

Earth Science and Applications

Using our unique expertise to better understand how Earth works
as a system for the benefit of society

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Water Cycle



Sea Level



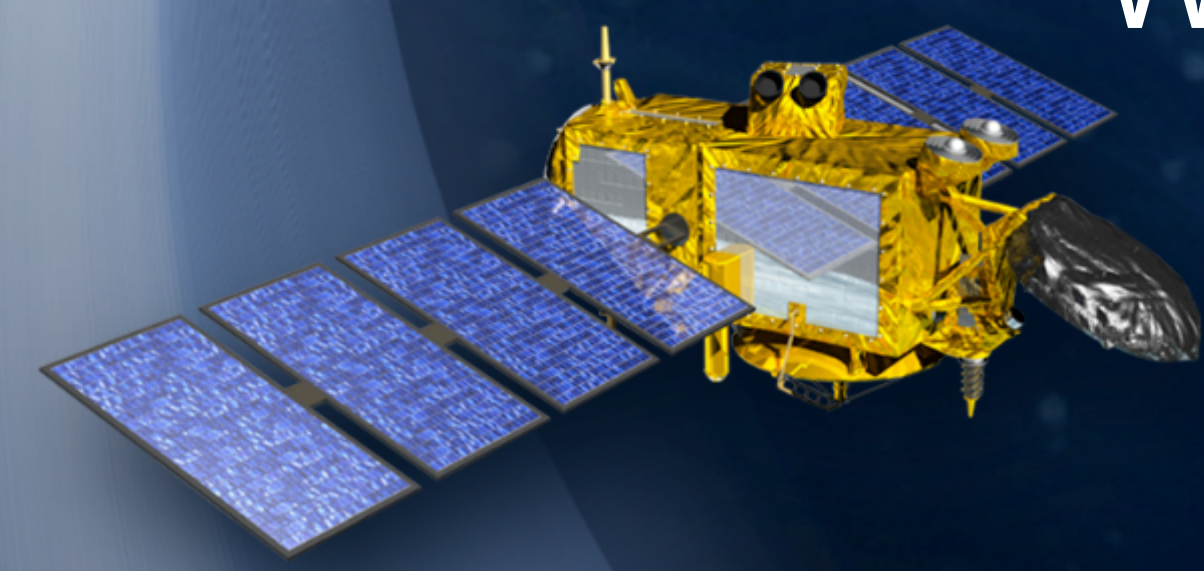
Natural Hazards



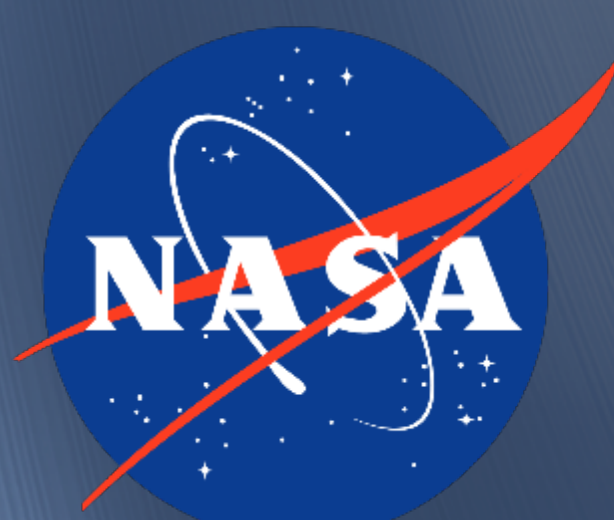
Carbon Cycle



Weather and Air Quality



INNOVATE • IMPLEMENT • IMPACT



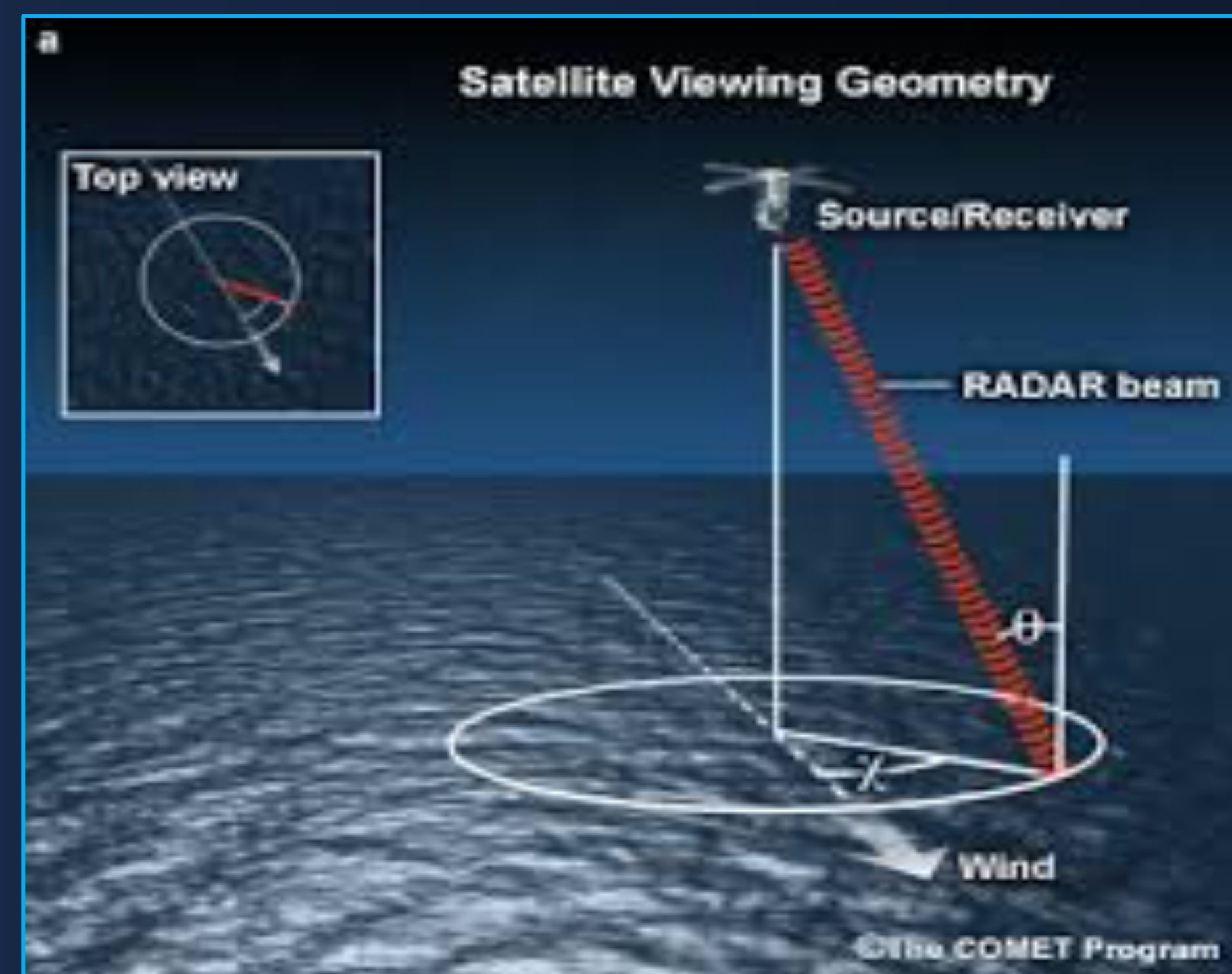
Jet Propulsion Laboratory
California Institute of Technology

Four Decades of Innovation

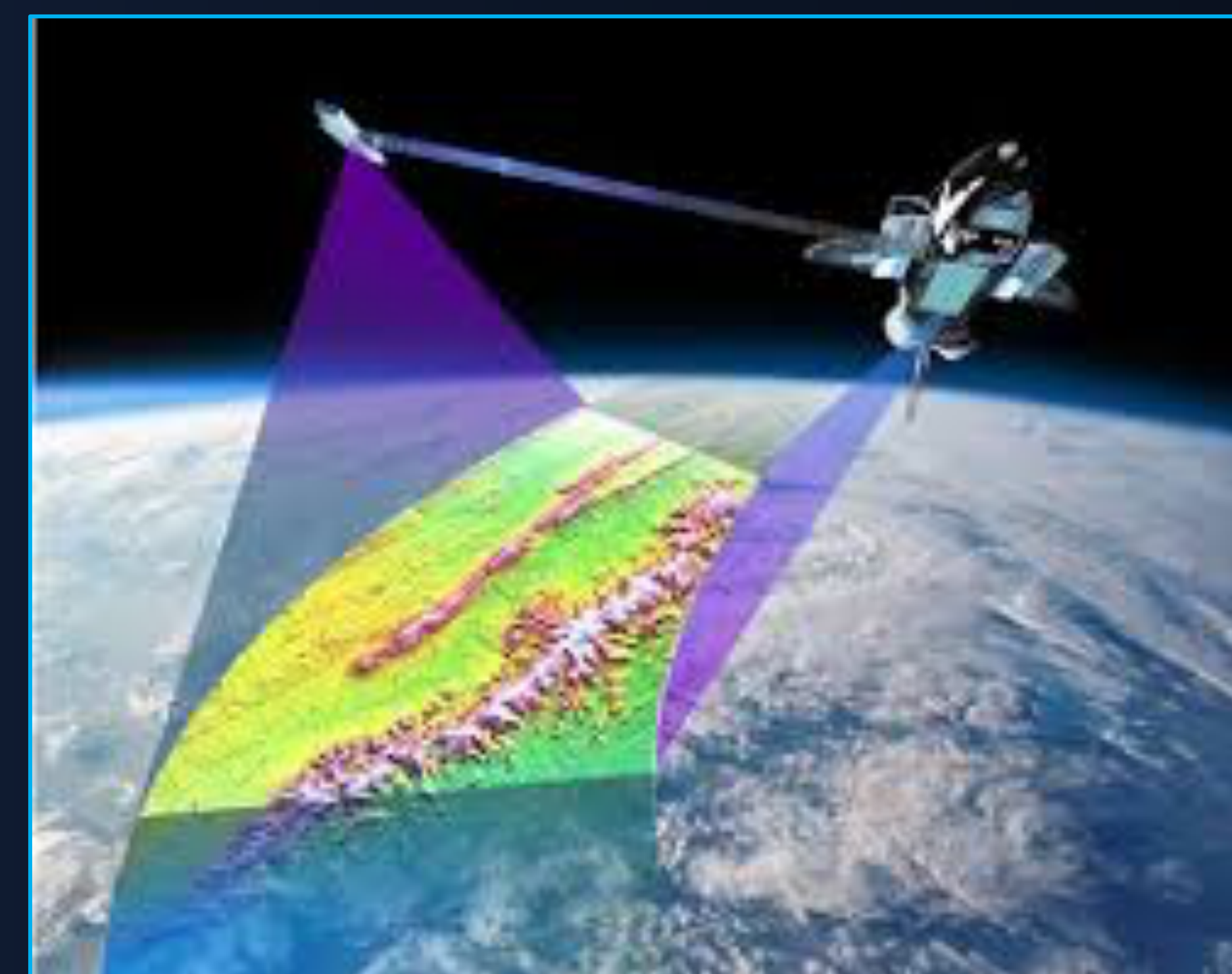
A SPECTRUM OF TOOLS



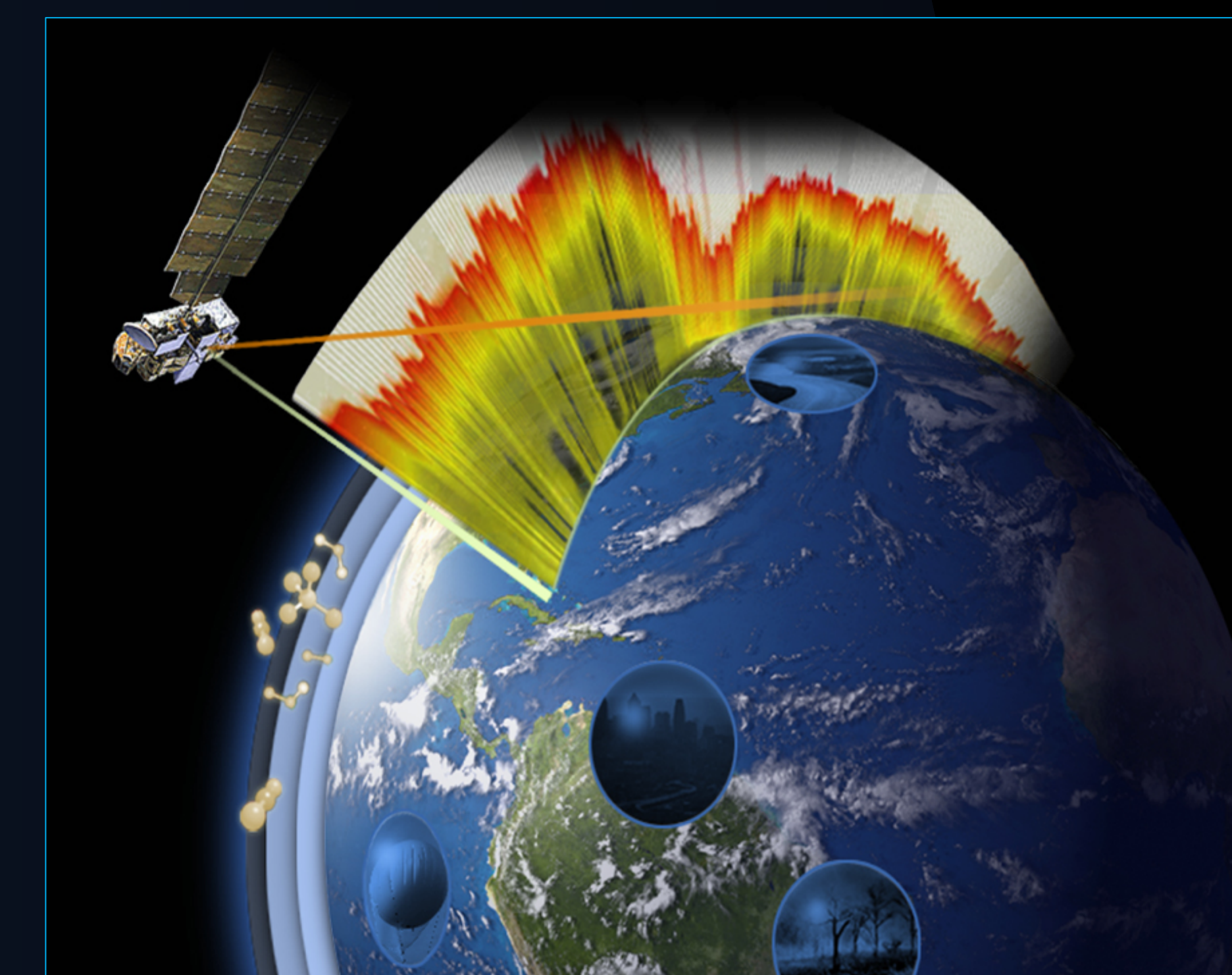
Sea Level Altimetry



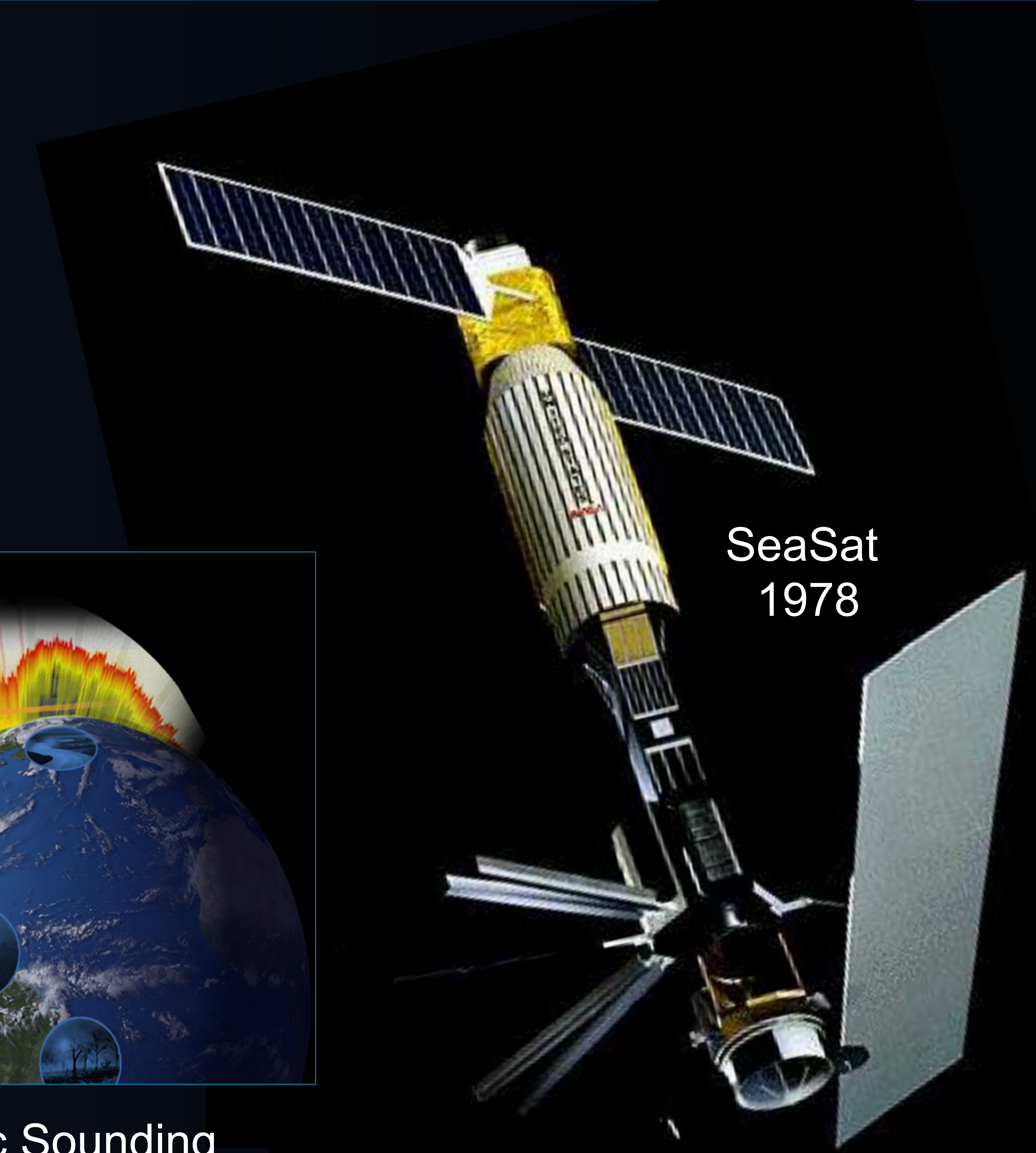
Ocean Wind Scatterometry



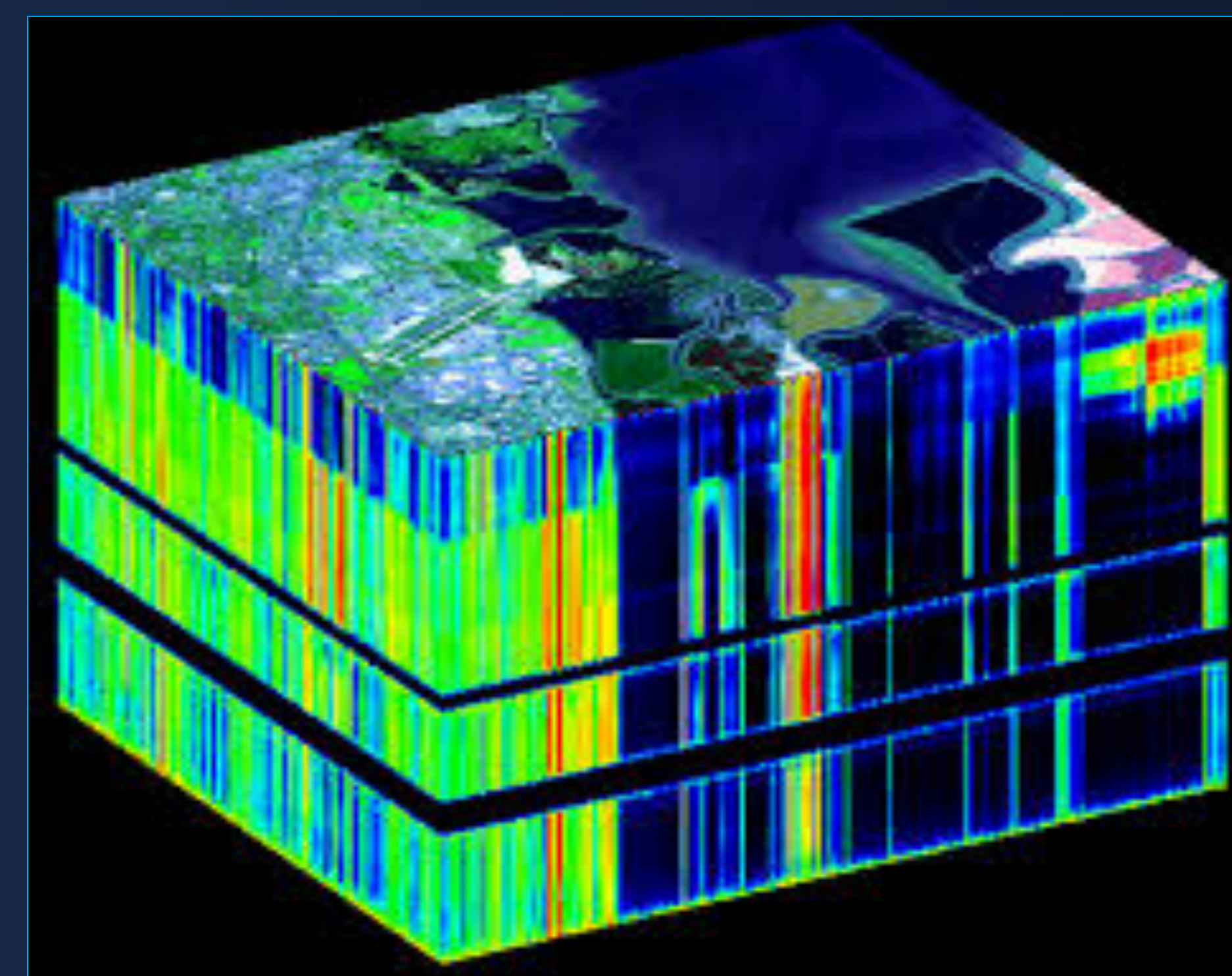
Radar for Surface Deformation



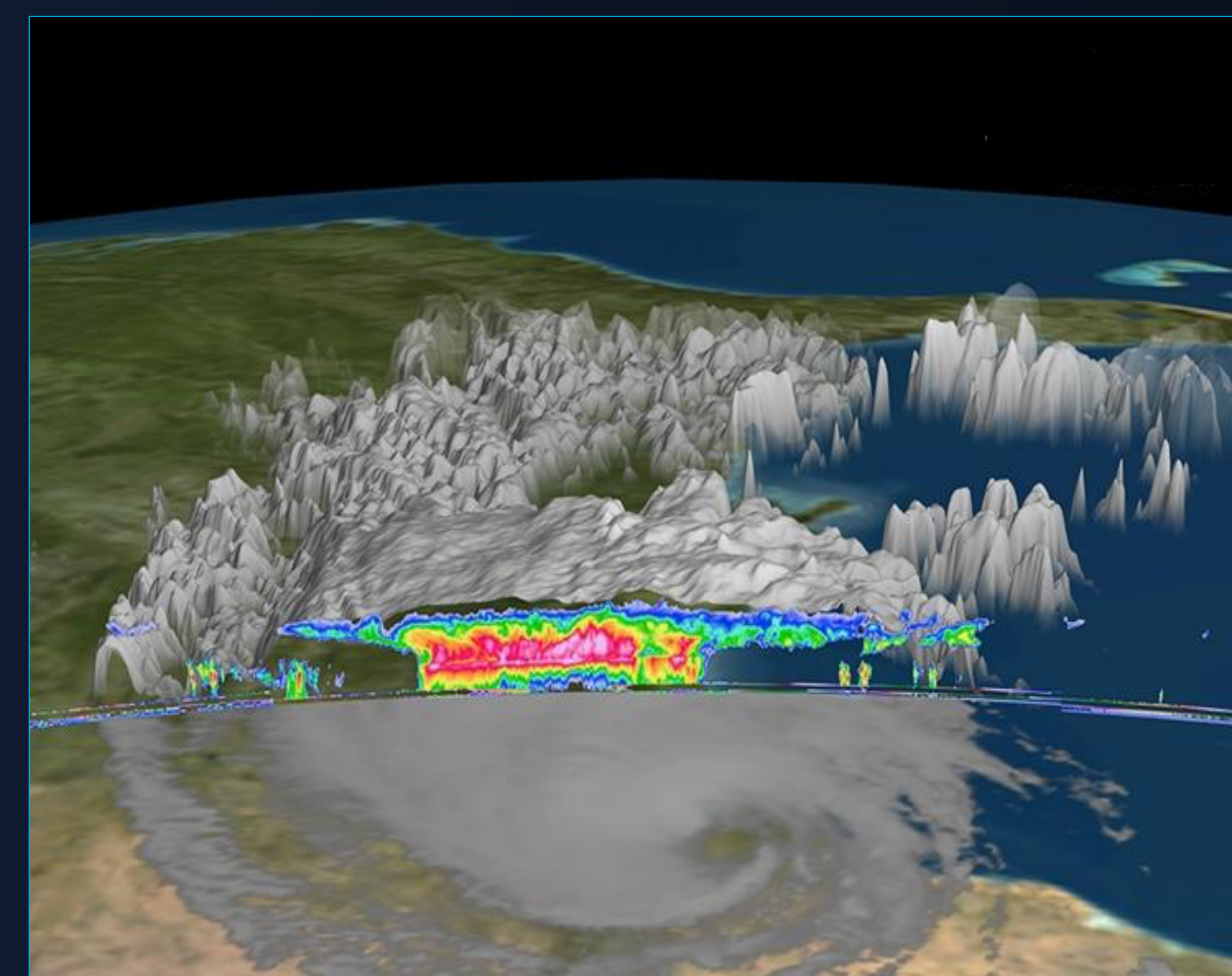
Atmospheric Sounding



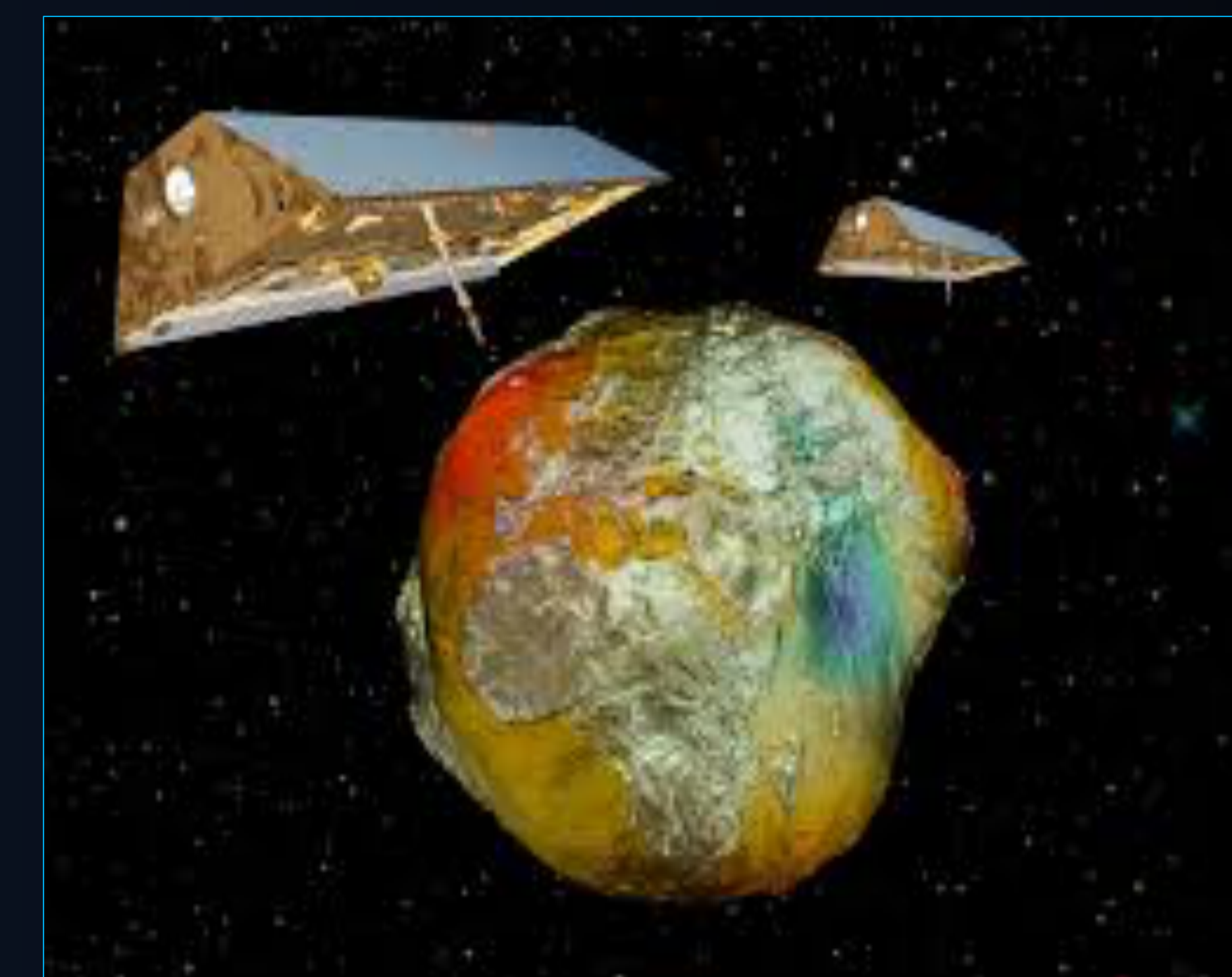
Multi-Angle Imagery



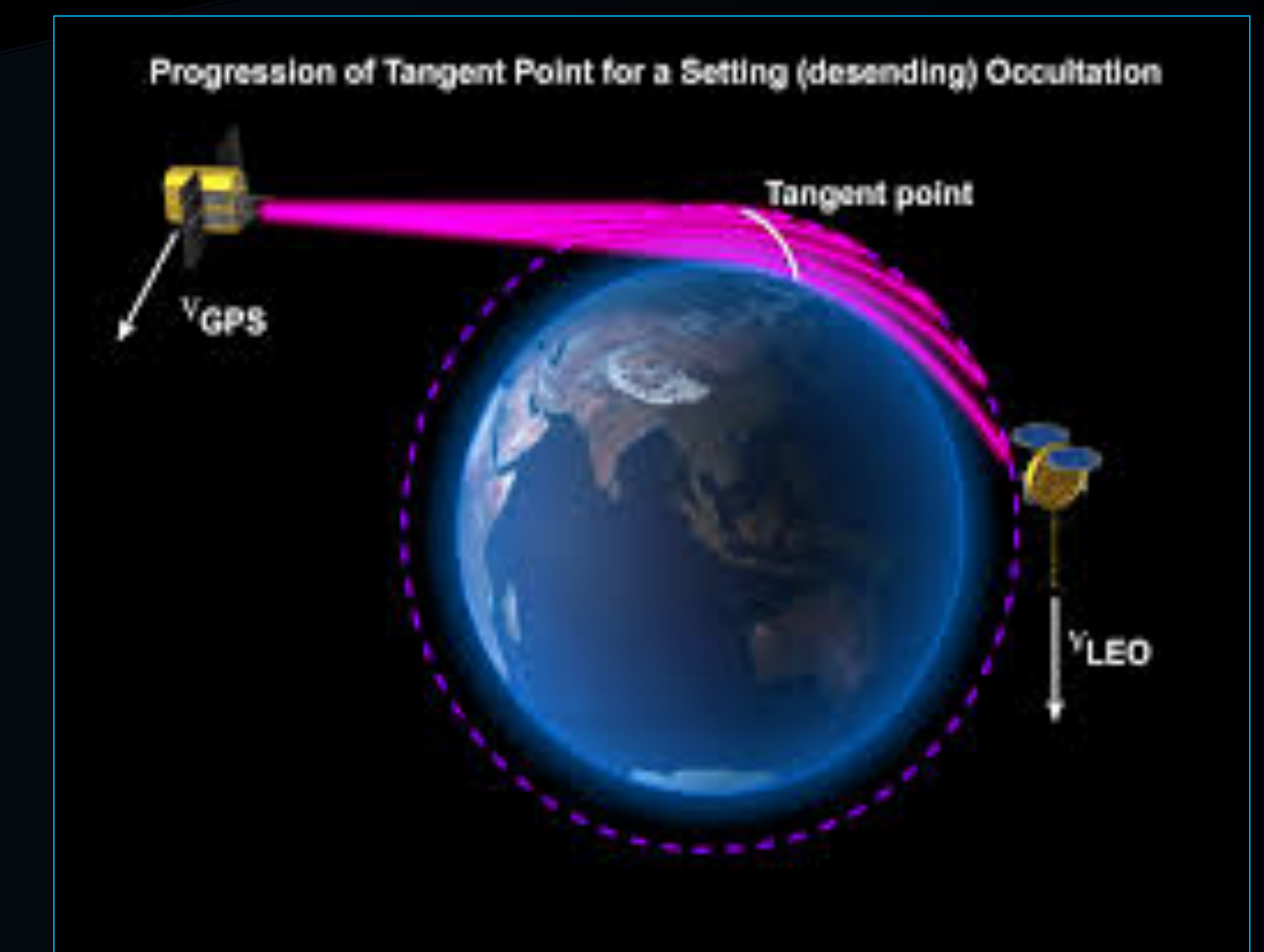
Imaging Spectroscopy



Cloud Radar



Gravity

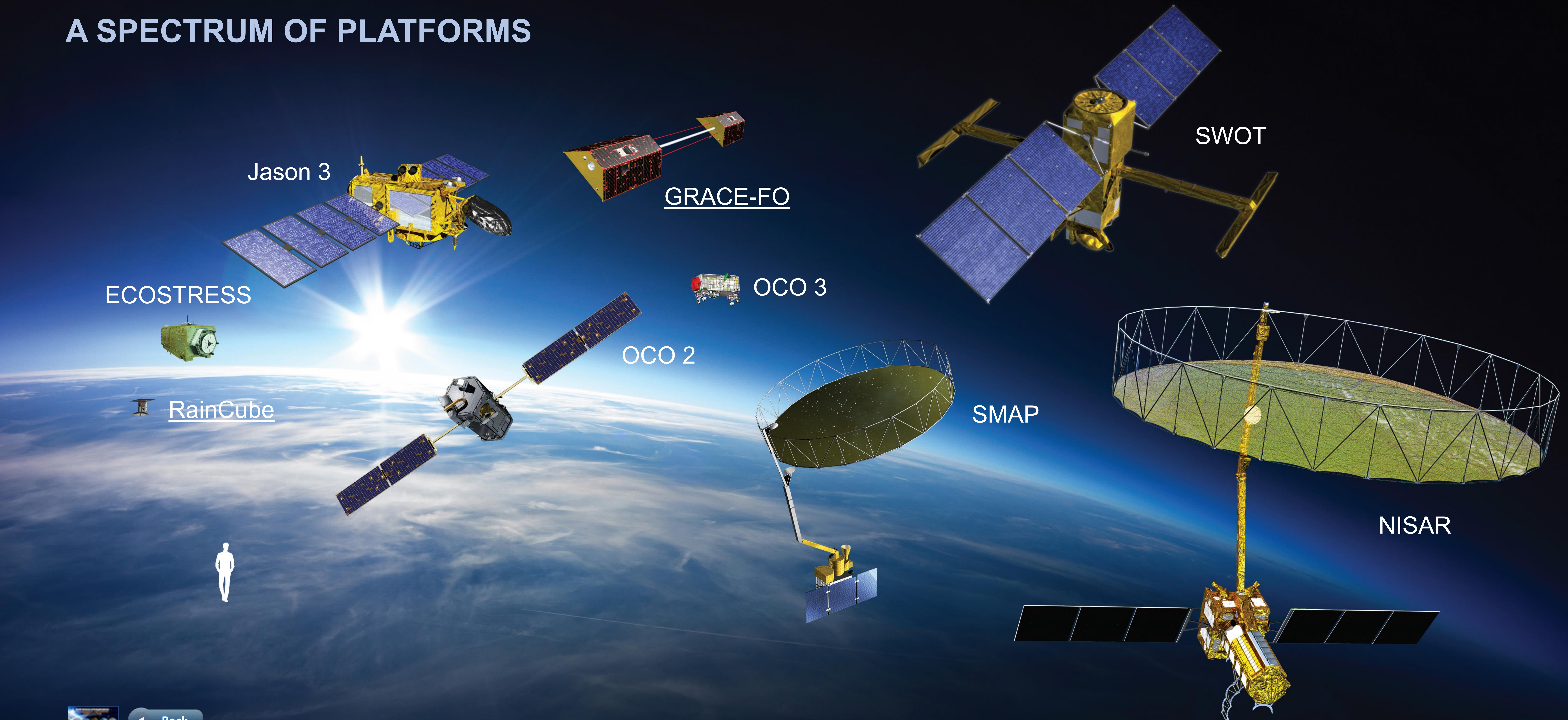


Radio Occultation



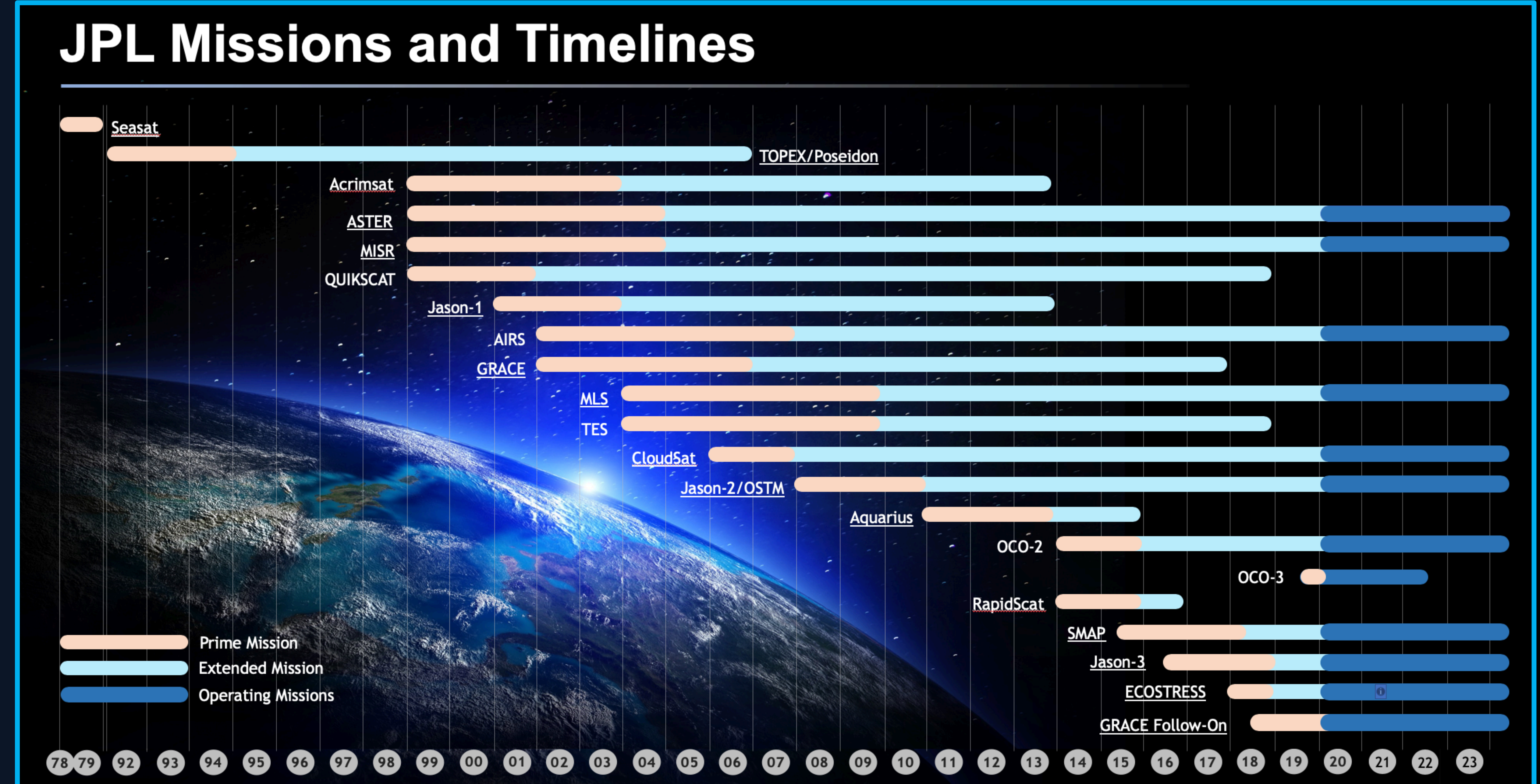
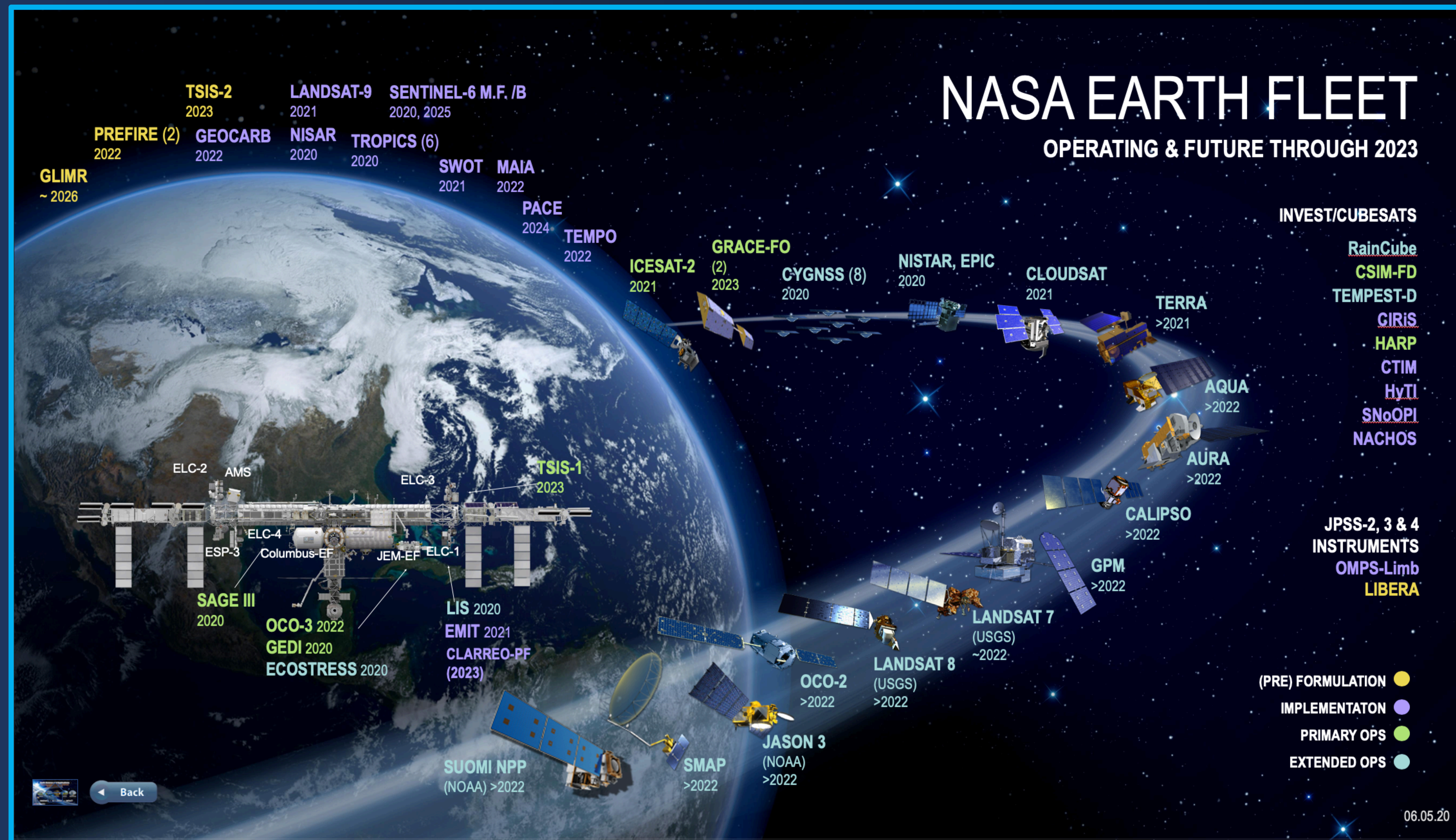
Earth Remote Sensing

A SPECTRUM OF PLATFORMS



Successful Mission Implementation

PARTNERSHIPS AND EXPERTISE SPANNING FOUR DECADES OF EARTH OBSERVATIONS



Major contributions to NASA's Earth observing fleet of satellites

History of successful mission implementation and extended missions

International Partners



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NASA EARTH FLEET

OPERATING & FUTURE THROUGH 2023

GLIMR
~ 2026

PREFIRE (2)
2022

GEOCARB
2022

NISAR
2020

TROPICS (6)
2020

SWOT
2021

MAIA
2022

TSIS-2
2023

LANDSAT-9
2021

SENTINEL-6 M.F. /B
2020, 2025

PACE
2024

TEMPO
2022

ICESAT-2
2021

GRACE-FO (2)
2023

CYGNSS (8)
2020

NISTAR, EPIC
2020

CLOUDSAT
2021

TERRA
>2021

AQUA
>2022

AURA
>2022

CALIPSO
>2022

GPM
>2022

LANDSAT 7 (USGS)
~2022

LANDSAT 8 (USGS)
>2022

OCO-2 (USGS)
>2022

JASON 3 (NOAA)
>2022

SMAP
>2022

SUOMI NPP (NOAA)
>2022

TSIS-1
2023

LIS 2020

EMIT 2021

CLARREO-PF (2023)

OCO-3 2022

GEDI 2020

ECOSTRESS 2020

SAGE III
2020

INVEST/CUBESATS

RainCube

CSIM-FD

TEMPEST-D

GIRiS

HARP

CTIM

HyTI

SNoOPI

NACHOS

JPSS-2, 3 & 4 INSTRUMENTS

OMPS-Limb

LIBERA

JPL Contributions ○

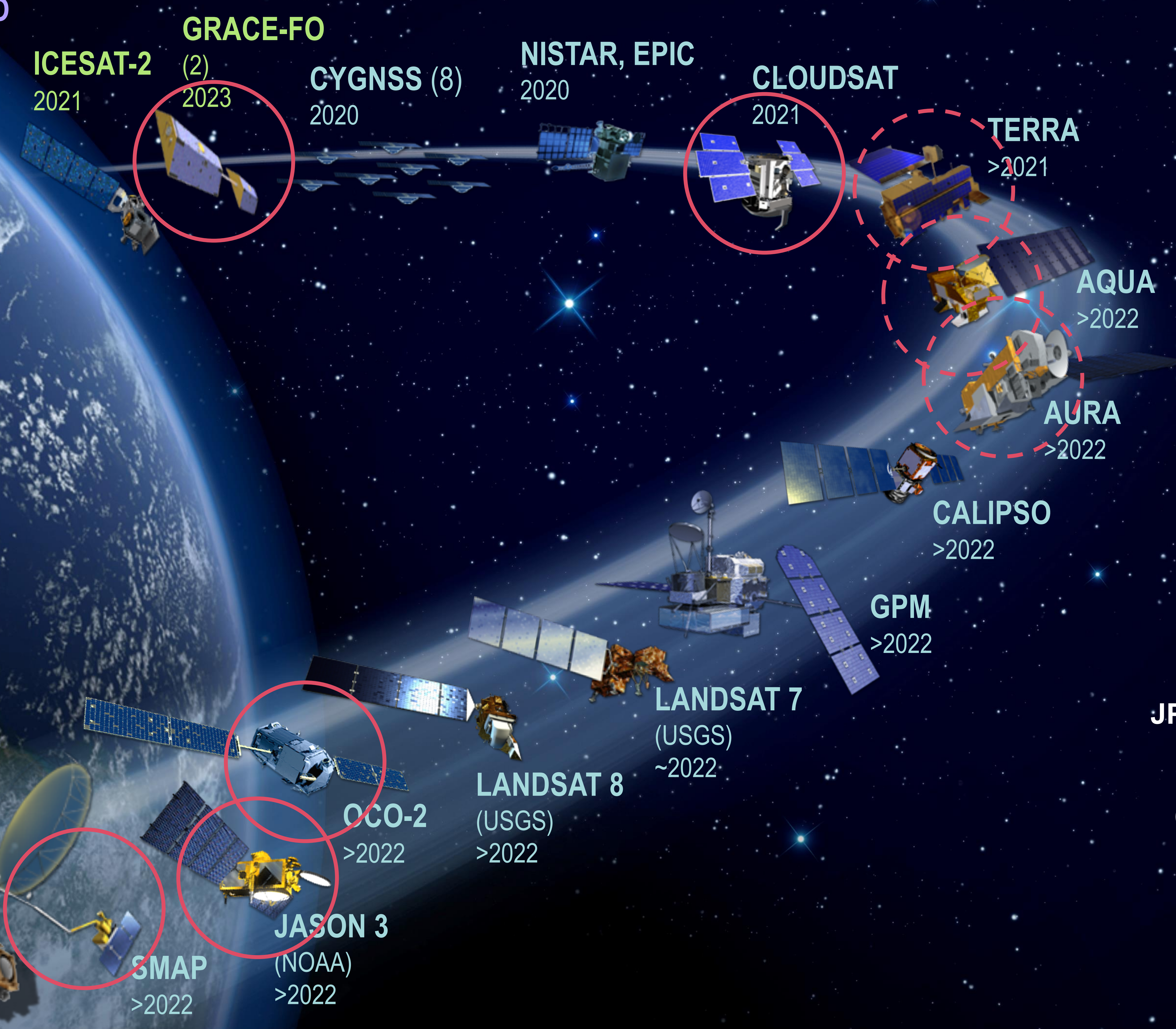
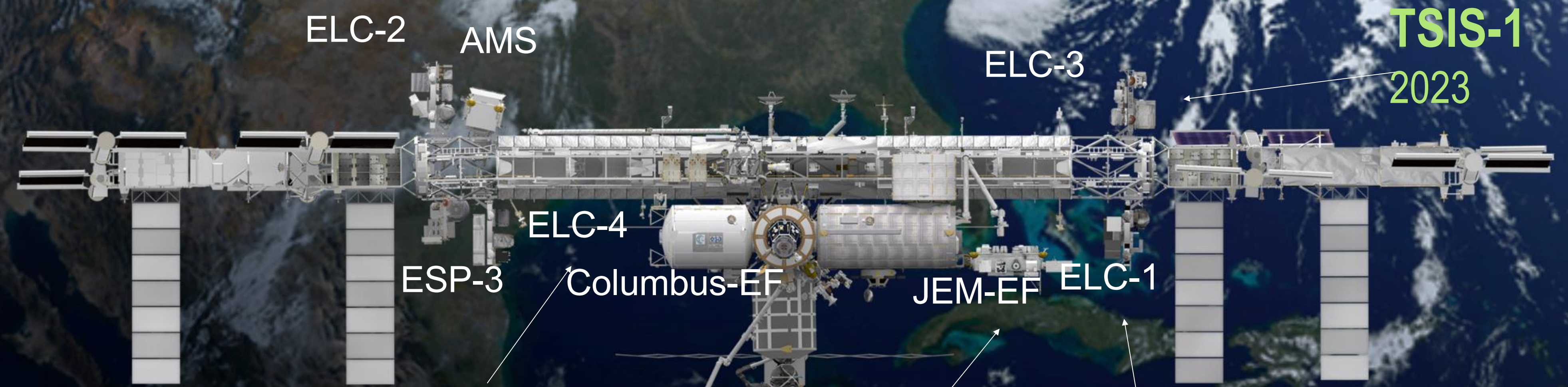
JPL Instruments ○

(PRE) FORMULATION ●

IMPLEMENTATION ●

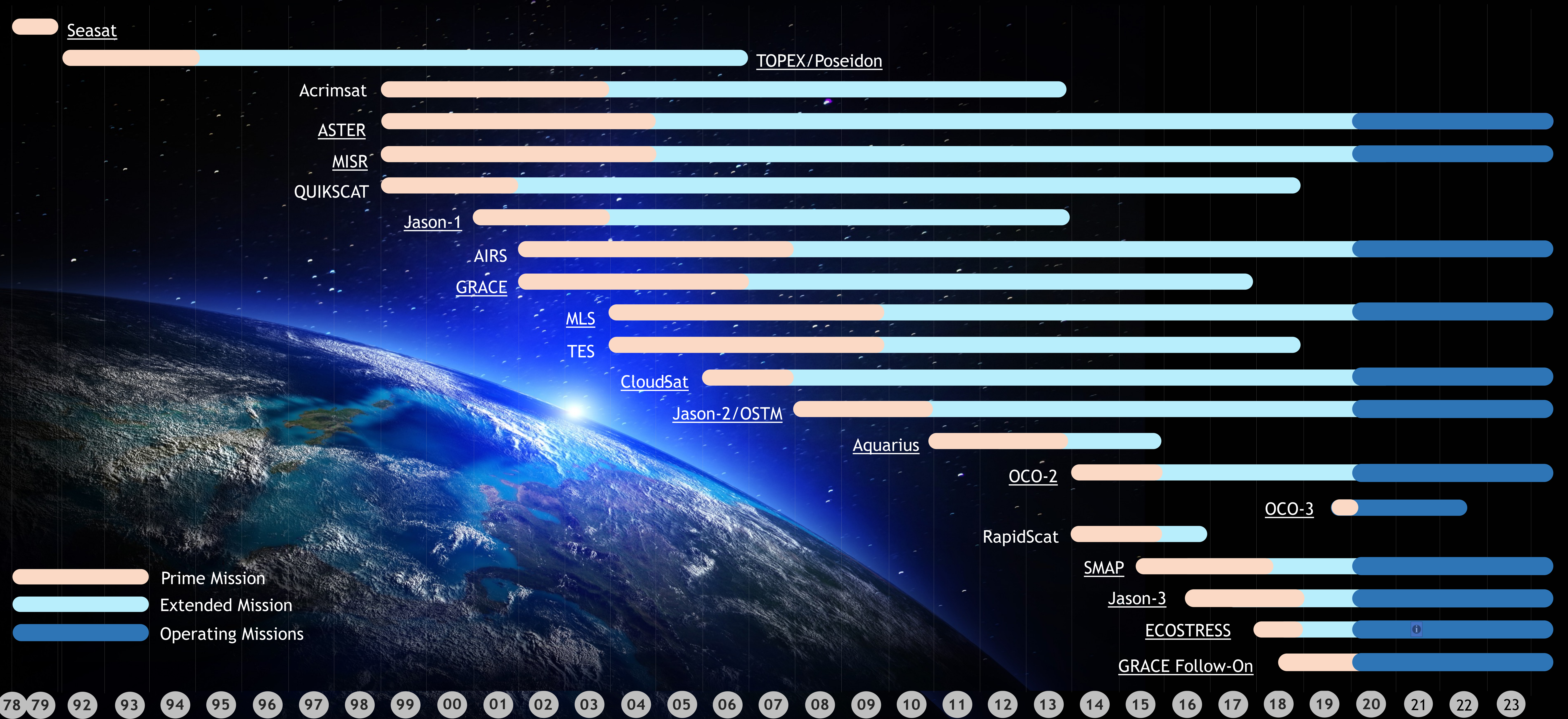
PRIMARY OPS ●

EXTENDED OPS ●



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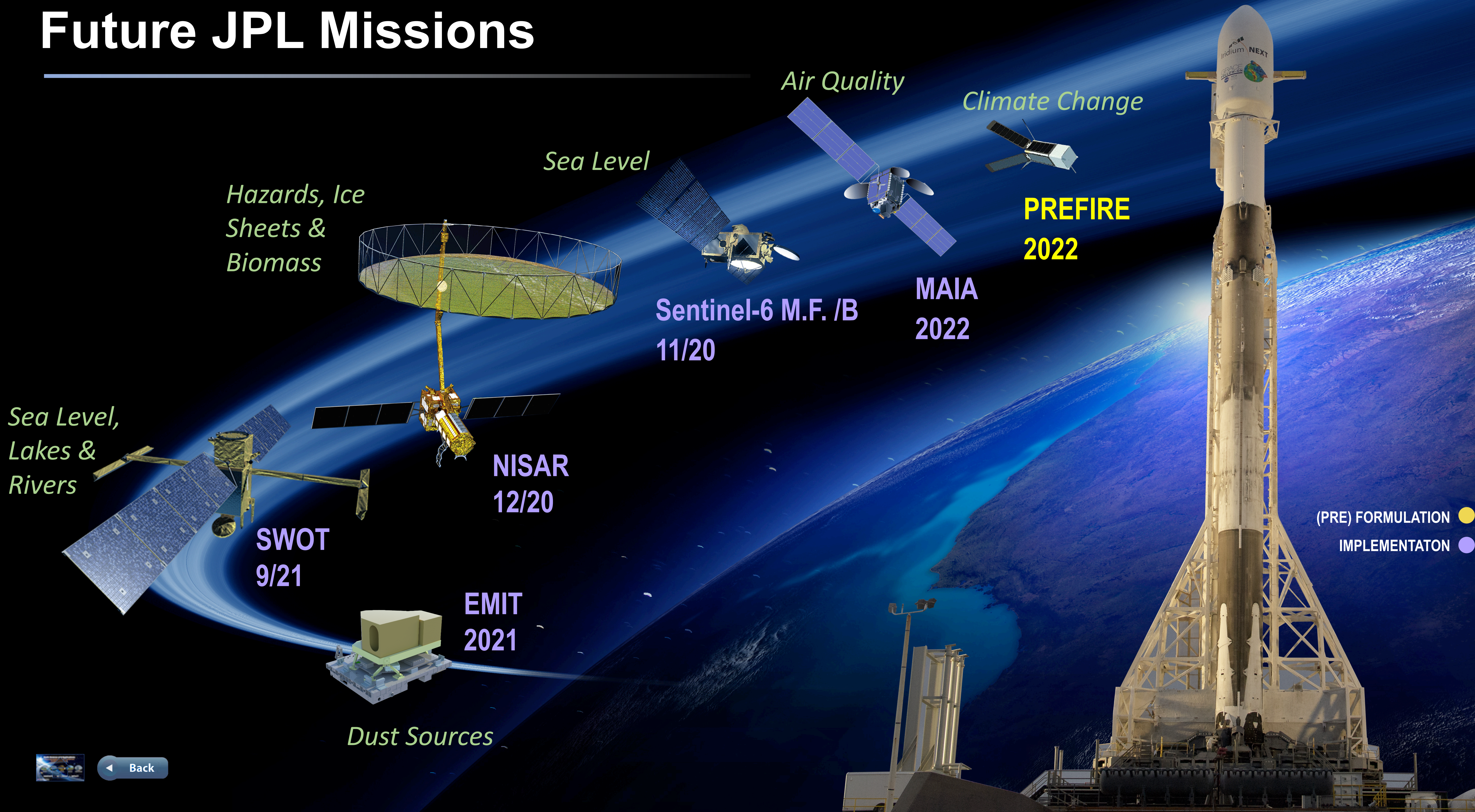
JPL Missions and Timelines



Legend:
Prime Mission (orange bar)
Extended Mission (light blue bar)
Operating Missions (dark blue bar)

Timeline: 78 79 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23

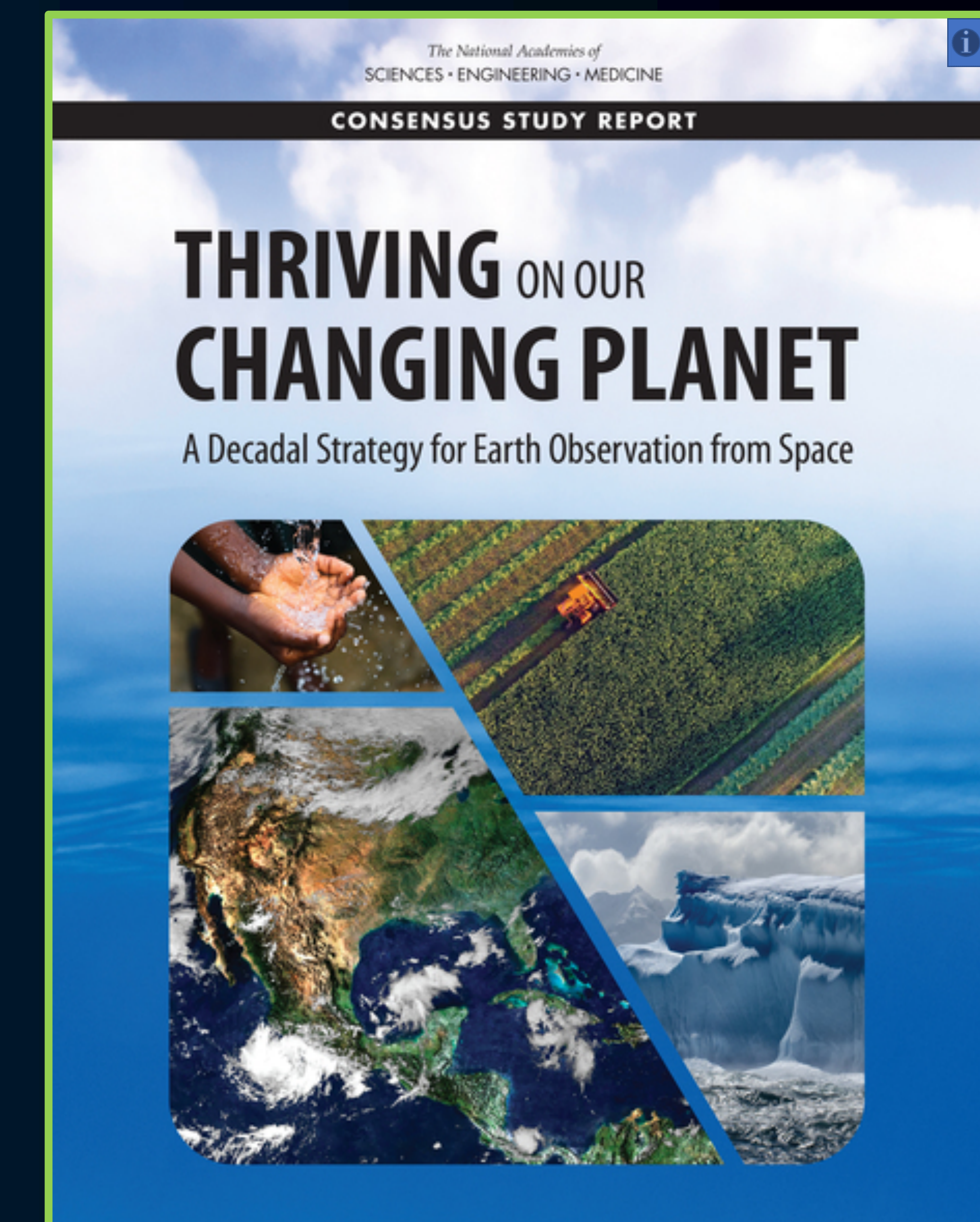
Future JPL Missions



Mission Impacts

ENABLING FUNDAMENTAL ADVANCES IN EARTH SCIENCE

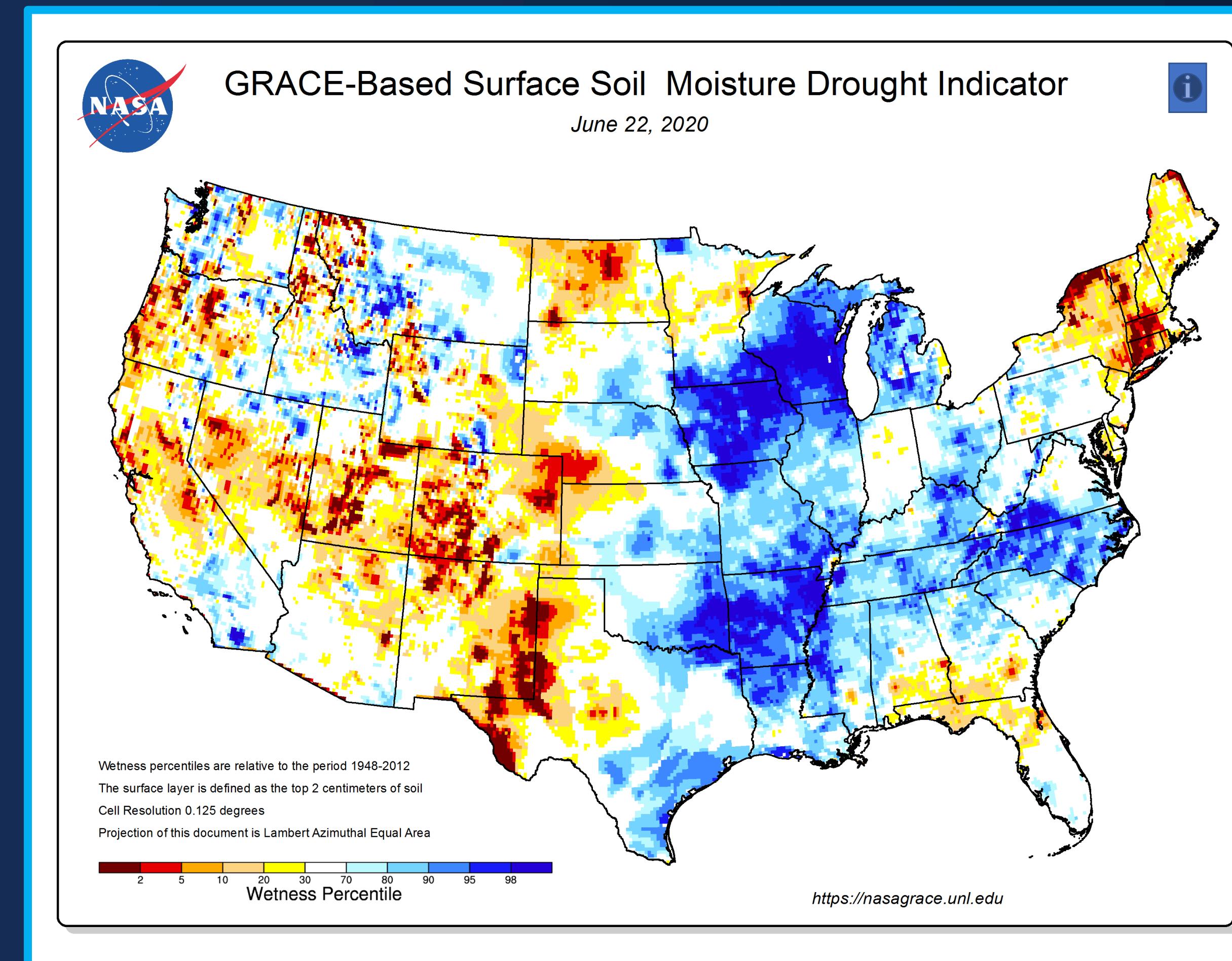
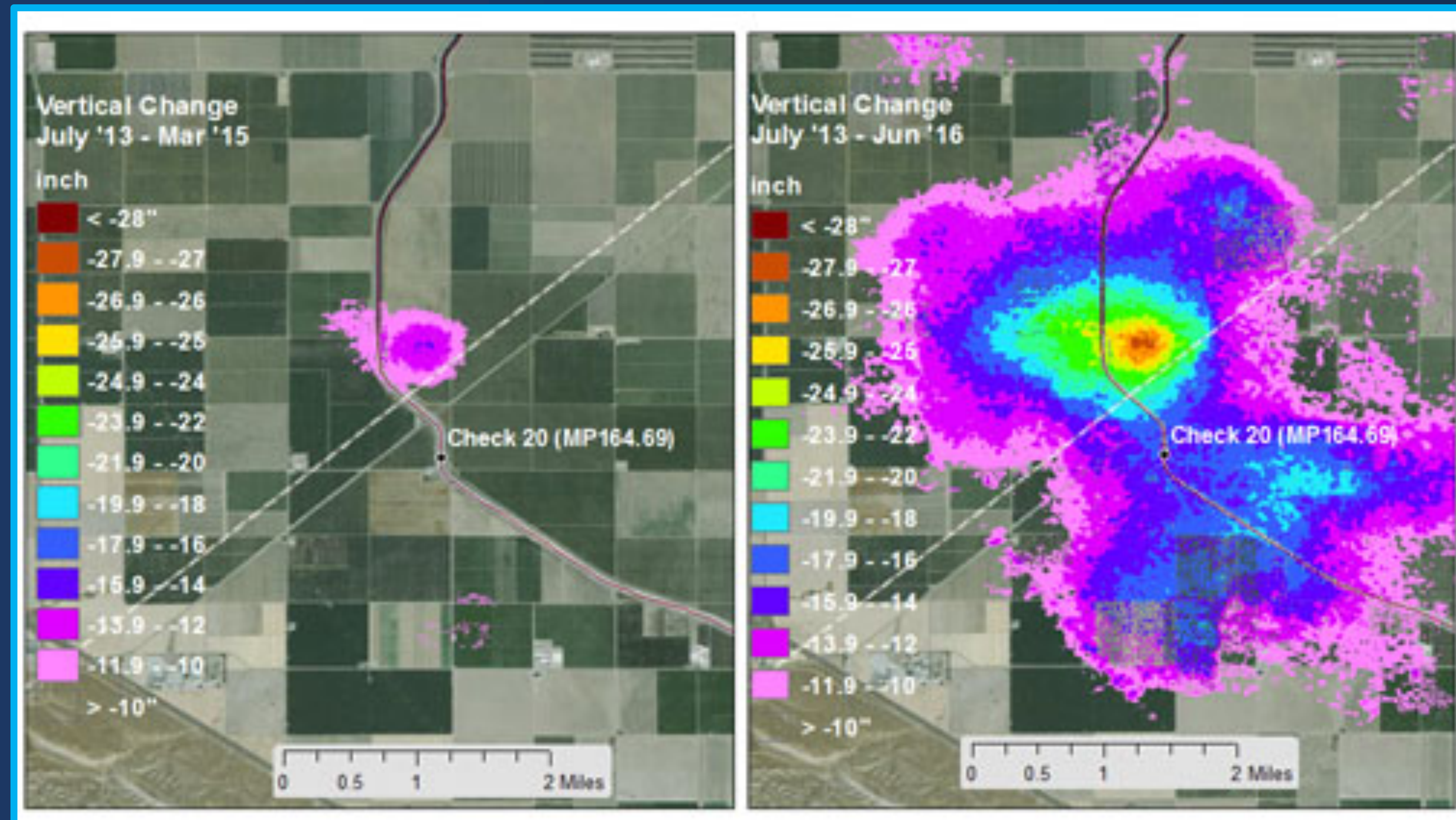
- Peer-reviewed science publications
 - > 400 publications/year involving JPL scientists
 - > 1000 publications/year based on JPL missions
- Training next generation Earth Science leaders
 - ~50 postdoctoral scientists
- Participation in National Academy of Science and Engineering studies



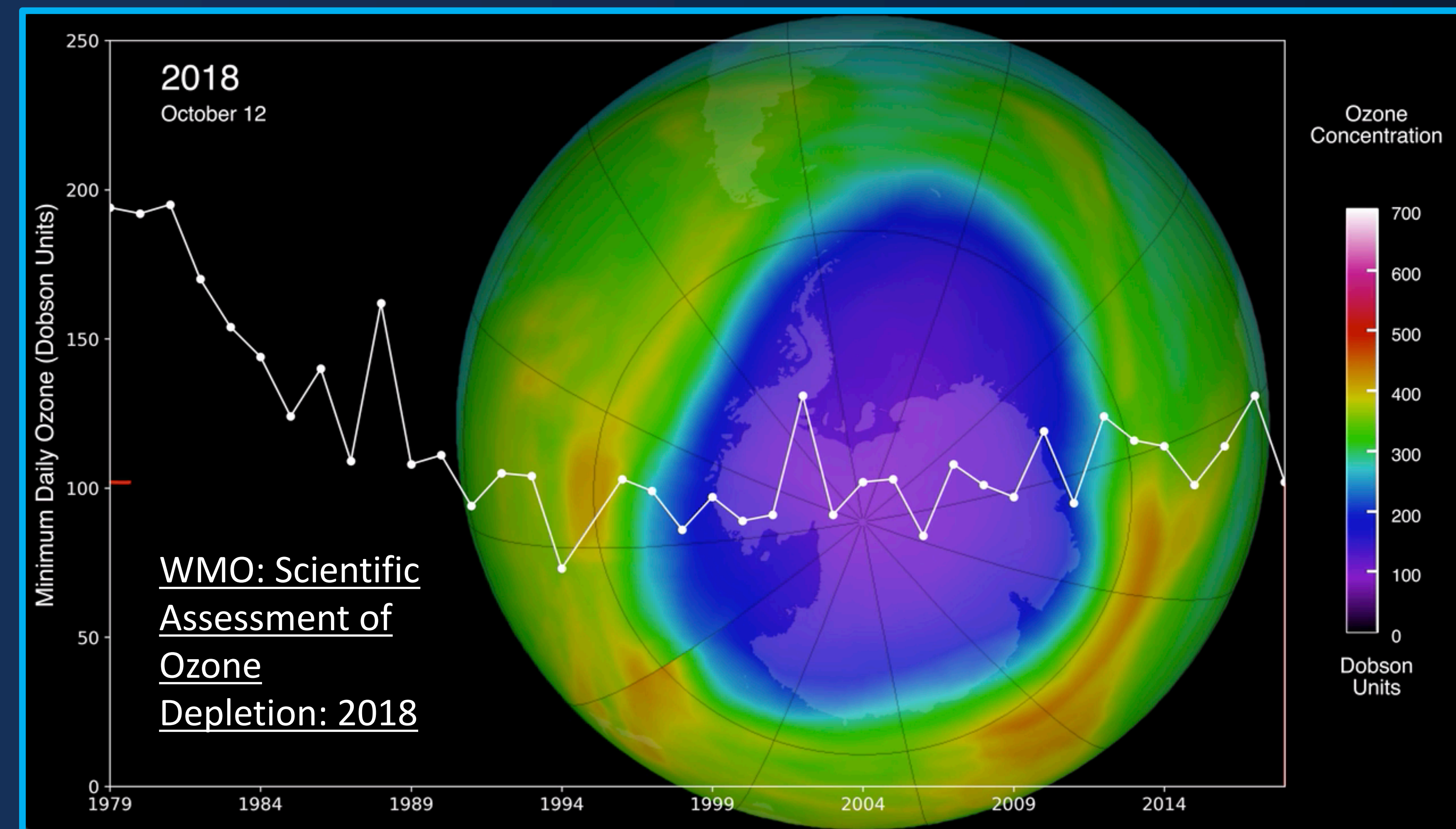
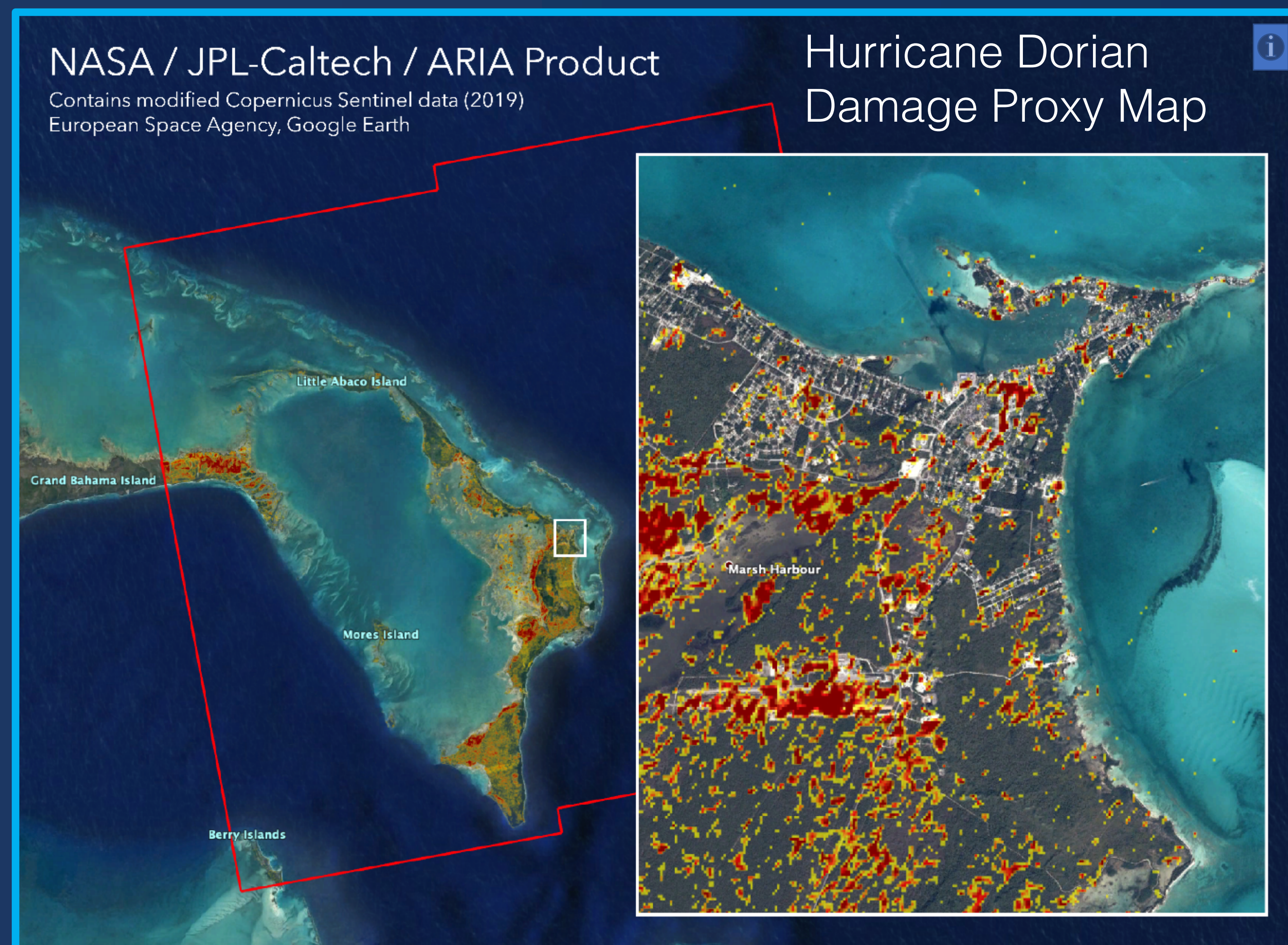
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Mission Impacts

APPLYING OBSERVATIONS FOR REAL WORLD BENEFITS



- FEMA and U.S. Homeland Security
- National Drought Monitor
- California Seismic Safety Commission
- World Meteorological Organization (WMO)
- National Climate Assessment
- California Department of Water Resources

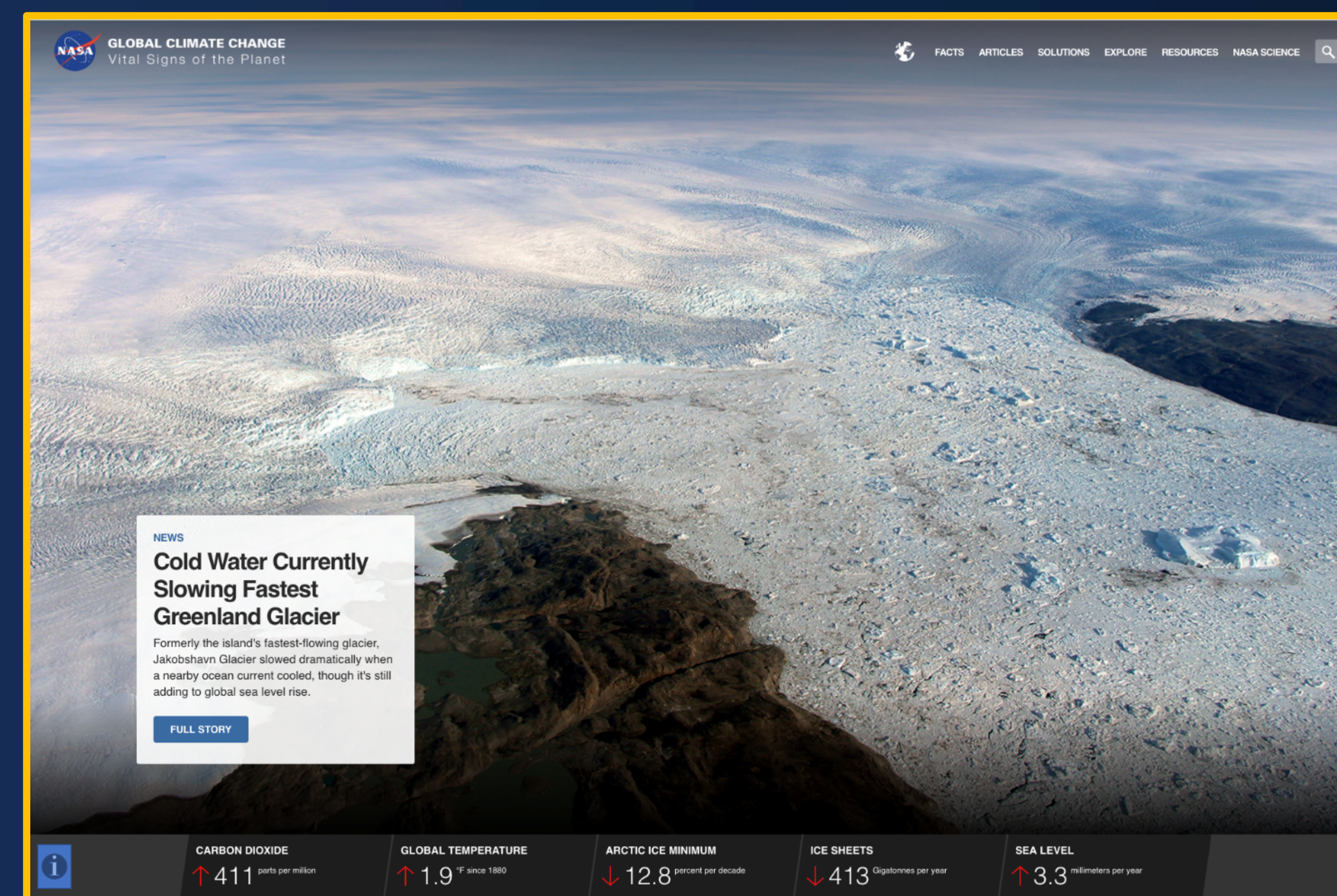
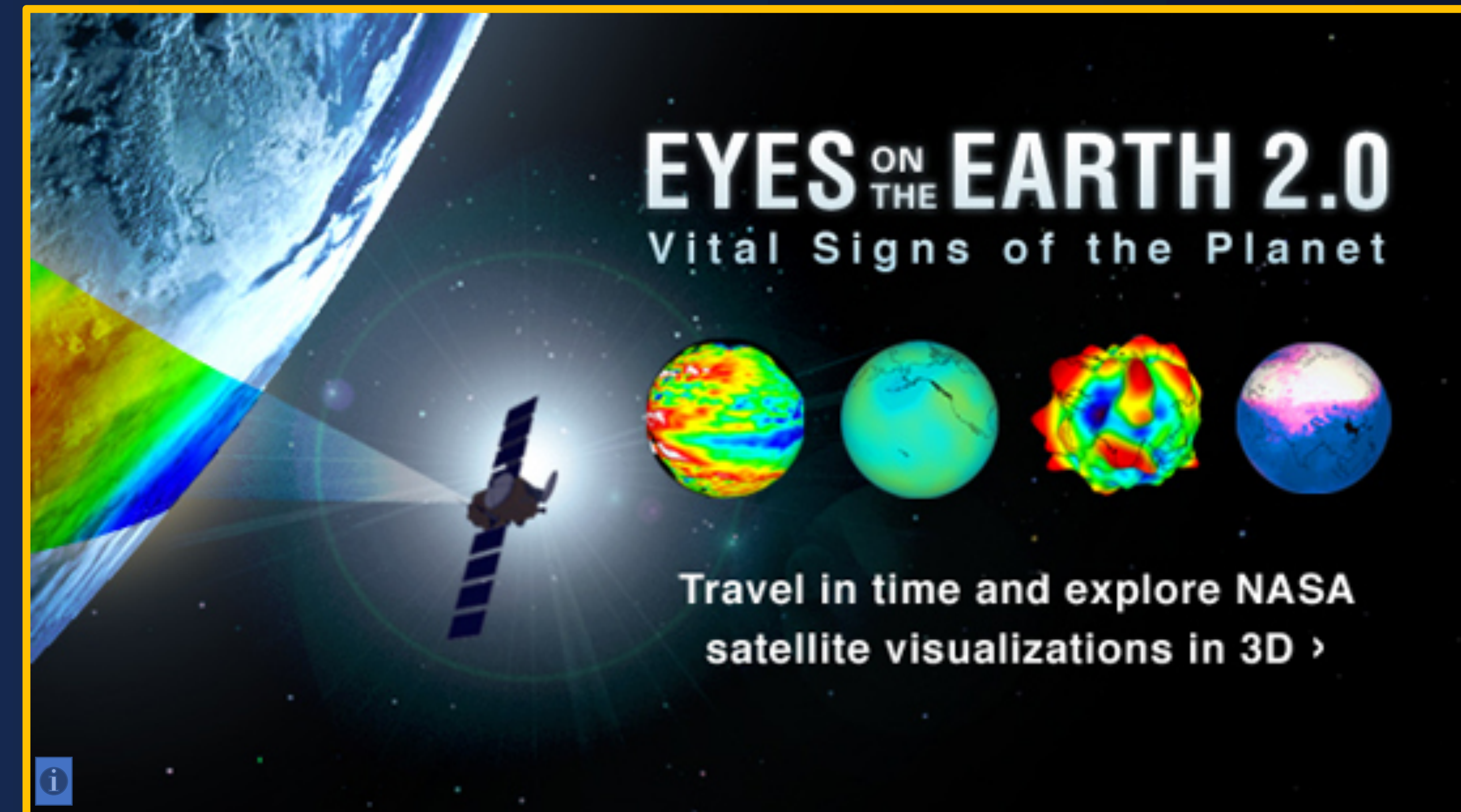


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Mission Impacts

SHARING KNOWLEDGE AND DATA WITH THE PUBLIC

- Award-winning NASA Global Climate Change website:
climate.nasa.gov
- Eyes on the Earth/Earth Now – real-time satellite and data for digital platforms
- In-person and social media outreach campaigns
- ~100 Earth Science press releases per year



June 18, 2020
NASA, Partner Space Agencies to Release Global View of COVID-19 Impacts
NASA, ESA (European Space Agency) and JAXA (Japan Aerospace Exploration Agency) will unveil a dashboard of satellite data showing impacts on the environment and socioeconomic activity caused by the global response to the coronavirus (COVID-19) pandemic during a media teleconference at 9 a.m. EDT Thursday, June 25.

June 11, 2020
New International Sea Level Satellite Completes Testing
A team of engineers in the U.S. and Europe subjected the Sentinel-6 Michael Freilich spacecraft to a battery of trials to ready it for liftoff later this year.

June 9, 2020
NASA Ocean Ecosystem Mission Preparing to Make Waves
NASA's Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission has successfully passed its design reviews and moved into its construction and testing phase, preparing to advance the fields of global ocean and atmospheric science when it launches in 2023.

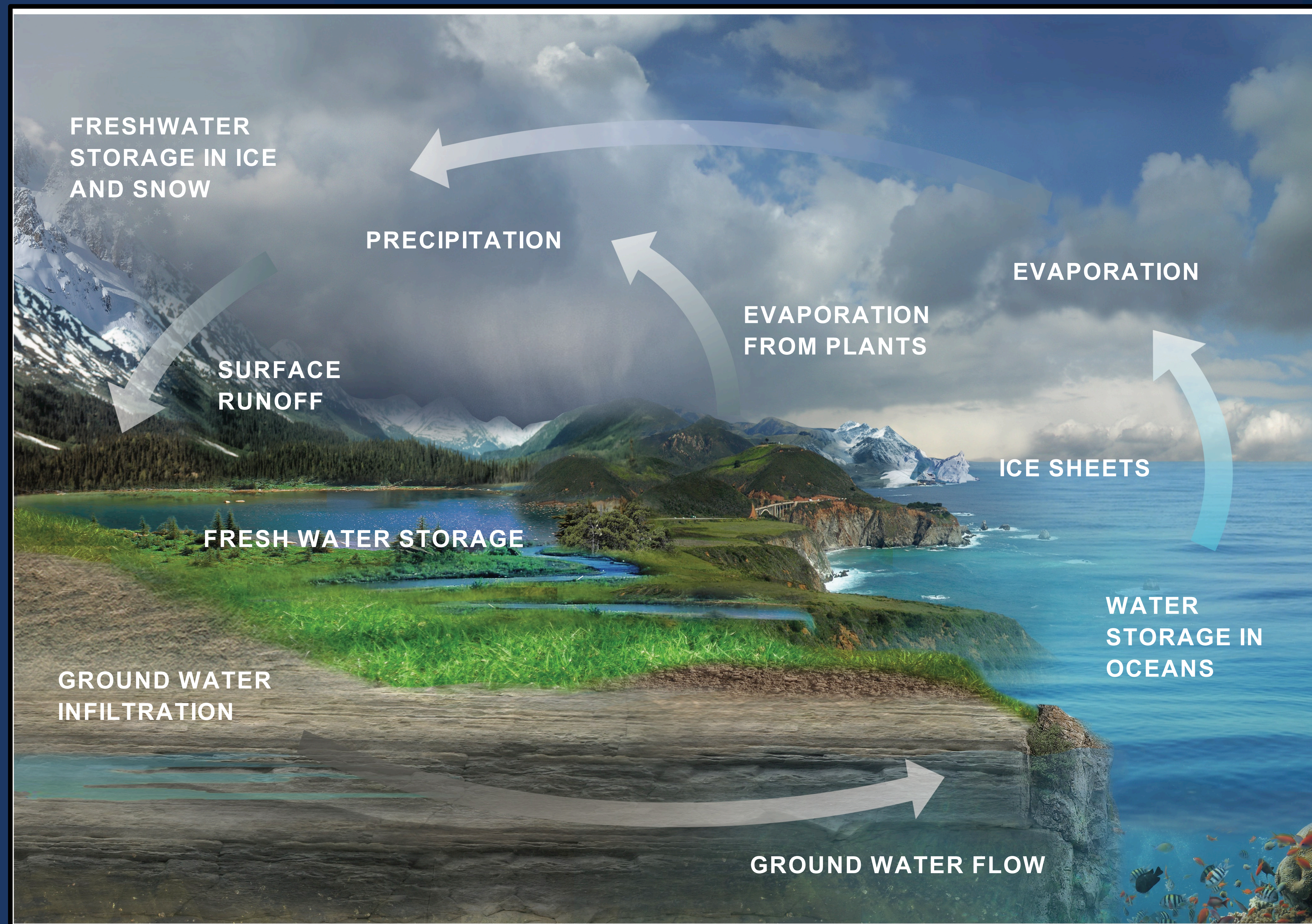


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Water Cycle

DEVELOP AND ENABLE PREDICTIONS FOR REGIONAL WATER SHORTAGES

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Challenge

Develop useful predictions of regional water shortages for lead times from weeks to years

Approach

- Design and build first-of-a kind instruments/satellites
- Measure the components of the Earth's water cycle
- Understand and model the flow of water through the Earth system
- Develop integrated programmatic approach between science and engineering
- Partner with international, federal, state and local agencies to improve predictions of water

Satellite Missions

GRACE-FO, SMAP, ECOSTRESS, SWOT, AIRS, CloudSat, Jason-2/3, NISAR

Other Activities

Western Water Applications Office

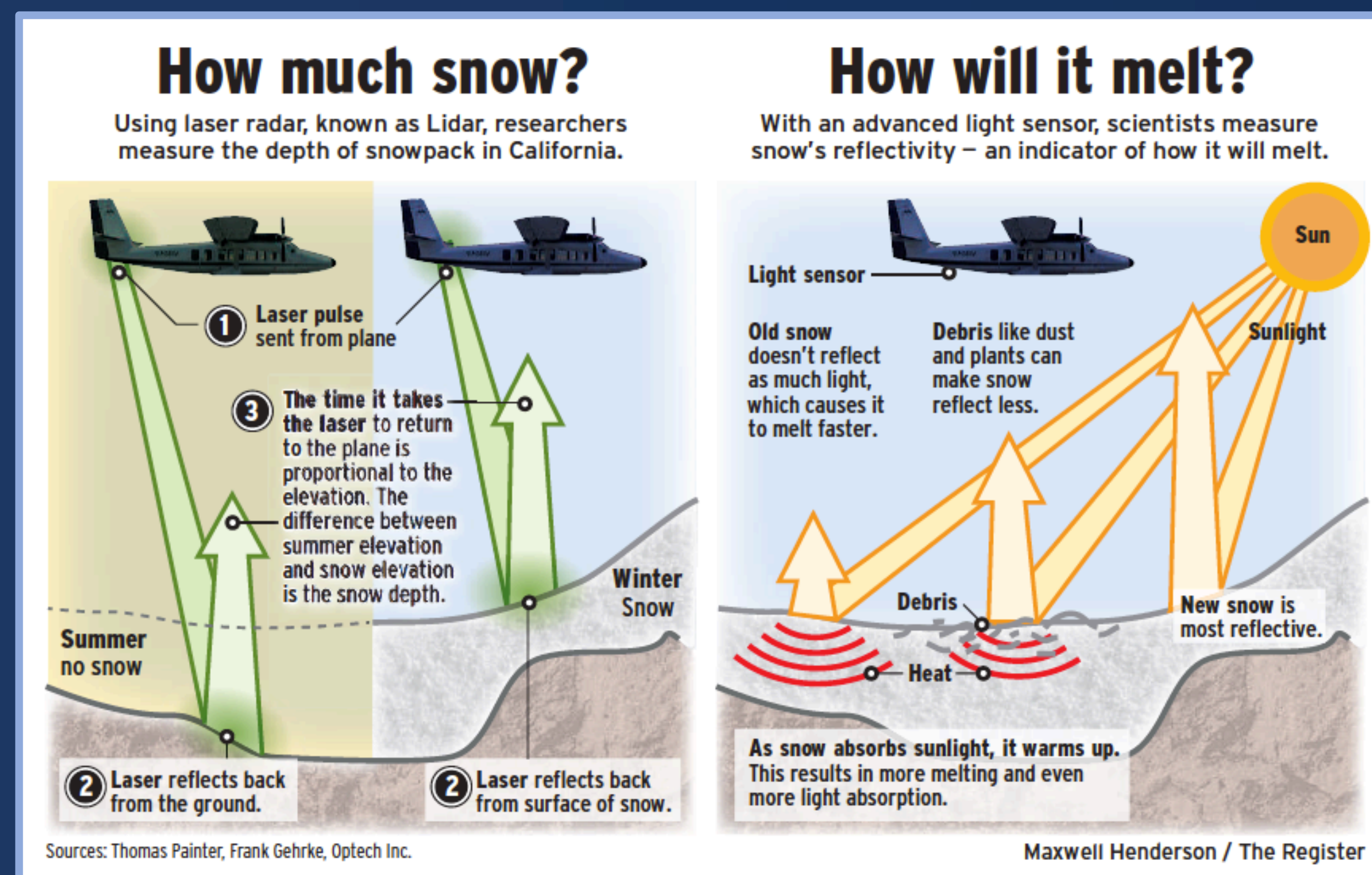


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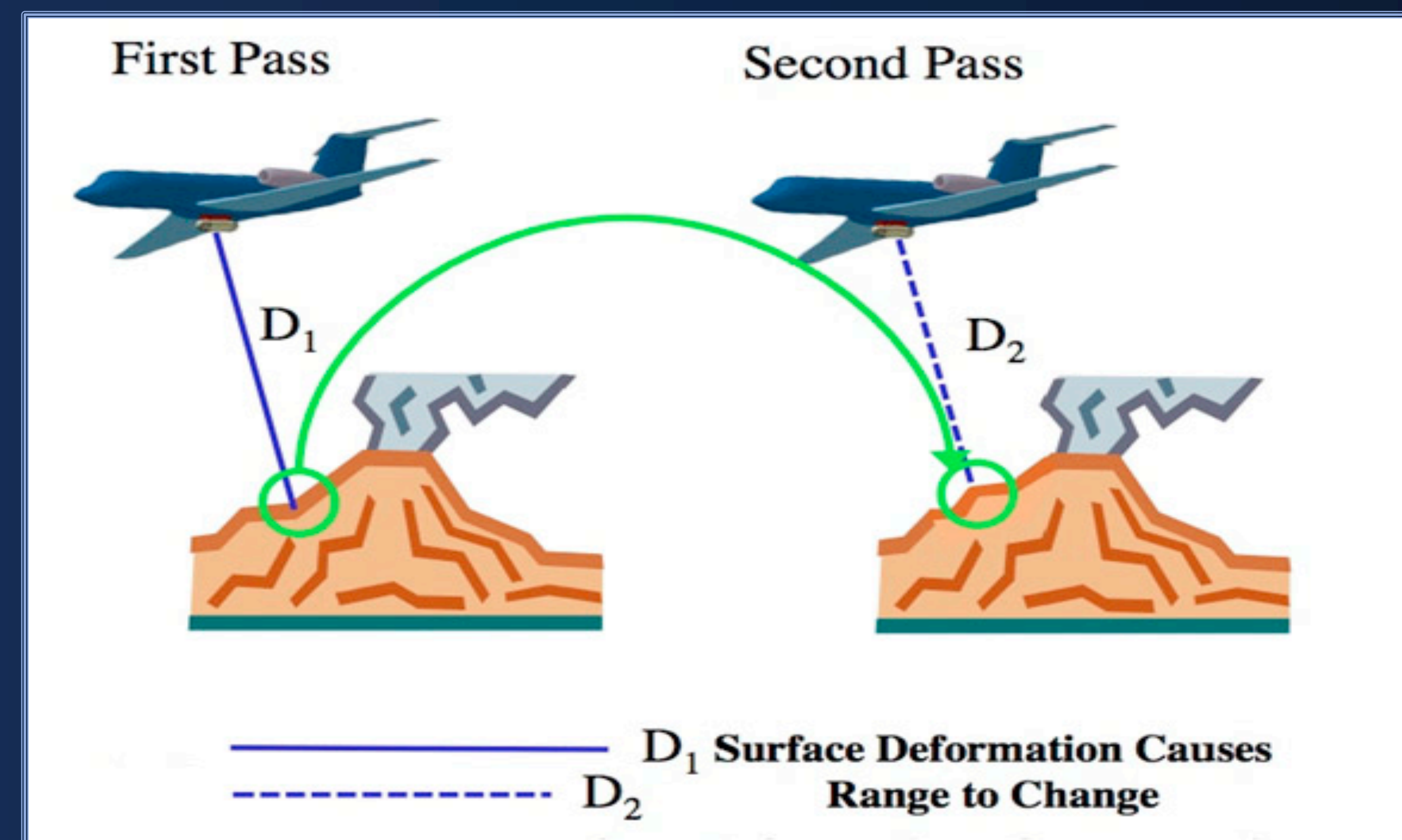
Water Cycle

DEVELOP USEFUL TOOLS AND INFORMATION FOR CALIFORNIA WATER MANAGEMENT

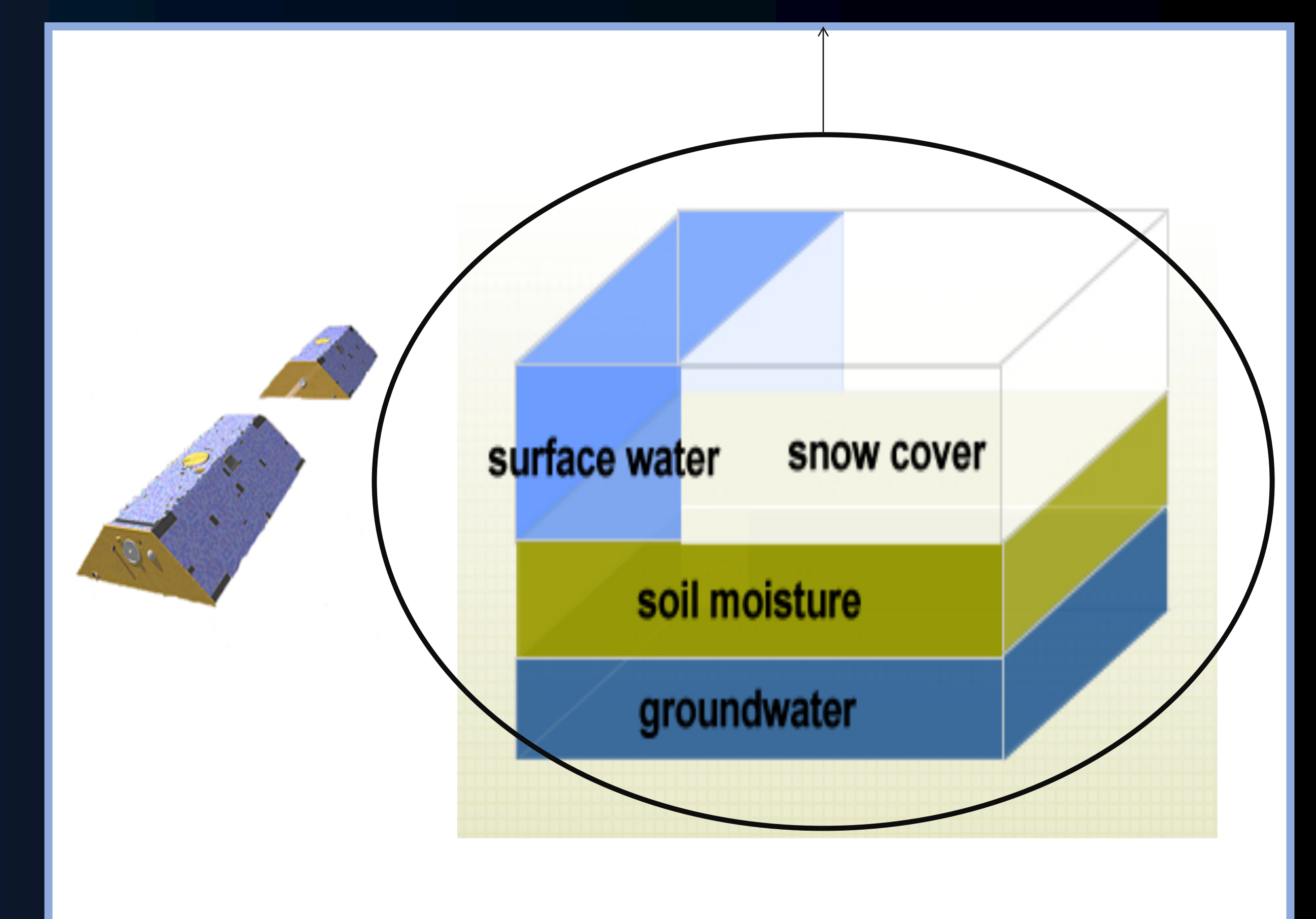
INNOVATE



Lidar + Hyperspectral Imagery
= Snowpack Observatory



Repeat pass radar interferometry
for Earth surface monitoring



Gravity observations to provide
groundwater estimates

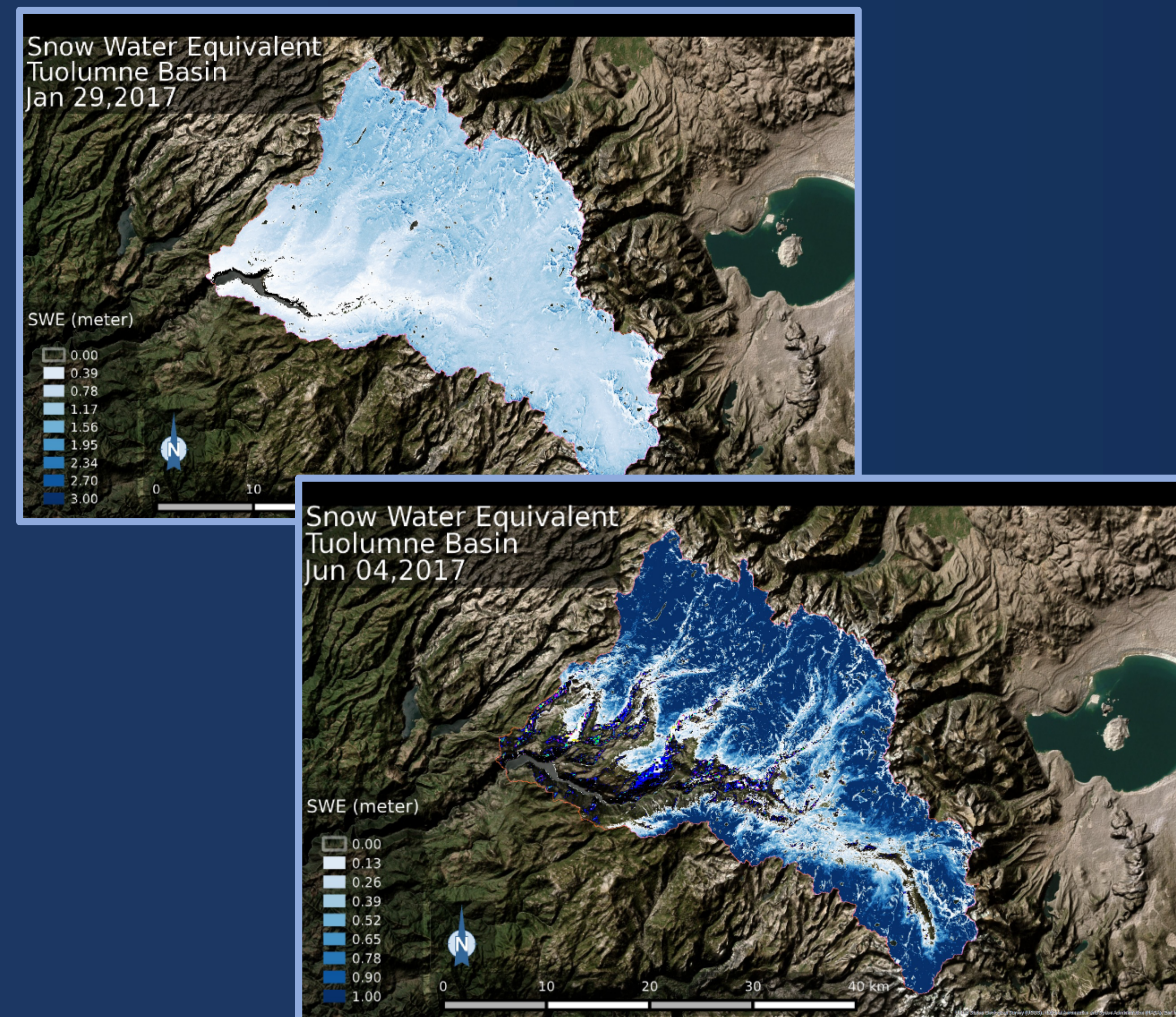


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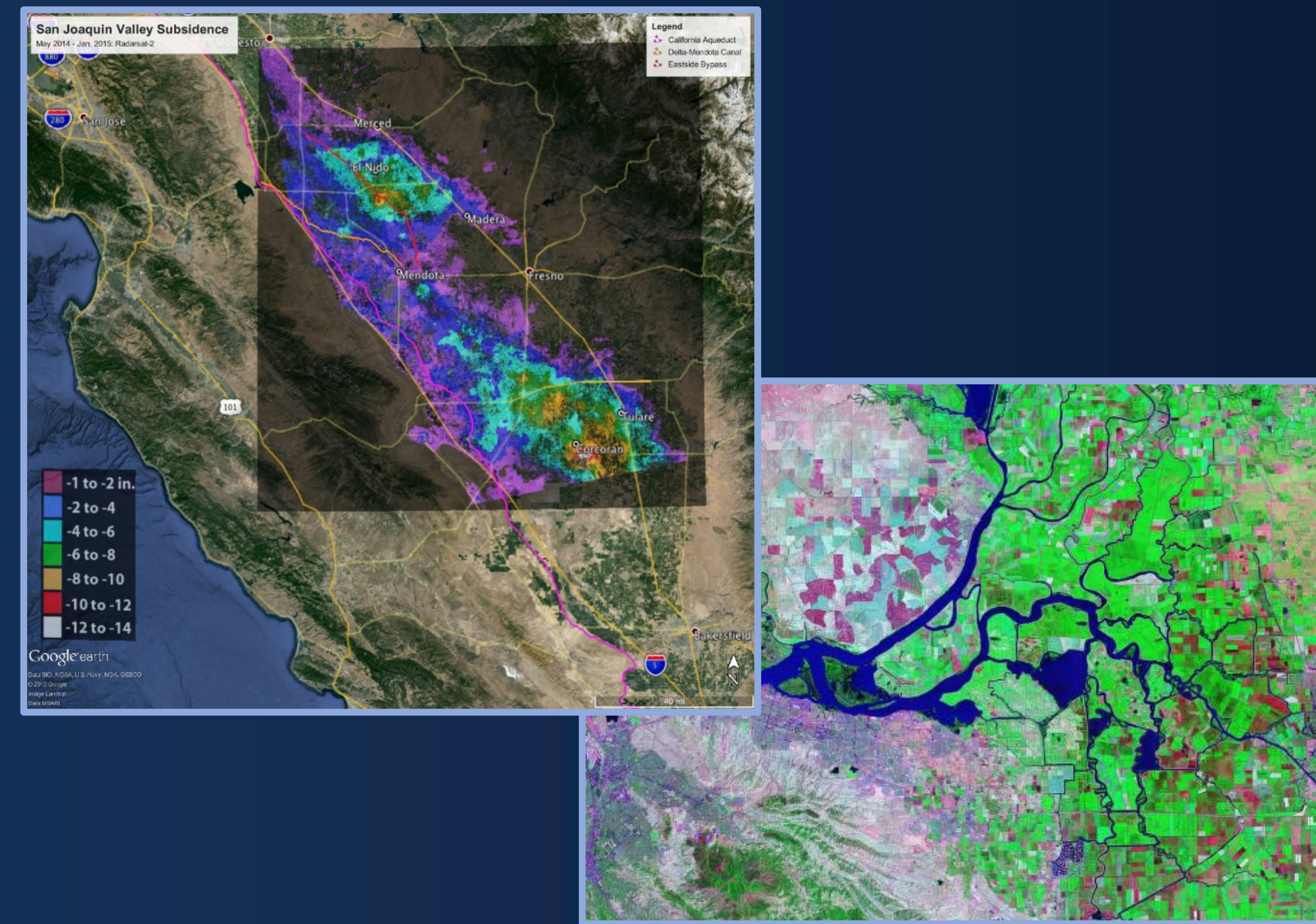
Water Cycle

DEVELOP USEFUL TOOLS AND INFORMATION FOR CALIFORNIA WATER MANAGEMENT

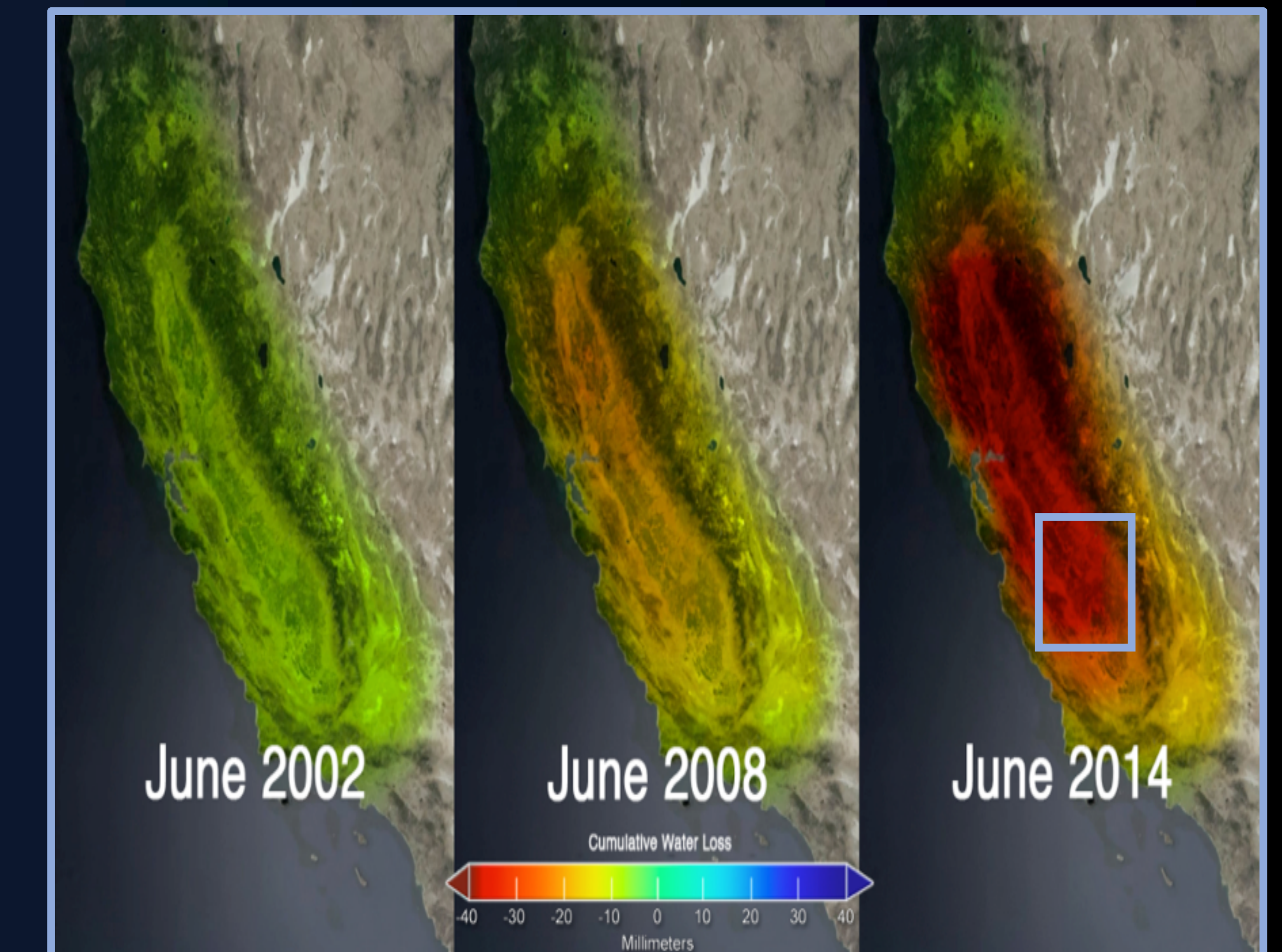
IMPLEMENT



ASO : Sierra snowpack measurements



UAVSAR & ARIA : Central Valley subsidence and Bay Delta levee integrity



GRACE & GRACE-FO : Central Valley groundwater variations

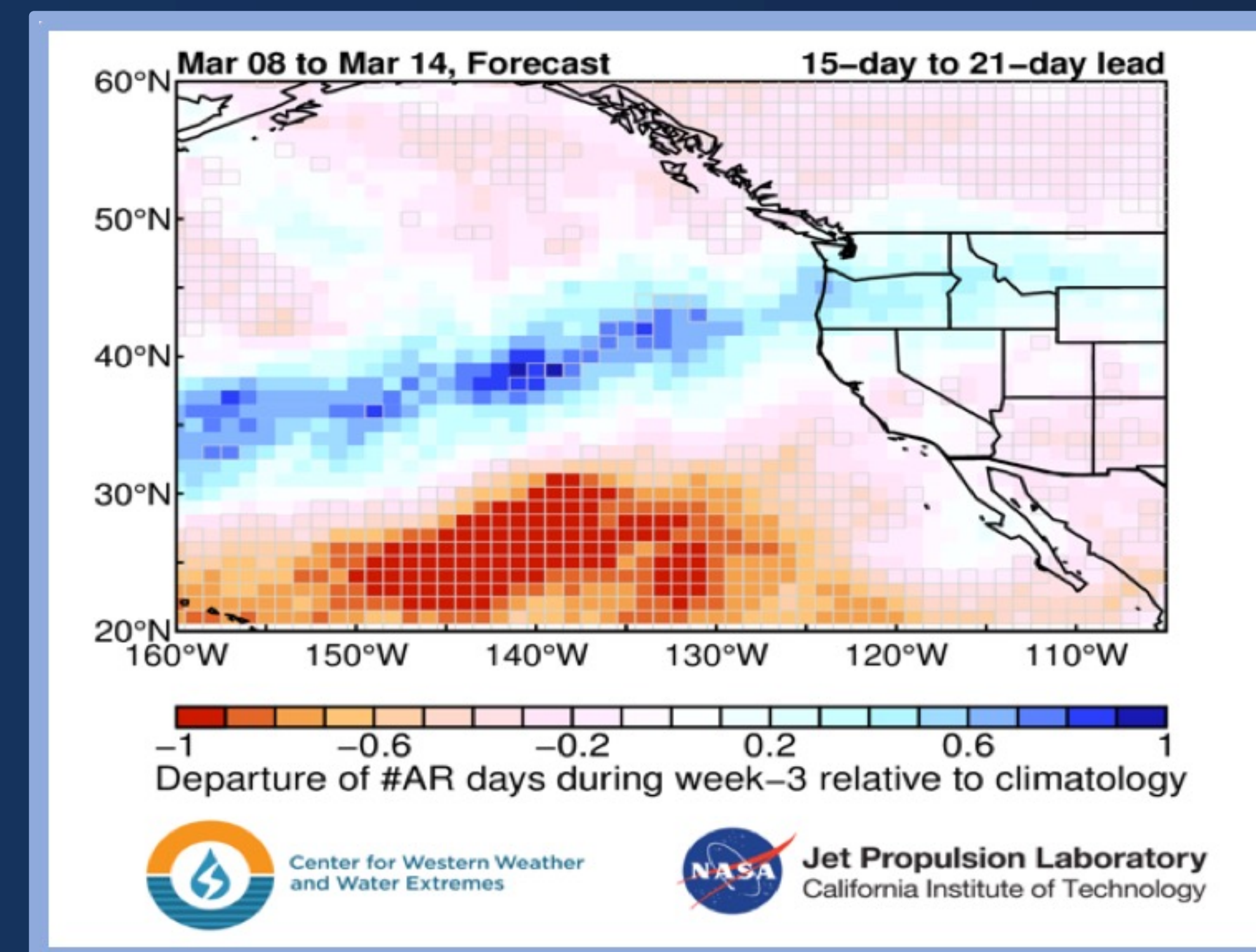


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Water Cycle

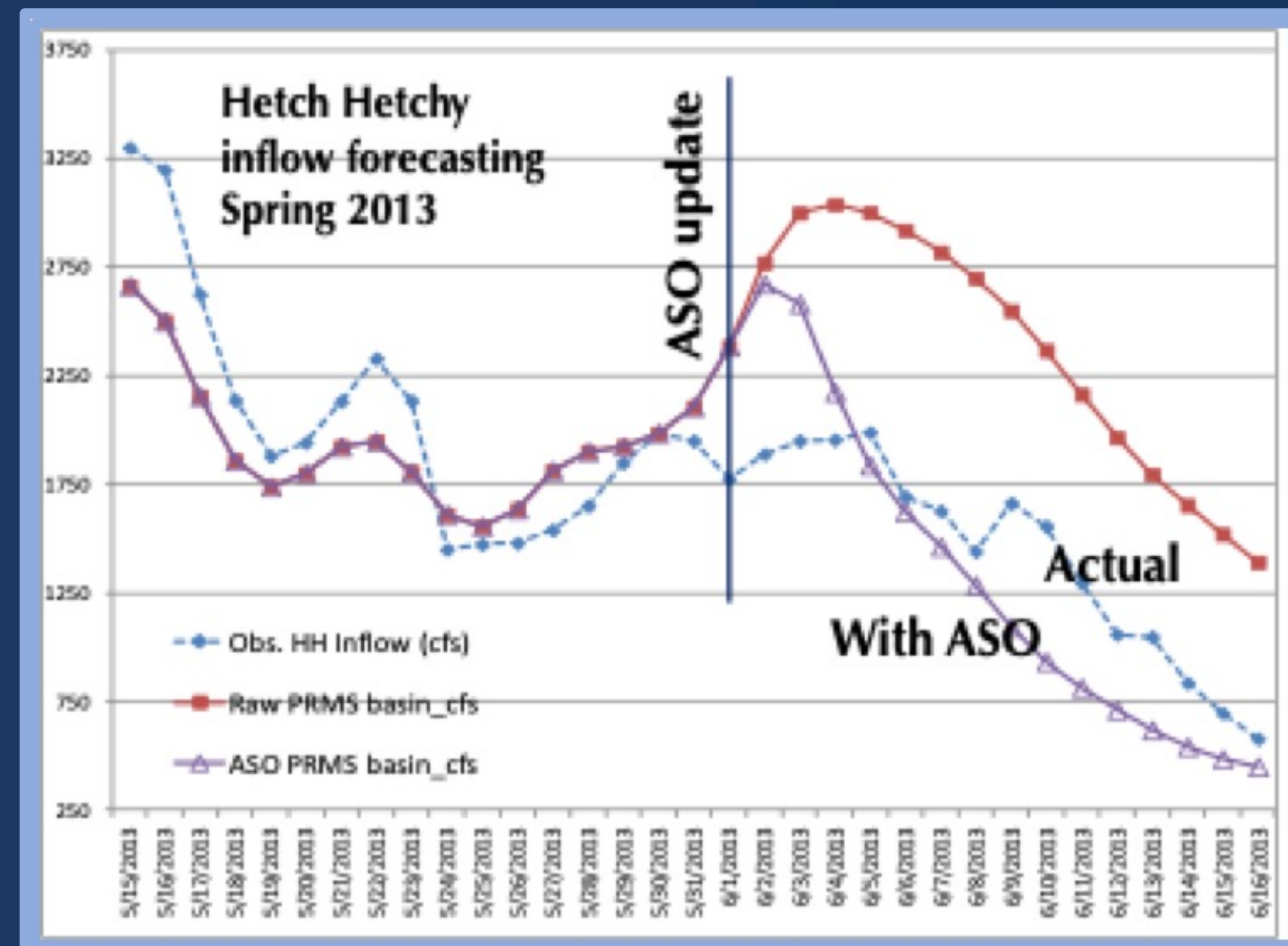
DEVELOP USEFUL TOOLS AND INFORMATION FOR CALIFORNIA WATER MANAGEMENT

IMPACT



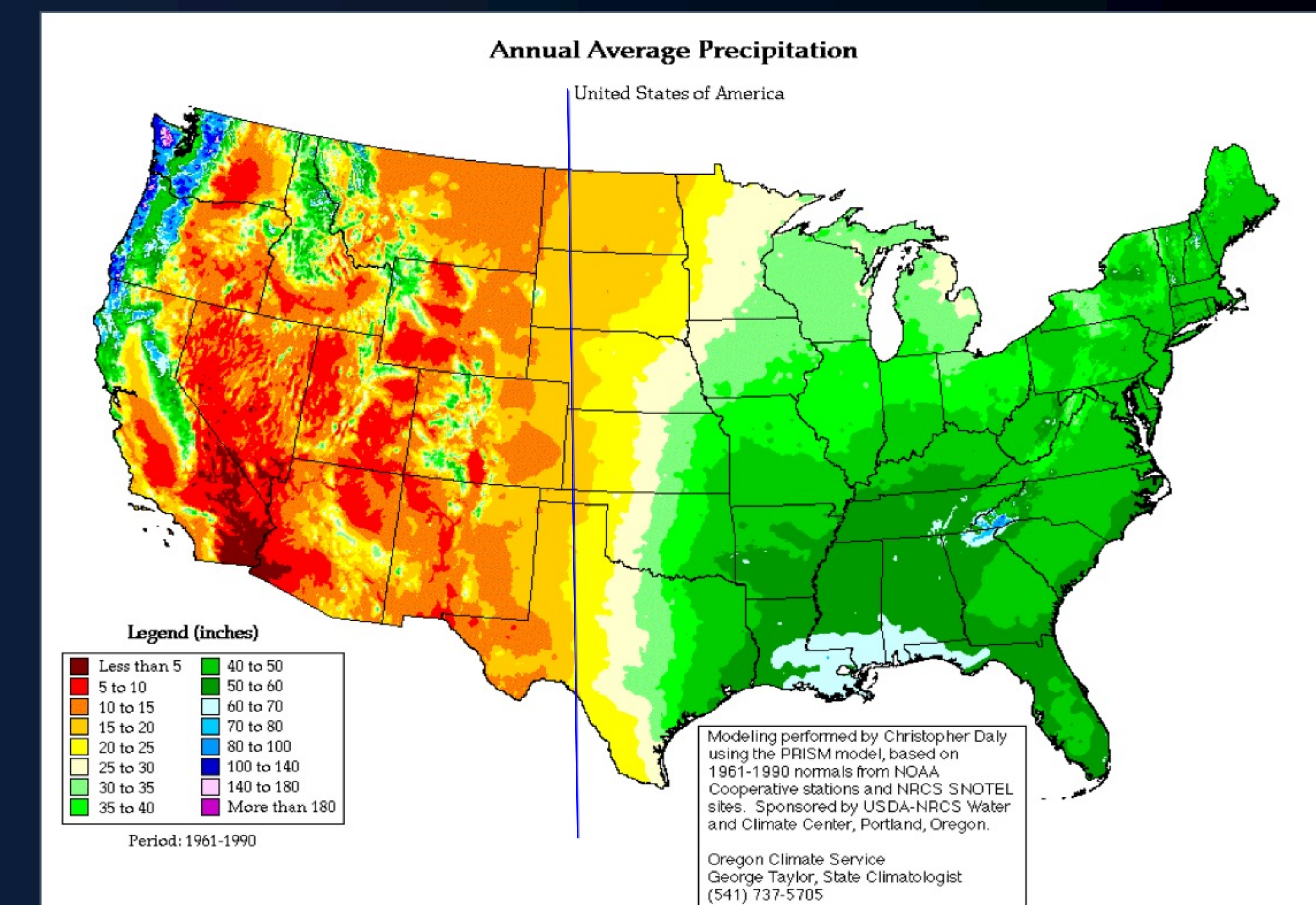
WWAO

- Connects stakeholders with NASA scientists, technology, tools, and data
- Assists application transition into operations
- Develops custom solutions through applications projects



Department of Water Resources

- Summer water supply
 - Snowpack
 - Groundwater
 - Evapotranspiration
- Atmospheric Rivers & flooding
- Levee monitoring



Weather and Air Quality

Stratospheric Ozone
Chemistry and
Transport

Aerosol and Trace
Gas Redistribution
& Attribution

Convection &
Storm Dynamics

Cloud &
Precipitation
Processes

Planetary Boundary
Layer Structure &
Evolution

Air Quality
Attribution
and Impacts

Hydrometeorology,
Floods & Drought

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Weather and Air Quality

ENABLE IMPROVEMENTS IN WEATHER FORECASTS AND AIR QUALITY ATTRIBUTION & FORECASTS

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Other Activities

Cubesats (RainCube, Tempest-D), FIREX-AQ, atmospheric composition state and flux estimates, A-CCP Designated Observable Study, PBL Incubation Study, HAQAST, Subseasonal Atmospheric River Forecast Development.

Challenge

Increase the lead-time and accuracy for weather (Wx) for safeguarding life and property, and provide accurate air quality (AQ) attribution to improve health and environmental conditions.

Approach

- Develop new remote sensing capabilities to characterize atmospheric physical and chemical processes.
- Develop and improve data assimilation methods to better exploit Wx and AQ relevant satellite observations.
- Use these capabilities to enable more skillful Wx and AQ forecasts and improve AQ attribution to inform adaptation and mitigation efforts.

Satellite Missions

AIRS, GNSS-RO, MISR, Quikscat, MLS, RapidScat, SMAP, CloudSat, TES, MAIA



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Sea Level

SNOW PACK

DISCHARGE

STORM SURGE

MELTING
GLACIERS &
ICE SHEETS

GLACIAL REBOUND

THERMAL EXPANSION

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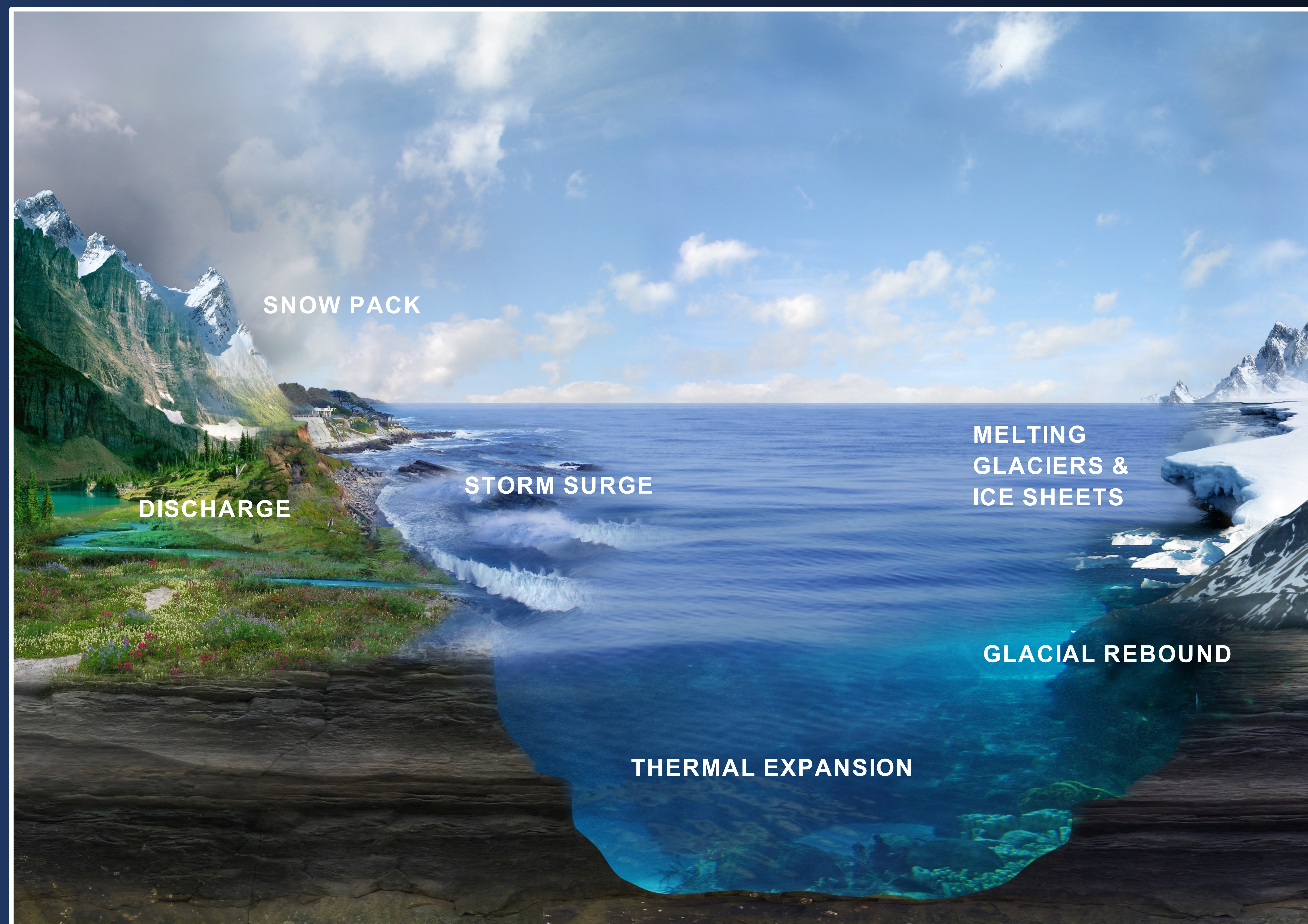


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Sea Level

IMPROVE PREDICTIONS OF SEA LEVEL NEAR URBAN POPULATIONS

INNOVATE • IMPLEMENT • IMPACT



Challenge

Improve long-term projections of regional sea level rise to help mitigate the consequences to urban populations

Approach

- Measure global sea level variations, maintaining a record for continuity
- Develop measurement capabilities for regional sea level variations and rise
- Identify contributing processes to global and regional sea level variations
- Partner to improve predictions of sea regional level variations and global sea level rise

Satellite Missions

Jason-2/Jason-3, GRACE-FO, NISAR, SWOT

Other Activities

NASA Sea Level Portal, Oceans Melting Greenland, Delta-X



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Natural Hazards



TSUNAMIS

SEVERE STORMS

VOLCANOES

AIR POLLUTION

FLOODS

DROUGHT

FOREST FIRES

LANDSLIDES

EARTHQUAKES

INNOVATE • IMPLEMENT • IMPACT



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Natural Hazards

INCREASE DECISION SUPPORT INFORMATION FOR NATURAL HAZARD RESPONSE

INNOVATE • IMPLEMENT • IMPACT



Challenge

Develop forecast potential for natural hazard events and improve our capabilities for hazard response and preparedness

Approach

- Measure changes over the Earth surface to identify and characterize earthquakes, volcanoes, landslides, wild fire, etc.
- Improve our physical understanding of the Earth surface process to better model and predict natural hazards when/where possible
- Develop and provide decision support products for natural hazards preparation and response

Satellite Missions

GRACE-FO, ECOSTRESS, SWOT, NISAR, MISR, TES, EMIT

Other Activities

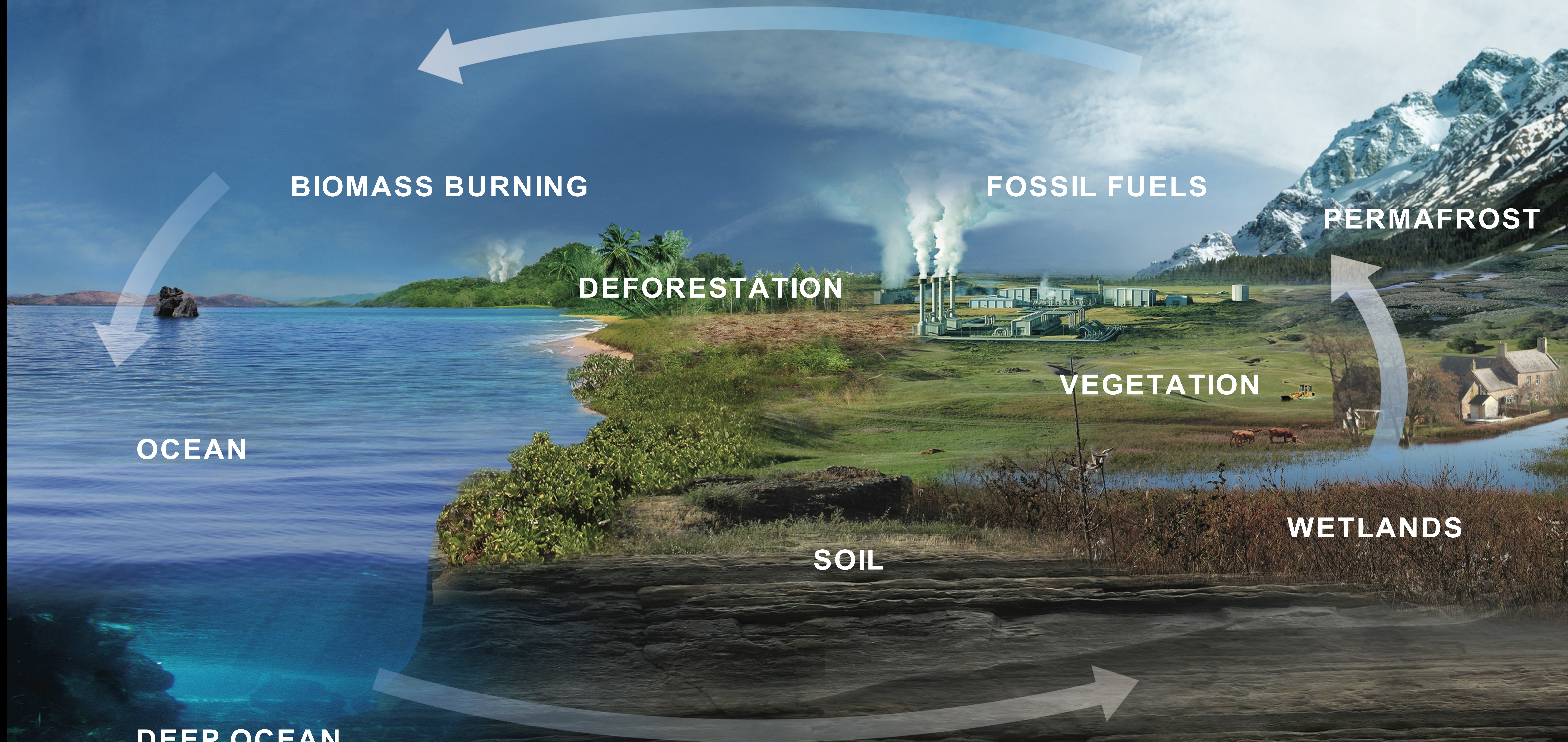
Advanced Rapid Image Analysis (ARIA)



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Carbon and Ecosystems

ATMOSPHERE — CO₂

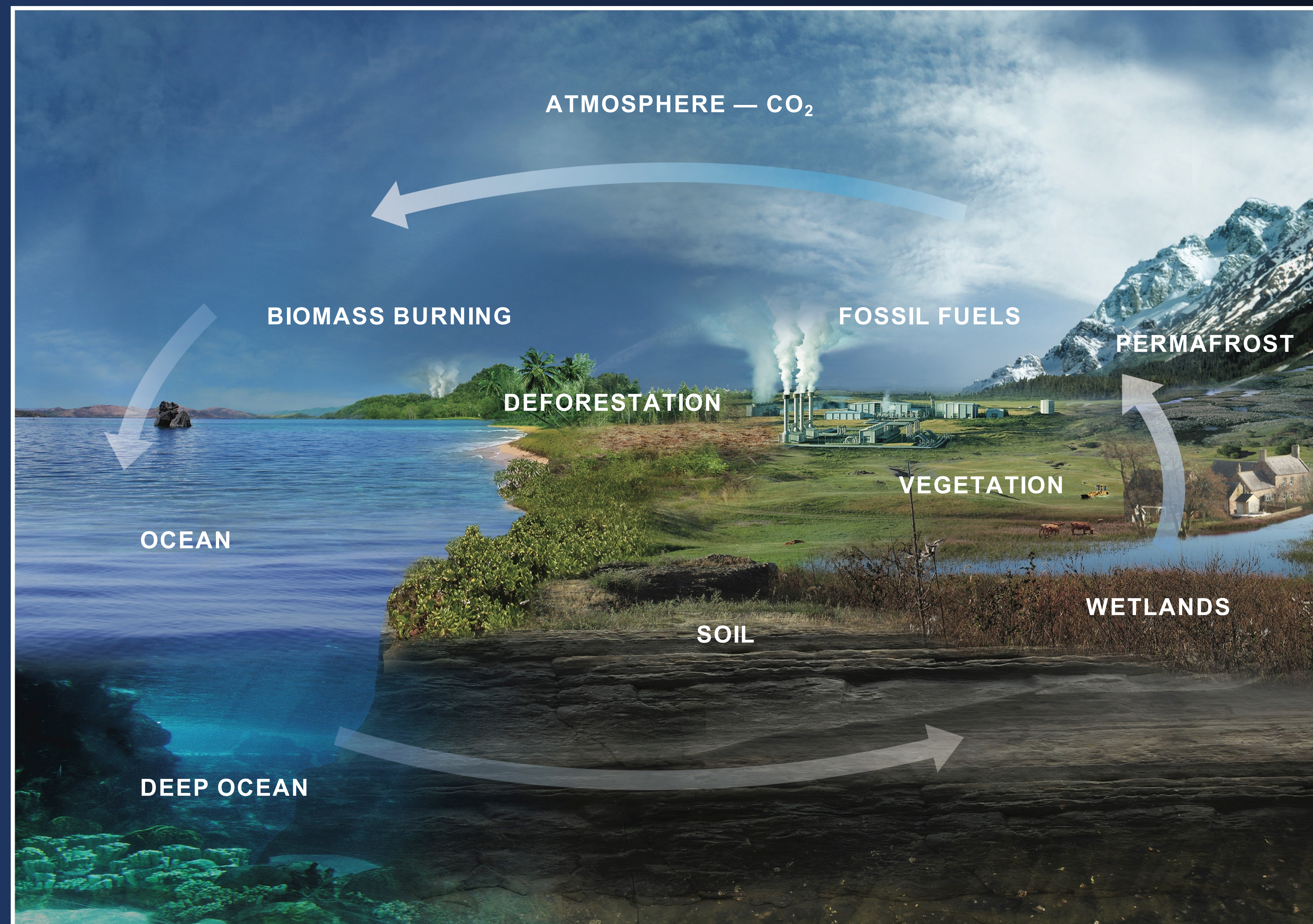


INNOVATE • IMPLEMENT • IMPACT

Carbon and Ecosystems

PROVIDE ESTIMATES AND PROJECTIONS OF THE CARBON CYCLE AT DECISION-RELEVANT SCALES

INNOVATE • IMPLEMENT • IMPACT



Challenge

Provide actionable estimates and projections of the global carbon system, considering natural ecosystems and anthropogenic emissions

Approach

- Measure the components of the Earth's carbon cycle
- Understand and model the flow of carbon through the Earth system
- Partner to develop predictions of land, ocean and atmospheric carbon for decision-relevant scales (e.g. seasonal to decadal)

Satellite Missions

OCO-2, OCO-3, ECOSTRESS, TES, SMAP, NISAR

Other Activities

Carbon Management System, California Methane Survey, CORAL, Delta-X



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