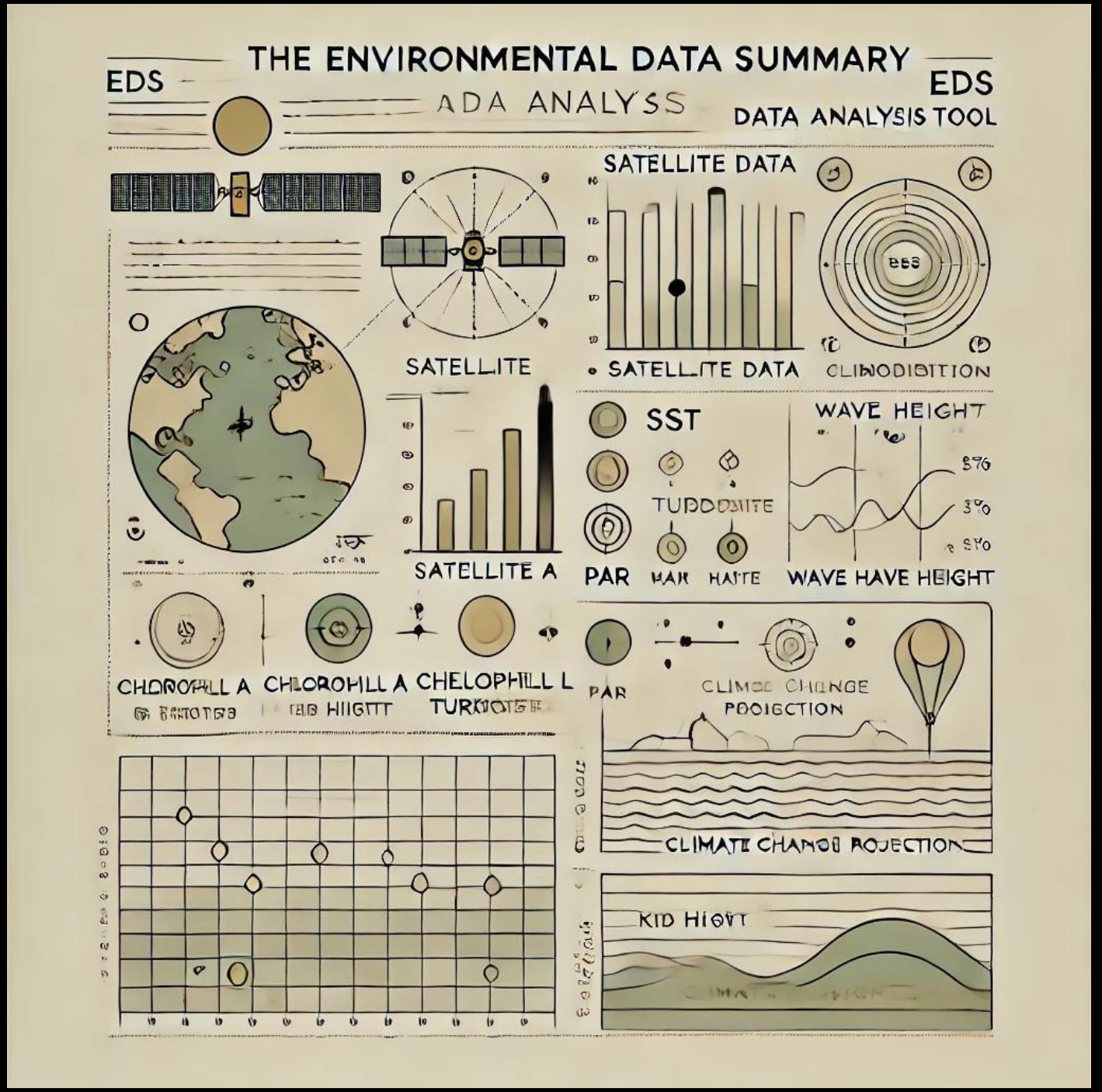
Environmental Data Summary (EDS) with Current & Next-Gen Satellite & Modelled Data

Kisei Tanaka | kisei.tanaka@noaa.gov
Lunch & Learn, June 25, 2024



Topics I'll Cover While You Eat

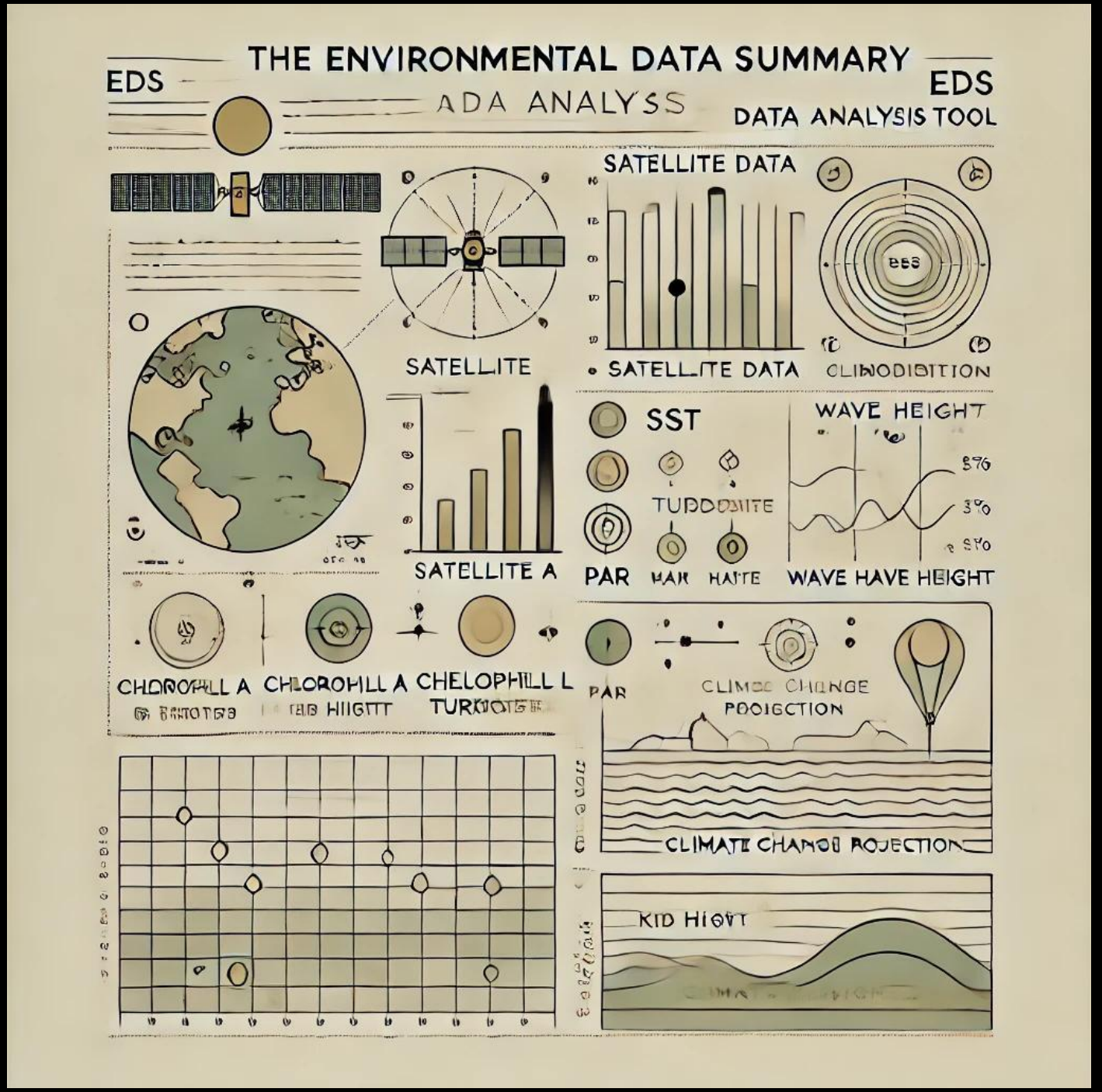
Environmental Data Summary 101

Current Datasets through EDS

Next Gen Datasets

- 2024 Annual coastwatch meeting

Prospects in EDS



Environmental Data Summary (EDS)

WHAT IS IT?

an R-based program to **enhance *in situ* data** with gridded external environmental data at different temporal scales

WHAT DOES IT DO?

download and extract **temporally-summarized** satellite and modeled oceanographic data by point and time

HOW IS IT USEFUL?

- **efficiency**
- data summaries specific to point locations
- subsequent **correlative & statistical analyses**

NOAA EDS Team

- Originally conceptualized and developed by Tom Oliver
- Revised and maintained by:

Tom Oliver

Kisei Tanaka

Jessie Perelman

Juliette Verstaen

- QA/QC archived on NOAA InPORT (#65209)

The history of EDS

Tom Oliver creates EDS

build an in-house repository of gridded satellite data for the PI region & provide end users with temporally summarized remote data paired with in situ survey data

submitted to NCEI

first version of EDS is submitted and archived

Jessie Perelman and Juliette Verstaen join

continue the work with Kisei

2018

2020

Kisei Tanaka joins

build out EDS into singular operational tool and add more regions and datasets

2021

Early 2022

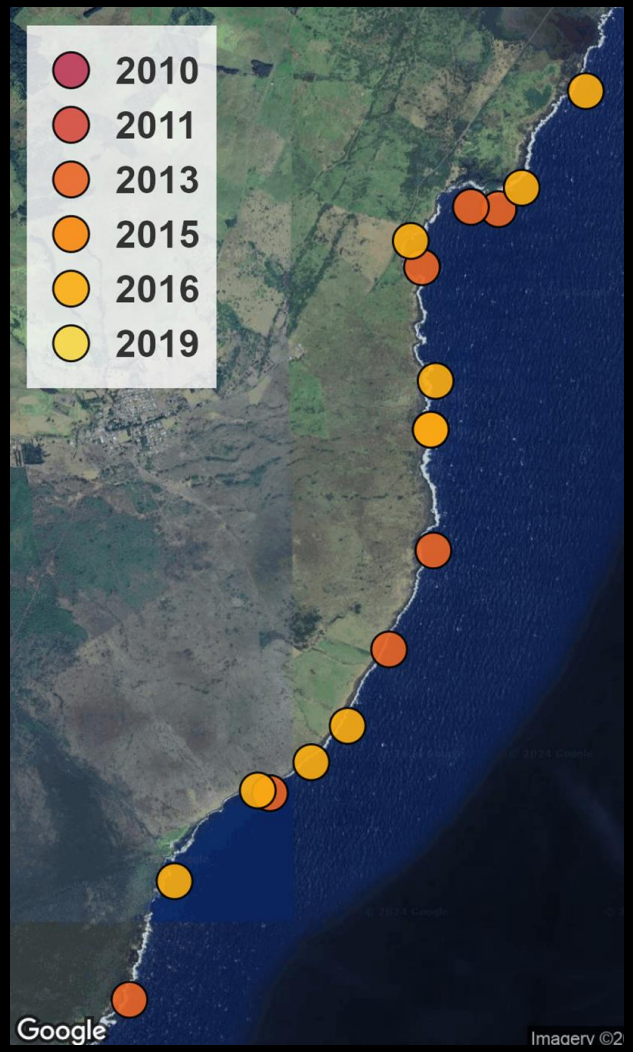
EDS outputs available on InPort

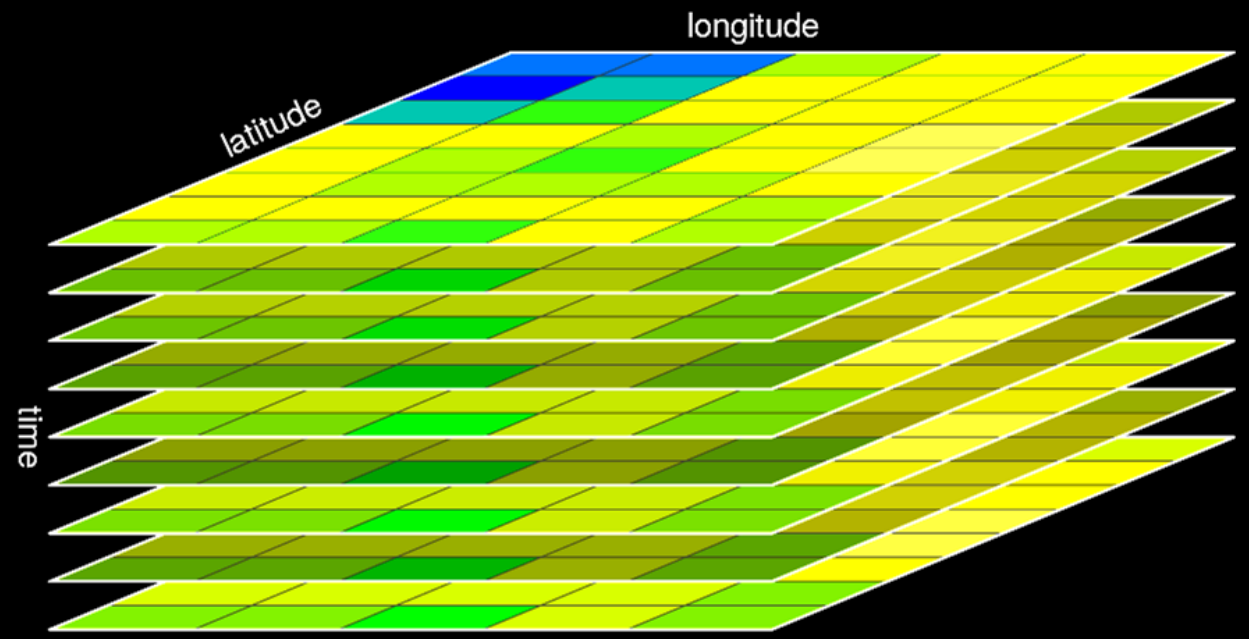
Fall 2022

EDS has evolved into an institutional resource, incorporated into over 40 projects and available as an R package.

How does EDS work? -

by matching in situ observations (*O*) with spatially and temporally resolved data (*D*)





$$M(O(x,y,t),D(x,y,t),P(x,y,t-n))$$

x, y = coordinates

t = time

Georeferenced and time-stamped survey

SST values matched by coordinates and time

Site	Lon	Lat	Date	Fish/m2	Daily SST
A	-157.85	21.28	07/21/2019	3.2	27.54
B	-158.28	21.57	08/02/2019	5.5	28.25
C	-157.65	21.29	10/31/2019	2.1	27.59

$$M(O(x, y, t), D(x, y, t))$$

Georeferenced and time-stamped survey

Temporally summarized historical SST values matched by coordinates and time

Site	Lon	Lat	Date	Fish/m2	Monthly SST Mean	Monthly SST SD
A	-157.85	21.28	07/21/2019	3.2	27.38	0.55
B	-158.28	21.57	08/02/2019	5.5	27.66	0.27
C	-157.65	21.29	10/31/2019	2.1	27.75	0.23

$$M(O(x, y, t), D(x, y, t), P(x, y, t - n))$$

Georeferenced and time-stamped survey

Combination of temporally summarized dynamic environmental drivers and anthropogenic values matched by coordinates and time

Site	Lon	Lat	Date	Fish/m2	Monthly Chl-a SD	10 years Precip Range	Pop. Density	Total Effluent
A	-157.85	21.28	07/21/2019	3.2	0.3	25.5	432	3.2
B	-158.28	21.57	08/02/2019	5.5	0.5	6.2	34	22
C	-157.65	21.29	10/31/2019	2.1	0.8	4.3	345	7.4

$$M(O(x,y,t),D(x,y,t),P(x,y,t-n))$$

Essential Fish Habitat, JCR-FMP, NCRMP, ESA Coral, AIS, Protected Species, Pelagic Ecosystem… (~40 projects)

Bathymetry & Rugosity

Continuously Updated Digital Elevation Model (~3m)

Coastal Relief Model (~30m)

ETOPO Global Relief Model (~450m)

Multibeam Bathymetry Synthesis (~5-50m)

Sea Surface Temperature

Geostationary-Polar-orbiting Blended Night-only SST Analysis

Multi-scale Ultra-high Resolution SST

Hadley Centre SST

Centennial in situ Observation-Based Estimates SST

NOAA Extended Reconstruction SST

Ocean Color (Chl-A, Turbidity.. etc)

ESA Climate Change Initiative Ocean Colour

Visible Infrared Imaging Radiometer Suite (VIIRS)

Aqua Moderate Resolution Imaging Spectroradiometer (MODIS)

And more…

Global Ocean Data Assimilation System ➡ mixed layer depth, sea surface height, etc.

CHIRPS: Rainfall Estimates

MIRAS Soil Moisture and Ocean Salinity satellite (SMOS)

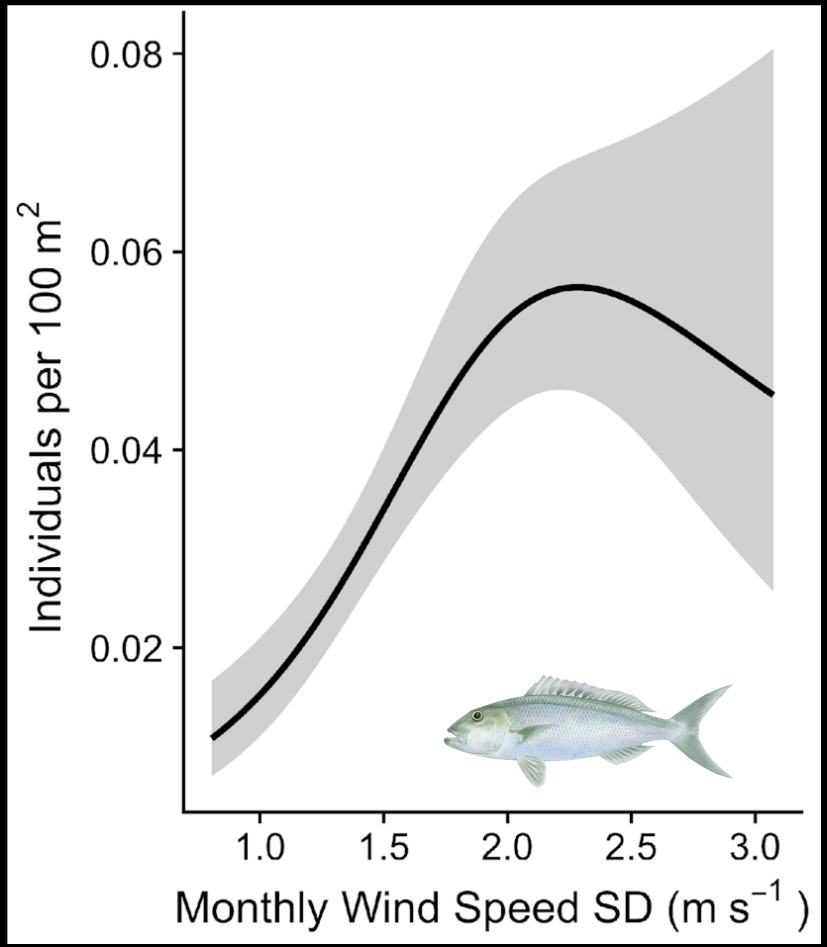
Wave Watch III & SWAN ➡ wave height, direction, period etc

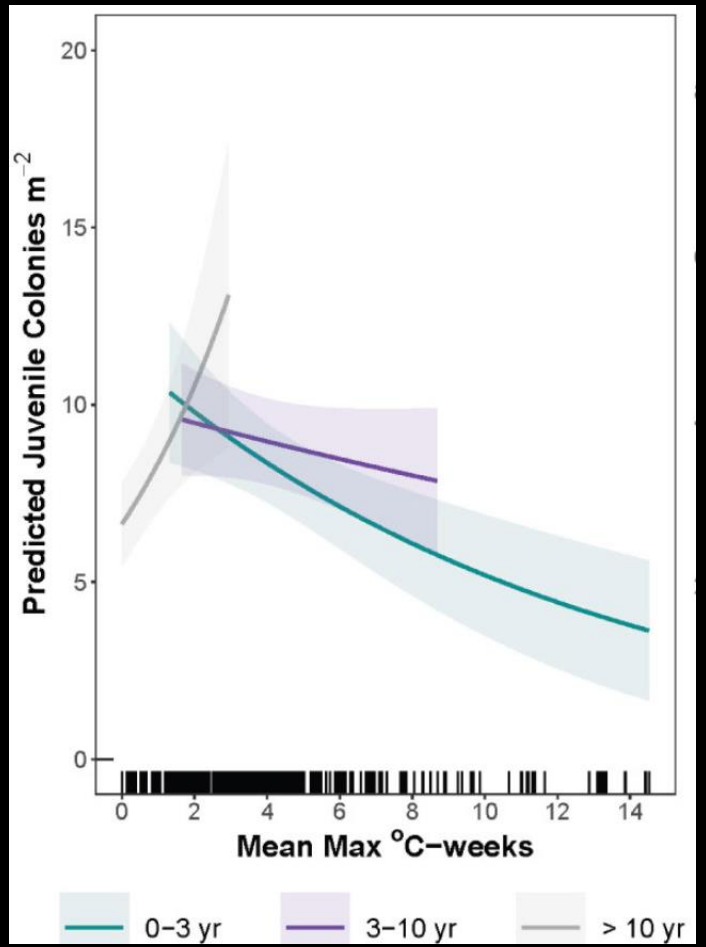
Advanced Scatterometer (ASCAT) ➡ wind speed, direction

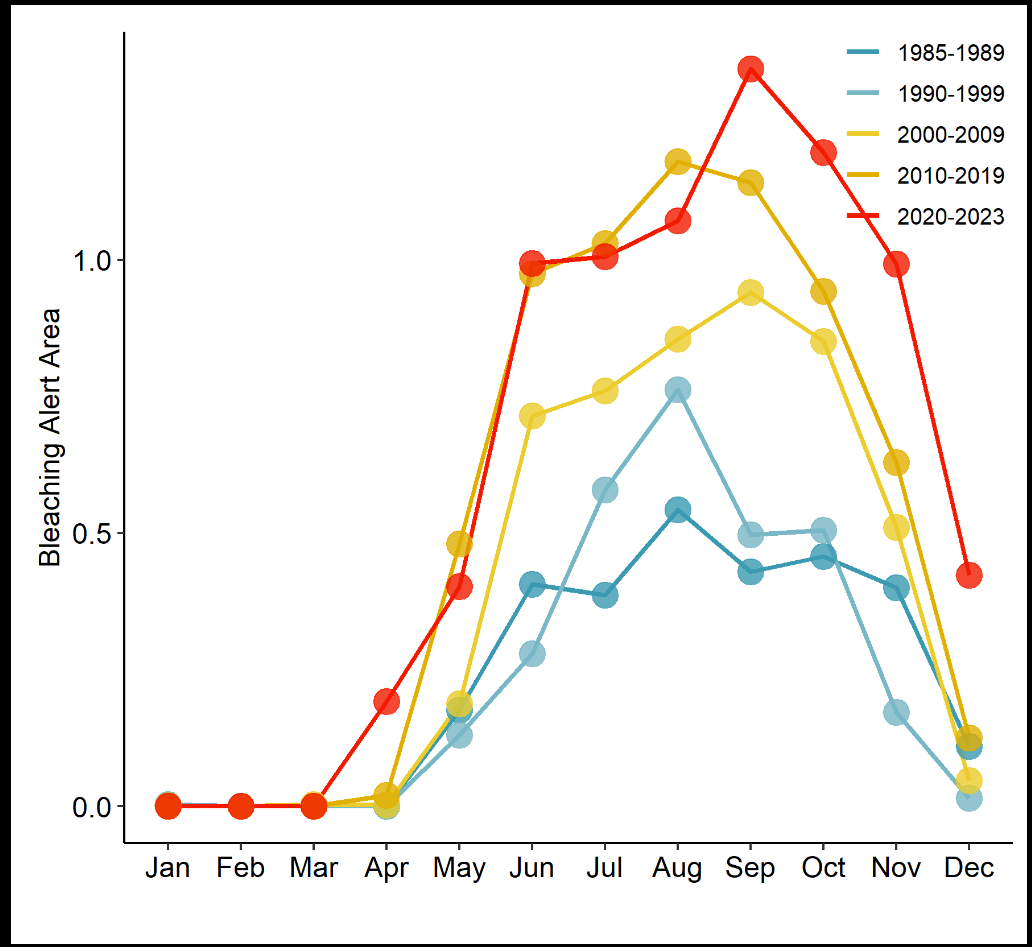
fish

reef

island







Tanaka et al. 2022

Couch et al. 2023

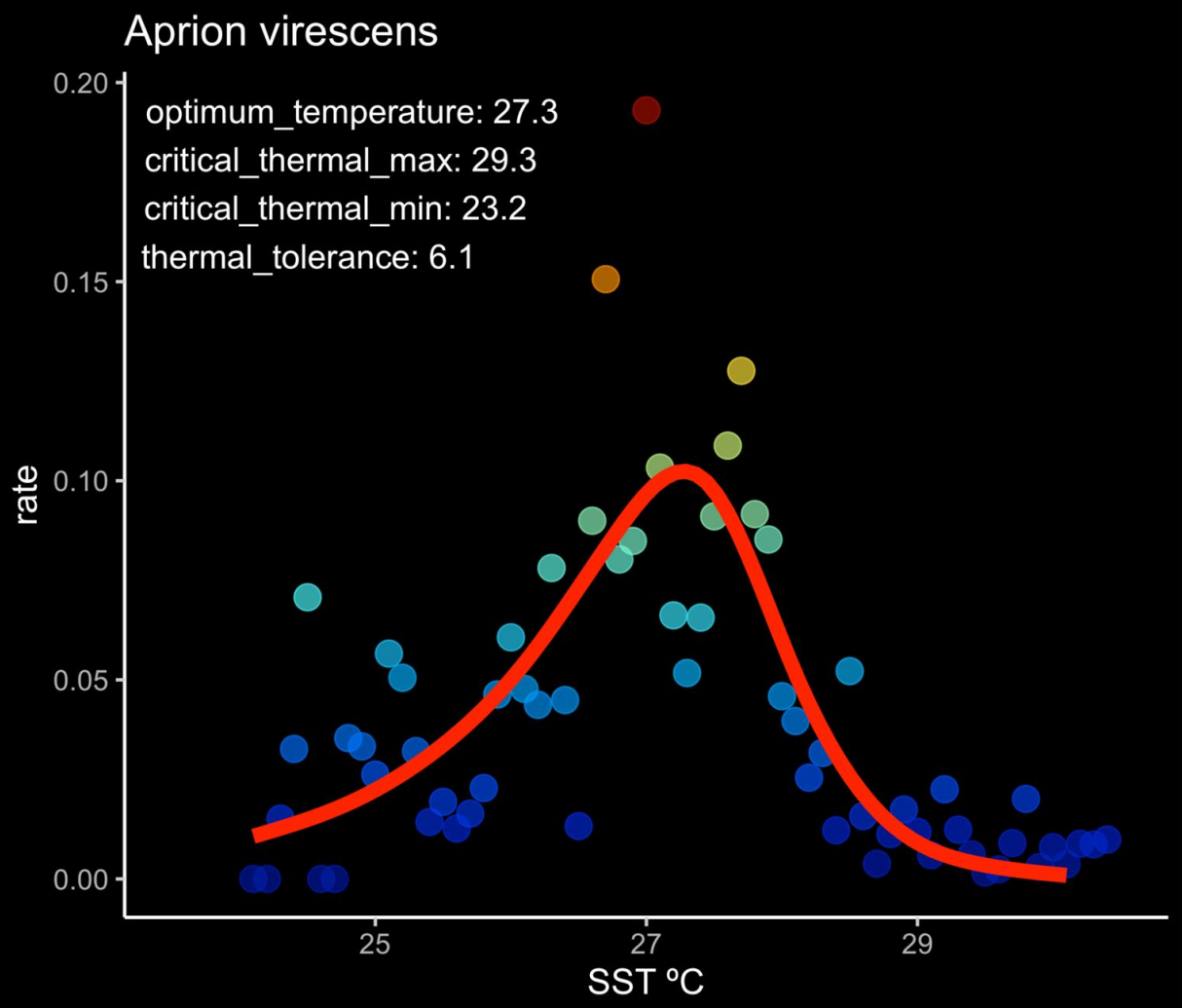
Perelman et al. 2024

Thermal envelope model

fitting and analyzing thermal performance curves

$$\text{rate} = \frac{r_0 \cdot e^{-\frac{e}{k \cdot (temp + 273.15)}}}{1 + e^{-\frac{e_h - \left(\frac{e_h}{(t_{opt} + 273.15)} + k \cdot \ln\left(\frac{e}{e_h - e}\right)\right) \cdot (temp + 273.15)}{k \cdot (temp + 273.15)}}}$$

Quantifying “Dynamic” Essential Fish Habitat



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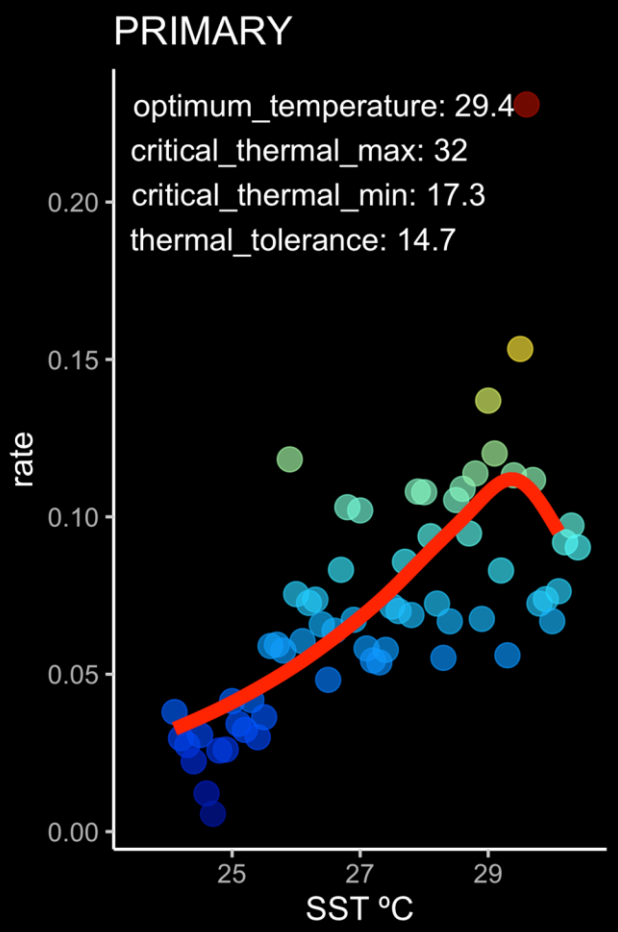
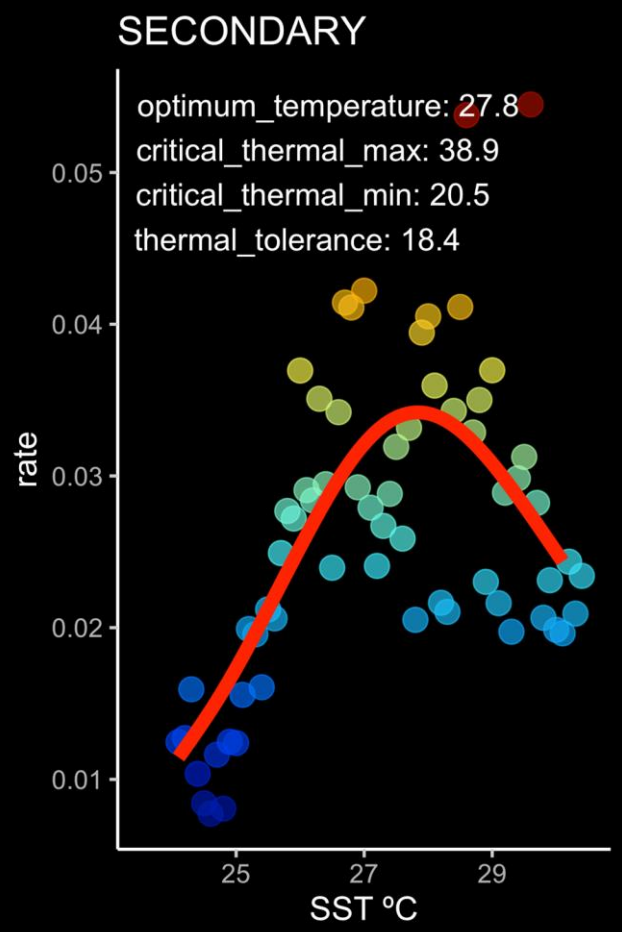
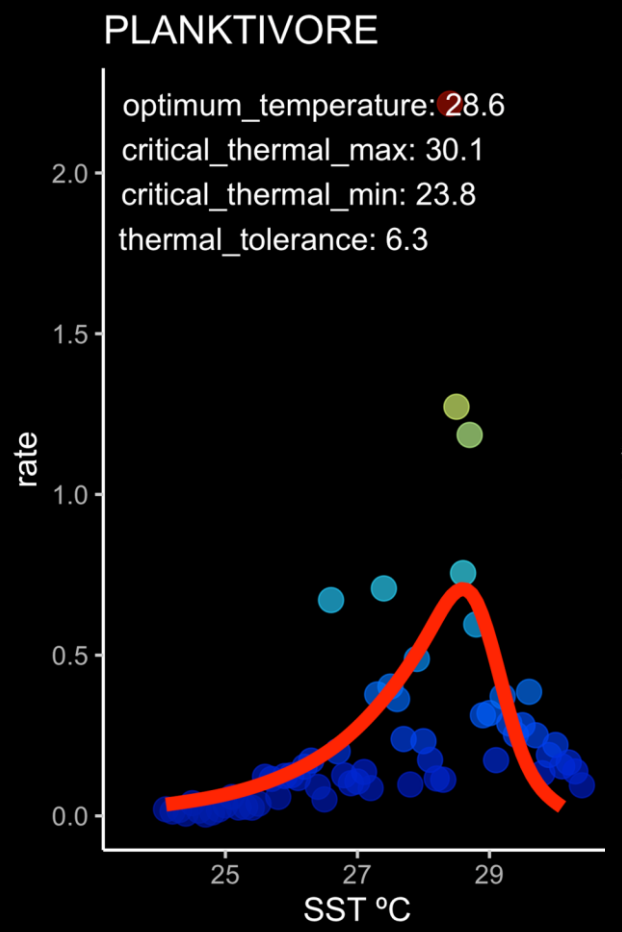
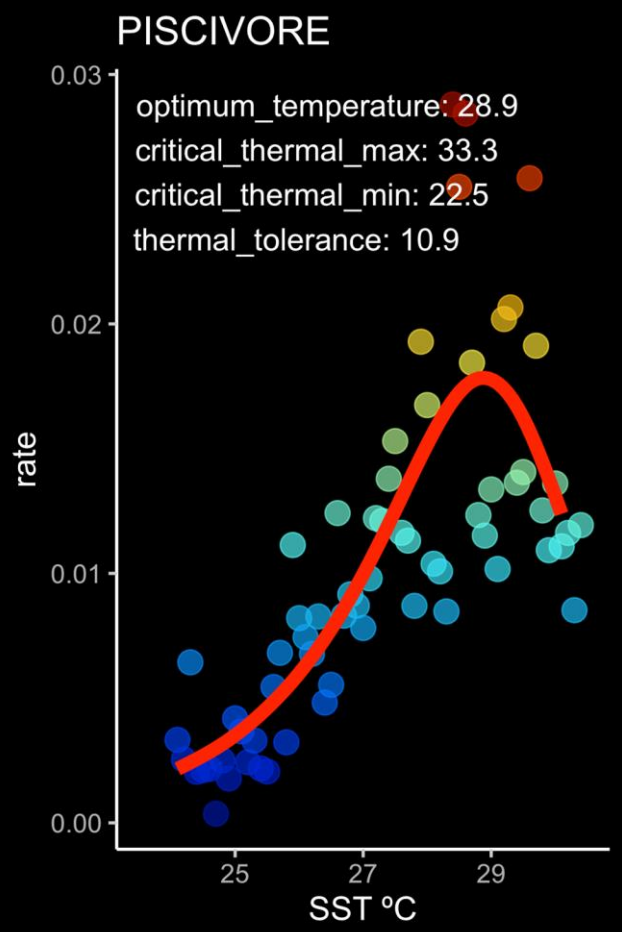
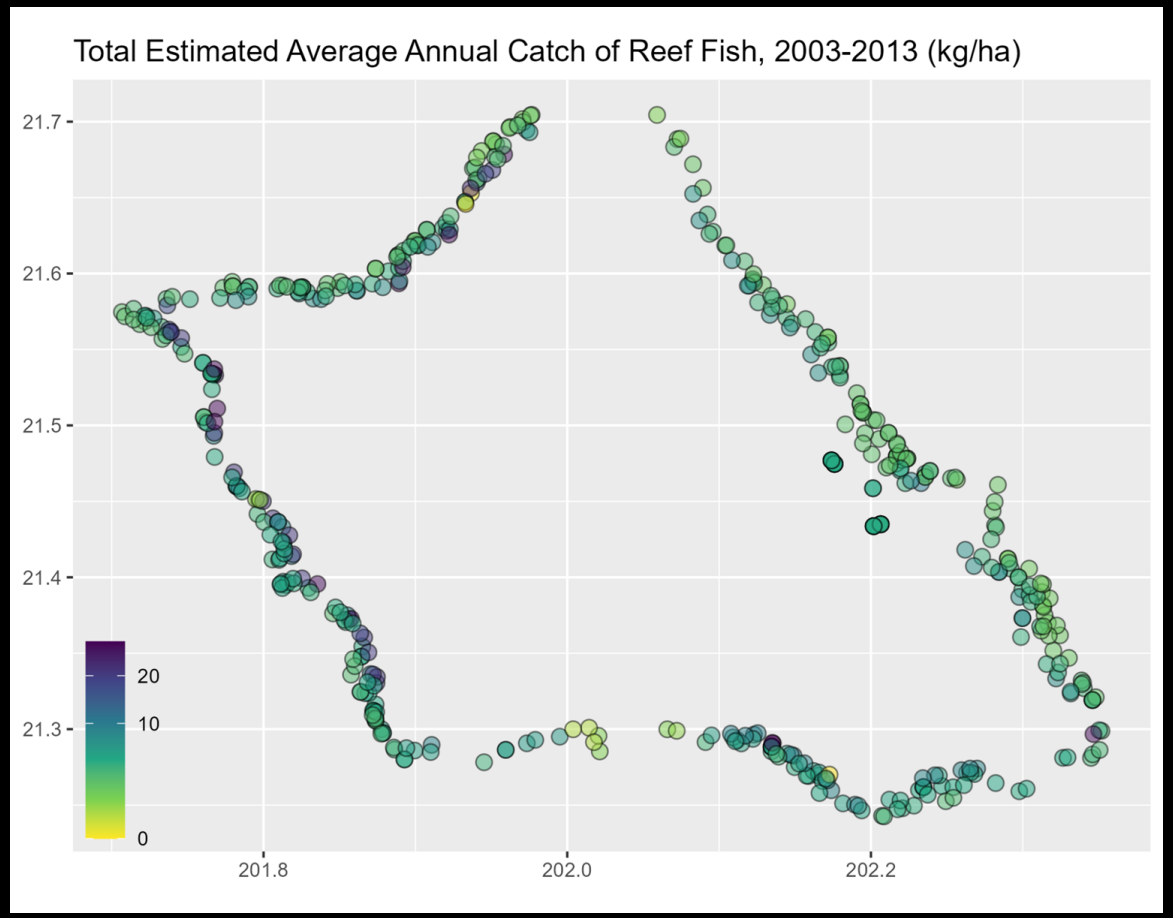


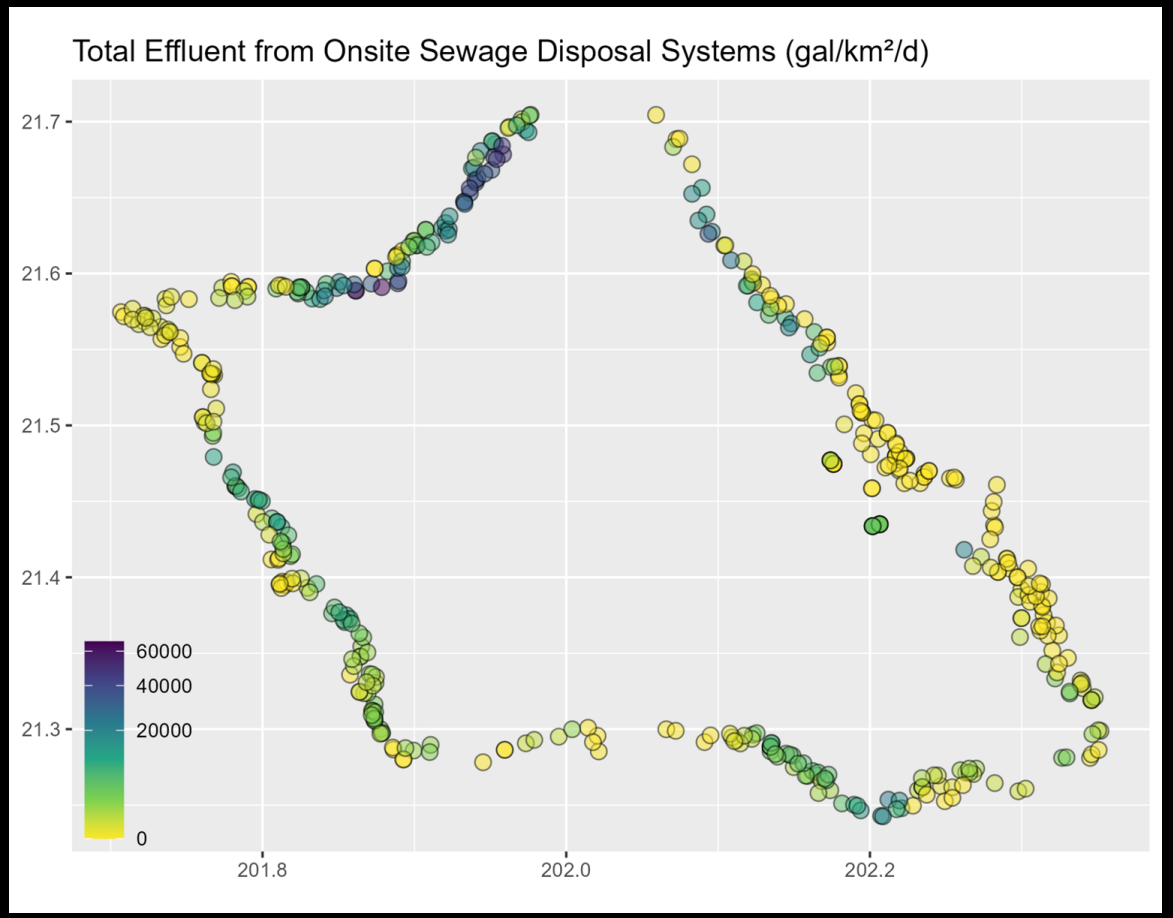






Anthropogenic drivers (population density, fishing pressures, pollutants etc.)





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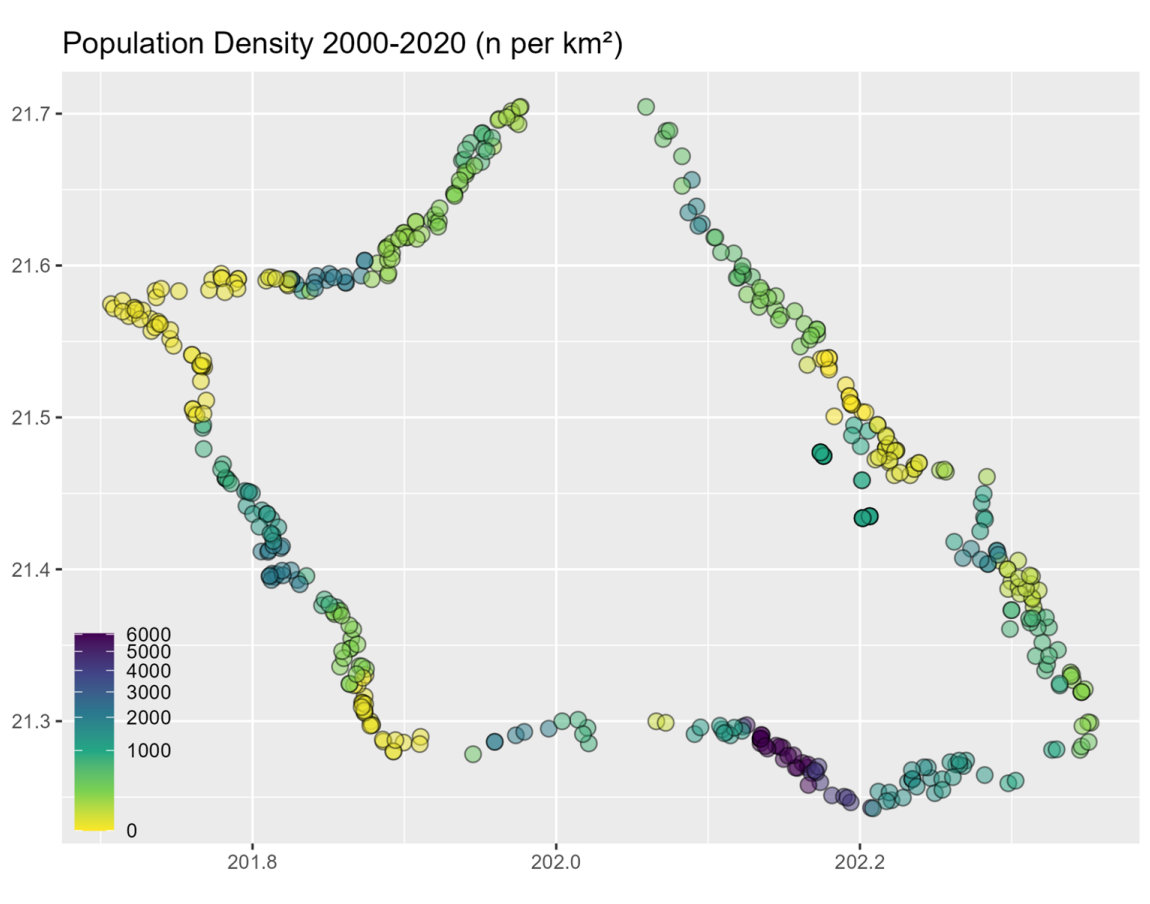
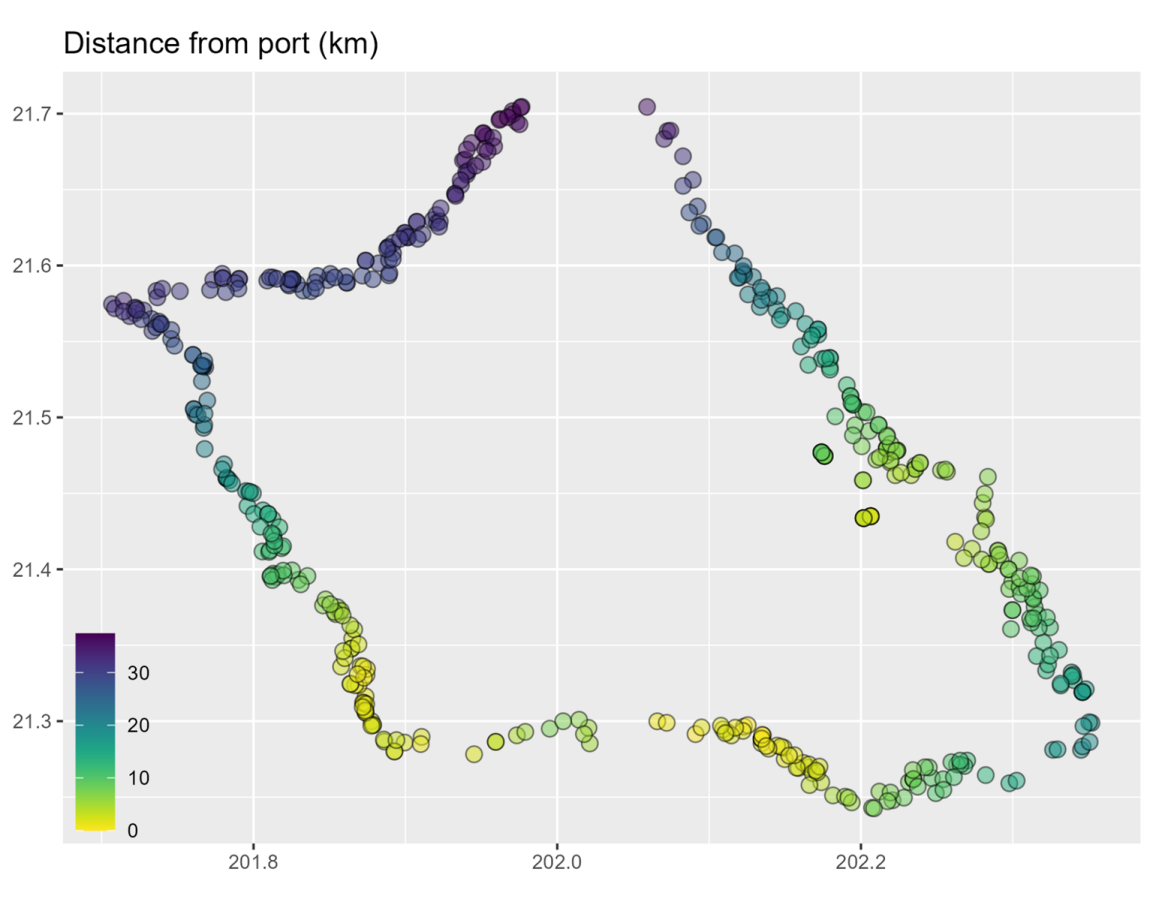
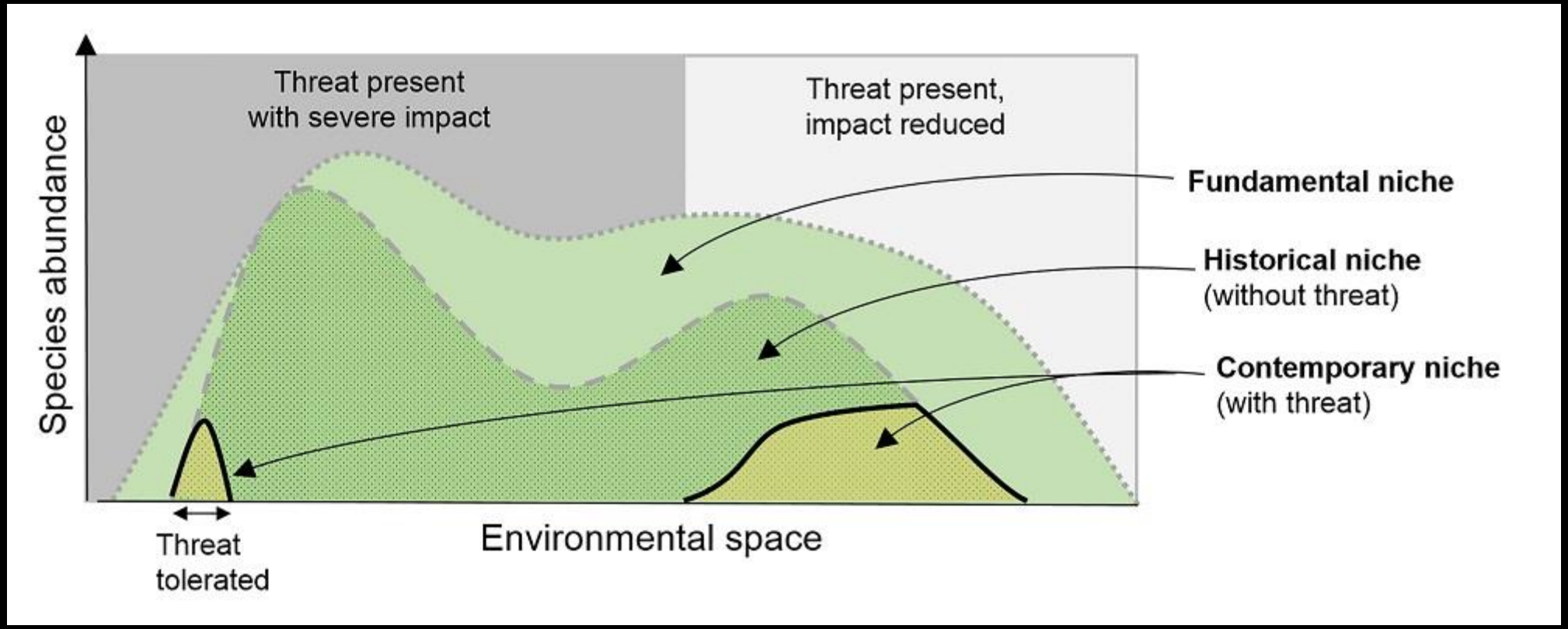




The Niche-Reduction Hypothesis



Scheele et al. 2017

EDS as a tool to better understand aquatic invasive species

RESEARCH ARTICLE | BIOLOGICAL SCIENCES |

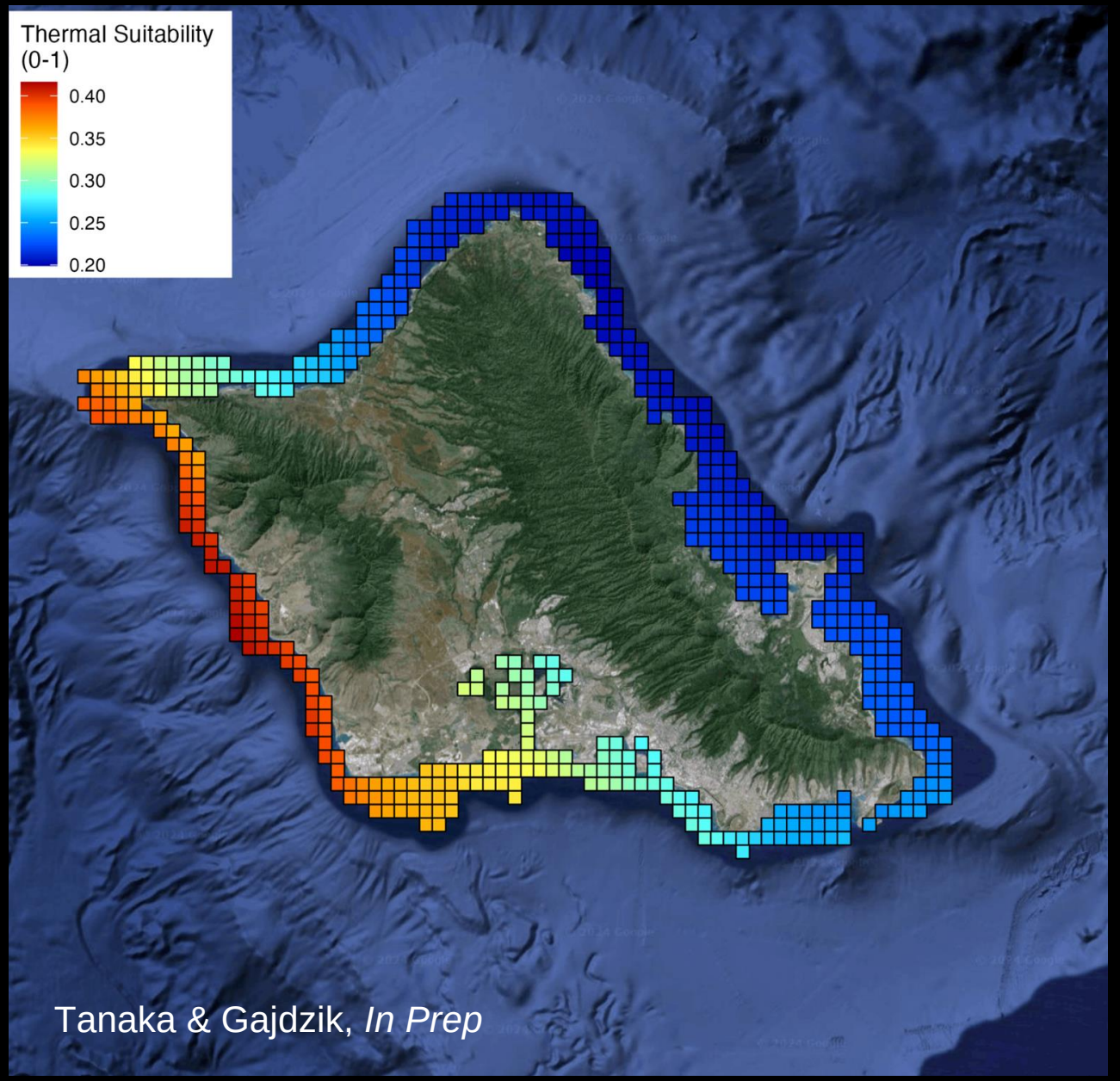
Most invasive species largely conserve their climatic niche

Chunlong Liu, Christian Wolter, Weiwei Xian, and Jonathan M. Jeschke Authors Info & Affiliations

Edited by Susan P. Harrison, University of California, Davis, CA, and approved August 6, 2020 (received for review March 6, 2020)

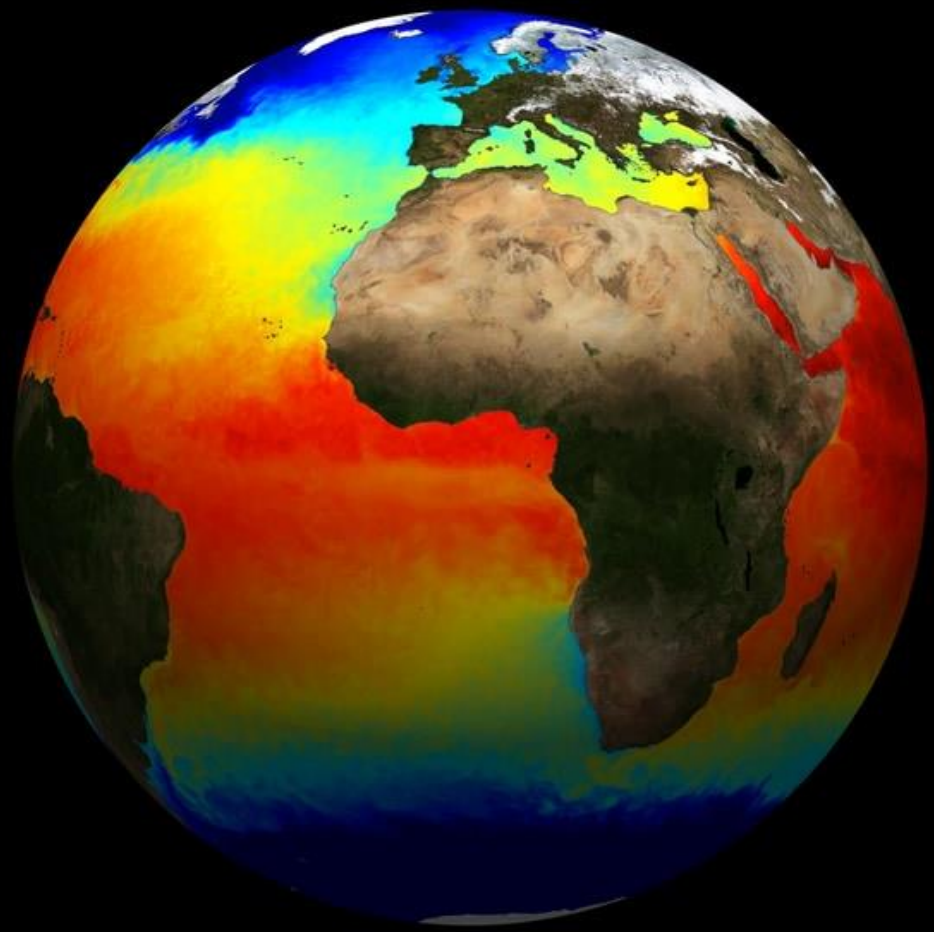
September 3, 2020 | 117 (38) 23643-23651 | https://doi.org/10.1073/pnas.2004289117

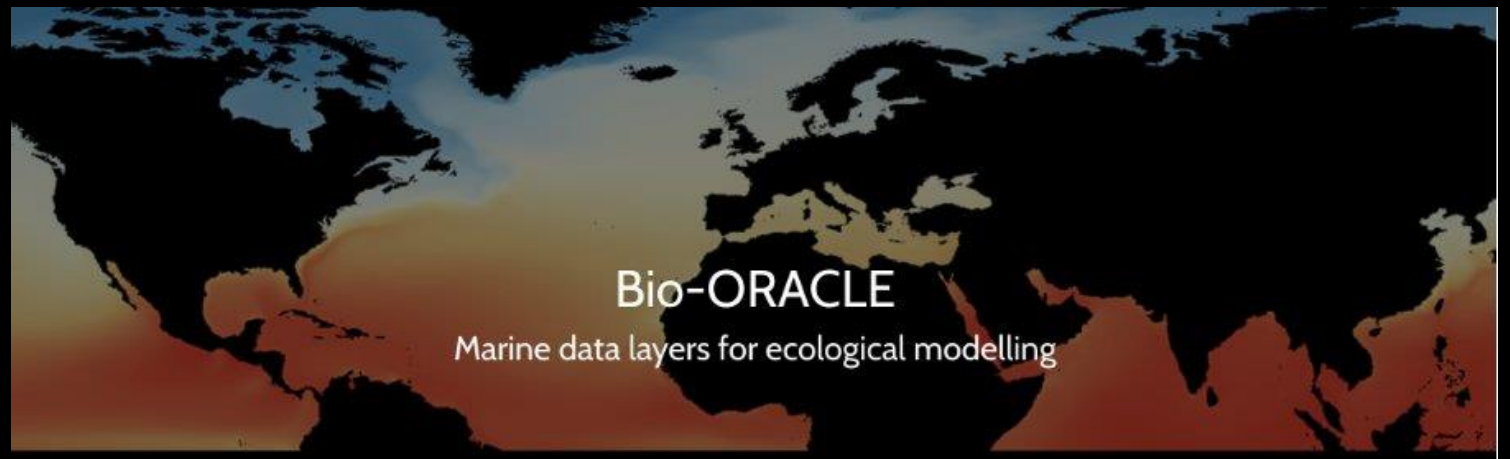
Spatial distribution of U. stolonifera realized thermal habitat



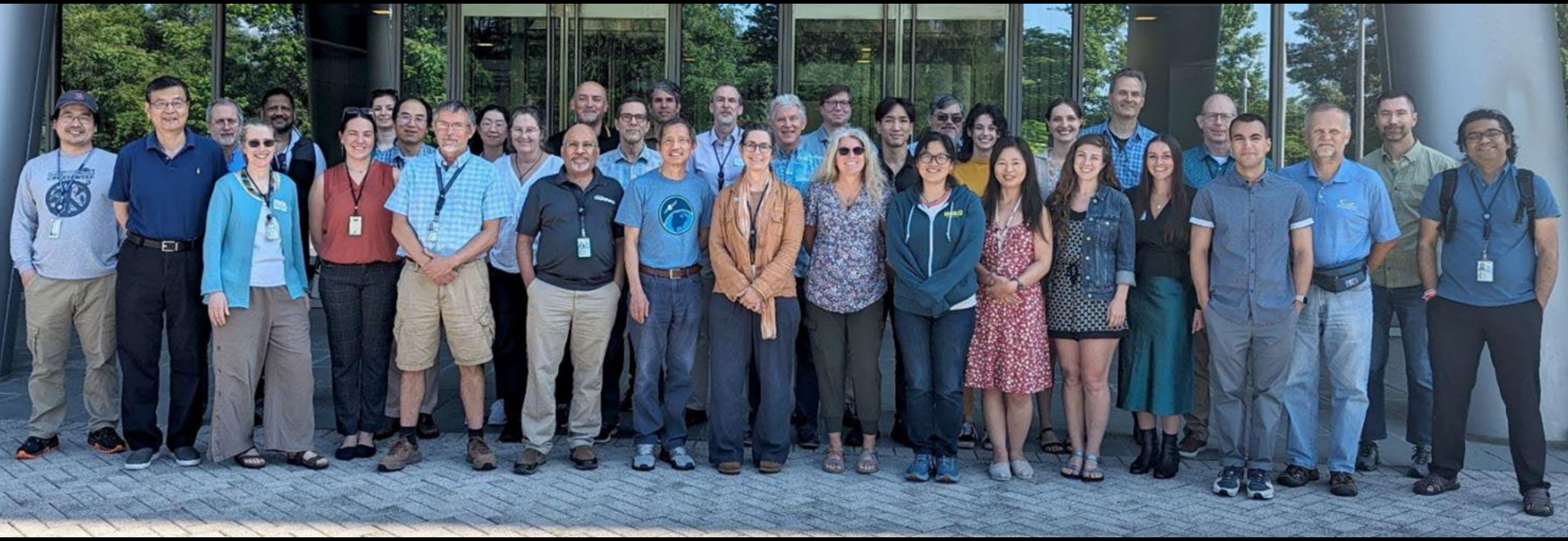
2024 Annual coastwatch meeting

Next Gen Datasets

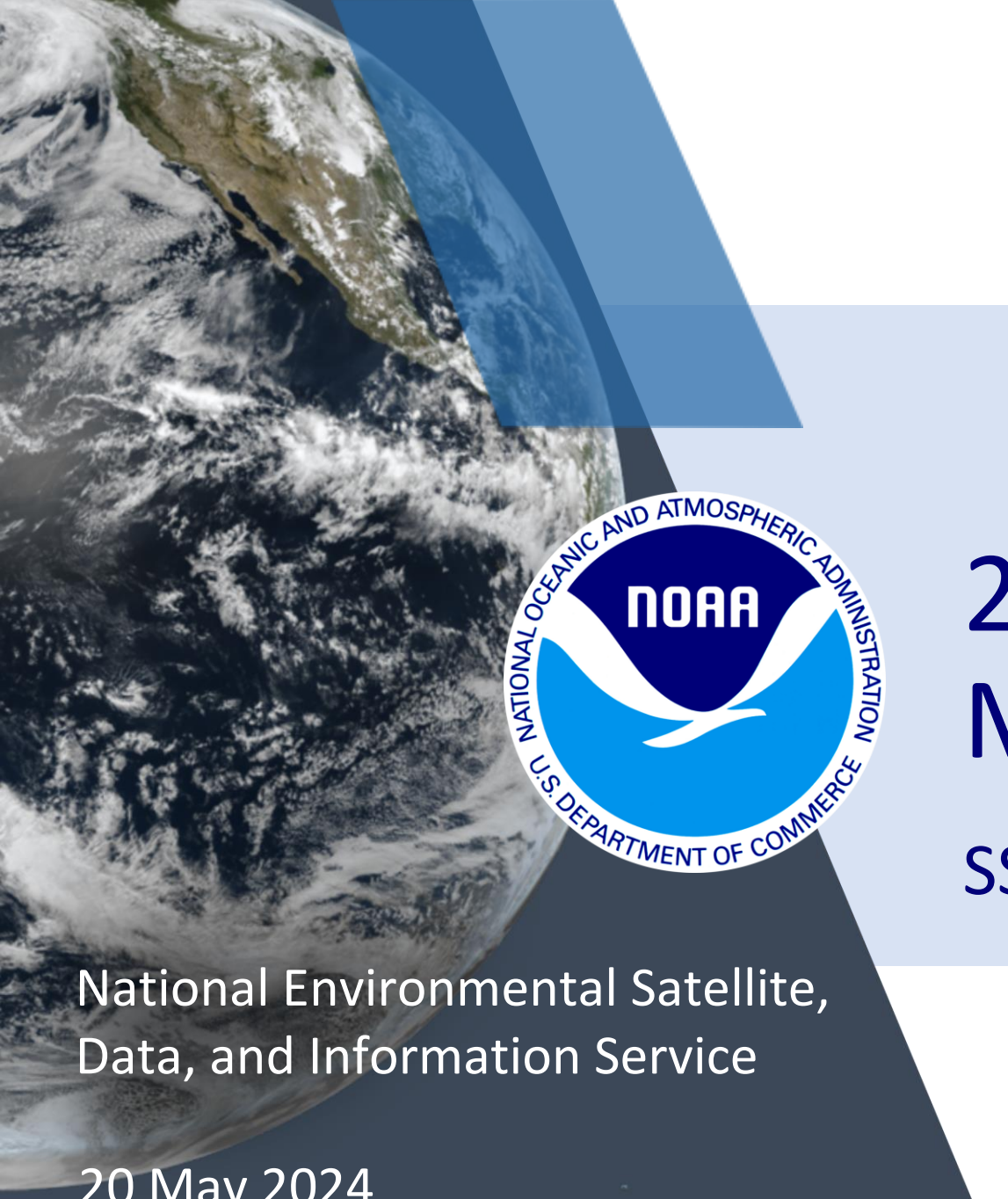




2024 Annual CoastWatch Meeting, College Park, MD



“We're in a golden age of satellite products…”



2024 CoastWatch Annual Meeting

SST User Panel and Discussion

National Environmental Satellite, Data, and Information Service

20 May 2024

Panelists

Dr. Jaime Martinez-Urtaza

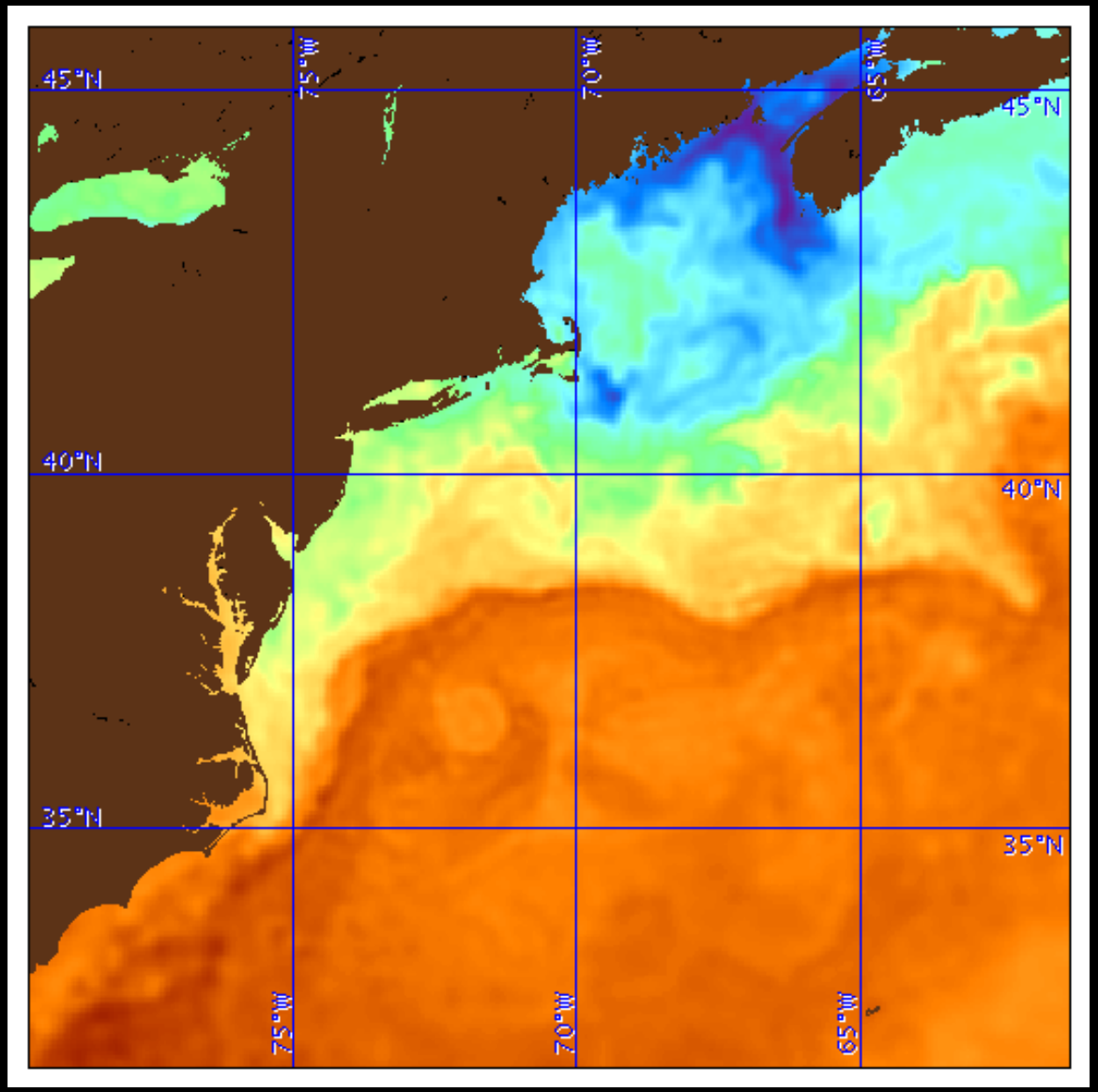
Dr. Kisei Tanaka

Dr. Maria Kavanaugh

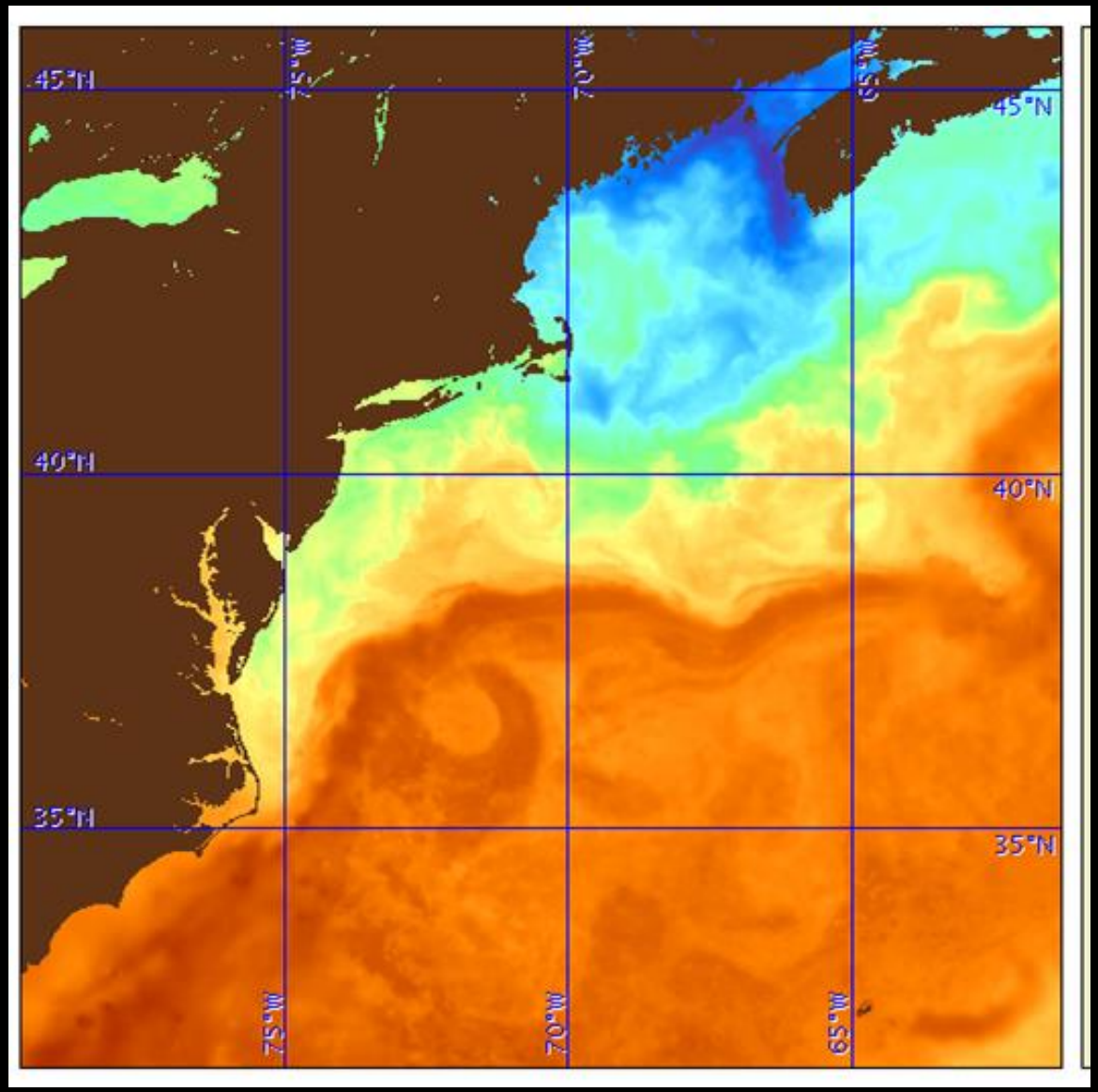
Dr. Joel Carr

Dr. Michael Craghan

Operational Sea Surface Temperature and Ice Analysis (OSTIA)

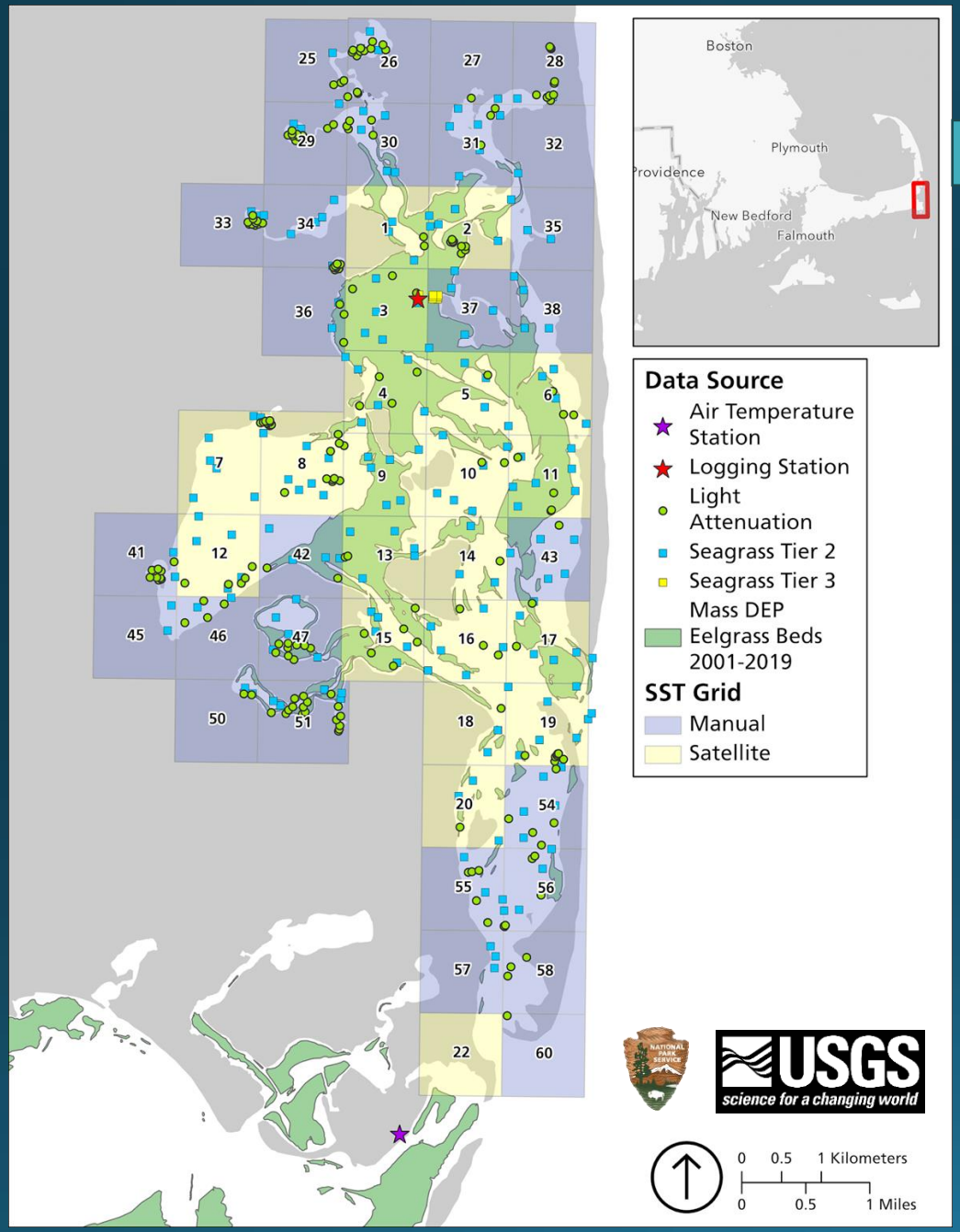


Multi-scale Ultra-high Resolution (MUR)

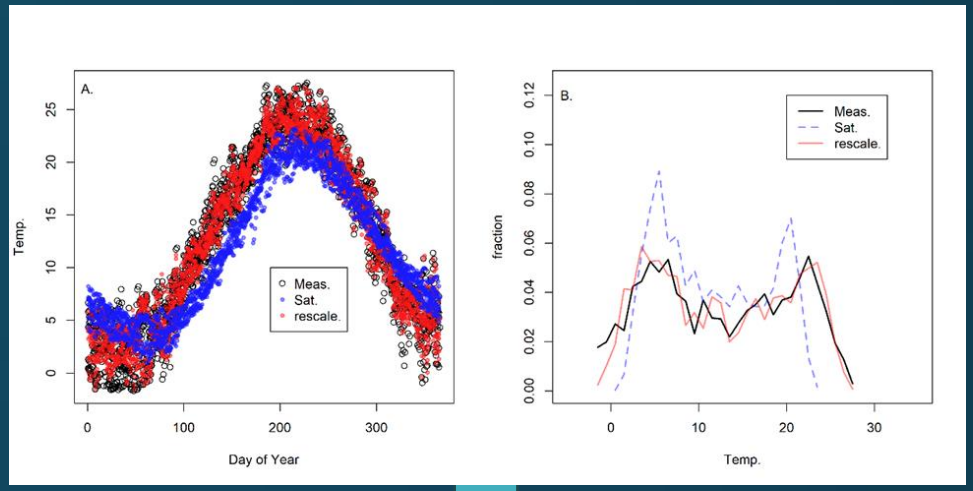


10/09/2022

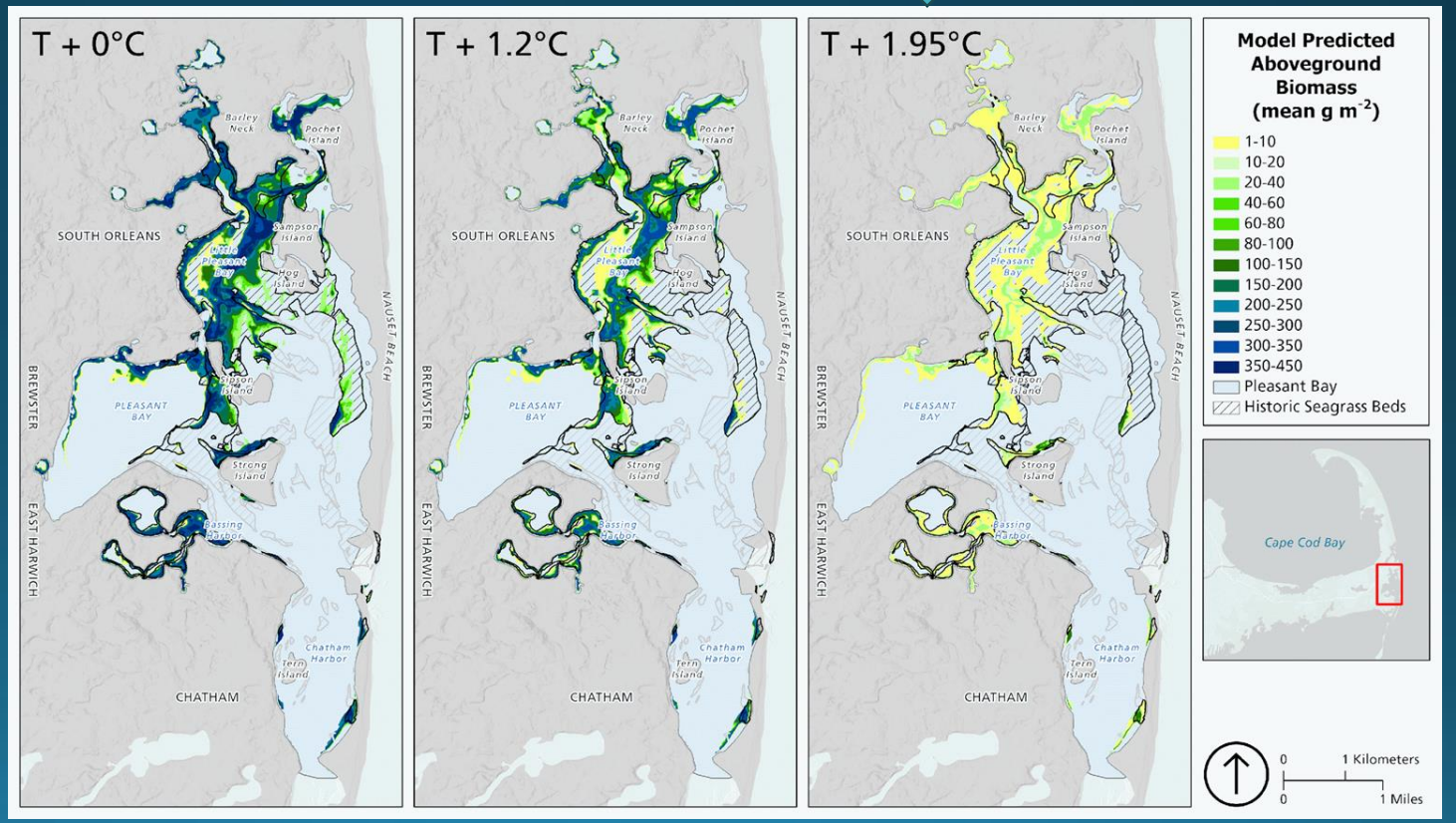
East Coast Multiscale Ultrahigh Resolution (MUR) Imagery SST 2013-2019



Quantile matching

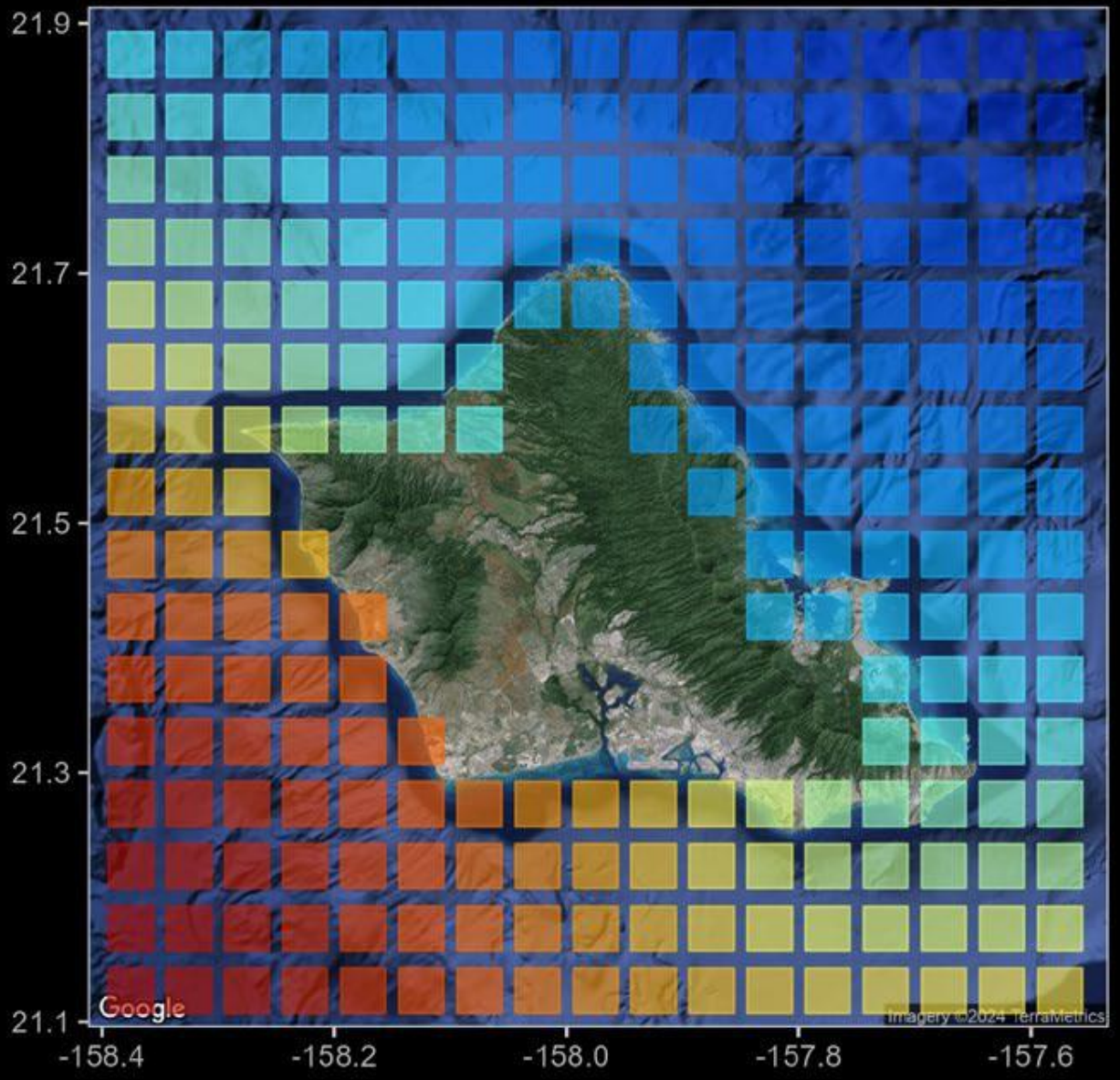


Application: Seagrass growth model

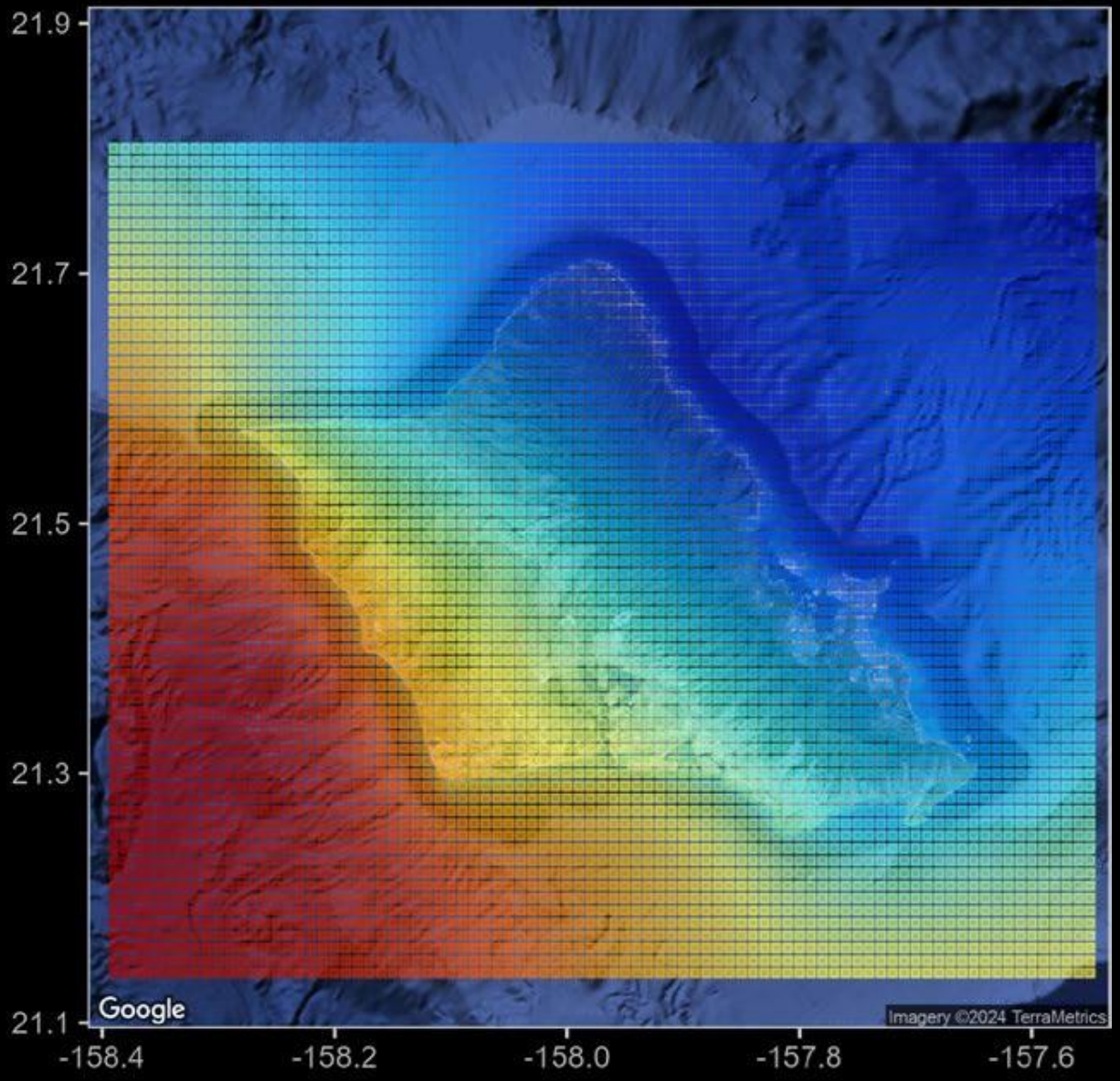


In our field…

~5km SST product



~1km SST product



Summary and Next Steps

Summary:

- Regional 1km Coastal SST products reprocessed back 30 years
- SST land mask and coastline improvements in parallel with remote sensing resolution
- Accessibility and promotion of SST in-situ quality validation products
- Continued conversations between users and developers discussing product development feasibility

Next Steps:

- 1 SST product suite identified in NESDIS 5-Year Plan
  - Ensuring the products meet user-needs
  - Increasing user engagement efforts and communication

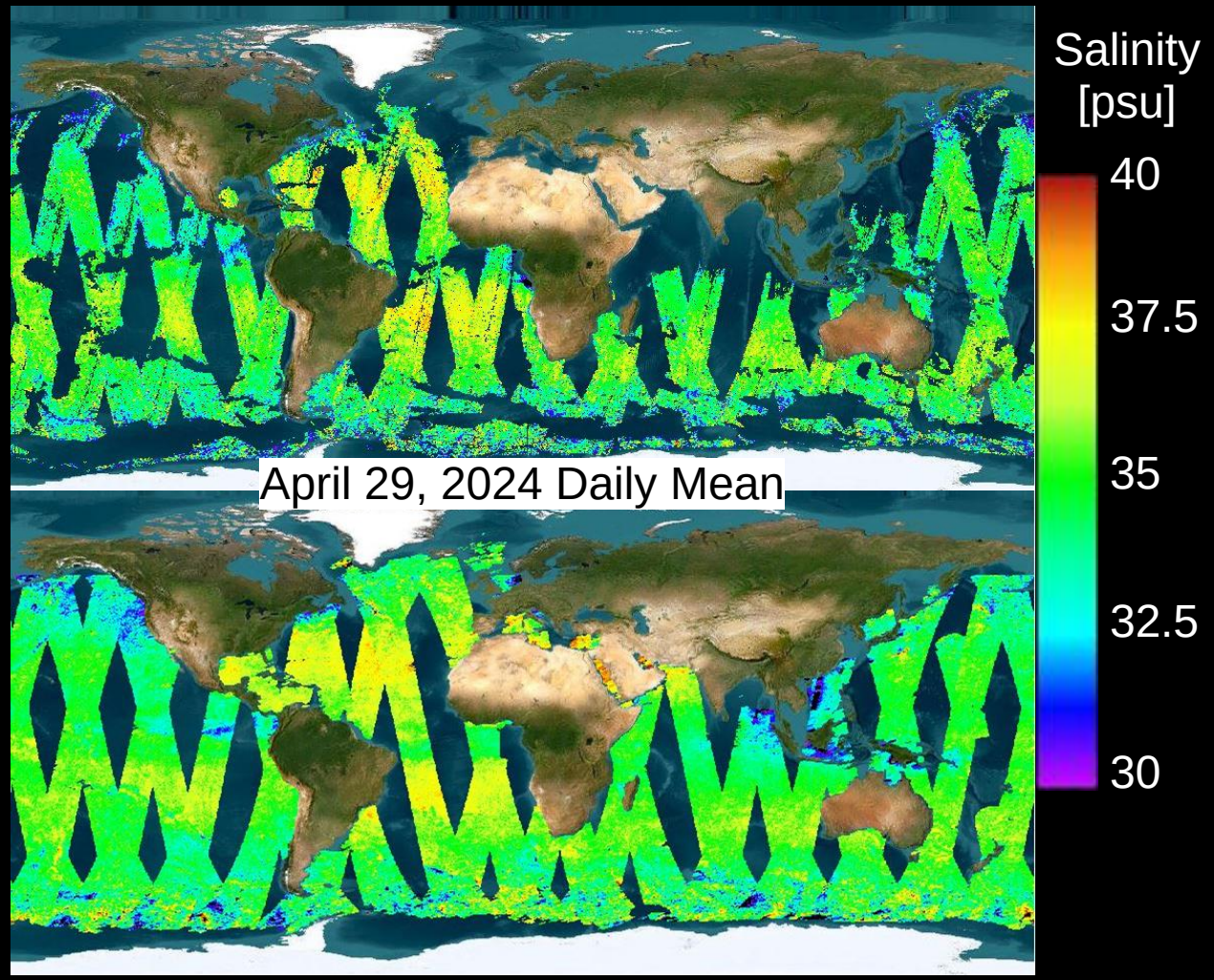
CoastWatch/OceanWatch: Sea Surface Salinity (SSS)

SMOS (ESA Mission)

- **Level-3** SSS, equal-grid (box averaged) at 0.25-degree longitude/latitude
- Daily and 3-day mean datasets
- Resolution ~ 50 km
- Latency: < 24 hours
- Formats: PNG, NetCDF

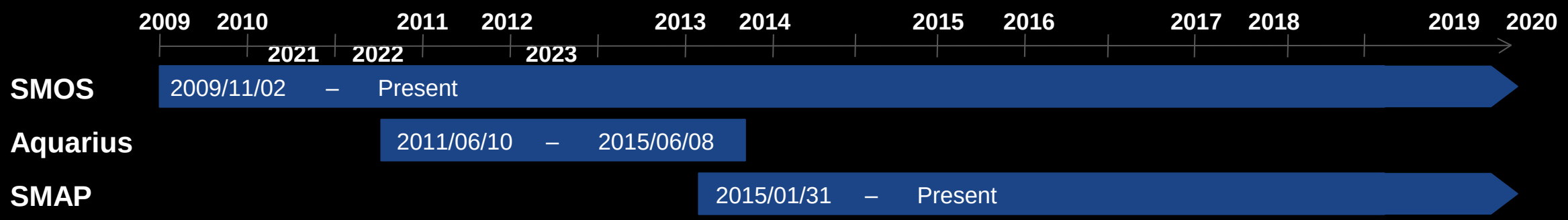
SMAP (NASA JPL/GSFC Mission)

- **Level-3** SSS, equal-grid (box averaged) 0.25-degree longitude/latitude
- Daily mean datasets
- Resolution ~ 30 km
- Latency: < 24 hours from L2 availability
- Formats: PNG, NetCDF



https://coastwatch.noaa.gov/cw_html/cwViewer.html

Satellite Missions - Sea Surface Salinity (SSS)

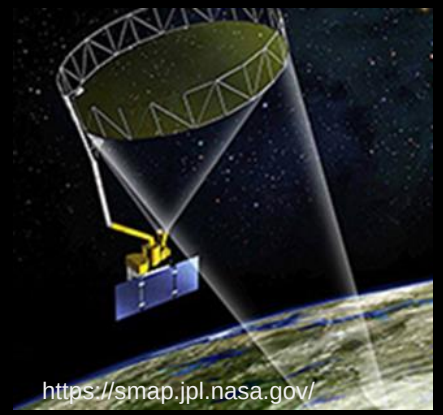


Soil Moisture and Ocean Salinity (SMOS)

Interferometric Radiometer
Spatial Resolution: ~43 km (30-80 km)
Swath: ~1000 km
Global coverage: ~2-3 days
Incidence: 0° - 60°
Full Polarization

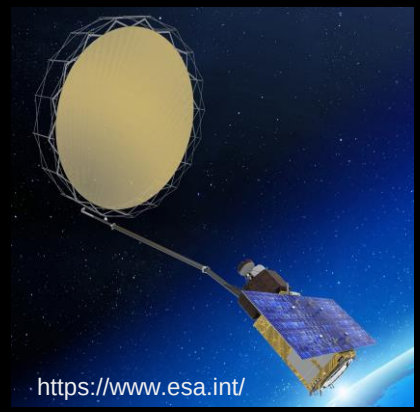
Aquarius

Radiometer & Scatterometer
Spatial Resolution: ~100 km
Swath: ~400 km
Global coverage: ~7 days
Incidence: 29°, 38°, 46°
Full Polarization



Soil Moisture Active Passive (SMAP)

Radiometer & SAR
Spatial Resolution: 40 km
Swath: 1000 km
Global coverage: ~2-3 days
Incidence: 40°
Full Polarization



Copernicus Imaging Microwave Radiometer (CIMR) **[Upcoming]**

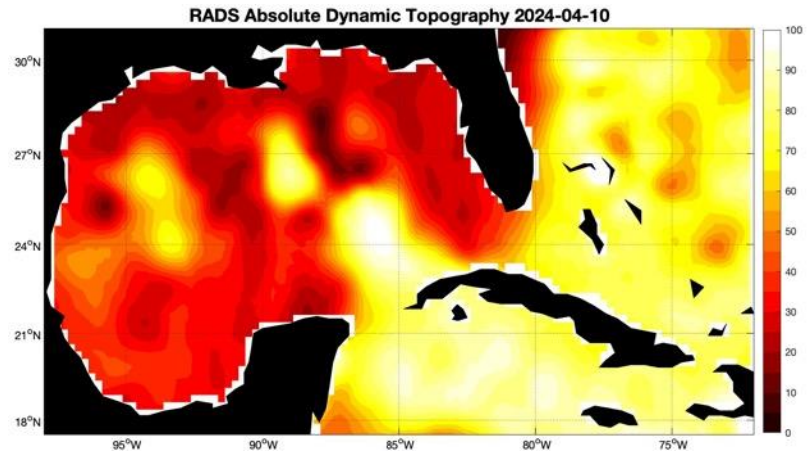
Conically Scanning Multi-frequency Microwave Radiometer
Spatial Resolution: 50 km
Swath: 1900 km
Global coverage: ~1.5 days
Incidence: 55°
Expected Launch Date: ~2029

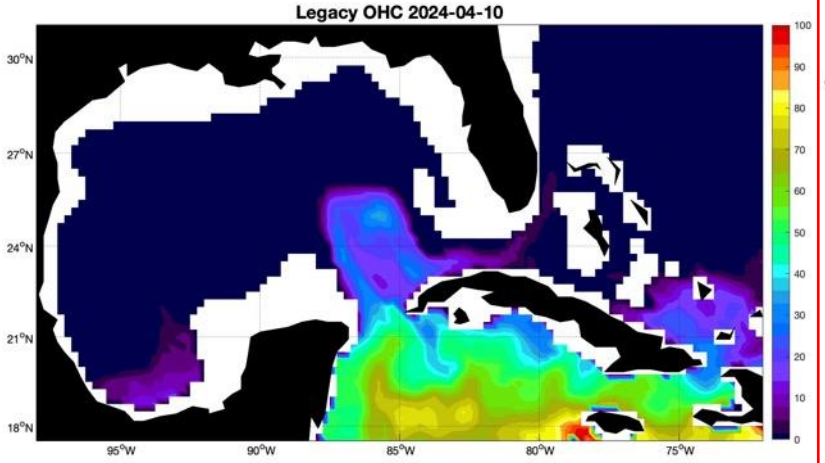
Ocean Heat Content: Operational and Next-Gen

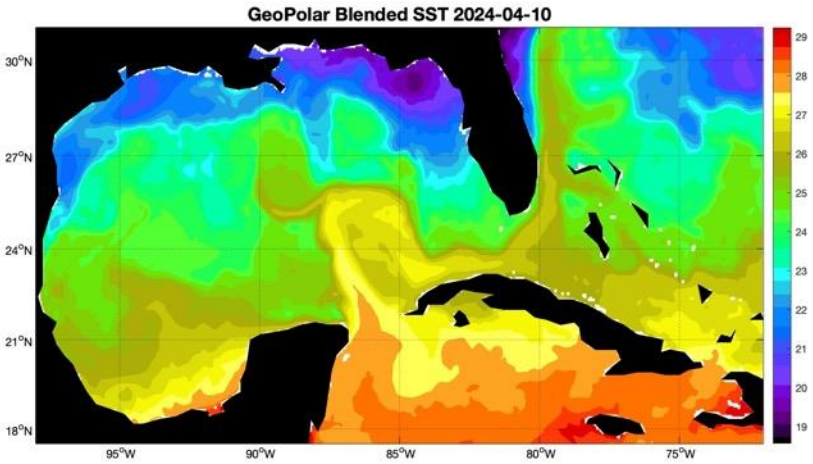
Snapshots from 2024-04-10

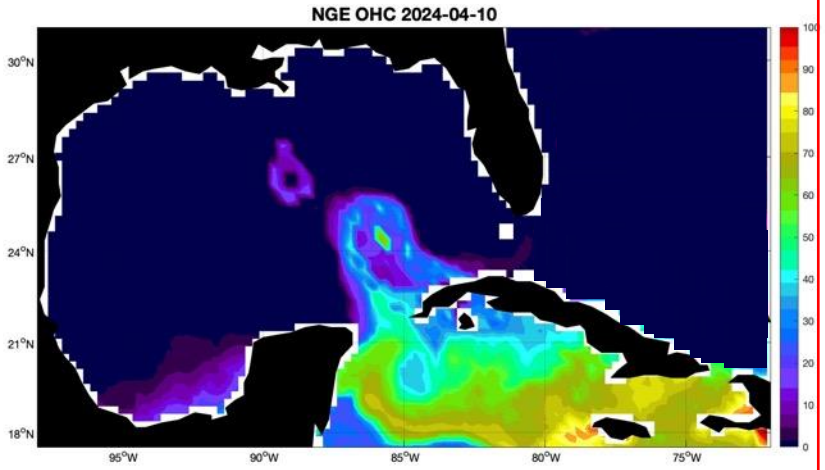
INPUTS

OUTPUTS

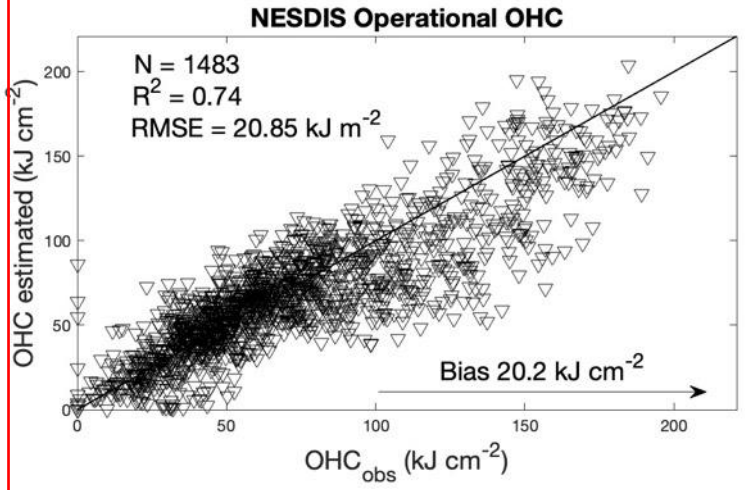


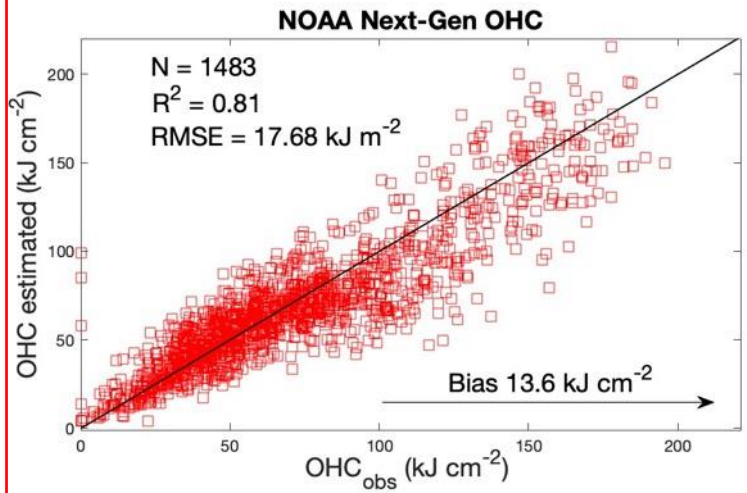




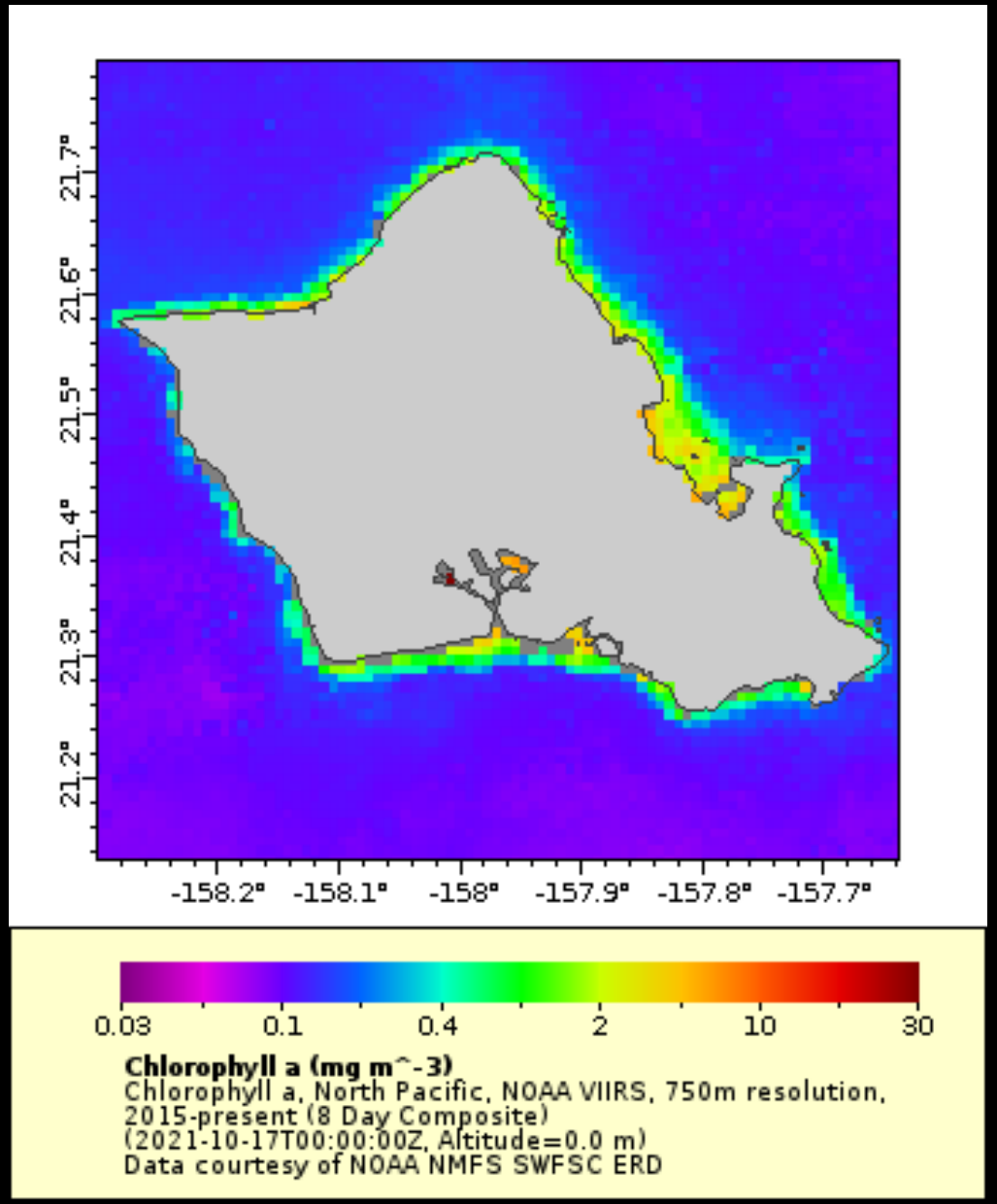


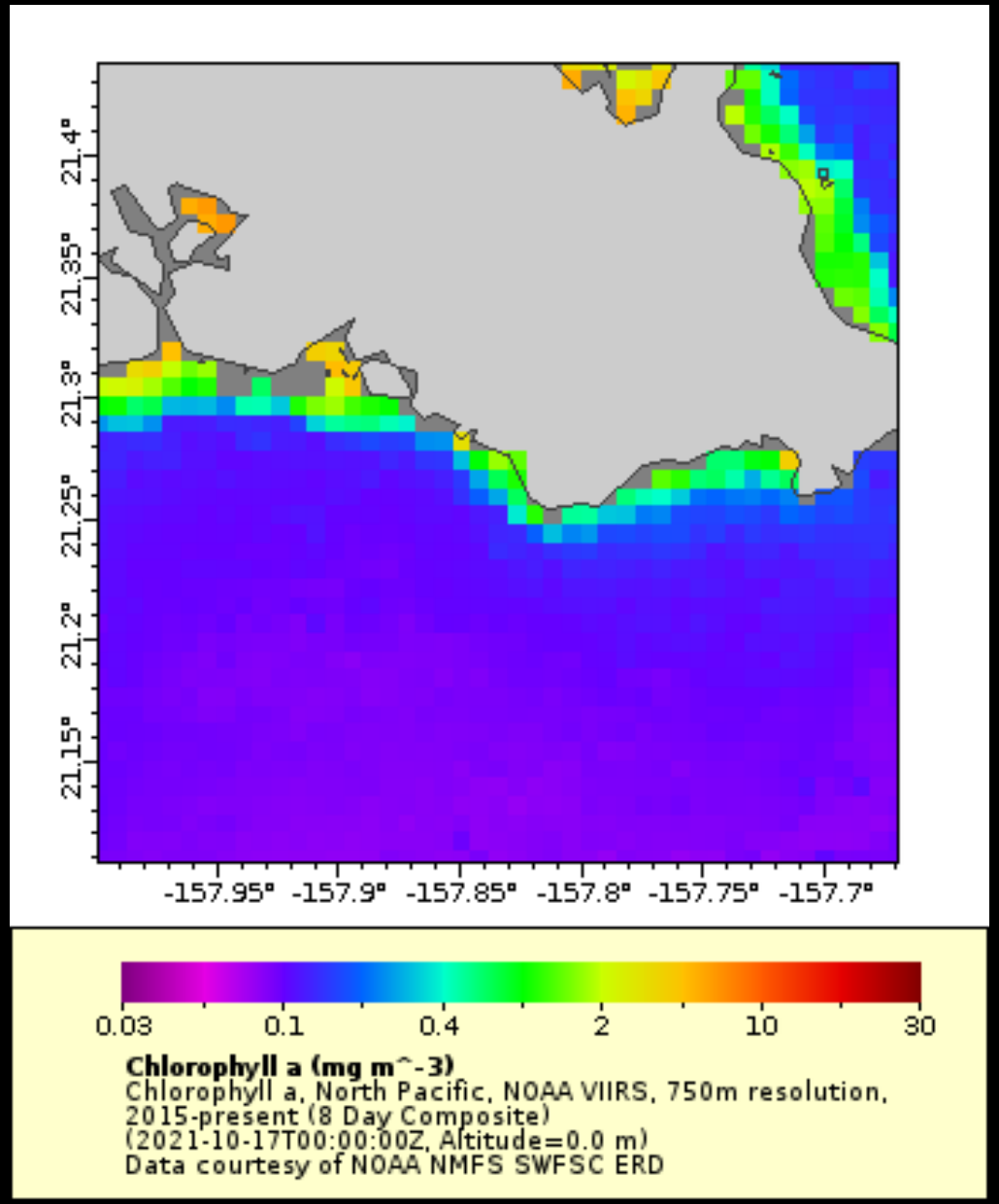
Hurricane Seasons 2020 & 2021





Visible Infrared Imaging Radiometer Suite (VIIRS)





Global Ecology and Biogeography / Volume 33, Issue 4 / e13813

DATA ARTICLE | Full Access

Bio-ORACLE v3.0. Pushing marine data layers to the CMIP6 Earth System Models of climate change research

Jorge Assis, Salvador Jesús Fernández Bejarano, Vinícius W. Salazar, Lennert Schepers, Lidiane Gouvêa, Eliza Fragkopoulou, Frederic Leclercq, Bart Vanhoorne, Lennert Tyberghein, Ester A. Serrão, Heroen Verbruggen, Olivier De Clerck ... See fewer authors

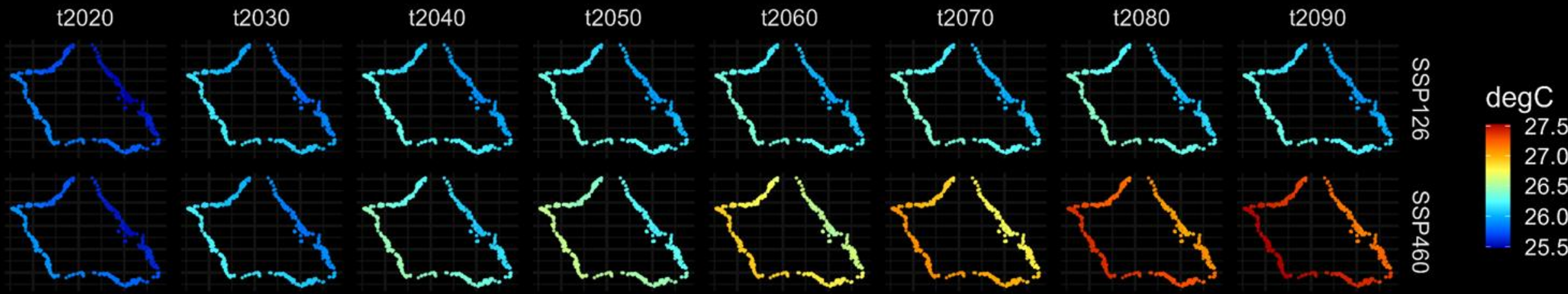
First published: 25 February 2024

https://doi.org/10.1111/geb.13813

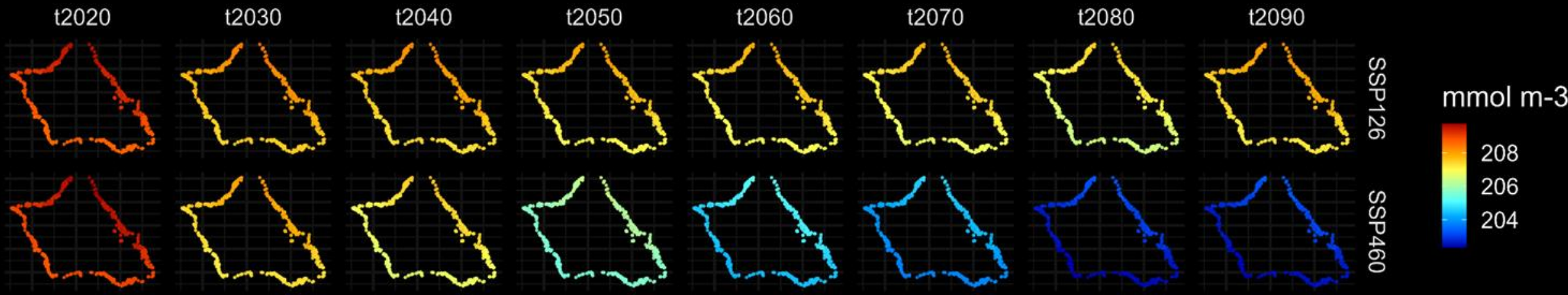
Citations: 1

Special thanks to Laura and Michael for making this happen

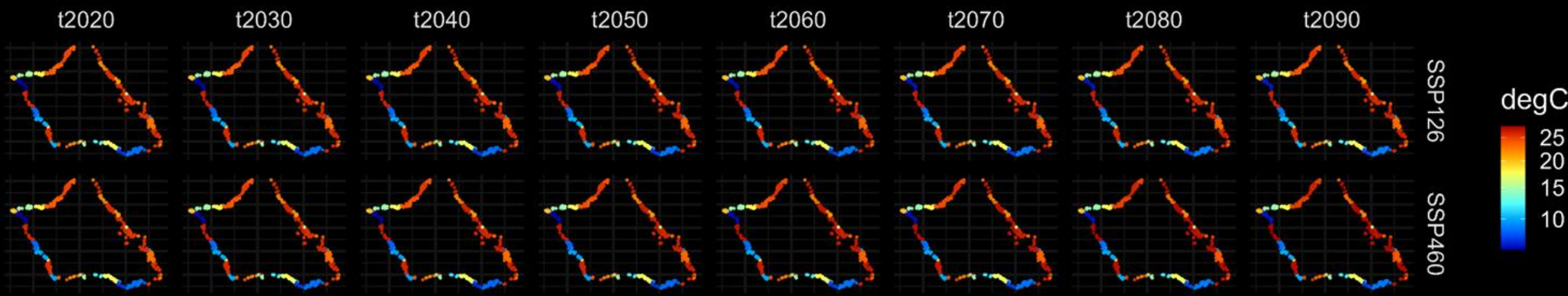
Surface Ocean Temperature 2020-2100



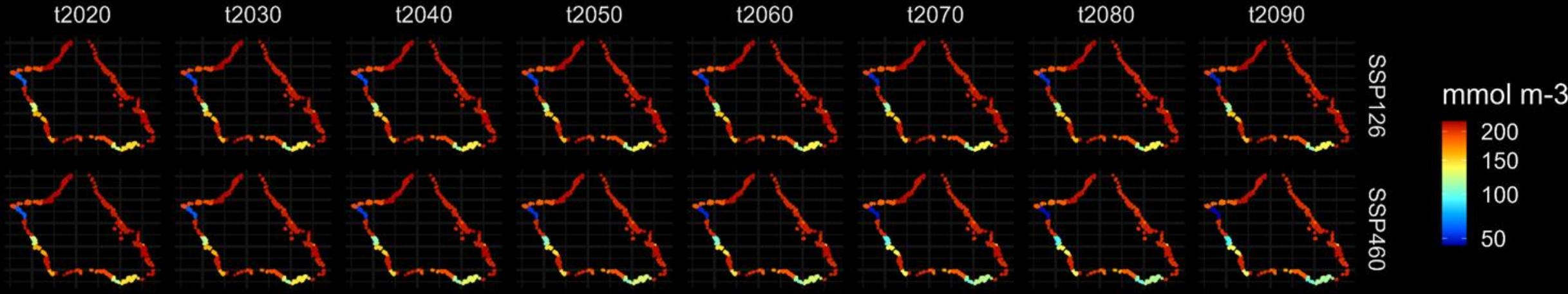
Surface Dissolved Molecular Oxygen 2020-2100



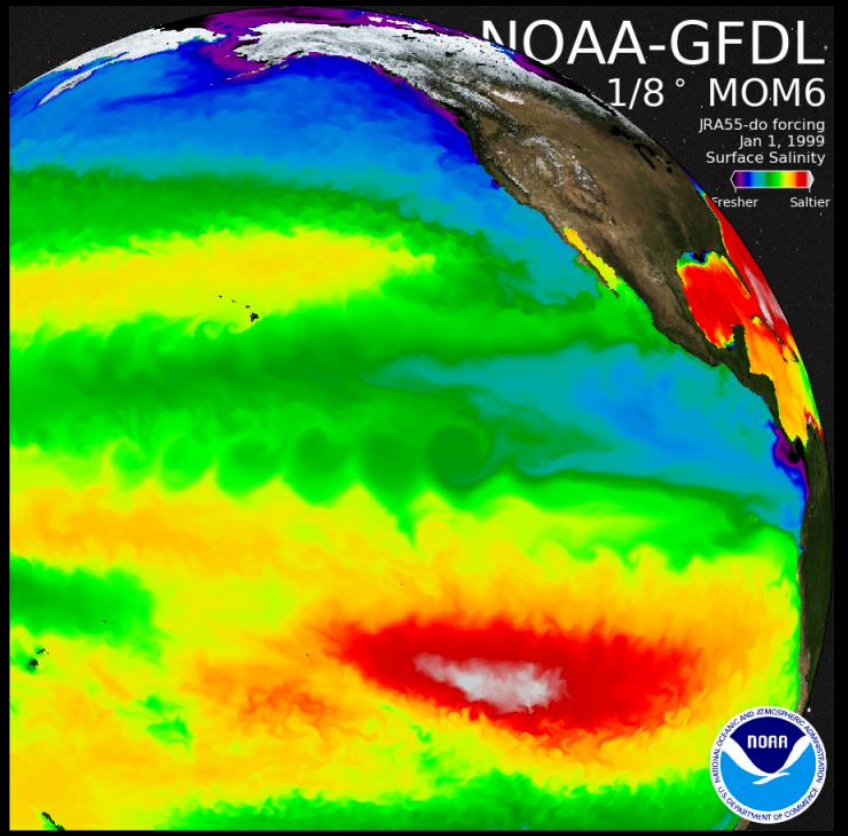
Bottom Ocean Temperature 2020-2100



Bottom Dissolved Molecular Oxygen 2020-2100



global & regional ocean model outputs



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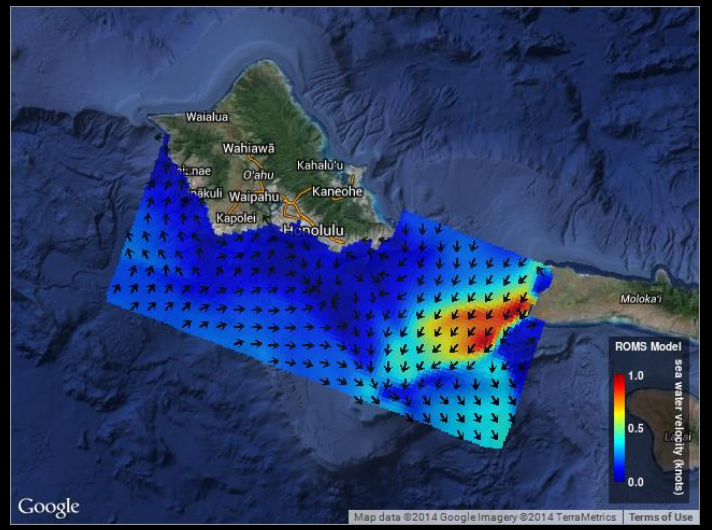
Subsurface temperature estimates from a Regional Ocean Modelling System (ROMS) reanalysis provide accurate coral heat stress indices across the Main Hawaiian Islands

Jessica N. Perelman, Kisei R. Tanaka, Joy N. Smith, Hannah C. Barkley & Brian S. Powell

Scientific Reports **14**, Article number: 6620 (2024) | Cite this article



How do you start using EDS?

contact Jessie Perelman, Kisei Tanaka, or myself to help you get up and running

Who has used EDS so far?

Groups include: NOAA, DAR, State of Guam, UH, etc

EDS Take Aways

Allows users to download, filter, extract and summarize large amounts of gridded and tabular data given user-defined time stamps and geographical coordinates.

The various external environmental data summarized at select survey sites & areas can aid scientists to assess and understand how living marine resources are impacted by the environmental variabilities.

Thank you!

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