EXPLORE EARTH

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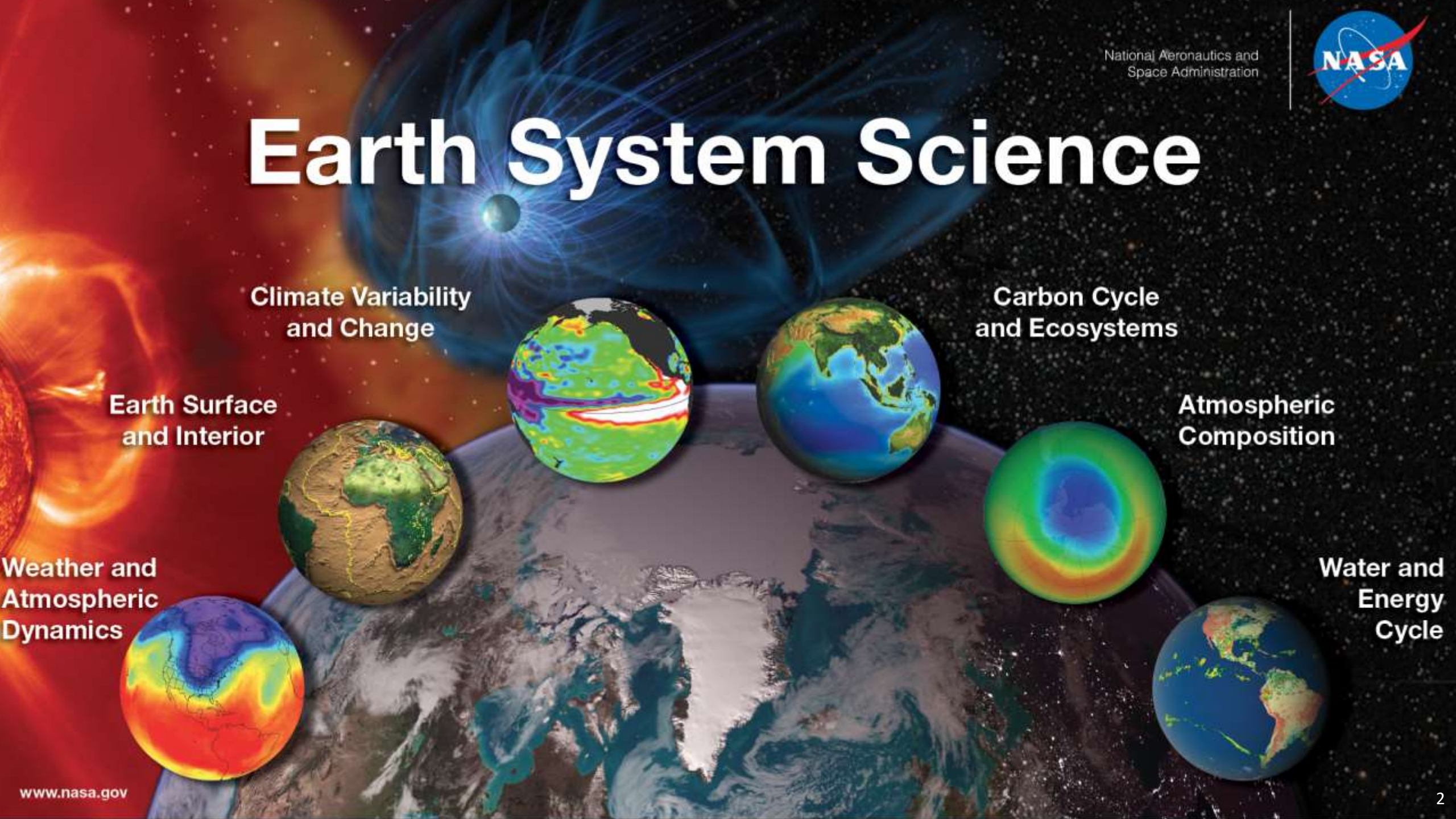
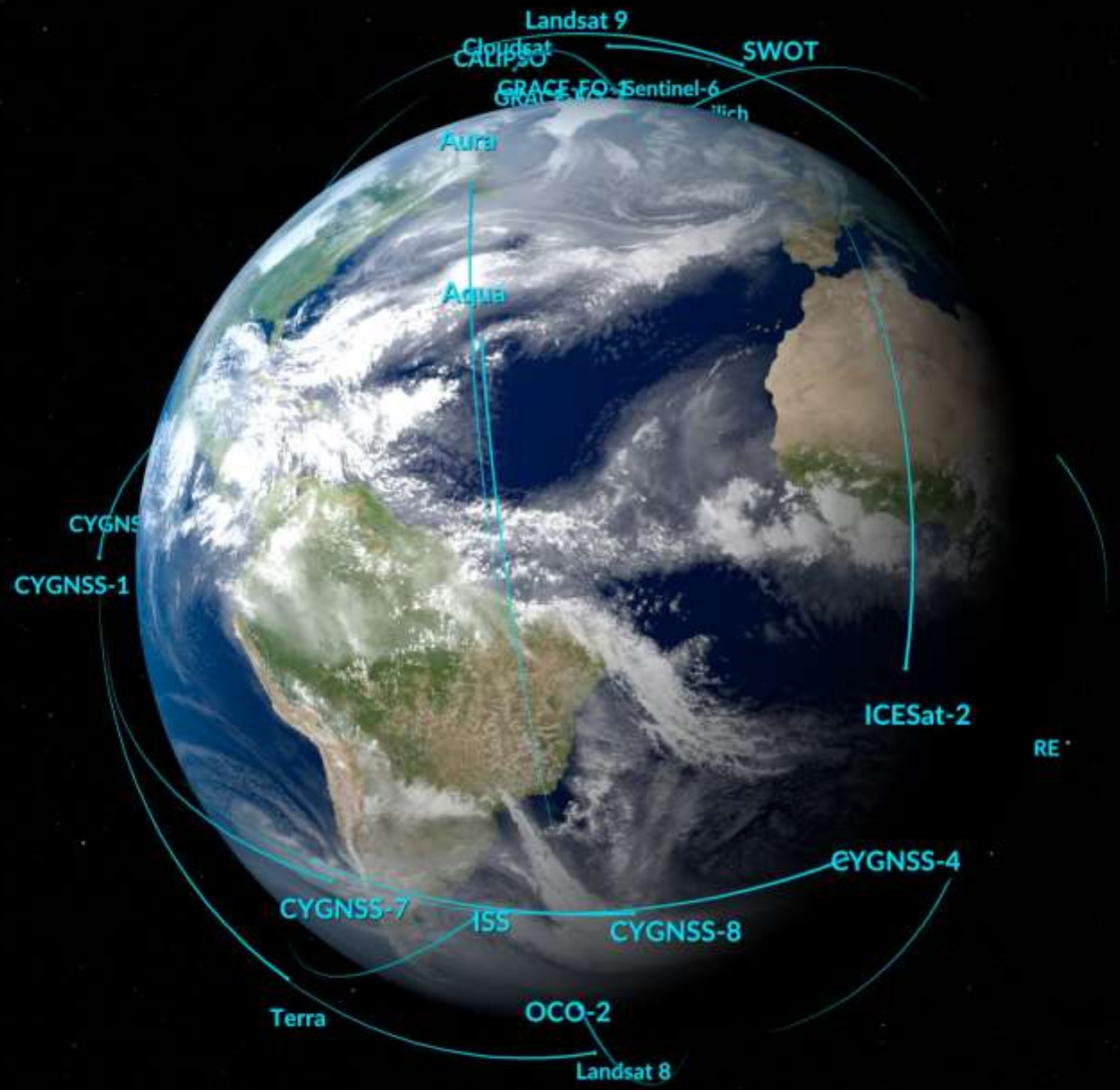
Deputy Director, Earth Science Division,
Science Mission Directorate

Sept 7th, 2023


National Aeronautics and Space Administration
NASA
Earth System Science
Climate Variability and Change
Carbon Cycle and Ecosystems
Earth Surface and Interior
Atmospheric Composition
Weather and Atmospheric Dynamics
Water and Energy Cycle
www.nasa.gov



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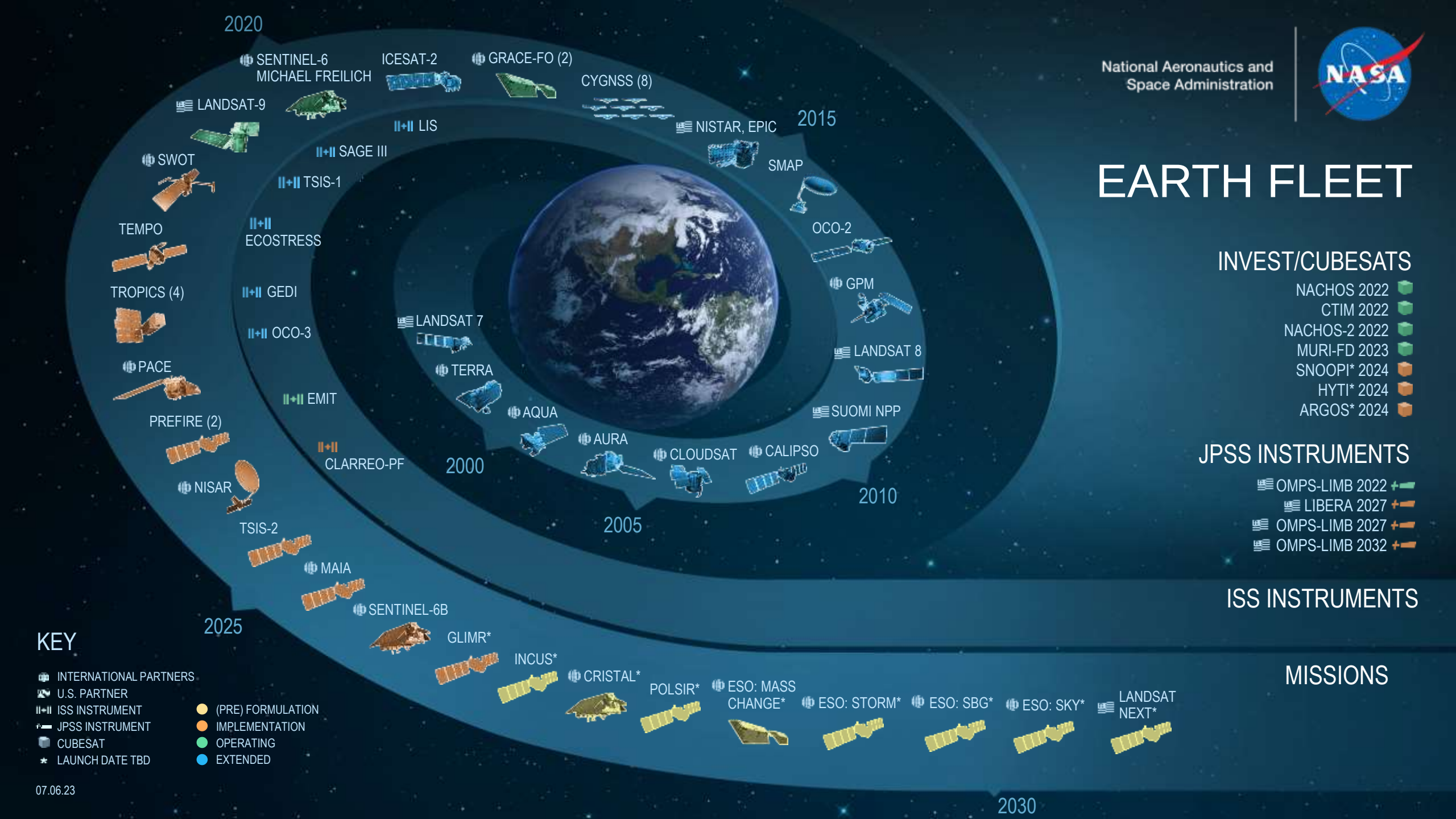
2020
SENTINEL-6 MICHAEL FREILICH
ICESAT-2
GRACE-FO (2)
CYGNSS (8)
LANDSAT-9
LIS
NISTAR, EPIC
2015
SAGE III
SWOT
SMAP
TSIS-1
TEMPO
ECOSTRESS
OCO-2
GPM
TROPICS (4)
GEDI
LANDSAT 7
OCO-3
LANDSAT 8
PACE
TERRA
EMIT
SUOMI NPP
AQUA
PREFIRE (2)
AURA
CLOUDSAT
CALIPSO
CLARREO-PF
2000
2010
NISAR
2005
TSIS-2
MAIA
SENTINEL-6B
2025
GLIMR*
INCUS*
CRISTAL*
POLSIR*
ESO: MASS CHANGE*
ESO: STORM*
ESO: SBG*
ESO: SKY*
LANDSAT NEXT*
2030
National Aeronautics and Space Administration
NASA
EARTH FLEET
INVEST/CUBESATS
NACHOS 2022
CTIM 2022
NACHOS-2 2022
MURI-FD 2023
SNOOPI* 2024
HYTI* 2024
ARGOS* 2024
JPSS INSTRUMENTS
OMPS-LIMB 2022
LIBERA 2027
OMPS-LIMB 2027
OMPS-LIMB 2032
ISS INSTRUMENTS
MISSIONS
KEY
INTERNATIONAL PARTNERS
U.S. PARTNER
ISS INSTRUMENT
JPSS INSTRUMENT
CUBESAT
LAUNCH DATE TBD
(PRE) FORMULATION
IMPLEMENTATION
OPERATING
EXTENDED
07.06.23

NASA EARTH FLEET

INTERNATIONAL COLLABORATIONS

Principles of Commercial Partnerships

- Strategic partnerships that leverage unique strengths to drive scientific progress
- Partnerships that innovate both in *what* we do with commercial partners and *how* we do it
- Evolving partnership models: experimentation is key and some experiments may fail
- Traditional and non-traditional partnerships for success in “enabling new science” and “more science per dollar”
- Leverage existing commercial capacity, demand, and expertise, while exploring emerging business areas
- Build on investments in partnerships across NASA and other parts of the government, sharing our own best practices

Core Links in USG Climate Services Knowledge Value Chain

Generate **climate information:**
- Observations
- Modeling and simulation
- Indigenous and traditional knowledge
- Lived experience

Deliver **climate services:**
- Mapping and visualization
- Extension services
- Training and capacity building
- Storytelling

Evaluate **climate services:**
- Peer review
- User surveys
- Benefit/cost analysis
- Randomized control trials

Develop **climate services:**
- Science translation
- User engagement
- Design co-production
- Application development

Use **climate services:**
- Risk assessment
- Hazard mitigation
- Project design and planning
- Investing and asset management

Source: A Federal Framework and Action Plan for Climate Services 2023

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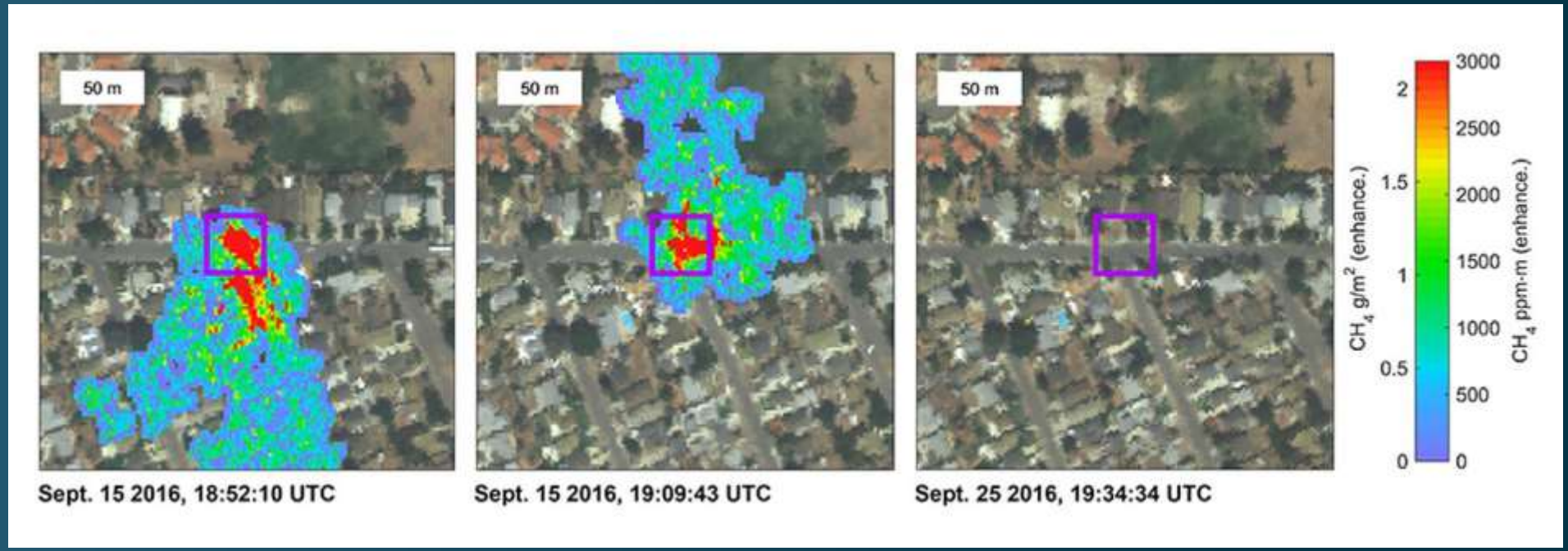
Building collaborations with industry

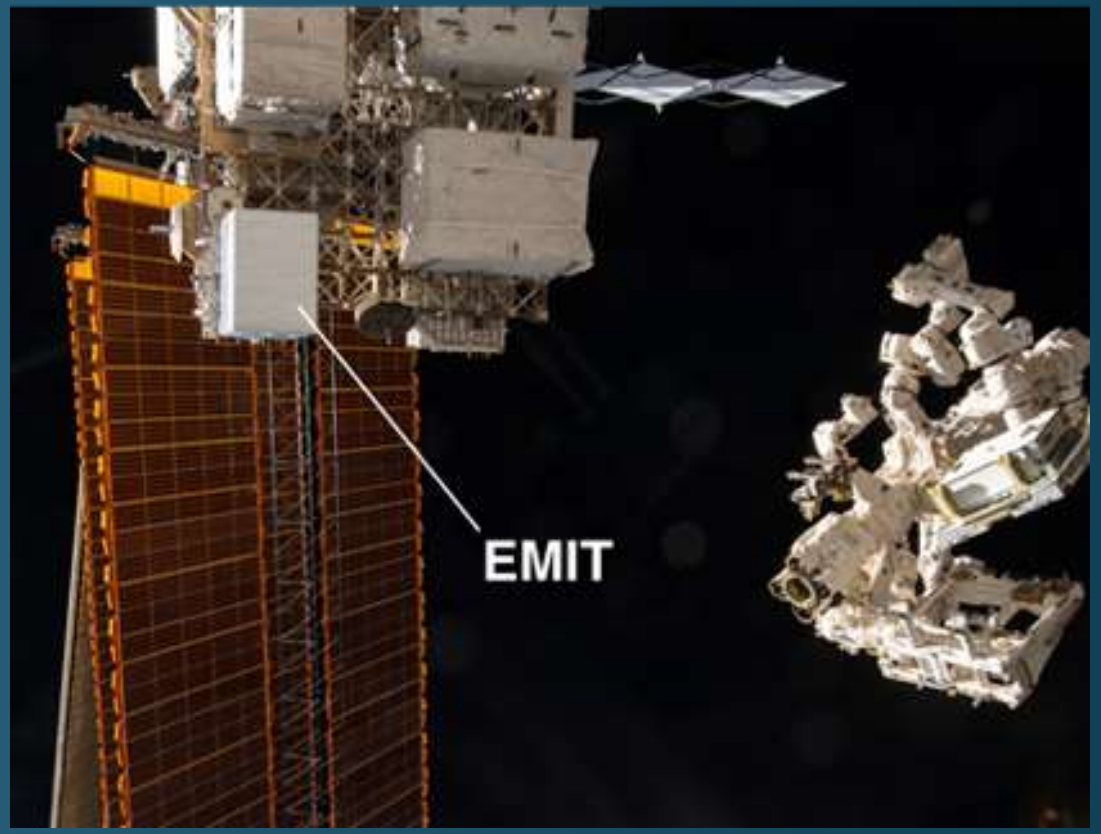
Rocket Lab’s Electron rocket lifts off from Launch Complex 1 at Māhia, New Zealand at 9:00 p.m., carrying two TROPICS CubeSats for NASA.
Credits: Rocket Lab

AVIRIS Methane detection: technology transfer example



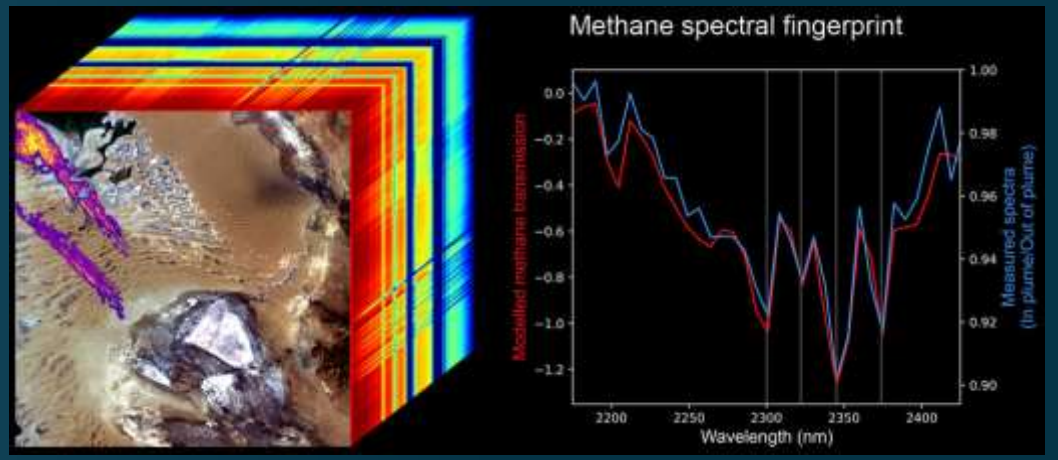
Starts with a NASA funded Airborne campaign to test the idea that the AVIRIS instrument can detect CH4 plumes

EMIT CH4 observations: technology transfer example

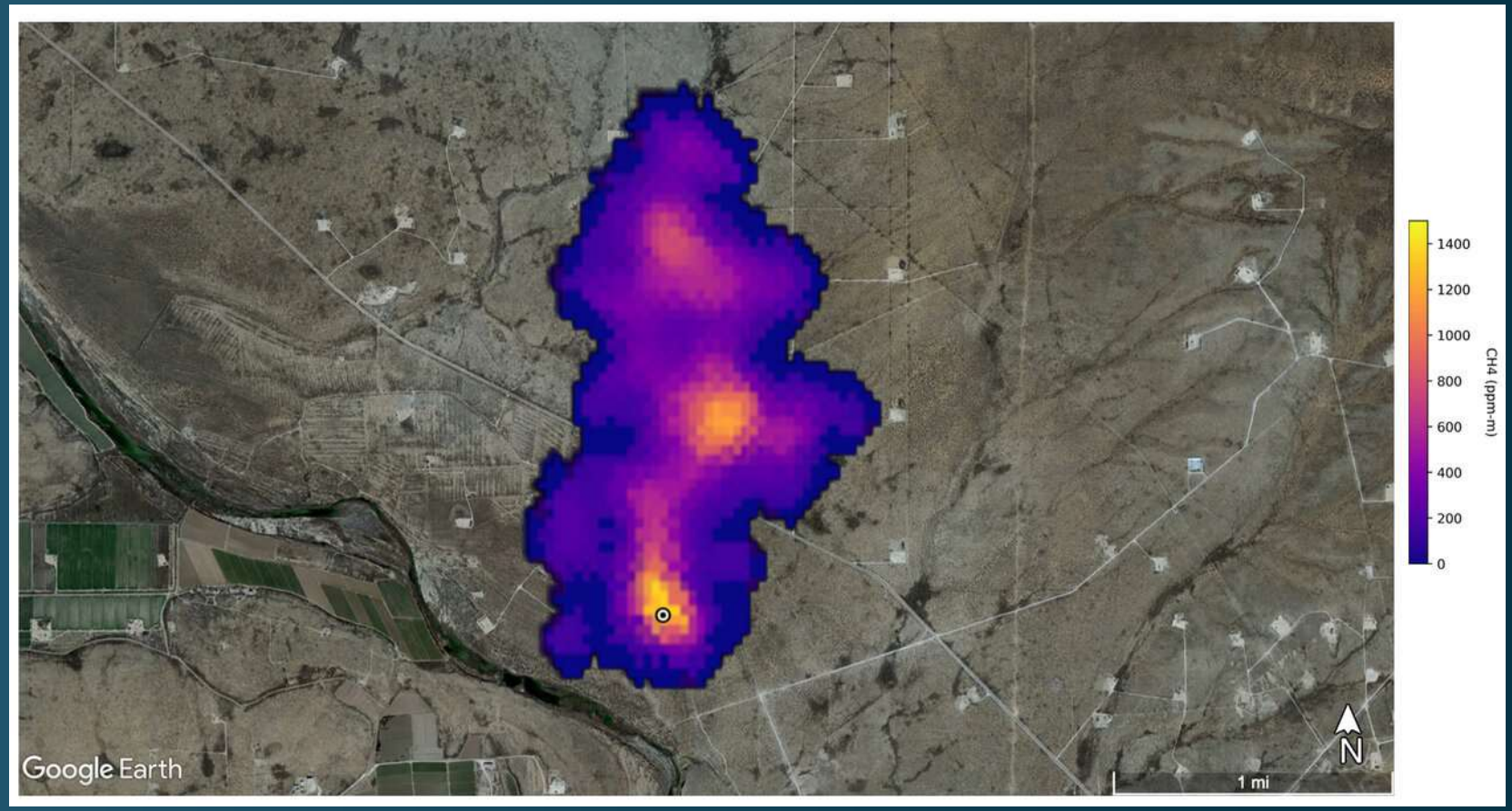


EMIT was proposed to Earth Venture Instrument to do mineral and dust observations

As EMIT is very much like the AVIRIS instruments, NASA HQ funded them to expand their mission to include CH4 observations

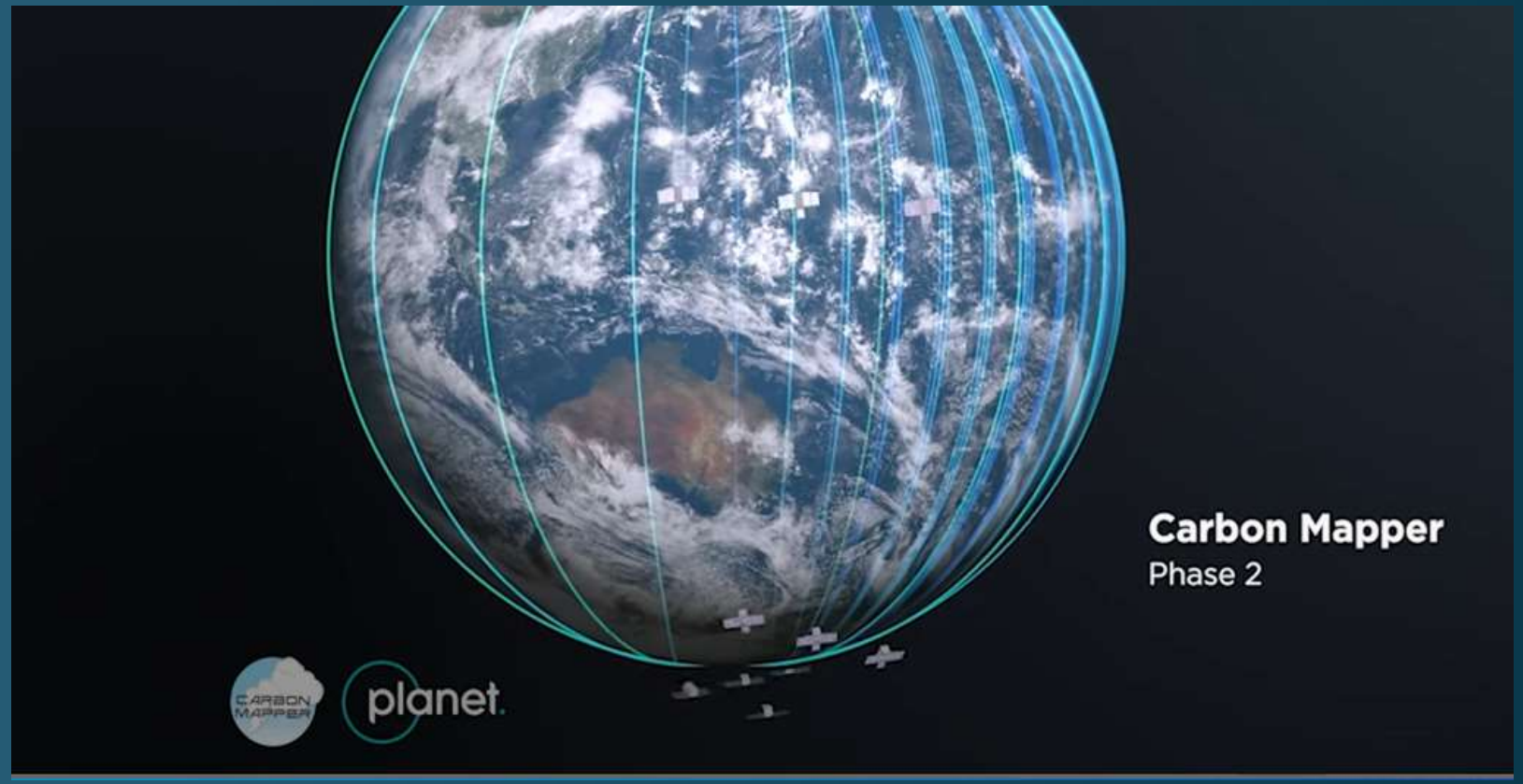


EMIT CH4 observations: technology transfer example



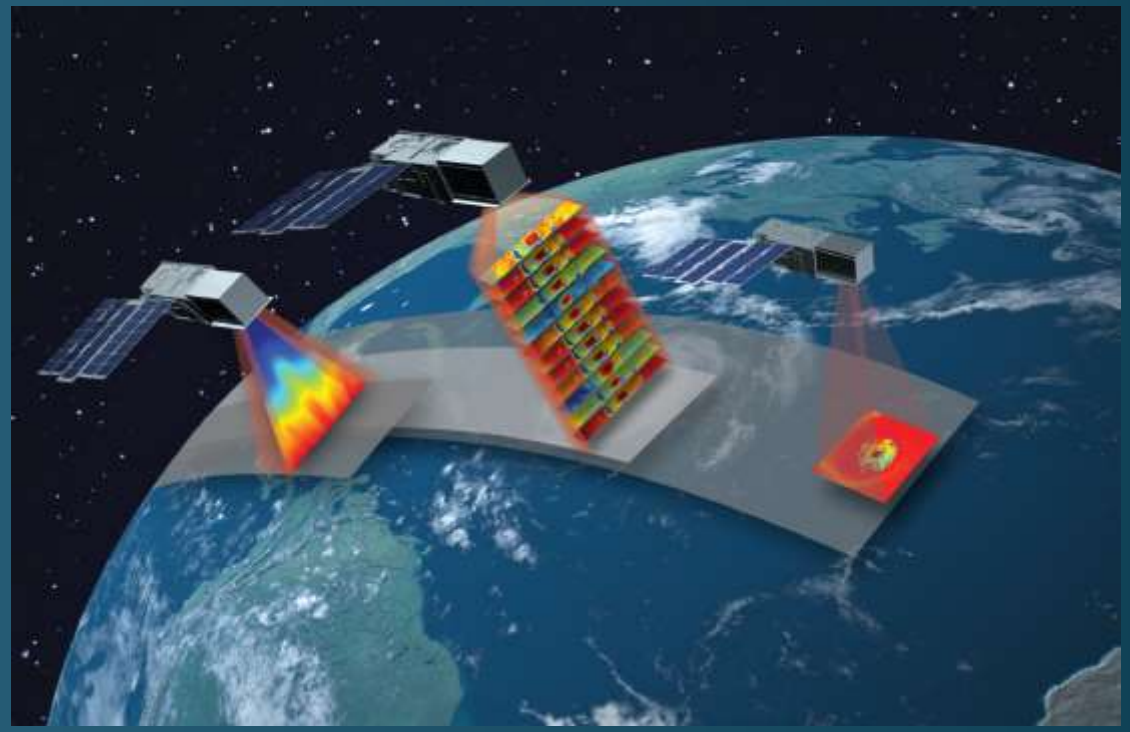
Methane plume 2 miles (3 kilometers) long that NASA's EMIT mission detected southeast of Carlsbad, New Mexico. Credit: NASA/JPL-Caltech

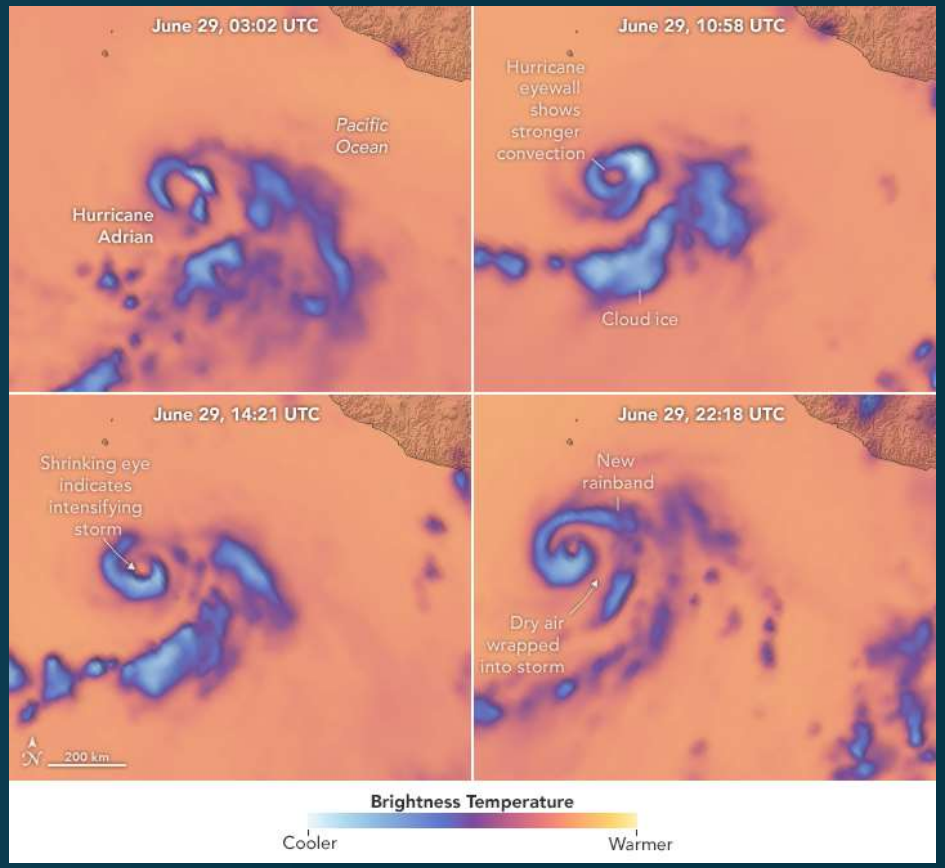
Methane Observations: technology transfer example



- The Carbon Mapper full constellation is designed to provide daily to weekly sampling depending on target prioritization.
- Offering a methane leak detection service for operators to enable timely repairs
- Contributing to methane intensity indicators to support market-based decarbonization of supply chains
- Providing independent quantification of CO2 emissions from industrial facilities globally

TROPICS Technology transition example





Commercial SmallSat Data Acquisition

NASA sees that commercial partnerships will comprise a growing role in the future of Earth Observations, through a spectrum of approaches, from data buys to public-private partnerships.

CSDA Data Holdings

Vendor	Constellations/ Products	Availability Dates	Orbit Characteristics	Spatial Resolution	Spectral Characteristics	Sample
Planet	PlanetScope, RapidEye	12/31/2005 - Present	Sun Synchronous	3 - 6.5 meters	RGB, NIR (440-860 nm), Panchromatic	
	SkySat	3/10/2015 – 12/12/2019		< 1 meter	RGB, NIR (450-900 nm), Panchromatic	
Spire Global, Inc	GNSS Radio Occultation, GNSS Grazing Angle Reflectometry, Satellite Precise Orbit Determination (POD) and Satellite Attitude, Total Electron Content, Ionospheric Profiles, Scintillation, Magnetometer, Raw IF	9/24/2018 - 4/18/2019 (partial) 11/1/2019 - Present (all)	GNSS-R and GNSS-RO receivers satellites: 37° and Sun Synchronous			
Maxar Technologies	Worldview 1-4, GeoEye-1, QuickBird, IKONOS	10/24/1999 - Present	Sun Synchronous	0.31 - 4.0 meters	Multispectral and Panchromatic (400 - 2245 nm)	
Teledyne Brown Engineering, Inc.	DESIS L1B, L1C, and L2A	11/21/2018 - Present	Non Sun Synchronous 52° N - 55° S (ISS)	30 meters	235 channels, 2.5nm from 402 to 1000 nm	
EarthDEM	individual strips and mosaics	2009 - Present		2 meters		

End User License Agreements Tiered Approach

Authorized User Community	Type of EULA		
	Public Release	U.S.G. Plus	U.S.G.
U.S. Federal Government including: • U.S. State/Local/Tribal Government; Contractors and Grantees associated with Government Agency			X
U. S Federal Government, Foreign Civil Partners		X	X
Public Release	X	X	X

Scientific Non-Commercial Use License

Utilize the tiered EULA approach to satisfy other agency commercial data request via *SNWG Assessment Process.*

Tiered EULA approach is modeled after NRO's family of EULAs

NASA Satellite Needs Working Group

White House National Science and Technology Council

U.S. Group on Earth Observations (USGEO)

Satellite Needs Working Group (SNWG)

Distribute Survey

Gather Inputs

The 20XX Cycle: Assessment

Congressional Appropriations and Selections

The 20XX Cycle: Solutions

Implementation and Stakeholder Engagement

Sustained Operations

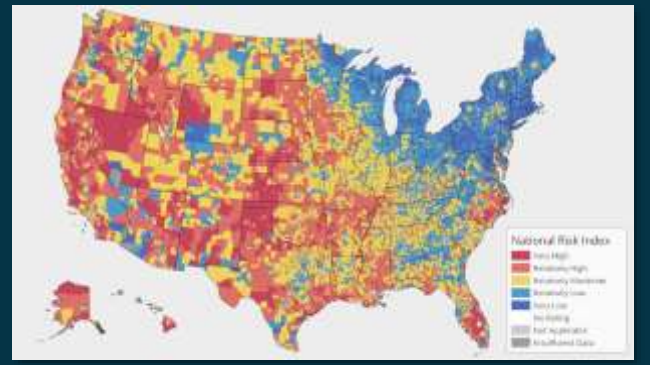
Lessons Learned
Next Survey
New Opportunities

New Solutions for Agencies

IMPACT
Interagency Implementation and Advanced Concepts Team

SNWG Management Office Roles

NASA Science Enables Operational Services Across the USG

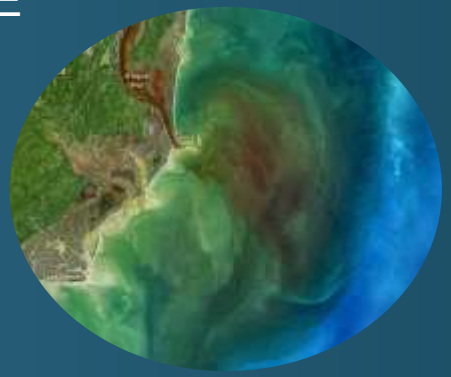


Earth Observation contributions to Natural Capital Accounting

Land accounting:
USGS/NASA Land use data sets

Water accounting:
OpenET (Landsat, Sentinel, GOES), GRACE/GRACE-FO, SMAP, SWOT

Ocean accounting:
PACE

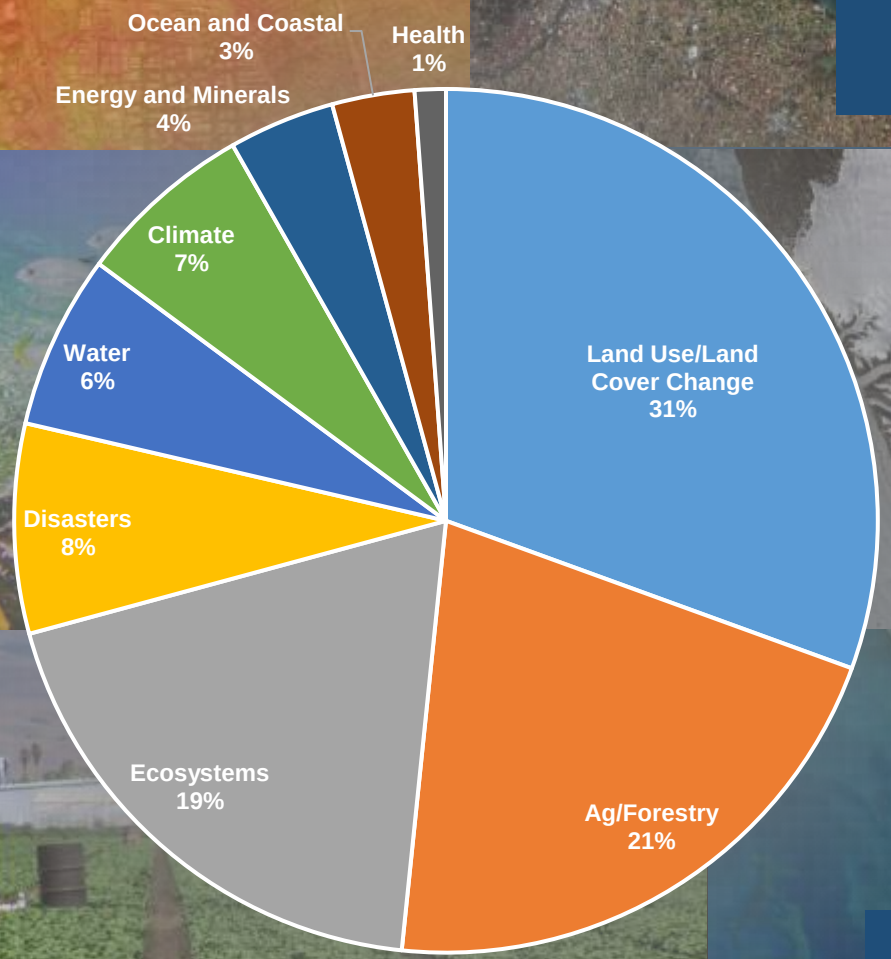


Ecosystem condition accounting:
MODIS (multiple products)

Forest accounting:
LIDAR products (GEDI), Radar (NISAR), thermal RS for wildfire

Health-related aspects of NCA:
TEMPO,MAIA

Landsat Applications



Landsat is the single most-used land imaging data set by U.S. Federal users and the 2nd highest in societal benefit impact (behind GPS) of 1300 Earth observation systems

- Federal Agencies (e.g. DOI, USDA, EPA, NASA, DOD, NOAA, State, USAID)
- State Agencies (planning, natural resources, Transportation)
- University Researchers and Educators
- International Organizations (e.g., UN agencies, GEO)
- Non Governmental Organizations (e.g., The Nature Conservancy, World Resources Institute, World Wildlife Fund, Resources for the Future)
- Commercial (e.g., Exxon-Mobil, MapBox, Descartes Labs, Esri, Gallo, Harris Corp, ITT, MDA Federal)
- Foreign space agencies
- U.S. and foreign commercial satellite operators
- Cloud Service Providers (e.g. Amazon Web Services, Google Earth Engine)
- General Public

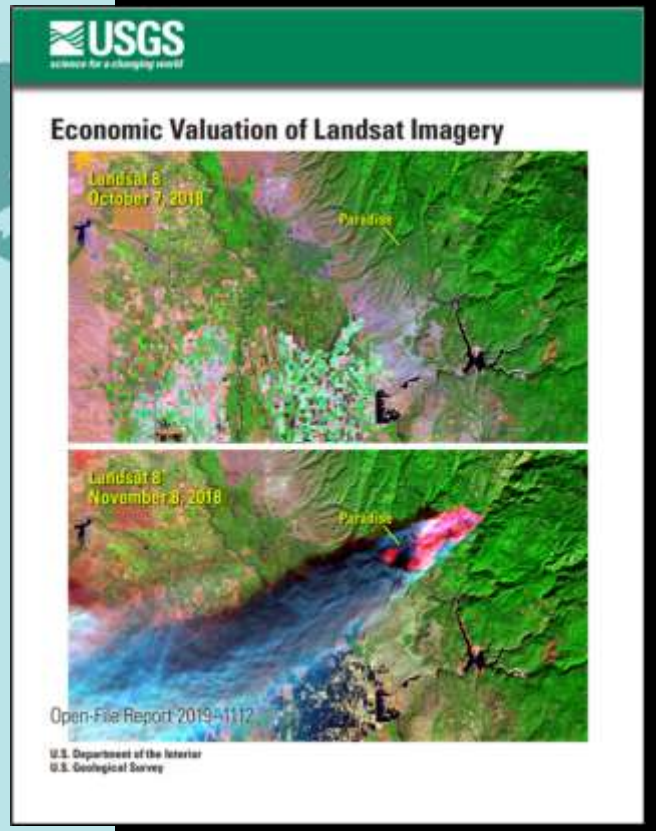
Supports Federal, state, local, tribal, academic, commercial, non-profit, and international use

USGS

Landsat Economic Benefit

"The economic value of just one year of Landsat data far exceeds the multi-year total cost of building, launching, and managing Landsat satellites and sensors"

Earth Imaging Journal article (2015)



Economic Valuation of Landsat Imagery
Open-File Report 2019-1112
Crista L. Straub, Stephen R. Koontz, and John B. Loomis
https://doi.org/10.3133/ofr20191112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