National Aeronautics and Space Administration

# EXPLORE AIRBORNE SCIENCE NEWSLETTER

Summer 2025

## Leadership Corner

Thanks for taking the time to learn about all the exciting things happening in the NASA Earth Science Division Airborne Science Program (ASP). NASA Airborne Science continues to thrive, developing new instruments, supporting space-based missions, and exploring earth system processes on our home planet. During the past 6 months we continued supporting NASA teams working on future satellite missions including the Planetary Boundary Layer (PBL) and Surface Topography and Vegetation (STV) with the WH$^2$yMSIE and APEX campaigns on the ER-2 and CASALS test flights aboard the NASA Langley B-200. CASALS was not the only one celebrating successful instrument development as AirMSPI-2 and CHAPS-D also proved themselves during inaugural flights. In typical ASP fashion, our aircraft teams continued to balance these missions with additional campaigns happening around the country: DUST to measure snow cover using the UAVSAR facility instrument, CODEX to measure contrails with LaRC's HALO instrument, and a stacked ER-2 payload to measure clouds and aerosols during GSFC's GLOVE mission. Finally, we tested our new precision aircraft guidance system, SoxNav, and continued to get the B777 ready for upcoming science flights. It's amazing to look back and reflect on all we accomplished over the past few months.

Thanks for your interest and support for Airborne Science, and please let us know how we can help move Earth Science forward.

**Bruce Tagg**
*Director,*
*Airborne Science Program*

**Derek Rutovic**
*Deputy Airborne Science*
*Program Director - Operations*

## What's Inside



S C I E N C E   H I G H L I G H T S

# WH$^2$yMSIE: A Prototype for a PBL Mission of Missions

Contributed by Alexander Kotsakis (NASA GSFC) and Rachael Kroodsma (NASA GSFC)

The Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment (WH$^2$yMSIE) occurred during October-November 2024 and marked a significant achievement in the study of the planetary boundary layer (PBL) and the novel technologies that can be utilized for remotely sensing the PBL. Born from a collaborative interest between NOAA and NASA, this field experiment successfully logged 54.8 flight hours while demonstrating the capabilities of hyperspectral microwave technology through the deployment of CoSMIR-H (Conical Scanning Millimeter-wave Imaging Radiometer - Hyperspectral) on the ER-2. CoSMIR-H was complemented

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*The ER-2 preparing to take off from Edwards Air Force Base before a flight offshore. Credit: G. Vavuris / NASA AFRC*

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## WH²yMSIE: A Prototype for a PBL Mission of Missions

*NASA G-III equipped with HALO, AWP, and dropsondes during a flight over southern California during WH²yMSIE. Credit: L. Losey*

*WH²yMSIE Science and NASA AFRC Operations Engineering teams in front of the fully instrumented ER-2 aircraft (L-R: N. Reid, A. Gambacorta, J. Moore, R. Kroodsma, T. Latsha, A. Kotsakis, E. Nowottnick). Credit: G. Vavuris / NASA AFRC*

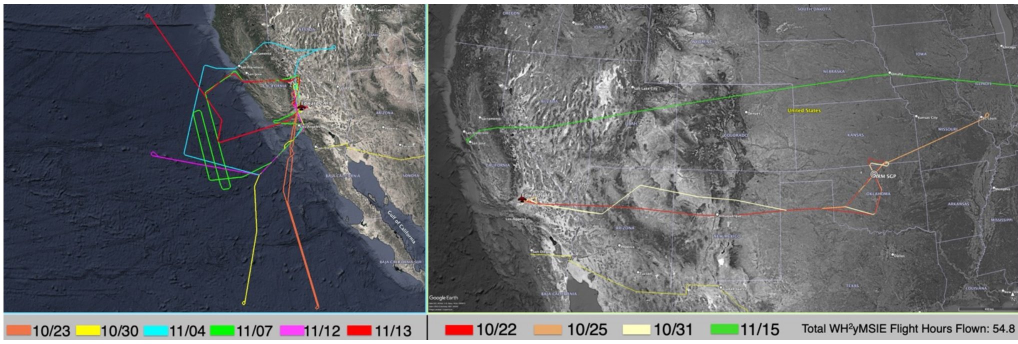
by an array of passive and active sensors that included Microwave Barometric Radar and Sounder (MBARS), Cloud Radar System (CRS), Cloud Physics Lidar (CPL), Scanning High-resolution Interferometer Sounder (S-HIS), National Airborne Sounder Testbed – Interferometer (NAST-I), Advanced Microwave Precipitation Radiometer (AMPR), MODIS/ASTER Airborne Simulator (MASTER), and Airborne Radio Occultation (ARO).

In addition to the ER-2, the G-III aircraft equipped with High Altitude Lidar Observatory (HALO), Aerosol Doppler Wind Lidar (AWP), and Dropsondes provided high-value measurements below the ER-2 to further contextualize the environment measured by the ER-2 payload. The mission effectively captured a wide range of atmospheric states across diverse surface types, including a highly impactful atmospheric river observed during a coordinated ER-2 and G-III flight on November 13, 2024. By bringing together a unique combination of airborne sensors and ground-based measurements, WH²yMSIE established itself as a pathfinder for future PBL mission architectures.

The experiment's success was significantly enhanced by extensive partnerships with ground-based collaborators. Radiosondes, Uncrewed Aerial Systems (UAS), remote sensing platforms, and other PBL-relevant networks provided critical validation data and contextual information for the airborne measurements collected by the ER-2, G-III, and University of Iowa Beechcraft Bonanza aircraft.

Over the ocean, the team successfully conducted flights under numerous program-of-record satellites in both clear and cloudy conditions; over land, they prioritized clear sky observations to enable proper surface characterization. This comprehensive approach allowed the capture of diurnal variability in the PBL across key ground-based sites and demonstrated the complementary capabilities of the diverse instrument payload, which included microwave sensors, radar systems, lidars, infrared instruments, and in-situ measurement tools.

WH²yMSIE represents the first-of-its-kind demonstration of hyperspectral microwave technology for PBL applications, serving as a model for future missions through its integration of passive and active sensors across multiple platforms. By leveraging existing networks of surface radiation, aerosol, and flux measurements, the experiment has laid the groundwork for continued analyses focusing on surface-atmosphere interactions and diurnal PBL dynamics. The mission has not only advanced our understanding of hyperspectral microwave sensors and their potential for retrieving geophysical variables in the PBL but has also strengthened the PBL research community across federal and state agencies, universities, and the private sector—creating a collaborative foundation for future innovations in Earth observation technology.




*Map of all the WH²yMSIE science flights over ocean (left) and land (right). Credit: A. Kotsakis*

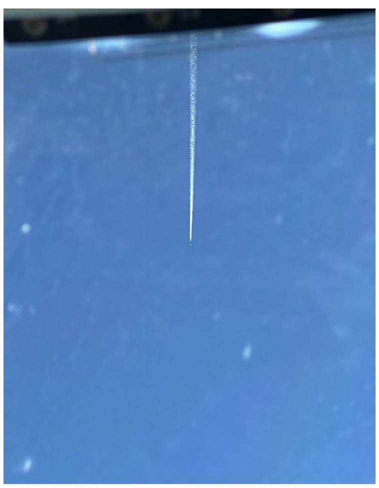
# Active Passive PBL Profiling EXperiment (APEX)

Contributed by Amin Nehrir (NASA LaRC)

The Active Passive PBL Profiling EXperiment (APEX) team successfully completed their airborne validation and instrument synergy campaign in coordination with the Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment (WH$^2$yMSIE) and 4-dimensional evolution of the marine boundary layer in joint coordination with the Office of Naval Research (ONR) Moisture and Aerosol Gradients/Physics Inversion Evolution (MAGPIE) campaign forming the APEX-MAGPIE Plus Up (AMP-Up).

Over 19 flight days and approximately 63 flight hours between October 28 and November 15, 2024, the APEX team completed 11 science flights on the NASA G-III:

- *6 coordinated with the NASA ER-2*
- *4 coordinated with the Naval Postgraduate School (NPS) CIRPAS Twin Otter*
- *1 solo science flight on the return transit*



*ER-2 captured from the LaRC G-III during a coordinated flight on October 31, 2024. Credit: Amin Nehrir / NASA LaRC*

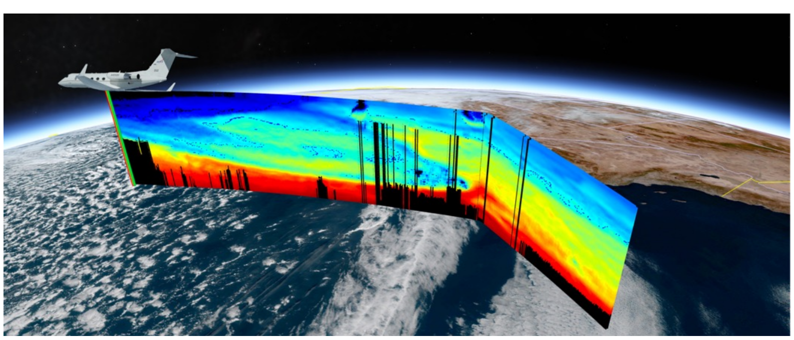
The flights were based out of Santa Maria and ARC/ Moffett Federal Airfield near Sunnyvale, California. Coordination with the ER-2 targeted different atmospheric conditions over the Eastern Pacific and western U.S. for evaluation and validation of emerging passive microwave technology and to create a benchmark dataset for joint active and passive retrievals of temperature and moisture using Differential Absorption Lidar (DIAL) and infrared and microwave sounders, respectively. These will be future developed under the Decadal Survey Planetary Boundary Layer Incubation program.

Instrument teams on the G-III, all from LaRC, included the following:

*Photo of the G-III taken from the C-20A during a dropsonde envelope chase flight on November 5, 2024. Credit: Lori Losey / NASA AFRC*

- *High-Altitude Lidar Observatory (HALO) water vapor DIAL and high spectral resolution lidar*
- *Aerosol Wind Profiler (AWP) Doppler wind lidar*
- *Advanced Vertical Atmospheric Profiling System (AVAPS) dropsondes.*

Coordination with the Twin Otter sought to characterize the capability of water vapor, aerosol, and wind lidars in the marine boundary layer as well as map boundary layer heterogeneity in pre-and-post frontal environments as well as the evolution of the lowest few hundred meters during offshore flow. By observing an evolving environment, the analysis will focus on mapping boundary layer variability to specific processes, and linking remotely sensed geophysical variables (water vapor, winds, and aerosol optical properties) to turbulent scale processes measured in-situ by the CIRPAS Twin Otter over different regimes (clear and cloudy boundary layers).

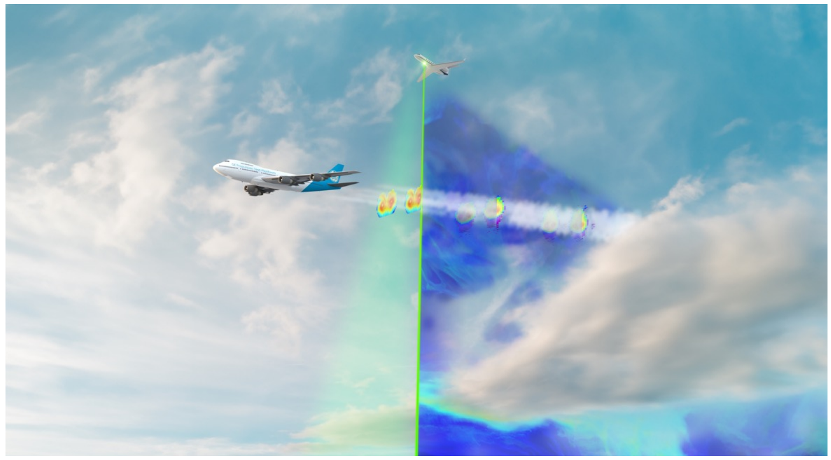


*HALO data collected from the G-III on November 13, 2024, across a weak frontal boundary. The color chart indicates water vapor concentrations from 12 km down to the surface with cooler and warmer colors representing dry and moist air masses, respectively, covering a dynamic range of approximately 10,000:1. The data are overlayed on a GOES-West/ABI true color image from 22 UTC. Credit: Amin Nehrir / NASA LaRC*

APEX was supported through the NASA Decadal Survey Incubation (DSI) program and ONR Code 322 through the US Naval Research Laboratory (NRL).

# Contrail Optical Depth Experiment (CODEX)

Contributed by Richard Moore (NASA LaRC)



*CODEX concept of operations showing the water vapor and backscatter curtains measured by the High Altitude Lidar Observatory (HALO) onboard the G-III as it chased the GE Aerospace 747 Flying Test Bed. Credit: Richard Moore / NASA LaRC*

Contrail cirrus are thought to have a greater radiative impact today than aviation carbon dioxide emissions over the past century. Despite large uncertainties in estimating contrail radiative forcing, policymakers worldwide are moving quickly to monitor, and potentially regulate, contrail cirrus formed by commercial aircraft. To ensure U.S. economic competitiveness in the global aviation market as well as to provide valuable observational data to enable U.S. policymakers to make the best data-driven decisions, NASA and GE Aerospace recently collaborated to conduct the Contrail Optical Depth Experiment (CODEX) in November 2024. The goal of CODEX is to measure contrail formation and optical properties and use these observations to evaluate the skill of numerical weather contrail prediction models that simulate atmospheric temperature and water vapor fields. The project was sponsored by the NASA Aeronautics Advanced Air Transport Technologies Project within the Advanced Air Vehicles Program as well as the Earth Science Division Radiation Sciences and Tropospheric Composition Programs.

Flying through the crisp November skies over the Atlantic seaboard was the GE Aerospace 747 Flying Test Bed – a four-engine aircraft commonly used for flight testing GE Aerospace's state-of-the-art, low-emitting aircraft engines. Trailing closely behind and a few thousand feet above the 747 was NASA's G-III aircraft equipped with the state-of-the-art High Altitude Lidar Observatory (HALO). The HALO instrument used laser light to profile the atmosphere below the aircraft, measuring a vertical curtain of water vapor concentrations as well as the amount of light being scattered by contrail and cirrus clouds. A few times per flight, the G-III would also launch a parachute-equipped sonde that fell through the atmosphere and transmit meteorological temperature and humidity measurements back to the aircraft. These observations allowed the NASA and GE Aerospace scientists and engineers to develop a three-dimensional view of the atmosphere – one that could be used to test state-of-the-art contrail prediction models.

*View of the GE Aerospace 747 Flying Test Bed as seen from the G-III. Only three contrails are visible behind the four-engine aircraft as the left, inboard engine was purposely throttled back to effect a change in the contrail properties. Credit: NASA*

An additional goal of the CODEX project was to demonstrate the capabilities of NASA's HALO lidar for quantitatively assessing aircraft engine emissions, which depend on the engine technology and jet fuel composition. As the G-III pilots slowly maneuvered the lidar beam through the contrails, the 747 pilots and aerospace engineers on the 747 manipulated the engine thrust conditions on the left, inboard (#2) engine. As the #2 engine thrust approached idle conditions, the thick, white

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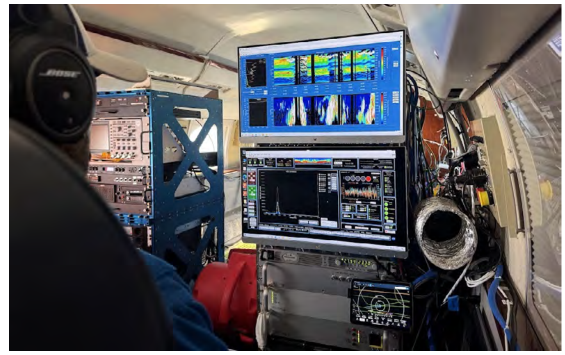
## Contrail Optial Depth Experiment (CODEX)

contrail forming behind it disappeared.

The science team is currently assessing the HALO data to see if the lidar can pick out the difference in contrail optical thickness at aircraft horizontal separation distances of only a few hundreds to thousands of feet. If successful, the remote sensing sampling techniques pioneered during CODEX will pave the way for future opportunities to support the U.S. aerospace industry and advance our scientific understanding of these important atmospheric phenomena.



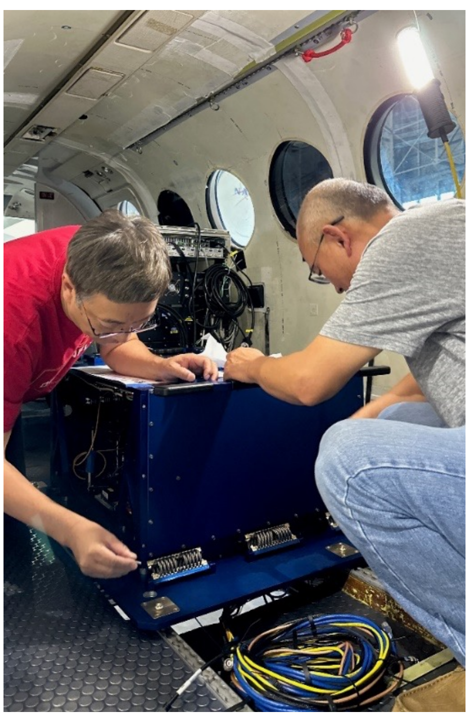
*NASA High Altitude Lidar Observatory (HALO) Principal Investigator, Amin Nehrir, looks on as the backscatter signal spike from the contrail becomes visible on the lower monitor. Credit: NASA*

# First Flights of the Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System (CASALS)

Contributed by Guangning Yang (NASA GSFC)

The airborne Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System (CASALS) has been developed to demonstrate advanced technologies and measurement approaches that can enable the first 3D lidar swath mapping of the heights of the Earth's surface from space. The 3D lidar mapping combined with spectrometry will contribute to improved understanding of the processes by which the Earth's heights are changing, such as forest growth and ice sheet mass loss due to melting, as compared to current generation 2D lidar profiling from space.

*Wei Lu (left) and Guangning Yang installing CASALS on the NASA B-200 King Air. Credit: NASA*



The enabling lidar technologies include:

- *A high-efficiency, near-infrared, fiber-amplified transmitter operating up to 150,000 pulses per second, using a fast wavelength-tuning seed laser.*
- *Transmission through a diffraction grating for passive wavelength-to-angle laser beam scanning to achieve adaptive 3D mapping across a 7 km wide swath from a 500 km orbit.*
- *A receiver diffraction grating that rejects solar background noise across the full range of tuned wavelengths.*
- *A state-of-the-art, low-noise, high-efficiency, linear-mode, detector array with single-photon sensitivity to image the scanned swath.*
- *Time-interleaved waveform digitizing to reduce electronics power.*

The first flights of airborne CASALS were conducted in November 2024 aboard a NASA B-200 King Air based at Langley Research Center. The flights focused on demonstrating the performance of its novel scanning lidar sensor, operating at altitudes from 4 to 8 kilometers during four flights at sites in Virginia and Delaware. All operational and performance requirements were fully met – an impressive accomplishment for flights of a new sensor. Along with the lidar, two commercial imaging spectrometers were flown to characterize land cover, a Headwall Hyperspec Co-Aligned VNIR-SWIR sensor and a Cubert Ultris X20 Plus Vis-NIR and panchromatic sensor. Airborne CASALS was developed by a team at NASA Goddard Space Flight Center, led by Guangning Yang, with funding from NASA's Earth Science Technology Office (ESTO).

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### First Flights of the Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System (CASALS)


*CASALS team members after the first flight. From Left: David Harding, William Hasselbrack, Guangning Yang, Jeff Chen, Wei Lu and Phil Coulter. Credit: NASA*

The CASALS lidar achieved the following accomplishments:

- *Dramatically improved measurement efficiency compared to previous lidars, enabling spaceflight wide-swath mapping while reducing size, weight and power (SWaP).*
- *Use of high technical readiness components with a direct path to space.*
- *Demonstration of a ground-breaking, non-mechanical beam scanning technique.*

The lidar acquires waveforms of the Earth's vertical structure, like the first ICESat and GEDI space-borne missions, but with single-photon sensitivity, like the photon-counting ICESat-2 mission. Going forward, CASALS will participate in campaigns to advance readiness for a Surface Topography and Vegetation (STV) mission recommended in the 2017 National Academy of Sciences Earth Science Decadal Survey.

# CHAPS-D Successful Airborne Demonstration

Contributed by William Swartz (JHU/APL)

Small satellites provide a number of potential advantages for Earth observation, including smaller size, weight, and power and greater agility, enabling constellation measurements with greater spatiotemporal resolution than currently available. The technological challenge is reducing instrument volume while maintaining enough of the performance afforded by larger instruments for scientific utility. The Compact Hyperspectral Air Pollution Sensor (CHAPS) is a compact hyperspectral imager for atmospheric composition measurements, designed for spaceflight in a small satellite or as a hosted payload and focused on making targeted, higher-resolution measurements needed by scientists to better understand sources and events.

*CHAPS-D PI and lead engineer next to the LaRC B-200. Credit: William Swartz / JHU/APL*


The development of a prototype instrument, CHAPS-Demonstrator (CHAPS-D), was funded by the NASA Earth Science Technology Office (ESTO) and was deployed in a series of airborne demonstrations aboard the NASA King Air B-200, based at NASA LaRC, in September–October 2024. The CHAPS-D optomechanical structure and detector assembly fit comfortably within the payload volume of a typical 6U CubeSat and make nadir-viewing, push-broom measurements of backscattered solar radiance (300–500 nm, $\Delta\lambda$ = 0.6 nm), from which trace gases are retrieved using differential optical absorption spectroscopy. The enabling technologies are freeform optics and additive manufacturing. Freeform optics in the all-reflective optical system leads to a compact


*CHAPS-D and GCAS (GSFC) integrated on B-200. Credit: William Swartz / JHU/APL*

instrument with a ground spatial resolution of 1 x 1 km$^2$ from low Earth orbit or ~20 m resolution from the B-200. The optomechanical housing was additively manufactured in a next-generation aluminum alloy, after computer-aided topology optimization to minimize mass while maintaining mechanical strength.

Three science flights targeting urban centers were flown from LaRC, totaling 11 flight hours. Raster scans over New York City, Philadelphia, Baltimore, Washington, D.C., and Charlotte were made. CHAPS-D was co-manifest-

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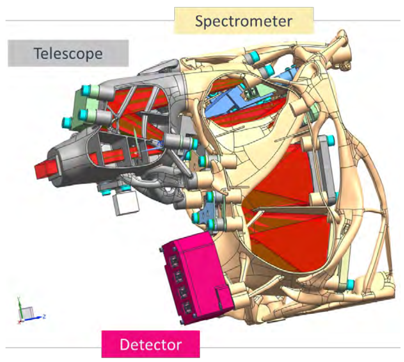
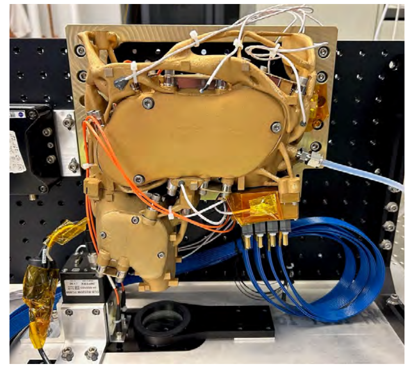
## CHAPS-D Successful Airborne Demonstration

ed with the NASA GEO-CAPE Airborne Simulator (GCAS) (PI: Scott Janz, NASA GSFC), for validation. The primary trace gas retrieval demonstrated was nitrogen dioxide, and preliminary results show excellent agreement between the two instruments.

A follow-on effort funded by ESTO will space-qualify CHAPS and prepare the instrument concept for a future deployment in space.




*CHAPS-D optomechanical design. Credit: NASA*



*CHAPS-D instrument configuration, nadir-viewing through bottom of B-200. Credit: William Swartz / JHU/APL*

# AirMSPI-2 Achieves First Science Flights, Expanding NASA's Airborne Observations of Aerosols, Clouds, and Surface Properties

Contributed by Felix Seidel (JPL, CalTech), David Diner (JPL, CalTech), Markus Scheucher (JPL, CalTech), Charles Wang (JPL, CalTech), Brian Rheingans (JPL, CalTech), and Ryan Applegate (JPL, CalTech)

JPL's second-generation Airborne Multiangle SpectroPolarimetric Imager (AirMSPI-2) completed its first science flights onboard NASA's ER-2 aircraft at Armstrong Flight Research Center (AFRC) in April 2025. These flights mark a significant step forward in NASA's airborne remote sensing capabilities, delivering high-quality, multi-angle polarimetric data across the ultraviolet, visible, near-infrared, and shortwave infrared spectrum essential for detailed characterization of aerosol, cloud, and Earth surface properties. Data from these flights will be publicly available at the NASA Atmospheric Science Data Center (ASDC): https://asdc.larc.nasa.gov.

As the closest airborne analog to the upcoming Multi-Angle Imager for Aerosols (MAIA) satellite mission, scheduled for launch in mid-2026, a primary objective of AirMSPI-2 is to support the development and validation of MAIA's retrieval algorithms and data products. MAIA's mission is focused on studying aerosol impacts on air quality and human health.

*AirMSPI-2 installed in the nose cone of NASA's ER-2 high-altitude aircraft at Armstrong Flight Research Center. April 2025 marked its first successful science deployment, collecting multi-spectral data critical for aerosol and surface studies. Credit: Genaro Vavuris / NASA AFRC*

Building on the original AirMSPI heritage documented by Diner et al. (2013), AirMSPI-2 incorporates significant upgrades, including expanded spectral coverage through the addition of oxygen A-band and shortwave infrared channels. These capabilities required a redesigned optical system housed in a vacuum-sealed enclosure and supported by a cryocooling system to stabilize infrared detector temperatures.

Engineering flights in October 2015, April 2023, and October 2023 highlighted technical challenges with vacuum control and

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## AirMSPI-2 Achieves First Science Flights, Expanding NASA's Airborne Observations of Aerosols, Clouds, and Surface Properties

maintaining stable detector temperatures. Between late 2023 and early 2025, the project team implemented targeted hardware upgrades, including a higher capacity cryocooler. These improvements resolved prior limitations, enabling stable cryogenic performance and reliable science data collection during the 2025 deployment.

Looking ahead, AirMSPI-2's robust multiangle polarimetric imaging, extended spectral range, and stable instrument performance make it well-suited for future NASA Airborne Science activities. The instrument is expected to contribute to a wide range of investigations, including air quality, aerosol-cloud interactions, and surface reflectivity, advancing scientific understanding of key atmospheric and terrestrial processes and supporting broader Earth system science objectives.

*JPL engineers supporting the April 2025 AirMSPI-2 deployment at AFRC. From left to right: Charles Wang, Ryan Applegate, Brian Rheingans, and Markus Scheucher. The team led key hardware upgrades enabling successful science flight performance demonstrated during recent flights. Credit: Genaro Vavuris / NASA AFRC.*

*NASA's ER-2 high-altitude aircraft carrying the AirMSPI-2 science instrument payload in the nose cone during MAIA science and launch preparation flights in April 2025. Credit: Carla Thomas / NASA AFRC.*

# Dense UAVSAR Snow Timeseries (DUST)

Contributed by Erica Heim (NASA AFRC) and Shadi Oveisgharan (JPL)

As part of a science mission tracking one of Earth's most precious resources – water – NASA's C-20A aircraft conducted a series of seven research flights in March 2025 over the Sierra Nevada mountains in California and the Rocky Mountains in Idaho. The agency's Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) installed on the aircraft collected measurements of seasonal snow cover that can help researchers quantify the performance of a new method in estimating snow water equivalent over the mountains.

*The C-20A aircraft, based at NASA's Armstrong Flight Research Center in Edwards, California, flies over the Sierra Nevada Mountains in California for the Dense UAVSAR Snow Time (DUST) mission on Feb. 28, 2025. The DUST mission collected airborne data about snow water to help improve water management and reservoir systems on the ground. Credit: Starr Ginn / NASA*

The Dense UAVSAR Snow Timeseries (DUST) mission mapped snow accumulation over mountains in the Western U.S. to estimate contained freshwater. Accurate measurement of snowpack is critical for effective water resource management. The DUST mission aims to assess the performance of this new estimation technique under varying snow and environmental conditions.

The DUST mission achieved a new level of snow data accuracy, partly due to the specialized flight paths flown by the C-20A: the aircraft's Platform Precision Autopilot (PPA) enables researchers to fly very specific routes at exact altitudes, speeds, and angles so the UAVSAR can more precisely measure terrain changes. Mission

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## Dense UAVSAR Snow Timeseries (DUST)

scientists can use these observations to more accurately estimate the amount of water stored in snow.

*Peter Wu, radar operator from NASA's Jet Propulsion Laboratory in Southern California, observes data collected during the Dense UAVSAR Snow Time (DUST) mission onboard NASA's C-20A aircraft on Feb. 28, 2025. The C-20A flew from NASA's Armstrong Flight Research Center in Edwards, California, over the Sierra Nevada Mountains to collect data about snow water. Credit: Starr Ginn / NASA*

Insights gained from the DUST mission will support future snow-monitoring missions, including an upcoming collaboration between NASA and the Indian Space Research Organisation (ISRO). The NASA-ISRO Synthetic Aperture Radar (NISAR) Mission will measure the motion of nearly all the planet's land and ice-covered surfaces at a pace that will give researchers a fuller picture of how Earth's surface changes over time.

# The Goddard Space Flight Center (GSFC) Lidar Observation and Validation Experiment (GLOVE)

Contributed by John Yorks (NASA GSFC)

*Some of the GLOVE and ER-2 team members in front of NASA ER-2 aircraft at NASA AFRC. Credit: Steve Freeman / NASA*

The Goddard Space Flight Center (GSFC) Lidar Observation and Validation Experiment (GLOVE) field campaign was conducted from January 27 to February 25, 2025, operating out of NASA Armstrong Flight Research Center (AFRC) at Edwards Air Force Base in California. The primary objective was to validate atmospheric data products from current satellite missions. Clouds and aerosols in the Earth's atmosphere play a significant role in affecting visibility, aviation safety, and public health. For instance, aerosols from dust storms and wildfires—such as the June 2023 pollution episode in New York City caused by Canadian wildfires—can impair visibility and pose health risks. In the upper atmosphere, clouds containing supercooled liquid droplets and volcanic plumes present serious hazards to commercial aviation.

Launched in 2024, the Earth Cloud, Aerosol and Radiation Explorer (EarthCARE) satellite mission—funded by the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA)—aims to study clouds and aerosols in detail. Similarly, the Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2), launched in 2018, measures the height and optical properties of cloud and aerosol layers, although its primary focus is on surface altimetry and monitoring the Cryosphere. Validating remote sensing data from missions like EarthCARE and ICESat-2 is essential to assess the accuracy, limitations, and reliability of their observations.

The GLOVE field campaign made use of NASA's high-altitude ER-2 aircraft, outfitted with four remote sensing instruments that closely replicate the capabilities of those on the ICESat-2 and EarthCARE satellites:

- *Cloud Physics Lidar (CPL)*
- *Roscoe Nadir/Zenith Lidar*
- *Cloud Radar System (CRS)*
- *enhanced MODIS Airborne Simulator (eMAS) spectrometer*

Across eight flights totaling 40 hours, the ER-2 performed 13 satellite underflight segments—each lasting 20 to 40 minutes—

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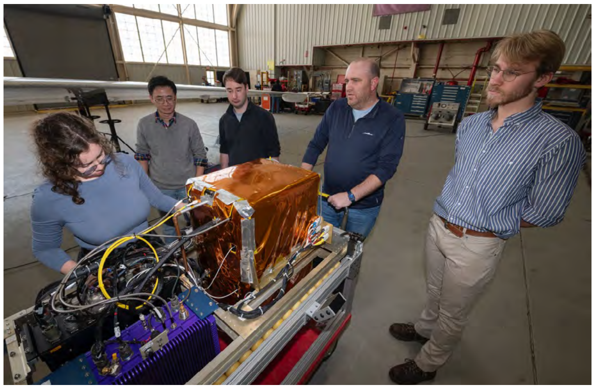
## The Goddard Space Flight Center (GSFC) Lidar Observation and Validation Experiment (GLOVE)

in diverse atmospheric conditions (e.g., aerosols, cirrus, and strato-cumulus clouds) and over various surface types (e.g., ocean, land, and mountainous regions).

Data from seven ICESat-2 under-flights, particularly those capturing cirrus clouds and aerosols, provide valuable insights for evaluating both operational and research-grade ICESat-2 atmospheric data products in daytime conditions. Similarly, the six EarthCARE underflights contribute a unique dataset to assess the accuracy and limitations of EarthCARE's groundbreaking Doppler velocity measurements within clouds—the first of their kind from space. All data products from the GLOVE campaign will soon be available through NASA's Distributed Active



*Members of the CPL instrument team work with students and staff from University of Iowa to install the CPL onto the ER-2 aircraft before the first GLOVE flight. Credit: Steve Freeman / NASA*

Archive Centers (DAAC). GLOVE also emphasized workforce development by giving five early-career scientists the opportunity to lead their first aircraft missions as mission scientists. Four students also were involved in forecasting, instrument integration, and data processing.

While flying out of NASA AFRC comes with operational constraints, such as limited flight possibilities due to airfield closures, the constant communication between the ER-2 and GLOVE teams, as well as hard work by all involved, enabled GLOVE to efficiently fly eight times over a three-week period, achieving its satellite validation objectives. GLOVE stands as a model for cost-effective and efficient airborne satellite data validation campaigns.

# Airborne Science **NEWS**

## NASA's B777 Airborne Research Laboratory: Advancements and Milestones

Contributed by Kirsten Boogaard (NASA LaRC)

NASA's effort to convert a Boeing 777 into a next-generation airborne science laboratory continues to make strong progress, with several major milestones recently achieved. The engineering design phase–led by L3Harris as a subcontractor to Yulista–is now complete, paving the way for physical modification of the aircraft.

The structural modification and installation contract was awarded in December 2024, and the aircraft was delivered to L3Harris Technologies in Waco, Texas, in January 2025. Since then, extensive structural work has begun, including the installation of four layers of doublers for all six nadir viewports. Cutting of the nadir openings is expected to begin in June 2025. Work on the four reinforced window viewports is also progressing, with approximately 52% of that modification now complete.

In parallel, preparations are underway to ready the aircraft for science operations. This includes installation of the experimenter control station, payload interfaces systems, wiring, and various other

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*B777 landing. Credit: L3Harris*

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## NASA's B777 Airborne Research Laboratory: Advancements and Milestones

B777 showcasing work in progress on window modification. Credit: L3Harris

subsystems that will support future missions.

These coordinated modifications–both inside and outside the aircraft–are laying the groundwork for a versatile science platform capable of supporting a wide range of instruments and research campaigns.

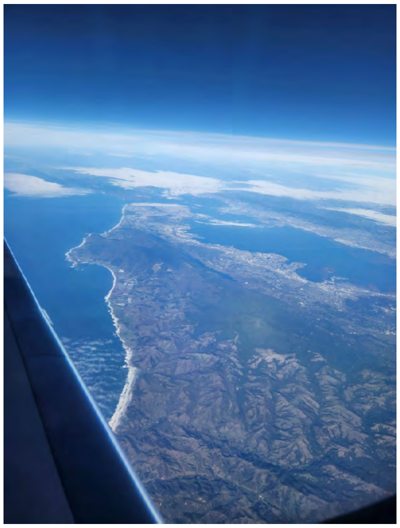
Planning is also underway for the aircraft's first science mission, North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment (NURTURE), scheduled for early 2027. Recent site surveys to two locations in Canada were conducted to help determine location suitability for the mission. Instrument integration design is in progress to ensure compatibility with the evolving aircraft configuration.

With structural and systems work progressing on schedule, NASA remains on track to achieve initial operating capability in 2026, positioning the B777 as a flagship platform for airborne science.

# Soxnav: NASA's New Precision Aircraft Guidance System

Contributed by John Sonntag (BAERI)

NASA's new precision aircraft guidance system, known as Soxnav, successfully flew aboard NASA Armstrong Flight Research Center's (AFRC) Gulfstream-IV aircraft, tail number N814NA, in December 2024. During two flights, pilots and engineers worked out flight line capture techniques and tuned Soxnav's control gains, ultimately achieving guidance results for the high-performance jet aircraft which were much better than expected. Soxnav maintained the aircraft's lateral and vertical position within a notional 5-meter (16.4 ft) radius "tube" over 99% of the time, compared to a design goal of doing so better than 90% of the time. It did so at true airspeeds often exceeding 500 miles per hour.



The San Francisco Bay area, as seen during the December 17, 2024 Soxnav test flight. Credit: John Sonntag / BAERI

Recent Soxnav development and the December test flights support NASA's Next Generation Airborne Synthetic Aperture Radar (AIRSAR-NG) development program, for which Soxnav is intended to provide aircraft guidance. However, Soxnav has also been designed as a more generalized tool for NASA's Airborne Science Program. The architecture of Soxnav permits it to be integrated, at low cost, aboard a very wide variety of aircraft, including most of the NASA fleet. NASA expects that this will make Soxnav readily suitable for many future airborne science efforts which require fine-grained aircraft guidance.

NASA-814, the AFRC-based Gulfstream-IV used for December 2024 Soxnav flight testing, with AFRC's Matthias Gastler at right. Credits: John Sonntag / BAERI

Soxnav provides guidance to its host aircraft via radio-frequency Instrument Landing System (ILS) signals, and to pilots via yoke-mounted tablet computers. This design approach will make

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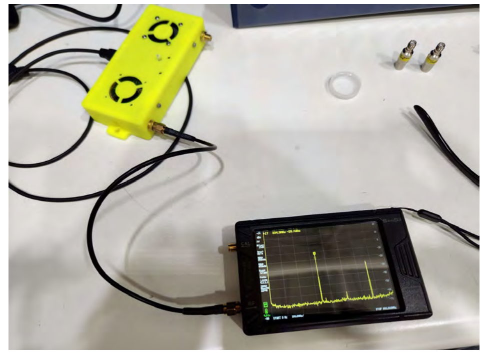
(continued from Pg. 11)

## Soxnav: NASA's New Precision Aircraft Guidance System

it straightforward to integrate Soxnav aboard any ILS-equipped aircraft with relatively simple cabling and switching hardware, thus enabling Soxnav to support many future airborne science efforts that might benefit from it.

Soxnav is the latest step in a nearly 35-year development process which started at Wallops Flight Facility in the early 1990s aboard the P-3 aircraft, tail number N426NA. Since then, Soxnav's predecessor systems provided aircraft guidance for several NASA efforts, most notably Operation IceBridge, where the systems were successfully integrated aboard numerous aircraft and kept them on-track for thousands of hours of precision flying over often featureless Arctic and Antarctic ice. Soxnav has evolved from these earlier systems into the far more accurate, automated, and miniaturized guidance system it is today. For most potential use cases, Soxnav will not require a dedicated operator and can be routinely operated, with minimal attention, effort and training, by the flight crew. The initial production Soxnav system will be delivered to AFRC by summer 2025. Once fully operational, Soxnav will be managed, and made available to the airborne science community, by the National Suborbital Research Center (NSRC).



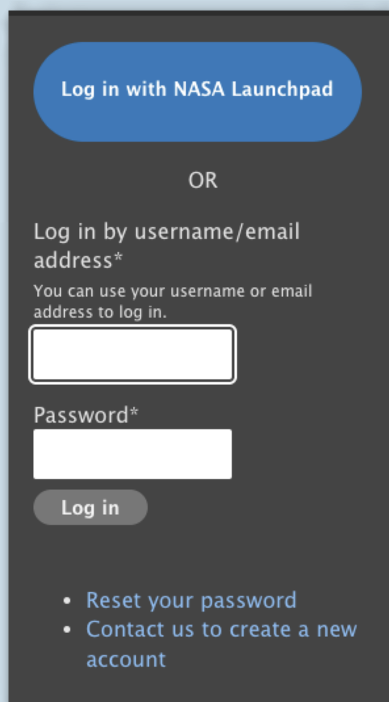
*The prototype Soxnav radio-frequency electronics module (yellow box), while under bench-testing with a portable spectrum analyzer at bottom. Credit: John Sonntag / BAERI*

## SOFRS Corner

Contributed by Sommer Nicholas (NASA ARC)

Science Operations Flight Request System (SOFRS) Corner
SOFRS Website: [https://airbornescience.nasa.gov/sofrs](https://airbornescience.nasa.gov/sofrs)

**Logging into your ASP account is now even easier!**
If you have NASA credentials, you now have the convenience of logging in to your ASP account via Launchpad. This enhancement is designed to simplify the login process and improve the overall user experience for badge-holders.




For our users without NASA badges, or for users who may occasionally need to log in to the site outside of the NASA network, we have implemented two-factor authentication for additional security when signing in with your username and password.

If you don't yet have an Airborne Science account, please click on the link in the login box to contact us, and we can help establish your account.

Please reach out to us at
**sofrs_curators@airbornescience.nasa.gov**
if you have any questions.

# Calendar of Events

**Aviation Forum + ASCEND**
**JULY 21-25, 2025** I Las Vegas, NV
https://aiaa.org/aviation/

**Hyperspectral/Multispectral Imaging and Sounding of the Environment (HISE) Meeting***
**JULY 20-24, 2025** I Long Beach, CA
https://www.optica.org/events/congress/optical_sensors_and_sensing_congress/
***Beneficial for SBG Community**

**2025 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)**
**AUGUST 3-8, 2025** I Brisbane, Australia
https://2025.ieeeigarss.org/index.php

**Ecological Society of America (ESA) Annual Meeting 2025**
**AUGUST 10-15, 2025** I Baltimore, MD
https://www.esa.org/baltimore2025/

**5th ESSP Program Forum**
**AUGUST 26-28, 2025**
NASA Langley Research Center

**EMIT and ECOSTRESS Science and Applications Team Meeting***
**September 15-18th** I 2025, Pasadena, CA
***(SBG's designated precursor instruments)**

**American Geophysical Union (AGU) Annual Meeting 2025**
**December 15-19, 2025** I New Orleans, Louisiana
https://www.agu.org/annual-meeting

## Airborne Science Program Platform Capabilities

Available aircraft and specs

| Platform Name | NASA Center | Payload Accommodations | Duration (Hours) | Useful Payload (lbs) | Max Altitude (ft) | Airspeed (knots) | Range (Nmi) |
|---|---|---|---|---|---|---|---|
| ASP Supported Aircraft | | | | | | | |
| B777 | LaRC | nadir ports, dropsondes, in situ sampling | 18 | 75,000 | 43,000 | 500 | 9,000 |
| ER-2 (2) | AFRC | Q-bay (2 nadir ports), nose (1 nadir port), wing pods (4 nadir, 3 zenith ports), centerline pod (1 nadir port) | 12 | 2,900 | >70,000 | 410 | 5,000 |
| G-III/C-20A | AFRC | UAVSAR pod | 7 | 2,610 | 45,000 | 460 | 3,000 |
| G-III | LaRC | 2 nadir ports, dropsonde / sonobuoy | 7 | 2,610 | 45,000 | 460 | 3,000 |
| G-IV | LaRC | AirSAR next gen (future) | 7.5 | 5,610 | 45,000 | 459 | 5,130 |
| P-3 | WFF | 1 large and 3 small zenith ports, 3 fuselage nadir ports, 4 P-3 window ports, 3 DC-8 window ports, nose radome, aft tailcone, 10 wing mounting points, dropsonde | 14 | 14,700 | 32,000 | 400 | 3,800 |
| WB-57 | JSC | Nose cone, 12 ft of pallets for either 3 ft or 6 ft pallets, 2 spearpods, 2 superpods, 14 wing hatch panels | 6.5 | 4,100 | 35,000 | 275 | 1,250 |
| Other NASA Aircraft | | | | | | | |
| B-200 | AFRC | 2 nadir ports | 6 | 1,850 | 30,000 | 272 | 1,490 |
| B-200 | LaRC | 2 nadir ports, wing tip pylons, zenith site for aerosol inlet, lateral ports | 6.2 | 4,100 | 35,000 | 275 | 1,250 |
| Cirrus SR22 | LaRC | Unpressurized belly pod | 6 | 932 | 17,500 | 175 | 970 |