

BioSpace25 - Biodiversity insight from Space
10 - 14 February 2025 | ESA-ESRIN | Frascati - Italy

 ROSENSTIEL SCHOOL
COOPERATIVE INSTITUTE for
MARINE & ATMOSPHERIC STUDIES



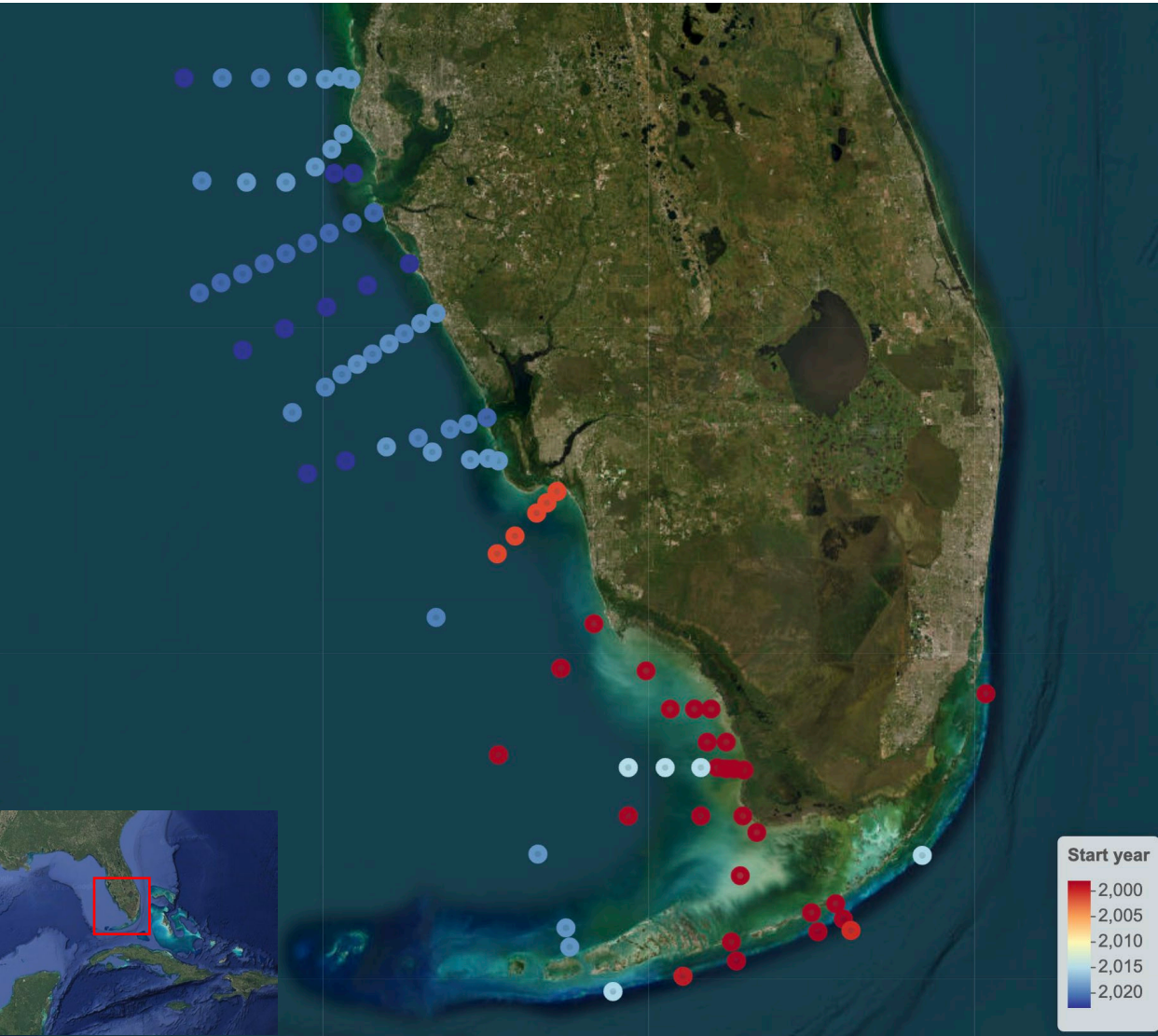
Scaling image-based marine plankton biodiversity using dynamic satellite seascapes: a contribution of the Southeast U.S. Marine Biodiversity Observation Network

E. Montes^{1,2}, M.T. Kavanaugh³, T. Christian^{1,2}, R. Cohn^{1,2}, F. Muller-Karger⁴, L.R. Thompson^{1,5}, C. Kelble¹

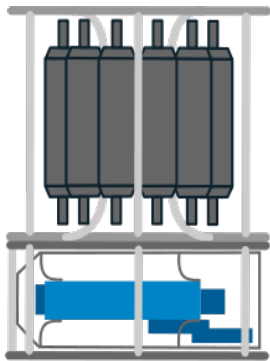
¹NOAA AOML, ²U. Miami CIMAS, ³Oregon State U., ⁴U. South Florida, ⁵Northern Gulf Institute, Mississippi State U.

Oceanographic surveys every ~ 6 weeks

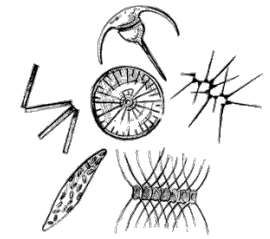
Southeast US Marine Biodiversity Observation Network



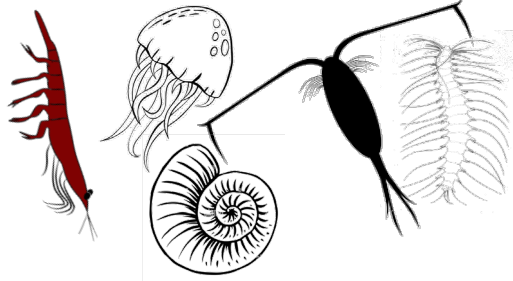
Hydrography
Trace metals
Carbonate system
Primary productivity



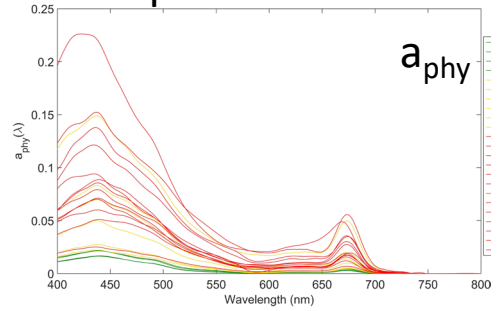
Phytoplankton pigments (HPLC)
Microscopy
IFCB imaging



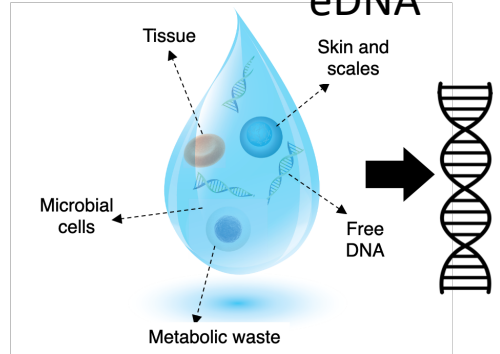
Zooplankton
Net tows and imaging



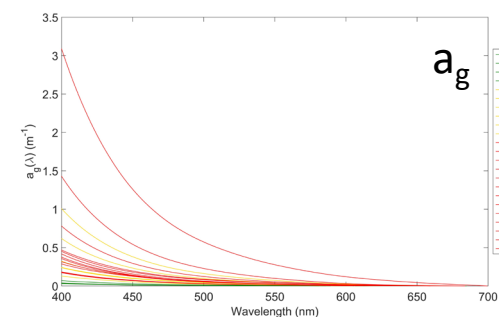
Absorption coefficients



eDNA



Graph of absorption coefficient (a_g) vs wavelength (nm)



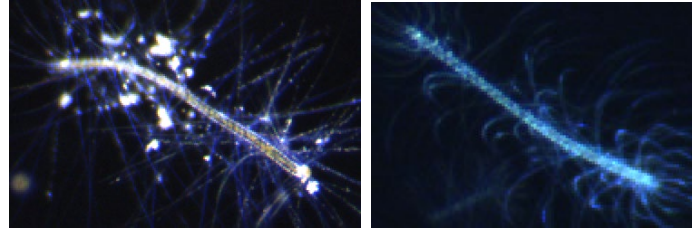
To what extent can we resolve the biogeography and phenology plankton groups with satellite data?

Continuous Particle Imaging and Classification System (CPICS)

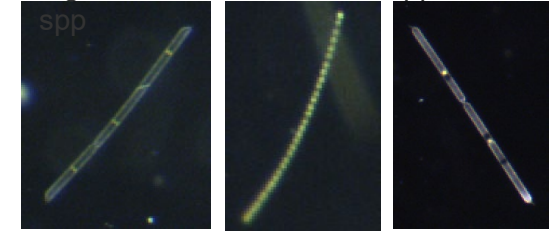


COASTAL
OCEAN
VISION 

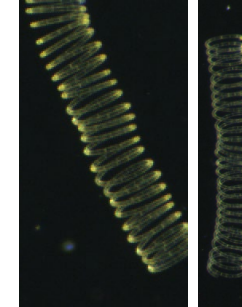
Chaetoceros spp



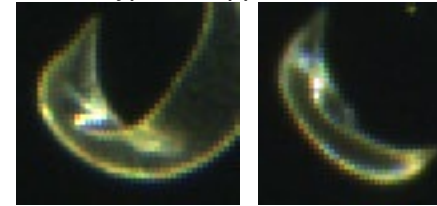
Chain diatoms
e.g. *P. alata*, *Skeletonema spp.*, *Pseudosolenia spp*



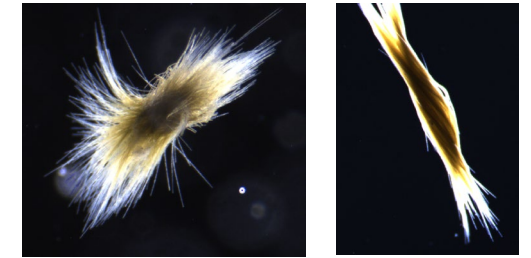
Guinardia striata



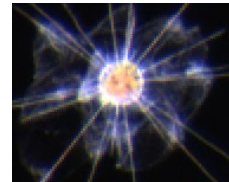
Neocalyptrella spp



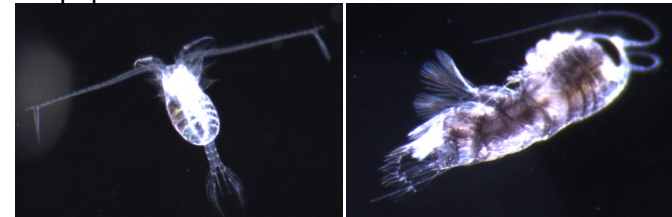
Trichodesmium



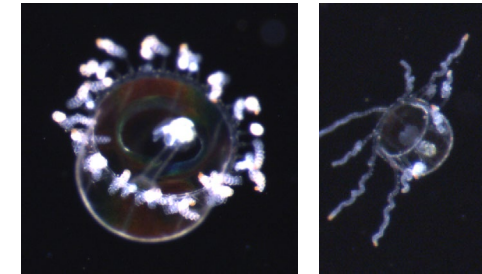
Rhizaria



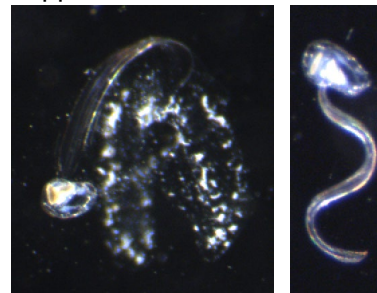
Copepods



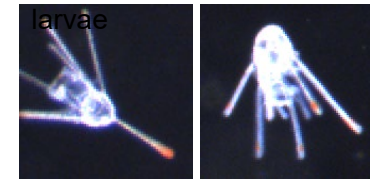
Gelatinuos



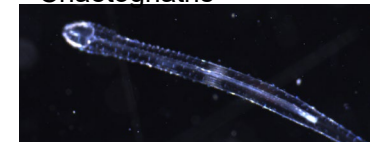
Appendicularians



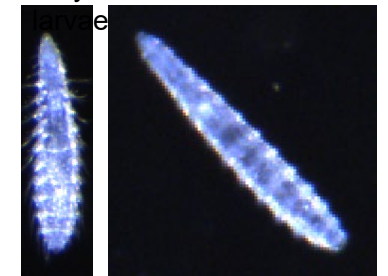
Echinoderm
larvae



Chaetognaths

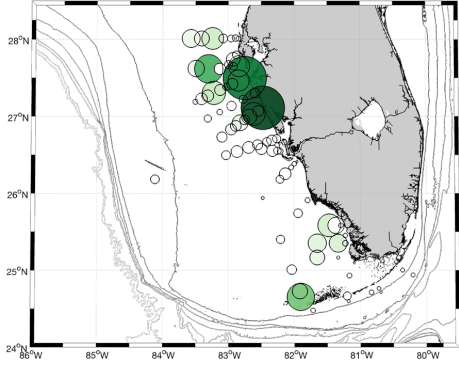


Polychaetes



Spatial distributions of plankton species

Mixed chain diatoms



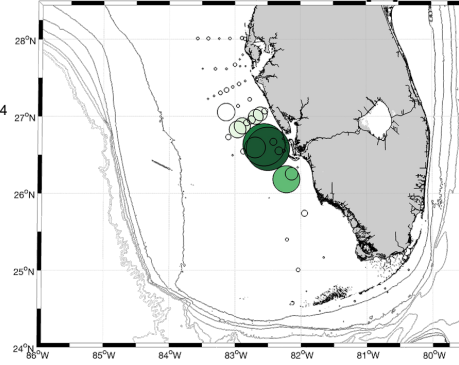
Org. $\text{m}^3 \times 10^4$

⑤

⑩

②①

Skeletonema spp



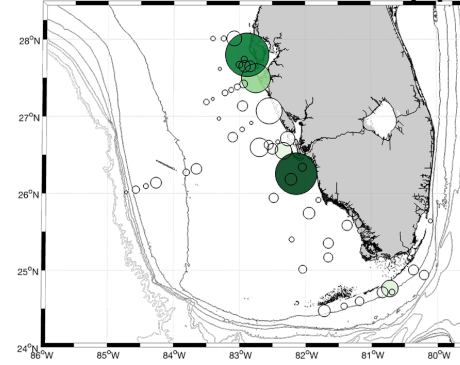
Org. $\text{m}^3 \times 10^5$

⑤

⑮

②①

Trichodesmium spp



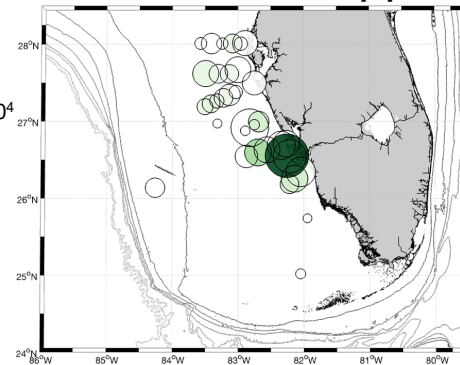
Org. $\text{m}^3 \times 10^4$

①

③

⑤

Neoceratium spp



Org. $\text{m}^3 \times 10^3$

③

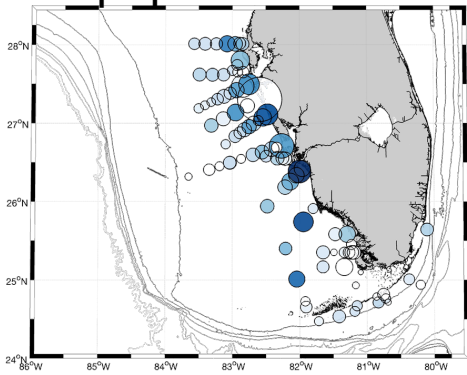
⑥

⑨



Standard deviation

Copepods



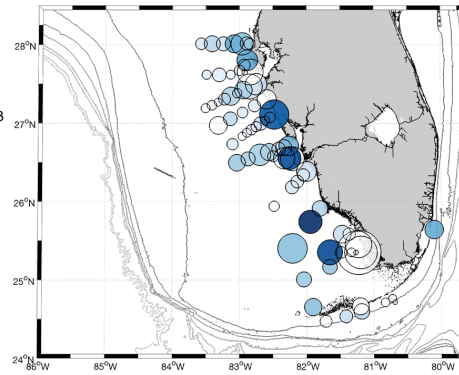
Org. $\text{m}^3 \times 10^3$

⑮

③①

⑥①

Larvaceans



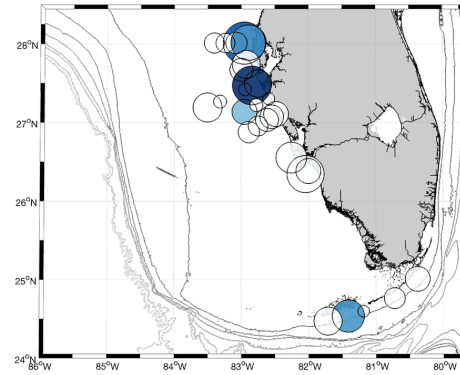
Org. $\text{m}^3 \times 10^3$

⑮

③①

⑥①

Echinoderms



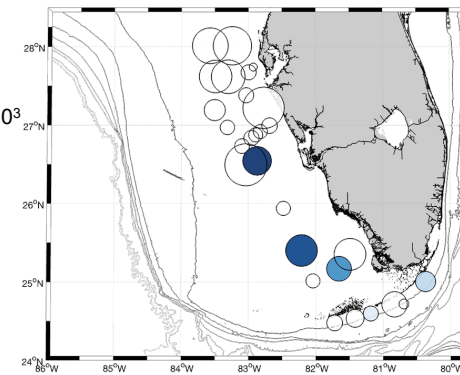
Org. $\text{m}^3 \times 10^3$

⑤

⑩

⑮

Ostracods



Org. $\text{m}^3 \times 10^3$

①

③

⑤

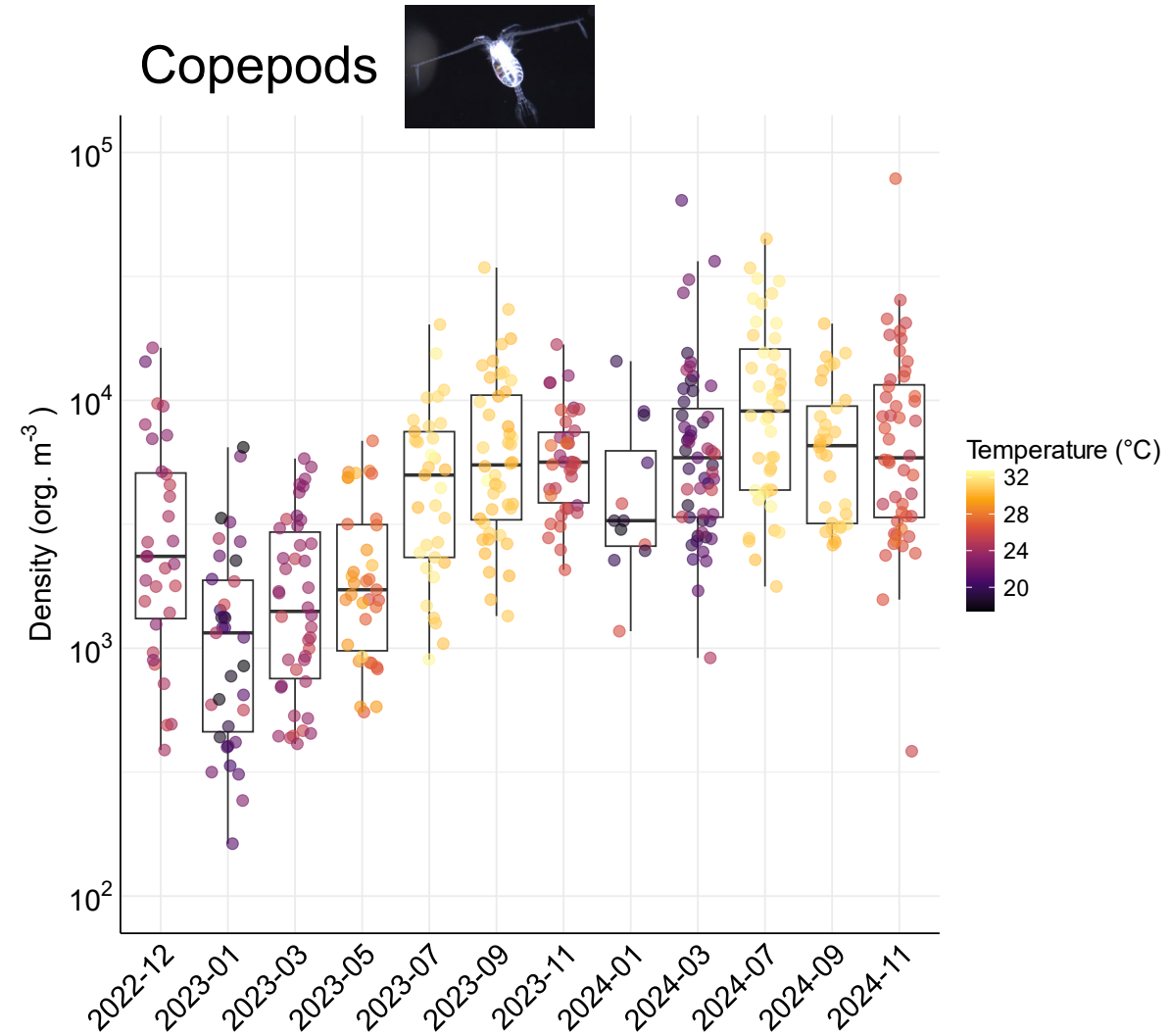
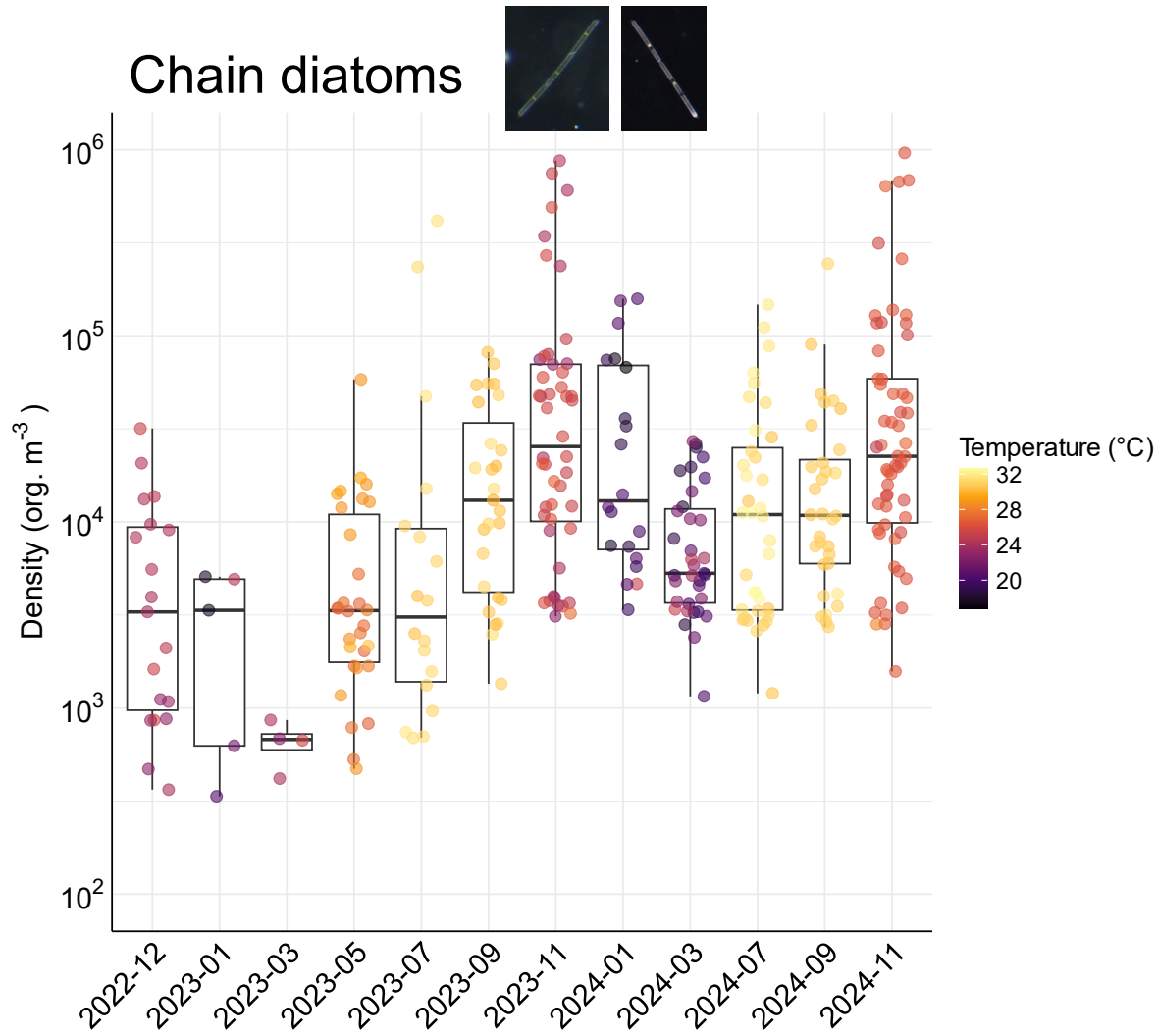


Standard deviation



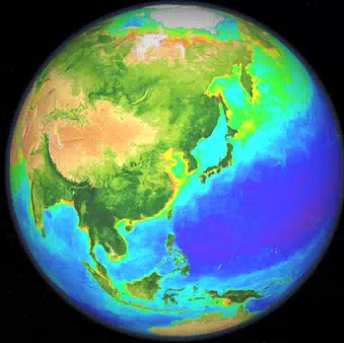
Depth (m)

Time series of plankton densities

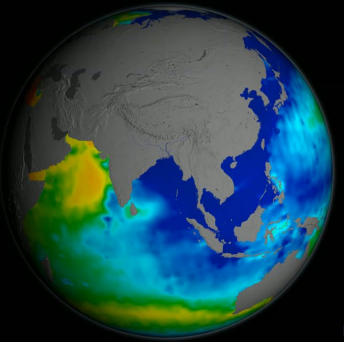


Dynamic pelagic satellite seascapes

Multiple NASA assets



Biology: Ocean Color



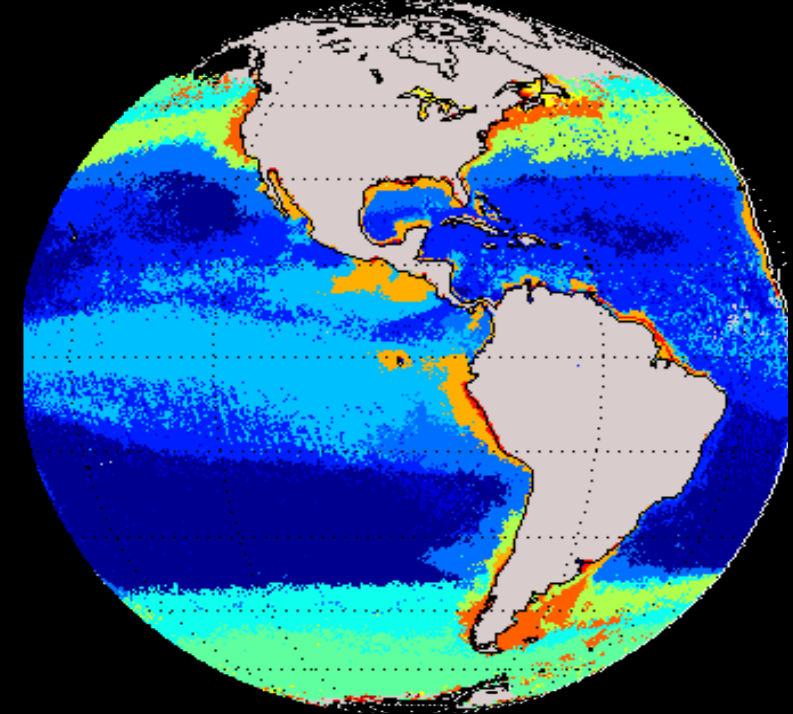
Sep 01, 2011

Physics: e.g.
SSS, SST, winds, SSHa

Self-organizing maps
+
Hierarchical clustering

Global dynamic classification

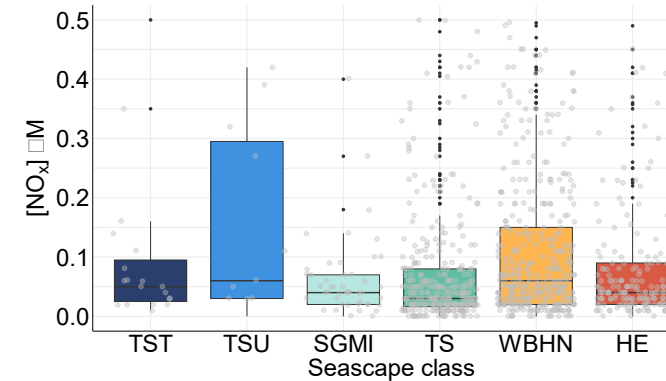
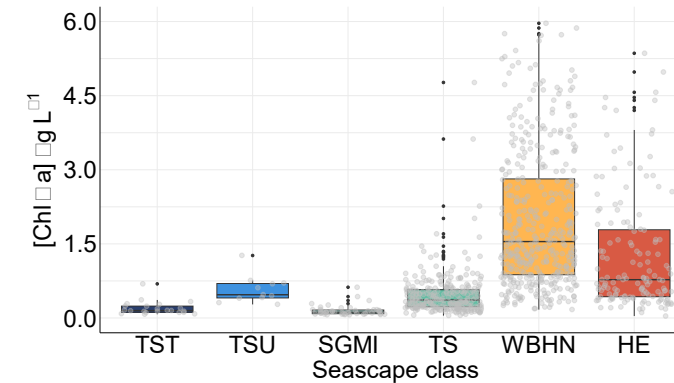
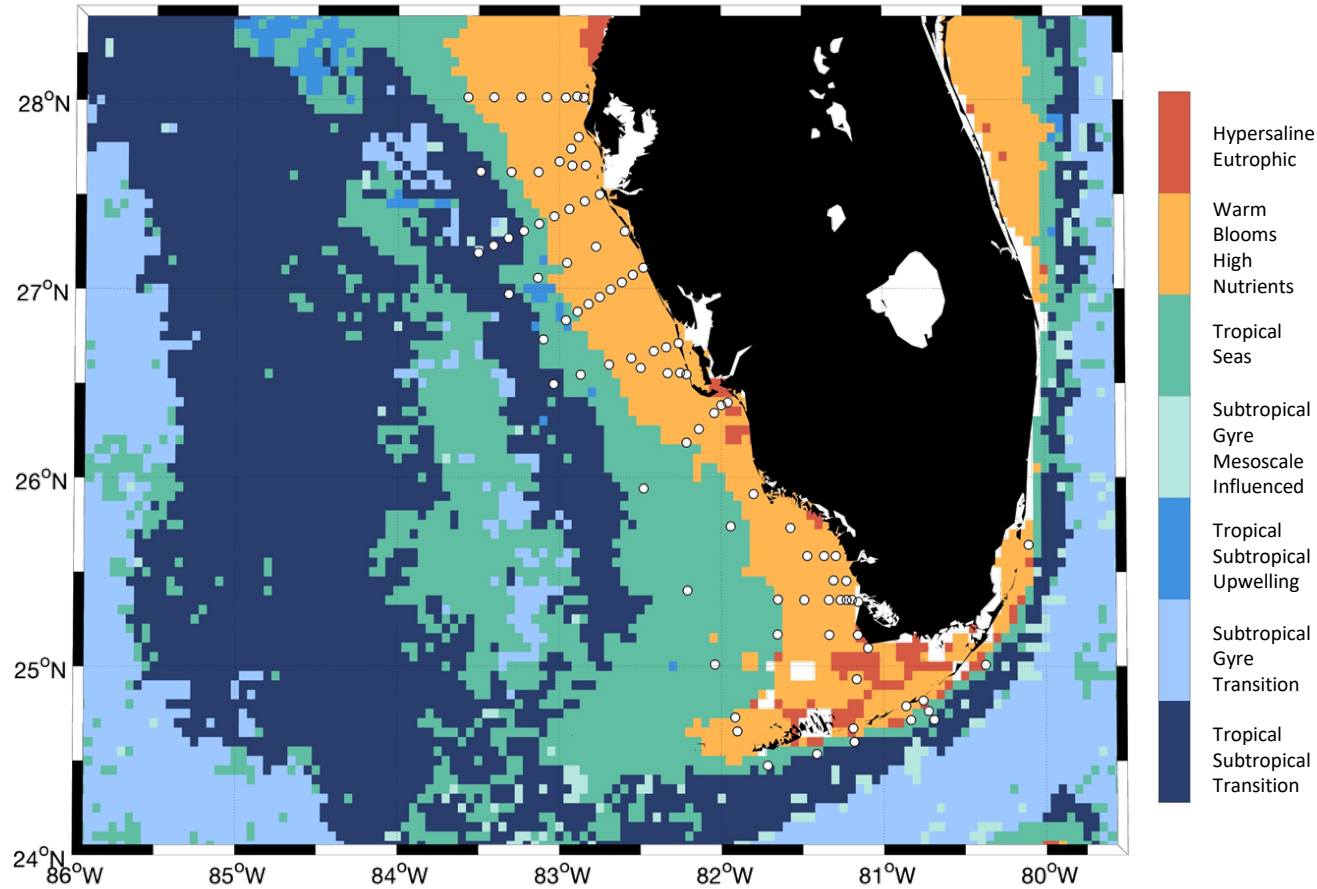
Month=1



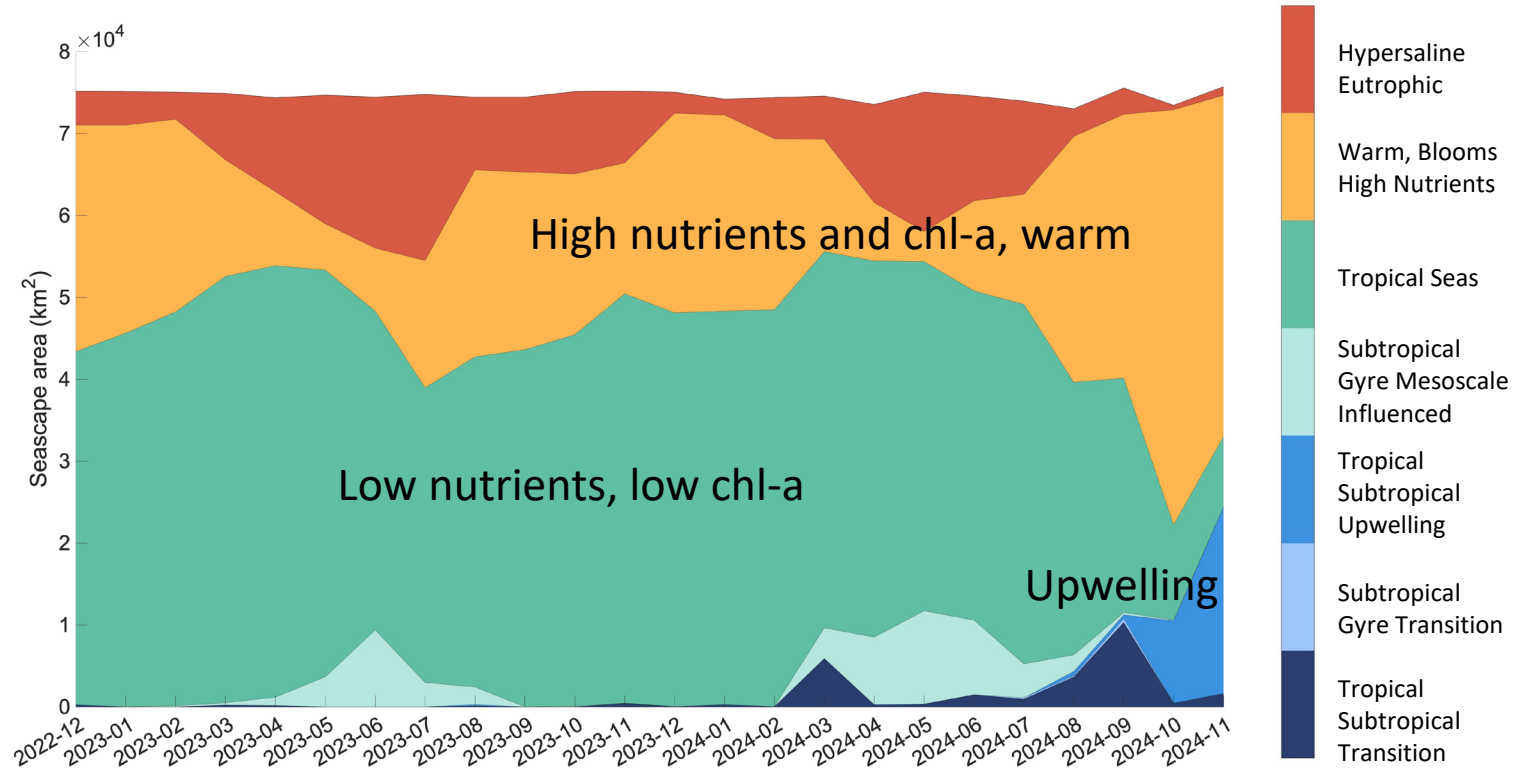
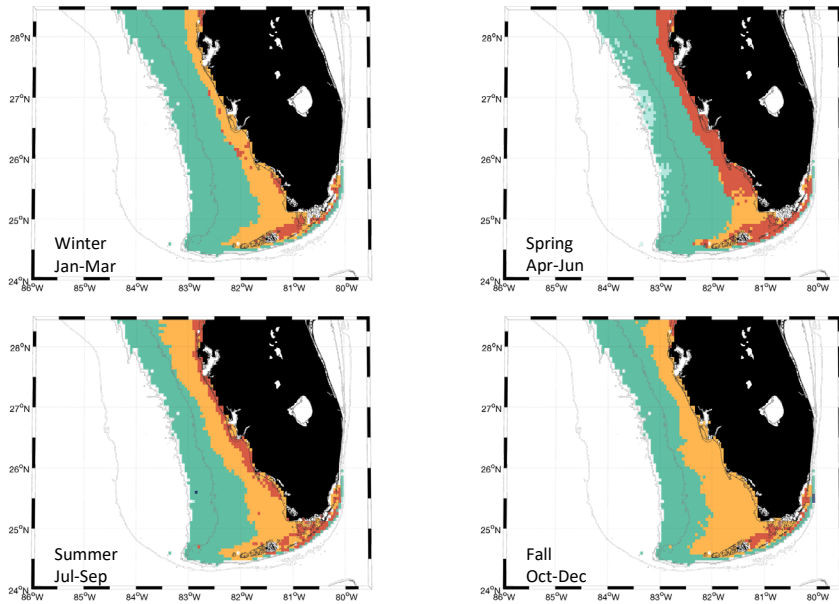
- Globally relevant variables:
 - SST, Chl-a, nFLH, ADT, SSS, CDOM, ice cover
- 8-day and monthly composites
- 5 km pixel resolution
- N= 33 (including sea ice)

Water quality properties of satellite seascapes

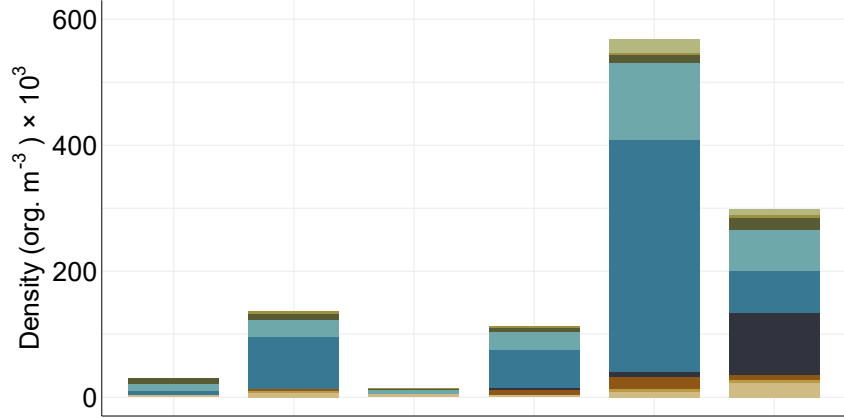
Monthly seascape: September 2024



Seasonal change in seascape composition (within the 50m isobath)

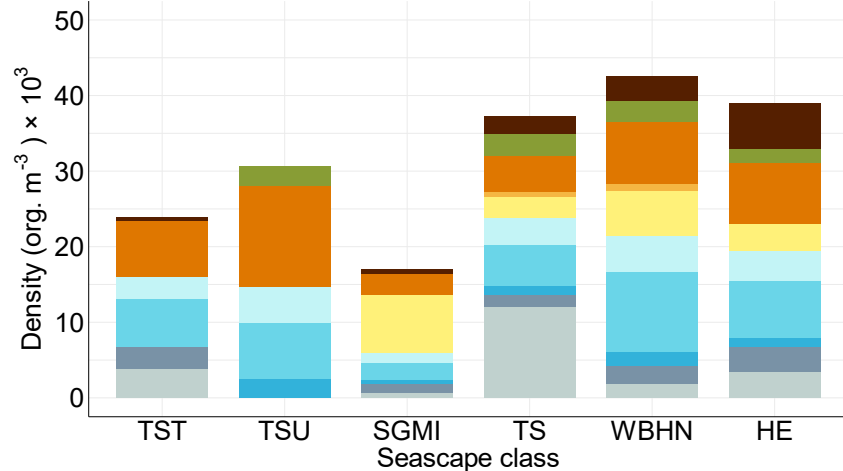


Plankton densities per seascape class



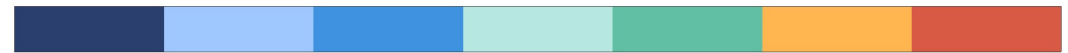
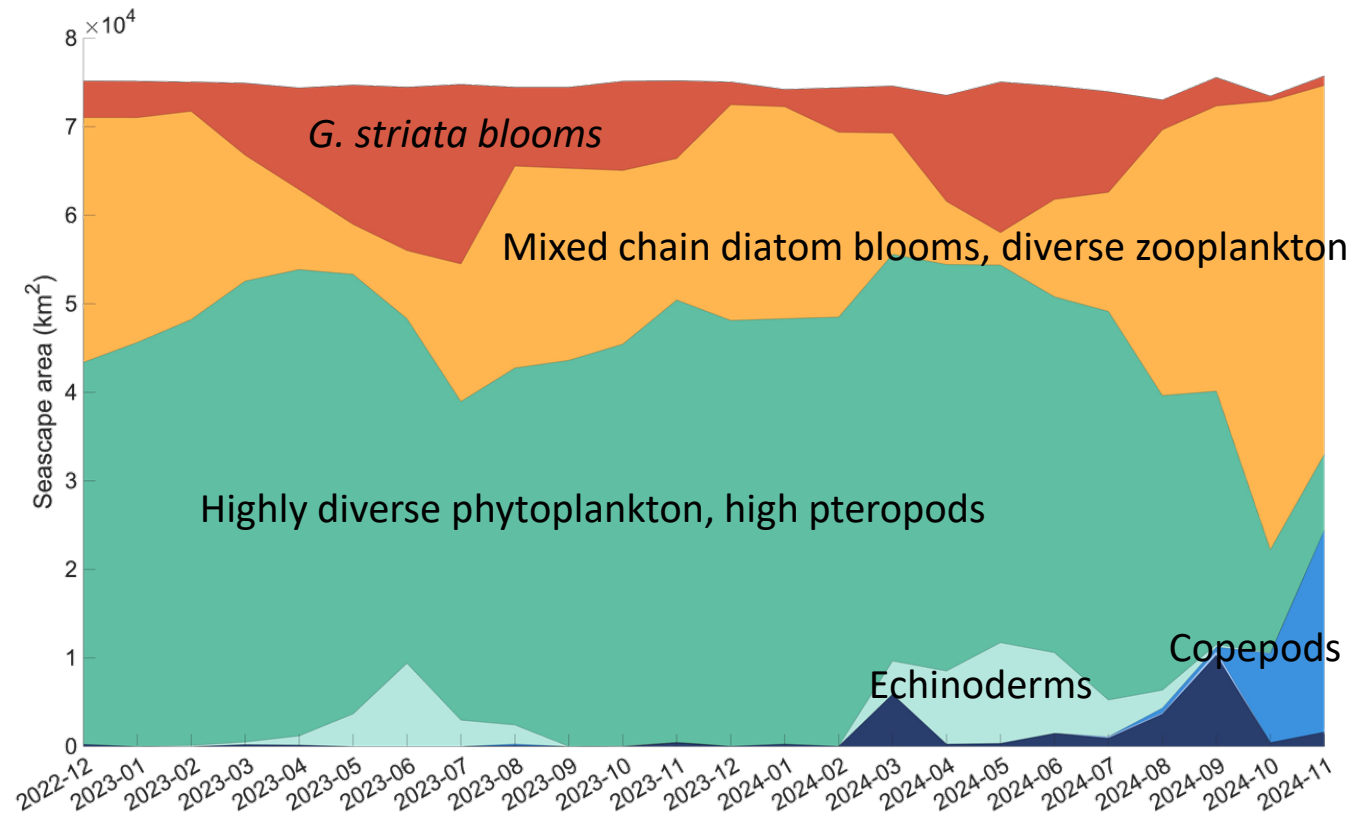
Phytoplankton

- Coscinodiscus spp
- Neoceratium spp
- Chaetoceros spp
- Chain diatoms
- Skeletonema spp
- Guinardia striata
- Neocalyptrella spp
- Hemidiscus spp
- Trichodesmium spp



Zooplankton

- Rhizaria spp
- Chaetognaths
- Copepods
- Decapods
- Echinoderms
- Gelatinous
- Larvaceans
- Ostracods
- Polychaetes
- Pteropods



- Tropical / Subtropical Transition
- Subtropical Gyre
- Tropical Subtropical Upwelling
- Mesoscale Influenced Subtropical Gyre
- Tropical Seas
- Warm, Blooms High Nutrients
- Hypersaline Eutrophic

Future work and recommendations



Outlook:

- Integrate CPICS data with other imaging datasets, e.g. IFCB
- eDNA metabarcoding to expand taxonomic range: microbes and higher trophic levels (invertebrates, fish, mammals).
- Develop seascape-based biodiversity indicators.

Recommendations:

- Standardizing field protocols and metadata for imaging datasets.
 - Enhancing access to automated classifiers for imaging observations.
 - Publishing imaging data on OBIS.
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