

Monitoring and forecasting of *Sargassum* Inundation Events (SIEs)



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Sargassum Monitoring Program Objectives



Sargassum influx monitoring

- Assessment of magnitude, spatial, and temporal variability of *Sargassum* Inundation Events (SIE) at basin and reef/key scales in La Parguera Marine Reserve (LPMR)



Biogeochemical Impacts

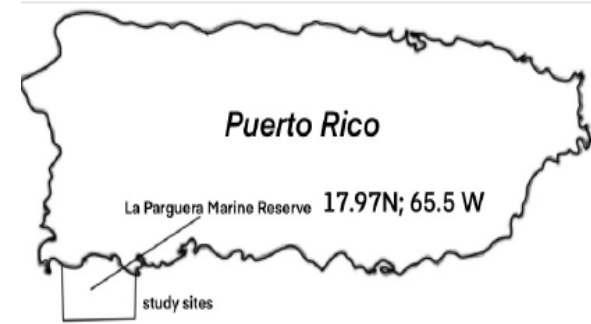
- Assessment of spatial and temporal variability of biogeochemical impacts on reefs and mangrove keys





Forecasting Tools

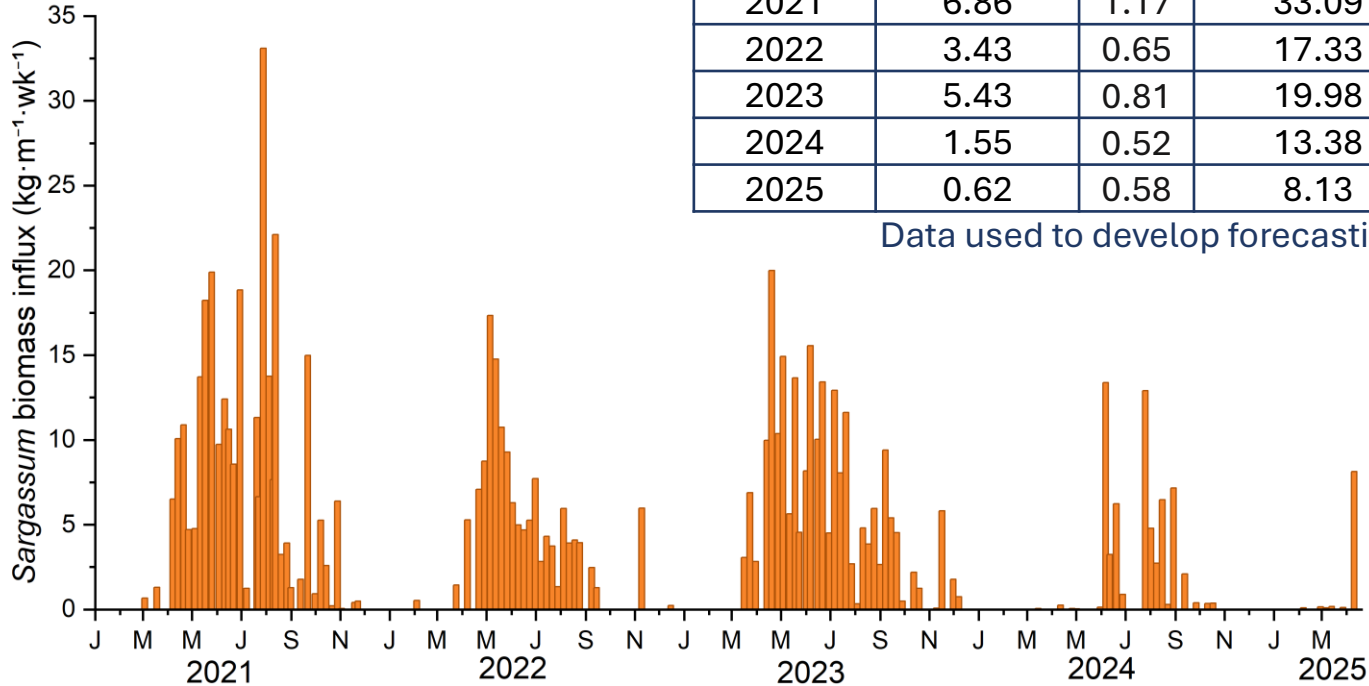
- Development and validation of inundation forecast tools
- Support for marine operations, tourism/recreation, coastal infrastructure, and ecosystem management

Study site: La Parguera Marine Reserve (LPMR)



-  = *Sargassum* biomass traps
-  = biogeochemical samples

Sargassum biomass influx kg per meter of shoreline per week

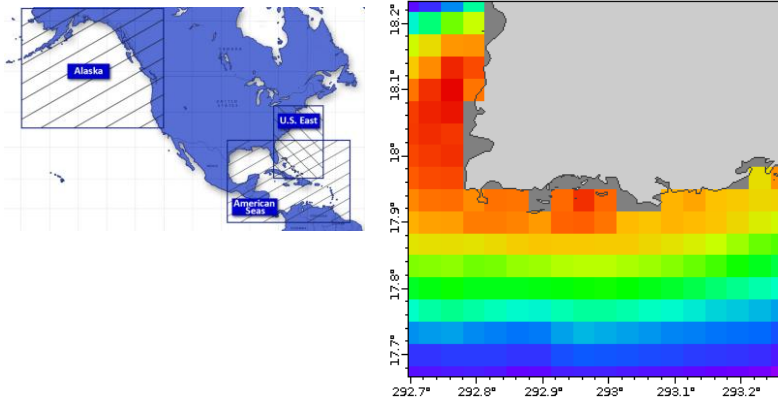


| Year | Mean (kg·m ⁻¹ ·wk ⁻¹) | SE | Maximum (kg·m ⁻¹ ·wk ⁻¹) | Minimum (kg·m ⁻¹ ·wk ⁻¹) |
|------|--|------|---|---|
| 2021 | 6.86 | 1.17 | 33.09 | 0 |
| 2022 | 3.43 | 0.65 | 17.33 | 0 |
| 2023 | 5.43 | 0.81 | 19.98 | 0 |
| 2024 | 1.55 | 0.52 | 13.38 | 0 |
| 2025 | 0.62 | 0.58 | 8.13 | 0 |

Data used to develop forecasting products and validation



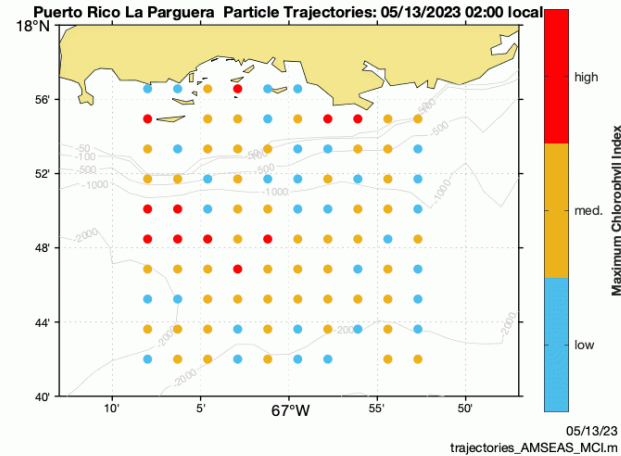
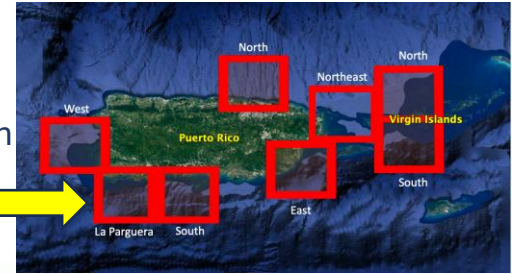
Evolution of Sargassum Forecasting Products – Version 1.0



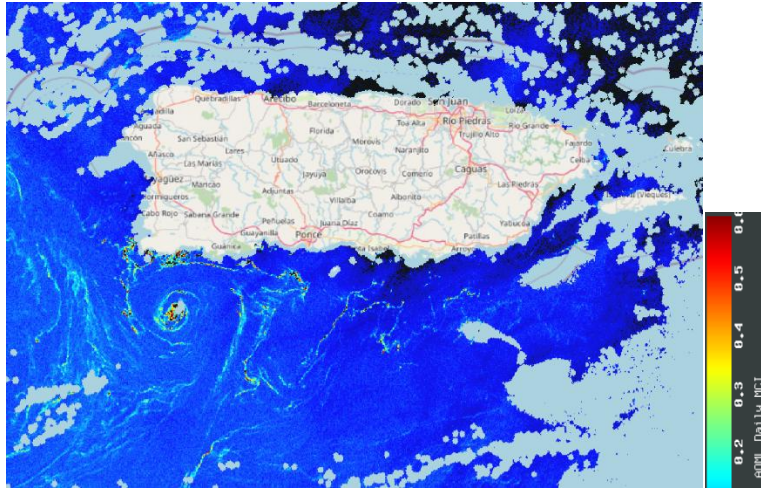
AmSeas

- ✓ regional versions of the Navy Coastal Ocean Model (NCOM) for American Seas.
- ✓ Data-assimilation applied
- ✓ Resolution: $1/30^\circ$ (~ 3.7 km)

1.6 km image resolution

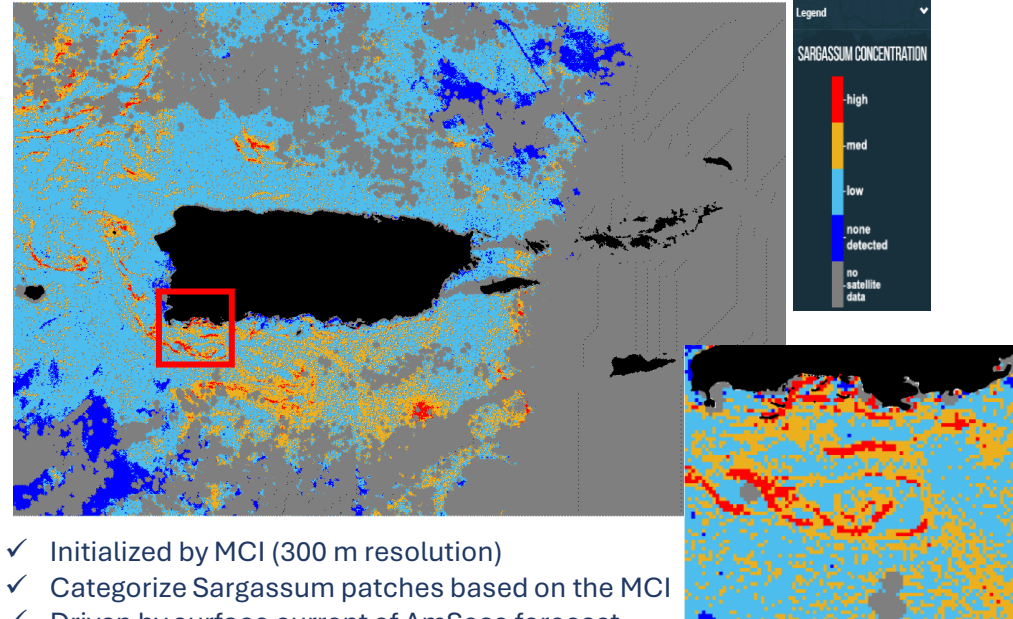


Sargassum Forecasting Products – Version 2.0



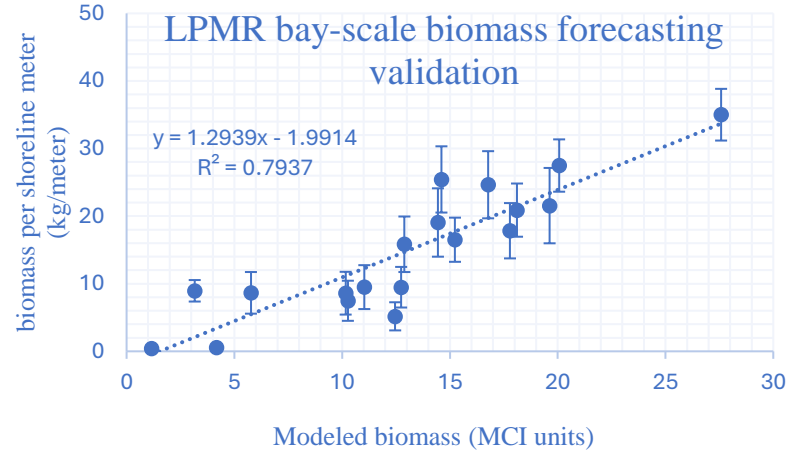
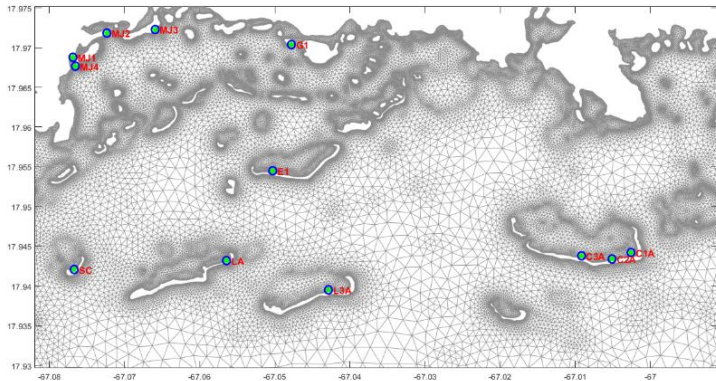
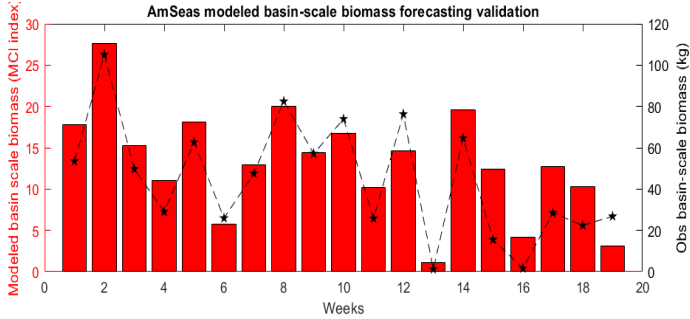
Sargassum observation: MCI (Maximum chlorophyll index)

- ✓ Available every other day
- ✓ Represent the distribution of Sargassum mats and its density
- ✓ The resolution is 300 m
- ✓ Gaps caused by the cloud cover



- ✓ Initialized by MCI (300 m resolution)
- ✓ Categorize Sargassum patches based on the MCI
- ✓ Driven by surface current of AmSeas forecast
- ✓ Operational on <https://www.caricoos.org/sargassum>
- ✓ Downsides

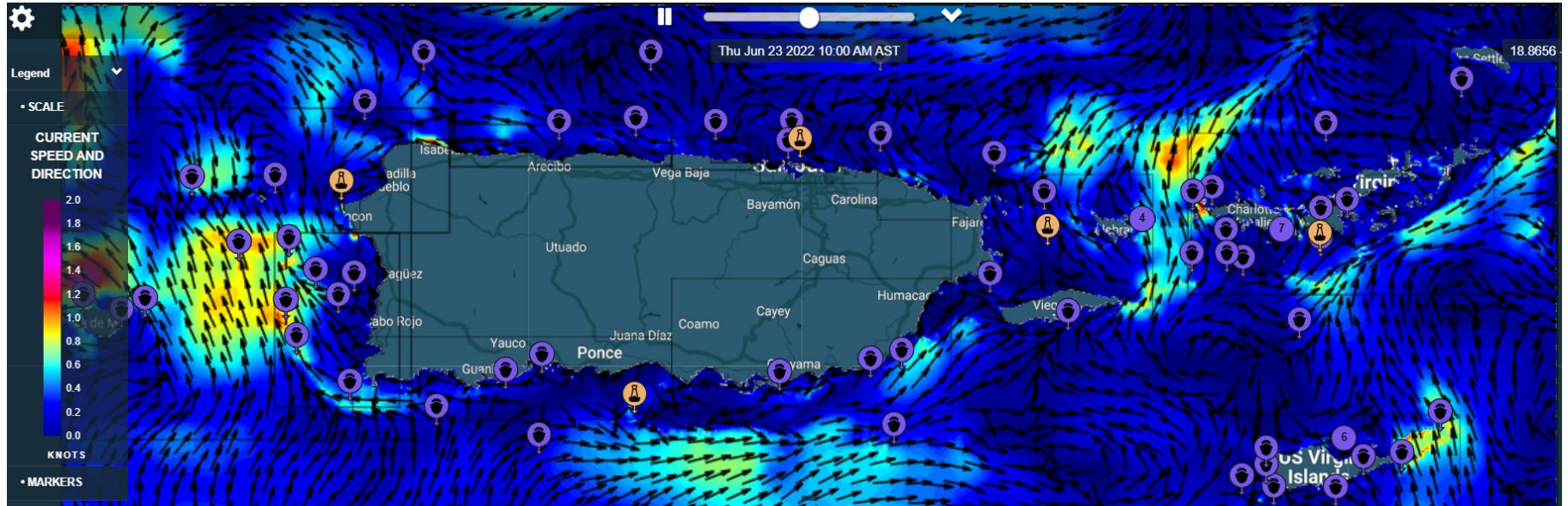
Sargassum Forecasting Products – Version 2.0



- ✓ Totally 12 Sargassum traps installed around La Parguera, PR
- ✓ Weekly Arrival Sargassum was weighed
- ✓ This product was validated by offshore biomass (kg/m)

Sargassum Forecasting Products – Version 3.0

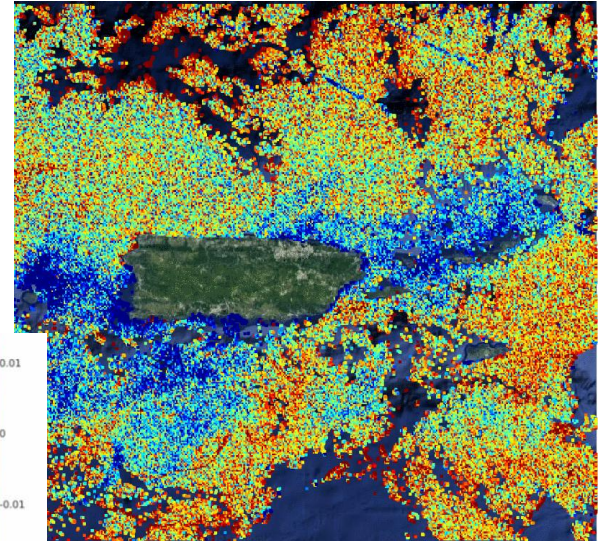
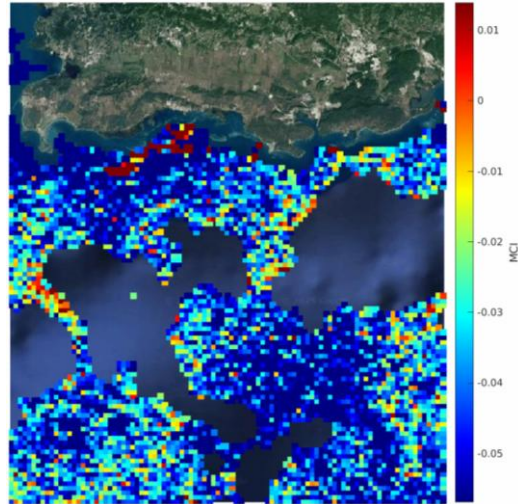
Operational 3D FVCOM provides 1-day hindcast and 3.5-day forecast



<https://www.caricoos.org/currents/forecast/FVCOM/PRVI/Currents>

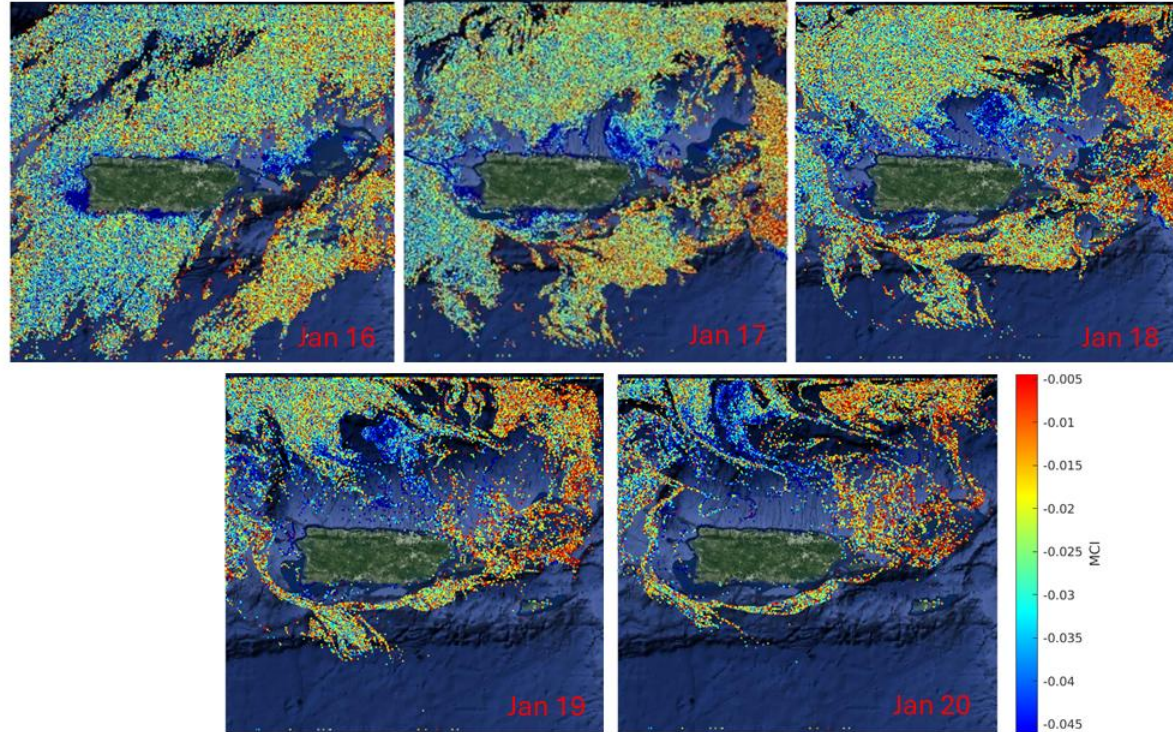
Sargassum Forecasting Products – Version 3.0

- ✓ Initialized by MCI
- ✓ High-resolution FVCOM (up to 80 m) – not restricted by the resolution as previous versions did
- ✓ Represent well the coastline and bathymetry
- ✓ Provide 3.5-day forecast – for rapid response to extreme beaching events
- ✓ Forecast the landfall at specific coastal sites.

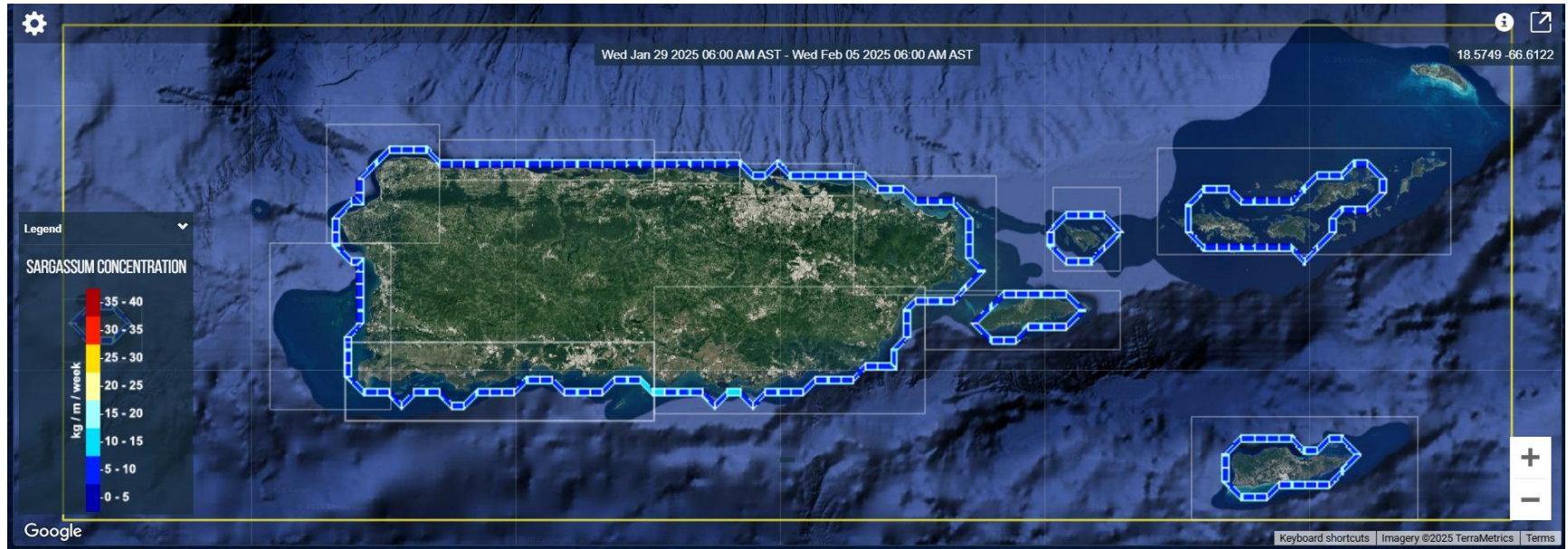


Sargassum Forecasting Products – Version 3.0

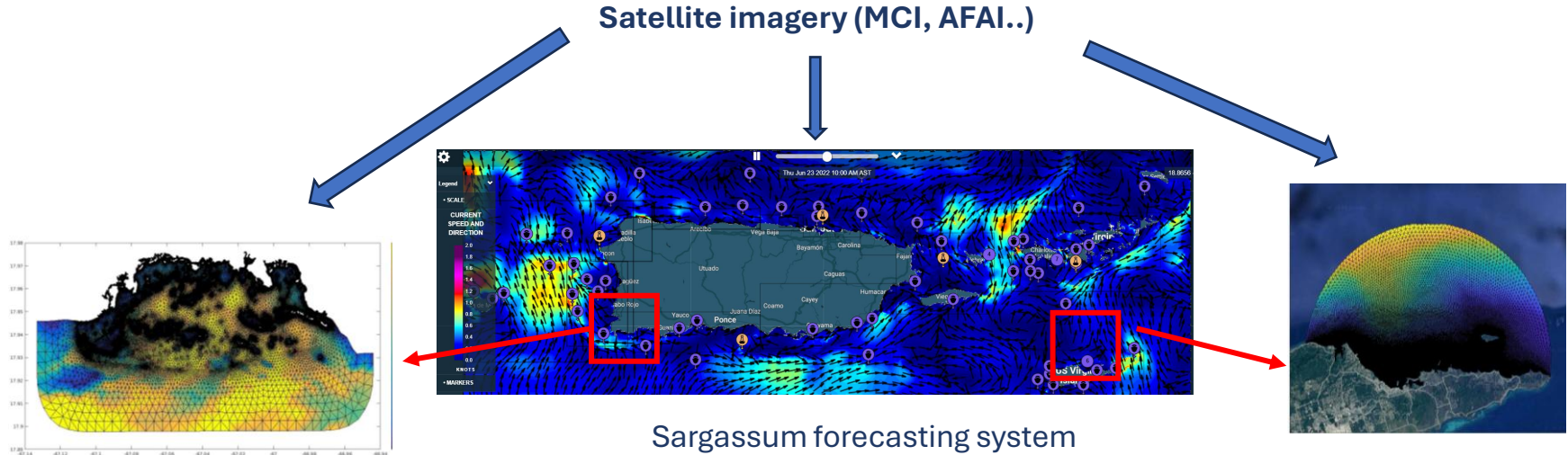
- ✓ This version has been ready for daily operation.
- ✓ Automatically run right after daily hydrodynamic model (FVCOM).
- ✓ The colorbar represented the raw value of MCI.
- ✓ Provide 3.5-day forecast.



7-Day Near-coastal *Sargassum* Inundation Forecast



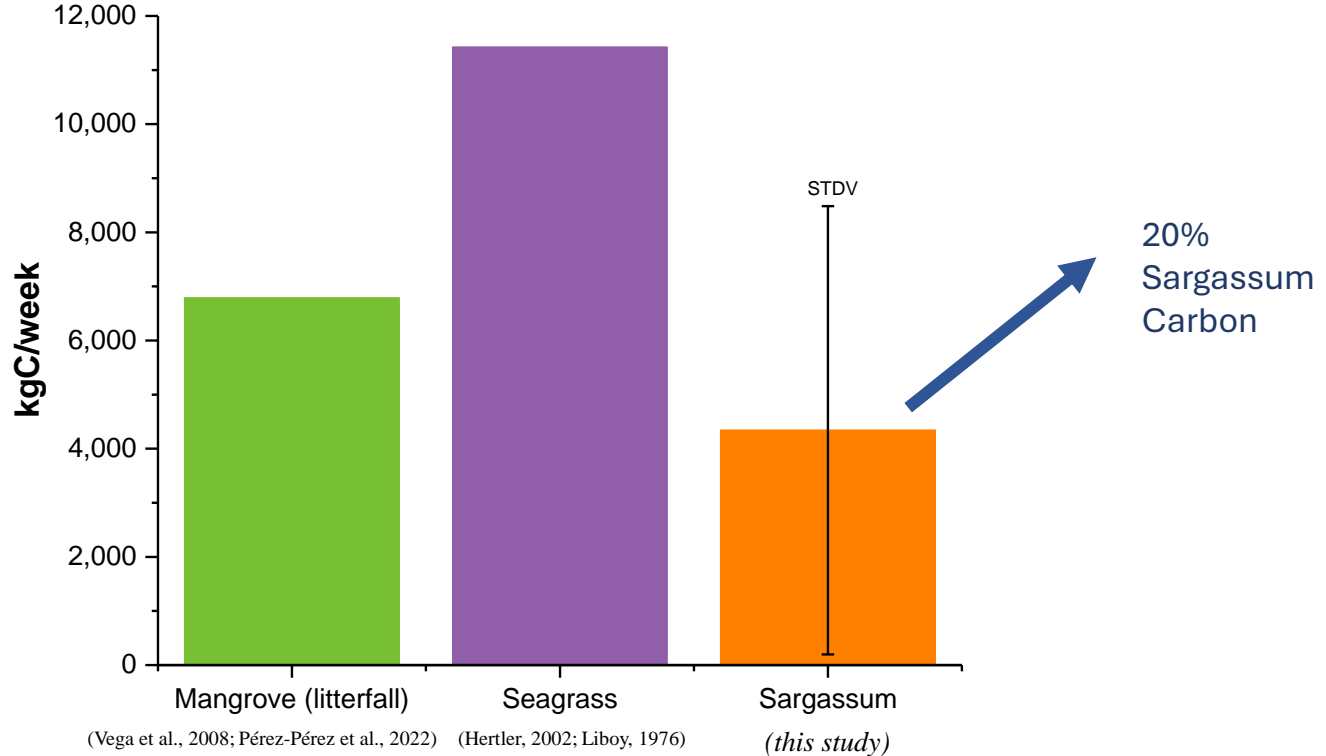
Sargassum Forecasting Products – Beta Version 4.0



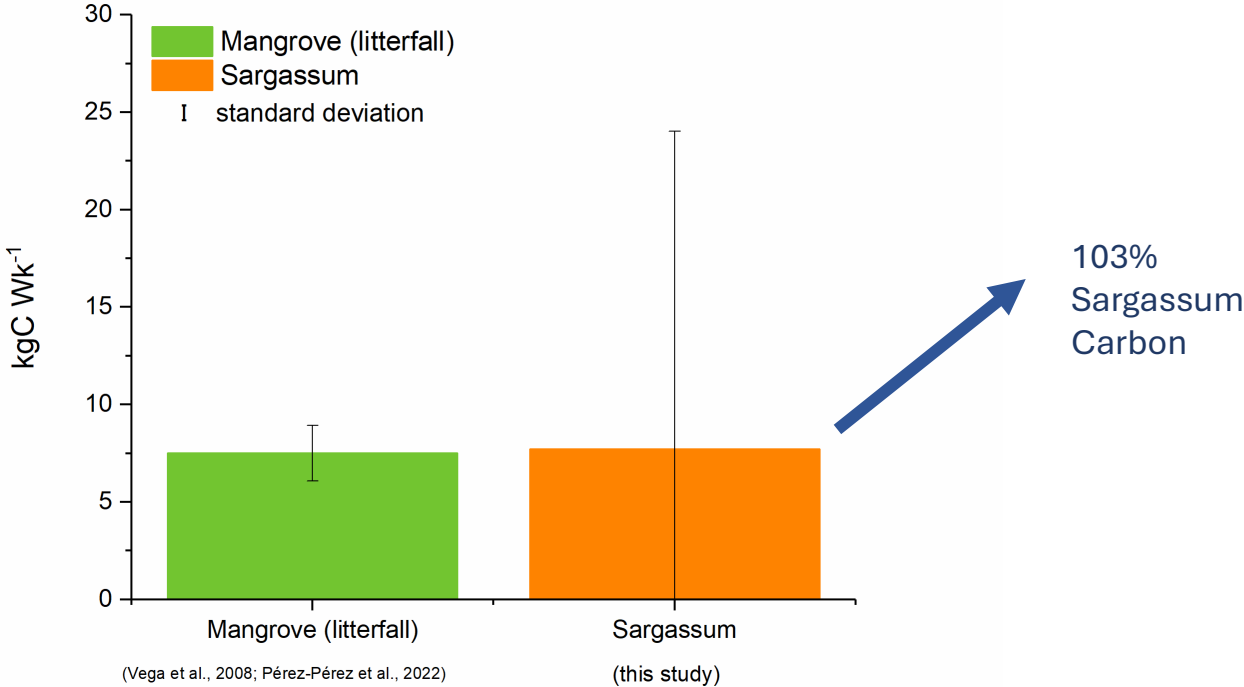
- Nesting into Regional FVCOM
- Finer resolution towards the coastal (up to 4 meters)
- Include features such as keys, mangroves
- Ready for the operational run

May 2025!

LPMR Particulate Organic Carbon (POC) sources

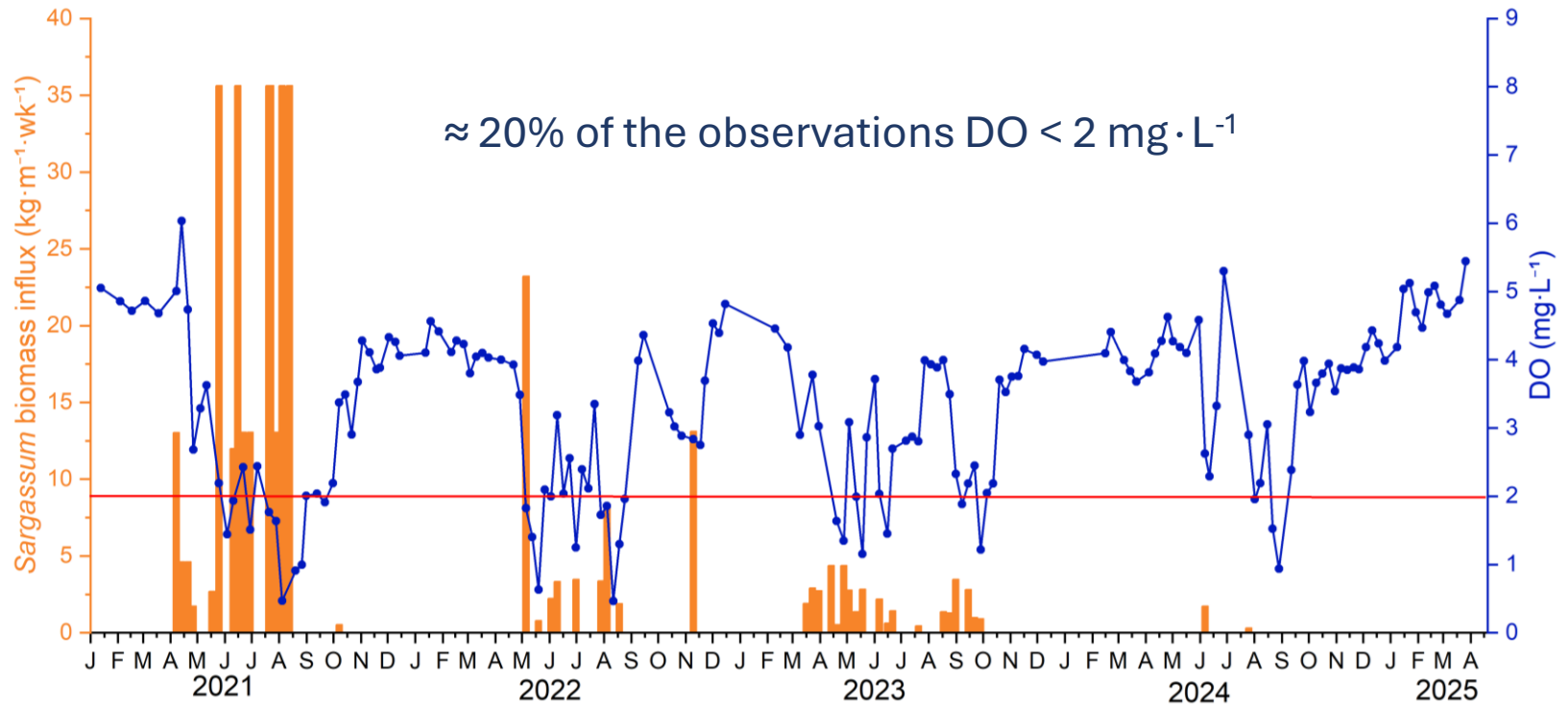


Particulate Organic Carbon Sources at Monsio Jose Key Bay



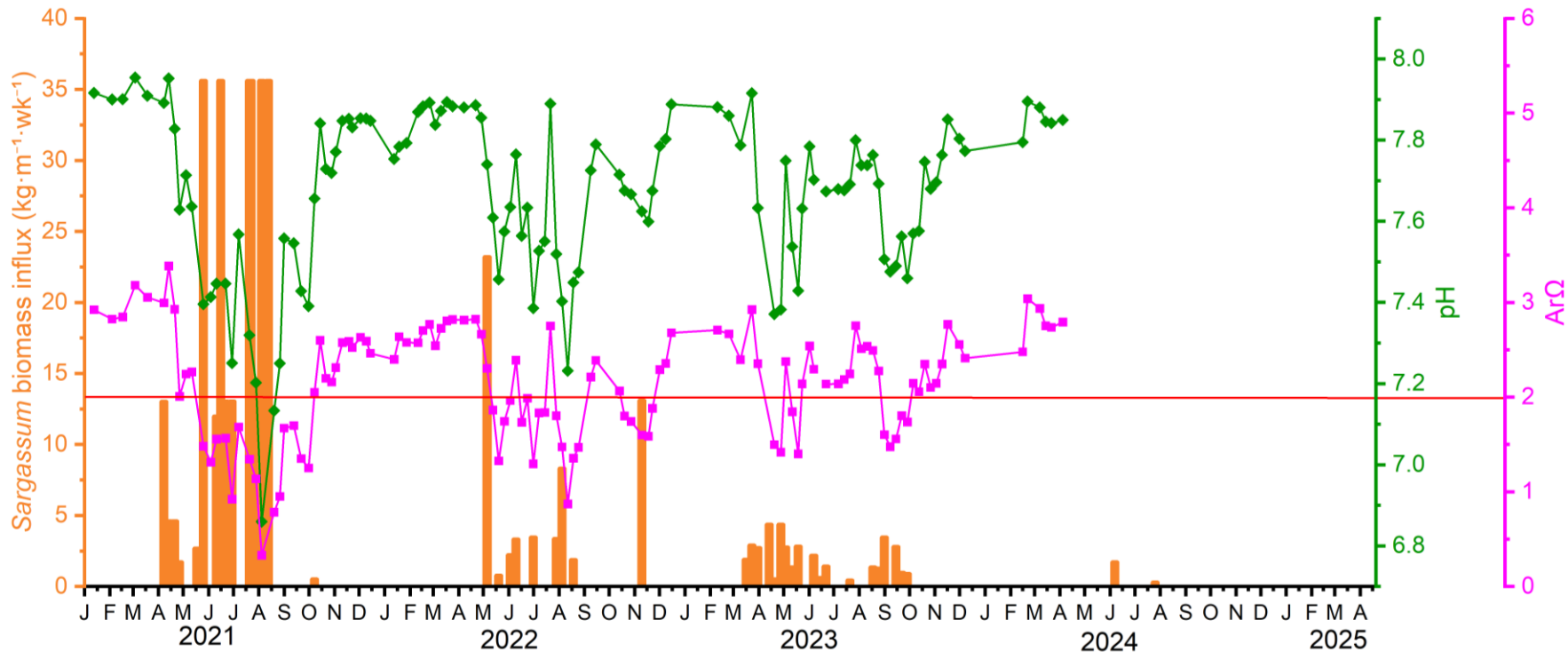
Nearshore mangrove

Monsio José



Nearshore mangrove

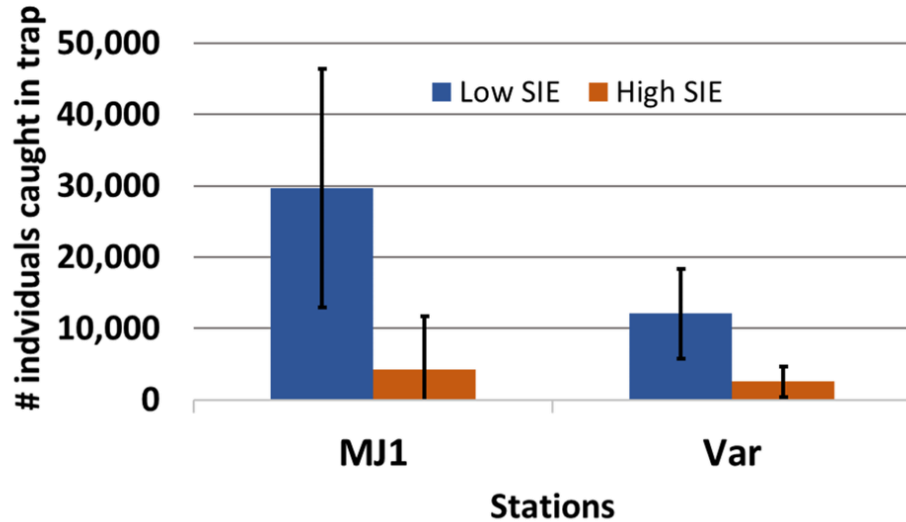
Monsio José



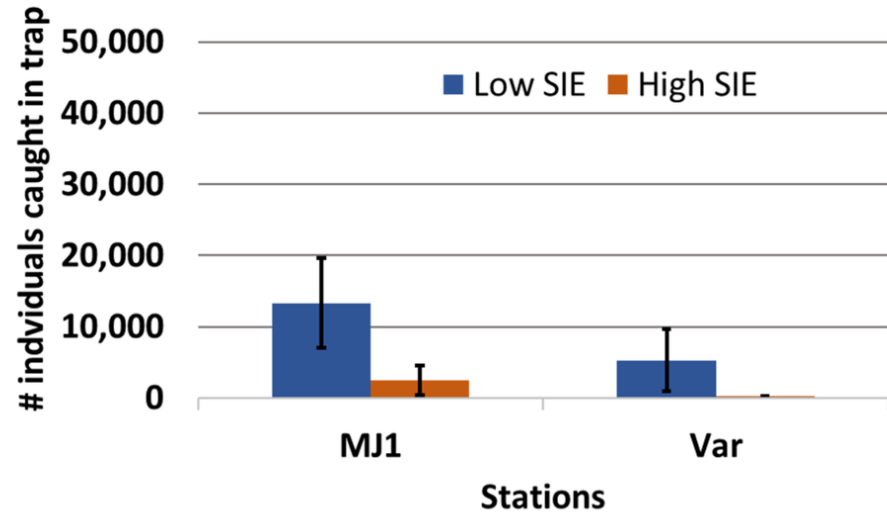
$\approx 30\%$ of the observations $\Omega < 2$

Holoplankton (A) and Meroplankton (B) captured using light traps under low and high *Sargassum* inundation events (SIE) during 2022 at MJ1, La Parguera, Puerto Rico.

A

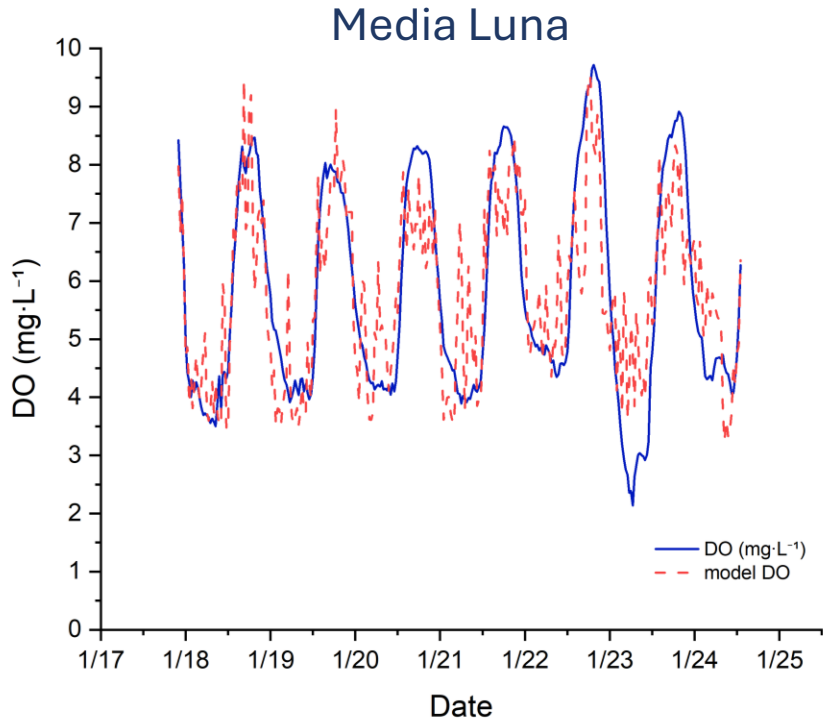


B



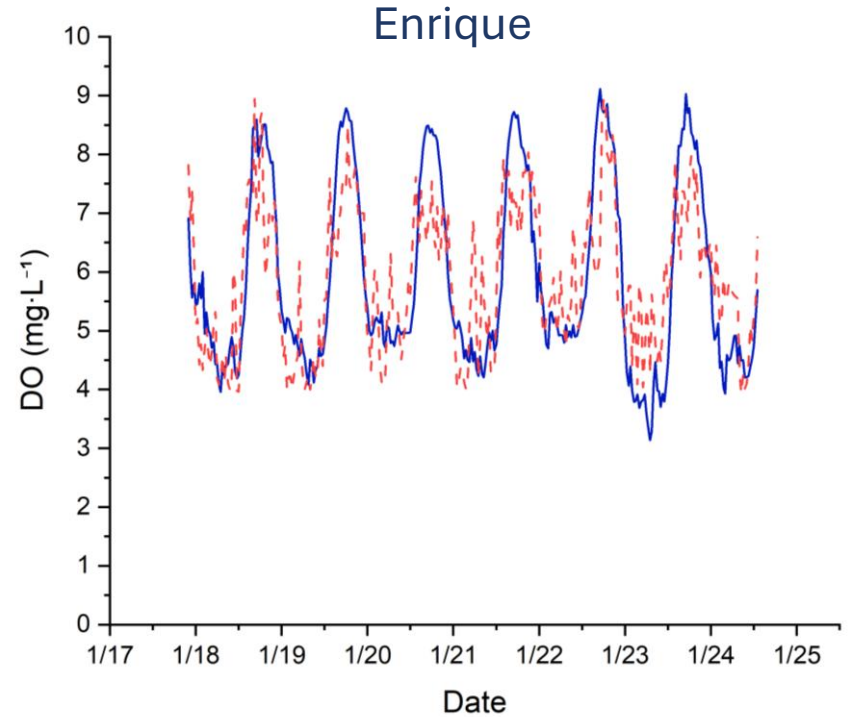
Bars= $\pm 2SE$. The low vs. Sargasso threshold used was 18,000 kg/week of Sargasso for La Parguera Marine Reserve Basin (Sargassum inundation estimates supplied by P. Molina for 2022).

Biogeochemical Modeling and Forecasting



$$DO = 5.79311 - 0.1699 * \Delta h + 1.48868 * wind\ speed\ (m \cdot s^{-1})$$

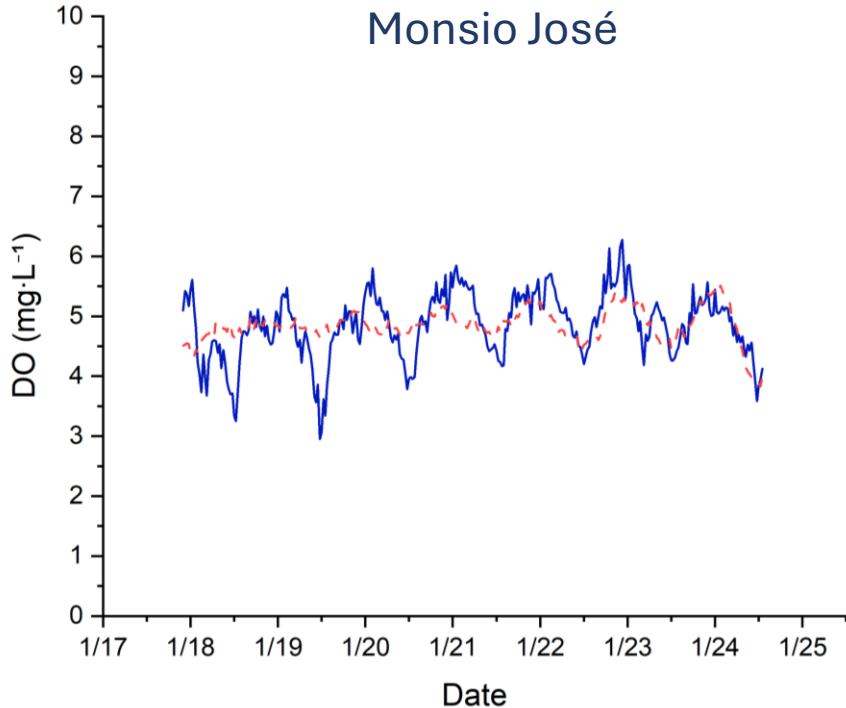
$r^2=0.647$



$$DO = 5.88365 - 0.07254 * \Delta h + 1.22967 * wind\ speed\ (m \cdot s^{-1})$$

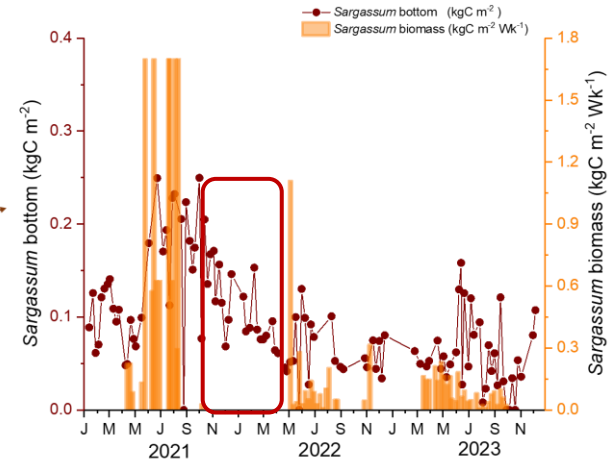
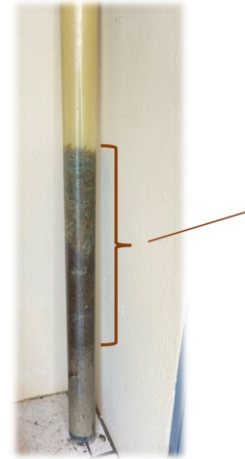
$r^2=0.605$

Biogeochemical Modeling and Forecasting



$$DO = 4.85168 - 0.26335 * \Delta h + 0.09977 * \text{wind speed } (m \cdot s^{-1})$$

$r^2=0.252$



The bottom at Monsio José is highly organic unlike the other stations where the bottom is composed of coral rubble



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CARIBBEAN COASTAL OCEAN OBSERVING SYSTEM

SISTEMA DE OBSERVACIÓN DEL OCEANO COSTERO DEL CARIBE

Thank you

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