NASA UPDATES SINCE CGMS-52 AND REPORT ON MEDIUM TO LONG-TERM FUTURE PLANS ON EARTH OBSERVATIONS

Presented to CGMS-53 Plenary Session, Agenda Item 3

Presenter: Sid Boukabara, NASA Headquarters

Report prepared based on inputs from numerous colleagues at NASA HQ, NASA Centers, and broader research community

Final 28 May 2025

Coordination Group for Meteorological Satellites

CGMS

REPORT HIGHLIGHTS

Earth Venture program

- Launch of Polar Radiant Energy in the Far InfraRed Experiment (PREFIRE)

Small Satellite Technology Demonstrations

- Aerosol Radiometer for Global Observation of the Stratosphere (ARGOS)

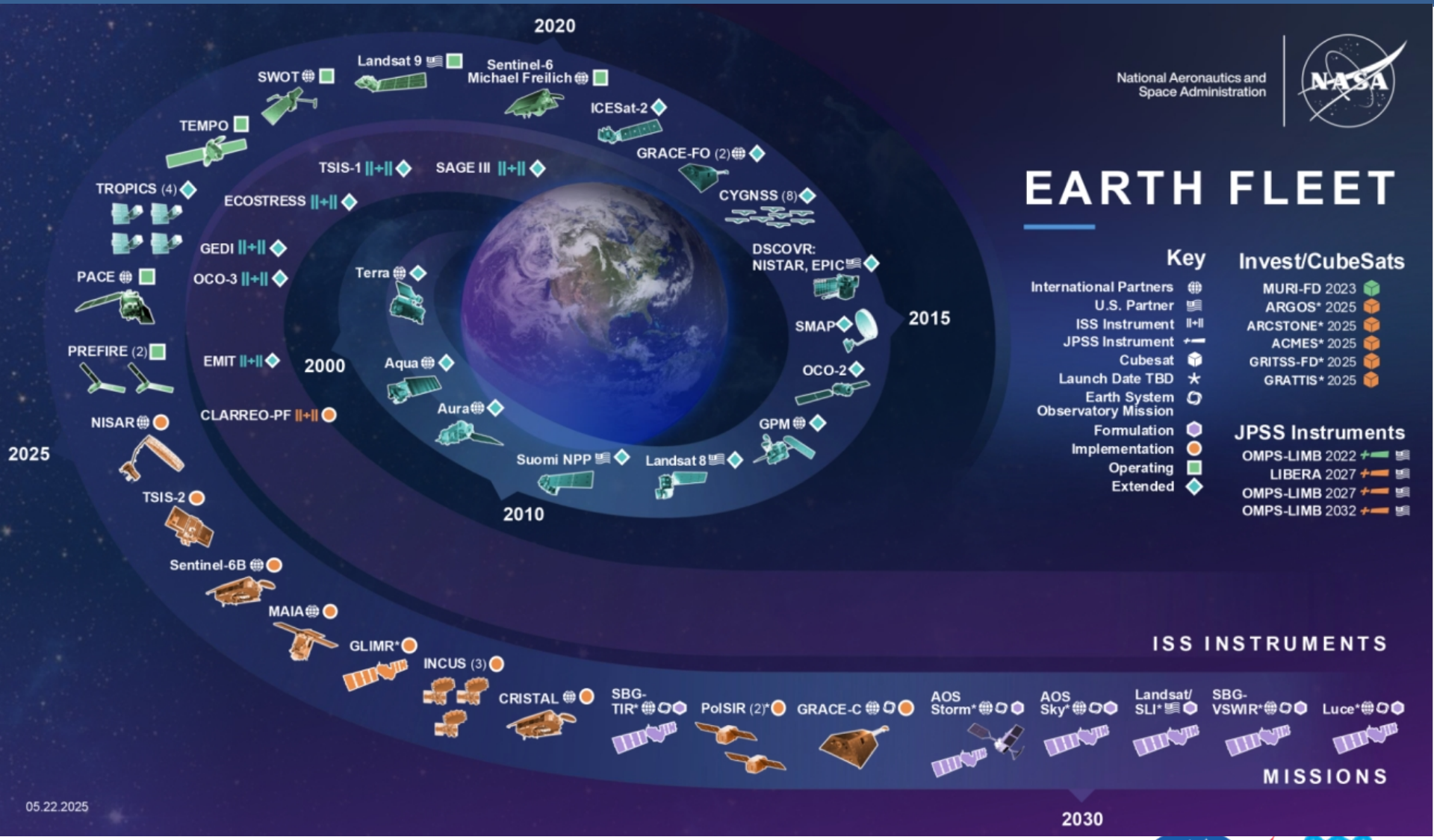
Instruments onboard the International Space Station

Future Satellite Systems

- Earth Systematic Mission
- Earth System Pathfinder
- NASA Response to Decadal Survey

Modifications and upgrades to B777-200ER

Coordination Group for Meteorological Satellites - CGMS



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Polar Radiant Energy in the Far InfraRed Experiment (PREFIRE)

Launch and Instruments

Significance:

- Nearly 60 percent of radiation emitted by the Arctic occurs at wavelengths greater than 15 μm. These have never been systematically measured.
- Data from the mission will help scientists determine how much heat – in the form of infrared radiation snow and ice surfaces emit to space, as well as how atmospheric water vapors and clouds influence the amount that escapes.
- PREFIRE will fill a major gap in our knowledge of the Arctic energy budget and the role of far infrared radiation in Arctic energy balance, sea ice loss, ice sheet melt, and sea level rise.

Description:

- PREFIRE consists of two CubeSats stationed in an asynchronous, near-polar orbit each with a Thermal Infrared Spectrometer (TIRS).
- It measures radiation in 3-54 μm wavelength range at an approximate spectral resolution of 0.84 μm
- Miniaturized for use in CubeSats, the TIRS instrument weighs less than 6 pounds (2.7 kilograms) and uses less than 6 watts of power.

PREFIRE CubeSats were carried onboard Rocket Lab's Electron rocket that lifted off from Launch Complex 1 in Māhia, New Zealand on May 25 and June 4 into sun-synchronous 8am/pm and 3:45am/pm.

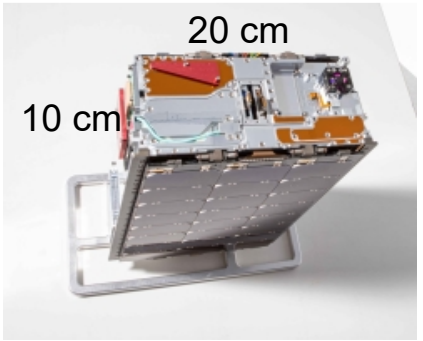
Polar Radiant Energy in the Far InfraRed Experiment (PREFIRE)

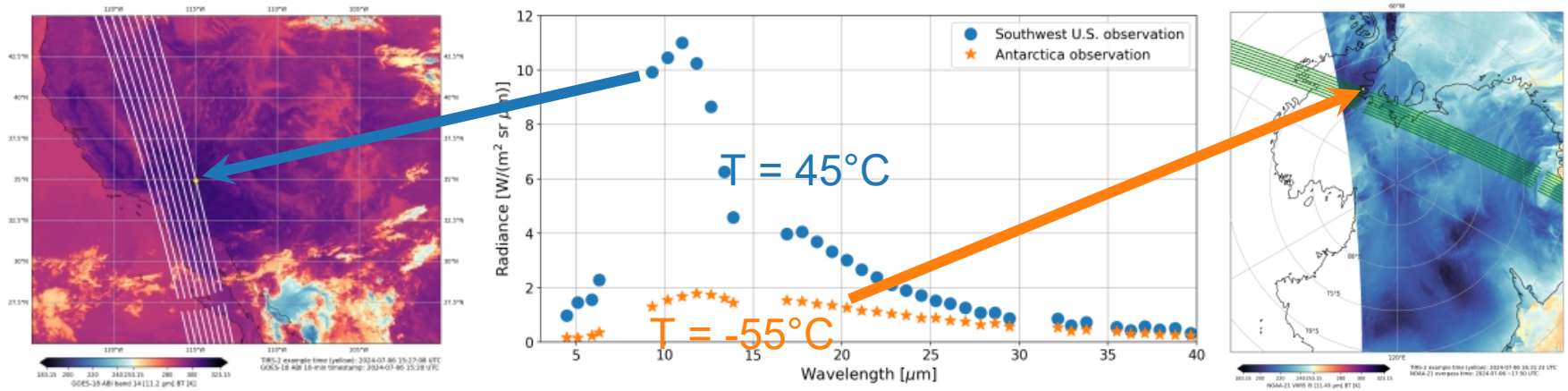
Current Status

Status

PREFIRE began prime operations in July 2024.

Both satellites are healthy and making the first systematic measurements of far infrared radiation that make up more than half of Earth's emission





Spectra Spanning 100°C in One Orbit

Small Satellite Technology Demonstrations

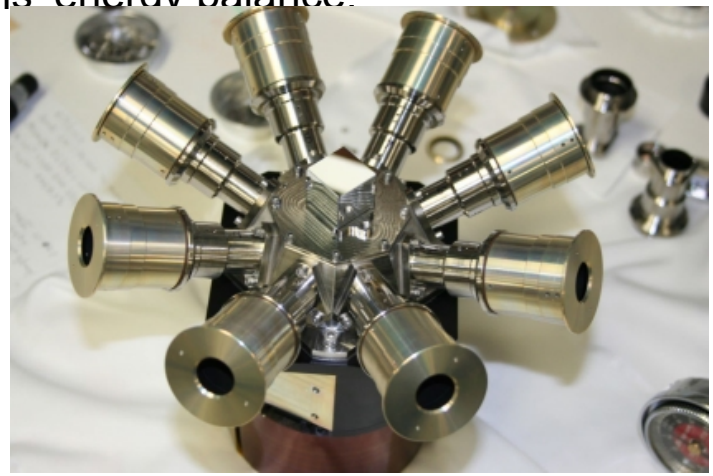
Aerosol Radiometer for Global Observation of the Stratosphere (ARGOS)

Aerosol Radiometer for Global Observation of the Stratosphere (ARGOS) will demonstrate a new capability - the simultaneous collection of limb scattering data – optimized for aerosol scattering between 850–1500 nm – from eight viewing directions.

A key element of the ARGOS design is the central prism, a multifaceted mirror that directs incoming radiation from each aperture towards a 2D detector array at the base of the sensor.

The approach has the potential to substantially improve our understanding of the radiative effects of stratospheric aerosols, and how they influence Earths' energy balance.

Launched on March 15, 2025, as a hosted payload on the Loft Orbital Yet Another Mission 8 (YAM-8) platform onboard the SpaceX Falcon 9 Transporter 13 mission from Vandenberg Space Force Base in California



ARGOS flight hardware. Show are eight apertures arrayed around a central optical hub containing the prism.
(credit: M. DeLand)

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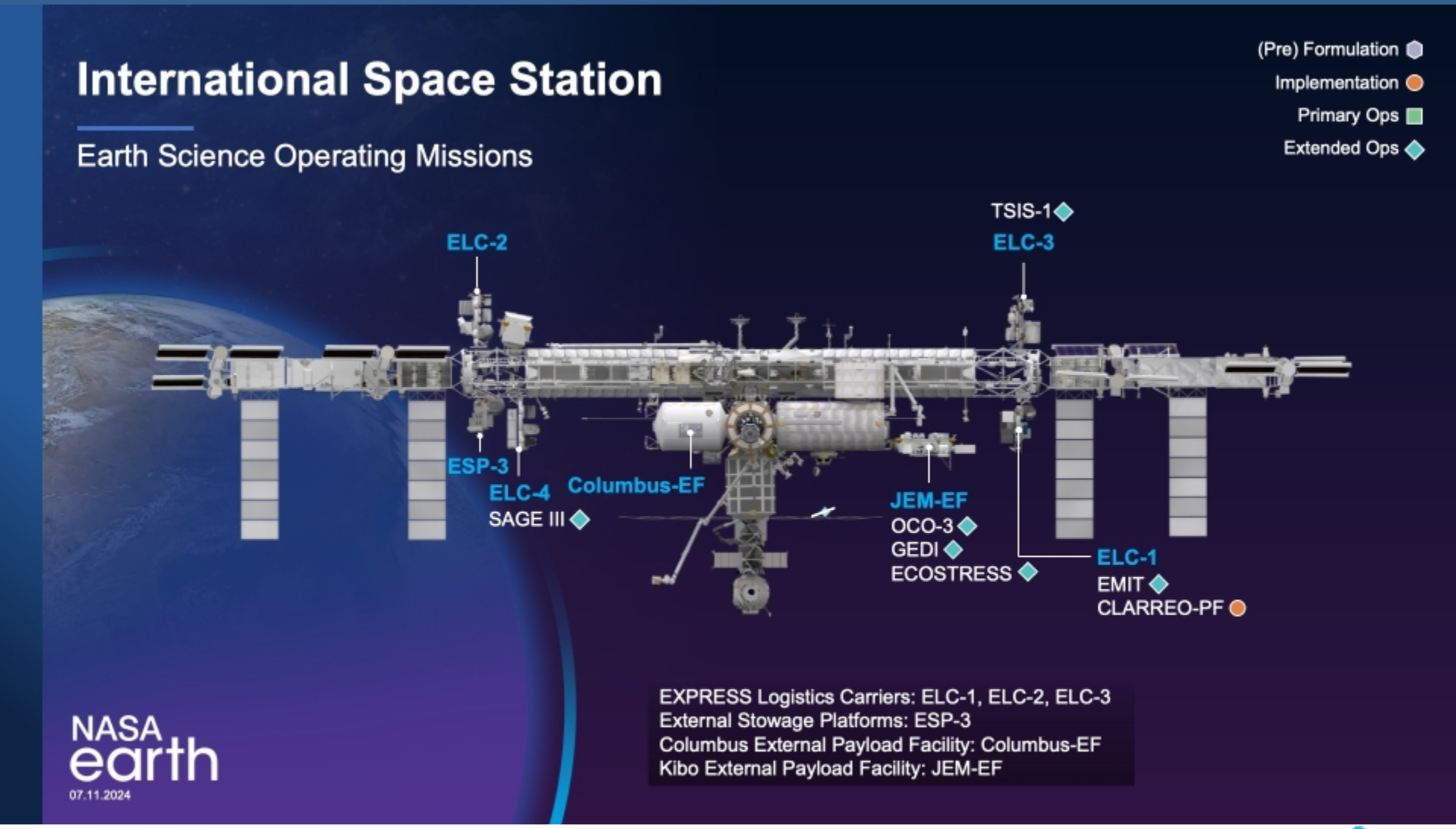

International Space Station
Earth Science Operating Missions
(Pre) Formulation
Implementation
Primary Ops
Extended Ops
TSIS-1
ELC-2
ELC-3
ESP-3
ELC-4
SAGE III
Columbus-EF
JEM-EF
OCO-3
GEDI
ECOSTRESS
ELC-1
EMIT
CLARREO-PF
EXPRESS Logistics Carriers: ELC-1, ELC-2, ELC-3
External Stowage Platforms: ESP-3
Columbus External Payload Facility: Columbus-EF
Kibo External Payload Facility: JEM-EF
NASA earth
07.11.2024

Instruments onboard the International Space Station (ISS)

- OCO-3 and GEDI instruments that were placed in temporary storage resumed science **operations in June 2024.**

Mission	Description	Launch Date
SAGE-III (Stratospheric Aerosol and Gas Experiment)	Solar Occultation Instrument for measuring the vertical distribution of aerosols, ozone, water vapor and other trace gases in Earth's stratosphere and troposphere to enhance understanding of O_3 recovery, climate change processes in the upper atmosphere	19 Feb 2017
TSIS-1 (Total Spectral Irradiance Sensor)	Measure total and spectral Solar irradiance (TSI & SSI) to better understand the Sun's natural influence on Earth's ozone layer, atmospheric circulation, clouds, and ecosystems	15 Dec 2017
ECOSTRESS (Ecosystem Spaceborne Thermal Radiometer Experiment on Space Station)	Thermal infrared radiometer for measuring evapotranspiration to provide insight to plant-water dynamics and how ecosystems change with climate	29 Jun 2018
GEDI (Global Ecosystem Dynamics Investigation)	A LIDAR for providing high-resolution observations of forest vertical structure to characterize the effects of changing climate and land use on ecosystem structure and dynamics and enable significantly improved quantification and understanding of the Earth's carbon cycle and biodiversity	05 Dec 2018
OCO-3 (Orbiting Carbon Observatory)	A grating spectrometer for acquiring measurements of atmospheric carbon dioxide to characterize sources and sinks on regional scales and over seasons	04 May 2019
EMIT (Earth Surface Mineral Dust Source Investigation)	VSWIR spectrometer for measuring the different wavelengths of light emitted by minerals on the surface of deserts and other dust sources to determine their composition to better understand how dust warms or cools the atmosphere	14 Jul 2022

NASA ISRO Synthetic Aperture Radar (NISAR)

NISAR will be the first radar of its kind in space to systematically map Earth, using two different radar frequencies to measure changes of our planet's surface, to movements as small as centimeter.

Status: Expected to launch in early-Summer 2025 from Satish Dhawan Space Centre on India's southeastern coast

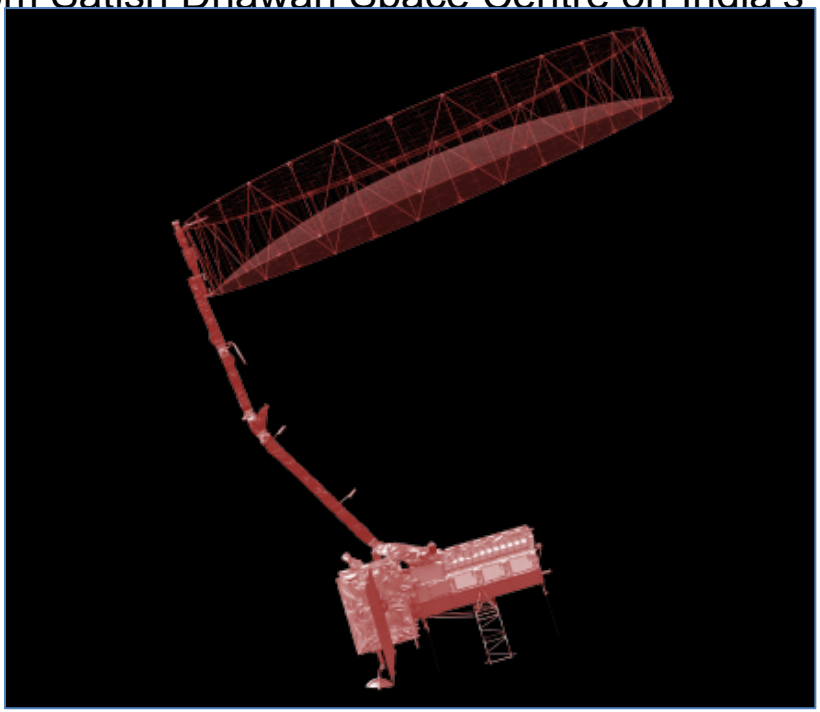
Instrument Frequency: L-band - 24 cm; S-band - 10 cm

Temporal Coverage: 12-day exact repeat for interferometry; On average 6-day coverage with ascending and descending orbits

Spatial Coverage: Near global land and ice coverage on every orbit

Science and Applications:

- Dynamics of water, hydrocarbon, and sequestered CO2 reservoirs
- Earthquake, volcanic, and landslide cycles, exploring potentials for urgent response and hazard mitigation
- Response of ice sheets and sea ice to ecosystem change
- Carbon storage and uptake dynamics in wooded, agricultural, wetland, and permafrost systems



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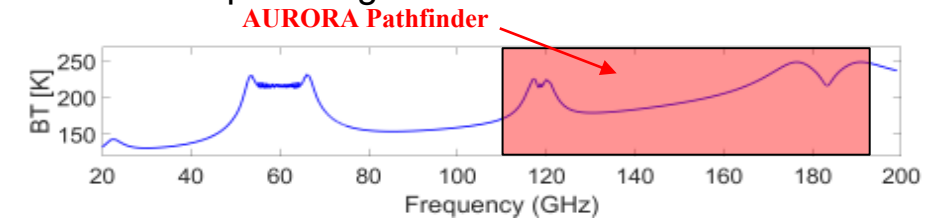
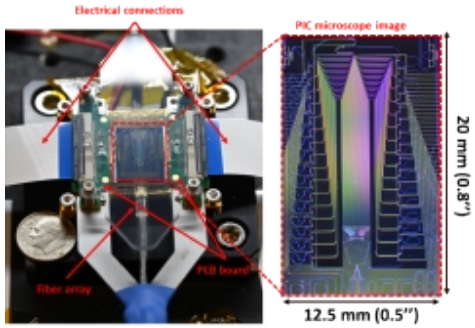
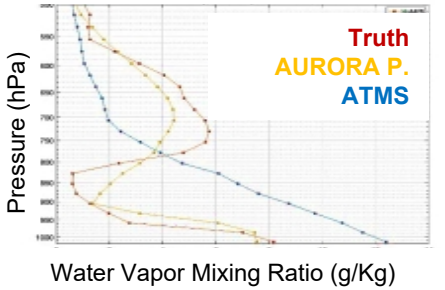
Advanced Ultra-high Resolution Optical and RAdio frequency (**AURORA**) Pathfinder

PI: Antonia Gambacorta, NASA Goddard Space Flight Center

- Develop the first-of-its-kind space-based hyperspectral microwave sensor to demonstrate the use of microwave components interfaced with photonic integrated components (PICs) **and** spectrometer Application Specific Integrated Circuits (ASICs) to sense Earth microwave radiation within the range of ~110-192 GHz.
- Demonstrate measurement science quality and enhanced information content and vertical resolution in atmospheric temperature, water vapor and hydrometeors via OSSEs, with a focus on the Earth Planetary Boundary Layer.







- Design instrument to meet objectives above
- Leverage lessons learned from HyMPI, CoSMIR-H, the Wh2yMSIE field campaign and other similar developments
- Use commercial-off-the-shelf (COTS) components as much as possible
- Verify performance of COTS parts prior to accepting use
- Integrate subsystems (optics, RF front end, photonics, IF assembly, ASICs, C&DH, PDU, Spin Mechanism) and validate complete AURORA system performance including noise figure, gain stability, and instrument calibration.
- Advance to TRL 6 through comprehensive environmental testing (ambient thermal, vibration, thermal vacuum)

Co-Is/Partners/Collaborators: M. Vega, F. Gambini, M. Stephen, V.Torres, P. Mohammed, J. Lucey, T. Kahn, N. Shahroudi, P. Stegmann, M. Coon, B. Bulcha, A. Kotsakis, D. Gershman, J. Caraballo, S. Nicholls, J. Piepmeier, VDI, TK, and Genesis.

• Kickoff	11/24
• Gateway review	04/25
• Authorization to Proceed	05/25
• Initiate long lead procurements	07/25
• System Integration Review	04/27
• Instrument I&T	06/27
• Environmental testing (vibe and TVac)	08/27
• Delivery of AURORA instrument	09/27

Coordination Group for Meteorological Satellites 06/25 DSI-24-0007

$TRL_{in} = 3$ $TRL_{current} = 3$

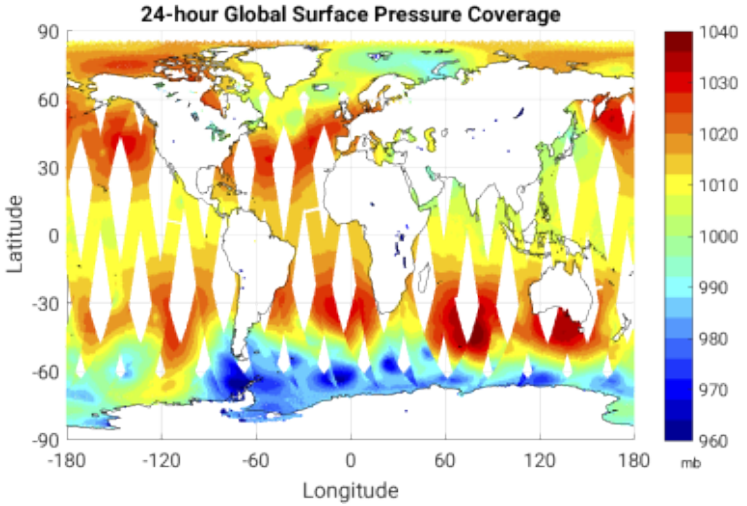
Microwave Barometric Radar and Sounder (**MBARS**)

PI: Matthew Walker McLinden, NASA GSFC

Develop a Microwave Barometric Radar and Sounder instrument to measure surface pressure over oceans using a combined V-band (64 -70 GHz) multi-frequency differential absorption radar (DAR) and hyperspectral radiometric temperature profiler

- •Target sensitivity from space is 1-2 hPa and spatial resolution is 10-50 km with a wide swath (250-1000 km).
- •The combination of hyperspectral temperature profiler and differential absorption radar (DAR) allows surface pressure and vertical pressure and temperature retrievals

The resulting instrument products would support several Earth Science Decadal Survey “most important” questions, including planetary boundary layer (W-1), severe storms (W-4), and weather forecasting (W-2)



Spaceborne MBARS will combine a V-band radar and hyperspectral radiometer to enable global 3D pressure sounding

- Develop MBARS sensor, a combined V-band (64-70 GHz) active/passive differential attenuation radar and temperature profiler.
- Fabricate combined radar/radiometer digital processor system transceiver, antenna, PDU, telemetry systems, mechanical housing, and thermal control.
- Develop and demonstrate retrieval algorithms and data assimilation.
- Integrate and test the MBARS system and demonstrate pressure retrievals from the NASA ER-2 high-altitude aircraft.

• System Requirements Review	05/22
• Preliminary Design Review	09/22
• Critical Design Review	02/23
• Digital Transceiver Complete	10/23
• Transceiver Subsystem Complete	02/24
• Antenna Subsystem Complete	02/24
• Integration and Testing Complete	06/24
• Flight Tests Complete	09/24

Co-Is/Partners: Bing Lin, Steven Harrah, LaRC; Nikki Prive, Gerry Heymsfield, Lihua Li, Kevin Horgan, GSFC; James Carswell, Tomorrow.io

05/24 IIP-21-0017

TRL_{in} = 3 $TRL_{current}$ = 3

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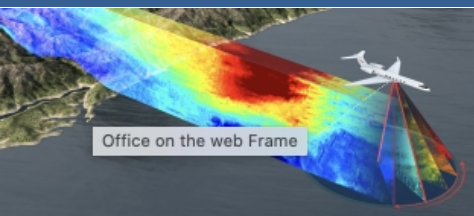


NASA Aerosol Wind Profiler (AWP) Airborne Doppler Wind Lidar

Instrument Scientist: Kristopher Bedka **Engineering Lead: John Marketon - NASA Langley Research Center**

Background

The Aerosol Wind Profiler (AWP) was supported by NASA's ESTO, Earth Science Division, and Langley Research Center to develop and demonstrate Doppler wind lidar technologies needed for space, and to serve as NASA's next-generation airborne wind measurement sensor

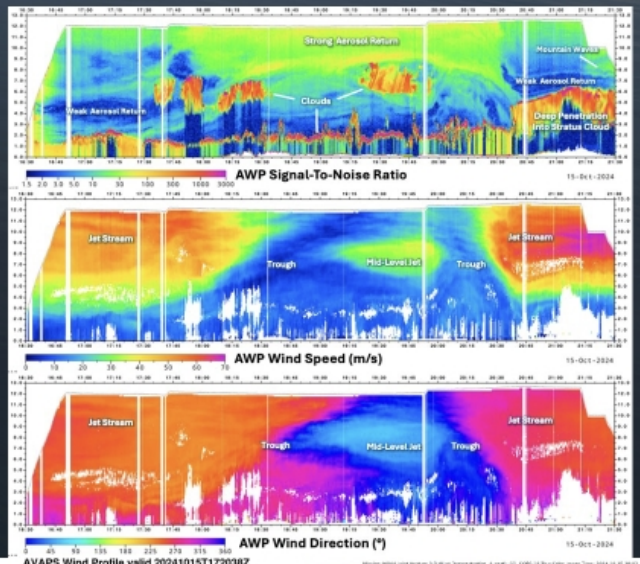
AWP builds on extensive 2 µm wavelength wind lidar technology development and airborne experience gained with its predecessor, the Doppler Aerosol Wind Lidar (DAWN, Bedka et al. (AMT, 2021))

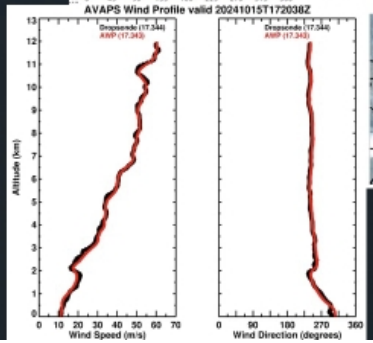
AWP detects the Doppler shift from aerosol and cloud particle motions
AWP laser pulses are emitted into a rotating prism scanning mechanism that redirects the light 30° off-nadir, enabling profiling of horizontal wind vectors

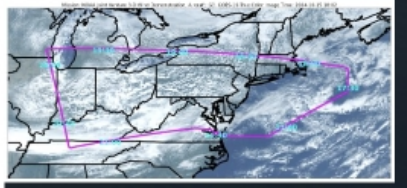
AWP's high rep rate (200 Hz) and pulse energy (40+ mJ) provides high backscatter sensitivity, and high spatial (≤ 2 km) and vertical (≤ 0.150 km) resolution

AWP provided unbiased vector wind data with just ~0.9 m/s uncertainty relative to AVAPS dropsonde data during the Fall 2024 NOAA Joint Venture 3-D Wind Demonstration and the WH²YMSIE Active-Passive PBL Profiling Experiment

AWP Data Products: Vertical profiles of 3-D wind components, line-of-sight wind speed profiles, aerosol/cloud backscatter, wind turbulence profiles







Click Here For AWP Data Animation
https://svs.gsfc.nasa.gov/5509/

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Modification and upgrades to Boeing 777-200ER

Accepting NASEM recommendations, NASA acquired a Boeing 777-200ER in December 2022. The aircraft is currently undergoing modifications and is expected to be ready for research flights in 2026.

Aircraft	Payload Weight (pounds)	Fuel load (percent)	Range (miles)	Endurance (hours)
B777-200 ER	50,000	55	5,400	11.7
	50,000	100	9,000	19
	100,000	85	7,400	15.6

In January 2025, the aircraft was flown to Texas for major structural modification.

In March, structural modification began in earnest with the installation of three, left-looking window viewports.

In April, the aircraft was jacked and shored to initiate the installation of six, nadir remote sensing ports. The team is in the process of installing four reinforcing structural doublers to support the nadir portals. Anticipating the first nadir hole to be cut in July 2025.

(Left) Boeing 777 jacking and shoring. (Right) Nadir portal doubler installation

Thank You