



National Aeronautics and
Space Administration

NASA Activities Relevant to EarthCARE

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NASA Earth System Science Research Program, Atmosphere
10 June 2026





Updates on Earth Science Research at NASA

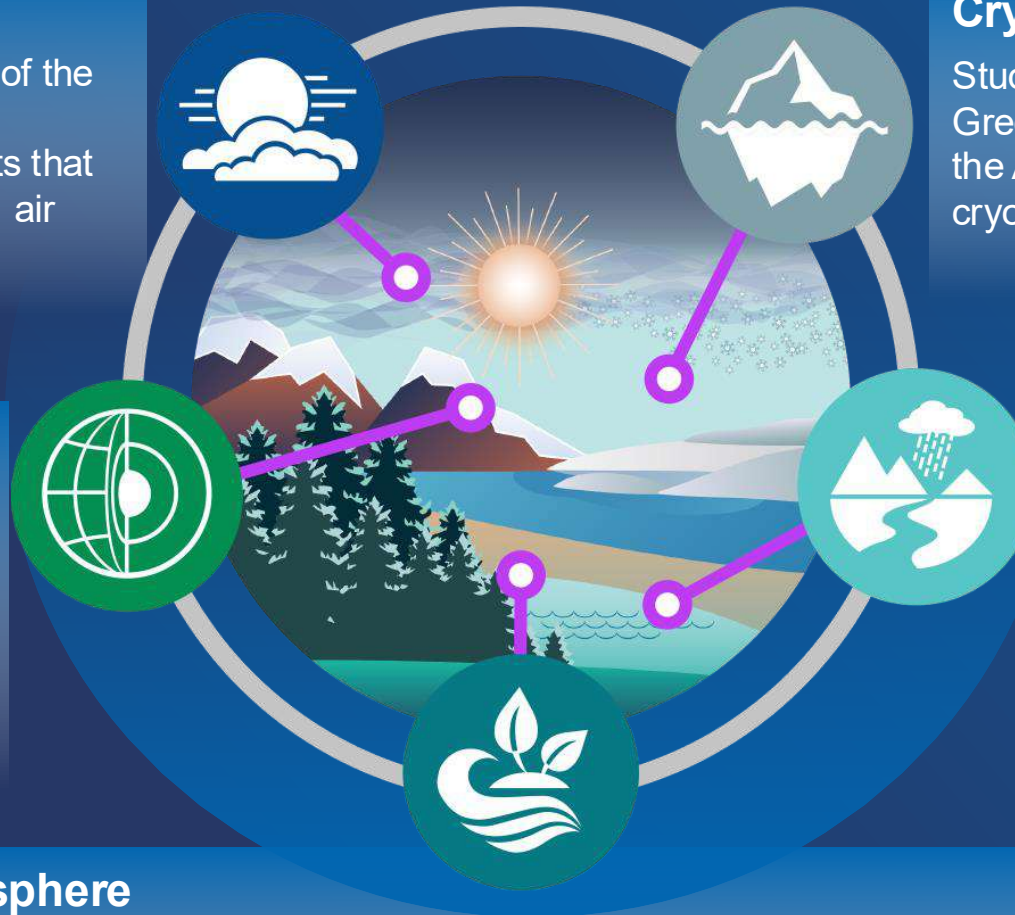
ESD Research advances Earth system science by enabling the use of satellite, airborne, and ground-based observations, along with modeling approaches, to improve understanding of Earth processes.

Atmosphere

Studies the dynamics and thermodynamics of the atmosphere, its physical and chemical composition, and the interdependent impacts that these have on the Earth's radiative balance, air quality, and weather.

Geosphere

Studies processes and changes in the Earth's core, mantle, and crust along with surface topography and geology, and the hazards they generate, along with studying geodesy and geodynamics.



Cryosphere

Studies polar ice, including the Antarctic and Greenland ice sheets, polar glaciers, sea ice in the Arctic and Southern Oceans, and the cryosphere's link to Earth system

Hydrosphere

Improves the observation, understanding, and prediction of water and energy in the Earth System across land, ocean, and the atmosphere through the integration of measurements from satellites, surface networks, and airborne campaigns.

Biosphere

Studies the interactions between/within terrestrial and aquatic ecosystems, along with changes in their biogeochemistry and biodiversity, to further understand the Earth system in which both human-induced and natural changes influence productivity and the availability of natural resources.

Earth System Science Research

The world's premier catalyst for understanding Earth as a unified and dynamic system, empowering humanity through transformative insights into Earth system science.

Scan the QR code
or go to
[science.nasa.gov/
earth-
science/research/](https://science.nasa.gov/earth-science/research/)



Science Spheres



Enabling Capabilities



**Research
Opportunities**



G-III



G-III



P-3



G-IV



B777



GV



WB-57



ER-2





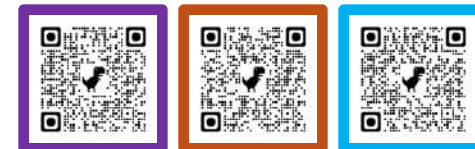
Recent NASA Cal/Val Efforts for EarthCARE



PACE Postlaunch Airborne Experiment (PACE-PAX): A field campaign for validation of the PACE mission *bonus: validation of ESA/JAXA EarthCARE*

Lancaster, Santa Barbara and Marina, California
Mission scientists: Kirk Knobelspiesse, Ivona Cetinić and Brian Cairns

PACE-PAX website: <https://pace.oceansciences.org/pace-pax.htm>
Ocean archive (SeaBASS) DOI: 10.5067/SeaBASS/PACE-PAX/DATA001
Atmosphere archive (ASDC): DOI: 10.5067/SUBORBITAL/PACE-PAX/DATA001



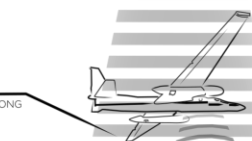
September 3-30th, 2024, California and nearby



PACE
NASA GODDARD
+ ESA/JAXA
EarthCARE

Satellite proxy and
other remote sensing
instruments

ER-2
NASA ARMSTRONG



CIRPAS TWIN OTTER
NAVAL POSTGRADUATE SCHOOL



R/V SHEARWATER
NOAA



In and above water ocean
and atmospheric sampling

In situ aerosol and
cloud sampling

Other assets

- R/V Blissfully: ocean sampling sailboat
- U. Delaware in water gliders
- HyperNAV vicarious calibration floats
- AERONET sun photometer sites
- CEOBS NRL Monterey Bay supersite
- PACE PVST coordinated efforts from Santa Barbara and on R/V Rachel Carson
- Bright desert calibration reference at Railroad Valley, NV, and Ivanpah Playa, CA

Highlights

- 13 NASA ER-2 science flights totaling 80.9 flight hours
- 17 NPS/CIRPAS Twin Otter science flights 60 flight hours
- 15 day trips of the R/V Shearwater, 9 day trips of the R/V Blissfully
- 16 days of observations during a PACE overpass
- 6 days of observations during an EarthCARE overpass
- Ground vicarious calibration at Ivanpah Playa, CA, overflights of Railroad Valley, NV
- Cooperation with PACE Validation Science Team (PVST) efforts
- Many overflights of AERONET, NEON, CEOBS ground sites
- Wildfires in Southern California, Red tides, and other events



See Kirk Knobelspiesse's talk to follow on more details on PACE-PAX



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- Aerosol algorithms determine multiple parameters simultaneously → validation data must incorporate simultaneous measurements.
- 9 algorithms/products compared:
 - HSRL-2 airborne lidar (reference)
 - Airborne RSP (MAPP algorithm)
 - SPEX Airborne (RemoTAP)
 - PACE/SPEXone (RemoTAP, RemoTAP Hybrid, FastMAPOL, FastMAPOL Component)
 - PACE/HARP2 (FastMAPOL)
 - PACE/OCI (UAA)

EarthCARE Cal/Val on September 17 2024

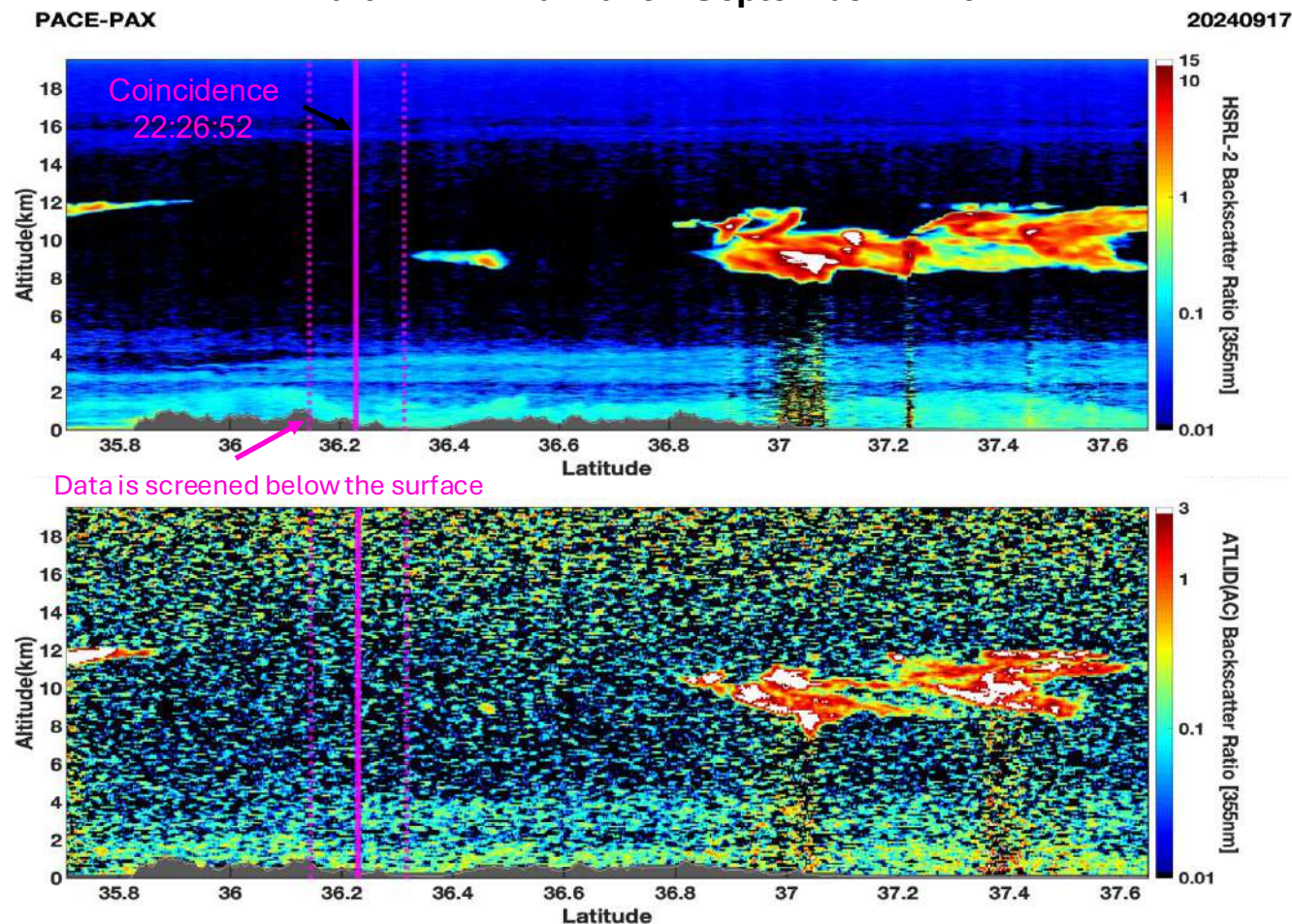


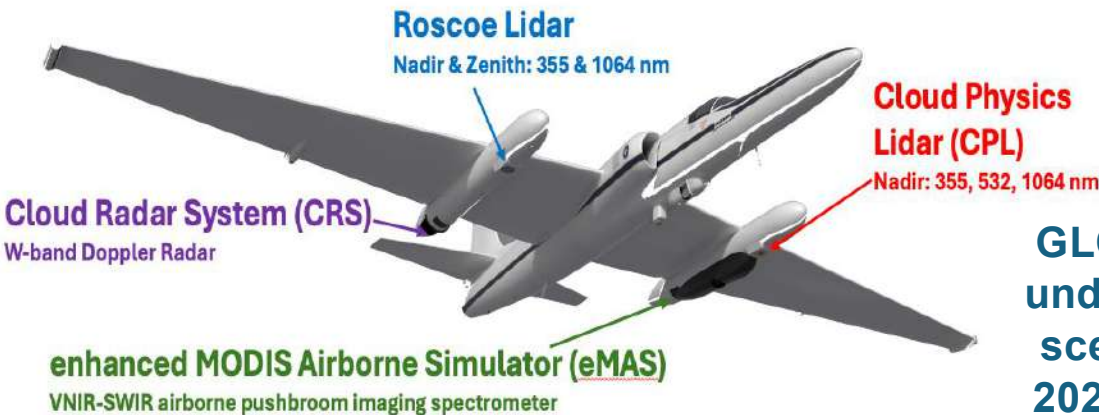
Figure Courtesy of John Hair & NASA LaRC HSRL-2 Team

GLOVE Details:

When: 27 Jan. to 28 Feb. 2025

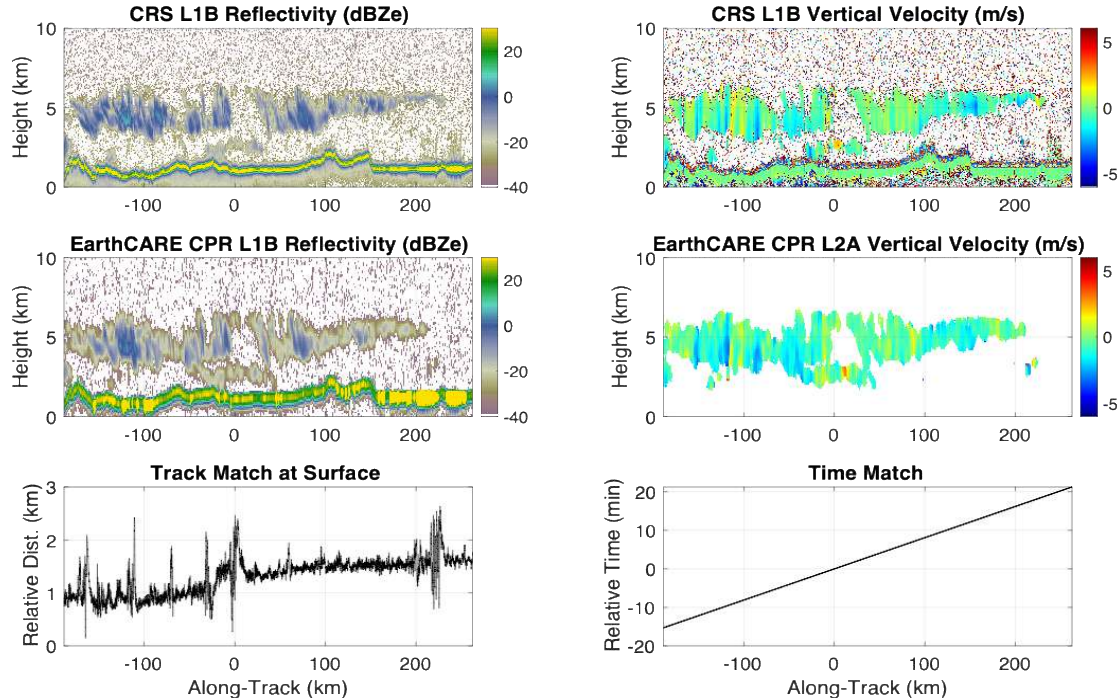
Where: Edwards AFB, California

Objectives: (1) validate new ICESat-2 research atmospheric data products, (2) validate EarthCARE lidar, radar, spectrometer data products, (3) test Roscoe receiver alignment.



7-Feb-2025: Gravity Waves

Thick clouds with gravity waves over terrain in Eastern Oregon, USA.
EarthCARE coincidence: 22:15:38 UTC

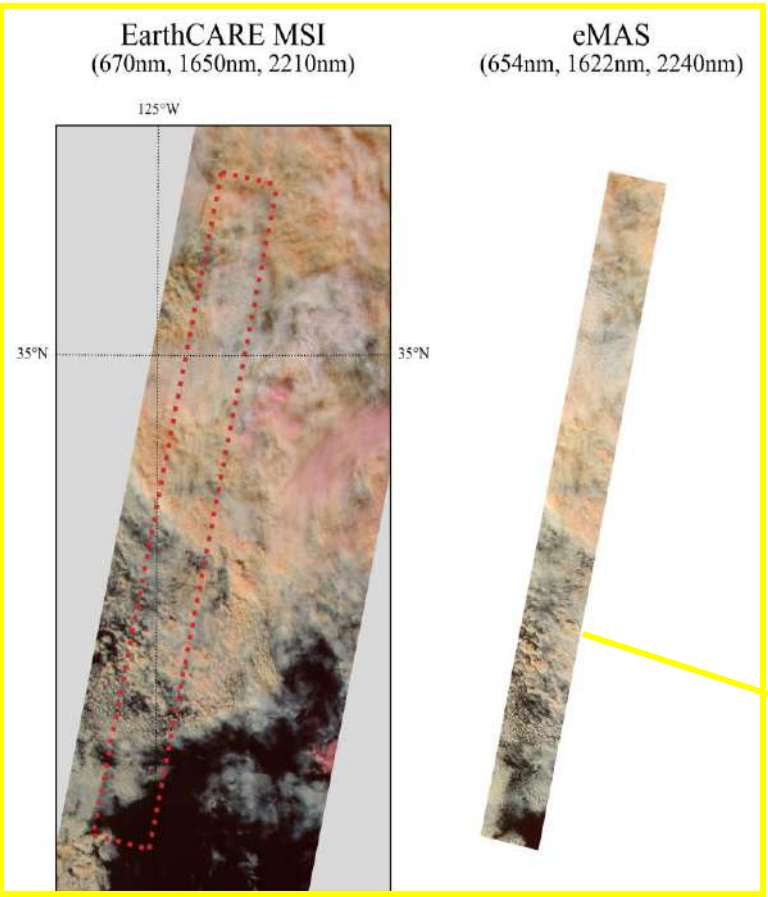


GLOVE performed 6 EarthCARE underflights several atmospheric scenes, including snow (20 Feb 2025, above) and multiple layers

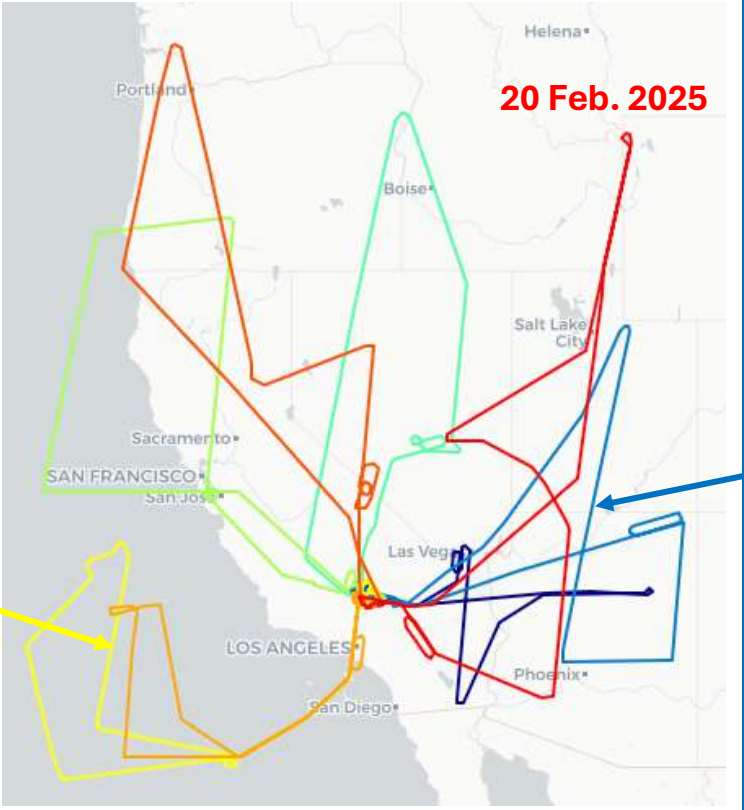
Scenes Observed by GLOVE	Cases
Snow	2
Cumulus and marine aerosol	2
Cirrus	4
Complex multilayer scenes	5

GLOVE Field Campaign

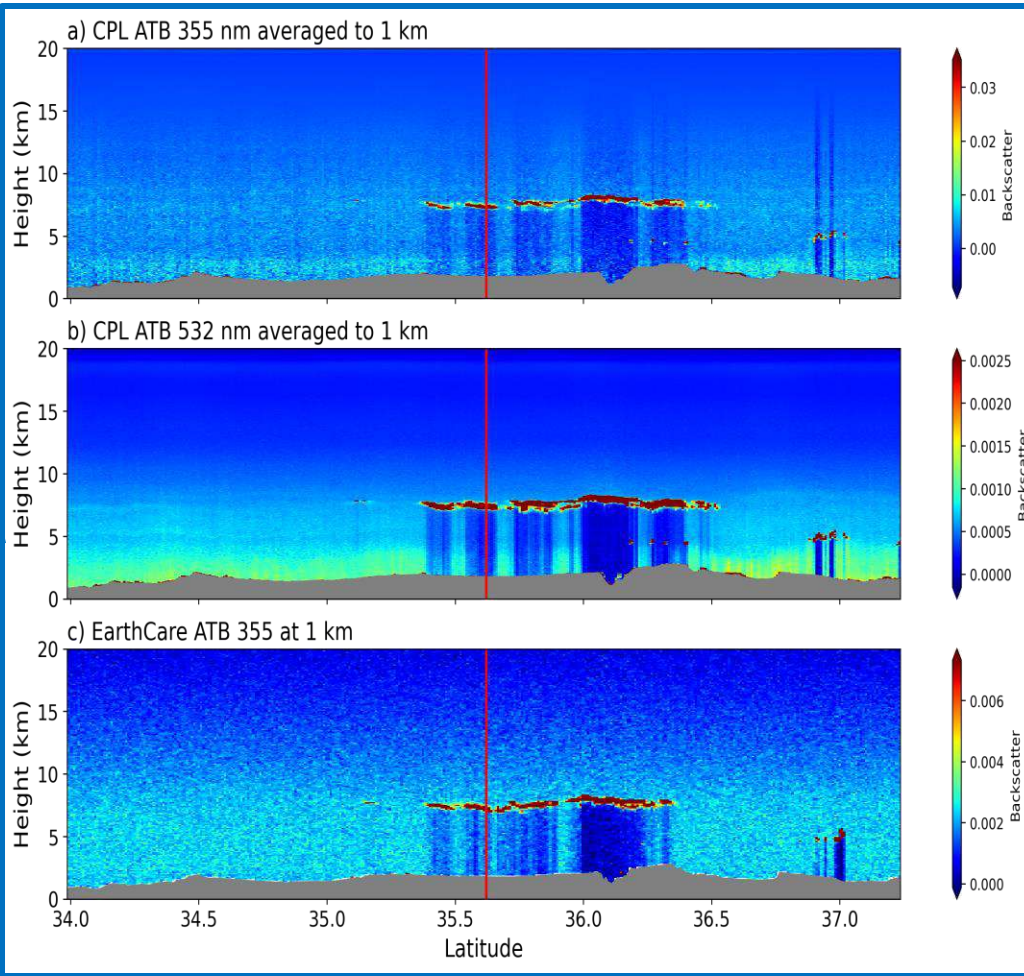
GSFC Lidar Observation and Validation Experiment



GLOVE EarthCARE Underflight
12 February 2025, ~22:37 UTC



GLOVE EarthCARE Underflight: 04 Feb. 2025



Nighttime Bermuda Lidar Underflights of EarthCARE - NightBLUE

Objective: Collect nighttime 355-nm HSRL measurements to assess the performance EarthCARE's Atmospheric Lidar (ATLID) L1B profiles and L2 aerosol and cloud data products.

Rationale: Nighttime validation is currently a high priority of the ATLID algorithm team. Lack of solar background noise makes nighttime observations optimal for investigating basic aspects of instrument performance and algorithm approaches.

Approach: Similar to CALIPSO nighttime validation flights from Bermuda conducted in 2022

- Deploy NASA's HSRL-2 on the G-III (13km)
- Base in Bermuda - September 2025, 3 weeks
- Conduct 10+ underflights along EarthCARE's ATLID ground track at night (~2:30 AM local time)
- Coordinate targets (aerosols, warm clouds, cirrus clouds) with ATLID algorithm team

NASA LaRC Gulfstream III



Example: CALIPSO Night Validation Flights 2022

High Spectral Resolution Lidar HSRL-2 355nm & 532nm

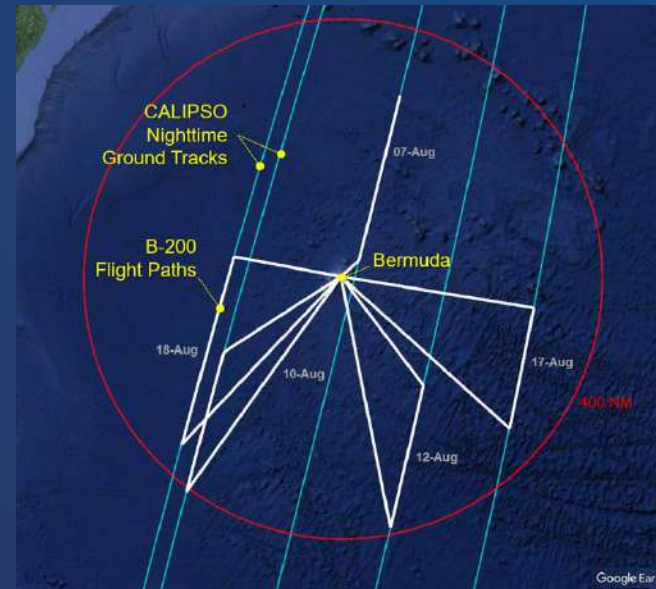
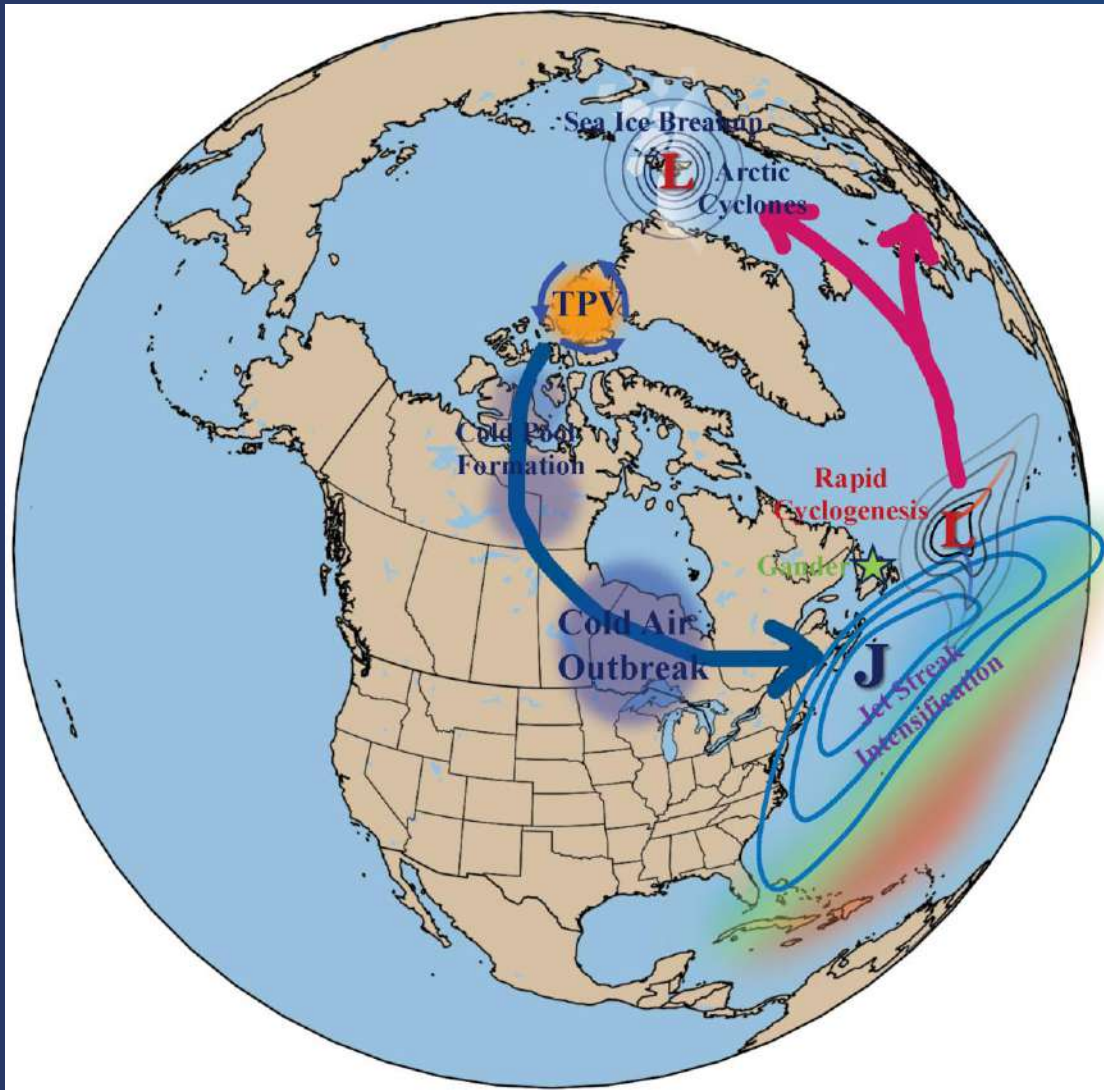


Figure Courtesy of John Hair & NASA LaRC HSRL-2 Team

The North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment (NURTURE) – 2026



The overarching goal of NURTURE is to quantify the impact that perturbations poleward of the jet stream have on jet stream variability and high-impact weather (HIW) events.

The Science Objectives are to advance the knowledge of:

- Processes that control upstream perturbations to the jet stream, such as *tropopause polar vortices (TPVs)*, *dry air intrusions*, *turbulence*, and interactions with the *jet stream*
- *Upper tropospheric and lower stratospheric* influences on tropopause and the jet stream
- *Boundary-layer* processes that facilitate communication between the troposphere and surface and that precondition the environment for *High Impact Weather (HIW)* events

<https://science.nasa.gov/mission/nuture/>

The North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment (NURTURE) – 2026



Phase 1 (2026) of NURTURE deployed the NASA LaRC G-III aircraft to Goose Bay, Canada equipped with:

- High Altitude Lidar Observatory (HALO)
 - 532 nm HSRL & water vapor
- Aerosol Wind Profiler (AWP)
- Dropsondes
- *In situ* trace gas measurements (O_3 and NO_2)

4 underpasses of EarthCARE, including one coordination with the NAWDIC campaign

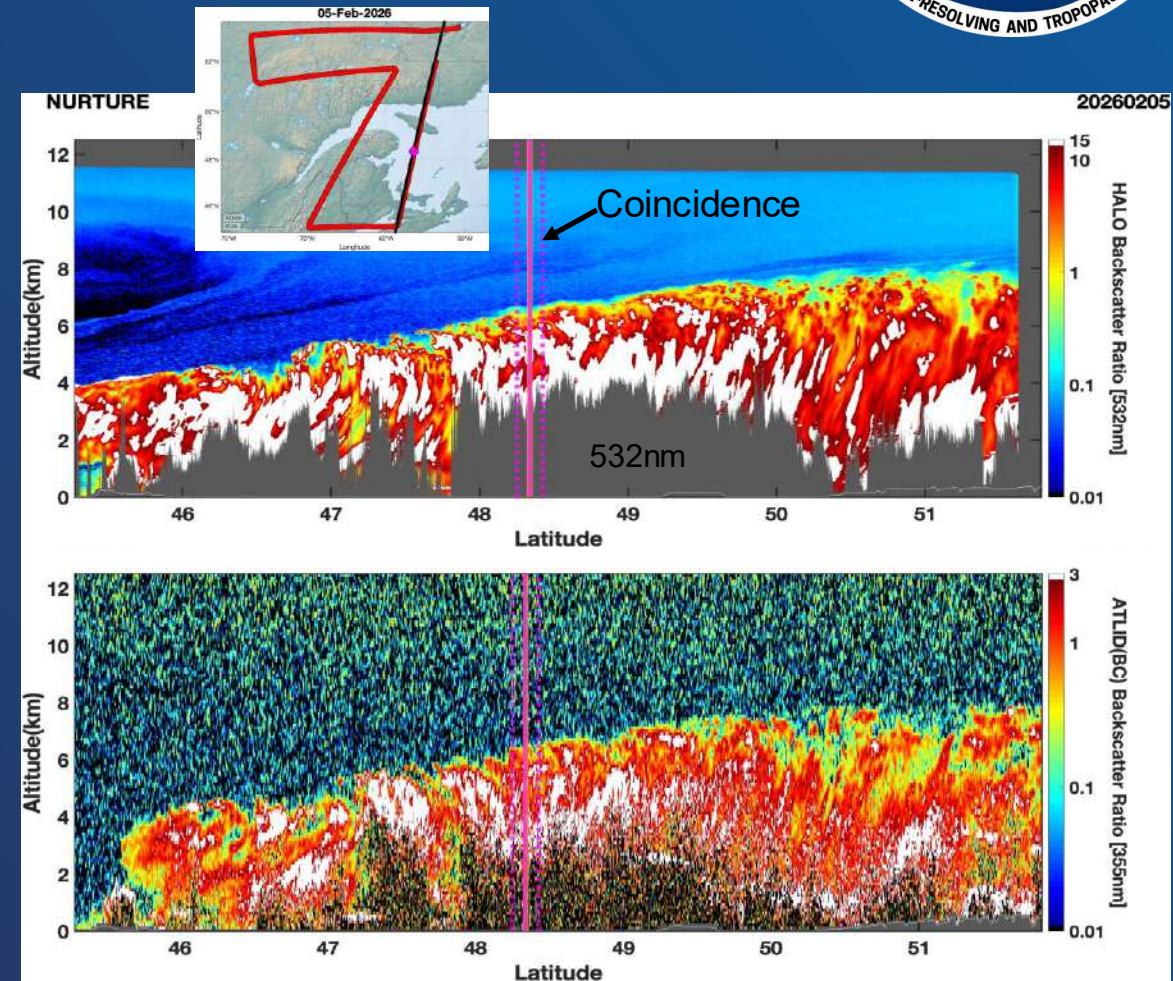


Figure Courtesy of John Hair & NASA LaRC HALO Team

Student Airborne Research Program

Field Campaign

Ellington Field, Houston, Texas

June 1-14, 2026



SARP will fly scientific payloads in the following aircraft and in collaboration with NOAA's AirMaps 2026 campaign



Gulfstream C-20A (GIII) - AFRC



Gulfstream V - JSC



Gulfstream III- LaRC



DA B200



WP-3D Orion - NOAA

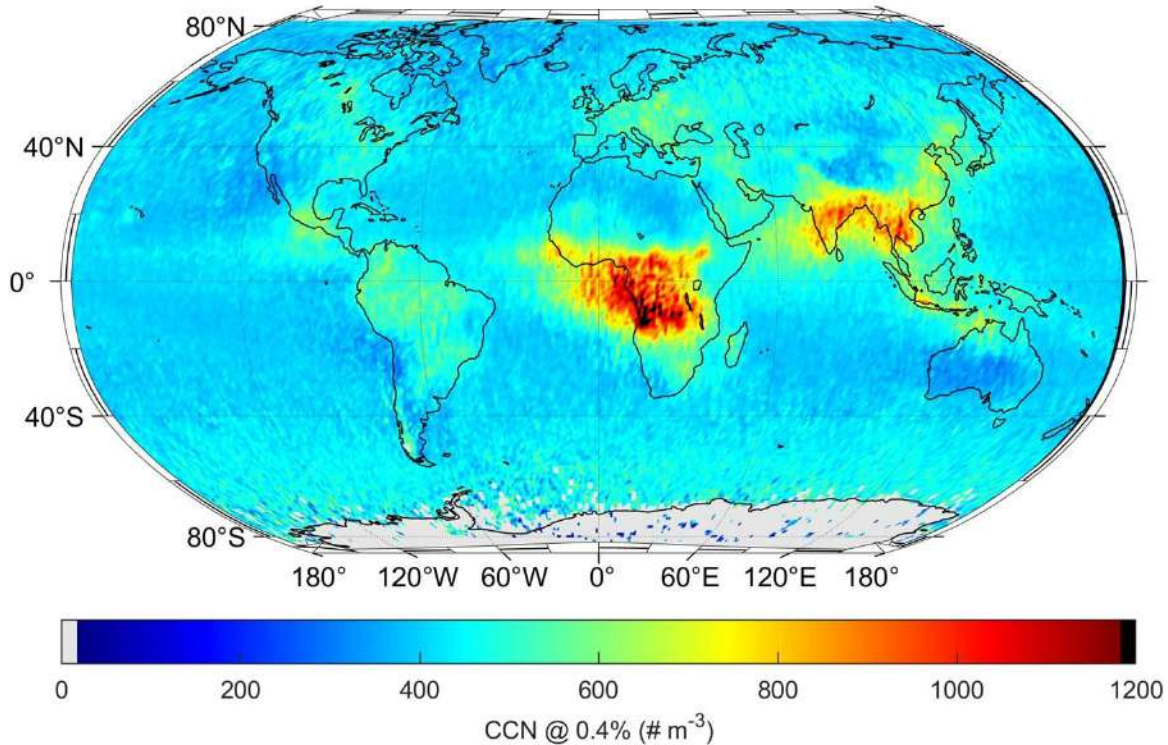


Scientific Payload

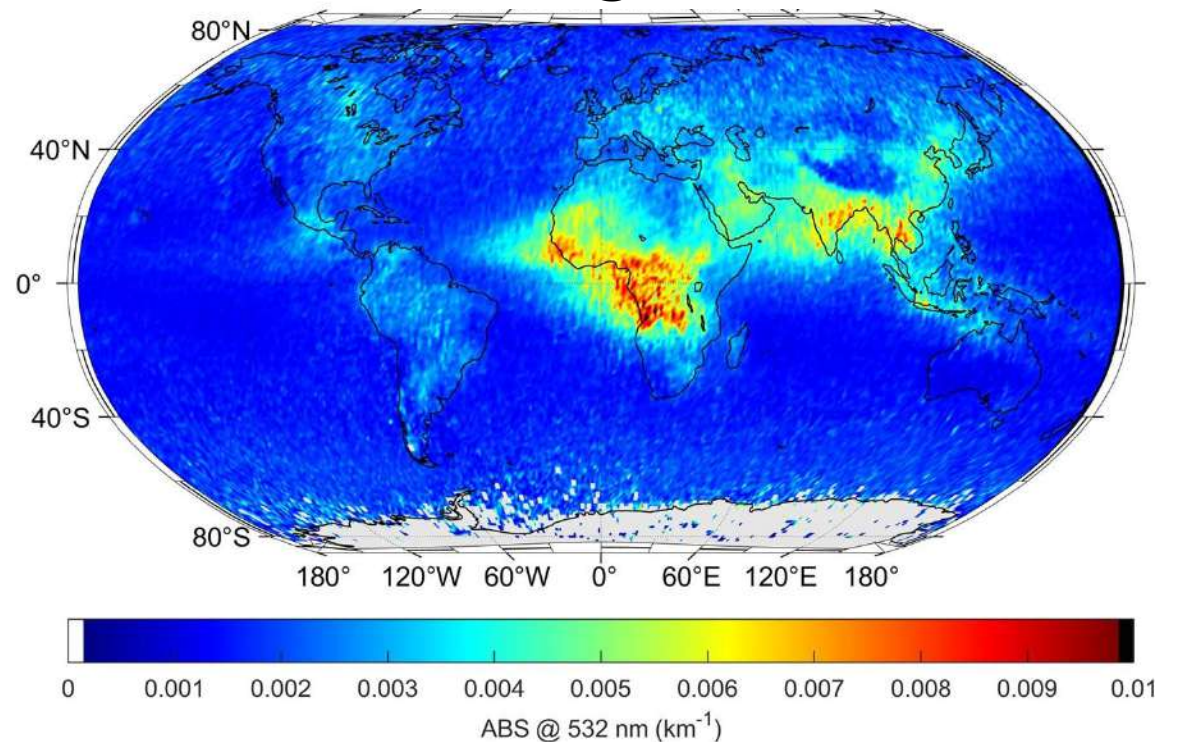
- GIII-AFRC – UAVSAR
- GV-JSC – HSRL-2
- WP-3D Orion – NOAA – AirMaps Chemistry payload
- GIII-LaRC – GCAS & AWP
- DA B200 – AVIRIS
- All aircraft will be based at Ellington Field, TX
- Tracking of all assets will be through MTS
- 40 hours per aircraft
- Each payload will pursue individual science objectives
- All aircraft will complete Operations Readiness Reviews prior to operations

New EarthCARE Products Enabled by NASA Suborbital Datasets

CCN @ 0.4% SS



ABS @ 532nm



Global maps of CCN and ABS using ML models applied to ATLID
September 2024 – August 2025



Upcoming NASA Activities Relevant to EarthCARE

The North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment (NURTURE) – 2026



NURTURE 2027 will deploy January-February 2027 using the NASA 777 for its first science mission with a significantly enhanced remote sensing and *in situ* payload



Instrument	Observables
High Altitude Lidar Observatory (HALO)	Profiles of H2O, aerosol, cloud; surface winds, PBLH
High Spectral Resolution Lidar 2 (HSRL-2)	Profiles of ozone, aerosol, cloud, ocean; surface winds, PBLH
Airborne Third Generation Precipitation Radar (APR-3)	Profiles of radar reflectivity, vertical velocity, in cloud H2O
Aerosol Wind Profiler (AWP)	Profiles of wind direction and speed
Vapor In-cloud Profiling Radar (VIPR)	High-vertical-resolution water vapor soundings within the PBL
Microwave Barometric Radar and Sounder (MBARS)	Profiles of radar reflectivity; surface pressure
Sub-mm Wavelength Radiometer (CoSSIR)	Profiles of ice cloud, H2O; snowfall
Conical Scanning Millimeter-wave Imaging Radiometer (COSMIR)	Profiles of H2O, T
Scanning High-resolution Interferometer Sounder (S-HIS)	Profiles of H2O, T, composition
Advanced Vertical Atmospheric Profiling System (AVAPS Dropsondes)	Profiles of H2O, T, P, wind speed, wind direction
Diode Layer Hygrometer (DLH)	Open path measure of water vapor at aircraft
Turbulent Air Motion Measurement System (TAMMS)	Aircraft level winds (20-100 Hz)
Aircraft Data System (NSRC)	Aircraft navigational, meteorological

CoSense - 2027

NASA would contribute the new NASA G-V aircraft during August-September 2027 equipped with HSRL-2 and the Research Scanning Polarimeter (RSP):

- Base operations out of Crete to validate satellite observations over the Mediterranean, an optically complex region that challenges modern remote sensing retrievals.
- Ongoing plans to collaborate with EU funded aircraft and ship assets
- Collect unique aerosol, cloud, and ocean measurements toward:
 1. Validation of current operational satellite retrievals (e.g. PACE, EarthCARE, and 3MI)
 2. Advance algorithm development for current and next-generation Earth observing missions (e.g. the EarthCARE, FALCON, and Luce lidars)
 3. Explore science questions relevant to the NASA Atmosphere and Biosphere programs



EARTH SYSTEM OBSERVATORY

INTERCONNECTED
CORE MISSIONS

SURFACE BIOLOGY AND GEOLOGY

EAGLE-VSWIR
EDGE
EAGLE-TIR

SURFACE DEFORMATION AND CHANGE

NISAR



CLOUDS, CONVECTION AND PRECIPITATION

INCUS
PoISIR
PMM
FALCON-Lidar
FALCON-Radar

AEROSOLS

FALCON-Lidar
STRIVE

MASS CHANGE

GRACE-C

*contributing, competitively-selected missions

Fleet for the Atmosphere Linking Commercial Observations with NASA **FALCON**

PMM (JAXA/GSFC)

Precipitation profiles

FALCON-Lidar (GSFC/LaRC)

Atmospheric structure and composition measurements

FALCON-Radar (JPL)

Cloud profiles to improve understanding of severe weather drivers.

FALCON-Radiometry (Commercial)

RFI Released this week for contribution options

Joining the FALCON fleet

- INCUS (CSU/JPL)
- PoSIR (Vanderbilt/GSFC)
- STRIVE (UW/GSFC)

Profiles



Structure



Composition





Questions?

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