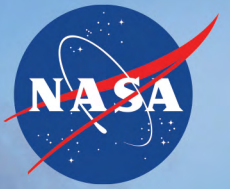


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Science Mission Directorate

Airborne Science Program

2025 Annual Report

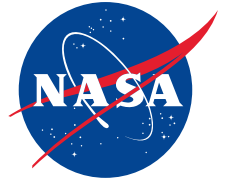


COVER IMAGES:

Front top: The G-IV aircraft lifts off from NASA's Armstrong Flight Research Center in Edwards, California, on March 18, 2025. G-IV was recently sent to Avenger Aerospace Solutions in Cartersville, Georgia, for modifications that will optimize the G-IV's performance as a research aircraft. Credit: Carla Thomas/NASA

Front Bottom: Crew members prepare NASA ER-2 aircraft for flight at Edwards, California, in September 2025, in support of the Geological Earth Mapping Experiment (GEMx). Credit: Genaro Vavuris/NASA

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1. Leadership Comments



Derek Rutovic, Director of the Airborne Science Program.

Thank you for taking the time to learn about the NASA Earth Science Division (ESD) Airborne Science Program (ASP).

This ASP Annual Report highlights Fiscal Year 2025 (FY25) Airborne Science missions and the unique people, platforms, payloads, and capabilities that made them possible. The Program had another successful year in 2025 by supporting nearly 1,700 flight hours across various Earth Science Spheres. NASA aircraft frequently conducted under flights of satellites and ISS systems for calibration and validation including EMIT, TEMPO, PACE, ICESat-2, ECOSTRESS-ISS, and NISAR.

Additionally, ASP supported important process, mapping, and modeling studies such as GLOVE, DUST, and MAGEQ, and tested new instruments including CASALS, APEX, CHAPS-D, and AirMSPI-2. Finally, we also collaborated with international and interagency partners to support multiple missions, including GEMx, WH²yMSIE, SWXRAD, and CODEX.

When not directly supporting airborne projects, ASP worked to improve Program capabilities. The B777 was flown to a vendor in FY25 to begin major structural modifications to install nadir and window viewports; first mission is slated for FY27. We have also continued modifications on our Gulfstream IV, which will serve as a developmental and operational platform for the UAVSAR follow-on mission, AirSAR-NG. Finally, we also acquired a science-dedicated GV just as the fiscal year came to an end. Modifications to the GV will take place in FY26 ready to support missions in FY27.

Lastly, we bid farewell to Bruce Tagg in June 2025 as he retired after spending 15 years at the helm of the Airborne Science Program. We encourage you visit our website and read about his distinguished career in our Fall 2025 newsletter.

All of these accomplishments were made possible by the excellence, perseverance, and dedication of the ASP community: flight crew, instrument operators, principal investigators, logistics team, ESD program leads, students, collaborators, and more. Together, we will continue to ensure our Program and assets meet the ongoing and upcoming science requirements and ensure our missions are completed on time and within budget. **Thanks to you** for your support of NASA Earth Science! Please let us know if you have any comments or suggestions for ASP leadership.

***Derek Rutovic
and the ASP Leadership Team,
Airborne Science Program***



2. Program Overview

The Airborne Science Program (ASP) is an important element of the NASA Science Mission Directorate (SMD) Earth Science Division (ESD) because of its involvement and support throughout the entire life cycle of Earth observing satellite missions. Aircraft modified with ports, inlets, internet, and communications systems support NASA Earth science missions by:

- Providing a platform for testing future satellite or International Space Station (ISS) instruments.
- Conducting underflights for calibration and validation of on-orbit missions.
- Simulating future satellite mission data for algorithm development with airborne prototype instruments.
- Supporting process studies to provide high-resolution temporal and spatial measurements of complex local processes, which can be coupled to global satellite observations for a better understanding of the complete Earth system.
- Leading workforce development through hands-on science and engineering opportunities.

ASP accomplishes these goals by providing support for operations of mission critical, or core, aircraft; engineering for instrument mechanical, electrical, and data network integration; and on-board data systems and communications capabilities. The Program also assists NASA Principal Investigators (PIs) with access to commercial aviation services and use of non-NASA aircraft and equipment for Earth Science, as needed..

Program Structure

The Program is administered through SMD/ESD, with oversight and close coordination from the Flight Projects and Research and Analysis (R&A) Programs (Figure 1). Aircraft operations and science support responsibilities are distributed among the multiple NASA flight centers – Armstrong Flight Research Center (AFRC), Langley Research Center (LaRC), Wallops Flight Facility (WFF), Johnson Space Center (JSC), and Ames Research Center (ARC) – where the aircraft and support personnel are based, as shown in Figure 2.

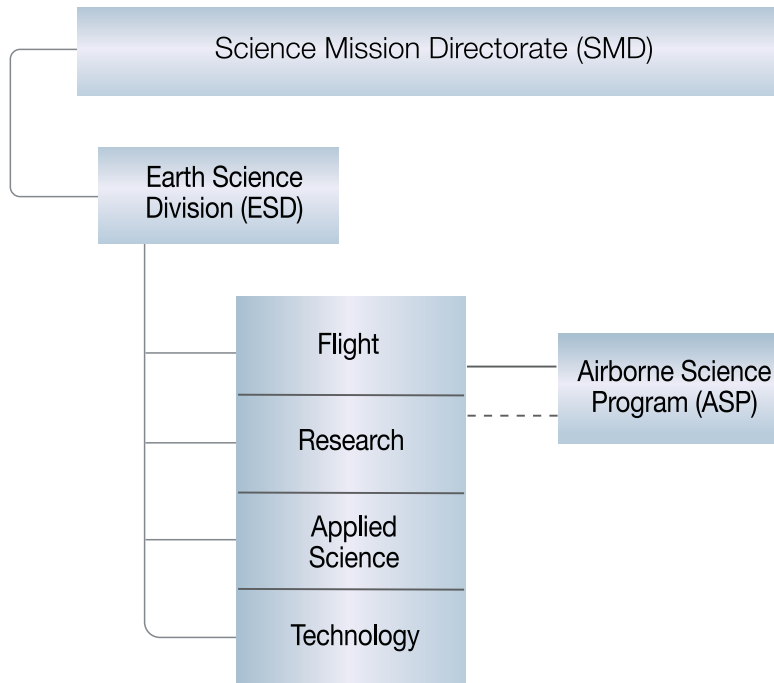


Figure 1. Science Mission Directorate organization chart.

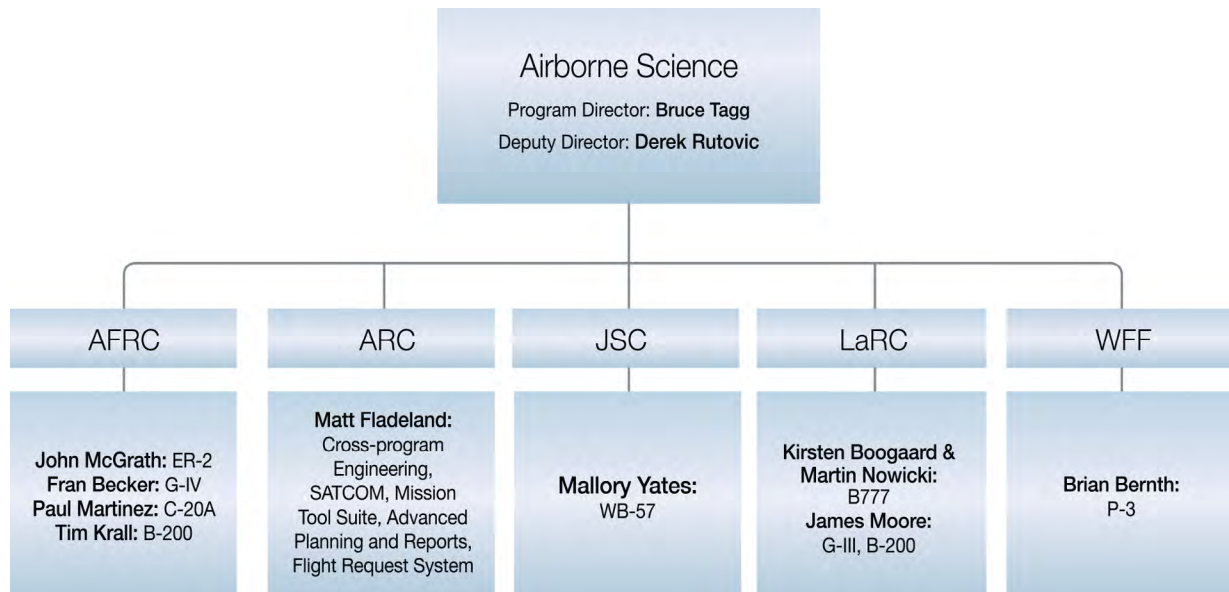


Figure 2. Airborne Science Program organization chart.



Flight Request System and Flight Hours

The Airborne Science Program (ASP) maintains science-capable aircraft and instrument assets for research use in support of NASA's Science Mission Directorate (SMD). The Science Operations Flight Request System (SOFRS) is a web-based tool used to track and facilitate the review and approval process for airborne science activities using ASP-supported aircraft, facility instruments, or any Earth Science

Division (ESD) funded activities/missions using aircraft. The way to schedule the use of NASA SMD platforms and instrument assets is to submit a Flight Request (FR) through SOFRS (<https://airbornescience.nasa.gov/sofrs>). The SOFRS team strives for continuous improvement by refining the user interface and reports produced. This year the SOFRS team collaborated with the web development team as they continued to fine tune the major software and interface upgrades made the previous year.

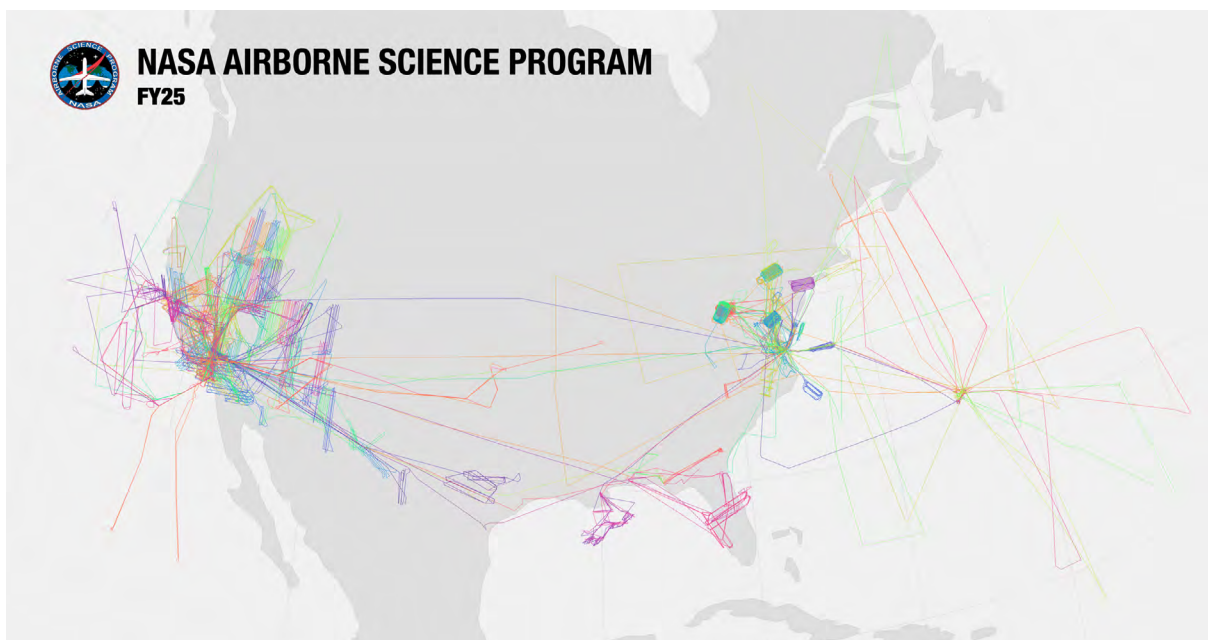


Figure 3. Flight tracks in FY25 generated using ASP's Mission Tool Suite (MTS). **Credit:** Aaron Duley/NASA

How to read Tables 1, 2, 3 and 4

- The "Total FRs Approved" column includes Flight Requests that were approved but may or may not have flown during FY25.
- The "Total Partial FRs" column includes Flight Requests for which the total approved hours were not fully expended during FY25 and have been rolled over to the following year.
- The "Total FRs Completed" column includes only Flight Requests with the final status of "Completed."

The "Total Hours Flown" column includes all "Flight Hours Flown" for Flight Requests with a status of "Completed" or "Partial" for FY25.

There were 90 Flight Requests submitted in Fiscal Year 25 (FY25) for flight activities using at least one of the following ASP components: an ASP-supported aircraft, ESD funding, or an ASP facility instrument (AVIRIS-3, AVIRIS-NG, AVIRIS-C, AVIRIS-5, PICARD, eMAS, LVIS,

MASTER, NAST-I and UAVSAR (L-Band, P/Ka Bands)). A total of 50 Flight Requests were completed using 15 different aircraft flying a total of 1669.6 flight hours. The details are listed below.

Table 1. NASA Airborne Science Total Hours Flown by Aircraft in FY25 (per funding source).^{1, 2}

Aircraft	NASA ESD	NASA SMD	Other NASA	Non - NASA	Total
ASP Supported Aircraft					
ER-2 - AFRC	356.1	0	0	0	356.1
Gulfstream C-20A (GIII) - AFRC	186.3	0	0	0	186.3
Gulfstream III - LaRC	260.4	0	9.2	26.1	295.7
Gulfstream V - JSC	0	0	0	0	0
P-3 Orion - WFF	92	0	0	0	92
Other NASA Aircraft					
B-200	68.6	28.9	0	0	97.5
C-130H - WFF	0	0	0	0	0
Gulfstream IV - AFRC	0	0	0	0	0
Other	594.3	0	0	47.7	642
TOTAL	1557.7	28.9	9.2	73.8	1669.6

Table 1 shows all SOFRS flight hours flown by all aircraft, including “Other (non-NASA) Aircraft,” by funding source. More details on other supported aircraft are shown in Table 4. Other NASA aircraft are NASA-owned aircraft but not subsidized by the ASP program.

Table 2. FY25 FR Status & Hours Flown by Aircraft.³

Aircraft	Total FRs	Approved	Partial	Completed	Total Hours Flown
ASP Supported Aircraft					
DC-8 - AFRC	2	0	0	0	0
ER-2 - AFRC	11	7	0	7	356.1
Gulfstream C-20A (GIII) - AFRC	20	17	0	17	186.3
Gulfstream III - LaRC	10	5	0	5	295.7
Gulfstream V - JSC	2	0	0	0	0
P-3 Orion - WFF	7	2	0	2	92
Other NASA Aircraft					
B-200	11	7	1	4	97.5
C-130H - WFF	1	0	0	0	0
Gulfstream IV - AFRC	1	0	0	0	0
Other	25	18	0	15	642
TOTAL	90	56	1	50	1669.6

¹The NASA Earth Science Division (ESD) is under the Science Mission Directorate (SMD).

²SMD (non-ESD) flight hours are those funded by SMD Program Managers not within ESD.

³Table 2 shows the total number of flight requests submitted and the total of flight hours flown. Of the total number of flight requests submitted, Table 2 shows how many flight requests were approved, completed, or partially completed. Of the remaining FRs, some were deferred, and the rest were canceled for various reasons.

**Table 3.** FY25 ESD Funded FR Status & Hours Flown by Aircraft.⁴

Aircraft	Total FRs	Approved	Partial	Completed	Total Hours Flown
ASP Supported Aircraft					
DC-8 - AFRC	2	0	0	0	0
ER-2 - AFRC	9	7	0	7	356.1
Gulfstream C-20A (GIII) - AFRC	18	17	0	17	186.3
Gulfstream III - LaRC	8	3	0	3	260.4
Gulfstream V - JSC	1	0	0	0	0
P-3 Orion - WFF	5	2	0	2	92
Other NASA Aircraft					
B-200	10	6	1	3	68.6
C-130H - WFF	1	0	0	0	0
Other	23	16	0	13	594.3
TOTAL	77	51	1	45	1557.7

Table 4. FY25 FR Status & Hours Flown by Other (non-NASA) Aircraft.⁵

Aircraft	Total FRs	Approved	Partial	Completed	Total Hours Flown
Other Aircraft					
A90 - Dynamic Aviation	3	1	0	1	209.7
B-200 - Dynamic Aviation	20	15	0	13	428.2
Black Swift S2 (ARC)	1	1	0	1	4.1
ISRO King Air	1	1	0	0	0
Twin Otter CIRPAS	2	0	0	0	0
TOTAL	27	18	0	15	642

Table 5. Flight Hours Flown by Funding Source for the Last Five Years from 2020 to 2025.

Fiscal Year	ESD	SMD	Other NASA	Non-NASA	Funding Sources Not Listed in FR	Total Funded Flight Hours
2020	1614	0	129.9	0	0	1743.9
2021	2166	0	193.5	0	2.7	2424.9
2022	2111.8	0	233	390.6	12.7	2748.1
2023	2115	18.4	0	273.9	7.9	2415.2
2024	2074.6	0	64.4	272.4	0	2411.4
2025	1557.7	28.9	9.2	73.8	0	1669.6

⁴Table 3 shows only ESD flight requests and flight hours flown by aircraft.⁵Table 4 shows the flight request status and total hours for the specific “Other (non-NASA) Aircraft” requested.

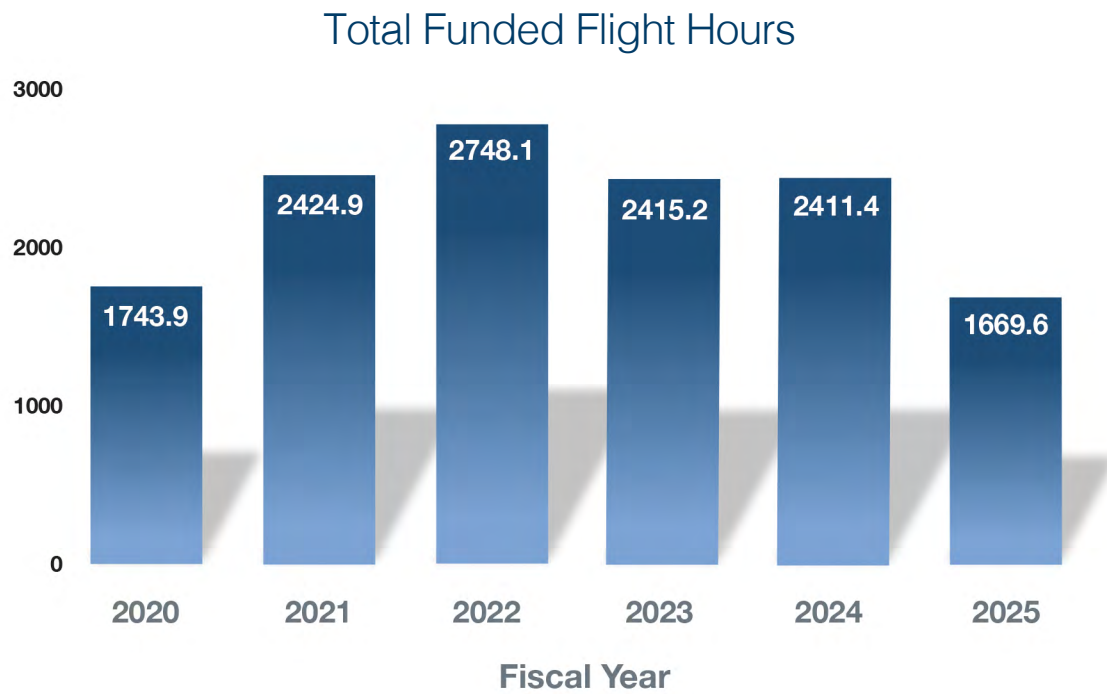


Figure 4. Histogram showing the total flight hours from 2020 to 2025.



3. Science

Major Mission Highlights

In FY25, ASP conducted over 1669 flight operation hours in support of Earth science process studies, instrument flight-testing, and support for Earth Science space missions in all phases, from definition to validation. NASA aircraft supported several model process studies across the United

States including DUST, WDTS, GEMx, Air-SHARP, GLOVE, WH²yMSIE, and CODEX in addition to supporting projects over Greenland (SWXRAD), Central America (AVUELO), and Bermuda (Night-BLUE). Table 6 shows locations for major ASP missions ordered by most flight hours.

Table 6. Major science missions supported by ASP in FY25.

Mission	Program	Flight Hours	Location(s)	Aircraft
G-LiHT Alaska 2025	Terrestrial Ecology, Mass Change	209.7	Alaska	DA A90
GEMx	Terrestrial Ecology	209.6	Western / Central U.S.	ER-2
APMAC for MAGEQ	GHG Center	126.6	Eastern U.S.	G-III
GHG Center Surveys for MAGEQ	GHG Center	113	CONUS	DA B-200
SARP + VAMOS 2025	GHG Center, Tropospheric Composition	96.3	CONUS	DA B-200
NightBLUE	Tropospheric Composition, Radiation Science	72.7	Bermuda	G-III
APEX	ESTO ACT	61.15	California	G-III
FireSense	Disasters / Wildfires	58.9	CONUS	DA B-200
WH ² yMSIE	Weather and Atmospheric Dynamics	50	California	ER-2
MAGEQ	GHG Center	50	Eastern U.S.	P-3



In addition to process studies and instrument testing, many of the ASP missions support spaceborne endeavors; this includes flying aircraft to support satellites and missions on the International Space Station (ISS). The Program provides platforms to collect data for algorithm development prior to launch, test instrument concepts for satellite/ISS payloads or airborne simulators and provide data for calibration or validation (cal/val) of satellite algorithms, measurements, or observations once missions are in orbit.

In FY25, NASA Airborne missions provided support to multiple operational and future Earth Science space-based missions. The Earth Surface Mineral Dust Source Investigation, which launched in 2022, received over 822 hours of support from ASP missions through not only the aptly named EMIT cal / val mission but also through GEMx, MAGEQ (including SARP, APMAC, GHG Methane Center Surveys), LA Basin Fire Burns, AVUELO, FireSense, and Foliar Functional Traits from Imaging Spectroscopy on Dynamic Aviation (B-200) and NASA aircraft (B-200, ER-2, G-III, P-3). The MAGEQ coordinated flights also supported TEMPO (launched 2023) and PBL (future launch).

The recently launched (2024) Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) satellite had over 83 hours of support from AirSHARP, AVUELO, airLUSI, and the Airborne Aquatic Science & Applications for the Sacramento-San Joaquin River Delta on the DA B-200 and NASA ER-2 throughout Central America and CONUS.

Over 960 hours of FY25 NASA Airborne Science flights also supported future spaceborne satellites and instruments, including Surface Biology and Geology (SBG), Planetary Boundary Layer (PBL), 3D-Winds, Geosynchronous Littoral Imaging and Monitoring Radiometer (GLIMR), Hyperspectral Infrared Imager (HyspIRI), NASA and ASI's Multi-Angle Imager for Aerosols (MAIA), and international missions such as Global Observing SATellite for Greenhouse gases and Water cycle (GOSAT-GW) from Japan. The Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) NASA facility instrument was especially busy in FY25, flying several missions on the C-20A for nearly 180 flight hours, partially in support of the recent launch of NASA-ISRO Synthetic Aperture Radar (NISAR) in July 2025. The table below summarizes the satellite support that NASA ASP provided, both nationally and across the world, in FY25.



Table 7. Airborne missions supporting various Earth Science space-based missions in FY25.

Satellite	Status	Agency	Mission(s)	Location(s)	Flight Hours	Aircraft
U.S.- Based Agencies						
EMIT	Launched 2022	NASA	AVUELO, EMIT cal / val, Foliar Functional Traits from Imaging Spectroscopy, LA Basin Fire Burns, FireSense, GEMx, MAGEQ (APMAC, SARP, GHG Methane Center Surveys)	Central America, CONUS (California, Northeast, Western, Central, Eastern)	822.6	DA B-200, NASA B-200, NASA ER-2, NASA G-III, NASA P-3
PBL	TBD	NASA	GHG Methane Center Surveys, SARP, APMAC, MAGEQ, WH ² yMSIE, APEX	CONUS	539.05	DA B-200, NASA B-200, NASA G-III, NASA P-3, NASA ER-2
TEMPO	Launched 2023	NASA	MAGEQ, SARP, FireSense, APMAC	CONUS (California, East Coast)	527.8	DA B-200, NASA B-200, NASA G-III, NASA P-3
Landsat Series	Various	NASA, USGS	G-LiHT, Airborne Aquatic Science & Applications for the Sacramento-San Joaquin River Delta, Acres East Coast Vineyard Disease Detection & Land Grant University Research Support, Acres Grapevine Viral Disease and Vector Detection, airLUSI, WDTs	Alaska, CONUS (Western, Central, California, New York)	296.7	DA A90, DA B-200, NASA ER-2
SBG	TBD	NASA	AVUELO, Foliar Functional Traits from Imaging Spectroscopy	Central America, CONUS (Northeast, Western, Central)	296.6	DA B-200, NASA ER-2
ECOSTRESS-ISS	Launched 2018	NASA	Airborne Aquatic Science & Applications for the Sacramento-San Joaquin River Delta, FireSense, GEMx	CONUS (California, Western, Central)	276	DA B-200, NASA B-200, NASA ER-2
ICESat-2	Launched 2018	NASA	G-LiHT, GLOVE	Alaska, California	244.7	DA A90, NASA ER-2
GED-ISS	Launched 2018	NASA	FireSense	CONUS	99.9	DA B-200, NASA B-200
PACE	Launched 2024	NASA	AVUELO, Airborne Aquatic Science & Applications for the Sacramento-San Joaquin River Delta, AirSHARP, airLUSI	Central America, California	83.3	DA B-200, NASA ER-2
HyspIRI	TBD	NASA	Airborne Aquatic Science & Applications for the Sacramento-San Joaquin River Delta, WDTs	CONUS (Western, Central)	58	DA B-200, NASA ER-2
3D-Winds	TBD	NASA	Aerosol Wind Profiler 3D Wind Demonstration	Virginia	26.15	NASA G-III
GLIMR	TBD	NASA	Airborne Aquatic Science & Applications for the Sacramento-San Joaquin River Delta	California	25.4	DA B-200
International Agencies and Collaborations						
NISAR	Launched 2025	ISRO	Milton Post-Hurricane Response, DUST, Central Valley Land Subsidence, UAVSAR P- / L-Band Engineering, Texas Hill Country Flood Mapping, Uncertainty and scaling of wildland fire emissions, Eel River Landslide Kinematics, Western US Change Detection, Portuguese Bend Landslides, Where the Fault Meets the Road, Southern California Wildfires, NISAR cal / val, CA and PNW Deep-Seated Landslides	CONUS (California, West Coast, Florida)	179.47	NASA C-20A
Sentinel Series	Various	ESA	FireSense, CHAPS-D, Portuguese Bend Landslides	CONUS	113.9	DA B-200, NASA B-200, NASA C-20A
EarthCARE	Launched 2024	ESA, JAXA, NICT	NightBLUE	Bermuda	72.7	NASA G-III
MAIA	TBD	NASA, ASI	AirMSPI-2 / MAIA Airborne Science	California	11.4	NASA ER-2
GOSAT-GW	TBD	JAXA, MOE, NIES	CHAPS-D	Virginia	7.6	NASA B-200

It is also worth noting that the FireSense program, which flew ~100 hours on the DA B-200 and NASA B-200 #801 in FY25, supports an additional 11 spaceborne assets: VIIRS, MODIS, GOES,

Umbra, Capella, ICEYE, BlackSky, SkySat, SMAP, SMOS, Aura. The airLUSI 2 campaign, which flew 8.7 hours on NASA ER-2, supported Aqua, SUOMI-NPP and Terra.

Select Missions on ASP Aircraft in FY25

The missions highlighted in this category flew ASP-supported aircraft in FY25 in support of studying Earth Science topics, including air quality, atmospheric chemistry, surface vegetation and topography, and more.

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

PI: John Yorks (NASA GSFC)

Program: ICESat-2 Project

Aircraft: NASA ER-2

Payload: CPL, Roscoe nadir / zenith lidar, CRS, eMAS

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



Figure 5. Some of the GLOVE and ER-2 team members in front of NASA ER-2 aircraft at NASA AFRC. **Credit:** Steve Freeman/NASA

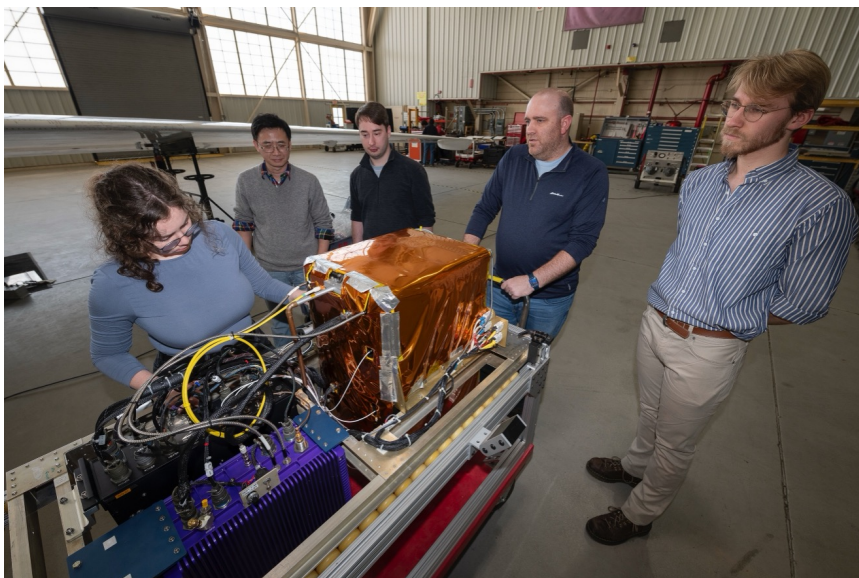


Figure 6. Members of the CPL instrument team work with students and staff from University of Iowa to install the CPL onto the ER-2 aircraft before the first GLOVE flight. **Credit:** Steve Freeman/NASA

Across eight flights totaling 40 hours, the ER-2 performed 13 satellite underflight segments—each lasting 20 to 40 minutes—in diverse atmospheric conditions (e.g., aerosols, cirrus, and stratocumulus clouds) over various surface types (e.g., ocean, land, and mountainous regions).

Data from seven ICESat-2 underflights, 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 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.

Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR)

PI: Yunling Lou
Programs: Geodetic Imaging, Disaster Management, Interior and Terrestrial Hydrology, Earth Surface and Interior, Disasters / Wildfires, Earth Action, Terrestrial Ecology
Aircraft: NASA C-20A
Payload: UAVSAR

In 2025, the Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) L-band radar aboard the NASA Gulfstream III (NASA 802) / C-20A conducted a total of 33 flights in 118 flight hours—32 science flights and one engineering flight. Following the launch of the NISAR satellite

on July 30, UAVSAR-based calibration and validation activities began, including two baseline flights over California fault lines. The UAVSAR project supported 11 flight requests and 9 principal investigators. In total, 338 data products were released to the public from 85 flight lines flown in the US. UAVSAR also supported additional campaigns, detailed below.

DUST: Dense UAVSAR Snow Time series

March 01 – 17, 2025

UAVSAR acquired pre- and post-snowstorm observations over sites in California and Idaho. These data are being used by Dr. S. Oveisgharan (JPL) to estimate snow accumulation from repeat-pass SAR measurements. When combined with ground-based observations, the analysis will characterize the dependence of retrieval accuracy on the temporal separation between acquisitions. These results will provide critical insight for the development of snow accumulation mapping algorithms for the NISAR mission. More about DUST can be found on Page 14.

Texas Flood Response

July 09 – 11, 2025

The UAVSAR team successfully flew three rapid response flights mapping the Texas Hill Country flooding near Kerrville, TX. The NASA Disaster Response Coordination System (DRCS) tasked UAVSAR to produce time-critical flood maps to assist the Texas Division of Emergency Management (TDEM) in identifying flooded infrastructure, roads, and human settlements to prioritize flood response efforts. UAVSAR deployed to Texas 1.5 days after the initial request and observed Guadalupe, San Gabriel, and Colorado River Basins, delivering Machine Learning flood products (30 m resolution) within 24 hours after first flight on July 9.

Fish Lake Wildfire Modeling Study

July 15 – September 22, 2025

UAVSAR conducted repeated observations over Fish Lake National Forest (UT) to retrieve forest fire burn severity and fuel load change. This study is part of a NASA/ROSES investigation



Figure 7. UAVSAR deployment team right after the College Station local flight on the Central Texas Flooding L-band deployment, July 10th, 2025. From left to right: Carrie Worth (pilot), Isac Mata (crew chief), Ian Elkin (mission director), Kirt Stallings (pilot), David Austerberry (radar operator), Kelly Jellison (avionics technician), Alvin Mitchell (flight mechanic), Brian Hawkins (data processor). **Credit:** D. Austerberry/NASA/JPL

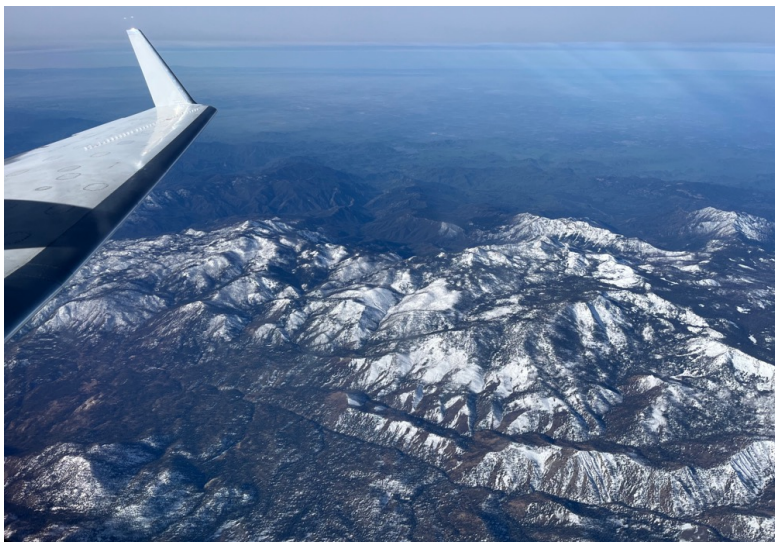


Figure 8. Looking west over the southern Sierras as the C-20A passed 30,000 ft on the initial climb on UAVSAR flight 25003, February 27th, 2025.

Credit: D. Austerberry/
NASA/JPL

on fire emissions led by N. French (Michigan Tech).

Central Valley Land Subsidence Mapping

February 27 – November 24, 2025

Nine flights were conducted over the California Central Valley to capture interseasonal ground deformation in the Sierra Nevada foothills. These observations are being analyzed by a science team led by R. Knight (Stanford) to estimate groundwater recharge rates.

Palos Verdes Landslides

February 26 – July 29, 2025

A. Handwerger (JPL) has analyzed UAVSAR data to track the movement of slow-moving landslides on the Palos Verdes Peninsula in Los Angeles County. The study found that over a four-week span in the fall of 2024, the ground in the residential area shifted toward the ocean at a rate of up to 4 inches (10 centimeters) per week. This never-before-seen result was shared with California Geological Survey and the

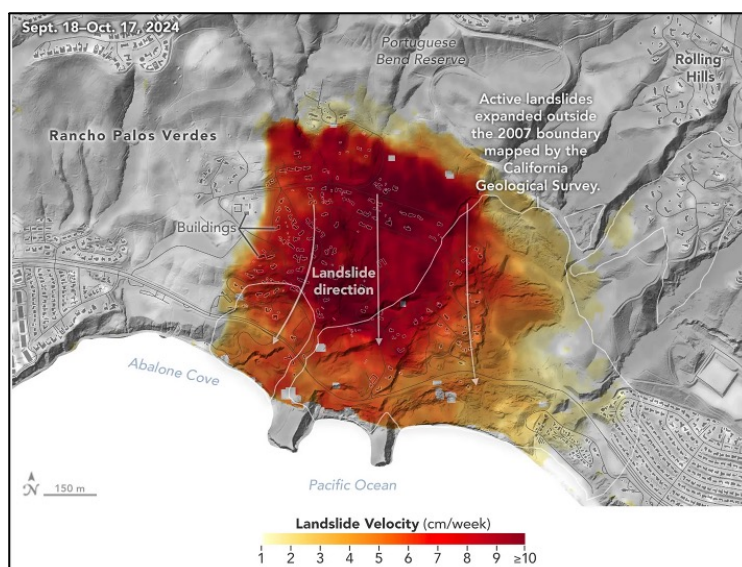


Figure 9. UAVSAR-derived deformation products show landslide acceleration (up to 10 cm per week).

Credit: A. Handwerger/
NASA/JPL



city of Racho Palos Verdes, who were relying on very sparse monthly GPS ground station measurements to track landslide trends. The UAVSAR result was also published on NASA's Earth Observatory's daily highlight (<https://science.nasa.gov/earth/earth-observatory/los-angeles-area-landslide-expands-153893/>) and subsequently picked up by major news outlets including the New York Times.

Publications

At least 100 peer-reviewed papers have been published utilizing UAVSAR data in 2025. Links to publications can be found here: <https://uavsar.jpl.nasa.gov/cgi-bin/publications.pl>.

Airborne Synthetic Aperture RADAR-Next Generation (AirSAR-NG)

The AirSAR-NG development has advanced substantially. The instrument development consists of two major subsystems: the L-band active array antenna which transmits and receives RF signals and the Software-defined radar electronics (SDRE) that serves as the “brain” of the radar. The SDRE controls the radar functionality, digitizes the received RF signal from 8 antenna subarrays, performs digital beamforming to “focus and shape” the received radar beam, and stores the output data. The SDRE development is now 90% complete, and subsystem testing is underway, including verification of digital beamforming functionality and timing/control operations. The L-band prototype antenna aperture has been received from the vendor, fit checks are in progress, and T/R modules are being installed on the backside of the aperture. The antenna feed network, calibration network, and Energy Storage Subsystems (ESS) have been fabricated and tested in the lab, and mechanical integration of components on the antenna subsystem is well underway. The integration of the antenna subsystem and SDRE will begin

in early 2026 followed by end-to-end system test in preparation for delivering the completed instrument to the aircraft in summer 2026.

Radar operations are progressing in parallel, with planning underway for the six-week TropiSAR L-band deployment campaign in May 2026 to support NISAR mission calibration/validation and ESA's Biomass calibration collaboration. In addition, troubleshooting and repair efforts are ongoing for the P-band radar transmitter subsystem. Programmatic milestones include participation in AFRC's G-IV Modification 90% Design Review and preparation for Vendor CDR scheduled for early April. More about AirSAR-NG can be found on Page 62.

Dense UAVSAR Snow Timeseries (DUST)

PI: Shadi Oveisgharan (JPL)
Program: Interior and Terrestrial Hydrology
Aircraft: NASA C-20A
Payload: UAVSAR/L-Band

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 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



Figure 10. 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

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

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.



Figure 11. 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

Appalachian Active Passive Methane Constraints (APMAC)

PI: Amin Nehrir (NASA LaRC)
Program: U.S. Greenhouse Gas Center
Aircraft: NASA G-III
Payload: HALO, MethaneAIR

The Appalachian Active Passive Methane Constraints (APMAC) Campaign was a NASA ESD-funded field campaign that took place during July and August 2025 as a part of the broader

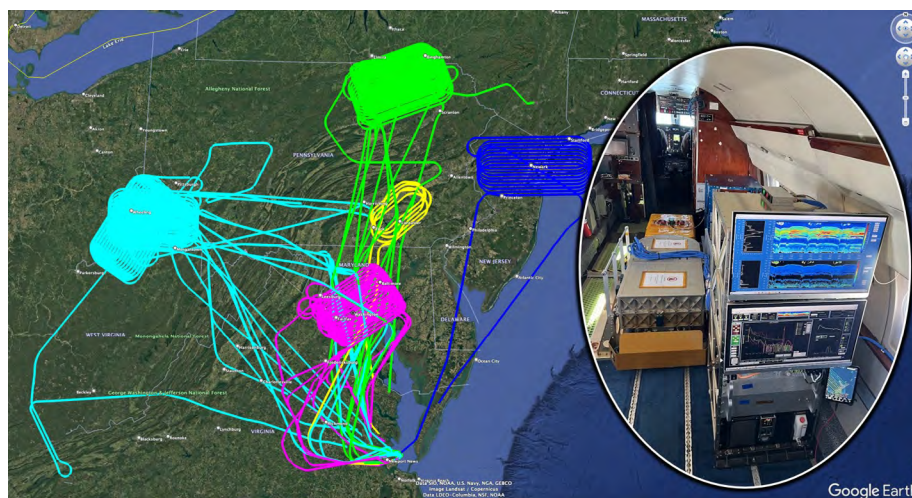


Figure 12. Flight track map of the G-III showing the geographic regions of intensive operation. The inset shows the MethaneAIR and HALO instruments on the forward and aft portals, respectively, along with the HALO real-time data display. **Credit:** Amin Nehrir/ NASA LaRC

Mid-Atlantic Gas Emissions Quantification (MAGEQ) project (Page 18). Over the course of 32 days, the APMAC project flew 28 research flights on the NASA G-III spanning ~130 hours. The team coordinated with four other aircraft (NASA P-3, NOAA Twin Otter, B-200 with a flux payload, and B-200 with AVIRIS payload) as well as satellite overpasses of Tanager-1 to sample emissions across the Mid-Atlantic.

The goal of APMAC was to create remote sensing datasets at regional scale that directly constrain methane emissions for important source regions (e.g., southwest and northeast Marcellus Shale, Washington D.C. / Baltimore metropolitan area). The payload consisted of the MethaneAIR spectrometer (i.e., airborne simulator for MethaneSAT) and the High-Altitude Lidar Observatory (HALO) lidar (i.e., methane lidar and high spectral resolution lidar). The sampling strategy repeated surveys of the same region three times a day for a two-day period to create a unique, comprehensive benchmark of methane concentrations and their changes over time that can fully constrain regional emission rates.

The goal was to deliver “benchmark datasets” at regional scale, rich in remote sensing

observations, where the emissions can directly be constrained in time and space within narrow limits. These datasets will enable rigorous testing of the accuracy of the inverse models used to quantify regional emissions and their transport, providing validation, and enhancing credibility for methane emission assessments based on remote sensing. These measurements were the first ever systematically measured day and night variations in column methane concentrations. Joint MethaneAIR and HALO observations provided this innovation by combining the HALO lidar’s unique ability to “see” at night and measure planetary boundary layer (PBL) height with the broad area coverage of MethaneAIR.

Current satellites only provide daytime information; understanding how emissions vary over the course of a day has been a missing piece of the puzzle. The APMAC campaign was also a unique opportunity to capture – for the first time – the terrestrial diurnal variability of the PBL height with airborne remote sensing observations. HALO diurnal distributions of PBL height will serve as a benchmark dataset for the Decadal Survey PBL Incubation Program as well as provide a critical constraint on PBL heights used for deriving emissions from point and regional sources.



Figure 13. The APMAC team in front of the G-III after the conclusion of the mission. **Credit:** Amin Nehrir/NASA LaRC

Select ASP Campaigns on Commercial Aviation Service (CAS Platforms)

As noted in the Program description (Section 2), many Earth Science missions fly on non-NASA aircraft. Some of these aircraft are commercially contracted, known as Commercial Aviation Service (CAS). The following are select missions that flew on CAS platforms, most of which from Dynamic Aviation (DA):

- MAGEQ (> 335 hours DA B-200, Beechcraft Air A90, NASA G-III, NASA P-3, NOAA Twin Otter)
- G-LiHT (209.7 hours on the DA A90)
- FireSense (58.9 hours on DA B-200, 41 hours on NASA B-200, additional hours on Trident Sensing Inc. Twin Comanche, Alta-X UAS, CopterSonde)
- Airborne Validation Unified Experiment Land to Ocean (AVUELO) (49.2 hours on DA B-200)
- Airborne Aquatic Science & Applications for the Sacramento-San Joaquin River Delta (25.4 hours on DA B-200)
- Carbon Mapper Methane Surveys (22.3 hours on the DA B-200)
- Acres Disease and Vector Detection (2 deployments for a total of 20.3 hours on DA B-200)

- EMIT cal/val (15.2 hours on DA B-200)
- Foliar Functional Traits from Imaging Spectroscopy, related to ABoVE (12.4 hours on DA B-200)
- LA Basin Fire Burns (8.4 hours on DA B-200)
- AVIRIS-3 cal / val (6.8 hours on DA B-200)
- Costa Rica Airborne research on forest Ecosystem Response to volcanic emissions (CRATER) (4.1 hours on Black Swift S2 UAS)

Mid-Atlantic Gas Emissions Quantification (MAGEQ)

PI: Glenn Wolfe (NASA GSFC)

Program: U.S. Greenhouse Gas Center, Research and Analysis, Tropospheric Composition, Terrestrial Ecology

Aircraft: DA B-200-FX, DA B-200-AV, NOAA Twin Otter, NASA P-3, Beechcraft Air A90, NASA G-III

Payload: A90: G-LiHT; B-200-AV: AVIRIS-3; Twin Otter: AiRMAPS; P-3 and B-200-FX: SARP payload; G-III: HALO, MethaneAIR

This summer, teams from different organizations and agencies coordinated flights over the mid-Atlantic United States. The effort, called MAGEQ (Mid-Atlantic Gas Emissions Quantification), is not one mission, but rather several individual ones (e.g., SARP (Page 59), APMAC (Page 16),



Figure 14. NASA Goddard's G-LiHT on the A90 flies over Shenandoah Valley in the US East Coast during the week of August 11-15, 2025, for MAGEQ. **Credit:** Shawn Serbin/NASA

MidFlux, MAGEQ), working together to maximize the potential of multi-tiered air quality data.

Scientists from NASA GSFC teamed up with NASA LaRC, NOAA, and other university and government partners and collaborators. Over the course of the campaign, aircraft flew over urban, wetland, agricultural, and coal mining areas, all with the goal of gathering data on emissions and air quality.

Coordinating flights requires both advanced planning and on-the-fly flexibility. Weather proved

to be a primary challenge for the team, who worked around cloudy days, wind, and storms to make sure flights were able to fly safely. The six different aircraft required different conditions. In general, the remote sensing aircraft fly at higher altitudes and are able to work around windy days but cannot measure through clouds; aircraft taking in-situ measurements can work under the clouds (but not in precipitation) and prefer steady winds for capturing the outflow of gases from surface emitters. Despite weather challenges, flight teams worked together to coordinate as many multi-aircraft flight days as possible.



Figure 15. The MAGEQ team poses in front of the P-3 aircraft at NASA's Wallops Flight Facility in Virginia. **Credit:** Roy Johnson/NASA



Figure 16. The MAGEQ team members from NOAA and NASA pose in front of the Twin Otter aircraft. **Credit:** Steve Brown/NOAA

Stakeholders can use the data being collected to support policy decisions. For example, wetlands in areas like the Chesapeake Bay absorb carbon from the atmosphere, and monitoring can benefit coastal communities for tourism and resilience to storms. In the case of facilities that produce methane, if there is a leak, monitoring facilitates faster interventions, which not only helps the environment and local community, but also helps the industry minimize waste and save money.

The measurements will also be used to verify satellite data. For example, spaceborne instruments like Tropospheric Emissions: Monitoring of Pollution (TEMPO) collect data similar to what the aircraft collected during the campaign. Scientists can compare the airborne and satellite data to identify discrepancies and improve the satellite retrievals. MAGEQ required a large group of scientists, coordinators, and flight operations teams, which all came together to make the campaign run smoothly.

FireSense

PI: Jennifer Fowler (NASA LaRC)
Program: Disasters / Wildfires

Aircraft: DA B-200, NASA B-200, Trident Sensing Inc. Twin Comanche, 2 Alta-X UAS, CopterSonde

Payload: DA B-200: AVIRIS-3; NASA B-200:

FireTIRS, MASTER; Trident Sensing Inc. Twin Comanche: TACFI-RS, smoke sampling filter;

2 Alta-X UAS: additional sensors;

CopterSonde: radiosonde

In Spring 2025, NASA's FireSense project conducted airborne observations over a total of 32 wildland fires in Alabama, Texas, Mississippi, Florida, and Georgia to test new instrumentation and collect both remotely-sensed and in-situ data. This campaign gathered data to inform fire management decisions, improve fire models, and test innovative technological capabilities with operational agencies.

FireSense campaign activities are a component of the project's overarching objective to deliver innovative technological capabilities to operational agencies to address challenges in

U.S. wildland fire management. To accomplish this, partners across State and Federal agencies, academic institutions, and private partners worked closely to coordinate measurements from research teams on the ground, in the air, and from space.

On the Ground

Ground crews measured micrometeorology, fuels, and fire behavior to capture pre-fire conditions, active fire characteristics, and post-fire effects.

In the Air

Three crewed aircraft flew over the burns, hosting a total of five instruments to collect measurements related to fire characteristics, smoke, and fuel consumption. Additionally, three uncrewed aircraft flew in Alabama collecting micrometeorology data, as well as fire and fuel characteristics before, during, and after fires.

The crewed assets included the following:

- Dynamic Aviation B-200 carrying NASA JPL's AVIRIS-3 (Airborne Visible and InfraRed Imaging Spectrometer) sensor
- NASA B-200 carrying the NASA / University of Texas FireTIRS infrared sensor and NASA's MASTER (MODIS / ASTER Airborne Simulator) sensor
- Trident Sensing Inc. Twin Comanche aircraft carrying the U.S. Forest Service-funded TACFI-RS infrared sensor and a filter for smoke sampling.

The uncrewed assets included the following:

- NASA-operated Alta-X carrying a NASA sensor
- InterMet-operated CopterSonde carrying a radiosonde
- Desert Research Institute-operated Alta-X carrying a NASA / Clemson multi-spectral sensor and a commercial sensor



Figure 17. Fire progression and ignition pattern captured by the MASTER sensor during a prescribed burn at Fort Stewart-Hunter Army Airfield on April 16, 2025. The image is a geocorrected false color composite showing the active fire as bright yellow and burning or recently burned areas as red and orange. **Credit:** ARC ASF MASTER Team/NASA

The teams for crewed and uncrewed aircraft completed a combined 104.45 flight hours, including six days of flying active wildfires and four days over prescribed fires.

From Space

Satellite sensors such as synthetic aperture radar, spaceborne LiDAR, imaging spectrometers, and more enabled the creation of integrated datasets and validated airborne and in-situ data.



Figure 18. As firefighters from the Alabama Forestry Commission fought a wildfire, NASA's AVIRIS-3 provided data on the active fire front and hot spots to support operational response.
Credit: AVIRIS Team/NASA JPL-Caltech

FireSense collaborated with agency partners to task public and commercial satellites for detailed data collection, including GEDI, ECOSTRESS, EMIT, VIIRS, MODIS, GOES, TEMPO, Umbra, Capella, ICEYE, BlackSky, SkySat, SMAP, SMOS, Aura, Sentinel-1, Sentinel-5, and others. With these sensors and subsequent data collection, NASA and its partners are developing products to capture fire radiative power, soil moisture, vegetative stress, active fire spread, fuel consumption, and air pollutants from wildfire smoke. Comparisons across ground, airborne and spaceborne data also help to identify areas of success and potential improvement, thereby advancing science and technologies for wildland fire management.

This coordinated ensemble of air and ground assets provided real-time intelligence to practitioners, evaluated in real time for its potential to assist in future 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.

FireSense is supported by the NASA Science Mission Directorate. The campaign was led by FireSense Project Scientist Jacquelyn Shuman (ARC), FireSense Project Manager Jennifer Fowler (LaRC), and FireSense Project Coordinator Harrison Raine (ARC), with communications



Figure 19. Three crewed aircraft outfitted with five total instruments sit on the tarmac at Fort Stewart Hunter Army Airfield. From front to back: a Dynamic Aviation B-200 carrying AVIRIS-3, NASA B-200 carrying the FireTIRS and MASTER sensors, and Trident Sensing's Piper Twin Comanche carrying the TACFI-RS sensor.
Credit: Milan Loiacono/NASA

support by Science Communication Specialist Milan Loiacono (ARC), and logistics support by Dan Hodkinson (GSFC). Future flight campaign operations will be coordinated for both prescribed burn activities and wildfires.

Airborne Validation Unified Experiment Land-to-Ocean (AVUELO)

PI – David Schimel (NASA, JPL)

Program: Biological Diversity

Aircraft: DA B-200

Payload: AVIRIS-3

Project Scientist - Erika Podest (NASA, JPL)

Coastal Component Lead: Kelly Luis (NASA, JPL)

Smithsonian Tropical Research Institute Lead:

Helene Muller-Landau

Co-Leads: Phil Townsend (Univ. of Wisconsin-Madison); Shawn Serbin (NASA Goddard)

The Airborne Validation Unified Experiment Land-to-Ocean (AVUELO) is a NASA led campaign designed to advance the calibration and validation of spaceborne imaging spectroscopy (hyperspectral) data for tropical terrestrial and marine ecosystems. The campaign combined airborne imaging spectroscopy over terrestrial and marine environments in Panama and Costa Rica with contemporaneous field measurements on land and at sea, collected in February 2025. AVUELO was led and supported by NASA and the Smithsonian Tropical Research Institute

(STRI) in Panama, with major contributions from additional scientists and partner institutions.

NASA's Airborne Visible-Infrared Imaging Spectrometer 3 (AVIRIS-3) was deployed aboard a King Air aircraft to collect hyperspectral imagery between February 6 and February 28, 2025. In Panama, terrestrial data acquisitions targeted a wide range of intensively studied sites spanning diverse soil types, geologic settings, rainfall regimes, and vegetation communities. These included managed landscapes, secondary forests of varying ages, and old-growth forests across lowland, montane, and coastal habitats, including mangroves. Most areas were collected at 3 m spatial resolution, with select focal sites of particular scientific interest imaged at 1 m resolution. Additional airborne surveys targeted methane emission sources, including Gatun Lake and a large landfill near Panama City.

In Costa Rica, AVUELO terrestrial activities focused on Rincón de la Vieja volcano, where data were collected to assess vegetation growth responses to naturally elevated CO₂ concentrations. The campaign also included airborne surveys over Pacific coastal waters to

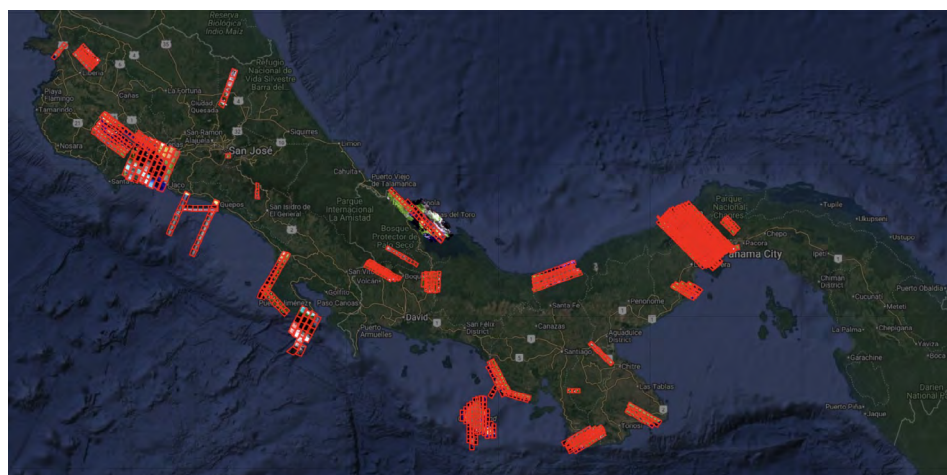


Figure 20. AVUELO collections with the AVIRIS sensor over Panama and Costa Rica spanning Feb. 6-28, 2025. **Credit:** NASA



Figure 21. The AVUELO team.
Credit: NASA

support the calibration and validation of PACE, a hyperspectral satellite mission with a strong focus on ocean biogeochemical observations. In total, the aircraft logged 64 science flight hours and acquired approximately 20 terabytes of AVIRIS-3 data.

The field campaign spanned 28 days and focused on characterizing the functional traits and taxonomic identity of canopy plant species observed in the airborne imagery. An intensive canopy leaf sampling program was conducted in close temporal proximity to the overflights. In Panama, the field team collected 941 leaf samples representing more than 406 plant species, including over 76 liana species. All samples were identified to species by expert botanists, and reflectance spectra were measured for each sample and absorbance spectra for a subset of the samples. In addition, key leaf functional traits, including leaf water content and leaf mass per area (LMA) were measured on fresh material. Analyses of leaf shape, venation, and stomatal characteristics are currently underway, as are planned chemical analyses of elemental composition, pigments, and carbohydrates. Functional trait measurements are ongoing. Complementary

field efforts include high-precision mapping of individual canopy crowns across more than

150 ha of forest plots. These data will enable direct linkage between airborne pixels and the species identity of canopy trees and lianas.

Coastal aquatic in situ measurements in support of PACE calibration and validation were conducted over four days in the Pacific waters off Costa Rica. Mounted with an autonomous hyperspectral radiometer, the boat collected continuous measurements of above water ocean reflectance. These efforts were paired with phytoplankton net tows and Niskin bottle sampling for analyses of HPLC pigments, chlorophyll, CDOM, nutrients, and bacterial communities across 23 sampling stations. This was the first comprehensive bio-optical campaign of the Pacific Costa Rica coast.

The AVIRIS data have been processed, although additional calibration is anticipated, and surface reflectance data are openly available through the ORNL DAAC (https://daacweb-prod.ornl.gov/cgi-bin/dsviewer.pl?ds_id=2479).

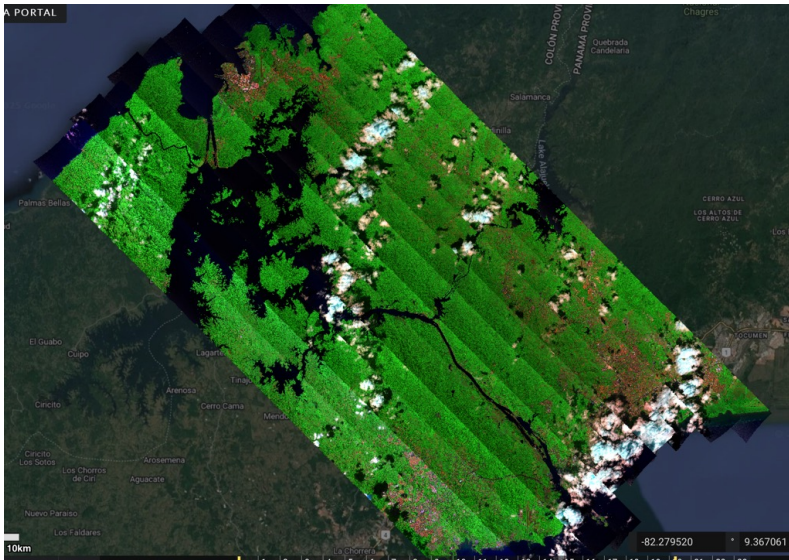


Figure 22. AVIRIS-3 quicklook mosaic of the Panama Canal Basin on Feb. 6, 2025. Credit: NASA

Future plans include AVUELO-2, which will involve overflights of some of the same areas using JPL’s Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR). This phase will focus on acquiring vegetation moisture and structural measurements and exploring synergies between UAVSAR observations and vegetation trait information derived from AVIRIS spectroscopy data. Ultimately, these efforts aim to scale the

ASP Support for Instrument Development

Aircraft provide an important test vehicle to determine the readiness of payloads for spaceflight missions. In FY25, ASP provided significant support to instruments from various NASA Programs,

including the Earth Science Technology Office (ESTO) under the Office’s Instrument Incubator Program (IIP) and Advanced Component Technology (ACT). ESTO demonstrates and provides technologies that can be reliably and confidently applied to a broad range of science measurements and missions. Some of the instruments are being developed specifically for airborne use, while others are being developed as precursors or simulators for satellite instruments.

In FY25, Active and Passive PBL Profiling EXperiment (APEX), Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System (CASALS), Airborne Multiangle SpectroPolarimetric Imager-2 (AirMSPI-2),

Table 8. Instrument development missions supported by airborne activities in FY25.

Mission	Flight Hours	Location	Aircraft	Program
APEX	61.15	California	NASA G-III (coordination with NASA ER-2, NPS CIRPAS Twin Otter)	ESTO ACT
CASALS	13.2	East CONUS	NASA B-200	ESTO IIP
AirMSPI-2	11.4	California	NASA ER-2	Radiation Science
MBARS	8.8	Pacific Coast	NASA ER-2	ESTO IIP
CHAPS-D	7.6	East CONUS	NASA B-200	ESTO IIP
C-FIRST	6.8	California	NASA B-200	ESTO IIP



Microwave Barometric Attenuation Radar and Sounder (MBARS), CHAPS-D, and the Compact Fire Infrared Radiance Spectral Tracker (C-FIRST) flew on NASA aircraft to support numerous Earth and space science missions.

Airborne Multiangle SpectroPolarimetric Imager (AirMSPI-2)

PI: Felix Seidel Caprez (JPL)
Program: Radiation Science
Aircraft: NASA ER-2
Payload: AirMSPI-2, A-SMLS

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, multiangle 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://www.earthdata.nasa.gov/centers/asdc-daac>.

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.

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.



Figure 23. 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.



Figure 24. 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.

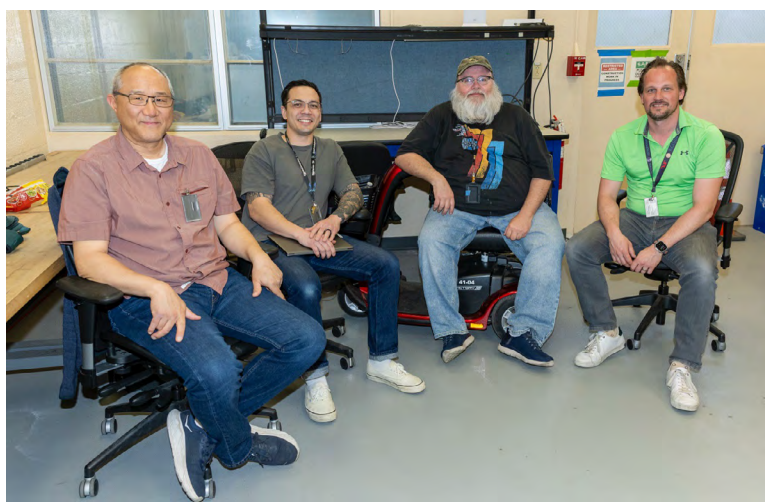


Figure 25. JPL engineers supporting the April 2025 AirMSPI-2 deployment at AFRC. From left to right: Charles Wang, Ryan Applegate, Brian Rheingans, and Markus Scheucher. The team led key hardware upgrades enabling successful science flight performance demonstrated during recent flights. **Credit:** Genaro Vavuris/ NASA AFRC.

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

Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System (CASALS)

PI: Guangning Yang (NASA GSFC)

Program: ESTO IIP

Aircraft: NASA B-200

Payload: CASALS, Headwall Hyperspec Co-Aligned VNIR-SWIR sensor, Cubert Ultris X20 Plus Vis-NIR and panchromatic sensor

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.

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.



Figure 26. Wei Lu (left) and Guangning Yang (right) installing CASALS on the NASA B-200 King Air. **Credit:** NASA

- 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).

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.

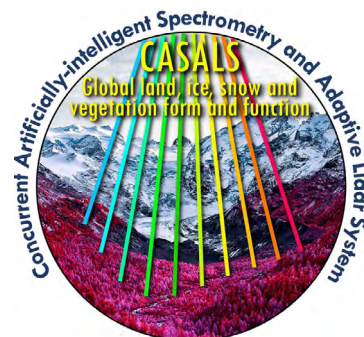


Figure 27. CASALS team members after the first flight. From Left: David Harding, William Hasselbrack, Guangning Yang, Jeff Chen, Wei Lu and Phil Coulter.
Credit: NASA

The lidar acquires waveforms of the Earth's vertical structure, like the first ICESat and GEDI spaceborne 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

PI: Benjamin Stewart (JHU)
Program: ESTO IIP
Aircraft: NASA B-200
Payload: CHAPS-D, GCAS

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. 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.

The development of a prototype instrument, CHAPS-D, was funded by the NASA Earth Science Technology Office (ESTO) and was

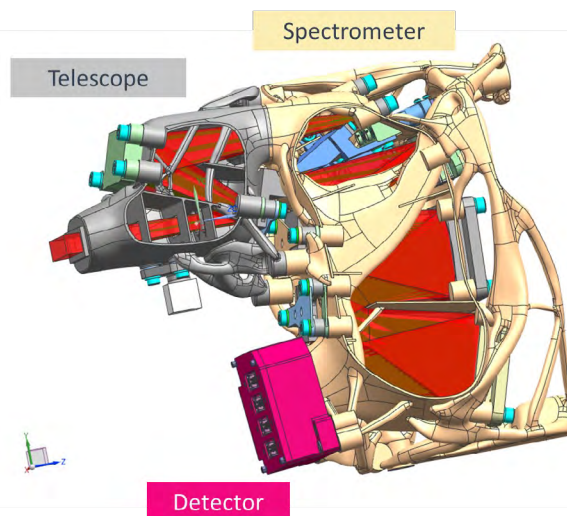


Figure 28. CHAPS-D optomechanical design. **Credit:** NASA



Figure 29. CHAPS-D and GCAS (GSFC) integrated on B-200. **Credit:** William Swartz/JHU/APL

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, $\text{DI} = 0.6 \text{ nm}$), 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 instrument with a ground spatial resolution of $1 \times 1 \text{ km}^2$ from low Earth orbit or $\sim 20 \text{ m}$ 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



Figure 30. CHAPS-D PI and lead engineer next to the LaRC B-200. **Credit:** William Swartz/JHU/APL

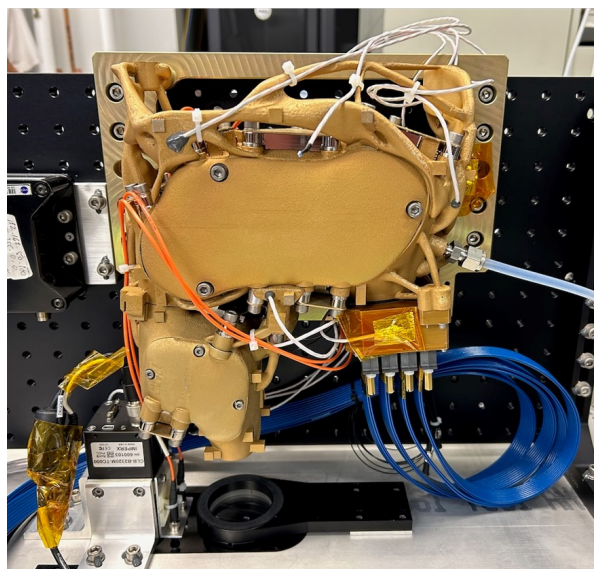


Figure 31. CHAPS-D instrument configuration, nadir-viewing through bottom of B-200. **Credit:** William Swartz/JHU/APL

made. CHAPS-D was co-manifested 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.

Active Passive PBL Profiling EXperiment (APEX)

PI: Amin Nehrir (NASA LaRC)

Program: ESTO ACT

Aircraft: NASA G-III (coordination with NASA ER-2, NPS CIRPAS Twin Otter)

Payload: HALO, AWP, AVAPS dropsondes

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 (WH²MSIE)

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

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



Figure 32. Photo of the G-III taken from the C-20A during a dropsonde envelope chase flight on November 5, 2024. **Credit:** Amin Nehrir/NASA LaRC

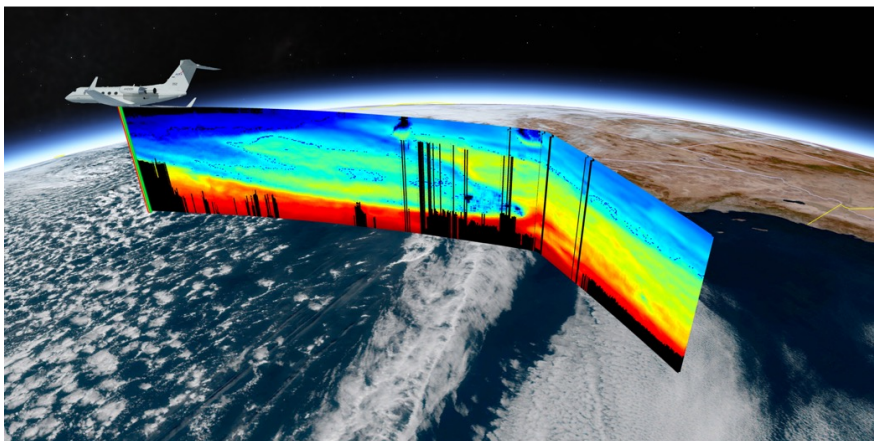


Figure 33. HALO data collected from the G-III on November 13, 2024, across a weak frontal boundary. The color chart indicates water vapor concentrations from 12 km down to the surface with cooler and warmer colors representing dry and moist air masses, respectively, covering a dynamic range of approximately 10,000:1. The data are overlaid on a GOES-West/ABI true color image from 22 UTC. **Credit:** Amin Nehrir/NASA LaRC

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:

- 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).

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



Figure 34. ER-2 captured from the LaRC G-III during a coordinated flight on October 31, 2024. **Credit:** Amin Nehrir/NASA LaRC

Additional ASP Partnerships and Interagency Support

NASA ASP projects extend beyond ESD, often partnering with other national or even international agencies for highly collaborative projects. In FY25, these projects included the following:

- GEMx was a joint campaign between NASA and the USGS to map portions of the southwest United States for critical minerals using advanced airborne imaging.
- The WH²yMSIE mission was a collaboration between NOAA and NASA to study the planetary boundary layer (PBL) and to demonstrate new technologies that can be utilized for remotely sensing the PBL.
- CODEX was a NASA ARMD and ESD mission that used the NASA G-III to assess aircraft engine emissions from a GE Aerospace 747.
- G-LiHT was a joint NASA-USFS mission that used G-LiHT on the DA A90 to improve regional estimates of aboveground forest biomass and terrestrial ecosystem carbon stocks in Alaska.
- AirSHARP was flown on the NPS CIRPAS Twin Otter to validate the PACE satellite, which launched in 2024.

- SWXRD with NASA SMD Heliophysics measured dosimetric quantities to validate and improve the NASA LaRC Nowcast of Aerospace Ionizing Radiation System (NAIRAS) model at commercial aviation altitudes.
- NightBLUE was a collaborative effort between NASA, ESA, and the Royal Netherlands Meteorological Institute (KNMI) using HSRL-2 on the NASA G-III aircraft to assess the performance of the ATLID instrument onboard the EarthCARE satellite.

Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment (WH²yMSIE)

PI: Antonia Gambacorta (NASA GSFC)

Program: Weather and Atmospheric Dynamics

Aircraft: NASA ER-2, NASA G-III, University of Iowa Beechcraft Bonanza, UAS

Payload: ER-2: CoSMIR-H, MBARS, CRS, CPL, S-HIS, NAST-I, AMPR, MASTER, ARO; G-III: HALO, AWP, dropsondes

The Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment (WH²yMSIE) 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



Figure 35. The ER-2 preparing to take off from Edwards Air Force Base before a flight offshore.
Credit: G. Vavuris/NASA AFRC



Figure 36. 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. Nowotnick). **Credit:** G. Vavuris/ NASA AFRC

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 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.



Figure 37. NASA G-III equipped with HALO, AWP, and dropsondes during a flight over southern California during WH²yMSIE. **Credit:** L. Losey/NASA

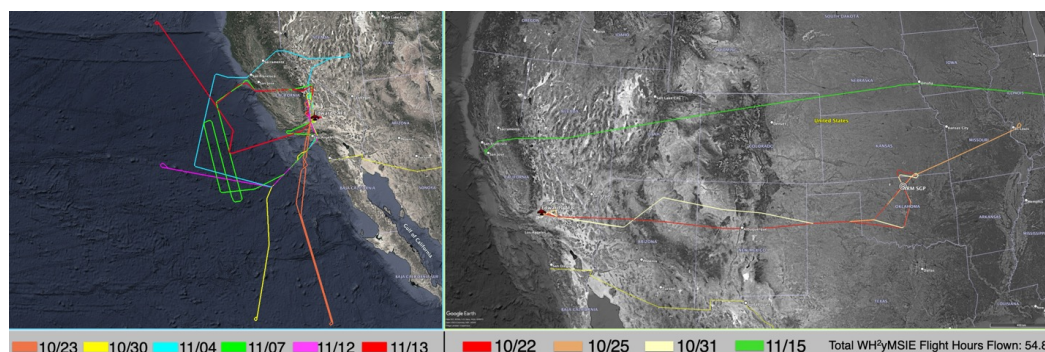


Figure 38. Map of all the WH²yMSIE science flights over ocean (left) and land (right). **Credit:** A. Kotsakis/NASA

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.

Geological Earth Mapping Experiment (GEMx)

PI: Raymond Kokaly (USGS)
Programs: USGS, Terrestrial Ecology, Earth Surface and Interior
Aircraft: ER-2
Payload: AVIRIS-C, AVIRIS-5, MASTER

The Geological Earth Mapping Experiment (GEMx) is a joint campaign between NASA and the USGS to map portions of the United States for critical minerals using advanced airborne imaging.

In 2022, the U.S. was 100% dependent on imports for 10 critical mineral commodities (e.g., arsenic, asbestos, cesium, graphite), and was

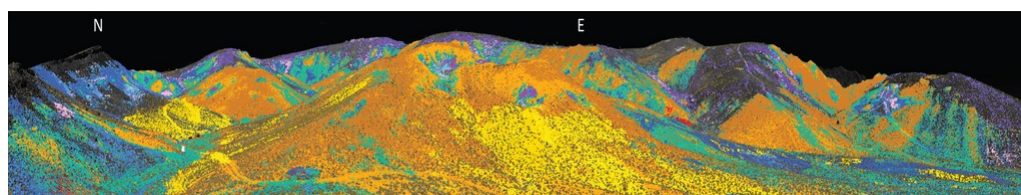


Figure 39. Various minerals are revealed in vibrant detail in this sample mineral map of Cuprite, Nevada, following processing of AVIRIS data. **Credit:** USGS



Figure 40. A photo of the NASA ER-2 high-altitude aircraft with the GEMx payload installed. **Credit:** NASA

at least 50% dependent on imports for another 33 critical mineral commodities (e.g., peat, tin, cobalt, zinc, nickel, aluminum). The U.S. needs better natural resource mapping to understand how to best mitigate this risk.

GEMx is a multi-year mission collecting measurements spanning visible through infrared throughout the U.S. to identify and map minerals at 15 m² resolution. In the 2025 campaign, the instruments listed below flew over 470,000 km² in 36 flights (200 flight hours) on the NASA ER-2, collecting new information about Earth's surface and atmosphere to help scientists understand Earth's geology:

- NASA's Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-C and AVIRIS-5)
- MODIS/ASTER Airborne Simulator (MASTER)

The 2025 campaign brings the total coverage close to 1,000,000 km², and covered areas in Nevada, California, Arizona, Utah, Idaho, Oregon, New Mexico, and Texas, some as far as 1,500 km away from home base at Edwards AFB.

This project will complement data from several of NASA's instruments on the International Space Station (ISS), including the Earth Surface Mineral Dust Source Investigation (EMIT), which maps the mineral dust source composition of Earth's arid

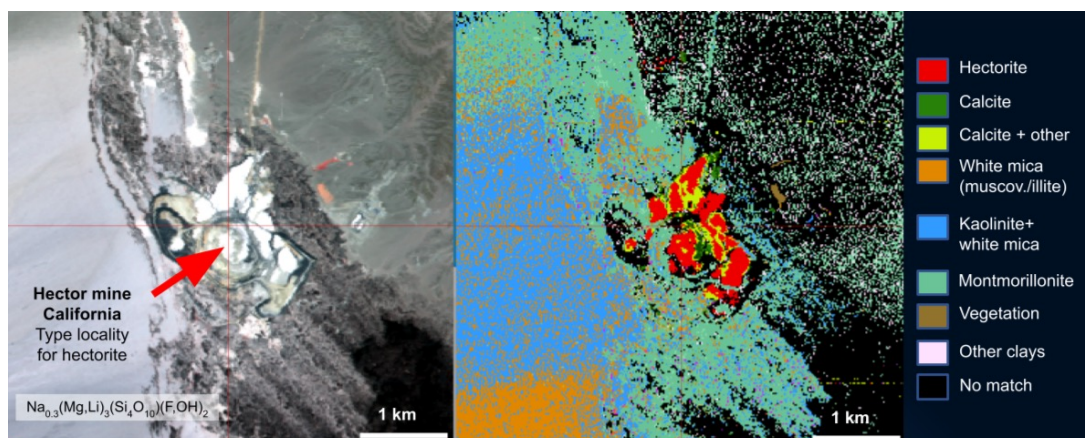


Figure 41. An example of data from GEMx showing lithium-bearing minerals in Nevada and California. **Credit:** Raymond Kokaly/USGS

regions to better understand mineral dust's role in climate change, as well as other instruments and missions like ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) and the upcoming Surface, Biology, and Geology (SBG) mission, part of NASA's Earth System Observatory (ESO).

GEMx data can be found here: <https://ideas-digitaltwin.jpl.nasa.gov/mmgis/?mission=GEMx>, and the GEMx website can be found here: <https://science.nasa.gov/mission/gemx/>

Contrail Optical Depth Experiment (CODEX)

PI: Richard Moore (LaRC)
Program: ARMD - Advanced Air Transport Technology (AATT), Tropospheric Composition, Radiation Science
Aircraft: G-III, GE Aerospace 747
Payload: HALO, dropsondes

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 the NASA G-III aircraft equipped with the state-of-the-art High Altitude

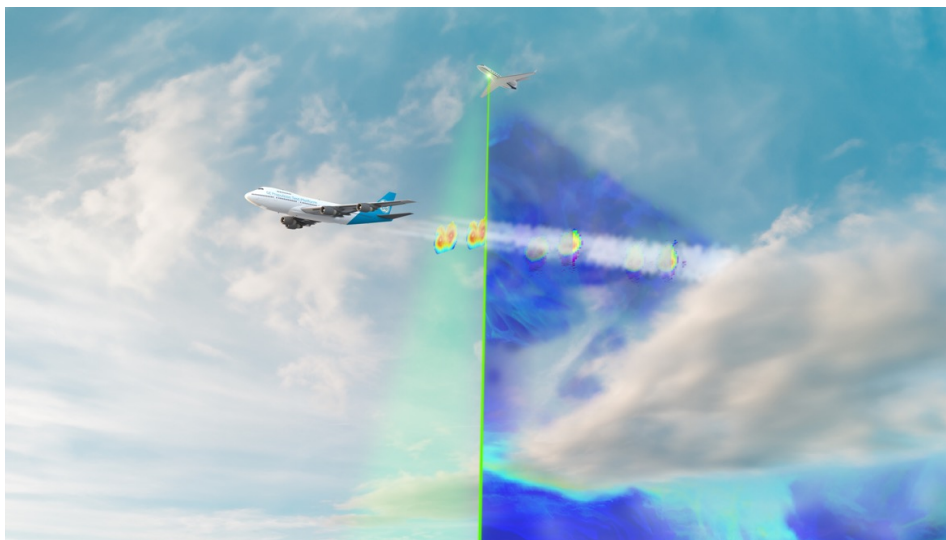


Figure 42. CODEX concept of operations showing the water vapor and backscatter curtains measured by the High Altitude Lidar Observatory (HALO) onboard the NASA G-III as it chased the GE Aerospace 747 Flying Test Bed. **Credit:** Richard Moore/NASA LaRC



Figure 43. 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

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 transmitted 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.

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 contrail forming behind it disappeared.



Figure 44. 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

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.

Airborne aSessment of Hyperspectral Aerosol optical depth and water-leaving Reflectance Product Performance for PACE (AirSHARP)

PI: Liane Guild

Program: Ocean Biology and Biogeochemistry,
Radiation Science Program

Platforms: NPS CIRPAS Twin Otter; R/V Shana Rae
Payload: C-AIR, 4STAR-B

In October 2024, California's Monterey Bay experienced an outsized phytoplankton bloom that attracted fish, dolphins, whales, seabirds, and – for a few weeks in October – scientists. A team from NASA ARC, with partners at the University of California, Santa Cruz (UCSC) and the Naval Postgraduate School (NPS), spent two weeks on the California coast gathering data on the atmosphere and the ocean to verify what the PACE (Plankton, Aerosol, Cloud, ocean Ecosystem) satellite sees from above. In May 2025, the team returned to gather data under different environmental conditions to validate the PACE Ocean Color Instrument (OCI).

Launched in February 2024, the PACE satellite was designed to provide a detailed look at life near the ocean's surface and the composition and abundance of aerosol particles in the

atmosphere. PACE has three instruments:

- OCI: measures sunlight reflected off of the ocean's surface and near-surface water column, providing details about what is in the water column below (e.g., water molecules, phytoplankton, and particulates like sand, inorganic materials, and even bubbles).
- Spectro-polarimeter for Planetary Exploration (SPeXone) and the Hyper Angular Research Polarimeter (HARP2): measures how polarization is changed by passing through clouds, aerosols, and the ocean

To validate OCI data, the AirSHARP (Airborne aSessment of Hyperspectral Aerosol optical depth and water-leaving Reflectance Product Performance for PACE) team ran simultaneous airborne and seaborne campaigns in different seasons to collect data (i.e., water-leaving reflectance, aerosol optical depth) under different environmental conditions, validating as much of OCI's range as possible.

Through 12 days of flights on the NPS Twin Otter, the NASA-led team used C-AIR (Coastal Airborne In-situ Radiometers) and 4STAR-B (Spectrometer for Sky-Scanning Sun-Tracking Atmospheric Research B) to gather data from the air. At the

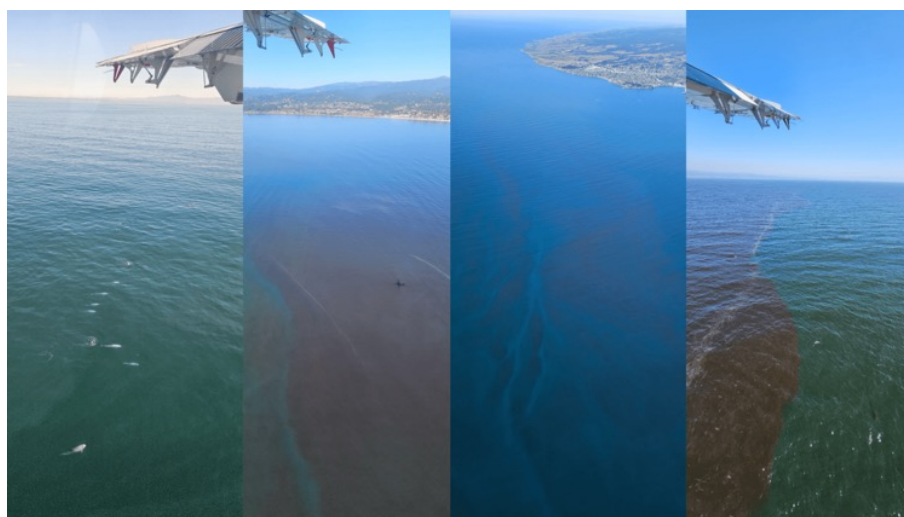


Figure 45. Photographs taken from the window of the Twin Otter aircraft during the October 2024 AirSHARP deployment showcase the variation in ocean color, which indicates different molecular composition of the water column beneath. The red color in several of these photos is due to a phytoplankton bloom – in this case a growth of red algae. **Credit:** Samuel Leblanc/NASA



Figure 46. NASA Ames research scientist Kristina Pistone operates the 4STAR-B instrument, flying over Monterey Bay during the October 2024 deployment of the AirSHARP campaign. **Credit:** Samuel Leblanc/NASA

same time, partners from UCSC used a host of matching instruments onboard the research vessel R/V Shana Rae to gather data from the water's surface and within the water column.

The AirSHARP team used radiometers with matching technology – C-AIR from the air and C-OPS (Compact Optical Profiling System) from the water – to gather water-leaving reflectance data. The C-AIR instrument is modified from an instrument that goes on research vessels. It takes measurements from the sky and of the water's surface to derive water-leaving reflectance from very close range. By putting it on an aircraft, measurements can be collected over the entire

Monterey Bay.

In addition to water-leaving reflectance, the team measured aerosol optical depth using the 4STAR-B spectrometer, which was engineered at NASA ARC and identifies aerosols and quantifies aerosol optical depth.

Both C-AIR and 4STAR-B flew on the NPS Twin Otter, which can perform extremely low-altitude flights, making passes down to 100 feet above the water in clear conditions. With the phytoplankton bloom attracting so much wildlife in a bay already full of ships, this was no small feat.



Figure 47. AirSHARP team in front of the NPS CIRPAS Twin Otter. **Credit:** Samuel Leblanc/NASA

Space Weather Aviation Radiation Flights (SWXRAD)

PI: Christopher J. Mertens (NASA LaRC)
 Program: SMD Heliophysics Division Space Weather Program
 Aircraft: LaRC B-200
 Payload: dosimeters (TEPC, Liulin dosimeter-spectrometer, 2 ARMAS)

The science goal of the space weather aviation radiation aircraft flight campaign is to measure dosimetric quantities to validate and improve the NASA Langley Research Center's (LaRC) Nowcast of Aerospace Ionizing Radiation System (NAIRAS) model at commercial aviation altitudes. The Earth is continuously bombarded by ionizing radiation from galactic cosmic rays (GCR), which increases the health risk to those exposed at aviation altitudes and in the space environment. Ionizing radiation exposure also poses a hazard to the functionality of vehicle electronic systems. Solar storm phenomena such as solar flares and coronal mass ejections (CMEs) can be associated with solar energetic particles (SEP) which further increase radiation exposure and risks to human health and avionic systems. The NAIRAS model provides real-time, global predictions of the atmospheric ionizing environment for radiation monitoring, assessment, and risk management. The NAIRAS radiation dose products are available from the Community Coordinated Modeling Center (CCMC) Integrated Space Weather Analysis (ISWA) web interface ([NAIRAS 3.0 | CCMC](#)). An example of the global effective dose rates predicted during the aircraft campaign is shown in Figure 48.

The objectives of the space weather aviation radiation flight campaign are to acquire aircraft dosimetric measurements at zero geomagnetic cutoff rigidity where radiation shielding by Earth's magnetic field is zero and ionizing radiation

exposure is maximum, and measure dosimetric quantities that are sensitive to charged particles, electromagnetic radiation, and neutrons. The region of zero cutoff rigidity is at latitudes near the polar regions. Thus, transpolar and transcontinental commercial airline flights along the North Atlantic corridor are some of the most highly exposed flight paths to ionizing radiation.

The science objectives were successfully met by the space weather aviation radiation flight campaign in Greenland August 25-28, 2025. The B200 (King Air) aircraft flew from Langley to Greenland with four radiation instruments on board. The LaRC-Greenland flight and return flight acquired 16 hours of flight measurements. Two station flights were conducted out of Nuuk Greenland for a total of 8 hours flight measurements at zero cutoff rigidity. The cruise altitudes were FL300-FL350. The onboard dosimeters included a tissue equivalent

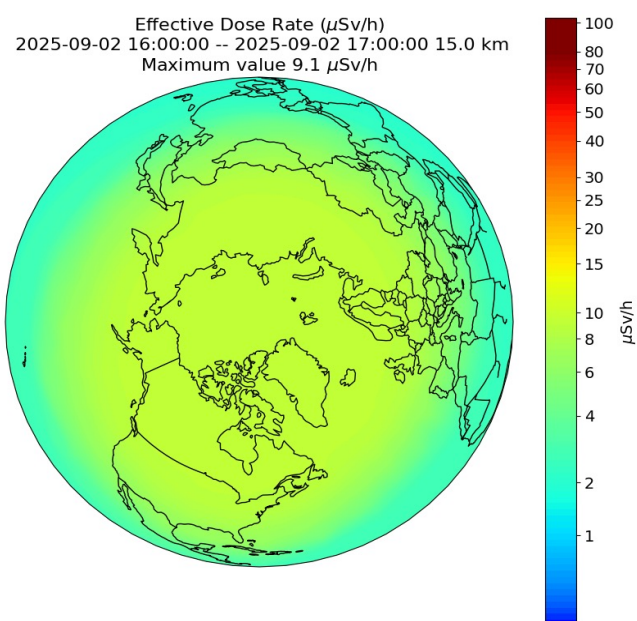


Figure 48. NAIRAS model global real-time predictions during the Space Weather Aviation Radiation flight campaign, taken from the Community Coordinated Modeling Center (CCMC) Integrated Space Weather Analysis (ISWA) web interface [NAIRAS 3.0 | CCMC](#). Credit: NASA

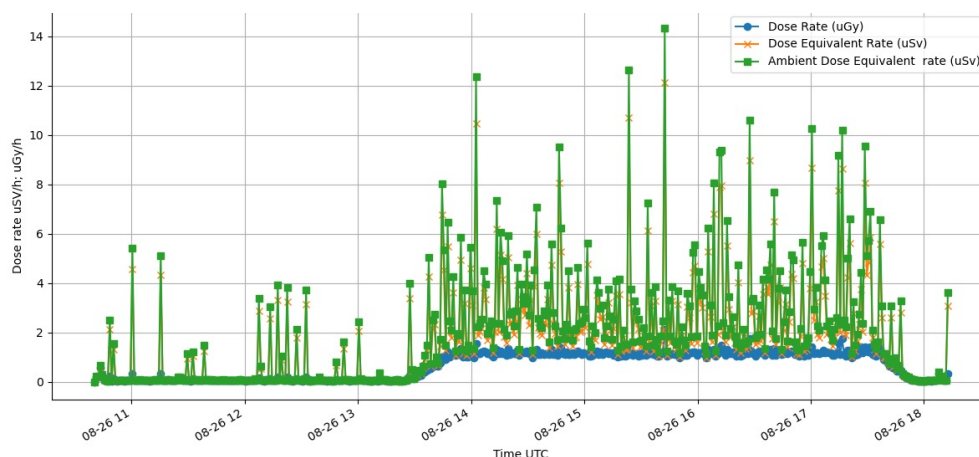


Figure 49. TEPC measurements of dosimetric quantities during the Greenland station flight out of Nuuk on August 26, 2025. The dosimetric quantities shown are absorbed dose rate in tissue, dose equivalent rate, and ambient dose equivalent rate. **Credit:** NASA

proportional counter (TEPC), a Liulin dosimeter-spectrometer, and two Automated Radiation Measurements for Aerospace Safety (ARMAS) dosimeter units. An example of the TEPC measurements is shown in Figure 2 during one of the station flights from Nuuk.

The science team is in the process of comparing the flight dosimeter measurements to the NAIRAS model. The aircraft flight measurements will provide essential data for validating a new free-space GCR model component of NAIRAS.

Aerosols, and Radiation Explorer (EarthCARE) satellite. Using NASA's G-III aircraft equipped with the second generation airborne high spectral resolution lidar (HSRL-2) instrument, a primary validation objective was to compare HSRL-2's 355 nm atmospheric data products (aerosol backscatter, extinction, and depolarization ratio) directly with ATLID's L1B and L2 data products to evaluate gain calibration, filter coefficients, polarization calibration, and background subtraction, during nighttime when signal-to-noise ratios are highest.

NightBLUE

PI: Johnathan Hair (NASA LaRC)
Program: Tropospheric Composition, Radiation
Science
Aircraft: NASA G-III
Payload: HSRL-2

The NightBLUE field campaign was conducted from Bermuda during September, 2025. It was a collaborative effort between NASA, the European Space Agency (ESA), and Royal Netherlands Meteorological Institute (KNMI) to assess the performance of the Atmospheric LIDar (ATLID) instrument on ESA/JAXA's Earth Clouds,



Figure 50. NASA G-III aircraft preparing for a nighttime research flight during the NightBLUE field campaign. **Credit:** NASA



Figure 51. Rachel Lazzaro working on the University of Delaware glider at the dock.
Credit: NASA

Another important validation objective was to perform an intercomparison of HSRL-2 ocean profiling measurements, satellite retrievals of ocean optical properties from the PACE (Plankton, Aerosol, Cloud and Ecosystem) and EarthCARE satellites, and in-water measurements from an autonomous ocean glider (University of Delaware, PI Matthew Oliver) and research cruises off Bermuda (R/V Atlantic Explorer, PIs Amy Mass and Eric Hochberg) and across the Gulf of Maine (R/V Bowditch, PI Catherine Mitchell). Satellite-derived ocean optical and biogeochemical properties were compared with coincident HSRL-2 multiwavelength measurements of subsurface scattering, extinction, and fluorescence, and targeted overflights of in-water assets provided a means to tie the remote sensing measurements back to in-water optical and acoustical measurements useful for studying ocean ecosystems.

NightBLUE provides a critical bridge between NASA's 17-year lidar data record from the CALIPSO satellite which ended in August 2023 to ATLID's level 2a data record which became public in March 2025. CALIPSO's measurements

were made at 532 and 1064 nm, whereas ATLID's are at 355 nm. The LaRC HSRL-2 makes observations at all three wavelengths, making the HSRL-2 data sets a means by which to connect the two satellite data records for long-term trend studies important to the US and international science community for understanding the evolution of clouds, aerosols, and their impact on radiation and weather patterns. Enhancing the connection is the long record of LaRC validation of underflights of CALIPSO. LaRC HSRL instruments were extensively used to validate the CALIPSO lidar measurements in past campaigns (147 underflights), and the team envisions providing a similar record of EarthCARE underflights as part of dedicated measurement campaigns and flights-of-opportunity on science-focused field missions.

NightBLUE exceeded its objectives by successfully executing 16 research flights (11 nighttime and 5 daytime), targeting EarthCARE underpasses over unique atmospheric conditions. These conditions included complex cloud scenes, Saharan dust plumes, and dehydrated sea-salt aerosol aloft, all providing



Figure 52. NightBLUE field campaign team in front of the NASA G-III. From left-to-right: David Donovan (KNMI), Chris Swanson (Pilot - NASA LaRC), Research Pilot - Pat Bookey (top; Pilot - NASA LaRC), John Hair (NASA LaRC), Taylor Shingler (NASA LaRC), and Madison Hetlage (NASA LaRC).
Credit: NASA

unique and valuable targets for ATLID and PACE validation. Coordination with the in-water assets included 21 glider overflights and a combined 5 overpasses of the two research vessels. NightBLUE built upon an already impressive record of validation underflights by other institutions and achieved the distinction of

executing the 100th science underflight of the EarthCARE satellite. The field deployment offered a unique opportunity for NASA's HSRL-2 science team to collaborate in-person with international partners from the EarthCARE science and algorithm development teams, ensuring validation objectives were properly prioritized.



4. Aircraft

NASA maintains and operates a fleet of highly modified aircraft, based at NASA Centers, able to uniquely support Earth observations. ASP-supported, or Core aircraft, have requirements from across ESD disciplines and so funding is provided to Flight Operations Centers personnel and equipment in order to reduce the flight hour cost to projects. Other NASA aircraft are also available for science missions. In addition, NASA missions employ commercial aviation services (CAS) under protocols established by NASA Headquarters. More information about using these aircraft is provided on the ASP website at: <https://airbornescience.nasa.gov>. The annual “Call Letter,” also available on the ASP website, is an excellent source of information describing how to request airborne services (<https://airbornescience.nasa.gov/sofrs/>).

FY2025 Aircraft Highlights

The ASP fleet includes aircraft that can support low-and-slow flights, as well as those capable

of flying high and fast. The aircraft also have a wide variety of payload capacities. One of the most exciting recent enhancements to the ASP fleet is the acquisition of a Boeing 777-200 Extended Range (B777-200ER or B777), which was acquired to replace and extend the capabilities of the NASA DC-8, which retired in 2024. The newly acquired B777 is currently undergoing modifications to include several nadir and window ports, power, data and communications systems, and instrument operator accommodations. The first NASA B777 science operations are planned for FY27 from LaRC.

ASP Fleet Summary Characteristics

ASP aircraft performance characteristics and payload accommodation summaries are provided in Table 9. The fleet of aircraft is shown in Figure 53. The altitude, endurance, and range capabilities are shown in Figure 54. Figure 55 indicates payload capability for each aircraft.



Table 9. NASA Airborne Science Program-supported aircraft.

Platform Name	NASA Center	Payload Accommodations	Duration (Hours)	Useful Payload (lbs)	Max Altitude (ft)	Airspeed (knots)	Range (Nmi)
ASP Supported Aircraft							
B777	LaRC	4 small nadir ports, 2 large nadir ports, dropsondes, in situ sampling	18	75,000	43,000		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)	8	2,900	70,000	410	5,000
GV	AFRC	2 nadir ports, dropsondes	13		51,000	500	5,500
G-III/C-20A	AFRC	UAVSAR pod	6	2,500	45,000	460	3,400
G-III	LaRC	2 nadir ports, dropsonde / sonobuoy	6	4,500	45,000	450	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	12	18,000	32,000	405	3,800



Figure 53. NASA Airborne Science Program-supported aircraft.

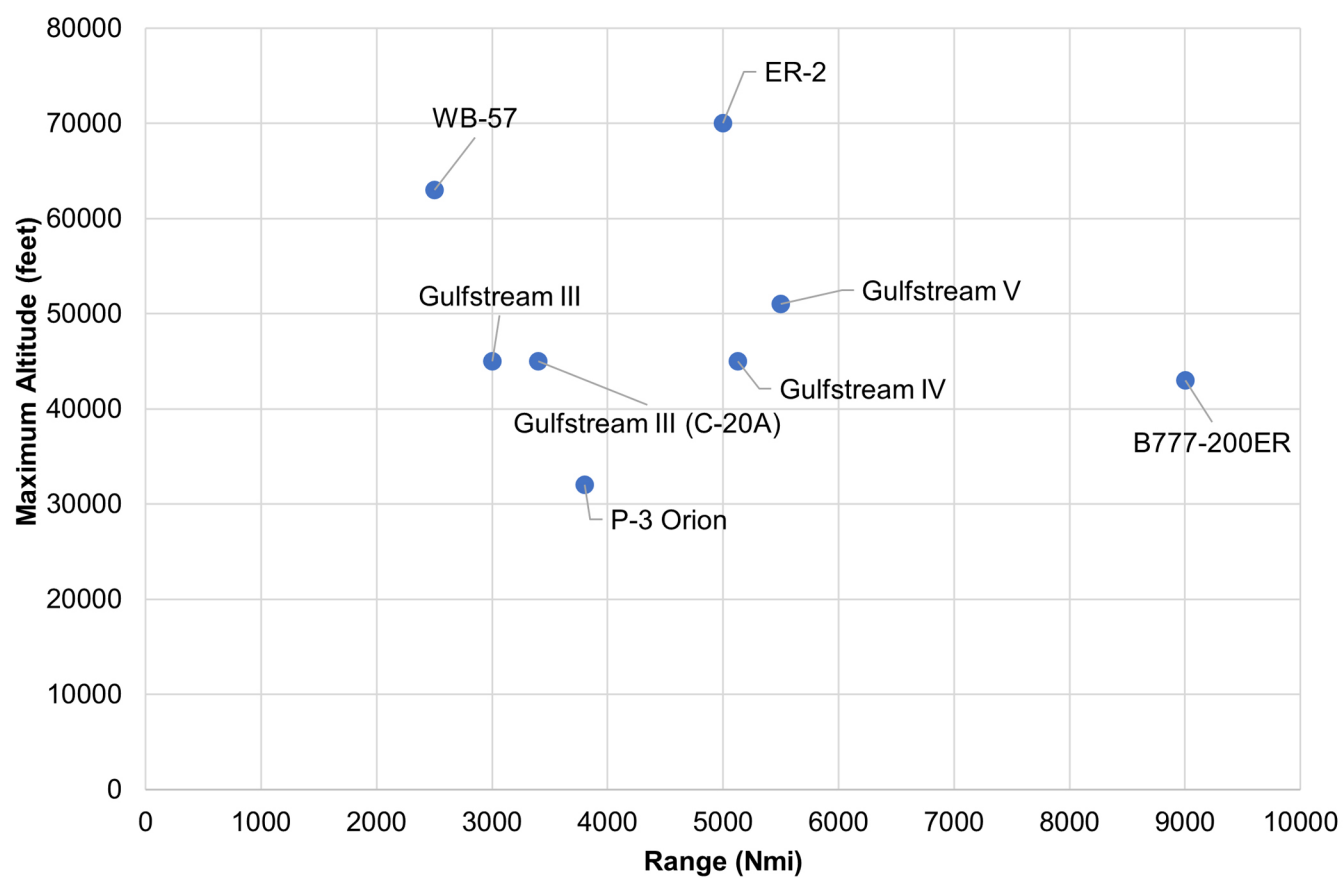


Figure 54. NASA Earth science aircraft capabilities in altitude and range.



ASP-Supported and Partially Supported Aircraft

ASP directly supports eight platforms with subsidized flight hours: two ER-2 high-altitude aircraft, one P-3 Orion, one C-20A (G-III), one

G-III, one G-IV, one B777, and a partially supported WB-57 at JSC. ASP has recently procured a new GV that will be exclusively used for science. More information can be found on Page 66.

B777 Flying Laboratory

Operating Center:

NASA LaRC

Aircraft Description:

The B777 airborne laboratory is a twin-engine, long-range commercial airliner that is being modified for NASA Airborne Science. It has a range of 9,000 Nm, a duration of up to 18 hours, a ceiling of 43,000 ft, and an experiment payload of 75,000 lbs (34,019 kg). This unique flying laboratory will have truly global reach, enabling data collection for NASA projects to include sensor development, satellite sensor calibration, data product validation, and field studies to better understand earth system processes to improve models and decision-making. First operations are planned for FY27 from NASA Langley Research Center.



Figure 55. B777 showcasing work in progress on window modification.
Credit: L3 Harris

FY25 Science Flight Hours: 0

FY25 B777 Modifications and Impacts on Performance and Science:

- 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.
- Two large nadir viewports, four small nadir viewports, and four reinforced window viewports were cut in FY25. These modifications

are expected to complete in FY26, along with internal aircraft modifications to prepare for the first science mission.

Significant Upcoming Maintenance Periods:

- Once the aircraft completes modifications, maintenance will be caught up in FY26 prior to the first scheduled mission in FY27.

Website:

https://airbornescience.nasa.gov/aircraft/NASA_B777

ER-2 High Altitude Aircraft

Operating Center:

NASA AFRC

Aircraft Description:

NASA operates two ER-2 aircraft (N806NA, N809NA) as readily deployable high-altitude sensor platforms to collect remote sensing and in situ data on earth resources, atmospheric chemistry and dynamics, and oceanic processes. The aircraft also are used for electronic sensor research and development, satellite calibration and satellite data validation. The aircraft can carry a useful payload of up to 2,900 lbs (1,315 kg) for up to 8 hours.

Operating at 70,000 feet, (21.3 km) the ER-2 acquires data above ninety-five percent of the earth's atmosphere. ER-2 sensors acquiring earth imagery or conducting atmospheric sounding replicate spatial, spectral and atmospheric characteristics of data collected by earth observing sensors aboard orbiting satellites.



Figure 56. 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

FY25 Science Flight Hours: 356.1

Table 10. ER-2 FY25 missions on N806NA and N809NA platforms.

Mission/Project	Location	Science Program Area
airLUSI	California	Research and Analysis, Ocean Biology and Biogeochemistry, Airborne Science Program
GLOVE	California	ICESat-2 Project
AirMSPI-2	California	Radiation Science
GEMx	Western CONUS	Terrestrial Ecology, USGS
WDTs	Western CONUS	Research and Analysis, Earth Surface and Interior, Biological Diversity
WH ² yMSIE	California	Weather and Atmospheric Dynamics
MBARS	Pacific Coast	ESTO IIP

FY25 ER-2 Modifications and Impacts on Performance and Science:

- N806NA 600-hr Maintenance (October 1, 2024 – April 1, 2025): minimal impacts.

Significant Upcoming Maintenance Periods:

- N809NA 600-hr Maintenance (November 13, 2025 – May 13, 2025): minimal impacts.

Website:

<http://airbornescience.nasa.gov/aircraft/ER-2>



WB-57 High Altitude Aircraft

Operating Center:

NASA JSC

Aircraft Description:

The WB-57 is a mid-wing, long-range aircraft capable of extended operation from sea level to altitudes greater than 60,000 feet with a range of up to 2,500 Nm. The sensor equipment operator (SEO) station contains navigational equipment and controls for operation of the payloads located throughout the aircraft. The WB-57 can carry up to 8,800 pounds of useful payload. JSC maintains three WB-57 aircraft (N926NA, N927NA, N928NA).

Note: The Airborne Science Program has provided partial funding to support the annual fixed costs of operating the WB-57 aircraft. Within this limited scope, subsidized flight hour rates are available to science mission customers. Contact Airborne Science and WB-57 program management for details.



Figure 57. The high-altitude WB-57 aircraft departed July 8, 2025, from Ellington Field in Houston, Texas, headed to the Texas Hill Country. The aircraft used the DyNAMITE (Day/Night Airborne Motion Imager for Terrestrial Environments) sensor system to take video mosaics of the area to assist with the emergency response effort. **Credit:** Morgan Gridley/NASA

FY25 Science Flight Hours: 30.4

Table 11. WB-57 FY25 missions.

Mission/Project	Location	Science Program Area
NOAA SABRE	Texas	NOAA
Texas Floods	Texas	NASA

FY25 WB-57 Modifications and Impacts on Performance and Science:

N/A

Website:

<https://airbornescience.nasa.gov/aircraft/WB-57> - JSC

Significant Upcoming Maintenance Periods:

- N926NA: Major phase inspection (6-8 months) started in August 2025 with expected operational status in late-February 2026.
- N927NA: Minor phase inspection (2-4 months) starting in September 2026 with expected operational status in January 2027.

Gulfstream III Business Jet

Operating Center:

NASA LaRC

Aircraft Description:

The Gulfstream III (G-III) is a twin-turbofan business-class aircraft supporting routine flight at 40,000 feet with a useful payload of 2,610 lbs (1,184 kg) for a range of up to 3,767 Nm. The G-III has the following features: an engine hush kit, research power distribution system, intercom system, drop-sonde capability, and two nadir portals in the fuselage. The hush kit enables the aircraft to be Stage III noise compliant, allowing the aircraft to deploy nationwide and worldwide without requiring engine noise waivers. The nadir portals allow the aircraft to install earth science sensors.



Figure 58. NASA G-III equipped with HALO, AWP, and dropsondes during a flight over southern California during WH²MSIE.
Credit: L. Losey/NASA

FY25 Science Flight Hours: 296

Table 12. G-III FY25 missions.

Mission/Project	Location	Science Program Area
APEX	California	Earth Science Technology Office
APMAC	Eastern CONUS	U.S. Greenhouse Gas Center
AWP	Eastern CONUS	NOAA, Weather and Atmospheric Dynamics
CODEX	Eastern CONUS	Advanced Air Transport Technology, Tropospheric Composition, Radiation Science
NightBlue	Bermuda Science	Tropospheric Composition, Radiation Science

FY25 G-III Modifications and Impacts on Performance and Science:

The following upgrades were completed to enhance situational awareness and comply with required phased maintenance activities.

- Installation of new Intercom system, to enhance crew and pilot situational awareness, improve communications reliability
- Added ground crew COM capability to enhance operations safety

- Added SATCOM capability
- Engine 11189 FOD repair
- Engine 11176 removal and 8562 install

Significant Upcoming Maintenance Periods:

- December 2025 – January 2026: scheduled maintenance
- February 2026: 150-hour maintenance
- April – May 2026: scheduled maintenance

Website:

https://airbornescience.nasa.gov/aircraft/Gulfstream_III_-_LaRC



C-20A Business Jet

Operating Center:

NASA AFRC

Aircraft Description:

The C-20A is a business jet supporting routine flight at 40,000 feet with a useful payload of 2,500 lbs (1,134 kg) for up to 3,400 Nm. The C-20A can support a single science flight (up to 6.0 flight hours) or two science flights in one day (up to 9.0 total flight hours) with one ground crew. This platform has been structurally modified and instrumented to carry the payload pod for the three versions of JPL's UAVSAR instrument (L-band, P-band, Ka-band).



Figure 59. The Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) underbelly pod is in clear view as NASA's Gulfstream III research aircraft banks away over Edwards Air Force Base, California.

Credit: NASA

FY25 Science Flight Hours: 186.3



Table 13. C-20A FY25 missions.

Mission/Project	Location	Science Program Area
California and Pacific Northwest Deep-Seated Landslides	California, Oregon, Washington	Interior and Terrestrial Hydrology, Earth Surface and Interior
Central Valley Land Subsidence	California	Earth Action, Geodetic Imaging
Dense UAVSAR Snow Time Series (DUST)	California & Idaho	Interior and Terrestrial Hydrology
Eel River Landslide Kinematics	California	Earth Surface and Interior
Hurricane Milton Post-Hurricane Response	Florida	Disaster Management
NASA-ISRO Synthetic Aperture Radar (NISAR) Calibration/Validation: Solid Earth	California	Interior and Terrestrial Hydrology
Portuguese Bend Landslides	California	Earth Surface and Interior
Salton Trough Fault Creep	California	Interior and Terrestrial Hydrology, Disasters / Wildfires
Texas Hill Country Flood Mapping	Texas	Disaster Management
UAVSAR L-Band Engineering Flights	California	Geodetic Imaging
UAVSAR P-Band Engineering Flights	California	Geodetic Imaging
Urban Hayward Fault	California	Earth Surface and Interior
Western US Change Detection	California	Interior and Terrestrial Hydrology
Wildland Fire Emissions	Western CONUS	Terrestrial Ecology
Southern California Wildfires	California	Earth Action, Earth Surface and Interior

FY25 C-20A Modifications and Impacts on Performance and Science:

- OPS1/OPS2 Maintenance
- 4,500-flight-hour inspection of the wing attach frames (December 2024 to February 2025)
- Throttle rigging and inertial navigation unit (INU) install

Significant Upcoming Maintenance Periods:

- November 2025 – February 2026: OPS1/OPS3 Maintenance

Website:

https://airbornescience.nasa.gov/aircraft/Gulfstream_C-20A_GIII_-_AFRC



G-IV Business Jet

Operating Center:

NASA AFRC

Aircraft Description:

The G-IV aircraft is twin turbofan business-class aircraft with a maximum of ten onboard operators. The G-IV can fly for a maximum of 8 hours with a useful payload of up to 5,610 pounds (2,545 kg). It can reach a maximum of 45,000 feet at an air speed of 459 knots over a range of up to 5,130 Nm.



Figure 60. The G-IV aircraft flies overhead in the Mojave Desert near NASA’s Armstrong Flight Research Center in Edwards, California. Baseline flights like this one occurred in June 2024, and future flights in service of science research will benefit from the installment of the Soxnav navigational system, developed in collaboration with NASA’s Jet Propulsion Laboratory in Southern California and the Bay Area Environmental Research Institute in California’s Silicon Valley. This navigational system provides precise, economical aircraft guidance for a variety of aircraft types moving at high speeds. **Credit:** Carla Thomas/NASA

FY25 Science Flight Hours: 9.2

Table 14. G-IV FY25 missions.

Mission/Project	Location	Science Program Area
Soxnav Engineering Check Flights	California	Airborne Science

FY25 G-IV Modifications and Impacts on Performance and Science:

- Modifications and maintenance to support the UAVSAR follow-on, AirSAR-NG.
- Preparations and testing for the new Platform Precision Autopilot (PPA), which will allow the aircraft to fly repeatable flight tracks data to identify centimeter-level changes in the Earth’s surface.

Significant Upcoming Maintenance Periods:

- March 2026: complete structural modification and heavy maintenance
- September 2026: complete mission systems modification

Website:

[https://airbornescience.nasa.gov/aircraft/Gulfstream IV - AFRC](https://airbornescience.nasa.gov/aircraft/Gulfstream_IV_-_AFRC)

P-3 Turboprop

Operating Center:

NASA WFF / NASA LaRC

Aircraft Description:

The P-3 is a four-engine turboprop aircraft designed for endurance (up to 12 hours) and range (up to 3,800 Nm). The aircraft can fly up to 32,000 feet with a useful payload of 18,000 lbs (8,165 kg). The P-3 is used for a wide range of scientific activities including ecology, meteorology, atmospheric chemistry, cryospheric research, oceanography, soil science, biology, and satellite calibration/validation. The P-3 is also used as a technology test bed for new airborne and satellite instrumentation.

The P-3 has been extensively modified to support airborne scientific research. Features include zenith ports, three nadir ports (aft of the wings), and seven windows that have been modified to provide externally mounted experiments. Additionally, there are tail cone ports, nose radome ports, and ten mounting locations on the wings. Most of the fuselage ports are contained within the pressurized cabin environment while a custom fairing allows the unpressurized bomb bay to be converted into experimenter ports. This fairing creates two large nadir ports and several oblique ports for large sensors and antennas. When the bomb bay fairing is removed and the bomb bay doors installed, the doors are functional in flight to support aerial deployments. Dropsonde and sonobuoy deployment systems are also available.



Figure 61. NASA P-3 Orion (N426NA) in flight. Credit: NASA

FY25 Science Flight Hours: 92 hours

Table 15. P-3 FY25 missions.

Mission/Project	Location	Science Program Area
SARP	Virginia, California	Tropospheric Composition, Atmospheric Composition
MAGEQ	Virginia	U.S. Greenhouse Gas Center

FY25 P-3 Modifications and Impacts on Performance and Science:

- Engine Instrument Display System (EIDS): modernized engine and oil display system from dial gauges to flat panel displays to increase maintenance reliability.
- Installed seat tracks around Nadir #2 port: this allows instruments mounted over the Nadir #1

port to also be mounted over the Nadir #2 port making these two Nadir ports interchangeable.

Current and upcoming maintenance periods:

- No planned maintenance periods beyond standard Condition Based Maintenance tasks when aircraft was transferred from WFF to LaRC in August 2025.

Website:

https://airbornescience.nasa.gov/aircraft/P-3_Orion_-_WFF



Other NASA Earth Science Aircraft

Other NASA aircraft, as described here, on the Airborne Science website, and in the annual ASP Call Letter, are platforms operated by NASA centers. Although not subsidized by the ASP program, these aircraft are also modified to support Earth-observing payloads. These aircraft are available for science through direct coordination with the operating center.

Table 16. Other NASA aircraft available for Earth science missions.

Aircraft	Operating Center
B-200 King Air	LaRC, AFRC, or contracted
GV	JSC
Small UAS	AFRC, ARC, LaRC, JPL

B-200 Turboprop

Operating Center:
NASA LaRC / NASA AFRC

Aircraft Description:
The Beechcraft B-200 King Air is a twin-turboprop aircraft capable of mid-altitude flight (up to 30,000 ft) with up to 1,000 pounds (454 kg) of useful payload for up to 6 hours. LaRC operates a conventional B-200 and AFRC operates a Super King Air B-200 modified for downward-looking payloads.



Figure 62. NASA's B200 King Air on the runway in Goose Bay, Canada, a stop during the flight to Nuuk, Greenland during the SWXRD mission. **Credit:** Guillaume Gronoff/ NASA

FY25 Science Flight Hours: 49.7 (N529NA); 47.8 (N801NA)



Table 17. B-200 Turboprop FY25 missions.

Mission	Aircraft	Location	Science Program Area
CHAPS-D	N529NA	Virginia	Earth Science Technology Office
CASALS	N529NA	Virginia	Earth Science Technology Office
SWXRD	N529NA	Arctic	Space Weather
FireSense	N801NA	CONUS	Earth Action
C-FIRST	N801NA	California	ESTO IIP

FY25 B-200 Turboprop Modifications and Impacts on Performance and Science:

LaRC B-200:

The following upgrades were complete to improve handling performance/safety. Upgrades also bridge (speed/altitude) performance-offering gaps between B200 and G-III aircraft that enable science mission cost and planning efficiencies.

- Raisbeck 5-bladed Swept Composite Propellers (STC SA2698NM-S)
- Raisbeck High Flotation Landing Gear Doors (STC SA4175NM)

- Raisbeck Dual Aft Body Strakes (STC SA3591NM)

- Centex HALO 275 Conversion (STC SA11103SC)

- Centex Saddle Tank Kit (STC SA11142SC)

Current and upcoming maintenance periods:

- LaRC B-200: Phase 1&2 June 2026

Websites:

LaRC B-200:

<https://airbornescience.nasa.gov/aircraft/B200 - LARC>

AFRC B-200:

https://airbornescience.nasa.gov/aircraft/B200_801 - AFRC



Gulfstream V Business Jet

Operating Center:

NASA JSC

Aircraft Description:

The Gulfstream V (GV) is a long-range, large business jet aircraft built by Gulfstream Aerospace, derived from the Gulfstream IV. It flies at speeds up to Mach 0.885, an elevation of up to 51,000 feet, and has a range of 5,000 nautical miles. JSC procured the GV in 2016 as part of a shared usage agreement between the ISS program and NASA ESD. The ISS program would use the GV for Crew Return missions and ESD would use it to support airborne science missions in remote locations around the world.

The Airborne Science Program removed core financial support for the GV in early FY25.

Note: The aircraft remains in the Agency to support increasing requirements for the human spaceflight program and is only available to ESD missions on a limited, fully reimbursable basis.



Figure 63. GV tail.
Credit: Otto Whitehead

FY25 Science Flight Hours: 0

FY25 Gulfstream V Business Jet Modifications and Impacts on Performance and Science:

This year, the program upgraded legacy satellite communication systems with the SpaceX Starlink system, which has improved data throughput by an order of magnitude. This capability was a much-needed upgrade and allows for better

real-time observation of instrument data by science teams on the ground and improves situational awareness during observation missions.

Current and upcoming maintenance periods:

N/A

Website:

https://airbornescience.nasa.gov/aircraft/Gulfstream_V_-_JSC



5. Education and Training

Student Airborne Research Program (SARP) and SARP-East 2025

In August 2025, 47 students from NASA's Student Airborne Research Program (SARP) completed a summer of science by presenting their research to an audience of mentors, professors, family, friends, and NASA personnel.

SARP is a summer internship for undergraduate students, hosted in two cohorts:

- SARP West in Southern California (Guardian Jet Center and the University of California (UC), Irvine)
- SARP East operated in Virginia (Wallops Flight Facility and Virginia Commonwealth University (VCU)).



Figure 64. The students and faculty of 2025 SARP East pose in front of NASA's P-3 aircraft. **Credit:** Milan Loiacono/ NASA



Figure 65. The students and faculty of 2025 SARP West pose in front of NASA's P-3 aircraft. **Credit:** Milan Loiacono/NASA

SARP randomly assigns students into different research disciplines to encourage interdisciplinary collaboration and give them the opportunity to work outside their comfort zone. Each discipline is led by a faculty researcher who is an expert in their field and supported by

a graduate mentor. This year, SARP research topics spanned three spheres: atmosphere, biosphere, and hydrosphere, covered between the two cohorts.

Over the course of two months, students learned more about NASA's Airborne Science Program and Earth Science through lectures led by SARP faculty and guest speakers from NASA and the Earth Science community, engaged in Earth science data collection while flying onboard the Dynamic Aviation B-200 and NASA P-3 aircraft, and performed ground sampling fieldwork. Students also visited NASA JPL, NASA GSFC, and NASA HQ. This summer, SARP also included other enriching opportunities such as visiting the WAVElab at UC San Diego and the Rice Rivers Center at VCU.



Figure 66. Principal Investigator Joshua DiGangi shows SARP students Jacob Garside and Robert Purvis how to use the Diode Laser Hygrometer (DLH) onboard the NASA P-3 during a SARP 2025 research flight. **Credit:** Milan Loiacono/NASA

Students attended introductory programming sessions and received hands-on support from a coding mentor to develop and strengthen their experience with code and incorporate code in their research project.



6. Major Program Changes and Updates

FY25 brought much excitement to the Airborne Science Program. We continued to prepare the newly acquired B777 for its first science mission, moved assets to new homes, and continued to modify our existing fleet.

The WFF Aircraft Office formally closed after 56 years of flight operations on September 30, 2025, leading to various transfers and transitions::

- Transferred the P-3 (N426NA), B-200 (N8NA), and a spare parts P-3 from WFF to LaRC.
- Transferred the C-130 Hercules (N436NA) aircraft from WFF to CalFire.
- Sold two remaining C-23 Sherpa aircraft.

- Worked to excess four additional spare parts aircraft at WFF.

Additionally, major modifications were completed for the NASA G-IV to prepare the aircraft to support AirSAR-NG and a GV was procured for NASA Earth Science.

NASA's B777 Airborne Research Laboratory: Advancements and Milestones

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



Figure 67. B777 landing.
Credit: L3 Harris



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 began in summer 2025. Work on the four reinforced window viewports is also progressing.

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 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.

G-IV Modifications for AirSAR-NG

The Next Generation AirSAR (AirSAR-NG) instrument development and the NASA G-IV aircraft modification continue to progress. In August 2024, a contract was awarded to Avenger



Figure 68. B777 showcasing work in progress on window modification. **Credit:** L3 Harris

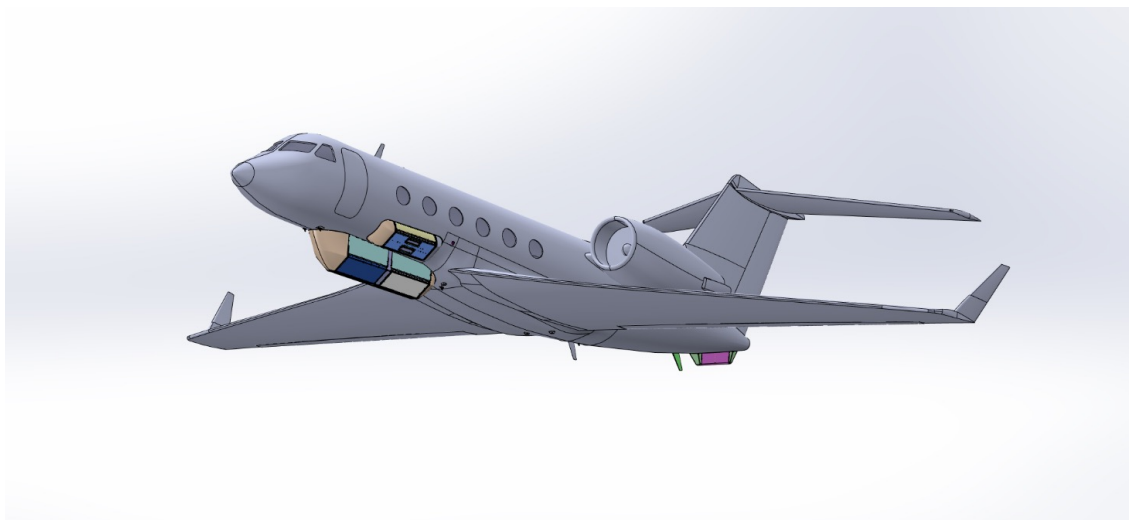


Figure 69. AirSAR-NG platform design. **Credit:** NASA

Aerospace Solutions for the engineering design work of the structural modification. Avenger utilizes a subcontractor, Phoenix Air Group, out of Cartersville, Georgia for the fabrication and installation of the structural modification. In addition, when the aircraft was delivered to Cartersville in March 2025, they conducted heavy maintenance inspections that were required. Subsequently, Phoenix began the fabrication of the structural modification parts in May 2025. That work is ongoing. The aircraft is expected to return to Armstrong Flight Research Center upon completion of the structural modification in early 2026, when it will then undergo the internal mission systems modifications required to operate AirSAR-NG. The team is targeting an Initial Operating Capability in Fall 2026.

AirSAR-NG is a follow-on to the Unmanned Air Vehicle Synthetic Aperture Radar (UAVSAR) instrument developed and operated by the Jet Propulsion Lab (JPL). UAVSAR has been deployed almost exclusively on the NASA C-20A,

which utilizes a large external centerline pod to house a single SAR antenna, configured for either L-, P-, or Ka- Band missions. When enabled with a Platform Precision Autopilot (PPA), the aircraft can fly repeatable flight tracks to identify centimeter level changes in the Earth's surface.

The new AirSAR-NG features improved design aspects and capabilities:

- **Multiband Radar Mission Capability:** Instead of one frequency band, the aircraft will be able to fly up to three frequencies simultaneously using the fuselage blister pod and ventral canoe. This improves data quality, reduces the need for multiple flights, and nearly eliminates the need to remove or swap radar systems when changing frequency.
- **Modular Radar System Design:** Sensitive radar equipment will be relocated from the external radar pod to the aircraft cabin environment. This simplifies system troubleshooting and maintenance, eliminates

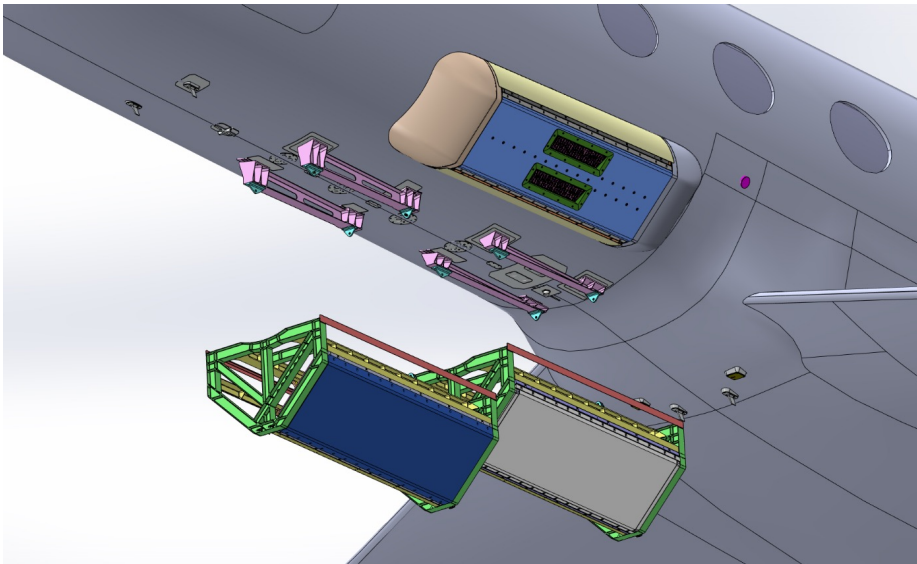


Figure 70. Removable modules on airborne platforms support AirSAR-NG.
Credit: NASA

the need for critical lift procedures, and replaces the centerline pod with a conformal radar enclosure.

- **Reduced Crew Requirement:** The majority of missions will require only one radar operator for all radars. Cockpit aircrew will serve as the PPA operator, eliminating the need for a dedicated operator position.
- **Standardizing the ASP fleet:** Unlike the NASA C-20A, the AirSAR-NG platform will take advantage of common ASP capabilities (e.g., NASDAT). In turn, AirSAR-NG will be first to implement a new PPA system, referred to as Soxnav, designed to be interchangeable with other ASP aircraft, such as the GV and B-777. More information about Soxnav can be found on Page 70.

P-3 Transitions from WFF to LaRC

In August 2024, a decision was made to transition the WFF Aircraft Office to the LaRC Research Services Directorate. This kicked off a yearlong effort to move and disposition aircraft located at WFF along with their associated equipment and

parts to LaRC and other locations. As part of this effort, the P-3 Orion (N426NA) was flown to LaRC in August 2025 after completing the last two WFF-based missions in the summer 2025, the Student Airborne Research Program (SARP) and the Mid-Atlantic Gas Emission Quantification (MAGEQ). During these missions, logistics personnel and maintenance staff packed and shipped items to LaRC in order to provide a smooth transition of P-3 flight operations and to allow the aircraft to continue flight operations as needed upon arrival at LaRC.

In addition to transitioning N426 to LaRC, the WFF Aircraft Office also completed the following:

- Transferred the C-130 Hercules (N436NA) aircraft to CalFire
- Transferred the B-200 aircraft (N8NA) and a spare parts P-3 aircraft to LaRC
- Sold two remaining C-23 Sherpa aircraft
- Worked to excess four additional spare parts aircraft at WFF.

N426's arrival at LaRC in August 2025 marked the end of 56 years of flight operations at WFF. The WFF Aircraft Office formally closed on September 30, 2025.

The WFF Aircraft Office officially opened in 1969 and supported dozens of aircraft types from fixed-wing aircraft to helicopters and even Unmanned Aerial Systems (UAS) over hundreds of missions worldwide. In the early days of WFF, missions varied from surveillance, telemetry, and recovery operations. Eventually, missions became more advanced, including highly technical aeronautics flight testing followed by a focus on airborne research flights. Impressively, WFF Aircraft Office was the first to land a NASA aircraft on Antarctica.

The L-188 Electra (the commercial aircraft model that the P-3 was based upon) and P-3 Orion aircraft variants were the most flown aircraft types at WFF. The final flown P-3 version operated by WFF was the P-3 known as NASA

426 (BuNo152735). It was built in 1966 and transferred from the US Navy to NASA in 1991. Over its 34-year history at WFF, the aircraft was extensively modified to support NASA's aviation needs and became one of the most modified aircraft in NASA's fleet, supporting a variety of Earth Science and technology demonstration missions. Due to the P-3's unique flight capabilities as a low, slow, heavy lift, long duration aircraft, the P-3 and the WFF Aircraft Office became a staple of cryospheric research in the Arctic and Antarctic as well as atmospheric chemistry missions.

The NASA P-3 is a bona fide world traveler: it circumnavigated the Earth near the Equator in the 1990s; in 2013, it became the only NASA-owned aircraft, to date, to utilize McMurdo Station, Antarctica as a basing location to conduct science flights. The P-3 has flown 8,695 total flight hours with WFF, averaging 250 flight hours per year. The aircraft still has many good flying years



Figure 71. WFF Aircraft Office team. **Credit:** NASA



Figure 72.
NASA P-3 Orion
(N426NA) in flight.
Credit: NASA

ahead. In 2016, WFF installed new wings on the aircraft, converting the aircraft from a P-3B to a P-3C aircraft. This provided increased payload capacity and extended the life of the aircraft into the 2040s.

While the P-3 has performed successfully for 34 years, it would not have been possible without the people of the WFF Aircraft Office – those today and those from years gone by. Hundreds of personnel, Civil Servants and Contractors, have passed through the WFF hangars over 56 years, all with one goal in mind: safe and successful NASA flight operations. To those individuals and their families, we say Thank You for your tireless dedication to the Aircraft Office, its planes, and its missions. Your efforts advanced NASA research activities and goals for decades, and will continue to inspire future NASA aviation pioneers to come. To those who moved on to other areas within or outside of NASA or who retired in 2025, they will always be a member of the Code 830 Aircraft Office family.

GV Acquisition for Earth Science

As part of ASP's aircraft modernization and recapitalization efforts, the program acquired a Gulfstream V (GV) at the end of FY25 to increase science capability within a robust and growing portfolio. AFRC led the procurement on behalf of the Agency, assembling an evaluation team with representation from AFRC, ASP, and JSC to evaluate the proposed aircraft to get the best value for Agency. The procurement process took just under four months to complete, demonstrating the effectiveness of early planning, clear authority, and close coordination between technical, procurement, and program stakeholders. The GV will undergo modification Q4 FY26 through Q2 FY27, targeting operational capability in the Spring of 2027. The modification approach will replicate the structural modifications installed on the existing Agency GV, implementing lessons learned to minimize cost and schedule.



Figure 73. ASP GV delivered on 9/30/25. **Credit:** NASA



7. Aircraft Cross-Program Support and IT Infrastructure

Onboard Data and Communications

All aircraft in the ASP fleet have been modified to enable acquisition, processing, and telemetry of data from their primary payloads to maximize the science return of each flight. Science teams access these data through the Mission Tools Suite (MTS). The sensor network architecture includes standardized electrical interfaces for payload instruments using a common Experimenter Interface Panel (EIP); the NASA Airborne Science Data and Telemetry (NASDAT) system, an airborne network server and satellite communications gateway; and a web-based application programming interface (API) for interfacing to customer software and other agencies.

A high bandwidth Ku-band system, which uses a large steerable dish antenna, is installed on the WB-57. Inmarsat Swift Broadband (SBB)

multi-channel systems, using electronically steered flat panel antennas, are available on many ASP core and other NASA aircraft. All aircraft in the ASP Fleet have been equipped with BlueSky's Skylink 7100 Certus Mid-band transceiver, which provides a baseline 88/22kbps worldwide. This system also provides for up to two high fidelity voice lines available using a Android or iOS device on the aircraft's payload network.

NASA cross-program engineering also operates and distributes science support data to primary payloads. These instruments collect important reference information used as a foundation for instrument data processing. These instruments include trajectory, aircraft performance and meteorological measurements, visible still and video imagery, and other airborne instrumentation.

Table 18. Satellite communications systems on ASP aircraft.

Satcom Type	Channels	Data Rate, Nominal	Supported Platforms	Support Group
Ku-band	1 channel systems	>1 Mb/sec	WB-57	JSC
Inmarsat BGAN	2 channel systems	432 Kb/sec per channel	WB-57, P-3, ER-2, GV	ARC/NSRC, JSC
Iridium	Certus	88 kbps in / 22 kbps out	Most ASP Platforms	ARC/NSRC

NASA cross-program engineering also operates and distributes science support data to primary payloads. These instruments collect important reference information that is used as metadata for instrument data processing. These instru-

ments include meteorological measurements, visible still and video imagery, and other airborne instrumentation. The instruments will likely be available on the B777 after modifications are complete.

Table 19. ASP science support instruments.

Airborne Science Program Facility Equipment				
Instrument/Description			Supported Platforms	Support Group
Dew Point Hygrometers			P-3	NSRC
IR Surface Temperature Pyrometers			P-3	NSRC
LN-251 Embedded GPS/INS Position and Orientation System			P-3	NSRC
Forward and Nadir 4K Video Systems			P-3	NSRC
Total Air Temperature Probes			P-3	NSRC
MVIS 2K Video Camera (Nadir)			ER-2	NSRC
EOS and R&A Program Facility Instruments				
Instrument		Description	Supported Platforms	Support Group
MASTER	MODIS/ASTER Airborne Simulator	50 ch multispectral line scanner V/SWIR-MW/LWIR	B-200, ER-2, P-3, WB-57	ASF/ARC
eMAS	Enhanced MODIS Airborne Simulator	38 ch multispectral scanner	ER-2	ASF/ARC
PICARD	Pushbroom Imager for Cloud and Aerosol R&D	400-2450 nm range, Δλ10 nm	ER-2	ASF/ARC
AVIRIS-NG	Airborne Visible/Infrared Imaging Spectrometer-Next Generation	Imaging spectrometer 380-2510 nm range,Δλ 5 nm	Twin Otter (CAS), B-200	JPL
PRISM	Portable Remote Imaging Spectrometer	350-1050 nm range, Δλ 3.5 nm	Twin Otter (CAS), ER-2, GV, LaRC G-III	JPL
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer	Classic imaging spectrometer 400-2500 nm range, Δλ 10 nm	ER-2, Twin Otter (CAS)	JPL
UAVSAR	Uninhabited Aerial Vehicle Synthetic Aperture Radar	Polarimetric L-band synthetic aperture radar capable of differential interferometry	G-III/C-20A	JPL
NAST-I	National Airborne Sounder Tester-Interferometer	Infrared imaging interferometer 3.5 -16 mm range	ER-2	LaRC
LVIS	Land, Vegetation and Ice Sensor	Geodetic laser altimeter system (1064 nm)	GV (NASA and NSF), LaRC G-III, B-200 (NASA and CAS), P-3, C-130	GSFC

NASDAT Next Generation Prototype

NASA Airborne Science Data and Telemetry System (NASDAT) Next Generation (NG) development continued throughout 2025. After a successful Preliminary Design Review, the National Suborbital Research Center (NSRC) at the Bay Area Environmental Research Institute (BAERI) constructed an initial NASDAT NG prototype to provide a test bed for the proposed internal components and software in a field operations environment.

This prototype was installed onboard the NASA P-3, where it successfully replaced several existing data system components during SARP and MAGEQ flights during June and July 2025. The system provided numerous improvements and new capabilities, including IT security improvements to meet agency standards and a new LTE-based communications capability, providing enhanced ground communications

services. These enhancements will enable remote management of the new systems, which saves money and increases operational flexibility for data system operations throughout the ASP fleet.

The NASDAT NG system promises to provide a single-box data system solution for small- and medium-sized aircraft, replacing capabilities currently provided by as many as 4 or 5 devices with a single, easily installed and replaced Line Replaceable Unit (LRU).

Soxnav Engineering Milestones

The Soxnav aircraft guidance system is the culmination of more than 30 years of development. It will help aircraft maintain a precise course even while flying at high speeds up to 500 mph. NASA and the BAERI have been working together to develop and test this technology on NASA aircraft, like the NASA G-IV.

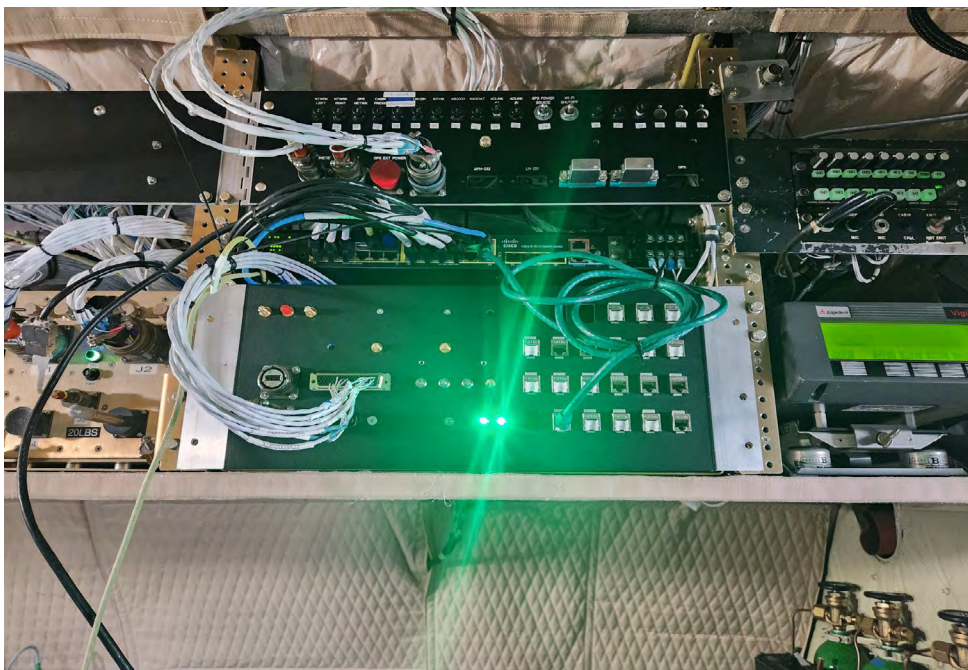


Figure 74. The NASDAT NG prototype system installed on the P-3. **Credit:** David Van Gilst/BAERI-NSRC and NASA



Figure 75. AFRC's Cryss Puntenev (left) and Karen Estes (right) preparing one of the Soxnav flight hardware assemblies for vibration testing. Red cables are accelerometer leads, which enable the response of the hardware to be monitored at many discrete points.
Credit: John Sonntag

The most recent developments include the following:

- The 3D-printed ABS plastic enclosures for the prototype Soxnav radio-frequency electronics modules were replaced with custom machined aluminum enclosures, utilizing an innovative and economical desktop CNC process. These modules also received alodine surface treatment for long-term corrosion resistance.
- Low-cost native global navigation satellite system (GNSS) real-time positioning modules were integrated into the Soxnav hardware. For its initial application within the NASA Airborne Science ecosystem, Soxnav will ingest

position and velocity information from a very high-quality JPL-developed GNSS system, which is part of the AirSAR-NG payload. Both as a backup to the JPL system and as an independent capability that may assist with other potential Soxnav applications, Soxnav now has its own inexpensive native position and velocity capability – Soxnav can be switched, easily and in real-time, between any properly formatted GNSS source, enhancing its operational flexibility for many use cases.

Both existing copies of the Soxnav flight hardware were put through their paces during a formal environmental testing procedure at



Figure 76. Production Soxnav radio-frequency electronics modules (top) and GNSS modules (bottom).
Credit: John Sonntag



NASA AFRC. The functioning hardware was subjected to prolonged vibrations in all three dimensions, and to heat, cold, and high altitudes, while continuously being monitored to ensure its correct operation before, during, and after the testing. These environmental extremes were selected by AFRC engineering leaders to ensure that Soxnav would survive and operate under – and well beyond – any environmental conditions it might encounter during its operational lifetime, on the ground or while airborne. Both copies of the Soxnav system passed all elements of the testing with no issues.

Most recently, Soxnav developers have focused on improving long-term sustainability of the Soxnav hardware, in particular for the unique radio-frequency electronics module. Taking advantage of lessons learned from prior work, design work aimed at segregating this hardware into modular sub-units has gone forward. This is expected to make the modules less expensive to manufacture and easier to troubleshoot and maintain. Soxnav engineers have also undertaken design work, and prototyping, of alternate design concepts for the hardware. These could help deal with parts obsolescence as time goes on, by reducing reliance on key electronic components in the original design. If the business case for wider Soxnav implementation in the Airborne Science Program develops in the future, this work will help ensure the long-term economic and technical viability of the Soxnav system.

Ongoing efforts will be focused on transferring management and maintenance of Soxnav to full-time personnel at BAERI's National Suborbital Research Center (NSRC).



Figure 77. Soxnav flight hardware inside one of AFRC's environmental test chambers. This chamber exposed the flight hardware to extremes of heat, cold, and altitude.
Credit: John Sonntag

NASA ASP Mission Tools Suite (MTS)

The Airborne Science Mission Tools Suite (MTS) is a decision-support and situational awareness platform designed to optimize the execution of airborne missions. Serving as a centralized interface, MTS enables real-time tracking of mission assets, mission reporting, and visualization of onboard instrument telemetry. Additionally, MTS integrates observations from land- and space-based systems to support diverse operational objectives. By facilitating responsive and collaborative coordination across aircraft, satellites, and ground systems, MTS helps to maximize the scientific return of every mission.

Progress on MTS Version 3

The MTS team is actively developing the system's next major iteration: **MTS v3.0**. Building on over a decade of customer-focused support, this release is directly shaped by user feedback to ensure it meets the evolving needs of the airborne science community. The overarching goal for v3.0 is to deliver a modernized, robust architecture that not only meets today's operational demands but lays the groundwork for the next generation of advanced mission capabilities.

As a critical tool for a diverse stakeholder base—ranging from Instrument Teams and Mission Scientists to Program Managers—MTS must be capable, intuitive, and efficient. The v3.0 interface is being rigorously optimized to streamline workflows, reducing the learning curve for new users while enhancing productivity for seasoned operators.

Under the hood, MTS continues its legacy of adopting cutting-edge web standards. By capitalizing on recent advancements in browser capabilities and native source code efficiencies, v3.0 will deliver significant performance optimizations and enhanced software reliability. This focus on technical excellence establishes a scalable architectural foundation, ensuring MTS remains responsive and adaptable for the future of airborne science operations.

Key Highlights of Version 3:

- *Modernized Workspace Layout:* The user interface has been completely reengineered with a new, flexible panel system. This update replaces the previous static layout with a responsive, drag-and-drop environment, allowing operators to effortlessly customize their workspace to fit their specific mission monitoring needs (Figure 78).

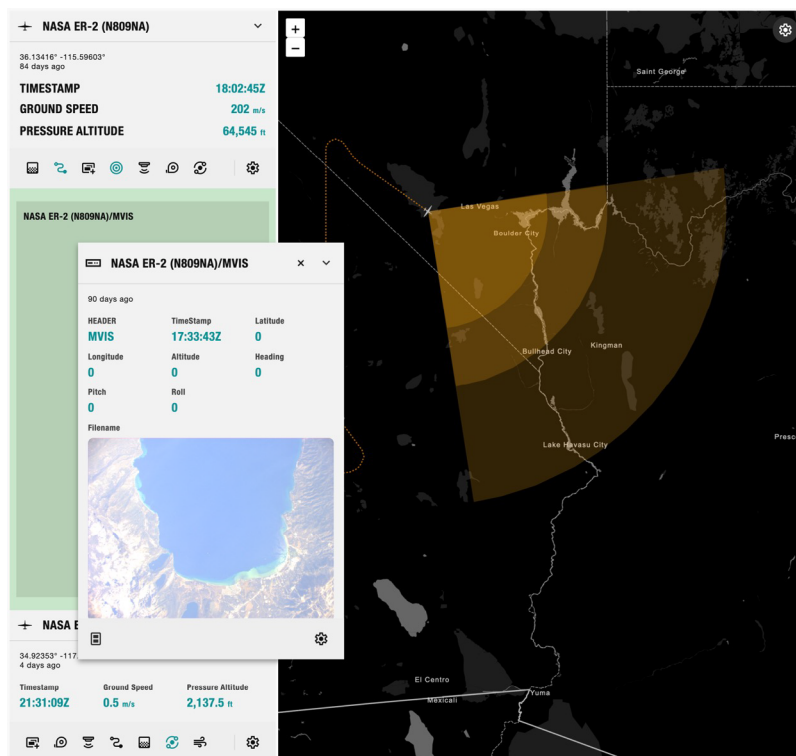


Figure 78. New flexible panel-based user interface. **Credit:** Aaron Duley/NASA ARC

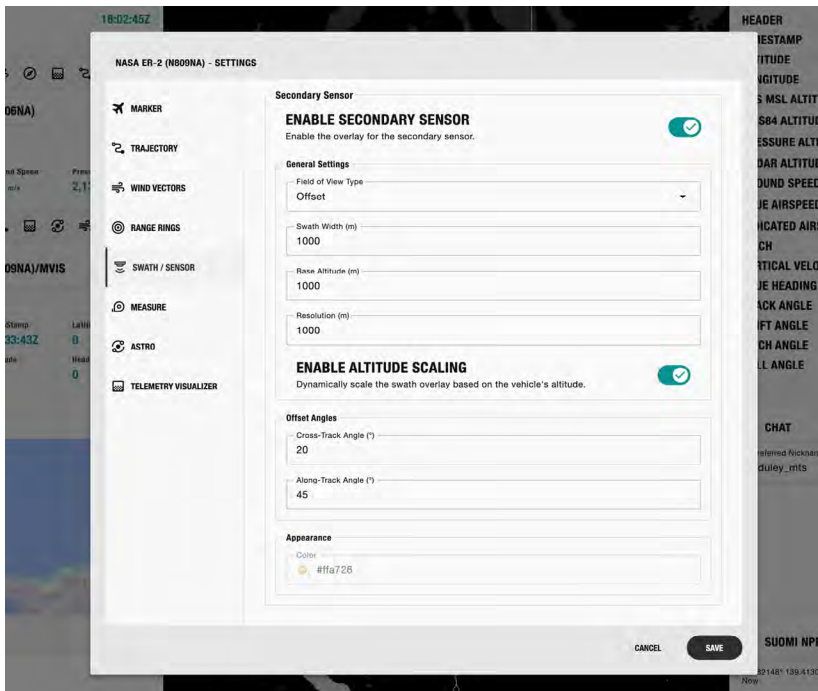


Figure 79. Revamped menu and settings architecture, which makes discovering and managing options faster and more intuitive. **Credit:** Aaron Duley/NASA ARC

- *Centralized Configuration:* A revamped menu and settings architecture make discovering and managing options faster and more intuitive. New context-aware menus allow users to quickly toggle overlays and access critical settings without navigating away from the main display (Figure 79).
- *Advanced Dynamic Swath Overlay:* The sensor footprint visualization has been significantly upgraded. Users can now configure primary and secondary sensors with precise nadir, cross-track, and along-track offsets (Figure 80).
 - *Attitude Correction:* An optional computation engine adjusts the sensor footprint in real-time based on aircraft attitude (pitch/roll/heading) derived from the IWG1 stream, providing a highly accurate estimate of the actual ground coverage.
 - *Resolution & Boresight:* The tool can now render ground resolution polygons to represent approximate pixel scale and includes a boresight vector to clearly indicate the center field of view.
- *Celestial Navigation Tools:* MTS v3 introduces a new overlay for tracking the real-time positions of the Sun and Moon (Figure 81).
 - *Solar & Lunar Tracking:* When enabled, the tool displays an azimuthal vector extending from the aircraft to the celestial target.
 - *Situational Awareness:* A dedicated popup provides critical lighting data for ground based flight following and planning, with displays that automatically compute azimuth and elevation both relative to True North (navigation) and relative to the aircraft's nose (pilot view).
- *Enhanced Telemetry Inspection:* The system now features a streamlined interface for viewing and monitoring instrument status packets. Operators can inspect live telemetry streams with improved formatting, filtering, and plotting capabilities, making it significantly



Figure 80. New advanced dynamic swath overlay depicting a nadir and off-nadir sensor configuration. **Credit:** Aaron Duley/NASA ARC

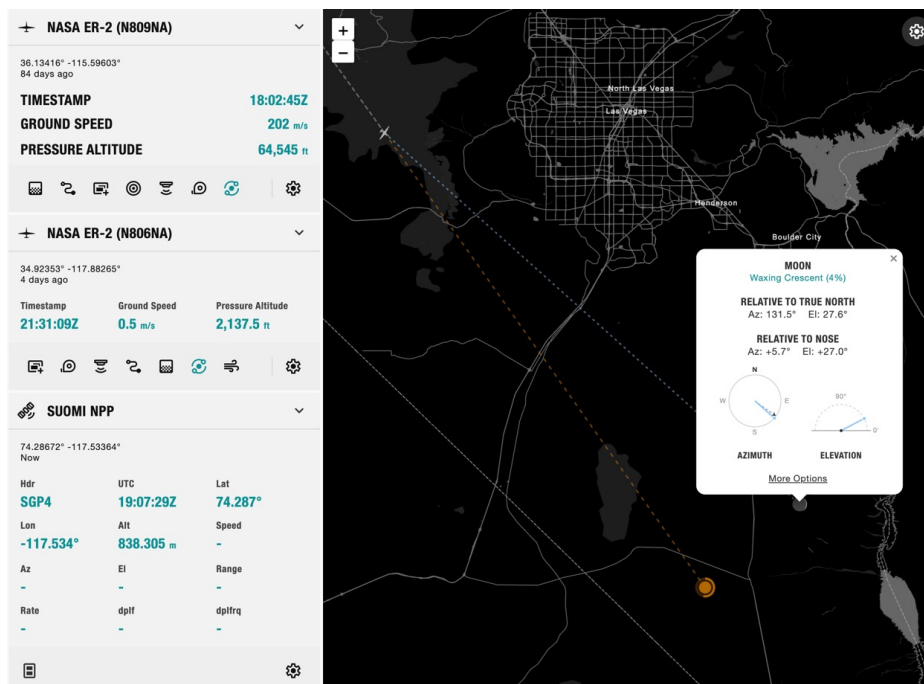


Figure 81. New celestial navigation overlay for quickly obtaining solar and lunar position vectors. **Credit:** Aaron Duley/NASA ARC



easier to monitor instrument health in real-time (Figure 82). In concert with an improved Telemetry Status Packet Visualizer (Figure 83), quickly plotting and observing telemetry values will be even easier.

In summary, MTSv3 is a ground up rewrite of the tool. These highlights represent but a small fraction of what is to come.

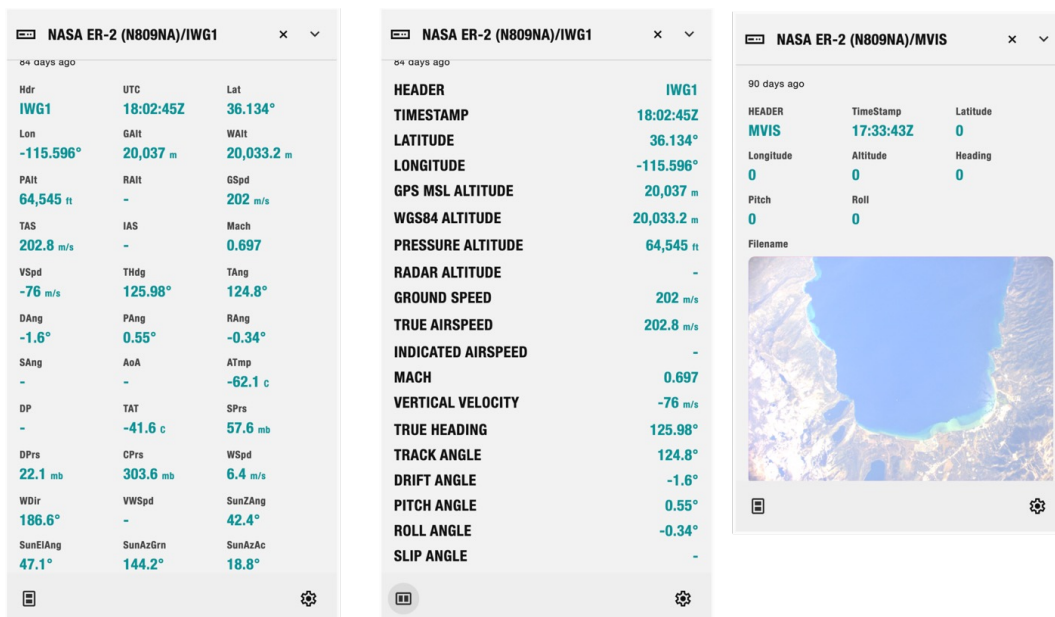


Figure 82. New flexible telemetry display for viewing instrument status packets, including quick look and onboard camera displays. **Credit:** Aaron Duley/NASA ARC

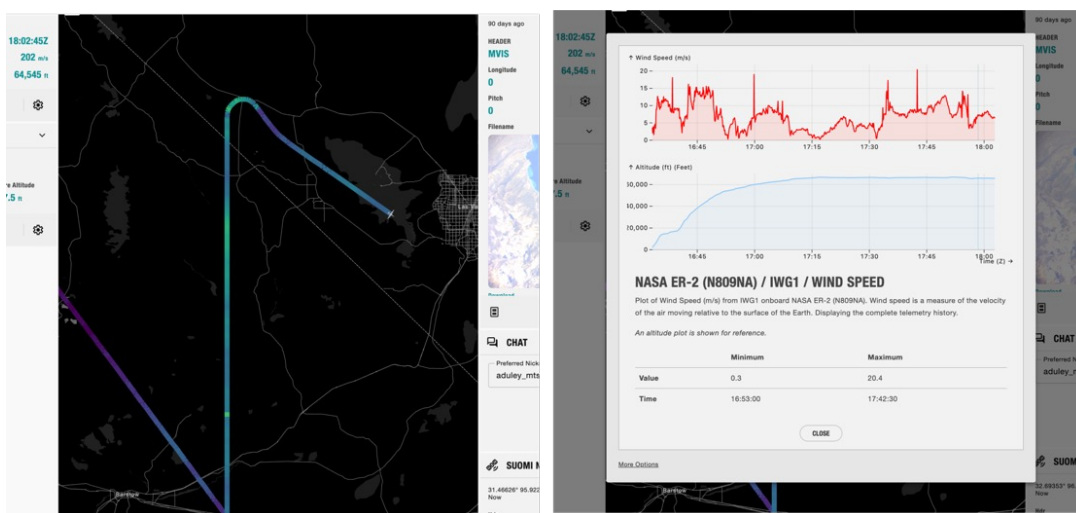


Figure 83. Telemetry Status Packet Visualizer screen view. **Credit:** Aaron Duley/NASA ARC

Communication and Outreach Services

Beyond operational mission support, MTS plays a pivotal role in producing high-quality visualizations for public outreach and official program communications. Over the past year, the MTS team has continued to deliver professional-grade graphics to support program management and the broader NASA Earth Science Division, ensuring complex mission data is accessible and engaging for diverse audiences.

The cornerstone of our graphics work are the freely available 3D aircraft models developed for program outreach and communication. Interested readers are encouraged to visit the 3D Model Page on the Airborne Science Website (<https://airbornescience.nasa.gov/3d-models/>) where you can download models directly in many common formats, or download a pre-rendered scene.



Figure 84. The NASA Airborne Science 2026 Fleet. All platform 3D models are available for download.
Credit: Aaron Duley/NASA ARC



Figure 85. Example of the 3D rendering and compositing.
Credit: Aaron Duley/NASA ARC



Appendix

Acronyms

2D	two-dimensional
3D	three-dimensional
4STAR-B	Spectrometers for Sky-Scanning, Sun-Tracking Atmospheric Research-B

A

AATT	Advanced Air Transport Technology
ABI	Advanced Baseline Imager
ABoVE	Arctic-Boreal Vulnerability Experiment
ACT	Advanced Component Technology
AFRC	Armstrong Flight Research Center
airLUSI	Airborne Lunar Spectral Irradiance
AIRMAPS	Airborne and Remote sensing Multi Air Pollutant Surveys
AIRMSPI-2	Airborne Multiangle SpectroPolarimetric Imager-2
AirSAR-NG	Next Generation Airborne Synthetic Aperture Radar
AirSHARP	Airborne aSsessment of Hyperspectral Aerosol optical depth and water leaving Reflectance Product Performance for PACE
AMPR	Advanced Microwave Precipitation Radiometer
AMP-Up	APEX-MAGPIE Plus Up
APEX	Active and Passive PBL Profiling EXperiment
API	Application Programming Interface
APMAC	Appalachian Active Passive Methane Constraints
ARC	Ames Research Center
ARMAS	Automated Radiation Measurements for Aerospace Safety
ARMDD	Aeronautics Research Mission Directorate
ARO	Airborne Radio Occultation
ASDC	Atmospheric Science Data Center
ASF	Airborne Sensor Facility
ASI	Italian Space Agency
A-SMLS	Airborne Scanning Microwave Limb Sounder

ASP	Airborne Science Program
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATLID	Atmospheric Lidar
AVAPS	Advanced Vertical Atmospheric Profiling System
AVIRIS	Airborne Visible/Infrared Imaging Spectrometer Classic
AVIRIS-3	Airborne Visible/Infrared Imaging Spectrometer 3
AVIRIS-5	Airborne Visible/Infrared Imaging Spectrometer 5
AVIRIS-C	Airborne Visible/Infrared Imaging Spectrometer Classic
AVIRIS-NG	Airborne Visible/Infrared Imaging Spectrometer-Next Generation
AVUELO	Airborne Validation Unified Experiment Land-to-Ocean
AWP	Aerosol Wind Profiler
B	
BAERI	Bay Area Environmental Research Institute
BGAN	Broadband Global Area Network
C	
C-AIR	Coastal Airborne In-situ Radiometers
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
Cal/Val	calibration/validation
CAS	Commercial Aviation Service
CASALS	Concurrent Artificially-intelligent Spectrometry and Adaptive Lidar System
CCMC	Community Coordinated Modeling Center
CDOM	Color Dissolved Organic Matter
CDR	Critical Design Review
C-FIRST	Compact Fire Infrared Radiance Spectral Tracker
CIRPAS	Center for Interdisciplinary Remotely Piloted Aircraft Studies
CODEX	Contrail Optical Depth Experiment
CONUS	Continental United States
C-OPS	Compact Optical Profiling System
CoSMIR-H	Conical Scanning Millimeter-wave Imaging Radiometer-Hyperspectral
CME	Coronal mass ejection



CNC	Computer Numerical Control
CPL	Cloud Physics Lidar
CRATER	Costa Rica Airborne research on forests Ecosystem Response to volcanic emissions
CRS	Cloud Radar System

D

DA	Dynamic Aviation
DAAC	Distributed Active Archive Center
DIAL	Differential Absorption Lidar
DLH	Diode Laser Hygrometer
DRCS	Disaster Response Coordination System
DSI	Decadal Survey Incubation
DUST	Dense UAVSAR Snow Timeseries
DyNAMITE	Day/Night Airborne Motion Imager for Terrestrial Environments

E

EarthCARE	Earth Cloud, Aerosol and Radiation Explorer
ECOSTRESS	ECOsysteM Spaceborne Thermal Radiometer Experiment on Space Station
EIDS	Engine Instrument Display System
EIP	Experimenter Interface Panel
eMAS	Enhanced MODIS Airborne Simulator
EMIT	Earth Surface Mineral Dust Source Investigation
ER	Extended Range
ESA	European Space Agency
ESD	Earth Science Division
ESO	Earth System Observatory
ESS	Energy Storage Subsystems
ESTO	Earth Science Technology Office

F

FOD	Foreign Object Damage
FR	Flight Request
FY	Fiscal Year

G

GCAS	GEO-CAPE Airborne Simulator
GE Aerospace	General Electric Aerospace
GEDl	Global Ecosystem Dynamics Investigation
GEMx	Geological Earth Mapping Experiment
GEO-CAPE	GEostationary Coastal and Air Pollution Events
GHG	Greenhouse gas
G-LIHT	Goddard's LiDAR, Hyperspectral & Thermal Imager
GLIMR	Geosynchronous Littoral Imaging and Monitoring Radiometer
GLOVE	GSFC Lidar Observation and Validation Experiment
GNSS	Global Navigation Satellite System
GOES	Geostationary Operational Environmental Satellite
GOSAT-GW	Global Observing SATellite for Greenhouse gases and Water cycle
GPS	Global Positioning System
GSFC	Goddard Space Flight Center

H

HALO	High Altitude Lidar Observatory
HARP	Hyper Angular Research Polarimeter
HPLC	High-Performance Liquid Chromatography
HSRL	High Spectral Resolution Lidar
HSRL-2	High Spectral Resolution Lidar-2
HyspIRI	Hyperspectral Infrared Imager

I

ICESat	Ice, Cloud, and land Elevation Satellite
IIP	Instrument Incubator Program
INS	Inertial Navigation System
INU	Inertial navigation unit
IR	infrared
ISRO	Indian Space Research Organization
ISS	International Space Station



ISWA Integrated Space Weather Analysis

IT Information Technology

J

JAXA Japanese Aerospace Exploration Agency

JPL Jet Propulsion Laboratory

JSC Johnson Space Center

K

KNMI Royal Netherlands Meteorological Institute

L

LaRC Langley Research Center

LiDAR Light Detection and Ranging

LMA Leaf Mass per Area

LRU Line Replaceable Unit

LTE Long Term Evolution

LVIS Land, Vegetation, and Ice Sensor

M

MAGEQ Mid-Atlantic Gas Emissions Quantification

MAGPIE Moisture and Aerosol Gradients / Physics Inversion Evolution

MAIA Multi-Angle Imager for Aerosols

MASTER MODIS/ASTER Airborne Simulator

MAIA Multi-Angle Imager for Aerosols

MBARS Microwave Barometric Attenuation Radar and Sounder

MODIS Moderate Resolution Imaging Spectroradiometer

MOE Ministry of Environment

MTS Mission Tools Suite

MVIS Miniature Video Imaging System

N

NAIRAS Nowcast of Atmospheric Ionizing Radiation for Aviation Safety

NASA	National Aeronautics and Space Administration
NASDAT	NASA Airborne Science Data and Telemetry
NAST-I	National Airborne Sounder Tester-Interferometer
NG	Next Generation
NICT	National Institute of Information and Communications Technology
NIES	National Institute for Environmental Studies
NIR	Near Infrared
NISAR	NASA-ISRO Synthetic Aperture Radar
NOAA	National Oceanographic and Atmospheric Administration
NPS	Naval Postgraduate School
NRL	Naval Research Laboratory
NSRC	National Suborbital Research Center
NURTURE	North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment

O

OCI	Ocean Color Instrument
ONR	Office of Naval Research
ORNL	Oak Ridge National Laboratory

P - Q

PACE	Plankton, Cloud, and ocean Ecosystem
PBL	Planetary Boundary Layer
PI	Principal Investigator
PICARD	Pushbroom Imager for Cloud and Aerosol Research and Development
PNW	Pacific Northwest
PPA	Platform Precision Autopilot
PRISM	Portable Remote Imaging Spectrometer

R

R&A	Research and Analysis
RADAR	Radio Detection and Ranging
RF	Radio Frequency



ROSES	Research Opportunities in Space and Earth Science
R/V	research vessel

S

SABRE	Stratospheric Aerosol processes, Budget and Radiative Effects
SAR	Synthetic Aperture Radar
SARP	Student Airborne Research Program
SATCOM	Satellite Communications
SBB	Swift Broadband
SBG	Surface Biology and Geology
SDRE	Software-defined radar electronics
SEO	Sensor Equipment Operator
SEP	Solar Energetic Particles
S-HIS	Scanning High-Resolution Interferometer Sounder
SMAP	Soil Moisture Active Passive
SMD	Science Mission Directorate
SMOS	Soil Moisture and Ocean Salinity
SOFRS	Science Operations Flight Request System
SPEX	Airborne Spectro-Polarimeter for EXploration
STC	Supplemental Type Certificate
STV	Surface Topography and Vegetation
Suomi NPP	Suomi National Polar-orbiting Partnership
SWaP	Size, Weight, and Power
SWIR	shortwave infrared
SWXRAD	Space Weather Aviation Radiation Flights

T

TACFI-RS	Tactical Fire Remote Sensing
TDEM	Texas Division of Emergency Management
TEMPO	Tropospheric Emissions: Monitoring of Pollution
TEPC	Tissue Equivalent Proportional Counter
TIR	Thermal Infrared



U

UAS	Uncrewed Aerial System
UAVSAR	Uninhabited Aerial Vehicle Synthetic Aperture Radar
UC	University of California
UCSC	University of California, Santa Cruz
US, U.S.	United States
USFS	United States Forest Service
USGS	United States Geological Survey
UTC	Coordinated Universal Time

V

v	Version
VCU	Virginia Commonwealth University
VIIRS	Visible Infrared Imaging Radiometer Suite
VNIR	Visible and Near Infrared

W

WAVE	Wide-Angle Virtual Environment
WDTS	Western Diversity Time Series
WFF	Wallops Flight Facility
WH²yMSIE	Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment

XYZ



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