A hierarchical, synoptic, and dynamic seascape framework for observing and understanding biodiversity patterns in marine ecosystems

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University of Maryland Center for Environmental Science

USF University of South Florida

OSU Oregon State University College of Earth, Ocean, and Atmospheric Sciences

UAF University of Alaska Fairbanks College of Fisheries and Ocean Sciences

NASA

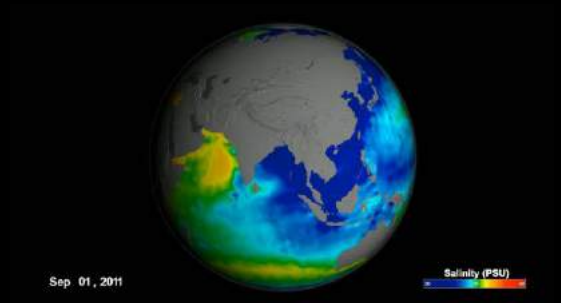
CoastWatch

National Oceanic and Atmospheric Administration U.S. Department of Commerce NOAA

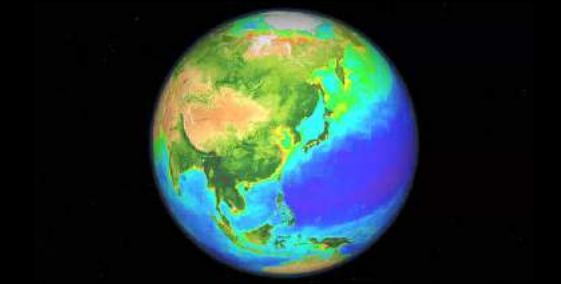
IOOS Integrated Ocean Observing System

Pelagic seascape ecology : framework to relate dynamic habitat to organisms for a global marine biodiversity observing network

Multiplatform Integration Machine Learning:
Satellite remote sensing, ecosystem models

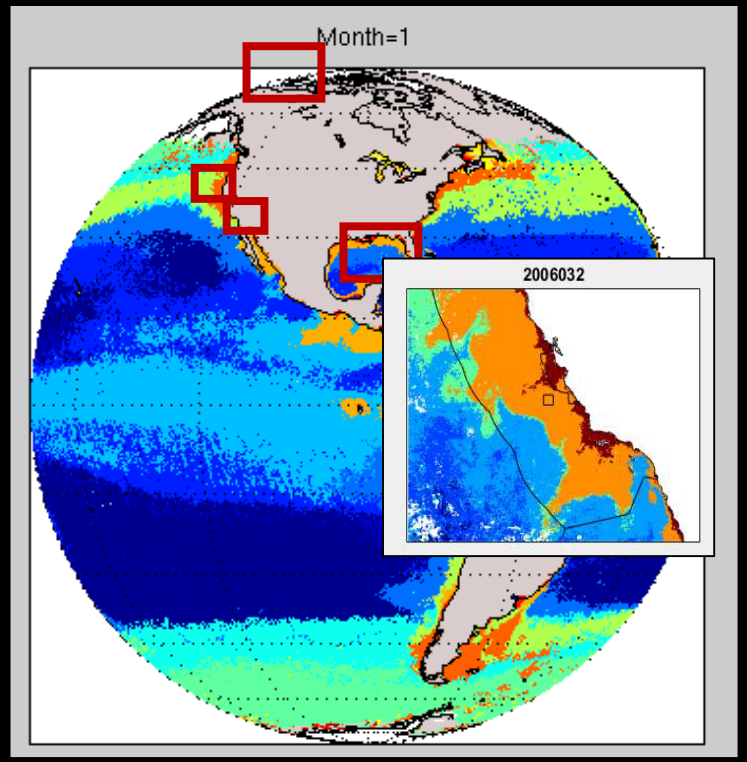


Physics: e.g.
SSS, SST, winds, SSHa



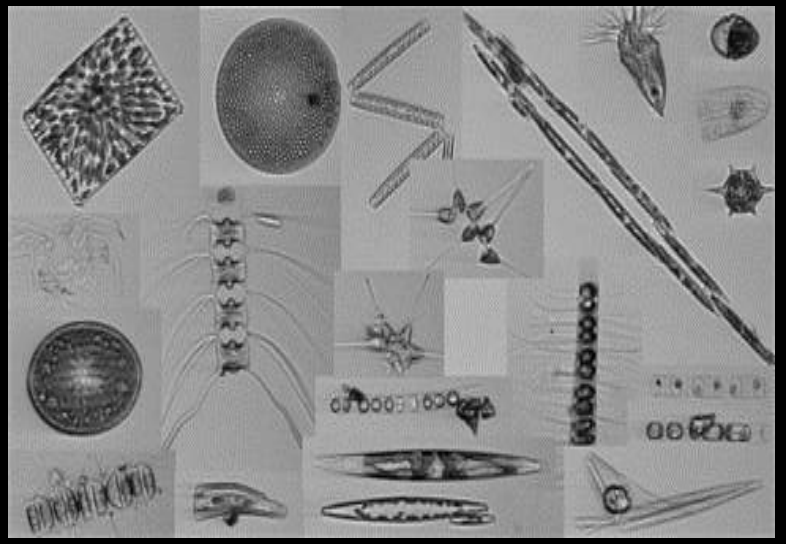
Biology:
Chl-a, nFLH, CDOM

Global – regional dynamics:
Seascape Classification/Prediction

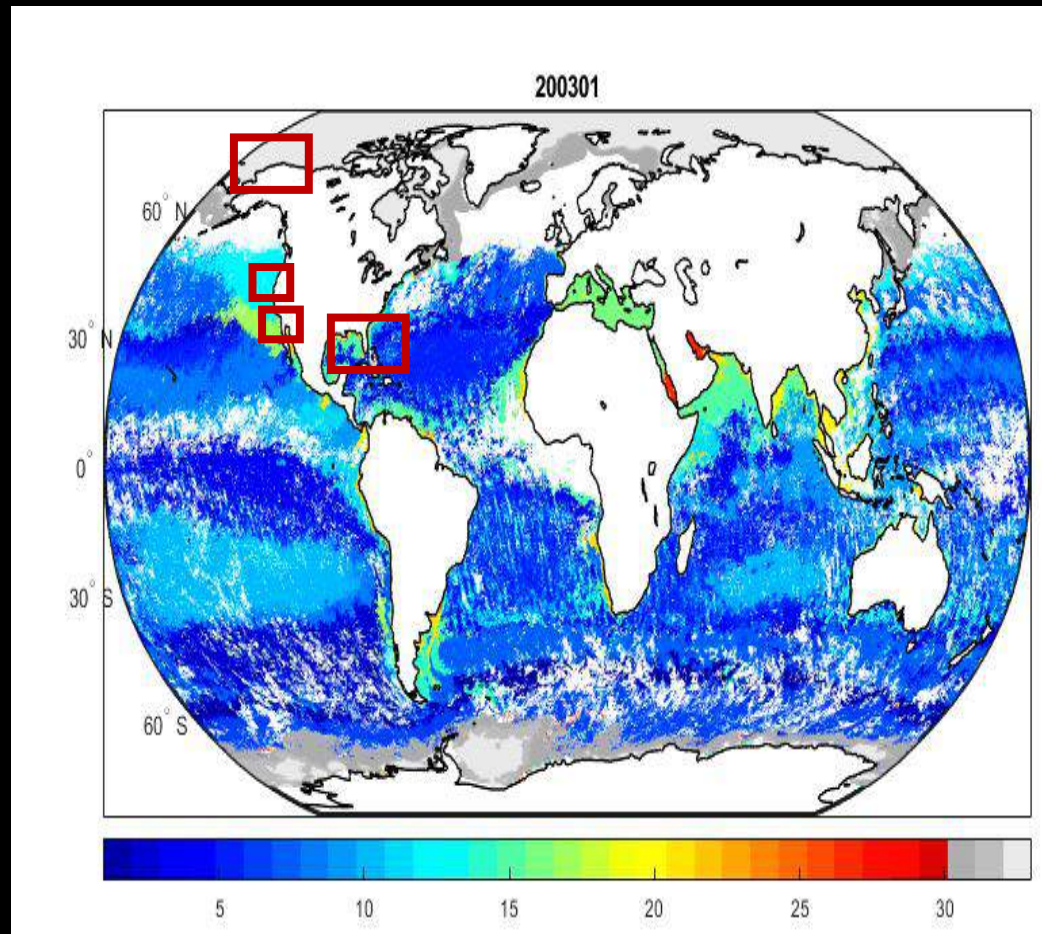


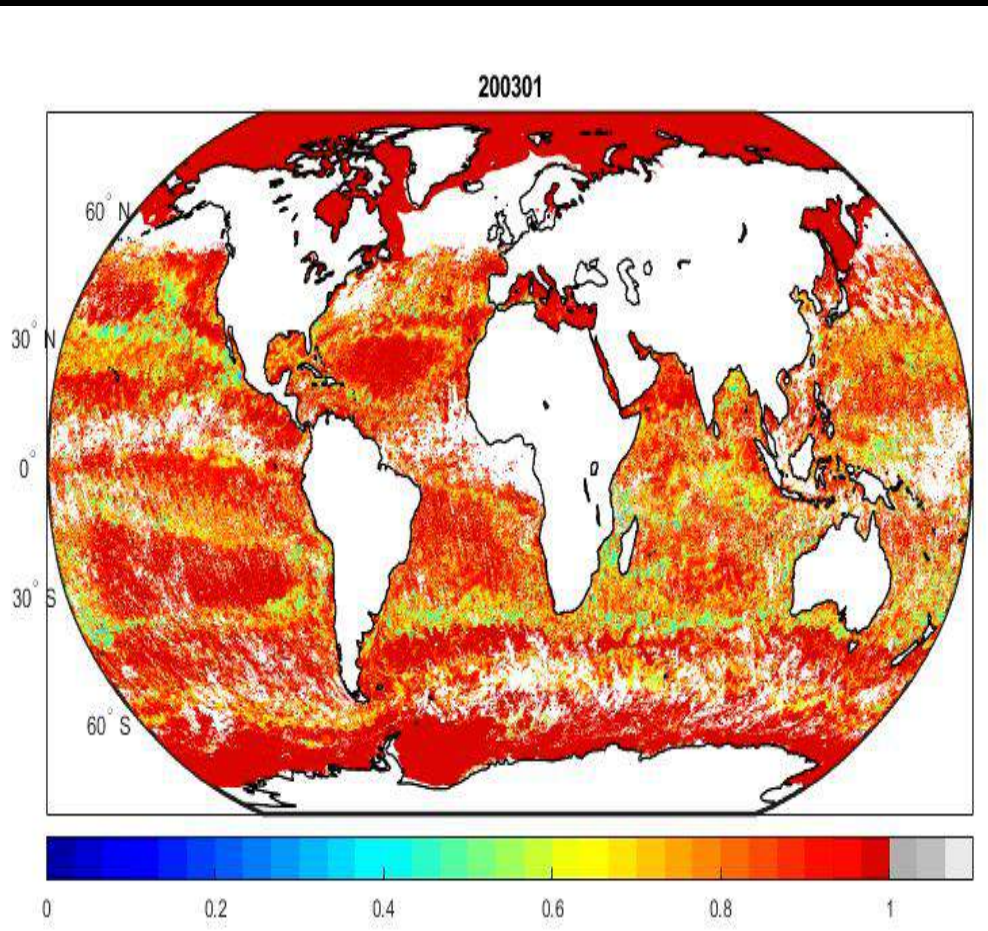
Hierarchical, non-linear, dynamic
See also Oliver et al., Devred et al, Platt and Sathyendranath,

Regional comparisons/parameterization:
diversity, biogeochemistry, fisheries habitat



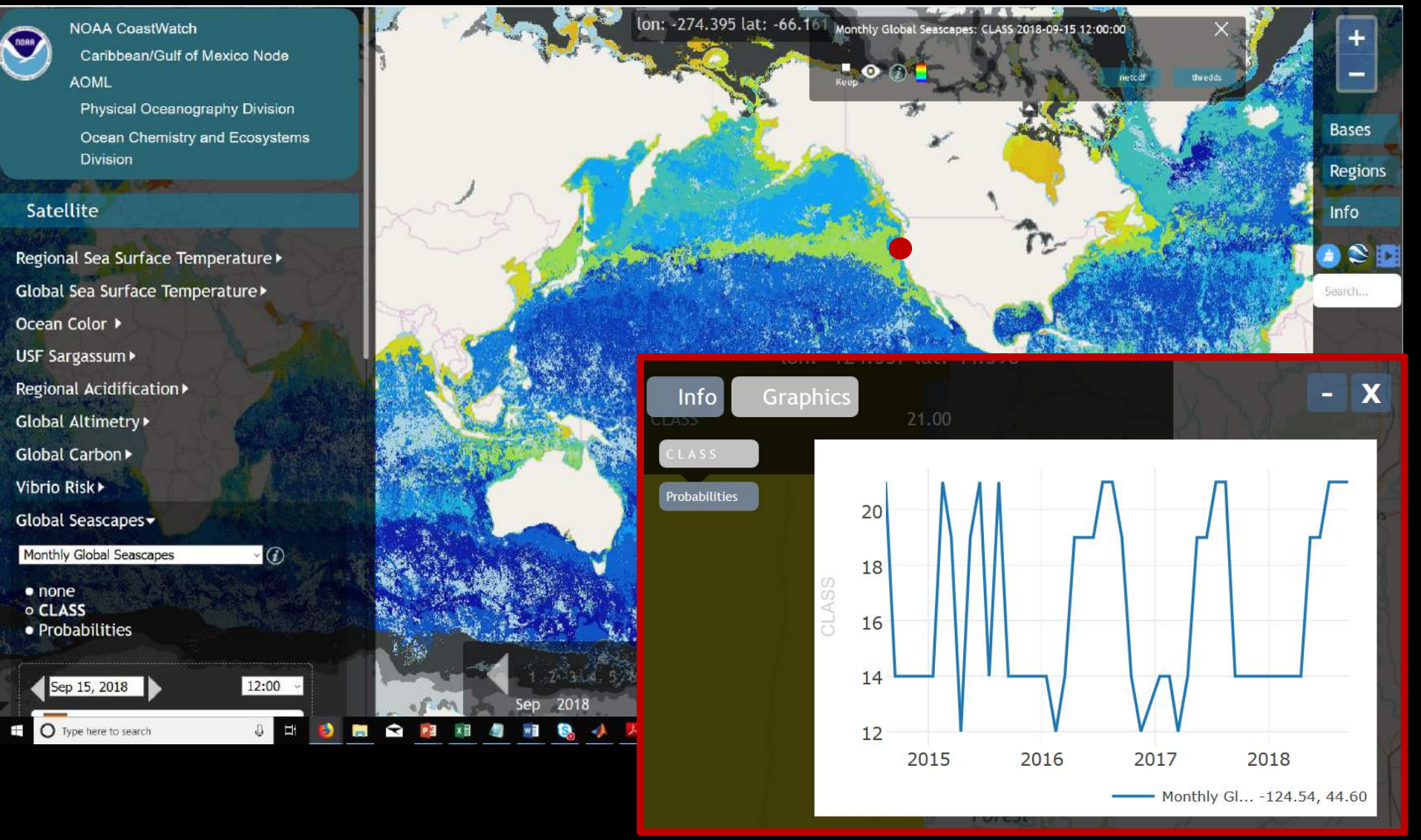
Dynamic Seascapes framework: Comparison, rarefaction, methods comparison, seasonal and interannual habitat variability





Method : attribution of uncertainty and the strength of ecotones or ecoclines (frontal regions).

NOAA CoastWatch: Operational Global Coverage Seascape Identity



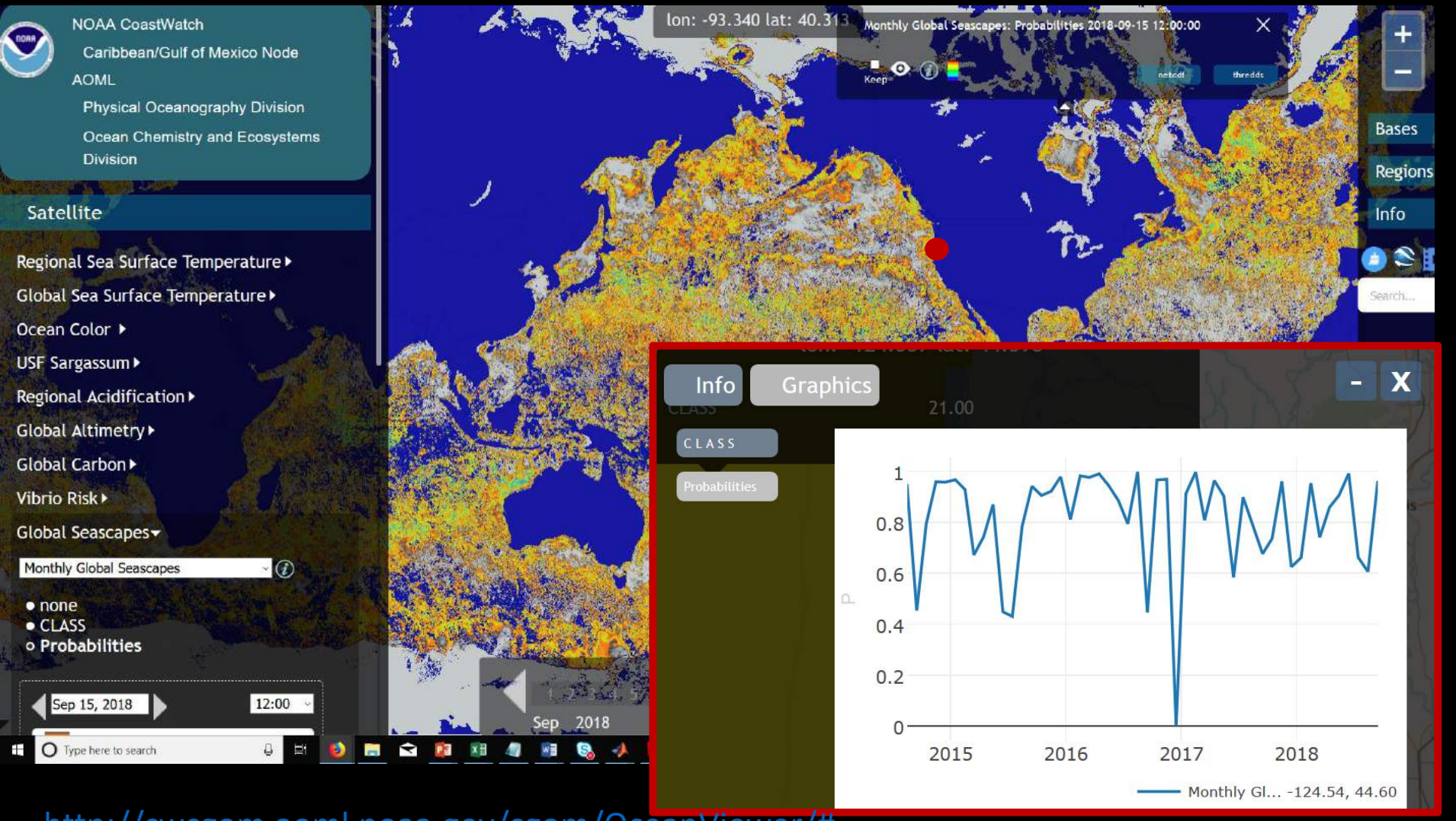
EBVs

Ecosystem Structure Class

- Habitat Structure
- Habitat Extent
- Habitat Function (time dynamics of seascape identity)

Other Classes:
Community Composition
Ecosystem Structure

NOAA CoastWatch: Operational Global Coverage Seascape Uncertainty



Science and Management

How well is the system characterized? How do we quantify atypical?

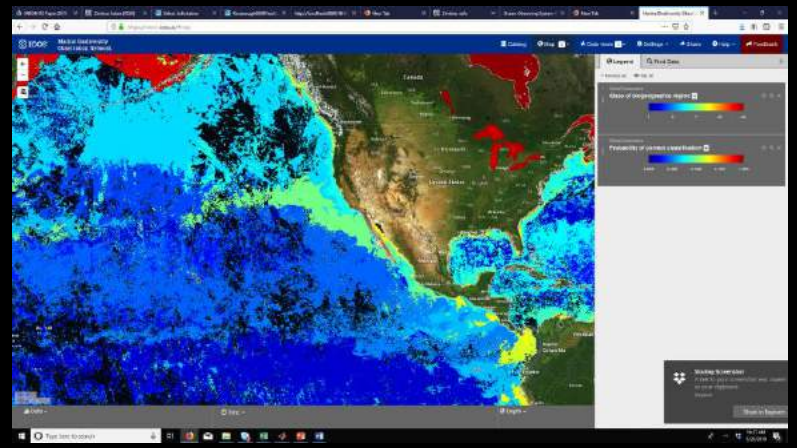
Where do we need better/more in situ data to classify habitat?

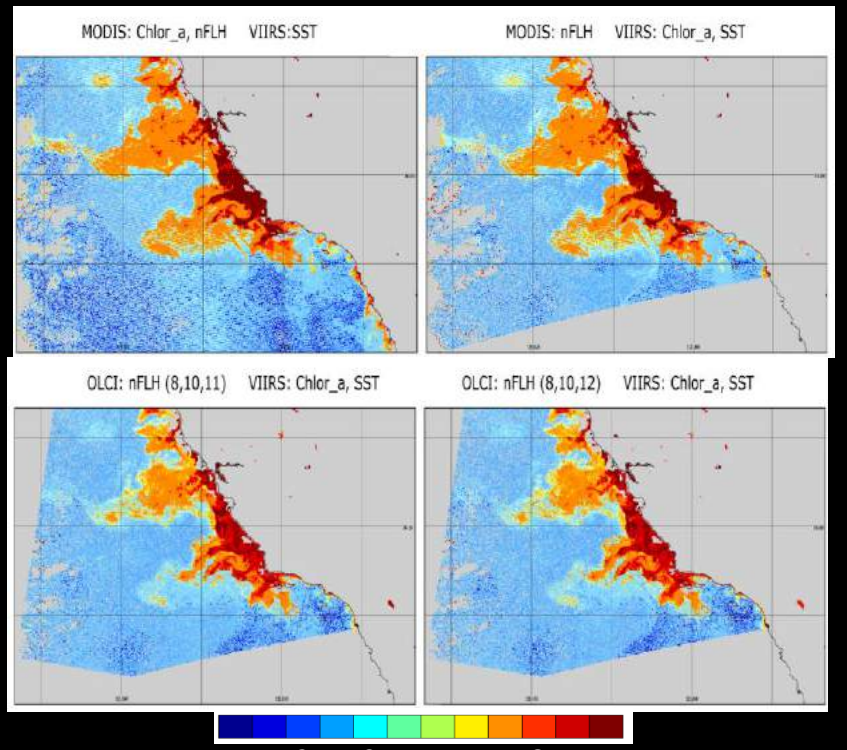
http://cwcgom.aoml.noaa.gov/cgom/OceanViewer/#

NOAA CoastWatch, NASA Coverage, MBON Explorer

Continuity: Comparisons between MODIS and VIIRS have been excellent

Opportunity for local downscaling case studies





Paul DiGiacomo, Michael Sarocco and Joaquin Trinanes, Vardis Tsontos and Jorge Vazquez, JPL, Axiom

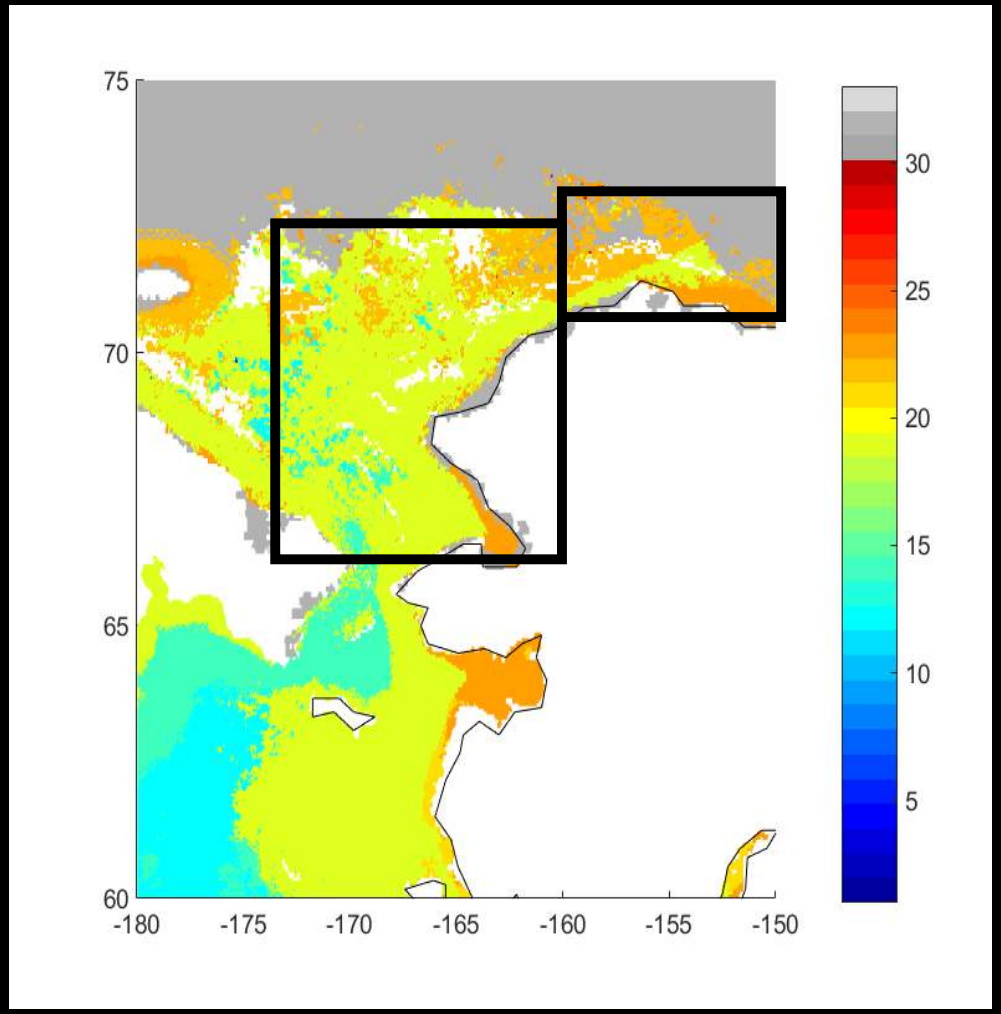
The CEOS Ocean Variables Enabling Research and Applications for GEO (*COVERAGE*) Initiative

CEOS
Committee on Earth Observation Satellites

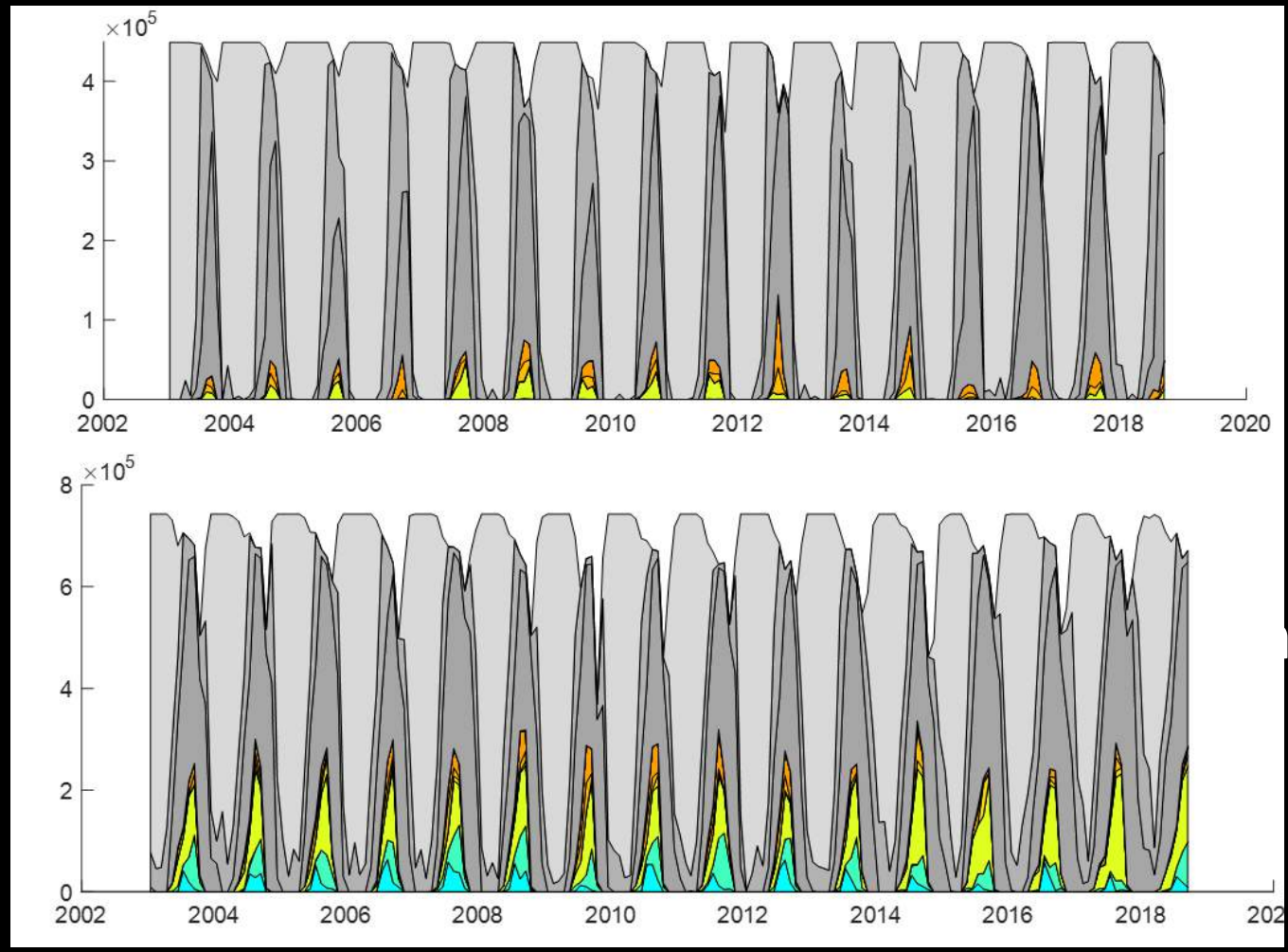
Dynamic Seascapes Metadata: Class ID, mean and variance of state, & dominant latitude, hemisphere and season

SEASCAPE ID NUMBER	NOMINAL DESCRIPTOR	SST (°C)	SSS (psu)	ADT (m)	ICE (%)	CDOM (m^-1)	CHLA (mg m^-3)	NFLH (W m^-2 um^-1 sr^-1)	NFLH:CHL	LATITUDE	DOMINANT HEMISPHERE	DOMINANT SEASON
1	NORTH ATLANTIC SPRING, ACC TRANSITION	5.08	34.18	-0.37	0	0.01	0.21	0.08	0.37	SUBPOLAR	SOUTH	SPRING-AUTUMN
2	SUBPOLAR TRANSITION	12.23	34.43	0.5	0	0.01	0.12	0.06	0.51	TEMPERATE	SOUTH	YEAR ROUND
3	TROPICAL SUBTROPICAL TRANSITION	24.12	35.34	0.68	0	0.01	0.15	0.06	0.4	TROPICAL	BOTH	YEAR ROUND
4	WESTERN WARM POOL SUBTROPICAL	28.25	34.4	1.1	0	0	0.06	0.05	0.79	SUBTROPICAL	BOTH	AUTUMN
5	SUBTROPICAL GYRE TRANSITION	23.95	35.89	0.71	0	0	0.07	0.04	0.5	SUBTROPICAL TEM	BOTH	AUTUMN-WINTER
6	ACC, NUTRIENT STRESS	1.38	34.01	-1	0	0.01	0.18	0.07	0.42	SUBPOLAR POLAR	SOUTH	WINTER
7	TEMPERATE TRANSITION	12.98	34.72	0.37	0	0.01	0.28	0.11	0.41	TEMPERATE	BOTH	WINTER
8	INDOPACIFIC SUBTROPICAL GYRE	25.13	34.52	0.99	0	0	0.07	0.02	0.34	SUBTROPICAL	BOTH	YEAR ROUND
9	EQUATORIAL TRANSITION	28.01	33.84	0.86	0	0.01	0.14	0.05	0.37	TROPICAL	BOTH	YEAR ROUND
10	HIGHLY OLIGOTROPHIC SUBTROPICAL GYRE	23.85	35.64	0.87	0	0	0.04	0.03	0.79	SUBTROPICAL	SOUTH	SUMMER
11	TROPICAL/SUBTROPICAL UPWELLING	22.94	34.79	0.83	0	0.01	0.27	0.11	0.39	TROPICAL,SUBTRO	BOTH	WINTER
12	SUBPOLAR	8.62	32.91	0.3	0	0.02	0.37	0.08	0.22	TEMPERATE/SUBP	BOTH	YEAR ROUND
13	SUBTROPICAL GYRE MESOSCALE INFLUENCED	23.47	35.89	0.52	0	0.01	0.1	0.02	0.19	SUBTROPICAL TEM	BOTH	SPRING-SUMMER
14	TEMPERATE BLOOMS UPWELLING	9.95	33.91	-0.01	0	0.03	0.84	0.16	0.19	TEMPERATE/SUBP	BOTH	SPRING SUMMER
15	TROPICAL SEAS	25.35	35.4	0.51	0	0.02	0.32	0.06	0.2	TROPICAL/SUBTRC	BOTH	WINTER
16	MEDITTERANEAN RED SEA	18.74	37.87	0.03	0	0.02	0.22	0.05	0.22	SUBTROPICAL/TEM	NORTH	WINTER
17	SUBTROPICAL TRANSITION LOW NUTRIENT STRESS	20.89	33.59	0.64	0	0.01	0.17	0.02	0.15	TROPICAL/SUBTRC	NORTH	SUMMER
18	MEDITTERANEAN RED SEA	21.94	37.72	-0.05	0	0.01	0.11	0.01	0.1	TEMPERATE/SUBP	BOTH	SPRING-SUMMER
19	ARTIC/ SUBPOLAR SHELVES	7.63	31.55	0.15	0	0.05	1.19	0.11	0.09	TEMPERATE/SUBP	BOTH	YEAR ROUND
20	SUBTROPICAL, FRESH INFLUENCED COASTAL	27.45	31.82	0.88	0	0.02	0.34	0.06	0.18	SUBTROPICAL	NORTH	WINTER/YEAR-ROUND
21	WARM, BLOOMS, HIGH NUTS	22.54	34.46	0.57	0	0.07	2.09	0.24	0.12	TROPICAL/SUBTRC	BOTH	WINTER/YEAR-ROUND
22	ARCTIC LATE SUMMER	6.26	30.1	-0.09	0.43	0.03	0.47	0.03	0.06	SUBPOLAR/POLAR	NORTH	SUMMER
	FRESHWATER INFLUENCED											

Regional Case Study: Arctic Marine Biodiversity Observing Network

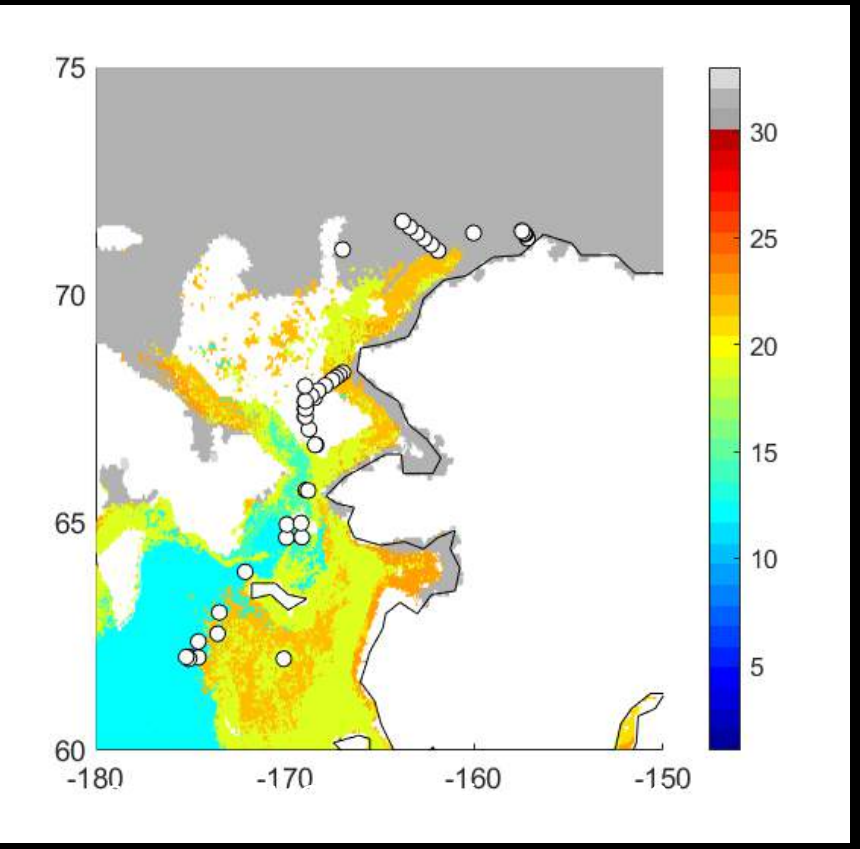


Dominant Seascape: Spatial Variability

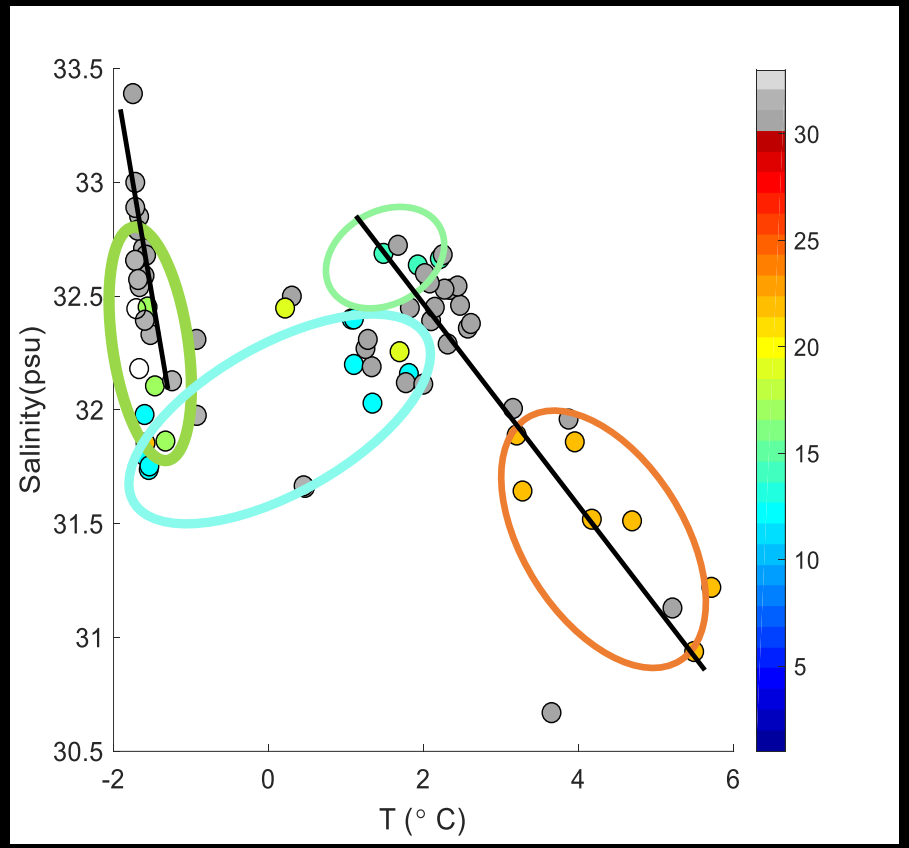


Areal extent of habitat in Beaufort (top) and Chukchi (bottom)

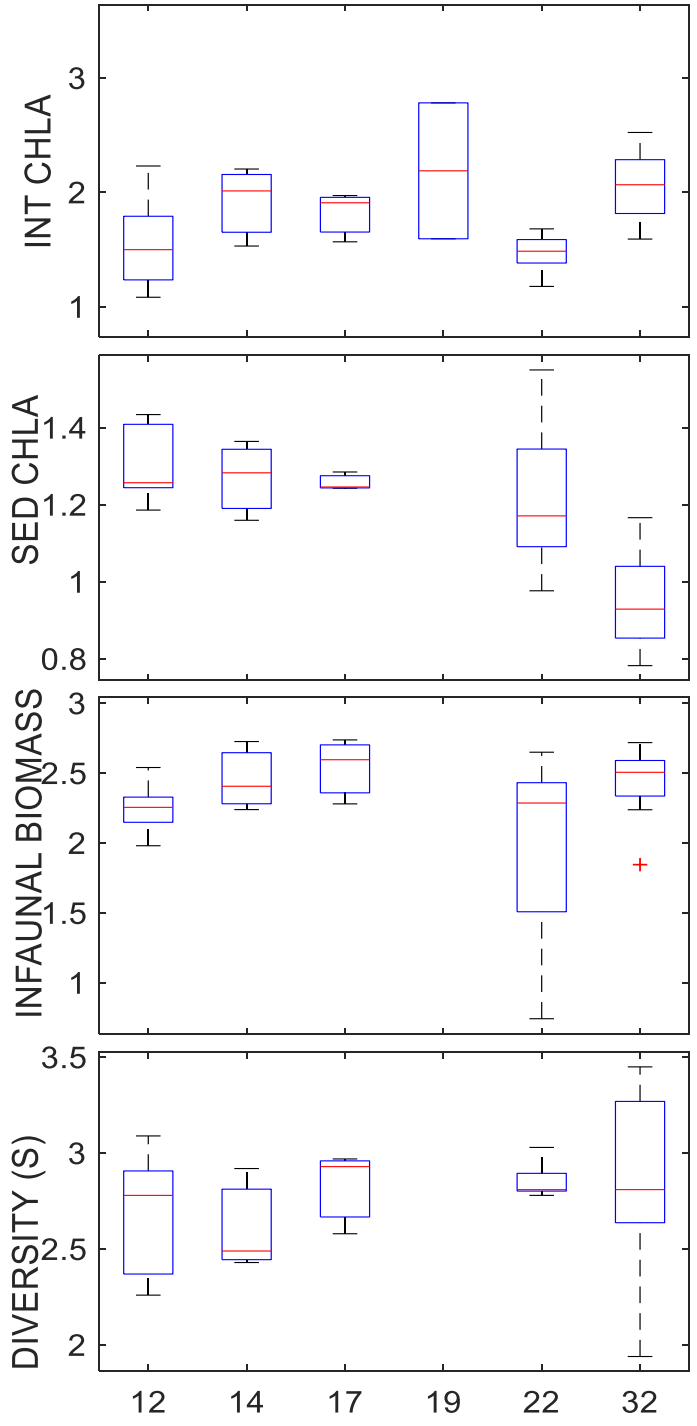
Distributed Biological Observatory: Do satellite seascapes reflect meaningful benthic patterns?



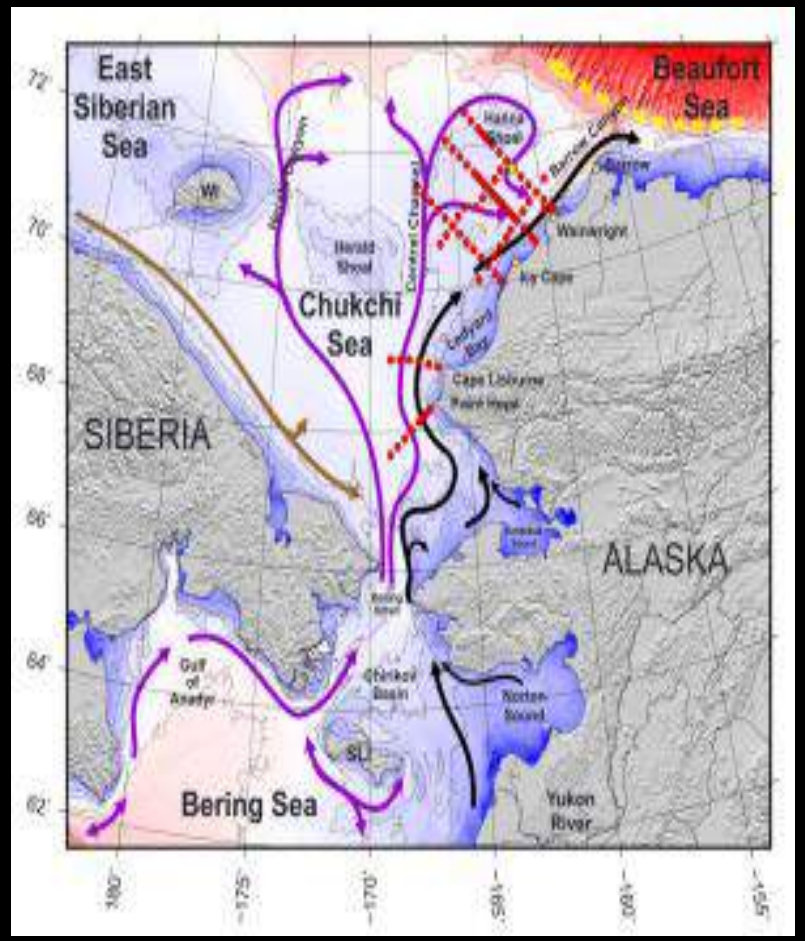
Dominant Seascape (July):
DBO sites 2013 and 2014



Benthic Temp and Salinity
Depth= 40-130 m



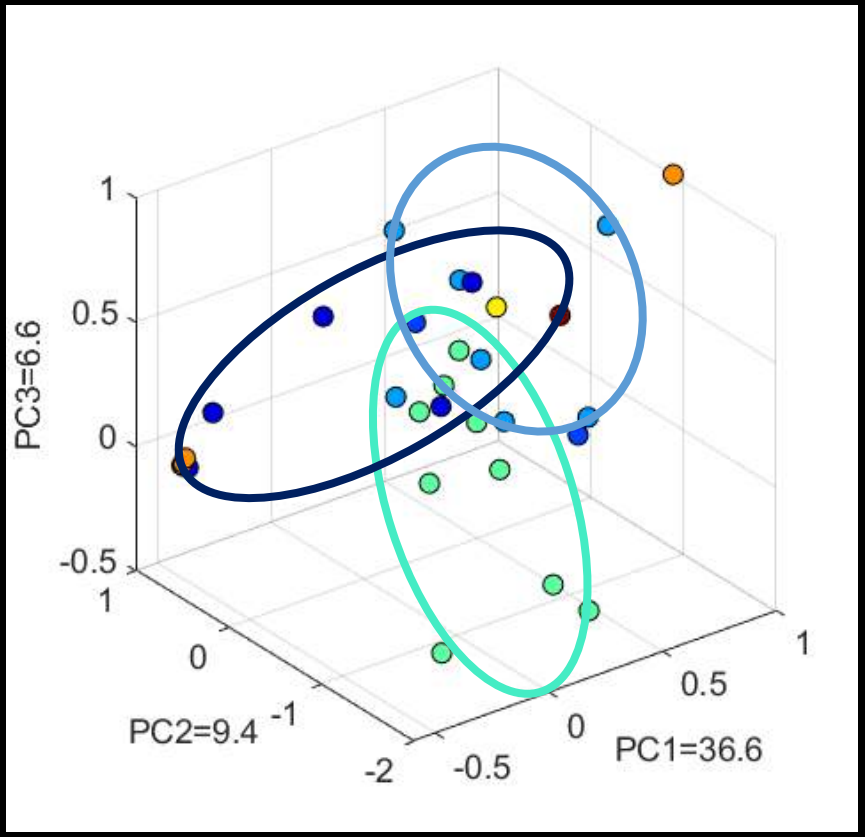
Regional Case Study: Arctic Marine Biodiversity Observing Network



Dataset: Zooplankton community structure 2008-2015

- 174 Unique Taxa
- ~1800 samples

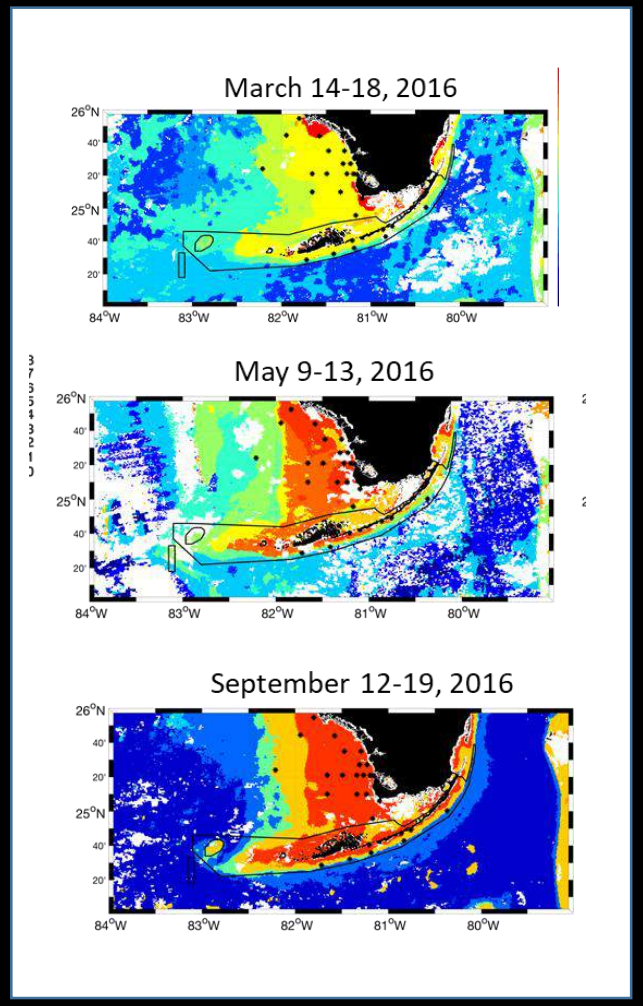
Current analysis: 0-50 m 150 mesh, Septembers



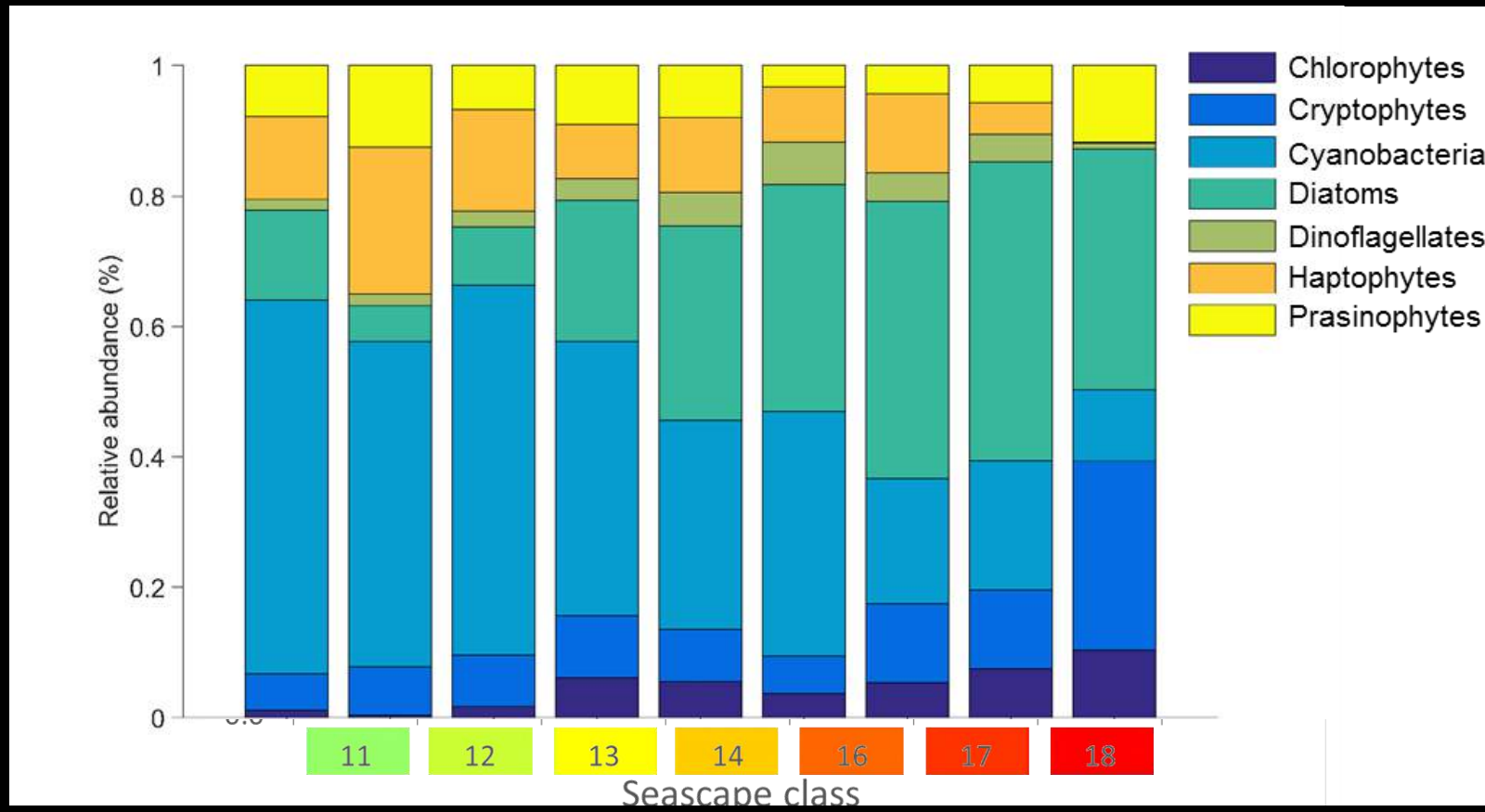
Arctic MBON; Distributed Biological Observatory

Florida: Seascapes plan ship-based studies & describe unique microplankton assemblages

Florida Keys NMS:
RV Walton Smith



Phytoplankton community structure varies with seascape



Enrique Montes et al., soon to be submitted

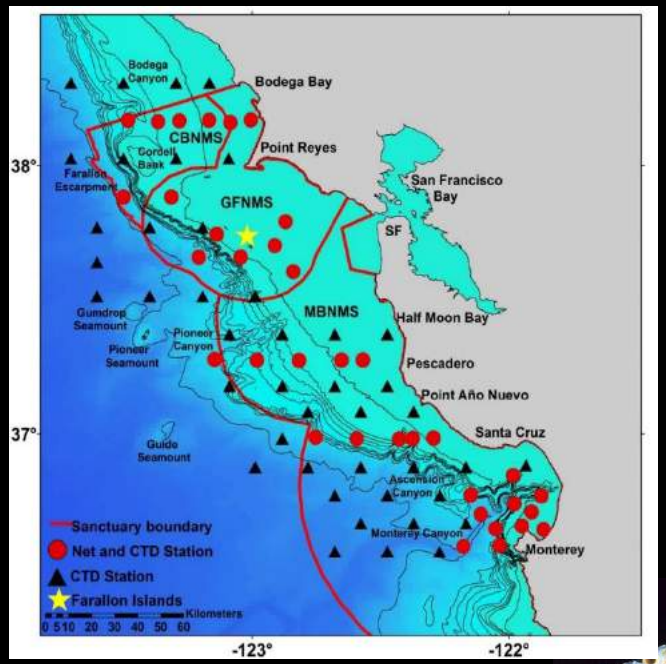
California: Seascapes as fish habitat indicator

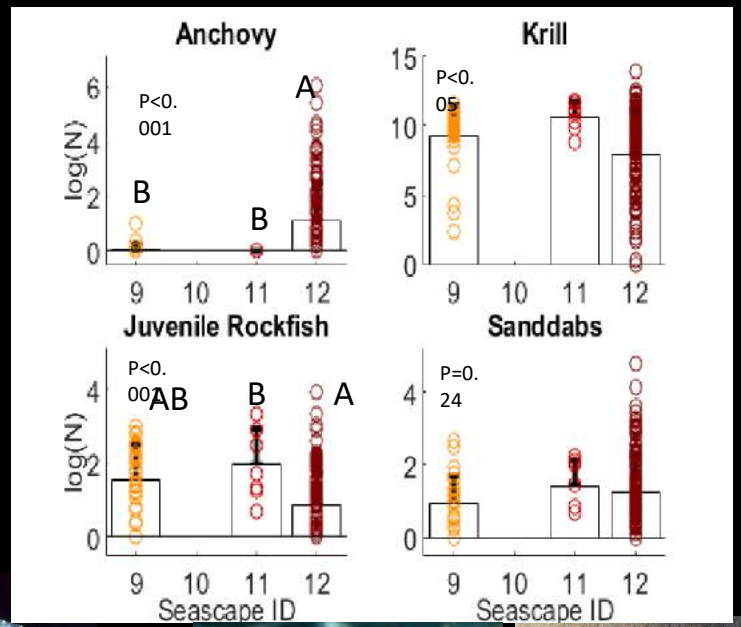
Forage fish abundance and occupancy across seascapes

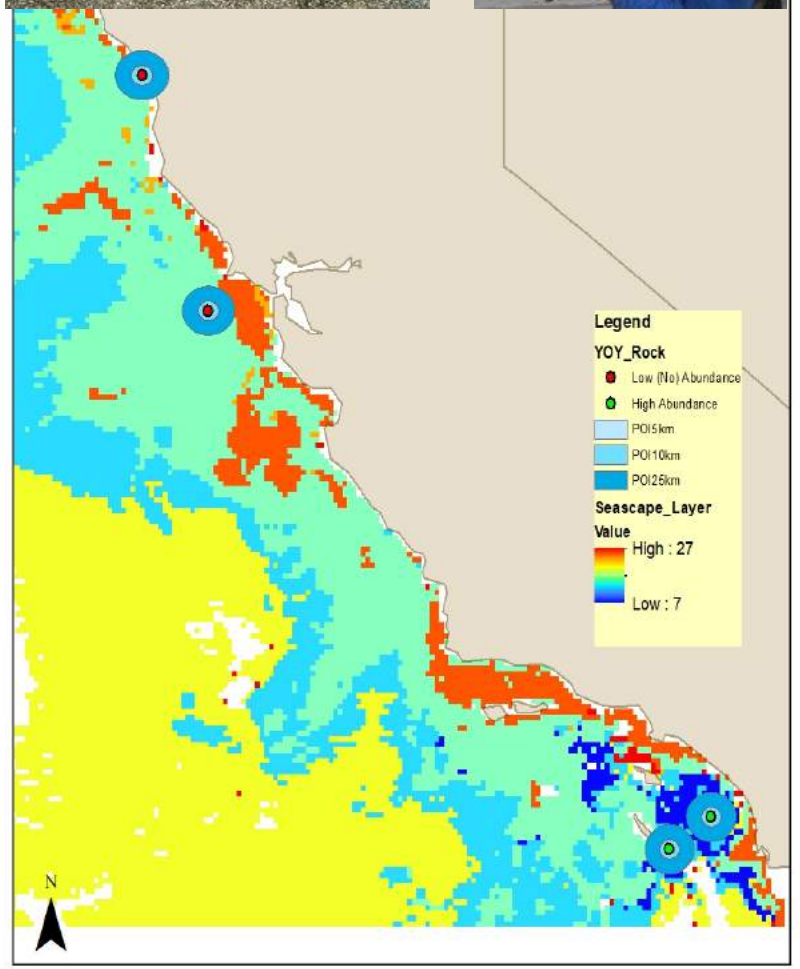
Collaboration with NOAA Southwest Fisheries Science Center

Monterey Bay National Marine Sanctuary

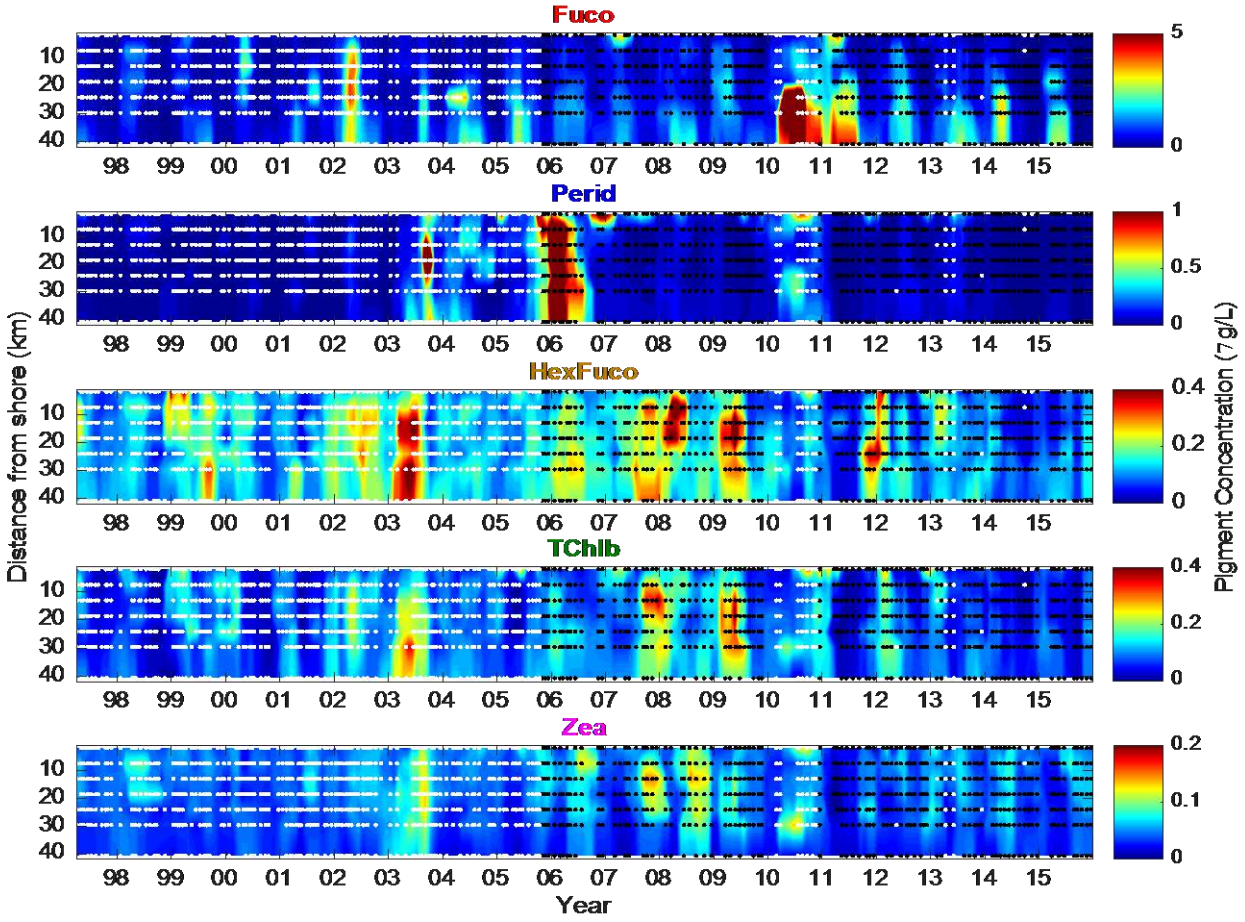
Will Klabjor, Marine Resource Management MS







SBCLTER MBON: Biomarker Pigment Time Series



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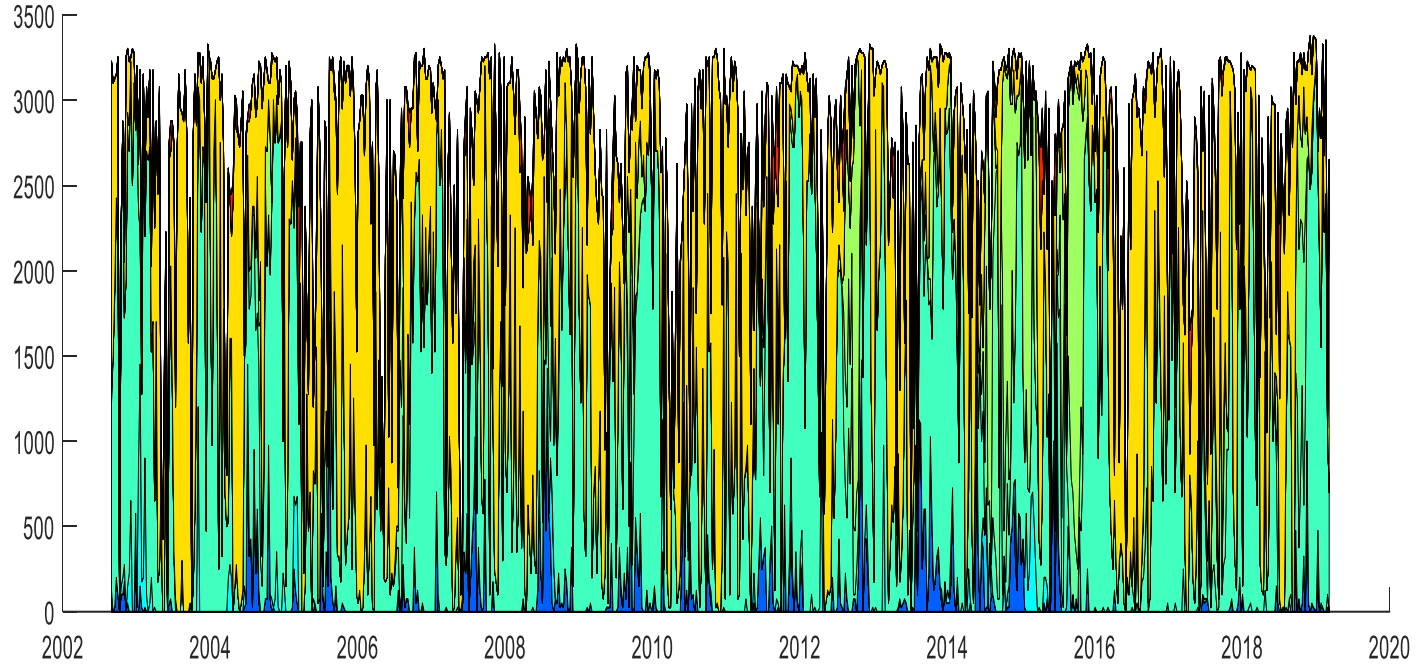
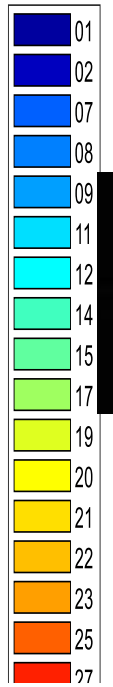
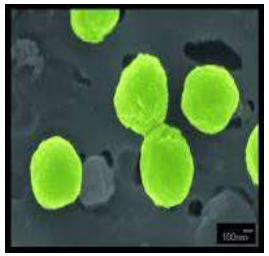
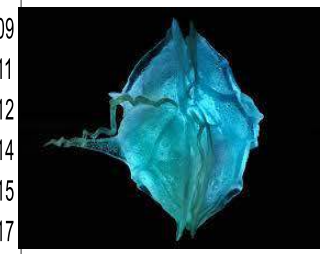
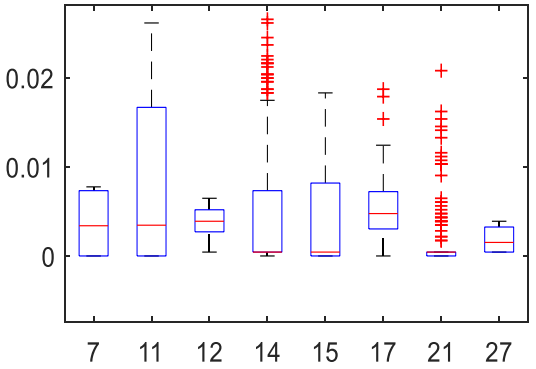
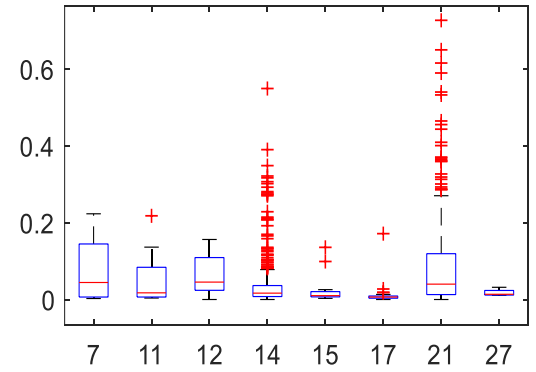


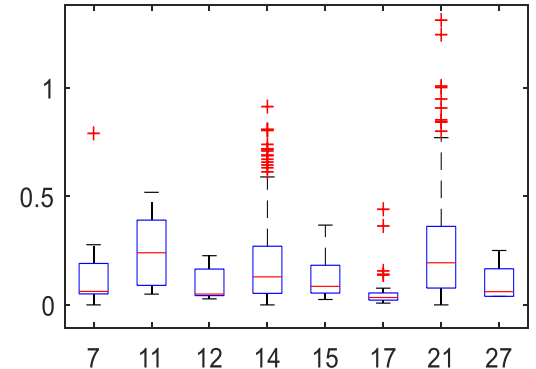












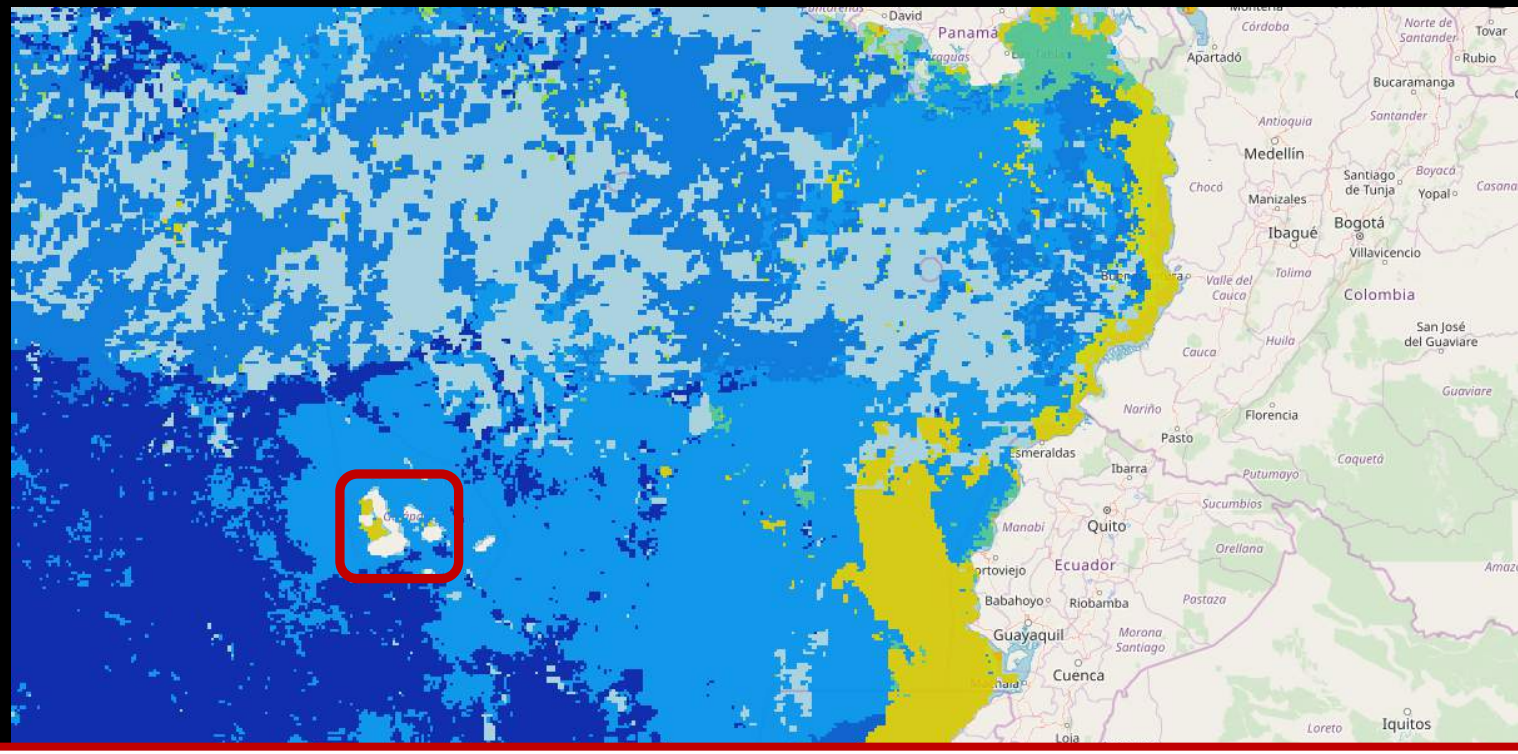
MBON Pole to Pole Montes et al.

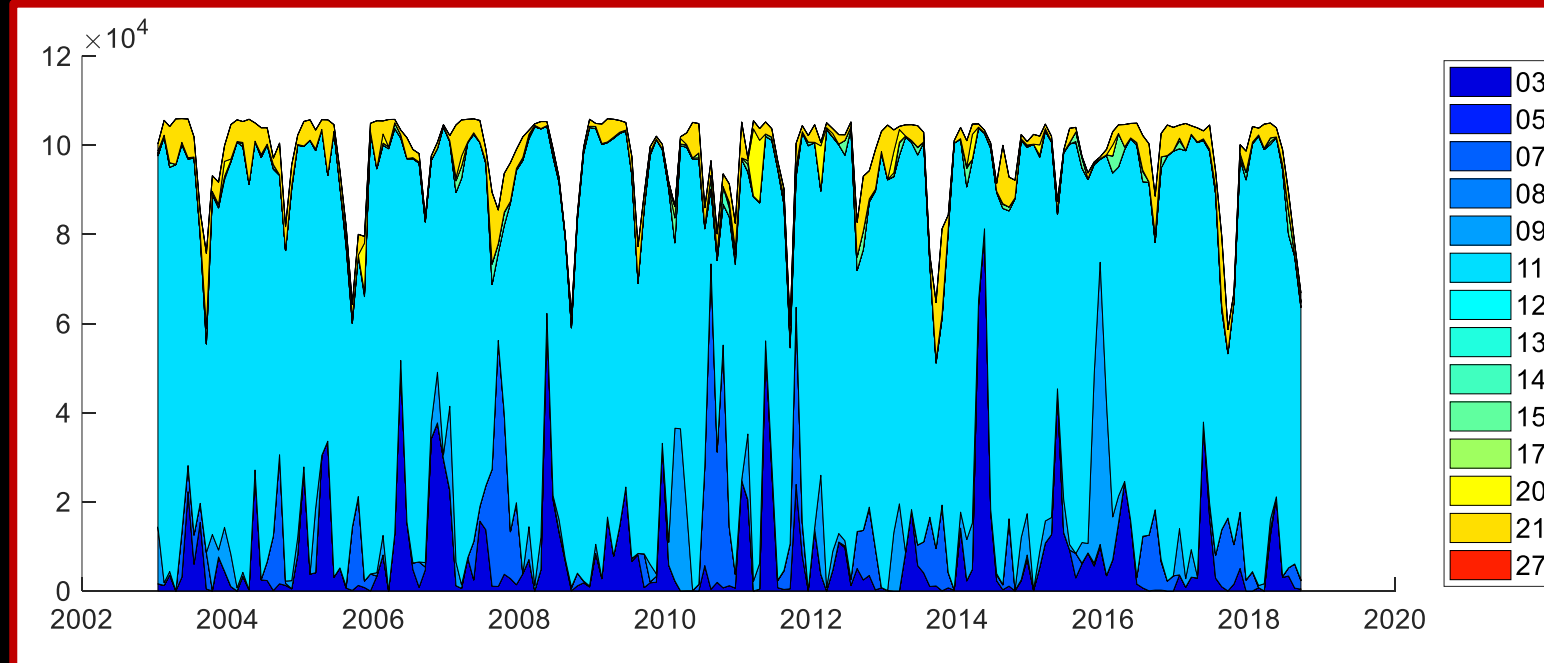
Littoral zone biodiversity monitoring across Americas

Community of Practice: sharing and synthesis

Building access and understanding of ocean remote sensing

Science informing management (re-zoning of Galapagos marine reserves)



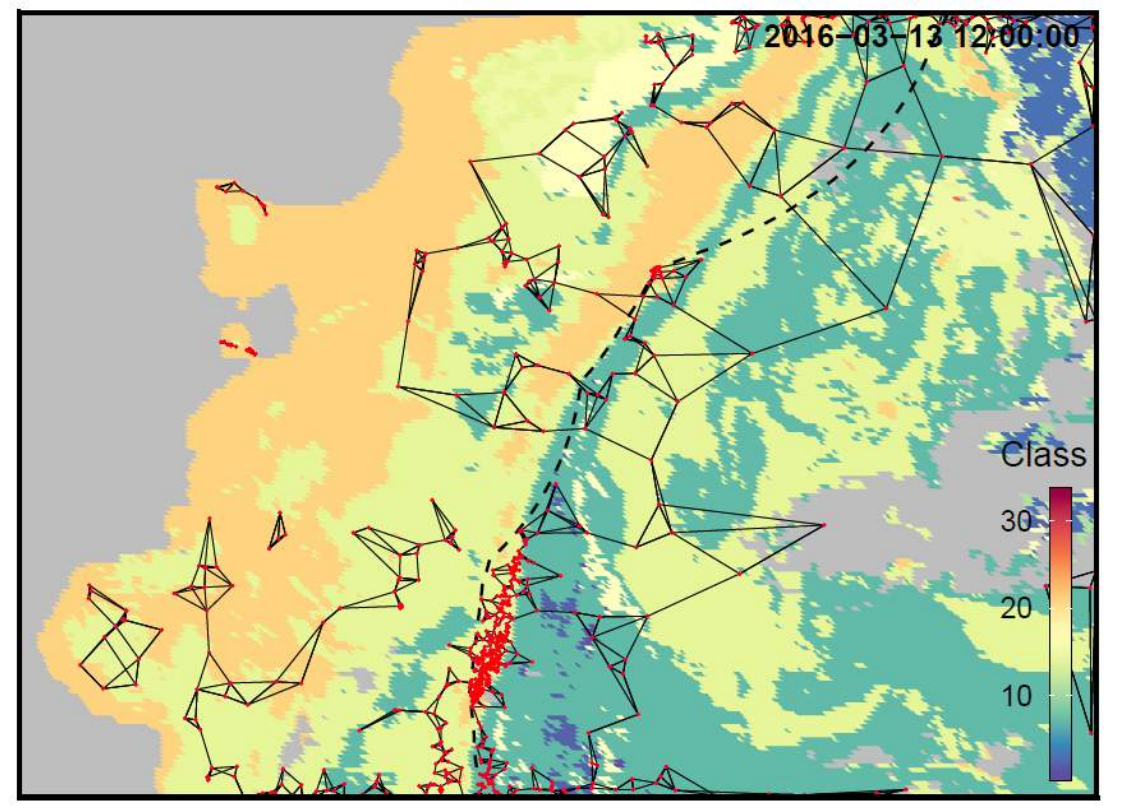


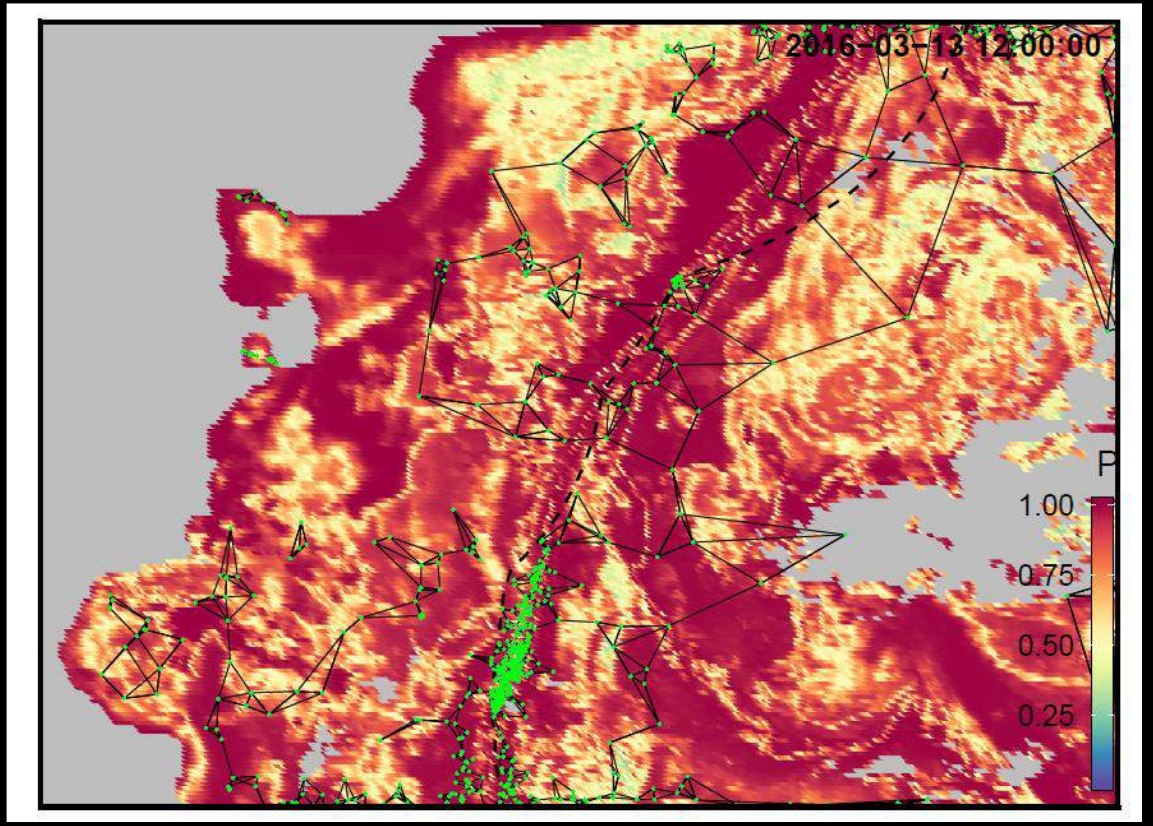
Anticipating Illegal, Unreported, Unregulated (IUU) Activities:

James Watson, John Woodill OSU

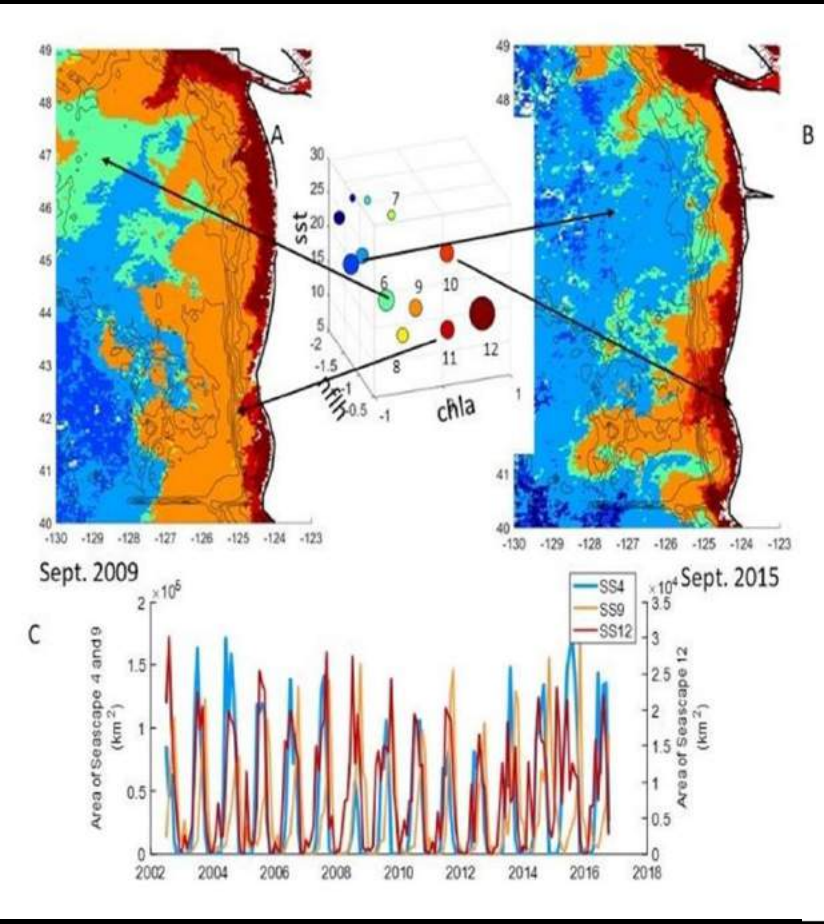
14 LIFE BELOW WATER

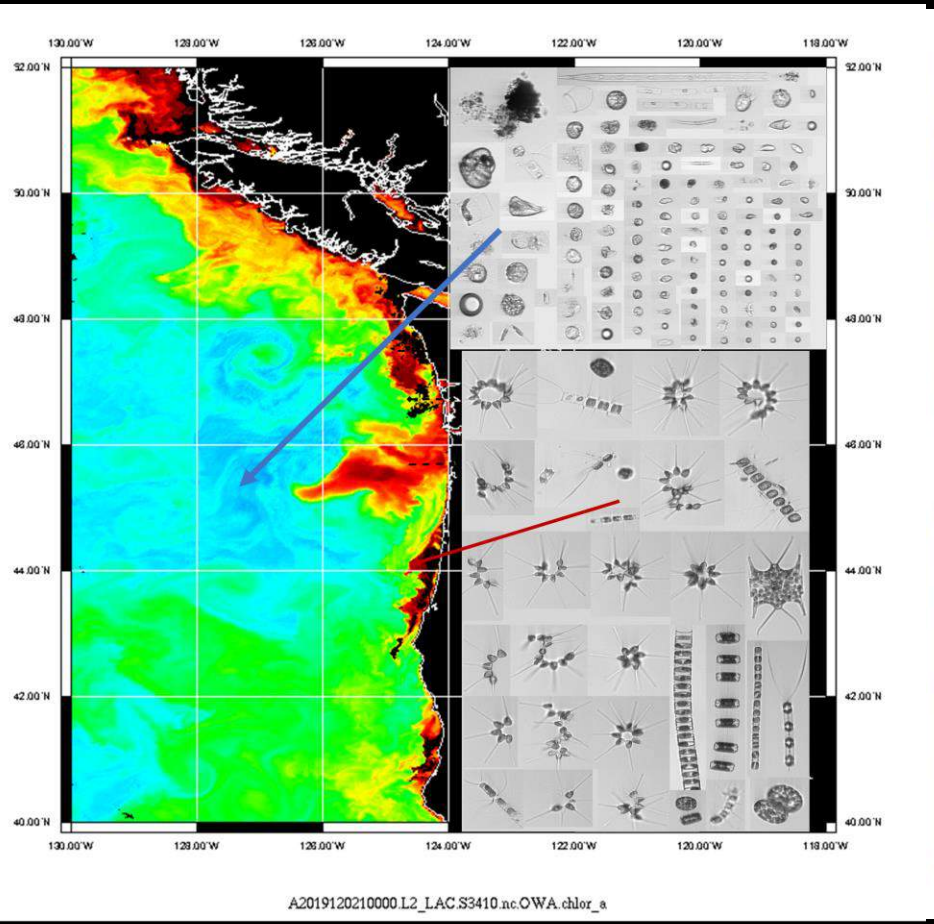
Does the fleet respond to dynamic features?

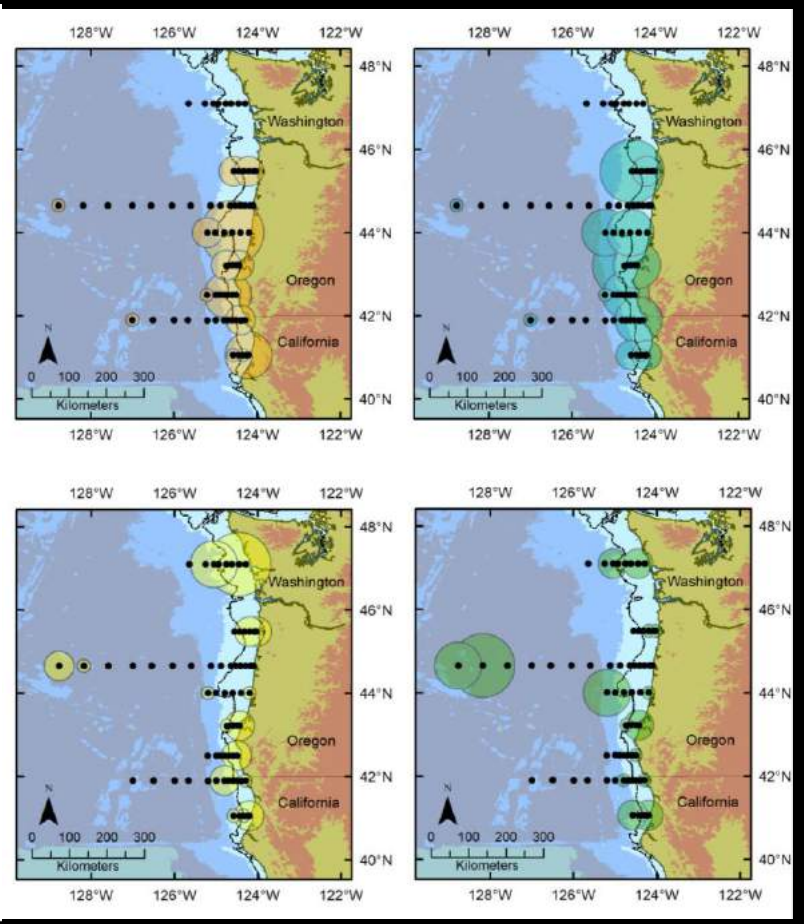




Testing hypotheses in the Northern California Current: Regional Capacity building, NH line (1993- present) context How portable is the MBON?







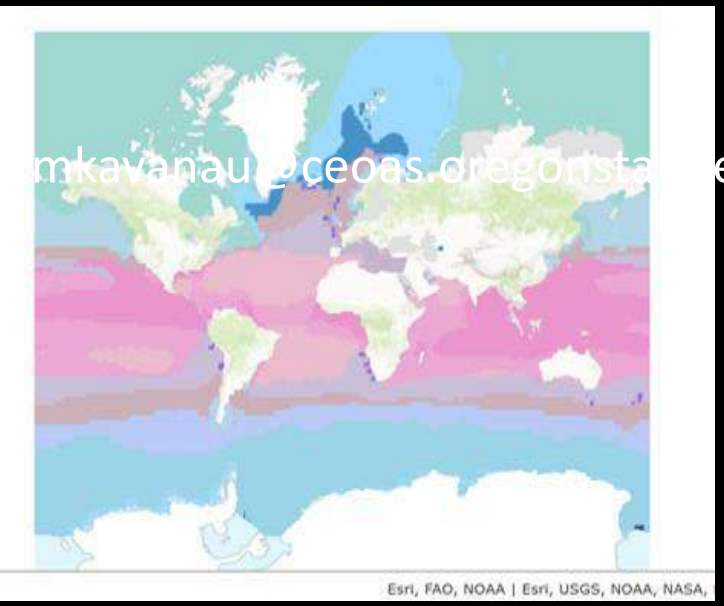
Dynamic seascapes: global M(arine)-BON

Ongoing: Satellite-derived seascapes provide a metric of pelagic habitat geography (extent, location, representativeness) to inform EBV process

Continue to test hypotheses across ecosystems, trophic levels, occupancy metrics, and species distribution models.

Partnership with ESRI/USGS for EMU seascape comparison
Matt Oliver (University of Delaware)- global classification comparisons

Real-time monitoring and adaptive management: Axiom and NOAA Coastwatch, MBON Explored, and NASA COVERAGE



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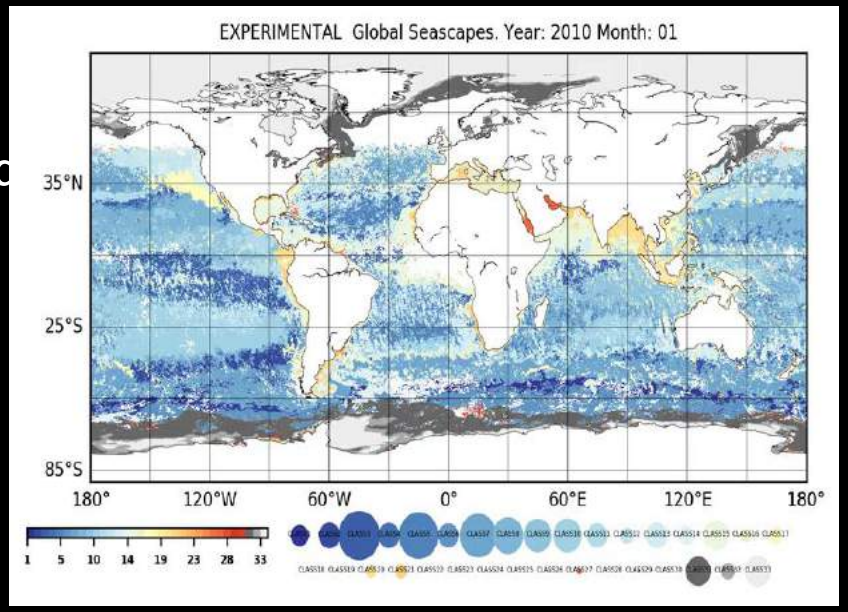
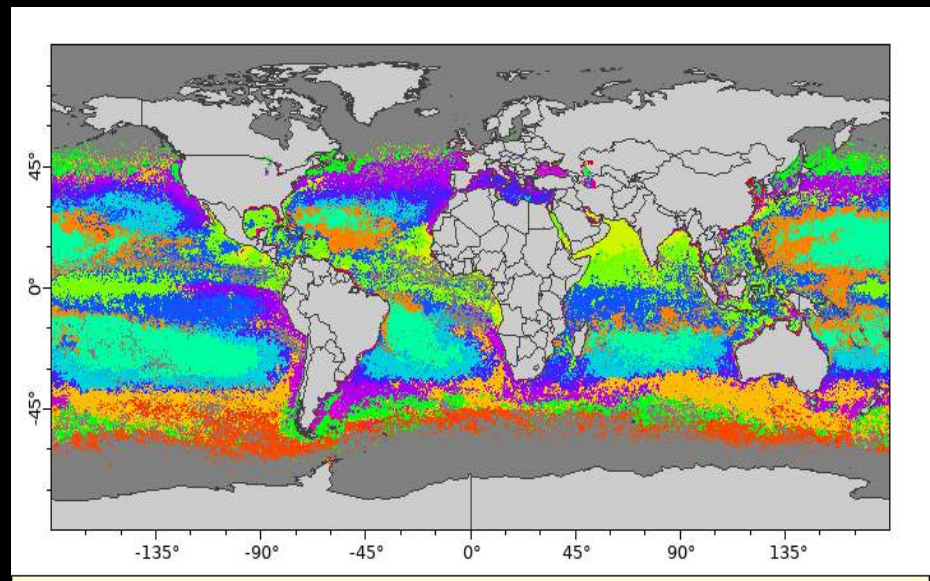
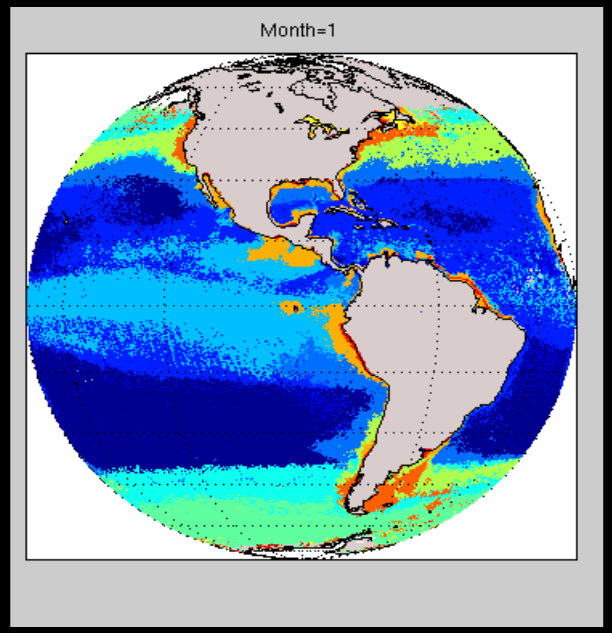




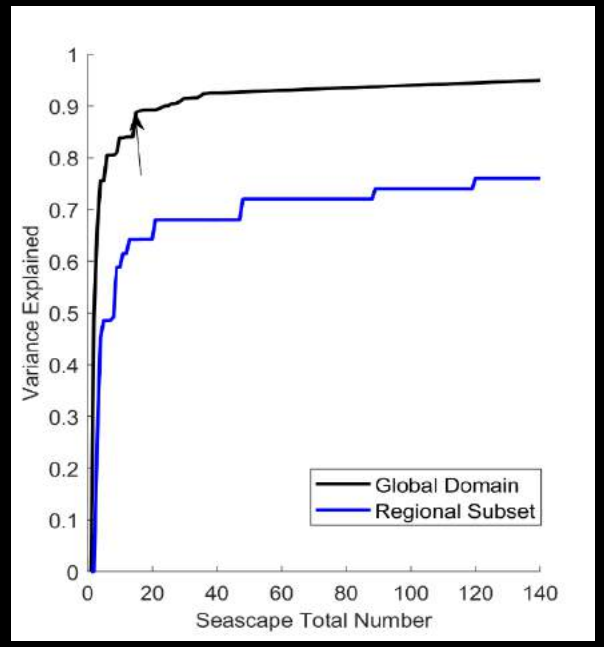
Global to regional trends: local variability and local products

Global classification



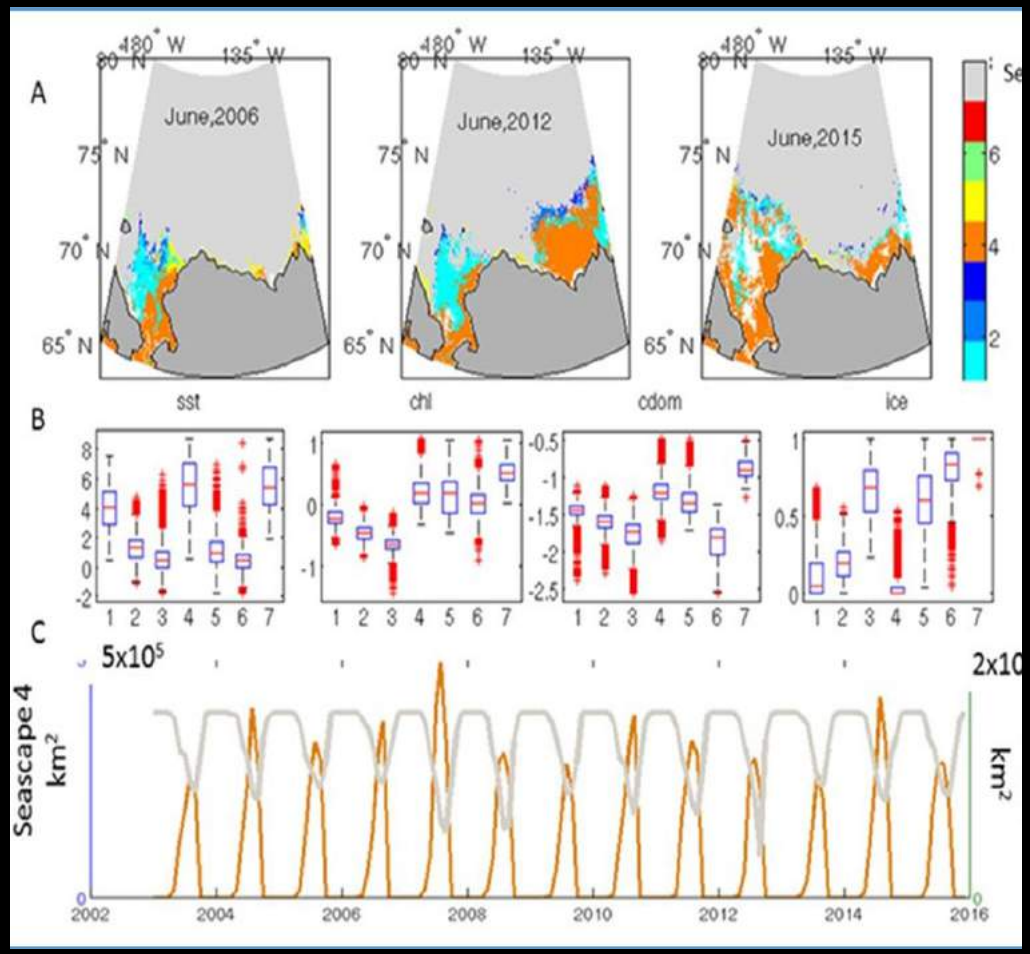
- Globally relevant variables:
- SST, chl-a, nFLH, SSH, SSS
- Seasonal, >9km resolution
- N=15 – 30 (variable dependent)

Systematic Hierarchical Downscaling



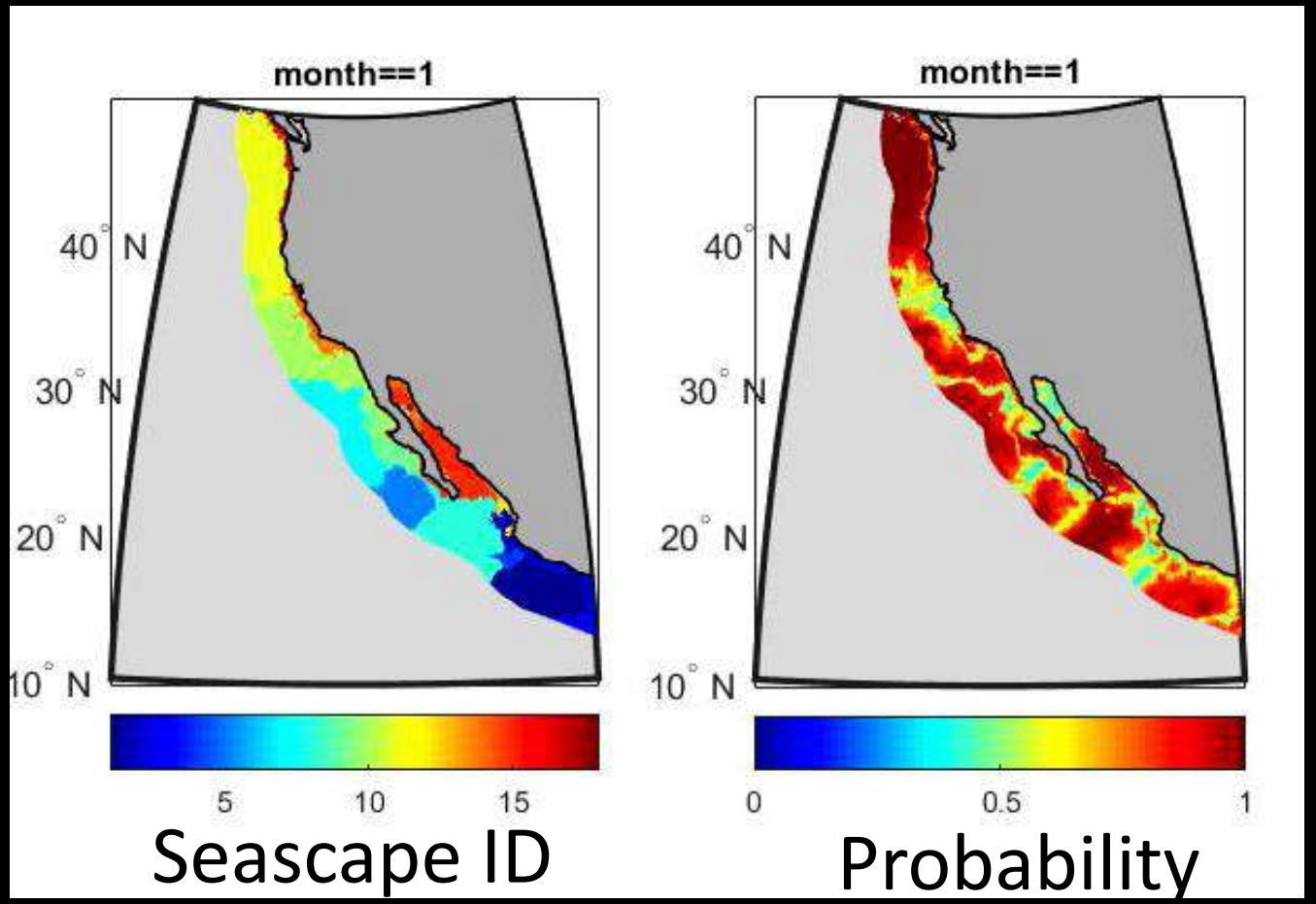
- Sequential MANOVA: regional domain using global seascapes (gSS)
- 7 regional SS (70%) > 20 gSS
- 12 regional SS (75%) > 50 gSS

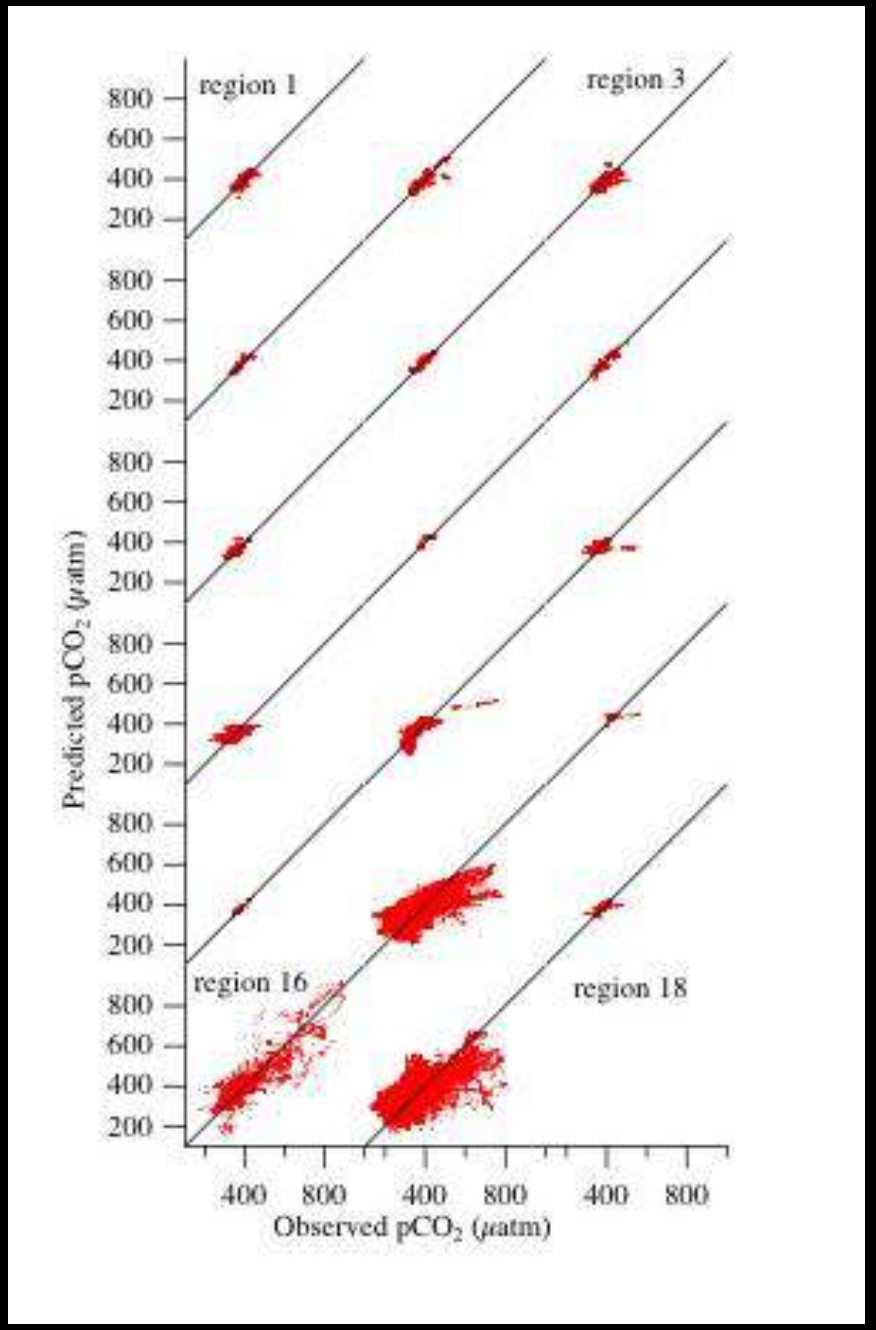
Regional dynamic maps



Research to transition?

Dynamic seascapes improve skill, models have fewer empirical parameters





A synoptic time series of carbonate system parameters from space is cool, but ……. Is it useful for ecology?