FIRST ANNUAL REPORT

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

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Message from the Director

This report is the first annual report for the NASA Goddard Earth Sciences, Technology and Research II (GESTAR II) cooperative agreement and covers the period December 1, 2021 to September 30, 2022. This report presents the successful operation of the cooperative agreement by the GESTAR II consortium of the University of Maryland, Baltimore County (UMBC) with Morgan State University (MSU), the Southwest University Research Association (SURA), Colorado State University (CSU), Pennsylvania State University (PSU), Arizona State University (ASU), and Earth Resources Technology, Inc. (ERT) along with industry partner Northrup Grumman. As a group, all members have been engaged in the smooth and effective operation of the cooperative agreement.

In this first year report, we summarize the research accomplishments of the GESTAR II scientists and their activity in implementing NASA's strategic goals in Earth Science in each of the Earth Science laboratories as well as facilitating access and opportunity to collaborative visitors and to student talent in NASA programs. This year is also a transition year from GESTAR to GESTAR II, cooperative agreement modifications, and the pandemic. Despite the programmatic and time urgencies, the partners and cooperative agreement central administration have responded with nimble and fast adjustments as well as commenced operating with "one center", uniform administration, for all scientists. The team has brought high-impact virtual seminars from partner university faculty and researchers who have garnered a high number of attendees.

The report summarizes how GESTAR II partners have responded and managed the pandemic era transition year in in cooperative agreement management in a smooth and effective way with minimum impact on morale and scientific output while concurrently bringing research and networking from across the country to seed partnerships and collaboration. This has led to the outstanding research and publication output by the scientists to enable the GSFC Earth Science Division to address NASA's SMD objectives.

Belay Demoz, 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 who then submitted to necessary authorities. Dr. Mohammed also worked closely with OfCom from the United Kingdom providing weekly data updates to aid identification of interference sources. Dr. Mohammed continues to monitor the instrument to provide RFI reports for SMAP.

Dr. Mohammed is also part of a team that recently initiated 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, she 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.

In the coming months, Dr. Mohammed will complete system modeling for the IIP project. She also will serve as the FARS Technical Committee Secretary https://www.grss-ieee.org/technical-committees/frequency-allocations-in-remote-sensing/.

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

Dr. Peng works on a collaborative team developing the microwave radiometers (SMAP—Soil Moisture Active/Passive, COWVR—Compact Ocean Wind Vector Radiometer, etc). His efforts include research and development of prelaunch and post-launch calibration theoretical bases, plans and activities, instrument calibration, calibration/validation tools, data reductions, etc.

The 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 the 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, and the unwanted emissions needs to be removed from the calibrated and RFI-free input signal.

The SMAP radar (active) and radiometer (passive) share a single feedhorn and mesh reflector. The antenna pointing was 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 9 months, Dr. Peng has been working on the antenna pointing calibration and validation for the SMAP radiometer. The to-be-calibrated radiometer antenna pointing can improve the water-body correction used in the soil moisture retrieval and improving 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. He has 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) has been validated by comparing to the results of the conventional two-point calibration (using two calibration sources). Future microwave radiometer missions could benefit from this research not only on reliability increment but also on cost reduction.

In addition, he continues to monitor the radiometer status and the L1B_TB data quality. Problems, such as missed ancillary and the antenna pointing error in the SDS (Science Data System) operational data processing for L1B products, have been monitored and solved to maintain or improve the SMAP radiometer data quality.

COWVR is a conically scanning, fully polarimetric radiometer with 3 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. The radiometer was launched in December 2021 and then mounted onto the International Space Station (ISS). Same as the other radiometers, the COWVR radiometer will be calibrated after launch. Dr. Peng has developed a TA forward model simulator to be used for the post-launch calibration, and a monitoring tool to evaluate the antenna pointing accuracy. During the commission period starting from January 2022, he focused on the COWVR radiometer antenna pointing calibration and validation, the validation results have been presented in IGARSS2022 and adopted by the COWVR radiometer cal/val team. He also presented the initial analysis of the RFI in the 3 frequency bands.
The GLOWS (Global L-Band Active/Passive Observatory for Water Cycle Studies) instrument uses an antenna consists of a 6m diameter flat transmitarray lens, fed by a small patch array at L-band. The new technique provides a path to smaller, lower cost, simpler, large-aperture antennas for L-band observation as the successor of the SMAP. Due to the characteristics of the transmitarray lens, the loss from the lens is relatively high and the antenna beam efficiency is relatively low than those of the SMAP antenna. Studies are undergoing to improve the system performance. Dr. Peng has evaluated the performance of current antenna design, analyzed the error budget of the GLOWS radiometer, and provided the requirement to the antenna assembly.

Going forward, Dr. Peng will continue working on the SMAP/COWVR radiometer projects and other microwave remote sensing instrumentation, algorithm, etc.

CODE 610.1: GLOBAL MODELING AND ASSIMILATION OFFICE (GMAO)

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

Recently, 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 in the GMAO, Dr. Karpowicz was responsible for simulating measurements from the shortwave imaging instrument, along with the coherent doppler LiDAR. A report with Dr Karpowicz as a co-author was presented to ESTO, along with a presentation in August 2022.

As part of the NASA Goddard Surface Emissivity Task Group, Dr. Karpowicz, along with Dr. Zhu (GSFC/610.1) and Dr. Munchak (GSFC/612) investigated the utility of a microwave emissivity database from Munchak et al., 2020 to better simulate observations from the Global Precipitation Measurement Mission Microwave Imager in the Global Earth Observing System-Atmospheric Data Assimilation system (GEOS-ADAS) over land, snow, and sea ice. The results showed a dramatic improvement over emissivity models available in the Community Radiative Transfer Model (CRTM). The results were published in the Journal of Atmospheric and Oceanic Technology (Karpowicz et al., 2022).

The Joint Center for Satellite Data Assimilation (JCSDA) is an organization created by NOAA, NASA, the US Navy, and 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). He recently contributed pyCRTM to the JCSDA, a Python package that he developed, which acts as wrapper to CRTM. The package allows for quick and easy simulation of various satellite instruments, and is widely used in the community, including researchers at NASA and the Naval Research Laboratory. A publication regarding pyCRTM and its applications was published in the Journal of Quantitative Spectroscopy and Radiative Transfer (Karpowicz et al., 2022). In addition to development of pyCRTM, Dr. Karpowicz has been working with Dr. Krzysztof Wargan, to migrate ozone assimilation capabilities from the current GEOS-ADAS to a JEDI based system. An initial system including all required quality control has been developed using currently used observations from the Microwave Limb Sounder (MLS), the Ozone Monitoring Instrument (OMI), and the Ozone Mapping Profiler Suite – Nadir Mapper (OMPS-NM).

In the coming months, Dr. Karpowicz will conduct follow-on studies to the ESTO Wind OSSE work, and develop a journal publication based on results from the OSSE study to be submitted to the Journal of Atmospheric and Oceanic Technology. Also, along with Dr. Wargan, Dr. Karpowicz will work to finalize the ozone assimilation component of the new JEDI based GEOS-ADAS, and will conduct GEOS-ADAS experiments to verify the performance of the new system.
As part of a team from GSFC and Vanderbilt University with Dr. Ralf Bernnartz as PI, Dr. Karpowicz will be a Co-Investigator on a proposed instrument called the Polarized Submillimeter Ice-cloud Radiometer (PolSIR) for the NASA Earth Venture Instrument-6 Call. If the proposal is accepted, Dr. Karpowicz will conduct Observation System Experiments using the new submillimeter instrument data using a clear sky and all-sky approach.

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

Dr. Privé completed calibration and validation of the updated global Observing System Simulation Experiment (OSSE) framework, including addition of CrIS-fsr. Dr. Privé ran three months of real data and OSSE controls with the full ensemble for validation and to act as the Control basis for ongoing and future OSSE experiments. The performance of the OSSE was analyzed and documented.

Following the departure from GSFC of the PI on the Earth Science and Technology Office (ESTO) project "Observing System Simulation Experiments for Spaceborne Measurements of Atmospheric Winds", Dr. Privé ran experiments for the CMIS atmospheric motion vector instrument and the MISTiC atmospheric motion vector instrument. She wrote a project report to deliver to ESTO, describing the results of the CMIS, MISTiC, and lidar experiments, and presented the findings to the instrument teams and ESTO.

The MBARS Instrument Incubator Program project started in February 2022. Dr. Privé submitted a publication on initial OSSE studies for a spaceborne version of the MBARS instrument for remote sensing of marine surface pressures to the Journal of Atmospheric and Oceanic Technology. She began running new OSSE experiments for spaceborne marine surface pressure observations using the updated GMAO OSSE framework, including the evaluation of impacts of the observations on tropical cyclone forecasting.

In the coming months, Dr. Privé may submit a ROSES proposal to the Weather and Dynamics call on observation uncertainty studies using OSSEs. Dr. Privé will add capability for simulating footprint observations to MBARS surface pressure data simulator and run additional OSSE forecasts for tropical cyclone analysis. She also will perform additional Control forecasts for the updated OSSE framework to capture 4x daily tropical cyclone forecasts. Additionally, she may begin additional Wind OSSE experiments, depending on ESTO/HQ funding and direction.

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

Dr. McGrath-Spangler has been working with Dr. Nikki Privé to update the observing system simulation experiment framework used for her work on this project to a newer version of the atmospheric data assimilation system (DAS). This will introduce larger differences between the experiments run and the nature run used for validation, producing more error for the simulated observations to correct. A further advantage of the updated DAS is the corresponding updated observing system and the greater consistency with the expected observing system that will be present when the hypothetical and future instrumentation (that is the subject of the OSSE) will be deployed. This process included incorporating the necessary framework for reading and assimilating geostationary hyperspectral infrared radiances into the DAS and generating the simulated observations.

Looking ahead, Dr. McGrath-Spangler anticipates the publication of the paper "Using OSSEs to

Evaluate the Impacts of Geostationary Infrared Sounders" to be published in Journal of Atmospheric and Oceanic Technology. She is lead author, with Dr. Privé and Dr. Bryan Karpowicz among the co-authors.

Name: Pamela Wales
Sponsor: Lesley Ott
Code: 610.1
Task: 022
Dr. Wales is a part of the GEOS Composition Forecast (GEOS-CF) team at the GMAO. She has contributed to the validation and monitoring of stratospheric constituents, published by Knowland et al. (2022). She has prepared a manuscript for submission to the Journal of Advances in Modeling Earth Systems on deriving emissions of brominated trace gases over the Arctic from the satellite measurements collected by the Ozone Monitoring Instrument using a model setup analogous to the GEOS-CF system. Dr. Wales is also involved in the Earth Information System (EIS) – Fire program on updating trace gas and aerosol emissions from agricultural and wildfires within the GEOS system. She has conducted GEOS simulations, coupled to the GOCART aerosol module, to evaluate the performance of an updated climatology for the diurnal variation in wildfire emissions.

In the coming months, Dr. Wales will be updating stratospheric monitoring scripts to be automated for an October 2022 preliminary update of the GEOS-CF system and will expand the validation datasets used to evaluate the GEOS-CF stratosphere. She will continue to evaluate the performance of the diurnal climatology for wildfire emissions using ground-based measurement stations.

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

Work has focused on assessing the impact of recent marine heatwaves in the Pacific Ocean on phytoplankton community composition. The final goal is to evaluate the final impact of such warm anomalies on the export of organic carbon in the context of the NASA EXPORTS program.

Dr. Arteaga and colleagues received positive feedback on the first submission of the manuscript "Impact of Pacific Heatwaves on Phytoplankton Community Composition". In the coming months, they will work on the reviews of this article and plan to resubmit. Additionally, Dr. Arteaga is the PI of a proposal in preparation titled "Delivering air-sea CO 2 flux and biogenic carbon export estimates for the Southern Ocean using and ocean color data-assimilating biogeochemical model". This proposal will be submitted to the ROSES call A.6 "Carbon Monitoring System" Continuing Prototype Product Development in October.

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

Dr. Knowland, a lead scientist of NASA GMAO's atmospheric composition forecast system (GEOS-CF), works in collaboration with Dr. Christoph Keller, the lead developer of the GEOS-CF, and other members of the GMAO and the Atmospheric Chemistry and Dynamics Lab (Code 614) to validate and further develop GEOS-CF. She directs the transition from research and

development to the production system; this year has involved incorporating updates from GEOS and GEOS-Chem chemistry module into the GEOS-CF run framework. Since Summer 2020, Dr. Knowland has been supervising support staff member, Ms. Megan Damon (SSAI) who is refactoring the GEOS-CF run scripts into a more user-friendly workflow python package, developing experiment evaluation plotting packages, and running GEOS-CF development simulations. Dr. Knowland guided Ms. Damon as to how best to incorporate the new updates into the workflow and provided scientific expertise on the simulation with the new GEOS-CF framework.

Dr. Knowland also leads the evaluation of stratospheric composition in the GEOS-CF, with a manuscript published in the Journal of Advances in Modeling Earth System (JAMES). With this publication, there was a release of additional GEOS-CF files with stratospheric composition. She worked with the GMAO production team to time the release of the GEOS-CF files with the published paper and to update the "File Specification for GEOS-CF Products", the GMAO documentation on publicly available GEOS-CF model output, written and maintained by Dr. Knowland (http://gmao.gsfc.nasa.gov/pubs/office_notes).

Dr. Knowland's research interests include both chemical and dynamical drivers of stratospheric and tropospheric composition, and, with her sponsor Dr. Lesley Ott, she leads a group of GMAO and Code 614 scientists on transport evaluation specific diagnostics, which can be used during the testing of GMAO GEOS Earth System model and how changes in model physics may impact the transport and chemistry in GEOS chemistry simulations.

Drs. Knowland and Keller meet monthly with Dr. Carl Malings (GMAO/MSU), and Dr. Stephen Cohn (GMAO), to discuss Dr. Malings's project of high-resolution data assimilation of surface air quality observations with the GEOS-CF forecasts. Dr. Knowland (PI) and Dr. Malings' (Science PI) proposal "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" was selected for funding by NASA. This new project will align with the NASA-Google Expanded partnership project, as both are targeting improving urban-scale air quality information through integrated observing systems. Drs. Knowland and Keller meet twice a month to provide scientific expertise to web developers, Mr. Callum Wayman (SSAI/GMAO) and Mr. Joe Ardizzone (SSAI/GMAO), as part of the NASA-Google Expanded partnership.

Looking ahead, Dr. Knowland will attend and present at the IGAC meeting (September 10-15), give a seminar at University of Edinburgh (September 16), and attend a joint WMO Science Advisory Group and GAFIS committee meeting in Geneva, Switzerland (September 27-29). Working with Ms. Damon, Dr. Knowland plans to test the latest GEOS-CF configuration with the refactored python workflow, working towards the next production version of GEOS-CF. The GEOS-CF research team, under the leadership of Drs. Knowland and Keller, are beginning routine group and sub-group meetings. She will be leading the validation and monitoring sub-group twice-monthly meetings.

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

Dr. Weir delivered 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.

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

Dr. Thomas has been researching extreme climate events using various indices and metrics. She is collaborating with GMAO scientists on an analysis of how updating the baseline climatology period affects the interpretation of extreme climate indices derived using MERRA-2. She is also examining extreme temperature indices in the GEOS S2S system and exploring ways to assess the skill of seasonal forecasts in predicting summertime heat wave frequency over the United States. In the upcoming period, Dr. Thomas will continue working on the research on the climatology period for extreme climate indices. This work has been submitted to be presented at the AGU fall meeting in December, and a paper on this work is in progress. She will also continue research on the evaluation of heat wave metrics in the GEOS S2S system.

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

Dr. Keller continued the development of a comprehensive constituent data assimilation system for the NASA GEOS Composition Forecast system (GEOS-CF). This involved the adaption and validation of the existing ozone assimilation infrastructure, as well as the extension of NASA's assimilation capabilities to nitrogen dioxide and sulfur dioxide.
In the coming months, Dr. Keller will continue to work with Drs. Emma Knowland (MSU), Pamela Wales (MSU), Carl Malings (MSU), Viral Shah (SSAI), and Obin Sturm (SSAI) on the development of the next version of GEOS-CF. Dr. Keller will also begin to work on optimizing the data assimilation code as part of the AIST-funded project (in collaboration with Dr. Jennifer Sleeman, JHU).

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 Dr. Yanqiu Zhu, modified and corrected the code to retrieve Land Surface Temperature (LST) from the selected IASI and CrIS surface-sensitive channels. She then used these retrieved LST in the assimilation of other IASI and CrIS surface-sensitive channels; she also ran several standalone experiments by taking one GEOS forward processing (FP) experiment as a reference (CTRL experiment). Dr. Boukachaba looked at the quality control for LST retrieval and

the bias correction, and tuned the existing cloud-detection algorithm over land/ocean. She then ran three completed cycled data assimilation experiments, including the new adjustments.
The first experiment includes the LST retrieval code, and the bias correction changes. The purpose of this experiment is to study the impact of IASI over land and LST retrievals compared to the control experiment. In the second experiment, Dr. Boukachaba tuned the cloud detection to study the impact of IASI land and ocean data along with cloud detection changes. In the third experiment, she tuned the LSTs for CrIS only. The goal of this experiment is 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, Dr. Boukachaba will be focusing on several manuscripts. She is the lead author of a paper tentatively titled "Implementation of a Cloud Clearing Algorithm into the NASA GEOS system: Application to the Atmospheric Infrared Sounder (AIRS)." As lead author, Dr. Boukachaba is also preparing the first draft of AIRS/CrIS cloud-cleared algorithm technical memorandum, temporarily titled "Implementation of AIRS/CrIS cloud-cleared algorithm into the NASA GEOS system." Also, she is lead author of a manuscript temporarily titled "Assimilation of IASI and CrIS Radiances Over Land into the NASA GEOS Earth System Model, Part I: LST Inversion and Validation."

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

Dr. Buchard has been working on the aerosol assimilation system in GEOS by bringing new aerosol optical depth observations from the geostationary satellites (Himawari, GOES16 and 17). She has produced aerosol analysis products to cover the period of the CAMP2Ex field campaign that took place in the Philippines in 2019. Results from this work have been presented by colleagues at conferences and science team meetings. In addition, she has evaluated the recent code refactoring of the aerosol module in GEOS, called GOCART2G, by developing new offline simulators of aerosol optical properties based on GOCART2G data structure. This work is part of the latest release of GOCART2G that is a candidate for the next GEOS Forward Processing (GEOS-FP) system.

In the coming months, Dr. Buchard plans to continue to work on developing offline simulators for aerosol optical properties in GOCART2G, as well as on adding some aerosol field exports needed for other research groups. In addition, she is going to focus on the future structure for the aerosol assimilation in GEOS based on the JCSDA/JEDI system.

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 GOCART2G. Her analysis has focused on the CAMP2Ex field campaign as well as a 10-year benchmark simulation utilizing the new version of

the aerosol module. CAMP2Ex was a suborbital campaign based out of the Philippines in 2019 that collected in situ and remotely sensed observations of aerosol mass and extinction. Dr. Collow submitted a first author manuscript for publication to Atmospheric Chemistry and Physics, analyzing biases in GEOS with respect to the field campaign observations. The 10-year benchmark simulation allows for GOCART2G to be evaluated in a global and climatological manner. This evaluation is ongoing.

During the fall of 2022, Dr. Collow plans to continue her evaluation of GOCART2G using the 10-year benchmark simulation, with hopes of submitting a manuscript for publication to Geoscientific Model Development. It is also anticipated that production of GEOS-IT, a reanalysis and near-real time weather and aerosol analysis intended for instrument teams, will begin and the configuration for the R21C reanalysis will be finalized. Dr. Collow will contribute to both through a rigorous evaluation of the aerosol products.

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

Dr. Ganeshan has worked with Dr. Erica McGrath-Spangler (MSU), Dr. Oreste Reale, Dr. Jana Kolassa, and Dr. Rolf Riechle on the project to assimilate Soil Moisture Active Passive (SMAP) observations in the NASA Goddard Earth Observing System (GEOS) and to evaluate its impact on landfalling tropical cyclones. For this project, Dr. Ganeshan contributed to running the 3DVar part of the control experiment for two storms viz. Idai (2019), which formed off the coast of eastern Africa in the Indian Ocean and Esther (2020) which made landfall in Australia, as well as the 4DVar control experiment for Esther. Dr. Ganeshan is currently running the land-atmosphere coupled 4DVar experiment assimilating SMAP observations covering the period before and during the formation and lifecycle of Esther.

Dr. Ganeshan contributes to analyzing and quantifying the impacts on Tropical Cyclone intensity, structure, and precipitation characteristics resulting from the assimilation of SMAP observations, and particularly provides support for validation against high-resolution Integrated Multi-satellitE Retrievals for GPM (IMERG) precipitation products.

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

Dr. McGrath-Spangler has worked with Dr. Manisha Ganeshan (MSU), Drs. Jana Kolassa and Oreste Reale (SSAI), and Dr. Rolf Reichle (NASA) to utilize the Goddard Earth Observing System (GEOS) coupled land-atmosphere data assimilation system (LADAS) for the evaluation of landfalling tropical cyclones. The development of this system is being led by the GMAO land modeling team with input from Dr. McGrath-Spangler and others on this project. This group is the first at NASA to run experimentation using this system for the assimilation of SMAP data. Several storms have been identified for the initial study including Idai (2019), which devastated Mozambique, Esther (2020), which tracked across northern Australia and redeveloped over land, and cyclones Gulab and Shaheen (2021), which developed over the Bay of Bengal, tracked across the Indian subcontinent to reenter the Indian Ocean in the Arabian Sea before making final landfall

in the Arabian Peninsula. The impact of assimilating SMAP data on the analysis and forecast of these cyclones is being investigated.

Dr. McGrath-Spangler will contribute to preparations for the presentation "Assessing the Impact of SMAP Soil Moisture Data Assimilation on the Simulation and Prediction of Tropical Cyclone Idai" to be given by Dr. Kolassa (SSAI) at the AGU Fall Meeting 2022 in December.

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

Dr. Lee works on a task that advances the surface flux estimation and prediction related to terrestrial processes, such as carbon and water cycle dynamics, using NASA GMAO's land model and GEOS Earth System Modeling. During this period, Dr. Lee investigated the seasonal forecast skill of land carbon uptake and published the results in Geophysical Research Letters. Dr. Lee also participated in writing two NASA ROSES proposals as a Co-Investigator, and both proposals were selected for funding.

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

The main goals of this task are to 1) demonstrate reliable capability of the NASA GEOS model/assimilation system for diverse climate research, 2) promote understanding of the earth's climate system, and 3) determine the right directions to better represent and forecast the earth's climates by our model system. Since Dec 2021, Dr. Lim has worked on this project with a particular focus on 1) the tropical intraseasonal oscillation and large-scale climate teleconnections forecasted by the NASA GEOS subseasonal to seasonal (S2S) prediction system and 2) the investigation of causes and dynamic mechanism of the extreme weather/climates that occurred in recent years across the Northern Hemisphere.

In the months ahead, Dr. Lim will work on the revision of peer-reviewed papers, of which he is a co-author: "Dynamical drivers of the exceptional warmth over Siberia during the spring of 2020" and "Understanding the weakening relationship of the Pacific Decadal Oscillation and Indian Ocean basin mode during boreal winter." He is also a co-author on a paper that will be submitted, and he is lead author of a presentation "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" for Weather and Climate Extremes and their Predictability conference, Barcelona, Spain, September 27-29.

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

Dr. Norris has continued his role as Radiative Transfer lead in the GMAO Modelling Group. Most of his time this past year has been devoted to adding new features or improving existing features of

the GEOS-5 radiative transfer codes.

Dr. Norris upgraded the new radiative code RRTMGP to include new cloud fraction and optical thickness diagnostics, added an efficient Raisannen and Pincus type McICA generalized cloud and condensate overlap generator to RRTMGP, and began to prepare RRTMGP for a validation study (comparing it to the existing RRTMG), in conjunction with Dr. Eli Mlawer of Atmospheric and Environmental Research (AER) Inc., one of the co-authors of RRTMGP. He also upgraded the existing RRTMG in various ways: adding additional cloud fraction and optical thickness diagnostics and improve speed.

Dr. Norris conducted extensive research and development (at the request of Dr. Andrea Molod (GMAO)) to eliminate an energy leak in the surface energy balance that is caused by the intermittent nature of the full solar radiation refresh scheme and its interaction with faster changing surface albedo features (snowfall, etc.). This has proved a challenging problem to solve at GMAO. Initial attempts centered on replacing the very approximate solar update scheme. This update runs at the model timestep and currently only updates for the temporal change in the solar projection at the top-of-atmosphere. It ignores changing solar pathlength and surface albedo. The first attempt at addressing the energy balance problem was to replace this simple update scheme with a delta-Eddington atmospheric slab model trained at the slower solar refresh frequency. This approach was able to include both fast solar pathlength and surface albedo changes. Although a useful diagnostic model, it failed to maintain the necessary vertical resolution in absorption and scattering effects. The second approach, continuing until the present, removes the energy leak problem by running a full RRTMG solar radiation refresh calculation *every timestep*. Since this is computationally too expensive, the success depends on speeding up the calculation by various efficiency measures, but particularly by updating slowly varying optical properties less frequently (while running the full solar radiative transfer calculation, including pathlength and albedo effects, every timestep). This work continues and is progressing well.

Dr. Norris will continue to speed up the new “every timestep solar calculation” in GEOS-5’s RRTMG code to solve the surface energy leak problem. If time permits, he will return to RRTMGP testing by running both RRTMG and RRTMGP in parallel within the same model run so that they both operate on exactly the same input fields. This involves some necessary code improvements.

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

On this second task, Dr. Ganeshan recently started work with Dr. Zhu on the project to assimilate hyperspectral infrared radiance measurements in areas affected by clouds in the GEOS, and to study the impact on Tropical Cyclones and Polar Lows. She works in close collaboration with PI (Dr. Oreste Reale/SSAI) and co-Is Drs. Erica McGrath Spangler (MSU) and Niama Boukachaba (MSU) on this project.

CODE 612: MESOSCALE ATMOSPHERIC PROCESSES LABORATORY

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

The Integrated Multi-SatellitE Retrievals for GPM (IMERG) dataset is the gridded global precipitation product from the NASA Global Precipitation Measurement (GPM) mission. With the next major version, V07, imminent for production, Dr. Tan is in the process of performing final in-house checks before the code package is delivered to the production facility for official testing and data release. In particular, he has assembled a suite of tools for rapid but in-depth analysis that can be deployed during the official testing in order to expedite the process. Concurrently, Dr. Tan has undertaken a last-minute investigation on the use of an alternative source of data, such that the IMERG record can be extended back in time for two years, with preliminary results revealing a promising outcome in this regard. Dr. Tan has presented work related to IMERG at the AGU Fall Meeting, the AMS Annual Meeting, the AOGS Annual Meeting, as well as an experimental scheme at the International Precipitation Working Group (IPWG) Workshop.

For the MEaSUREs project to produce a dataset of Unified Weather States from the International Satellite Cloud Climatology Project (ISCCP) and the Moderate Resolution Imaging Spectroradiometer (MODIS), Dr. Tan collaborated with Drs. Nayeong Cho (UMBC) and Lazaros Oreopoulous (GSFC) to publish the revised MODIS Cloud Regimes products on the official archive site and a paper demonstrating its use in evaluating satellite precipitation. At the same time, Dr. Tan wrote reports on two different efforts explored while producing Unified Weather States—performing a *k*-means clustering on collocated observations and devising a machine learning model to predict MODIS Cloud Regimes from ISCCP observations—which consolidated the investigations on these fronts and served as the basis for further examination pending directions from the PI.

Looking ahead, with the imminent reprocessing of IMERG, Dr. Tan expects to be engaged in working with the processing facility to ensure smooth operation of the algorithm and perform final tests. He will concurrently contribute to the documentation to ensure that the changes are properly communicated to users. Once reprocessing begins, he will analyze the early results to check for issues and quantify the features in the new IMERG record. Of particular focus is the potential improvement compared to the existing version.

As part of the IMERG algorithm team, Dr. Tan will be assisting in mentoring an undergraduate from the University of Maryland on the project "Exploring the Cubed-Sphere Map Projection for the Integrated Multi-satellitE Retrievals for GPM (IMERG)".

For the MEaSUREs project, with the project approaching its end, Dr. Tan will work with the team to identify the final steps. A meeting is being planned, during which his reports and progress from the PI will form the basis for determining how the project winds down. Additionally, he will present an introductory seminar on the topic of satellite precipitation products for the AGU Precipitation Technical Committee's Early Career Scientist Quarterly Seminar series. This event will be held virtually on September 20. He also will attend the NASA PMM Science Team Meeting in October.

Name: J. J. "Roger" Shi
Sponsor: Scott Braun
Code: 612
Task: 067

Dr. Shi's research is two-fold. First, he works on the analysis of the representation of the vertical structure of the Saharan Air Layer (SAL) over northern Africa and the eastern Atlantic using MERRA-2 and NU-WRF. The SAL is a warm, dry, and often dusty isentropic layer that results from intense surface heating and dry convection over the Saharan Desert. The SAL is critical to the formation of both the African easterly jet and African easterly waves, which directly impact the weather of northern Africa and downstream tropical cyclogenesis. His team's investigation is to characterize the structure of the SAL as represented in the NASA Modern Era Retrospective-analysis for Research and Applications (MERRA-2) global analyses with the Goddard Chemistry Aerosol Radiation and Transport (GOCART) at 0.5°x0.625° grid resolution and in the NASA Unified WRF (NU-WRF) model including real-time aerosol-cloud-radiation coupling with a 3x3 km grid resolution. Using these model data sets, they have investigated how the vertical structure (of dust and thermodynamic properties) of the SAL evolves during its transit from northern Africa to the eastern Atlantic. The objectives are 1) to understand the capabilities of MERRA-2 and NU-WRF to reproduce observed thermodynamic and aerosol structures, and 2) to reveal the diurnal and seasonal variation of the WML/SAL and the Saharan dust distribution.

Second, he works on improving coupled atmosphere-ocean processes in NU-WRF for the simulation of coast-threatening extratropical cyclones in the northeastern US. In this project, they are developing an ocean-atmosphere-wave coupled modeling capability within the NASA Unified Weather Research and Forecasting (NU-WRF) framework to improve our understanding and representation of the planetary boundary layer (PBL) that focuses on the marine atmospheric boundary layer (MABL) and surface layer (SL) processes and their dependence on varying surface characteristics including temperature, waves, and currents. Geographically, the project focuses on the US East Coast and the New England Shelf (NES) region, capitalizing on the detailed *in situ* and remotely sensed observations of key coupled boundary layer variables and air-sea fluxes uniquely available in the region. The coupling capability will, however, be applicable to any location in the global coastal and open ocean.

The simplest way to improve the ocean/wave coupling effect in NU-WRF is to force it with the daily high-resolution satellite SST datasets along with the surface wave and ocean surface current information. Surface wave fields will be provided by the global/regional NOAA WaveWatch III (WW3) hindcasts (https://polar.ncep.noaa.gov/waves/) or WW3 simulation from the fully coupled NU-WRF (once completed). Surface current fields will be taken from ocean reanalysis datasets or the Regional Ocean Modeling System (ROMS) in the coupled NU-WRF. The comparison of the simulations with and without waves and ocean currents will highlight how the coupled boundary layers react to wave-based formulations of the surface fluxes or surface current affecting the wind shear and vertical profiles of thermodynamics in the PBL. The wave states and surface current fields from the fully coupled NU-WRF (once completed) could be provided as the low-boundary conditions for the NU-WRF atmosphere-only simulations for offshore forecasting applications. The team's current efforts are to couple ROMS and WW3 with the WRF in the framework of the NU-WRF. As these works only started about eight months, all works are still ongoing. They will show more results in the following years.

Over the next three months, Dr. Shi will continue the work on improving coupled atmosphere-

ocean processes in NU-WRF. He also is a co-author on a paper in preparation titled "Influence of the Saharan Air Layer on Hurricane Nadine (2012). Part II: Ensemble Model Simulations."

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

Dr. Han participated in the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Storms (IMPACTS) EVS-3 field campaign from Feb 4-14, 2022 at Wallops Flight Facility. She supported the field operations as a forecaster and a scientist on P-3 aircraft.

In the coming months, Dr. Han plans to prepare and write a proposal to the Weather and Atmospheric Dynamics Focus Area, ROSES 2022. She will conduct research for both the IMPACTS field campaign and the GPM project. She will participate in the GPM Science Team Meeting, and will prepare for next year's 3rd IMPACTS field operation.

Name: Chamara Rajapakshe
Sponsor: Hongbin Yu
Code: 612
Task: 105

Dr. Rajapakshe investigates aerosol-cloud-radiation interactions. Currently, his research has 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). Dr. Rajapakshe has 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. He also has investigated the spatial and temporal distribution of dust and combustion aerosol around MCs and quantify the aerosol removal caused by the clouds and precipitation associated with the MCs.

Future plans include the presentation "Aerosol 3D distribution around North Pacific cyclones observed by CALIOP and MODIS" at the CALIPSO and CloudSat Science Team Meeting.

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

Dr. Tokay is a member of NASA's Global Precipitation Measurement (GPM) ground validation team led by David Wolff of NASA GSFC/WFF. His research focuses on falling snow algorithms including precipitation phase identification, global mapping of precipitation, and blind zone regime below minimum detectable signal of GPM core observatory.

Dr. Tokay will continue working on GPM ground validation research focusing on the recently completed NASA's IMPACTS field campaign. The third year of the IMPACTS field campaign will be conducted during winter of 2023. Dr. Tokay is responsible for the several in-situ precipitation measuring devices data processing.

CODE 613: CLIMATE AND RADIATION LABORATORY

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

Dr. Korkin continues to learn and develop numerical tools/techniques/software for simulation of multiple scattering and absorption of solar light (signal for remote seasoning systems) in the Earth atmosphere. His tools primarily support Dr. Lyapustin's algorithm MAIAC, as well as some other Earth Science teams located at NASA GSFC.

In the coming months, Dr. Korkin is planning to help revise the submitted (not yet online for discussion) article, led by Dr. Andy Sayer (UMBC), "The CHROMA cloud top pressure/height retrieval algorithm for the forthcoming NASA PACE OCI." As lead author, Dr. Korkin also is planning to submit a full-length article titled "Decoupling of atmosphere and surface using matrix-operator method and radiative transfer code IPOL."

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

Dr. Ganeshan has worked with Dr. Yuekui Yang and Stephen Palm to develop a methodology to study the impact of sky condition (viz. blowing snow and clouds) on the surface and atmospheric boundary layer properties over Antarctica using CALIPSO satellite measurements that are co-located with in-situ observations. The results over Dome C were presented as a virtual talk at the 2021 AGU Fall Meeting and as a manuscript that is currently under review with the Journal of Geophysical Research – Atmospheres. The study, led by Dr. Ganeshan, found that clouds at Dome C abate surface longwave radiative cooling losses thereby causing warming in all seasons, and that blowing snow is accompanied by intense winds, which weaken the temperature inversion; however, it is often restricted vertically by strong background stability.
Dr. Ganeshan contributes to evaluating atmospheric products (level 2 data) from the Spire GNSS RO constellation as part of NASA Commercial Smallsat Data Acquisition Program led by subject matter expert Dr. Dong Wu.

Dr. Ganeshan and Dr. Jie Gong (UMBC) contributed as co-authors (lead author, Dr. Dong Wu) to the published journal article that describes the GNSS RO methodology for studying marine atmospheric boundary layer water vapor.

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

Under this task, Dr. Gong's major responsibility is to perform analyses of radiance data for cloud and wave-modulated cloud phenomena, using satellite data acquired from IceCube, GPM-GMI, MLS, AIRS, and GPS in conjunction with numerical model simulations. She is responsible for determining and correcting radiance biases and implement consistent coefficients for cloud ice and

boundary layer water vapor retrievals.

In the coming months, she plans to submit as PI one proposal by 11/09/2022. She will attend the CloudSat-CALIPSO science team meeting, and work on completing two first author manuscripts, one on ice water path retrieval, the other on PBL water vapor profile retrieval.

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

The main tasks for this project are 1) investigation on the radiative processes and energy balances based on the satellite-based observations and reanalysis products to better understand the observation uncertainties and reanalysis model deficiencies and 2) improvement in understanding of the sea ice variation by time-lagged impact of the dynamic/thermodynamic processes. Dr. Lim has evaluated the radiative properties from reanalyses and two independent observations of CERES and DSCOVR/EPIC to address their ability to represent the Earth's radiative energy distribution and variation. The Arctic sea ice variation determined by the time-lagged impact of the Arctic Oscillation has been also actively studied this year.

Upcoming plans include submitting a lead author paper titled "Improved understanding of the Antarctic ice variability in association with planetary-scale wave propagation originating from the tropics" as well as presenting as lead author "Impact of the Arctic Oscillation from March on summertime sea ice" NOAA's Climate Diagnostics and Prediction Workshop in Utah, October 25-27.

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

The MODIS cloud regime framework is a great tool to dissect and sort of global cloud types. Aerosol-Cloud interaction, Earth's radiation budget and precipitation variations can be analyzed to diagnose their relationships with different global cloud systems. The MEaSUREs project aims to provide unified weather states from the International Satellite Cloud Climatology Project (ISCCP) and the Moderate Resolution Imaging Spectroradiometer (MODIS). Dr. Cho works with Drs. Jackson Tan (UMBC) and Lazaros Oreopoulous (GSFC) on this project. They successfully presented an updated 17-year dataset with three different spatial and temporal product of global cloudiness classification from the space-based MODIS instrument on the official archives (GES DISC) and completed two manuscripts.

Dr. Cho has performed data transformation and configuration for subcolumn generators as part of CloudSat/CALIPSO project tasks. She also created two-dimensional cloud optical depth variability of liquid, ice and mixed-phase clouds input dataset on optimal ways to blend different CloudSat products to run the subcolumn generators used in Global Climate Models. Results were published in the paper "Assessment of Two Stochastic Cloud Subcolumn Generators Using Observed Fields of Vertically Resolved Cloud Extinction" in Journal of Atmospheric and Oceanic Technology. Dr. Cho has worked on parameters of cloud occurrence and layer cloud optical depth to overlap vertically to improve numerical models used for climate simulations as another part of the project.

Looking ahead, Dr. Cho will examine the detailed decomposition of radiative flux anomalies to cloud changes using the new CERES FlxByCldTyp (FBCT) product. She also will present work relating to FBCT analysis at the upcoming AGU Fall Meeting. Work will continue on preparing a publication related to cloud overlap parameter.

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

Since 2019, Dr. Jin has participated in the project "Combined analysis of GPM and MODIS datasets to unveil the climatological relationships between clouds and precipitation" as a Co-I, which is the part of ROSE 2018 PMM Science Team. This project was successfully completed with several published papers.
Dr. Jin is currently working on the issue of abrupt change of cloud patterns associated with 2015/16 El Niño, and the results are expected to organized for a future publication.

Upcoming plans may include giving a presentation at the AGU Fall Meeting, as Dr. Jin has submitted an abstract. He also has submitted a paper "QBO deepens MJO convection" to Nature-Comm. in July 2022, and is awaiting feedback.

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

Dr. Várnai and his colleagues analyzed long-term statistics of the sun glint product that they had developed and then helped release as a new operational data product of the DSCOVR spacecraft's EPIC camera earlier last year. They examined how the observed glint effects were influenced by scene properties and instrumental effects. Also, they identified some possibilities for improving the product; the envisioned refinements are expected to be implemented in the coming months.

Dr. Várnai also contributed to the team's analysis of near-cloud aerosol observations and to the development of a machine learning algorithm for satellite measurements of aerosol optical depth in regions of broken cloudiness. The new method seeks to provide aerosol measurements in the gaps where current methods cannot provide either aerosol or cloud information, and to improve the accuracy of aerosol measurements by considering the effects of sunlight that nearby clouds scatter into the satellite field-of-view.

Finally, Dr. Várnai made several improvements to the first publicly available online simulator of three-dimensional radiative processes that occur in cloudy regions. The improvements made the simulator easier to use and expanded its capabilities to allow simulations for a wider range of situations.

In the coming months, Dr. Várnai will contribute to further testing of the team's newly developed aerosol retrievals to evaluate its robustness under a wider range of conditions. The team also expects the publication of a recently accepted paper that describes the new method. Dr. Várnai also plans to make improvements to the online simulator of 3D radiative processes and to the

operational EPIC sun glint product.

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

Currently Dr. Zhou is working on three separate projects. Two of them are related to the remote sensing of cloud and aerosol. A third project is science-driven investigation in 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). She has focused on improving the EPIC cloud products such as cloud mask and cloud effective height utilizing EPIC's unique oxygen channels. Dr. Zhou also conducts radiative transfer model simulations as a research tool for algorithm development and evaluation for the instrument stability.
Dr. Zhou is also a team member of Goddard's Dark Target (DT) aerosol retrieval algorithm. Her main research with the group is to improve the dust retrieval of the DT algorithm over ocean. Over the past few years, she has developed a dust detection algorithm and a non-spherical dust model for the DT's operational ocean algorithm for the MODIS instruments. Dr. Zhou is currently working on adjusting the dust detection algorithm for the DT algorithm package that is being applied to several different instruments across different satellite platforms (i.e., MODIS, VIIRS, ABI and AHI).

For the science investigation, Dr. Zhou is a Co-investigator of a TASNPP project, titled "Investigating the Relationships of Cloud and Radiative Properties and Extreme Precipitation with Convective Clustering in the Tropics with Observations". For this project, Dr. Zhou will combine dynamic and thermodynamic indices generated from MERRA-2 reanalysis and extreme precipitation events from IMERG with the radiation and cloud properties derived from the CERES instrument to study the relationships between cloud, radiation and large-scale dynamic and thermodynamic effect on convective aggregations.

In the next three months, Dr. Zhou will work on two proposals as Co-I. She plans to finish a paper titled "Evaluation of EPIC Oxygen Band Calibration with Radiative Transfer Model Simulations Over South Pole". In late September, she will attend the DISCOVR science team meeting to be held at NASA GSFC. For the aerosol project, Dr. Zhou will help the DT group in evaluating potential new RTM for generating LUT and continue working on dust algorithm. For the TASNPP project, Dr. Zhou will generate EPE from IMERG data in tropics. The EPE data will combine with other cloud and radiation products in tropics to examine the interactions between cloud, radiation and precipitation and their role in convective aggregation.

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 of the SORCE mission. The Total Irradiance Monitor (TIM) is taking measurements of the total amount of radiant energy emitted from the Sun coming to the Earth (total solar irradiance), and the Spectral Irradiance Monitor (SIM) is measuring solar spectrum (spectral solar irradiance).

Dr. Lee's major task is to provide a theoretical and physical basis for the TSIS-1 mission operation and TSIS-2 mission development. The TSIS-2 mission, which will be flown in 2025, will continue to measure solar irradiance toward a continuous climate data record as suggested by last decadal survey, as a follow-up of the TSIS-1. Throughout mission activities, Dr. Lee has and will manage science data quality and engage in validations and calibration status so that the mission can fulfill all levels of requirements and science objectives.

Dr. Lee's research is especially involved in rotational and solar cycle variations in Total Solar Irradiance and Spectral Solar Irradiance. Besides the Sun, her major scientific research area is Sun-Climate connection, which is a complex combination of multiple non-linear processes involving Earth's ozone layer, atmospheric circulation, clouds, and ecosystem.

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

Dr. Wang has been developing and improving infrared optimal estimation (IROE) retrieval algorithm for ice cloud property retrievals using passive spectrometers (MODIS/VIIRS/ABI). Also, Dr. Wang has been developing machine learning-based cloud mask/phase detection algorithms for passive spectrometers; developing machine learning-based cloud and aerosol masking and typing algorithms using Geostationary imagers; and, developing machine learning algorithms to detect Atmospheric Gravity Waves using VIIRS Day Night Band.

Dr. Wang is working on providing a flexible platform for satellite data collocation system and ready-to-use collocation datasets for users. In addition, he and colleagues are working on developing multiple end-to-end ML based algorithms (Domain Adaptation, VAE etc.) for cloud/aerosol detection.
Dr. Wang submitted two abstracts as presentations in the AGU Fall meeting 2022 and AMS annual meeting, and fully expects to participate in these meetings.

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

The MAIAC is a new-generation atmospheric algorithm that uses a time series approach and an image-based (rather than pixel-based) processing system to perform simultaneous retrievals of atmospheric aerosols and surface spectral bi-directional reflectance (BDRF)/albedo without empirical assumptions. In the past year, Dr. Wang delivered a new MAIAC MODIS collection 6.1 version algorithm, and the code is currently running in MOSDAPS to create MAIAC version 6.1 data suite. In addition, Dr. Wang developed MAIAC MODIS CMG algorithm to aggregate MAIAC data in standard daily 0.05-degree grid, which is used widely in the science community. This code has been submitted to the operational team and is at the final testing stage.

The team has been continuously working on extending the MAIAC MODIS algorithm to fit other satellite platforms. Dr. Wang delivered the MAIAC VIIRS operational code to the operational team, and the code is currently under testing. In order to mitigate the impact of map projection distortion, Dr. Wang developed a new MAIAC VIIRS gridding algorithm to resample VIIRS L1B data to the new Rotated and Zoned Sinusoidal projection. This code also was submitted to the operational team and is ready to run.

Further, Dr. Wang developed version 2 MAIAC EPIC operational code and generated MAIAC Version 2 EPIC data set, and this data has been published on the Atmospheric Science Date Center (ASDC) website. He also developed operational MAIAC code for geostationary AHI and ABI sensor; the code has been submitted to NASA Ames center for testing.

Dr. Wang performed a thorough analysis to calibrate VIIRS SNPP and JPSS1 sensors, using MODIS Aqua as the benchmark. He first created a 10-year time series of normalized VIIRS TOA reflectance for Libya4 calibration site, performed detrending process, and then matched the time series with MODIS Aqua TOA reflectance time series to derive cross-calibration coefficients. These coefficients are comparable with those coefficients published in literature.

In the upcoming months, Dr. Wang will first finalize the MAIAC VIIRS operational code, submit it to the operational team, and start the MAIAC VIIRS CMG code development. He also will finish the VIIRS SNPP and JPSS1 sensor calibration analysis, perform large-scale comparison with MODIS Aqua AOD and surface reflectance. Dr. Wang will continue to provide support for MAIAC data users.

Name: Sujung Go
Sponsor: Alexei Lyapustin
Code: 613
Task: 119

Dr. Go also works on the MAIAC, a new-generation atmospheric algorithm that uses a time series approach and an image-based (rather than pixel-based) processing system to perform simultaneous retrievals of atmospheric aerosols and surface spectral bi-directional reflectance (BRF)/albedo without empirical assumptions. In the past year, Dr. Go contributed to the validation of 11 years of MAIAC MODIS collection 6.1 version products. In addition, Dr. Go received funding for a three-year grant ("EPIC Aerosol Retrieval Datasets for Diagnosing and Improving Aerosol Optical Treatments in the Navy Aerosol Analysis and Prediction System"), based on the developed version 2 MAIAC EPIC operational algorithm that includes new aerosol speciation retrieval algorithm. Dr. Go developed the MAIAC TROPOMI algorithm, which is a prototype for PACE OCI mission. The first version of the operational algorithm is planned to be delivered this year.

Upcoming plans include finalizing retrieved spectral surface reflectance from MAIAC TROPOMI and will submit the v1 prototyped operational code for PACE OCI project. Dr. Go will participate in a forum organized by UNEP UNESCAP and sponsored by the Embassy of the Republic of Korea to Thailand as a panelist (Sep 2022). Dr. Go will participate in NASA ARSET training as well as the AGU Fall Meeting, the DSCOVR EPIC Science Team Meeting, the NOAA Geostationary Science Team Meeting, and the ICAP meeting, sponsored by NASA Radiation Sciences Program and the Office of Naval Research.

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

Dr. Choi inferred light-absorbing carbonaceous aerosol components in smoke aerosols from UV-visible DSCOVR/EPIC measurements with the MAIAC processing. Dr. Choi characterizes spatiotemporal changes in smoke optical properties, specifically inferred BC and BrC, over regional-to-continental scales. Statistical assessment of EPIC smoke properties shows regional differences based on different source types in smoke-dominant regions. The inferred EPIC BC and BrC speciation information can improve radiative forcing estimates and air quality studies by constraining smoke particle composition in climate and air quality models.

Dr. Choi supported spectral calibration of VIIRS aboard S-NPP and J1 and Maxar constellation sensors referred to MODIS/Aqua measurements based on the MAIAC processing. Dr. Choi provided spectral conversion factors from MODIS/Aqua to target sensors by leveraging the DESIS hyperspectral measurements. Further evaluation of spectral calibration provides confidence in the long-term stability of satellite measurements and their application to climate studies.

Dr. Choi as a co-author had a paper published in September 2022 in Atmosphere Chemistry and Physics, titled "Airborne observations during KORUS-AQ show that aerosol optical depths are more spatially self-consistent than aerosol intensive properties."

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

Dr. Shi has been generating a validation system for increased number of Dark Target (DT) products on various sensors. The validation system has been adopted and tested by the entire Dark Target group and feedback has been compiled. The system is undergoing improvements to meet the new needs of the research. A thorough validation has been done 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.

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. L. Remer). Various tests and validation of the model results were performed to ensure the quality of the model output.

Dr. Shi continued to study the satellite observability of small smoke plume during FIREX_AQ campaign. 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 plume optical characteristics in retrieved products due to product spatial resolution have been extensively studied, and a related paper is in preparation.

Dr. Shi also collaborated with Dr. Reed to create a collocated dataset between AERONET level1 observation, level2 inversion product and ABI-16/17 DT level2 data to provide a dataset that can be implemented into GRASP algorithm to retrieve aerosol optical properties with a focus on aerosol

absorption.

For the remainder of 2022, Dr. Shi expects to continue working on thorough validation of MEASURES project-related DT products quality and quantifying the uncertainties within the products. And continue maintain and improve the validation and collocation system for the group. Dr. Shi is expected to submit a paper regarding her work on analyzing the observability of satellite aerosol products on small fire plumes. Dr. Shi will continue work on validation and evaluation of products from PACE project regarding the accuracy of the ML AOD output.

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

Dr. Zhai is responsible for the development and implementation of the improved pseudo spherical shell approximation for better look-up tables closer to the edge of the EPIC images. In order to improve remote sensing of the environment in polar regions, he designed an improved pseudo spherical shell (IPSS) approximation for simulating the polarized radiance field in the Earth system (Zhai et al., 2022b). The radiative transfer solution in a plane-parallel geometry is a good approximation for many applications in the Earth or other planetary systems as the Earth's radius is quite large (~6371 km). However, the plane-parallel geometry is problematic in polar regions where the solar zenith angle is usually large (~60 degrees) and the spherical shell effect is significant. One simple solution is the so-called pseudo-spherical shell (PSS) approximation, which treats the solar beam attenuation exactly along the nadir in the spherical shell atmosphere while keeping the plane parallel geometry for multiple scattering calculation. The PSS approximation improves the solution for intermediately large solar zenith angles, though the error is still large for large-viewing zenith angles.

The IPSS approximation further improves the treatment of a spherical shell geometry by using the following techniques: 1) the single scattering solution is solved exactly for the spherical shell atmosphere; 2) the multiple to single scattering solution ratio is solved using the plane-parallel geometry with our radiative transfer code based on successive order of scattering method; and 3) the ratio of the multiple to single scattering solution is assumed to be the same for both the plane parallel and spherical shell geometry. He and his team tested the performance of IPSS with two benchmark cases involving the Rayleigh scattering matrix. If the Rayleigh optical thickness is 0.25, the error is smaller than 1% for most of the viewing directions (~70 degrees). If the Rayleigh optical thickness is 1.0, the error is bounded within ±2%. The error does not show obvious dependence on the viewing zenith angle. This newly developed IPSS scheme is highly accurate and has been implemented in the PACE radiative transfer simulator and the aerosol reflectance lookup table software package. Both have been delivered to GSFC Ocean Biology Processing Group (OBPG). This new function would enhance the retrieval accuracy of ocean color remote sensing over polar regions.

In addition to the IPSS algorithm, Dr. Zhai and his team also updated a Monte Carlo code for Spherical Shell Atmosphere (MCSSA), which can be used to simulate the polarized radiance field in a full spherical shell geometry. He participated in a project that aims to produce benchmark data for validating polarized radiative transfer in spherical shell geometries (Korkin et al., 2022). In this project, he used MCSSA to generate highly accurate data of polarized radiance (0.1%), which will be valuable in validating future radiative transfer and remote sensing algorithms.

CODE 614: ATMOSPHERIC CHEMISTRY AND DYNAMICS LABORATORY

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

Dr. Anderson developed a new methodology to produce a parameterization of the hydroxyl radical which has been successfully integrated into the GEOS model. This new parameterization will allow for the efficient calculation of feedbacks on methane, allowing users to more efficiently model and understand atmospheric methane variability. Dr. Anderson also participated in the NASA-sponsored ACCLIP field campaign based in Osan, South Korea. He made observations of formaldehyde on the NASA WB-57 airplane, in an effort to help understand the impacts of pollutant transport from the Asian monsoon on the upper atmosphere.

Looking ahead, Dr. Anderson will participate in the ACCLIP science team meeting, presenting preliminary findings from the campaign conducted in Aug. 2022. He will also write and submit a paper to Atmospheric Chemistry and Physics, summarizing a new methodology to constrain tropospheric column hydroxyl radical using space-based observations of its drivers.

Name: Junhua Liu
Sponsor: Lesley Ott
Code: 614
Task: 014

Dr. Liu's current research focuses on quantifying the factors controlling the observed interannual variations and trends in tropospheric O3 and precursors in the recent decades using an ensemble of satellite, aircraft, surface observations and GEOSCCM model, and investigating their interaction with the Earth's climate. She has finished the analysis of quantifying changes in tropospheric ozone in the recent decades and its contribution to global total ozone using ozone simulations from the GEOSCCM RefD1 and satellite observations. Dr. Liu submitted the results of this work to JGR-atmosphere, and she is working on her response to the reviewers' comments. Dr. Liu is working with Dr. Dan Anderson and Dr. Julie Nicely on identifying the main drivers for OH changes using Matlab based box model (F0AM) and aircraft measurements. She has finished 10+ sensitivity runs of F0AM model with different chemistry set up with various aircraft measurements and evaluated the F0AM model performance on simulating observed OH. In addition, Dr. Liu is participating in examining the stratospheric and tropospheric exchanges based on stratospheric fraction analysis using ozone and H2O correlations from MERRA2GMI simulations and aircraft measurements from IAGOS – In-service Aircraft for a Global Observing System.

Work will continue on the manuscript that will be resubmitted to JGR-Atmosphere.

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

Dr. Strode completed a 150-year simulation of the pre-industrial climate with the GEOS coupled atmosphere-ocean model, and an additional 150-year simulation with 4 times as much CO_2. She

also conducted a 4 times CO_2 simulation with fixed sea surface temperature. These simulations are used to evaluate the climate sensitivity of the GEOS model.

Dr. Strode contributed to the development of a NASA ARSET training on Tools for Analyzing NASA Air Quality Model Output. She is also contributing to the implementation of a parameterization of hydroxyl radical concentrations in the GEOS model.

Looking ahead, Dr. Strode plans to simulate the interactions between methane, CO, and OH using the new OH parameterization within GEOS. She expects to conduct sensitivity studies based on the GEOS pre-industrial climate simulations and contribute to the presentation of the results of this study.

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. As PI of MEaSUREs NO_2 project, Dr. Lamsal manages 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 consistent long-term (1995-present) global trend-quality data records of tropospheric NO_2 columns and value-added surface NO_2 concentrations and NO_x emissions. He also leads an effort to develop NO_2 product from airborne sensors that have been deployed during various NASA field campaigns.

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

Dr. Jethva is an integral part of the core OMI aerosol group in lab 614. Over the past year, he took major responsibility for integrating the capability of aerosol layer height retrievals in the operational aerosol algorithm designed for DSCOVR-EPIC and S5p-TROPOMI sensors. This task involved extensive radiative transfer calculation followed by preparation of aerosol look-up tables, writing and integrating new aerosol modules into the operational algorithm framework, and analysis/validation of the processed dataset. For the OMI aerosol algorithm, he suggested an improved scheme of cloud screening based on the collocated MODIS cloud information. He also contributed as a co-author in a paper (published in JGR) describing EPIC aerosol product and its validation.

In the coming months, Dr. Jethva will continue working on the OMI, TROPOMI, and EPIC projects. He will work on the implementation and validation of O2-B observation-based retrievals of aerosol layer height and optical depth for EPIC and TROPOMI sensors, and he will work towards the final checks and delivery of the OMI Collection 4 aerosol product.

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

Dr. Strahan continues to direct chemistry transport model simulations that are used in her research and by measurement scientists that are part of the Network for the Detection of Atmospheric Composition Change (NDACC). She uses model simulations and NASA satellite data to provide near real-time analysis of stratospheric ozone in support the polar ozone working group in Code 614. She participates in biweekly Chemistry Climate Model development group meetings.

In fall 2022, Dr. Strahan will participate in-person in the NDACC Steering Committee meeting and give two presentations. She will continue monitoring the progress of 2022 O3 Hole and will help draft the annual NASA/NOAA press release. She will continue to monitor and assess the stratospheric chemical perturbations from the Hunga Tonga eruption.

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

From early winter 2021 through the spring of 2022, Mr. Swanson participated in the NASA GSFC BLUEFLUX Airborne campaign. The campaign utilized in-situ airborne instruments to measure methane and carbon dioxide fluxes over the Everglades. Mr. Swanson was responsible for instrument preparation and integration into research aircraft.

Later in the spring and through the summer, Mr. Swanson worked on the NASA DCOTSS field campaign. He planned and assisted with NASA GSFC In Situ Observation Laboratory instruments used in the campaign. This included the integration of three research instruments – CAFE, CANOE, and ROZE – as well as their gas sampling probes and other ancillary components. He later assisted with their field operation and maintenance.

Early in the summer, Mr. Swanson also worked on the NASA ACCLIP campaign. This consisted of integrating the lab's research instrument, ISAF, into the NASA WB-57 aircraft. Mid-summer, Mr. Swanson also helped with ROZE preparations for a USDA funded project measuring ozone fluxes above a soybean field in Urbana, IL.

Throughout the reporting period, Mr. Swanson continued working on a NASA GSFC IRAD funded nitrogen dioxide (NO2) sonde project. He did the instrument's mechanical design, oversaw manufacturing, assembly, and assisted with field testing. There were two successful test flights with instrument recoveries during the period. On both occasions, the sonde got stuck at the top of trees in heavily wooded areas of Prince George's County and Anne Arundel County, Maryland. Thanks to their successful recovery, Mr. Swanson and his team are planning on more test flights later in the year after instrument modifications are made for improving measurement radio transmission.

In the upcoming period, Mr. Swanson plans to continue assisting with the ACCLIP field campaign. He will be traveling to Ellington Field outside of NASA JSC to de-integrate ISAF from the NASA WB-57 and then shipping it back to GSFC. He also will work on additional modifications and field testing of the lab's NO2 sonde. Also, Mr. Swanson will work on parts procurement, assembly, and

testing of an additional ROZE instrument for the lab.

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

Dr. Liao began work on the NASA Pandora network project this year. She wrote codes to compare the Pandora NO2 and HCHO data at different sites (up to near 70 sites) to daily TROPOMI data for collocated time for the year 2021. The NO2 and HCHO measurements from Pandora generally agree well with TROPOMI data for most of the sites. The results are presented by Pandora project PI Tom Hanisco at several meetings. Dr. Liao started to learn about the Pandora instruments and the measured data. She is in charge of the Pandora lab radiometric, wavelength and straylight calibration for the Pandora instruments. She also has conducted lab calibration analysis and will continue to learn more about the field calibration analysis.

For the NOAA project, Dr. Liao wrote the MATLAB codes to generate the gridded L3 HCHO satellite data (OMI and TROPOMI) from L2 data and shared them with a colleague who has been working on the NOAA project the past year.

In fall 2022, Dr. Liao will continue to work on Pandora lab calibration and move toward the Pandora lab and field calibration analysis. She also will begin comparing different HCHO satellite datasets.

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

EPIC, OMI, and OMPS satellite instruments are operational at the current time, producing ozone measurements that Dr. Ziemke uses together for deriving long-record tropospheric ozone data products. The newest EPIC tropospheric ozone product provides maps of tropospheric ozone every 1-2 hours and is updated and uploaded to the Langley ASDC via NASA Goddard NCCS.

Upcoming plans include continuing the development of tropospheric ozone products with new added improvements involving boundary-layer, clouds, and aerosols adjustments. Dr. Ziemke will continue to participate in weekly meetings on development of SBUV, and OMI/OMPS total ozone products. He plans to attend upcoming meetings (in person or virtual) for DSCOVR (27-29 September 2022), Sentenel-5p 5-year anniversary meeting (10-14 October 2022), and fall AGU meeting (12-16 December 2022).

Name: Ghassan Taha
Sponsor: Glen Jaross
Code: 614
Task: 084

On May 19, 2022, the version 2.1 Suomi National Polar-orbiting Partnership (SNPP) Ozone Mapping and Profiler Suite (OMPS) aerosol extinction profiles product was publicly released at GES DISC: https://snpp-

omps.gesdisc.eosdis.nasa.gov/data/SNPP_OMPS_Level2/OMPS_NPP_LP_L2_AER_DAILY.2/. The new product, developed by OMPS LP aerosol science team PI Ghassan Taha (614/MSU) and Co-Is Robert Loughman, and Pete Colarco (614), features some improvements in the aerosol extinction coefficient profiles, especially the shorter wavelengths.

In the coming months, Dr. Taha expects the following papers to the published: "SAGE III/ISS Ozone and NO_2 Validation using Diurnal Scaling Factors," in Atmos. Meas. Tech. Discuss.; "Tracking the 2022 Hunga Tonga-Hunga Ha'apai aerosol cloud in the upper and middle stratosphere using space-based observations" in Geophysical Research Letters; "Analysis and impact of the Hunga Tonga-Hunga Ha'apai Stratospheric Water Vapor Plume" in Earth and Space Science Open Archive; and,"Hunga-Tonga eruption: stratospheric aerosol evolution in a water-rich plume," which is presently available at Research Square [https://doi.org/10.21203/rs.3.rs-1647643/v1].

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

Mr. Kucsera processed large volumes of satellite data products. He processed data products for ingestion and use in atmospheric modeling runs, as well as computer simulations model runs and results. He created results for inter-model comparison studies and international scientific collaboration. Mr. Kucsera post-processed NASA GEOS modeling results for the AEROCOM 3 model inter-comparison project. The control base case results labeled by the project as AP3-CTRL were processed into the strict and required structure that was mandated by the organizing committee and in which all participating researchers must follow to aid in the inter-comparison of the results. This standardized format will eliminate the requirement of dealing with different and model dependent output data structures and formats. The year 2010 was selected, by the committee, as the control year which requires that detailed and comprehensive results must be generated. In addition, to the control experiment base, the 39-year multi-year modeling results from 1980-2018 were post-processed. These 39 years of analyses are being generated and post-processed for the history (aka, "HIST") portion of the AEROCOM 3 multi-model inter-comparison. He also created products for the multiple UTLS scenarios, which required special processing to include volcanic emissions and associated chemical products. Mr. Kucsera processed fire emission products, and generated global daily emission products for several chemical species assumed to be emitted and derived from biomass burning data products, in which small-scale-sized fires were included in the analysis. Products were broken up by biome type and quantified by the satellite based and derived GFED 1.4s amounts of area burnt over multiple number of years. Simulations were later made with the GMAO GEOS model using these comprehensive biomass burning emissions.

Mr. Kucsera managed and maintain his group's computer equipment resources and software; managed IT resources in line with NASA mandated regulations; and, archived generated scientific products and maintained the computer storage devices to hold petabytes of data products and results. In addition to his long-term software and hardware maintenance workload, the linux-based AVDC workstations were added to his work requirements. He was approached to perform this additional work by NASA officials after the previous administrator had left. Mr. Kucsera was sought out because of his expertise with system administration. He has provided technical and project assistance to his group members despite the pandemic and the imposed physical restrictions. He would often use direct telephone, MS Teams, or his NASA-funded Webex account to conduct

technical sessions to interact with the group members.

Because of his additional work assignment as the administrator of the AVDC workstations, Mr. Kucsera has been learning the management of the Ubuntu operating system to better handle these workstations. He has already improved these systems' overall operation with improvements that included a long overdue upgrade to a supported version of the operating system (which is a NASA mandatory requirement). He found that these inherited workstations were lacking critical security updates that were more than a year and half out of date. In addition, the version of IDL on the AVDC workstations were upgraded to the latest version, which immediately improved software development and production capability on these machines.

Looking ahead, Mr. Kucsera will continue to process Satellite and Model data for supportive research missions. He will prepare the latest modeling results for the intercomparison AEROCOM project and deliver the results to the project's archive to allow for detail intercomparison of results with other research groups involved in the program. He will continue to administer and maintain his group's clustered workstations and his extended workload of the ADVC associated workstations.

Name: Keith Evans
Sponsor: Stephen Merkowitz
Code: 614/61A
Task: 128

To advance the understanding of natural and anthropogenic sources of trace gases and their impacts on Earth's climate, air quality and environment, this collaborative effort involves research on volcanic and anthropogenic gaseous emissions, primarily but not limited to sulfur dioxide (SO_2) and nitrogen dioxide (NO_2), in support of NASA's legacy and ongoing atmospheric composition missions, such as TOMS, OMI, OMPS, and ESA/Copernicus S5P/TROPOMI. Mr. Evans works on maintaining and further developing the NASA/Goddard Sulfur Dioxide Monitoring Web Site (http://so2.gsfc.nasa.gov), archiving OMPS, OMI and TOMS SO_2 data in NASA-required formats, and participating in NASA's ESD SWG. He and colleagues also have created, developed, and continue to maintain the NASA/Goddard Nitrogen Dioxide Web Site (http://so2.gsfc.nasa.gov/no2/no2_index.html) using OMI and TROPOMI data.

Mr. Evans worked on developing ways to use machine learning for data analysis, creating maps of (mostly) volcanic SO_2 outgassing from OMI, OMPS and TROPOMI data as needed (ESD SWG), creating weekly reports of worldwide volcanic so2 outgassing from OMI, OMPS and TROPOMI data, and comparing those maps for validation. The goal is 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.

For fall 2022, Mr. Evans will gather statistics of SO2 comparisons using OMI, OMPS and TROPOMI data and will continue maintenance of the SO2 and NO2 web sites. He will prepare an AGU presentation; as lead author, he has submitted an abstract for the AGU Fall 2022 Meeting titled "Comparing satellite measurements of volcanic SO_2 mass from OMI, OMPS, and TROPOMI."

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

As an ISS/SAGE III Science Team Member (Co-I with R. Wang, Georgia Tech), Dr. Thompson helps collect ozonesonde data for validation of satellite data products and models, in particular for the tropical SHADOZ network and for the NASA/Wallops NDACC stations. As Co-Chair of the WMO-sponsored (World Meteorological Organization) ASOPOS (Assessment of Standard Operating Procedures (SOPs) for OzoneSondes) 2.0, she co-leads international efforts to enhance the quality of ozonesonde profile data. For these activities, since December 2021, Dr. Thompson has helped organize and presented talks at 6-7 online workshops and SHADOZ regional meetups. All four of her published papers during the latter period derive from the quality assurance research. The Ozonesonde Chapter in the Nalli book is an important study. Additionally, a major undertaking with Code 614 (R. Stauffer) this year was the conversion of the Wallops sondes from a 60+ year old radiosonde system to a Vaisala system that Dr. Thompson purchased while still a NASA/GSFC Senior Scientist. They had two training trips to Wallops in spring and summer 2022 to work on guiding the operators on use of new equipment as well as to ensure by launching two instruments on the same balloon that the systems measure within required precision.

Dr. Thompson also is a researcher for tasks of the Interagency Agreement between NASA/GSFC and the Department of the Interior Bureau of Ocean Energy Management (BOEM). This continues research from a 2017-2020 IAA on the impact of oil and natural gas offshore activities in the Gulf of Mexico (GOM). They use both satellite (TROPOMI, OMI) and ground-based (Pandora ship-based) data to see if remote sensing can be used for verification of pollutant emissions that BOEM can only estimate through industrial fuel usage statistics. The new IAA is delayed, but a first-author paper submitted in June 2022 (Thompson et al., Earth Space Sci. https://www.essoar.org/doi/10.1002/essoar.10511687.1,) summarizes their positive findings from a 2019 GOM cruise for which Dr. Thompson served as Chief Scientist. The in-press Earth Observer article (Stauffer, Thompson et al.) is a plain-English summary of their paper.

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

Throughout the reporting period, Dr. St. Clair traveled for field campaigns, with ~115 days away from home. Two of the projects were for Dr. St. Clair's task, both on high altitude NASA aircraft studying the transport of water vapor and reactive gases into the lower stratosphere by monsoons. Dr. St. Clair led the Goddard team supporting three in situ instruments (HCHO, NO_2, O3) aboard the NASA ER-2 for the second deployment of the EVS-3 Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) project out of Palmdale, CA and Salina, KS. All three instruments performed well, benefitting from improvements made between the first and second DCOTSS deployments.

Dr. St. Clair was the primary instrument support for the Goddard in situ formaldehyde measurement during the second half of the NASA Asian Summer Monsoon Chemical & CLimate Impact Project (ACCLIP) deployment in South Korea, and he supported some of the ACCLIP test flights out of Houston, TX.

In fall 2022, Dr. St. Clair plans to finalize data from the ALPACA and DCOTSS measurement campaigns. He will be guiding engineering staff for two projects: 1) the fabrication and assembly of a duplicate ROZE in situ ozone instrument and 2) the development, fabrication, and assembly of our next-generation in situ formaldehyde instrument, a replacement for the ISAF instrument.

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. Over this reporting period, activities have focused on minimizing the various errors in the brightness temperature measurements acquired over the ocean to perform a reliable retrieval of sea surface salinity One particular aspect that is being considered is the mitigation of the effect of Radio Frequency Interference (RFI) on the radiometer measurements, both through RFI detection and filtering in the data and by reporting interference to the competent authorities so its sources can be identified and removed.

In the months ahead, Dr. de Matthaeis will be awaiting feedback on an article he co-authored that was submitted IEEE TGRS and is currently under review. An internal technical report is currently under preparation, and he is preparing for a potential field campaign in Utah.

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

Dr. Felikson is co-leading the Sea-Level Change component of the Earth Information System (EIS). The aim of this project is to implement numerical process models of the ice sheets, the firn (layer of compacting snow on top of the ice sheets), the ocean, and the solid earth on NASA-managed cloud-computing platforms, such as the Science Managed Cloud Environment (SMCE). The EIS Sea-Level Change project involves about 20 researchers, programmers, and cloud architects at the Goddard Space Flight Center, the Jet Propulsion Laboratory, academic institutions, and NASA contractors.

Dr. Felikson is supporting the Ice, Cloud and land Elevation Satellite 2 (ICESat-2) mission by serving as the data product lead for the Land Ice Height data product (ATL06). In this role, Dr. Felikson performs routine product quality assurance by performing crossover analysis for every batch of data products, prior to them being made public. Dr. Felikson delivered an updated algorithm theoretical basis document (ATBD) to the ICESat-2 Project Science Office, in preparation for release 6 of the ATL06 data product, which is scheduled to be made public in Fall of 2022.

During the next three months, Dr. Felikson will continue co-leading the Earth Information System: Sea-Level Change project, with expected live demos to be given to NASA Earth Science Division. Additionally, he will support the acceptance review for release 6 of the ICESat-2 ATL06 data product, and he expects to continue to perform quality assurance checks of ATL06 data products.

Name: Akiko Elders
Sponsor: Linette Boisvert
Code: 615
Task: 141

Dr. Elders works with Earth System Modelling and is evaluating the sea ice representation in GISS modelE and the impact of that representation on surface fluxes in the Arctic. Dr. Elders has found that multi-year sea ice is under-represented in the model while sea ice along the edges is over-represented. In addition, the sea ice area and extent also are over-estimated in the model. Concurrently, surface fluxes show bias in regions with biased sea ice in the model.

The focus of Dr. Elders's future work will be to submit a peer-reviewed journal publication for the impact of sea ice representation on Arctic fluxes as well as present preliminary findings at the American Geophysical Union's 2022 Fall Meeting. An IDS proposal is also planned with collaborators in the Cryospheric Sciences Branch, Oklahoma University, and University of Colorado.

CODE 616: OCEAN ECOLOGY LABORATORY

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

Work under the task has focused heavily on the NASA bio-Optical Marine Algorithm Dataset (NOMAD) database. During this year, NOMAD specifics have been finalized, including scientific data requirements, metadata information, file formatting, etc., to input individual products on NOMAD. NOMAD requirements have been coordinated with validation activities as the same input and output files are provided to NOMAD. Datasets for radiometry and pigments have been generated to create stations for many cruises acquired in the past years, including all VIIRS validation cruises in a wide variety of optical conditions.

There has been significant effort to finalize the data processing software Visual Seabass, which is used to process radiometry for validation activities and product generation for NOMAD. The software has been completely updated following the most recent data processing protocols by the community. It includes radiometric data processing in single cast acquisition and in multicast acquisition, grouping several acquisitions within a specific space and time interval to increase data density and therefore calculate water leaving radiances with more robust statistical processing. This activity has generated significant interest at EUMETSAT, FRM4SOC-2 project, and its progress has been shared with them. EUMETSAT is developing a community processor for radiometry. Visual Seabass currently ingests data from a variety of sensors and data specifics and applies required calculations for generating water leaving radiances with uncertainty estimates.

In the next few months, Dr. Sanjuan Calzado expects to finalize a technical document for NOMAD specifications as a preparation for external publication. Work will continue towards NOMAD data processing for other products and cruises as well as regular coordination with the validation team for data processing.

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

Dr. Aurin's research has continued in the field of in situ estimation of ocean color in support of Earth observing missions including Plankton, Aerosol, Cloud, ocean Ecosystem (PACE; due to launch in January 2024), the Ocean Ecology Laboratory (OEL), and the OEL Field Support Group (FSG) campaigns. This research is advancing capacity for validation of hyperspectral orbital platforms as well as the development of improved hyperspectral algorithms for retrieving key ocean constituents such as suspended and dissolved materials, and inherent optical properties of the surface ocean. He has continued to improve an open-source community processor, HyperInSPACE (https://github.com/nasa/HyperInSPACE), developed by him in recent years to incorporate the latest protocols for hyperspectral above-water radiometric measurement and processing, while evaluating and promoting emerging methodologies such as the incorporation of a hyperspectral glint correction with polarization sensitivity.

Since December 2021, HyperInSPACE has been adopted by numerous international colleagues,

most notably the European consortium Fiducial Reference Measurements for Satellite Ocean Colour (FRM4SOC) funded through EUMETSAT. FRM4SOC recently became a contributing collaborator in the growth of HyperInSPACE, with contributions from the National Physical Laboratory, UK and the University of Tartu, Estonia for incorporation of complete instrument radiometric characterization into uncertainty estimates in the final products (e.g., remote sensing reflectance), and from ACRI-ST, France for adding an additional radiometer manufacturer (TriOS) to the suite supported by the software (i.e., Satlantic/Sea-Bird).

HyperInSPACE was recently selected to be trialed at the second FRM4SOC Fiducial Inter-Comparison Experiment (FICE) at the Acqua Alta Oceanographic Tower in the northern Adriatic Sea. Dr. Aurin joined radiometry experts from eight EU and US institutes for two weeks in July 2022. The goal of FICE is to intercompare in situ radiometry, assess data consistency, and characterize potential differences between instruments and methods. All legacy processors used outside NASA will be benchmarked against HyperInSPACE, and all above-water radiometry will be compared to in-water radiometry and longstanding validation platforms (AERONET-OC/SeaPRISM) at the site. Research results from this experiment are expected to appear with Dr. Aurin's co-authorship in a peer reviewed manuscript in the coming year. Research findings related to the HyperInSPACE community processor resulting from NASA cruises and culminating in the FICE22 campaign are being prepared in a manuscript for peer review.

Dr. Aurin has supported the OEL's Field Support Group in processing a multi-year backlog of autonomous above-water radiometry collected during many oceanographic campaigns over the past ten years, as well as ongoing cruises during these past nine months (e.g., KORUS-OC, EXPORTSNP, VIIRS_2019_Gunter, EXPORTSNA) and submitting these data to the SeaWiFS Bio-optical Archive and Storage System (SeaBASS). This effort is often complicated by the necessity to obtain external datasets (e.g., ancillary ship measurements and concurrent radiometry) from cruise partners, often several years after the fact.
Dr. Aurin also supported his NASA sponsor, FSG, and external collaborators by processing field radiometry (in-water) collected during cruises in Alaskan Arctic waters in recent years. These cruises are continuing this summer and next with NASA support. He plans to apply the in situ radiometry and constituent measurements sampled during this pre-Artic-COLORS campaign to algorithm development for retrieving constituents, such as total suspended material and particulate organic carbon in order to advance remote sensing in the region for improved estimation of carbon transport from land to ocean.

In the coming months, Dr. Aurin's first priorities are to advance his HyperInSPACE manuscript and collaborate with FRM4SOC partners on both HyperInSPACE developments and FICE22 campaign data processing and analysis. HyperInSPACE will be highlighted again in the September 7, 2022 Ocean Color Research Team Meeting (virtual). The results of the FICE22 campaign and HyperInSPACE evaluations will also be featured at the FRM4SOC2 workshop in Darmstadt, Germany in early December 2022.

He will also be developing and expanding a robotic radiometric platform by merging the current pySAS autonomous above-water radiometry system with newly acquired radiometers from TriOS. RAMSES sensors will be mounted on the pySAS platform, and the data control and acquisition system will be developed in preparation for the upcoming Atlantic Meridional Transect (AMT) cruise in early 2023 and other campaigns in the busy FY23 FSG plan. Acquisition of another automated platform for deployment is being explored to help cover the many supported campaigns.

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

Throughout the reporting period, Dr. Cetinić has supported the PACE mission and continues to support the EXPORTS field campaign. Under PACE, she supported the implementation of several new algorithms in preparation for PACE, worked on upgrades in validation approaches, communicated with the PACE science and application team, and supported PACE and Ocean Ecology Lab science needs (including the co-chairing of the session at Ocean Science Meeting, and organization of a PACE class). She continued to serve as a lead editor for PACE TM series. Along with other mission co-leads, she started preparations for PACE-PAX, PACE validation campaign (Fall 2024).

Under EXPORTS, she collaborated with scientists and supported the projects through publications (technical memos and peer-reviewed articles), meeting organizations, and data dissemination. She co-organized sessions at Ocean Sciences Meeting, targeting biological carbon pump questions.

Future plans include several papers and field campaign support. Currently, Dr. Cetinić has four papers in review, four underway, and two in early stages. She will participate in fall meetings of the Committee on Earth Science and Applications from Space (CESAS) under National Academy and PACE application meeting as a presenter. As part of her work on PACE, she will continue to support the implementation of the biogeochemical algorithms as preparation for PACE, as well as work on the validation procedures for Ocean Color BGC. She will finalize and submit the paper written by the phytoplankton group under the PACE SAT. She will continue to support PACE-PAX planning, finalize the overview (white) paper, and start working on the field safety protocols. For EXPORTS, she will continue to organize the meetings and facilitate the data submission and science results dissemination. She will support the science team and HQ and their needs as EXPORTS is moving towards the Stage 2 of its mission.

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

Dr. Seegers and the CyAN project had a successful year. The amount of data available to the end-users was expanded by creating the Inland Waters Data set, which includes inland radiometry and estimates of cyanobacteria in the water. There were many opportunities for outreach and presentations as interest in the CyAN project and remote sensing of water quality continues to grow.

Upcoming plans for Dr. Seegers include a continued analysis of in situ lake data from Wisconsin, Minnesota, and North Carolina to better understand how the chlorophyll concentrations can be related to the radiometry from boat measurements and from satellites. The analysis includes both a hyperspectral and multispectral approach. She will travel to Argentina in October to give invited talks on satellite remote sensing of water quality at a workshop for La Plata Basin with local organizations in coordination with NASA Applied Sciences Program and the USACE through NASA's State Department supported program SHARE.

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. The main accomplishments related to continued testing and refinement of scientific algorithms to monitor aerosols and clouds from PACE, ensuring that, at its launch in January 2024, the project will be able to provide scientifically useful data sets rapidly after the instrument is functioning on-orbit.

Some of his key achievements in 2022 towards this include 1) the delivery of an algorithm to determine cloud altitude from PACE, which is being implemented and tested on both simulated data and measurements from the European instrument OLCI, and has been submitted for publication in an international peer-reviewed journal; 2) the development of innovative techniques based on neural networks for the identification of cloudy scenes in satellite images, for which Dr. Sayer's own research has been augmented through his mentoring of a summer intern and a GESTAR II Graduate Fellow; and 3) his contributions to cloud modeling for the mission's pre-launch simulated data stream (PyTOAST), vital for testing data processing systems and providing sample data products to Science Team members and end-users in advance of the satellite's launch. All of these areas represent original lines of research going beyond what has been achieved with heritage NASA Earth-observation missions, and help to reduce risk to the PACE mission and maximize the utility of its forthcoming data.

In addition to this, he has supported others' research improving the characterization of uncertainty and error sources in ocean observation from hyperspectral imagery and polarized sensors that will fly on PACE, which has resulted in several publications. He has continued to support PACE outreach efforts through presentations at applications-focused workshops, delivered several lectures as part of a PACE Summer School held at UMBC, and co-leads the mission's working group on uncertainty characterization.

In the coming months, Dr. Sayer will devote extensive time to outreach and conference/workshop events scheduled to occur during the last few months of 2022. He will continue his annual role presenting and leading discussion on atmospheric data at the virtual PACE Applications Workshop in September 2022. He will also continue his annual service evaluating entries to the American Association for the Advancement of Science (AAAS)'s prestigious annual Kavli science journalism awards, who are convening to assess entries in September. In October, Dr. Sayer will be a co-convener of the annual AeroCom/AeroSat community of modeling and remote sensing scientists specializing in aerosol research. This is a hybrid in-person (Oslo) and virtual meeting (he will attend virtually). His duties involve assisting in compiling the agenda, chairing sessions, recording notes, and keeping track of the online participation. He will give a presentation assessing cloud contamination identification in future satellite-based aerosol data sets. Also in October, he will attend the annual International Cooperative for Aerosol Prediction (ICAP) meeting, where he has been invited to give updates about aerosol data from the NASA Deep Blue project and PACE mission. Dr. Sayer also will be supporting the work in some presentations made by others at the AeroCom/AeroSat and (December 2022) AGU Fall Meeting. Scientifically, he will continue supporting the PACE mission. Expected activities include continued refinement and documentation of cloud top pressure and cloud masking Algorithms.

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

Dr. Soto-Ramos supports three major projects: EXPORTS, SeaBASS, and PACE. For EXPORTS, Soto-Ramos continues to assist as a data manager. During this time period, Dr. Soto-Ramos archived and/or updated nearly 5000 files from both EXPORTS field campaigns (EXPORTS North Pacific 2018 and EXPORTS North Atlantic 2020). Dr. Soto-Ramos continues to support all the PI's by assisting them prepare, update, and submit their datasets to SeaBASS. She also keeps track of data submissions and makes sure data are submitted timely and in compliance. For SeaBASS, she continues to assist with data processing and ingestion. For this time period, Dr. Soto-Ramos archived/updated over 8,200 files. This includes formatting and making sure they comply with all SeaBASS and OB.DAAC requirements. Dr. Soto-Ramos continued to assist data submitters with questions regarding data submission, accounts, new collections, DOI's and all data-related questions. She assisted with the preparation of python codes to facilitate data management, as well as with maintaining and updating the collections (DOI's, metadata). She assisted with website material and presentations. Additionally, she had to adjust the metadata of thousands of historic files to allow proper machine-interpretation and distribution via OB.DAAC. For PACE, Dr. Soto-Ramos is being trained on the validation process. She also communicates with PI's regarding potential validation datasets and helps during the QA/QC process by communicating with data submitters.

In the coming months, Dr. Soto-Ramos will continue to support SeaBASS, EXPORTS and PACE. She will continue training and preparing for PACE validation process; also, she has three manuscripts in preparation. Data processing and archival will continue as usual, as well as communication with PI's and data submitters.

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

Since December 1, 2021, Dr. Aurin has continued to advance the validation of commercial satellite imagery for application to optically complex waters, such as the Chesapeake Bay, in association with NASA grant funding, on which he is co-investigator. This research has included growing the library of targeted DLR Earth Sensing Imaging Spectrometer (DESIS) hyperspectral imagery from the International Space Station collected over globally distributed validation sites (AERONET-OC; https://aeronet.gsfc.nasa.gov/new_web/ocean_color.html) to over 200 images, including over 100 images over the Chesapeake Bay. Applying the atmospheric correction he had adapted during summer 2021 for the open-source community processor Acolite, Dr. Aurin has shown reasonable agreement between the commercial DESIS orbital imager and collocated MODIS imagery as well as AERONET-OC validation sites. Results generally score well against new benchmark indexes for hyperspectral reflectance (i.e., QWIP). These results were presented in biweekly meetings. Dr. Aurin uploaded resultant atmospherically corrected imagery to the GSFC ADAPT server for use by project partners in machine learning algorithm development for retrieving water quality parameters in the Chesapeake Bay. Preliminary results were also presented to the NASA/GSFC Ocean Ecology Laboratory in a seminar on April 19, 2022.

Dr. Aurin will continue during the fall to acquire and process targeted commercial satellite imagery from DESIS and potentially WorldView3 (Maxar), which he will then deliver to the project team via ADAPT in support of ocean color product algorithm development. In addition, the imagery will be added to the atmospheric correction parameterization and validation effort, the results of which he will begin preparing into a manuscript for peer review.

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

This past year, Dr. Clark and his colleagues have made progress on both the NOS-T project (NASA Earth Science Technology Office), the NASA Ocean Biology and Biogeochemistry (OBB) project in the Arctic, and the NASA Carbon Cycle Science (CCS) Project in the Yukon.

For his work on NOS-T, he is first author of a paper that will be presented at the OCEANS 2022 Conference in Hampton Roads, VA, Oct 17-20, 2022. This paper will be submitted for peer review to a Special Issue of AGU Journal of Geophysical Research by the end of 2022.

Regarding the OBB project, Dr. Clark spent significant time re-configuring the core model code in the later winter/ early spring to run with a new scheme to solve the model, and the model now includes dynamic sea ice for the first time. To his knowledge, this is the first model of its kind that has such a high resolution and can simulate sea ice across the river-lagoon-ocean interface in the Arctic Ocean. An initial paper on the physical model results and interannual variability of ocean currents is in draft form and will be submitted for peer review.

With the CCS project, Dr. Clark was the NASA scientist in a field campaign in the first two weeks of August to the remote Alaska Native village of Alakanuk, AK in the Yukon River delta. He and others worked with scientists from UC Davis and Florida State in the field to collect many samples and measurements related to carbon cycling and water optical properties. They work closely with Alaska Native Collaborators in the village and Delta on sample processing, logistics, ship transportation, and local knowledge/wisdom. This data will feed directly into the model development that Dr. Clark is continuing, which is his core responsibility on the project. They also published a paper on the physical transport model that began with his NPP (https://www.frontiersin.org/articles/10.3389/fmars.2021.793217/full) and a research highlight through the NCCS (https://www.nccs.nasa.gov/news-events/nccs-highlights/yukon-river).

Looking ahead, Dr. Clark will be Co-I on two proposals to be submitted, one to NASA ROSES Carbon Monitoring System (PI: Rousseaux, NASA) and one to NASA ROSES Interdisciplinary Science (PI: Grunert, Cleveland State). He also has a first author paper in review at JGR-Biogeosciences titled “The Transformation and Export of Organic Carbon Across and Arctic River-Delta-Ocean Continuum” and another first author paper in revision to be submitted to Global Biogeochemical Cycles titled “Relative Enrichment of Colored Dissolved Organic Carbon with Increasing River Discharge for the Six Largest Arctic Rivers”.

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

Dr. Xu's task is sponsored by the Science Data Segment (SDS) of NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission to support Level 1 data operation for the Hyper-Angular Rainbow Polarimeter 2 (HARP2) instrument. Designed and built at the UMBC Earth and Space Institute (ESI), HARP2 observes the intensity and polarization of Earth-reflected radiation in 4 spectral bands in visible and near-infrared from 90 view angles, which will be used to obtain detailed microphysical properties of atmospheric aerosols and clouds. HARP2 is one of the two contributed polarimeters to fly with the primary PACE payload, the Ocean Color Instrument (OCI), with a scheduled launch in early 2024. The goal of this task is to develop a validated, robust, and computationally efficient Level 1 processing pipeline system producing HARP2 Level 1B/1C data products to support HARP2 data operation at PACE SDS. Specifically, the task pursues three-stage objectives.

The first stage involves the design and building of a Hyper-angle Image Processing Pipeline (HIPP) system to transform HARP2 unprocessed instrument data into Level 1B and Level 1C data products. HIPP system integrates, in an efficient manner, a set of processing components including the determination of ground location for each pixel of the three HARP2 detectors, calculation of view geometry, correction of imagery detector counts and derivation of intensity and polarization, extraction and resampling of pushbroom HARP2 images from detector frames, and package of relevant data fields into formatted Level 1B and 1C data files. To efficiently address HARP2's high data acquisition rate, HIPP software is primarily written in advanced Fortran 95 with implementation of multi-thread OpenMP paralleling.

The second stage focuses on testing, improving, and validating the performance of the constructed HIPP system with observations from the HARP CubeSat and airborne HARP (AirHARP) observations. HARP CubeSat was deployed from the International Space Station on February 19, 2020 and has been collecting data since April 2020. AirHARP has participated in two NASA aircraft campaigns (i.e., LMOS and ACEPOL) in 2017. Those observations can well serve as HARP2 proxy data for testing and improving various components of the HIPP system (such as geolocation and calibration), as well as to validate the processed Level 1 data products.

In the third stage of this task, the team will support the PACE SDS to perform on-flight HARP2 Level 1 data operation and instrument calibration after the launch of the PACE satellite.

Dr. Xu's upcoming plans include continued support of the PACE SDS with developments of HARP2 Level 1 data processing software. The software will be tested with simulated HARP2 level 0, 1A, 1B, and 1C datasets. In addition, the simulated HARP2 Level 1C datasets will be distributed to the PACE data user community.

CODE 617: HYDROLOGICAL SCIENCES LABORATORY

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

In addition to working on his task, Dr. Emberson works as part of NASA leadership: since April, he has been one of the two Associate Program Managers for the NASA Disasters program. Dr. Emberson has been involved with setting up the new Disaster Response Coordination Office, with those initial activities ending at the end of August to be followed by set-up activities in September and beyond. He is closely involved with stakeholder engagement and program strategic planning for the Disasters program. Dr. Emberson supports the development of the IT and GIS capabilities of the program and also conducts financial analysis for grants awarded by the program. He coordinates between grant PIs and program leadership to ensure that new discoveries are documented and distributed through outreach activities. Dr. Emberson also spends a significant proportion of time supporting the production and distribution of disaster-relevant NASA data to support stakeholder decision-making during active disasters. Since Dec 2021, this has included supporting USG agencies providing data to the Ukraine government relating to the conflict there, as well as flooding in South Africa (supporting WFP and World Central Kitchen), and the landslides around Yellowstone National Park (supporting NPS). Dr. Emberson also is involved in several grant-related research projects, for which he is presenting at AGU 2022, and as Co-I on two grants, supporting two different projects with the GSFC landslides team.

In the coming months, Dr. Emberson plans to submit a paper on rainfall-driven soil erosion. He also plans to attend the Understanding Risk Conference in Brazil (Nov-Dec 2022) and the Global Flood Partnership Conference in Leeds, UK (Sept 2022).

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

Mr. Stanley assisted Dr. Nishan Biswas (UMBC) with the development of the LHASA-Mekong system for real-time landslide hazard assessment in Southeast Asia. He also planned and participated in several training sessions for stakeholders in this region. Mr. Stanley also published the open-source code necessary to run the global landslide nowcast (https://github.com/nasa/LHASA). This software enables any interested stakeholder to make maps of landslide hazards in either forecast or near-real-time modes.

In the coming months, with Dr. Biswas, Mr. Stanley will plan and lead the LHASA-Mekong Handover Workshop. This workshop will take place September 27-30 in Bangkok, Thailand. During the workshop, the LHASA-Mekong system will be officially adopted by the Asian Disaster Preparedness Center (ADPC). Participants may also be trained on semi-automated landslide detection. Additionally, Mr. Stanley will determine historical and projected trends in landslide hazard across High Mountain Asia, by combining downscaled climate data with landslide inventories.

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

Dr. Amatya's work covers three main topics: High Mountain Asia (HMA), NASA Disasters Team, and SERVIR.

Dr. Amatya led a project in support of World Bank's Risk Assessment of Landslides in Upper Arun Hydropower Project in Nepal. As part of this project, the team created a multitemporal landslide inventory and conducted landslide susceptibility and runout analysis for the Arun River Basin. They also conducted an online training for participants from Nepal on landslide inventory and susceptibility mapping using open-source techniques created by the landslide team at Goddard.

As part of an internal NASA Disasters funded project meeting in Anasco, Puerto Rico, Dr. Amatya participated in a Puerto Rico tabletop scenario exercise. The main objective of this meeting was to lay the foundation for a landslide disaster playbook to map out protocols for disaster response to landslides in future. The Semi-automated Landslide Detection (SALaD) system developed by Dr. Amatya was used to generate rapid response landslide product for Hurricane Agatha in Mexico (https://maps.disasters.nasa.gov/arcgis/home/item.html?id=7e0c03caf6164bc9bef5906bc3e398f9). He also experimented with using SALaD to map flood damage post 2022 Kentucky flooding in the US. The maps were shared internally with FEMA and received positive feedback (https://maps.disasters.nasa.gov/arcgis/home/item.html?id=9b4c350604f04fd7b999b8b643b6d245).

For the SERVIR project, Dr. Amatya published a paper documenting production of rainfall-induced landslide inventory for the Lower Mekong Region. These inventories enabled training of the LHASA-Mekong model and quantification of the role of land use and land cover change on landslides. He led annual reports and participated in capacity building activities in the Lower Mekong Region.

In the coming months, Dr. Amatya and Mr. Thomas Stanley will lead efforts to leverage their experience on the HMA team, engagement across the HiMAT PIs, regional stakeholder discussions and existing technology needs to extend collaboration and make connections across HMA, SERVIR Hub and regional partners. Dr. Amatya will further explore the feasibility of utilizing SALaD for mapping disasters other than landslides. Also, Dr. Amatya will lead the close-out reporting for the SERVIR project and will be actively involved in SERVIR closeout scheduled for the end of September 2022.

CODE 618: BIOSPHERIC SCIENCES LABORATORY

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

Dr. Resende de Sousa continued working on Phase II of the NASA-Conservation International partnership. He focused on developing training materials and online tutorials for applying his published methodology on mapping land cover and ecosystems on African countries. In person/in-country trainings are being scheduled for Fall 2022 in Liberia.

He also served as an Associate Program Manager for the Applied Sciences' Ecological Forecasting Program at NASA Headquarters. He worked with a broad portfolio of projects, assisting PIs with reporting on the ERS system, and other activities within the program.

In the coming months, Dr. Resende de Sousa will part of scheduled training for Liberian stakeholders. A 3-day-training course on land cover mapping and ecosystem extent accounting is being produced in partnership with Conservation International. Also, a new land cover map for Senegal 2022 has been initiated as an initial step for expanding our activities to new country members of the Gaborone Declaration for Sustainability in Africa.

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

The goal of this work is to examine and quantify the likelihood of predicted changes in Tundra-Taiga Ecotone (TTE) forest structure patterns occurring within the ABoVE extended domain, using airborne imagery and lidar observations, site-scale (i.e., high resolution spatially-explicit individual-based) forest and tundra vegetation modeling and a Landsat-derived map of the extent & pattern of the TTE. Using the mapped extent of the TTE to spatially guide our modelling, the specific project objectives are to 1) parameterize the spatially-explicit individual-based gap model SIBBORK for the TTE forest study sites using leveraged field data and forest structure derived from LVIS and GLiHT datasets; 2) improve permafrost, allometry routines, introduce litterfall and integrate the ArcVeg (tundra) model parameters into the SIBBORK (forest) model to extend the simulation domain across the full tundra-taiga boundary at the individual scale; 3) predict future forest and tundra productivity and ecotone location using CMIP6 projections; and 4) quantify the ability of the tree cover abruptness variable to predict patterns of TTE change.

Calibrated with an ABOVE airborne product (LVIS) and initialized with a Landsat-derived map, the modeling framework will deliver the first high resolution, spatially-explicit forest and tundra model that has the capability to model ecotone shift across the ABoVE study domain. The research aims to provide a deeper understanding of the current productivity dynamics along the TTE, and allow for informed prognostication about the shift in the extent of tree cover, and the spatial variability in the direction, rate, and magnitude of these shifts.

The first year of this project was focused on upgrading the team's spatially explicit individual-based gap model, SIBBORK-TTE, to include permafrost and to be initialized using the ArcticDEM,

soil parameters derived from SoilGrids products, and with daily climate directly from MERRA2 climate data (from 1980-2016). The project team also worked to gather calibration/validation datasets to test their model updates, and utilizing CO-I Montesano's treeline abruptness map in selecting sites on which to focus their initial simulation tests. In the second year, they worked to leverage new datasets with which to parameterize and test the model upgrades from year one. They also worked to improve the ability to handle the large datasets that are created with each modeling run.

As part of her task, Dr. Armstrong has been serving as the co-Chair of the Applied Earth Observations Innovation Partnership (AEOIP) (February 2021-July 2022).

Starting in October, Dr. Armstrong will begin work on a NASA GSFC IRAD project, where the goal is to combine "SIBBORK" forest growth model with the "3-D Coherent SAR Model (3-D CSM)" and "Snow Microwave Radiative Transfer (SMRT)" model. While the SMRT model can generate SAR backscatter values for snow, it does not allow analysis of snow under canopy. SIBBORK can simulate individual trees over any terrain, providing realistic stem maps of forest canopy, which can then be converted into SAR backscatter through 3-D CSM. The overarching goal will be achieved in four steps: 1) Development of python extensions for 3-D CSM C/Fortran-code; 2) Combining SIBBORK with 3-D CSM Python; 3) Combining SMRT with 3-D CSM Python; and 4) Validation of results.

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

Dr. Elders's research in Code 618 focuses on using Earth Observing Systems and Machine Learning for Crop Monitoring. Earth Observing Systems are a powerful tool to estimate crop composition and yield in remote regions, particularly important for food security. Dr. Elders used moderate resolution Sentinel-2 and Random Forest models to estimate crop composition with as much as 88% accuracy in the rainy season in Burkina Faso. These machine-learning models were then leveraged to predict interannual crop composition in an uncalibrated approach, with 60% accuracy, which is important since data collection in these regions is often difficult and costly. This work was published in the August 2022 issue of Remote Sensing Applications Society and Environment.

Dr. Elders is also exploring the utility of more complex Machine learning algorithms, finding that Extreme Gradient Boosting trees can increase the skill 7% over Random Forest models using the same moderate resolution imagery as training data in the Dry season.

Upcoming plans include leveraging more complex machine learning algorithms in new agricultural perimeters to evaluate their skillfulness in estimating crop composition and yield.

Name: Thomas Eck
Sponsor: Lahouari Bounoua
Code: 618
Task: 085

Mr. Eck performed sun channel calibrations utilized for measurement of AOD for the NASA/GSFC portion of the AERONET global network. He also contributed to analysis of extended wavelength retrievals of aerosol single scattering albedo with the application of relaxed constraints on the spectral variation of the imaginary refractive index. This resulted in a related article. Additionally, he participated in analysis of various techniques for the calibration of sky radiance measurements including the vicarious technique, sky radiance target technique (under low AOD conditions), and the laboratory measurements made at the World Radiation Center in Davos, Switzerland.

Mr. Eck as co-author has submitted a paper titled "A Global Evaluation of Daily to Seasonal Aerosol and Water Vapor Relationships Using a Combination of AERONET and NAAPS Reanalysis Data" to Atmospheric Chemistry and Physics. Two other manuscripts will be submitted for Peer Review in Atmospheric Environment, the first as lead author, the second as co-author: **"**The extreme forest fires in California/Oregon in 2020: Aerosol optical and physical properties and comparisons of aged versus fresh smoke" and "Relationship between the sub-micron Fraction (SMF) and fine mode fraction (FMF) : case of AERONET retrievals."

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

Throughout the reporting period, Dr. Campbell contributed to three ROSES proposals, which were submitted, one of which has been funded. Another proposal has also been funded, on which he is Science PI. Dr. Campbell attended the Living Planet Symposium, sharing project-related research as part of an oral session. Progress on all projects was made with work mapping bathymetry with country-wide maps completed for Liberia and IceSAT-2 data processed for Senegal and Mozambique.

Upcoming plans include fieldwork in the Everglades (October 16-23) as well as work on a paper for Nature as first author.

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). Dr. Huemmrich leads an effort funded by the NASA Commercial Smallsat program to combine commercial spectral imaging from the DLR Earth Sensing Imaging Spectrometer (DESIS) 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.

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. He represents the remote sensing land community in the SAT and is working to define potential terrestrial products from PACE.

In the coming months, work will continue on a new task that supports the Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System (CASALS) project. Dr. Huemmrich will work

on producing datasets combining hyperspectral imagery, lidar canopy structure descriptions, and eddy covariance flux tower observations for training and testing of machine learning approaches for describing forest function. (Note, the PACE activities have been enhanced with extra funding and will be spun off into a separate task. Dr. Huemmrich will lead a group including; Dr. Petya Campbell (UMBC), Dr. Joanna Joiner (NASA/GSFC), and Dr. Yasuko Yoshida (SSAI), developing PACE terrestrial products using existing ground, aircraft, and satellite data to develop and evaluate algorithms.) Additionally, Dr. Huemmrich is teaching Arctic Geography GES 301 at UMBC this fall.

II. Supplemental Information

Awards & Recognition

Ivona Cetinić (616/MSU) was recognized with a NASA Robert H. Goddard Award for Exceptional Achievement for Science – EXPORTS Project Science Team.

Ivona Cetinić (616/MSU) also received a NASA Robert H. Goddard Award as part of the PACE Science Algorithm Team.

Ivona Cetinić (616/MSU) additionally received a NASA Group Achievement Award for her role with the EXPORTS Project Office.

Nayeong Cho (613/UMBC) received a NASA GSFC Climate and Radiation Laboratory Award for Best First-Authored Paper.

Robert Emberson (617/UMBC) was recognized with a 2022 Robert H. Goddard Award for Science.

Robert Emberson (617/UMBC) also received a NASA GSFC Hydrosphere, Biosphere, and Geophysics (HBG) Annual Peer Award: Best Publication - First Author Non-Civil Servant.

Denis Felikson (615/MSU) was recognized with a Hydrosphere, Biosphere, and Geophysics (HBG) Annual Peer Award for Scientific Achievement.

Sujung Go (613/UMBC) received an award for Outstanding Scientific Support from the NASA GSFC Climate and Radiation Laboratory.

Jie Gong (613/UMBC) received a Scientific Leadership Award from the Climate and Radiation Lab, NASA GSFC.

Sergey Korkin (613/UMBC) received a NASA GSFC Climate and Radiation Laboratory Scientific Achievement Award for Best First-Authored Paper.

Fadji Maina (617/UMBC) was listed among the 25 Outstanding African Women Scientists by the United Nations Economic Commission for Africa, 2022: https://www.africanwomenscientists.com.

Violeta Sanjuan Calzado (616/UMBC) received a Robert H. Goddard Award for Exceptional Achievement for Science as part of the PACE Project Science Team.

Andrew Sayer (616/UMBC) was recognized with a Robert H. Goddard Honor Award as part of the PACE Science Algorithms Team.

Bridget Seegers (616/MSU) received a Robert H. Goddard Award for Science for her role in the CyAN Team.

Bridget Seegers (616/MSU) also received a Robert H. Goddard Award as part of the PACE Project Science Team.

Jackson Tan (613/UMBC) was recognized with a 2022 Robert H. Goddard Honor Award for Science.

Outreach

Amanda Armstrong (618/UMBC) gave a presentation as part of Ask an Expert Outreach: How NASA Analyzes Tree Growth, presented to Brooklyn High School students: https://www.youtube.com/watch?v=B8iV-AHE1F8.

Nishan Biswas (617/UMBC) and Thomas Stanley (617/UMBC) presented the methodology for LHASA-Mekong, a landslide hazard model for the Lower Mekong Region, to staff from the Asian Disaster Preparedness Center and SERVIR.

Nishan Biswas (617/UMBC) and Thomas Stanley (617/UMBC) led a virtual hackathon entitled "Satellite Observations and Tools for Landslide Monitoring and Forecasting" for the Thai Department of Mineral Resources, July 26-27, 2022.

Nishan Biswas (617/UMBC), Robert Emberson (617/UMBC), and Thomas Stanley (617/UMBC) taught Online Regional LHASA 2.0 Training on Satellite Observations and Tools for Landslide Monitoring and Forecasting. The training introduced key stakeholders to the Landslide Hazard Assessment for Situational Awareness (LHASA) system version 2.0 and related topics, including Google Earth Engine and XGBoost (August 23-25, 2022). Participants gained hands-on experience in setting up and operating a system for landslide forecasting.

Robert Emberson (617/UMBC) mentored intern Allisen Case, NASA Applied Sciences, in the Summer and will continue in upcoming Fall semester.

Denis Felikson (615/MSU) virtually supervised two summer NASA interns: one undergraduate student and one graduate student.

Denis Felikson (615/MSU) and Dr. Steven Fons (Cryospheric Sciences Laboratory, NASA GSFC) gave a virtual public talk via the Wildling Museum's Fire & Ice series, titled *A Precise Look at Ice: Measuring the Earth's Cryosphere with Centimeter Accuracy from Space* (available here).

Jie Gong (613/UMBC) is serving as an advisor to intern Linkai Wu of Montgomery Blair High School in Maryland. They have researched eclipse-generated gravity waves in satellite images and submitted an abstract for AGU. She is also mentoring Yiding Wang, American University, Computer Science Major (Co-supervised with Prof. Leah Ding, American University). Their research is "Deep-learning Algorithm development for Precipitation Type Classification", and they have published a related paper and presented at a conference. Finally, Dr. Gong advised Hannah Woody, Montana State University, from March 2021 – May 2022. They worked on "Eclipse-driven gravity wave analysis and source ray-tracing for December 2020 total solar eclipse", which resulted in a poster presentation at AGU.

Jie Gong (613/UMBC) has served as a 610 Mentoring Program coordinator from Sept 2021 to present. She has been part of the AoS Pre-Phase A study team since June 2021 and served as the seminar coordinator for Climate and Radiation Lab until August 2022. She also presented at Career Day events for K-12 public schools in May 2022.

Daeho Jin (613/UMBC) presented "Introduction of NASA GSFC and the life of NASA earth scientist" to Hansung Science High School, Seoul, Korea on August 22, 2022.

Ryan Kramer (613/UMBC) is serving on the PhD committee of Haozhe He, University of Miami (present).

Ryan Kramer (613/UMBC) is an Organizing Committee member for the Annual AMS Speed Networking Event.

Since 2021, **Carl Malings** (610.1/MSU) has volunteered with Community Scientist for the AGU Thriving Earth Exchange.

Carl Malings (610.1/MSU) was a volunteer moderator for the virtual NASA Earth Day event chat, April 22, 2022.

Carl Malings (610.1/MSU) was a volunteer judge for the 2022 GLOBE International Virtual Science Symposium student contest, April 2022. He also was a volunteer judge for the 2022 NASA's Power to Explore Student Challenge, May 2022.

Nikki Privé (610.1/MSU) gave a seminar titled "Revealing Data Assimilation Issues with the GMAO OSSE" to graduate students at the University of Maryland College Park on December 6, 2021.

Celio Resende de Sousa (618/UMBC) served as Co-Advisor to Valeria Ribeiro, a MSc. Student from the University of Bahia, Brazil. Ms. Ribeiro defended her thesis on January 2022.

Jason St. Clair (614/UMBC) worked closely with a graduate student, James Campbell, at U. Alaska Fairbanks on a project to measure and analyze formaldehyde data in wintertime Fairbanks. Dr. St. Clair taught him how to operate two Goddard formaldehyde instruments and guided him through making measurements during the ALPACA campaign in Jan/Feb 2022. They have subsequently worked together on analyzing the data, and he presented some of the findings at the August 2022 ALPACA data meeting at Johns Hopkins University.

Andrew Sayer (616/UMBC) co-mentored with Ian Carroll (616/UMBC) two students working to support cloud masking from the PACE mission: Taha Al-Nufaili, an undergraduate student at UMD College Park, during a summer internship, and Xingyan Li, a PhD student at UMBC (supervised by Dr. Jianwu Wang), as part of a GESTAR II Graduate Fellowship.

Andrew Sayer (616/UMBC) served as a mentor in NASA GSFC's Mentoring Circle program, which brings together GSFC employees of different career paths and experience levels in small groups. The goal is to bring pairs of mentors with groups of less senior employees to better understand the challenges each faces and to offer practical suggestions on how to address these.

Andrew Sayer (616/UMBC) also continues as a volunteer tutor for low-income children with Northstar Tutoring (https://www.northstartutoring.org/) at a local Teen Center.

Bridget Seegers (616/MSU) was a panelist during an Earth to Sky workshop for teachers in Idaho. The goal was to connect educators with scientists to break down some of the "ivory tower", between our educators and researchers.

Bridget Seegers (616/MSU) was a science advisor for NASA DEVELOP, December 2021 – August 2022. She was a co-advisor for five students on a project titled "Maine Ecological Forecasting: Using NASA Earth Observations to Assess Federally Endangered Atlantic Salmon Habitat in Maine." DEVELOP is part of NASA's Applied Sciences Capacity Building Program.

Bridget Seegers (616/MSU) presented to first- and third-grade students at Silvergate Elementary School, San Diego, CA, in May 2022.

Yingxi Shi (613/UMBC) presented "Aerosol remote sensing from space", a Student Airborne Science Activation (SaSa) Internship GSFC Earth Science Tour Introduction talk, at the NASA GSFC Visitor Center, Greenbelt, MD, June 9, 2022.

Inia Soto Ramos (616/MSU) gave a virtual seminar titled "My journey from the mountains to the ocean; from the microscope to space" to attendees at the Environmental Policy and Metrology Master's program (EMAP) at Georgetown University on February 17, 2022.

Inia Soto Ramos participated in NASA Earth Day 2022 at Union Station as part of the PACE mission: https://pace.oceansciences.org/blog.cgi?id=13.

Media/Communication

Pukar Amatya was among the Early Career Scientist Spotlights on September 1, 2022: https://science.gsfc.nasa.gov/600/ECSS/Pukar-Amatya.html.

Henrique Barbosa's paper in PNAS was featured on EurekAlert! Less rain in the rainforest: Amazon even more vulnerable than previously thought, https://www.eurekalert.org/news-releases/960954

Niama Boukachaba was featured in the NASA's Early Career Scientist Spotlight for January 2022.

Blake Clark was part of a research highlight through the NASA Center for Climate Simulation: https://www.nccs.nasa.gov/news-events/nccs-highlights/yukon-river.

Allison Collow's research was featured in an NCCS User Spotlight, March 23, 2022: https://www.nccs.nasa.gov/news-events/nccs-highlights/user-spotlight-collow.

Her research was featured in a GMAO Snapshot: The Detection of Atmospheric Rivers in Reanalyses and its Influence on Precipitation, posted July 2022: https://gmao.gsfc.nasa.gov/research/science_snapshots/2022/reanalyses_AR.php

Her research was also conveyed in a visualization: A 3-D view of an Atmospheric River from an Earth System Model, posted January 25, 2022, https://svs.gsfc.nasa.gov/4960

Also, Allison Collow's research was selected as an Editor Highlight: Comparing Methods for Analysis of Atmospheric Rivers, posted July 4, 2022: https://eos.org/editor-highlights/comparing-methods-for-analysis-of-atmospheric-rivers.

Jie Gong was featured in NASA Goddard's social media during the 2022 AANHPI month:

Facebook: https://www.facebook.com/NASAGoddard/posts/380064994164471

LinkedIn: https://www.linkedin.com/feed/update/urn:li:activity:6932754182969982976

Twitter: https://twitter.com/NASAGoddard/status/1526988492152221703

Hiren Jethva contributed to an article about a middle-east dust storm in Washington Post (May 26, 2022): https://www.washingtonpost.com/world/2022/05/26/sand-storms-middle-east-climate-change/.

Hiren Jethva was interviewed and cited for a NASA Earth Observatory Image Of The Day (IOTD) article (Jan 25, 2022): https://earthobservatory.nasa.gov/images/149378/dust-storm-envelops-the-arabian-sea.

Bryan M. Karpowicz's research with K. Wargan was a GMAO snapshot in February 2022: Investigating the utility of hyperspectral sounders in the 9.6 μm Band to improve ozone analyses, https://gmao.gsfc.nasa.gov/research/science_snapshots/2022/O3_hyperspectral_sounders.php.

Emma Knowland's research was highlighted on March 16, 2022 on NASA social media (NASA Supercomputing Facebook and NASA_NCCS tweet) posts on the NCCS News Highlight, Using the Power of Global Air Quality Models and NCCS Supercomputing Resources, NYU and NASA Collaborators Create a Novel Index to Communicate Children's Respiratory Health Risk:

https://www.nccs.nasa.gov/news-events/nccs-highlights/respiratory-health?utm_source=TWITTER&utm_medium=NASA_NCCS&utm_campaign=NASASocial&linkId=156624363

Ryan Kramer was interviewed by the Washington Post for a story on the climate impacts of water vapor injected into the atmosphere by the Hunga Tonga volcano (July 2022): https://www.washingtonpost.com/climate-environment/2022/08/05/volcano-eruption-tonga-record-climate/.

Ryan Kramer also was interviewed by WUSA9, DC's CBS affiliate for TV segment on the human causes of climate change (February 2022): https://www.wusa9.com/article/tech/science/environment/dnp-yes-humans-are-contributing-to-climate-change-global-warming-greenhouse-gas-emissions/65-8a6e9b6a-faa2-4560-80a3-cfcfbadf56f5.

Fadji Maina was featured in two online articles: Earth, Ocean, and Skies, insight from selected outstanding African women scientists and One scientist's journey from Niger to NASA.

Bridget Seegers gave NASA temperature release and Earth Day "live shot" interviews in January and April 2022. She gave 12 interviews to media outlets across the country to discuss NASA earth and climate science and what Earth Day means to NASA. Live shots are an important part of NASA's outreach strategy to connect NASA scientists with people.

Selected interviews from "live shots":

https://www.cbs8.com/video/news/local/celebrating-earth-day-with-a-nasa-scientist/509-44f49b83-3639-4bb5-8baa-2c0e136aab4a

https://www.wired.com/story/the-world-was-cooler-in-2021-than-2020-thats-not-good-news/

https://www.wbez.org/stories/they-study-earth-so-what-has-nasa-learned-about-the-climate-crisis/87759f76-0bb7-41b2-b609-7574ed0580cc

She also participated in a NASA TwitterSpaces live event for Earth Day to talk about how we study Earth: https://twitter.com/nasaearth/status/1517202958055710721.

Bridget Seegers was featured in an Ebook STEM Connector project that focused on scientist and the environment: https://www.stemconnector.com/download-resource/environmental-sustainability-is-stem.

Susan Strahan worked with Communications staff at the New Zealand National Institute of Water and Atmospheric Research (NIWA) on a press release on recent publication. The publication had many NIWA co-authors. The topic was the effect of the 2020 Australian wildfire on stratospheric chemistry and ozone: 2020 Australian wildfires reveal significant hole in our understanding of ozone | NIWA.

Susan Strahan worked with journalist Kasha Patel of The Washington Post, contributing to her article on the stratospheric chemical impacts of the Hunga Tonga volcanic eruption: Tonga volcano blasted unprecedented amount of water into atmosphere - The Washington Post.

Andrew Swanson provided an interview for Purdue University's Superheroes of Science media group while working on the NASA DCOTSS field campaign in Salina, KS, on June 9, 2022.

During this 15-minute recorded segment, Mr. Swanson discussed the engineering process and experience he had designing and developing the GSFC In Situ Lab's CAFE and CANOE instruments, which were two of the lab's instruments utilized for the campaign. The Superheroes of Science is a part of Purdue University's College of Science, which provides educational and development opportunities for teachers and learning experiences for students.

Ghassan Taha contributed to an Earth Observatory Item of the Day related to the Hunga-Tonga Volcano Plume, 16 February 2022. https://earthobservatory.nasa.gov/images/149474/tonga-volcano-plume-reached-the-mesosphere?src=eoa-iotd.

Ghassan Taha was interviewed by the German public radio about the Hunga-Tongs Volcanic eruption on January 18 2022. https://www.deutschlandfunk.de/tonga-vulkan-klima-auswirkung-100.html

Ghassan Taha was interviewed by a fact-checking journalist with AFP (Agence France-Presse) news agency regarding social media posts sharing misinformation about the Hunga-Tonga volcanic eruption on January 15.

Natalie Thomas was part of the research team with Allison Collow for this visualization: A 3D View of an Atmospheric River from an Earth System Model (Authors: Allison Collow, Natalie Thomas, Michael Bosilovich; Lead Visualizer: Greg Shirah; Lead Producer: Jefferson Beck), https://svs.gsfc.nasa.gov/4960, 25 January 2022.

Anne Thompson contributed to the July 2022 SPARC Newsletter: A. M. Thompson (UMBC), R. M. Stauffer, D. E. Kollonige, K. Wargan, "Tropical Ozone Trends (1998-2019) from SHADOZ Sondes: A Definitive Reference for LOTUS Analyses," https://www.sparc-climate.org/publications/newsletter/sparc-newsletter-no-59/.

Anne Thompson also co-authored an article to appear in the Sept-Oct 2022 issue of "Earth Observer:" R. M. Stauffer, A. M. Thompson (UMBC), D. E. Kollonige, N. M. Fedkin, "SCOAPE: NASA tracks offshore oil and gas pollution with satellite and ship cruise measurements," Earth Observer, Sept.-Oct. 2022.

Brad Weir was quoted in a New Scientist article about monitoring CO_2 emissions: https://www.newscientist.com/article/2317175-we-can-now-tell-how-much-co2-in-the-air-is-due-to-fossil-fuel-burning/.

Reviewer Activities and Training

Reviewer Activities

Daniel Anderson reviewed two papers for Atmospheric Chemistry and Physics, one for Environmental Science and Technology, and one for Scientific Reports.

Amanda Armstrong reviewed three publications for Ecological Modelling and two for Remote Sensing of the Environment. She serves as Subject Editor for Ecological Modelling. Additionally, she is serving as a guest editor for Remote Sensing of the Environment for a Special Issue.

Lionel Arteaga reviewed one paper each for these journals: Communications Earth and Environment, JGR-Oceans, and one for Elementa: Science of the Anthropocene.

Henrique Barbosa co-edited eight manuscripts for Brazilian Journal of Meteorology, two manuscripts for Acta Amazonica, and one for Frontiers in Earth Science. He also reviewed one paper for JGR-Atmos (AMS), one for Atmosphere (MPDI), and one for Remote Sensing (MPDI).

Virginie Buchard reviewed one publication for Journal of Advances in Modeling Earth Systems.

Anthony Campbell reviewed two papers for Environmental Research Letters and one paper for Estuarine, Coastal and Shelf Science. He served as Associate Editor for All Earth for two papers and a Special Issue. He also reviewed a STEREO proposal for the Belgian Space Agency.

Ian Carroll reviewed one manuscript for Regional Studies in Marine Science.

Myungje Choi reviewed one publication for Remote Sensing of Environment and two publications for Atmospheric Environment.

Blake Clark reviewed two NSF proposals as well as one paper for Progress in Oceanography and one for Ocean Modelling.

Allison Collow reviewed one paper each for the Journal of Hydrometeorology, Journal of Climate, Journal of Geophysical Research – Atmospheres, and Journal of Applied Meteorology and Climatology.

Paolo de Matthaeis reviewed two articles for IEEE Transactions on Geoscience and Remote Sensing (TGRS) and one for IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (J-STARS).

Thomas Eck performed peer review for publications in the following scientific journals: Atmospheric Chemistry and Physics, Journal of Geophysical Research - Atmospheres, Nature Communications, Atmospheric Environment, and ACS Earth and Space Chemistry. He continued to serve as an Associate Editor for the journal Atmospheric Measurement Techniques.

Robert Emberson reviewed one paper each for Landslides, Earth and Planetary Surface Processes, Geochimica et Cosmochimica Acta, and Earth Science Reviews. He also reviewed three proposals for JCET/UMBC.

Denis Felikson reviewed two publications for Nature Climate Change and the Journal of Glaciology.

Manisha Ganeshan reviewed two publications for Journal of Geophysical Research-Atmospheres.

Jie Gong reviewed nine journal manuscripts for Geophys. Res. Letters, Remote Sensing of Environment, BAMS, Remote Sensing, and ACP. She reviewed 11 proposals for three programs and served on one NASA panel.

Fred Huemmrich reviewed papers for Geophysical Research Letters and Remote Sensing of Environment.

Hiren Jethva served as an Associate Editor in the Journal of Atmospheric Measurement Techniques.

Daeho Jin reviewed one publication for Geophysical Research Letters.

Christoph Keller reviewed four publications (JAMES, EST, Frontiers, and TLPBLH), and served on two proposal review panels (NOAA OARWPO and NASA A49).

Dongchul Kim reviewed four publications for JGR-Atmos, BAMS, CLDY, as well as one PhD thesis for Pune University.

Emma Knowland reviewed two publications for Geoscientific Model Development (GMD), and she participated in one NASA ROSES proposal review panel.

Sergey Korkin commented on one full length article and one short communication article, both submitted to Journal of Quantitative Spectroscopy and Radiative Transfer.

Feng Li reviewed one publication for Journal Climate, and he reviewed a proposal for NSF.

Jin Liao reviewed one publication for GRL and one for ACS Earth and Space Chemistry.

Fei Liu reviewed two publications for ACP, one for AMT, one for Nature Communication, and two for Remote Sensing of Environment.

Junhua Liu reviewed one paper for the journal Remote Sensing of Environment.

Fadji Maina reviewed 13 papers for the following journals: Geophysical Research Letter, AMBIO, Journal of Hydrometeorology, Communication Earth and Environment, One Earth, Frontiers in Water, James, and Frontiers in Climate. In professional service, Dr. Maina served as an NSF Panelist (2022), a User Working Group Member of NSIDC, and a Jury Member of the UNESCO-Al Fozan Prize for the Promotion of Young Scientists in STEM, 2022-present.

Carl Malings reviewed three publications for MDPI-Remote Sensing, three publications for MDPI-Atmosphere, and one publication each for MDPI-Sustainability, AGU-Geohealth, EGUsphere, Atmospheric Measurement Techniques, Building and Environment, Environmental Pollution, Applied AI Letters, and Springer Scientific Reports. He also served on a NASA ROSES proposal review panel, May 16-18, 2022.

Priscilla Mohammed-Tano reviewed five papers for the IEEE International Geoscience and Remote Sensing Symposium.

Jinzheng Peng reviewed one publication for TGRS which has been accepted for publication later.

Nikki Privé reviewed publications for Monthly Weather Review and Meteorology.

Chamara Rajapakshe reviewed four papers for MDPI-Remote sensing, one paper for ELSEVIER-Remote sensing of Environment, two papers for MDPI-Environmental Research and Public Health, and one paper for AMS-Journal of Applied Meteorology and Climatology.

Andrew Sayer reviewed 23 papers for international peer-reviewed journals, including: seven for Atmospheric Chemistry and Physics, four for Atmospheric Environment, one for Applied Optics, two for Atmospheric Pollution Research, two for Atmospheric Research, one for the Egyptian Journal of Remote Sensing and Space Sciences, one for Frontiers, two for Geophysical Research Letters, one for Remote Sensing of Environment, one for IEEE Transactions on Geosciences and Remote Sensing, and one for Remote Sensing Letters. He continues to serve on the editorial board of Atmospheric Measurement Techniques.

Yingxi Shi reviewed seven publications for Remote Sensing, Remote Sensing Environment, Frontiers in Earth Science, Earth System Science Data (ESSD), Journal of Selected Topics in Applied Earth Observations and Remote Sensing (JSTARS), and Atmospheric Measurement Techniques (AMT).

Inia Soto Ramos reviewed one article for Journal of Sea Research and also was part of a NASA proposal review panel.

Thomas Stanley reviewed papers for the following journals: Geomorphology, Catena, Applied Artificial Intelligence, Scientific Data, and Landslides.

Susan Strahan reviewed one manuscript for the Journal of Geophysical Research Atmospheres and one for Geophysical Research Letters. She also reviewed the Polar Ozone chapter of the 2022 WMO Scientific Assessment of Stratospheric Ozone report.

Sarah Strode reviewed papers for Atmospheric Chemistry and Physics, JGR-Atmos., and Atmospheric Environment.

Ghassan Taha reviewed one publication for Science. Ali Tokay reviewed a paper for Journal of Atmospheric Sciences.

Jackson Tan reviewed two manuscripts for Journal of Hydrology, two manuscripts for Remote Sensing, one manuscript for Scientific Reports, one manuscript for Scientific Advances, one manuscript for Atmospheric Research, and one manuscript for Journal of Climate.

Zhining Tao reviewed two manuscripts each for Atmospheric Chemistry and Physics and Environmental Pollution.

Natalie Thomas reviewed two publications for GRL, one for Journal of Climate, one for Weather and Climate Extremes, and one for Nature Reviews.

Anne Thompson reviewed manuscripts for Bulletin of the Am. Meteorological Society (BAMS), Atmospheric Chemistry & Physics, and Nature Research Reports.

Tamas Várnai reviewed seven manuscripts for Remote Sensing, plus one each for Remote Sensing of Environment, J. Quant. Spectr. Rad. Transfer, JGR-Atmos, and Remote Sensing Applications: Society and Environment.

Chenxi Wang reviewed four publications for Remote Sensing of Environment, one for J. Climate, two for Remote Sensing, one for J. of Applied Meteorology and Climate, and two for JGR-Atmos.

Yujie Wang served as reviewer for following journals: Frontiers in Earth Science, Remote Sensing, Atmospheric Research, Atmospheric Environment, and Environmental Pollution.

Brad Weir reviewed one publication for Journal of Advances in Modeling Earth System (JAMES) and one for Atmospheric Measurement Techniques (AMT).

Xiaoguang Xu reviewed two publications for Remote Sensing of Environment, one for Frontiers in Remote Sensing, and one for Remote Sensing.

Yaping Zhou reviewed three proposals for the JCET fellowship 2022 and a total of eight papers: two for Journal of Atmospheric Science, one for Atmospheric Measurement and Technology, three for Remote Sensing Environment, and one for Geophysical Research Letters.

Training/Certificates

Dirk Aurin completed the following SATERN trainings: Cybersecurity and Privacy Awareness Training; Counter Threat Awareness Training; GSFC and HQ Property Accountability Training. He also completed SATERN Fall Protection Authorized User and SATERN Module 1: NASA's Export Control On-the-job Training as well as Comtrain 4th Edition Authorized Climber/Rescuer #25884-76308-1.

Niama Boukachaba virtually attended the MSU's cybersecurity awareness training and Sexual Harassment Training. Dr. Boukachaba also completed NASA's training courses: Cybersecurity and Privacy Awareness, GSFC-Building Emergency Plan Annual Refresher, GSFC-Building Emergency Plan (BEP) for New Employees, and GSFC and HQ Property Accountability.

Ian Carroll has completed three required SATERN trainings, one optional SATERN training (Bystander Intervention Workshop), and he earned UMBC's PIRATE certificate.

Denis Felikson completed four NASA SATERN trainings: Export Control, Cybersecurity, Property Accountability, Building Emergency Plan.

Manisha Ganeshan completed two SATERN trainings: GSFC And HQ Property Accountability Training and Cybersecurity And Privacy Awareness Training. Dr. Ganeshan also completed MSU's Sexual Harassment Training.

Jie Gong completed UMBC required training courses on implicit bias and microaggression awareness, making campus safe for LGBTQ+ students, Office of Equity and Inclusion Supplemental Employee Training, Title IX and Sexual Harassment Prevention for Employees, PI training. She also completed SATERN trainings on building emergency plan annual refresher, cybersecurity and privacy awareness, and property accountability.

Bryan Karpowicz completed the following required SATERN training: Cybersecurity And Privacy Awareness Training; GSFC And HQ Property Accountability Training; Mobile Device Management (MDM) User Agreement; GSFC Building Emergency Plan Annual Refresher.

Christoph Keller conducted all required SATERN trainings (5 total).

Emma Knowland completed two required NASA SATERN trainings and participated in the eVIZ and iVIZ tutorials held in May 2022.

Tom Kucsera completed several training courses: Cybersecurity and Privacy Awareness Training; Cybersecurity and Privacy Awareness Training for New Employees; GSFC Building Emergency Plan Annual Refresher; GSFC and HQ Property Accountability. He also completed IT Security for Systems Administrators – Intermediate Level; CompTIA Linux+ 2014 Powered By LPI: LX0-104 Security, Data, and Accessibility; IT Security for Systems Administrators – Beginning Level; Elevated Privileges on NASA Information Systems; and Securing UNIX Systems.

Fei Liu attended AI/Machine Learning tutorial held by the AI Center of Excellence https://ai.gsfc.nasa.gov and Sciences and Exploration Directorate (SED) 600 Task Group.

Junhua Liu completed the SATERN Cybersecurity And Privacy Awareness Training as well as the MSU Sexual Harassment training.

Erica McGrath-Spangler completed the SATERN training GSFC Building emergency plan and the SATERN training GSFC and HQ property accountability training.

Peter Norris completed all regular SATERN training (e.g., property accountability).

Jinzheng Peng completed and received certificates for these trainings: GSFC-Building Emergency Plan Annual Refresher, GSFC and HQ Property Accountability Training, and CyberSecurity and Privacy Awareness Training.

Jason St. Clair completed several SATERN training courses since Dec 2021: GSFC-Lab Manager; NASA Foreign National Escort Training Module; GSFC and HQ Property Accountability Training; Counter Threat Awareness Training; MAC OS Security; Elevated Privileges on NASA Information Systems; GSFC-Building Emergency Plan (BEP) for New Employees; GSFC-Building Emergency Plan Annual RefresherSarah Strode earned a certificate for completing NASA ARSET's "Atmospheric CO_2 and CH_4 Budgets to Support the Global Stocktake" webinar.

Violeta Sanjuan Calzado completed three trainings: Cybersecurity and privacy awareness training; GSFC Building emergency plan annual refresher; GSFC and HQ property accountability training.

Andrew Sayer completed all mandated NASA and UMBC trainings.

Bridget Seegers completed two NASA SATERN trainings: Cybersecurity and Privacy Awareness Training and GSFC and HQ Property Accountability Training.

Yingxi Shi finished all required and recommended SATERN and UMBC training courses.

Inia Soto Ramos completed five SATERN Training courses: GSFC and HQ property accountability training, NASA Foreign National Escort Training module, GSFC Building emergency plan, cybersecurity and privacy awareness. She also completed MSU's mandatory Sexual Harassment Training.

Thomas Stanley completed the following trainings: GSFC Building Emergency Plan Annual Refresher; GSFC and HQ Property Accountability, Cybersecurity and Privacy Awareness Training. He also completed Introduction to GeoPandas.

Stephen Steenrod completed SATERN trainings: GSFC-Building Emergency Plan Annual Refresher; Cybersecurity and Privacy Training; GSFC and HQ Property Accountability Training.

Susan Strahan completed all mandatory NASA trainings: Cybersecurity and Privacy Awareness, GSFC-Building Emergency Plan, and GSFC and HQ Property Accountability.

Sarah Strode completed the following SATERN trainings: GSFC Building Emergency Plan Annual Refresher, GSFC and HQ Property Accountability Training, and Module 1: NASA's Export Control On-The-Job Training (Introductory).

Andrew Swanson completed the following trainings: NASA Cybersecurity and Privacy Awareness Training; NASA Elevated Privileges on NASA Information Systems; NASA Microsoft Windows 10: Supporting Authentication, Permissions, and Data Security; GSFC Building Emergency Plan Annual Refresher; and GSFC and HQ Property Accountability Training.

Ghassan Taha completed the following SATERN Trainings: Cybersecurity And Privacy Awareness Training, NASA Foreign National Escort Training, and GSFC And HQ Property Accountability Training.

Jackson Tan completed the SATERN training courses: GSFC and HQ Property Accountability Training, GSFC-Building Emergency Plan Annual Refresher, and Cybersecurity and Privacy Awareness Training. He also completed mandatory UMBC training courses: Implicit Bias and Microaggression Awareness, Making Campus Safe for LGBTQ+ Students, and Office of Equity and Inclusion Supplemental Employee Training.

Zhining Tao earned the certificates for these SATERN trainings: GSFC and HQ Property Accountability Training, GSFC-Building Emergency Plan Annual Refresher, and Cybersecurity and Privacy Awareness Training.

Anne Thompson completed two SATERN trainings: Cybersecurity and Privacy Awareness, GSFC-Building Emergency Plan.

Yaping Zhou completed two SATERN trainings: Federal Records 101 and Cybersecurity and Privacy Awareness.

Jerry Ziemke completed all SATERN activities on time and with certificates.

Courses Taught

Andrew Sayer gave lectures on cloud remote sensing; uncertainty analysis; validation of spaceborne aerosol and cloud data sets; evaluation of pixel-level uncertainty estimates, at PACE Summer School, University of Maryland, Baltimore County, Summer 2022.

Amanda Armstrong taught a Remote Sensing Foundations course, University of Vermont, Summer 2022 (note, this was independent of her work with GESTAR II.)

Blake Clark co-taught a three-hour laboratory course with Dr. Cassie Gurbisz at St. Mary's University on using water quality modeling for Management in Chesapeake Bay. The course utilized a modeling system he has written into python and made publicly available at https://github.com/bclark805/pyICM.

Xiaoguang Xu taught a course at University of Maryland, Baltimore County, Physics and Chemistry of Atmosphere (PHYS335) in Fall 2021 and will again in Fall 2022.

III. Appendices

Publications:

Amatya, P., Kirschbaum, D., and **Stanley, T.** (2022). Rainfall-induced landslide inventories for Lower Mekong based on Planet imagery and a semi-automatic mapping method. *Geoscience Data Journal*, http://dx.doi.org/10.1002/gdj3.145.

Anderson, D. C., Follette-Cook, M. B., **Strode, S. A.**, Nicely, J. M., **Liu, J.**, Ivatt, P. D., and Duncan, B. N. (2022). A machine learning methodology for the generation of a parameterization of the hydroxyl radical. *Geosci. Model Dev.*, 15, 6341–6358, https://doi.org/10.5194/gmd-15-6341-2022.

Arteaga, L. A., Behrenfeld, M. J., Boss, E., Westberry, T. K. (2022). Vertical structure in phytoplankton growth and productivity inferred from Biogeochemical-Argo floats and the carbon-based productivity model. *Global Biogeochemical Cycles*, 36, e2022GB007389, https://doi.org/10.1029/2022GB007389.

Bi, J., **Knowland, K.E.**, **Keller, C.A.**, and Liu, Y. (2022). Combining Machine Learning and Numerical Simulation for High-Resolution PM2.5 Concentration Forecast. *Environmental Science & Technology*, 56 (3): 1544-1556, https://doi.org/10.1021/acs.est.1c05578.

Bittner, A., Cross, E., Hagan, D., **Malings, C.**, Lipsky, E., and Grieshop, A. (2022). Performance characterization of low-cost air quality sensors for off-grid deployment in rural Malawi. *Atmospheric Measurement Techniques*, https://doi.org/10.5194/amt-15-3353-2022.

Bruening, J.M., Fischer, R., Bohn, F.J., Armston, J., **Armstrong, A.H.**, Knapp, N., Tang, H., Huth, A. and Dubayah, R.O. (2021). Challenges to aboveground biomass prediction from waveform lidar. *Environmental Research Letters*.

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Presentations

Amatya, P., Landslide inventories for the Lower Mekong using Semi-Automatic Landslide Detection (SALaD) system and Planet imagery, Servir Applied Sciences Team exchange, virtual, May 10-12, 2022.

Amatya, P., Open-source techniques for automated landslide inventory generation for the Lower Mekong Region and the Hindu Kush Himalaya, AGU Fall Meeting, virtual, Dec 14, 2021.

Amatya, P., Rapid response landslide map generation using optical/SAR imagery and open-source tools, Puerto Rico tabletop scenario exercise, Anasco, Puerto Rico, May 20-25, 2022.

Anderson, D., Can we constrain tropical OH with satellite observations of its drivers?, University of Washington Atmospheric Sciences Departmental Seminar, virtual, May 9, 2022.

Armstrong, A. (lead), High Resolution Simulations of Forest Structure Project Heterogeneous Change Across the North American Taiga-Tundra Ecotone, 2021 AGU Fall Meeting, New Orleans, LA, virtual, Dec 13-17, 2021.

Armstrong, A. (lead), Vulnerability of the Taiga-Tundra Ecotone: Predicting the Magnitude, Variability, and Rate of Change at the Intersection of Arctic and Boreal Ecosystem, ABoVE STM 8 Talk, Fairbanks, AK, May 2022.

Arteaga L. (lead), Seasonal modulation of phytoplankton blooms in the Southern Ocean, Ocean Sciences Meeting, virtual, February 2022.

Arteaga, L. (lead), Impact of Pacific Ocean heatwaves on phytoplankton community composition, Global Modeling and Assimilation Office Theme Meeting, virtual, March 2022.

Arteaga, L. (lead), Impact of Pacific Ocean heatwaves on phytoplankton community composition, European Space Agency (ESA) Ocean Carbon from Space Workshop, virtual, February 2022.

Barbosa, H. M. J., Shallow-to-Deep Convection Transition in Amazonia from GOES and GoAmazon 2014/5 Observations, 3rd PAN-GASS Meeting: Understanding and Modeling Atmospheric Processes, Monterey, CA, July 25 - 29, 2022.

Barbosa, H. M. J**.,** The Amazon rainforest: environmental justice, politics, and science, Earth Day Symposium, April 22, 2022 (invited).

Boukachaba, N. (lead), Toward enhancing the use of IASI and CrIS surface-sensitive radiances over land in the NASA GMAO GEOS data assimilation framework, AMS Collective Madison Meeting, Topic: Satellite Applications for Hydrological and Land Science, Madison, WI, Aug 9, 2022.

Boukachaba, N. (lead), Improving the assimilation of IASI surface-sensitive radiances over land in the NASA GMAO GEOS data assimilation framework, AGU Fall Meeting, virtual, Dec 13-17, 2022.

Boukachaba, N. (lead), Toward improving the assimilation of IASI and CrIS radiances over land in the NASA GEOS, GMAO virtual science theme meeting, NASA GSFC, Feb 3, 2022.

Campbell, A., A review of Carbon Monitoring in Wet Carbon Systems using Remote Sensing, ABoVE Wetland Working Group, virtual, Aug 3, 2022.

Campbell, A., Mapping Aboveground Biomass and Carbon in Salt Marshes across the Contiguous United States, Living Planet Symposium, Bonn, Germany, May 25, 2022.

Cetinić , I. (lead), Chasing Carbon in North Atlantic, Ocean Sciences Meeting, virtual, Feb 28 – March 4, 2022.

Cetinić , I. (lead), EXPORTS North Atlantic, NASA hyperwall at Ocean Sciences Meeting, virtual, Feb 28 – Mar 4, 2022.

Cetinić , I. (lead), Sticky Wicket: Carbon for PACE, Ocean Carbon from Space, virtual, Feb 14-18, 2022.

Cetinić , I., Changing the Field Culture (AKA What Happens on Field Should Not Stay on Field), NASA GSFC, Code 616 Seminar Series, virtual, Jan 20, 2022.

Cetinić , I., Changing the Field Culture (AKA What Happens on Field Should Not Stay on Field), Center for Dark Energy Biosphere Investigations seminar series, virtual, Dec 3, 2021.

Cho, N. (lead), Combined analysis of coincident MODIS and ISCCP joint histograms for probing the differences in their respective cloud regime classifications, 2021 AGU Fall Meeting, virtual, Dec 13-17, 2021.

Clark, J.B., (lead), Assessing Carbon Properties in Coastal Waters with a New Observing System Testbed, Joint Ocean Sciences Meeting, virtual, Feb. 27-Mar. 4, 2022.

Clark, J.B., (lead), The Transformation and Export of Organic Carbon in the Yukon River Delta and Plume, Joint Ocean Sciences Meeting, virtual, Feb. 27-Mar. 4, 2022.

Collow, A., Aerosols in future reanalysis products from the GMAO, 37th CERES Science Team Meeting, virtual, April 27, 2022.

Collow, A., An Overview of ARTMIP's Tier 2 Reanalysis Intercomparison: Uncertainty in the Detection of Atmospheric Rivers and Their Associated Precipitation, 102nd Annual Meeting of the American Meteorological Society, virtual, Jan 27, 2022.

Collow, A., GEOS CAMP2Ex Reanalysis, CAMP2Ex Science Team Meeting, virtual, July 12, 2022.

Collow, A., The Vertical Distribution of Aerosols and Their Optical Properties in GEOS during CAMP2Ex, 102nd Annual Meeting of the American Meteorological Society, virtual, Jan 25, 2022 (invited).

Craig, S. E. (lead), Training data for Phytoplankton Community Characterization from Ocean Color. Ocean Sciences Meeting, virtual, Feb 24 – Mar 4, 2022.

de Matthaeis, P. (lead), Megaconstellations of Telecommunication Satellites and their Potential Impact on Remote Sensing, RFI 2022 Workshop, virtual, Feb 14-18, 2022, www.rfi2022.org.

de Matthaeis, P. (lead), Radio Frequency Interference Issues in Earth Observation and the Activities of the IEEE GRSS Frequency Allocations in Remote Sensing (FARS) Technical Committee to Address Them, ESA Living Planet Symposium (LPS) 2022, Bonn, Germany, May 23-27, 2022.

Elders, A., An Unlikely Pair Agriculture and Sea Ice: A Modelling Story, AICOE Seminar Series, virtual, January 2022.

Elders, A., Atmospheric Response to Sea Ice Decline and Sea Ice Representation in GISS ModelE, NASA GISS Cryospheric Sciences Seminar Series, virtual, May 2022.

Elders, A., Atmospheric Response to Sea Ice Decline, NASA Goddard Cryospheric Sciences Weekly Meetings, virtual, February 2022.

Elders, A., Estimating Crop Type and Yield in Burkina Faso, Biopsheric Sciences Seminar Series, virtual, January 2022.

Emberson, R., Moving from landslide hazard to exposure and risk: lessons learned and the view forward, AGU Fall Meeting 2021, virtual, Dec 13-17, 2021.

Emberson, R., NASA Applied Sciences Week: Landslides: Susceptibility & Exposure, virtual, August 2022.

Emberson, R., SERVIR Training: Landslide Susceptibility and Exposure, virtual, March 7-10, 2022.

Evans, K. (lead), Monitoring Nitrogen Dioxide during COVID-19 in over 300 Cities Using OMI Satellite Data, Abstract A, AGU 2021 Fall Meeting, New Orleans, LA, Dec 13-17, 2021.

Felikson, D. (lead), Bayesian calibration of ice sheet projections using gravimetry, altimetry, and velocity observations." NASA Goddard Institute of Space Science – Sea Level Rise Seminar, virtual, May 2022.

Felikson, D. (lead), Collaborative Sea-Level Science on NASA's Science Managed Cloud Environment: Toward an Earth Information System, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Felikson, D., Bayesian calibration of ice sheet projections using various observations leads to differences in sea-level rise probabilities." Georgia Institute of Technology – Glaciology Seminar, virtual, July 2022 (invited).

Felikson, D., Improving Sea-Level Rise Projections: Greenland and Antarctic Ice Sheet Model Ensemble Calibration Using Remote Sensing Observations, NASA New Investigators Program Lightning Talks, virtual, April 2022.

Felikson, D., The best way to constrain ice sheet projection uncertainty is … uncertain," NASA GSFC Sciences and Exploration Directorate Director's Seminar, virtual, August 2022.

Felilkson, D. (lead), Bayesian calibration of ice sheet projections using gravimetry versus altimetry lead to different probability distributions for sea-level rise, NASA Sea-Level Change Team Meeting, La Jolla, CA, May 2022.

Ganeshan, M. (lead), Study of Antarctic Boundary Layer Properties under Different Sky Conditions, AMS Collective Madison Meeting. AMS, August 2022.

Ganeshan, M. (lead)**,** Using CALIPSO and in-situ observations to establish the relationship between Antarctic planetary boundary layer structure and sky condition, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Go, S. (lead), Inferring iron oxides species content in atmospheric mineral dust from DSCOVR EPIC observations, 2021 AGU Fall Meeting, New Orleans, LA, Dec 13-17, 2021.

Gong, J. (lead), A GCM-Oriented and Artificial Intelligence Based Passive Microwave Diurnal Ice/Snow Cloud Retrieval Product using CloudSat/CALIPSO as the Baseline, AGU Fall Meeting, hybrid, Dec 13-17, 2021.

Gong, J. (lead), 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, Sept 2022.

Gong, J. (lead), A GCM-Oriented Synergistic Passive Microwave Diurnal Ice/Snow Cloud Retrieval Product using CloudSat/CALIPSO as the Baseline, IPWG meeting, Fort Collins, CO, June 2022.

Gong, J. (lead), A ML/AI Based GMI-only Precipitation Type Classification Algorithm, IPWG meeting, Fort Collins, CO, June 2022.

Gong, J. (lead), Passive Microwave Precipitation Type Classification Using Machine Learning – Results Comparison and Lessons Learnt, AGU Fall Meeting, hybrid, Dec 13-17, 2021.

Gong, J. (lead), Polarimetric measurements at microwave and sub-millimeter spectra – a new way toward connecting remote sensing to atmospheric dynamics, APOLO-3 meeting, Silver Spring, MD, Sept 2022.

Gong, J. (lead), Solar Eclipse Impact on Gravity Wave Generation and Propagation in the Lower Atmosphere, SPARC Gravity Wave Symposium, Germany, hybrid, March 2022.

Gong, J., Polarization Difference at infrared, sub-millimeter and microwave frequencies - a new way toward connect radiative transfer with atmospheric dynamics, Polarization lab seminar, University of Arizona, Aug 2022 (invited).

Han, M. (lead), A study of precipitation mean particle size with the GPM combined radar-radiometer algorithm, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Han, M. (lead), An Investigation of Supercooled Water Near the Top of a Cold Cloud Layer During the IMPACTS 2022 Feb 8th Flight, IMPACTS Science Team meeting, Boulder, CO, July 26-28, 2022.

Han, M. (lead), Investigation of Microphysics Properties with GPM and Aircraft Observations for IMPACTS, American Meteorological Society's 16th Conference on Cloud Physics, Madison, WI, Aug 8-12, 2022.

Jethva, H., Estimating Instantaneous Direct Radiative Effects of Absorbing Aerosols Above Clouds from UV Sensors, AMS Collective Madison Meeting: Joint with the 16th Conference on Atmospheric Radiation Challenges in the Understanding of Absorbing Aerosol and Its Impacts on Clouds, Radiation, and Climate, virtual, Aug 8-12, 2022.

Jethva, H., Retrieving UV-VIS Single-scattering albedo of Absorbing Aerosols above Clouds from Synergy of Airborne Sensors and A-train Satellites, 2021 AGU Fall Meeting, New Orleans, LA, virtual, Dec 13-17, 2021.

Jin, D., Large-scale convective systems identified by hybrid cloud-precipitation regimes and their modulations by MJO and QBO, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Karpowicz, B.M., Assessment of retrieved GMI emissivity over land, snow and sea ice in the GEOS system, AGU Annual Fall Meeting, virtual, Dec 12 - 16, 2021.

Kim, D., Spring dust in western North America and its interannual variability – Understanding the role of local and transported dust, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Knowland, K., Bridging the SAGE data gap: Toward a climate data product with ozone and water vapor data from NASA SAGE and Aura missions and NASA reanalyses, American Meteorological Society (AMS) 102nd Annual Meeting, virtual, Jan 27, 2022.

Knowland, K., NASA GEOS Aerosol DA System and $PM_{2.5}$, Committee on Earth Observation Satellites (CEOS) Atmospheric Composition Virtual Constellation AC-VC-18 meeting, virtual, March 14-18, 2022.

Knowland, K., NASA GEOS Composition Forecast System: "GEOS-CF", Interagency Arctic Research Policy Committee (IARPC) Atmospheric Composition Modeling in the Arctic: Chemistry and Transport Forecasts with GEOS-CF - Modeling Collaboration Team February Meeting, virtual, Feb 23, 2022.

Knowland, K., NASA GEOS Composition Forecast System: "GEOS-CF", TRACER-AQ Workshop, virtual, April 26-29, 2022.

Knowland, K., NASA GEOS Composition Forecast System: "GEOS-CF", US EPA Stratospheric Intrusion Working Group February Meeting, virtual, Feb 15, 2022.

Knowland, K., NASA GEOS Composition Forecast system: GEOS-CF, TEMPO Science Team Meeting, virtual, June 1-2, 2022.

Knowland, K., Supporting NASA missions with the GEOS Composition Forecast System, The 10th International GEOS-Chem Meeting (IGC10), St. Louis, MO, June 7-10, 2022.

Korkin, S., A practical guide to writing a radiative transfer code (new paper summary), PACE Science and Application Team (SAT) meeting, virtual, NASA Goddard Space Flight Center, March 18, 2022.

Korkin, S., Decoupling of atmosphere and surface using matrix operator method and radiative transfer code IPOL, 3rd Advancement of Polarimetric Observations (APOLO) Conference, virtual, Aug. 9-12, 2022.

Kramer, R. Intermodel spread in radiative forcing across climate drivers". AGU Fall Meeting, Dec 13-17, 2021.

Kramer, R. Using AIRS to diagnose radiative forcing and feedbacks on the hydrological cycle, 2022 NASA Sounders Science Team Meeting, NASA JPL, Pasadena, CA, May 8, 2022.

Kramer, R., In the red: how an imbalance in Earth's energy budget is warming the planet, Goddard Scientific Colloquium Series, virtual, March 30, 2022 (invited).

Kramer, R., Intermodel spread in radiative forcing across climate drivers, 3rd Tri-MIP-athlon Meeting, Dec 2021.

Kramer, R., Observations of the greenhouse effect can help validate satellite datasets, Workshop on Developing a Framework for Satellite Observations of Climate, Caltech, Pasadena, CA, August 16, 2022.

Kramer, R., Observing, interpreting, and modeling Earth's energy imbalance in a warming world, NOAA Geophysical Fluid Dynamics Laboratory, virtual, August 30, 2022 (invited).

Lamsal, L. (lead), Improved Nitrogen Dioxide Product from TROPOMI, 102nd AMS Annual Meeting, virtual, Jan 23-27, 2022.

Lamsal, L. (lead), Multi-Decadal Nitrogen Dioxide and Derived Products from Satellites (MINDS): Application to GOME, OMI, and TROPOMI, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Lee, E. (lead), Contributing Mechanisms to Skillful Seasonal Forecasts of Spring Carbon Uptake, AGU 2021 Fall meeting, virtual, Dec 16, 2021.

Lee, E., Seasonal-scale variability of land's carbon uptake: response to a regional drought and forecast skill, Seminar at the Hydrology & EcoClimate Lab, Department of Civil and Environmental Engineering, Yonsei University, Seoul, Korea, May 4, 2022.

Lee, J., Non-Gaussian PDFs of TOA SW Flux, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Lee, J., Probability Density Functions of TOA ShortWave Flux from CERES and MISR, Sun Climate Symposium, Madison, WI, May 2022.

Lee, J., Seasonal and Interannual Variability of Upper Mesospheric Carbon Monoxide's Migrating Diurnal Tide Component as simulated by SD WACCM X, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Li, F., Stratospheric ozone impacts Southern Hemisphere and Southern Ocean response to quadruped CO_2, 21st AMS Conference on Middle Atmosphere, Houston, TX, Jan 24-27, 2022.

Lim, Y.-K., MERRA-2 Ocean, GMAO's one-way coupled reanalysis, GMAO Science theme seminar, NASA GSFC GMAO, June 23, 2022.

Liu, F. (lead), A new method for inferring city emissions and lifetimes of nitrogen oxides from high-resolution nitrogen dioxide observations: A model study, AGU Fall Meeting, virtual, Dec 12-16, 2021.

Liu, F. (lead), A new method for inferring city emissions and lifetimes of nitrogen oxides from high-resolution nitrogen oxides from high-resolution nitrogen dioxide observations: A model study, AMS Annual Meeting, virtual, Jan 23-27, 2021.

Liu, J. (lead), Change in Tropospheric Ozone in the Recent Decades and its Contribution to Global Total Ozone, AMS meeting 2022, virtual, Jan 23 - 27, 2022.

Liu, J. (lead), Quantify tropospheric ozone trends and its contribution to global total ozone changes in the recent decades, AGU meeting 2021, New Orleans, LA and virtual, Dec 13-17, 2021.

Maina, F.Z., On the 21st century techniques to boost the achievement of groundwater related SDG targets, International Conference "Groundwater, key to the Sustainable Development Goals", virtual, 2022 (invited).

Maina, F. Z. (lead), Drivers of greening in High Mountain Asia: a multivariate analysis based on remote sensing data, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Maina, F.Z. (lead), Evaluation of the impacts of warming, greening, and irrigation on the surface albedo in High Mountain Asia, AMS Annual Meeting, virtual, 2022.

Malilngs, C., Air Quality Forecasting with NASA GEOS-CF, Presentation to Ghana EPA on behalf of Dr. Daniel Westervelt and Mr. Emmanuel Appoh, virtual, June 23, 2022 (invited).

Malings, C. (lead), Air quality forecasting at sub-city scale by combining models, satellites, and surface measures. Air Sensors International Conference, Pasadena, CA, May 11-13, 2022.

McGrath-Spangler, E. (lead), Impacts of Assimilating Geostationary Infrared Sounders within NASA's Observing System Simulation Experiment Framework, AMS's Collective Madison Meeting, Madison, WI, Aug 8-12, 2022.

McGrath-Spangler, E. (lead), Impacts of Geostationary Infrared Sounders within NASA's Observing System Simulation Experiment Framework, AMS Annual Meeting, virtual, Jan 23-27, 2022.

Mohammed, P. (lead), Radio Frequency Interference Study from 500 MHz to 2 GHz, RFI 2022, a workshop organized under URSI and in collaboration with and hosted by the European Centre for Medium-Range Weather Forecasts (ECMWF), virtual, Feb 14-18, 2022.

Peng, J., SMAP Radiometer Antenna Pointing Calibration, IGARSS 2022 Symposium, Kuala Lumpur, Malaysia, July 17-22, 2022.

Privé, N., Diminishing returns: how many GNSS-RO observations are 'enough'?, NASA Commercial Smallsat Data Acquisition program Lunch and Learn, virtual, July 25, 2022.

Resende de Sousa, C., The use of Earth Observations for Land Cover and mangrove Extent Mapping: Examples from West Africa, The Society for Conservation Geographic Information Systems Annual Conference, virtual, June 2022.

Resende de Sousa, C., The use of Earth Observations for Land Cover and mangrove Extent Mapping: Examples from West Africa, 10th Regional Coastal and Marine Forum, Saly, Senegal, March 2022.

Sanjuan Calzado, V., NOMAD v3.0. Supporting PACE validation activities, Water Quality Validation Workshop, University of Wisconsin Madison, June 8, 2022.

Sanjuan Calzado, V., NOMAD v3.0: supporting PACE mission for validation and algorithm development, Ocean Sciences Meeting, March 1, 2022.

Seegers, B., CyAN: Getting Near Real Time Data to You, New Jersey HAB Summit, virtual, March 2022.

Seegers, B., Plankton, Space, Earth, and Us, TEDx Miami, Miami, FL, May 19, 2022.

Seegers, B., Success stories of apps, trainings, and engagement: Getting near real time data to water managers monitoring for cyanobacteria blooms, Virtual Ocean Sciences Meeting, Feb 2022.

Shi, Y. (lead), Evaluating aerosol retrievals from LEO and GEO orbits: A step towards consistent global aerosol data records, AGU Fall Meeting, Dec 2021.

Shi, Y**.** (lead), Using Geostationary aerosol products to characterize the Spatial and Temporal Variabilities in Biomass Burning Emissions During FIREX_AQ Field Campaign, AGU Fall Meeting, New Orleans, LA, virtual, Dec 13-17, 2021 (invited).

Stanley, T. (lead), Using remotely sensed information to support landslide hazard and exposure assessment throughout the disaster lifecycle, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Strahan, S., Repartitioning of Extratropical Stratospheric Inorganic Chlorine Reservoirs after the 2020 Australian Wildfires, American Meteorological Society annual meeting, virtual, January 25, 2022.

Strahan, S., Repartitioning of Extratropical Stratospheric Inorganic Chlorine Reservoirs after the 2020 Australian Wildfires, NASA GSFC Code 614 Lunch and Learn seminar, virtual, Feb 17, 2022.

Strode, S., Tools for Analyzing NASA Air Quality Model Output, NASA ARSET training, virtual, March 1, 2022.

Taha, G. (lead), The Ozone Mapping and Profiler Suite (OMPS) Limb Profiler (LP) Global 3-D View of the Aerosol Extinction in the Upper troposphere/ Lower stratosphere (UT/LS), AGU Fall meeting, New Orleans, LA, virtual, Dec 13-17, 2021.

Taha, G. (lead), Tracking the January 2022 Hunga-Tonga aerosol cloud using space-based observations, 3rd International Workshop on Stratospheric Sulfur and its Role in Climate (SSiRC), University of Leeds, U.K., May 16-18, 2022 (invited).

Taha, G., The Ozone Mapping and Profiler Suite (OMPS) Limb Profiler (LP) Global 3-D View of the Stratospheric Aerosol, Center for Atmospheric Research and Education, Hampton University, April 6, 2022 (invited).

Tan, J., A Convective or Stratiform Prototype Scheme for IMERG, 10th Workshop of the IPWG, Ft. Collins, CO, June 13-17, 2022.

Tan, J., Are You Using the Correct Type of Satellite Precipitation Product? Knowing the Difference between CDRs and HRPPs, AMS Annual Meeting (36th Conference on Hydrology), virtual, Jan 23-27, 2022.

Tan, J., GPM Fundamentals and the IMERG Product, GPM Mentorship Program, virtual, April 6, 2022.

Tan, J., IMERG V07: Improvements and Early Results, AOGS Annual Meeting, virtual, Aug 1-5. 2022.

Tan, J., IMERG V07: SHARPEN, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Tao, Z. (lead), Investigation of Urban Effect on Precipitation – A Modeling Study over Houston, 102nd AMS Annual Meeting, virtual, Jan 23-27, 2022.

Thomas, N., Mechanisms Associated with Heat Waves over the United States, SED Director's Seminar, virtual, Dec 3, 2021.

Thompson, A. M. (lead), Regional and Seasonal Trends in Tropical Ozone in the Lowermost Stratosphere (LMS) from SHADOZ Profiles: Reference for Models and Satellite Products, 2021 AGU Fall Meeting, Dec 13-17, 2021.

Várnai, T. (lead), EPIC observations of sun glint from horizontally oriented ice crystals in clouds, AMS 16th Conference on Atmospheric Radiation, Madison, WI, Aug. 11, 2022.

Várnai, T. (lead), EPIC operational sun glint product, 2021 AGU Fall Meeting, virtual, Dec 14, 2021.

Várnai, T. (lead), Publicly available online simulator of 3D radiative processes, International Radiation Symposium 2022, Thessaloniki, Greece, July 5, 2022.

Várnai, T. (lead), Satellite observations of cloud-related variations in aerosol properties, International Radiation Symposium 2022, Thessaloniki, Greece, July 7, 2022.

Wales, P. (lead), Application of the GEOS-Chem Mechanism in the GEOS-CF Stratosphere, 10th International GEOS-Chem Meeting, St. Louis, MO, June 7-10, 2022.

Wales, P. (lead), Satellite-Based Emission Estimates of Tropospheric Bromine During Arctic Spring and Application within the GEOS-Chem, Cryosphere and Atmospheric Chemistry (CATCH) Open Science Workshop, virtual, May 9-13, 2022.

Wales, P. (lead), Satellite-Based Emission Estimates of Tropospheric Bromine During Arctic Spring and Application within the GEOS-Chem, Interagency Arctic Research Polity Committee (IARPC) Modeling Team Meeting, virtual, Feb 23, 2022.

Wales, P. (lead), Satellite-Based Emission Estimates of Tropospheric Bromine During Arctic Spring and Application within the GEOS-Chem, American Geophysical Union (AGU) Fall Meeting, virtual, Dec 13-17, 2022.

Weir, B., Data assimilation for carbon monitoring, WMO Greenhouse Gas/Carbon Monitoring Workshop, World Meteorological Organization (WMO), Geneva, Switzerland, May 11, 2022.

Weir, B., The Orbiting Carbon Observatory-2 project: Monitoring atmospheric carbon dioxide, Carbon Tracking and Reporting Energy Conference Network, Houston, TX, March 22, 2022.

Wen, G. (lead), Impact of Atmospheric Rivers on Global Average Reflectance from DSCOVR/EPIC, Madison, WI, Aug 8-12, 2022.

Wen, G. (lead), Water vapor variations in the vicinity of clouds from ARM's shortwave spectrometer, International Radiation Symposium, Thessaloniki, Greece, July 4-8, 2022.

Xu, X. (lead), Synergy of PACE's OCI and Polarimeters for Aerosol Height Retrievals: Capabilities and Challenges, AGU 2021 Fall Meeting, New Orleans, LA, Dec 13-17, 2021.

Zhou, Y. (lead), New ocean dust aerosol algorithm to unite and improve Dark Target dust retrievals across platforms: MODIS, VIIRS, ABI and AHI, AGU Fall Meeting, virtual, Dec 13-17, 2021.

Ziemke, J. (lead), Global tropospheric ozone trends and anomalous reductions in year 2020 in the NH during Covid-19 inferred from EPIC, OMPS, OMI, and MLS satellite measurements, AGU Fall Meeting, Dec 13-17, 2021.

Ziemke, J. (lead), Hourly and daily maps of tropospheric ozone determined from EPIC, OMPS, OMI, and MLS satellite instruments: A bridge to connect geostationary with polar-orbiting platform measurements, AGU Fall Meeting, virtual, Dec 15, 2021.

Proposals Submitted

Proposal Title	Funding Agency	PI (GESTAR II)	CO-I(s) (GESTAR II)	Status
A Biosphere-Scale Cuvette: Leveraging the Geostationary Perspective to Advance Simulation of Photosynthesis in Earth System Models	Carnegie Institu-tion of WA	Korkin, S. (UMBC)	Wang, Y. (UMBC)	Pending
Improving understanding and model representation of aerosol-cloud interactions for cloud-clear transition zone and internal cloud structure using ARM shortwave spectrometer data	DoE		Wen, G. (MSU)	Pending
Assimilation of ECOSTRESS land surface temperature into a land surface model	NASA	Maina, F. (UMBC)		Pending
Coastal land use adaptation- the multifaceted response of tidal marsh and mangroves to climate change with implication for future coastal zone resilience	NASA		Campbell, A. (UMBC)	Pending
Wideband-Accurate Reconfigurable Multi-State Calibration (WARMCAL)	NASA		Mohammed, P. (MSU)	Pending
Investigating the Role of Wildfire Smoke on Stratospheric Chemistry and Composition using an Aerosol-Chemistry coupled Global Model	NASA Aura ACMAP		Steenrod, S. (UMBC)	Pending
Atmospheric Correction of DSCOVR EPIC Measurements	NASA DSCOVR		Choi, M. (UMBC), Go, Sujung (UMBC), Korkin, S. (UMBC), Wang, Y. (UMBC)	Pending
The Polarized Submillimeter Ice-cloud Radiometer (POLSIR)	NASA Earth Venture		Gong, J. (UMBC)	Pending
On the Whole Atmosphere Eclipse-Gravity Wave Generation, Propagation, and Coupling Mechanism Using a Unique Set of Ground to Ionosphere Observations and WACCM-X Model Simulations	NASA Interdiscip-linary Science for Eclipse 2024	Gong, J. (UMBC)		Pending
Rapid Detection of Human-Induced Fire for Protection and Support of Agroforestry-Based Value Chains in Madagascar	NASA LCLUC Step 1	Armstrong, A. (UMBC)		Pending
Developing a Comprehensive and Augmented Multi-decadal Remote-sensing Observations of Dust (CAMRO-Dust) Data Record for Earth Science Research and Application	NASA MEASUR ES		Zhou, Y. (UMBC), Zhang, Z. (UMBC), Rajapakshe, C. (UMBC), Shi, Y. (UMBC)	Pending

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)	Pending
An Air Quality Reanalysis: Integration of surface, satellite, and model outputs to generate a level 4 PM2.5 dataset	NASA ROSES		Buchard, V. (UMBC)	Pending
Continuation of Multi-Decadal Global SO2 and NO2 Earth Science Data Records	NASA ROSES		Lamsal, L. (UMBC)	Pending
Evaluating the Planetary Boundary Layer Height derived from GeoOptics GNSS RO Measurements	NASA ROSES	Ganeshan, M. (UMBC)		Pending
Evaluation of ICEYE data for landslide disaster response product generation	NASA ROSES	Amatya, P. (UMBC)		Pending
Flexible framework for landslide forecasting and capacity building tools for SERVIR-HKH	NASA ROSES		Amatya, P., Stanley, T., Biswas, N. (all UMBC)	Pending
Global High-Resolution Dataset of Convective or Stratiform Type for Precipitation	NASA ROSES	Tan, J. (UMBC)		Pending
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		Rajapakshe, C. (UMBC), Zhang, Z. (UMBC), Bian, H. (UMBC)	Pending
Investigating stratospheric extremes with EOS Aura data and chemical reanalyses	NASA ROSES		Weir, B. (MSU), Knowland, K. (MSU)	Pending
Investigating the climate impacts of Hunga Tonga – Hunga Ha'apai volcanic eruption	NASA ROSES	Li, F. (UMBC)		Pending
Making a Long-term Data Record of Opportunistic Experiments for Studying Aerosol-Cloud Interactions	NASA ROSES	Yuan, T. (UMBC)	Wang, C. (UMBC)	Pending
S2S variability and prediction skills of western U.S. precipitation extremes: role of MJO and QBO	NASA ROSES		Lim, Y.-K. (UMBC)	Pending
Spatiotemporal analysis of extreme event characteristics using S2S forecasts to inform hydrometeorological hazard assessment	NASA ROSES	Emberson, R. (UMBC)	Stanley, T. (UMBC)	Pending
Spatiotemporal Fusion of Satellite-Inferred Estimates and Bottom-Up Inventory Data for Global Anthropogenic Emissions	NASA ROSES	Liu, F. (MSU)	Knowland, E. (MSU)	Pending
Atmospheric formaldehyde in the recent decades: Its sources, long-term change, and contribution to tropospheric ozone change	NASA ROSES AURA ACMAP	Liu, J. (MSU)	Strode, S. (MSU)	Pending
Cloud composition from the analysis of sun glints off horizontally oriented ice crystals	NASA ROSES AURA ACMAP	Várnai, T. (UMBC)		Pending

Intraseasonal to interannual variabilities of aerosols in the upper troposphere-lower stratosphere and their connections to multiple timescale oscillations	NASA ROSES AURA ACMAP		Bian, H. (UMBC), Taha, G. (MSU), Kucsera, T. (UMBC)	Pending
Linking LEO to GEO: Long-term and diurnal nitrogen dioxide trends based on consistent multi-satellite observations and global chemistry simulations	NASA ROSES AURA ACMAP	Lamsal, L. (UMBC)	Liu, J. (MSU)	Pending
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 ACMAP	Bian, H. (UMBC)	Strode, S. (MSU)	Pending
Impact of Lightning-NO_X on free-troposphere NO_X trends and atmospheric composition	NASA ROSES Aura/ ACMAP	Anderson, D. (UMBC)		Pending
Linking Inter-Model Differences in Simulated Hydroxyl Radical (OH) and its Interannual Variability to Transport Processes	NASA ROSES Aura/ ACMAP	Strode, S. (MSU)		Pending
Volcanology from Space: Combining NASA's Earth Observing System (EOS) with traditional lightning and infrasound observations to investigate active volcanism.	NASA ROSES Earth Surface and Interior	McKee, K. (UMBC)		Pending
A Multi-Instrument Record of Radiative Forcing and Feedback Responses for Climate Monitoring and Global Change Studies	NASA ROSES MEaSURES	Kramer, R. (UMBC)		Pending
Global Daily Tropospheric Ozone Maps from Multiple NASA Missions from 1980 to Present for Use in Research Environments	NASA ROSES MEaSURES	Ziemke, J. (MSU)	Strode, S. (MSU)	Pending
Over Four Decades of Consistent Aerosol Data Records: Fusing AVHRR with EOS Sensors for Climate Studies	NASA ROSES MEaSURES		Sayer, A. (UMBC)	Pending
How sensitive is North Atlantic climate to realistic future Greenland freshwater forcing?	NASA ROSES Physical Oceanography		Felikson, D. (MSU)	Pending
Enhancing Ice Cloud Imager (ICI) ice cloud retrieval products and preparation for all-sky data assimilation for ICI observations	NASA RRNES Program	Gong, J. (UMBC)		Pending
Understanding the dynamics of arctic-boreal vegetation structure, composition and function: using the remote sensing record to explore 21st century ecological simulations across the ABoVE Domain	NASA TE ABoVE Program	Armstrong, A. (UMBC)		Pending
Improving Historical Greenland Ice Sheet Elevation Data with ASTER	NSF		Felikson, D. (MSU)	Pending

Proposals Awarded

Proposal Title	Funding Agency	PI (GESTAR II)	CO-I(s) GESTAR II)	Period of Performance
Using LASSO to bridge the gap between model and observations and to learn about atmospheric convection	DOE	Barbosa, H. (UMBC)	Li, X. (MSU)	09/01/22 – 11/01/24
Continuing total and tropospheric ozone column products from DSCOVR EPIC to study regional scale ozone transport	NASA		Ziemke, J. (MSU)	
Hyperspectral Capability for CoSMIR: Enhancing Capability for Future PBL Suborbital Campaigns and Enabling PBL Science from Space	NASA		Moham-med, P. (MSU)	05/01/2022 – 04/30/2025
Identifying public health applications of satellite-derived drought indicators: improved monitoring for respiratory health	NASA		Tao, Z. (MSU(	07/01/22 – 06/30/25
Photonic Integrated Circuits (PICs) in Space: The Hyperspectral Microwave Photonic Instrument (HyMPI)	NASA		Moham-med, P. (MSU)	02/01/2022 – 01/31/2025
Support for Applied Earth Observations Innovation Partnership (AEOIP)	NASA		Armstrong , A. (UMBC)	
A Prototype Machine learning-based all-sky radiance data assimilation framework at microwave and submillimeter frequencies in preparation for AOS and CoSSIR	NASA Goddard IRAD		Gong, J. (UMBC)	10/2022 – 08/2023
Modeling of SAR observations of snow under forest canopy	NASA GSFC IRAD		Armstrong , A. (UMBC), Albayrak, A. (UMBC)	
Atmospheric Radiative Transfer Simulator (ARTS) to support the Electrojet Zeeman Imaging Explorer (EZIE) mission	NASA Heliophy-sics Tool & Methods Program	Gong, J. (UMBC)		10/2022 – 09/2024
Continuation of Multi-Decadal Global SO_2 and NO_2 Earth Science Data Records	NASA MEaSURES		Lamsal, L. (UMBC), Evans, K. (UMBC)	
An improved understanding of the role of the ocean surface salinity and salinity stratification in modulating tropical atmospheric intraseasonal oscillations	NASA ROSES		Lim, Y.-K. (UMBC)	03/2022 – 02/2026
Atmospheric Correction of DSCOVR EPIC Measurements	NASA ROSES		Choi, M. (UMBC), Go, S. (UMBC), Korkin, S. (UMBC), Wang, Y. (UMBC)	03/01/22 – 02/28-25
BioREaCH: Biodiversity-Remote sensing for Estuarine and Coastal Habitat research	NASA ROSES	Campbell, A. (UMBC),		

		Science PI		
Coastal resilience over time - feedbacks between coastal ecosystems, cyclone activity, and coastal protection benefits	NASA ROSES		Campbell, A. (UMBC)	
Exploring Strategies and Developing PBL Data Assimilation Including PBL Height from Multiple Observing Systems in the Global GEOS System	NASA ROSES		Ganeshan, M. (MSU)	08/2022 – 07/2025
Generating Advanced VIIRS Climate Data Records with Algorithm MAIAC	NASA ROSES		Choi, M. (UMBC), Go, S. (UMBC), Korkin, S. (UMBC), Wang, Y. (UMBC)	09/01/21 – 08/31/24
GEOS-Carb IV: Delivering low-latency carbon flux and concentration datasets in support of NASA's Carbon Monitoring System	NASA ROSES		Arteaga, L. (UMBC)	
Global-Scale Spatiotemporal Uncertainty Estimation for IMERG to Improve Hydrologic Prediction	NASA ROSES		Tan, J. (UMBC)	05/01/22 – 04/30/24
Improved hydrometeorological prediction in an S2S system through improved treatments of evapotranspiration, runoff, and carbon cycle processes	NASA ROSES		Lee, E. (UMBC)	07/2022 – 06/2025
Machine learning based automatic detection of upper atmosphere gravity waves from NASA satellite images	NASA ROSES	Wang, C. (UMBC)		02/2022 – 08/2023
Near-cloud changes in CALIOP and MODIS/VIIRS aerosol observations	NASA ROSES		Varnai, T. (UMBC), Wen, G. (MSU)	2022 – 2025
New sea ice and ice sheet OSSE frameworks for determining ice topography science requirements from a future STV mission	NASA ROSES		Felikson, D. (MSU)	08/15/22 – 08/14/2026
Spatiotemporal analysis of extreme event characteristics using S2S forecasts to inform hydrometeorological hazard assessment	NASA ROSES	Emberson, R. (UMBC)	Stanley, T. (UMBC)	07/01/22 – 06/30/25
Subseasonal-to-Seasonal Forecasting for Informed Decision-Making in the Mekong River Basin	NASA ROSES		Lee, E. (UMBC)	01/2023 – 12/2025
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	NASA ROSES	Knowland, K.E. (MSU)	Malings, C. (MSU), Keller, C. (MSU)	05/01/22 – 04/30/25
Investigating the Vertically-Resolved Radiative Constraints on Tropical Precipitation with CloudSat and CALIPSO	NASA ROSES – CloudSat/CALIPSO	Kramer, R. (UMBC)		2022 - 2024
Development of a next-generation ensemble prediction system for atmospheric composition	NASA ROSES AIST	Keller, C. (MSU)		08/01/22 – 07/31/25
Integration of Observations and Models into Machine Learning for Coastal Water Quality	NASA ROSES AIST		Clark, B. (UMBC)	07/2022 – 07/2024

Intelligent Long Endurance Observing System	NASA ROSES AIST		Strode, S. (MSU)	08/2022 – 07/2024
EPIC Hourly Aerosol Optical Centroid Height (AOCH) product: mapping the diurnal variation of smoke and dust vertical distributions for air quality and climate studies	NASA ROSES DSCOVR		Xu, X. (UMBC)	
Developing the NOAA Next Generation Hyperspectral Microwave Sensor (HyMS): Instrument Concept and Demonstration of Benefits for the NOAA Mission	NOAA		Moham-med, P. (MSU), Gong, J. (UMBC), Kotsakis, A. (ERT)	07/01/2023 – 06/30/2025
Collaborative Research: Machine-enabled modeling of terminus ablation for Greenland's outlet glaciers	NSF		Felikson, D. (MSU)	08/01/22 – 09/30/25
EPIC Aerosol Retrieval Datasets for Diagnosing and Improving Aerosol Optical Treatments in the Navy Aerosol Analysis and Prediction System	ONR 2022	Go, S. (UMBC)	Wang, Y. (UMBC)	02/01/2022 – 01/31/2025

ACRONYMS

ACCLIP	Asian Summer Monsoon Chemical & CLimate Impact Project
AERONET	Aerosol Robotic Network
AIRS	Atmospheric Infrared Sounder
AOD	Aerosol Optical Depth
ATBD	Algorithm Theoretical Basis Document
AVDC	Aura Validation Data Center
BOEM	Bureau of Ocean Energy Management
CAMP2Ex	Cloud, Aerosol and Monsoon Processes Phillippines Experiment
CASALS	Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System
CCS	Carbon Cycle Science project
CESAS	Committee on Earth Science and Applications from Space
CMIS	Compact Midwave Imaging System
COWVR	Compact Ocean Wind Vector Radiometer
CrIS	Cross Track Infrared Sounder
CRTM	Community Radiative Transfer Model
CyAN	Cyanobacteria Assessment Network
DCOTSS	Dynamics and Chemistry of the Summer Stratosphere
DESIS	DLR Earth Sensing Imaging Spectrometer
DSCOVR	Deep Space Climate Observatory
DT	Dark Target
EPIC	Earth Polychromatic Imaging Camera
ESTO	Earth Science and Technology Office
GEOS	Goddard Earth Observing System
GEOS-ADAS	Global Earth Observing System-Atmospheric Data Assimilation system
GEOS-CF	GEOS Composition Forecast system
GEOS-FP	GEOS Forward Processing system
GES DISC	Goddard Earth Science Data and Information Services Center

GIS	Geographic Information Systems
GLOWS	Global L-Band Active/Passive Observatory for Water Cycle Studies
GOCART	Goddard Chemistry Aerosol Radiation and Transport
HARP2	Hyper-Angular Rainbow Polarimeter-2
HIPP	Hyper-angle Image Processing Pipeline
HMA	High Mountain Asia
IAGOS	In-service Aircraft for a Global Observing System
IASI	Infrared Atmospheric Sounding Interferometer
ICESat-2	Ice, Cloud and land Elevation Satellite 2
IMERG	Integrated Multi-SatellitE Retrievals for GPM
IMPACTS	Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms
IPSS	Improved Pseudo Spherical Shell
ISCCP	International Satellite Cloud Climatology Project
JEDI	Joint Effort in Data Integration
LADAS	Land-Atmosphere Data Assimilation System
LHASA	Landslide Hazard Assessment for Situational Awareness
LST	Land Surface Temperature
MC	Mid-latitude Cyclones
MCSSA	Monte Carlo code for Spherical Shell Atmosphere
MLS	Microwave Limb Sounder
MODIS	Moderate Resolution Imaging Spectroradiometer
NDACC	Network for the Detection of Atmospheric Composition Change
NOMAD	NASA bio-Optical Marine Algorithm Dataset
OBB	Ocean Biology and Biogeochemistry project
OCI	Ocean Color Instrument
OCO-2	Orbiting Carbon Observatory 2
OMI	Ozone Monitoring Instrument
OMPS-NM	Ozone Mapping Profiler Suite – Nadir Mapper

OSSEs	Observation System Simulation Experiments (OSSEs)
PACE	Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission
RRTMG	Rapid Radiative Transfer Model Global
SAFE	Structure and Function of Ecosystems
SALaD	Semi-automated Landslide Detection (SALaD) system
SeaBASS	SeaWiFS Bio-optical Archive and Storage System
SMAP	Soil Moisture Active and Passive Mission
SNPP	Suomi National Polar-orbiting Partnership
TSIS-1	Total and Spectral solar Irradiance Sensor
TTE	Tundra-Taiga Ecotone
TROPOMI	TROPOspheric Monitoring Instrument (TROPOMI)