National Aeronautics and
Space Administration

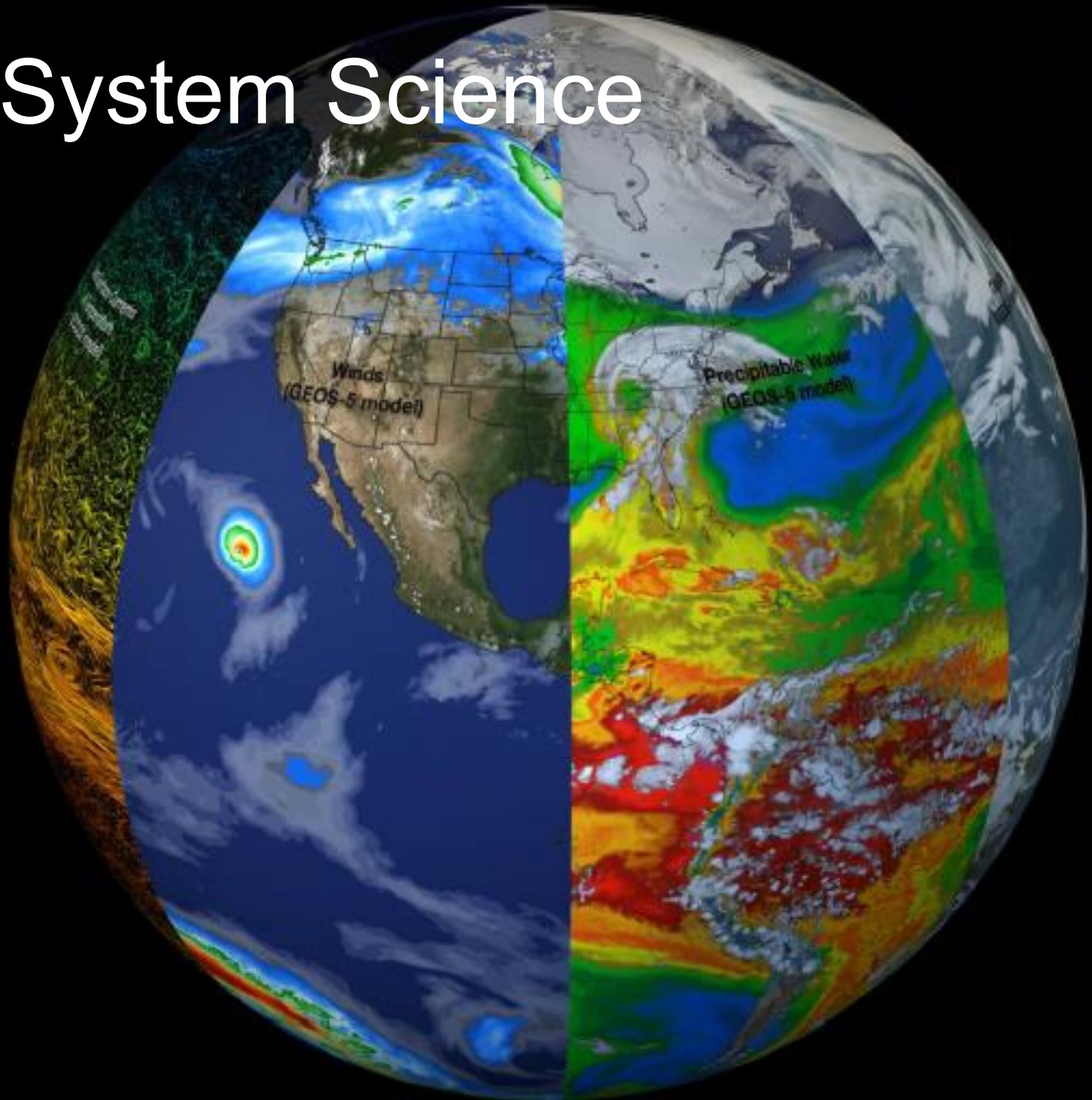
NASA earth

NASA Earth Science Perspectives:
Shaping the Next Earth Science Decadal Survey

Karen St. Germain, PhD
Director
Earth Science Division

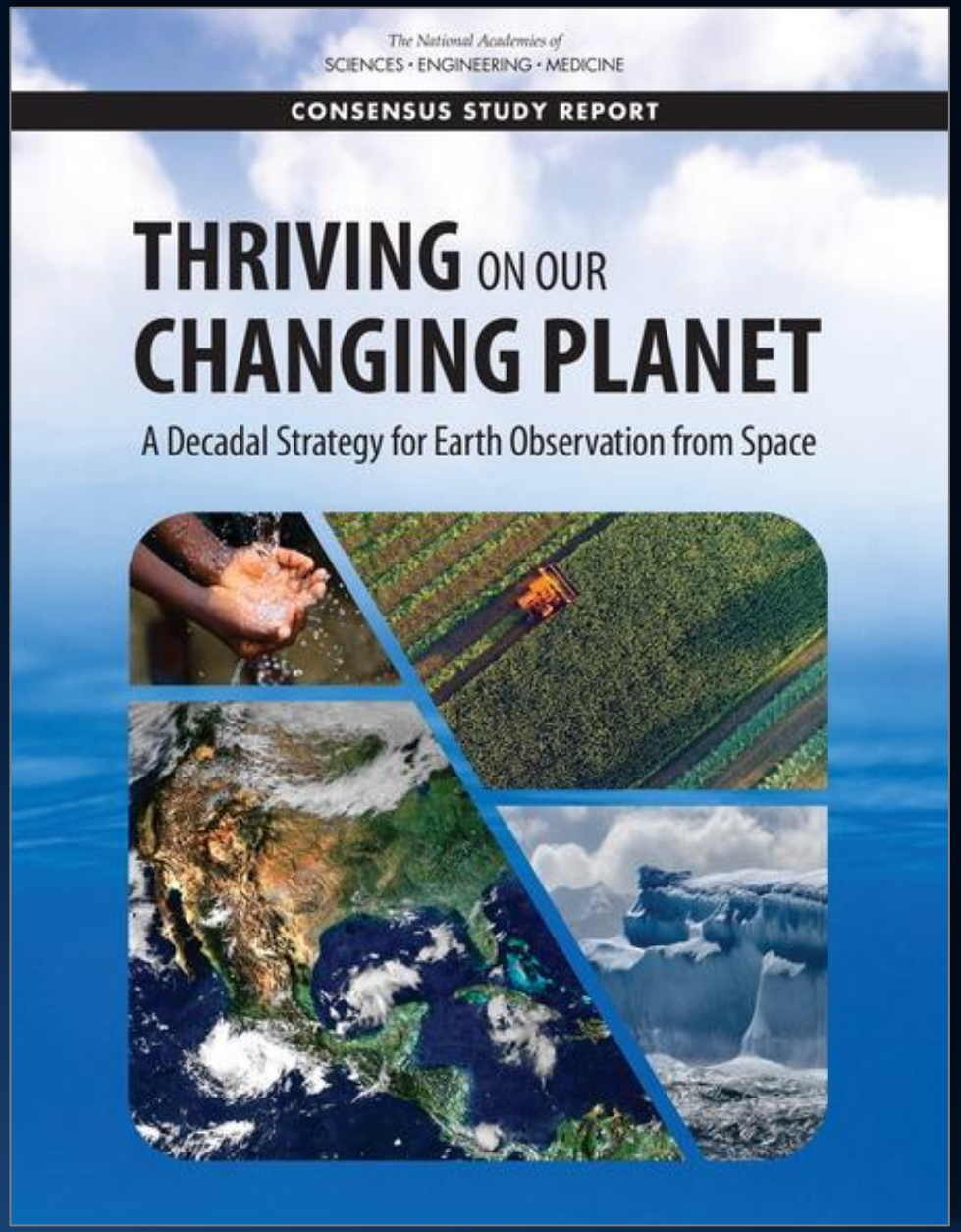
NASA Earth System Science

Atmosphere
Ocean
Land
Biomes
Inland Water
Ice
Earth Interior
Energy



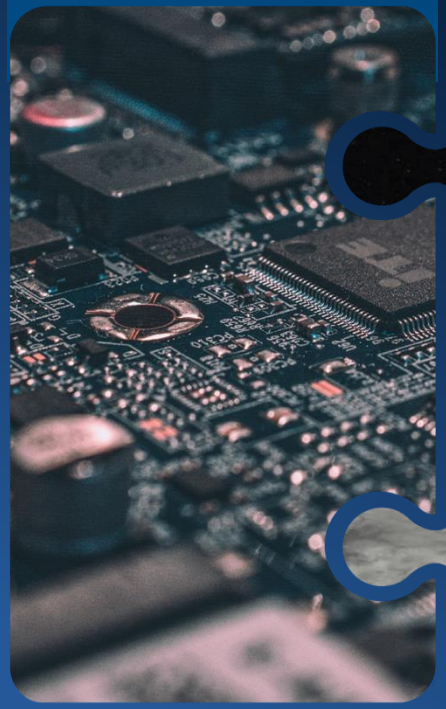
The Decadal Survey: Guiding NASA Earth Science

- Cost-effectively implement next-generation capability to meet National Academies of Science objectives
- Advance technology, flight, research, modeling, data, and applications
- Position NASA Earth Science Division to maximize science and societal benefit



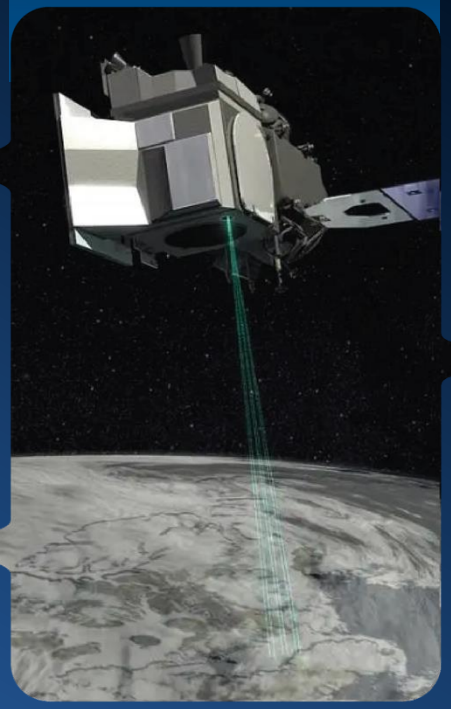
NASA's End-to-end Earth System Science Capability

Technology



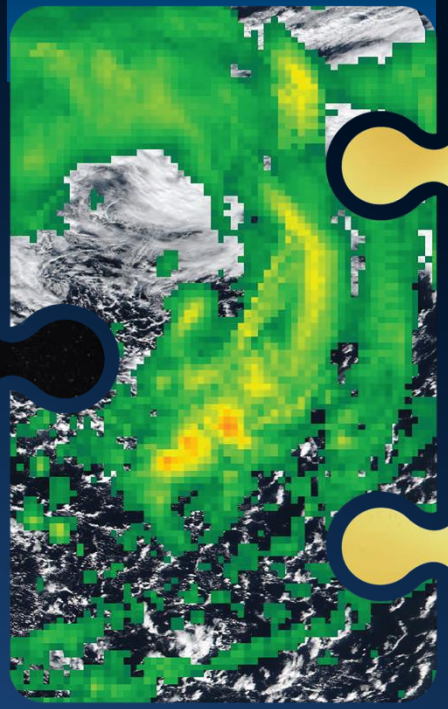
10 Tech Infusions/year

Flight



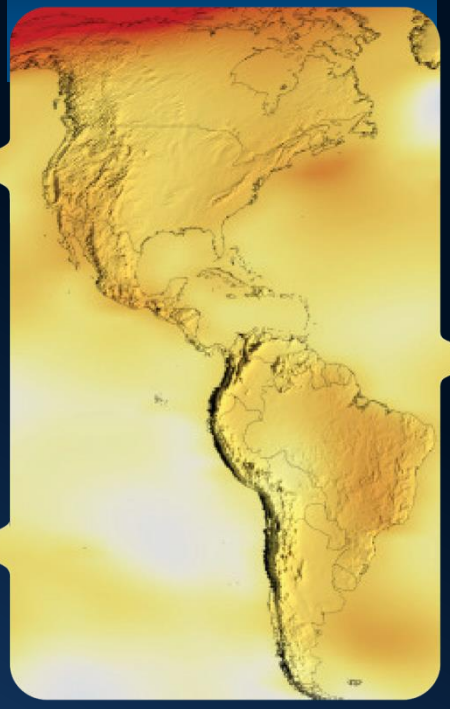
24 missions on orbit

Data and Modeling



Collect 160 TB/Day
Serving 600 TB/Day
>10M Users
World-Class Models

Research



1,330 Active Research Projects
48 States

Earth Action

Agriculture
Energy
Disasters
Wildfires
& more

Earth Science to Action Strategy

Virtuous Cycle
- User needs inform next iteration of programs, missions and initiatives

Public Understanding & Exchange
- Put more scientific understanding into public sphere
- Deliver applied science to users
- Participate in multi-way info exchange
- Use input to inform subsequent work

Solutions with Value to the Nation
- Offer models, scientific findings and info through Open-Source Science principles
- Support private sector development of applications of Earth observations
- Provide science applications and tools to inform decisions

Earth System Science & Applied Research
- Grow scientific understanding of Earth's systems
- Develop predictive models of dynamic Earth systems and tools to understand and adapt to changes

Foundational Knowledge, Technology, Missions & Data
- Technology innovation
- Earth observations missions
- Data collected from space, air and ground

Engaging our Stakeholder Community

Sharing Results of Earth Science Discovery

Two-Way Communication with Data Users, the Science Community, and the Public

Prioritizing engagement with data users:

- Earth Action Agriculture, Water, Air Quality and Private Sector outreach
- Early Adopters part of mission development requirements

Frequently updating the Earth science community:

- Earth Science Division monthly newsletter
- Earth Science to Action roundtables at 2024 AGU
- Town halls and community forums at AGU and AMS annual conferences
- Regular meetings with the National Academies Committee on Earth Science and Applications from Space (CESAS)

Meeting the public where they are:

- Earth Information Center locations at Smithsonian and Kennedy Space Center
- Congressional briefings and NASA Days on the Hill
- Earth Science Division stories, videos and social media designed to share knowledge – inspiring curiosity, innovation, and progress

Subscribe to NASA Earth Science Postcards
https://go.nasa.gov/4eMXPKd

NASA Earth Co-Develops Next-Gen Science and Tools with Data Users: Farm Program Example

2022-2024: On-site and field tours to farms, ranches, business and research institutions in Nebraska, Kansas, Iowa, Illinois & New York

Finding out what kinds of data farmers need and how they need it delivered:

- Field visits to better understand challenges
- Bilateral meetings with major commodity groups to initiate projects
- NASA Acres: domestic consortium working directly with U.S. agriculture

Acres

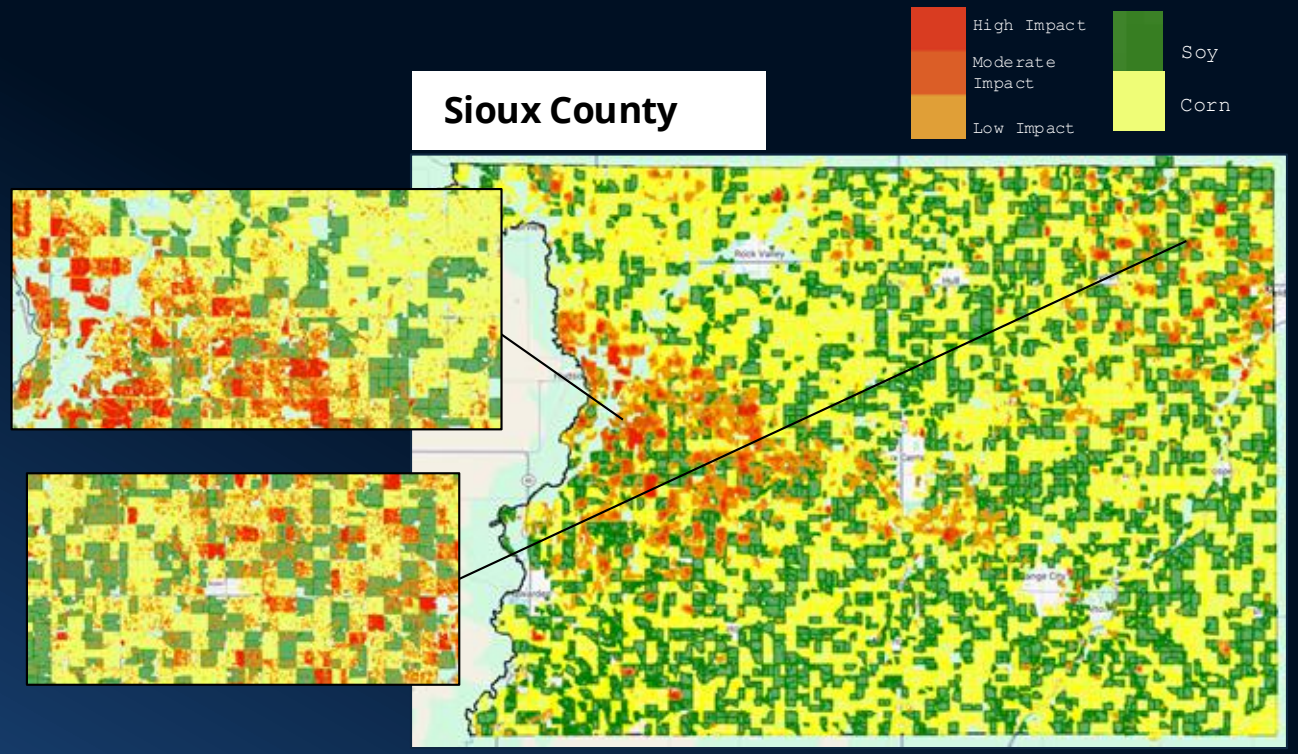
- Domestic agriculture consortium launched in 2023
- Acres brings together leaders from public & private sectors to put NASA data, science & tools into the hands of U.S. ag producers

NASA Acres FIAT

Farm Innovation Ambassador Team (FIAT): Launched March 2025 by NASA Acres

NASA Acres Responds to July 28, 2025 Derecho in Iowa:

Rapid Analysis of Damage for Gov. Reynolds & Iowa Dept. of Homeland Security & Emergency Management (HSEM)



- Sentinel-1 Synthetic Aperture Radar Data combined with crop type area estimates and yield estimates (e.g., USDA NASS Surveys)
- Estimates of damage to soybeans

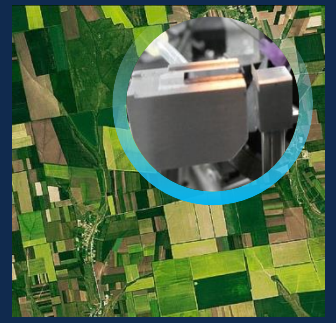
Advancing Technology

Earth Science Technology Office

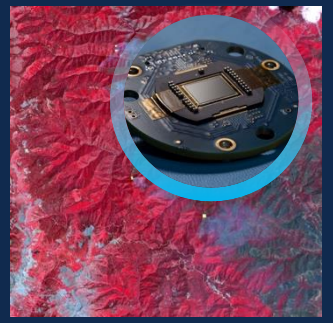
Key Technology Investment Areas

Earth Science Technology investments address a broad range of Earth observation needs. Maintaining some investment in all areas, with increased investment in QG Gradiometry:

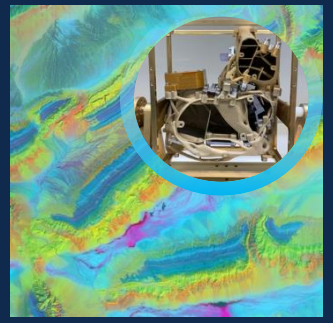
Electro Optical Earth Imaging



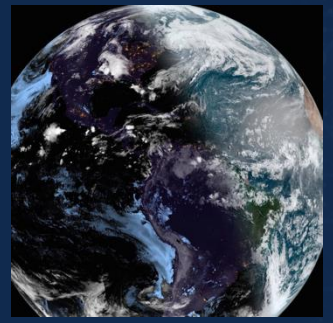
SW / MW / LW Infrared



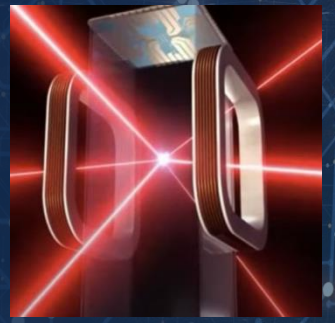
Hyperspectral



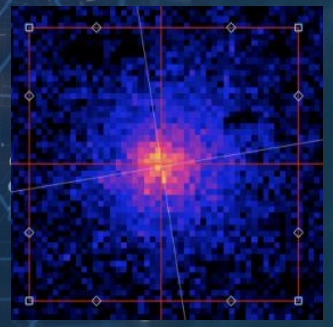
Multispectral



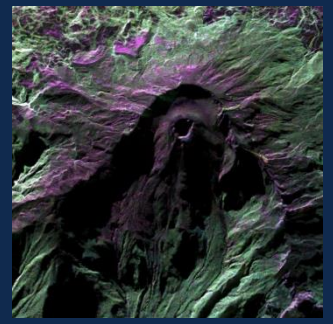
Quantum Sensing



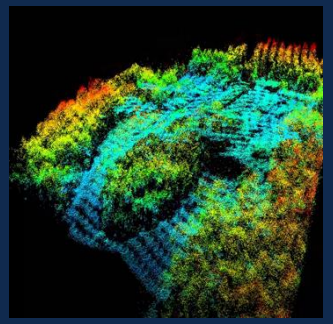
Quantum Gravity Gradiometry



Radar

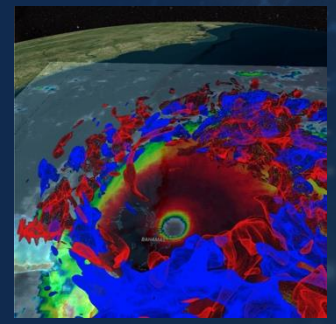


Laser / LiDAR



Quantum Computing

AI / ML Modeling



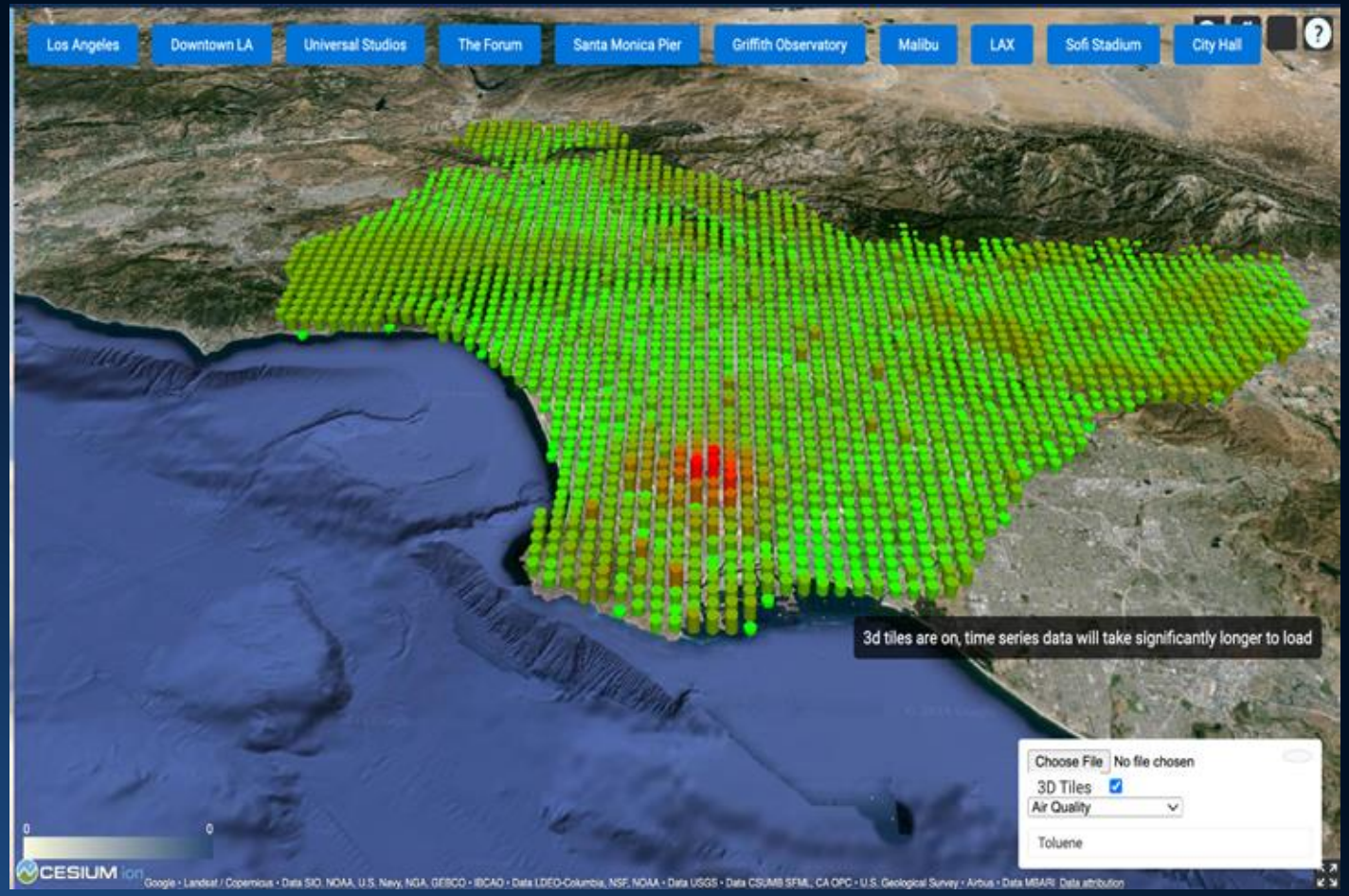
Digital Twins

Technology Highlight: Predicting What We Breathe

The City of Los Angeles using NASA data with machine learning (ML) to predict air quality, improving human health outcomes

Objectives:

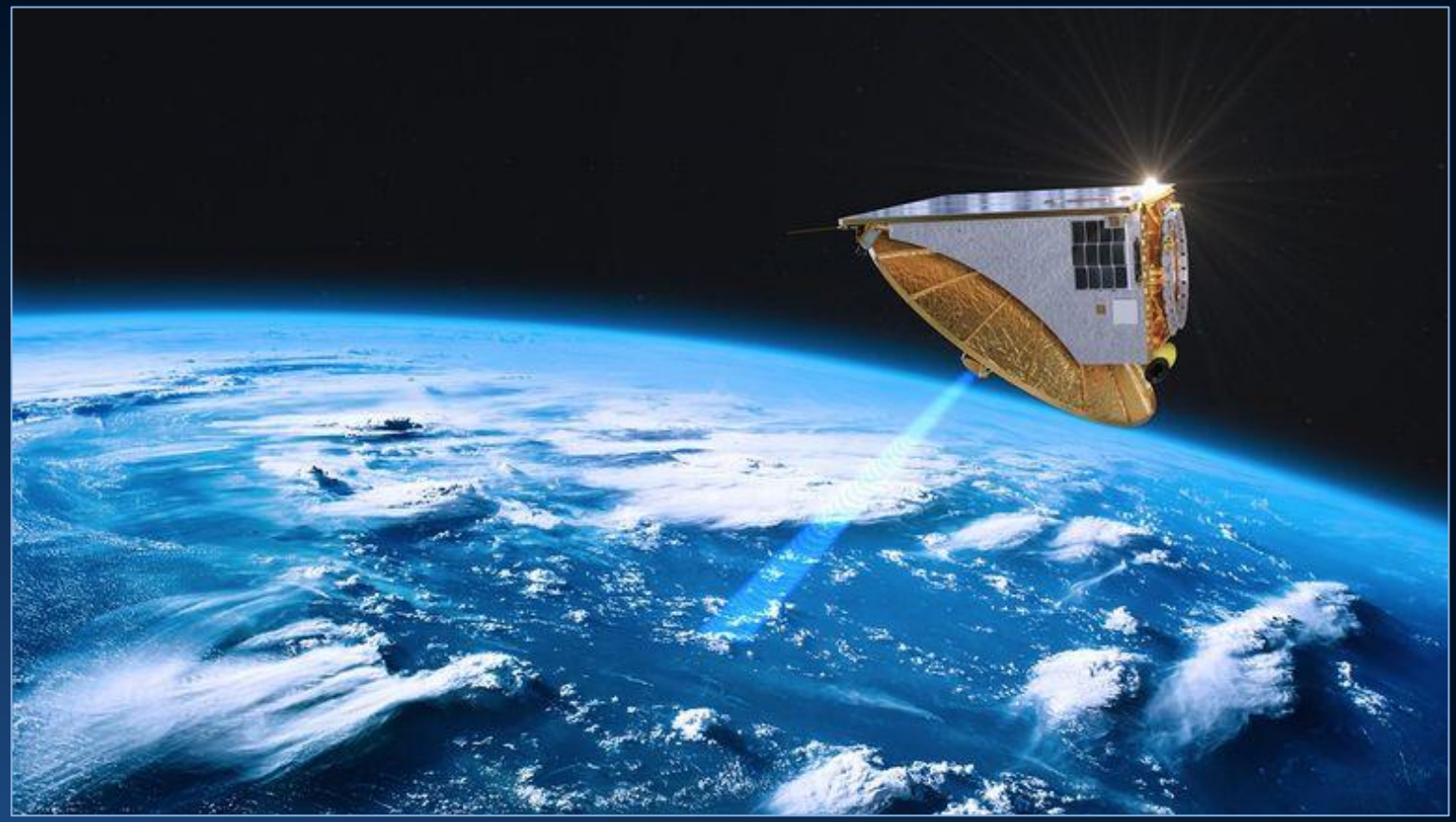
- Train ML models on measurements of particulate matter, ozone, nitrous oxide and other pollutants
- Integrate ground and space data
- Run on the cloud
- Create a Los Angeles-based predictive model and interventions that can be transferred for use in other cities



Tomorrow io: NASA-developed Technology and Science at Work

- We are creating next-generation satellites and sensors that deliver precise data about our nation's resources, from freshwater supplies to rare Earth minerals

- U.S. weather satellite company Tomorrow.io is leveraging breakthrough miniaturized radar technology -- RainCube – FIRST developed by NASA



Tomorrow.io satellite equipped with proprietary radar technology that leans on previous NASA development such as RainCube

Advancing Satellite Missions

Earth Science Flight Program

NISAR Launch

July 30, 2025

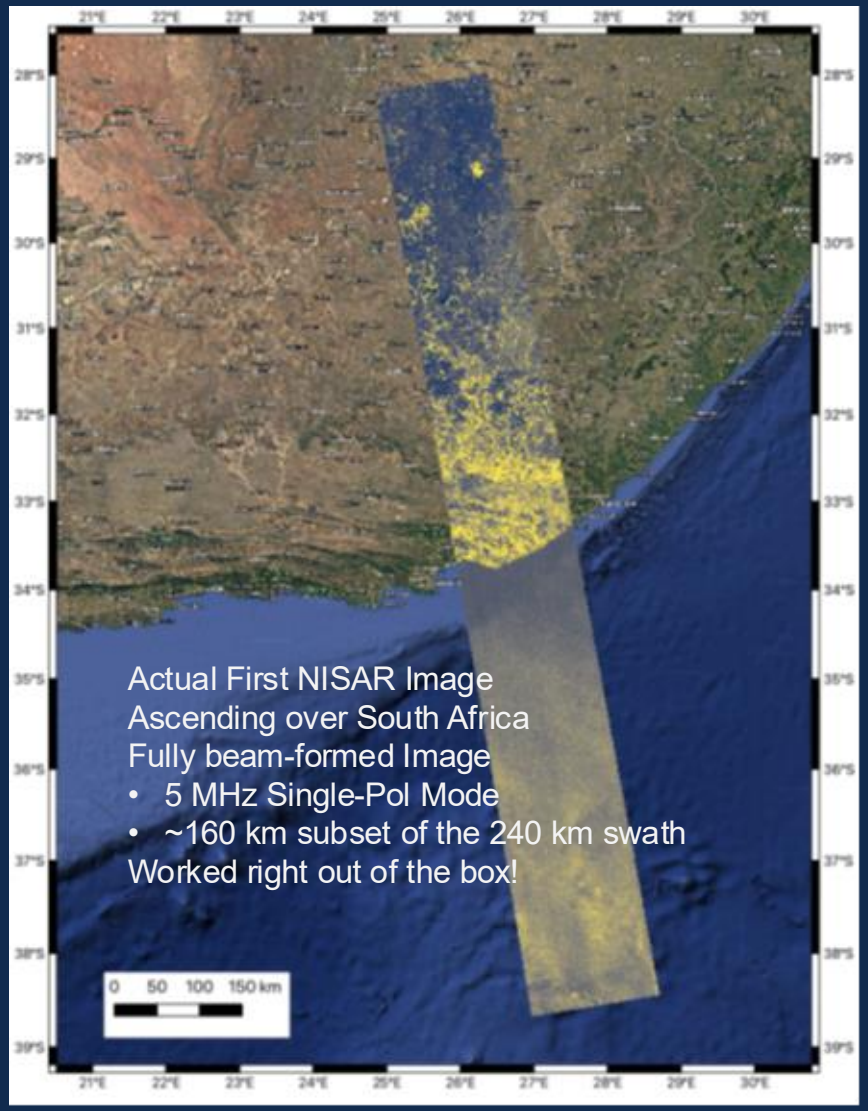
The NASA-ISRO partnership launched humanity's first-of-its kind dual-band satellite

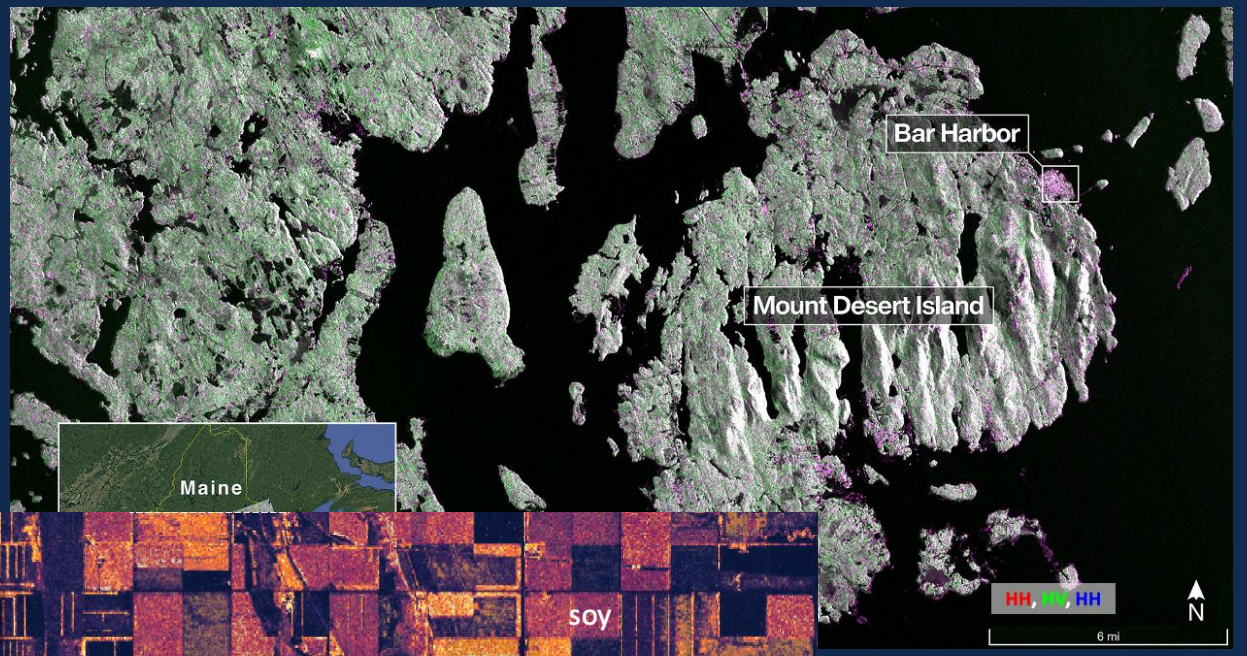
Actional information in:

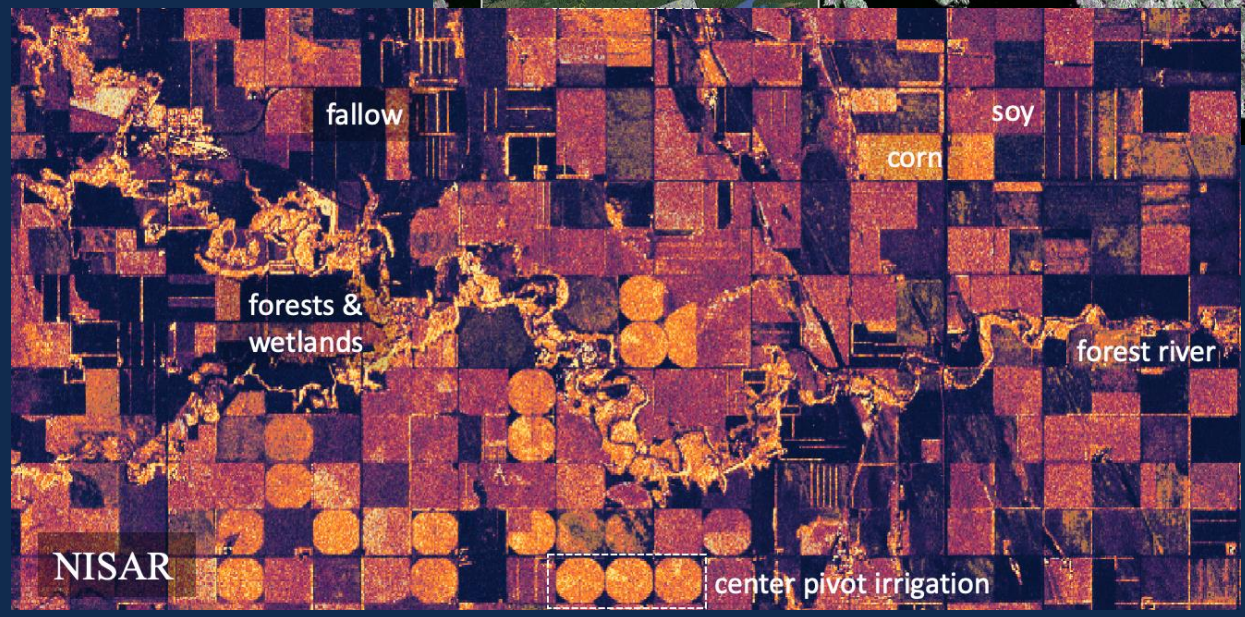
- Disaster response
- Infrastructure monitoring
- Land-use planning
- Farming
- Water management

The Indian Space Research Organisation's Geosynchronous Satellite Launch Vehicle lifts off from Satish Dhawan Space Centre on India's southeastern coast at 8:10 a.m. EDT (5:40 a.m. IST), July 30, 2025. Credit: ISRO

From first-light images to first science results







First released images (September 25)

NISAR's Actionable Science

More than 180 organizations ready to use NISAR science and data

An official website of the United States government Here's how you know

A coordinated effort

U.S. Sea Level Change

Rising Seas, Changing Coasts

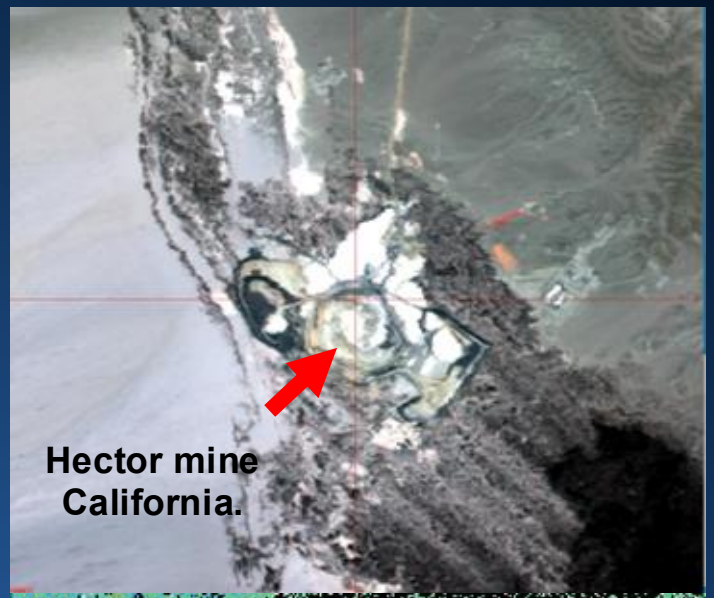
This site provides federally supported data visualizations coupled with explanations and science education to help communities prepare for challenges that will affect our coastal environments. By showing how sea levels are changing regionally, the site provides a foundation to inform decision-making related to coastal planning, resource management, and emergency operations.

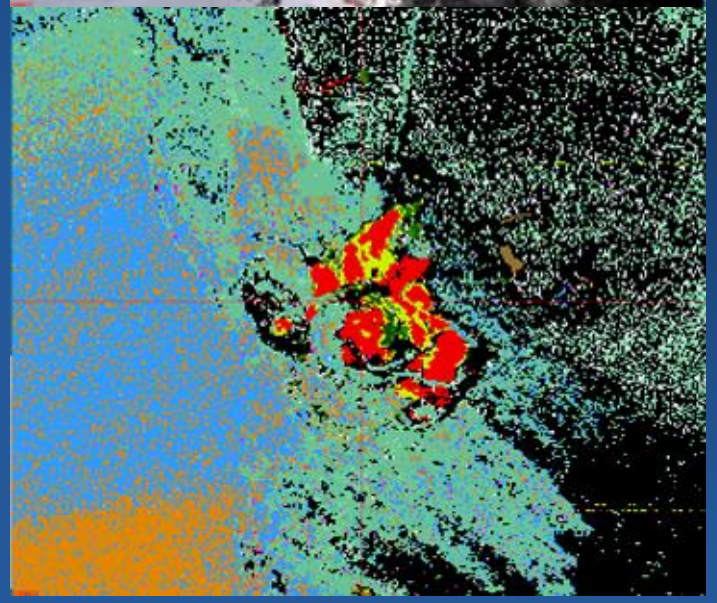
SEA LEVEL 101 NATIONAL SEA LEVEL EXPLORER

FEMA NOAA U.S. Department of Defense USGS science for a changing world

A coordinated effort ›

Searching for Critical Minerals from Air and Space

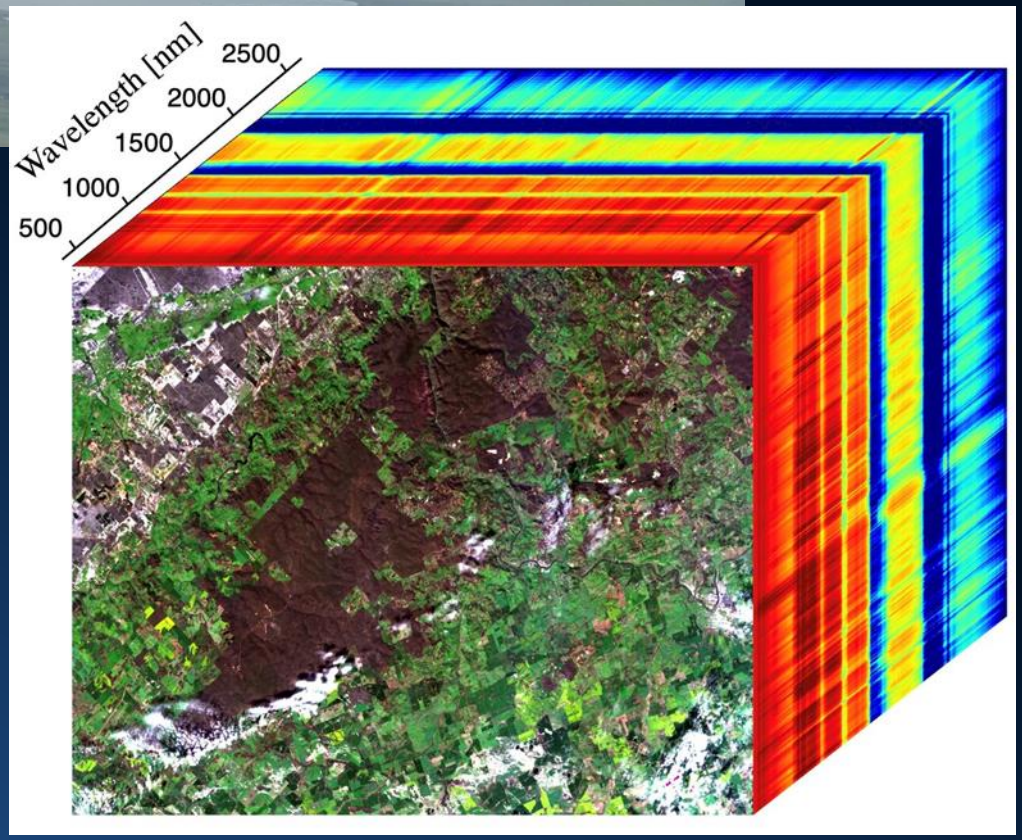




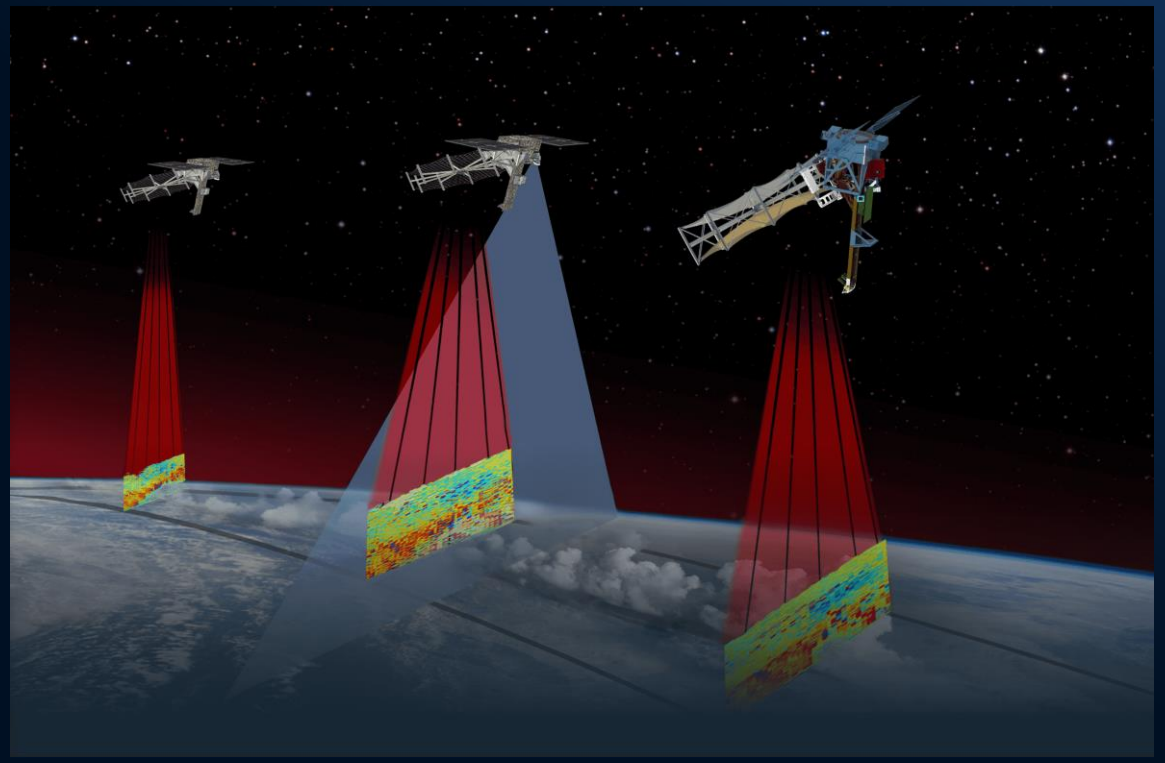
Left: high-resolution, hyperspectral instruments Identify surface minerals in California

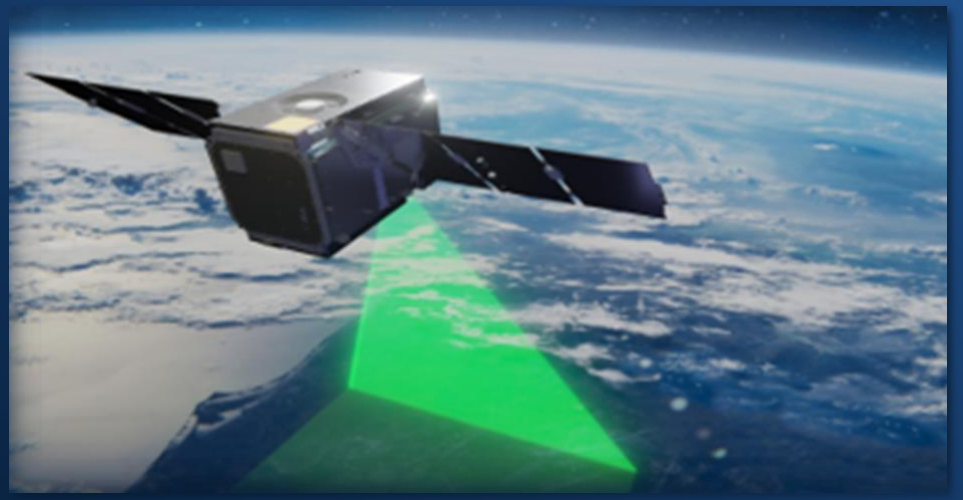
Top: Geological Earth Mapping Experiment (GEMx) airborne mission

Right: Images from EMIT on the ISS show a mix of minerals in Western Australia



Advancing Understanding of Extreme Weather: INCUS and PolSIR





***Above**: Rendering of INCUS constellation of three smallsats to study tropical convective storms*

***Top right:** Rendering of one of two PolSIR cubesats measuring high-altitude tropical ice clouds*

***Bottom right:** Actual image of high-altitude ice clouds that impact the Earth system's weather cycle*

Driving Earth Science Data

Earth Science Data Systems

ESD Operates One of the Largest Open Archives on the Planet

EARTH DATA BY THE NUMBERS FY 25

End User Average Distribution Volume
600 TB/Day

End User Distribution Files incl. From Cloud
7.8 Billion (4.3B in Cloud)

Total Archive Volume Including in Cloud (not inc duplicate on-prem)
148.8 PB

Website Sessions (Google Analytics)
14.9 Million

Average Archive Growth
160 TB/Day*

EOSDIS Customer Satisfaction Index Score (2024)
78

Total Archive Volume In Cloud Only
116.2PB

Total Number of Files Cataloged (On-Prem and Cloud)
4.6 Billion

Unique Datasets
18,755

Distinct Users of EOSDIS Data & Services
28.6 Million

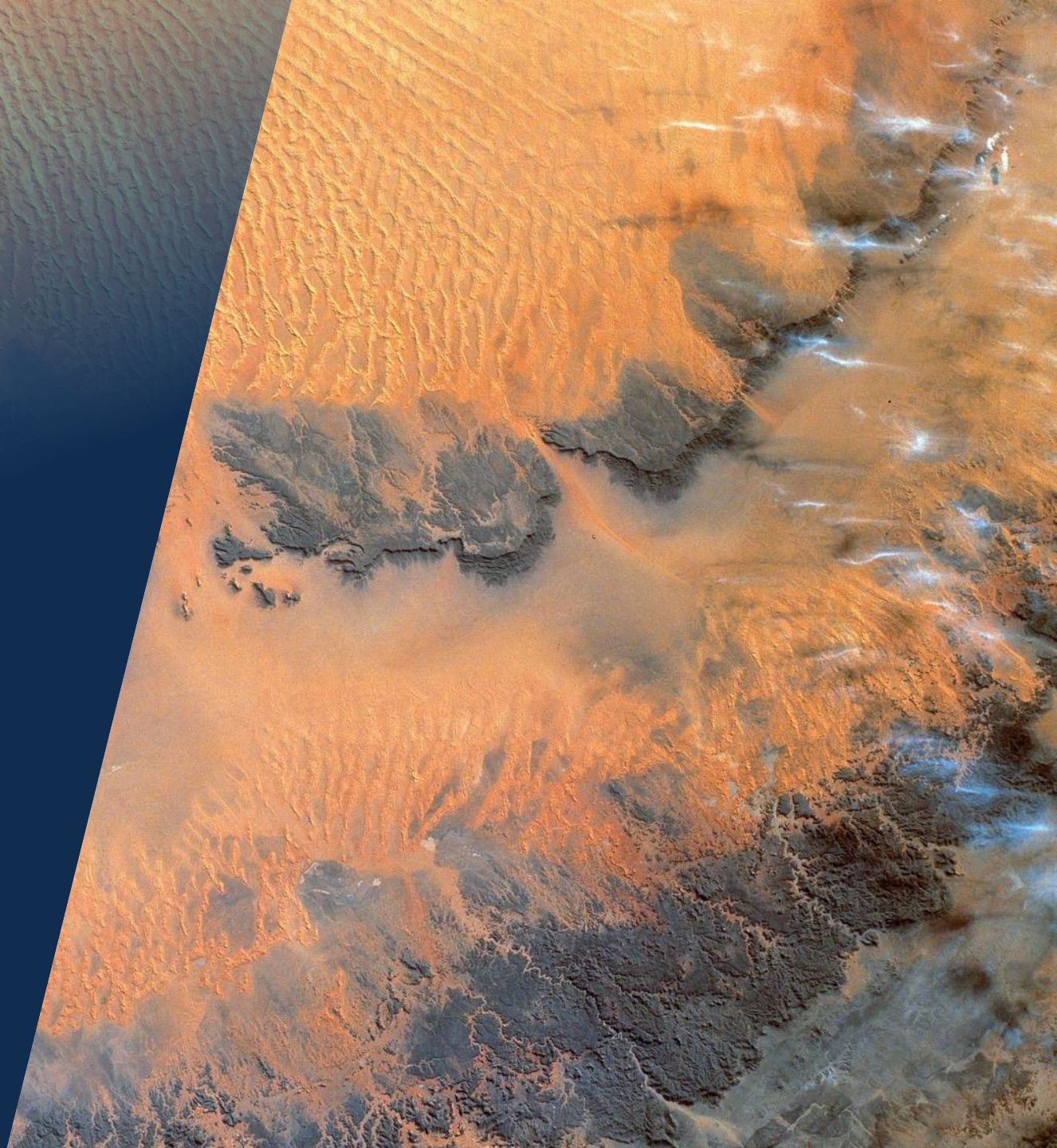
Service Users **17 Million**

Data & Web Users **11.6 Million**

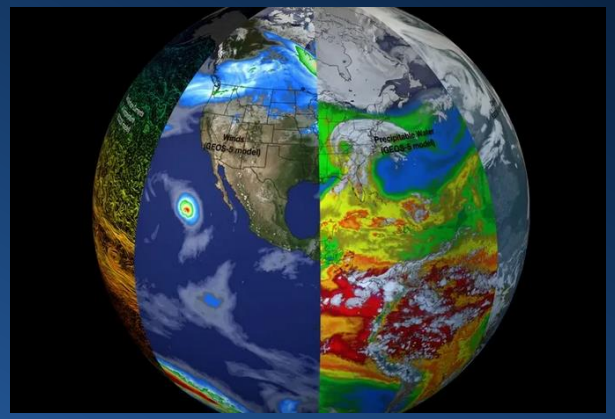
*NISAR may add ~66TB/day

Advancing Scientific Understanding of Earth

Earth Science Research

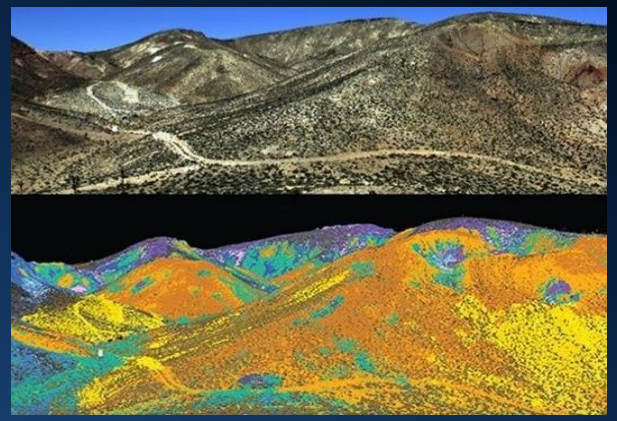


Earth Science Research Projects Overview



Earth System Science Research

- Competed discipline and interdisciplinary research
- Early career research
- Field campaign support

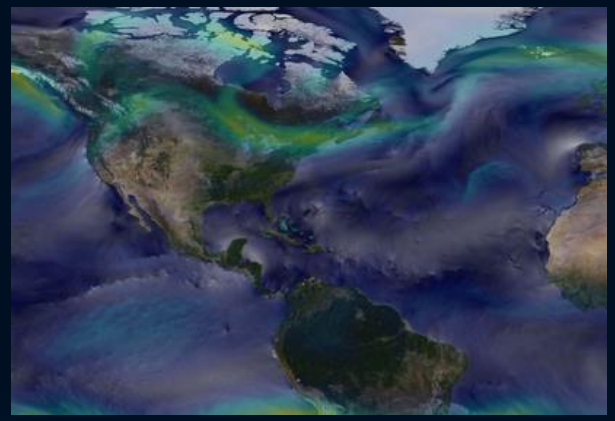


Airborne Science

- High altitude (ER-2, WB-57)
- Large airborne laboratory (B777)
- Remote sensing jets (G-V, UAVSAR, airSAR-ng)

Space Geodesy

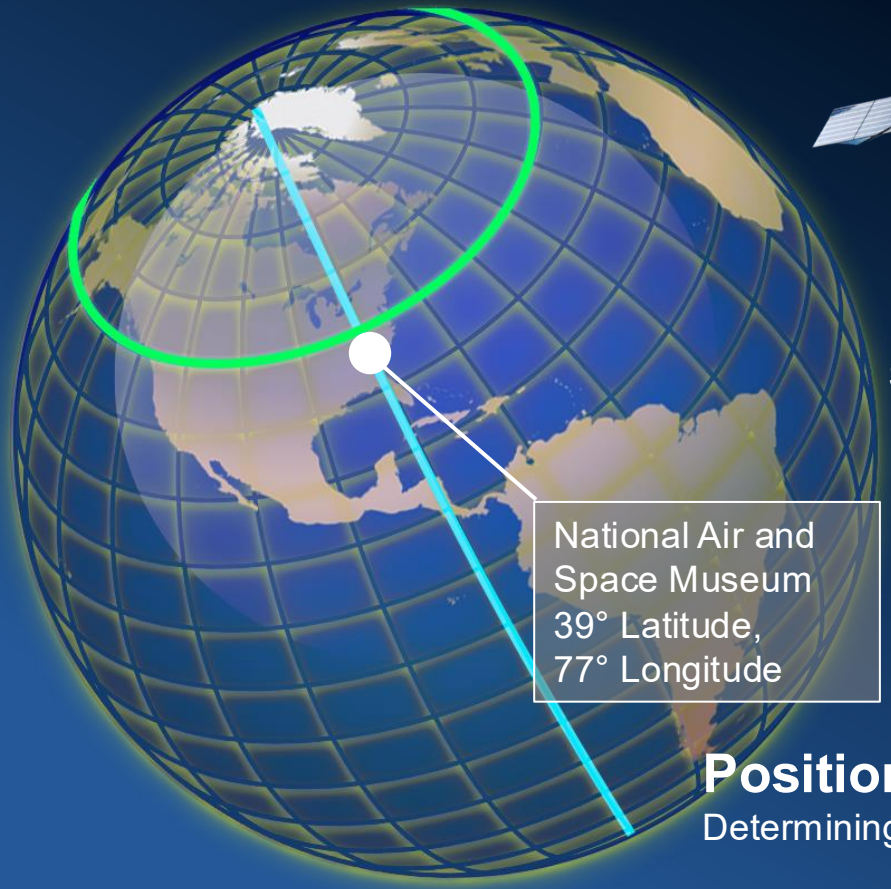
- Very Long Baseline Interferometry (VLBI)
- Satellite Laser Ranging (SLR)
- Global Navigation Satellite System (GNSS)



Integrated Earth System Modeling

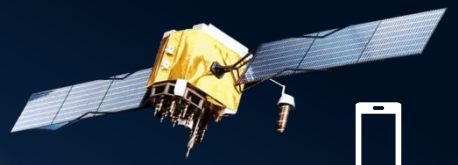
- Virtual Modeling Institute (was Model-E, GEOS, ECCO, ISSM, LIS, others)
- Scientific Computing

NASA is the backbone of cutting-edge U.S. positioning, navigation, and timing (PNT) capabilities



National Air and Space Museum
39° Latitude,
77° Longitude

Positioning
Determining location.



Cell Phone

Power Grid

Stock Traders

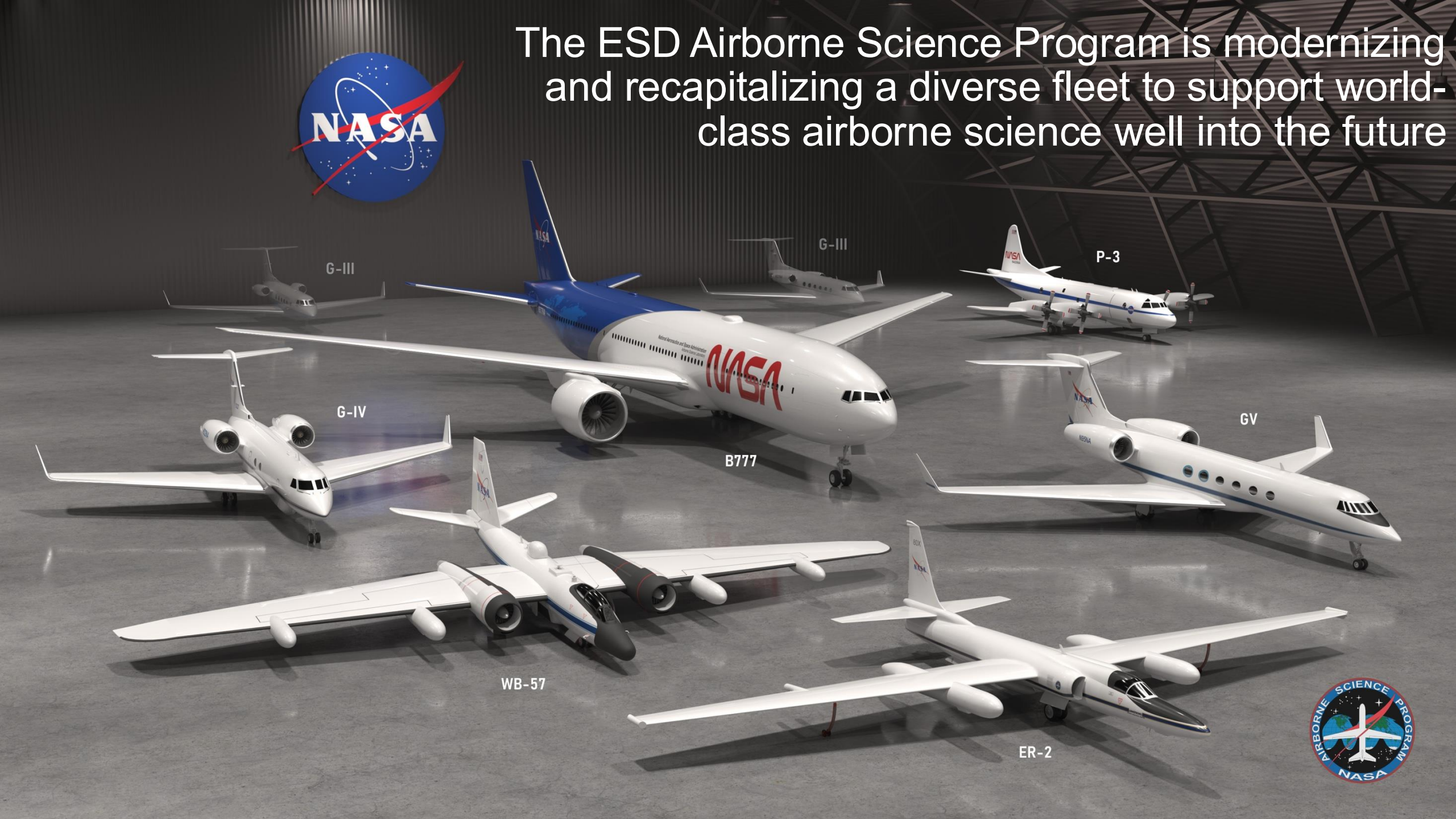
Timing
Supplying highly accurate time to synchronize complex systems.

All three are used together with map data and other information (weather or traffic data, for instance) in modern navigation systems.

Navigation
Finding your way from one place to another.

- NASA’s Geodesy program tracks Earth's constantly changing shape, orientation in space, rotation, and gravity field, enabling precise positioning of assets on the ground and in space
- NASA 's Space Geodesy Program is the U.S. backbone for both civilian and national security PNT accuracy

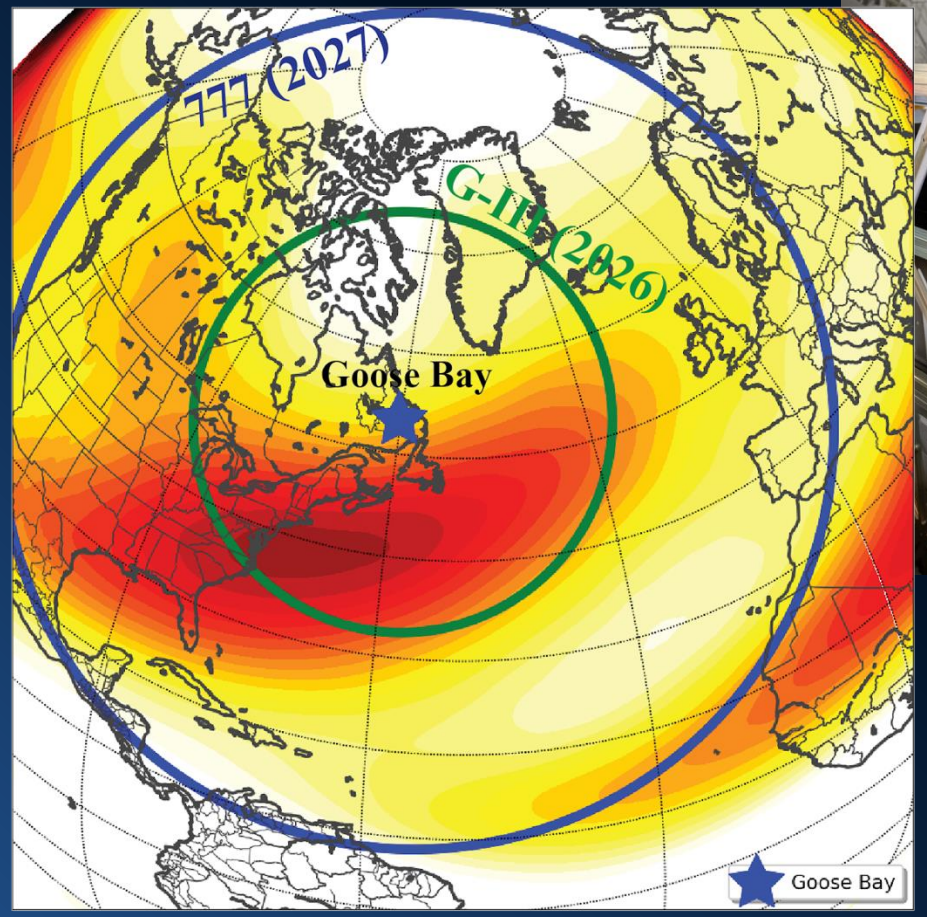
The ESD Airborne Science Program is modernizing and recapitalizing a diverse fleet to support world-class airborne science well into the future



NURTURE: Understanding High-Impact Winter Weather

North American Upstream Feature-Resolving and Tropopause Uncertainty Reconnaissance Experiment (NUTURE)

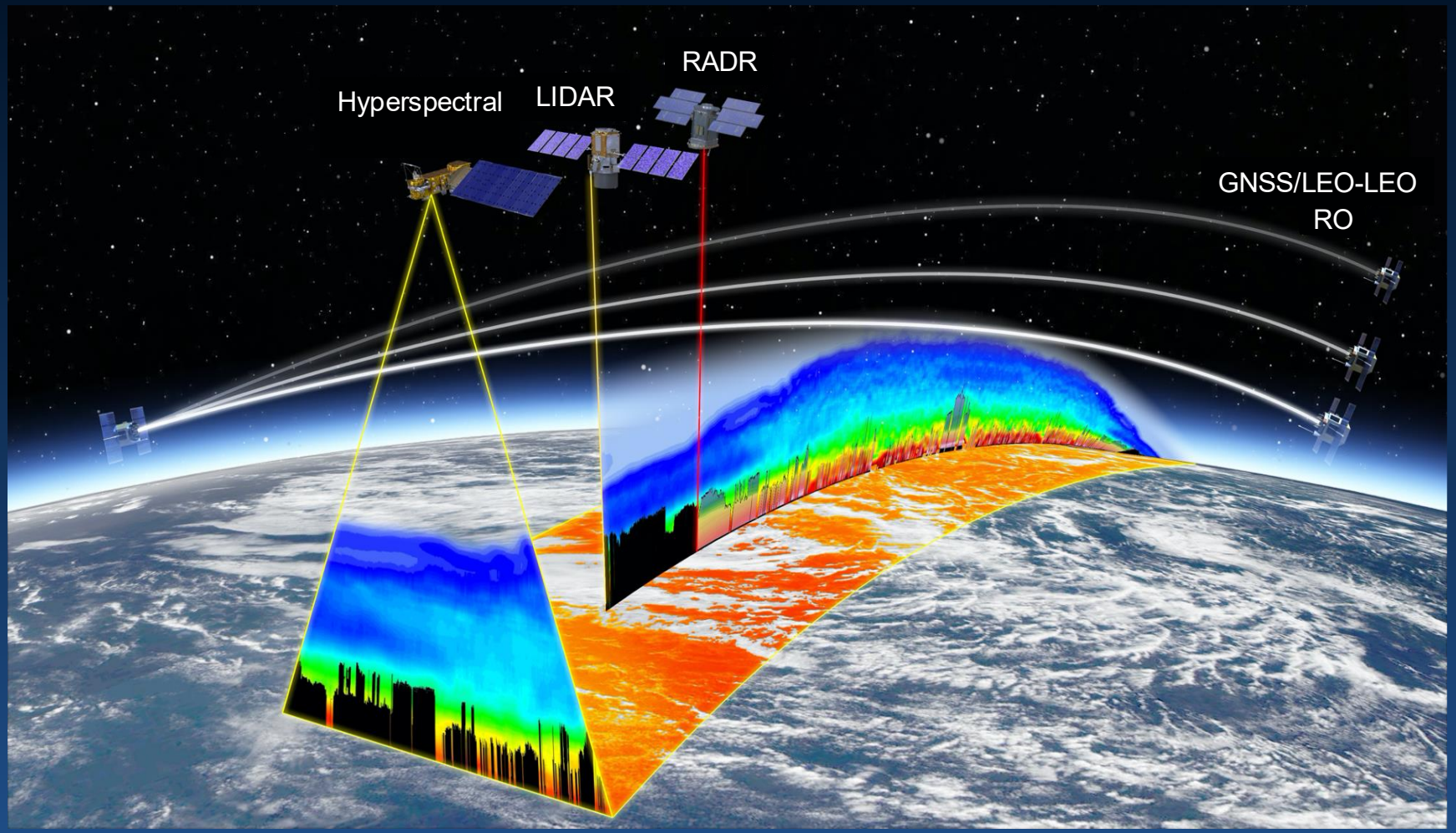
Phase One:
NASA G-III flying January 26 - February 20, 2026
Phase Two:
NASA 777 to fly January - February 2027



Decadal Survey: Study of the Planetary Boundary Layer to Improve Numerical Weather Prediction

The **Planetary Boundary Layer** is:

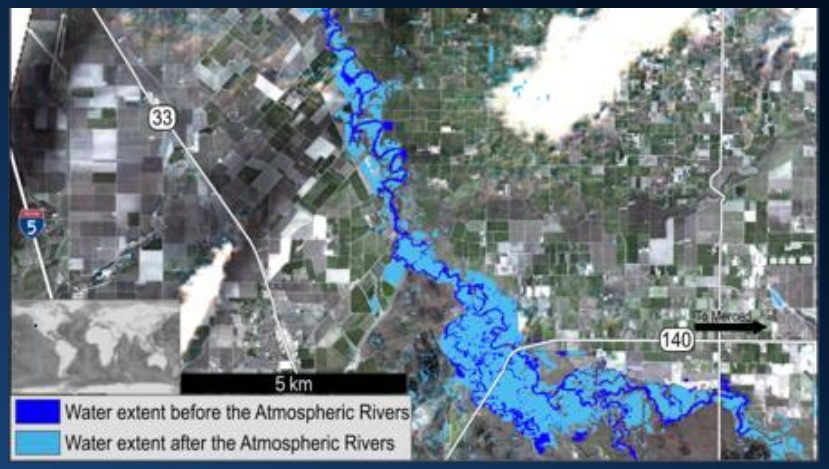
- Where the atmosphere meets the surface
- The most complex part of the atmosphere
- The part of the atmosphere where humans live
- ***The most difficult part of the atmosphere to observe and understand***



Advancing Use of Actionable Science

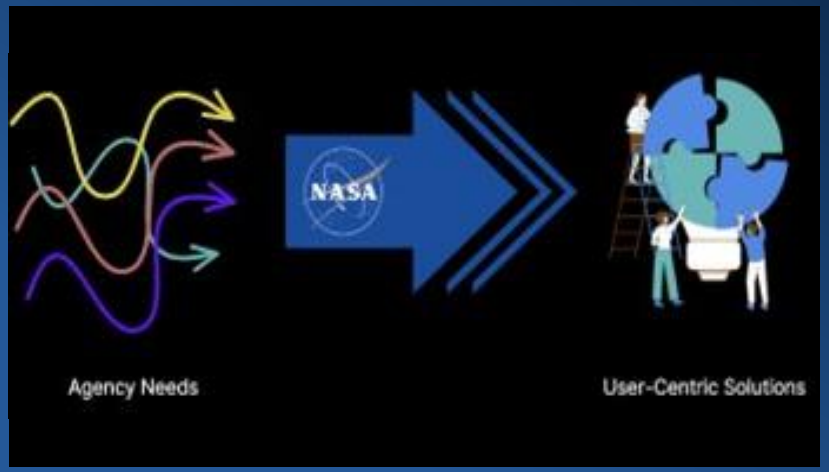
Applied Science and Responsive Science Initiatives

Earth Action Projects Overview, Part I



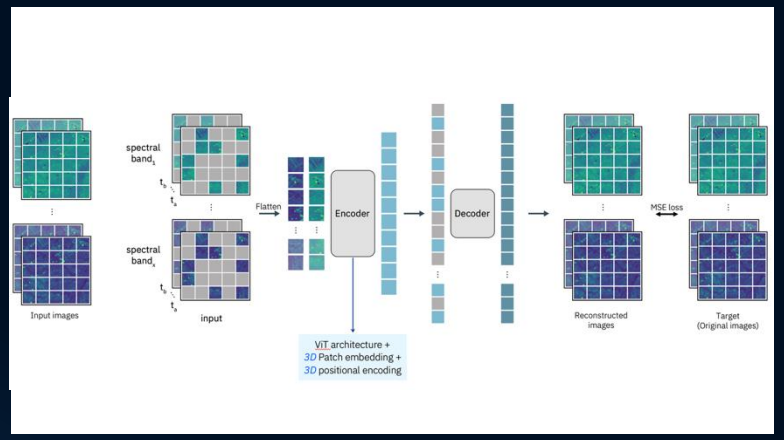
Application Innovation

- Water Resources, Health and Air Quality, Ecological Conservation
- Energy and Infrastructure



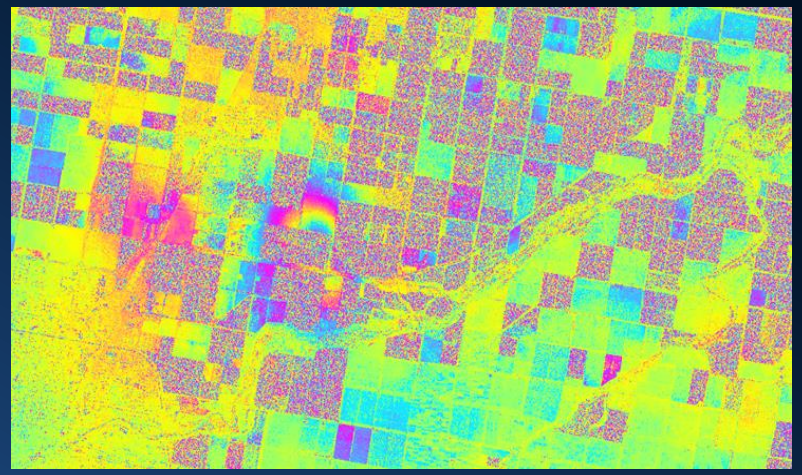
Interagency Satellite Observation Needs

- Assesses and fulfills needs identified by federal agencies
- Develops some of NASA's most used data products



AI and Advanced Modeling Applications

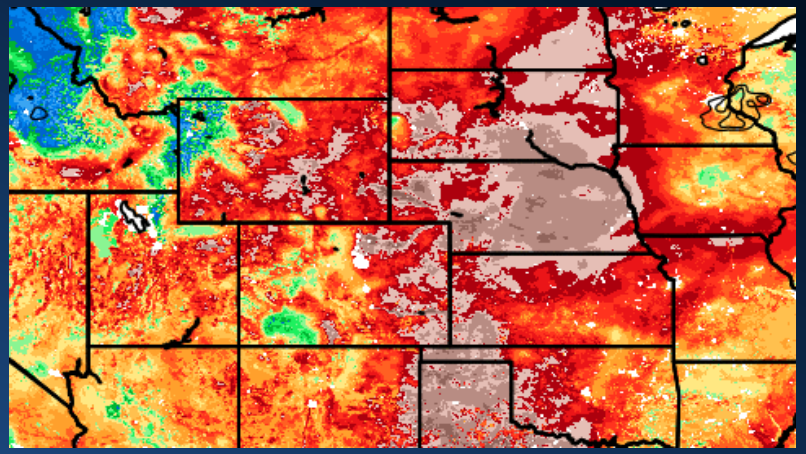
- GeoAI to improve decision-making
- Other advanced modeling



Commercial Satellite Data Acquisition

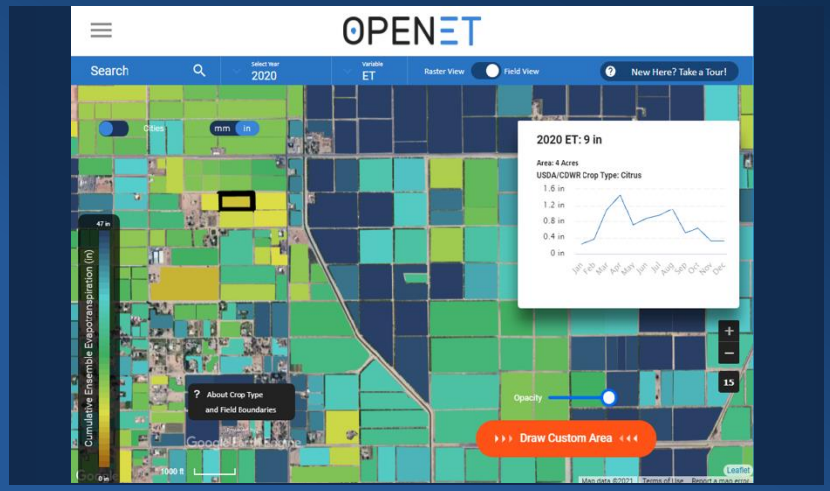
- Data purchases to support ESD needs
- Sector support through product evals, cal-val, etc.

Earth Action Projects Overview, Part II



RSI Crosscutting
- ARSET, EarthRISE
- Earth Information Center
- Private Sector Engagement

Wildland Fires
- Competed programs
- Field campaigns
- New technologies



Agriculture
- Large consortia awards
- Domestic productivity
- International food security

Disasters
- Disaster Response
- Competed Disaster program

How can NASA's actionable data power your business?

Decadal Survey is how we continue to shape this question

74% of U.S. Fortune 100 companies routinely use NASA Earth Science data to support business operations, logistics, and risk management

78% of U.S.-based users accessing Earth Science Division data in FY2024 were from the commercial sector, demonstrating Earth science information is a critical resource to more than academia*

We provide pre-competitive insights on vital water resources to help large grocers and retailers anticipate long-term impacts on agricultural and supply chain impacts

**NASA review of FY24 database exports show 78% of users use .com domain; 3.7% from .edu, 1.1% from .gov, and 16.1% from other*

Questions?

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