National Aeronautics and Space Administration

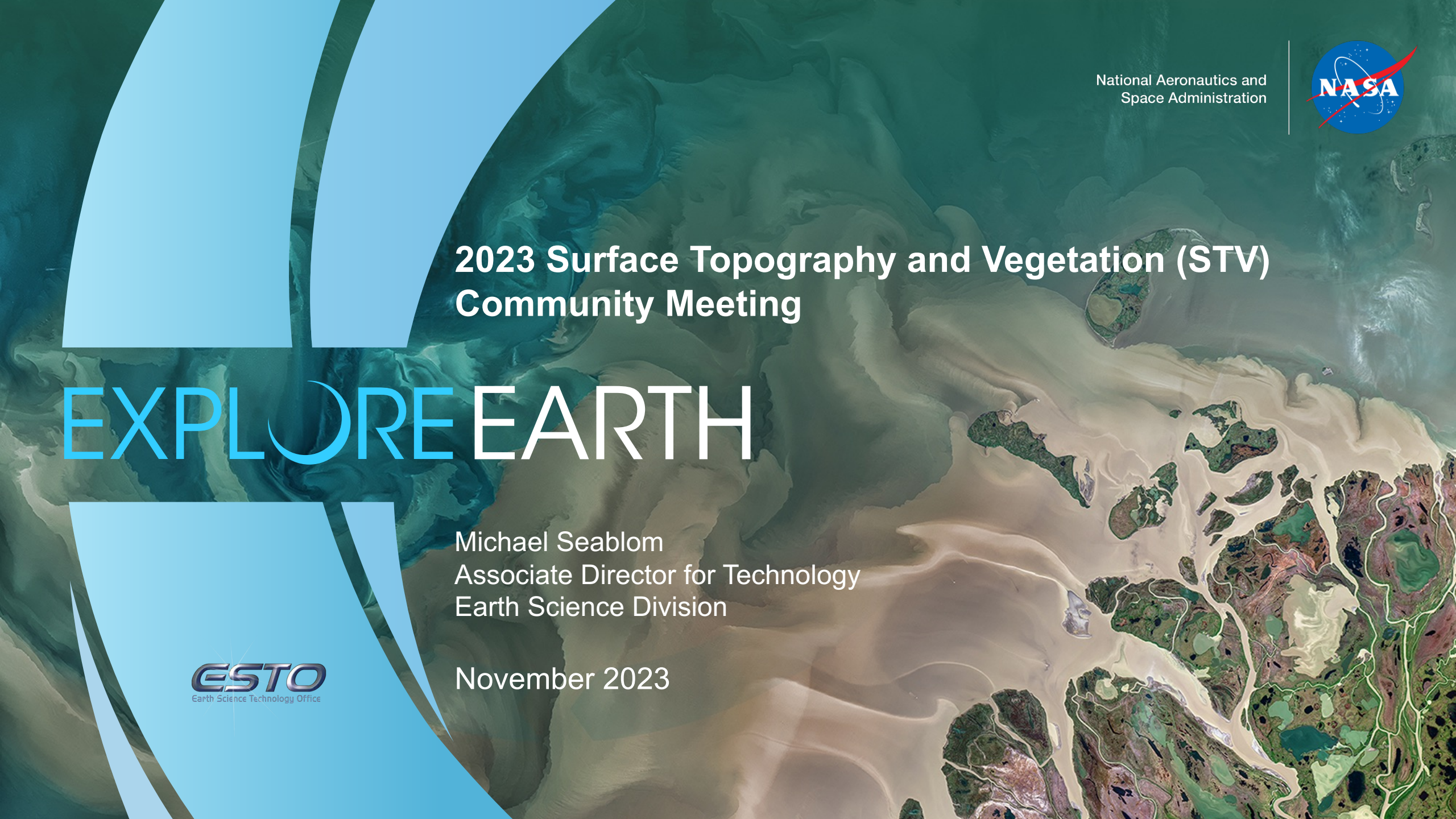
2023 Surface Topography and Vegetation (STV) Community Meeting

EXPLORE EARTH

Michael Seablom
Associate Director for Technology
Earth Science Division

November 2023

ESTO
Earth Science Technology Office



NASA HQ Earth Science Division

Karen St. Germain
DIVISION DIRECTOR

Julie Robinson
DEPUTY DIRECTOR

Sid Boukabara
Senior Program Scientist, Strategy

Lawrence Friedl
Senior Engagement Officer

Wendy Mihm
Communications Lead

ELEMENTS

Michael Seablom
Associate Director

EARTH SCIENCE TECHNOLOGY OFFICE

Deputy Associate Director
Vacant

Scott Schwinger
Associate Director (Acting)

FLIGHT PROGRAMS

Deputy Associate Director
Vacant

Katie Baynes
Earth Data Officer

EARTH SCIENCE DATA SYSTEMS

Deputy Earth Data Officer
Vacant

Jack Kaye
Associate Director

RESEARCH & ANALYSIS

David Considine
Rotational Deputy

Deputy Associate Director
Lucia Tsaoussi

Thomas Wagner
Associate Director

EARTH ACTION

Deputy Associate Director
Emily Sylak-Glassman

EMBEDS

Karen Fox
Office of Communications

Kim Hurst
Office of International & Interagency Relations

Andrew Rowe
Legislative & Intergovernmental Affairs

Peifen Heesch
Resource Management Division

Sara Schwartzman
Policy Branch

Shanee Hill
Administrative Branch

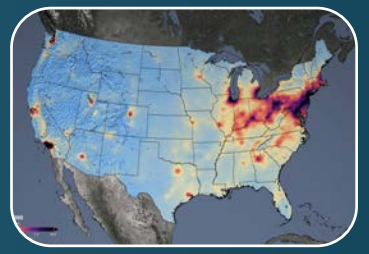
Current as of 10-27-2023

The Path Forward for NASA Earth Science

Earth Science to Action Strategy

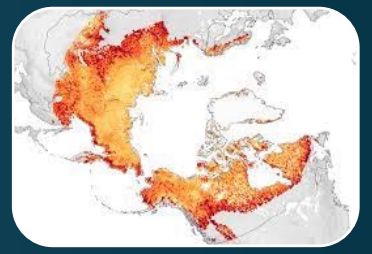
Initial Earth Action Focal Areas

Agriculture



Air Quality

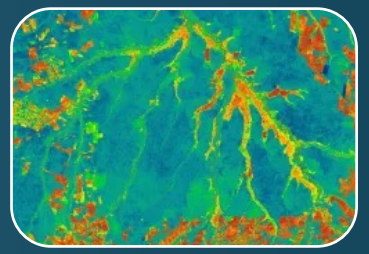
Biodiversity



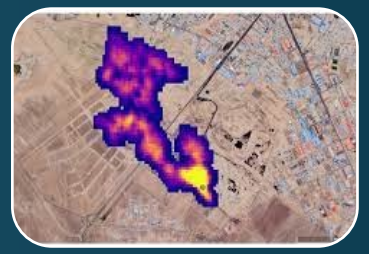
Carbon Accounting

Disasters

Energy & Infrastructure



Environmental Health



Greenhouse Gases

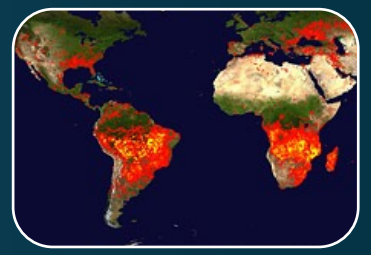
Human-Ocean Interactions

National Security

Sea Level Rise & Coastal

Urbanization

Water Resources



Wildfires

NASA FireSense

Technology Development

Airborne Demonstration

Information Delivery

The Earth System Observatory

EARTH SYSTEM OBSERVATORY

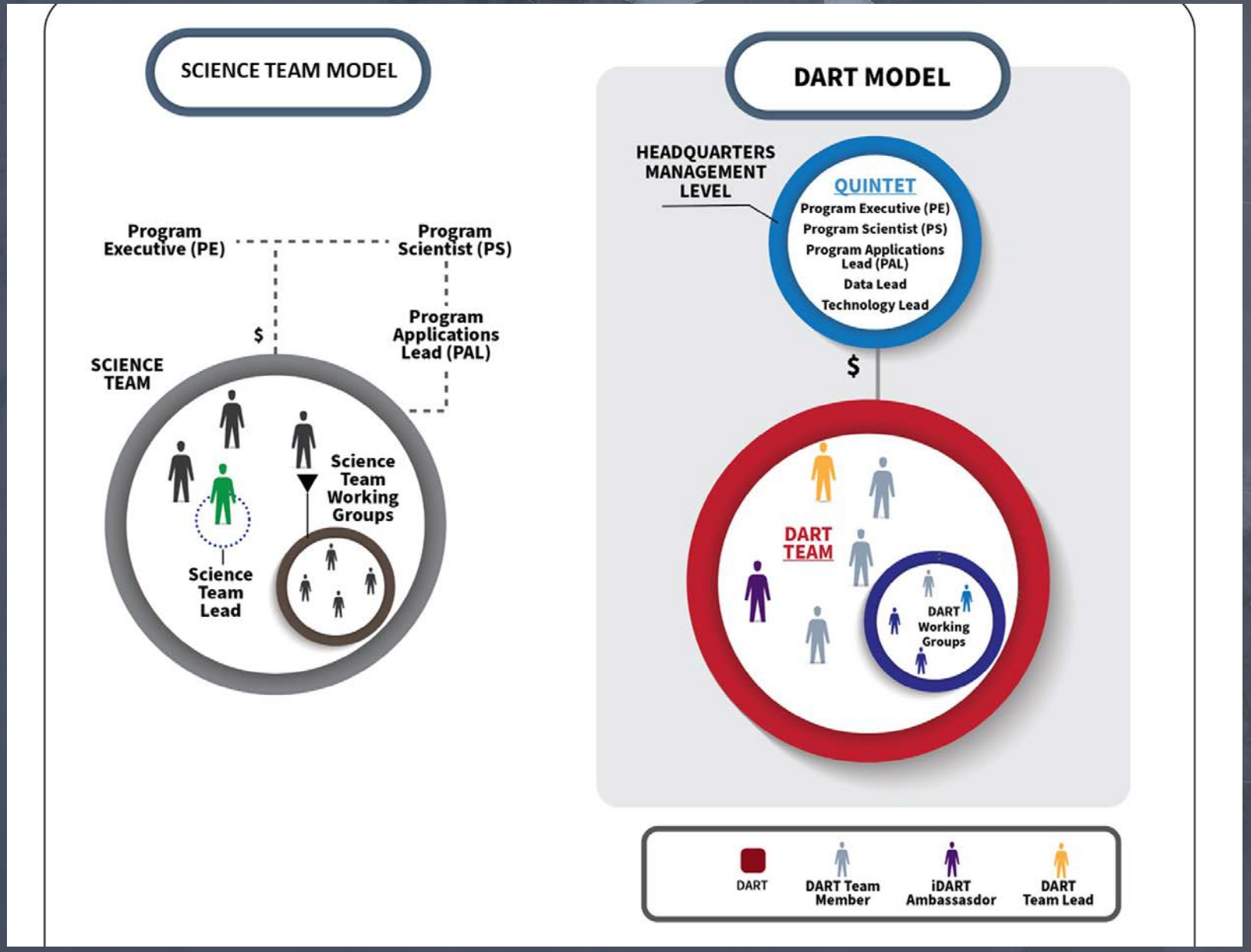
VISION & GOALS

Maximize the potential of an integrated observatory to advance Earth system science for the benefit of humanity

Develop a flexible framework for addressing inter-disciplinary, multi-mission science/applications/technical challenges, while ensuring success and impact of individual missions

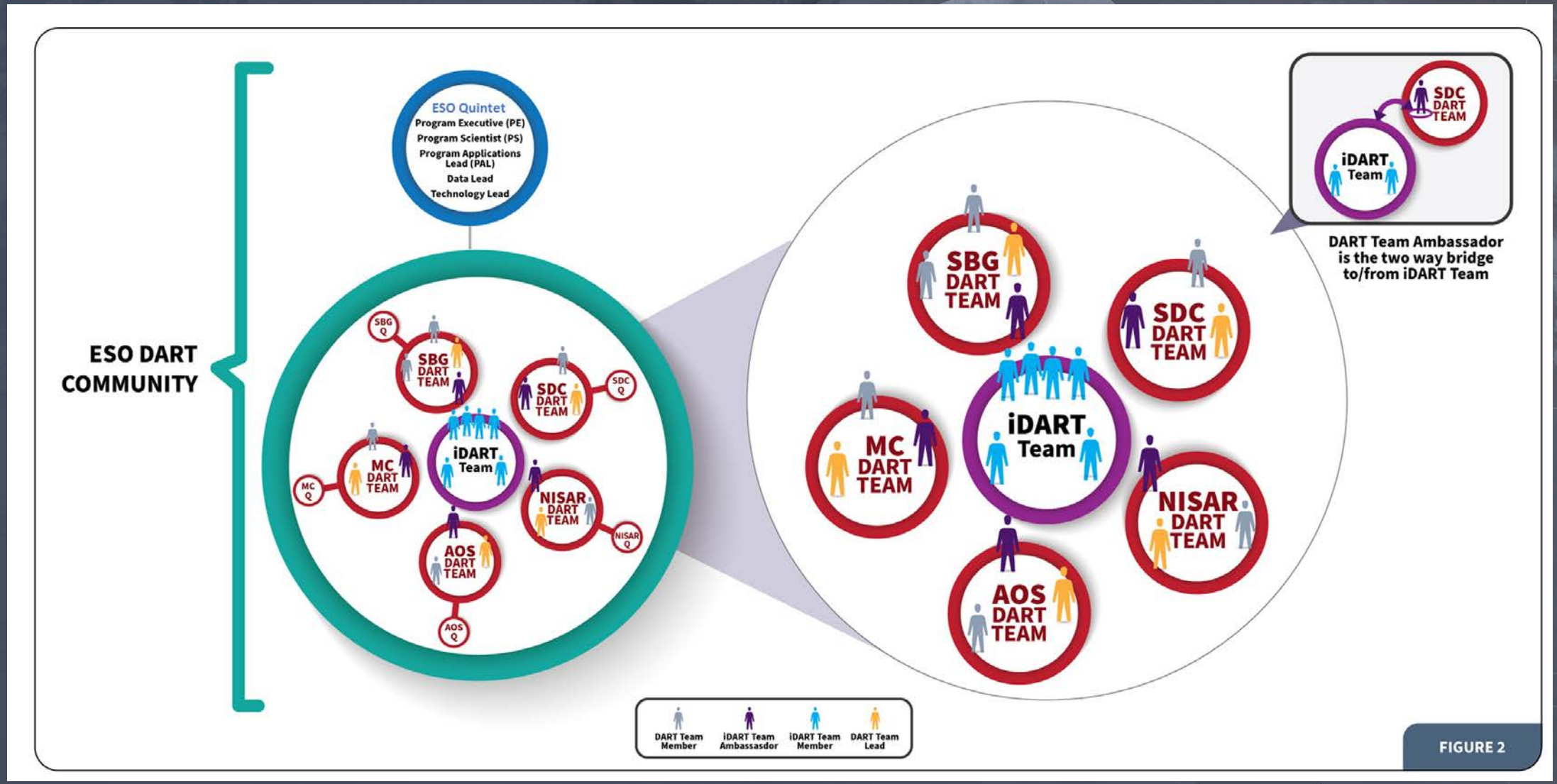
Future of Earth Science Teams

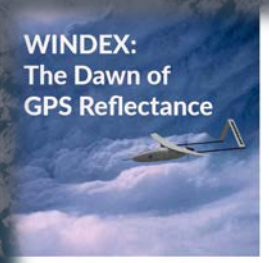
EARTH SYSTEM OBSERVATORY

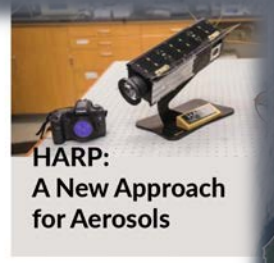


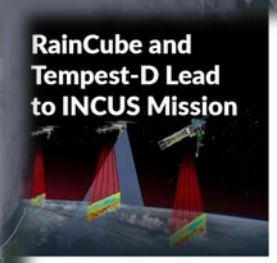
Integrated Science Teams (iESO)

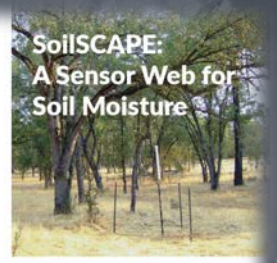
EARTH SYSTEM OBSERVATORY

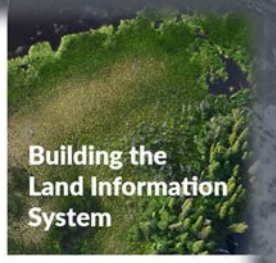


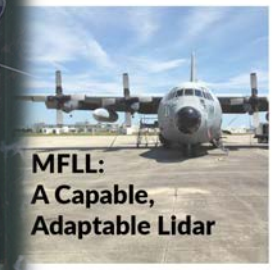


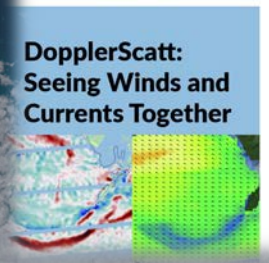


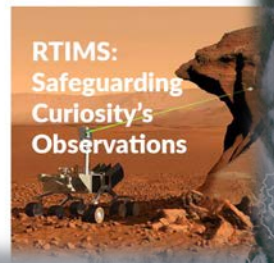


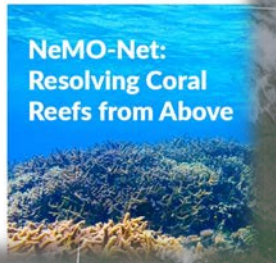












ESTO

Earth Science Technology Office

25 YEARS

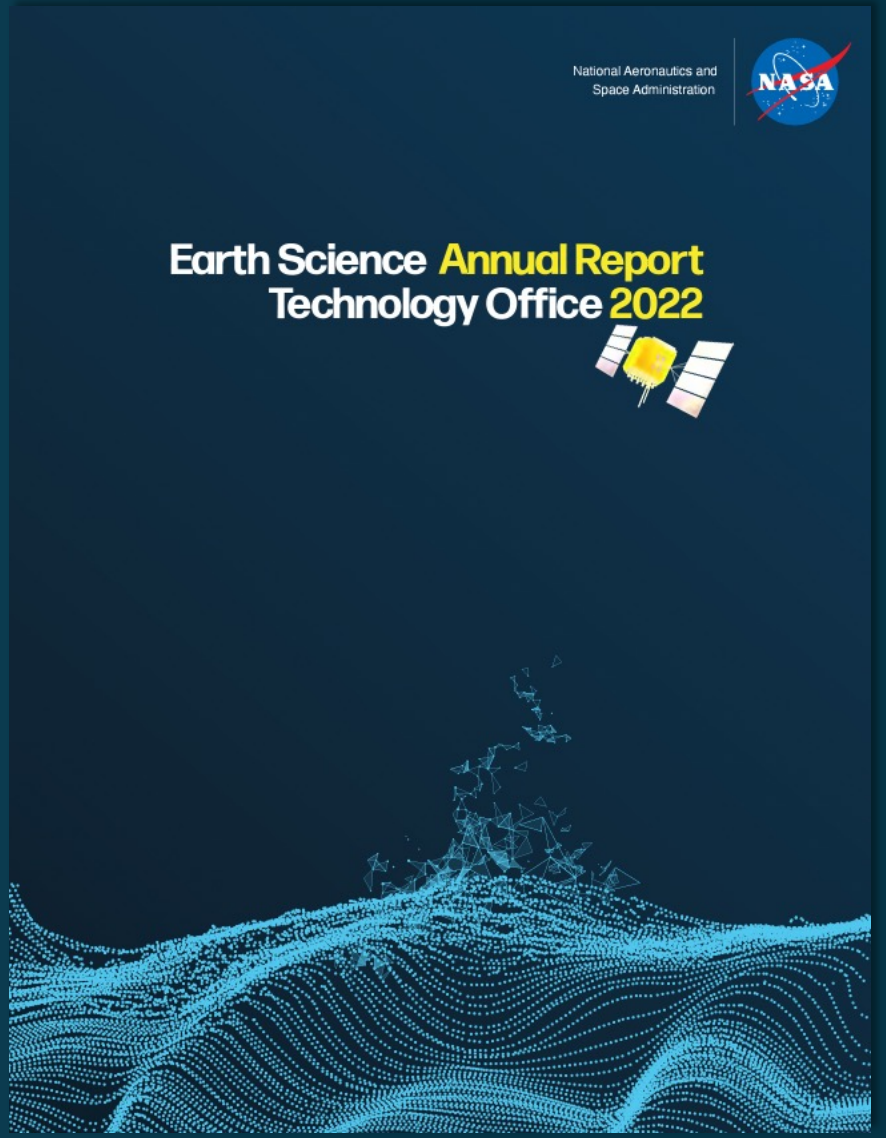
ESTO Objectives

Enable science and applications programs to reduce the cost and risk of Earth Science measurements, and increase their capabilities

Implement focused technology programs that foster innovation from NASA field centers, industry, academia

Integrate the technology investments across the Agency and beyond

- STMD programs (NIAC, SBIR, GCD, SSTP, STRI, others)
- NASA field centers - internal research & development initiatives
- Other SMD divisions
- Other Government agencies
- Collaborations with foreign entities, when possible



Implementation Approach

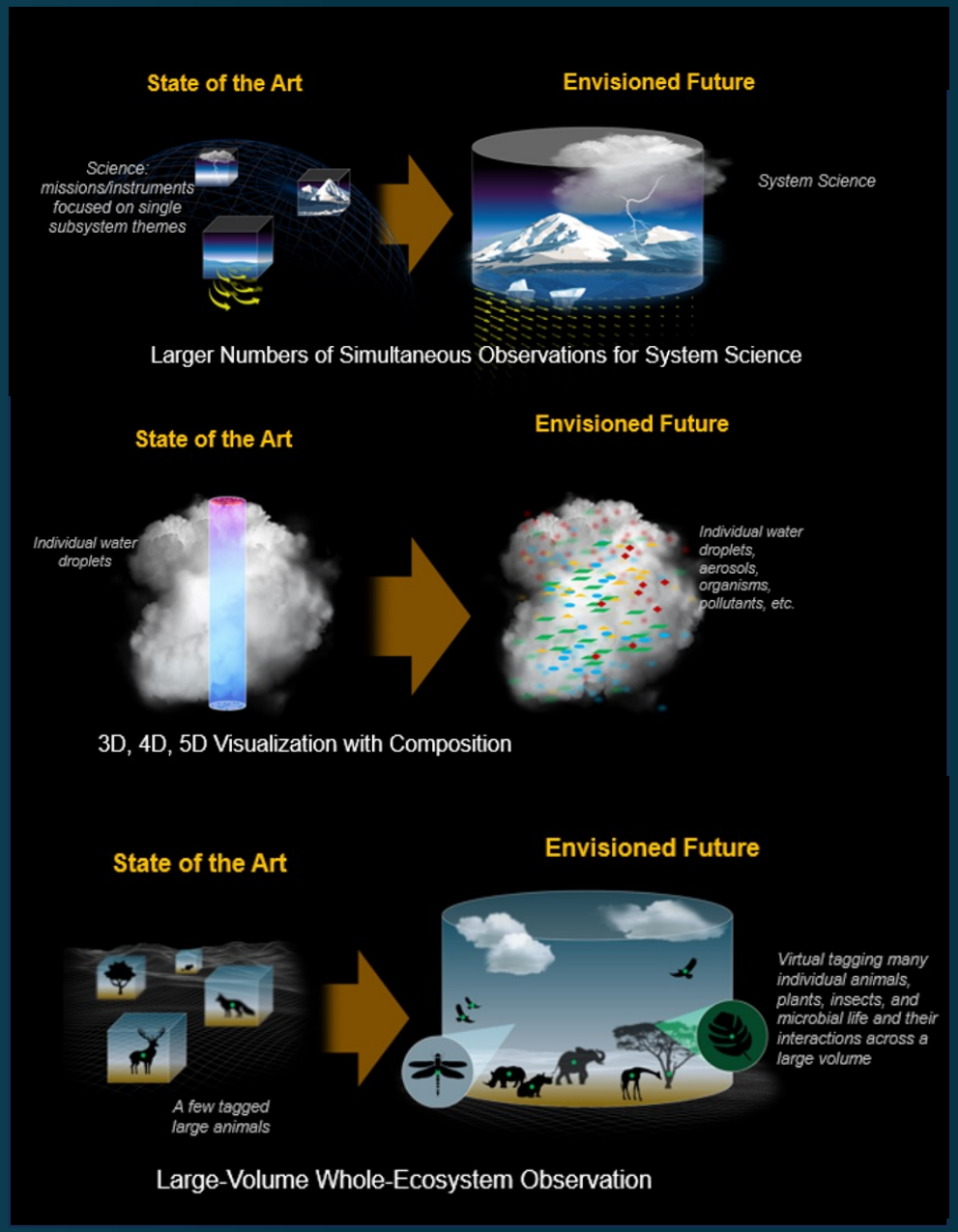
Engage with the Earth Science community to plan investments through careful analyses of long-term science needs

ESTO's **Earth Science – STMD Working Group (ESSWG),** established in 2021, identifies science measurement needs for the period 2030-2040

- Builds upon the science needs identified in the 2017 Decadal Survey
- Engages the R&A and Applied Sciences elements to prioritize:
  - *Revolutionary Capabilities (new efforts or areas of study)*
  - *Evolutionary Capabilities (continuation of existing measurements, but at higher resolution, accuracy, lower uncertainty, etc.)*

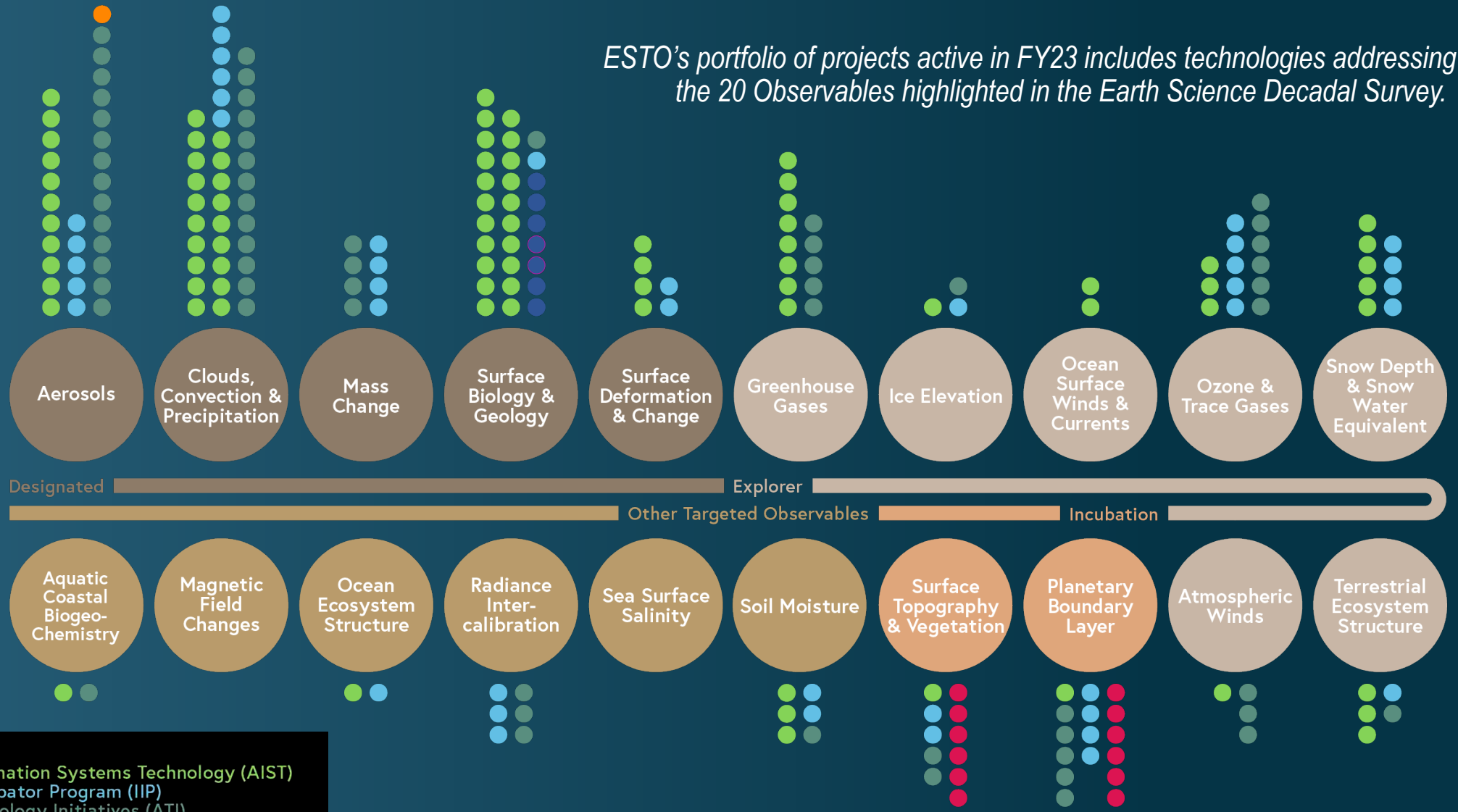
Examples of Revolutionary Capabilities under discussion:

- *Transformational Modeling (e.g., next generation Digital Twins)*
- *Direct measurements of 3D/4D coupled systems (e.g., tomography)*
- *Leaps in sensitivity (e.g., quantum sensors)*
- *Dynamic intercalibration*
- *Adaptive targeting of measurements by numerical models*



Technology Investments Mapped to 2018 Decadal Survey

ESTO's portfolio of projects active in FY23 includes technologies addressing 18 of the 20 Observables highlighted in the Earth Science Decadal Survey.



- Advanced Information Systems Technology (AIST)
- Instrument Incubator Program (IIP)
- Advanced Technology Initiatives (ATI)
- Decadal Survey Incubation
- Sustainable Land Imaging-Technology (SLI-T)
- FireSense Technology

Decadal Survey Incubation Program (DSI)

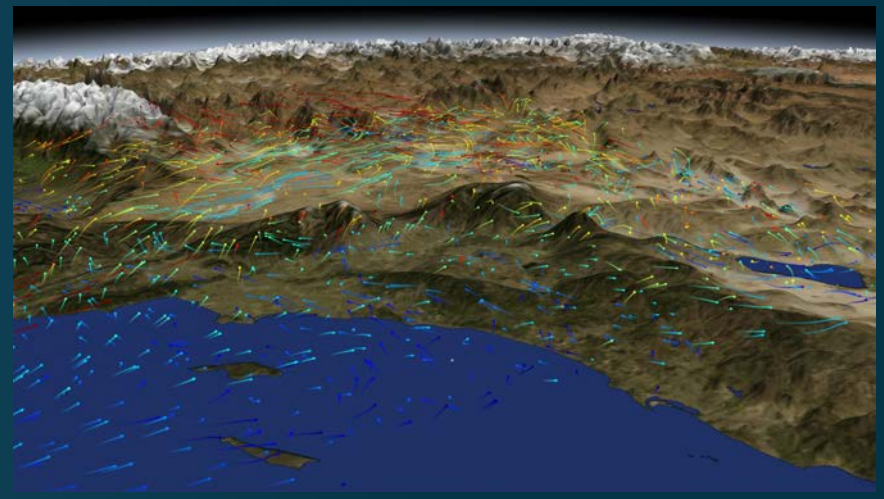
Program established based on Decadal recommendation for an incubation program for high priority measurements that lack technical maturity, including for the **Planetary Boundary Layer** and **Surface Topography and Vegetation.**

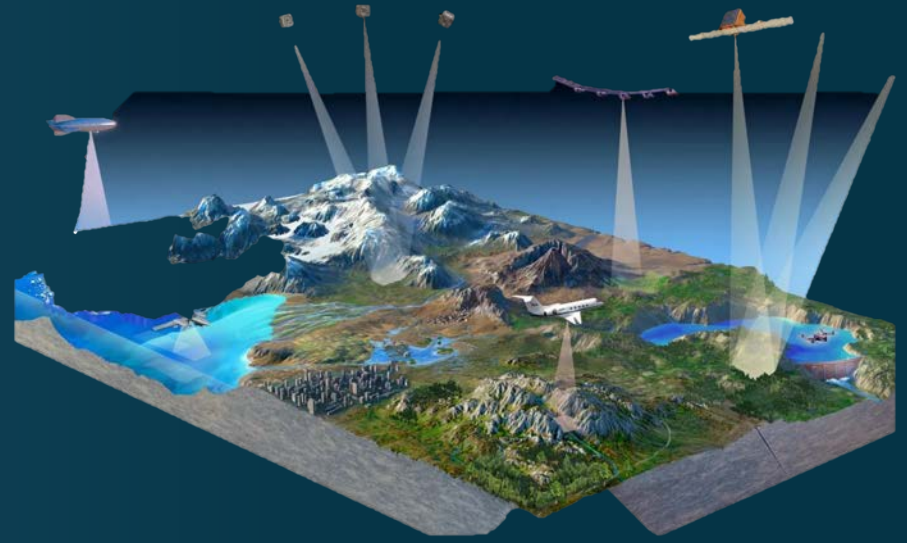
- *Improve understanding of measurement needs through modeling and concept studies and to identify technology gaps*
- *Identify needs which can be addressed through ground-based, airborne, or other sub-orbital platforms*
- *Identify commercial opportunities*

ESTO's DSI program is closely coordinated with R&A focus areas:

- Weather and Atmospheric Dynamics
- Earth Surface and Interior

FY21 solicitation produced **35 funded projects, 6** of which were targeted at technology development for PBL and STV



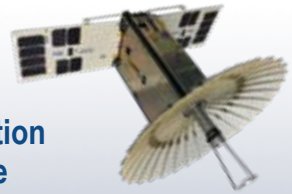


Earth Science Technology Program Elements

ESTO manages, on average, 138 active technology development projects. Most are funded through the primary program lines below. Over 900 projects have completed since 1998.

Advanced Components and In-Space Validation

Advanced Component Technologies (ACT)
Critical components and subsystems for advanced instruments and observing systems
Average award: $600k per year over 2/3 years.



In-Space Validation of Earth Science Technologies (InVEST)
On-orbit technology validation and risk reduction for small instruments and instrument systems.
Avg award: $3M/yr over 4 yrs

New Instrument Technologies

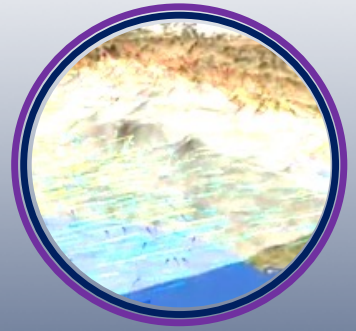
Instrument Incubator Program (IIP)
Innovative remote sensing instrument development from breadboard and demonstration through maturation to TRLs 4-6.
Average award IDD: $1.5M per year over 3 years. (Instrument Development and Demonstration)
Average award ITM - NEW: $2.5M over 2 years (Instrument Technology Maturation, starting with IIP-23)

Advanced Information Systems Technology (AIST)

Advanced Information Systems Technology (AIST) Innovative information systems for: new measurements from distributed sensing; Science missions ROI optimization; agile Science investigations; integrated information frameworks for mirroring Earth systems evolution and what-if scenarios.
Average award AET: $650k per year over 2-3 years.
Average award EST: $600k total over 1.5 years

Decadal Incubation

Maturation of observing systems, instrument technology, and measurement concepts for Planetary Boundary Layer and Surface Topography and Vegetation.
Avg tech award: $500k /yr for 3 years
Avg science award: $200k /yr for 3 years
Average OSSE award: $200k per year (STV) / $500k per year (PBL) for 2 years



Other Agency Technology Activities Managed by ESTO

ESTO also manages specific sets of technology development and integration projects on behalf of NASA's Earth Science Division, ESD, Research and Flight programs.

Wildland Fire Management

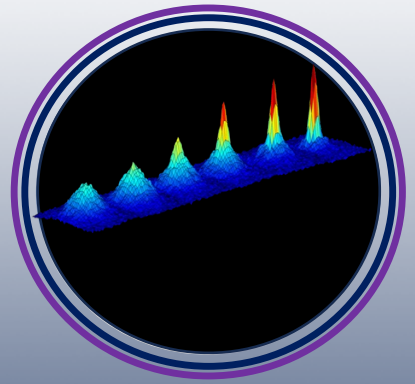
The **Wildland Fire Management Technology** program, established in 2022, invests in technologies that are designed for rapid infusion into products to be used by operational fire management agencies.
Total funding available: $4M in FY24; there are currently 8 active projects

Airborne Instrument Technology Transition

The **Airborne Instrument Technology Transition (AITT)** program provides campaign ready airborne instrumentation to support the objectives of the R&A Program. AITT converts mature instruments into operational suborbital assets that can participate in field experiments, evaluate new satellite instrument concepts, and/or provide calibration and validation of satellite instruments.

Quantum Sensing Institute NEW

The Space Technology Research Institute program, managed by the Space Technology Mission Directorate, awarded the **University of Texas – Austin** a five-year grant to study the physics behind quantum sensing, what Earth Science applications might be enabled, and quantify the engineering required to build useful space-based systems.




NASA
NASA EARTH
Your Home. Our Mission.

PROPOSED CONCEPT

EARTH SYSTEM OBSERVATORY

1. Define technical/science/application challenges:
   - Focus on broad and rapidly-evolving Earth system processes with high socio-economic impacts
   - “Earth Challenges”, Earth fundamental cycles (water, energy) that cut across atmosphere-land-ocean-solid Earth components
   - Key: Define a broader processes than we do today within existing teams, e.g., sea level, coastal, hazards, air-sea, etc.
2. Map Earth processes to (1) human and socio-economic domain and (2) needed observational assets and missions
   - Create cross-cutting links to Earth Actions, data and informational needs, and missions (ESO, ESD/ESO+)
   - Key: Make mapping inversible, to fit different contexts, from Earth to Humans, and from Humans to Earth

Table 1: Examples of fundamental Earth Challenges within Earth-Human system enabled by integrated core and broader ESO (first thoughts, not complete)

Earth Challenge	Environmental Impacts	Human and Socio-Economic Impacts	Earth Actions (proposed)	Data & Information Needed	Core ESO Missions	“Evolved” or ESO+ Missions
Earth Water	Water cycle change, sea level rise, coastal changes, loss of freshwater, biodiversity, …	Agriculture, Infrastructure Energy National Security Public Health, …	Water Resources, Sea Level, Extremes, Disasters, …	Water elevation, precipitation, soil moisture, surface and groundwater, fluxes, winds, …	AOS, MC,	S6, SWOT, SMAP, GFO, NISAR, ..
Earth Energy	…	…	…	Radiation, Clouds, Gases (GHG), Aerosols, Air-sea fluxes, Winds, ..	AOS,	OCO-2, 3, PACE, SWOT, S6