Ames Research Center Cooperative for Research in Earth Science and Technology

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INTRODUCTION

On page 14 of the Cooperative Agreement for the Ames Research Center Cooperative for Research in Earth Science and Technology (ARC-CREST), the Required Publications and Reports section states that a Performance Report is due annually, 60 days prior to the anniversary date of the grant/cooperative agreement.

Accordingly, we present a Performance Report for the first year (2024–25) of this Cooperative Agreement.

The major goals and objectives of ARC-CREST are to work cooperatively with NASA Ames Research Center's Earth Science Division and related groups 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.

As detailed in this report, the current ARC-CREST participants—the Bay Area Environmental Research Institute, California State University Monterey Bay, and San José State University—achieved each of these objectives during the first year of the renewed ARC-CREST cooperative agreement. There have been no significant changes in approach or methods from the approved ARC-CREST application.

What was accomplished under these goals: During the 2024–25 reporting period, the ARC-CREST scientific team, working closely with the NASA Ames Earth Science Division, participated in 48 project areas covering the gamut of Earth science research. Major accomplishments include successful deployment of field campaigns (e.g., PACE-PAX, ARCSIX, FireSense), development and deployment of new technologies (e.g., NASDAT Next Generation, AI-enhanced lunar mapping tools, context-aware Earth-observing sensor web (3D-CHESS), and D-SHIELD), and continued progress in atmospheric composition data analysis and satellite validation efforts. ARC-CREST made significant contributions to interagency planning, public data access tools, and next-generation instrument development, all of which support NASA's Earth science and technology priorities. Detailed information on major activities, specific objectives, significant results, key outcomes, and other achievements for each project area are provided in the sections below.

Opportunities for training and professional development were tailored to the specific needs of each project area. During the 2024–25 reporting period, ARC-CREST provided training and mentorship to over 50 higher education students through field campaigns, direct mentorship, and formal academic programs. Additionally, the project reached over 4,000 K–12 students through outreach activities by the Airborne Science Program, and provided specialized training to more than 900 professionals through programs such as the Applied Remote Sensing Training

Program (ARSET). For detailed information on these activities, please see the project descriptions in the “Education, Outreach, and Workforce Development” section below.

Results were disseminated to communities of interest through multiple channels, including scientific presentations, school visits, conferences, and public events. During the 2024–25 reporting period, ARC-CREST team members produced 98 publications and delivered 60 presentations at scientific conferences and workshops. Data products were archived in NASA's public repositories (e.g., SeaBASS, Langley DAAC) and made freely available to the research community. Team members presented research findings at major scientific meetings including AGU, Optica, CalCon, and NASA science team workshops. Specific outreach activities and dissemination efforts for each project area are detailed in the task reports below.

Research plans for the next reporting period will be detailed in our annual Research Plan, which will be submitted separately on October 31, 2025.

Robert W. Bergstrom, Ph.D., J.D.
Director of Research, Bay Area Environmental Research Institute

FLIGHT

Airborne asSessment of Hyperspectral Aerosol optical depth and water-leaving Reflectance for PACE (AirSHARP3)

Project Participants

BAERI: Samuel LeBlanc, Kristina Pistone

Project Description

This project supports the PACE (Plankton, Aerosol, Cloud, ocean Ecosystem) Validation Science Team (PVST) by deploying an airborne radiometer package. The radiometers, 4STAR+C-AIR (Sky-Scanning, Sun Tracking Atmospheric Radiometer; Coastal Airborne In-situ Radiometers), will produce repeated validation measurements of the Hyperspectral Aerosol Optical Depth, its derived properties and water leaving radiances spanning a range of atmospheric conditions and optical water types. We deployed this airborne sensor package on the Naval Postgraduate School Twin Otter (NPS TO) platform in October 2024 and again in May 2025, along with the aligned ocean-going field instrumentation for robust PACE Ocean Color Instrument (OCI) and advanced data products from OCI and polarimeter validation over relevant aquatic targets. Access to relevant matching/demonstrated field instrumentation for aquatics (e.g., University of California Santa Cruz (UCSC) Compact Optical Profiling System (C-OPS) and Hyperspectral Profiling Radiometer (HyperPro) with in-water sampling from a vessel) and atmospheric (AErosol RObotic NETwork (AERONET), rooftop Cimel at Ames Research Center (ARC) and additionally at Marina Airport (where NPS Twin Otter is hosted), and Microtops II) will coincide with airborne overflights and PACE overpasses +/- 2 hr. The study area is along the California coast that has been covered in past NASA Coastal and Ocean Airborne Science Testbed (COAST), Hyperspectral Infrared Imager (HyspIRI), Ocean Color Ecosystems Assessment using Novel Instruments and Aircraft (OCEANIA), and Coastal High Acquisition Rate Radiometers for Innovative Environmental Research (C-HARRIER) campaigns (Kudela et al. 2015, Guild et al., 2020; Hooker et al., 2020, Houskeeper et al., 2021).

This portion of the project supports the 4STARB implementation on board the Twin Otter, the data collection efforts, and the data archival for both C-AIR and 4STARB for PACE product validation.

Accomplishments

- Integration of 4STARB and C-AIR onto NPS Twin Otter, and relevant 4STARB airworthiness protocols managed by ARC, AFRC (Armstrong Flight Research Center), NPS, Zivko Engineering, and Nav-AIR.
- Successful deployment of 4STARB and C-AIR during five research flights in October 2024 for the first deployment of AirSHARP over the Monterey Bay, targeting minimal aerosol loading with red algal bloom.

- Successful deployment of 4STARB and C-AIR during seven research flights in May 2025 for the second and last deployment of AirSHARP over the Monterey Bay, targeting transported dust and bluer waters.
- Successful data quality assessment and assurance of 4STARB and C-AIR measurements from October 2024 and May 2025.
- Deployment of AERONET at Marina Airport for cross-calibration and validation of 4STARB airborne aerosol optical depth (AOD) measurements. Successful operations of 4STARB on the roof of N245 at ARC for similar cross-calibration and validation with the ARC AERONET.
- Radiance calibration of 4STARB at Airborne Sensor Facility (ASF), for enabling a backup of the C-AIR sky measurements to compensate for an instrument that failed during May 2025.
- Archival of 4STARB data within 60 days of measurements to the NASA Langley airborne DAAQ - first time such a short delay between airborne sampling and archival.
- First time data reduction, QA, analysis and archival for C-AIR data to the SeaBASS DAAQ, within 60 days of measurements and following current standards, for both October and May AirSHARP campaigns.

Outreach and Community Service

Mentorship of PhD student Logan Mitchell from University of Oklahoma on deployment of 4STARB.

Presentations

AirSHARP (Airborne asSessment of Hyperspectral Aerosol optical depth and water-leaving Reflectance for PACE), Guild, LeBlanc, Kudela, Pistone, Bucholtz, Eilers, Dunagan, Negrey, Sirio, and Flynn, PACE Validation Science Team, 18–21 February 2025, NASA Goddard Institute for Space Studies (NASA GISS), PAC^3 STM.

Airborne Science Program (ASP) Advanced Planning

Project Participants

BAERI: Brenna Biggs, Gary Ash

NASA: Matt Fladeland

Project Description

The ASP Advanced Planning team creates two newsletters each year for the airborne community and an annual report detailing the accomplishments of the year. Additionally, the team interviews NASA affiliates (e.g., project managers, project scientists, instrument operators, instrument developers) to understand the needs of the community and to draft plans for

outgoing years. This culminates in an annual five-year plan as well as auxiliary documents like needs assessments, science value compilations, and other internal reports. Most recently, this role has also involved tracking and supporting high-altitude activities using uncrewed systems with long endurance.

Accomplishments

- Made weekly updates of ASP five-year plan, and developed individual plans for each Earth Science Division (ESD) Program.
- Met with program managers at NASA HQ in November 2025 regarding five-year plan and Science Operations Flight Request System (SOFRS) activities.
- Helped update the ASP website, including the look, feel, and testing.
- Created/creating a database for High Altitude Pseudo-Satellites/High Altitude Long Endurance (HAPS/HALE) platforms and payloads. This involved some data collection as well as interviews and conversations with various platform and payload leads, as well as attending the Stratospheric Operations and Research Symposium (SoARS), UxS meetings in person.
- Assisting with Advanced Supersonic Parachute Inflation Research Experiments (Hightower/ASPIRE) as well as other high-altitude flight activities.
- Sent weekly updates regarding ASP activities, including flights and other outputs.
- Compiled, edited, and published the NASA ASP FY24 Annual Report with input from dozens of members of the NASA community.
- Compiled, edited, and published the fall 2024 and spring 2025 ASP Newsletters with input from dozens of members of the NASA community.
- Participated in Ames Airborne Science division semi-monthly meetings and ARC quarterly check-ins.
- Hosted ASP table at NASA Booth at AGU in December 2024 by creating, printing, and supporting materials and models as well as meetings throughout the year. The same will likely be done in 2025 starting in ~September.
- Attended various meetings (e.g., SBG TIM, SOaRS, PBL, STV) to gather inputs for ASP five-year planning. Detailed notes (i.e., typically 25–50 pages) were written and executive summaries prepared for each meeting.
- Reviewed Small Business Innovation Research and National Science Foundation proposals.

Earth Observing System (EOS)

Project Participants

BAERI: James Jacobson, Edward Hildum, Rose Dominguez, Paul Windham, Thomas Ellis, Jeff Grose, Nikolas Gibson, Alex Polakis Roy Vogler, Eric Fraim, Gary Hoffmann, Haiping Su, Jian Zheng

Project Description

The Airborne Sensor Facility (ASF) at NASA Ames supports a variety of airborne research activities for the NASA Earth Science Division. It conducts engineering development of remote sensing instrumentation and supports their operational use on science field campaigns. The ASF maintains a suite of facility instruments that are made available for use by NASA-approved research projects, with all resulting data being made available free of charge through public archives. These data are typically used for fundamental Earth science process studies, satellite calibration and validation, development of retrieval algorithms, and disaster response. The ASF includes elements for sensor engineering, optical and infrared sensor calibration, and data processing. (See https://asapdata.arc.nasa.gov/.)

Accomplishments

- Participated in field activities for the Western Diversity Time Series (WDTS) spring/summer 2025 mission, observing California's ecosystems and providing critical information on natural disasters such as volcanoes, wildfires, and drought. It will provide a benchmark on the state of the ecosystems against which future changes can be assessed. The MODIS/ASTER Airborne Simulator (MASTER) has collected 64 flight tracks over seven field sorties for this mission and will continue through the end of the 2025 Fiscal Year.
- Participated in field activities for the Geological Earth Mapping Experiment/Earth Mapping Resources Initiative (GEMx/EMRI) summer 2025 mission to map critical minerals over much of the western United States. MASTER has collected 87 flight tracks over 10 field sorties for this mission and will continue through the end of the 2025 Fiscal Year.
- Participated in field activities for the FireSense 2024 mission as part of a larger NASA-wide Wildland Fire Initiative involving the Science Mission Directorate (SMD), the Aeronautics Research Mission Directorate (ARMD), and the Space Technology Mission Directorate (STMD) to provide unique Earth science and technological capabilities to operational agencies, striving towards measurable improvement in US wildland fire management. MASTER collected 167 flight tracks over seven field sorties for this mission in the southern US states of Alabama, Florida, and Georgia.
- Participated in field activities for the GSFC Lidar Observation and Validation Experiment (GLOVE) 2025 mission to validate new ICESat-2 atmospheric data products, validate the EarthCARE lidar/radar/spectrometer data products, and test the new Roscoe receiver

alignment. The Enhanced MODIS Airborne Simulator (eMAS) collected 42 flight tracks over four field sorties.

- Participated in field activities for The Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment (WH2yMSIE) fall 2024 mission to demonstrate the first-of-its-kind hyperspectral microwave airborne measurements (CoSMIR-H) and will be complemented by other passive (infrared, visible) and active (lidar) sensors onboard the NASA ER-2 aircraft. MASTER collected 128 flight tracks over 10 field sorties for this mission.
- Participated in field activities for The Plankton, Aerosol, Cloud, Ocean Ecosystem Postlaunch Airborne eXperiment (PACE-PAX), a field campaign to gather data for the validation of the recently launched PACE mission. PICARD collected 209 flight tracks over 14 field sorties for this mission.
- Coordinated the co-characterization of the ASF Calibration lab with the Radiometric Calibration Laboratory at NASA Goddard.

Presentations

Thomas Ellis, Alok Shrestha, Gary Hoffmann, Haiping Su, Roseanne Dominguez, James Jacobson, Matthew Birkebak. “Spectroradiometric Calibration Facilities at the NASA Ames Airborne Sensor Facility. CalCon 2025.

Gary Hoffmann, Thomas Ellis, Haiping Su, Roseanne Dominguez, Eric Fraim, Alok Shrestha, James Jacobson, Steven Platnick, G. Thomas Arnold, And Kerry Meyer. “Introducing NASA’s Pushbroom Imager for Cloud and Aerosol Research and Development (PICARD): a compact hyperspectral radiometer for ER-2 and G-III aircraft.” Optica 2025.

Earth Science Project Office (ESPO)

Project Participants

BAERI: Judy Alfter, Quincy Allison, Brad Bulger, Daisy Gonzalez, Lynn Kennedy, Sam Kim, Ayuta Padhi, Stevie Phothisane, Jaden Ta, Bri Milano

NASA: Marilyn Vasques, Jhony Zavaleta, Erin Czech

Project Description

The Ames Earth Science Project Office (ESPO) provides project management for NASA’s Science Mission Directorate (SMD) 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 Earth Observing System satellite validation program. Annually, the ESPO team manages the deployment of between six and 10 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.

Accomplishments

The ESPO team supported the following research campaigns under the Ames Research Center Cooperative for Research in Earth Science and Technology (ARC-CREST) agreement:

- **PACE-PAX (Plankton, Aerosol, Cloud, Ocean Ecosystem Postlaunch Airborne Experiment):** A NASA satellite validation campaign which took place at multiple deployment sites in California during September 2024. Numerous platforms helped validate spectrometer and imaging instrument data aboard the PACE satellite, launched in February 2024 (Cape Canaveral Space Force Station). Validation instruments were included on the NASA ER-2 (Armstrong Flight Research Center), CIRPAS Twin Otter (Marina Municipal Airport), and the NOAA R/V Shearwater (Santa Barbara). Nearly 200 scientists and support personnel from more than 20 teams added to the mission's success. The ER-2 and CIRPAS Twin Otter completed 81 and 60 flight hours respectively, while the R/V Shearwater conducted 15 successful day trips. Multi-day science team meetings were held March 2024 (NASA Ames) and February 2025 (NASA GISS). The PACE satellite continues to make major contributions both locally and globally in the areas of air quality, health, fisheries, and the impact of harmful algal blooms on the marine environment. ESPO personnel were fully engaged in supporting all science team meetings, logistics, and deployment activities.

- **ARCSIX (Arctic Radiation Cloud Surface Interaction Experiment):** A NASA-funded campaign focused on understanding how surface properties, clouds, aerosols, and precipitation influence the Arctic summer surface radiation budget and early-season sea ice melt. The goal is to improve scientific understanding of rapid Arctic climate change and enhance future satellite retrievals.
    - From July 22 to August 16, 2024, three NASA aircraft (P-3, G-III, and C-130) and one commercial research aircraft (SPEC Inc. Learjet) were deployed to Pituffik Space Base, Greenland. The four-week campaign involved 81 participants, including 16 graduate students from various universities, with over 75 personnel continuously in the field. The team completed 24 research flights, totaling 141 flight hours across all platforms.

- **SARP (Student Airborne Research Program):** An eight-week summer internship program for junior undergraduate students. During the program, students acquire hands-on research experience in all aspects of a scientific campaign using one or more NASA Airborne Science Program flying science laboratories. The WFF P-3 and Dynamic Aviation B-200 conducted science flights over Virginia and California (aircraft used for SARP have included the DC-8, P-3B, C-23, UC-12B, and ER-2) in the summer of 2025. ESPO supported flight operations in both SARP East and SARP West.

- **SCIFLI (Scientifically Calibrated In-Flight Imagery) Support:** The observation of SpaceX's Starship orbital demo reentry in the southern Indian Ocean. The project utilized NASA JSC G-V equipped with airborne imaging equipment. The team deployed to Perth, Western Australia, in January 2025.

- **CRATER (Costa Rica Airborne research on foresT Ecosystem Response to volcanic emissions):** NASA Ames Research Center's Flight Operations and Earth Science Divisions, in collaboration with Black Swift Technologies LLC, deployed the fixed-wing S2 UAS in Costa Rica. The mission collected airborne infrared imagery and measured gas concentrations (CO_2, H_2O, H_2S, SO_2) along with SO_2 plume cross-sections on the south-southeastern flank of Rincón de la Vieja volcano. This effort enhances concept-of-operations and deployment logistics, enabling NASA to conduct routine and ad-hoc airborne investigations into the impacts of persistent volcanic emissions on tropical ecosystems. ESPO supported logistics and flight operations in the field.

- **SABRE (Stratospheric Aerosol processes, Budget and Radiative Effects):** This project is an extended airborne science measurement program that uses the NASA WB-57 high-altitude research aircraft to study the transport, chemistry, microphysics, and radiative properties of aerosols in the upper troposphere and lower stratosphere (UTLS). Complete execution of flight campaigns would provide extensive detailed measurements of aerosol size distributions, composition, and radiative properties, along with relevant trace gas species in different regions and seasons, which are critical for improving the ability of global models to accurately simulate the radiative, dynamical, and chemical impacts of changes to stratospheric aerosol loading. This project has been temporarily postponed.

- **NURTURE (North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment):** A NASA-funded large-scale aircraft field campaign. It will advance knowledge of the processes that lead to extreme high-impact weather (HIW) events during the winter, such as severe cold air outbreaks, windstorms and hazardous seas, snow and ice storms, sea ice breakup, and extreme precipitation. NURTURE's activities will advance dynamical meteorology and predictability research and promote the quantification of forecast uncertainty. NURTURE's first science team meeting will be held the 3rd through the 5th of September with ESPO providing support via procurement of a hotel room block for those traveling into the area, as well as managing registration for the event.

- **AIR4US (Air-quality Information Resource for the United States):** A multi-agency effort to consolidate air quality data and information from observations and models and provide access to specialized tools and services to enable open access to data and visualizations. Scientific experts from NASA, EPA, and NOAA work together to curate the data and services ensuring decision makers and air quality managers have what they need. ESPO has been supporting and facilitating the AIR4US's interagency collaborations. The primary goal of the AIR4US is to make access to air quality data more efficient and easier to use for all.

- **MAGEQ (Mid-Atlantic Gas Emissions Quantification):** During summer 2025, NASA has had multiple aircraft in the MD/VA area flying separate missions. Leveraging these systems in a coordinated fashion allows us to better support GHG Center priorities and needs of local stakeholders. MAGEQ is the coordination of independent missions and assets (ground-based, airborne, remote-sensing) to support and augment observations for synergistic science and prototype and cross-validate tiered observing strategies. It also strengthens partnerships between scientists and stakeholders. Near-term priorities are to demonstrate and compare emission measurements in priority regions, and to provide regional context for longer-term ground observations. Priority regions include petrochemical, urban, agricultural, and wetland areas. ESPO supported the MRR and flight operations out of NASA Wallops Flight Facility.

- **TOKYO - Field Campaign (T - FC):** An international, multi-platform satellite validation mission scheduled for early 2026. The primary objective is the post-launch calibration and validation of geophysical data products from the Global Observing Satellite for Greenhouse gases and Water Cycle (GOSAT-GW), which was launched in June 2025.
    - The campaign is a collaborative effort between NASA and key Japanese scientific institutions, including the Japan Aerospace Exploration Agency (JAXA), the National Institute for Environmental Studies (NIES), and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC).
    - The ESPO team conducted a site visit to Yokota Air Base during June 2025 and facilitated meetings between mission science and base leadership to assess logistical support. During ESPO's visit, meetings also occurred with the Japanese Ministry of Foreign Affairs and the Ministry of Land, Infrastructure, Transport, and Tourism. ESPO personnel have been instrumental in supporting and participating in all aspects of T-FC planning and implementation.

In addition, the ESPO group managed the following Earth Venture Suborbital-3 and Suborbital-4 (EVS-3 and EVS-4) Missions:

- **IMPACTS (Investigation of Microphysics and Precipitation for Atlantic Coast–Threatening Snowstorms):** A multi-NASA-center project studying the formation of snow bands in East Coast winter storms in order to improve forecasts of extreme weather events. This study involved flights of NASA's ER-2 and P-3 aircraft over the northeastern

United States from January-March during 2020, 2022 and 2023. The IMPACTS KDP-F was held April 8, 2025 at NASA Headquarters in Washington, DC to successfully close out the project.

- **S-MODE (Sub-Mesoscale Ocean Dynamics Experiment)**: A multiyear project exploring the potentially large influence that small-scale ocean eddies have on the exchange of heat between the ocean and the atmosphere. The experimental region is located in the San Francisco Bay Area, with NASA aircraft operations based at Moffett Field at Ames Research Center. The first deployment (Pilot Campaign) was completed in November 2021. The participating platforms were the NASA AFRC B-200, a Twin Otter, the Research Vessel Oceanus, as well as ocean surface drifters, wave gliders, and saildrones. Most of the mission planning and control center operations were done remotely, showcasing the team's resiliency. The team completed IOP-1 (intensive observation period-1) in November of 2022. An open data workshop was conducted in December of 2022. The third and final deployment (IOP-2) took place in Spring 2023. Hybrid science team meetings took place in October 2024 and May 2025 at NASA Ames Research Center, California. The S-MODE KDPF was held April 24, 2025 at NASA Headquarters in Washington, DC to successfully close out the project. ESPO has supported all science team meetings and the KDPF.
- **DCOTSS (Dynamics and Chemistry of the Summer Stratosphere)**: A five-year NASA project investigating how strong summertime convective storms over North America can change the chemistry of the stratosphere. Aircraft operations were based in Salina, Kansas, with the NASA ER-2 aircraft. The first deployment was successfully completed in the summer of 2021 after a yearlong postponement because of the COVID-19 pandemic. The second and final deployment occurred in the spring and summer of 2022. The science teams were heavily engaged in data analysis, and an open data workshop took place in December 2022. Hybrid science team meetings took place in January 2023 in College Station, Texas; and November 2024 in Cambridge, MA to discuss the most recent findings. The DCOTSS KDP-F was held June 5, 2025 at NASA Headquarters in Washington, DC to successfully close out the project.
- **INSPYRE (INjected Smoke PYRocumulonimbus EXperiment):** A five-year mission to constrain the role of pyrocumulonimbus (pyroCb) in the warming climate system, and characterize their physical links to extreme wildfire behavior using in situ and remote sensing measurements. INSPYRE was competitively selected for funding in response to ROSES 2024 under NASA's Earth Venture Suborbital-4 program. Panel reviews occurred in Spring 2025 and the planning phase is currently underway. BAERI teams will participate in upcoming site surveys along with the first science team meeting in the fall of 2025 in preparation for a summer deployment in 2026.
- **FORTE (Arctic Coastlines – Frontlines Of Rapidly Transforming Ecosystems):** This project will observe how ecosystems (rivers, deltas, lagoons, and estuaries) respond to changing climate on the North Slope of Alaska. A ROSES call was released in December 2024 and panel reviews occurred in July 2025. Science teams and

platform selections took place throughout the fall of 2025. The multi-year project will have its first science team meeting in early 2026. ESPO personnel continue to be busy supporting and facilitating pre-deployment activities.

- **FarmFlux (Nitrogen and Carbon Fluxes: Agriculture, Atmospheric Composition, and Ecosystems):** An airborne mission led by NASA, CSU, and BU to study the cycling of nitrogen between agriculture and the atmosphere, that aims to minimize agricultural nitrogen losses, maximize efficiency, and improve air quality. The mission has four science objectives: quantify emissions from animal feeding operations, quantify bidirectional gas exchange over croplands, explain properties of particulate matter related to agricultural activities, and link satellite applications to agricultural activities. Measurements will be taken using a large aircraft (P-3) for gas and aerosol surveys in the U.S. Midwest and California, and a small aircraft (B200) for focused measurements of gases from animal feeding operations. Various models will be used, including chemical-transport and machine learning. Flights will sample the growing season for crops and downwind of animal husbandry facilities in 2026 and 2027, across locations like Texas, Colorado, Iowa, and California. ESPO will conduct site surveys and support both deployments.

The ESPO team planned and supported/will support the following meetings and events (all meetings are hybrid):

- S-MODE (Sub-Mesoscale Ocean Dynamics Experiment) Science Team Meeting, October 21-24, 2024, NASA Ames Conference Center, Moffett Field, CA
- DC-8 Workshop, October 24-25, 2024, NASA HQ, Washington, DC
- DCOTSS (Dynamics and Chemistry of the Summer Stratosphere) Science Team Meeting, November 4-8, 2024, Cambridge, MA
- NDAAC (Network for the Detection of Atmospheric Composition Change) Steering Committee Meeting, November 11-15, 2024, Santiago, Chile
- AGAGE70 (Advanced Global Atmospheric Gases Experiment) Technical Session, December 2-6, 2024, La Jolla, CA
- ASIA-AQ (Airborne and Satellite Investigation of Asian Air Quality) Science Team Meeting, January 20-24, 2025, Kuala Lumpur, Malaysia
- PACE-PAX (Plankton, Aerosol, Cloud, ocean Ecosystem Postlaunch Airborne Experiment) Science Team Meeting, February 17-21, 2025, NASA GISS, New York, NY
- PBL (Planetary Boundary Layer) Decadal Survey Incubation Program Community Technical Meeting, April 1-3, 2025, Silver Spring, MD

- ARCSIX (Arctic Radiation-Cloud-Aerosol-Surface Interaction eXperiment) Science Team Meeting, May 18-21, Boulder, CO

- S-MODE (Sub-Mesoscale Ocean Dynamics Experiment) Science Team Meeting, May 28-29, 2025, NASA Ames Conference Center, Moffett Field, CA

- AGAGE71 (Advanced Global Atmospheric Gases Experiment) Technical Session, June 9-13, 2025, Dübendorf, Switzerland

- ARMD/ESD Industry Roundtables, August 6-7, 2025, NASA Ames Conference Center, Moffett Field, CA

- TEMPO (Tropospheric Emissions: Monitoring of Pollution) / ACX (GeoX Atmospheric Composition Instrument) Joint Science Team Workshop, August 19-22, Cambridge, MA

- NURTURE (North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment) Science Team Meeting, September 3-5, 2025, Langley Research Center, Hampton, VA

- NASA Carbon Monitoring System (CMS) Science Team Meeting NASA Ames Conference Center, Moffett Field, CA

- PBL (Planetary Boundary Layer) Decadal Survey Incubation Program Community Technical Meeting, September 15-16, Washington DC area

Meteorological Measurement System (MMS)

Project Participants

BAERI: Jonathan M. Dean-Day, Rajesh Poudyal, Kristen Okorn, Cecilia S. Chang, T. Paul Bui

NASA: Charles Gatebe

Project Description

The Meteorological Measurement System (MMS) provides in situ measurements of static pressure (P), static temperature (T), and 3D winds on a number of NASA airborne research platforms. Platforms have included unmanned aerial vehicles (Global Hawk and Sierra), and aircraft (DC-8, ER-2, WB-57F, and the H211 Alpha Jet). These measurements are useful to chemistry studies, which rely on our basic state measurements to compute reaction rates of atmospheric pollutants; to microphysical studies, which focus on the formation and growth of ice crystals in cirrus clouds; and to large-scale transport studies, which rely on our data to initialize back trajectories. The data are also useful for characterizing advection of pollutants in the planetary boundary layer and the structure and morphology of mesoscale waves, which

modulate the freeze-drying process of air rising through the tropical tropopause layer into the lower stratosphere.

The MMS is a fast-response (20 Hz) system capable of measuring fine scales of turbulence and thus is useful for computing fluxes of heat and momentum, as well as chemical contaminants when high-rate in situ chemistry instruments are also operating. It is also highly accurate (P, T, and 3-D winds are accurate to +/- 0.3 hPa, 0.3K, and 1 m/s), making it superior to facility-type navigation instruments, which may provide similar data, but with much degraded accuracy and reliability. This research focuses on maintaining the scientific validity of the MMS data and on performing basic research with the measurements as time allows.

Accomplishments

- Re-processed and re-submitted revised MMS data from seven flights of the Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) 2021 mission to the NASA Langley data archive. On the remaining flights, no revision was necessary.
- Calibrated MMS maneuvers and Stratospheric Aerosol processes from the Asian Summer Monsoon Chemical and Climate Impact Project (ACCLIP), and completed the test flight series for the Stratospheric Aerosol processes, Budget and Radiative Effects (SABRE) project. This included four ACCLIP flights from August 2021 and seven SABRE flights from February 2022, flown on the WB-57 aircraft based out of Ellington Field near Houston, Texas.
- Determined ideal Mach and altitude flight conditions for MMS maneuvers during DCOTSS-2022, based on common ER-2 flight patterns executed during the 2021 campaign. The quality of maneuvers was evaluated in real time to assess the necessity of repeat execution, and we updated calibration constants for the 2022 campaign. Analysis of MMS temperature data helped determine whether glitch storms were generated by the Tfast probe, its attached amplifier, or by a faulty wiring harness within the aircraft body.
- Identified ideal Mach and altitude flight conditions for MMS maneuvers during ACCLIP, based on WB-57 flight patterns executed during the ACCLIP-2021 and SABRE test flight series. We identified glitch storms in temperature data on a subset of science flights flown from Osan, South Korea, and developed filtering algorithms to mitigate impact on temperature accuracy.
- Analyzed in-flight calibration maneuvers of WB-57 MMS data from the ACCLIP mission, and updated statistical modeling of individual flight calibrations in order to determine continuous calibration functions needed through the flight envelope. Applied redundant measurements to reconstruct missing or errant data, and reprocessed and archived final MMS data to the Langley project data archive.
- Evaluated laboratory data obtained from immersed bath calibration of four Rosemount fast temperature probe/amp assembly pairs at an Armstrong Flight Research Center (AFRC) test

facility. Checked experimental data for self-consistency and discussed results with the Primary Investigator as needed. Obtained and analyzed corrected bath values and applied curve fits to produce accurate voltage-to-temperature conversions for later data reduction of DCOTSS-2022 flight temperature data.

- Monitored WB-57 MMS data quality during the SABRE mission in early 2023. Identified ideal Mach and altitude flight conditions for MMS maneuvers during the campaign. Examined science flight data for ongoing proper operation of MMS analog/digital sensors and inertia navigation systems.
- Responded to researcher questions about the strengths and limitations of MMS turbulence data and calculation methods from prior field campaigns (e.g., Fire Influence on Regional to Global Environments Experiment-Air Quality (FIREX-AQ), DCOTSS, and ACCLIP).

National Suborbital Research Center (NSRC)

Project Participants

BAERI: Gary Ash, Adam Webster, David Van Gilst, Tu Phan, Terry Hu, Ryan Bennett, Pat Finch, Brenna Biggs, Tyler Thompson

NASA: Matt Fladeland

Project Description

The NSRC is responsible for two tasks for the Airborne Science Program:

Science Mission Operations:

NSRC provides aircraft support across the centers within the Airborne Science Program (ASP). Aircraft support entails aircraft facility instrument operations and management, engineering support for payload integration, flight planning, and mission management tools, flight navigation data hardware and software support, support and maintenance of aircraft data networks and satellite communications to support science activities, and flight data archiving and distribution. NSRC also supports the ASP with engineering expertise in a variety of areas, currently in support of ASP's new Boeing 777 platform.

The ASP provides a suite of facility instrumentation and data communications systems for community use by approved NASA investigators. Currently available ASP instrumentation includes stand-alone precision navigation systems and a suite of digital tracking cameras and video systems. Real-time data communications capabilities, which differ from platform to platform, are integral to a wider sensor network architecture. Access to any of these assets is initiated through the ASP Flight Request process.

(Note: For NSRC Communications and Training task descriptions and accomplishments, please see the ASP Advanced Planning and ASP Communications tasks within this ARC-CREST Annual Report.)

Major NSRC accomplishments from FY2025, organized by project or aircraft platform:

I. The NASDAT (NASA Airborne Science Data Acquisition and Telemetry) Next Generation (NG):

Purpose: Replacement and upgrade of legacy data acquisition and distribution hardware systems into a single, streamlined form-factor which can be readily deployed to both NASA and NASA-supported aircraft assets.

- Completed Preliminary Design Review for new system design, which will combine or incorporate several of the line replaceable units, including small form factor server, Wifi access points, LTE modem capability, Ethernet switches and navigation recorder, all into a single, rapidly deployable unit.
- Deployed engineering prototype to Wallops P-3 in support of Student Airborne Research Program (SARP)/ Mid-Atlantic Gas Emissions Quantification (MAGEQ) mission in order to gather component performance data in a field environment before proceeding with final packaging and detailed design.
- Considerable work to streamline, modernize and document legacy software for inclusion in the NASDAT NG.
- Considerable work to ensure the NASDAT NG will bring Aircraft Payload Systems into compliance with current NASA IT Security guidelines.

II. Major Support Updates:

- Overhaul of the NSRC/ASP quality assurance and quality control (QAQC) data reduction code bank (January 2025 to ongoing) in support of the less hands-on post-flight tool for non-NSRC manned aircraft or Commercial Aviation Services (CAS).
- Created a NESSUS virtual machine to scan for IT vulnerabilities on NSRC managed NASA Airborne Science aircraft IT assets.
- Developed a SAMBA share structure (software that allows for file sharing services between windows machines and linux machines) to provide experimenters with convenient file access during research flights.
- Ongoing support of the NASA Mission Tools Suite (MTS) ground-side situational awareness platform used across NASA and other federal agencies for airborne asset, science and engineering instrument telemetry. NSRC supports the growth, development, infrastructure, and continued integration of MTS within the core NASA Airborne Science data systems.

- Data system engineering expertise to a broader mission set, such as the upcoming Hightower High Altitude Platform System (HAPS) mission.

III. 777 Specific activities:

- Continued engineering and design reviews as well as overseeing manufacturing of aircraft modifications and components to support initial operational requirements.
- Traveled to L-3 in Waco, TX, where the aircraft is undergoing major modifications to take measurements of specific areas necessary to complete designs of payload interfaces.
- Design of experimenter data system which includes sensors, housekeeping rack, network distribution racks, and panels.
- Mission Director console engineering (called the eXperimenter Control Station, XCS), which includes control panels for similar systems as the DC-8, as well as integrated ways to monitor the data system eliminating the need for a separate laptop.
- Engineering and design of an airborne conference lab for scientists' use while onboard.
- Completing final design of Payload Network. Working to finalize selection of network and IT equipment before the end of FY25.
- Continued support of external sensors (such as total air temperature, camera pod, etc.) design, as Langley continues through computational fluid dynamics (CFD) modeling to determine optimum installation locations.
- Ongoing work in disposition support of equipment from the DC-8 Program.

IV. NURTURE mission readiness specific activities:

- Managing engineering activities associated with payload integration and aircraft modifications required to support this integration effort.
- Working with the Turbulent Air Motion Measurement System (TAMMS) team to ensure requirements for integration aboard 777 for NURTURE are met.

V. P3 specific activities:

- Refresh of the NSRC Data System including distribution of new open source maps for aircraft situational awareness.
- Major hardware upgrade re: the NASDAT NG testbed, installation of experimenter fast total air temperature probe and RS-485 capable signal conditioner, and an experimenter cabin pressure sensor.
- Major electrical drawing updates for P3 to accommodate the new hardware (above). This includes deliverability of the aircraft radar altimeter data to experimenters.

- Continued support of SARP (aircraft operations—both P3 and Dynamic Aviation B200), including project test flights: five flights at Wallops flight facility, five flights in Southern California. Raspberry Pi NASDAT (PiDAT) system installed and configured on B200.
- Support of the MAGEQ multi-aircraft mission out of Wallops flight facility (both P3 and Dynamic Aviation B200, plus associated Langley Gulfstream III).

VI. G-III Specific Activities:

- Aircraft cabin modifications and resultant NSRC hardware reconfiguration. Significant edits to accommodate network rewiring and utilization of additional ports on the network switch.
- September–November 2024: NSRC support of the Aerosol Wind Profiler (AWP) flights and a NASA/GE Aerospace collaborative project titled Contrail Optical Depth Experiment (CODEX) flights including flight data, situational awareness tools (near-real time satellite imagery reprojection and uplink to aircraft to assist in flight path decision making).
- Software re-deployment as part of the above work.

VII. ER-2 Specific Activities:

- Worked with the ER-2 program to improve the efficiency of payload system management to reduce operational overhead.
- Identified a modification of the Experimenter Interface Panel (EIP) to address ongoing issues with reliability of the IRIG signal. Work is in progress to develop a post modification test procedure and modify additional EIPs in stock.
- Worked with ER-2 team to modify the satellite communications canoe design in allowing for more efficient mission operation.
- Continued advancement in data acquisition and distribution software to provide scientists and engineers with the best possible real-time data feeds.
- Troubleshooting high resolution downward facing camera, and software work to downlink imagery within mission defined geographically outlined target bounding boxes.
- Hardware work to improve on legacy data communication protocols.

VIII. ER-2 Mission Support:

- Supported the GSFC Lidar Observation and Validation Experiment (GLOVE) mission, consisting of eight flights.
- Supported the Airborne Multi-angle SpectroPolarimetric Imager (AirMSPI) mission, consisting of three flights.

- Supporting the Geological Earth Mapping Experiment (GEMx) mission; 18 flights completed and ongoing.

IX. G-IV Specific Activities:

- A new-to-NASA Airborne Science Program platform requiring major engineering and data system work/modifications.
- Providing electrical design support for aircraft power, data, and satcom modifications required for AirSAR and future airborne science payloads.
- Managing electrical engineering team supporting NASA Armstrong's in-house engineers.
- Working with the Armstrong Flight Research Center (AFRC) team to integrate standard payload IT and satcom system(s) aboard the G-IV.

X. Supported CAS Aircraft Projects:

Dynamic Aviation G-IV:

- Work with the AFRC team to integrate standard Payload IT and SATCOM system(s) aboard their G-IV.

Dynamic Aviation B200:

- Deployment of a containerized data system to support summer flight activities associated with SARP and MAGEQ.

XI. Various Airborne Science Data Projects:

- Analysis of the NASA ER-2 facility instrumentation and renewed flight data specifications (limits, uncertainties) in support of Earth Venture Suborbital (EVS)-4.
- Airborne and Satellite Investigation of Asian Air Quality (ASIA–AQ) publication data quality of the NSRC Meteorological and Navigation dataset released October 2024.
- Attended ASIA–AQ science team meeting in January 2025 (Kuala Lumpur, Malaysia) as the NSRC data representative.
- Arctic Radiation-Cloud-Aerosol-Surface-Interaction Experiment (ARCSIX) publication data quality of the NSRC Meteorological and Navigation dataset released February 2025.
- Attended ARCSIX science team meeting in May 2025 (Boulder, CO, USA) as the NSRC data representative.

North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment-Forecasting and Flight Planning (NUTURE-FFP)

Project Participants

BAERI: Samuel LeBlanc (PI)

NASA Ames Research Center: Rei Ueyama, Leslie Lait

Project Description

This project provides flight planning and meteorological forecasting support for the upcoming field campaign: NURTURE. The flight planning and meteorological forecasting help translate scientific goals into aircraft waypoints and track through targeted meteorological environments to obtain the relevant measurements. NURTURE is aimed at resolving the impact that perturbations poleward of the jet stream have on jet stream variability and high-impact weather (HIW) events, with particular emphasis on the tropopause polar vortices. These mesospheric and synoptic scale disturbances will be observed from airborne platforms based on north-eastern North America. The first deployment of NURTURE will be during January 2026 with the NASA G-III. This campaign will be the first to utilize the NASA 777 airborne sampling platform during the Winter 2027 deployment.

Since bespoke flight planning and forecasting tools are needed to ensure the success of NURTURE, our proposed work includes the adaptation and improvement of the current flight planning tool for the new NASA airborne asset, the Boeing 777. It will also include the development of various forecast products customized for NURTURE science objectives and the seamless integration of those products into the research flight planning tool “Moving Lines.”

The work during this first year is in preparation for the field campaign deployment in early 2026, with science team meetings, and engagement with the PI and science team for planning out sampling strategies.

Accomplishments

- New version of Moving Lines with early parameterization of 777 flight characteristics.
- Participation in Science Team meeting in September 2025 at Langley Research Center.
- NURTURE meteorological forecasting website with bespoke generation of forecast fields.

Presentations

LeBlanc et al., Moving Lines Research flight planning tool—usage and summary. NURTURE Science Team meeting, Langley Research Center, September 2025.

RESEARCH AND ANALYSIS

Ultra-Stable Spectrometers for Sky-Scanning Sun-Tracking Atmospheric Research (5STAR)/Engineering-Science

Project Participants

BAERI: Stephen Broccardo

Project Description

The Ames Research Center (ARC) Sun-photometer Satellite Group supports a variety of instruments with a specific focus on airborne sun photometers that provide measurements of tropospheric aerosols (i.e., low-level atmospheric particles, such as from smoke, dust, or pollution) and trace gases. ARC maintains the existing instruments 4STAR-A and -B, and is developing the next generation instrument: 5STAR (ultra-Stable Spectrometers for Sky-Scanning Sun-Tracking Atmospheric Research). 5STAR depends on precision radiometers and spectrometers and includes a variety of transmissive, diffractive, and diffusive optical elements, including fiber-optic light-path technology. Robotics technology is required for sun-tracking and sky-scanning functionality in the aircraft environment, with the detector head exposed to free-stream environmental conditions up to the tropopause.

The 5STAR airborne instrument (in development) is the next-generation instrument that will present improvements over the current instruments in terms of reducing measurement uncertainty and improving calibration stability, all with smaller weight and power (SWAP) packaging enabled by modern sensor and digital-processing technology. 5STAR adopts a new means of sun-tracking, miniature fiber spectrometers, and custom circuitry. The design includes a camera for sun-tracking purposes in place of the quadrant detector used by 4STAR. It also includes custom circuitry to thermally stabilize both silicon and InGaAs photodiodes at discrete wavelengths, in addition to custom circuit boards, to amplify the signal.

Accomplishments

The Goddard Space Flight Center (GSFC) Pandora project deploys a global network of ground-based hyperspectral sun-tracking instruments using a fiber-coupled spectrometer to quantify the atmospheric integrated column of trace-gases such as NO2 and O3. Their experience indicates that precise temperature control of the spectrometer is essential for consistent measurements. Since in the field, temperature control can only be achieved with some degree of variation around the set-point, Pandora must extensively lab test and hand-select Commercial off-the-shelf (COTS) spectrometers for their relative insensitivity to variations in temperature, with many spectrometers not meeting their stringent requirements.

5STAR similarly aims to use a miniature spectrometer to quantify trace-gas integrated column amount. Since the 5STAR design concept places the spectrometer in the instrument head, it will likely be subjected to variations in temperature as the aircraft encounters a variety of ambient

conditions. We will build a laboratory testing rig for quantification of spectrometer performance at various temperatures. This design will also feed into the design of the 5STAR thermal management architecture.

The design for this testing apparatus (shown in the Figure below) includes a pair of bidirectional thermoelectric coolers and a vapor chamber as a way to transfer heat into or out of the spectrometer without creating hot-spots. A foam jacket around the spectrometer insulates it from the surroundings, and an aluminum heatsink dissipates waste heat from the thermoelectric coolers. This apparatus will allow the temperature of the spectrometer to be precisely controlled to a variety of setpoints, while sampling light from spectral calibration line lamps in the laboratory. Evaluation of the spectrometer performance at various temperatures will allow us to define limits on acceptable temperature variability inside the 5STAR instrument.

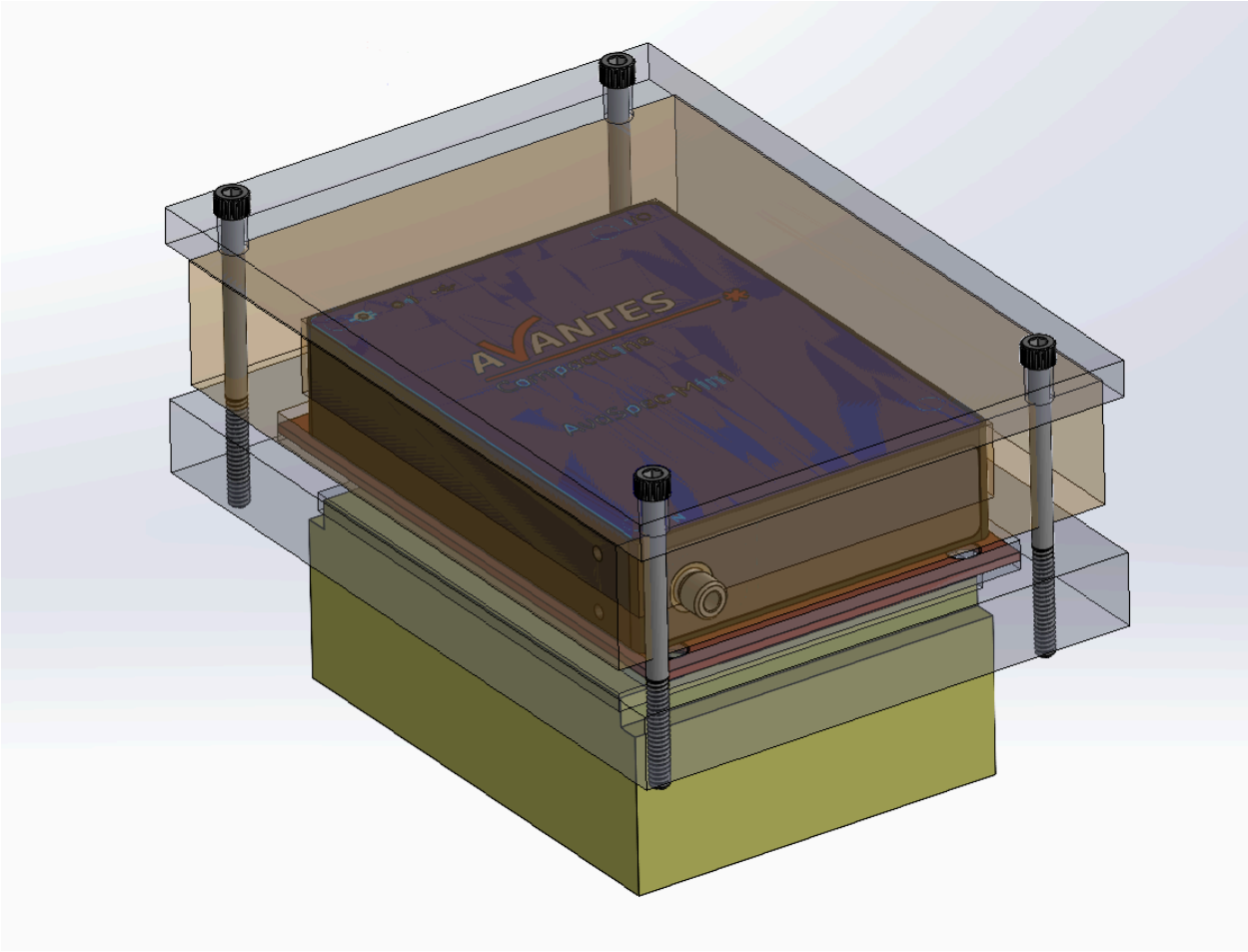

Figure: A COTS mini spectrometer encased in an insulated temperature control apparatus, comprising thermoelectric coolers and a vapor chamber to transfer heat into or out of the spectrometer, thus precisely maintaining its temperature.

5STAR/Science

Project Participants

BAERI: Samuel LeBlanc

Project Description

As part of multiple previous airborne field campaigns, the Ames Research Center (ARC) Sun-photometer Satellite Group has developed expertise and tools in flight planning for optimizing coordination and sampling strategies in research flight planning.

This expertise developed by Dr. LeBlanc, encompassed in a research flight planning tool “moving lines” [LeBlanc 2018], has been recently applied to the ARCSIX field campaign (Arctic Radiation-Cloud-Aerosol-Surface Interaction Experiment) and was supported by the NASA Internal Scientist Funding Model (ISFM) for Sunsat, funded through the BAERI 5STAR project.

The overarching goal of ARCSIX is to quantify the contributions of surface properties, clouds, aerosol particles, and precipitation to the Arctic summer surface radiation budget and sea ice melt during the entire melt season (May through mid-August). It encompasses three main science questions and one objective linked to quantifying surface radiation, cloud life cycle, sea ice evolution, and to advance remote sensing of clouds, aerosol, and sea ice in the arctic.

To accomplish ARCSIX's science and objectives, three aircraft flew in coordination. Two aircraft, the NASA WFF P-3 and the Spec, Inc. LearJet, acquired in-situ aerosol particle, cloud, atmospheric, and surface properties along with radiation below, above, and inside the cloud layer, while the third, the NASA LaRC G-III, served as a bridge to satellite observations by surveying with heritage and novel remote sensing instruments from above. This provided the required near-simultaneous characterization of radiative fluxes, surface, and cloud properties to address Science Questions one and three. Statistical sampling of cloud vertical structure, temperature, and humidity profiles, complemented by simultaneous remote sensing, addressed Science Question two and the Remote Sensing and Modeling Objective. To extrapolate the spatially and temporally limited field observations beyond ARCSIX itself, the ARCSIX airborne data were integrated with satellite remote sensing observations and model simulations. Targeted sampling of distinct regimes defined by cloud type and the associated prevailing surface and meteorological conditions enabled more valuable combinations of airborne and satellite remote sensing observations and model simulations. This combination of observations and model simulations pushed the performance of remote sensing algorithms towards more realism for various conditions. It culminated in a more realistic depiction of radiative processes, cloud life cycles, and sea ice evolution in climate, regional forecast, and process models.

During the two Summer 2024 deployments (May 24 to June 17 and July 22 to August 17, 2024), the ARCSIX project flew a combined 31 science flights (15 P-3 and 16 G-III), accumulating a combined total of 159 research flight hours. All of these flights were planned by Dr. LeBlanc,

either leading all the planning (in the first deployment), or through final quality checks, and advisory (during the second deployment).

Continuation of this project is linked to manuscript building, formalizing the lessons learned during flight planning, and ongoing science analysis of data gathered.

Accomplishments

- Archival and summary of flight plans, flight paths flown, and lessons learned in flight planning for the two ARCSIX deployments in Spring/Summer 2024.
- Summary of Satellite validation work achieved by ARCSIX observations.

Presentations

LeBlanc, S., Schmidt, S., Knobelspiesse, K., Taylor, P., Crosbie, E., Peterson, C., Nataraja, V., Cairns, B., Cetinic, I. and Becker, S., “Planning and flying research flights during the suborbital airborne field campaigns ARCSIX and PACE-PAX.” AGU Fall meeting 2024, Poster A53D-2107, ESS Open Archive eprints, 118, pp.essoar-173445461., 2024.

LeBlanc S., Flight planning team, et al., ARCSIX Flight planning lessons learned and Satellite Validation, ARCSIX Science Team Meeting, Boulder, Colorado, May 21, 2025.

Artificial Intelligence/Machine Learning (AI/ML) Enhancements to the NASA Celestial Mapping System

Project Participants

BAERI: Graham Mackintosh

NASA Ames: Mark Newfield, Parul Agrawal

Project Description

AI-enhanced data pipeline to import lunar-image data into the NASA Celestial Mapping System. This will offer direct value to the Artemis mission planners for south pole landing site selection and subsequent lunar excursion path planning.

Accomplishments

Completed control point mapping and advanced image aggregation functions. Now commencing AI model for control point pairing and automated mosaicing.

Panels or Committees

Participated in panel on planetary subsurface exploration for science and resources. USGS Workshop. May 22, 2024.

Presentations

CMS_USGS Year-end Report. NASA/USGS Mini-Summit to assess progress in the enhancements of the NASA Celestial Mapping System and the plan ahead
Presented to USGS lunar data team. “AI-enhanced lunar image processing pipeline for the NASA Celestial Mapping System.” Dec. 2024.

Conference on Planetary subsurface exploration for science and resources - In-person USGS/NASA co-sponsored conference at Ames. Presented to 105 attendees “AI enhanced data-pipeline for the detection of lunar subsurface resources.” May 22, 2024.

Code TI All-hands Tech Talk. Presented “Federated Learning using In-Space Data” to all code-TI. June 4, 2024.

TxTuesday—Digital Transformation All-team presentation. Presented to 67 virtual attendees “AI techniques to enable the remediation of orbital debris.” Nov. 12, 2024.

Code TI Seminar. Presented to Code TI all-hands: “Project FLUID and the imperative to link terrestrial and space-borne data for the next generation of AI models.” May 6, 2025.

AI/ML Enhancements to the NASA Celestial Mapping System: NASA/US Space Force/US Air Force Research Lab—Joint Technology Innovation Workshop.

Presented to 15 USSF/AFRL researchers: “Project RETRO: AI and the remediation of orbital debris.” Apr. 3, 2025.

ARC Biodiversity Planning

Project Participants

BAERI: Justin Fain, Gabriela Colombo (previous employee), Cynthia Schmidt (now retired)

NASA: Ian Brosnan

Project Description

This project was initiated as a first step to identify information system needs for NASA's proposed Catalyst project and to assess existing NASA-funded information systems that could fulfill Catalyst requirements. The project aimed to support biodiversity and ecological conservation efforts under NASA Earth Sciences by gathering insights from key stakeholders through a series of user interviews. Understanding potential end users is essential for the successful development of future biodiversity initiatives.

Accomplishments

- Conducted a series of user-focused interviews to determine the needs, wants, and goals of stakeholders to guide the mission of the Catalyst project for biodiversity.
- Delivered a report of findings to NASA HQ.

Atmospheric Composition Campaign Data Analysis and Modeling (ACCDAM) Bio

Project Participants

BAERI: Kristina Pistone

Desert Research Institute (DRI): Eric Wilcox, Marco Giordano

Project Description

The climatological effects of atmospheric aerosol particles are primarily regional in scale yet are of global importance. Aerosols alter cloud properties by changing cloud microphysics (e.g., droplet size), macrophysics (e.g., thickness and altitude), the total cloud amount, or the local atmospheric dynamics. Stratocumulus clouds, by covering large regions of the subtropical oceans, are a large component of global albedo, and changes in the reflectivity of these regions may thus have global impacts. We use observations from the NASA ObseRvations of Aerosols Above CLouds and their IntEractionS (ORACLES) airborne campaign in the Southeast Atlantic (SEA) between 2016 and 2018 to observationally quantify the impact of water vapor under different aerosol conditions. The SEA stratocumulus clouds are seasonally subjected to biomass burning (BB) emissions advected from springtime agricultural fires in southern Africa, and the ORACLES campaigns saw a humid layer co-located with the BB plume. Studies of these two major atmospheric components, separately and together, can thus provide valuable insights into the complex radiative and dynamic interactions between water vapor, aerosols, and clouds in current and future climate.

In this project, we seek to explain how atmospheric water vapor governs aerosol effects on stratocumulus clouds and establish how cloud-top radiative fluxes vary with above-cloud humidity and aerosol, and how this affects cloud macrophysics (specifically, cloud liquid water and cloud fraction). Our analysis will use a combination of observations from suborbital field campaigns, satellite data, and reanalysis products to gain a better understanding of the impacts of water vapor on cloud properties in the SEA stratocumulus regime, how water vapor varies with aerosol loading, and the radiative and dynamic effects of this covariance. We will incorporate vertically-resolved and geostationary satellite observations and large-scale reanalysis to understand the conditions preceding and following aircraft measurements and to capture the range of variability in water vapor and aerosol conditions over the two regions. Finally, we will use this understanding to quantify the relative radiative effects of atmospheric humidity and aerosol in these regions. By better understanding the importance of water vapor to the radiative and dynamic processes that control aerosol effects on stratocumulus clouds, we

will ultimately be able to better quantify direct, semi-direct, and indirect aerosol effects in the present-day and future climate.

Accomplishments

- Extended the results of Pistone et al. (2021) to examine all three ORACLES deployments, including analysis of an additional atmospheric chemistry reanalysis (Copernicus Atmosphere Monitoring Service (CAMS)). Despite the differing locations and season of each deployment, we find that good agreement between the airborne ORACLES dataset and large-scale reanalyses continues, specifically the European Centre for Medium-Range Weather Forecasts reanalysis version 5 (ECMWF ERA5) and CAMS reanalyses. Other reanalyses (specifically NASA's Modern Era Retrospective—Analysis for Research and Applications 2 (MERRA-2)) preserved the observed correlation between meteorology and BB conditions, but were frequently displaced spatially, relative to the observations.
- Extended the results beyond BB tracers to consider reanalysis aerosol properties in CAMS and MERRA-2.
- Because of the good CAMS/ORACLES agreement, we examined multi-year seasonal patterns and trends beyond the three months with available aircraft data. We found distinct variations between each month/deployment in terms of vertical smoke distribution and correlation to atmospheric specific humidity, due to changing conditions over the BB season. Using k-means clustering of climatological data, we identified six canonical atmospheric profile types of varying total atmospheric humidity and vertical structure and described their overall incidence and spatial/temporal changes throughout the region and season.
- The DRI team has led an analysis of the broader radiative and dynamical implications of these results for conditions of aerosols overlying stratocumulus clouds. Radiative transfer calculations have been run based on the above canonical profiles, working towards an integrated radiative heating calculation for the region, with attribution to each of the two primary components, and writing a publication by the end of the year (led by M. Giordano).
- PI Pistone has led an analysis using satellite observations to identify and quantify resulting cloud property distinctions between each of the canonical atmospheric profiles (both for water vapor and for BB tracer) across the region and the season. Consistent with previous work, there is an observed lower boundary layer height (BLH) for gap layer cases, and lower cloud top heights for higher smoke conditions. When accounting for sampling bias of some satellite sensors, there is also a small signal indicating higher cloud liquid water content under higher smoke conditions. As may be expected, the cloud liquid water is also observed to be greater under the higher humidity profile conditions. A paper describing these two effects is in progress for planned completion by the end of the project year.

Outreach and Community Service

- American Geophysical Union Local Science Partners (2021–present): AGU program to facilitate relationship-building between science experts and local policymakers https://thebridge.agu.org/2021/12/10/agu-welcomes-first-cohort-of-local-science-partners/.
- Sustainability Commissioner, Sunnyvale Sustainability Commission (June 2021–present), volunteer advisory position to city council regarding sustainability issues in the city of Sunnyvale.
- Letters to a Pre-Scientist (Aug 2018–present): one-on-one pen-pal mentorship program for science classrooms in low-income schools.
- Skype a Scientist (May 2017–present): virtual interactions with groups and classes of K–12 students regarding atmospheric/climate science and scientific careers.

Publications

Pistone et al. “Vertical structure of a springtime smoky and human troposphere over the southeast Atlantic from aircraft and reanalysis.” *Atmos. Chem. Phys*., 2024 https://doi.org/10.5194/acp-24-7983-2024.

Giordano et al., “Radiative Experiments and Simulations: Effect of Column Water Vapor and Biomass Smoke Aerosol on Atmospheric Heating Rates.” in prep for *Atmos. Chem. Phys*.

Pistone et al., “Observed stratocumulus cloud properties vary with absorbing aerosol and water vapor over the southeast Atlantic Ocean.” in prep.

Aerosol Rapid Analysis Combined Entry Probe/Sonde Technology (AERACEPT)

Project Participants

BAERI: Caroline Dang

NASA: Diana Gentry, Andrew Mattioda, Laura Iraci

Impossible Sensing: Pablo Sobron, Cody Hyman, Fredrik Rehnmark

Project Description

Venus is a high-priority target for near-term exploration, particularly to advance our understanding of its atmosphere, clouds, and hazes. The Aerosol Rapid Analysis Combined Entry Probe/sonde Technology (AERACEPT) is a sampling system designed to be integrated into an aeroshell for in situ sampling and analysis of cloud aerosol particles during a planetary probe descent, such as the Nephele small-spacecraft mission concept to Venus’s middle and lower cloud layers.

To assess the potential performance of this approach, a suite of Venus cloud analog materials have been analyzed using the Raman instrument at the Ames In Situ for Carbon Evolution Experiments (ICEE) Facility, along with two prototype instruments developed by Impossible Sensing: a UV Fluorescence (UVF) Imager and a Laser Induced Breakdown Spectroscopy (LIBS) system. These techniques were evaluated for their sensitivity to aerosol and analyte detection, their molecular analysis cadence, and their durability in Venus's extreme, high-temperature, acidic environment. We found that Raman can detect most analytes, although fluorescence from some organic-H_2SO_4 mixtures reduces the sensitivity of this approach. We also determined that the UVF Imager can image particles as small as five microns.

The particle capture efficiency of the AERACEPT design has been evaluated through wind tunnel testing at NASA Ames's Fluid Mechanics Laboratory. Tests were conducted using a simplified AERACEPT flow geometry under simulated passive descent conditions corresponding to altitudes of 57 km and 47 km. Micrographs of the resulting size-graded particle samples were analyzed to assess particle capture efficiency and separation. The results were then compared with predictions from fluid mechanics and particle tracking modeling. Preliminary findings indicate that the number of captured particles for each size bin aligns with model predictions within an order of magnitude.

Accomplishments

Completed:

- Impossible Sensing's UV Fluorescence imager integrated with flow testing for analysis of aerosols deposited in real-time.
- Wind tunnel testing at two mach speeds corresponding to 57 km and 47 km altitudes above Venus's surface.
    - Worked on script for analyzing particle size across substrate for wind tunnel testing.
    - Iterated through substrates and substrate holders for optimal configuration for particle deposition and for immersion microscopy.
    - Analyzed a suite of Venus aerosol analogs with Raman micro spectrometry.
    - Analyzed a suite of Surface Enhanced Raman Spectrometry (SERS) substrates for Raman.
    - Tested thermal and chemical stability of substrates.

Still to complete:

- Help to move Laser Induced Breakdown instrument to SETI institute, if needed.

- Prepare solutions of our Venus analog in 0.1M and 0.01M concentrations, and assist SETI partner with measurements of the solutions for sensitivity to individual analytes in sulfuric acid.
- Perform reanalysis of particle deposition from wind tunnel tests to understand any discrepancies from flow and particle modeling and in-situ tests.
- Finalize any testing of aerosol analogs using Raman.
- Assist in write-up of final report.

Presentations

Dang, C., Hyman, C., Iraci, L., Mattioda, A., Rehnmark, F., Sobron, P., Davila, A., Gentry, D. *Optical Spectroscopy and Analysis Methods of Venus Aerosol Analogs.* AGU 2024, Washington D.C.

Dang, C., Iraci, L., Mattioda, A., Sobron, P., Hyman, Rehnmark, F., Davila, A., Gentry, D. *Instrumentation for In-Situ Analysis of Venus Aerosol.* Cloud Workshop, Caltech. June 25, 2025.

Panels or Committees

Invited science conference at Cloud Workshop, Caltech.

Alpha Jet Atmospheric eXperiment (AJAX)

Project Participants

BAERI: Emma Yates
NASA: Laura Iraci

Project Description

The Alpha Jet Atmospheric eXperiment (AJAX) team takes airborne measurements of ozone, formaldehyde, CO2, methane, and meteorological parameters. BAERI's role includes identifying science questions, designing and planning flights, data analysis (Interactive Data Language, Python), maintaining instruments, and scientific writing and presentations.

Since 2016, BAERI has been responsible for facilitating collaborations by setting up a new laboratory of atmospheric instruments (CO_2, CO, carbonyl sulfide (COS), C-isotopes) and making them available for use within the broader scientific community. The project has been awarded four grants to deploy instrumentation on an Unmanned Air System (UAS) in Alaska, in a car and on an aircraft and to measure COS uptake from coastal redwood forests.

Accomplishments

- Co-investigator on NASA Earth Science Division, Atmospheric Composition Campaign Data Analysis and Modeling, Research Opportunities in Earth and Space Science (ROSES) 2020 Program Element A.23, NNH20ZDA001N-ACCDAM. Project Title: Solving the Mystery of the Disappearing Low Ozone Values: Attributing Ozone Trends over the Eastern Pacific Ocean and Western North America.
- Primary investigator for selected NASA ROSES proposal NNH24ZDA001N-CSESP, A.50 Citizen Science for Earth Systems Programs title: Ozone Measurements from General Aviation: Supporting TEMPO (Tropospheric Emissions: Monitoring Pollution) Satellite Validation and Addressing Air Quality Issues in California's San Joaquin Valley with Citizen Science. (NEW BAERI TASK "SJV O3")
- Maintained, calibrated, and serviced AJAX and Trace Gas Group (TGGR) instruments.
- Used AJAX wing pod instruments to cross-calibrate a number of low-cost sensors (Kristen Okorn, BAERI).
- Asian Summer Monsoon Chemical & CLimate Impact Project (ACCLIP) data analysis and manuscript preparation. (See publication list for new publication.)

Publications

Yates, E. L., Golston, L. M., Podolske, J. R., Iraci, L. T., Okorn, K. E., Dang, C., Johnson, R. R., Eilers, J., Kolyer, R., Astley, I., and Leen, J. B.: Description and Validation of a Carbon Monoxide and Nitrous Oxide Instrument for High-Altitude Airborne Science (COMA), EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-1081, 2025.

Carbon Monitoring Systems (CMS)

Project Participants

BAERI: Taejin Park

Collaborators

University of Delaware: Rodrigo Vargas, Pinki Mondal, Manan Sarupria

University of Texas: Akash Awasthi

University of Connecticut: Zhe Zhu

Project Description

Mexico is a high-biodiversity country. Nearly 40% of its territory is forested. During the last decade, the scientific capacity of Mexican scientists has rapidly increased, and there are state-of-the-art measurements on carbon dynamics available at representative landscapes and

at the national level. Mexico is now recognized as one of the few non-Annex I countries capable of implementing Reducing Emissions from Deforestation and Forest Degradation (REDD+). This proposal builds on previous work supported by NASA CMS to improve monitoring, reporting, and verification (MRV) for implementation of REDD+ in Mexico.

This project will increase the ARLs of ongoing CMS prototypes and develop new CMS prototypes with the ultimate aim of supporting implementation of REDD+ across Mexico. In this project, our specific commitment is to adapt CMS prototypes developed from other NASA efforts for testing, validation, and improvement across Mexico. Specifically, we will adapt and develop CMS prototypes for improving MRV of forest structure and carbon dynamics at the national scale (ARLs 4-6).

This project supports NASA carbon cycle research through:

- Validating CMS-related applications.
- Advancing remote sensing-based approaches for MRV and local-to-global carbon dynamics.
- Supporting implementation of international REDD+ projects.
- Working with stakeholders and sharing value-added products and information derived from this proposal.

Accomplishments

- Developed a machine learning-based framework to generate Landsat-based annual percent tree cover maps for Mexico (Figure 1).

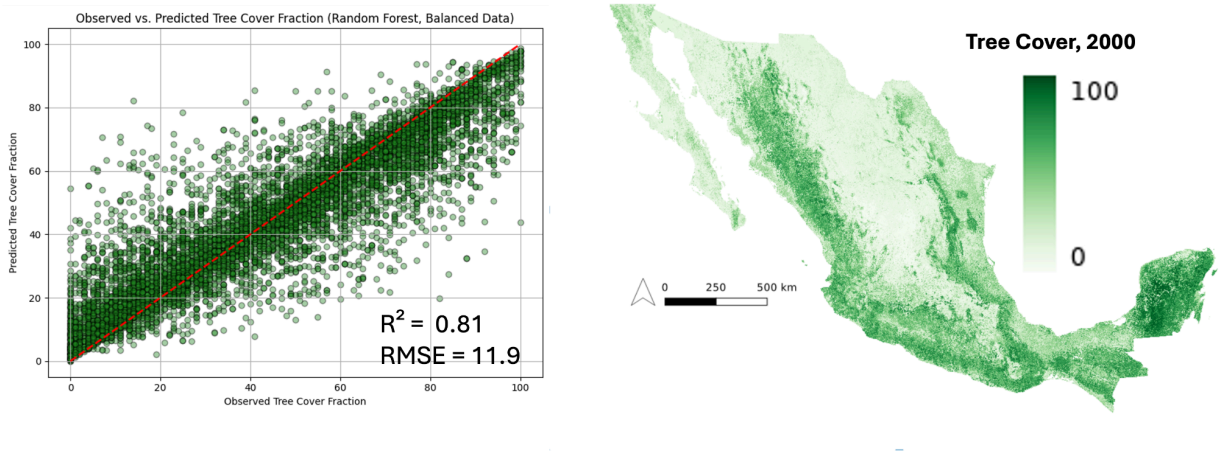

Figure 1: Performance of the developed random forest regression model for percent tree cover mapping (left). An example of country-wide percent tree cover mapping generated using Landsat data and the developed machine learning model.

- Built and tested a landsat-based biomass estimation framework using landsat, GEDI, and Continuous Change Detection and Classification algorithm (Figure 2).

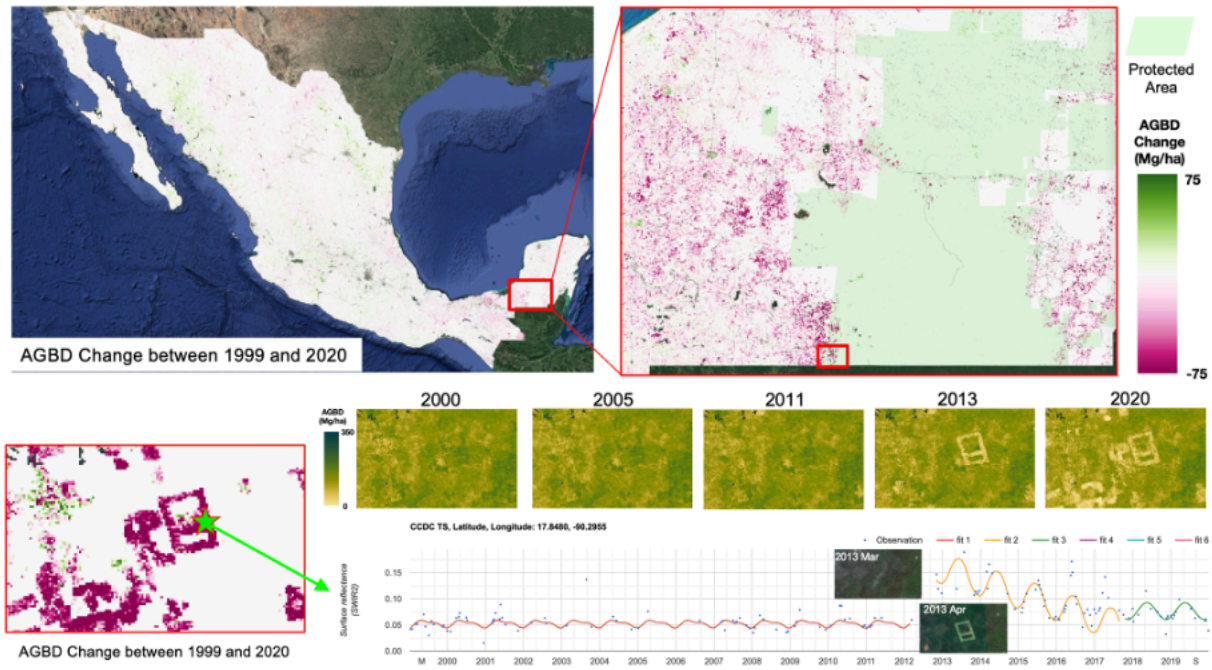

Figure 2: Spatial distribution of aboveground biomass density (Mg/ha) changes during the period between 1999 and 2020.

- Co-advised a Master's student (Dustin Braden) and two PhD students (Elena Diez Pastor & Manan Sarupria) from the University of Delaware.

Presentations

Park, T., Vargas, R., Nemani, R.R. and Brosnan, I.G., 2024, December. Continuous Nationwide Forest Aboveground Biomass Mapping in Mexico: Integrating GEDI and Landsat Time Series Data. In *AGU Fall Meeting Abstracts* (Vol. 2024, No. 1573, pp. B13D-1573).

Publications

Duncanson, L., Hunka, N., Jucker, T., Armston, J., Harris, N., Fatoyinbo, L., Williams, C.A., Atkins, J.W., Raczka, B., Serbin, S. and Keller, M (including Park, T.), 2025. Spatial resolution for forest carbon maps. *Science*, *387*(6732), pp.370-371.

Peano, D., Hemming, D., Delire, C., Fan, Y., Lee, H., Materia, S., Nabel, J.E., Park, T., Wårlind, D., Wiltshire, A. and Zaehle, S., 2025. Plant phenology evaluation of CRESCENDO land surface models. Part II: Trough, peak, and amplitude of growing season. Biogeosciences. Under Review.

You, H., Ji, F., Park, T., Radeloff, V.C., Hurtt, G., Jiang, M., Chen, M. Global Forest Edges and Their Dynamics in the 21st century, Nature Plant (under review).

You, H.,Chen, M., Park, T. Continuous forest loss and edge expansion in the US (in preparation).

Dynamics and Chemistry of the Summer Stratosphere (DCOTSS)

Project Participants

BAERI: Ju-Mee Ryoo

NASA: Rei Ueyama

Project Description

BAERI's Ju-Mee Ryoo will conduct research and data analysis on the relationship between atmospheric rivers and overshooting convection observed during DCOTSS, as well as on climatological data.

Accomplishments

Preparing a peer-reviewed journal paper on the DCOTSS project results.

Formaldehyde to Nitrogen Dioxide Ratio (FNR) Trends

Project Participants

BAERI: Jia Jung

NASA Ames: Matthew S. Johnson

NASA Goddard/Morgan State University: Amir H. Souri

National Center for Atmospheric Research (NCAR): Rajesh Kumar

Project Description

Recent satellite remote-sensing platforms have demonstrated pronounced improvements in spatiotemporal resolution, reduced noise, and higher accuracy. These improvements in newer satellites, combined with a rich legacy of nitrogen dioxide (NO2) and formaldehyde (HCHO) column retrievals, underpin many scientific capabilities for demonstrating spatiotemporal changes in NO2, HCHO, and ozone (O3) production sensitivity regimes using the ratio of HCHO and NO2 (FNR). However, uncertainties in bottom-up emission inventories—associated with poor classification of emission sources and limited knowledge of emission factors—often result in significant bias in chemical transport model results and misclassification of ozone (O3) production sensitivity regimes. Therefore, in this project, we constrain bottom-up emission

inventories using multiple NO2 and HCHO column retrievals and analytical joint-species/sensor inversion over the Continental United States (CONUS) between 2019 and 2023. We employ a suite of numerical modeling tools, including the Weather Research and Forecasting (WRF) and Community Multiscale Air Quality (CMAQ) modeling system, along with analytical data-driven emissions estimates using the direct decoupled method (DDM). Top-down estimates of NOx and Non-Methane Volatile Organic Compounds (NMVOCs) emissions, derived from the rich legacy of satellite retrievals from the Ozone Monitoring Instrument (OMI), Ozone Mapping and Profiler Suite-Nadir Mapper (OMPS-NM), TROPOspheric Monitoring Instrument (TROPOMI), and the upcoming Tropospheric Emissions: Monitoring of Pollution (TEMPO), will illuminate trends in ozone precursor emissions and the trend of the ratio of HCHO and NO2 (FNR).

Accomplishments

- Preliminary results of inversion with TROPOMI and OMI were evaluated based on ground measurements.
    - Changes in the averaging kernel showed more improvement (smaller errors) in the posterior emissions with TROPOMI than OMI.
    - The inversion results showed that TROPOMI estimates lower NOx emissions over the CONUS by 22.20 % (higher NOx over the polluted area by 19.11%) and lower VOCs (by 42.61 %) compared to OMI.
    - When comparing against AQS measurement, improvements over the surface tend to be higher.
- We found low correlations between modeled surface NO2 concentration (with prior emissions) and AQS measurement, which is unsalvageable by conducting inversion. Therefore, we explored possible causes such as prior emissions and wind fields.
    - Compared to AQS measurement (wind direction and wind speed), slight overestimation of wind speed was found. Simulated daytime wind fields demonstrated the ability for reproducing wind direction, especially where land-sea breezes were present.
    - We processed several anthropogenic emissions (e.g., EPA 2016fj and GEOS-Chem 2016) and validated their simulated surface NO2 concentrations against the AQS measurements. By using the GEOS-Chem 2016 emissions, accompanied with vertical/temporal profile, correlation has increased by 1.68% (2019), 13.11% (2020), and 12.53% (2021) based on 16 US cities, resulting in an averaged correlation of 0.68 - 0.72.
- We found inversion with satellite-measured tropospheric NO2 columns often enhances model bias at surface, mostly in rural areas. This decoupling between column and surface seems to be caused by NOx emissions (dominantly from aviation and lightning emissions) in the upper troposphere, which can be a significant contributor to the tropospheric NO2 column due to increased scattering.

- It means the current inversion method, using tropospheric NO2 column for adjusting total NOx emissions (summed over the model layers), is likely challenging where it has significant influence of the upper tropospheric NO2.
- As shown in East et al. (2022), we found that separately adjusting NOx emissions in the upper troposphere (> 700 hPa) and near-surface (< 700 hPa) could relieve the decoupling between column and surface.
- We have worked on updating the inversion framework to deal with NOx emissions in the upper troposphere and near surface.

Presentations

J Jung, MS Johnson, AH Souri, R Kumar, 2025, Top-down estimate of NOx and NMVOC emissions over the CONUS for the summers of 2019-2021: assessing the benefits of improved satellite remote-sensing observations, 105th Annual AMS Meeting 2025.

MS Johnson, J Jung, AH Souri, R Kumar, 2025, Improved Assessment of Recent Trends in NOx and VOC Emissions and Ozone Production Sensitivity Regimes Using Satellite data, 105th Annual AMS Meeting 2025.

Publications

Johnson, M. S., Philip, S., Meech, S., Kumar, R., Sorek-Hamer, M., Shiga, Y. P., and Jung, J.: Insights into the long-term (2005–2021) spatiotemporal evolution of summer ozone production sensitivity in the Northern Hemisphere derived with the Ozone Monitoring Instrument (OMI), Atmos. Chem. Phys., 24, 10363–10384, https://doi.org/10.5194/acp-24-10363-2024, 2024.

Formaldehyde to Nitrogen Dioxide Ratio (FNR) Trends Paper in progress: Assessment of the capabilities of satellite measurements in detecting the spatiotemporal variations of surface NO2, HCHO, and FNR over the major US cities.

Panels or Committees

- Jung served as a panelist for NASA ROSES 2024 A.43 (Earth Action: Health and Air Quality).

Global Ecosystem Dynamics Investigation (GEDI)

Project Participants

BAERI: Taejin Park, Ramakrishna Nemani

Collaborators

University of Wisconsin-Madison: Min Chen, Hangkai You

Project Description

The aim of this project is to map and project current (circa 2020) and future (circa 2100) forest height, aboveground biomass, and carbon sequestration potential over the continental USA (CONUS) using a theory-based integrative approach. This research will synergistically use a biophysical model, called Allometric Scaling and Resource Limitation (ASRL), with spaceborne/airborne remote sensing data, including foundational GEDI lidar altimetry data, to generate large-scale and continuous patterns of forest height and aboveground biomass. The model has been developed on the basis of metabolic scaling theory and water-energy balance equations. Local resource availability (i.e., water, light, and temperature) and disturbance history are explicitly implemented in the model to predict maximum forest growth. The biophysical mechanism integrated within the model enables prognostic applications, in contrast to conventional black-box approaches.

The objectives of this work are to:

- Refine and expand the current form of ASRL model to predict tree height, aboveground biomass, and carbon sequestration potential by accounting for specific biophysical parameters in different disturbance histories.
- Test a theory-based integrative approach using independent and comparable measurements.
- Map and project changes in forest height, biomass, and carbon sequestration potential over the CONUS with different climate scenarios.

In this research, input geo-predictors to the model are topography, climate variables, and nutrients. Lidar and optical observations such as NASA's GEDI, ICESat-2, LVIS, MODIS, and Landsat will produce current patterns of forest structure, which are used to initialize model parameters regarding tree metabolism, crown geometry, and resource accessibility and use efficiency. We will utilize NASA's NEX CMIP6 climate projection to project changes in forest height, biomass, and carbon sequestration potential. Model evaluation and uncertainty estimation will incorporate independent in situ, FLUXNET, and remote sensing data.

This research directly responds to the 2020 NASA "Global Ecosystem Dynamics Investigation Science Team (NNH20ZDA001N-GEDIST)" call and the carbon science program, both of which aim at characterizing, quantifying, understanding, and predicting the evolution of global carbon

sources/sinks through spaceborne, airborne, and field monitoring. The proposed research will not only facilitate the current NASA Carbon Monitoring and Terrestrial Ecology Programs, but will also support ongoing NASA space missions including GEDI and ICESat-2.

Accomplishments

- We investigated how GEDI forest canopy height improves ASRL model optimization. The model was able to predict the maximum potential height (Figure 1, left), and GEDI-derived forest canopy height helped optimize the estimation of contemporary forest canopy height (Figure 1, right). Additional stand-age information also helps account for the impacts of land disturbance on forest growth and contemporary maximum canopy height.

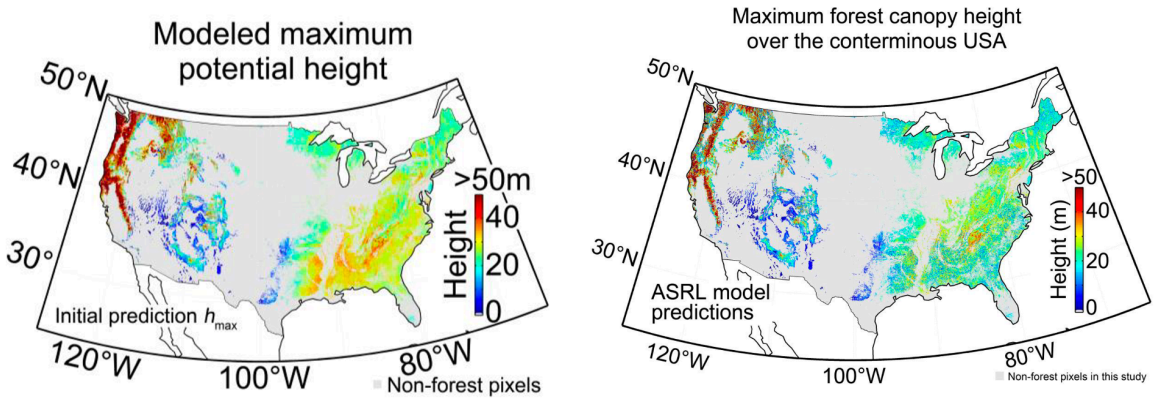

Figure 1: Spatial distribution of maximum forest canopy height from ASRL model runs without (left) and with (right) optimization using GEDI data and stand age information.

- Based on the modeled maximum forest canopy height, we developed the ASRL biomass module that was able to predict aboveground biomass (AGB) across the CONUS. Compared to the Forest Inventory and Analysis (FIA) data, the modeled AGB reasonably captured the spatial variation in AGB estimates (Figure 2).

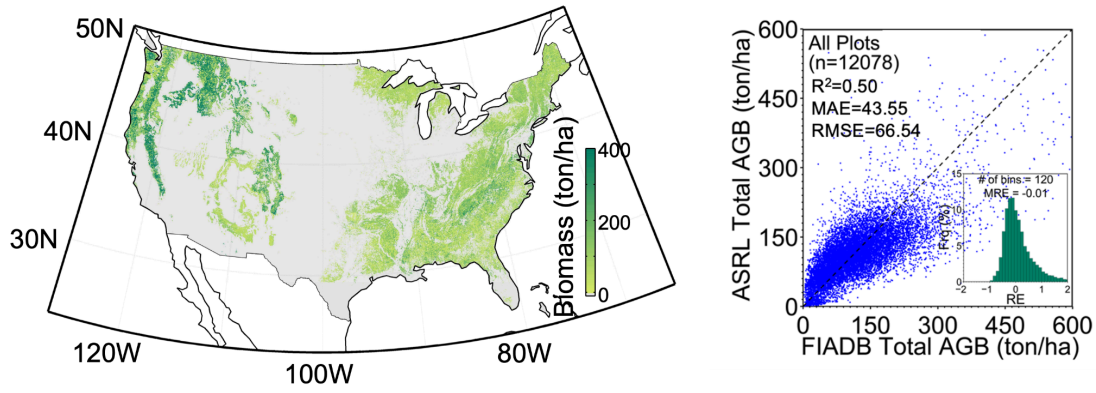

Figure 2: Modeled aboveground biomass over CONUS and its comparison to Forest Inventory Analysis (FIA) data.

- We investigated how U.S. forest cover and edge distribution have changed, and found that the U.S. has been continuously losing forest cover while forest edges have expanded (Figure 3).

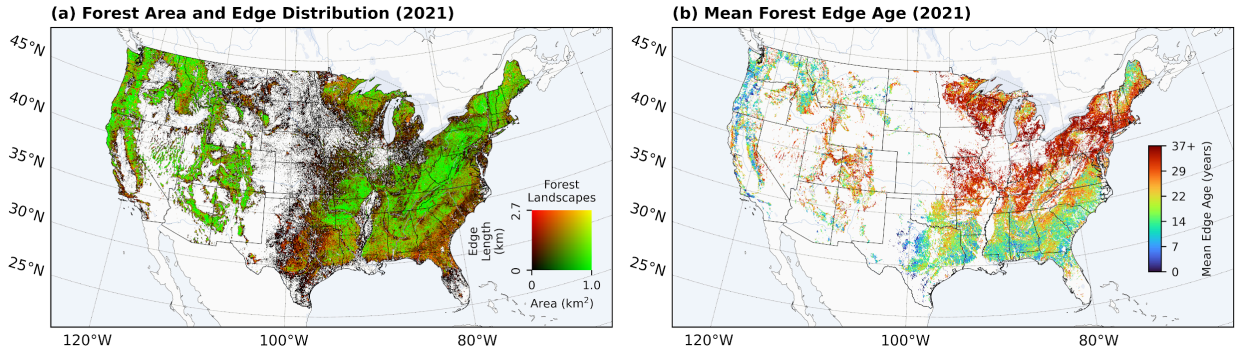

Figure 3: Spatial distribution of forest cover and edge length (left), and years since forest edge creation.

Publications

You, H., Ji, F., Park, T., Radeloff, V.C., Hurtt, G., Jiang, M., Chen, M. Global Forest Edges and Their Dynamics in the 21st century, Nature Plant (under review).

You, H.,Chen, M., Park, T. Continuous forest loss and edge expansion in the US (in preparation).

Park, T., Nemani, R. Modeling maximum forest canopy height and aboveground biomass using spaceborne LiDAR and metabolic scaling theory (in preparation).

Kim, M. and Park, T., 2024. Quantifying forest resource change on the Korean Peninsula using satellite imagery and forest growth models. Korean Journal of Environmental Biology, 42(2), pp.193-206.

GeoFlux

Project Participants

BAERI: Taejin Park

NASA Ames: Weile Wang

CSUMB: Hirofumi Hashimoto

University of Oklahoma: Xianming Xiao

Project Description

In this proposed research, we aim to synergistically use GeoNEX products derived from hypertemporal geostationary data streams, collocated and concurrent ground measurements from AmeriFlux sites, and the latest developments in photosynthesis and chlorophyll fluorescence equations to parameterize and calibrate terrestrial ecosystem models (TOPS-BGC and VPRM). This approach will consistently and accurately quantify land-atmosphere carbon and water exchanges over the continental United States at diurnal and longer time scales. We will conduct research to address the following questions:

- How do high-frequency geostationary observations compare with corresponding in-situ measurements?
- Can we identify and quantify rapid ecosystem responses to environmental changes from geostationary data?
- Can we calibrate ecosystem models to accurately simulate diurnal variations of carbon and water fluxes using hypertemporal geostationary data?
- Can the multi-angle characteristics of geostationary observations help us estimate total solar-induced fluorescence emitted by the canopy to better constrain gross primary production?
- What improvements do diurnal-cycle resolving ecosystem models provide in simulating large-scale gross primary production and evapotranspiration compared to traditional daily-based estimates?

We expect that integrating improved vegetation models with hypertemporal data streams from geostationary satellite sensors will significantly improve our understanding of the biogeochemical and biogeophysical processes that regulate carbon and water exchanges between the biosphere and atmosphere at multiple time scales. This will ultimately help us refine land surface schemes in Earth system models and further improve the fidelity of future climate projections.

Accomplishments

- The project team successfully contributed to the development and release of high-temporal-resolution Earth monitoring products derived from next-generation geostationary (GEO) satellites through the AmeriFlux community web platform (Figure 1). The newly launched platform provides sub-hourly datasets for key environmental variables, including vegetation indices (NDVI, NIRv), surface downward shortwave radiation, and land surface temperature. These datasets offer unprecedented temporal resolution for AmeriFlux sites, enabling advanced research on fine-scale ecosystem dynamics and processes: https://ameriflux.lbl.gov/geonex_intro_blog/

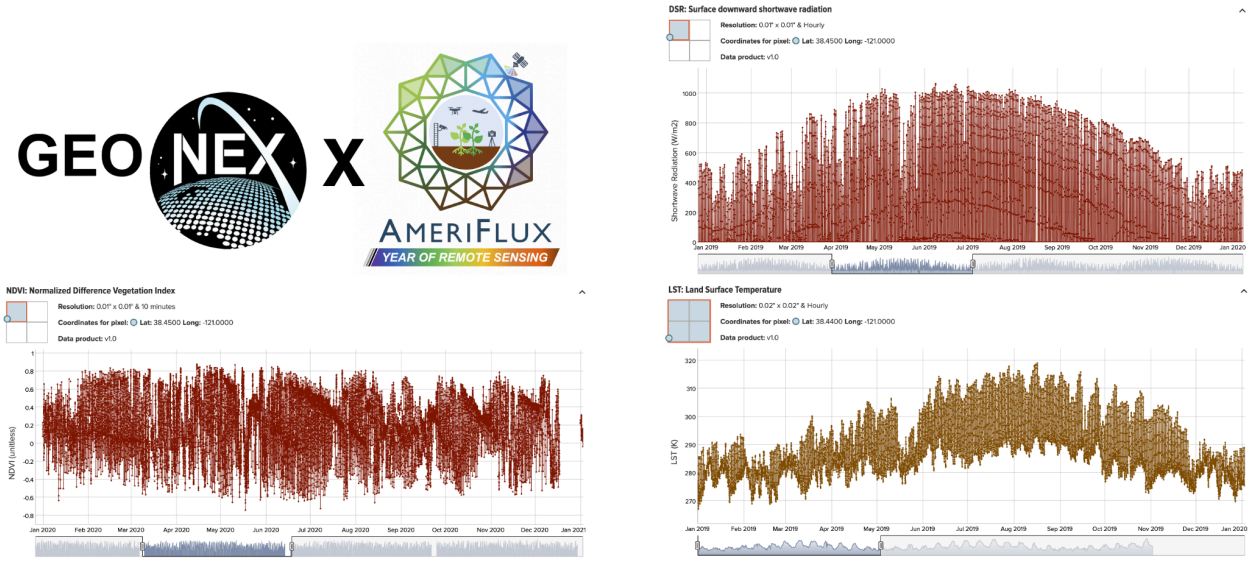

Figure 1: An example site (CA-BOU) of GeoNEX data sharing through AmeriFlux community webpage.

- Seasonality and diurnality in photosynthetic activity are key drivers of the carbon, water, and energy cycles in the Earth system, reflecting plants' adaptive responses to environmental conditions. Using high-frequency carbon flux data from eddy-covariance tower networks, we identified significant spatiotemporal variations in carbon flux seasonality and diurnality across climate gradients (Figure 2).

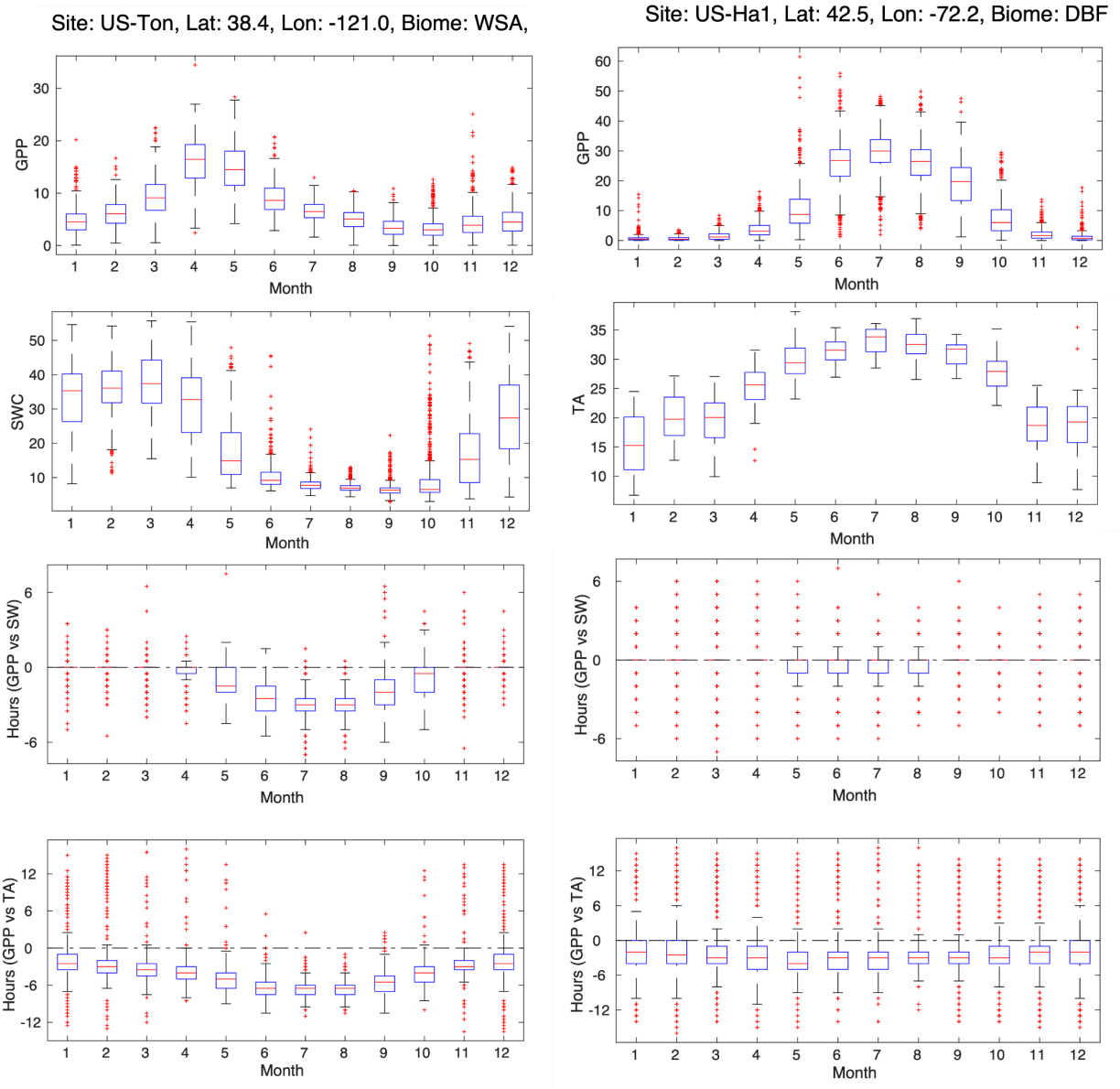

Figure 2: Seasonal and diurnal carbon flux, climate, and their relations across multiple example EC-tower sites: US-Ton (left column, semiarid ecosystem) and US-Ha1 (right column, temperate forest ecosystem).

Presentations

Park, T., Hashimoto, H., Wang, W., Xiao, X., Vargas, R., Brosnan, I.G. Seasonality and Diurnality in Carbon Fluxes Across Climate Gradients Inferred from Eddy Covariance Flux Tower Networks and Geostationary Satellite Observations, 2024 AGU Fall Meeting.

Hashimoto, H., Wang, W., Park, T., Brosnan, I.G. Toward community-driven terrestrial ecosystem science using international geostationary satellites and ground-observation

networks: a case intercomparison study of GeoNEX and NOAA products, 2024 AGU Fall Meeting.

Publications

Meng, C., Xiao, X., Newman, G.S., Pan, L., Zhang, C. Chen, W., Pan, B., Yao, Y., Hashimoto, H., Park, T., Wang, W. Vegetation apparent maximum light absorption capacity is site- and season-specific and acclimates to the local light condition. Nature Plant, In Review.

Hashimoto, H., Wang, W., Park, T., Khajehei, S., Ichii, K., Michaelis, A., Guzman, A., Nemani, R., Torn, M., Yi, K. and Brosnan, I., 2025. Subsets of geostationary satellite data over international observing network sites for studying the diurnal dynamics of energy, carbon, and water cycles. Earth System Science Data Discussions, Accepted.

Intelligent Long Endurance Observing System (ILEOS)

Project Participants

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Project Description

ILEOS is a science activity planning system built to enable new observing strategies for satellites and High Altitude Long Endurance, Unmanned Aerial System (UAS)-mounted instruments. UAS observation targets are generated by fusing coarse-grained satellite data and environmental forecast data (e.g., wind, weather, airspace constraints). Explainable plans are generated for optimal fine-grained spatiotemporal resolution data collection. The system is designed to ensure science mission planners understand all key choices being made while generating targets and plans. The project's intended impact is to reduce the cost for Earth observations in environments ranging from the Arctic, to urban centers, to some previously inaccessible offshore regions.

The objectives of this project are to:

- Develop a novel automated target generation technology.
- Create state-of-the-art automated planning and scheduling algorithms.

- Build innovative techniques for user control and review of decision making.

Accomplishments

We have developed a semi-automated science activity planning system and conducted simulation-based studies for the following three science cases:

- Monitoring for wildfire activity based on NOAA Hazard Mapping System Fire and Smoke Product and the USGS Fire Danger products. A case study with the Jan. 2025 Los Angeles fires was conducted.
- Monitoring of offshore Nitrogen Oxides (NOX) emissions (a harmful pollutant) over the Gulf of Mexico due to ships, oil rigging platforms, and miscellaneous sources. This work would allow for the estimation of these emission sources, e.g., point (large rigs), line (shipping lanes) and area (small wells, support ships).
- Monitoring for Methane (CH4) (a greenhouse gas (GHG)) emissions over interior Alaska. CH4 is emitted over large areas of the Arctic-Boreal zone, especially from wetlands, at a rate which is strongly influenced by water table level and air temperature. The data may be used for scientific modeling and to pinpoint sources needing migration for safety reasons.

Executable software was developed to run the proposed activity planning system, integrating the Targeter, Planner, and Reporter components.

Presentations

Sarah A. Strode, Meghan Saephan, Douglas A. Caldwell, Bryan N. Duncan, Kristen Manies, Vinay Ravindra, William H. Swartz, and Kate Bartlett. “Scientific Target Prioritization with the Intelligent Long Endurance Observing System (ILEOS).” Poster presented at the American Geophysical Union Fall Meeting, Washington, DC, December 9–13, 2024.

Publications

Richard Levinson, Vinay Ravindra, Jeremy Frank, and Meghan Saephan. “Time-dependent Orienteering for High Altitude UAVs to Monitor Greenhouse Gases: Mixed Integer Programming vs. Monte Carlo Tree Search.” accepted at 22nd International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR), Melbourne, Australia, November 2025.

NASA Earth Exchange (NEX) / Ecological Forecasting

Project Participants

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Project Description

The NASA Earth eXchange (NEX) is a collaborative supercomputing and data analytics platform that improves the availability of Earth science data from NASA missions and other sources, models, analysis tools and research results through a centralized environment that fosters knowledge sharing, collaboration, and innovation. NEX was initiated in response to American Recovery and Reinvestment Act (ARRA) funding and had an official kick-off in December 2011. It was funded by five programs: High End Computing, Earth Science Technology Office (ESTO), Research and Analysis (R&A), Applied Sciences, and Data Systems. In FY15-16, NEX was funded by Science Enabling Research Activities (SERA) and in December 2017, the NEX team began working under an Internal Scientist Funding Model (ISFM) five-year work plan.

In 2022, NEX prepared an Internal Scientist Funding Model (ISFM) five-year work plan for the 2023-2027 period. This plan was subject to a non-advocate peer review sponsored by the Office of the Chief Scientist at NASA Ames Research Center. The review panel examined the work plan and participated in a day-long presentation and discussion with the NEX team to evaluate the scientific merit, relevance, and achievability of the plan. The review panel concluded that it met the criteria for an ISFM and provided minor recommendations that were incorporated by the NEX team.

In 2024, NEX was transitioned into the new Earth Action element of NASA's Earth Science Division as a cross-cutting capability. As a part of that plan, NEX submitted a Research and Technology (R&T) Plan to replace the ISFM Work Plan, but covering the same 2023-2027 period.

This mid-period review covers work done under the ISFM Work Plan and the nascent R&T plan. It specifically addresses the metrics described in the R&T plan, but it is not an exhaustive description of the work accomplished by the NEX team under NEX R&T (née ISFM) funds.

The current 'core' of NEX is GeoNEX, Chem/DART, and downscaled climate projections. These core components are the foundation for Earth science research, remote sensing products, reanalysis and projection products, and other outputs from NEX.

National Climate Assessment

The latest version of the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6) was released in 2022. The archive contains downscaled historical and future projections for 1950–2100 based on output from Phase 6 of the Climate Model Intercomparison Project (CMIP6). The downscaled products were produced using a daily variant of the monthly bias correction/spatial disaggregation (BCSD) method and are at 1/4-degree horizontal resolution. Currently, eight variables from five CMIP6 experiments (historical, SSP126, SSP245, SSP370, and SSP585) are provided as available from thirty-five global climate models.

This dataset was made available at the NASA Center for Climate Simulation (NCCS), https://doi.org/10.7917/OFSG3345 and was recently released on Amazon Web Services (AWS), https://registry.opendata.aws/nex-gddp-cmip6/, and the Microsoft Planetary Computer https://planetarycomputer.microsoft.com/dataset/nasa-nex-gddp-cmip6 to facilitate broader access by research and applications.

The team published the NASA Global Daily Downscaled Projections, CMIP6 in Nature's Scientific Data journal. https://www.nature.com/articles/s41597-022-01393-4

The team is also utilizing NEX-GDDP-CMIP6. They have developed visualizations and derived climate indices for the new Earth Information System, and partnered with the Finnish Meteorological Agency to complete an evaluation of NEX-GDDP-CMIP6 output in Northern Europe. They also used the NEX-GDDP-CMIP6 data to assess global fire weather conditions

using the Canadian Fire Weather Framework (Fig. 1). This data has the potential to be broadly used not only for wildfire risk assessment but also for various future climate change impact assessments and preparedness. The data (https://doi.org/10.25966/p394-qc98) and source codes (https://doi.org/10.5281/zenodo.10433232) are publicly available.

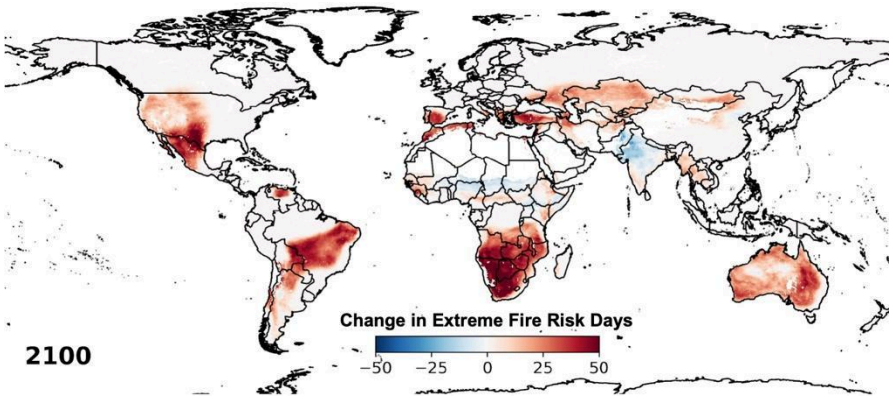


Figure 1: Changes in extreme fire risk days (number of days FWI>30) between baseline (1950-1979) and the end of 21st century under SSP2-4.5 scenario.

In 2024, the team also completed an update of the NEX-DCP30 product to incorporate the CMIP6 output, which has been released via the NAS Data Portal. We have also submitted a publication describing the dataset.

GeoNEX

GeoNEX is a collaborative project led by scientists from NASA, NOAA, and many other institutes around the world to generate Earth monitoring products using data streams from the latest Geostationary (GEO) sensors including the GOES-16/17 Advanced Baseline Imager (ABI), the Himawari-8/9 Advanced Himawari Imager (AHI), GK2A Advanced Meteorological Imager (AMI), and more. An accurate and consistent product of the Top-Of-Atmosphere (TOA) reflectance and brightness temperature is the starting point in the scientific processing pipeline and has significant influence on the downstream products. In addition to the existing efforts for ABI and AHI, the team built a processing pipeline for geolocation correction and orthorectification. The team successfully produced GeoNEX AMI L1G products (Fig. 2).

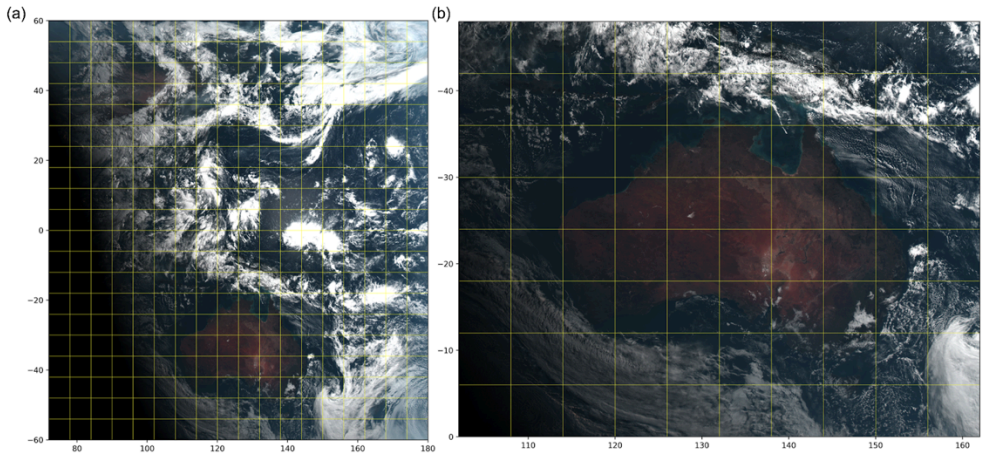


Figure 2: Example natural color RGB composite of GeoNEX GK2A AMI L1G product.

Prototype GeoNEX Level 2 products were developed, including atmospheric aerosol optical depth and surface reflectance/ bi-directional reflectance distribution function (BRDF) for Himawari 8/9 AHI and GOES16/17 ABI data sets (Fig. 3). The BRDF describes the fundamental optical property of a surface and therefore has been retrieved from both geostationary (GEO) and polar-orbiting (or Low-Earth Orbit, LEO) satellite observations. In theory, although GEO and LEO observations feature different illumination-view geometries, they reflect the same physical property and the retrieved BRDF should be mutually consistent. We investigated this by comparing Terra/Aqua MODIS and GOES-16/17 ABI surface BRDF retrieved with the MAIAC algorithm. The results indicated both agreements and discrepancies. In particular, the GEO BRDF seems to have a stronger volumetric scattering component in the tropical region. Further research is being conducted to identify the sources of the discrepancies between GEO and LEO BRDFs.

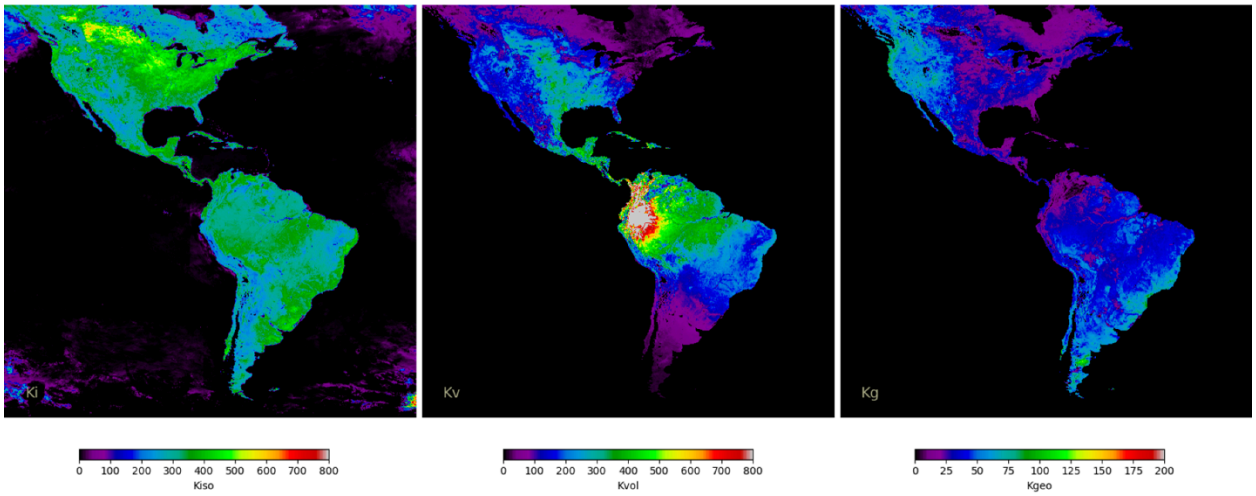
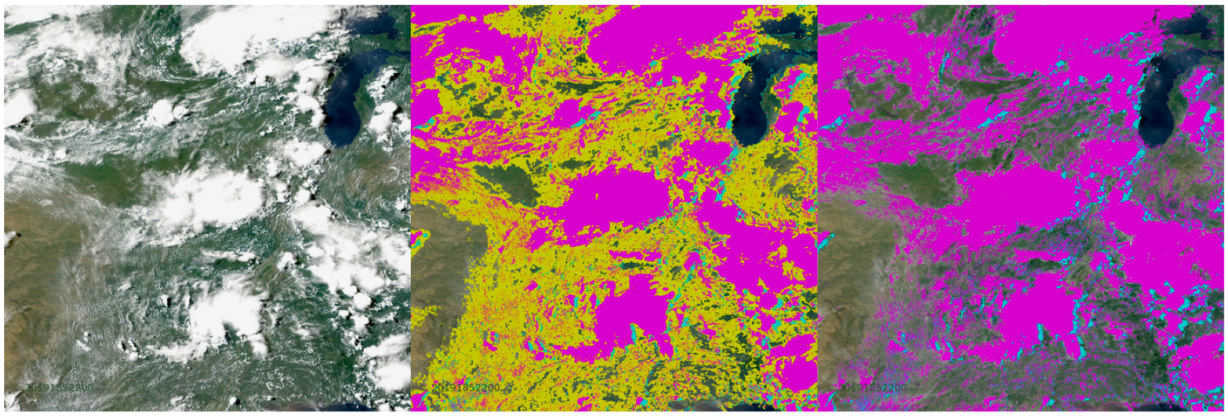


Figure 3: Example of GeoNEX L2G Surface BRDF components retrieved from GOES-16/ABI on 2019/07/15: (left) isotropic component, Kiso; (middle) volumetric component, Kvol; (right) geometric component. Values shown are scaled by 1000.

Analyses of the current MAIAC outputs indicate that the algorithm tends to overestimate cloudy pixels (i.e., false positives), which introduces more data gaps than expected in the L2G products, especially in the tropics. This motivated us to develop a new cloud detection algorithm that takes full advantage of the high temporal resolution of the GEO observations. The algorithm combines the roughness/smoothness index we developed for the GeoNEX time series processing with well-known computer vision and image processing techniques to classify TOA images into three categories: clear, cloud, and shadow pixels. We eliminate the traditional "partial cloud/partial clear" category in our algorithm so that the classification is firm and can be readily used by the MAIAC algorithm.



(a) Preprocessed TOA Image (b) 4-Category Cloud Mask (c) 3-Category Cloud Mask

Figure 4: Example of GeoNEX Cloud Mask retrieved from GOES-16/ABI on 2019/07/02, 22:00UTC. The yellow color in (b) indicates the "partial cloud/partial clear" category in traditional 4-category cloud mask algorithms. This category is eliminated in the new 3-category algorithm (c), which has only categories for clear, cloud, and shadow pixels.

The new cloud detection algorithm can be further extended to include a temporal compositing component (Fig. 5). For Geostationary data, compositing TOA data allows us to obtain the clearest diurnal cycle of the surface at regular (e.g., monthly) time steps. These data are very useful in calibrating the atmospheric correction algorithm. They can also be used as surface

prior information for cloud detection in the next time steps.

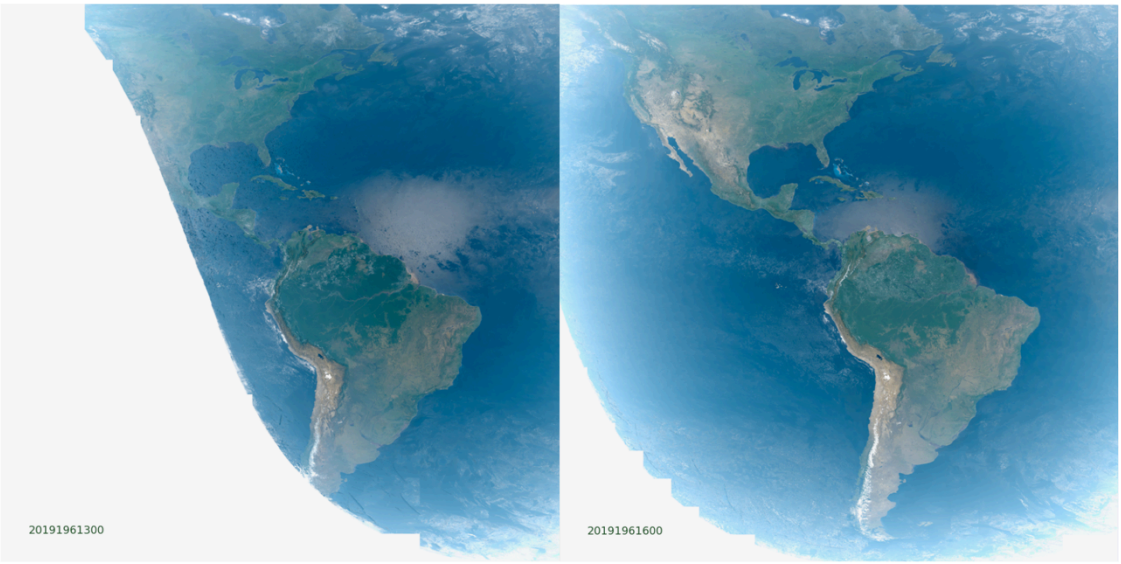


Figure 5: Composited Clear-Sky TOA images of GOES16 observations in July of 2019: (left) 13:00UTC; (right) 16:00UTC.

We have also explored the potential of incorporating modern deep neural network approaches to the problem of cloud masking. Over a few select tiles from GOES-16/17, we created 1000 training RGB images and corresponding labels to identify pixels that contain clouds, shadows, or neither of the two. We tested a custom U-Net deep learning model with this small dataset, with promising initial results such as a classification accuracy that exceeds 90%, but with some limitations. For example, the labels for training were originally derived from the 4-category cloud mask product, so these labels inherit the inaccuracies associated with this cloud mask. Furthermore, the U-Net architecture uses only the spatial context within an image and does not leverage the high temporal resolution of the GOES-16/17 satellites. Our future strategy involves addressing these limitations, such as exploring spatiotemporal deep learning architectures, fixing inaccuracies in the dataset labels such as snow being classified as clouds, and using more channels beyond RGB.

Several experimental level-3 data products were prototyped using a GEO-LEO approach. The team prototyped a land surface phenology (LSP) product, in collaboration with South Dakota State University. The LSP has been derived from Landsat-8 and Sentinel-2 time series (HLS), which provide detailed spatial patterns but have relatively poor temporal resolution. With the availability of data from Advanced Baseline Imager (ABI) onboard a new generation of geostationary satellites that observe the earth every 10–15 min, daily cloud-free time series are available. The LSP detections from HLS-ABI are compared with those from HLS or ABI alone and are further evaluated using PhenoCam observations. An emulated Land Surface Temperature (LST) was prototyped using convolutional neural networks. This novel approach was used to predict land surface temperature with improved spatial and temporal resolution compared to standard products. While multiple satellite types provide data to monitor surface temperature, geostationary (GEO) sensors provide near-continuous, continental-scale

observations which can better capture the diurnal variability of land surface temperature (LST) than intermittent observations from low-earth orbit (LEO) sensors. However, standard products from GEO satellites are available at coarsened spatial and temporal resolutions compared to the native sensor resolution. Using datasets from the NASA Earth Exchange, we leveraged co-located, co-temporal observations from LEO and GEO satellites to learn a data-driven mapping by means of a convolutional neural network.

We want to apply GEO observations in addressing global ecology challenges faced by the science community. With their 10-minute temporal resolutions, GEO satellites can have 50-100 times more opportunities than LEO satellites to get a clear view of the surface. Because the time series are so dense, we can accurately fill the data gaps by interpolation and other more advanced techniques. With the help of radiative transfer models, we can further estimate solar radiation and land surface temperature under cloud cover. As such, GEO observations help us generate gap-filled continuous data sets to model diurnal ecosystem fluxes of carbon, water, and energy (Fig. 6). We are actively working on this project.

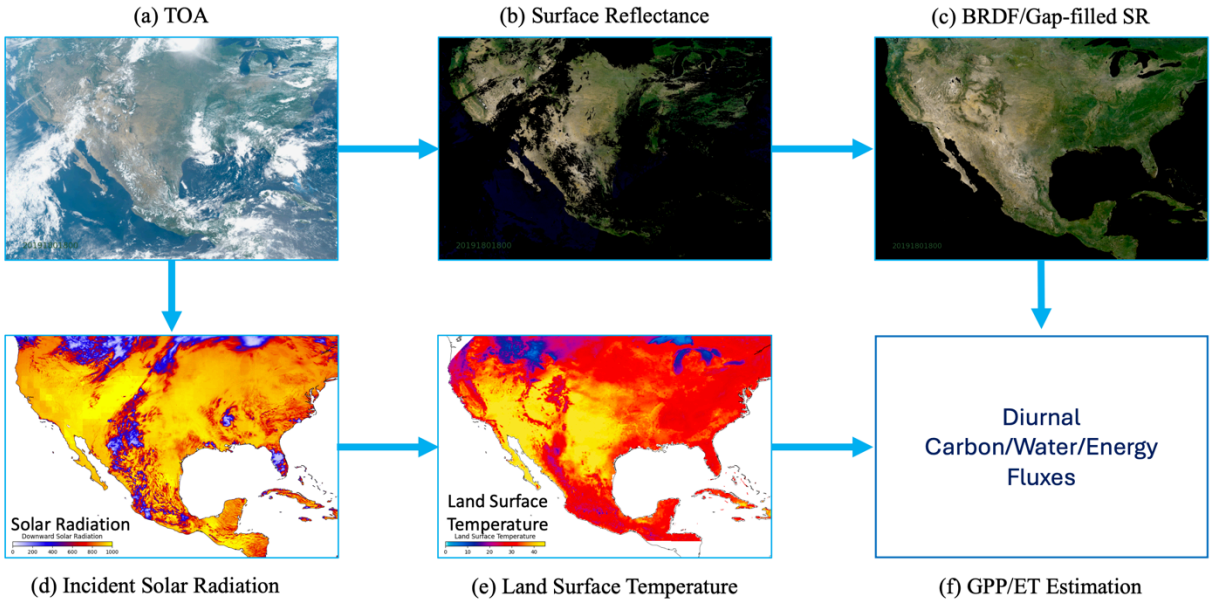


Figure 6: Processing Diagram that uses GEO observations to generate gap-filled, continuous data sets and model diurnal ecosystem processes.

We teamed up with the AmeriFlux data management team to build a visualization webpage within the AmeriFlux website (Fig. 7). This webpage provides a quick overview of a suite of GeoNEX products, including vegetation indices, land surface temperature (LST), downwelling solar radiation, and more. We expect this data dissemination will promote GeoNEX and open new scientific areas for the community to contribute. We provided the subset data as GeoNEX Coincident Ground Observations (GeCGO). To make it convenient for our users to access the GeCGO dataset, we also released the GeoNEXTools on the NASA Github website.

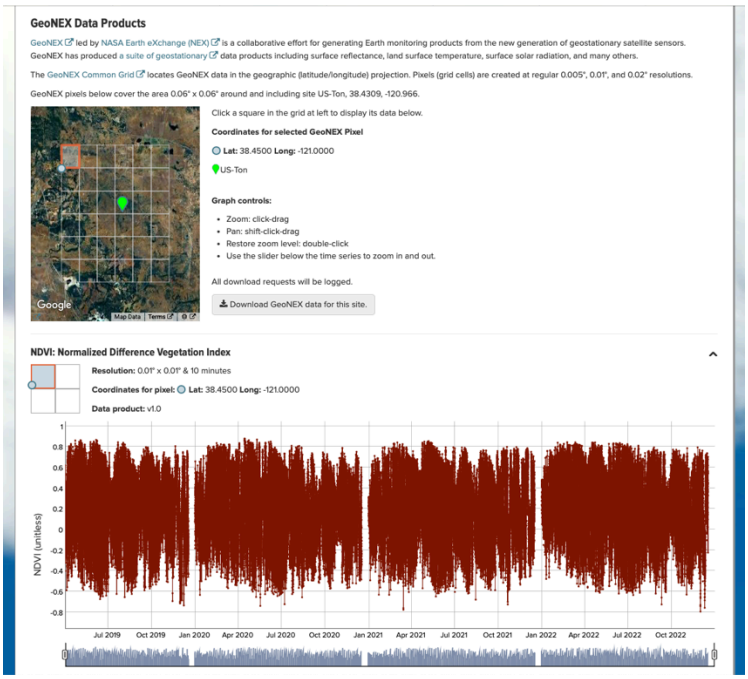


Figure 7: Example AmeriFlux website of GeoNEX data at Tonzi Ranch, CA. The AmeriFlux website directly provides our GeCGO data for each site.

When the Meteosat Third Generation (MTG) Flexible Combined Imager (FCI) data became available, we created the code for processing the FCI Level 1c data into GeoNEX grid like the other geostationary satellite data. By adding the FCI data, the GeoNEX dataset can cover the whole globe from 60°N to 60°S (e.g. Fig. 8).

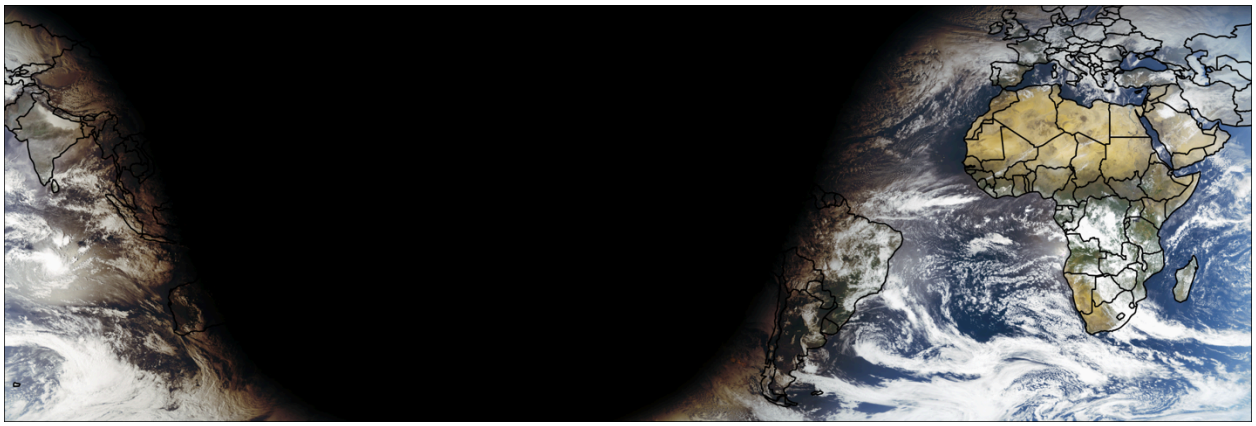


Figure 8: One shot of global geostationary satellite True Color Image at 2025-01-017 10:20GMT. The FCI covers Africa, Europe, and the Middle East. The image consists of GOES-16 ABI, GOES-17 ABI, GK2A AMI, and MTG FCI data.

Carbon Monitoring System (CMS) and Global Ecosystem Dynamics Investigation (GEDI)

As part of the CMS project, we implemented a machine learning-based framework to generate Landsat-based yearly percent tree cover maps for Mexico and evaluated uncertainty of the existing seven different tree cover products (Fig. 7). Based on this uncertainty evaluation process, an area of 288,749 km^2 is identified as very likely forested (identified as forested by 6 or 7 products), while an area of 340,661 km^2 is identified as potential forest (identified as forested by 3-5 products as forested). This represents a significant area of uncertainty, most of which fall within the tropical dry forest and subtropical mountain system – and represents up to 1.8 Gt aboveground biomass, around half of the total aboveground biomass estimated for Mexico. These findings quantify the uncertainty surrounding various forest cover estimates in Mexico and identify critical ecozones where additional ground data and research are needed.

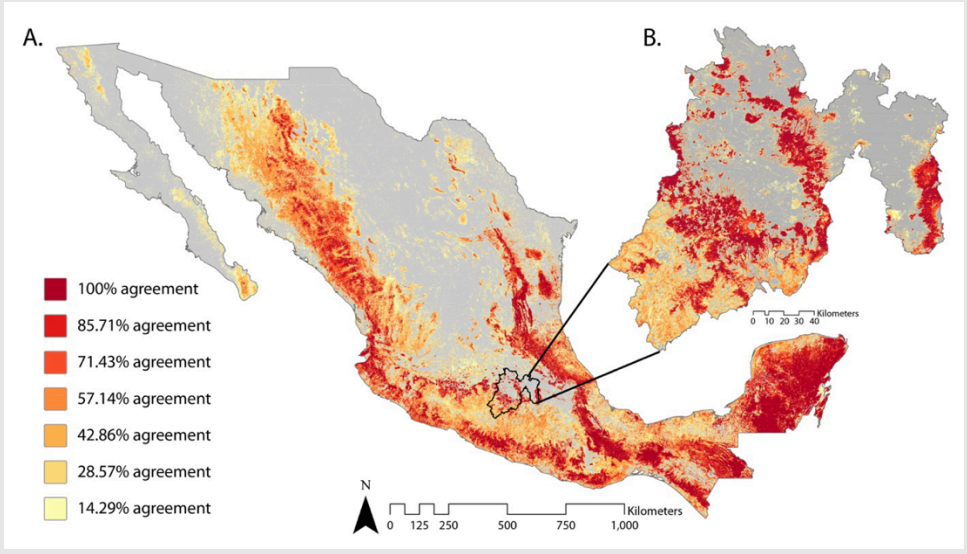


Figure 9: Hybrid uncertainty heat map showing the percent agreement across the 7 products. The percentage represents how many products identified each pixel as being forested. B. Closeup of the state of Mexico.

The NEX team has also built and tested a remote sensing-based aboveground biomass estimation framework using Landsat and Sentinel-1 and -2, GEDI, and Continuous Change Detection and Classification (CCDC) algorithm over Mexico. The CCDC algorithm uses all available satellite observations and fits piecewise harmonic regression models to identify the timing and location of statistically significant breaks. The algorithm can provide a spatiotemporal database of model breaks and harmonic regression coefficients for producing smoothed, interpolated synthetic reflectance data at each pixel. The CCDC-based synthetic reflectance data is extremely useful in reconstructing time series of surface reflectance when only a few and temporally inconsistent observations are available. GEDI is capable of providing high-resolution 3D canopy structural and aboveground biomass information of various forest ecosystems. By synergistically integrating Landsat, GEDI, CCDC, and a machine learning approach, the team

plans to create a long-term aboveground biomass product (1984-present) at 30 m spatial resolution and support local stakeholders in implementing REDD+ across Mexico.

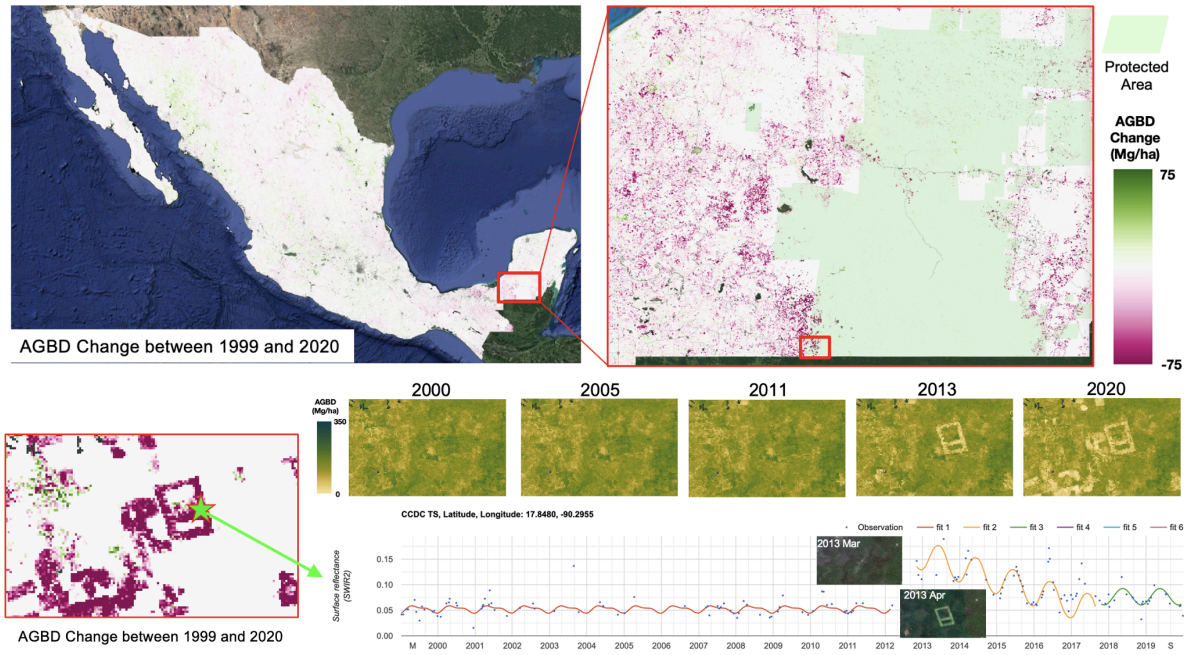


Figure 10: Spatial distribution of aboveground biomass density (Mg/ha) changes during the period between 1999 and 2020.

The NEX team has built a lidar processing workflow which can ingest airborne lidar point cloud data to produce important 3D data for topography, vegetation, and built structures (Fig. 9). This processing workflow that be used to produce state-wide lidar-derived 3D metrics.

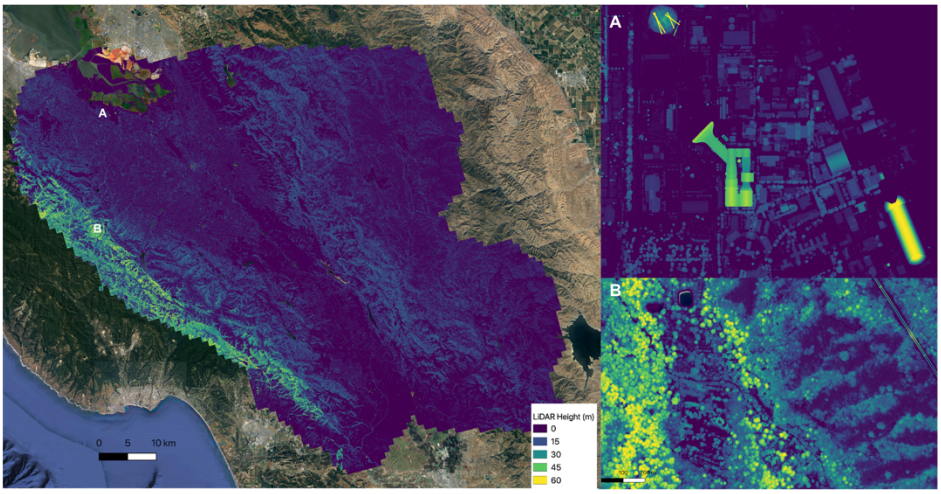


Figure 11: Example lidar canopy height model over the Santa Clara county (A: Ames Research Center, B: Redwood forest near Saratoga).

Surface Biology and Geology (SBG)

In 2018, NASA initiated a new study for the Surface Biology and Geology (SBG) Designated Observable, identified in the National Academies of Sciences, Engineering and Medicine (NASEM) 2017 Decadal Survey. SBG is entering Phase A in mission formulation and the NEX team is contributing tools for algorithm development and science data system engineering. The NEX team has developed the Ames Global Hyperspectral Synthetic Data (AGHSD) algorithm based on the spectral invariant theories and Monte-Carlo Ray-Tracing simulation results. The algorithm emphasizes that hyperspectral surface BRDF (RTLS) parameters can be accurately approximated by the weighted sum of the spectra of soil surface reflectance, leaf single albedo, and the canopy scattering coefficient. Figure 10 shows some examples of the AGHSD Surface BRDF dataset based on MODIS data and pre-selected spectral libraries over CONUS.

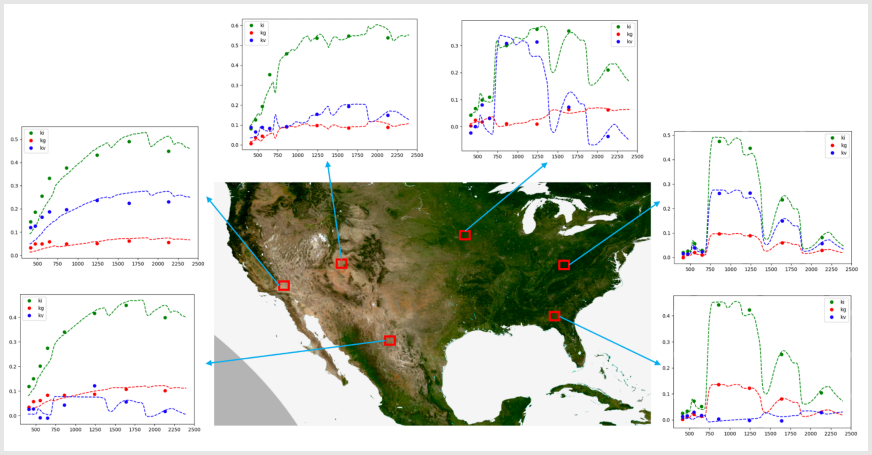
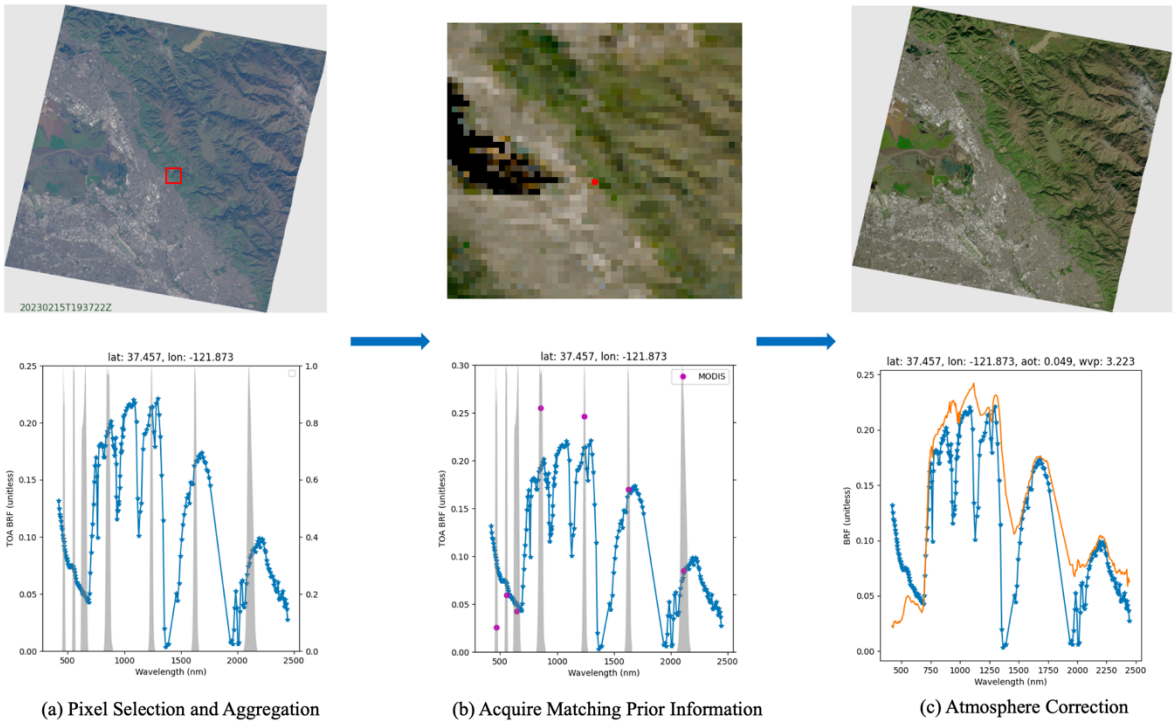


Figure 12: Comparison between the synthetic hyperspectral BRDF RTLS parameters (lines) with the corresponding MODIS data (dots) at the chosen sites over CONUS.

Using MODIS/AGHSD datasets as priors, we expanded our radiative transfer modeling capabilities developed for GeoNEX to perform atmospheric correction for hyperspectral sensors like PRISMA, EnMAP, EMIT, and future SBG (Figure 11). This algorithm is based on the assumptions that: (1) atmospheric aerosol optical depth varies at relatively large spatial scales (e.g., 50 km); (2) observations of moderate resolution satellite (like MODIS/VIIRS/GOES ABI) provide prior information to retrieve surface reflectance from the high resolution (e.g., 30 m) hyperspectral sensors. We applied the algorithm to process PRISMA/EnMAP data and submitted our results to the third atmospheric correction intercomparison experiment (ACIX-III). ACIX is an initiative to bring together the developers of Atmospheric Correction algorithms to generate Bottom-Of-Atmosphere (BOA) products from Top-Of-Atmosphere (TOA) optical satellite data. The exercise is a collaborative activity of ESA and NASA. ACIX-III particularly focuses on hyperspectral remote sensing. We used the above-described methodology to perform atmospheric correction on a set of PRISMA and EnMAP data cubes and submitted the results for comparison with other ACIX-III participants. We had a virtual (hybrid) workshop on March 25. A manuscript that compares the atmospheric correction results is in preparation.



(a) Pixel Selection and Aggregation (b) Acquire Matching Prior Information (c) Atmosphere Correction

Figure 13: Diagram of GeoNEX Atmospheric Correction Algorithm for Hyperspectral Sensors.

NEX-Fire/Air Quality (AQ), Weather Research and Forecasting model with online chemistry into the Data Assimilation Research Testbed (WRF-Chem/DART)

WRF-Chem/DART is a regional, ensemble, atmospheric composition (AC) forecast/assimilation/emissions inversion system based on integrating the Weather Research and Forecasting model (WRF) with online chemistry into the Data Assimilation Research Testbed (DART) with an expansion of DART to include chemical data assimilation and emissions estimation. WRF-Chem and DART are state-of-the-science computational tools. WRF-Chem is a chemical transport model that contains online atmospheric chemistry. It is used internationally, domestically, and by the U.S. government for air quality (AQ) forecasting research and operations. DART is an ensemble data assimilation system based on the 'ensemble adjustment Kalman filter' (EAKF) of Anderson (2001; 2003). It is used internationally and domestically for various data assimilation applications. It includes adaptive inflation, physical and state space localization, and a non-Gaussian formulation. Under this and other non-BAERI projects, we have extended DART within the context of WRF-Chem/DART to include, or applied WRF-Chem/DART as follows:

- Assimilated OMI O_3, NO_2, SO_2, HCHO; TROPOMI CO, O_3, NO_2, SO_2, HCHO, CH_4; TES CO, CO_2, O_3, NH_3, CH_4; CrIS CO, O_3, NH_3, CH_4, PAN; GOME2a NO_2, SCIAMACHY NO_2; MLS O_3, HNO_3, and TEMPO O_3, NO_2 total/partial column and/or profile retrievals.

- Streamlined and cleaned-up the WRF-Chem/DART code and scripts to make the user interface, maintenance, and interface to the DART repository more efficient.
- Enhanced WRF-Chem/DART's use of the 'state augmentation method' for constraining emissions to enable assimilation cycle-based (dynamic) emissions estimation, and demonstrated that dynamic emissions estimation improves forecast skill and predictability.
- Applied WRF-Chem/DART to joint assimilation of observations from multiple satellite and in situ platforms to constrain the forecast of all criteria pollutants and their associated emissions at medium (15 km) and high (4 km) spatial resolutions.
- Applied WRF-Chem/DART to an 'observing system assimilation experiment' (OSSE) for the COVID period (COVID OSSE) to find that the assimilation of geosynchronous (GEO) satellite observations (synthetic TEMPO NO_2 tropospheric column retrievals) can recover the COVID period NO_2 emissions over the continental U.S. (CONUS) more accurately and more quickly than the assimilation of low earth orbiting (LEO) satellite observations (synthetic TROPOMI NO_2 tropospheric column retrievals). This work is being done and sponsored in collaboration with NOAA and the University of Colorado at Boulder (CUB).
- Participating in the NASA Data Assimilation Working Group.
- Participating as a NASA representative to the U.S. Department of State Wildfire Study Group.
- Participating on the NASA FireSense Implementation Team.

Tropospheric Regional Atmospheric Composition and Emissions Reanalysis (TRACER-1)

Regional atmospheric composition (AC) and air quality (AQ) significantly impact tropospheric chemistry, climate change, and human health. Although in situ measurements of atmospheric composition offer valuable insights into long-term regional air quality trends, the observational content in these measurements is very limited in space and time for atmospheric gases and aerosols with short lifetimes.

In recent years, global reanalysis products of AC have demonstrated the potential of combining information content from satellites with models, using chemical data assimilation techniques. Some of these studies have also optimized emissions along with chemical concentrations to understand the impact of improved emissions on air quality. However, we do not have a regional reanalysis dataset for the Continental United States that includes chemical data assimilation (DA) of satellite and in situ AQ observations and dynamic emission updates. A regional reanalysis is crucial for identifying the sources of criteria pollutants and implementing effective regional air quality policy measures.

The TRACER-1 project aims to build a high-resolution 20-year regional AC reanalysis (2005-2024) for the continental United States (CONUS), focusing on the months April-September. For the forecast and assimilation system, we use the Weather Research and

Forecasting model with Chemistry (WRF-Chem) as integrated in the Data Assimilation Research Testbed (DART) as modified to include chemical data assimilation and emissions estimation (Chem-DART; collectively called WRF-Chem/Chem-DART). We interface WRF-Chem/Chem-DART with JPL's Multi-model Multi-constituent Chemical data assimilation (MOMO-Chem) dataset to supply chemical initial and boundary conditions. We have added various forward operators for satellite AC observations into Chem-DART to enable a seamless analysis of AC in TRACER-1. We use an ensemble Kalman filter technique that generates an optimized estimate of both chemical concentrations and emissions. We plan to leverage the TRACER-1 reanalysis dataset to understand the impact of a regional model with chemical DA in the analysis of tropospheric AC, discern air quality trends across the CONUS, investigate the influence of emission variations on regional air quality, and evaluate the effects of data assimilation on regional DA increments for correlated chemical species. The deliverables from TRACER-1 will be a 20-yr (2005-2024; April-September) dataset of the concentrations, emissions, and uncertainties for the criteria pollutants (excluding PM) and selected trace gases across the CONUS.

Internet of Animals (IOA)

The Internet of Animals project aims to combine animal telemetry data with Earth observations to better support applied ecological management, architect a next-generation space-based animal tracking system and develop technology that can link to biodiversity and habitats via remote sensing.

IOA group activities:

- The Internet of Animals group is continuing an assessment of the “community of practice” for animal telemetry within federal government agencies. We consulted 22 federal research scientists and program managers from eight U.S. federal agencies to determine their animal tracking priorities and completed a report describing our findings.
- Members are also participating in Remote Sensing for Animal Movement (RSAM), which is a gap analysis of remote sensing use in movement ecology. We initiated an effort to gather and analyze global animal tracking data to characterize overlaps and gaps between in situ meteorological observations and animal tracks for >2,000 species to demonstrate impact of incorporating biologging into existing in situ cal/val networks (analyses led by Ms. Stephanie Pass).
- We also led a NASA ARSET training “Introduction to the Integration of Animal Tracking and Remote Sensing” in May 2025. A total of 1,875 people registered for the training and 1,128 people attended the live webinars. These participants represented 550 unique organizations from 115 countries. The materials posted to YouTube had an additional 785 visitors during the first week after they were published.
- We demonstrated the value of space-based biologging data by quantifying use of marine protected areas and drivers of disease transmission in two peer-reviewed publications:

- Palmyra Bluewater Research: Results from this project were published in Global Change Biology in April 2025: https://doi.org/10.1111/gcb.70138 (Figure 12). This collaborative project with The Nature Conservancy, USGS, NOAA, UC Santa Barbara, San Jose State University, Stanford University, the University of Hawaii, and the University of Washington quantified the efficacy of a marine protected area (MPA) at Palmyra Atoll in the central Pacific Ocean. MPAs are a conservation tool that have been applied widely to conserve marine resources and protect marine flora and fauna. However, once established, large remote MPAs, such as those in pelagic bluewater regions, are difficult to monitor. To address this issue, we combined remote sensing and animal telemetry data from nine marine megafauna species, including seabirds, cetaceans, tuna, sharks, and manta rays, to quantify movements and habitat use within the context of the boundaries of the Palmyra Atoll unit of the Pacific Remote Islands Marine National Monument under current conditions and under climate change scenarios. Overall, the MPA overlapped with 39% of the area where species traveled and on average, 73% of the MPA contained highly suitable habitats. The sizes of suitable habitats both increased and decreased under two climate scenarios for all species.

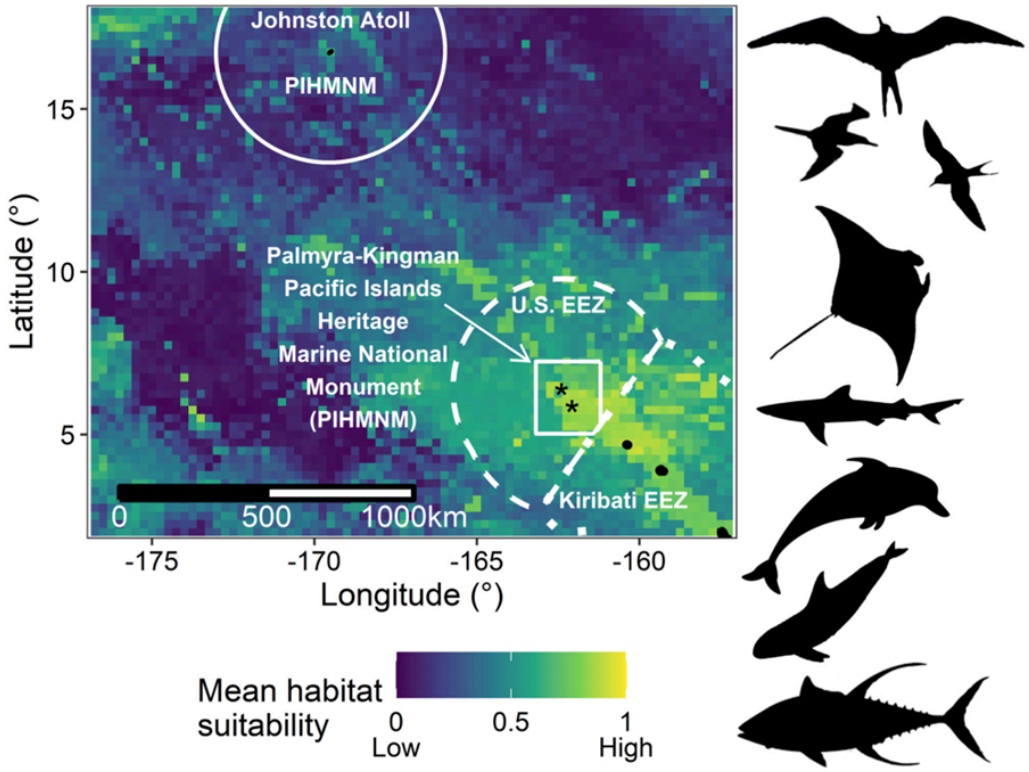


Figure 14: On average, habitat suitability was highest within the Palmyra Atoll MPA (white rectangle) and the oceanographic corridor connecting it to neighboring Line Islands in Kiribati in the central Pacific Ocean; the United States Exclusive Economic Zone (EEZ) is indicated by dashed lines. Habitat suitability was calculated for current environmental conditions (2022–2023) from nine marine species (pictured on right) in a species distribution model. Suitability is represented by a dark-light color scale, where dark colors indicate low suitability, and light colors indicate high suitability.

Additional IOA projects include:

- Remote sensing in disease ecology
    - This project combined systematic and traditional review methods to characterize uses of remote sensing data in disease ecology and identify opportunities for future advancements. Disease ecology could benefit from the use of remote sensing data because many diseases are linked to environmental conditions and can be spread across large spatial scales, which makes it difficult to collect field data. The review identified that remote sensing data is commonly used for species distribution modeling with disease applications, but that disease ecologists could benefit from more critically appraising remote sensing products and from using more modern, advanced approaches. This research was published in Proceedings of the Royal Society B in 2024 here: https://doi.org/10.1098/rspb.2024.1712 (Figure 13).

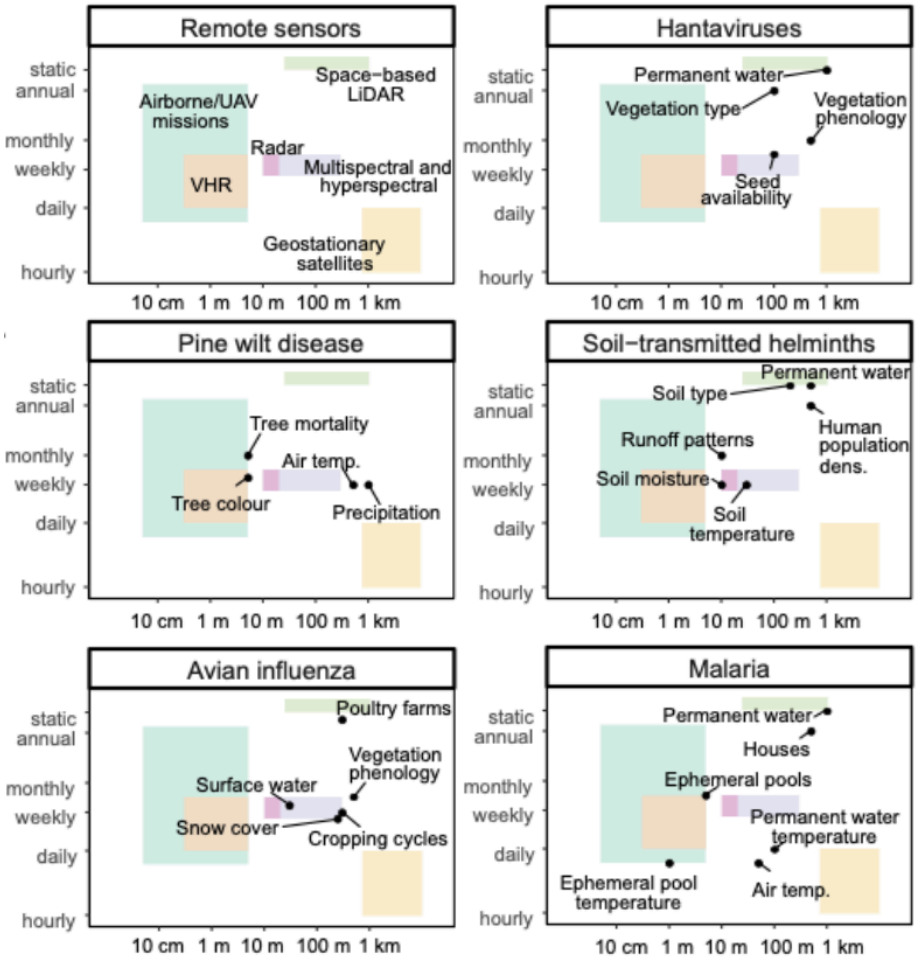


Figure 15: Matching environmental drivers of disease systems to existing remote sensing capabilities. The top-left panel shows the spatial (x-axis) and temporal (y-axis) resolutions available from remote sensing platforms. All other panels map environmental correlates of disease onto these resolutions to

identify which needs are already met by existing data, and which require data at higher spatial and/or temporal resolutions.

- Advanced biologging knowledge to understand new processes:
    - Assessment of planetary boundary layer height with seabird flight heights: Great frigatebirds are highly mobile and far-ranging tropical seabirds that use thermals and wind to soar and glide across the ocean. Using this low-cost flight strategy, frigatebirds can reach altitudes of 4,000 meters, a height that coincides with the planetary boundary layer. Working with other NASA scientists, we are exploring frigatebirds' vertical movements and flight behaviors in relation to boundary layer dynamics. We are revising a manuscript submitted to Science Advances (Figure 14). We presented this research at the annual AGU meeting in December 2024 and at the PBL Community Team Meeting in April 2025.

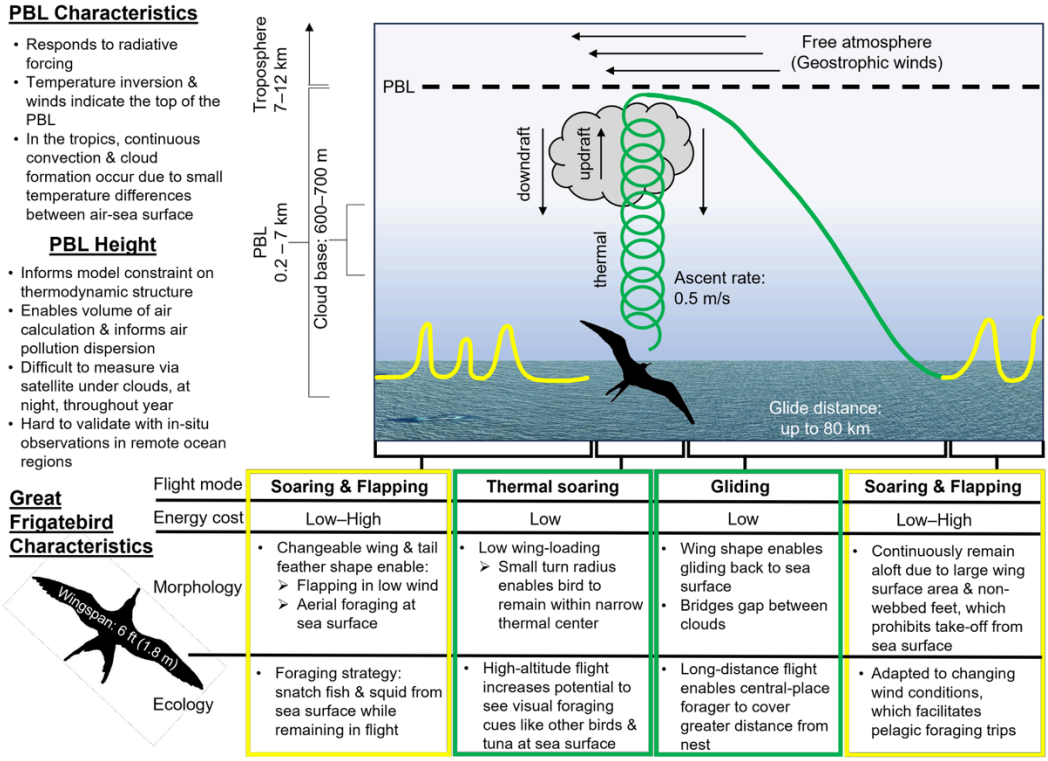


Figure 16: Schematic illustrating morphological and ecological characteristics of frigatebird flight strategy (colored lines) within the context of PBL processes over the ocean. Colored lines and boxes indicate relative energy expenditure between flight modes, where green represents low energy expenditure and yellow represents the energy gradient from low to high. Figure part of manuscript in revisions, submitted to Science Advances.

- Comparative analysis of waterfowl movement behavior:
    - This project compiles global data sets on telemetry of waterfowl to study relationships between waterfowl movement behavior and environmental conditions, including

landscape features, weather, and climate (Figure 15). Waterfowl are among the primary natural hosts of avian influenza viruses, so understanding the ecological drivers of their movement patterns can advance our understanding of how these zoonotic viruses spread in wild populations, and how these movements might shift under future climate and land-use change. Data are being analyzed from more than 4,000 individual tracked birds from 30 species, with data derived from 79 studies. Preliminary results show that habitat composition and human population density are two key determinants of waterfowl movement, more so than weather or vegetation variables.

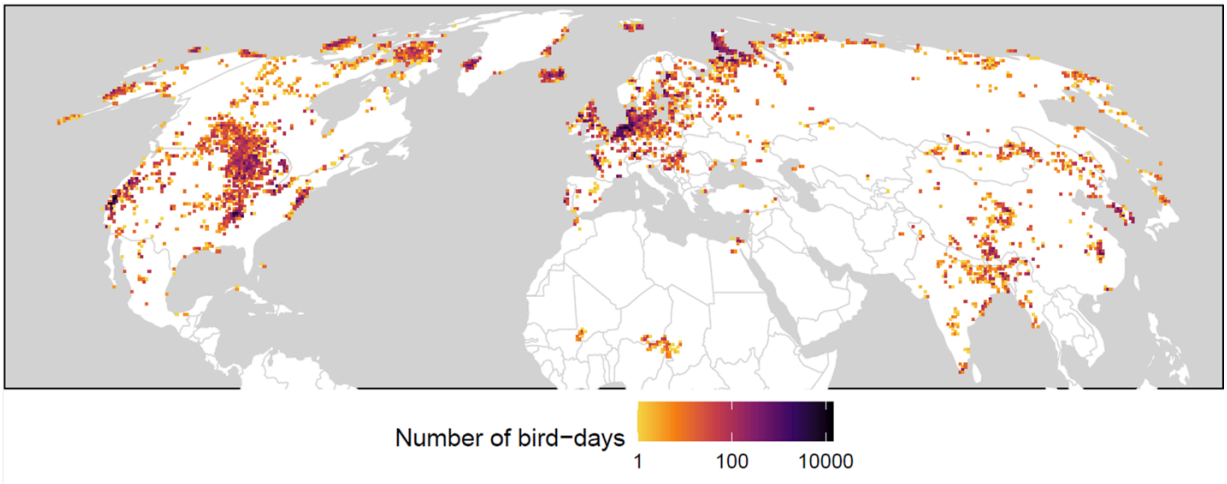


Figure 17: Locations from 79 studies of 30 species included in global waterfowl telemetry data sets. Data sets include GPS and Argos telemetry from diving ducks, dabbling ducks, geese, swans, and shelducks tracked between 2004 and 2023. Only winter and breeding season data are shown (i.e., migration is excluded).

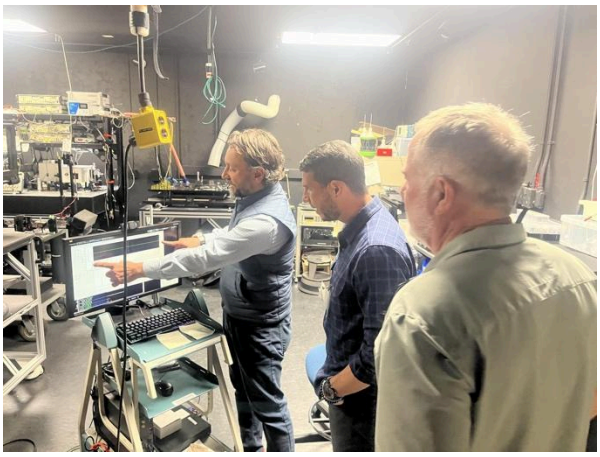
Biodiversity and Ecological Conservation

Between September and December 2024, NEX undertook a strategic effort to define its role in advancing biodiversity and ecological conservation. We engaged 32 experts from 16 entities, including government agencies, academic institutions, nonprofits, private sector companies and individual researchers, through a series of stakeholder interviews that helped shape our direction and surfaced opportunities for collaboration. In parallel, NEX contributed to the White House Office of Science and Technology Policy's National Nature Assessment (NNA) by mapping our existing products to the NNA, clarifying how our capabilities support national biodiversity research priorities.

As a result, the team advanced the following initiatives and products:

- NEX BioClim (CONUS): A forthcoming dataset derived from NEX's DCP30 product, featuring 19 bioclimatic variables for the contiguous United States. Technical documentation is underway, and the dataset will be made publicly available.
- Global BioClim Using Foundation Models: A new effort to downscale NEX's GDDP data to approximately 6 km global resolution using the Prithvi-WxC foundation model, enabling the generation of high-resolution global bioclimatic indicators.

- ARC-Sentinel Site Network Partnership: In partnership with the University of California Natural Reserve System, NEX is working to bridge field-based biodiversity monitoring and NASA datasets. This collaboration supports California's 30x30 conservation initiative and includes dedicated postdoctoral roles focused on data synthesis and integration.
- Edge Computing for Wildlife Monitoring: In collaboration with Microsoft, the Channel Islands, and the Sentinel Site Network, NEX is facilitating discussions around the use of edge computing devices for real-time, automated wildlife monitoring in remote environments. This effort aims to support the adoption and refinement of these technologies by convening partners and aligning them with NASA data products.



Steve Monfort (right), Executive Director from the UC Natural Reserve System, and Gary Bucciarelli (center), Director of Strategic Engagement, learn about the PICARD calibration process at the AMES Airborne Sensor Facility on May 20, 2025

Keiko Nomura (left) discusses the weather station at Quail Ridge Reserve with Collin Bode (right), Director of Environmental Monitoring & Data Science at the UC Natural Reserve System, on June 10, 2025.

NASA Disaster Response Coordination System (DRCS)

The NEX team has actively supported NASA DRCS activations in response to multiple emergency requests throughout 2025. In January 2025, the team responded to requests from the California Office of Emergency Services (CalOES) during devastating wildfires in southern California. In June 2025, NEX supported the Federal Emergency Management Agency (FEMA) in mapping the Trout and Seven Springs Fires and flash flood events in New Mexico. Most recently, the team assisted the Texas Department of Emergency Management and the Save the Children Organization with flood mapping support for the Texas floods that began in the early hours of July 4, 2025.

As a result, the following products were produced and used by DRCS and stakeholders:

- Wildfire Burn Severity across southern California: https://maps.disasters.nasa.gov/arcgis/home/item.html?id=ac41ac23863d4c76aeaf80387b1ea2bf

- Flood mapping in Roswell, New Mexico: https://maps.disasters.nasa.gov/arcgis/home/item.html?id=66dda7ec979a4778bae672dc0885f840

- Flood mapping in Kerr, Texas: https://maps.disasters.nasa.gov/arcgis/home/item.html?id=d95b9664f7a84eb885c85bf71144c364

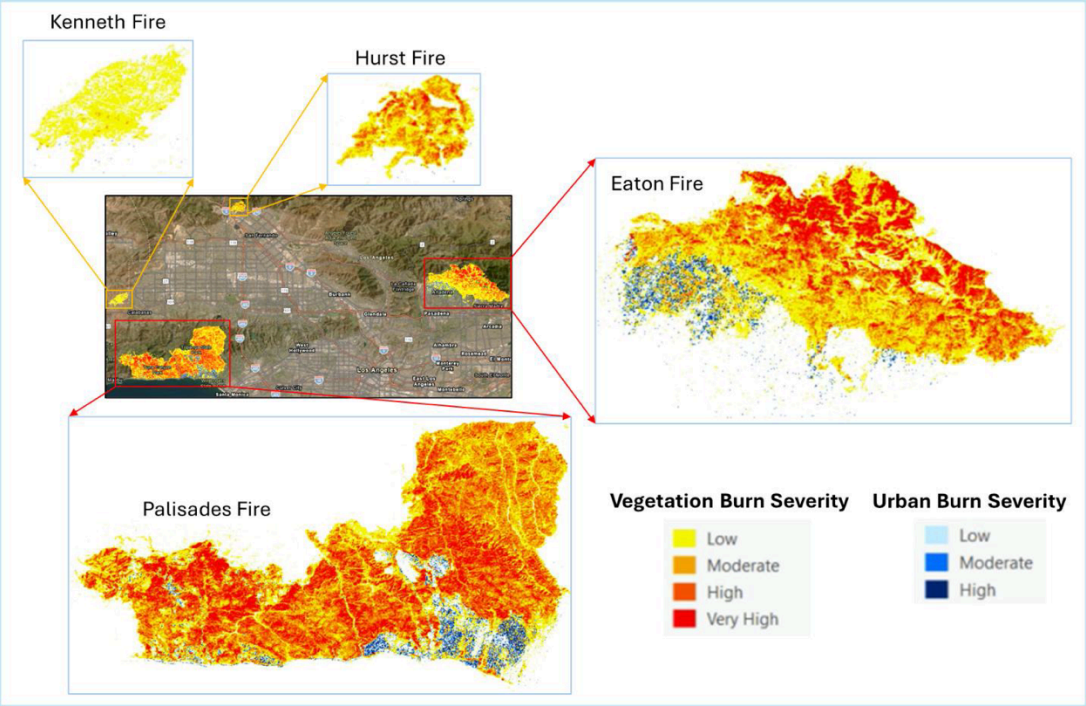


Figure 18: The detection of vegetation and urban-burned areas with the severity levels for Southern California fires (Palisades, Eaton, Kenneth, and Hurst fires) using combined Sentinel-1 and Sentinel-2 data.

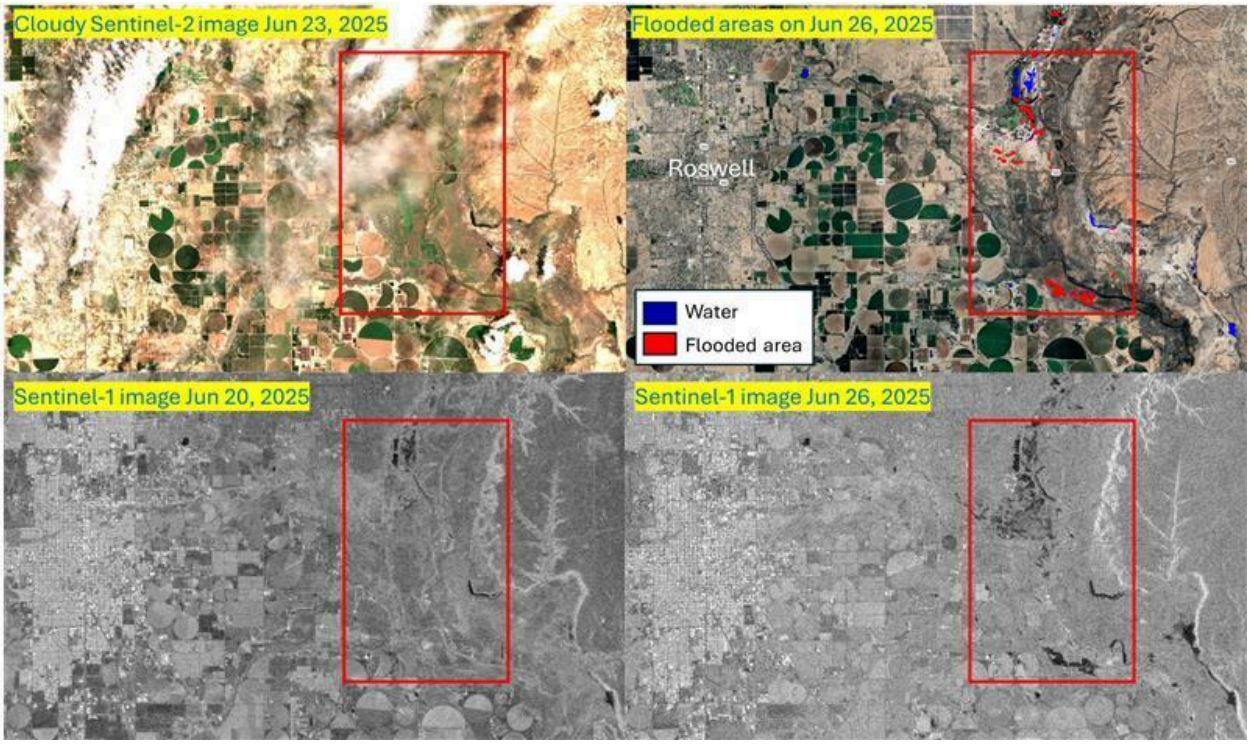


Figure 19: Flash flood detection in Roswell, New Mexico using Sentinel-1 Synthetic Aperture Radar data.

Proposals (Submitted / Selected)

- Eco-evolutionary modeling of tropical vegetation transitional dynamics with fire and climate changes in GISS ModelE (NNH24ZDA001N-MAP, selectable)
- Leveraging the Satellite Record to Build a Better Model (NNH24ZDA001N-MAP, selectable)
- AI-Driven Integration of GPM and CloudSat Data for Enhanced Atmospheric River Precipitation Modeling (NNH24ZDA001N-PMMCCST, selectable)
- Bidirectional Reflectance Distribution Function (BRDF) Theory, Modeling and Correction in the Era of Earth Observations Featuring Rich Spectral Information (NNH24ZDA001N-RST, submitted)
- Characterizing photosynthetic light use efficiency through radiative transfer theory and multi-source satellite data (NNH24ZDA001N-RST, submitted)
- Statistical Modeling of Sub-Pixel Structural Variability Using Optical and Lidar Data to Address Scaling Issues in Remote Sensing of Vegetation (NNH24ZDA001N-RST, submitted)
- Integrating machine learning and remote sensing for dynamic forest mapping: Stage-2 (New Zealand MBIE-NASA Catalyst, selected)

- Dimensional Reduction for TEMPO and ACX Profile Retrieval Production, Delivery, Storage, Assimilation, and Emissions Estimation (NNH24ZDA001N-TEMPOACX, submitted)
- Are Dryland Vegetations Where We Expect Them? An AI-Based Spatial Analysis of WorldView-3 Satellite Imagery (NNH24ZDA001N-CESRA, submitted)
- Ecosystem Processes at the Watershed Scale: Vegetation feedbacks modulate water, carbon and nutrient response to hydroclimate extremes (NNH24ZDA001N-ECOHYD, submitted)
- Quick response of dryland to rainfall and flush drought observed by GOES ABI and TEMPO (NNH24ZDA001N-CARBON, submitted)
- Advancing biologging technology in support of NASA's future atmospheric science satellite missions (NASA ECI FY2026, submitted)
- Near-real-time fire spread and smoke transport for domestic human-dominated fire landscapes and transboundary fire events (NASA Disaster Response, submitted)
- Actionable Risk Zone Maps for Extreme Air Quality Events: Dissemination via Python API and Google Earth Engine (NASA Disaster Response, submitted)

Partnerships (proposed / ongoing)

- Wildfire, Ecosystem Resilience, & Risk Assessment (WERK) - California Natural Resource Agency
- Urgent computing using a hybrid Cloud-HPC architecture for streaming satellite data analysis and event-driven modeling (BAERI; 80NSSC22M0158, 22-NUP2022-0046) – synergies with ARC-CREST NEXFire work.
- Integrating machine learning and remote sensing for dynamic forest mapping: Stage-1 (New Zealand MBIE & NASA Catalyst program).
- Morgan Gilmour (SGE) has accepted an invitation to be a member of the Editorial Advisory Board at the journal Regional Environmental Change.
- Dr. Arthur Mizzi was asked by the Tropospheric Emissions: Monitoring of Pollution (TEMPO) Mission to join the Ozone Validation Team. He will work with early release of TEMPO ozone profiles and attempt to evaluate whether these have the near-surface sensitivity they are assumed to have.
- Dr. Arthur P. Mizzi Collaborate with NOAA/CSL, Maintain and develop Chem-DART as necessary, and Assist with appling Chem-DART to greenhouse gas (GHG) and wildfire emissions estimation observing system simulation experiments (OSSEs).
- ARC-Sentinel Site Network Partnership – University of California Natural Reserve System

Data Assimilation and Chemical Modeling Initiatives

NEX participated in three key collaborative efforts focused on data assimilation: the NASA Data Assimilation Working Group, the NASA/NOAA collaboration, and Ames Research Center (ARC) support for the development and application of the Joint Effort for Data Assimilation Integration (JEDI). Through these partnerships, we pursued the following initiatives:

Technical Development Projects

- CMAQ/JEDI Installation**:** We installed and configured the Community Multi-Scale Air Quality (CMAQ) model coupled with JEDI (CMAQ/JEDI) on the NASA ARC Pleiades computing system. Mr. Andrew Michaelis led this work.
- CMAQ/Chem-DART Integration: We integrated CMAQ into Chem-DART, which is the NCAR Data Assimilation Research Testbed (DART) system modified to include chemical data assimilation and "top-down" emissions estimation. Dr. Arthur P. Mizzi led this ongoing project. The focus recently shifted from incorporating CMAQ into Chem-DART to modifying EPA's CMAQ-to-WRF-Chem/WRF-Chem-to-CMAQ output converters to make CMAQ output compatible with WRF-Chem output for input to Chem-DART.
- Chem-DART Forward Operators Expansion: We expanded Chem-DART to include forward operators for TROPOMI methane (CH4) and formaldehyde (HCHO), and CrIS carbon monoxide (CO), ozone (O3), CH4, and peroxyacyl nitrates (PAN). Dr. Arthur P. Mizzi led this ongoing project.
- Chem-DART Error Correlation Modifications: We modified Chem-DART so that the atmospheric constituent (AC) and emissions perturbation error correlation patterns are species independent. Dr. Arthur P. Mizzi led this project, which is now winding down.

Collaborative Research Support

We assisted researchers at multiple institutions with setting up, running, and applying WRF-Chem/Chem-DART systems. Dr. Arthur P. Mizzi provided technical support for all these projects:

- NOAA Greenhouse Gas Emissions Studies: NOAA/CSL and NOAA/GML are running observing system simulation experiments (OSSEs) with WRF-Chem/Chem-DART to recover greenhouse gas emissions. NOAA/CSL is conducting a CH4 emissions estimation OSSE, with Dr. Mizzi advising Dr. Islam Nazrul, a NOAA/CSL/CIRES junior scientist. NOAA/GML is conducting a CO2 emissions estimation OSSE, with Dr. Mizzi advising Dr. Michael Trudeau, a NOAA/GML research scientist.
- NOAA Wildfire Research: NOAA/CSL is conducting a wildfire OSSE to recover plume injection heights from assimilation of height-dependent aerosol optical depth (called aerosol

layer heights or ALHs). Dr. Mizzi is advising Dr. Congmeng Lyu, a NOAA/CSL/CIRES postdoctoral researcher.

- California Air Resources Board Partnership: CARB is conducting a CH4 emissions estimation OSSE over California. Dr. Mizzi is advising Dr. Yuyan Cui, a CARB research scientist.

- Mexico Research Collaboration: UNAM is applying WRF-Chem/Chem-DART over Mexico with higher resolution over the Mexico City megalopolis for internally funded projects and in preparation for NASA's Earth Venture Suborbital-3 field program called "Hemispheric Airborne Measurements of Air Quality" (HAMAQ). Dr. Mizzi is advising Prof. Victor Almanza Veloz, a UNAM/Institute for Atmospheric Chemistry and Climate Change junior faculty member, and his postdoctoral researcher Dr. Gilberto Maldonado.

Academic Collaborations:

- University of Colorado Boulder Partnership: We advised Mr. Chia-Hua Hsu at the University of Colorado at Boulder Paul Rady Department of Mechanical Engineering (CUB Mec-E) with his application of WRF-Chem/Chem-DART for the COVID OSSE as part of his doctoral research. This research was published as: Hsu, C.-H., et al., 2024. "An observing system simulation experiment analysis of how well geostationary satellite trace-gas observations constrain NOx emissions in the US." *Journal of Geophysical Research: Atmospheres* 129, e2023JD039323. https://doi.org/10.1029/2023JD039323.

- Doctoral Committee Service: We served on the Research Preliminary Exam and Comprehensive Exam committees for Mr. Chia-Hua Hsu and Mr. Worapop Thingsame, both doctoral students in CUB Mec-E.

Additional Professional Service Activities:

- EPA Methane Emissions Estimation Workshop: invited speaker and moderator
- NASA FireSense Implementation Team: invited member
- US State Department Facilities Smoke Impact Assessment: invited expert
- Joint Science Meeting for TEMPO, GeoXO ACX, and TOLNET, Air Quality Modeling: invited panelist
- International Research Station Workshop on Mathematical Approaches for Chemical Data Assimilation and Inverse Modeling, Chemical Data Assimilation: invited speaker
- NASA Chemical Data Assimilation Working Group: member

Publications

Hashimoto, H., Wang, W., Park, T., Khajehei, S., Ichii, K., Michaelis, A., Guzman, A., Nemani, R., Torn, M., Yi, K. and Brosnan, I., 2025. Subsets of geostationary satellite data over international observing network sites for studying the diurnal dynamics of energy, carbon, and water cycles. Earth System Science Data Discussions,

Barrio, I. C., Vuorinen, K. E., Barbero Palacios, L. B., Defourneaux, M., Petit Bon, M., Greer, E. A., ..,Park, T. ... & Kamenova, S. 2025. Emerging priorities in terrestrial herbivory research in the Arctic. Arctic Science, (ja). https://doi.org/10.1139/as-2024-0080

Park, T., Choi, Y. R., Ko, Y., Kim, N., Oh, D., & Moores, N. 2025. Airport plan imperils South Korea's tidal flat. Science, 387(6736), 834-835.

Doherty, C.T., & Mauter, M.S. 2024. Fisher Discriminant Analysis for Extracting Interpretable Phenological Information from Multivariate Time Series Data. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 18: 3371-3384. https://doi.org/10.1109/JSTARS.2024.3517415

Gao, S., Zhang, X., Zhang, H.K., Shen, Y., Roy, D.P., Wang, W. & Schaaf, C., 2024. A new constant scattering angle solar geometry definition for normalization of GOES-R ABI reflectance times series to support land surface phenology studies. Remote Sensing of Environment, 315, p.114407. https://doi.org/10.1016/j.rse.2024.114407

*Feldman, D., Ullrich, P., … Khajehei, S., ... et. al. (2024). Understanding Decision-Relevant Regional Climate Data Products. A Workshop Report. DOE/SC-2021. US Department of Energy, Office Of Science, Biological and Environmental Research Program Workshop Report October 2024, 68pp. https://doi.org/10.2172/2474992

*Jenkins, J.M., Tenenbaum, P.T., Wohler, B., Michaelis, A.R., & Brosnan, I.G. (2024). Ziggy, A Flexible, Robust, and Scalable Science Pipeline Infrastructure Package for Building Complex Science Pipelines. American Astronomical Society Meeting Abstracts 56(2): 134.05.

Teitelbaum, C.S., Ferraz, A., De La Cruz, S.E., Gilmour, M.E., Brosnan, I.G. 2024. The potential of remote sensing for improved infectious disease ecology research and practice. Proceedings of the Royal Society B. 291: 20241712. https://doi.org/10.1098/rspb.2024.1712

Thrasher, B., Khajehei, S., Kim, J.B., & Brosnan, I. 2024. NASA Earth Exchange Downscaled Climate Projections 30 Arcseconds CMIP6. Scientific Data 11: 1346. https://doi.org/10.1038/s41597-024-04188-x

Doherty, C.T., Wang, W., Hashimoto, H. and Brosnan, I.G., 2025. A Method for Quantifying Uncertainty in Spatially Interpolated Meteorological Data with Application to Daily Maximum Air Temperature. Geoscientific Model Development (in-press). https://doi.org/10.5194/egusphere-2024-1886

Duncanson, L., [...], Park., T, [...], & Goetz, S. J. (2025). Spatial resolution for forest carbon maps. Science 387(6732): 370-371. https://doi.org/10.1126/science.adt6811

Frost, G. V., [...], Park., T., [...], & Yang, D. (2025) The Changing Face of the Arctic: Four Decades of Greening and Implications for Tundra Ecosystems. Frontiers in Environmental Science 13: 1525574. https://doi.org/10.3389/fenvs.2025.1525574

Gilmour, M.E., Pollock, K., Adams, J., Block, B.A., Caselle, J.E., Filous, A., Friedlander, A.M., Game, E.T., Hazen, E.L., Hill, M., Holmes, N.D., Lafferty, K.D., Maxwell, S.M., McCauley, D.J., Schallert, R., Shaffer, S.A., Wolff, N.H., & Wegmann, A.S. (2025) Multi-species telemetry quantifies current and future efficacy of a remote marine protected area. Global Change Biology 31: e70138. https://doi.org/10.1111/gcb.70138

Lyapustin, A., Wang, Y., Korkin, S., Schaaf, C., Wang, W. & Wang, Z., 2025. Scaled RTLS BRDF model extended to high zenith angles. Frontiers in Remote Sensing, 6, 1533803. https://doi.org/10.3389/frsen.2025.1533803

Tian, J., X. Luo, W. Wang, L. Yu, D. Ng, et al. (2025). Seasonality of vegetation greenness in Southeast Asia unveiled by geostationary satellite observations. Remote Sensing of Environment 319: 114648. https://doi.org/10.1016/j.rse.2025.114648

Tran, K.H., Zhang, X., Zhang, H.K., Shen, Y., Ye, Y., Liu, Y., Gao, S. and An, S., 2025. A transformer-based model for detecting land surface phenology from the irregular harmonized Landsat and Sentinel-2 time series across the United States. Remote Sensing of Environment, 320, p.114656.

Gao, S., Zhang, X., Shen, Y., Tran, K.H., Ye, Y. and Liu, Y., 2025. Improvement of land surface phenology monitoring by fusing VIIRS observations with GOES-16/17 ABI time series. Remote Sensing of Environment, 326, p.114803.

Shen, Y., Zhang, X., Tran, K.H., Ye, Y., Gao, S., Liu, Y. and An, S., 2025. Near real-time corn and soybean mapping at field-scale by blending crop phenometrics with growth magnitude from multiple temporal and spatial satellite observations. Remote Sensing of Environment, 318, p.114605.

Vo, T.Q., Pham, L.H., Tran, K.H., Pham, P.H., Tri, V.P., Lee, S.O., Shin, H.J. and Kim, J., 2025. Refined Detection and Classification of Shallow and Deep Flooding in Agricultural Landscapes: Integrating Harmonic Regression with SAR Time Series. Earth Systems and Environment, pp.1-20.

Liu, Y., Zhang, X., Tran, K.H., Ye, Y., Shen, Y. and An, S., 2025. Heterogeneous land surface phenology challenges the comparison among PlanetScope, HLS, and VIIRS detections in semi-arid rangelands. Agricultural and Forest Meteorology, 366, p.110497.

Conference sessions (Chair/Co-Chair), Workshops/Training & Working Group Participation

** denotes non-technical*
(P) denotes a public-facing presentation
(!) denotes an invited presentation

(P) (!) Brosnan, I.G. (2024, July 30). NASA Earth Climate Modeling & Protection. [Presentation]. INNOVIT: Space Economy Acceleration Program. San Francisco, CA, USA.

(P) (!) Brosnan, I.G. (2024, October 28) NASA Assets Monitoring from the Sky and Ocean. [Presentation]. Terna Innovation Forum. San Francisco, CA, USA.

(P) (!) Brosnan, I.G. (2024, November 1). PublicNEX Computing & Simulation. [Presentation] CITRIS & Berkeley Space Center Innovation Intensive for Bay Area Start-ups. Mountain View, CA, USA.

Taejin Park and Weile Wang will co-chair a session, Earth Observations from Geostationary Satellites: Progress, Challenges, and Opportunities at the 2025 Asia Oceania Geosciences Society (AOGS) annual meeting in Singapore.

NEX team members will deliver a tutorial entitled Climate Downscaling with Statistical, Dynamical, and AI/ML Approaches at the Asia Oceania Geosciences Society Annual Meeting 2025, Singapore, July 27 – Aug. 1.

Awasthi, A., Kabasares, K.K., Nguyen, H.V., Brosnan, I.G., Park, T. (2024, December 9-13). Refined Urban Mapping: Integrating LIDAR Data and Aerial Imagery for Enhanced Semantic Segmentation of Trees and Buildings. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Brosnan, I.G., Berndth, E.B., Lee, K., Wang, W., & Lee, T.J. (2024, December 9–13). Climate Information and Lessons Learned from the NASA Earth eXchange (NEX), Short-term Prediction Research and Transition Center (NASA SPoRT), and the NASA Regional Climate Model Evaluation System (RCMES). [Poster session] AGU Annual Meeting, Washington, DC, United States.

Doherty, C.T., Brosnan, I.G., and Wang. W. (2024, December 9–13). Characterizing Spatiotemporal Uncertainty in Interpolated Meteorological Data. [Poster session] AGU Annual Meeting, Washington, DC, United States.

Gilmour, M.E., Adams, J., Castillo-Guerrero, J.A., Clark, B.L., Costantini, D., Cruz, S., Khajehei, S., Leat, E., Maxwell, S.M., Oppel, S., Pavlick, R., Rattenborg, N., Sebastiano, M., Shaffer, S.A., Vallarino, A., Weber, S., Wegmann, A.S., Weimerskirch, H., & Brosnan, I.G. (2024, December 9–13). Frigatebirds monitor planetary boundary layer dynamics across multiple ocean environments [Poster presentation] AGU Annual Meeting. Washington, DC, United States.

Hashimoto, H., Wang, W., Park, T., Brosnan, I.G. (2024, December 9–13). Toward community-driven terrestrial ecosystem science using international geostationary satellites and

ground-observation networks: a case intercomparison study of GeoNEX and NOAA products. [Conference presentation] AGU Annual Meeting, Washington, DC, United States.

Hsu, C.-H., D. Henze, A. P. Mizzi, B. McDonald, C. Harkins, C. Lyu, J. He, and R. Schwantes (2024, December 9–13): Intercomparison of top-down estimates of anthropogenic and soil NOx emissions using TEMPO and TROPOMI NO2 remote sensing observations in the US [Conference presentation] 2024 AGU Annual Meeting, Washington, D.C.

Kabasares, K.K., Park, T., Khajehei, S., Brosnan, I.G. (2024, December 9–13). Developing an Open-Source USGS 3DEP Data Processing Workflow for Actionable Products. [Conference presentation] AGU Annual Meeting, Washington, DC, United States.

Park, T., Hashimoto, H., Wang, W., Xiao, X., Vargas, R., & Brosnan, I. G. (2024, December 9–13). Seasonality and Diurnality in Carbon Fluxes Across Climate Gradients Inferred from Eddy Covariance Flux Tower Networks and Geostationary Satellite Observations. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Park, T., Vargas, R., Nemani, R.R., Brosnan, I.G. (2024, December 9–13). Continuous Nationwide Forest Aboveground Biomass Mapping in Mexico: Integrating GEDI and Landsat Time Series Data. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Pastor, E.D., Yin, Y., Park, T., Le, V.H., Vargas, R. (2024, December 9–13). Solar-Induced Chlorophyll Fluorescence as a Proxy to Monitor Water Availability in Mexican Ecoregions. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Purdy, A.J., Carrara, W., Doherty, C.T., Guzman, A., Johnson, L.F., and Melton, F.S. (2024, December 9–13). Evaluating time integration methods to produce daily evapotranspiration data. [Poster session] AGU Annual Meeting, Washington, DC, United States.

Raman, A., A. P. Mizzi, J. T. Benik, C.-H. Hsu, C. Harkins, K. Miyazaki, R. Kumar, M. Johnson, B. McDonald, K. Bowman, K. Knowland, and I. Brosnan (2025): Advancing regional air quality and atmospheric composition analysis: Introducing TRACER-I (Tropospheric Regional Atmospheric Composition and Emissions Reanalysis, AGU Annual Meeting, Washington, D.C., USA, December 9–13, 2024 (poster presentation).

Sarupria, M., Vargas, R., & Park, T. (2024, December 9–13). Annual High-Resolution Tree Cover Mapping for Mexico Using Landsat Time Series and G-LiHT LiDAR Data. AGU24.

Wang, W., C. Doherty, W. Ni-Meister, T. Park, Y. Knyazikhin, R.B. Myneni, and I.G. Brosnan. (2024, December 9–13). Spatial Scaling Issue in Land Surface Bidirectional Reflectance Distribution Function. [Conference Presentation] AGU Annual Meeting, Washington, DC, United States.

Wang, W., H. Hashimoto, T. Park, K.K. Kabasares, Y. Wang, I.G. Brosnan. (2024, December 9–13). Development of the GeoNEX Diurnal Cloud Mask Products. [Conference Presentation] AGU Annual Meeting, Washington, DC, United States.

You, H., Ji, F., Park, T., Radeloff, V., Hurtt, G.C., Jiang, M., Chen, M. (2024). Global Forest Edge Dynamics from 2000 to 2020. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Brosnan, I.G., Berndt, E. (2025, March 6). iESO Lessons from NEX & SPoRT. [Workshop presentation] Integrated Earth System Observatory Workshop, Washington, DC, USA.

Chhabra, A., including (Park, T) (2025, April 27 - May 2). Synergistic use of Optical and SAR observations for Enhancing Forest Structure and Biomass estimation. [Conference presentation] 2025 European Geophysical Union Annual Meeting. Vienna, Austria.

Chhabra, A., including (Park, T) (2025, August 3–8). OptiSAR Framework for Enhanced Forest Disturbance Monitoring: Application to Fire Severity Mapping in Australian Forests Using Multi-Sensor Satellite Data. [Conference presentation] 2025 IEEE International Geoscience and Remote Sensing Symposium. Brisbane, Australia.

Gilmour, M.E., Adams, J., Castillo-Guerrero, J.A., Clark, B.L., Costantini, D., Cruz, S., Khajehei, S., Leat, E., Maxwell, S.M., Oppel, S., Pavlick, R., Rattenborg, N., Sebastiano, M., Shaffer, S.A., Vallarino, A., Weber, S., Wegmann, A.S., Weimerskirch, H., & Brosnan, I.G. (2025, April 1–3). Frigatebirds monitor planetary boundary layer dynamics across multiple ocean environments. [Poster presentation] PBL Community Meeting, Silver Spring, MD, United States.

Gilmour, M.E. (2025, April 1–3). Frigatebirds provide a novel PBL-observing technology [Paper presentation] PBL Community Meeting, Silver Spring, MD, United States.

Gilmour, M.E., Adams, J., Albores-Barajas, Y., Castillo-Guerrero, J.A., Clark, B.L., Clarke, R., Costantini, D., Cruz, S., Leat, E., Maxwell, S.M., Mott, R., Oppel, S., Pavlick, R., Rattenborg, N., Sebastiano, M., Shaffer, Soldatini, C., S.A., Vallarino, A., Weber, S., Wegmann, A.S., Weimerskirch, H., & Brosnan, I.G. (2025, July 29–August 1). Frigatebirds monitor marine planetary boundary layer dynamics [Poster presentation] AOGS Annual Meeting, Singapore.

Hashimoto, H. including (Park, T) (2025, July 27–August 1). Detecting Vegetation Response to Rainfall and Droughts by Vegetation Productivity Indices from Abi and Tempo Over the US Drylands. [Conference presentation] 2025 Annual Asia Oceania Geosciences Society meeting. Singapore.

Laakso, L., including Park, T. (2025, April 27–May 2). Assessing the Impact of Climate Change on Forest Fire Weather Index Using Downscaled Climate Model Data. [Conference presentation] 2025 European Geophysical Union Annual Meeting. Vienna, Austria.

Park, T., Vargas, R., Nemani, R.R., Brosnan, I.G. (2025, July 27–August 1). Continuous Nationwide Forest Aboveground Biomass Mapping in Mexico: Integrating GEDI and Landsat

Time Series Data. [Conference presentation] 2025 Annual Asia Oceania Geosciences Society meeting. Singapore

Wang, W., H. Hashimoto, T. Park, I.G. Brosnan. (2025, planned). Intercomparison and Potential Synergy among TEMPO, PACE, and GOES ABI sensors. [Conference Presentation] SBG Technical Interchange Meeting, Washington, DC, United States.

Wang, W., H. Hashimoto, T. Park, I.G. Brosnan, H. Chen, and T. Lee. (2025, planned) Climate Downscaling with NASA's Prithvi WxC Foundation Model. AOGS Annual Meeting, Singapore, Singapore.

(!) Tran, K.H., (2025, May 7). Multi-Domain Applications of Remote Sensing: Ecology, Agriculture, Water & More. [Research Talk] Department of Agricultural Biology, Colorado State University [Virtual].

Tran, K.H., Zhang, X., Ye, Y., Shen, Y., Liu, Y., Gao, S. and Shuai, A., (2024, December 9–13). Evaluation of long-term continuity in global land surface phenology between MODIS and VIIRS sensors. [Conference Presentation] AGU Annual Meeting, Washington, DC, United States.

Tran, K.H., Zhang, X., Zhang, H., Shen, Y., Ye, Y., Liu, Y., Gao, S. and Shuai, A., (2024, December 9-–3). Development of a new transformer-based model for land surface phenology detection across the United States using the Harmonized Landsat and Sentinel-2 time series. In AGU Fall Meeting 2024 (Vol. 2024, No. 1732, pp. B53B-1732).

Quintero, D., Tran, K.H., Phalke, A., Dutta, R. and Jayasinghe, S., (2024, December 9–13). Estimating crop management input for a regional crop model using Earth Observation and Bayesian Optimization. [Poster Presentation] AGU Annual Meeting, Washington, DC, United States.

Liu, Y., Zhang, X., Tran, K.H., Ye, Y. and Shen, Y., 2024, December. Multi-Scale Land Surface Phenology in Semi-Arid Rangelands Observed from PlanetScope, HLS, and VIIRS. [Poster Presentation] AGU Annual Meeting, Washington, DC, United States.

Keiko Nomura attended the California 30x30 Partnership 2024 Summit between October 2–4 2024 in Sacramento, CA.

Keiko Nomura and Taejin Park attended the Biodiversity Monitoring Workshop between June 9–11 2025 in Davis, CA.

Media Coverage

- Dr. Taejin Park was interviewed by Jonathan Hahn, the managing editor of Sierra magazine, the national magazine of the Sierra Club. Mr. Hahn had read Dr. Park's recent paper describing global land climate at 2°C warming and was preparing a reported story considering the implications for the Sierra Club.

- Morgan Gilmour and Ian Brosnan were interviewed for an article in Audubon Magazine about how animals can record environmental observations. The article was published in March 2025: https://www.audubon.org/magazine/many-ways-scientists-are-turning-birds-feathered-field-assistants

- Morgan Gilmour was interviewed for an article in Meteorological Technology International about frigatebirds and PBL dynamics. The article was published in September 2024: https://met.mydigitalpublication.com/meteorological-technology-international-september-2024-issue/page-36.

- Morgan Gilmour and Claire Teitelbaum were interviewed for a BAERI 30th anniversary news story about the Internet of Animals, published here: https://baeri.org/mixing-movement-migration-and-modeling-the-internet-of-animals/.

- Morgan Gilmour and Claire Teitelbaum led the ARSET training “Introduction to the Integration of Animal Tracking and Remote Sensing” in May 2025. https://appliedsciences.nasa.gov/get-involved/training/english/arset-introduction-integration-animal-tracking-and-remote-sensing.

- The AGU presentation 'Mapping national forest aboveground biomass in Mexico by integrating GEDI and Landsat time series data' led by Taejin Park in the NEX team has been featured in Landsat Science news article: https://landsat.gsfc.nasa.gov/article/landsat-at-agu23/

- Taejin Park’s research and publications were quoted in a major newspaper in Germany (in German), the Stuttgarter Zeitung https://www.stuttgarter-zeitung.de/inhalt.alarmierende-studien-zum-klimawandel-wo-hitzewellen-und-starkregen-weltweit-haeufiger-werden.afa0d2c4-0876-433c-a87e-231f0958811f.html

- Kyle Kabasares was quoted, related to his PhD research on black holes prior to joining NASA Ames, in the following Nature News article, 'In awe': Scientists impressed by latest ChatGPT model o1”, on October 1, 2024: https://www.nature.com/articles/d41586-024-03169-9

Plankton, Aerosol, Cloud, ocean Ecosystem Postlaunch Airborne eXperiment (PACE-PAX)

Project Participants

BAERI: Samuel LeBlanc

Project Description

The Plankton, Aerosol, Cloud, ocean Ecosystem Postlaunch Airborne eXperiment (PACE-PAX) is a field campaign to gather data for the validation of the ocean and atmospheric products coming from the OCI (Ocean Color Instrument), SPEXone (polarimeter), and HARP2 (Hyper-Angular Rainbow Polarimeter #2) instruments onboard the PACE mission. PACE-PAX sampled the ocean, atmosphere, and ground surfaces during September 2024, roughly nine months after the launch of PACE. The operational area is Southern and Central California and nearby coastal regions. During this deployment we successfully conducted 13 flights at 81 flight hours for the NASA ER-2, 17 flights at 60 flight hours for the NPS (Naval Postgraduate School) CIRPAS Twin Otter, 15 day trips by the NOAA R\V Shearwater, and 9 day trips by the Research Vessel Blissfully.

This project supported the PACE-PAX field campaign by providing flight plans and sampling strategies for all platforms in coordination with PACE and EarthCARE observations. This project is a subset of the larger meteorological forecasting support project for PACE-PAX.

Beyond the support during deployment, this project also encompasses the manuscript writing efforts devoted to summarize and share lessons learned during the campaign.

Accomplishments

- Supported the flight planning during field deployment (ending in October 2024) and subsequent closeout work, e.g., gathering the documentation and summary of flight plans.
- Revised all individual flight reports for accuracy and prepared for inclusion in a technical memo manuscript.
- Revised the validation traceability matrix description, used in planning of the flight campaign, which is now subject of a publication.
- Presented flight paths summaries and lessons learned from PACE-PAX deployment and planning to match the validation and science goals.

Presentations

LeBlanc, S., Schmidt, S., Knobelspiesse, K., Taylor, P., Crosbie, E., Peterson, C., Nataraja, V., Cairns, B., Cetinic, I. and Becker, S., “Planning and flying research flights during the suborbital

airborne field campaigns ARCSIX and PACE-PAX." AGU Fall meeting 2024, Poster A53D-2107, ESS Open Archive eprints, 118, pp.essoar-173445461., 2024.

Knobelspiesse et al., "PACE-PAX Post-campaign data discovery and plans." PACE-PAX Science Team Meeting, NASA GISS, New York, February 2025.

Publications

Knobelspiesse, K.D., J. Alfter, B. Cairns, I. Cetinić, I., S. LeBlanc, S. Nicholas, and R. Ueyama. "Field campaign design and implementation with traceability matrix decision support." Submitted to Journal of Atmospheric and Oceanic Technology.

Knobelspiesse, K.D., PACE-PAX Science team, et al. "PACE-PAX Post Campaign Technical Memo." to be submitted to NASA Goddard technical memo registry.

Orbiting Carbon Observatory (OCO)-2 Profile

Project Participants

BAERI: Susan Kulawik
NASA/GSFC: Sourish Basu

Project Description

This project is in support of the ROSES 17-OCO2-17-0013 project "Reducing the impact of model transport error on flux estimates using CO2 profile information from OCO2 in concert with an online bias correction," Sourish Basu, PI.

Accomplishments

- Updated main analysis from proprietary Interactive Data Language (IDL) code to open-source python code (partially done by Saswati Das as part of her postdoctoral work on OCO-2).
- Started development and analysis of v11.2 OCO-2 lowermost tropospheric product for delivery to Zenodo archive.

Sea-going Sky-Scanning Sun-Tracking Advanced Robotic Research Radiometer (SeaSTAR/SeaSTAR-PACE)

Project Participants

BAERI: Stephen Broccardo, Steven Tammes

Project Description

The project aims to develop and deploy a ship-based robotic sun/sky photometer for the quantification and characterization of marine aerosol particles. We have integrated radiometer

technology that was developed for Ames's next-generation airborne sunphotometer (5STAR) with a robot platform that was developed using Ames Innovation Fair funds from 2018, and through the efforts of three student interns (Saketh Muvva in 2019 and Chaitu Nookala in 2020/2021).

We are developing an instrument to make direct-sun absorption measurements, as well as polarized sky-radiance measurements, to allow retrieval of aerosol particle optical properties. A third aim is to be able to make measurements of upwelling radiances from the sea surface. The robot incorporates an inertial measurement unit to enable for compensation of the movement of the vessel while making sky- and ocean-radiance measurements.

Accomplishments

- Deployed the prototype SeaSTAR instrument on five test cruises (two days in Sept 2024, and day-cruises in April, July and Aug 2025 on board NOAA's research vessel "Shearwater").
- Developed a desktop-sized robot (dubbed "HomeSTAR") to continue development of motion-control algorithms while maintaining the SeaSTAR instrument ready for deployments.
- Continued development of feed-forward motion compensation based on the output from an inertial measurement unit (IMU).
- Further developed sun-tracking based on a camera image of the sun. Since a pure feedback controller cannot be optimally tuned for all sea-states, angular velocities from the IMU are used to predict the motion of the field of view (FOV) across the sky. This hybrid approach uses simultaneous data from the IMU and camera to dramatically improve sun-tracking in a variety of conditions.
- Continued development and refinement of ancillary software for performance measurement and tuning.
- Further improved software performance for communication with the servomotors, allowing a speedup of approximately two times. Procurement of a higher frame-rate camera would allow the control system to be operated with a similar speedup.

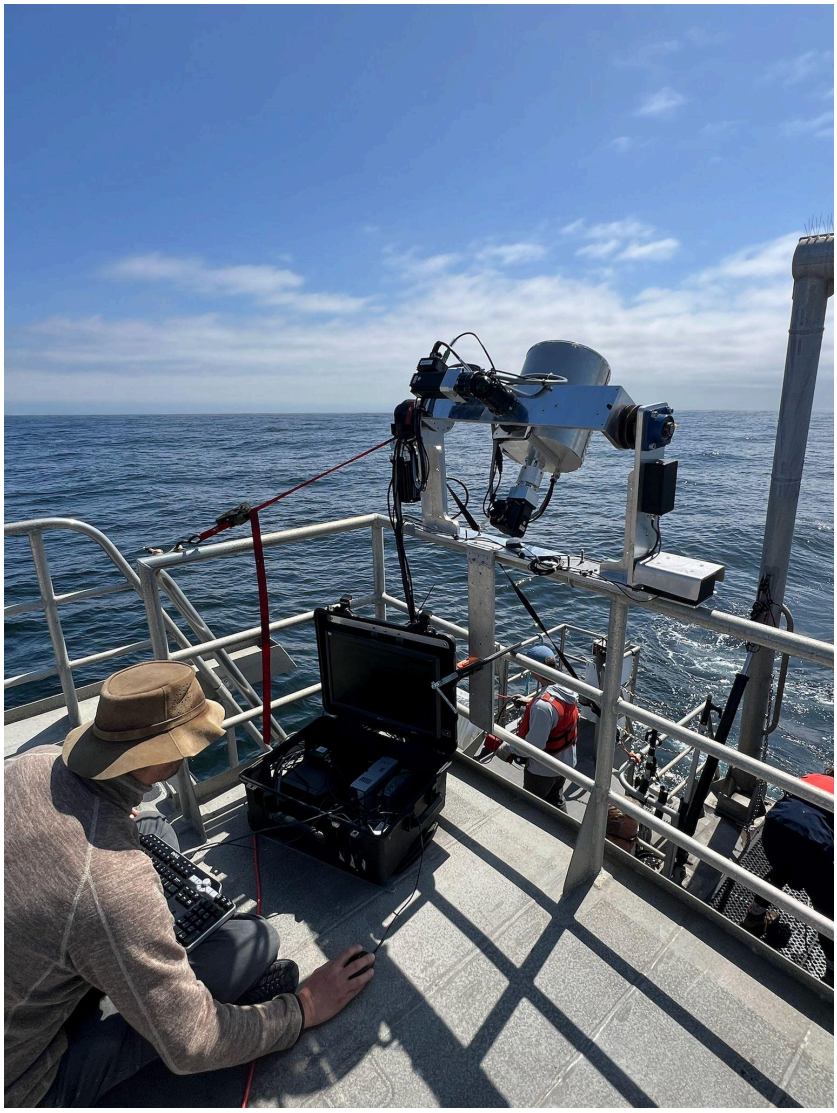


Figure: Steve Broccardo with SeaSTAR on board RV Shearwater during a day cruise on April 29, 2025.

San Joaquin Valley (SJV) O3

Project Participants

BAERI: Emma Yates

NASA: Laura Iraci, Kristen Okorn, Matthew Johnson

NASA Postdoctoral Program: Claudia Bernier

Collaborators

Central California Asthma Collaborative; Civil Air Patrol; Root Access Hackerspace, Fresno

Project Description

Started in January 2024, OWWL, Ozone Where We Live is a NASA Citizen Science Project evaluating air quality in and around California's San Joaquin Valley (https://www.nasa.gov/ozone-where-we-live/). This project is scheduled to be funded from Jan. 2025 through Jan. 2028. The project will incorporate data from volunteer pilots and from residents living in the San Joaquin Valley to both assess and validate NASA's TEMPO ozone data products as well as to evaluate air quality model performances within the region. Volunteer pilots will use a commercial ozone sensor designed to fly on UASs, ground-based volunteers will use a low-cost trace gas sensor built in-house (Kristen Okorn, INSTEP).

Accomplishments

- OWWL project was officially launched through the NASA citizen science program in June 2025:
  - Ozone Where We Live (OWWL)
  - Live or Fly a Plane in California? Help NASA Measure Ozone Pollution!
  - Citizen Science
- First OWWL data from volunteer pilots June 2025.
- INSTEP sensor build to commence Summer 2025.

Soil Moisture Active-Passive Carnegie-Ames-Stanford Approach (SMAP CASA)

Project Participants

BAERI: Stephanie Pass

NASA: Christopher Potter, PhD

The University of Montana: K. Arthur Endsley, PhD

Project Description

This project focuses on assimilating satellite data of daily soil freeze-thaw state into the terrestrial carbon model, CASA (Carnegie-Ames-Stanford-Approach), to understand the ecosystem health of vegetation and soil in post-fire environments in northern latitudes. The NASA-CASA model leads the way in global biogeochemical research and is the most used carbon model in history. These Soil Moisture Active-Passive Mission (SMAP) enhancements to CASA will improve our understanding of fire emissions and carbon activity by making advancements not only to the current model but also through these downstream products from CASA-GFED (a global fire emissions database), as well as potentially informing future model development for the SMAP Level 4 Carbon (L4C) product. Soil moisture and its freeze-thaw state are key to understanding Earth's water, energy, and carbon cycles. These improvements will help us better understand how fire affects vegetation, provide insights into fire trends, and aid with risk assessment. This project is directly aligned with NASA's objectives to understand Earth's ecosystem health and improve life on our planet.

Current models do not accurately analyze the freeze-thaw state of carbon ecosystem health in arctic/boreal burned areas. This project will provide an opportunity to reduce the uncertainty of global and regional carbon flux estimates and allow data-driven decision making to help with resource management.

Accomplishments

- Successfully ran the CASA model using an ease grid format.
- Implemented a SMAP freeze-thaw override into CASA to better simulate soil moisture conditions.
- Identified inaccuracies in SMAP data in some coastal regions; actively working on correction methods.

Presentations

"Assimilation of SMAP Global Freeze Thaw (FT) Products to Improve the CASA Ecosystem Model and Our Understanding of Northern Latitude Carbon Fluxes and Wildfire Impacts." 18th SMAP Science Team meeting, held April 22–24, 2025.

Total Carbon Column Observing Network (TCCON)

Project Participants

BAERI: Emma Yates

CalTech: Coleen Roehl, Jean-Francios Blavier

NASA Ames: Jim Podolske, Laura Iraci, Reem Hannun

Project Description

Total Carbon Column Observing Network (TCCON): maintenance, operation, and data analysis of the TCCON Armstrong site. This includes; maintaining Armstrong TCCON site through regular monitoring of instrument status (instrument reports are sent via email multiple times a day), site visits to perform operational checks and service to the TCCON instrumentation at Armstrong, coordination and collaboration with other TCCON network sites and colleagues. Updating TCCON IT to comply with updated IT security protocols at Armstrong.

Accomplishments

- Maintained TCCON functionality at Armstrong.
- Participated in TCCON working groups and meetings.

Wildfire, Ecosystem Resilience, and Risk Assessment Initiative (WERK)

Project Participants

BAERI: Taejin Park, Wen Yip, Khuong Tran, K.C Pratima., Kyle Kabasares

CSUMB: Hirofumi Hashimoto

NASA Ames: Scott Horner, Ian Brosnan, Bill Wohler

Project Description

The Wildfire, Ecosystem Resilience, and Risk Assessment Initiative (WERK) is a collaborative project between NASA and the State of California focused on creating ecosystem monitoring data products and assessments to support the state's urgent efforts to protect public safety and natural resources amid increasing wildfire risks and growing environmental variability. California faces significant challenges in tracking and planning for landscape changes caused by wildfire, environmental variability, land management actions, and other disturbances—all of which affect the state's ability to maintain vital ecosystem services. As these dynamic factors interact across regions, it is critical to monitor their impacts on the state's environmental program objectives, policy goals, and legislative targets. To meet interagency mandates and respond effectively to rapidly changing ecosystems, there is an urgent need for detailed, statewide mapping and analysis tools aligned with both state and Federal operational requirements. In response, the

California Natural Resources Agency (CNRA) and the California Air Resources Board (CARB) are partnering with NASA to develop advanced monitoring and assessment tools that leverage NASA's cutting-edge remote sensing technologies and high-performance computing capabilities. The WERK project will bring together existing algorithms and techniques to provide data products tailored to the environments of California and its specific use cases.

The WERK project consists of five key science data developments which are tightly interconnected:

- Change Detection & Attribution Product [WERK-1] (Section 3.1): Develop comprehensive, timely, updatable, and accurate accounting of statewide ecological disturbance and recovery, attributed by disturbance types. This product will deliver annual (or more frequent) maps of where wildfires, forest and fire management, restoration, and other disturbance (e.g., drought or insect induced mortality events) have occurred throughout California.
- Land Cover Classification & Mapping Product [WERK-2] (Section 3.2): Establish updatable, wall-to-wall, high-resolution land cover classification maps to improve understanding of vegetation in California.
- Individual Tree Monitoring Product [WERK-3] (Section 3.3): Establish updatable, wall-to-wall tree canopy delineation along with live and dead tree canopy maps using high resolution imagery. This product will help improve our understanding of the impact of disturbances such as drought and fire in forest ecosystems of California.
- Built Structure Mapping Product [WERK-4] (Section 3.4): Create wall-to-wall, updatable polygon representations of structures (e.g., habitable dwellings, accessory structures, and industrial/commercial buildings) to enable buildings to be accounted for in state-level decision making, including during the estimation of structure fire emissions and various land use applications.
- WERK-Wide Analysis & Assessment Products [WERK-5] (Section 3.5): These analyses will incorporate the products listed above, and ancillary data, to generate new insights and data products. These include quantifying the number of trees lost through disturbance, quantifying ecosystem carbon, and assessing the number of properties out of compliance with defensible regulations, among others.

Accomplishments

- The project commenced on March 17, 2025, and a core team of 3 management team members and 5 science team members has worked collaboratively to begin executing the project plan. The team is actively recruiting research and data scientists who will lead the development of science products for the WERK-4 and WERK-5 tasks.
- The first deliverable listed in Contract No. 0CA23008, Exhibit A, Article 4 "WERK-1, 2, 3, and 4 Overall data processing outlines" was delivered on May 8, 2025. A draft version of the Science Plan (v0.1) was prepared and shared with CNRA and CARB. This document outlines the updated methodologies for the development of WERK science products and

serves as a foundation for aligning scientific goals with partner needs. The team anticipates updating the Science Plan as necessary in cooperation with the State.

- A kick-off meeting was held in Sacramento on Tuesday, May 13, 2025 (Figure 1). The purpose of the meeting was to present a co-developed plan for creating cutting-edge data products and assessments, initiate collaboration, discuss priorities, and gather feedback from state partners.

Figure 1: Group photo of the CNRA, CARB, and WERK teams during the kick-off meeting (May 13, 2025 @ CNRA).

- A Memorandum of Understanding was established with NASA Advanced Supercomputing Division (NAS) to secure computing and storage resources necessary for the WERK science data product development, processing, and analysis.
- An in-person quarterly meeting is scheduled for Sacramento in mid-September.
- A draft risk and opportunity table was created, and a risk and opportunity board meeting will be scheduled for next quarter.
- Initial meetings were held to lay the groundwork with the software release authority and legal to publicly release the WERK software.
- A draft Project Plan has been circulated for internal comment.

Presentations

Park, T. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Co-developing California's Land Monitoring and Assessment System. WERK Kick-off meeting at CNRA, May 13, 2025.

Hashimoto, H. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Change Detection and Attribution Product. WERK Kick-off meeting at CNRA, May 13, 2025.

Tran, K. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Land Cover Classification & Mapping Product. WERK Kick-off meeting at CNRA, May 13, 2025.

Pratima, K.C. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Individual Tree Monitoring Product. WERK Kick-off meeting at CNRA, May 13, 2025.

Park, T. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Built Structure Mapping Product. WERK Kick-off meeting at CNRA, May 13, 2025.

Park, T. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): WERK-Wide Analysis & Assessment Products. WERK Kick-off meeting at CNRA, May 13, 2025.

Park, T. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Co-developing California's Land Monitoring and Assessment System. Ames Executive Council, June 2, 2025.

Panels or Committees

- Taejin Park serves on CALFIRE's California Statewide Fire Severity Technical Advisory Committee.

APPLIED SCIENCES

Agriculture, Health, and Marine Applied Sciences

Project Participants

CSUMB: Adam J. Purdy PhD, Lee Johnson, Alberto Guzman, Will Carrara, Conor Doherty PhD, Jon Detka PhD, Michael Biedebach, Michael Hang, Ryan Solymar, Kristen Burroughs, Pam Hansen

NASA Ames: Forrest Melton, Ian Brosnan, Jessica McCarty, Jacquelyn Shuman

CSUMB student team members: Trent Taylor, Jon Logie, Jason Pham, Robin Fishman, Brandon San Luis, Joe Spota, Zachary Theodore, Darren Baty, Brandon Alexander

Project Description

CSUMB personnel have a history of participation and support of NASA research and applied science missions to apply satellite data to improve our understanding of environmental conditions and processes that affect agriculture, public health and vector-borne disease, and coral reefs and other marine ecosystems. Under this task, CSUMB conducts research and applied science activities in these areas, in collaboration with the NASA Ames Earth Science Division and numerous collaborators in other government agencies, nonprofits and NGOs, and the commercial sector. This task applies remote sensing data; agricultural models; ecological and weather models; and epidemiologic, vector, and pathogen models to advance the ability of US and international institutions to understand and manage these processes. The activities under this task include analysis of satellite data, management of airborne and field campaigns to collect data, development of numerical and statistical models, and development/evaluation of decision support systems.

The primary objectives of this task are to:

1. Apply satellite data, airborne data, flux towers, and other ground-based instrumentation to model and map agricultural productivity, evapotranspiration, and crop water demand.
2. Apply satellite data, climate models, and ecological models to map habitat for disease vectors and model vector-borne disease transmission risk.
3. Apply satellite multispectral and airborne hyperspectral data, coupled with field measurements of biological data, to contribute to research on ecosystem health, ecological structure, and benthic habitat biodiversity of coral reefs and associated biotypes.

No funds were available to research objectives 2 and 3 in the last year, so there are no updates on those objectives in this year's report.

Accomplishments

- Published eight peer-reviewed journal articles.
- Presented more than 15 scientific and technical talks/posters at science conferences and technical/stakeholder meetings.
- A. Purdy led four technical OpenET historical data review reports in collaboration with OpenET science leads (including L. Johnson). The reports appear as part of the OpenET technical series.
- A. Purdy, W. Carrara, and A. Guzman provided training to support the adoption and use of OpenET data to a number of state and federal agencies, including California Department of Water Resources, the Colorado River Authority of Utah among others.
- OpenET launched the Farm and Ranch Management Support system (FARMS) in March (NASA press release), following several months of beta testing. W. Carrara led backend development on FARMS. FARMS is intended to accelerate and support OpenET data adoption and use by water managers in the western US.
- The CSUMB ARC-CREST team (W. Carrara & A. Guzman) continue to advance the API to support OpenET data adoption and integration into third party software. The API currently supports more than 10,000 users. Since 2023, the API has supported more than 350,000 queries of OpenET data for more than 250,000 unique locations.
- Mentored five CSUMB students (Trent Taylor, Jon Logie, Zach Theodore, Daren Baty and Joe Spota). Trent Taylor contributed to research exploring the impact of reference surface quality on surface meteorology observations. Jon Logie and Zach Theodore support fuel moisture data collection and analysis. Joe Spota and Zach Theodore support eddy covariance tower deployment and data analysis. Daren Baty supports UAV data collection and analysis. Additional research internships will be offered in 2024–25.
- Secured an additional ~$1 million in FY25 from competitively awarded grants to support research activities, science advances, and applications related to the OpenET project. The OpenET project is advancing the availability of field scale information on ET via open web data services and APIs. A. Purdy supports F. Melton in the coordination of >35 leading experts on remote sensing of ET. F. Melton serves as the NASA Project Scientist for OpenET and technical lead for a team. Purdy and co-Investigators A. Guzman, W. Carrara, L. Johnson, and C. Doherty have led the implementation and improvement of the NASA Satellite Irrigation Management Support (SIMS) ET model on the Earth Engine platform, development and implementation of a sub-model for deriving effective precipitation and corresponding ET of applied water and production of field-scale ET. W. Carrara and A. Guzman continue to lead development of the OpenET API to support ongoing data production and have made multiple key contributions to the development of the OpenET platform.

    - Purdy (PI) and Johnson (Co-I) led a two-year $440K proposal to USGS Cooperative Ecosystem Studies Units (CESU) grant for OpenET: Cooperative Agreement for CESU-affiliated Partner with Californian Cooperative Ecosystem Studies Unit. (Awarded 1/2025 ~$315K to CSUMB).
    - Johnson (Campus PI) and Purdy (Co-I) are co-investigators on a five-year $10M project funded by the USDA Sustainable Agriculture Systems led by Dr. Susan Metzger at Kansas State University to support agricultural systems in the Southern Great Plains in adapting to climate change and enhancing resilience. (Awarded 2/25, ~$660K to CSUMB + $300K to OpenET Inc. via subaward).
    - Johnson (PI) and Purdy (Co-PI) submitted a 2.75 yr, ~$500K proposal to the 2025 California Department of Food and Agriculture (CDFA) Specialty Crop Block Grant Program (In review).
    - Purdy (Campus PI) and Johnson (Co-I) were co-investigators on a five year $10M proposal to the Schmidt Sciences Virtual Institute for Earth's Water. (not-selected)

- With support from NASA's Water Resources Applied Science Program, Johnson has been working with UC Cooperative Extension to integrate OpenET data into CropManage irrigation scheduling tool. This allows data from OpenET to extend CropManage to growers across the western US for operational support of irrigation and fertilizer management decisions.

- Continued to deploy eddy covariance flux towers in collaboration with Central Coast growers to measure ET from select fields and enhance understanding of water requirements in high-value Salinas Valley crops and provide a basis for further evaluation of output from OpenET and the CropManage decision support system operated by UC Cooperative Extension. M. Biedebach led the deployment and operation of eddy covariance instrumentation in commercial vegetable fields in the past year. Under the guidance of A. Purdy, Biedebach is applying quality control, surface energy balance corrections, and generating flux footprints with support from R. Fishman and A Purdy. The data from these flux towers are currently being used to evaluate ET values from OpenET and CropManage.

- Additionally, for a second winter season, the field team continued to collect valuable ET observations using an eddy covariance flux tower and an in-ground lysimeter at the UC WestSide Research and Extension Center (WSREC). The data are being used to develop an ET dataset for bare ground conditions and quantify soil water carryover from winter precipitation.

- In partnership with USDA Agricultural Research Service (ARS) in Salinas, California, the project team continued to use an Unmanned Aerial Vehicle (UAV) platform and Micasense Altum camera to collect imagery over agricultural fields in the Salinas Valley. The project team of Purdy (Campus-PI) and Detka (post-doctoral scholar) with support from the USDA are working to evaluate whether drone-based multispectral imagery, when paired with

spatial and temporal modeling of plant-level canopy metrics, can be used to detect and predict early-stage canopy decline. In the next year J. Detka will be working to develop an automated data processing workflow to transform UAV images into plant locations, assess vegetation health, and deliver actionable information to pest control advisors and growers.

- C. Doherty, A. Guzman, with support from R. Fishman and guidance from A. Purdy, F. Melton, and L. Johnson are developing an automated approach to computation of effective precipitation (rainwater stored in the rootzone and is available to support crop growth). The procedure can be fully automated within the OpenET framework or run as a standalone model in conjunction with other sources of gridded actual evapotranspiration (ETa) data. The procedure can ultimately be used to derive ET attributable to applied irrigation water. The work was presented for comment at a meeting of the Western States Water Council in April.

Publications

Cahn, M., L. Johnson, S. Benzen, 2025. “Evapotranspiration-Based Irrigation Management Effects on Yield and Water Productivity of Summer Cauliflower on the California Central Coast.” *Horticulturae* 11, 322 (Special Issue Advancements in Horticultural Irrigation Water Management). https://doi.org/10.3390/horticulturae11030322.

Felton, A., … Purdy, A.J., … et. al., 2025. “Global estimates of the storage and transit time of water through vegetation.” *Nature Water* 3:59-69. https://doi.org/10.1038/s44221-024-00365-9.

Rohde, M.M., …, Purdy, A.J.,… et al., 2024. “Groundwater-dependent ecosystem map exposes global dryland protection needs.” *Nature* 632, 101-107. https://doi.org/10.1038/s41586-024-07702-8.

Nassar, A., ..., Purdy, A. J.,... et al.. 2025. “Intercomparison of the U.S. National water model with OpenET over the Bear River Basin.” *U.S. Journal of Hydrology*, 132826. https://doi.org/10.1016/j.jhydrol.2025.132826.

Pierrat, Z. A., Purdy, A. J., ..., et al., 2025. “Evaluation of ECOSTRESS Collection 2 evapotranspiration products: Strengths and uncertainties for evapotranspiration modeling.” *Water Resources Research,* 61, e2024WR039404. https://doi.org/10.1029/2024WR039404.

Reitz, M., Volk, J.M., Ott, T., Anderson, M., Senay, G.B., Melton, F., Kilic, A., Allen, R., Fisher, J.B., Ruhoff, A., Purdy, A.J., and Huntington, J., 2025. “Performance maps, weights, and associated data sets for Version 2.0 of the OpenET evapotranspiration models for the conterminous U.S.” U.S. Geological Survey data release. https://doi.org/10.5066/P1HY5TUM.

Doherty, C. T., Wang, W., Hashimoto, H., and Brosnan, I. G., 2025. “A method for quantifying uncertainty in spatially interpolated meteorological data with application to daily maximum air temperature.” *Geosci. Model Dev.*, 18, 3003–3016, https://doi.org/10.5194/gmd-18-3003-2025

Doherty, C.T. and Mauter, M.S., 2025. “Fisher Discriminant Analysis for Extracting Interpretable Phenological Information From Multivariate Time Series Data.” *IEEE Journal of Selected Topics*

in Applied Earth Observations and Remote Sensing, vol. 18, pp. 3371-3384. https://doi.org/10.1109/JSTARS.2024.3517415.

Detka, J., Jafari, M. Gomez, M., Gilbert, G., 2025. “Machine learning vs. empirical models: Estimating leaf wetness patterns in a wildland landscape for plant disease management.” *Agricultural & Forest Meteorology*, 362, 110392. https://doi.org/10.1016/j.agrformet.2025.110392.

Conference Proceedings

Melton, F.,& OpenET Team. OpenET: Supporting Sustainable Water Management with Earth Observations and Open Science. ASCE World Environmental and Water Resources Congress 2025. Pages: 567–574. https://doi.org/10.1061/9780784486184.052 (Purdy., A.J., Carrara, W., Doherty, C., Guzman, A., Johnson, L.)

Technical Reports

Purdy, A. … Johnson, L., Melton, F…et al., 2025. “Historical Review of OpenET Data in New Mexico and the San Luis Valley, CO from 1991–2023” Prepared by California State University Monterey Bay, Cornell University, Desert Research Institute, Evapotranspiration Plus LLC., Federal University of Rio Grande do Sul, GreenBlue ET LLC, National Aeronautics and Space Administration, OpenET Inc., United States Department of Agriculture with contributions from United States Geological Survey. Prepared for the U.S. Bureau of Reclamation and the New Mexico Office of the State Engineer.

Purdy, A. …Johnson, L., Melton, F…et al., 2025. “Historical Review of OpenET Data in Montana from 1991–2023” Prepared by California State University Monterey Bay, Chapman University, Cornell University, Desert Research Institute, ETPlus LLC., Federal University of Rio Grande do Sul, GreenBlue ET LLC, National Aeronautics and Space Administration, OpenET Inc., United States Department of Agriculture, with contributions from United States Geological Survey. Prepared for Montana Department of Natural Resources and Conservation.

Purdy, A. …Johnson, L., Melton, F…et al., 2024. “OpenET Historical Review (1990–2023) for the Colorado River Authority of Utah” Prepared by California State University Monterey Bay, Cornell University, Desert Research Institute, Evapotranspiration Plus LLC., Federal University of Rio Grande do Sul, GreenBlue ET LLC, Mississippi State University, National Aeronautics and Space Administration, OpenET Inc., United States Department of Agriculture with contributions from United States Geological Survey. Prepared for Colorado River Authority of Utah.

Purdy, A. …Johnson, L., Melton, F… et al., 2024. “Historic Review of OpenET Data in Oregon from 1990–2022.” Prepared by California State University Monterey Bay, Cornell University, Desert Research Institute, Evapotranspiration Plus LLC., Federal University of Rio Grande do Sul, GreenBlue ET LLC, Mississippi State University, National Aeronautics and Space

Administration, OpenET Inc., United States Department of Agriculture with contributions from United States Geological Survey. Prepared for Oregon Water Resources Department.

Selected Presentations

Biedebach, M., R. Solymar, M. Cahn, A. Purdy, L. Johnson. Measuring evapotranspiration rates in commercial broccoli fields - Salinas Valley, CA. Amer. Soc. Horticultural Science Annual Conference, 28 July–1 Aug., 2025, New Orleans.

Cahn, M., L. Johnson, M. Biedebach, A. Purdy, R. Solymar, F. Melton, S. Zhuang, L. Bettiga. CropManage online decision support tool for irrigation scheduling of vineyards. GiESCO Congress (Group of International Experts in Vitivinicultural Systems for Cooperation), 27–31 July, 2025. Geisenheim, Germany.

Purdy, A., C. Doherty, A. Guzman, J. Spotta, W. Carrara, L., Johnson, F. Melton. Modeling evapotranspiration from applied water and effective precipitation using OpenET. CSU WATER Conference, 10–11 Apr., 2025, Sonoma.

Johnson, L. A. Purdy, M. Biedebach, M. Cahn, D. Chambers, N. Cabrera. Validating OpenET satellite measurements of water use in broccoli and lettuce. UCCE Irrigation and Nutrient Management Meeting, 19 Feb., 2025, Salinas. (invited).

Johnson, L., M. Cahn, N. Cabrera, D. Chambers. Verification of satellite estimates of horticultural crop canopy cover in the Salinas Valley. AGU Annual Meeting, 9–13 Dec., 2024, Washington DC (#H06-63).

Biedebach, M., R. Solymar, A. Purdy, F. Cassel, L. Johnson, F Melton. On-Ground observations of water fluxes over bare soil—San Joaquin Valley, CA. AGU Annual Meeting, 9–13 Dec., 2024, Washington DC (#H11Q-0918).

Purdy, A., W. Carrara, C. Doherty, A. Guzman, L. Johnson, F. Melton. Evaluating time integration methods to produce daily evapotranspiration data, 2024. AGU Annual Meeting, 9–13 Dec., 2024 Washington DC (#H11P-0892).

Guzman, A., C. Doherty, A. Purdy, F. Melton, L. Johnson. Mapping effective precipitation and ET of applied water using OpenET and GEE. AGU Annual Meeting, AGU Annual Meeting, 9–13 Dec., 2024 (#H23F-1065).

Chandanpurkar, H., … Purdy, A.J., Continental Drying, Changing Freshwater Availability, and Sea Level Rise. AGU Annual Meeting, 9–13 Dec., 2024. (Oral, #H42I-03).

Halverson, G., … Purdy, A.J., … et al., Open-Science Development of Thermally Sensitive Evapotranspiration Products for the ECOSTRESS and SBG Missions. 2024. (#GC41H-0029).

Ruhoff, A., … Purdy, A., Carrara, W., … et al.. OpenET-Brazil: Remote sensing of evapotranspiration for water management in Brazil. AGU Annual Meeting, 9–13 Dec, Washington DC, 2024. (#H13S-04).

Melton, F., Doherty, C.,. OTTER—Open Tool for Tracking Effective Precipitation, Western States Water Council Spring Meeting, 22–25 April, 2025. Lincoln, NE.

Biedebach, M., R. Solymar, J. Logie, B. San Luis, J. Spota, M. Villareal, C. Wang, A. Purdy, L. Johnson, M. Cahn, F. Cassel, F. Melton,. Field level evapotranspiration monitoring. CSU Agricultural Research Institute Annual Conference, 7 November, 2024, Sacramento.

Logie, J., Biedebach, M., Melton, F., Purdy, A.. On-ground Live Fuel Moisture Content Sampling Along California's Central Coast. CSU Agricultural Research Institute Annual Conference, 7 November, 2024, Sacramento.

Purdy, A., OpenET Demonstration. Colorado Master Irrigator Program. Holyoke, CO, 2025.

Panels or Committees

- L. Johnson participated in NASA's Satellite Needs Working Group.
- L. Johnson was a reviewer for the 2025 IGARSS 2025 Conference.
- A. Purdy and W. Carrara served on hiring committee for OpenET.

Disaster Management

Project Participants

CSUMB: Vincent Ambrosia, A.J. Purdy

NASA: Michael Falkowski, Forrest Melton

Project Description

The Disaster Task is composed of two principal elements:

1. Support of the NASA Earth Action Program (EAP)—Wildland Fires Program.
2. Support of the NASA FireSense Project.

V. Ambrosia retired in 2024. Between 2013 and 2024, V. Ambrosia served as an APM and managed a portfolio of projects within the (Applied Science Program (ASP)-Wildfire Program. Ambrosia continued this year with minor support of the NASA Global Observations of Forest Cover and Land-use Dynamics (GOFC-GOLD) Mediterranean Regional Information Network (MedRIN). He was a co-coordinator of MedRIN with two European co-coordinators. His activities transitioned to Dr. F. Schwandner (NASA Ames Research Center (ARC) Earth Science Division Chief), and he advises on MedRIN workshops and coordination for the near term on an "as-needed" basis.

NASA EAP Support:

The EAP portfolio management includes the development of NASA EAP Wildland Fires topical solicitations as well as organizing and managing the review panels and selection of NASA proposals to those solicitations; supporting scientific oversight of the program goals and objectives; budgetary management of the funded efforts; metrics monitoring for the investigations; interactions with partner agencies involved in the projects; and serving as a supporting NASA representative on regional, national, and international wildland fire science and applications panels and boards. Additional activities include organization and planning of national and international symposia and forums, participating and collaborating in workshops and webinars, and highlighting the EAP Wildland Fire Program area and the FireSense Project efforts to access/operationalize Earth observations (EO) data/information to support wildfire science and applications by the community.

NASA FireSense Support:

The NASA Science Mission Directorate (SMD) FireSense project (https://cce.nasa.gov/firesense/index.html) is focused on delivering NASA's unique Earth science and technological capabilities to operational agencies, striving towards measurable improvement in US wildland fire management. The NASA SMD FireSense project is part of a larger NASA-wide Wildland Fire Initiative involving SMD, the Aeronautics Research Mission Directorate (ARMD), and the Space Technology Mission Directorate (STMD). The FireSense project will include an airborne science component (annual campaigns), where improved capabilities and technologies will be developed, evaluated, and ultimately demonstrated to agency stakeholders in a large capstone airborne campaign in year five of the project (2027–2028).

MedRIN Support:

Assist in managing/transitioning the coordination role of the NASA Land-Cover/Land-Use Change Program (LCLUC), MedRIN effort. The tasks include coordination of annual meetings and workshops with regional coordinators from the Mediterranean countries, with a focus on dynamic land/biosphere changes common to the area, and participation in the NASA LCLUC Annual Team Meeting. V. Ambrosia assisted in the transition of MedRIN coordination to staff at NASA-ARC, through the leadership of F. Schwandner.

Accomplishments

- V. Ambrosia served on the FirEUrisk Scientific Forum Board; a European Commission (EC)-funded trans-European wildfire program, led by University of Coimbra (Portugal) and University of Alcala (Spain), 2019–2025. Participated in virtual meetings and annual progress reviews.
- V. Ambrosia served as an External Advisory Board (EAB) member—EXCELSIOR Program (ERATOSTHENES: Excellence Research Centre for Earth Surveillance and Space-Based

Monitoring of the Environment), Cyprus University of Technology (CUT), Limasos, Cyprus (2019–2027). Participated in virtual and in-person meetings and reviews.

- Continued collection of live fuel moisture in Carmel Valley, California, to support regional applications of fire risk assessment. In collaboration with the CAL-FIRE San Benito-Monterey Unit, the team continues to collect fuel moisture samples on the Santa Lucia Preserve and Monterey Peninsula Regional Park District lands. With support from NASA Firesense project and the CSU-ARI campus award, the team (A.J. Purdy, M. Biedebach, J. Logie, and Z. Theodore) was able to purchase an instant fuel moisture reader to expand fuel moisture sampling in 2024/2025 to support regional fire risk assessment and evaluate remote sensing models.

- Secured ~$250K in FY25 from competitively awarded grants and program directed funding to field measurements and science advances of fuel moisture mapping. Purdy (campus PI) was a co-investigator on a three year, $820K proposal to a SMD FireSense Invited Proposal led by Michigan Tech University to develop state-of-the art fuel moisture data (selected, ~$200K to CSUMB). Additionally, PI Purdy received $20K in funding to support additional Live Fuel Moisture Content (LFMC) ground data collection to support LFMC algorithm development and evaluation. PI Purdy received a contract from the Environmental Defense Fund to support applications of ET data to support Forest Health Management & Fire Risk.

Ecological Forecasting

Project Participants

BAERI: Cindy Schmidt

NASA: Woody Turner, Keith Gaddis

Project Description

As an associate program manager for the NASA Applied Science Ecological Conservation program, Schmidt tracked projects in the Ecological Conservation portfolio, supported strategic planning activities, helped coordinate annual program review meetings, and participated in interagency activities and meetings as required by the program managers. She managed 10 projects for FY25.

Accomplishments

- Attended American Geophysical Union (AGU) in December. Co-convened a Biological Diversity oral session.

- Organized Ecological Conservation team retreat in Atlanta in January.

- Developed an agenda, helped organize, and attended the Ecological Conservation and Biodiversity programs team meeting in Washington, DC, in May.

- Participated as a panelist in an Ecological Conservation proposal review in April.
- Participated as a HQ Reviewer for a Biodiversity proposal review panel in February.

Panels or Committees

- Review committee for Applications Guidebook.
- Board member for UC Berkeley Geospatial Innovation Lab.

FireSense

Project Participants

FireSense Implementation Team (FSIT) Affiliations: University of Idaho; University of Utah; Michigan Technical University; University of Wisconsin, Madison; University of Maryland; University of California, Irvine; US Geological Survey; Los Alamos National Laboratory; BAE Systems; University of Utah; California State University, Monterey Bay; University of New Mexico; San Diego State University; University of Nevada, Reno; San Jose State University; Universities Space Research Association; Muon Space; US Naval Research Laboratory; NASA GSFC; NASA LARC; NASA Jet Propulsion Lab (JPL); NASA MSFC; NASA ARC; BAERI; Colorado State University; University of Texas; Clemson University; University of Maryland, Baltimore Campus; Oklahoma State University; Urban Sky.

Project Description

FireSense is dedicated to advancing Earth sensing and technological capacities for operational wildland fire agencies. This approach focuses on the co-development of new tools, data, and capabilities between scientists and wildland fire practitioners, and subsequent transfer of those developments to operations. These outcomes are designed to address all aspects of the fire lifecycle, including pre-fire planning, active fire response, post-fire recovery, and air quality management. FireSense will support these goals through the facilitation of project development between the FireSense Implementation Team (FSIT) and Stakeholder Practitioners. Additionally, FireSense supports deployment and testing of new tools and data through field, airborne, and satellite campaigns.

The FireSense Program is associated with a wide range of public and private partners that engage in wildfire-related areas. These partners represent academic institutions, federal, state, and local operational agencies, and private industry.

As part of its work, the FireSense Program engages with numerous wildfire management organizations including: Environmental Protection Agency, U.S Forest Service, Alabama Department of Forestry, US Fish and Wildlife Service, CAL FIRE, Napa County, and others.

Accomplishments

Scoping Sessions

The FireSense Project completed scoping sessions between the FireSense Implementation (FSI) team researchers and groups of practitioners dedicated to Pre-Fire, Active Fire, Air Quality, Post-Fire, and Tech Transfer. Each group of practitioners received two 3.5-hour sessions intended to identify existing technological gaps in their area of wildland fire management and inspire potential research ideas and collaborations with members of the FireSense Implementation Team. Sessions began November of 2024 and concluded in January 2025.

The Pre Fire Scoping Sessions included focused engagement with the LANDFIRE Group from the US Forest Service (USFS) and Bureau of Land Management. With a total of 31 participants in attendance, nine were practitioners from LANDFIRE and 22 were members of the FSI team. At the closure of the meeting six teams formed around 11 ideas. Ultimately three teams were successfully awarded.

The Active Fire Scoping Sessions focused on projects to develop incident awareness and assessment capabilities for wildland fire managers. Practitioners in this session included US Forest Service, Evergreen Fire and Rescue Service, and others. A total of eight practitioners met with 24 members of the FSI team to discuss challenges and identify potential pathways forward. At the end of the Active Fire sessions, a total of eight teams formed. Ultimately two teams were successfully awarded.

The Air Quality Scoping Sessions included focused engagement with the Environmental Protection Agency (EPA), with a total of 21 members of the FSI Team brainstorming potential project ideas with eight practitioners from EPA. At the closure of the Air Quality sessions, mixed groups of practitioners and FSI members coalesced around five teams. Ultimately two teams were awarded.

The Post Fire Scoping Sessions included focused engagement with members of Burned Area Emergency Response (BAER) Teams to develop projects related to post-fire recovery and assessment. Practitioners from this session were largely from the USFS, National Park Service, Bureau of Land Management, and select state agencies. In total, nine practitioners attended and 17 members of FSI attended. Following the conclusion of the sessions, seven teams formed. Ultimately one was selected.

The Technology Transfer Scoping Sessions included a wide range of expertise, with practitioners representing CAL FIRE, NOAA, USFS, Colorado Dept of Public Safety, Napa County Fire Administration, Michigan Dept of Natural Resources, and others. A total of 14 practitioners were present to discuss ideas with 19 FSI team members. At the closure of the Tech Transfer sessions, mixed groups formed around five teams.

Following the conclusion of the sessions, FSI team members formed project teams around research ideas derived from the sessions and submitted their ideas for review by FireSense

leadership in early March. Fourteen projects were submitted from which nine were selected for further development. Several of these projects have received funding and will begin in July 2025.

2025 Spring Campaign

The FireSense Project completed its spring airborne campaign demonstration that collected data over 34 wildfires and prescribed fires in Alabama, Texas, Florida, Oklahoma, Mississippi, and Georgia. The campaign focused on developing, testing, and demonstrating Earth observation data collected from crewed and uncrewed aircraft, balloons, and satellites to support wildland fire management and technology transfer. During the campaign, the teams for crewed and uncrewed aircraft completed a combined 104.45 flight hours. This included six days of flying active wildfires and four days over prescribed fires, for a total of 34 wildland fires characterized.

Active fire measurements were taken with JPL's Airborne Visible/Infrared Imaging Spectrometer (AVIRIS)-3 airborne instrument over active wildfires in Alabama, Texas, and Florida. The AVIRIS-3 sensor provided new Real Time Spectroscopic Products (RTSP) to detect and track wildfires in real time. These data were sent directly from the aircraft to fire managers on the ground. The RTSPs were used to rapidly digitize fire perimeters and ultimately provided actionable intelligence to firefighters, who were able to modify and enhance firefighting response based on the data. Adjustments made to the RTSP after feedback from wildland fire managers improved the products, which will continue to be tested and improved over the duration of the FireSense Project.

On March 18th, as part of the spring 2025 campaign, FireSense coordinated with the Incident Awareness and Assessment (IAA) group from the National Interagency Fire Center's (NIFC) to compare data and evaluate the RTSPs from AVIRIS-3. The Crabapple fire in central Texas just west of Austin and the Persimmon fire in eastern Texas near the coast at the Louisiana border were sampled. The Persimmon fire was a bog fire which is challenging to detect the heat signature and generate a fire perimeter, so the AVIRIS-3 capability to detect CO2 will be evaluated for fire perimeter creation. Data collected for these fires were shared with the IAA and FireSense team for evaluation and comparison against other products. This mission demonstrated the viability of coordination between IAA and FireSense and the capability of AVIRIS-3 in the wildland fire operational environment. The FireSense stakeholder engagement team actively coordinated with the National Weather Service (NWS) Southern Region and the NWS in Austin/New Braunfels and provided a quick guide for the RTSPs from AVIRIS-3 imagery. Initial feedback from the NWS indicated that this type of imagery as RTSPs provides "a whole other level of support, especially if local air reconnaissance is hampered by wind, smoke, resources..."

On March 21, as part of the FireSense spring 2025 campaign an aircraft carrying JPL's AVIRIS-3 sensor completed successful flight and data collection in coordination with the Alabama Forestry Commission (AFC) over seven wildfires in Alabama and one in Mississippi.

RTSPs from AVIRIS-3 were able to provide actionable intelligence in Alabama. A coordinated Earth Science Technology Office (ESTO)-sponsored Uncrewed Aircraft System (UAS) team was also on the ground. The UAS team was able to collect additional data that were used by firefighters to direct a bulldozer dozer line that ultimately saved four occupied and three unoccupied structures. Additionally, the AVIRIS-3 flight of the Greene fire in Mississippi allowed the creation of a digitized perimeter by FireSense Project staff that identified hotspots outside the containment area. With this information, the Mississippi Forestry Commission was able to respond in a timely manner to prevent the fire from spreading and maintain containment.

The FireSense project successfully coordinated ground, airborne, and spaceborne data collection on a prescribed fire at Geneva State Forest (GSF), Alabama, during the week of March 24–March 29, 2025. The FireSense team and the AFC tightly coordinated five ground sampling teams, an atmospheric modeling team, three uncrewed aircraft, and three crewed aircraft, while supporting burn crews during the prescribed fire. The data collected during this prescribed fire will be used to analyze regional fire weather forecasts, comparative assessment across airborne and spaceborne sensors, and evaluate sensor applications for pre- and post-fire use.

The second phase of the FireSense Spring 2025 campaign included simultaneous ground, airborne, and spaceborne data collection on the Department of Defense (DoD)-managed prescribed burns at Fort Stewart-Hunter Army Airfield in Georgia from April 14–20, 2025. FireSense, their science collaborators, and the Environment and Natural Resources Division (ENRD) Forestry Branch at Fort Stewart coordinated simultaneous measurements from research teams associated with the DoD Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP), the United States Forest Service, University of Alabama Huntsville (UAH) Severe Weather Institute for Research and Lightning Laboratories (SWIRLL), as well as additional academic, agency, and private partners.

Three crewed airborne assets, with five instruments, were deployed over the active flaming phase of the prescribed burns to collect measurements related to fire characteristics, smoke, and fuel consumption. These assets included: a B200 carrying JPL's AVIRIS-3 Sensor, a NASA AFRC B200 carrying the Ames Airborne Sensor Facility's MASTER (MODIS/ASTER Airborne Simulator) sensor, which is a modified Daedalus Wildfire scanning imaging spectrometer, and the NASA Science Mission Directorate ESTO-funded FireTIRS infrared sensor, and a Twin Comanche carrying the USFS-funded Small Business Innovation Research TACFI-RS infrared sensor, as well as a filter for smoke sampling. AVIRIS-3, MASTER, and FireTIRS also collected pre-and post-fire data.

Ground crews measured micrometeorology, fuels, and fire behavior to capture pre-fire conditions, active fire characteristics, and post-fire effects. FireSense deployed researchers to demonstrate near real-time data from the NASA JPL AVIRIS-3 sensor as it flew over the prescribed burn at Fort Stewart-Hunter Army Airfield in Georgia. This coordinated ensemble of air and ground assets provided real-time intelligence to practitioners on the ground to assist in

their wildland fire operations. Additionally, the consistent spatial and temporal overlap of the data collection provides each sensor team with opportunities to comparatively assess their data collection and products.

Media and communications teams who provided coverage of the FireSense Spring 2025 campaign included outlets from NBC News, Fox News, ABC News, Houston Chronicle, NOAA, National Weather Service, and NASA. Coverage can be found here: NBC Today Show, Fox News 26, Fox News 54, ABC, Houston Chronicle, National Weather Service, NASA AFRC, NASA JPL, and NASA Earth Observatory.

Presentations

The FireSense Project hosted its Annual Review on June 9 and 10, 2025, which included presentations from 22 FireSense Implementation Team and FireTech Projects. The Review also included breakout group discussions dedicated to Research to Operations, Campaign Planning, and Cross-project Coordination.

From May 20–22, 2025, the Wildland Fire Program participated in the virtual Surface Biology and Geology (SBG) Science & Applications Technical Interchange Meeting 2025, which was organized to engage the SBG community in productive discussions around synergies, priorities, and collaboration opportunities. FireSense Project Scientist Jacquelyn Shuman presented a poster on the FireSense project. The poster highlighted the spring 2025 campaign and its successful coordination with on the ground wildland firefighters, partners, and collaborators in the southeastern US for sampling over wildfires and prescribed fires. The data collected in FireSense campaigns can serve as validation/calibration data for SBG activities.

FireSense hosted “On the Fireline: a FireSense Conversation” with guests Ben Strahan, Superintendent of the El Dorado Interagency Hotshot Crew, and Linda Chappell, a USFS retired Incident Management Team Planning Section Chief on January 17, 2025. Ben and Linda presented to 34 members of the Implementation Team on their practical experience fighting wildfires and their perspectives on improving the flow of information for frontline decision makers.

FireSense Project Manager Jennifer Fowler gave the invited presentation “Addressing Critical Knowledge Gaps on Wildland Fires with UAS Technology” for a session part of the Joint Session J1A and titled “Wildfire Influence on Aerosol, Cloud, and Climate I” (Joint between the 17th Symposium on Aerosol Cloud Climate Interactions and the 27th Conference on Atmospheric Chemistry) at the American Meteorological Society in New Orleans on January 13.

FireSense hosted members from the OpenET science team on January 10, 2025, with guests AJ Purdy and Forrest Melton, both senior research scientists in the Department of Applied Environmental Science at CSU Monterey Bay and the NASA Ames Research Center Cooperative for Research in Earth Science and Technology (ARC-CREST). Purdy and Melton presented to members of the Implementation Team on the success of OpenET and its potential to inform wildland fire decision making and planning.

Panels or Committees

FireSense provided a one-page submission summarizing the goals of FireSense and the 2024 campaign activities sampling fires in CA and campaign deployment in Missoula, Montana to the Coordination Group for Meteorological Satellites (CGMS) 53 working group II report. For the Missoula campaign in the Fall of 2024, the FireSense project completed a flight campaign in a wildfire smoke-impacted airshed in Missoula to conduct atmospheric vertical soundings, validate third party forecast models, and further explore AI computing paired with airborne weather sensors and the data links required. The article will be included in ESD's annual submission to the Coordination Group for Meteorological Satellites (CGMS).

FireSense Implementation Team (FSIT)

Project Participants

BAERI: Kristina Pistone

NASA Ames: Clayton Elder

Project Description

The NASA Science Mission Directorate (SMD) FireSense project is focused on delivering NASA's unique Earth science and technological capabilities to operational agencies, striving towards measurable improvement in US wildland fire management. The NASA SMD FireSense project is part of a larger NASA-wide Wildland Fire Initiative involving SMD, the Aeronautics Research Mission Directorate (ARMD), and the Space Technology Mission Directorate (STMD).

The FireSense project will include an airborne science component (annual campaigns) where improved capabilities and technologies will be developed and evaluated and ultimately demonstrated to agency stakeholders in a large capstone airborne campaign in year five of the project (2027–2028).

Through initial stakeholder engagement activities, the FireSense project will begin by focusing on four uses-cases focused on characterization and measurement of (i) pre-fire fuels conditions, (ii) active fire dynamics, (iii) post fire impacts and threats, and (iv) air quality impacts and forecasting, each co-developed with identified stakeholders.

Accomplishments

- FY24: in conjunction with SMEs from all NASA centers, Kristina Pistone participated in the FireSense case study implementation plan white paper drafting, development, and dissemination, particularly for the Air Quality (AQ) and Active Fire use cases, with a key role in formulating the AQ five-page white paper.
- FY25: worked to make connections to deploy low-cost air quality sensors (LCS) in anticipation of the April 2025 FireSense airborne deployment over Merritt Island National

Wildlife Refuge. Three additional sensors were installed (in collaboration with colleagues at Langley Research Center and Kennedy Space Center) and although the planned deployment was diverted due to drought conditions, the groundwork is promising for future deployments to the region. This effort furthers the science goals of EPA stakeholder Barron Henderson regarding improvement of AQ nowcasts in the continental US, with a specific focus on the southeastern US with many prescribed fires and few AQ sensors or monitors.

- FY25: Dr. Pistone participated in three of the five stakeholder engagement FireSense Scoping Sessions (Air Quality, Tech Transfer, Active Fire) between November and February. This resulted in three proposal "pitch" submissions for FSIT projects. Two of these were selected to submit a full proposal to the SMD. Selected pitches:
    - "Improving EPA Near-Real-Time Air Quality Nowcasts through targeted deployment of PM2.5 LCSs in under-sampled areas" FireSense PIs/CoIs: Kristina Pistone, Margaret Pippin, Liz Wiggins, Ana Prados, Tatiana Loboda, and Kelley Murphy.
    - "Optimization and benchmarking of fire spread model performance to build trust and accelerate innovation in US operational fire management" FireSense PIs/CoIs: Douglas Morton, Yang Chen, Kyle Hilburn, Kristina Pistone, James Thompson, and Jim Randerson.
- Both of the above projects were approved by headquarters for a three-year project starting July 2025.

Presentations

Presentation on above LCS pitch at the FSIT annual review meeting, June 9–10.

Marine Carbon Dioxide Removal (mCDR)

Project Participants

San José State University: Dustin Carroll

NASA Ames Research Center: Daniel Whitt

Project Description

Marine Carbon Dioxide Removal (mCDR) encompasses a suite of methods proposed to artificially increase the transfer of atmospheric carbon dioxide to the deep ocean, as reviewed in a National Academy of Sciences Report (National Academy of Sciences 2022). These approaches are being pursued from a variety of angles by stakeholders including private industry, nonprofits and philanthropy, as well as US government entities (including DOE, NOAA, EPA, California Air Resources Board (ARB), and other state and federal agencies), based on established and anticipated value of atmospheric carbon sequestration.

This project aims to deploy NASA ocean modeling capabilities and expertise to simulate and estimate the impacts of mCDR over a range of scales from coastal field trials to sustained

regional deployments that might result in significant reductions in atmospheric carbon dioxide. The project supports the two personnel at 25% level to engage with stakeholders in this space, build knowledge of their needs, and tailor the provision of NASA information.

Accomplishments

The project resulted in two technical accomplishments in year one. First, NASA's 2-km resolution global ocean simulation "LLC4320" was used to simulate the surface dispersion from two sites of proposed or ongoing field trials on the west coast: the Port of Los Angeles, CA, and Port Angeles, WA. Ultimately, this helps understand where perturbations at these sites are expected to be observed and how diluted they will be (Fig 2). Second, major revisions were completed on a manuscript that uses NASA's ECCO-Darwin model to constrain Ocean Alkalinity Enhancement (OAE) scenarios in the open ocean (Fig 1). This study demonstrates that regional and large-scale differences in ocean circulation significantly impact the efficiency by which OAE reduces atmospheric carbon dioxide.

One key impact of the latter work has been the realization, among stakeholders in the community, that there is significant uncertainty in the OAE carbon sequestration estimates based on other global-ocean circulation models, because there are still significant biases in the regional and large-scale circulation that are mitigated in NASA's data constrained models (ECCO). This has motivated a community model intercomparison effort by Google and Carbon to Sea, which we are participating in.

In addition, we are engaging in numerous collaborations with external colleagues and stakeholders. Notable examples include:

- Working with Vincent Le Fouest and graduate student Oceanne Bousquet at La Rochelle Universite (France) on combining rapid-mCDR and ocean parcels (Lagrangian modeling) to compute OAE efficiency.
- Mentoring JPL intern Lynsie Warr on uncertainty quantification in OAE.
- Collaboration with Mike Tyka at Google to compare OAE scenarios in Community Earth System Model (CESM) and ECCO-Darwin in global coastal deployments.
- Collaboration with Mike Tyka on the OAEMIP effort supported by Carbon to Sea.
- Working with Isometric to develop a Direct Air Capture protocol.
- Development of the C-GEM (Carbon – Generic Estuary Model) estuary box model so it can be used for mCDR/OAE quantification.
- Discussions with the European company Pronoe on using ECCO-Darwin to simulate OAE.
- Discussions with Jim Falter and Rachel Danielson at California ARB on activities related to mCDR.

Changes and Delays

More time has been spent on disseminating results from regional ocean alkalinity enhancement simulations in ECCO-Darwin than anticipated. We felt that it was valuable to help get this manuscript out to the community, rather than let it languish in the review process. The second round of revisions were completed, and the paper was resubmitted to *Journal of Advances in Modeling Earth Systems* (*JAMES*) on May 6. We expect it to be published in FY25. This has also somewhat delayed our work on the dispersion of mCDR perturbations in coastal sites. But the analysis of mCDR impacts in coastal deployments is ongoing from multiple angles, including both the high-resolution dispersion calculations and the C-GEM estuary box model, and the coastal analysis will be a priority for this year if funded.

There were some delays in distributing the year-one funds from NASA Ames to SJSU, but this was completed by the end of fiscal year 2024. More recently, there have been delays spending FY24 funds on Whitt's civil servant labor in FY25 due to a recent freeze in FY24 spending. As this is resolved, budget admins at Ames will ensure all of Whitt's CS labor on the project is properly accounted for (fixing any issues due to prior fund freezes) and then send any remaining small balance to SJSU via ARC-CREST.

References

National Academies of Sciences, Engineering, and Medicine. 2022. A Research Strategy for Ocean-based Carbon Dioxide Removal and Sequestration. Washington, DC: The National Academies Press. https://doi.org/10.17226/26278

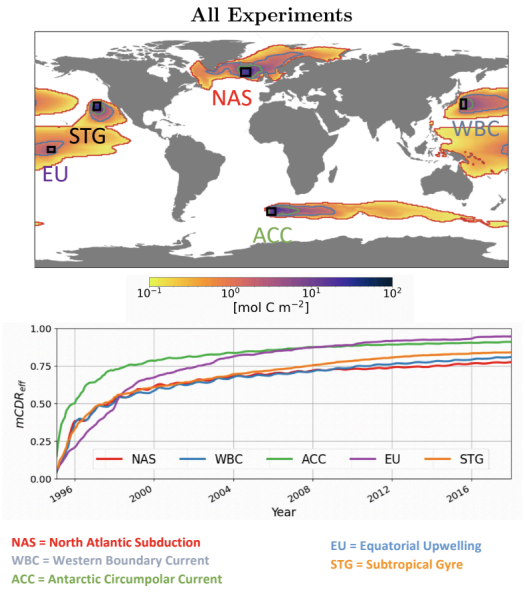


*Figure 1: Simulated spatial distribution of mCDR impacts spreading out from five regional deployment sites marked by black boxes (darker shading indicates greater impact). The color also quantifies the cumulative atmospheric carbon sequestration (1995–2018) from ocean alkalinity enhancement (OAE) in five regional deployments in different ocean circulation regimes [**Top**] and time series of the efficiency of the sequestration at each deployment site [**Bottom**].*

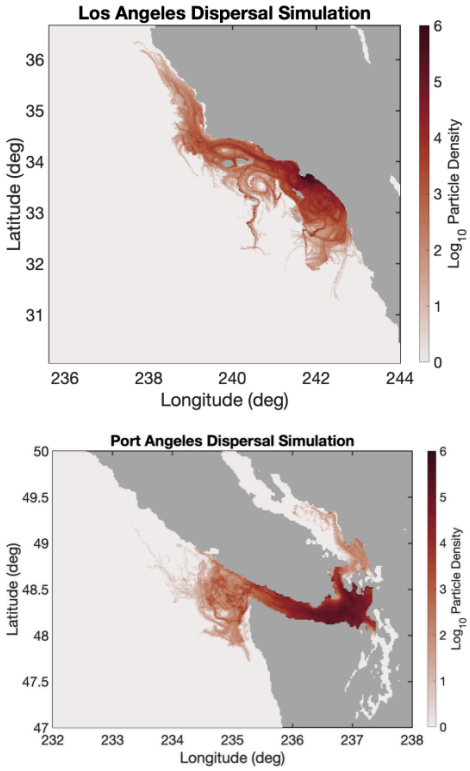


*Figure 2: High-resolution ocean simulations of dispersal from the Port of Los Angeles, CA [**Top**] and Port Angeles, WA [**Bottom**] are used to examine the potential spread of biogeochemical perturbations associated with mCDR in the coastal ocean. Areas with the darkest color will be most strongly impacted.*

Presentations

2025 US Ocean Carbon and Biogeochemistry summer workshop. Dan Whitt co-organized a session on Bridging Scales in the Ocean Carbon Cycle, which includes an emphasis (half of talks) on mCDR. https://web.whoi.edu/ocb-workshop/. June 3, 2025.

Ocean Solutions Research at Ames. Dan Whitt gave a presentation which highlighted work on marine carbon dioxide removal for the UC Berkeley Center for Information Technology Research in the Interest of Society and the Banatao Institute (CITRIS) Innovation Intensive on Climate. https://ntrs.nasa.gov/api/citations/20240013598/downloads/Ocean%20Solutions%20at%20Ames.pdf. Nov 1, 2024.

Publications

Suselj, K., D. Carroll, D. Whitt, B. Samuels, D. Menemenlis, H. Zhang, N. Beatty, A. Savage. May 6, 2025. Quantifying Marine Carbon Dioxide Removal via Alkalinity Enhancement Across Circulation Regimes Using ECCO-Darwin and 1D Models. Version 3. Under review at

JAMES. Version 1 is available publicly as a pre-print:
http://doi.org/10.22541/essoar.170957083.34212619/v1

United States Department of Agriculture-Agricultural Research Services (USDA-ARS) California Delta Areawide Project for Integrated Resource Management

Project Participants

CSUMB: Vanessa Genovese

California State Parks, Division of Boating and Waterways (DBW): Edward Hard, Jeffrey Caudill, Guphy Gustafson

NASA Ames: David Bubenheim

Project Description

The San Francisco Delta Floating Aquatic Vegetation Mapping project was a collaboration between NASA, the USDA-ARS, and the California State Parks, DBW to map invasive aquatic vegetation throughout the San Francisco Delta region using satellite data to assist with environmental mitigation projects. In addition, we developed an ArcGIS dashboard as a mapping interface for the DBW field operators to use.

Accomplishments

- Completed deliverables for the San Francisco Delta Floating Aquatic Vegetation Mapping Project using satellite-based, remote sensing methods to provide, for the first time ever, a comprehensive view of floating aquatic vegetation (FAV) distribution across the Delta. The DBW were able to use these maps integrated into an ArcGIS Online Dashboard that we developed to support Delta-wide operational decision making and enhanced assessment capabilities in order to increase the efficiency of their resource management efforts across the region. All of the models and data for mapping the Delta have been transferred to the DBW and are available through their ArcGIS Online website.
- In addition to aiding in the dashboard development, we engaged in transition and training of the new DBW personnel hired to run the dashboard in the past few years.
- A significant amount of time was spent in researching various vegetation indexes that could distinguish the different vegetation species throughout the seasons and across the Delta. Over 20 different vegetation indices were tested across the region and at different times during the year to determine the vegetation species distributions. The conclusions were that, although there were a handful of indices that gave good estimates of some of the species, because of the variety of species and density and growth variability throughout the Delta, it was very difficult to create a set of indices that would work consistently throughout the year. The most promising indices were those that incorporated the Green and Near Infrared (NIR) or RedEdge bands. In particular, the Normalized Difference Water Index (NDWI) index

((Green-NIR)/(Green+NIR)) developed from Normalized Difference Vegetation Index (NDVI) but applied to water background was helpful to determine the plant densities over water whereas the NDVIre, Chlorophyll index green (Clg) ((NIR/Green)-1) and Simple Ratio (SR) (NIR/Red) all provided information on the health and stage of the individual plants. Finally, several remote sensing models for classifying data were used to try to separate out the individual species.

Water Resources Program

Project Participants

CSUMB: A.J. Purdy, Pam Hansen, Sean Fleming

NASA: Forrest Melton (ARC), Ian Brosnan (ARC), Brad Doorn (HQ), Erin Urquhart-Jephson (HQ)

Project Description

The primary objectives of this task are to:

- Support the NASA Applied Sciences Program (ASP), Water Resources application area by serving as program scientist and a science team member for NASA's Western Water Action Office (WWAO).
- Engage and support WWAO project teams in identifying and resolving project issues and coordinate the WWAO science team.
- Conduct outreach and engage and support the NASA Applied Sciences Water Resources stakeholder community.

Accomplishments

- Participated in meetings with WWAO. Monitored project progress and provided strategic advice for multiple projects being supported by WWAO in the Rio Grande Basin. A.J. Purdy supported technical progress on projects supported by WWAO in the Rio Grande. Additionally, A.J. Purdy and S. Fleming served as subject matter experts in outreach engagements to the private sector partners.
- A.J. Purdy and S. Fleming will attend NASA's WWAO Needs Assessment Workshop for the Great Basin. A.J. Purdy will provide technical expertise related to agriculture use-cases and S. Fleming will provide WWAO science program leadership support. The needs assessment will be held in Salt Lake City, Utah, in September 2025.
- Assisted with organization and planning for the NASA presence at meetings and conferences. S. Fleming delivered an in-person plenary presentation ("Navigating the Research-Applications Continuum: NASA Water Resources Program & Western Water Action Office") at the NOAA/University of Alabama CIROH Developers Conference held in

Burlington, Vermont in May 2025. S. Fleming gave a short virtual presentation ("NASA Capabilities") at a pre-conference WWAO-led snow needs assessment workshop at the Western Snow Conference in May 2025 and provided support to the organization of the workshop. S. Fleming submitted a session proposal (subsequently accepted) on behalf of WWAO and the Water Resources Program (WRP) ("Innovating across Boundaries for Operational Uptake of NASA Earth Observations (EO) by the Western US Water Community") to the AGU Fall Meeting to be held in New Orleans, Louisiana in December 2025.

- P. Hansen organized and supported the annual 2025 NASA WWAO meeting in Albuquerque, New Mexico, from April 30–May 2, 2024; the 2024 NASA Water Resources Team Meeting in Boston, Massachusetts, from September 17–19, 2024, and the 2025 WWAO annual meeting in Albuquerque, NM from May 13–15, 2025. Hansen vetted potential venue locations (hotel block, catering, conference venue, A/V support), organized all meeting logistics, facilitated online and in-person attendance, created all meeting materials, and organized and facilitated all meeting communication and post-meeting analysis and outreach.
- A.J. Purdy joined the WWAO and participated in the WWAO Annual Retreat to provide input on the strategic plan. The meeting was held in Pasadena, California, in October 2024.
- A.J. Purdy and S. Fleming participated in the WWAO Annual Meeting, held in Albuquerque, New Mexico in May 2025. S. Fleming participated in its organization and planning, including leading a panel session on NASA missions and water resources, co-leading a panel session on AI and water resources, and serving as a panelist on a session about the western water practitioner community. A.J. Purdy served as a panelist on a session about NASA missions and water resources.
- S. Fleming co-wrote an article with NASA WWAO and WRP program leads in the April 2025 AGU Hydrology Section Newsletter ("NASA's Western Water Applications Office: Leveraging Earth Observation Data for Practical Water Management in the Western US").

Panels or Committees

- A.J. Purdy and S. Fleming participated in NASA review panels (WWAO).
- A.J. Purdy & S. Alexander served on the hiring panel for the WWAO Program Scientist position.
- S. Fleming served on a review panel for NOAA National Integrated Drought Information System (NIDIS) research funding proposals around drought assessment.
- S. Fleming served as an Associate Editor for the AGU peer-reviewed journal, Water Resources Research.

- S. Fleming began serving on an Oregon Water Resources Department Technical Advisory Group (TAG) related to the Oregon Water Availability Model.
- S. Fleming served on the Project Advisory Board of the University of Idaho-led Idaho Community-engaged Resilience for Energy-Water Systems (I-CREWS) NSF Established Program to Stimulate Competitive Research (EPSCoR) research project.

Wildfire Emissions - Atmospheric Rivers

Project Participants

BAERI: Ju-Mee Ryoo, Aishwarya Raman, Taejin Park

Project Description

The task objectives for this work include understanding pre-fire conditions and their linkage to fire characteristics, with a focus on atmospheric rivers, and evaluating changes in atmospheric river dynamic characteristics (frequency, intensity, and duration) over time and their relationship to fire behaviors and emission characteristics.

Accomplishments

- Detect atmospheric rivers over the western U.S. and California, with sub-regional analyses based on ecoregions (2000–2024).
- Analyze atmospheric rivers over the western U.S. and California for 25 years (2000–2020).
- Refine the analysis based on the following, while taking into account different fuel/vegetation types and soil moisture conditions:
    - A large domain over California and western U.S. (classified by 3 regions)
    - Ecoregions (e.g., California Water Department defined ecoregions
- Perform analyses based on finer ecoregions (e.g., 10 ecoregions) depending on the availability of atmospheric river detection data and Moderate Resolution Imaging Spectroradiometer fire data during the study period.
- Compute relationships between atmospheric rivers and fire behavior by ecoregion in California and the western United States.

Presentations

We plan to submit an abstract to present at the American Geophysical Union (AGU) fall meeting in December 2025.

Western Water Applications Office (WWAO)

Project Participants

BAERI: Nikki Tulley

CSUMB: A.J. Purdy

NASA Headquarters: Erin Urquhart

JPL: Stephanie Granger, Alphan Altinok, Sharon Ray, Mark Davidson, Sean Fleming, Renato Fasson

NASA Goddard Space Flight Center: Bailing Li, Amita Mehta

Project Description

Water challenges in the western US have made enhanced resource management solutions with NASA's Earth-observation capabilities pivotal. In addressing this multifaceted paradigm, it is crucial to have a science-based understanding of water-resource issues and to match those with NASA's capabilities. Moreover, fostering user-driven approaches to water management and decision-making is essential for effective and sustainable solutions. NASA's WWAO has identified six critical areas in water management, each containing various needs that could benefit from NASA Earth science observations and capabilities. These include water availability, use, quality, and infrastructure; extreme events; and watershed health and management. The goal of WWAO is to increase use of NASA Earth Observations (EO) by water organizations in the western US and maximize the impact of NASA EO and capabilities to improve water management in these complex water management environments. WWAO was established to further the Earth Action Water Resources Program Area goals by leveraging the broader Water Resources Program and contributing to Earth Science Division achievements. The program aims to engage both water managers and scientists to identify and co-develop promising EO-informed solutions and partner with organizations to transition these solutions into operations. Nikki Tulley serves as the Impact and Transition Lead for the WWAO Program Office, thus the plans outlined below pertain to that specific role.

Accomplishments

- Worked with Metropolitan Group to co-author new ways to think about WWAO's impact and transition. Focused on developing WWAO actions to organize values identifying ways that the program makes an impact.
- WWAO Final Mile Project Quarterly Report meeting with Implementing a Surface Water Monitoring Dashboard for Colorado using NASA's Western Land Data Assimilation System (WLDAS), October 2024. This project is aimed at analyzing the WLDAS outputs more for drought monitoring and other applications. This quarter focused on adding more outputs to

the drought dashboard, analyzing evapotranspiration estimates, and integrating soil moisture products.

- WWAO Final Mile Project Quarterly Report meeting with Implementing a Surface Water Monitoring Dashboard for Colorado using NASA's WLDAS, March 2025. In this quarter the aim was focused on adding more outputs to the drought dashboard with evaporation graphics, meeting with partners and stakeholders, working with graduate students to analyze data, and integrating soil moisture products.
- Attended and presented at WWAO Annual Meeting in Albuquerque, NM, on the funded WWAO Final Mile Project with the Navajo Nation Drought Severity Tool stakeholder engagement. This panel presentation was aimed at discussing WWAO stakeholder engagement through Final Mile Projects.
- WWAO Final Mile Project Quarterly Report meeting with JPL on the US Bureau of Reclamation (USBR) NM Evapotranspiration (ET) Toolbox, June 2025. This quarter focused on integrating and testing ET toolbox, streamlining codes, working towards steps to hand products over to partners. Meetings between JPL, WWAO, and USBR took place to discuss final steps in the project to begin working towards closure.
- WWAO Final Mile Project Quarterly Report meeting with Implementing a Surface Water Monitoring Dashboard for Colorado using NASA's WLDAS, June 2025. In this quarter we worked towards adding more WLDAS output into the dashboard and continued analysis of soil moisture, snowpack, and water storage.
- Organizing ways to collaborate with Earth RISE on the USBR NM ET Toolbox to create deployment and scientific validations for the tool to support the Final Mile project. Creating more ways beyond this Final Mile Project to collaborate with Earth RISE and using this project as a starting point for these future opportunities to do cross-section projects.
- Creating a formalized process for selecting WWAO Final Mile Projects. This systematic process will help in selecting and funding projects based on WWAO goals and objectives.
- WWAO Great Basin Needs Assessment Workshop. Salt Lake City, UT. September 2025.

EARTH SCIENCE TECHNOLOGY

Decentralized, Distributed, Dynamic, and Context-aware Heterogeneous Sensor Systems (3D-CHESS)

Project Participants

BAERI: Vinay Ravindra, Sreeja Roy Singh

Texas A&M University: Daniel Selva (PI), Huilin Gao

Virginia Tech: George Allen

UCLA: Ankur Mehta, Yizhou Sun

JPL: Cedric David

Arizona State University: Paul Grogan

Project Description

This project explores a proof of concept technology at Technology Readiness Level 3 (TRL 3) for a context-aware Earth-observing sensor web, integrating space, aerial, and ground-based nodes. The system considers context awareness—enabling each node to collect, share, and interpret contextual data such as the capabilities/status of other nodes, its own capabilities and status and environmental conditions. This allows the network to dynamically respond to task requests in alignment with broader mission objectives. The project also explores the development of an eco-system of open-source tools for AI-assisted analysis and tradespace exploration of Earth science missions and campaigns.

Accomplishments

See list below for publications that have resulted from our research.

Publications

Ben Gorr, Alan Aguilar Jaramillo, Huilin Gao, Daniel Selva, Ankur Mehta, Yizhou Sun, Vinay Ravindra, Cédric H. David, and George H. Allen. “Decentralized Satellite Constellation Replanning for Event Observation.” Journal of Spacecraft and Rockets (Jan 2025): 1–19.

David Fornos, Daniel Selva, Alexander Demagall, Paul Grogan, Vinay Ravindra, “Flexible Open-Source Tool Ecosystem for Automated Tradespace Analysis and Exploration of Earth Observation Missions”, accepted at 2025 IEEE International Geoscience and Remote Sensing Symposium, Australia, August 2025.

Vinay Ravindra, Molly Stroud, George Allen, Daniel Selva, Sarah Godsey, Ken Fritz, Jacob Honsen, Michelle Busch, and Shang Gao. “Optimizing Monitoring Routes for Electric Vehicles With Access to Multiple Charging Stations Using Mixed Integer Programming: Case Study With Non-Perennial Rivers.” In AIAA SCITECH 2025 Forum, p. 2284. Jan 2025.

Alan Aguilar Jaramillo, Ben J. Gorr, Huilin Gao, Ankur Mehta, Yizhou Sun, Vinay Ravindra, Cedric David, George Allen, and Daniel Selva. “Decentralized Consensus-Based Algorithms for Satellite Observation Reactive Planning With Complex Dependencies.” In AIAA SCITECH 2025 Forum, p. 1148. Jan 2025.

Alan Aguilar, Benjamin J. Gorr, Huilin Gao, Ankur Mehta, Vinay Ravindra, Cedric H. David, George H. Allen, and Daniel Selva. “Decentralized Consensus-based Planning Algorithms for Monitoring Inland Bodies of Water with Autonomous Sensor Webs.” Poster presented at the American Geophysical Union Fall Meeting, Washington, DC, December 9–13, 2024.

Commercial Satellite Data Acquisition; Synthetic Aperture Radar (CSDA SAR) FireSense

Project Participants

BAERI: Taejin Park, Khuong Tran, Ju-Mee Ryoo

Oak Ridge Associated Universities (ORAU) (NPP): Aakash Chhabra

Project Description

Low-latency, high-resolution mapping of burned areas and burn severity is critical for rapid response to fire impacts, efficient resource allocation, and recovery planning. Umbra’s microsatellite constellation, with its timely data delivery and dynamic tasking capabilities, offers significant potential to enhance our ability to collect data in response to short-term, unpredictable Earth system events. This project aims to assess the capability of Umbra’s X-band Synthetic Aperture Radar (SAR) data to characterize rapidly changing fire-affected landscapes during NASA’s FireSense airborne campaigns.

Specifically, we will address two key research questions:

1. What is the accuracy of burned area and burn severity maps derived from Umbra data?
2. Under what conditions does Umbra X-band SAR provide added value over existing spaceborne assets for capturing fine-scale variability in post-fire impacts?

To achieve these goals, this project will pursue three objectives:

1. Evaluate data accessibility and user support through dynamic tasking requests by testing Umbra’s Canopy tasking system during both prescribed burns and unplanned wildfires.
2. Assess data quality, metadata, and its utility for fire-impact assessments through time series analyses of burned areas and burn severity.
3. Leverage the OptiSAR framework to enhance post-fire assessments through the integration of optical and SAR data, supported by airborne and ground measurements from FireSense.

This evaluation will provide valuable insights to the CSDA program manager and inform the broader community about Umbra's potential for rapid tasking and fire-related applications. Ultimately, the proposed work supports NASA's Earth Action strategy and complements ongoing efforts, including the FireSense project, the Disasters program, and the NISAR mission, by demonstrating how multi-sensor systems—civilian and commercial—can improve our responsiveness to rapidly evolving Earth system events.

Accomplishments

- The project team closely collaborated with the FireSense Project office to coordinate Umbra data tasking over four planned prescribed fire sites and two wildfire locations (2024 Winter Australia fire and 2025 January LA fire). Except Fishlake State Forest, all data collection and prescribed fires were executed successfully (Figure 1).

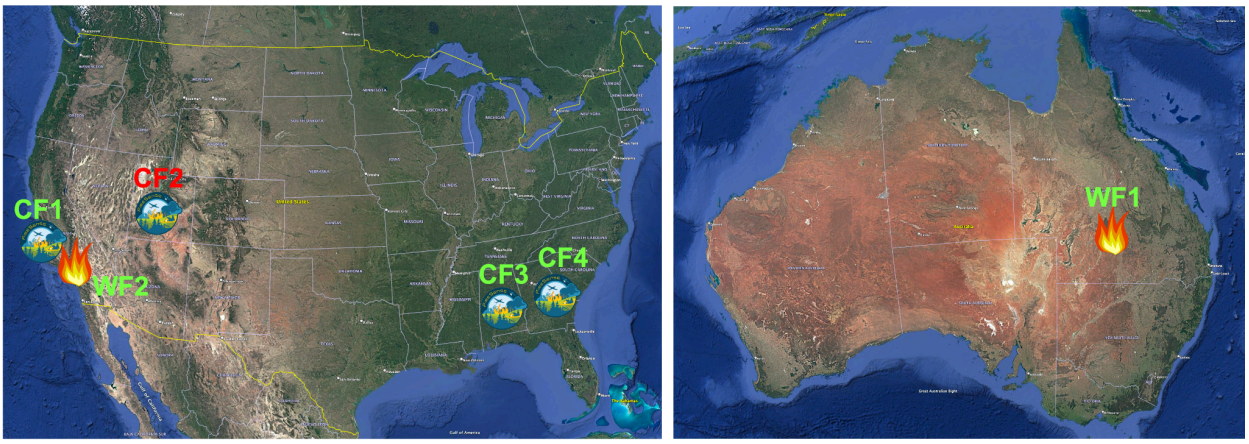


Figure 1: Locations of Umbra tasking sites for controlled fires (CF) and wildfires (WF): CF1- TREX Sedgwick Reserve Burn, CF2 - FASMEE Fishlake National Forest Control Burn CF3 - Alabama Conservancy Geneva State Forest Control Burn, CF4 - DoD Innovation Land Fort Stewart Burn, WF1 - Australia bush fire, and WF2-Southern California Eaton and Palisades fires.

- The investigation over a wildfire in Australia active fire highlights the potential of Umbra X-band SAR tasking as a valuable tool for tracking the progression of active wildfires, providing critical information to support rapid response, damage assessment, and post-fire recovery efforts (Figure 2).

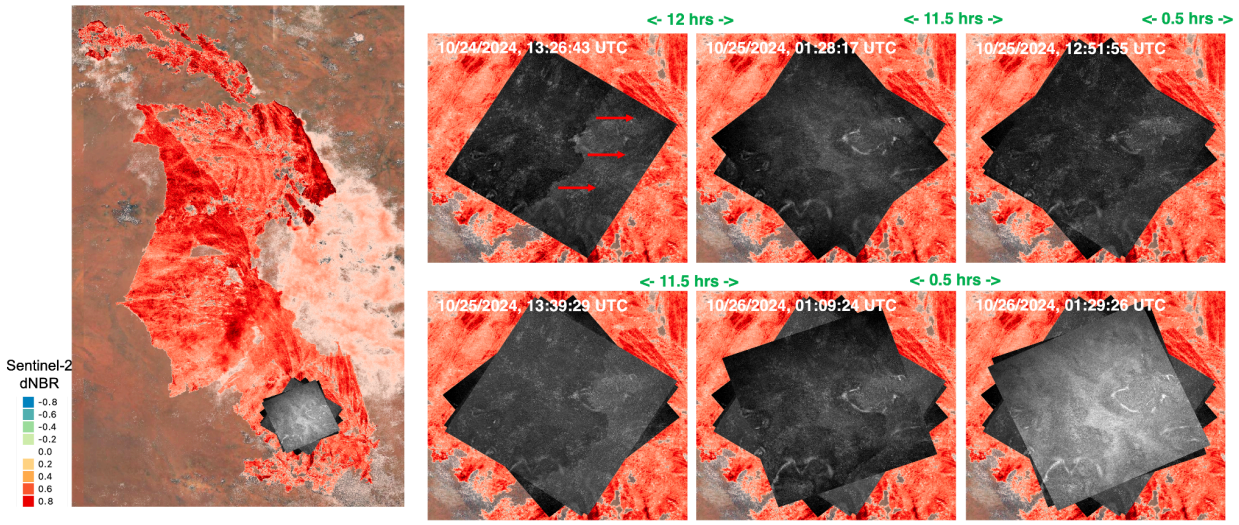


Figure 2: Umbra VV backscatter data were collected over a wildfire that occurred in Australia during the week of October 24, 2024. This demonstrates the potential of Umbra X-band SAR tasking for tracking active fire progression.

- Umbra X-band VV backscatter data were collected over the Palisades Fire to investigate the sensitivity of SAR signals to fire-induced structural damage in urban environments. Comparisons with optical Maxar WorldView-3 imagery and multitemporal LiDAR data highlight that increases in backscatter are clear indicators of wildfire-related structural damage (Figure 3).

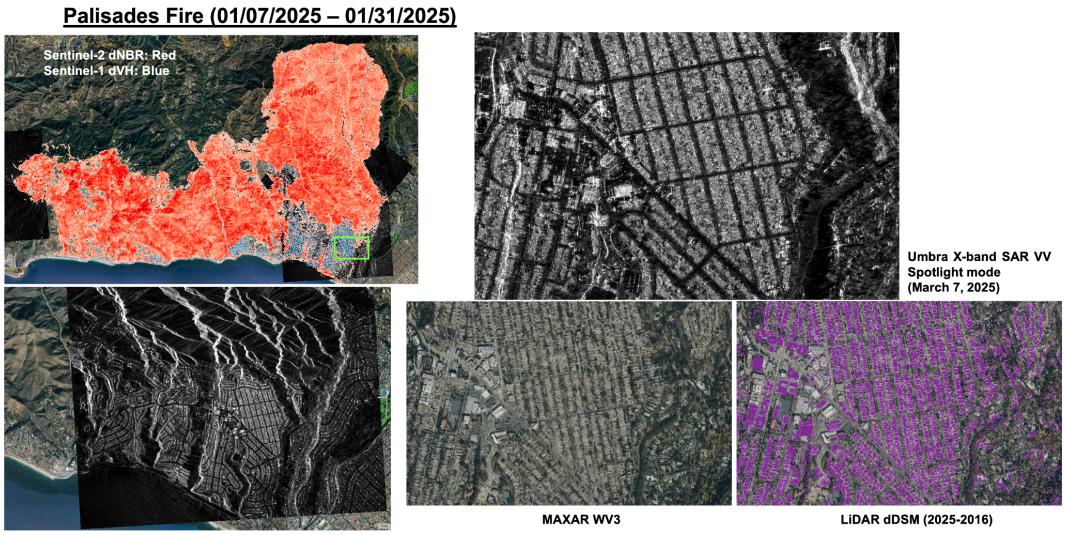


Figure 3: Examples of Umbra VV backscatter data over the Palisades Fire. Multitemporal Maxar WorldView-3 and LiDAR data indicate that Umbra X-band VV backscatter is sensitive to structural damage in urban areas.

Presentations

Park, T., Tran, K., Chhabra, A. Embracing CSDA-Supported Spaceborne SAR Data in NASA FireSense Airborne Campaigns, CSDA Program Umbra Mid-term Evaluation, March 11, 2025.

Publications

Chhabra, A., Park, T., Brosnan, I. Opti-SAR: Enhancing vegetation disturbance mapping using multi-wavelength and multi-agency integration, in preparation.

Panels or Committees

Taejin Park serves on CALFIRE's California Statewide Fire Severity Technical Advisory Committee.

Distributed Spacecraft with Heuristic Intelligence to Enable Logistical Decisions (D-SHIELD)

Project Participants

BAERI: Sreeja Roy Singh, Vinay Ravindra, Ryan Ketzner

Collaborators

NASA Ames Research Center and KBR Wyle Services, LLC: Richard Levinson

San Jose State University: Adam Kochanski, Angel Farguell Caus

United States Geological Survey (USGS), South Dakota: Kurtis Nelson

University of Colorado, Boulder: Jan Mandel

University of Southern California: Mahta Moghaddam, Amer Melabari, Archana Kannan

University of Utah: Derek Mallia

Project Description

D-SHIELD is a suite of scalable software methods and frameworks that helps schedule payload operations of large constellations, with multiple payloads per and across spacecraft, such that the collection of observational data and their downlink, constrained by the constellation constraints (orbital mechanics), resources (e.g., power), and subsystems (e.g., attitude control) results in maximum science value for a selected use case. Constellation topology, spacecraft, and ground-network characteristics can be imported from design tools or existing constellations and serve as elements of an operations design tool. The framework includes a science simulator to inform the scheduler of the predicted value of observations and hence operational decisions.

We are developing D-SHIELD in the context of wildfire response with remote-sensing data from Global Navigation Satellite System Reflectometry (GNSS-R) satellites. Alongside our collaborators, we will develop an adaptive, intelligent, and responsive observation strategy, which will produce actionable intelligence for incident management teams from GNSS-R-derived fire-data products feeding into fire-danger and active fire-prediction models. The system will demonstrate how autonomous tasking of satellite observations and downlinks can be used to optimize the data collection needed in operational fire-modeling systems and provide important tools needed for monitoring wildfires responsively in near real time.

Accomplishments

- Developed a Monte Carlo Tree Search (MCTS) approach for scheduling satellite-observation and downlink operations, with simulation studies for pre- and active fire monitoring over the Continental US (CONUS) region.
- Currently streamlining and enhancing the fidelity of mission operations simulation software (EO-Sim).
- Ongoing development of data products using GNSS-R Cyclone Global Navigation Satellite System (CYGNSS) data for wildfire applications. This includes creating a burned-area product, enhancing the USGS Fire Danger product, enhancing LANDFIRE products, retrievals of soil-moisture, and experimenting with joint retrievals of soil moisture and vegetation water content.
- Continuing progress in developing a Machine Learning (ML)-based wildfire-severity predictor for the CONUS region. This tool will aid in driving satellite observations and optimizing resource utilization.
- Progress in assimilation of GNSS-R derived burned area product into active fire simulations.
- Progress on USGS-based utilization of First Order Fire Effects Model (FOFEM)-generated data products (from the SJSU-based WRFx simulator) for the LANDFIRE product enhancement

Presentations

Jan Mandel, Samira Alkaee Taleghan, Angel Farguell, Archana Kannan, Adam Kochanski, James Haley, Cheng Da, Farnoush Banaei-Kashani, Basma Tumi, Sreeja Roy-Singh, Kyle A. Hilburn, Mahta Moghaddam, and Vinay Ravindra. “Machine Learning-Based Data Assimilation of Satellite Data in the Coupled Atmosphere-Fire Model WRF-SFIRE.” In 2025 AMS Denver Summit, May 2025.

A.K. Kochanski, H. Levander, A. Farguell Caus, J. Mandel, S. Roy-Singh, “A Customizable Fire Weather Index for Predicting Wildfire Size and Duration Leveraging Machine Learning.” American Meteorological Society (AMS) Denver Summit, Denver CO, May 2025.

J. Mandel, B. Tumi, S. A. Taleghan, A. Farguell, J. Haley, A. Kannan, A. Kochanski, C. Da, S. Nag, K. Hilburn, M. Moghaddam, V. Ravindra, “Enhanced Fire Detection and Simulation Using Multi-Satellite Data Assimilation and CYGNSS Reflectometry in the Coupled Atmosphere-Fire Model WRF-SFIRE.” American Geophysical Union Fall Meeting, December 2024.

Publications

Richard Levinson, Vinay Ravindra and Sreeja Nag. “Optimal Planning to Coordinate Science Data Collection and Downlink for a Constellation of Agile Satellites with Limited Storage.” accepted in the 34th International Joint Conference on Artificial Intelligence (IJCAI-25), Montreal, Canada, 2025.

Sreeja Roy-Singh, Vinay Ravindra, Richard Levinson, Mahta Moghaddam, Jan Mandel, Adam Kochanski, Angel Farguell Caus, Kurtis Nelson, Samira Alkaee Taleghan, Archana Kannan, Amer Melebari. “Optimal Planning and Machine Learning for Responsive Tracking and Enhanced Forecasting of Wildfires using a Spacecraft Constellation.” accepted in the Artificial Intelligence & Sustainability Workshop 14, IJCAI25, Montreal, Canada, 2025.

Kurtis Nelson, Sreeja Roy-Singh, Vinay Ravindra, Mahta Moghaddam, Archana Kannan, Amer Melebari. “Integration of GNSS-R Derived Soil Moisture into the USGS Wildland Fire Potential Index.” accepted at 2025 IEEE International Geoscience and Remote Sensing Symposium, Australia, August 2025.

Archana Kannan, Amer Melebari, Grigorios Tsagkatakis, Angel Farguell, Kurtis Nelson, Adam Kochanski, Vinay Ravindra, Sreeja Nag, Chris Ruf, Mahta Moghaddam. “Enhanced Mapping of Wildfire-Burned Areas using GNSS-Reflectometry RAW Intermediate Frequency Data.” accepted at 2025 IEEE International Geoscience and Remote Sensing Symposium, Australia, August 2025.

Large Scale Machine Learning with Evolutionary Algorithms

Project Participants

BAERI: Ramakrishna Nemani

Syracuse University: Subodh Kalia, Chilukuri K. Mohan

Project Description

Deep neural networks are typically trained using gradient-based optimizers such as error backpropagation. Gradient-based computations are one of the most time-consuming steps, which, if carried out on CPUs, pose major bottlenecks in terms of the run time for the training. Recent advancements in GPUs handle this issue; however, GPU resources are costly, overburdened, and always in high demand. To overcome these limitations and fully exploit existing traditional CPU cores, we developed a heuristics-based optimizer to train large-scale deep neural networks without gradients. We exploited that performing derivative-free inferences

was much faster than the gradient-based backpropagation. Our framework trained machine learning models using forward propagation only, and we showed scalability at the Pleiades supercomputer using up to 800+ CPU cores distributed across multiple nodes.

Accomplishments

We trained a Convolutional Neural Network (CNN) model with 4,381,449 parameters using the derivative-free optimizer on CPUs and backpropagation training on GPU. We used the NASA Earth Exchange-Global Daily Downscaled Projections (NEX-GDDP) dataset to train the models. We compared the following metrics between CPU- and GPU-based training: number of cores, RAM, batch size, number of simultaneous models, dataset passes through the model, Floating Point Operations (FLOPS) per sample, training time, Standard Billing Unit (SBU), and testing error statistics.

Presentations

Guest presentations at Syracuse University. Course: CIS 400/600, Evolutionary Machine Learning. Instructor: Professor Chilukuri K. Mohan. Sessions: Spring 2023, Spring 2025.

Publications

Subodh Kalia, Chilukuri K. Mohan, and Ramakrishna Nemani. 2022. *Evolutionary training of deep neural networks on heterogeneous computing environments.* In Proceedings of the Genetic and Evolutionary Computation Conference Companion (GECCO '22). Association for Computing Machinery, New York, NY, USA, 2318–2321.

EDUCATION, OUTREACH, AND WORKFORCE DEVELOPMENT

Applied Remote Sensing Training Program (ARSET)

Project Participants

BAERI: Sativa Cruz, Justin Fain

NASA: Juan Torres-Pérez

Project Description

As part of the Capacity Building Program, the Applied Remote Sensing Training Program, or ARSET, conducts online and in-person training designed with the user in mind. We have a variety of application areas, such as training focused on water resources, disasters, health and air quality, and land management. The Ecological Conservation team at NASA Ames focuses on land and wildfire training. This includes training on change detection, wildfire detection, tracking deforestation, freshwater monitoring, time series analysis, and more. Through ARSET, participants are introduced to the fundamentals of remote sensing, and can build and grow their skills; they learn how to find and download NASA data and to process and analyze data using geospatial software to aid in decision-making. Our materials are freely available in both English and Spanish: https://www.earthdata.nasa.gov/data/projects/arset.

These courses are for beginners and advanced practitioners alike. Since 2009, the program has reached over 100,000 participants from 170 countries and more than 8,500 organizations worldwide. The ARSET team at NASA Ames focuses on the application area of Land Management.

Accomplishments

- Delivered training: Field Spectroscopy hands-on training for airborne image validation
    - This training occurred the week of October 7, 2024 in Cape Town, South Africa and consisted of two sessions with hands-on exercises and lab time. Participants learned how to use spectroscopy instruments and record the spectral profiles of polluted water samples in the field. In the second session, participants returned to the lab to learn how to use the R programming language to process, graph, and draw conclusions about the spectral samples recorded in the field. This training was conducted in collaboration with the BioSCape team, ORNL DAAC, and the University of Wisconsin, Madison. The session was attended by approximately 40 participants representing local government and non-governmental organizations focused on resource conservation.
- Delivered training: Calculating Spectral Indices for Land and Aquatic Applications Using QGIS
    - This one-part training conducted on February 27, 2025 provided participants with an overview of spectral indices for land and aquatic applications as they are calculated with a QGIS platform. A number of land-based indices were discussed in the training such as

the Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), Soil-Adjusted Vegetation Index (SAVI), and Normalized Burn Ratio (NBR), along with their calculation, uses, and applications in diverse thematic areas (agriculture, disasters, etc.). Spectral indices primarily used in aquatic ecosystems, such as the Normalized Difference Chlorophyll Index (NDCI), Normalized Difference Aquatic Vegetation Index (NDAVI), Floating Algal Index (FAI), and Normalized Difference Turbidity Index (NDTI) for aquatic applications were also covered in this training. Participants were given the opportunity to calculate these indices across relevant study areas using the QGIS platform and encouraged to think critically about when and where certain indices might be appropriate to their research questions. This training saw 912 participants representing 450 organizations from 107 countries and 31 US states.

- Attended ARSET Retreat:
    - The ARSET team virtually attended the annual retreat for three days beginning April 8th, 2025. During the retreat we discussed future plans for the ARSET program, conducted exercises to improve our targeting of specific audience segments, and established best practices for creating trainings we could offer on a continuing basis through the planned implementation of a learning management system which allows for self-paced learning online.
- Delivered training series: Introduction to the Integration of Animal Tracking and Remote Sensing
    - This two-part training occurred on May 20 and May 22, 2025. The training provided participants with an overview of animal tracking sensors, NASA's history of animal tracking, NASA's Internet of Animals project, and the types of remote sensing data that can be paired with animal telemetry. Participants received hands-on experience using the R programming language to process and standardize data collected from animal tracking and its integration with time-coupled remote sensing observations for both marine and terrestrial applications.
- Hyperspectral Data for Land and Coastal Systems- LMS Conversion
    - The team converted a past training to be offered through our LMS. Description: Hyperspectral data presents a unique opportunity to characterize specific vegetation types and biogeochemical processes across the land and oceans. Applications of hyperspectral data include plant species identification, invasive species management, assessment of phytoplankton functional types, mapping of wetlands and shallow benthic communities, and detection of harmful algal blooms. The ability of hyperspectral data to characterize chemical, physiological, and morphological traits allows decision-makers to better understand critical components of ecosystem dynamics such as invasive species encroachment, forest decline and pest infestation, and ocean dynamics. This training is also an opportunity to build capacity in a large user community prior to the launch of the highly anticipated global hyperspectral SBG mission

- Produced FY26 Training Plan
- Remote Sensing for Invasive Species Mapping
    - This advanced training will focus on the use of NASA airborne data to map and monitor invasive plant species. It is a collaboration between NASA ARSET and the ORNL DAAC.

ASP: Communications

Project Participants

BAERI: Brenna Biggs, Gary Ash

Project Description

In addition to their science work, the Airborne Science Program (ASP) does outreach to K–12 schools, occasionally teaming up with the Global Learning and Observations to Benefit the Environment program (GLOBE) program to host students to collect their own scientific data concurrently with an airborne campaign. Many schools connect with the scientists virtually through Zoom and Mission Tools Suite, but as we gather support for more in-person opportunities, students will also have a chance to connect with scientists face-to-face. Biggs also attends the NASA SMD ESD Communications meetings on a weekly basis.

Note: ASP outreach is on hiatus as of June 2025.

Accomplishments

- 2025 NASA Group Achievement Award—Asia Airborne and Satellite Investigation Team
- Geological Earth Mapping Experiment (GEMx) outreach: Approximately 1,778 students from 32 schools, ranging from transitional kindergarten to grade 12, learned about GEMx through 61 customized virtual presentations during May 2025. Schools spanned eight US states and eight countries total.
- Plankton, Aerosol, Cloud, ocean Ecosystem Postlaunch Airborne eXperiment (PACE-PAX) outreach: Created and delivered 63 virtual presentations, reaching over 2,600 students in every grade from transitional kindergarten through grade 12 at 25 schools in three countries (US, South Africa, the Philippines). Three events were bilingually interpreted (two English/Spanish, one English/Tagalog). Virtual laboratory tours and research vessels tours were also offered during four presentations.
- UxS Meeting: Participated in weekly meetings with various government agencies (i.e., NASA, USGS, NOAA, BIE, FEMA) for planning an outreach, engagement, and recruiting event targeted toward tribal undergraduate students and high schoolers at Southwestern Indian Polytechnic Institute (SIPI) in New Mexico in September 2024.
- Continued to update the ASP website with News and Current Activities.

Panels

Contributions of the DC-8 to Earth System Science at NASA: A Workshop, October 24–25, 2024: Provided a voice for the importance of student outreach as NASA Airborne Science Program transitions from the historical DC-8 aircraft to the newly acquired B777.

CSUMB Educational Program

Project Participants

CSUMB: Susan Alexander

Students: Trent Taylor, Jon Logie, Jason Pham, Robin Fishman, Brandon San Luis, Joe Spota, Zachary Theodore, Darren Baty, Brandon Alexander

Project Description

The Department of Applied Environmental Science at CSUMB offers a Bachelor of Science degree in Environmental Science, Technology, and Policy (ESTP) and a Master of Science degree in Environmental Science (ENSCI). These interdisciplinary programs emphasize the critical thinking and technical skills necessary to develop workable solutions to complex environmental problems. Our 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 our 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 skillsets for students pursuing Earth system science careers.

The MS in ENSCI offers two degree options: Professional Science Master's (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. The PSM option within ENSCI emphasizes professional skillsets 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, students mature their skills learned in the classroom through professional internships. The program satisfies a demand for highly skilled professionals within environmental technology and applied science-based companies, governmental agencies, and nonprofit organizations.

The team will apply 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 will work to:

- Offer programs and career development opportunities within the Science, Technology, Engineering, and 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.
- Communicate results of our scientific activities through community outreach events, conferences, publications, and other venues.

Accomplishments

- Students participated in the CSUMB ARC-CREST Ag, Health, Marine, and Water Resources task, including being co-authors on several publications and presentations:
    - Purdy, A., C. Doherty, A. Guzman, J. Spotta, W. Carrara, L., Johnson, F. Melton. Modeling evapotranspiration from applied water and effective precipitation using OpenET. CSU WATER Conference, 10–11 Apr., 2025, Sonoma.
    - Biedebach, M., R. Solymar, J. Logie, B. San Luis, J. Spota, M. Villareal, C. Wang, A. Purdy, L. Johnson, M. Cahn, F. Cassel, F. Melton. Field level evapotranspiration monitoring. CSU ARI Agricultural Research Institute Annual Conference, 7 November, 2024, Sacramento.
    - Logie, J., Biedebach, M., Melton, F., Purdy, A. On-ground Live Fuel Moisture Content Sampling Along California's Central Coast. CSU ARI Agricultural Research Institute Annual Conference, 7 November, 2024, Sacramento.
- Joe Spota is currently completing his PSM through the Water, Agriculture, Technology and Remote Sensing (WATRS) Lab. The goal of Joe's PSM project is to curate a high fidelity metered irrigation or water diversion dataset and develop a systematic process to harmonize and QAQC metered data and place of use boundaries from disparate data sources. The dataset will be used to assess an effective precipitation model under development in the WATRS lab.

Fire&Air

Project Participants

BAERI: Samiah Moustafa, Jia Jung

California State University (CSU) Stanislaus: Wing To (Institutional PI)

NASA: Chris Potter, Jessica McCarty, Matthew Johnson

Project Description

Burning Issues in the Central Valley: Unraveling Fire's Influence on Air Quality, Fuel Mapping, and Carbon Dynamics.

Fire&Air is a two-year collaborative research and mentoring program between CSU Stanislaus and NASA Ames Research Center. The project supports NASA's research priorities by integrating satellite and ground-based Earth observations with machine learning and ecological data to address the growing wildfire-related air quality and climate risks in California's Central Valley.

The initiative pairs faculty and NASA subject matter experts (SMEs) with undergraduates from CSU Stanislaus, building capacity in environmental data science and atmospheric research. Fire&Air advances applied science for community benefit, climate adaptation, and workforce development in STEM, while generating tools and insights to inform land management and public health strategies.

Accomplishments

Advanced research on wildfire-climate-air quality interactions

- Linked NASA's AERONET ground-based atmospheric measurements with satellite data to study aerosol optical depth variations across the Central Valley.
- Developed machine learning (ML) models to correlate fire radiative power, weather parameters, and fuel characteristics, improving understanding of wildfire dynamics.

Promoted workforce development in STEM

- Recruited and mentored three undergraduates from CSU Stanislaus through a multi-tier mentorship model involving NASA scientists and CSU Stanislaus faculty.
- Delivered an eight-week structured training program on research communication, self-efficacy, group norms, and data analysis.

- Supported undergraduate presentations at NASA Ames, the American Geophysical Union Conference, and the Mentorship and Opportunities in STEM with Academic Institutions for Community Success (MOSAICS) meeting, enhancing visibility for emerging scholars.

Strengthened applied science and educational tools

- Designed web-based applications to visualize and correlate AErosol RObotic NETwork (AERONET) aerosol data, integrated into undergraduate atmospheric science courses to enhance student engagement and learning.

- Created digital twin models of Sacramento and Bakersfield to predict how land cover and land use changes affect atmospheric dynamics.

Responded to challenges and sustained student engagement

- Navigated funding disruptions from related programs by securing interim support for students to continue research activities.

- Shifted research resources and mentorship to an accessible Canvas platform, enabling continued collaboration, feedback, and skill development.

Contributed to NASA's climate and community benefit mission

- Produced actionable science linking wildfire risks, air quality, and land use change to support climate resilience and community health.

- Laid the groundwork for continued partnerships and proposed future funding to sustain research and program growth through NASA's MOSAIC program.

FireSage

Project Participants

BAERI: Samiah Moustafa, Kyle Kabasares

NASA: Keiko Nomura, Jessica McCarty, Matthew Johnson, and Juan Torres-Perez

University of California, Santa Cruz (UCSC): Bo Yang

San José State University (SJSU): Kate Wilkin (Institutional PI), Julia Gaudinski

Project Description

FireSage is a collaborative initiative led by SJSU in partnership with NASA Ames Research Center (ARC), supported under NASA's SJSU-ARC Bridge Seed Program. The project advances NASA's research priorities by integrating Earth observation data, cutting-edge remote sensing, and hands-on workforce training to address the growing wildfire crisis. The initiative

emphasizes applied science that supports climate adaptation, community resilience, and novel solutions for vulnerable regions impacted by wildfires.

Through hybrid internships, mentorships, and research partnerships, FireSage builds capacity in the next generation of STEM leaders while delivering actionable insights for Home Ignition Zone (HIZ) mitigation and post-fire forest recovery. By leveraging NASA datasets (e.g., National Agriculture Imagery Program (NAIP), Landsat, Sentinel-2, Global Ecosystem Dynamics Investigation (GEDI)) alongside emerging technologies (e.g., LiDAR, UAVs), FireSage contributes to the co-creation of knowledge and tools vital for federal, state, and local decision-making.

Accomplishments

Advanced wildfire science for climate resilience

- Developed integrated models combining NASA satellite data and field plots to assess burn severity and forest biomass change after the 2020 CZU Lightning Complex fire.
- Piloted HIZ detection methods using NAIP imagery, public records, and machine learning to evaluate defensible space and mitigation efforts.

Promoted STEM workforce development

- Recruited and mentored five interns from local institutions through a hybrid internship program.
- Provided hands-on training in NASA data analysis, Geographic Information System (GIS), remote sensing, and drone-based fieldwork.
- Supported mentorship from SJSU, NASA, and UCSC researchers, with students producing technical reports and presenting at NASA, SJSU, and national conferences (e.g., Association of American Geographers, American Geophysical Union).

Strengthened applied science for community benefit

- Produced preliminary tools and data products that can support state agencies, insurers, and community stakeholders in wildfire hazard assessments.
- Shared research findings through presentations at NASA, SJSU, and the NASA Mentorship and Opportunities in STEM with Academic Institutions for Community Success (MOSAICS) conference, with peer-reviewed publications in progress.

Enhanced data integration and method development

- Generated burn-severity maps using relativized differenced Normalized Burn Ratio (RdNBR) and predictive biomass models cross-validated with GEDI and field data.

- Identified limitations of NAIP imagery for HIZ classification and recommended integration of higher resolution datasets, such as LiDAR and WorldView imagery.

Local Engagement Team (LET)

Project Participants

BAERI: Nikki Tulley, Sativa Cruz, Victoria Ly, Elizabeth Arbuckle

NASA HQ: Natasha Sadoff, Tom Wagner

Collaborators

Marshall Space Flight Center: Daniel Irwin, Ashutosh Limaye, Kevin Horn, Eric Anderson

Project Description

The Local Engagement Team (LET) works within NASA's Capacity Building Program Area (CBP) in the EarthRISE program. LET seeks to support and cultivate efforts within communities and NASA to increase the use of Earth Observations (EO) to inform decisions, policies, and actions. The team's goal is to foster respectful and reciprocal relationships between NASA and communities to sustainably co-develop trainings, projects, and tools. LET continues to center place-based remote sensing training, community engagement, and creating intergovernmental Earth science opportunities. Through dialogue and discussion focused on end-user needs and priorities, our remote sensing trainings provide participants with the data and resources needed to address specific natural resource issues facing their lands.

Accomplishments

- Ran and/or participated in a total of 17 community engagement events and trainings. The work reached approximately 1,603 people in different communities across the United States and Canada. Selected events include:
    - October 16-18, 2024. IMW Canada, in collaboration with the Canadian Space Agency's (CSA) smartEarth team. (Series of 5 training sessions)
    - October 23-24, 2024; Geospatial Data Governance, USGS Headquarters, Reston, Virginia
    - Nov 18-22, 2024. 4th Southwest Fire Ecology Conference, Santa Fe, NM
    - Nov 25, 2024. Community Based Education (CBE) Symposium, Santa Fe, NM
    - Nov 20-21, 2024. Clear Lake Hitch Symposium, Clear Lake, CA
    - Dec 9-13, 2024. AGU, Washington, DC
    - Jan 15, 2025. NASA's AISES Webinar (virtual)
    - Feb 18-21, 2025 CBP Retreat, Shepherdstown, West Virginia.
    - March 5, 2025, ORNL DAAC UWG Orientation (Liz Arbuckle was recently appointed to the Oak Ridge National Laboratory Distributed Active Archive Center User Working Group)

- March 26, 2025, GEMx Engagement meeting with community members in northern Nevada. (virtual)
- April 16, 2025, NASA Earth Capacity Building Program presentation (virtual)
- April 17, 2025, Webinar series, “Connect the Drops”. NASA’s Western Water Action Office (WWAO) (virtual)
- May 14, 2025, Panel session, “Bridging NASA Research and Water Management Communities.” WWAO Annual Meeting, Albuquerque, New Mexico

Student Airborne Research Program (SARP)

Project Participants

BAERI: Jaden Ta, Joelle Hopkins, Rachel Wegener, Sam Kim, Stephanie Olaya

NASA: Barry Lefer, Erin Czech, Jack Kaye, Roy Johnson, Ryan Pavlick, Sommer Nicholas, Yaitza Luna-Cruz

Arctic Slope Regional Corporation: Cynthia Hall

Faculty:

- California State University, San Bernardino: Andreas Beyersdorf
- San Diego State University: Daniel Sousa
- University of California, Irvine: Donald Blake
- University of New Hampshire: Stacey Hughes
- Virginia Commonwealth University: Brandon Alveshere, Chris Gough, Lisa Haber
- Woods Hole Oceanographic Institution: Tom Bell, Henry Houskeeper
- William & Mary: Dominick Ciruzzi

Graduate Mentors:

- Disha Sardana, Sufian Aldogom
- Georgia Institute of Technology: Katie Paredero
- San Diego State University: Megan Ward-Baranyay
- University of Arizona: Kayla Preisler
- University of California, Riverside: Bradley Ries
- University of California, Los Angeles: Camille Pawlak
- University of California, Santa Barbara: Sarah Payne

- University of Connecticut: Oluwaseun Akinola
- University of Rhode Island: Sarah Lang

Students:

- SARP East Cohort: Aashi Parikh, Alek Libby, Carson Turner, Carolyn Chen, David Jeffery, Eli Mally, Ellery Moore, Emmanuel Kaiser-Veyrat, Ethan Bledsoe, Hannah Suh, Joshua Chapin, Katherine Wilson, Kaylena Pham, Mohammad Matonding, Philip Espinal, Quinn Koch, Rachel Faessler, Rylee Chafin, Sara Typrin, Sarah Gryskewicz, Sumaya Tandon, Tj Ochoa Peterson, Ty Kaji (dismissed)
- SARP West Cohort: Alexander Lacayo, Brianna Francis, Charlotte Perry, Eli Garcia, Grace Woerner, Jacob Garside, John Lund, Justin Staley, Kiersten Sunell, Kyra Shimbo, Lilly Kramer, Maria McKellar, Martha Santiago, Melanie Lin, Morgan Rasic, Nimay Mahajan, Owen Rader, Patricia Sibulo, Riley Gallen, Robert Purvis, Ryan Glenn, Sarah Kinlaw, Stephen Shaner, Timothy Jewell

Project Description

The NASA Student Airborne Research Program (SARP) is an 8-week long internship that allows undergraduate students in Science, Technology, Engineering, and Mathematics (STEM) fields to conduct their own research in airborne science. Topics include whole air sampling, atmospheric aerosols, and remote sensing of terrestrial ecology and the ocean. SARP selects a total of 48 students, split in half between SARP East and West cohorts. Each cohort is divided into four groups of six, each focusing on a different topic and led by faculty and graduate student mentors. Before flying on scientific research flights, students attend rigorous lectures and receive training about climate change, coding, each of the four research areas, and instrumentation. SARP East flights are based out of Wallops Flight Facility (WFF) in Wallops Island, Virginia, and SARP West flights are based out of the Guardian Jet Center in Ontario, California. 2025 flights utilized NASA's P-3 Orion and Dynamic Aviation's B200.

Once the flights are completed, students travel to ground truthing locations to collect additional samples from the ground to validate those collected from the airplane. They spend the remainder of the summer at either the University of California, Irvine or Virginia Commonwealth University analyzing data and executing their own individual research projects. Students continue to attend various presentations about coding and science throughout the summer. At the end of the program, students present their findings to their cohort, mentors, and NASA personnel.

Accomplishments

- Selected 48 students from across the United States from various academic and personal backgrounds to participate in the program.

- Recruited 11 faculty members and 10 graduate students to act as mentors for the duration of the program.
- Conducted 40 hours of science flights to collect samples and data.
- Supported each of the 8 groups to conduct field trips to various locations for ground truthing: on the West coast the Whole Air Sampling and Atmospheric Aerosols Groups collected samples at the Salton Sea; the Oceans Remote Sensing Group collected samples in the Santa Barbara Channel, and the Terrestrial Ecology Group visited the Sedgwick Reserve. On the East coast the Atmospheric Science group collected samples at the Dismal Swamp and Alligator River; the Oceans group collected samples at the Virginia Coastal Reserve; the Terrestrial Fluxes group collected samples at the Rice Rivers Center, and the Hydroecology group collected samples near William and Mary University.
- Invited a variety of scientists to share their backgrounds, experiences, and expertise with the students, with the goal of inspiring the students to attend graduate school and remain in STEM.
- Supported lodging and transportation for the mentors and students, as well as weekend enrichment activities, for the entirety of the summer.
- Hosted students in-person and virtually to present their final projects at the end of the program to their cohort and guests.

PRESENTATIONS

“Assimilation of SMAP Global Freeze Thaw (FT) Products to Improve the CASA Ecosystem Model and Our Understanding of Northern Latitude Carbon Fluxes and Wildfire Impacts.” 18th SMAP Science Team meeting, held April 22–24, 2025.

AI/ML Enhancements to the NASA Celestial Mapping System: NASA/US Space Force/US Air Force Research Lab—Joint Technology Innovation Workshop.

AirSHARP (Airborne asSessment of Hyperspectral Aerosol optical depth and water-leaving Reflectance for PACE), Guild, LeBlanc, Kudela, Pistone, Bucholtz, Eilers, Dunagan, Negrey, Sirio, and Flynn, PACE Validation Science Team, 18–21 February 2025, NASA Goddard Institute for Space Studies (NASA GISS), PAC^3 STM.

Awasthi, A., Kabasares, K.K., Nguyen, H.V., Brosnan, I.G., Park, T. (2024, December 9-13). Refined Urban Mapping: Integrating LIDAR Data and Aerial Imagery for Enhanced Semantic Segmentation of Trees and Buildings. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Biedebach, M., R. Solymar, A. Purdy, F. Cassel, L. Johnson, F Melton. On-Ground observations of water fluxes over bare soil—San Joaquin Valley, CA. AGU Annual Meeting, 9–13 Dec., 2024, Washington DC (#H11Q-0918).

Biedebach, M., R. Solymar, J. Logie, B. San Luis, J. Spota, M. Villareal, C. Wang, A. Purdy, L. Johnson, M. Cahn, F. Cassel, F. Melton,. Field level evapotranspiration monitoring. CSU Agricultural Research Institute Annual Conference, 7 November, 2024, Sacramento.

Biedebach, M., R. Solymar, M. Cahn, A. Purdy, L. Johnson. Measuring evapotranspiration rates in commercial broccoli fields - Salinas Valley, CA. Amer. Soc. Horticultural Science Annual Conference, 28 July–1 Aug., 2025, New Orleans.

Brosnan, I.G. (2024, July 30). NASA Earth Climate Modeling & Protection. [Presentation]. INNOVIT: Space Economy Acceleration Program. San Francisco, CA, USA.

Brosnan, I.G. (2024, November 1). PublicNEX Computing & Simulation. [Presentation] CITRIS & Berkeley Space Center Innovation Intensive for Bay Area Start-ups. Mountain View, CA, USA.

Brosnan, I.G. (2024, October 28) NASA Assets Monitoring from the Sky and Ocean. [Presentation]. Terna Innovation Forum. San Francisco, CA, USA.

Brosnan, I.G., Berndt, E. (2025, March 6). iESO Lessons from NEX & SPoRT. [Workshop presentation] Integrated Earth System Observatory Workshop, Washington, DC, USA.

Brosnan, I.G., Berndth, E.B., Lee, K., Wang, W., & Lee, T.J. (2024, December 9–13). Climate Information and Lessons Learned from the NASA Earth eXchange (NEX), Short-term Prediction Research and Transition Center (NASA SPoRT), and the NASA Regional Climate Model

Evaluation System (RCMES). [Poster session] AGU Annual Meeting, Washington, DC, United States.

Cahn, M., L. Johnson, M. Biedebach, A. Purdy, R. Solymar, F. Melton, S. Zhuang, L. Bettiga. CropManage online decision support tool for irrigation scheduling of vineyards. GiESCO Congress (Group of International Experts in Vitivinicultural Systems for Cooperation), 27–31 July, 2025. Geisenheim Germany.

Chandanpurkar, H., … Purdy, A.J., Continental Drying, Changing Freshwater Availability, and Sea Level Rise. AGU Annual Meeting, 9–13 Dec., 2024. (Oral, #H42I-03).

Chhabra, A., including (Park, T) (2025, April 27 - May 2). Synergistic use of Optical and SAR observations for Enhancing Forest Structure and Biomass estimation. [Conference presentation] 2025 European Geophysical Union Annual Meeting. Vienna, Austria.

Chhabra, A., including (Park, T) (2025, August 3–8). OptiSAR Framework for Enhanced Forest Disturbance Monitoring: Application to Fire Severity Mapping in Australian Forests Using Multi-Sensor Satellite Data. [Conference presentation] 2025 IEEE International Geoscience and Remote Sensing Symposium. Brisbane, Australia.

CMS_USGS Year-end Report. NASA/USGS Mini-Summit to assess progress in the enhancements of the NASA Celestial Mapping System and the plan ahead

Code TI All-hands Tech Talk. Presented “Federated Learning using In-Space Data” to all code-TI. June 4, 2024.

Code TI Seminar. Presented to Code TI all-hands: “Project FLUID and the imperative to link terrestrial and space-borne data for the next generation of AI models.” May 6, 2025.

Conference on Planetary subsurface exploration for science and resources - In-person USGS/NASA co-sponsored conference at Ames. Presented to 105 attendees “AI enhanced data-pipeline for the detection of lunar subsurface resources.” May 22, 2024.

Dang, C., Hyman, C., Iraci, L., Mattioda, A., Rehnmark, F., Sobron, P., Davila, A., Gentry, D. Optical Spectroscopy and Analysis Methods of Venus Aerosol Analogs. AGU 2024, Washington D.C.

Dang, C., Iraci, L., Mattioda, A., Sobron, P., Hyman, Rehnmark, F., Davila, A., Gentry, D. Instrumentation for In-Situ Analysis of Venus Aerosol. Cloud Workshop, Caltech. June 25, 2025.

Doherty, C.T., Brosnan, I.G., and Wang. W. (2024, December 9–13). Characterizing Spatiotemporal Uncertainty in Interpolated Meteorological Data. [Poster session] AGU Annual Meeting, Washington, DC, United States.

Ellis, Thomas; Alok Shrestha; Gary Hoffmann; Haiping Su; Roseanne Dominguez; James Jacobson; Matthew Birkebak. “Spectroradiometric Calibration Facilities at the NASA Ames Airborne Sensor Facility. CalCon 2025.

FireSense hosted “On the Fireline: a FireSense Conversation” with guests Ben Strahan, Superintendent of the El Dorado Interagency Hotshot Crew, and Linda Chappell, a USFS retired Incident Management Team Planning Section Chief on January 17, 2025. Ben and Linda presented to 34 members of the Implementation Team on their practical experience fighting wildfires and their perspectives on improving the flow of information for frontline decision makers.

FireSense hosted members from the OpenET science team on January 10, 2025, with guests AJ Purdy and Forrest Melton, both senior research scientists in the Department of Applied Environmental Science at CSU Monterey Bay and the NASA Ames Research Center Cooperative for Research in Earth Science and Technology (ARC-CREST). Purdy and Melton presented to members of the Implementation Team on the success of OpenET and its potential to inform wildland fire decision making and planning.

FireSense Implementation Team: Presentation on above LCS pitch at the FSIT annual review meeting, June 9–10.

FireSense Project hosted its Annual Review on June 9 and 10, 2025, which included presentations from 22 FireSense Implementation Team and FireTech Projects. The Review also included breakout group discussions dedicated to Research to Operations, Campaign Planning, and Cross-project Coordination.

FireSense Project Manager Jennifer Fowler gave the invited presentation “Addressing Critical Knowledge Gaps on Wildland Fires with UAS Technology” for a session part of the Joint Session J1A and titled “Wildfire Influence on Aerosol, Cloud, and Climate I” (Joint between the 17th Symposium on Aerosol Cloud Climate Interactions and the 27th Conference on Atmospheric Chemistry) at the American Meteorological Society in New Orleans on January 13.

Gilmour, M.E. (2025, April 1–3). Frigatebirds provide a novel PBL-observing technology [Paper presentation] PBL Community Meeting, Silver Spring, MD, United States.

Gilmour, M.E., Adams, J., Albores-Barajas, Y., Castillo-Guerrero, J.A., Clark, B.L., Clarke, R., Costantini, D., Cruz, S., Leat, E., Maxwell, S.M., Mott, R., Oppel, S., Pavlick, R., Rattenborg, N., Sebastiano, M., Shaffer, Soldatini, C., S.A., Vallarino, A., Weber, S., Wegmann, A.S., Weimerskirch, H., & Brosnan, I.G. (2025, July 29–August 1). Frigatebirds monitor marine planetary boundary layer dynamics [Poster presentation] AOGS Annual Meeting, Singapore.

Gilmour, M.E., Adams, J., Castillo-Guerrero, J.A., Clark, B.L., Costantini, D., Cruz, S., Khajehei, S., Leat, E., Maxwell, S.M., Oppel, S., Pavlick, R., Rattenborg, N., Sebastiano, M., Shaffer, S.A., Vallarino, A., Weber, S., Wegmann, A.S., Weimerskirch, H., & Brosnan, I.G. (2024, December 9–13). Frigatebirds monitor planetary boundary layer dynamics across multiple ocean environments [Poster presentation] AGU Annual Meeting. Washington, DC, United States.

Gilmour, M.E., Adams, J., Castillo-Guerrero, J.A., Clark, B.L., Costantini, D., Cruz, S., Khajehei, S., Leat, E., Maxwell, S.M., Oppel, S., Pavlick, R., Rattenborg, N., Sebastiano, M., Shaffer, S.A.,

Vallarino, A., Weber, S., Wegmann, A.S., Weimerskirch, H., & Brosnan, I.G. (2025, April 1–3). Frigatebirds monitor planetary boundary layer dynamics across multiple ocean environments. [Poster presentation] PBL Community Meeting, Silver Spring, MD, United States.

Guzman, A., C. Doherty, A. Purdy, F. Melton, L. Johnson. Mapping effective precipitation and ET of applied water using OpenET and GEE. AGU Annual Meeting, AGU Annual Meeting, 9–13 Dec., 2024 (#H23F-1065).

Halverson, G., … Purdy, A.J., … et al., Open-Science Development of Thermally Sensitive Evapotranspiration Products for the ECOSTRESS and SBG Missions. 2024. (#GC41H-0029).

Hashimoto, H. including (Park, T) (2025, July 27–August 1). Detecting Vegetation Response to Rainfall and Droughts by Vegetation Productivity Indices from Abi and Tempo Over the US Drylands. [Conference presentation] 2025 Annual Asia Oceania Geosciences Society meeting. Singapore.

Hashimoto, H. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Change Detection and Attribution Product. WERK Kick-off meeting at CNRA, May 13, 2025.

Hashimoto, H., Wang, W., Park, T., Brosnan, I.G. (2024, December 9–13). Toward community-driven terrestrial ecosystem science using international geostationary satellites and ground-observation networks: a case intercomparison study of GeoNEX and NOAA products. [Conference presentation] AGU Annual Meeting, Washington, DC, United States.

Hashimoto, H., Wang, W., Park, T., Brosnan, I.G. Toward community-driven terrestrial ecosystem science using international geostationary satellites and ground-observation networks: a case intercomparison study of GeoNEX and NOAA products, 2024 AGU Fall Meeting.

Hoffmann, Gary; Thomas Ellis; Haiping Su; Roseanne Dominguez; Eric Fraim; Alok Shrestha; James Jacobson; Steven Platnick; G. Thomas Arnold; And Kerry Meyer. “Introducing NASA’s Pushbroom Imager for Cloud and Aerosol Research and Development (PICARD): a compact hyperspectral radiometer for ER-2 and G-III aircraft.” Optica 2025.

Hsu, C.-H., D. Henze, A. P. Mizzi, B. McDonald, C. Harkins, C. Lyu, J. He, and R. Schwantes (2024, December 9–13): Intercomparison of top-down estimates of anthropogenic and soil NOx emissions using TEMPO and TROPOMI NO2 remote sensing observations in the US [Conference presentation] 2024 AGU Annual Meeting, Washington, D.C.

J Jung, MS Johnson, AH Souri, R Kumar, 2025, Top-down estimate of NOx and NMVOC emissions over the CONUS for the summers of 2019-2021: assessing the benefits of improved satellite remote-sensing observations, 105th Annual AMS Meeting 2025.

Johnson, L. A. Purdy, M. Biedebach, M. Cahn, D. Chambers, N. Cabrera. Validating OpenET satellite measurements of water use in broccoli and lettuce. UCCE Irrigation and Nutrient Management Meeting, 19 Feb., 2025, Salinas. (invited).

Johnson, L., M. Cahn, N. Cabrera, D. Chambers. Verification of satellite estimates of horticultural crop canopy cover in the Salinas Valley. AGU Annual Meeting, 9–13 Dec., 2024, Washington DC (#H06-63).

Kabasares, K.K., Park, T., Khajehei, S., Brosnan, I.G. (2024, December 9–13). Developing an Open-Source USGS 3DEP Data Processing Workflow for Actionable Products. [Conference presentation] AGU Annual Meeting, Washington, DC, United States.

Keiko Nomura and Taejin Park attended the Biodiversity Monitoring Workshop between June 9–11 2025 in Davis, CA.

Keiko Nomura attended the California 30x30 Partnership 2024 Summit between October 2–4 2024 in Sacramento, CA.

Knobelspiesse et al., “PACE-PAX Post-campaign data discovery and plans.” PACE-PAX Science Team Meeting, NASA GISS, New York, February 2025.

Kochanski, A.K.; H. Levander; A. Farguell Caus; J. Mandel; S. Roy-Singh. “A Customizable Fire Weather Index for Predicting Wildfire Size and Duration Leveraging Machine Learning.” American Meteorological Society (AMS) Denver Summit, Denver CO, May 2025.

Laakso, L., including Park, T. (2025, April 27–May 2). Assessing the Impact of Climate Change on Forest Fire Weather Index Using Downscaled Climate Model Data. [Conference presentation] 2025 European Geophysical Union Annual Meeting. Vienna, Austria.

LeBlanc et al., Moving Lines Research flight planning tool—usage and summary. NURTURE Science Team meeting, Langley Research Center, September 2025.

LeBlanc, S., Schmidt, S., Knobelspiesse, K., Taylor, P., Crosbie, E., Peterson, C., Nataraja, V., Cairns, B., Cetinic, I. and Becker, S., “Planning and flying research flights during the suborbital airborne field campaigns ARCSIX and PACE-PAX.” AGU Fall meeting 2024, Poster A53D-2107, ESS Open Archive eprints, 118, pp.essoar-173445461., 2024.

Liu, Y., Zhang, X., Tran, K.H., Ye, Y. and Shen, Y., 2024, December. Multi-Scale Land Surface Phenology in Semi-Arid Rangelands Observed from PlanetScope, HLS, and VIIRS. [Poster Presentation] AGU Annual Meeting, Washington, DC, United States.

Logie, J., Biedebach, M., Melton, F., Purdy, A.. On-ground Live Fuel Moisture Content Sampling Along California’s Central Coast. CSU Agricultural Research Institute Annual Conference, 7 November, 2024, Sacramento.

Mandel, J.; B. Tumi; S. A. Taleghan; A. Farguell; J. Haley; A. Kannan; A. Kochanski; C. Da; S. Nag; K. Hilburn; M. Moghaddam; V. Ravindra. “Enhanced Fire Detection and Simulation Using Multi-Satellite Data Assimilation and CYGNSS Reflectometry in the Coupled Atmosphere-Fire Model WRF-SFIRE.” American Geophysical Union Fall Meeting, December 2024.

Mandel, Jan; Samira Alkaee Taleghan; Angel Farguell; Archana Kannan; Adam Kochanski; James Haley; Cheng Da; Farnoush Banaei-Kashani; Basma Tumi; Sreeja Roy-Singh; Kyle A. Hilburn; Mahta Moghaddam; and Vinay Ravindra. “Machine Learning-Based Data Assimilation of Satellite Data in the Coupled Atmosphere-Fire Model WRF-SFIRE.” In 2025 AMS Denver Summit, May 2025.

Melton, F., Doherty, C.,. OTTER—Open Tool for Tracking Effective Precipitation, Western States Water Council Spring Meeting, 22–25 April, 2025. Lincoln, NE.

MS Johnson, J Jung, AH Souri, R Kumar, 2025, Improved Assessment of Recent Trends in NOx and VOC Emissions and Ozone Production Sensitivity Regimes Using Satellite data, 105th Annual AMS Meeting 2025.

NEX team members will deliver a tutorial entitled Climate Downscaling with Statistical, Dynamical, and AI/ML Approaches at the Asia Oceania Geosciences Society Annual Meeting 2025, Singapore, July 27 – Aug. 1.

Ocean Solutions Research at Ames. Dan Whitt gave a presentation which highlighted work on marine carbon dioxide removal for the UC Berkeley Center for Information Technology Research in the Interest of Society and the Banatao Institute (CITRIS) Innovation Intensive on Climate. https://ntrs.nasa.gov/api/citations/20240013598/downloads/Ocean%20Solutions%20at%20Ames.pdf. Nov 1, 2024.

Park, T. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Built Structure Mapping Product. WERK Kick-off meeting at CNRA, May 13, 2025.

Park, T. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Co-developing California’s Land Monitoring and Assessment System. Ames Executive Council, June 2, 2025.

Park, T. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Co-developing California’s Land Monitoring and Assessment System. WERK Kick-off meeting at CNRA, May 13, 2025.

Park, T. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): WERK-Wide Analysis & Assessment Products. WERK Kick-off meeting at CNRA, May 13, 2025.

Park, T., Hashimoto, H., Wang, W., Xiao, X., Vargas, R., & Brosnan, I. G. (2024, December 9–13). Seasonality and Diurnality in Carbon Fluxes Across Climate Gradients Inferred from Eddy Covariance Flux Tower Networks and Geostationary Satellite Observations. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Park, T., Hashimoto, H., Wang, W., Xiao, X., Vargas, R., Brosnan, I.G. Seasonality and Diurnality in Carbon Fluxes Across Climate Gradients Inferred from Eddy Covariance Flux Tower Networks and Geostationary Satellite Observations, 2024 AGU Fall Meeting.

Park, T., Tran, K., Chhabra, A. Embracing CSDA-Supported Spaceborne SAR Data in NASA FireSense Airborne Campaigns, CSDA Program Umbra Mid-term Evaluation, March 11, 2025.

Park, T., Vargas, R., Nemani, R.R. and Brosnan, I.G., 2024, December. Continuous Nationwide Forest Aboveground Biomass Mapping in Mexico: Integrating GEDI and Landsat Time Series Data. In AGU Fall Meeting Abstracts (Vol. 2024, No. 1573, pp. B13D-1573).

Park, T., Vargas, R., Nemani, R.R., Brosnan, I.G. (2024, December 9–13). Continuous Nationwide Forest Aboveground Biomass Mapping in Mexico: Integrating GEDI and Landsat Time Series Data. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Park, T., Vargas, R., Nemani, R.R., Brosnan, I.G. (2025, July 27–August 1). Continuous Nationwide Forest Aboveground Biomass Mapping in Mexico: Integrating GEDI and Landsat Time Series Data. [Conference presentation] 2025 Annual Asia Oceania Geosciences Society meeting. Singapore

Pastor, E.D., Yin, Y., Park, T., Le, V.H., Vargas, R. (2024, December 9–13). Solar-Induced Chlorophyll Fluorescence as a Proxy to Monitor Water Availability in Mexican Ecoregions. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

Pratima, K.C. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Individual Tree Monitoring Product. WERK Kick-off meeting at CNRA, May 13, 2025.

Purdy, A., C. Doherty, A. Guzman, J. Spotta, W. Carrara, L., Johnson, F. Melton. Modeling evapotranspiration from applied water and effective precipitation using OpenET. CSU WATER Conference, 10–11 Apr., 2025, Sonoma.

Purdy, A., OpenET Demonstration. Colorado Master Irrigator Program. Holyoke, CO, 2025.

Purdy, A., W. Carrara, C. Doherty, A. Guzman, L. Johnson, F. Melton. Evaluating time integration methods to produce daily evapotranspiration data, 2024. AGU Annual Meeting, 9–13 Dec., 2024 Washington DC (#H11P-0892).

Purdy, A.J., Carrara, W., Doherty, C.T., Guzman, A., Johnson, L.F., and Melton, F.S. (2024, December 9–13). Evaluating time integration methods to produce daily evapotranspiration data. [Poster session] AGU Annual Meeting, Washington, DC, United States.

Quintero, D., Tran, K.H., Phalke, A., Dutta, R. and Jayasinghe, S., (2024, December 9–13). Estimating crop management input for a regional crop model using Earth Observation and Bayesian Optimization. [Poster Presentation] AGU Annual Meeting, Washington, DC, United States.

Raman, A., A. P. Mizzi, J. T. Benik, C.-H. Hsu, C. Harkins, K. Miyazaki, R. Kumar, M. Johnson, B. McDonald, K. Bowman, K. Knowland, and I. Brosnan (2025): Advancing regional air quality and atmospheric composition analysis: Introducing TRACER-I (Tropospheric Regional

Atmospheric Composition and Emissions Reanalysis, AGU Annual Meeting, Washington, D.C., USA, December 9–13, 2024 (poster presentation).

Ruhoff, A., … Purdy, A., Carrara, W., … et al.. OpenET-Brazil: Remote sensing of evapotranspiration for water management in Brazil. AGU Annual Meeting, 9–13 Dec, Washington DC, 2024. (#H13S-04).

Sarupria, M., Vargas, R., & Park, T. (2024, December 9–13). Annual High-Resolution Tree Cover Mapping for Mexico Using Landsat Time Series and G-LiHT LiDAR Data. AGU24.

Strode, Sarah A.; Meghan Saephan; Douglas A. Caldwell; Bryan N. Duncan; Kristen Manies; Vinay Ravindra; William H. Swartz; and Kate Bartlett. “Scientific Target Prioritization with the Intelligent Long Endurance Observing System (ILEOS).” Poster presented at the American Geophysical Union Fall Meeting, Washington, DC, December 9–13, 2024.

Syracuse University, Guest presentations. Course: CIS 400/600, Evolutionary Machine Learning. Instructor: Professor Chilukuri K. Mohan. Sessions: Spring 2023, Spring 2025.

Taejin Park and Weile Wang will co-chair a session, Earth Observations from Geostationary Satellites: Progress, Challenges, and Opportunities at the 2025 Asia Oceania Geosciences Society (AOGS) annual meeting in Singapore.

Tran, K. Wildfire, Ecosystem Resilience & Risk Assessment Initiative (WERK): Land Cover Classification & Mapping Product. WERK Kick-off meeting at CNRA, May 13, 2025.

Tran, K.H., (2025, May 7). Multi-Domain Applications of Remote Sensing: Ecology, Agriculture, Water & More. [Research Talk] Department of Agricultural Biology, Colorado State University [Virtual].

Tran, K.H., Zhang, X., Ye, Y., Shen, Y., Liu, Y., Gao, S. and Shuai, A., (2024, December 9–13). Evaluation of long-term continuity in global land surface phenology between MODIS and VIIRS sensors. [Conference Presentation] AGU Annual Meeting, Washington, DC, United States.

Tran, K.H., Zhang, X., Zhang, H., Shen, Y., Ye, Y., Liu, Y., Gao, S. and Shuai, A., (2024, December 9-–3). Development of a new transformer-based model for land surface phenology detection across the United States using the Harmonized Landsat and Sentinel-2 time series. In AGU Fall Meeting 2024 (Vol. 2024, No. 1732, pp. B53B-1732).

TxTuesday—Digital Transformation All-team presentation. Presented to 67 virtual attendees “AI techniques to enable the remediation of orbital debris.” Nov. 12, 2024.

US Ocean Carbon and Biogeochemistry summer workshop, 2025. Dan Whitt co-organized a session on Bridging Scales in the Ocean Carbon Cycle, which includes an emphasis (half of talks) on mCDR. https://web.whoi.edu/ocb-workshop/. June 3, 2025.

USGS lunar data team presentation. “AI-enhanced lunar image processing pipeline for the NASA Celestial Mapping System.” Dec. 2024.

USSF/AFRL researchers presentation: “Project RETRO: AI and the remediation of orbital debris.” Apr. 3, 2025.

Wang, W., C. Doherty, W. Ni-Meister, T. Park, Y. Knyazikhin, R.B. Myneni, and I.G. Brosnan. (2024, December 9–13). Spatial Scaling Issue in Land Surface Bidirectional Reflectance Distribution Function. [Conference Presentation] AGU Annual Meeting, Washington, DC, United States.

Wang, W., H. Hashimoto, T. Park, I.G. Brosnan, H. Chen, and T. Lee. (2025, planned) Climate Downscaling with NASA’s Prithvi WxC Foundation Model. AOGS Annual Meeting, Singapore, Singapore.

Wang, W., H. Hashimoto, T. Park, I.G. Brosnan. (2025, planned). Intercomparison and Potential Synergy among TEMPO, PACE, and GOES ABI sensors. [Conference Presentation] SBG Technical Interchange Meeting, Washington, DC, United States.

Wang, W., H. Hashimoto, T. Park, K.K. Kabasares, Y. Wang, I.G. Brosnan. (2024, December 9–13). Development of the GeoNEX Diurnal Cloud Mask Products. [Conference Presentation] AGU Annual Meeting, Washington, DC, United States.

Wildfire Emissions - Atmospheric Rivers: We plan to submit an abstract to present at the American Geophysical Union (AGU) fall meeting in December 2025.

Wildland Fire Program participated in the virtual Surface Biology and Geology (SBG) Science & Applications Technical Interchange Meeting 2025, May 20–22, 202,. This meeting was organized to engage the SBG community in productive discussions around synergies, priorities, and collaboration opportunities. FireSense Project Scientist Jacquelyn Shuman presented a poster on the FireSense project. The poster highlighted the spring 2025 campaign and its successful coordination with on the ground wildland firefighters, partners, and collaborators in the southeastern US for sampling over wildfires and prescribed fires. The data collected in FireSense campaigns can serve as validation/calibration data for SBG activities.

You, H., Ji, F., Park, T., Radeloff, V., Hurtt, G.C., Jiang, M., Chen, M. (2024). Global Forest Edge Dynamics from 2000 to 2020. [Conference presentation] 2024 AGU Annual Meeting, Washington, DC, United States.

PUBLICATIONS

Aguilar Jaramillo, Alan; Ben J. Gorr; Huilin Gao; Ankur Mehta; Yizhou Sun; Vinay Ravindra; Cedric David; George Allen; and Daniel Selva. “Decentralized Consensus-Based Algorithms for Satellite Observation Reactive Planning With Complex Dependencies.” In AIAA SCITECH 2025 Forum, p. 1148. Jan 2025.

Aguilar, Alan; Benjamin J. Gorr; Huilin Gao; Ankur Mehta; Vinay Ravindra; Cedric H. David; George H. Allen; and Daniel Selva. “Decentralized Consensus-based Planning Algorithms for Monitoring Inland Bodies of Water with Autonomous Sensor Webs.” Poster presented at the American Geophysical Union Fall Meeting, Washington, DC, December 9–13, 2024.

Barrio, I. C., Vuorinen, K. E., Barbero Palacios, L. B., Defourneaux, M., Petit Bon, M., Greer, E. A., ..,Park, T. ... & Kamenova, S. 2025. Emerging priorities in terrestrial herbivory research in the Arctic. Arctic Science, (ja). https://doi.org/10.1139/as-2024-0080

Cahn, M., L. Johnson, S. Benzen, 2025. “Evapotranspiration-Based Irrigation Management Effects on Yield and Water Productivity of Summer Cauliflower on the California Central Coast.” Horticulturae 11, 322 (Special Issue Advancements in Horticultural Irrigation Water Management). https://doi.org/10.3390/horticulturae11030322.

Chhabra, A., Park, T., Brosnan, I. Opti-SAR: Enhancing vegetation disturbance mapping using multi-wavelength and multi-agency integration, in preparation.

Detka, J., Jafari, M. Gomez, M., Gilbert, G., 2025. “Machine learning vs. empirical models: Estimating leaf wetness patterns in a wildland landscape for plant disease management.” Agricultural & Forest Meteorology, 362, 110392. https://doi.org/10.1016/j.agrformet.2025.110392.

Doherty, C. T., Wang, W., Hashimoto, H., and Brosnan, I. G., 2025. “A method for quantifying uncertainty in spatially interpolated meteorological data with application to daily maximum air temperature.” Geosci. Model Dev., 18, 3003–3016, https://doi.org/10.5194/gmd-18-3003-2025

Doherty, C.T. and Mauter, M.S., 2025. “Fisher Discriminant Analysis for Extracting Interpretable Phenological Information From Multivariate Time Series Data.” IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 18, pp. 3371-3384. https://doi.org/10.1109/JSTARS.2024.3517415.

Doherty, C.T., & Mauter, M.S. 2024. Fisher Discriminant Analysis for Extracting Interpretable Phenological Information from Multivariate Time Series Data. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 18: 3371-3384. https://doi.org/10.1109/JSTARS.2024.3517415

Doherty, C.T., Wang, W., Hashimoto, H. and Brosnan, I.G., 2025. A Method for Quantifying Uncertainty in Spatially Interpolated Meteorological Data with Application to Daily Maximum Air

Temperature. Geoscientific Model Development (in-press). https://doi.org/10.5194/egusphere-2024-1886

Duncanson, L., [...], Park., T, [...], & Goetz, S. J. (2025). Spatial resolution for forest carbon maps. Science 387(6732): 370-371. https://doi.org/10.1126/science.adt6811

Duncanson, L., Hunka, N., Jucker, T., Armston, J., Harris, N., Fatoyinbo, L., Williams, C.A., Atkins, J.W., Raczka, B., Serbin, S. and Keller, M (including Park, T.), 2025. Spatial resolution for forest carbon maps. Science, 387(6732), pp.370-371.

Feldman, D., Ullrich, P., … Khajehei, S., ... et. al. (2024). Understanding Decision-Relevant Regional Climate Data Products. A Workshop Report. DOE/SC-2021. US Department of Energy, Office Of Science, Biological and Environmental Research Program Workshop Report October 2024, 68pp. https://doi.org/10.2172/2474992

Felton, A., … Purdy, A.J., … et. al., 2025. “Global estimates of the storage and transit time of water through vegetation.” Nature Water 3:59-69. https://doi.org/10.1038/s44221-024-00365-9.

Formaldehyde to Nitrogen Dioxide Ratio (FNR) Trends Paper in progress: Assessment of the capabilities of satellite measurements in detecting the spatiotemporal variations of surface NO2, HCHO, and FNR over the major US cities.

Fornos, David; Daniel Selva; Alexander Demagall; Paul Grogan; Vinay Ravindra. “Flexible Open-Source Tool Ecosystem for Automated Tradespace Analysis and Exploration of Earth Observation Missions”, accepted at 2025 IEEE International Geoscience and Remote Sensing Symposium, Australia, August 2025.

Frost, G. V., [...], Park., T., [...], & Yang, D. (2025) The Changing Face of the Arctic: Four Decades of Greening and Implications for Tundra Ecosystems. Frontiers in Environmental Science 13: 1525574. https://doi.org/10.3389/fenvs.2025.1525574

Gao, S., Zhang, X., Shen, Y., Tran, K.H., Ye, Y. and Liu, Y., 2025. Improvement of land surface phenology monitoring by fusing VIIRS observations with GOES-16/17 ABI time series. Remote Sensing of Environment, 326, p.114803.

Gao, S., Zhang, X., Zhang, H.K., Shen, Y., Roy, D.P., Wang, W. & Schaaf, C., 2024. A new constant scattering angle solar geometry definition for normalization of GOES-R ABI reflectance times series to support land surface phenology studies. Remote Sensing of Environment, 315, p.114407. https://doi.org/10.1016/j.rse.2024.114407

Gilmour, M.E., Pollock, K., Adams, J., Block, B.A., Caselle, J.E., Filous, A., Friedlander, A.M., Game, E.T., Hazen, E.L., Hill, M., Holmes, N.D., Lafferty, K.D., Maxwell, S.M., McCauley, D.J., Schallert, R., Shaffer, S.A., Wolff, N.H., & Wegmann, A.S. (2025) Multi-species telemetry quantifies current and future efficacy of a remote marine protected area. Global Change Biology 31: e70138. https://doi.org/10.1111/gcb.70138

Giordano et al., “Radiative Experiments and Simulations: Effect of Column Water Vapor and Biomass Smoke Aerosol on Atmospheric Heating Rates.” in prep for Atmos. Chem. Phys.

Gorr, Ben; Alan Aguilar Jaramillo; Huilin Gao; Daniel Selva; Ankur Mehta; Yizhou Sun; Vinay Ravindra; Cédric H. David; and George H. Allen. “Decentralized Satellite Constellation Replanning for Event Observation.” Journal of Spacecraft and Rockets (Jan 2025): 1–19.

Hashimoto, H., Wang, W., Park, T., Khajehei, S., Ichii, K., Michaelis, A., Guzman, A., Nemani, R., Torn, M., Yi, K. and Brosnan, I., 2025. Subsets of geostationary satellite data over international observing network sites for studying the diurnal dynamics of energy, carbon, and water cycles. Earth System Science Data Discussions,

Hashimoto, H., Wang, W., Park, T., Khajehei, S., Ichii, K., Michaelis, A., Guzman, A., Nemani, R., Torn, M., Yi, K. and Brosnan, I., 2025. Subsets of geostationary satellite data over international observing network sites for studying the diurnal dynamics of energy, carbon, and water cycles. Earth System Science Data Discussions, Accepted.

Jenkins, J.M., Tenenbaum, P.T., Wohler, B., Michaelis, A.R., & Brosnan, I.G. (2024). Ziggy, A Flexible, Robust, and Scalable Science Pipeline Infrastructure Package for Building Complex Science Pipelines. American Astronomical Society Meeting Abstracts 56(2): 134.05.

Johnson, M. S., Philip, S., Meech, S., Kumar, R., Sorek-Hamer, M., Shiga, Y. P., and Jung, J.: Insights into the long-term (2005–2021) spatiotemporal evolution of summer ozone production sensitivity in the Northern Hemisphere derived with the Ozone Monitoring Instrument (OMI), Atmos. Chem. Phys., 24, 10363–10384, https://doi.org/10.5194/acp-24-10363-2024, 2024.

Kalia, Subodh; Chilukuri K. Mohan; and Ramakrishna Nemani. 2022. Evolutionary training of deep neural networks on heterogeneous computing environments. In Proceedings of the Genetic and Evolutionary Computation Conference Companion (GECCO '22). Association for Computing Machinery, New York, NY, USA, 2318–2321.

Kannan, Archana; Amer Melebari; Grigorios Tsagkatakis; Angel Farguell; Kurtis Nelson; Adam Kochanski; Vinay Ravindra; Sreeja Nag; Chris Ruf; Mahta Moghaddam. “Enhanced Mapping of Wildfire-Burned Areas using GNSS-Reflectometry RAW Intermediate Frequency Data.” accepted at 2025 IEEE International Geoscience and Remote Sensing Symposium, Australia, August 2025.

Kim, M. and Park, T., 2024. Quantifying forest resource change on the Korean Peninsula using satellite imagery and forest growth models. Korean Journal of Environmental Biology, 42(2), pp.193-206.

Knobelspiesse, K.D., J. Alfter, B. Cairns, I. Cetinić, I., S. LeBlanc, S. Nicholas, and R. Ueyama. “Field campaign design and implementation with traceability matrix decision support.” Submitted to Journal of Atmospheric and Oceanic Technology.

Knobelspiesse, K.D., PACE-PAX Science team, et al. “PACE-PAX Post Campaign Technical Memo.” to be submitted to NASA Goddard technical memo registry.

Levinson, Richard; Vinay Ravindra; and Sreeja Nag. “Optimal Planning to Coordinate Science Data Collection and Downlink for a Constellation of Agile Satellites with Limited Storage.” accepted in the 34th International Joint Conference on Artificial Intelligence (IJCAI-25), Montreal, Canada, 2025.

Levinson, Richard; Vinay Ravindra; Jeremy Frank; and Meghan Saephan. “Time-dependent Orienteering for High Altitude UAVs to Monitor Greenhouse Gases: Mixed Integer Programming vs. Monte Carlo Tree Search.” accepted at 22nd International Conference on the Integration of Constraint Programming, Artificial Intelligence, and Operations Research (CPAIOR), Melbourne, Australia, November 2025.

Liu, Y., Zhang, X., Tran, K.H., Ye, Y., Shen, Y. and An, S., 2025. Heterogeneous land surface phenology challenges the comparison among PlanetScope, HLS, and VIIRS detections in semi-arid rangelands. Agricultural and Forest Meteorology, 366, p.110497.

Lyapustin, A., Wang, Y., Korkin, S., Schaaf, C., Wang, W. & Wang, Z., 2025. Scaled RTLS BRDF model extended to high zenith angles. Frontiers in Remote Sensing, 6, 1533803. https://doi.org/10.3389/frsen.2025.1533803

Meng, C., Xiao, X., Newman, G.S., Pan, L., Zhang, C. Chen, W., Pan, B., Yao, Y., Hashimoto, H., Park, T., Wang, W. Vegetation apparent maximum light absorption capacity is site- and season-specific and acclimates to the local light condition. Nature Plant, In Review.

Nassar, A., ..., Purdy, A. J.,... et al.. 2025. “Intercomparison of the U.S. National water model with OpenET over the Bear River Basin.” U.S. Journal of Hydrology, 132826. https://doi.org/10.1016/j.jhydrol.2025.132826.

Nelson, Kurtis; Sreeja Roy-Singh; Vinay Ravindra; Mahta Moghaddam; Archana Kannan; Amer Melebari. “Integration of GNSS-R Derived Soil Moisture into the USGS Wildland Fire Potential Index.” accepted at 2025 IEEE International Geoscience and Remote Sensing Symposium, Australia, August 2025.

Park, T., Choi, Y. R., Ko, Y., Kim, N., Oh, D., & Moores, N. 2025. Airport plan imperils South Korea’s tidal flat. Science, 387(6736), 834-835.

Park, T., Nemani, R. Modeling maximum forest canopy height and aboveground biomass using spaceborne LiDAR and metabolic scaling theory (in preparation).

Peano, D., Hemming, D., Delire, C., Fan, Y., Lee, H., Materia, S., Nabel, J.E., Park, T., Wårlind, D., Wiltshire, A. and Zaehle, S., 2025. Plant phenology evaluation of CRESCENDO land surface models. Part II: Trough, peak, and amplitude of growing season. Biogeosciences. Under Review.

Pierrat, Z. A., Purdy, A. J., ..., et al., 2025. “Evaluation of ECOSTRESS Collection 2 evapotranspiration products: Strengths and uncertainties for evapotranspiration modeling.” Water Resources Research, 61, e2024WR039404. https://doi.org/10.1029/2024WR039404.

Pistone et al. “Vertical structure of a springtime smoky and human troposphere over the southeast Atlantic from aircraft and reanalysis.” Atmos. Chem. Phys., 2024 https://doi.org/10.5194/acp-24-7983-2024.

Pistone et al., “Observed stratocumulus cloud properties vary with absorbing aerosol and water vapor over the southeast Atlantic Ocean.” in prep.

Ravindra, Vinay; Molly Stroud; George Allen; Daniel Selva; Sarah Godsey; Ken Fritz; Jacob Honsen; Michelle Busch; and Shang Gao. “Optimizing Monitoring Routes for Electric Vehicles With Access to Multiple Charging Stations Using Mixed Integer Programming: Case Study With Non-Perennial Rivers.” In AIAA SCITECH 2025 Forum, p. 2284. Jan 2025.

Reitz, M., Volk, J.M., Ott, T., Anderson, M., Senay, G.B., Melton, F., Kilic, A., Allen, R., Fisher, J.B., Ruhoff, A., Purdy, A.J., and Huntington, J., 2025. “Performance maps, weights, and associated data sets for Version 2.0 of the OpenET evapotranspiration models for the conterminous U.S.” U.S. Geological Survey data release. https://doi.org/10.5066/P1HY5TUM.

Rohde, M.M., …, Purdy, A.J.,… et al., 2024. “Groundwater-dependent ecosystem map exposes global dryland protection needs.” Nature 632, 101-107. https://doi.org/10.1038/s41586-024-07702-8.

Roy-Singh, Sreeja; Vinay Ravindra; Richard Levinson; Mahta Moghaddam; Jan Mandel; Adam Kochanski; Angel Farguell Caus; Kurtis Nelson; Samira Alkaee Taleghan; Archana Kannan; Amer Melebari. “Optimal Planning and Machine Learning for Responsive Tracking and Enhanced Forecasting of Wildfires using a Spacecraft Constellation.” accepted in the Artificial Intelligence & Sustainability Workshop 14, IJCAI25, Montreal, Canada, 2025.

Shen, Y., Zhang, X., Tran, K.H., Ye, Y., Gao, S., Liu, Y. and An, S., 2025. Near real-time corn and soybean mapping at field-scale by blending crop phenometrics with growth magnitude from multiple temporal and spatial satellite observations. Remote Sensing of Environment, 318, p.114605.

Suselj, K., D. Carroll, D. Whitt, B. Samuels, D. Menemenlis, H. Zhang, N. Beatty, A. Savage. May 6, 2025. Quantifying Marine Carbon Dioxide Removal via Alkalinity Enhancement Across Circulation Regimes Using ECCO-Darwin and 1D Models. Version 3. Under review at JAMES. Version 1 is available publicly as a pre-print: http://doi.org/10.22541/essoar.170957083.34212619/v1

Teitelbaum, C.S., Ferraz, A., De La Cruz, S.E., Gilmour, M.E., Brosnan, I.G. 2024. The potential of remote sensing for improved infectious disease ecology research and practice. Proceedings of the Royal Society B. 291: 20241712. https://doi.org/10.1098/rspb.2024.1712

Thrasher, B., Khajehei, S., Kim, J.B., & Brosnan, I. 2024. NASA Earth Exchange Downscaled Climate Projections 30 Arcseconds CMIP6. Scientific Data 11: 1346. https://doi.org/10.1038/s41597-024-04188-x

Tian, J., X. Luo, W. Wang, L. Yu, D. Ng, et al. (2025). Seasonality of vegetation greenness in Southeast Asia unveiled by geostationary satellite observations. Remote Sensing of Environment 319: 114648. https://doi.org/10.1016/j.rse.2025.114648

Tran, K.H., Zhang, X., Zhang, H.K., Shen, Y., Ye, Y., Liu, Y., Gao, S. and An, S., 2025. A transformer-based model for detecting land surface phenology from the irregular harmonized Landsat and Sentinel-2 time series across the United States. Remote Sensing of Environment, 320, p.114656.

Vo, T.Q., Pham, L.H., Tran, K.H., Pham, P.H., Tri, V.P., Lee, S.O., Shin, H.J. and Kim, J., 2025. Refined Detection and Classification of Shallow and Deep Flooding in Agricultural Landscapes: Integrating Harmonic Regression with SAR Time Series. Earth Systems and Environment, pp.1-20.

Yates, E. L., Golston, L. M., Podolske, J. R., Iraci, L. T., Okorn, K. E., Dang, C., Johnson, R. R., Eilers, J., Kolyer, R., Astley, I., and Leen, J. B.: Description and Validation of a Carbon Monoxide and Nitrous Oxide Instrument for High-Altitude Airborne Science (COMA), EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-1081, 2025.

You, H., Ji, F., Park, T., Radeloff, V.C., Hurtt, G., Jiang, M., Chen, M. Global Forest Edges and Their Dynamics in the 21st century, Nature Plant (under review).

You, H., Ji, F., Park, T., Radeloff, V.C., Hurtt, G., Jiang, M., Chen, M. Global Forest Edges and Their Dynamics in the 21st century, Nature Plant (under review).

You, H.,Chen, M., Park, T. Continuous forest loss and edge expansion in the US (in preparation).

You, H.,Chen, M., Park, T. Continuous forest loss and edge expansion in the US (in preparation).

GLOSSARY

3D-CHESS—Decentralized, Distributed, Dynamic, and Context-aware Heterogeneous Sensor Systems
4STAR—Sky-scanning, Sun-tracking Atmospheric Research
4STARB—Replica of 4STAR instrument
5STAR—ultra-Stable Spectrometers for Sky-Scanning Sun-Tracking Atmospheric Research
ABI—Advanced Baseline Imager
AC—Atmospheric Composition
ACCDAM—Atmospheric Composition Campaign Data Analysis and Modeling
ACCLIP—Asian Summer Monsoon Chemical & CLimate Impact Project
ACIX—Atmospheric Correction Intercomparison Experiment
ACX—GeoX Atmospheric Composition Instrument
AERACEPT—Aerosol Rapid Analysis Combined Entry Probe/Sonde Technology
AERONET—AErosol RObotic NETwork
AFC—Alabama Forestry Commission
AFRC—Armstrong Flight Research Center
AGAGE—Advanced Global Atmospheric Gases Experiment
AGB—Aboveground Biomass
AGHSD—Ames Global Hyperspectral Synthetic Data
AGU—American Geophysical Union
AHI—Advanced Himawari Imager
AI—Artificial Intelligence
AIR4US—Air-quality Information Resource for the United States
AirSAR—Airborne Synthetic Aperture Radar
AirSHARP3—Airborne asSessment of Hyperspectral Aerosol optical depth and water-leaving Reflectance for PACE
AISES—American Indian Science and Engineering Society
AJAX—Alpha Jet Atmospheric eXperiment
ALH—Aerosol Layer Heights
AMI—Advanced Meteorological Imager
AMS—American Meteorological Society

AOD—Aerosol Optical Depth
AOGS—Asia Oceania Geosciences Society
API—Application Programming Interface
AQ—Air Quality
AQS—Air Quality System (EPA's air quality monitoring network)
ARB—Air Resources Board
ARC-CREST—Ames Research Center Cooperative for Research in Earth Science and Technology
ARC—Ames Research Center
ARCSIX—Arctic Radiation-Cloud-Aerosol-Surface-Interaction Experiment
ARI—Agriculture Research Institute at CSU
ARLs—Application Readiness Levels
ARMD—Aeronautics Research Mission Directorate
ARRA—American Recovery and Reinvestment Act
ARS—Agricultural Research Service
ARSET—Applied Remote Sensing Training
ASF—Airborne Sensor Facility
ASIA-AQ—Airborne and Satellite Investigation of Asian Air Quality
ASP—Airborne Science Program
ASP—Applied Science Program
ASPIRE—Advanced Supersonic Parachute Inflation Research Experiments
ASRL—Allometric Scaling and Resource Limitation
ASTER—Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVIRIS—Airborne Visible/Infrared Imaging Spectrometer
AWS—Amazon Web Services
BAER—Burned Area Emergency Response
BAERI—Bay Area Environmental Research Institute
BB—Biomass Burning
BCSD—Bias Correction/Spatial Disaggregation
BIE—Bureau of Indian Education
BioSCape—NASA Biodiversity field campaign in the Greater Cape Floristic Region of South Africa

BLH—Boundary Level Height
BOA—Bottom-Of-Atmosphere
BRDF—Bidirectional Reflectance Distribution Function
BU—Boston University
C-AIR—Coastal Airborne In-situ Radiometers
C-GEM—Carbon - Generic Estuary Model
C-Harrier—Coastal High Acquisition Rate Radiometers for Innovative Environmental Research
C-OPS—Compact Optical Profiling System
CALFIRE—California Department of Forestry and Fire Protection
CalOES—California Office of Emergency Services
CAMS—Copernicus Atmosphere Monitoring Service
CARB— California Air Resources Board
CAS—Commercial Aviation Services
CASA—Carnegie-Ames-Stanford-Approach
CBE—Community Based Education
CBP—Capacity Building Program
CCDC—Continuous Change Detection and Classification
CDFA—California Department of Food and Agriculture
CESM—Community Earth System Model
CESU—Cooperative Ecosystem Studies Units
CFD—Computational Fluid Dynamics
CGMS—Coordination Group of Meteorological Satellites
CH4—Methane
CIg—Chlorophyll index green
CIRES—The Cooperative Institute for Research in Environmental Sciences
CIROH—Cooperative Institute for Research to Operations in Hydrology
CIRPAS—Center for Interdisciplinary Remotely Piloted Aircraft Studies
CITRIS—Center for Information Technology Research in the Interest of Society and the Banatao Institute
CMAQ—Community Multiscale Air Quality
CMIP6—Climate Model Intercomparison Project Phase 6
CMS—Carbon Monitoring Systems

CNN—Convolutional Neural Network
CNRA—California Natural Resources Agency
COAST—Coastal and Ocean Airborne Science Testbed
CONUS—Continental United States
CoSMIR—Conical Scanning Millimeter-wave Imaging Radiometer
COTS—Commercial off-the-shelf
CPU—Central Processing Unit
CRATER—Costa Rica Airborne research on foresT Ecosystem Response to volcanic emissions
CRESCENDO—Coordinated Research in Earth Systems and Climate: Experiments, kNowledge, Dissemination and Outreach (European climate modeling project)
CrIS—Cross-track Infrared Sounder
CSDA—Commercial Satellite Data Acquisition
CSL—Chemical Sciences Laboratory
CSU—California State University
CSU—Colorado State University
CSUMB—California State University, Monterey Bay
CSUStan—California State University at Stanislaus
CUB—University of Colorado at Boulder
CUT—Cyprus University of Technology
CYGNSS—Cyclone Global Navigation Satellite System
D-SHIELD—Distributed Spacecraft with Heuristic Intelligence to Enable Logistical Decisions
DA—Data Assimilation
DAAC—Distributed Active Archive Center (or DAAQ)
DART—Data Assimilation Research Testbed
DBW—Division of Boating and Motorways
DCOTSS—Dynamics and Chemistry of the Summer Stratosphere
DCP30—Downscaled Climate Projections 30 arcseconds
DDM—Direct Decoupled Method
DoD—Department of Defense
DOE—Department of Energy
DRCS—Disaster Response Coordination System

DRI–Desert Research Institute
DSI PBL—Decadal Survey Incubation Planetary Boundary Layer
EAB—External Advisory Board
EAKF—Ensemble Adjustment Kalman Filter
EAP—Earth Action Program
EarthCARE—Cloud, Aerosol and Radiation Explorer (ESA and JAXA satellite mission)
EC—European Commission
ECCO—Estimating the Circulation and Climate of the Ocean
ECI—Early Career Investigator
ECMWF ERA5—European Centre for Medium-Range Weather Forecasts (5th generation)
ECOSTRESS—ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station
EEZ—Exclusive Economic Zone
EID—Experimenter Interface Panel
eMAS—Enhanced MODIS Airborne Simulator
EMIT—Earth surface Mineral dust source InvesTigation
EMRI—Earth Mapping Resources Initiative
EnMAP—Environmental Mapping and Analysis Program
ENRD—Environment and Natural Resources Division
ENSCI—Environmental Science
EO-Sim—Earth Observations Simulator
EO—Earth Observations
EPA—Environmental Protection Agency
EPSCoR—Established Program to Stimulate Competitive Research
ER-2—Earth Resources Aircraft
ERATOSTHENES—Excellence Research Centre for Earth Surveillance and Space-Based Monitoring of the Environment
ESA—European Space Agency
ESD—Earth Science Division
ESPO—Earth Science Project Office
ESS—Earth and space science
ESTCP—Environmental Security Technology Certification Program
ESTO—Earth Science Technology Office

ESTP—Environmental Science, Technology, and Policy
ET—Evapotranspiration
EVS—Earth Venture Suborbital
FAI–Floating Algal Index
FarmFlux—Nitrogen and Carbon Fluxes: Agriculture, Atmospheric Composition, and Ecosystems
FARMS—Farm and Ranch Management Support system
FAV—Floating Aquatic Vegetation
FCI—Flexible Combined Imager
FEMA—Federal Emergency Management Agency
FFP—Forecasting and Flight Planning
FIA—Forest Inventory and Analysis
FireTIRS—Fire Thermal Infrared System
FIREX-AQ—Fire Influence on Regional to Global Environments Experiment-Air Quality
FLOPS—Floating Point Operations
FLUXNET—Global network of micrometeorological tower sites that measure ecosystem-atmosphere exchanges
FNR—Formaldehyde to Nitrogen Dioxide Ratio
FOFEM—First Order Fire Effects Model
FOIA—Freedom of Information Act
FORTE—Arctic Coastlines – Frontlines Of Rapidly Transforming Ecosystems
FOV—Field of View
FSIT—FireSense Implementation Team
FT—Freeze Thaw
FWI—Fire Weather Index
GDDP—Global Daily Downscaled Projections
GeCGO—GeoNEX Coincident Ground Observations
GEDI—Global Ecosystem Dynamics Investigation
GEDIST— Global Ecosystem Dynamics Investigation Science Team
GEMx—Geological Earth Mapping Experiment
GEO—Geostationary

GeoNEX—A collaborative effort for generating Earth monitoring products from the new generation of geostationary satellite sensors
GEOS-Chem—Goddard Earth Observing System Chemistry (model)
GEOS—Goddard Earth Observing System
GFED—Global Fire Emissions Database
GHG—Greenhouse Gas
GIS—Geographic Information System
GISS—Goddard Institute for Science Studies
GLM—Global Modeling Laboratory
GLOBE—Global Learning and Observations to Benefit the Environment program
GLOVE—GSFC Lidar Operations and Validation Experiment
GMAO—Global Modeling and Assimilation Office
GNSS-R—Global Navigation Satellite System Reflectometry
GOES—Geostationary Operational Environmental Satellite
GOFC-GOLD—Global Observations of Forest Cover and Land-use Dynamics
GOSAT—The Greenhouse gases Observing SATellite
GPS—Global Positioning System
GPU—Graphics Processing Unit
GSF—Geneva State Forest
GSFC—Goddard Space Flight Center
HALE—High Altitude Long Endurance
HAMAQ—Hemispheric Airborne Measurements of Air Quality
HAPS—High Altitude Platform System
HARP2—Hyper-Angular Rainbow Polarimeter two
HCHO—Hemispheric Airborne Measurements of Air Quality
HIW—High Impact Weather
HIZ—Home Ignition Zone
HLS—Harmonized Landsat Sentinel-2
hPa—Hectopascals (pressure unit)
HyperPro—Hyperspectral Profiling Radiometer
HyspIRI—Hyperspectral Infrared Imager
I-CREWS—Idaho Community-engaged Resilience for Energy-Water Systems

IAA— Incident Awareness and Assessment
ICEE—In Situ for Carbon Evolution Experiments
ICESat-2—Ice, Cloud, and land Elevation Satellite-2
IDL—Interactive Data Language
ILEOS—Intelligent Long Endurance Observing System
IMPACTS—Investigation of Microphysics and Precipitation for Atlantic Coast–Threatening Snowstorms
IMU—Inertial Measurement Unit
InGaAs—Indium Gallium Arsenide
INSPYRE—INjected Smoke PYRocumulonimbus EXperiment
INSTEP—Inexpensive Network Sensor Technology for Exploring Pollution
IOA—Internet of Animals
IOP—Intensive Observation Period
IRIG—Inter-Range Instrumentation Group
ISFM—Internal Scientist Funding Model
JAMES—Journal of Advances in Modeling Earth Systems
JAMSTEC—Japan Agency for Marine-Earth Science and Technology
JAXA—Japan Aerospace Exploration Agency
JEDI—Joint Effort for Data Assimilation Integration
JPL—Jet Propulsion Laboratory
JSC—Johnson Space Center
KDF/KDFP— Knowledge Development and Project Formulation
KSC—Kennedy Space Center
L4C—Level 4 Carbon
LARC—Langley Research Center
LCLUC—Land-Cover and Land-Use Change
LEO—Low Earth Orbit
LET—Local Engagement Team
LFMC—Live Fuel Moisture Content
LIBS—Laser Induced Breakdown Spectroscopy
LSP—Land Surface Phenology
LST—Land Surface Temperature

LVIS—Land, Vegetation, and Ice Sensor
MAGEQ—Mid-Atlantic Gas Emissions Quantification
MAIAC—Multi-Angle Implementation of Atmospheric Correction
MAP—Modeling, Analysis and Prediction
MASTER—The MODIS/ASTER Airborne Simulator
MBIE—Ministry of Business, Innovation and Employment (New Zealand)
mCDR—Marine Carbon Dioxide Removal
MCTS—Monte Carlo Tree Search
MedRIN—Mediterranean Regional Information Network
MERRA-2—Modern Era Retrospective-Analysis for Research and Applications
ML—Machine Learning
MLS—Microwave Limb Sounder
MODIS—Moderate Resolution Imaging Spectroradiometer
MOMO-Chem—Multi-model Multi-constituent Chemical
MOSAICS—Mentorship and Opportunities in STEM with Academic Institutions for Community Success
MPA—Marine Protected Area
MRV—Measurement, Reporting, and Verification
MTG FCI—Meteosat Third Generation, Flexible Combined Imager
MTS—Mission Tools Software
NAIP—National Agriculture Imagery Program
NAS—NASA Advanced Supercomputing
NASDAT—NASA Airborne Science Data and Telemetry System
NASEM—National Academies of Sciences, Engineering and Medicine
NAVAIR—Naval Air Systems Command
NBR—Normalized Burn Ratio
NCAR—National Center for Atmospheric Research
NCCS—NASA Center for Climate Simulation
NDACC—Network for the Detection of Atmospheric Composition Change
NDAVI–Normalized Difference Aquatic Vegetation Index
NDTI–Normalized Difference Turbidity Index
NDVI–Normalized Difference Vegetation Index

NDWI—Normalized Difference Water Index
NESSUS—Numerical Evaluation of Stochastic Structures Under Stress
NEX—NASA Earth Exchange
NG—Next Generations
NIDIS–National Integrated Drought Information System
NIES—National Institute for Environmental Studies (Japan)
NIFC— National Interagency Fire Center
NIR—Near Infrared
NMVOC—Non-Methane Volatile Organic Compounds
NNA—National Nature Assessment
NOAA—National Oceanic and Atmospheric Administration
NOx—Nitrogen Oxides
NPP—NASA Postdoctoral Program
NPS TO—Naval Postgraduate School Twin Otter
NPS—Naval Postgraduate School
NSF—National Science Foundation
NSRC—National Suborbital Research Center
NURTURE—North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment
NWS—National Weather Service
OAE—Ocean Alkalinity Enhancement
OAEMIP—Ocean Alkalinity Enhancement Model Intercomparison Project
OCEANIA—Ocean Color Ecosystems Assessment using Novel Instruments and Aircraft
OCI—Ocean Color Instrument
OCO-2—Orbiting Carbon Observatory 2
OMI—Ozone Measuring Instrument
OMPS-NM—Ozone Mapping and Profiler Suite-Nadir Mapper
OpenET—Open Evapotranspiration
ORACLES—ObseRvations of Aerosols Above CLouds and their IntEractionS
ORNL—Oak Ridge National Laboratory
OSSE—Observing System Simulation Experiment
OWWL—Ozone Where We Live

PACE-PAX—Plankton, Aerosol, Cloud, ocean Ecosystem Postlaunch Airborne eXperiment
PACE—Plankton, Aerosol, Cloud, ocean Ecosystem
PAN—Peroxyocetyl nitrate
PBL—Planetary Boundary Layer
PICARD—Pushbroom Imager for Cloud and Aerosol Research
PM—Particulate Matter
PRISMA—Precursore Iperspettrale della Missione Applicativa
PSM—A Professional Science Master's Degree
PVST—PACE Validation Science Team
QAQC—Quality Assurance and Quality Control
QGIS–open source GIS
R&A—Research and Analysis
R&T—Research and Technology
RAM—Random Access Memory
REDD+—Reducing Emissions from Deforestation and Forest Degradation in Developing Countries. A voluntary climate change mitigation approach that has been developed by Parties to the UN Framework Convention on Climate Change (UNFCCC). It aims to incentivize developing countries to reduce emissions from deforestation and forest degradation, conserve forest carbon stocks, sustainably manage forests and enhance forest carbon stocks
RGB—Red Green Blue
ROSES—Research Opportunities in Space and Earth Science
RSAM—Remote Sensing for Animal Movement
RTLS—Ross-Thick Li-Sparse
RTSP—Real Time Spectroscopic Products
S-MODE—Sub-Mesoscale Ocean Dynamics Experiment
SABRE—Stratospheric Aerosol processes, Budget and Radiative Effects
SAR—Synthetic Aperture Radar
SARP—Student Airborne Research Program
SAVI–Soil-Adjusted Vegetation Index
SBG TIM—SBG Technical Interface Meeting
SBG—Surface Biology and Geology
SBIR—Small Business Innovation Research

SBU—Standard Billing Unit
SCIAMACHY—Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SEA—SouthEast Atlantic
SeaBASS—SeaWiFS Bio-optical Archive and Storage System
SERA—Science Enabling Research Activities
SERS—Surface Enhanced Raman Spectrometry
SETI—Search for Extraterrestrial Intelligence
SIMS—Satellite Irrigation Management Support
SIPI—Southwestern Indian Polytechnic Institute
SJSU—San José State University
SMAP—Soil Moisture Active-Passive Mission
SMD—Science Mission Directorate
SME—Subject Matter Expert(s)
SOaRS—Stratospheric Operations and Research Symposium
SOFRS—Science Operations Flight Request System
SPEXone—Spectro-polarimeter for Planetary Exploration one
SPoRT—Short-term Prediction Research and Transition
SR—Standard Ratio
SRDP—Strategic Environmental Research and Development Program
SSP—Shared Socioeconomic Pathway
STEM—Science, Technology, Engineering, and Math
STMD—Space Technology Mission Directorate
SWAP—Smaller Weight And Power
SWIRLL—Severe Weather Institute for Research and Lightning Laboratories
TACFI-RS—Tactical Fire Remote Sensing
TAG—Technical Advisory Group
TAMMS—Turbulent Air Motion Measurement System
TCCON—Total Carbon Column Observing Network
TEMPO—Tropospheric Emissions: Monitoring Pollution
TES—Tropospheric Emission Spectrometer
TGGR—Trace Gas Group

TOA—Top-Of-Atmosphere
TOLNET—Tropospheric Ozone Lidar Network
TOPS— Terrestrial Observation and Prediction System
TRACER—Tropospheric Regional Atmospheric Composition and Emissions Reanalysis
TRL 3—Technology Readiness Level 3
TROPOMI—The TROPOspheric Monitoring Instrument
UAH—University of Alabama, Huntsville
UAS—Unmanned Air Systems
UC—University of California
UCLA—University of California Los Angeles
UCSC—University of California Santa Cruz
UNAM—National Autonomous University of Mexico
USBR—US Bureau of Reclamation
USFS—The United States Forest Service
USGS—United States Geological Survey
UTLS—upper troposphere and lower stratosphere
UVF—Ultraviolet Fluorescence
UWG—User Working Group
VIIRS—Visible Infrared Imaging Radiometer Suite
VPRM—Vegetation Photosynhesis and Respiration Model
WATRS—Water, Agriculture, Technology and Remote Sensing
WDTS—Western Diversity Time Series
WERK—Wildfire, Ecosystem Resilience, & Risk Assessment
WFF—Wallops Flight Facility
WHyMSIE—Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment
WLDAS—Western Land Data Assimilation System
WRF-Chem/DART—Weather Research and Forecasting model coupled to Chemistry
WSREC—WestSide Research and Extension Center
WWAO—Western Water Applications Office
WWRP— Wester Water Resources Program
XCS—eXperimenter Control Station