EDMW 2025

Introduction to using earth data in the cloud for scientific workflows

Introduction to Hyperspectral Ocean Color

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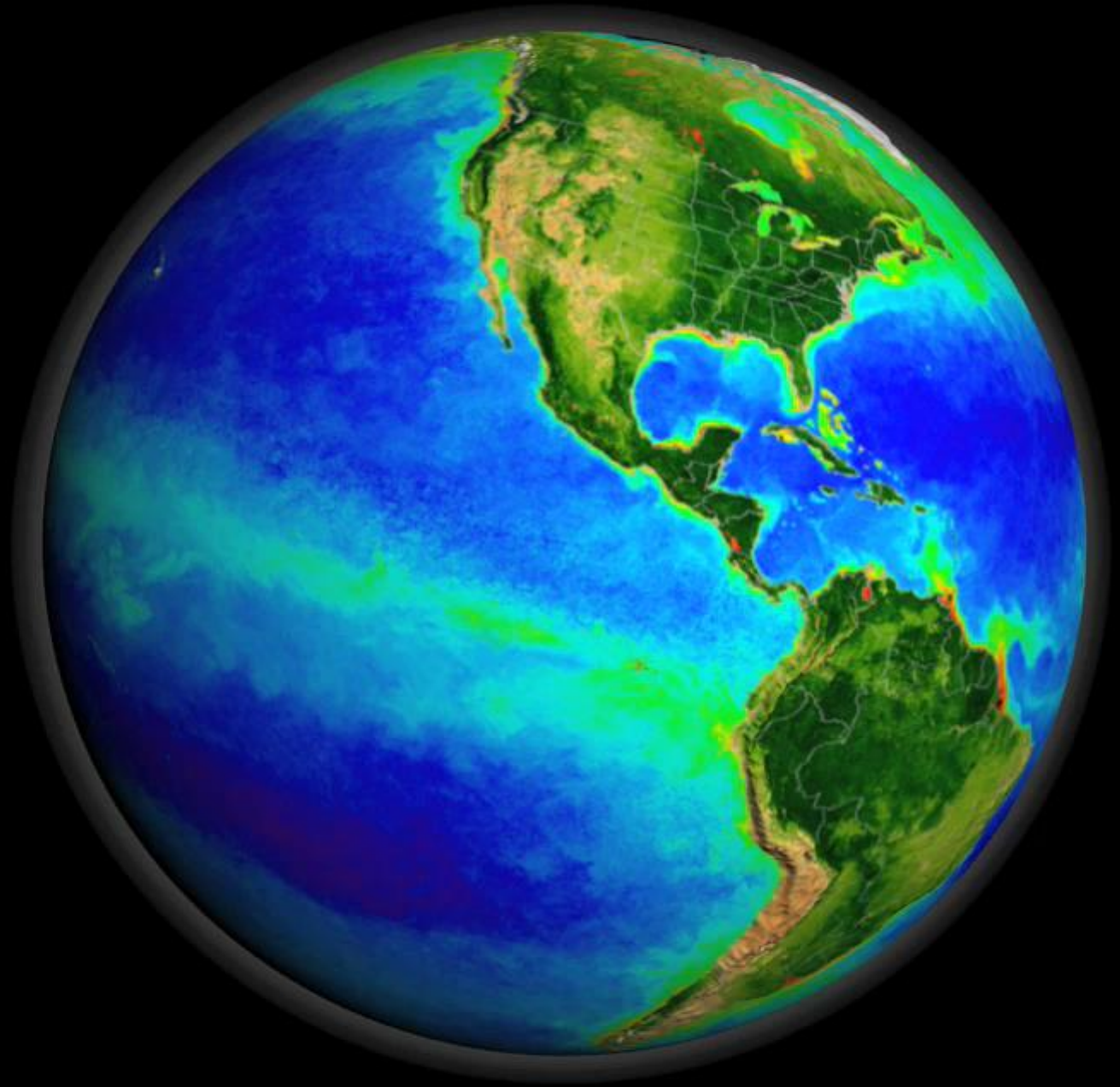
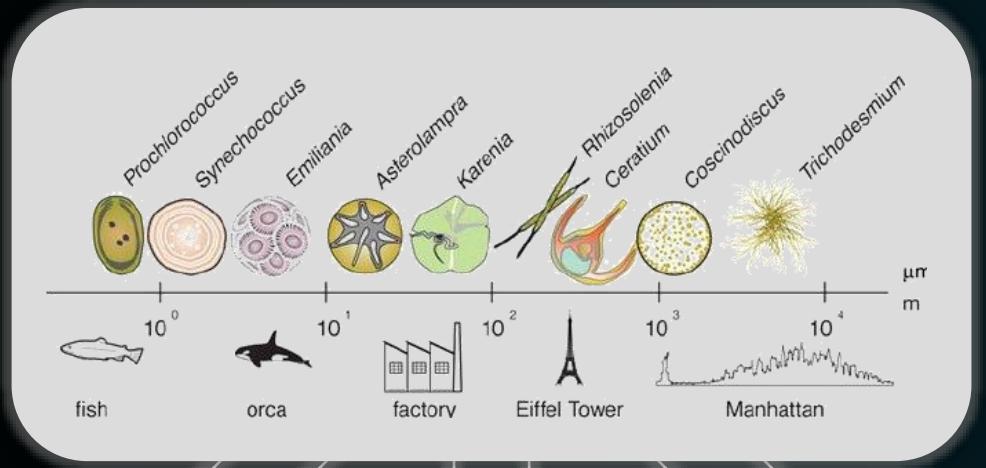


Satellite remote sensing of ocean color offers the only global insight into the biology of the sea

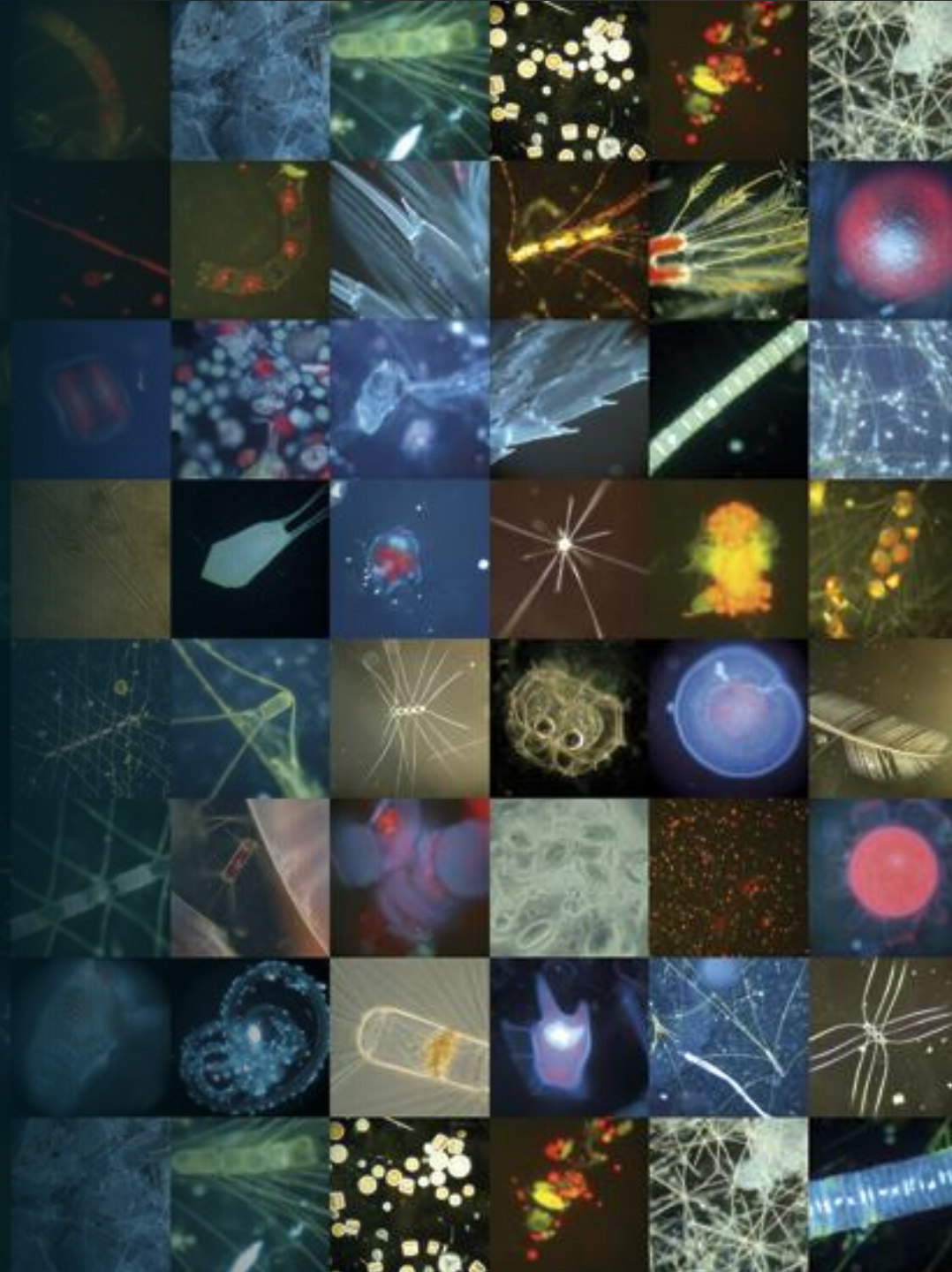
There is more to the story than just chlorophyll-a…



Small copepods

Large copepods

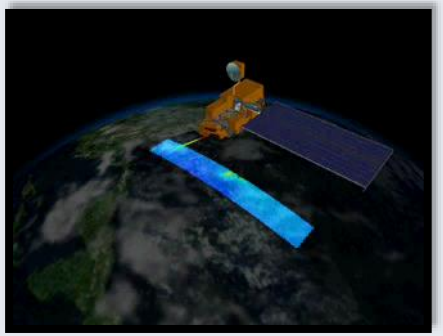
Gelatinous zooplankton



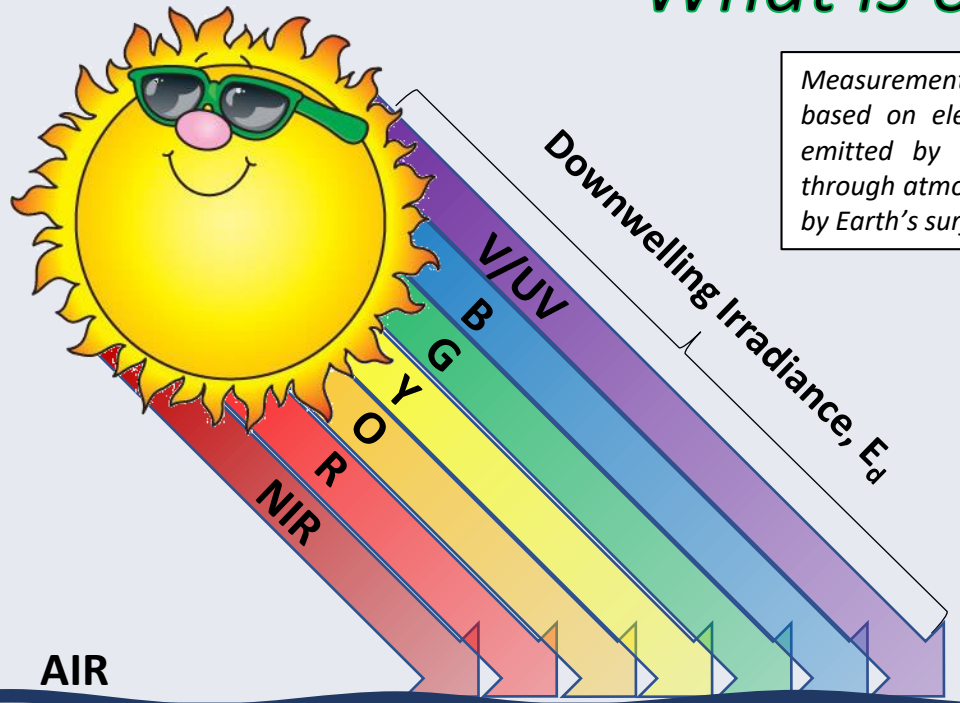
Sanseverino et al. 2016

What is ocean color?

*Measurements of ocean color are based on electromagnetic energy emitted by sunlight, transmitted through atmosphere, and **reflected** by Earth's surface.*



Water-leaving Radiance, L_w

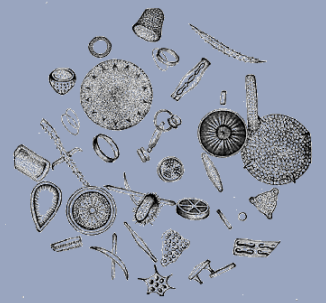


AIR

SEA

There are two possible things that can happen to a photon in water

SCATTERING (b_b)

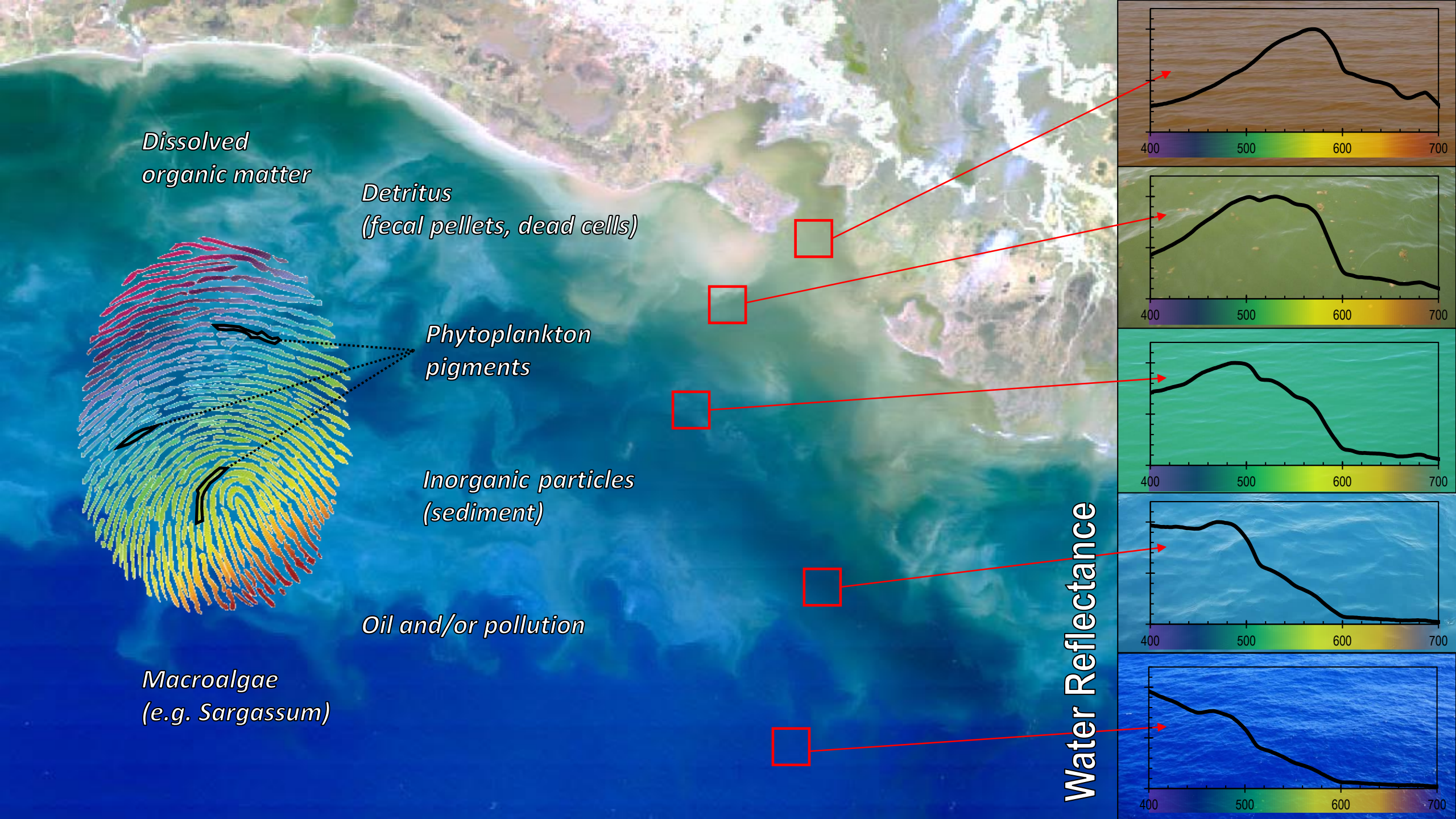


Organic Matter

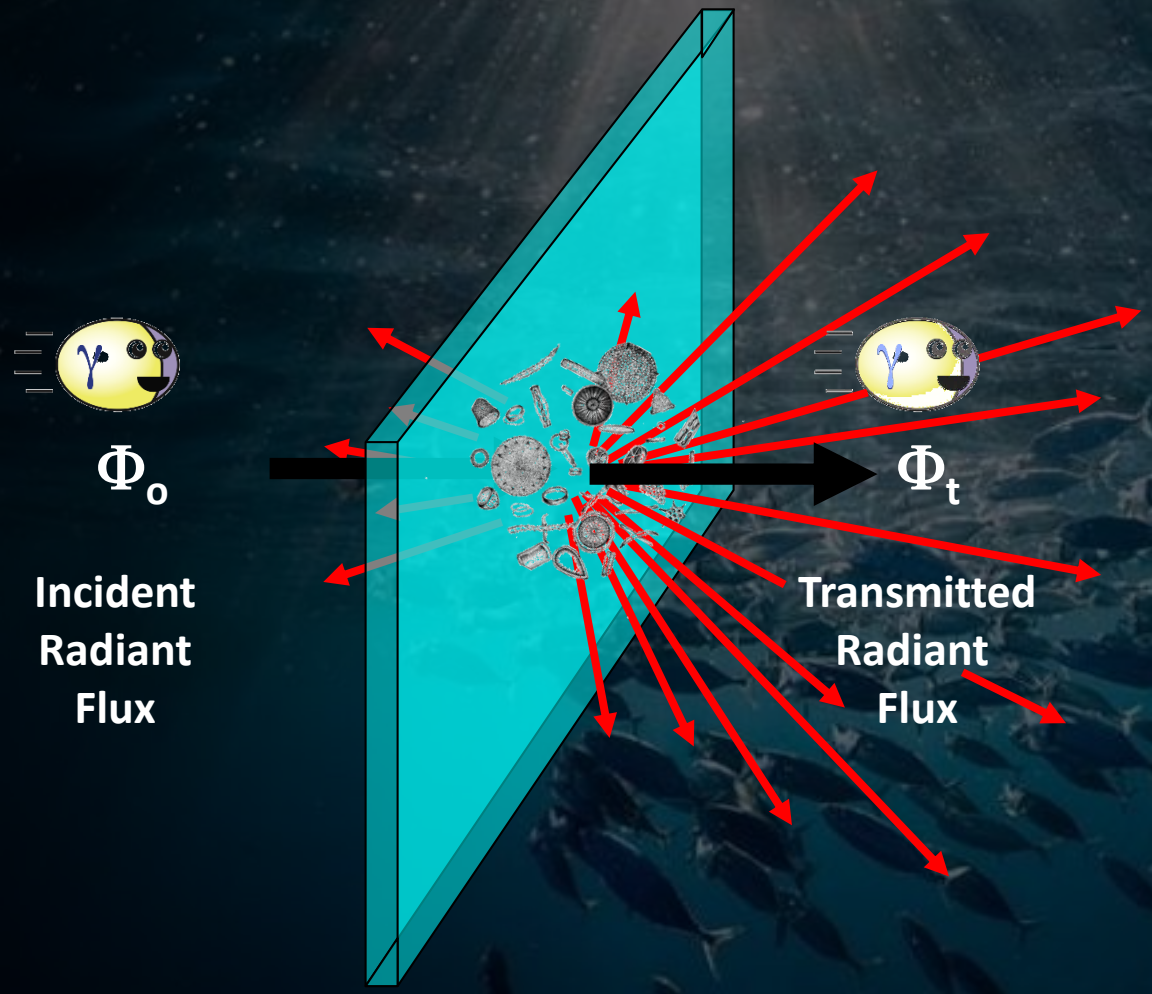
Detritus

Phytoplankton

ABSORPTION (a)


Dissolved
organic matter
Detritus
(fecal pellets, dead cells)
Phytoplankton
pigments
Inorganic particles
(sediment)
Oil and/or pollution
Macroalgae
(e.g. Sargassum)
Water Reflectance
400
500
600
700

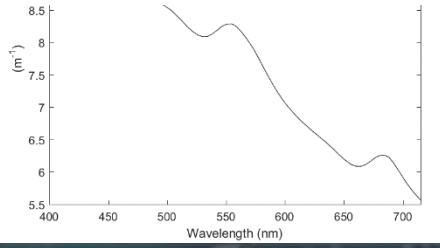
Two things can happen when light interacts with water:



Φ_a – Absorbed Radiant Flux
Φ_b – Scattered Radiant Flux

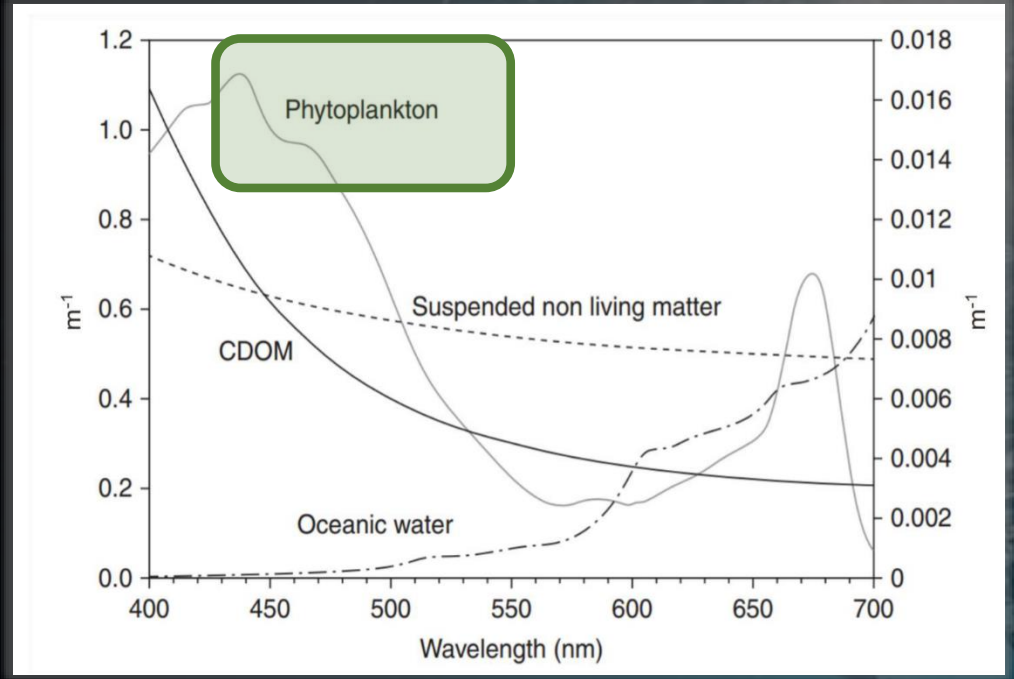
R_{rs} = Remote Sensing Reflectance

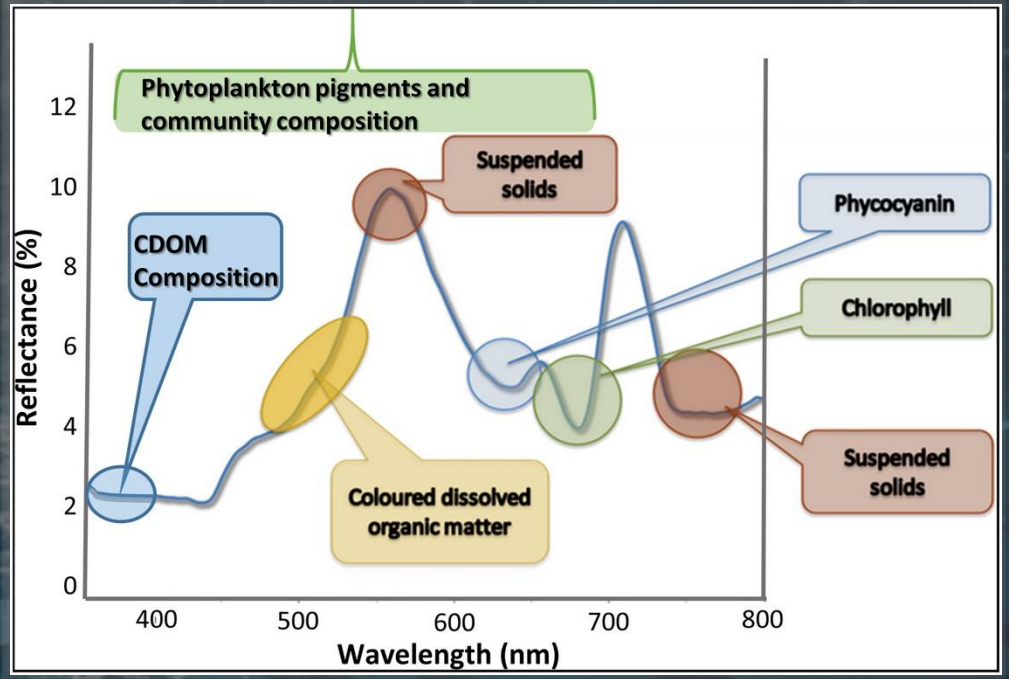
$$R_{rs} \approx F\,[bb(\lambda) / a(\lambda) + bb(\lambda))]$$



INTENSITY and ***DIRECTION*** of light at different wavelengths will change and can be measured to further define optical properties of water.

These “IOPs” uniquely vary with water composition



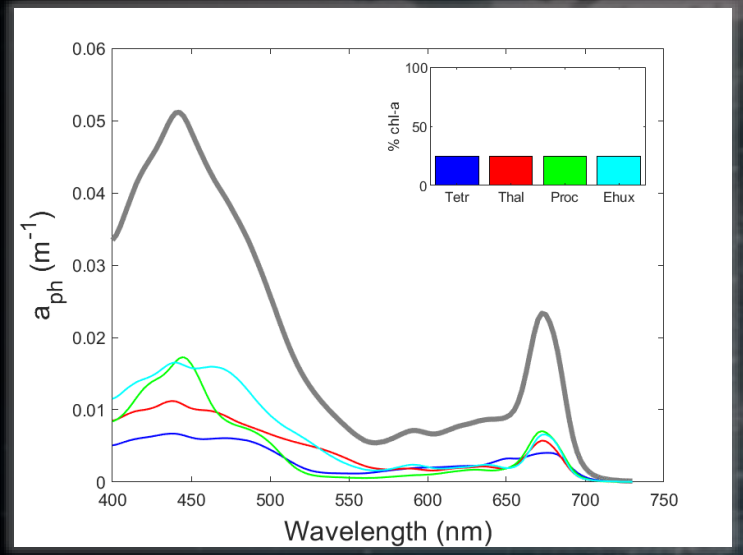


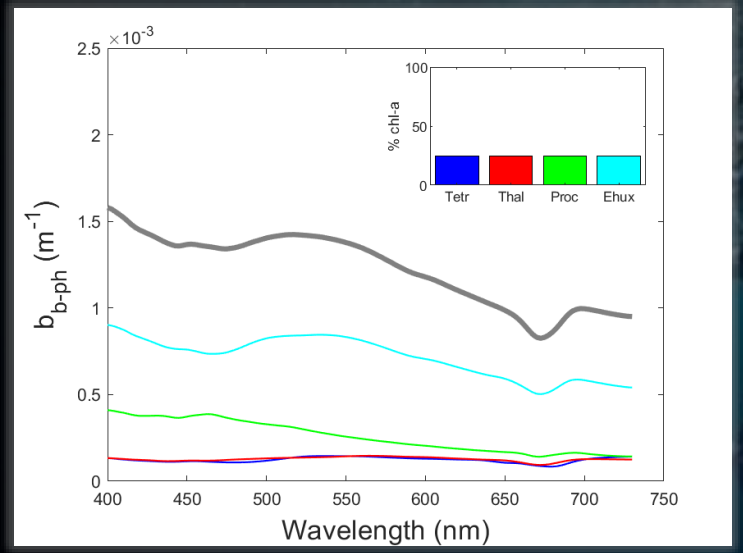
Absorption

Inherent *optical property*

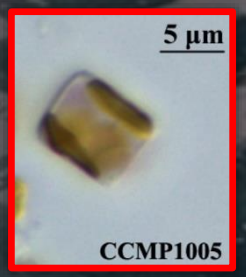
Reflectance

Apparent *optical property*

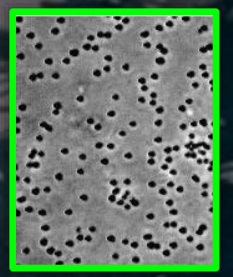




Tetraselmis sp.

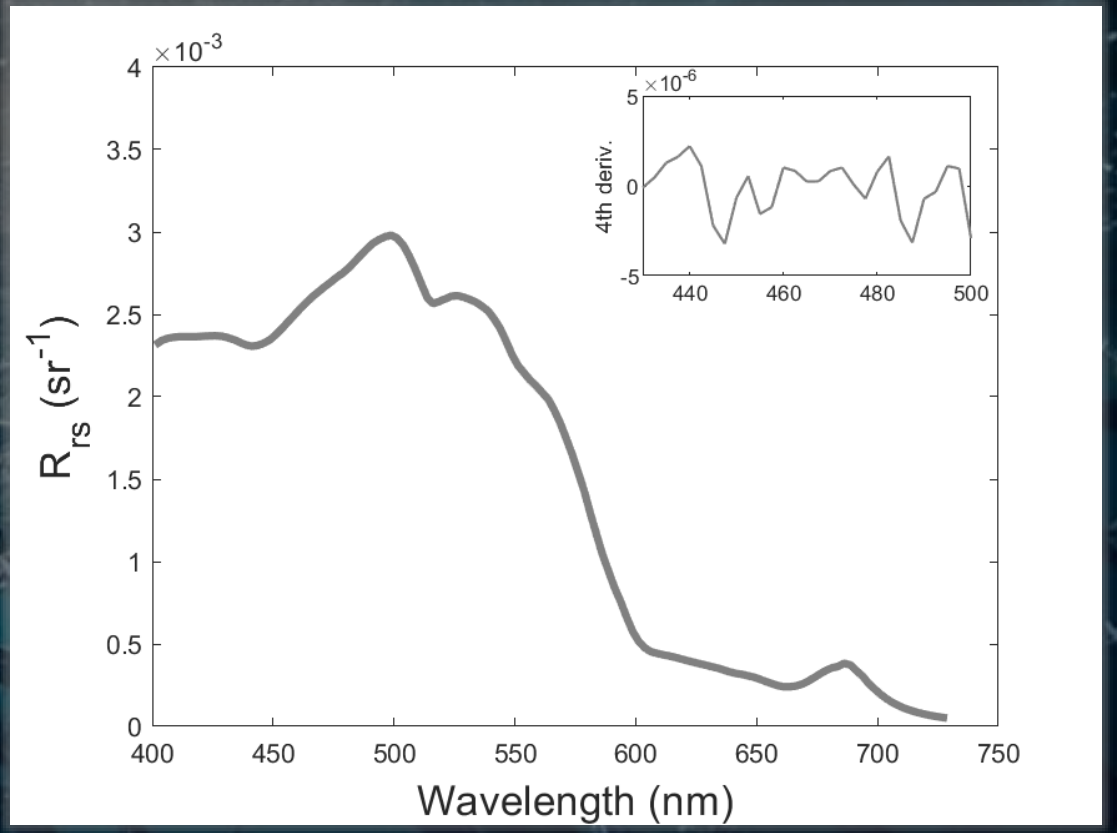


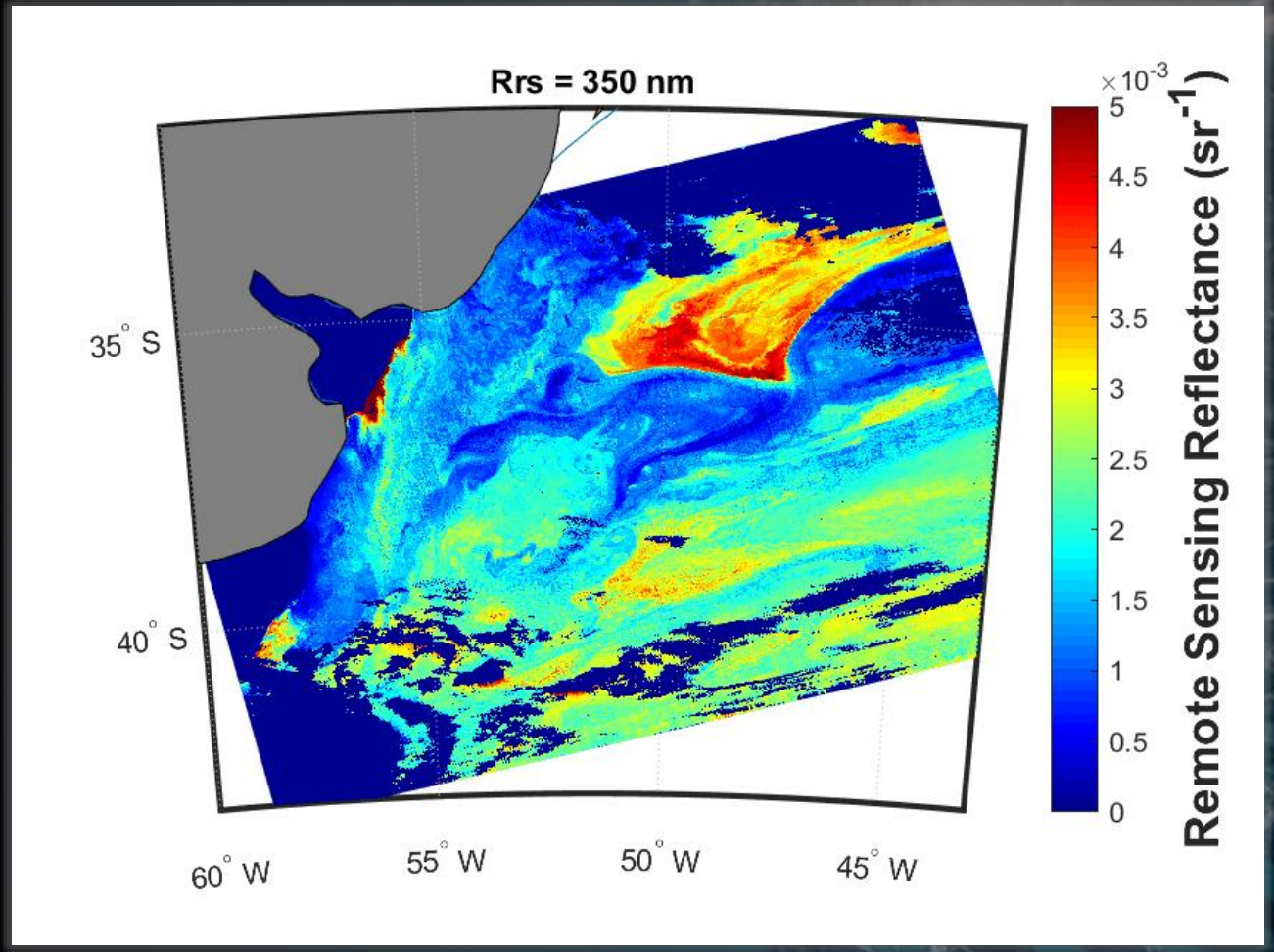
Thalassiosira oceanica

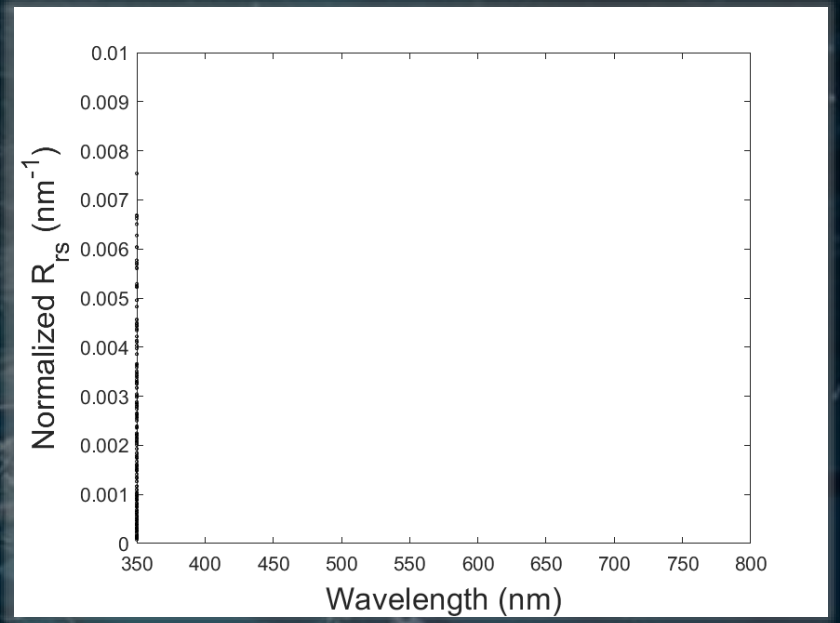


Prochlorococcus marinus

Emiliania huxleyi





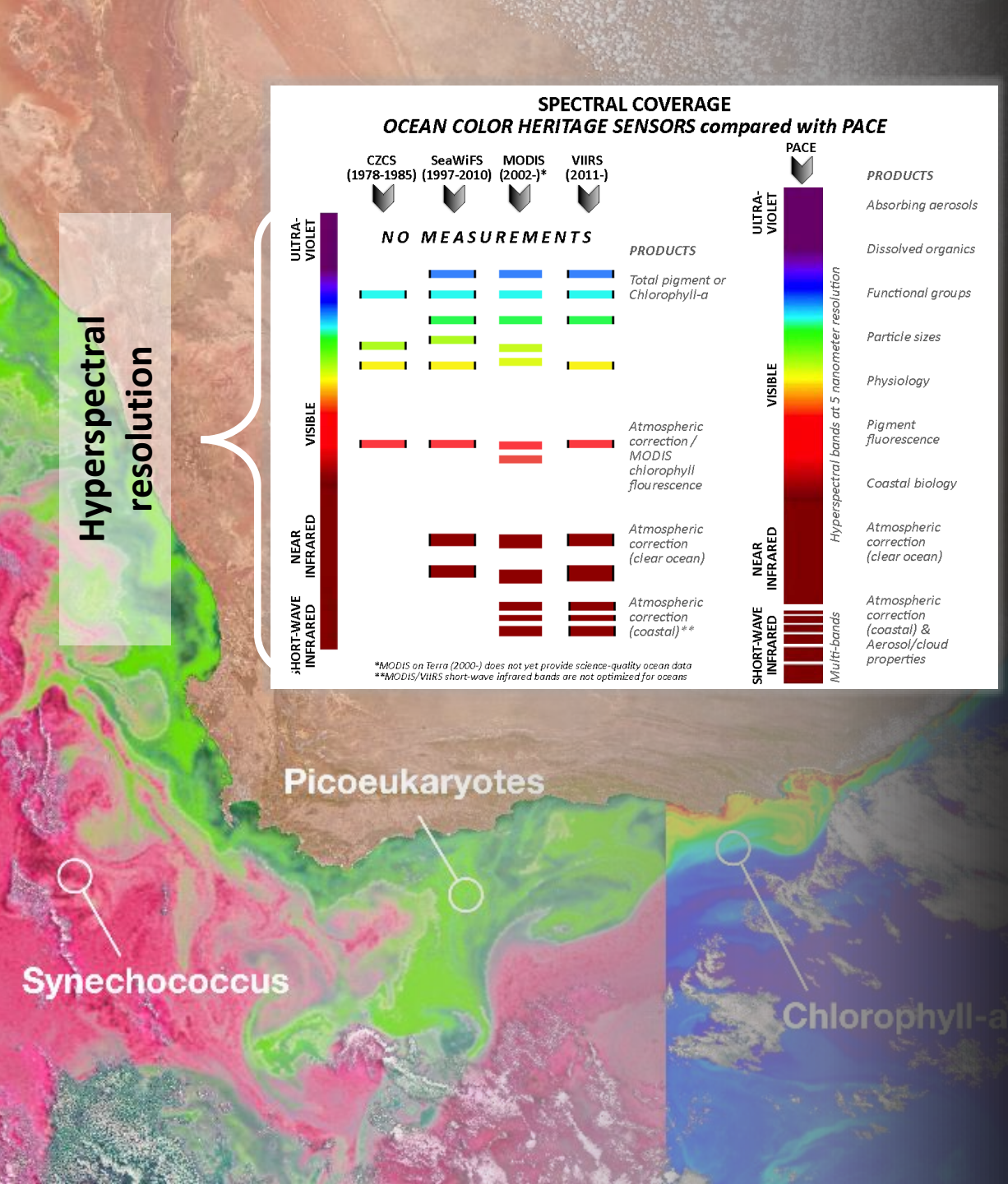


Example of dynamic range of reflectance data for optically complex waters

PACE launched!

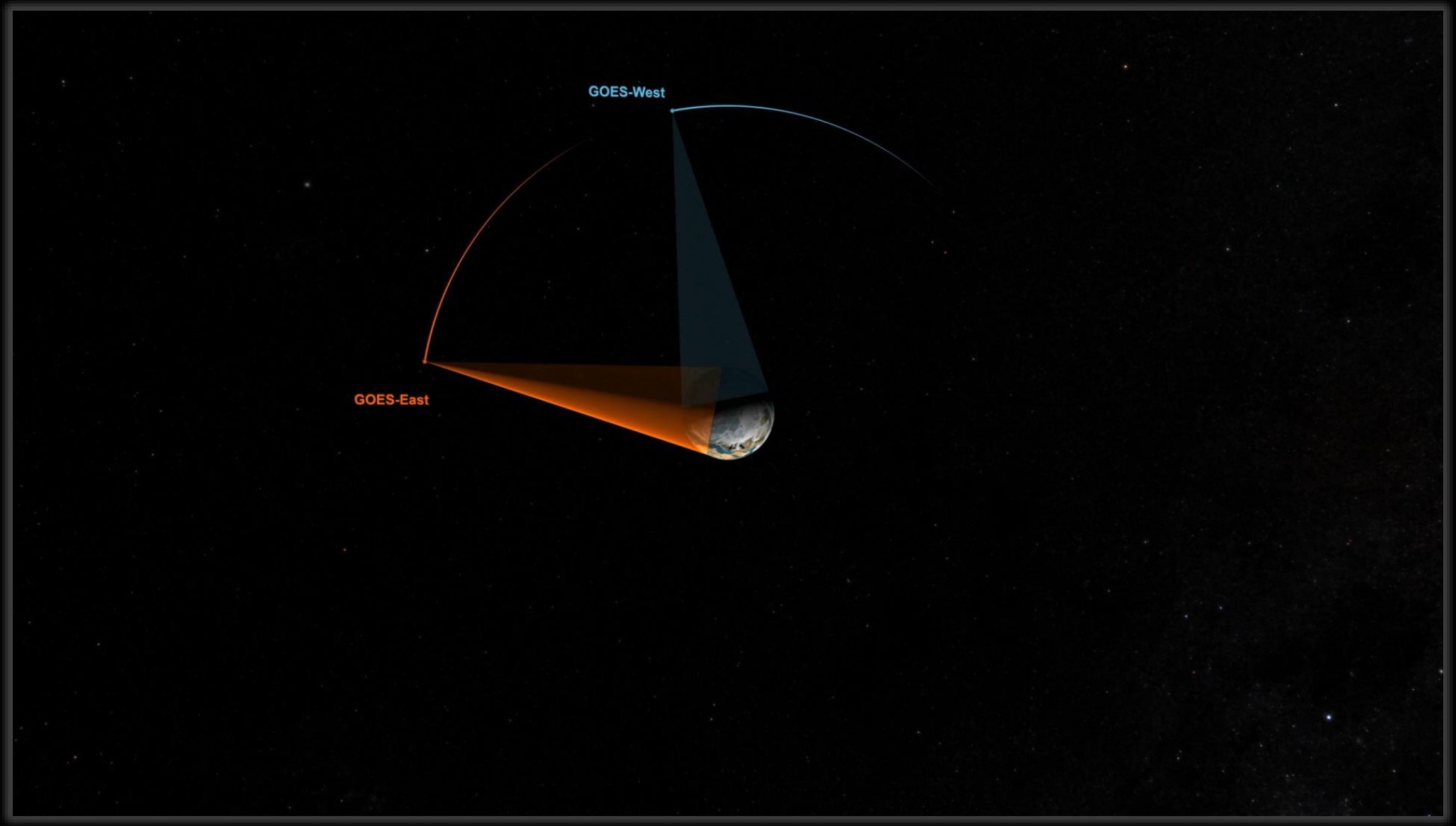
A step beyond chlorophyll-a

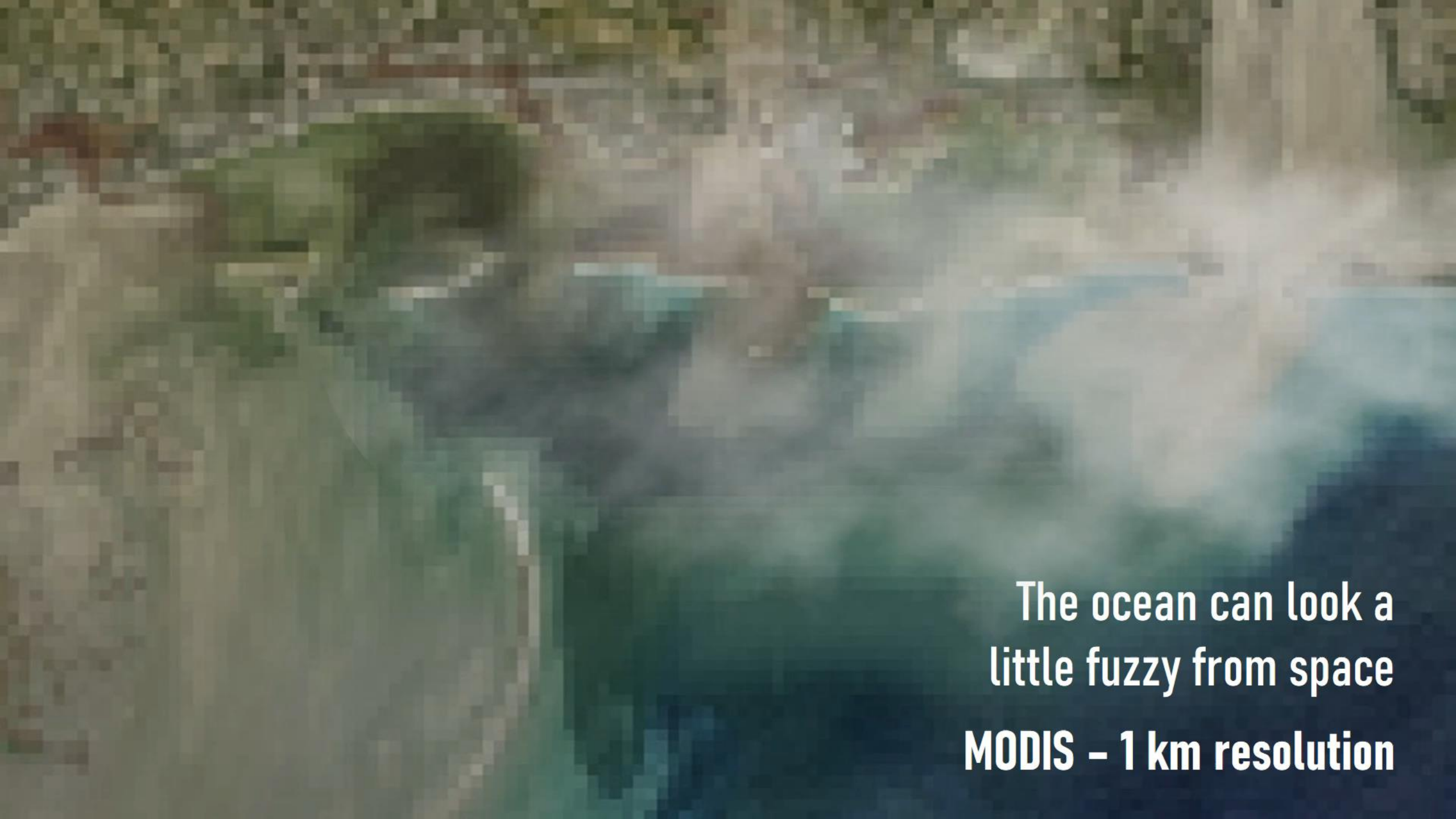
- **P**lankton, **A**erosol, **C**loud, and ocean **E**cosystem (**PACE**) mission
- Launched in February 2024
- First global “hyper” spectral ocean mission (the whole rainbow!).
- Providing critical insights into the aquatic optical environment that we have been blind to for 25 years.



Plankton, Aerosol, Cloud, and ocean Ecosystem (PACE)

GEO (geostationary)




The ocean can look a
little fuzzy from space
MODIS – 1 km resolution

NOAA Fisheries | U.S. Department of Commerce

Thank you!

Contact me at:
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