



PRISM, PACE, and ECOSTRESS
for aquatic biodiversity
Erin Hestir

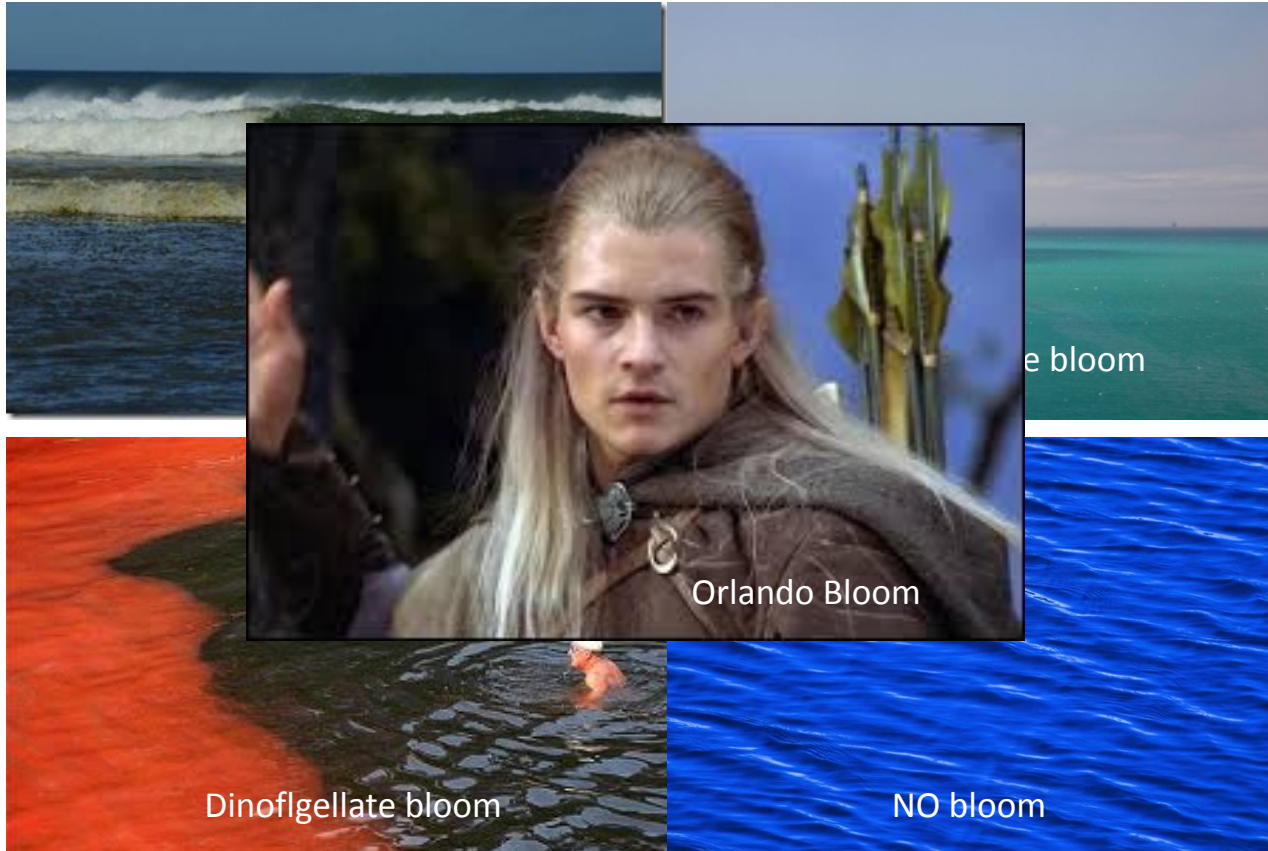


What color is the water?

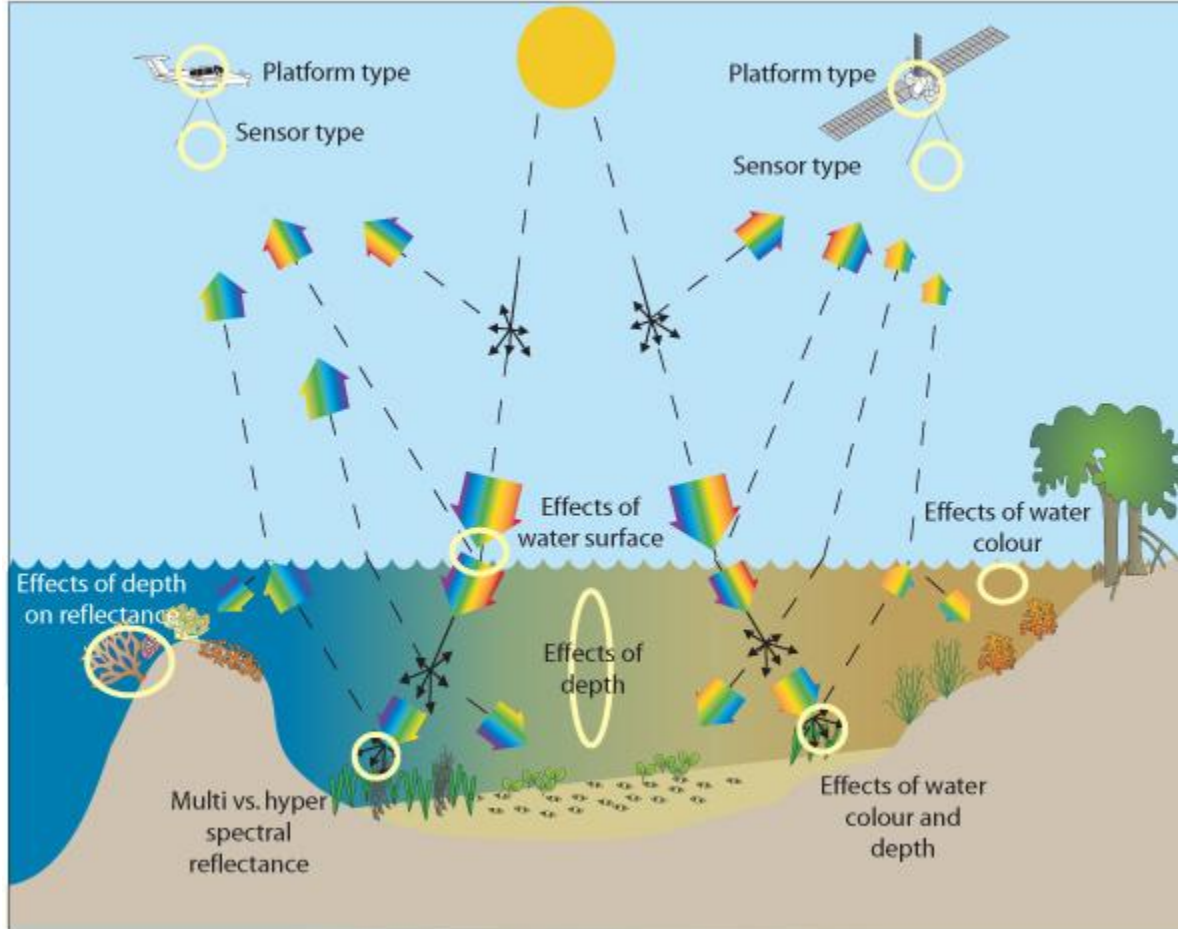
Isn't it blue?



The 'color' of phytoplankton



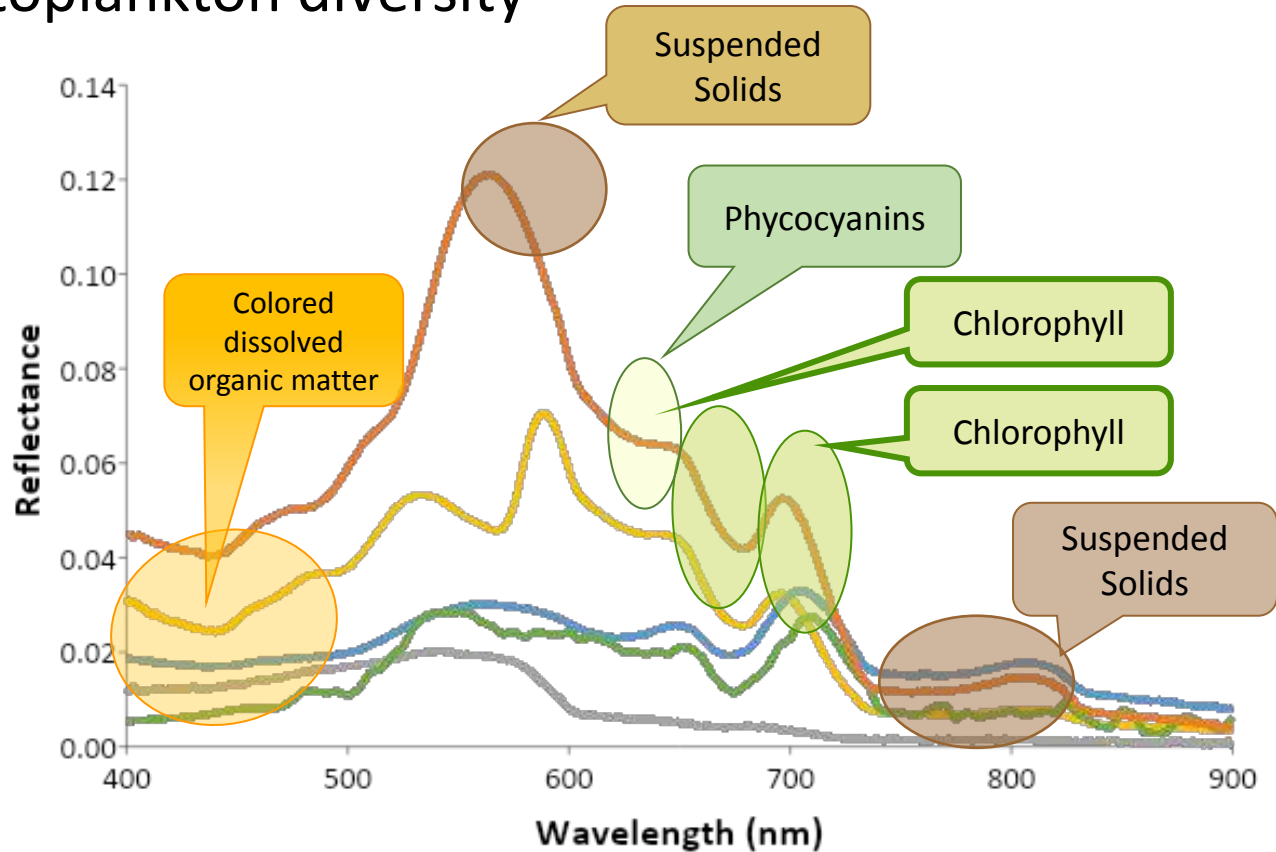
How do we measure color?



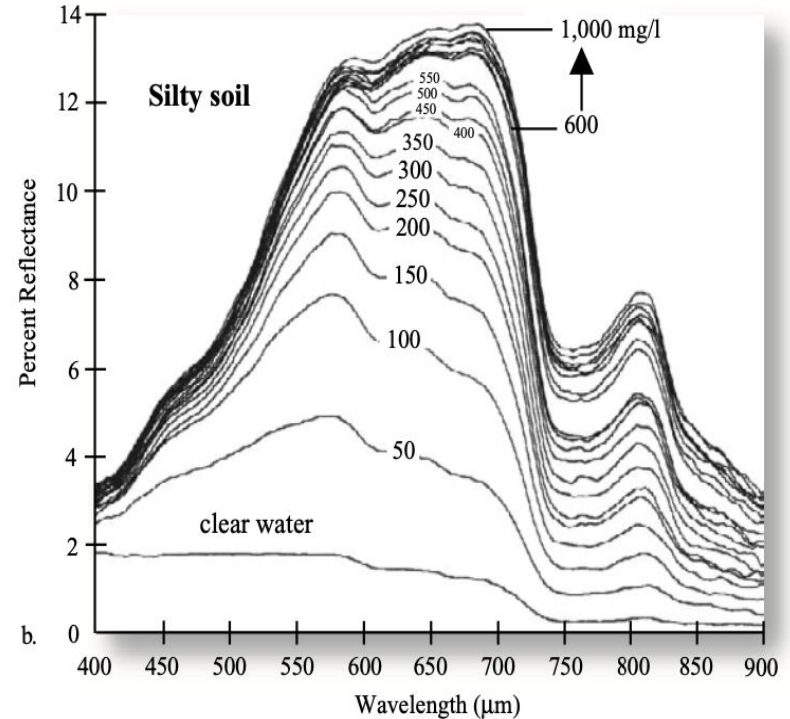
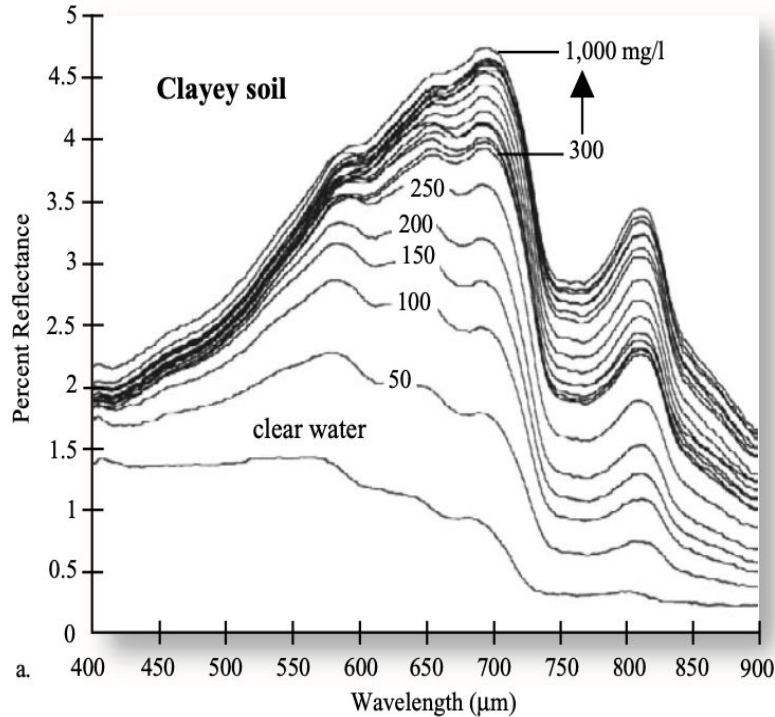
<https://sees-rsrc.science.uq.edu.au/rstoolkit/en/html/marine/resources/what-is-remote-sensing.html>



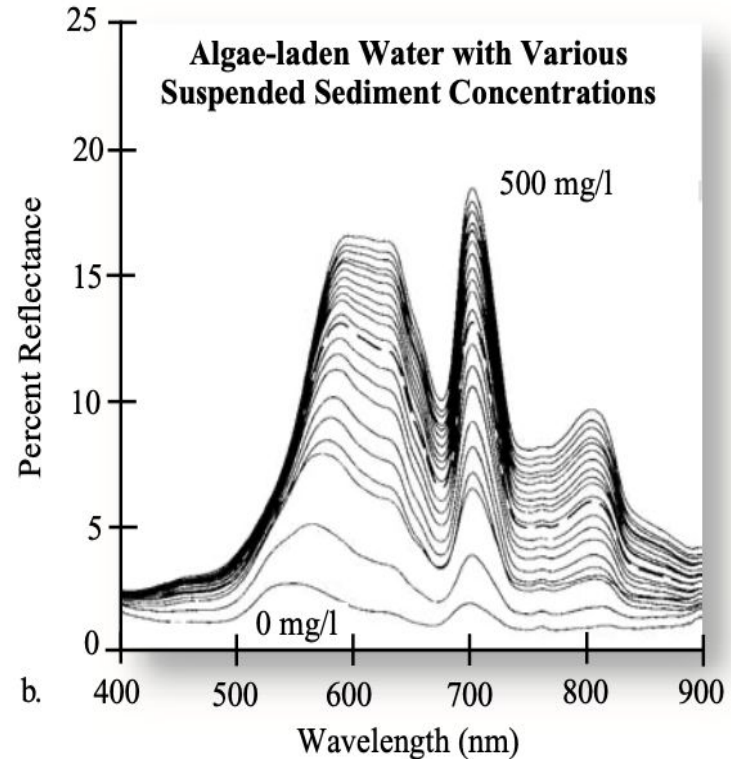
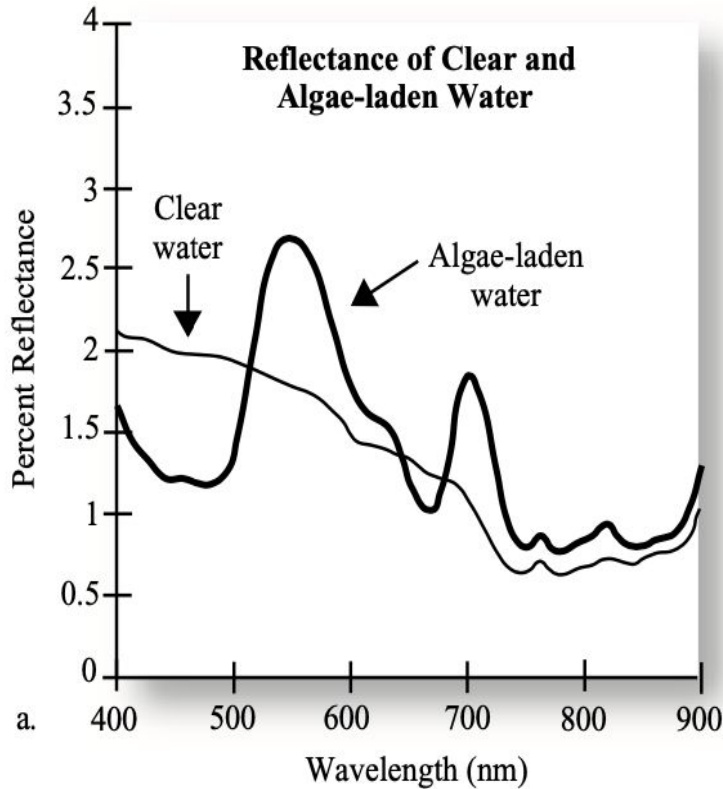
Imaging spectroscopy enables better water quality measurements + and phytoplankton diversity



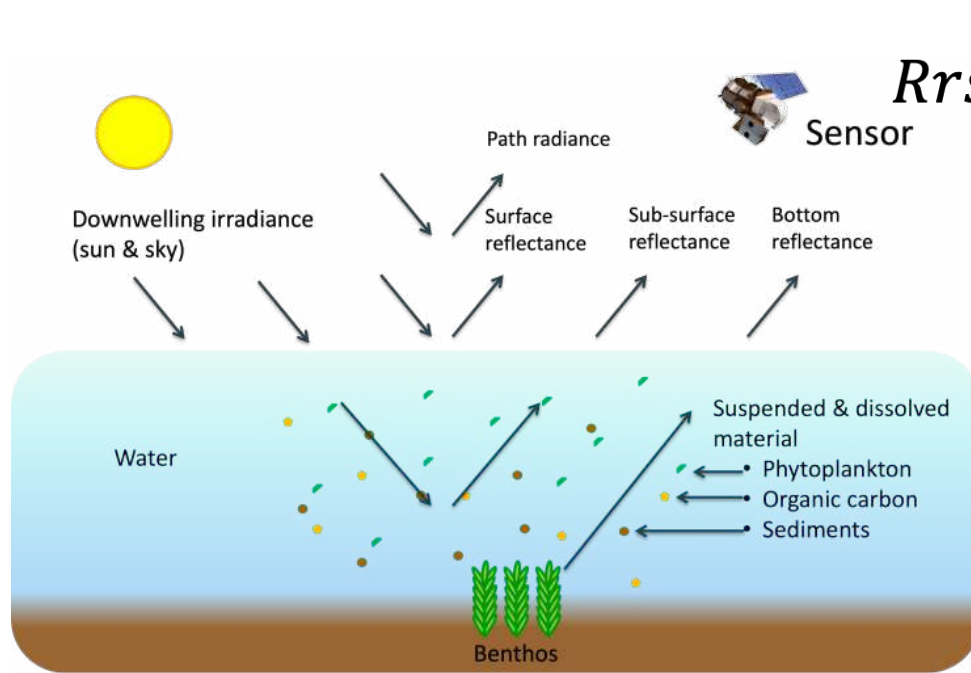
Spectral response of water as a function of suspended minerals



Spectral response of water as a function of chlorophyll



Remote sensing reflectance (R_{rs}) aka "ocean color"



$$R_{rs}(\lambda, 0^+) \cong C \frac{b_b(\lambda)}{a(\lambda) + b_b(\lambda)}$$

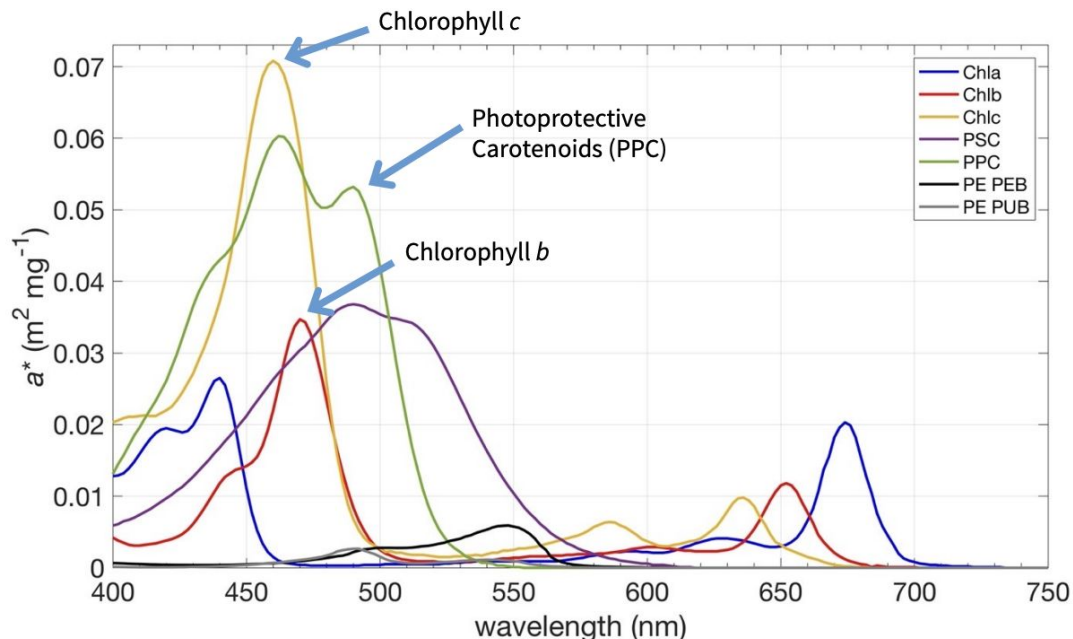
$$a = a_{phy} + a_{nap} + a_{CDOM} + a_w$$

$$b = b_{water} + b_{particles}$$



Beyond chlorophyll: discriminating phytoplankton functional types

Phytoplankton pigments drive spectral absorption features



Slide from Ali Chase, IOCCG 2022 Summer School.
https://ioccg.org/wp-content/uploads/2022/09/chase_ioccg_sls_2022_hyperspectral_perspectives.pdf



$$a = a_{phy} + a_{nap} + a_{CDOM} + a_w$$

Living up to the Hype of Hyperspectral Aquatic Remote Sensing: Science, Resources and Outlook

Heidi M. Dierssen^{1*}, Steven G. Ackleson², Karen E. Joyce³, Erin L. Hestir⁴,
Alexandre Castagna⁵, Samantha Lavender⁶ and Margaret A. McManus⁷

Data Transformations

Spectra subject to one or more transformations

- Band Math
- Derivative Analysis
- Coordinate Transformations

Retrieval Approaches

Spectra as Descriptors

used as indices or categories

- Hue Angle
- Cluster Analysis
- Object Based Image Analysis

Spectra as Predictors

used as independent variables to predict system properties

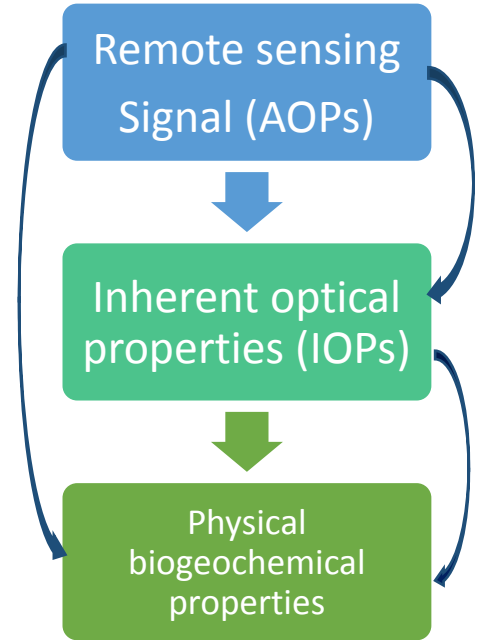
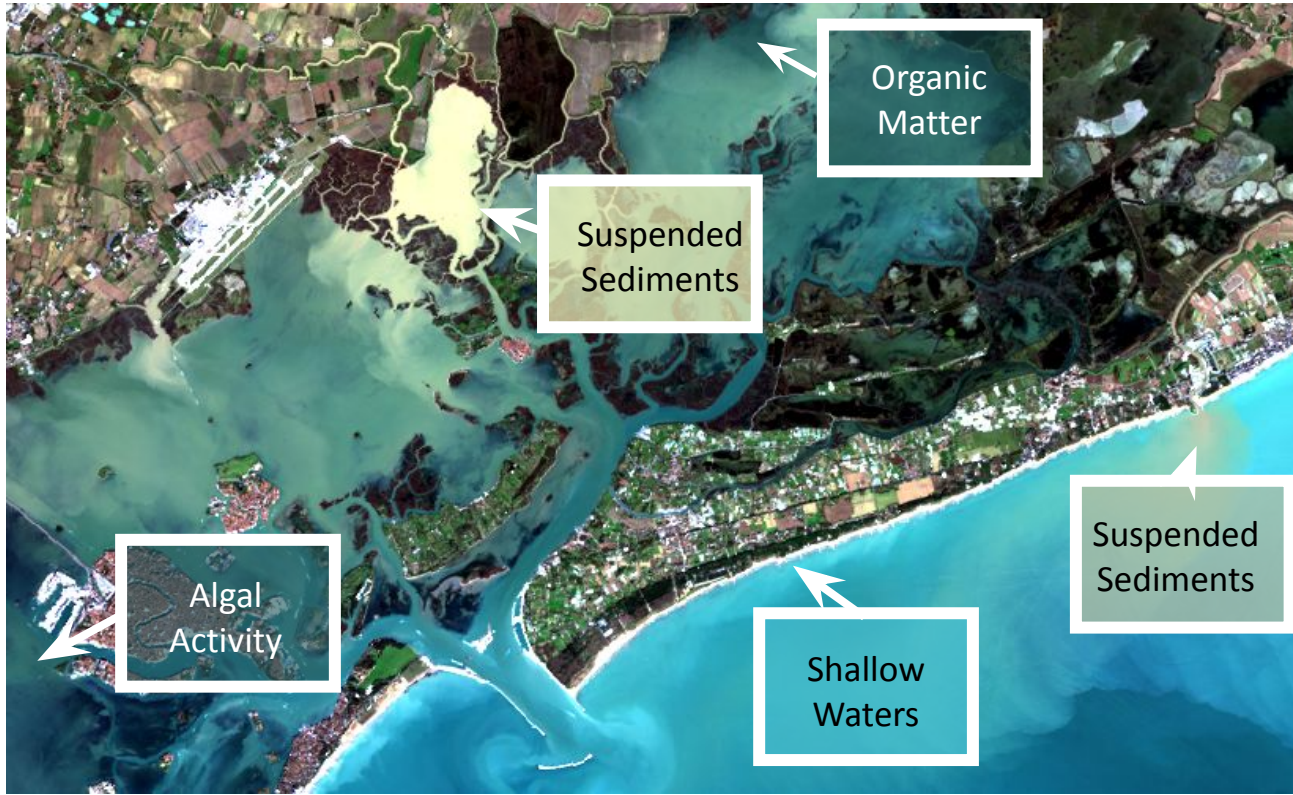
- Parametric Regression
- Neural Networks
- Decision Trees

Spectra as References

used as a reference against modeled or measured spectra

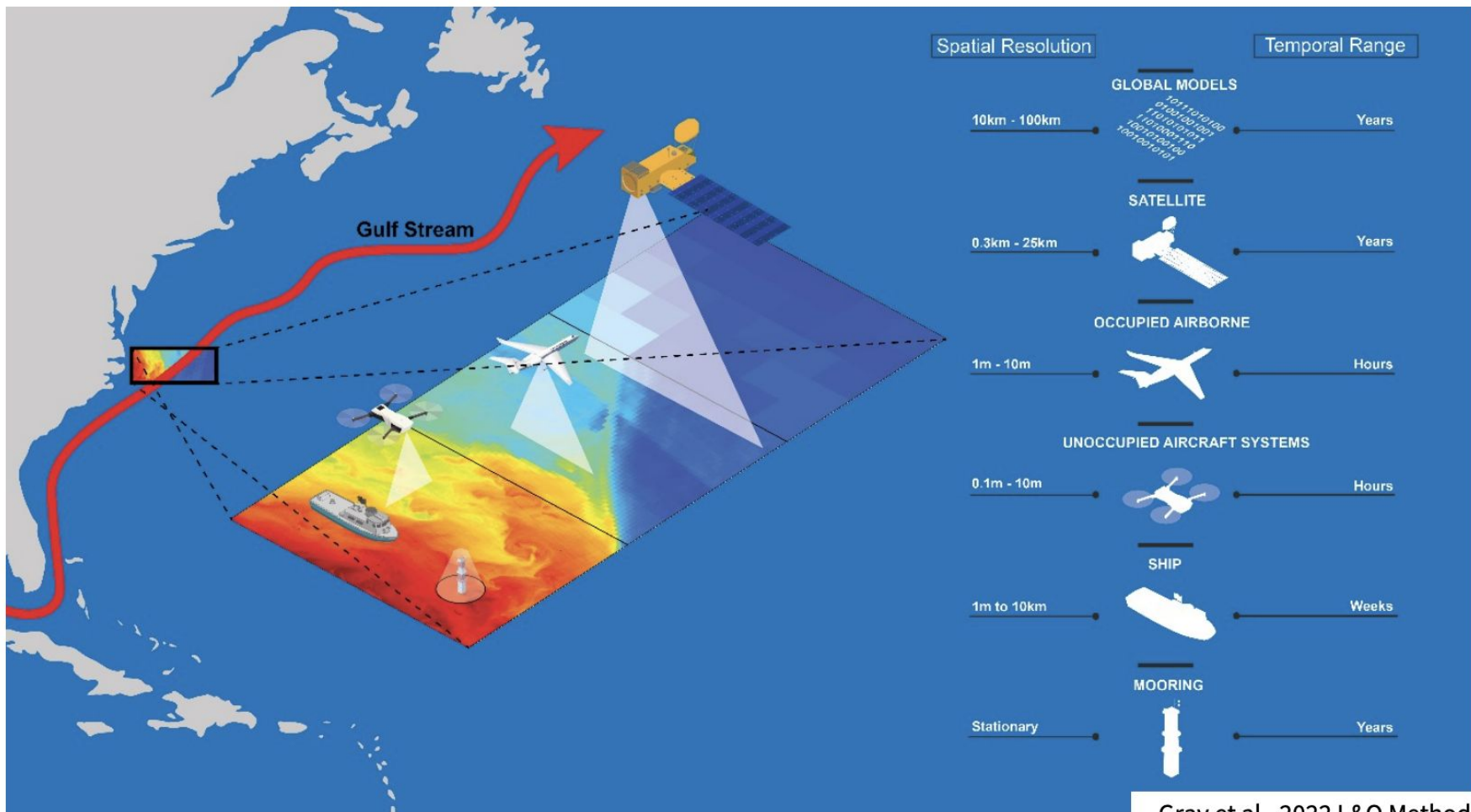
- Optimization Algorithms
- Linear Matrix Inversion

Water quality & phytoplankton diversity from space (or planes or...)



Transfer coefficients are often regional/ temporally dependent

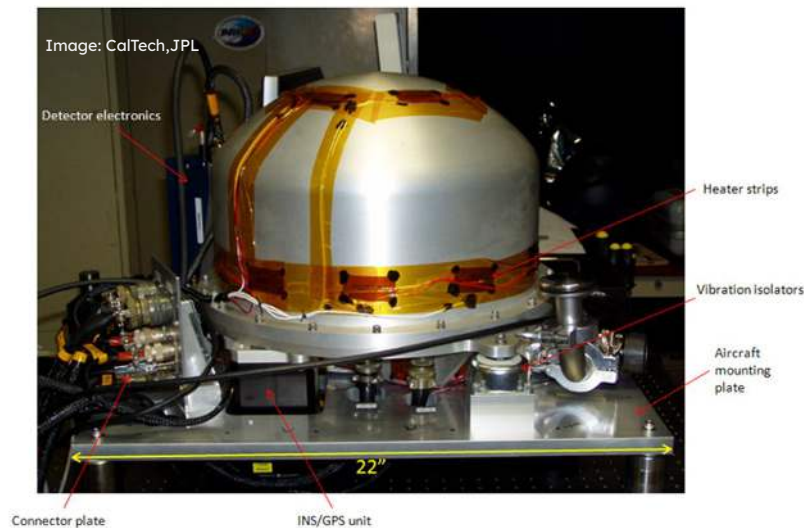




Gray et al., 2022 L&O Methods



Portable Remote Imaging Spectrometer (PRISM)



Designed especially for aquatic environments!

- Very high spectral sampling (< 3 nm, 3.5 nm FWHM)
- Very high SNR for water

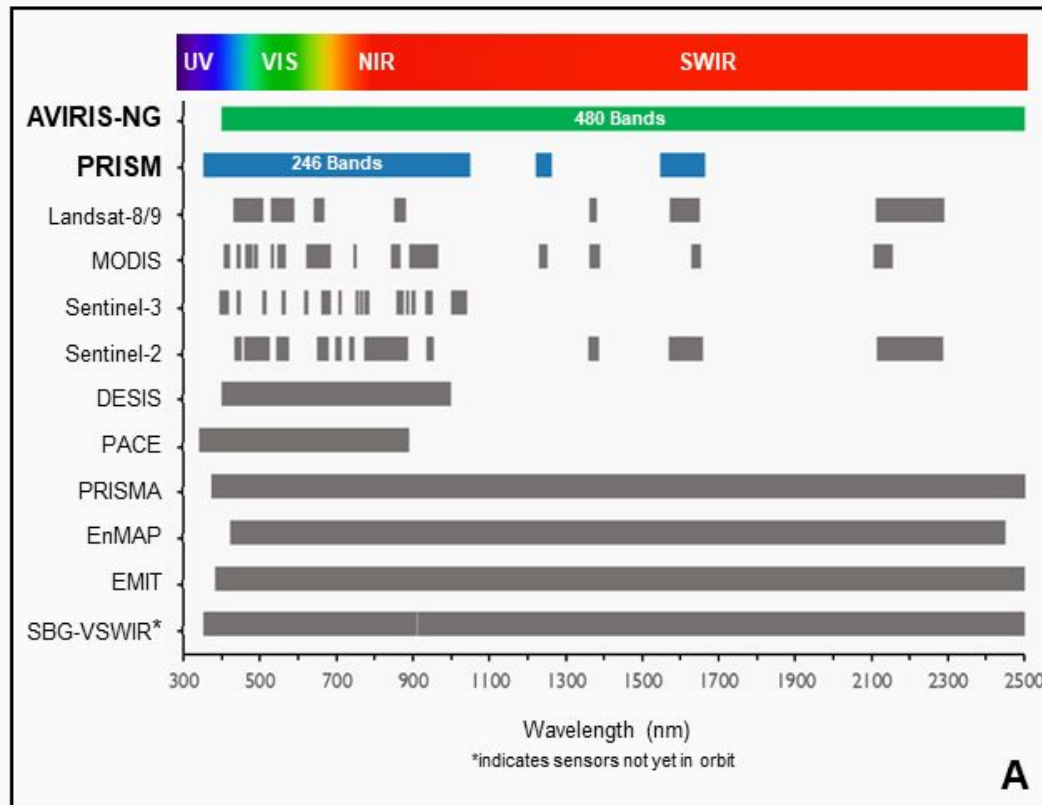


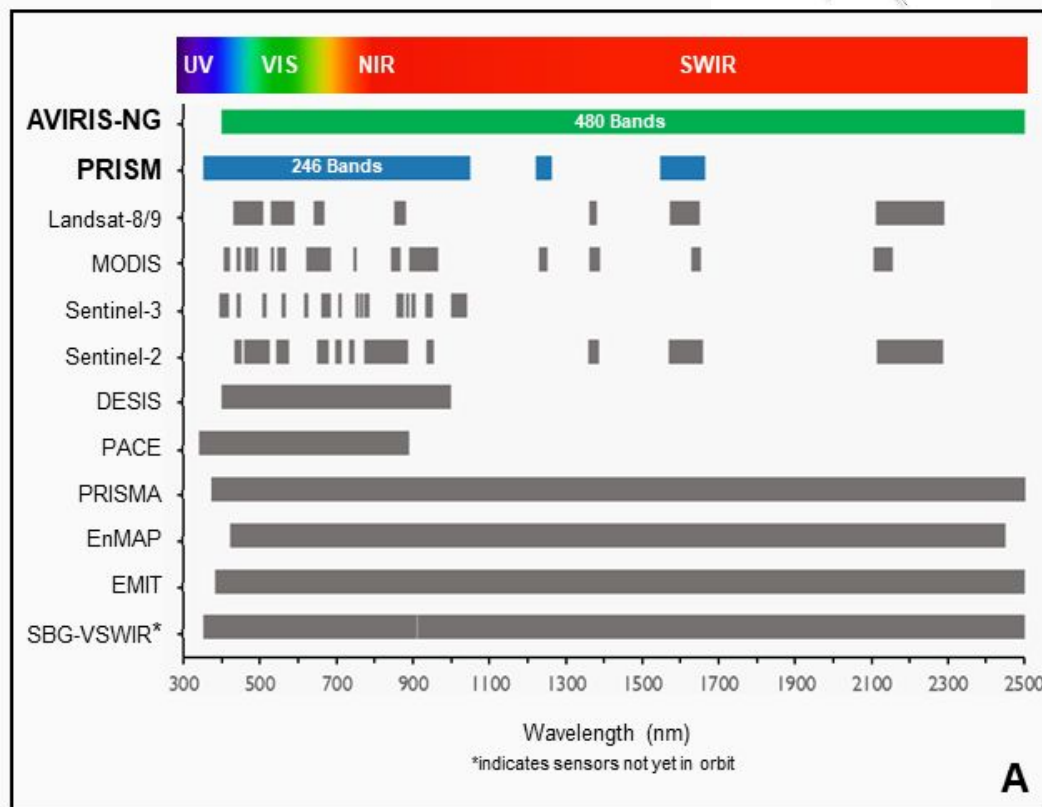
Figure: J. Nessler

Phytoplankton Aerosol Cloud ocean Ecosystem (PACE)



Designed especially for oceans!

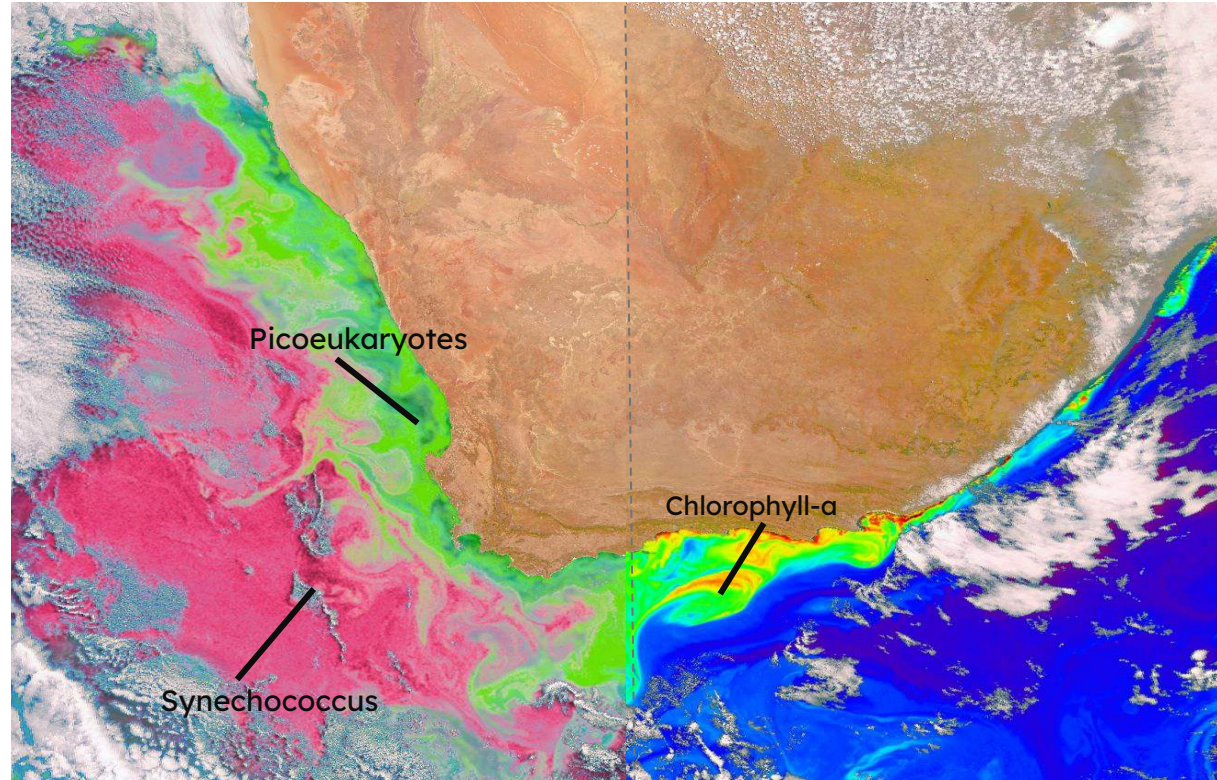
- Launched Jan 20204
- 1 km pixels
- Community composition data are coming...



A

Phytoplankton Aerosol Cloud ocean Ecosystem (PACE)

 Global change	<ul style="list-style-type: none">• latitudinal distributional shifts• phenology shifts• bloom dynamics
 Biogeochemical modeling	<ul style="list-style-type: none">• phytoplankton community composition• nutrient cycling• export of particles
 Ecological processes	<ul style="list-style-type: none">• rates of primary production• nitrogen fixers, DMS producers, silicifiers, calcifiers• trophic dynamics & food web efficiency
 Ecological indicators	<ul style="list-style-type: none">• hypoxia• eutrophication• informed monitoring and assessment
 Environmental reporting	<ul style="list-style-type: none">• meeting thresholds• species composition• detecting anomalies
 Hazard Monitoring	<ul style="list-style-type: none">• detection and tracking of harmful algal blooms• assessing storm impacts• monitoring oil spill extent and cleanup
 Food Security	<ul style="list-style-type: none">• finding pelagic and benthic habitats for fisheries• locations/monitoring for aquaculture• food safety & toxin production

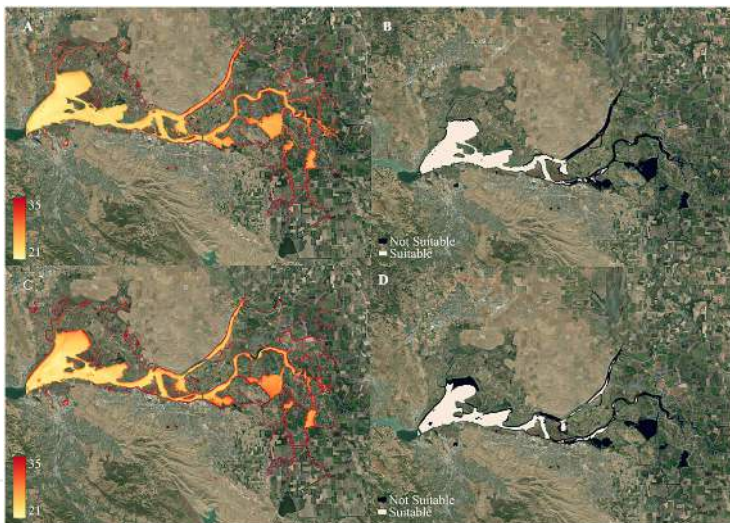
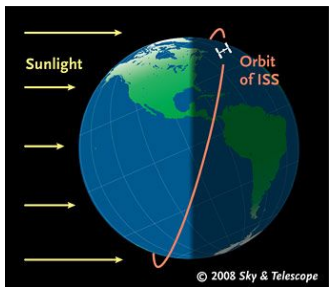


Dierssen et al. 2021. See also Cetinic et al. 2024 RSE

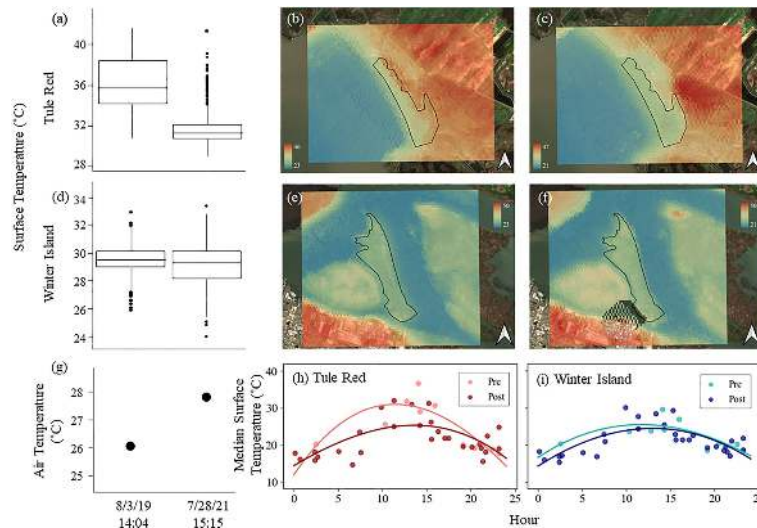
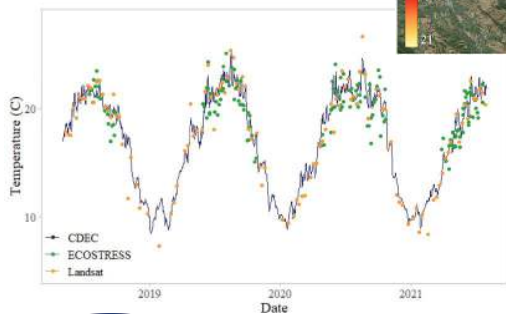


ECOSTRESS Surface Temperature

Modeling diurnal bulk temperature variability, fish habitat thermal suitability and restoration outcomes



Gustine et al. 2021



Gustine et al. 2023



Resources: IOCCG

International Ocean Color Coordinating Committee

Includes training courses, tutorials, free textbooks, practicals and more! Almost a one-stop shop!

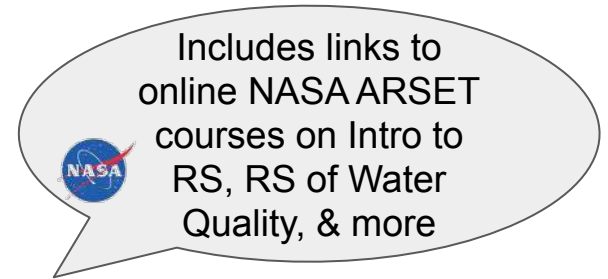
- <https://ioccg.org/what-we-do/training-and-education/>

Working Group Reports & Protocols : plain language summaries of state of science, measurement protocols

- <https://ioccg.org/what-we-do/ioccg-publications/>

Information on missions, sensors contributed by countries and agencies around the world (including NASA)

- <https://ioccg.org/resources/missions-instruments/>



Welcome to the International Ocean Colour Coordinating Group

Promoting development and applications of science and technology that underpin remote sensing of ocean colour across all aquatic environments (in-land, coastal, open ocean), through coordination, training, liaising between providers and users, advocacy, and provision of expert advice.

Resources: NASA Ocean Color DAAC



OCEAN COLOR
OB.DAAC | OBPG

<https://oceancolor.gsfc.nasa.gov/resources/docs/tutorials/>

- Earthdata cloud access
- Working with Jupyter Notebooks
- Match-ups with in situ data
- Machine Learning
- Parallel and larger than memory computing
- Collaboration with Git & GitHub
- **Working with SeaDAS**
- Working with PACE data
- Working with MODIS data
- And more...



krissapuu

Resources: (free) Software

SeaDAS

<https://seadas.gsfc.nasa.gov/>



[ABOUT](#) ▾ [DOCS](#) ▾ [PROCESSING](#) ▾ [DOWNLOADS](#) ▾ [SUPPORT](#) ▾



SEADAS

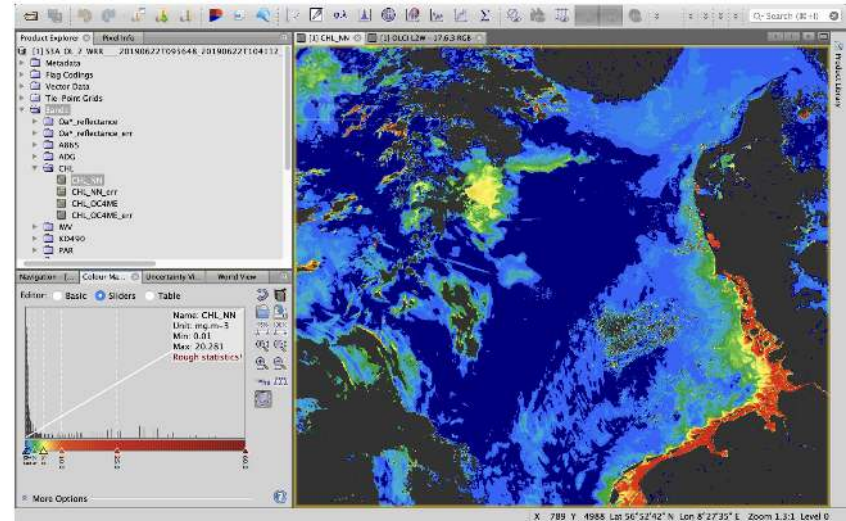
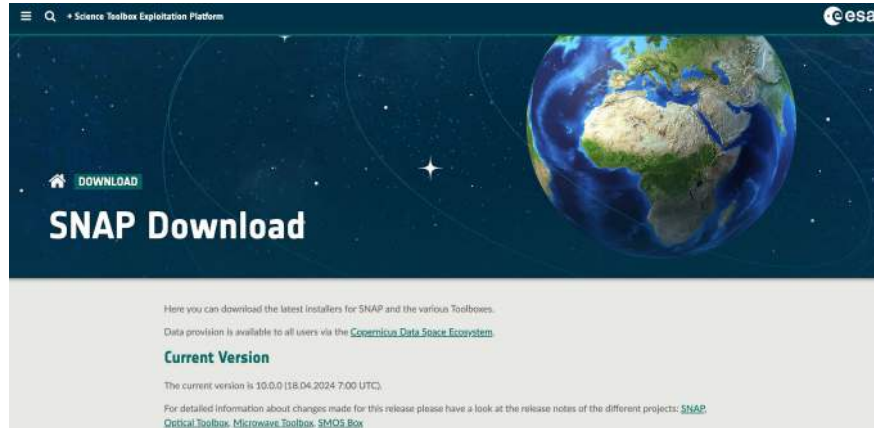
New Release! SeaDAS 9.1.0 has been released. Download it today!

Resources: (free) Software



SNAP: ESA Sentinel Application Platform

<https://step.esa.int/main/download/snap-download/>



Welcome to HyperCoast

↑ Back to top

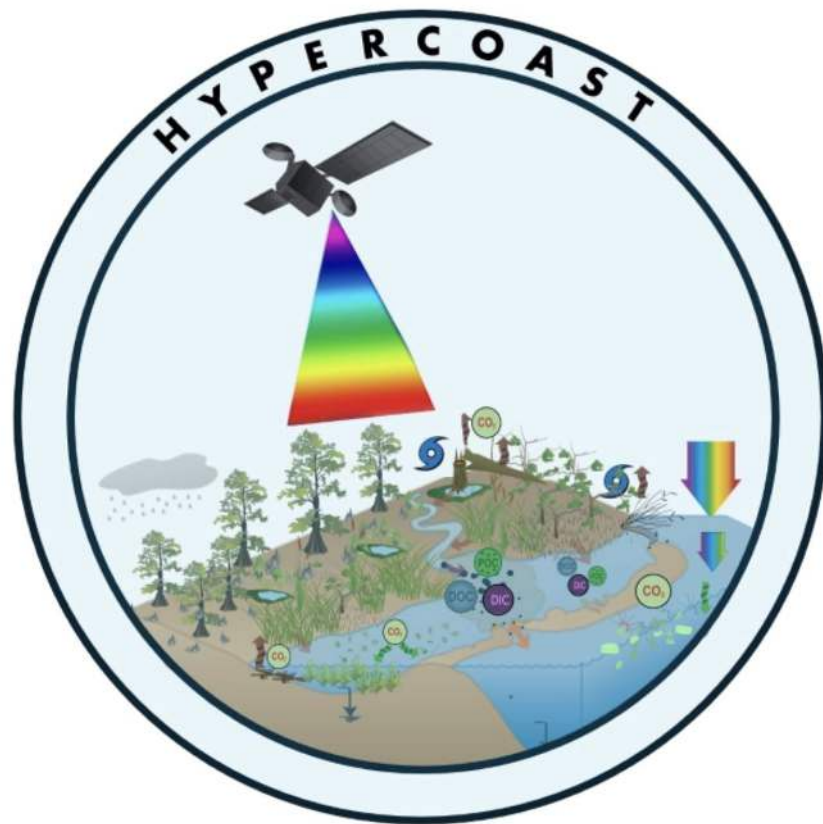
pypi v0.8.2 downloads 31k conda-forge v0.8.2 recipe hypercoast downloads 10k JOSS 10.21105/joss.07025

Resources: (free) Software

Hypercoast: A Python Package for Visualizing and Analyzing Hyperspectral Data in Coastal Environments

hypercoast.org

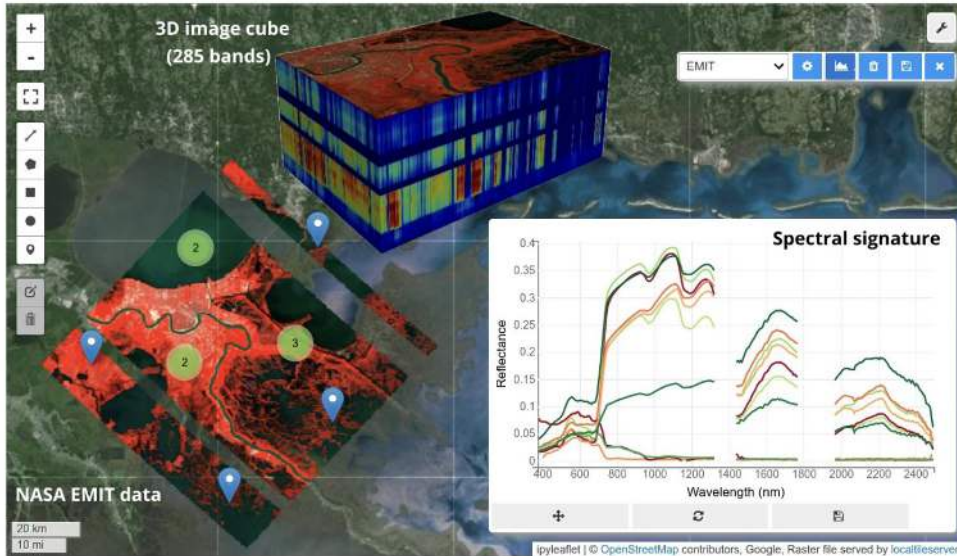
By Bingqing Liu



Hypercoast continued

Lots of examples, including two nice workshop examples online for working with EMIT & PACE data

Visualize the data with HyperCoast.



```
In [ ]: m = hypercoast.Map()
m.add_basemap("HYBRID")
m.add_raster(filepath, colormap="jet", layer_name="LST")
m.add("spectral")
m
```

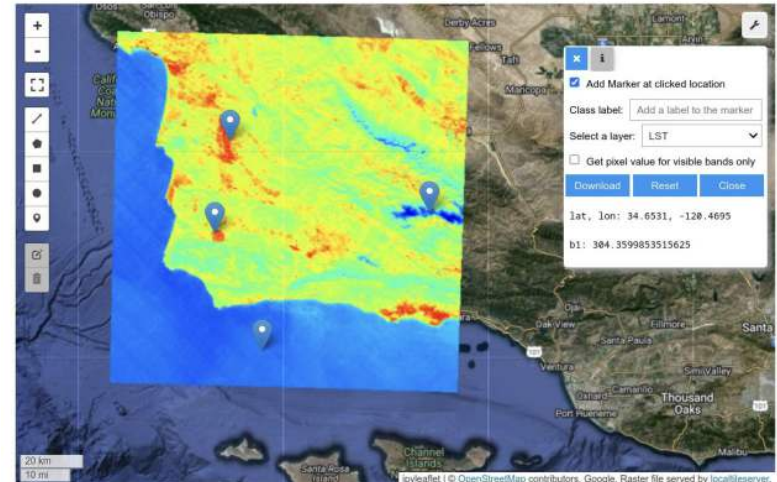
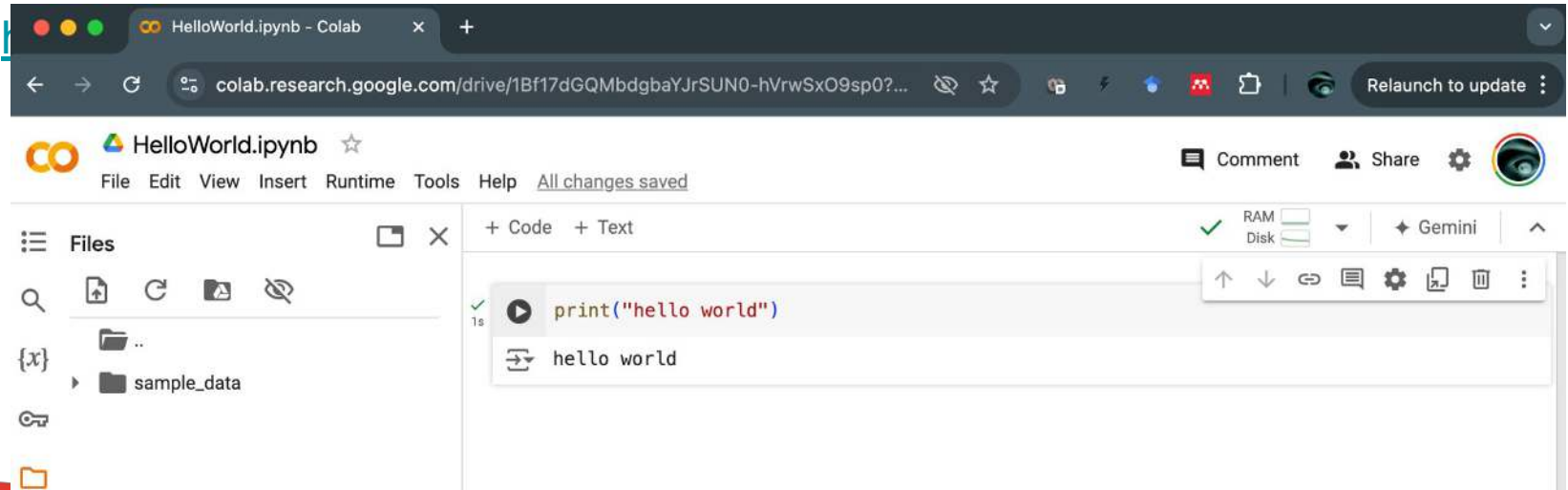


Figure 1. An example of visualizing NASA EMIT hyperspectral data using HyperCoast.

Resources: (free) Cloud Compute

Google Colaboratory: An AWS alternative for when you want to analyze non-BioScape data



The screenshot displays a web browser window with a single tab titled "HelloWorld.ipynb - Colab". The address bar shows the URL "colab.research.google.com/drive/1Bf17dGQMbdgbaYJrSUN0-hVrwSxO9sp0?...". The notebook interface includes a top menu bar with "File", "Edit", "View", "Insert", "Runtime", "Tools", and "Help", along with a status indicator "All changes saved". On the left, a "Files" sidebar shows a folder named "sample_data". The main workspace contains a code cell with the text `print("hello world")` and its output, "hello world". The top right of the workspace shows resource usage for RAM and Disk, and a "Gemini" icon.



BioSCape Special Collection in JGR Biogeosciences



**Deadline to complete:
Friday 11 October**



Google form:
tinyurl.com/manuscriptform

