMI)
TSIS-1	Total and Spectral solar Irradiance Sensor
TTE	Tundra-Taiga Ecotone
WSF-M	Weather Satellite Follow-on-Microwave