ANNUAL REPORT 2015

Ames Research Center: Cooperative Research in Earth Science and Technology

ARC-CREST

Bay Area Environmental Research Institute

www.baeri.org

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LETTER FROM **THE DIRECTOR**

I am pleased to present the annual report for the Ames Research Center Cooperative for Research in Earth Science and Technology (ARC-CREST). NASA awarded the ARC-CREST cooperative agreement to the Bay Area Environmental Research Institute (BAERI), the California State University at Monterey Bay (CSUMB) and the National Suborbital Education and Research Center at the University of North Dakota (NSERC/UND) in 2012. This report covers the performance period March 1, 2015 to February 28, 2016.

During the period of performance, ARC-CREST staff from the partner institutions worked side by side with their collaborators at NASA Ames Research Center on 37 separate Earth Science research, research support, and education or outreach projects. This report summarizes their accomplishments during that time. Through their hard work and commitment, the ARC-CREST team made many significant achievements to support NASA's Earth Science mission goals. In 2015, ARC-CREST researchers,engineers, staff, and students contributed to the success of over 10 airborne field campaigns, gave presentations to the White House Office and Science and Technology Policy and U.S. Global Change Research Program, conducted three large scale student outreach and education programs, were featured in the award-winning documentary Years of Living Dangerously, and provided key research to California officials dealing with the drought, to name just a few accomplishments.

Congratulations and thank you to the ARC-CREST team and our NASA partners for another great year in this exciting partnership!

Dr. Robert Bergstrom
Director

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INTRODUCTION

NASA Ames Research Center (ARC) awarded Bay Area Environmental Research Institute (BAERI) and partners (University of North Dakota and California State University at Monterey Bay) the ten-year, Ames Research Center Cooperative for Research in Earth Science and Technology (ARC-CREST) in March 2012. NASA ARC-CREST scientists and staff, in collaboration with NASA and other investigators, work cooperatively with NASA -ARC's Earth Science Division (Code SG) to achieve NASA's strategic Earth Science objectives. These objectives include:

1) the conduct of research into fundamental questions related to the atmosphere, the oceans, the biosphere, and Earth's land masses;

2) the use of informational and computational sciences to visualize, analyze, and interpret Earth Science data;

3) the application of technology necessary for Earth Science research; and

4) the provision of outreach and education to the general public regarding Earth Science.

This document describes the progress and achievements made in 2015 of the 37 research, education and support projects within the ARC-CREST cooperative agreement.

For more information please contact Dr. Robert Bergstrom, ARC-CREST Director (bergstrom@baeri.org), or Mark Sittloh, ARC-CREST Business Manager (msittloh@baeri.org).

ARC-CREST **PARTNERS**

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2. NASA Ames Research Center – Earth Sciences Division
3. University of North Dakota – National Suborbital Education and Research Center

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EARTH SCIENCE FOCUS AREAS

4STAR and Satellite Data Analysis

NASA: J. Redemann,
BAERI: C. Chang, M. Kacenelenbogen, Y. Shinozuka, M. Segal-Rozenhaimer, Q. Zhang

The Ames 4STAR (Sky-scanning, Sun-tracking Atmospheric
The Ames 4STAR (Sky-scanning, Sun-tracking Atmospheric
Research) Project uses ground and airborne sun-photometer instruments to study aerosol radiative properties and measure atmospheric trace gases. Instruments currently in use include: the recently developed 4STAR ground and air instruments and the Ames Airborne Tracking Sun-photometer (AATS-14). Scientists analyze measurements from these instruments to yield atmospheric aerosol optical depth and extinction spectra, aerosol size distributions, water vapor columns and profiles, and ozone columns. They also have used the sun-photometer instruments to validate measurements from 12 satellite instruments, two airborne simulators of satellite instruments, and several airborne and ground-based LIDARS. The AATS instrument has also been used in studies of aerosol radiative forcing of climate, aerosol light absorption spectra, and consistency (closure) between in situ and radiometric measurements. The 4STAR ground and air instruments broaden the types of usable aircraft and add the additional measurement capabilities of sky-scanning and improved wavelength resolution.

2015 Accomplishments

- Produced global seasonal clear-sky aerosol radiative forcing results based on multi-satellite sensor aerosol retrievals; those results were then compared to values derived from a subset of models that participated in the latest AeroCom initiative;
- Developed an alternate retrieval of aerosol above opaque water cloud using the CALIOP/ CALIPSO Depolarization Ratio Technique over the globe;
- Used aerosol retrievals from a combination of MODIS, OMI and CALIOP satellite observations to infer aerosol types over the globe;
- Used the full capacity of the 14-channel Ames Airborne Tracking Sunphotometer (AATS--14) as input to an atmospheric correction model for an improved water color characterization; and
- Assisted in the management of the ORACLES experiment and, more specifically, improved real-time mapping of geostationary and sun-synchronous satellite maps for flight planning purposes.
- **Instrument Development (AITT)**
  Continued working on improving instrument reliability and accuracy through the AITT project. Specifically, we have performed laboratory measurement of temperature dependence under various conditions, for the various instrument parts and revealed that the diffuser on the fiber optic side was the main problem. We have mitigated this by changing the diffuser/fiber-optic connectivity path.

  o Developed initial capability of tracking the sun via a wide FOV visible camera.
  o Developed a procedure to adjusting the Langley calibration using an FEL lamp calibration to improve 4STAR UV measurement signal.
- **Data analysis (SEAC4RS and ARISE)**
  Worked on SEAC4RS data archival and reprocessed the data based on the recent findings of temperature sensitivity. 4STAR SEAC4RS data has been used in several SEAC4RS publications (see for example Jethva et al., 2015).
- Worked on archiving final data for the ARISE 2014 campaign and applied thin cirrus retrievals on the 4STAR instrument to compare with the CERES satellite overpasses during the ARISE campaign (see Smith et al., 2015). In addition, we are working on analyzing multi- sensor data from ARISE to get insights on cloud radiative forcing magnitude and sensitivity over the Arctic Sea-Ice.

- **Flight Operations**
  For the NAAMES deployment in November, adjusted the fiber optic set-up, cleaned the FORJ and all elements in the 4STAR optical path, and performed laboratory calibrations;

- Integrated 4STAR on the C-130 for the NAAMES campain.; and

- Worked logistic aspects in preparation for the KORUS-AQ campaign and participated in the STM held in October.

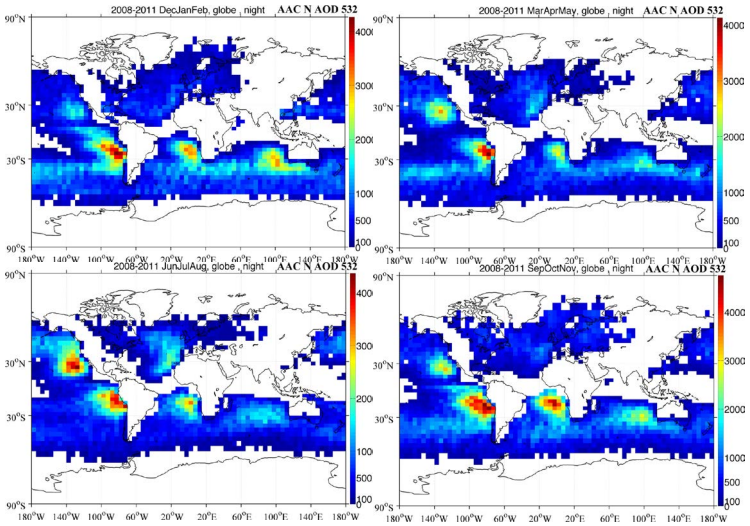


Figure 1: Global seasonal nighttime number of aerosol above cloud cases from 2008 to 2012 using CALIOP and the alternate depolarization ratio method

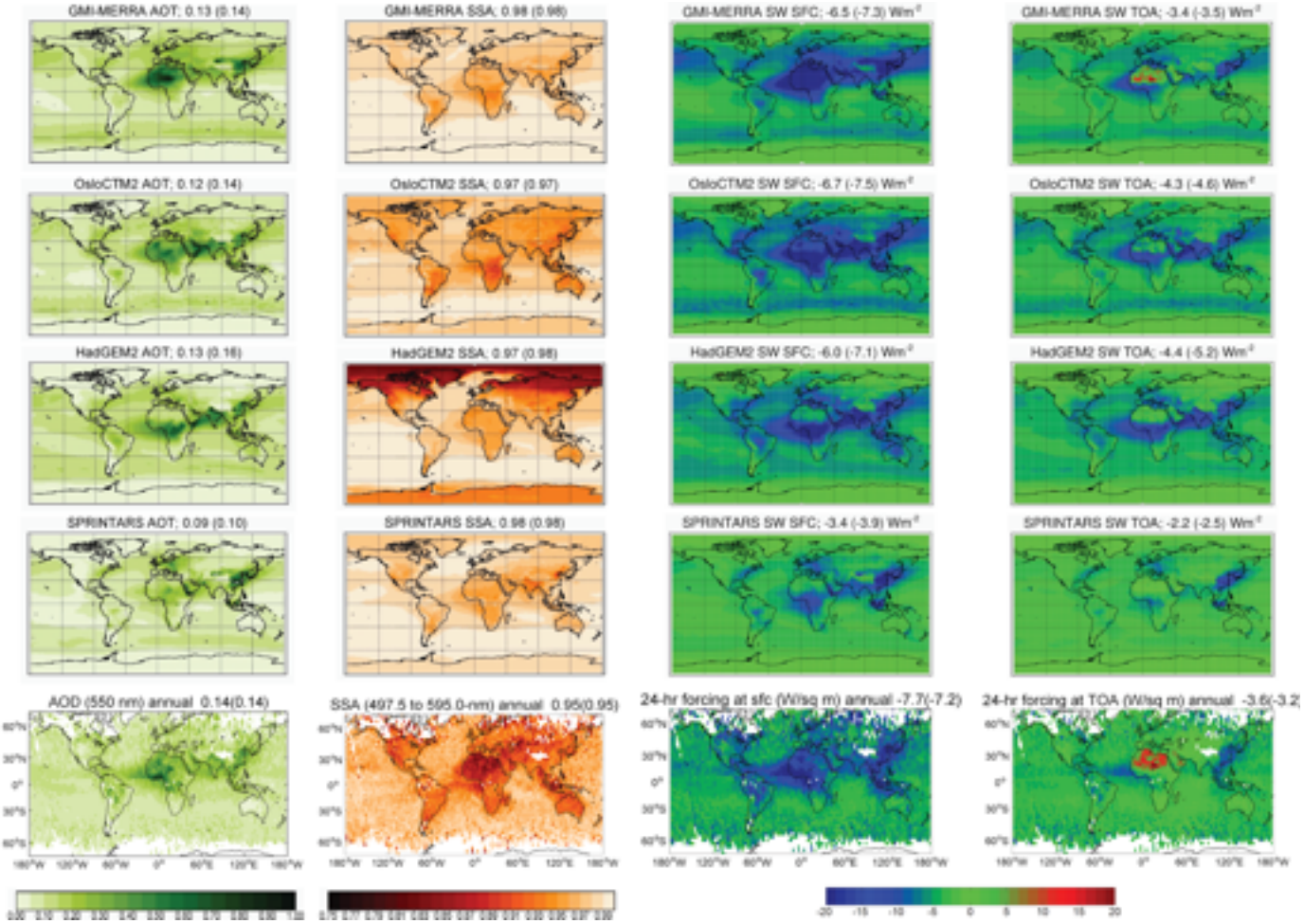


Figure 2: Annually averaged AOD, SSA, surface and TOA shortwave forcing from GMI-Merra, OSLO-CTM, HadGEM2, SPINTARS, compared to MODIS-OMI-CALIOP retrieval results (last row).

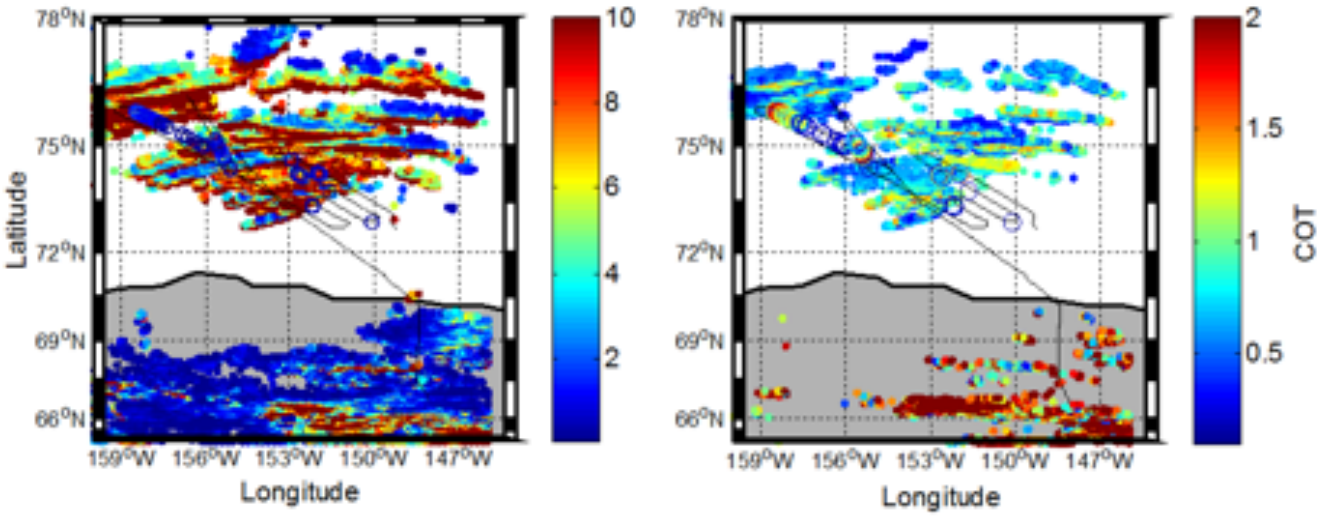


Figure 3: (adapted from Smith et al., 2015, submitted): (a) COT for all multi-layer ice clouds with top above 5 km height derived by CERES (solid circles),overlaid by direct sun cirrus retrievals (based on procedure developed in Segal-Rosenheimer et al., 2013) from the 4STAR instrument on-board C-130 (open circles), and (b) COT for only upper layer clouds, as derived by CERES, overlaid by direct sun cirrus retrievals from 4STAR (open circles) for September-15 flight. Note the different colorbar scales.

Publications and Presentations

Jethva et al., Validating Above-cloud Aerosol Optical Depth Retrieved from MODIS-based 'Color Ratio' Algorithm using NASA's Airborne AATS and 4STAR Direct Measurements, in preparation for GRL, 2015.

Saide, P. E. et al. (Kacenelenbogen, M. and Redemann, J. among 10 authors): Central American biomass burning smoke can increase tornado severity in the U.S. Geophys. Res. Lett., 2014GL062826,10.1002/2014gl062826, 201

Saide, P. E. et al. (Redemann, J. and Shinozuka, Y.) among 26 authors. (2015), Revealing important nocturnal and day-to-day variations in fire smoke emissions through a multiplatform inversion. Geophys. Res. Lett., 42, 3609–3618. doi: 10.1002/2015GL063737.

Smith L. William Jr. et al.s, Arctic Radiation-IceBridge Sea and Ice Experiment (ARISE): The Arctic radiant energy system during the critical seasonal ice transition. Bull. Amer. Meteor. Soc., submitted (August, 2015).

Segal-Rozenhaimer et al., Relative roles of atmospheric state and boundary layer clouds on Arctic cloud radiative forcing forecasts: The ARISE 2014 case study, in preparation for J. of Climate, 2015

Shinozuka, Y., et al. (2015), The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, Atmos. Chem. Phys., 15, 7585-7604, doi:10.5194/acp-15-7585-2015.

Flynn et al., 4STAR sky-scanning retrievals of aerosol intensive optical properties including size distribution, coarse mode fraction, complex index of refraction and single scattering albedo: comparisons to AERONET during TCAP I & II and SEAC4RS, American Geophysical Union (AGU),12/14-18 2015.

Redemann et al., Aerosol-cloud interactions in the South-East Atlantic: future suborbital activities to address knowledge gaps in satellite and model assessments, American Geophysical Union (AGU), 12/14-18 2015

LeBlanc et al., Implication of using transmitted vs. reflected light or determining cloud properties, cloud radiative effect and aerosol-cloud-interactions, American Geophysical Union (AGU), 12/14-18 2015

Kacenelenbogen et al., Preparing for ORACLES: A few satellite derived aerosol and cloud properties in the South East Atlantic, Poster, ORACLES Science Team, NASA AMES, USA, September 2015

Kacenelenbogen et al., Aerosol types from spaceborne remote sensing observations over the globe: from clear-sky to above low opaque water clouds, Poster, National Academy of Science, Irvine, USA, 06/23-24 2015.

Palacios S. et al., Bringing the ocean into finer focus, Climate Change and Ecosystems Joint Workshop in College Park, MD, April 20-24, 2015.

Le Blanc S. E. et al., Cloud Properties Retrieved from Airborne Measurements of transmitted and Reflected Shortwave Spectral Radiation, SEAC4RS science team, Boulder, CO, April 2015.

Le Blanc S. E. et al., Cloud shortwave radiative effect and cloud properties estimated from airborne measurements of transmitted and reflected light, EGU, Vienna, Austria, 12-17 April, 2015.

Segal-Rozenhaimer, M. et al., Cloud radiative forcing sensitivity to Arctic synoptic regimes, surface type, cloud phase and cloud properties during the Fall 2014 Arctic Radiation, IceBridge and Sea-Ice Experiment (ARISE). European Geophys. Union General Assembly, 12-17 April 2015, Vienna, Austria.

Segal-Rozenhaimer, M., et al., Investigating cloud radiative effects sensitivity over the marginal ice zone during ARISE 2014, ARISE Science Team Meeting, NASA Goddard Space Flight Center, Greenbelt, Md., 19-20 May 2015

Shinozuka, Y., et al. (2015), The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, ORACLES Science Team Meeting.

Shinozuka, Y., et al. (2015), The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, NAAMES Science Team Meeting.

Shinozuka, Y., et al. (2015), The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, Arthur M. Sackler colloquium on Improving Our Fundamental Understanding of the Role of Aerosol-Cloud Interactions in the Climate System.

Shinozuka, Y., et al. (2015), Airborne observation of aerosol optical depth, Phil Russell Retirement Symposium.

Awards
NASA Group Achievement award for ARISE campaign

ORACLES Radiative Transfer Algorithm Development

NASA: Kirk Knoblespeisse, Jens Redemann
BAERI: M. Segal-Rozenhaimer,

The primary goal of this research is to develop new algorithms to retrieve atmospheric aerosol and cloud optical properties from observations by polarimetrically sensitive instruments. These algorithms are intended for the analysis of aerosols lofted above clouds, the main target of ORACLES (ObseRvations of Aerosols Above CLouds and their IntEractionS). The ORACLES experiment will consist of 3 deployments in 2016, 2017, and 2018 offshore from Namibia involving 2 airplanes with numerous ground-based and airborne remote sensing and in-situ instruments. ORACLES provides multi-year airborne observations over the complete vertical column of the key parameters that drive aerosol-cloud interactions in the South-East Atlantic, an area with some of the largest inter-model differences in aerosol forcing assessments on the planet. Algorithms will be applied to observations by the Research Scanning Polarimeter (RSP) and the Airborne Multiangle SpectroPolarimetric Imager (AirMSPI).

An algorithm will be created to retrieve the optical properties of Aerosols Above Clouds (AAC), observed during ORACLES concurrently with some of the optical properties of the underlying clouds. The basis of this algorithm is the ability that multiviewing angle, polarimetrically sensitive instruments have to separate the effects of aerosols and (liquid phase) clouds. Since the polarimetric expression of the liquid phase cloudbow is very distinct, observations of the spectral and geometric expression of this cloudbow can be used to accurately determine the droplet effective radius and variance at the top of the cloud. Observations at scattering angles away from the cloudbow can then be used to determine aerosol characteristics because the underlying reflectance properties of the cloud have already been constrained (polarized reflectance is only sensitive to the top three cloud optical depths, so additional information such as overall cloud optical thickness and physical dimensionality are not needed).

Vertical distribution of the aerosols and clouds must either be assumed or specified by external data. Standard polarimetric retrievals are often performed using some version of optimal estimation, whereby a radiative transfer model representing the scene is tuned until its output matches observations. This can be very computationally expensive. The proposed algorithm uses a trained neural-network (NN) scheme that captures the various scenes expected to be observed during the campaign (with varying properties of both aerosol and cloud layers). NN allows the training (i.e., optimization) of a large dataset of options, using simulated inputs (i.e., polarimetric measurements of various scenes) that link (i.e., creates the best possible modeled coefficients) inputs (measurements) to outputs (retrieved properties of aerosol and clouds). After the training process is completed, retrievals are achieved by inputting sets of measurements, using the obtained coefficients from the training process.

2015 Accomplishments

- Created simulated measurements of cloud fields and tested various variable datasets to make the training process more efficient;
- Performed a principle component analysis (PCA) on the simulated cloud data where necessary input parameters were reduced to less than 100 inputs;
- Explored how to apply real instrument noise to simulated data so that the trained NN can be applied on real-world measurements;
- Prepared to train the cloud NN scheme to test robustness (i.e., specificity and accuracy) of the method on the simulated cloud fields;
- Produced global seasonal clear-sky aerosol radiative forcing results based on multi-satellite sensor aerosol retrievals; those results were then compared to values derived from a subset of models that participated in the latest AeroCom initiative;
- Developed an alternate retrieval of aerosol above opaque water cloud using the CALIOP/ CALIPSO Depolarization Ratio Technique over the globe; and
- Inferred aerosol types over the globe using aerosol retrievals from a combination of MODIS, OMI, and CALIOP satellite observations.

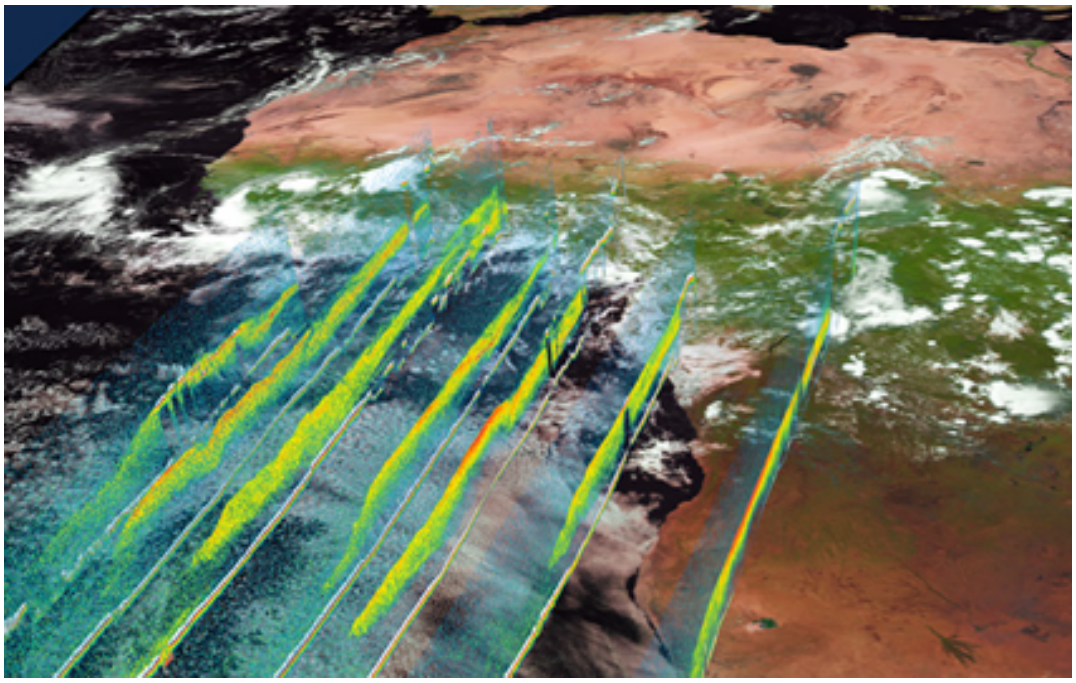


Figure 4: Composite CALIPSO lidar backscatter curtains show pervasive transport of BB aerosol transport during the first week of September 2008 as well as the underlying cloud tops over the South-East Atlantic (region of the ORACLES field campaign)

Publications and Presentations

Segal-Rozenhaimer et al., Polarimetric aerosol above cloud retrieval algorithm development using neural networks, ORACLES STM, NASA Ames Research Center, Sep-9-11, 2015.

Segal-Rozenhaimer et al., Neural Network algorithm development for polarimetric measurements of above cloud aerosols (ACA), American Geophysical Union (AGU), 12/14-18, 2015.

Aerosol Modeling

NASA: Mian Chin
BAERI: : Qian Tan

Based on observations, there is an increasing trend of stratospheric aerosols in recent decades. Aerosols from high altitude can affect the earth radiation budget and climate. The reason for this observed upwelling trend is still being debated, since stratospheric aerosols are formed by various physical and chemical processes. In this three-year project, we are trying to quantify the contribution from various sources, i.e. increased man-made emissions from Asia due to industrialization and heavy coal use, and/or the continuous small-to-medium size volcano eruption and degassing in recent decades.

2015 Accomplishments

- Created simulated measurements of cloud fields Focused on the important precursor of stratospheric aerosol: SO_2;
- Collected available SO_2 measurement at high elevations using both satellites and aircraft; each platform has their strength and weakness. Based on the agreement and discrepancy between the model simulation and observations, we are trying to choose the regions where the contributions are identifiable; and
- Studied the trends in stratospheric aerosols. Both ground-based and satellite-based measurements showed that stratospheric aerosols exhibit some trends in the post Pinatubo era. Various reasons have been proposed to explain this observation. They evaluated the global aerosol model simulation in the UTLS region with multiple observation datasets with a focus on SO_2, the important aerosol precursor. Both online and offline versions of GOddard Chemistry Aerosols Radiation Transport (GOCART) model, which is driven by NASA Goddard Earth Observing System Model Version 5, i.e. GEOS-5, meteorological conditionare used in this evaluation. When compared to available satellite retrieval of SO_2, the GOCART model is able to capture the volcanic SO_2's magnitude and variation in the UTLS region in general.
- They further compare the GOCART results with in-situ SO_2 measurement from various aircraft campaigns in the recent decades.
- Sparse SO_2 measurements in the UTLS region show significant temporal and spatial variations. Model simulation with different emission inputs, spatial resolution, SO_2 in-cloud vertical transport and chemistry parameterization all contribute to significant model variations.

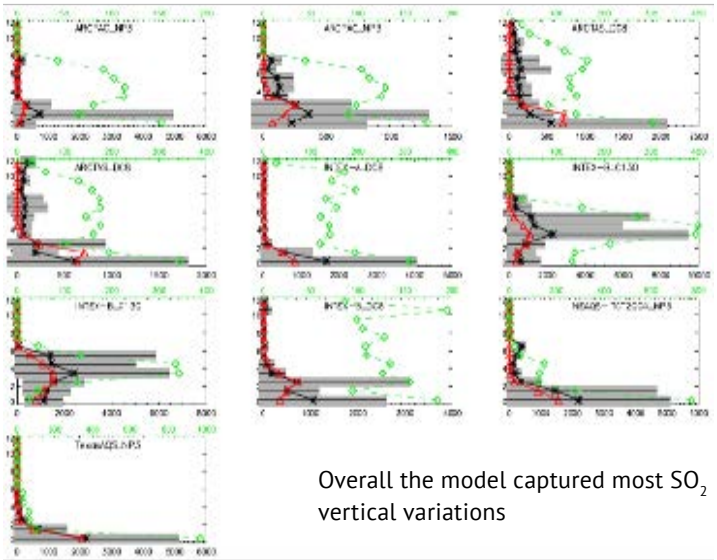
Publications and Presentations

Peters-Lidard, C.D., et al. (Q. Tan among 23 co-authors), 2015, Integrated modeling of aerosol, cloud, precipitation and land processes at satellite-resolved scales, Environmental Modelling & Software, 67, 149–159. doi: http://dx.doi.org/10.1016/j.envsoft.2015.01.007

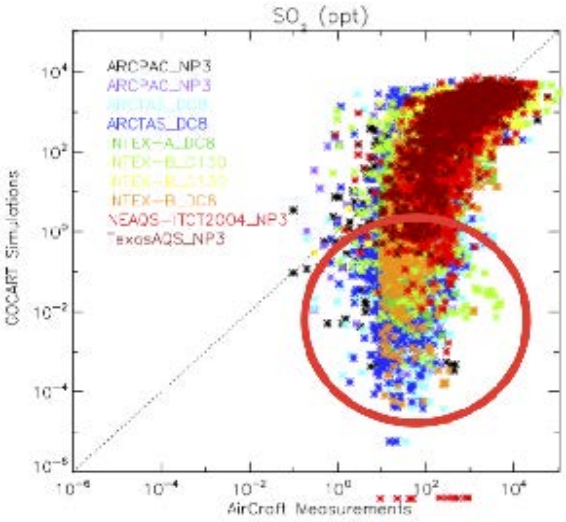
Tan, Q., M. Chin, V. Aquila, H. Bian, J. Barnes, Modeling Study of Atmospheric Aerosol Trend in Stratosphere in Recent Decades, Poster presented at the NAS Colloquia, "Improving Our Fundamental Understanding of the Role of Aerosol-Cloud Interactions in the Climate System", June, 2015, Irvine, CA (poster).

Tan, Q., M. Chin, V. Aquila, H. Bian, G. Chen, A. B. Early, Evaluation of Modeled SO_2 in the UTLS Region with Aircraft Data from Multiple Campaigns, AeroCom Workshop, Oct. 2015 (poster).

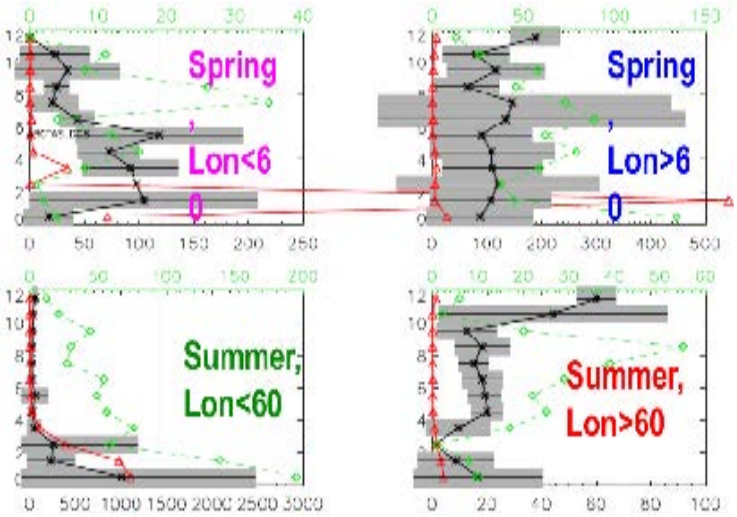
Tan, Q., M. Chin, V. Aquila, H. Bian, G. Chen, A. B. Early, Evaluation of Modeled SO_2 in the UTLS Region with Both Satellite and Aircraft Data, AGU, Fall Meeting, 2015.



Overall the model captured most SO_2 vertical variations

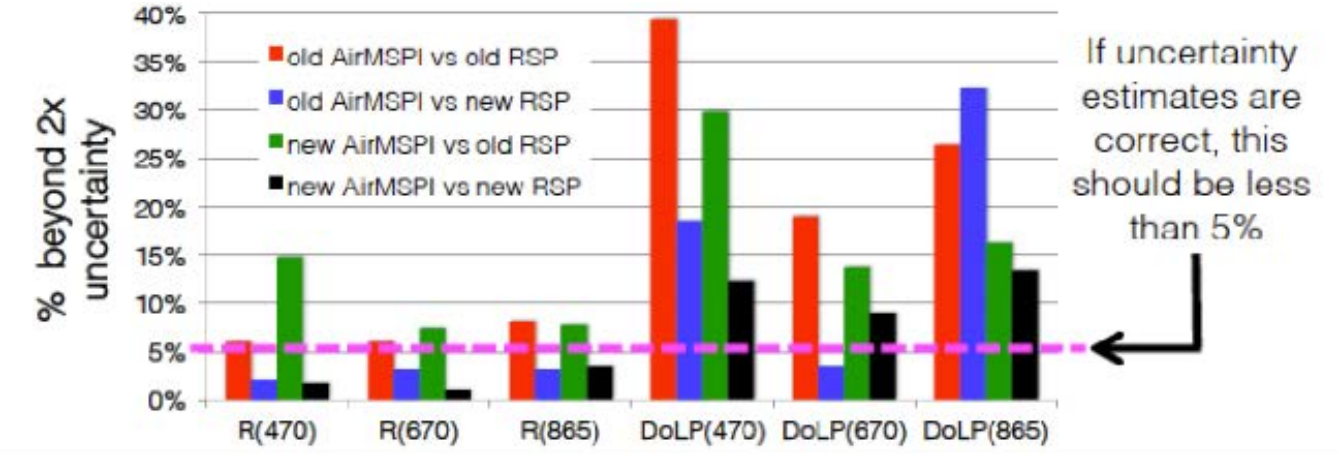


Low [SO_2]: instrument detection limit vs. small numerical value in model



Model underestimated SO_2 in high latitude in spring time.

Figure 5: Evaluation if modeled SO_2 vertical distributions



Aerosol Remote Sensing

NASA: Jens Redemann
BAERI: M. Kacenelenbogen, Y. Shinozuka, M. Segal-Rozenhaimer, Q. Zhang

In 2015 NASA selected a team led by BAERI's Dr. Meloë Kacenelenbogen to study atmospheric aerosols. Through the three-year project, Dr. Kacenelenbogen will work with scientists from NASA, NOAA, and several universities on a number of tasks designed to improve the predictions made by chemical transport models regarding the composition of aerosols present in the atmosphere. The team has developed a flexible aerosol classification algorithm called Specified Clustering and Mahalanobis Classification (SCMC) that assigns an aerosol type to multi-parameter retrievals by spaceborne, airborne, or ground-based passive remote sensing instruments. This algorithm aims to improve the predictions of aerosol composition in chemical transport models (CTMs) and global climate models (GCMs). The method uses Mahalanobis classification with pre-specified clusters (or classes). The pre-specified classes were defined using parameters retrieved from AERONET stations where a single aerosol type tends to dominate in certain months. The aerosol types identified by this scheme are pure dust, polluted dust, urban-industrial/developed economy, urban-industrial/developing economy, dark biomass smoke, light biomass smoke, and pure marine.

2015 Accomplishments

- Applied the SCMC method to two different total-column datasets of aerosol optical properties: inversions from the ground-based AErosol RObotic NETwork (AERONET) and retrievals from the space-borne POLDER (Polarization and Directionality of Earth's Reflectances) instrument;
- Produced global monthly maps of the most common POLDER-derived and AERONET- derived SCMC aerosol types, respectively over ocean and over land surfaces;
- Investigated how total-column "effective" SCMC aerosol types relate to different aerosol types within the column; and
- Translated each SCMC aerosol type into a unique distribution of GEOS-Chem aerosol composition (e.g. biomass burning, dust, sulfate, sea salt).

Publications and Presentations

Kacenelenbogen et al., Aerosol types using passive remote sensing: global distribution, consistency check, total-column investigation and translation into composition derived from climate and chemical transport models, Oral, American Geophysical Union (AGU), 12/14-18 2015.

Kacenelenbogen et al., Preparing for ORACLES: A few satellite derived aerosol and cloud properties in the South East Atlantic, Poster, ORACLES Science Team, NASA AMES, USA, September 2015.

Kacenelenbogen et al., Aerosol types from spaceborne remote sensing observations over the globe: from clear-sky to above low opaque water clouds, Poster, National Academy of Science, Irvine, USA, 06/23-24 2015.

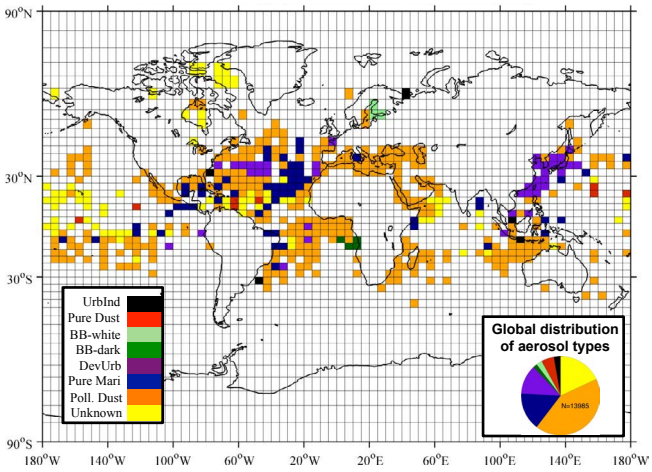


Figure 6: -Preliminary results- POLDER/PARASOL satellite-derived SCMC aerosol types (i.e. UrbInd: urban-industrial/developed economy, Pure dust, BB-white: light biomass smoke, BB-dark: dark biomass smoke, devUrb: urban-industrial/developing economy, Pure Marine, Polluted dust, unknown/other) in August 2006. "Unknown" aerosol types (yellow) have <1% probability of belonging to any of the aerosol types cited above. The map shows the most common aerosol type with a unique maximum occurrence frequency of at least 5 occurrences in each 4 x 5° grid cell. The insert pie chart shows the distribution of all daily 2 x 2° POLDER-derived aerosol types.

Alpha Jet Atmospheric Experiment (AJAX)

NASA: Warren Gore, Laura Iraci
BAERI: Quincy Allison, Steven Todorov, Emma Yates, Chris Camacho

The Alpha Jet Atmospheric Experiment (AJAX) project at NASA-ARC makes in situ measurements of the important greenhouse gases, CO_2, CH_4, and O_3 as well as associated meteorological measurements during flight. Using a jet aircraft, the project routinely collects vertical profiles of 3-D wind speeds and gas concentrations from near the surface up to ~ 27,000 ft. and over locations such as: the California Central Valley, Edwards Air Force Base, Railroad Valley, NV, and over the Pacific Ocean. Boundary layer measurements like these can indicate surface sources of greenhouse gases such as fires, oil and gas infrastructure, livestock, and urban pollution.

AJAX project goals are to: 1) study local photochemical smog production, 2) provide data for long-term studies of Pacific transport of pollution, and 3) support the observation of greenhouse gases from satellites through in situ validation measurements. Because of the jet's range and fuel load, measurements are focused along the California coast and locations in the far western United States. However, NASA's flexible relationship with the aircraft provider together with the aircraft's base at Moffett Field allow the AJAX team to collect data on a bi-weekly basis over multiple seasons, and often on demand for specific events such as California wildfires. Further, the long-term and dedicated availability of this platform provides for long term in situ data collection, a unique complement to surface and tower-based observations in the region. Validation data for satellite sensors can also be obtained over months and years with this platform to help assess sensor health and calibration.

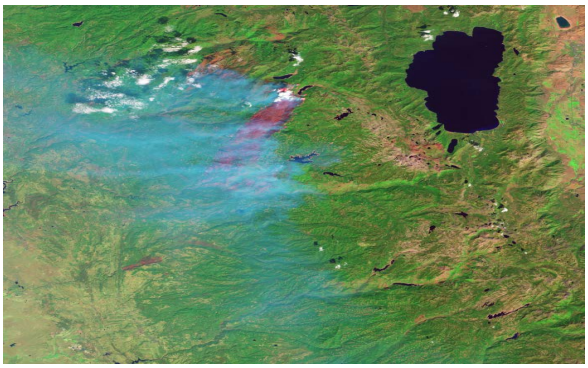


Figure 7: The King fire, burning in El Dorado National Forest as captured by Landsat-8 . ARC-CREST researchers measured CO_2 and CH_4 in the King fire plume from the Alpha Jet platform.

AJAX supports NASA's Orbiting Carbon Observatory (OCO-2) Science Team and is developing collaborations with NASA-ARC personnel in the areas of instrument development, systems engineering, science mission development, and project management.

Figure 8: A view of the Alpha Jet research platform, based at NASA-ARC. Instruments are housed in specially designed wing pods.

2015 Accomplishments

- Provided hands-on training for Ames personnel in the areas of instrument development, systems engineering, science mission development, and project management;
- Collected greenhouse gas measurements above the sampling towers in Walnut Grove, California;
- Began a series of upwind/downwind ozone profile measurements intended to address the inflow of ozone during a variety of weather patterns and seasonal cycles; and
- Provided direct mapping of the vertical and horizontal ozone concentrations offshore and over the San Joaquin Valley to better understand trans-Pacific pollution transport and its effects on air quality in California.

Publications and Presentations

J. Mee Ryoo, et al. Investigation of ozone sources in California using AJAX airborne measurements and models: Implications for stratospheric intrusion and long range transport, presented at the AGU Fall Meeting, Dec 2015.

Yates, E. et al, Investigating the Impacts of Wildfires on Air Quality in the Western US Presented at the AGU Fall Meeting, Dec 2015.

Cirrus Cloud Modeling

NASA: Eric Jensen
BAERI: Bill McKie

This project provides computer hardware selection, hardware assembly, hardware maintenance, system software installation, system software maintenance, system administration, application programming consulting, documentation, testing, networking, and security in support of atmospheric science cloud studies that include modeling and observed data analysis. Computing platforms include three Beowulf clusters with remote network access to interactive and batch computing under Linux operating systems, a central gateway Linux system for remote access to the clusters, plus support for several versions of the OS-X operating systems configured with add-on software and configurations for use in scientific environments.

2015 Accomplishments

- Completed bi-weekly, weekly, bi-monthly, monthly online, off-line, and off-site user file safety backups;
- Obtained and installed Linux and OS-X system updates;
- Updated online system documentation;
- Kept familiarity with various flavors of Linux systems up-to-date by doing installs and explorations on test bed systems;
- Maintained NASA Certified System Administration credentials by completing the annual coursework and tests;
- Completed annual review of Linux system NASA Ames Code-S and Center for Internet Security controls;
- Installed, tested, and documented the latest OS-X 10.11 [El Capitan] system on test bed hardware in preparation for possible future use by group members;
- Assembled PC test bed computer, installed latest Scientific-Linux system software, and explored the KVM virtualization system with various Linux and Windows virtual machines;
- Created programming language demos for analysis and graphics for group members; and
- Explored a preliminary exposure to the Apple Swift programming language under OS-X, using command line scripting and the Xcode development environment.

Orbiting Carbon Observatory – 2 Errors/Profiles (OCO-2 E/ OCO-2 P)

NASA: Steve Hipskind, Dave Alfano
BAERI: Susan Kulawik
Colorado State University: Chris O'Dell

Susan Kulawik and Chris O'Dell, together with other members of the Orbiting Carbon Observatory-2 (OCO-2) science team, are developing algorithms for analyzing the data from the OCO-2 instrument that is aboard a satellite in earth orbit. The instrument, consisting of three high-resolution grating spectrometers, is acquiring precise measurements of atmospheric CO_2, at high spatial and temporal resolution and with global coverage. OCO-2 was launched from the Vandenberg Air Force Base in California on a dedicated Delta II rocket in July 2014. OCO-2 has a planned operational life of two years and is taking measurements crucial scientists improving their understanding of the carbon cycle. For example, comparison of OCO-2's measurements of atmospheric CO_2 with carbon model outputs will allow scientists to verify the magnitude of the carbon sink in tropical forests or the amount of carbon released by forest fires.

OCO-2 is unprecedented not only in the sheer number of atmospheric CO_2 measurements it can take each day (~ 1 million measurements across a single swath) but also in the precision of the measurements. OCO-2 acquires data in three different measurement modes.

In Nadir Mode,the instrument views the ground directly below the spacecraft. In Glint Mode, the instrument tracks near the location where sunlight is directly reflected on the Earth's surface. Glint Mode enhances the instrument's ability to acquire highly accurate measurements, particularly over the ocean. In Target Mode, the instrument views a specified surface target continuously as the satellite passes overhead.

Target Mode is especially important to the data processing as it provides the capability to collect a large number of measurements over sites where ground based and airborne instruments also measure atmospheric CO_2 and the satellite and ground based measurement can be compared. Because the changes in atmospheric CO_2 that OCO-2 seeks to measure are so small, the science team takes unusual precautions to ensure the measurements are free of errors. Comparison to ground based sites such as the Total Carbon Column Observatory Network (TCCON), which is fully calibrated and extremely accurate, and an extensive algorithm development and testing process are critical to ensuring the Observatory's measurements are error free.

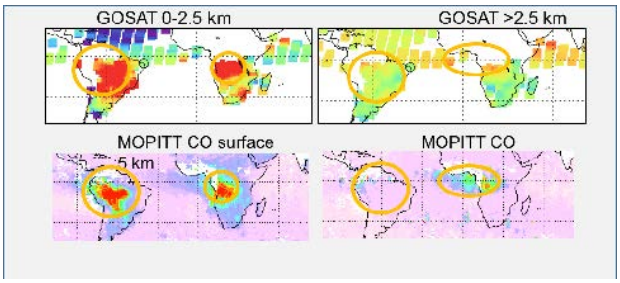


Figure 9: MOPITT multi-spectral CO is used to validate the partitioning between LMT-XCO_2 and U-XCO_2 in the tropics where the GOSAT prior is constant vertically. In the burning season, high values are seen at the surface in South America for GOSAT LMT-XCO_2 and MOPITT. Outflow shows up in the free troposphere in later months.

2015 Accomplishments

- Developed and validated a GOSAT lowermost tropospheric product for the entire ACOS-GOSAT record;
- Worked on the assimilation of a new product that was introduced at the OCO-2 meeting, California Institute of Technology, 4-6 November, 2015 and was presented at the AGU meeting, 14-18 December, 2015;
- Quantified the different errors affecting OCO-2 results using simulated runs: non-linear error, measurement error, interferent error, and smoothing error;
- Used runs with the simulated system to test possible updates to the OCO-2 constraint;and
- Results have been shared with the algorithm team and are being written up into a paper.

Publications and Presentations

Kulawik, S. S., Wunch, D., O'Dell, C., Frankenberg, et al., Consistent evaluation of GOSAT, SCIAMACHY, CarbonTracker, and MACC through comparisons to TCCON, Atmos. Meas. Tech. Discuss., 8, 6217-6277, doi:10.5194/amtd-8-6217-2015, 2015.

Frankenberg,C., Susan Kulawik, Steve Wofsy, Gregory Osterman, Edward T. Olsen, Christopher O'Dell, Andy Jacobson, Frederic Chevallier, and HIPPO team. Using airborne HIAPER Pole-to- Pole Observations (HIPPO) to evaluate model and remote sensing estimates of atmospheric carbon dioxide.

11th International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-11), California Institute of Technology, 16-18 June 2015.

Initial OCO-2 comparisons to TCCON at OCO-2 meeting, California Institute of Technology, 4-6 November, 2015.

Total Carbon Column Observing Network (TCCON)

NASA: Laura Iraci, Jim Podolskie
BAERI: Patrick Hillyard

NASA Ames deployed a Fourier Transform Spectrometer (FTS) as part of the Total Carbon Column Observing Network (TCCON) to the Armstrong Flight Research Center (AFRC) in July 2013. The TCCON FTS is a solar-looking spectrometer that captures solar interferograms throughout the course of the day. After post-processing and converting the interferograms into spectra, fitting routines and further processing can be performed to obtain column-averaged dry-air mole fractions for gases of interest by looking at specific spectral regions. Currently, TCCON provides mole fractions for CO_2, CH_4, CO, N_2O, HF, H_2O, and HDO. The TCCON data can be used alone, as part of the international TCCON network, or in conjunction with other instrumetation to perform studies that relate to the above-mentioned gases.

Furthermore, the launch of the OCO-2 satellite has brought with it the need for highly accurate data with which calibrations can be performed. The NASA Ames TCCON has provided a great deal of data for the purpose of OCO-2 calibration. It has additionally been utilized for comparison with GOSAT data, in conjunction with aircraft in-situ measurements, and for comparision of data from the relatively new, portable Bruker EM27 solar spectrometer.

2015 Accomplishments

- Maintained and managed the Linux workstation that is used for data processing and storage;
- Downloaded the data from the Armstrong Flight Research Facility (AFRC), and processed it according to the TCCON protocol in order to be comparable to other instruments in the network;
- Analyzed data including the processing of FTS interferograms as well as the fitting of the spectra in spectroscopic regions of interest for a given gas;
- Managed quality control, transferred the data to the California Institute of Technology, and safely archived the data at NASA Ames; and
- Used the FTS data in conjunction with GOSAT data and in-situ data taken at a network of sites around Indianapolis.

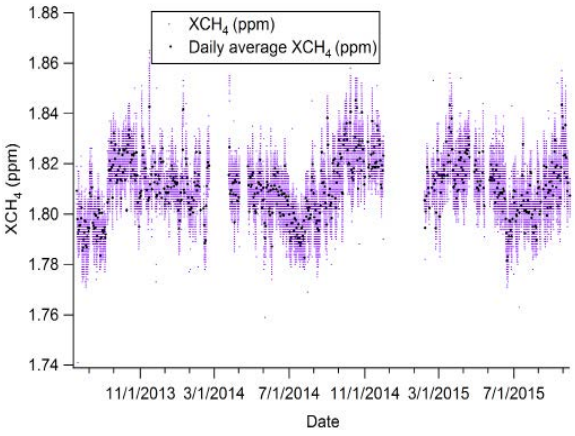


Figure 10: Column averaged, mole fractions of CH_4 in parts per million as measured by the TCCON instrument deployed at NASA-AFRC. Daily averages are shown in black.

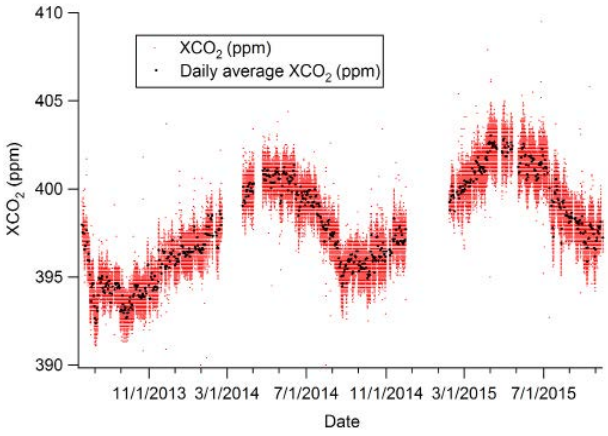


Figure 11: Column averaged, mole fractions of CO_2 in parts per million as measured by the TCCON instrument deployed at NASA-AFRC. Daily averages are shown in black.

Publications and Presentations

M. Inoue, et al. (L. Iraci, J.R. Podolske and P. Hillyard are among 46 co-authors). Bias corrections of GOSAT SWIR XCO_2 and XCH_4 with TCCON data and their evaluation using aircraft measurement data, Atmospheric Chemistry and Physics, submitted.

P. Hillyard et al. 2015. Detecting CO_2 and CH_4 urban emissions using column-integrated dry air mole fractions, in-situ tower atmospheric mixing ratios, and WRF modeling. 2015 AGU Fall Meeting.

Tropospheric Emission Spectrometer (TES)

NASA: John Worden
BAERI: Susan Kulawik

The Tropospheric Emission Spectrometer (TES) is an infrared spectrometer flying aboard the Aura satellite, currently in Earth orbit. Its high spectral resolution enables it to measure concentrations of many chemical constituents in our atmosphere including: ozone (O_3), carbon monoxide (CO), water vapor (H_2O), peroxyacetyl nitrate (PAN), formic acid (CH_2O_2), methanol (CH_3OH), methane (CH_4), and other gases. Measurements made by TES advance our understanding of the atmosphere's chemistry, knowledge that is a prerequisite to addressing air pollution and climate change. TES focuses on the troposphere, the layer of atmosphere that stretches from the ground to approximately 32,000 ft. TES can distinguish concentrations of gases at different altitudes, a key factor in understanding their behavior and impact. It is the first orbiting instrument able to measure ozone profiles, a very important chemical with regard to both global warming and air pollution.

ARC-CREST researchers and their partners at NASA-JPL are analyzing and interpreting TES data, making high quality TES data products available to the scientific community.

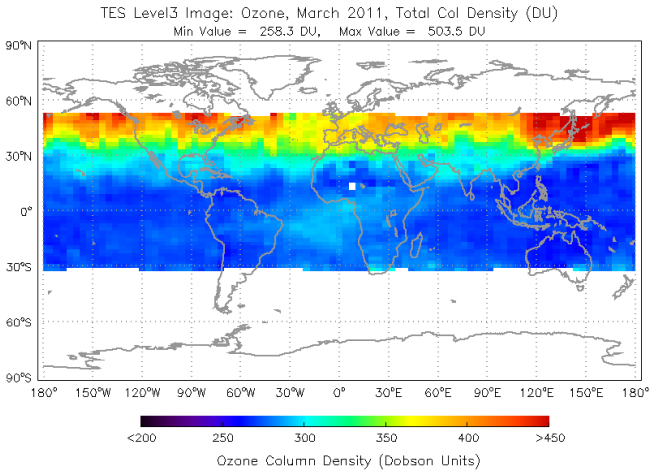


Figure 12: An example of data collected by the TES instrument. The figure is a global image of the total column density of ozone for the month of March in 2011. The ARC-CREST members of the TES team work to continually improve and expand the retrieval algorithms for TES data products.

Their work requires close coordination with the NASA Distributed Active Archive Center where these large datasets are hosted. Further, they work closely with the TES science team to expand the retrieval algorithms to capture additional atmospheric gas concentrations, to improve existing algorithms by reducing or better quantifying errors, and to conduct comparisons with other satellite or ground-based retrievals.

2015 Accomplishments

- Organized a bi-weekly conference call;
- Followed all and participated in many algorithmic changes;
- Participated in TES papers and promoted use of TES data. Papers in progress include: "Satellite observations of ethylene (C_2H_4) from the Aura Tropospheric Emission Spectrometer" and, "Inter-annual and spatial variability in tropospheric peroxyacetyl nitrate in the tropics from new infrared satellite observations"; and
- Made substantial algorithmic updates to the TES prototype so that it can easily process combined satellite observations (e.g. TES plus OMI and AIRS plus OMI).

Earth Science Data Records (ESDR)

NASA: Steve Hipskind, , Dave Alfano
BAERI: Susan Kulawik

The ESDR project supports the NASA Earth Science Data Systems Program. The Program's mission is to both manage and expand the many Earth science data records obtained from NASA satellites, airborne platforms, ground stations, and other sources. Management of these datasets includes archiving, algorithm development, calibration and validation, processing, quality control, and continued support to the user community. One component of the ESDR Program, the Earth System Data Records Uncertainty Analysis, seeks to extend and enhance Earth system data records used by NASA communities, including climate data records, through rigorous estimation of errors. Projects under the Earth System Data Records Uncertainty Analysis umbrella increase the scientific value of the measurements by identifying and validating systematic uncertainties in input data and physical models, and improving error estimations.

ARC-CREST scientists are working on developing and validating long-term records of atmospheric trace gases, including CO_2. They are using multiple remote sensing derived data products as well as airborne and ground-based data to create long-term, consistent data records of atmospheric CO_2 and other trace constituents. This data can be used for mitigation of natural hazards, K-12 science education, and other societal benefits.

2015 Accomplishments

- Compared measurements of carbon dioxide (CO_2) taken from satellites (TES, AIRS, GOSAT) and estimated from models (Carbon Tracker, and MACC) to aircraft data, starting with comparisons to the HIAPER Pole-to-Pole Observations (HIPPO);
- Updated comparisons between SCIAMACHY, GOSAT, MACC, and Carbon Tracker to TCCON, with a manuscript in preparation; and
- Focused on incorporating onto the analysis additional aircraft sets, sets co-located at TCCON sites and sets of OCO-2 data.

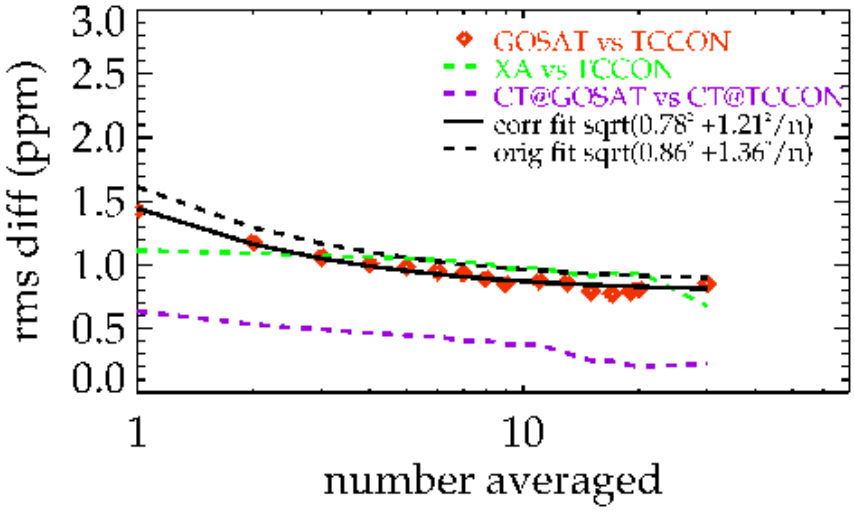


Figure 13: The ARC-CREST ESDR team is working with multiple measurements of CO_2, seeking to optimize the processing of this data for minimum error. In the plot above, the team is comparing the standard deviation in measurements of CO_2 in parts per million from GOSAT satellite to that of those from the TCCON ground network (red) and predictions from the CarbonTracker model (green). This plot shows that averaging only 3 GOSAT observations results in greatly reduced error.

Making Earth System Data Records for Use in Research Environments (MEaSUREs)

NASA: Cristina Milesi
BAERI: Pardha Teluguntla

The MEaSUREs project is part of NASA's Earth Science Data Systems Program, the mission of which is to both manage and expand the many Earth science data records obtained from NASA satellites, airborne platforms, ground stations, and other sources. The MEaSUREs project monitors global croplands to ensure sustainable water and food security. Development and maintenance of this data is important to climate scientists, agricultural scientists, farmers, natural resource managers, and national leaders.

Global Food Security-Support Analysis Data at 30 m (GFSAD30)

The goal of this research is to develop and implement spectral matching techniques (SMTs) and automated cropland classification algorithms (ACCA's) for production of multi-year cropland products that will help address food security issues using MODIS 250m time-series data for Australia.

Specific objectives include:

1. Development of reference cropland products for the year 2014 using novel spectral matching techniques based on ideal spectra of croplands generated using extensive field knowledge applied on MODIS time-series data;

2. Development of automated cropland classification algorithms using the reference data generated to train algorithms and then apply them to reference year 2014, as well as each year from 2000 to 2013;

3. Establish the accuracy of cropland products generated using spectral matching techniques and automated cropland classification algorithms, highlighting the ability of the algorithms to predict drought by applying them to data collected from 2000 to 2014.

Publications and Presentations

Teluguntla, P.,et al. 2015. Global Food security Analysis Data at nominal 1km(GFSAD) derived from Remote Sensing in Support of Food Security in the Twenty-first Century: Current Achievements and Future Possibilities. Chapter 6, Vol. II. Land Resources: Monitoring, Modelling, and Mapping, Remote Sensing Handbook edited by Prasad S. Thenkabail.

"Global Cropland Extent Products of Australia @ Nominal 250 m (GCE V2.0) Using MODIS Time-series Data and Cropland Mapping Algorithms: Results-2014" during GFSAD30m workshop conducted at U.S. Geological Survey, Reston,Virginia;

"Cropland Products of Australia @ MODIS 250m from 2000-2014 Using Spectral Matching Techniques and Automated Cropland Classification Algorithms (ACCA)" during GFSAD30m workshop conducted at Madison, Wisconsin.

2015 Accomplishments

- Produced Global Cropland Extent Version 2. 0 (GCE V2.0) at 250 m resolution for the reference year 2014 using MODIS time-series data, ground knowledge and Spectral Matching Techniques (SMTs) for Australia;
- Developed model for sub-pixel area calculations to estimate annualized crop area from different crop seasons;
- Developed Automated Cropland Classification Algorithm(ACCA) for Australia based on SMT derived reference cropland product for the year 2014;
- Applied ACCA on MODIS time series data for production of multi-year cropland products year to year from 2000 to 2013;
- Released beta version of ACCA products for Australia through www.cropland.org;
- Prepared manuscript on "Spectral Matching Techniques (SMTs) and Automated Cropland Classification Algorithms (ACCA's) for Production of Multi-Year Cropland Products to Address Food Security Issues using MODIS 250m Time-series Data for Australia."

NASA Earth Exchange (NEX)

NASA: Rama Nemani
BAERI: Sangram Ganguly, Gong Zhang, Hengyue Zhang, Ed Boyda, Bridget Thrasher, Saikat Basu, Eileen Loh, Shrutiben Pavagadhi, Zhu Gu
CSUMB: Forrest Melton, Petr Votava, Alberto Guzman, Hirofumi Hashimoto, Andrew Michaelis, John Shupe, Weile Wang
University of California, Berkeley: Maggi Kelly
Louisiana State University: Supratik Mukhopadhyay

Under the NASA Earth Exchange (NEX) project (Nemani et al., 2011), ARC-CREST scientists and software engineers collaborated with scientists and engineers in the NASA Ames Earth Science Division and the NASA Advanced Supercomputing (NAS) Division to implement a first of its kind, collaborative supercomputing environment for global change research.

ARC-CREST researchers support the further development of NEX. They build and incorporate new technologies and extend NEX capabilities for research and applied science. Since its inception in 2011, the NEX project has evolved from having a single focus on ecological forecasting to providing access to large datasets, supercomputing capability, and the support of online collaborative space, thereby maximizing the scientific output of NASA's satellite data products and climate models and greatly facilitating collaboration in a way that was not previously possible. NEX maintains a large set of satellite observation and climate model data for use by NASA-supported researchers who are tackling science questions over large regional or global areas. NEX brings the Earth science community members into a virtual collaborative, where scientists can process large data sets, run model codes, and share the results and knowledge. As the data products and models available within NEX and the community utilizing NEX grow, the support needed to maintain this unique collaborative environment also grows.

ARC-CREST researchers collaborate closely with scientists in NASA Ames Earth Science Division, as well as the broader NASA Earth science community to apply NEX capabilities in assessing long-term and emerging trends in ecosystem conditions, conduct simulations of climate and land use change impacts on terrestrial and aquatic ecosystems, map patterns in biodiversity, and monitor biomass at local to continental scales. The NEX team also supports applied science activities, such as development of indicators of climate change impacts for Landscape Conservation Cooperatives and NASA Centers, development of information products to support land managers, agricultural producers, and water managers throughout the U.S. NEX also supports monitoring and modeling of natural disasters and emerging public health threats.

NEX is currently funded by NASA as an "Enabling Tool" to support the National Climate Assessment (related research and "Sustained Assessment" activities). NEX is now also part of the Big Data and Climate Data initiatives that aim to promote the use of government data for creating new solutions for climate change. The OpenNEX initiative, a collaboration between NASA and Amazon Web Services, develops cloud-hosted tools and solutions for dealing with satellite and climate data (e.g. virtual labs) and also climate science through lectures by experts and challenges. Development of these tools and maintenance and administration of the OpenNEX platform are also done by ARC-CREST researchers. Additional information about NEX can be found at: https://nex.nasa.gov/nex/

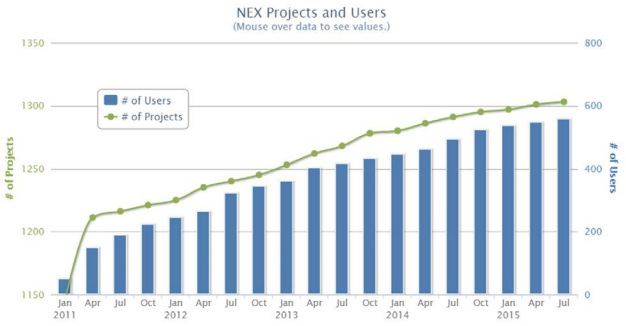


Figure 14: The NEX community of users has grown substantially over the past 3 years. ARC-CREST researchers now provide support for over 1300 projects and nearly 600 users. NEX is a one of its kind virtual platform for studying and collaborating on Earth science projects.

2015 Accomplishments

• Supported 181 NEX users and more than 22 active research projects on NEX;

• Worked with 10 science team to scope use of NEX as part of the NASA Climate Indicators program;

• Completed and released the NEX Global Daily Downscaled Projections in support of the President's Climate Initiative and the U.S. - India Bilateral agreement on climate change;

• Completed a prototype of global Landsat high-resolution visualization pipeline for NASA's EOSDIS. This will provide native (30-m) resolution imagery to the Global Image Browse Services (GIBS) while processing over 5PB of data;

• Completed integration of new generation Landsat production pipeline for NASA-funded WELD project. This pipeline consists of over 30 different components and currently produces monthly and annual Landsat surface reflectance composites. To accommodate the WELD project this system will process over 20PB of data;

• Successfully completed 3-year project funded by NASA's Advanced Information Systems Technology (AIST) program - "Semi-Automatic Science Workflow Synthesis for High-End Computing on the NASA Earth Exchange." This project demonstrated an important set of capabilities for the NEX science platform-transparent knowledge capture by observing user actions; automatic conversion of user processes into workflows; seamless workflow execution in both supercomputing as well as cloud environments; process and data provenance capture, indexing and search capabilities; API for building and tearing down cloud infrastructure depending on the processing needs;

• Successfully completed 3-year project funded by NASA's Advanced Information Systems Technology (AIST) program - "Semi-Automatic Science Workflow Synthesis for High-End Computing on the NASA Earth Exchange." This project demonstrated an important set of capabilities for the NEX science platform-transparent knowledge capture by observing user actions; automatic conversion of user processes into workflows; seamless workflow execution in both supercomputing as well as cloud environments; process and data provenance capture, indexing and search capabilities; API for building and tearing down cloud infrastructure depending on the processing needs;

• Expanded development of NEX analytics capabilities by improving SciDB scalability, adding additional data loaders and co-developing SPARK-based large-scale analytics and visualization solution with Kitware;

• Completed national modeling of combined impacts of climate and land-use change at 800m spatial resolution. Presented research results at Ecological Society of America meeting and at meetings with National Park Service. Summary of results for Landscape Conservations Cooperatives accepted for publication; and

•Organized and hosted the NEX Advisory Committee and NEX User Working Group meetings.

Publications and Presentations

Melton, F.et al. 2015. Quantifying Impacts of Climate and Land Use Change on Ecosystem Processes in the Great Northern and Appalachian Landscape Conservation Cooperatives. In Climate change in wildlands: Pioneering approaches to science and management in the Rocky Mountains and Appalachians, A. Hansen, W. Monahan, and D. Theobald (eds.), Island Press, (in press).

Zhang, J., C. Lee, P. Votava, T. J. Lee, R. Nemani, I. Foster. 2015. A community-oriented workflow reuse and recommendation technique, International Journal of Business Process Integration and Management.

Wang, W. and R. Nemani. 2015. Dynamic Responses of Atmospheric Carbon Dioxide Concentration to Global Temperature Changes between 1850 and 2010, Advances in Atmospheric Sciences (in press).

Maurer, E.P., D.L. Ficklin, and W. Wang. 2015. The impact of spatial scale in bias correction of climate model output for hydrological impact studies, Hydrol. Earth Syst. Sci.

Tian, H., C. Lu, J. Yang, Wang, W. and et al. 2015. Global patterns and controls of soil organic carbon dynamics as simulated by multiple terrestrial biosphere models: current status and future directions", Global Biogeochemical Cycles, 775-792.

Schwalm, C.R., D.N. Huntzinger, J.B. Fisher, W. Wang, and et al., 2015. Toward 'optimal' integration of terrestrial biosphere models, Geophysical Research Letters, 4418-4428.

Mao, J., W. Fu, X. Shi, W. Wang, and et al., 2015. Disentangling climatic and anthropogenic controls on global terrestrial evapotranspiration trends, Environ. Res. Lett. doi:10.1088/1748-9326

Basu, S. et al. 2015. A Semiautomated Probabilistic Framework for Tree-Cover Delineation From 1-m NAIP Imagery Using a High-Performance Computing Architecture, Geoscience and Remote Sensing, IEEE Transactions on, vol.53, no.10, pp.5690,5708, Oct. 2015.

Goward, S.N., C. Huang, F. Zhao, K. Schleeweis, K. Rishmawi, M. Lindsey, J.L. Dungan, and A. Michaelis. 2015. NACP NAFD Project: Forest Disturbance History from Landsat, 1986-2010. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1290.

Basu, S., Karki, M, Ganguly, S., DiBiano, R., Mukhopadhyay, S., Nemani, R.R. 2015. Learning Sparse Feature Representations using Probabilistic Quadtrees and Deep Belief Nets, European Symposium on Artificial Neural Networks, ESANN 2015.

Basu S., Karki M., Stagg M., DiBiano R., Ganguly S. and Mukhopadhyay S. 2015. MAPTrack -A Probabilistic Real Time Tracking Framework by Integrating Motion, Appearance and Position Models. In Proceedings of the 10th International Conference on Computer Vision Theory and Applications, ISBN 978-989-758-091-8, pages 567-574. DOI: 10.5220/0005309805670574.

Basu S., Ganguly S., Mukhopadhyay S., DiBiano R., Karki M., and Nemani, R.R. 2015. DeepSat - A Learning framework for Satellite Imagery, ACM SIGSPATIAL 2015. (pdf).

Tang, H., Brolly, M., Zhao, F., Strahler, A. H., Schaaf, C., Ganguly, S., Zhang, G. and R. Dubayah. 2014. Deriving and validating Leaf Area Index (LAI) at multiple spatial scales through lidar remote sensing: A case study in Sierra National Forest, CA, Remote Sensing of Environment, 143 (5),131-141, DOI: 10.1016/j.rse.2013.12.007.

Tang, H., Ganguly, S., Zhang, G., Hofton, M. A., Nelson, R. F. and R. Dubayah. 2015. Characterizing Leaf Area Index (LAI) and Vertical Foliage Profile (VFP) over the United States, Biogeosciences Discussions, 12, 13675-13710.

Bi, J., et al., (Ganguly, S. amongst 23 authors). 2015. Sunlight mediated seasonality in canopy structure and photosynthetic activity of Amazonian rainforests, Environmental Research Letters, 10 (6), DOI: 10.1088/1748-9326/10/6/064014.

Invited Talk, Sangram Ganguly, Comsnets 2015, January 6-10, 2015, Bangalore, India. Web URL: http://www.comsnets.org/agrinets_workshop.html

Invited Talk, Sangram Ganguly, Global Maritime Workshop 2015. Web URL: http://nmio.ise.gov/Portals/16/GMF%20Reports/Docs/GMF%202015.pdf?ver=2015-12-08-

Invited Talk, Jennifer Dungan, Sangram Ganguly, NASA Carbon Cycle and Ecosystems Joint Science Workshop, April 20-24, 2015, College Park, MD, "NEX system processing for Landsat-8/Sentinel-2 data" Web URL: http://lcluc.umd.edu/Documents/ScienceTeam-Mtg/2015_APR/AGENDA%20Sentinel2%20Meet ing%202015%20-College%20Park.pdf

Invited Talk, Sangram Ganguly, Comsnets 2015, January 6-10, 2015, Bangalore, India. Web URL: http://www.comsnets.org/agrinets_workshop.html

Invited Talk, Sangram Ganguly, Global Maritime Workshop 2015. Web URL: http://nmio.ise.gov/Portals/16/GMF%20Reports/Docs/GMF%202015.pdf?ver=2015-12-08-105435-287

Invited Talk, Sangram Ganguly, EDIP-Fed, Asilomar, 2015. Web URL: http://earthsciencefoundation.org/esipfed-summer-meeting/

Invited Talk, Sangram Ganguly, Expeditions in Computing: Understanding Climate Change, Minnesota 2015. Web URL: http://climatechange.cs.umn.edu/annual_program_2015.php

Invited Talk, Sangram Ganguly, Berkeley Institute for Data Science Lecture Series, Berkeley, 2015 Web URL: http://bids.berkeley.edu/resources/videos/nasa-earth-exchange-nex-big-data-challenges-high-performance-computing-and-machine

F. Melton, W. Wang, J. Xiong, A. Guzman, A. Quackenbush, C. Milesi, R. Nemani et al. 2015. Modeling Impacts of Climate and Land Use Change on Ecosystem Processes: Quantifying Exposure to Climate Change in Two Landscape Conservation Cooperatives. Ecological Society of America, Baltimore, MD, Aug 11, 2015.

P. Votava, S. Ganguly, A. Michaelis. 2015. "NASA Earth Exchange (NEX). Supporting Science at a Petabyte Scale". Big Data Big Think Workshop. NASA Ames, April 2015.

P. Votava, A.Michaelis. 2015. "Building Petabyte Data Production Systems with the NASA Earth Exchange (NEX)". IEEE Supercomputing Conference, Austin, TX.

P. Votava, A. Michaelis, R. Nemani. 2015. "Reproducibility and Knowledge Capture Architecture for the NASA Earth Exchange (NEX)". AGU 2015, San Francisco.

W. Wang, R. Nemani. 2015. "The Dynamics of Global Atmospheric CO_2 Concentration from 1850 to 2010: A Linear Approximation". NACP 5th Workshop, Washington DC.

W. Wang. 2015. "The dynamics of atmospheric CO_2 over interannual to multidecadal scales in the past 150 years". Fluxnet Synthesis Workshop, Beijing, China.

W. Wang, H. Hashimoto, R. Nemani, and et al. 2015. "Impacts of Lateral-Boundary-Condition Errors on Regional Climate Downscaling: lessons learned from the NASA Downscaling Project". AGU 2015, San Francisco.

H. Hashimoto, R. Nemani, and et al. 2015. "Estimation of spatial variability in humidity, wind, and solar radiation using the random forest algorithm for the conterminous USA". AGU 2015, San Francisco.

U. Kumar, R. Nemani, S. Ganguly, C. Milesi, K. Raja, W. Wang, P. Votava, A. Michaelis, "Continental Spatio-temporal Data Analysis with Linear Spectral Mixture Model using FOSS". AGU 2015, San Francisco.

Sentinel-2

NASA: Jennifer Dungan, Ramakrishna Nemani
BAERI: Sangram Ganguly

Sentinel-2 (S2) is a land monitoring constellation of two satellites that provides high resolution optical imagery by European Space Agency (ESA). Sentinel-2A is the first of two satellites was successfully launched in June 2015. Its MultiSpectral Instrument (MSI) capitalizes on the technology and the vast experience acquired with SPOT and Landsat over the past three decades. The S2 MSI samples 13 spectral bands: four bands at 10 meters, six bands at 20 meters and three bands at 60 meters spatial resolution.

NASA Earth Exchange (NEX) team has been working on radiometric cross-calibration of the S2MSI and Landsat-8 OLI sensors based on the latest released sample S2 images from ESA. An S2 processing pipeline has also been developed to provide research ready S2 imagery to the remote sensing community. The algorithm used for S2 atmospheric correction is consistent with standard Landsat OLI product, which provides potential data harmonization between Landsat 8 and S2. NEX supercomputing facility will be used to process daily-acquired S2 images.

Publications and Presentations

NASA Earth Exchange (NEX) Sentinel-2 Processing Pipeline. NASA LCLUC Spring Science Team Meeting, Apr. 22-23, 2015, College Park, MD.

Improving the frequency of high spatial resolution leaf area index maps using Landsat OLI and Sentinel-2 MSI. AGU Fall Meeting, Dec. 14-18, 2015, San Francisco, CA.

2015 Accomplishments

- Deployed S2 atmospheric correction tool (ESA) on NASA NEX;
- Processed all the released sample S2 data and compared with Landsat 8 images;
- Determined that the atmospheric correction tool (developed by ESA) is not reliable in its current status. Abnormal pixel values from derived S2 L2A products (surface reflectance) occur in all land cover types;
- Planned for the preparation of a process chain (scale codes from NASA's Goddard Space Flight Center) - the process chain involves multiple modules related to BRDF correction, georegistration, atmospheric correction, and regridding/reprojection routines;
- Prepared for the deployment of process codes to provide research-ready data (Surface Spectral Reflectance production) to MuSLI PIs; and
- Prepared to implement LAI algorithm for higher level product demo.

Carbon Monitoring Systems (CMS)

NASA: Rama Nemani
BAERI: Sangram Ganguly, Saikat Basu
CSUMB: Shuang Li

An unresolved issue with coarse-to-medium resolution satellite-based forest carbon mapping over regional to continental scales is the high level of uncertainty in above-ground biomass (AGB) estimates caused by the absence of forest cover information at a high enough spatial resolution (current spatial resolution is limited to 30-m). To put confidence in existing satellite-derived AGB density estimates, it is imperative to create continuous fields of tree cover at a sufficiently high resolution (e.g. 1-m) such that large uncertainties in forested area are reduced. In addition, validation and accuracy assessments of present remote-sensing AGB modeling approaches rely on the Forest Service Inventory and Analysis Program (FIA) AGB estimates at regional grids (e.g. county, subecoregions) as a benchmark. The goal of this project is to reduce the uncertainty of present CMS AGB Products and FIA-based regional estimates. In order to achieve the project goal, our primary objective will be to create Very High Resolution (VHR) estimates of tree cover at a spatial resolution of 1-m for the continental United States using all available National Airborne Imaging Program (NAIP) color-infrared imagery from 2010 through 2012.

The proposed 1-m tree cover map can be further aggregated to provide percent tree cover at any medium-to-coarse resolution spatial grid, which will aid in reducing uncertainties in AGB density estimation at the respective grid and overcome current limitations imposed by medium-to-coarse resolution land cover maps. Estimates of VHR tree cover will complement and enhance the accuracy of present remote-sensing based AGB modeling approaches and forest inventory based estimates at both national and local scales as part of ongoing CMS activities. A requisite step will be to characterize the inherent uncertainties in tree cover estimates and propagate them to estimate AGB. To perform the proposed tasks, the team will leverage the existing capabilities of the NASA Earth Exchange (NEX) high-performance computing and storage facilities.

2015 Accomplishments

• Built the deep learning module and trained and tested the algorithm over the state of

California;

• Validated the results with both LiDAR and manual samples. Accuracies are in the order of ~90% for homogeneous forested areas and in the order of ~80% for urban and heterogeneous landscapes;

• Ran the algorithm for the whole state of California comprising ~13000 NAIP 1--m scenes; and

• Deployed the algorithm on the Amazon Web Services cloud architecture to demonstrate the scalability of this Big Data project.

Publications and Presentations

Reducing Uncertainties in Satellite-Derived Forest Aboveground Biomass Estimates Using a High Resolution Forest Cover Map, CMS Science Team Meeting, Nov 16-18, 2015, Pasadena, CA.

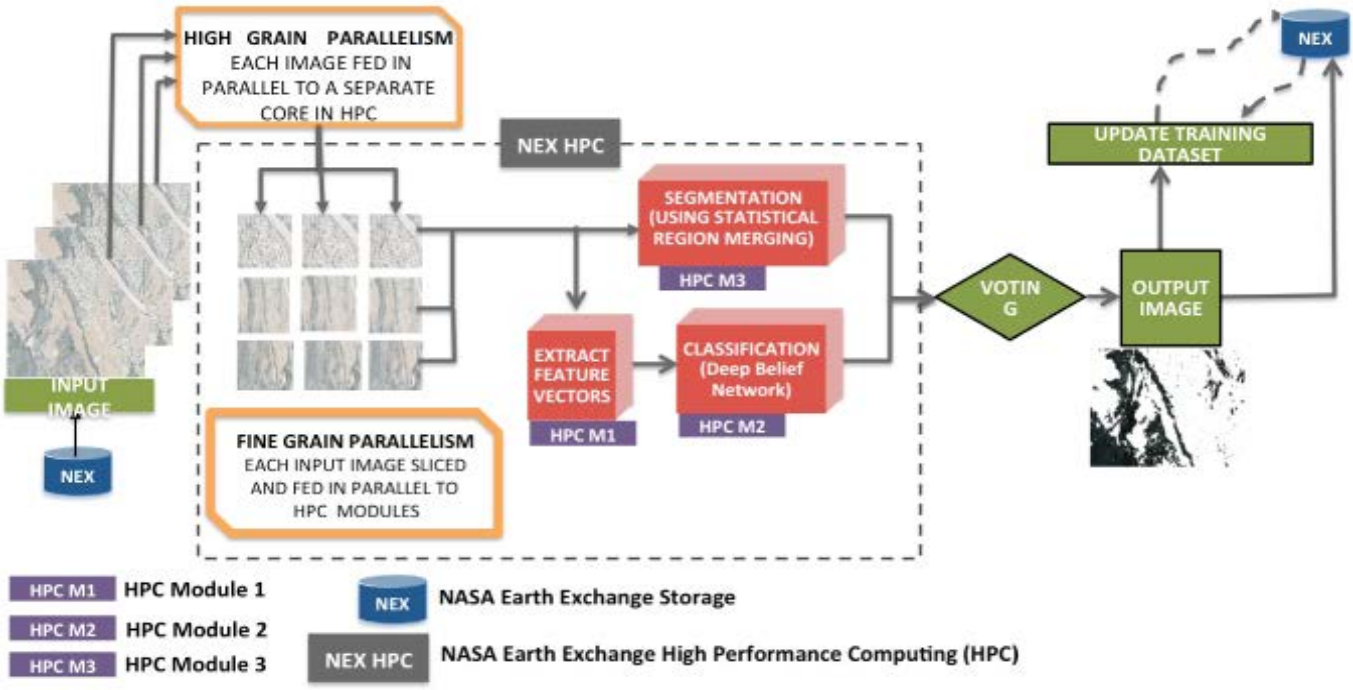


Figure 15: High performance computing architecture for generating very high resolution tree cover map. The processing (classification and segmentation) was performed on a quarter million NAIP image scenes.

Plant Physiology

NASA: Dave Bubenheim
BAERI: Dave Wilson, Greg Schlick

ARC-CREST researchers on the Plant Physiology team are studying the ecophysiology of biological systems in both synthetic and natural environments. In natural environments, the team is investigating how plants respond to environmental toxicity, bioremediation, and adaptation to climate change, as well as how invasive plant species impact ecosystem functions. This investigation is especially important because the range of many plant species is expected to shift with changing climate and associated changes in resource availability. As the climate changes, different types of plants may be co-located that were not historically within the same ecosystem. This project is currently focused on the Yellowstar Thistle and Cheatgrass, invasive species to California.

The team uses a variety of techniques including: forward osmosis for determining toxicity thresholds; growth chambers, and experiments to induce phenology changes; soil water dynamic studies; and remote sensing techniques (e.g. hyper-spectral imaging to view accumulation of toxins). These techniques are also used to investigate carbon flux and plant physiology.

Finally, the Plant Physiology team is developing "Sustainable, Closed Ecology Systems" to provide life support for space travel and other planetary habitats. Using plants to produce food, oxygen, and water while removing CO_2 from the air and recovering nutrients from wastes is important to achieving sustainable, self-sufficient human settlements in space or on other planets.

2015 Accomplishments

Water Hyacinth (WH) Mapping

• Developed a new methodology for generating bi-weekly WH percent cover maps from (30 meter) Landsat satellite imagery for the SF Bay and Delta;

• Created and shared with CA-DBW a new SF Bay and Delta online map viewer for 30 meter WH percent cover layers from the past five years (http://cquest.arc.nasa.gov:8399/flexviewers/sf_wetlands/) ;

• Acquired and processed AVIRIS (15 meter) airborne hyperspectral imagery and classified pure stands of WH in the Delta for Landsat product verification; and

• Conducted on-water, field verification of mapping tool accuracy and relevance to directing field management practices such as herbicide application.

Submerged Aquatic Plant Mapping

• Acquired and processed AVIRIS (15 meter) airborne hyperspectral imagery and tested classification methods for Egaria densa; and

•Acquired and processed (2 meter) airborne hyperspectral imagery and tested classification methods for Egaria densa.

Delta Ecosystem Modeling

• Set-up successfully the USDA Soil and Water Assessment Tool (SWAT) for the Legal Delta area and tested agricultural drainage water quality simulations; and

• Overlaid actual agricultural drainage return pumping locations for Delta Island tracts.

Plant Environmental Response Testing

• Collected reviewed Water Hyacinth growth models;

• Developed environmental response input structure for model development; and

• Initiated controlled environment response studies with Water Hyacinth and Egaria densa.

Terrestrial Ecosystem and Carbon Simulation Modeling

NASA: Chris Potter
CSUMB: Steven Klooster; Vanessa Brooks Genovese

The main focus of this group is the study of trace gas fluxes (CO_2, CH_4, N_2O, and NO) and plant production at global and regional scales using the NASA-CASA (NASA-Carnegie-Ames-Stanford Approach). This model simulates controls over terrestrial production processes, interactions of trace gas flux components through nutrient substrate availability, soil moisture availability, temperature stress, soil texture, and microbial activity.

The NASA-CASA model is used for predicting ecosystem responses to global climate warming and changes resulting from land use patterns, understanding influences on terrestrial net primary productivity, quantifying carbon pools, and understanding biosphere-atmosphere interactions.

The NASA-CASA model has been used to generate maps of annual net primary production (NPP) and aboveground biomass carbon stocks or pools in forests over various regions of the world. An advantage of NASA-CASA results over most other available map products for forest carbon accounting is that NASA-CASA can cover an entire country at a relatively high resolution using a consistent method.

2015 Accomplishments

The Area-wide Management of Aquatic Weeds in the Delta

• Used LANDSAT (30 meter) biweekly satellite overflights and aerial imagery to produce maps of water hyacinth area coverage and standing biomass in order to predict where water hyacinth and other invasive aquatic plants are growing and moving in the Bay Area Delta;

• Customized the maps for the California State Parks, Division of Boating and Waterways (DBW) by adjusting reporting cells to align with treatment sites and categorization of sloughs and waterways; and

• Used the newest AVIRIS (15 meter) and SPECTIR (2 meter) airborne hyperspectral imagery to assess and verify the invasive maps.

The Hawaii Coffee Berry Borer Modeling

• Prepared to use the HERMES model to predict environmental and meteorological conditions which are favorable to the coffee berry boring beetle which is causing widespread damage and destruction of coffee fields in the state of Hawaii. This project is tracking and predicting the spread of the pest in order to assist in its management; and

• Worked with the HERMES modeling team to provide all of the environmental datasets needed to run the model as well as the development of a decision support system to enable data querying and visualization for the team.

Figure 16: The team provides support to users of SilvaCarbon, a technical assistance program sponsored by U.S. agencies and intended for forest managers around the world who use SilvaCarbon's models and outputs to understand changes in forest carbon.

Coastal Ocean Biology

NASA: Liane S. Guild, Kirk Knobelspiesse, Jens Redemann
BAERI: Juan L. Torres-Pérez, Sherry L. Palacios, Meloe Kacenelenbogen

One of the current projects, **Human Impacts to Coastal Ecosystems in Puerto Rico (HICE-PR**) aims at studying how anthropogenic impacts to watersheds in Puerto Rico eventually cause detrimental effects on the shallow coastal reefs of the Island. This is a highly interdisciplinary project involving scientists from diverse disciplines such as remote sensing, hydrology, geography, coral reef biology and ecology, and sociology. Remotely sensed images are used to study land cover/land use changes in PR along with extensive fieldwork to assess for changes in coral reefs structure through time. Bio-optical techniques are used to study changes in the spectral shape of coral reef benthic components and beach sediments as a tool to validate satellite or airborne images.

The High-Quality Optical Observations (H-Q2O) project aims to improve Atmospheric Correction and Remote Sensing of Water Quality in the Coastal Zone. It combines the use of an airborne sensor suite to characterize coastal atmospheric and aquatic properties through an end-to-end assessment of image acquisition, atmospheric correction, and sea-truth observations.

Hyperspectral Infrared Imager (HysplRI) is being used to understand ocean biodiversity through the development of remote sensing algorithms that enable a synoptic view of phytoplankton community structure using airborne and satellite ocean color observations. Statistical and deterministic approaches are used to define and track water masses in river plume systems and to discriminate among algal taxa in phytoplankton blooms. The team contributed an optical proxy for low salinity water to identify the Columbia River plume on the coastal shelf using satellite imagery, a statistical model to identify and track the evolution of sub-mesoscale features within the larger river plume water mass, and a bio-optical algorithm based on first principles of aquatic optics to discriminate among major phytoplankton taxa within an algal bloom. The phytoplankton discriminator is an important tool for detecting harmful algal blooms and tracing pathways of carbon through different phytoplankton- dominated ecosystems.

2015 Accomplishments

- In April 2015, the group presented two posters at the NASA Joint Sciences Meeting in Washington DC;
- Presented a poster summarizing results from both watersheds at the International Ocean Color Symposium in July 2015 in San Francisco;
- Held the 2nd Soil and Water Assessment Tool (SWAT) workshop in Puerto Rico in July 2015 where they worked with hydrological data from one of the watersheds. Additionally, during the 34th US Coral Reef Task Force Meeting in Fajardo, PR the students working on this project had the opportunity of presenting their particular results to NASA and other federal and local agencies' representatives;
- Collected benthic coral reef data for two reefs associated with the Manatí river watershed in the north coast of the Island during April-May;
- Collected additional benthic data from the reefs located in the southwest coast associated with the Río Loco watershed in October-November. The benthic data collected so far in both watersheds sums to more than 6,000 photogrids;
- Collected field spectral information at Pinto Lake in Watsonville with a GER 1500 spectroradiometer for the validation of airborne images obtained with the AVIRIS and MASTER sensors on-board the ER-2 aircraft;
- Used the full capacity of the 14-channel Ames Airborne Tracking Sunphotometer (AATS-14) as input to an atmospheric correction model for an improved water color characterization;
- Completed field component of the HysplRI Airborne Campaign;
- Published work from the HysplRI project in a special issue of Remote Sensing of Environment;

• Made progress on employing different atmospheric correction algorithms on the airborne imagery from COAST (H-Q2O project);

• Worked with members of the coastal and inland aquatic studies community to write a white paper for the National Research Council Decadal Survey; and

• For the HyspIRI Preparatory Mission in Monterey Bay, the team collected field spectral information at Pinto Lake in Watsonville and at a white target site in Moss Landing for the validation of airborne images obtained with the AVIRIS and MASTER sensors on-board the ER-2 aircraft.

Figure 17: ARC-CREST researcher Dr. Juan Torres-Perez takes measurements of corals off of Puerto Rico's south coast to better understand changes to this environment from riverine inputs.

Publications and Presentations

Torres-Pérez JL, LS Guild, RA Armstrong, J Corredor, A Zuluaga-Montero, and R Polanco. In Press. Relative pigment composition and remote sensing reflectance of Caribbean shallow-water corals. PLoSONE.

Palacios S, RM Kudela, LS Guild, KH Negrey, J Torres-Pérez, and J Broughton. 2015. Remote sensing of phytoplankton functional types in the coastal ocean from the HyspIRI Preparatory Flight Campaign. Remote Sensing of the Environment. 167. DOI:10.1016/j.rse.2015.05.014.

Kudela RM, SL Palacios, DC Austerberry, EK Accorsi, LS Guild, and J Torres-Pérez. 2015. Application of hyperspectral remote sensing to cyanobacterial blooms in inland waters. Remote Sensing of the Environment. 55. DOI:10.1016/j.rse.2015.01.025.

Barreto-Orta M, JL Torres-Pérez, J Ortiz-Zayas, L Santiago, S Setegn, L Guild, C Ramos-Scharrón, and RA Armstrong. 2015. Human impacts to coastal ecosystems in Puerto Rico (HICE-PR): Río Grande de Manatí watershed, a remote sensing, hydrologic, ecologic and socio-economic assessment with management implications. NASA Joint Sciences Workshop, April 2015, Maryland.

Torres-Pérez JL, Barreto-Orta M, J Ortiz-Zayas, L Santiago, S Setegn, L Guild, C Ramos-Scharrón, and RA Armstrong. 2015. Human impacts to coastal ecosystems in Puerto Rico (HICE-PR): Río Loco watershed (southwest coast PR), a remote sensing, hydrologic, ecologic and socio-economic assessment with management implications. NASA Joint Sciences Workshop, April 2015, Maryland.

Torres-Pérez JL, Barreto-Orta M, J Ortiz-Zayas, L Santiago, S Setegn, L Guild, C Ramos-Scharrón, and RA Armstrong. 2015. Human impacts to coastal ecosystems in Puerto Rico (HICE-PR): the Guánica and Manatí watersheds. International Ocean Color Symposium, July 2015, San Francisco, California. This poster was also presented at the 34th US Coral Reef Task Force Meeting in Fajardo, Puerto Rico, October 2015.

Disaster Management

NASA: Jim Brass
CSUMB: Vince Ambrosia, Robert Dahlgren, , Lee Johnson

The Disaster task is composed of two principal elements: 1) supporting the NASA Applied Science Program's Wildfire Program (formerly under the NASA HQ Disaster Program element, and 2) supporting the development of airborne UAS and related sensor system technologies to enable improved science and applications data collection mission for NASA and partnering agencies and organizations.

NASA-ARC and the Disaster team has a long-standing relationship (dating to 1980's) with various disaster management entities including the U.S. Forest Service (wildfires), CalFire (wildfires), and the California Office of Emergency Services (all hazard events). The primary focus has been development and application of NASA-derived technologies and scientific expertise within the wildfire characterization element. Since the 1990's, the ARC-CREST Disaster team has spearheaded the utilization of UAS and autonomous sensor systems optimized to support the remote sensing of fire. The team, working with NASA, USFS, and CalFire, has successfully demonstrated that UAS, with its payload and associated data analysis and communications suite, is a highly-developed (high Technology Readiness Level (TRL)) tool for wildfire decision support in an operational environment.

UAS case study missions demonstrate optimum flight and mission performance of UAS and drive development of aeronautical enhancements to optimize performance, endurance, and science mission capabilities. This approach encompasses maturation of new aircraft components through 3D printing as well as the development of adaptable platform payload configurations to enable sensor system interchangeability.

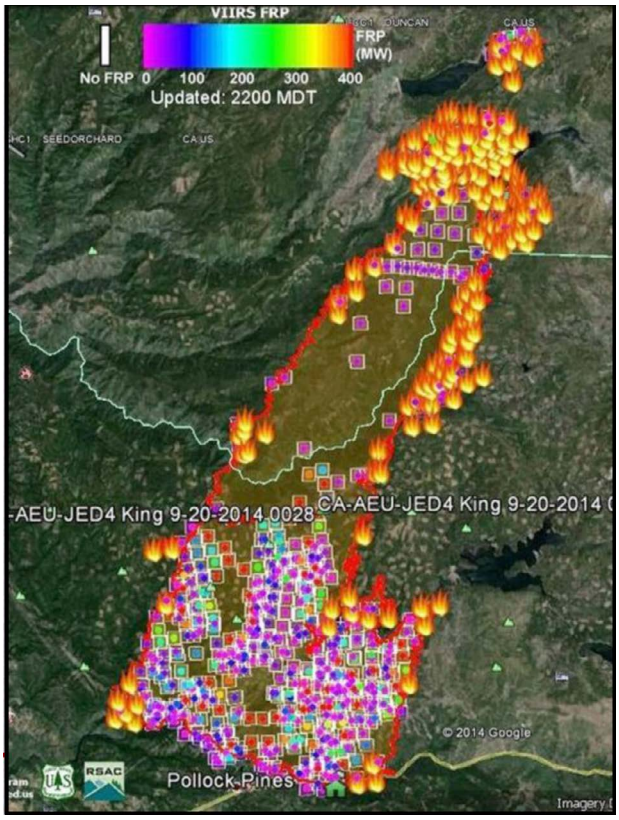


Figure 18: At the Tactical Fire Remote Sensing Advisory Committee Meeting, CalFire representatives reported that California Fire Agencies used remote sensing on 55 incidents in 2014 with 348 flights.

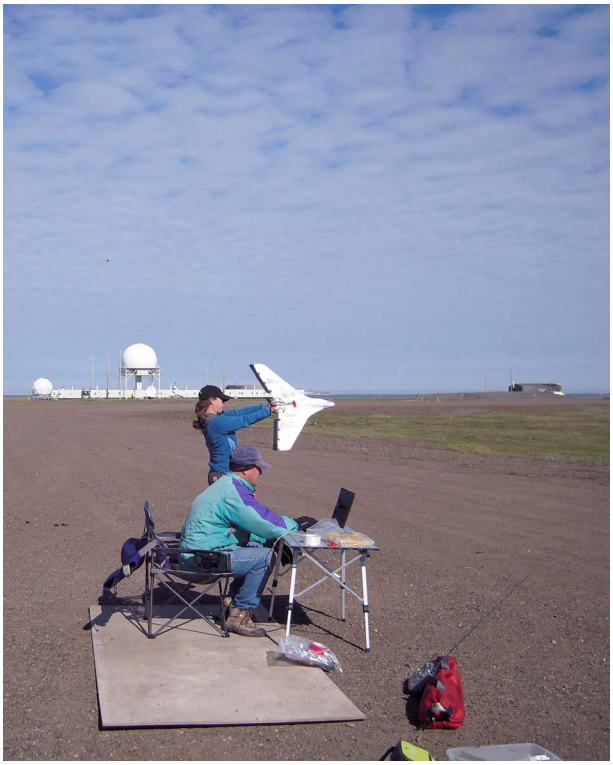


Figure 19: Pre-flight checks on the DataHawk UAS being conducted at Crows Landing, California.

2015 Accomplishments

- Focused on metrics development and accomplishment, budgetary control, and interface with partner organizations;
- Developed a number of wildfire remote sensing workshops for the applications community, provided programmatic outreach and materials to NASA HQ Administration, the White House Office of Science, Technology and Policy (OSTP), and briefing materials for the legislative branch and subcommittees;
- Implemented sensor capabilities on small UAS to fill a low-altitude sampling niche in ecosystem processes studies; and
- Co-led two Tactical Fire Remote Sensing Advisory Committee (TFRSAC) meetings in Boise, Idaho and at NASA-Ames in 2015.

Publications and Presentations

Dahlgren, R., "Fused PM fiber single-polarization resonator," US Patent 9,115,993 (2015).

Ambrosia, V.G., A. Soja, L. Friedl, 2015. NASA Fire Science and Applications: Building Capacity and Understanding of Ecosystem Dynamics. Keynote Address at 10th European Remote Sensing Laboratories (EARSeL) Forest Fire Special Interest Group Workshop, Limassol, Cyprus, 2 November 2015.

Ambrosia, V. G., A. Soja, L. Friedl, 2015. NASA Applied Science Program -Wildfires: Driving Research to Operations. 36th International Symposium on Remote Sensing of Environment (ISRSE), Berlin, Germany, 14 May 2015.

Ambrosia, V.G., R. P. Dahlgren, A. Watts, K. W. Reynolds, and T. Ball, 2014. UAS Developments Supporting Wildfire Observations. American Geophysical Union (AGU) fall Meeting, Poster: A23B-3221, San Francisco, CA, 16 December 2014.

Ambrosia, V. G., A. Soja, L. Friedl, 2014. NASA and Wildfires: Driving Research to Operations. 7th International Conference on Forest Fire Research, Coimbra, Portugal, 17-21 November 2014.

Dahlgren, R., "Modular UAVs for Bespoken Airborne Platforms for Science Applications," Eye on the Environment: Summit on Drones for Research and Conservation, (California Academy of Sciences, 17 Sept. 2015).

Dahlgren, R.P., "Customizing UAS platforms for the Federal mission: volcano hazards example" USGS Unmanned Aircraft Systems Technologies Workshop, (Reston, VA, 19-21 May 2015).

Dahlgren, R., O. Dary, J. Ogunbiyi, E. Pinsker, K. Reynolds, C. Werner, "Upcycling UAS into modular platforms for Earth science and autonomy research," AGU Fall Meeting, Abstract NH43C-1909 (San Francisco, 2015).

Dunagan, S., R. Johnson, C. Chang, Y. Shinozuka, M. Kacenelenbogen, R. Dahlgren, M. Segal Rozenhaimer, S. LeBlanc, B. Schmid, C. Flynn, "Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR)," NASA Instrumentation Workshop, (Moffett Field, CA,16 Sept. 2015).

Flynn, C., R.P. Dahlgren, S. Dunagan, B. Holben, R. Johnson, M. Kacenelenbogen, S. LeBlanc, J. Livingston, J. Redemann, B. Schmid, S. Schmidt, Y. Shinozuka, M. Segal Rozenhaimer, A. Sinyuk, Q. Zhang, "Highlights from 4STAR Sky-Scanning Retrievals of Aerosol Intensive Optical Properties from Multiple Field Campaigns with Detailed Comparisons of SSA Reported During SEAC4RS," AGU Fall Meeting, Abstract A23F-0394 (San Francisco, 2015).

Koltunov, A., B. Quayle, E. M. Prins, V. G. Ambrosia, and S. Ustin, 2014. From Data to Knowledge— Faster: GOES Early Fire Detection System to Inform Operational Wildfire Response and Management. American Geophysical Union (AGU) Fall Meeting, Oral Presentation: IN41D-02, San Francisco, CA, 18 December 2014.

Redemann, J., S. Dunagan, R. Johnson, C. Chang, Y. Shinozuka, M. Kacenelenbogen, R. Dahlgren, M. Segal Rozenhaimer, S. LeBlanc, B. Schmid, C. Flynn, "Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR)," NASA Instrumentation Workshop, (Moffett Field, CA, 16 Sept. 2015).

Reynolds, K.W., R.P. Dahlgren, M.M. Fladeland, D.E. Manosalvas, I.M. Suresh, M.R. López, M.J. Lowen, O.G. Dary, S. Hening, N.I. Nguyen, L.K. Byun, R.A. Miller, M. Sumich, C.A. Ippolito, D.B. Herlth, R. Kolyer, and V.G. Ambrosia, 2015. "Repurposing Surplus Unmanned Aircraft SystemsInto UAS Platforms for Science Missions." Proceedings of Association of Unmanned Vehicle Systems International (AUVSI) Unmanned Systems 2015, AUVSI, Atlanta, GA., 5 May 2015.

Reynolds, K.W., R.P. Dahlgren, M.M. Fladeland, D.E. Manosalvas, I.M. Suresh, M.R. López, M.J. Lowen, O.G. Dary, S. Hening, N.I. Nguyen, L.K. Byun, R.A. Miller, M. Sumich, C.A. Ippolito, D.B. Herlth, R. Kolyer, and V.G. Ambrosia, 2015. "Repurposing Surplus Unmanned Aircraft Systems into UAS Platforms for Science Missions." Proceedings of Association of Unmanned Vehicle Systems International (AUVSI) Unmanned Systems 2015, AUVSI, (Atlanta, GA, 5 May 2015).

Soja, A., V. Ambrosia, and L. Friedl, NASA Applied Science, Wildland Fire Program: Sustaining Land Imaging: UAS to Satellites. 19th Pecora Symposium, Denver Colorado, 17-21 Nov. 2014.

Soja, A., V. Ambrosia, and L. Friedl, NASA Applied Science, Wildland Fire Program: Wildland Fire Program: Potential Use for Suomi-NPP. Second S-NPP Application Workshop, Huntsville, Alabama, 19 November 2014.

Vanderbilt, V.C., C. Daughtry, R.P. Dahlgren, "Relative Water Content, Bidirectional Reflectance and Bidirectional Transmittance of the Interior of Detached Leaves during Dry Down," IGARSS, (Milan, Italy, 26-31 July 2015).

Vanderbilt, V.C., C. Daughtry, R.P. Dahlgren, "Remotely Sensing the Photochemical Reflectance Index, PRI," Proc. SPIE 9613, Polarization Science and Remote Sensing VII, (San Diego, CA, 23 Sept. 2015).

Vanderbilt, V.C., C.S.T. Daughtry, R.P. Dahlgren, "Is There Ecological Information in Optical Polarization Data?" Carbon Cycle Ecosystem Joint Science Workshop, (College Park, MD, 20-24 April 2015).

Vanderbilt, V., C. Daughtry, M. Kupinski, C. Bradley, R. Dahlgren, "Coming of Age: Polarization as a Probe of Plant Canopy Water Status," AGU Fall Meeting, Abstract B53C-0582 (San Francisco, 2015).

Werner, C., Robert Dahlgren, C. Kern, P. Kelly, M. Fladeland, K. Norton, M. Johnson, A. Sutton, T. Elias, "Volcano Gas Measurements from UAS – Customization of Sensors and Platforms," AGU Fall Meeting, Abstract NH43C-1901 (San Francisco, 2015).

Watts, A., T. Ball, R. Dahlgren, V.G. Ambrosia, "Evaluating and operationalizing unmanned aircraft for wildland fire use" AGU Fall Meeting, Abstract NH43C-1898 (San Francisco, 2015). Watts, A., V. Ambrosia, and E. Hinkley, 2015. Unmanned Aircraft for Wildland Fire Science and Operations: Classification and Considerations for Use. 36th International Symposium on Remote Sensing of Environment (ISRSE), Berlin, Germany, 15 May 2015.

Ecological Forecasting

NASA: Jim Brass
BAERI: Cindy Schmidt

The Ecological Forecasting program is a sub-program within NASA's Applied Science Program whose larger goal is to advance innovative and practical uses of Earth observations and modelling in order to enhance stewardship of natural resources and decision making of public and private organizations. ARC-CREST staff are part of the Program management team. In this capacity, they track the projects in the Ecological Forecasting portfolio, support strategic planning activities, help coordinate annual program review meetings and participate in interagency activities and meetings as required by the Program Manager for Ecological Forecasting. ARC-CREST staff help manage the following projects:

1. Projecting Effects of Climate Change on River Habitats and Salmonid Fishes, PI: Gordon Luikart, University of Montana

2. Bayesian Data-Model Synthesis for Biological Conservation and Management in Antarctica, PI: Heather Lynch, Stony Brook University

3. Bringing Wildlife Management into Focus: Integrating Camera Traps, Remote Sensing and Citizen Science to Improve Population Modeling, PI: Phil Townsend, University of Wisconsin.

2015 Accomplishments

• Organized and attended the Ecological Forecasting principal investigators meeting in April;

• Attended the team meeting for the Bayesian Data-Model Synthesis Biological Conservation and Management in Antarctica project in Stonybrook, New York in September;

• Worked with all principal investigators throughout the year to ensure that requisite Application Readiness Level (ARL) reports and annual reports were submitted;

• Presented project summaries during the bi-monthly Applied Sciences program reviews; and x Developed a Monthly Status Report (MSR) for the Bayesian Data-Model Synthesis Biological Conservation and Management in Antarctica project to be presented to the director of NASA Earth Sciences in September.

Publications and Presentations

Forum on Citizen Science and Earth Observations in July.

Geostationary Coastal and Air Pollution Events Mission (GEO-CAPE)

NASA: Laura Iraci
BAERI: Susan Kulawik

The GEOstationary Coastal and Air Pollution Events (GEO-CAPE) mission was recommended by the National Research Council's Earth Science Decadal Survey to measure tropospheric trace gases and aerosols as well as coastal ocean phytoplankton, water quality and biogeochemistry from geostationary orbit. Multiple observations per day are required to determine tropospheric composition and air quality over spatial scales ranging from urban to continental, and over temporal scales ranging from diurnal to seasonal. High frequency satellite observations are also critical to studying and quantifying biological, chemical, and physical processes within the coastal ocean and beyond.

ARC-CREST researchers are involved in mission planning and the development of instrument concepts for this upcoming satellite mission. GEO-CAPE is planned to be in orbit in the 2020 time frame. At this preliminary stage, several instrument concepts are being studied to ensure that a range of potential instruments can meet GEO-CAPE requirements.

2015 Accomplishments

• Simulated multi-spectral ozone retrievals in support of the alternative mission implementation concepts. The team ran 4,050 simulations for 17 different surface sites, with different wavelengths and with different netcdf products. The team was then able to characterize sensitivity as a function of the atmospheric state for different simulated instruments.

Figure 20: ARC-CREST researchers are contributing to the planning and development of the GEO-CAPE Mission. Planned to be in orbit ~ 2020, GEO-CAPE will measure tropospheric trace gases and aerosols and coastal ocean phytoplankton, water quality and biogeochemistry from geostationary orbit, providing multiple daily observations within the field of view.

Water Quality Monitoring for National Geospatial Agency (NGA)

NASA: Jim Brass
BAERI: Cindy Schmidt, Chase Mueller, Sherry Palacios, Elias Herrara

This project is using remotely sensed imagery to assess water quality in the Niger River Basin. The team is working to develop and transfer water quality information obtained from remotely sensed data and other geospatial data or models to support the project's Geonarrative development. The primary goals of NASA-ARC and ARC-CREST researchers are to:

1. Identify existing geospatial data and data gaps, hydrologic models, and methodologies for water quality assessment;

2. Utilize data analysis methodologies and tools for water quality assessment and modeling;

3. Establish a data sharing and processing environment on the NASA Earth Exchange; and

4. Strengthen and expand upon existing work in various US government, international agencies, and academic institutions.

Data products will ultimately be prepared in a format suitable to be incorporated in the NGA online hydro-visualization tool and also shared via NEX.

Figure 21: The Niger River Basin in West Africa from highlands in Guinea, through Mali, Niger and Nigeria. ARC-CREST researchers are evaluating remote sensing data and available tools and models for assessing water quality in the region. Data products will eventually be shared via the NEX platform.

Publications and Presentations

FORESIGHT Initiative meeting at Arizona State University in February.

2015 Accomplishments

- Developed scripts for processing water quality indices for Landsat and MODIS for Niger Basin;
- Developed and tested the SWAT hydrological model;
- Accessed NEX data and processed in the NEX computing environment;
- Produced several required deliverables including: a) tradecraft document describing instructions on how to acquire the required data, and run the processes required to calculate the water quality indices and run the hydrological model and b) final report summarizing the entire project;
- Made significant progress towards an Interagency Agreement between NASA and NGA; and
- Attended several meetings between NASA Headquarters program managers and NGA program managers including one in March and a second one in July.

Water Resources Program

NASA: Jim Brass
CSUMB: Forrest Melton

The primary objectives of this task are to:

1) Support the NASA Applied Sciences Program, Water Resources application area by serving as an Associate Program Manager for Water Resources, and a Deputy Program Manager for the Suomi NPP satellite mission.

2) Monitor progress across the project portfolio, engage and support project teams in identifying and resolving project issues, and coordinate the ASP Water Resources science community.

3) Engage and support the NASA Applied Sciences stakeholder community.

Publications and Presentations

AghaKouchak, A. et al. (Melton, F.S. among 7 authors). Hain, C.R. Remote Sensing of Drought: Progress, Challenges, and Opportunities. *Geophysical Research Letters, (in review)*.

2015 Accomplishments

• Co-organized the annual NASA Applied Sciences Program (ASP) Water Resources PI Meeting held at the NOAA Center for Weather Prediction in College Park, MD. Co-authored the meeting report;

• Led the organization of a joint workshop with the World Bank on the topic of Remote Sensing of Evapotranspiration for Food and Water Security, held at the World Bank in Washington, DC. The meeting was attended by more than 150 scientists, water resource managers, World Bank staff, and stakeholders from around the world. Co-authored the meeting report and a whitepaper submitted to the NRC Decadal Survey request for information;

• Co-organized the Climate Change and Water Resources Working Group interagency workshop at the NOAA Fisheries Science Building in Seattle, WA, attended by 60 scientist and water resource managers;

• Maintained the ASP Water Resources website (http://c3.nasa.gov/water);

• Co-authored the 2016 ROSES Water Resources solicitation and jointly organized the review panel with the Program Manager for Water Resources;

• Tracked and coordinated 9 ASP Water Resources projects. Monitored financial and technical progress and engagement with partners and stakeholders. Communicated regularly with project PIs to identify and resolve issues. Reported project progress to ASP PMs and Associates at 6 ASP Program Reviews;

• Served as the NASA Representative to WESTFAST and the Climate Change and Water Working Group, which are federal interagency coordinating organizations;

• Jointly organized and chaired 3 hydrology sessions at the 2015 Fall AGU Meeting on Remote Sensing Applications for Water Resources Management; and

• Collaborated with other scientists in the program to author a review of Remote Sensing Applications of Drought (AghaKouchak et al., 2015).

Designing and Operating Distributed Space Systems for Better Earth Observations

NASA: David Alfano
BAERI: Sreeja Nag

The research focuses on designing and operating distributed space systems (DSS) comprising small satellites. Miniaturization of satellite hardware and affordable launch options have enabled access to space with fewer resources and shorter time span. It has also allowed flexible deployment of multiple space assets, opening up the possibility of dynamic information networks in space. Satellites can be designed as revolutionary observatories deployed according to consumer needs. The group wants to build a consumer-centric, systems-based approach to design, plan, schedule and operate small satellite DSS, using pre-defined metrics of accuracy of consumer-driven downstream products, technical feasibility and reduction of gratuitous complexity as the design objectives. The approach couples Model-Based Systems Engineering (MBSE) with Observing System Simulation Experiments (OSSE), and can be modified based on the domain and application. The proposed approach is:

1. Development of an open-source, Python-based software, leveraging GSFC's General Mission Analysis Tool (GMAT), internal payload models and an MIT-developed risk analysis tool for trade space exploration of satellite constellations for earth observation.

2. Design of optimal small-sat constellations for receiving and relaying ADS-B signals from airplanes flying over remote locations (e.g. Alaska) to terrestrial ground stations. The constellation design will trade between performance (% ground area covered at %certainty with time delay) and cost – all of which is calculated by coupling MBSE with air traffic simulations using NASA's FACET tool. The approach is very similar to an OSSE for Earth Science observations.

3. Concept and operations of a small sat cluster in formation flight for measuring the reflectance of the Earth at different 3D angles. The end product is called bi-directional reflectance (BRDF), required for accurate estimation of albedo, photosynthetic efficiency and outgoing radiation.

2015 Accomplishments

• NASA GSFC Monthly Highlights (October 2015) - Featured as the monthly highlight for the NASA's Climate and Radiation Division, which showcased results published in September 2015 in the International Journal of Applied Earth Observation and Geoinformation http://atmospheres.gsfc.nasa.gov/climate/index.php?section=146 ;

• Appointed the lead for the Satellite Communication subsystem for NASA ARC's Unmanned Air Traffic Management Team to look at how airborne and ground assets can be covered using existing satellites and to conceptualize the need for new satellite systems to monitor in the future ; and

• S. Nag was appointed a co-investigator and a member of the Science Team for a proposal led by Lawrence Berkeley National Lab in response to the Earth Venture Mission - 2 solicitation. The proposal is titled "Earth's Radiation Imbalance System (ERIS)".

HELIOPHYSICS

Collaborative Space Weather Modeling

NASA: Jeff Scargle, Nagi Mansour
BAERI: Bob Stein, Thomas Hartlep

The Collaborative Space Weather Modelling project is one of three projects under the ARC-CREST umbrella that support NASA's larger Heliophysics Modeling and Simulation (HMS) and Living with a Star (LWS) initiatives. ARC-CREST researchers are simulating solar surface magneto convection by solving the conservation equations of mass, momentum, and internal energy together with the induction equation for the magnetic field and the transfer equation for radiation on a three-dimensional grid stretched in the vertical direction. To achieve as much realism as possible, so that direct comparisons with solar observations can be made, the teamis using a tabular equation of state including equilibrium ionization and excitation of all the abundant elements as a function of density and internal energy. Another goal of this work is to speed up the calculations. To this end, the team is approximating radiation transfer by binning the opacity into 4-12 bins according to its magnitude with corresponding source functions. The radiation is calculated on long characteristics with only one vertical and 4 slanted rays; the latter are rotated by an incommensurable amount each time step to sweep out the entire three-dimensional volume. Previous calculations assumed the incident field was horizontal, uniform, untwisted, and constant in time. New calculations will take the magnitude, spatial extent, and temporal variation from global dynamo simulations. The new calculations with larger horizontal scale and stronger fields at the bottom boundary are expected to lead to even more solar-like active regions. Models like these provide a predictive understanding of the Sun's system, specifically of the space weather conditions near Earth and in the interplanetary medium.

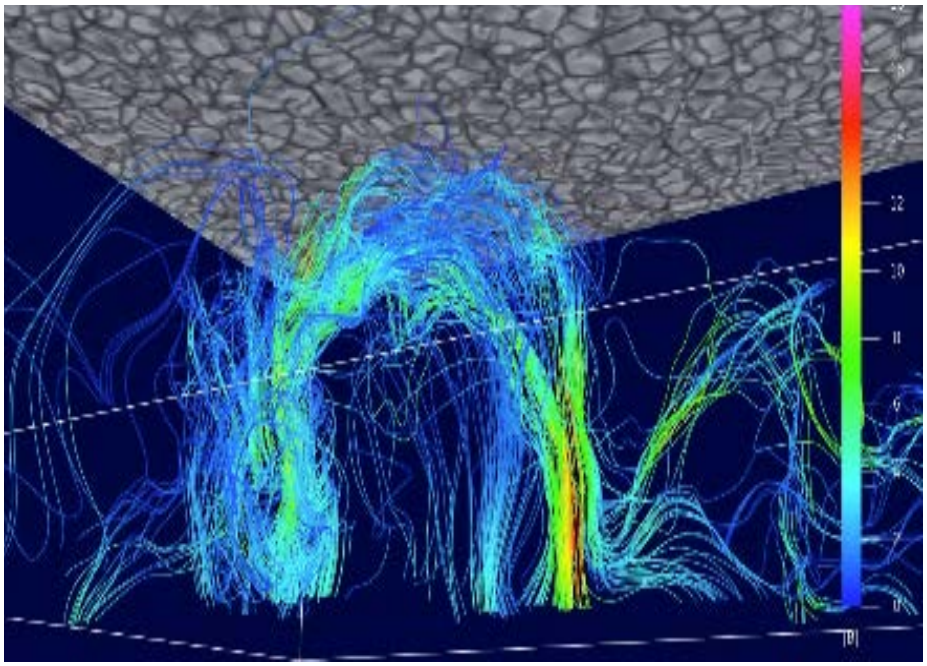


Figure 22: Magnetic field lines of an emerging Omega-loop. Color indicates magnetic field magnitude with scale on the right in kG. Gray scale image at the top is the surface continuum radiation intensity showing the granulation pattern. Convection shreds the magnetic field into multiple filaments, but also confines the large-scale loop topology. The length of the loop is that of a typical supergranule diameter. The team is now working on modeling a larger version of the image above (only 48 Mm wide with weak 1 kG horizontal input magnetic field at 20 Mm depth).

2015 Accomplishments

• Continued to work towards an accurate, physics-based model of solar magnetic flux and transport as part of the larger collaborative Heliophysics Modeling and Simulation community;

• Continued to address the problem of unnaturally strong shocks developing in the photosphere;

• Wrote an IDL procedure for converting global dynamo simulation magnetic field data from Yuhong Fan to a format for input into STAGGER code;

• Modified boundary routines of the STAGGER code to read in the data and interpolate it in time to apply in the magnetic boundary conditions; and

• Debugged the new IDL and associated STAGGER procedures.

Publications and Presentations

The Surface of Stellar Models- Now with more 3D simulations!, The Space Photometry Revolution -CoRoT Symposium 3, Kepler KASC-7 Joint Meeting, Toulouse, France, Edited by R.A. Garcia; J. Ballot; EPJ Web of Conferences, Volume 101, id.06064.

Subsurface Structure of Pores and Sunspots, HMI nugget, May 2015.

Comparisons of Non-buoyant and Buoyant Flux Emergence Events - Flux Emergence workshop, Boulder, CO June 2015.

Simulations of Magnetic Fluxe Emergence, High Altitude Observatory, Boulder CO, June 2015.

Granules, Flux Emergence and the Subsurface Structure of Sunspots, Max Planck Institute forSolar System Research, Goettingen, Germany, January 2015.

Heliophysics Modeling and Simulation (HMS)

NASA: Nagi Mansour
BAERI: Thomas Hartlep

The Heliophysics Modeling and Simulation (HMS) project is the second of three projects under the ARC-CREST umbrella that support NASA's larger Heliophysics Modeling and Simulation (HMS) and Living With a Star (LWS) initiatives. This team is developing and conducting numerical simulations of the 3-D helioseismic wave field in the whole solar interior and under the influence of magnetic fields, flows, and thermal perturbations. They are generating synthetic data to test and calibrate helioseismology methods. The team seeks to advance our understanding of detection and measurement of large-scale magnetic structures in the deep solar convection zone and also to determine thresholds on detectable magnetic fields. Together with other projects within NASA's HMS/LWS program, models like these advance our progress towards a predictive understanding of the Sun-Earth system.

Publications and Presentations

Hartlep,T., David H. Hathaway, Nagi N. Mansour. In preparation: "Effective Diffusion Coefficients of Supergranules in Solar Surface Flux Transport" .

2015 Accomplishments

• Continued to work towards an accurate, physics-based model of solar magnetic flux and transport;

• Completed initial development of a numerical code in for simulating the transport of magnetic field on the solar surface. The code solves surface flux transport by advecting magnetic elements with solar differential rotation, meridional flow, super-granular flows, all of which are matched to the observed profiles and spectra as determined by our collaborator David Hathaway (NASA Ames Research Center); and

• Showed, using the numerical code, that the effect of the super granules is similar to Fickian diffusion and that using the simulation, we can estimate an effective diffusion coefficient.

Solar Physics Modeling

NASA: Helen Yee
BAERI: Dmitry Kotov

The Solar Physics Modeling project used high-order numerical methods to examine the accuracy of performance of different combinations of flow sensors for Direct Numerical Simulation (DNS) and Large Eddy Simulation (LES) of low-speed turbulent flows, and high-speed shock-turbulence interactions.

The study examined the versatility of the Yee & Sjögreen scheme which presented a general framework for a local dissipation control. Different flows sensors were considered, including a problem-specific constant parameter for numerical dissipation and local dissipation control based on local Mach number. The advantage of the scheme with local dissipation control is that it does not require the knowledge of the flow structure of the entire evolution a priori in order to select the proper constant for the dissipation parameter.

Publications and Presentations

Kotov, D, H. C. Yee, A. Wray, A. Hadjadj, and B. Sjogreen. High order numerical methods for the dynamic SG.

2015 Accomplishments

- Confirmed the loss of accuracy in the vicinity of a shock by standard SGS model;
- Performed a comparative study of different approaches to reduce loss of accuracy within the framework of the dynamic Germano Subgrid-scale (SGS) turbulence models; and
- Found that the modifications of SGS filtering procedure are more accurate than the results obtained using the standard dynamic SGS filtering procedure.

Synthetic Biology

NASA: Michael Flynn
BAERI: Rocco Mancinelli

This project aims to generate the knowledge required to engineer a potentially broad range of space biotechnology applications employing synthetic organisms and microbial bioreactors for in situ resource utilization and biological life support systems. The project focused on two missions this year: Euglena and Combined Regenerative Organic-food Production in Space (Eu:CROPIS) and Synthetic BioMembranes.

Eu:CROPIS: A significant part of using biological systems (synthetic or naturally occurring) in space is to understand the function of gravity from the gene level to the ecosystem level. Eu:CROPIS will elucidate the nitrogen cycle of an ecological system during spaceflight. Because Earth has a 1 x g environment, understanding how the nitrogen cycle operates as a function of gravity is key to sustaining life off Earth. To change the gravity levels, the spacecraft will be maneuvered (by spinning) to produce three different gravity regimes during the mission. The three gravity regimes will be 0.01 x g - 0.1-x g (essentially microgravity); 0.16 x g (Moon gravity) and 0.38 x g (Mars gravity). Each gravity regime will last for six months. The Eu:CROPIS core element is a microbiological trickling filter of lava rock – the habitat of a multitude of microorganisms that purify and decontaminate water. It will be the first time nitrogen- transformation reactions will be measured as a function of gravity.

Publications and Presentations

Mancinelli, R.L., Hauslage, J, Bornemann, G, and Richter, P. 2015. Elucidating the nitrogen cycle of Eu:CROPIS: Euglena: Combined Regenerative Organic-food Production In Space. International Society for Gravitational Physiology. Annual Meeting Abt. Book 2015, Igor B. Mekjavic (ed) pg.120. ISBN 978-961-93848-0-0.

2015 Accomplishments

- Demonstrated Euglena growth on NO_3^- as well as on NH4+;
- Demonstrated Euglena growth on NH_4^+ produced by cyanobacteria in co-culture in 2 types of media;
- Colorimetric assays for the various nitrogen species produced variable results leading to the decision to use ion-chromatography for the ground controls and flight experiment;
- Finalized the decision to use gas sensors to measure atmospheric gases in the primary payload instead of a gas chromatograph;
- Monitored the concentration of the ammonium, nitrate, and nitrite in the system as well as net rate of the reactions from a batch of 20% synthetic urine run through the CROP system using the ion chromatograph; and
- Refined computer simulations of the microbial and nitrogen species changes in the Eu:CROPIS system to better incorporate the data obtained from the CROP portion of the system.

Membranes

NASA: Michael Flynn
BAERI: Rocco Mancinelli

Membranes are a vital component of biological processes. Lipid-based membranes are also used commercially in separation and purification processes. Membranes are used extensively in modern spacecraft for separations, sensors, space suits, and structural components. Man-made membranes created using current technologies have short lifespans due to a susceptibility to chemical, physical, and radiation-exposure damage, resulting in a sizable resupply penalty for long-duration missions. The mission proposes to develop biomimicry capabilities critical for long-duration missions using principles of synthetic biology.

2015 Accomplishments

• Identified Octanoic Acid, Hexanoic Acid, and Decanoic Acid as top three acids that prevent calcium fouling effecting biomembrane performance;

• Identified sources of engineered organisms that produce fatty acids;

• Completed an analysis of the organismal characteristics as they relate to abiotic components (e.g., nutrients, nutrient ratios, salinity, temperature, and light), cultivation (biomass density, growth rate, conversion efficiency/photosynthetic rates, etc.), based on data obtained from the various sources; and

• Developed an understanding of the range of FA's produced by the organisms (target molecule and shorter/longer) by various suppliers.

AIRBORNE SCIENCE AND MISSION SUPPORT

Airborne Science Support

NASA: Matt Fladeland
BAERI: Patrick Finch, Ronnie Instrella

The goal of this task is to provide software support to the NASA Airborne Science Program. There are currently three projects:

MTS (Mission Tools Software) Aircraft Tracking: The team has created and is maintaining and improving the software used as the back-end service to the Mission Tools Suite for tracking aircraft. The team makes use of multiple hardware devices, some portable, some less so, which leverage the Iridium network to pass data from a moving vehicle to our server. The team has written software for this data and have made it retrievable over the web for display in MTS. The software infrastructure will be built out to support a new handheld device (Iridium 9575 Extreme handset) offering not just tracking services, but also emergency communication services.

MTS Network Infrastructure: The team is building out a Virtual Private Network to communicate directly with the FAA to effect the tracking of all civilian aircraft over the United States. This effort supplements the individual tracking of specific NASA assets by allowing NASA to track aircraft near its specific assets in real-time. Storing this data will allow users to see how air traffic and weather affect data collection missions.

Airborne Science Data Repository: The team is building a software and storage system to automate the task of uploading data from NASA Airborne Science facilities instruments. At present, all data must be QC'd, uploaded, and made available by hand. This software and storage system will reduce the amount of time between data collection and dissemination.

2015 Accomplishments

- Deployed Iridium Extreme handsets for the MTS Aircraft Tracking project; thus, initial configurations are completed and any further development can be pushed to the platform remotely;

- Made the initial VPN connection for the MTS Network Infrastructure project, so the data machine behind the VPN is live and accessing data. We are in the process of moving out of R&D to the FAA staging network and are using FAA data to track aircraft; and

- Finished initial experimentation for the Airborne Science Data Repository, and a path forward has been identified to automate QC and file uploads.

Airborne Science Advanced Planning

NASA: Matt Fladeland
BAERI: Susan Schoenung, Gailynne Bouret, Patrick Finch, Justin Humphrey

The Airborne Science Advanced Planning activity seeks to collect information on the needs of the NASA Earth Science community for support from NASA's Airborne Science Program (ASP). ASP provides flight services for Earth Science using NASA aircraft platforms, both manned and unmanned, operating out a several NASA Centers. ASP also provides payload integration services and mission assistance including flight planning, data management, and communications. To ensure that the right capabilities are available and will be available for future science activities, Advanced Planning maintains an out-year schedule of mission plans and the assets and services required. Information is gathered from NASA Earth Science program and from the science community through workshops, conferences, and ongoing interactions.

Publications and Presentations

Albertson, R., Schoenung, S., Fladeland, M., Cutler, F., Tagg, B. "Enabling Earth Science Measurements with NASA UAS Capabilities," 36th International Symposium on Remote Sensing of the Environment.

Schoenung, S., Fladeland, M., Albertson, R., "UAS Payload and Platform Experience for Earth Science," AUVSI Unmanned Systems 2015.

Panels

Using Unmanned Aerial Systems (UAS) for Invasive Plant Assessment and Management in Terrestrial and Aquatic Settings: A Special Workshop Sponsored by the California Invasive Plant Council and NASA-Ames.

2015 Accomplishments

- Updated the ASP 5-year plan, monthly, for ASP management;
- Completed "Airborne Science Program 2015 Requirements Update";
- Prepared the ASP 2015 Annual Report and two semi-annual newsletters;
- Participated in various science team meetings related to NASA Earth Science space missions to gather airborne requirements data; and
- Made presentations at the 2015 Unmanned Systems Conference and 2015 International Symposium on Remote Sensing of the Environment.

Figure 23: Pre-flight checks are completed on the SIERRA aircraft, one of several UAS managed by the Airborne Science Advanced Planning team.

Earth Science Project Office (ESPO)

NASA: Mike Craig, Marilyn Vasques
BAERI: Erin Czech, Dan Chirica, Erin Justice, Michaela Herman, Quincy Allison, Sue Tolley, Steven Todorov, Sommer Beddingfield, Elizabeth Juvera

The Ames Earth Science Project Office (ESPO) provides project management for NASA's Science Mission Directorate field research. ESPO provides planning, implementation, and post-mission support for large, complex, multi-agency, national and international field missions, especially airborne missions. ESPO has a long history of managing successful field missions, beginning in 1987 with the Stratosphere-Troposphere Exchange Project and the Airborne Antarctic O_3 Expedition experiments. More recently, ESPO's NASA customers have included the Atmospheric Chemistry and Modeling Analysis Program, the Tropospheric Chemistry Program, the Radiation Sciences Program, Atmospheric Dynamics and Remote Sensing, the Suborbital Science Program, and the EOS satellite validation program. Annually, the ESPO team manages the deployment of between six and ten major field missions and continues to provide support to the science team, airplane team, and the larger scientific community for previous years' missions. Finally, the ESPO team plays a critical role in planning for future missions, interfacing with NASA Headquarters, NASA and university scientists, crew members of airborne platforms, local support staff, and the larger scientific community. The unique work done by the ESPO team makes NASA Earth Science's core mission of collecting Earth Science data from airborne platforms with global coverage possible.

Figure 24: The RV Endeavor departing Narragansett, RI for the SABOR Mission.

Figure 25: The NASA P3-B aircraft and Operation IceBridge (OIB) team in Thule Greenland during the OIB field campaign.

[1] The ESPO team supported additional missions through EVS-1 (Earth Venture Sub-orbital-1) and EVS-2 (Earth Venture Sub-orbital-2) projects that were not under the ARC-CREST agreement. These included: ATTREX, HS3, ORACLES, and ATom. Information about these missions can be found at https://espo.nasa.gov/.

2015 Accomplishments

• In 2014, the NASA-ARC-based ESPO team supported 10Supported the following airborne missions under the ARC-CREST agreement1:

o SUAS (Small Unmanned Aircraft Systems)

o SHOUT (Sending Hazards with Operational Unmanned Technology)

o RADEX (Radar Definition Experiment)

o OIB (Operation Ice Bridge)

o Keflavik Polar Winds

• Provided, for all missions, logistical support for the deployment, including: management of deployment sites (facilities, lodging, transport, customs); interface between mission managers, instrument teams, NASA Program Managers and aircraft crew members; coordination of all shipping of equipment and materials (NASA-ARC shipping, university shipping, freight forwarding, customs, local transportation); and deployment setup and on-site support for the duration of mission;

• Managed, for all missions, the Science Operations Flight Request System or SOFRS. SOFRS manages and tracks the allocation of NASA's fleet of scientific aircraft and sensors. In 2015, ESPO team members trained new team members on the management and administration of the system and upgraded the system to allow NASA Headquarters to use the flight request process for tracking of their aircraft use;

• Provided, for select missions, additional and specialized support related to instrument integration and operation, data systems support, and communications support for mission teams.

• Provided, for many missions, programming and IT support such as: in-field IT support for website, system and network setup, printer access, local ISPs, and user support for deployments; creation of new websites for missions beginning in 2015; improvement or additions to existing websites including ESPO, ESD, and ASP; maintenance of the ESPO Mission Database, ESPO Data Archive, and ESD Publications Database; maintenance of archives of all older websites; monitoring of internet technologies and security options for deployment sites; improvement of file sharing options for mission participants; and

• Provided, for many of missions, education, outreach, and communications support including: attendance at conferences, support for SAT communications between teachers and in-flight scientists; and support for open-house events at facilities hosting field deployments.

Figure 26: Missions supported by the NASA-ARC based ESPO team

Meteorological Measurement Systems (MMS)

NASA: Thaopaul Bui
BAERI: Jon Dean-Day, Cecilia Chang

The Meteorological Measurement System (MMS), developed at NASA-ARC, is a proven airborne instrument package for measuring high resolution in situ state parameters like pressure, temperature, turbulence index, and 3-dimensional wind vectors. Accurate measurements of these quantities from a variety of airborne platforms require judicious choices of sensor locations, repeated laboratory calibrations, and proper corrections for compressibility, adiabatic heating, and flow distortion.

The MMS is used to investigate atmospheric mesoscale phenomena (gravity and mountain lee waves) as well as microscale phenomena (turbulence). An accurate characterization of the turbulence phenomenon is important for the understanding of dynamic processes in the atmosphere, such as the behavior of buoyant plumes within cirrus clouds, diffusion of chemical species within wake vortices generated by jet aircraft, and microphysical processes in breaking gravity waves. Additionally, the MMS is deployed in conjunction with other airborne, or satellite-based sensors so that the MMS data can provide a critical piece of the data interpretation. ARC CREST researchers supporting the MMS system provide on-going support to the scientific community accessing these measurements. The MMS team also works with scientists developing new instruments or payloads to modify the MMS system for each new platform and mission.

Publications and Presentations

Dean-Day,J., T.Paul Bui, Cecilia S. Chang. Evaluating Spatial Scales of Eddy Covariance Fluxes over the Southeast U.S. using 20 Hz Wind and Temperature Data from the NASA DC-8, Meteorological Measurement System SEAC4RS Science Meeting; Pasadena, CA; Apr 2015.

2015 Accomplishments

- Participated in the ATTREX (Airborne Tropical Tropopause EXperiment) science mission in

Guam;

- Participated in the VIRGAS (Volcano-plume Investigation Readiness and Gas-phase and Aerosol Sulfur) October Science Flights and the AJAX (Alpha Jet Atmospheric eXperiment) campaign in California;

- Maintained the MMS payload on the Alpha Jet and Global Hawk airborne platforms;

- Performed MMS data processing and archiving for the science flights including calibrations and decoding of the Alpha Jet's internal Garmin for comparison; and

- Improved the MMS platform on the Alpha Jet by simulating the Alpha Jet's flight system in the laboratory.

Figure 27: An MMS payload is installed on the DC-8.

Meteorological Support

NASA: Leonhard Pfister
BAERI: Patrick Hillyard, Bill McKie, Rei Ueyama, John Bergman

The NASA-ARC based Meteorological Support group provides meteorological support in the planning, execution, and research phases of NASA airborne missions in both the troposphere and stratosphere. This support covers a range of forecasting tasks including preparing historical, climatological, and meteorological summaries for proposed airborne mission field sites, providing detailed flight day forecasts, and creating specific meteorological data products.

This support needs to be coincident to a specific place and time of scientific measurements and requires forecasting knowledge, familiarity with meteorological data archives, familiarity with satellite measurements being used by the mission science team, familiarity of atmospheric models being used by the science team, and attendance at mission planning meetings and field missions. It also requires continually interfacing and supporting scientists in the community and utilizing mission data in the years following the mission. The ability to provide these met-based mission tools in a timely manner is critical to mission success. The team is also responsible for the construction and maintenance of the requisite computing platforms needed for data storage, modeling, and virtual collaboration. In 2015, the team was primarily focused on the final deployment of the ATTREX mission. Beginning in 2012 and ending in 2015, the ATTREX Mission was focused on understanding water vapor and ozone in the critical tropical tropopause layer of the atmosphere.

2015 Accomplishments

• Provided meteorological support to 3 NASA funded field missions: ATTREX, SEAC4RS, and ORACLES. For these missions, the team did the following:

1. Analyzed and plotted meteorological data forecast data from NCEP GFS and NASA GEOS-5 model products multiple times per day;

2. Managed websites for meteorological data dispersal including integration of satellite data and from multiple instrument groups

3. Visualized data from multiple satellites (as relevant to the particular mission) and data analysis from the missions, including visible, IR, and water vapor imagery and made available to mission community;

• Completed successfully the final ATTREX deployment out of Edwards Air Force Base in February and March 2015. Team members provided meteorological support for the planning and execution of the flights. They assisted with flight planning and served as mission scientist during some flights;

• Constructed and maintained computer platforms and services for mission scientists needing meteorological data and in support of atmospheric science cloud studies that included modeling and observed data analysis. This entailed computer hardware selection, hardware assembly, hardware maintenance, system software installation, system software maintenance, system administration, application programming, and application programming, consulting, documentation, testing, networking, and security;

• Maintained and administered three Beowulf clusters with remote network access to interactive and batch computing under Linux operating systems, a central gateway Linux system for remote access to the clusters; and

• Provided support for several versions of the OS-X operating systems configured with add-on software and configurations for use in scientific environments.

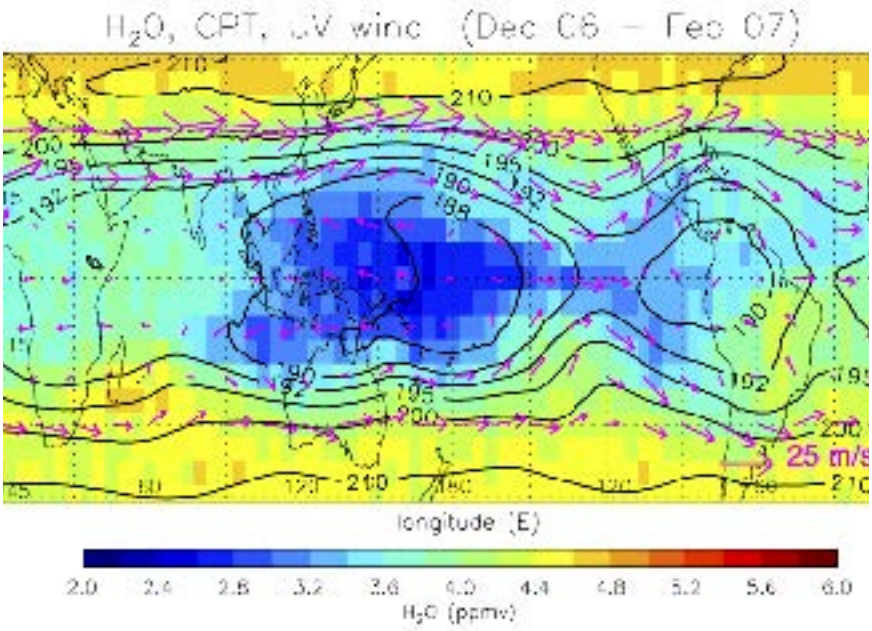


Figure 28: The 100 hPa level boreal winter (Dec 2006 to Feb 2007) mean H_2O mixing ratios (ppmv; color shading) from MLS data superimposed with ERA-Interim cold point tropopause temperature (K; contours) and 100 hPa horizontal wind (m s-1; vectors) fields.

Publications and Presentations

Ueyama, R., E. J. Jensen, L. Pfister, and J.E. Kim. 2015. Dynamical, convective, and microphysical control on wintertime distributions of water vapor and clouds in the tropical tropopause layer. J. Geophy. Res. Atmos., 120; doi:10.1002/2015JD023318.

Jensen, E. J., L, Pfister, R. Ueyama, J. Bergman, and D. Kinnison. 2014. Investigation of the transport processes controlling the geographical distribution of carbon monoxide at the tropical tropopause. J. Geophy. Res. Atmos., 120; doi:10.1002/2014JD02261.

Ueyama, R., E. J. Jensen, L. Pfister, Impact of radiative heating rates on wintertime distributions of TTL water and clouds (presented at 95th American Meteorological Society Annual Meeting, Phoenix, AZ, Jan 2015).

Ueyama, R., Trajectory and microphysical modeling of H_2O and clouds in the tropical tropopause layer (presented at NASA Ames Earth Science Division poster session, Moffett Field, CA, Feb 2015).

Ueyama, R., Trajectory and microphysical modeling of H_2O and clouds in the tropical tropopause layer (presented at Composition and Transport in the Tropical Troposphere and Lower Stratosphere Meeting, Boulder, CO, Jul 2015).

National Suborbital Education and Research Center (NSERC) Mission Operations

NASA: Matt Fladeland
UND/NSERC: Rick Shetter, Melissa Yang, Adam Webster, David Van Gilst, Eric Stith, Michael Delaney, Eric Buzay, Karen Katrinak, Emily Schaller, Jane Petersen

The University of North Dakota's National Suborbital Education and Research Center (NSERC) is a partner in the ARC-CREST cooperative agreement. NSERC works with the NASA Airborne Science Program and is responsible for two tasks:

Task 1: Science Mission Operations and
Task 2: Education and Training

In support of Task 1, NSERC addresses all data, satellite communications, engineering and maintenance needs for the following manned NASA airborne science platforms: DC-8, C-130, B-200, ER-2 and P3-B. In addition, in 2014, NSERC supported the following field missions: ATTREX, DISCOVER-AQ, HS3, GHOC, OIB, ASCENDS, SARP, HyspIRI, and ARISE. Accomplishments related to specific airborne platforms are listed. NSERC accomplishments specific to missions are discussed in their respective sections in this document.

In support of Task 2, the NSERC team conducts education and training activities around select fields. Separately, the NSERC team leads outreach programs missions designed to build capacity with science students and teachers. In 2014, NSERC conducted the following education and training activities: SARP, HS3 Outreach, ATTREX Outreach, Ice Bridge Outreach, outreach to K-12 science teachers, and general outreach. The latter two are described below. SARP and mission-specific education and outreach are discussed in 5heir respective sections.

Figure 29 : DC-8

2015 Accomplishments

Accomplishments for Task 1 were as follows:
Overall ASP Development Work

Total Air Temperatire Measurement

• Researched TAT signal conditioner options. Found three plausible options;

• Ordered a signal conditioner, conducted bench testing on the Ethernet and analog outputs;

• Created a wiring diagram for signal conditioner to tap into existing TAT and HIWC nose cable runs;

• Investigated accuracy of available TAT truth sources at altitude; and

• Sourced heater and thermostat for signal conditioner enclosure.

Aventech Probes

• Worked with Martin Nowicki to install a modified ARIM-200 mount on N439NA for NAAMES; and

• Installed a Vectornav with the ARIM-200 on the 439. This installation features a number of improvements over the HIWC Version.

Data, SATCOM and Engineering – DC-8

• Worked with DC-8 Engineering and Avionics staff to design a tap on the TCAS system for improving situational awareness;

• Worked with Aventech to determine appropriate air data equations and application of calibration constants to raw AIMMS-20 Format;

• Improved the RAW Can Bus parsing code for AIMMS-20 and the ARINC 708 output code for weather radar, ensured compatibility with new weather radar;

• Worked to develop software to calculate AIMMS-20 wind solution without use of Aventech attitude and reference source;

• Designed and mostly implemented a system for determining the orientation and acceleration of the DC-8 wing tip with the intent of better understanding the air flow and motion of wing tip mounted probes, including the AIMMS-20 / ARIM-200 systems;

• Conducted environmental testing on all necessary equipment/instruments;

• Wrote software for the MicroGoose Ethernet-based Temperature/Humidity sensor and worked with the integration engineer and AFRC to install a MicroGoose in the housekeeping rack;

• Started working with AFRC calibration lab to calibrate TAT sensors;

• Wrote environmental test procedures for the spare PC and Iridium modems for the Multichannel system;

• Painted the new Forward Camera black for installation in the DC-8 cockpit;

• Updated onboard mapping system from OpenLayers 2.1 to 3.4, and made several other improvements to make the system more manageable and less labor-intensive; and

• Provided a 3D model of the DC-8 to MTS for inclusion in some future MTS applications.

Methane Sounder Instrument on the DC-8 (August-September 2015)

• Collected all requirements for instruments, data systems and engineering;

• Re-designed the optical window assembly for the Methane Sounder instrument and provided essential feedback on selection of the laser chiller and installation of large optics breadboard;

• Assisted the COSS instrument team with design and installation of their instrument; x Coordinated the shipment of an equipment rack to the Methane Sounder team; and

• Supported the flights in the roles of Mission Director and data system operator. Data, SATCOM and Engineering – ER-2

• Completed the final assembly on the second ER-2 Inmarsat canoe;

• Completed software configuration checkout;

• Provided canoe to ER-2 crew for on-aircraft testing during "Red Wildcat" flights;

• Supported investigation of N809NA 429 output issues. Determined that INMARSAT canoe as a unit is well within relevant 429 specs, and as such has a negligible effect on the 429 output bus characteristics. The canoe is therefore unlikely to have been the cause of the NASDAT 429 output failures on N809NA;

• Reconfigured a pressure/temperature sensor to move it between 809 to 806 for multiple projects. Worked to configure the NASDAT on 806 to support the sensor; and

• Converted ER-2 Pilot Phones to DoD SIM Cards.

Figure 30: ER-2

Figure 31: B-200

Data, SATCOM and Engineering – C-130 (436)

• Worked on a draft budget for the modifications and installations;

• Started purchasing of long-lead time components;

• Worked with Wallops to acquire APN-232 RTs;

• Worked with Pinnacle engineer to determine shelf locations for installation of equipment;

• Traveled to Andalusia, Alabama to discuss installation location details for data system equipment; and

• Installed all antennas and inlets required for the data system.

Data, SATCOM and Engineering – C-130 (439)

• Arranged with Pinnacle systems staff for permanent location of data system UPS in newly freed up rack space;

• Coordinated with Todd Stanley to ensure that RJ-45 pass thru on patch panel would keep shield continuity on Cat-5 runs in cabin; and

• Coordinated with Martin Nowicki to further instrument the wing-tip ARIM-200 Probe installation.

CalWater Mission Support on the ER-2 (January-February 2015)

• Communicated network requirements to instrument teams;

• Configured NASDAT, Inmarsat, and ground modem server and the database on asp-interface;

• Supported instrument integration, CST and supported all flights; and

• Performed troubleshooting and fixed communication problem between CPL and NASDAT over RS232.

ATV-5 Mission Support on the DC-8 (January-February 2015)

•Assisted with the upload integration and cabling;

•Attended communications telecons with ESA and the video group at Armstrong. Worked to provide a real-time streaming solution over the Inmarsat;

• Investigated INMARSAT capabilities for ATV-5 Video streaming:

  o Configured and tested Cobham channel bonding software. Determined that this software has potential use for future rocket telemetry flights, but has limited usefulness for normal operations;

  o Evaluated the INMARSAT provided PEP. This can provide a significant advantage when sending data from aircraft using TCP-based protocols;

  o Investigated Linux-based PEP for TCP connections -Found that although we do not need this for the video streaming project, investigation shows that this can improve our performance in transferring data to the aircraft, and could potentially cut our latency in transporting weather imagery and other products to the aircraft.

• Assembled Navigator Iridium phone with DOD SIM and tested it on the aircraft;

• Provided extensive documentation to ATV C&C personnel based in Toulouse, France to allow them to communicate with the DC-8 via phone, X-Chat and secure file transfer. These efforts culminated in a successful outdoor coms check on Monday, Feb 2;

• Designed and fabricated parts for the installation of several instruments including CEFIR. This also included drawings and structural analysis work.

• Developed document explaining the installation of Hexchat for scientists' computers.

• Worked on solution for streaming camera imagery from an experimenter provided camera to the DC-8 cockpit for re-entry targeting purposes;

• Worked extensively with the Armstrom Flight Research Center (AFRC) video group to successfully stream video from the DC-8 to ustream.tv.

• Had numerous meetings with the shop staff to discuss dropsonde tube manufacture, procured the needed tube material, created electronic files to facilitate part manufacture, and performed some research to determine the optimal applicable welding/heat treat processes;

• Worked extensively with TWiLiTE on upload and DC-8 network communications. This included performing the TWiLiTE electronics components installation, redesign/drawings/component purchase and fabrication. Also performed the design/component purchased/fabrication for the TWiLiTE ground support equipment to hoist and transfer the optics pallet into the aircraft. Designed a port cover for TWiLiTE so that they could operate for ground laser ops, requisitioned the shop to make the cover, and modified the window blank plate to mount it.

OIB Mission Support on the C-130 (April-May 2015)

• Worked with Sean Kirby at Wallops to make wiring changes to C-130 system to support the OIB Spring Campaign;

• Sent information to Wallops to facilitate their design for yoke mounts for the C-130;

• Developed software to support control of devices via the Adlink DIO outputs;

• Prepared End-user documentation on data, video, and SATCOM systems;

• Provided onboard personnel with access to post flight data and a drop box for exchanging files.

• Ported dirpoll to run on Python 2 and installed dirpoll and dependencies to clean out NASDAT and make files available for download via ftp on the airplane; and

• Modified the KT19 reader to provide UDP status packets and made KT-19 data available on the airplane via ftp by creating a bind mount

HIWC Mission Support on the DC-8 (July-August 2015)

• Collected requirements for instruments, data systems, and weather imagery;

• Created instrument preview slides, instrument matrix, and "finalized" floor plan;

• Supported all integration/upload and download activities;

• Created tech brief slides and presented the instrument payload status/details in the brief;

• Planned wiring installation in the nose for the new weather radar, TAT, and WCM-2000 instruments. This included creating all the design planning and drawings for the various installations and ordering or fabricating all the parts to support it. Structural analyses were also done on all installations, followed by testing;

• Conducted research and provided some substantiation documentation for the bulkhead pass-through for the high-power wiring to the nose; provided precise locational information for connector locations;

• Supported HIWC team member on getting the Weather Radar Recorder set up in the lab;

• Planned wiring installation in the nose for the new weather radar, TAT, and WCM-2000 instruments. This included creating all the design planning and drawings for the various installations and ordering or fabricating all the parts to support it. Structural analyses were also done on all installations, followed by testing;

• Conducted research and provided some substantiation documentation for the bulkhead pass-through for the high-power wiring to the nose; provided precise locational information for connector locations;

• Supported HIWC team member on getting the Weather Radar Recorder set up in the lab;

• Planned wiring installation in the nose for the new weather radar, TAT, and WCM-2000 instruments. This included creating all the design planning and drawings for the various installations and ordering or fabricating all the parts to support it. Structural analyses were also done on all installations, followed by testing;

• Conducted research and provided some substantiation documentation for the bulkhead pass-through for the high-power wiring to the nose; provided precise locational information for connector locations;

• Supported HIWC team member on getting the Weather Radar Recorder set up in the lab;

• Finalized the modification designs needed to the wingtip sleds to accommodate the HIWC instrumentation, created drawings, coordinated with the shop to perform modifications, and performed the final assembly prior to the ping test;

• Built up several racks including the pitot-probe/WCM power distribution tray for installation into the RDR-4000 equipment rack, the VectorNav cabin rack shelf, and the RDR-4000 weather radar cabin instrumentation rack;

• Worked extensively with Louis Nguyen, Eric Stith and Aaron Duley to refine data ingest requirements:

• Modified DC-8 system to use ARIM-200 instead of AIMMS-20 probe due to mission requirements;

• Created software for recording high rate pressure transducer from HIWC pitot static probe

(Probe has a much larger than normal heater);

• Completed the following electrical drawings for HIWC:

o Nose instruments installations. This included their TAT and Water Content Measurement System, as well as a new pitot-static probe. The data from the pitot-static probe was recorded at housekeeping and broadcasted to the flight crew for risk mitigation;

o Wingtip instruments installations. HIWC had 4 instruments in the wingtip pylons. We also added the ARIM-200 probe to the right side for a 3D wind measurement. In addition, added Vectornav IMU's to the cabin and wingtip pylon to improve the wind measurements; and

o In-cabin wiring diagrams for ARIM-200 and Vectornav installations.

• Flew instrument shakedown flights on August 4 and on local science checkout flight on August 5;

• Provided extensive support to HIWC situational awareness tools;

• Implemented ARIM-200 wiring and software changes;

• Deployed as Data System Operator for three weeks, 80 science flight hours.

ATTREX/CAST on the GlobalHawk (February☒March 2015)

• Set up databases on both GHOC network and asp-interface-2 and accompanying software;

• Supported CST remodel; and

• Supported Range Flight remotely.

SARP Mission Support on the DC-8 (June-August 2015)

• Designed and fabricated components for the integration of a number of new instrument installations and associated sample inlets;

• Prepared an instrument installation floor plan and supported all upload and download activities;

• Lectured SARP students on engineering, data systems, facility instruments and flight planning;

• Worked with the DC-8 flight crew to design flight plans to accommodate all of thefaculty data collection requirements while staying within funded flight hours;

• Submitted final aircraft parameters data set to the SARP archive;

• Created an installation design for the zenith jNO2 radiometer installation as well as modified the NAST-I installation for the nadir jNO2 radiometer installation, created/updated the respective installation drawings, and sent the zenith blank off plates out for manufacturing; and

• Provided the 36 SARP students each with laptops containing data-reduction software. Training was also provided to ensure that they were able to use programs such as Matlab and the procedures associated with it.

PECAN Mission Support on the DC-8 (June-July 2015)

• Designed and fabricated components for the integration of a number of new instrument installations and associated sample inlets. This included drawings, stress analyses, and instrument check-fits and installation. Engineering activities also including the buildup of RainCube/MASC main cabin rack and the installation design and structural analyses of piggyback instruments;

• Supported both integration and download activities, as well as all PECAN flights;

• Attended the PECAN meeting in Boulder, CO to determine requirements for the mission;

• Provided guidance to the AFRC shop staff in regards to fabricating NAST-I sensor support structure;

• Created instrument preview slides, instrument matrix, and finalized the floor plan in support of the system safety working group meeting;

• Created dirpoll modules for Pecan for LASE and for various radar and forecast products; and

• Supported PECAN Real-Time Situational Awareness requirements.

Keflavik Polar Winds Mission Support on the DC-8 (April-May 2015)

• Created the instrument installation floor plan and supported all upload and download activities;

• Created structural analysis reports and updated installation drawings for several of the instruments. The NSERC Lead engineer also designed and fabricated components for the integration of a number of new instrument installations and associated sample inlets. This included drawings, stress analyses, and instrument check-fits and installation;

• Supported test flights and all science flights. Provided data sets, flight tracks, and video to experimenters for all of the flights;

• Coordinated with the DLR Falcon staff to work the tracking aspect for MTS;

• Created instrument preview slides, instrument matrix, and finalized the floor plan in support of the system safety working group meeting;

• Set up a new Amazon Web Service server for the SMTP gateway, and for other things down the road, with asp-interface.info and asp-interface.com domains;

• Worked to provide the science team on-board real-time weather imagery; and

• Rewrote Matlab programs to include the LTN-92 INS's. They are now a part of the standard data sets provided to experimenters.

OLYMPEX Mission Support on the DC-8 (October-December 2015)

• Collected mission requirements and began setting up database;

• Created the instrument installation floor plan and supported all upload and download activities;

• Created structural analysis reports and updated installation drawings for several of the instruments (AVAPS, CoSMIR, MASC, APR-3 FS370, WCM probe, COSS). The NSERC Lead engineer also designed and fabricated components for the integration of a number of new instrument installations and associated sample inlets. This included drawings, stress analyses, and instrument check-fits and installation;

• Supported the SSWG meeting by creating the instrument loading floor plan, instrument matrix, and instrument preview slides, and then presented the information at the meeting;

• Created the APR-3 FS370 forward cargo pit rack installation design, created drawings and the structural analysis report for review, and provided fabrication guidance to the shop for the buildup;

• Provided INMARSAT SATCOM estimates.

• Designed and purchased components for improved VectorNav setup;

• Supported all test flights and science flights; and

• Served as Mission Director.

NAAMES Mission Support on the C-130 (October-November 2015)

• Gathered data system requirements from investigators;

• Sent design info on the AATS-14 instrument in support of possible inclusion on NAAMES;

• Worked to appropriately capture wiring changes made to the N439NA data system during the initial install and the last OIB Period;

• Worked with Wallops staff to get the data system UPS and Network switch permanently mounted and to get the DC UPS remounted in the forward bulkhead of the cabin, where people are unlikely to interfere with it when moving to the cockpit;

• Worked to get the onboard network integrated with the C-130 power rack and power distribution boxes. Wired access ports are now provided alongside the power distribution boxes throughout the cabin; and

• Worked with to integrate the Zenith looking camera and the AIS into the C-130 data system; installed LN-251.

ATom Mission Support for the DC-8

• Used the PIFs and developed the instrument layout on the DC-8;

• Supported a coordinated effort to handle all the inlets/exhausts to avoid any cross-contamination;

• Determined if additional instruments could be added to the payload. This included evaluating/updating/correcting lists of aircraft and experimenter required spares, mapping out their planned locations on the aircraft, "finalizing" the floor plan and incorporating the spares into it, and developing an accurate 3D model of aft cargo compartment with cargo. Three additional instruments were added: AO2, Medusa and CPSPD; and

• Supported the various instrument group in instrument rack configuration and instrument installations.

KORUS-AQ Mission Support for the DC-8

• Provided initial instrument integration feedback/guidance to Korean investigators via telecom;

• Worked with the AON instrument team to determine their optimal instrument/inlet layout for and provided feedback on instrument rack buildup;

• Created a comprehensive refinement of the floor plan, based on PIFs and other responses from the instrument PI's. Created the instrument matrix;

• Attended the science team meeting to meet with various investigators and laid out some of the instrument integration plans. Worked out various issues/questions with team members present at the meeting;

• Met with several Korean instrument teams onsite in Palmdale to go over details of their instrument planning/accommodation/integration;

• Planned out and modeled the combined HD-SP2/K-SP2/K-CCN instrument rack layout; and

• Created the design for the addition to the inlet controller for the CAMS inlet.

SHOUT Mission Support on the Global Hawk (July-September 2015)

• Reimaged workstations in GHOC and set up of da•

• Began setting up the new Thecus for the Global Hawk imagery. Finished setting up a Thecus server, created an account for ASF staff, and gave instructions on how to use it;

• Provided technical support and consulting for staff manning SHOUT; and

• Remotely supported database and accompanying software in SHOUT testing and initial flights.

RADEX Mission Support on the ER-2 ((October-December 2015)

• Collected requirements for and set-up database to support some test flights with a payload consisting of AVRIS, EMAS and AirMSPI2;

• Set-up for PRISM to fly in place of AirMSPI2 with

• Supported two flights with AirMSPI and one flight with PRISM; and

• Tested the Inmarsat receiving of 429 after the INS was changed out.

ACT-America Mission Support on the C-130

• In preparation for the 2016 deployments, NSERC staff has begun assembling the requirements list. This involved traveling to Wallops to inspect the C-130 aircraft in order to determine the appropriate avionics and data systems required;

• Contacted personnel at AFRC, Rockwell Collins, and the Coast Guard in an attempt to get some proper documentation for the C-130 and current avionics;

• Contacted NAVAIR Pax River flight test organization (PMA 209) for more information on the newest C-130, including wiring diagrams for avionics and air data system accuracy;

• Contacted Air Force Test Center / 418th FLTS to see if USAF C-130Hs that also use the Rockwell Collins air data system to see if they can provide accuracy information;

• Contacted Honeywell to get the ICD for the INS/EGI;

• Provided detailed information on the DC-8 shutter installations for potential use on C-130;

• Created installation designs and drawing for various components of the aircraft such as the forward and nadir cameras. Data system cables were mapped out and measured, electrical designs were finalized;

• Worked with Aerovation to get antennas and inlets installed in the aircraft; and

• Supported C-130 mods by traveling to Alabama to work out details of the N436 data system installation designs.

HsypIRI Mission Support on the ER-2

• Supported the integration and the set-up of the database;

• Supported all flights during the campaign;

• Drew up procedures to ensure that the SATCOMs were working for a flight and when the go/no-go calls that should occur; and

• Diagnosed and fixed several Inmarsat failures.

Accomplishments for Task 2 were as follows: ATTREX/ CAST Global Hawk Mission (March 2015)

• Coordinated and ran online educational chats with the Mission Tools Suite for Education (MTSE) during Global Hawk flights that reached 323 K-12 students in the US and Mexico;

• Prepared a report with data from all ATTREX educational chats (numbers of students and teachers online during each flight) for submission to the OEPM (Office of Education Performance Management) system; and

• Between 2013 and 2015, connected with 1,237 students in twenty different schools in CA, IL, KS, MD, NY, NC, UT, Guam, Mexico and Chile through MTSE.

Operation IceBridge C-130 Mission (April-May 2015)

• Prepared and sent a summary of the Operation IceBridge mission to K-12 teachers and encouraged their participation in online chats;

• Coordinated and ran live classroom chats during C-130 flights over Greenland;

• Thirty-five classrooms with 723 total students in CA, IL, KS, LA, MA, MD, MN, NJ, NY, PA, and Mexico connected directly with OIB scientists and engineers onboard the C-130 and on the ground in Greenland; and• Prepared a report with data from all OIB educational chats (numbers of students and teachers online during each flight) for submission to the OEPM (Office of Education Performance Management) system.

NAAMES C-130 Mission (November 2015)

• Coordinated educational chats with K-12 classrooms during C-130 flights in November 2015.

EDUCATION AND OUTREACH ACTIVITY

Applied Remote Sensing Training (ARSET)

NASA: Jim Brass, Ana Prados (GSFC)
BAERI: Cindy Schmidt, Amber Kuss

NASA's Applied Remote Sensing Training Program (ARSET) in NASA's Applied Sciences program provides professional training in the application of NASA Earth Science data for water resources, disaster, and land and air quality management. ARSET builds the skills needed to integrate NASA Earth science into national and international organizational decision-making activities. Through online webinars and in-person workshops, attendees learn how to access, visualize and apply NASA remote sensing data and imagery using various web-based tools and open-source software. The program has reached over 1600 participants world-wide using the combined online and interactive approach.

Publications and Presentations
Wildfire Applications PI meeting in February.

2015 Accomplishments

- Conducted the webinar series Introduction to Remote Sensing for Wildfire Applications(March 31 –April 28)
- Conducted the webinar series Introduction to Remote Sensing for Conservation Management (May 5 – June 2)
- Conducted the webinar series Fundamentals of Remote Sensing, Part 1 and 2 (September)
- Conducted the workshop Remote Sensing for Wildfire Applications in Pocatello, Idaho (October 6-8)

California State University at Monterey Bay (CSUMB) Educational Program

NASA: James Brass
CSUMB: Susan Alexander, Kenneth Weinstock

The Division of Science and Environmental Policy at CSUMB offers a Bachelor of Science degree program in Environmental Science, Technology, and Policy (ESTP) and a Master of Science degree program in Applied Marine and Watershed Science (AMWS). These interdisciplinary programs emphasize the critical thinking and technical skills necessary to develop workable solutions to complex environmental problems. The curriculum integrates training in science, technology, economics, and policy that focus on marine, coastal, and watershed systems.

Among its many components, the CSUMB mission emphasizes an educational approach that fosters in students distinctive technical and educational skills, the experience and abilities to start a successful career, the critical thinking abilities to be productive citizens, and the entrepreneurial spirit needed for innovation and success. Because the knowledge and understanding of the Earth system and its processes are increasingly dependent on advanced technologies for acquiring, analyzing and visualizing geospatial information about our planet, expertise in geospatial applications is one of the most sought after skill sets for students pursuing Earth system science careers.

The M.S. in AMWS offers two degree options: PSM and thesis. Within their chosen option, students elect an emphasis in marine or watershed science. Advanced technology training is integrated throughout the applied environmental science and policy curriculum.

Figure 32: CSUMB students in the Environmental Science, Technology and Policy Department survey wetlands in the Elkhorn Slough area, near Monterey California.

Photo credit: CSUMB Environmental Science, Technology and Policy Department

The PSM option within AMWS emphasizes professional skill sets that will distinguish students as they enter the workforce, including: advanced technologies for acquiring, analyzing, modeling and visualizing spatially explicit environmental data; professional and scientific communication; scientific ethics; and environmental economics and policy analysis. Within the PSM option, skills learned in the classroom are matured by students through professional internships. The program satisfies a demand for highly skilled professionals within environmental technology and applied science-based companies, governmental agencies, and non-profit organizations.

The team applies its educational, scientific, and technological expertise to train the next generation of Earth System scientists and to reach out to the public about the project. Specifically, we work to:

- Offer programs and career development opportunities within the Science, Technology, Engineering, or Mathematics (STEM) fields that specifically foster the identification, recruitment, and success of Hispanic, and other under-represented and low-income students;

- Provide hands-on training for undergraduate and graduate students in Earth Science research activities including participation in field campaigns, internships, apprenticeships, and other research experiences;

- Lead educational activities aimed at K-12 students, college and graduate students, and the general public utilizing NASA-developed technologies and results; and

- Communicate results of scientific activities through community outreach events, conferences, publications, and other venues.

2015 Accomplishments

The California State University at Monterey Bay (CSUMB) Educational Program continues to facilitate research collaborations between AMWS graduate students, ESTP senior undergraduate students, Cooperative Agreement Research Scientists, and NASA PIs at Ames Research Center on the following projects:

• AMWS students (or recent graduates) David Hamblin, Andrew Hill, Daniel Muratore, Rachel Spellenberg, Erin Stanfield, Aimee Teaby, John Urness, Sean Windell, and Isabel Zaragosa conducted research and assisted with field activities under the mentorship of ARC CREST Senior Scientist Forrest Melton and Research Scientist Kirk Post (within the Ecocast and Ag/Health/Marine tasks);

• CSUMB Faculty Member Dr. Dan Fernandez collaborated with NASA PI Dr. Chris Potter on local fog research;

• CSUMB Faculty Members Dr. Arlene Haffa and Dr. Timothy Miles collaborated with ARC CREST Senior Scientist Forrest Melton on local agricultural research;

• They promoted student research opportunities at NASA Ames Research Center related to the Cooperative Agreement (e.g. DEVELOP) and will continue to facilitate student involvement in the Cooperative Agreement.

Support Products and Benefits:

• Provided hardware/software support and mentoring for 15+ students participating in the DEVELOP Summer 2015 session and year-round support for permanent DEVELOP staff and project teams during the fall and spring sessions. DEVELOP support activities are expected to continue in 2016 at the same level;

• Planned/coordinated acquisition (from another NASA Ames organization) and installation of 7 Dell C2100 servers to support additional system backup services and to upgrade/replace aging systems supporting the NASA Airborne Sciences aircraft asset tracking system. This included physical installation of a new 19-inch computer rack, and associated electrical power and network connectivity;

• Acquired/installed/configured a Netbotz 450 environmental monitoring system to provide real-time monitoring and alert notifications (via email and text messaging) for computer systems providing critical functionality to Code SGE programs; and

• Provided year-round large-format poster graphics output support for scientific meetings with large effort prior to the AGU Fall Meeting.

DEVELOP

NASA: James Brass
BAERI: Juan L. Torres-Pérez

The Applied Sciences' DEVELOP National Program addresses environmental and policy issues through interdisciplinary research projects that apply NASA Earth Observations to community concerns around the globe. DEVELOP bridges the gap between NASA Earth Science and society, building capacity in both its participants and partner organizations to better prepare them to handle the challenges that face our society. The projects during 2015 have comprehended a wide range of themes such as drought, decision support systems for federal and local agencies, partnerships with Native American entities, biological oceanography, coral reef biology and ecology, and health and air quality problems.

2015 Accomplishments

- Mentored multiple teams on the use of different imagery available for analysis, methodologies, and results;
- Participated in the Annual DEVELOP Closeout at NASA Headquarters in Washington D.C. along with representatives of each of the three summer projects;
- Presented project results and the Earthzine videos to the local scientific community; and
- Presented at the AGU Fall Meeting in San Francisco in December 2015.

Figure 33: A Geospatial Evaluation of Drivers, Occurrences, and Distribution of Hypoxic Events within the Grijalva-Usumacinta River Delta System and the Southern Coast of the Gulf of Mexico

Student Airborne Research Program (SARP)

NASA: Jack Kaye
UND/NSERC: Rick Shetter, Emily Schaller, Jane Peterson, and Karen Katrinak

The Student Airborne Research Program (SARP) is an eight-week summer program for junior and senior undergraduate and early graduate students to acquire hands-on research experience in all aspects of a scientific mission using NASA's DC-8 or P-3 airborne science laboratories. The DC-8 and P-3 are major NASA resources for studying Earth system processes, calibration/validation of space-borne observations, and prototyping instruments for possible satellite missions. Participants assist in the operation of instruments on board the aircraft to sample atmospheric chemicals and to image land and water surfaces in multiple spectral bands.

Along with airborne data collections, students participate in taking measurements at field sites. The program culminates with formal presentations of research results and conclusions. Students participating in the program have a strong academic background in disciplines relevant to the Earth system, including the physical, chemical, or biological sciences or engineering. Many have experience with image processing and GIS systems.

Figure 34: SARP students with the DC-8.

2015 Accomplishments

• Provided and added frequent content about missions to the Airborne Science Program web page and social media accounts;

• Ran a successful Student Airborne Research Program with 32 undergraduate students, 5 graduate student/postdoc mentors and 6 faculty members;

o Organized all science flights;

o Organized final student presentations, the final graduation meeting, collection of student evaluations and SARP laptops, and checkout from the UCI housing, return of the students for their flights home to the John Wayne airport, and return of SARP equipment and staff to Armstrong Building 703

o Selected the top student presentations for participation at the AGU conference;

o Assisted the 12 SARP 2015 students attending AGU with preparing their presentations;

o Organized SARP alumni reunion dinner during AGU;

• Staffed the NASA booth at the National Science Teachers Association Meeting in Chicago to promote the Mission Tools Suite for Education (MTSE) to science teachers and hosted a workshop "Real Student Science with NASA Airborne Scientists" in the meeting;

• Represented the Airborne Science Program in the "Earth Right Now" communications campaign;

• Gave 10 in-person presentations to schools and summer camps about Airborne Science Program missions that reached over 500 K-12 students and their teachers in Southern California

• Coordinated virtual educational chats and flight following using the Mission Tools Suite for Education during ATTREX/CAST and IceBridge Arctic that reached over 1,000 K-12 students;

• Coordinated educational chats for NAAMES in November 2015;

• Staffed NASA booth at the Fall 2015 AGU meeting in San Francisco to promote SARP and K-12 mission communication activities;

• Completed SARP 2015 documentary/recruitment video;

• Produced an educational video and wrote an article focusing on school outreach during the final campaign of the Hurricane and Severe Storm Sentinel mission "HS3 Mission Connects with K-12 Classrooms";

• Produced a NASA Airborne Science mission video "Planning and Executing a Major NASA Airborne Science Campaign" focusing on Operation IceBridge;

• Produced a documentary video summarizing the findings of the Hurricane and Severe Storm Sentinel mission;

• Obtained HQ budget approval for an 8 week SARP 2016 with 32 students.

• Received commitments from SARP faculty and currently gathering information on their funding requirements for field trips, integration and analysis costs for inclusion into our budget;

• Posted SARP 2016 application on NSERC website and https://intern.nasa.gov.

•Published SARP 2016 announcement in the Student Opportunities section of AGU EOS, the SACNAS job register, the Pathways to Science Institute for Broadening Participation job register, Earth Science Women's Network and NASA Education Express; and

• Sent Emails about SARP with a flyer that will be sent to over 1000 U.S. college and university STEM departments in November 2015.

PUBLICATIONS AND PRESENTATIONS

11th International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-11), California Institute of Technology, 16-18 June 2015.

Albertson, R., Schoenung, S., Fladeland, M., Cutler, F., Tagg, B. "Enabling Earth Science Measurements with NASA UAS Capabilities," 36th International Symposium on Remote Sensing of the Environment.

Ambrosia, V. G., A. Soja, L. Friedl, 2014. NASA and Wildfires: Driving Research to Operations. 7th International Conference on Forest Fire Research, Coimbra, Portugal, 17-21 November 2014.

Ambrosia, V. G., A. Soja, L. Friedl, 2014. NASA and Wildfires: Driving Research to Operations. 7th International Conference on Forest Fire Research, Coimbra, Portugal, 17-21 November 2014.

Ambrosia, V. G., A. Soja, L. Friedl, 2015. NASA Applied Science Program -Wildfires: Driving Research to Operations. 36th International Symposium on Remote Sensing of Environment (ISRSE), Berlin, Germany, 14 May 2015.

Ambrosia, V. G., A. Soja, L. Friedl, 2015. NASA Applied Science Program -Wildfires: Driving Research to Operations. 36th International Symposium on Remote Sensing of Environment (ISRSE), Berlin, Germany, 14 May 2015.

Ambrosia, V.G., A. Soja, L. Friedl, 2015. NASA Fire Science and Applications: Building Capacity and Understanding of Ecosystem Dynamics. Keynote Address at 10th European Remote Sensing Laboratories (EARSeL) Forest Fire Special Interest Group Workshop, Limassol, Cyprus, 2 November 2015.

Ambrosia, V.G., A. Soja, L. Friedl, 2015. NASA Fire Science and Applications: Building Capacity and Understanding of Ecosystem Dynamics. Keynote Address at 10th European Remote Sensing Laboratories (EARSeL) Forest Fire Special Interest Group Workshop, Limassol, Cyprus, 2 November 2015.

Ambrosia, V.G., R. P. Dahlgren, A. Watts, K. W. Reynolds, and T. Ball, 2014. UAS Developments Supporting Wildfire Observations. American Geophysical Union (AGU) fall Meeting, Poster: A23B-3221, San Francisco, CA, 16 December 2014.

Ambrosia, V.G., R. P. Dahlgren, A. Watts, K. W. Reynolds, and T. Ball, 2014. UAS Developments Supporting Wildfire Observations. American Geophysical Union (AGU) fall Meeting, Poster: A23B-3221, San Francisco, CA, 16 December 2014.

Barreto-Orta M, JL Torres-Pérez, J Ortiz-Zayas, L Santiago, S Setegn, L Guild, C Ramos-Scharrón, and RA Armstrong. 2015. Human impacts to coastal ecosystems in Puerto Rico (HICE-PR): Río Grande de Manatí watershed, a remote sensing, hydrologic, ecologic and socio-economic assessment with management implications. NASA Joint Sciences Workshop, April 2015, Maryland.

Basu S., Ganguly S., Mukhopadhyay S., DiBiano R., Karki M., and Nemani, R.R. 2015. DeepSat - A Learning framework for Satellite Imagery, ACM SIGSPATIAL 2015. (pdf).

Basu S., Karki M., Stagg M., DiBiano R., Ganguly S. and Mukhopadhyay S. 2015. MAPTrack -A Probabilistic Real Time Tracking Framework by Integrating Motion, Appearance and Position Models. In Proceedings of the 10th International Conference on Computer Vision Theory and Applications, ISBN 978-989-758-091-8, pages 567-574. DOI: 10.5220/0005309805670574.

Basu, S. et al. 2015. A Semiautomated Probabilistic Framework for Tree-Cover Delineation From 1-m NAIP Imagery Using a High-Performance Computing Architecture, Geoscience and Remote Sensing, IEEE Transactions on, vol.53, no.10, pp.5690,5708, Oct. 2015.

Basu, S., Karki, M, Ganguly, S., DiBiano, R., Mukhopadhyay, S., Nemani, R.R. 2015. Learning Sparse Feature Representations using Probabilistic Quadtrees and Deep Belief Nets, European Symposium on Artificial Neural Networks, ESANN 2015.

Bi, J., et al., (Ganguly, S. amongst 23 authors). 2015. Sunlight mediated seasonality in canopy structure and photosynthetic activity of Amazonian rainforests, Environmental Research Letters, 10 (6), DOI: 10.1088/1748-9326/10/6/064014.

Comparisons of Non-buoyant and Buoyant Flux Emergence Events - Flux Emergence workshop, Boulder, CO June 2015.

Dahlgren, R., "Fused PM fiber single-polarization resonator," US Patent 9,115,993 (2015).

PUBLICATIONS AND PRESENTATIONS

Dahlgren, R., "Fused PM fiber single-polarization resonator," US Patent 9,115,993 (2015).

Dahlgren, R., "Modular UAVs for Bespoken Airborne Platforms for Science Applications," Eye on the Environment: Summit on Drones for Research and Conservation, (California Academy of Sciences, 17 Sept. 2015).

Dahlgren, R., "Modular UAVs for Bespoken Airborne Platforms for Science Applications," Eye on the Environment: Summit on Drones for Research and Conservation, (California Academy of Sciences, 17 Sept. 2015).

Dahlgren, R., O. Dary, J. Ogunbiyi, E. Pinsker, K. Reynolds, C. Werner, "Upcycling UAS into modular platforms for Earth science and autonomy research," AGU Fall Meeting, Abstract NH43C-1909 (San Francisco, 2015).

Dahlgren, R., O. Dary, J. Ogunbiyi, E. Pinsker, K. Reynolds, C. Werner, "Upcycling UAS into modular platforms for Earth science and autonomy research," AGU Fall Meeting, Abstract NH43C-1909 (San Francisco, 2015).

Dahlgren, R.P., "Customizing UAS platforms for the Federal mission: volcano hazards example" USGS Unmanned Aircraft Systems Technologies Workshop, (Reston, VA, 19-21 May 2015).

Dahlgren, R.P., "Customizing UAS platforms for the Federal mission: volcano hazards example" USGS Unmanned Aircraft Systems Technologies Workshop, (Reston, VA, 19-21 May 2015).

Dunagan, S., R. Johnson, C. Chang, Y. Shinozuka, M. Kacenelenbogen, R. Dahlgren, M. Segal Rozenhaimer, S. LeBlanc, B. Schmid, C. Flynn, "Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR)," NASA Instrumentation Workshop, (Moffett Field, CA,16 Sept. 2015).

Dunagan, S., R. Johnson, C. Chang, Y. Shinozuka, M. Kacenelenbogen, R. Dahlgren, M. Segal Rozenhaimer, S. LeBlanc, B. Schmid, C. Flynn, "Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR)," NASA Instrumentation Workshop, (Moffett Field, CA,16 Sept. 2015).

Flynn et al., 4STAR sky-scanning retrievals of aerosol intensive optical properties including size distribution, coarse mode fraction, complex index of refraction and single scattering albedo: comparisons to AERONET during TCAP I & II and SEAC4RS, American Geophysical Union (AGU),12/14-18 2015.

Flynn, C., R.P. Dahlgren, S. Dunagan, B. Holben, R. Johnson, M. Kacenelenbogen, S. LeBlanc, J. Livingston, J. Redemann, B. Schmid, S. Schmidt, Y. Shinozuka, M. Segal Rozenhaimer, A. Sinyuk, Q. Zhang, "Highlights from 4STAR Sky-Scanning Retrievals of Aerosol Intensive Optical Properties from Multiple Field Campaigns with Detailed Comparisons of SSA Reported During SEAC4RS," AGU Fall Meeting, Abstract A23F-0394 (San Francisco, 2015).

Frankenberg,C., Susan Kulawik, Steve Wofsy, Gregory Osterman, Edward T. Olsen, Christopher O'Dell, Andy Jacobson, Frederic Chevallier, and HIPPO team. Using airborne HIAPER Pole-to- Pole Observations (HIPPO) to evaluate model and remote sensing estimates of atmospheric carbon dioxide.

Goward, S.N., C. Huang, F. Zhao, K. Schleeweis, K. Rishmawi, M. Lindsey, J.L. Dungan, and A. Michaelis. 2015. NACP NAFD Project: Forest Disturbance History from Landsat, 1986-2010. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1290

Granules, Flux Emergence and the Subsurface Structure of Sunspots, Max Planck Institute forSolar System Research, Goettingen, Germany, January 2015.

Hartlep,T., David H. Hathaway, Nagi N. Mansour. In preparation: "Effective Diffusion Coefficients of Supergranules in Solar Surface Flux Transport" .

Hashimoto, H., R. Nemani, and et al. 2015. "Estimation of spatial variability in humidity, wind, and solar radiation using the random forest algorithm for the conterminous USA". AGU 2015, San Francisco.

Hillyard P. et al. 2015. Detecting CO_2 and CH_4 urban emissions using column-integrated dry air mole fractions, in-situ tower atmospheric mixing ratios, and WRF modeling. 2015 AGU Fall Meeting.

Improving the frequency of high spatial resolution leaf area index maps using Landsat OLI and Sentinel-2 MSI. AGU Fall Meeting, Dec. 14-18, 2015, San Francisco, CA.

PUBLICATIONS AND PRESENTATIONS

Initial OCO-2 comparisons to TCCON at OCO-2 meeting, California Institute of Technology, 4-6 November, 2015.

Inoue, M. et al. (L. Iraci, J.R. Podolske and P. Hillyard are among 46 co-authors). Bias corrections of GOSAT SWIR XCO_2 and XCH_4 with TCCON data and their evaluation using aircraft measurement data, Atmospheric Chemistry and Physics, submitted.

Invited Talk, Jennifer Dungan, Sangram Ganguly, NASA Carbon Cycle and Ecosystems Joint Science Workshop, April 20-24, 2015, College Park, MD, "NEX system processing for Landsat-8/Sentinel-2 data" Web URL: http://lcluc.umd.edu/Documents/ScienceTeamMtg/2015_APR/AGENDA%20Sentinel2%20Meet ing%202015%20-College%20Park.pdf

Invited Talk, Sangram Ganguly, Berkeley Institute for Data Science Lecture Series, Berkeley, 2015 Web URL: http://bids.berkeley.edu/resources/videos/nasa-earth-exchange-nex-big-data-challenges-high-performance-computing-and-machine

Invited Talk, Sangram Ganguly, Comsnets 2015, January 6-10, 2015, Bangalore, India. Web URL: http://www.comsnets.org/agrinets_workshop.html

Invited Talk, Sangram Ganguly, EDIP-Fed, Asilomar, 2015. Web URL: http://earthsciencefoundation.org/esipfed-summer-meeting/

Invited Talk, Sangram Ganguly, Expeditions in Computing: Understanding Climate Change, Minnesota 2015. Web URL: http://climatechange.cs.umn.edu/annual_program_2015.php

Invited Talk, Sangram Ganguly, Global Maritime Workshop 2015. Web URL: http://nmio.ise.gov/Portals/16/GMF%20Reports/Docs/GMF%202015.pdf?ver=2015-12-08-105435-287

Jensen, E. J., L, Pfister, R. Ueyama, J. Bergman, and D. Kinnison. 2014. Investigation of the transport processes controlling the geographical distribution of carbon monoxide at the tropical tropopause. J. Geophy. Res. Atmos., 120; doi:10.1002/2014JD02261.

Jethva et al., Validating Above-cloud Aerosol Optical Depth Retrieved from MODIS-based 'Color Ratio' Algorithm using NASA's Airborne AATS and 4STAR Direct Measurements, in preparation for GRL, 2015.

Kacenelenbogen et al., Aerosol types from spaceborne remote sensing observations over the globe: from clear-sky to above low opaque water clouds, Poster, National Academy of Science, Irvine, USA, 06/23-24 2015.

Kacenelenbogen et al., Aerosol types from spaceborne remote sensing observations over the globe: from clear-sky to above low opaque water clouds, Poster, National Academy of Science, Irvine, USA, 06/23-24 2015.

Kacenelenbogen et al., Aerosol types using passive remote sensing: global distribution, consistency check, total-column investigation and translation into composition derived from climate and chemical transport models, Oral, American Geophysical Union (AGU), 12/14-18 2015.

Kacenelenbogen et al., Preparing for ORACLES: A few satellite derived aerosol and cloud properties in the South East Atlantic, Poster, ORACLES Science Team, NASA AMES, USA, September 2015

Kacenelenbogen et al., Preparing for ORACLES: A few satellite derived aerosol and cloud properties in the South East Atlantic, Poster, ORACLES Science Team, NASA AMES, USA, September 2015.

Koltunov, A., B. Quayle, E. M. Prins, V. G. Ambrosia, and S. Ustin, 2014. From Data to Knowledge— Faster: GOES Early Fire Detection System to Inform Operational Wildfire Response and Management. American Geophysical Union (AGU) Fall Meeting, Oral Presentation: IN41D-02, San Francisco, CA, 18 December 2014.

Kotov, D, H. C. Yee, A. Wray, A. Hadjadj, and B. Sjogreen. High order numerical methods for the dynamic SG.

Kudela RM, SL Palacios, DC Austerberry, EK Accorsi, LS Guild, and J Torres-Pérez. 2015. Application of hyperspectral remote sensing to cyanobacterial blooms in inland waters. Remote Sensing of the Environment. 55. DOI:10.1016/j.rse.2015.01.025.

Kulawik, S. S., Wunch, D., O'Dell, C., Frankenberg, et al., Consistent evaluation of GOSAT, SCIAMACHY, CarbonTracker, and

PUBLICATIONS AND PRESENTATIONS

MACC through comparisons to TCCON, Atmos. Meas. Tech. Discuss., 8, 6217-6277, doi:10.5194/amtd-8-6217-2015, 2015.

LeBlanc et al., Implication of using transmitted vs. reflected light or determining cloud properties, cloud radiative effect and aerosol-cloud-interactions, American Geophysical Union (AGU), 12/14-18 2015

LeBlanc S. E. et al., Cloud Properties Retrieved from Airborne Measurements of transmitted and Reflected Shortwave Spectral Radiation, SEAC4RS science team, Boulder, CO, April 2015.

LeBlanc S. E. et al., Cloud shortwave radiative effect and cloud properties estimated from airborne measurements of transmitted and reflected light, EGU, Vienna, Austria, 12-17 April, 2015.

Mancinelli, R.L., Hauslage, J, Bornemann, G, and Richter, P. 2015. Elucidating the nitrogen cycle of Eu:CROPIS: Euglena: Combined Regenerative Organic-food Production In Space. International Society for Gravitational Physiology. Annual Meeting Abt. Book 2015, Igor B. Mekjavic (ed) pg.120. ISBN 978-961-93848-0-0.

Mao, J., W. Fu, X. Shi, W. Wang, and et al., 2015. Disentangling climatic and anthropogenic controls on global terrestrial evapotranspiration trends, Environ. Res. Lett. doi:10.1088/1748-9326

Maurer, E.P., D.L. Ficklin, and W. Wang. 2015. The impact of spatial scale in bias correction of climate model output for hydrological impact studies, Hydrol. Earth Syst. Sci.

Mee Ryoo, J. et al. Investigation of ozone sources in California using AJAX airborne measurements and models: Implications for stratospheric intrusion and long range transport, presented at the AGU Fall Meeting, Dec 2015.

Melton, F., W. Wang, J. Xiong, A. Guzman, A. Quackenbush, C. Milesi, R. Nemani et al. 2015. Modeling Impacts of Climate and Land Use Change on Ecosystem Processes: Quantifying Exposure to Climate Change in Two Landscape Conservation Cooperatives. Ecological Society of America, Baltimore, MD, Aug 11, 2015.

Melton, F.et al. 2015. Quantifying Impacts of Climate and Land Use Change on Ecosystem Processes in the Great Northern and Appalachian Landscape Conservation Cooperatives. In Climate change in wildlands: Pioneering approaches to science and management in the Rocky Mountains and Appalachians, A. Hansen, W. Monahan, and D. Theobald (eds.), Island Press, (in press).

NASA Earth Exchange (NEX) Sentinel-2 Processing Pipeline. NASA LCLUC Spring Science Team Meeting, Apr. 22-23, 2015, College Park, MD.

Palacios S. et al., Bringing the ocean into finer focus, Climate Change and Ecosystems Joint Workshop in College Park, MD, April 20-24, 2015.

Palacios, S., RM Kudela, LS Guild, KH Negrey, J Torres-Pérez, and J Broughton. 2015. Remote sensing of phytoplankton functional types in the coastal ocean from the HyspIRI Preparatory Flight Campaign. Remote Sensing of the Environment. 167. DOI:10.1016/j.rse.2015.05.014.

Peters-Lidard, C.D. et al. (Q. Tan among 23 co-authors), 2015, Integrated modeling of aerosol, cloud, precipitation and land processes at satellite-resolved scales, Environmental Modelling & Software, 67, 149–159. doi: http://dx.doi.org/10.1016/j.envsoft.2015.01.007

Redemann et al., Aerosol-cloud interactions in the South-East Atlantic: future suborbital activities to address knowledge gaps in satellite and model assessments, American Geophysical Union (AGU), 12/14-18 2015

Redemann, J., S. Dunagan, R. Johnson, C. Chang, Y. Shinozuka, M. Kacenelenbogen, R. Dahlgren, M. Segal Rozenhaimer, S. LeBlanc, B. Schmid, C. Flynn, "Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR)," NASA Instrumentation Workshop, (Moffett Field, CA, 16 Sept. 2015).

Reducing Uncertainties in Satellite-Derived Forest Aboveground Biomass Estimates Using a High Resolution Forest Cover Map, CMS Science Team Meeting, Nov 16-18, 2015, Pasadena, CA.

Reynolds, K.W., R.P. Dahlgren, M.M. Fladeland, D.E. Manosalvas, I.M. Suresh, M.R. López, M.J. Lowen, O.G. Dary, S. Hening, N.I. Nguyen, L.K. Byun, R.A. Miller, M. Sumich, C.A. Ippolito, D.B. Herlth, R. Kolyer, and V.G. Ambrosia, 2015. "Repurposing Surplus

PUBLICATIONS AND PRESENTATIONS

Unmanned Aircraft SystemsInto UAS Platforms for Science Missions." Proceedings of Association of Unmanned Vehicle Systems International (AUVSI) Unmanned Systems 2015, AUVSI, Atlanta, GA., 5 May 2015.

Saide, P. E. et al. (Redemann, J. and Shinozuka, Y.) among 26 authors. (2015), Revealing important nocturnal and day-to-day variations in fire smoke emissions through a multiplatform inversion. Geophys. Res. Lett., 42, 3609–3618. doi: 10.1002/2015GL063737.

Saide, P. E. et al. (Kacenelenbogen, M. and Redemann, J. among 10 authors): Central American biomass burning smoke can increase tornado severity in the U.S. Geophys. Res. Lett., 2014GL062826,10.1002/2014gl062826, 201

Schoenung, S., Fladeland, M., Albertson, R., "UAS Payload and Platform Experience for Earth Science," AUVSI Unmanned Systems 2015.

Schwalm, C.R., D.N. Huntzinger, J.B. Fisher, W. Wang, and et al., 2015. Toward 'optimal' integration of terrestrial biosphere models, Geophysical Research Letters, 4418-4428.

Segal-Rozenhaimer et al., Neural Network algorithm development for polarimetric measurements of above cloud aerosols (ACA), American Geophysical Union (AGU), 12/14-18, 2015.

Segal-Rozenhaimer et al., Polarimetric aerosol above cloud retrieval algorithm development using neural networks, ORACLES STM, NASA Ames Research Center, Sep-9-11, 2015.

Segal-Rozenhaimer et al., Relative roles of atmospheric state and boundary layer clouds on Arctic cloud radiative forcing forecasts: The ARISE 2014 case study, in preparation for J. of Climate, 2015

Segal-Rozenhaimer, M. et al., Cloud radiative forcing sensitivity to Arctic synoptic regimes, surface type, cloud phase and cloud properties during the Fall 2014 Arctic Radiation, IceBridge and Sea-Ice Experiment (ARISE). European Geophys. Union General Assembly, 12-17 April 2015, Vienna, Austria.

Segal-Rozenhaimer, M., et al., Investigating cloud radiative effects sensitivity over the marginal ice zone during ARISE 2014, ARISE Science Team Meeting, NASA Goddard Space Flight Center, Greenbelt, Md., 19-20 May 2015

Shinozuka, Y., et al. (2015), Airborne observation of aerosol optical depth, Phil Russell Retirement Symposium.

Shinozuka, Y., et al. (2015), The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, Atmos. Chem. Phys., 15, 7585-7604, doi:10.5194/acp-15-7585-2015.

Shinozuka, Y., et al. (2015), The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, ORACLES Science Team Meeting.

Shinozuka, Y., et al. (2015), The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, NAAMES Science Team Meeting.

Shinozuka, Y., et al. (2015), The relationship between cloud condensation nuclei (CCN) concentration and light extinction of dried particles: indications of underlying aerosol processes and implications for satellite-based CCN estimates, Arthur M. Sackler colloquium on Improving Our Fundamental Understanding of the Role of Aerosol-Cloud Interactions in the Climate System.

Simulations of Magnetic Fluxe Emergence, High Altitude Observatory, Boulder CO, June 2015.

Smith L. William Jr. et al.s, Arctic Radiation-IceBridge Sea and Ice Experiment (ARISE): The Arctic radiant energy system during the critical seasonal ice transition. Bull. Amer. Meteor. Soc., submitted (August, 2015).

Soja, A., V. Ambrosia, and L. Friedl, NASA Applied Science, Wildland Fire Program: Sustaining Land Imaging: UAS to Satellites. 19th Pecora Symposium, Denver Colorado, 17-21 Nov. 2014.

PUBLICATIONS AND PRESENTATIONS

Soja, A., V. Ambrosia, and L. Friedl, NASA Applied Science, Wildland Fire Program: Wildland Fire Program: Potential Use for Suomi-NPP. Second S-NPP Application Workshop, Huntsville, Alabama, 19 November 2014.

Subsurface Structure of Pores and Sunspots, HMI nugget, May 2015.

Tan, Q., M. Chin, V. Aquila, H. Bian, G. Chen, A. B. Early, Evaluation of Modeled SO_2 in the UTLS Region with Aircraft Data from Multiple Campaigns, AeroCom Workshop, Oct. 2015 (poster).

Tan, Q., M. Chin, V. Aquila, H. Bian, G. Chen, A. B. Early, Evaluation of Modeled SO_2 in the UTLS Region with Both Satellite and Aircraft Data, AGU, Fall Meeting, 2015.

Tan, Q., M. Chin, V. Aquila, H. Bian, J. Barnes, Modeling Study of Atmospheric Aerosol Trend in Stratosphere in Recent Decades, Poster presented at the NAS Colloquia, "Improving Our Fundamental Understanding of the Role of Aerosol-Cloud Interactions in the Climate System", June, 2015, Irvine, CA (poster).

Tang, H., Brolly, M., Zhao, F., Strahler, A. H., Schaaf, C., Ganguly, S., Zhang, G. and R. Dubayah. 2014. Deriving and validating Leaf Area Index (LAI) at multiple spatial scales through lidar remote sensing: A case study in Sierra National Forest, CA, Remote Sensing of Environment, 143 (5),131-141, DOI: 10.1016/j.rse.2013.12.007.

Tang, H., Ganguly, S., Zhang, G., Hofton, M. A., Nelson, R. F. and R. Dubayah. 2015. Characterizing Leaf Area Index (LAI) and Vertical Foliage Profile (VFP) over the United States, Biogeosciences Discussions, 12, 13675-13710.

The Surface of Stellar Models- Now with more 3D simulations!, The Space Photometry Revolution -CoRoT Symposium 3, Kepler KASC-7 Joint Meeting, Toulouse, France, Edited by R.A. Garcia; J. Ballot; EPJ Web of Conferences, Volume 101, id.06064.

Tian, H., C. Lu, J. Yang, Wang, W. and et al. 2015. Global patterns and controls of soil organic carbon dynamics as simulated by multiple terrestrial biosphere models: current status and future directions", Global Biogeochemical Cycles, 775-792.

Torres-Pérez JL, Barreto-Orta M, J Ortiz-Zayas, L Santiago, S Setegn, L Guild, C Ramos-Scharrón, and RA Armstrong. 2015. Human impacts to coastal ecosystems in Puerto Rico (HICE-PR): Río Loco watershed (southwest coast PR), a remote sensing, hydrologic, ecologic and socio-economic assessment with management implications. NASA Joint Sciences Workshop, April 2015, Maryland.

Torres-Pérez JL, Barreto-Orta M, J Ortiz-Zayas, L Santiago, S Setegn, L Guild, C Ramos-Scharrón, and RA Armstrong. 2015. Human impacts to coastal ecosystems in Puerto Rico (HICE-PR): the Guánica and Manatí watersheds. International Ocean Color Symposium, July 2015, San Francisco, California. This poster was also presented at the 34th US Coral Reef Task Force Meeting in Fajardo, Puerto Rico, October 2015.

Torres-Pérez JL, LS Guild, RA Armstrong, J Corredor, A Zuluaga-Montero, and R Polanco. In Press. Relative pigment composition and remote sensing reflectance of Caribbean shallow-water corals. PLoSONE.

U. Kumar, R. Nemani, S. Ganguly, C. Milesi, K. Raja, W. Wang, P. Votava, A. Michaelis, "Continental Spatio-temporal Data Analysis with Linear Spectral Mixture Model using FOSS". AGU 2015, San Francisco.

Ueyama, R., E. J. Jensen, L. Pfister, and J.E. Kim. 2015. Dynamical, convective, and microphysical control on wintertime distributions of water vapor and clouds in the tropical tropopause layer. J. Geophy. Res. Atmos., 120; doi:10.1002/2015JD023318.

Ueyama, R., E. J. Jensen, L. Pfister, Impact of radiative heating rates on wintertime distributions of TTL water and clouds (presented at 95th American Meteorological Society Annual Meeting, Phoenix, AZ, Jan 2015).

Ueyama, R., Trajectory and microphysical modeling of H_2O and clouds in the tropical tropopause layer (presented at NASA Ames Earth Science Division poster session, Moffett Field, CA, Feb 2015).

Ueyama, R., Trajectory and microphysical modeling of H_2O and clouds in the tropical tropopause layer (presented at Composition and Transport in the Tropical Troposphere and Lower Stratosphere Meeting, Boulder, CO, Jul 2015).

Vanderbilt, V., C. Daughtry, M. Kupinski, C. Bradley, R. Dahlgren, "Coming of Age: Polarization as a Probe of Plant Canopy

PUBLICATIONS AND PRESENTATIONS

Water Status," AGU Fall Meeting, Abstract B53C-0582 (San Francisco, 2015).

Vanderbilt, V.C., C. Daughtry, R.P. Dahlgren, "Relative Water Content, Bidirectional Reflectance and Bidirectional Transmittance of the Interior of Detached Leaves during Dry Down," IGARSS, (Milan, Italy, 26-31 July 2015).

Vanderbilt, V.C., C. Daughtry, R.P. Dahlgren, "Remotely Sensing the Photochemical Reflectance Index, PRI," Proc. SPIE 9613, Polarization Science and Remote Sensing VII, (San Diego, CA, 23 Sept. 2015).

Vanderbilt, V.C., C.S.T. Daughtry, R.P. Dahlgren, "Is There Ecological Information in Optical Polarization Data?" Carbon Cycle Ecosystem Joint Science Workshop, (College Park, MD, 20-24 April 2015).

Votava, P., A. Michaelis, R. Nemani. 2015. "Reproducibility and Knowledge Capture Architecture for the NASA Earth Exchange (NEX)". AGU 2015, San Francisco.

Votava, P., A.Michaelis. 2015. "Building Petabyte Data Production Systems with the NASA Earth Exchange (NEX)". IEEE Supercomputing Conference, Austin, TX.

Votava, P., S. Ganguly, A. Michaelis. 2015. "NASA Earth Exchange (NEX). Supporting Science at a Petabyte Scale". Big Data Big Think Workshop. NASA Ames, April 2015.

Wang, W. and R. Nemani. 2015. Dynamic Responses of Atmospheric Carbon Dioxide Concentration to Global Temperature Changes between 1850 and 2010, Advances in Atmospheric Sciences (in press).

Wang, W., H. Hashimoto, R. Nemani, and et al. 2015. "Impacts of Lateral-Boundary-Condition Errors on Regional Climate Downscaling: lessons learned from the NASA Downscaling Project". AGU 2015, San Francisco.

Wang, W., R. Nemani. 2015. "The Dynamics of Global Atmospheric CO_2 Concentration from 1850 to 2010: A Linear Approximation". NACP 5th Workshop, Washington DC.

Wang. W. et al. 2015. "The dynamics of atmospheric CO_2 over interannual to multidecadal scales in the past 150 years". Fluxnet Synthesis Workshop, Beijing, China.

Watts, A., T. Ball, R. Dahlgren, V.G. Ambrosia, "Evaluating and operationalizing unmanned aircraft for wildland fire use" AGU Fall Meeting, Abstract NH43C-1898 (San Francisco, 2015). Watts, A., V. Ambrosia, and E. Hinkley, 2015. Unmanned Aircraft for Wildland Fire Science and Operations: Classification and Considerations for Use. 36th International Symposium on Remote Sensing of Environment (ISRSE), Berlin, Germany, 15 May 2015.

Werner, C., Robert Dahlgren, C. Kern, P. Kelly, M. Fladeland, K. Norton, M. Johnson, A. Sutton, T. Elias, "Volcano Gas Measurements from UAS – Customization of Sensors and Platforms," AGU Fall Meeting, Abstract NH43C-1901 (San Francisco, 2015).

Yates, E. et al, Investigating the Impacts of Wildfires on Air Quality in the Western US Presented at the AGU Fall Meeting, Dec 2015.

Zhang, J., C. Lee, P. Votava, T. J. Lee, R. Nemani, I. Foster. 2015. A community-oriented workflow reuse and recommendation technique, International Journal of Business Process Integration and Management.

GLOSSARY

ASPRS – American Society of Photogrammetry and Remote Sensing

ASRL– Allometric Scaling and Resource Limitations Model

ASTER – Advanced Spaceborne Thermal Emission and Reflection Radiometer

ATTREX – Airborne Tropical Tropopause Experiment

AATS – Ames Airborne Tracking Sunphotometer ATom – Atmospheric Tomography Mission

AVAPS – Advanced Vertical Atmospheric Profiling System

AVHRR – Advanced Very High Resolution Spectroradiometer

AVIRIS – Airborne Infrared Imaging Spectrometer

AWS – Amazon Web Services

BAER or BAERI – The Bay Area Environmental Research Institute

BCCA – Bias Correction/Constructed Analogs

BCSD – Bias Correction/Spatial Downscaling

BGAN – Broadband Global Area Network

CAAP – CELSS Antarctic Analog Project

CALIPSO – Cloud Aersol Lidar and Infrared Pathfinder Satellite Observations

CAN – Cooperative Agreement Notice

CARVE – Carbon in Arctic Reservoirs Vulnerability Experiment

CASA – Carnegie-Ames-Stanford Approach

CASI – Climate Adaptation Science Investigators

CDWR – California Department of Water Resources

CELSS – Controlled Ecological Life Support System

CERES – California Environmental Resources Evaluation System

CH_4 – Methane

CHAART – Center for Health Applications of Aerospace Related Technologies

CIMIS – California Irrigation Management Information System

CME – Coastal and Marine Ecosystems

CMIP5 – Coupled Model Intercomparison Project Phase 5

CMS – Carbon Monitoring Systems

CO – Carbon Monoxide

COAST – Coastal and Ocean Airborne Science Testbed

COMEX – Carbon Dioxide (CO_2) and MEthane eXperiment

COMPASS – Common Operations and Management Portal for Airborne Science Systems

CQUEST – Carbon Query and Evaluation Support Tools

CRUSH – Canopy Remotesensing for Uniformly Segmented Harvest

CSIRO – Commonwealth Scientific and Industrial Research Organisation

CSC – Climate Science Center

CSGC – California Space Grant Consortium

CSTARS – The Center for Spatial Technologies and Remote Sensing

CSUMB – California State University Monterey Bay

CWSP – Coastal and Watershed Science and Policy

DAAC – Distributed Active Archive Center

DAYMET – Daily Surface Weather and Climatological Summaries

DB AOD – Deep Blue Aerosol Optical Depth

DC3 – Deep Convective Clouds and Chemistry Experiment

DFRC – Dryden Flight Research Center (NASA)

DLR – Deutsches Zentrum für Luft- und Raumfahrt (the German Aerospace Center) DNS – Direct Numerical Simulation

DRI – Desert Research Institute

DRECP – Desert Renewable Energy Conservation Plan

DEVELOP – Digital Earth Virtual Environment and Learning Outreach Project

GLOSSARY

DISCOVER-AQ – Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality

DPM – Department of Payment Management

Dropsondes – Advanced Vertical Atmospheric Profiling System

DSEP – Division of Science and Environmental Policy

EARSeL – European Association of Remote Sensing Laboratories

EF – Ecological Forecasting

eMAS – Enhanced MODIS Airborne Simulator

EOS – Earth Observing System

EOS-PSO – EOS Project Science Office

ER-2 – Earth Resources 2 (Single-engine,high-altitude aircraft)

ESDR – Earth Science Data Record

ESTP – Environmental Science, Technology, and Policy

ETM – Enhanced Thematic Mapper

Eu:CROPIS – Euglena: Combined Regenerative Organic-food Production In Space

EVS-2 – Electronic Vibration Switch

FAI – Floating Algal Index

FCMC – Forest Carbon, Markets and Communities

FEL – Field Emission Lamp

FFSIG – Forest Fire Special Interest Group

FIA – Forest Inventory and Analysis

FOV – Field Of View

FPAR – Fraction of Photosynthetically Active Radiation

FRET – Forecast Reference Crop Evapotranspiration

FSun – Total Solar Flux

FTS – Fourier Transform Spectrometer

GCAD30 – Global Cropland Area Database at Nominal 30m

GCEV 1.0 – Global Cropland Extent Version 1.0

GEE – Google Earth Engine

GEO – Group on Earth Observations

GEO Ag. SBAs – Agriculture and Water Societal Beneficial Areas

GEO-CAPE – GEOstationary Coastal and Air Pollution Events

GEO GLAM – Global Agricultural Monitoring Initiative

GEOS-5 – Goddard Earth Observing System Model, Version 5

GEOSS – Global Earth Observation System of Systems

GeoTIFF – Public domain metadata standard which allows geo-referencing information to be embedded within a TIFF file.

GFS – Global Forecast Model

GH – Global Hawk

GHOC – Global Hawk Operations Center

GIS – Geographic Information System

GLAS – Geoscience Laser Altimeter System GOSAT – Green house gases Observing SATellite GPD – Generalized Pareto Distributions

GSFC – Goddard Space Flight Center

HAMSR – High Altitude MMIC Sounding Radiometer HICO - Hyperspectral Imager for the Coastal Ocean HDF – Hierachical Data

HIAPER – High-performance Instrumented Airborne Platform for Environmental Research

HIRAD – Hurricane Imaging Radiometer

HIWRAP – High-Altitude Imaging Wind and Rain Airborne Profiler

HS3 – Hurricane and Severe Storm Sentinel HYDRA – Hydrological Routing Algorithm HyspIRI – Hyperspectral Infrared Imager

IARPC – Interagency Arctic Research Policy Committee

ICCAGRA – Interagency Coordinating Committee for Airborne

GLOSSARY

Geoscience Research and Applications

ICESat – Ice, Cloud and Land Elevation Satellite

IGARRS – International Geoscience and Remote Sensing Symposium iGEM – International Genetically Engineered Machine

INMARSAT – International Maritime Satellite Organization

INPE – Instituto Nacional de Pesquisas Espaciais

INTEX – Intercontinental Chemical Transport ExperimenT

ISE – Information System for the Environment

ISPRS – International Society for Photogrammetry and Remote Sensing

ISRSE – International Symposium on Remote Sensing of Environment

IT – Information Technology

IUFRO – International Union of Forest Research Organizations

IWGADTS – Interagency Working Group for Airborne Data and Telecommunications Systems

KORUS-AQ – An International Cooperative Air Quality Field Study in KoreA LAI – Leaf Area Index (LAI)

LES – Large Eddy Simulation

Lidar – Light Detection and Ranging

LMSAL – Lockheed Martin Solar & Astrophysics Laboratory

LPDAAC – Land Processes Distributed Active Archive Center

LSAMP – Louis Stokes Alliance for Minority Participation program

MACC – Monitoring Atmospheric Composition & Climate

MAIAC – Multi-Angle Implementation of Atmospheric Correction

MASMODIS – Airborne Simulator

MASTER – MODIS/ASTER (airborne simulator)

MATLAB – Material Laboratory

MEaSUREs – Making Earth System Data Records for Use in Research Environments

MERIS – Medium Resolution Imaging Spectrometer (on Envisat satellite)

MHD – Magnetohydrodynamic

MILAGRO – Megacity Initiative: Local and Global Research Observations

MMS – Meteorological Measurement System

MODIS – Moderate Resolution Imaging Spectroradiometer

MTS – Mission Tools Suite

MWIR – Mid-wavelength infrared

NAIP – National Agricultural Imagery Program

NASA – National Aeronautics and Space Administration

N_2O – Nitrous Oxide

NACP -North American Carbon Program

NAFD – North American Forest Dynamics

NAS – NASA Advanced Supercomputing

NASDAT – NASA Airborne Science Data and Telemetry

NCAR – National Center for Atmospheric Research

NCEP – National Center for Environmental Prediction

NEX – NASA Earth Exchange

NGA - National Geospatial-Intelligence Agency

NGO – Non-Governmental Organization

NIDIS – The National Integrated Drought Information System

NIST – National Institute of Standards and Technology

NLFFF – Non-Linear Force Free Field

NOAA – National Oceanic and Atmospheric Administration

GLOSSARY

NOI – Northern Oscillation Index

NPP – NASA Postdoctoral Program

NPP – Net Primary Production

NPR – NASA Procedural Requirements

NSERC – National Suborbital Education and Research Center

NSF – National Science Foundation

NSSC – NASA Shared Services Center

NWS – National Weather Service

OCO-2 – Orbiting Carbon Observatory

OCS – Carbonyl Sulfide

OIB – Operation IceBridge

OLI – Operational Land Imager

ORACLES – Observations of Aerosols Above Clouds and their Interactions

OSTP – Office of Science and Technology Policy

PANAK – PAN/Aldehyde/Ketone (instrument)

P3 – Four-Engine Turboprop

PAO – Public Affairs Office

PBL – Planetary Boundary Layer

PM2.5 – Particulate Matter less than 2.5 Microns in Diameter

PMS – Particle Measuring System

RDAS – Rotating Disk Analytical System

REDD+ – Reducing Emissions from Deforestation and Forest Degradation

RESA – Renewable Energy Study Areas

RSAC – Remote Sensing Applications Center

SABOR – Ship-Aircraft Bio-Optical Research Experiment

SAFARI 2000 – Southern African Regional Science Initiative

SARP – Student Airborne Research Program

SCIAMACHY – Scanning Imaging Absorption Spectrometer for Atmospheric CHartographY

SEAC4RS – Southeast Asia Composition, Cloud, Climate Coupling Regional Study

SEAGRASS – High Resolution Assessment of Carbon Dynamics in Seagrass and Coral Reef

SGS – Sub-Grid Scale

S-HIS or SHIS – Scanning High-resolution Interferometer Sounder

SIERRA – Sensor Integrated Environmental Remote Research Aircraft

SIMS – Satellite Irrigation Management Support

SIPS – Science Investigator-led Processing Systems

SOFRS – Science Operations Flight Request System

StareWAI – Staring Wide Area Imager

STEM – Science, Technology, Engineering, or Mathematics

STEP – Stratosphere-Troposphere Exchange Project

sUAS – small Unmanned Aerial Systems

SWIR – Short Wavelength Infrared

TARFOX – Tropospheric Aerosol Radiative Forcing Observational eXperiment

TCAP – Two Column Aerosol Project

TCCON – Total Carbon Column Observing Network

TES – Tropospheric Emission Spectrometer

TFRSAC – Tactical Fire Remote Sensing Advisory Committee

TMAS – Thermal Mapping Airborne Simulator

TOP – Terrestrial Observation and Prediction System

GLOSSARY

TOPS-SIMS – Terrestrial Observation and Prediction System-Satellite Irrigation Management

TPI – Task Principal Investigator

TTL – Tropical Tropopause Layer

TWiLiTE – Tropospheric Wind Lidar Technology Experiment

UAS – Unmanned Aerial Systems

UAV – Uninhabited Aerial Vehicles

UC-12B – Military Version of a Beechcraft B200 King Air.

UCD – University of California at Davis

UND – University of North Dakota

UROC – Undergraduate Research Opportunities Center

USAID -United States Agency for International Development

USCRTF – United States Coral Reef Task Force

USFS – United States Forest Service

USGS – United States Geological Survey UV – Ultraviolet

VIIRS – Visible Infrared Imaging Radiometer Suite

VINTAGE – Viticultural Integration of NASA Technologies for Assessment of the Grapevine Environment

VSIM – Vineyard Soil Irrigation Model

WAI -Wide Area Imager

WRAP – Wildfire Research and Applications Partnership