JCET
The Joint Center for Earth Systems Technology

Second Annual Report for Cooperative Agreement NNX15AT34A

Twenty-second Annual Report for the Joint Center for Earth Systems Technology

Submitted August 1, 2017

Message from the Directors

This volume is the second in the new, five year renewal period (2015-2020), and it is the twenty-second annual report, describing the scientific accomplishments and status of the Joint Center for Earth Systems Technology (JCET) at the University of Maryland, Baltimore County (UMBC). This report satisfies the annual report requirement for Cooperative Agreement NNX15AT34A.

JCET was established in 1995 to promote close collaboration between scientists at UMBC and the NASA Goddard Space Flight Center (GSFC) in areas of common interest related to developing new technologies for environmental remote sensing and conducting multidisciplinary research on advanced concepts for observing Earth and planetary atmospheres, the solid Earth and planets, and the hydrosphere, using ground stations, aircraft, and space-based platforms. JCET also serves as a means to increase the effectiveness of university research and teaching resulting from the collaboration and provides a venue to train personnel for research in relevant Earth science and technology areas. The NASA Earth Sciences Division funds and collaborates with JCET administration. At UMBC, JCET is administered through the Office of the Vice President for Research. JCET's administrative office is located at the BWTech Research Park at UMBC. JCET also has offices in the Physics building, the Sondheim building, and the Technology Research Center on the UMBC campus. Most of JCET scientists work in offices at Goddard, and a substantial number also reside on campus at UMBC, contributing to research and education of graduate and undergraduate students.

In this second year of the five-year cooperative agreement period, there are 54 JCET faculty members who conduct their research among 14 branches at Goddard, and who collaborate and teach in four departments at UMBC. JCET faculty are supported at the level of 58% by tasks from Goddard within the Cooperative Agreement, 37% by independent grant funding and 5% from state funding, which supports, for example, teaching in UMBC departments, proposal writing and bridge support when a JCET scientists research funding falls short.

JCET is unique compared to other Cooperative Agreements of its kind at GSFC for its advocacy and inclusion of teaching and student mentorship as an integral part of its faculty's activities. JCET faculty members contribute to teaching, advising graduate students, and collaborate with and/or are affiliated with UMBC's academic departments. Prominent in this collaboration within this reporting period include the departments of Physics; Geography and Environmental Systems; Chemistry; Mathematics and Statistics; Chemical, Biochemical and Environmental Engineering; Computer Science and Electrical Engineering, and the Office of Undergraduate Education. JCET Associate Director for Academics coordinates the activities among the academic departments at UMBC, the JCET research faculty and students. Through a competitive process, JCET selects a Graduate Fellow each year and supports her/his stipend, tuition, health care and travel to one professional conference. Each semester, the JCET-supported graduate students participate in a weekly seminar series. In the Fall semesters, the seminars are given by the students on their research topics. In the Spring semesters, an Earth-science related topic is chosen for exploration. In Spring 2017, the graduate students explored the science behind the

American Physical Society's “Statement on Earth's Changing Climate.” More than 15 graduate and 22 undergraduate students have benefited within the past year from these activities.

JCET Faculty and students are activity involved in on-campus activities. This year, JCET Faculty participated in the UMBC “Seeing Science” project that highlights how imagery is used to communicate science, by bringing students to GSFC. JCET faculty members were also actively involved in UMBC’s 50th Anniversary celebration, demonstrating the new Dynamic Planet Exhibit, among other activities. JCET faculty members serve on university-wide committees, such as the Sustainability Committee, the Faculty Advisory Committee for Interdisciplinary Activities and the Strategic Planning Committee. JCET hosts the monthly Public Stargazing events at the UMBC Observatory.

The Technical Volume of this report comprises tasks that are aligned with GSFC research areas. The task summaries present brief accounts of group members’ accomplishments, provided by the respective principal investigators supported through a JCET task that was active during the period from October 1, 2016 to September 30, 2017. Each report includes a description of the research, and accomplishments for the reporting period. Following the Technical Volume is supporting material that includes academic affiliations, courses taught, publications, biographies, and a list of abbreviations and acronyms.

This year saw the resumption of the annual JCET Executive Board Meeting. Supervisory representatives from key organizations in GSFC 610 included Christa Peters-Lidard (610HBG), Torry Johnson (610HBG), Steve Platnick (610AT), Lazaros Oreopoulos (613), Jim Gleason (614), and Carlos Del Castillo (616). UMBC representatives included Karl Steiner (Vice President for Research), William LaCourse (Dean, College of Natural and Mathematical Sciences) and the chairs of departments that have affiliated JCET faculty. JCET, UMBC and Goddard management have agreed to get the schedule back on an annual track.

JCET continues to be a vibrant research organization, contributing to the Earth science mission at NASA Goddard Space Flight Center, as well as research and education of the next generation of Earth science researchers at UMBC. JCET looks forward to its continued collaboration in the coming year.

Belay Demoz, Director
Susan Hoban, Associate Director for Academics

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I. Technical Volume: Tasks

Task 101

Task Sponsor
Thomas Hanisco, Code 614

JCET Personnel
Jason St. Clair, Research Assistant Professor

Summary
Airborne in situ measurements of formaldehyde are used, in conjunction with other measurements from aircraft payloads, to better understand the photochemistry of the atmosphere. New instruments are developed to provide formaldehyde measurements from numerous aircraft platforms with different environmental and measurement requirements. The formaldehyde data can be used to improve retrievals of formaldehyde and isoprene (by proxy) from satellites. As a part of a suite of measurements, analysis of field data advances our understanding of atmospheric photochemistry and its effect on air quality and climate.

Accomplishments
Field Work: The COFFEE (Compact Formaldehyde Fluorescence Experiment) instrument continued to provide airborne formaldehyde measurements as part of the AJAX (Alpha Jet Atmospheric eXperiment) project out of NASA Ames, and St. Clair continues to support the instrument, including all data processing. The instrument paper describing COFFEE will be submitted in late July. St. Clair supported the first two deployments of ISAF (In Situ Airborne Formaldehyde) for the Atmospheric Tomography (ATom) mission, and traveled to New Zealand to join the research aircraft for the second half of ATom1. The objective of the ATom campaign is to survey the global atmospheric composition and understand what controls the composition in regions far from emission sources. Glenn Wolfe (JCET) also participated in ATom2. In November 2016, the CAFE (Compact Airborne Formaldehyde Experiment) instrument flew engineering test flights on the NASA ER-2. St. Clair served as the instrument lead for CAFE. In future upper troposphere/lower stratosphere (UT/LS) aircraft campaigns, CAFE will provide measurements of HCHO in the UT/LS that indicate the presence of recent convective transport.

Data Analysis: ATom provides a unique data set to understand important global processes such as ozone production and methane loss. St. Clair is currently collaborating with Glenn Wolfe (JCET) and Jin Liao (USRA) on using the observations and a chemically explicit 0-D box model to investigate the oxidative environment along the aircraft flight track. Also in collaboration with Jin Liao (USRA), who leads the project, and Glenn Wolfe (JCET), St. Clair contributed to analysis of 2016 KORUS-AQ mission data to better understand the link between HCHO and organic aerosol, with the ultimate goal of a creating a global space-based organic aerosol data product using satellite HCHO observations. St. Clair presented the analysis at the 2017 KORUS science team meeting in South Korea.

Analysis of data collected from a collaborative laboratory study at Caltech resulted in a paper on the potential for ISOPOOH, an oxidized organic compound, to cause a measurement artifact in the ISAF formaldehyde instrument. The published paper, led by St. Clair, is available on the web at : https://www.atmos-meas-tech.net/9/4561/2016/.

Instrument Development: A duplicate of the CAFE instrument is being constructed to provide a swap-in backup for field campaigns. In addition, both the optical system and the data processing used for COFFEE and CAFE are being evaluated for potential improvements.

Plans for next year

The COFFEE instrument paper will be published during FY2018, and upon completion of laboratory improvements in the optical system and flight intercomparison with ISAF on ATom3, the CAFE instrument will be described in a manuscript. Josette Marrero, a collaborator at NASA Ames, is working on a paper describing biomass burning emissions using COFFEE data. Biomass burning chemistry will be a focus for the JCET HCHO team (St. Clair and Wolfe) as well, in preparation for upcoming NASA and NOAA campaigns.

Fieldwork in FY2018 will include the continued flights of COFFEE aboard the Alpha Jet at NASA Ames for AJAX. St. Clair will support both ATom3 and ATom4, traveling to New Zealand for ATom3 and possibly ATom4. Laboratory work will continue the evaluation and improvement of the CAFE and COFFEE optical systems.

Task 102

Task sponsor

Thomas Hanisco, Code 614

JCET Personnel

Glenn M. Wolfe, Research Assistant Professor

Summary

This task is entails collection and analysis of in situ airborne observations of trace gases, including formaldehyde (HCHO), carbon dioxide (CO_2), and methane (CH_4). Formaldehyde is a ubiquitous product of hydrocarbon oxidation and is observable from space-borne sensors. It is valuable for quantifying hydrocarbon emission source strength, and it is also a key participant in radical cycling throughout the lower atmosphere. CO_2 and CH_4 are greenhouse gases. Work on this topic centers on developing an airborne system to directly measure surface-atmosphere exchange (fluxes) of these gases. Data from this work will constrain both high-level satellite products and biophysical model algorithms used in carbon-climate models.

Accomplishments

Formaldehyde: In February, Wolfe traveled to New Zealand to participate in the second phase of the Atmospheric Tomography (ATom) mission. ATom uses the NASA DC-8 to circumnavigate North and South America while observing global background atmospheric composition. Preliminary analyses indicate that the variability of HCHO in remote regions is largely controlled by hydroxyl radical (OH) levels. This is significant because OH determines the "self-cleansing" capacity of the atmosphere and is key to the production of ozone and loss of methane. With the HCHO-OH link established by in situ observations, the next question is whether space-based HCHO observations could be used to evaluate OH chemistry within global chemistry-climate models. Wolfe is currently collaborating with Jin Liao (USRA) and Jason St. Clair (JCET) on this project, as well as on analyses from the 2016 KORUS-AQ mission in South Korea.

Greenhouse Gases: Wolfe has worked diligently to analyze airborne flux observations from the 2016 Carbon Airborne Flux Experiment (CARAFE). This analysis is complex and partly exploratory, as this type of observation is exceedingly rare. Preliminary results are encouraging, and Wolfe has begun exploring collaborations with modeling groups at GSFC and elsewhere to evaluate emissions models for wetland methane. This work was presented at the North American Carbon Program (NACP) annual meeting and a manuscript is in preparation. As part of the NASA Carbon Monitoring System (CMS) program, Wolfe also participated in another similar series of flights in May 2017. Part of this effort included training a new Post-doc, Reem Hannun (JCET).

Student Airborne Research Program (SARP): SARP is a summer program established by NSRC to immerse rising senior undergraduates in airborne science research. In June 2017, Wolfe traveled to sunny Palmdale to teach and interact with 32 students and operate several instruments onboard the C-23 Sherpa. This mission was so successful that several additional flights are planned for mid-July 2017 in support of the OWLETS mission in VA.

Plans for next year
Wolfe will complete the CARAFE methods paper mentioned above. He is also lead mission scientist for the above-mentioned OWLETS flights. FY2018 will include the remaining two phases of ATom, and Wolfe will likely fly for the final campaign in May 2018. New funding from NOAA and NASA will also begin this year, specifically to focus on the chemistry of biomass burning and to prepare for fire-focused field missions in summer 2019. This will be the next major focus of Wolfe's research efforts, in addition to facilitating research by fellow group members and 2 students at UMD. Wolfe is also involved in planning for several airborne missions slated for 2019 and beyond.

Task 103

Task Sponsor
Steven Kempler, Code 610.2

JCET Personnel
Chung-Lin Shie, Associate Research Scientist

Summary
As Project Scientist of Goddard Earth Sciences Data and Information Services Center (GES DISC) since January 2013, Shie provides scientific advice and suggestions with an objective to

properly and effectively engage the data products/services distributed at GES DISC with the current or/and the in-development science research applications performed internally (GES DISC) or externally (science communities outside GES DISC). He also works closely with the GES DISC Manager (Kempler) and the GES DISC/User Working Group (UWG) Chair (Eric Fetzer at JPL), coordinating interactions/meetings between GES DISC and its UWG aiming to bridge together the user community, the data providers, and GES DISC (as the data distributor and the service provider), for improving the current user and data services and developing new services, as well as creating opportunity in collaborative works. Shie actively participates in Focus Groups within GES DISC, as well as collaborates in research projects (involving data and science) internally or externally (data or science communities outside GES DISC), and participates in Working Groups (WG) (involving data) mainly hosted either by ESDIS or ESIP.

Accomplishments

GES DISC UWG Meetings: there were three telecon meetings held (Oct 2016-Jun 2017). Several subjects were presented and discussed. Here are a few such as "Unified User Interface (UUI)" - the GES DISC newly developed and implemented website system; the ongoing project "Datalist" (see details as follows); "Giovanni in Cloud" - an ongoing project in preparation of implementing the powerful visualization system Giovanni into the (future) Cloud system; "GES DISC Info Forum" - a newly implemented online service, also considered a "partner" of the "Earthdata Forums" of a bigger scope involving the entire Earth science data archived at NASA.

"Datalist" Project/Service: this project/service aims to provide Earth science community with "efficient" services containing "proper and advanced" (knowledge-based and value-added) science data variables shown in a "list" that can be "quickly" fetched by users "all at once". For example, the first developed datalist "Hurricane Datalsit" includes a derived group of related data variables that can be freely selected for download by users interesting in hurricane studies (Shie et al. 2016).

"Information Quality" Papers: Shie has participated the ESIP Information Quality Cluster (IQC) working group, which was formed to ensure and improve information quality for Earth science data and products. An extended abstract introducing definitions and background of the information quality of scientific data generated by Earth observation systems and their derived data products, as well as discussing on the current activities, along with the projected future actions of the ESIP IQ was accepted and orally presented in the SciDataCon 2016 conference (Ramapriyan et al. 2016). This extended abstract has been further developed into a full paper that is lately accepted and published in D-Lib Magazine (Ramapriyan et al. 2017).

"Metrics" Studies: Shie has actively studied the metrics, i.e., the collectible records of users' usages of data and services provided by GES DISC. Considering such metrics studies as research of "data analysis", Shie also believed that such analysis studies would help GES DISC better understand its overall data distributions and services, and then learn how to further improve them. One interesting (still tentative, though) finding (Shie et al. 2017a; 2017b) is worth mentioning. Summer was generally found as the most "relaxed" (least active) season (per "distinct users") for both Northern and Southern Hemisphere (Jun/Jul/Aug or Dec/Jan/Feb).

Mar/Apr/May appeared as the most "exciting" (hardworking) season in both NH (Spring) and SH (Fall) that might be related to the respective ending month/date of the fiscal year?!

Plans for next year
As project scientist at GES DISC, Shie will continue providing advices and suggestions, as well as coordinating the UWG activities, and participating focus group activities. He will also continue participating a few working groups organized by ESDIS or ESIP. Shie may start collaboratively working on a new research project should a recently submitted proposal to the NASA MEaSUREs program be successfully funded.

Task 104

Task Sponsor
Steve Platnick, Code 610

JCET Personnel
Qianqian Song, Graduate Student

Summary
In comparison to short-wave (SW) direct radiative effect DRE_{LW} of dust in clear-sky conditions, clear-sky dust DRE_{LW} and DREs of above-cloud dust are less studied and not well understood. As a result, the net DRE of dust—the summation of the DRE_{SW} and DRE_{LW} in both clear-sky and cloudy-sky conditions—is still poorly constrained by the observations. The cutting-edge satellite-based remote sensing techniques from NASA (namely the A-Train satellite constellation) and other space agencies have provided a great opportunity to fill this gap in our knowledge. Graduate student Qianqian Song is tasked to advance our understanding of the net DRE of dust aerosols, through observation-based quantification of both SW and LW DRE of dust aerosols in both clear-sky and above-cloud conditions. More specifically, the objectives of the project are:

- Quantify observation-based DRE_{LW} and DRE_{SW} of dust in clear sky and above cloud conditions.
- Perform a comprehensive uncertainty analysis of DREs and identify the property that most limit the accuracy in quantification of DREs.

Accomplishments
The first major task the student has finished is to compute DRE_{LW} and DRE_{SW} of dust aerosols constrained by observations from A-Train instruments (CALIPSO, CloudSat, CERES and MODIS) The CERES, CALIPSO, CloudSat, and MODIS merged product (CCCM) developed by Kato et al. [2011] provides a convenient collocated dataset derived from CALIPSO, CloudSat and MODIS within CERES field of view. Song used this product and the atmospheric profiles and aerosol extinction profiles derived from the CALIPSO observations in CCCM product to drive the Rapid Radiative Transfer Model (RRTM) [Mlawer et al., 1997]; and computed both DRE_{SW} and DRE_{LW} of dust in clear sky conditions.

In the control run, Song used dust microphysical properties derived from AERONET observations [Omar et al., 2004] and refractive indices from Colarco et al. [2014] to derive dust optical properties, such as single scattering albedo, extinction efficiency and phase function. Dust aerosols will be assumed to be spherical in the control run. The sensitivity of DRE to microphysical properties, refractive index and non-sphericity of dust particles has been investigated as part of uncertainty study.

Plans for next year

Note that CCCM product provides only instantaneous CERES observations at A-Train overpassing time (cross signs in Fig.3). However, outgoing SW fluxes and DRE_{SW} strongly depend on solar zenith angle, the outgoing LW fluxes and DRE_{LW} also depend on surface temperature that has diurnal variation. Thus, the major task for next year is to calculate diurnally averaged DRE_{LW} and DRE_{SW} of dust aerosol.

Task 105

Task Sponsor

David Whiteman, Code 614

JCET Personnel

Kevin Vermeesch, Research Analyst

Summary

The tasks for this research included analysis of data from the NASA-GSFC ALVICE (Atmospheric Laboratory for Validation, Interagency Collaboration and Education) collected during various campaigns across the nation, as well as deployment and operation of related instrumentation. Analysis and deployment design of a multi-agency, multi-instrument, multi-nation field experiment, the Plains Elevated Convection at Night (PECAN) is a major task under this research work. PECAN is designed to advance the understanding of continental, nocturnal, warm-season precipitation. PECAN will focus on nocturnal convection in conditions with a stable boundary layer (SBL), a nocturnal low-level jet (NLLJ) and the largest CAPE (Convectively Available Potential Energy) located above the SBL. In addition, this task also supports activities related to the operation of ALVICE at the Howard University Beltsville Campus and work related to the NASA Network for the Detection of Atmospheric Composition Change (NDACC). These activities will include the preparation, launch and analysis of the Cryogenic Frost point Hygrometer (CFH) and analysis of climate trends associated with the Global Climate Observation Site (GCOS) Reference Upper Air Network (GRUAN).

Accomplishments

Monthly cryogenic frostpoint hygrometer (CFH) launches to coincide with Suomi National Polar-orbiting Partnership (NPP) satellite overpasses continue at the Howard University Beltsville Research Campus (HUBRC). Plotting code was updated to allow easier visual comparison between water vapor profiles of various sources (radiosonde, lidar, and satellite). A new Vaisala radiosonde ground station was installed at the HUBRC and allows for both the old and new Vaisala radiosonde models to be flown at the same time to assess performance and data continuity issues arising from changing the radiosonde model being flown.

Ceilometer data from several external institutions were provided to our project team for use in analysis. These data were converted into our uniform project format. Cloud base height statistics and distributions were calculated for all the sites in our study. It was found that for continental temperate and desert climates over 40% and up to 80% of cloud bases are currently not recorded by National Weather Service's Automated Surface Observing System (ASOS) network due to the current restriction of only recording cloud bases up to 12,000 feet. For the final project report and proof of concept demonstration of capturing and saving ceilometer backscatter profiles, ceilometer data collection code was written to show complete processing from acquisition of data to generation of the final product for distribution to the user community. A summary of the project and data collection demonstration was presented at the American Meteorological Society Annual Meeting.

To compare water vapor measurements from various sources during PECAN, code was written to determine coincidences when data could be paired-up for comparison. Work is progressing on the water vapor comparisons and analysis.

Plans for upcoming year

- Complete PECAN water vapor comparisons
- Continue monthly CFH launches

Task 106

Task Sponsor
Xiaoxiong Xiong, Code 618

JCET Personnel
William Barnes, Senior Research Scientist

Summary
The Moderate Resolution Imaging Spectroradiometer (MODIS) sensors, currently operated onboard the EOS Terra and Aqua spacecraft, were launched on December 18, 1999 and May 04, 2002, respectively. This task supports the ongoing calibration and characterization of both MODIS sensors and the documentation of more than 30 years of on-orbit performance.

Accomplishments
Tasks during the last year were principally in the ongoing areas of sensor calibration and performance monitoring. Barnes provided support to the MODIS Calibration Support Team (MCST) via input provided during biweekly calibration telecons with the MODIS sensor Working Group (MsWG). In addition, he reviewed several scientific manuscripts describing recent progress in MODIS characterization and calibration.

Plans for next year
Monitoring of the performance of the MODIS sensors will continue with particular emphasis on Terra/MODIS, which after more than 17 years on-orbit is beginning to display anomalous behavior.

Task 107

Task Sponsor
Thomas Neumann, Code 615

JCET Personnel
Valerie Casasanto, Education and Public Outreach Manager

Summary
ICESat2 (Ice, Cloud, and land Elevation Satellite) is a satellite mission to be launched in late 2017 and will use precision lasers to measure the height of the Earth from Space and provide a 3D view of the Earth's elevation, specifically to monitor changing ice sheets and land surfaces. To communicate the important science of the mission, an Education and Public Outreach (EPO) program is underway through Task 107. The goals of the EPO efforts are to engage the general public in the mission and communicate its benefits, and to inspire, engage, and educate youth to pursue Science, Technology, Engineering and Math (STEM) careers. The unique aspects of the ICESat2 mission will be communicated to the public and to the youth, through a wide array of programs and initiatives. Casasanto is leading a team of four to develop and implement the mission's EPO and communications efforts.

Accomplishments
Casasanto and team completed and launched an array of education and outreach products, including activities such as the photon bouncy ball activity https://icesat-2.gsfc.nasa.gov/fun_zone. Various communications products were also realized including the animated feature "Photon Jump," https://svs.gsfc.nasa.gov/12525 created by art and design students of the Savannah College of Art and Design, and released on March 3, 2017. As part of the Photon Jump release, partnerships with 5 museums were established where events were held and the film is now being shown on a regular basis and is being integrated into programming.

The final video on timing as part of a series as released on March 27. Team member Kate Ramsayer (Telophase), wrote an accompanying feature for NASA.gov https://www.nasa.gov/feature/goddard/2017/timing-a-space-laser-with-a-nasa-style-stopwatch. Casasanto worked with the outreach team and the NASA web team to ensure proper operation and updates to the ICESat-2 website, as well as provide inputs to the mobile version. Social media was consistently kept covered throughout the year.

The team participated in many outreach events during the year with booth space, presentations, and hands-on activities. The first event in this reporting period was a sleep-over held on November 4: 'STEM Girls Night In" at GSFC. Casasanto and volunteers ran the ICESat-2 altimeter exhibit for 50 high school girls and talked about the mission. Next, there was a UMBC

Seeing Science digital art high school student visit to NASA on November 18, 2016, the next a poster presentation on citizen science, booth presence, and preview of “Photon Jump” (one of the winners of the AGU Film Fest) at the American Geophysical Union (AGU) conference in San Francisco, CA, (December 2016). From March 3-5, 2017, Casasanto supported the Polar Science Weekend at the Pacific Science Center, in Seattle, WA. A STEM day on April 13th was held at the Baltimore Port Discovery Museum with the ICESat-2 altimeter exhibit. The exhibit has been stationed at the museum until present. Next, Earth Day celebrations at Union Station, Washington, DC, (April 2017). On April 28, 20 New Jersey teachers and school board members visited GSFC and Casasanto provided a hands-on workshop on the hands-on experiments “Motion in the Ocean” using recycled tennis ball tubes. From May 19-20, 2017, Casasanto attended and presented the ICESat-2 GLOBE ground validation program to 200 students and teachers at the GLOBE Northeast & Mid-Atlantic Regional Student Research Symposium held at the Palmyra Cove Nature Center, in Palmyra, NJ. From June 16-18, the team participated in Awesome Con, at the DC Convention Center. During the convention, the team also led a multi-mission panel, “NASA Space Lasers,” with Goddard laser experts and cryospheric scientists and laser engineers. Next, on July 10, Casasanto spoke with 40 high school girls with the SISTER program and led hands-on experiments on the global thermohaline circulation system and the role ice plays at GSFC. Casasanto also supported two educator professional development workshops in July (July 6 and 8) at NASA Goddard for middle school and high school teachers. Casasanto and team supported GSFC’s Annual Science Jamboree on July 12, 2017. Finally, in this reporting period, Casasanto created a new hands-on art activity for the Artscape Festival in Baltimore (July 21-23, 2017) and led the activity at the event.

Throughout the reporting period, Casasanto coordinated the team with individual and group weekly and bi-monthly meetings, attended and reported at weekly senior mission management meetings, GSFC Earth Science EPO tag-ups, provided weekly status inputs to Code 610 management, and continued development and implementation of EPO goals and milestones.

Plans for next year

As the launch date approaches, Casasanto will continue planning and developing ICESat2 initiatives into pre-launch operations. Specifically, she will implement the GLOBE citizen science program, launch the mobile version of the website, finalize the Outreach Plan, Mission Brochure and Fact Sheet, and lead preparations for the mission’s outreach and communications products and programs such as the Laser Social and Friends and Family Day to be held in the Fall of 2017. She will also organize ICESat-2’s participation in events such as the International Astronautical Congress (September 2017, Australia), and AGU in San Francisco (December 2017). This includes attending the conferences, presenting papers, and leading participants through hands-on activities.

Task 108

Task Sponsor
Alexei Lyapustin, Code 613.2

JCET Personnel
Yujie Wang, Associate Research Scientist

Summary
The main objective of Dr. Wang's research consists of four areas: 1) Operational performance of the Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithm; 2) Adapting the MAIAC algorithm to different satellite sensors such as GLI, VIIRS, EPIC etc.; 3) Conducting MODIS/VIIRS calibration-validation analysis for surface reflectance products; and 4) Provide support for MAIAC data users.

The MAIAC is a newly developed atmospheric algorithm which 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. The contemporary paradigm of atmospheric correction algorithms developed for instruments such as MODIS and AVHRR are pixel based and depend on only single-orbit data. It produces a single measurement for every pixel characterized by two main unknowns, AOT and BRF. This raises a fundamental concern: the remote sensing problem cannot be solved without either a priori assumptions or ancillary data. These priori constraints are approximate, and limit the accuracy and/or applicability of the current operational aerosol/atmospheric correction algorithms. On the contrary, The MAIAC algorithm is an algorithm for simultaneous retrieval of the aerosol optical thickness and surface bidirectional reflectance from MODIS. It uses the time series of gridded geolocated and calibrated L1B MODIS measurements, and an image-based rather than pixel-based processing. If we take into account the facts that the surface changes much slower than measurement frequency and the AOT varies over rather large scale, the number of measurements will be more than the number of unknowns, which becomes a solvable problem. The new algorithm is generic and works over vegetated regions of the Earth as well as over bright deserts. The aerosol retrievals are performed at high 1 km resolution, which is a highly requested product in different science and application disciplines, such as Air Quality/Urban Pollution. MAIAC has an advanced cloud mask (CM) and an internal dynamic land-water-snow classification that helps the algorithm to flexibly choose a processing path in changing conditions.

Accomplishments
Dr. Wang continuously worked on MAIAC algorithm improvement, tested large scale areas with various land surface types and aerosol features such as heavily clouded and vegetated Amazon area, highly polluted Eastern Asia area and Sahara desert area with very bright surface. The results were used for aerosol mode improvements, also distributed to user communities and used in air quality, ecosystem studies. In addition, collaborating with Dr. Lyapustin, Dr. Wang also added regional specific aerosol models to MAIAC algorithm, which dramatically improved the quality of Aerosol Optical Depth (AOD) retrievals.

Dr. Wang developed new software to create 8-day/monthly composite continental level vegetation index (NDVI, EVI) and angular corrected surface reflectance products. These products provided new opportunity for researchers to study vegetation dynamics.

Dr. Wang also continuously worked with MODIS Adaptive Processing System (MODAPS) crews to test/update MAIAC operational code. The code has passed 24-day global test. The initial results showed satisfactory performance.

As another application, Dr. Wang adapted the full MAIAC data processing system to MODIS Directly Readout system to create near real time MAIAC products. Initial test results have been created. Dr. Wang is working with DRL people to further improve the processing flow.

Dr. Wang also adapted the improved MAIAC code to GLI sensor, large scale process of GLI data was performed and the results were analyzed.

Based on the MAIAC algorithm, Dr. Wang also developed experimental 250m vegetation index and normalized bi-directional reflectance factor as new MAIAC products.

Plans for next year
In the coming year, Dr. Wang will continue working on MAIAC algorithm improvements. The MAIAC global data production will start soon. Dr. Wang will also monitor operational code performance and test the quality of global MAIAC data. Various tools for MAIAC products visualization, time series analysis and product validation will be developed.

The improved MAIAC code will be adapted to VIIRS sensor, first version of operational MAIAC VIIRS code will be delivered.

Dr. Wang will perform global MAIAC data analysis and create global database of monthly averaged ancillary surface information such as surface brightness temperature, spectral ratio, cloud fraction, average AOD, BRDF parameters. This database will be used for next version of MAIAC algorithm to create near real time products. Also it is a good data source for climate model study.

Task 109

Task Sponsors
Kenneth Pickering, Code 614

JCET Personnel
Nader Abuhassan, Associate Research Engineer; Jay Herman, Senior Research Scientist

Summary
The goals of this task include 1) to develop, improve and maintain a network of the Pandora spectrometer systems, 2) to determine levels of ozone and nitrogen dioxide, their altitude profiles, and validate the results in comparison with in-situ instrumentation, 3) to demonstrate the capability of the Pandora Spectrometer to support ground base and aircraft campaigns, as

well as satellite validation activities, 4) to deploy Pandora systems at permanent sites in order to develop long-term records, 5) to present results at national and international meetings.

Accomplishments
Multiple deployments took place in support of NASA's national and international research activities. Instruments were deployed in south Korea in support of both KORUS-AQ and KORUS-OC 10. Two of the instruments will continue to operate there for long-term monitoring records.

Two Pandora systems also participated in the CINDI-2 annual instruments intercomparison campaign in Cabauw, Netherlands.

At the national level, a total of 21 Pandora were deployed in multiple fields campaigns such as the Lake Michigan Ozone Study (LMOS), Student Airborne Research Program (SARP) and Ozone Water-Land Environment Transition Study OWLETS.

Results and deployment progress activity were also presented at the last TEMPO science team meeting.

Plans for next year

- Continue the expansion of the Pandora network.
- Support NASA educational programs
- Work on long-term deployments to help demonstrate Pandora's long-term stability, as well as its ability to obtain trace gas amounts and their trends without calibration transfer from a reference instrument.
- Present the results of the Pandora measurements at scientific meetings.

Task 110

Task Sponsor
Carlos Del Castillo, Code 616.2

JCET Personnel
Kevin R. Turpie, Research Associate Professor

Summary
Turpie performs scientific evaluation of ocean color remote sensing measurements using the Visible Infrared Imaging Radiometer Suite (VIIRS) as a member of the NASA Science Team, which is part of the Suomi National Polar-orbiting Partnership (NPP) mission. This involves the role of Ocean Color Science Co-Investigator for evaluating data quality, supporting calibration efforts, and providing a liaison with NOAA to support research to operations transfer. Efforts require the analysis of remote sensing data products or models and documenting findings through reports to the government and publication in the peer-reviewed literature.

Accomplishments
Turpie collaborated in the evaluation of solar and lunar calibration trending of changes in the responsivity of the VIIRS instrument. He was embedded in evaluation of new temperature response effects on solar and lunar calibration trending, which were found to be greater than originally thought. Despite these corrections, the ocean calibration team continued to struggle to understand why all new trending of the calibration with time was leading to drifts in the ocean color data products, including retrospective effects. Turpie conducted an analysis of the ocean color data product test time series to be sure that the observed effects were not stemming from somewhere else in their production, confounding the evaluation of the calibration trending. He found nothing conclusive.

Turpie organized semi-regular meetings between the ocean calibration team and the VIIRS Calibration Science Team (VCST). He continued the discussion regarding the effects of spectral drift in the Solar Diffuser Stability Monitor (SDSM) on the calibration time series, identify data that would help understand the scale of the effect. This ongoing exchange involved the instrument contractor team and VCST, which highlighted the uncertainty in the VIIRS solar calibration trending generated by uncertainty in knowledge of the SDSM behavior and the need of the lunar trending to offset of trend bias in the solar calibration trending. Turpie made a new attempt to acquire SDSM spectral response data from VCST. Turpie extended his analysis of calibration trend uncertainty with updated calibration time series and look at the implications for ocean color data product time series.

Plans for next year
Uncertainty of the solar trending will be presented at the upcoming SPIE meeting in San Diego and published in the corresponding proceedings. This includes a focus on how spectral drift in VIIRS total band responsivity can affect the overall calibration trending and influence the ocean color data product time series. Turpie will continue to look at sources of uncertainty in the trending of calibration and also look at effects in aggregated data sets, such as global composites and time series of associated statistics.

Task 111

Task Sponsor
Nickolai A. Krotkov, 614

JCET Personnel
Keith D. Evans, Research Analyst

Summary
The goal of the NASA/Goddard Sulfur Dioxide Monitoring web site is to create and maintain long-term SO_2 cross-satellite climate data records that started with Nimbus7-TOMS UV SO_2 measurements in 1978 and presently continuing with AIRS, Aura/OMI and NPP/OMPS SO_2 data. 34 regions of the world are monitored and displayed on a daily basis. The web site will be developed into the "public face" of the volcanic disasters project that will be more useful for near-real time users from different agencies, the general public and for aviation safety. Evans participates in NASA's Earth Science Data Systems Working Group which focuses on the

exploration and development of recommendations derived from pertinent community insights of NASA's heterogeneous and distributed Earth science data systems.

Accomplishments
The web site currently includes automatic generation of daily OMI and OMPS SO_2 images for volcanic regions. When automatic data processing failed, was able to identify the problem and resolve it quickly. Updated and reprocessed SO_2 images for clarity and improved resolution for the Mideast, China, Norilsk regions by using PBL data and for Hawaii using data at 3 km. Reprocessed all OMI data to display the latest version of the SO^2 data using the PCA (Principal Components Algorithm) algorithm. Updated the web site pages for security reasons.

Actively participated in three Working Groups (WG) of the Earth Science Data System Working Group (ESDSWG). Contributed to the Airborne Metadata, ICARTT (International Consortium for Atmospheric Research on Transport and Transformation), and Time SeriesML WGs in 2016. The recommendations from the 2015 ICARTT WG were accepted (ESDS-RFC-029 ICARTT Format Enhancements based on ESDSWG Recommendations) and are published as ICARTT File Format Standards V2.0 (https://earthdata.nasa.gov/standards/icartt-file-format) as a guideline for airborne datasets.

Plans for next year
SO_2 trajectory modeling capability will be added to the NASA SO_2 site. Continued involvement in the Earth Science Data System Working Groups (ESDSWG) by contributing to the Atmospheric Composition Standard Variable Name and Time Series Working Groups. Assist other team members with data program generation. Extending long-term monitoring of sulfur dioxide with new satellite instruments as they become available. Reprocess OMPS data to display the data for the PCA algorithm.

Task 112

Task Sponsor
Nickolay Krotkov, 614

JCET Personnel
Leonid Yurganov, Senior Research Scientist; Nathaniel Lebedda, Undergraduate Student Assistant

Summary
This task is a part of the entire MEASURES project that is lead by Dr. Yurganov, focussing on development and quantification of the infrared retrieval techniques for sulfur dioxide using radiation data gathered by NASA satellites (Atmospheric InfraRed Sounder(AIRS)/Aqua, Cross-track Infrared Sounder (CrIS)/Suomi). The NASA grant supports satellite-based methane remote sensing using the thermal infrared radiation used by satellite-based instruments like AIRS (since 2002) and IASI (since 2007). In this project Dr. Yurganov is responsible for preparation, validation, and analysis of all satellite methane data. Dr. Yurganov supervises the work of the student on this task.

Accomplishments
The activity during the second half of 2016-2017 focused on improvement of FORTRAN code that is planned to be incorporated into standard NASA retrieval procedures. In an attempt to include maximum real information about the atmospheric state, Dr. Yurganov used data archived by the Earth Observing System Data and Information System (EOSDIS) and the Global Modeling Initiative (GMI). Profiles of temperature and humidity were supplied by AIRS as well as data for the surface emissivity. The new improved algorithm was applied for retrieval of SO2 from AIRS data for 15 eruptions occurred during the operational period of AIRS. These data were used by Dr. Krotkov for comparison with corresponding OMI and OMPS data.

Plans for next year
The task expires in September 30, 2017.

Task 113

Task Sponsor
David Whiteman, Code 612

JCET Personnel
Igor Veselovskiy, Associate Research Scientist

Summary
This task includes two research activities. First is analysis of potential of Raman and fluorescence lidars for remote identification the molecular fingerprint of gases, liquids, and solids. The project was funded by National Geospatial Intelligence Agency to develop an active airborne system for desired Active Chemical-Gas Identification. The second activity is focused on evolution of the supercooled liquid water and ice fractions in the middle troposphere clouds with better spatial and temporal resolution compared to previous studies.

Accomplishments
Analysis of capabilities of Raman and fluorescence techniques for detection of gases in atmosphere and films on the water surface from an aircraft:

The project was funded by National Geospatial Intelligence Agency The goal of this research is to ultimately use the LIDAR (Light Detection and Ranging) techniques to develop an active airborne system to provide consistent streaming of remote sensing data using Raman spectroscopy. The desired Active Chemical-Gas Identification and Detection (ACID) system will provide an analytical tool for identification the molecular fingerprint of gases, liquids, and/or solids directly. Raman spectroscopy is highly selective, which allows for use of Raman spectral libraries to identify, verify, and differentiate among molecules and chemical species. The goal of this Phase-I research was to study the feasibility of an active sensing approach for the identification, verification, and differentiation of molecules, materials, and chemical species involved in illicit drug manufacture. The numerical simulations performed confirm that certain gases of interest can be detected from aircraft at 2000 m height. For detection of substances on the water surface the methods based on the laser induced fluorescence and resonant UV Raman scattering were proposed.

Analysis of supercooled liquid water layers in the middle troposphere:

Mixed-phase clouds in the middle and upper troposphere over West Africa were studied by means of a multiwavelength polarization Mie-Raman lidar during the SHADOW field campaign that took place in Dakar, Senegal. The lidar measurements were performed at a slant angle of 43 deg off zenith. Lidar measurements were used to monitor the evolution of the supercooled liquid water (SCLW) and ice fractions in these clouds with better spatial and temporal resolution compared to previous studies. Supercooled liquid water was regularly observed in the form of extended layers at the tops of clouds for several hours at temperatures as low as -32^{0}C. The measurements demonstrate that SCLW layers contain ice crystals, still such two-phase systems can exist in the state of apparent equilibrium for hours without glaciation. The lidar measurements were performed at 532 nm and 355 nm and for all cases the spectral dependence of the backscattering coefficient, extinction coefficient and depolarization ratio was analyzed and the possible contribution of the corner reflection (CR) effect to the ice crystals backscatter was considered. We did not observe any spectral features, pointing to the presence of CR of randomly oriented hexagonal columns or plates, still we had observations, where positive values of backscattering Angstrom exponent can be attributed to the CR of horizontally oriented ice plates.

Design of compact multiwavelength Raman lidar:

The compact multiwavelength Raman lidar capable to measure simultaneously three depolarization ratios at 355, 532, 1064 nm wavelengths was be designed. The system uses the telescope from the carbon fibers of 400 mm aperture. The laser is fixed on the telescope, so the measurements at any angle to horizon are possible. In 2016 the telescope has been manufactured. The system is expected to be completely assembled during 2017.

Plans for upcoming year

- Validation of MERRA transport model by comparing the modeled vertical distribution of aerosol parameters with multiwavelength lidar observations.
- Development of new retrieval code for profiling of particle properties based on synergy of lidar measurements and the MERRA modeling.

Task 114

Task Sponsor
J. Susskind, Code 610

JCET Personnel
Jae Lee, Assistant Research Scientist

Summary
The objective of this task is to develop an accurate sounder based multi-decade climate data set using Aqua AIRS and TOVS Pathfinder Path-A products. The task involves studying

characteristics of TOVS, AIRS, CERES, and MODIS data products, both from the inter-validation perspective and also to identify and help remove biases between AIRS and TOVS products.

Accomplishments
Under the task 114, Lee is working on climate research and participating in the validation of AIRS products, as a member of the AIRS SRT (sounding radiative transfer) team. She presented her work at AIRS 2016 spring and fall sounding meeting. AIRS V-6 OLR (Outgoing Longwave Radiation) is analyzed and compared with those from CERES and MERRA 2 in terms of climatology and inter-annual variability, including Averaged Rates of Change (ARCs), indicative of the slopes of anomaly time series, and El Nino Correlations (ENCs), indicative of correlations of anomaly time series with the El Nino Index, down to the spatial grid point level.

Lee is working on record-breaking warm year of 2016 and its influence on Arctic

environment, as the AIRS surface temperatures show that 2016 was the warmest year ever observed by GISTEMP. To validate AIRS surface temperatures and to improve the products, comparative analysis with reanalysis is performed.

Plans for next year
This task has been cancelled.

Task 115

Task Sponsor
Alexander Marshak, Code 613

JCET Personnel
Tamás Várnai, Research Associate Professor

Summary
The ultimate goal of this work is to help better understand and characterize the role atmospheric aerosols and aerosol-cloud interactions play in our climate. The research focuses on two main areas. First, it examines the systematic changes in aerosol properties that occur near clouds. This includes characterizing the way these changes vary with season, location, and scene properties, and understanding their causes and estimating their radiative impacts. This first area also includes examining the abundance and radiative impact of undetected cloud droplets that occur outside the clouds identified in satellite images, and exploring the benefits of observing aerosols from multiple view directions. Second, the research investigates the uncertainties 3D radiative processes cause in satellite retrievals of cloud properties and aerosol properties near clouds. This involves combining data from several satellites with radiation simulations, and developing a method that enables satellite data interpretation algorithms to consider the impact of 3D radiative processes.

Accomplishments
Várnai and team continued their research on systematic cloud-related changes in satellite-based aerosol observations. They work on this issue because several studies found systematic changes in clear-sky observations near clouds, and also because over oceans, half of all clear areas lie within a few kilometers from clouds.

The research revealed that throughout the globe, the optical thickness of aerosols is 30-50% higher on the cloudier half of days than on the less cloudy other half of days. A combination of MODIS observations with global aerosol simulations revealed that the optical thickness of main aerosol types (sulfate, dust, carbon, and sea salt) all increase with cloud cover.

The observations also indicate that over large regions of the Earth, aerosol size distributions tend to shift toward smaller particles if there are clouds nearby. This occurs because of an especially strong cloud-related increase in the optical thickness of small aerosol particles. The results also show that this occurs mainly due to changes in large-scale conditions, and not the impact of individual clouds. Finally, quality assessment flags based on local variability were shown to help identify when measured aerosol parameters were affected by surrounding clouds.

The team also expanded a model that estimates how sunlight scattered from clouds will affect near-cloud aerosol measurements. The expansion allows the model to consider that some of the cloud-scattered light is reflected toward the satellite by the underlying surface. Testing suggests that the expansion allows the model to remove much of the biases caused by nearby clouds.

The work also included analyzing airborne CAR (Cloud Absorption Radiometer) measurements of sunlight reflected into multiple directions. The team developed methods for combining CAR observations with radiation simulations, with the goal of estimating the radiative properties and radiative impacts of wildfire smoke plumes.

Finally, the research included the analysis of observations collected by the DSCOVR spacecraft from a location four times farther than the Moon. The team examined the origins of colorful bright spots that appear in hundreds of satellite images, and found that these spots are caused by specular reflection (glint) from ice platelets that float inside clouds with a nearly perfect horizontal orientation. The team then developed a method for the automatic detection of horizontally oriented ice crystals in clouds. Such deep space detection of atmospheric ice can be used to constrain the likelihood of oriented crystals and their contribution to Earth albedo. The observations also support proposals for using starlight glints to help characterize exoplanets.

Plans for next year
The team plans to continue research on the properties of near-cloud aerosols. As part of this work, they plan to combine MODIS and CALIOP observations with MERRA-2 global reanalysis data, and examine how different types of aerosols respond to cloudiness and environmental factors such as humidity.

The team also plans to refine their model for improving satellite-based aerosol measurements in the vicinity of clouds. Specifically, they plan to characterize the model's impact on aerosol properties retrieved by the MODIS Dark Target aerosol retrieval algorithm.

The plans also include completing the study on using airborne multiangle measurements for characterizing the properties and radiative impacts of wildfire smoke.

Finally, the team plans to examine the frequency of horizontally oriented ice crystals using deep-space observations by the DSCOVR spacecraft, and to analyze how the occurrence of such crystals depends on environmental conditions. Expanding the DSCOVR data analysis, the team will also examine the spectral dependence of sunlight reflected from the Earth as a whole, and will explore the role of key factors such as cloudiness.

Task 116

Task Sponsor
James Butler, Code 618

JCET Personnel
Kevin R. Turpie, Research Associate Professor

Summary
Turpie participates in the review, analysis, and ocean color science impact assessment of test data from Visible Infrared Imaging Radiometer Suite (VIIRS) instruments, as part of the greater Joint Polar Satellite System (JPSS). His support as an ocean color subject matter expert includes the following: (1) supporting VIIRS ambient and thermal vacuum test data reviews either at GSFC or at Raytheon El Segundo, (2) reviewing Raytheon VIIRS test plans and technical memos particularly those on spectral and radiometric calibration and characterization, (3) assessing the impacts to science of J1 VIIRS instrument performance as reflected in the instrument ambient and thermal vacuum test results and level 1 requirements.

Accomplishments
Turpie participated in routine evaluation of the characterization data analysis for the JPSS2 VIIRS instrument by the Data Analysis Working Group. He also identified and acquired characterization tables for the JPSS1 VIIRS instrument for use by the Ocean Biology Processing Group (OBPG), which generates and publically distributes ocean color data products for NASA. Turpie participated in discussions regarding waivers for the JPSS2 VIIRS polarization response, which was predicted by an optics model to go out of the bounds of the instrument specifications.

Turpie wrote a brief report for the JPSS project providing details regarding the production of Level-1 data products by the OBPG and the use of those Level-1 data products in creating ocean color data products (Level-2 and Level-3). This also provided information on where instrument characterization enters the process. In particular, the use and effects of polarization and relative spectral response and other instrument behavior were described. Also described in detail was the insertion of vicarious calibration, necessity for, and the nature of its uncertainty on, data product quality. The report then explained how these affect propagate to downstream products, especially chlorophyll concentration.

Plans for next year
Turpie will be working with the OBPG in preparing for the data processing that is expect after the launch of the JPSS-1 satellite in the autumn of 2017 (launch date slipped for April 2017).

Turpie will assess quality new data from the JPSS-1 VIIRS instrument after its launch as early as October 2017. This will include the quantification of striping and other imagery artifacts and characteristics of the calibration data.

Turpie will liaise between the NASA VIIRS Calibration Science Team (VCST) and the VIIRS ocean calibration team. He will also continue to interact with NOAA colleagues in order to facilitate research to operations technologies transfer.

Task 117

Task Sponsor
Dong Wu, Code 613

JCET Personnel
Jae Lee, Assistant Research Scientist

Summary
This task is focused primarily on supporting Total and Spectral Solar Irradiance Sensor-1 (TSIS-1) mission, which will be launched to International Space Station, in late 2017. This task includes reviewing the mission's calibration/validation and management plans in collaboration with Laboratory for Atmospheric and Space Physics (LASP). This task also focused on Sun-Earth related research, by analysis from multi-sensor spaced based terrestrial observations of physical variables and atmospheric tracers in conjunction with the solar irradiance observations to develop appropriate Sun-Climate system model. For this research, Lee will investigate characteristics of both total and spectral solar irradiance, both with the inter-validation perspective and also with the identification of biases potentially caused by irradiance sensor degradation from the SORCE (Solar Radiation and Climate Experiment), TCTE (TIM Calibration Transfer Experiment), and upcoming TSIS-1. The primary science objective is to keep developing and exploring the solar impact on Earth's climate using a variety of existing terrestrial and solar satellite observations and model results.

Accomplishments
The primary accomplishments during this period are focused on the preparation for smooth launch of TSIS-1. Lee also supported number of mission reviews and mission related workshops. Lee also contributed to mission communication and outreach program, including development of Sun-Climate website and TSIS-1 "Fact Sheet". While she was working as a member of the TSIS-1 science team, she reviewed number of documents, including TSIS-1 ATBD, TIM and SIM Calibration/Validation plan and participated in two TSIS-1 quarterly reviews and delta Pre-Environmental Review to examine the ground Cal/Val uncertainties. Lee is continue to support weekly staff meetings and telecoms.

For science, the spectral solar irradiance (SSI) variability from space-based observations and solar irradiance models are analyzed. In her recent work with the SSI analysis, Lee clearly identifies phases and amplitudes of solar rotational variations of solar irradiance from TIMED/SEE, SORCE/SOLSTICE, and SORCE/SIM, throughout the whole observation periods of each instrument. Lee compared those modes with those from SORCE/TIM Total Solar Irradiance (TSI) observations, SATIRE-S solar model, and also with two other solar proxies (sun spot numbers and F10.7 index). The rotational variations of SSI from independent observations are generally consistent with each other, but show distinct solar rotational modulations at each wavelength.

Lee has been an organizer of the SORCE meeting since 2008 and continues to serve for the chair of climate related session in 2018 Sun-Climate Symposium.

Plans for next year
Lee will support to finalize the Cal/Val plan of TSIS-1, and the review for the TSIS-1 ATBD, which describes characteristics of the data and algorithms used to produce all data levels for Total Solar Irradiance Monitor (TIM) and Spectral Solar Irradiance Monitor (SIM). Lee will also work on comparison of solar irradiance data from multi-sensor observations, and diverse solar spectral models to get a reference spectrum, which is scientifically valid.

Task 118

Task Sponsor
Ellsworth J. Welton, Code 612

JCET Personnel
Simone Lolli, Research Assistant Professor

Summary
MPLNET (Micro Pulse Lidar NETwork) is in the process of incorporating other than Micro Pulse Lidar into the network, with different wavelengths than green, like in the UV. However, the wavelength and signal noise characteristics are different. Specifically, the current standard algorithms for layer height detection and aerosol and cloud retrievals should be tested on new data retrieved at different wavelength. Methods are being developed to incorporate the data successfully. Taking advantage of the two wavelengths, when available, it is possible to retrieve microphysical properties of the precipitation (evaporation), cloud and aerosols. The double wavelength measurements on cirrus clouds will help to assess the fundamental contribution to the radiative forcing by those higher troposphere clouds.

Accomplishments
Lolli conducted research on cirrus cloud radiative forcing by lidar means using the Fu-Liou-Gu Radiative Transfer model applied to cirrus clouds detected by MPLNET lidar network using multi-year data from different station at different latitudes.

Lolli participated in the framing of 7-SEAS NASA mission, a measurement campaign planned for summer 2017 in the Philippines and in South East Asia region. The goal of the campaign is to assess direct and indirect aerosol interaction with meteorological phenomena.

Plans for next year
This task was cancelled in January 2017.

Task 119

Task Sponsor
Ellsworth J. Welton, Code 612

JCET Personnel
Jasper Lewis, Assistant Research Scientist

Summary
This research is focused on the development of cloud and boundary layer detection algorithms for the Micropulse Lidar Network (MPLNET). These retrieval algorithms are applied to a global network of elastic backscatter lidars in order to produce long-term climatologies showing diurnal, seasonal, and annual trends. In particular, boundary layer retrievals are used to quantify and understand spatiotemporal gradients in the Baltimore-Washington DC urban corridor. A regionally dense network of micropulse lidars, along with aircraft-, ship-, and satellite-deployed lidar systems, are used for comparison with modeled mixed layer heights in order to reduce errors in estimates of urban pollutant emissions and air quality modeling.

Accomplishments
Beta-level cloud and boundary layer products have been added to the MPLNET website for evaluation. Quality assurance flags have been developed to assist data users in interpreting the products. A series of papers were published on the subject of the cirrus cloud radiative effect, one of which was awarded the Naval Research Laboratory Alan Berman Research Publication Award. A multi-year comparison of MPLNET and Weather Research and Forecasting model boundary layer heights has been completed as part of NASA Grant NNH14CM13C which are being used to evaluate the ability of the model to simulate spatiotemporal variability in an urban region. A proposal was submitted to develop a data record of hourly planetary boundary layer heights informed by NASA satellite observations of skin temperature from Aqua, TRMM, and GPM, as well as geostationary satellite observations. If accepted, MPLNET boundary layer heights will be used as a part of the validation of the data record.

Plans for next year
Two papers will be submitted. The first will focus on data collected during the DISCOVER-AQ field campaign and bay breeze circulations from the Chesapeake Bay. The second will use the multi-year comparisons completed using the NASA Goddard Space Flight Center and UMBC MPLNET sites. Research will be continued showing macrophysical and optical properties of

cirrus clouds measured from ground-based and spaceborne lidar instruments. The radiative effects of these high-altitude clouds will also be examined.

Task 120

Task Sponsor
Mian Chin, Code 614

JCET Personnel
Bian Huisheng, Associate Research Scientist

Summary
Atmospheric aerosol and gas tracers affect air quality and climate. To pursue scientific objectives of improving atmospheric aerosol simulation and understanding their impact, Huisheng Bian contributes to several scientific studies and assessments: (1) leading AeroCom III nitrate experiment to assess driving reasons for uncertainty in multi-model nitrate simulations; (2) participating other 4 international assessments for atmospheric aerosol and its impact on atmospheric pollution and dynamic fields; (3) supporting the ATom field campaign by providing GEOS-5 forecast chemical fields; (4) improving chemical lateral boundary conditions for the National Air Quality Forecasting Capability (NAQFC) operated within NOAA; (5) Assisting the study of connection between East Asian air pollution and monsoon system; (6) Assisting the study of the role of surface wind and vegetation cover in multi-decadal variations of dust emission in the Sahara and Sahel; and (7) Proposing new studies about aerosol and its impact and 4 of them have been funded by NASA agency.

Accomplishments
Huisheng Bian devotes much of her efforts to several national and international assessments of aerosols and their impacts. She is leading the AeroCom III nitrate experiment to assess the diversity of nitrate simulations by AeroCom models and understand the reasons for intermodal differences by comparing model nitrate results with various measurements and by investigating how nitrate formation changes in response to the perturbation of precursor emissions and meteorological conditions. She has submitted a manuscript in April and the revised manuscript in July for the work. Huisheng Bian, representing the NASA GEOS-5 aerosol group, also supports other 4 international assessments for aerosol at Poles, biomass burning aerosol transport and vertical distribution over the South African-Atlantic region, global and regional radiation forcing from 20% reductions in BC, OC and SO4, and the impact of Aviation Environmental Design Tool (AEDT) prepared aircraft emission on surface PM2.5 level. Papers have been published for the first three assessments and a paper is under review for the last one.

Huisheng Bian supported the NASA Atmospheric Tomography Mission (ATom) phase II during Jan-Feb 2017. She provided daily flight track guidance for flight planning remotely via email/WebEx. As a co-organizer, she worked with Mian Chin (NASA GODDARD) to propose a study to engage the international community of AeroCom to be involved in the ATom study. This proposal has been approved by the ATom science team. Huisheng Bian is working to provide a quick, “first look” of model simulation and analysis with respect to the origin of aerosols and related trace gases using the NASA GEOS5 GOCART. She has given an oral report in ATom phase I science team meeting and updated their study in ATom phase II science team meeting in July 2017.

Huisheng Bian is also involved in several scientific studies of aerosols and their impacts. She is a co-I of a NOAA project that helps developing a framework to integrate the near-real time results out of NASA GEOS-5 into NAQFC for improved chemical lateral boundary conditions. She is in charge of providing the GEOS-5 data and guides the data application. Preliminary results show encouraging improvement of NAQFC simulation, particularly for the model in capturing aerosol events. Huisheng Bian also worked with her colleagues investigating the connection between East Asian air pollution and monsoon system (paper accepted) and the role of surface wind and vegetation cover in multi-decadal variations of dust emission in the Sahara and Sahel (paper published).

Plans for next year
Huisheng Bian will continuously contribute to the on-going NOAA projects. She will also continuously support the ATom field campaign. In the meanwhile, she is a co-organizer of an upcoming AeroCom-ATom activity (Global modeling and analysis of aerosol composition, distribution, and processes with observations from Atmospheric Tomography Mission). She will be working with Mian Chin and the instrument teams to provide quick, "first look" of GEOS-5 model simulation and analysis with respect to the origin of aerosols and related trace gases as well as information on the age of air the aircraft had encountered. Huisheng Bian has also got funded for four NASA projects in 2017 (one PI, one co-PI and two co-I). She has started to work on these funded projects.

Task 121

Task Sponsor
Lazaros Oreopoulos, Code 613

JCET Personnel
Tianle Yuan, Assistant Research Scientist

Summary
This task entails analysis of climate data records and model simulation data to find useful patterns of information. Specifically, we are researching clouds' behavior under changing climatic conditions and seeking to identify cloud feedback patterns. It also involves probing dust activity under changing climate conditions.

Accomplishments
We use long-term satellite cloud data records to reveal new insights about how low clouds around the world respond to interannual variations of sea surface temperature. There are internal modes of variability in both SST and low cloud fraction in the observational data. Internal modes of variability in both SST and low clouds are intimately linked and physically can be interpreted

as a positive feedback process. The results have been written up and submitted to Nature Communications. It was reviewed and we are in the process of revising.

A paper is published in Atmospheric Chemistry and Physics this year. My contribution is to provide MODIS-based satellite observations to supplement results from aircraft based remote sensing instruments. This paper opens the possibility of expanding the MODIS-based approach to a global application.

We are in the process of writing a manuscript regarding dust variability and implication of past and future climate change scenarios.

We initiated a project to combine artificial intelligence with crowdsourcing. We wrote a proposal that is highly rated although not funded. We hope to work on this and get it funded in the future.

Plans for next year
In the coming year, we are continuing the efforts in the fronts of dust variability and low cloud studies.

Task 122

Task Sponsor
Jeff Masek, Code 618

JCET Personnel
Forrest Hall, Senior Research Scientist

Summary
This task involves joint development of algorithm and analytic techniques from a variety of data sources to quantify vegetation/atmosphere energy and mass exchange from space.

Accomplishments
Hall worked on the development of algorithm and analytic techniques from a variety of data sources to quantify vegetation/atmosphere energy and mass exchange from space.

Plans for next year
This task was cancelled in December 2016.

Task 123

Sponsor
Robert Levy, code 613.2

JCET Personnel
Dominic Ceislak, Faculty Research Assistant

Summary
This task covers the detailed characterization of aerosol particles and its effects on the radiative balance of the atmosphere and in cloud microphysics by the Laboratory for Aerosol, Clouds and Optics (LACO) at UMBC. These topics are addressed with a variety of new techniques and methodologies covering instrument development, laboratory and field measurements from the ground and aircraft platforms, algorithm development, satellite remote sensing from existing and new platforms, and model calculations. In particular, this task covers the development and application of the HARP satellite, the ACE project, and similar platforms for the remote sensing of aerosol and cloud properties.

Accomplishments
Our group continues to work on the HARP project for both, the CubeSat satellite and for an ER2 airborne version of the HARP imaging polarimeter called Air-HARP. The HARP CubeSat is scheduled for launch to the International Space Station in January 2017 and to be released for autonomous operation shortly after. Cieslak tested and validated several components of the HARP and AirHARP systems including stripe filters, detector assemblies, polarizers and calibration systems. He has also participated in the integration, testing and participation of AirHARP in the LMOS field campaign in Wisconsin. He has also supported all activities in the LACO laboratory including the operation, maintenance, and upgrades to the Imaging Nephelometer systems in operation at UMBC. Our group owns several of these systems that are currently being used for the analysis of aerosol and cloud particles, including volcanic ash particles provided by the Volcanology group at NASA GSFC.

Plans for next year
- Launch the HARP satellite and start operations
- Support the Implementation of HARP's Science Operation Center
- Support the development of the HARPP polarimeter for the PACE mission.
- Participate in the implementation and test of the Air-HARP instrument to the NASA ER2 aircraft
- Support the ACEPOL experiment
- Support work with the PI-Neph instruments.

Task 124

Sponsor
Robert Levy, code 613.2

JCET Personnel
Vanderlei Martins, JCET Fellow, Professor/Physics

Summary
This task covers the detailed characterization of aerosol particles and its effects on the radiative balance of the atmosphere and in cloud microphysics by the Laboratory for Aerosol, Clouds and Optics (LACO) at UMBC. These topics are addressed with a variety of new techniques and methodologies covering instrument development, laboratory and field measurements from the

ground and aircraft platforms, algorithm development, satellite remote sensing from existing and new platforms, and model calculations. In particular, this task covers the development and application of the HARP satellite, the ACE project, and similar platforms for the remote sensing of aerosol and cloud properties.

Accomplishments

Our group continues to work on the HARP project for both, the CubeSat satellite and for an ER2 airborne version of the HARP imaging polarimeter called Air-HARP. The HARP CubeSat is scheduled for launch to the International Space Station in January 2017 and to be released for autonomous operation shortly after. The HARP payload has been completed and is currently awaiting final integration at Space Dynamics Lab in Utah, where the final environmental testing and calibration will be performed. We have also completed the assembly and integration of the AirHARP system to the NASA Langley UC12 aircraft. AirHARP has successfully participated in the LMOS campaign in Wisconsin where we collected cloud and aerosol data for about a month in May/June 2017. The system is also scheduled to participate in the ACEPOL campaign with the ER2 aircraft in October/November 2017.

On the analysis of other in-situ data we have continued analysis and inversion of the microphysical data from the PI-Neph instrument concluding the analysis of data from the SEAC4RS experiment and laboratory analysis of Volcanic Ash samples provided by the Volcanology group from GSFC.

Plans for next year

- Launch the HARP satellite and start operations
- Implement HARP's Science Operation Center
- Continue to work on GRASP microphysical retrievals for HARP and AirHARP
- Continue the analysis of PI-Neph data
- Continue the interaction with the Volcanology group at GSFC.
- Start the development of the HARPP polarimeter for the PACE mission.

Task 125

Sponsor

Robert Levy, code 613.2

JCET Personnel

Roberto Fernandez-Borda, Assistant Research Scientist

Summary

This task covers the detailed characterization of aerosol particles and its effects on the radiative balance of the atmosphere and in cloud microphysics by the Laboratory for Aerosol, Clouds and Optics (LACO) at UMBC. These topics are addressed with a variety of new techniques and methodologies covering instrument development, laboratory and field measurements from the ground and aircraft platforms, algorithm development, satellite remote sensing from existing and new platforms, and model calculations. In particular, this task covers the development and application of the HARP satellite, the ACE project, and similar platforms for the remote sensing of aerosol and cloud properties.

Accomplishments
Our group continues to work on the HARP project for both, the CubeSat satellite and for an ER2 airborne version of the HARP imaging polarimeter called Air-HARP. The HARP CubeSat is scheduled for launch to the International Space Station in January 2017 and to be released for autonomous operation shortly after. Borda has completed the firmware and the software of the HARP payload as well as the integration and testing of the overall system. He has also assisted the final implementation of the AirHARP system in the NASA Langley UC12 airplane and its successful participation in the LMOS field campaign in Wisconsin.

Plans for next year
- Launch the HARP satellite and start operations
- Implement HARP's Science Operation Center
- Support the development of the HARPP polarimeter for the PACE mission.
- Participate in the implementation and test of the Air-HARP instrument to the NASA ER2 aircraft
- Support the ACEPOL experiment
- Support HARP's operation and data analysis

Task 126

Task Sponsor
Ken Pickering, Code 614

JCET Personnel
Ana Prados, Research Assistant Professor; Brock Blevins, Research Analyst; David Barbato, Graduate Student

Summary
Managed and coordinated NASA's Applied Remote Sensing Training Program. ARSET offers satellite remote sensing training that builds the skills to integrate NASA Earth Science data into agency's decision-making activities. Trainings were offered in air quality, climate, disaster, health, land, water resources, and wildfire management. Through online and in person training, ARSET has reached nearly 12,500 participants from 152 countries and 2800 organizations worldwide since 2009. In FY17 ARSET reached 4315 participants from 132 countries and more than 1900 organizations.

Accomplishments
Managed and coordinated 8 webinars and 4 in-person trainings between October 2016 and July 2017. This included the first ARSET webinar on Remote Sensing Training Methods and Best Practices (October 2016, 156 attendees), the first two ARSET trainings focussed on the United Nations Sustainable Development Goals (air quality applications, March 2017, 391 attendees; and land applications, June 2017, 446 attendees), the first webinar on Synthetic Apperture Radar

applications (June-July 2017, 982 attendees), and an air quality training at the Indian Institute of Tropical Meteorology (May 2017). The SAR webinar was a record for the largest participation to date.

Ana Prados provided overall program management for the ARSET team at four NASA centers. She presented and led discussion sessions for end-users at the Air Quality and Health, and MERRA-2 showcase held at NASA Goddard in November 2016 and June 2017. She also served on the NASA GES DISC, NASA Langley ASDC, and LANCE User Working Groups and shared feedback from ARSET participants so that NASA data centers can better serve the needs of end-users. Brock Blevins coordinated all ARSET training activities, grew the outreach and promotional elements of the program, incorporated a new software platform for the delivery of online trainings, maintained the participant database for ease of internal and external reporting, and managed students. He was also a co-author in an article highlighting the success of one ARSET's SDG webinars:

http://sdg.iisd.org/commentary/guest-articles/using-free-remote-sensing-data-to-implement-sdg-targets-on-air-quality/

Student David Barbato translated most of the training materials into Spanish, and one webinar was delivered in both Spanish and English. Heather Mortimer assisted with communications and the design of the first quarterly ARSET newsletter, and Selwyn Hudson-Odoi assisted with record keeping and outreach.

Plans for next year

About 13-15 online and in-person trainings are planned for the next year in air quality, climate, disaster, health, land, water resources, and wildfire applications. One example is an air quality training in collaboration with the South Coast Air Quality Management District, in California. A collaboration with UNESCO will culminate in a 'satellite remote sensing for watershed management' training in Brazil in the Fall of 2017. ARSET will also develop new training modules using an e-learning platform. The advantage of this platform is that it fully integrates all aspects of the online learning experience, such as presentations, homework, and other resources. End-users will be able to take these courses on-demand, and they will also serve as prerequisites for ARSET trainings. In response to end-user demand, the program will also expand its portfolio of trainings on SAR applications for water resources and disaster management.

Task 127

Task Sponsor

Peter R. Colarco, Code 614

JCET Personnel

Adriana Rocha Lima, Post-doctoral Research Associate

Summary
A more comprehensive description of the optical properties of dust and volcanic ashes is needed to better represent aerosols in global models. To assess that, this project aims to incorporate measurements of optical and microphysical properties of mineral dust and volcanic ash into a new optical module of the GEOS-5 model. The new optical module is in development, and it will be tested under different scenarios to evaluate the importance of the variability of the optical and microphysical properties of dust for prediction of dust lifecycle, global mass distributions, and ultimately radiative forcing.

Accomplishments
A paper containing optical and microphysical properties of Saharan dust was submitted on March to the Atmospheric Chemistry and Physics journal (ACP) and since June it is available for public review in the ACPD. Additionally, Rocha-Lima has continued to support the LACO-UMBC group with the efforts to create a database of optical properties of volcanic ashes.

Plans for next year
In order to evaluate the sensitivity of satellite observations to differences in dust mineralogy, we will use the Ozone Monitoring Instrument (OMI) simulator built on the Vector Radiative Transfer Model (VLIDORT) to evaluate the OMI top-of-atmosphere radiances based on the GEOS-5 simulated aerosol profiles. We will compare simulated radiances in which dust optical properties are assigned to be globally uniform with simulations using different scenarios where more than one set of the optical properties are used to represent dust properties. This study will allow us to investigate the potential to observe differences in dust mineral composition in remote sensing observations. In the next month, Rocha-Lima will give an oral presentation at the Goldschmidth 2017 conference, where she will be presenting a summary of the last results on the dust apportionment study.

Task 128

Task Sponsor
Elizabeth Middleton, Code 618

JCET Personnel
Petya Campbell, Research Associate Professor

Summary
The goal of this task is to develop methods for using spectral optical and thermal measurements to characterize vegetation traits, physiological condition and productivity. The task consists of four components:

1. science support for the Earth Exploring 1 satellite mission;
2. collection and analysis of field measurements; and
3. science support for the development of NASAs Hyperspectral Infrared Imager (HyspIRI) mission concept.

4. Coordination of the GOFC-GOLD South Central and Eastern European Regional Information Network (SCERIN)

Accomplishments

Science support for EO-1 mission: component one included evaluation of the stability of the Hyperion spectral observations at desert sites; and evaluation of the Hyperion spectral time series at flux sites for evaluation of ecosystem function. I corrected for atmospheric effects a time series of EO-1 Hyperion images (more than 300 total) at two desert sites (Railroad Valley and Libyan desert 4), and eight eddy co-variance globally distributed sites representative of different ecosystems. I worked with a student assistant – Sarah Voorhees, to quality check the correction of the images and improve the estimated reflectance by collecting additional atmospheric and sensor information and optimizing the input parameters of the atmospheric correction models to better reflect the site specifics. I analyzed the spectra and screened the data to exclude outliers.

The spectral time series collected at desert sites was evaluated for temporal changes associated with the precession of the satellite to lower altitude. The data was contributed for the materials for mission review at NASA/HQ, and for the development of a peer-reviewed publication describing the stability of the EO-1 Hyperion reflectance time series, which is currently under review.

For the vegetative sites I matched and merged the spectra with the mid-day carbon flux measurements for each site. The data was used to derive spectral parameters describing vegetation pigment, cellulose and water contents and function. The relationships among the vegetation spectral parameters and the carbon flux measurements by the flux towers are currently being evaluated to develop common/transferable approaches for determining ecosystem productivity, using the spectral images.

Field measurements at the OPE3 cornfield study site at the Beltsville Agricultural Research Center. As part of this project I deployed two automated passive system for measuring canopy fluorescence and reflectance: a ground system called FLoX , which was installed on a tower to collect nadir measurement 1 m above the corn canopy; and UAV based system called PICCOLO. I also installed one automated active system for measuring leaf fluorescence called MONI-PAM. For comparison as part of field campaign at the site we are measuring every 1-2 weeks vegetation photosynthesis, reflectance and fluorescence using handheld systems (ASDs and LI6400). The task also includes the analysis of these corresponding datasets including leaf and canopy reflectance, fluorescence and photosynthesis, which will be completed during the Fall 2017.

The results from analysis using similar, prior data collections (collected in 2012 -2014) were summarized into a poster and presented at the SAIL 35 meeting in Enschede, Netherlands. I evaluated actively-excited fluorescence emission patterns from corn leaves and canopy, and examined how they change diurnally and seasonally. Using SYSTAT, I developed statistical models relating the measured vegetation reflectance and fluorescence parameters to productivity, as measured by the flux tower at the site. At the SAIL 35 meeting made a poster presentation reporting the results from the analysis of the relationship between the MONI-PAM and the carbon flux measurements by the eddy covariance tower.

As a co-author contributed to presentations and submission of manuscripts by Dr. Middleton and Dr. Huemmrich which are presently in review.

Campbell attended the following meetings and made the presentations listed below:

- SCERIN-5, Pecs, Hungary (June 19-24, 2017)
- OPTIMISE/ESA Annual Workshop and MC Meeting, Limassol, Cyprus, 22-24th February, 2017.
- AGU, San Francisco, (December 16, 2016)
- HyspIRI Science and Applications Workshop, California Institute of Technology, Beckman Institute Auditorium, 1200 E California Blvd, Pasadena, CA 91125 (October 2016)
- SAIL35, Enschede, Netherlands (October, 2016)

Plans for next year
Campbell is working on the analysis of EO-1 Hyperion spectral time series in relationship to ecosystem seasonal flux dynamics to submit (by December) a manuscript for publication: "EO-1 Hyperion spectral time series for remote sensing of ecosystem carbon dynamics at select globally distributed eddy covariance sites."

Task 129

Task Sponsor
Elizabeth Middleton, Code 618

JCET Personnel
Kevin R. Turpie, Research Associate Professor

Summary
Dr. Kevin Turpie leads research efforts related to the development and evaluation of coastal and in-land water aquatic remote sensing data products and applications for the Hyperspectral and Infrared Imager (HyspIRI). He functions as the founding chair of the HyspIRI Aquatic Studies Group (ASG), directing the dialogue of ASG members and other members of the coastal and in-land aquatic remote sensing community to identify and lay the groundwork for development of aquatic data products for HyspIRI and related missions. This work leverages community collaboration, scientific literature, and analysis and be documented in reports submitted to project management and through peer review publications.

Accomplishments
Dr. Kevin Turpie participated in the annual HyspIRI Science Workshop in October, in Pasadena, California. He presented ideas regarding the development of a capability for remote sensing of coastal / inland water ecosystems from space focused on selected, representive sites around the globe. He also presented an update on community activities of the ASG. Turpie hosted a

HyspIRI Town Hall at the bi-annual Ocean Optics XXIII meeting, this year in Victoria, British Columbia.

In January, Turpie submitted a short paper regarding the need of hyperspectral remote sensing to assess and monitor habitat loss in coastal ecosystems. The paper will be presented in Ft. Worth, Texas at the annual International Geophysical and Remote Sensing Symposium (IGARSS) this July. A similar paper will also be published in the peer-review literature as a front piece for a special research topic, for which Turpie is the lead editor.

Turpie co-chaired a workshop at the International Ocean Colour Science (IOCS) meeting in Lisbon, Portugal in May. He moderated a discussion on instrument requirements for aquatic observations and supported a presentation regarding the Committee for Earth Observing Satellites (CEOS) Water Strategy team feasibility study on a remote sensing instrument for coastal and inland aquatic observations of ecosystems and water quality.

By request of the Canadian Space Agency team, Turpie was invited to participate in meetings regarding the Canadian Coastal Ocean Color Instrument (COCI). He attended one meeting in Canada remotely to comment on presentations regarding requirements and justifications for funding by the Canadian government for a COCI mission, which as to be attached to the NASA Phytoplankton, Aerosols, Clouds and ocean Ecology (PACE) mission. He also attended a meeting providing an overview of the COCI capability at NASA's Goddard Space Flight Center. Unfortunately, NASA all but completely declined involvement in supporting the COCI instrument on PACE. However, the Canadians continue to look for a path forward for their proposed remote sensing capability.

Turpie continue to contribute to the CEOS Water Strategy team feasibility study and participated in an April CEOS meeting in Paris, France to support a status report on the study's progress. Turpie was selected by NASA HQ as their representative, per the request of the international feasibility study team. His trip to the Paris meeting was funded internally by NASA HQ.

Plans for next year

In the international arena, Turpie will help wrap up the report by the CEOS feasibility study group and will continue to advise the Ad Hoc Science Team for the COCI, as necessary.

Turpie will continue to lead the HyspIRI Aquatic Studies Group (ASG). This will include developing a Town Hall for coastal and inland water remote sensing at the Ocean Science Meeting in Portland, Oregon to collect and organize input from the community.

Turpie will also organize the next HyspIRI Aquatic Data Forum at the at the HyspIRI Science Workshop sponsored by JPL in Pasadena, California, and he will participate in the HyspIRI Project Steering Committee meetings, and other related meetings.

Turpie will continue to function as lead Research Topic editor for the open access journal Frontiers in Marine Sciences. Turpie will publish material from his two white papers on coastal and inland remote sensing in the Frontiers in Marine Sciences Research Topic.

Task 130

Task Sponsor
Elizabeth Middleton, Code 618

JCET Personnel
Karl Fred Huemmrich, Research Assistant Professor

Summary
This task supports development of methods for using optical and thermal data to describe vegetation physiological condition and relating that information to ecosystem processes, such as productivity. This work is directed in three areas: the collection and analysis of field measurements; science support for the Earth Exploring 1 satellite mission; and support for the development of the Hyperspectral Infrared Imager (HyspIRI).

Accomplishments
Support of field work included continued analysis of data from the FUSION automated field spectrometer system. Huemmrich evaluated bidirectional reflectance and emission patterns from corn and examined how they change diurnally and seasonally. Huemmrich developed programs in R to calculate statistical models relating FUSION reflectance and fluorescence with ecosystem productivity as measured by a nearby flux tower. Results from this analysis were presented as a poster at the fall AGU meeting in San Francisco Dec. 12-16, 2016, titled "Tower-Based Optical Sensing of Ecosystem Carbon Fluxes." Huemmrich also attended the joint North American Carbon Program (NACP) and Ameriflux PI meeting in Bethesda MD, March 27-30, 2017, presenting a different version of "Tower-Based Optical Sensing of Ecosystem Carbon Fluxes."

Huemmrich set up automated sensor system using Decagon sensors for measuring plant reflectance. Deployed this system in cornfield at study site in Beltsville Agricultural Research Center. Huemmrich has continued to be involved with the Decagon-Specnet network which combines similar measurements collected by multiple investigators at a number of different sites, attended and co-chaired the Spectnet investigators meeting in San Francisco, CA, Dec. 14, 2016.

Huemmrich attended the ABoVE Airborne Campaign Meeting in San Francisco Dec. 17, making a presentation on planned activities for the research project "Causes and Consequences of Arctic Greening" in ABoVE in 2017. Huemmrich also attended the ABoVE science team meeting in Boulder CO, Jan. 17-20, 2017 making an oral presentation describing the objectives of that research project. Huemmrich collected field measurements of ground spectral reflectances of tundra sites on the North Slope of Alaska, July 18-28, 2017 in support of this project.

Huemmrich took part in the FLuorescence Airborne Research Experiment (FLARE) field campaign in Puerto Rico, March 1-10, 2017, collecting data on the reflectance, transmittance, and chlorophyll fluorescence of leaves from tropical trees and supporting calibration activities for the airborne fluorescence imager by collecting ground measurements in conjunction with instrument overflights. A second FLARE campaign measured temperate forests, following the same protocols for measurements in the Smithsonian Environmental Research Center (SERC) in Edgewater, MD, July 31-Aug. 11, 2017.

Huemmrich took part in the Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC) User Working Group meeting held in Oak Ridge, TN, May 11-12, 2016.

Huemmrich participated in a USGS/NASA Landsat Science Workshop in Reston, VA May 23-24, 2017. This workshop discussed science advancements that could be achieved through improvements to future Landsat missions.

Huemmrich was lead author for the manuscript "ISS as a Platform for Optical Remote Sensing of Ecosystem Carbon Fluxes: A Case Study Using HICO" accepted by the Journal for Selected Topics in Geosciences and Remote Sensing.

Huemmrich was a coauthor of presentation on lessons learned to create long term data archives at the meeting How FIFE and BOREAS Changed the World, in Greenbelt, MD, October 6-7, 2016.

Huemmrich taught the class "Arctic Geography" in the Fall 2016 semester for the Geography and Environmental Sciences department at UMBC.

Plans for next year
Huemmrich will utilize tundra measurements collected on the North Slope of Alaska to develop algorithms to describe patterns of vegetation type and function from imagery collected by NASA's Airborne Visible / Infrared Imaging Spectrometer Next Generation (AVIRIS NG) as part of the ABoVE airborne campaign.

Task 131

Task Sponsors
George Huffman, Code 612

JCET Personnel
Amita Mehta, Research Assistant Professor

Summary
This task is designed to conduct capacity building activities for NASA Applied Remote Sensing Training (ARSET) program and focuses on developing training material and conducting on-line and in-person trainings in using NASA remote sensing data for water resources and disasters (extreme precipitation, flooding, hurricanes) management. The trainings include overview presentations of NASA data products, data access web-tools, data applications, and demonstrations of computer-based case studies to facilitate NASA data usage by water resources and disasters management stakeholders.

Accomplishments

Mehta, as a part of the Applied Remote Sensing Training (ARSET) program team, developed training material for and conducted four on-line trainings on using NASA remote sensing and earth system modeling data for water resources and disasters management. These trainings included webinars on i) Applications of Remote Sensing of Soil Moisture and Evapotranspiration (September, 2016), ii) Satellites, Sensors, and Earth Systems Models for Water Resources Management (January 2017), iii) Overview of the Global Disasters Alert and Coordination System (February 21, 2017); iv) Remote Sensing of Droughts (July 12 & 19, 2017). In addition, Mehta, with two other ARSET colleagues conducted an in-person training on 'Application of Satellite Remote Sensing to Support Water Resources Management in Latin America and the Caribbean' in Centro Internacional de Hidroinformática (CIH), Brazil (July 11-20, 2016). Mehta led another in-person training on 'NASA Remote Sensing for Flood Monitoring and Management' for a private company, Dewberry, in Fairfax, Virginia (April 18-20, 2017). These trainings included applications of NASA rainfall, soil moisture, land cover, terrain, evapotranspiration, and ground water data based on GPM, SMAP, Terra and Aqua-MODIS, Landsat, Shuttle Radar Topography Mission, and GRACE satellites observation. The trainings also focused on teaching usage of a variety of NASA Earth Science data portals and web-tools for data access and geospatial analysis for applications in water resources and flood-related disasters management. These trainings were attended by more than 1200 national and international participants. All the training materials are available from (arset.gsfc.nasa.gov).

In order to prepare for a future ARSET training, Mehta attended a workshop on using Variable Infiltration Capacity (VIC) model, a hydrology model, from 15-17 February 2017 at University of Alabama, Huntsville. She also attended NASA Surface Water Ocean Topography (SWOT) mission data and applications meeting at USGS on 5-6 April 2017 and provided an overview of ARSET program.

Plans for next year

Mehta will continue to conduct several on-line and in-person trainings for ARSET using NASA remote sensing observations for water resources and disaster management. Mehta will be involved in conducting a webinar on 'Introduction to Remote Sensing of Harmful Algal Bloom' in September 2017.

Mehta will submit an internal project proposal to NASA DEVLOP in August 2017 for 'Costal Flood Monitoring using Remote Sensing'.

Task 132

Sponsor
James Gleason, Code 614

JCET Personnel
L. Larrabee Strow, Research Professor; Sergio De-Souza-Machado, Research Associate Professor; Howard Motteler, Associate Research Scientist; Christopher Hepplewhite, Associate Research Scientist; Steven Buczkowski, Research Analyst

Summary
UMBC supports NASA GSFC in the following areas: (1) performance evaluation of the J1 CrIS instrument during observatory level and early on-orbit instrument activation, (2) pre-launch performance evaluation of the J2 CrIS instrument, and (3) review/analysis support of the development of the J3 and J4 CrIS instruments. These activities are conducted at Exelis and at UMBC and include participation in meetings and telecons, analysis of instrument performance data, and documentation review in an effort to ensure the CrIS instruments are meeting or will meet their performance requirements.

Accomplishments
An extensive analysis of the CrIS high-spectral resolution (FSR) radiances with the new extended interferograms has shown that the most simple radiometric calibration algorithms are as good, or better, than the much more complicated algorithm used by NOAA. However, these differences are small, and their importance on the climate record will be uncertain until we attempt to connect SNPP/CrIS-1 with the upcoming JPSS/CrIS-2.

Some minor anomalies with the SNPP/CrIS-2 FOV5 were discovered. These are only visible in cold deep convective clouds scenes where some kind of non-linear mixing produces spectral features at the 0.5% level at the wavenumber difference between sharp stratospheric Q-branch lines. Although interesting, at the moment this anomaly is likely to affect science studies.

We did an extensive analysis of the CrIS-1 noise covariances, which are important for data assimilation (MERRA2). The NWP community initially was concerned about high (empirically derived) off-diagonal noise covariances for CrIS. Analysis of this showed that this is primarily just a consequence of the lower noise of CrIS versus AIRS and IASI. However, under separate work, we produced the first measurement of forward model noise covariances (which cannot be easily distinguished from instrument noise covariances). Comparing these results to our work on CrIS noise covariances we found that with the lower noise values of CrIS, forward model noise covariances are more important and likely need attention for the long-term full use of the CrIS sensor for data assimilation.

Work is continuing on preparing for the launch of CrIS-2 on the JPSS-1 platform. Very little time will be given to us for spectral calibration of the three sensor focal planes, so we are working to ensure that process goes smoothly. This will be slightly more difficult than for CrIS-1 because the CrIS-2 center FOV (out of a 3x3 array) for the longwave band is quite non-linear, with the result that we must correct for the non-linearity while doing the spectra calibration, which was not needed for CrIS-1.

We have examined orbit differences between AIRS (AQUA) and CrIS (SNPP) and how they may affect detection of climate-level trends and the rate of occurrence of extreme events. Although both spacecraft have the same, tightly controlled 1:30 pm equator crossing time, the different orbit heights and the use of off-nadir scans introduces mean observation time differences for these sensors that varies some with latitude, but significantly with longitude. The effects are longitudinally banded, with mean time differences of up to 0.6 days. This will affect global gridded products and needs to be taken into account when combining AQUA and SNPP products.

Plans for next year
We are presently preparing for the October 2017 launch of JPSS-1, which is scheduled to have a very short turn-on period (partly to satisfy Congressional concerns that without such a short commissioning that there could be a data gap between NPP CrIS-1 and JPSS-1 CrIS-2). A key task once CrIS-2 is operational is to determine how well the two instruments compare radiometrically and what impact any differences will have on producing a long-term radiance record combining AIRS + CrIS-1 + CrIS-2.

Task 133

Task Sponsors
Dalia Kirschbaum, Code 617

JCET Personnel
Amita Mehta, Research Assistant Professor

Summary
This task involves development of training modules and holding quarterly webinars describing sensor characteristics, data products, and potential applications of the Global Precipitation Measurement (GPM) mission that was launched in February 2014.

Accomplishments
Mehta conducted two webinars for the GPM Applications Program on: i) Tutorial on Using Python Scripts for Reading GPM Data (September 13, 2016); ii) Status of Global Precipitation Measurement (GPM) Mission data Products and Applications (May 3, 2017). In collaboration with the GPM Applications lead Dalia Kirchbaum and Education Specialist Dorian Janney, Mehta helped plan and conduct an in-person training for the World Bank water resources managers in Washington DC (22 March 2017). As a result of this training NASA and the World Bank are developing an 'E-book' describing remote sensing data and applications for water resources management (http://www.appsolutelydigital.com/Nasa/index.html).

For continuation of an ongoing project with Dr. George Huffman, Mehta guided a prospective Ph. D. student, Jessica Fayne, for the assessment and analysis of GPM and TRMM precipitation data comparison with that collected on TAO, PIRATA, and RAMA buoys in the Pacific, Atlantic, and Indian Oceans respectively. As a part of this project, the buoy data sampled at 10-minutes (covering a few months to about 15 years at various locations) were first corrected to remove measurement noise from the data. Comparison of GPM data with the corrected data are currently being carried out. Results of this analysis were presented in GSFC Code 612 on 5 December 2016. This project will conclude in 2017-18 with a publication of the results.

Plans for next year
Mehta will continue to conduct training for GPM applications community. On 1 August 2107 Mehta will help conduct a GPM Agricultural Workshop hosted by the World Resources Institute (WRI) in Washington DC. Mehta will also serve as a rapporteur for a session on 'Water Resources Management for Agriculture.'

Task 134

Task Sponsor
Scott Braun, Code 612

JCET Personnel
William S. Olson, Research Associate Professor

Summary
The main emphasis of the research is on the calibration of satellite passive microwave and infrared estimates of precipitation and latent heating using coincident, high-resolution estimates from spaceborne radar as a reference. Spaceborne radar methods for estimating precipitation/latent heating vertical structure are being developed and tested for applications to 14 GHz radar (Tropical Rainfall Measuring Mission; TRMM) and 14 + 36 GHz radar (Global Precipitation Measurement mission; GPM) in conjunction with passive microwave radiometer multi-frequency observations. The GPM combined radar-radiometer algorithm (CORRA) is continually upgraded and tested against ground-based radar estimates of precipitation.

Accomplishments
The CORRA algorithm was revised to include new modeling of the surface radar backscatter and microwave emissivity, the introduction of nonspherical ice-phase particles in calculations of precipitation scattering properties, the use of empirical relationships between parameters describing the precipitation particle size distribution, and a new representation of the effects of radar target non-uniform beam-filling by precipitation. Dr. Olson led the effort on these changes to CORRA for the GPM V05 product release and was personally responsible for improvements in the description of ice-phase precipitation and the validation of rain estimates from CORRA using raingauge-calibrated, ground-based radar from the US Multi-Radar Multi-Satellite (MRMS) network. The introduction of nonspherical ice particles produced much lower simulated radiances at higher microwave frequencies using the CORRA algorithm's forward model, and these lower radiances were demonstrated to be in much better agreement with actual microwave observations from the GPM Microwave Imager. In comparisons to the MRMS data, CORRA precipitation estimates yielded a correlation of 0.85 over one year of observations, and the bias and mean absolute error of the estimates were largely within the mission science

requirements (less than 50% and 25% bias and mean absolute error at 1 and 10 mm h^{-1}, respectively). Estimates of parameters describing the size-distributions of precipitation particles were also in better agreement with parameters derived from coincident ground-based polarimetric radar.

Plans for next year

The effort to improve CORRA algorithm estimates of precipitation will continue: nonspherical ice-phase precipitation particle descriptions will be extended to melting precipitation. A thermodynamic model of snow particle melting, which includes self-collection of particles, will be used to determine the approximate vertical distributions and composition of precipitation in the melting layer of stratiform rain regions. The masses and meltwater contents of the melting particles derived from the thermodynamic model will be used to link these particles to representative calculations of their scattering properties from separate, detailed simulations of the geometries and electromagnetic characteristics of nonspherical melting particles. It is expected that the introduction of nonspherical snow and melting particles in CORRA will improve estimates of surface rain rates, particularly in regions with low freezing levels. The CORRA algorithm will also be adapted for applications to radar and radiometer data from the TRMM mission. Validation of CORRA precipitation estimates will be expanded to include comparisons at higher-latitude ground sites, emphasizing the evaluation of light rain and snow estimates.

Task 136

Task Sponsor

Anne Thompson, Code 614

JCET Personnel

Jay Herman, Senior Research Scientist

Summary

This task is implemented to 1) develop and improve the Pandora spectrometer system to determine ozone and nitrogen dioxide, their altitude profiles, and validate the results comparing with in-situ instrumentation, 2) correct problems with the Pandora optics to enable retrieval of other trace gases such as formaldehyde and bromine oxide, 4) deploy Pandora at permanent sites to develop long-term records, 5) present results at national and international meetings, and 6) publish results in refereed journals.

Accomplishments

Herman deployed 9 Pandora Spectrometer Instruments in Korea to support the KORUS-AQ campaign completed the campaign and retrieved 7 of the instruments. Two Pandoras remain in Korea as part of a loan agreement. The final processing of the data is complete, showing that is of high precision and accuracy. The O3 and NO2 data from 9 Pandora instruments used in the KORUS-AQ campaign have been delivered to the KORUS-AQ project. Results were presented at the Quadrennial Ozone Symposium in September 2016. Results have been published. An advanced design of the Pandora system was built that is more robust and can retrieve additional trace gases such as Formaldehyde.

We participated in the CINDI-2 instrument comparison campaign in Cabauw, Netherlands during September 2016. The results have been finalized and prepared for publication.

Herman attended planning meetings for deployment of an extended Pandora network in support of the future US, European, and Korean geostationary satellite validation effort. The result will be a major expansion of the Pandora network.

Two new campaigns are underway, one in California and one in Maryland-Virginia.

Plans for next year

- Continue the expansion of the Pandora network.
- Analyze and publish long-term Pandora results
- Publish the results from profile determinations. Three publications are in-press or being reviewed.
- Present or prepare presentations of the results of the Pandora and EPIC measurements at scientific meetings.

Task 137

Task Sponsor
Paul Racette, Code 555

JCET Personnel
Mustafa Aksoy, Post-Doctoral Research Associate

Summary
Two main research efforts are included in Task 137. The first one focuses on techniques to improve Doppler measurements via space-borne radar systems. The specific goal is to develop a computational framework for an ensemble detector which mixes correlated noise signals with radar returns to improve Doppler estimations by eliminating the spectral spread of Doppler velocity induced by the high velocity of the spacecraft. Accurate Doppler velocity measurements are important for hydrometeor particle size retrieval and classification, thus understanding the weather system dynamics. The second research effort addresses the accuracy and stability of the calibration of microwave radiometers. Drs. Aksoy and Racette are studying 3-point onboard calibration systems to track and correct measurement errors due to calibration drifts in space-borne radiometers. Furthermore, Dr. Aksoy joined the IceCube team(more information about the project can be found at https://directory.eoportal.org/web/eoportal/satellite-missions/i/icecube) to analyze the calibration stability of the spinning cubesat.

Accomplishments
Dr. Aksoy, with Dr. Racette, has mathematically described the ensemble detection theory as a noise assisted signal analysis method to examine uncertainty and stability of a signal using wide sense stationary Gaussian noise signals. This theoretical description has been tested using different radiometer (NIST, Aquarius etc.) and environmental (Atmospheric temperatures

measured by Atmospheric Radiation Measurement (ARM) Climate Research Facility) datasets. Also several studies have been conducted to apply this theory to space-borne radars to reduce the uncertainty in Doppler velocity measurements. Dr. Aksoy, with Dr. Racette submitted two abstracts which summarize their results to the XXXIIth URSI General Assembly and Scientific Symposium (URSI GASS 2017), and Dr. Aksoy will present them in Montreal, Canada on August 22, 2017.

Drs. Aksoy and Racette also demonstrated the advantages of having 3-point onboard calibration structures in space-borne radiometers to track and correct errors due to calibration drifts. With two blackbody calibration targets in addition to the cold space, drifts in blackbody measurements can be tracked using the cold space as a measurand periodically in the calibration cycle. The algorithm details and the results were accepted as a conference paper to the 2017 IEEE International Geoscience and Remote Sensing Symposium, July 25, 2017 in Fort Worth, TX.

Plans for next year
Dr. Aksoy will continue his research on the ensemble detection theory and focus on analyzing data from IceCube which was launched in April and started providing data in June 2017. Dr. Aksoy will leave JCET at the end of August 2017 to join the State University of New York at Albany as an Assistant Professor in Electrical and Computer Engineering. However, he will continue his collaboration with Dr. Racette and other NASA GSFC scientists and engineers.

Task 138

Task Sponsor
Matthew Schwaller, Code 612

JCET Personnel
Ali Tokay, Research Associate Professor

Summary
The theme of the study is to improve the precipitation measurements under the umbrella of the NASA's Precipitation Measurement Mission. The investigator takes four major avenues in improving precipitation measurements. First, the collocated measurements of disdrometers, profilers, and scanning radars have been employed to diagnose the measurement accuracy and error bars of each measurement. Second, the variability of raindrop size distribution and rain parameters has been investigated within the radar pixel and satellite field of view. Third, the efforts have been made in determining precipitation microphysics in rain, mixed precipitation, and snow. Four, the steps have been take to evaluate the existing operational rainfall products that can be used to validate the satellite precipitation products.

Accomplishments
A footprint scale variability of raindrop size distribution has been investigated through two-dimensional disdrometer network during Mid-latitude Continent Convective Clouds experiment. Specifically, the footprint of GPM Dual-frequency radar was simulated through kringing and inverse distance weight methods. Non-uniform beam filling was quantified for the

algorithm developers. A peer-reviewed article has been accepted for publication in Journal of Hydrometeorology [Tokay et al. 2017a].

A manuscript on the pixel-space variability of raindrop size distribution has been published in Journal of Hydrometeorology [Tokay et. al. 2016]. This study uses disdrometer network at NASA Wallops Flight Facility where the spatial variability of the fifteen different physical parameters was investigated.

As part of the GPM Level 1 requirement, empirical relationships between the size distribution parameters and radar observables were developed through disdrometer observations from GPM field campaigns. A manuscript has been submitted to the Journal of Atmospheric and Oceanic Technology [Tokay et al. 2017b].

The vertical variability of raindrop size distribution is currently investigated through joint disdrometer and micro rain radar measurements during GPM IFloodS field campaign. A manuscript in this topic has been drafted [Adirosi et al. 2017].

Two interns worked on the comparison of snow detection algorithms at NASA Wallops Flight Facility (WFF) and Continental US. This work is also linked to the GPM level 1 requirement. The first intern examined 10 events using operational and research assets at WFF, while the second intern compared the radar based precipitation type algorithms with surface reports at 11 sites for over 150 events. The findings will be presented at the 38^{th} AMS radar meteorology conference [Tokay et al. 2017c].

The investigator co-authored five studies including simulation of snow size distribution retrieval from dual frequency radar measurements [Liang et al. 2016], validation of level-three GPM imerg product [Tan et al. 2016], mid-latitude continental convective clouds experiment [Jensen et al. 2016], microphysical aspects of falling snow in Finland [Tiira et al. 2016], and optimization of areal pointwise rainfall estimation [Tapiador et al. 2017]

The investigator was a co-chairperson of 9th European Radar Meteorology Conference in Turkey. He is also chair of AMS radar meteorology committee and associate editor of Journal Applied Meteorology and Climatology and Journal of Atmospheric and Oceanic Technology.

Plans for next year

GPM ground validation program participates to field campaigns: The disdrometer based size distribution measurements will be conducted at semi-arid Arizona. The disdrometer, gauge, and radar measurements will participate 2018 Winter Olympic games in South Korea. The investigator will join both efforts through data processing. An additional winter field study with 12 weighing bucket gauges will be conducted in Marquette, Michigan. The snow detection, vertical variability of raindrop size distribution, and relationships between size parameter and rain rate are among other research activities.

Task 139

Task Sponsor
Sophie Nowicki, Code 615

JCET Personnel
Jae Lee, Assistant Research Scientist

Summary
This task is designed to (1) provide a more complete documentation of conditions associated with recent melt events, (2) improve our understanding of forcing mechanisms that influence surface conditions on the Greenland Ice Sheet, and (3) identify the impacts of recent, enhanced runoff on Greenland's eustatic contribution and on productivity and circulation in the adjacent ocean.

Accomplishments
Lee is working on the surface temperature and cloud fraction changes and their impact on Greenland Ice Sheet mass loss. She worked on validation of AIRS surface skin and air temperatures in comparison with in-situ measured and MERRA2 reanalysis temperatures. In-situ measured temperatures are acquired from the Greenland Climate Network and NOAA station. She contributed to two publications as a co-author on recent temperature anomaly pattern changes and their relations with tele-connections.

Plans for next year
This task has been cancelled.

Task 140

Task Sponsor
Sophie Nowicki, Code 615

JCET Personnel
Christopher A. Shuman, Research Associate Professor

Summary
Dr. Shuman continues to work with Dr. Nowicki at GSFC to study temperature data in central Greenland's 'Summit' Station area despite the station's perilous funding situation. Shuman's efforts with Dr. Nowicki, extending work initially done with Dr. Hall, have expanded this work more broadly across Greenland including investigations of the MERRA and related output and reanalysis products from other institutions in conjunction with Drs. Hearty and Culather.

Accomplishments
A paper that quantifies why current reanalyses and typical AWS from ice sheet locations may provide inconsistent data for satellite calibration studies s being reviewed internally. This activity, was begun with support by Dr. Hall on Task 373 before her retirement and was later supported by Dr. Nowicki on Task 390 before the transition to Task 140. By extracting and

quality controlling near-surface temperature data from NOAA ESRL TAWO sensors and two adjacent 'standard' AWS installed near Greenland's Summit Station, Dr. Shuman has been able to document the magnitude and 'seasonality' of temperature errors in central Greenland due largely to passive shield errors. This has lead to additional efforts with Drs. Hearty and Cullather to try to understand the impact of such problems.

The initial goal was to provide a reference data set for assessing reanalysis products such as MERRA but has now expanded to providing insights on sub-seasonal issues in the code related to solar illumination. Other insights have been incorporated in a NSF 'white paper' intended to sustain climate data monitoring at Summit Station:
http://104.236.112.202/geosummit/wp-content/uploads/2017/05/SummitSummitReport_FINAL.pdf

Plans for next year
Dr. Shuman will continue to work towards a publication with Hearty and Cullather toward the assessment of in situ and reanalysis temperature records from central Greenland.

Task 141

Task Sponsor
James Gleason, Code 614

JCET Personnel
L. Larrabee Strow, Research Professor; Sergio De-Souza-Machado, Research Associate Professor; Howard Motteler, Associate Research Scientist; Christopher Hepplewhite, Associate Research Scientist; Steven Buczkowski, Research Analyst

Summary
The University of Maryland Baltimore County (UMBC) Atmospheric Spectroscopy Laboratory (ASL) and the University of Wisconsin (UW) Space Science and Engineering Center (SSEC) support NASA climate research by providing a climate quality Level 1B (geolocation and calibration) algorithm and long-term measurement record for CrIS. The related objectives of the work have been to: 1. Create software that produces climate quality CrIS Level 1B data to continue EOS-like data records, and provide this software and associated documentation to the appropriate NASA data processing groups. 2. Provide samples of CrIS Level 1B data for the Suomi-NPP science team in advance of production for validation by the science team. 3. Provide a) long-term monitoring and validation of the CrIS Level 1B data record and b) long-term maintenance and refinement of the Level 1B software. 4. Provide a CrIS radiative transfer algorithm and code for use by the L1b and L2 NPP Science Teams. Details of this effort are outlined in the proposals by Larrabee Strow titled, "NASA CrIS Level 1B and VIIRS Level 1 Algorithm and Software Development" dated August 1, 2014 and in "CrIS RTA Development" dated January 30, 2015.

Accomplishments
During the reporting period, the CrIS L1B team developed and delivered Version 1.0 of the CrIS L1B software, which was used to generate the initial public version of the CrIS L1B product at

the GES DISC. This software release included the capability to process the Suomi NPP CrIS Level 0 mission data record, generating a consistent calibrated, navigated radiance product at Normal Spectral Resolution (NSR). In addition, the software generates a Level 1A product consisting of unpacked telemetry values. Documentation was delivered in the form of an Algorithm Theoretical Basis Document (ATBD), a Software Users' Guide, and a Product Users' Guide. In addition to the Version 1.0 NSR software, we developed an initial version of the Full Spectral Resolution (FSR) calibration algorithm, and worked with the Sounder SIPS to release a sample FSR dataset intended for use in Level 2 algorithm development by the Sounder and VIIRS Science Teams, as well as proposal preparation in response to the 2017 ROSES call. We evaluated the L1B products through a number of techniques including comparisons with the operational IDPS product, inter-FOV analyses and product trend analyses. Other science-related activities during this period included work on polarization correction, lunar intrusion detection and FIR convolution correction. We regularly interacted with the Sounder SIPS and GES DISC to coordinate beta and final software deliveries, to develop common CrIS and ATMS file formats and functionality, to discuss software interfaces and documentation, to provide technical support and troubleshoot product issues, and to determine schedule and delivery expectations. We interacted with the CrIS Level 2 Science Team to discuss progress and coordinate schedules, to obtain input regarding product preferences and to gather feedback regarding products. We participated in EDOS meetings and supported testing of JPSS-1 Level 0 data and distribution systems.

We also developed a new CrIS radiative transfer algorithm (RTA) for the FSR data set for use by the CrIS Level 2 retrieval team. Changes to our existing CrIS RTA included the increase in spectral resolution from NSR to FSR, algorithm improvements for reflected thermal radiation, and updates to the spectral line parameters (we moved to HITRAN 2012 from HITRAN 2008). We are now using the popular AER line-by-line algorithm (LBLRTM) for the line-mixing in carbon dioxide and methane. Our pseudo line-by-line code (kCARTA) was trained on LBLRTM but is more than an order of magnitude faster. This allowed us to do extensive testing of the RTA on much larger sets of representative profiles. We have started testing improvements to the RTA parameterizations using neural-net approaches and had some success, work is continuing.

Plans for next year

A Version 2.0 delivery of the CrIS FSR is planned for Fall 2017, which will add preliminary support for JPSS-1, as well as FSR product generation and science improvements.

Approaches to create better CrIS RTA parameterizations will continue with special emphasis of polar profiles and reduction of error correlations between spectral channels.

Task 142

Task Sponsor
Karen I. Mohr, Code 610

JCET Personnel
Stephen D. Nicholls, Post-Doctoral Research Associate

Summary

Task 142 funded research falls into three main research project sub-tasks:

Projecting potential future precipitation climate properties (total, coverage, and diurnal cycle) change in the Central Andes resulting from land cover and climate changes with a regional climate model (RCM);

Determining the capability of space-based infrared (IR)-based atmospheric sounders to detect and characterize the bulk properties (temperature, moisture content, thickness, etc.) of the well-mixed layers over North Africa;

Provide RCM data to support the multi-disciplinary research efforts of NASA's High Mountain Asia Team (HiMAT) to determine potential future water resource variability in High Mountain Asia.

Work on sub-task 1 provides a glimpse into how future water resources in the Central Andes may change in response regional and global climate drivers. Results from this effort will provide needed information in a data sparse region where political leaders could use it to help guide future water resource policy decisions. Sub-task 2 attempts to fill a data void over the Sahara Desert and its associated well-mixed layer (WML) called the Saharan Air Layer (SAL). The SAL is significant for its impact on the global radiation budget, air quality, regional agriculture, and Atlantic tropical cyclone development. Space-based IR sounder retrievals provide a consistent and reliable means to measure the size, scope and properties of WMLs where in-situ observations are scarce. Finally, sub-task 3 (similar to sub-task 1) focuses on future, regional water resources, but for a region that is home to over 2 billion people and has a strong dependence on glacial melt water. The multi-disciplinary approach to HiMAT is key to its success and understanding all the pieces that shape this region's climate. Data generated from Task 142 will drive HiMAT glacier and hydrological models and represents the cutting edge of regional climate simulation efforts.

Accomplishments
Central Andes: Nicholls has complete an extensive series of RCM simulations of the Central Andes using four global climates for input. Due to its high computational expense, RCM output is arranged into a series of year-long "snapshots" (spaced roughly 30 years apart), starting in 2003. Simulation results show a wide degree of precipitation coverage variability amongst RCM simulation sets, however, all simulations agree on a future characterized by less frequent, but more intense precipitation in the Central Andes. Nicholls presented results from his research at the 31st Conference on Hydrology in January 2017.

IR Sounding/SAL: Nicholls has developed an algorithm capable of successfully diagnosing WMLs and their associate properties from IR sounder retrievals, weather balloons (rawinsondes), and weather model reanalysis. Combining his algorithm output with a backwards parcel tracer model, he subdivided SALs from other WMLs. From these data he created first of its kind regional "quick look" maps depicting the SAL and its relationship to other key climate drivers (precipitating systems, African Easterly jet, Saharan dust, etc.). Results from his efforts show IR sounders capable of detecting and characterizing WMLs with similar skill to model analysis, however, the former compared more favorably to rawinsonde observations in the data sparse Sahara. He presented his results before NASA Science Technology Group (STG) in November 2016.

HiMAT: Nicholls is the lead regional climate modeler in his GSFC-based HiMAT subteam. Following the official HiMAT project start (Dec. 2016), Nicholls updated, configured, and tested his RCM from his Central Andes efforts for HMA. Once configured, he ran two pilot test simulations in 2007 and 2014 to provide test data for his HiMAT team members and validate the RCM for this region. Results from these pilot simulations were generally favorable and were recently shown at the HiMAT team meeting in May 2017.

Plans for next year

Central Andes: Nicholls plans to complete additional statistical analyses on RCM simulation output to draw additional details concerning the mechanisms controlling future precipitation changes in the Central Andes. Concurrently, he plans to consolidate his research results and complete his peer-reviewed journal submission concerning his evaluation of his RCM relative to observations in 2003. Once complete, he will then co-author a second paper describing how future precipitation and its associated properties may change in response to predicted climate and land-use changes.

IR Sounding/SAL: Nicholls is currently authoring a PI proposal to continue his research efforts in Africa and to expand it into other low-latitude deserts. He plans to synthesize his results and co-author a peer-reviewed journal paper on his African research efforts.

HiMAT: While the initial RCM results for 2007 and 2014 were promising, these data did exhibit a distinct dry bias in HMA and a delayed onset of the South Asian monsoon over India. Nicholls plans to investigate and diagnose the root causes of these simulation concerns via additional month-long RCM simulations. Based upon these results, he will first reconfigure and re-run his two pilot simulations and then run his RCM for at least a 10-year period to provide model input of sufficient length for HiMAT hydrological models for both recent and future climate.

Task 143

Task Sponsor
Bruce Gentry, Code 612

JCET Personnel
Kevin Vermeesch, Research Analyst

Summary
The tasks for this research included analysis of data from GLOW (the Goddard Lidar Observatory for Winds) collected during various campaigns across the nation, as well as deployment and operation of related instrumentation. Also included in this task is the operation and design of lidar/ceilometer network instrumentation and production of Planetary Boundary Layer (PBL) values useful for model and air pollution dispersion use. Integration of multi-instrument atmospheric observations, in particular lidar-based water vapor, temperature and wind profiles, is important in understanding atmospheric lower atmospheric dynamics and physics. Analysis and deployment design of a multi-agency, multi-instrument, multi-nation field experiment, the Plains Elevated Convection at Night (PECAN) is a major task under this research work. PECAN is designed to advance the understanding of continental, nocturnal, warm-season precipitation. PECAN will focus on nocturnal convection in conditions with a stable boundary layer (SBL), a nocturnal low-level jet (NLLJ) and the largest CAPE (Convectively Available Potential Energy) located above the SBL. In addition, this task also supports activities related to the operation of GLOW at the Howard University Beltsville Campus.

Accomplishments
Task work was winding down during this period. Minimal work involved operating instruments during weather balloon flights at Beltsville facility.

Plans for next year
Task ended in April 15, 2017.

Task 144

Task Sponsor
Bruce Gentry, Code 612

JCET Personnel
Brian Carroll, Graduate Student

Summary
This task provides support for a graduate student to support two GSFC wind lidar systems: 1) the Goddard Lidar Observatory for Winds (GLOW), a ground based mobile direct detection Doppler lidar, and 2) the Tropospheric Wind Lidar Technology Experiment (TWiLiTE), a fully autonomous Doppler lidar system designed to fly on NASA research aircraft including the DC-8,

ER-2 and Global Hawk. Both instruments collected extensive data sets during field experiments in 2015. The task involves working with the PI and instrument team members to design and develop algorithms and computer code to optimize the acquisition, analysis and validation of the wind profile data from the two lidar systems. The task also involves analysis of the data sets obtained during the field missions and comparisons with wind data obtained from other instruments. Researcher will also participate in the scientific and technical interpretation of the data and collaborate with members of relevant science teams to publish the results of these investigations.

Accomplishments
Task work was winding down during this period. Minimal work involved operating instruments during weather balloon flights at Beltsville facility.

Plans for next year
Task ended in April 15, 2017.

Task 145

Task Sponsor
Dean Kern, Code 160

JCET Personnel
Catherine Kruchten, Instructional Designer

Summary
Based on collaborative experience with a previous NASA Grant "NASA's BEST Students" (Hoban, PI), wherein over 7,000 participants were provided Science, Technology, Engineering and Mathematics (STEM) professional development using NASA content, Catherine Kruchten collaborates with Goddard Education to develop and deliver authentic Earth and space science and engineering experiences for NASA's Educator Professional Development (EPD) Institutes and Community-requested EPD events. These activities draw upon the expertise of Kruchten in the area of STEM education and are designed and delivered using research-based methods.

Accomplishments
Kruchten delivered EPD on existing NASA's BEST curriculum. A follow-on week-long session to last year's Rhode Island workshop was conducted in January 2017, using the DLN studio at Goddard to provide remote instruction to 30 teachers (4^{th} grade teachers from a single district). Digital Learning Network staff again conducted a survey showing that teacher confidence in engineering increased as a direct result of the workshop.

Kruchten also facilitated a workshop training Girl Scout troop leaders in preparation for a Girl Scout STEM Engagement event at GSFC; this program ran once in October/November and once in February/March; a total of 30 participants were trained across both programs. The October training session also included a further online component for two participants who were unable to attend the face-to-face session. BEST training also supported another STEM Engagement partnership with Prince George's County Public Schools, training 40 mathematics lead educators as part of their annual meeting.

The ongoing partnership with Anne Arundel County Public Schools continued, with the annual EPD workshop held in October 2016; 18 elementary and middle school teachers participated, and subsequently managed afterschool programs at AACPS using BEST content.

An ongoing series of EPD sessions was conducted through the Goddard Institute for Space Studies (GISS) that both extended the amount of face-to-face EPD contact time for participants and piloted a new online platform to facilitate EPD delivery. This hybrid model was piloted starting in November 2016, and ran through May 2017 with monthly sessions for participants. 35 educators from the New York metropolitan area participated in the extended program, with grades taught ranging from kindergarten through high school. This mixed-model prototype also involved partnerships with the Intrepid Sea, Air, & Space Museum, as well as Math for America. Another week-long DLN workshop was held in May 2017, similar to the Rhode Island model developed last year. This EPD workshop was held in partnership with the Hopatcong School district in New Jersey, and reached all district science teachers for grades kindergarten through middle school.

Kruchten's efforts with BEST also supported the MEI (MUREP Education Institute, for Minority-Serving Institutions) program in June, training approximately 50 educators on BEST content, as well as the STEM Education and Accountability Projects program with the Eastern Shore consortium in June, reaching a further 30 elementary and middle school educators.

At the request of GSFC Education leadership, Kruchten also conducted BEST training for GSFC Education staff in Greenbelt and Wallops in order to support staff efforts to continue BEST training following the end of this task.

Plans for next year
This task ends September 30, 2017.

Task 146

Task Sponsor
Dean Kern, Code 160

JCET Personnel
Susan Hoban, Senior Research Scientist

Summary
Based on collaborative experience with a previous NASA Grant "NASA's BEST Students" (Hoban, PI), wherein over 7,000 participants were provided Science, Technology, Engineering and Mathematics (STEM) professional development using NASA content, Susan Hoban collaborates with NASA Armstrong to develop and deliver authentic Earth and space science and

engineering experiences for NASA's Educator Professional Development (EPD) Institutes and Community-requested EPD events. These activities draw upon the expertise of Hoban in the area of STEM education and are designed and delivered using research-based methods.

Accomplishments
Hoban participated in the annual NASA's BEST project meeting, hosted by NASA AFRC on February 28 - March 2. Hoban reviewed and edited new curriculum, and the refresh of the NASA's BEST Legacy Guides and the NASA's BEST Next Generation Guides. These Guides were submitted to the Science Mission Directorate for peer review during July 2017.

Plans for next year
This task ends on September 30, 2017.

Task 147

Task Sponsor
Dean Kern, Code 160

JCET Personnel
Catherine Kruchten, Instructional Designer

Summary
Based on collaborative experience with a previous NASA Grant "NASA's BEST Students" (Hoban, PI), wherein over 7,000 participants were provided Science, Technology, Engineering and Mathematics (STEM) professional development using NASA content, Catherine Kruchten collaborates NASA Armstrong to develop and deliver authentic Earth and space science and engineering experiences for NASA's Educator Professional Development (EPD) Institutes and Community-requested EPD events. These activities draw upon the expertise of Kruchten in the area of STEM education and are designed and delivered using research-based methods.

Accomplishments
Kruchten worked to revise and update existing BEST activities (nine "next generation" lessons for middle school audiences) in collaboration with educators at NASA Armstrong. A workshop showcasing proposed revisions was held at the BEST meeting in February, with feedback solicited from BEST educators and subject-matter experts from other NASA centers that helped shape the new direction of the work; initial feedback from Science Mission Directorate (SMD) review in January was also incorporated. The rewritten/revised activities were completed and submitted for SMD review in July.

Kruchten has also been part of the Badging task team, working with BEST educators at Glenn and Armstrong on developing a plan for leveraging the existing Texas State badge framework to provide another means of reaching educators through online learning.

Plans for next year
This task ends September 30, 2017.

Task 148

Task Sponsor
Adam Szabo, Code 672

JCET Personnel
Jay Herman, Senior Research Scientist

Summary
As Instrument Scientist for EPIC satellite instrument on board the DSCOVR (Deep Space Climate Observatory) satellite, the researcher will lead the effort to characterize the optical performance of the EPIC instrument including stray light determination, laboratory and in-flight calibration, and provide initial algorithms for retrieving ozone, aerosol index, and surface reflectivity. The researcher will assist and manage the transformation of the initial algorithm development to the ROSES-supported science team.

Accomplishments
Herman worked on developing the in-flight calibration and processing the UV DSCOVR EPIC data obtained at the Lagrange-1 point to retrieve ozone, aerosol index, and cloud reflectivity. The results have been validated against low-earth orbiting satellites such as OMI and OMPS. The entire UV EPIC data set has now been processed (Version 2) from June 2015 to July 2017 and released to the public.

Global ozone values have been derived from EPIC and calculated erythemal irradiances have been obtained and published for the period June 2015 to December 2016. These values have successfully been compared with ozone data derived from low-earth orbiting satellite instruments (OMPS and OMI) and with the Pandora Spectrometer Instrument at Boulder, Colorado. As part of this effort, new calibration coefficients have been derived using on-orbit calibration techniques. Results were presented at Quadrennial Ozone Symposium and AGU.

Plans for next year

- In-flight EPIC instrument calibration and analysis of the calibrated data for the standard products will continue.
- Presentations of the results of the Pandora and EPIC measurements will be made at scientific meetings (Quadrennial Ozone Symposium and AGU).

Task 149

Task sponsor
Nathan Kurtz, Code 615

JCET Personnel
Sergio DeSouza-Machado, Research Assistant Professor, JCET/Physics

Summary
Using a fleet of research aircraft, NASA's Operation IceBridge images Earth's polar ice to better understand connections between polar regions and the global climate system. IceBridge studies annual changes in thickness of sea ice, glaciers and ice sheets.

IceBridge, a six-year NASA mission, is the largest airborne survey of Earth's polar ice ever flown. It will yield an unprecedented three-dimensional view of Arctic and Antarctic ice sheets, ice shelves and sea ice. These flights will provide a yearly, multi-instrument look at the behavior of the rapidly changing features of the Greenland and Antarctic ice.

Data collected during IceBridge will help scientists bridge the gap in polar observations between NASA's Ice, Cloud and Land Elevation Satellite (ICESat) -- in orbit since 2003 and providing data till 2009 -- and ICESat-2, planned for 2018.

IceBridge will use airborne instruments to map Arctic and Antarctic areas once a year. IceBridge flights are conducted in March-May over Greenland and in October-November over Antarctica. Other smaller airborne surveys around the world are also part of the IceBridge campaign.

S. DeSouza-Machado will provide output from the kCARTA radiative transfer model over flight lines from the Operation IceBridge mission beginning in 2015. The output will be used to correct surface temperature retrievals for absorbed and emitted atmospheric radiation at the level of the aircraft over the flight lines. Specific output will be the reflected and emitted atmospheric radiance as well as the optical depth. Collaboration will be used to identify flight and Arctic specific input parameters to consider in radiative transfer model (kCARTA), as well as the steps and quality control parameters to get in the finalized output.

Accomplishments
We developed an Optimal Estimation retrieval scheme which was used to retrieve surface temperature from the Operation Icebridge mission data of 2015 and 2015, using ECMWF re-analysis as a first guess. In addition we also provided output from the kCARTA spectroscopic computations over the same flight . The output included the reflected and emitted atmospheric radiance as well as the optical depth.

Plans for next year

- Continue providing support for IceBridge mission data.
- Look into using WRF to provide higher resolution surface temperature and cloud model data for retrieval initialization.
- Work with Task Sponsor on paper.

Task 150

Task sponsor
Weijia Kuang, Code 698

JCET Personnel
Andrew Tangborn, Research Associate Professor

Summary
Research for this task is carried out on geomagnetism and satellite observations of the atmosphere using the Atmospheric Infrared Sounder (AIRS), supported by three NASA grants. The work on geomagnetism involves the development and application of geomagnetic data assimilation methods to study the source and evolution of the Earth's magnetic field. The overall goals of this work are to understand the causes of changes in the geomagnetic field through geodynamo modeling, and to improve our ability to predict future changes to the field.

Accomplishments
During the past year we have continued on assimilation of the longer term data records into a geodynamo model. Because many of the processes in the Earth's core occur on timescales of thousands to millions of years, we need to make use of the early geomagnetic data contained in the paleo- and archeomagnetic record. We use these records in the form of field models that determine long term Gauss coefficients of the geomagnetic field. 2000 year assimilation runs using a geodynamo model are used to show how the early geomagnetic record can impact current day forecasts of the geomagnetic field. In particular, we show that Gauss coefficients up to degree 3 have a positive impact on forecast accuracy, while higher order terms degrade the forecasts.

Plans for next year
Work on geomagnetism is continuing with the development of an ensemble Kalman filter. This system will use accurate forecast error estimates to optimize geomagnetic forecasts, and also to improve the corrections to core flows from the geomagnetic observations. This will allow us to make more accurate geomagnetic forecasts, and to make improved estimates of fluid motion in the Earth's core.

Task 151

Task sponsor
Jeremy Werdell, Code 616

JCET Personnel
Pengwang Zhai, Assistant Professor

Summary
This task supports the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission for exploring novel methods for using the increased spectral resolution to be provided by PACE to advance their ocean color atmospheric correction process and improve their in-water bio-optical algorithms. One substantial part of this involves radiative transfer modeling. Dr. Pengwang Zhai developed and maintains radiative transfer software that perfectly suits the PACE mission needs (vector-based, with polarization) for our PACE-related activities. Specifically, Dr. Zhai (and his Post-doc Dr. Meng Gao, to be supported under a separate JCET task) will utilize his radiative transfer code to produce aerosol look-up tables for atmospheric correction and enhance his existing radiative transfer code to include inelastic scattering processes, such as phytoplankton fluorescence. We will incorporate his aerosol tables into our prototype PACE data processing system and use his at-water radiative transfer output to generate synthetic datasets for algorithm development and testing. We expect all work to be done iteratively and collaboratively, with the additional goal of publishing all results and findings.

Accomplishments
Professor Zhai implemented all inelastic scattering mechanism in the vector radiative transfer model for coupled atmosphere and ocean system (CAOS).

Zhai constructed an aerosol retrieval algorithm using polarimeter data, which can retrieve multi aerosol size modes, optical depth, and single scattering albedo. The use of this retrieval algorithm will be atmospheric correction.

Zhai published two papers on the inelastic scattering in the CAOS.Studied the coupling effect due to water vapor absorption and aerosol scattering, and the possible implications to atmospheric correction.

Zhai constructed a PACE simulator which can simulate the hyperspectral polarized radiance at the TOA, which have all physics mechanisms included, for example, gas absorption and ocean water inelastic scattering, and polarization.

Zhai contributed to the PACE science team report.

Plans for next year
Continue to work on the PACE simulator to include major gas absorptions. Study the impacts of gas absorptions to the ocean scattering and publish results on journal papers.

Task 152

Task sponsor
Jeremy Werdell, Code 616

JCET Personnel
Meng Gao, Research Associate

Summary
This task supports the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission for exploring novel aerosol inversion methods for accurate ocean color atmospheric correction. Non-linear least square inversion algorithm is implemented in the retrieval algorithm. Advanced forward radiative transfer modeling is developed and maintained by Dr. Pengwang Zhai with precise treatment of both the absorption and scattering in atmosphere and ocean. To improve retrieval algorithm efficiency and robustness, complex aerosol refractive index spectrum representation is optimized using the Principle Component Analysis technique, and multi-mode aerosol volume distribution is implemented in the algorithm. The scattering and absorption in the ocean water is evaluated through a bio-optical model suited for both open and coastal water. The water leaving radiance contribution at the top of atmosphere is estimated for the atmospheric correction.

Accomplishments
Gao developed an aerosol retrieval algorithm using multi-bands polarimeter data, which can retrieve multi aerosol size modes, optical depth, refractive index spectrum, single scattering albedo, and ocean bio-optical parameters. The water leaving radiance contribution at the top of atmosphere is obtained for atmospheric correction.

Gao constructed synthetic polarized measurement data using the advanced radiative transfer model including both fine and coarse aerosols and ocean contribution through a bio-optical model considering chlorophyll co-variant particle, CDOM, and NAP. The use of this data is for retrieval model validation.

Gao developed principle components representation of the complex refractive index spectrum for aerosols, and implemented this representation in the retrieval algorithm to promote efficiency.

Gao studied the retrieval error using the Fisher information matrix, and possible improvement in the retrieval parameter selection.

One paper was published on the inelastic scattering in the CAOS.

Plans for next year
- Continue to work on the retrieval algorithm to include validation concerning more types of ocean water.
- Evaluate the sensitivity of the retrieval parameters and compare with the retrieval statistical study and publish results on journal papers.

Task 153

Task sponsor
Compton Tucker, Code 610

JCET Personnel
Christopher Shuman, Research Associate Professor

Summary
The activity is an effort to reanalyze all remaining tropical glacier areas using Landsat 8 and commercial high-resolution imagery. An ancillary goal of the task is to use high resolution DEMs to assess glacier area changes for selected high elevation ice masses with changes in climate variables extracted from the MERRA-2 reanalysis product.

Accomplishments
Besides cross-referencing the Randolph Glacier Inventory (RGI) and the Global Land Ice Measurements from Space (GLIMS) databases with the relevant USGS 1386 chapters on tropical glaciers, Dr. Shuman working with Dr. Tucker and Ms. Melocik and Ms. Jepsen, was able to create a searchable database in Google Earth Pro for all the mountainous areas in the tropics where ice was, and is still found today. In one case, we have identified an entire (small) mountain range (in South America, 'cordillera') has been left out of both the RGI and GLIMS databases. We have also found missing ice areas in cordillera elsewhere as well as features classified as glaciers that are not ice masses. In addition, we have identified cordilleras not identified by the initial USGS 1386 study as well as multiple areas where ice is now completely gone (e.g. Ecuador now has ice on only 6 of 18 areas originally mapped).

Multiple ice area have now had imagery acquired, selected, and analyzed for their areas during the Landsat 8 time frame and those results are now being collated between the participants. Further, selected ice areas have been further investigated using similar low-cloud, low snow cover imagery from Landsat 5 and 7 and commercial high-resolution imagery. The results of this research are ongoing but preliminary results will be presented at a meeting in August.

Further, a recent publication using Landsat imagery "Ice loss processes in the Seal Nunataks Ice Shelf Region from satellite altimetry and imagery" (published in September 2016) provided an opportunity to update a visualization of the changing ice shelf area of the Antarctic Peninsula. This, in turn, has led to multiple contributions to posts on the Earth Observatory and (on July 25) on NASA.gov. The evolution of a rift on the Larsen C ice shelf, well to the south of the Seal Nunataks area, led to multiple media publications before and after a large iceberg broke from the Larsen C on July 11, 2017. In addition, Dr. Shuman has contributed material to multiple Monthly Status Reviews and NASA HQ on this region.

Plans for next year
We intend to continue to acquire and utilize Landsat 8 imagery through 2017 and improve our processing of the commercial high-resolution imagery (very large files). A database of our results and publications will then be prepared to summarize our results for all remaining tropical areas. Because of the scale of these changes and the ease of visualizing them, Dr. Shuman has

been able to utilize remote sensing imagery to show the ice changes on NASA's hyperwall, updated into 2017 with Landsat 8 Thermal Infrared Sensor imagery. These data have and will be in presentations at NASA and UMBC as well as the upcoming Fall AGU. Such education and outreach activities remain an area of interest both at GSFC and UMBC.

Task 154

Task Sponsor
George Huffman, Code 612

JCET Personnel
Amita Mehta, Research Assistant Professor;Jessica Fayne, Student

Summary
The focus is to assist Dr. Amita Mehta and Dr. George Huffman (the UMBC Responsible JCET Member and NASA Task Sponsor, respectively) with analyzing rainfall observations collected by siphon gauges mounted on ATLAS II moored buoys in the tropical oceans, including 1) their noise characteristics and time-series behavior, and 2) comparison to TRMM, GPM, GPCP, and other data sets at relevant time scales, from sub-hourly to long-term averages.

Accomplishments
For continuation of an ongoing project with Dr. George Huffman, Mehta guided a prospective Ph. D. student, Jessica Fayne, for the assessment and analysis of GPM and TRMM precipitation data comparison with that collected on TAO, PIRATA, and RAMA buoys in the Pacific, Atlantic, and Indian Oceans respectively. As a part of this project, the buoy data sampled at 10-minutes (covering a few months to about 15 years at various locations) were first corrected to remove measurement noise from the data. Comparison of GPM data with the corrected data are currently being carried out. Results of this analysis were presented in GSFC Code 612 by Mehta on 5 December 2016.

Plans for next year
Mehta will continue working on multi-temporal scale (30 minutes, 3 hour, day, month, season) inter-comparison of TRMM and GPM precipitation with the precipitation measured on TAO, PIRATA, and RAMA buoys. This project will conclude in 2017-18 with a publication of the results.

Task 155

Task Sponsor
Thomas Hanisco, 614

JCET Personnel
Reem A. Hannun, Postdoctoral Research Associate

Summary

This task involves the observation and analysis of trace atmospheric gases – including carbon dioxide (CO_2), methane (CH_4), and formaldehyde (HCHO) – from airborne platforms. In situ, high frequency measurements of CO_2 and CH_4, both greenhouse gases, enable direct quantification of their surface-atmosphere exchange (fluxes). These observations will provide a useful dataset to constrain carbon-climate model algorithms as well as carbon data products from satellite. In situ measurements of HCHO, a key tracer of atmospheric oxidation chemistry, will also help constrain satellite retrievals and aid our general understanding of atmospheric photochemistry.

Accomplishments

In May 2017, Hannun participated in the Carbon Airborne Flux Experiment (CARAFE), a month-long field campaign based out of Wallops Flight Facility in Virginia. Instruments sampling CO_2 and CH_4 were deployed as part of an airborne payload on NASA's C-23 Sherpa aircraft. A total of eleven science flights traversed a variety of regional land and vegetation types, including forests, agricultural lands, and wetlands. In addition to calibrating the instruments, Hannun is processing the CARAFE dataset to determine CO_2 and CH_4 fluxes and will compare these data to both local tower flux observations and regional-scale carbon model outputs.

Plans for next year

In the next fiscal year, Hannun will be a participant in the Atmospheric Tomography (ATom-3) field campaign in October 2017 and will deploy the In-Situ Airborne Formaldehyde (ISAF) instrument as part of a payload aboard the NASA DC-8 aircraft. The mission comprises several flights over the Pacific and Atlantic oceans to survey reactive gases and quantify the background atmospheric composition globally. Hannun will assist in preparing the instrument for ATom and analysis of the campaign data. In addition, she will continue operating the suite of greenhouse gas flux instruments and related data analysis projects.

Task 156

Task sponsor

Joseph Santanelo, Code 617

JCET Personnel

Vanessa Caidedo, Post-doctoral Research Associate

Summary

The determination of mixing layer height as derived from lidars, microwave radiometers, satellites and other instrumentation as needed. A strong collaboration with the MPLnet group to bring together results from ongoing NOAA/ASOS network, EPA and university collaborators as well as integrate NASA tropospheric chemistry studies.

Accomplishments
This is a new task with work expected to commence in August 2017.

Plans for next year
This task supports a new hire with start date pending at time of annual report submission. Goals for the coming year will be established once new Post-Doc is on board.

Task 157

Task sponsor
Trena Ferrell, Code 610

JCET Personnel
Christopher Shuman, Research Associate Professor

Summary
The NASA Earth Science Education Collaborative project is working with WGBH to help review the K-12 learning resources that WGBH is producing for NASA SMD. As part of WGBH's process, they are identifying media (e.g., video clips, animations, visualizations) that could support learning related to science concepts in the Next Generation Science Standards.

Dr. Shuman and Dr. LeGrande are reviewing these unfinished education products as Subject Matter Experts (SMEs) before WGBH goes too far along the production pathway (editing videos, creating the learning resources). The goal is to ensure the basic media pieces are scientifically accurate and appropriate for the learning concepts identified.

Accomplishments
Work on this task is only now beginning at the time of this report.

Plans for next year
To ensure that WGBH's selections of content are more accessible and complete than they have appeared so far. In short, we are hoping to be involved earlier in WGBH's process.

Task 158

Task sponsor
Gerald Heymsfield, Code 612

JCET Personnel
Stephen Guimond, Assistant Research Scientist

Summary
Research focus is on the analysis of data sets from NASA and NOAA field campaigns with emphasis on hurricanes to address questions such as the role of convection on intensification. Various algorithms developed and applied to data sets.

Accomplishments
This is a new task with work expected to commence in August 2017.

Plans for next year
This task supports a new hire with start date coinciding with this annual report submission.
Goals for the coming year will be established once new hire is on board.

Task 159

Task sponsor
Yuekui Yang, Code 613

JCET Personnel
Pengwang Zhai, Assistant Professor

Summary
This task provides radiative transfer supports for the Earth Polychromatic Imaging Camera EPIC) onboard the Deep Space Climate Observatory (DSCOVR) mission, which acquires the Earth's images from the L1 point. We will develop a radiative transfer package which simulate what EPIC measures for a variety of different cloud scene for major EPIC channels. The radiative transfer package will be used to simulate radiance field exiting at the top of the atmosphere, which will be in turn used to design cloud retrieval algorithms for EPIC. We expect all work to be done iteratively and collaboratively, with the additional goal of publishing all results and findings.

Accomplishments
Work on this task is pending a start date.

Plans for next year
Develop and validate a radiative transfer package for all major EPIC channels.

Task 160

Task sponsor
Yuekui Yang, Code 613

JCET Personnel
Meng Gao, Research Associate

Summary
This task provides radiative transfer supports for the Earth Polychromatic Imaging Camera EPIC) onboard the Deep Space Climate Observatory (DSCOVR) mission, which acquires the Earth's images from the L1 point. We will develop a radiative transfer package which simulate what EPIC measures for a variety of different cloud scene for major EPIC channels. The radiative transfer package will be used to simulate radiance field exiting at the top of the atmosphere, which will be in turn used to design cloud retrieval algorithms for EPIC. We expect all work to be done iteratively and collaboratively, with the additional goal of publishing all results and findings.

Accomplishments
Work on this task is pending a start date.

Plans for next year
Use Radiative transfer tools to study the radiance field existing the TOA for different cloud scenes, and construct a look-up table for the EPIC cloud retrieval algorithm. Specifically, the cloud product includes cloud mask, optical depth, and study the feasibility of retrieving cloud height from the EPIC instrument.

Task 161

JCET Sponsor
Stephen Merkowitz (61A)

JCET Personnel
Erricos Pavlis, Senior Research Scientist; Magda Kuzmicz-Cieslak, Faculty Research Assistant; Keith Evans, Research Analyst

Summary
The purpose of this activity is to maintain the JCET/GSFC Analysis and Combination Center of the ILRS by: (a) maintaining a state-of-the-art Satellite Laser Ranging (SLR) data analysis capability for the primary geodetic satellites to support the IERS and ITRS contributed products of the ILRS, (b) generating weekly, daily and annual analysis products to be submitted to the IERS/ITRF as required by the ILRS, (c) generating quality check (QC) reports for SLR data in support of the ILRS Rapid Response service and Quality Control Board, (d) generating weekly and daily combination ILRS products, (e) developing the infrastructure required to combine SLR products with those from other space geodetic techniques (e.g. VLBI, GPS, DORIS), (f) executing studies for future geodetic SLR missions (including the tracking of future GNSS targets) and (g) generating and evaluating optimized geodetic network designs using simulations based on future system parameters.

Accomplishments
We co-organized the ILRS Tech. Workshop in Potsdam, Germany during October 8-14, 2016 and the one-day ILRS ASC meeting. In April of this year we organized and chaired the ILRS ASC meeting during the EGU 2017 week in Vienna, Austria, attended by two-dozen ILRS associates, where several pilot projects were discussed, and more planned for the next year. We

are now in the process of developing a product to alert the stations of these estimates and develop a prototype of the routine service for the network that is envisioned by ILRS' Quality Control Board.

Our group has an international collaboration for several years between with the Italian groups at the Rome university "La Sapienza" and the University of Salento. Following our successful launch of the LARES satellite in February 2012, we designed and proposed a follow-on mission, LARES-2, which was approved by the Italian Space Agency (ASI) on July 5, 2017. The new project is based on a proposal to NASA and the Italian Space Agency (ASI), in the early '90s to launch a third LAGEOS-class satellite (LAGEOS-3), which was shelved for lack of funds at the time. With a free launch from ESA and the same Italian company that launched LARES in 2012 already secured, this effort has focused on the design of a modified LARES spacecraft that will perform like LARES, despite the higher altitude of the LARES-2 mission (1450 km vs. 6000 km).

Plans for Next Year

The near-term plans for our SLR work are the practical implementation of the results from the "Systematic Error Pilot Project" and the transition to a routine service-like process with direct delivery of the information to the network station engineers. By the end of summer 2017 we will complete a reanalysis of all SLR data since 1983 and up to present, using the recently adopted ITRF2014 model. We are currently working on several papers on the LARES-2 mission, to be published in appropriate journals later this year. We are currently planning the next ILRS Technical Workshop in Riga, Latvia, first week of October 2017. We are continuing our guest editorship for the Journal of Geodesy Special Issue on Laser Ranging. We have over forty abstracts that we are presenting to the editor in chief for initial approval, to be followed by formal review process. Publication is expected in the spring of 2018, although online versions are likely to start appearing by the end of 2017.

Task 162

JCET Sponsor

Stephen Merkowitz (61A)

JCET Personnel

Erricos Pavlis, Senior Research Scientist; Magda Kuzmicz-Cieslak, Faculty Research Assistant; Keith Evans, Research Analyst

Summary

The purpose of this task is to support the development of the GEOCON mission concept. Develop simulations and analysis techniques for measuring geodetic system ties using a CubeSat constellation. Modify existing network simulations to incorporate GEOCON observables and perform the simulation analysis.

Accomplishments

The team started with the verification of the proper functioning of the GEODYN software and generated some initial orbits for the proposed GEOCON mission. Using the information provided by NASA's Flight Dynamics group we have generated simulated data that contain attitude errors as expected for the actual mission and we will generate estimates of the level of this effect on the proposed GEOCON observable. This will be used to constrain the errors associated with the proposed system.

Plans for Next Year

The near-term plans for our SLR work are the practical implementation of the results from the "Systematic Error Pilot Project" and the transition to a routine service-like process with direct delivery of the information to the network station engineers. By the end of summer 2017 we will complete a reanalysis of all SLR data since 1983 and up to present, using the recently adopted ITRF2014 model. We are currently working on several papers on the LARES-2 mission, to be published in appropriate journals later this year. We are currently planning the next ILRS Technical Workshop in Riga, Latvia, first week of October 2017. We are continuing our guest editorship for the Journal of Geodesy Special Issue on Laser Ranging. We have over forty abstracts that we are presenting to the editor in chief for initial approval, to be followed by formal review process. Publication is expected in the spring of 2018, although online versions are likely to start appearing by the end of 2017.

Task 163

Task sponsor

Thomas McGee, Code 614

JCET Personnel

John T. Sullivan, Post-Doctoral Research Associate

Summary

This new task entails collection and analyses of ground-based observations of atmospheric composition, focusing primarily on air pollution studies. Specifically, measurements of trace gases, mainly tropospheric ozone, and atmospheric constituents are obtained using remote sensing techniques (e.g. lidar), balloon-borne instrumentation, and in-situ UV photometry. Ozone is a harmful atmospheric species and is federally regulated. Therefore, providing nearly continuous measurements of ozone profiles are critical for fully assessing pollution events that may be toxic to humans during extended exposure times. Unfortunately, it very difficult to measure tropospheric ozone from space with a high level of accuracy or vertical information. However, ozone lidar can provide high spatio-temporal measurements of ozone from near surface to the top of the troposphere. This is critical in connecting surface measurements to the next generation of geostationary air quality satellites (e.g. TEMPO, GEOCAPE). Work on this topic centers on deploying lidar instrumentation and performing high quality analyses. With these observations of the detailed ozone structure, satellite science teams and the modeling

community can study the character of lower-atmospheric ozone and also assess the accuracy and vertical resolution with which a geosynchronous instrument could retrieve the observed laminar ozone structures.

Accomplishments

In July-August 2017, Sullivan was a Co-I and identified as the Early Career Scientist for the NASA OWLETS (Ozone Water-Land Environmental Transition Study) field mission in the greater Hampton Roads region. This campaign involved several ground sites, research vessel, the NASA GEOTASO airborne instrument, and the Wallops C-23 Sherpa chemical payload. The tropospheric ozone lidar, based out of NASA GSFC, was deployed to NASA LaRC during this campaign with improved monitoring capabilities. A second ozone lidar, based out of NASA LaRC, was deployed to the Chesapeake Bay Bridge Tunnel. Vertical and horizontal gradients in ozone were assessed between the two lidar sites and analyses are still ongoing. The aircraft and research vessel data, in conjunction with the lidars, will help provide a novel data set for the modeling and satellite communities.

Plans for next year

2017 will be filled with data analyses from several previous campaigns and deployments of several lidars. In the first quarter, Sullivan will focus on analysis of data collected during the OWLETS campaign in July-August 2017. Because of the interest in this campaign, we have also begun talks with state agencies and NASA to begin planning an OWLETS-2 campaign in Summer 2018. Previous campaign data taken from Seoul, Korea during the NASA KORUS-AQ campaign will also be analyzed. Changing focus from tropospheric measurements, Sullivan will also deploy instrumentation and analyze data from several stratospheric lidar inter-comparison campaigns. As the TEMPO validation team begins to update their algorithm for tropospheric ozone, Sullivan is expected to continue interacting with them in order to support validation and calibration efforts.

Supporting Information

A. Departmental Affiliations

JCET Faculty Member	**Departmental Affiliation**
Petya Campbell	Geography & Environmental Systems
Ruben Delgado	Physics
Sergio de Souza-Machado	Physics
Forrest Hall	Physics
Susan Hoban	Computer Science & Electrical Engineering Physics

K. Fred Huemmrich	Geography & Environmental Systems
Simone Lolli	Physics
Amita Mehta	Geography & Environmental Systems
William Olson	Physics
Lorraine Remer	Geography & Environmental Systems Physics
Christopher Shuman	Geography & Environmental Systems
Jason St. Clair	Chemistry
Andrew Tangborn	Mathematics & Statistics
Ali Tokay	Geography & Environmental Systems
Kevin Turpie	Geography & Environmental Systems
Tamás Várnai	Physics

B. Courses Taught

JCET Faculty Member	Course	Term
Ruben Delgado (50%) Sergio deSouza-Machado (50%)	PHYS 335: Physics & Chemistry of the Atmosphere	Fall 2016
Susan Hoban	CMSC 626: Computer Security	Fall 2016
K. Fred Huemmrich	GES 302: Arctic Geography	Fall 2016
Amita Mehta	GES 315: Climate Change	Fall 2016
Belay Demoz	PHYS 622: Cloud Physics	Spring 2017
Tamás Várnai	PHYS 640: Computational Physics	Spring 2017
Susan Hoban	PHYS 112: Basic Physics II	Spring 2017
Keith Evans	SOCY 101: Basic Concepts in Sociology	Spring 2017

C. Publications

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D. Proposals & Status

Proposal Title	**Funding Agency**	**PI (JCET)**	**CO-I(s) (JCET)**	**Status**
The effect of atmospheric aerosols and clouds on Amazon forest productivity	NASA	Bian, Huisheng		Awarded
In Support of NOAA's commitment to the Global Climate Observing System (GCOS) Reference Upper Air Network (GRAUN)	UMD/ ESSIC/ CICS (NOAA)	Demoz, Belay	Vermeesch, Kevin	Awarded
Investigate and validate the effectiveness of the Vaisala CL31 ceilometer algorithm at selected sites across the U.S. for the Automated Surface Observing System (ASOS) program product improvement	UMD/ ESSIC/ CICS (NOAA)	Demoz, Belay		Awarded
Something to CHEW On (Climate, Health, Ecosystems, Weather)	USM	Hoban, Susan	St. Pé, Alex	Awarded
Retrievals of Aerosol and Cloud Droplet Microphysical Properties with the Hyper-Angular Rainbow Polarimeter (HARP)	NASA	Martins, Vanderlei	McBride, Brent	Awarded
Calibration and Validation of the CrIS Operational Sensor	NOAA	Strow, Larrabee	Heppelwhite, Christopher	Awarded
Calibration and Validation of the CrIS Operational Sensor	NOAA	Strow, Larrabee		Awarded

Emissions and Chemistry of Formaldehyde in Biomass Burning Plumes	NOAA	Wolfe, Glenn		Awarded
Development of a consummate semi-analytical model for polarized ocean reflectance	NASA	Zhai, Pengwang		Awarded
Cloud scavenging of aerosols in the NASA GEOS-5 model: Physically based parameterizations, uncertainties, and impact on aerosol direct and indirect effects	NIA/ LaRC (NASA)		Bian, Huisheng	Awarded
NOAA Educational Partnership Cooperative Science Center Solicitation for the Center: Earth System Sciences and Remote Sensing Technologies	CUNY (NOAA)		Delgado, Ruben	Awarded
NOAA Cooperative Science Center in Atmospheric Sciences and Meteorology at Howard University	NOAA		Demoz, Belay	Awarded
Using the 2017 Eclipse viewed by DSCOVR/EPIC & NISTAR from space and spectral radiance and broadlband irradiance instruments from below to perform a 3-D radiative transfer closure experiment	NASA		Herman, Jay	Awarded

Geodetic System Ties Using a CubeSat Constellation	GSFC		Pavlis, Erricos; Kuzmicz-Cieslak, Magda; Koenig, Daniel; Evans, Keith	Awarded
Adapting MODIS MAIAC Algorithm to Geostationary Sensors	NASA		Wang, Yujie	Awarded
Causes and consequences of arctic greening: the importance of plant functional types and surface hydrology	NASA	Huemmrich, Karl F.	Campbell, Petya	Selected
An Homogenous Infrared Hyperspectral Radiance and Level 3 Climate Record	NASA	Strow, Larrabee	Hepplewhite, Christopher	Selected
Reconstruction of Antarctic Climate History by Remote Sensing of Ice Sheet Subsurface Temperatures	NSF	Aksoy, Mustafa		Declined
Global marine organic aerosol and DMS: Emissions, distributions, and climate impacts via aerosol-cloud-radiation interaction	NASA	Bian, Huisheng		Declined
Collaborative Proposal: Investigating the Long-range transport of tropospheric ozone to the Tropical South Atlantic (STA) from continental natural and anthropogenic sources	NSF	Demoz, Belay		Declined

Upper Atmosphere Long-Term Monitoring and Aircraft Campaign Support of Ozone, NO2, and other Atmospheric Trace Gas at Multiple Sites using the Pandora Spectrometer Instrument Network	NASA	Herman, Jay	Abuhassan, Nader	Declined
Radiometric Calibration of the DSCOVR-EPIC Satellite Spectrometer with Data from Multiple NASA and non-NASA Satellites	NASA	Herman, Jay		Declined
Combining plant functional responses from hyperspectral imagery with ecosystem models to improve estimates of carbon balance in savanna ecosystems	NASA	Huemmrich, Karl F.	Campbell, Petya	Declined
Mission HiTech	NSF	Kruchten, Catherine	Hoban, Susan	Declined
Compact Visible to Shortwave Infrared Hybrid Imaging Sensor (HIS) for Landsat Imagers	NASA	Martins, Vanderlei	Remer, Lorraine; Borda, Roberto Fernandez	Declined
Development of a Nano-Satellite Science Consolidation Center	NASA	Martins, Vanderlei		Declined
Improving Forward Radiative Simulations of Satellite Observations Affected by Ice-Phase Precipitation for Earth System Model/Assimilation Systems	NASA	Olson, Bill		Declined

SGP Network Architecture and Geodetic Data Combination (SNAGDAC) for an improved development, maintenance and distribution of the ITRF	NASA	Pavlis, Erricos	Kuzmicz-Cieslak, Magda; Konig, Daniel; Evans, Keith	Declined
Diurnal signatures in aerosol-cloud processes as viewed by geostationary sensors	NASA	Remer, Lorraine	Martins, Vanderlei	Declined
Satellite Investigation and model representation of the diurnal signature in aerosol-cloud processes	NASA	Remer, Lorraine	Martins, Vanderlei	Declined
Establishing the Sun and the Moon as Primary Absolute Standards for Interconsistent Calibration of Earth- viewing Satellite Sensors	NASA	Turpie, Kevin		Declined
An Innovative Atmospheric Correction Scheme Ocean Observations Using Combined Active and Passive Measurements	NGIA	Zhai, Pengwang	Demoz, Belay	Declined
Development of an exact polarized radiative transfer model for coupled atmosphere and ocean systems with both elastic and inelastic scattering mechanisms	Navel Research	Zhai, Pengwang		Declined
Multiple-satellite-based retrieval of tropospheric absorbing aerosols using lidar backscatter	NASA	Zhai, Pengwang		Declined

profiles and hyperspectral oxygen A-band spectra				
Observation based Quantification of the Net Direct Radiative Effects by Dust Aerosols	NASA	Zhai, Pengwang		Declined
Development of a Test-Bed on the Basis of NASA A-Train Satellite Cloud Measurements for Evaluating and Improving the CFMIP-COSP	NASA	Zhang, Zhibo		Declined
GRASP: Geodetic Reference Antenna in Space	NASA		Pavlis, Ericcos	Declined
The transport and impact of light absorbing aerosols on Himalayan glaciers	NASA		Remer, Lorraine	Declined
A Satellite-based Global Ocean Evaporation Product (including Polar Regions)	NASA		Shie, Chung-Lin	Declined
Phenology Imaging Spectrometer for Coastal Ecology Studies (PISCES)	NASA		Turpie, Kevin	Declined
A Compressive Line Sensing Hyperspectral Imaging System	DoN/ ONR		Zhai, Pengwang	Declined
Calibration Framework for Constellations of Similar Microwave Sensors	NASA	Aksoy, Mustafa		Pending
Evolution of the Radio Frequency Interference Environment Faced by Earth Observing Microwave Radiometers: Aqua and Suomi	NASA	Aksoy, Mustafa		Pending

NPP Observations from 2002 to Present, and Preparation for the Joint Polar Satellite System				
Coordinated Multi-Instrument UAS Constellations to Monitor Biophysical Traits, Function and Structure in Operational Field Environments	NASA	Campbell, Petya	Huemmrich, Fred	Pending
Multi-year record of thermodynamic profiles, trace gases and clouds retrieved from allsky sub-sampled AIRS and CrIS single footprint radiances	NASA	DeSouza-machado, Sergio	Strow, Larrabee	Pending
Time Evolution Studies of Geophysical Properties using AIRS and CrIS hyperspectral radiance measurements	NASA	DeSouza-machado, Sergio	Tangborn, Andrew	Pending
The dynamcis of turbulent buoyant plumes using the Non-hydrostatic Unified Model of the Atmosphere (NUMA)	DOD/NPS	Guimond, Andrew		Pending
Development of a Multiyear Sounder-Based Outgoing Longwave Radiation Climate Data Record Using Products Derived from TOVS, AIRS, and CrIS	NASA	Lee, Jae		Pending
PIRE: Microphysical Properties of Aerosols and Clouds in the Amazon Basin and its Relationship with Climate	NSF	Martins, Vanderlei	Cieslak, Jan; Borda, Roberto; Remer, Lorraine	Pending

A Process-Oriented, Atmospheric Heating Data Record Derived from Multiple-Satellite Remote Sensing Observations	NASA	Olson, Bill		Pending
Understanding airborne fertilization of oceanic ecosystems from analysis of MODIS, VIIRS and CALIOP observations.	NASA	Remer, Lorraine		Pending
AIRS plus CrIS/IASI Climate Level Trends and Anomalies with Full Spatial Sampling and Rigorous Error Characterization	NASA	Strow, Larrabee	DeSouza-machado, Sergio	Pending
Analyses of Tropospheric Ozone Profiles within Complex Environments	NASA	Sullivan, John		Pending
Validation of Rain Enhancement over UAE	NCMS	Tokay, Ali		Pending
MODIS and VIIRS aerosol properties in partly cloudy regions	NASA	Varnai, Tamas		Pending
A Comprehensive Data Record of Marine Low-level and Deep Convective Cloud Systems Using an Object-Oriented Approach	NASA	Yuan, Tianle		Pending
Cells in the field of clouds: discovery in NASA data by citizens	NASA	Yuan, Tianle		Pending

Improving the Understanding of Stratocumulus Cloud Morphology and its Radiative Effect by Using Satellite Measurements from Terra, Aqua, and Suomi NPP	NASA	Yuan, Tianle		Pending
Atmospheric correction for complex scenes using co-located polarimetric and ocean color observations	NASA	Zhai, Pengwang	Gao, Meng	Pending
Bidirectional reflectance distribution function characterization for ocean waters	NASA	Zhai, Pengwang		Pending
Using the combination of ASTER, CALIPSO-WFC and MODIS to better understand the optical and microphysical properties of sub-kilometer marine boundary layer cloud fields	NASA	Zhang, Zhibo	Werner, Frank	Pending
ASR: Improve Understanding and GCM representation of BB aerosols	DOE	Zhang, Zhibo		Pending
Vegetation functional amplitudes along a rainfall gradient in Indian ecosystems using AVIRIS-NG	NASA		Campbell, Petya	Pending
Developing a Data Record of Planetary Boundary Layer (PBL) Thermodynamic Profiles at Diurnal Scales	NASA		Demoz, Belay	Pending

Consortium for Training of Underrepresented STEM Professionals (CTUSP)	FAMU (NSF)		Demoz, Belay; Hoban, Susan	Pending
Multi–Decadal Sulfur Dioxide Climatology from Satellite Instruments: Continuation	NASA/GSFC		Evans, Keith	Pending
An optically-based terrestrial ecosystem production product from combined MODIS land and ocean bands	NASA		Huemmrich, Fred	Pending
Development of a Multiyear Sounder-Based Outgoing Longwave Radiation Climate Data Record Using Products Derived from TOVS, AIRS, and CrIS	NASA		Huemmrich, Fred; Campbell, Petya	Pending
Machine Learning for Detecting Fires from Cubesats in Space Principal Investigator	NASA		Huemmrich, Fred; Campbell, Petya	Pending
Monitoring Recent Climate Variability and Trends by use of Aqua, Terra, And NPP Data Products and Re-analyses	NASA		Lee, Jae	Pending
A Constrained Global Planetary Boundary Layer Height Product for Comprehensive Earth System Studies	NASA		Lewis, Jasper	Pending
A High-Efficiency Multi-band Communication System to support CubeSat Science	NASA		Martins, Vanderlei	Pending

Building Capacity to Monitor Water Quality of Fresh Water Bodies in Latin America	NASA		Mehta, Amita	Pending
An IR sounder-centered investigation of well-mixed layers in low-latitude deserts	NASA		Nichols, Stephen	Pending
Global Ocean Latent/Sensible Heat and Freshwater Fluxes (GOLaSeFF)	NASA		Shie, Chung-Lin	Pending
A Global and Daily Ammonia and Carbon Monoxide Product for Biomass Burning and Air Quality Research	NASA		Strow, Larrabee	Pending
Ocean Discipline Leads for MODIS and VIIRS	NASA		Turpie, Kevin	Pending
Exoplanet Research	NASA		Varnai, Tamas	Pending
Evaluation of the cloud horizontal heterogeneity effect for multi-sensor inter-comparisons of solar and thermal IR cloud optical property retrievals	NASA		Zhang, Zhibo	Pending
High temporal resolution cloud data with uncertainty estimate by fusing MODIS, VIIRS, and geostationary observations to study cloud diurnal cycle in the climate system	NASA		Zhang, Zhibo	Pending
Improving the Understanding of Dust Variability and Net Radiative Effect in Recent Decades by Using Satellite Measurements from Terra,	NASA		Zhang, Zhibo	Pending

Aqua, and Suomi NPP				
Investigating the Impact of Aerosol Above Clouds (AAC) on Photolysis Frequencies and Photochemistry Using a Global Chemical Transport Model in Conjunction With Satellite Observations	NASA		Zhang, Zhibo	Pending
Simultaneous retrievals of clouds and above-cloud absorbing aerosols from MODIS and VIIRS: Algorithm refinement and transition to production	NASA		Zhang, Zhibo	Pending

E. Biographies

Nader Abuhassan, Associate Research Engineer, holds a PhD in Geophysics from the University of Pierre and Marie Curie. Dr. Abuhassan participated in the design and development of multiple world recognized sensors such as the Cimel sun photometers, Solar Viewing Interferometer and the Pandora Spectrometer. He participated in multiple national and international satellite validation and ground based instruments inter comparison campaigns. For the past four years he was heavily involved in the NASA's DISCOVER_AQ project " Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality" where he managed to deploy and maintain up 15 Pandora spectrometers for each of the 4 field campaigns. Dr. Abuhassan's research is focused on designing and developing new sensors in support of the atmospheric chemistry research activities. He is highly interested in providing new tools to help scientists develop new methods to better understand the atmosphere composition, its dynamics and air-surface interactions.

Mustafa Aksoy, Post-Doctoral Research Associate, holds a PhD in Electrical Engineering from The Ohio State University. Research interests are in remote sensing of earth using microwave radiometry, electromagnetic theory, data analytics, and signal processing. Specific research efforts involve remote sensing of ice sheets and developing radio frequency interference (RFI) detection and mitigation algorithms for microwave radiometers.

William Barnes, Senior Research Scientist, holds a PhD in Physics from Florida State University. Dr. Barnes is also an emeritus research scientist with the Earth Sciences Directorate of NASA's Goddard Space Flight Center. He served as the MODIS Sensor Scientist, and a member of the MODIS Science Team for more than 12 years. He led the MODIS Characterization Support Team (MCST) for more than two years and was NASA's member on the National Polar Orbiting Environmental Satellite System's Joint Agency Requirements Group (NPOESS/JARG) for more than five years. He has over thirty years experience in the development and radiometric calibration of Earth-observing imaging radiometers including TIROS/AVHRR, AEM-1/HCMR, NOSS/CZCS-2, OrbView-1/SeaWiFS, TRMM/VIRS, EOS/MODIS and NPP/VIIRS. Dr. Barnes has over thirty years experience in the development of space-borne, Earth-viewing sensors. His interests include the characterization, calibration and scientific support of imaging optical systems capable of mapping the Earth's surface in the visible and infrared portions of the electromagnetic spectrum.

Huisheng Bian, Associate Research Scientist, holds a PhD from the University of California Irvine. Dr. Bian worked in Chinese Meteorological Academy as an assistant researcher, where her research interest was regional air quality modeling. Her Ph.D. work focused on improving, validating, and applying UCI global chemistry transport model for tropospheric ozone simulation, as well as on developing a module (Fast-J2) to accurately simulate stratospheric photolysis in global chemistry models. Upon graduation, Dr. Bian became interested in atmospheric aerosols, their distribution and their photolytic and heterogeneous impacts on tropospheric chemistry. Her current major research interest involves improving atmospheric aerosol simulation by including nitrate aerosol and secondary organic aerosol and by investigating aerosol micro-physics for aerosol-cloud interaction.

Brock Blevins, Research Analyst, holds a BS in Biological Sciences from the University of Nebraska at Omaha and a Graduate Certificate in Geographic Information Systems from the University of Maryland, Baltimore County (UMBC). Mr. Blevins supports the NASA Applied Remote Sensing Training Program (ARSET) and has extensive experience working with NASA Earth Science Datasets and Geographic Information Systems (GIS).

Roberto Fernandez Borda, Assistant Research Scientist, holds a PhD in Physics from the University of Buenos Aires. Dr. Roberto Fernandez Borda is interested in scientific instrumental design and experimental physics. Since his Master thesis, he was involved in the design of scientific instrumentation like HRXS (part of the payload of SAC-B, Conae Argentina) and HASTA telescope (International agreement between the Max Plank Institute, Germany and IAFE, Argentina). Dr Borda got an strong background in different instrument design areas like optics, digital electronics, sensors and real time software. He came to United State, as National Research Council Post-Doctoral Fellow, to work with Dr. Mario H Acuna at GSFC NASA in 2002. In 2006, he became an Assistant Research Scientist at JCET-UMBC. Dr. Borda, as member of the research group of Dr. Vanderlei Martins at JCET-UMBC, was involved in many instrumental projects for avionics applications (Cloud Scanner, Rainbow camera, PACS VNIR) and for satellite applications (HARP)and also he was part of many field campaigns (Milagro, Vocals, Podex). Dr. Borda has received two awards for instrumental design: first by the Laboratory of Atmospheres, Climate & Radiation Branch, GSFC NASA (2007) and the second time by the Climate & Radiation Branch, GSFC NASA (2009).

Steven Buczkowski, Research Analyst, holds a MS in Physics from West Virginia University and an M.S. in Atmospheric Physics from the University of Maryland, Baltimore County

(UMBC). Mr. Buczkowski works in the Atmospheric Spectroscopy Lab at UMBC designing data analysis software for hyperspectral remote sensing products from orbiting instruments such as AIRS and CrIS. His research interests include remote sensing of clouds and aerosols, scientific computation, and the design of robust software systems for instrument control and data analysis.

Vanessa Caicedo, Post-doctoral Research Associate, holds a Ph.D. in Atmospheric Science from the University of Houston. Dr. Caicedo studies the atmospheric boundary layer by using various remote sensing instruments and boundary-layer height retrieval methods to continuously investigate the temporal, seasonal, and spatial evolution of the atmospheric boundary layer. Dr. Caicedo's Ph.D. dissertation focused on boundary-layer height retrieval methods and their implementation in studies of urban and coastal boundary layers. Dr. Caicedo's research interests include atmospheric boundary layer observations and modeling, boundary layer meteorology and atmospheric chemistry.

Petya Campbell, Associate Research Scientist, holds a PhD in Forest Analysis/Remote Sensing from the University of New Hampshire. Dr. Campbell is an experienced scientist, forest engineer and ecologist by training, she has conducted numerous field campaigns in support of satellite and airborne acquisitions. Her research focus is on Remote Sensing for Natural Resources, specifically spectral analysis for vegetation assessment, ecosystem monitoring and forest damage detection using reflectance, fluorescence and thermal measurements. Dr. Campbell has taught undergraduate and graduate courses in remote sensing, has mentored students and served on graduate student committees. Dr. Campbell's research focus is on spectral analysis for the retrieval of vegetation biophysical and morphological parameters for monitoring vegetation function and damage detection. Dr. Campbell has experience collecting and analyzing vegetation reflectance and fluorescence measurements, ecosystem gas exchange parameters, as well as measuring other associated biophysical characteristics. She has worked with optical data collected in the laboratory, on the ground, from aircraft, and from satellite for a variety of ecosystem types (forests and crops, C3 and C4 vegetation). She has experience using the integrated model for Soil-Canopy spectral radiance Observations, Photosynthesis and Energy balance (SCOPE, C. van der Tol and W. Verhorf) for estimating leaf and canopy spectral reflectance and fluorescence properties and GPP.

Valerie Casasanto is the Education and Public Outreach Manager for the ICESat-2 mission. Ms. Casasanto has more than 20 years of experience in designing, managing and implementing Earth and space science educational programs to diverse audiences. She has successfully integrated student designed and PI science microgravity payloads on 15 space missions. Ms. Casasanto is member of the International Astronautical Federation (IAF) Space Education and Outreach Committee, member of GSFC's Education Implementation Team and GSFC's Native American Advisory Committee.

Ding-Chong (Allen) Chu, Associate Research Scientist, holds a PhD in Atmospheric Sciences from Georgia Institute of Technology. Dr. Chu has 26 years experience in satellite remote sensing, radiative transfer modeling and statistical analysis on atmospheric measurements. He has been involved in UARS ISAMS and EOS MODIS satellite missions since 1988. He served as a PI in multiple NASA field campaigns between 2004 and 2010. His recent involvement in

NASA DISCOVER-AQ airborne missions targets column AOD with surface PM2.5 for air quality application over the US. Dr. Chu's research focus includes 1) radiative transfer modeling with line-by-line and band models on satellite sensor development, 2) retrieval methodology development of ozone and aerosols, 3) application of satellite data to air quality and public health, 4) atmospheric radiative forcing, and 5) aerosol-cloud interaction.

J. Dominik Cieslak, Faculty Research Assistant, is a graduate of Poznan University of Technology. Cieslak is an experienced engineer that started his career working in the heavy printing industry. He gained his experience by servicing the instrumentation used in process of printing. In 2005 he joined JCET in J. Vanderlei Martins' group. Since then he has lead the design of new ground and airborne instruments that were built and used in many NASA campaigns. Mr. Cieslak uses cutting-edge techniques to build unique instruments that deliver new sets of data that are used by scientist to better understand human impact on climate changes. He has been involved in many NASA campaigns contributing to the development of the PiNeph Nephelometer, the PACS polarimetric camera, the RPI polarimetric camera and the OiNeph. All of this instrumentation was designed and built by UMBC LACO laboratory group.

Belay Demoz, Professor and Director of JCET, holds a doctoral degree in Atmospheric Physics from the University of Nevada and Desert Research Institute in Reno, Nevada. Dr. Demoz is Professor of Physics at University of Maryland Baltimore county and the current Director of the Joint Center for Earth Systems Technology (JCET: http://jcet.umbc.edu). Prior to joining UMBC/JCET, Dr. Demoz was Professor of Physics at the Department of Physics and Astronomy at Howard University, where he was Director of Graduate Studies for the Physics Department and also one of the Principal PI's at the Beltsville Research Campus. At the Howard University Beltsville Campus, Dr. Demoz worked on a number of areas including LIDARs, Microwave Remote Sensing and upper air balloon measurements. Before joining academia, Dr. Demoz worked for the private industry as a NASA contractor, followed by time spent as a Civil Servant at NASA/GSFC in the Mesoscale Dynamics Branch. He has chaired the Committee for Atmospheric LIDAR Application Studies (CLAS) for the American Meteorological Society; is a member of the Atmospheric Observation Panel for Climate (AOPC) Working Group on GRUAN (WG-GRUAN); and has served as Associate Editor for the Journal of Geophysical Research, the web magazine Earthzine (http://www.earthzine.org/) and many other editorial boards. Dr. Demoz is active in organizing national and international research field observations including WAter Vapor Experiment-Satellite (WAVES 2007); International H_2O Project (IHOP2002), Plains Elevated Convection At Night (PECAN 2015) and numerous other experiments across the United States.

Sergio DeSouza-Machado, Research Assistant Professor, holds a phD in Plasma Physics from the University of Maryland, College Park. Dr. DeSouza-Machado joined the Atmospheric Spectroscopy Laboratory at UMBC to work on radiative transfer, spectroscopy, retrievals and climate studies. He has written a state-of-the-art line-by-line code and KCARTA, a clear/cloudy sky radiative transfer code for the (Earth atmosphere) thermal infrared region which is the Reference Forward model for NASA's AIRS instrument. His research interests include dust and volcanic ash detection and retrievals, trace gas, cloud and atmospheric geophysical retrievals, and climate studies of extremes and evolution of probability functions. In addition he performs teaching duties on campus, as well as is the faculty advisor for one of the UMBC student clubs. Dr. DeSouza-Machado's current interests in Atmospheric Physics include updating spectroscopy and radiative transfer calculations used by kCARTA, flux calculations in the longwave, and dust/volcanic ash detection and atmospheric. loading/height retrievals. He also does retrievals for broader target species, notably trace gas and geophysical retrievals both under clear and cloudy conditions. In addition he uses 12+ years of hyperspectral AIRS data for climate studies. Dr. DeSouza-Machado also pursues some interest in Plasma Physics, notably MHD simulations and kinetic theory.

Ruben Delgado, Assistant Research Scientist, holds a PhD in Chemistry from the University of Puerto Rico. Dr. Delgado is experienced in remote sensing technology for air quality, wind energy, and meteorology applications. His interest and experience in active and passive remote sensing measurements has allowed him to participate in numerous field campaigns with NASA, NOAA, NSF and DOE. Dr. Delgado has mentored undergraduate and graduates students from diverse majors (Math, Physics, Chemical Engineering, Mechanical Engineering, Geography and Environmental Systems) in atmospheric and remote sensing topics, and serves on graduate committees. Dr. Delgado's research interests focus on atmospheric chemistry and physics, and laser remote sensing technology. Elastic, Raman, and Doppler wind lidar measurements are integrated with satellite retrievals, ground based concentration measurements of gases and aerosols (TEOM, BAM, filters), and numerical weather prediction models to reach a thorough understanding of the coupling of chemistry and dynamics in air-land-marine interactions.

Keith Evans, Research Analyst, holds a M.S. in Physics from American University, and a MS in Meteorology from University of Maryland. Mr. Evans began work as a physicist at the Vitro Corp. in 1979 and worked on solar energy systems, submarine subsystems, and cruise missiles. In 1984, he worked as a contractor at the Naval Research Laboratory on the first SSM/I instrument, satellite subsystems testing, and in acoustics. He wrote the data retrieval program for the Broad Band X-ray Telescope when he started working as a contractor at NASA/Goddard Space Flight Center (GSFC) in 1989. He began working with LiDAR (Light Detection and Ranging) in 1991, performing various atmospheric studies including: atmospheric temperature, and spectral and multifractal analysis of atmospheric water vapor data. He is currently employed by the Joint Center for Earth Systems Technology of the University of Maryland, Baltimore County as a Research Analyst at NASA/GSFC. His current tasks include webmaster and scientific programmer for the Sulfur Dioxide Monitoring Group at NASA and scientific programmer in space geodesy. He is co-author on over 30 peer-reviewed publications and over 100 conference publications. Mr. Evans is interested in the determination of the impact of trace gases in the atmosphere radiatively and for aviation and human safety.

Steve Guimond, Assistant Research Scientist, hold a Ph.D. in Atmospheric Science from the Florida State University. Dr. Guimond has just joined UMBC/JCET and has been working at NASA/GSFC since September 2010, where he studies atmospheric dynamics with a focus on hurricanes, radar remote sensing and numerical modeling. Dr. Guimond started at NASA/GSFC as a NASA Postdoctoral Program (NPP) fellow in 2010. Dr. Guimond's research interests include geophysical fluid dynamics with a focus on computational methods, hurricane science, radar remote sensing and algorithm development.

Forrest Hall, Senior Research Scientist, holds a PhD in Physics from the University of Houston. Dr. Hall specializes in global change research using earth-observing satellites. He has served as Project Manager on three major field campaigns in the US and Canada (COVER, FIFE and BOREAS). Dr. Hall's research focuses on the development of physically based algorithms for the remote sensing of vegetation condition, structure and function and the modeling of surface carbon, water and energy exchange. He has authored more than 75 scientific papers. Dr. Hall's current research interests focus on terrestrial vegetation including photosynthesis, vegetation structure, terrestrial ecosystem-Atmosphere carbon, water and energy exchange, and ecology.

Reem Hannun, Postdoctoral Research Associate, has been at NASA/GSFC and UMBC/JCET since March 2017. Her research interests include atmospheric oxidation chemistry and the surface-atmosphere exchange of greenhouse gases. Prior to arriving at NASA, Dr. Hannun received her PhD in Chemistry from Harvard University, followed by a six-month Climate and Energy policy internship with the American Physical Society.

Christopher Hepplewhite, Associate Research Scientist, holds a PhD in Remote Sensing of Sea Surface and Atmosphere from the University of Oxford. Dr. Hepplewhite is an experienced atmospheric physicist, remote sensing instrument scientist and developer. He has 20+ years in the academic environment and supported teaching and research at undergraduate and graduate level. Dr. Hepplewhite has worked on remote sensing instrument teams in the U.K. with ESA and NASA, including ship-borne infra-red radiometry; solar occultation radiometry, Mars Orbiter, Saturn Cassini, and NASA EOS missions. This has included all phases of mission life-cycle, including design, development, calibration, test, operation and data analysis. Dr Hepplewhite has supported project management, aerospace industry, systems engineering and project science lead. He has worked in atmospheric physics and chemistry and meteorology and has a keen interest in climate dynamics. Dr. Hepplewhite is currently involved in supporting research to quantify and improve the inter-calibration of space-based hyper-spectral infra-red observations of the Earth using data from weather satellite sensors. These include NASA EOS Terra AIRS, Suomi-NPP CRIS and ESA Metop IASI sensors. Dr. Hepplewhite has interest in observation of climate change signals from space based sensors and the underlying physical processes. An understanding of the nature and morphology of climate change processes is essential when looking for signals in the observations and differentiating sensor artifacts.

Jay Herman, Senior Research Scientist, holds a PhD in Physics from Pennsylvania State University. Dr. Herman has had wide experience in a number of diverse fields. Early in his career at Goddard Space Flight Center (1965-1970) he worked in the fields of ionospheric and plasma physics and planetary atmospheres. Starting in 1970, he developed a theoretical model of the earth’s atmosphere that included extensive chemistry analysis to estimate the effects of accumulating chlorine on the ozone layer. This led to an interest in satellite instruments measuring ozone (Total Ozone Mapping Spectrometer, TOMS). Dr. Herman devised a corrected calibration method that led to the capability of the TOMS instrument successfully producing long-term ozone trends. As part of this effort, he became the Principal Investigator to the joint US-Russian Meteor-3 TOMS project. Dr. Herman worked on distribution of aerosols as detected by the TOMS instrument and published the first papers on the motions of dust, smoke, and volcanic ash over the entire earth. He also developed an analysis of cloud amount and the long-term trends of cloud amount. This data was used to estimate the amount of ultra-violet radiation reaching the earth's surface and discussions of potential health effects. In 1998, Dr. Herman became the Project Scientist of the Triana spacecraft project, now known as DSCOVR, which was just launched (February 2015) to the Lagrange-1 point to measure ozone, aerosols, cloud properties, and vegetation. Starting in 2006, Dr. Herman began the development of a new ground-based instrument, Pandora, capable of accurately measuring ozone and other trace gases in the atmosphere. The Pandora instrument is now mature and being deployed widely in the US and other countries. Dr. Herman started work at UMBC in 2009 where he continued the work on DSCOVR as EPIC instrument scientist and the Pandora spectrometer system project. Dr. Herman has 160 peer reviewed scientific journal publications.

Susan Hoban, Senior Research Scientist, holds a PhD in Astronomy from the University of Maryland, College Park. Dr. Hoban has worked with NASA for over two decades, first as a scientist studying comets and the interstellar medium, then as a STEM Educator. Dr. Hoban serves on the STEM Advisory Board for Anne Arundel County Public Schools. Dr. Hoban also teaches in the Department of Astronomy at the University of Maryland, College Park. Dr. Hoban's research interests include the effectiveness of various pedagogical models on teacher preparation and student outcomes, composition and evolution of comets, and cybersecurity. Dr. Hoban is currently on the faculty of the University of Maryland, Baltimore County, as an Affiliate Associate Professor of Physics, Affiliate Associate Professor of Computer science & Electrical Engineering, an Honors College Fellow and the Associate Director for Academics for the UMBC Joint Center for Earth Systems Technology.

Raymond Hoff, *Emeritus*, holds a PhD in Physics from Simon Fraser University, Physics. Dr. Hoff has 39 years of experience in atmospheric research. His research interests are in the optical properties of aerosols and gases in the atmosphere. Dr. Hoff has been central in formulating major research programs on Raman, differential absorption, airborne and spaceborne lidar, volcanic emissions, atmospheric transport of toxic chemicals to the Great Lakes, atmospheric visibility, Arctic Haze, and dispersion of pollutants. He has led or participated in over 20 major field experiments.

K. Fred Huemmrich, Research Associate Professor, holds a PhD in Geography from the University of Maryland, College Park. Dr. Huemmrich has a life-long interest in understanding the natural world. This interest, coupled with his training in physics has lead him to work on remote sensing of ecosystems. He has performed fieldwork in a variety of different ecosystems, including working on NASA field studies in grasslands and boreal forests. Dr. Huemmrich's research focuses on the use of remote sensing to describe biophysical characteristics of terrestrial ecosystems and to utilize that information to improve understanding and modeling of ecosystem processes. He is interested in developing approaches that lead to global observations from satellite based sensors.

Leonid Iourganov, Senior Research Scientist, holds a PhD in Atmospheric Physics from Obukhov Institute of Atmospheric Physics. Dr. Iourganov specializes in atmospheric physics, optics, spectroscopy, and remote sensing of atmospheric gaseous composition from satellites. He has been being involved in different geophysical projects in USSR/Russia for 26 years. Between 1995 and 2011 he was working in Canada, Japan, and USA, and took part in validation and analysis of carbon monoxide satellite measurements. During last three years he devoted most of his time to investigation of atmospheric sulfur dioxide and methane concentrations measured by US and European satellite sounders. Both of the projects that he is involved in now are connected with Global Change and funded by NASA. A goal of the first project is to study interconnections between the currently progressing Arctic warming that is twice as fast compared to the global warming and methane concentrations in the Arctic. Methane is known as an important greenhouse gas. Huge amounts of methane are buried in the Arctic permafrost and under the Arctic Ocean sea floor. Sooner or later these amounts would be released into the atmosphere and amplify the ongoing warming (positive feedback). Satellite data, analyzed by Dr. Yurganov, make possible monitoring of methane concentration in this climatically sensitive area. The second project is connected with climatic impact of volcanic aerosols. Volcanic sulfur dioxide is a precursor of sulfur aerosols and can be easily measured in the Thermal IR spectral region by several sounders (AIRS, IASI, TES, GOSAT, CrIS). These instruments deliver valuable global data on sulfur dioxide, year round, day and night. Retrieval algorithms being developed by Dr. Yurganov are supposed to be realized in the NASA processing schemes.

Catherine Kruchten, Instructional Designer**,** holds an Ed.D. from Johns Hopkins University. Catherine supports STEM educational programming for students and educators as part of the NASA's BEST Students project. Before coming to UMBC, she was the Informal Educator for the Visitor Center at NASA's Goddard Space Flight Center, where she was charged with creating and implementing STEM engagement in out-of-school programs and supporting informal educator professional development. While an undergraduate at MIT, she earned her teaching license for secondary level mathematics before bridging her classroom experiences to informal education. Dr. Kruchten has developed educational programming, research, and evaluation for several museums, including the Smithsonian Institution, the Capitol Visitor Center, the Museum of Science in Boston, the Newseum, and the International Spy Museum. Dr. Kruchten's research interests focus on informal learning, particularly in STEM. She is seeking to understand how to better engage underrepresented students (e.g., girls) with STEM content and how informal education environments can support such learning. Dr. Kruchten is also interested in how formal and informal education complement each other, and how informal learning reaches beyond just engagement of students and promotes broader and deeper content understanding.

Jae Lee, Assistant Research Scientist, holds a PhD in Marine and Atmospheric Science from Stony Brook University. Lee is working with on TSIS (Total Solar Irradiance Sensor) due for launch on JPSS Free Flyer in 2017. She is also working on the climate responses to solar forcing in different time scales by integrating satellite measurements and model simulations. She worked at JPL as a NASA postdoc fellow. During her postdoc, she worked on dynamics and transport in the middle atmosphere and variability in cloud and aerosol caused by natural and anthropogenic forcings. Dr. Lee's research interests include observation of total and spectral solar irradiance, analysis of solar irradiance variability, and its impact on earth's climate. She uses numerical models of the sun and earth's atmosphere as well as remote sensing observations to investigate solar activities, climate variability and their interconnections. Besides this, she also find that remote sensing of cloud and aerosol is an important problem to addressing the climate change from both the natural and anthropogenic forcings.

Jasper Lewis, Research Associate, holds a PhD in Physics from Hampton University, Physics. Dr. Lewis performed ground-based and aircraft lidar measurements to observe air quality from NASA Langley Research Center. Currently, he conducts research at the NASA Goddard Space Flight Center as a member of the Micropulse Lidar Network (MPLNET) team. Dr. Lewis' research interests include remote sensing of cirrus clouds and the planetary boundary layer.

Simone Lolli, Assistant Research Scientist, holds a PhD in Physics from Ecole Polytrechnique. Simone Lolli is affiliated with NASA MPLNET lidar network science team. The network is operative since 1999, with more than 20 lidar instruments, deployed worldwide, from Arctic and Antarctic regions to tropical and equatorial zones. Simone Lolli principal research interests are to assess the impact on air quality and radiative transfer of natural and anthropogenic aerosol particles and their interaction and effects on clouds ,precipitations and climate change, focusing especially in South-East Asia, a wild and remote region, important source of smoke due to natural and anthropogenic biomass burning, during the dry season. This research is part of 7-SEAS NASA mission (7_seas.gsfc.nasa.gov), established to quantitatively characterize aerosol-meteorological interactions in tropical to sub-tropical environments. A Fellow of American and European Geoscience Union, he has published more than 20 peer-reviewed papers and 100 conference proceedings. Dr. Lolli's main research interests are to quantify the impact on climate change and air quality of the natural and anthropogenic aerosol particle emissions, especially their interaction with clouds and precipitation formation.

Vanderlei Martins, Associate Professor, holds a PhD in Physics from the University of Sao Paulo (USP, Brazil. Dr. Martins is an Experimental Physicist by training specializing in the development of instrumentation and algorithms for the measurement of the properties of aerosol and cloud properties via remote sensing from ground, aircraft, and space as well as in situ and laboratory measurements. He has designed, built and integrated several instruments for multiple NASA aircrafts including the ER-2, P3, DC8 and Langley B200, and has participated in numerous aircraft and ground based field campaigns. Dr, Martins is a tenured Professor in the Physics Department at UMBC and has mentored several students from undergraduate to the PhD level. Dr. Martins is particularly interested in the effect of natural and anthropogenic aerosol particles on cloud microphysical and thermodynamic properties as well and in the radiative properties of aerosol and cloud particles from UV to thermal infrared. In particular Dr. Martins and his group has developed methods for measuring the spectral the refractive index of aerosols from the UV to SWIR, in situ instrumentation for measuring the angular dependence of the particle scattering matrix for clouds and aerosols, remote sensing imagers for the vertical profile of cloud droplet sizes, and multi-angle imaging polarimeters for airborne and space applications. He is also working with NASA GSFC on the development of remote sensing instrumentation for next generation of Earth Science satellites required by the National Academy of Sciences Decadal Survey on Earth Science Missions.

Amita Mehta, Research Assistant Professor, holds a PhD in Meteorology from Florida State University. Dr. Mehta's interest and expertise are in satellite remote sensing of geophysical parameters and their analysis to understand climate and its variability. Dr. Mehta has extensive experience in a variety of topics including retrievals of clouds, rain, and radiative fluxes from satellite measurements, use of cloud resolving models, use of a hierarchy of radiative transfer models, statistical analyses of in situ and remote sensing observations, and climate model outputs to understand climate variability. Dr. Mehta is a member of NASA Atmospheric Remote Sensing Training group and conducts online and in-person trainings of NASA remote sensing data utilization for water resources and disaster management. Dr. Mehta's research interests include satellite remote sensing of geophysical parameters and their analysis to understand weather and climate variability from storm-scale to global scale. In addition, Dr. Mehta's is interested in analysis of global climate change model data to understand climate impacts on regional and global water cycle.

Howard Motteler, Research Professor, holds a PhD in Computer Science from the University of Maryland, College Park. Dr. Motteler has worked in radio and television and as an academic support and systems programmer at the University of Puget Sound and Purdue University. He was an associate professor of computer science in the UMBC CSEE department and then a research associate professor at JCET. He retired from that position but later returned to JCET as a research associate scientist. Dr. Motteler's research interests are in the areas of scientific computation and applications, including instrument modeling and calibration, passive infrared and microwave sounding, atmospheric radiative transfer calculations, and parallel and distributed processing.

Stephen Nicholls, Post-Doctoral Research Associate, holds a PhD in Atmospheric Science from Rutgers University. Dr. Nicholls has extensive expertise with ocean and atmosphere numerical prediction models, proficient in multiple scientific programming languages, and experienced with analyzing large space-based and in-situ datasets in the GIS environment. Models used and adapted for weather and regional climate modeling include the Weather Research and Forecasting (WRF) model, Regional Ocean Modelling System (ROMS), the Coupled-Ocean-Atmosphere-Wave-Sedimentation Transport (COAWST) modeling system, and Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) Model. Programming languages applied in my research include: Python, Matlab, IDL, FORTRAN, BASH and C-shell.

William Olson, Research Associate Professor, holds a PhD in Meteorology from the University of Wisconsin. Dr. Olson studied physics and astronomy as an undergraduate, and became interested in planetary atmospheres research with encouragement from Prof. Peter Gierasch and Prof. Warren Knapp at Cornell University. He continued these studies as a graduate student at Univ. of Wisconsin under the advisement of Prof. James Weinman, using satellite microwave remote sensing to diagnose precipitation and latent heating in convective storms. This led to collaborations with Dr. William Raymond in an effort to assimilate precipitation/heating in numerical weather prediction forecasts. Since joining NASA in 1994, he has continued these studies using data from the Tropical Rainfall Measuring Mission and Global Precipitation Measurement mission satellites. He leads a team that continues to develop a method for estimating precipitation profiles and latent heating from a combination of radar and passive microwave radiometer observations from the TRMM and GPM satellites. Olson’s main professional focus is in radar and passive microwave measurement of precipitation and latent heating, but his research interests go beyond remote sensing. Some of his side interests include cloud physics, diagnosis of latent heating and generation of available potential energy in convective systems, stratocumulus modeling, the earth's energy and water cycles, and data assimilation.

Ana Prados, Research Assistant Professor, holds a PhD in Chemistry from the University of Maryland, College Park. Dr. Prados has 12 years experience in the application of satellite remote sensing to air pollution monitoring. She currently manages the NASA Applied Remote Sensing Training Program, where she develops courses worldwide on the application of satellite imagery to environmental decision-making activities related to climate change, water resources, disaster, land, and air quality management. She has +10 years of environmental policy experience working with local governments on the implementation of local and regional climate and air pollution initiatives. She has also coordinated multiple workshops for federal agencies on how to assess the benefit of Earth Science information and improve stakeholder collaboration. Dr. Prados is interested in environmental policy-making in the context of water resources management and climate change, air quality policy, program/project evaluation, and communicating scientific information to the public.

Lorraine Remer spent 21 years at the NASA Goddard Space Flight Center involved in the remote sensing of aerosol and the use of remote sensing data for the study of aerosols in climate processes, how aerosol particles affect clouds, aerosol transport and particulate air pollution. Her first position at Goddard in 1991 was in the role of a support scientist, employed by Science Systems and Applications, Inc. (SSAI), where she contributed to the development of the MODIS aerosol algorithms. In 1998 Dr, Remer joined the Federal civil service, and in 2012 she left NASA to become a part of JCET-UMBC. Currently she is working on aerosol remote sensing for the MODIS, VIIRS and PACE missions. She also contributes to measuring aerosols from ground-based and air-borne sensors Dr. Remer has served on a variety of national and international panels. She has co-edited a textbook, Aerosol Remote Sensing, and is currently an editor of the Journal of the Atmospheric Sciences. Dr. Remer was named a 'highly cited' scientist in geosciences by Thomson-Reuters for the time period 2002 - 2012, and recently was elected as Fellow of the American Geophysical Union. Dr. Remer's research interests include remote sensing of aerosol and the use of remote sensing data for the study of aerosols in climate processes, how aerosol particles affect clouds, aerosol transport and particulate air pollution. She is also interested in atmospheric correction for ocean and land remote sensing.

Adriana Rocha Lima, Post-Doctoral Research Associate, holds a PhD in Atmospheric Physics from the University of Maryland, Baltimore County. She is working in the Atmospheric Chemistry and Dynamics Laboratory in NASA Goddard since 2015. Dr. Rocha-Lima has conducted laboratory experiments to characterize optical and microphysical properties of different types of aerosol particles, including mineral dust and volcanic ashes. Currently, Dr. Rocha-Lima is performing simulations of aerosol distributions using the Goddard Earth Observing System Model (GEOS-5). Her goal is to improve the representation of aerosol optical properties in the model, aiming to provide more reliable information about dust aerosol distributions, total mass loading, and dust processes in the Earth’s atmosphere.

Chung-Lin Shie, Associate Research Scientist, holds a PhD in Meteorology from Florida State University. Dr. Shie, originally trained as a dynamic meteorologist, is an experienced and versatile research scientist involving in numerous interdisciplinary studies. He has played crucial roles in several projects of diverse interests such as (1) Air-sea interaction; Goddard Satellite-based Surface Turbulent Fluxes (GSSTF) datasets production [as PI in a MEaSUREs project], (2) Cloud modeling (GCE); Radiative-convective system simulations; Latent heating retrieval [as Co-I in NEWS; as Collaborator in TRMM], and (3) Hurricane simulations using WRF; Impact of the Saharan Air Layer (SAL) dust on tropical cyclone and hurricane/typhoon [as PI/Co-I in EOS; as Co-I in NAMMA; as Collaborator in TCSP]. Dr. Shie has served as the Project Scientist of GES DISC since January 2013, providing scientific consultations and advices to the data center and engaging with the GES DISC User Working Group (UWG) aiming to further improve the data distributions and user services. He also serves as an editor of International Journal of Atmospheric Sciences since September 2012. Dr. Shie has mentored numerous post-docs, and graduate, undergraduate, and high school students on diverse research subjects, particularly during 1996-2006. Dr. Shie has been involved and played crucial roles in several projects of diverse interests. He has studied air-sea interaction, as well as developed a series of successively improved global air-sea surface turbulent fluxes datasets (i.e., from GSSTF2b, GSSTF2c to GSSTF3), derived from improved remote sensing data and updated reanalysis data, by using updated algorithms [NASA funded project of MEaSUREs]. Dr. Shie has also investigated the potential influence of SAL dust on intensity of tropical cyclone and hurricane/typhoon using multi-sensors data and modeled simulations (applying the WRF model) [NASA funded projects of EOS; NAMMA; TCSP]. He has also applied the cloud-resolving model (GCE): studying the radiative-convective system (clouds) and its interaction with large-scale environment; producing numerical vertical heating profiles and improving the satellite latent heating profile retrieval [NASA funded projects of NEWS; TRMM]. Dr. Shie, as the project scientist of GES DISC (the data center at Goddard) since January 2013, has recently extended his interests into the "Data Science" field focusing on better understanding characteristics of the massive and heterogeneous Earth Science data, as well as aiming to further (how to) improve the science data distributions and user services.

Christopher Shuman, Research Associate Professor, holds a PhD in Geoscience from Pennsylvania State University. Dr. Shuman works within the Cryospheric Sciences Laboratory at NASA Goddard Space Flight Center (GSFC). He has been employed by JCET since 2011. Before joining JCET, he was with UMBC's Goddard Earth Sciences & Technology Center for four years. In 2014, he became affiliated with UMBC's Geography and Environmental Systems Department as an Research Associate Professor. From 2001-2007, Dr. Shuman was a Physical Scientist with the Cryospheric Sciences Branch (now Laboratory) at GSFC, and the Deputy Project Scientist for the Ice, Cloud, and land Elevation Satellite (ICESat) Mission from 2001 to 2005, as well as an Adjunct Research Faculty at the Earth System Science Interdisciplinary Center (ESSIC) at University of Maryland, College Park. From 1999-2001, Dr. Shuman was an Assistant Research Scientist at ESSIC. From 1996-1998, he was a Visiting Research Fellow with the Universities Space Research Association at GSFC's Oceans and Ice Branch working with Dr. Robert A. Bindschadler. From 1994-1996, he was a National Research Council, Resident Research Associate at GSFC's Oceans and Ice Branch, Greenbelt, MD working with Dr. Robert A. Bindschadler. From 1992-1994, he was a Research Associate at the Earth System Science Center and Department of Geosciences of The Pennsylvania State University, working with Dr. Richard B. Alley. Currently, Dr. Shuman is primarily working on in situ, satellite, and modeled temperature data sets from Greenland in collaboration with other researchers at NASA GSFC.

Previously, he has authored or co-authored research papers on ice elevation changes and glacier mass losses using altimetry in combination with other remote sensing in the Antarctica Peninsula, on the accuracy of the first ICESat mission's data over Antarctica's large subglacial lakes. He has also worked on composite temperature records derived from automatic weather stations (AWS), passive microwave data from SMMR and SSM/I and IR data from AVHRR satellite sensors. In addition, Dr. Shuman has successfully matched those records through stratigraphic correlation with stable isotope temperature proxy profiles in shallow snow layers. He has worked extensively in Greenland (7 deployments) and Antarctica (6 field deployments plus more recent Operation Ice Bridge flights from Punta Arenas, Chile). He began his cryospheric career helping to date the 3054 m long Greenland Ice Sheet Project 2's (GISP2) deep ice core in 1992. He was the longest serving member of the Polar DAAC Advisory Group (PoDAG) and also served on the Center for Remote Sensing of Ice Sheets (CReSIS) advisory board and is also on the Executive Committee of the Cryospheric Focus Group of AGU.

Hua Song, Postdoctoral Research Associate, holds a PhD in Marine and Atmospheric Science from the Stony Brook University. Dr. Song has been at UMBC/JCET since January 2016, where she evaluates the cloud and precipitation simulations in the Community Climate System Model using the satellite data and satellite simulators. Prior to arriving at JCET, Dr. Song was a research associate at the Brookhaven National Laboratory, Upton, NY. Dr. Song's research interests include climate change analysis and modeling, model evaluations using the ARM measurements and NASA satellite observations, and cloud parameterization in GCMs.

Jason St. Clair, Assistant Research Scientist, holds a PhD in Physical Chemistry from Harvard University.Over the last 14 years, Dr. St. Clair has worked on developing and deploying novel instrumentation for the in situ measurement of trace atmospheric compounds, with science goals ranging from quantification of the convective transport of water into the stratosphere to understanding how biogenic emissions can lead to ozone and aerosol formation. Dr. St. Clair's Research interests broadly include the chemical evolution of reactive compounds in the atmosphere. Specific subjects of interest include (1) high and low NO oxidation of biogenic compounds and their role in the formation of ozone and secondary organic aerosol, (2) the chemical evolution of forest fire plumes, and (3) the use of common oxidative products such as formaldehyde to trace the influence of polluted environments on more remote parts of the atmosphere.

Larrabee Strow, Research Professor, holds a PhD in Physics from the University of Maryland, College Park. Dr. Strow's research focuses on remote sensing of the earth in the infrared using high spectral resolution satellite instruments. His research interests include molecular spectroscopy, especially spectral line shapes, and radiative transfer, and atmospheric remote sensing. His primary goal is to measure climate trends using NASA, NOAA, European, and Japanese satellites. To that end, Dr. Strow is a Science Team Member on NASA's AQUA AIRS instrument, the NPOESS CrIS and EUMETSAT's IASI suite of instruments, and the Japanese GOSAT greenhouse gas mission. His group provides NASA and NOAA with the radiative transfer algorithms for the retrieval of geophysical variable using AIRS, IASI, and CrIS. Present research topics include measurements of atmospheric CO_2 and dust in order to better understand their effects on climate change. He is a Member of the NASA AIRS and NPP (CrIS Sensor) science teams, and a Co-Investigator on EUMETSAT's IASI sounder on the new METOP platform.

John Sullivan, Post-Doctoral Research Associate, holds a PhD in Atmospheric Physics from UMBC. He currently works in the Atmospheric Chemistry and Dynamics Laboratory at the NASA Goddard Space Flight Center (Greenbelt, MD). His expertise is in performing measurements of atmospheric constituents using active remote sensing techniques, such as lidar (light detection and ranging), for applications such as air quality, satellite validation, and climate change. Dr. Sullivan has been critical in designing, calibrating, and deploying a transportable lidar for measuring tropospheric ozone profiles in NASA campaigns, such as DISCOVER-AQ and KORUS-AQ. Dr. Sullivan was awarded the NASA Postdoctoral Program (NPP) Fellowship to continue his contribution of novel observations of the atmosphere to further NASA's science exploration.

Andrew Tangborn, Research Associate Professor, holds a PhD in Mechanical Engineering from the Massachusetts Institute of Technology. Tangborn joined JCET in 1998, when he also became a member of the technical staff at the Data Assimilation Office at Goddard Space Flight Center. Since 2012 he has been a member of the Planetary Geodynamics Laboratory, where he works on geomagnetic data assimilation. He is also affiliated with the Mathematics Department at UMBC. Dr. Tangborn's research interests include geomagnetic data assimilation, stochastic modeling of climate variability, and radiative transfer modeling.

Ali Tokay, Research Associate Professor, holds a PhD in Atmospheric Sciences from the University of Illinois at Urbana-Champaign. Dr. Tokay is an atmospheric scientist and meteorological engineering by training and conducted numerous field campaigns under the umbrella of NASA's precipitation measurement mission. Dr. Tokay published 40+ peer-reviewed journals and served as a anonymous reviewer for more than 20 different journals and NASA, NSF, and DOE proposals. Dr. Tokay was the co-chair of the 34th AMS radar meteorology conference and will be co-chair of an upcoming European conference on radar meteorology and hydrology. He is a member AMS radar meteorology committee and is also associate editor of Journal of Applied Meteorology and Climatology. Dr. Tokay focuses on precipitation measurements including microphysics, spatial variability, and measurement accuracy. Dr. Tokay was a principal investigator during a series of field campaigns under NASA Tropical Rainfall Measuring Mission. He is a member of NASA Precipitation Science Team.

Kevin Turpie, Research Associate Professor, holds a PhD in Geographical Sciences from the University of Maryland, College Park. Dr. Turpie is affiliated with the Geography and Earth Sciences (GES) department, where he teaches remote sensing classes. Dr. Turpie has over two decades of experience with ocean color remote sensing, where he has been heavily involved in remote sensing models, instrument calibration and mission design, data quality assessment, and uncertainty analysis. Turpie's work also has a focus on coastal and inland aquatic remote sensing, where he specializes in hyperspectral remote sensing and applications in wetlands where he has done field campaigns and developed a marsh canopy reflectance model. His work has involved several NASA space borne instruments, including the Coastal Zone Color Scanner (CZCS), the Sea-viewing Wide Field-of-View Sensor (SeaWiFS), the MODerate resolution Imaging Spectroradiometer (MODIS), the Visible Infrared Imaging Radiometer Suite (VIIRS), and the Hyperspectral Infrared Imager (HyspIRI). In support of his academic work and coastal research, he has also worked with data from Landsat, Hyperspectral Imager for the Coastal Ocean (HICO), the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), and the European Space Agency's Compact High Resolution Imaging Spectrometer about the Project for On-Board Autonomy (CHRIS/Proba). He was the Ocean Color Science Principal Investigator and Ocean Discipline Lead on the VIIRS NASA Science Team, which is part of the Suomi National Polar-orbiting Partnership (Suomi-NPP) mission and led the VIIRS Ocean Science Team, part of the NASA Ocean Ecology Branch. He continues to advise the Joint Polar-orbiting Satellite System (JPSS) project regarding future VIIRS instruments. He is also an appointed member of the Hyperspectral Infrared Imager (HyspIRI) Science Study Group (SSG), where he is applying his combined experience of terrestrial and aquatic problems to help define the future HyspIRI mission. He has expanded this role by becoming the founding chair of the international HyspIRI Aquatic Data Products Working Group (HASG). Dr. Turpie has also work with astronomy missions. In 1993, he also worked with Nobel laureate Dr. John Mather on the NASA Cosmic Background Explorer (COBE), where he mapped the distribution of foreground emission lines that marked the location of water and carbon across our galaxy using the interferometric data from the Far Infrared Absolute Spectrophotometer (FIRAS). Dr. Turpie's current research can be divided into two major areas: ocean color and coastal remote sensing. For the former, he is interested in studying sensor calibration and behavior, and how these influence remote sensing applications in marine and aquatic remotes sensors. He developed methods for data quality assessment and visualization and has done research in ocean color uncertainty analysis. He is also interested in development of remote sensing models that model the transmission and reflection of light at the air-water interface and how this changes with deep or the presence of emergent vegetation. With regard to the latter major area, Dr. Turpie is exploring ways to retrieve information about the conditions in shallow water environment, including coastal marsh ecosystems, through remote sensing. In particular, he is interested in developing methods to assess and record changes in the canopy typical of coastal marshlands that are caused by climate change and human activities. His research looks to accomplish this through satellite data applications, ground data, and radiative transfer modeling. It is his hope that the result will contribute a methodology to understand, monitor and manage these precious ecological resources.

Támas Várnai, Research Associate Professor, holds a PhD in Atmospheric and Oceanic Sciences from McGill University. Prior to joining UMBC in 1999, Dr. Várnai worked as researcher at the Hungarian Meteorological Service, and as postdoctoral fellow at McGill University and at the University of Arizona. Dr. Várnai's research aims at improving our ability to measure the properties of clouds and atmospheric aerosols from space, and to use satellite data for better understanding the impact of clouds and aerosols on the solar heating of our planet. He is particularly interested in the way the three-dimensional nature of atmospheric radiative processes affects satellite observations, and in understanding the way atmospheric particle populations change in the vicinity of clouds. His work involves analyzing data from satellite instruments such as MODIS or CALIOP and airborne instruments such as THOR or CAR, and combining the data with theoretical simulations of radiative processes.

Kevin Vermeesch, holds a M.S. in Atmospheric Science from Purdue University in 2007. He joined JCET in 2015, but since 2008 has worked on analysis of ALVICE, GLOW, and TWiLiTE lidar data at the NASA Goddard Space Flight Center and the Howard University Beltsville Research Campus (HUBRC). The analysis includes data processing and comparison of wind and water vapor data from lidar, radiosonde, and satellite. Kevin participated in the Plains Elevated Convection At Night (PECAN) field campaign (May - July 2015) to deploy ceilometers to collect and transmit data and provide operational support launching weather balloons. Since October 2014 and continuing to the present, he has overseen monthly launches of the cryogenic frostpoint hygrometer (CFH) from the HUBRC to acquire high-quality water vapor data in the upper troposphere and lower stratosphere to compare with satellite and lidar observations. Kevin is working with partners from the National Weather Service to assess the operational reporting of Automated Surface Observing System (ASOS) ceilometer backscatter and planetary boundary layer (PBL) height (derived from the backscatter) and the benefits of having such products available operationally nationwide.

Igor Veselovsky, Associate Research Scientist, holds a PhD in Physics from Moscow Engineering Physical Institute (MEPI). His research interests include the development of the lidar systems for monitoring of atmospheric aerosol and ozone; inverse problems of atmospheric remote sensing and Raman spectroscopy.

Yujie Wang, Associate Research Scientist, holds a PhD in Geography from Boston University. Dr. Wang is experienced on radiative transfer theory and algorithm development. He also has conducted numerous field campaigns in support of satellite and airborne acquisitions. During 1998-2002, Dr. Wang worked on MODIS Leaf Area Index (LAI) and Fraction of Absorbed Photosynthetically Active Radiation (FPAR) algorithm development and validation. After that, he has been working on a new generation atmospheric correction algorithm --- Multi-Angle Implementation of Atmospheric Correction (MAIAC). Dr. Wang's research interests include radiative transfer theory on vegetation and atmosphere, satellite generated products analysis and validation, and new algorithm development.

Glenn Wolfe, Assistant Research Scientist, holds a PhD in Chemistry from the University of Washington. Dr. Wolfe has been at NASA/GSFC and UMBC/JCET since October 2012, where he studies the chemistry of the lower atmosphere using a combination of airborne field observations and detailed numerical modeling. Prior to arriving at NASA, Dr. Wolfe was a NOAA Climate and Global Change Post-doctoral fellow at University of Wisconsin, Madison, WI. Dr. Wolfe's research interests include atmospheric chemistry, forest-atmosphere interactions and instrument development.

Tianle Yuan, Research Associate, holds a PhD in Atmospheric and Oceanic Sciences from the University of Maryland, College Park. Dr. Yuan has conducted several ground-breaking analyses on interactions between aerosols and clouds. His interests and experience include Remote Sensing , cloud physics, aerosol and cloud feedbacks, aerosol-cloud-climate interactions. Dr. Yuan has given undergraduate and graduate lectures in remote sensing and statistics. He has mentored students. Dr. Yuan's research interest includes the role of aerosols and clouds in the climate system and their feedback to climate change. He uses the vast amount of satellite data together with other sources of observations to tackle a range of issues. He also employs models with a hierarchy of complexity to model observational results. Dr. Yuan also has interest in developing novel theories to understand cloud statistics.

Pengwang Zhai, Assistant Professor, holds a PhD in Physics from Texas A&M University. Dr. Zhai's research interests are in light scattering by irregular particles, vector radiative transfer in coupled atmosphere and ocean systems, and remote sensing of aerosols and hydrosols. He is enthusiastic about understanding inherent optical properties of hydraulic algae particles and developing algorithms to monitor and retrieve these particles in our natural environments. In order to extract information from optical signals, the multiple scattering in the turbid media has to be taken care of. One of his main research focuses is to explore accurate and efficient ways to solve the polarized radiative transfer equation. With the help of light scattering and radiative transfer theories, Dr. Zhai strives to develop new and better remote sensing algorithms for aerosols and ocean color using satellite or airborne measurements from multi-directional, multi-wavelength, multi-polarized sensors.

Zhibo Zhang, Assistant Professor, holds a Ph.D. in Atmospheric Sciences) from Texas A&M University. His Ph.D. thesis is on the satellite-based remote sensing of ice clouds. In Jan. 2009 he joined the Goddard Earth Sciences and Technology Center at UMBC, where he worked with the MODIS cloud science team led by Dr. Steven Platnick on the development of infrared cloud property retrieval algorithm. In 2011, he joined JCET as a Research Associate; he was then appointed to Assistant Professor with UMBC's Physics Department and became a Fellow with JCET.

E. Acronyms and Abbreviations

AACPS, Anne Arundel County Public Schools
ABC, Arboreal to Benthic Communities
ACID, Active Chemical-Gas Identification and Detection
ABoVE, Arctic-Boreal Vulnerability Experiment
ACP, Atmospheric Chemistry and Physics
AEDT, Aviation Environmental Design Tool
AGU, American Geophysical Union
air-LUSI, LUnar Spectral Irradiance
AIRS, Atmospheric Infrared Sounder
AJAX, Alpha Jet Atmospheric eXperiment
ARCs, Averaged Rates of Change
ARM, Atmospheric Radiation Measurement
AOD, Aerosol Optical Depth
AOT, Alignment Optical Telescope
ARTEMIS, Autonomous Robotic TElescope Mount Instrument Subsystem
ASC, Analysis Standing Committee
ASG, Aquatic Studies Group
ASL, Atmospheric Spectroscopy Laboratory
ASOS, Automated Surface Observing System

ASTER, Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR, Advanced Very High Resolution Radiometer
AVIRIS NG, Airborne Visible / Infrared Imaging Spectrometer Next Generation
AWWA, American Water Works Association
ARSET, Applied Remote Sensing Training
ATom-3, Atmospheric Tomography
BEST, Beginning Engineering, Science, & Technology
BP, Biophysical Parameters
BRF, bi-directional reflectance
CAFE, Compact Airborne Formaldehyde Experiment
CALIOP, Cloud-Aerosol Lidar with Orthogonal Polarization
CAR, Cloud Absorption Radiometer
CARAFE, Carbon Airborne Flux Experiment
CASIS, Center for the Advancement of Science in Space
CEOS, Committee for Earth Observing Satellites
CFH, Cryogenic Frostpoint Hygrometer
CHIMAERA, Cross-platform HIgh resolution Multi–instrument AtmosphEric Retrieval Algorithms
CM, cloud mask
CMS, Carbon Monitoring System
COCI, Canadian Coastal Ocean Color Instrument
COFFEE, Compact Formaldehyde Fluorescence Experiment
CORRA, Combined Radar-Radiometer Algorithm
CR, Corner Reflection
CrIS, Cross-track Infrared Sounder
DEMs, Digital Observation Models
DSCOVR, Deep Space Climate Observatory
ECMWF, European Center for Medium Range Weather Forecasting
ENCs, El Nino Correlations
ENSO, El Niño-Southern Oscillation
EOS, NASA Earth Observatory
EOSDIS, Earth Observing System Data and Information SystemEPD, Educator Professional Development
EPIC, Earth Polychromatic Imaging Camera
ESDIS, Earth Science Data and Information System
ESDSWG, Earth Science Data System Working Group
ESIP, Earth Science Information Partners
ESRL, Earth System Research Laboratory
FLARE, FLuorescence Airborne Research Experiment
F0AM, Framework for 0-D Modeling
FSR, Full Spectral Resolution
GASS, General Assembly and Scientific Symposium
GEO-CAPE, GEOstationary Coastal and Air Pollution Events
GEODYN, Orbital and Geodetic Parameter Estimation
GEOS-5, Goddard Earth Observing System Model, Version 5

GeoTASO, Geostationary Trace Gas and Aerosol Sensor Optimization
GES DISC, Goddard Earth Sciences Data and Information Services Center
GISS, Goddard Institute for Space Studies
GISTEMP, GISS Surface Temperature Analysis
GLI, Global Imager
GLIMS, Global Land Ice Measurements from Space
GLOW, Goddard Lidar Observatory for Winds
GMI, Global Modeling Initiative
GNSS, Global Navigation Satellite System
GOCART, Goddard Chemistry Aerosol Radiation and Transport
GOFC/GOLD, Global Observations of Forest and Land Cover Dynamics
GPM, Global Precipitation Measurement
GSFC, Goddard Space Flight Center
HERA, High-altitude ER-2 Adaption
HiMAT, High Mountain Asia Team
HISS, Hawk Institute of Space Sciences
HRS TECF, Hyperspectral Remote Sensing of Terrestrial Ecosystem Carbon Fluxes
HUBRC, Howard University Beltsville Research Campus
HyspIRI, Hyperspectral Infrared Imager
IASI, Infrared Atmospheric Sounding Interferometer
ICARTT, International Consortium for Atmospheric Research on Transport and Transformation
ICESat-2, Ice, Cloud, and Land Elevation Satellite
IERS, International Earth Rotation and Reference Frame Service
IFloodS, Iowa Flood Studies
IGARSS, International Geophysical and Remote Sensing Symposium
ILRS, International Laser Ranging Service
IOCS, International Ocean Colour Science
IQC, Information Quality Cluster
IR, Infrared
IRIS, IRradiance Instrument Subsystem
ISAF, In-Situ Airborne Formaldehyde
ISOPOOH, Isoprene Oxidation Product
ITRS, International Terrestrial Reference System
JPL, Jet Propulsion Laboratory
JPSS, Joint Polar-orbiting Satellite System
KCARTA, kCompressed Radiative Transfer Algorithm
KORUS-AQ, KORean-U.S. Air Quality
LACO, Laboratory for Aerosol and Cloud Optics
LaRC, Langley Research Center
LASP, Laboratory for Atmospheric and Space Physics
LBLRTM, Line-by-Line Algorithm
LIDAR, Light Detection and Ranging
LOBO, Land to Ocean Biodiversity Observations
LUT, Look-up table
MAIAC, Multi-Angle Implementation of Atmospheric Correction

MCST, MODIS Calibration Support Team
MEaSUREs, Making Earth System Data Records for Use in Research Environments
MEI, MUREP Education Institute, for Minority-Serving Institutions
MODIS, Moderate Resolution Imaging Spectroradiometer
MPLNET, Micropulse Lidar Network
MRMS, Multi-Radar Multi-Satellite
NACP, North American Carbon Program
NAQFC, National Air Quality Forecasting Capability
NIFA, NSF-USDA-National Institute for Food and Agriculture
NIST, U.S. National Institute of Standards and Technology
NLDAS, North American Land Data Assimilation
NACP, North American Carbon Program
NPP, National Polar-Orbiting Partnership
OBPG, Ocean Biology Processing Group
OLR, Outgoing Longwave Radiation
OMI, Ozone Monitoring Instrument
OMPS, Ozone Mapping Profiler Suite
OPE3, Optimizing Production Inputs for Economic and Environmental Enhancement
ORNL DAAC, Oak Ridge National Laboratory Distributed Active Archive Center
OWLETS, Ozone Water-Land Environmental Transition Study
PACE, Phytoplankton, Aerosols, Clouds and Ocean Ecology
PBL, Planetary Boundary Layer
PC, Polarization Correction
PCL, Partially CLoudy
PECAN, Plains Elevated Convection at Night
PDR, Preliminary Design Review
PPHB, Plane-parallel Homogeneous Bias
PSS, Project Statement of Scope
RCM, Regional Climate Model
RGI, Randolph Glacier Inventory
RTA, Radiative Transfer Algorithm
SAL, Saharan Air Layer
SARP, Student Airborne Research Program
SCERIN, South Central and Eastern European Regional Information Network
SCLW, Supercooled Liquid Water
SDG, Sustainable Development Goals
SDSM, Solar Diffuser Stability Monitor
SEAC4RS, Studies of Emissions, Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys
SERC, Smithsonian Environmental Research Center
SEUS, Southeast United States
SMD, Science Mission Directorate
SMEs, Subject Matter Experts
SoRCE, Solar Radiation and Climate Experiment
SOW, Statement of Work

SRT, Sounding Radiative Transfer
SSAI, Science Systems and Applications, Inc.
SSEC, Space Science and Engineering Center
STEM, Science, Technology, Engineering and Math
STG, Science Technology Group
SWOT, NASA Surface Water Ocean Topography
TAWO, Temporary Atmospheric Watch Observatory
TCTE, TIM Calibration Transfer Experiment
TEMPO, Tropospheric Emissions: Monitoring Pollution
TIR, Thermal Infrared
TRMM, Tropical Rainfall Measuring Mission
TSI, Total Solar Irradiance
TSIS-1, Total and Spectral Solar Irradiance Sensor-1
TwiLiTE, The Tropospheric Wind Lidar Technology Experiment
UAS, Unmanned Aerial Systems
UKMO, United Kingdom Meteorological Office
UMD ESSIC, University of Maryland Earth System Science Interdisciplinary Center
UNESCO, United Nations Educational, Scientific and Cultural Organization
USGS, United States Geological Survey
UT/LS, upper troposphere/lower stratosphere
UW, University of Wisconsin
UWG, User Working Group
VCST, VIIRS Calibration Science Team
VNIR, Visible and Near Infra-Red
VIC, Variable Infiltration Capacity
VIIRS, Visible Infrared Imaging Radiometer Suite
VLIDORT, Vector Radiative Transfer Model
WFF, Wallops Flight Facility
WG, Working Groups
WGBH, Local public broadcaster serving southern New England
WINTER, Wintertime Investigation of Transport, Emissions, and Reactivity
WML, Well-Mixed Layer
WRF, Weather Research and Forecasting