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Image from “CALIPSO observes Saharan dust crossing the Atlantic Ocean”. Credits include Kel Elkins, Lead Animator; Joy Ng, Scientist (JCET/UMBC), among others.
LETTER from GESTAR DIRECTOR

June 10, 2015

We are pleased to offer this fourth NASA Goddard Earth Sciences, Technology, and Research (GESTAR) Cooperative Agreement Annual Report for the period: 11 May 2014 - 10 May 2015. NASA awarded GESTAR to the team of Universities Space Research Association (USRA), Morgan State University (MSU), Johns Hopkins University (JHU), I.M. Systems Group (IMSG), Institute for Global Environmental Strategies (IGES), and Ball Aerospace for a period of five years (2011-2016). Last year, we welcomed Global Science and Technology (GST) to our team. During the past year, GESTAR continued to be among major NASA Goddard Space flight Facility partnerships. During Year 4, the number of GESTAR tasks grew approximately 15 percent from our third year.

This report summarizes multidisciplinary efforts of GESTAR-affiliated researchers, technologists, students, visitors, and staff. We describe accomplishments for the past year and technical progress in all research areas identified in the GESTAR Annual Research Program Plan, submitted to NASA on 31 July 2014. Within the report and its appendices are: a) abstracts and papers published by GESTAR-affiliated staff; b) GESTAR-affiliated presentations at conferences, seminars, and workshops; c) education and public outreach engagements by GESTAR-affiliated staff; d) awards received by GESTAR-affiliated staff; and e) engagement of GESTAR-affiliated staff in reviewing/advising/committee participation activities.

This past year, everyone at GESTAR worked diligently with our NASA sponsors/collaborators to ensure success of critically important projects that support NASA’s mission in Earth Sciences and beyond. Their efforts have resulted in many substantive accomplishments, highlighted in this report. Our sincerest thanks go out to all for their commitment and professionalism. We look forward to applying our knowledge and experience to the upcoming year to ensure GESTAR continues to exceed all of our expectations.

William Corso

Joseph Whitaker (Associate Director – Morgan State University) Darryn Waugh (Associate Director – Johns Hopkins University) Le Jiang (Associate Director – IMSG)

The GESTAR TEAM

Founded in 1969, Universities Space Research Association (USRA) is an independent nonprofit research corporation that conducts basic and applied research and operates programs and national facilities for government and industry, many of which are in support of NASA. USRA currently manages 20 programs with distinction while meeting the educational needs of an increasingly diverse society. Designated as Maryland’s Public Urban University, USRA will continue its prominence in Maryland’s educational future. In many fields, particularly in engineering and the sciences, MSU accounts for large percentages of degrees received by African-Americans from Maryland institutions. At the graduate level, it awards doctoral and master’s degrees in several selected fields. The University has made a major commitment to academic excellence, investing substantial resources to enhance its research infrastructure, and stimulate research development in a broad range of disciplines, especially STEM. In addition to the Clarence M. Mitchell, Jr. School of Engineering complex, MSU has the Eustatius Research Center, the Richard N. Dixon Science Research Center, a state-of-the-art research facility that provides space for specialized research laboratories in physics, chemistry, and biology, and the modern Murphy Fine Arts Center.

I.M. Systems Group (IMSG) has over 15 years of providing environmental, scientific, technical, and support to the US government as well as environmental services to government agencies in Africa and Asia. Over 60% of its workforce has advanced degrees with over 100 PhD researchers. IMSG is NOAA’s largest support service, with its largest concentration of researchers and support scientists in the Satellite Applications Research Center and the NWS Environmental Modeling Center.

Rounding out the GESTAR Team are Ball Aerospace and Technologies, The Institute for Global Environmental Strategies (IGES) and Global Science & Technology (GST). GESTAR Management continues to work to identify appropriate, GESTAR-affiliated activities in which they may become meaningfully engaged.

Morgan State University (MSU), founded in 1867, is one of the nation’s premier Historically Black Colleges and Universities (HBCUs). The University offers a comprehensive program of studies at both the undergraduate and graduate levels. Morgan State has continuously served the community with distinction while meeting the educational needs of an increasingly diverse society. Designated as Maryland’s Public Urban University, USRA will continue its prominence in Maryland’s educational future. In many fields, particularly in engineering and the sciences, MSU accounts for large percentages of degrees received by African-Americans from Maryland institutions. At the graduate level, it awards doctoral and master’s degrees in several selected fields. The University has made a major commitment to academic excellence, investing substantial resources to enhance its research infrastructure, and stimulate research development in a broad range of disciplines, especially STEM. In addition to the Clarence M. Mitchell, Jr. School of Engineering complex, MSU has the Eustatius Research Center, the Richard N. Dixon Science Research Center, a state-of-the-art research facility that provides space for specialized research laboratories in physics, chemistry, and biology, and the modern Murphy Fine Arts Center.

The Johns Hopkins University (JHU) is one of the leading research institutions in the nation. JHU is composed of nine academic divisions, including Arts & Sciences, Education, Engineering, the School of Public Health, plus JHU Applied Physics Laboratory. The Krieger School of Arts and Sciences is the home of the Department of Earth and Planetary Sciences. A major focus within this department is global change science, with active research groups in atmospheric, oceanic, and hydroospheric sciences as well as planetary geodynamics. The department maintains state-of-the-art design and engineering facilities, as well as laboratories for high performance computing and large-scale data analysis that are also being used for Earth system science. JHU’s Whiting School of Engineering consists of faculty who possess experimental, computational, robotic and modeling capabilities. Additionally, faculty at the School of Public Health are involved with the application of Earth system science and remote sensing to the study and teaching of public/environmental health.

Ball Aerospace and Technologies, The Institute for Global Environmental Strategies (IGES) and Global Science & Technology (GST). GESTAR Management continues to work to identify appropriate, GESTAR-affiliated activities in which they may become meaningfully engaged.
In preparation for the assimilation of SMAP observations, satellite observations from the Soil Moisture Ocean Salinity (SMOS) mission were used to build a prototype system for the L4_SM product. This prototype system was updated with many new aspects, mainly to improve the assimilation of SMAP TB observations and to improve soil moisture estimates (more information is available in Dr. De Lannoy’s report, Code 610.1). Dr. Gabrielle de Lannoy supported colleagues in implementing the science system for operational purposes and was instrumental in providing a SMAP “Nature Run v04” to JPL’s Science Team. Prior to the mission’s launch, the SMAP L4_SM system was heavily exercised with SMOS brightness temperature data. To facilitate the transition from SMOS to SMAP data, a preprocessor was developed to convert SMOS brightness temperature observations from the Top-of-the-Ionosphere to the Bottom-of-the-Atmosphere. A paper on this research has been conditionally accepted (De Lannoy et al., GRSL, 2015).

Up on analysis of radiometer test data, it was decided to update two of the RFI detection algorithms. Detection performance was improved by implementing formulae to determine threshold levels for detection. All of the detection algorithms also use look up tables to determine threshold levels for detection; these restore the satellite data before reprocessing. The radiometer algorithm was developed in Matlab to produce outputs for direct comparison to the outputs of the production code. Upon completion of the algorithm review for the SMAP L1B_TB algorithm in September 2013, it was decided to include loss due to the radome (the structure which covers the antenna feedhorn) when computing counts to brightness temperatures (TB).

Based on the algorithm provided by NASA GSFC’s algorithm team, JPL’s science data system produces SMAP data products. The SMAP L1B_TB algorithm. A week of simulated radiometer level 1A data was ingested and processed by the L1B_TB processor. This data was then analyzed using cal/val tools which were developed; such analyses included time series and global plots to help validate the algorithm.

SMAP launched on January 31, 2015, and the radiometer was turned on for various instrument tests; for about two days each in February and in March, such tests included an instrument health check and a non-spin test, respectively. During this time, data was collected and processed by JPL’s science data system, and cal/val tools were used to analyze the L1B_TB products to check for algorithm performance and to produce global plots of brightness temperatures. The calibration and validation part of the mission continued as the instrument was turned on permanently in September 2013, it was decided to include loss due to the radome (the structure which covers the antenna feedhorn) when computing counts to brightness temperatures (TB).

As part of NASA’s Soil Moisture Active and Passive (SMAP) mission, Dr. Jinzheng Peng (sponsor: J. Piepmeier) works on a collaborative team at NASA GSFC to develop the L1B TB algorithm which converts radiometer data into calibrated estimates of brightness temperature. His efforts include research and development of medium-to-fine frequency interference (RFI) detection and removal algorithms plus prototype instrument algorithm code for the L1B_TB algorithm, which is part of ground processing. The Science Data System (SDS) at the Jet Propulsion Laboratory (JPL) is responsible for implementing the production code for the radiometer L1B_TB algorithm. Dr. Mohammad provided support to help verify the product output provided by the production code, which involves using the prototype code in Matlab to produce outputs for direct comparison to the outputs of the production code. Upon completion of the algorithm review for the SMAP L1B_TB algorithm in September 2013, it was decided to include loss due to the radome (the structure which covers the antenna feedhorn) when computing counts to brightness temperatures (TB).

Prior to the mission’s launch, Dr. Peng was working on the simulation theoretical bases, plans and activities, and data analysis and developing pre-launch and post-launch calibration theoretical bases, plans and activities, and data analysis and developing pre-launch and post-launch calibra-

Dr. Jinzheng Peng (sponsor: J. Piepmeier) also works as part of a collaborative team on NASA’s Soil Moisture Active/Passive (SMAP) mission. In addition to research- ing and developing pre-launch and post-launch calibra-

A major risk-reduction asset for the SMAP radiometer L1B algo-

Figure 1: Global coverage of H polarization TB using data from ascending files. Footprints collected with the antenna in the aft position of the spinning mode were averaged in a 1 degree bin. Image provided by P. Mohammed.
has been successfully used for the radiometer instrument’s health check after it was first turned on and for calibrating the radiometer channels for external calibration.

Mr. Cote has the primary responsibility for coordinating and drafting the Annual Atmospheric Research Report each year, which summarizes all research and administrative activities carried out during the year. The 2014 draft report is approximately 325 pages. Various portions were written; material for other sections was collected and compiled from information provided by Laboratory scientists. The draft report was submitted to the TIMS group for editing, layout and printing. Final reports for all years can be found at: www.atmospheres.gsfc.nasa.gov. The 2015 report preparation is now underway. Also, science research highlights are prepared each month by the Atmospheric Laboratories and eventually awarded. For the 2015 contractor awards process, the Wallops Support Office. Mr. Cote reviewed and edited submissions for accuracy and format as well as persuasiveness to attract readers. Highlights were then forwarded to management for final review and distribution to Goddard, NASA Headquarters and colleagues among universities and other science organizations.

The March-April issue of The Earth Observer Publication of the Earth Observation (EO) featured the Nimbus 50th anniversary event with summaries of all the presentations including introductions by Chris Scolese (Director, GSFC), Dr. Ellen Stofan (Chief Scientist, NASA), Dr. Richard Spinaid (Chief Scientist, NOAA), and Rick Oberschain (Deputy Director, GSFC). Mr. Cote played a key role in planning and coordinating the event including recruiting speakers and preparing introductory remarks for speakers, as well as preparing the list of invitees, the closing remarks and the preparation of material for a Nimbus historical document. He served as MC for the event and also delivered a presentation on the Nimbus Data Collection and Location Systems experiments he managed in meteorology, oceanography and Search and Rescue (SAR). The Solar System Explorers was the Space Science Division's forward brightness simulator which could generate simulated L1A data, which was used to test all other cal/val tools. After launch, the simplified SMAP simulator could generate simulated L1A data products to test the radiometer L1B SDS, which generates the L1B data product. These simulated L1A and L1B data products were used to test all other cal/val tools. After launch, the simplified SMAP forward brightness simulator continues to generate modeled antenna temperature for other radiometer cal/val tools. Dr. Peng also developed the external calibration and drift correction cal/val tool, which is used to monitor the post-launch status of the radiometer and for external calibration.

Dr. Peng also developed several cal/val tools, one being the simplified SMAP L1B forward brightness simulator. Before launch, in conjunction with the Counters simulator, which simulates the radiometer output with given antenna temperature and the L1A shell file, the simplified SMAP simulator could generate simulated L1A data products to test the radiometer L1B SDS, which generates the L1B data product. These simulated L1A and L1B data products were used to test all other cal/val tools. After launch, the simplified SMAP forward brightness simulator continues to generate modeled antenna temperature for other radiometer cal/val tools. Dr. Peng also developed the external calibration and drift correction cal/val tool, which is used to monitor the post-launch status of the radiometer and for external calibration.
Margaret Hurwitz, AAAS Science & Technology Policy Fellow

From September 2013 through November 2014, Dr. Hurwitz served as an AAAS Science & Technology Policy Fellow with the Middle East Regional Cooperation (MERC) program at the U.S. Agency for International Development (USAID). MERC, a grants program, funds joint Arab-Israeli, U.S.-Arab, and U.S.-Israeli projects to support regional problem-solving, builds capacity in the Arab world and contributes to Arab-Israeli diplomacy and peace-building. Dr. Hurwitz’s duties included reading and reviewing research proposals, responding to inquiries from applicants and grantees, recruiting reviewers, attending conferences, events, interagency meetings and team meetings, giving presentations, interpreting U.S., foreign and agency policy in the context of the MERC program, and planning site visits to the Middle East. Dr. Hurwitz visited MERC grantees in Israel, Jordan, Egypt and the West Bank. In addition, Dr. Hurwitz served as a MERC grantees and applicants and grantees, recruiting reviewers, attending conferences, as well as with the Ghana Space Agency on Satellite Technology and Application, The NASA ACMAP (HFC-23, HFC-32, HFC-125, HFC-134a, HFC-143a and CF4) into AER about the six fluorinated species, including atmospheric pro- files and maximum expected surface concentrations. Mr. Fleming and Dr. Hurwitz will run and analyze sensitivity simulations with new RRTMG code in spring and summer 2015. These simulations will investigate the radiative impacts of HFCS and other key fluorinated species using various emissions scenarios.

Dr. Hurwitz analyzed existing coupled ocean-atmosphere GEOSCCM simulations, testing the climate and ozone sensitivity to doubled CO2 and elevated HFC-22, and planned further GEOSCCM sensitivity simulations with Dr. Feng Li. Meanwhile, Dr. Li tested the existing RRTMG radiation code in the Ganymed version of the GEOS-S atmospheric model within GEOSCCM. The existing RRTGM code does not include HFCS species and its performance has not been thoroughly evaluated. Drs. Hurwitz and Li will carry on a series of simulations with the updated RRTMG radiation code that have been ongoing for some time. The main motivation for furthering the investigation of the impacts of HFCS on simulated climate and climate change.

Dr. Hurwitz participated in many publications and presenta- tions over this past year. One lead author manuscript about the atmospheric response to El Nino/Southern Oscillation (ENSO) was published in Climate Dynamics, and she also contributed to two manuscripts, which are currently in varying stages. Her work contributed to two poster presentations given at the 2014 European Geosciences Union (EGU) General Assembly, Vienna, Austria in May, as well as an oral presentation given at the 2015 European Geosciences Union (EGU) General Assembly, Vienna, Austria in April. Dr. Hurwitz and co-investigators have submitted an abstract to the 11th International Conference on Southern Hemisphere Meteorology and Oceanography (ISHMO), to be held in October 2015 in Santiago, Chile. In June 2014, she attended the AGU Science Policy Conference, which focused on policy related to natural resources, natural hazards and climate change. Dr. Hurwitz also attended the Seventh International Symposium on Non-CO2 Greenhouse Gases in November 2014 in Amsterdam. Climate policy experts gave a European perspective on climate mitigation and the IPCC AR5 synthesis report, energy policy and best agricultural practices. Speakers stressed the need for short-term, dramatic actions to reduce greenhouse gas emissions and to meet future climate targets. Researchers presented atmospheric measurements and modeling studies of methane, nitrous oxide and various halogenated species. Most studies were of individual species; of note, there was no mention of modeling HFCS in a cli- mate model, reinforcing the value of the planned HFC simulations with the GEOSCCM and GSFC 2D model.

Work performed by Dr. Leslie Lait (sponser: P. Newman) centers on investigating the dynamical context of atmospheric measure- ments, to aid in their interpretation. Data from a wide variety of sources are analyzed with an emphasis on techniques that assist in combining disparate data sources to yield a unified picture of the whole. Specifically, investigations examine the use of quasi-observed quantities (such as potential vorticity and potential temperature) as coordinates to construct composite fields of atmospheric constituents that can be mapped back into real-space. In addition, support is provided to aircraft field experi- ments, including the use of forecasts and modeling results to aid in planning aircraft flights to maximize the scientific return and test the feasibility of various flight path scenarios. For this work, and the final science campaign of the Hurricane and Severe Storm Sentinel (HS3) field experiment staged from NASA’s Wallops Flight Facility from August 19 through September 25, 2014, Dr. Lait provided preparation and flight planning support. Prepara- tions included packaging equipment and initiating arrangements for shipment to Wallops and participating in teleconferences. On-site field mission support involved planning science flights; evaluat- ing various scenarios for timing and feasibility, and determining way points and dropzone locations. From the resulting plans, Dr. Lait prepared materials for the flight crew (including high-altitude meteorological forecasts) and the leading mission scientists, and he uploaded forecasts to the project’s collaborative net-work-enabled web site for use by all participants. In addition, he used meteorological forecasts to model the fuel temperature on the aircraft, to avoid dangerously cold regions in which the fuel could be prone to freezing. He also assisted in revising the flight path for in real time during flight to adjust for the movement of the tropical storm systems being examined. In addition, he set up and main- tained the computer systems used for flight planning.

Because of the lack of an overstorm aircraft during the Wallops Island deployment, HS3 project management arranged for a partial extension of the mission in combination with the Tropical Cyclone Intensity (TDI) mission of the Office of Naval Research (ONR) in the Department of Defense. Consequently, some of the overstorm instruments that were to have been used in the over- storm Global Hawk were transferred to the NASA WB-57 aircraft and flown during test flights of the ONR’s new dropsonde system. From October 1 through November 20, Dr. Lait provided remote support from GSFC for these flights, including assisting in planning flight paths (including estimating time intervals) and par- ticipating in mission teleconferences. He also updated the aircraft performance characteristics of the WB-57 in the flight planning software. Dr. Lait participated in the HS3 Science Team meeting held at NASA’s Ames Research Center in Mountain View, Califor...
Dr. Lait incorporated into his model of Global Hawk fuel temperature several new data flights of fuel from last year’s ATTREX Guarm deployment, and obtained data from previous Global Hawk missions. The model worked well for all but two flights. Further investigation indicates that suspicious fuel load readings are the cause for those two day’s discrepancies. He attended the ATTREX science team meeting in Boulder, Colorado 19-29, where he participated in planning discussions for the joint ATTREX/CAST deployment scheduled for February-March 2015. In preparation for the 2015 ATTREX/CAST campaign, Dr. Lait investigated the way that the Atmospheric Chemistry and Dynamics Lab obtains and extracts GEO5 meteorological forecasts and analysis data for local use. The new method, which uses locally-developed workflow software, is much more robust in the face of disruptions and late model runs. From February 25 through March 15, Dr. Lait was on site at NASA’s Armstrong Flight Research Center in California to participate in the ATTREX/CAST field experiment, where his main duties involved planning science flights: evaluating various scenarios for timing, solar angles, and feasibility, as well as determining waypoints. As with the HS3 campaign, he prepared materials for the flight crew and the leading mission scientists, and uploaded descriptive files to the project’s web-based collaboration tools site for use by all participants. Dr. Lait also assisted in revising the flight paths in real time during flight to adjust for meteorological conditions encountered. In addition, he set up and maintained the computer systems used for flight planning.

Dr. Lait analyzed data from NASA’s DC-8 aircraft during the recent SEAC4RS experiment, with the aim of characterizing recent aircraft performance. Parameters related to this aircraft were then calculated in the flight plan and incorporated in the newly operated Global Hawk model and used to assess the impact of interactive chemistry. In the previously version of the model, particularly in the North Pacific and North Atlantic regions, the model has made significant improvements in reducing errors of the stratospheric ozone layer using monthly and zonally averaged ozone field; however, the prescribed ozone underestimated the impact of using interactive stratospheric chemistry. Dr. Li investigates the impacts of using interactive stratospheric chemistry, instead of prescribed ozone, on simulations of climate change in the Antarctic and Southern Ocean.

The second major activity was serving as a leader for the Carbon Cycle & Ecosystems (CC&E) Focus Area. The CC&E JSW is a triennial meeting of the CC&E focus areas (biogeochemistry, land use and land cover change, agriculture programs) that brings together the NASA research community in an interdisciplinatory setting to discuss program accomplishments and develop future plans. The 2015 meeting took place April 20-24, 2015 in College Park, MD. Dr. Leidner led the steering committee that identified the meeting themes, plenary speakers, breakout topics, keynote speakers, and other special events to take place during the meeting, including a panel discussion on uncertainty characterization, a student mentoring lunch, and student early career poster speed talks. Approximately 450 scientists from NASA, other federal agencies, and the academic community attended.

This year, Dr. Leidner advanced her professional development by taking a three-day workshop on Team Leadership offered through NASA headquarters, as well as a half-day workshop on communicating climate change. In the coming year, she will continue working with the Biodiversity and Ecological Forecasting programs, especially by serving as a liaison to the conservation remote sensing community. To this end, she is organizing an oral symposium on local to regional-scale conservation and a remote sensing training session at the International Congress for Conservation Biology this summer. She also will continue to help guide the NCA process as plans are implemented for the next quadrennial assessment cycle. She will participate in USGCRP working groups and work with the ESD program and senior managers to coordinate assessment activities, as well as help define a strategy for NASA’s participation in the NCA in the year ahead.

Dr. Allison Leidner (sponsior: J. Richards) has two main areas of responsibility with the Earth Science Division (ESD) at NASA Headquarters. First, she leads with NASA’s National Climate Assessment (NCA) by representing NASA on various interagency working groups at the U.S. Global Change Research Program (GCRP) and by working within ESD to coordinate assessment-relevant activities. She also provides a variety of support for activities within the Carbon Cycle & Ecosystems (CC&E) Focus Area, especially those efforts taking place in conjunction with the CC&E Focus Area Programs. Dr. Leidner is NASA’s representative on the USGCRP Intergovernmental National Climate Assessment (INCA) Working Group and serves on several interagency, international, and other working groups. Additionally, she manages NASA’s coordination of NASA’s military involvement in the strategic planning effort to identify, assess, and address the implications of climate change for national security and military operations. In this role, she briefs ESD senior managers and coordinates NASA-funded research activities conducted in support of the strategic planning effort. Furthermore, she is a member of the American Meteorological Society and the American Geophysical Union.

Recent achievement and current activities. The Goddard Earth Observing System - Coupled Atmosphere-Ocean System (GES) is one with interactive stratospheric chemistry and the other with prescribed ozone. Comparing climate trends in 1979-2010 between the interactive chemistry and prescribed ozone simulations revealed that interactive chemistry has important effects on climate change not only in the Antarctic but also in the Southern Ocean and Antarctic Circumpolar Current. The interactive chemistry simulations produce stronger cooling in the Antarctic lower stratosphere and stronger circumpolar westerly acceleration from the Southern Ocean to Antarctica. The significantly stronger trends in surface wind-stress cause a larger increase of the Southern Ocean Meridional Owing Current Circulation, which brings warm water to the surface and a large decrease in Antarctic sea ice. He presented these results at the 2014 AGU Fall Meeting and the 17th AMS Middle Atmosphere Conference, and will submit a related manuscript.

Another recent achievement is the development of the Goddard Earth Observing System - Coupled Atmosphere-Ocean Chemistry Climate Model (GES-OACC) which has been updated with new atmosphere and ocean components. This updated model has made significant improvements in reducing errors in the previously version of the model, particularly in the North
Atlantic sea surface temperature and salinity. Dr. Li has started a control simulation in perpetual 1950 conditions with the updated model. In the coming year, Dr. Li will continue to investigate the effects of stratospheric ozone recovery on Southern Hemisphere climate change in the 21st century using GEOS-ADOCM simulations. He will conduct three sets of ensemble simulations from 2010-2100 in order to identify the relative roles of greenhouse gas increase and ozone-depleting substance decrease in driving climate change in the Southern Hemisphere’s atmosphere and the Southern Ocean. Additionally, Dr. Li will continue to collaborate with Dr. Margaret Hurwitz to integrate HFC radiation into the GEOS-ADOCM. He will conduct control and sensitivity simulations to investigate the impacts of HFCs on stratosphere, particularly stratospheric ozone recovery. Another collaboration with Dr. Judith Perlwitz (ORES, University of Colorado) will continue in which they investigate the impacts of atmosphere-ocean coupling on stratospheric processes from daily to annual timescales in the Northern Hemisphere.

Dr. Li co-authored a paper (Obrt, et al.) that has been accepted Journal of Climate. This study presents the first climate model assessment of the Asian monsoon air-mass origin in the Arctic in terms of rigorously defined air mass fractions that partition air according to where it last contacted the PBL. Over 700 hPa model results were presented at the SEAC4RS science meeting in Pasadena, CA (April 30-May 3, 2015). Dr. Liang has completed new GEOS-5 model simulations with additional model resolutions with finer vertical and temporal resolutions for more meaningful comparisons with SEAC4RS and ATTREX observations and more accurate lifetime estimates. These model results were presented to Prof. Steve Wofsy (Harvard Univ.) and Dr. Janas Pittman (Harvard Univ.), and part of these results will be presented at the SEAC4RS science meeting in Pasadena, CA. This collaboration will continue in the coming year regarding analyzing the model’s CD2-CD5 correlations to quantify the lifetimes of these substances. Further work on this project will include new model simulations with the GEOS-5 Gantry version.

Dr. Fredric Lipschutz (sponsoring: J. Richards) broadly coordinates Federal climate activities, especially the sustained climate assessment, that support regional science needs and activities within USGCRP, while actively interacting with other USGCRP leaders to meet the broader goals of the program. In addition, he supports the U.S. Head of Delegation to the Arctic Council’s Arctic Monitoring and Assessment Program (AMAP), bringing expertise from the U.S. sustained assessment process to bear on AMAP programs.

The major accomplishment this past year was the release of the Third NCA Report. Dr. Lipschutz was responsible for coordinating 10 of 30 chapters and authored two chapters of this highly influential report. He also received an Award for Excellence from the Office of Science and Technology Policy (OSTP) at the White House for his work, gave 15 presentations on different aspects to varied audiences and helped organize several meetings about the report. As USGCRP transitions its focus from producing the report to a more sustained process, Dr. Lipschutz also shifted his emphasis from report-related activities. He recently initiated, planned and ran a 25-person workshop to discuss coordinated climate outlooks across Federal agencies and now leads the interagency team in developing the climate outlook as a component of the Climate Resilience Toolkit. He actively participates in a range of meetings to plan and implement aspects of the sustained assessment and the next quadrennial report due in 2018, as well as related meetings to understand how the NCA3 report is being used across the nation. To coordinate with NASA, he will continue to work as an advisor to the executive integration team that guides the entire AACA process. In addition to modifying NCA3 guidance documents and experience in reaching a wider audience via online approaches, Dr. Lipschutz has attended meetings in Seattle, Ottawa and Oslo to work directly with the AMAP Secretariat.

Over the next year, Dr. Lipschutz will continue developing the sustained assessment process within USGCRP while also contributing to the Updated Strategic Plan for USGCRP. Working across the Federal agencies, he will continue to lead the climate projections task team for the CRF and to implement climate screening for international development in response to EO13677. He will continue to act as an advisor to the U.S. Head of Delegation to AMAP focusing on developing the AACA report by the end of the U.S. chairmanship of the Arctic Council.

Dr. Benjamin Marchant (sponsoring: S. Platnick) works on the development of new algorithms to continue improving the cloud optical products of instruments such as MODIS, VIIRS, eMAS, etc. He has supported the MODIS cloud phase classification algorithm for the MODIS Collection 6, which also has been applied to the VIIRS (Visible and Infrared Imaging Radiometer Suite) instrument with success. He developed geo-registration codes to compare MODIS cloud optical products against CALIOP and POLDER cloud products. Those comparisons studies have shown a substantial improvement of the MODIS cloud phase products as compared to MODIS collection 5 (see Figure 1, which is from “Optical classification of georeferenced cloud data derived from MODIS and CALIOP”, Marchant et al, to be submitted). This work was presented at the 2014 AGU Fall Meeting. Also, Dr. Marchant’s research included the development and implementation of new techniques based on machine learning (such as the SVM support vector machine and Bayesian Networks) and image processing tools to continue improving the
and the MOD08 L3 global gridded product, to be included in the C6 roll-out. He also completed drafts of FAQ sections for MOD06 “beta” version was made publicly available in September 2014, Research-Atmospheres in April 2015. He also continued to help this paper was accepted for publication in Journal of Geophysical MOD06 failed cloud optical and microphysical property retrievals; retrieved and provided support for the eMAS calibration efforts that have included eMAS reflectance comparisons with collocated Terra and Aqua MODIS for select satellite under-flights, as well as comparisons with ground-based vicarious calibration efforts post-campaign. He assisted with finalizing the eMAS operational cloud retrieval algorithms (MAS06) for the official production of the eMAS SEACARS cloud products. In late 2014, the SEACARS eMAS calibration was finalized, and the SEACARS L2 cloud products were expected to be released the week of April 20, 2015. In addition, a draft version of a paper detailing a new thin cirrus retrieval using spectral reflectance measurements within the 1.88µm water vapor absorption band has been completed.

Dr. Meyer has submitted a manuscript detailing the MODIS multispectral cloud and above-cloud absorbing aerosol retrieval to Journal of Geophysical Research-Atmospheres. The manuscript describes the retrieval methodology, and provides case study results, uncertainty analyses, a comparison with CALIOP, gridded multi-year statistics, and preliminary cloudy sky direct radiative effect calculations. After peer reviews and revisions, this manuscript will be submitted for publication in the fall of 2015. Dr. Meyer presented on the cloud/above-cloud aerosol retrieval at the 14th AMS Conference on Radiation and Cloud Physics in July 2014, at the 2014 AGU Fall Meeting in December 2014, and at the 2014 CALIPSO-CloudSat Science Team Meeting in November 2014, and at the 2014 AGU Fall Meeting in December 2014. An Aerocenter seminar also was presented in March 2015 in which he discussed algorithm details and the results included in the manuscript submitted to JGR-A.

Dr. Teppel Yasunari (sponsor: K.-M. Kim) conducts the data analysis and modeling studies of the impacts of light absorbing aerosols (LAA) such as dust, black carbon (BC), and organic carbon (OC), on the changes of snow-related variables (called snow darkening effect, SDE) and on climate via feedbacks between the atmosphere and the land surface in the Asian monsoon and Eurasian regions. While his research is focused on the modeling part) on light-absorbing particles in snow and ice led by Dr. Yun Qian (PNNL), that was published in Advances between observations and GEOS-5 simulations in Toyama, Japan, in the spring of 2009. Their related paper, titled “Understanding tropospheric and stratospheric ozone by combining measurements from TOMS and OMI,” was published in the 14th AMS Conference on Radiation and Cloud Physics in July 2014. They also have written a paper titled “Tropospheric and Stratospheric Impurity Module (GOSWIM), a new snow impurity module in the GSWM, and its impact on climate,” which was published in the 14th AMS Conference on Radiation and Cloud Physics in July 2014. Their revised paper was resubmitted to JGR-A, and summarized the results in a paper that is currently in review with Journal of Geophysical Research - Atmospheres (Yasunari et al.; this also was introduced in a two-minute presentation at the Town Hall Meeting at NASA GSFC in December 2014. Finally, Dr. Yasunari and his NASA colleagues carried out ten-year by ten-ensemble GEOS-5/GOSWIM simulations for both non-SDE and SDE cases to discuss the fundamental role of SDE in boreal spring climate, and summarized the results in a paper that is currently in review with Journal of Geophysical Research-Atmospheres and Atmospheric Research and is now in revision.

Dr. Jerald Zielke (sponsor: P. Newman) has several objectives related to this task: (1) to develop a long-record (1979-current) of tropospheric and stratospheric ozone by combining measurements from TOMS and OMI, (2) to reprocess OMI/MLS ozone measurements using UOMS and MLS ozone profile data upon availability and validate these fields using ozonesondes and satellite measurements, (3) to use the Code 614 GM model and free-running CCM and our ozone datasets to study ozone from short to decadal time scales, (4) to determine impact of stratosphere-troposphere exchange (STE) on tropospheric ozone, (5) to quantify the strengths and weaknesses of four ozone products: Cloud Slicing, trajectory mapping, data assimilation, and direct profile retrieval, (6) to evaluate ENSO and the Madden-Julian Oscillation and shorter timescale variability for their effects on ozone, (7) to perform algorithm maintenance and direct profile retrieval, (6) to evaluate ENSO and the Madden-Julian Oscillation and shorter timescale variability for their effects on ozone, (7) to perform algorithm maintenance and the data from field observations, etc.

Dr. Yasunari and colleagues have continued to update their snow impurity module, GOSWIM, from the Fortuna 2.5 version of GEOS-5 to the latest version. Some test simulations at each step of the GOSWIM updates were carried out with the Gurney version; however, the latest version of GEOS-5 is now the Heracles version. Therefore, they recently decided to start work on GOSWIM in a Heracles version, merging the GOSWIM components to the Heracles version of GEOS-5.

Over the past year, Dr. Yasunari and his co-workers presented on relevant topics on the Snow Darkening Effect (SDE) at the Young Scientists Forum in June 2014, at the Workshop on Perspectives in Computational Climate Science and the 7th OFES International Workshop in October 2014, at the 2014 Autumn Meeting of Meteorological Society of Japan, and at the 2014 AGU Fall Meeting in December 2014. He also co-authored a review paper (especially on the modeling part) on light-absorbing particles in snow and ice led by Dr. Yun Qian (PNNL), that was published in Advances in Atmospheric Sciences (Qian et al., 2015). Also, Dr. Yasunari and his NASA colleagues carried out ten-year by ten-ensemble GEOS-5/GOSWIM simulations for both non-SDE and SDE cases to discuss the fundamental role of SDE in boreal spring climate, and summarized the results in a paper that is currently in review with Journal of Geophysical Research - Atmospheres (Yasunari et al.; this also was introduced in a two-minute presentation at the Town Hall Meeting at NASA GSFC in December 2014. Finally, Dr. Yasunari and his collaborators have worked on revising the paper on comparisons of total dust deposition flux during precipitation between observations and GEOS-5 simulations in Toyama, Japan, in the spring of 2009. Their related paper, titled “Understanding tropospheric and stratospheric ozone by combining measurements from TOMS and OMI, (2) to reprocess OMI/MLS ozone measurements using UOMS and MLS ozone profile data upon availability and validate these fields using ozonesondes and satellite measurements, (3) to use the Code 614 GM model and free-running CCM and our ozone datasets to study ozone from short to decadal time scales, (4) to determine impact of stratosphere-troposphere exchange (STE) on tropospheric ozone, (5) to quantify the strengths and weaknesses of four ozone products: Cloud Slicing, trajectory mapping, data assimilation, and direct profile retrieval, (6) to evaluate ENSO and the Madden-Julian Oscillation and shorter timescale variability for their effects on ozone, (7) to perform algorithm maintenance and direct profile retrieval, (6) to evaluate ENSO and the Madden-Julian Oscillation and shorter timescale variability for their effects on ozone, (7) to perform algorithm maintenance and
Dr. Deepthi Achuthavarier’s research has resulted in several publications and presentations. In September 2014 and two that were given at the Aura Science Team Meeting in September 2014, and at the 2014 AGU Fall Meeting in December 2014. She contributed to three others: one that was presented at the 13th IGAC/CCM Connect 2014 conference in Lisbon and one in the Bulletin of AMS, and co-authored three ensembles.

The evaluation of the GEOS-5 model involved Dr. Achuthavarier diagnosing data on several of the latest runs of the GEOS-5, with a particular emphasis on ENSO (El Niño-Southern Oscillation) and MJ. Her results indicated that, in the latest GEOS-5 atmosphere-ocean coupled run, the ENSO periodicity is nearly four years, as observed, and the tropical portion of the PDO is closer to the observations. She worked in collaboration with the combined model development team to better understand convective control of ENSO in GEOS-5, where she proposed to examine the sensitivity to the Tokioka parameter, the minimum entrainment rate threshold in the cumulus parameterization. She examined the outputs of Tokioka sensitivity runs and found that the ENSO amplitude is considerably reduced when deep convection is suppressed. Dr. Achuthavarier also studied MJ variability in both GEOS-5 coupled and stand-alone atmospheric versions, where she concluded that coupling with the ocean model did not improve the MJ. From her extensive work, she was nominated by her sponsor, Dr. Schubert, to a proposed committee on subseasonal variability and predictability at the US Climate Variability and Predictability (US CLIVAR) program.

Dr. Achuthavarier was involved in the GEOS-5 7km run evaluation efforts. To this end, she examined tropical cyclone lifecycle parameters as influenced by large scale variations in tracks and evaluated them against observational Best Track data from the National Hurricane Center and the Joint Typhoon Warning Centre. In addition to being a co-author of two presentations at GMAO Nature Run evaluation meetings, Dr. Achuthavarier contributed to and is a co-author of the NASA technical memorandum titled “Evaluation of the 7-km GEOS-5 Nature Run.” She also presented a poster and co-authored another at the American Meteorological Society’s annual meeting held in Phoenix, AZ.

Dr. Deepthi Achuthavarier published a paper that was submitted and accepted for full funding. This proposal is available online at NASA TECHNICAL MEMO, which was co-authored by Dr. Deepthi Achuthavarier, Michael Bosilovich, Virginia Buchard, Winston Chao, Lawrence Cox, Richard Gellar, Arndt de Silva, Anton Damreenguin, Ronald M. Enrici, Morangely Fuentes, Min-Jeong Kim, Randall Koster, Will McCarty, Jothi Nattlala, Gary Perryka, Siegfried Schubert, Guillaume Vernieres, Yuri Vikhliaev, and Kristojar Wargan. Evaluation of the 7-km GEOS-5 Nature Run, NASA TM-2014-104606, Vol. 36, edited by R. Koster.

This seven-chapter document is 300+ pages long, and chapters are co-authored by GESTAR members and other scientists from NASA GSFC’s Global Modeling, Assimilation Office. As such, there are several references to this Nature Run GEOS-5 Nature Run Technical Memo throughout this section on accomplishments.


NASA Technical Memo


This seven-chapter document is 300+ pages long, and chapters are co-authored by GESTAR members and other scientists from NASA GSFC’s Global Modeling, Assimilation Office. As such, there are several references to this Nature Run GEOS-5 Nature Run Technical Memo throughout this section on accomplishments.


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mean diurnal cycle of precipitation over North America. Compari-
sions were made with the high-resolution CMORPH precipitation
estimates.

In the coming months, Dr. Chang will use the GEOS-coupled GCM to study the root cause of the Pacific warming and its impact on the global extreme weather. At present, waters in a huge area of the Pacific Ocean have been running 5.5 degrees warmer than normal over the past two years. It is possible that this is affecting the West Coast drought and the record cold and snow in the Midwest and Northeast over the last two seasons, including the record snowstorms of 2015 in Boston and Detroit. While this may be due to a Pacific Decadal Oscillation and a long-lasting El Ninño-like pattern in the Pacific, currently the answer is not clear.

Dr. Gabrielle J.M. De Lannoy (sponsor: R. Reichle) works on the development of the Soil Moisture Active Passive (SMAP) Level 4 soil moisture (L4_SM) data product. In preparation for the assimilation of SMAP observations, satellite observations from the Soil Moisture Ocean Salinity (SMOS) mission are used to build a prototype system for the L4_SM product. During the past year, the system has been updated with numerous new aspects, mainly to improve the assimilation of SMAP brightness temperature observations and ultimately to improve soil moisture estimates. This includes the generation of updated land surface model and radiative transfer model parameters, corrections to and optimization of the assimilation framework, improved quality control of brightness temperature simulations and observations, advanced treatment of brightness temperature observations and assimilation modules to assimilate freeze/thaw information. A selection of this research has been submitted for publication. Dr. De Lannoy supports her colleagues in the implementation of the scientific system for the assimilation framework, improved quality control of observations and ultimately to improve soil moisture estimates. He also conducted the first test of the validity of the GMAO high-resolution nature run in an OSSE context. In an OSSE context, model error is implicitly simulated by the difference between the model used to simulate nature (the “nature run”) and the model used in the data assimilation system. Since the GMAO high-resolution nature run and data simulation models have a common heritage, it is likely that the use of these at the GMAO will under- represent model error leading to unrealistic behavior in the OSSE. A preliminary test was conducted, revealing different degrees of unreality for different metrics.

In the coming months, Dr. Erico will use the GMAO OSSE framework to investigate, understand and improve functionality of the new data assimilation schemes under development at the GMAO. This OSSE application exploits the fact that, within its simulation framework, the “true” atmospheric state is known, being given by the nature run. Further, the GMAO OSSE framework will be used to estimate the usefulness of proposed new atmospheric observing systems, and their competing designs, in the context of data assimilation. Additionally, this OSSE application exploits the fact that, within its simulation framework, it is unnecessary that observations exist in reality.
Holdaway and a collaborator at the University of Michigan tested small-scale features. The highly nonlinear advection schemes identified issues around the linearized transport of these quantities. Weather Review. The development of the linearized cloud scheme was revised.

Additionally, Dr. Holdaway assisted the EPIC cloud algorithms team to determine the appropriate time-stepping to be used on the Deep Space Climate Observatory (DeepSCoR) Earth-observing instruments. He is using output from the GEOS-5 operational forecasts and Nature Run to provide a long time series of the aspects of the atmosphere observable by the instrument. In particular, the Nature Run is very useful for this kind of study, since it provides a simulation of the atmosphere with very high temporal and spatial resolution. Under this contract, he and the EPIC team are able to determine the optimal step-size to use. This is an essential question for the instrument as limited storage is available and the orbit prevents data transmission for long periods of time. As the satellite comes online in late June, his role will transition to validating the products being introduced.

Dr. Hanjun Jin (sponsor: R. Gelaro) conducts radiance data assimilation using NASA Goddard Earth Observing System (GEOS) model and Global Modeling and Assimilation System (GeMoSyS) data assimilation systems into the up-to-date model framework for SMOS data assimilation. She has been investigating and learning about data assimilation tools used by the GMAO. After an initial implementation, she completed a major revision to the linearized cloud scheme. He recognized the need to split the approach to handling issues around the generation of cloud between different uses of the linearized model. He implemented a high-efficiency tangent linear model approach to prevent spurious perturbation growth. This model can replace the previously used Jacobian filtering technique and allow the scheme to be used more efficiently in data assimilation settings.

The 4DVAR technique requires maximum efficiency in the linearized model, due to the numerous calls to the model. Splitting the approach also allows for a more extensive filtering to be applied for the observation impacts use of the linearized model. Observation impacts are run over 24 hours and only one integration of the adjoint is required; therefore, accuracy is more important than efficiency. For both 4DVAR and observation impact applications, the accuracy of the linearized model improved with the updates. For 4DVAR, the number of observations being assimilated at each step is increased, and for observation impact applications, the percentage of the observation impacts captured by the linear estimate also increases. A paper covering the development of the linearized cloud scheme was revised to include these changes and is in submission to Monthly Weather Review.

Dr. Jin and colleagues with the Joint Center for Satellite Data Assimilation (JCSDA) at NOAA, 2014 fall newsletter in an article co-authored by Dr. Jin (Dr. William McCarty, GSFC, lead author) in which they reported the team’s initial results from assimilating GMI data for a hurricane case.

Dr. Jin also helped GMAO in updating its stratospheric temperature observation data set. The Microwave Limb Sounder (MLS) temperature data version 3 is being assimilated in producing GMAO’s analysis data sets for the Joint Polar Satellite System (JPSS) in the next step. The new MLS observation data set was released this past winter, and Dr. Jin built new computer programs to process these new MLS observation data and assisted with testing these new data. New MLS observations will be used for producing future GEOS-5 data sets.

Dr. Young-Kwon Lim (sponsor: S. Schubert) supports scientific research on climate variability and weather extremes using modeling and assimilation tools developed by the GMAO. In his investigation of the impact of large-scale climate modes on the Atlantic tropical cyclone activity on seasonal time scales and predictability of those modes, Dr. Lim found that the seasonal Atlantic tropical cyclone (TC) activity is very different each year and that the combined effect of the Atlantic Meridional Mode (AMM), North Atlantic Oscillation (NAO), and ENSO explains largely the year-to-year variation of TC frequency, landfalls, dominant genesis locations and track patterns over North America. This indicates that any seasonal forecast of TC activity relying solely on ENSO phase would have a large risk of forecasting errors. For example, his study found that a strong impact of the positive AMM in 2010/2011 constructed the negative Sea Level Pressure (SLP) anomaly over the North Atlantic, leading to an active TC season despite a weak El Niño phase. A weak TC activity in 2013, despite the La Niña phase, is reasonably explained by the impact of a positive NAO (and weak negative AMM as well) that drives the negative SST and positive SLP anomaly and stronger vertical wind shear over the low latitudes of the North Atlantic. He also investigated the impact of Madden-Julian Oscillation (MJO) on the TC genesis location. From both observations and the GEOS-5 model data set obtained from “replay run with spectral filter”, he found that timing of the TC genesis depends on the phase of MJO: while TC genesis is generally more active in the western North Pacific during the positive MJO phases, the TC genesis becomes weakest when the positive MJO passes the western North Pacific. Dr. Lim also performed multi-members (20 members) forced with prescribed sea surface temperature (SST) for the Atlantic hurricane season period to investigate the model’s predictability of the leading climate modes. He investigated cases from four different TC years, two of which were very active (2005 & 2010) and two which were very calm (2006 & 2013). He found that GEOS-5 model has a great predictability
of the AMM, while the predictability of the ENSO is a little lower than that of the AMM. Also, the ENSO-related large-scale pattern over the extra tropical central to the eastern Atlantic exhibits a large uncertainty. Large ensemble spread, along with negative signal-to-noise ratio, is also found for the assessment of the NAO predictability. Also, Dr. Lim found that reasonable predictability of the NAO and further improved simulation of ENSO-related extra-tropical atmospheres are essential to improve the seasonal prediction of TOC's genesis locations and track patterns over the Atlantic. Future work will involve global model simulations to produce the MJO in collaboration with scientists from the Mesoscale Modeling group.

This past year, Dr. Lim became involved in an interdisciplinary research project titled "Feedbacks, processes and impacts of contemporary changes in the Arctic", which explores the atmospheric and oceanic climate variability associated with the ice mass variation/loss over the area of Greenland. He investigated the role of large-scale teleconnections in the North Atlantic in explaining the variation of temperature and ice mass over Greenland. He decomposed upper level geopotential height data to capture the first major teleconnections over the Atlantic and calculated temperature anomalies and advective temperature changes driven by the impact of each teleconnection. He found that, compared with the contribution by oceanic circulation, the role of atmospheric circulation is important in explaining the temperature and precipitation variability to complete a review paper. Dr. Lim contributed to documentation of the role of the Arctic sea ice in the Northern hemisphere warm/cold extremes, and summarized the capability of the CMMP-5 models in reproducing the temperature extreme statistics for the present climate. Regarding precipitation extremes, he led a section on the large-scale influences on precipitation extremes (globally or regionally over North America) in a review paper. He has been working on multiple papers with the US CLIVAR Hurricane working group scientists; in these papers, Dr. Lim addressed precipitation and capability of the North Atlantic to produce extreme precipitation patterns and their trends. The seasonal variations in the Russia region under the Arctic Oscillation and their interactions are topics of the future papers directed by him. Dr. Lim advanced the analysis on comparing the large-scale impacts of the Arctic Oscillation (AO) and other large-scale teleconnections (NAO, EA, etc.) on the weather over the Arctic as well as over the central US. His work is being extended in the future to include the impacts of the AO on the large-scale teleconnections (NAO, EA, etc.) on the weather over the central US. His work is currently in review with ACP. He gave an oral presentation of his work at the Young Scientist Forum hosted at NASA GSFC in June 2014, and she supplied a high-light slide for the GMAO booth at the NASA GSFC Science Jambores; the slide showed the effect of PBL depth definition on the diagnosed global PBL depth, Saharan dust, and the mat/case. In May 2015, Dr. McGrath-Spangler will attend the Joint Center for Satellite Data Assimilation Science Workshop, where top level findings from various national centers will be presented.

Dr. McGrath-Spangler was involved with two NASA proposals that were selected for funding. The first was submitted to the NASA ROSES14 ACPM call and is being led by Dr. Jennifer Hagner (AER Inc.), while the other is serving as a Co-Investigator. Dr. McGrath-Spangler performed work in support of research under a NASA Grant of which she is the PI (Program Manager: Dr. Edman); funding began in February 2015. She analyzes atmospheric PBL trends in the geos-5 atmospheric model and the CALIPSO satellite record and the impact on the atmospheric tracer concentration and transport. She success-fully ported her PBL depth retrieval algorithm to the NASA Center for Climate Simulation (NCS) computer system and tested the production of PBL depths from the CALIPSO level 1B data. Ad-di-itionally, Dr. McGrath-Spangler created and developed an online tool for processing the lidar data from first light in 2006 through 2008. This code also computes the number of orbit tracks for each grid cell and their mean values. She has completed extensive quality control, she tested modifications to two existing PBL depth data analysis codes, and provided quality-controlled PBLH retrievals from the CALIPSO satellite, refining these retrievals in light of the science analyses (e.g., publications with the data used by GMAO). She has also coded a code to calculate PBL depth from the CALIPSO satellite at the kick-off meeting for this contract at Sigma Space Corporation, Lanham, MD. She has been working on this task to use space-based observations and earth observations to calculate forecasting statistics and plot the results using tools de-veloped within the GMAO. Using these skills, she was able to cre-ate perturbation experiments that varied the amount of infrared satellite data assimilated. She then ran seven multi-month experiments and their associated forecasts.

Over the past year, Dr. McGrath-Spangler has published a lead author article with Dr. Andrea Molod in the journal Atmospheric Chemistry and Physics, and has a second lead author paper cur-rently in review with JCP. She gave an oral presentation of her work at the Young Scientist Forum hosted at NASA GSFC in June 2014, and she supplied a high-light slide for the GMAO booth at the NASA GSFC Science Jambores; the slide showed the effect of PBL depth definition on the diagnosed global PBL depth, Saharan dust, and the mat/case. In May 2015, Dr. McGrath-Spangler will attend the Joint Center for Satellite Data Assimilation Science Workshop, where top level findings from various national centers will be presented.

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Dr. Norris conducted an extensive validation against CERES data of cloud and radiation properties in the GMAO’s new GEOS-5 Nature Run. He was team leader for this part of the validation and oversaw contributions by several others. The results of this validation were presented at the GMAO nature run validation meeting in June 2014, and he also presented a short talk on the topic at the SED-Director’s Seminar on October 3, 2014. Dr. Norris subsequently contributed a chapter on Cloud and Radiation validation to the GMAO Technical Report on the Nature Run, published in March 2015 (Code 601.1). Future efforts will include the preparation of a journal article on this behavior in the new GEOS-5 Nature Run.

Since joining GESTAR in October 2010, Dr. Tomohiro (Tom) Oda (sponsoring: S. Pawson) has been involved in developing high-resolution CO2 emission datasets for fossil fuel combustion and biomass burning and evaluating them using atmospheric transport models and correlative measurements. As PI, Dr. Oda leads a NASA ROSES-funded project and develops and maintains a global fossil fuel carbon dioxide (CO2) emission model (ODIAC - Open-source Data Inventory for Anthropogenic CO2) that produces global CO2 emission fields at a very high spatial resolution (1x1km). Several upgrades have been made to his ODIAC model, and he has distributed the 2014 version of this ODIAC dataset to the international user community. He gave a presentation on the recent upgrades and modifications at the NASA Carbon Cycle and Ecosystem Joint workshop held at College Park, MD, and currently is working with PI’s and an extension summarizing his recent version of this model. A team at NOAA/ESRL implemented a simulation of fossil fuel emissions in the atmosphere using a version of ODIAC data, and a movie of the simulation became available for display on NOAA’s Science On A Sphere (http://www.noaa.gov/Datasets/dp10/504). At present, Dr. Oda is testing the use of different satellite data (DSM, Suomi/NPP/VIIRS and LandSat) to improve the spatial emission representation. He contributed to four AGU presentations, two Japanese conference abstracts and four EGU presentations related to this project. Dr. Oda also works on the modeling of biomass burning. He has imposed a method to estimate biomass burning emissions using combustion parameters retrieved by the VIIRS/Nighttime algorithm developed by Co-Investigator Dr. Chris Elvidge and his group at NOAA/NOAA. Dr. Oda is currently developing a model to calculate the emissions with the NOAA/NGDC team and a collaborator at NCAR.

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Other work involved studying the impact of AERONET observations on the GEOS-5 aerosol retrieval. He was also working on a new OSSE (Observing System Simulation Experiment) design to seriously affect the full multi-layer algorithm. Dr. Norris continued supporting Gaia Wind and Arlindo da Silva on the radiative validation of the CDA system.

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specific to different categories of tropical storms. Since October 1st, Dr. Reale has been involved in the GM Ao monitoring effort, contributing to the ongoing evaluation and assessment of the impacts of AIRS data assimilation on tropical cyclones. Reale has co-authored four presentations given at the Monitoring Meetings from November 2014 – April 2015; all have involved an assessment of the operation caused by changes in convective parametrization. This article was published in January in the Journal of Geophysical Research-Oceans and in one in Journal of Geophysical Research-Atmospheres. She also co-authored three articles, one of which was published in Ocean Modelling. Over the past year, Rousseaux was first author on five presentations and co-author on five others, which were given at the Ocean Optics Conference, the 2nd Gregory G. Leptoukh Workshop, the NASA PACE Science Team Meeting, the 5th North American Carbon Program, the Program for Arctic Regional Climate Assessment meeting, the NASA OMS meeting, and the NASA Carbon Cycle and Ecosystem Focus Area workshop (among others). She was invited to and participated in the Pre-Decadal Carbon Workshop in Oklahoma and contributed to the development of the Marine Ecosystem Model (MEM) Climate Simulation. She will participate in the MOSIS Science Team Meeting, and in June 2015, she will give a talk at the Hyperspectral Remote Sensing Meeting.

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excess of low clouds in this region. Work in the coming months will involve an update of the ocean component of the GEOSS-5 AOGCM to MOM6, which is the next major release of the GFDL Modular Ocean Model. Also, Dr. Vikhliaev will continue to assess the performance of GEOSS-5 AOGCM based on the AGCM version of Hercules 3.0. Dr. Vikhliaev collaborated on a variety of work with the GMAO. He worked with the GMAO data assimilation group incorporating diurnal warm and wave model into the GEOSS-5 framework, a project that is still in progress. The NOAA Wave Watch III wave model has been assimilated into the GMAO's Modular Ocean Model. Dr. Vikhliaev has also extended the trace gas assimilation component of GEOSS-5 to include the option of using GEOS-Chem as an online chemical component. This improved upon existing GEOS-Chem assimilation systems, which were restricted to using meteorology fields and in-situ observations to develop reanalyses for CO and CO2, distributions from 2009-2016, and to use similar observations to estimate surface fluxes.

**CODE E10.2 GLOBAL CHANGE DATA CENTER**

Dr. Radina Soebiyanto (sponsor: R. Langi) uses remote sensing technology to monitor, predict and facilitate the control of infectious disease transmission. The objective is to develop empirical and theoretical models and techniques that can be used by public health organizations for disease surveillance and control. This past year, much of her research resulted in publications and presentations. One published in PLoS ONE, titled “The Role of Temperature and Humidity on Seasonal Influenza in Tropical Areas: Guatemala, El Salvador and Panama, 2008–2013,” was in collaboration with the US Centers for Disease and Control Prevention (CDC), CDC Central America Region and several public health institutions in Central America. Dr. Soebiyanto used specific humidity and temperature data from GLDAS, as well as precipitation from TRMM. Her findings highlighted the association between influenza activity and specific humidity in the three tropical countries studied. Positive association with humidity was found in El Salvador and Panama. Negative association was found in the more subtropical Guatemala, similar to temperate regions. Of all the study locations, Guatemala had annual mean temperature and specific humidity that were lower than the others. The second publication, published in the SPRES International Journal of Geoinformation, was a result of a collaboration with a colleague at her branch to demonstrate the use of remote sensing data for public health application - with her study on influenza as an illustration.

Dr. Soebiyanto has been working on assessing the relationship of influenza with meteorological conditions in European countries (Germany, Slovenia and Spain) and in Israel. She found that influenza was inversely associated with specific humidity in these study locations. She also found that influenza models using minimum temperature performed slightly better for temperate locations, whereas models using specific humidity were better for subtropical locations. This work was in collaboration with the CDC, World Health Organization (WHO) - Euro region, and each country’s public health institution. A related manuscript is currently under revision.

In September 2014, Dr. Soebiyanto and her sponsor, Dr. Richard Kiang, participated in the White House Office of Science and Technology Policy (OSTP) Dengue Prediction Workshop. The workshop aimed to review major dengue modeling projects in the US as well as the epidemiological, entomological and environmental data generally needed for modeling. Her work also was discussed in a symposium organized and chaired by Dr. Kiang at the Annual Meeting for the American Society for Tropical Medicine and Hygiene in New Orleans, LA. At the Federation of Earth Science Information Partners (ESIP Federation) Winter Meeting - Data Analytic Session, she discussed the process of using analytic tools for different sets of data for the purpose of modeling and prediction. Going forward, Dr. Soebiyanto will be working with Dr. Oreste Repetto Orelli at the University of California at Santa Barbara, the hilbert Huang Transform) on several GEOS-5 assimilation experiments that used AIRS-derived products. Also, pending a submitted proposal, Dr. Soebiyanto will work with Dr. Aasaan Anyamba (Code 61B) to develop ecological-based monitoring and risk mapping system for chikungunya using data such as MODIS LST & NDVI, GLDAS temperature and specific humidity, and SRTM elevation.

Under his task, Dr. Sushel Unninayar (sponsor: S. Wharton) supports NASA HQ in a variety of internal, interagency, and international programs, such as the NASA Energy and Water Cycle Studies (NEWS) Program, the Group on Earth Observations (GEO) that coordinates the Global Observing System of Systems (GEOSS), the GEOSS Integrated Global Water Cycle Observations (IWCO) Community of Practice (CoP), the U.S. participation to the UNFCCC, the science assessments of the IPCC, the international WCRP/GEWEX program, and the activities of the Committee on Earth Observation Satellites (CEOS). Dr. Unninayar is the lead author for several sections of the recently published GEO/GEOSS-IWCO Water Strategy for the next decade. His work included considering strategic options for the implementation of the GEO/GEOSS IWCO Water Strategy for the next decade titled “From Observations to Decisions.” Topics included: integration across the water cycle and beyond; the role of research in integration; water cycle data integration; water cycle model integration; representing the water cycle in Community Earth System Models; land data assimilation systems; the impact of water cycle observational and modeling error on end user applications; observations to support climate change impact assessments and adaptation, among others. In September 2014, the CEOS appointed a Task Team to study the Water Strategy Report and develop CEOS implementation priorities. In late May 2014, the first EO Novel Data Assimilation Task Team Meeting was held in Tokyo, Japan. Following this meeting, Dr. Unninayar was invited by the IGWOD to assist in defining and completing a draft Matrix Indicator table in order to bring EO to the monitoring activities of the UN system, in particular, the joint WHO/HABITAT-UNEP project designed to develop, establish, and maintain an effective monitoring mechanism for waste water, water quality management, and water resource management. He was also the lead author for the Report on the “Contributions of Earth Observations, Novel Data Collection and Data Integration” to the monitoring of indicators for Sustainable Development Goals. In the joint WHO/HABITAT-UNEP project, Dr. Unninayar was invited to the second a following meeting as a member of the Task Team on Earth Observations, which was held in Tokyo, Japan. The meeting was held in Tokyo, Japan. The meeting was held in Tokyo, Japan. The meeting was to discuss policy issues related to monitoring for Water Sustainable Development Goals.

At the 2014 AGU Fall Meeting, Dr. Unninayar co-chaired a session titled “Joint EO Assimilation” (USGEO/0151) and reviewed options for moving from observations to decisions for both international and US GEO activities, and explored design components of a potential “cloud-based” GEOSS-AI (Artificial Intelligence) system comprised of modules maintained by contributors but readily accessible to end-users. Interoperability and integration will be important elements of the system, which will allow for the automated flow-through of information and products. Dr. Unninayar was invited to join the NASA HQ effort to develop US-GEO as a component of GEOSS entitled GEOGLWR (GEO Global Water Sustainability). This activity, presently led by NASA, will be opened to all other US agencies for a more coordinated effort. GEOGLWR will be presented to the GEO Plenary following its further development within the context of US-GEO. Further, Dr. Unninayar co-authored several articles and reports with Douglas Cripe, Rick Lawford (Code 617) and Rifat Hassain (WHO) that appeared in GEnAW, News, that were submitted to the Meeting of the United Nations (WHOHABITAT-UNEP) on the UN Sustainable Development Goals (SDGs). Dr. Unninayar continues to co-chair the meeting of the UN Statistical Commission (UNSC) on the Sustainable Development Goals (SDGs) Water. Additionally, as an expert member of the Development Task Team (EDT), he provided input to the First Consultation on Post-2015 Monitoring: Global Enhanced Water Monitoring Initiative (GEAWMI), held in Geneva, Switzerland.

He continued to develop the “Water Cycle (Variability) and Extremes—WCEs” theme within the GEOSS-IWCO-GAP as a part of the implementation of the GEOSS Water Strategy. Following the initial interaction within the IWGOD, a draft report on initial responses received was released in January 2015. To follow up on this initial activity, Dr. Unninayar is the primary convener of a session to be proposed to the 2015 AGU Fall Meeting entitled “Integrated Observations and Modeling of Water Cycle (Variability) Extremes (WCEs).” Extremes in the water cycle are becoming more frequent and intense as the climate changes. Many of the impacts of these climate-related events and extremes are mediated through the water cycle, and they are particularly important because of their large impacts on socio-economic structures and activities and on natural ecosystems. WCEs are at the center of changes in the water-food-energy-health ecosystem nexus. They provide a cross-cutting focus for water cycle research and applications.
Adequately characterizing WCEs is a challenge to both space-based and in-situ observing systems, and data assimilation/modeling systems. Papers will be invited to review the capabilities and limitations of the systems to characterize extremes and variability for the following: Precipitation (Droughts & Floods); Evapotranspiration; Soil Moisture (Near surface & Root-Zone); Surface Water (Run-off, Evaporation, River Discharge, Lakes & Reservoirs); Snow & Ice; and Ground Water Storages (Aquifers, Discharge/Re-Charge). In 2016, a comprehensive review of the topic of extremes is planned for the IGWDD and US GEO-Water.

**CODE 612: MESOSCALCME ATMOSPHERIC PROCESSES**

**Dr. Mircea Grecu** (sponsor: R. Meneghini) develops precipitation retrievals from combined radar radiometer observations. Over this past year, several improvements were implemented into the GCM combined algorithm. These include a computationally light procedure to account for multiple scattering effects in the Ka-band radar observations; a more accurate convolution procedure; a Backus-Gilbert brightness temperature decetration procedure; and a collocation procedure to enable the use of SZ brightness temperature observations in the combined retrievals. These improvements had a significant impact on the consistency between single- and dual-frequency radars and improved the agreement between simulated and observed brightness temperatures. While the multiple scattering procedure is already included in the current public version of the algorithm, the three other procedures are undergoing testing in a Precipitation Processing Systems (PPS) environment, and will be incorporated in the next version of the operational algorithm to be released in June 2015.

**Dr. Mei Han** (sponsor: S. Braun) applies satellite-based observations from NASA satellites (GPM and TRMM) and numerical models (WRF) to study precipitation associated with extratropical cyclones over ocean and land, and evaluates the performances of cloud and precipitation retrieval algorithms and the other three procedures undergoing testing in a Precipitation Processing Systems (PPS) environment, and will be incorporated in the next version of the operational algorithm to be released in June 2015.

**Dr. Han** was invited to speak at the Winter Weather Course hosted in UCAR, Boulder, CO, a residence course hosted by the Meteorological Service of Canada (MSC) and the UCAR Cooperative Program for Operational Meteorology, Education and Training (COMET). Her presentation focused on the dynamics associated with heavy snow bands in comma-shaped clouds of extratropical cyclones. Future work includes work on a Precipitation Measurement Missions (PMM) science team proposal.

Fig. 1: Sensitivity run in which size and mass spectrum of most types of hydrometeor species were impacted (M. Han).

**Dr. Hyokyoung Kim** (sponsor: R. Meneghini) studies the path-integrated attenuation (PIA), which can be used to improve precipitation estimates from high frequency space-borne radar. One approach that provides an estimate of PIA is the surface reference technique (SRT) which uses the measurements of the normalized radar cross section of surface (NRCS), in the presence and absence of precipitation. Measurements from the dual-frequency precipitation radar (DPR) onboard the GPM core satellite now afford the first opportunity to assess the SRT performance for the space-borne radar at Ka-band as well as for the Ku/Ka dual frequency combination. For several years, Dr. Kim has focused on developing and refining the SRT algorithm, developing the DPR radar simulator, and providing simulated radar test data for algorithm teams. Since the launch of GPM/DPR in February 2014, she adjusted the focus of her research to assessing the accuracy of PIA estimates derived from single and dual frequency SRT algorithms with real measured DPR data instead of simulated data. The initial assessment of PIA estimates from the DPR show encouraging results from the dual-frequency SRT (DSRT). This tentative conclusion follows from the rain-free statistics of NRCS and from the degree of consisten- cy among PIA estimates derived from different types of reference data. The primary reason that the DSRT is more accurate than its single-frequency counterpart (SSRT) is because the variance of differences between the rain-free normalized surface cross sections, sigma0(Ka) - sigma0(Ku), is usually smaller than the variance of either sigma0(Ka) or sigma0(Ku) alone. That is, the surface cross-sections at the two frequencies are usually highly correlated so that the differences in the reference measurements are smaller and changes in this quantity can be attributed to the degree of attenuation caused by the presence of precipitation and cloud liquid water aloft.

One way to improve both the single- and dual-frequency surface techniques is to use a database of previously measured rain-free surface cross sections, as in a look-up table ordered according to latitude, longitude and incidence angle. The many years over which the TRMM PR data were accumulated enabled computa- tion of a high resolution temporal file at 0.1 degree x 0.1 degree for each month. For the DPR, the data are much fewer and collected over a larger area, 65S to 65N. With a coarser resolution comes a higher variance, so the temporal files are less useful than they would be otherwise. Some ideas on how to improve the temporal reference files are being explored including make separate look-up tables for land, ocean and coast. While there are several ways to construct this table, the objective is to find a choice of averaging domains that minimizes the average variance. Dr. Kim will contribute to determining the best way to construct the tem- poral reference look-up table and to improve the SRT method to the next level.
Dr. Xiaowen Li (sponsor: W.-K. Tao) studies cloud microphysics and dynamics, aerosol-cloud-precipitation interactions, as well as their implications in global climate. Research has involved the set of large-scale force-driven GCE model to simulate the November event of the DYNAMO field campaign. This is part of a modeling inter-comparison in collaboration with Mathew Janga (Univ. of Miami) and Shuguang Wang (Columbia Univ.). Three sets of radar data (TRMM Precipitation Radar, ground-based S-POL, and ship-borne (C-band) Radar) are used to compare and validate the GCE simulations. Li found that the model simulated excessive cloud ice at the upper troposphere. By reducing ice nucleation concentrations in the Goddard microphysics scheme, results improved significantly. A related manuscript is underway.

Additionally, a coupled atmosphere-ocean-wave model (COWAWSTM model) was used to simulate both October and November MJO events during the DYNAMO field campaign. TRMM 3B42, REMSS-SWOT, and NCEP reanalysis data were used to drive the COWAWSTM model. Li also worked on validating early measurements and estimates of GPM DPR. With the launch of the GPM satellite, the Dual-frequency Precipitation Radar (DPR) onboard provides measurements of three-dimensional storm structures within 65 degrees in latitude. To evaluate the performance of the DPR attenuation correction procedures and estimates of rainfall rate, the attenuation-corrected radar reflectivity factors and surface rain rate estimates are compared with the results of ground-based radar, although there are 1-2 dB biases in radar reflectivity along the vertical direction, which might result from an offset of ground radars calibration. Using an effective snow scattering model, Dr. Liao performed a study of the dual-wavelength technique that employs the differential frequency ratio (DFR) of the Ku- and Ka-band radar reflectivities and the Ku-band reflectivity is carried out for snow estimates. An analysis of the retrieval uncertainties associated with the PSD model and the particle scattering model, such as the assort ratio of ellipsoidal particles and effective particle mass density, was performed in order to improve snow retrieval accuracy with proper model settings. To aid in the development of the Ku- and Ka-band dual-wavelength radar technique and to further evaluate its performance, measurements of the snow size distribution and fall velocity acquired from the Precipitation Image Probe (PPI) and the two-dimensional Video Disdrometer (2DVD) are used in this study.

In this first task, Dr. Jiaojong (Roger) Shi (sponsor: W.-K. Tao) studies physical and dynamical processes related to convection-regional scale precipitation systems. He has been working on developing the new wet-deposition and rainout process in the new aerosol-radiation-microphysics coupling code in the NASA Unified Weather Research and Forecasting (NU-WRF) Model. Under the current coding effort, a new aerosol wet deposition scheme has been developed and added into the Goddard cloud microphysics scheme, which includes below-cloud wash out and in-cloud scavenging through condensation-nucleus activation. For the wash-out process, when the precipitation particles are falling down through the atmosphere, they will collide with aerosol particles, collect some of them, and eventually bring the aerosol particles to the ground if the precipitation particles reach the ground. For in-cloud scavenging, each aerosol concentration is reduced when cloud condensation and ice nucleation occur, but partially regain the loss when evaporation and sublimation occur inside the cloud. The effort also includes adding aerosol cloud into the new Goddard 4-ice cloud microphysics scheme in the NU-WRF. The new deposition is being tested using the Hurricane Nadine (2012) case.

Hurricare Sandy was the most destructive hurricane of the 2012 hurricane season, wreaking havoc along the entire eastern Atlantic- tic Seaboard from Florida to Maine. It is also the second most costly hurricane in U.S. history, with damages estimated at over $68 billion. Most of the destruction and damages occurred along the northern New Jersey shore and in the New York City area, where Sandy caused landfall. As reported in forecast bulletins, Sandy arose from the alignment of favorable meteorological conditions in the tropics and extratropics, leading to its unusual track and evolution compared to more typical Atlantic hurricanes. The oft-asked question is: Does the occurrence of Hurricane Sandy have anything to do with global warming? What would happen to Hurricane Sandy, if the same initial atmospheric conditions were to repeat themselves under sea surface temperature forcing in a global warming world? Two sets of 10-day integrations of the NCEP-WRF model, starting from initial atmospheric conditions from 00Z October 22, 2012, with 6-hourly increments, through 00Z October 23, 2012 were carried out. In the first, referred to as present day SST (PSST), the atmosphere is forced by prescribed October 2012 mean SST. The second is forced by a future SST (FSST) derived by superimposing on PSST a projected mean October SST anomaly pattern under global warming. As expected, PSST is much warmer than PSST. The maximum warming (>2°C) is found in the tropics, the Caribbean Sea, the Gulf of Mexico and regions along the southern and southeastern Atlantic Seaboard. The FSST warming extends northward in the form of a warm tongue emanating from the tropics toward the extratropics, away from the Atlantic coast.

Under PSST, the storm track of Hurricane Sandy for each of the five simulations mimics observations reasonably well throughout the hurricane season, yet differing in the speed and strength of propagation, followed by a slight northeasterly recurvature, and finally a sharp northwest turn of the storm towards the New Jersey coast. Under FSST, the initial northeastward path of the storm is simi- lar to that of PSST up to the first 5 days, beyond which the tracks bifurcate into two groups. Two tracks show a northwest turn, while three tracks show a continuous northeast recurvature.

Dr. Xiaowen Li (sponsor: W.-K. Tao) studies cloud microphysics and dynamics, aerosol-cloud-precipitation interactions, as well as their implications in global climate. Research has involved the set of large-scale force-driven GCE model to simulate the November event of the DYNAMO field campaign. This is part of a modeling inter-comparison in collaboration with Mathew Janga (Univ. of Miami) and Shuguang Wang (Columbia Univ.). Three sets of radar data (TRMM Precipitation Radar, ground-based S-POL, and ship-borne (C-band) Radar) are used to compare and validate the GCE simulations. Li found that the model simulated excessive cloud ice at the upper troposphere. By reducing ice nucleation concentrations in the Goddard microphysics scheme, results improved significantly. A related manuscript is underway.

Additionally, a coupled atmosphere-ocean-wave model (COWAWSTM model) was used to simulate both October and November MJO events during the DYNAMO field campaign. TRMM 3B42, REMSS-SWOT, and NCEP reanalysis data were used to drive the COWAWSTM model. Li also worked on validating early measurements and estimates of GPM DPR. With the launch of the GPM satellite, the Dual-frequency Precipitation Radar (DPR) onboard provides measurements of three-dimensional storm structures within 65 degrees in latitude. To evaluate the performance of the DPR attenuation correction procedures and estimates of rainfall rate, the attenuation-corrected radar reflectivity factors and surface rain rate estimates are well correlated with the results of ground-based radar, although there are 1-2 dB biases in radar reflectivity along the vertical direction, which might result from an offset of ground radar calibration. Using an effective snow scattering model, Dr. Liao performed a study of the dual-wavelength technique that employs the differential frequency ratio (DFR) of the Ku- and Ka-band radar reflectivities and the Ku-band reflectivity is carried out for snow estimates. An analysis of the retrieval uncertainties associated with the PSD model and the particle scattering model, such as the assort ratio of ellipsoidal particles and effective particle mass density, was performed in order to improve snow retrieval accuracy with proper model settings. To aid in the development of the Ku- and Ka-band dual-wavelength radar technique and to further evaluate its performance, measurements of the snow size distribution and fall velocity acquired from the Precipitation Image Probe (PPI) and the two-dimensional Video Disdrometer (2DVD) are used in this study.

In this first task, Dr. Jiaojong (Roger) Shi (sponsor: W.-K. Tao) studies physical and dynamical processes related to convection-regional scale precipitation systems. He has been working on developing the new wet-deposition and rainout process in the new aerosol-radiation-microphysics coupling code in the NASA Unified Weather Research and Forecasting (NU-WRF) Model. Under the current coding effort, a new aerosol wet deposition scheme has been developed and added into the Goddard cloud microphysics scheme, which includes below-cloud wash out and in-cloud scavenging through condensation-nucleus activation. For the wash-out process, when the precipitation particles are falling down through the atmosphere, they will collide with aerosol particles, collect some of them, and eventually bring the aerosol particles to the ground if the precipitation particles reach the ground. For in-cloud scavenging, each aerosol concentration is reduced when cloud condensation and ice nucleation occur, but partially regain the loss when evaporation and sublimation occur inside the cloud. The effort also includes adding aerosol cloud into the new Goddard 4-ice cloud microphysics scheme in the NU-WRF. The new deposition is being tested using the Hurricane Nadine (2012) case.

Hurricare Sandy was the most destructive hurricane of the 2012 hurricane season, wreaking havoc along the entire eastern Atlantic- tic Seaboard from Florida to Maine. It is also the second most costly hurricane in U.S. history, with damages estimated at over $68 billion. Most of the destruction and damages occurred along the northern New Jersey shore and in the New York City area, where Sandy caused landfall. As reported in forecast bulletins, Sandy arose from the alignment of favorable meteorological conditions in the tropics and extratropics, leading to its unusual track and evolution compared to more typical Atlantic hurricanes. The oft-asked question is: Does the occurrence of Hurricane Sandy have anything to do with global warming? What would happen to Hurricane Sandy, if the same initial atmospheric conditions were to repeat themselves under sea surface temperature forcing in a global warming world? Two sets of 10-day integrations of the NCEP-WRF model, starting from initial atmospheric conditions from 00Z October 22, 2012, with 6-hourly increments, through 00Z October 23, 2012 were carried out. In the first, referred to as present day SST (PSST), the atmosphere is forced by prescribed October 2012 mean SST. The second is forced by a future SST (FSST) derived by superimposing on PSST a projected mean October SST anomaly pattern under global warming. As expected, PSST is much warmer than PSST. The maximum warming (>2°C) is found in the tropics, the Caribbean Sea, the Gulf of Mexico and regions along the southern and southeastern Atlantic Seaboard. The FSST warming extends northward in the form of a warm tongue emanating from the tropics toward the extratropics, away from the Atlantic coast.

Under PSST, the storm track of Hurricane Sandy for each of the five simulations mimics observations reasonably well throughout the hurricane season, yet differing in the speed and strength of propagation, followed by a slight northeasterly recurvature, and finally a sharp northwest turn of the storm towards the New Jersey coast. Under FSST, the initial northeastward path of the storm is similar to that of PSST up to the first 5 days, beyond which the tracks bifurcate into two groups. Two tracks show a northwest turn, while three tracks show a continuous northeast recurvature.
and only a weak northwest turn beyond day 7-8, when the storm is already far out in the open ocean. This result was presented in the 2014 AGU Fall Meeting in San Francisco, CA, as well as a publication in Journal of Geophysical Research - Atmospheres. She attended the CloudSat and CALIPSO Science Team Meeting in Washington, DC and obtained scientific and programmatic information related to her research. Future work will involve efforts toward testing and evaluating the improvement of cloud regimes.

Dr. Richard Damoah (sponsor: C. Ichoku) supports NASA's Interdisciplinary Research in Earth Science through the amplified study of the vee Storms in the Marine Boundary Layer. Also, he is working on various aspects of cloud regimes and water cycle dynamics across the Northern sub-Saharan African region (NSSA). Led by Dr. Ichoku, this effort aims to provide a robust analysis of the impacts of recent biomass-burning events over the NSSA. He successfully completed four separate two-year NASA GMI Model simulations to investigate NSSA biomass burning as part of the DDS project. He has constructed an analysis system for the DDS project, available at https://ocean.weather.gov/products/MM5/.

Dr. Ganeshan recently investigated the important relationship between surface sensible heat flux and the mixed layer height over the open Arctic Ocean during cruise ship observations collected from the Japanese research vessel “MIRAI.” The results serve as crucial evidence of ground truth for the changing Arctic atmosphere in response to sea-ice retreat. She is eager to publish this work in the journal Atmospheric Chemistry and Physics, where it has already been reviewed once.

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Dr. Ganeshan seeks to investigate cold air outbreak (CAO) events that occur over the marginal sea-ice zone of the Arctic Ocean using COSMIC RO observations. The marginal sea-ice zone is considered important for the study of dynamic cloud processes and their effect on the Arctic. Currently she is exploring the sensitivity of RO penetration to atmospheric moisture, and the ability to detect dry (moist) advection associated with cold (warm) outbreaks in the Arctic.

Dr. Ganeshan has published a manuscript, currently being revised for possible publication in the Journal of Geophysical Research - Atmospheres, describes an algorithm based on radiosonde data from the SHEBA radiative forcing by wildfire aerosols derived using multi-angular/spectral airborne measurements and 3D radiative transfer modeling. This effort involves data analysis and modeling of airborne campaign data from the following NASA-supported experiments: Arctic Research of the Composition of the Troposphere from Arctic Research of the Composition of the Troposphere from...
 Aircraft and Satellite (ARCTAS), the Southern African Regional Science Initiative-2000 (SAFARI-2000), and the Smoke, Clouds, and Radiation-Brazil (SCAR-B). These campaigns were conducted in regions that are considered the world’s largest sources of biomass burning emissions that influence the warming climate. This investigation is expected to lead to new angular distribution models (ADMs) for biomass burning smoke for estimation of shortwave direct radiative forcing of biomass-burning aerosols.

Dr. Gatebe used MODIS white-sky albedo data to quantify changes in the albedo after vegetation fires in Africa and to investigate how the resulting surface brightening/darkening phenomena affects radiative forcing, the surface and atmospheric heating rates, moisture regime and rainfall, and their implications for the regional climate. Part of an IDP project, this project, an amplified study of the interactions and feedbacks between biomass burn- ing and water cycles in the Southern African region, is led by Dr. Charles Ichoku (Code 613).

The purpose of the proposed work “GEOCAPE Oceans SWAG” is to undertake a systematic study of the bidirectional dependence of the water-leaving radiance in turbid coastal/inland waters. Conducting BRDF (bidirectional reflectance distribution function) studies leading to BRDF correction of the ocean water-leaving radiances or spectral remote sensing reflectances at relevant solar angles is a high priority for GeoCAPE Ocean Science Studies for FY15. The GEOCAPE Aerosols SWG effort includes producing BRDF products from the CAR DISCOVER-AQ 2014 mission in Colorado and providing support to the GEOCAPE Aerosol SWG in evaluating satellite aerosol products. BRDF data products will be submitted to the DISCOVER-AQ archive.

Airplane CHASERS (C. K. Godson, J. A. Hoft, V. Ramanathan, R. R. Shukla, D. J. Seliga, and K. A. Emery) works on developing retrieval techniques and delivery of retrieval products such as cloud ice water path, cloud top height, ice particle size) of AMSU/B on board NOAA satellite series. She also compares radiative diagnostics to evaluate retrieval performances and uncertainties. Research findings from this past year resulted in several lead author publications in J. Geophyys., Res., Atmos. Chem., Phys., and Atmos. Meas. Tech. The study derives new trajectories of coal-fire aerosol plumes in the Southern African region. The results include ongoing participation in projects to study the interactions and feedbacks between biomass burn- ing and moisture regime and rainfall, and their implications for the regional climate. Part of an IDP project, this project, an amplified study of the interactions and feedbacks between biomass burn- ing and water cycles in the Southern African region, is led by Dr. Charles Ichoku (Code 613).

Future work includes preparing a NASA ROSES proposal to help in “linking together” various EO data sets. Dr. Gatebe will develop this proposal in collaboration with J. P. Muller (University College London) and other calibration teams at NASA Goddard. He also plans to focus on the analysis of MODIS airborne data from the Arctic Research of the Composition of the Troposphere from Aircraft and Satellite (ARCTAS) and Clouds and the Earth’s Radiant Energy System (CERES) data over Canada.

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Dr. Gatebe and colleagues are continuing to reduce the cost and risk for the BACAR instrument in order to establish a pathway for future funding from the Instrument Incubator Program (IIP) and Earth Venture class missions. This instrument is needed to advance the knowledge of clouds, aerosols, ecosystem structure and function, snow & ice, albedo, and climate feedbacks. BACAR will provide critical and much needed ground truth measurements to support many upcoming missions such as the Decadal survey (PACE). Dr. Gatebe used MODIS white-sky albedo data to quantify changes in the albedo after vegetation fires in Africa and to investigate how the resulting surface brightening/darkening phenomena affects radiative forcing, the surface and atmospheric heating rates, moisture regime and rainfall, and their implications for the regional climate. Part of an IDP project, this project, an amplified study of the interactions and feedbacks between biomass burning and water cycles in the Southern African region, is led by Dr. Charles Ichoku (Code 613).

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Dr. Jeong (sponsoring: D. Wu) works on developing retrieval techniques and delivery of retrieval products such as cloud ice water path, cloud top height, ice particle size) of AMSU/B on board NOAA satellite series. She also compares radiative diagnostics to evaluate retrieval performances and uncertainties. Research findings from this past year resulted in several lead author publications in J. Geophyys., Res., Atmos. Chem., Phys., and Atmos. Meas. Tech. She also participated in four proposals which have been submitted to the DISCOVER-AQ archive.

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Dr. Falguni Patadia

Dr. Falguni Patadia (sponsor: R. Levy) evaluates the MODIS aerosol optical depth product to quantify the uncertainty in the product and identify sources of error. This past year, she and her colleagues considered six sources of errors in their retrievals: calibration uncertainty, atmospheric correction error, aerosol properties, spatial variability in reflectance within retrieval region, surface reflectance, and cloud contamination. Surface reflectance and cloud contamination errors were incorporated into the retrieval algorithm this year. In examining surface reflectance error, Dr. Patadia found that for MODIS-DT retrievals over ocean, the surface reflectance is tied with winds that drive white caps and foam over the ocean; however, the error in ocean surface reflectance has now been propagated into AOD depth retrievals and results are analyzed for various global oceanic regions, i.e., clear ocean, dust over ocean, smoke over ocean. For global oceans and for several test granules, uncertainty from various sources has been compared to analyze their relative importance / impact on AOD. Total uncertainty, from the six error sources mentioned above, has been calculated for global oceanic regions for four different seasons (winter, summer, spring, fall). The uncertainty estimates were carried out by comparing against AOD retrievals from ground-based AERONET sun photometer measurements. The validation of uncertainty estimates was closely examined for parsing out effects of cloud contamination. A method for estimating biases in AOD due to cloud contamination within the retrieval was also proposed. The uncertainty estimates were used to support Sandia’s MODIS-DT aerosol retrieval. A cloud-free regions, as clouds obscure the aerosols beneath them. In most cases, spaceborne aerosol data sets are confined to cloud-free regions, as clouds obscure the aerosols beneath them. In many cases, Dr. Sayer also was involved with additional poster presentations made at these events. These meetings offered numerous valuable opportunities for Dr. Sayer to present the work that he and others have performed to international experts. This feature can be seen on NASA GSFC’s YouTube channel: http://youtu.be/KCM1EXMKjz0

Future efforts will involve Dr. Sayer working on methods to determine aerosol loading above clouds, for cases of absorbing aerosols. In most cases, spaceborne aerosol data sets are confined to cloud-free regions, as clouds obscure the aerosols beneath them. Due to the limited capabilities of current satellite sensors, this task is difficult but also very important since aerosols above clouds are a regular feature of the aerosol system in many regions (e.g., smoke above clouds in central/southern Africa or south-eastern Asia).

Aerosol-cloud interaction is one of the major sources of uncertainties in accurately estimating the radiative budget. From the aspect of aerosols, near-cloud aerosol property may be different when compared to aerosol far from cloud due to the interac-

Dr. M. Chin, GSFC) that used multiple satellite data sets and model simulations to determine aerosol loading (e.g., from mineral dust, sea spray, wildfire smoke globally). Over the past year this has had two main bores. The first is a continued analysis of and user outreach related to the new ‘Collection 6‘ MODIS data product suite, released in early 2014. As well as one further peer-reviewed journal paper in the Journal of Geophysical Research: evaluating this data set over the past year, Dr. Sayer gave numerous presentations about the Deep Blue project and presented two webinars (available online at http://modis.gsfc.nasa.gov/products_C6/modis6 introduce users with the new Collection 6 products. The second has been the application of the Deep Blue algorithm to the VIIRS sensor: a project successfully funded by NASA GES DIS in the previous years’ AEROCENTER Annual Meeting. He has been collaborating on a study (currently in review) led by Dr. Y. Liu (Emory University) on the application of MODIS aerosol data for monitoring ground-level air pollutants in China. Finally, Dr. Sayer was involved in a study (led by Dr. C. F. Herb) that updates to works worldwide relating to the SeaWiFS and MODIS aerosol data products which he has been involved with.

Dr. Sayer has continued to collaborate with other scientists nationally and internationally. He was a co-author on a study (led by Dr. M. Din, GFSC) that uses new models to estimate output to attempt and quantify and global and regional trends in aerosol loading. He was also co-author on a review paper summarizing the current status and challenges of satellite aerosol-cloud interactions in Southeast Asia, and on a BAMMS Meeting Summary of the previous year’s AEROCENTER Annual Update. He has been investigating the effect of aerosol backscatter enhancement near the clouds can be reduced by one-third to two-thirds. In addition, because of different cloud features over land and ocean, they have found that the composite statistics features of near-cloud aerosol behavior over land and ocean might be different. Further investigation is ongoing. Dr. Yang would like, according to the results of this investigation in Geophysical Research Letters, and others also have mentioned new variations in near-cloud aerosol backscatter enhancement near the clouds can be reduced by one-third to two-thirds. In addition, because of different cloud features over land and ocean, they have found that these composite statistics features of near-cloud aerosol behavior over land and ocean might be different. Further investigation is ongoing. Dr. Yang would like, according to the results of this investigation in Geophysical Research Letters, and others also have mentioned new variations in near-cloud aerosol backscatter enhancement near the clouds can be reduced by one-third to two-thirds. In addition, because of different cloud features over land and ocean, they have found that these composite statistics features of near-cloud aerosol behavior over land and ocean might be different. Further investigation is ongoing. Dr. Yang would like, according to the results of this investigation in Geophysical Research Letters, and others also have mentioned new variations in near-cloud aerosol backscatter enhancement near the clouds can be reduced by one-third to two-thirds. In addition, because of different cloud features over land and ocean, they have found that these composite statistics features of near-cloud aerosol behavior over land and ocean might be different. Further investigation is ongoing. Dr. Yang would like, according to the results of this investigation in Geophysical Research Letters, and others also have mentioned new variations in near-cloud aerosol backscatter enhancement near the clouds can be reduced by one-third to two-thirds. In addition, because of different cloud features over land and ocean, they have found that these composite statistics features of near-cloud aerosol behavior over land and ocean might be different. Further investigation is ongoing. Dr. Yang would like, according to the results of this investigation in Geophysical Research Letters, and others also have mentioned new variations in near-cloud aerosol backscatter enhancement near the clouds can be reduced by one-third to two-thirds. In addition, because of different cloud features over land and ocean, they have found that these composite statistics features of near-cloud aerosol behavior over land and ocean might be different. Further investigation is ongoing. Dr. Yang would like, according to the results of this investigation in Geophysical Research Letters, and others also have mentioned new variations in near-cloud aerosol backscatter enhancement near the clouds can be reduced by one-third to two-thirds. In addition, because of different cloud features over land and ocean, they have found that these composite statistics features of near-cloud aerosol behavior over land and ocean might be different. Further investigation is ongoing. Dr. Yang would like, according to the results of this investigation in Geophysical Research Letters, and others also have mentioned new variations in near-cloud aerosol backscatter enhancement near the clouds can be reduced by one-third to two-thirds. In addition, because of different cloud features over land and ocean, they have found that these composite statistics features of near-cloud aerosol behavior over land and ocean might be different.
under this task, Dr. Yuekai Yang (sponsor: A. Marshak) conducted comprehensive radiative transfer studies on cloud properties at the near backscattering directions. With the Discrete Ordinate Ra-
diative Transfer model (DOIART), Dr. Yang simulated the behavior of top-of-atmosphere cloud reflectance for different solar and view angles and for different cloud properties. The simulations were done for multi-wavelengths, including the UV channel at 388 nm and the visible channels at 443 nm, 680 nm and 780 nm. Insight on this topic will be very helpful in understanding the cloud obser-
vations made by the Deep Space Climate Observatory (DSCOVR).
Cloud properties at the near-backscattering directions were also studied using the MODIS data. These studies are relevant for the DSCOVR mission, because DSCOVR will be located at the Earth’s L1 point and make observations of the Earth at a near-back-
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Dr. Valentina Aquila (sponsor: P. Colarco) develops stratospheric aerosol and chemistry modules in the NASA GEOS CCM model-
ning system, as well as conducts and analyzes experiments made with this system to investigate the various roles of stratospheric aerosols and chemistry in Earth’s climate system. Dr. Aquila started a new collaboration with Drs. P. K. Bhartia, R. Loughner, and J. H. L. glasses to integrate this code and model calculated aerosol phase functions in order to improve
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CODE 014: ATMOSPHERIC CHEMISTRY AND DYNAMICS LABORATORY

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through combining the EPIC A- and B-band measurements.
Using past and present satellite observations in the UV through near IR, Dr. Gassó intended to develop a stand-alone aerosol retrieval system that could be used by the GOSAT science team in India. In June 2014, as a GOSAT science team member, Dr. Gassó presented the 6th Annual GOSAT Science Team Retreat in Tsukuba, Japan. He gave a presentation introducing the project he will be working on: initial results of the Evaluation of the Ozone Monitoring Instrument (OMI) Near-UV Aerosol Retrievals with the Cloud and Aerosol Imager 380nm band.

Under this second task, Dr. Santiago Gassó (sponsor: O. Torres) derives the spectral slope of aerosol absorption characteristics from OMI/Aura aerosol retrievals by using a combination of size distribution and ground-based remote sensing. The GOSAT science team has already made major dust storm observations, performing evaluations of OMI/OMAERUV aerosol products, and conducting work under the GEO-CAPE Task that involves validating the algorithm of the AOT retrieved from the MODIS/MISR AERONET data. Also, there were discussions on a potential collaboration between NASA and Google in the area of training. Most recently, in Janu- ary 2015, Dr. Gupta gave an invited talk (provided remotely) on “Applications of satellite remote sensing for air quality monitoring” at the National Forum on Air Quality: Transport, Health and Sustainability, held at the Indian Institute Technology in Bombay, India. The goal of this two-day-long forum was to develop a plan on synchronizing and synergizing efforts for Air Quality Manage- ment in India. Participants included the Central Pollution Control Board, the Maharashtra Pollution Control Board, the Indian Space Research Organization (ISRO), the Indian Institute of Tropical Me- teorology and many other national institutes involved in various aspects of air quality research. As part of the ARSET program, Dr. Gupta provided a short training for participants on NASA satellite data and tools available for air quality monitoring.

Also this past year, Dr. Gupta co-authored an article published in Atmospheric Environment that was prepared by the NASA Applied Science Team for the satellite data users in air quality application. He contributed to the development of a training material, which is available for remote sensing trainings for the NASA Atmospheric Environment Service by the NASA Applied Science Team.

Gupta was in Atlanta for the NASA-AGU Astronaut Retreat in 2015, and he gave a presentation on “GEO-CAPE: The GEDI Satellite for Aerosol and Trace Gas Monitoring” and discussed future collaboration between programs and the NASA Center. He attended a one-day workshop at Google’s office on Google’s Geo-Cloud tools to analyze and visualize satellite data (as well as additional- ly), there were discussions on a potential collaboration between NASA and Google in the area of training. Most recently, in January 2015, Dr. Gupta gave an invited talk (provided remotely) on “Applications of satellite remote sensing for air quality monitoring” at the National Forum on Air Quality: Transport, Health and Sustainability, held at the Indian Institute Technology in Bombay, India. The goal of this two-day-long forum was to develop a plan on synchronizing and synergizing efforts for Air Quality Manage- ment in India. Participants included the Central Pollution Control Board, the Maharashtra Pollution Control Board, the Indian Space Research Organization (ISRO), the Indian Institute of Tropical Me- teorology and many other national institutes involved in various aspects of air quality research. As part of the ARSET program, Dr. Gupta provided a short training for participants on NASA satellite data and tools available for air quality monitoring.
OMI's capability of retrieving aerosol optical thickness above cloud has been a major highlight and achievement of a decade-long Aura/OMI mission. Dr. Jethva has been placed in a lead role to develop, test, and deliver the global research product of aerosols above cloud. First, Dr. Jethva conducted an analysis of the global frequency of the occurrence of aerosols above clouds. He also planned to conduct an analysis of the global trend of aerosols above cloud. In parallel, he developed a stand-alone version of the algorithm which was largely based on his earlier research published in Torres et al. (2012). A successful retrieval of the above-cloud AOT required appropriate ancillary data sets. After testing several approaches for representing aerosol micro-physical and optical properties of aerosols, he derived optimum settings of these parameters which include the global representation of single-scattering albedo and aerosol layer heights. The algorithm was applied to the OMI observations for one full year (2007), and results were analyzed and found to be satisfactory. An operational code, which has been developed by a team member, Dr. Changwoo Ahn (SSAI), will be modified in accordance with the results and suggestions presented at the meeting.

Dr. Jethva also conducts performance evaluations of OMI/OMAERUV aerosol products via validation, data analysis, and up keeping of the OMI/OMAERUV aerosol algorithm. He conducted an in-depth analysis of the different research version of the OMAERUV algorithms and suggested some important changes for improvements. On the basis of his findings, a latest research version (V1.5.3) was created and tested for its accuracy using the ground-based AERONET aerosol database. He also created the global monthly mean maps of aerosol parameters which were compared and contrasted against previous versions of the algorithm. All the newly processed OMI data were also compared and contrasted against previous versions of the algorithm. He presented this work in the bi-weekly OMI science team meeting held at SEDSA facility.

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Dr. Jethva developed the "color ratio" technique and applied it to the satellite measurements made by OMI and MODIS; this has been provided the unprecedented maps of above-cloud aerosol optical depth. While the quantitative information on aerosol loading above cloud is now available from A-train sensors, a greater challenge lies in the development of a technique to compare and contrast two independent retrievals at wavelengths other than the actual domain of their retrievals, which required extrapolation of OMI aerosol retrievals to the visible wavelengths. He carried out the comparative analysis for many important AERONET sites that span across major biomass burning and regions of the world. The basis of this analysis, Dr. Jethva designed a proposed and improved wavelength conversion scheme for the carbonaceous aerosols that converts the actual near-visible retrieval to the one at the visible wavelengths. The proposed scheme was tested over the major biomass burning regions of the world and is now ready for the use in the OMAERUV operational environment. Further, Dr. Jethva analyzed global OMAERUV aerosol data to study their dependency on viewing geometry. Specifically, the aim of this exercise was to compare the monthly mean values of aerosol parameters derived from the observations collected over the left and right side of the OMI swath.

During the past year, Dr. Jethva received a software package from Oleg Dubovik (Univ. of Lille, France) that simulates the phase function of as well as the spherical shape particles. The need for this software arose when Dr. Jethva realized that treating coarse mode dust particles as spheres can cause significant differences in the aerosol retrievals at certain geometries, which is an indication of inefficiency in handling the directional aerosol properties accurately. Following successful testing of this software package, he carried out the calculation of phase function of the standard OMI/OMAERUV dust and carbonaceous aerosol models. Results obtained from this software will be used in conjunction with the ARIZONA radiative transfer code to simulate the radiance fields for the dust models.

The goal of the MeaSUREs task is to create a long-term global record of aerosols from multiple UV sensors flown on board different platforms (i.e., Nimbus 7/TOMS, EP-TOMS, and Aura/OMI). As part of this goal, Dr. Jethva created the multi-wavelength cloud look-up-tables for the calculation of the UV Aerosol Index under cloudy situations.

Since 2013, Dr. Jethva has been an integral part of the GEO-CAPE Aerosol Working Group. He conducted the validation analyses of the MODIS/MACAU AOT retrieval using ground based AERONET direct measurements for many sites located over the North America region. The results of the comparison, when independent retrievals were co-located with the AERONET measurements in space and time for all sites over the region. Several space and time windows were considered to analyze the impact of co-location scheme on the validation results. The results showed the differences between MACAU and AERONET AODs in terms of the range of the year and seasons. He presented the results of both studies in the regular monthly GEO-CAPE aerosol working group meeting.

Throughout this past year, Dr. Jethva gave several presentations and talks: he presented a first-author poster titled “Retrieval, Inter-comparison, and Validation of Above-cloud Aerosol Optical Depth from A-train Sensors” at the 13th Workshop on AEROCOM held in Steamboat Springs, CO, and also presented this poster at the AEROCENTER poster bash. He presented a branch lunch seminar titled “Characterization of aerosols above cloud from Passive Sensors” at the Atmospheric Chemistry & Dynamics Laboratory on November 13th, 2014, wherein he highlighted his work on detection, retrieval, and validation of above-cloud aerosol retrievals from satellite measurements. At the 2014 AGU Fall Meeting held in San Francisco, CA, he presented a talk titled “Validating Above-cloud Aerosol Optical Depth Retrievals” at the poster session “MODIS and AMSR-E/Aqua, Airborne Sun Tracking Photometric and Spectrometric (AATS and 4STAR) Measurements”, prepared a poster, and also assisted his colleague, Changwoo Ahn, on his poster titled “Assessment of 30-Year Global Record of Aerosol Product from the OMI Near-
The UV multi-filter shadow band radiometer (UV-MFRSR) was used in this study. Over this past year, Dr. Jethva also was involved in several collaborations. Dr. Jethva worked on the Sahelian dust in North Africa, Dr. Kim is investigating the long-term relationship between vegetation and dust. The Southern Sahara region north of 10° N to 20° N consists of the Sahara desert, the Sahel, and the Savanna, and the abundant dust from this region has an impact on health, and even the local economy. The goal is to better understand the role of surface condition and atmospheric circulation to dust emission, using a novel Sahel area map determined from the Normalized Difference Vegetation Index (NDVI) from satellite observations and a global aerosol model. Dr. Matthew Kowalewski (sponsor: M. Chin) provides scientific and engineering support to the Radiometric Calibration and Development Laboratory (RCDL) at GSFC. This support includes proof of concept instrument, calibration standards, and technical guidance to the backscatter ultraviolet (BUV) community. Programs supported include GEOStationary Coastal and Air Pollution Events (GEOCAPE), Suomi National Polar-orbiting Partnership (NPP) and Joint Polar Satellite System’s (JPSS) Ozone Mapping Profiler Suite (OMPS). Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ), and North Atlantic Aerosols and Marine Ecosystems (NAAMES). The RCDL develops and maintains prototype instrumentation and components for use in solar backscatter research. Dr. Kowalewski ensures that the lab’s technical activities are in alignment with NASA’s overall mission activities and the lab’s Principal Investigator. The primary focus of RCDL was to successfully test and deploy the GeoCAPE Airborne Simulator (GCAS) instrument as part of the DISCOVER-AQ Earth Venture campaign. Serving as the lab’s systems engineer, he directed a diverse team of mechanical and electrical engineers, technicians and analysts in ensuring the aircraft’s safe and successful completion of tests and reviews for the JPSS OMPS Flight Model 2 (FM2) instrument suite, and participated in data analysis and program requirements for the Flight Model 3 (FMS) OMPS instrument. He directed the test and analysis efforts for evaluating the JPSS OMPS lidar reflectivity in vacuum while coordinating with NASA’s Earth Venture projects. These efforts supported the investigation into the OMPS instrument’s potential failure to meet its wavelength dependent calibration requirement. This past year, he began to support the lab’s involvement in the North Atlantic Aerosols and Marine Ecosystems Study (NAMES) Earth Venture campaign. These preliminary efforts are related to developing concepts to integrate the GCAS instrument onto the NASA Wallops C-130 aircraft and to define science requirements that drive the instrument operations. Dr. Kowalewski led the instrument team’s activities in determining preliminary requirements and starting to design and fabricate the necessary hardware for integration. He attended multiple integration concept meetings at Wallops and worked with the lead mechanical engineers to design the aircraft interface. He continues to develop the electrical, mechanical, and thermal requirements for the GCAS instrument. Dr. Kowalewski completed a short-term research project for Code 460 to determine the relative optical reflectivity of multiple sample materials used for their flight projects. A report comparing relative reflectivity of multiple coating types over a small range of viewing geometries was submitted. Also, he published two papers, as first and secondary author, respectively, “Comparison of spectral radiance responsibility calibration techniques used for backscatter ultraviolet satellite instruments” in Metrologia and “Characterization and Calibration of ACAM Data for Trace Gas Retrievals during the 2011 DISCOVER-AQ Flight Campaign” in Atmospheric Measurement Techniques. Mr. Tom Kucsera (sponsor: M. Chin) supports global and regional modeling and analysis of aerosol properties and trace gases and supports NASA-sponsored observational programs. Among other responsibilities, he compiles observations from satellite, ground-based, and in-situ measurements for model input, evaluation, and improvement; executes and evaluates atmospheric modeling codes; and performs software and hardware management, as well as computer administration duties. Over this past year, Mr. Kucsera generated re-gridded HTAP version-2 emissions and regional maps. The emission data products and regionally specified maps from the HTAP program’s repository were retrieved, and the products were re-gridded to 1.25° x 1.25°deg, resolutions for use in the GOCART model. These data sets consisted of multiple global emission sectors that were used within the GOCART model. QFED fire emission products were stored and made accessible on local linux clustered workstations. These satellite-derived fire emission products consist of daily emission products; the available time period covered by this data is from the year 2000 up until the middle of March 2015, inclusively. Mr. Kucsera also was involved in theAura Project Analysis. Test cases for evaluating pyroconus events, such as the Milford Flat fires in Utah that occurred in July 2007, were made. The ability to estimate the injection height of combustion-released aerosol and gaseous products is underway. Going forward, he plans to generate trajectory analyses for numerous pyroconus cases, as well as assist in determining and providing model volcano injection heights. A series of several GOCART modeling simulations were made consisting of unique and specifically crafted scenarios for the HTAP inter-comparison modeling program. Each scenario consisted of 3 years of model simulations with the 2.5x2.5 deg. GOCART model. Multiple combinations of model-specified requirements and simulations were made on the NCCS supercomputers. Results from the offline GOCART simulations were compiled into CMOR compatible formats and then submitted to the HTAP archive. The resulting scenarios are being used in the HTAP inter-comparison project. Also, the GEOS-5 global simulations model (Ganymed_4.0_BETA8 version) was acquired, compiled, and successfully run on the NCCS supercomputer. These baseline emissions and meteorological inputs were used in generating this scenario. As part of his computer administration duties, several new laptops were acquired and the mandatory NASA IT-required controls were installed along with standard software products. The Lab’s printer pool was added to the printer zone, along with other group accessible printers and these required administrative changes on all group member machines. Windows 7 computers were made PIV-managed. Telecommuting by Multiple Access to Daycare (MADAC) Software is being used. The GOCART model output goes to group computers and workstations were completed as necessary. Mr. Kucsera managed and maintained group-owned Windows, Mac, and Linux workstations.

Dr. Michael Kurylo (sponsor: J. Rodriguez) provides support for a variety of national and international activities important to NASA’s Atmospheric Composition Focus Area in Earth Science. This past year, Dr. Kurylo continued to serve as an Emeritus Member of the international Steering Committee (SC) for NDACC and is responsible for maintaining and updating the NDACC Measurements and Analyses (M&A) Directory based on presentations and discussions at the annual SC Meeting and additional inputs from NDACC scientists. As part of this responsibility, he worked with representatives from the eight NDACC Cooperating Networks to revise and update their network documentation for inclusion in the latest version of the M&A Directory. He assisted the SC Co-
Chair in finalizing the agenda for the November 2014 meeting of the committee, which he attended, and in representing NDACC activities in the Network for Remote Sensing (NORS) / NDACC of the Atmospheric Sciences Section of AGU related to what occurred as an adjunct activity to the SC Meeting. This workshop explored how the quality and validation of the products delivered by the Copernicus Atmospheric Monitoring Service (CAMS) could be improved using independent ground-based remote sensing data from the NDACC. Following the SC Meeting, Dr. Kurylo assisted in the development of an Appendix to the NDACC Validation Protocol specific to the certification of frost point (water vapor) sondes, which were recently included as an NDACC measurement capability.

On a related topic, he is working with the water vapor sonde representatives on the NDACC Sonde Working Group to develop a long-term strategy for water vapor measurements within the network. Further, he assisted the NDACC Co-Chairs in preparing a presentation on NDACC evolution for the 9th Meeting of Ozone Research Managers of the Parties to the Vienna Convention (9th ORM). Finally, he drafted two brief articles for the NDACC Newsletter covering (1) the recommendations from the 9th ORM pertinent to NDACC goals and objectives and (2) actions and presentations from the 2014 NDACC SC Meeting.

Dr. Kurylo also continued to serve as an atmospheric observations liaison for the SPARC project of the WCRP for the GRUAN. In this capacity, he contributes to the coordination of common organizational and implementation aspects among various international monitoring activities. He also contributed in the drafting of GRUAN Report No. 3 on GRUAN Expansion Priorities, presented an NDACC measurement capability status report at the 21st session of the International Cryosphere Conference (as a co-author of Chapter 3, “Evaluation of Atmospheric Loss Processes” in SPARC Report No. 6, “Lifetimes of Stratospheric Ozone-Depleting Substances, Their Replacements, and Related Species”) and other presentations.

Dr. Kurylo continued to collaborate with NIST scientists in laboratory studies to determine the atmospheric lifetime, including the change in the amplitude of the seasonal 2 trends from 2005–2013 over the U.S. Using surface measurements from the U.S. Environmental Protection Agency (EPA) Air Quality System (AQS) and an improved tropospheric NO\textsubscript{2} vertical column density (VCD) data product from the OMI on the Aura satellite. He developed a trend model that accounts for the non-linear dependence of NO\textsubscript{2} concentration on emissions associated with the seasonal variation of the chemical lifetime, including the change in the amplitude of the seasonal cycle associated with the significant change in NO\textsubscript{2} emissions. Using a CTM, he examined the theoretical relationship of the trends estimated from NO\textsubscript{2} VCDs to those estimated from ground-level concentrations. He explored some of the important factors affecting the relationship, including known problems (e.g., NO\textsubscript{2}, interferences) associated with the AQS data. Using the improved trend model and the enhanced OMI data product, Dr. Lamsal found that both OMI and AQS data show substantial downward trends from 2005 to 2013. Dr. Lamsal also contributed to several other studies examining the trends observed in emissions and surface concentrations.

Dr. Lamsal applied a newly developed Goddard spectral fitting algorithm to OMI measurements to retrieve NO\textsubscript{2} from both OMPS-covered UV (351-379 nm) and conventional visible (405-465 nm) windows. He demonstrated that OMPS wavenumber could be used to retrieve NO\textsubscript{2} with decreased sensitivity compared to visible wavenumber. Retrieval sensitivity is dependent on spectral contrast in the NO\textsubscript{2} absorption coefficient and also on the scene reflectance. He adapted the spectral fitting algorithm for OMPS measurements. The primary NO\textsubscript{2} retrievals from OMPS are similar to those from the UV window of OMI. To retrieve NO\textsubscript{2} from the airborne ACAM measurements, he conducted sensitivity studies of air mass factor below and above aircraft to several retrieval parameters, including solar and viewing geometries, height of aircraft, surface reflectivity, aerosols, and NO\textsubscript{2} profile shape. Accurate information on input parameters is critically important for air mass factor below aircraft. This study allows estimation of uncertainties in the retrieval of NO\textsubscript{2} from the ACAM instrument.

Manuscripts on ACAM NO\textsubscript{2} retrievals are in preparation. Additional, a publication relevant to this research was published in 2015 in Atmos. Meas. Tech. titled “Characterization and Validation of the Spectral Channel Ranges in the OMPS-NOMI Sensor”. This research was promoted further in a video for which Dr. Liang was awarded the AGU Operational Support Award.

Dr. Qing Liang (A. Douglass) determines the coupling between chemical composition and the climate system and investigates issues related to the role of ozone in the upper troposphere and lower stratosphere on climate. This year, Dr. Liang published her research in a first-author article in Geophysical Research Letters (GRL) titled “Constraining the Carbon Tetrachloride (C\textsubscript{4}Cl\textsubscript{4}) budget using cloud chamber intercomparisons”. This research garnered much attention and was featured in a NASA & AGU Joint News release titled “Ozone-Depleting Compound Persists”, and she participated in follow-up interviews with USA Today, Science@NASA, Geochemical News, EARTH Magazine (August 2014), as well as BBC Music & Radio (February 2015). This research was promoted further in a series of interviews with Dr. Liang and Dr. Paul Newman (GSFC) were interviewed. They worked in collaboration with Kayvon Sharghi and Joy Ng (both of Code 130) and prepared an interview of approximately 10 minutes of audio and video details at NASA Goddard’s YouTube channel.
Dr. Liang (PI) received funding for her proposal titled “Conective transport of chemical compounds from the free troposphere to the lower troposphere: timescale, efficacy, and climate impact.” She also co-led on two proposals selected for funding: “Characterizing Thawing Permafrost Carbon Emissions: An Integrated Project in Support of Satellite Evaluation/Design and Earth System Modeling Capabilities” (PI: Dr. Emily Wilson, GSFC), and “An examination of the global budget of carbon tetrachloride (C2Cl4) using observations and models, a NASA ACCDAM project. This past year, she was lead author on three articles, one published in Atmos. Chem. Phys., another in Atmospheric Chemistry and Physics (mentioned above), and a third that has been submitted to GRL.

Dr. Liang has been working in collaboration with several scientists on a variety of projects. As a continuation of the FAA ACCD project, Dr. Liang works with Dr. Henry Selkirk (Code 614) in providing additional model runs for the FAA-led multi-model harmonization project to examine the impact of aviation emission on surface ozone. She has finished the proposed two sets of GEOS-5 stratosphere-troposphere chemistry simulation in the REPLAY mode: the first set is with free running H2O, one simulation with aviation NOx emissions and one without aviation NOx, and the second set is the same as the first set but with H2O nudged to MERRA, assimilated H2O. The results from both sets of simulations were assessed to quantify the impact of aviation NOx on tropospheric O3 and OH, and the required model output was submitted to the FAA ATAC project for multi-model harmonization analysis. In addition, Dr. Liang has been working closely with Dr. Henry Selkirk and Dr. Du Hongbing (both participating from various institutions, in analyzing and interpreting the multi-model intercomparison results to quantify and harmonize the impact of aviation emissions on surface ozone and PM2.5 concentrations. The multi-model intercomparison results were published as a FAA report in April 2015.

Dr. Liang (coprincipal investigator) and Dr. Junhua Liu (principal investigator) have proposed a GiViT project titled “High-Resolution Simulation of the Transport and Transformation of Ozone and its Precursors in the Stratosphere and Troposphere using a New Model Framework (GViT-C).” The GEOS-5 CCM BrO abundance to the Harvard GEOS-Chem model simulations in simulating the tropospheric abundance of BrO as well as its impact on tropospheric O3 and OH.

Her work on the ACCDAM Convection Project has included an examination of measurements of CO2, CO, various VOCs (C2H6, C3H8, CH4, CH2O), as well as CHBr3 and CH2Br2 from the NASA SEAC4RS mission to look at the surface-to-UHI (upper troposphere and lower stratosphere) transport timescale and efficiency for air of different source regions (contingent pollution vs. marine biogenic emissions). To evaluate model performance and determine likely reasons of the existing model biases, the aircraft measurements were compared with model output for the same time period and location. In addition, these measurements were compared against measurements obtained along the western Pacific during the ATTREX/CONTRAST missions to examine the regional differences in convective transport. The analyses results were presented at the SEAC4RS science meeting in Pasadena, CA (Apr 30-May 3, 2015).

Dr. Qing Liang (Sponsor: Dr. Wilson) works on a second task, supporting perturbs atmospheric transport which includes fingerprinting carbon source types using suborbital measurements. This project involves a variety of analyses. Dr. Liang has performed an analysis of CH4 and CO2 mixing ratios characteristics as well as column abundance characteristics in various air masses observed during three NASA aircraft missions: ARCTAS-A, ARCTAS-B, and INTEX-A. This measurements-based information was compiled to generate lower tropospheric CH4 versus CO2 concentration signatures for anthropogenic sources in both hemispheres, biomass burning, and ground air. In addition, Dr. Liang has combined the information from the field missions and the CO2 and CH4 abundance information from the ARCTAS-B and INTEX-A mission to generate a time series of CH4 and CO2 column abundance in air masses of various origins. The column abundance calculation will make it possible to perform direct comparisons with the upcoming field measurements that will be collected in Alaska in summer 2015.

Dr. Liang will continue the CH4, CO2, tracer-tracer correlations analysis. Also, she will extend the same analysis that was performed for the previous three missions to the remaining three missions originally proposed: (1) INTEX-B, (2) ABLE-3A, (3) ABLE-3B. Information compiled from the campaigns will be compared with the proposed measurements collected in Alaska in summer 2015 for this project.

Dr. Junhua Liu (Sponsor: Dr. Rodriguez) conducts research that focuses on quantifying contributions of the stratospheric intrusion and biomass emissions to the observed interannual variations (IAV) and trends in tropospheric O3 and precursors during the past 20 years over the subtropics and mid latitudes and investigating their interaction with the Earth’s climate. Dr. Liu provides expertise on global chemistry-transport modeling (CTM), data analysis on satellite measurements and surface observations. She evaluated the GMO 20-year hindcast simulation based on selected ozone sondes data from mid latitude regions of the northern and southern hemispheres. Two assimilated columns were compared on DM/MLS, and variable satellite observations (IARUS/MLS, TOMS/MLS, SUBV merged ozone data).

Dr. Liu examined possible causes of the observed ozone variation at Reunion Island using hindcast simulations by the fully coupled stratosphere-troposphere GMI CTFM for 2001-2011 driven by assimilated MERRA meteorological fields. Her analysis suggested that a large interannual variation (IAV) of upper tropospheric ozone over Reunion Island was driven by the large IAV of the stratospheric influence, which could be possibly related to large-scale changes in its surrounding meteorological regimes associated with the mean location changes in subtropical jet streams. She compared model simulations with yearly varying and constant emissions to detect the influence from surface emissions. Her study suggested that the effects of increasing emissions were limited to the lower troposphere near the surface area in August - September. In the coming months, Dr. Liu will finish her analysis of the interannual variation and trends of tropospheric ozone over Reunion Island with GMI and observed dataset from satellite and ozonesondes measurements, and will submit a related manuscript.

Also, Dr. Liu examined the variations of stratosphere and troposphere exchange on stratospheric Ozone IAV based on several GM1 hindcast sensitivity simulations, a stratospheric tracer run and observations from ozonesondes as well as satellite measureme consisted of the CCMI BrO abundance to the Harvard GEOS-Chem model simulations in simulating the tropospheric abundance of BrO as well as its impact on tropospheric O3 and OH.

The multi-model intercomparison results were published as a FAA report in April 2015.

For the ACMA (Bromocarbons Project, Dr. Liang has been conducting a set of GEOS-5 CCM simulations to quantify the contribution of long-range and very-long-range transport to atmospheric BrO abundance, including sensitivity simulations of various seasonal variation in emissions of very-short-lived bromocarbons, and newly proposed bi (BrO)BrO-reaction rates to examine their impact on atmospheric BrO abundance. These results were evaluated against AURO DMI BrO measurements to BrO abundance estimates. The modeled BrO, as well as the very-short-lived source gases (CHBr3 and CH2Br2) were compared against aircraft field measurements collected during CONTRAST/ATTREX/SEAC4RS and ARCTAS-MB. The collective information gathered from these satellites, in situ and model BrO comparisons will be used to explain the current discrepancy between the BrO abundance estimates from various sources and potential causes. Dr. Liang worked in close collaboration with Dr. Johan Schmidt and Prof. Daniel Jacob (Harvard University) in providing the GEOS-5 CCM BrO abundance to the Harvard GEOS-Chem model simulations in simulating the tropospheric abundance of BrO as well as its impact on tropospheric O3 and OH.

Work on the ACCDAM Convection Project has included an examination of measurements of CO2, CO, various VOCs (C2H6, C3H8, CH4, CH2O) as well as CHBr3 and CH2Br2 from the NASA SEAC4RS mission to look at the surface-to-UHI (upper troposphere and lower stratosphere) transport timescale and efficiency for air of different source regions (contingent pollution vs. marine biogenic emissions). To evaluate model performance and determine likely reasons of the existing model biases, the aircraft measurements were compared with model output for the same time period and location. In addition, these measurements were compared against measurements obtained along the western Pacific during the ATTREX/CONTRAST missions to examine the regional differences in convective transport. The analyses results were presented at the SEAC4RS science meeting in Pasadena, CA (Apr 30-May 3, 2015).
in the lower stratosphere and troposphere, and the coupling of stratosphere and troposphere in both global atmospheric data sets and outputs from global models. Global, regional and process studies on seasonal, annual and longer time scales are used to investigate topics concerning trends, exchange, circulation and transport, influences of layers, and evaluation of models. Regarding ENSO and Tropospheric Column Ozone Variability, Dr. Olsen continued research on the tropical and middle latitude response of tropospheric column ozone to ENSO using analyses of OMI and MLS ozone recently extended through mid-2014. The change in the tropospheric column ozone was found to be linear with respect to the Nino3.4 model. The tropical Pacific, the column decreases by up to 1.5 DU per degree increase in the index. Over Indonesia and the Indian Ocean, the column increases by up to 1.2 DU per degree increase in the index. In the stratosphere, the sensitivity is smaller, yet statistically significant, and the changes in circulation patterns are closely aligned with the sensitivity of ozone to ENSO. Regions of negative sensitivity are coincident with anomalous cyclonic circulations over the North Pacific, United States, and North Atlantic that increase the upwelling and destabilize the atmosphere to convection. Likewise, midlatitude regions of positive sensitivity are coincident with anomalous anti-cyclonic circulation and downwelling. The impact of tropopause height changes associated with ENSO is estimated to account for about 1/4 of the tropospheric column ozone response over the United States.

Dr. Olsen is investigating the impact of using a high horizontal resolution general circulation model in the ozone assimilation system. It is found that using high-resolution background/analysis structures such as tropopause folds are better represented, plus the structural integrity is better maintained, bringing both higher ozone and PV to the tropopause at a higher resolution results in less ozone in the upper troposphere, particularly around the regions of jets. The annual northern hemisphere extratropical ozone burden is reduced by 2% - 5%, depending on latitude, and in the southern hemisphere, the reduced upper tropospheric burden is offset by increased ozone in the lower troposphere. This hemispheric difference will be investigated in the coming year.

Dr. Olsen produced a year-long assimilation of OMI and MLS ozone that incorporated explicit stratospheric chemistry into the assimilation system. The evaluation of this new configuration focused on the representation of the Southern Hemispheric polar ozone hole in the analyses. The timing of the Antarctic ozone hole formation and break-up is nearly unchanged from the perspective of zonal and column ozone. The greatest difference in column ozone is found around the colar region of the Antarctic vortex; however, the differences are less than the variability in that region. This evaluation is ongoing with an examination of the chemical processes compared to the analysis increments.

Dr. Olsen co-authored a paper published in the Journal of Geophysical Research Atmospheres in February 2015 that discusses the improvements to the assimilation of OMI and MLS ozone data and applications and outcomes in research. A first author paper based upon the investigation of ENSO-driven variability of tropospheric column ozone is in progress and Dr. Olsen plans to submit this to a journal in summer 2015. OMI presentations on work completed this year were given at the Aura Science Team meeting held in College Park, MD and at the AMS General Assembly/Middle Atmosphere Conference held in Phoenix, AZ. Results from the study on the tropical and midlatitude response of tropospheric column ozone were presented at the Aura meeting, while the high-resolution ozone assimilation was discussed at AMS.

Over the next year, Dr. Olsen plans to complete an investigation of the variability in the meridional mixing in the lower stratosphere that is correlated with the atmospheric index of refraction above the subtropical jet and modulated by the phase of the Quasi-Biennial Oscillation. Additionally, the study of the impact of high-resolution assimilation of ozone will continue in the context of a jet-tropopause coordinate to quantify the impact of the resolution on ozone transport and exchange across the tropopause in the vicinity of the subtropical jet. Dr. Olsen also will contribute work on the downward flux of ozone to the change in transport, influence of layers, and evaluation of models. Regard the variability in the meridional mixing in the lower stratosphere by deep convection upstream of both Houston and aircraft flight legs over a wide range of mid-continental locations. In many instances, the deep convection sources could be traced to the deep tropics.

July 2015 marks the tenth anniversary of the Ticosonde sounding project in Costa Rica. Ticosonde has been a collaborative effort between NASA and Costa Rican scientists from the beginning, and is the longest continuing series of water vapor/ ozone profiles in the tropics. In the past twelve months (May 2, 2014-April 23, 2015), the team at the University of Costa Rica in San José has added 32 more balloon sondes launches to the Ticosonde data set. These yielded 32 ozone profiles and 12 water vapor profiles, bringing the totals since 2003 to 442 using balloon sounding.

Upcoming plans include a presentation of results from his analysis of the SO2 soundings at the annual conference of the NOA Global Monitoring Division in Boulder, CO, May 2015. Dr. Selkirk also plans to attend an open meeting entitled “Composition and Transport in the Tropical Troposphere and Lower Stratosphere” in Boulder, CO in July 2015. He will travel to Costa Rica in the year to review the Ticosonde science program with Co-I Jorge Andrés Diaz and his team at the University of Costa Rica, and will have discussions with the Instituto Meteorológico Nacional on progress to establish a GRUAN site in Costa Rica. This paper analyzes joint balloon sonde profiles of water vapor and ozone made in Costa Rica from 2005-2011 using compositing techniques, tracer vector analysis and back-trajectory methods. The analysis reveals important seasonal differences in structure in upper troposphere and lower stratosphere. Water vapor amounts in boreal winter at Costa Rica are much lower than expected from local ice saturation temperatures. The boreal summer data show both higher water vapor amounts and a much higher level of variability than the winter data. To understand this seasonal contrast, three sources of tracer variability are considered: wave-induced vertical motion along strong vertical gradients (‘wave variability’), eddy transport in source air masses resulting from horizontal transport (‘source variability’), and changes induced along polar paths due to physical processes (‘path variability’). The winter and summer seasons show different mixtures of these three sources of variability.

At the SEAC4RS Science Team Meeting in Pasadena, CA, April 28-May 1, 2015, Dr. Selkirk presented his analysis of the water vapor data from both SEAC4RS balloon sondes as well as the NASA ER-2 collected during the field phase of the SEAC4RS mission at Ellington Field, Houston, TX in August and September 2013. A distinguishing feature of the water vapor profiles is that there is evidence of injection of water vapor well into the local stratosphere by deep convection upstream of both Houston and aircraft flight legs over a wide range of mid-continental locations. In many instances, the deep convection sources could be traced to the deep tropics.

This capability has borne fruit in April and again on the morning of May 13, the stratovolcano Turrialba, located approximately 35 km east of the researchers’ Ticosonde balloon sounding launch site at the University of Costa Rica (UCR) in San José, had the largest ash eruption since it became active again in the mid-1990s. On the morning of May 13, the UCR team launched a dual balloon sounding, SJ470, which intercepted the plume, and in their dual sonde payloads, Dr. Selkirk and colleagues take advantage of this by adding a second ozone sonde fitted with a SO2 filter. Careful differentiation of the unfiltered and filtered sonde sondes yields profiles of both SO2 and ozone. The profiles for SJ470, shown in Figure 1, were prepared by Ticosonde Co-I Prof. Gary Morris (St. Edwards University). Image provided by H. Selkirk.

Figure 1: Profiles for SJ470, prepared by Prof. Gary Morris (St. Edwards University). Image provided by H. Selkirk.

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Dr. Henry Selkirk was an integral part of the Ticosonde project of which this task’s activities have been an integral part. The RHcrit (Critical Relative Humidity) for the Global Modeling Initiative (GMI) investigations of chemical and dynamical aspects of the middle and lower atmosphere, which involves the development, optimization, multiprocessing, execution, and evaluation of atmospheric modeling codes; development of diagnostic software for analysis of model output and satellite data; and development of general user software to allow simple access to large central databases of model output.

This year, Dr. Steenrod worked on several issues with the GMI CTM model, including several enhancements to the model’s capabilities. In the work with the coupled aerosol gas phase chemical mechanism, he added the ability to use a database of volcanic eruptions to emit sulfur dioxide into the model domain at the actual locations in space and time. He added mixed phase aerosol chemistry to the coupled aerosol gas phase chemical mechanism, allowing for a more accurate representation of the aerosol interaction. He also added the capabilities of the offline transport tracer suite by adding additional constituents. Two more species that other groups often run were added, an SFG species with no ice, and a CO2 tracer. Mr. Steenrod developed a new set of tagged carbon monoxide tracers that run separately to look at the regional influences of different source regions on atmospheric CO and ozone. In the coming months, work will continue on improving the GMI model and fixing issues as they are discovered. There are plans to update the latest version of the photochemistry reaction rate calculation. He also needs to solve a problem that currently prevents the coupled aerosol gas phase chemical mechanism from being run at a high resolution.

Mr. Steenrod, working with others, had to adapt the GMI model to run under the new mainframe hardware and software on the NCCS™ massively parallel computer system. The computer was newly modernized during the year, adding many new nodes and eliminating older ones, and the operating system was changed, moving to the latest release after having been at an obsolete version for a while. They moved the GMI model code to a new release of the Fortran compiler, and they changed the version control software that the model is stored under. Each of these changes presented issues, and before and after these changes, Mr. Steenrod ran several simulations. One set of simulations was used to look at the chemical reaction rate sensitivity of methane oxidation long term simulations through 2014 and ran the tracer suite in conjunction with several full chemistry runs; additionally, he developed and ran the GMI chemistry model to support preliminary work in support of the upcoming AFM aircraft mission. These runs are designed to simulate the data that will be retrieved during the mission and to use the model to fully understand the many different influences on the chemistry that results in the measured species. Mr. Steenrod continued with the CMU simulation post-processing for submission to the CCMi repository.

Further, his systems administration support included updating and securing the operating systems of the CD41 computer cluster, as well as updating and maintaining the hardware on this cluster in a timely and unobtrusive manner. This included replacing computers and printers, adding new and replacement hard-drives, preparing for Goddard infrastructure changes and helping users migrate to the new desktop environments on the cluster. These activities will continue, especially with regard to the OS security updates and installation of new and replacement hardware.

Dr. Susan Strahan (sponsor: J. Rodriguez) analyzes stratospheric observations to improve the understanding of stratospheric transport processes, their variability, and their effects on the chemistry of trace gases, including ozone. The results of observational analysis, model simulations, and chemical mechanism representation are compared to data from chemical, physical, and in situ measurements in NASA models, including the Global Modeling Initiative (GMI) chemistry transport model and the GEOS Chemistry-Climate Model (CCM). This past year, a study was completed that quantified interannual variability of inorganic chlorine inside the ozone hole and determined its impact on Antarctic ozone depletion over the past decade, scientists have continuing evidence that the Antarctic ozone hole was becoming less severe due to declining stratospheric chlorine levels. This study determines that the large chlorine variability complicates the detection of a decline in ozone hole severity. However, this study also revealed a linear relationship between Q2 loss area and Cl (Chlorine) levels during very cold years in the Antarctic. On this basis, the study concluded that ozone holes smaller than 20-million square kilometers – an area exceeded for most of years since 1992 – will occur after 2040, no matter how cold the Antarctic winter is. This work was presented at the Aura Science Team Meeting (College Park, MD), the Network of Remote Detection Workshop (Brussels, Belgium), and was published in the Journal of Geophysical Research – Atmospheres. This research was highlighted in a video titled “Big Ozone Holes For Extinction By 2040” that includes an interview with Dr. Strahan and was produced by Joy Ng and Kayvon Sharghi (Code 130). This video is available on the SVS webpage (http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=11781) and on the NASA Goddard YouTube channel; it is also the subject of a Weatherscasters video and was posted to Instagram.

The surprising source of the large interannual chlorine variability was identified as the quasi-biennial oscillation (QBO) of the tropical stratospheric wind direction. The QBO, which has an average period of 28 months, was found to cause stratospheric composition variability throughout the extratropics (i.e., regions outside the tropics). Using a decade of NASA satellite observations, differing impacts of the westerly and easterly phases of the QBO on the midlatitude values of long-lived trace gases N2O and HCl were found in both hemispheres. In the southern hemisphere, the midlatitude QBO effects found in the middle stratosphere were transported by the mean stratospheric circulation, first to polar latitudes in summer and then to the lower stratosphere the following winter. This unexpected and coherent transport pathway allows the dynamics of the tropical stratosphere to impact the composition of the Antarctic ozone hole! Because of greater dynamical variability in the northern hemisphere, this coherent transport is not observed. This work was accepted for publication in Geophysical Research Letters.

As the Global Modeling Initiative (GMI) project manager, Dr. Strahan continued to oversee the integration of several multi-decadal simulations that investigate how changing anthropogenic emissions affect atmospheric composition. Dr. Strahan also participated in the development and evaluation of a new chemistry transport modeling (CTM) effort in the GMAO (Code 610.1). This new CTM, called GEOS CTM, is the Global Modeling Initiative’s new CTM. The new CTM is integrated with GMAO meteorological reanalyses, such as MERRA and MERRA2. Pending a successful evaluation, this model will serve as an updated replacement for the GMI CTM. The first round of testing identified significant tracer transport problems. Additional consistent transport problems have been identified in the diagnostic software and these continue. It is hoped that this modeling tool will be ready for scientific investigations later this year.

Mr. Steenrod accepted an invitation to join the steering committee of the Network for the Detection of Atmospheric Composition Change (NDACC). This is an international group of atmospheric scientists focused on making and analyzing ground-based atmospheric composition measurements from a worldwide network of observing stations. She will be working to support and advance the use of NDACC ground-based data by providing model output to instrument users, to further understand the NDACC data in model studies. [See Dr. Michael Kurylo’s report [also Code 614] for more information on the NDACC SC.]

Over this past year, Dr. Strahan collaborated with NASA and university scientists on several topics. The collaborations that resulted in publications included the following: a study of the influence of the El Nino Southern Oscillation (ENSO) and Madden–
Work for the year ahead will involve the utilization of the findings on tropical wind (QBO)-driven composition variability to investigate trends in stratospheric composition over the year-to-year variability in the stratospheric circulation caused by increasing greenhouse gases (GHGs). Increasing atmospheric GHG concentrations are expected to produce long-term changes in the stratospheric circulation, but phenomena like the QBO are driven by the same meteorology to reduce the model uncertainty. This way, CO2 fluxes and PCTM global model results into the NU-WRF framework and study the CO2 spatial-temporal variability including the 4th iLEAPS Science Conference, the 7th International Conference on the Global Water and Energy Cycle, AGU Fall Meeting, the MICS-Asia Workshop, and others. At the iLEAPS conference, he chaired a session of “Linking the gap between Hydro-meteorological and Biogeochemical Land-Surface Modeling”, for a newly funded project that investigates the interaction between Asian air pollution and Asian monsoon, Dr. Tao will assume the role of NL-WRF simulation. Dr. James Wang (sponsor: S. R. Kawa) works on two tasks. This first task is involved with inverse modeling of atmospheric CO2 using satellite and in situ observations. This past year, his research has resulted in publications and presentations; he also was involved with proposal submissions. In June 2014, he was a co-PI on a NASA ROSES proposal titled “GEOS-Cart II: Delivering Carbon Flux and Concentration Products Based on the GEOS Data Centre (AVDC) activities and supports various Aura and NPP calibration and validation activities. He also maintains and updates the AVOC software, hardware and web page, as well as provides support to the AVDC users. He has added and updated multiple data and overpass files to the latest version. He expanded the AVDC database by adding OMI (SAO) ozone profiles data, GOME-2 fluorescence data for LL and LS, GMAO/GEOS OM/MLS assimilated ozone, and OMI (SAO) water vapor. Dr. Taha also updated and expanded the ozonesonde and ground-based database, and updated the AVDC webpage and data links. In July 2014, in support of the DISCOVER-AQ campaign, the AVDC provided OMI, MLS and OMPS FOUV prediction over DISCOVER-AQ sites. Dr. Taha attended the CEOS Atmospheric Composition Constellation Meeting, at NCWCP (MD) in June 2014, and the EOS Aura Science Team Meeting in September 2014, held in College Park, MD). Work ahead will involve maintaining the AVDC web page and systems; harvesting, hosting, and harmonizing correlative measurements needed for satellite validation; and, coordinating the Generic Earth Observation Metadata Standard (GEOMS) work and maintaining all required technical aspects.

Dr. Ghassan Taha (sponsor: G. Janossy) works on a second task in investigating SNPP OMPS Limb sensor data quality with the goal of identifying improvements to current and future Limb sensors. His research focuses on alternative approaches to data reduction that have potential implications for sensor and algorithm design. He also supports OMPS limb level 1&2 development activities. This past year, Dr. Taha performed a detailed comparison of OMPS LP ozone profile version 2 with MLS, OISIRI, MIPAS, SCIAMACHY, GOMOS satellites, as well as lidar and ozone sonde measurements, in order to evaluate the accuracy of OMPS retrieval, tangent high offset, and slit differences. For an analysis of OMPS LP level 1, Dr. Taha investigated OMPS LP v2.X radiances gain differences to estimate the tangent height offset between high and low gain. He also derived an empirical straylight correction model, and analyzed the resulting residuals. The proposed SL corrections were tested using the ozone and aerosol retrievals. Dr. Taha assessed OMPS LP aerosol profiles and evaluated the accuracy of aerosol products and compared it to OISIRI aerosol. Subsequently, Dr. Taha proposed an experimental algorithm that improves the multi-wavelength aerosol profile's retrieval and extends the algorithm to lower and higher altitudes in the upcoming Atmospheric Tomography Mission (ATom).

Dr. Zhining Tao completed an impact study of transpacific aerosol (dust and pollution) on U.S. surface air quality using NU-WRF. Unlike previous investigations, he extended his study to include the biogenic vs. oceanic, etc. Dr. Tao assisted in dynamic dust source map development and implementation in NU-WRF, as well as in the completion of a NU-WRF-LB test simulation of the 2011 Arizona dust storm. He took part in the NU-WRF workshop in GSFC and held discussions with the AFWA dust and aerosol experts about the improvement of the AFWA dust and aerosol observation network. Work ahead will involve implementing and testing a modified empirical straylight correction of OMPS LP radiances and testing its effect on ozone and aerosol retrievals. He also will finalize the OMPS LP ozone profile validation study to be presented at the upcoming ATOM Workshop 2015, and will repeat the validation study for the upcoming release of V2.5. Finally, he will conduct a study of three years of OMPS LP records of aerosol index and extinction coefficient global distribution, and will compare this to the Goddard GEOSCCM model and other correlative measurements.

Julian Oscillation (MO) on simulated and observed troposphere ozone variability (with Dr. Jerry Ziemke, Code 610); an evaluation of the Community Earth System Model with several chemistry options to probe how factors such as simulated NO concentrations affect the simulated CO and OH. Going forward, she plans to submit a paper on the implications of model results and extend her analysis to parallel this ongoing investigation. Dr. Strahan contributed GMI CTM simulations and their analysis to these collaborations and assisted in writing and editing.

Dr. Sarah Strode (sponsor: J. Rodriguez) contributes to the three-dimensional chemical transport model and chemical climate model for both the Chemical Transport Models and Chemistry Climate Models. She carries out simulations for the Atmospheric Chemistry-Climate Model Intercomparison Project (ACCMIP) using boundary conditions for past and future simulations. This past year, she submitted a paper entitled “Trends and Variability in Surface Ozone over the United States” to the Journal of Geophysical Research, and gave a branch lunch seminar on this topic. Surface ozone in summer over the eastern U.S. decreased over the past 20 years, but increases in ozone are seen at some sites in other regions and seasons. She used hindcast model simulations to investigate these trends and the year-to-year variability in U.S. surface ozone. Dr. Strode is using model simulations to investigate possible causes of the reported trends in carbon monoxide (CO) seen in satellite observations. She gave a presentation entitled “Can the CCM Simulations Reproduce the MOPITT CO Trends and Variability?” at the Chemistry-Climate Model Initiative (CCMI) workshop and also presented this work at the Goddard Young Scientist Forum.

Chemistry climate models (CCMs) often show a low bias in carbon monoxide at the high northern latitudes. Dr. Strode is investigating how this bias is formed and is affected by the simulated concentrations of OH, an important atmospheric oxidant. She is using a CCM with several chemistry options to probe how factors such as simulated NO concentrations affect the simulated CO and OH. Going forward, she plans to submit a paper on the implications of model results and extend her analysis to parallel this ongoing investigation. Dr. Strahan contributed GMI CTM simulations and their analysis to these collaborations and assisted in writing and editing.

The proposed SL corrections were tested using the ozone and aerosol retrievals. Dr. Taha assessed OMPS LP aerosol profiles and evaluated the accuracy of aerosol products and compared it to OISIRI aerosol. Subsequently, Dr. Taha proposed an experimental algorithm that improves the multi-wavelength aerosol profile's retrieval and extends the algorithm to lower and higher altitudes in the upcoming Atmospheric Tomography Mission (ATom).
Dr. Wang contributed to a study presented in a poster at the 2014 AGU Fall Meeting in San Francisco, CA, in December titled "Model Analysis of the Factors Regulating Trends and Variability of Methane Emissions over Nights, Days, and Seasons". This work was published in December 2014. Dr. Wang contributed to the interpretation of the measurements collected with the firn aquifer of Helheim Glacier more than 20 years ago. Therefore, this analysis suggests that the firn aquifer is not a recent feature associated with the last decade of enhanced melt. Nonetheless, it was shown that the firn aquifer has tended to migrate toward higher elevation since 2008. This work enabled discussions on firn aquifer stability, lateral flow of water, and impacts on Greenland ice sheet mass balance changes. The Greenland ice sheet influences the Earth’s climate through the release of freshwater into the ocean. With an increasing melt water runoff (estimated to account for more than 50% of the Greenland ice sheet mass loss), the freshwater input can change the salinity of the seas surrounding Greenland. In January 2015, Dr. Brucker gave a presentation on "Incorporating observations related to remote sensing data" in conjunction with the Earth Observation System (EOS) 5 assimilation and forecast model. An anomalous freshwater was detected in the Baffin Bay and Labrador Sea in 2012. The unusually large volume of freshwater that ran off the Greenland ice sheet during the 2012 summer was advected southward by the West Greenland current and crested a large freshwater intrusion into the North Atlantic current. Other research involves studying snow depth on sea ice. At present, only space-based microwave radiometers provide operational snow depth on seasonal sea ice retrievals. To provide the data users with the best retrievals, Dr. Brucker worked on improving analysis parameters and the overall simulation using ground-based atmosphere CH4 measurements. He is applying the wetland parameterization to assimilated meteorology and free-running versions of the GEOS-5 atmospheric model.

Dr. Ludovic Brucker (sponsoring: S. Nowicki) conducts research to improve the algorithms that he implemented against atmospheric methane observations, and compare the simulation with one using an alternative wetland emissions estimate. He will consider creating predictive capabilities for those sources for future simulations. Work will involve contributing to writing a scientific paper on this interdisciplinary project aimed at studying the impact of changes in the Arctic. Specifically, he analyzes in-situ observations related to remote sensing data. Dr. Brucker attempted to estimate sea ice thickness using Aquarius Radiometer data. Based on this work, he gave presentations at both the 2015 AGU Fall Meeting in San Francisco, CA, and the 2016 IEEE International Geoscience and Remote Sensing Symposium in Canada, Quebec, and at the International Satellite Snow Products Intercomparison (SnowPEx) workshop in College Park, MD. Dr. Brucker also was a co-chair of the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) workshop on polar geophysical parameterization and the overall simulation using ground-based atmosphere CH4 measurements. He is applying the wetland parameterization to assimilated meteorology and free-running versions of the GEOS-5 atmospheric model.
nation in Aquarius and SMOS data at the Aquarius science meet-
ing in Seattle, WA. In May 2015, he also will be presenting at the 2nd SMOS Science Conference in Spain.

Through his research, he has discovered that, when averaging large quantities of data from sensors, biases start to appear between the ascending and descending orbits and between the three Aquarius radiometers. An empirical solution for this was proposed in version 3.0 of the Aquarius data. Dr. Sido has shown that while this empirical solution generally improves the quality of the data, it does introduce errors; therefore, he has proposed a different approach consisting of a more sophisticated minimiza-
tion of these biases. He also has studied the sensitivity of the biases to different geophysical variables.

As a member of the Frequency Allocations in Remote Sensing (FARS) IEEE Technical Committee, Dr. Sido is working on a web-based tool to distribute information about RFI in L-band. He pro-
vided all relevant information from the SMOS mission and from the Aquarius instrument. He has joined the SMAP RFI working group, and is hoping to mentor a student intern on L-band RFI.

**CODE 617: HYDROLOGICAL SCIENCES LABORATORY**

Ms. Debbie Belvedere (sponsor: D. Toll) serves as a liaison for the NASA Energy and Water Cycle Focus Area and is a part of the GESTAR activity that supports scientific collaboration, cross-
cutting and integration for NASA’s global and water cycle research initiatives introduced by interagency and government-
administration scientific panels. She also represents the inter-
est of the project both inside and outside the organization and reports to the NASA Project Manager.

Each year, NASA HQ seeks publications that will support NASA’s contribution of scientific advancement regarding the following: to demonstrate progress in quantifying the key reservoirs and fluxes in the global water cycle and in improving models of water cycle change and fresh water availability. Ms. Belvedere and Dr. Robert Schiffer assisted HQ Project Manager by gathering publications and preparing documentation required by the ESS to review and evaluate ESD progress for FY 2014. The Annual GPR’A Report includes an overall summary, key accomplishments, description of high-impact research results of the last year that appear in peer-reviewed literature, and major programmatic accom-
plishments. She and Dr. Schiffer have been working on another publication, the News 10-Year Summary Document, which showcases the wonderful work that NASA has accomplished to date. The document included 25 pages of highlights of a press release, and pertinent text. At present, a draft is posted on the NASA website.

Ms. Belvedere also contributed to several communication and outreach efforts related to NEWS. She had a productive meeting with Ms. Pearce (GSFC) to discuss changes and new requirements for the NEWS website. Ms. Belvedere is currently working with the NASA Web Software Engineer to update the NEWS website as NEWS had a productive meeting with Ms. Pearce (GSFC) to discuss changes and new requirements for the NEWS website. Ms. Belvedere is currently working with the NASA Web Software Engineer to update the NEWS website as NEWS had a productive meeting with Ms. Pearce (GSFC) to discuss changes and new requirements for the NEWS website. Ms. Belvedere is currently working with the NASA Web Software Engineer to update the NEWS website as NEWS had a productive meeting with Ms. Pearce (GSFC) to discuss changes and new requirements for the NEWS website.

**Dr. Andrea Andrew** (sponsor: C. Del Castillo) works on determin-
ing the quantum photoproduction efficiency of dissolved organic carbon via photodegradation of colored dissolved organic matter (CDOM) in mangrove coastal environments. She conducts photo-
degradation experiments in the laboratory using a solar simul-
or. Other efforts include capturing CDOM dynamics in marine/terrestrial environments, via the analysis of absorption and fluorescence measurements as well as other parameters including salinity, tidal patterns and location. Dr. Andrew uses airborne and satellite ocean color data, radiative transfer modeling, photoproduction efficiencies of DIC and ancillary data to estimate photoproduction rates in mangrove coastal environments.

For this relatively new task, Dr. Andrew optimized the data col-
lection and analysis protocol for the spectrophotometer and completed initial data collection and analysis of two sets of CDOM samples. She reviewed and supplemented the SOP protocol for obtaining and analyzing excitation-emission spectra (EEMS) using the Horiba Aqualog fluorometer, and also updated the software and host computer for the instrument. She collected optical measurements of fluorescence and absorbance for 68 CDOM samples from two cruises in the mangroves on the Coastal plain of Southwest Florida. She derived spectral slopes, scope ratios and quantum yield, and is working on data analysis to assess trends between optical properties, salinity and location (coastal intertidal trends).

Future plans include the initial set-up of the solar simulator instru-
mant, which will be done with assistance by a technician from the vendor. Preliminary experiments will follow for optimizing experi-
mental parameters and becoming acquainted with the instru-
mant and initial method development for the photodegradation experiments, in order to determine the quantum photoproduction efficiencies of dissolved inorganic carbon (DIC).

**Dr. Manika Gupta** (sponsor: J. Bolten) applies GRACE terrestrial water storage (TWS) anomalies to improve estimates of Avail-
able Water Capacity (AWC) in the Lower Mekong River Basin (LMB). These estimates of AWC will be used to improve modeled stream discharge. Dr. Gupta will assess the dynamic range and trends of GRACE TWS and modeled TWS from the Land Information System (LIS)-based Catchment Land Surface Model (CLSM) to character-
ize the maximum water storage over selected sub-basins in the Lower Mekong River Basin. The TWS anomalies were utilized to improve modeled surface and root zone soil moisture. The Catchment Land Surface Model integrated with Land Information System (LIS) has been utilized along with the GRACE terrestrial water storage TWS anomalies to improve the estimation of soil moisture. She has implemented new soil hydraulic parameters in the CLSM to improve soil moisture simulations through simultane-
ous utilization of Genetic Algorithm optimization approach along with the data assimilation of GRACE TWS anomalies in LIS. The results have been validated in the Oklahoma region and found useful for irrigation scheduling as soil moisture estimation was found to improve, which is required for determining the irri-
dation depth and irrigation timing. This study is useful as it helps to accurately quantify the soil moisture at a given time; under-
estimation of soil moisture implies higher soil moisture deficit and thus results in employing higher irrigation quantity. The second factor that also was compared in this study is the available water capacity, which again is required in determining the soil moisture deficit. This study is compared with other ongoing studies as part of the studied approach. This work was recently presented at EGU-
2015, titled “Optimizing available water capacity using microwave satellite observations to improve irrigation scheduling.” A new approach has been further applied in the Lower Mekong River Basin and a related manuscript will be submitted. Dr. Gupta has assessed the trends of GRACE TWS and modeled TWS from the Land Informa-
tion System (LIS)-based Catchment Land Surface Model (CLSM) to characterize the maximum water storage over selected sub-bas-
s. A new approach has been shown in prior publications to use the tools like data assimilation and the NASA Land Informa-
tion System (LIS) platforms. The ultimate objective is to further ex-
tend this work and deliver a prototype product for the operational use of this method and demonstrate its operational capability, implementation using GRACE, SMAP and NASA LIS system. In the coming months, she will conduct the analysis for the GRACE TWS assimilation in the LIS-CLSM for the Lower Mekong River Basin to improve the simulation of the streamflow discharge. Also, Dr. Gupta will submit a chapter in Irrigation management using satel-
lite soil moisture in upcoming book titled “Satellite Soil Moisture Retrievals: Techniques & Applications”.

Under his task, **Dr. Richard Lawford** (sponsor: D. Toll) is involved with the development and coordination of water resource ap-
lications and Water Cycle activities within the Group on Earth Observations (GEO) and in the wider community, a broad-based activity that requires substantial coordination and nurturing both within and outside the US. He is involved in maintaining the coor-
dination, reporting and synergies needed to advance NASA data products and water activities both in international GEO and in U.S. GEO, as well as developing applications of NASA data products in areas of water resources management and other related societal benefit areas and enhancing the coordination of GEO water cycle activities in areas of interest to NASA (e.g., drought, precipitation, soil moisture, groundwater, evapotranspiration, capacity building, user engagement, etc.).

Mr. Lawford has been involved with the U.S. development of its stronger coordination role for domestic GEO activities and inputs to the international GEO program. Strengthening the U.S. GEO Water activity is an important part of this strategy. To this end, through the efforts of Mr. Lawford and several NASA colleagues, NASA is developing a plan for GEOGLows (GEO Global Water Sustainability) Strategy. The plan was first drafted in the spring of 2014, and Mr. Lawford provided a briefing to several NASA program managers to obtain feedback on edits for the docu-
ment. Based on this feedback, the revised report is now ready for circulation to agencies for a second round of comments. In order to make the science community more aware of GEOGLows and GEOSS Water Strategy activities, a scientific session on interna-
tional and U.S. water strategy and related activities was held at the 2014 Fall AGU meeting in San Francisco, CA. Mr. Lawford pre-
sented a poster in this session and was a co-author on a poster by David Schwartz. Following this work, he presented a brief overview of GEOSS Water Strategy activities, a scientific session on interna-
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...
Earth Observations in the Water-Energy-Food (W-E-F) Nexus. The increased understanding and raised awareness of the role of food transportation and processing. Mr. Lawford has successfully been critical for sustainable development. For example, food production.

Mr. Lawford, launched an activity to address the recommendations in this report. This included making presentations to raise the awareness of content and needs of the GEOSS Water Strategy, providing guidance on possible actions that could be undertaken by groups and negotiating the actions of other groups. In addition, Mr. Lawford, he co-chaired a workshop on Earth Observations could be used, and he co-authored a second paper on the role of GEO in this process. Several articles in the IGW GWP Newsletter highlighted this work as well as an interview on a similar topic. Working with collaborators from JAXA (Lucie Pluschke) and ESA (Dr. Catherine Downing), Mr. Lawford completed and electronically distributed the report from a W-E F Water Nexus workshop held at FAO in Rome in March 2014. He also helped to organize a special AGU Union session on Future Earth at the 2014 AGU Fall Meeting and gave an invited paper on Advancing Water and Water-Energy-Food Cluster Activities within Future Earth. He has drafted a discussion paper that is under review for the article in the IGW Nexus. Mr. Lawford will continue to contribute to the development of NASA programs and services with attendees at the World Water Forum (WWF) held in South Korea in April 2015. Mr. Lawford worked to strengthen NASA’s role at the World Water Forum by developing a proposal for a scientific theme session. The WWF organizers identified six speaking slots for NASA representatives. In addition, NASA had a booth at the U.S. Pavilion and presented three briefings. In September 2014, he participated as a member of the Freshwater Panel held at the 65th Astronautical Congress in Toronto, Canada, which focused on the role of Space in ensuring water for future generation.

Mr. Lawford, working with others, led the assessment of the potential role of Earth Observations in the assessment of indicators for the proposed water SDG. Mr. Lawford participated in the IGW Nexus. These activities are relevant to this project as the IGW Nexus is a platform for discussions related to the proposed water SDG and as a means to raise awareness of the importance of Earth Observations to support the implementation of the SDG.

Future plans involve possibly adding a new dG/G spec, which could guarantee that the striping would not be an issue for the new generations of ATMS. This work is still in progress, and results need to be validated after the J1 ATMS rework. Dr. Lyu will prepare for on-site monitoring of the upcoming J1 ATMS TVAC test. NASA/NOAA NGES ATMS Technical Team members, including NOAA/STAR, MIT-LL, Space Dynamics Lab, NGES and Raytheon to support JPPS/ATMS calibration and validation activities. He plans to study ATMS data quality spikes related to Lunar Intrusion found in data products and to send a report to the JPPS/ATMS SDR & management team.

GEWEX

The Global Energy and Water Exchanges (GEWEX) Project of the World Climate Research Programme (WCRP) brings together a significant component of the world-climate community in joint initiatives to advance understanding of the coupled hydrologic and atmospheric processes on a global scale and to apply global water cycle understanding, observations, and models to the problems of climate and water resources around the world. Scientists from over 45 countries participate in major GEWEX projects aimed at quantifying the hydrologic cycle, understanding the mean states and variability of the global hydrologic cycle, and developing the ability to predict local and regional hydrologic processes and water resources and their re-
response to environmental change; and fostering the development of observational techniques, as well as data management and assimilation systems.

GEWEX Activities involve understanding and modeling land atmosphere coupling and cloud systems, global data set development, water resource applications, and the effective use of Earth Observations in policy science.

Dr. Robert Schiffer (spokesperson: D. Toll) serves as the Principal Investigator for the NASA Grant covering the operation of the International GEWEX Project Office (IGPO). IGPO facilitates and coordinates GEWEX research across GEWEX studies, activities, and products, oversees the implementation of recommendations given by the GEWEX Scientific Steering Group (SSG) in its role as GEWEX’s central role in the outreach of GEWEX through its website, quarterly newsletter, and through the organization of science conferences and workshops. IGPO also provides an interface between GEWEX and other WCRP activities, as well as other global environmental science programs and the space sciences.

Over the past year, the Science and Technology Corporation (STC) provided directly or indirectly the support required to meet the obligations and responsibilities of IGPO and its Director, Dr. Peter van Oevelen (spokesperson: D. Toll). For activities related to the GEWEX Scientific Steering Group (SSG), IGPO coordinated a one-day Joint GEWEX/CLIVAR SSG meeting that was held in The Hague after the 7th International GEWEX Conference on July 19, 2014. IGPO also coordinated the SSG meeting held January 26-30, 2015 in Medellin, Colombia. IGPO is now coordinating the next full meeting of the SSG, which is scheduled for 25-29 January 2016 at the ETH, Zurich, Switzerland.

For the 7th International GEWEX Scientific Conference on the Global Water and Energy Cycle and Associated Meetings held at The World Forum, The Hague, The Netherlands, from July 14-19, 2014, IGPO was responsible for planning, coordinating, making logistical arrangements, and providing onsite support for all aspects of the Conference and associated meetings, which were attended by over 560 scientists from 45 countries. There were 218 students and early career scientists at the Conference, and of those who participated in the Presentation Competition for Young Scientists, there were 38 winners from 12 countries. Prior to the Conference, IGPO coordinated the GEWEX Summer Sessions held at Delft University of Technology, July 10-12, 2014. After the Conference, GEWEX and CLIVAR held joint sessions, followed by a meeting between the scientific steering groups of both projects to outline joint activities that would make important contributions to the WCRP Grand Challenges. IGPO also organized the Pan GEWEX Meeting, where discussions included plans for a new high-resolution modeling initiative and new themes for GEWEX, and activities to be proposed as part of the soon-to-be-formed US GEWEX project office.

At the request of WCRP and via a “Letter of Agreement” between USRA and STC, IGPO handled the processing of travel claims and distribution of WCRP travel funds for approved candidates. There were six categories of funding: Pan GEWEX Meeting, Pan CLIVAR Meeting, Early Career Scientists and Students, Developing Countries, and the WCRP Grand Challenges. Support was based upon the applicant’s abstract rating by the session conveners and his/her qualifications within a particular category. IGPO also coordinated the joint GEWEX Hydroclimatology Panel (JHCP) annual meeting and International Global Drought Information System Workshop: Next Steps, held in Pasadena, CA at the California Institute of Technology in December 2014.

IGPO also is responsible for providing several communication products. IGPO develops, edits, and formats these for layout in the newsletter. All past issues of the newsletter are available on the GEWEX website. The August 2014 newsletter features results from the 7th International GEWEX Conference and associated GEWEX meetings held after the conference. Also, IGPO periodically distributes an electronic newsletter that includes recent news of interest to the GEWEX community that is time sensitive, including calls for papers and research and position announcements. IGPO hosts (including domain registration), maintains, and updates the GEWEX website (http://www.gewex.org), which provides recent GEWEX science results, overviews of the structure and organization of GEWEX and its projects, access to GEWEX reports and publications and GEWEX data sets, updates on recent and planned activities, and a calendar of project meetings and conferences. IGPO is in the process of revamping the GEWEX website to a responsive design that is easy to read on tablets and cell phones. In addition, IGPO developed a stand-alone website to handle the registration, collection of abstracts, and requests for travel funding for GEWEX conferences and meetings.

IGPO is supporting the development of a new CLIVAR/GEWEX task group on extreme weather and climate that was requested by the JSC. Dr. van Oevelen, Director of IGPO, co-chairs the International Soil Moisture Working Group, one of the drivers in establishing the global soil moisture in situ network, and supports the ESA Water Cycle Multi-Mission Observation Strategy (WACMOS) as the Chair of the Advisory Board. He supports the European Union project Global Water Scarcity Information Service (GLOWWISIS) as a scientific advisor and is a member of its Science Advisory Board. Dr. van Oevelen also serves on the Executive Board of the Science Committee for the Integrated Global Water Cycle Observations (IGWCO) Multi-Mission Community of Practice (COP) of the Group on Earth Observations (GEO). He also provides inputs to the Water Cycle Societal Benefit Area under GEO, and he serves on the Board of the P7 Project Earth2Observe Project.

Dr. Robert Schiffer assisted in coordinating the planning for the North American Water Program (NAWP) through developing a proposal, coordinating with the Federal Agency support. NAWP coalesces an interdisciplinary, international, and interagency effort to make significant contributions to continental to decision-scale hydro-climate science, policy, and practice. The objective of NAWP is to entrench, integrate and coordinate the vast array of interdisciplinary observational and prediction resources available to significantly advance skill in predicting as well as assessing and managing water and climate issues in North American water resources, as an integral part of the global climate system. The mission is to advance measurement and prediction of North American energy and water variations, trends, and extremes, thereby providing scientific underpinnings of future climate services and water resource reliability. NAWP would exploit the vast North American observation networks to understand a wide variety of regional climates and enable science, technology and solution transferability across these regions. This program would build upon previous North American contributions to the Global Energy and Water Cycle Systems (GEWEX), but will include the broader climate, carbon, ecology, and decision communities. As such, it will address more than just the physical Earth System and include human impacts and infrastructure. It is anticipated that NAWP will provide an integrating continental scale framework for both large scale studies, and basin and field scale projects.
calibrated and tested against the Global Landslide Catalog (GLC), a record of landslides from 2007 to 2013, as well as three other landslide catalogs. In an independent validation dataset, Mr. Stanley updated the GLC to cover the years 2014-2015 with the assistance of two summer interns. The most current version of the GLC can be viewed online (https://earthquake.usgs.gov/earthquakes/data_list/), and the catalog can be downloaded in various formats. The landslide susceptibility map also can be viewed at this website. The public is encouraged to report landslides at the site as well. A paper describing the landslide susceptibility map of the Caribbean has been published in the journal Landslides. After the susceptibility map was completed, it was incorporated into LHASA, a model developed at NASA Goddard Space Flight Center by Dr. Dalia Kirschbaum, Mr. Stanley, and Jack Simmons. LHASA uses a decision tree to evaluate whether conditions are hazardous in near real-time by accessing NASA’s 3B42RT data product. Current daily rainfall is above a locally determined threshold and the ground is susceptible, a “nowcast” is issued for that site. This output is shown as a map on the natural hazards website. Currently, the prototype system produces both a “moderate” hazard nowcast and a “high” hazard nowcast for cases of extreme rainfall. Mr. Stanley calibrated the thresholds for Central America with the GLC for 2007-2013, and then evaluated the model’s performance with landslide reports from 2014. Then, he evaluated the effect of spatial error in validation datasets upon model evaluation results. Mr. Stanley also advised DEVELOP’S Himalayan Disasters team on the adaptation of LHASA to the Koshi River basin, which spans China, Nepal and India. In the coming months, in Nepal/South Central Asia, a new integrated Development Observation and Monitoring Network (DIONM), Mr. Stanley will adapt LHASA to conditions in the Himalayan region (Afghanistan, Pakistan, India, Nepal, Bhutan, and Bangladesh).

Ms. Kristen Weaver (sponsor: D. Kirschbaum) is an Education Specialist for GPM’s E/PO, which involves managing and supporting multiple projects within the GPM E/PO portfolio. She works with the GPM E/PO team to implement new initiatives that align with GPM’s E/PO plan and lead or support E/PO projects. Over the past year, Ms. Weaver has run or helped run 30 distinct educator professional development sessions reaching over 850 participants, ranging from K-12 classroom teachers, librarians, and informal educators. Formats ranged from one-hour webinars to several-hour-long in-person workshops, and included presentations and posters at conferences of the North American Association for Environmental Education and the National AfterSchool Association. Ms. Weaver coordinated the first-ever GPM-GLOBE Student Field Campaign for schools to get involved in their own version of satellite ground validation using a simple rain gauge mounted at their school. The data, collected from February 1st to April 15th, are reported into the GLOBE database, and webinars and blogs by educators and scientists throughout the campaign period taught students about the mission and precipitation measurement concepts, as well as how to access data for students to perform their own analyses. Data was reported from over 217 sites around the world, blog posts were viewed by 4600 people (to date), and webinars were attended by 200 teachers and students from 24 U.S. states and Puerto Rico, and 17 non-U.S. countries.

Upcoming outreach activities include Weather and Climate Day at the National Aquarium on May 16th, and, along with education specialists from other NASA Earth science missions, Ms. Weaver will travel to the Odyssey of the Mind World Finals May 20-23 to host a table at their Creativity Festival, share hands-on activities with students in a NASA classroom, and give presentations about NASA Earth science topics. Also, the GPM Education Team with other Earth Science Education Specialists from Goddard and沃尔特will hold a summer institute for Maryland teachers focused on how NASA studies the Chesapeake Bay region. The 25 attendees were competitively selected out of 150 applicants.

Dr. Assaf Anyamba (code 618, sponsor: C. Tucker) conducts research using time series satellite vegetation index measurements from various satellite instruments including MODIS, SPOT Vegetation, NOAA’s Advanced Very High Resolution Radiometer (AVHRR), Tropical Rainfall Measuring Mission (TRMM) and associated ground-based rain gauge measurements. His research also focuses on land surface response to interannual climate variability, in particular climate dynamics (via satellite-derived vegetation indices), and the geospatial risk assessment of plant pathogens in support of the Food and Drug Administration (FDA). Over the past year, Dr. Anyamba has conducted fieldwork in several regions. For much of August 2014, Dr. Anyamba and Dr. Richard Damoah (Code 618) travelled to Kenya to service in-situ meteorological equipment at four sites for an NIH-funded Chikungunya Project and to work with collaborators at USAMRU-K. Also, from late October to mid-November, Dr. Anyamba conducted fieldwork in South Africa to survey and identify field sites for intensive mosquito sampling, rainfall, and NDVI measurements in the Free State Province. The fieldwork is a critical component of a five-year project on Rift Valley fever (RVF) in South Africa funded by the Defense Threat Reduction Agency (DTRA), led by EcoHealth Alliance in collaboration with South Africa’s Center for Emerging and Zoonotic Disease National Institute for Communicable Diseases (CEZD-NICD) and GIMMS Group (618). The project’s aim is to achieve a comprehensive understanding of the relationship between mosquito abundance and succession, rainfall and ecology dynamics (via satellite-derived vegetation indices), wild and domestic ruminant immunity to the virus at multiple scales and in multiple species and a better understanding of the patterns of human infection with RVFV in South Africa. This research also provides the critical data needed to better predict the spread of the virus should it ever be introduced into the United States.

Fluctuations in climate lead to extremes in temperature, rainfall, flooding, and droughts, and these extremes create ideal ecological conditions that promote mosquito-borne disease transmission that impact global human and animal health. For example, abnormally high temperatures can affect mosquito populations by reducing mosquito survival, altering susceptibility of mosquitoes to pathogens, increasing mosquito development rates, changing their seasonal activity, increasing pathogen replication and shortening the extrinsic incubation period in the mosquito, and change disease transmission patterns and seasonality. Elevated rainfall may increase immature habitats for mosquitoes and elevated humidity can increase mosquito survival. Drought conditions can change immature mosquito habitats and enhance container breeding mosquito habitats. One well-known driver of such global scale climate fluctuations is the ENSO phenomenon that is exemplified by periodic extreme warming and cooling of the eastern equatorial Pacific Ocean with attendant consequences on precipitation and temperature worldwide especially across the global tropics. Such extremes include flooding as a result of persistent and above-normal rainfall and drought resulting from extended periods of below-normal rainfall and above-normal temperatures. Extremes in regional climate can create ecological conditions that influence the emergence of mosquito vectors, their distribution and abundance, population dynamics, and transmission of mosquito-borne disease. Dr. Anyamba co-authored “Climate Teleconnections, Weather Extremes, and Vector-Borne Disease Outbreaks” in a publication by The Institute of Medicine (IOM) of the National Academies, in which the authors show that outbreaks of Rift Valley fever and chikungunya, two important emerging mosquito-borne diseases, are coupled to specific climate anomaly patterns. They also describe significant worldwide weather anomalies that impacted vector-borne disease outbreaks during 2010-2012. Utilizing 2000–2012 vegetation index (NDVI) and land surface temperature (LST) data from NASA’s satellite-based MODIS, they mapped the magnitude and extent of weather anomalies for diverse regions including the continental United States, Russia, East Africa, Southern Africa, and Australia, and demonstrated that shifts in temperature and/or precipitation have significant impacts on ecology patterns with attendant consequences for public health. Weather extremes resulted in...
significant concern for international spread and use in bioterror. In Africa and the Middle East, listed as a select agent with presents significant threats to global public health and agricultural and nutritional impacts on humans from illness and livestock loss.

As mentioned, ENSO is a global climate phenomenon that impacts human infectious disease risk worldwide through droughts, floods, and other climate extremes. Throughout summer and fall 2014 and winter 2015, NOAA issued El Niño Watch, which assessed likely El Niño development during the Northern Hemisphere’s fall and winter, persisting into spring 2015. Geographic regions were identified where environmental conditions may present infectious disease transmission, if the predicted El Niño occurs, using El Niño indicators (Sea Surface Temperature (SST), Outgoing Longwave Radiation (OLR), and rainfall anomalies) and a literature review of El Niño-infectious disease associations. SSTs in the equatorial Pacific and western Indian Oceans were anomalously elevated during August-October 2014, consistent with a developing weak El Niño event. Teleconnections with local climate are evident in global precipitation patterns, with positive OLR anomalies (other than average conditions) across Indonesia and coastal Southeast Asia, and negative anomalies across northern China, the western Indian Ocean, central Asia, north-central and northeast Africa, Mexico/Central America, the south-western United States, and the north-eastern to south-western tropical Pacific. Persistence of these conditions could produce environmental conditions conducive to increased transmission of cholera, dengue, malaria, Rift Valley fever, and other infectious diseases in regional hotspots as during previous El Niño events (see figure). The development of weak El Niño conditions may have mitigating health impacts. This research resulted in a 2015 publication in PLoS Current Outbreaks that Dr. Anyamba co-authored.

A new signal analysis technique, ensemble empirical mode decomposition (EEMD), has been applied to a set of long-term water level datasets in the coastal Everglades. This is one of the first long-term water level datasets that has been analyzed with this technique. Dr. Lagomasino is working on a manuscript that compares the EEMD method with Fourier analysis, and highlights the importance of long-term data to identify accelerations in sea level rise and water levels in coastal areas.

From the stereophotogrammetry of sub-meter resolution WorldView 2 spaceborne imagery, Dr. Lagomasino processed this imagery and published a related manuscript featuring one of the first high-resolution mangrove canopy height maps generated. Findings from this manuscript serve as proof of concept and lay the foundation for a series of manuscripts that will investigate bio-mass, land cover and geomorphic processes. (See image.) Future collaborations are planned with Everglades researchers, and Dr. Lagomasino will help process and disseminate Goddard’s LiDAR, Hyperspectral, and Thermal (G-LiHT) products. Many aspects of the Everglades can be compared with other coastal wetlands. Hyperspectral, and Thermal (G-LiHT) products. Many aspects of the Everglades can be compared with other coastal wetlands. Additional, new findings have been accepted to IGARRS 2015 and will continue to be presented at other remote sensing and coastal science conferences. Globally, Dr. Lagomasino and others are helping with forest inventories in Bangladesh and accounting for carbon in East Africa.

was recently published in Carbon Balance and Management. In March 2015, Dr. Leitold spent two weeks at the EMBRAPA Satellite Monitoring Center in Campinas, Brazil, to meet with Amazon Project collaborators. Each participant gave a short presentation on current tasks and preliminary results and future collaboration efforts were discussed and planned. She also presented research results at the XVIII Brazilian Remote Sensing Symposium in late April in Joao Pessoa, Brazil. Over this past year, Dr. Hank Margolis (sponsors: R. Nelson and B. Cook) has processed and analyzed airborne data from a campaign in Mexico. Maps were created, and he assisted the US Forest Service personnel with understanding the data set. Additionally, he estimated the aboveground carbon stocks in the North American Boreal Forest, analyzing results, making figures and tables, and writing, submitting and revising a manuscript for the Canadian Journal of Forest Research reporting on results using a spaceborne sensor (GLAS). For the June 2014 meeting of the Mexican Carbon Program held in Merida, Yucatan, he prepared an abstract describing the AMIGA-Carb-Mexico mission and data set. He also presented a conference talk on research results for the Forest Carbon Session of the IGARS-2014 Congress in Quebec City. In January 2015, he wrote an abstract on research results for the American Carbon Program (NACP) meeting in Washington, DC and at the NASA Joint Carbon Cycle Science and Ecosystems meeting in College Park, MD.

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nouncement of Opportunity within ROSES. He also assisted with a white paper describing NASA priorities for research for the next decade in terrestrial ecology, carbon cycle science, land use/land cover change, and biodiversity for the TCCLB effort. He served as member of the core sub-group for the carbon cycle science section and provided input to different portions of the document, and attended a workshop at NASA Goddard to support this effort.

Dr. Tian Yao (sponsor: J. Masek) estimates vegetation biomass, carbon fluxes and by using remote sensing data and land surface model CLM. From her research results, she present- ed a poster at the American Meteorological Society's 2nd Con- ference on Atmospheric Biogeosciences in May 2014, another presentation at the AGU 2014 Fall Meeting in San Francisco, CA, and participated in the 2015 NASA Carbon Cycle & Ecosystems Workshop in April 2015. She is working on a manuscript, submit- ting an abstract for the 2015 AGU Fall Meeting.

Dr. Qingyuan Zhang (sponsor: E. Middleton) supports the two NASA hyperspectral satellite missions: the Earth Observing One (EO-1) satellite mission and the Hyperspectral Infrared Imaging (HysPIRI) satellite mission. His findings resulted in several publications and presentations. He has had three lead author publications that were related to research on the estimation of crop gross primary production (GPP), two in Agricultural and Meteorology and one in Remote Sensing of Environment, and one he co-authored that was related to light use efficiency and IPCC parameterization on GPP modeling in Agricultural and Forest Meteorology. Additionally, presentations were given at the AGU Fall 2015 meeting in San Francisco, CA and at the 2015 Carbon Cycle and Ecosystem Joint Workshop in MD. In summer 2015, Dr. Zhang will attend an experimental field campaign to measure corn chlorophyll content, leaf fluorescence, soil moisture, and canopy height, etc.

CODE 699: PLANETARY ENVIRONMENTS

Dr. Charles Malespin (sponsor: P. Mahaffy) works on the development and testing of experimental procedures for the Sample Analysis at Mars (SAM) instrument suite. He is the lead testbed operator for the SAM testbed at GSFC. Dr. Malespin is also a part of the MSL Science and Tactical team and serves as the SAM strategic science lead. The Mars Science Laboratory (MSL) was launched in November 2011 and the Curiosity rover landed in Gale Crater, Mars on August 6, 2012. This past year, as a result of many exciting discoveries by SAM, Dr. Malespin was a co-author of several publications. First, the SAM instrument onboard the Curiosity rover made detections of Martian methane, the first positive measurements made on the surface in situ. These detections were discussed and published in a paper in the journal Science. Dr. Malespin helped develop the experiment using the SAM testbed at NASA GSFC. Additionally, the SAM instrument onboard Curiosity made the first definitive detection of organics on Mars in the form of chlorobenzene and dichloroalkanes in a Sheepbed mudstone sample. Dr. Malespin and several other SAM team members co-authored a related article that was published in the Journal of Geophysical Research. Finally, the SAM instrument onboard Curiosity measured the ancient O/H ratio in a Martian Clay sample. These results were published in an article in the Journal Science. Dr. Malespin was responsible for developing this experimental procedure on the SAM testbed at NASA GSFC. Further, a recent SAM experiment measured Xenon in the Martian atmosphere. Dr. Malespin developed and tested the experiment using the SAM testbed at GSFC over the course of several months before it was run on Mars.

NASA’s Mars Curiosity rover has reached the Red Planet’s Mount Sharp, a Mount Rainier-size mountain at the center of the vast Gale Crater and the rover mission’s long-term prime destination. This was a major milestone for the mission and occurred at the start of the first ‘extended mission’ for Curiosity. The MSL will drive up the mountain over the next several years, stopping to drill samples and analyze them along the way. As Curiosity climbs up Mt. Sharp, SAM will be used to analyze samples, which will require the development of new techniques. Dr. Malespin will lead the testing and development of these experiments on the SAM testbed. A more detailed analysis of the SAM testbed work will be presented at the Lunar and Planetary Science Conference. As product development lead of the MEMS pirani pressure sensor of the MOMA instrument for the ExoMars 2018 rover, Dr. Adrian Southard (sponsor: S. Getty) is chiefly re- sponsible for flight qualifying a miniature pressure gauge to the MSL integration team for eventual use on the 2018 Exomars rover (a joint ESA/Roscosmos mission). Other tasks include designing, modeling, and testing a liquid chromatography-mass spectrometer interface for the OASIS (Organics analyzer for sampling icy surfaces) instrument. He also sup- ports the design, modeling, and testing of a high energy electron gun array for an x-ray instrument.

The MOMA-MS (Mars Organic Molecular Analyzer Mass Spectrometer) instrument uses a novel approach to analyzing Mar- tian soil for organic content. It uses laser desorption ionization mass spectrometry (LDI-MS) and ingests volatiles through an aperture valve that is pulsed open and closed. After being closed, pressures are too high for the mass spectrometer to op- erate safely (most of the atmosphere is around 10 torr), so a pump must reduce the pressure inside the MS. In addition, volatiles formed via an LDI process are not stable for long; hence, a powerful pump was required to reduce the pressure quickly. Ideally, the mass spectrometer should be turned on as soon as the pressure is low enough for it to operate. This requires a fast-responding pressure gauge that can work in the torr to sub-mtorr pressure range under Martian atmospheric conditions. The MOMA-MS also required accurate slow pressure prediction under helium flow to accommo- date gas chromatography mass spectrometry. Dr. Southard and his “pirani team” demonstrated that a MEMS pirani sensor could achieve the fast response time needed and could be calibrated to predict pressures from ambient temperatures varying from -20 to 80 degrees Celsius and with different gas compositions. The team confirmed that the sensor passed flight tests including lifetime testing, radiation exposure, vibration, shock, and thermal testing, and could be integrated into MOMA-MS’s electronics without loss of sensitivity or accuracy. An example of a MOMA-MS pressure pulse using Mars mix (a gas composition simulating the Martian atmosphere) is shown in Figure 1 with predictions by the pirani sensor and a much longer commercial reference gauge. A related paper is in progress.

Dr. Southard’s work on OASIS (Organics Analyzer for Sampling icy surfaces) resulted in a publication that described how the OASIS microchip enables electrospray or thermospray of analyte for subsequent analysis by the OASIS time-of-flight mass spec- trometer (TOF-MS). Electrospray of buffer solution containing the nucleobase adenine was performed using the microchip and detected by a commercial TOF-MS. Future testing of thermospray and electrospray capability will be performed using a test fixture and vacuum chamber developed especially for the optimization of ion spray at atmosphere and in low pressure environments. Dr. Southard will be presenting OASIS-related work at ASMS 2015 and Absicon 2015.

Dr. Samuel Teinturier (sponsor: P. Mahaffy) supports SAM (Sam- ple Analysis at Mars) by working on the development and testing of experimental procedures for SAM. He assists Dr. Charles Malespin with writing and developing scripts, with conducting


A MOMA-MS pressure pulse using Mars mix, with predictions by pirani sensor. Image credit: A. Southard.

MOMA-MS pirani sensor calibrated by Southard et al. Pressure reference gauge

MOMA-MS pressure pulse using Mars mix, with predictions by pirani sensor. Image credit: A. Southard.
tests and experiments on the SAM Testbed, and with reviewing and analyzing the data. He is also part of the MSL Science and Tactical team. Dr. Teinturier worked for five years in France on the French team with scientists and engineers who built the Gas Chromatograph, one of the main parts of the SAM experiment, thus he is particularly involved in experiments on SAM or the Testbed concerning rock pyrolysis analysis by gas chromatography, or by wet chemistry experiments. He has led and developed a pyrolysis analysis using the presence of vapors of MTBSTFA (a fluid known as N-methyl-N-tert-butyldimethylsilyl-trifluoroacetamide, used to preserve and identify suspect carbon-containing components in samples drilled out from rocks). Dr. Teinturier has conducted the reviews and experiments on the Testbed for this new kind of analysis, and then helped analyze the data to improve the experiment, and to run it on Mars. This work was presented during the Lunar and Planetary Science Conference in Houston, Texas, by Dr. Daniel Glavin. Dr. Teinturier also participated in the Mars Conference, in Pasadena, CA last July, and at the 2014 AGU Fall Meeting in San Francisco, CA. Work will continue regarding the development of a new method for using the Gas Chromatographic columns during pyrolysis analysis.

Members of GSFC’s Scientific Visualization Studio (Code 606.4, sponsor H. Mitchell), the Office of Communications (Code 130, sponsor W. Sisler), the Science Program Support Office (POC: Winnie Humberson, GST; sponsor: S. Platnick), and High-Performance Computing (Code 606.2, sponsor: P. Webster) have all supported an incredible amount of missions and events, and have produced products to engage and convey the discoveries from NASA research. The team’s products are distributed on a variety of social media platforms and quite often make an impact through high-profile news media outlets. Visualizations and animations are searchable by keyword or by name at http://svs.gsfc.nasa.gov/ and the SVS continues to showcase work by its partners: the Conceptual Image Lab, Goddard Multimedia Studios, and Scientific Hyperwall Presentations. Hyperwalls were in high demand this past year, most notably at the SMAP launch, at Earth Day at Union Station, and at national and international workshops and conferences, and close to home at Goddard’s NCCS in Building 28. The Office of Education (Code 160, sponsor: J. Harrington) also works to engage students and the public on certain goals. In fact, throughout this annual report, collaborative efforts are represented as scientific research is translated and shared through technology, animation, visualization, and interviews.

**CODE 130 (Sponsor: W. Sisler)**

**Jefferson Beck** supports the NASA Goddard Office of Communications and NASA Earth science outreach efforts with a variety of multimedia products. Additionally, Jefferson again served on search committees for new team members, including a new GOES and JPSS producer and a new Multimedia Fellow. As of February 2015, he assumed the responsibilities of the Operation IceBridge E/PO lead, while a search is underway. He provided much support to OIB this past year, producing seven live action videos, four of them utilizing footage from his previous campaign to McMurdo Field Station. He also documented integration efforts for a sister campaign called ARISE and visited Wallops Flight Facility to produce a video on the first-ever instrument integration for IceBridge on a NASA C-130. As the storytelling focus for IceBridge continues to shift toward science results, Jefferson oversaw the production, scripting, and narration of data visualizations, including a video exploring the first 3D map of the layers within the Greenland ice sheet. This video was viewed more than 150,000 times and was selected as Wired’s Science Graphic of the Week.

While Jefferson directed the overall visual outreach efforts for the mission, he helped select two producers to capture the action in the field, and supported their efforts from the home office. In his role as the temporary IceBridge E/PO lead, he coordinated external media visits for the Arctic field campaign, including a photographer, a noted author, and National Geographic film crew, and also provided daily social media postings including photographs from the field and flight plans. During the Antarctic deployment, he provided visuals and logistical support for a Google Hangout featuring NASA Chief Scientist Ellen Stofan and the U.S. Ambas-
sador to Chile, Michael Hammer, and actually participated in the event himself, providing a “day in the life of Issiboide” perspective.

Jefferson often covers topics related to sea ice and this year he helped support a live shot campaign on the Arctic minimum, produced a video on a record low Arctic sea ice maximum, and produced a popular two-part video entitled “A Selective History of Sea Ice Observations” which broke new ground with its documentary spirit.

This year Jefferson produced a string of four consecutive Earth science videos in a two-month period that all received 150,000 hits or more on YouTube and were picked up by multiple media outlets, including NBC News, Popular Science, CBS News, The Guardian, Smithsonian, Popular Mechanics, The Huffington Post, National Geographic, USA Today, Scientific American, and the Washington Post. Two of those videos were in support of an AGU press conference on NASA’s ability to see the world’s holiday lights from space. His Spanish language version of that video garnered nearly 200,000 views. Another video covered model predictions that the American Southwest was likely to experience more severe droughts by the end of the century than at any other time in the last 1,000 years. Also, he produced his third annual “Earth from Orbit” highlight video in conjunction with NASA’s Earth Day and the Earth Right Now campaign and activities. This video was broadcast on NASA TV, used on the hyperwall at Union Station, was quite popular on Facebook, and was picked up by Wired UK, which called it “gorgeous, but harrowing.”

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As Lead Multimedia Producer for Heliophysics, Genna Duberstein maintains hands-on creative responsibilities, and organizes the overall multimedia team and plans media campaigns and release strategies. Genna is also the lead producer on Solarium (see sidebar), an exhibit created from SDO solar images. In the coming year, she will continue to work for new venues for Solarium. This past year, Atlanta’s local TED affiliate, TEDx Peachtree, invited Genna Duberstein to present about Solarium. The October 2014 event was held before a sold-out crowd at Atlanta’s historic Buckhead Theater. Other work that involved the SDO included the videos “SDO 5 Year Time-lapse” and “Holiday Lights on the Sun”. These visualizations allowed the newly launched GPM mission. Ryan oversaw the “first light” and subsequent visualizations which focused on hurricanes, super typhoons and snow storms. These visualizations allowed the public to see these storms at a much higher resolution.

Genna about the video. The time-lapse video featured one frame per every 8 hours of SDO’s five years of solar imagery. It ran on

Video Credit: R. Andreoli; Image provided by R. Fitzgibbons.

with the project managers and videographers in order to document significant milestones in ICESat-2’s pre-launch phase. He documented such events as the optics bench fit test, thermal vacuum testing for the spacecraft, and the installation of the sunshade for the main telescope. In addition, Ryan produced 30–60 second highlights of these I&T milestones for ICESat-2’s Facebook feed. Finally, Ryan has produced part one of three videos focusing on the ATLAS instrument, titled “Laser Focus,” which should see release in May or June.

With the public release of the Integrated Multi-satellite Retrievals for GPM (IMERG), Ryan headed the media push in order to introduce the general public to precipitation maps from space. This year Jefferson produced a string of four consecutive Earth science videos in a two-month period that all received 150,000 hits or more on YouTube and were picked up by multiple media outlets, including NBC News, Popular Science, CBS News, The Guardian, Smithsonian, Popular Mechanics, The Huffington Post, National Geographic, USA Today, Scientific American, and the Washington Post. Two of those videos were in support of an AGU press conference on NASA’s ability to see the world’s holiday lights from space. His Spanish language version of that video garnered nearly 200,000 views. Another video covered model predictions that the American Southwest was likely to experience more severe droughts by the end of the century than at any other time in the last 1,000 years. Also, he produced his third annual “Earth from Orbit” highlight video in conjunction with NASA’s Earth Day and the Earth Right Now campaign and activities. This video was broadcast on NASA TV, used on the hyperwall at Union Station, was quite popular on Facebook, and was picked up by Wired UK, which called it “gorgeous, but harrowing.”

Genna also is the lead producer on Solarium (see sidebar), an exhibit created from SDO solar images. In the coming year, she will continue to work for new venues for Solarium. This past year, Atlanta’s local TED affiliate, TEDx Peachtree, invited Genna Duberstein to present about Solarium. The October 2014 event was held before a sold-out crowd at Atlanta’s historic Buckhead Theater. Other work that involved the SDO included the videos “SDO 5 Year Time-lapse” and “Holiday Lights on the Sun”. These visualizations allowed the newly launched GPM mission. Ryan oversaw the “first light” and subsequent visualizations which focused on hurricanes, super typhoons and snow storms. These visualizations allowed the public to see these storms at a much higher resolution.

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and to view the frozen layers atop hurricanes. Also during 2014, Ryan supported the Hurricane and Severe Storm Sentinel (HS3) campaign, producing three videos, a campaign kick-off and two instrument-focused videos.

In the coming year, Ryan will increase his support of the ICESat-2 mission, which will include documenting its departure from Goddard to Orbital in Arizona, and also complete the next two videos in the ATLAS series. Materials will be produced to expand on the IMERG/Week in the Life of Rain project. Ryan will work with the outreach team to create modules that incorporate the near real-time data and outreach team to create modules that incorporate the near real-time data and outreach materials to expand the ATLAS campaign.

As a multimedia producer, Dan Gallagher produces and edits videos that inform the public about missions and scientific research being conducted at Goddard Space Flight Center. As the lead video producer for the Planetary Department at GSFC, Dan provides video support for the Lunar Reconnaissance Orbiter (LRO), MAVEN, and OSIRIS-REx missions, as well as for general planetary research at Goddard. In September 2014, Dan wrote, produced, and edited a short video explaining how NASA's MAVEN mission traveled from Earth to Mars according to the laws of orbital mechanics, and how MAVEN used its thrusters to enter Martian orbit once it arrived. The video includes new spacecraft animations from Goddard’s Conceptual Image Lab studio and visualizations by the SVS depicting MAVEN’s trajectory before, during, and after the MOI maneuver. The video was posted on NASA Explorer (YouTube), nasa.gov, and the SVS archive on 09/28/14, and has received over 350,000 views to date on NASA Explorer. “Targeting Mars” was also broadcast on NASA TV during MAVEN’s arrival at Mars on 9/21, and the new animations were reposted on multiple websites including Slate.

In November, Dan co-produced and co-wrote “Asteroid Bennu’s Journey,” a signature animation showing the formation and evolution of the solar system as witnessed by near-Earth asteroid Bennu, the target of NASA’s OSIRIS-REx mission. The video was animated at the Goddard Conceptual Image Lab (CiLab) studio. “Asteroid Bennu’s Journey” was posted to NASA Explorer (YouTube), nasa.gov, the SVS archive, and Facebook, and the official OSIRIS-REx website of the University of Arizona, astromission.com.

In spring 2015, Dan produced, edited, and released three “Measuring Mars’ Ancient Ocean” videos to support a new measurement of the volume of water that existed on ancient Mars. Scientists Geronimo Villanueva (Catholic Univ.) and Mike Mumma (NASA/GSFC) used ground-based telescopes to measure the ratio of different isotopes of water vapor in Mars’ present-day ice caps, allowing them to determine that Mars once possessed an ocean covering approximately 20% of its surface. This new measurement is considerably lower than many previous estimates, raising the odds for the habitability of ancient Mars. Drs. Villanueva and Mumma announced their findings in the March 2015 issue of “Science.” Dan interviewed them, wrote and recorded narration, and worked with animators in the Conceptual Image Lab to create three edited videos supporting the finding: a long video, a short video, and a Spanish-language video. The Mars ocean story was featured on CNN, npr.org, Space.com, and Engadget. To date, the long video has received 607,000+ views on NASA Explorer (YouTube). See it here on the SVS Archive: http://svs.gsfc.nasa.gov/yt/31796.

Also in March, Dan produced and edited a video featuring the Lunar Reconnaissance Orbiter Camera (LROC) principal investigator, Mark Robinson, talking about his team’s discovery of present-day impact craters on the Moon. Dr. Robinson’s team compared recent pictures of the lunar surface with pictures of the same sites taken earlier in the mission, in order to search for subtle changes on the lunar surface. This technique led the LROC team to discover over 25 new impact craters on the Moon, including an 18-meter diameter crater caused by a lunar bright flash observed on March 17, 2013. “New Craters on the Moon” was released on NASA Explorer (YouTube), nasa.gov, and the SVS archive, and has received over 57,000 views to date on NASA Explorer.

Looking ahead, Dan will produce new science operations video for MAVEN, as he works in collaboration with MAVEN Principal Investigator, Bruce Jakosky. Dan interviewed Dr. Jakosky in December 2014 to discuss MAVEN’s upcoming stellar occultation campaign, deep dive maneuvers, and early science results. Also, new animations and instrument footage will be developed for OSIRIS-REx, as Dan works with animation lead Walt Feimer (HTSI) as well as with the PI of the OSIRIS-REx visible and infrared spectrometer. He will work with Goddard Planetary Scientist Veronica Pennek to produce instrument animations and footage of the Mars Organics Molecule Analyzer (OMA), which will be carried aboard ESA’s ExoMars Rover. MOMA builds on Goddard’s heritage of mass spectrometers, such as the Sample Analysis at Mars (SAM) instrument aboard Curiosity, while incorporating new laser desorption technology. He plans to film MOMA at Goddard before the instrument ships to Europe in mid-2016.

Robert Garner is involved in multimedia science communication including the creation of data visualization, science illustration, multimedia and video programs, interactive web and software products, and web features. This past year, after months of preparation, the redesign of NASA.gov was launched on April 20, 2015. The new nasa.gov design represents the most significant overhaul of the agency’s website in a decade. Under Robert’s direction, the Office of Communications Web Team of four manually rebuilt some 750 individual webpages to ensure Goddard (as well as Goddard-managed missions) had a wide share of the new language of nasa.gov. Additionally, Robert worked to redesign the Hubble Space Telescope page on NASA.gov (see sidebar on the Hubble’s 25th anniversary). As part of the MAVEN communications and outreach team, Rob- ert received a 2014 Robert H. Goddard Honor Award for his role. He assisted with live online coverage of the mission’s arrival and successful orbit insertion at Mars in September. Robert traveled to Wallops in July and October 2014 to provide real-time coverage for nasa.gov of Orbital’s CRS launches (Nos. 2 and 3). He main- tained the launch blog for both missions, the first (and second) time this function was carried out by Goddard. Traffic grew from about 25,000 launch-day page views for CRS-2 to about 100,000 for the first attempt of CRS-3. Although the ultimate launch circ- umstances for CRS-3 were unfortunate, the launch blog served a vital role in communicating contingency and area safety informa- tion.

The photo archives Robert has developed in earnest over the past several months have been relied upon to locate imagery to support a variety of functions, including the Nimbus 50th anni- versary, a documentary crew’s search for images of Sen. Barbara Mikulski’s visits in the 1990s (tied to Hubble), and the agency’s...
tribute to Leonard Nimoy, as well as a recent spate of historical stories about Apollo-era activities. Prior to the catalog Mr. Garner developed, supporting these activities and events would not have been possible.

Michelle Handelman Seff coordinates and produces satellite media tours across the spectrum of science disciplines at Goddard Space Flight Center. She produces short news videos and b-roll material for This Week @ NASA and NASA TV, as well as Goddard’s website, server and social media pages, and assists the media and documentary filmmakers with interview and file video requests. This past year, she organized a successful satellite media tour on April 24th to celebrate the 25th anniversary of the Hubble Space Telescope’s launch into space (see sidebar on Hubble). Michelle also conducted a satellite media tour on the breaking news that 2014 was the warmest year on record. She booked 23 interviews for her three scientists on this topic, and highlights included features on NBC Nightly News; LiveScience; and Radio Caracol, which is based out of Miami but also serves markets nationwide.

Michelle produced a satellite media tour to promote the Soil Moisture Active Passive (SMAP) mission ahead of its launch. She booked 23 interviews for the two mission scientists she was working with. Highlights included two hits with the Weather Channel, CBS News Radio; Fox News/Ed affiliate service and seven interviews with top 20 television markets.

Michelle conducted live shots to promote the Magnetospheric Multiscale (MMS) mission the morning of its launch. She organized 23 radio and satellite interviews as well as one-in-person interview for the three scientists participating in these live shots. Highlights include interviews on: WTOP radio, Washington, D.C.; Telemundo national morning news; Fox News/Ed affiliate service and radio Caracol, which is based out of Miami but also serves listeners in Spain and Colombia. In addition, six of the interviews conducted that day were with television stations in the Top 20 markets nationwide.

On two separate occasions, Michelle coordinated interviews at Goddard’s Visitors Center for Washington, D.C. ABC affiliate WJLA/News Channel 8. First, WJLA highlighted the new Solarium exhibit on its morning show. Next, WJLA’s meteorologist Eileen Whalen and the station’s server producer highlighted locations inside the Visitor Center including the Lunar Reconnaissance Orbiter exhibit and the Science on a Sphere theater. Upcoming media campaigns will include the September 28th Supermoon and total lunar eclipse happening the same day, the Arctic sea ice minimum in August, and a campaign focusing on technology in October.

Michelle will continue to build her media base as she reaches out to non-television outlets including more radio stations and online media outlets like Mashable.com. Also, she plans to explore more ways of integrating radio and in person interviews into her satellite media tour campaigns.

David Ladd is a Video Producer with Goddard Television, working in the Planetary Science division. David produces and edits videos for numerous NASA missions, including but not limited to the Lunar Reconnaissance Orbiter, MAVEN, and OSIRIS-Rex. David produced and edited two videos for “The Moon As Art” campaign. The first was a Hubbert promotional video designed to encourage viewers to visit the Lunar Reconnaissance Orbiter website to vote for their favorite image of the moon in the LRO collection. The public could vote on five images selected by the LRO team. The second was the feature video which explained the contest, showed the collection, and announced the winning image, available here: http://www.youtube.com/watch?v=4WtAM5ScT.

David was the Producer and Editor for “Goddard In the Galaxy,” a music video that highlights the many ways NASA Goddard Space Flight Center explores the universe. In making this promotional video, David worked with the world renowned band Fall Out Boy and their management team to obtain the licensing rights to their song, “My Songs Know What You Did in The Dark/Light Em Up.” Fall Out Boy liked the video so much that they shared and put it on their personal pages. Launched in conjuction with NASA’s presentation at the AGU conference, this video revealed the most recent findings by the Curiosity rover’s SAM instrument suite: variations in methane levels in the Martian atmosphere and the first definitive detection of organic molecules on the Red Planet. More information on SAM is presented in this report by Dr. Charles Malespin (Code 699). The video can be seen on YouTube: https://www.youtube.com/watch?v=R92S450JAJ or is searchable on the NASA Goddard SVG page.

David consistently helps produce and organize visuals for Goddard Television’s “Live Shot” news productions; this past year, Live Shots included the Meteor Shower production, 5/23/14; the Supermoon production, 6/6/14; the Moon Orbit Insertion production, 9/13/14; and, the Comet Siding Spring production, 10/17/14. These broadcasts connect with some of the country’s biggest news stations and television markets, as well as international channels and websites.

Michael Lentz creates animations and visuals to support NASA Goddard’s missions, science and education outreach for the office of communication in addition to providing creative and technical advice to the Conceptual Image Lab. This past year, Michael has been involved with OSIRIS-Rex mission. Michael has become a tent pole to push the Conceptual Image Lab animation capabilities. The plan is to refine the animation pipeline and push the look and feel of visual storytelling even further through the OSIRIS-Rex mission. “Bennu’s Journey” was released in the fall and had over 12.5 million views on the Goddard Facebook page in the first week of release. This was another ambitious animation project with many complex visual elements. Michael created 23 of the 31 animations used in the 6-minute-long film. The animation was created in USD 4k and was an important project in designing a pipeline for creating high resolution animations in the Conceptual Image Lab. The animation shows the formation of the solar system and how the aster- oid Bennu came to be and why OSIRIS-Rex will be going there to take a sample to return to Earth. Michael is creating concept art for the next OSIRIS animation “Journey to Bennu”.

Michael created several animations for the MAVEN mission to show its launch and deployment as well as the Mars Orbit Insertion (MOI). Another animation explained MAVEN’s deep dip orbital maneuver and showed the passing of comet Siding Spring. Another animation was one Michael created to show the laser scattering from the Cloud-Aerosol Transport System (CATS) module to be launched and installed on the ISS in addition to showing how the single laser is split into three beams. The animation “Neutron Star” created by Michael explained new observations on why the polar jets from a neutron star can dim at certain times.

Future work will involve creating 4k animations as more animations are starting to be created in this high-resolution format in the Conceptual Image Lab. Michael will be pushing the look of animations in the CI Lab, an example of which is spacecraft being shown to scale with people, using different visual styles and creating more photo real imagery. Additionally, Michael is currently training on zBrush, a new 3D sculpting program in the CI Lab, which will eventually be used to model 3D objects from terrain to spacecraft. “Journey to Bennu” is the next big animation project coming through
Brian Monroe has supported the Conceptual Image Lab to produce a number of animations for press releases, conferences, and live studio productions. The objective was to bring a different style and technique to the portfolio of Conceptual Image Lab while helping with some of the visual workload that the lab takes on with each year. In early September 2014, Brian helped create a stylized timeline for “A Selective History of Sea Ice Observation”, a video produced by Jefferson Beck that recounts significant events and pioneers in the sector over the millennium. The task was to create a unique look for the timeline that would engage and keep the viewer’s attention over the course of the animation and visually help the viewer with the sequence in which they occur. Brian helped create several animations for use in Thomas Madura and Francis Reddy’s presentation at AAS in January on the latest findings of the Eta Garaione nebula. The video short produced by Scott Weissinger showcases these animations and has received over 200,000 views on NASA Goddard’s YouTube channel. The video was highly praised at the AAS conference for its visuals. See https://www.youtube.com/watch?v=VQJbQv2x2to.

For Paul Mahaffy and Sushil Atreya’s presentation at the 2014 AGU Fall Meeting on Curiosity finding organic chemistry on Mars, Brian helped to turnaround a diagram depicting potential sources of methane of Mars for use in the presentation and in the media. Brian helped to produce several animations visualizing the movement of dust from the Sahara to the Amazon, used in a short production for a video produced by Jefferson Beck that recounts significant events and pioneers in the sector over the millennium. The task was to create a unique look for the timeline that would engage and keep the viewer’s attention over the course of the animation and visually help the viewer with the sequence in which they occur.

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Matthew produced nine new videos or multimedia items about Landsat science that were distributed through Landsat social media channels, the Goddard YouTube channel, and NASA’s Earth Observatory website. One of the videos illustrated how a pixel on a Landsat sensor is the same size as a baseball diamond. Another showed how Landsat uses the moon as a calibration reference. Others covered water quality, environmental monitoring, volcanoes in Siberia, and the changing date for snowmelt in the mountains of Wyoming. In support of a press conference at the annual AGU conference in December 2014, Matthew produced a video explaining Landsat’s role in monitoring a unique flow of water into the Lower Colorado River, and how it improved the vegetation along the course of the river. Additionally, he supported Dr. Allison Leidner’s presentation at the World Parks Congress. In the year ahead, he plans to produce videos on Landsat’s role in developing habitats for birds migrating through California, monitoring water usage by agriculture in Nebraska, and determining the amount of biomass in our nation’s forests. He also will work on producing a series of short videos featuring images from Landsat.

Beginning with Fiscal Year 2015, Matthew assumed a new role of Lead Producer for Code 610, the Earth Science Division at Goddard. In that role, he produced videos on some new instruments built at Goddard: the microwave radiometer for the SMAP mission, and the QATS instrument that is operating from the ISS. He also recorded an interview with Dr. Gavin Schmidt for a new episode of “Ask A Climate Scientist”.

Kayvon Sharghi oversees multiple storytelling projects and wears many hats to guide each project toward achieving its goals. Projects include reporting on NASA Earth science findings through digital platforms, producing new releases and strategic communications and storytelling. He is also managing the editorial content and release of stories on the NASA Visualization Explorer app. As editor of the NASA Viz app, Kayvon manages all aspects of the editorial process, including the scheduling, production and release of two new stories each week. In the past year, he directed the release of more than 100 new stories.

As Earth science producer, Kayvon produces video and animation products in support of NASA Earth Science news releases. This year he worked on multiple projects, many of which went viral on the web.

In addition to these projects, Kayvon directed the activities of 2014 Earth Science Multimedia Fellow Joy Ng. She oversaw the release of more than 30 video products created by her in support of communicating NASA Earth science results. He has participated in selecting and hiring a 2015 Multimedia Fellow to assist him in the creation of products. In preparation for the Fellow’s arrival, Kayvon drafted a 12-month work plan that details monthly objectives and expected output.

Kayvon also worked on the branding and launch of NASA On Air, a new platform for delivering NASA stories in short video packages that local and national TV weathercasters can include in their daily broadcasts. In June, Kayvon will present a talk about the project at the 2015 American Meteorological Society meeting and will meet with weathercasters from across the country.

Scott Wiessinger provides visual support for the WFIRST mission and Heliophysics and Astrophysics divisions at Goddard, which includes producing short videos, creating static graphics, guiding the creation of animations and data visualizations, creating animations, providing materials to outside media and producers, collecting, creating and organizing visuals for press conferences, and curating visuals online. Over the past year, Scott produced, co-produced, edited and/or animated 22 released videos, which videos ranged from animations, to breaking news footage of solar flares and CMEs, to narrated features about science results.

As of April 26, 2015, these videos accounted for a cumulative 5.2 million YouTube views. Additionally, Scott produced several products for specific events. He produced a booth video for the WFIRST mission at the Boston American Astronomical Society (AAS) conference in June 2014. For the January AAS conference, Scott created or supervised 11 hyperwall resolution animations for a lecture by Neil Gehrels. Scott’s largest achievement of the year was co-producing the digital art installation called Solarium. The installation used SDO data and opened at the Goddard Visitor Center in February 2015. It took two years to design and build the venue but production.

Although this resulted in a slight decline in the absolute number of videos released, he has done more with longer-form videos and continues to expand his skill set.

Scott has taken a smaller role overall with heliophysics and a larger one within astrophysics. In the last year he has produced a great deal of content for the upcoming WFIRST mission, including a publicly released trailer, the six-minute booth video, and nearly seven minutes of hyperwall content. Additionally, Scott has been engaged by the LISA gravitational wave group to produce a booth video and, potentially, other content for them. He is advising on the astrophysics-themed National Air and Space Museum event in late September, is supporting all the high-energy astrophysics science results, and is supporting the WFIRST, Fermi and Swift presence at the IAU and AAS meeting in Hawaii this August. Scott’s complete collection of work can be found here: http://svs.gsfc.nasa.gov/search/Person/WiessingerScott.html.
In addition to these two major accomplishments, Scott also had several releases that garnered a lot of attention. In October, he released an image of the Sun that resembled a pumpkin-o’lantern. The timing before Halloween was good, and the image received terrific exposure, featured by the following: The Wall Street Journal, Huffington Post, Mashable, Gizmodo, Discover Magazine, The Weather Channel, HLN, ABC, CNN, Slate, CBS News, and USA Today. It even showed up on television, when it was featured on the Today show.

In January, for SDO’s 100 millionth image, he created a photomosaic, which also did well online.

This year’s astrophysics releases were primarily results-driven and quite varied in nature. The first release of the year, on May 13th, also turned out to be one of the largest. Scott edited a video using 4k-resolution frames of a supercomputer simulation showing the merger of two neutron stars. The video now has 500,000+ views on YouTube. The variety of stories in high-energy astrophysics along with time constraints and budget constraints have led Scott to be flexible and creative with producing visuals. He has produced animations using an outside freelance and in-house animators, and on his own. The animations he has created include one of the most dramatic changes in the solar wind, an active galactic nucleus changing from one form of emission to another, and another active galaxy nucleus having an outburst that ripples through the expanding star formation. Scott also has made several illustrations, either as the primary visual for a story, or to compliment other story products, like videos or animations. These illustrations include a flaring red dwarf star, white-dwarf nebulas, and neutron stars experiencing “star quakes”.

There were many standard video releases as well this year. Two noteworthy ones were about the Eta Carinae binary star system and nebula. These videos included 3D-printed and animated models of the system and interviews with the scientists involved. One dealt with the best ever 3D map of the nebula and the other dealt with supercomputer simulations of the interactions of the two incredibly massive stars at the center of the nebula. This second video, on 200,000 views on YouTube, is excellent for the usually complicated topic of astrophysics.

This year marked the 10th anniversary of the Swift satellite’s launch. Scott worked hard to produce videos commemorating the event. One video showcased some of the important results from Swift over the last 10 years, while another, that was much more complex, used 11 interviews with scientists in the U.S., England and Italy. Some of these scientists had been with Swift from the beginning, and the longer-format video added depth to the history, accomplishments, and future of Swift with a personal touch. The Swift anniversary was also the spark to begin the creation of an infographic about Swift. After many iterations and additions, the infographic is about to be released as an image and poster. The poster will measure 2.500 copy print run and will appear at the August IAU/ASM meeting.

In addition to his regular high-energy astrophysics work, Scott spent most of May and December 2014 working on projects for WFIRST. He supervised animations, created a dramatic “trailer” for the upcoming mission, made a boots video which included new animations and animated titles, and created or supervised a series of hyperwall-resolution animations. Later, he made a similar booth video for the potential Laser Interferometer Space Antenna (LISA) mission that will search for gravitational waves in space. The use of that video was delayed, but there are plans for it in the future.

Finally, Scott worked with Neil Gehrels on developing a side project: a video series in which Neil has conversations with notable scientists about interesting topics, such as exotic black holes, and the end of the universe. They have shot two sets of conversations so far, one with Mario Livio, and one with Michelle Thaller. They plan to shoot one more before beginning to release the videos.

Upcoming projects include a gamma-ray constellation interactive for Fermi, as well as several videos about groundbreaking new techniques to process the Fermi data. Scott has been working on products for several upcoming releases including a simulation of dark matter orbiting a black hole, a fluctuating pulsar, and a flaring blazar. He also will be producing content for the upcoming IAU/ASM meeting. For WFIRST, Scott will be updating the hyperwall animations and booth video for the IAU/ASM conference. During the conference, in Hawaii, he will visit one of the facilities constructing elements for the WFIRST space telescope. Scott will be attending and some of the engineering and construction of those elements.

CODE 606.4 (sponsor: H. Mitchell)

This year, Tom Bridgman generated products that covered a broad scope of NASA missions. It was recently reported that a June 23, 2012 coronal mass ejection (CME), which struck the STEREO-A spacecraft, had such high speed and intensity that it might have been similar to the Carrington Event of 1859 that disrupted early electrical networks. Since this was an event that would probably be referenced extensively in future stories and releases, Tom requested and received an Enlil model run of the event from the Community Coordinated Modeling Center (CCMC). He rendered a version of this dataset using the quick-turnaround space weather pipeline. With this event also being observed by the Solar Dynamics Observatory (SDO), STEREO-A, and STEREO-B, Tom retrieved these datasets and generated several animations with them. The animations are regarded as largely complete, but are awaiting an opportunity for a coordinated release. (On the SVS, animation IDs are 4167, 4172, 4172, and 4177.) See http://svs.gsfc.nasa.gov/search/series/TheCarringtonClassCMEs2012.html.

Additionally, two GOCSC scientists generated a BATS-R-US (Block-Adaptive-Tree-Solarwind-Roe-Upwind-Scheme) model run of Earth’s magnetosphere under the impact of a Carrington-Class CME. Tom completed a project using this simulation. To make the product useful for comparisons, December 2006 BATS-R-US data of a smaller CME was used for a matching visualization. The products were released in late September 2014 as part of CME Week. Tom was also asked to narrate a short audio clip for the release. See http://svs.gsfc.nasa.gov/search/series/ComparativeMagnetospheres.html.

In support of Magnetospheric Multiscale (MMS) Mission Media Day on December 17, 2014, Tom collected and organized NASA media into playlists for the NASA Center for Climate Simulation (NCCS) hyperwall. For this effort, he also continued a development project on a short script to convert hyperwall playlists into a more human-readable report linking the hyperwall playlist entries to the entries on the SVS website. Additionally, in preparation for the launch of the MMS mission, there was interest in a visualization of a July 2012 CME that struck Earth’s magnetosphere. Tom requested a model run from the CCMC of the event. Using the framework being developed for standardizing the magnetosphere visualizations, Tom opted to do this during the quiet time between major projects. The following five visualizations were released on the Heliophysics Education Resources web page (http://svs.gsfc.nasa.gov/gallery/HeliophysicsEducationResources.html): Gromon-2D (#4261), Gromon-3D (#4262), Magnetic Gradient (#4263), E & B Parallel-Byrdcurrent (#4264), and E cross B drift (#4265).

Other work outside of generating these products included Tom’s work on maintaining the SVS Heliophysics Website Gallery with new releases (http://svs.gsfc.nasa.gov/Gallery/NASA’Sun-EarthGallery.html). Several SVS resources of more general interest that illustrate more general concepts and principles were collected into a Heliophysics Education Resources Gallery (http://svs.gsfc.nasa.gov/gallery/HeliophysicsEducationResources.html). Also, some Heliophysics producers have expressed interest in implementing the Noise-Adaptive Fuzzy Equalization (NAFE) image processing algorithm for SDO images, which appears to be relatively simple to implement. (See, for example, this report: http://tpc.nsf.gov/0067/0067-2007/25/25, http://www.zm.fime.ub.es/~druck/NAFefile/index.html). Tom’s initial implementation in Python works well but is single processor and very slow compared to the author’s highly optimized multicore version written for Windows. Tom’s project continues to work on a multicore version that can process a wider variety of image formats than the author’s version and run on the SVS rendering cluster.

Leann Johnson provides the Scientific Visualization Studio (SVS) with a highly visible and accessible representation of the greatness and diversity of the group. Software development is focused on but not limited to the database, website, and hyperwall systems. This past year, Leann added in the completion of the transition of the entire SVS website from static HTML webpages to a combination of static and dynamic HTML5/CSS3 webpages using the Bootstrap 3 framework and created a public user that combines several pages’ worth of content from the old website into one consolidated page in the new design. Leann also developed a dynamic script to display the top and bottom navigation bars that appear on every web page to maintain consistency from the geomagnetic field as well as drift motions in the appropriate directions. He integrated this particle set into the rendering system and also included the radiation belt model from a previous release for the Van Allen Probes. A release involving the plasma-sphere was scheduled, and Tom adapted the above framework to include the plasmasphere boundary into a visualization for this release. Development will continue on the ring current component as time permits. See http://svs.gsfc.nasa.gov/goto/4241.

Using the particle simulation code employed in the radiation belt and plasmapause model release mentioned above, Tom generated five simple simulations of positive and negative charged particle motion in several basic electric and magnetic field configurations. While such animations of basic plasma processes had been discussed, there had not been much commitment. Tom opted to do this during the quiet time between major projects. The following five visualizations were released on the Heliophysics Education Resources web page (http://svs.gsfc.nasa.gov/gallery/HeliophysicsEducationResources.html): Gromon-2D (#4261), Gromon-3D (#4262), Magnetic Gradient (#4263), E & B Parallel-Byrdcurrent (#4264), and E cross B drift (#4265).

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Leann created a new pipeline that results in a movie being released the software and made it available to all users, and create it or save any new changes. With all data migrated to a subset of frames and have the ability to add a watermark for drafting purposes. She also added the ability to encode frames in any order, with added support for encoding higher-resolution MPEGs, including 4K and UltraHD. The implementation of these features ultimately made svsmovie faster and more robust.

Several updates were made to the graphical hypewall editing software for greater efficiency and stability. Leann updated the hypewall show writer to incorporate changes that Eric Sokolowski made to the underlying tools. Special character support was also added. Leann supported new and existing hypewall content for various demonstrations held at NASA or off-site locations, which included creating or updating hypewall shows and facilitating metadata entry with other team members into the current hypewall database system. In particular, Leann assisted Horace Mitchell in developing an automatically updating hypewall show from IMERG data. Additionally, Leann supported the operation of the hypewall at the Earth Day event in Washington, DC.

Alex Kekesi provides visualizations and is the lead data visualization for the Global Precipitation Measurement (GPM) mission team. Alex was a key player in providing visual content for many of the GPM outreach activities, which led to NASA Goddard granting him a 2014 Robert H. Goddard Honor Award to the GPM Outreach Team. During this reporting period, Alex not only halved GPM animation turnaround times from 12 to six hours (thereby making quick-turnaround visualizations possible within a single 8-hour work day), but he also added the capability to visualize GPM/ DPR’s complex volumetric radar data in a unique new way. Alex also trained new SVS hire Kel Elkins to act as backup for the GPM visualization pipeline to ensure GPM visualization products are turned around in a timely manner and consistently. Alex also continued to maintain the Web Map Service (WMS) that provides an "overlay" for the climate model, showing users visualizations of the various parameters and processes. The WMS is a "window" into the climate model, showing users visualizations of the various parameters and processes. The WMS is a "window" into the climate model, showing users visualizations of the various parameters and processes. The WMS is a "window" into the climate model, showing users visualizations of the various parameters and processes. The WMS is a "window" into the climate model, showing users visualizations of the various parameters and processes.

Eric Sokolowski continued to develop and maintain software for running the hypewall, a cluster of machines connected to a tiled display used to convey NASA science to the public. He updated the Digital Earth PC program (used to show much of the hypewall content) to use the newest versions of FLTK, a programming graphical interface toolkit, and OpenGLGraph, a graphics rendering toolkit. He also built virtual machines to make the building of all the hypewall software and other support software easier to automate and standardize. He completed the adaptation of bigvug, a program developed for hypewalls by NASA Ames Research Center, to the hypewalls used at NASA Goddard Space Flight Center. He also completed a program to create text caption images dynamically and automatically, making it much easier to create and update captions shown at hypewall events. He added a way to more easily change the orientation of the master screen on each hypewall, since sometimes a portrait orientation is needed and other times a landscape orientation is needed. He also fixed many bugs and added many other small features to the hypewall software.

Much effort went into getting new machines to work with the hypewall. NASA purchased new machines by XIG Corp. that are very small and efficient, ideal for use when traveling, and Eric installed Fedora 20 Linux on these machines; they have been very successful at running the hypewall. The older Mac Minis running Fedora 17 have been discontinued since the new machines are much faster and more reliable. He provisioned three sets of the new machines for use when traveling. Also, in order to foster communication among hypewall content developers and users, Eric created a mailing list through the NASA mailing list facility. At the request of Goddard TV, Eric and other team members conducted two different sessions of training on the creation and use of hypewall technology.

Eric also continued to maintain the Web Map Service (WMS) that has been developed for use by NASA Center for Climate Simulation (NCSS) and its customers and users runs on the Earth system model called the Goddard Earth Observing System (GEOS) and the users of NASA’s Goddard Earth Observing System (GEOS) and the users of NASA’s Goddard Earth Observing System (GEOS).
Eric continued to travel to conferences and meetings in support of the hyperwall and NASA’s public outreach efforts. NASA routinely travels with the hyperwall system to display at various scientific meetings where NASA scientists explain their research in front of an audience. Eric provided support to load presentation material, ran the presentations on behalf of the presenters, and provided technical support for the hyperwall system. This past year, he traveled to the following meetings with the hyperwall system: the Japan Geoscience Union Meeting, Yokohama, Japan; the launch of the Orbiting Carbon Observatory 2 (OCO-2), Vandenberg, CA; the Asia Oceanias Geosciences Society Annual Meeting, Sapporo, Japan; the Supercomputer, Beijing, China; the United Nations Framework Convention on Climate Change (UNFCC) Conference of Parties (COP) meeting, Lima, Peru; the AGU Fall Meeting, San Francisco, CA; the American Meteorological Society Annual Meeting, Phoenix, AZ; the National Council for Science and the Environment Meeting on Science, Policy and the Environment, Crystal City, VA; and the NASA-run Earth Day event at Union Station, Washington, DC. He also helped prepare machines and content for use at many other meetings held around the world. After each meeting he brought the content changes back to the main server to be archived or reused at future events.

Future work will involve the exploration of using CentOS7 to see if it will be suitable for use on the traveling hyperwall systems. CentOS is maintained longer than the Fedora Linux currently used on the hyperwall systems, and using CentOS should provide a more stable platform for longer use and easier updates; also, all of the machines will be able to use CentOS, reducing effort in maintain- ing multiple operating systems. Eric still plans to experiment with running multiple screens from a single machine, reducing power requirements and transportation costs, and also aims to finish the development of the 3D structure of the atmosphere and shader networks to access the data. He created appropriate animations for a news release about research showing that the collapse of the West Antarctic Ice sheet is inevitable. The result was titled “West Antarctica Collides with the Ice Age” and was published in Geophysical Research Letters (115,000 years old). He incorporated two 150-meter resolution datasets of the surface elevation and bedrock provided by Mathieu Morlighem (University of California, Irvine). He created a lofted surface based on an OIB flight over the northern part of Green- land and mapped the radar stratigraphy data from the flight onto its surface. She generated curves from the dataset defining 156 traces through the radiostratigraphy data and added them to the scene, and corrected and incorporated the P3 aircraft object into the scene.

Several rough-cut versions of the animation were created for review by the scientists and other SVS visualizers. She incorporated the feedback into the product design, improving the quality of the final animation. She received an updated dataset of the surface, bed and thickness of the Greenland ice sheet from Morlighem, and incor- porated the new data into the scene. The producer provided the final animation in early December 2014 and Cindy revised the animation to match the timing of the new audio track. The final animated frames were delivered to the producer to be integrated with live footage into the final movie. Cindy prepared and submit- ted a revision of this animation to the 2015 SIGGRAPH Computer Animation Festival.

Cynthia Starr works on visualizations, primarily on but not limited to Greenland and Antarctica. In support of the Opera- tion IceBridge science team, Cindy worked cooperatively with the producers at JPL, and with glaciologist Eric Rignot to provide animations for a news release about research showing that the collapse of the West Antarctic Ice sheet is inevitable. She focused the animation on the area around the Amundsen Sea, identifying the glaciers and ice shelves in the region, and incorporated velocidadity flows along with data showing an increase in ice sheet velocity. She used vector data of grounding line locations derived by the Smith glacier. A line of the Smith glacier had retreated inland over time. Cindy provided two versions of the animation to JPL editors, who in turn generated a narrated movie. “West Antarc- tic Glaciers: Past the Point of No Return” used a collage of live footage and animation segments to explain the changes that are occurring on the West Antarctic Ice Sheet. “Runway Glaciers in West Antarctica” was an edited version of the original animation.

Cindy developed an animation in support of the Operation Ice- bridge science team (see “Eating the last 200 meters of Greenland ice sheet. Joseph MacGregor (University of Texas, Austin) provided 3D data that depicted the age of the ice sheet from the present back to 130,000 years ago. Cindy wrote several programs in IDL to process the raw data into a format that could be used in the animation software. She integrated this data into her scene and generated two cutting planes, reflecting the age of the ice sheet on the cutting planes. She derived two surfaces from the age data depicting the ice remaining from the last ice age (more than 11,700 years ago) and also from the Eemian period (more than 115,000 years old). She incorporated two 150-meter resolution datasets of surface elevation and bedrock provided by Mathieu Morlighem (University of California, Irvine). She created a lofted surface based on OIB flight over the northern part of Green- land and mapped the radar stratigraphy data from the flight onto its surface. She generated curves from the dataset defining 156 traces through the radiostratigraphy data and added them to the scene, and corrected and incorporated the P3 aircraft object into the scene.

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Cindy designed an animation to portray the snow cover over North America and the ice that formed on the Great Lakes during the cold 1913–2014 winter (see http://svs.gsfc.nasa.gov/cgi-bin/ details.cgi?id=4256). Data was downloaded and processed for the snow cover and the lake ice, and Cindy created a Maya scene and shader networks to access the data. She created appropriate outline masks of the US state and Canada provincial lines as well as an outline of the Great Lakes. Several rough-cut versions of the animation were provided to the scientists for review. Revisions were made based on their recommendations; Cindy then finalized and rendered the animation, and generated a hyperwall version of this animation.

Cindy worked on several more animations related to sea ice. She created an animation comparing the area, volume, and depth of the average September Arctic sea ice in 1979 and 2013 using data from the Pan-Arctic Ice Ocean Modeling and Assimilation System. She obtained the data from Horace Mitchell, who had prepared the data for the animation. She generated several terrains of the animation before a final look was approved. For AMSR-2 Sea Ice Animations (see http://svs.gsfc.nasa.gov/cgi/bin/details.cgi?id=4219, http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?id=4218), Cindy used the AMSR-2 daily sea ice concentra- tion and the 89 GHz brightness temperature data to generate an animation of the melt of the Arctic sea ice during the summer of 2014. She used similar data for the South Pole to generate an animation of the growth of ice over the Antarctic to the maximum extent in February 2015.

Since joining the Science Visualization Studio (SVS) in October 2014, Kel Elkins has created several visualizations to support NASA’s earth science missions and research. Kel has visualized data from the Global Precipitation Measurement (GPM), Aquarius, and CALIPSO satellites. He also has worked on development proj- ects to improve visualization processes within SVS.

Kel produced ‘quick-turn’ storm visualizations using data from the Global Precipitation Measurement (GPM) satellite for storms occurring on the West Antarctic Ice Sheet. “Runaway Glaciers in West Antarctica” was an edited version of the original animation. The result was titled “West Antarc- tic Ice Sheet: Past the Point of No Return” used a collage of live footage and animation segments to explain the changes that are occurring on the West Antarctic Ice Sheet. “Runway Glaciers in West Antarctica” was an edited version of the original animation.

Kel produced ‘quick-turn’ storm visualizations using data from the Global Precipitation Measurement (GPM) satellite for storms including both 2D (rectangular and mollweide projections) and 3D representations. High-resolution (15760 by 4320 pixels) hyperwall versions also were created.

In February 2015, Dr. Hongbin Yu (an atmospheric scientist at University of Maryland, Baltimore County who works at NASA Goddard) published a paper providing the first satellite-based estimate of phosphorus dust transport between Africa and South America. To support this publication and the associated NASA press release, Kel developed a series of visualizations depicting dust in the atmosphere traveling from Africa across the Atlantic Ocean towards South America. He developed a method to visualize dust - flux - showing the seasonal variations in dust quantities transported through a region. Dust routes were also visualized in a way that could be compared to Google Earth. Some of these images were used in Dr. Yu’s published paper, and many of the visualiza- tions were used in a short video that was released by the Goddard Media Studio. The dust trans- port story, along with supporting graphics and videos, was pub- lished on many media websites, including Time, the Washington Post, and the...
Huffington Post.

Upcoming plans include work on a visualization comparing early data from the CATS instrument onboard the International Space Station with similar data from the CALIPSO satellite, and an aircraft that was flown under both satellites on a mission to validate the data. Kel is working on a method to automate the creation of storm routes and labels within the SVS visualization pipeline using external storm track data. He will be providing early visualization support for the Joint Solar System (JSSS) mission.

Helen-Nicole Kostis continues to serve as the Project Manager of the NASA Visualization Explorer (NASAViz), a free iPhone, iPad, and iPod app that provides access to visualizations of current NASA research. Through the app, two visualization-based science stories are released per week about cutting edge research efforts in Earth and Planetary science, Helioseismology, and Astrophysics. The stories present the data visualization work of many NASA groups, including NASA’s Scientific Visualization Studio, Earth Observatories, and the Space Telescope Science Institute. The app’s archive of 391 stories (as of 04/25/15) includes animations, erotic images, and descriptive text. The Nasaviz app and content are developed and produced in-house by an interdisciplinary team. In addition to search capabilities, the app includes teacher-requested features, such as the ability to save stories for offline use and to create, save, and share custom playlists of stories. The app includes social networking interfaces to Facebook and Twitter for easy sharing of stories. The project is comprised of two teams: (i) Software Development and User Interface Design and (ii) Editorial (Editor: Kayvon Sharghi).

Over this past year, NASA Viz released two updates. On August 29th, Version 1.9.2 update was released to address bug fixes and a revised mechanism for parsing stories within the app. On March 10th, Version 1.9.3 update added push notifications, improved the appearance on iOS8, added Apple Share Sheet support on iOS8, and improved the parsing of stories within the app and addressed various bug fixes. Ninety-seven visualization-based stories were released covering all NASA Science themes: Earth, Planets, Sun and the Universe.

The NASAViz was recognized with two awards this year. At the 2015 Vizizzies, NASAViz won the NSF Choice Award for Games & Apps, a second grade teacher in Lambertville Michigan, shared this about the NASAViz: “NASA adds new articles and visuals twice a week, creating the most up-to-date app a teacher could dream of.” NASAViz was featured at the Earth Day 2015 events at the National Mall (April 17-18, 2015) and at the Union Station events (April 21-22, 2015). Thousands attended the events, and tailored presentations were provided to teachers and students. To read more about the National Mall events and a review of the NASA and NASAViz presence, please see the article “NASA among Rock Stars at DC Earth Day concert”: http://www.spaceflight Now.com/articles/nasa-rock-stars-dc-earth-day-concert/.

Last year, Helen-Nicole launched the ICESat-2 Collaborative Student Project. For the purposes of this project, she collaborates with digital media faculty and students from academic institutions for the development of innovative outreach concepts and products for the ICESat-2 mission. During the past year, Helen-Nicole worked in collaboration with Bowling Green State University. From the end of August to mid December 2014, she worked with faculty member Bonnie Mitchell and a group of students. At the end of this period, the students presented seven proposals to the ICESat-2 team. Additionally, she worked in collaboration with the Savannah College of Art & Design. From September 1st December 18th, Helen-Nicole led the production development of outreach in collaboration with SCAD students and a faculty member. On December 18th, Helen-Nicole delivered to the ICESat-2 team the following products: 1) an animation (1.5 mins) - SD resolution; 2) 2 characters/mascots for the mission; 3) a poster; 4) a lenticular bookmark; and 5) design (wireframes and photo-real) of the new ICESat-2 website. From mid-February to early April 2015, Helen-Nicole worked with three SCAD students for the development of a double-sided poster with original artwork for the ICESat-2 mission.

Upcoming events and plans include participation at the World Science Festival, NY, NY, in May 2015, where she and Kayvon Sharghi will showcase the NASAViz, a redesign of the app’s User Interface, and an expansion of collaborations and partnerships within the NASA ecosystem. Helen-Nicole will continue to assist the NASA ICESat-2 EPO team and lend Product Management skills for the development of digital media products. For the ICESat-2 Collaborative Project, she will continue to develop collaborations with academic institutions and students for the development of innovative outreach media.

Trent Schindler translated research from Lok Lamsal (Code 614) and others that demonstrated a reduction in nitrogen dioxide across the U.S. into a set of visualizations. He created a visualization showing tropospheric column concentrations of nitrogen dioxide as detected by the Ozone Monitoring Instrument on NASA’s Aura satellite, averaged yearly from 2005-2011. These visualizations immediately went viral and were published in blogs such as Popular Science, Discover, BoingBoing, Smithsonian, Gannado, and CNN, among others. Work was also highlighted on NASA Goddard’s website: http://www.nasa.gov/content/goddard/new-nasa-images-highlight-us-air-quality-improvement/#.VWiq989VhBd

Trent also created a visualization showing soil moisture measurements taken by NASA’s Aquarius instrument from September 2011 to September 2013. And he created an updated version of an animation showing two cases: the ‘World Avoided’ case, where the rate of CFC emission into the atmosphere is assumed to be that of the period before regulation as a result of the Montreal Protocol, and the ‘projected’ case (World Expected), which assumes the current rate of emission, under regulation. Both cases extrapolate to the year 2065. The new animation incorporates chlorine into the date. Trent will continue to provide visualization support to the SVS, while working towards a master’s degree in International Science and Technology Policy at George Washington University.

Ernest Wright has greatly expanded LRO’s presence on NASA’s hyperviz player display system. The hyperviz is used to exhibit NASA mission diagrams, simulations, and hyperviz player. The NASA Center for Climate Simulation (NCCS) hosts a permanent hyperviz installation at GSFC’s building 8L. Hyperviz allow also to scientific and public outreach events around the world. LRO hyperviz content was used at the AGU Fall Meeting in December 2014 and at the April 2015 Earth Day event at Union Station in Washington, DC.

Over the past year, Ernie has created the cover art for several publications, including the May 28, 2014 Geophysical Research Letters, the October 2, 2014 Nature, and the December, 2014 Journal of Geophysical Research: Planets. These are searchable on the SVS page at http://svs.gsfc.nasa.gov/index.html respectively at 4175, 4218, and 4258, respectively. He also created visualizations of the Apollo 11 landing site, the appearance of the Moon’s phases on the side never seen from Earth, and seen in the figure below, the shadow of the Moon crossing the Earth during the March 20, 2015 total solar eclipse. As with the above visualizations, these are available on the SVS page at 4185, 4253, 4275 (solar eclipse), and 4193, 4236, 4237, and 4242, respectively.

Since joining the Science Visualization Studio (SVS) in January 2015, Cheng Zhang has created several visualizations to support NASA’s earth science missions and research, including Mega- droughts, CCMP – Winds over Ocean Salinity, and The Lightning Project. For the Megadroughts project, Cheng created an animation showing the Southwest Central Plains Project of the United States in the second half of the 21st century, drier conditions longer than experienced in the past 1,000 years.

COMP – Winds over Ocean Salinity is an ongoing project led by Jessica Hausman and David Moroni at JPL. The goal is to visualize the motion of wind, changes of ocean salinity, and the potential relations between the winds and ocean salinity. Cheng has
finished two preliminary animations – the winds over salinity of the entire earth range and those of the selected region. The Lightning Project is led by NOAA scientist Scott Lottusky. The research focuses on the evaluation of ground-based lightning detection networks relative to satellite observations, and the development and evaluation of operational lightning products including the detection of wildfires from space. Cheng has provided visual support to the research and public outreach with regards to the coming storm season. During her work on this project, Cheng has encountered several challenges, such as simulating the lightning that occurs in a lightning event, but the goal will be achieved.

On February 9, 2015, Cheng gave a talk titled “Enhancing Learning Experiences in Interactive Digital Media” hosted by the Program of Art and Technology at the University of Texas at Dallas. She introduced her research in virtual reality, game design, and gamification of Art and Technology at the University of Texas at Dallas. Two months later on April 16th, she gave a seminar titled “Enhancing Learning Experiences in Digital Media” at the School of Interactive Games and Media at Rochester Institute of Technology. In this talk, she discussed the research and work from the Scientific Visualization Studio at NASA Goddard Space Flight Center. Future plans involve the submission of a book chapter for “Geogames and Geoplay: Game-based Approaches to Geo-Information” in June, participation in the workshop “Introduction to IDL” in July and participation in the SIGGRAPH conference in August.

The first task is acting as the primary point of contact for NASA’s Earth Science Divison’s science exhibit outreach and product development. For the ESD, the team provided support to several conferences over this past year. In June 2014, Our Oceans Conference was hosted by the Department of State (DoS) in Washington, DC. The U.S. DoS chose NASA’s hyperwall as one of the exhibits at the Ocean Science Meeting hosted by Secretary John Kerry. The SPSO organized the NASA team, working closely with senior management from ESD at NASA’s Goddard Space Flight Center (GSFC) and with External Affairs at NASA Headquarters to identify existing NASA science content that could be used to support the themes of the conference. One highlight was when Secretary Kerry and Leonardo DiCaprio stopped by Eric Lindstrom’s presentation.

At the Orbiting Carbon Observatory-2 (OCO-2) Mission Launch, Vandenberg Air Force Base, CA, June 28–July 1, 2014, the SPSO team provided support, which included writing, design, and production of the OCO-2 mission brochure and lenticular card, as well as administrative, technical, science visualization, and logistical support for the “L-minus-2” guest event prior to launch. In October 2014, at The Climate Symposium, Darmstadt, Germany, they organized a joint international hyperwall presentation for the symposium. Interagency and international participants included NOAA, the European Space Agency, EUMETSAT, and other international partners. The objective was to convey the importance of international Earth-observation and climate science programs. NASA presenters included Dr. Michael Freilich, Director of NASA’s Earth Science Division, and Dr. Jack Kaye, Associate Director for Research, NASA’s Earth Science Division. In December 2014, at The 20th Conference of the Parties (COP 20) held in Lima, Peru, SPSO worked with NASA HQ management and the DoS to formulate NASA’s contribution to the U.S. Center exhibit which included several hyperwall presentations. Images from the Global Precipitation Measurement (GPM) mission of Typhoon Hagupit as it approached the Philippines were featured on the hyperwall within days of being acquired. This kind of up-to-date display helped to highlight the important role satellites play in monitoring the Earth. NASA’s delegation consisted of Dr. Jack Kaye, Dr. Michelle Gerach, (NASA Jet Propulsion Laboratory (JPL)), Dr. Piers Sellers (GSFC), and Daniel Irwin (NASA Marshall Space Flight Center). SPSO staff members also were in California in late January 2015 when the SMAP Mission launched. As part of the Soil Moisture Active Passive (SMAP) Mission Launch Guest Operations in Buellton, CA, the team provided support which included writing, design, and production of the SMAP mission brochure, as well as support of the “L-minus-2” guest event prior to launch. SPSO worked closely with the SMAP Education and Public Outreach team from JPL and GSFC to organize a slate of speakers to give hyperwall presentations at the guest briefing. These activities were tweeted through the @NASAhyperwall Twitter account.

SPSO staff worked to secure an agreement for “Our Planet Earth” display, an Earth science exhibit at Dulles Airport. They developed and designed the science stories (adapting some existing material) and oversaw installation of the display in the train park to the A gates at Dulles. This exhibit will be on display from April 12 until at least May 29. Also in Washington, DC, for Earth Day 2015, SPSO staff played a lead role in coordinating NASA’s activities for the 45th Earth Day. NASA had activities at two different venues: one at the Global Citizen 2015 Earth Day on April 17–18 on the National Mall, and another at the kickoff for the official exhibits at the Ocean Science Meeting hosted by Secretary John Kerry and Leonardo DiCaprio stopped by Eric Lindstrom’s presentation.

Science Program Support Office (SPSO)  
Over the past year, the Science Program Support Office (SPSO) (sponsored by S. Platnick), which consists of Global Science and Technology (GST) staff members, provided support on three different tasks. The success of these endeavors requires contributions from the entire team, which includes Winnie Humberson (lede), Ryan Barker, Sally Bonnusen, Steve Graham, Heather Hanson, Marti Jentoft-Nilsen, Mark Malanoski, Debbi McLean, Kevin Miller, Amy Moran, Ishon Prescott, Cindy Trapp, and Alan Ward.

SPSO staff worked closely with Earth Day Network and NASA HQ’s Office of Communication to secure a high-profile stage time for NASA’s Administrator to appear on the Global Citizen stage with “will.i.am” to deliver a short message to the public on the importance of understanding our own planet. GSFC’s Piers Sellers joined the VIP stage and another at the kickoff for the official exhibits and with Secretary John Kerry and Leonardo DiCaprio stopped by Eric Lindstrom’s presentation.

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When the Global Pre-
with Lesley Ott (GSFC GMAO) to generate a hyperwall version of a new GEO-S global atmospheric carbon dioxide visualization. At the Fall 2014, new hyperwall stories and posted them on the SVS hyperwall website. These stories include Projected Suitable Habitats for Whitebark Pine: Climate Change in Yellowstone; ENSO Sea Surface Temperature Anomalies; 2009-2010; ENSO Sea Surface Anomalies: 1997-1998; Global Sea Surface Temperature and Winds; North Atlantic Sea Surface Temperature and Winds; Surface Winds Colored by Velocity; Global Surface Winds; and California Drought. They also created the following: a new graphic for use on the hyperwall for a presentation on Earth’s Complex Natural Systems; new visualizations showing seasonal land cover change in Hokkaido, Japan using Landsat-8 imagery; a nighttime image of Japan using the most recent Suomi NPP VIIRS day night band nightlights mosaic from May 2014; and an updated visualization of global CO₂ from DMI. Further, a hyperwall version was created of an SVS visualization that showed the improvement in U.S. air quality between 2005 and 2011, and SPSO staff coordinated with GMAO modellers to have a new global CO₂ visualization created for the hyperwall.

SPSO staff members are preparing for many upcoming meetings and symposiums in the coming year: the International Symposium on Remote Sensing and the Environment (ISRSE), Berlin, Germany, May 11–15; the XIX General Assembly of the International Union of Geodesy and Geophysics (IUGG) Prague, Czech Republic, June 22–July 2; the International Geoscience and Remote Sensing Symposium (IGARSS), Milan, Italy, July 26–31; the Asia Oceania Geosciences Society (AOGS), Singapore, August 2–7; and the Conference of the Parties (COP-21), Paris, France, November 30–December 11. Staff members are adding to the Understanding Earth series of booklets, and work will continue with upcoming issues of the Earth Observer Newsletter, which is published six times a year. The hyperwall, and SPSO staff will create visualizations that feature data from new missions (such as GPM, OCO2, SMAP, CATS, RapidScat, etc.), update popular but older visualizations with current data; and address the Earth Right Now campaign messages.

Under their second task, SPSO staff (sponsor: S. Platnick) acts as the primary point of contact for NASA’s Science Mission Directorate’s science exhibit outreach and product development. In October 2014, the Geological Society of America’s (GSA) Annual Meeting was held in Vancouver, Canada. Science Program Support Office (SPSO) staff attended the talk included organizing the hyperwall presentations, creating announcements and display slides for the hyperwall, and providing technical assistance to the speakers. The talks were very well attended, with standing-room-only every evening. In December 2014, at the 2014 American Geophysical Union (AGU) Fall Meeting was held in San Francisco, CA, the SPSO team coordinated a 40×50-foot interagency science exhibit that was staffed by over 40 exhibitors from NASA HQ, GSFC, GSC, ARC, WFF, and JPL. Fourteen missions and programs were represented along with other NASA-funded institutes. Thirty hyperwall stories and 47 in booth talks on a variety of subjects were very well attended. Hyperwall presenters included Dr. Michael Freilich, Director of NASA Earth Science Division; Dr. Jack Kaye, Associate Director for Research, NASA Earth Science Division; Mers Sellers, Deputy Director, Sciences and Exploration Directorate at GSFC; Jim Green, Director of the Planetary Science Division at NASA HQ; and Jeffery Newmark, Director of the Earth Sciences Division at NASA HQ. In addition to the science exhibit, staff organized a Community Meet and Greet for all the NASA exhibitors. This informal gathering was an opportunity for the SPSO staff to come together and share information and lessons learned from previous AGU Meetings. A Q&A discussion featured Jack Kaye; Lawrence Friedl, Director, Applied Sciences Program, Earth Science Division; and Dr. Ming-Ying Wei, Manager of Education Programs, Office of Earth Science. Most recently, in January 2015, the American Astronomical Society (AAS) Annual Meeting was held in Seattle, WA. The SPSO team organized and managed NASA’s science exhibit and served as NASA’s POC at the conference. Seven NASA programs participated, including NASA’s Astrophysics Division and NASA’s Postdoctoral Program. Hyperwall topics organized by SPSO included Hubble, James Webb Space Telescope, WFIRST, Sofia, Kepler, NICER and Herschel, and ranged in scope from Dr. Frank Summers’ dramatic 25 Years of Hubble and Dr. Ira Thorpe’s approachable Listening to the Universe with Gravity and Gravitation Waves to the more detailed presentations such as Dr. Eric Smith’s James Webb Space Telescope. SPSO staff created communication products in addition to providing support, as described above. Again this year, they created the interior and exterior design and layout of the 2015 Science Calendar, wrote and edited the captions, and then worked with representatives from each division at NASA HQ on final reviews. A 508-compliant electronic version was prepared for posting on the EOS/SPSO website.

SPSO staff worked together to produce multiple items and signage for the 2014 Fall AGU Meeting, including hyperwall agenda posters, kiosk agenda displays, and the events program. A detailed design and layout for NASA’s 40×50-foot exhibit space was created for the event contractors as well as the exhibit staff. Additionally, SPSO Staff created an ebook Hyperwall QR code advertising for the hyperwall, included in video loops during conferences.

The hyperwall was the centerpiece of the meetings described above, and much effort has been devoted to developing new content and maintaining the system. SPSO staff have generated a hyperwall version of a popular morph of Hubble Monocerotis images, and added four new images to the Universe section of the hyperwall catalog. They also provided hyperwall content for the GSA Annual Meeting, where there were 10 hyperwall presentations covering topics such as meteorites, caves on the Moon, and results from the Mars rover. Curiosity. After the conference, about 20 high-resolution images from the presentations were added to the hyperwall catalog for future re-use. Additionally, they provided a caption for a new hyperwall show: Hubble Sees Rare Stellar Light Echo.

Work is already underway for three up-coming conferences: the International Astronomical Union (IAU), Honolulu, HI, August 3 – 14, 2015; the GSA Annual Conference, November 1–4, 2015; and the 2015 AGU Fall Meeting, December 14 – 18, 2015. As with last year’s meetings, graphic products will be developed for conferences. With regard to the hyperwall, efforts will be on covering data/subjects not currently covered in the hyperwall catalog, and will try to add existing content so information can be found in the new version of the online hyperwall catalog.

For the third task, SPSO staff (sponsor: S. Platnick) acts as primary point of contact for NASA’s Applied Sciences Division’s science exhibit outreach and product development. In June 2014, the Air and Waste Management Association (A&WMA) Annual Meeting was held in Long Beach, CA, and supported included organizing NASA’s science exhibit and the hyperwall speakers. Matthew Turner (University of Boulder Colorado), John Haynes (Weather, Public Health & Air Quality Program Manager for Applied Sciences at NASA Headquarters), and Ali Omar (NASA Langley Research Center) gave hyperwall presentations ranging from aerosols in the atmosphere to a review of NASA’s Air Quality research programs. In early October, the World Congress hosted the International Union of Forest Research Organizations XXIV in Salt Lake City, UT. During this conference, SPSO staff explained Applied Sciences in relation to forestry as a 5×5 plasma displayed various visualizations of NASA data. One month later, the World Parks Congress met in Sydney, Australia from November 12 –19. The SPSO team coordinated NASA’s science exhibit and served as NASA’s POC at the conference venue. Additional support included coordinating the hyperwall speakers and playlist plus assisting the speakers with their content. NASA’s science exhibit attracted a distinguished audience that included Dr. Sylvia Earle, a renowned American marine biologist, and the Honorable Maggie Barry, New Zealand’s Minister of Conservation. NASA’s hyperwall presentations were very well attended throughout the conference. Another popular feature of NASA’s science exhibit was a tour of science visualizations presented to a group of 30 students from Sydney Girls High School, an academically selective State girls’ school. In addition to providing meeting and conference support, SPSO staff created and produced a 3D lenticular card/ruler for the World Parks Congress held in Australia.

During the past year, SPSO staff assisted hyperwall presenters with preparing content for the A&WMA Annual meeting, operated the hyperwall during presentations, and acted as hyperwall docents; they created new time-series visualizations for the World Parks Congress showing deforestation in Indonesia, ployankton blooms around the Galapagos at the end of the 1997–98 El Niño, and the retreat of the Upsala Glacier in Argentina; and, they wrote and edited hyperwall captions for new shows at the World Parks Congress conference on the following: Tessa Nilo National Park, Upsala Glacier Retreat in Argentina, and Galapagos Blooms After El Niño.

Looking ahead, the team is creating products for upcoming conferences, working on visuals for the hyperwall, and preparing for the 108th A&WMA Annual Meeting, Raleigh, NC, June 22 –25; and the GEO-Ill Plenary and Ministry of Foreign Affairs, Mexico City, Mexico, November 11–13, 2015.
in media relations, Jarrett collaborated with CISTO and NCICS senior staff and computer vendor SGI on the media release “NASA Chooses SGI Compute Solution to Power Climate Research,” which elicited coverage by computing publications. Providing key support to an international documentary on climate change, Jarrett arranged access to NCICS facilities for a video journalist’s January visit, assembled a hyperwall playlist of illustrative visualizations, ran the hyperwall during interview segments with Goddard Institute for Space Studies Chief Gavin Schmidt, recruited an NCICS staff member to serve as an “actor” to enliven supercomputer footage, answered modeling and visualization questions, and arranged access to HD visualizations.

Jarrett managed High-End Computing (HEC) Program participation in the ever-popular NASA exhibit at the 2014 AGU Fall Meeting, which attracted a record 25,000+ attendees to San Francisco, CA, from December 15-19. Pre-meeting, he submitted edited abstracts for four side-event presentations, helped to recruit hyperwall presenters, and scheduled CISTO and NAS staff to cover the HEC table. Onsite, he worked at the HEC table, distributing engagement products and talking with visitors; took photographs of all presenters for Twitter and reporting; and tweeted on @NASA_NCCS. For the AGU Scientific Program, he edited and arranged printing of eight CISTO posters.

Jarrett also supported GSF’s 8th Annual Sciences and Exploration Directorate (SED) New Year’s Poster Party Blowout on January 31, 2015 by helping to hang CISTO posters, supplying handouts, taking photos of researchers presenting posters and at the hyperwall, and tweeting selected photos on @NASA_NCCS. Additionally, for NASA’s Earth Day event on April 22nd at Washington, DC’s Union Station, Jarrett recruited SSV Director Horace Mitchell to serve as a hyperwall speaker and took photographs for Twitter and reporting.

Another facet of this task is Website Management. On the HEC website (http://www.hec.nasa.gov), Jarrett posted 25 news items and event summaries, created 2014 News & Publications archive pages, updated About Us section pages with the latest NAS and NCICS supercomputer performance information, refreshed the Image Gallery with new NCICS supercomputer and hyperwall photos, posted Request Computing Time deadlines and created a 2014 archive page, worked with NCICS staff to simplify and clarify NCICS procedures on the Getting Accounts page, and posted the latest Funding Opportunities.

Within a day of HEC Program Manager Tsergäl Lee’s request, Jarrett developed a draft page simplifying the explanation of standard billing units (SBUs) and subsequently incorporated management edits before publishing at: http://www.hec.nasa.gov/user/policies.shtml. Also, to fulfill CISTO management’s request, Jarrett transitioned from the paid Google Site Search to the freely available Search USA/DigitalGov Search. He optimized the search experience by customizing the search engine page appearance, adding related social media accounts, and “masking” the domain so that users appear to stay within the NASA domain rather than go to an external website.

Maria Ealey handled Allocations Coordination by processing just over 450 requests submitted for NASA HEC Resources for SMD Supported Research during the FY15-Q1 & Q3 open calls. This effort included analyzing the number of SBUs requested by principal investigators, the number of SBUs available on the NAS Pleiades and Endeavour supercomputers and the NCICS Discover supercomputer, and previous usage on established projects. She met with Discipline Leads at NASA HQ in October 2014 and April 2015 with recommendations for annual allocations awards. Also, she worked on questions submitted to NAS and NCICS regarding modifications to current SMD allocation awards as well as requests submitted for limited-out-of-cycle awards.

Going forward, support will continue regarding communications, event, and website activities, as well as allocations activities. Jarrett plans to develop additional NCICS success stories; support events including ExploreNASA Goddard, the SC’15 conference, and the 2015 AGU Fall Meeting; document new NCICS and HEC-related hyperwall shows; and refresh and refine the HEC website. Maria will continue to respond to allocation modification requests, analyze current usage data of projects allocated SBUs and coordinate access to other NCICS facilities; and prepare innovative engagement products for distribution at Fall 2015 conferences and events. For the NASA Center for Climate Simulation (NCCS) and Computing at NASA’s Goddard Space Flight Center (GSFC) Technical Communication, Outreach, and Engagement Office (OCTO), these efforts represent continued engagement activities since that date.
CODE 160: OFFICE OF EDUCATION

Astrobiology, a multidisciplinary science that explores whether there are other life forms in the universe, is a field that continues to be a useful research tool to bring together students and faculty from diverse cultures and backgrounds to address key scientific questions. Astrobiology also stimulates student and faculty interest in the exciting field of space science. Dr. Benita Bell (sponsor: J. Harrington) aims to strengthen existing initiatives in the field of astrobiology and potential partnership development projects. The Minority Institution Astrobiology Collaborative (MIAC) and the NASA Astrobiology Institute Minority Research Support Program (NAI-MIRS) have been two pivotal programs that continue to lead a national minority effort in astrobiology. NAI-MIRS, the faculty research sabatical program in astrobiology for faculty at minority institutions, has existed for over a decade. Dr. Bell focuses on the additional involvement of the K-12 STEM Community within the two programs.

AtSciCon, the national astrobiology conference, has a powerful and significant presence of both oral and poster presentations from faculty and students from MSIs. This will be the largest presence of MSIs and presentations in the 10 years of MSI involvement in the field of astrobiology. As Co-Chair of the MIAC Workshop at AtSciCon 2015, Dr. Bell’s role is to develop the agenda for the workshop which will highlight the research conducted by faculty. The conference will take place in June 2015 in Chicago, IL. MIAC is a virtual collaboration of minority universities with the goal of generating research opportunities for faculty and students in the area of astrobiology. As Co-Director of MIAC along with Dr. Todd Gary of Fisk University and Dr. Michael Ceballos of University of Minnesota-Morris, Dr. Bell’s role is to serve as a key collaborator to develop research partnerships. Currently over ten institutions are in the collaborative, and Dr. Bell works toward expanding the collaborative to include more underrepresented institutions. MIAC members consist of several Hispanic-serving institutions and Native American Institutions as well as NAI-MIRS Fellows. The first Native American Research Laboratory (NARL) was established by Dr. Michael Ceballos, an NAI-MIRS Fellow and MIAC member, who received the Obama Singh 21st Century Knowledge Award. Dr. Ceballos is engaging Native American students and other students from historically underrepresented groups in cutting-edge interdisciplinary research in three different countries. The students conduct research focused on the impact of climate change and changes in socio-economic structures on traditional agriculture, ethnobotany, regional biodiversity, animal husbandry and the development of sustainable indigenous communities in the U.S., India, Malaysia and Mexico. Other areas of student research include biofuel suitability, analysis of tribal plants and crops, antimicrobial and antioxidant properties of traditional medicinal plants, genetics and the prevalence of common bovine diseases in tribally-owned cattle and changes, and availability of water resources and more. The idea of Indigenous Americans interacting with indigenous communities from around the world in research that merges traditional knowledge with modern science provides a research platform to engage indigenous scientists with mainstream researchers. This model is a unique and transformative approach towards the global effort to more effectively understand our planet, its resources and the changes that we are facing as a global community. This summer, 11 students will conduct research in Malaysia. Drs. Bell and Ceballos will assist the students with follow-up data analysis.

The Research Experience for Undergraduates (REU) provides an excellent opportunity for students to strengthen science and research literacy. Global and cultural diversity is a key focus of the program. Dr. Bell served as both Recruiter and Collaborator for the 2015 REU International Summer Internship Program Malaysia and Mexico. Students selected will be from minority-serving institutions. For the 2015 summer internship program, students will conduct research in Malaysia and Mexico with a research focus on astrobiology-related projects, climate change and sustainable agriculture among indigenous communities. Native American students, Hispanic students and African-American students will jointly participate in this international research program. REU will be led by Dr. Ceballos and Dr. Gary at Minnesota-Morris.

In other activities, Dr. Bell was involved in InRoads in collaboration with NASA Ames to advance internship opportunities, mentorship opportunities and professional development models for undergraduate and graduate students. The broad goal is career development for undergraduates and graduate students to ensure student placement in professional job careers. She also has been working with the Principal of North Carolina A&T State University Early Middle College to incorporate an astrobiology research component for the annual international trip to Costa Rica (in progress). Early Middle College is an African-American all-male school; each year, students take an international trip but to date there has been no research emphasis. Additionally, Dr. Bell has been involved in acting as a recruiter for the NAI-MIRS Faculty Sabbatical Program and as a representative for the NASA Goddard African American Advisory Committee.

MANIAC TALKS

The GESTAR Maniac Talks offer the opportunity to “discuss and learn”. The Maniac Talks “…promote scientific interaction between young and experienced scientists in order to learn/improve/review the knowledge of basics/fundamentals of science and scientific methods for research.” Charles Gatebe continues to be instrumental in hosting and maintaining this exciting series. Since late May 2014, speakers have included the following from NASA GSFC: James Garvin, Aprille Joy Ericsson, P.K. Bhartia, Brian Dennis, Jim Irons, John Mathee, Paul Newman and Richard Stolarski (Emeritus). Speakers from outside NASA/GSFC included Jack Kaye (NASA Headquarters), Michael Mishchenko (NASA GISS) and Eugenia Kalnay (University of MD, College Park). The Maniac Talk blog contains a schedule of upcoming speakers as well as videos of previous talks: http://maniactalk.gestar.nasa.gov/. This past year, a new website for the Maniac Talks was developed and is supported by Suzanne Pearce (GSFC/613), Web Software Engineer: http://atmospheric.gsfc.nasa.gov/mentors/

NASA VIZ

The NASA Visualization Explorer (NASA Viz) app continues to excite, educate and engage audiences through its media rich content and stories. Since the app’s launch on July 26, 2011, it has received more than 1.43 million unique downloads, and currently ranks as the #1 NASA app on the App Store on iTunes. The app continuously receives positive ratings and reviews from tech enthusiasts and in tech blogs and news websites. This year the NASA Viz app won the NSF and Popular Science People’s Choice Award for Games and Apps at the 2015 Vizies. The award was featured in the March 2015 print issue of Popular Science magazine, and on the magazine’s and NSF’s websites.

As of late May 2015, more than 400 stories have been published. The collection of stories highlight findings from all four NASA science themes—Earth, Heliophysics, Planetary, Astrophysics—and includes contributions from NASA Earth Observatory and NASA’s science mission outreach teams. Through the ongoing efforts of GESTAR team members Helen-Nicolette Koits (NASA Viz project manager) and Rayvon Shafrig (NASA Viz editor), two new stories appear in the app each week. Among the highlights from this past year: the NASA Viz app was displayed to the public at an exhibit at the 2015 Earth Day Festival at the National Mall (April 17-19) and Union Station (April 21-23), in Washington, D.C.; the NASA Viz App received Teacher’s Pick Award 2015 and was featured in the Instructor Scholastic magazine, Spring 2015 issue; and the app was nominated for NASA Goddard Software of the Year 2015 Award.

This year the NASA Viz software development team released three app updates to address new features within the app and provide adapt to the new iOS 8 requirements and guidelines. NASA Viz released a responsive and mobile friendly website where all the content available on the app is featured on the web. In addition, NASA Viz collaborated with the MSFC/CIMA team to provide push notification capability within the app with a new update. In the next year, the team will add High-Definition capabilities within the app, will work on redesigning the user interface and will run a pilot project for the development of interactive stories.
Student Engagements

Benita Bell has served as a mentor to many students ranging from high school to post-doctoral. She has mentored three Morgan State University STEM Majors to assist in securing internships and career development. Students shadow her involvement in STEM-related projects and conferences. She also mentors a NASA Goddard Spaceflight Center post-doctorate whose studies relate to biostatistics. Others she mentors are STEM Early College Students (9th - 10th Grade) at the same institute and is now providing remote guidelines on how to process and interpret the results.

Hiren Jethva is supervising two Morgan State University students, who have begun work on their projects.

Hiren Jethva provided the latest OMI research version retrievals to Junghin Mok, a graduate student at UMCp, for his ground-satellite comparative analysis of aerosol absorption for Goddard, Santa Cruz Bolivia, and Thessaloniki, Greece. He also helped Li Zhang at Colorado State Univ. in interpreting the global OMAERUV monthly aerosol data files.

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Matt Kowaleski continued his mentorship of a Morgan State graduate student. The purpose of this internship is to build upon previous work related to motor control and support circuitry and create a prototype sun tracker for use with fiber coupled remote sensing instrumentation.

Tom Kucsera assisted three summer students: Zachary Fasnacht to UMD students of Anne Thompson - Code (614), Caitlin Schaefer (a UMD student of Anne Thompson – Code 614), Caitlin Schaefer (a UMD student of Anne Thompson – Code 614), and John Bolten, Land Degradation (Jim Tucker), Downscaling the GEOS-5 GCM (Steve Pasko) and GSFC's Mass Spectrometer on Mars (Melissa Trainer). Drs. Tucker and Anyamba conducted a tour of GSFC Testing and Integration Facilities for the ~30 TEM participants.

Assaf Anyamba participated in a Q & A session at the Cosmos Club, Washington, D.C. in June 2014 following a presentation by Dr. Rossi (Eckerd College) on Rift Valley Fever: An EcoHealthly Approach to Preventing a Deadly Disease. This was the public presentation to kick start the work on Understanding Rift Valley Fever in Republic of South Africa funded by Defense Threat Reduction Agency (DTRA).

Valentina Aquila created and taught a course titled “Freshman Seminar: Introduction to Climate Change” at Johns Hopkins University during the Fall semester 2014.

Valentina Aquila gave a 30-minute-long introduction on how climate data can be used in health science during the project JumpStart (held at University of MD, College Park), a 2-week summer camp for high school students sponsored by the Howard Hughes Medical Center.

Valentina Aquila gave a lecture followed by a Q&A session on volcanic eruptions, climate, and geoengineering at the Rockville Science Cafe. RSC is held on the third Tuesday of every month as part of the Rockville Science Center, Rockville, MD. Science Cafes are live events in casual settings, are open to everyone, and feature a scientist engaging and leading the discussion to encourage conversation, debate, and interaction. Successful cafes create an atmosphere that reaches out to everyone, and typically reaches out to people who don’t typically get involved in scientific discussions.

At the Ron McNair Research Symposium, an annual Commemorative Conference to honor Astronaut Ron McNair, held at North Carolina A&T State University, students from area colleges and universities as well as area K-12 schools presented their STEM re- search projects. Benita Bell attended this conference and spoke with undergraduate and graduate students.

Benita Bell gave a STEM-related talk to students at Southeast Middle School, Greensboro, NC.

Benita Bell gave a talk on Astrobiology and NASA Technologies to students at STEM Early College, a merger and collaboration between Guilford County Public Schools, NC A&T State University and Corporate Partners. The School is specifically targeted toward highly motivated and high performing junior and senior high school students interested in science, technology, engineering and mathematics. The students are fully integrated into college courses and focus on one of 3 STEM pathways: biomedical sciences, renewable energy and engineering. The STEM curriculum incorporates courses such as robotics and scientific visualization.

Benita Bell is an NSF Transforming Undergraduates in Science, Technology, Engineering and Mathematics (TUES) Proposal Team Member.

Benita Bell was an invited attendee for the media coverage and press conference for STEM Early College Award NASA Student Spaceflight Competition, for which 64 proposals were submitted.

Six STEM Early College students submitted a proposal entitled “GPS Used in Finding and Tracking Small Satellites in Space” for NASA Student Spaceflight Experiment Competition. The experiment is scheduled to be conducted aboard ISS. The students will proceed to the Governor’s Cup STEM competition, held at Washington, DC.

In March 2015, Benita Bell participated in Morgan State University’s Innovation Day (MDI) 2015, hosted by Morgan State University at the State Capitol Building in Annapolis, MD. The purpose of the event was to highlight groundbreaking, innovative research and economic impact on the region.

On October 4, 2014 Richard Damoah participated in the 2014 Morgan State STEM EXPO Fair, and he participated in the MSU-Maryland Science Olympiad on March 7, 2015 held on MSU campus.

Richard Damoah proposed and supervised the installation of Morgan State University’s Weather Station on September 3, 2014. The new station received campus-wide recognition that led to a press release by the director of public relations and communications about the weather station. Data from the station will be used in the meteorology course that Dr. Damoah is teaching, climate-related research on campus, and weather reports by the campus radio and TV stations.
Ron Enrico and Nikí Privé worked together to organize the Workshops on Sensitivity Analysis and Data Assimilation in Meteorology and Oceanography, to be held June 2015 in Roanoke, West Virginia. Also known as the “10th” Adjacent Workshop, this will convene 60 scientists from eight countries. Dr. Privé created a website for the workshop and is maintaining a database of all attendees.

Manuela Girotto is a committee member responsible for GMAO at the Young Scientist Forum that will be held at GSFC on July 14-15, 2015.

Jie Gong served as a board member of the Chinese-American Oceanic and Atmospheric Association (CAOA) and is in charge of the quarterly newsletter.

Hiren Jethva was interviewed by NASA’s Earth Observatory personnel, Adam Voland, for the image of the Day (IOTD) that appeared on their web portal (http://earthobservatory.nasa.gov/). Three topics or IOTD were broadcasted during Oct – Dec 2014; two of these highlighted Dr. Jethva’s work on characterization of aerosols above cloud and seasonality of aerosols over the northern India region. See his work at the following sites: http://earthobservatory.nasa.gov/IOTD/view.php?id=84557 http://earthobservatory.nasa.gov/IOTD/view.php?id=84731 http://earthobservatory.nasa.gov/IOTD/view.php?id=84862&eo=n=home&eoci=iotd_image


At ACM SIGGRAPH 2014, Helen-Nicole Kostis served as a SIGGRAPH Late-Breaking Juror for the selection of Posters, and also served as a Student Research Competition Juror.

Matt Kowalewski served as a community scientist for the 3rd annual Linton Springs Elementary Science Fair (Eldersburg, MD). He interacted with the elementary school students learning about their projects and answering questions regarding his involvement at NASA.

David Lagomasino served as a judge at the 2015 NASA International Space Apps Challenge held at Johns Hopkins University’s Applied Physics Laboratory in Laurel, MD. This hackathon is a 2-day global event that occurred in over 138 cities with 12000+ participants worldwide during the weekend of April 11-12, 2015. Two local presentations at APL went on to the Global Competition: 1) Water Finder app—a tool to help end-users and super-users locate areas of potable water, and 2) Mars Lava Tubes: Survival Game—kid-friendly game where the object is to survive in the harsh conditions on Mars. (2015.spaceappschallenge.org)

David Lagomasino served as a judge for the STEM Fair at Greenbelt Middle School, Greenbelt, MD.

David Lagomasino volunteered as Coordinator for the Outstanding Student Award Presentation for the Education Session of the AGU Fall Meeting 2015. In this position, he helped to recruit, organize and assign judges to student presentations.

Allison Leidner gave a hypervall talk at the public festival for the IUCN World Parks Congress in Sydney, Australia, held from Nov 13-19, 2014.

Xiaowen Li organized and participated in the Morgan State University Innovation Day in Annapolis, MD on March 19, 2015, where she presented an exhibition titled “What makes rain?” On March 31, 2015, Erica McGrath-Spangler served on a peer review panel for the NASA Earth and Space Science Fellowship awards.

Erica McGrath-Spangler volunteered at the Goddard Visitor Center Sunday experiment hosted by GPM and organized by Kristen Weaver on March 15, 2015.

Erica McGrath-Spangler interacted with high school junior and sophomore women at the Women in Engineering Developing Revolutionary Engineers And Mentors (WIE DREAM) conference information fair held at the University of Maryland, College Park on February 14, 2015. The DREAM conference had over 690 participants with the mission to recruit, retain, and advance women in STEM fields.

Erica McGrath-Spangler was responsible for collecting outreach materials and engaging the public at the Women@NASA booth at the National Air and Space Museum’s Women in Aviation and Space family day.

At the NASA Education Resource Center, Greenbelt, MD, Perry Meyer discussed clouds and satellite remote sensing at a workshop for 5th grade science teachers.

Mark Olsen was invited to provide a lecture for the University of Maryland, College Park class, “Physics for Decision Makers: the

Global Energy Crisis”, to present an overview of climate change and the types of related research done at Goddard.

Nikí Privé was a co-presenter at the Northeast public library in DC on the use of satellites in weather forecasting as part of a summer lecture series. The presenters included Nikí Privé, Clara Draper, and Paolo de Matteis.

Nikí Privé and Ron Enrico attended Morgan Innovation Day in Annapolis, Maryland, on March 19, 2015 to showcase GESTAR projects to members of the Maryland state legislature. They discussed Observing System Simulation Experiments and numerical weather prediction research at GMAO with attendees.

Cecile Rousseaux worked with several other Earth Science Goddard employees (Dorothy Zukor, Anne Douglas, Gail Jackson, etc.) to develop a new concept of informal mentoring lunches at Goddard. Dr. Rousseaux was also the lead organizer of the 2014 Science Jamboree. This included organizing the display as well as having a staff to showcase the display on the day of the event.

Kayvon Sharghi supported outreach activities at the 2015 Earth Day festival on the National Mall and at Union Station. He talked to hundreds of people about the NASA Vis app and NASA’s exploration of the solar system and beyond. In May, Kayvon will speak to attendees at the 2015 World Science Festival in New York.

Sarah Strode attended a Town Hall Meeting on the Future of Atmospheric Chemistry presented by the National Research Council in Washington, DC.

Brad Web organized the constituent assimilation meeting, contributed a slide for and helped out at the Science Jamboree, held at NASA Goddard in July 2014. Other GMAO scientists who assisted with this event include Manuela Girotto, Min Jeong Kim, Yury Vikhaliev and Dan Holdaway.

Emrie Wright presented his work in talks at technical conferences (SIGGRAPH 2014) and at public outreach events, such as 2014 International Observe the Moon Night and 2015 Earth Day at Union Station (see image).

In December 2014, Teppei Yasunari contributed to marking the students’ presentations for Outstanding Student Paper Awards (OSPA) as a judge at AGU Fall Meeting 2014 in San Francisco, CA.

(E. Wright at Earth Day, Union Station, Washington, DC)}
In August 2014, both Valentina Aquila and Richard Damoah were each awarded the NASA Group Achievement Award, for outstanding accomplishments during their participation in the SEAC4RS project, Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Survey (SEAC4RS).

On August 26th, at the 2014 Hydroospheric and Biospheric Sciences (HOBI) Annual Awards Ceremony, cryospheric scientist Ludovic Brucker (sponsor: S. Nowicki) was recognized “for his excellent and innovative work advancing microwave research over the cryosphere from multiple sensors and through field work.”

At the Earth Sciences Division - Atmospheres (Code 610A) Awards Ceremony held on Wednesday, August 27th, three GESTAR members were honored with Contractor Performance Awards. For Best Senior Author Publication, Hiren Jethva (sponsor: O. Torres) was recognized “For the development of a remote sensing approach to retrieve optical depth of aerosols above clouds using MODIS visible observations”. For Outstanding Performance - Technical Support, Tom Kucsera (sponsor: M. Chinn) was recognized “For outstanding support of global modeling, satellite data retrieval, data analysis and management, and IT administration”. For Outstanding Performance - Science, Xiaowen Li (sponsor: W. K. Tao) was recognized “For her outstanding scientific research in using sophisticated microphysical processes to improve our understanding of the interactive processes between cloud, precipitation and aerosols.”

On Thursday, October 30th, 2014 at the NASA Headquarters Honors Ceremony, Allison Leidner was recognized with a Special Service Award, “For her leadership role in support of NASA’s involvement in the Third National Climate Assessment Report. Dr. Leidner’s contributions to the work of the NBS/NIST, now includes approximately 300 people. NIST was formerly known as the National Bureau of Standards.” Along with six others, Dr. Kurylo will be inducted in an official ceremony on October 9, 2015. Portraits and biographies of those selected will be on display in the main corridor leading to the NIST cafeteria (NIST, Gaithersburg, MD), and in the Digital Portrait Gallery at the NIST Gaithersburg and NIST Boulder sites. His citation reads as follows: “Michael J. Kurylo (Materials Measurement Laboratory: 1969-2003) For leadership and key contributions to the Global Precipitation Measurement (GPM) program to advance our understanding of the interactive processes between cloud, precipitation and aerosols.”

In late February 2015, Popular Science teamed up with the National Science Foundation to award the Vizzies, announcing the winners in the article “The 10 Best Science Images, Videos, and Visualizations from the 2015 Vizzies”. The NSF Visualization Challenge awards work that visually and successfully communicate science and engineering research and phenomena. The Vizzies recognize the finest illustrations, photographs, videos, graphics and apps, whether produced by academic researchers, artists or hobbyists. This year, the NASA Visualization Explorer (project manager: Helen-Nicole Kostis, sponsor: H. Mitchell) won the People’s Choice Award for Games and Apps. For more information, see https://www.popsci.com/2015-02-01/vizies/science-visualizations-videos-images-or https://www.nsf.gov/news/special_reports/vizies/vizies_2014.jsp.

The NASAVis also received the Teacher’s Pick Award from Scholastic Instructor (Magazine and Website). Following the award it was featured in the magazine as a STEM staple that inspires the next generation of scientists.

For his participation in the MAVEN communications and outreach team, Robert Garner received a 2014 Robert H. Goddard Honor Award for his role.

For providing visual content for many of the GPM outreach activities, Alex Kesesi and Kel Elkins were recipients of a 2014 Robert H. Goddard Honor Award presented to the GPM Outreach Team.

Michael Kurylo (sponsor: J. Rodriguez) was recently informed he has been selected for inclusion in the NIST Portrait Gallery of Distinguished Scientists, Engineers and Administrators. His career with the National Institute of Standards and Technology (NIST) began over 40 years ago. The NIST Portrait Gallery, established in the early 1970s to honor NIST/NASA for outstanding career contributions to the work of the NBS/NIST, now includes approximately 300 people. NIST was formerly known as the National Bureau of Standards.) Along with six others, Dr. Kurylo will be inducted in an official ceremony on October 9, 2015. Portraits and biographies of those selected will be on display in the main corridor leading to the NIST cafeteria (NIST, Gaithersburg, MD), and in the Digital Portrait Gallery at the NIST Gaithersburg and NIST Boulder sites. His citation reads as follows: “Michael J. Kurylo (Materials Measurement Laboratory: 1969-2003) For leadership and key contributions to the Global Precipitation Measurement (GPM) program to advance our understanding of the interactive processes between cloud, precipitation and aerosols.”

In May 2015, nine GESTAR members were recognized with a GESTAR 2015 Exceptional Service Award.

Richard Damoah (code 610, sponsor: C. Tucker) “For his personal initiative to install a meteorological/climate observatory at MSU that will benefit students and university for many years to come. His initiative to identify, train students and build partnerships with other GESTAR scientists at Goddard that contributes towards the development and advancement of STEM education at MSU.”

Gabrielle De Lannoy (code 610.1, sponsor: H. Reicht) “For her extraordinary contribution to the success of the SMAP Mission and her outstanding scientific productivity (author and co-author more than 30 publications since GESTAR inception).”

Ryan Fitzgbobbin (code 130, sponsor: W. Sisler): “From launch coverage, including a live broadcast, to developing a new treatment for visualizations of hurricanes and storms, Ryan has worked at a consistently high level of excellence.”

Alex Kesesi (code 606.4, sponsor: H. Mitchell): “He has made key contributions to the Global Precipitation Measurement (GPM) Outreach Team. As the leader for GPM visualization efforts, Alex developed and refined the GPM visualization pipeline that he and SVS colleagues have used continuously since the March 25, 2014 first light release to create world-class GPM visualizations.”

Joseph Lye (code 617, E. Kim): “For his support of JPS/NPP AMS/RIS Cal/Val & Algorithm Development. He works as both a senior scientist and a senior system engineer.”

Nikki Privi (code 610.1, sponsor: R. Gelaro): “During the past year, Nikki has made outstanding contributions to the GESTAR task of developing a framework for conducting Observing System Simulation Experiments (OSSEs) at NASA Goddard’s Global Modeling and Assimilation Office (GMAO).”

Andrew Swanson (code 614, sponsor: T. Hanisco): “Andrew has been working on new technology development projects for in situ aircraft instrumentation. He has supported GSFC Internal Research and Development (IRAD) and Earth Science Technology Office (ESTO) projects developing new instruments for the in situ detection of formaldehyde and methane flux.”

Stephen Ungar (code 618, sponsor: E. Middleton): “For his sustained contributions to the Earth Observing 1 Mission (EO-1) satellite and the Hyperspectral Infrared (HysIRI) imager.”

Kristen Weaver (code 612, sponsor: D. Kirschbaum): “For her outstanding and innovative contributions to the communication of NASA’s science mission to the public.”
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<th>ACRONYMS</th>
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<td>2DVD</td>
<td>Two-dimensional Video Disdrometer</td>
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<td>4STAR</td>
<td>Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research</td>
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<td>AACA</td>
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<td>AATS-14</td>
<td>AMES Airborne Tracking Sunphotometer</td>
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<td>ABL</td>
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<td>ACAM</td>
<td>Airborne Compact Atmospheric Mapper</td>
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<td>ACCRI</td>
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<td>ACOMAP</td>
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<td>Atmospheric Data Assimilation System</td>
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<td>AERONET</td>
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<td>AGCM</td>
<td>Atmospheric General Circulation Model</td>
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<td>AGU</td>
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<td>AIRS</td>
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<td>AGGCM</td>
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<td>Cloud Data Assimilation</td>
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<td>CDC</td>
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<td>CDOM</td>
<td>Colored Dissolved Organic Matter</td>
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<td>CME</td>
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<td>DFR</td>
<td>Differential Frequency Ratio</td>
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<td>IMERG</td>
<td>Integrated Multi-satelliteE Retrievals for GPM data product</td>
</tr>
<tr>
<td>IMPROVE</td>
<td>Interagency Monitoring of Protected Visual Environments</td>
</tr>
<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>IRAD</td>
<td>Internal Research and Development Program</td>
</tr>
<tr>
<td>IRIS</td>
<td>Interface Region Imaging Spectrograph</td>
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<tr>
<td>IUCN</td>
<td>International Union for the Conservation of Nature</td>
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<tr>
<td>JAXA</td>
<td>Japan Aerospace Exploration Agency</td>
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<tr>
<td>JCSA</td>
<td>Joint Center for Satellite Data Assimilation</td>
</tr>
<tr>
<td>JPL</td>
<td>Jet Propulsion Laboratory</td>
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<tr>
<td>JPSS</td>
<td>Joint Polar Satellite System</td>
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<td>JSC</td>
<td>Joint Scientific Committee</td>
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<tr>
<td>JWST</td>
<td>James Webb Space Telescope</td>
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<td>KSC</td>
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<td>LDAS</td>
<td>Land Data Assimilation System</td>
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<tr>
<td>LDCM</td>
<td>Landsat Data Continuity Mission</td>
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<tr>
<td>LHI</td>
<td>Laser Desorption Ionization Mass Spectrometry</td>
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<tr>
<td>LIHA</td>
<td>Landsat Hazard Assessment for Situational Awareness</td>
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<td>LISA</td>
<td>Laser Interferometer Space Antenna</td>
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<tr>
<td>LRO</td>
<td>Lunar Reconnaissance Orbiter</td>
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<tr>
<td>LROC</td>
<td>Lunar Reconnaissance Orbiter Camera</td>
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<tr>
<td>MACC</td>
<td>Monitoring Atmospheric Composition and Climate</td>
</tr>
<tr>
<td>MAVEN</td>
<td>Mars Atmosphere and Volatile Evolution Mission</td>
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<tr>
<td>MC3E</td>
<td>Middle Latitude Continental Convective Clouds Experiment</td>
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<tr>
<td>MEaSUREs</td>
<td>Making Earth Science data records for Use in Research for Earth Science</td>
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<tr>
<td>MERRA</td>
<td>Modern Era Retrospective-Analysis for Research and Applications</td>
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<tr>
<td>MHS</td>
<td>Microwave Humidity Sounder</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>MISR</td>
<td>Multi-angle Imaging SpectroRadiometer</td>
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<td>MJO</td>
<td>Madden-Julian Oscillation</td>
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<tr>
<td>MLS</td>
<td>Microwave Limb Sounder</td>
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<tr>
<td>MMF</td>
<td>Multi-scale Modeling Framework</td>
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<td>MMS</td>
<td>Magnetospheric Multiscale Mission</td>
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<td>MODIS</td>
<td>Moderate Resolution Imaging Spectroradiometer</td>
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<td>MOMA</td>
<td>Mars Organic Molecule Analyzer</td>
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<td>MOPIT</td>
<td>Measurements of Pollution in the Troposphere</td>
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<td>Multi-Radar-Multi-System</td>
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<td>NAAMES</td>
<td>North Atlantic Aerosols and Marine Ecosystems Study</td>
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<td>NAI</td>
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<td>NA-MIRS</td>
<td>NASA Astrobiology Institute Minority Institutions Research Support Program</td>
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<td>NAO</td>
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<td>NASA Viz</td>
<td>NASA Visualization Explorer app</td>
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<td>NASM</td>
<td>National Air and Space Museum</td>
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<td>NAWP</td>
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<td>NCA</td>
<td>National Climate Assessment</td>
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<td>NCAR</td>
<td>National Center for Atmospheric Research</td>
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<td>NCSS</td>
<td>NASA Center for Climate Simulation</td>
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<td>National Centers for Environmental Prediction</td>
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<td>NDACC</td>
<td>Network for the Detection of Atmospheric Composition Change</td>
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<td>NDVI</td>
<td>Normalized Difference Vegetation Index</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<td>NOSB</td>
<td>NASA Ocean Biogeochemical Model</td>
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<td>NPP</td>
<td>NPOESS Preparatory Project</td>
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<td>NPP OMPS</td>
<td>NPOESS Preparatory Project's Ozone Mapping Profiler Suite</td>
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<tr>
<td>NSIDC</td>
<td>National Snow and Ice Data Center</td>
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<td>NU-WRF</td>
<td>NASA Unified Weather Research and Forecasting</td>
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<td>OASIS</td>
<td>Organics Analyzer for Sampling Icy Surfaces</td>
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<td>OCO-2</td>
<td>Orbiting Carbon Observatory-2</td>
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<tr>
<td>ODAC</td>
<td>Open-source Data Inventory for Anthropogenic CO2</td>
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<td>ODS</td>
<td>Ozone Depleting Substances</td>
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<td>OIB</td>
<td>Operation IceBridge</td>
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<td>QBO</td>
<td>Quasi-Biannual Oscillation</td>
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<tr>
<td>QL</td>
<td>Outgoing Longwave Radiation</td>
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<tr>
<td>OMAERUV</td>
<td>OMI/Aura level-2 near UV Aerosol data product</td>
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<tr>
<td>OMI</td>
<td>Ozone Monitoring Instrument</td>
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<tr>
<td>OSIRIS-REx</td>
<td>Origins-Spectral Interpretation-Resource Identification Security Regolith Explorer</td>
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<tr>
<td>OSSE</td>
<td>Observing System Simulation Experiments</td>
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<tr>
<td>OSTP</td>
<td>Office of Science and Technology Policy (at the White House)</td>
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<tr>
<td>PACE</td>
<td>Pre-Aerosol, Clouds, and ocean Ecosystem</td>
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<tr>
<td>PBL</td>
<td>Planetary Boundary Layer</td>
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<tr>
<td>PDO</td>
<td>Pacific Decadal Oscillation</td>
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<td>PIA</td>
<td>Path Integrated Attenuation</td>
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<tr>
<td>PICARD</td>
<td>Pushbroom Imager for Cloud and Aerosol Research and algorithm Development</td>
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<tr>
<td>PIP</td>
<td>Precipitation Image Probe</td>
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<td>PPS</td>
<td>Precipitation Processing Systems</td>
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<td>PSD</td>
<td>Particle Size Distribution</td>
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<tr>
<td>RCDL</td>
<td>Radiometric Calibration and Development Laboratory</td>
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<tr>
<td>RFI</td>
<td>Radio Frequency Interference</td>
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<td>RMSE</td>
<td>Root Mean Square Error</td>
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<td>RO</td>
<td>Radio Occultation</td>
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<td>RT</td>
<td>Radiative Transfer</td>
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<tr>
<td>SAR</td>
<td>Synthetic Aperture Radar</td>
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<td>SBO</td>
<td>Spectral Bin Microphysics</td>
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<td>SCAR-B</td>
<td>Smoke, Clouds, and Radiation Brazil (SCAR-B)</td>
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<tr>
<td>SDD</td>
<td>Solar Dynamics Observatory</td>
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<td>SDSU</td>
<td>Satellite Data Simulation Unit</td>
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<tr>
<td>SEAC4RS</td>
<td>Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys</td>
</tr>
<tr>
<td>SHEBA</td>
<td>Surface Heat Budget of the Arctic Ocean (a ship-based observational campaign that collected radiosonde data over the North Pole in 1997-1998)</td>
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<tr>
<td>SLP</td>
<td>Sea Level Pressure</td>
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<tr>
<td>SMAP</td>
<td>Soil Moisture Active/Passive</td>
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<tr>
<td>SMOS</td>
<td>Soil Moisture and Ocean Salinity</td>
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<tr>
<td>SOS</td>
<td>Science on a Sphere</td>
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<tr>
<td>SPARC</td>
<td>Stratospheric Processes And their Role in Climate</td>
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<tr>
<td>SRT</td>
<td>Surface Reference Technique</td>
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<tr>
<td>SSG</td>
<td>Scientific Steering Group</td>
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<td>SST</td>
<td>Sea Surface Temperature</td>
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<td>STE</td>
<td>Stratosphere-Troposphere Exchange</td>
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<td>SVS</td>
<td>Scientific Visualization Studio</td>
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<tr>
<td>TC</td>
<td>Tropical Cyclone</td>
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<tr>
<td>TMW</td>
<td>TRMM Microwave Imager</td>
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<tr>
<td>TOA</td>
<td>Top of the Atmosphere</td>
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<tr>
<td>TOMS</td>
<td>Total Ozone Mapping Spectrometer</td>
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<tr>
<td>TRMM</td>
<td>Tropical Rainfall Measuring Mission</td>
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<tr>
<td>USDA</td>
<td>U.S. Department of Agriculture</td>
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<tr>
<td>VIIRS</td>
<td>Visible Infrared Imager Radiometer Suite</td>
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<tr>
<td>VLIDORT</td>
<td>Vector linearized radiative transfer model</td>
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<tr>
<td>WCRP</td>
<td>World Climate Research Program</td>
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<tr>
<td>W-E-F</td>
<td>Water-Energy-Food</td>
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<tr>
<td>WFIRST</td>
<td>Wide-Field Infrared Survey Telescope</td>
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<tr>
<td>WiSM</td>
<td>Widesband Instrument for Snow Measurements</td>
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<tr>
<td>WMS</td>
<td>Web Map Service</td>
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<tr>
<td>WRF</td>
<td>Weather Research and Forecast</td>
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