National Aeronautics and Space Administration

EXPLORE
AIRBORNE SCIENCE
NEWSLETTER
Spring 2024

Leadership Corner

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Dear NASA Airborne Science enthusiasts!

It's hard to believe that we are already halfway through FY2024! The NASA Airborne Science Program has had an extremely busy and successful year so far thanks to our dedicated teams across the NASA flight centers. In this latest installment of our newsletter, you'll learn about the BioSCape mission that deployed to South Africa with the NASA G-III and GV carrying a variety of imagers and lidar to conduct the first NASA flight project dedicated to characterizing biodiversity. NASA Earth Science is also taking the growing threat of wildfires in the U.S. seriously by working closely with wildfire scientists and managers through the FireSense project to evaluate and mature existing NASA technologies to advance fire science management. The FireSense project team flew their first campaign in the Fall of 2023 over a prescribed burn using two NASA B-200s (AFRC & LaRC) and the NASA G-III with UAVSAR to image fires and collect information on forest structure and fuels. ASIA-AQ also recently finished flying the DC-8 loaded with Atmospheric Chemistry and Dynamics instruments out of South

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What's Inside

SCIENCE HIGHLIGHTS

BioSCape: Success Stories from NASA's First Biodiversity-Focused Airborne Campaign

Contributed by Anabelle Cardoso

Members of the BioSCape Science, Aircraft, and Instrument teams in front of the JSC GV and the LaRC G-III in Cape Town, South Africa. Photo: O. Whitehead

BioSCape, or the Biodiversity Survey of the Cape, is NASA's first biodiversity-focused airborne campaign. The BioSCape domain in South Africa covers two global biodiversity hotspots, with the richest temperate flora and the third-highest marine endemism in the world. BioSCape is testing the limits and potential of remote sensing for biodiversity applications worldwide and will take us one step closer to measuring biodiversity variables globally from space.

BioSCape's Unprecedented Dataset Focuses on Accessibility for Biodiversity Science

Concurrent measurements from AVIRIS-NG, PRISM, HyTES, and LVIS were captured across the region in October and November 2023. Such a spectrally extensive dataset is unprecedented

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BioSCape: Success Stories from NASA's First Biodiversity-Focused Airborne Campaign

BioSCape Science Team member Andrew Turner (CapeNature) deploying an Audiomoth acoustic logger in South Africa. Photo: J. Shelton

in airborne science and, when coupled with structural lidar data, has immense potential to increase the impact of current and upcoming satellite missions including ECOSTRESS, GEDI, EMIT, PACE, and SBG. The GV (HyTES + LVIS) flew 16 science flights while the G-III (AVIRIS-NG + PRISM) flew 22 science flights, together covering ~45,000 km^2 and meeting the data priorities of all 18 PI-led projects in BioSCape. In addition to traditional L1 and L2 products, BioSCape will produce a co-registered mosaic of L2 data from all four instruments. This is the first time an airborne campaign has done this, and we expect this to dramatically increase the accessibility of the data, especially for new users. You can view the current versions of the airborne data at bioscape.io/data. Data access and analyses will be supported for both South African and U.S. data users via the "BioSCape Cloud" computing environment.

The airborne data are accompanied by a large amount of biodiversity field data, including the following:

- Over 200 vegetation survey plots across environmental gradients, and field spectroscopy measurements from all dominant species
- Phytoplankton, bio-optics, and water quality data from marine and freshwater systems
- eDNA surveys from rivers' source to sea
- Sound recordings and point counts of birds and frogs across the region
- Terrestrial lidar scans across a fire return time gradient
- Quantification of essential biodiversity variables in estuaries along the coastline
- Detailed biodiversity and ecosystem function measurements in plots with varying levels of invasion by alien plants
- Species surveys and field spectroscopy measurements on kelp forests along the coastline.

This comprehensive collection of ground-based data is vital for interpreting and validating the insights gleaned from the airborne campaign.

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BioSCape PI Jinghui Wu (Columbia U.) taking radiometric measurements of coastal ocean waters in South Africa. Photo: O.Whitehead

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Leadership Corner (cont.)

Korea, the Philippines, and Thailand. This was a bittersweet mission as it was the final science journey of the storied NASA DC-8 Flying Laboratory, soon to be replaced by the NASA B777. This newsletter also highlights the important work our teams do, while in the field, to communicate the important science we are doing to the public and to schools around the world. My sincere thanks go out to the NASA Airborne Science team for all their hard work and dedication to the Agency. And thank you for your support and interest in NASA Earth Science!

Derek Rutovic
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BioSCape: Success Stories from NASA's First Biodiversity-Focused Airborne Campaign

BioSCape's Support for Decision-Making Needs in the Region and Globally

Since its conceptualization, BioSCape emphasized ensuring impact of the work, creating and maintaining deep and meaningful collaboration between researchers in the U.S. and South Africa and continuously emphasizing the importance of co-developing research. Early inclusion of South Africans led to a diverse Science Team of ~130 members, of which approximately half are affiliated with South African institutions and half with U.S. institutions. The U.S. participation on the team ensured global applicability, access to best-in-class technology, and bridged gaps in capacity. The strong South African presence on the team ensured that the research agenda for BioSCape was locally relevant and that local ecological expertise was incorporated. Many South African collaborators are embedded within local, provincial and national public conservation and environmental management agencies.

BioSCape Science Team members Jacob Nesslage (UC Merced) and Matthew Rossi (U Colorado) collecting environmental DNA samples in a river in South Africa. Photo: J. Shelton

To take advantage of this, before starting data collection, we brought the science team and local stakeholders together for a five-day in-person workshop to ensure the research was relevant for local decision-making needs for biodiversity conservation and natural resource management.

School students participating in NASA's GLOBE outreach program in Cape Town, South Africa (run by Brenna Biggs NASA ASP-GLOBE Engagement Coordinator). Photo: B. Biggs

"From the South African perspective, what [international collaboration] has really done is accelerate our research… to have this opportunity, to have hands and support and people and expertise and bringing instruments and funds and enabling us to do this work and enabling us to contribute to their work as well is the most magnificent opportunity. We've collected more data in the last month than probably the prior six years, it really is quite extraordinary." ~Lisl Lain, South African Council for Industrial and Scientific Research

BioSCape's Support for Outreach and Capacity Building

BioSCape supported several community outreach events, including a public lecture attended by 150 local stakeholders, a school education program run by GLOBE that reached nearly 170 students from 10 schools, the development of a NASA Space Apps challenge attempted by 71 teams around the world as well as two local NASA SpaceApps events for high school students and the Graduate Student Conference for the South African Environmental Observation Network where 144 students had the opportunity to engage with BioSCape scientists. We also ran a workshop on the Nagoya Protocol (co-hosted by a U.S. and South African representative), which guided documentation of shared benefits of the research (i.e., ways in which both South African and U.S. counterparts benefit from the research). Such a document is vital for managing expectations and keeping teams focused on how South African and U.S. members benefit from working together. BioSCape also has a Code of Conduct that includes clear authorship guidelines, ran a pre-deployment Ethical Participation training course, and had zero reports of harassment or safety issues during the campaign.

To ensure equitable access to and understanding of the data that were collected, BioSCape worked

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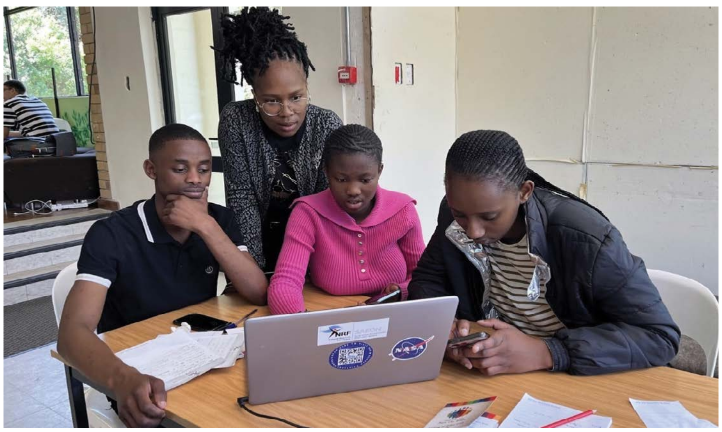
BioSCape: Success Stories from NASA's First Biodiversity-Focused Airborne Campaign

with NASA's Applied Remote Sensing Training (ARSET) program to host a training webinar series that focused on the BioSCape sensors and how they could be applied to biodiversity monitoring, and will be hosting an in-person 2-day capacity development workshop in Cape Town focusing on field spectroscopy. BioSCape also worked with NASA's ORNL DAAC to present a training webinar on the NASA DAACs, what they do, how to use them to archive your data, and data best practices. Additionally, BioSCape is supporting the ORNL DAAC to host an in-person 2-day workshop in South Africa that will focus on teaching users how to access and do basic analyses on the BioSCape data sets, as well as similar training workshops at AGU and ESA conferences in the United States.

BioSCape Science Team member Elhadi Adam (U Pretoria) collecting spectroscopy measurements of estuarine vegetation in South Africa. Photo: J. Shelton



School students participating in NASA's Space-Apps Hackathon event organized by BioSCape's partners at the South African Environmental Observation Network in Cape Town, South Africa. Photo: A. Wilson

With additional funding from UNESCO, BioSCape is helping South African students and researchers to attend an international conference, visit a U.S. University for data skills training, support for travel, food and accommodation for fieldwork missions, and the running costs of a capacity-building workshop.

FireSense: NASA's Role in Improving Wildland Fire Management

Contributed by Milan Loiacono and Jacquelyn Shuman

Coordinated action is essential for addressing wildland fire management challenges. FireSense, a NASA Science Mission Directorate project, aims to develop and deliver trailblazing technology and tools to support wildland fire management before, during, and after wildland fires. In addition to technology development, FireSense employs airborne campaigns, in close partnership with practitioners, to evaluate capabilities and technologies to support decision making in wildland fire management and air quality forecasting.

In the Fall of 2023, the FireSense Program completed a flight campaign spanning nine locations across four states in the western U.S., over the course of eight weeks. The campaign was centered around four aircraft: the NASA AFRC B-200, the NASA Langley B-200, the NASA AFRC C-20A, and a Dynamic Aviation B-200. Two aircraft coordinated with a United States Forest Service (USFS) aircraft for day and nighttime flights over an active fire. The five sensors aboard these aircraft gathered data in pre-fire, active fire, and post-fire environments, which will be used to inform practitioners (i.e., firefighters) about fire behavior.

Pre-fire flights focused on collecting measurements for vegetation and soil moisture as well as vegetation structure and composition, which was compared with simultaneous soil and vegetation moisture sampling on the ground. These flights employed three main instruments:

- Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR),

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FireSense: NASA's Role in Improving Wildland Fire Management

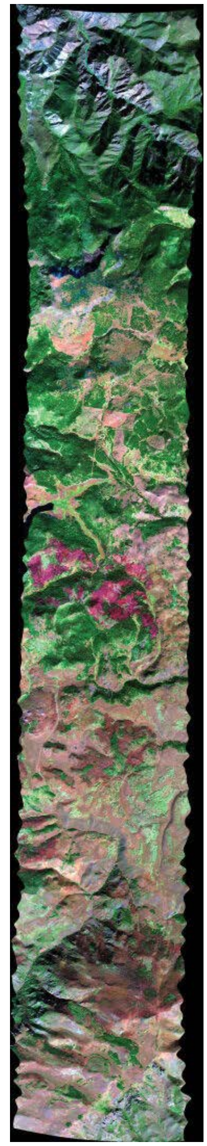
an L-band active radar that estimates moisture in vegetation, fuels and soil

- Scanning L-band Active Passive (SLAP), an L-band active and passive radar that estimates fuel moisture, soil moisture, and fuel quantity
- Airborne Visible/Infrared Imaging Spectrometer 3 (AVIRIS-3), an imaging spectrometer that observes vegetation composition, fire intensity, and fire effects

Together, these instruments collected data on pre-fire fuel conditions, providing scientists a baseline to compare with measurements during and after the fire.

Active fire observations used thermal and imaging spectroscopy to cut through smoke and measure fire radiative power; a phrase referring to the energy a fire produces. Understanding the radiative power of a fire enables researchers to analyze the temperature and duration of the blaze, which also impact how high into the atmosphere the smoke plume from the fire will travel. This information is critical for decision makers on the ground as they make real-time calls about how to inform and protect affected communities, deploy firefighting personnel and technology, and calculate long-term effects.

Post-fire flights focused on imaging spectroscopy and radar observation of burn sites to analyze post-fuel consumption and burn severity. Airborne sensor data from UAVSAR and AVIRIS-3 were compared with field samples pre- and post- burn to determine how much fuel was consumed in the fire. This information gets fed into models, which compile data such as wind patterns, fuel moisture, fuel consumption, land cover type, fire radiative power, and burn duration to lend greater insight into fire behavior and effects.



A false-color image of the prescribed burn in Fishlake National Forest, taken by the AVIRIS-3 instrument on October 19, 2023, clearly outlines the burn scar in bright pink. AVIRIS-3 uses imaging spectroscopy to provide information on fuels and vegetation pre-fire, as well as the burn zone in the wake of a blaze.

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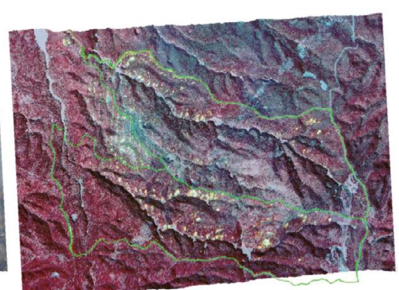

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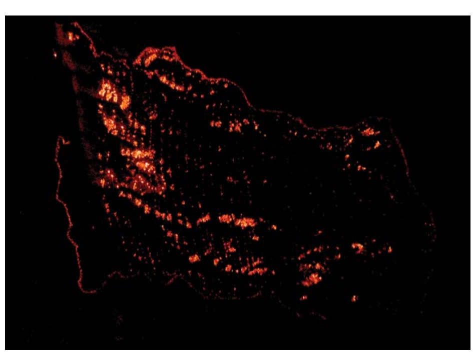

C

Side-by-side views of the same burn site in the Kaibab Plateau, AZ, taken October 20-21, 2023. These images demonstrate the multifaceted capabilities of the MASTER instrument. The natural color composite (A) shows the burn area as it would appear to the human eye, replete with smoke during the day, and the glow of the active fire at night (C). The false-color image (B) is a thermal and short-wave infrared rendition, penetrating the smoke and portraying the active fire lines.

Airborne sampling gives scientists the information required to calibrate models of fire behavior and smoke forecasting, as well as informing the uncertainty of satellite sensors. A major focus of this campaign was the simultaneous element of data collection between ground, airborne, and satellite platforms; this is a critical component in creating reliable tools that can be utilized effectively in high-

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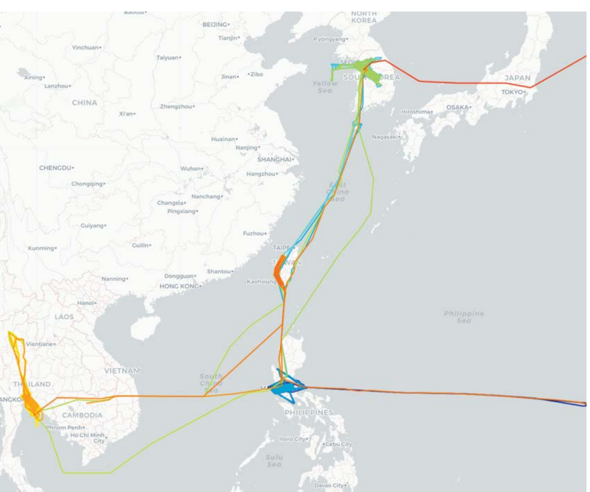
FireSense: NASA's Role in Improving Wildland Fire Management

stakes situations. Using UAVSAR, MASTER (MODIS/ASTER Airborne Simulator that uses mid-wave infrared and thermal infrared to observe fire radiative power), SWIS (San Jose State University Wildfire Imaging System that uses visible and infrared imagery to observe fire dynamics and radiative power) and AVIRIS-3, FireSense was able to coordinate sampling flights with USFS ground and airborne sensor teams to gather simultaneous data in both daytime and nighttime operations. Collecting this information over prescribed burns enables researchers and practitioners to parameterize and calibrate models to more accurately predict fire behavior and smoke production in advance, and to understand how and when to apply data during a wildfire.

The AFRC B-200 arrives on the tarmac at the Richfield Airfield ahead of a planned media outreach day with local high schools. During the flight campaign, the platform flew the MASTER and SWIS instruments over active prescribed burns to gather data on fire radiative power. Photo: M. Loiacono

The Fall 2023 flight campaign demonstrates the agency-wide nature of the FireSense Program, bringing together flight crews, instrument specialists, project managers, communications personnel, and scientists from NASA centers across the country. Beyond NASA, the campaign worked closely with the USFS, United States Geological Survey (USGS), as well as partners in academia and the private sector.

Looking ahead, FireSense plans to focus on deploying uncrewed aerial systems (UAS) such as the FreeFly Alta X and the SuperVolo. UAS provide an affordable way to increase scalable data collection, and, most importantly, reduce risk to personnel by providing data from zones too dangerous to send in crewed aircraft. On a broader level, FireSense will continue to coordinate with existing and new partners in wildland fire management across the nation, with plans to expand airborne campaign activities to other parts of the country, including the southeastern U.S., where prescribed fires are prevalent.



Mission Tools Suite (MTS) graphic showing the flight tracks for LaRC G-III, AFRC DC-8, and Korean partner aircraft in the Philippines, South Korea, Taiwan, and Thailand for ASIA-AQ.

ASIA-AQ Takes to the Skies for the DC-8's Final Mission

Contributed by Brenna Biggs

The Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ) occurred from late January 2024 to the beginning of April 2024. The mission aimed to study air quality in various Asian nations, including the Philippines, South Korea, Taiwan, and Thailand. ASIA-AQ was a hugely collaborative mission with formal partners from the National Institute of Environmental Research (NIER, South Korea), Department of Environment and Natural Resources (DENR, Philippines), Universiti Kebangsaan Malaysia (UKM, Malaysia), Geo-Informatics and Space Technology Development Agency (GISTDA, Thailand), and the Ministry of Environment (MOENV, Taiwan).

The ASIA-AQ science team was composed of experimenters, pilots, engineers, modelers, forecasters, and scientists from around the world with the same goals:

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ASIA-AQ Takes to the Skies for the DC-8's Final Mission

The ASIA-AQ science team poses in front of the LaRC G-III and AFRC DC-8 in Clark, Philippines. Photo: D. Gonzalez

The DC-8 flies low over the city of Chiang Mai, Thailand, consistently one of the world's most polluted cities. Photo: R. Luis Méndez Peña

- Improve our understanding of the factors controlling local air quality across Asia through multi-perspective observations and modeling.
- Conduct airborne sampling across various locations in collaboration with local scientists, air quality agencies, and other relevant government partners.

ASIA-AQ flew instruments on two NASA aircraft, the LaRC G-III and AFRC DC-8. The G-III's nadir ports supported the remote sensing payload, flying at higher altitude (~28 kft) in raster patterns to measure swaths of air pollution indirectly.

The DC-8 flew much closer to the ground and housed the in situ payload, which pumped air from outside the fuselage to the instruments on the inside to measure air pollution directly. The DC-8, which was built in 1969, will be retiring at the end of ASIA-AQ after decades of service. The two aircraft complemented each other, often flying the same days to gather concurrent information.

Both aircraft successfully acquired airborne data from the Philippines, Taiwan, South Korea, and Thailand across multiple flight days. In addition to the airborne component, ASIA-AQ partner countries also set up ground monitoring stations to complement the flights and data from satellites, including South Korea's Geostationary Environment Monitoring Spectrometer (GEMS) spaceborne instrument.

The DC-8 returns home to AFRC after ASIA-AQ, its final mission. Photo: S. Freeman

SnowEx Measures Seasonal Snow Cover

Contributed by Batu Osmanoglu and Carrie Vuyovich

The 2023 NASA SnowEx campaign focused on studying snow in the tundra and boreal forest regions of Alaska. This comprehensive effort included a no-/low-snow data acquisition in October 2022 and October 2023, a snow-on campaign in March 2023 utilizing airborne radar, radiometer, LiDAR, and stereophotogrammetry observations, and a snow melt campaign in April 2023 targeting hyperspectral data collection.

Ground-based measurements were crucial for validation, covering both ground and snow conditions such as soil moisture, freeze-thaw state, and snow characteristics. These measurements included soil samples, snow pits, snow depth transects, and microstructure assessments. Airborne observations complemented ground data with active/passive microwave using

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SWESARR flight crew in Fairbanks, AK in front of the NPS Twin Otter. The radar antenna is behind the yellow radome installed in the port-aft door.

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SnowEx Measures Seasonal Snow Cover

the Goddard Space Flight Center's Snow Water Equivalent (SWE) Synthetic Aperture Radar and Radiometer (SWESARR) instrument, LiDAR and stereo imagery from the University of Alaska Fairbanks, and hyperspectral data collection using the Jet Propulsion Laboratory's Airborne Visible / Infrared Imaging Spectrometer – Next Generation (AVIRIS-NG) instrument. Coincident satellite observations further enhanced the dataset.

Instruments like SWESARR contributed significantly to data collection and algorithm enhancement by delivering multi-frequency active and passive microwave observations. Together with the ground measurements, the SWESARR data will help advance SWE retrieval algorithms and validate microwave radiative transfer models for SWE. SWESARR was flown on the Naval Postgraduate School's Twin Otter aircraft during the March and October 2023 Intensive Observing Periods, collecting 10 TB of data during 12 total flight lines over three boreal forest and two tundra sites.

The SnowEx campaign addressed critical gaps in snow science, aiming to improve understanding and monitoring techniques for SWE and snow-surface energy balance, and pave the way for future advancements in global snow monitoring and understanding. The campaign leveraged the expertise of scientists and students from multiple organizations and universities, aiming to expand the pool of experienced observers. Safety was paramount, with rigorous training and risk reduction measures implemented.

SnowEx 2023 supported the overall NASA Terrestrial Hydrology Program's goals by focusing on snow remote sensing challenges unique to tundra and boreal forest environments. The campaign's

Measuring snow profile information and depth at the SnowEx Upper Kuparuk-Toolik tundra site. Photo: S. Stuefer

objectives included evaluating the impact of forest on SWE retrievals, assessing the accuracy of modeled snow microstructure, and understanding the temporal and spatial variability of snow reflectance/albedo and other snow physical properties. A unique sampling strategy was designed by the SnowEx leadership team, which included ground and airborne data over sites multiple sites in Alaska. By combining these distinct datasets, SnowEx 2023 will help meet the objectives and advance global science related to seasonal snow.

NASA's DC-8 Studies the Engine Exhaust and Climate-Altering Contrails Formed by a Boeing ecoDemonstrator Explorer 737 MAX (Video)

Contributed by Rich Moore (LaRC)

The NASA DC-8 and Boeing 737-10 fly over the northwest United States. Photo: Boeing / A. Wolfe

As airborne scientists, we all probably have given some thought to our carbon footprint and the environmental impact of flights crisscrossing the globe. Yet, a recent scientific assessment indicates that contrail cirrus clouds being formed by jetliners today may have an even greater climate warming effect than the cumulative aviation CO_2 emissions since the dawn of the jet age (Lee et al., 2021). Sustainable aviation fuels (SAFs)

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NASA's DC-8 Studies the Engine Exhaust and Climate-Alterin Contrails Formed by a Boeing ecoDemonstrator Explorer 737 MAX (Video)

hold great promise for the future of aviation by combatting both effects by reducing the emissions of fossil-derived carbon as well as the soot particles that seed contrails.

Recently, teams from NASA LaRC, AFRC, GRC, and ARC joined with Boeing, United, GE Aerospace, DLR, FAA and other national and international partners to study how SAFs affect contrail formation in some of the cleanest-burning aircraft engines currently on the market – the CFM LEAP-1B engines on a Boeing 737-10. Through a series of 11 joint science sorties over the northwest United States in October 2023, the team garnered over 100 combined DC-8 and Boeing 737-10 flight hours sampling both contrail and clear air conditions. The twin-engine Boeing aircraft burned 100% SAF as well as two different conventional, petroleum-based Jet A fuels with low and moderate fuel sulfur content. The project was sponsored by the NASA ARMD Advanced Air Vehicles Program and the Radiation Sciences and Tropospheric Composition Programs within SMD's Earth Science Division.

The DC-8 follows the wake of the Boeing 737-10. Photo: Boeing / P. Weatherman

The goal of this research was to understand how fuel composition impacts the engine particle emissions at cruise altitudes with specific interest in aromatics as non-volatile soot precursors and sulfur, organic, and oil compounds that can nucleate volatile particles. NASA has conducted similar past studies behind a German A320 during the 2018 ND-MAX flight test and behind the DC-8 itself during the 2014 ACCESS flight series, but the modern state-of-the-art LEAP-1B engines were a game changer that made it challenging for the researchers to discern almost any soot particles in the plume relative to the background atmosphere. The team is now actively working to quantify the effects of reduced soot particles and formation of volatile particles on the contrail ice crystal numbers and sizes, and they presented their initial findings at a project science team meeting in Washington, D.C. in May 2024. Final data will be released to the public online by the end of 2024 at https://science.larc.nasa.gov/aero-fp/.

Getting the project off the ground required a substantial effort from subject matter experts within NASA's Aeronautics Research Mission Directorate and the Airborne Science Program (notwithstanding the threat of a narrowly averted government shutdown). Initial efforts focused on modeling the formation and decay of wingtip vortices from the lead aircraft that could pose in-flight hazards to the trailing DC-8. The engineering team at NASA AFRC used these model calculations to establish the project flight rules and fly / no-fly zones, which in turn helped the airborne scientists to refine their instrument requirements. One new and exciting aspect of the project is the use of the HALO high-spectral resolution lidar to map the structure and descent of the contrail after the ice crystals become entrained in the vortices. Not only does this allow the scientists to study the

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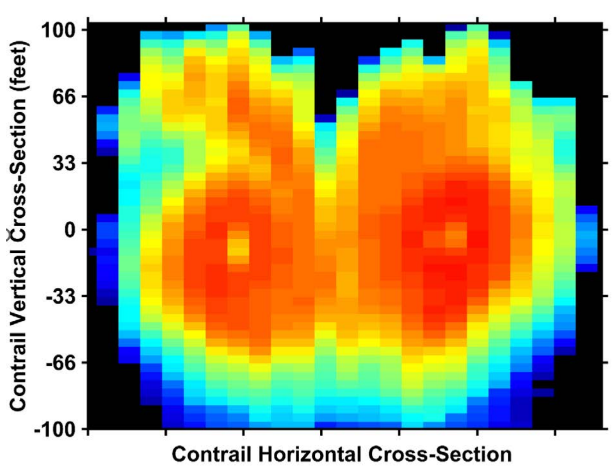

Cross-sectional view of the two contrail vortices measured by the nadir High Altitude Lidar Observatory (HALO) instrument onboard the DC-8. Courtesy of Amin Nehrir, NASA Langley Research Center.

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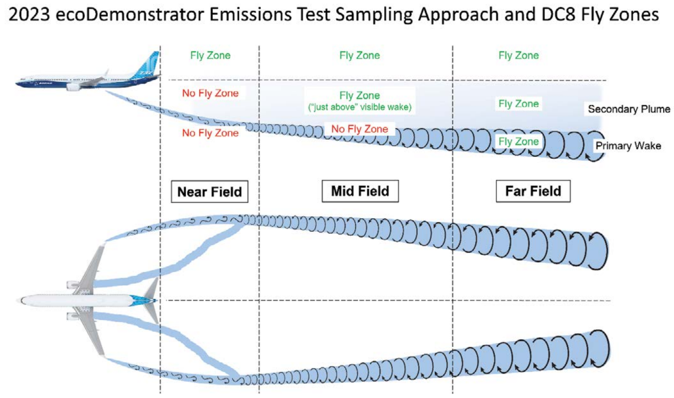
NASA's DC-8 Studies the Engine Exhaust and Climate-Alterin Contrails Formed by a Boeing ecoDemonstrator Explorer 737 MAX (Video)

microphysical and optical properties of the contrail (relevant for climate), but these data also feedback and improve the assumptions that went into the vortex hazard models. The project also broke new ground in flight testing novel water vapor sensors currently being developed for commercial aircraft through NASA's [Small Business Innovation Research (SBIR) Program].



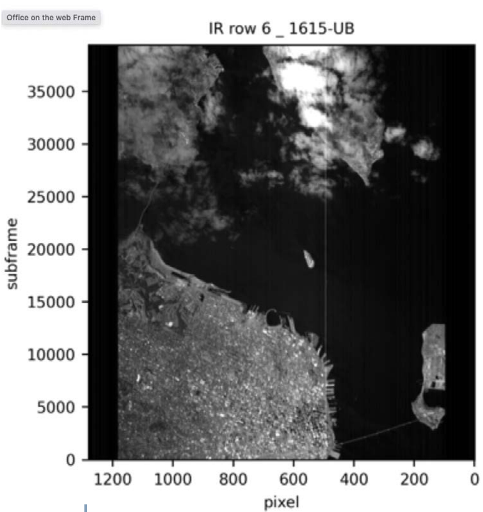
Concept of operations and fly / no-fly zones zones for the chase plane experiment. Most of the time was spent sampling the secondary emissions plume in situ just above the visible wake at about 5 miles in trail. Lidar remote sensing legs conducted with 3-5 kft. vertical separation allowed the DC-8 to profile the contrail from the near field to the far field. Image courtesy of NASA.

The DC-8 provided an ideal test-bed to evaluate and advance these sensors alongside the state-of-the-art research sensors available through the Airborne Science Program, such as the [Diode Laser Hygrometer (DLH)]. These low-TRL, NASA-funded technologies would then be infused throughout the commercial aviation fleet in order to improve the meteorology in contrail forecasting models by leveraging investments from industry and other government programs (e.g., [ARPA-E PRE-TRAILS]). The aviation sector is critical to the global economy, and this exciting collaboration between the SMD Airborne Science Program and the ARMD Advanced Air Vehicles Program continues to advance the fuels, technologies, and operational models needed to ensure a sustainable future.

Instrument Tests

Airborne Multiangle SpectroPolarimetric Imager-2 (AirMSPI-2) Demonstrates Successful Flights

Contributed by Lance Christensen



A quicklook image acquired by AirMSPI-2's 1615 nm polarization channel on 12 April 2023.

In mid-2023, ESTO's Airborne Instrument Technology Transition (AITT) work on the second generation Airborne Multiangle SpectroPolarimetric Imager (AirMSPI-2) culminated with a series of successful engineering flights on the NASA ER-2 in FY24. The effort was focused on improving the optical and electrical performance of the UV-SWIR AirMSPI-2 camera, installation of an on-board polarized light source for verifying polarimetric performance in flight and upgrading the vacuum system required for cold operation of the SWIR detector array. Meanwhile, the Multi-Angle Imager for Aerosols (MAIA) Earth Venture Instrument (EVI) project is gearing up to collect AirMSPI-2 data to support pre-launch aerosol and cloud mask algorithm testing. This will pave the way for the use of AirMSPI-2 in future airborne science campaigns.

High-altitude Aerosols, Water vapor and Clouds (HAWC) Canadian Instrument Flies from AFRC

Contributed by Adam Bourassa

The High-altitude Aerosols, Water vapor and Clouds (HAWC) airborne capability demonstration occurred in November and December 2023 on the ER-2 at AFRC. HAWC is an upcoming Canadian satellite mission consisting of three Canadian instruments:

- Aerosol Limb Imager (ALI)
- Spatial Heterodyne Observations of Water (SHOW)
- Thin Ice Clouds in Far InfraRed Emissions (TICFIRE)

HAWC is supported by the University of Saskatchewan, the Université du Québec à Montréal, and the Canadian Space Agency (CSA). These instruments will fly in a polar orbit as part of a four-satellite constellation on NASA's Atmosphere Observing System (AOS).

Members of the HAWC team during the first flight of the HAWC ER-2 campaign based at AFRC in Palmdale, California. Photo: P. Loewen

This was the first suborbital flight demonstration campaign for HAWC. It included airborne prototypes of ALI and SHOW, instruments that were integrated in the starboard wing pod to make measurements of limb scattered sunlight spectra that were used to retrieve distributions of aerosol and water vapor above clouds. SHOW observed the limb through a window in the front of the forebody, and ALI measured the same scene using a periscope mounted below the aft body.

Top: Photo from cockpit of starboard wing pod during flight. Middle: SHOW (L) and ALI (R) integrated in the wing pod before flight. Bottom: NASA ER-2 aircraft during the HAWC campaign. Photo: P. Loewen

The campaign included one engineering flight and two science flights which focused on collecting coincident measurements with multiple satellite and ground-based instruments. The first science flight path headed north along the Microwave Limb Sounder (MLS) track over the ocean and a strong low-pressure system. The ER-2 turned east to catch a Stratospheric Aerosol and Gase Experiment III/International Space Station (SAGE III/ISS) observation and then south along the Ozone Mapping and Profiler Suite (OMPS) trajectory. The flight concluded with a flyover of a frost point hygrometer (FPH) balloon launched at Table Mountain. The second science flight path was similar but also included an overpass with OMPS-JPSS-2.

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High-altitude Aerosols, Water vapor and Clouds (HAWC) Canadian Instrument Flies from AFRC

ALI experienced a radiofrequency driver failure during descent on the engineering flight and operated in safe mode during the first science flight. The team rallied and were able to procure and install a replacement part in time for the second science flight with only a couple days delay!

Preliminary analysis of the data shows compelling synergy between ALI and SHOW. ALI retrieved aerosol and cloud top are used in the SHOW forward model and these agree very well with the measurements. The full impact of aerosol scattering on the SHOW water vapor retrievals has not yet been studied but is important future work.

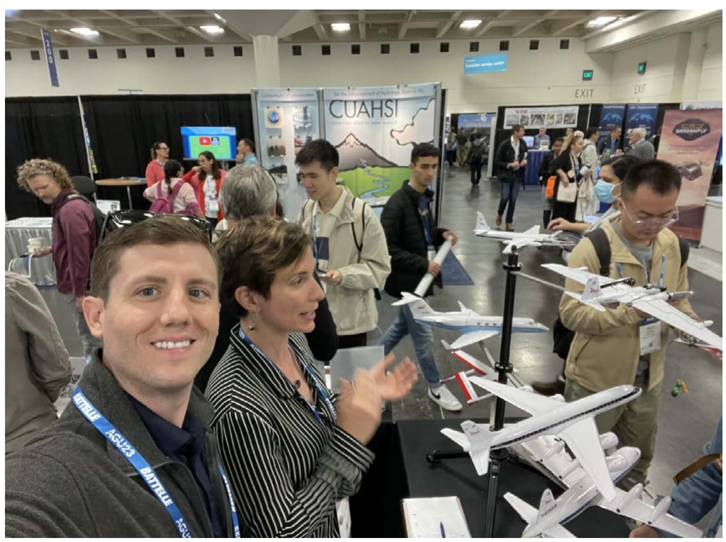
HAWC on ER-2 is led by Dr. Adam Bourassa (Principal Investigator of ALI), Dr. Doug Degenstein (Principal Investigator of SHOW), and the CSA. The Canadian Space Agency and NASA negotiated the Space Act Agreement, which enables Canadian instruments to test hardware in a space-like environment in order to advance technology and science to prepare for a mission. The HAWC team is grateful for the NASA AFRC team, which provided an excellent facility and expert guidance during the flight campaign. The HAWC mission leverages Canada's exceptional strengths in atmospheric and climate science and represents an outstanding opportunity to launch a new era of innovation and discovery that is driven by university, government, and industry partnerships.

PEOPLE IN THE NEWS

Ryan Bennett's Commitment to Airborne Science

Contributed by Gary Ash

Ryan Bennett typifies the multi-talented professional that enables the Airborne Science Program (ASP) to be the success for which it is known. A meteorologist by training, he also was a public-school science and math teacher for several years before becoming the Airborne Science Data Manager for the National Suborbital Research Center (NSRC) at the Bay Area Environmental Research Institute (BAERI) in 2017. The breadth of his expertise has enabled him to fill a variety of roles in NSRC's ASP support. As a seasoned long-distance runner, he is well suited with the patience and endurance needed to effectively execute the science campaigns that the ASP routinely supports.



NSRC colleagues Ryan Bennett and Brenna Biggs at the ASP table in the NASA booth at the 2023 AGU Union Fall Meeting in San Francisco, CA. Photo: R. Bennett

In addition to Airborne Science Data Manager, Ryan is an active in-flight data system operator, flying on both ASP's DC-8 and P-3. He also was the Program Manager for the 2023 NASA Student Airborne Research Program (SARP), managing all details of student solicitation and selection as well as the successful execution of the entire student element of the program. He provided the SARP program with meteorological briefings prior to each mission and is overseeing the successful handoff of the program to the Early Career Research Program at NASA HQ. Additionally, he provided significant support to ASP's Earth Science Exhibit at

(continued on Pg. 13)

(continued from Pg. 12)

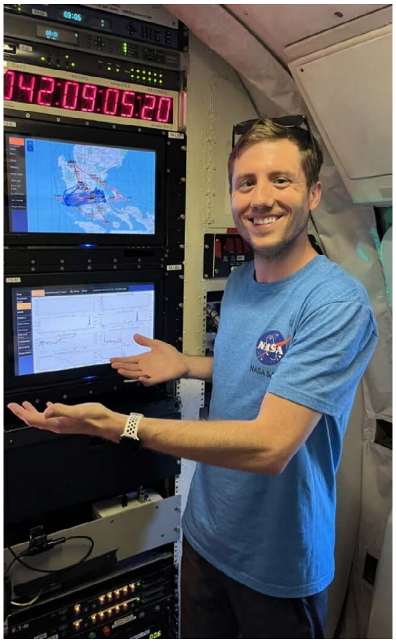
Ryan Bennett's Commitment to Airborne Science

the 2023 American Geophysical Union (AGU) Fall Meeting in San Francisco, CA.

Ryan is also a key member of the NSRC staff that designs and modifies ASP's aircraft data recording, acquisition, distribution, and satellite communication systems that keep pace as technology advances. He worked the reinstallation and checkout of the NSRC data and SATCOM systems as well as atmospheric instrumentation on the WFF P-3 following heavy maintenance on the aircraft at L3Harris in Waco, Texas.

Recently, Ryan participated in the integration of instruments and execution of multiple flight campaigns including EcoDemonstrator at Boeing in Seattle, Washington with aircraft flight data and a situational awareness products suite of additional cameras in support of contrail science. In addition to the AEROMMA campaign data management and production, he was a data system operator on the integration and first phase of the ASIA-AQ campaign transiting to and operating from Clark Air Base in the Philippines. He expertly handled critical equipment failures and executed effective workarounds that contributed to continuing mission success. Currently, Ryan is working the integration of instrumentation on to the WFF P-3 for the ARCSIX campaign where he will also be the primary data system operator on deployments to Greenland.

Personnel like Ryan are what make the NSRC and airborne science community great!



Ryan Bennett's last DC-8 flight in the Philippines for ASIA-AQ. Bennett is standing in front of the NSRC data system and highlighting the various mission data, including the DC-8 and G-III flight track. Photo: J. DiGangi and Y. Choi

SOFRS Corner

Contributed by Vidal Salazar

Aircraft Schedules and the 5-Year Plan

Each of the ASP-supported aircraft maintains a detailed schedule of planned campaigns and maintenance, accessible under "Schedule" on the ASP website site or directly at **https://airbornescience.nasa.gov/aircraft_detailed_cal**

You can select a specific aircraft ("ASP Supported" or "Other NASA") and from the drop-down, there are menus to select a specific month and year. Even if the desired aircraft appears busy, submitting a flight request is encouraged because schedules do change.
For non-NASA Aircraft, contact the managing institution for specific details.

Additionally, the 5-year plan outlines long-term campaign and priority plans by science area and aircraft, offering insight into future plans. Access the 5-year plans at **https://airbornescience.nasa.gov/content/5_Year_ASP_Plan**

Calendar of Events

18th International Congress on Combustion By-Products and Their Health Effects
May 19-22, 2024 I Durham, NC
https://web.cvent.com/event/0baa2cd6-c19b-4f90-b9de-1999a05c4c6a/summary

AGES+ Workshop
May 29-31, 2024 I Boulder, CO
https://csl.noaa.gov/events/ages2024/

SBG 2024 Community Meeting
May 29-31, 2024 I Washington, DC
https://sbg.jpl.nasa.gov/

Surface Topography and Vegetation (STV) study team meeting
June 10-13, 2024 I Golden, CO
https://science.nasa.gov/earth-science/decadal-surveys/decadal-stv/

ESTF2024 (ESTO Forum)
June 11- 12, 2024 I Crystal City, VA
https://esto.nasa.gov/forum/estf24/

PANGEA Town Hall at ATBC
July 15 -19, 2024 I Kigali, Rwanda
https://tropicalforestscoping.com/

IGARSS 2024
July 7-12 I Athens, Greece
https://www.2024.ieeeigarss.org/

The Quadrennial Ozone Symposium 2024
July 15-19 I Boulder, CO
https://qos2024.colorado.edu/home

AIAA Aviation
July 29 – August 2, 2024 I Las Vegas, NV
https://www.aiaa.org/aviation

11th International Carbon Dioxide Conference (ICDC11)
29 July – August 2, 2024 I Manaus, Brazil
www.icdc11.com

Snow Community Meeting
August 14-15, 2024 I Boulder, CO
https://docs.google.com/forms/d/e/1FAIpQLScQjRKEt2q5Qp1RMX9b3fmMYTFPsnCL5zLf57z21tU1ZOZ8lw/viewform

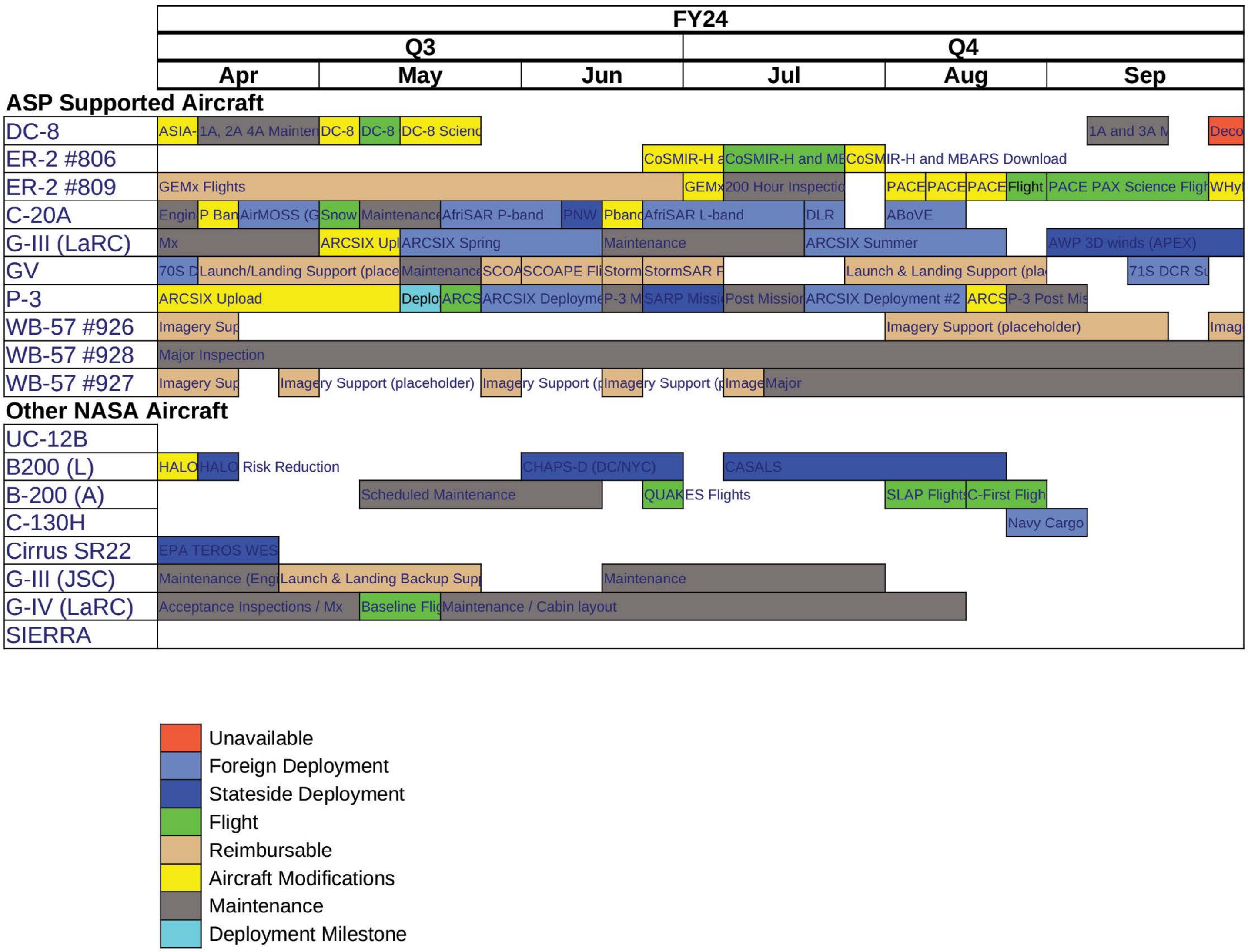
PANGEA Special Session at ESA
August 2024 I Long Beach, CA
https://www.esa.org/longbeach2024/

Contributions of the DC-8 to Earth System Science at NASA: A Workshop
August 21–22, 2024 I Washington, D.C.
https://www.nasa.gov/history/contributions-of-the-dc-8-to-earth-system-science-at-nasa-a-workshop/

6th Federal UxS Workshop
September 10-12, 2024 I Albuquerque, New Mexico
https://www.usgs.gov/centers/national-innovation-center/science/6th-federal-uxs-workshop

ECOSTRESS Science and Applications Team Meeting
October 2-3, 2024 I JPL, Pasadena, CA
https://ecostress.jpl.nasa.gov/

NASA Airborne Science Program 6 Month Plataform Schedule Starting April 2024 *(generated 4/16/2024)*



Source: https://airbornescience.nasa.gov/aircraft_overview_cal

Airborne Science Program
Platform Capabilities
Available aircraft and specs

Platform Name	NASA Center	Payload Accommodations	Duration (Hours)	Useful Payload (lbs)	Max Altitude (ft)	Airspeed (knots)	Range (Nmi)
ASP Supported Aircraft							
DC-8	AFRC	4 nadir ports, 1 zenith port, 14 additional view ports	12	50,000	41,000	450	5,400
ER-2 (2)	AFRC	Q-bay (2 nadir ports), nose (1 nadir port), wing pods (4 nadir, 3 zenith ports), centerline pod (1 nadir port)	12	2,900	>70,000	410	5,000
G-III/C-20A	AFRC	UAVSAR pod	7	2,610	45,000	460	3,000
G-III	LaRC	2 nadir ports, dropsonde / sonobuoy	7	2,610	45,000	460	3,000
G-IV	LaRC	AirSAR next gen (future)	7.5	5,610	45,000	459	4,000
GV	JSC	2 nadir ports, dropsonde capability	12	8,000	51,000	500	5,500
P-3	WFF	1 large and 3 small zenith ports, 3 fuselage nadir ports, 4 P-3 aircraft window ports, 3 DC-8 aircraft window ports, nose radome, aft tailcone, 10 wing mounting points, dropsonde capable	14	14,700	32,000	400	3,800
WB-57	JSC	Nose cone, 12 ft of pallets for either 3 ft or 6 ft pallets, 2 Spearpods, 2 Superpods, 14 Wing Hatch Panels	6.5	8,800	>60,000	410	2,500
Other NASA Aircraft							
B-200	AFRC	2 nadir ports	6	1,850	30,000	272	1,490
B-200	LaRC	2 nadir ports, wing tip pylons, zenith site for aerosol inlet, lateral ports	6.2	4,100	35,000	275	1,250
C-130	WFF	3 nadir ports, 1 zenith port, 2 rectangular windows, wing mount for instrument canisters, dropsonde capable, cargo carrying capable	10	36,500	33,000	290	3,200
Cirrus SR22	LaRC	Unpressurized belly pod	6	932	17,500	175	970
Matrice 600 (UAS)	ARC	Imager gimbal	1	6	8,000	35	3
SIERRA-B (UAS)	ARC	Interchangeable nose pod for remote sensing and sampling, 1 nadir port	10	100	12,000	60	600

More information available at: https://airbornescience.nasa.gov/aircraft