



## NASA Earth Science Division Update



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NASA Earth Science Division

July 15, 2024 | GLOBE Annual Meeting

*\* Prepared with inputs from numerous colleagues from NASA HQ, centers, and investigator community*





## Overview of Talk

- Introduction to NASA Earth Science Division (ESD)
- Current and Future Satellite Missions
- Field Campaigns that Integrate Vantage Points
- ESD and International Collaboration
- GLOBE and its contributions to ESD





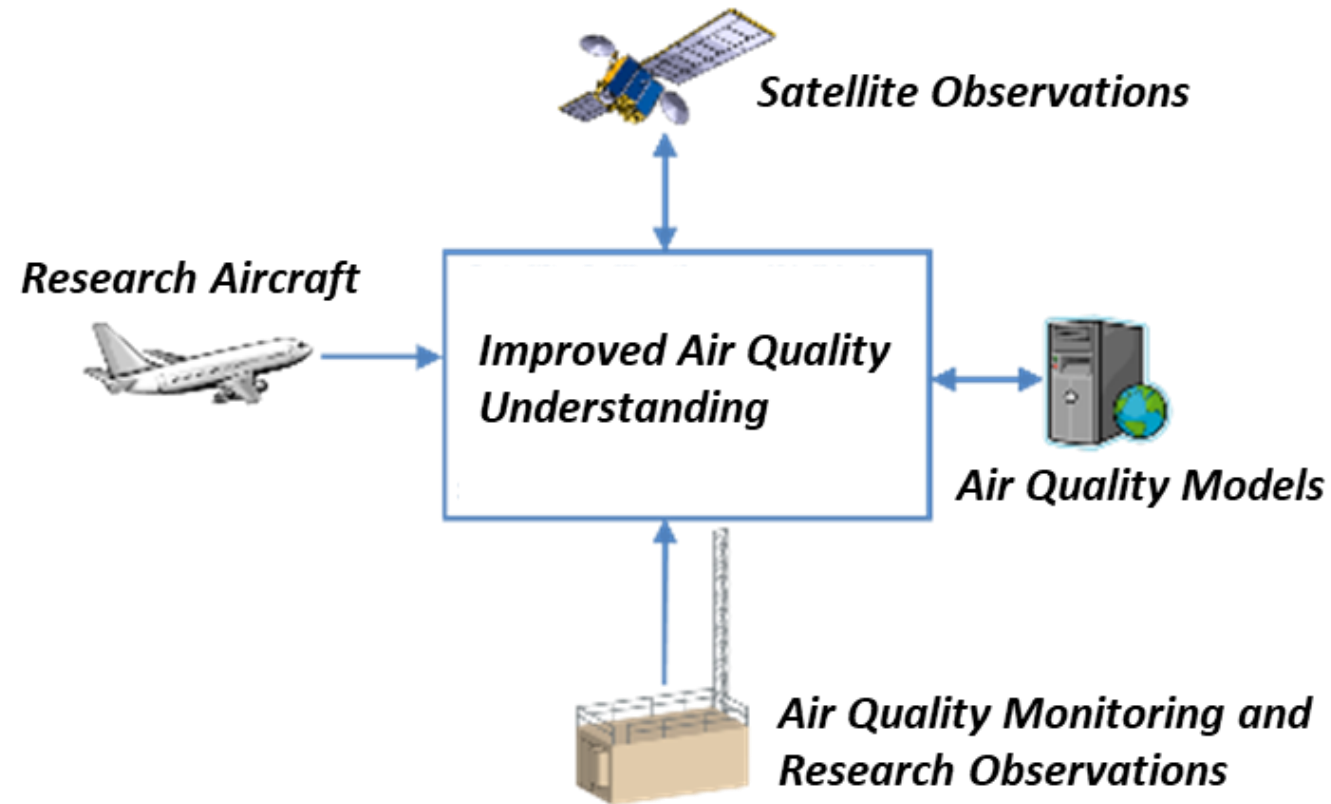


# NASA Earth Science Division Elements





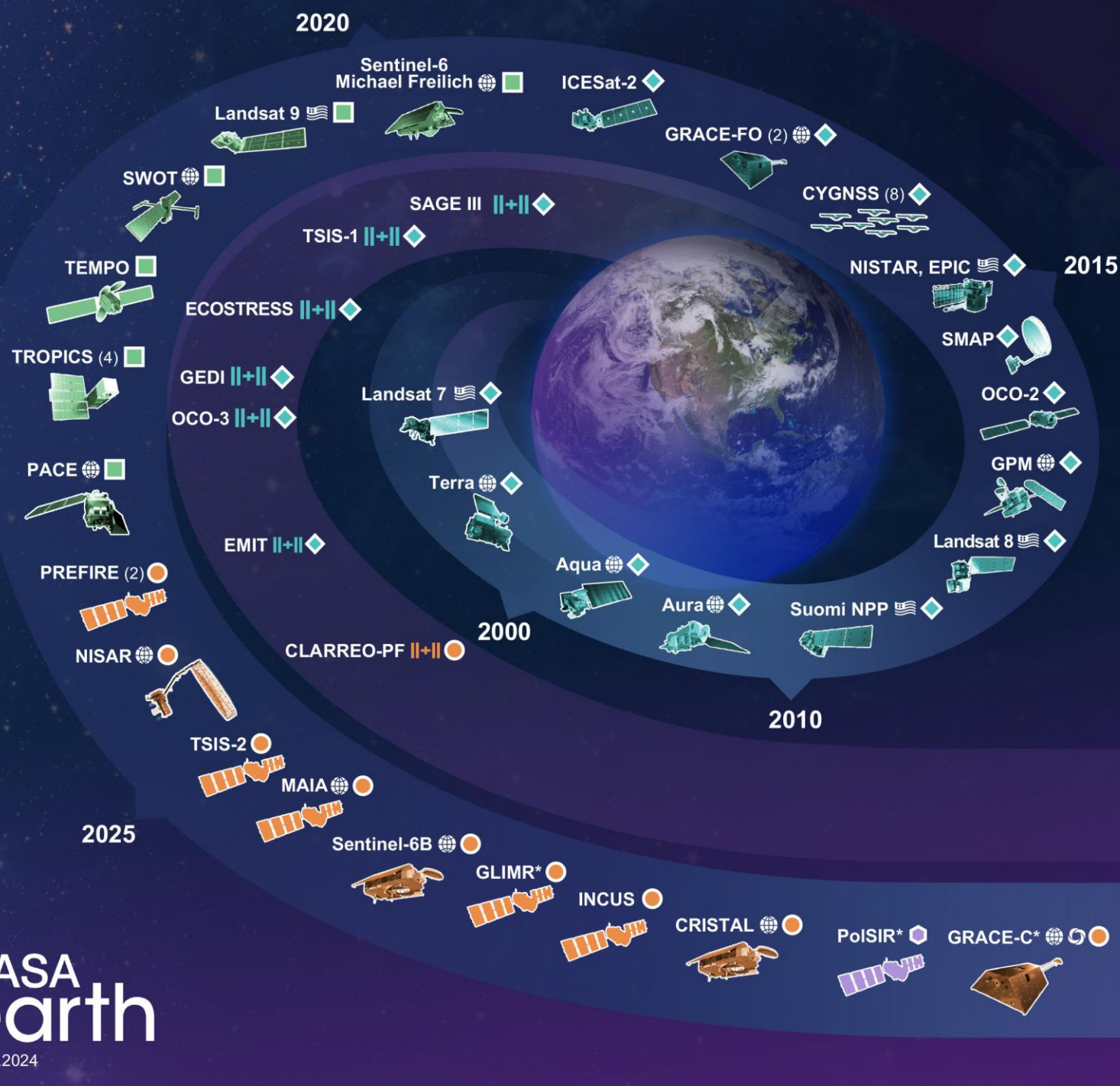
# Integration of Vantage Points and Approaches – Example of Air Quality







# EARTH FLEET



## Key

- International Partners
- U.S. Partner
- ISS Instrument
- JPSS Instrument
- Cubesat
- Launch Date TBD
- Earth System Observatory Mission (Pre) Formulation
- Implementation
- Operating
- Extended

## Invest/CubeSats

- MURI-FD 2023
- SNOOPI 2024
- HYTI 2024
- ARGOS\* 2024
- ARCSTONE\* 2025
- GRITSS\* 2025
- GRATTIS\* 2026

## JPSS Instruments

- OMPS-LIMB 2022
- LIBERA 2027
- OMPS-LIMB 2027
- OMPS-LIMB 2032

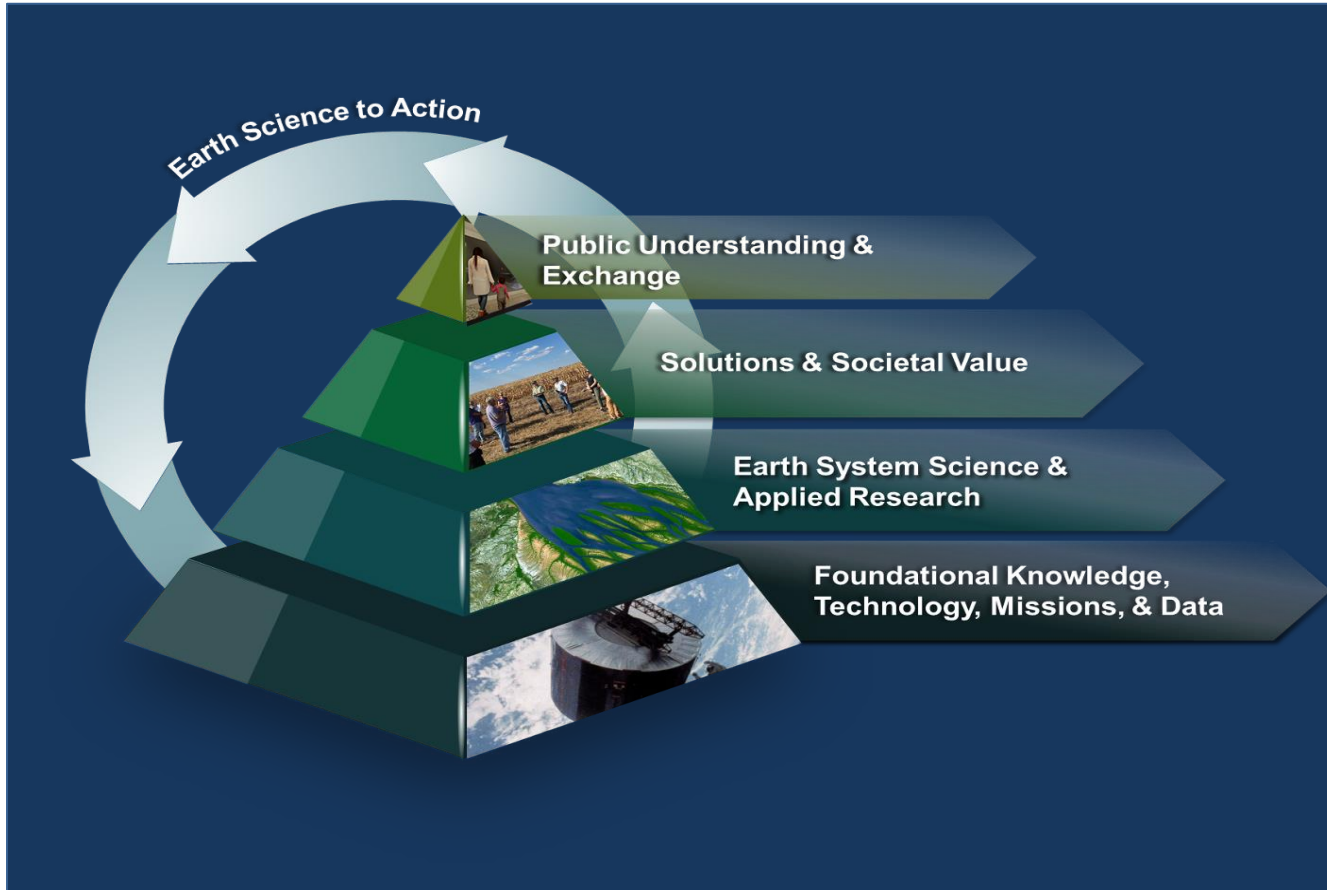
## ISS INSTRUMENTS

- PoSIR\*
- GRACE-C\*
- PMM\*
- SBG\*
- AOS Sky\*
- Landsat Next\*

## MISSIONS



## Earth Science to Action Strategy



**More on this on Thursday,  
July 18, 9 – 10 AM ET,  
during the GPO Session led  
by Amy P. Chen, GLOBE  
Program Manager**





## Tropospheric Emissions: Monitoring of Pollution (1)

- **TEMPO** is a grating spectrometer, sensitive to visible and ultraviolet wavelengths of light. It is attached to the Earth-facing side of a commercial telecommunications satellite that is stationed in a geostationary orbit. It will collect high-resolution measurements of ozone, nitrogen dioxide and other pollutants, data which will revolutionize air quality forecasts. It is integrated onto a Maxar 1300 Series Spacecraft bus and hosted on a Intelsat Commercial Satcom mission (IS40e) stationed at 91 deg W.
- Instrument was successfully powered (07 June)
- First light in August, 2023.
- Public release of standard products in October 2023.
  - Species: NO<sub>2</sub>, O<sub>3</sub>, HCHO, SO<sub>2</sub>, Aerosol products
  - Spatial resolution: 2.1 km N/S × 4.7 km E/W = 9.8 km<sup>2</sup> (native) at center of FOR



[https://weather.ndc.nasa.gov/tempo/green\\_paper.html](https://weather.ndc.nasa.gov/tempo/green_paper.html)

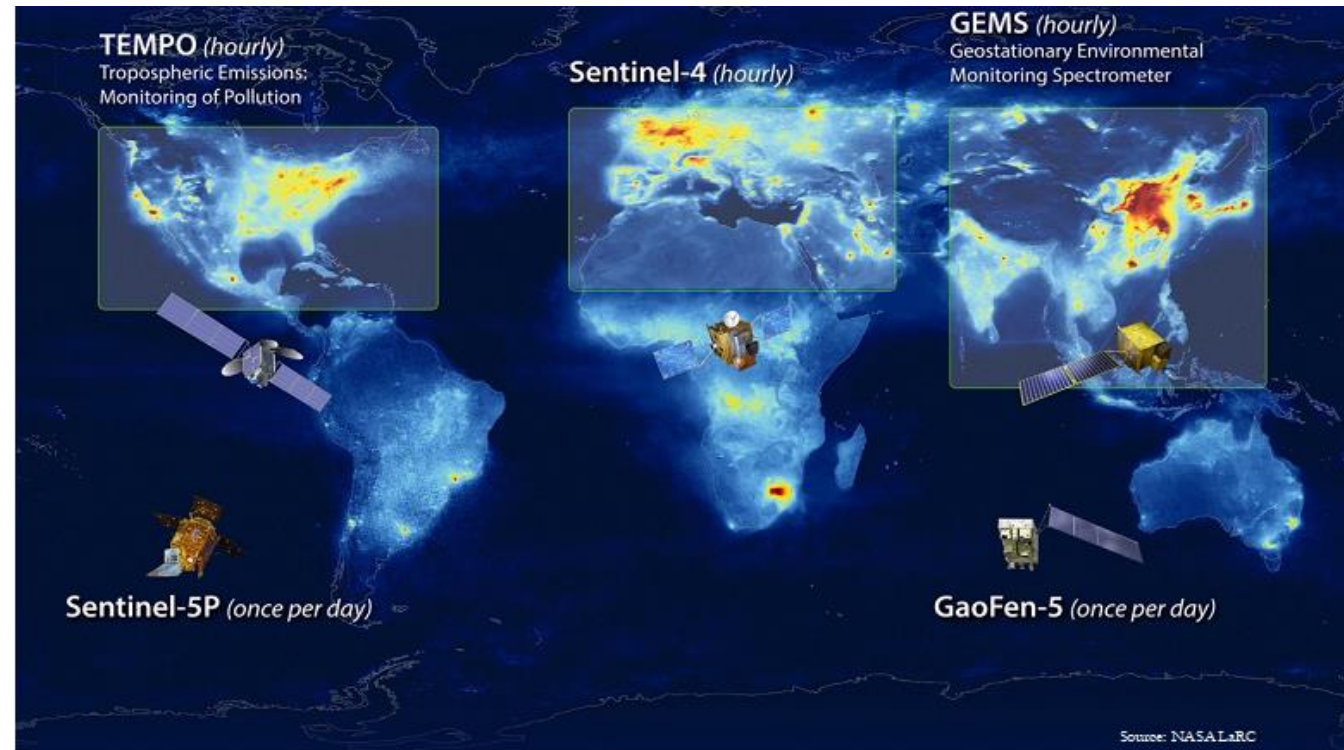




## Tropospheric Emissions: Monitoring of Pollution (2)

### Significance

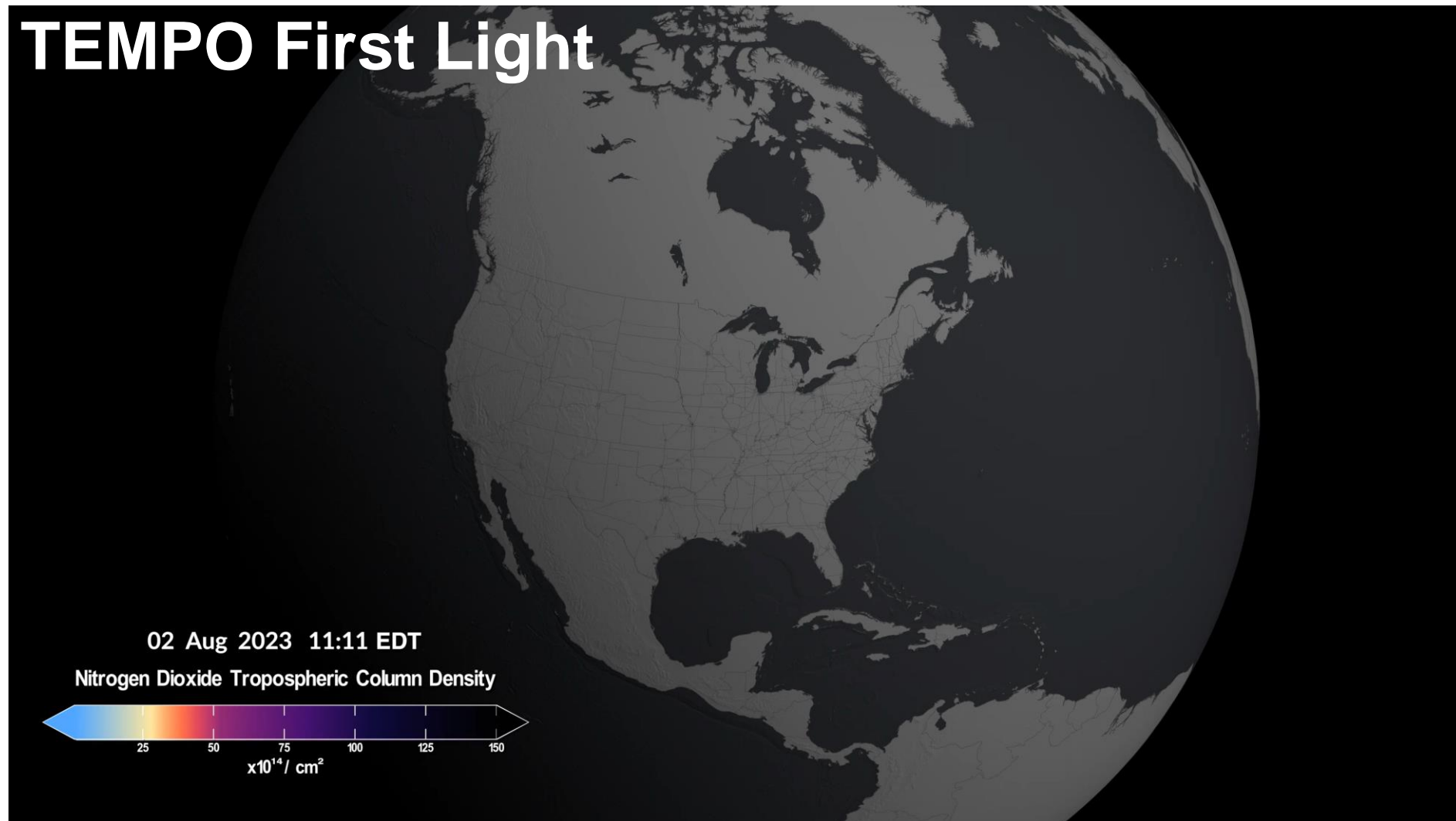
- It is NASA's first mission that will measure air pollution over North America, from Mexico City to the Canadian oil sands, and from the Atlantic to the Pacific at hourly temporal and high spatial resolution.
- It is the part of a global constellation of satellites that includes The European Sentinel-4 mission that will measure pollution over Europe, and Korean Geostationary Environmental Monitoring Spectrometer (GEMS).
- It continues from the geostationary orbit observations that were acquired from the polar orbits by the Ozone Monitoring Instrument (OMI), SCIAMACHY, and Global Ozone Monitoring Experiment (GOME).







## TEMPO First Light

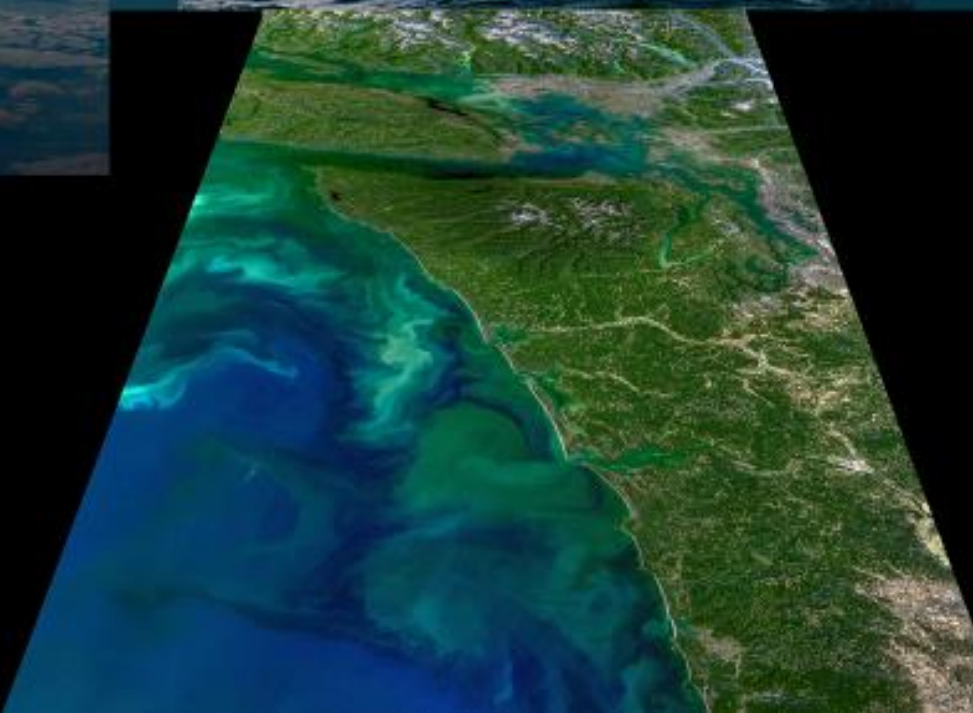


<https://svs.gsfc.nasa.gov/5142/>



## PACE Advances Ocean Science

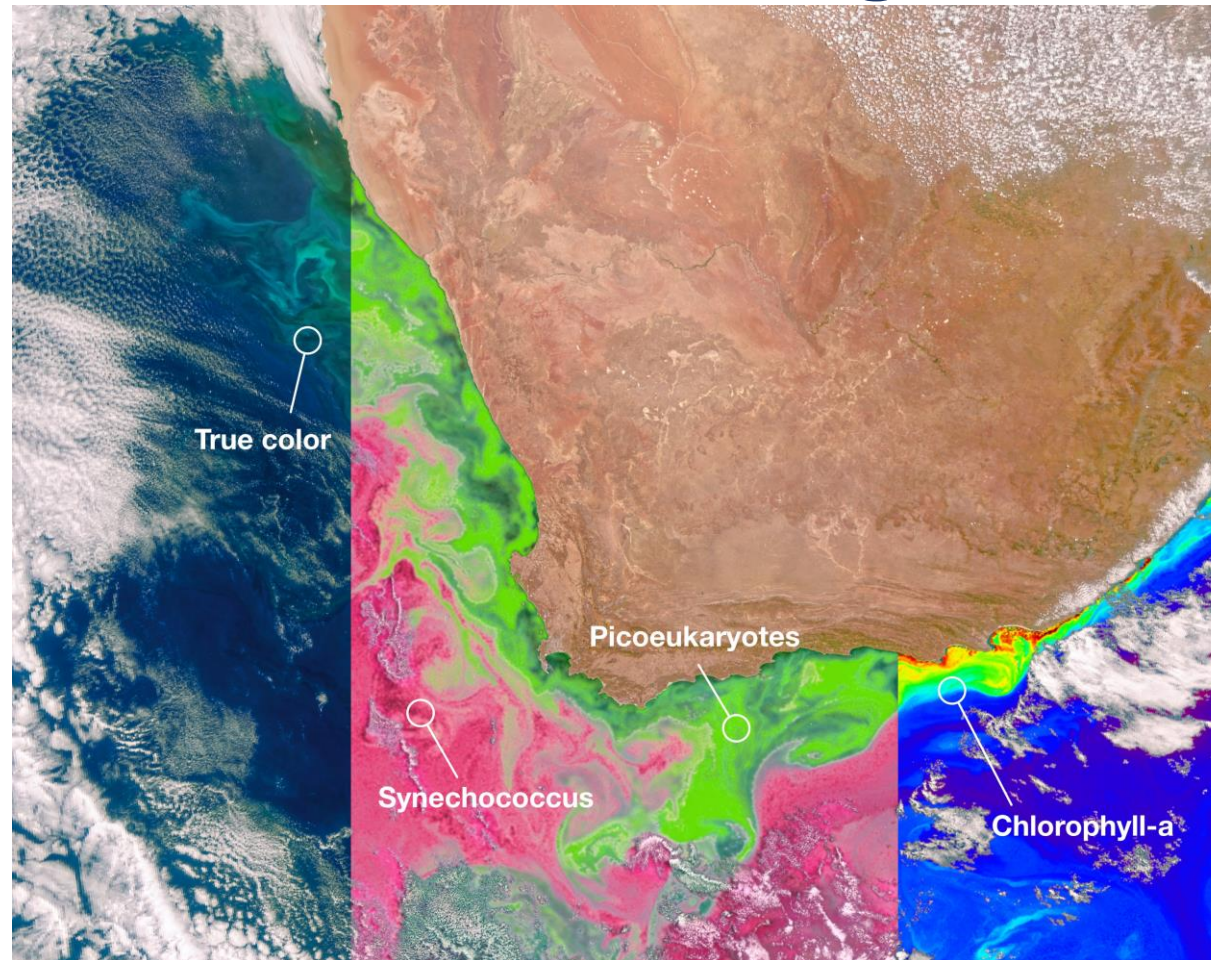
- Monitor fisheries
- Respond to toxic algae blooms
- Key ocean and atmosphere data for forecasting air quality and weather that will improve our understanding of Earth's climate







## PACE First Light



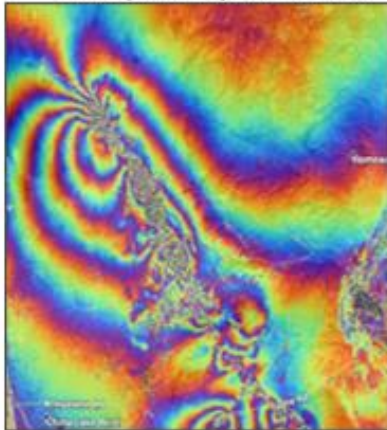
<https://www.nasa.gov/earth/nasas-pace-data-on-ocean-atmosphere-climate-now-available/>



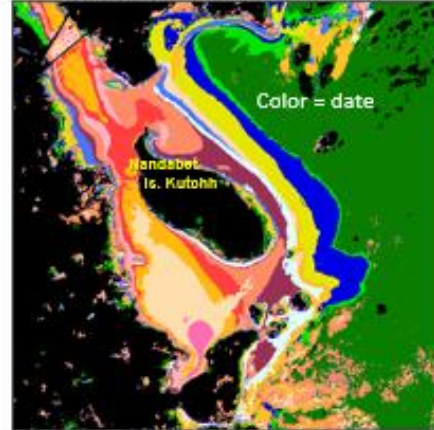


## NISAR Science Capturing a Dynamic Earth

Earthquake Dynamics, CA



Wetland Inundation, India



Disaster Monitoring:  
Bobcat Fire, Pasadena

NASA / JPL-Caltech / ARIA Product  
Contains modified Copernicus Sentinel data 2020.  
Revised: 10/06/2020. Contact: [unreadable]

- Dynamics of Ice: Ice sheets, Glaciers, and Sea Level**
  - Will there be catastrophic collapse of the major ice sheets, including Greenland and West Antarctic and, if so, how rapidly will this occur?
  - What will be the resulting time patterns of sea-level rise?
  - How are alpine glaciers changing in relation to climate?
- Ecosystems and Biomass Change**
  - How do changing climate and land use in forests, wetlands, and agricultural regions affect the carbon cycle and species habitats?
  - What are the effects of disturbance on ecosystem functions and services?
- Solid Earth Deformation: Hazard Response**
  - Which major fault systems are nearing release of stress via strong earthquakes?
  - Can we predict future eruptions of volcanoes?
  - What are optimal remote sensing strategies to mitigate disasters and monitor/manage water and hydrocarbon extraction and use
- Coastal Processes: India**
  - What is the state of important mangroves?
  - How are Indian coastlines changing?
  - What is the shallow bathymetry around India?
  - What is the variation of winds in India's coastal waters?



## Motivation for the MAIA Earth Venture Instrument Mission

Ambient airborne particulate matter (PM) is the top environmental health risk worldwide (2019 Global Burden of Disease)

- 1 High systolic blood pressure
- 2 Smoking
- 3 High fasting plasma glucose
- 4 High body-mass index
- 5 High LDL cholesterol
- 6 Ambient particulate matter pollution
- 7 Kidney dysfunction
- 8 Alcohol use

Metabolic risks  
 Environmental/occupational risks  
 Behavioral risks

The toxicity of different **PM types**—mixtures of particles with different sizes, shapes, and compositions—is not well understood.



“[T]here is not enough evidence to identify differences in the effects of particles with different chemical compositions...”  
(WHO, 2013)

MAIA will explore linkages between exposure to different types of PM and human health.

- Daily-averaged total PM<sub>10</sub>, total PM<sub>2.5</sub>, and speciated PM<sub>2.5</sub> will be mapped in selected areas on a 1-km grid

Sulfate
  Nitrate
  OC
  EC
  Dust



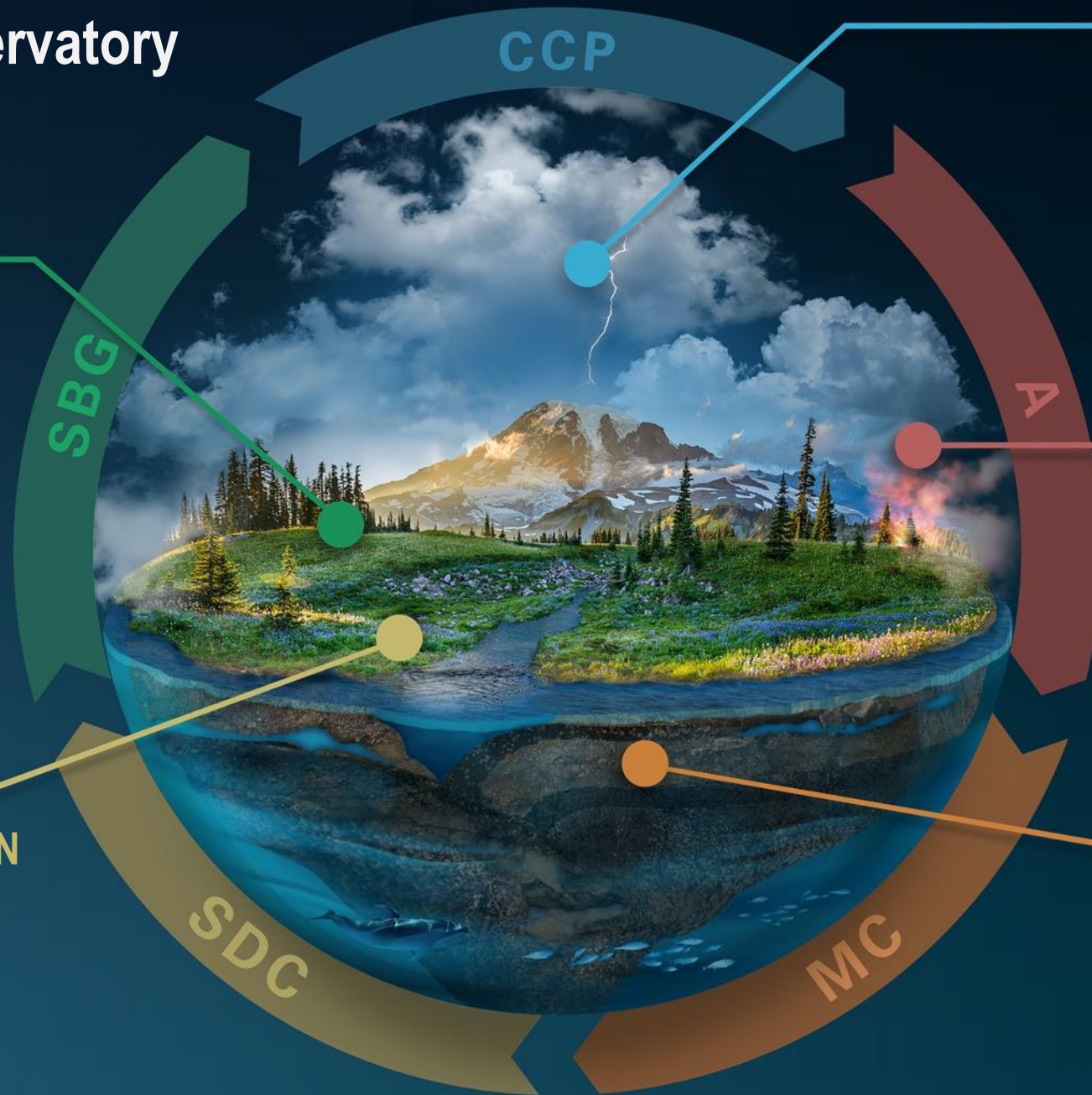
# Earth System Observatory

## SURFACE BIOLOGY AND GEOLOGY

Earth Surface & Ecosystems

## SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics



## CLOUDS, CONVECTION AND PRECIPITATION

Water and Energy in the Atmosphere

## AEROSOLS

Particles in the Atmosphere

## MASS CHANGE

Large-scale Mass

Redistribution



# Earth System Explorers (ESE)

**EARTH  
SYSTEM  
OBSERVATORY**

**EARTH  
SYSTEM  
OBSERVATORY**

INNOVATION & COMPETITION  
EARTH EXPLORER MISSIONS

Snow Depth and  
Water Content

3D Ecosystem  
Structure

Ocean Surface  
Winds and Currents

CCP

SBG

SDC

MC

Greenhouse  
Gases

Ozone and  
Trace Gases

Atmospheric  
Winds

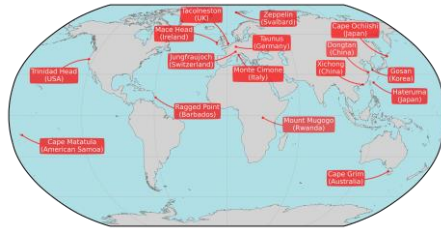
Ice Elevation

- The Stratosphere Troposphere Response using Infrared Vertically-Resolved Light Explorer (STRIVE)
- The Ocean Dynamics and Surface Exchange with the Atmosphere (ODYSEA)
- Earth Dynamics Geodetic Explorer (EDGE)
- The Carbon Investigation (Carbon-1)



## Examples of NASA-Supported Ground Networks

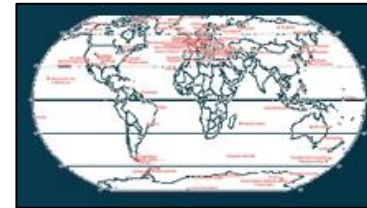
### AGAGE (in



### GGN



### NDACC



### NSGN



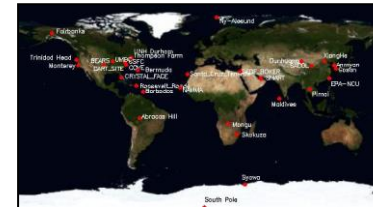
### AERONET



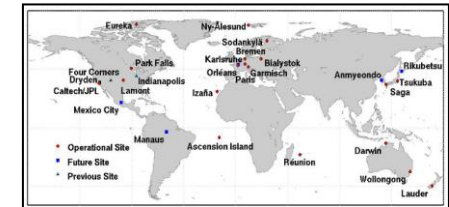
### SHADOZ (balloon



### MPLNet



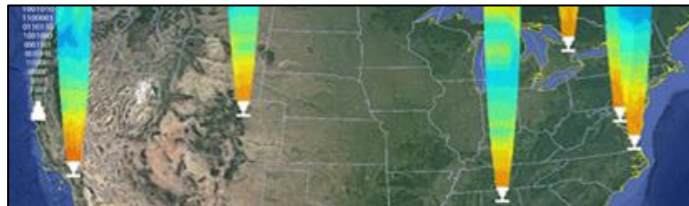
### TCCON



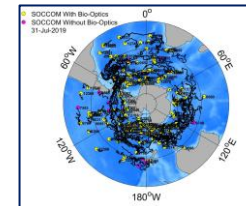
### PANDORA



### TOLNet



### SOCCOM







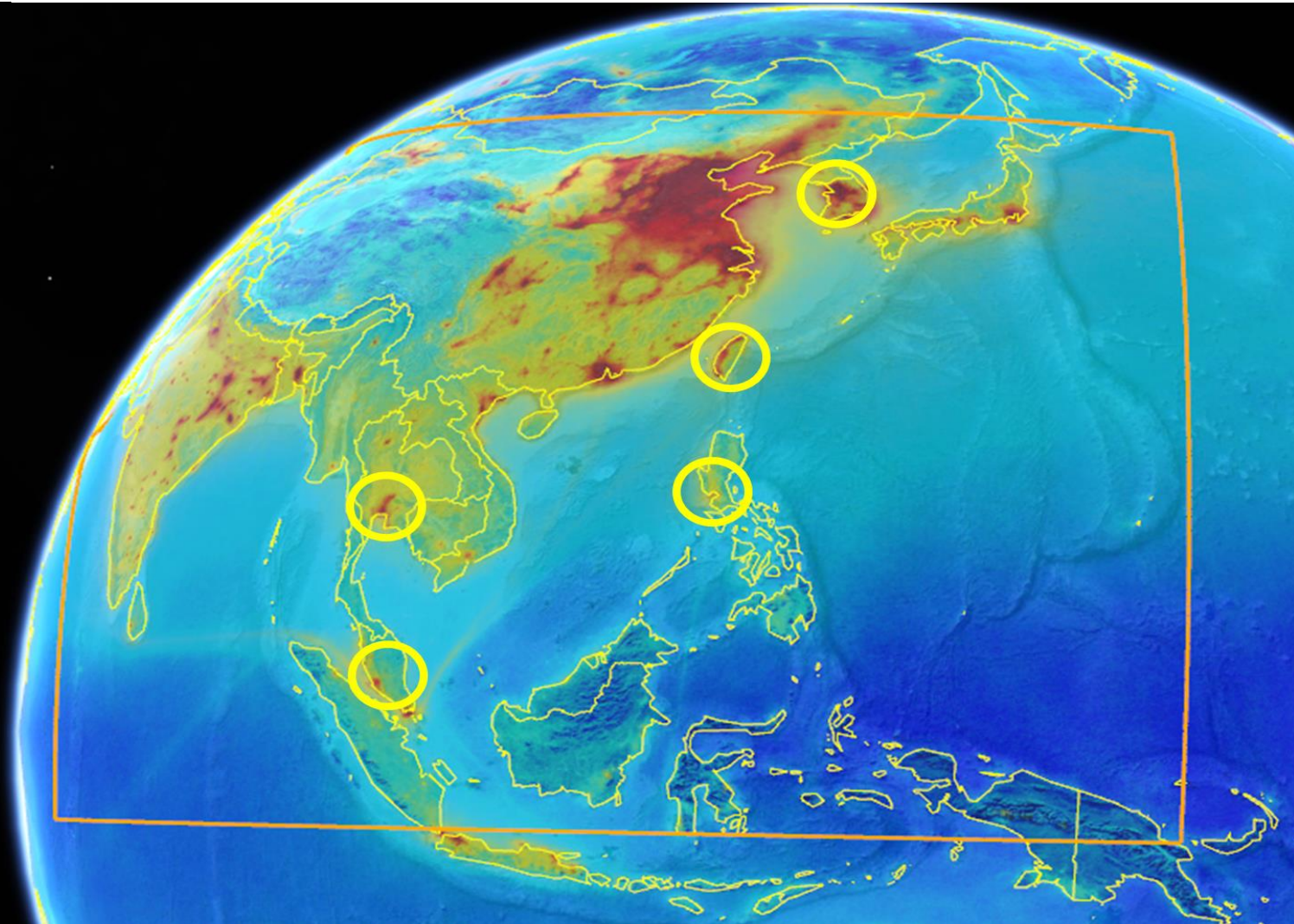
# The GLOBE Program

#GLOBEMeeting2024



## February-March 2024

- Working hand in hand with local scientists and environmental agencies across five locations.
- Connecting satellite observations to surface monitoring for improved air quality forecasting and decision making.
- Multi-perspective observations will be used to evaluate emissions, chemistry, and transport influences.



Sponsored by:



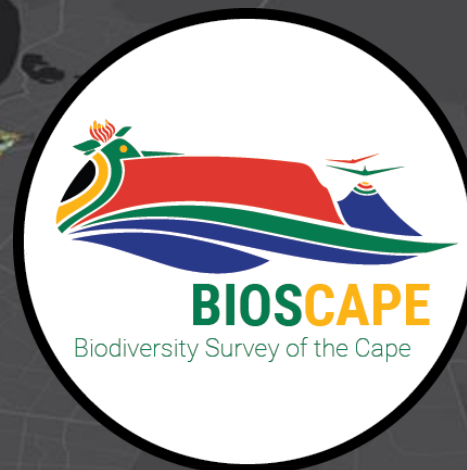
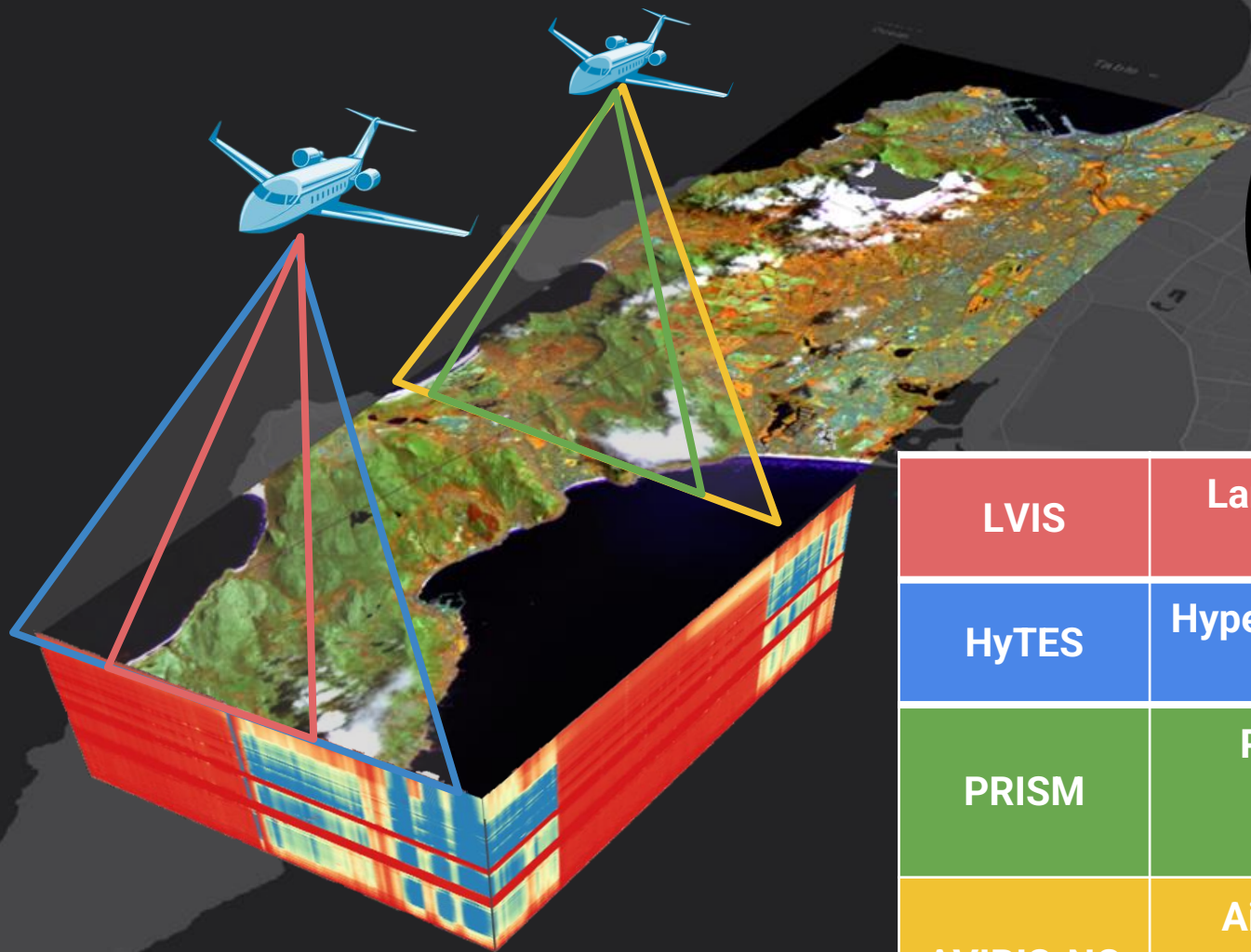
Supported by:







## BioSCape: Exploring Biodiversity's Role in Ecosystem Function and Services



*Flights in South Africa  
Oct-Nov 2023*

[www.bioscape.io](http://www.bioscape.io)

LVIS	Land, Vegetation, and Ice Sensor (Laser altimeter: 1064nm) <i>3D Vegetation Structure</i>
HyTES	Hyperspectral Thermal Emission Spectrometer (TIR: 7.5-12µm) <i>Land and Water Surface Temperatures, Plant ET</i>
PRISM	Portable Remote Imaging Spectrometer (UV-VNIR: 350-1050nm) <i>Composition of Aquatic Constituents, H2O Quality</i>
AVIRIS-NG	Airborne Visible-Infrared Imaging Spectrometer-Next Gen (VSWIR: 380-2510nm) <i>Ecosystem Vegetation Composition, H2O Quality, Geology</i>



## SnowEx 2023 Alaska Observations

### Ground conditions:

- Soil moisture
- Freeze-thaw state
- TLS - to characterize under/within canopy snow and no-snow conditions

### Snow conditions:

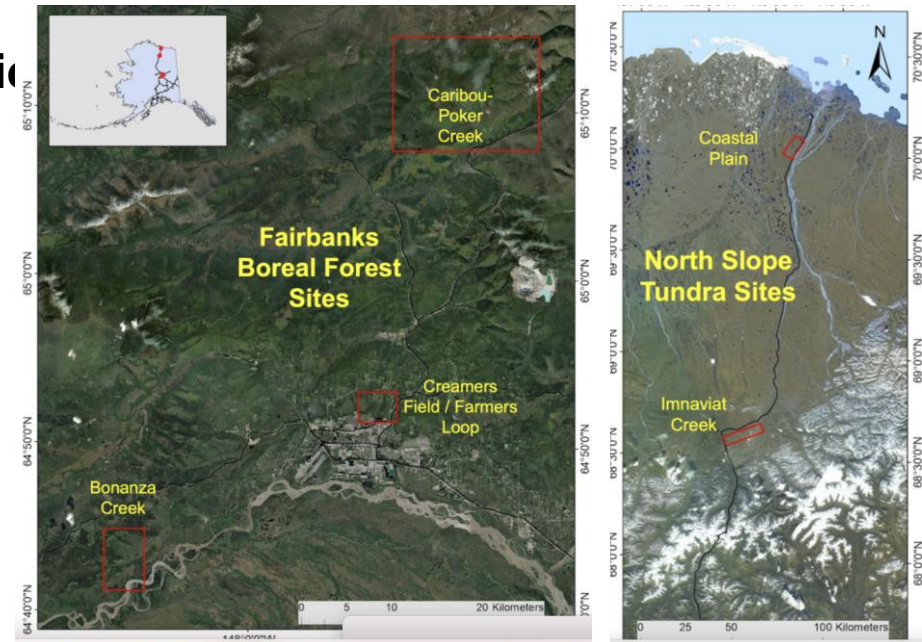
- Snow pits - selected with input from models, 2022 lidar data
- Snow depth transects or spirals (magnaprobe, GPR)
- mini-pits/SMP - variability in stratigraphy
- SWE tubes - snow density variability
- Microstructure (SSA, SMP, Casting)

### Airborne Measurements

- Active/passive microwave (SWESARR) during no/low-snow and snow-on conditions (GSFC)
- Lidar & stereo imagery during no/low-snow and snow-on conditions (UAF)
- Hyperspectral (AVIRIS-NG) during melt period at boreal forest sites (JPL)

### Coincident satellite observations

- ICESat-2 (lidar)
- Worldview (optical)
- Pleiades-HR (optical)
- BlackSky (optical)
- Planet SkySat-C (optical)
- Capella (X-band)
- ICEYE (X-band)
- Sentinel 1A (C-band)



<https://snow.nasa.gov/campaigns/snowex-2023-tundra-and-boreal-forest>





## GLOBE Program's collaboration with Airborne Science Program



GLOBE Philippines & CAMP2Ex (2019)



GLOBE NE USA & IMPACTS (2023)



GLOBE Alaska & SnowEx (2023)



GLOBE S. Africa & BioSCape (2023)



*Not pictured: GLOBE Mission Earth & SnowEx (2017); GLOBE Philippines & ASIA-AQ (2024)*



## Key Types of International Engagement

### ■ Observations

- Bilateral cooperation in missions and related science
- Multi-lateral organizationally-mediated cooperation
- Field work (airborne, balloon, surface, shipborne)
- Surface-based measurement networks

### ■ Research, Applications, and Assessment

- Research: WCRP, Future Earth
- Applications: UN/SDGs, Disasters
- Assessment: IPCC, WMO/UNEP, IPBES, WOA, AMAP
- Internationally-Focused Opportunities

### ■ Education and Capacity Building

- Education: **GLOBE**
- Capacity Building: SERVIR, ARSET, others







# The GLOBE Program

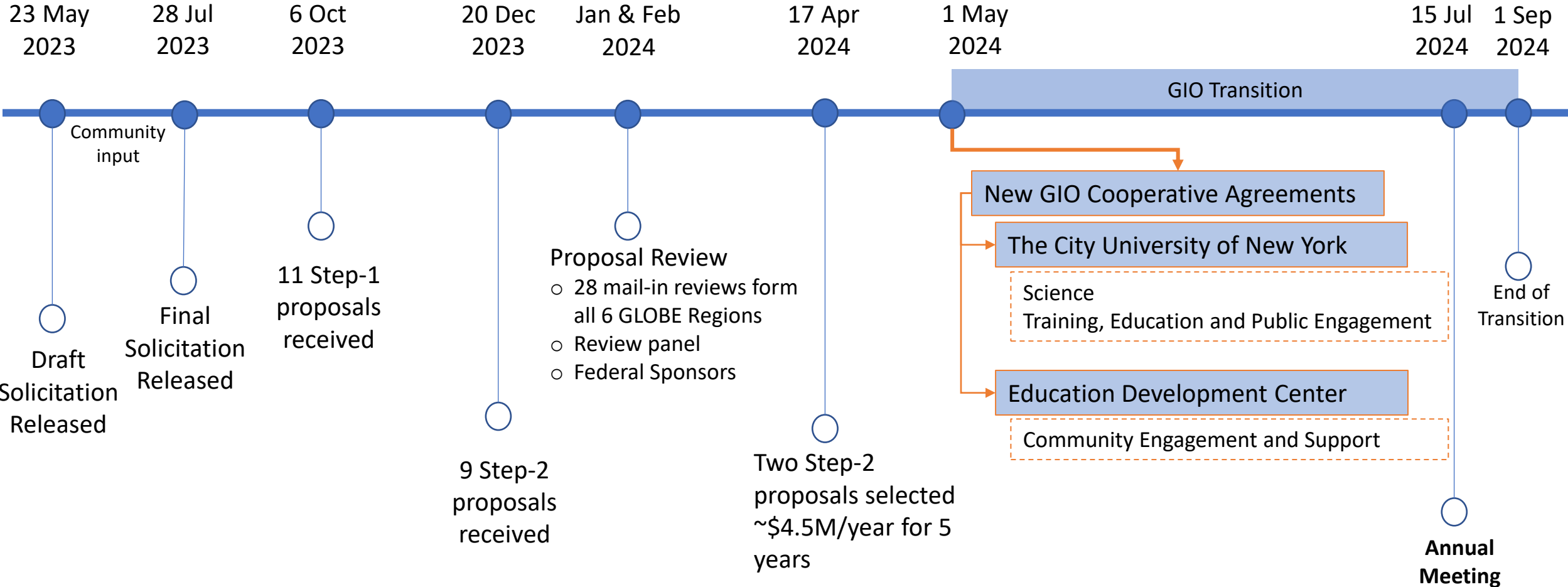
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Solicitation

Proposal Reviews

Selection

Transition Period





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