National Aeronautics and
Space Administration

NASA earth

Nearing a “Golden Age” of Ocean Science

Dr. Karen St. Germain
Director
Earth Science Division

ICESat-2
Sentinel-6
Michael Freilich
Landsat 9
CYGNSS-8
CYGNSS-2
CYGNSS-1
CYGNSS-3
SWOT
Aura
TROPICS-07
PACE
TROPICS-01
CYGNSS-4
OCO-2
TROPICS-06
Suomi NPP
SMAP
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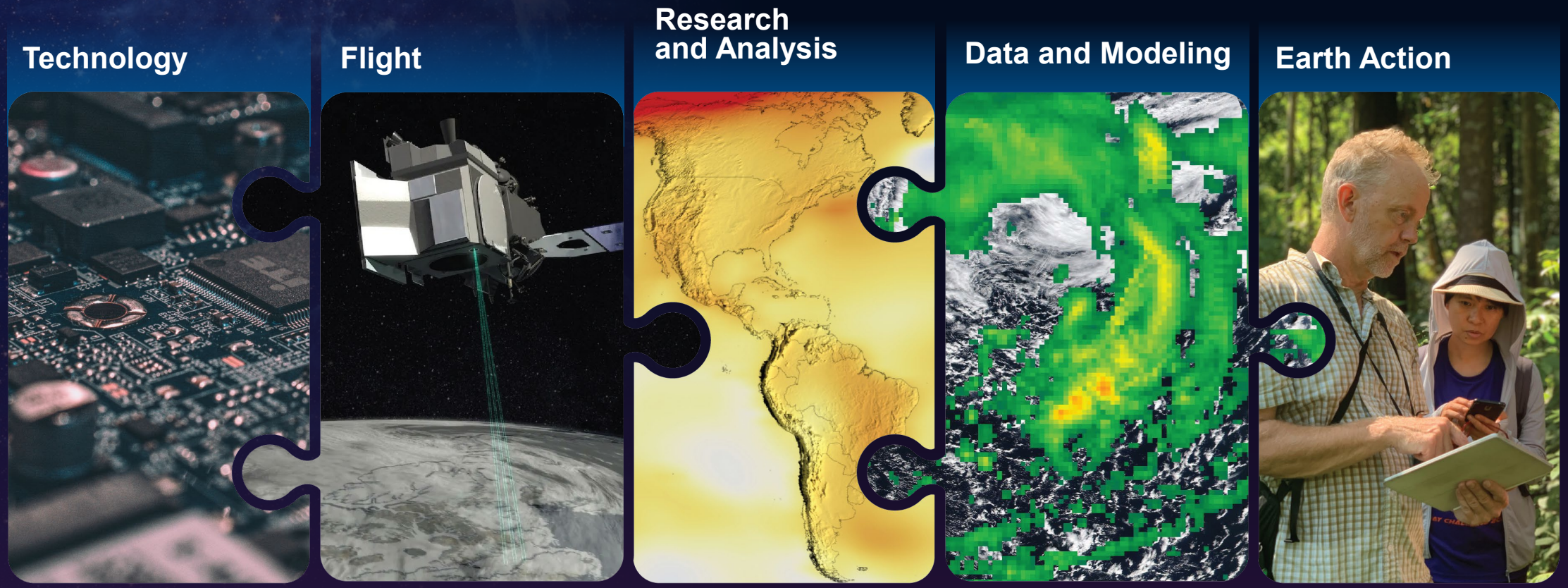
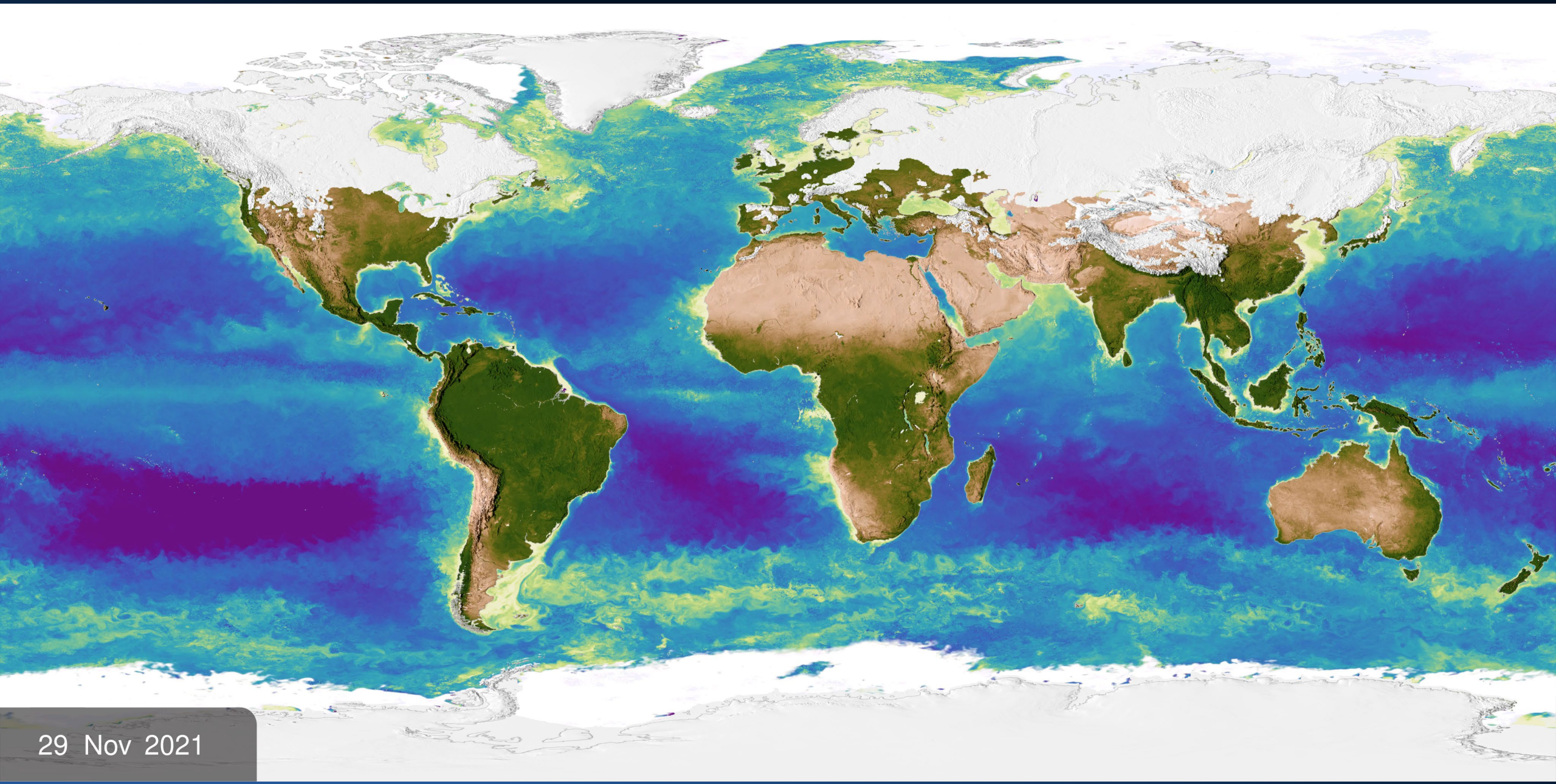
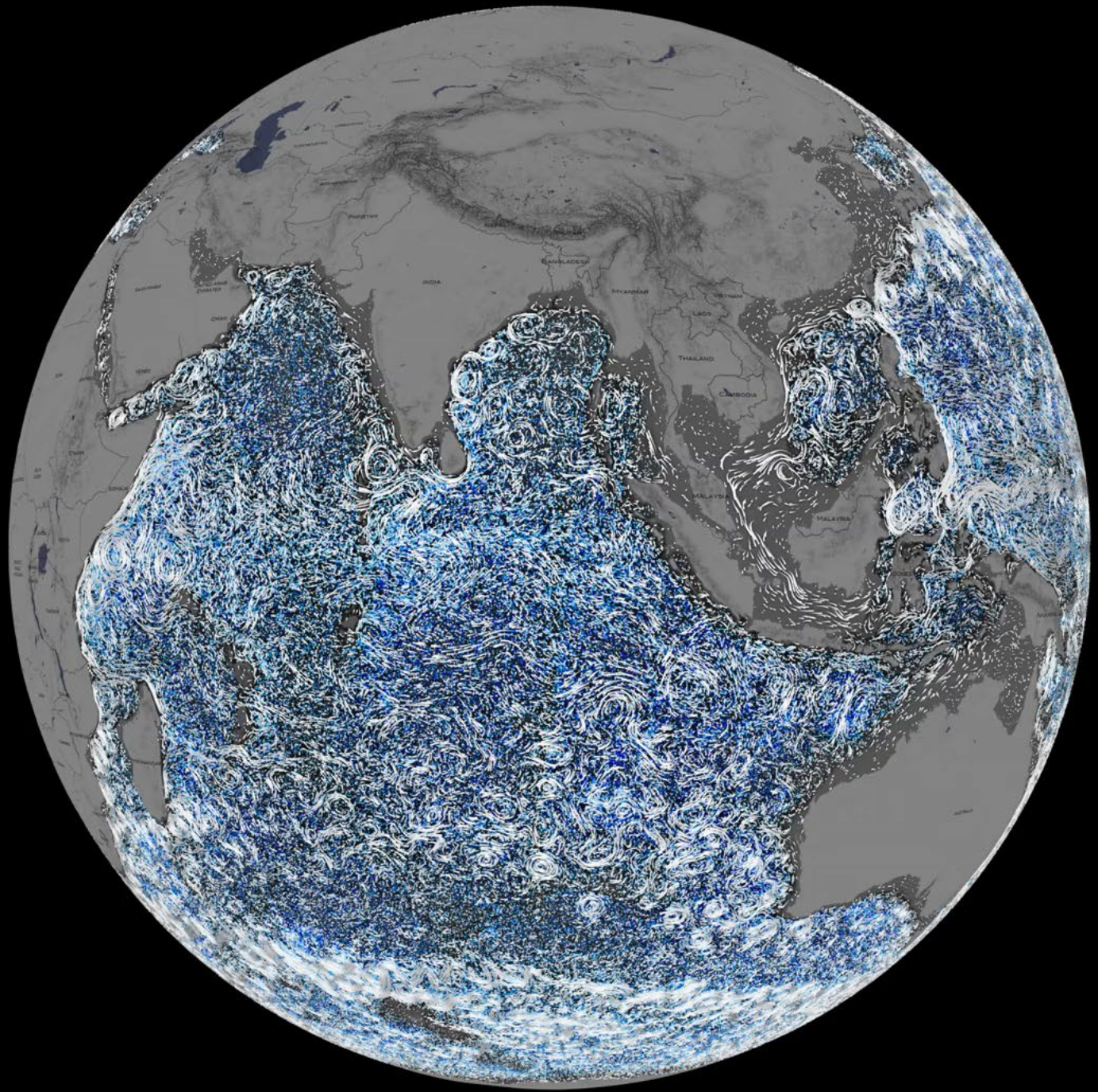
Advancing Earth System Science End-to-end



NASA earth


29 Nov 2021


PAKISTAN
INDIA
BANGLADESH
MYANMAR
VIETNAM
LAOS
THAILAND
CAMBODIA
MALAYSIA

SWOT launched Dec. 16, 2022 from Vandenberg Space Force Base in California

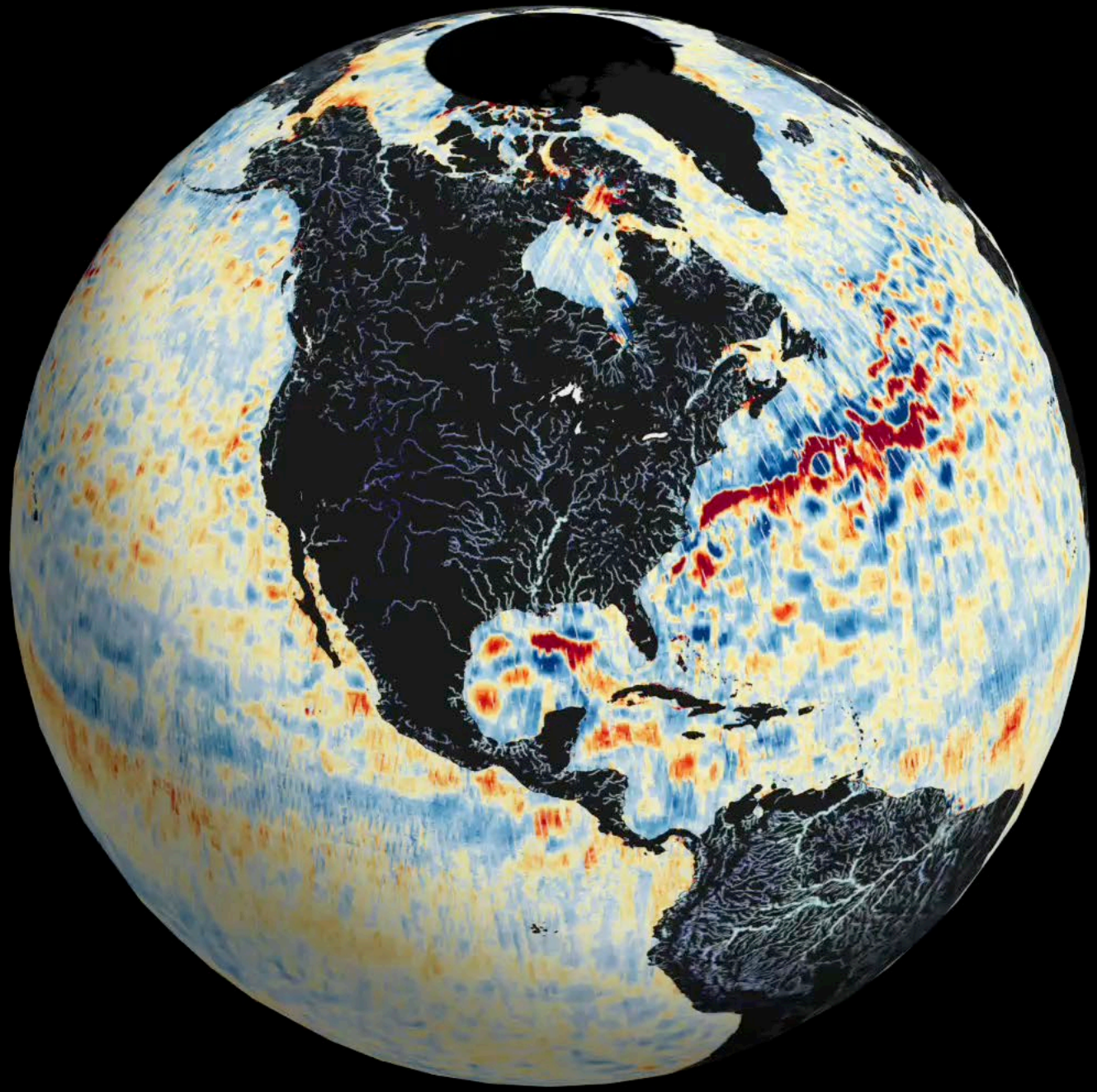
Source: NASA TV

PACE launched Feb. 8, 2024 from Cape Canaveral Space Force Station in Florida

Source: NASA TV

SWOT: Sea Surface Height Anomalies

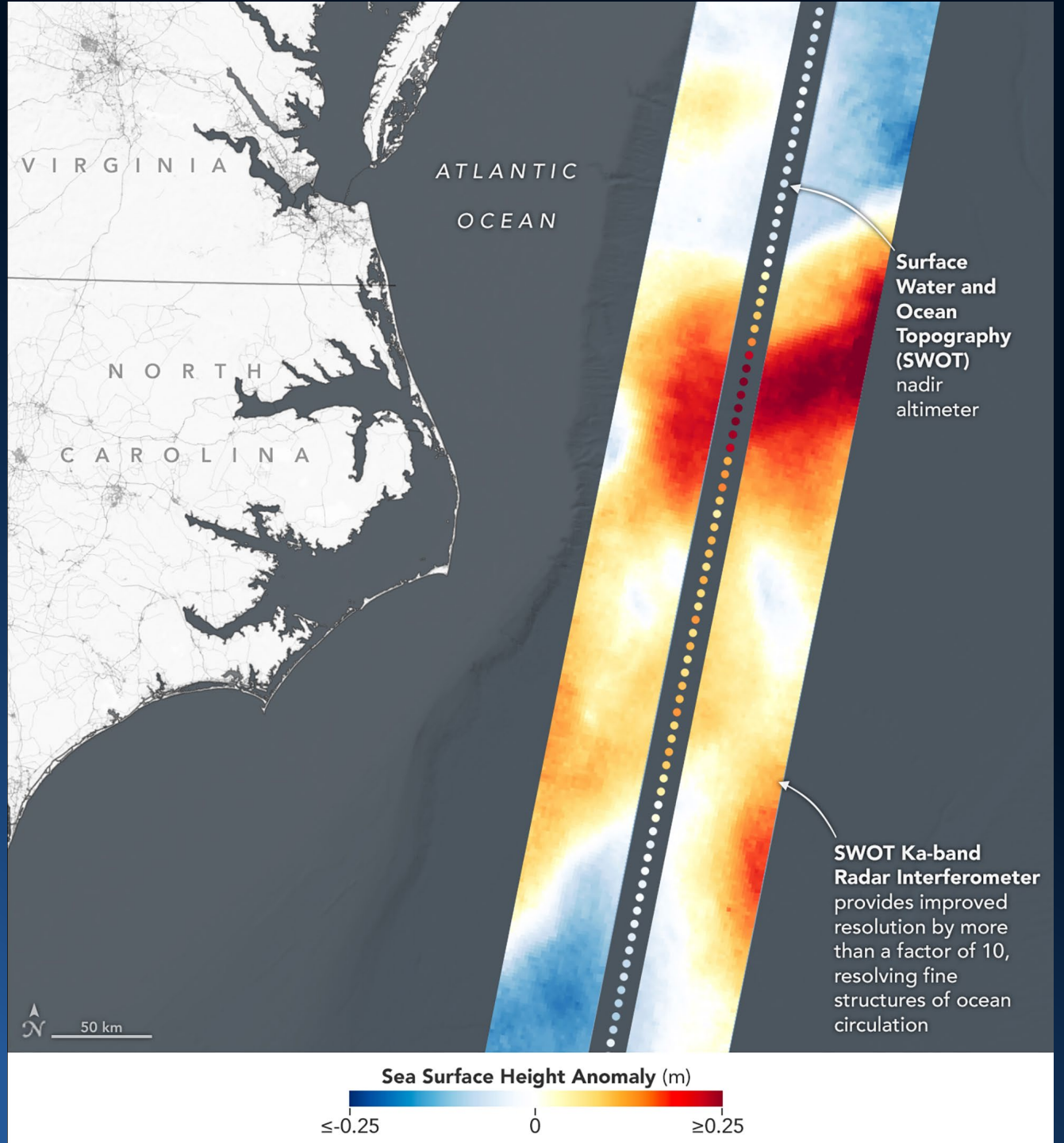
First 21-day cycle of SWOT measurements – first complete global coverage of Earth water elevation, including sea surface height observations



SWOT: Gulf Stream Sea Surface Height

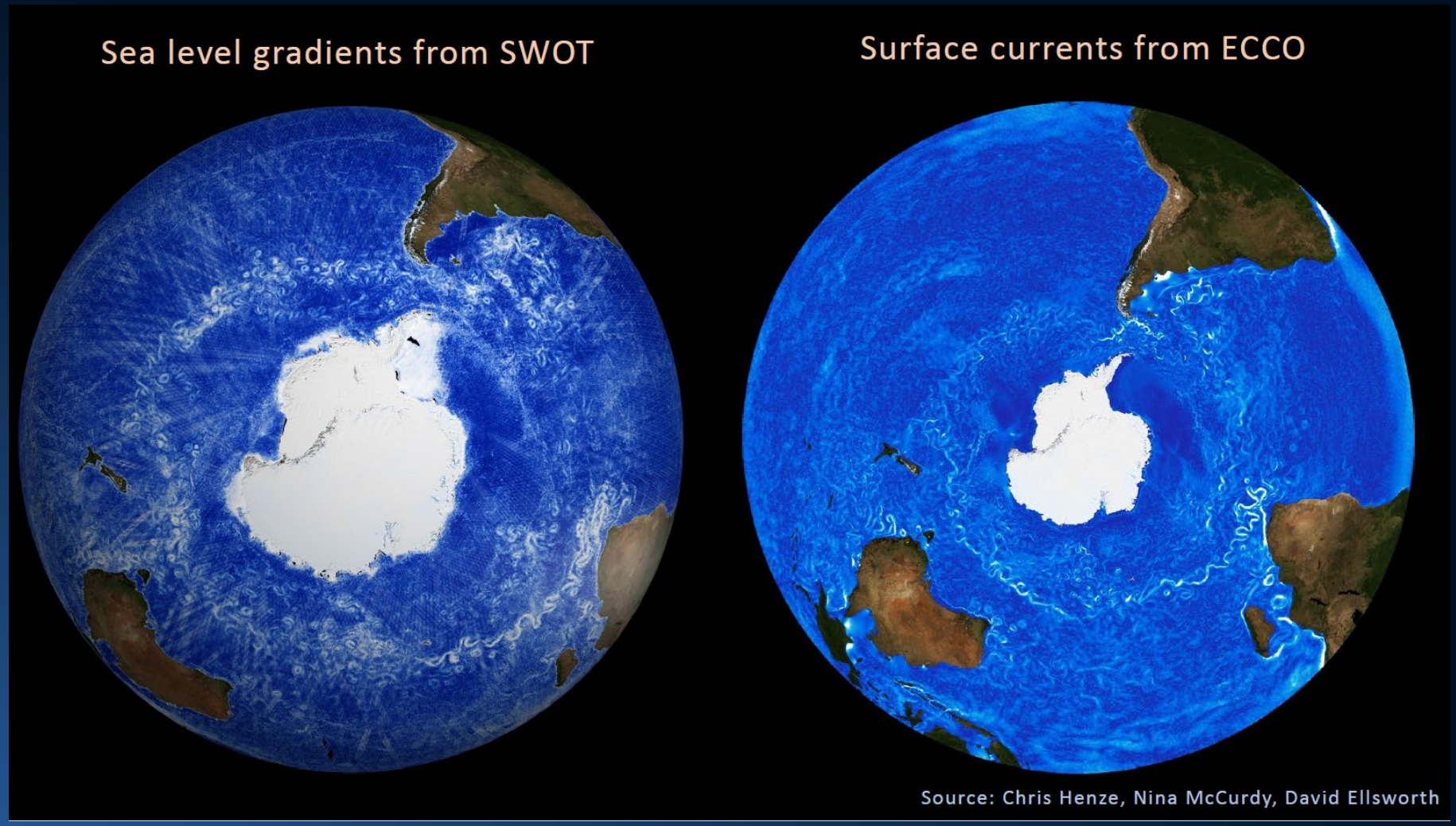
Red and orange represents sea levels higher than global average. Blue shades are lower than average.

SWOT's spatial resolution is 10 times greater than composite data gathered over the same area by seven other satellites on Jan. 21, 2023



SWOT Measurements of Ocean Topography & Circulation: Higher Resolution

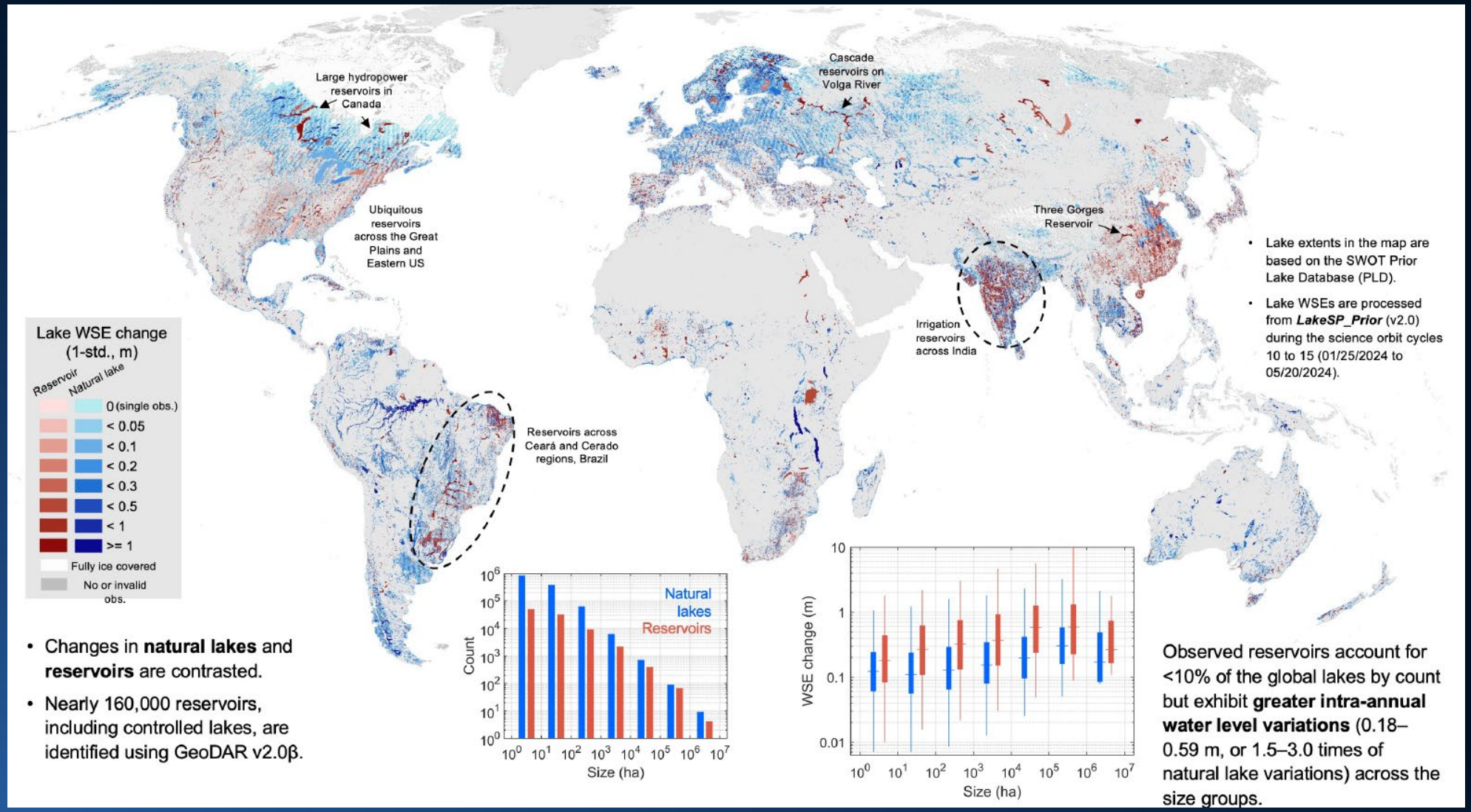
SWOT objective is to observe ocean topography and 3D ocean circulation >10km versus conventional >200km



SWOT Measurements of Inland Water: Water Level Changes

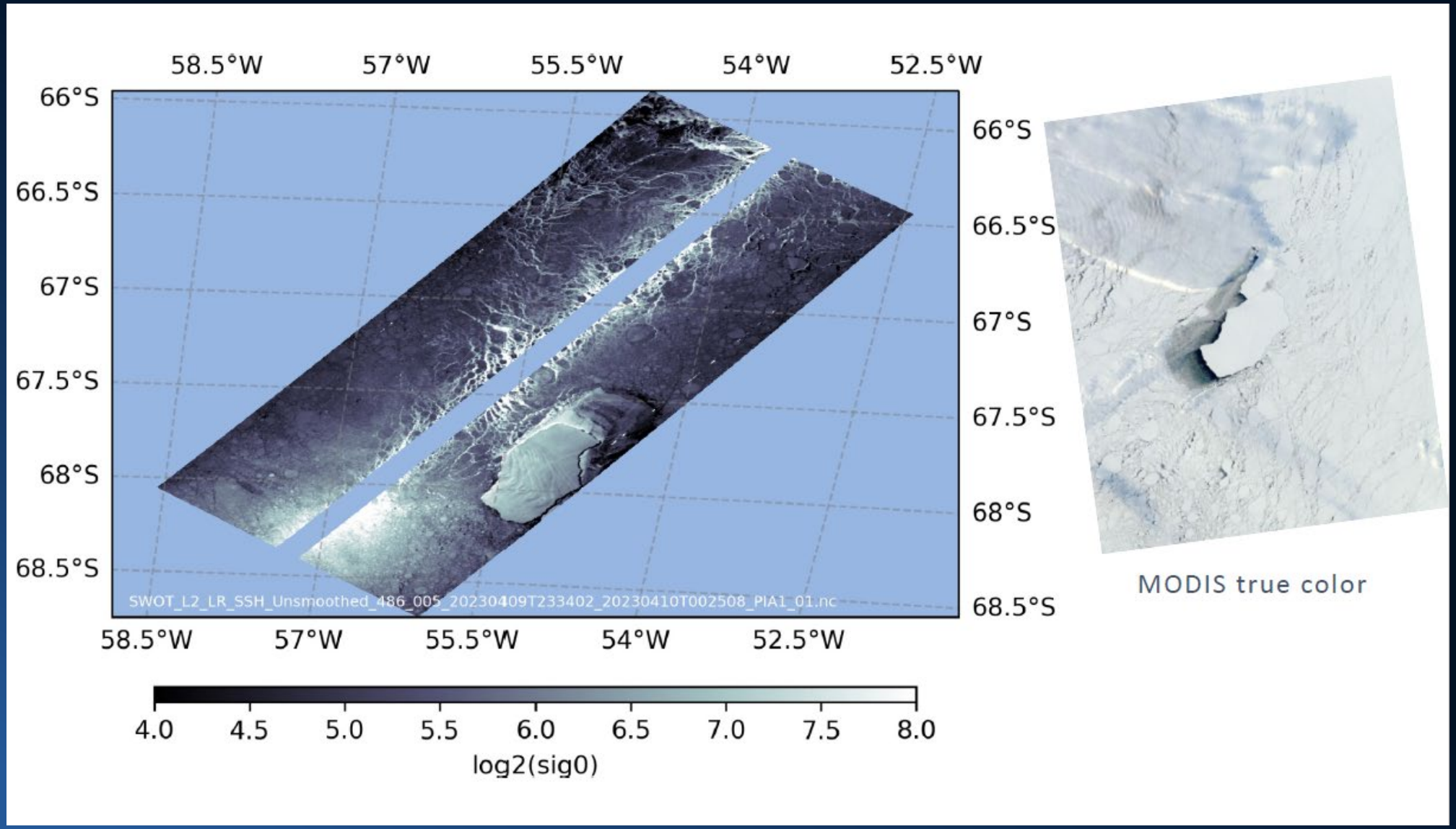
Global lake water level changes from January to May, 2024.

First global, high-resolution view of interior waters (reservoirs, lakes, rivers)



SWOT: Monitoring of ocean ice

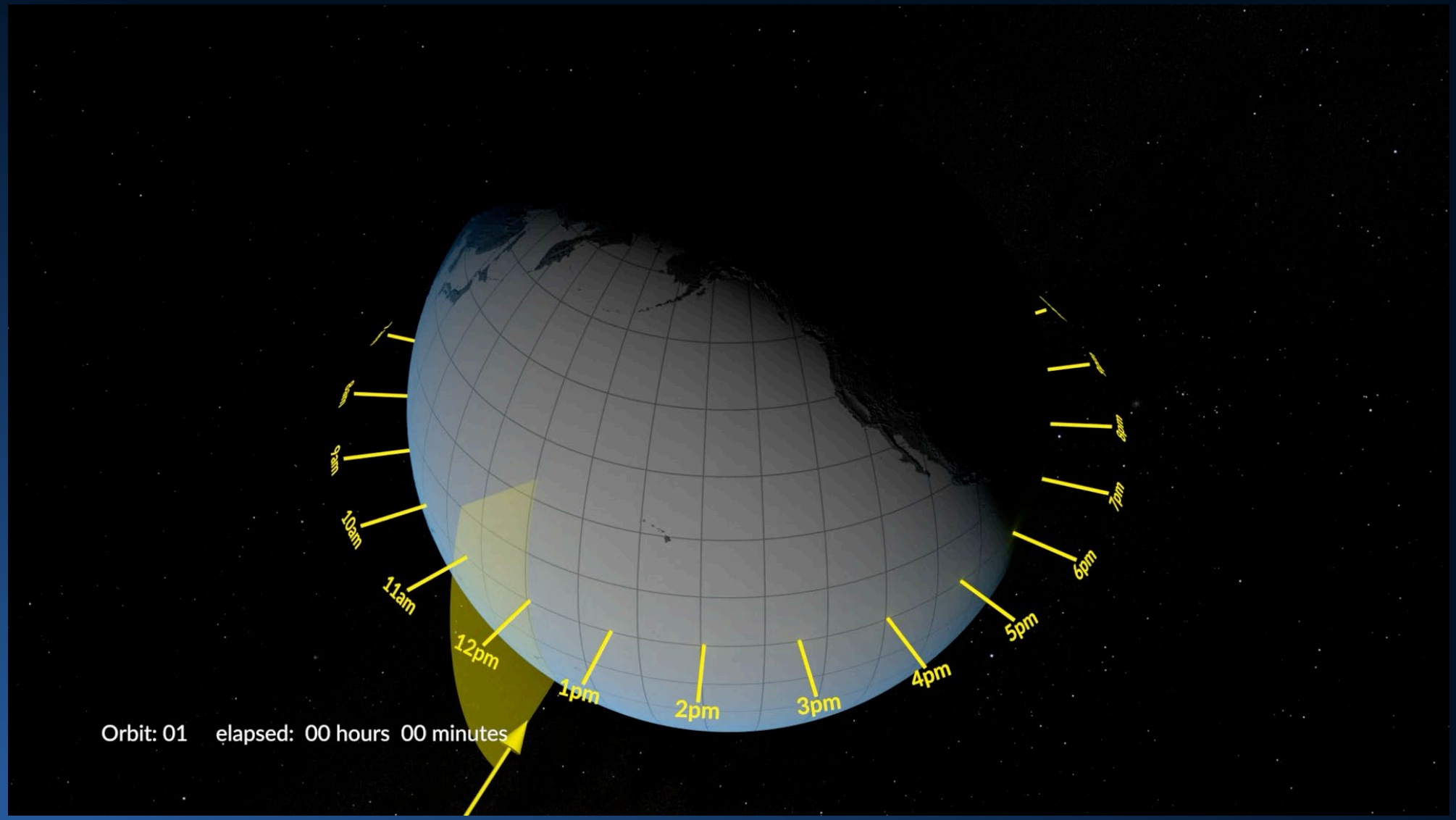
All-weather high latitude for measurements of sea ice and km-scales icebergs



Credit: Jinbo Wang

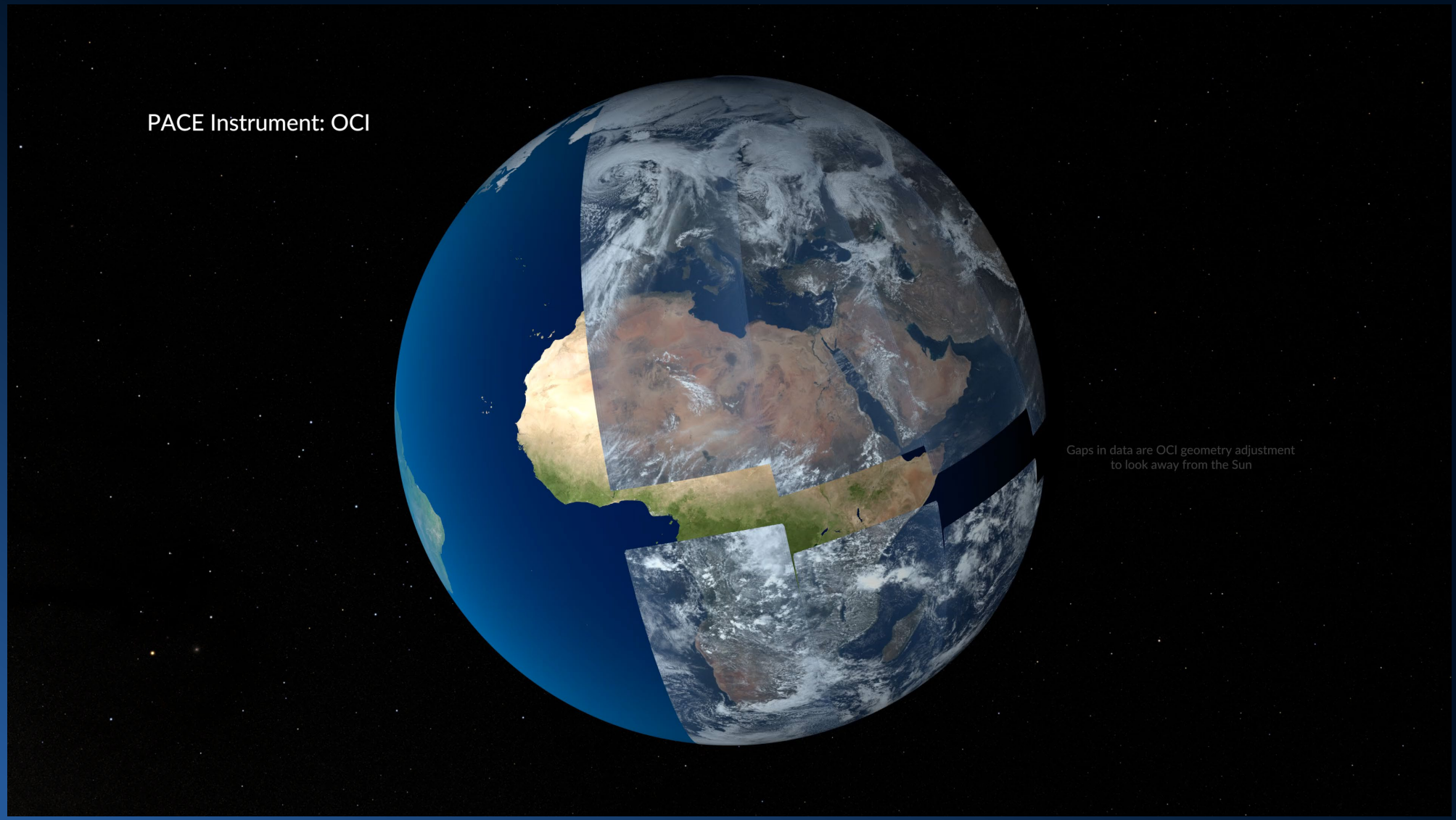
PACE Technology: Ocean Color Instrument & Two Polarimeters

Completing orbit in 98.3 minutes, PACE carries OCI, HARP2 and SPEXone



What PACE shows us: Ocean Color

PACE reveals the colors of Earth. The color of the ocean can be used to determine phytoplankton abundances, and with PACE, phytoplankton community composition.

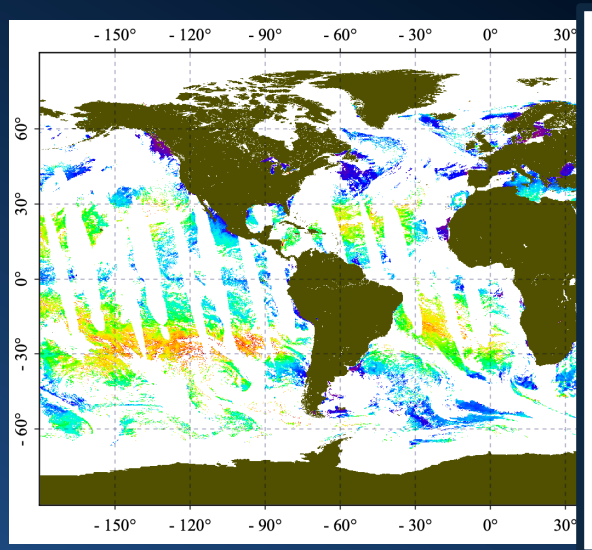


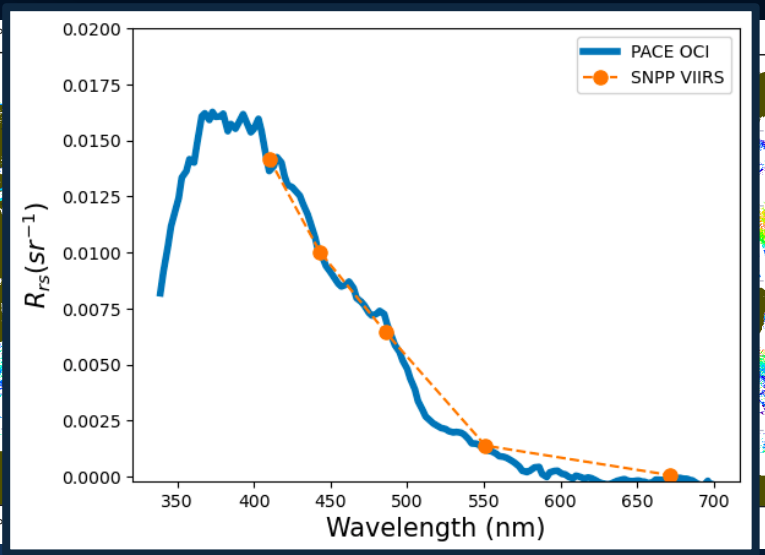
OCI & VIIRS Rrs(445)

PACE Observations: Higher Resolution

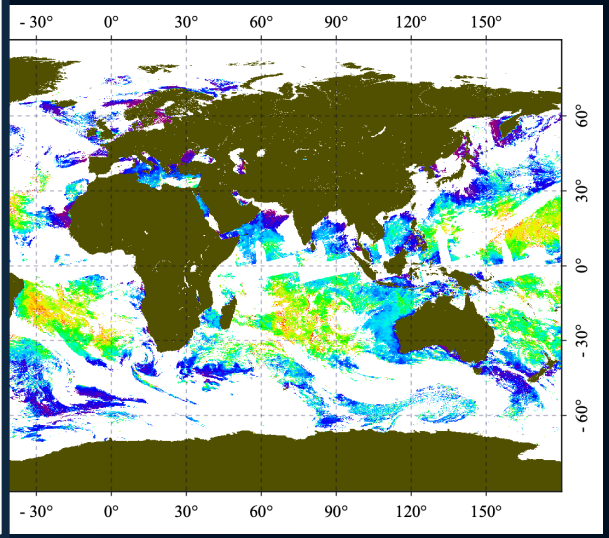
OCI agrees with VIIRS retrievals on global scales – but with improved spatial resolution.

NOAA-20 VIIRS





PACE OCI

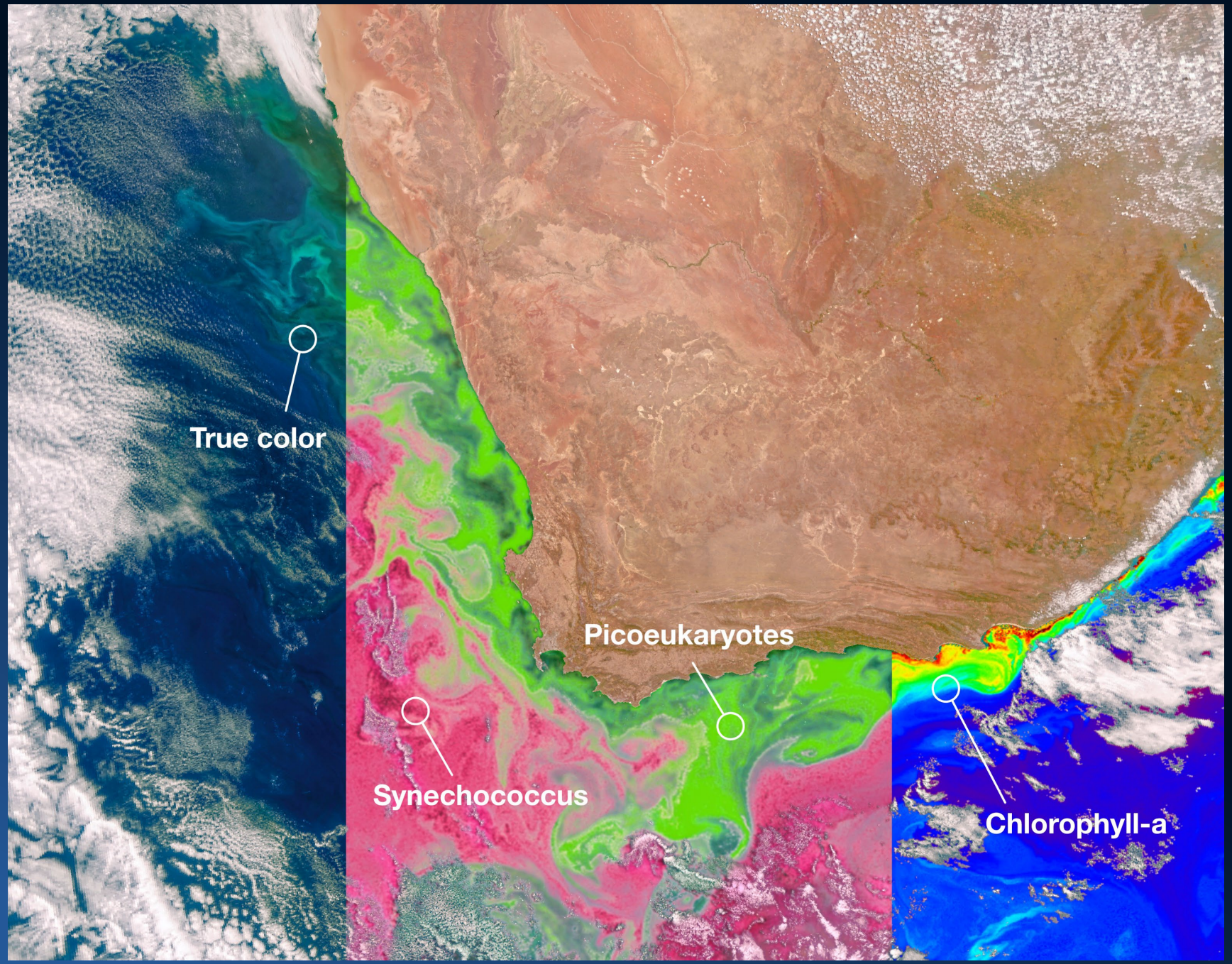


4-km daily composite from 23 March 2024

OCI and VIIRS Rrs retrievals agree well on global scales

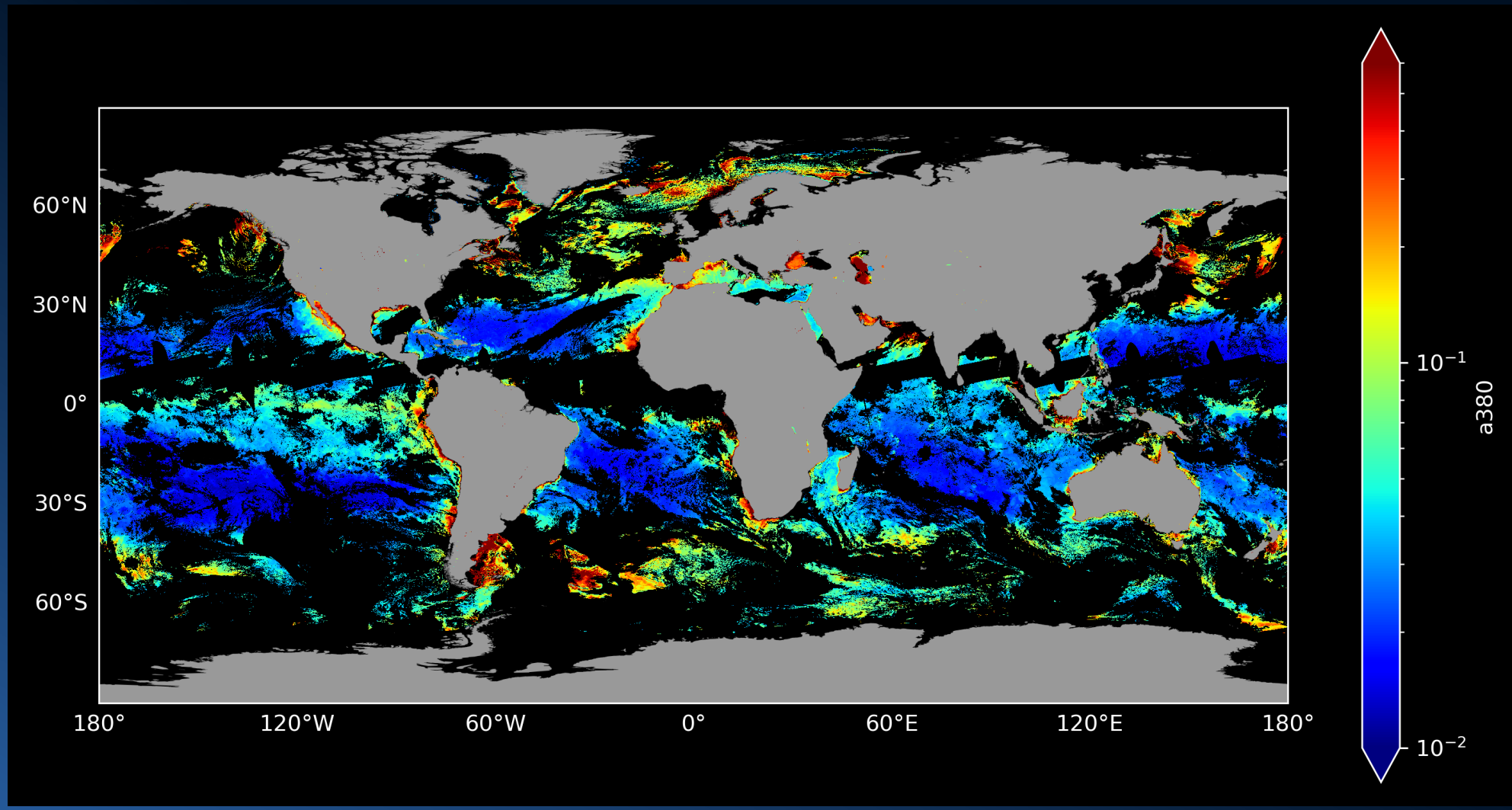
PACE Science and Data: Phytoplankton

What does it mean, what does it tell us



PACE Science and Data: Phytoplankton & Carbon

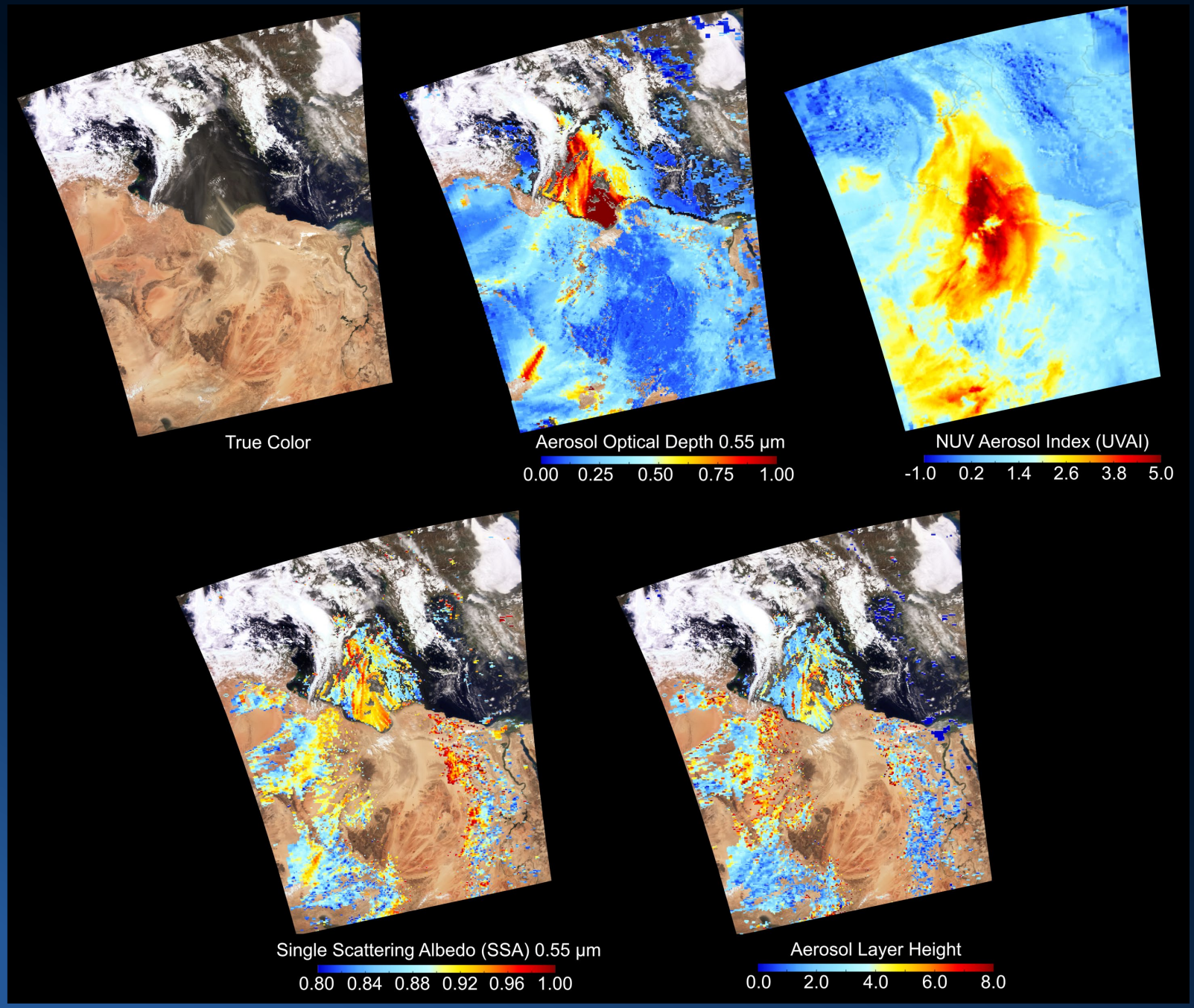
PACE offers first use of a UV sensor from space to collect a global view of aquatic dissolved organic matter, critical to the carbon cycle and understanding contribution from the land to the ocean



Credit: Antonio Mannino, NASA/GSFC

PACE Science and Data: Aerosols & Role in Climate Change

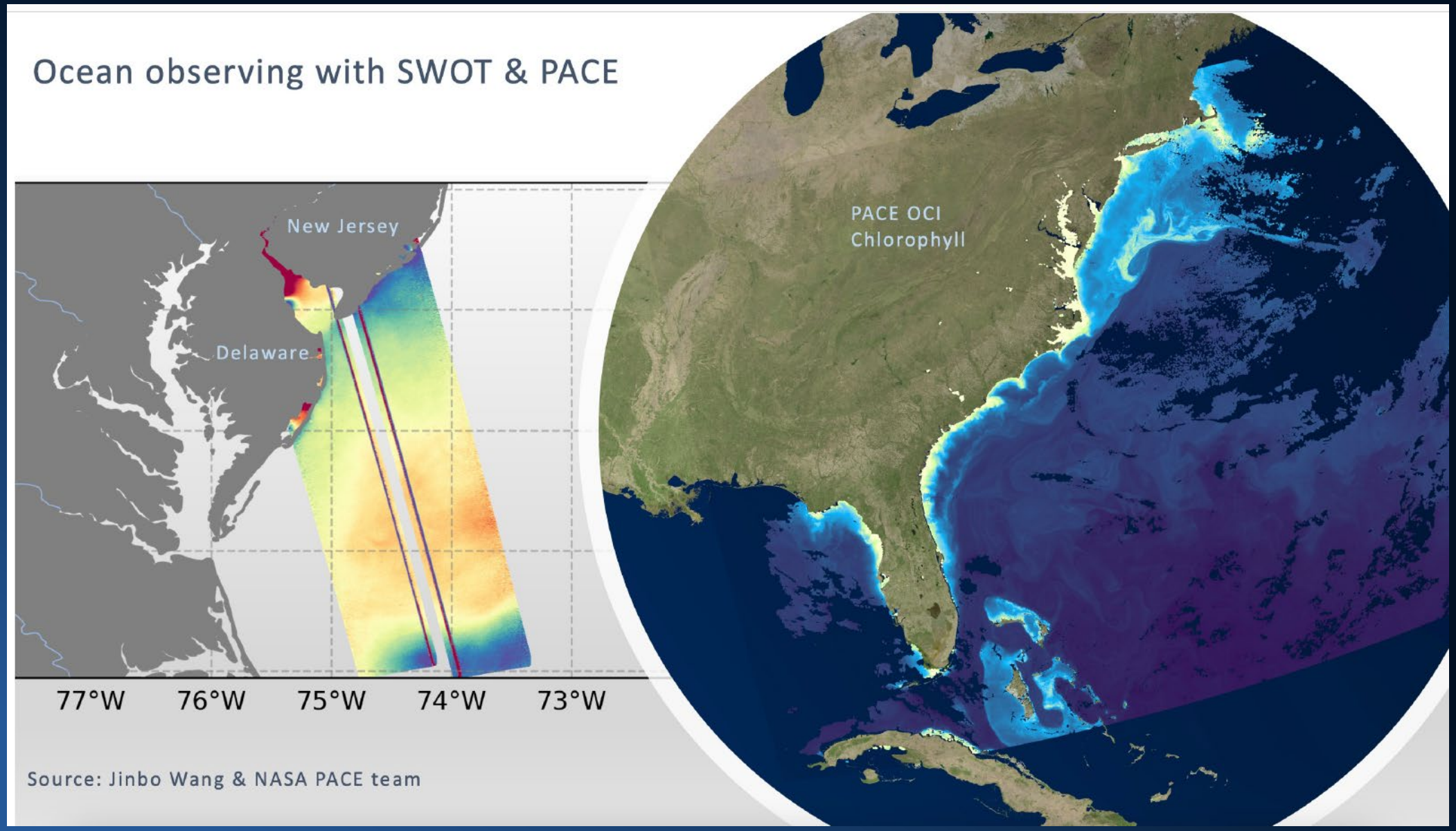
Preliminary aerosol products – still in process of validation – measuring differences in aerosols



Courtesy: Lorraine Remer & team, UMBC

Integrating SWOT and PACE data

We are entering a “Golden Age of Ocean Science”



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 & Societal Value
- Offer models, scientific findings and info through Open-Source Science principles
- Support climate services
- Provide science applications and tools to inform decisions

Earth System Science & Applied Research
- Grow scientific understanding of Earth's systems
- Develop predictive modeling for science applications and tools to mitigate, adapt and respond to climate change

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

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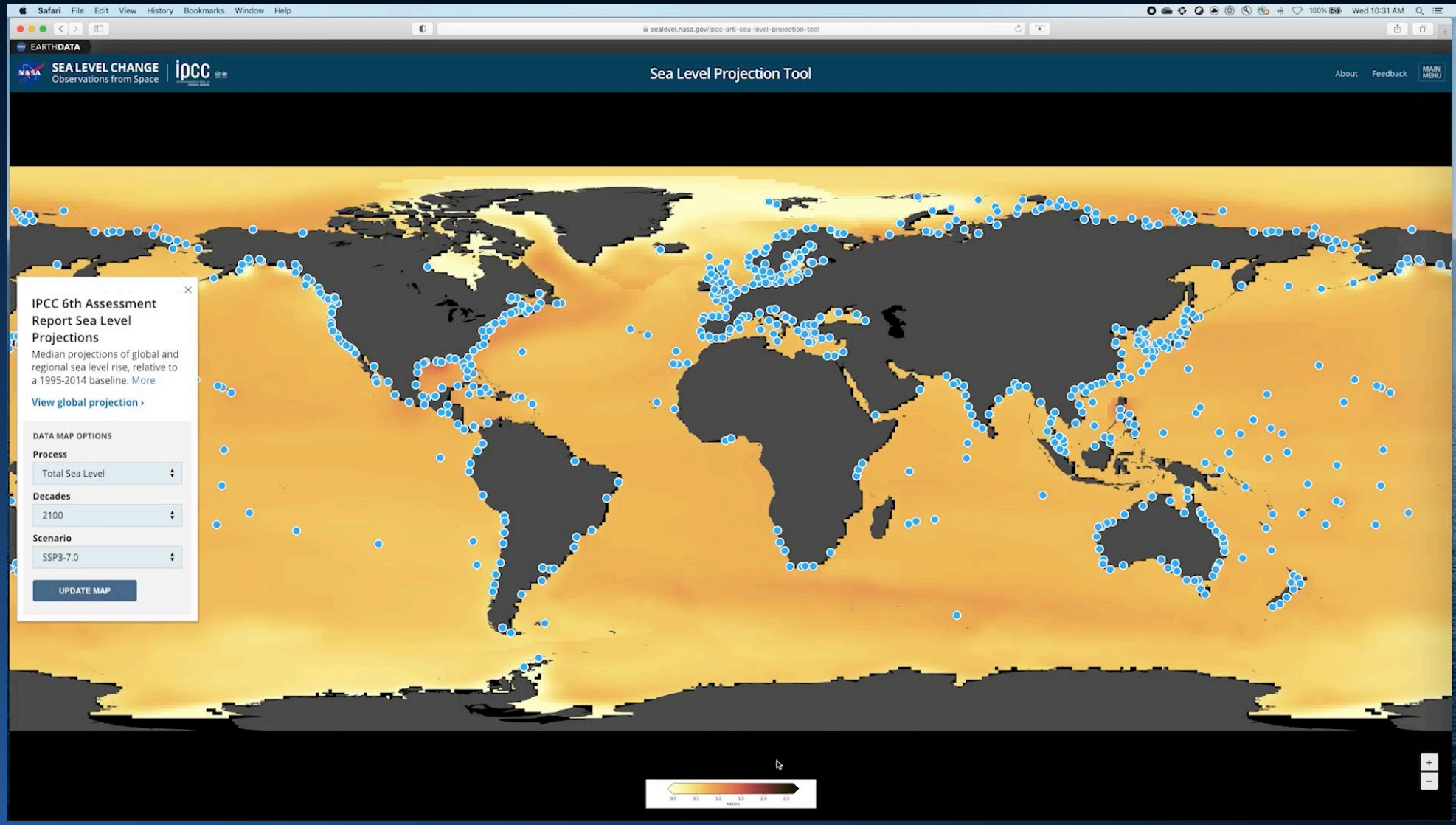
NASA Informs Actionable Climate Decision Making: Sea Level Rise

NASA data and knowledge are open and free, enabling informed decision-making

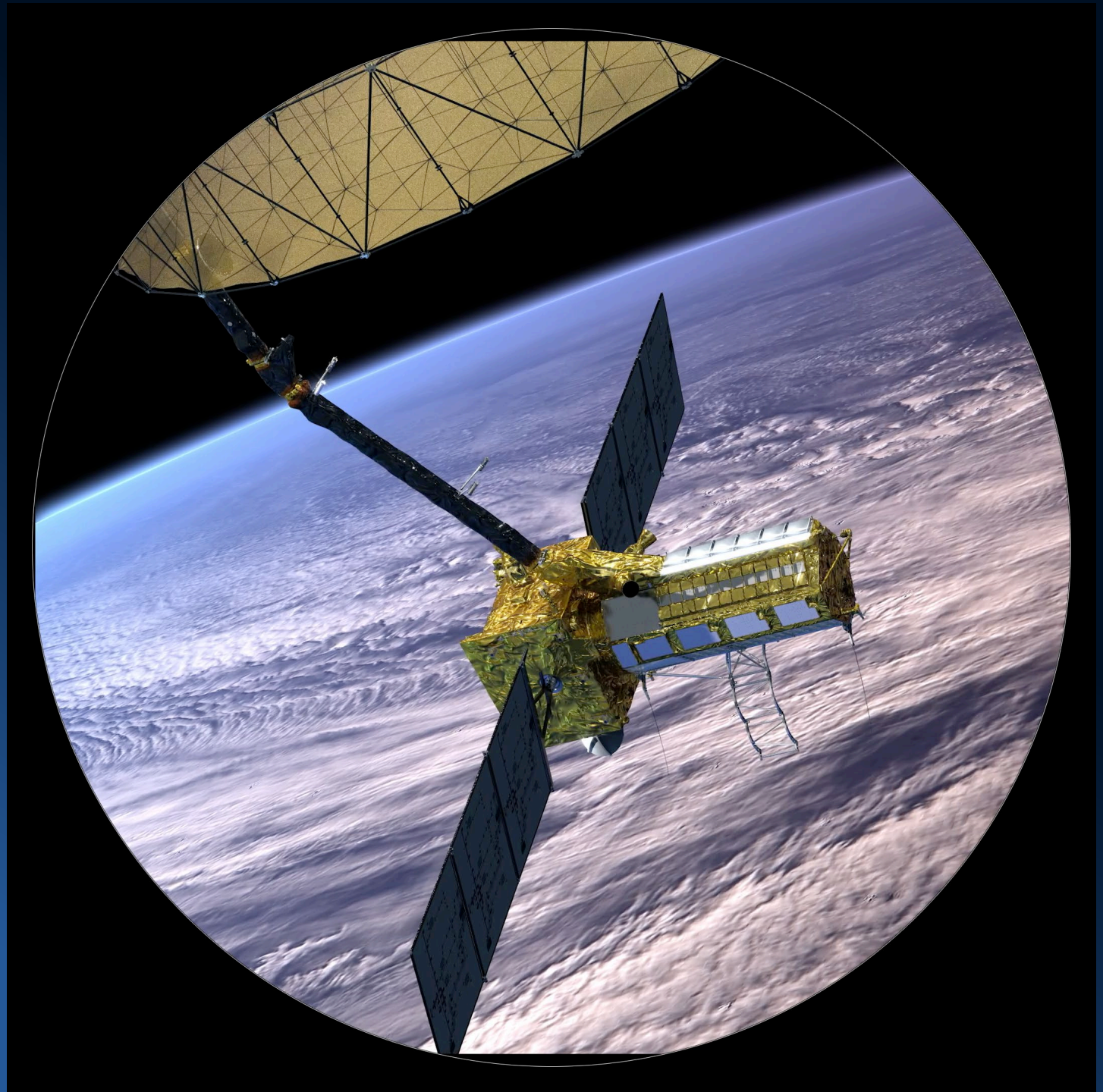
Example: planning for sea level rise on 10-100 year horizons at your coastal city



https://sealevel.nasa.gov (also at UNFCCC)

Upcoming Missions: NISAR

NASA-ISRO Synthetic Aperture Radar



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