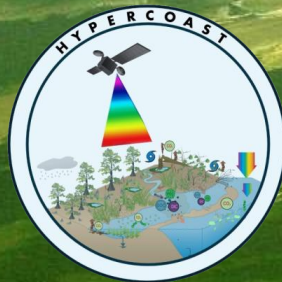
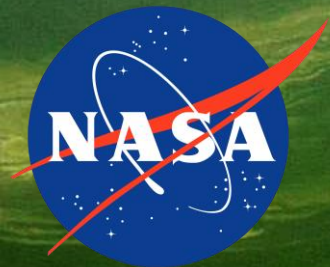


# HyperCoast: Monitoring Coastal Water Quality from PACE-OCI

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University of Louisiana Lafayette  
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<https://bingqingliu.com>



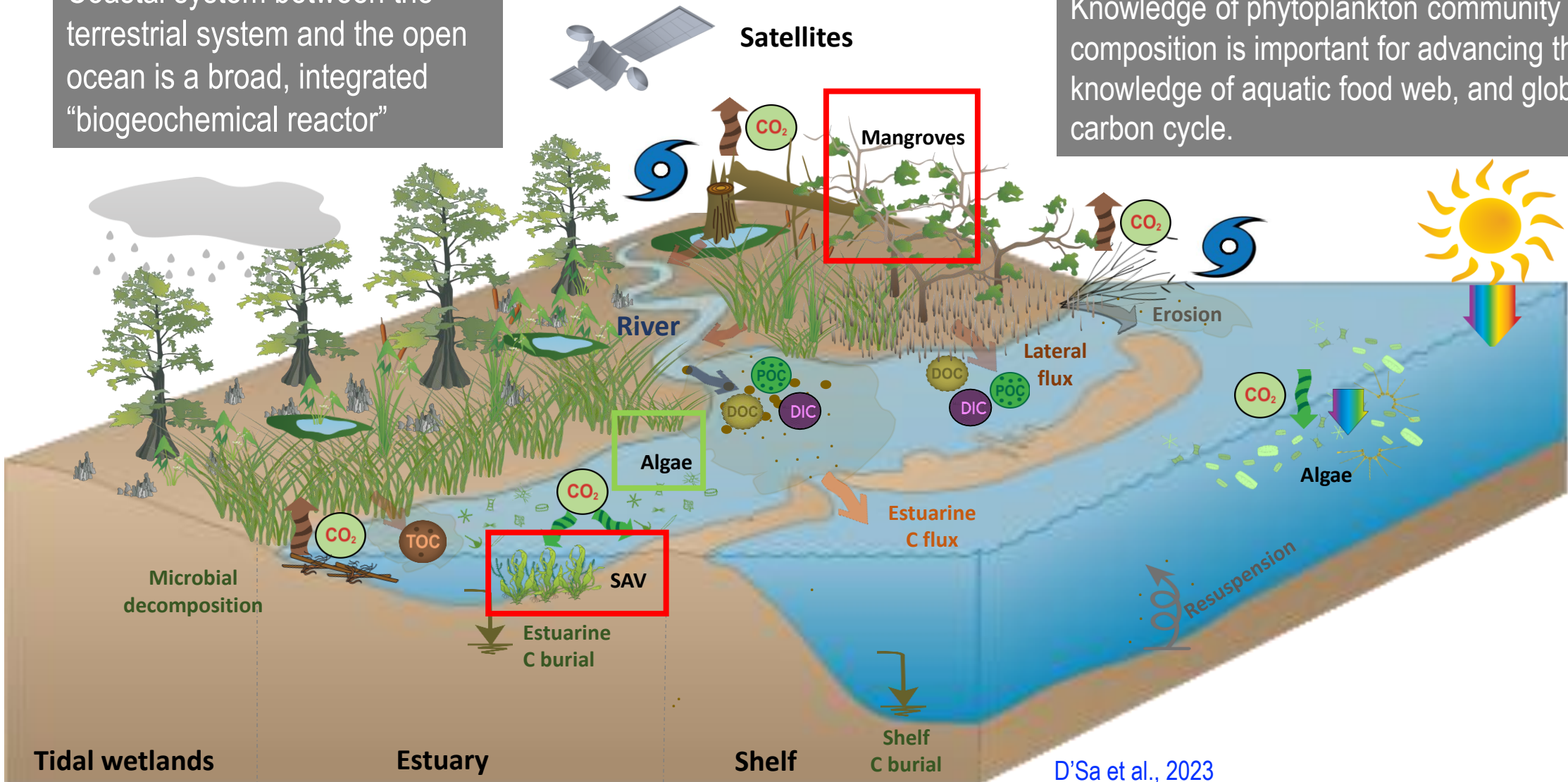
Collaborators: Qiusheng Wu (UTK), Xu Yuan (UD)  
Songyang Zhang (ULL), and Beth Stauffer (ULL)

09/05/2024

# Optically-complex Coastal Waters

Coastal system between the terrestrial system and the open ocean is a broad, integrated "biogeochemical reactor"

Knowledge of phytoplankton community composition is important for advancing the knowledge of aquatic food web, and global carbon cycle.



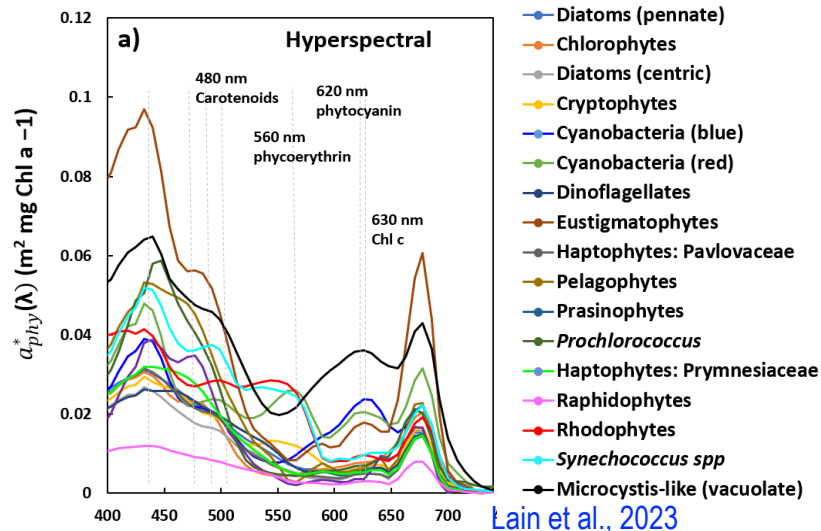
[D'Sa et al., 2023](#)

# Phytoplankton in Earth's Carbon Cycle

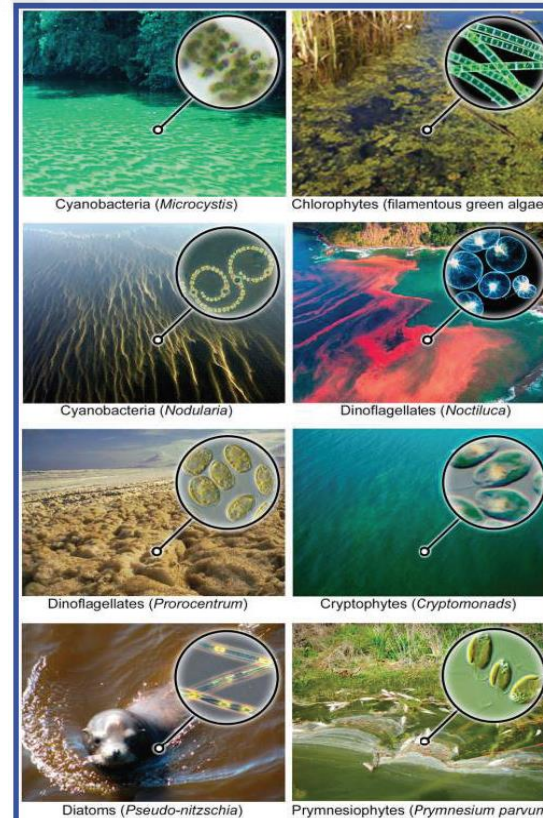
Phytoplankton is an extremely **DIVERSE** set of microorganisms!

- Cell morphologies
- Biogeochemical functions
- Physiological response to climate-related factors

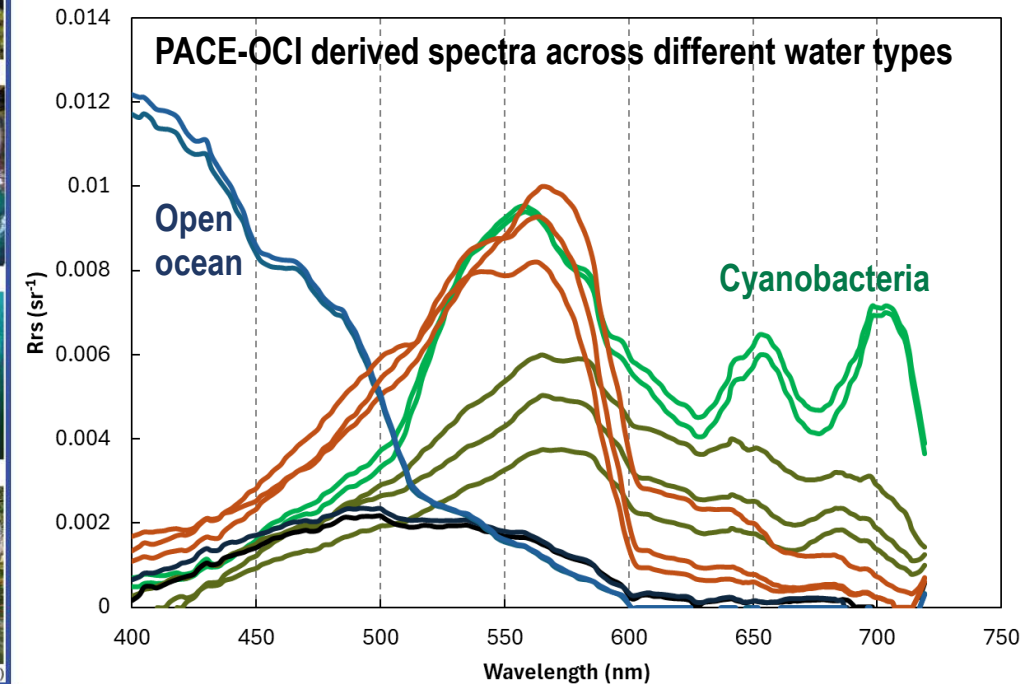
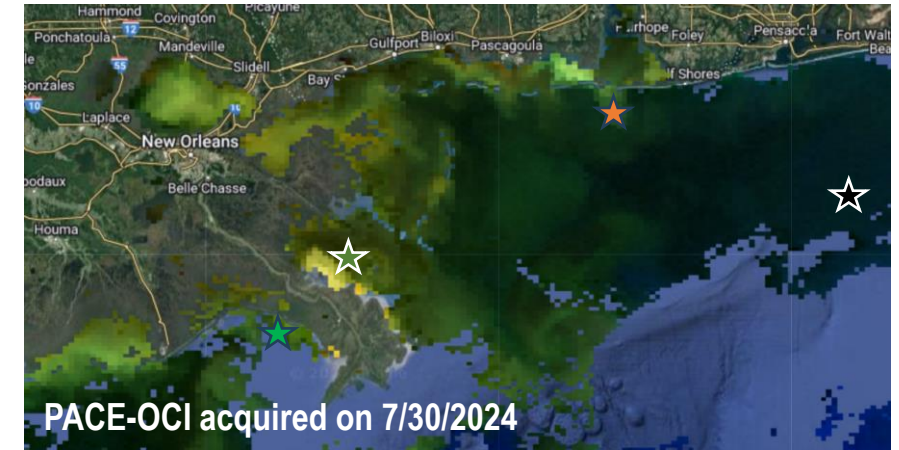
**Optical proxies:** phytoplankton contain diverse pigment in their cells, which absorb light differently...



Credit: Ocean Color Web Book

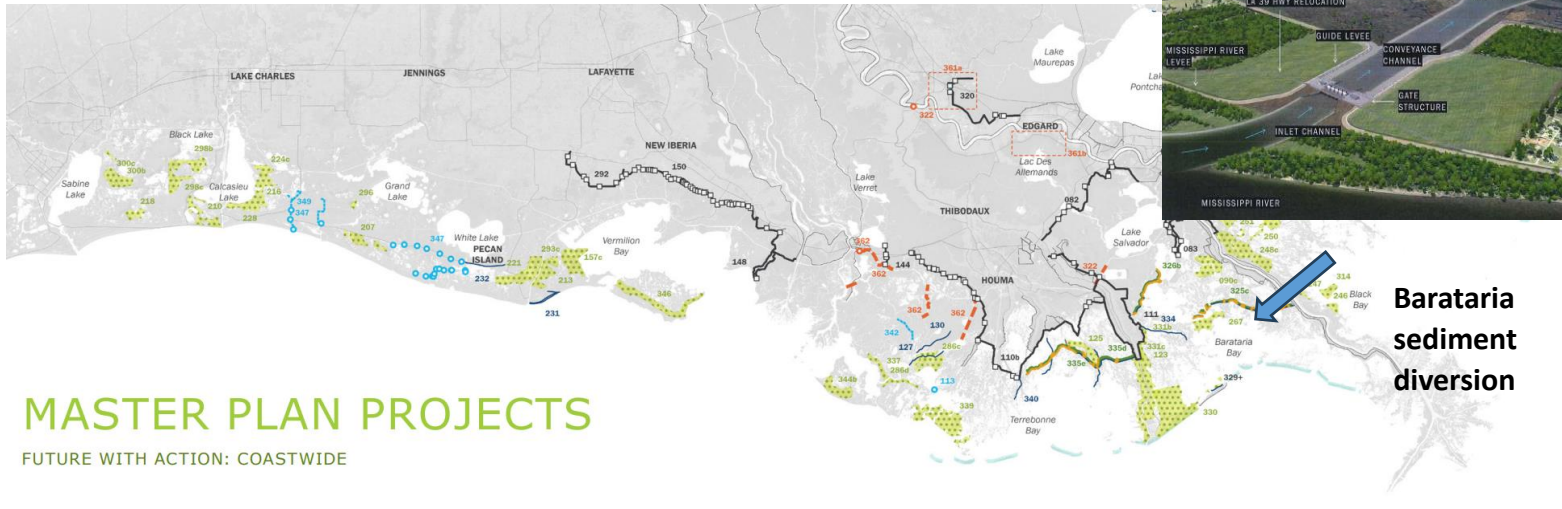


Credit: Paerl et al., 2019



# A Working Coast Facing Climate Change

Warming climate, and coastal restoration actions in Louisiana, such as existing freshwater and proposed sediment diversions in various Louisiana estuaries, exerts significant influence on phytoplankton biomass and taxa, producing episodic HAB events.



## MASTER PLAN PROJECTS

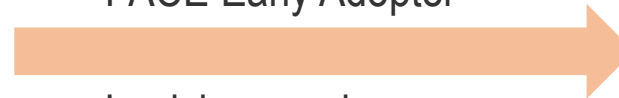
FUTURE WITH ACTION: COASTWIDE

FUTURE WITHOUT ACTION | HIGHER SCENARIO | YEAR 50

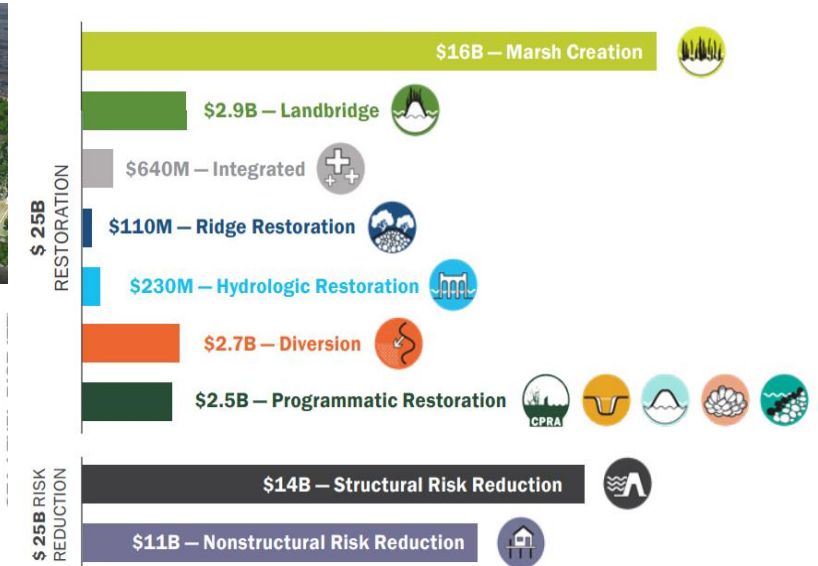
Credit: [CPRA](#)

It is increasingly needed to enhance **monitoring techniques** and advance **forecast capabilities** to provide valuable insights for **natural resource management** and **restoration practices**, particularly in the context of climate change.

PACE Early Adopter

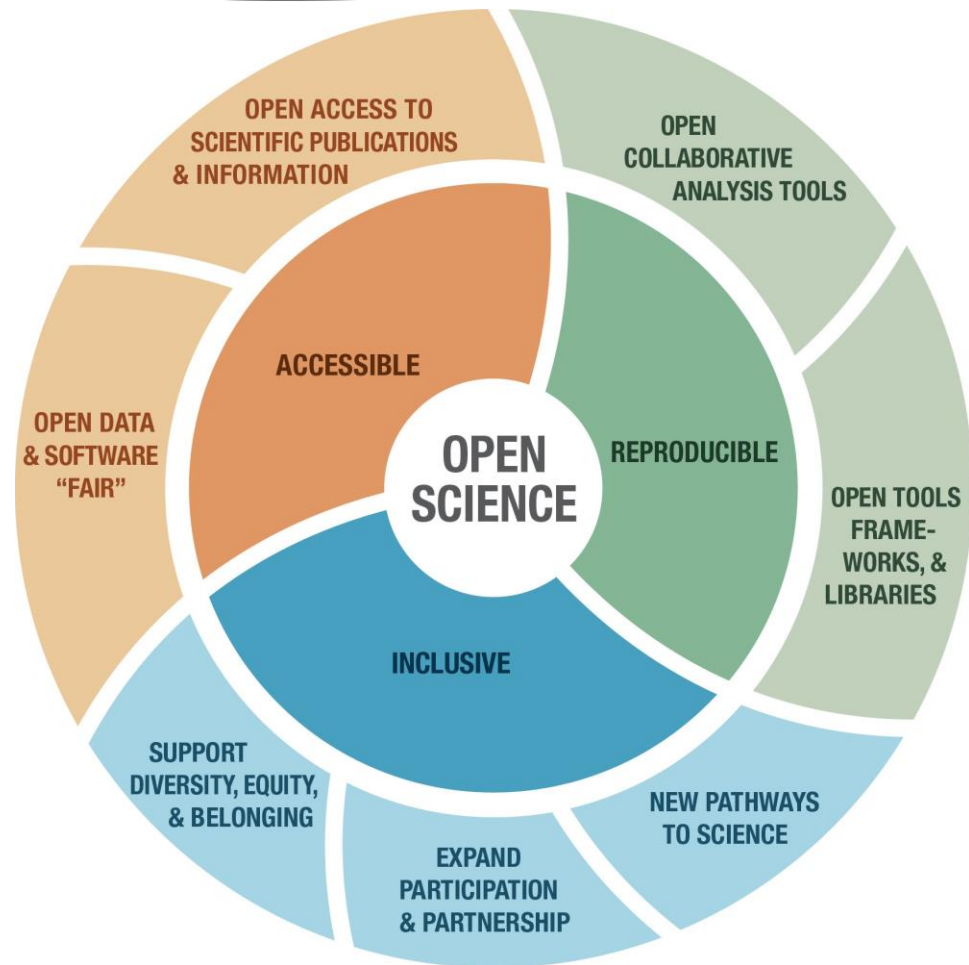


Louisiana end users



Logos for the Coastal Protection and Restoration Authority (CPRA), Barataria-Terrebonne National Estuary Program (BTNEP), Louisiana Department of Wildlife & Fisheries, Louisiana Department of Environmental Quality (DEQ), and Pontchartrain Conservancy.

# HyperCoast and Open Science



- HyperCoast is a Python package designed to provide tools for **visualizing** and **analyzing** hyperspectral data for coastal ecosystem studies.
- HyperCoast was published on 04/19/24!  
<https://hypercoast.org/>

HyperCoast

Welcome to HyperCoast

Table of contents

- Introduction
- Citations
- Features
- Demos
- Acknowledgement
- License

Open science is defined as “a collaborative culture enabled by technology that empowers the open sharing of data, information, and knowledge within the scientific community and the wider public to accelerate scientific research and understanding (<https://doi.org/10.1029/2020EA001562>).

# HyperCoast for Processing PACE Data

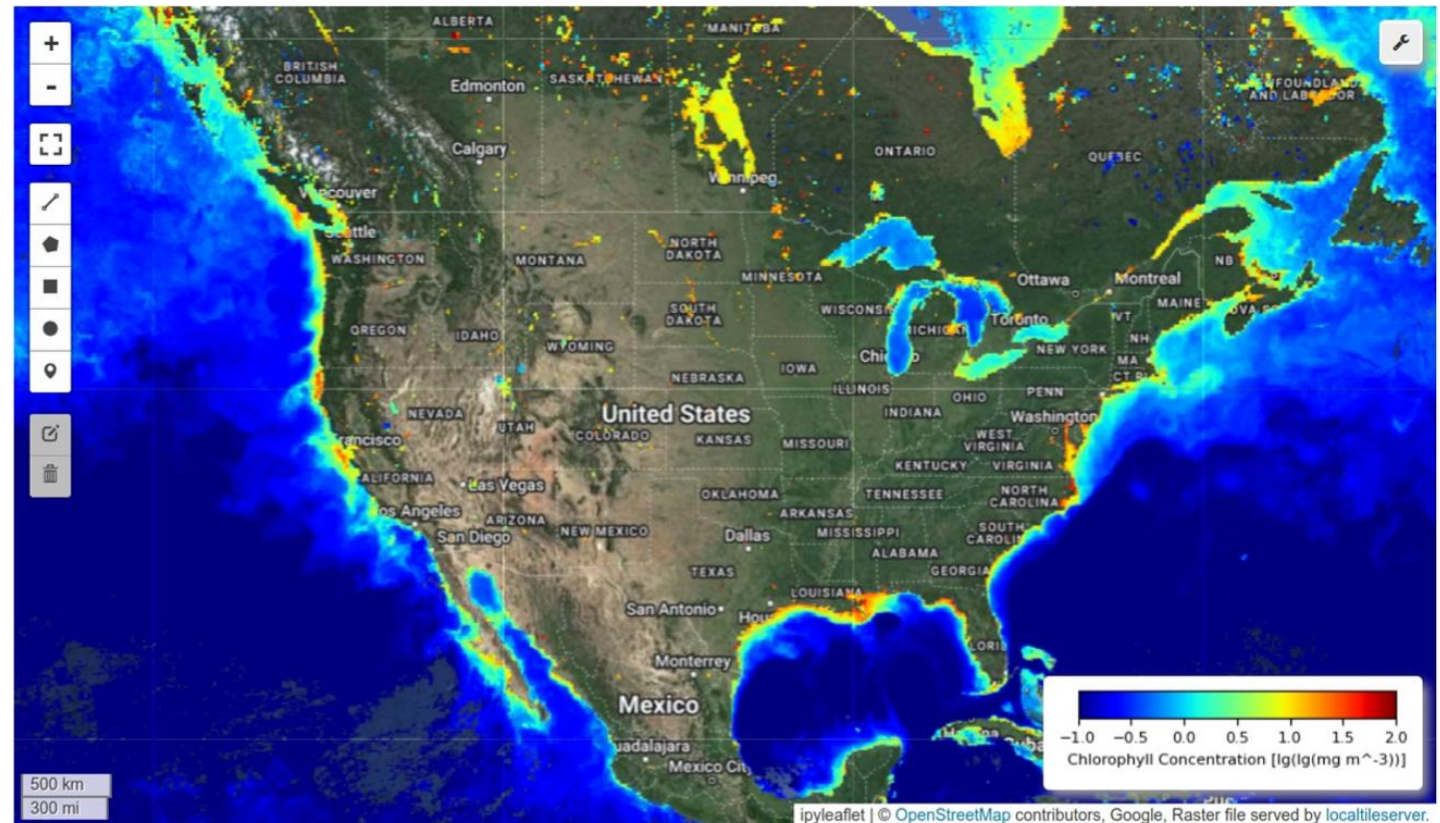
HyperCoast supports the processing of PACE-OCI hyperspectral data as well as other existing spaceborne and airborne missions (e.g., EMIT, AVIRIS, NEON, and DESIS) and upcoming hyperspectral missions, such as SBG and GLIMR.

## Data Visualization Tools:

- **Data Search Tools:** Integrates with NASA's earthaccess package to facilitate interactive searching and downloading of NASA's PACE data
- **Interactive Exploration:** Allows users to interactively explore PACE-OCI level 1, 2 and 3 datasets.
- **Spectral Signature Extraction:** Enables the extraction of specific spectral signatures.
- **Customization Options:** Provides the ability to change band combinations and colormaps.

## Upcoming Analysis Tools:

- Phytoplankton-related toolbox



# HyperCoast Demo: Search and Download

## Working with PACE-OCI data in HyperCoast:

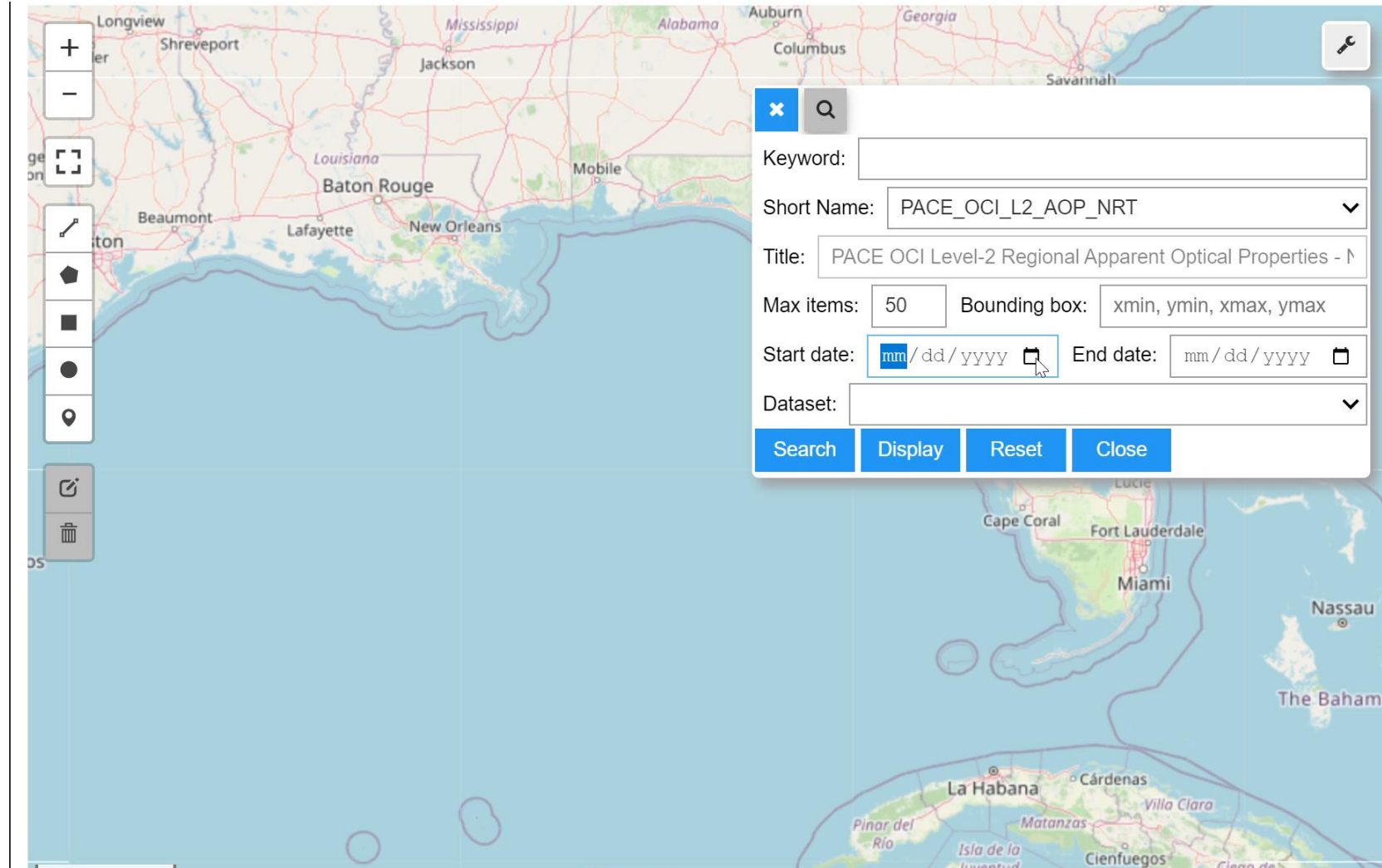
- Install hypercoast
- Use Google Colab

`hypercoast.search_pace`

`hypercoast.download_pace`

API reference for PACE:

<https://hypercoast.org/pace/>



# HyperCoast Demo: Data Loading and Static Visualization

Load the PACE-OCI dataset as a 'xarray.Dataset':

```
hypercoast.read_pace_aop
```

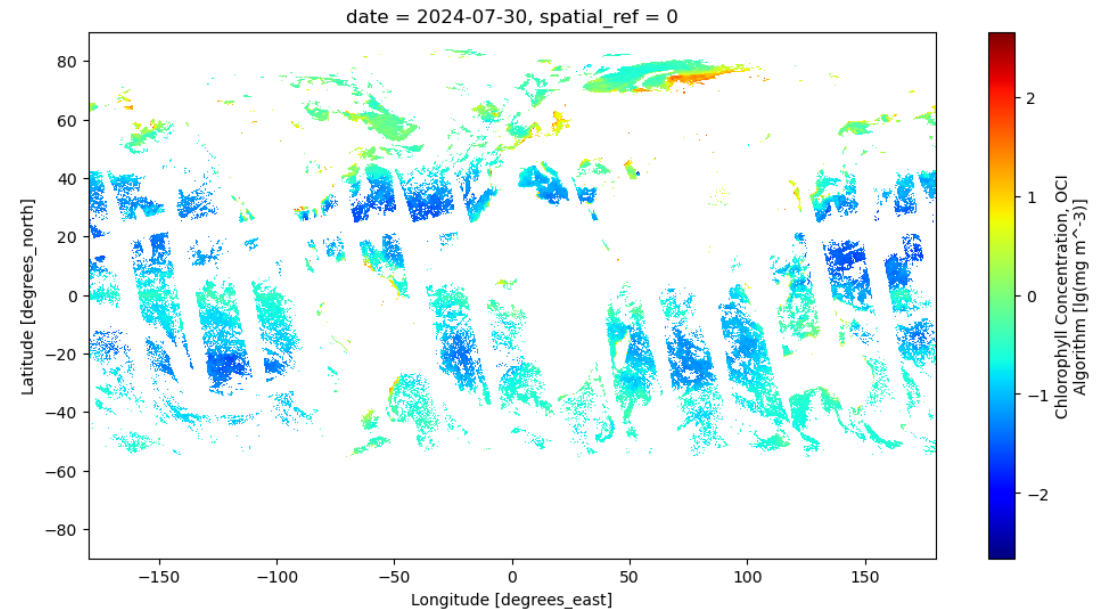
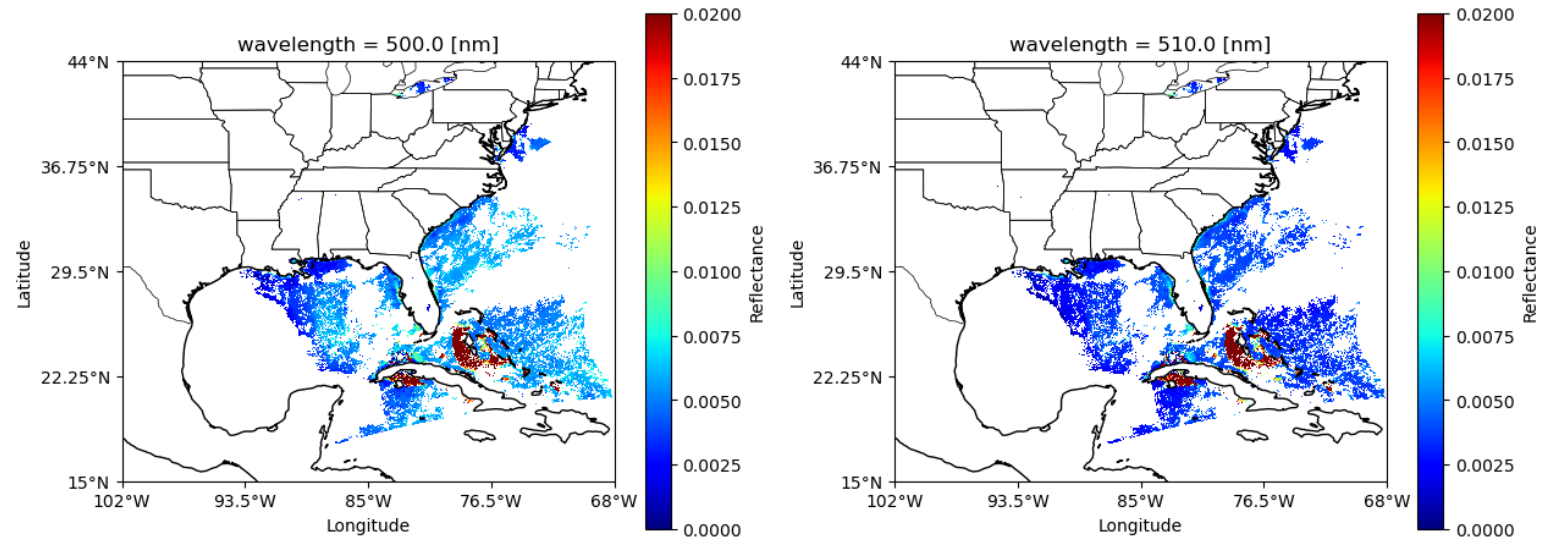
```
hypercoast.read_pace_bgc
```

```
hypercoast.read_pace_chla
```

Extract PACE-OCI pixel info and produce static visualization:

```
hypercoast.extract_pace
```

```
hypercoast.viz_pace
```



# HyperCoast Demo: Swath Data & Gridded Data

Convert Level 2 swath data to gridded data:

```
hypercoast.view_pace_pixel_locations
```

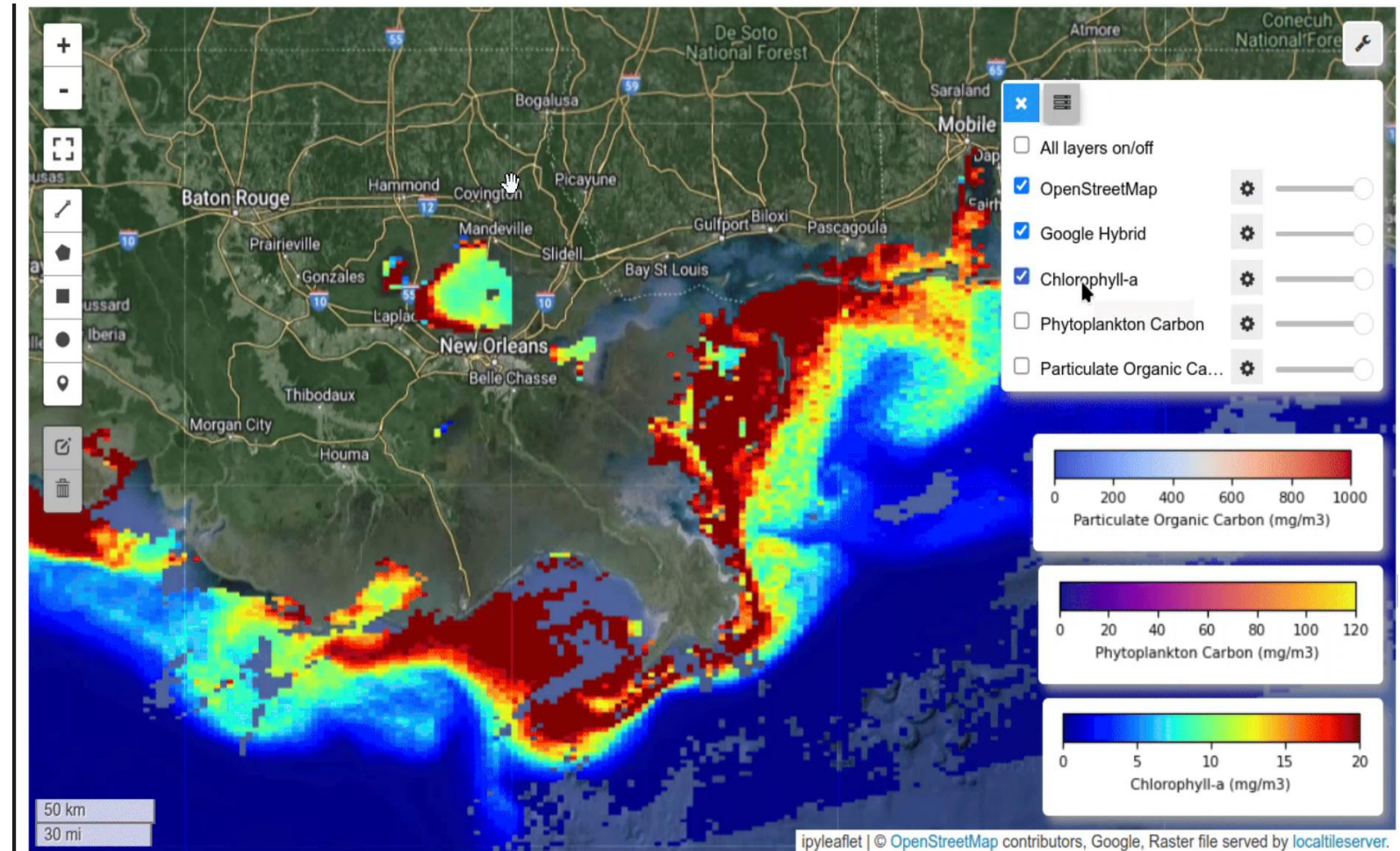
Scatter plot of the pixel locations to visualize the irregular spacing.

```
hypercoast.grid_pace
```

Converting to gridded data is useful for interactive visualization.

```
hypercoast.pace_chla_to_image
```

Level 3 .nc to image so that it can be displayed on interactive map

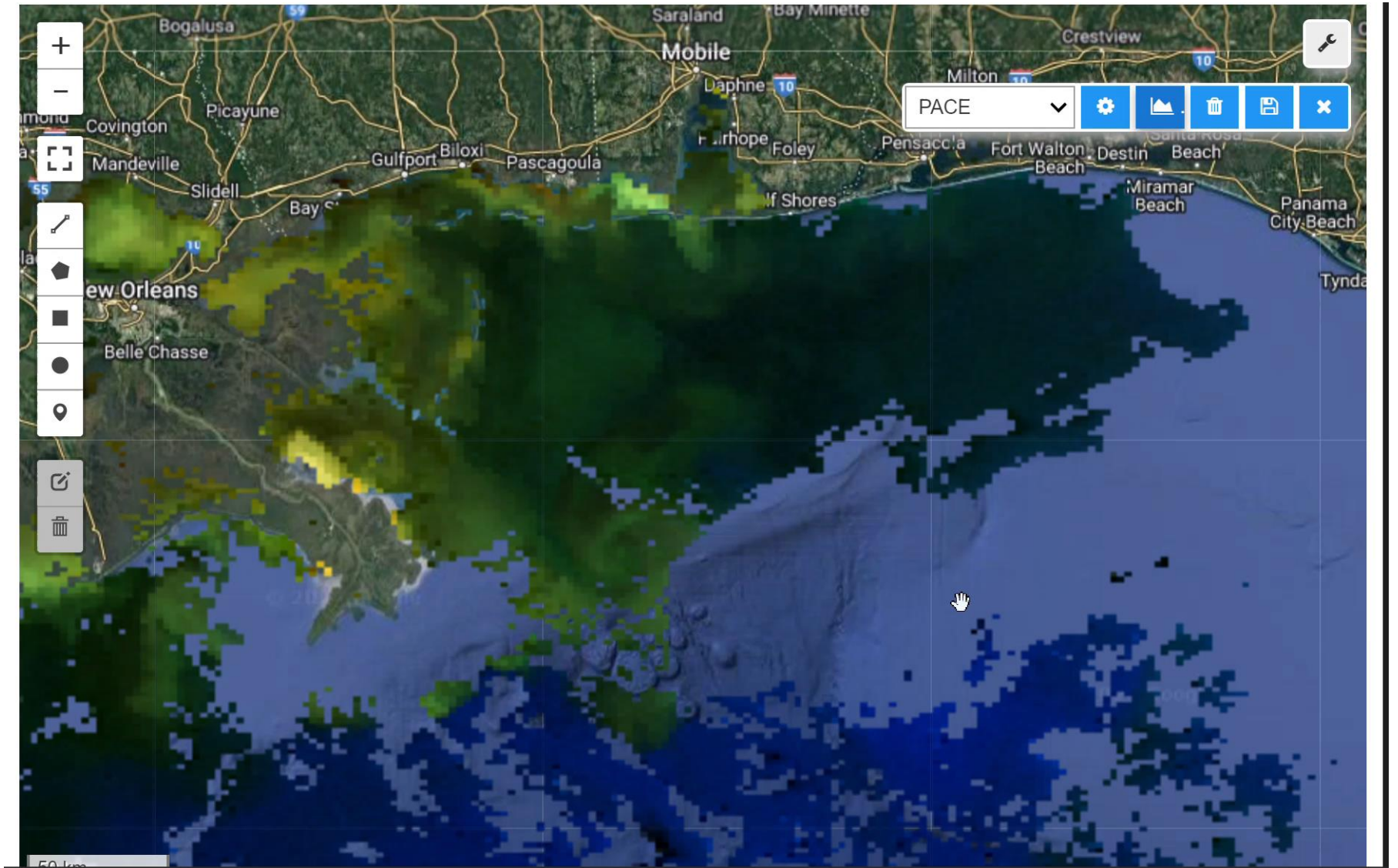


# HyperCoast Demo: Interactive Visualization

`hypercoast.Map`

`m.add_pace`

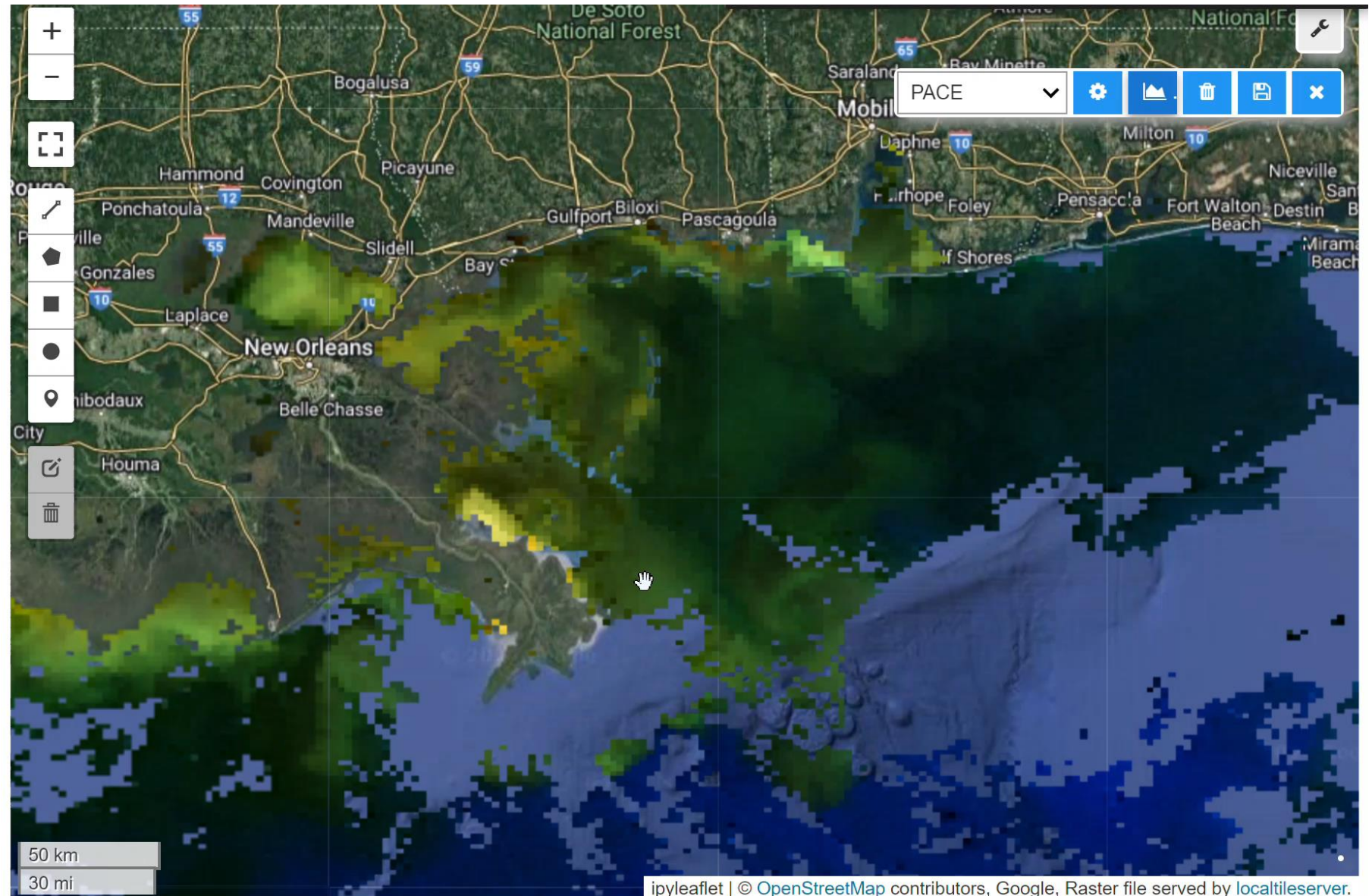
**Customization Options:**  
Allows changing band combinations and colormaps.



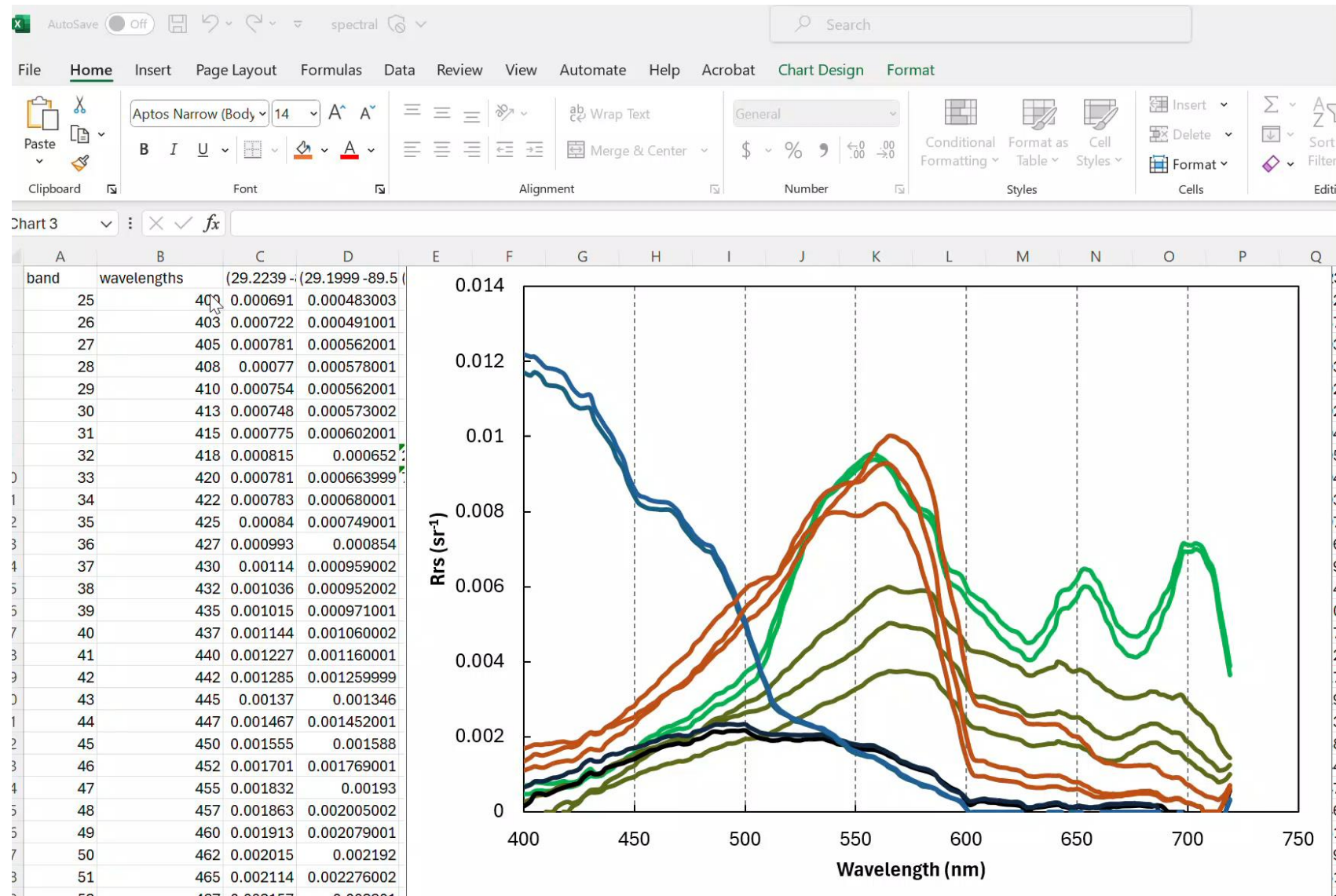
# HyperCoast Demo: Spectral Signature Extraction

**Spectral Signature Extraction:** Enables the extraction and export of spectral signatures.

```
m.add("spectral")
```



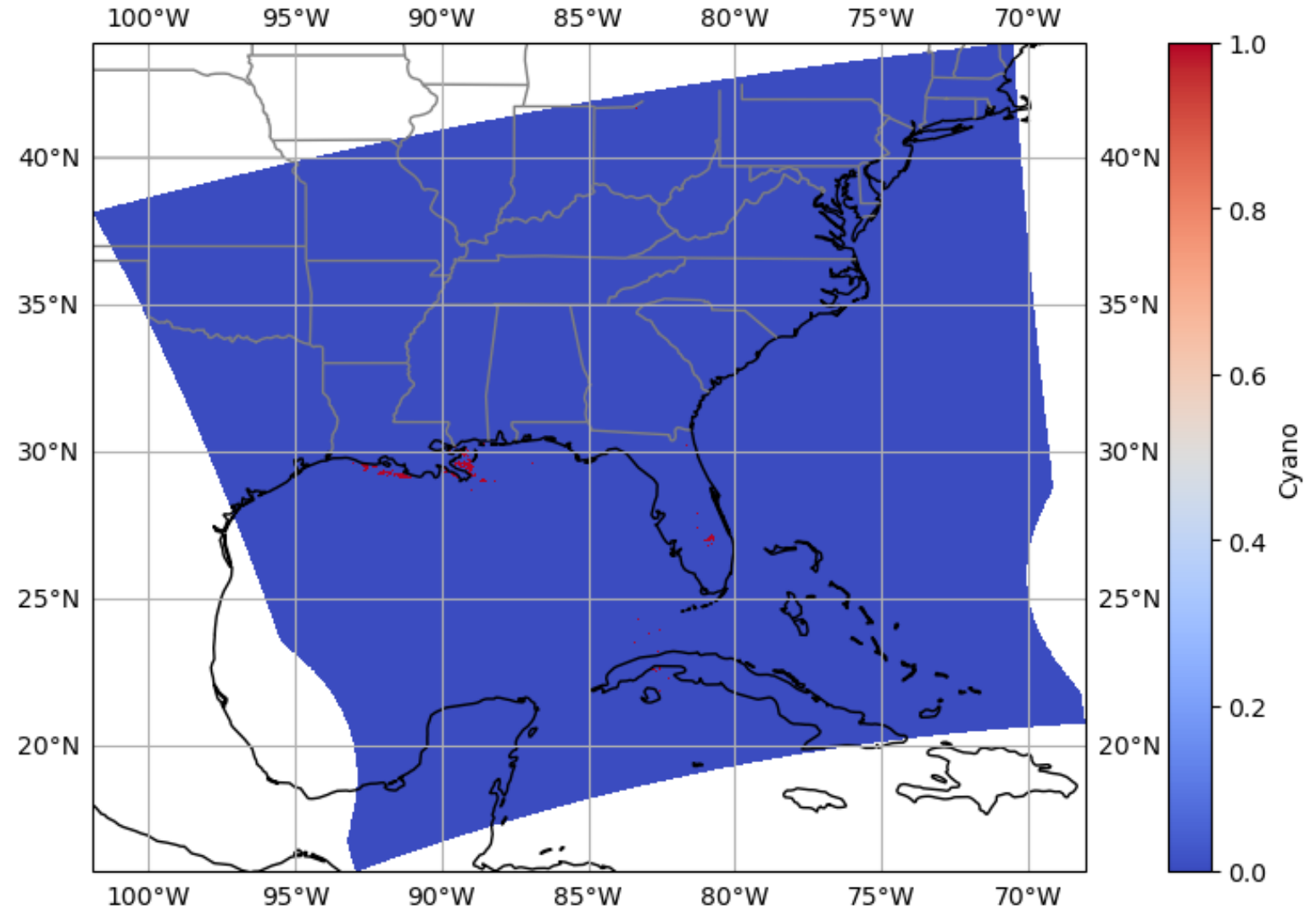
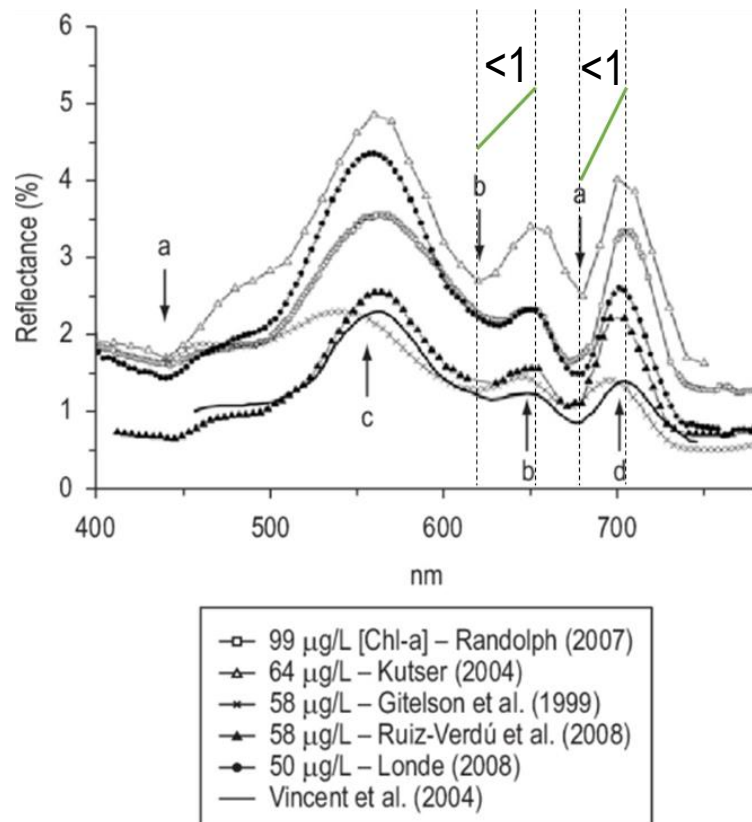
# HyperCoast Demo: Spectral Signature Extraction



# HyperCoast Demo: CyanoHAB Analysis Tools

Spectral curves presented common cyanobacteria features:

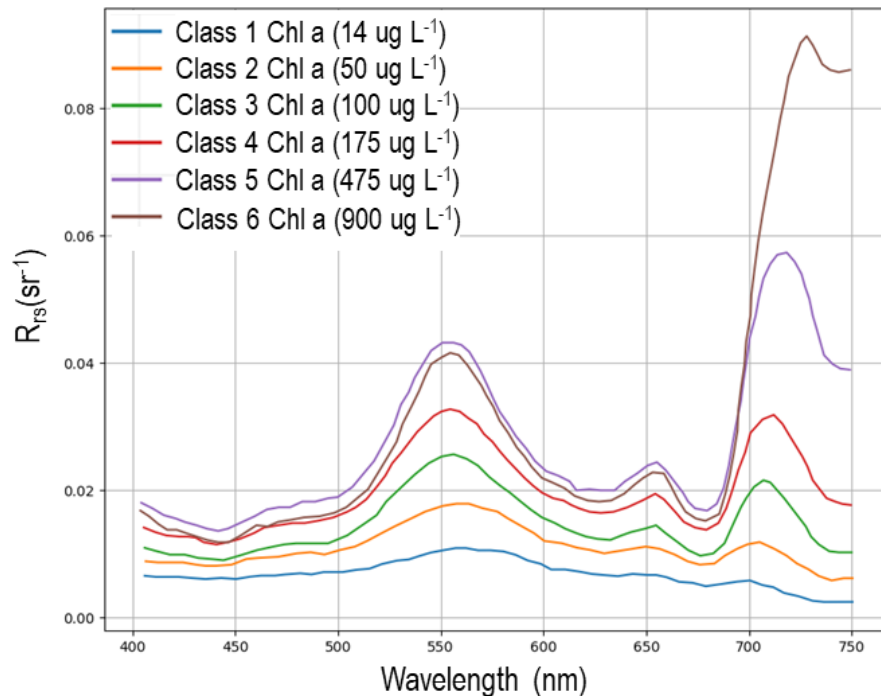
- Chl-a absorption at 440 and 675 nm;
- Phycocyanin absorption at 620 nm and fluorescence at 650 nm;
- Near-infrared scattering



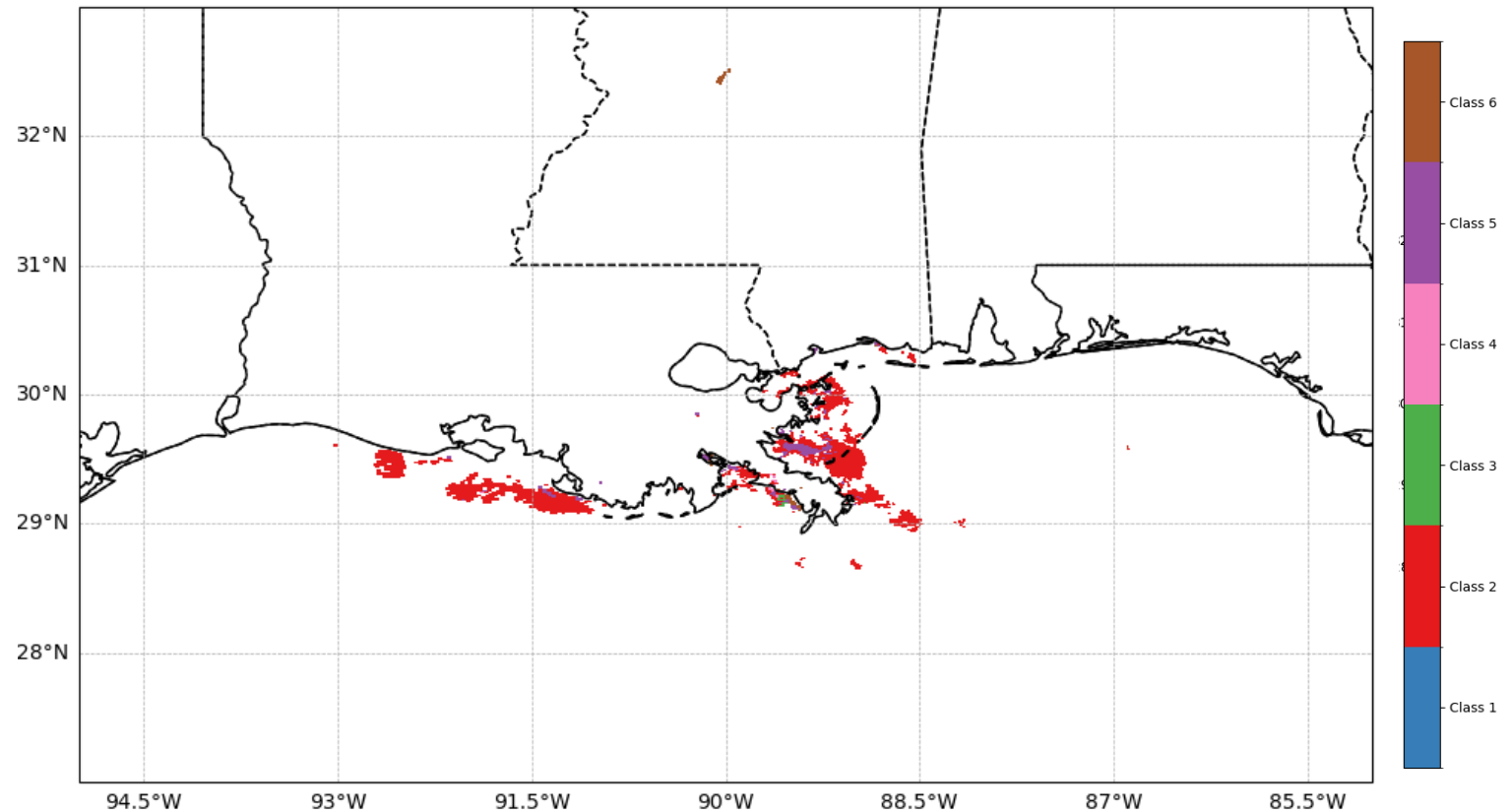
# HyperCoast Demo: Spectral Angle Mapper (SAM)

The Spectral Angle Mapper (SAM) determines the spectral similarity between two spectra by computing the angle between them.

## Spectral libraries:



Londe (2008) reported spectra of *Microcystis* and *Anabaena* bloom waters, at Chl a concentrations varying from 5 to 1,000  $\mu g L^{-1}$ .

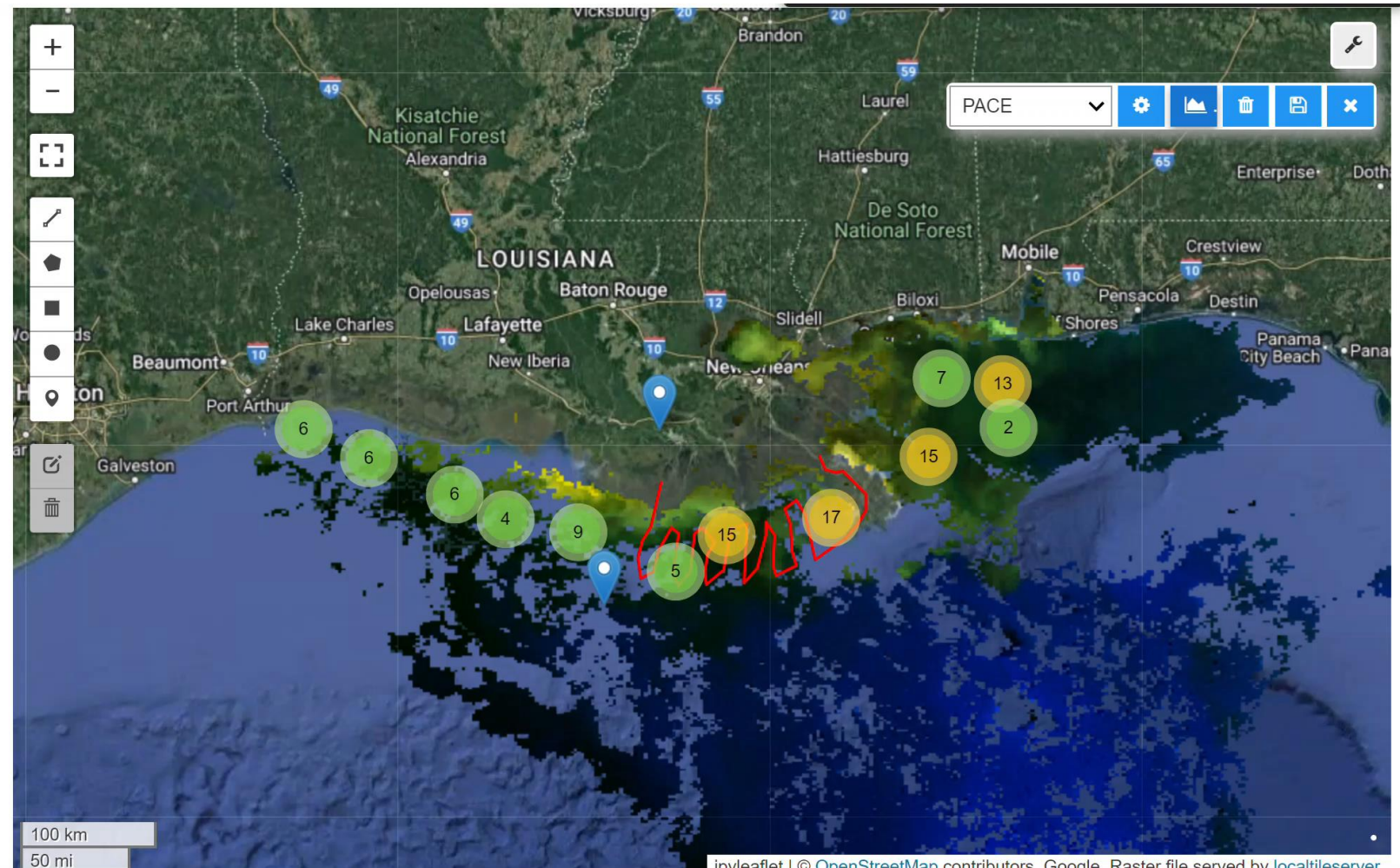


Note: As with all supervised algorithms, SAM accuracy is highly sensitive to the choice of reference spectra.

# HyperCoast Demo: Visualize Sampling Locations

Field observations are crucial for PACE algorithm development and validation. HyperCoast includes tools that easily compare field observations with PACE-OCI data, simplifying the validation process.

```
m.add_pace  
m.add_kml  
m.add_points_from_xy  
m.add_field_data
```



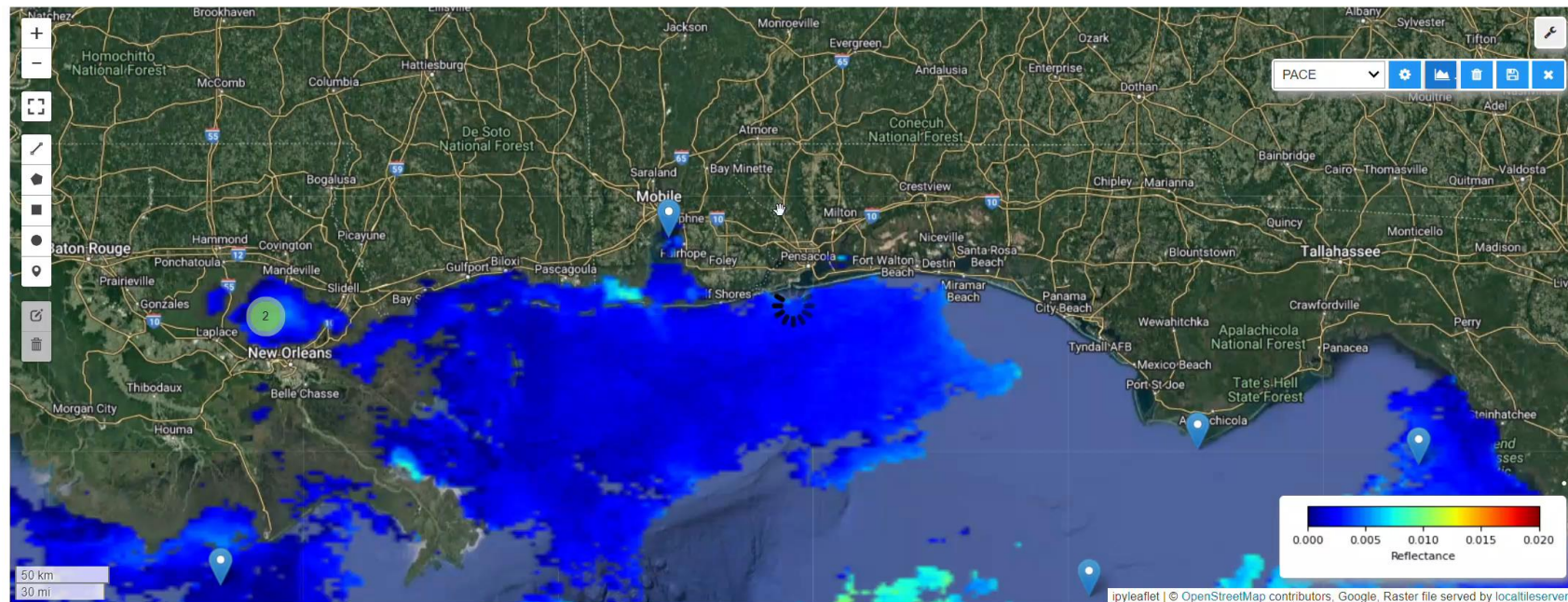
# HyperCoast Demo: Visualize in-situ Data

Field observations are crucial for PACE algorithm development and validation. HyperCoast includes tools that easily compare field observations with PACE-OCI data, simplifying the validation process.

Sampling sites

```
m.add_pace
m.add_kml
m.add_points_from_xy
m.add_field_data
```

band	wavelength	(30.1926 -90.1318)	(30.1594 -90.2856)	(29.3295 -92.3071)	(28.8783 -90.4559)	(30.5481 -87.9840)	(29.5305 -85.0671)	
0	0	339.0	NaN	NaN	0.000100	NaN	NaN	NaN
1	1	341.0	NaN	NaN	NaN	NaN	NaN	NaN
2	2	344.0	NaN	NaN	0.001816	NaN	NaN	NaN
3	3	346.0	0.000346	NaN	0.002393	NaN	NaN	NaN



# HyperCoast Live Demo

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HyperCoast GitHub Repository:

<https://github.com/opengeos/HyperCoast>

PACE Notebook: <https://hypercoast.org/workshops/pace/>

# Acknowledgement

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- The HyperCoast development draws inspiration from [Ocean Color Tutorials](#) and [NASA PACE Hackweek repository](#).
- The team acknowledges the funding support from the NASA PACE Science Team through grant no. 80NSSC24K1415.
- We thank the NASA PACE Early Adopter Program
- We also thank Dr. Nima Pahlevan for graciously sharing data with us to make this work possible.



# Thank you!

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 <https://bingqingliu.com>

