SEVENTEENTH ANNUAL REPORT
JOINT CENTER FOR EARTH SYSTEMS TECHNOLOGY

A Cooperative Agreement Between:
University of Maryland, Baltimore County and
NASA Goddard Space Flight Center

July 1, 2011 – June 30, 2012

The Joint Center for Earth Systems Technology

Seventeenth Annual Report
July 1, 2011 – June 30, 2012

This page intentionally left blank.

I. EXECUTIVE SUMMARY

This volume is the seventeenth annual report describing the scientific accomplishments and status of the Joint Center for Earth Systems Technology (JCET). This Center was established in 1995 to promote close collaboration between scientists at the University of Maryland, Baltimore County (UMBC) and the NASA Goddard Space Flight Center (GSFC) in areas of common interest related to developing new technologies for environmental remote sensing. The Center's objective is to conduct multidisciplinary research on advanced concepts for observing Earth and planetary atmospheres, the solid Earth and planets, and the hydrosphere, all from ground stations, aircraft, and space-based platforms. This research continues to lead to improved understanding of global processes and increased capability to predict global environmental changes. The Center serves as a means to increase the effectiveness of university research and teaching resulting from the collaboration, and provides a venue to train personnel for research in relevant Earth science and technology areas. The NASA Earth Sciences Division has participated in establishing, funding, and collaborating with JCET. At UMBC, JCET is administered through the Office of the Vice President for Research. JCET personnel are currently associated with the university's Departments of Physics, Geography and Environmental Systems, Chemistry, and Mathematics and Statistics. JCET's administrative office is located at the BWTech Research Park at UMBC. JCET also has offices in the Physics and Technology Research Center buildings on the UMBC campus.

There are 36 JCET faculty members (listed in Section III.9) and 16 Fellows (listed in Section III.10). This category of JCET membership includes civil servants from NASA, in addition to tenured/tenure track UMBC faculty. JCET research is also supported by two research analysts (listed in Section III.11). Brief biographies of each JCET faculty and associate staff members are presented in Section III.8. The overall management and administration of JCET is governed by the executive board and carried out by an expert administrative staff (listed in Section III.12). After serving 6 years as JCET's Associate Director of Academics, Dr. Jeffrey Halverson relinquished this position effective June 30, 2012. Dr. Susan Hoban will assume the position of Associate Director of Academics July 1, 2012. Dr. Hoban is a Senior Research Scientist and works with NASA Goddard's Education Department. The Board Chairman is a civil servant scientist at GSFC.

The body of this report (see Section II) is divided into nine sections. These groups are aligned with GSFC research areas. Within each section are presented brief accounts of group members' accomplishments, provided by the respective principal investigators supported through a JCET task and/or grant from NASA or other government agencies that was active during the reporting year July 1, 2011 to June 30, 2012. Each report includes a description of the research, accomplishments for FY 11-12, and Objectives for FY 12-13. Although some of the efforts were not initiated at the beginning of the fiscal year, research completed during this period that was supported by both JCET and previous sources is also included in these descriptions. References cited in the reports are listed in Section III.1, while those papers that were submitted, in press, or published in the refereed literature by JCET authors this fiscal year are also listed separately in Sections III.2 and III.3. The 65 refereed papers (and 21 others submitted for review), along with 132 conference presentations and publications and non-refereed publications (see Section III.4) comprise the principal direct contribution of JCET scientists to the Earth sciences. In addition to their current research, JCET scientists planned for the future through submission of 59 grant proposals, listed in Section III.7.

JCET scientists also contributed to education at UMBC by teaching and mentoring graduate students in the Departments of Physics and Mathematics/Statistics. The 4 different courses they taught this past year are listed in Section III.5. Colloquia and seminars are an integral method to share knowledge in the academic community, and JCET researchers regularly provide such instruction, as listed in Section III.6. In addition, JCET faculty are mentoring or providing direct supervision for approximately 15 graduate students, and providing research opportunities for a number of additional undergraduate and graduate students from UMBC and other universities.

We welcome this talented and productive group of scientists into JCET. As you can see from the great diversity in their specializations, our new faculty members add a significant degree of breadth to JCET's mission to study the myriad facets of Earth and our environment.

June 2012

Danita Eichenlaub, Director
Jeffrey Halverson, Associate Director, Academics

TABLE OF CONTENTS

This page intentionally left blank.

II. TECHNICAL VOLUME

This page intentionally left blank.

Global Modeling and Assimilation Office
(Code 610.1)

This page intentionally left blank.

Task 359: Trace Gas Retrievals using AIRS (Sponsor: Steven Pawson)

NASA Grant: Validation of the CrIS Sensor Products for Climate Research (NNX11AK78G)

NASA Grant: Hyperspectral Infrared Earth Radiance Time Series (NNX12AG66G)

Investigators: Breno Imbiriba, Post-Doc Research Associate, JCET; L. Larrabee Strow, Fellow, JCET, Physics, (PI)

Description of Research

The research entails the development of an accurate Atmospheric CO_2 retrieval for evaluating inter-annual CO_2 variability, using the AIRS Thermal Infrared spectrometer, together with atmospheric models.

Accomplishments in FY 11-12

The investigators continue the task of using their UMBC/JCET Atmospheric CO_2 retrieval method [Strow and Hannon, 2008] to produce accurate interannual CO_2 time series and regional maps.

The team noticed that the CO_2 time series varies abnormally with time and this can be correlated to the variability of the underlying Atmospheric model used, ECMWF. In order to minimize such abnormalities the team switched to the ECMWF-ERA reanalysis model, but still seems to see unphysical behavior.

The investigators traced back such abnormalities to the sensitivity of their retrieval model to errors in the atmospheric temperature profiles which can vary from 18ppm/K to 33ppm/K depending on the spectral region used in the retrieval. In order to verify this calculation the team compared the ECMWF model and the ERA reanalysis model, with the GMAO-NASA MERRA Atmospheric reanalysis model, independently produce at NASA GSFC.

The investigators saw that both ERA and MERRA are much more stable along the years than the ECMWA model. They also noticed that the ERA model still suffers from some spurious variability that spoils the inter-annual variability, and they clearly see that the MERRA model allows their CO_2 retrieval system to generate consistent results with the broader CO_2 community [Imbiriba at al., 2012, in preparation].

In parallel, the GMAO-NASA group integrated the team's UMBC/JCET retrieved CO_2 data into their assimilated CO_2 transport system and was able to reduce the standard deviations at the surface sources/sinks [Tangborn et al., 2012]. They were not able to obtain such reduction with the alternate JPL CO_2 retrieval model, indicating that their UMBC/JCET CO_2

retrieval contains enough information close to the surface to improve the transport simulation.

Objectives for FY 12-13

In the coming year, the team will focus on continuing the CO_2 retrieval system with a more robust, baesyan method, using more AIRS IR channels and the MERRA atmospheric model. Together with a transport model, the UMBC/JCET CO_2 retrieval system can be useful as a CO_2 monitoring tool.

Task 308: Carbon Cycle Data Assimilation (Sponsor: Michele Rienecker)

NSF Grant: Geomagnetic data Assimilation using a Variational Approach (EAR-0757880)

Investigator: Andrew Tangborn, Research Associate Professor, Mathematics, JCET

Description of Research

Tangborn's research is in the area of carbon cycle data assimilation, including assimilation of satellite measurements of carbon monoxide and carbon dioxide into the GEOS-5 data assimilation system at GSFC. The purpose of this work is to evaluate the impact of new satellite measurements of carbon species, and to improve estimates of spatial and temporal variations in trace gas distribution. Data assimilation is useful for these goals because it allows the comparison of satellite measurements with generally more accurate ground based measurements by putting them onto a model grid and spreading the satellite information throughout the atmosphere using a Global Circulation Model (GCM). Improved comparisons with ground data are an indication that the satellite data contains useful information and that the resulting new trace gas fields are an improvement over existing models.

Accomplishments in FY 11-12

Carbon cycle research for the past year has involved both carbon monoxide (CO) and carbon dioxide (CO_2). The CO work involves the continued development and testing of the Gridspace Statistical Analysis (GSI) assimilation module within the GEOS-5 data assimilation system. CO observations from Measurement of Pollution in the Troposphere (MOPITT) have been successfully assimilated into this system. Testing of the system has been accomplished by varying estimated errors for the model, and running for 3 month periods so as to produce an optimal estimate of the analyzed CO field during the final month. Comparisons with aircraft based measurements from In-service Aircraft for a Global Observing System (IAGOS) during the last month of assimilation show that the CO field estimates in the assimilation system are improved in much of the atmosphere, with the largest error reduction in the tropics.

Work on CO_2 has been ongoing for several years, with an initial focus on observations from the Atmospheric Infrared Sounder (AIRS). The team has used retrievals from 2 distinct wavelengths, which provide sensitivity to CO_2 in both the middle and upper troposphere. A two year reanalysis of CO_2 (2005-2006) has been produced which show that observations from AIRS can significantly reduce the bias in the modeled CO_2 fields, and also improve the prediction of the CO_2 annual cycle.

Objectives for FY 12-13

During the coming year, Tangborn will be moving to both the Planetary Geodynamics Laboratory at GSFC and the Atmospheric Spectroscopy Laboratory at UMBC. He will begin working on geomagnetic data assimilation as part of a newly awarded grant from NASA, and continuing his work on carbon cycle data assimilation. In the former, an ensemble Kalman filter for geomagnetic data assimilation will be developed. The purpose of this work is to improve understanding of the processes taking place in the Earth's core. Carbon cycle research will involve continued work with AIRS CO_2 retrievals, with the ultimate goal of producing a longer term reanalysis of CO_2.

NASA Grant: The Climate Record Uncertainty Analysis, Uncertainty Analysis of Tropospheric Carbon Monoxide Data Records Using AIRS and IASI From a Uniform Algorithm (NNX11AL22A)

NASA Grant: New Global Measurements of Tropospheric NH_3 and HDO (NNX11AG39G)

JPL Grant: Optimization, Validation, and Integrated EOS Analysis (Contract 01/16/2008)

Investigators: Juying Warner, (formerly JCET, currently University of Maryland, College Park); Zigang Wei, Assistant Research Scientist, JCET

Description of Research

The research objective is to quantify the errors and uncertainties in the tropospheric Carbon Monoxide (CO) products from recent and upcoming satellite missions and to provide a uniform algorithm that generates tropospheric CO retrievals from the Atmospheric Infrared Sounder (AIRS)/EOS/Aqua [Aumann, et al., 2003] and the Infrared Atmospheric Sounding Interferometer (IASI)/MetOp [Coheur et al., 2009] to address some known issues. The expected product of this study is primarily daily and global measurements of tropospheric CO total columns and profiles with known quality for a period from 2002 through the lifetime of AIRS and continues with IASI instruments for the current and planned missions of 15 years started in late 2006 to obtain consistent CO climate records. These products will be quantified with errors and uncertainties through sensitivity analyses, inter-comparisons between AIRS and IASI, and validations based on both NASA in situ profiles and surface data, as well as existing satellite products from MOPITT and Tropospheric Emission Spectrometer (TES).

Accomplishments in FY 11-12

In the last year, Warner and Wei mainly focused on producing the improved tropospheric CO products from AIRS and IASI with an existing retrieval system that addresses known issues using AIRS (from NASA/DAAC) and IASI (from NOAA/NESDIS) L2 meteorological data and cloud-cleared radiances. The team provided retrieval sensitivity properties such as: the Averaging Kernels (AKs), error covariance matrices, and the Degrees Of Freedom for Signal (DOFS). The team quantified and analyzed errors, uncertainties, and sensitivities of tropospheric CO datasets from AIRS and IASI using outputs described above by validation against in situ field measurements and ground spectrometer measurements. They studied the biases between these sensors that are due to measurement differences, such as spectral resolution, signal to noise, overpass time, and spatial resolution. In addition, they studied factors in the algorithm that affect the quality of CO retrievals of both sensors, such as cloud clearing, surface impacts, and interfering gases. Warner and Wei first inter-compared the current operational CO products for AIRS (from NASA/DAAC) and IASI (from NOAA), both of which use a physical retrieval algorithm described by Susskind, et al. (2003) [Aumann, et al., 2003]. The core portion of this study is to build a new retrieval algorithm for IASI CO using an Optimal Estimation (OE) approach [Rodgers, 2000] in the same manner as the team's existing AIRS OE CO (a research product funded by a previous NASA ROSES grant) to build a consistent CO data record from 2002 into the near future. There are a number of challenges the team needed to address that affect the new IASI retrievals. These include the cloud-clearing and the related performance, Noise and Error Analysis for the Radiances and Forward Model, which are needed by the retrievals, and finally the CO Preliminary Results from the IASI OE method before the Summary and Future Work.

The team also found that the AIRS operational CO is higher globally than IASI primarily due to the overpass time and the spectral band differences. The IASI OE CO does show slightly higher CO in the Northern Hemisphere (NH) and lower in the Southern Hemisphere (SH) compared with the NOAA/IASI. Because the IASI OE CO retrievals are still at the very preliminary stage, some gaps are shown due to un-converged pixels.

Objectives for FY 12-13

One of the true benefits of this study is to develop CO retrievals from IASI using the OE method, which will not only provide possibly more realistic CO values, but may provide a number of sensitivity and error information from the same formulation the community is accustomed to. One of the critical variables that define the measurement information content is the DOFS. From the comparison of the DOFS computed from the team's research, OE codes between AIRS and IASI, it clearly demonstrates that IASI has higher information content (1.2-1.5 in low-latitudes) than AIRS (0.9-1.0 in the same latitude range). This is due to the spectral resolution of IASI being twice as high as AIRS in the same spectral range. The DOFS should show even higher values for IASI once Warner and Wei use the full spectral range. Warner and Wei will continue to refine and improve the IASI OE CO retrieval codes to fix imperfections such as this. Both Warner and Wei will continue their research at the University of Maryland, College Park (UMCP).

Earth Sciences Division
(Code 610)

This page intentionally left blank.

Task 328: Summer Institute in Earth Sciences (SIES), (Sponsor: Jack Richards)

Task 329: Graduate Student Summer Program (GSSP), (Sponsor: Jack Richards)

Investigators: Valerie Casasanto, Program Coordinator, JCET; Jeffrey B. Halverson, Fellow, JCET, Associate Professor, Geography and Environmental Systems; Ali Tokay, Research Associate Professor, JCET, Geography and Environmental Systems

Description of Research

The Summer Institute in Earth Sciences (SIES) and Graduate Student Summer Program (GSSP) are 10-week summer programs sponsored by GSFC's Earth Sciences Division and managed by the University of Maryland Baltimore County (UMBC) Joint Center for Earth Systems & Technology (JCET). Undergraduate and graduate students are selected on a competitive basis and paired with Earth Science researchers to work on actual research, benefiting both mentor and intern. Both programs took place from June 6 to August 12, 2011.

Accomplishments in FY 11-12

The summer programs were successfully organized and carried out by Casasanto and team. Nine undergraduate students were accommodated in the SIES program and eight graduate students in the GSSP program. Students received administrative assistance such as payroll processing and travel reimbursement, and benefited from a variety of events during their summer. In addition, students received guidance on academic issues, as needed.

During the summer, students participated in a variety of events coordinated by Casasanto including the Earth Science Seminar Series, Friday bag lunches, roundtable discussion on career paths with NASA scientists, NASA poster session, final presentations of their summer work, and farewell events. The Seminar Series concluded with a special event by Dr. Jeffrey Halverson, who presented a "Tour of Earth Science on the Science on a Sphere" at GSFC's Visitor Center.

At the conclusion of the programs in mid-August, 2011, a program survey was implemented of both students and mentors. The survey results were gathered and reviewed. Follow-up tasks were completed to close all financial obligations such as final payment of housing, final paycheck processing and travel reimbursements. To close out the programs, budgets were produced and expense summaries finalized. Final reports were produced, including final budget, participants list, evaluation results, and student final reports.

Objectives for FY 12-13

Both Tasks 328 and 329 for the summer programs ended in January 2012.

CCNY Subcontract: Cooperative Remote Sensing Science and Technology (NOAA-CRESST) Center (49173B)

MDE Grant: UMBC Monitoring of Atmospheric Pollution: Vertical Profiling of Baltimore's Lower Troposphere During Nocturnal Low Level Jets, Air Quality Events and Determination of Planetary Boundary Layer With UMBC Lidars (U00P1401314)

Investigators: Rubén Delgado, Research Assistant Professor, JCET, Physics; Raymond Hoff, Science Advisor, JCET and Professor, Physics; Timothy A. Berkoff, Assistant Research Engineer, JCET; and several co-investigators from institutions outside UMBC

Students: Jaime Compton, Undergraduate Student; Patricia Sawamura, Graduate Student; Daniel Orozco, Graduate Student, John Sullivan, Graduate Student; Ingrid Venero, Summer Intern; Lauren Woods, Summer Intern, UMBC JCET

Description of Research

Elastic lidar measurements have been conducted to measure the vertical distribution of aerosols over the Baltimore-Washington metro area to understand and aid in the assessment of whether exceedances of air pollutants and particulate smaller than 2.5 μ (PM2.5) in the Baltimore-Washington metropolitan area which are due to local sources or long-range transport. Active remote sensing lidar measurements support the NOAA CRESST Lidar Network (CLN), which monitors air quality in the vertical from multiple locations on the eastern coast of the United States, the North American Global Atmospheric Watch: Aerosol Lidar Observation Network, and Nocturnal Low Level Jet studies, sponsored by the Maryland Department of the Environment (MDE).

Accomplishments in FY 11-12

Lidar measurements carried out by UMBC's Atmospheric Lidar Group (ALG) provide a set of atmospheric profiles of aerosols, by which analysts can query their vertical distribution in near real time and compare to the inputs of three dimensional forecast models. The UMBC lidar measurements have been useful for NASA A-train (Aqua, Terra, CALIPSO, etc.) satellite retrieval studies, performing instrument accuracy assessments and using data generated by various independent active and passive remote sensing instruments for case studies of regional aerosol variability due to long range transport of smoke, dust and pollutants, and to determine the relative impact of long-range transport versus local emissions during Nocturnal Low Level Jet (NLLJ) and pollution events over the Baltimore-Washington region.

Identification and apportionment of PM2.5 to their sources is an important step in air quality management. Different receptor models have been developed in order to quantify and identify the source contributions to particle matter and organic compounds by measuring the different chemical components. In addition, receptor models are used to develop emission reduction strategies for managing total suspended particles standards to reduce human exposure to toxic substances. A cluster analysis of column aerosol optical properties of aerosols was carried out for aerosol classification. This method provides an a priori method for identification of aerosols without the timely constraint of chemical sampling analysis. The absorption and extinction Angstrom exponents and single scattering albedo were evaluated in the cluster analysis to provide physical and chemical characteristics of urban aerosols and their influences upon the air quality and solar radiation budget in Baltimore. Analysis revealed that Baltimore particle pollution is made up of anthropogenic sources, in agreement with Positive Matrix Factorization (PMF) results.

Jaime Compton successfully defended his master thesis titled: “Determination of Planetary Boundary Layer Height from Ground Based Wind Profiler and Lidar Measurements using the Covariance Wavelet Transform (CWT).” He is also the lead author in the journal article “Determination of planetary boundary layer height on short spatial and temporal scales: A demonstration of the Covariance Wavelet Transform in ground based wind profiler and lidar measurements,” submitted to the *Journal of Atmospheric and Oceanic Technology*.

An electronic mail distribution list continues to be hosted by ALG, cln@lists.umbc.edu, for immediate communication between CREST institutions prior to and during air quality events aiding in the determination and impact of regional and long-range transport of pollutants into the eastern United States and the Caribbean.

UMBC had an active participation in NASA’s Venture Class project called DISCOVR-AQ (James Crawford, PI) which was designed to examine the representativeness of column optical properties from satellites to ground-based air quality. This campaign was carried out in Baltimore during July 2011 and the UMBC team was involved in the ground based verification of NASA aircraft fly over data. Algorithms for planetary boundary layer height (PBLH) determination were developed for lidar and wind profilers measurements, and compared to those generated with Vaisala radiosondes and CL51 ceilometer, and Micropulse lidars, launched and operated during the campaign, respectively.

Objectives for FY 12-13

Urban centers near coastal areas are often subject to poor air quality through either direct downwind transport of pollutants, in-situ production of O_3, or a recirculation brought about by a bay or sea breeze. The role of bay breeze circulation in air quality exceedances at the MDE monitoring stations will be investigated. Ground O_3 measurements will be correlated to wind measurements (speed, direction, etc.) to determine the frequency of bay breeze circulation at these locations and their association with O_3 air quality events. These measurements will provide detailed information of the structure of the PBL over Maryland, and aid in the assessment of pollutant sources (long range transport vs. local).

NASA Grant: CLARREO Development Guided by Existing Hyperspectral Satellite Knowledge Base (NNX11AG61G)

Investigators: Sergio DeSouza-Machado, Research Assistant Professor, Physics, JCET (Co-I); L. Larrabee Strow, Fellow, JCET, Physics, (PI)

Description of Research

NASA's Atmospheric Infrared Sounder (AIRS) has been operational since September 2002. Orbiting 16 times a day on the Aqua platform, this new generation instrument has proved to be very stable, and is now beginning to provide an opportunity to study a high quality 10 year dataset of atmospheric observations. When pieced together with comparable new generation instruments that have recently come online, this should provide scientists with a comprehensive climate quality data record.

DeSouza-Machado is working with his team to retrieve large aerosol particle (dust and volcanic ash) information contained in AIRS radiances. Collaborations with NOAA scientists (Dr. Eric Maddy), UMBC scientists (Dr. Vanderlei Martins and Dr. Yuval Ben-Ami) and international scientists (Dr. Gareth Thomas, University of Oxford) should pay dividends by enabling the team to improve operational retrievals in the presence of these aerosols.

Accomplishments in FY 11-12

More than ten years of AIRS data obtained over ocean (known emissivity) was analyzed to provide estimates of atmospheric trace gas, temperature and humidity trends. The data was first filtered to reduce interference of the signal due to clouds; this reduced the dataset to 5% of available data. Radiance trends were obtained from the filtered set, from which trace gas (CO_2, N_2O and CFC-11) trends were retrieved using Optimal Estimation techniques. Comparison with in-situ data provided evidence of the applicability of this method. For example, CO_2 rates of 1.76 +/- 0.05 ppmv/year were obtained for the Northern Hemisphere.

DeSouza-Machado and team are now studying the full 10+ year AIRS radiance dataset (i.e., without any cloud filtering), in order to elucidate cloud and OLR trends, amongst others.

A collaboration has begun with Dr. Vanderlei Martins and Dr. Yuval Ben-Ami. They are in possession of an AERI interferometer on the UMBC campus, and the team is exploring studying the radiances obtained by the instrument. The team hopes this will lead to an improved understanding of dust in the atmosphere.

Another new collaboration with Dr. Eric Maddy of NOAA (Camp Springs) involves using the Fast Radiative Transfer Model with Scattering (SARTA-Cloudy) developed at UMBC, to analyze AIRS radiances in the presence of dust. The aim is to improve AIRS L2 products in the presence of dust. The collaboration has already yielded one publication in GRL.

A continuing collaboration with Dr. Ruben Delgado of JCET focuses this year on volcanic ash transport. Together with Dr. Gareth Thomas of University of Oxford and Dr. Eric Maddy of NOAA, the team plans to provide a test-bed case of retrievals in the presence of volcanic ash, in order to assess the progress of improving AIRS L2 retrievals.

Objectives for FY 12-13

DeSouza-Machado will utilize the 10+ years of AIRS data to look for climate trends in collaboration with Dr. Larrabee Strow, UMBC JCET. DeSouza-Machado will develop AIRS L2 retrievals using cloudy sky RTA in collaboration with Dr. Larrabee Strow and Dr. Eric Maddy. Finally, DeSouza-Machado will analyze BBAERI infrared radiances in collaboration with Dr. Vanderlei Martins, and Dr. Yuval Ben-Ami, UMBC.

NOAA Grant: GOES-R Air Quality Proving Ground (AQPG) (NA10NES4280016, NA11NES4400009)

NASA Grant: UMBC Participation in Discover AQ (NNX10AR38G)

Investigators: Raymond Hoff, Science Advisor, JCET and Professor, Physics; Rubén Delgado, Faculty Research Assistant, JCET; Timothy A. Berkoff, Assistant Research Engineer, JCET, Amy Huff, Battelle Memorial Institute; Shobha Kondragunta, NOAA STAR; and several co-investigators from institutions outside UMBC.

Students: Jaime Compton, Undergraduate Student; Patricia Sawamura, Daniel Orozco, John Sullivan, Graduate Students, UMBC; Interns: Alexandra St. Pé, UMBC, Chris Lo, Centennial HS, R.J. Powers, Johns Hopkins, Andrea Thomas, Bowie State

Description of Research

The correlation of column measurements of aerosols as seen from NASA and NOAA satellites with ground based measurements of aerosol light scattering and aerosol mass is a challenging problem, but one which must be assessed in order to advance the utility of those satellite observations. DISCOVER-AQ is a five-year "mission" in the Earth Venture series designed to address this issue. UMBC hosted a site which was an over-flight location for the NASA P3-B and UC-12 aircraft.

The second related project is to prepare State, local and tribal air quality forecasters for the next generation satellite measurements which will be available from the Advanced Baseline Imager on the GOES-R series of satellites which will launch in 2015. GOES-R is in a geostationary orbit so it views the western hemisphere at least once every 5 minutes so it will add aerosol and cloud motion to the suite of measurements that the team has become used to from polar orbiters. GOES-R ABI aerosol optical depth adds visible and infrared channels that are similar to those on MODIS and VIIRS.

Accomplishments in FY 11-12

The DISCOVER-AQ project ran for the month of July 2012. Fourteen days of overflights were available from the project, five days that were extremely polluted and two days that were extremely clean. It was a remarkable period to get the range of aerosol pollution over Baltimore and Washington. UMBC's ELF lidar, Leosphere ALS-450 lidar, BAMS and TEOM ground particulate mass monitors, CIMEL sunphotometer, TSI 3 wavelength nephelometer, and Micropulse Lidar were run at UMBC. In addition, Tim Berkoff and Ruben Delgado added five other MPL lidars and a Leosphere Windcube to the region to profile aerosols and boundary layer structure. UMBC will contribute to knowledge of the PBL height across the region. In addition, the group is correlating it's ground based and profile data with the High Spectral Resolution Lidar on the UC-12 aircraft and the in-situ light scattering and aerosol size data obtained during the P3-B spirals in the region. As a side note, Ms. Sawamura got a publication from the detection of the Nabro Volcano over UMBC from this work [Sawamura et al., 2012].

Results from the analysis of the experiment have come up with several conclusions. There is good congruity between ground-based lidars and the HSRL in terms of extinction profiles. There is good agreement between UMBC lidars and HSRL in terms of PBL height. There is less agreement between P3-B light scattering parameters and the UMBC nephelometer measurements. This can be explained by the aerosol microphysics related to the relative humidity of the in-situ sampling. This will be important in closing on the column ambient extinction. There is agreement between expected specific extinction coefficients of the ambient aerosol over Baltimore from HSRL and ELF, if the variation in humidity is considered. The experiment has pointed out weaknesses in the profiling through the entire atmosphere in Baltimore (limited by air traffic control and by overlap functions of the lidar). The researchers are currently addressing these issues and the ones related to aerosol humidification for the next deployment in California.

The GOES-R Air Quality Proving Ground (AQPG, http://alg.umbc.edu/aqpg/) is designed to show state and local forecasters what they will have available after GOES-R launches. Since the ABI sensor has never been in orbit, the imagery needs to be synthetically created. The process is to use an aerosol forecast model (WRF-CMAQ-SMOKE) to generate hourly predictions of aerosol state over the US, and then use an optical model (CRTM) to predict the on-orbit radiances at geostationary orbit. Using these radiances as "data," the GOES-R ABI processing algorithm is used to generate AOD and aerosol type products. The products are displayed hourly on a NOAA website as they would be after launch.

A user group of 39 state and local forecasters volunteered to advise the project on the utility of such data. In the 2011 demonstration project that ran during the DISCOVER-AQ period, forecasters were generally pleased with what they saw. Concerns over color scales and potential misinterpretation of EPA air quality index colors were identified. Since GOES-R will have 2x2 km resolution, the forecasters were very interested in zooming in, even to the county scale, to identify aerosol features. In the pre-demonstration period, some fires in Georgia were particularly useful in predicting how the forecasters will use these data when GOES-R goes up. These results were presented in a two-day workshop at UMBC in January 2012.

Two publications have been drafted. The first describes the process of creating the synthetic imagery from the model output. The second paper, designed primarily for air quality management personnel and forecasters, describes the AQPG demonstration projects and invites user to join in on future demonstration periods.

Objectives for FY 11-12

In January-February 2013, DISCOVER-AQ will carry out a six week project in the San Joaquin Valley of California. UMBC will participate with MPL lidars and a new hydrated nephelometer that Daniel Orozco is constructing as part of his Ph.D. research. As part of her Ph.D. project, Patricia Sawamura will continue to analyze data from the

Baltimore/Washington experiment and using a technique called "3β/2α," she will infer the aerosol microphysical properties from the lidar retrievals.

The GOES-R AQPG will conduct the second demonstration project in September 2012 and the third AQPG user workshop will be held at UMBC on November 1, 2012.

Finally, the team will report next year on the construction of an ozone DIAL system on a JCET Task employing John Sullivan, Ph.D. student, and Thomas McGee of GSFC.

NASA JPL Contract: **AIRS Climate and Calibration Algorithms (1364443)**

NASA Grant: **Validation of the CrIS Sensor Products for Climate Research (NNX11AK78G)**

NOAA Grant: **Calibration and Validation of CRIS Sensor (NA11NES4400001)**

NOAA Grant: **Fast Radiative Transfer Modules for CRIS (DG133E-10-SE-3188)**

NASA Grant: **Hyperspectral Infrared Earth Radiance Time Series (NNX12AG66G)**

Investigators: L. Larrabee Strow, Fellow, JCET, Physics; Sergio De Souza-Machado, Assistant Research Professor; JCET, Physics; Scott Hannon, Faculty Research Associate, JCET; Breno Imbiriba, Post-Doc Research Associate, JCET; Howard Motteler, UMBC

Description of Research

The AIRS sensor on the EOS/Aqua satellite has now been operating for 10+ years. This positions AIRS for use in climate trending as it enters its second decade of operation with the expectation that the instrument and satellite may continue to produce science data for seven more years. Moreover, the NPP/CrIS (Cross-track Infrared Sounder) sensor is already operating in the same orbit as AIRS with the promise of extending the AIRS radiance record by 15 years. The National Academy of Science and the NASA Earth Science Decadal Survey have endorsed the idea of a climate mission lasting 15+ years to measure the earth's infrared emission with high accuracy in order to determine which models best predict climate feedbacks. Unfortunately the CLARREO mission selected by the Decadal Survey for this purpose was recently cancelled.

On NASA Grant NNX11AK78G, the CrIS Sensor on the NPP satellite is the first new NOAA operational sounder since the 1970's when NOAA first started flying the HIRS sensor. CrIS follows the NASA research sensor AIRS that is flying on the NASA/EOS AQUA satellite. The NASA Earth Science Enterprise needs to determine if this NOAA operational sensor will have sufficient performance with accurate products in order to continue the earth science data record started with the EOS series of satellites.

For NOAA Grant NA11NES4400001, CrIS is NOAA's first operational hyperspectral infrared sounder and will be developed, designed, and analyzed by the investigator and team.

NOAA uses the NASA AIRS, METOP IASI, and JPSS CrIS sensor to produce "value-added" products, separate from the operational weather products, such as carbon monoxide, surface emissivity, etc. Under NOAA Grant DG133E-10-SE-3188, the investigator and team provide NOAA with a fast radiative transfer algorithm that has identical physics (spectroscopy) for all three sensors. These algorithms, especially AIRS, use the latest calibration information as well.

Under NASA Grant NNX12AG66G**,** necessary research will begin to form a uniform hyperspectral radiance time series from AIRS, IASI, and CrIS.

Accomplishments in FY11-12

Under the AIRS contract, the team has been working to improve the AIRS instrument calibration in order to enable the use of AIRS for climate trending and potentially provide a CLARREO level radiance climate record. The investigator is focusing on both spectral and radiance calibration of AIRS. UMBC has a long history in AIRS calibration, being responsible for pre-flight spectral calibration of the 2378 AIRS spectral channels. The investigator found that in-orbit the AIRS spectral calibration varies with orbit position and season along with a slow exponential drift. The calibration also varies with detector array. UMBC has developed a model for the frequency calibration that will be used in the Version 6 AIRS products which should be available in late 2012. UMBC also modified the AIRS radiative transfer algorithm that is used for the AIRS Level 2 temperature and water vapor retrievals in order to track the variable AIRS frequency calibration. The investigator also provided the AIRS NASA/JPL Project with independent analyses of the Version 6 AIRS retrievals that highlight quite strong dependence of these products on the first guess.

Work under NASA Grant NNX11AK78G involved evaluating the CrIS RDR (Raw Data Record) and EDR (Environmental Data Record) datasets for earth science applications. In particular, UMBC has been in the process of evaluating the spectral and radiometric accuracy and stability of the CrIS radiances.

Under NOAA grant NA11NES4400001, the investigator participated in the development of the CrIS sensor, including design and analysis of the CrIS thermal vacuum tests that measured the CrIS spectral response functions and frequency calibration. After launch of CrIS, Strow and his group calibrated the position of the three CrIS focal plans in orbit, as well as the frequency calibration of the CrIS Neon spectra reference source. Although the focal plane moved slightly during launch (slightly better focus), the Neon calibration stayed stable since thermal vacuum testing. Strow’s analysis of the CrIS spectral parameters has led to a CrIS frequency calibration that is 10 times better than specification, and accurate enough that numerical weather assimilation systems (NWP) should be able to use all nine CrIS detectors interchangeably. This was not the case for the METOP IASI sounder where the NWP centers can only use one of the four detectors on each focal plane.

Under NASA Grant NNX12AG66G, the team has been carefully evaluating the radiometric performance of all three sensors in order to determine if a stable time series can be constructed by piecing together appropriately massaged radiances from each sensor. This may also involve improving the calibration of each sensor, especially AIRS. The team has recently developed a new algorithm to convert the AIRS radiances to the CrIS spectral response functions and channel centers. This serves to intercalibrate AIRS and CrIS.

Objectives for FY 12-13

For the JPL AIRS contract, the team plans to produce a 10-year frequency calibration dataset for publication, and develop an on-line capability for users to shift the AIRS Level 1b radiances to a standard frequency grid. Work to evaluate the AIRS Level 1b radiometric accuracy will also continue.

Under NASA Grant NNX11AK78G, the investigator will examine the accuracy of the CrIS cloud-cleared radiances that are used in the EDR retrieval algorithm. A number of techniques will be utilized in these evaluations, including SNOs (Simultaneous Nadir Observations).

For the NA11NES4400001 NOAA grant, the investigator will continue to perform calibration and validation of the sensor and will actively work to improve the radiance calibration accuracy.

For NOAA Grant DG133E-10-SE-3188, Strow and team will continue to improve the CrIS operational radiances. This may include improvements to the frequency calibration algorithm and algorithms to convert CrIS off-axis detector radiances to equivalent on-axis radiances. In addition, UMBC is working on getting the CrIS high-spectral resolution mode (for the shortwave band) operational.

Finally, under NASA Grant NNX12AG66G, the team will examine new ways to “grid” hyperspectral radiances to lower radiance accuracy requirements, specifically with regard to doing radiance averages based on effective cloud amount rather than averaging all-sky radiances.

NOAA Grant: GOES-R Air Quality Data Distribution System (NA11NES4400005)

Investigators: Hai Zhang, Assistant Research Scientist, Research Faculty, JCET; Raymond Hoff, Science Advisor, JCET, and Professor, Physics

Description of Research

Designed to disseminate NOAA GOES Aerosol and Smoke Product (GASP) data, NASA MODIS data, and EPA ground-based PM2.5 measurements, infusing Satellite Data into Environmental Applications (IDEA) has become a core product in the toolkits used by State and local air quality analysts and forecasters. In order to provide the air quality community continuous service and make a seamless transition of the IDEA product using GOES-R data when GOES-R is launched, Zhang and team are developing an IDEA-like GOES-R air quality data distribution system using GOES-R proxy data from the Air Quality Proving Ground (AQPG) team. As GOES-R ABI proxy data is made available from AQPG, the team revises the IDEA algorithms to accommodate the high temporal and spatial resolution GOES-R data. Zhang and team work closely with the AQPG team to improve this product based on feedback from the user group.

Two aerosol retrieval algorithms over land are under development for GOES-R ABI data: one uses a method similar to MODIS dark pixel algorithm (MOD04 algorithm); the other uses a MAIAC (Multi-Angle Implementation of Atmospheric Correction) method. MAIAC algorithm can complement MOD04 on bright surfaces since MOD04 only works on dark pixels. However, MAIAC algorithm has not been tested in geostationary satellite geometry. In this project, Zhang and team apply MAIAC algorithm on SEVIRI (Spinning Enhanced Visible and Infrared Imager) data to evaluate its performance in geostationary satellite geometry. To evaluate the accuracy of surface BRDF retrieval from MAIAC, the team also develops a new method to retrieve surface BRDF and compare it against MAIAC retrievals. This work is a risk reduction activity for improving aerosol retrieval over bright surfaces.

Accomplishments in FY 11-12

Zhang and team worked together with the GOES-R AQPG team on setting up the GOES-R AQPG demonstration system. The system uses CMAQ (Community Multi-scale Air Quality modeling system) and CRTM (Community Radiative Transfer Model) to generate TOA reflectance at GOES-R geometry. The TOA reflectance is then fed as input for GOES-R ABI aerosol retrieval algorithm. The final data output is displayed on an experimental web site (http://www.star.nesdis.noaa.gov/smcd/spb/aq/aqpg_v2/). The system was demonstrated in near-real-time in July, 2011 and was also demonstrated during the GOES-R AQPG workshop held in January, 2012.

Since GOES-R does not contain a green band, the team developed a method for generating a synthetic natural color image for GOES-R and applied it in the AQPG demonstration. In order to generate green band reflectance, Zhang and team used the linear regression relationship between green band reflectance and the other two visible bands reflectance, which is derived from the MODIS land surface BRDF and MODIS TOA reflectance. A lookup-table was constructed of the slopes and intercepts since the relationship varies over different types of surfaces, seasons, and atmospheric conditions.

MAIAC algorithm developed for MODIS was revised to apply on SEVIRI data to examine the applicability of the algorithm on geostationary satellite geometry. In this algorithm for MODIS, the surface BRDF shape is assumed to be the same between the 2.1 μm channel and the red and blue channels. For SEVIRI data, the team uses the 1.6 μm channel to substitute the 2.1 μm channel and assume that the 1.6 μm channel BRDF shape is the same as that in the red channel. After revising the MAIAC code and applying it on SEVIRI data, however, Zhang and team found that the 1.6 μm BRDF shape was different from that in the 0.6 μm channel. Therefore, the team modified the algorithm. Zhang and team tested the algorithm over the AERONET sites across Europe using the data of a half year period in 2006. The comparisons of the SERVIRI AOD and AERONET AOD are good. The correlation for all the coincidence over 39 European sites is 0.78, the RMSE is 0.07, and there are 77% of data points which are within the error range of $\pm(0.05+0.15\tau)$.

An algorithm was developed using both GOES-East and GOES-West data to retrieve AOD over the western US. The algorithm first uses MAIAC for GOES-East AOD retrieval to estimate average daily AOD, then retrieves surface BRDF from GOES-East and GOES-West data, then the surface BRDF shape is used in the following day for surface reflectance and AOD retrieval. A near-real-time system was set up and the AOD imagery is available at http://idea.umbc.edu/~hzhang/GAODW/.

Zhang and team collaborated with EPA scientists for the AIRNOW site to deliver near-real-time PM2.5 estimates from MODIS AOD, which uses the algorithm developed by Aaron van Donkelaar from Dalhousie University. The algorithm was implemented on the IDEA system. The PM2.5 estimates data sent to EPA AIRNOW in near-real-time, and in addition, the imagery is presented on the IDEA site. EPA scientists then merged the satellite estimate and in-situ measurement to generate PM2.5 field and presented it to the public.

Objectives for FY 12-13

Zhang and team will revise and improve the IDEA system for GOES-R according to user feedback.

The team will support GOES-R AQPG on the near-real-time demonstration to the users, which will take place in September, 2012.

The team will analyze the ability of the SEVIRI aerosol retrieval, in particular, determine whether they can retrieve more information if they add 0.8 μm channel in the algorithm. They will also analyze the effect of aerosol model on the retrieval.

The team will thoroughly test the MAIAC algorithm for SEVIRI data over AERONET sites in both Europe and Africa, perform regional case studies, and publish the results.

Finally, the VIIRS product will be added to IDEA.

Task 333: Investigation of Polarimetric Remote Sensing of Cloud Particle Microphysics (Sponsor: Steven Platnick)

Investigator: Zhibo Zhang, Fellow, JCET, Physics

Student: Daniel Miller, Graduate Student, Physics, UMBC

Description of Research

The objective of Task 333 is to investigate the sensitivity of polarimetric cloud reflection measurements to cloud particle microphysics.

Accomplishments in FY 11-12

Zhang and team performed a cross-comparison/validation of vector radiative transfer codes, including a 1-D polarized adding/doubling code from the Global Institute for Space Studies (GISS) Aerosol Polarimetry Sensor (APS) group, a 3-D polarized Monte-Carlo code from the Polarization and Directionality of Earth's Reflectances (POLDER) group, and a 3-D unpolarized radiative transfer code from the I3RC (Intercomparison of 3D Radiation Codes) group.

Zhang has been working on a book about polarimetric remote sensing of cloud and aerosol properties. Zhang has already derived some 200+ equations and performed an extensive literature review. Drs. Platnick, Yang, and Baum are co-authors of this effort.

Objectives for FY 12-13

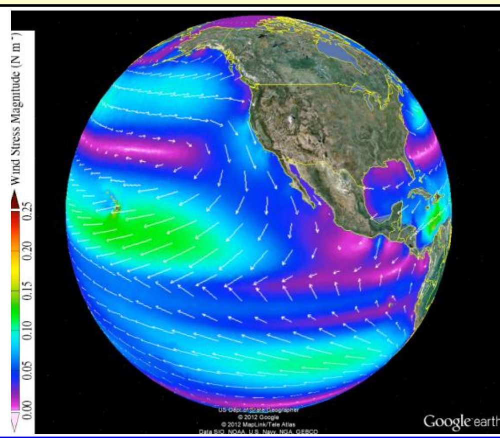
In the coming year, the team will investigate how cloud horizontal and vertical inhomogeneity influences polarimetric cloud reflectance and thereby cloud microphysical property retrievals from passive satellite sensors, such as POLDER and MODIS. The team will also use the combination of CALIPSO, CloudSat, MODIS and POLDER to study how ice cloud microphysics, in particular ice particle shape, vary with cloud macrophysical properties, such as cloud top temperature, convection strength and cloud phase.

Mesoscale Atmospheric Processes Laboratory
(Code 612)

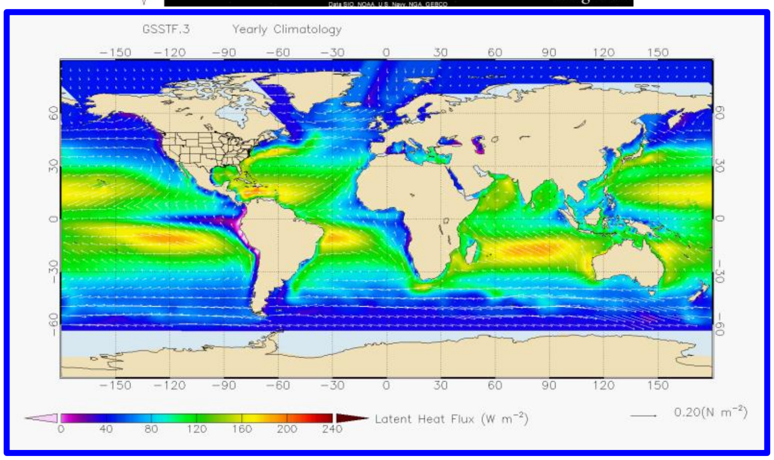
This page intentionally left blank.

JCET Highlight: Global Air-Sea Turbulent Fluxes
Investigator: Dr. Chung-Lin Shie

(A)



(B)



(C)

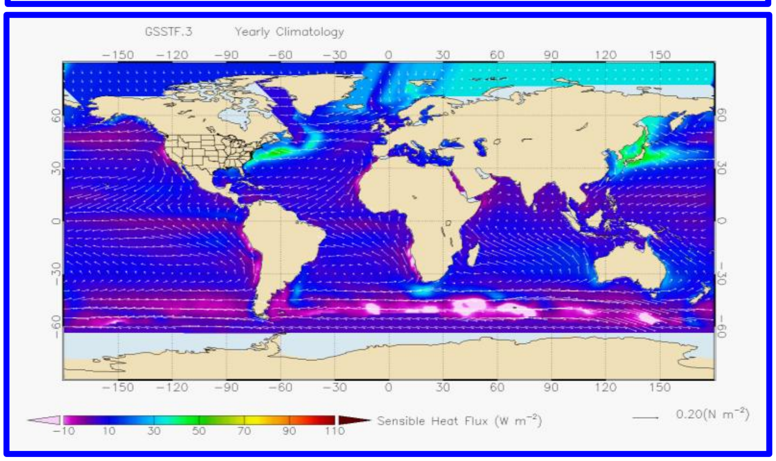


Fig A: There are three major components of Air-sea Turbulent Fluxes, i.e., Surface Wind Stress, Latent Heat Flux, and Sensible Heat Flux. Winds drive oceanic surface circulation that carry the warm upper waters poleward from the tropics. Surface Wind Stress (vectors) and its magnitude (shades; units in N m-2), Figs B and C: About two-thirds of global precipitation mainly contributed by air-sea surface fluxes, fall in the tropics, providing about three-fourths of the energy driving global atmospheric circulation through latent heating release. Fig B: Latent Heat Flux (shades; units in W m-2), Fig C: Sensible Heat Flux (shades; units in W m-2) from the GSSTF Version 3 (GSSTF3) Yearly Climatology, 1998-2008. (Figures were prepared with the help of Andrey Savtchenko at GES DISC.)

This page intentionally left blank.

Task 337: The Micro-Pulse Lidar Network Research and Development (Sponsor: Judd Welton)

Task 336: DISCOVER-AQ Field Campaign and Analysis (Sponsor: Ken Pickering/Jim Crawford)

Task 342: DABUL Lidar Upgrade and Calibration at Howard University (Sponsor: David Starr)

Fibertek, Inc. Award: New Lidar Laser Configuration for Earth Science Measurements (0550-001-02-80217)

Investigators: Timothy Berkoff, Assistant Research Engineer, JCET; Raymond Hoff, Science Advisor, JCET, and Professor, Physics; Rubén Delgado, Faculty Research Assistant, JCET; Rasheen Connell, Howard University; Belay Demoz, Howard, University; Demetrius Venable, Howard University; Youming Chen, Fibertek; Shantanu Gupta, Fibertek

Students: Patricia Sawamura, Graduate Student, Jamie Compton, Undergraduate Student, Daniel Orozco, Graduate Student John Sullivan, Graduate Student, UMBC; Andrea Thomas, BSU

Description of Research

Berkoff's research is focused on the development and implementation of lidar and photometer observational techniques for the characterization of clouds and aerosols for air quality and climate studies. This work benefits NASA's programs such as the Micro-Pulse Lidar Network (MPLNET) and Aerosol Robotic Network (AERONET) that are used as a ground-based complement to NASA's Earth Observing System (EOS) satellite data and related modeling efforts.

Accomplishments in FY 11-12

Support for data collection and ongoing studies to support related MPLNET base-line calibrations were accomplished. MPLNET is a world-wide network of ground-based lidars that provide vertical backscatter properties of aerosols and clouds. Activities include the operation of a wide field-of-view (WFOV) receiver at UMBC to help interpret the stability and residual calibration issues that are applied to lidar systems at GSFC. Cross-comparisons were conducted comparing MPL WFOV derived geometrical overlap functions to UMBC's ELF lidar system, leading to an updated calibration for the UMBC site, as well as providing multi-lidar confirmation of the calibrations being applied at GSFC. The WFOV data stream from UMBC continues to remain a key cross-calibration reference for MPLNET.

Ongoing work was carried out to further develop and establish a nighttime aerosol optical depth (AOD) measurement capability using the moon as a light source. The measurement of nighttime AOD is important to understanding the full diurnal cycle of aerosols, and is particularly useful at high latitude regions during winter seasons when extended periods of darkness occur when other EOS sensors relying on sunlight cannot be used. The lunar system was upgraded and operated at GSFC for a multi-month period of time, significantly expanding upon prior data sets. Feedback from this study led to the manufacturer proceeding with further instrumental changes and NASA procurement of an enhanced version of an instrument from the manufacturer for future use in MPLNET/AERONET.

A collaboration with atmospheric researchers at the Beltsville, MD campus of Howard University took place in the summer of 2011. This activity included the upgrade and realignment of an existing lidar system. In addition, this site has collected data for MPLNET for approximately one year, and an overlap calibration for the existing data was developed and compared to the MPLNET lidar system at GSFC. The data is anticipated to benefit short range aerosol gradient studies because of its relatively close proximity to the GSFC MPL, and also complement other measurement resources at Howard.

In addition, UMBC partnered with Fibertek, Inc. for a Phase I demonstration of a new laser system to obtain atmospheric aerosol measurements based on the high-spectral resolution lidar (HSRL) technique. A HSRL system was implemented with a new fiber-based laser source and receiver using an iodine gas-phase cell as a narrow line-width filter to delineate between atmospheric molecular and aerosol scattering profiles. The HSRL approach provides a more direct measurement of aerosol backscatter and extinction than traditional lidar systems used in MPLNET. Atmospheric data collected with a laboratory based lidar system demonstrated the ability of this new laser source to be used in future lidar systems, similar to those operating in MPLNET. The success of this demonstration led to funding of the second phase of the project that is expected to deliver the first prototype system designed to be operationally compatible with MPLNET.

UMBC also participated in NASA's Venture Class project called DISCOVER AQ (James Crawford, Langley Research Center PI). This first field component of the mission occurred in the summer of 2011 in the Baltimore-Washington region and focused on how EOS satellite data can best be used to provide surface air quality assessments. In this effort, UMBC led the ground-based MPL lidar effort resulting in the deployment of several systems at fixed locations in the Baltimore-Washington I-95 corridor for four weeks, and one ship-based system that collected data for 6 days on the Chesapeake Bay. UMBC implemented algorithms needed to enable multi-site real-time Internet display of the lidar data streams, and later applying higher-level processing, analysis, and uploading of MPL data to the DISCOVER-AQ archive.

Objectives for FY 12-13

The team will continue the development and demonstration of advanced remote sensing techniques and data analysis of existing data collected. This includes the design of a transportable HSRL lidar system as part of the recently awarded Phase II Fibertek grant, implementation of the first high performance fully operational lunar photometer for MPLNET/AERONET, and analysis and interpretative studies for the DISCOVER-AQ campaign. These activities will lead to further improvements in the operation of lidar and photometer systems used in NASA EOS observations.

NASA Grant: Multiscale Analysis of Tropical Cyclone Hot Tower And Warm Core Interactions Using Field Campaign Observations (NNX09AG03G)

NASA Grant: In Situ Measurement of Meteorological State Variables Using Dropsonde On the NASA DC-8 and Global Hawk During NASA GRIP, and Composite Analysis of a Large Dropsonde Database (NNX09AV79G)

NASA Grant: Hurricane Severe Storm Sentinel (HS^3) (NNX11AQ94G)

Investigators: Jeffrey B. Halverson, Fellow, JCET, Associate Professor, Geography and Environmental Systems; Scott Braun, GSFC; Paul Newman, GSFC, Gerald Heymsfield, GSFC

Students: Janel Thomas, Graduate Student, Alexandra St. Pe, Graduate Student, UMBC

Description of Research

Halverson studies the dynamics and thermodynamics of severe storms including tropical cyclones, Nor'easters and thunderstorms. His goal is to better understand how these storms develop and evolve in the complex physiographic setting of the Middle Atlantic Region, and also to discern their socioeconomic impacts.

Accomplishments for FY 11-12

Halverson continued his research as a member of NASA's Hurricane Science Team. He and his M.S. graduate student, Ms. Janel Thomas, continued to investigate the properties of lightning during the rapid intensification phase of Hurricane Earl, which was sampled in the NASA GRIP (Genesis and Rapid Intensification Processes) experiment. Halverson and Thomas started collaborating with Dr. Robert Pasken at St. Louis University. Halverson and his M.S. graduate student, Ms. Alexandra St. Pe, started to develop a scientific framework to better understand the relationship between Sahelian rainfall and dust outbreaks on Atlantic hurricane genesis and intensity change. This involved evaluation of satellite, tropical model reanalysis and multi-year dropsonde datasets.

Halverson and Dr. Owen Kelley (NASA GSFC) co-wrote a manuscript called, "How much tropical cyclone intensification can result from the energy released inside of a convective burst," which has been accepted in the *Journal of Geophysical Research*.

Halverson is on the science team for the Hurricane and Severe Storm Sentinel (HS^3) Venture Class mission. The mission will fly two instrumented Global Hawks into the Atlantic from the NASA Wallops Flight Facility to study hurricane structure and dynamics. In 2011 and early 2012, the Science Team has prepared for the first mission, conducted during the August-September-October timeframe, 2012.

Halverson's PhD student, Mr. Aaron Poyer, has started to examine the relationship between thunderstorm formation, precipitation and electrification in the Washington-Baltimore urban corridor using a high-resolution, regional lightning detection array.

Halverson and UMBC Geography colleague, Professor Tom Rabenhorst, started preparing chapters for their introductory, undergraduate textbook called "Severe Storms and Their

Environmental Impacts". This is a four-year contract to write 26 chapters. Thus far five chapters have been completed and subject to peer-review.

Objectives for FY 12-13

Halverson is now full time in UMBC's Geography and Environmental Sciences Department, and will take sabbatical leave from teaching in Fall, 2012. His research will continue to focus on storminess along the East Coast and the Mid-Atlantic region. Diverse physiographic influences including the Atlantic, Chesapeake Bay, Blue Ridge Mountains and Appalachians interplay to weave a dynamic mosaic of meteorological processes influencing the genesis, evolution and decay of severe storms. The fate of summertime, wintertime and tropical-season storms continues to profoundly influence the socio-economic condition for millions in this region. Many new analyses of these storms and their impacts in the Mid Atlantic will be developed for the text "Severe Storms and Their Environmental Impacts." Additionally, Professor Halverson will further expand the readership of an educational blog he developed in 2012 highlighting severe weather events in the Mid Atlantic, as they occur (the UMBC Storm Page: http://umbcstormpage.blogspot.com/).

Halverson will also continue his investigations of hurricane intensity change. The HS^3 Science Team will prepare to embark on the 2013 summer-fall hurricane field campaign. The Global Hawks will be flown out of NASA Wallops Flight Facility and over developing tropical cyclone targets in the tropical Atlantic, Caribbean and Gulf of Mexico. Halverson will be in the field with his two graduate students supporting the mission.

This team will publish a peer-reviewed manuscript providing an overview of NASA's GRIP campaign, on which Halverson is co-author. Halverson is also co-submitting a paper on the impact of African dust on the intensification of Atlantic hurricanes during GRIP, with lead-author, post-doctoral student Mr. Michael Folmer (St. Louis University).

Task 304: Passive And Active Microwave Retrievals Of Frozen And Melting Precipitation Hydrometeors (Sponsor: Gail Skofronick-Jackson)

NASA Grant: Improvements Of Passive And Active Microwave Precipitation Retrieval Algorithms For Mixed-Phase Precipitating Clouds (NNX11AR55G)

NASA Grant: Improved Ice and Mixed-Phase Precipitation Models for Combined Radar-Radiometer Retrieval Algorithm Applications (NNX10AI49G)

Investigators: Benjamin T. Johnson, Assistant Research Scientist, JCET; William Olson, Research Associate Professor, JCET; Gail Skofronick-Jackson, GSFC

Description of Research

Research has focused primarily on improving multi-sensor microwave (passive and active) retrievals of cold-cloud and mixed phase precipitation. The primary goal is to obtain a higher quality retrieval of precipitation properties such as particle size distribution, particle density, precipitation rate, and particle shape.

Accomplishments in FY 11-12

The primary accomplishments during this reporting period are focused on precipitation retrieval algorithm development for the upcoming Global Precipitation Measurement Mission (GPM). The team's primary focus has been on modifying an existing Bayesian retrieval algorithm to improve snowfall retrieval accuracy. In support of the development of the retrieval algorithm, the investigator has focused on computing the microwave properties of realistically shaped aggregates of hydrometeors and incorporating this into a database for use in the retrieval algorithm.

Johnson is principal investigator on a proposal to study the microwave scattering properties of melting ice particles, such as snowflakes and aggregates of snowflakes. The primary goal is to accurately simulate satellite-based observations of snowfall and light rain events.

Johnson is also currently a co-investigator with Dr. William Olson of JCET on creating a melting-layer model for use in the official combined radar/radiometer retrieval algorithm for GPM. This involves the development of a three dimensional precipitation particle melting model, which is designed to realistically simulate the melting of complex ice-particle shapes and aggregates of these shapes.

In addition to Johnson's research, he is a member of the GPM combined radar/radiometer precipitation algorithm development team, and radiometer-only algorithm team. As members of these teams, Johnson is tasked with developing the standard GPM algorithm for combined retrievals. Johnson is also an active member of the ice/mixed phase working group, and the precipitation detection working group; both of which operate in support of GPM/PMM.

As for Johnson's professional obligations, he has been an active reviewer for the *Journal of Applied Meteorology and Climatology* (JAMC), and *Journal of Geophysical Research Atmospheres* (JGR-A).

In January 2012, Johnson served as mission scientist with Walt Petersen of NASA Wallops for two weeks during the NASA/PMM GCPEx field experiment in Toronto, Canada. Johnson also served as Instrument Scientist onboard the University of North Dakota Citation research aircraft for two weeks during the same experiment. The primary purpose of the experiment was to provide a high quality ground and aircraft validation dataset for use in developing and improving GPM related precipitation retrieval algorithms.

Objectives for FY 12-13

The primary objective is to develop, test, and validate GPM-era combined passive microwave/radar (GMI/DPR) retrieval algorithm(s) for light rain and snow over both land and ocean using a variety of existing satellite and ground based observations, new retrieval methods, and field experiment results.

Specifically, Johnson and team have the official GPROF (Goddard PROFiling) algorithm for use in passive microwave remote sensing; Johnson is tasked with modifying GPROF to operate at the higher frequencies consistent with GPM and to align GPROF with a database for snowfall retrievals.

The research direction is toward developing a working “real-time” algorithm for GPM which will combine all aspects of the aforementioned research: realistically shaped melting particles, improved retrieval capability, improved forward modeling capability, retrieval over land and ocean of both rain and snowfall, with validation and an estimation of the uncertainties in the retrieved quantities.

Additionally, Johnson and team are investigating the relationship between the complex physical properties of ice-phase precipitation particles (including melting particles) and their interaction with active and passive microwave radiation at wavelengths typically employed by remote sensing platforms.

Similar to the objectives above, Johnson and team are developing a radar algorithm for over-land retrievals of snowfall using CloudSat radar observations, as part of an ongoing study to better utilize CloudSat data in conjunction with passive microwave observations. This is funded through Task 304.

These research topics are expected to continue to generate material suitable for publication and presentation at conferences and seminars.

Task 347: UV Lidar Integration under MPLNET Lidar Network (Sponsor: Judd Welton)

Investigator: Simone Lolli, Post-Doctoral Research Associate, JCET

Description of Research

MPLNET is in the process of incorporating a new UV elastic lidar into the network. The new lidar is manufactured by Leosphere, Inc. from France, and is similar to the NASA patented micro pulse lidar currently used in MPLNET. However, the wavelength and signal noise characteristics are different. Specifically, the current standard algorithms for layer height detection and aerosol and cloud retrievals should be tested on new data retrieved at different wavelengths and develop methods to incorporate the data successfully. In addition, the developments of new algorithms are part of a next data processing system release scheduled for 2012.

Accomplishments in FY 11-12

A manuscript entitled "The origin, transport, and vertical distribution of atmospheric pollutants over the northern South China Sea during 7SEAS/Dongsha experiment," has been submitted to the Atmospheric Environment special issue. In this study, data from the NASA/COMMIT and Lidar measurements, as well as trajectory simulations, have been analyzed to explore the relationships between the origin, transport, and vertical distribution of atmospheric pollutants over Dongsha. The investigator, in the process of integrating the UV Lidar into MPLNET, developed an algorithm to retrieve aerosol optical and microphysical properties from UV Lidar measurements. The results were compared to the MPLNET adapted algorithm.

Lolli was Co-chair at the European Geoscience Union (EGU) in Vienna, Austria in April 2012. Lolli developed a parallel algorithm, under MATLAB, to retrieve aerosol layer optical and microphysical properties at both wavelengths (UV-VIS). The algorithm shows closures over sun photometer columnar AOD measurement when available. Once validated, a stand-alone version will be released under MATLAB and will be available to the scientific community.

Objectives for FY 12-13

A field campaign will be held in the August-September 2012 time frame in South East Asia, in the framework of the 7-SEAS mission. The purpose of the campaign is to study the aerosol transport over this key region. During this period, 5 UV Lidar will be deployed on the field and plugged into MPLNET, with the adapted algorithms.

Lolli is expected to analyze data from the campaign and submit three manuscripts to peer-reviewed journals. The upcoming field campaign in South East Asia in the framework of the 7-SEAS mission will bring new opportunities to validate the integration of the UV Lidar in the network and to take advantage, when possible, of the dual wavelengths. Lolli plans to release a stand-alone version of MPLNET algorithms under MATLAB.

Task 301: Research Support for NASA Energy and Water Cycle Studies (NEWS) (Sponsor: Eric Smith)

Task 330: Development of Training Module for Water Resources (Sponsor: David Starr)

Task 362: Evaluation of Data Impact Assimilation Runs to Assess the Impact of and Potential Interaction Among Different Sources of Satellite Data in the GEOS-5 and NCEP GDAS/GFS Data Assimilation Systems (Sponsor: Joel Susskind)

NSF Grant: Predictability and Prediction of Decadal Climate and its Societal Impacts in the Missouri River Basin with Climate, Hydrologic, and Crop Yield Earth System and Economic Land Use Models (2011-67003-30213)

Investigators: Amita V. Mehta, Research Assistant Professor, JCET, Geography and Environmental Systems; Vikram M. Mehta, CRCES; Cody L. Knutson, NDMC; Bruce McCarl, Texas A&M,\; Norman J. Rosenberg, CRCES; Raghavan Srinivasan, Texas A&M

Students: Andrew Raim, Graduate Student, Alison Hoy, Graduate Student, UMBC

Description of Research

There are four major research and application activities undertaken by Mehta this year: 1) NASA Applied Sciences Program-sponsored project to develop information modules and provide hands-on trainings about NASA hydrologic products from satellites and earth system models for water resource managers and other users, 2) NASA Energy and Water Cycle Studies (NEWS) project to analyze the atmospheric water cycle over the central United States Great Plains (USGP) from satellite measurements and atmospheric model, 3) National Institute for Food and Agriculture (NIFA) - US Department of Agriculture (USDA) project, conducted with collaborators from the Center for Research on the Changing Earth System, National Drought-Mitigation Center, and Texas A&M University, to downscale surface temperature and rainfall from climate prediction model simulations over the USGP region using a statistical technique, and 4) NASA AIRS Science Team project to assess impact of AIRS data assimilation on NCEP-GFS forecast skill.

Accomplishments for FY 11-12

Mehta joined the Applied Remote Sensing Training Team and participated in launching the Water Resource Management project in collaboration with Dr. Ana Prados of JCET. Under this project, a variety of presentations and hands-on training modules about NASA water products (rain, snow, evapotranspiration, soil moisture, humidity, clouds, and ground water) were developed for water resource users and managers (http://water.gsfc.nasa.gov). An international training session was conducted as a part of the Group of Earth Observations (GEO) – Latin America and Caribbean Water Cycle Capacity Building workshop in Cartagena, Colombia during November 27 – December 2, 2011. Moreover, a training session focused on the US southern Great Plains was held in Norman, Oklahoma during June 19-20, 2012. In both the trainings, information about NASA's satellite missions and earth system models for measuring water cycle components was provided along with a number of computer-based trainings in access, analysis, and interpretation of NASA water products. Mehta guided a senior undergraduate student, Ms. Allison Hoy from the University of Maryland, College Park, for this project and exposed her to a variety of NASA data and tools for applications.

Under an ongoing NASA's Energy and Water Cycle project, Mehta conducted a detailed analysis of diurnal variability of extreme rainfall events. Results of this study were presented at the American Geophysical Union (AGU) Fall meeting in December 2011. In another ongoing project, Cloud Dynamics and Radiation Database (CDRD) for improved rainfall retrievals from passive microwave measurements, two papers were submitted (Smith et al., 2012 and Casella et al., 2012) describing the CDRD technique and preliminary results of the project.

As a co-investigator of a USDA-NIFA multi-disciplinary project, with multi-institute team members, Mehta is involved in downscaling rainfall (R) and surface temperature (T) from Coupled Model Inter-comparison Project phase 5 (CMIP-5) climate model simulations for forcing land use and crop models. Under this project, multi-decadal historical simulations of four climate models (HadCAM3, GFDL, NCAR, and MIROC5) were selected for downscaling R and T over the US Great Plains region. Using observed, high-resolution (0.125°x0.125° latitude-longitude) R and T data from Maurer et al. (2002) a statistical regression technique has been developed and tested to downscale these historical simulations. This regression relationship will now be used to downscale decadal hindcast simulations from the same models. Mehta guided a graduate research assistant, Mr. Andrew Raim from UMBC, to work on this project. Moreover, Mehta participated in the submission of a new proposal to USDA-NIFA with the same team.

Mehta participated in a project with Dr. Joel Susskind from the AIRS Science Team in conducting data assimilation experiments with NCEP-GFS analysis–forecast system. The objective of this project is to assess how assimilation of AIRS temperature retrievals impact medium range forecast skill as well as weather phenomena such as extreme rain and storm intensity and track in the GFS. Several experiments were conducted including i) no AIRS data were assimilated, ii) AIRS radiances were assimilated, and iii) AIRS version-5 temperature retrievals were assimilated. Results of these experiments are currently being analyzed.

Objectives for FY 12-13

Mehta will continue to work on the ARSET-Water Resource capacity building project including i) identify and interact with water resource managers and end-users, ii) plan and execute training sessions, and iii) develop a web-based course for NASA water products and applications. Mehta will submit a paper based on the USGP extreme rain analysis. Under the NIFA-USDA project, Mehta will lead the effort in improving climate model downscaling technique. Additionally, Mehta will work with other team members of this project to assess impact of the downscaled data in forcing land-use and crop models. Mehta will continue to analyze impact of AIRS data assimilation in the NCEP-GFS model. Moreover, Mehta will participate in assimilation of AIRS version-6 retrievals in the GEOS model. Mehta will teach an undergraduate course on 'Weather and Climate' in the Department of Geography and Environmental Systems at UMBC in Fall 2012.

NASA Grant: Improved Ice and Mixed-Phase Precipitation Models for Combined Radar-Radiometer Retrieval Algorithm Applications (NNX10AI49G)

Task 325: Global Retrieval of Precipitation and Latent Heating Distributions from Spaceborne Radiometer/Radar Observations (Sponsor: Arthur Hou)

NASA Grant: A Long-Term Precipitation Dataset with Uncertainty Information (NNX08AT04A)

Investigators: William S. Olson, Research Associate Professor, JCET, Physics; Mircea Grecu MSU/GESTAR; Lin Tian, MSU/GESTAR; Benjamin Johnson, Assistant Research Scientist, JCET; Kwo-Sen Kuo, Caelum Research Corporation; Arthur Hou, GSFC; Christian D. Kummerow, Colorado State University

Description of Research

The main emphasis of the research is on the calibration of satellite passive microwave estimates of precipitation and latent heating using coincident, high-resolution estimates from spaceborne radar as a reference. Spaceborne radar methods for estimating precipitation/latent heating vertical structure are being developed and tested for applications to 14-GHz radar (Tropical Rainfall Measuring Mission; TRMM) and 14 + 36 GHz radar (Global Precipitation Measurement mission: GPM) in conjunction with a range of passive microwave radiometer multispectral observations. Regarding precipitation, the specific objectives are to improve the representations of ice and mixed-phase particles in combined radar-radiometer algorithms. The remote sensing of latent heating vertical distributions using spaceborne radar-radiometer data is a related area of study, with implications for understanding the Earth's water and energy cycles.

Accomplishments in FY 11-12

With an anticipated launch date in February 2014, the GPM core mission observatory will feature a spaceborne radar (14 and 36 GHz) and a multi-channel passive microwave radiometer (10-183 GHz). Data from these instruments will be used to derive "best" estimates of precipitation and latent heating vertical profiles, and these profiles, in turn, will be used to cross-calibrate radiometer-only profile estimates from an international fleet of radiometers flying in complementary orbits. Prof. Hirohiko Masunaga of Nagoya University and Olson co-led a team that will develop and implement a combined radar-radiometer precipitation/heating algorithm to be applied operationally to the GPM core instruments.

In the past year, the prototype GPM combined radar-radiometer algorithm was revised to incorporate an ensemble Kalman filter for bringing radar-derived precipitation profiles into accord with observed microwave brightness temperatures. Olson and project staff adapted the code to the parallel computing environment of the GPM Precipitation Processing System. Olson and team also co-located combined radar-radiometer estimates (based on TRMM data) and ground-based radar observations of precipitation for the purpose of pre-launch algorithm validation.

In addition, Olson, Grecu, Tian, Kuo, and Johnson applied a variant of the GPM prototype combined algorithm to observations of stratiform precipitation from the Midlatitude Continental Convective Clouds Experiment (MC3E) in order to test the algorithm's internal parameterizations of ice-phase and mixed-phase precipitation scattering properties. In particular, Drs. Kuo and Johnson developed a computer simulation of snow particle aggregation, and then used the Discrete Dipole Approximation (DDA) to derive the microwave scattering properties of the snow. The calculation of snow particle scattering properties using DDA is computationally-intensive, but Dr. Kuo utilized NASA's Pleiades cluster to compute the scattering properties of 6500 simulated aggregate snow particles in one month. Olson and Grecu adapted these scattering calculations for use in the prototype combined algorithm, and Dr. Tian provided calibrated radar data (14 and 36 GHz) from the High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) and collocated upwelling microwave brightness temperatures (89 to 183 GHz) from the Conical Scanning Millimeter-wave Imaging Radiometer (CoSMIR). The team's objective was to estimate precipitation profiles from HIWRAP using the algorithm, and then determine whether or not simulations of upwelling brightness temperatures based on the estimated profiles were statistically consistent with the CoSMIR observations, allowing for uncertainties in the properties of the precipitation and its environment. Preliminary comparisons indicate that very good agreement can be achieved using the aggregate snow particle model. On the other hand, snow particle models with simple spherical geometry could not be made to fit the radar and radiometer observations simultaneously.

Supported by the NASA's Making Earth Science Data Records for Use in Research Environments (MEaSUREs) program, long-term, global precipitation products are being tested for their sensitivity to input microwave brightness temperature calibration and precipitation algorithm parameterizations. During the past year, production software was developed to calibrate geostationary infrared observations using revised Special Sensor Microwave/Imager (SSM/I) algorithm estimates of precipitation to update the current Global Precipitation Climatology Project (GPCP) multisensor precipitation algorithm.

A project to derive and evaluate latent heating estimates from both combined radar-radiometer and radiometer-only observations continues under the NASA Energy and Water cycle Study (NEWS) program. In particular, Drs. Olson and Grecu, in collaboration with Dr. Xianan Jiang of UCLA, are developing error models for space-time average estimates of latent heating that are appropriate for climate analysis applications.

Objectives for FY 12-13

The GPM combined radar-radiometer precipitation algorithm will undergo further testing, using both TRMM observations and synthesized GPM observations, with final delivery in June 2013. The ice/mixed-phase precipitation team will extend the current database of simulated aggregate snow particles to include large particles (> 3 mm liquid-equivalent diameter), as well as melting aggregates, and evaluate different precipitation particle models using remote-sensing and in situ observations from the MC3E and GPM Cold-season Precipitation Experiment field campaigns. The long-term record of consistently calibrated rainfall estimates from SSM/I will be used to adjust GPCP infrared rain estimates. The latent heating estimation method will be revised to improve estimates in warm-cloud precipitation events, and error models for heating estimates will be derived.

Task 361: Develop a Simulation of Hurricane Helene from 2006 from NCEP Global Forecast Systems (Sponsor: Scott Braun)

NASA Grant: Reprocessing of Goddard Satellite-based Surface Turbulent Fluxes (GSSTF) Data Set for Global Water and Energy Cycle Research (NNX08AP35A)

NASA Grant: Study of the Influence of the Saharan Air Layer on Tropical Cyclone Intensity Using Data from Aqua Multi-Sensors and Other A-Train Satellites (NNX08AF52G)

Investigators: Chung-Lin Shie, Associate Research Scientist, JCET; Scott Braun, GSFC; Liguang Wu (UMBC Visiting Scientist), Long S. Chiu, GMU; Robert Adler, UMCP

Description of Research

Research tasks consist of two major projects. The first study, Reprocessing of Goddard Satellite-based Surface Turbulent Fluxes (GSSTF), is a fourth-year project intended to resume processing the widely used GSSTF product. The second study of the Influence of the Saharan Air Layer on Tropical Cyclone Intensity, involves a final year (fourth-year) project and Task 361, both focusing on investigating the impacts of the SAL on Atlantic hurricane formation and intensification using numerical simulations, satellite retrievals, and sounding observations. In the GSSTF study, two series of improved global air-sea turbulent fluxes datasets, i.e., GSSTF2c [Shie et al. 2011] and GSSTF3 [Shie et al. 2012], using corrected SSM/I brightness temperatures (TB) have been produced and distributed to the scientific community.

Accomplishments in FY 11-12

The first project (GSSTF) funded by the NASA MEaSUREs Program, involving developing and producing GSSTF datasets, has occupied the JCET Investigator a majority of his overall research time. The previous GSSTF product had been widely used by the scientific community for global energy and water cycle research since its official release in 2001. However, the original GSSTF production halted indefinitely until May 2008 when this project (led by the Investigator) aiming to revive the GSSTF production has been successfully awarded by NASA MEaSUREs. GSSTF2b (1°x1° globally; July 1987-December 2008) using improved and upgraded input datasets such as the updated SSM/I V6 TB and the NCEP-DOE R2 SKT and Tair, was then produced and distributed in October 2011. Brunke et al. (2011) found that GSSTF2b performed well, especially in LHF and SHF, among the 11 accessed global oceanic surface turbulent fluxes datasets including 6 reanalysis, 4 satellite-derived, and 1 combined. Shie (2010), however, also found that a gradually increased (positive) temporal trend shown in the globally averaged LHF of GSSTF2b, especially post 2000, was systematically related to artificial trends found in the SSM/I TBs, which were used to retrieve WB, Qa, and subsequently LHF. Hilburn and Shie (2011) and Shie and Hilburn (2011) later confirmed that the SSM/I TBs trends were due to a temporal variation/drifting (decreasing) of Earth incidence angle (EIA) of the SSM/I satellites. They subsequently successfully developed a simple and accurate method for removing such EIA dependence from TB. An upgraded and improved version GSSTF2c (1°x1°, July 1987-December 2008) [Shie et al., 2011; Shie, 2011] using the corrected SSM/I TBs based on the method [Hilburn and Shie, 2011] has therefore been produced and distributed. The temporal trends (% per year during 1988-2008) of globally-averaged (90°N-90°S) parameters, i.e., WB; Qa; LHF, were properly reduced from -0.27; -0.20; 1.12 in GSSTF2b (Set1) to -0.04; -0.03; 0.53 in GSSTF2c, respectively. In GSSTF2b and GSSTF2c, Qa was retrieved via a two-step approach applying a WB-TB formulation [Schulz et al. 1993] and an EOF method [Chou et al., 1997]. A one-step method for retrieving Qa directly from the SSM/I TB has very recently been used in the GSSTF3 production (0.25°x0.25°; 1998-2008 so far) [Shie et al. 2012; Shie 2012]. The new method, i.e., using the Qa-TB formulation in Bentamy et al. (2003), has been found further reducing the trends in the retrieved Qa, and LHF that are considered more realistic. The temporal trends (% per year during 1998-2008) of the globally averaged Qa and LHF have further been reduced from -0.12 and 0.53 in GSSTF2c to -0.09 and 0.45 in GSSTF3, respectively. According to records updated monthly by EMS, they have shown 247,467 numbers of product (granules) and 369 GB data volume delivered to 335 distinct users since the official releases of GSSTF2b and GSSTF2c in October 2010/2011, and up to June 2012. It is expected that the number of users should increase steadily, especially after the recent release of GSSTF3 in June 2012. Besides Brunke et al. (2011), there are several other scientific studies using the currently available GSSTF datasets, involving diverse interests such as ocean flux intercomparison [Chiu, Si and Shie 2012], global LHF temporal trend analysis [Chiu, Si and Shie 2012], typhoon and ocean interaction, and global water and energy budget analysis. In a citation survey recently requested by the MEaSUREs Program, this Investigator has reported 99 peer-reviewed journal papers and 123 non-peer-reviewed papers (e.g., conferences, book chapters, dissertations, etc.) that are GSSTF product-related after performing a survey via online search engines such as "Google," "Google Scholar," and "Web of Science."

The second study funded by NASA EOS and Task 361 focused on studying the influence of the SAL on Atlantic hurricane formation and intensification. The studies on the impact of the SAL on tropical cyclone genesis and intensification have yielded interesting results. In a recent study by Braun, Sippel, and Shie (2011) investigating Tropical Storm Debby and Hurricane Helene using a suite of remote sensing data, global meteorological analyses, and high-resolution simulations, the results suggested only a very limited impact of the SAL once genesis has occurred. In a second study by Sippel, Braun and Shie (2011) examining environmental influences on the strength of Tropical Storm Debby, the results showed that the relationship between the SAL and developing tropical cyclones was not straightforward and mainly limited to Debby's pre-depression stage. In another study by Pan, Wu and Shie (2011), the SAL has, however, been found playing two roles in the formation of Atlantic storms: it first helped trigger the development of two tropical disturbances associated with Hurricane Isabel and Tropical Depression 14 (TD14) in the early stage, while later on slowed down the formation of Isabel and inhibited TD14 becoming a named tropical cyclone. In an additional NEWS-related study, Grecu, Olson and Shie (2011) investigated the utility of radiometer observations particularly in overland space-borne radar retrievals of precipitation and associated latent heating.

Objectives for FY 12-13

Two major projects will be carried on for next year. For the GSSTF project, a retrospect production for GSSTF3 from July 1987 to December 1997 will be one primary objective for next year. A "sister" version of GSSTF3, yet with a coarse spatial resolution (1^ox1^o) will also be produced. For the project funded by NASA EOS, the study of SAL's impacts on Atlantic hurricanes will continue.

Task 327: Measurements of Hydrometeor Size Distributions during Global Precipitation Measurement (GPM) Field Campaigns (Sponsor: Matthew Schwaller)

NASA Grant: Measurements of the Size Distribution of Hydrometeor through Surface-based Instruments (NNX07AF45G)

NASA Grant: Quantifying Particle Size Distributions in Support of GPM Combined Precipitation Retrieval Algorithms (NNX10AJ12G)

Investigators: Ali Tokay, Research Associate Professor, JCET, Geography and Environmental Systems; Walter Peterson, GSFC, Daniel J. Cecil, Frank LaFontaine, NASA; Courtney Buckley, NASA ; Lawrence Carey, Texas A&M; V. N. Bringi, CSU

Student: Elisa Adirosi, Visiting Student, University of Rome-Sapienza, Italy

Description of Research

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

Accomplishments in FY 11-12

A manuscript has been published in a peer-reviewed journal on the variability of rainfall within the spaceborne radar footprint. The study has been conducted employing six dual rain gauges at NASA Wallops Flight Facility (WFF). The correlation distance of two-year long observations showed noticeable in rainfall variability between the seasons, 6-month periods, and years [Tokay and Ozturk, 2012].

A field campaign, Midlatitude Continental Convective Clouds Experiment (MC3E), was conducted in Northern Central Oklahoma where the deep convective events were sampled as part of the upcoming Global Precipitation Measurement (GPM) validation efforts. A network of autonomous Parsivel and video disdrometers as well as rain gauges were deployed with a satellite footprint. A visiting scholar, Jan-Bernd Schroer of the University of Bonn, Germany investigated the variability of raindrop size distribution parameters using video disdrometer observations.

A visiting doctoral student, Elisa Adirosi of University of Rome-Sapienza, Italy, investigated parametric forms of raindrop size distribution using the video disdrometer network during MC3E. She noticed that the parameters of gamma distribution had noticeable differences between truncated and untruncated fits. A correlation between the shape and slope parameters was evident.

A field campaign was conducted in Egbert, Ontario where the focus was on snow measurements under the validation of NASA's GPM mission. The experiment involved five sites where each site had two laser-optical disdrometer (Parsivel), a 2-d video disdrometer (2dvd), weighing bucket gauges as well as other ground and airborne instruments. The investigator processed all the disdrometer and gauge data.

A comprehensive study on the accuracy of collocated Parsivel, JW, and 2dvd was conducted through employing six month long databases from Northern Alabama. The impact-type disdrometer measured small drops more accurately while 2dvd was able to capture large drops. The collocated gauge was considered to be reference for event rainfall. A manuscript was submitted to a peer-reviewed journal [Tokay et al., 2012].

An investigation on the variability of rainfall within the instantaneous field of view has begun using the rain gauge network in the Southern Delmarva Peninsula. A summer intern, Rigoberto Roche of Florida International University, has worked on this topic using 5+ years' worth of gauge observations from 11 sites. He reported that the variability depends on the physical characteristics of rainfall.

A summer intern, Frank Harris of UMBC, has been working on the validation of National Mosaic & Multi-Sensor Quantitative Precipitation Estimate (NMQ) product using independent gauges from the Southern Delmarva Peninsula where there is no topography and good radar coverage.

A new version of Parsivel became available for testing purposes and the comparisons with impact-type disdrometer, old version of Parsivel, and rain gauges are underway on the roof of Building 33 at GSFC. The new version measures the small raindrops more accurately than the old version.

Objectives for FY 12-13

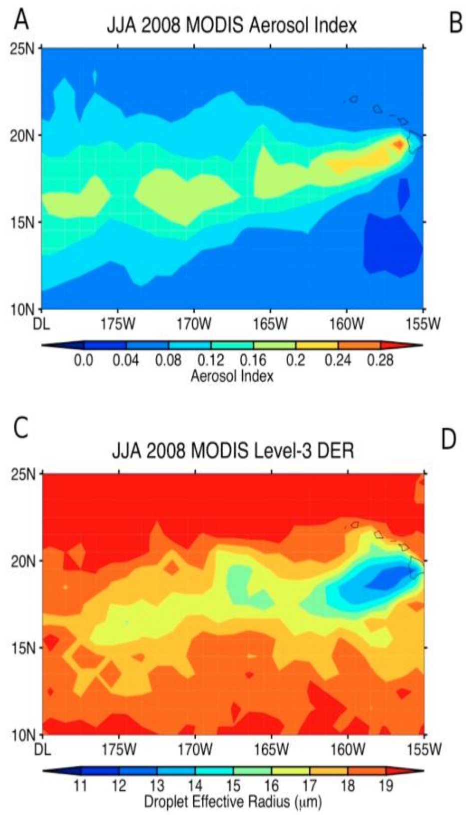
Tokay is expected to complete ongoing studies and submit three manuscripts to peer-reviewed journals. The recently completed field campaign datasets brought new opportunities to study the variability of rainfall and snowfall within a satellite footprint. The field studies are also important resources to investigate the microphysics of rainfall and snowfall. The small-scale variability of rainfall will be further evaluated through a specialized rain gauge network in the mid-Atlantic region. The new network will include dual 25 gauge sites, which will cover a 5 x 5 km array. The gauge network in the Southern Delmarva Peninsula has also expanded to 16 sites. Measurements of raindrop size distribution have been continuously collected at GSFC on the roof of Building 33. This site is expected to serve multi-purpose science objectives among GSFC colleagues. Tokay will participate in a field campaign in Iowa during the April-May 2013 timeframe.

This page intentionally left blank.

Climate and Radiation Laboratory
(Code 613)

This page intentionally left blank.

JCET Highlight: Aerosol Indirect Effect on Cloud Amount
Investigator: Dr. Tianle Yuan



A: June, July and August aerosol concentration map. The starting point of the aerosol plume is the Big Island of Hawaii; **B:** Same as A, but a map for cloud optical depth; **C:** Same as A and B, but for cloud droplet size; **D:** same as A, B and C, but for cloud fraction. All data are from MODIS. The figures illustrate, using a natural event, **the aerosol indirect effects** on clouds, both the Twomey effect and the cloud amount effect.

Kilauea is a volcano on the Big Island of Hawaii and it was constantly emitting sulfur dioxide (SO_2) gases during the summer of 2008, which are then converted into aerosols (Chart A). For the first time, Dr. Yuan and his co-authors are able to observe large-scale increase in cloud fraction resulting from aerosol-cloud interactions. Aerosol increase triggers a chain reaction in the cloud field: it increases cloud droplet number and decrease their sizes, suppresses drizzle formation, makes clouds brighter and larger and finally increases cloud coverage. Direct satellite observations suggest as much as $20Wm^{-2}$ more solar energy is reflected back to space as a result of aerosol-cloud interaction. This is only possible with observations by a suite of instruments onboard of the NASA A-Train satellite. For details see the paper by Yuan et al. (2011).

This page intentionally left blank.

NASA Grant: Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality (NNX10AR41G)

NASA Grant: Improve EPA's AIRNow Air Quality Index Maps with NASA Satellite Data (NNX11AI76G)

Investigator: Allen Chu, Associate Research Scientist, JCET; James Crawford, LaRC; Kenneth Pickering GSFC; P.K. Bhartia, GSFC; Robert Chatfield, ARC; Gao Chen LaRC; Rich Ferrare, LaRC

Description of Research

Both projects have used airborne HSRL aerosol extinction measurements to serve as the baseline study of the relationship between AOD and PM2.5 while DISCOVER-AQ also provides extensive surface networks of sun photometer and lidar measurements during a series of field campaigns over the CONUS. These surface networks are to better estimate the uncertainties and biases for satellite remote sensing measurements. Lidar measurements are the key to evaluate the approximation using HLH (=PBLH + scale height) that leads to the mean PBL extinction (=AOD/HLH). The ratio of near-surface and mean PBL extinctions is used as an indicator whether aerosols are well mixed within PBL. Correlation and linear regression (e.g., slope, intercept, and root-mean-square error) are used to assess goodness of fit between baseline and satellite-derived aerosol optical depths with and without the HLH approximation on the derivation of surface PM2.5.

Accomplishments in FY 11-12

It is clear that the normalization of AOD by HLH accounting for all aerosol abundance within HLH best correlate with MPE with R > 0.93 and RMSE < 0.022. Note that the linear regression obtained based upon the approximation leads to slopes close to 1 (0.9-0.98) and intercepts close to 0 (< 0.003). The results, independent of season, (R~0.93-0.96; RMSE~0.011-0.022) further illustrate that the approximation based upon HLH can be used throughout the year. This approximation successfully estimates PM2.5 within two RMSE of linear fit (RMSE ~4.861; slope ~0.79; intercept ~4.05) and correlation R~0.88 using HSRL data in the DISCOVER-AQ campaign over Baltimore-Washington region. The quality of using columnar AOD is approximately the same as the statistics obtained by using mean PBL extinction (R~0.88; RMSE ~4.878; slope ~0.8; intercept ~4.05). Note that the mean PBL extinction represents the state of well-mixed aerosols within boundary layer. Such close results indicate columnar AOD would be possible to estimate the mean state of aerosol extinction in correlating with surface PM2.5. Preliminary analysis of using HSRL data help narrow the range of exponent of f(RH). The self-validation of using AOD and mean PBL extinction (MPE) as well as near-surface extinction (NSE) illustrate that the best correlated NSE with f(RH) (R ~0.8-0.9) determine the exponent (i.e., gamma value ~0.4-0.8) of (RH) and the normalization of AOD by HLH best correlates with MPE (R~0.97) (http://discover-aq.larc.nasa.gov/2012-02Workshop/).

Airborne HSRL measurements acquired from repeated flight patterns over Baltimore-Washington together with ground DRAGON sunphotometer observations are particularly useful to studying the spatial variation of AOD in comparison to that of AOD/HLH. Note that HLH values are taken from HSRL while AOD values are acquired by HSRL and sunphotometers respectively. Centered at each DRAGON site, AOD observed by HSRL and sunphotometer are matched within 15 minutes of the observational interval of sunphotometer regardless of the distance where airborne HSRL was geo-located. The continuous measurements of HSRL enables the team to derive correlation coefficients as a function of distance with DRAGON observations from fixed locations of 42 DRAGON sites. The results of correlation derived with 0.1° increment show steep decrease in correlation within 0.5° and flatten out outside 0.5° range. That said, spatial variation is most significant when the distance is within 0.5°. The normalization of AOD by HLH results in better correlation as opposed to AOD and 1/2 of RMSE derived using AOD only. Slopes are found close to 1 (0.95 – 1.02 for AOD/HLH and 0.97 – 1.06 for AOD) and intercepts are less than 0.01 for AOD/HLH and 0.03 for AOD. On the other hand, HSRL-derived HLH data within 0.1° around GSFC are used to correlate with local PM2.5 over the B-W area. This is intended to establish an integrated system using micropulse lidar measurements at GSFC (from MPLNet) alone to routinely derive HLH and apply to the adjacent areas. How far the HLH data are away from GSFC will be a valid question. A test was performed to correlate AOD/HLH at GSFC with corresponding ratios at Beltsville, Edgewood, and Fair Hill but using HLH at GSFC. The results led to the conclusion that the correlation coefficients over the entire campaign area are greater than 0.9 - no difference is found at Beltsville compared to that at GSFC (R~1), slightly lower (R ~0.97) at Fair Hill, and R~0.92 at Edgewood. In terms of distance, there is nearly no difference found in correlation since Fair Hill site is the farthest from GSFC (~110 km) while Beltsville is the closest to GSFC (~8 km). The slightly lowered correlation obtained at Edgewood might be due to influence by oceanic air mass. This research is ongoing and expected to expand to the period from 2008-2011. The gradient of AOD with respect to a range of distance of 0.1 to 2.0° shows a great fit to inverse power law, which is potentially associated with visibility (or so-called visual range). Presentations of some of the results were made at the AGU Fall Meeting in 2011, and the DISCOVER-AQ Science Team Meeting in February 2012.

Objectives for FY 12-13

The main objectives for the coming year will be focused on building a monitoring system using MODIS AOD, MPLNet extinction profile, and surface meteorological and PM2.5 data. Three-dimensional data of 2008-2010 will be used to establish the system and 2011 data will be used to assess the system. Multi-resolution satellite AOD data are to be used to evaluate the sensitivity to the correlation with surface PM2.5. Uncertainties and biases associated with and without the approximation will be documented. DISCOVER-AQ Field campaign in San Joaquin Valley is planned to take place in February-March 2013 and Houston in September 2013. Collaborations with NASA Langley Research Center and a number of Universities are ongoing and planned for preparing a number of manuscripts.

Task 312: **Anthropogenic Effects on Clouds and Precipitation (Sponsor: Charles Ichoku)**

Investigators: Ilan Koren, Assistant Research Scientist, JCET; J. Vanderlei Martins, Fellow, JCET, Associate Professor, Physics; Lorraine Remer, Senior Research Scientist, JCET

Description of Research

Anthropogenic actions such as aerosol emissions, surface albedo changes, or deforestation are known to affect cloud properties. These effects pose one of the largest uncertainties in the estimation of the anthropogenic contribution to climate change.

The investigators develop new approaches for studying anthropogenic effects on cloud fields and rain, approaching the challenge from both scientific ends: from the process level and from a larger view of a dynamic system. During the last year, the focus was on questions related to cloud invigoration by aerosols. In particular, how does enhanced aerosol loading change the cloud microphysical properties and how do these changes propagate and affect cloud dynamics?

The investigators are seeking robust methodologies that use observations and models interactively, which allow them to “peel apart” detailed physical processes. Better understanding of key processes in a detailed manner enable them to formulate the important basic rules that control the field and look for the emergence of the overall effects.

Accomplishments in FY 11 - 12

The investigators studied cloud invigoration by aerosols and demonstrated the wide-spread effects on the climate and water cycle systems. In particular they showed how aerosols affect rain formation [Koren et al., 2012]: Higher loads of particles suspended in the atmosphere stimulate the creation of more, but smaller, droplets. The progression from cloud formation to rainfall is far from being linear. Many different feedbacks link microphysics to dynamics and therefore changes in the droplets’ size-distribution affect the latent heat release, updraft profiles, vertical extent of the cloud and freezing efficiency. All of these changes affect patterns of rainfall in all types of clouds from weak drizzle ones to heavy Cumulonimbus (CB’s). This study, based on analysis of MODIS and TRMM satellite data, provides a first global picture of aerosol potential to change rain patterns.

In a following study, the investigators analyzed global rain patterns from TRMM satellite radar data [Heiblum et al., 2012]. They introduced the concept of rain Center Of Gravity (COG) and showed how an increase in aerosol loading systematically increases the rain COG suggesting a delay in the rain onset in polluted clouds, more mass transfer to the cold phase, and therefore, once rain does initiate, stronger rain rates occur.

So far cloud properties have been inverted from satellites, which apply mostly to the cloud tops. This limits the team’s ability to understand the physical processes that take action mostly near the cloud base and below the tops. A new inversion approach that provides the much needed information of the vertical evolution of microphysical properties of clouds is described in a recently published paper [Martins et al., 2011]. Such methodology can shine new light on many cloud processes that are not being directly measured.

The results of one additional study were reported this year on dust patterns. The investigators describe a non-symmetric dependency of Saharan dust emissions to the Atlantic on the large scale dynamics. Moreover, it is shown how a relatively small area in the Sahara (the Bodele depression) serves as the largest dust source in the world and how this source modulates dust emission patterns of the whole Sahara [Ben-Ami et al., 2012].

Objectives for FY 12-13

The investigators plan to continue and expand the study of how manmade actions affect clouds and climate and to explore theoretical questions related to cloud evolution in time and space. In particular, they will keep on developing a system view of the problem where the goal is to find robust rules that control the system as the end result of all internal feedbacks. As part of this effort, they will develop new ways to isolate the net anthropogenic effect from apparent effects driven by meteorology and from apparent correlations due to cloud contamination.

Task 326: Statistical Modeling of Rainfall Statistics from Satellite and Ground Based Radar and Rain Gauge Measurements (Sponsor: Matthew Schwaller)

Investigators: Prasun K. Kundu, Research Associate Professor, Physics, JCET; Matthew R. Schwaller, GSFC

Description of Research

There are four major goals of the research performed under Task 326: 1) developing mathematical models of rainfall statistics that quantify the natural space-time variability of rain; 2) applying these models to describe statistical behavior of precipitation data sets from a variety of sources including satellite and ground based radar and rain gauge measurements including the upcoming Global Precipitation Measurement (GPM) Mission; 3) development of statistical techniques for validation of ground radar observations of rain against rain gauge observations at the GPM ground validation sites including one being set up at the Wallops Flight Facility in Virginia; and 4) inter-comparison of satellite and ground observations of rain from GPM.

Accomplishments in FY 11-12

With Mr. James Travis, a Ph.D. candidate at the Department of Mathematics and Statistics, UMBC, Kundu and team have formulated a comprehensive statistical model of area- and time-averaged precipitation from co-located radar and rain gauge measurements at a GV site. A new statistical model based on a linear stochastic differential equation of fractional order for the point rain rate field is introduced to describe the second moment statistics of space- and/or time-averaged rainfall data. It improves upon a previous model of Bell and Kundu (1996) and Kundu and Bell (2003) that was originally devised to primarily describe the statistics of radar rainfall observations. The new model successfully fits the second moment statistics of precipitation data over a much larger range of length and time scales that encompass both radar and gauge measurements. Once the parameters of the model are tuned to the space-time covariance statistics of area-averaged rain rate derived from a gridded radar data set, such as the Melbourne radar data (TRMM standard product 2A-53), the model is able to reproduce the covariance statistics of time-averaged point rain rate from a network of rain gauges located within the radar field of view (TRMM standard product 2A-56) fairly well without any further adjustment. A preliminary account of the work was presented at the 2011 AGU Fall Meeting and a full-length paper on the subject is nearing completion. The goal of the work is to quantify the statistical difference between radar and gauge observations of rain at the same spatial location over a period of time [Bell and Kundu 2003] and thus helps calibrate the radar using the gauge observations as reference.

Progress was made in utilizing the second moment statistics to formulate an error model for improving the regression analysis of pairs of nearly space-time collocated satellite observations of rain over an area (in collaboration with T.L. Bell (GSFC, retired) and X. Lin (GESTAR) in connection with inter-comparison of GPM satellite rain rate estimates from the core satellite and one of the constellation satellites from the regions of their swath crossings. The results were presented at the AGU Fall Meeting in San Francisco.

Objectives for FY 12-13

In the coming year, the immediate goals are: 1) to apply the new fractional stochastic dynamics model to various radar-gauge inter-comparison scenarios relevant for GPM validation as the Wallops data becomes available; 2) examine spatial statistics of TRMM PR (Precipitation Radar) derived rain data and test the model predictions with regard to the multiscaling behavior; and finally 3) pursue the problem of obtaining a parameterized model of the probability distribution of area-averaged rain rate [Kundu and Siddani, 2007] and the joint distribution as function of time lag in terms of a suitably chosen copula using existing ground radar data from the validation sites.

Task 322: Collaboration on Solar Forcing of Climate Change (Sponsor: Robert Cahalan)

Task 358: NASA Grant: Observational Study of Solar Variability Impacts on the Troposphere, Stratosphere and Mesosphere (Sponsor: Dong L. Wu)

Investigators: Jae N. Lee, Assistant Research Scientist, JCET; Robert Cahalan, GSFC; Dong L. Wu, GSFC; Alexander Ruzmaikin, JPL/Caltech

Description of Research

The research is focused primarily on analyzing multi-sensor spaced based observations of physical variables and atmospheric tracers in conjunction with the solar insolation data from SORCE (SOlar Radiation and Climate Experiment) to develop appropriate Sun-Earth interaction processes.

Accomplishments in FY 11-12

Under NASA's Living With a Star Program, the primary accomplishments during this reporting period are focused on impacts of the solar spectral variability on atmospheric trace gases obtained in MLS (Microwave Limb Sounder) observations and global climate models.

As a science PI of the NASA's Living With a Star program, Lee is continuing a quantitative examination of the significant temporal variabilities (e.g., 11 year and 27 day period) of atmospheric CO, ozone, OH and temperature, extending an earlier study of Lee and Hameed (2007), and Lee et al. (2007; 2009; 2011). Lee investigated the variability of the mesospheric Carbon Monoxide (CM) composition in the polar middle atmosphere and its relation to the total solar irradiance. She found that an increased solar insolation led to more abundant CO amount, due to more CO production from photolysis of carbon dioxide in the upper mesosphere and thermosphere.

Under Task 322, Lee is working as a member of the JPSS Free Flyer TSIS (Total Solar Irradiance Sensor) science team. As a member of the team, she is participating in the development of the TSIS and TCTE (TIM Calibration Transfer Experiment) missions.

Lee has been an active reviewer for the *Geophysical Research Letters* and *Journal of Geophysical Research* and SORCE (Solar Radiation and Climate Experiment) 2012 science team meeting organizer.

Objectives for FY 12-13

Lee's primary objective is to develop and validate the solar impact on Earth's climate using a variety of existing satellite observations and model results. Additionally, she is investigating the modes of the solar spectral variability, which will combine all aspects of the solar variability from the solar spectral observations and models. Lee will collaborate with Juan Fontenla (NorthWest Research Associates Inc.), who performed a series of WACCM (Whole Atmosphere Community Climate Model) experiments. In these experiments, Fontenla implemented different solar spectral irradiance from his own solar model (Solar Irradiance Physical Modeling: SRPM) system [Fontenla, 2011].

Lee and the TSIS team will be working on the development of TSIS instruments towards the data continuity of the Total Solar Irradiance (TSI) and Spectral Solar Irradiance (SSI). One additional objective is recently initiated to fill the data gap of TSI records. The new objective is to modify the existing TIM (Total Solar Irradiance Monitor) from SORCE and to fly the TCTE instrument and launch it onboard STP Sat3 in 2013, which can be used as a TSI data gap filler between the SORCE and TSIS.

Task 311: **Instruments and Methods to Study the Radiative Properties of Aerosol and Cloud Particles (Sponsor: Charles Ichoku)**

Subtasks: **313, 314, 315, 316, 317, 318**

NASA Grant: **Remote Sensing Measurements of Aerosol Absorption and its Effects on Climate Forcing (NNX08AJ78G)**

NASA Grant: **Rainbow and Cloud Side Remote Sensing: A Novel Look at Cloud-Aerosol Interaction and its Effect on Cloud Evolution (NNX08AU97H)**

NASA Grant: **Development and Evaluation of Validation Tools by Experimenters (DEVOTE) (NNX10AK56G)**

NASA Grant: **Airborne, Polarized Imaging Nephelometer for Measuring Aerosol Phase Matrix: In Situ Experiments and Comparison to the New Generation of Remote Sensors (NNX11AL61H)**

STC Grant: **Development of the Qbscout-S1 – Pocket Qub satellite**

NASA Grant: **A Statistically Robust Evaluation of the AERONET Retrieval Algorithm (NNX12AH30A)**

NASA Grant: **Deployment of the PACS Imaging Polarimeter and the Polarized Imaging Nephelometer for the Measurement of Cloud and Aerosol Properties during the SEAC4RS and DC3 Campaigns (NNX12AC37G)**

NASA Grant: **Development of Algorithm and Instrumentation for Integration of the PACS Imaging Polarimeter in the ER-2 Aircraft (NNX11AN11G)**

NASA Grant: **Airborne, Polarized Imaging Nephelometer for Measuring Aerosol Phase Matrix: In Situ Experiments and Comparison to the New Generation of Remote Sensors (NNX11AL61H)**

DOE Grant: **Airborne Open Polar/Imaging Nephelometer for Ice Particles in Cirrus Clouds and Aerosols (160790)**

Investigators: J. Vanderlei Martins, Fellow, JCET, Associate Professor, Physics; Lorraine Remer, Senior Research Scientist, JCET; Roberto Fernandez-Borda, Assistant Research Scientist, JCET ; Dominik Cieslak, Research Engineer, JCET; John Hall, General Associate, JCET, Oleg Doubovik, General Associate, JCET, Hamilton Townsend, General Associate, JCET

Students: Steven Buczkowski, PhD Student; Gergely Dolgos, PhD Student; Li Zhu, PhD Student; Adriana Rocha Lima, PhD Student; William Espinoza, PhD Student; Timothy Kuester, Graduate Student; Trevor Miller, Graduate Student; Ronald Rider, Graduate Student; Travis Robinson, Graduate Student; Jeremy Salkin, Graduate Student; Haotian Sun, Graduate Student; Bryant Szelistowski, Graduate Student, UMBC

Description of Research

The optical properties of aerosol particles and their effects on the radiative balance of the atmosphere and on cloud microphysics constitute major uncertainties in determining the anthropogenic impact on Earth's climate and weather. These issues are addressed in this task with a variety of new techniques and methodologies that cover instrument development, laboratory and field measurements from the ground and aircraft, algorithm development, satellite remote sensing, and model calculations. These tasks continue to address the spectral absorption properties of aerosols on wide wavelength range (300-2500nm) for samples from several regions around the globe including India, China, Brazil, Israel, USA, Mexico, UAE, Bodele, Mauritania, Algeria, and most recently from volcano sources.

The impact of aerosol in clouds and precipitation is another very important topic in aerosol research. These tasks address this topic via the study of aerosol microphysical properties and via the measurement of cloud spectral properties using novel instrumentation developed in the team's laboratory. Major efforts in these tasks are also devoted to the development of new ground based, airborne, and satellite techniques to measure aerosol, clouds, and its interactions and consequences. Prototype instruments were built and are being applied to the measurement of cloud properties from the ground and from aircraft. For instance, the Polarized Imaging Nephelometer was built and flown on the NASA B200 and on the NASA DC8 aircrafts collecting aerosol polarized phase function information for different aerosol types. These instruments are also being studied as prototypes for future satellite measurements, including the PACS (Passive Aerosol and Cloud Suite) polarimeter that is part of the ACE Mission, which is included in the National Academy of Sciences Decadal Survey. Recent efforts are also being devoted to the development of Pico-satellites for the measurement of aerosol and cloud properties.

Accomplishments in FY 11-12

The investigators have continued their efforts on the development of algorithms, instrumentation and methods for the measurement of aerosol absorption and scattering properties via remote sensing and in situ techniques, on the development and application of instrumentation for the measurement of the effect of aerosols on the vertical profile of cloud effective radii and thermodynamics, and on the development of instrumentation and methods for the measurement of polarized radiances for the retrievals of aerosol and cloud microphysical and thermodynamic properties. The team has also continued the collection and analysis of in situ data from several field campaigns and ground stations. Significant efforts were made towards the development of new remote sensing measurement concepts from aircraft and space. Important efforts were also dedicated to the understanding of the effect of aerosol particles on cloud formation, evolution, and lifetime. The team continued the effort to build and fly the airborne simulator of the PACS polarimeter which is being proposed as part of the ACE Decadal Survey Mission. Vanderlei and team have also continued developments on the laboratory setup for the generation and study of aerosol and cloud particles. The team has finished the first version of the PI-Neph (Polarized Imaging Nephelometer) system that flew in the DEVOTE and DC3 field campaigns collecting detailed scattering information of aerosol particles.

Specific developments include: construction of automated sampling stations for the collection of aerosol filters, construction and flight test of the PACS airborne multi-angle imaging polarimeter prototype for the ACE Mission proposal, development of algorithms and methods for the measurement of cloud microphysical propertied using the polarized cloud-bow, development of dry and wet aerosol generators for the production and measurement of various types of aerosols in the laboratory, development of the PI-Neph instrument for the measurement of the polarized aerosol phase function, development and application of techniques for the measurement of the spectral absorption properties of aerosols from 200-2500nm, and development of a concept and instrumentation for the measurements of cloud microphysical properties using Pico Satellites.

Objectives for FY 12-13

The team will fly the PACS polarimeter in the NASA ER-2 aircraft during the PODEX experiment and will demonstrate the use of multi-angle imaging polarimeters on the retrieval of aerosol and cloud particles. The team will continue the development of new in situ instrumentation for aerosol sampling and for the measurement of aerosol scattering and absorption properties, as well as the development of remote sensing techniques for the measurement of aerosol absorption and direct radiative forcing, and the development of polarization algorithms for the detailed retrieval of aerosol and cloud particles. The team will also continue the development of laboratory techniques for the generation, conditioning and measurement of aerosol and cloud particles, allowing for the study of phase transitions between water and ice, detailed properties of cloud ice particles, and their interaction with several aerosol types including dust, smoke, etc. The team also plans to continue using the PI-Neph instruments for the measurement of aerosol scattering on ground and aircraft experiments.

NASA Grant: Deployment of the PACS Imaging Polarimeter and the Polarized Imaging Nephelometer for the Measurement of Cloud and Aerosol Properties during the SEAC4RS and DC3 Campaigns (NNX12AC37G)

NASA Grant: Assessing Contributions of Foreign Aerosol Investigators: Sources to Atmospheric Composition, Air Quality and Regional Climate Impacts in the U.S. Using Satellite Products and Models (NNX12AK81G)

Investigators: Lorraine Remer, Senior Research Scientist JCET; J. Vanderlei Martins, Fellow, JCET, Associate Professor, Physics

Description of Research

The overarching goal of these two projects is to achieve a better understanding of atmospheric aerosols. The specific goal of the DOE grant is to evaluate aerosol products of new satellite sensors, first in terms of their overall accuracy and precision, and secondly in terms of how well they will meet the needs of the air quality community. The project involves working directly with the Suomi-NPP VIIRS cal/val team to evaluate the VIIRS aerosol products, prepare documentation of the evaluation, shepherd the new product through its various stages of maturity and make algorithmic changes that will improve the product. The specific goal of NASA Grant NNX12AC37G is to participate in field experiments, develop and fly innovative remote sensing instruments that measure multi-wavelength, multi-angle polarized reflectance signal from targets on the ground and atmosphere, then to analyze and interpret the data, and prepare papers for publication. The specific goal of NASA Grant NNX12AK81G is to better understand the relative contributions of foreign and domestically-produced aerosols in a variety of aerosol-related interests. How much of the particle mass above North America is produced in North America and how much originates overseas? Then once here, how much of an air quality concern are these particles? Do they change regional climate? Do they modify local weather systems? The goal of NASA Grant NNX12AK81G also includes developing measurement-based analysis methods to answer these questions, communicating the results and taking stock of the historical context of intercontinental aerosol transport.

Accomplishments in FY 11-12

NASA Grant NNX12AC37G had several setbacks due to circumstances beyond the control of the team. Two experiments were supposed to be flown in June: DC3 and PODEX. DC3 was flown as scheduled, but PODEX was postponed week by week and finally rescheduled for January. There is still opportunity to fly an engineering flight to test the new instrument, PACS, in the ER-2 in July, but that is beyond this reporting period. The second setback is that the team was to participate in SEAC4RS in August and September, but that experiment was also cancelled. Despite these setbacks, the down time enabled better characterization of PACS and debugging of problems, while the smaller polarimeter, RPI, did fly during June in DC3 and returned promising data for analysis. The other accomplishment on this project during the reporting period is that the team used the time to refine the team's forecasting and mission planning skills with two separate 'dress rehearsals' for the mission planning team.

NASA Grant NNX12AK81G enjoyed an unusual major accomplishment during this period when the team received notice in June that the team's paper was accepted in *Science* [Yu et al., 2012]. The paper is a collaboration between ESSIC, JCET and NASA scientists. It describes a measurement-based study of intercontinental transport of aerosols to North America. There were three surprising results of this study. First, it was discovered that half of all aerosol mass above North America comes from overseas and is not locally produced. Second, these particles come in high in the atmosphere, so humans don't breathe them in and so they are not a health concern. Third, it was found that most of the imported particles are dust and not industrial pollution. The paper is due for publication 3 August 2012, and during June, JCET faculty extended a significant amount of effort preparing for the publicity and press releases.

Objectives for FY 12-13

The objectives for the coming year are to continue working with the VIIRS cal/val team to evaluate the product, update documentation, implement needed changes to the algorithm and represent the new products to the community at large. Other objectives are to participate in PODEX in January, serving on the mission planning team and to publish an introductory paper on the science behind remote sensing of cloud microphysical properties using innovative instruments such as PACS and RPI. On NASA Grant NNX12AK81G, the objectives are to publish a review article on measurement-based estimates of aerosol intercontinental transport.

Task 321: Retrieval of Cloud and Sea Ice Properties from THOR Lidar Measurements (Funded by NASA Grants "MODIS Aerosol Properties in the Vicinity of Clouds," and "Use of CALIPSO in Understanding the Effect of Clouds on Aerosol Properties and Interpreting MODIS Aerosol Observations Near Clouds") (Sponsors: Robert Cahalan, Alexander Marshak)

DOE Grant: Parameterization and Analysis of 3D Solar Radiative Transfer in Clouds (2442)

Investigators: Tamás Várnai, Research Associate Professor, JCET, Physics; Alexander Marshak, Fellow, GSFC; Robert F. Cahalan, Fellow, JCET, GSFC; Stefani Huang, SSAI; Weidong Yang, USRA

Description of Research

The overall goal of this research is to improve understanding of 3D radiative processes that occur in and around clouds. The team's work focuses on four areas in particular. First, it examines the influence of 3D radiative interactions on solar heating. Second, it investigates the uncertainties 3D radiative processes cause in satellite retrievals of cloud optical thickness and aerosol properties near clouds, and uses the results to examine the changes in aerosol properties that occur near clouds. Third, it examines new opportunities of using 3D radiative transfer in airborne remote sensing of thick clouds. Fourth, it brings improvements to the 3D radiative transfer tools available to the research community by providing on-line resources.

Accomplishments in FY 11-12

This year Várnai and team continued their research on the impact of 3D radiative processes on solar radiative heating. The team also completed the analysis of 3D radiative processes in the dataset built in previous years, which includes observed cloud structures and simulated radiation fields for clouds observed over three years at three sites of the Department of Energy Atmospheric Radiation Measurement program. The results show that 3D processes typically affect radiation fields up to and beyond 5 km from cloud edges. Overall, 3D processes increase average clear-sky zenith radiances, cloud absorption, and surface absorption in cloudy columns, but they decrease average clear-sky surface absorption near clouds.

Várnai and his team also continued their research on 3D radiative processes that affect satellite retrievals of aerosol properties in the vicinity of clouds. For this, the team analyzed 1 km-resolution aerosol properties provided by the atmospheric correction algorithm of the MODIS ocean product. The results indicate substantial increases in particle size and optical thickness near clouds. To help understand changes in particle properties without interference from 3D radiative processes, the team also continued analyzing a yearlong dataset of co-located CALIOP and MODIS data. It was found that clouds drifting with the wind between the two satellites' overpasses did not cause serious complications, and that MODIS greatly facilitates the interpretation of near-cloud CALIOP observations by detecting clouds that lie just outside the CALIOP track [Várnai and Marshak, 2012]. Analyzing the dataset also revealed that near-cloud changes are different for regions dominated by different aerosol types (e.g., desert dust vs. sulfate aerosols from human pollution). Also, the near-cloud changes are more pronounced in MODIS data than in CALIOP lidar data, which is consistent with the expectation of 3D radiative processes and, to a smaller degree, instrument blurring near clouds. When examining in detail the properties of Saharan dust being transported over the Atlantic Ocean, the team found systematic changes in particle shape as well, both along the transport route and, for low-level dust, near clouds.

Third, Várnai and team contributed to studies on interpreting airborne measurements of thick clouds. The results revealed the importance of 3D radiative processes in shaping the observations of the airborne CAR instrument inside pyrocumulus clouds that contain abundant smoke [Gatebe et al., 2012]. The team's results also indicate that measurements of lidars having multiple fields-of-view can specify the internal cloud structure of moderately thick clouds [Pounder et al., 2012].

Finally, as part of the I3RC (Intercomparison of 3D Radiation Codes) project, Várnai and team completed and released to the public the first online 3D radiative transfer calculator. This calculator aims to help researchers and students become familiar with 3D processes and easily test new hypotheses. Since its release in December 2011, the calculator had over 120 unique returning visitors from over 20 countries.

Objectives for FY 12-13

Next year the team plans to continue exploring the 3D radiative effects through which clouds influence aerosol measurements near them, and to refine their method for taking 3D processes into account in aerosol measurements. This will include both radiative simulations and further analysis of raw MODIS and CALIOP observations, and high-resolution retrievals of aerosol optical thickness and particle size distribution.

The team also plans to further analyze their new dataset of co-located MODIS and CALIOP data and to include information from a global chemical transport model on aerosol type. Their goal is to better understand the causes and the spatial and seasonal patterns of particle changes near clouds, and to understand the impact of aerosol and cloud properties on these changes.

Additionally, Várnai and team plan to expand their 3D radiation model to include radiative processes in vegetation. The team will then use the model to examine the abilities of a new method for airborne measurements of canopy height.

Finally, the team plans to further improve the I3RC website, most notably to enhance the capabilities of the new online 3D radiative transfer calculator.

Task 319: A Multi-spectral Approach to Evaluating the Response of Deep Organized Convection to Aerosols (Sponsor: Charles Ichoku)

Investigators: Tianle Yuan, Assistant Research Scientist, JCET, Eric Wilcox, GSFC; Hongbin Yu, University of Maryland; Lazarous Oreopoulos, GSFC

Description of Research

The focus of Yuan's research is in the area of aerosol-cloud-climate interactions. This is among the least understood aspects of our understanding of climate change. Yuan's effort along with that of his collaborators and colleagues is targeted at reducing the uncertainties surrounding the interactions among aerosol, cloud and climate. Specifically, Yuan's current research deals with how aerosols change deep and shallow convective cloud properties and the consequences of these changes using modeling and observational tools.

Accomplishments in FY 11-12

In total, Yuan and team published three journal papers in *Atmospheric Chemistry* and *Physics* and *Remote Sensing of Environment* during this period.

One of the papers was published in *Atmospheric Chemistry and Physics* [Yuan et al, 2011] demonstrating that modifications of trade cumulus cloud fields including decreased droplet size, decreased precipitation efficiency and increased cloud amount are associated with volcanic aerosols. The team found that cloud tops are significantly higher for polluted clouds. In addition, they find significantly higher cloud tops for polluted clouds. Yuan and team demonstrated that the observed microphysical and macrophysical changes cannot be explained by synoptic meteorology or the orographic effect of the Hawaiian Islands. The "total shortwave aerosol forcing," resulting from direct and indirect forcings including both cloud albedo and cloud amount, is almost an order of magnitude higher than aerosol direct forcing alone. Furthermore, the precipitation reduction associated with enhanced aerosol leads to large changes in the energetics of air-sea exchange and trade wind boundary layer. The team's results represent the first observational evidence of large-scale increase of cloud amount due to aerosols in a trade cumulus regime, which can be used to constrain the representation of aerosol-cloud interactions in climate models. The findings also have implications for volcano-climate interactions and climate mitigation research.

Another paper was published in *Remote Sensing of Environment* [Yu et al., 2012]. In this study, Yuan and team conducted an integrated analysis of aerosols above clouds by using multi-sensor A-Train measurements, including above-cloud aerosol optical depth at 532 nm (AOD532) from CALIPSO lidar, the UV aerosol index (AI) from OMI, and cloud fraction and cloud optical depth (COD) from MODIS. The analysis of Saharan dust outflow and Southwest African smoke outflow regions showed that the above-cloud AOD correlates positively with AI in an approximately linear manner, and that the AOD532/AI ratio decreases with increasing COD. The dependence of AOD532/AI ratio on COD doesn't depend on aerosol type when potential biases in the CALIOP AOD measurements are empirically accounted for. Yuan and team's results may suggest the potential of combining OMI AI and MODIS cloud measurements to empirically derive above-cloud AOD with a spatial coverage much more extensive than CALIPSO measurements, which needs to be further explored in the future.

Another paper was published in *Remote Sensing of Environment* [Yu et al., 2012]. In this study, Yuan and team conducted an integrated analysis of aerosols above clouds by using multi-sensor A-Train measurements, including above-cloud aerosol optical depth at 532 nm (AOD532) from CALIPSO lidar, the UV aerosol index (AI) from OMI, and cloud fraction and cloud optical depth (COD) from MODIS. The analysis of Saharan dust outflow and Southwest African smoke outflow regions shows that the above-cloud AOD correlates positively with AI in an approximately linear manner, and that the AOD532/AI ratio decreases with increasing COD. The dependence of AOD532/AI ratio on COD doesn't depend on aerosol type when potential biases in the CALIOP AOD measurements are empirically accounted for. Yuan and team's results may suggest the potential of combining OMI AI and MODIS cloud measurements to empirically derive above-cloud AOD with a spatial coverage much more extensive than CALIPSO measurements, which needs to be further explored in the future.

Objectives for FY 12-13

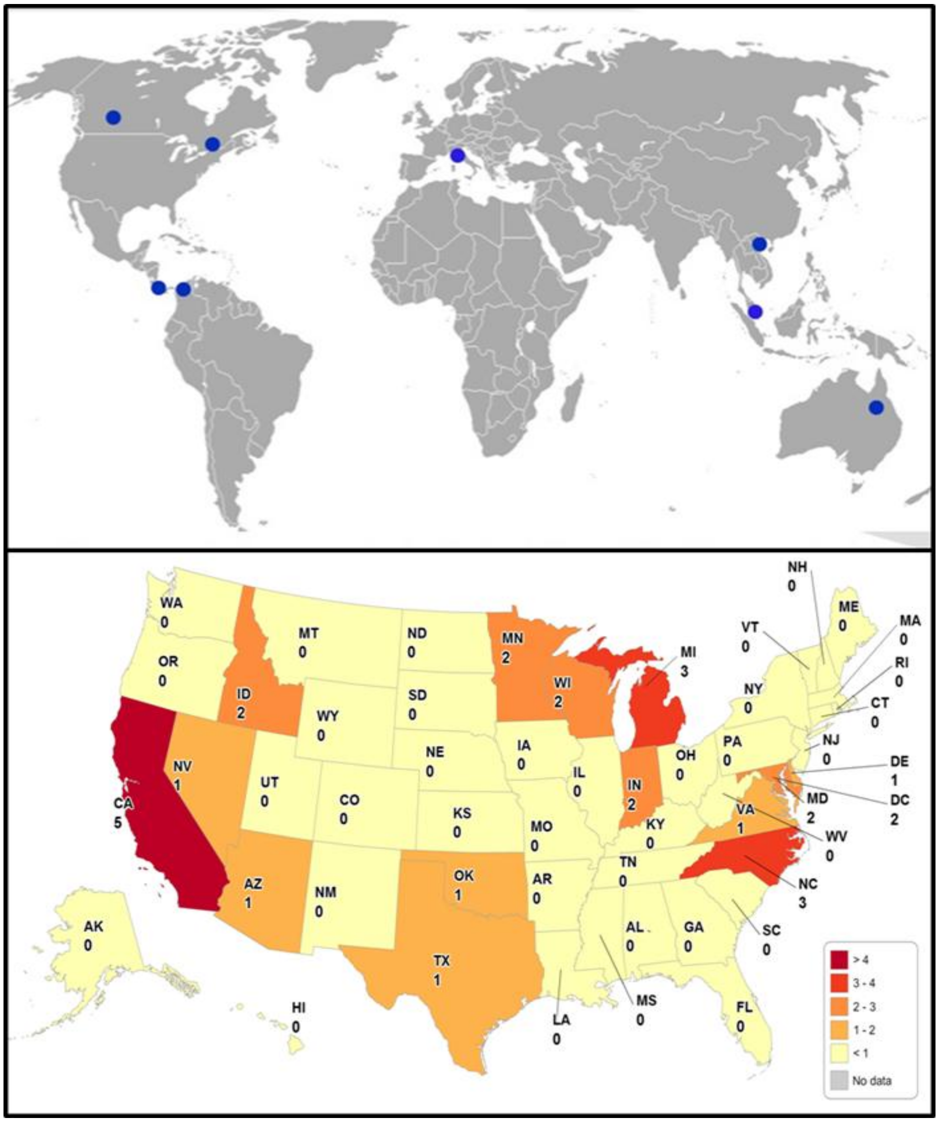
Yuan and team will continue to work on the issue of aerosol-deep convective cloud interactions. A comprehensive study [Yuan et al., 2012] that investigates the impact of aerosols on ice particle size and glaciation temperature will be finalized this year. This study investigates how aerosols may change cloud top ice particle size and cloud glaciation process. Furthermore, it studies the variation of aerosol effect that changes with aerosol type. The team is revising a manuscript [Yuan et al., 2012] that quantitatively addresses the relationship between aerosol and lightning activity. This aerosol-lightning link has implications for tropospheric ozone production and the team's paper will estimate its global impact. With collaborators, the team is also writing two manuscripts that address the statistics of deep convective cloud size and macrophysics as well as their thermodynamic control. In addition, Yuan and team are interested in how aerosols affect the size of deep convective clouds and why, using both modeling and observational tools.

This page intentionally left blank.

Atmospheric Chemistry and Dynamics Laboratory (Code 614)

This page intentionally left blank.

JCET Highlight: NASA’s Applied Remote Sensing Training Program (ARSET)
Investigator: Dr. Ana Prados



From classroom to real world applications, ARSET (managed by JCET faculty member Ana Prados and funded by the NASA Applied Sciences Program) provides online and hands-on remote sensing courses for agencies in the public and private sectors since 2008. Courses teach the application of NASA data to air quality, water resources, and disaster management. The top figure shows countries where ARSET has taught courses. The bottom figure shows the number of online and hands-on trainings attended by key agency personnel in each state. In 2012-2013 ARSET will conduct additional trainings in Canada and the central US (air quality) and in the southwestern US (snow products for water resources management).

This page intentionally left blank

NASA Grant:	**Global Modeling of Nitrate and Ammonium at Present Day and the Year 2050: Implications for Atmospheric Radiation, Chemistry, and Ecosystems (NNX10AK61G)**
MIT Subcontract:	**A Modeling Analysis of the Impact of Aerosols from Combustion Sources on Actinic Fluxes and Photolysis Rates Constrained by Aircraft and Satellite Data (5710003068/NASA Prime NNX11AN72G)**
NASA Grant:	**Integrating Carbon Monoxide and Aerosol Retrievals: Improving Estimates of Aerosol Vertical Distribution, Carbon Component & Local Radiative Forcing (NNX11AP62G)**
Task 350:	**Modeling of Atmospheric Aerosols and Trace Gases (Sponsor: Mian Chin)**
Task 355:	**Modeling of atmospheric aerosols and trace Gases (Sponsor: Peter Colarco)**
Task 356:	**Modeling of Atmospheric Aerosols and Trace Gases (Sponsor: Jose Rodriguez)**
Investigators:	Huisheng Bian, Associate Research Scientist, JCET; Mian Chin, GSFC; Jose Rodriguez, GSFC; Peter Colarco, GSFC; Chien Wang, Massachusetts Institute of Technology; David Edwards, National Center of Atmospheric Research; Hongbin Yu, ESSIC, University of Maryland, College Park

Description of Research

Atmospheric aerosol and gas tracers affect air quality and climate. Huisheng Bian contributed to the investigation of atmospheric tracers, especially aerosol component nitrate and greenhouse gas CH_4, in the following areas: (1) implementing aerosol nitrate and ammonium components into the NASA Global Modeling Initiative (GMI) and participating in a multi-model comparison (AeroCom) for aerosol direct radiative forcing; (2) implementing CH_4 in the NASA Parameterization Chemistry Transport Model (PCTM) and participating in an international multi-model intercomparison for greenhouse gas CH_4; (3) updating and upgrading the photolysis module, fastJX, in GMI and assisting the study of improving fastJX by better representing the impact of combustion aerosols on actinic fluxes and photolysis rates; and (4) analyzing the ARCTAS aircraft measurement for the study of integrating carbon monoxide and aerosol retrievals and the study of source attribution to the Western Arctic.

Accomplishments in FY 11-12

Bian led the development of new capabilities in GMI that can simulate aerosol components nitrate and ammonium with a thermodynamic equilibrium model that partitions semi-volatile HNO_3 between gas phase and aerosol phase. During fiscal year 11-12, Bian and her team evaluated model simulation using results of other models and measurements from ground networks and satellite. In addition to the aerosol mass study, they calculated the radiative forcing of nitrate and investigated the impact of nitrate on atmospheric chemistry. They have reported GMI results of nitrate along with other aerosol components to recent AeroCom II aerosol direct radiative forcing activity. The nitrate data has been used in one published paper and one revised paper.

Bian also led a group effort of CH_4 study at GSFC using the NASA PCTM model by participating in an international activity, Transcom-CH_4, which is a multi-model assessment of global long-term CH_4 distribution during 1990-2007. During this fiscal year, she assisted the preparation of three Transcom-CH_4 papers that addressed CH_4 long term trend, surface concentration and vertical convection by analyzing the CH_4 results from the participated models that were constrained by surface and satellite measurements.

Bian updated and upgraded fastJX scheme, the photolysis scheme that is used by GMI and GEOS CCM for atmospheric photochemical calculation. The work stands for a major upgrade in terms of the new model framework for the cloud and aerosol processing. Bian is also involved in a NASA project led by Chien Wang to use the Aerosol Simulation Program (ASP), constrained by in situ observations of aerosol size, composition, and mixing state from ARCTAS and INTEX-B, to develop updated optical property lookup tables for aerosol from combustion sources for use in fastJX. She trained and directed a MIT post-doc in understanding GMI and fastJX in order to conduct the proposed studies to pursue their goals.

Bian analyzed the ARCTAS aircraft measurements of CO and various aerosol components and summarized the correlation between CO and aerosols under various different atmospheric environments. The work aims to support assessing how well the combination of MOPITT CO and MODIS aerosol optical depth (AOD) improves estimates of aerosol vertical distribution, carbon component and local radiative forcing, one of the objectives proposed by an on-going NASA project led by David Edwards. Using the ARCTAS measurement and combining it with the GEOS-5 model simulation, she led a study of investigating source attribution to the Western Arctic.

Objectives for FY 12-13

Bian and her team will continue working on the study of nitrate and its impact on atmospheric chemistry and radiation field during the coming fiscal year, which is the last year of the project. Based on the study, they will prepare a paper for a comprehensive nitrate study using GMI and assist the writing of Aerocom papers that use GMI results. Bian will also continue contributing to the two on-going NASA projects that involve the integration of carbon monoxide and aerosol retrievals and improving photolysis calculation by investigating the impact of aerosols from combustion sources on actinic fluxes and photolysis rates constrained by aircraft and satellite data. As Principal Investigator, Bian submitted a proposal regarding a secondary organic aerosol (SOA) study to ROSES 2012 Modeling, Analysis, and Prediction (MAP). If it is selected, she will lead the team to improve SOA simulation in NASA GMI and study the impact of SOA on air quality and climate.

Task 343: Volcanic SO_2 Web Pages (Sponsor: Nickolai A. Krotkov)

NASA Grant: Eastern Mediterranean Altimeter Calibration Network - E-MACNET (Continuation of DYNMSLAC and GAVDOS) (NNX08AR50G)

NASA Grant: Space Geodetic Networks Data Analysis (NNX11AI44G)

Investigators: Keith D. Evans, Research Analyst, JCET; Nickolai A. Krotkov, GSFC; Erricos Pavlis, UMBC/GEST (PI)

Description of Research

Evans maintains and expands Goddard's SO_2 web site (http://so2.gsfc.nasa.gov) posting SO_2 and Aerosol images from the NASA Aura Ozone Monitoring Instrument (OMI), adding images from new instruments (e.g., NPP/OMPS) and updating heritage (e.g., TOMS) images. Evans ensures continuous timely generation and display of the TOMS and OMI SO_2 images and maintains an archive of the SO_2 maps and images. Evans updates web site content on a regular basis and continues the long-term record with SO_2 data from NPP/OMPS. Evans continues long-term processing of GPS (Global Positioning System), ILRS (International Laser Ranging Service) and JASON-2 (and follow-ons) satellite data.

Long-term records are obtained from GPS, ILRS and NASA satellite data. These long-term records using satellite data will allow changes in the Earth climate system to become visible.

Accomplishments in FY 11 - 12

The Volcanic SO_2 web site has been moved from UMBC computers to GSFC computers. The web site currently includes automatic generation of daily OMI SO_2 images for volcanic regions. These volcanic regions will be added and expanded, if necessary, due to new eruption activity. Evans wrote software to process SO_2 data from the NPP/OMPS instrument.

Evans started retrieving GPS data from terrestrial sites and processed the data through GAMIT (GPS analysis software) on a regular basis to obtain station positions and velocities, especially for new ground stations created by Dr. Pavlis. Evans was responsible for running the ILRS (International Laser Ranging Service) combination solutions on a daily and weekly basis and debugging bad runs. Evans obtained data from JASON-1 and JASON-2 satellites, updated a database, and derived SLAs (Sea-Level Anomalies). These tasks are ongoing and add to longer time-series to study the variability of these and other parameters, and for satellite altimeter calibration. Results were presented and published.

Objectives in FY 12 - 13

Evans will explore feasibility of automatically generating imagery from recently launched NPP/OMPS SO_2/AI data and post them concurrently with the Aura/OMI images on the web site. SO_2 trajectory modeling capability will be added to the NASA SO_2 site. Evans will complete development of the code for creating SO_2 data from the NPP/OMPS instrument and display these data on the Volcanic SO_2 web pages.

Evans will continue processing GPS data through GAMIT, ILRS and Jason-2 data and will add these data to the earlier records. Evans will calibrate the data, as necessary and compare to other data, such as tide gauge data.

Task 302: Development of Active and Passive Sensors for Remote Sensing Applications (Sponsor: William Heaps)

Task 344: Development of a Miniaturized, Low-power, Low-cost Gas Correlation Radiometer Instrument for Mapping Multiple Trace Gases on the 2016 Mars Science Orbiter (Sponsor: Emily Wilson Steel)

Investigators: Elena Georgieva, Research Associate Professor, JCET, Physics; William Heaps GSFC; Elizabeth M. Middleton, GSFC; Petya Entcheva-Campbell, Research Assistant Professor, JCET; Emily Wilson Steel, GSFC; Wen Huang, SSAI

Description of Research

The research for Task 302 is focused on the development of passive and active sensors for remote sensing determination of various atmospheric trace gases. The objective for the active sensor work is to build up a unique airborne LIDAR system for measuring carbon dioxide changes in the lower atmosphere using as its detector a section of the Fabry-Perot (FP) Interferometer constructed as a passive sensor during previous years.

The advantages of this new approach are that it reduces the number of lasers required for measurement—thereby reducing the risk for a space borne system. It places much of the responsibility for wavelength control on the detector rather than the laser eliminating one of the difficulties facing presently proposed laser systems. It also provides a straightforward path to space since the majority of components involved in the construction of the system have already flown on satellites.

The research for Task 344 is to develop the Hollow fiber gas correlation radiometer and a Laser Heterodyne Radiometer for CO_2 column measurements.

Accomplishments in FY 11-12

Georgieva actively worked to support the successful outcome of the ASCENDS flight campaign in the July August time frame. The team led by Bill Heaps started working on a new broadband LIDAR instrument on NASA's DC-8 that they hope will fly on the ASCENDS satellite mission. The goal of the ASCENDS mission is to measure the sources, distribution and variations in carbon dioxide gas with very high precision all over the Earth. Mapping carbon dioxide is important for understanding the global carbon cycle and for modeling global climate change. The work was featured on NASA’s webpage http://www.nasa.gov/centers/dryden/Features/broadband_lidar_tested_prt.htm.

Georgieva performed all the data analysis and calibration work for the passive CCD methane sensor and presented results at the IGARSS 2012 meeting. She was involved in data analysis, writing papers, reports and posters, giving an oral presentation at the SPIE 2011conference and poster presentation at the NASA Carbon Cycle and Ecosystems Joint Science Workshop in October, 2011 in Alexandria, VA. She identified problems with narrow bandpass filters, performed measurements of filters and etalons, data analysis, performed a suntracker alignment and worked on bringing new fiberoptic cables from the lab on the third floor to the roof of GSFC’s Building 33.

For Task 344, Emily Wilson's Planetary Instrument Definition and Development Program (PIDDP), Georgieva worked on the assembly of the four different channels CH_4, CO_2, H_2CO and HDO together, worked on the lab design and testing of the miniaturized laser heterodyne radiometer setup, helped with mentoring students, contributed to reports, did the laboratory testing of the three new lasers and identified new collimators for the suntracker, participated in data analysis, wrote new proposals, made poster presentations and attended group meetings.

Another research performed by Georgieva was on an innovative instrument to measure CH_4 and other species using CCD array to sample both the Fabry-Perot and Reference channel simultaneously on different areas of the array.

Georgieva contributed to two IRAD proposals: Spectrally Resolving Receiver for ASCENDS Broadband LIDAR with PI William Heaps and Chlorophyll Fluorescence Instrumentation Development & Evaluation with PI Elizabeth Middleton.

Georgieva wrote reviews for several papers including the *Journal of Remote Sensing* (ISSN 2072-4292) and *JSTARS*.

Georgieva presented the results of her work at the SPIE, IGARSS, and NASA Carbon Cycle meetings.

In FY 11–12, Georgieva served as a lab manager and has successfully completed all lab manager training courses for NASA/GSFC.

Objectives for FY 12-13:

The team's principal goal is to demonstrate the ability of the Fabry-Perot Interferometer technique to be used to make ultra-precise determinations of the total column abundance for CO_2 and O_2. The first activity will be to fly the improved LIDAR system in February 2013.

The team expects to have a lab version for the fluorescence sensor, built and tested by September 2013.

The team will continue development of the methane instrument for Earth and Mars applications by optimizing the design.

Georgieva will collaborate with Dr. Paul Mahaffy on the PSS Raman and microscopy optical interface and with Dr. James Butler on calibration work.

Task 303: Research on Atmospheric Composition, Atmospheric Radiation and Satellite Refurbishment (Sponsor: Jose Rodriguez)

Project 1-Validation of AURA OMI Satellite Data using the Pandora Spectrometer System

Investigators: Jay Herman, Senior Research Scientist, JCET; Jose Rodriguez GSFC, (PI); GSFC Material Contributors Nader Abuhassan, USRA/Morgan State University, Alexander Cede, USRA, Maria Tzortziou, ESSIC, University of Maryland, College Park

Project 2-Discover-AQ Use of the Pandora Spectrometer System as Part of a Series of Coordinated Ground and Air Campaigns

Investigators: Jay Herman, Senior Research Scientist, JCET; Kenneth Pickering, GSFC, (PI); James Crawford, NASA Langley; Material Contributors Nader Abuhassan, USRA/Morgan State University, Alexander Cede, USRA.

Project 3-MEASURES Earth Surface and Atmospheric Reflectivity ESDR Since 1979 from Multiple Satellites (TOMS, SBUV, SBUV-2, OMI, SeaWiFS, NPP, and NPOESS)

Investigators: Jay Herman, Senior Research Scientist, JCET; Jose Rodriguez, GSFC, (PI); GSFC Material Contributors Gordon Labow, SSAI, Liang-Kang Huang, SSAI

Description of Research

Task 303 covers the work of three separate projects: Project 1: Validation of AURA OMI satellite data using the Pandora Spectrometer System, Project 2: Discover-AQ: Use of the Pandora Spectrometer System as part of a series of coordinated ground and air campaigns, and Project 3: MEASURES Earth Surface and Atmospheric Reflectivity ESDR Since 1979 from Multiple Satellites (TOMS, SBUV, SBUV-2, OMI, SeaWiFS, NPP, and NPOESS).

The AURA OMI satellite data and Discover-AQ projects make use of an instrument, Pandora, developed as part of the work on the AURA OMI task during the past 5 years. The MEASURES Task is a long term project to join the data from multiple satellites into a 33-year climate data record suitable for measuring cloud amounts.

Accomplishments in FY 11-12

For the AURA OMI Project, before and since July 1, 2011, the Pandora instruments have been used for validation of OMI NO_2 and Ozone data. The basic result found by the investigators is that the OMI ozone data agree well with Pandora measurements and the older standard Brewer spectrometer data. However, OMI NO_2 is substantially below the more accurate Pandora data. These results will be presented at the upcoming AURA Science Team Meeting (October 1, 2012) and have been presented at the AGU meeting in December 2011 and published in peer-reviewed journals [Herman et al., 2009; Piters et al., 2012; Tzortziou et al., 2012].

For the Discover-AQ project, starting in July 2011, Pandora instruments were installed at 12 sites around Maryland, including one each at UMBC and at UMCP, in a coordinated campaign to measure trace gas amounts in the Baltimore Washington area. The sites extended up to the Pennsylvania border. A journal article is in preparation for these results. A similar new campaign is in preparation for the California Central Valley (near Fresno). The Pandoras measured the geographical distribution of Ozone and NO_2 in comparison with both aircraft measurements and the OMI satellite data. The results showed good agreement with the aircraft data, and good agreement with OMI ozone, but not NO_2. The conclusion is that OMI values are too small.

The Measures project neared completion during the end of 2011 and into 2012. As part of this, a paper was published describing the diurnal variation of cloud amounts [Labow et al., 2011] using 33 years of data from a series of 10 SBUV (Solar Backscatter Ultraviolet) satellite instruments from 1979 to 2011. A follow-on paper is in preparation showing the long-term change in cloud amount indicating that there is a positive feedback mechanism associated with global warming.

Objectives for FY 12-13:

The AURA OMI and Measures projects are in their final year (end September 2012 with a no cost extension until December 2012). However, there are two proposals that have been submitted to extend the work. For AURA OMI, the proposal is to obtain altitude profiles of Ozone and NO_2 from Pandora data and to compare this with values retrieved from OMI and the current JPSS/NPP OMPS satellite instruments.

The Discover-AQ project has 3 more years. Next year the team will deal with the results from two campaigns: one in Central Valley California and the other in Houston, Texas. An attempt will be made during these campaigns to measure altitude profiles and compare the measurements with aircraft data overflying the Pandora sites.

A new task will be started in FY13 to work on the DSCOVR (formerly Triana) spacecraft project to develop the science algorithms for ozone, aerosols, vegetation, reflectivity, and cloud height.

Task 309: Monitoring the Air Quality Effects of Anthropogenic Emissions Reductions and Estimating Emissions from Natural Sources and Dynamic Updating of Emissions by Systematic Integration of Bottom-Up Activities (Sponsor: Ken Pickering)

Task 310: NASA Roses 2009: Utilization of NASA Atmospheric Products for Improved Nutrient Control Decisions in the Gulf of Mexico (Sponsor: Ken Pickering)

Task 323: Management of the Applied Remote Sensing Training Program (ARSET) (Sponsor: Ken Pickering)

Task 360: Creating an Objective "Air Quality Applied Sciences Team (AQAST) Recommendations for AQ Satellite Missions" Document to Guide AQ Mission Planning. (Sponsor: Bryan Duncan)

NASA Grant: Multi-Sensor Data Synergy Advisor (NNX09AH65G)

NASA Grant: Building Capacity for Project Evaluation via NASA and ESIP Participation in the Environmental Evaluators Network Annual Conference (NNX11AR66G)

Investigators: Ana I. Prados, Research Assistant Professor, JCET; Amita Mehta, Research Assistant Professor, JCET; Tom Painter and Chris Mattmann, NASA/JPL; Cindy Schmidt, NASA/Ames; Richard Kleidman, Pawan Gupta, and Jaquie Witte, SSAI; Yang Liu, Emory University; Bryan Duncan, Ken Pickering, Shahid Habib, and Greg Leptoukh, GSFC; Dale Allen and Jeff Stehr, University of Maryland, College Park (UMCP)

NASA Grant: Beautiful Earth: Learning Science in a New and Engaging Way (NNX11AH30G)

Investigators: Ana I. Prados, Research Assistant Professor, JCET (Co-I); Valerie Casasanto, Program Coordinator, JCET (PI); Kenji Williams, Remedy Arts (Co-I); Ronan Hallowell, Remedy Arts (Co-I)

Description of Research

The investigator's research centers around providing online and hands-on courses on the utilization of NASA remote sensing data for water resources, disaster, and air quality management internationally and in the U.S.

Accomplishments in FY 11-12

Prados led the NASA Applied Remote Sensing Training Program (ARSET - Task 323). A total of 10 air quality, water resources and disaster management remote sensing courses were provided, reaching over 150 end-users. ARSET expanded to include courses for water resources management, including a workshop in Cartagena, Colombia in November 2011. Training modules were developed using NASA precipitation and snow products, with case studies tailored to South America. Other new ARSET courses built capacity for flood and drought monitoring for end-users in Oklahoma and in Latin America.

Prados also collaborated with NASA's Air Quality Applied Sciences Team (AQAST) by using ARSET end-user feedback to begin developing a recommendations document for NASA mission planning. End-users from several countries participated in the course. Modules are archived in English and Spanish at the ARSET water resources training website: http://water.gsfc.nas.gov. Air Quality online and hands-on remote sensing courses (http://airquality.gsfc.nasa.gov) were developed for state regulatory agencies in the US and Canada, the Vietnamese Academy of Sciences, and Canadian industry professionals. ARSET also conducted its first training for health professionals at the International Society for Exposure Science (ISES) annual conference in Baltimore, MD. Prados also provided ARSET presentations at several conferences [Prados, 2011, 2012] and seminars at GSFC [Prados, 2012]. The ARSET program was favorably reviewed by an external review panel in April 2012. In addition, Prados applied her newly acquired skills in program evaluation to initiate a formal evaluation of the ARSET program. Prados coordinated the evaluation of ARSET that included end-user interviews and future online surveys that will assess the impact of ARSET on end-user decision making.

Interview results were also used to identify the barriers to utilization of NASA data for air quality applications and to develop an objective recommendations document for NASA (Task 360) for 1) future AQAST activities and 2) remote sensing data product design that is optimized for air quality applications.

Prados also built capacity for program evaluation within the earth science community (Grant NNX11AR66G). This was accomplished by organizing NASA sessions at professional evaluation conferences and developing evaluation workshops for earth scientists and data managers. She organized a NASA session at the Environmental Evaluators Network annual meeting in Washington DC. The session focused on defining the audience when establishing performance metrics, assessing the return investment, and identifying earth science success stories. Prados also organized a project evaluation workshop at the Earth Science Information Partner's annual meeting in January 2012. The outcomes of this workshop were published in the NASA Earth Observer in March 2012 [Prados, 2012].

In support of the Beautiful Earth grant (PI Valerie Casasanto), Prados conducted a teacher workshop at GSFC in March 2012 (http://beautifulearth.gsfc.nasa.gov/SEDModule/). Other research focused on examining OMI NO_2 trends over the eastern U.S. (Tasks 309 and 310) using EPA Community Multiscale Air Quality (CMAQ) Model data to identify areas of influence from coal burning plants.

Objectives for FY 12-13

Prados will expand the ARSET training program to reach new end-users in the US and internationally. Hands-on and online courses for the application of land products, and specifically snow and evapotranspiration, to water resources management will be developed. Prados will also lead the development of NASA courses in the area of ecological forecasting in 2013. The ARSET program evaluation and related missions recommendations document to AQAST will be completed in the Spring of 2013 and used to help inform future directions for ARSET and AQAST. Prados will also conduct remote sensing teacher trainings for the Beautiful Earth project and continue student mentoring for NASA Applied Sciences DEVELOP students at GSFC, Wise County, Virginia, and Mexico.

Task 352: Use of NASA MODIS AOD Product for Evaluation of EPA's CMAQ Model (Sponsor: Ken Pickering)

Task 357: Develop Forward Radiative Transfer Model for Simulating SO_2 Absorption Effect in the Thermal IR Band. (Sponsor: Nickolai A. Krotkov)

Investigator: Leonid Yurganov, Senior Research Scientist, JCET (Co-I)

Description of Research

Aerosol Optical Depth (AOD) are available from a 1-year simulation over the continental US using the EPA CMAQ model at 12-km horizontal resolution. MODIS AOD observations are used to evaluate the model AOD.

Accomplishments in FY 11-12

Due to some technical problems (unavailability of AOD data) the implementation of the job started with CMAQ NO_2 comparisons with OMI data. The problem was found in different pixels, both locations and sizes, for two data sets. It was necessary to develop an algorithm for re-gridding of OMI NO_2 onto the CMAQ grid. This was completed by the end of 2011. A further problem was connected with a drawback of OMI data, that originates from using some special first guess data set in the retrievals. There have been two different ways for adjustment of OMI NO_2 for CMAQ. After intense discussions with PI's and collaborators, a concrete version of this adjustment has been chosen. As a result, the re-gridded adjusted OMI was compared to CMAQ data and a good correlation was found for ~90% of data. The remaining 10% of the data are for areas with strong emissions. Future research should help to understand the reason(s) for this discrepancy.

AOD data became available in 2012. The problem of different shapes and sizes of the pixels was similar to that for NO_2. Moreover, MODIS AOD data do not contain the shapes of the pixels, only central points of them. An original algorithm for shapes of pixels was developed. The data for two MODIS instruments have been processed for making them comparable with CMAQ data. It was found that for areas with anthropogenic aerosol, CMAQ simulates AOD with fair quality. However, natural aerosol in most cases is not calculated so well. The obtained data set would allow for further analysis of discrepancies.

Task 352 has been completed. Dr. Pickering, PI of the project, plans to extend the task for several months to summarize the results. Further continuation of the work is to be determined.

For Task 357, a Matlab code was developed at the Atmospheric Spectroscopy Laboratory (UMBC) by Scott Hannon et al. allowing for the retrieval of SO_2 from volcanoes both over areas illuminated by sunlight and in dark conditions with equal accuracy. However, a priori information on the height of the volcano plume is necessary for a retrieval. During this period, preparatory work has been completed: a computer was moved from UMCP to UMBC, a Fortran compiler was installed and the UMBC codes were recompiled for the new environment. Several test retrievals were performed. A proposal for re-processing of all available OMI SO_2 data has been submitted to NASA.

Objectives for FY 12 - 13

MODIS Level II (10-km horizontal resolution) data shall be gridded to the CMAQ grid using existing software. Contribution to a final report for the NASA Applied Sciences Program will be required. Evaluation will be conducted in terms of monthly means and variability over each month. Evaluation of the procedure used in AOD calculation from model PM mass concentrations will also be performed. Evaluation of the MODIS AOD using available AERONET data from the period of interest will also be necessary. Later, this task will be supplemented by evaluation of model NO_2 data based on OMI measurements in terms of monthly and 10-day averages and variability.

The investigator will develop a forward radiative transfer model for simulating the SO_2 absorption effect on the TOA radiances in the short to thermal IR spectral band (up to 15 micron). He will also compare forward model spectra with measured satellite radiances from AIRS and IASI (GOSAT) instruments. The investigator will perform retrievals of volcanic SO_2 in IR and compare with UV retrievals.

If the SO_2 proposal is awarded, the available AIRS data since 2002 will be processed for SO_2 retrievals and the results will be included in the NASA data set on volcanic SO_2.

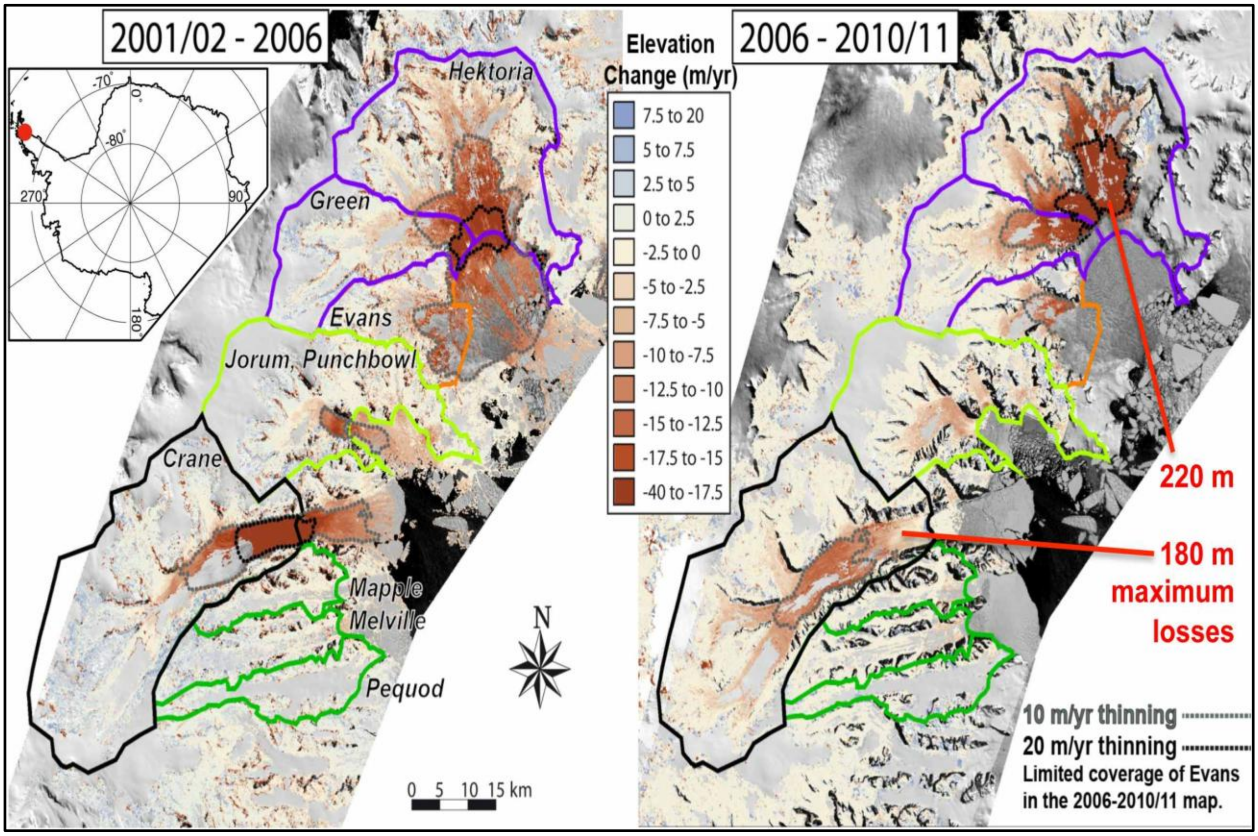
A proposal to NASA on methane analysis will be submitted.

Cryospheric Sciences Laboratory
(Code 615)

This page intentionally left blank.

JCET Highlight: Glacier Loss in the Antarctic
Investigator: Dr. Christopher Shuman

2001 - 2006 **2006 - 2011**



Digital Elevation Model (DEM) derived rates of ice elevation change (m a-1) for selected glaciers in the Larsen B embayment, Antarctic Peninsula. Differences were calculated between (left) combined ASTER DEMs (2001/02) and a SPOT5 DEM (2006) and (right) the SPOT5 DEM (2006) and combined ASTER/SPOT5 DEMs (2010/11). Selected maximum losses are pointed out in red for Crane and Hektoria glaciers (names at left). The 10 m a-1 thinning contour is shown for both time periods with a gray dotted line, the 20 m a-1 with a dark dotted line.

This page intentionally left blank.

Task 346 Native Homelands Climate Change Workshop Final Report (Sponsor: Nancy Maynard)

Investigator: Valerie Casasanto, Program Coordinator, JCET

Description of Research

The Native Peoples-Native Homelands Climate Change Workshop was held November 18-21, 2009, in Prior Lake, Minnesota (http://www.nativepeoplesnativehomelands.org/) to discuss and propose strategies for addressing the impacts of climate change on Indigenous Peoples and Native Homelands. An additional goal of the workshop was to update the findings conducted in conjunction with the 2009 U.S. National Assessment of the Potential Consequences of Climate Variability and Change. The workshop is the second in a series following the first Native Peoples-Native Homelands Climate Change Workshop in 1998 [Maynard, 2002]. The purpose of Task 346 is to assist in compiling and completing the final workshop report book for publication by NASA.

Accomplishments in FY 11-12

Casasanto worked with the sponsor, Dr. Nancy Maynard of Code 615, to develop a plan, create a task milestone list, action item list, and report first working draft. In addition, Casasanto interfaced with the NASA printing office to coordinate printing production and obtain price quotes. Statistical fact finding research was completed.

Objectives for FY 12-13

A complete draft of the report is expected to be completed by the end of October. After which, Casasanto will work in conjunction with the Sponsor and the NASA printing office to review the document, make edits, and complete any remaining research (i.e., reference citations, photo credits). It is expected that the report will be printed in the first quarter of calendar year 2013.

Task 341: IceBridge, ICESat 1/2 Calibration Validation Assessment (Sponsor: Thorsten Markus)

NASA Grant: Using Refined ICESAT-1 Altimetry to Investigate the Limits of Change Detection on the East Antarctic Plateau: Analysis of Megadune Migration and Other Signatures of Heterogeneous Accumulation (NNX10AH01G)

Investigator: Christopher Shuman, Associate Research Scientist, JCET (PI)

Description of Research

Shuman joined JCET in Spring 2011 after being with GEST for four years. He is currently working with Dr. Thorsten Markus for calibration and validation of the planned Ice, Cloud, and land Elevation Satellite 2 (ICESat-2). With launch still planned for 2016, detailed documentation of post-launch plans is required for crucial upcoming NASA HQ reviews. On a related note, Shuman continues to assess ICESat-1 data to assess very small elevation changes from specific study areas in Antarctica through an ongoing NASA grant. Collaborative research on large ice elevation changes and estimated mass losses in the Antarctic Peninsula has been particularly rewarding with elevation losses of more than 160 m in less than a decade observed on some major glaciers. A fourth paper on observed changes across the rest of the Antarctic Peninsula is already underway and may be submitted prior to the IPCC deadline.

Accomplishments in FY 11-12

Three related publications on Antarctic Peninsula glacier changes from a combination of airborne and satellite altimetry data were the main effort from the past year. The *Journal of Glaciology* [Shuman et al., 2011] publication was announced with releases from NASA, UMBC, International Glaciology Society, and the National Snow and Ice Data Center (NSIDC) as well as web coverage (e.g. http://www.nasa.gov/topics/earth/features/larsen-collapse.html). Additional interest has been provided by the detailed story in the *Annals of Glaciology* [Scambos et al., 2011] of a small subglacial lake that drained from under the Crane Glacier as well as the just published *Geophysical Research Letters* research that extends the time line and confirms the scale of the ongoing ice changes.

The underlying science described in these papers is informative for predicting future ice mass changes at similar glaciers elsewhere. The research can be summarized as follows: 1) once ice shelf collapse is initiated through a combination of atmospheric surface melting and warm ocean water thinning, glacial ice mass losses will continue for many years, probably decades; 2) extensive floating ice area loss will also continue long after the initial ice shelf collapse (since the early 2002 Larsen B ice shelf collapse, more than 50% of the initial ice area lost has similarly become exposed ocean); 3) glaciers once bounded by the now-collapsed (early 1995) Larsen A ice shelf continue to thin and retreat but at a reduced rate; 4) significant glacier elevation losses have now extended as much as 50 km inland, encompassing the full glacial flow system of the major glaciers; 5) rapid elevation losses (up to 90 m in one year) may be associated with small subglacial lake basal water releases in deep glacial troughs; 6) early altimetry data suggest that ice shelf and grounding line (where the glacier loses touch with the underlying bedrock and sediment and begins to float) changes had begun prior to the collapse event, perhaps by several years; 7) larger glaciers in the southern part of the Larsen B embayment that are still bounded by a shrinking remnant of the ice shelf are showing signs of changes near their grounding line so additional large ice mass losses will be expected with additional ice shelf losses; 8) the spatial and temporal analysis of mass losses has been enabled by a combination of airborne and satellite altimetry data with accurate ASTER and SPOT5 Digital Elevation Models (DEMs) both preceding the initial airborne altimetry data and post-dating the ICESat-1 mission's data.

In addition to this, the post-launch planning in support of ICESat-2 has ramped up rapidly. Activities and achievements include attending a Science Definition Team (SDT) meeting in La Jolla, CA where a gain bias and its impact on the earliest ICESat-1 data was first illustrated. This problem and its impact on derived elevations has been documented at NSIDC. Numerous subsequent meetings have occurred at GSFC and a post-launch calibration and validation plan is being outlined and written by a small team at GSFC with the support of the SDT. Shuman and team are also involved with plans for component and instrument testing prior to final instrument integration on ICESat-2. Part of the challenge is that ICESat-2 is a fundamentally different measurement approach (photon-counting lidar) as opposed to ICESat-1 (analog waveform lidar) among other differences. There is broad recognition that not all the biases in the ICESat-1 time series, including the received energy bias documented in East Antarctica, have been resolved in the final data release. Because of the differences in the laser altimetry techniques, it is not clear that the lessons learned from ICESat-1 will be applicable to ICESat-2.

Objectives for FY 12-13

Shuman's goals and Objectives for FY 12-13 include: to help publish the broader Antarctic Peninsula study of glacier and mass changes (actually the 5th paper in a series going back to the first one in GRL in 2004); to assess a large area of megadunes for any interpretable elevation changes from ICESat-1 during 2003-2009; to continue to assess the data from other sites in East Antarctica such as Lake Vostok for a correction of the residual received energy bias in the ICESat-1 data; to support the ICESat-2 SDT and the evolving post-launch calibration and validation plan, to affiliate with the Physics Department at UMBC and to contribute to teaching at UMBC; to continue mentoring (now graduate) student Michael Schnaubelt; and to complete the team's assessment of temperature records from central Greenland.

Task 332: Operation Icebridge (Sponsor: Thorsten Markus)

Investigator: Michael Studinger, Associate Research Scientist, JCET

Description of Research

Studinger leads the Project Science Office at GSFC and its day to day operations in support of NASA's Operation IceBridge. NASA's Operation IceBridge images Earth's polar ice in unprecedented detail to better understand processes that connect the polar regions with the global climate system. IceBridge utilizes a highly specialized fleet of research aircraft and the most sophisticated suite of innovative science instruments ever assembled to characterize annual changes in thickness of sea ice, glaciers, and ice sheets. In addition, IceBridge collects critical data used to predict the response of Earth's polar ice to climate change and resulting sea-level rise. IceBridge also helps bridge the gap in polar observations between NASA's ICESat satellite missions. In 2011/12 the mission wrapped up another year with two successful campaigns, one over the Arctic and one over the Antarctic.

Accomplishments in FY 11-12

During October – November 2011, Operation IceBridge completed a successful Antarctic campaign with NASA's DC-8 and NSF's G-V aircraft. The science targets included sea ice in the Arctic Ocean and glaciers and ice sheet targets over Greenland.

Objectives for FY 12-13

Studinger's JCET appointment ended August 26, 2012. Studinger has transitioned to a Civil Service position at GSFC.

Biospheric Sciences Laboratory
(Code 618)

This page intentionally left blank.

Task 306: NASA Terrestrial Ecosystems, Spectral Bio-Indicators of Ecosystem Photosynthetic Light Use Efficiency (Sponsor: Elizabeth Middleton)

Investigators: Petya Entcheva-Campbell, Research Assistant Professor, JCET, Geography and Environmental Systems, (Co-I); Elizabeth Middleton, GSFC, (PI)

NASA Grant: Assessing Ecosystem Diversity and Urban Boundaries using Surface Reflectance and Emissivity at Various Spectral Scales (NNX10AE66G)

Investigators: Petya Entcheva-Campbell, Research Assistant Professor, JCET, Geography and Environmental Systems, (Co-I); Elizabeth Middleton, GSFC; Stephen Ungar, GSFC

Description of Research

In the NASA Terrestrial Ecosystems project (Task 306), Campbell is Co-I, leading the EO-1 Hyperion satellite and associated data processing, assisting with project coordination, participating in data collections, image processing, data analysis, spectral algorithm development, data base coordination, and publications. Campbell's goals include: Detection of early vegetation stress based on bio-physiological, fluorescence and spectral optical reflectance remote sensing, using field, airborne and spaceborne (EO-1 Hyperion) spectral radiometers. The research will result in the development and validation of algorithms and cost-effective remote sensing techniques for assessing vegetation stress and physiological condition. With this research, the abilities of passive and active spectral measurement approaches for assessing vegetation photosynthetic rate and physiological conditions, will be compared. Evaluation of change in vegetation spectral reflectance as affected by CO_2 and N variability, and by diurnal and seasonal dynamics will also be conducted.

Remote sensing offers a unique opportunity to monitor ecosystems at synoptic time and space scales through observation and understanding of ecosystem carbon-related spectral responses. A measure of ecosystem carbon uptake is the photosynthetic light use efficiency (LUE), a ratio of the Gross Ecosystem Production (GEP) to the Absorbed Photosynthetically Active Radiation (APAR), or LUE = GEP/APAR.

Accomplishments for FY 11-12

The contributions of fluorescence to reflectance of crop and tree species were assessed, on a range of C3 and C4 species under a full range of environmental stress regimes. The utility of spectral ratios computed from CF emission measurements and the reflectance ratios were compared for detecting vegetation at the leaf and canopy level. The research produced new algorithms and recommendations for cost-effective remote sensing techniques for assessing vegetation physiological condition. Processing and analysis of 2011 and 2012 reflectance (R) and fluorescence (F) data was completed. A draft was prepared of the bio-physical measurements and the R and F trends in the datasets for a peer-reviewed publication. A collection was made of new 2012-13 spectral R, F and bio-physical data.

Campbell presented research findings at professional meetings: IGARSS 2012, HyspIRI Symposia at NASA/GSFC, HyspIRI Workshop, and AmeriFlux Science Meeting & NACP All-Investigators Meeting.

Objectives for FY 12-13

Campbell and her team will develop and test models of leaf and canopy level radiative transfer, photosynthesis, and spectral reflectance, utilizing the team's existing body of accumulated measurements to simulate ecosystem-level carbon and water dynamics in the team's experimental systems (cornfield, deciduous forest). The team will supplement its existing datasets with focused field measurements where necessary for model parameters and with EO-1 Hyperion satellite imagery. From their combined in-situ information (including spectral, structural, flux, and micro-meteorological data) and remote sensing (spectral, structural) data, the team will determine how the carbon uptake/efficiency is affected by the partitioning of the canopy into functionally different sunlit and shaded foliage fractions, as expressed with the PRI and other stress indices including solar-induced chlorophyll fluorescence (SIF), as well as chlorophyll-related spectral indices. The team will verify that the daily and seasonal changes in the sunlit and shaded canopy fractions constitute an important ecological factor in carbon balance that affect the GEP as determined for the whole ecosystem by eddy covariance methods. The team will extend its investigation of carbon uptake/efficiency through models for selected ecosystems utilizing several IPCC future climate scenarios that affect PAR environments such as increased cloudiness or increased diffuse/direct PAR ratios due to atmospheric aerosols. This research will support future missions (e.g., HyspIRI) by providing optimal remote sensing strategies and a critical modeling tool for monitoring ecosystem stress (i.e., down-regulation of GEP) and provide a better understanding of the role of canopy structure in defining ecosystem carbon uptake.

Task 306 research will develop algorithms and cost-effective remote sensing techniques for assessing vegetation stress and physiological condition. With this research, the abilities of passive and active spectral measurement approaches for assessing vegetation photosynthetic rate and physiological conditions will be compared. Evaluation of change in vegetation spectral reflectance as affected by CO_2 and N variability, and by diurnal and seasonal dynamics will also be conducted.

The EO-1 Spectral Bio-Indicators of Ecosystem Stress will continue, adding new research sites to expand the testing and establish which spectral algorithms perform rigorously with respect to correlation to photosynthetic function and efficiency. This project addresses NASA's program on plant functional types and physiology, and supports research to justify missions currently under development by several agencies, including NASA (HyspIRI) and the European Space Agency (FLEX, Fluorescence Explorer).

Task 320: **Algorithm and Analytic Techniques via Various Sources (Sponsor: Jon Ranson)**

BU Subcontract: **Synergistic Study for Lidar and Passive Optical Remote (GC202505 NGA)**

NASA Grant: **Multi-Sensor Retrieval of Vegetation 3-D Structure and Biomass using Physically-Base Algorithms (NNX11AF92G)**

Investigator: Forrest G. Hall, Senior Research Scientist, JCET (PI)

Description of Research

Hall's research in FY2012 involved six activities: (1) PI on a 2nd of 3 year radar/optical satellite project (BioPhys) to combine radar and passive optical satellite data for biophysical parameter estimation (2) Development of a new satellite concept for direct measures of light use efficiency and gross primary production (3) Formulating and presenting the DESDynI mission science plan to measure vegetation 3D structure using lidar (4) Developing a proposal to install a lidar instrument aboard space station: Global Ecosystem Dynamics Mission (GEDI) to measure tropical biomass. (5) Utilizing the spectrometer techniques developed in the past 4 years to achieve first-time ever, direct quantification of evapotranspiration and respiration. (6) Collaborate with Dr. Alexi Lyapustin to employ improved MODIS cloud screening techniques to explore vegetation trends in the tropics.

Accomplishments in FY 11-12

First year research was conducted in an effort to retrieve vegetation biophysical parameters using both radar and optical satellite data. This resulted in a rehire of Dr. Derek Peddle to JCET. The first year, the algorithm to retrieve the parameters and a data set to test the algorithm was developed.

The satellite instrument development effort to measure light use efficiency from space was focused on a multi-view angle narrow-band spectral sensor. The effort was a collaboration with an international team of investigators. Hall and team are developing a new satellite concept and proposing a hardware build. Hall wrote with Dr. Compton Tucker an internal research and development proposal to continue development of a satellite instrument to measure photosynthesis from space. Dr. Hall's research team has demonstrated using tower and a space borne sensor data that multi-view angle remote sensing can retrieve vegetation light use efficiency and gross primary production across vastly different biomes, climate zones and years. This technique was utilized at several eddy-correlation tower sites to show that traditional eddy correlation based estimates of gross primary production and respiration are both biased low. The team's spectral technique should open the door to a better understanding of the factors affecting photosynthesis and respiration, both key to understand our climate future.

Hall collaborated with the DESDynI mission formulation group, developing DESDynI mission requirements and participating in mission design exercises. Hall also participated in the development of the DESDYnI mission review, which passed pre-phase A review with flying colors.

Hall collaborated with Dr. Ralph Dubayah to develop a proposal, the Global Ecosystem Dynamics Mission (GEDI), to fly a lidar mission aboard the International Space Station. As a follow on to the DESDynI mission, (not funded as a result of budget constraints), Hall collaborated with Dr. Ralph Dubayah to write an EV-2 proposal to fly an improved DESDynI Lidar design on Space Station. The proposal received high marks, but a competing proposal to measure sea-surface wind speed was selected instead.

Hall continues to collaborate with Dr. Thomas Hilker, Dr. Compton Tucker, and Dr. Piers Sellers, Deputy Director of the Goddard Science Directorate and former astronaut, to use the spectrally based techniques for measuring photosynthesis, in addition to infer evapotranspiration and respiration at tower sites. This work has been submitted for publication. Hall and Dr. Hilker also developed a new model to incorporate spectrally measured GPP and extend these in space and time.

Hall collaborated with Dr. Alexi Lyapustin, Dr. Hilker, Dr. Tucker and Dr. Sellers to employ a new MODIS data set developed by Dr. Lyapustin to investigate vegetation growth trends in the Amazon Basin. This work showed weak trends over the last 10 years raising the issue as to the underlying cause, which will be explored in 2013.

Hall collaborated with Drs. Hilker, Tucker, Lyapustin and Sellers to use MAIAC, an improved technique for cloud screening, aerosol and bi-directional reflectance correction of MODIS data to investigate vegetation growth trends in the Amazon Basin. A paper has been published in *Remote Sensing of Environment*.

Hall and Dr. Hilker developed a carbon uptake model to compute GPP as a function of spectral measures of GPP and the effects on GPP of environmental variables such as the intensity of photosynthetic radiation, relative humidity and temperature. These variables, readily available globally, can be used to extend satellite estimates in space and time to produce spatially and temporally contiguous maps of GPP, evapotranspiration and respiration. Two papers were published, and two have been submitted for publication.

Objectives for FY 12 – 13

In the radar/optical satellite project Hall and team will extend a physically-based algorithm developed in past research (BioPHYS) to incorporate L-band radar data together with passive optical data to infer vegetation 3D structure in sparse to medium density forested ecosystems. Hall will also continue the BioPhys research, and continue work on the new Photosynthesis instrument. Hall will also participate in a new GSFC task force to coordinate GSFC research activities on the Arctic “Carbon Bomb.” Hall will also continue to write proposals for new funding.

Task 305: Spectral Bio-Indicators of Ecosystem Photosynthetic Efficiency and NASA Earth Observing - 1 (EO - 1) Mission, Scientific support for Hyperion data analysis and product development (Sponsor: Jon Ranson)

Investigators: K. F. Huemmrich, Research Assistant Professor, JCET, Geography and Environmental Systems; Elizabeth Middleton, GSFC, (PI); Petya Entcheva-Campbell, Research Assistant Professor, JCET, Geography and Environmental Systems; Y-B Cheng, ERT; Q. Zhang, USRA; C. Daughtry, USDA/ARS; G. Parker, Smithsonian Environmental Research Center; L. Corp, Sigma Space Corporation

Description of Research

The focus of this research is to develop methods of using hyperspectral remote sensing observations of landscapes to determine biophysical characteristics of vegetation, and to link those characteristics to carbon fluxes, plant growth, biodiversity, and disturbance. Hyperspectral and narrow-band multispectral data can detect changes in apparent leaf spectral reflectance due to biochemical status or fluorescence associated with plant stress. Combining reflectance data with in situ measurements of carbon flux provides opportunities to link vegetation photosynthetic rates to spectral reflectances. Leaf level measurements are used in models merging canopy reflectance with photosynthesis models to examine relationships between spectral reflectance and carbon, water, and energy fluxes. These relationships are also explored at a canopy level using canopy-level reflectance measurements combined with ecosystem carbon flux measurements from flux towers and extended to wider scales using observations from the Earth Observing-1 (EO-1), Aqua, and Terra satellites.

Accomplishments in FY 11-12

Studies using ground- and satellite-based observations for a number of different ecosystem types have begun to study the use of narrow spectral bands to detect plant stress and relate that to ecosystem carbon exchange. The satellite approach uses data from the Hyperion imaging spectrometer on EO-1 and narrow MODIS spectral bands intended for ocean studies over land. The team’s work has shown that indices using a number of different spectral bands are related to ecosystem light use efficiency, the rate of carbon dioxide taken up by plants for photosynthesis per unit of light absorbed by the canopy. This work has been done for a number of globally distributed sites with different vegetation types, where carbon fluxes between the ecosystem and atmosphere were measured.

To further examine vegetation spectral reflectance changes associated with stress in a more detailed manner, field experiments were conducted where measurements of leaf level reflectance and carbon exchange were made in conjunction with measurements of whole canopy reflectance and carbon exchange. This fieldwork was performed on tulip poplar trees and in a cornfield in conjunction with Smithsonian and Department of Agriculture scientists. Hyperspectral reflectance data were collected at multiple times diurnally in a cornfield and compared with carbon fluxes measured in the same field. Preliminary results indicate that short-term changes in apparent spectral reflectance are associated with photosynthetic down-regulation and the reduction of carbon uptake by the plants.

Huemmrich combined field measurements of tundra vegetation reflectance and carbon flux to identify optical-functional tundra plant types, such as lichens, mosses, and vascular plants. The relationships developed from the field measurements were used to map regional patterns of the coverage of these plant types for an area around Barrow, Alaska using Hyperion imagery and relating the vegetation patterns with carbon fluxes.

Huemmrich is chair of the NASA Terrestrial Ecology Field Campaigns Working Group. As chair, he led evaluation panels of scoping studies for two prospective NASA field campaigns and organized recommendations for programmatic changes to increase the productivity of existing field activities. Huemmrich was chosen to be a member of the Pelagic and Coastal Ecosystem (PACE) science definition team (SDT), attended three team meetings and wrote sections of the SDT report. Huemmrich organized and chaired a session on Remote Sensing of Terrestrial Carbon Fluxes at the Fall American Geophysical Union meeting.

Huemmrich is presently on the committees for three PhD students, two in the Forestry Department at Virginia Tech and one in the Geography Department at UMCP. He is also on the committee of a Masters student at the University of Idaho. Dr. Huemmrich served on the promotion committee of Yujie Wang.

Objectives for FY 12-13

Huemmrich will continue his work on remote sensing of plant stress. Huemmrich will publish analysis using MODIS and Hyperion data to detect light use efficiency for multiple vegetation types, leading to the development of a model for ecosystem carbon uptake driven only by satellite data. Models of vegetation canopy radiative transfer dynamically linked to leaf level photosynthesis and stress response will be created. Such a model will provide a physical link between the leaf- and canopy-level observations. The use of narrow spectral band data to detect chlorophyll fluorescence and its relation to carbon fluxes will be examined. Huemmrich will work with combining thermal and spectral data to determine ecosystem water and energy fluxes along with carbon flux. Work will continue on the development of research activities on monitoring high latitude ecosystem change. In addition, the use of high temporal frequency reflectance data in describing vegetation seasonality and temporal patterns of carbon flux will be examined.

Heliophysics & Solar System Divisions
(Codes 670-690)

This page intentionally left blank.

U.S. Army Corps of Engineers, Institute for Water Resources: Global Change Communication and Assessment (IPA-11-0011)

Cambridge University Press: Landslide; Types, Mechanisms, and Modeling, edited by John J. Clague and Douglas Stead (ISBN 9781107002067)

NASA Grant: Topography Data on Mars: Optimizing its Collection and Application Using Laser Scanning (NNX08AT15G)

Investigator: Mark Bulmer, Associate Research Scientist, JCET

Description of Research

Current collaborations are with U.S. Army Corps of Engineers, NASA GSFC Cryospheric Sciences Laboratory and Geodynamics and Geodesy Group at GSFC, UMBC Department of Mechanical Engineering, RUSI, and University of Northern Colorado. Current research interests include: remote sensing applications to the Earth, terrestrial planets and icy satellites; landslide hazard and risk assessment; emergency management and adaptation strategies; integrating spaceborne, airborne, surface and sub-surface data; configuring Unmanned Aerial Vehicles (fixed wing, rotor and lighter-than-air) and sensors (cameras), and designing data collection devices. In addition, Bulmer is involved in resilience and adaptation planning related to natural hazards and disasters. Bulmer provides assistance during civil emergencies.

Accomplishments in FY 11-12

The Cambridge University Press two volume book on landslides is aimed at fourth year and graduate students and contains 34 chapters. Part 1 covers Landslide Types and Mechanisms, Part 2 Geotechnical Aspects of Landslides and Part 3 Case Studies. Bulmer has written Chapter 32 of the book: Landslides on Other Planets. This chapter is contained in Part 1 entitled "Landslides on Other Planets." Additional information was added from observations by NASA's Dawn spacecraft that entered orbit around Vesta on 16 July 2011. Final proof reading has been completed and the book is due to be published in October 2012. In keeping with the theme of this book, the term landslide, which is a type of mass movement, is used to describe a movement of a mass of rock, earth or debris down a slope. In this chapter, Bulmer defines mass movement as the geomorphic process by which soil, regolith and rock moves downslope under gravity. Mass movement categories include falls, topples, slides, flows and creep, each of which has its own characteristics. Here specific focus is given to an examination of selected landslides on Mars, Venus and on the moon of Io orbiting Jupiter because they all have characteristics of long-run out landslides but have been triggered and emplaced in very different environments.

In the one year no-cost extension of the NASA Grant, the project team has continued to make advances in their ability to identify the optimal collection parameters, analytical protocols, and supplemental data needed to resolve features on a terrestrial rocky surface. Further understanding has been gained of the value of laser scanned point clouds over traditional digital elevation or digital terrain models for first and last return points as well as intensity data. Concepts for future orbital and planetary missions to obtain topographic data has been further informed by post-earthquake field investigations in Haiti conducted in January 2012 by the PI and scanning of lava flows on the Big Island in Hawaii led by Dave Finnegan and Steve Anderson. These experiences have been used to further refine the team's thinking on sensor design, mounting, deployment, operation, recovery, data handling, processing and analysis. Presentations on topography collection, analysis and dissemination have been given in expert and non-expert academic, government and commercial forums. The Chapter on Landslides on other Planets referred to above contains results from this project. A manuscript submitted to *JGR-Planets* addressing the characteristics of surface structures on blocky lava flows, handling of laser data and DEM generation is being revised based upon reviewer comments. Results from this project have been included in the Final Technical Report for Water on Mars: Inferences from Mass Movement Studies (MASSMOVE) NASA NAG5-12271 and used by Bulmer in his work with the U.S. Army Corps of Engineers. A variety of reports have been written predominantly focused on the natural hazards and the utility of topography data.

Hydroclimatic disasters, like floods, make up 40% of natural disasters worldwide. In the USA, Hurricane Katrina which occurred in 2005 and numerous other recent natural disasters such as the Cumberland Basin Floods in 2010, have demonstrated the challenge in providing operational hydrologic information to support short-term water management decisions in emergency situations. Hydrological events cause emergencies at scales from local communities, to whole watersheds and the decisions made in response involve responsible local, state and Federal agencies.

Bulmer was on the editorial team for the paper "Short-Term Water Management Decisions: User Needs for Improved Weather and Climate Prediction Information," U.S. Army Corps of Engineers Civil Works Technical Series. In this technical report, the investigator wrote a section on decision making in water related emergencies. Bulmer represented the Institute of Water Management for the U.S. Army Corps of Engineers (USACE) at water and disaster management workshops and seminars in the USA and abroad.

Objectives for FY 12-13

The aim is to get the manuscript detailing examination of blocky flows resubmitted. In addition, three separate contributions are being submitted to Encyclopedia of Planetary Landforms edited by H. Hargitai and A. Kereszturi due to be published by Springer in mid-2013. Proposals will be submitted to NASA Mars Data Analysis and Army Research Programs related to the manipulations of point cloud data.

NASA Grant: High-Resolution Regional Analysis of GRACE Data for Validation of Time-Variable Gravity ad Earthquake-Triggered Change (NNX08AJ69G)

NASA Grant: Improved Crust Mantle Dynamics and State of Stress Models from the Combination of Satellite Gravity and Seismic Data (NNX08AH89G)

NASA Grant: Improved Gravity Fields on the Mars by Means of Localized Harmonic Analysis (NNX09AO75G)

NASA Grant: Improved Global Gravity Fields on the Moon from Re-analysis of Lunar Prospector Radio Tracking Data (NNX09AO80G)

Investigators: Shin-Chan Han, Associate Research Scientist, JCET, (PI); David Rowlands, Scott Luthcke, Richard Ray, Frank Lemoine, Jeanne Sauber, Erwan Mazarico, GSFC; In-Young Yeo, University of Maryland; Hyungjun Kim, Taikan Oki, Pat Yeh, University of Tokyo; Douglas Alsdorf, Ohio State University; Emile Okal, Northwestern University

Description of Research

The satellite gravity measurements such as Gravity Recovery And Climate Experiment (GRACE) are sensitive to mass re-distribution on the Earth's surface and interior with a spatial resolution of some hundreds of kilometers and temporal resolution of 10 days or so. In the case of geophysical mass variation with known temporal frequency (for example, tides), it is possible to study such phenomena even with a sub-daily interval. The major goal of this investigation is to optimally process the satellite tracking data to analyze hydrological mass fluxes over large river basins, ocean tides over the coastal areas and polar regions, and solid earth dynamics related to the coseismic change and postseismic relaxation caused by large earthquakes. The spacecraft tracking data from MRO for Mars and from LP and LRO for the Moon need to be better analyzed to maximize the science return from the orbiters. An improved regional approach has been developed to characterize the lithosphere from the gravity and topography data.

Accomplishments in FY 11-12

The investigators found that the 10-year time-series (since April 2002) of global gravitational potential data are characterized consistently not only with coseismic (episodic) offsets but also postseismic (gradual) relaxation, when localized at the respective area of each earthquake. The recently available Release-05 (RL05) global gravity data (Level-2 data) show ongoing postseismic changes prevailing over other signals and noise, nearly 8 years after the 2004 rupture, and 1 and 2 years after the 2011 and 2010 ruptures, respectively. The abrupt changes in the time-series are consistent with the predicted gravity changes from various seismic solutions, when the centroids located within the crustal layers (24 km deep or less) with a specific range of compressibility, ruling out the deeper centroid sources. The transient or steady-state changes after all three earthquakes, evident in a decade-long time-series, may imply viscoelastic mantle flow triggered by megathrust ruptures and, ultimately, constrain the asthenosphere rheology and viscosity. For all three megathrust ruptures, the GRACE gravity observations consistently show large-scale interior deformation associated with density change (dilatation).

A new analysis of the Doppler tracking data from the Lunar Prospector mission in 1999 revealed a number of previously-unseen gravity anomalies at spatial scales as small as 27 km over the nearside. The tracking data at low altitudes (50 km or below) were better analyzed to resolve the nearside features without dampening from a power law constraint, by partitioning the gravity parameters concentrated on either the nearside or farside. The resulting model presents gravity anomalies correlated with topography with a correlation coefficient of 0.7 or higher from degree 50 to 150, the widest bandwidth yet. The gravity-topography admittance of ~70 mGal/km is found from numerous craters of which diameters are 60 km or less. In addition, the new model produces orbits that fit to independent radio tracking data from the Lunar Reconnaissance Orbiter and Kaguya (SELENE) better than previous gravity models.

The investigators developed theoretical and numerical methods of gravity modeling from topography data to interpret the regional gravity solutions in association with the lithosphere structure. The high-resolution regional gravity fields over various regions were estimated from the LOS range-rate data, compared with global (constrained) gravity solution, and validated with the theoretical gravity model from topography. Geophysical model parameters, that describe the lithospheric strength and density of the loads, were delineated from the regional gravity solutions.

Objectives for FY 12-13

With observation of low admittance with high topography correlation, the investigators hypothesized the effect of low density material from megaregolith and breccia, particularly over the local areas of the southern nearside highlands. The megaregolith is a layer of highly brecciated and fractured materials, formed by the materials excavated and deposited around a crater and the disruption of the underlying crust during an impact. The investigators plan to develop a suite of geophysical models that take into account the properties and thickness of the megaregolith, lithospheric flexure, and the presence of impact-melts to analyze the lithospheric structure over the southern highlands from high-resolution gravity anomalies and from the LOLA topography. The team also plans to validate its megaregolith models with Apollo seismic recordings.

The regional Mars gravity solutions will be improved by exploiting an additional 5–6 years of MRO data from 2006 to 2012. The flexure theory will be compared with the method based on the load Love number theory considering the elastic structure of Mars. A hypothetical internal structure of Mars needs to be introduced. Some tracking data such as MGS SPO 1 & 2, Mars Odyssey transition orbit, and MRO transition orbit would be sensitive to high-degree gravity anomalies due to the lower altitude. These data will be examined, with particular care for resolving some of the ambiguity in geophysical models and for testing various model parameters. The optimization technique will be explored to delineate the range of geophysical model parameters that characterize the lithosphere structure over various regions.

TASK 307: Analysis of Geomagnetic Field Model Outputs, Geomagnetic Data, and Assimilation Results from MoSST_DAS (Sponsor: Weijia Kuang)

Investigator: Zigang Wei, Assistant Research Scientist, JCET

Description of Research

Task 307 focuses on analyzing the spatial/temporal properties of the geomagnetic field at the Earth's surface and at the Core-Mantle Boundary (CMB) from various geomagnetic field models, and from surface and near surface geomagnetic observations. It also includes analysis of 3-D time-varying dynamo assimilation solutions obtained from MoSST_DAS (Modular Scalable Self-consistent and Three dimensional core dynamic model and Data Assimilation System), in particular, the magnetic field and fluid velocity field near the CMB and deep inside the fluid outer core.

Accomplishments in FY 11-12

In the last year, Wei put a quarter of his efforts into the analysis of the outputs of MoSST_DAS and geomagnetic field forecasting. He collected the global field models of historical geomagnetic, archeo-magnetic and paleomagnetic data, and combined them into a uniform time series of observation models up to 7 millennia. These series of observation models were fed into the MoSST_DAS model to forecast the magnetic declination and inclination. Wei and his colleagues compared the forecast results of 100-year, 400-year and 7000-year assimilation runs with the Preliminary Geomagnetic Reference Field (PGRF), and used the differential technique to forecast the real geomagnetic Secular Variation (SV) fields up to the year 2019. The SV forecast of 2010~2015 was contributed to the 11th International Geomagnetic Reference Field (IGRF-11) as a candidate model.

Objectives for FY 12-13

Wei will continue working with his main projects, satellite remote sensing algorithm development, at the University of Maryland, College Park (UMCP). He will no longer work on geomagnetic field data assimilation and forecast.

This page intentionally left blank.

Office of Education
(Code 160)

This page intentionally left blank.

JCET Highlight: GSFC "I'm an Engineer" Afterschool Program
Investigator: Dr. Susan Hoban

NASA needs engineers! "I'm an Engineer" afterschool programming at the NASA Goddard Visitor Center utilizes NASA's BEST Students (Beginning Engineering, Science and Technology) engineering education curriculum. In response to the need for more American students in engineering and other STEM fields, the JCET STEM Education group offers professional development for STEM educators from K-12 and informal learning environments. The Goddard Visitor Center is one of many educational venues that has adopted NASA's BEST. (Photos: NASA) For more information visit: www.nasa.gov/audience/foreducators/best/

This page intentionally left blank.

NASA Grant: NASA's BEST Students: Dissemination and Expansion to Other Centers (NNX11AI16G)

Subcontract: Anne Arundel County Public Schools (from NASA Grant: NASA Earth & Space: Online "Missions" for High School Students and Accompanying Professional Development for Educators) (PO#01B10010400257)

NSF Grant: Collaborative Research; Establishing a Center for Hybrid Multicore Productivity Research (IIP-0934364)

CRSST Task 690.002: PDS College Student Investigators

Investigators: Susan Hoban, Senior Research Scientist, JCET; Anuradha Koratkar, UMBC GEST, Laurie Cook, UMBC GEST; Michelle Graf, UMBC GEST; Carmel Conaty, GSFC; Catherine Kruchten, GSFC; Maureen McMahon, Anne Arundel County Public Schools; Richard Cerkovnik, Anne Arundel Community College; Charles Wood, Wheeling Jesuit University; Milton Halem UMBC

Description of Research

The JCET STEM (Science, Technology, Engineering and Mathematics) Education team is active in several projects. The NASA's BEST Students project (NBS) involves research, development and application of educational technologies to communicate NASA science and engineering concepts to educators and students. The NBS team provides professional development for educators and curriculum support resources with a space exploration theme for engineering clubs for elementary and middle school students and for robotics clubs for high school students. The project also hosts engineering challenges and two-week summer bridge programs centering on lunar exploration for middle and high school students. The JCET STEM Education team also collaborates with Anne Arundel County Public Schools, Anne Arundel Community College and Wheeling Jesuit University on the development and implementation of NASA Earth & Space, an online course for high school students and the accompanying professional development for educators. This innovative course places students in the roles of scientists, as they solve problems and collaborate on-line with actual scientists around the world.

Accomplishments in FY 11-12

The NBS project reached over 1300 educators in 23 states and the District of Columbia through 64 professional development sessions. NBS also utilized the Distance Learning Network (DLN) to reach educators with limited access to NASA Centers. Professional development sessions included both short-term and long-term face-to-face engagement.

NBS utilizes the "train the trainer" model optimizing the impact of NASA resources. Additionally, NBS models focused partnerships with Districts, as with the D.C. Public School District, in which professional development is long term, increasingly challenging, and for which NBS mentorship extends throughout the school year. DCPS educators were granted up to 54 seat hours of professional development credit; the credit exchange model is pursued by NBS when possible. Additionally, the Los Angeles Unified School District

(LAUSD), the second largest school district in the nation with nearly 700,000 students, adopted the NASA's BEST Students curriculum for their acclaimed afterschool program, "Beyond the Bell." The JCET team used the "train the trainer" model to train educators who then went back into the LAUSD system to broaden the reach of the training. During the reporting period, the first cohort of students completed the NASA's BEST curriculum. In some cases the "train the trainer" method has broadened its reach iteratively, as in the case with Palisades Elementary School in Lake Oswego, Oregon. NBS trained employees of Learning.com, a curriculum clearinghouse company, who consequently brought the Activities to teachers at Palisades Elementary where it was introduced to their K-6 student body.

Although the primary focus of the NBS project is professional development of formal and informal educators, the team members do function within the Goddard Education Office, and as such, are called upon to serve the needs of the office which often includes student activities.

In total, 1091 students participated in twenty separate NBS-led events.

The Goddard Visitor Center has adopted NBS Activities for after-school programming entitled "I'm An Engineer!" for grades 1-3. All sessions were filled to capacity with waiting lists, prompting the Visitor Center to offer the program again in the coming months. To accommodate older students, the Goddard Visitor Center has adopted NBS Activities for after-school programming entitled "Engineering Rules!" for Grades 4-6. Designed for students in grades 4-6, each pair of sessions examined the basic elements of engineering and included designing and building lunar rovers, rockets, and other NASA-related projects. All sessions were filled to capacity with waiting lists, prompting the Visitor Center to offer the program again in the coming months.

The NASA Earth and Space course was offered for the second year in Anne Arundel County Public Schools during the reporting period. Revisions to the course materials are still ongoing.

Objectives for FY 12-13

The team expects the NBS project to expand five-fold. The project is developing curriculum that will be centered on human exploration in space. This curriculum will be piloted in local schools and delivered to NASA for the educational review process. The NBS team will continue to provide professional development on the extant NBS engineering education and robotics curriculum. The JCET team will continue to coordinate NBS activities across NASA GSFC, GRC, DFRC, MSFC and SSC.

The NASA Earth and Space project will enter into its professional development phase. A non-local pilot is also under discussion with educators in Illinois, part of a collaboration with Goddard Education and Bradley University.

III. SUPPORTING INFORMATION

This page intentionally left blank.

III.1 References

Aumann, H.H., M.T. Chahine, C. Gautier, M. Goldberg, E. Kalnay, L. McMillin, H. Revercomb, P.W. Rosenkranz, W.L. Smith, D. Staelin, L. Strow, and J. Susskind (2003), AIRS/AMSU/HSB on the Aqua Mission: Design, Science Objectives, Data Products and Processing Systems, *IEEE Transactions on Geosci. Rem. Sens.*, Vol. 41, pp. 253-264.

Bell, T.L. and P.K. Kundu (1996), A study of sampling error in satellite rainfall estimates using optimal averaging of data and a stochastic model, *J. Climate*, 9, 1251-1268.

Bell, T.L. and P.K. Kundu (2003), Comparing satellite rainfall estimates with rain gauge data: Optimal strategies suggested by a spectral model, *J. Geophys. Res.* 108, D3, 4121 doi:10.1029/2002JD002641.

Ben-Ami, Y., I. Koren, O. Altaratz, A. Kostinski, and Y. Lehahn (2012), Discernible rhythm in the spatio/temporal distributions of transatlantic dust, *Atmospheric Chemistry and Physics*, 12(5), 2253-2262.

Bentamy A., K.B. Katsaros, M. Alberto, W.M. Drennan, E.B. Forde, and H. Roquet (2003), Satellite Estimates of wind speed and latent heat flux over the global oceans, *J. Climate*, 16, 637-656.

Braun, S.A., J. Sippel, and C.-L. Shie (2011), The role of the Saharan Air Layer in the evolution of Hurricane Helene (2006), presented at the *14th Conference on Mesoscale Processes*, Los Angeles, CA, 1-4 August.

Brunke, A.M., Z. Wang, X. Zeng, M. Bosilovich, and C.-L. Shie (2011), An assessment of the uncertainties in ocean surface turbulent fluxes in 11 reanalysis, satellite-derived, and combined global data sets, *J. Climate*, 24, 5469-5493. doi:10.1175/2011JCLI4223.1

Casella, D., P. Sanò, A. Mugnai, G. Panegrossi, E.A. Smith, G.J. Tripoli, S. Dietrich, M. Formenton, H.W.-Y. Leung and A.V. Mehta (2012), Transitioning from CRD to CDRD in Bayesian retrieval of rainfall from satellite passive microwave measurements: Part 2. Overcoming database profile selection ambiguity by consideration of meteorological control on microphysics. *IEEE Transactions on Geosci. Rem. Sens.*, submitted.

Chiu, L.S., S. Gao, and C.-L. Shie (2012), Oceanic evaporation: Trends and variations (book chapter title), Book title: Remote Sensing / Book 2. 261-278. InTech - Open Access Publisher.

Chiu, L.S., S. Gao, and C.-L. Shie (2012), Satellite-based ocean surface turbulent fluxes (book chapter title), Book title: Satellite-based Applications of Climate Change, Editors: J. Qu and A. Powell. *CRC Press*.

Chou S.-H., C-L. Shie, R.M. Atlas, and J. Ardizzone (1997), Air-sea Fluxes Retrieved from Special Sensor Microwave Imager Data, *Journal of Geophysical Research*, 102, 12705-12726.

Coheur, P.-F., L. Clarisse, S. Turquety, D. Hurtmans, and C. Clerbaux (2009), IASI measurements of reactive trace species in biomass burning plumes, *Atmos. Chem. Phys.*, 9, 5655–5667.2009

Fontenla, J. M., J. Harder, W. Livingston, M. Snow, and T. Woods (2011), High-resolution solar spectral irradiance from extreme ultraviolet to far infrared, *J. Geophys. Res.*, 116, D20108, doi:10.1029/2011JD016032.

Gatebe, C. K., T. Várnai, R. Poudyal, C. Ichoku, and M. D. King (2012), Taking the pulse of pyrocumulus clouds, *Atmospheric Environment*, 52, 121-130.

Grecu, M., W.S. Olson, and C.-L. Shie (2011), Instantaneous precipitation and latent heating estimation overland from combined spaceborne radar and microwave radiometer observations. (A chapter of Book entitled “*Environmental Informatics Series (I): Advances in Hydrological Remote Sensing to Monitor Global Changes*” by publisher John Wiley).

Heiblum, R. H., I. Koren, and O. Altaratz (2012), New evidence of cloud invigoration from TRMM measurements of rain center of gravity, *Geophysical Research Letters*, 39.

Herman, J.R., Alexander Cede, Elena Spinei, George Mount, Maria Tzortziou, Nader Abuhassan (2009), NO_2 Column Amounts from Ground-based Pandora and MFDOAS Spectrometers using the Direct-Sun DOAS Technique: Intercomparisons and Application to OMI Validation, *J. Geophys. Res.*, 114, D13307, doi:10.1029/2009JD011848.

Hilburn, K. A., and C.-L. Shie (2011), Decadal trends and variability in Special Sensor Microwave Imager (SSM/I) brightness temperatures and Earth incidence angle, report number 092811, *Remote Sensing Systems*, 53 pp.

Imbiriba, B., Strow, L., Hannon, S., de Souza-Machado, S., Powers, L., Schou, P. (2012), in preparation.

Koren, I., O. Altaratz, L. A. Remer, G. Feingold, J. V. Martins, and R. H. Heiblum (2012), Aerosol-induced intensification of rain from the tropics to the mid-latitudes, *Nature Geoscience*, 5(2), 118-122.

Kundu, P.K. and T.L. Bell (2003), A Stochastic Model of Space-time Variability of Mesoscale Rainfall: Statistics of Spatial Averages, *Water Resources Res.*, doi: 10.1029/2002WR001802.

Kundu, P.K. and R.K. Siddani (2007), A new class of probability distributions for describing the spatial statistics of area-averaged rainfall, *J. Geophys. Res.* 112, D18113, doi:10.1029/2006JD008042.

Labow, G.J., J.R. Herman, L.-K. Huang, S.A. Lloyd, M. T. DeLand, W. Qin, J. Mao, and D.E. Larko (2011), Diurnal Variation of 340 nm Lambertian Equivalent Reflectivity due to Clouds and Aerosols over Land and Oceans, *J. Geophys. Res.*, doi:10.1029/2010JD014980.

Lee J.N., D.L. Wu, G.L. Manney, M.J. Schwartz, A. Lambert, N. J. Livesey, H. C. Pumphrey, and W. G. Read (2011), Aura Microwave Limb Sounder Observations of the Polar Middle Atmosphere: Dynamics and Transport of H2O and CO, *J. Geophys. Res.*, 116, D05110.

Lee, J.N. and S. Hameed (2007), The Northern Hemisphere Annular Mode in summer, its Physical Significance and its Relation to Solar Activity Variations," *J. Geophys. Res.,* 112, D15111.

Lee, J.N., S. Hameed, and D.T. Shindell (2007), The northern annular mode in summer and its relation to solar activity variations in the GISS ModelE, *Journal of Atmospheric and Solar-Terrestrial Physics*, 70/5, 730-741.

Lee, J.N., D.T. Shindell, and S. Hameed (2009), The role of solar forcing in the tropical circulation, *J. Climate*, 22, 5870.

Lee, J.N., D.L. Wu, G.L. Manney, and M.J. Schwartz (2009), Aura Microwave Limb Sounder observations of the Northern Annular Mode in the Mesosphere through the Upper Troposphere, Geophys. Res. Lett.*Geophys. Res. Lett.*, 36, L20807.

Martins, J. V., A. Marshak, L. A. Remer, D. Rosenfeld, Y. J. Kaufman, R. Fernandez-Borda, I. Koren, A. L. Correia, V. Zubko, and P. Artaxo (2011), Remote sensing the vertical profile of cloud droplet effective radius, thermodynamic phase, and temperature, *Atmospheric Chemistry and Physics*, 11(18), 9485-9501.

Maurer, E.P., A.W. Wood, J.C. Adam, D.P. Lettenmaier, and B. Nijssen (2002), A Long-Term Hydrologically-Based Data Set of Land Surface Fluxes and States for the Conterminous United States, *J. Climate*, 15(22), 3237-3251.

Maynard, N.G., (2002), Native Peoples-Native Homeland Climate Change Workshop: Final Report, Circles of Wisdom, U.S. Global Change Research Program, October 28-November 1, 1998, Albuquerque Convention Center, Albuquerque, New Mexico, published by *NASA Goddard Space Flight Center*.

Pan, W., L. Wu, and C.-L. Shie (2011), Influence of Saharan Air Layer on Atlantic Tropical Cyclone Formation during 1-12 September 2003, *Advances in Atmospheric Sciences*, 28(1), 16-32.

Piters, A. J. M. (Many authors incl J.R. Herman), (2012), The Cabauw Intercomparison campaign for Nitrogen Dioxide measuring Instruments (CINDI): design, execution, and early results, *Atmos. Meas. Tech.*, 5, 457-485, doi:10.5194/amt-5-457-2012.

Pounder, N. L., R. J. Hogan, T. Várnai, A. Battaglia, and R. F. Cahalan (2011), A variational method to retrieve the extinction profile in liquid clouds using multiple field-of-view lidar, *J. Appl. Meteor. Climatol.*, 51, 350-365.

Prados, A. (2011), NASA Air Quality Capacity Building Activities: Bridging the gap between science and policy, *NASA GSFC Aerocenter Seminar*, February 15.

Prados, A. (2011), NASA Air Quality Capacity Building Activities: Bridging the gap between science and policy, *NASA GSFC Atmospheric Chemistry and Dynamics Branch Seminar*, March 31.

Prados, A. (2011), NASA Capacity Building Activities: Bridging the gap between science and policy, Invited talk, The GAIA Climate, *Climate Change and Public Health Conference*, Johns Hopkins University, Baltimore, Maryland, April 12-14.

Prados, A. (2011), Teaching Climate Science and Policy, *Sally Ride Educator's Institute: Connecting with Climate Change 2011*, NASA Jet Propulsion Laboratory, Pasadena, CA, February 26.

Prados, A., R. Kleidman, and L. Friedl (2011), NASA Applied Sciences Remote Sensing Education and Training, presented at the *American Association for the Advancement of Science Annual Meeting*, Washington D.C, February 17-21.

Prados, A., R. Kleidman, and L. Friedl (2011), NASA Applied Sciences Remote Sensing Education and Training, *Federation of Earth Science Information Partners, Winter Meeting*, Washington, DC, 4-6 January.

Prados, A., (2012), NASA Sponsored Workshop on Evaluating the Impact of Earth Science, *The Earth Observer*, National Aeronautics and Space Administration, Volume 24, Issue 2, March-April.

Prados, A., A. Meta, (2012), NASA Applied Remote Sensing Training: Building Capacity to Integrate NASA Earth Science into Water Resources Management Applications, presented at the *USG-World Bank Remote Sensing Workshop*, Washington D.C, 29 February.

Rodgers, C.D. (2000), Inverse Methods for Atmospheric Sounding, Theory and Practice, Ser. Atmos. Oceanic Planet. Phys., 2, *World Sci.*, Hackensack, NJ.

Rodgers, C.D. (2000), Inverse Methods for Atmospheric Sounding, Theory and Practice, *World Sci.*, River Edge, NJ.

Scambos, T.A., E. Berthier and C.A. Shuman (2011). The triggering of sub-glacial lake drainage during the rapid glacier drawdown: Crane Glacier, Antarctic Peninsula. *Annals of Glaciology, 52(59), pp.74-82.*

Schulz J., P. Schluessel, and H. Grassl (1993), Water vapor in the atmospheric boundary layer over oceans from SSM/I measurements, *Int. J. Remote Sens.*, *14*, 2773–2789.

Shie, C.-L., (2010), Science background for the reprocessing and Goddard Satellite-based Surface Turbulent Fluxes (GSSTF2b) Data Set for Global Water and Energy Cycle Research. Science Document for the Distributed GSSTF2b via *Goddard Earth Sciences (GES) Data and Information Services Center (DISC)*, 18 pp. (Available online at: ftp://mesoa.gsfc.nasa.gov/pub/shieftp/fluxdocu/gsstf2b/Science_of_the_data.GSSTF2b.pdf or http://disc.sci.gsfc.nasa.gov/measures/documentation/Science-of-the-data.pdf)

Shie, C.-L. (2011), Science background for the reprocessing and Goddard Satellite-based Surface Turbulent Fluxes (GSSTF2c) Data Set for Global Water and Energy Cycle Research, Science Document for the Distributed GSSTF2c via *Goddard Earth Sciences (GES) Data and Information Services Center (DISC)*, 19 pp.

Shie, C.-L., and K. Hilburn (2011), A newly revived satellite-based global air-sea surface turbulent fluxes dataset and its dependence on the SSM/I brightness temperature, *the 2011 IEEE IGARSS*, Vancouver, Canada, 25-29 July, Proceedings, 4 pp. (published in CD)

Shie, C.-L., and K. Hilburn (2011), A satellite-based global ocean surface turbulent fluxes dataset and the impact of the associated SSM/I brightness temperature, *The 2011 EUMESAT Meteorological Satellite Conference*, Oslo, Norway, 5-9 September, Proceedings, 8 pp.

Shie, C.-L. (2012), Science background for the reprocessing and Goddard Satellite-based Surface Turbulent Fluxes (GSSTF3) *Data Set for Global Water and Energy Cycle Research*, Science Document for the Distributed GSSTF3 via *Goddard Earth Sciences (GES) Data and Information Services Center (DISC)*, 21 pp.

Shie, C.-L., K. Hilburn, L. S. Chiu, R. Adler, I-I Lin, E. Nelkin, J. Ardizzone, and S. Gao (2012), The Goddard Satellite-Based Surface Turbulent Fluxes Dataset --- Version 3 (GSSTF 3) [global (grid of 0.25ox0.25o) daily air-sea surface fluxes from January 1998 to December 2008] distributed via *Goddard Earth Sciences (GES) Data and Information Services Center (DISC)* in June 2012.

Shuman, C.A., E. Berthier and T. Scambos, (2011), 2001-2009 elevation and mass losses in the Larsen A and B embayments, Antarctic Peninsula, *Journal of Glaciology*, 57(204), pp.737-754.

Sippel, J.A., S.A. Braun, and C.-L. Shie (2011), Environmental influences on the strength of Tropical Storm Debby (2006), *J. Atmos. Sci.*, 68(11), 2557-2581.

Smith, E.A., H.W.-L. Leung, A.V. Mehta, G.J. Tripoli, D. Casella, A. Mugnai, G. Panegrossi and P. Sanò (2012), Transitioning from CRD to CDRD in Bayesian retrieval of rainfall from satellite passive microwave measurements: Part 3, Acquisition of optimal meteorological tags. *Nat. Hazards & Earth Sys. Sci.*: Special Issue on Plinius 13, submitted.

Strow, L., Hannon, S. (2008), A 4-year zonal climatology of lower tropospheric CO2 derived from ocean-only Atmospheric Infrared Sounder observations, J.Geophys.Res., Vol. 113, D18302.

Tangborn, A., Strow, L., Imbiriba, B., Ott, L., Pawson, S. (2012), Evaluation of a new middle-lower tropospheric CO2 product using data assimilation - Submitted to ACP.

Tokay, A. and K. Ozturk, (2012), An experimental study of small-scale variability of rainfall, *J. Hydrometeorology*, 13, 351-365.

Tokay, A. and W.A. Petersen, P. Gatlin, and M. Wingo, (2012), Comparison of raindrop size distribution measurements by collocated disdrometers, *Journal of Atmopsheric and Oceanic Technology*.

Tzortziou, Maria,, Jay R. Herman, Alexander Cede, and Nader Abuhassan, (2012), High Precision, Absolute Total Column Ozone Measurements from the Pandora Spectrometer System: Comparisons with Data from a Brewer Double Monochromator and Aura OMI, *J. Geophys. Res.*, D16303, doi:10.1029/2012JD017814.

Várnai, T., and A. Marshak (2011), Global CALIPSO observations of aerosol changes near clouds, *IEEE Geosci. Remote Sens. Lett.*, 8, 19-23.

Yu, H., L.A. Remer, M. Chin, H. Bian, Q. Tan, T. Yuan and Y. Zhang (2012), Aerosols from overseas rival domestic emissions over North America, *SCIENCE*, Vol. 337, no. 6094, pp. 566-569, doi: 10.1126/science.1217576, 3 August.

Yu, H., Y. Zhang, Chin, M., Z. Liu, A. Omar, L.A. Remer, Y. Yang, T. Yuan and J. Zhang (2012), An integrated analysis of aerosol above clouds from A-Train multi-sensor measurements. *Remote Sensing Environment*, 121, 125-131, doi:10.1016/j.rse.2012.01.011.

Yuan, T., L.A. Remer, and H. Yu (2011), Microphysical, macrophysical and radiative signatures of volcanic aerosols in trade wind cumulus observed by the A-Train, *Atmospheric Chemistry and Physics*, 11, 7119-7132, doi:10.5194/acp-11-7119-2011.

Yuan, T., L. A. Remer, H. Bian, J. R. Ziemke, R. Albrecht, K. E. Pickering, L. Oreopoulos, S. J. Goodman, H. Yu, and D. J. Allen (2012), Aerosol indirect effect on tropospheric ozone via lightning, *J. Geophys. Res.*, 117, D18213, doi:10.1029/2012JD017723.

III.2 Peer-Reviewed Publications

Barreto, A., E. Cuevas, B. Damiri, C. Guirado, T.A. Berkoff, A.J. Berjón, Y. Hernández, F. Almansa, and M. Gil (2012), A new method for nocturnal aerosol measurements with a lunar photometer prototype, *Atmos. Meas. Tech.* Discuss., 5, 5527-5569.

Ben-Ami, Y., I. Koren, O. Altaratz, A. Kostinski, and Y. Lehahn (2012), Discernible rhythm in the spatio/temporal distributions of transatlantic dust, *Atmospheric Chemistry and Physics*, 12(5), 2253-2262.

Berkoff, T.A., M. Sorokin, T. Stone, T. F. Eck, R.M. Hoff, E. Welton, B. Holben (2011), Nocturnal Aerosol Optical Depth Measurements with a Small-Aperture Automated Photometer Using the Moon as a Light Source. *J. Atmos. Oceanic Technol.*, 28, 1297–1306.

Berthier, E., T.A. Scambos, and C.A. Shuman (2012), Mass loss of Larsen B tributary glaciers (Antarctic Peninsula) unabated since 2002, *Geophysical Research Letters*, 39, L13501.

Brunke, A.M., Z. Wang, X. Zeng, M. Bosilovich, and C.-L. Shie (2011), An assessment of the uncertainties in ocean surface turbulent fluxes in 11 reanalysis, satellite-derived, and combined global data sets, *J. Climate*, 24, 5469-5493. doi:10.1175/2011JCLI4223.1

Bulmer, M.H. (2011), Worst-Case Scenario: The Tohoku-Pacific Ocean Earthquake. *Royal United Services Institute*, Analysis, Commentary, ref:C4D99EFC6CE5B5. 5 April.

Bulmer, M.H. (2012), Civil Military Cooperation Two Years After the 2010 Haitian Earthquake. *Royal United Services Institute*, Analysis, ref: C4FA271E5754CB, London, 3 May.

Bulmer, MH. (2012), Landslides on other planets. In Part 1. Landslide Types and Mechanisms. Types, Mechanisms, and Modeling Edited by John J Clague and Douglas Stead. Cambridge University Press, ISBN:9781107002067, pp.393-408.

Chen G., L.D. Ziemba, D.A. Chu et al. (2011), Observations of Saharan Dust Microphysical and Optical Properties from the Eastern Atlantic during NAMMA Airborne Field Campaign, *Atmos. Chem. Phys.*, 11 (2), 723-740, DOI: 10.5194/acp-11-723-2011.

Delgado, R., J.T. Fentzke, J.S. Friedman, S. Raizada, C.A. Tepley, Q. Zhou (2011), Sporadic metal atom and ion layers and their connection to chemistry and temperature structure in the mesopause region at Arecibo, J. Atmos. Solar. Terr. Phys., 74, 11–23, doi:10.1016/j.jastp.2011.09.004.

Foster, J.L., G. Skofronick-Jackson, H. Meng, J.R. Wang, G. Riggs, P.J. Kocin, B.T. Johnson, J. Cohen, D.K. Hall, S.V. Nghiem (2012), Passive Microwave Remote Sensing of the Historic February 2010 Snow Storms in the Middle Atlantic Region of the U.S., *Hydrol. Process.* doi:10.1002/hyp.8418.

Grecu, M., L. Tian, W.S. Olson, and S. Tanelli (2011), A Robust Dual-Frequency Radar Profiling Algorithm, *J. Appl. Meteor. and Climatol.*, 50, 1543-1557.

Grecu, M., W.S. Olson, and C.L. Shie (2012), Instantaneous Precipitation and Latent Heating Estimation over Land from Combined Spaceborne Radar and Microwave Radiometer Observations, in *Multiscale Hydrologic Remote Sensing: Perspectives and Applications*, CRC Press, 568 pp.

Hall, F.G., Hilker, T., & Coops, N.C. (2012), Data assimilation of photosynthetic light-use efficiency using multi-angular satellite data: I. Model formulation. *Remote Sensing of Environment*, 121 (2012) 301–308.

Han, S.-C., E. Mazarico, D. Rowlands, F. Lemoine, S. Goossens (2011), New analysis of Lunar Prospector radio tracking data brings the nearside gravity field of the Moon with an unprecedented resolution, *Icarus*, 215, 455-459, doi:10.1016/j.icarus.2011.07.020.

Han, S.-C., J. Sauber, R. Riva (2011), Contribution of satellite gravimetry to understanding seismic source processes of the 2011 Tohoku-Oki earthquake, *Geophysical Research Letters*, 38, L24312, doi:10.1029/2011GL049975.

Heiblum, R.H., I. Koren, and O. Altaratz (2012), New evidence of cloud invigoration from TRMM measurements of rain center of gravity, *Geophysical Research Letters*, 39.

Hilker, T., F.G. Hall, C.J. Tucker, N.C. Coops, T.A. Black, C.J. Nichol, P.J. Sellers, A. Barr, D.Y. Hollinger, & W.H. Munger (2012), Data assimilation of photosynthetic light-use efficiency using multi-angular satellite data: II Model implementation and validation. *Remote Sensing of Environment*, 121 287–300.

Huang J., C. Hsu, S. Tsay, B.N. Holben, E.J. Welton, A. Smirnov, M. Jeong, R. Hansell, T. Berkoff, Z . Liu, G. Liu, J. Campbell, S. C. Liew, J.E. Barnes (2012), Evaluations of cirrus contamination and screening in ground aerosol observations using collocated lidar systems, J. Geophys. Res., 117, D15204, doi:10.1029/2012JD017757.

Hwang, J.S., H.-C. Han, S.-C. Han, K.-O. Kim, J.-H. Kim, M.-H. Kang, C. H. Kim (2012), Gravity and geoid model in South Korea and its vicinity by Spherical Cap Harmonic analysis, *Journal of Geodynamics*, 53, 27-33, doi:10.1016/j.jog.2011.08.001

Jiang, X., D.E. Waliser, W.S. Olson, W.-K. Tao, T.S. L'Ecuyer, S. Shige, K.-F. Li, Y. L. Yung, S. Lang, and Y. N. Takayabu (2011), Vertical Diabatic Heating Structure of the MJO: Intercomparisons between Recent Reanalyses and the TRMM Estimates, *Mon. Wea*. Rev., 139, 3208-3223.

Kacenelenbogen, M., M. A. Vaughan, J. Redemann, R.M. Hoff, R.R. Rogers, R.A. Ferrare, P.B. Russell, C.A. Hostetler, J.W. Hair, and B.N. Holben (2011), An accuracy assessment of the CALIOP/CALIPSO version 2/version 3 daytime aerosol extinction product based on a detailed multi-sensor, multi-platform case study, *Atmos. Chem. Phys.*, 11, 3981-4000, doi:10.5194/acp-11-3981-2011.

Koren, I., O. Altaratz, L.A. Remer, G. Feingold, J.V. Martins, and R.H. Heiblum (2012), Aerosol-induced intensification of rain from the tropics to the mid-latitudes, *Nature Geoscience*, 5(2), 118-122.

Kumar N., D.A. Chu, A. Forst, T. Peters, R. Willis (2011), Satellite Remote Sensing for Developing Time-Space Resolved Estimates of Ambient Particulate in Cleveland, OH, *AST*, 45(9), 1090-1108, DOI: 10.1080/02786826.2011.581256.

Labow, G.J., J.R. Herman, L.-K. Huang, S.A. Lloyd, M. T. DeLand, W. Qin, J. Mao, and D.E. Larko (2011), Diurnal Variation of 340 nm Lambertian Equivalent Reflectivity due to Clouds and Aerosols over Land and Oceans, *J. Geophys. Res.*, doi:10.1029/2010JD014980.

Lai, Q., L. Wu, L., and C.-L. Shie (2012), Sea Surface Response to Typhoon Morakot (2009) and the Influence on its Activity, *Journal of Tropical Meteorology*, (in Chinese).

Lee, C.-K., K.-W. Seo, S.-C. Han, J. Yu, T.A. Scambos (2012), Ice velocity mapping of Ross Ice Shelf, Antarctica by matching surface undulations measured by ICES at laser altimetry, *Remote Sensing of Environment*, 124, 251-258, doi:10.1016/j.rse.2012.05.017.

Lee, C.K., S.-C. Han, D. Bilitza, J. Chung (2011), Validation of International Reference Ionosphere models using in situ measurements from GRACE K-Band ranging system and CHAMP planar Langmuir probe, *Journal of Geodesy*, 85, 921-929, doi:10.1007/s00190-011-0442-6.

Lee, C.K., S.-C. Han, D. Bilitza, K.-W. Seo (2012), Global characteristics of the correlation and time lag between solar and ionospheric parameters in the 27-day period, *Journal of Atmospheric and Solar-Terrestrial Physics*, 77, 219-224, doi:10.1016/j.jastp.2012.01.010.

Lee, C.K., S-C. Han, B. Steinberger (2011), Influence of variable uncertainties in seismic tomography models on constraining mantle viscosity from geoid observations, *Physics of the Earth and Planetary Interiors*, 184, 51-62, doi:10.1016/j.pepi.2010.10.012.

Liang, Q., J. M. Rodriguez, A.R. Douglass, J.H. Crawford, J.R. Olson, E. Apel, H. Bian, et al. (2011), Reactive nitrogen, ozone and ozone production in the Arctic troposphere and the impact of stratosphere-troposphere exchange, *Atmos. Chem. Phys.*, 11, 13181-13199.

Lolli, S., et al. (2012), Aerosol layer decoupling in the northern South China Sea profiled by MPLNET Lidar during the spring 2010 Dongsha island experiment, *ILRC proceedings*, 25-29 June.

Lyapustin, A.I., Y. Wang, I. Laszlo, T. Hilker, F.G. Hall, P.J. Sellers, C. J. Tucker, S.V. Korkin (2012), Multi-Angle Implementation of Atmospheric Correction for MODIS (MAIAC): Atmospheric Correction. *Remote Sensing of Environment*.

Maddy, E.S. De Souza-Machado, Nalli, N.R., Barnet, C.D., Strow, L.L., Wolf, W.W., Xie, H., Gambacorta, A., King, T.S., Joseph, E., Morris, V., Hannon, S.E., Schou, P. (2012), On the effect of dust aerosols on AIRS and IASI operational level 2 products, *Geophysical Research Letters*, v. 39, L10809, doi:10.1029/(2012)GL052070.

Marks, D.A., D.B. Wolff, L.D. Carey, and A. Tokay (2011), Quality control and calibration of the dual-polarization radar at Kwajalein, RMI. *J. Atmos. Oceanic Technol.*, conditionally accepted for publication, 28, 181-195.

Martins, J.V., A. Marshak, L.A. Remer, D. Rosenfeld, Y.J. Kaufman, R. Fernandez-Borda, I. Koren, A.L. Correia, V. Zubko, and P. Artaxo (2011), Remote sensing the vertical profile of cloud droplet effective radius, thermodynamic phase, and temperature, *Atmospheric Chemistry and Physics*, 11(18), 9485-9501.

McMillan, W.M., K. Evans, C. Barnet, E. Maddy, G. Sachse, and G. Diskin (2011), Validating the AIRS Version 5 CO Retrieval with DACOM in situ Measurements During INTEX-A and -B, *IEEE Transactions on Geoscience and Remote Sensing*, 49, no. 7, pp. 2802-2813, doi: 10.1109/TGRS.2011.2106505.

Mehta, A., D. Casella, P. Sanò, A. Mugnai, G. Panegrossi, E.A. Smith, G.J. Tripoli, S. Dietrich, M. Formenton, H.W.-Y. Leung and A.V. Mehta (2012), Transitioning from CRD to CDRD in Bayesian retrieval of rainfall from satellite passive microwave measurements: Part 2. Overcoming database profile selection ambiguity by consideration of meteorological control on microphysics. *IEEE Transactions on Geosci. Rem. Sens.*

Middleton, E.M., K.F. Huemmrich, Y-B. Cheng, and H.A. Margolis (2011) Spectral Bio-Indicators of Photosynthetic Efficiency and Vegetation Stress. In *Hyperspectral Remote Sensing of Vegetation*, edited by P.S. Thenkabail, J.G. Lyon and A. Huete, *CRC Press*, 265-288.

Onana, V., N. Kurtz, S. Farrell, L. Koenig, M. Studinger, and J. Harbeck (2012), A Sea-Ice Lead Detection Algorithm for Use With High-Resolution Airborne Visible Imagery, *IEEE Transactions on Geoscience and Remote Sensing*, 50(12).

Pan, W., L. Wu, and C.-L. Shie (2011), Influence of Saharan Air Layer on Atlantic Tropical Cyclone Formation during 1-12 September 2003, *Advances in Atmospheric Sciences*, 28(1), 16-32.

Patra, P.K., S. Houweling, M. Krol, P. Bousquet, D. Belikov, D. Bergmann, H. Bian, et al. (2011), TransCom model simulations of CH_4 and related species: linking transport, surface flux and chemical loss with CH_4 variability in the troposphere and lower stratosphere, *Atmos. Chem. Phys.*, 11, 12813–12837.

Peddle, D.R., K.F. Huemmrich, F.G. Hall, J.G. Masek, S.A. Soenen, and C.D. Jackson (2011), Applications of the BIOPHYS Algorithm for Physically-Based Retrieval of Biophysical, Structural and Forest Disturbance Information. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 4(4): 971-982.

Piters, A.J.M., J.R. Herman, et al. (2012), The Cabauw Intercomparison campaign for Nitrogen Dioxide measuring Instruments (CINDI): design, execution, and early results, *Atmos. Meas. Tech.*, 5, 457-485, doi:10.5194/amt-5-457-2012.

Prados, A., D. J. Allen, K.E. Pickering, R. W. Pinder, B.H. Henderson, K. W. Appel, and, A. Prados (2012), Impact of lightning-NO on eastern United States photochemistry during the summer of 2006 as determined using the CMAQ model, *Atmos. Chem. Phys.*, 12, 1737-1758, doi:10.5194/acp-12-1737-2012.

Sawamura, P., J.P. Vernier, J.E. Barnes, T.A. Berkoff, E.J. Welton, L. Alados-Arboledas, F. Navas-Guzmán, L. Mona, F. Madonna, D. Lange, M. Sicard, S. Godin-Beekmann, G. Payen, Z. Wang, S. Hu, R.M. Hoff, S.N. Tripathi and C. Cordoba-Jabonero (2012), Stratospheric AOD from lidar observations over the Northern Hemisphere from the 2011 Nabro Volcano eruption, *Environ. Res. Lett.* 7 034013.

Scambos, T.A., E. Berthier and C.A. Shuman (2011), The triggering of sub-glacial lake drainage during the rapid glacier drawdown: Crane Glacier, Antarctic Peninsula. *Annals of Glaciology*, 52(59), pp.74-82.

Shuman, C.A., E. Berthier and T. Scambos (2011), 2001-2009 elevation and mass losses in the Larsen A and B embayments, Antarctic Peninsula. *Journal of Glaciology*, 57(204), pp.737-754.

Skofronick-Jackson, G., B.T. Johnson (2011), Surface and Atmospheric Contributions to Passive Microwave Brightness Temperatures, *J. Geophys. Res.*, 116, D02213, doi:10.1029/2010JD014438.

Sippel, J.A., S.A. Braun, and C.-L. Shie (2011), Environmental influences on the strength of Tropical Storm Debby (2006), *J. Atmos. Sci.*, 68(11), 2557-2581.

Smith, E.A., H.W.-L. Leung, A.V. Mehta, G.J. Tripoli, D. Casella, A. Mugnai, G. Panegrossi and P. Sanò (2012), Transitioning from CRD to CDRD in Bayesian retrieval of rainfall from satellite passive microwave measurements: Part 3. Acquisition of optimal meteorological tags. *Nat. Hazards & Earth Sys. Sci.*: Special Issue on Plinius 13, submitted.

Song, Y.T. and S.-C. Han (2011), Satellite Observations Defying the Long-Held Tsunami Genesis Theory, Remote Sensing of the Changing Oceans, D. Tang (Ed.), 396 p. 182 illus., 130 in color, Springer, ISBN 978-3-642-16540-5.

Ten Hoeve, John E., Mark Z. Jacobson and Lorraine A. Remer (2012), Comparing results from a physical model with satellite and in situ observations to determine whether biomass burning aerosols over the Amazon brighten or burn off clouds. J. Geophys. Res., 117, D08203, doi: 10.1029/2011JD016856.

Thurai, M., W.A. Petersen, A. Tokay, C. Schultz, and P. Gatlin (2011), Drop size distribution comparisons between Parsivel and 2-D video disdrometers, *Advances Geophysics*, 30, 3-9.

Tokay, A. and K. Ozturk (2012), An experimental study of small-scale variability of rainfall. *J. Hydrometeorology*, 13, 351-365.

Tsai T.C., J.-H. Tseng, D.A. Chu, J.-P. Chen, S.-C. Chang (2011), Analysis of the relationship between MODIS aerosol optical depth and particulate matter from 2006 to 2008, *Atmos. Environ.*, 45(27), 4777-4788, DOI: 10.1016/j.atmosenv.2009.10.006.

Tzortziou, M., J.R. Herman, A. Cede, and N. Abuhassan (2012), High Precision, Absolute Total Column Ozone Measurements from the Pandora Spectrometer System: Comparisons with Data from a Brewer Double Monochromator and Aura OMI, *J. Geophys. Res.*, D16303, doi:10.1029/2012JD017814.

Wiese, D.N., R.S. Nerem, S.-C. Han (2011), Expected improvements in determining continental hydrology, ice mass variations, ocean bottom pressure signals, and earthquakes using two pairs of dedicated satellites for temporal gravity recovery, *J. Geophys. Res.*, 116, B11405, doi:10.1029/2011JB008375.

Wong S., E.J. Fetzer, B.H. Kahn, B. Tian, B.H. Lambrigtsen, and H. Ye (2011), Closing the Global Water Vapor Budget with AIRS Water Vapor, MERRA Reanalysis, TRMM and GPCP Precipitation, and GSSTF Surface Evaporation, *J. Climate*, 24, 6307-6321.

Wu, D.L. and J.N. Lee (2012), Arctic low cloud changes as observed by MISR and CALIOP: Implication for enhanced autumnal warming and sea ice loss, *J. Geophys. Res.*, 117, D01707.

Yu, H., M. Chin, L.A. Remer, H. Bian, Q. Tan, T. Yuan and Y. Zhang (2012), Aerosols from overseas rival domestic emissions over North America, *SCIENCE*, Vol. 337, no. 6094, pp. 566-569, doi: 10.1126/science.1217576, 3 August.

Yuan, T., L.A. Remer, H. Bian, J.R. Ziemke, R. Albrecht, K.E. Pickering, L. Oreopoulos, S.J. Goodman, H. Yu, and D. J. Allen (2012), Aerosol indirect effect on tropospheric ozone via cloud lightning, *J. Geophys. Res*.

Yurganov, L., V. Rakitin, A. Dzhola, T. August, E. Fokeeva, G. Gorchakov ,E. Grechko, S. Hannon, A. Karpov, L. Ott, E. Semutnikova, R. Shumsky, and L. Strow (2011), Satellite- and ground-based CO total column observations over 2010 Russian fires: accuracy of top-down estimates based on thermal IR satellite data, *Atmos. Chem. Phys., 11*, 7925–7942.

Zhang, H., A. Lyapustin, Y. Wang, S. Kondragunta, I. Laszlo, P. Ciren, and R.M. Hoff (2011), A multi-angle aerosol optical depth retrieval algorithm for geostationary satellite data over the United States, *Atmos. Chem. Phys.*, 11, 11977-11991, doi:10.5194/acp-11-11977-2011.

Zhang, Y., H. Yu, T.F.F. Eck, A. Smirnov, M. Chin, L.A. Remer, H. Bian, Q. Tan, R. Levy, B.N. Holben, S. Piazzolla (2012), Aerosol daytime variations over North and South America derived from multiyear AERONET measurements, *J. Geophys. Res.*, Vol. 117, D05211, doi:10.1029/2011JD017242.

III.3 Publications Submitted for Review

Bian, H., P. Colarco, M. Chin, G. Chen, A.R. Douglass, J.M. Rodriguez, Q. Liang, J. Warner, D.A. Chu et al. (2012), Investigation of source attributions of pollution to the Western Arctic during the *NASA ARCTAS field campaign*, submitted to *ACP*.

Bulmer, M.H. (2012), Short-Term Water Management Decisions in Emergency Situations. Section 3.3.4 In Short-Term Water Management Decisions: User Needs for Improved Weather and Climate Prediction Information. *U.S. Army Corps of Engineers Civil Works Technical Series*.

Cheng, Y.-B., E.M. Middleton, Q. Zhang, K.F. Huemmrich, P.K.E. Campbell, L.A. Corp, A.L. Russ, & W.P. Kustas (2012), Simulations of bio-indicators from directional reflectance in a corn field. Submitted to *Journal of Applied Remote Sensing*.

Chu, D.A., T.-C. Tsai, et al. (2012), Interpreting Lidar Aerosol Extinction Profiles and Meteorological Data to Better Estimate Surface PM2.5 for Columnar AOD Measurements, submitted to *Atmos. Environ.*

Compton, J.C., R. Delgado, T.A. Berkoff, R.M. Hoff (2012), Determination of planetary boundary layer height on short spatial and temporal scales: A demonstration of the Covariance Wavelet Transform in ground based wind profiler and lidar measurements, submitted to *Journal of Atmospheric and Oceanic Technology*.

Han, S.-C., R. Riva, J. Sauber, E. Okal (2012), Source parameter inversion for recent megathrust earthquakes from global gravity field observations, *Journal of Geophysical Research*, submitted, doi:10.1029/2012JB009735.

Huemmrich, K.F., J.A. Gamon, C. Tweedie, P.K.E. Campbell, D. Landis, E.M. Middleton (2012), Arctic Tundra Vegetation Functional Types Based on Photosynthetic Physiology and Optical Properties. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* (accepted).

Huff, A.K., R.M. Hoff, S. Kondragunta, H. Zhang, P. Ciren, C. Xu, S. Christopher, E.-S. Yang, and J. Szykman (2012), The Air Quality Proving Ground (AQPG): Preparing the Air Quality Community for Next Generation Products from the GOES-R Satellite, *Environmental Management*.

Iguchi, T., T. Matsui, A. Tokay, and P. Kollias (2012), Two distinct modes in one-day rainfall event during MC3E field campaign: Analyses of disdrometer observations and WRF-SBM simulation, *Geophysical Research Letters*.

Iguchi, T., T. Matsui, W.K. Tao, A. Hou, R. Cifelli, R. Shi, A. Tokay (2012), Numerical analysis using WRF-SBM for the cloud microphysical structures in the C3VP field campaign: Impacts of supercooled droplets and resultant riming on snow microphysics, *Journal of Geophysical Research-Atmospheres*.

Jethva, H., O. Torres, L.A. Remer and P.K. Bhartia (2011), A color ratio method for simultaneous retrieval of aerosol and cloud optical thickness of above cloud absorbing aerosols from passive sensors: Application to MODIS measurements. Submitted to *IEEE Trans. Geosc. and Rem. Sens.*

Johnson, B.T., G. W. Petty, G. Skofronick-Jackson (2012), Microwave Properties of Ice-Phase Hydrometeors for Radar and Radiometers: Sensitivity to Model Assumptions, accepted, *Journal of Applied Meteorology and Climatology*.

Joiner, J., Y. Yoshida, A.P. Vasilkov, E.M. Middleton, and K.F. Huemmrich (2012), The Seasonal Cycle of Terrestrial Fluorescence and Its Relationship to Global Primary Productivity (GPP). *Geophysical Research Letters*.

Kim, D., M. Chin, H. Bian, Q. Tan, M. Brown, T. Zheng, R. You, T. Diehl, P. Ginoux, T. Kucsera (2012), The Effect of the Dynamic Surface Bareness to Dust Source Function, Emission, and Distribution, *J. Geophy. Res.*

Knepp, T., M. Pippin, J. Crawford, J. Szykman, R. Long, L. Cowen, A. Cede, N. Abuhassan, J. Herman, R. Delgado, J. Compton, T.A. Berkoff, J. Fishman, D. Martins, R. Stauffer, A. Thompson, A. Weinheimer, D. Knapp, D. Montzka, D. Lenschow, and D. Neil (2012), Towards a Methodology for Estimating Surface NO2 and SO2 Mixing Ratios from High Spatial and Temporal Resolution Retrievals, and its Applicability to High-resolution Space-based Observations, submitted to *Journal of Atmospheric Chemistry*.

Lee, C.K., S.-C. Han, B. Steinberger (2011), Influence of variable uncertainties in seismic tomography models on constraining mantle viscosity from geoid observations, *Physics of the Earth and Planetary Interiors*, 184, 51-62, doi:10.1016/j.pepi.2010.10.012.

Mišurec, J., V. Kopačková, Z. Lhotáková, J. Hanuš, J. Weyermann, P.K.E. Campbell, and J. Albrechtová (2012), Utilization of hyperspectral image optical indices to assess the Norway spruce forest health status, Submitted to *Journal of Applied Remote Sensing*.

Skofronick-Jackson, G., B.T. Johnson, S.J. Munchak (2012), Detection Thresholds of Falling Snow from Satellite-borne Active and Passive Sensors, submitted to *IEEE Trans. Geosci. Remote Sens.*

Song, Y.T. and S.-C. Han (2011), Satellite Observations Defying the Long-Held Tsunami Genesis Theory, *Remote Sensing of the Changing Oceans*, D. Tang (Ed.), 396 p. 182 illus., 130 in color, Springer, ISBN 978-3-642-16540-5.

Tokay, A., and W.A. Petersen, P. Gatlin, and M. Wingo (2012), Comparison of raindrop size distribution measurements by collocated disdrometers, *Journal of Atmopsheric and Oceanic Technology*.

Yu, H., M. Chin, J.J. West, C.S. Atherton, N. Bellouin, D. Bergmann, I. Bey, H. Bian, et al. (2012), A HTAP multi-model assessment of the influence of regional anthropogenic emission reductions on aerosol direct radiative forcing and the role of intercontinental transport, *J. Geophys. Res.*

This page intentionally left blank.

III.4 Conference Presentations, Non-reviewed Publications and Technical Reports

Berkoff, T.A., et al. (2012), DISCOVER-AQ UMBC ground Lidar status and future plans, *DISCOVER-AQ Data Workshop*, Newport News, VA, 14 - 16 February.

Berkoff, T.A., R.M. Hoff, R.M. Delgado, J. Sullivan, A. Thomas, W. T. Lawrence, T. Jones, P. Decola, S. Mathur, Y. Zheng, G.J. Wyant, R. Blucher, R. Piatt, M. Abderrahman, D.K. Martins, R. Auvil, M. Woodman, R. Connell, M. Hicks, D. D. Venable, B. Demoz, M. Tzortziou, K.E. Pickering, D. Starr, E.J. Welton, B.N. Holben, R.A. Ferrare, J.H. Crawford (2011), Field deployment and initial results from micro-pulse lidar systems during NASA's DISCOVER AQ campaign, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Berkoff, T.A., R.S. Stone, E.G. Dutton, J. Wendell, D. Longenecker, A. Jordan, E. Hall, M. Sorokin, T. Stone, R.M. Hoff, E. Welton, and B. Holben (2012), Using Moonlight to Obtain Nocturnal Aerosol Optical Depth Measurements, *NIST Lunar Calibration Workshop*, Gaithersburg, MD, 14-15 May.

Bian, H., et al. (2011), Investigation of Atmospheric Nitrate and Ammonium and their Impact on Air Quality in GMI, *10th Aerocom Workshop*, Fukuoka, Japan, 3-6 October.

Bian, H., et al. (2011), Investigation of Atmospheric Nitrate and Ammonium and their Impact on Air Quality in GMI, *AGU Fall Meeting*, San Francisco, CA, 5-9 December.

Bian, H., et al. (2011), GMI Aerosol Study: New Capabilities and Assessment Activities, *GMI Science Team Meeting*, MD USA, 3-4 August.

Bian, H., et al. (2011), Investigation of Atmospheric Nitrate and Ammonium and their Impact on Air Quality in GMI, *Goldschmidt*, Prague, Czech Republic, 14-21 August.

Braun, S.A., J. Sippel, and C.-L. Shie (2011), The role of the Saharan Air Layer in the evolution of Hurricane Helene (2006), presented at the *14th Conference on Mesoscale Processes*, Los Angeles, CA, 1-4 August.

Bulmer, M.H. (2012), Back brief from SO2 Civil Assessment on Exercise ARCADE RETURNER 2, pp. 4, *MSSG/ARRC*, 4-12 May.

Bulmer, M.H. (2012), Post Deployment Report for MSSG Deployment to Haiti, pp. 4, January 4-9, *MSSG/Haiti*, 28 February.

Bulmer, M.H. (2012), Setting up a company based around Invention Disclosure Ref. No. 2561MB. *MTech Open Entrepreneur*, University of Maryland. 8 May.

Bulmer, M.H. (2012), Summary Report Week 16-22 January, MSSG Deployment for BRABAT 1, UN MINUSTAH Mission in Haiti, p. 5, *MSSG/Haiti*, 22 January.

Bulmer, M.H. (2012), Summary Report Week, MSSG Deployment for BRABAT 1, UN MINUSTAH Mission in Haiti. p. 6, *MSSG/Haiti*, 23-29 January.

Bulmer, M.H. (2012), Summary Report Week 29 January – 5 February, MSSG Deployment for BRABAT 1, UN MINUSTAH Mission in Haiti, p. 5, *MSSG/Haiti*, 5 February.

Bulmer, M.H. (2012), Summary Report Week 7-15 January, MSSG Deployment for BRABAT 1, UN MINUSTAH Mission in Haiti. *MSSG/Haiti*, 15 January.

Bulmer, M.H. (2012), Invited Talk: The Use of Geospatial Data in Response to the 2010 Earthquake in Haiti. *Department for Geography and Environmental Sciences*, University of Maryland, Baltimore County, 28 March.

Bulmer, M.H. (2012), Invited Talk: Two Years After the Haitian Earthquake: Conducting Humanitarian Relief and Development in Port-au-Prince. *Center for Urban Environmental Research and Education Seminar Series*, 24 February (2012).

Bulmer, M.H. (2012), Two Years After the Haitian Earthquake: Observations by a member of JCET Faculty. Edited by N. Ruediger, *UMBC Insights News for the UMBC Community*, 15 February.

Bulmer, M.H. (2012), Two Years After the Haitian Earthquake: Observations by a Team from the MSSG, Edited by O. Turvey. *MSSG Newsletter for the Stabilization Community*, Camberley, UK, April.

Bulmer, M.H. (2012), Invited Reader: All About Our Solar System, *Davidsonville Elementary School*, Davidson, MD, 6 March.

Bulmer, M.H. (2012), Geo Brief: Closure of Latest La Nina Event, *Geophysical Flow Observatory*, *JCET*, p. 3, 15 May.

Bulmer, M.H. (2012), Short-Term Water Management Decisions in Emergency Situations. Section 3.3.4 In Short-Term Water Management Decisions: User Needs for Improved Weather and Climate Prediction Information. Report to U.S. Army Corps of Engineers Civil Works Technical Series. *Geophysical Flow Observatory, Open-file Report, JCET*, p. 12. 20 June.

Bulmer, M.H., and S. Peacock (2012), Invited Talk: Introduction to the Military Stabilization Support Group Knowledge Exchange with Brazilian Battalion 1, *UN MINUSTAH Mission in Haiti*. Operations Staff, Headquarters Brazilian Battalion 1, Camp Charlie, Port-au-Prince, Haiti, 23 January.

Bulmer, M.H., and S. Peacock (2012), Invited Talk: Military Stabilization Support Group Knowledge Exchange with Brazilian Battalion 1, *UN MINUSTAH Mission in Haiti, Operations Staff*, Headquarters Brazilian Battalion 1, Camp Charlie, Port-au-Prince, Haiti, 23 January.

Bulmer, M.H., and S. Peacock (2012), Invited Talk: Military Stabilization Support Group Knowledge Exchange with Brazilian Battalion 1, *UN MINUSTAH Mission in Haiti*,

Operations Staff, Headquarters Brazilian Battalion 1, Camp Charlie, Port-au-Prince, Haiti, 28 January.

Bulmer, M.H. and S. Peacock (2012), Invited Talk: Military Stabilization Support Group Knowledge Exchange with Brazilian Battalion 1, *UN MINUSTAH Mission in Haiti*, Command and Staff, Headquarters Brazilian Battalion 1, Camp Charlie, Port-au-Prince, Haiti, 2 February.

Bulmer, M.H. and S. Peacock (2012), Invited Talk: Military Stabilization Support Group Knowledge Exchange with Brazilian Battalion 1, *UN MINUSTAH Mission in Haiti. Ministry of Defense*, Whitehall, London, 6 February.

Bulmer, M.H. (2012), Brazilian Battalion 1 Civil Military Activities Briefing, *BRABAT 1 Headquarters*, Camp Charlie, Port-au-Prince, Haiti. 18 January.

Bulmer, M.H. (2012), Delta Management Under Climate Uncertainty: Methods and tools for designing robust and flexible strategies, *The East Asia Disaster Risk Management Tea, The World Bank*, Washington, DC. 20 March.

Bulmer, M.H. (2012), Innovative Planning for Flood Resilience – A Stakeholder Workshop to Explore New Approaches to Flood Control and Water Quality Management in the Washington DC Region, *Northern Virginia Regional Commission*, VA, 17 April.

Bulmer, M.H. (2012), Introducing Cerge-C: Certification Program in Geological and Climate Related Risk, *The World Bank*, Washington, DC, 5 March.

Bulmer, M.H. (2012), Joint Workshop: Role of Hydrometeorological Services in Disaster Risk Management, *The World Bank*, Washington, DC. 12 March.

Bulmer, M.H. (2012), Military Public Information Office (MPIO). Introduction to Public Information, *UN MINUSTAH Headquarters*, Camp Delta, Port-au-Prince, Haiti, 10 January.

Bulmer, M.H. (2012), Quick Impact Project (QIP) Overview, UN MINUSTAH Headquarters, Camp Delta, Port-au-Prince, Haiti, 16 January.

Bulmer, M.H. (2012), U9 Civil Military Cooperation, *UN MINUSTAH Headquarters*, Camp Delta, Port-au-Prince, Haiti. 11 January.

Campbell, P.K.E. (2012), Participation at the HyspIRI Products Symposium on Identifying Priority Products, *NASA/GSFC*, Greenbelt, MD, 16-17 May.

Campbell, P.K.E. (2011), Poster presentation at the *Annual HyspIRI Science Workshop*, Washington, DC, 23-25 August.

Cheng, Y-B., E.M. Middleton, K.F. Huemmrich, Q. Zhang, L. Corp, P. Campbell, and W. Kustas (2011) Spectral Bio-indicator Simulations for Tracking Photosynthetic Activities in

a Corn Field. Remote Sensing and Modeling of Ecosystems for Sustainability VIII, *Proceedings of SPIE 8156*, Article Number: 815607, doi: 10.1117/12.892333.

Chu, D.A., Ferrare R.A., Welton, E.J., Hostetler C. A, Hair J.A., Szykamn, J.A. Al-Saadi, T.-C. Tsai (2011), Interpreting Lidar Measurements to Better Estimate Surface PM2.5 in Study Regions of DISCOVER-AQ Abstract A22D-02, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Chu, D.A. (2012), Interpreting Lidar Measurements to Better Estimate Surface PM2.5 from Columnar Measurements During *NASA DISCOVER-AQ Science Meeting*, Newport News, VA, 14-16 February.

Compton, J.C., R. Delgado, T. Berkoff, L. Landry, R.M. Hoff (2012), Determining Planetary Boundary Layer Heights with Ground-based Lidar and Wind profiler on Short Spatial and Temporal Scales, *NASA DISCOVER-AQ Science Meeting*, Newport News, VA, 14-16 February.

Compton, R. Delgado, R.M. Hoff (2012), Determining Planetary Boundary Layer Heights with Ground-based Lidar and Wind profiler on Short Spatial and Temporal Scales, *6th National Oceanic and Atmospheric Administration-Educational Partnership Program Meeting*, Tallahassee, FL, 26-28 March.

Delgado, R., T. Berkoff, J.S. Compton, A. St Pé, B. Baker, R. M Hoff, D.K. Martins, A.M. Thompson, E.-S. Yang, S.A. Christopher, E. Joseph, M. Tzortziou, S. Lolli, L. Landry, M. Woodman, R.A. Ferrare, C.A. Hostetler (2012), Determination of Planetary Boundary Layer Heights on Short Spatial and Temporal Scales from Surface and Airborne Vertical Profilers during DISCOVER-AQ, *American Meteorological Society Annual Meeting*, New Orleans, LA, 22-26 January.

Delgado, R., T. Berkoff, J.S. Compton, A. St Pé, B. Baker, R. M Hoff, D.K. Martins, A.M. Thompson, E.-S. Yang, S.A. Christopher, E. Joseph, M. Tzortziou, S. Lolli, L. Landry, M. Woodman, R.A. Ferrare, C.A. Hostetler (2011), Determination of Planetary Boundary Layer Heights on Short Spatial and Temporal Scales from Surface and Airborne Vertical Profilers during DISCOVER-AQ, *American Geophysical Society Annual Meeting*, San Francisco, 5-9 December.

Delgado, R., T. Berkoff, J.S. Compton, A. St Pé, B. Baker, R.M. Hoff, D.K. Martins, A.M. Thompson, E. Yang, S. A Christopher, E. Joseph, M. Tzortziou, L. Landry, M. Woodman, S. Lolli, A.J. Weinheimer, D.D. Montzka, D. J. Knapp, R.A. Ferrare, C.A. Hostetler, J.H. Crawford (2011, 2012), Determination of Planetary Boundary Layer Heights on Short Spatial and Temporal Scales from Surface and Airborne Vertical Profilers during DISCOVER-AQ, *NASA DISCOVER-AQ Science Meeting*, Newport News, VA, February 2012; *92nd American Metereological Society Meeting*, Seattle, Washington, January 2012; *American Geophysical Union Fall Meeting*, San Francisco, CA, December 2011.

Duncan, B., and Prados, A. (2012), Creating an Objective “AQST Recommendations from Air Quality Satellite Missions” Document for NASA Mission Planners, *NASA AQAST meeting*, presented by Ana Prados, 13-15 June.

Evans, K.E.C. Pavlis, Paraskevas Milas, Demitris Paradissis, Basil Massinas, and X. Frantzis (2011), “Eastern Mediterranean Altimeter Calibration Network – eMACnet,” AGU Fall Meeting, San Francisco, CA, 5-9 December.

Ferrare, R.A., C.A. Hostetler, J.W. Hair, M.D. Obland R. Rogers, A. Cook, D. Harper, R. Hare, S.P. Burton, B.E. Anderson, J.H. Crawford, A.J. Swanson, M. Clayton, K. L. Thornhill, B.N. Holben, K.E. Pickering, R.A. Kahn, A. DaSilva, A. Chu, R.M. Hoff, R.M. Delgado, J.S. Compton, T. Berkoff, P. Lee (2011, 2012), Airborne High Spectral Resolution Lidar Aerosol Measurements During the First DISCOVER-AQ Field Mission, *NASA DISCOVER-AQ Science Meeting*, Newport News, VA, February 2012; *American Geophysical Union Fall Meeting*, San Francisco, CA, December 2011.

Georgieva E., W. Heaps, Huang, W. (2011), New Broadband LIDAR for Greenhouse Carbon Dioxide Gas Sensing in the Earth’s Atmosphere, *SPIE, Conference on Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing VII*, 19-20 September.

Grecu, M., and W. Olson (2011), Over-Ocean Evaluation of a GPM Radar-Radiometer Combined Algorithm Using TRMM-Based Synthetic Data, presented at the *American Geophysical Union Fall Meeting*, San Francisco, CA, 4-9 December.

Hall, F.G. (2012), Improved GPP estimates using spectral data assimilation, plenary presentation to the *MODIS Land Workshop*, 9 May.

Hall, F.G. (2011), Remote Sensing of Light Use Efficiency from Space, *American Geophysical Union Fall Meeting*, San Francisco, 5-9 December.

Hilburn, K., and C.-L. Shie (2011), Decadal trends and variability in Special Sensor Microwave / Imager (SSM/I) brightness temperatures and Earth incidence angle, presented at the *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Hilburn, K., and C.-L. Shie (2011), Decadal trends and variability in SSM/I brightness temperatures and Earth incidence angle, presented at the *World Climate Research Program Open Science Conference*, Denver, CO, 24-28 October.

Hilburn, K., and C.-L. Shie (2011), The impact of influence of incidence angle variations on climate trends from simple water vapor retrieval algorithms, presented at the *2011 EUMESAT Meteorological Satellite Conference*, Oslo, Norway, 5-9 September.

Hoban, S., (2011), NBS Activity Guide Training presented at *NSTA Regional Conference* in Seattle, WA, 8 December.

Hoban, S. (2011), NBS Activity Guide Training at *National Science Teachers Association (NSTA) Regional Conference* in Hartford, CT, 24 October.

Hoban, S. (2011), Association of Science & Technology Centers (ASTC) Museum Educators Share-a-Thon at *GSFC Visitor Center*, 14 October; *Museum Educators Workshop at GSFC*, Greenbelt, MD, 7-9 September.

Hoff, R.M. (2012), Correlation between Satellite AOD and Surface PM2.5 Measurements, *NOAA Air Quality Proving Ground Workshop*, *UMBC*, Catonsville, MD, 12 January.

Hoff, R.M., H. Zhang, A. Huff, S. Kondragunta, C. Xu, P. Ciren, S.A. Christopher, and E.S. Yang (2012), The GOES-R Air Quality Proving Ground: Building an Air Quality User Community for the Next Generation of Products. *American Meteorological Society Annual Meeting*, New Orleans, LA, 22-26 January.

Hoff, R.M. (2012), *NOAA Profiling Workshop Commentary*, Sterling, VA, 28 March.

Hoff, R.M., T. Berkoff, R. Delgado, D. Orozco, K.J. McCann, J.H. Crawford, B.E. Anderson, C.A. Hostetler, J.W. Hair, R.A. Ferrare, R. Rogers, M.D. Obland, B.N. Holben, E.J. Welton (2011, 2012), Multidimensional Lidar, Sunphotometer and Aircraft Observations of Urban Aerosols during the *DISCOVER-AQ Mission*, *92nd American Metereological Society Meeting*, Seattle, WA, January 2012; *American Geophysical Union Fall Meeting*, San Francisco, CA, December 2011.

Hoff, R.M., T. Berkoff, R. Delgado, K. McCann, B. Anderson, J. Crawford, J. Hair, C.A. Hostetler, R.R. Rogers, M. Obland, R. Ferrare, B. Holben and E.J. Welton (2012), Multidimensional Lidar Observations of Urban Aerosols during the *DISCOVER-AQ Mission*, *American Meteorological Society Annual Meeting*, New Orleans, LA, 22-26 January.

Hoff, R.M., T. Berkoff, R. Delgado, K. McCann, B. Anderson, J. Crawford, J. Hair, C.A. Hostetler, R.R. Rogers, M. Obland, R. Ferrare, B. Holben and E.J. Welton (2011), Multidimensional Lidar, Sunphotometer and Aircraft Observations of Urban Aerosols during the *DISCOVER-AQ Mission, American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Hoff, R.M., T. Berkoff, R. Delgado, P. Sawamura, R. Ferrare, J. Hair, C. Hostetler, R. Rogers, M. Obland, B. Anderson, J. Crawford, B. Holben and E.J. Welton (2012), Discover-Aq: Determining The Relationship Between Satellite Retrieved Column AOD, Extinction Profiles, And Surface PM2.5, *26th International Lidar Research Conference*, Porto Heli, Greece, 25-29 June.

Hoff, R.M., T. Berkoff, R. Delgado, D. Orozco, K.J. McCann, J.H. Crawford, B.E. Anderson, C.A. Hostetler, J.W. Hair, R.A. Ferrare, R. Rogers, M.D. Obland, B.N. Holben, E.J. Welton (2011, 2012), Multidimensional Lidar, Sunphotometer and Aircraft Observations of Urban Aerosols during the DISCOVER-AQ Mission, *92nd American Metereological*

Society Meeting, Seattle, WA, January 2012; *American Geophysical Union Fall Meeting*, San Francisco, CA, December 2011.

Holben, B., J. Schafer, T. Eck, D. Giles, M. Sorokin, A. Smirnov, A. Sinyuk, A. Tran, P. Kenny, C.-H. Huang, B. Anderson, R. Ferrare, C. Hostetler, J. Crawford, K. Pickering, R.M. Hoff, J. Hains, T. Berkoff, P. Goloub, A. Mortier, E. Joseph, R. Clark, L. Thornhill, A. DaSilva, R. Dickerson, S.-C. Tsay, J.W. Stehr, A. Thompson, L. Remer, R. Levy, E. Welton, I. Abboud, L. Blare, T. Podvin, Y. Liu, S. Mukai, J. Kim, and I. Sano (2011), DRAGONs DISCOVER Air Quality over Baltimore, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Huemmrich, K.F. and P.P.K. Campbell (2012), Remote Sensing of Fluxes: EO-1 Hyperion and Flux Towers, *HyspIRI Products Symposium*, Greenbelt, MD, 16-17 May.

Huemmrich, K.F., J. Gamon, C. Tweedie, P.P.K. Campbell, D. Landis and E. Middleton (2011), Arctic Tundra Vegetation Functional Types Based on Photosynthetic Physiology and Optical Properties, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Huemmrich, K.F., J. Gamon, C. Tweedie, P.P.K. Campbell, D. Landis and E. Middleton (2011), Spectral Unmixing ofArctic Tundra Vegetation Functional Types, *NASA Carbon Cycle and Ecosystems Meeting*, Alexandria, VA, 3-6 October.

Huff, A. K., H. Zhang, Hoff, R.M., Xu, C., Ciren, P., Kondragunta, S., Yang, E., Christopher, S.A. (2011), The GOES-R Air Quality Proving Ground: Introducing the Air Quality User Community to the Next Generation of NOAA Geostationary Satellite Products, Abstract #IN53C-1640, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Johnson, B.T. (2011), Recent Advances And Improvements In Snowfall Retrieval Algorithm Development. *Precipitation Measurement Mission Science Team Meeting*, Denver, Colorado, 4-11 November.

Johnson, B.T., G. Skofronick-Jackson (2011), Ice-Phase Precipitation Remote Sensing Using Combined Passive and Active Microwave Observations, Invited presentation at the *International Geoscience and Remote Sensing Symposium (IGARSS)*, Vancouver, Canada, 24-30 July.

Johnson, B.T., G. Skofronick-Jackson (2011), Precipitation Remote Sensing Using Combined Passive and Active Microwave Observations, Poster presentation at *The American Geophysical Union*, San Francisco, CA, 4-10 December.

Joiner, J., Y. Yoshida, A.P. Vasilkov, E.M. Middleton, P.K.E. Campbell, Y. Yoshida, A. Kuze, and L.A. Corp (2012), Filling-in of near-infrared solar lines by terrestrial fluorescence and other geophysical effects: simulations and space-based observations from SCIAMACHY and GOSAT, *Atmos. Meas. Tech.*, 5, 809-829, doi:10.5194/amt-5-809-(2012).

Kleidman, R., A. Prados, and P. Gupta (2012), Best Practices in Using Satellite Data for Air Quality, EPA Satellite Observations for Air Quality Management, *University of Maryland, Baltimore County*, 11 January.

Kondragunta, S., R.M. Hoff, A. Huff, C. Xu, P. Ciren, H. Zhang, S.A. Christopher, and E.S. Yang (2012), The GOES-R Air Quality Proving Ground: Building An Air Quality User Community for the Next Generation of Products, *NOAA Satellite Science Week*, Kansas City, 30 April - 4 May.

Koren, I., O. Altaratz, G. Feingold, L.A. Remer (2011), Why do we see strong associations between aerosol loading and convective clouds?, Abstract A13G-02 presented at *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Koren, I., G. Feingold (2012), A systems approach to evolution of cloud fields, Geophysical Research Abstracts Vol. 14, EGU(2012)-10793, *EGU General Assembly*, Vienna, 7-12 April.

Koren, I. (2012), On the deep relationship between clouds and maritime aerosol, *SOLAS Open Science Conference*, Cle Elum, Washington State, USA, 7-10 May.

Kundu, P.K., T.L. Bell and X. Lin (2011), Some Statistical Issues Regarding Inter-comparison and Validation of GPM Rain Rate Estimates (Poster), Paper No. H43C-1237, Poster presentation at the 2011 AGU Fall Meeting, San Francisco, CA, 5-9 December.

Lee, J. (2011), Aura Microwave Limb Sounder Observations of the middle atmosphere; Transport of CO and H2O, World Climate Research Program (WCRP), Denver, CO, 23-28 October.

Lee, J. (2011), Decadal and Inter-annual Variability of the Polar Middle Atmosphere, *SORCE 2011 science meeting*, Sedona, AZ, 13-16 September.

Lee, J. (2011), MISR cloud/aerosol and their variability with ENSO, APCP science team meeting, Honolulu, Hawaii, 17-18 October.

Lolli, S., R. Delgado, J.S. Compton, R.M. Hoff (2011), Planetary Boundary Layer Height Retrieval at UMBC in the Frame of NOAA/ARL Campaign, *SPIE Lidar Technologies, Techniques, and Measurements for Atmospheric Remote Sensing VII*, Prague, Czech Republic, 19 September.

Mehta A.V (2012), Global and North American Land Data Assimilation System (GLDAS and NLDAS), *NASA Remote Sensing Training*, Norman, OK, 19-20 June.

Mehta A.V. (2012), Introduction to NASA's Modern Era Retrospective-analysis for Research and Applications (MERRA), *NASA Remote Sensing Training*, Norman, OK, 19-20 June.

Mehta, A.V. (2011), Introduction to NASA Water Products, *NASA Remote Sensing Training*, *GEO Latin America and Caribbean Water Cycle Capacity Building Workshop,* Cartagena, Colombia, 28 November – 2 December.

Mehta, A.V. (2011), Tropical Rainfall Measuring Mission (TRMM): Data products and Usage, *NASA Remote Sensing Training, GEO Latin America and Caribbean Water Cycle Capacity Building Worksho*p, Cartagena, Colombia, 28 November – 2 December.

Mehta, A.V. (2012), NASA Atmospheric Products for Weather and Climate Monitoring, *NASA Remote Sensing Training*, Norman, OK, 19-20 June.

Mehta, A.V. and E.A. Smith (2011), Extreme Rainfall Events over the US Great Plains during the Last Decade, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Munchak, S.J., M. Grecu, and W.S. Olson (2012), Information Content of Combined Dual-Frequency Radar and Radiometer Observations of Precipitation From GPM, presented at the *American Meteorological Society's 18th Conference on Satellite Meteorology and Oceanography*, New Orleans, LA, 22-26 January.

Pavlis, E.C., K. Evans, P. Milas, D. Paradissis, B. A. Massinas, and X. Frantzis (2012), Aegean Sea Level NetworkL Eastern Mediterranean Altimeter Calibration Network – eMACnet, *EGU Spring Meeting*, accepted, Vienna, Austria, 22-27 April.

Pickering, K., A. Prados, and S. Napelenok (2011), Monitoring Air Quality Changes in Regions Influenced by Major Point Sources over the Eastern and Central United States Using Aura/OMI NO2, *Community Modeling and Analysis System Annual Conference*, Chapel Hill, NC, 24-26 October.

Pickering, K., R. Kahn, A. DaSilva, A. Chu, R.M. Hoff, T. Berkoff, P. Lee (2011), Airborne High Spectral Resolution Lidar Aerosol Measurements During the First DISCOVER-AQ Field Mission, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Powers, R.J., R. Delgado, R.M. Hoff (2011), Positive Matrix Factorization (PMF) Analysis of PM2.5 Speciation Data, *UMBC's Fourteenth Annual Summer Undergraduate Research Fest (SURF)*, UMBC, Baltimore, MD, 10 August.

Prados, A. and A.V. Mehta (2011), The NASA Applied Sciences Remote Sensing Training Program, *GEO Latin America & Caribbean Water Cycle Capacity Building Workshop*, Cartagena, Colombia, 28 November - 2 December.

Prados, A. and A.V. Mehta (2011), Building Capacity to Integrate NASA Earth Science into Water Resources Management Applications in the Context of a Changing Climate, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Prados, A. (2011), NASA Air Quality Products and Applications, Environmental Monitoring: Emerging Technologies for characterization of atmospheric emissions and air quality, *Quebec chapter of the Air and Waste Management Association*, Montreal, Quebec, 8-10 November.

Prados, A. (2012), The NASA Applied Remote Sensing Training Program, *NASA Air Quality Applied Sciences Team (AQAST) meeting*, 13-15 June.

Prados, A. (2012), NASA Sponsored Workshop on Evaluating the Impact of Earth Science, *The Earth Observer, National Aeronautics and Space Administration,* Volume 24, Issue 2, March-April.

Prados, A. and A.V. Meta (2012), NASA Applied Remote Sensing Training: Building Capacity to Integrate NASA Earth Science into Water Resources Management Applications, presented at the *USG-World Bank Remote Sensing Workshop*, Washington, DC, 29 February.

Prados, A. (2012), Connecting NASA Science to Policy Through Capacity Building, *NASA Education and Public Outreach Seminar*, NASA GSFC, 19 January.

Prados, A. (2012), NASA Sponsored Workshop on Evaluating the Impact of Earth Science, *The Earth Observer, National Aeronautics and Space Administration*, Volume 24, Issue 2, March-April.

Prados, A. (2012), The NASA Applied Remote Sensing Program, *NASA Goddard Earth Sciences Data and Information Services Center Seminar*, 28 March.

Sawamura, P., J. P. Vernier, J.E. Barnes, T.A. Berkoff, E.J. Welton, L. Alados-Arboledas, F. Navas-Guzmán, G. Pappalardo, L. Mona, F. Madonna, D. Lange, M. Sicard, S. Godin-Beekmann, G. Payen, Z. Wang, S. Hu, S.N. Tripathi, C. Cordoba-Jabonero and R.M. Hoff (2012), Stratospheric AOD after the 2011 eruption of Nabro volcano measured by lidars over the Northern Hemisphere, *Environ. Res. Lett.* 7 034013.

Shie, C.-L., K. Hilburn, L.S. Chiu, R. Adler, I.-I. Lin, E. Nelkin, and J. Ardizzone (2011), The Goddard Satellite-Based Surface Turbulent Fluxes Dataset – Version 2c (GSSTF 2c) [global (grid of 1ox1o) daily air-sea surface fluxes from July 1987 to December 2008] distributed via *Goddard Earth Sciences (GES) Data and Information Services Center (DISC),* October.

Shie, C.-L., K. Hilburn, L.S. Chiu, R. Adler, I.-I. Lin, E. Nelkin, J. Ardizzone, and S. Gao (2012), The Goddard Satellite-Based Surface Turbulent Fluxes Dataset – Version 3 (GSSTF 3) [global (grid of 0.25ox0.25o) daily air-sea surface fluxes from January 1998 to December 2008] distributed via *Goddard Earth Sciences (GES) Data and Information Services Center (DISC)*, June.

Shie, C.-L. (2012), The Goddard Satellite-based Surface Turbulent Fluxes (GSSTF) datasets: updates, improvements and applications, seminar given at the *UMBC/JCET All Hands Meeting*, Greenbelt, MD, 14 March.

Shie, C.-L. (2012), Invited talk: The Goddard Satellite-based Surface Turbulent Fluxes (GSSTF) datasets: updates, improvements and applications, presented at the *18th Conference on Satellite Meteorology, Oceanography and Climatology* (SatMOC) Conference, New Orleans, LA, 22-26 January.

Shie, C.-L., I.-I. Lin, K. Hilburn, and L.S. Chiu (2011), Lin presented the talk on behalf of Shie: The newly revived satellite-based global ocean surface turbulent fluxes datasets and impact of the SSM/I brightness temperature, presented at the *2011 AOGS*, Taipei, Taiwan, 8-12 August.

Shie, C.-L., K. Hilburn, & L.S. Chiu, R. Adler, I.-I. Lin, E. Nelkin, J. Ardizzone, S. Gao, A. Savtchenko (2011), The Goddard Satellite-based Surface Turbulent Fluxes (GSSTF) Datasets and the uncertainties/impact due to the SSM/I brightness temperature, presented at the *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Shie, C.-L., K. Hilburn, and L.S. Chiu, R. Adler, I.-I. Lin, E. Nelkin, J. Ardizzone, S. Gao, A. Savtchenko (2012), The Goddard Satellite-based Surface Turbulent Fluxes (GSSTF) Datasets and the uncertainties/impact due to the SSM/I brightness temperature, presented at the *5th Annual NASA/GSFC Sciences & Exploration Directorate (SED) New Year's Poster Party*, Greenbelt, MD, 31 January.

Shuman, C.A. (2012), Ice Sheets: Waking Giants, *Howard County Legacy Leadership Class 4*, http://www.howardllie.com/(2012)-classes-4-6, Goddard Space Flight Center, 13 February.

Shuman, C.A. (2012), Illustration of Gain-Related Saturation Bias in ICESat Laser 1 Campaign Data from Lake Vostok Area Crossovers, *Technical Report, National Snow and Ice Data Center,* Digital Media, 3p. http://nsidc.org/data/icesat/pdf/illustration_of_gain_bias_laser_1.pdf

Shuman, C.A. (2012), *NASA's Earth Day on the National Mall*. Digital media. http://www.flickr.com/photos/eospso/sets/72157629897488021/, Washington, D.C., 20 April.

Shuman, C.A. NASA Celebrates Earth Day (2012) in the Washington Area, http://www.youtube.com/watch?v=Kfp29h20y-o&feature=youtube, *NASA GSFC*, Washington, D.C., 20 April.

Shuman, C.A., T.A. Scambos, M.A. Fahnestock and V.P. Suchdeo (2011). Antarctic Megadunes – Assessment of Topographic Form and Windward Progradation from ICESat

Altimetry, 2003-2009 (Invited), abstract and presentation, C32B-07, 7, *American Geophysical Union Fall Meeting,* 5-9 December.

Skofronick-Jackson, G. and B.T. Johnson (presenter) (2012), The Global Precipitation Measurement (GPM) Mission and Falling Snow Algorithm Development, presentation at the *National Radio Science Meeting*, Boulder, CO, 9-12 January.

St. Pé, A., R.M. Hoff, H. Zhang, A. Huff, S. Kondragunta, C. Xu, P. Ciren, S. Christopher, and E.S. Yang (2012), Air Quality Proving Ground: Evaluating GOES-R ABI Products with Proxy Data, *American Meteorological Society Annual Meeting*, New Orleans, LA, 22-26 January.

Stauffer, R.M., A.M. Thompson, D.K. Martins, R. Clark, J.R. Herman, T. Berkoff, B. Baker, R. Delgado (2012), Bay Breeze Impact on Surface Ozone at Edgewood, MD, *NASA DISCOVER-AQ Science Meeting*, Newport News, VA, February.

Strow, L., S. DeSouza-Machado (2011), "AIRS Clear Sky PDFs," *AIRS Science Team Meeting*, Greenbelt, MD, 8-11 November.

Strow, L., S. DeSouza-Machado (2012), "AIRS Clear Sky PDFs," *CLARREO Science Team Meeting*, Langley, VA, 10 April.

Studinger, M. & IceBridge Science Team and IceBridge Instrument Team (2011), NASA's Operation IceBridge: using instrumented aircraft to bridge the observational gap between ICESat and ICESat-2 laser altimeter measurements, Abstract C41E-0472 presented at *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Tangborn, A., L. Strow, B. Imbiriba, L. Ott, S. Pawson (2012), Assimilation of AIRS CO_2 retrievals from 2 distinct wavelengths, *AIRS Science Team Meeting*, Pasadena, CA, 24-26 April.

Tangborn, A., L. Strow, B. Imbiriba, L. Ott, S. Pawson (2012), Assimilation of AIRS CO_2 Retrievals from Channels with Sensitivity in the mid and upper Troposphere, *IWGGMS*, Pasadena, CA, 18-21 June.

Tangborn, A., L. Strow, B. Imbiriba, L. Ott, S. Pawson (2011), Global CO_2 Analyses from Assimilation of AIRS Channels that Peak in the Middle to Lower Troposphere, *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Tao, W.-K., S. Lang, W.S. Olson, S. Shige, and Y. N. Takayabu (2011), Latent Heating Products: Status and Applications, presented at the 2011 *American Geophysical Union Fall Meeting*, San Francisco, CA, 5-9 December.

Thompson, A.M., R.J. Salawitch, R.M. Hoff, J.A. Logan, F. Einaudi (2012), Environment Canada Cuts Threaten the Future of Science and International Agreements, *AGU EOS Forum*, 14 February.

Wilson, E., M. Neveu, H. Riris, E. Georgieva, and W. Heaps (2011), “A hollow-waveguide gas correlation radiometer for ultra-precise column measurements of formaldehyde on Mars,” *Meas. Sci Tech.*, vol.22, No 8.

Zhang, H. (2012), Development of a Simulated Synthetic Natural Color ABI Product for GOES-R AQPG. *NOAA Air Quality Proving Ground Advisory Group Workshop, University of Maryland, Baltimore County*, 12 January.

Zhang, H., R.M. Hoff, S. Kondragunta (2012), IDEA-like GOES-R air quality data distribution system, *NOAA Science Week*, NWS Kansas City Office, Kansas City, MO, 30 April – 4 May.

This page intentionally left blank.

III.5 Courses Taught

Physics 721: Fall 2011 (four weeks)

This is a graduate level course introducing the student to formal radiative transfer theory, which is simplified quickly for application to Earth's atmosphere. The physical processes, which contribute to absorption and scattering in the Earth's atmosphere, are examined. Topics include molecular absorption via vibration-rotation transitions and spectral line formation in homogeneous atmospheres. Raleigh and Mie scattering theory are covered, as well as their application to radiative transfer in clouds and aerosol-laden atmospheres. The importance of radiative transfer to the heat balance of the Earth and implications for weather and climate will be examined. If time permits, various parameterizations and approximation schemes for atmospheric radiative transfer will be developed. (Taught by Sergio DeSouza-Machado and Dr. Vanderlei Martins.)

HONR 300: Robots in Society (Fall 2011)

Robots are becoming an increasingly ubiquitous part of modern society, though ideas about robots date back to at least the era of DaVinci. The objective of this course is to introduce students to concepts related to the use of robots in society. The course delves into technical, ethical, legal and creative ideas surrounding the increasing role of robots in our lives. Students build an extremely simple robot to help them understand some of the realities of robotics and dispel certain misconceptions about how robots make decisions and act on those decisions. (Taught by S. Hoban, Fall 2011.)

Geography and Environment Systems 311: Weather and Climate (Fall 2011)

This class covers fundamentals of meteorology including atmospheric radiation, cloud microphysics, weather analysis and severe weather, global circulation and global climate. The student’s grade was based on four tests, and four homework sets. The daily weather briefing is presented at the beginning of each class period. The class notes, homework material, past tests are available through class web page, http://userpages.umbc.edu/~tokay. There were 40 students on the roster for this class. (Taught by A. Tokay, Fall 2011.)

PHYS 602: Atmospheric Physics II - Guest-lecturer. The following topics were covered: Fundamentals of drop size distribution and measurement techniques of individual raindrops and snowflakes, and bulk rainfall at the ground. (Guest Lecturer A. Tokay, Spring 2012.)

This page intentionally left blank.

III.6 Colloquia and Seminars

Hall, F.G., (2012), *Howard County Legacy Leadership Institute: The Global Carbon Cycle*, GSFC, February 2012.

Hall, F.G., (2012), *The world view from Newton to Einstei*n, Seminar to the Montgomery College Round Table, 3 March 3.

Johnson, B.T., G. Skofronick-Jackson, W.S. Olson (2011), *Combined Radar / Radiometer Remote Sensing of Snowfall*, Invited colloquium speaker at University of North Dakota, Atmospheric Science Seminar Series, Grand Forks, North Dakota, 8-10 September.

Johnson, B.T., G. Skofronick-Jackson, W.S. Olson (2012), *Passive and Active Microwave Remote Sensing of Snowfall*, colloquium speaker at University of Maryland Baltimore County Joint Center for Earth Systems Technology, Columbia, Maryland, 11 January.

Lee, J., (2011), *Two Satellite Remote Sensing Applications: (1) MISR cloud/aerosol and their variability with ENSO, and (2) MLS diagnosis of CO and H2O transport*, University of Hawaii, 31 August.

This page intentionally left blank.

III.7 Proposals Submitted by JCET Members

(primary sort alphabetical by funding agency, then proposal title)

Proposal Title	Funding Agency	PI (JCET)	CO-I(s) (JCET)	Status
Applications of Satellite Products for Air Quality Monitoring, Analysis, Forecasting, and Visualization in the SERVIR Mesoamerica and Himalaya Regions	Battelle (NASA)	Zhang, Hai		Pending
Integrating VIIRS Aerosol Products into the Air Quality Proving Ground	DOC	Remer, Lorraine		Awarded
Characterization of 3D cloud variability and its radiative impacts	DOE	Várnai, Tamas		Pending
Convective cloud life cycle and aerosol impact: ASR based observational and modeling investigation	DOE	Yuan, Tianle		Pending
New lidar-laser configuration to enable Earth Science measurements	Fibertek (NASA)	Berkoff, Tim		Awarded
A Statistically Robust Evaluation of the AERONET Retrieval Algorithm	GSFC	Martins, Vanderlei		Awarded
Assessing contributions of foreign aerosol sources to atmospheric composition, air quality and regional climate impacts in the U.S. using satellite products and models (1980-2010)	GSFC	Martins, Vanderlei		Awarded
Development of a Polarized Imaging Nephelometer (DEVOTE)	GSFC	Martins, Vanderlei		Awarded
AEROSUMS: Robust Unification of Aerosol Data Products from Multiple Satellite Sensors for Research and Applications	NASA		Chu, Allen	Pending
Airborne, Polarized Imaging Nephelometer for Measuring Aerosol Phase Matrix: In Situ Experiments and Comparison to the New Generation of Remote Sensors	NASA	Martins/Dolgos	Martins/Dolgos	Awarded

Proposal Title	Funding Agency	PI (JCET)	CO-I(s) (JCET)	Status
AIRS and IASI Near-real Time Measurements and Data Analysis in Support of the SEAC4RS Campaign	NASA	Warner		Not Funded
An improvement on secondary organic aerosol simulation in NASA GMI/CCM at present day and the year 2050:Implication for air quality and climate studies	NASA	Bian, Huisheng		Pending
Assess rain Frequency and Intensity Spectra of Synoptic-Scale, Mesoscale, and Cloud-Scale Rain Events from NEXRAD Observations and a NASA Cloud-System resolving Global Model Over Continental United States	NASA		Mehta, Amita	Pending
Building capacity for project evaluation via NASA and ESIP Participation in the Environmental Evaluators Network Annual Conference	NASA	Prados, Ana		Awarded
Carbon Monitoring and Ecosystem Feedbacks	NASA	Huemmrich, Fred		Pending
Satellite-Derived Surface-Temperature CDRs and Melt Maps of the Greenland and Antarctic Ice Sheets	NASA	Shuman, Christopher		Pending
Characterizing Uncertainties in Large-Scale Atmospheric Heating Distributions Derived from TRMM Observations and Reanalysis Datasets	NASA	Olson, William		Pending
Combining surface reflectance and emissivity to assess the changes in ecosystem diversity and function due to natural and anthropogenic stress factors / disturbance effects	NASA	Campbell, Petya		Pending
Consistent multi-satellite data records for carbon dioxide and methane	NASA	Strow, Larrabee		Pending

Proposal Title	Funding Agency	PI (JCET)	CO-I(s) (JCET)	Status
Continuing the Production of the Useful and Popular Satellite-based Global Air-sea Turbulent Fluxes (GSSTF) Datasets for Global Water and Energy Cycle Research	NASA	Shie, Chung-Lin	Shie, Chung-Lin	Pending
Climate Scholars: Educating Undergraduate Students in Using NASAs Earth Science Data and Information in Global Climate Change Applications	NASA	Prados, Ana		Not Funded
Creating an objective “Air Quality Applied Sciences Team (AQAST) Recommendations for AQ Satellite Missions” document to guide AQ mission planning. NASA Air Quality Applied Sciences Team, 2011	NASA	Duncan, Bryan	Prados, Ana	Awarded
Development and Evaluation of Improved Ice and Mixed-Phase Precipitation Models for GPM Combined Radar-Radiometer Retrieval Algorithm Applications	NASA	Olson, Bill	Olson, Bill	Pending
Development of a Laboratory Based Data Base of Aerosol Optical Properties	NASA	Martins, Vanderlei		Pending
Evaluate and constrain aerosol indirect effect in the trade cumulus regime with NASA data and models	NASA	Yuan, Tianle	Yuan, Tianle	Pending
Evaluation of the Synergy Between Airborne BRDF and Lidar Measurements In Remote Sensing of the Canopy Structure and Biophysical Properties of Forested Landscapes	NASA		Várnai, Tamas	Pending
Extending the Earth Surface and Atmospheric Reflectivity ESDR (1979-2011) into the past 1970-1978 using NIMBUS/BUV and into the future (2012-2018) using OMI and SBUV satellite Data	NASA	Herman, Jay		Pending

Proposal Title	Funding Agency	PI (JCET)	CO-I(s) (JCET)	Status
GRACE and Tides	NASA	Han, Shin-Chan		Awarded
GSFC collaborative effort on the ESA Swarm geomagnetic data product development and validation	NASA	Han, Shin-Chan		Pending
Hyperspectral Infrared Earth Radiance Time Series	NASA	Strow, Larrabee		Awarded
Improving estimates of CO emissions from biomass burning using FRP and its applicability to atmospheric models	NASA	Hoff, Raymond	GRA Karandana, Thishan Gamalathge	Pending
Integrating Mass Balance Measurements in the Antarctic Peninsula and Getz ice Shelf Areas: Assessing timing, rates, and causes of mass balance change	NASA	Shuman, Christopher		Not Funded
Interannual Variability of Fundamental Global and Monsoonal Water Cycles using Satellite-based Estimation of Precipitation and Evaporation	NASA		Mehta, Amita	Pending
Interannual Variability of Fundamental Global and Monsoonal Water Cycles using Satellite-based Estimation of Precipitation and Evaporation	NASA		Mehta, Amita	Pending
Interferometric NIR Receiver for ASCENDS Lidar	NASA		Georgieva, Elena	Not Funded
Low cost laser heterodyne radiometer for highly sensitive detection of CO_2. GOSAT validation	NASA		Georgieva, Elena	Not Funded
Management of the NASA Applied Remote Sensing Training Program (ARSET), NASA Headquarters, April 2012	NASA	Prados, Ana		Awarded

Proposal Title	Funding Agency	PI (JCET)	CO-I(s) (JCET)	Status
Mapping Ecosystem Light Use Efficiency Using Aqua and Terra MODIS Data	NASA	Huemmrich, Fred		Not Funded
Model Assimilation of New Spaceborne Light Use Efficiency Estimates to Quantify Spatially Explicit, Diurnal and Seasonal Exchanges of Biogenic Carbon	NASA	Hall, Forrest		Pending
Multi-decadal sulfur dioxide climatology from satellite instruments	NASA	Yurganov, Leonid	Evans, Keith	Pending
Near Real-time Volcanic Cloud Products for Aviation Alerts	NASA	Evans, Keith		Pending
Parametric Form of the Particle Size Distribution: Relevance to the Validation Efforts of the TRMM and GPM Precipitation Retrieval Algorithms	NASA	Ali Tokay		Pending
Radiometer Retrieval Algorithm Evaluation and Enhancements for Falling Snow and Light Rain Detection and Estimation	NASA	Johnson, Benjamin		Pending
Spectral Bio-Indicators of Ecosystem Photosynthetic Efficiency III:	NASA	Huemmrich, Fred	Campbell, Petya	Pending
Synthesis of GPM GV Hydrometeor Datasets for Combined Precipitation Retrieval Algorithms	NASA		Tokay, Ali	Pending
The Global Ecosystem Dynamics Mission (GEDI)		Dubayah, Ralph	Hall, Forrest	Pending
The representation of PBL physics in mesoscale models with applications to air quality and wind resource modeling in the Mid-Atlantic	NASA	Sparling, Lynn	GRA Baker, Barry	Pending
Urbanization and Environmental Changes in Developing Countries	NASA		Chu, Allen	Not Funded

Proposal Title	Funding Agency	PI (JCET)	CO-I(s) (JCET)	Status
Use of the Pandora Spectrometer Network to Validate NPP/OMPS, AURA/OMI, AURA/MLS Ozone Column Amount and Profiles and OMI Trace Gases (NO2, HCHO, BRO	NASA	Herman, Jay		Pending
GOES-R air quality data distribution system	NOAA	Zhang		Awarded
Central Greenland Temperatures 1978-2015 - Combination and Calibration of Satellite and AWS Records for Climate Trends and Model Validation	NASA	Shuman, Christopher		Pending
Collaborative Research: Hydrological and thermal regimes as drivers of ecosystem change in Alaskan tundra: the 2nd generation manipulation	NSF	Huemmrich, Fred		Not Funded
Dimensions: An integrated cross-scale analysis of the physical, biological and chemical context of forest diversity	NSF	Campbell, Petya	Huemmrich, Fred	Pending
Interannual Variability of Fundamental Global and Monsoonal Water Cycles using Satellite-based Estimation of Precipitation and Evaporation	NSF		Mehta, Amita	Pending
Direct Remotely Sensed Quantification of Light Use Efficiency and GPP in North America	Ohio State University (NASA)	Hall, Forrest		Pending
Evaluation of differences between Dobson and Brewer ozone measurements specific to calibration scheme	U of Colorado, Boulder (NASA)	Herman, Jay		Pending
New CO and O3 Products for Climate and Air Quality Studies Using Data Fusion from Multiple Sensors on A-train Satellites	UMCP (NASA)	Tangborn, Andrew		Pending

Proposal Title	Funding Agency	PI (JCET)	CO-I(s) (JCET)	Status
Waste Dumping in Drainage Channels in Port-au-Prince, Haiti: A Method for Floating Trash Separation During Periods of Storm Water Flow	USAID	Bulmer, Marko		Pending
STEM Innovation Incubator	USDE	Hoban, Susan		Pending

This page intentionally left blank.

III.8 Biographies

This page intentionally left blank.

JCET Highlight: 2012 NASA Distinguished Public Service Medal
Investigator: Dr. Raymond Hoff

On August 2, 2012, NASA held the 2012 Agency Honor Awards Ceremony. Dr. Hoff, JCET's Science Advisor and Professor of physics, was one of the honorees. Dr. Hoff received the Distinguished Public Service Medal (DPSM). The award represents NASA's "highest form of recognition that is awarded to any non-Government individual or to an individual who was not a Government employee during the period in which the service was performed, whose distinguished service, ability, or vision has personally contributed to NASA's advancement of United States' interests," according to the agency's website. Hoff received the medal "for distinguished service and leadership in Earth observations and their application for societal benefit." Photo: NASA.

This page intentionally left blank.

Dr. William Barnes is a Senior Research Scientist with the Joint Center for Earth Systems Technology, University of Maryland, Baltimore County and an emeritus research scientist with the Sciences Exploration Directorate of NASA's Goddard Space Flight Center. He served as the MODIS Sensor Scientist and a member of the MODIS Science Team for more than 12 years. He led the MODIS Characterization Support Team (MCST) for more than two years and was NASA's representative on the National Polar Orbiting Environmental Satellite System's Joint Agency Requirements Group (NPOESS/JARG) for more than five years. He has over thirty years' experience in the development and radiometric calibration of Earth-observing imaging radiometers, including TIROS/AVHRR, AEM-1/HCMR, NOSS/CZCS-2, OrbView-1/SeaWiFS, TRMM/VIRS, EOS/MODIS and NPP/VIIRS.

Mr. Timothy Berkoff is an Assistant Research Engineer at the Joint Center for Earth Systems Technology, University of Maryland, Baltimore County. He has more than 15 years of experience in the development of optical instrumentation for remote sensing applications and has served as the instrument manager for NASA's Micro-Pulse Lidar Network, a global network of lidar systems to provide long-term observations of aerosols and clouds. Mr. Berkoff's research background includes lidar, fiber-optic sensing techniques, interferometry, spectroscopic gas detection, tunable diode lasers, optical design, opto-electronics, and optical diagnostics. This includes the successful demonstration of new sensor technology on aircraft and as well as surface and submersible ships in various field campaigns. He has more than 20 peer-reviewed publications, numerous conference proceedings, and is an inventor on two patents in the field of optical sensing. Mr. Berkoff obtained a B.S. in Optics from the University of Rochester.

Dr. Huisheng Bian received a B.S. in atmospheric science from Nanjing University in 1985, a M.S. in 1988, and a Ph.D. from University of California, Irvine in 2001. From 1988 to 1995, she worked in Chinese Meteorological Academy as an assistant researcher, where her research interest was regional air quality modeling. Her Ph.D. work focused on improving, validating, and applying UCI global chemistry transport model for tropospheric ozone simulation, as well as on developing a module (Fast-J2) to accurately simulate stratospheric photolysis in global chemistry models. Upon graduation, Dr. Bian became interested in atmospheric aerosols, their distribution and their photolytic and heterogeneous impacts on tropospheric chemistry. Her current major research interest involves improving aerosol simulation, particularly nitrate aerosol and secondary organic aerosol, and applying multiple CTMs to the atmospheric chemistry studies.

Dr. Roberto A. Fernandez Borda received his Master's degree in Physics in 1996, from the University of Buenos Aires (UBA), Argentina, working in the development of a Solar Hard X ray sensor which was part of the payload of the first Argentinian Satellite, Sac-B. In 1997, he received a graduate-fellowship to finish his Ph.D at the Institute of Astronomy and Space Physics at UBA. During this period, under the framework of an international agreement with the Max Plank Institute for Extraterrestrial Physics, Germany, he was involved in the instrument automation and the calibration algorithms of a new H-alfa telescope for Solar Physics. As a result of his work, he obtained his PhD in 2001 in Physics/Applied Physics from UBA. In 2002, he got a Post-Doctoral fellowship from the National Research Council, United States, to work at the Planetary Physics branch of NASA GSFC. He was involved in the instrumental development of flux magnetometers for planetary applications (Ares Mission), as well as signal processing algorithm designs for their onboard calibrations and data analysis (Wind and Voyager Missions). In 2006, he became part of the Goddard Earth Sciences and Technology Center, University of Maryland Baltimore County (UMBC), working in the Climate and Radiation Branch of NASA GSFC. As a member of this team, he was involved in different instrumental projects: the Particles Aerosols & Cloud Physics Suite (PACS), the Cloud Scanner Cube-sat, and many field experiments: Milagro campaign (Mexico), Co-Claim Campaign (Brazil), and Vocals Campaign (Chile). In 2009, he received an award from the Climate and Radiation branch of GSFC for his contributions to the optical design of PACS and the Rainbow Camera. In 2010, he joined JCET as a Research Assistant Scientist.

Dr. Mark Bulmer has 17 years of experience in pure and applied fields of geology, remote sensing, GIS, emergency management plus instrument design. He became a NATO Civil Expert on Civil Protection and in 2011 contracted to the Institute for Water Research at the US Army Corps of Engineers. He has taught undergraduate and graduate courses in Natural Hazards, Geomorphology and Planetary Geology. He is an expert in geophysical flows combining field derived measurements with remotely sensed data and emergency management. He has led or participated in over 30 major field tests, campaigns and responses to natural disasters working on land (volcanoes, mountains, deserts and glaciers), at sea, or in the air. He has experience as project and team leader, chief instructor, assessor and planner. He has worked in real, synthetic and simulated environments. In the field, he has worked in Haiti, Nepal, Taiwan, Italy, Spain, Peru, New Zealand, Pakistan, Morocco, Iceland, North America and the UK. This has involved collaborations with government and international agencies (e.g. UN, UNHCR, DFID/UKAID, USAID, World Bank) and non-government organizations (e.g. Red Cross, Oxfam, CRS, MercyCorps). Dr. Bulmer has installed prototype hazard monitoring systems on the Hubbard Glacier in Alaska, in the Sierra Nevadas in USA, mountain slopes in eastern Nepal, around Muzaffarabad in Pakistan and in the Peruvian rain forest. He has an on-going collaboration with emergency medical teams to examine the nature and survivability of injuries sustained in landslide disasters.

Dr. Petya K. Entcheva Campbell received a BS in Forestry from the Academy of Forest Engineering, Sofia, Bulgaria in 1988, MS in Forest Sylviculture and Ecology from the University of Massachusetts at Amherst, MA and a Ph.D. in Natural Resources Management / Remote Sensing in 2000 from the University of New Hampshire, Durham, NH, where her research focus was on the development of remote sensing techniques for forest health assessment. In 2000, Dr. Petya Entcheva Campbell joined NASA as a NRC associate and worked at Goddard Space Research Center for two years before joining JCET/UMBC where she is currently employed. Her experience and expertise are in remote sensing for natural resources (PhD), with a specific interest in remote sensing, especially spectral analyses and assessments for the development of methods (algorithms and measurement techniques) for vegetation stress assessments and land cover change detection. Dr. Campbell started work in this direction as a post-doctoral research associate of Dr. Middleton at NASA/GSFC, and later continued as a Prime Investigator on a NSF project for the "*Evaluation of vegetation Solar Chlorophyll Fluorescence properties"*. Of high interest to this end is the currently under development at ESA FLEX mission, which targets the assessment of solar exited ChlF. At GSFC she participates in the NASA's "*Light Use Efficiency and Carbon Science"* research led by Dr. Middleton and has participated in the development of the satellite hyperspectral mission/s *Flora/SpectraSat/HyspIRI* for vegetation assessment led by Drs. Green, Ungar and Asner. Currently, she is a part of a research effort to develop spectral bio-indicators of vegetation stress, to facilitate the remote sensing assessment of vegetation photosynthesis and carbon sequestration. As part of the spectral research she has used various spectrometers and simulated/compared the abilities of the currently available earth observing sensors for vegetation stress detection. Currently, she participates in an EO-1 Hyperion data intercalibration and analysis effort, with the goal to compare existing and suggest new land cover products, addressing vegetation type and function. At the University of Maryland, Baltimore County (UMBC) Dr. Campbell teaches the class “Introduction to Remote Sensing for Environmental Applications” for undergraduate and graduate students at the Department of Geography and Environmental Systems (GES).

Ms. Valerie Casasanto is Program Coordinator for the University of Maryland, Baltimore County’s Joint Center for Earth Systems & Technology (JCET) since 2005. In addition, Ms. Casasanto is Principal Investigator for the NASA ROSES Education and Public Outreach (E/PO) award, Beautiful Earth: Experiencing and Learning Science in a New and Engaging Way (beautifulearth.gsfc.nasa.gov) engaging students and the general public in NASA Earth Science through music, art, and indigenous perspectives. Ms. Casasanto has more than 20 years of experience in designing, managing and implementing small and large-scale earth and space science educational programs to diverse age groups in multicultural environments. She has successfully managed and integrated student designed and PI science microgravity payloads on 15 space missions. Ms. Casasanto is a graduate and former employee of the International Space University (ISU), where she organized summer programs in a different host country each year. Ms. Casasanto is an active member and Vice-Chair of the International Astronautical Federation (IAF) Space Education and Outreach Committee (since 2002), member of GSFC’s Education Implementation Team (since 2006), and member of GSFC’s Native American Advisory Committee (since 2008).

Dr. Hyoun-Myoung Cho obtained a B.S. (1999) and M.S. (2002) in Atmospheric Sciences from Seoul National University. He then worked at Forecast Research Lab in National Institute of Meteorological Research, Korea as an assistant researcher. Dr. Cho received a Ph.D. from Texas A&M University in December 2011. In Jan. 2012, he joined the Joint Center for Earth Systems Technology at UMBC, where he works on the development of infrared cloud property retrieval algorithm with Dr. Zhibo Zhang.

Dr. D. Allen Chu received a BS in Atmospheric Sciences from the National Taiwan University in 1982 and a Ph.D. in Atmospheric Sciences from Georgia Institute of Technology. In 1989, he joined ISAMS (Improved Stratospheric and Mesospheric Sounder) team at NASA Langley Research Center where he worked on the ozone and nitric acid retrievals using ISAMS measurements as well as radiance simulations using line-by-line/broadband radiative transfer models. In 1996, he was recruited by MODIS (Moderate Resolution Imaging Spectroradiometer) aerosol team at NASA Goddard Space Flight Center to work on MODIS aerosol retrieval and lead quality assurance for the MODIS atmosphere products. In 2004, he joined the JCET of UMBC as an associate research scientist. Since then, he has been heavily involved in a number of projects including the application of MODIS AOD to air quality, evaluation of aerosol radiative forcing in a number of field campaigns to study of dust radiative and microphysical process on precipitation and energy budgets over the tropical Atlantic Ocean, and intercomparison of model (e.g., GOCART, GEOS-CHEM, and CMAQ) and MODIS-derived aerosol properties. In 2007, he joined the GEST to continue his researches. He served as a PI of NASA INTEX-B, NAMMA, and ARCTAS programs, and EPA AMI pilot project, as well as UMBC PI of DISCOVER-AQ and AirNow.

Dr. Marcianna P. Delaney received her B.S. in Marine Biology with a concentration in Physics at the University of North Carolina in Wilmington in 1994. She earned her M.Sc. and Ph.D. in Biological Oceanography at Memorial University of Newfoundland in St. John's, Newfoundland. Her graduate research for both degrees focused on the effects of small-scale turbulence on the marine microbial food web of a cold-ocean environment. She has turned her love of science into a career with the GSFC Office of Education as a scientist on staff. Dr. Delaney serves as the GSFC Digital Learning Network Team (DLN) Lead, in which she designs STEM content for interactive videoconferencing, actively teaches to students and teachers across the United States, and establishes partnerships across NASA for additional STEM collaboration on projects for e-Education. In addition to her extensive experience with teacher professional development, she is currently designing an on-line synchronous and asynchronous STEM PD course with blended schools.net utilizing NASA science and engineering content.

Dr. Ruben Delgado is a Faculty Research Assistant in JCET. He received a Ph.D. In Chemistry from the University of Puerto Rico in 2011, for his dissertation work entitled "Observations and Modeling of Sporadic Metal Layers over the Arecibo Observatory." He joined JCET as a Research Associate in November 2006. Currently, he is working with the Atmospheric Physics Group at UMBC, under the supervision of Dr. Raymond M. Hoff, in research involving active atmospheric measurements of atmospheric aerosols and gases with LIDAR.

Dr. Sergio DeSouza-Machado obtained a B.A. from the College of Wooster, OH in 1988, and an M.Sc and Ph.D. in 1990/1996 from the University of Maryland at College Park (Plasma Physics). After this, he joined the Atmospheric Spectroscopy Laboratory at the University of Maryland, Baltimore County in September 1996. He has developed kCARTA, a package that rapidly computes monochromatic absorption spectra, radiances and jacobians, and does scattering and NonLTE computations. In addition, he has developed a line-by-line code that includes CO2 P/R linemixing and water continuum corrections. His current research work is on retrievals of dust heights and optical depths, radiative transfer codes and trace gas retrievals. Dr. DeSouza-Machado also actively participates in teaching Physics classes, at both the undergraduate and graduate levels.

Mr. Keith Evans received a B.S. in Nuclear Science from Virginia Polytechnic Institute and State University in 1979, a M.S. in Physics from American University in 1984 and a M.S. in Meteorology at the University of Maryland in 1997. He has worked as a physicist on solar energy systems, submarine systems, and cruise missiles at the Vitro Corp. He has worked on the first Special Sensor Microwave Imager (SSM/I) instrument, on satellite subsystems testing, and in acoustics as a contractor at the Naval Research Laboratory. He wrote the software to retrieve data from the Broad Band X-ray Telescope, which flew on the Space Shuttle as a contractor at NASA/Goddard Space Flight Center and he received two Group Awards for this effort. Mr. Evans began working with LIDAR in 1991, performing various atmospheric studies, including: atmospheric temperature, spectral and multi-fractal analyses of atmospheric water vapor data. He is currently employed by the Joint Center for Earth Systems Technology of the University of Maryland Baltimore County as a Research Analyst. His current tasks include maintaining the volcanic so2 web pages and scientific programming and data analyses of GPS and ILRS and NASA satellite data.

Dr. Elena M. Georgieva received her PhD in physics in 1998 from the University of Sofia. She was a research associate at Lasers and Optical characterization Laboratory, Georgetown University where she worked on nanoparticles characterization and correlation spectroscopy (2000-2001). Georgieva also was a research associate at NIST Center for neutron research and Johns Hopkins University (2001-2002). For four years, she was a Senior Systems Scientist/Engineer at Science systems and Applications, and worked at Goddard Laser and Electro-optics branch on instrument development for measurement of atmospheric species (2002-2006). She has research experience in remote sensing, data analysis and validation, instrument development, spectroscopy, interferometry, 3-D imaging laser radar system and polarimetry. Previous positions held by Georgieva include Assistant Professor at the Institute of Applied Physics, Technical University of Sofia; Bulgaria (1995 - 1999); Graduate Research Assistant, Department of Physics, University of Sofia (1988 - 1994); Research Associate, Institute of Applied Mineralogy, Bulgarian Academy of Sciences, Sofia (1987-1988). She has authored 28 refereed publications and is a member of the Optical Society of America and The International Society for Optical Engineering (SPIE). In July 2010, she transferred from GEST to JCET.

Dr. Forrest Hall a physicist, currently with the University of Maryland, Baltimore County, is located at the Goddard Space Flight Center, in the GSFC/UMBC Joint Center for Earth Systems Technology. Dr. Hall has been active since 1980 in global change research using earth-observing satellites to monitor human-induced and natural changes to the earth's land ecosystems and the effects those changes have had on the earth's climate. He has authored or co-authored 60 scientific papers on satellite monitoring, the global carbon cycle and climate change. In addition to many other awards, in 2009 Dr. Hall received the William T. Pecora Award recognizing outstanding contributions toward understanding the Earth by means of remote sensing, and the Career Achievement Award from the Canadian Remote Sensing Society. Dr. Hall has a BS in Mechanical Engineering from the University of Texas, and an MS and PhD in Physics from the University of Houston.

Dr. Jeffrey B. Halverson has traveled the world's tropical latitudes to better understand how intense storms of rain and wind develop and intensify. He has conducted research in Brazil, Australia, the South China Sea, Costa Rica, the Marshall Islands, West Africa and various locations in the Caribbean studying tropical weather systems. His research examines the atmospheric factors that cause hurricanes to rapidly change intensity. In 2001, he helped pioneer a new aircraft-based, upper atmospheric measuring system to take direct measurements in the eye of a mature hurricane from an altitude of 70,000 feet. Dr. Halverson is currently an Associate Professor of Geography at the University of Maryland Baltimore County (UMBC). He also serves as Associate Director-Academics at the Joint Center for Earth Systems Technology (JCET), a cooperative institute between NASA and UMBC. He also served as Deputy Project Manager at NASA Headquarters, where he managed NASA field programs to investigate hurricanes in 2005 and 2006. Dr. Halverson has authored more than 28 professional papers and writes a monthly column on severe and unusual weather for *Weatherwise Magazine*. He is currently examining the extra-tropical transition of hurricanes making landfall over the Mid Atlantic.

Dr. Shin-Chan Han received a Ph.D. (2003) and a MS (2000) in Geodetic Science from Ohio State University (OSU), Columbus, OH, and a BS (1998) in Earth Science from Seoul National University, Seoul, Korea. His MS thesis is on absolute point positioning from Global Positioning System (GPS) and Ph.D. dissertation is on the global and regional gravity recovery from satellite tracking data and geophysical applications. He worked for two years as a Postdoctoral Research Associate at the Space Geodesy and Remote Sensing Laboratory at OSU and for one year as a Research Scientist at the School of Earth Sciences as OSU. During this period, he made several invited talks on Earth gravity field at various institutions and universities. In 2006, he joined the Planetary Geodynamics Laboratory at NASA Goddard Space Flight Center and GEST at UMBC, as a member of the research faculty; in 2011, he joined JCET at UMBC. He has been publishing papers on gravity estimation theory, coseismic and postseismic deformation, hydrological mass variation over the large river basins, ocean tides in polar regions, GPS/INS, and gravity gradiometry.

Mr. Scott Hannon received his BA and MS in physics at UMBC, and stayed on as a research assistant with Dr. Strow since 1991. His work has primarily focused on the development of fast radiative transfer algorithms for AIRS and other infrared spectrometers.

Dr. Jay Herman received an MS in physics from Clarkson College in Potsdam, New York in 1959 followed by PhD at Pennsylvania State University in 1965. He then worked for NASA until September 2009 followed by an appointment to JCET. The current primary focus of his research is the continuing development of the Pandora spectrometer system deployed for satellite validation and for developing a long-term climate data record of cloud amount and its change since 1979. Previously, he was Project Scientist for the Triana mission 1998 - 2009, and the Principal Investigator for NASA's Meteor-3/TOMS mission. During this time, he published extensive studies of UV radiation, aerosol amounts, and ozone distribution. Prior to working on the TOMS series of instruments he developed the first complete photochemical model of the Earth's atmosphere. He has extensive experience in radiative transfer for visible and UV radiation. Dr. Herman currently has 133 peer-reviewed articles in scientific journals.

Dr. Susan Hoban is JCET’s Associate Director, Academics, Prior to joining JCET, Dr. Susan Hoban was a Senior Research Scientist at GEST. She received her Ph. D. in astronomy from the University of Maryland in 1989. She conducted research in cometary science at NASA Goddard Space Flight Center, first as a National Research Council fellow, then as part of USRA Visiting Scientist Program, from 1989 - 1993. In 1993, she began working on information systems for science and education. In 1996, Dr. Hoban received the NASA Special Service Award for her work on web-based educational outreach. She joined UMBC's Computer Science and Electrical Engineering Department in 1996 as part of the Center of Excellence in Space Data and Information Science (CESDIS) at Goddard. From 1998-99, Dr. Hoban served as Acting Associate Director of CESDIS and from 1999 through the conclusion of CESDIS in 2000 as Acting Director. Her interests include scientific information systems, and information technologies for science, technology, engineering and mathematics (STEM) education. Dr. Hoban is the PI on the NASA's BEST Students (Beginning Engineering, Science and Technology) project that provides professional development for educators and curriculum support resources with a space exploration theme for engineering clubs for elementary and middle school students. The project also hosts engineering challenges and two-week summer bridge programs centering on lunar exploration for middle and high school students. She has a particular interest in contributing to our nation's educators' understanding of STEM subjects. She serves on the STEM Council at UMBC and on the STEM Advisory Council for Anne Arundel County Public Schools. Dr. Hoban's research interests include scientific information systems, and information technologies for science, technology, engineering and mathematics (STEM) education. She has a particular interest in contributing to the STEM foundation of our nation's K-12 educators.

Dr. Ray M. Hoff is a Professor of Physics at the University of Maryland, Baltimore County. He is the Science Advisor for the Joint Center for Earth Systems. Dr. R.M. Hoff has 37 years of experience in atmospheric research. His research interests are in the optical properties of aerosols and gases in the atmosphere. Dr. R.M. Hoff has been central in formulating major research programs on Raman, differential absorption, airborne and spaceborne lidar, volcanic emissions, atmospheric transport of toxic chemicals to the Great Lakes, atmospheric visibility, Arctic Haze, and dispersion of pollutants. He has led or participated in over 20 major field experiments. He is the author of 99 journal articles and book chapters, 97 other refereed works and numerous public presentations of his work. Dr. R.M. Hoff obtained a Bachelor of Arts degree in Physics at the University of California Berkeley in 1970 and a Ph.D. in Physics from Simon Fraser University in 1975. He has conducted research at UMBC, Environment Canada, NASA Langley Research Center, the Jet Propulsion Laboratory, and the National Oceanographic and Atmospheric Administration's Environmental Research Laboratories. Dr. R.M. Hoff was a member of the Science Advisory Group for the NASA Laser In-Space Technology Experiment (LITE), a space shuttle experiment. He was a member of a proponent team for a spaceborne Differential Absorption Lidar (DIAL) involving NASA, the Canadian Space Agency and the Meteorological Service of Canada. He is also a science team member on the ESSP-2 spaceborne lidar, named CALIPSO. He was a member of the International Radiation Commission International Coordination Group on Laser Atmospheric Studies (ICLAS), the American Meteorological Society Committee for Laser Atmospheric Studies (CLAS) and the Stratospheric and Upper Tropospheric Aerosol focus of the International Global Aerosol Program (SUTA/IGAP/IGAC). He was Rapporteur for Long Range Transport on the WMO Executive Committee Panel of Experts/Commission of the Atmospheric Science Working Group on Environmental Pollution and Atmospheric Chemistry. He was a member of the Science Advisory Group on Aerosols to the Commission of the Atmospheric Sciences of the World Meteorological Organization. He served on a National Academy of Sciences/National Research Council Panel on Mesoscale Meteorological Observations for Multiple National Needs. He is the Chair of the NASA Applied Sciences Advisory Group and is a member of the Earth System Science Advisory Panel for the agency. Recently, he has become an external science committee member on the European Commission's ACTRIS project. He has had committee and peer-review roles at NASA, NOAA, DOE, DOD, CSA, EPA, Environment Canada, and the European Economic Community. He has held memberships in six scientific societies and served as Chairman of committees for those societies. In 2008, he became a Fellow of the American Meteorological Society. In 2012, he was awarded the NASA Distinguished Public Service Medal.

Dr. Karl Fred Huemmrich received a B.S. in physics from Carnegie-Mellon University in 1977 and a Ph.D. In Geography from the University of Maryland, College Park in 1995. In 1978 he began working as a NASA contractor at Goddard Space Flight Center, initially as operations analyst on the satellite attitude determination and control. Later he provided programming and analysis support of passive microwave remote sensing data of sea ice, where he was task leader. In 1987, he joined the team for the First International Satellite Land Surface Climatology Project Field Experiment (FIFE), a multidisciplinary field experiment on the Kansas prairies. Following the completion of FIFE, he worked on the Boreal Ecosystem and Atmosphere Study (BOREAS), a field experiment in the Canadian boreal forests. Dr. Huemmrich was the assistant Information Scientist on these experiments and has experience in the development and operation of interdisciplinary information systems in support of large field experiments. He has developed and used models of light interactions with vegetation, has studied the use of remotely sensed data to collect information on biophysical variables using both computer models and field measurements concentrating on uses of bidirectional and hyperspectral reflectance data. He has performed field work in a variety of habitats including arctic and sub-arctic tundra, boreal and temperate forests, croplands, prairies, and deserts.

Dr. Breno Imbiriba received his B.Sc. degree in 1997 from the Universidade Federal do Para (UFPA), Belem, Brazil. In 1999, he received his M.Sc. degree in Theoretical Physics from the Instituto de Fisica Teorica (IFT), Sao Paulo, Brazil. In 2007, he received his Ph.D. in Physics from the University of Maryland at College Park (UMCP). His research was on numerical simulation of binary black hole collision and gravitational wave extraction. Since Fall 2006, he has been a Research Associate at the Joint Center for Earth Systems Technology (JCET) at the University of Maryland, Baltimore County (UMBC), in Baltimore, MD. His research interests are on remote sensing studies of atmospheric trace gases retrieval, trace gases climate record, climate change and numerical modeling. From August 2010 to March 2012, he was a Visiting Professor at UFPA-Brazil where his research was on thermal infrared remote sensing techniques for Tropospheric CO2 Retrieval, and on land use change in the Amazon Region. Presently Dr. Imbiriba is a Postdoctoral Research Associate at JCET.

Dr. Benjamin Johnson received his Bachelor of Science degree in Physics from Oklahoma State University in 1998, a Master of Science degree in Atmospheric Sciences from Purdue University in December 2001, and completed his Ph.D. degree in December 2007 from the University of Wisconsin—Madison. He is currently an Assistant Research Scientist in JCET. His research interests cover a broad spectrum of precipitation cloud modeling, radiative transfer, cloud microphysics, and radar/radiometer remote sensing from air, space, and ground. Dr. Johnson is focusing on combined dual-frequency radar and multi-channel radiometer retrievals of frozen and mixed-phase precipitation at microwave frequencies in the 10 to 340 GHz range, with a focus on the upcoming Global Precipitation Measurement (GPM) and ongoing CloudSat missions. He is a member of the GPM radiometer algorithm team, combined radar/radiometer algorithm team, and is a member of several working groups, including the International Precipitation Working Group (IPWG), and is actively involved in developing improved retrieval algorithms for measuring falling snow using passive microwave and radar remote sensing methods.

Dr. Ilan Koren received his degrees from the Department of Geophysics and Planetary Sciences in Tel Aviv University, Israel. He received his Ph.D with distinction in 2002 where his major research interest was on spatial and temporal patterns in clouds and aerosols. He joined NASA's MODIS aerosols team –as a National Research Council (NRC) fellow and received two awards for Best Senior Author Publication for his work on cloud-aerosol interaction. In summer 2004 he joined JCET as an Assistant Research Scientist. His research interests include remote sensing and modeling of clouds and aerosols, the role of aerosols on climate, and the impact of aerosols on the lifecycle and optical properties of clouds.

Dr. Prasun K. Kundu received a B.Sc. (with honors) in Physics from Calcutta University, India in 1974 and an M.Sc. in Physics from the Indian Institute of Technology, Kharagpur, India in 1976. He then joined the High Energy Physics Group at the University of Rochester in New York where he earned his Ph.D. degree in 1981 in theoretical physics for his work on a new class of exact and asymptotic solution the Einstein field equations of general relativity. During 1980-82 he was a postdoctoral research associate at the Enrico Fermi Institute, University of Chicago and subsequently during 1982-85 he was an instructor at the University of Utah, Salt Lake City. In 1985 he joined the Department of Physics and Astronomy at Ohio University, Athens, an assistant professor where he taught a variety of graduate and undergraduate courses in Physics and continued research in relativistic gravitation theory. Since 1992 he has worked at the Climate and Radiation Branch, GSFC on various aspects of rainfall statistics related to Tropical Rainfall Measuring Mission (TRMM) and other satellite and ground based remote sensing measurements of precipitation. For his work he received an exceptional scientific support award in 2000. Dr. Kundu is currently a research associate professor at JCET, UMBC. He has taught graduate level physics courses in thermodynamics and statistical mechanics at UMBC and Johns Hopkins Applied Physics Laboratory. His past work in collaboration with Dr. T. L. Bell at GSFC involves theoretical development of stochastic dynamical models of precipitation and their application to rainfall sampling problem. He has recently co-supervised the Ph.D. dissertation of Mr. R.K. Siddani, a graduate student at the Mathematics and Statistics Department, UMBC, leading to the discovery of a novel type of probability distribution governing the statistics of rainfall.

Dr. Jae N. Lee received a BS in Physics from Yonsei University, Seoul, Korea and a PhD in Marine and Atmospheric Science from Stony Brook University in 2008. The primary focus of her research activities has been in the application of remote sensing observations to climate studies, with particular emphasis on the sun-climate connections. Her current research interests include TSIS observation of total and spectral solar irradiance, analysis of solar irradiance variability, and its impact on earth’s climate. She uses numerical models of the sun and earth’s atmosphere as well as remote sensing observations to investigate solar activities, climate variability and their interconnections. During her NASA NPP fellow years at JPL, she found interests in remote sensing of cloud and aerosol to addressing the climate change from both the natural and anthropogenic effects, especially in the Arctic region.

Dr. J. Vanderlei Martins received a Bachelor’s degree in physics in 1991, a Master’s degree in physics/nuclear applied physics in 1994, and a Ph.D. in physics/applied physics in 1999 from the University of Sao Paulo (USP), Brazil. He joined the Group of Air Pollution Studies at the Institute of Physics (USP) in 1990, and conducted research in environmental and atmospheric applied physics. In particular, he developed analytical nuclear techniques using particle accelerators for material analysis, including aerosols and tree-rings, and participated in several ground-based and aircraft field experiments studying properties of aerosols from biomass burning and biogenic emissions. He was a member of the University of Washington, Department of Atmospheric Sciences, Cloud and Aerosols Research Group, from November 1995 to August 1996, and of the NASA GSFC Climate and Radiation Branch from August to December 1996, both as a Visiting Scientist. He taught at the University Sao Judas Tadeu between 1998 and 1999 while conducting research at the University of Sao Paulo. After starting his postdoctoral work at the University of Sao Paulo, he joined JCET in December 1999 as a Visiting Assistant research Scientist. He has authored and co-authored over 25 refereed papers and has given over 60 presentations in international conferences, the most recent being on the spectral absorption properties of aerosol particles, on the measurement of the vertical profile of cloud microphysical and thermodynamic properties, and on the development of new instrumentation for the measurement of aerosol and cloud particles. He served as elected member of the International Radiation Commission from 2001-2008. In 2006 he assumed an Associate Professor position in the Department of Physics of the UMBC, while keeping his affiliation with JCET.

Dr. Amita Mehta joined JCET as a research scientist in May 2000. Dr. Mehta obtained her M.Sc. in Physics from Gujarat University, India in 1982, and obtained her Ph.D. in Meteorology from Florida State University in 1991. After completion of her Ph.D., Dr. Mehta worked as a research scientist in the Sounder Research Team (SRT) at Goddard Space Flight Center until August 2001. Since then Dr. Mehta has been working in the Mesoscale Atmospheric Processes Branch as a research scientist, and is an affiliated assistant professor in the Department of Geography and Environmental Sciences, UMBC. Her interest and expertise are in satellite remote sensing of geophysical parameters and their analysis to understand climate and its variability.

Dr. William Olson received an AB in Physics from Cornell University in 1978 and a Ph.D. in Meteorology from the University of Wisconsin-Madison in 1987. The primary focus of his research activities has been in the field of satellite microwave radiometry, with particular emphasis on the remote sensing of precipitation and latent heating distributions. In 1987 he developed the first minimum variance approach for the physical retrieval of rain distributions from satellite microwave data. He later designed, with Dr. William Raymond, a method for assimilating latent heating estimates from SSM/I into numerical weather prediction model forecasts, and more recently collaborated with scientists at NCEP and NASA to assimilate precipitation distributions into global models. His current work involves the development of combined radar-radiometer methods for estimating precipitation and latent heating vertical structure, and the creation of a satellite-based, atmospheric diabatic heating record for evaluating climate models and closing the atmosphere's energy budget.

Dr. Ana I. Prados is a Research Assistant Professor at the Joint Center for Earth Systems Technology, University of Maryland Baltimore County. She has a Ph.D in Chemistry and is also currently a candidate in Public Policy at the University of Maryland, College Park. Her main research expertise is the application NASA imagery for monitoring air pollution and the development of web-tools for access to NASA Earth Science data. Dr. Prados also currently coordinates and conducts remote sensing education and public outreach workshops for the NASA Applied Sciences Program, where she teaches the application of satellite imagery to environmental decision-making activities related to air quality, water resources management, and climate.

Dr. Lorraine Remer spent 21 years at the NASA Goddard Space Flight Center involved in the remote sensing of aerosol and the use of remote sensing data for the study of aerosols in climate processes, how aerosol particles affect clouds, aerosol transport and particulate air pollution. Her first position at Goddard in 1991 was in the role of a support scientist, employed by Science Systems and Applications, Inc. (SSAI), where she contributed to the development of the MODIS aerosol algorithms. In 1998 Dr, Remer joined the Federal civil service, and in 2012 she left NASA to become a part of JCET. Dr. Remer has been a member of NASA's MODIS, CloudSat/CALIPSO, NPP, Glory and Global Aerosol Climatology Project Science Teams. She has contributed to the U.S. Climate Change Science Change Program (US CCSCP) and to the WMO International Task Force on Hemispheric Transport of Air Pollution (HTAP). She has contributed leadership to more than 12 major field experiments and has over 120 publications in the refereed literature. Her Ph.D. is from the University of California, Davis (U.C. Davis) in Atmospheric Science (1991). She also has a M.S. in Oceanography from the Scripps Institution of Oceanography, University of California, San Diego and a B.S. in Atmospheric Science from U.C. Davis.

Mr. Paul Schou received a B.A. from Michigan Technology University in Physics in 2006 and currently is working on finishing his M.S. in Atmospheric Physics at UMBC. His research interests include retrieving atmospheric profiles from 600 mb to the surface from various skydiving sites, as well as collocating AIRS and IASI radiance data with ECMWF geophysical fields.

Dr. Chung-Lin Shie received a B.S. in Atmospheric Sciences from National Taiwan University, an M.S. In Meteorology from Pennsylvania State University and a Ph.D. in Meteorology from Florida State University. He started working at NASA/GSFC as a research scientist since February 1993, affiliated first with SSAI (as Research Meteorologist till February 1997, then Senior Research Meteorologist till March 2001), and then as Associate Research Scientist with UMBC/GEST (in April 2001) before joining UMBC/JCET in May 2011. During his early career, Dr. Shie had played a crucial role in assisting his late mentor Dr. S.-H. Chou successfully establishing their pioneering project in producing GSSTF (Goddard Satellite-based Surface Turbulent Fluxes) datasets. The GSSTF1 and GSSTF2 datasets were thus distributed by NASA GES DISC in 2000 and 2001, respectively. Dr. Shie has resumed the GSSTF project since early 2008 by winning a NASA MEaSUREs proposal. He and his collaborators have thus successfully developed and issued a series of improved air-sea turbulent fluxes datasets, i.e., GSSTF2b, GSSTF2c, and GSSTF3 in Oct 2010, Oct 2011, and June 2012, respectively. Dr. Shie has been involved in diverse research interests and projects. One in particular involved in research projects performing numerical simulations (using the GCE model) and scientific analysis for studying radiative-convective systems and their interactions with large-scale environment. Other NASA projects include (i) TCSP and EOS: investigating the Saharan Air Layer (SAL) impacts on Atlantic hurricane formation and intensification; (ii) NAMMA: focusing on the SAL's dust impact, yet more on regional storm systems; (iii) NEWS: using GCE model simulations to build up look-up tables for improving satellite latent heating profile retrieval. In 2006, Dr. Shie won a "Meritorious Service Award" from COAA for his genuine performance serving as one of the COAA Board Directors during 2003-2004. He also won the "Annual Outstanding Performance Award" of Mesoscale Atmospheric Processes Branch, NASA/GSFC twice in 2000 and 2004, respectively, as well as won an "Outstanding Mentoring Award," and "Academic Apportionment Funds" (twice) from UMBC in 2003, and 2007/2010, respectively. During his association with SSAI (1993-2000), he won Annual Performance Awards eight years in a row.

Dr. Christopher A. Shuman joined JCET in May 2007 as Associate Research Scientist. He is currently working with Dr. David J. Harding, Planetary Geodynamics Branch, NASA GSFC, on enhanced laser altimetry concepts for cryospheric science. From 2001-2007, he was a Physical Scientist with the Cryospheric Sciences Branch, and the Deputy Project Scientist for the ICESat Mission (2001-2005), as well as an Adjunct Research Faculty, ESSIC, University of Maryland, College Park (UMCP). From 1999-2001 he was an Assistant Research Scientist, Earth System Science Interdisciplinary Center, UMCP. For four years he worked with Dr. Robert Bindschadler at NASA GSFC's Oceans and Ice Branch, first, from 1994-1996 as a Resident Research Associate through the National Research Council; second, from 1996-1998 as a Visiting Research Fellow with the Universities Space Research Association. From 1992-1994, he was a Research Associate at the Earth System Science Center and Department of Geosciences of The Pennsylvania State University, working with Dr. Richard B. Alley. Dr. Shuman received his Ph.D. in Geosciences in 1992 and his M.S. In Geology in 1987 from The Pennsylvania State University, and his B.S. In Geology in 1982 from Moravian College. Dr. Shuman has authored or co-authored research papers on laser altimetry and its combination with other remote sensing data to define subglacial lakes in Antarctica, on the accuracy of early ICESat-1 data, on composite temperature records derived from AWS passive microwave data from SMMR and SSM/I and IR data from AVHRR, as well as correlating those records through stratigraphic correlation with stable isotope ratio profiles in shallow snow layers. He has worked extensively in Greenland and Antarctica, and began his cryospheric career helping to date the GISP2 ice core. He is currently the longest serving member of PoDAG (http://nsidc.org/daac/podag.html) and is on the Executive Committee of the Cryospheric Focus Group of AGU (http://www.agu.org/focus_group/cryosphere/membership.html#exec).

Dr. Lynn C. Sparling is an Associate Professor of Physics at UMBC and is a UMBC affiliate member of JCET. She received a B.S. in Chemistry from the University of New Mexico in 1976, a M.S. in Physics from the University of Wisconsin-Madison in 1980 and a Ph.D. in Physics from the University of Texas at Austin in 1987. She held postdoctoral research positions in chemical engineering and pharmacology, and conducted research in biophysics at the National Institutes of Health until 1992. She joined STX Corp. In 1993, working under contract to NASA at Goddard Space Flight Center, became a member of JCET in 1998 and joined the faculty at UMBC in 2001. During her career, Dr. Sparling has performed theoretical work in a variety of different areas in statistical mechanics, biophysics and hydrodynamics, and is currently working in the areas of atmospheric dynamics and tracer transport and mixing.

Dr. L. Larrabee Strow received the B.S. degree in physics from University of Maryland, Baltimore County in 1974, and M.S. and Ph.D. degrees from the University of Maryland at College Park in 1977 and 1981, respectively. He is currently a Professor with the Department of Physics at UMBC. His research interests include molecular spectroscopy, especially spectral line shapes, and atmospheric remote sensing. He is a member of the AIRS Science Team.

Dr. Michael Studinger received the Ph.D. degree from the Alfred Wegener Institute for Polar and Marine Research, Germany, in 1998. He is the Project Scientist for NASA's Operation IceBridge mission at the Goddard Space Flight Center in Greenbelt, MD. His research interests include physical processes in polar regions linking tectonics, ice sheet dynamics, and life in extreme environments, such as subglacial lakes. He is using integrated sets of aerogeophysical data, including gravity, magnetics, ice-penetrating radar, and laser altimeter measurements, to answer key questions in solid earth geophysics and glaciology. His main research projects focus on the role of subglacial environment in a global framework.

Dr. Andrew Tangborn received his undergraduate degrees from the University of Washington in Mathematics and Mechanical Engineering, and MS and PhD from MIT in Mechanical Engineering. He has been a faculty member at JCET and UMBC for the past 14 year, working in the Data Assimilation Office (later GMAO) at Goddard Space Flight Center. This year he will move to the Planetary Geodynamics Laboratory at NASA. His work has centered on data assimilation in a variety of geophysical fields, including geomagnetism and atmospheric trace gases. He has been funded by research grants as PI and Co-I from both NSF and NASA continuously during his time at UMBC. He has taught both undergraduate and graduate courses in the Mathematics Department, including computational fluid dynamics, data assimilation and wavelets.

Dr. Ali Tokay received his BS from Istanbul Technical University in 1984, MS from Saint Louis University in 1988, and Ph.D. from University of Illinois at Urbana-Champaign in 1993. Dr. Tokay was a research associate through the National Research Council Fellowship between 1993 and 1995. He then joined Saint Louis University as assistant professor in 1995 and the University of Maryland, Baltimore County (UMBC) as a research assistant scientist in 1997. He was later promoted to research assistant professor and in 2007. Dr. Tokay was a principal investigator during a series of field campaigns under the NASA Tropical Rainfall Measuring Mission. He has taught a number of undergraduate and graduate courses at both Saint Louis University and UMBC. Dr. Tokay was an advisor of a MS student who graduated in 1998. He also mentored 14 undergraduate and 8 graduate students. Dr. Tokay is an affiliated associate professor of the Department of Geography and Environmental Sciences and research associate professor of JCET at UMBC. Dr. Tokay is a member of the NASA precipitation science team. Dr. Tokay was the co-chair of the 34th AMS radar meteorology conference and he is a member AMS radar meteorology committee.

Dr. Tamás Várnai received his M.Sc. equivalent degree in Meteorology from the Eötvös Loránd University, Budapest, Hungary in 1989. He then joined the Hungarian Meteorological Service for two years, after which he enrolled to McGill University in Montreal, Canada. His research focused on how cloud heterogeneities influence the way clouds reflect solar radiation. After receiving his Ph.D. in Atmospheric and Oceanic Sciences in 1996, he continued his research as a post-doctoral fellow first at McGill University, then at the University of Arizona. In addition to examining the theory of three-dimensional radiative effects, his work also included the development of operational algorithms for the MISR (Multi-angle Imaging SpectroRadiometer) instrument on board the Terra satellite, calculating the amount of solar radiation clouds reflect. Dr. Várnai joined JCET in 1999, where he works on considering 3D radiative effects in satellite retrievals of cloud and aerosol properties, focusing mostly on the MODIS (Moderate Resolution Imaging Spectroradiometer) satellite instrument, the CALIPSO satellite, and the airborne THOR (THickness from Offbeam Returns) lidar system.

Dr. Juying X. Warner received a B.S. from Nanjing University in Atmospheric Physics in 1983 and a Ph.D. In Meteorology in 1997 from the University of Maryland College Park where her major research interest was radiative transfer modeling. In 1997 she joined the National Center for Atmospheric Research and worked at Atmospheric Chemistry Division until she joined the University of Maryland Baltimore County at JCET in 2004.

During her career after her doctorate degree she has focused on the remote sensing of atmospheric chemistry and other properties using satellite and airborne technologies. She has published over 25 refereed publications on the analyses of the atmospheric composition and remote sensing algorithms and techniques and received four awards from NASA and NCAR for her contributions to the science and technology advancements.

Dr. Zigang Wei received his Bachelor degree from the Department of Application Physics of Beijing Institute of Technology, Peoples Republic of China in 1996, and his Ph.D. degree in Geomagnetism from the Institute of Geology and Geophysics, Chinese Academy of Science in 2001. He subsequently joined the Institute of Geology and Geophysics as a research associate. His research experiences ranged from the geomagnetic observation, modeling geomagnetic survey data and compiling charts, studying main geomagnetic field and its secular variations. He joined JCET in August 2005. Since 2007 he has been involved in the retrieval of atmospheric satellite data.

Dr. Tianle Yuan received a B.S. in both Atmospheric Science and Computer Science from the Peking University in 2001 and a Ph.D. in atmospheric and oceanic sciences in 2008 from the University of Maryland, College Park. His major interests are cloud physics, radiation, and aerosol science. In 2008, he joined JCET as a research associate. His research interests include aerosol radiative forcing, aerosol-cloud interactions, and aerosol-chemistry-climate interaction.

Dr. Leonid Yurganov, a Senior Research Scientist with UMBC's Physics Department, has been with JCET since 2006. His research expertise is connected with remote sensing of tropospheric composition, mostly CO and other members of carbon family, as well as ozone. He graduated from Leningrad State University in 1969 (MS) and Institute of Atmospheric Physics in 1979 (Ph.D.) (both in Russia). During many years he has been using grating spectrometers for atmospheric research in Moscow and St. Petersburg (Russia). He studied total column and surface CO abundances in 1995 - 1996 at the Geophysical Institute, UAF, Fairbanks, Alaska. Validation of the MOPITT Terra instrument was his duty during 1997-2001 at the University of Toronto. Between 2001 and 2006, he studied variations of CO burden in the Northern Hemisphere at the Japan Marine and Earth Science and Technology Center (JAMSTEC) in Yokohama. He is a co-author of 43 refereed publications.

Dr. Hai Zhang received his B.S. in physics in 1992 from Nankai University and M.S. in optics in 1995 from Xi'an Institute of Optics and Precision Mechanism in China. He received his M.S. in computer science in 2002 from Towson University. He received his Ph.D. in atmospheric physics from the University of Maryland, Baltimore County in 2006. He joined JCET in 2006 and is currently an assistant research scientist. During his PhD study, he carried out research on atmospheric circulation modeling using quasi-uniform grids. After graduation, he has been working on satellite remote sensing of aerosols and its application in air quality monitoring and forecasting. He developed and enhanced the IDEA (Infusing satellite Data into Environmental Applications) system at NOAA, which provided air quality community near-real-time satellite imagery and AQ forecasting. He also worked on the development of aerosol retrieval algorithms for geostationary satellites, such as current GOES, SEVIRI, and GOES-R.

Dr. Zhibo Zhang received a Ph.D. in Atmospheric Sciences (2008) and an MS (2004) from the Texas A&M University and a BS in Meteorology (1998) from the Nanjing University, China. His Ph.D. thesis is on satellite-based remote sensing of ice clouds. In January 2009, he joined the Goddard Earth Sciences and Technology Center (GEST) at the University of Maryland, Baltimore County, where he worked with the MODIS cloud science team led by Dr. Steven Platnick on the development of infrared cloud property retrieval algorithm. In 2011, he joined JCET.

This page intentionally left blank.

III.9 Table 1: JCET Faculty (as of June 30, 2012)

NAME	TITLE	AFFILIATION
Dr. William Barnes	Senior Research Scientist	Research Faculty
Mr. Timothy Berkhoff	Assistant Research Engineer	Research Faculty
Dr. Huisheng Bian	Associate Research Scientist	Research Faculty
Dr. Roberto Borda	Assistant Research Scientist	Research Faculty
Dr. Mark Bulmer	Associate Research Scientist	Research Faculty
Dr. Petya Entcheva-Campbell	Research Assistant Professor	Geography & Environmental Sys.
Dr. Allen Chu	Associate Research Scientist	Research Faculty
Dr. Ruben Delgado	Research Associate	Research Faculty
Dr. Sergio deSouza-Machado	Research Assistant Professor	Physics
Dr. Elena Georgieva	Research Associate Professor	Physics
Dr. Forrest Hall	Senior Research Scientist	Research Faculty
Dr. Shin-Chan Han	Associate Research Scientist	Research Faculty
Mr. Scott Hannon	Research Assistant	Research Faculty
Dr. Jay Herman	Senior Research Scientist	Research Faculty
Dr. Susan Hoban	Senior Research Scientist	Research Faculty
Dr. K. Fred Huemmrich	Research Associate Professor	Geography & Environmental Sys.
Dr. Breno Imbiriba	Research Associate	Research Faculty
Dr. Ben Johnson	Assistant Research Scientist	Research Faculty
Dr. Ilan Koren	Assistant Research Scientist	Research Faculty
Dr. Prasun Kundu	Research Associate Professor	Physics
Dr. Jae Nyung Lee	Assistant Research Scientist	Research Faculty
Dr. Simone Lolli	Assistant Research Scientist	Research Faculty
Dr. Amita Mehta	Research Assistant Professor	Geography & Environmental Sys.
Dr. William Olson	Research Associate Professor	Physics
Dr. Ana Prados	Research Assistant Professor	Chemistry
Dr. Lorraine Remer	Senior Research Scientist	Research Faculty

Dr. Chung-Lin Shie	Associate Research Scientist	Research Faculty
Dr. Christopher Shuman	Associate Research Scientist	Research Faculty
Dr. Michael Studinger	Associate Research Scientist	Research Faculty
Dr. Andrew Tangborn	Research Associate Professor	Mathematics & Statistics
Dr. Ali Tokay	Research Associate Professor	Geography & Environmental Sys.
Dr. Tamás Várnai	Research Assistant Professor	Physics
Dr. Zigang Wei	Assistant Research Scientist	Research Faculty
Dr. Tianle Yuan	Research Associate	Research Faculty
Dr. Leonid Yurganov	Senior Research Scientist	Research Faculty
Dr. Hai Zhang	Research Associate	Research Faculty

III.10 Table 2: JCET Fellows (as of June 30, 2012)

NAME	AFFILIATION
Dr. Robert Cahalan	NASA GSFC
Dr. Jeffrey Halverson	UMBC Geography & Environmental Systems
Mr. Ernest Hilsenrath	NASA GSFC (retired)
Dr. Raymond Hoff	UMBC Physics
Dr. Weijia Kuang	NASA GSFC
Dr. Thorsten Markus	NASA GSFC
Dr. Alexander Marshak	NASA GSFC
Dr. Vanderlei Martins	UMBC Physics
Dr. Harvey Melfi	Emeritus
Dr. Lazaros Oreopoulos	NASA GSFC
Dr. Steven Platnick	NASA GSFC
Dr. Lynn Sparling	UMBC Physics
Dr. David Starr	NASA GSFC
Dr. Larrabee Strow	UMBC Physics
Dr. David Whiteman	NASA GSFC

NAME	AFFILIATION
Dr. Zhibo Zhang	UMBC Physics

III.11 Table 3: JCET Associate Staff (as of June 30, 2012)

NAME	TITLE
Mr. Keith Evans	Research Analyst
Mr. Paul Schou	Research Analyst

III.12 Table 4: JCET Administrative Staff (as of June 30, 2012)

NAME	TITLE
Ms. Valerie Casasanto	Program Coordinator
Ms. Mary Dawson	Business Manager
Ms. Danita Eichenlaub	Director
Dr. Jeffrey Halverson	Associate Director, Academics
Dr. Raymond Hoff	Science Advisor
Mr. Kevin Mooney	Accountant I
Ms. Brizjette Lewis	Executive Administrative Assistant
Ms. Cathy Manalansan	Administrative Assistant II
Ms. Margo Young	Business Manager

This page intentionally left blank.

III.13 Acronyms and Abbreviations

ABI	Advanced Baseline Imager
ACARS	Aircraft Communications Addressing and Reporting System
ACE	Aerosol-Cloud-Ecosystems
AERI	Atmospheric Emitted Radiance Interferometer
AERONET	Aerosol Robotic Network
AGU	American Geophysical Union
AIRS	Atmospheric Infrared Sounder
AK	Averaging Kernels
ALEX	Atmospheric Lidar Experiment
ALG	Atmospheric Lidar Group
AOD	Aerosol Optical Depth
APAR	Absorbed Photosynthetically Active Radiation
APS	Aerosol Polarimetry Sensor
AQAST	Air Quality Applied Sciences Team
AQPG	Air Quality Proving Ground
ARM	Atmospheric Radiation Measurement
ARSET	Applied Remote Sensing Training Program
ASP	Aerosol Simulation Program
BAMS	Bio-Aerosol Mass Spectrometry
BBAERI	The Baltimore Bomem Atmospheric Emitted Radiance, Interferometer
BEST	Beginning Engineering, Science, and Technology
BOREAS	Boreal Ecosystem Atmosphere Study
BRDF	Bidirectional Reflectance Distribution Function
C3VP	Canadian Cloudsat/CALIPSO Validation Project
CALIOP	Cloud-Aerosol Lidar with Orthogonal Polarization
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations

CAR	Cloud Absorpiton Radiometer
CB	Cumulonimbus
CCD	Charge Coupled Device
CCM	Chemistry-Climate Model
CDRD	Cloud Dynamics and Radiation database
CLN	CRESST Lidar Network
CMAQ	Community Multiscale Air Quality
CMB	Core Mantle Boundary
CMIP	Coupled Model Inter-Comparison Project
COG	Center of Gravity
CONUS	Contiguous US
CoSMIR	Conical Scanning Millimeter-wave Imaging Radiometer
CRESST	Cooperative Center for Remote Sensing Science and Technology
CrIS	Cross-track Infrared Sounder
CRM	Cloud Resolving Model
CRTM	Community Radiative Transfer Model
CWT	Covariance Wavelet Transform
DAAC	NASA Data Active Archive Center
DDA	Discrete Dipole Approximation
DEMs	Digital Elevation Models
DIAL	Differential Absorption Lidar
DISCOVER-AQ	Deriving Information on Surface Conditions from COlumn and VERtically Resolved Observations Relevant to Air Quality
DLN	Distance Learning Network (DLN)
DOE	U.S. Department of Energy
DOFS	Degrees Of Freedom for Signal
ECMWF	European Centre for Medium-Range Weather Forecasts
EGU	European Geoscience Union
EIA	Earth Incidence Angle

ELF	Elastic Lidar Facility
EOF	Empirical Orthogonal Function
EOS	Earth Observation System
EPA	Environmental Protection Agency
ERA	ECMWF Re-Analysis
ESA	European Space Agency
ESSIC	Earth System Science Interdisciplinary Center
EUMETSAT	European Organization for the Exploration of Metrological Satellite
GALION	Global Atmosphere Watch Atmospheric Lidar Observation Network
GASP	GOES Aerosol and Smoke Product
GCM	Global Circulation Model
GCPEx	GPM Cold-season Precipitation Experiment
GEDI	Global Ecosystem Dynamics Mission
GEO	Group of Earth Observations
GEOS	Goddard Earth Observing System
GEP	Gross Ecosystem Production
GEST	Goddard Earth Sciences and Technology
GESTAR	Goddard Earth Sciences Technology And Research
GISS	Goddard Institute for Space Sciences
GMAO	Global Modeling and Assimilation Office
GMI	Global Modeling Initiative
GOES	Geostationary Operational Environmental Satellite
GOES-R	Geostationary Operational Environmental Satellite “R” Series
GOME	Global Ozone Monitoring Experiment
GPCP	Global Precipitation Climatology Project
GPM	Global Precipitation Measurement Mission
GPP	Gross Primary Production
GPROF	Goddard PROFiling algorithm

GPS	Global Positioning System
GRACE	Gravity and Climate Recovery Experiment
GRIP	Genesis and Rapid Intensification Processes
GRL	Geophysical Research Letters
GSFC	Goddard Space Flight Center
GSSP	Graduate Student Summer Program
GSI	Gridspace Statistical Analysis
GSSTF	Goddard Satellite-based Surface Turbulent Fluxes
GV	Ground Validation
HDO	Hydrogen Deuterium Oxide
HIWRAP	High-Altitude Imaging Wind and Rain Airborne Profiler
HLH	Haze Layer Height
HSRL	High Spectral Resolution Lidar
I3RC	Intercomparison of 3-D Radiation Codes
IAF	International Astronautical Federation
IAGOS	Aircraft for a Global Observing System
IASI	Infrared Atmospheric Sounding Interferometer
ICESat	Ice, Cloud, and land Elevation Satellite
IDEA	Infusing satellite Data into Environmental Applications
IEEE	Institute of Electrical and Electronics Engineers
IGAC	International Global Atmospheric Chemistry Project
IGARSS	IEEE International Geoscience and Remote Sensing Symposium
IGRF	International Geomagnetic Reference Field
ILRS	International Laser Ranging Service
IPCC	Intergovernmental Panel on Climate Change
IR	Infrared
IRAD	Internal Research and Development
ISAMS	Improved Stratospheric and Mesospheric Sounder

ISES	International Society for Exposure Science
ISU	International Space University
JCET	Joint Center for Earth Systems Technology
JPL	Jet Propulsion Laboratory
L2	Level 2
LaRC	Langley Research Center
LHF	Latent Heat Fluxes
LIDAR	Light Detection and Ranging
LITE	Lidar In-Space Technology Experiment
LOLA	Lunar Orbiter Laser Altimeter
LP	Lunar Prospector
LRO	Lunar Reconnaissance Orbiter
LUE	Light Use Efficiency
MAIAC	Multi-Angle Implementation of Atmospheric Correction
MC3E	Midlatitude Continental Convective Cloud Experiment
MDE	Maryland Department of the Environment
MDSA	Multi-Sensor Data Synergy Advisor
MEaSUREs	Making Earth Science Data Records for Use in Research Environments
MERRA	Modern-Era Retrospective Analysis for Research and Applications
MISR	Multiangle Imaging SpectroRadiometer
MIT	Massachusetts Institute of Technology
MLS	Microwave Limb Sounder
MODIS	Moderate Resolution Imaging Spectroradiometer
MOPITT	Measurements of Pollution In The Troposphere
MoSST_DAS	Modular Scalable Self-consistent and Three dimensional core dynamic model Data Assimilation System
MPE	Mean PBL Extinction
MPLNET	Micropulse Lidar Network
MRO	Mars Reconnaissance Orbiter

NACP	North American Carbon Program
NASA	National Aeronautics and Space Administration
NBS	NASA BEST Students
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NESDIS	National Environmental Satellite, Data, and Information Service
NEWS	NASA Energy and Water cycle Study
NExT	NASA's Engineering Exploration Training
NH	Northern Hemisphere
NIFA	National Institute for Food and Agriculture
NLLJ	Nocturnal Low Level Jet studies
NMQ	National Mosaic & Multi-sensor Quantitative Precipitation Estimate
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NSE	Near-Surface Extinction
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
OE	Optimal Estimation
OMI	Ozone Monitoring Instrument
PACS	Passive Aerosol and Cloud Suite
PAR	Photosynthetically Active Radiation
PBL	Planetary Boundary Layer
PBLH	Planetary Boundary Layer Height
PCTM	Parameterization Chemistry Transport Model
PGRF	Preliminary Geomagnetic Reference Field
PIDDP	Planetary Instrument Definition and Development Program (PIDDP)
Pi-Neph	Polarized imaging Nephelometer

PMF	Positive Matrix Factorization
POLDER	POlarization and Directionality of Earth's Reflectiveness
PRI	Photochemical Reflectance Index
RMSE	Root-Mean-Square Error
ROSES	Research Opportunities in Space and Earth Sciences
RTA	Radiative Transfer Algorithm
RUSI	Royal United Services Institute
SAL	Saharan Air Layer
SBUV	Solar Backscatter UltraViolet
SDT	Science Definition Team
SEMAA	Science, Engineering, Mathematics and Aerospace Academy
SEVIRI	Spinning Enhanced Visible and Infrared Imager
SH	Southern Hemisphere
SHF	Sensible Heat Flux
SiB	Simple Biosphere
SIES	Summer Institute in Earth Sciences
SIF	Solar Induce Fluorescence
SLA	Sea Level Anomaly
SOA	Secondary Organic Aerosol
SORCE	Solar Radiation and Climate Experiment
SSM/I	Special Sensor Microwave/Imager
STEM	Science Technology Engineering and Math
SV	Secular Variation
TCTE	TIM Calibration Transfer Experiment
TEOM	Tapered Element Oscillating Microbalance
TES	Tropospheric Emission Spectrometer
THOR	Thickness from Offbeam Returns
TIROS	Television Infrared Observation Satellite

TMI	TRMM Microwave Imager
TOA	Top Of Atmosphere
TOMS	Total Ozone Mapping Spectrometer
TRMM	Tropical Rainfall Measuring Mission
TSI	Total Solar Irradiance
TSIS	Total Solar Irradiance Sensor
UMBC	University of Maryland, Baltimore County
UMCP	University of Maryland, College Park
USDA	United States Department of Agriculture
USGP	United States Great Plains
UWNMS	University Wisconsin Non-hydrostatic Modeling System
VIEWS	Visibility Exchange Web System
WACCM	Whole Atmosphere Community Climate Model
WFOV	Wide Field of View
WMO	World Meteorological Organization
WRF-CMAQ-SMOKE	Weather Research and Forecasting Model Community Multi-Scale Air Quality Model