PACE and GLIMR: NASA's upcoming hyperspectral missions advancing global and coastal ocean colour science and applications

Antonio Mannino

Jeremy Werdell and Joe Salisbury

antonio.mannino@nasa.gov

Credit: PACE Project team

Credit: GLIMR Project team

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission

Primary hyperspectral radiometer:

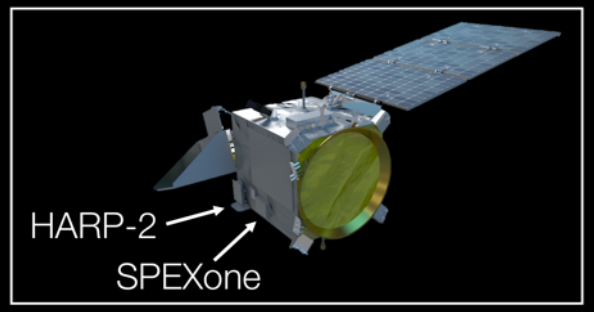
- Ocean Color Instrument (OCI) (GSFC)

2 contributed multi-angle polarimeters:

- HARP2 (UMBC)
- SPEXone (SRON/Airbus)

Key characteristics:

- Early 2024 launch (**?**)
- 676.5 km altitude
- Polar, ascending, Sun synchronous orbit; 98° inclination
- 13:00 local Equatorial crossing
- 3-yr design life; 10-yr propellant
- Ka-band downlink rate 600 Mbps; avg Observatory 40 Mbps

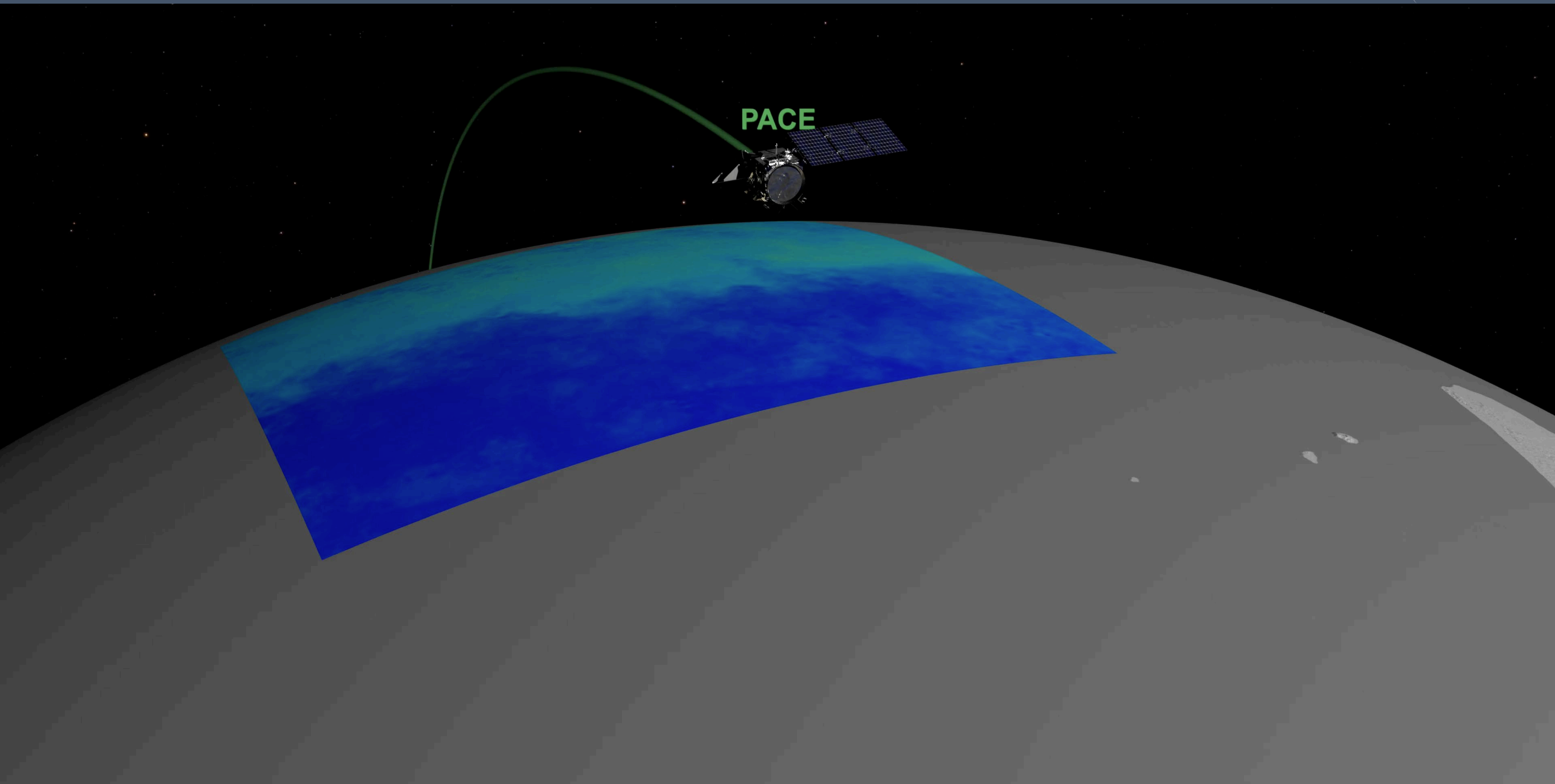


	SPEXone	HARP2
Attributes	Hyperspectral (UV) & narrow swath	Hyperangular & wide swath
Spectral range [resolution]	385-770 nm [hyperspectral 4 or 2 nm]	440, 550, 670 [10 nm] & 870 nm [40 nm]
Number of viewing angles [degrees]	5 [-52°, -20°, 0°, 20°, 52°)	20 for 440, 550, 870 nm & 60 for 670 nm [114°]
Coverage [swath width]	9° [100 km]	94° [1550 km]
Ground sample distance	2.5 x 2.5 km	3 x 3 km

more on Polarimeters see NASA Hyperwall 10:10am Weds.

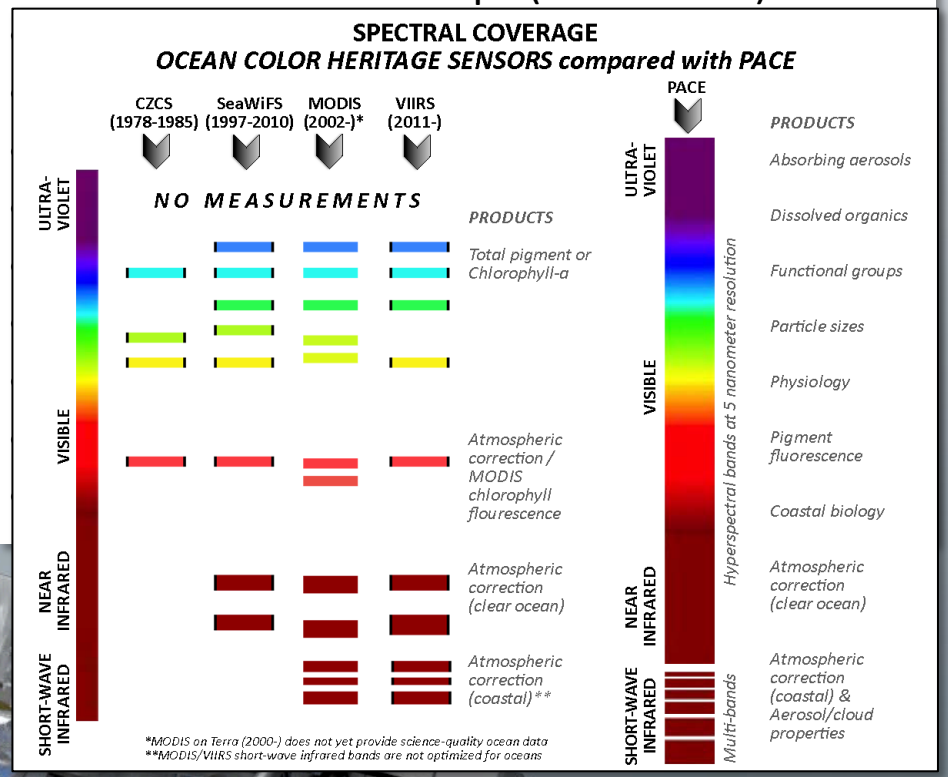
https://pace.gsfc.nasa.gov
@NASAOcean

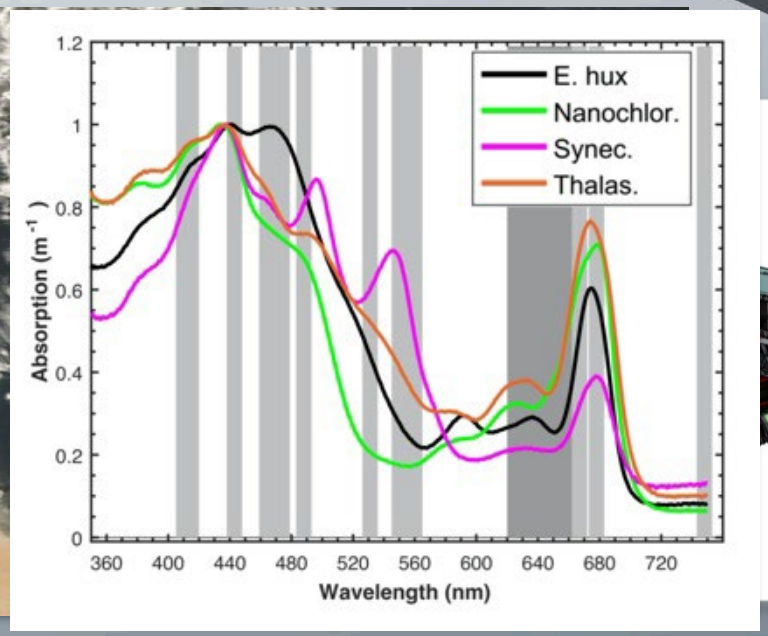
PACE Science Objectives

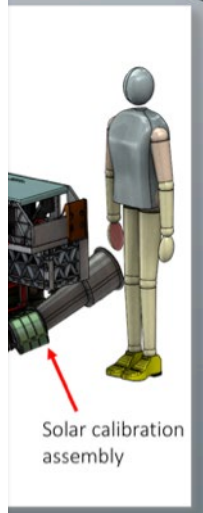


Key OCI Advances

- Hyperspectral scanning radiometer
- 5 nm resolution (320) 340-890 nm
  - Data at 2.5 nm steps (or 1.25 nm)



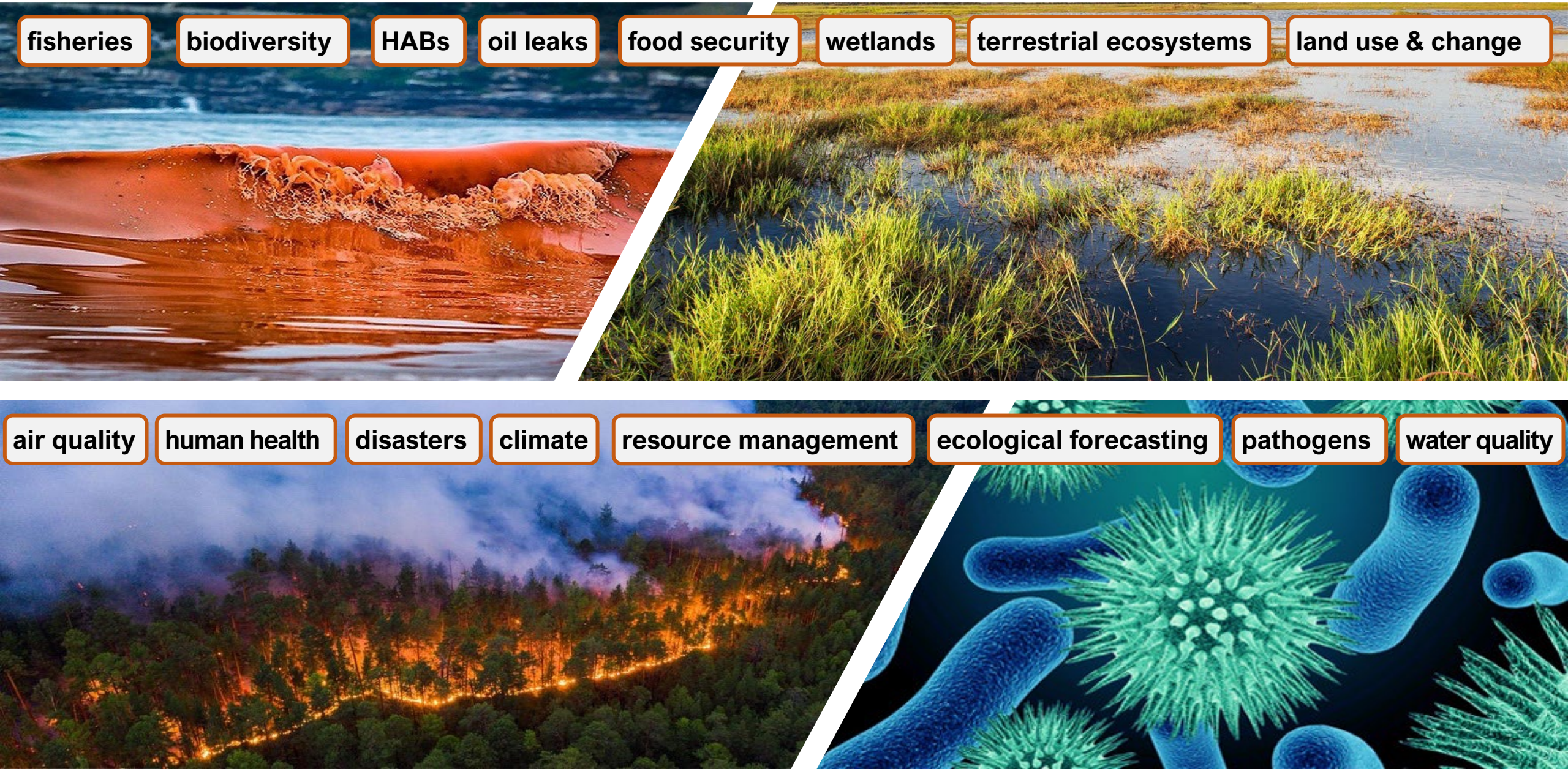




Credit: NASA's Conceptual Image Laboratory

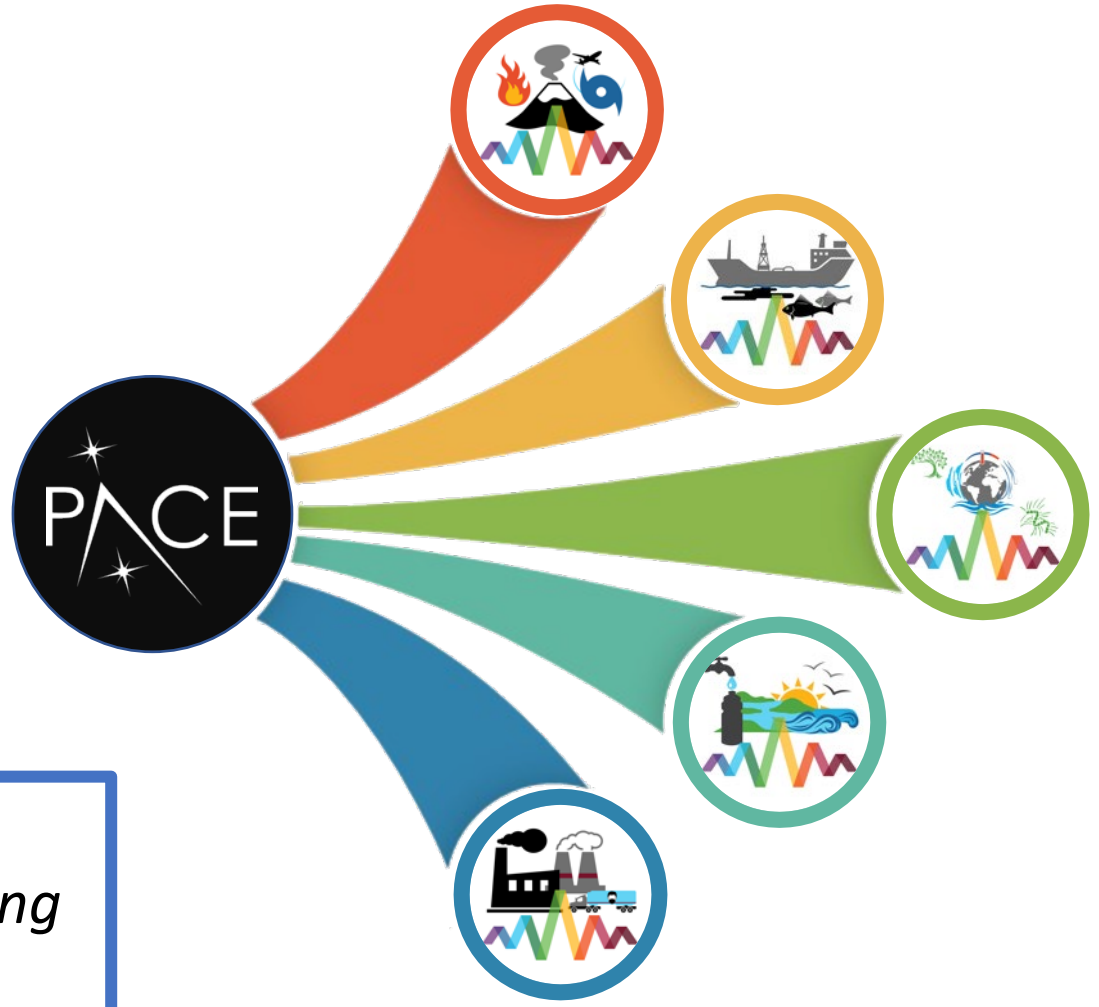
Designed and built at NASA Goddard Space Flight Center

PACE: Interdisciplinary applied science objectives



PACE Applications Program

- *Addressing community user needs* & concerns with PACE data products
- *Grow relevance* & sustainability of PACE
- *Demonstrate the societal value* & utility of PACE



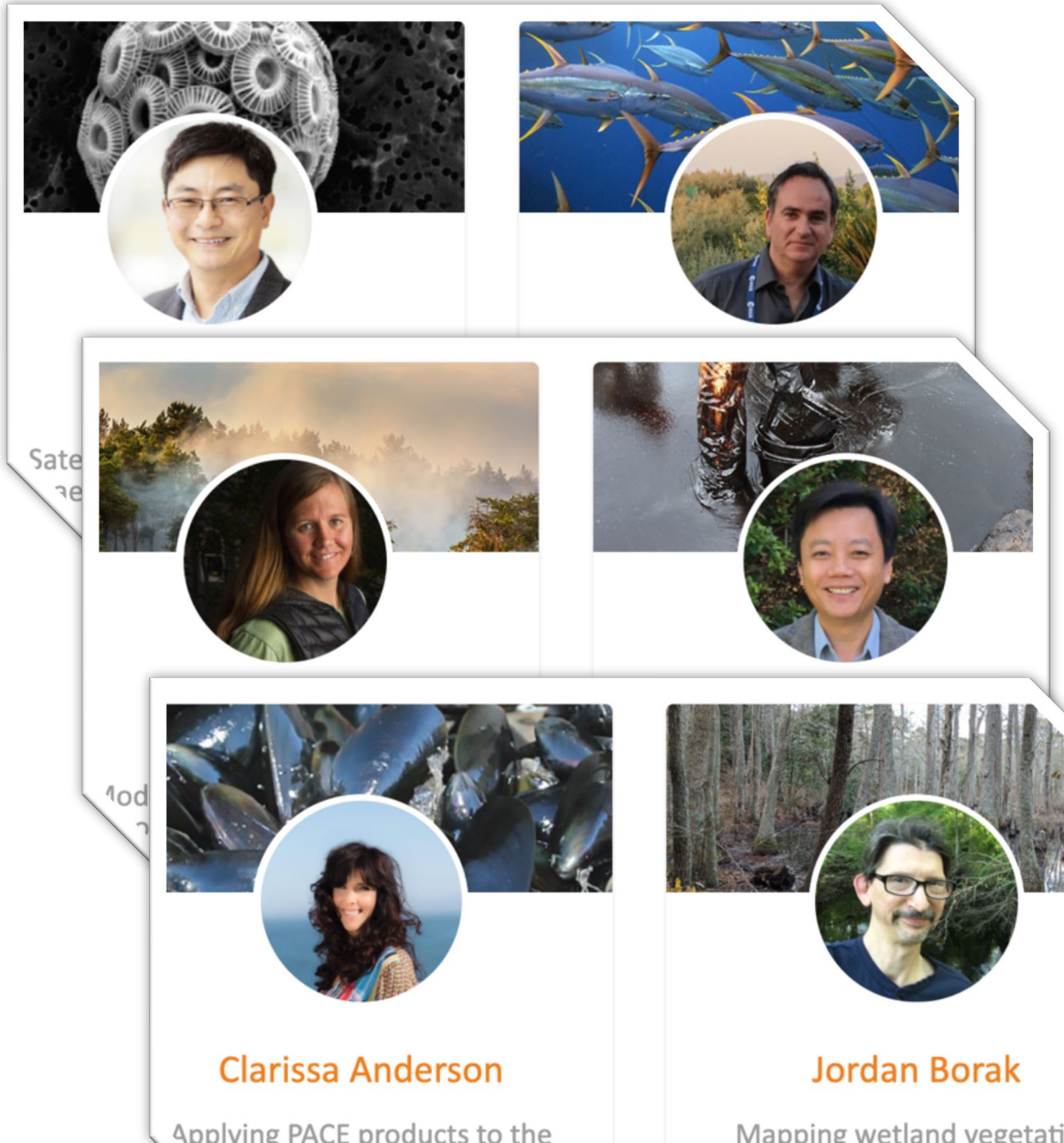
The goal of the PACE Applications Program is to foster new partnerships and out-of-the-box thinking that will generate inventive solutions that aid society.

PACE Early Adopter Program

The PACE Early Adopter program promotes applied science and applications research designed to scale and integrate PACE data into policy, business, and management activities that benefit society and inform decision making.

Goals:

- Expand the user communities with tangible and potential applications that would benefit from the use of PACE data
- Facilitate feedback on PACE data products pre-launch
- Accelerate the use and integration of PACE products into applications post-launch by providing specific support to Early Adopters who commit to engage in pre-launch applied research



PACE Early Adopters

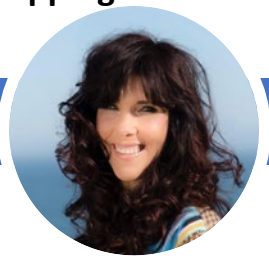
Aquaculture/Fisheries

Air-sea exchange

Marine mammals & Climate

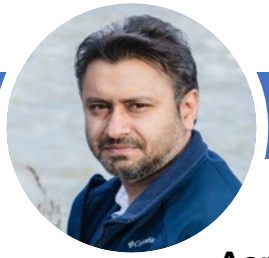
Oil Spills

Mapping HABs Risk



Aquaculture/Fisheries

Waterborne Pathogens



Aerosols& Human Health

HABs Detection

Wetland Ecosystems

Data Integration

Food Security

Water Clarity-Waters Resources

Mobile Apps & Decision Making

Water Clarity-Water Resources

Data management

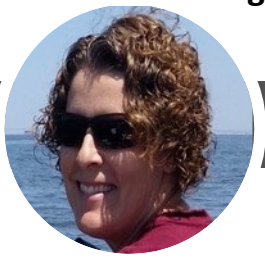
Air Quality & Human Health

Global Carbon Budget

HABs Monitoring

Air Quality & Climate

HABs Monitoring



HABs Monitoring

Water Clarity & Ecosystem Health

Data Integration

GLIMR

University of New Hampshire

GODDARD EARTH SCIENCES

Raytheon Intelligence & Space

SwRI

https://eos.unh.edu/glimr

What is GLIMR?

- Geostationary hyperspectral ocean color mission
- PI managed satellite instrument
- NASA Earth Venture Instrument 5 (EVI-5) competition
- Budget cap ~$110M: instrument, mngmt, Ops, science, & data processing
- Orbit: geostationary at ~98° W ± 10°; equator
- Study Regions: U.S. coastal waters and other areas of interest

Status and Schedule

- Project start May 17, 2021
- Currently: design review (“Phase B”)
- Mission confirmation Fall 2022
- Instrument delivery Fall 2024
- Launch TBD: ~2027
- **Science operations – 2 years (+)**

PI: Joe Salisbury (UNH)
Deputy PI: Antonio Mannino (GSFC)
Project Management & Science Ops Center: UNH
Instrument: Raytheon
Safety Mission & Assurance: Southwest Research Institute
Science Data Segment: Sean Bailey (GSFC: OBPG/OEL)
GLIMR Science & Applications Team: various institutions
NASA Program Office: ESSP PO (LaRC)

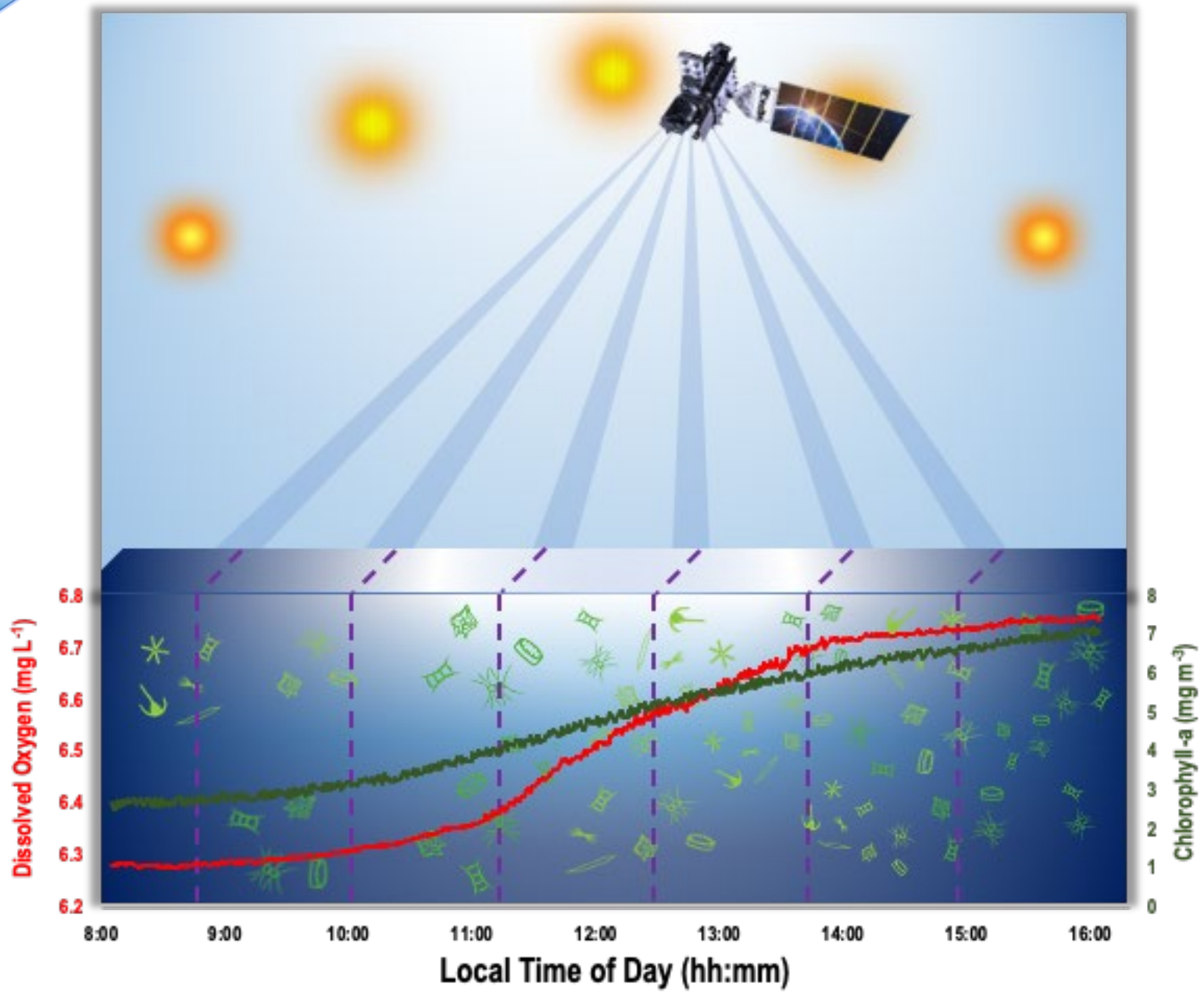
GLIMR Science Goals

Phytoplankton Growth and Physiology

Observe, quantify, and understand processes associated with rapid changes in phytoplankton growth rate and community composition at their intrinsic timescales.

Short Term Coastal Processes

GLIMR Science Goals



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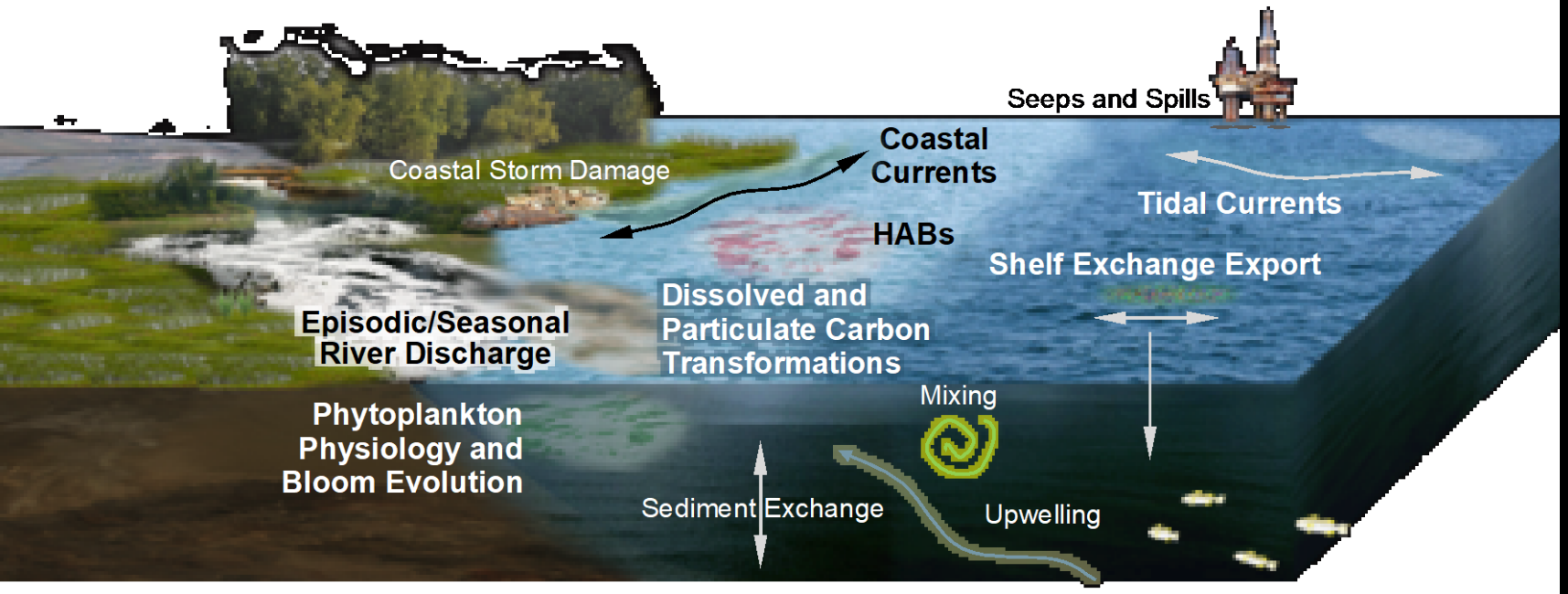


Phytoplankton Growth and Physiology

Observe, quantify, and understand processes associated with rapid changes in phytoplankton growth rate and community composition at their intrinsic timescales.

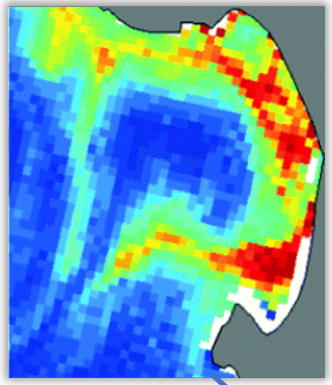
Short Term Coastal Processes

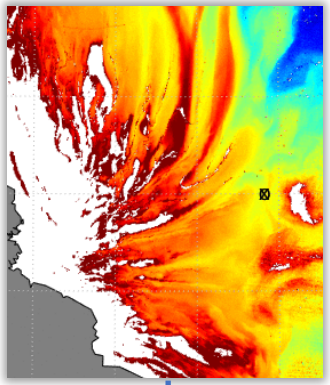
Investigate how high frequency fluxes of sediments, organic matter, and other materials between and within coastal ecosystems regulate the productivity and health of coastal ecosystems.

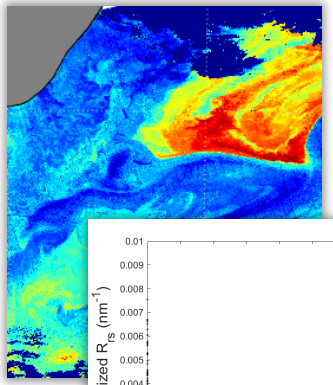
A glimpse into GLIMR

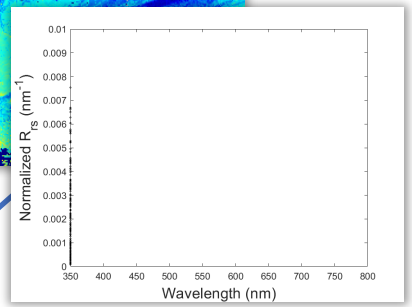
Geostationary **L**ittoral **I**maging and **M**onitoring **R**adiometer

Spatial *Temporal* *Spectral*

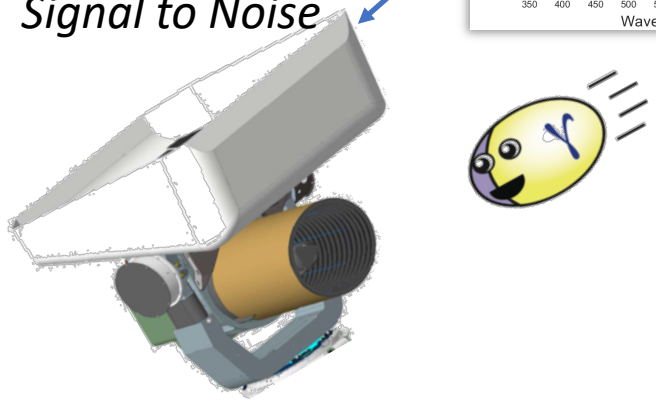








Signal to Noise



Telescope mounted on a 2-axis gimbal that actively scans an imaging spectrometer across the Gulf of Mexico.

Hyperspectral

- 340-1040 nm
- <10 nm UV-Vis resolution
- <5 nm UV-Vis sampling

High Temporal

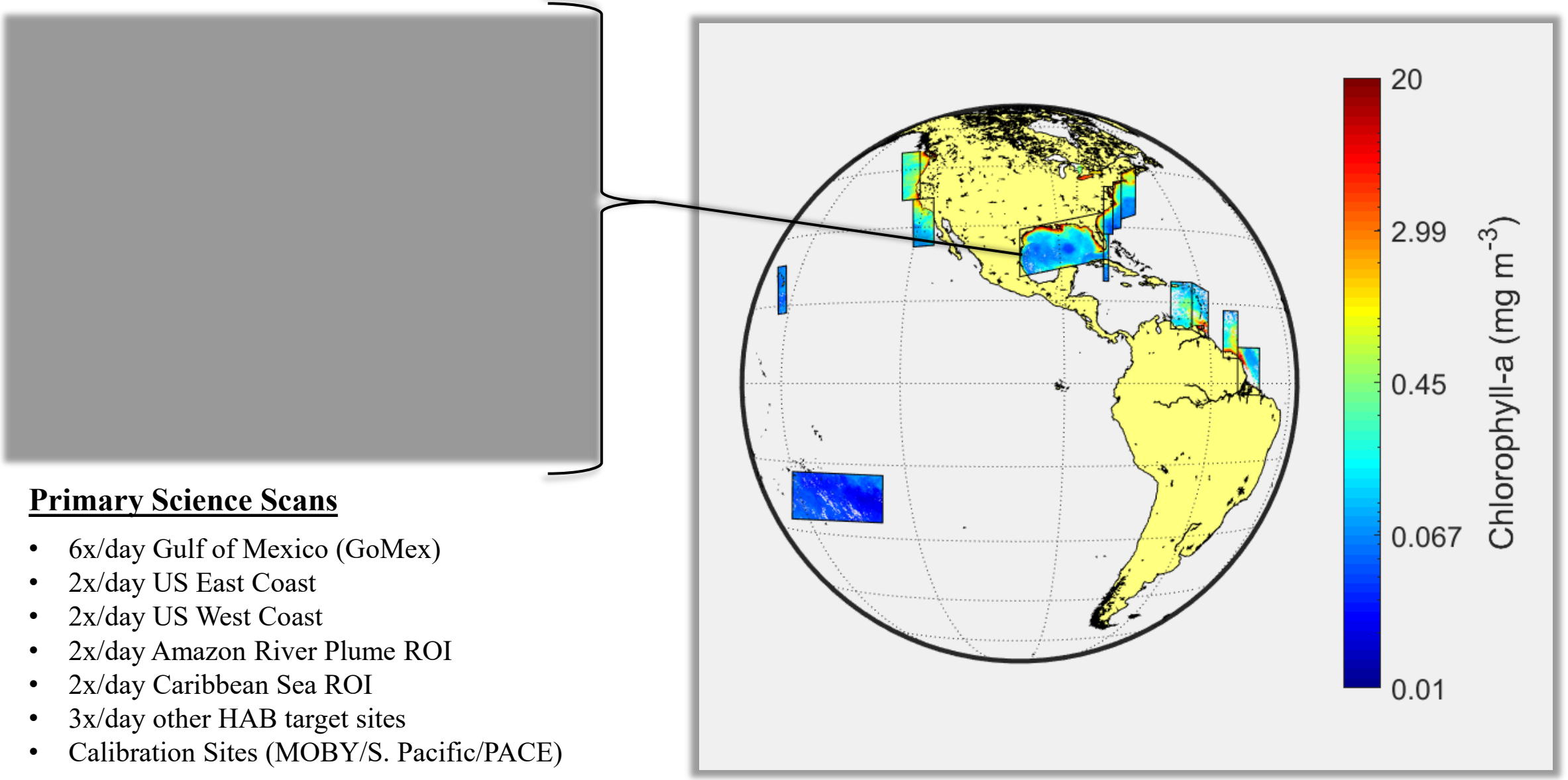
- ~hourly scans of Gulf of Mexico (6x/day)
- 2x to 3x/day other regions
- 3x/day HAB target sites

High Spatial

- 300 m GSD nadir
- ~328 m Gulf of Mexico
- <500 m over coastal CONUS

High SNR *(requ's at Ltyp)*

- > 420 in UV
- > 1000 for 400-580 nm
- > 750 for 580-650 nm
- > 580 for 650-710 nm
- > 650 for 710-880 m



Primary Science Scans

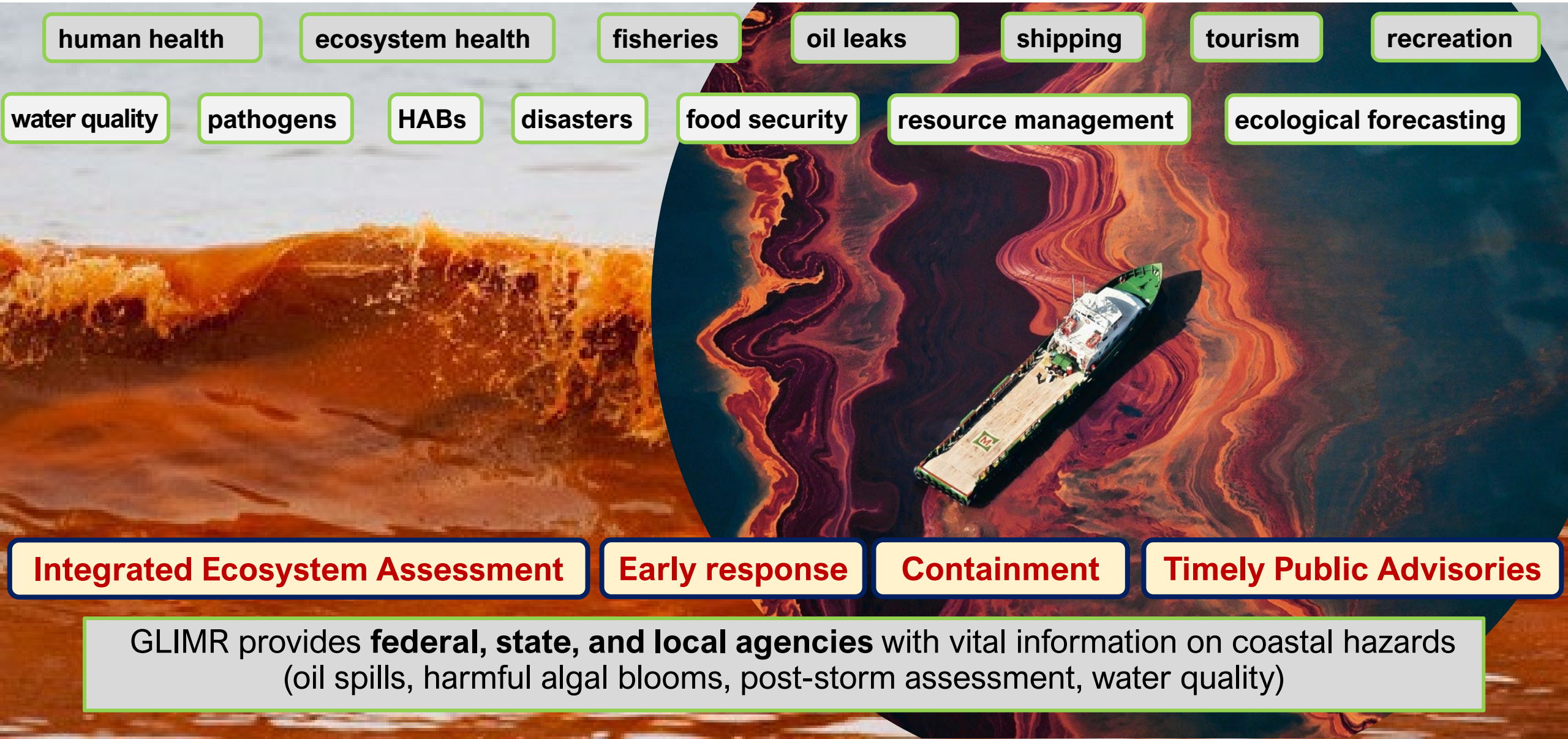
- 6x/day Gulf of Mexico (GoMex)
- 2x/day US East Coast
- 2x/day US West Coast
- 2x/day Amazon River Plume ROI
- 2x/day Caribbean Sea ROI
- 3x/day other HAB target sites
- Calibration Sites (MOBY/S. Pacific/PACE)

GLIMR: Applied Science Foci Areas

Targeting the formation, magnitude, and trajectory of **harmful algal blooms** and **oil spills**.

human health | ecosystem health | fisheries | oil leaks | shipping | tourism | recreation

water quality | pathogens | HABs | disasters | food security | resource management | ecological forecasting



Integrated Ecosystem Assessment | **Early response** | **Containment** | **Timely Public Advisories**

GLIMR provides **federal, state, and local agencies** with vital information on coastal hazards (oil spills, harmful algal blooms, post-storm assessment, water quality)

PACE and GLIMR planned OC data products

"Typical" Ocean Color Products
Remote sensing reflectance (UV-Vis)
Spectral diffuse attenuation coefficients
Apparent visible wavelength
Spectral absorption (a_t, a_p, a_{ph}, a_{cdm}, a_g) and backscatter coefficients
CDOM absorption spectral slope coefficients
Chlorophyll-*a*
Phytoplankton pigments
Phytoplankton community composition
Daily and instantaneous PAR
Fluorescence line height
Euphotic depth
Particulate organic carbon
Dissolved organic carbon
Suspended particulate matter
Particle size distribution
Net Primary Production (NPP) - modeled

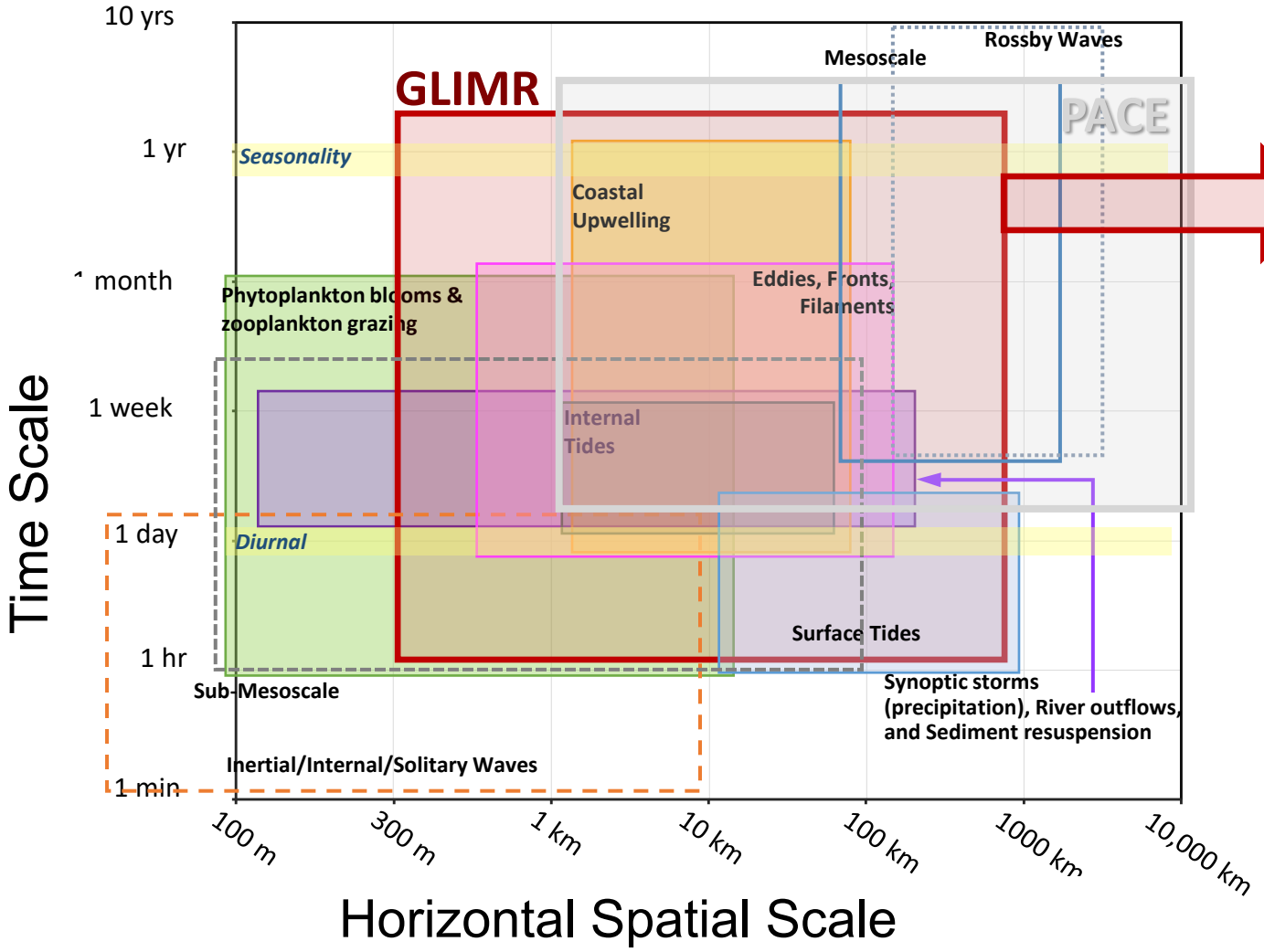
Rates and Fluxes Products ***
Net primary production (NPP)
Net community production of POC
Fluxes of SPM, POC and DOC
Surface Ocean Currents

Applications Products
HAB detection index * **
Karenia brevis cell count index * **
Mycrocystis cell count index * **
Floating algae biomass
Water type classification
Petroleum detection and thickness
Oil density

*** GLIMR only

GSFC Ocean Biology Processing Group - 25 years of ocean color heritage

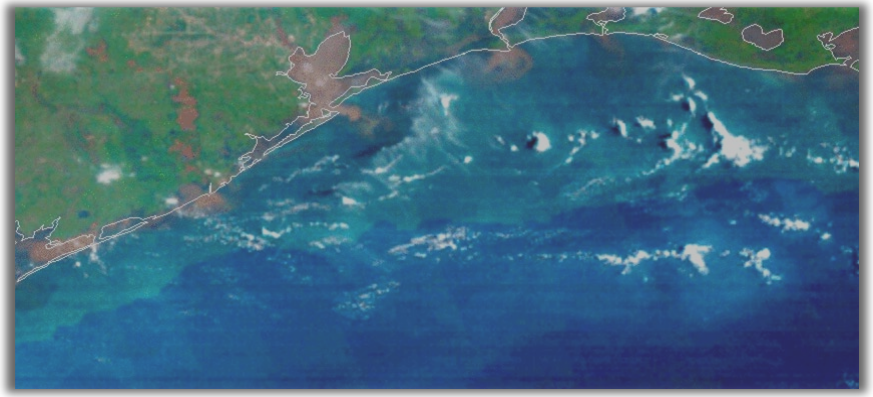
GLIMR



(Adapted from Chelton 2001, Dickey et al. 2006; Kim 2015)

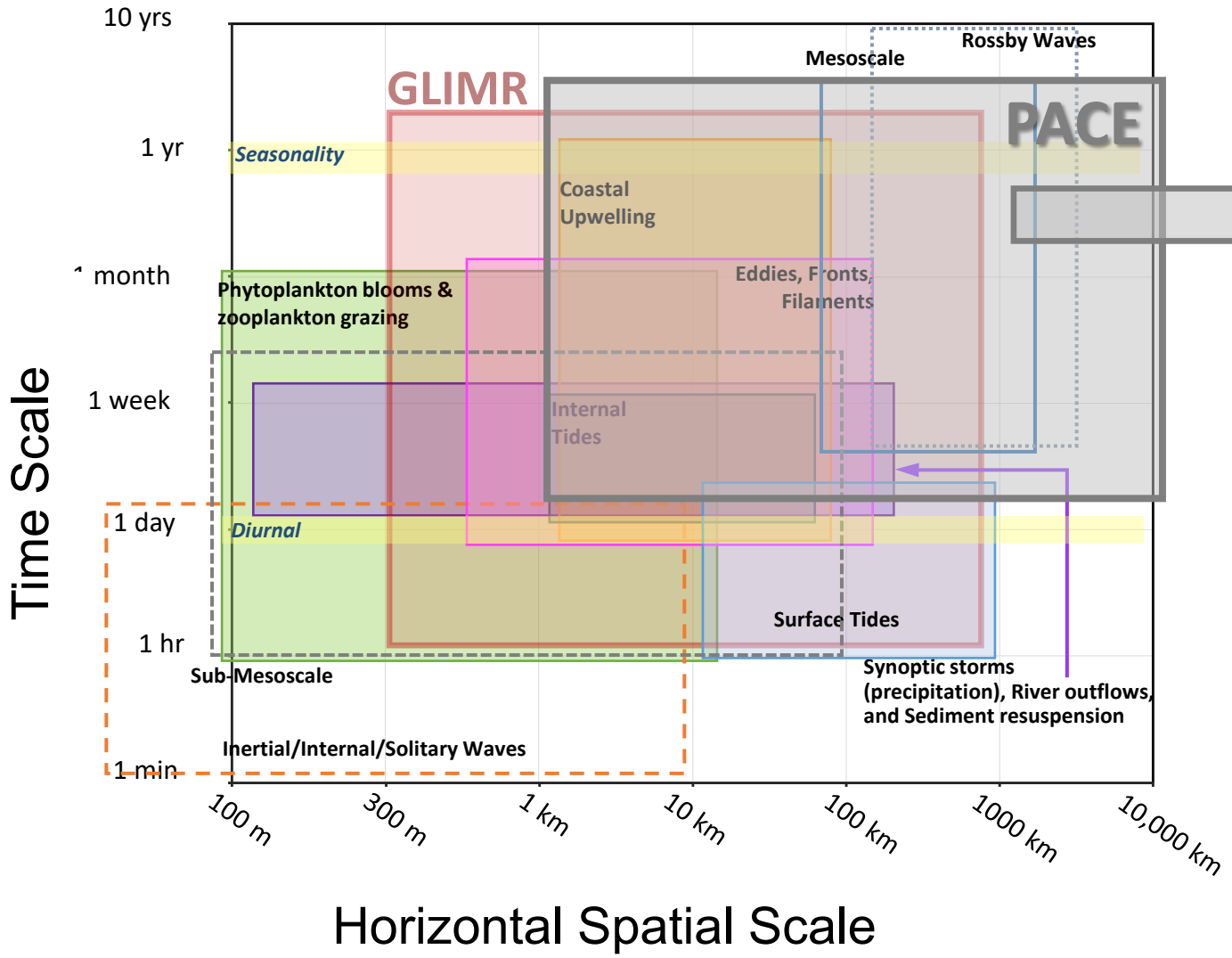
Regional scale at sub-diurnal frequency

- Phytoplankton growth and community composition
- Fluxes of carbon and sediments
- Physical processes at timescales that impact aquatic constituents
- Detect and track HABs, oil spills and other coastal hazards



For more: see NASA Hyperwall on Thurs. @ 10:25am

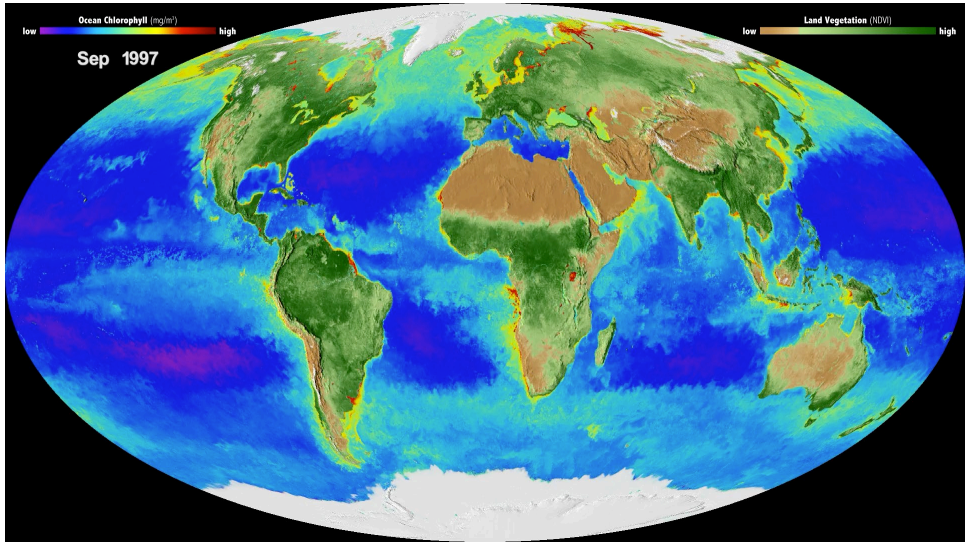
Plankton, Aerosol, Cloud, ocean Ecosystem



Global and regional scale ocean

- climate data continuity,
- phytoplankton communities,
- constituent distributions
- biogeochemical processes

at 2-day frequency.



For more: see Werdell talk in Tokyo Rm Thurs. @ 11:55am; NASA Hyperwall talks Weds. @ 10:10am and 10:25am

BACKUP

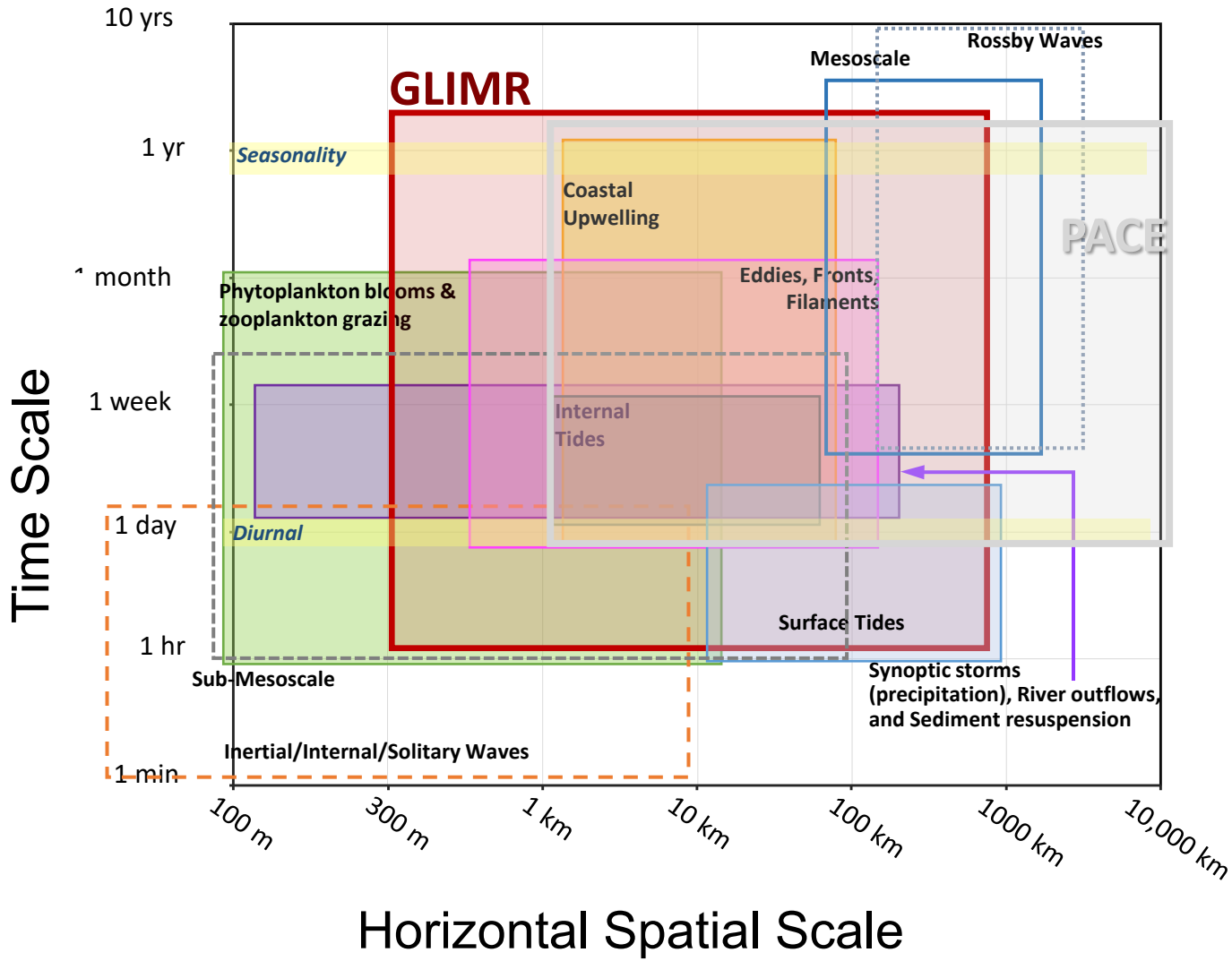
GLIMR Science – temporal and spatial scales

… ~70 min to 2x/day observation frequency

… nadir ground sample distance of ~300 m

provide suitable capability
(1) to observe physical processes that regulate the spatial-temporal dynamics of biological and biogeochemical processes and constituent distributions

(2) to resolve the rates of these processes and constituents in nearshore, continental shelf and open ocean waters as well as sub-mesoscale features



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