GULF OF MAINE LOBSTER FOUNDATION

NERACOOS
NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS

Ocean Data Visualization Tools Workshop

April 17, 2025
Ellsworth, ME

WORKSHOP REPORT

Suggested Document Citation:

Proceedings of the 2025 Ocean Data Visualization Tools Workshop. Northeastern Regional Association of Coastal Ocean Observing Systems. January 2026.

Workshop Funding Source

Workshop funded by the Sea Grant American Lobster Initiative, under grant # NA220AR4170639-T1-01. The Sea Grant American Lobster Initiative, funded by the National Oceanic and Atmospheric Administration's National Sea Grant College Program, is addressing critical knowledge gaps about American lobster and its iconic fishery in a dynamic and changing environment. The initiative, which began in 2019, supports both scientific research and a regional Sea Grant extension program in the Northeast U.S. Together, the research and extension components of this initiative will develop and share new knowledge and understanding with industry stakeholders and resource managers from Maine to New York.

Sea Grant
American Lobster Initiative

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Executive Summary

The Ocean Data Visualization Tools Workshop convened 30 fishing industry participants and 11 ocean data tool developers, researchers, and collaborators for a full-day workshop on April 17, 2025, in Ellsworth, Maine. The workshop was part of the Sea Grant American Lobster Initiative–funded project *Providing the lobster industry new gear technology in response to regulatory and environmental changes*. The purpose of the workshop was to connect fishermen directly with ocean observing programs and data visualization tools, gather targeted feedback on existing products, and identify emerging data needs to better support on-water decision-making in a rapidly changing Gulf of Maine.

Through plenary discussions and hands-on breakout sessions focused on the eMOLT program, the observing system near Downeast Maine, and four data visualization tools (the Mariners' Dashboard, Climatology Viewer, eMOLT Deckbox, and Fishing Ocean Data Portal), participants emphasized the importance of accurate, timely, and accessible ocean data for safety, operational efficiency, and long-term planning. Fishermen shared extensive field-based observations pointing to ecological and physical changes in the Gulf of Maine, including concerns related to dissolved oxygen, algal blooms, invasive species, shifting temperature and salinity patterns, and large-scale circulation changes. These discussions highlighted both the value of fishing-vessel-based observations and sustained sea state observations from buoys and other stations. They also identified critical gaps in monitoring coverage, particularly in Downeast Maine, nearshore habitats, riverine inputs, and offshore regions important for understanding broader circulation dynamics.

Across tools, participants consistently called for intuitive, fisherman-centered data products that balance simplicity with flexibility, offer localized and customizable views, and integrate real-time observations with historical data and models. The workshop underscored the importance of sustained collaboration between fishermen, scientists, and data providers, and reinforced the role of fishing-vessel-based observing systems like eMOLT as an essential complement to fixed infrastructure. Participants expressed strong interest in continued engagement, expanded participation, and ongoing co-development of data tools to support the resilience and adaptability of Gulf of Maine fisheries.

Glossary

D.O.	Dissolved Oxygen
DMAC	Data Management and Cyberinfrastructure
eMOLT	Environmental Sensors on Lobster Traps and Large Trawlers
ERDDAP	A data server
FVCOM	Finite-Volume Community Ocean Model
GMRI	Gulf of Maine Lobster Institute
GOMLF	Gulf of Maine Lobster Foundation
HF Radar	High Frequency Radar
IOOS	Integrated Ocean Observing System
Maine DMR	Maine Department of Marine Resources
MCCF	Maine Center for Coastal Fisheries
MCFA	Maine Coast Fishermen's Association
MDI	Mount Desert Island
Metocean	Meteorological and Oceanographic
NDBC	National Data Buoy Center
NEFSC	Northeast Fisheries Science Center
NERACOOS	Northeastern Regional Association of Coastal Ocean Observing Systems
NOAA	National Oceanic and Atmospheric Administration
ODN	Ocean Data Network
OOI	Ocean Observatories Initiative
ONSET	Onset Computer Corp.
QC	Quality Control
SST	Sea Surface Temperature
UConn	University of Connecticut
UMaine	University of Maine
UNH	University of New Hampshire
URI	University of Rhode Island
VEMCO	Vemco Monitoring
WMO	World Meteorological Organization

Introduction

The Ocean Data Visualization Tools Workshop brought together 30 fishing industry participants with 11 ocean data tool partners and collaborators for a full-day workshop in Ellsworth, ME. Participants and collaborators are listed in Appendix I. The Workshop was a component of the project *Providing the lobster industry new gear technology in response to regulatory and environmental changes*, funded by the Sea Grant American Lobster Initiative in 2022. This report details the workshop proceedings and outcomes.

The overarching project aims to provide lobstermen the necessary data visualization tools to navigate a changing environmental and regulatory landscape by deploying additional sensors, and developing and upgrading models and data products that effectively deliver critical information to the fleet. Improving environmental data collection and sharing within the Gulf of Maine helps lobstermen work in ways that are more strategic, surgical, cost-effective and ultimately profitable, all of which are more important than ever as the fishery faces a growing number of operational challenges. More information about the project can be found on the American Lobster Initiative storymap, "Mapping Seafloor Temperature".

The workshop was organized by the Gulf of Maine Lobster Foundation (GOMLF - Erin Pelletier and Emma Weed), and Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS - Katy Bland, Tom Shyka, and Jake Kritzer), with advising from National Oceanic and Atmospheric Administration (NOAA) Northeast Fisheries Science Center (NEFSC - George Maynard and Jim Manning [retired]).

Workshop Proceedings

Overview

The full-day workshop was held at the Moore Community Center Theater in Ellsworth, Maine on April 17, 2025. The morning session focused on providing context for the workshop, providing background information on the types of data available, and discussion on how data is able to meet the needs of fishermen. The afternoon session was structured around breakout sessions to enable participants to provide feedback on specific data visualization products.

Erin Pelletier kicked off the day with housekeeping notes, round-the-room introductions, and an overview of the workshop goals and agenda.

Workshop Goals

- Provide an overview of the data types and products associated with the eMOLT program, which is a collaborative program that facilitates real-time observational data collection with the fishing industry.

- Provide an overview of NERACOOS ocean data products.
- Hear fishermen's targeted feedback and ideas on specific data visualization products, ideas on arising information needs, and observations of changing data uses to best support on-water decisions.

See Appendix III for slides presented during the workshop.

Background

Gulf of Maine Lobster Foundation

During her introduction, Erin overviewed the Gulf of Maine Lobster Foundation (GOMLF), an entity established in 2000 by members of the Maine lobster industry in response to the growing demand for improved lobster science and the need to establish long-term datasets. GOMLF has been the lead organization for the eMOLT program since 2003.

NERACOOS

Tom Shyka provided an overview of Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS), one of eleven Regional Associations of the U.S. Integrated Ocean Observing System (IOOS). NERACOOS works with regional operators and partners to generate data about the ocean, consolidate data, and share it with anyone who wants or needs it. Certified by NOAA as a Regional Coastal Observing System (RCOS) Entity, the data NERACOOS serves meets the high standards set for federal data gathering and management. Examples of ocean observing technologies used in the Northeast are data buoys, land-based high-frequency radars, tide gauges, gliders, and various biological monitoring technologies. Data collected across the region is integrated into oceanographic models, and is translated into information and data products that make the data accessible. See Appendix III, slides 2-33, for more detail.

eMOLT Program

George Maynard provided an overview of the Environmental Monitors on Lobster Traps and Large Trawlers (eMOLT) program, which has been "democratizing ocean observing since 1996". Jim Manning began the program in 1996, working with fishermen to deploy low-cost ONSET Tidbit temperature loggers primarily out of Massachusetts ports. These sensors archived temperature data and at certain intervals would be manually sent to Jim Manning for data download. The program expanded throughout New England through 2014 to 402 sites, with better temperature sensor accuracy using the VEMCO Minilog. George showed multiple examples of the insights gained through the early days of the program, highlighting papers (see Appendix III, slides 42-51) that show the value of these fishing vessel observations . With individual captains' permission, he also showed examples of long-term data from individuals, which has shown increasing bottom temperatures over time.

Starting in 2015, the eMOLT system collaboratively developed and expanded to include real-time data loggers, which collect temperature profiles or dissolved oxygen/temperatures. Unlike the archival data loggers, the real-time wireless loggers sync with low-cost, on-vessel deckboxes to display data, and utilize 4G cell service to transfer data to shore-based servers. George showed visualizations of recent data collection expansion into Maine. Since 2022, Downeast Maine fishermen have been growing participants in the eMOLT system and have dramatically augmented the amount of data being collected.

After highlighting funders, and those funding sources that may be lost with prospective budget cuts, George highlighted the many uses of the data when aggregated (see Appendix III, slides 82-111), showing participants the value of the system of data beyond fishermen's individual uses. Highlighted uses of aggregated data include 1) providing insight into coastal dissolved oxygen levels when algal blooms occur, 2) data assimilation into ocean models to provide more accurate forecasts, and 3) ground-truthing ocean models to understand how well models reflect reality. See Appendix III, slides 34-111, for more detail.

Plenary Discussion

Jake Kritzer briefly provided additional context for a group discussion, emphasizing that feedback regarding observing needs directly from users is essential to continuing to run an effective and accessible observing system that is responsive to changing environmental and economic conditions.

Emma Weed then facilitated a full group discussion, with the following prompts:

Information Uses

- What kind of information do you rely on before heading out and when you are out on the water—and what do you wish you had more of?
- How does the ocean data provided influence your on-water decisions?
- What data do you wish existed?
- How do your data needs shift under different regulations (e.g., if the gauge increase had gone into effect, would that change any ocean data needs)?
- What models do you rely on?
- Are there examples of when ocean data confirmed something you had previously thought was happening? What about vice versa, where the data was different than you thought it would be.

Changes Over Time

- What kind of changes have you seen and has that changed how you work?
- How are your data needs shifting over time? Are these different across seasons?

Scale - What space and time scales are important & interesting to you?

- Spatial scale: Just your fishing ground? Your lobster zone? Entire Gulf?
- Time scale: tidal, daily, weekly, monthly, seasonal, annual, decadal?

Tools & Delivery Formats

- How do you most prefer to get information about ocean conditions? (e.g., Websites/Portals, Apps, Email updates, Newsletters mailed to you, Texts, Social media)

Summary of Plenary Discussion

In addition to expressing steadfast support for existing observing assets in the region and passion for the use of eMOLT sensors to contextualize their fishing practices, participants primarily shared their field-based observations that have raised concerns about ecological change in the Gulf of Maine (GoM). These observations, grounded in their fishing activity and long-term experience, prompted questions about system drivers and highlighted the limitations of existing monitoring to explain observed trends. As understanding upstream conditions was viewed as critical for anticipating changes entering the Gulf of Maine, participants emphasized the need for stronger connections with Canadian researchers and fishermen (e.g., Fishermen's Scientist Research Society). The following summary of the plenary discussion is broken into the following categories: core variables and coverage of measurements; biological observations; large-scale physical oceanography changes; impacts of manmade infrastructure; data access, usability, and communication challenges.

Core Variables and Coverage of Measurements

Participants identified several foundational environmental variables that are of continued and expanded monitoring interest. These included bottom and water column temperature, nutrient inputs, and dissolved oxygen (DO), all of which are critical for understanding recent variability and apparent reversals in warming trends. Dissolved oxygen near Jonesport was highlighted following a salmon aquaculture die-off associated with an algal bloom. Participants noted that algal blooms appear to be moving eastward, increasing concern for under-monitored areas. In response to fishermen observing dead zones, additional DO sensors have been deployed in Blue Hill Bay. These deployments were described as important for establishing baseline conditions and providing evidence to inform management. Participants emphasized the need for improved inshore monitoring of nearshore critical habitats and expressed interest in expanding the use of eMOLT sensors (approximately 180 deployed through MassTech) as well as exploring sensor placement on scallop lines.

Regional gaps in coverage were also emphasized. Riverine inputs into the Gulf of Maine were repeatedly cited as poorly characterized despite their likely influence on nutrients, temperature, and oxygen dynamics. Downeast Maine, primarily Washington County, was identified as a major coverage gap due to the absence of a buoy, leaving large portions of the coastline without a consistent offshore context. While an existing surface buoy (NDBC 44027) is located approximately 25 miles offshore, it was described as insufficient for full water column conditions and nearshore temperature monitoring, and not serviced frequently enough.

Participants also highlighted the need for improved monitoring further offshore to understand interactions between the Gulf Stream and the Labrador Current, noting the Northeast Channel (former location of Buoy N) as particularly valuable for detecting deepwater inflows to the Gulf of Maine. In its absence, participants emphasized the importance of eMOLT data in these regions, which help support system-wide understanding and improve forecasts despite inherent limitations. However, the limitations of eMOLT data were also noted. As the eMOLT sensors are frequently moved and there is interference from tides and currents, interpretation at larger scales is less straightforward.

Biological Observations

Participants described several biological observations while lobstering that have spurred questions about system drivers of change. Increased abundance of sea squirts offshore was observed, with questions raised about potential links to dissolved oxygen conditions. Concerns were also raised about the impact of invasive crab species on early lobster settlement. Participants suggested that green crab populations in southern Maine are likely already affecting settlement and expressed concern about how blue crab range expansion into the Gulf of Maine may further influence recruitment.

Another observation was the rapid expansion of *Dasysiphonia japonica* (purple hair algae). Participants reported that it is “choking out” benthic habitats and has recently expanded offshore and further Downeast. While *Dasysiphonia japonica* has been present in the region for approximately 15 years, its recent growth raised heightened concern. A collaborator noted that research has shown *Dasysiphonia japonica* can increase acidity, although it has not been shown to affect lobster settlement. Nonetheless, participants expressed concern about broader ecosystem and harvest impacts.

Large-Scale Physical Oceanography Changes

Participants discussed recent physical changes that diverge from longer-term trends. Following multiple years of warming, the past year (2024) was characterized by colder and lower salinity water. This raised questions about whether colder, fresher water, may be influencing conditions. Collaborators noted there may be a shift in large-scale circulation. Participants questioned how to predict the behavior of these currents on annual timescales, and a recent paper (Record et al. 2024) was repeatedly referenced as helpful for considering how deep oceanographic signals in the fall could help to forecast upcoming regime changes in the Gulf of Maine.
A collaborator noted that traditionally, sea surface height at the Grand Banks has been used as an indicator of water stacking and the likelihood of the Gulf Stream pinching off the Labrador Current, with a proposed lag of one to two years before impacts are observed in the GoM. However, collaborators also noted that this approach would not have accurately predicted conditions in the past two years, suggesting a breakdown in previously reliable indicators. Nick Record’s annual forecasting efforts were highlighted as a positive example of scientists ability to make forecasts, noting his accurate prediction that 2024 would be a good year for *Calanus spp.*. and North Atlantic Right Whales.

Impacts of Manmade Infrastructure

Participants questioned whether the rapid expansion of floating oyster aquaculture, particularly black oyster cages in Midcoast, could be contributing to localized warming in bays by absorbing heat. Related questions focused on how increasing water temperatures may affect plankton communities, clam spat, and lobster life stages.

Wind energy development prompted discussion of potential circulation impacts. Participants questioned whether wind farms could affect Gulf Stream flow. A collaborator noted that circulation modeling related to wind farms is underway in Southern New England and the Mid Atlantic, and emphasized the need for robust before-and-after turbine installation data to detect impacts. While the North Sea provides insight into impacts from fixed pilings, which is relevant to projects south of Cape Cod, much less is known about subsurface circulation changes associated with floating wind turbines, which would be the substructure used in the Gulf of Maine. Participants and collaborators distinguished between surface and subsurface effects and noted the latter as a major knowledge gap. A collaborator suggested that while this infrastructure may have an impact, climate-driven changes in winds and currents are likely the dominant driver of a changing Gulf Stream, citing decades of surface current data from drifters deployed throughout the Gulf of Maine.

Data Access, Usability, and Communication Challenges

Participants discussed both the importance of access to the data, and noted specific challenges related to data access and usability. Many rely heavily on the buoy data, mainly accessing through Fishweather, Windfinder, and the Mariners' Dashboard. Participants reported regular data delays between 4–6 a.m., a particularly problematic window given that fishermen often make go/no-go decisions during this time.

Concerns were also raised about data accuracy and availability. Participants noted that at times the Portland weather buoy west-originating wind speed data appears to be tempered by the Mainland and islands, so it is not a good indicator of wind speed slightly further offshore. Additionally, the Eastern Maine Shelf buoy is visible on the Mariners' Dashboard, but water temperature data are not reliably displayed across other platforms, so the live data connections need to be reestablished.

There was strong interest in a centralized portal where users could view eMOLT data from deployments across the region. George referenced the Commercial Fisheries Research Foundation's ERDDAP system, acknowledging usability challenges, and described ongoing collaborative work to develop a more accessible public-facing data product, Cape Cod Ocean Watch, which has been released since the workshop.

Participants emphasized the need for more intuitive data visualization tools, such as clickable maps that display temperature values. A collaborator described limitations of the Deckbox, which displays model output as a continental shelf-wide image, and expressed interest in automated, zoomed-in model views tailored to individual fishing grounds, and well as integrated into the Mariners' Dashboard.

Breakout Session: Data Visualization Tools

The afternoon session focused on gathering participants feedback on specific data products. Following an overview of four data visualization tools by different speakers, participants rotated through small-group breakout sessions (8 per group), each centered on a different tool. An overview (given in plenary) and takeaways from the breakout session for each tool are below. The first two tools (Mariners' Dashboard and Climatology Viewer) have a primary focus on region-wide data, while the second two tools (eMOLT Deckbox and the Fishing Ocean Data Portal) primarily focus on visualizing fishermen's individual data.

Following the breakout sessions, Tom Shyka, Riley Young Morse, Cooper Van Vranken, and Andrew Goode provided high-level takeaways from their respective discussions.

Mariners' Dashboard

mariners.neracoos.org

Tom Shyka provided an overview and brief, live demonstration of the Mariners' Dashboard Tool, which delivers high-quality, timely data from a growing network of buoys and sensors into the hands of mariners heading to sea. He demonstrated the ability to see real-time observations for a suite of metocean variables, and forecasts for a subset. The buoys and sensors shown on the Dashboard are from both NERACOOS-funded assets and external assets (e.g., NDBC).

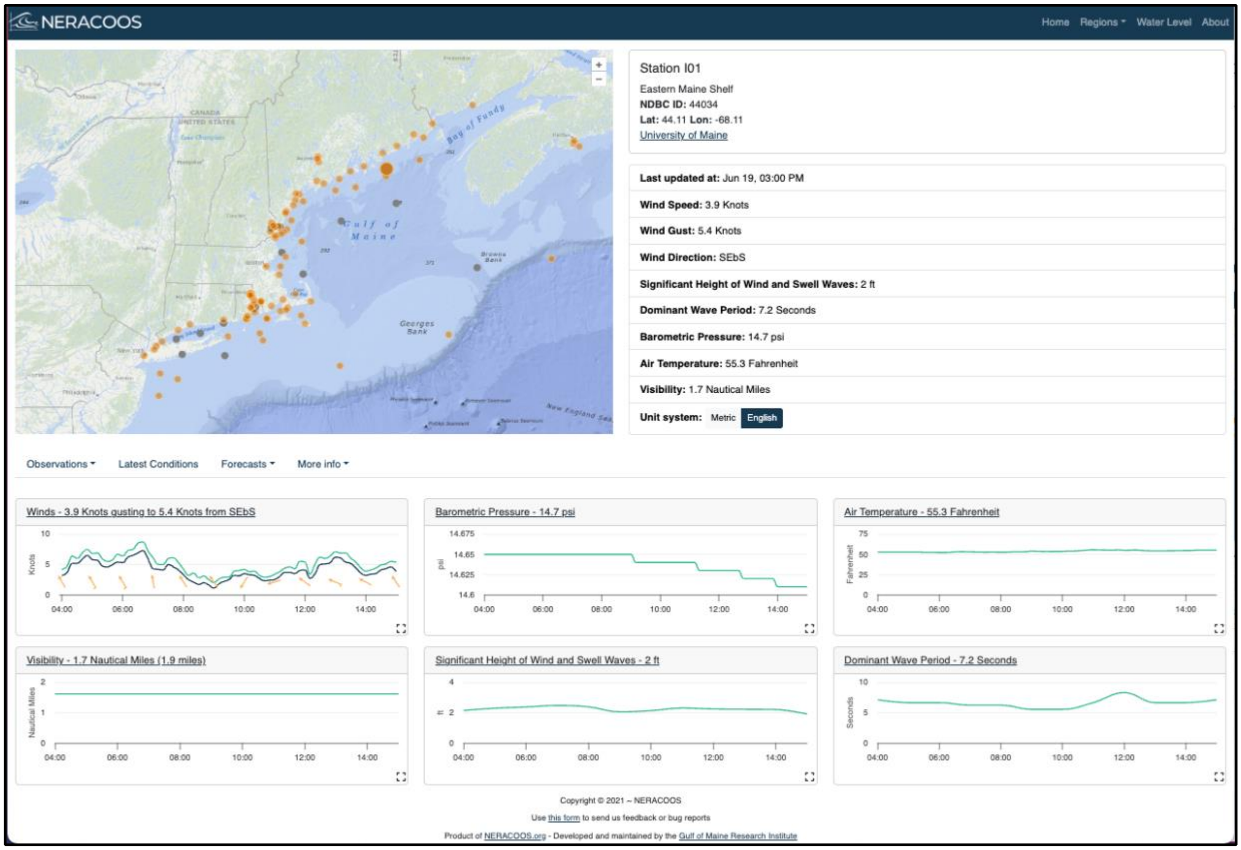


Figure 1: Screenshot of the Mariners' Dashboard

Breakout Summary (Mariners' Dashboard)

Tom Shyka led group breakout discussions on the Mariners' Dashboard. Discussion prompts aimed to understand when and how participants looked at data, what data they were looking for, and what factors, if any, influenced their decision to go on the water that day.

At a high level, participants expressed that having buoys in the water with sustained, accurate and timely data was important for safety. Multiple participants emphasized the importance of continuing to support the delivery of sea state data from the buoys and to minimize delays in real-time updates. In addition to using the data early in the day to understand current conditions and view forecasts, participants see the data as useful for building a long-term knowledge base and understanding trends. Each participant has built their own individual mental "model" of how different combinations of conditions, temporal and spatial, result in fit or unfit fishing conditions. Participants heavily rely on this mental model, as forecasts are sometimes wrong; this may lead to a missed day of fishing (if calling for bad weather when it turns out to be okay), or worse, the conditions are more extreme than anticipated and it becomes a safety concern. The 24 hours of recent data lookback on the Dashboard can be helpful to understand how the previous day's forecast compared to the actual data, but this feature isn't a primary reason for visiting the Dashboard. More details on the breakout sessions are described below, and are grouped into the following categories: Core and Secondary Variables; Timing of Data Use; Data Access Points; Data Visualization Insights; Buoy Locations.

Core and Secondary Variables.
Wind speed, significant wave height (average of highest third of waves), and wave period were consistently identified as the most important variables for determining if it is safe to go fishing. Participants expressed that peak wave height is interesting, but not as useful for decision-making as significant wave height. Air temperature is particularly useful in the winter. Visibility measurements from the NERACOOS buoys' visibility sensors are useful but not a key determinant of whether to go fishing. The visibility observations are unique to the Mariners' Dashboard because they are not being delivered by other apps. The participants also discussed the value of buoy-based webcams, which would enable them to monitor sea state and see if other vessels are operating nearby. There was some interest in this, but it was not a high priority because the decision to go to sea is often made early in the morning, when it is dark.

Timing of Data Use - Participants noted that they check conditions early in the day before heading out. Once out on the water, they are not as likely to check the current conditions. Instead, they will use the marine radio to understand high-level weather forecasts. Because of the importance of early morning access, participants agreed that system updates (which may cause data lags) should occur mid-day, while they are already on the water and not looking for real-time data.

Data Access Points - Participants shared their access points for data, and expressed differences in usability across these platforms. In addition to asking fellow fishermen already out on the water, the most used platforms are FishWeather, Windy, WindFinder, Marine Traffic, Marine Weather (App), Windfinder, Mariners' Dashboard (saved as shortcut on phone), and NOAA NDBC.

Data Visualization Insights - Participants highlighted that since they usually use the same set of buoys in a sub-region, it would be helpful to be able to select a set of "favorite" buoys on the Dashboard, to avoid clicking between. Although buoy pages can be bookmarked, this process should still be streamlined. Participants also indicated that they would like to be able to compare 2-3 locations of real-time data side by side. Additionally, participants noted that a way to compare forecasts for a single location would be helpful; and that additional data overlays could be useful (e.g., plankton data as an indicator for whale presence).

Buoy locations - Participants highlighted multiple areas where buoys would be helpful: Downeast Maine, Matinicus Rock, Jeffrey's Ledge, Cashes Ledge, and between the eastern and central Maine Shelf buoys near Seal Island. Additionally, participants expressed that bringing in more data from Canada into the Dashboard (e.g., Davis weather link) would be helpful for a more comprehensive regional picture. Additionally, participants had insights into specific buoys: Portland Buoy (44007) often reports west-originating winds much lower than fishermen have observed on the water, possibly because it is being shielded by the mainland; the

Isles of Shoals buoy is in shallow water, so the conditions being reported are often much rougher than in the general area.

Climatology Viewer

https://p5.neracoos.org/products/clim_test/drupal_clim.html

Riley Young Morse provided an overview of the climatology viewer, which is a tool to visualize changes in ocean conditions across time. Climate, in a narrow sense, is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years (WMO definition). For certain assets shown on the viewer, two decades of hourly observations are available. Riley outlined the current climatology viewer's attributes and limitations, and contrasted those with the new climatology viewer in development. In addition to many backend changes, the new viewer will allow users to select constraints (e.g., time period to average) to create custom climatology visualizations. As part of the upgrade, more eMOLT sites will be added to the viewer. Riley prompted the breakout session by noting that user input is crucial to refine feature enhancements and implement additional functionality.

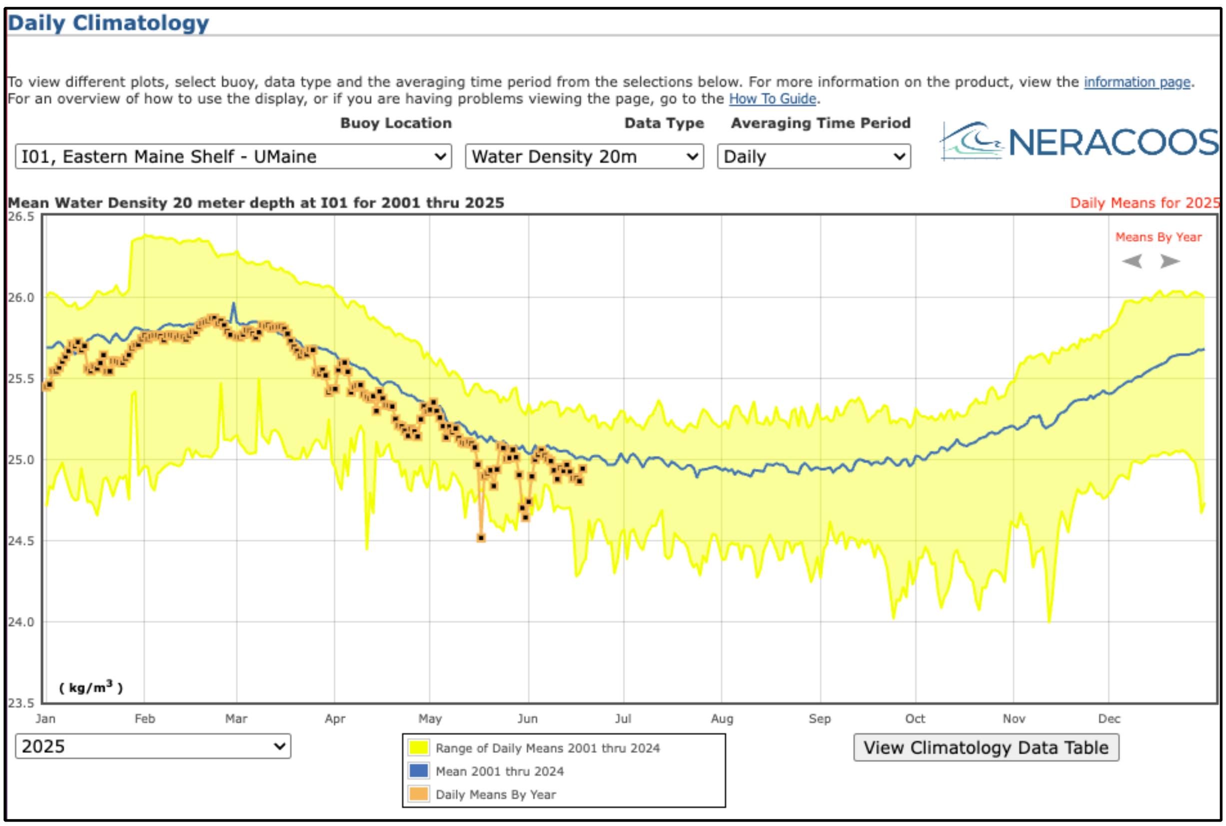


Figure 2: Screenshot of the Climatology Tool

Breakout Summary (Climatology Viewer)

Riley Young Morse led the group discussions on the Climaology viewer. As many of the participants were new to the tool, the breakout group sessions largely focused on digging into the tool in more detail than in the introductory presentation. Following these smaller demonstrations, participants introduced the following ideas that could enhance usability: Ability to compare climatologies of two locations side-by-side; Ability to toggle between colorways to better see on screens (e.g., dark mode), as it is hard to look at on phones; Ability to see fishery landings data on top of climatology data; Ability to show a climatology for a specific site on the Mariners' Dashboard; Ability to overlay moon cycle and tide data; Ability to visualize multiple individual years at once against the reference period, not just a single year. As participants already know where the measured sites are, many expressed it was not necessary to add a regional map to the page. The following ideas are already planned to be included in the Climatology tool upgrade, so it was affirming to hear that these would be welcome updates: Ability to toggle between fahrenheit and celsius; Ability to change reference period to custom years.

Participants additionally asked about specific data trends, such as why 2023 salinity data were so low, and about trends across Buoy I in 2015. A Climatology tool superuser noted that she looked at the tool multiple times across the year to understand how quickly temperatures start falling in the fall and rising in the spring, to understand when lobster movement may occur.

eMOLT Deckbox

On behalf of George Maynard, Andrew Goode provided an overview of the heart of the eMOLT system, the deckbox. Deckboxes are a touchscreen microcomputer outfitted with a GPS receiver to track sensor deployments and bluetooth antenna to gather data from the sensor. An integrated cell modem allows the eMOLT team to provide technical support and allows for automatic data transmission anytime the vessel is in cell range. In addition to showing data from individual hauls, the deckboxes show an image of modeled bottom temperatures across the Northwest Atlantic continental shelf, from the Doppio-ROMS model (Lopez et al. 2020).

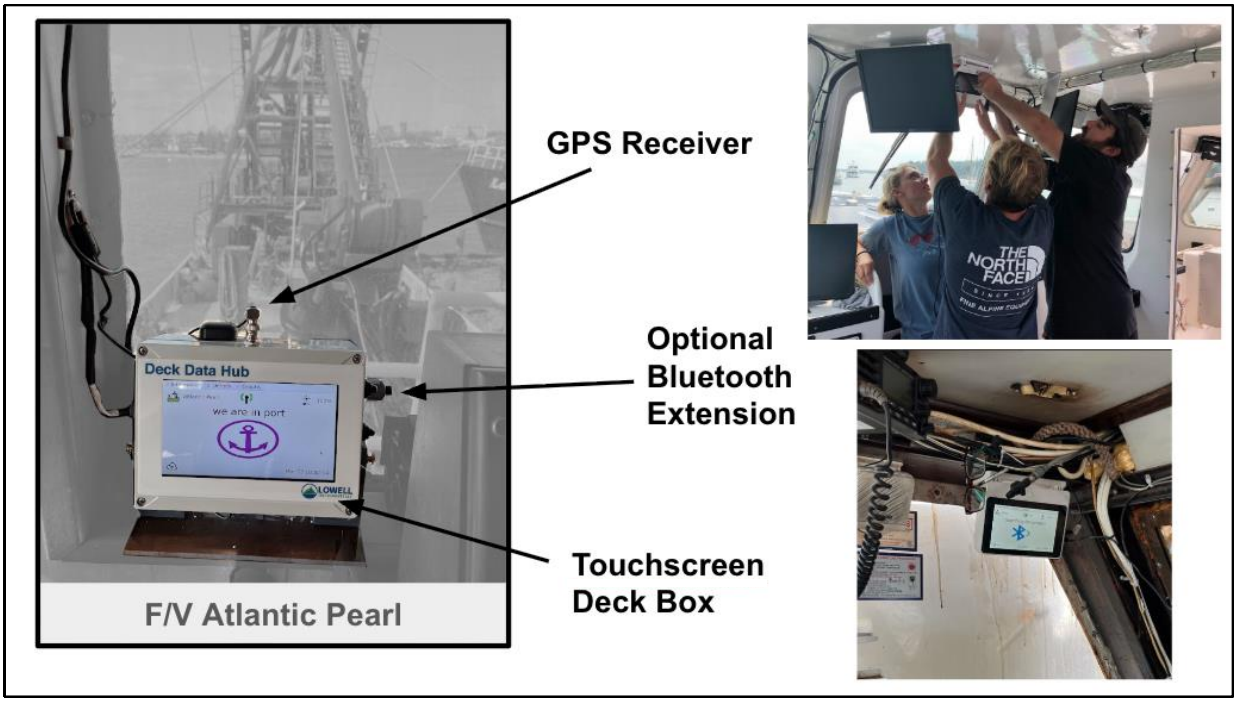


Figure 3: An annotated image of a deckbox, and deckbox installation

Breakout Summary (eMOLT Deckbox)
Following the overview in plenary, Andrew Goode led a breakout group focused on hands-on demonstrations and discussion of two deckbox options that offer the same core functionality but differ in cost and physical design, and three sensor types. One deckbox option was the lower-cost GOMLF box, which is better suited for larger vessels where the less corrosion-resistant equipment can be protected. The second deckbox option was a ruggedized deckbox, which is more corrosion resistant and durable in harsher deck environments so it can be deployed on smaller vessels with more exposed wheelhouses. Andrew also demonstrated and discussed tradeoffs (e.g., ease of servicing; cost) of the following three compatible sensors: Lowell Instruments dissolved oxygen sensors; Moana temperature/depth sensors; and Lowell Instruments temperature/depth sensors. Participants appreciated being able to directly compare the two formats and understand tradeoffs of the sensors and deckboxes.

Discussion then turned to potential deckbox enhancements and possible use cases. There was particular interest in accessing summary statistics and vertical profiles for each haul; while ascent and descent vertical profiles are collected by the two temperature/depth sensors, they are not currently visible on the deckbox interface and need to be accessed through the Fishery Ocean Data Portal or the eMOLT ERDDAP. The groups also discussed the current spatial scale of modeled bottom temperature data (Doppio-ROMS) shown on one of the tabs, noting that outputs showing the entire Gulf of Maine are interesting but not especially useful operationally. Participants emphasized that smaller, personalized areas of interest with clearer visualization would make the data more actionable. Participants also expressed interest in the ability to quickly document the presence of species of interest, such as black sea bass and *Dasysiphonia japonica*, associated with a certain haul.

Fishing Ocean Data Portal (Ocean Data Network)

Cooper Van Vranken provided an overview and live demonstration of the Fishing Ocean Data Portal, a tool for individual fishermen to visualize their own eMOLT data. Cooper highlighted the ability to see plots of depth vs. temperature and depth vs. time, as gear outfitted with eMOLT sensors are deployed or retrieved, as well as average data for selected tows/soaks. The Ocean Data Network (ODN) project leads the Fishing Vessel Ocean Observing Network (FVON), which is the international coordinating group dedicated to advancing fishing vessel based ocean observing.

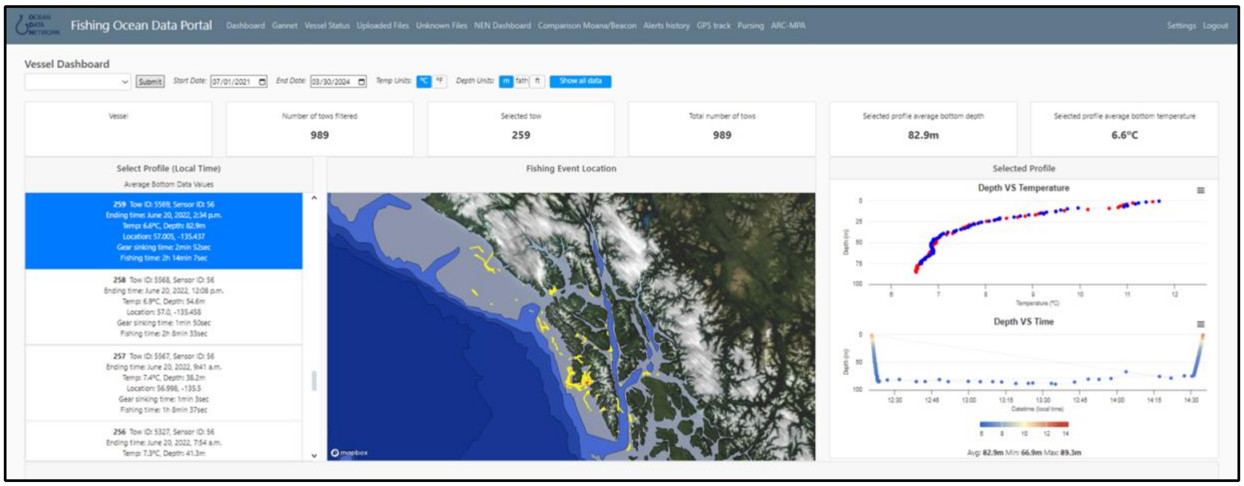


Figure 4: A screenshot of the Fishing Ocean Data Portal.

Breakout Summary (Fishing Ocean Data Portal)

Cooper Van Vranken led breakout discussions, which spanned individuals' uses of sensor data, confidentiality considerations, data visualization requests and ideas, and the importance of integration of new technology with existing sensors and portals to enable fishermen to spend more time fishing and less time troubleshooting technology. The conversation underscored that the Fishing Ocean Data Portal (the Portal) does not replace the deckbox, but is instead a complementary tool for eMOLT users to visualize the entirety of their data to gain insight into their fishing region.

Existing eMOLT participants highlighted that by looking at their haul datasets, they are able to characterize lobster pot trawls' movement, speed, and orientation and therefore envision the physical conditions of the water column where they set (e.g., tidal and non-tidal currents at different depths; depth of thermocline; tidal movement via "bouncing" along seafloor), and compare these across different tides, seasons, and locations. These insights help these users to find "magic spots" over time that have seasonal steadiness in temperatures and tidal flow, understand patterns across the region and make a more effective trawl set pattern, understand when spawning may occur, and see if it will be a “good season” based on early season temperature indicators. Additionally, they can identify if the gear was hauled by others between their visits. Poagie fishermen expressed interest in using the sensors to monitor the seine, which would help to properly position the seine with regards to the thermocline, and to improve techniques in currents and tides.

With regards to the data access on the Portal, participants discussed appreciation for the login and data confidentiality and in certain circumstances, expressed interest in expanding the ability to access the data. For example, a captain may be interested in sharing the data with deckhands, or there may be a group of trusted vessels that would like to share data. Publicly-available aggregated data at the 7km grid size is helpful, but for some purposes it is too coarse. Additionally, participants posited that something to explore is creating a process for embargoing individual data until retirement from the industry, to maintain competitive advantage while fishing but make the data available once competitive advantage is no longer needed. At the fishery level, participants expressed interest in sharing the data that they are already required to submit to federal and state agencies (e.g., VTR) with researchers and modelers that would aggregate and share back the data.

Participants expressed that the Portal is useful across a range of computing skillsets, and urged that if making upgrades to the Portal, to keep it simple by having the default be simple, with the option to view more complex options depending on the user interest and computing skillset. Additionally, “how-to” videos for different skill levels would make the Portal more accessible for a range of users. Participants also expressed interest in adding other relevant datasets to the Portal to provide context for the eMOLT data, as well as the ability to manually add data and non-realtime data. For example, required data like VTR and individual yield/catch data, ideally automatically added would be helpful. In the high season from June to September, daily resolution is best, while from October-March lower resolution (e.g., weekly, monthly) overlays would be sufficient. Visualizing bottom temperature models over a chart would be helpful to see differences in shoals vs. deep waters.

Participants also compared the functionality of various chart plotters, and opportunities for integration of the Portal with TimeZero systems. While on the water, the Portal isn’t usable due to high expense of wifi at-sea (e.g., Starlink). Additionally, participants discussed their experiences with troubleshooting specific issues on-board and questions surrounding functionality of the systems when in light of low battery levels disrupting data collection.

Through funding from MCFA, dissolved oxygen (D.O.) sensors becoming more widespread through the eMOLT network. Cooper prompted the group to imagine how D.O. visualizations may be most helpful on the Portal. Participants underscored that their main priority for the D.O. sensors would be to have seamless integration with existing on-board deckboxes, to not add additional screen infrastructure to the vessels.

Wrap Up

Following the breakout session highlights from each breakout lead, the group had an opportunity to share any final thoughts from the day. As participants left the workshop, many individuals expressed interest in both becoming eMOLT participants and continuing to engage with workshop collaborators and partners to hone these data visualization products.

References

López, A. G., Wilkin, J. L., and Levin, J. C. (2020). Doppio – a ROMS (v3.6)-based circulation model for the Mid-Atlantic Bight and Gulf of Maine: configuration and comparison to integrated coastal observing network observations. *Geoscientific Model Development*, 13, 3709–3729. https://doi.org/10.5194/gmd-13-3709-2020

Record, N. R., Pershing, A. J., and Rasher, D. B. (2024). Early warning of a cold wave in the Gulf of Maine. *Oceanography*, 37(3), 6–9. https://doi.org/10.5670/oceanog.2024.506

Appendix I: Participant List

Fishing Industry

Jeremy Alley
Xander Amuso
Bill Anderson
Jim Barclay
Jack Cunningham
Jordan Drouin
John Drouin
Jeremy Elwell
Bruce Fernald
Emma Fernald
Mark Fernald
Sam Flavin
Matt Gilley
Cote R. Hadlock
Jamien Hallowell
Richard Howland
Matthew Huntley
Samuel Hyler
Kristofer Koerber
Thea LaMastra
Joseph Locurto
Joe Locurto
Peter Locurto
Brian Moody
Forrest Moody
Ronald Musetti
Nate Snow
Garrett Steele
Steve Train
Dominic Zanke

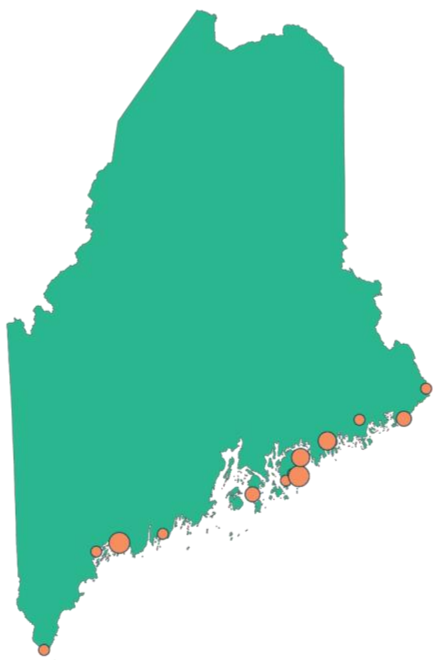


Figure 5: Geographic distribution of participants' home fishing ports, represented as a bubble chart.

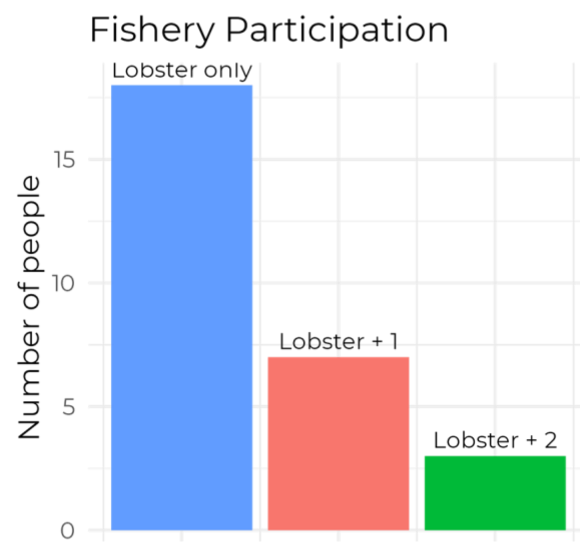


Figure 6: Fishery participation of participants, with representation of non-lobster fisheries including crab, menhaden (poagies), halibut, scallop, kelp, and Atlantic tuna.

Partners and Collaborators

Michelle Brown (Maine Sea Grant)
Chris Cash (UMaine Lobster Institute)
Andrew Goode (UMaine)
Carl Guenther (MCCF)
Kathleen Reardon (Maine DMR)
Cooper Van Vranken (ODN)
Riley Young Morse (GMRI)
Huanxin Xu (GOMLF)*

Workshop Organizers

Katy Bland (NERACOOS)
Jake Kritzer (NERACOOS)*
Jim Manning (NOAA NEFSC, retired)*
George Maynard (NOAA NEFSC)*
Erin Pelletier (GOMLF)
Caitlin Shanahan (NERACOOS)
Tom Shyka (NERACOOS)
Emma Weed (GOMLF)

**denotes remote participation from respective office location*

Appendix II: Workshop Agenda

Ocean Data Visualization Tools Workshop
Logistics and Agenda for Participants

Pre-Workshop Dinner *(Optional*)*
April 16, 2025, 6:00PM – 8:00PM
Fogtown Brewing
25 Pine St, Ellsworth, ME 04605
**Please RSVP to katy@neracoos.org if you haven't already via the registration form*

Ocean Data Visualization Tools Workshop
April 17, 2025, 8:00 AM – 4:00 PM
Moore Community Center Theatre
125 State Street, Ellsworth, ME 04605

Workshop Goal: While you will learn more about various ocean data tools, the focus of this workshop is hearing your feedback, ideas, and observations. The goal of each tool we dig into is to support your on-water decisions — we want to know how to best do this by hearing arising information needs, and providing targeted feedback on data visualization products. We will dig into tools affiliated with the eMOLT program, which is a collaborative program that facilitates real time observational data collection with the fishing industry, and products of NERACOOS (e.g., Ocean Climate Tool; Mariners Dashboard). Your feedback will directly impact how these products are developed and upgraded—so they work better for you.

Participant Logistics

Stipend and Reimbursement: As part of the funding for this workshop, there are travel and hotel funds available. Erin Pelletier will ask you to fill out a form at the workshop to initiate reimbursement and stipend processing through GoMLF. Contact Erin Pelletier at erin@gomlf.org for stipend-related questions.

- **Stipend** - Fishermen will be given a $750 stipend for your participation.
- **Mileage** - You will be reimbursed for your mileage to travel to/from the workshop at the current GSA rate.
- **Hotel** - If you need a hotel for the evening of April 16, please make a reservation at the Comfort Inn Ellsworth - Bar Harbor (130 High St., Ellsworth, ME, 04605, US) by clicking here or calling (207) 667-1345.

Workshop Parking: Please park at the Knowlton Park Parking Lot A (State Street) or Parking Lot B (3rd Street). Both are 4-minute walks to the Moore Community Center. There will be an event at the Community Center that morning for seniors, so we need to make sure there is enough parking for non-able-bodied seniors.

Materials to Bring: Notebook, Laptop (*optional)*

Agenda - April 17, 2025

Time	Activity
8:00 AM	Check-in and Light Breakfast (provided)
8:30 AM	Welcome and Introductions
9:00 AM	Session 1: Overview of Data Systems & Discussion (with Break)
11:30 AM	Lunch (provided)
12:30 PM	Session 2: Data Product Presentations & Breakouts
2:30 PM	Break
2:45 PM	Synthesis and Wrap Up
4:00 PM	Adjourn

Thank you to our workshop funder and partner!

Sea Grant
American Lobster Initiative

The Sea Grant American Lobster Initiative, funded by the National Oceanic and Atmospheric Administration's National Sea Grant College Program, is addressing critical knowledge gaps about American lobster and its iconic fishery in a dynamic and changing environment. The initiative, which began in 2019, supports both scientific research and a regional Sea Grant extension program in the Northeast U.S. Together, the research and extension components of this initiative will develop and share new knowledge and understanding with industry stakeholders and resource managers from Maine to New York.

GULF OF MAINE LOBSTER FOUNDATION

NERACOOS NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS

Appendix III: Presenter Slides

Ocean Data Visualization Tools Workshop

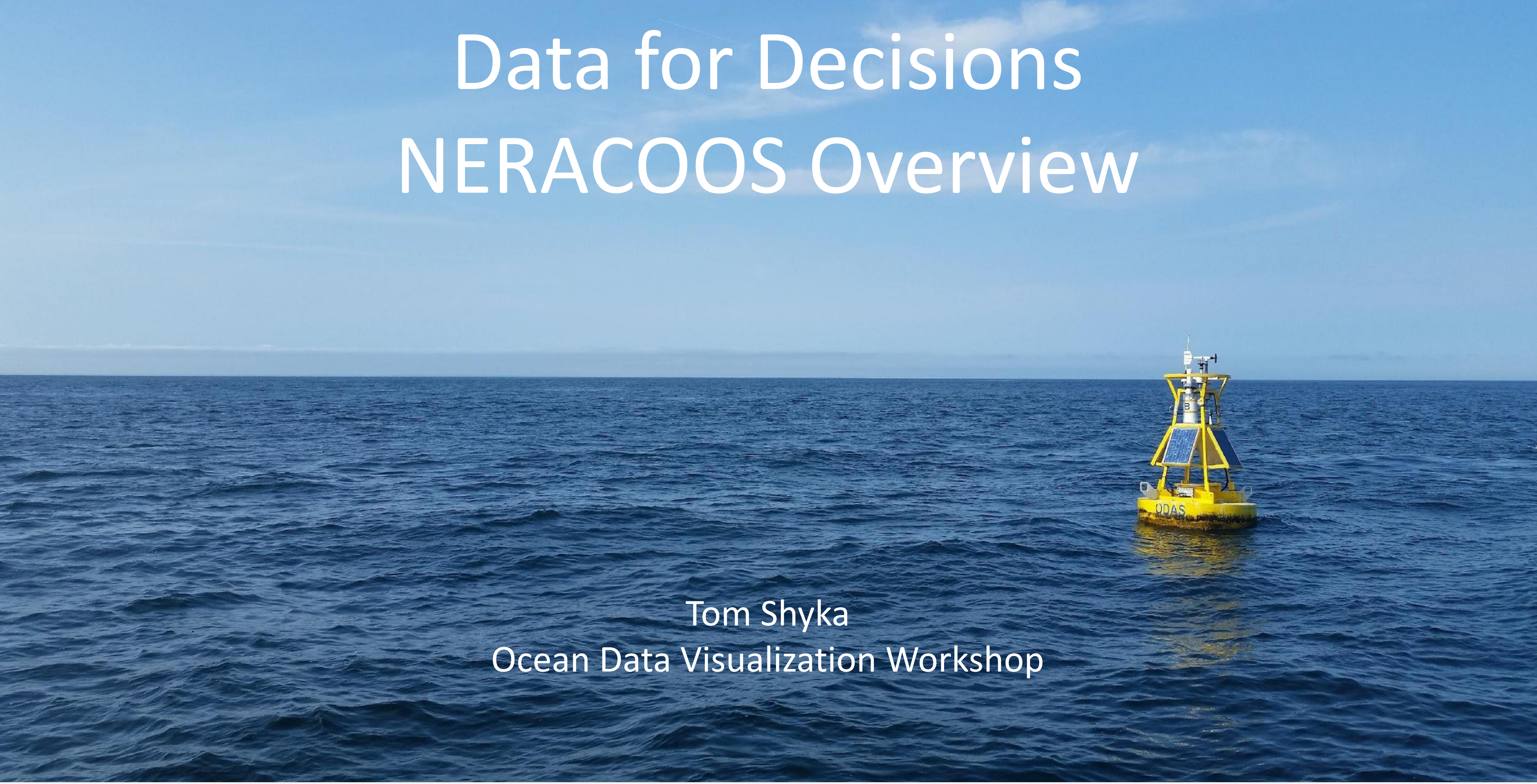
Ellsworth, ME
April 17, 2025

Gulf of Maine Lobster Foundation
Northeastern Regional Association of Coastal Ocean Observing Systems

GULF OF MAINE LOBSTER FOUNDATION

NERACOOS NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS

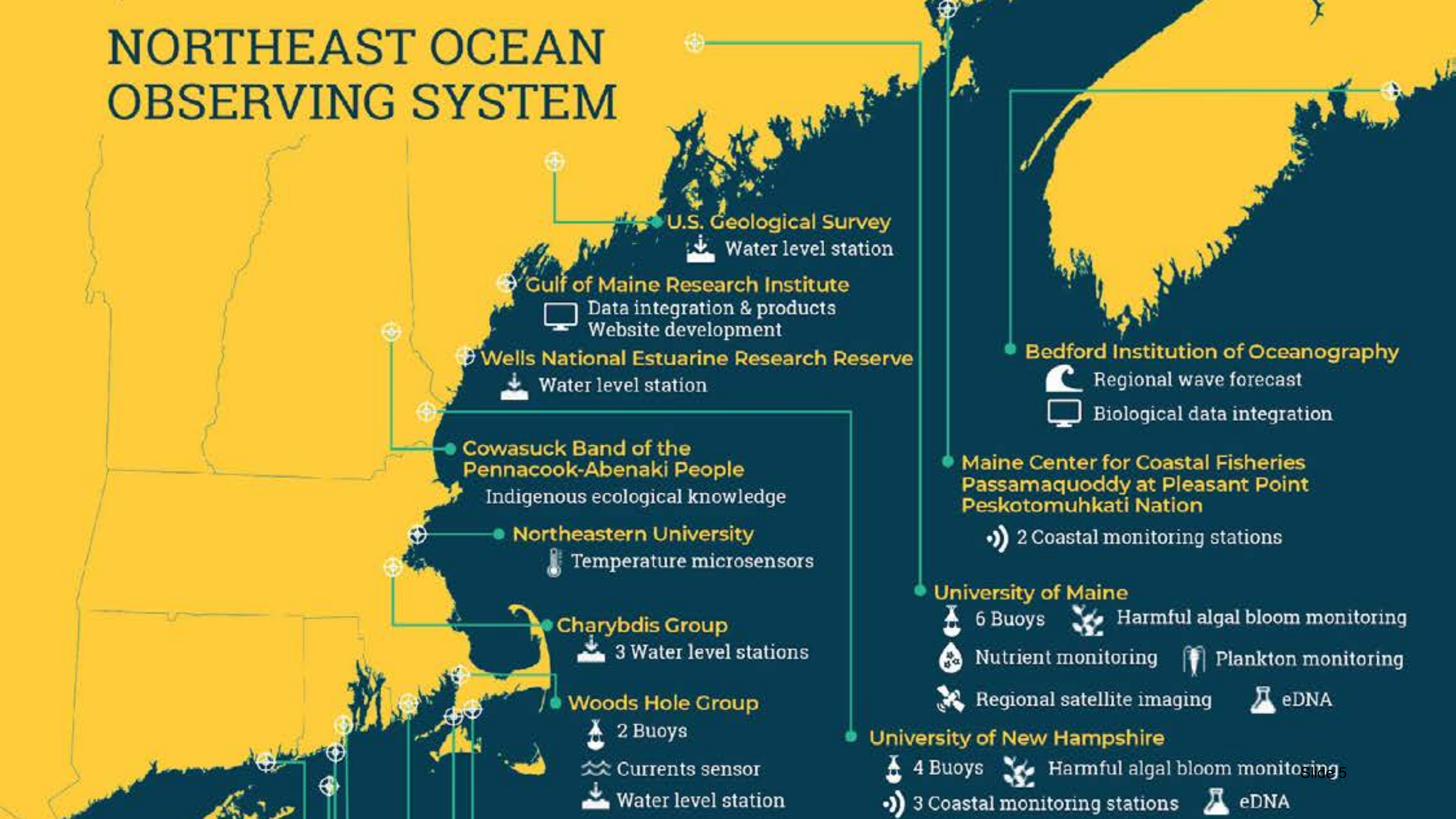
Data for Decisions
NERACOOS Overview



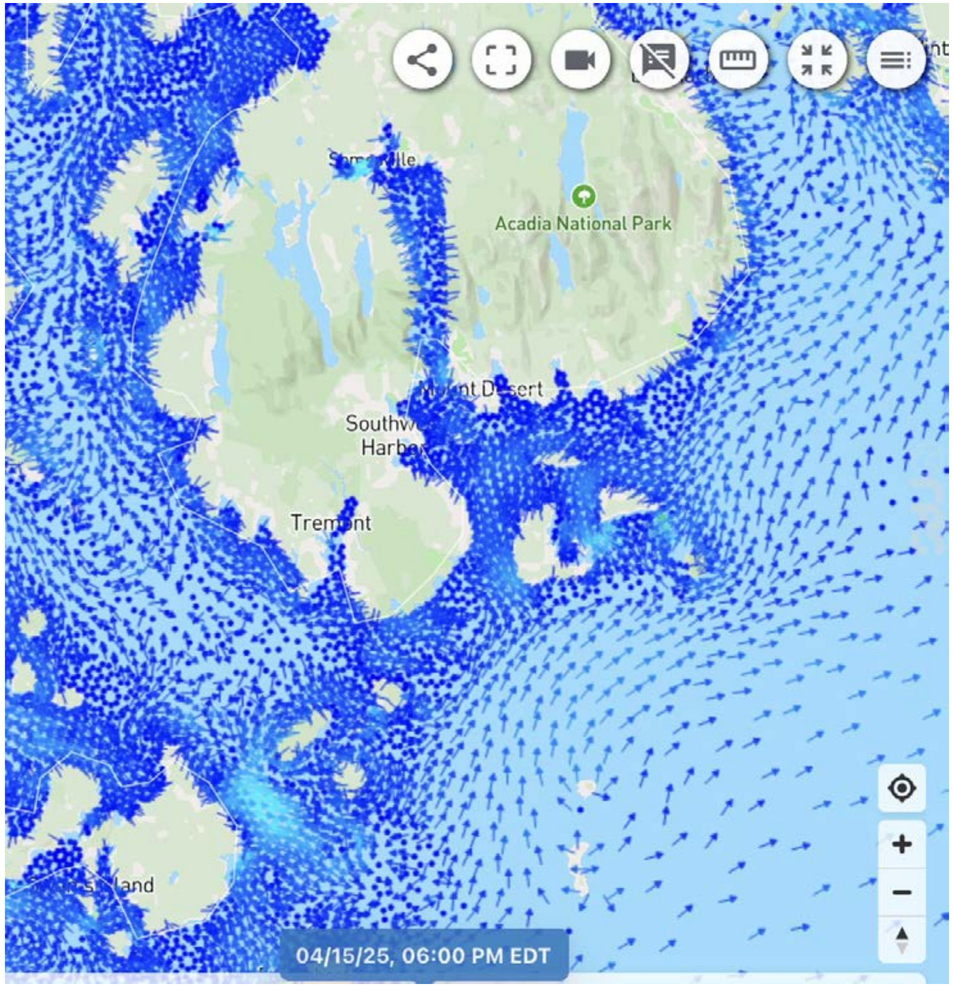
Tom Shyka
Ocean Data Visualization Workshop

Wake up with NERACOOS!

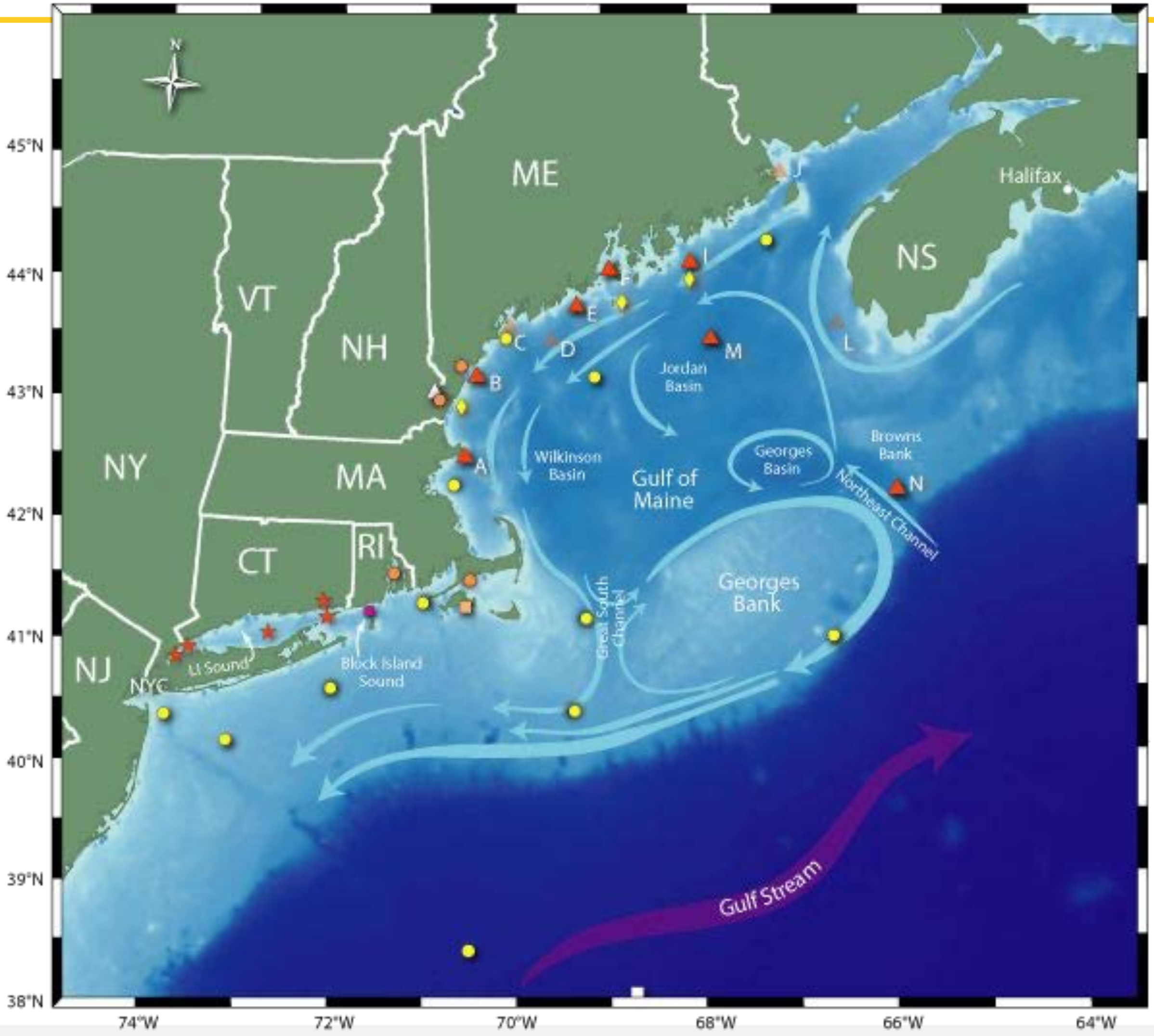
U.S. Integrated Ocean Observing System (IOOS)


NORTHEAST OCEAN OBSERVING SYSTEM
U.S. Geological Survey
Water level station
Gulf of Maine Research Institute
Data integration & products
Website development
Wells National Estuarine Research Reserve
Water level station
Cowasuck Band of the Pennacook-Abenaki People
Indigenous ecological knowledge
Northeastern University
Temperature microsensors
Charybdis Group
3 Water level stations
Woods Hole Group
2 Buoys
Currents sensor
Water level station
Bedford Institution of Oceanography
Regional wave forecast
Biological data integration
Maine Center for Coastal Fisheries
Passamaquoddy at Pleasant Point
Peskotomuhkati Nation
2 Coastal monitoring stations
University of Maine
6 Buoys
Harmful algal bloom monitoring
Nutrient monitoring
Plankton monitoring
Regional satellite imaging
eDNA
University of New Hampshire
4 Buoys
Harmful algal bloom monitoring
3 Coastal monitoring stations
eDNA

Ocean Observing Tech



Data Buoys

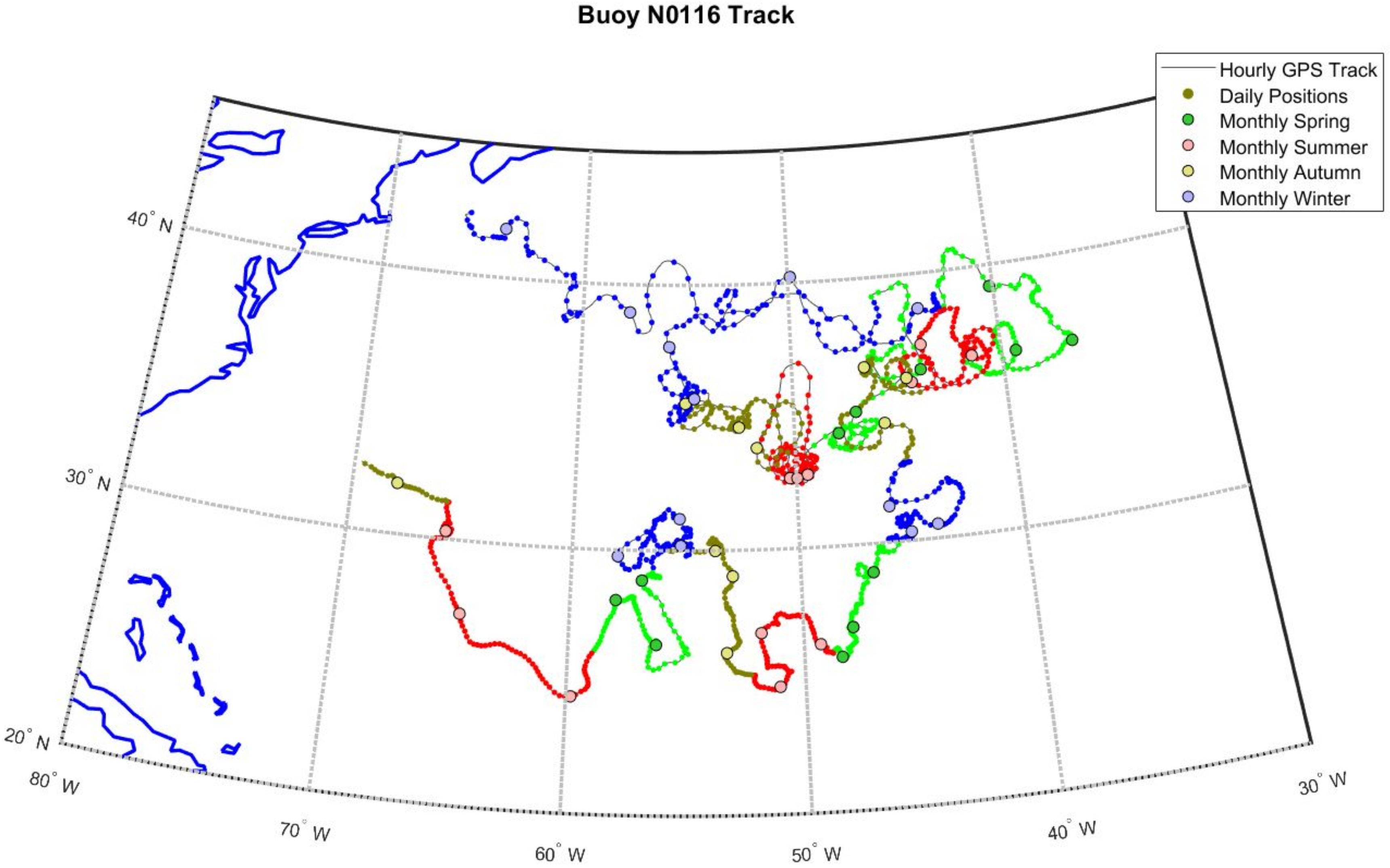

45°N
44°N
43°N
42°N
41°N
40°N
39°N
38°N
74°W
72°W
70°W
68°W
66°W
64°W
ME
VT
NH
NY
MA
CT
RI
NJ
NYC
NS
Halifax
LI Sound
Block Island Sound
Wilkinson Basin
Jordan Basin
Gulf of Maine
Georges Basin
Browns Bank
Northeast Channel
Georges Bank
Great South Channel
Gulf Stream
A
B
C
D
E
F
I
J
L
M
N

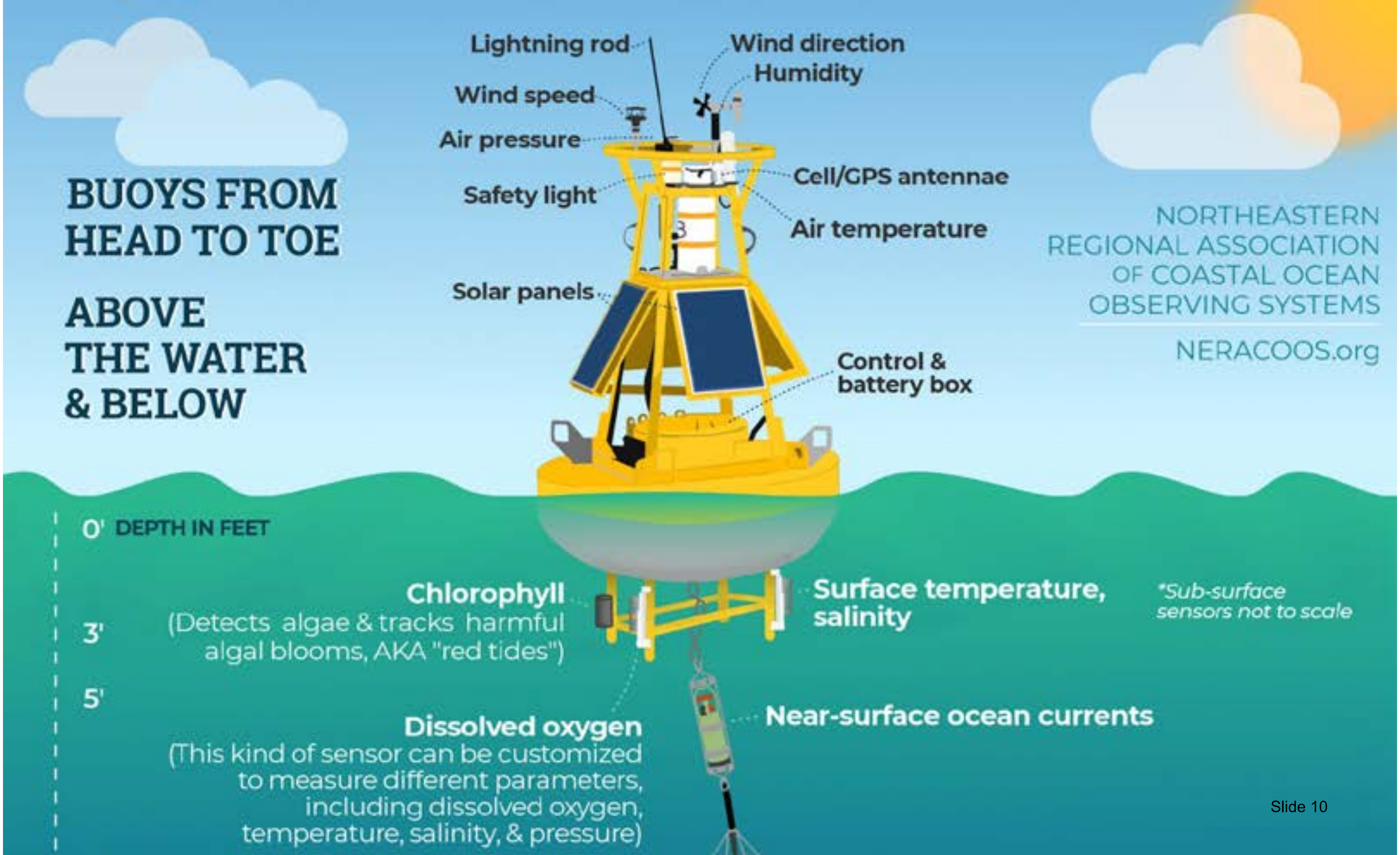
Profile of a NERACOOS Data Buoy

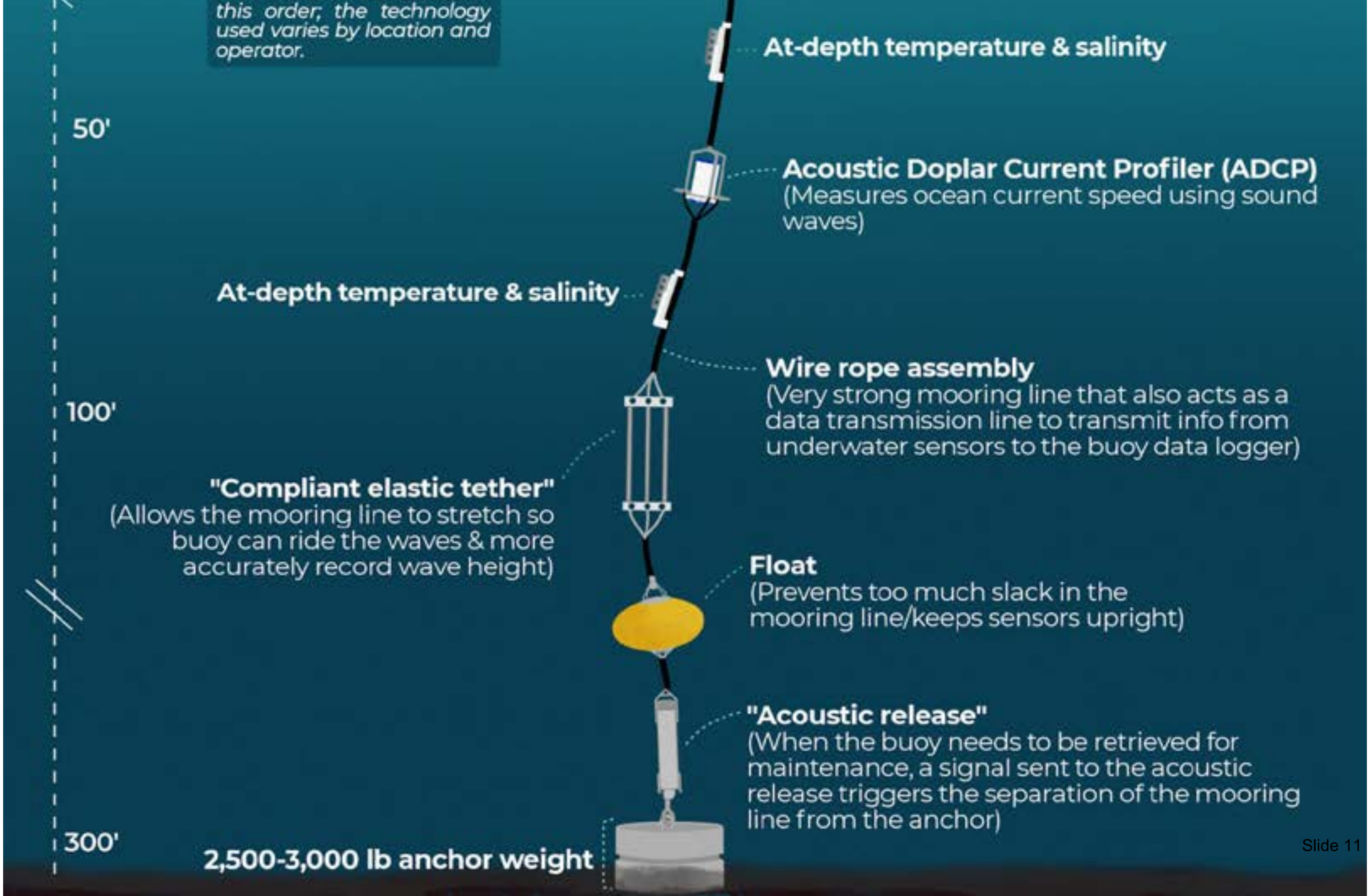
- Designed to withstand waves over 30 feet and heavy ice loads
- Solar panels provide power for data loggers and communications
- Capable of accommodating multiple sensors at various depths
- Over 6 feet in diameter, 8 feet tall, and weighing over a ton
- “Smart Buoy” knows when to call home

The GoMOOS Moored Buoy Design, J.Wallinga, N.Pettigrew, J.Irish, Oceans 2003

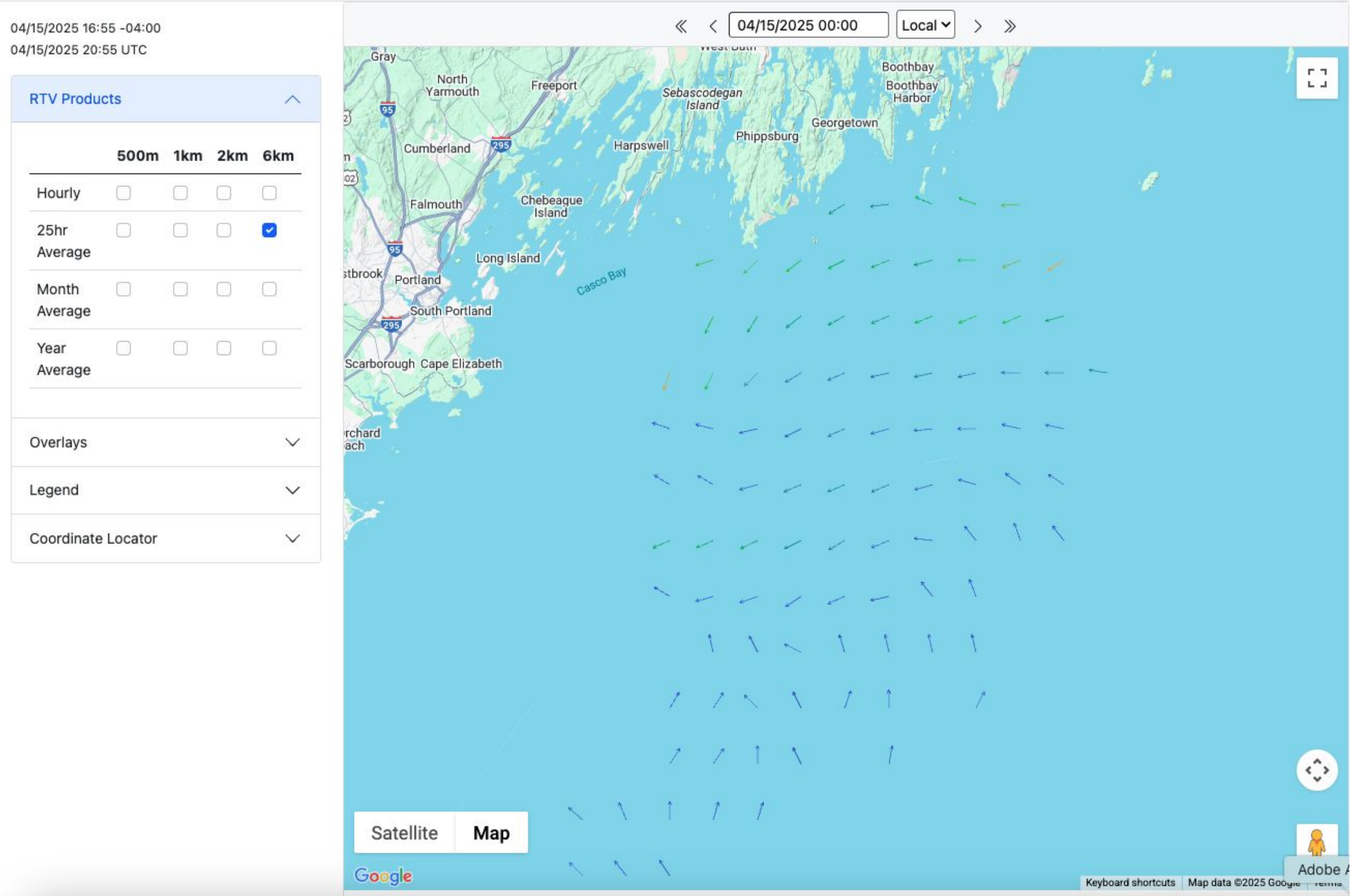
Buoy N Voyage (2014-2017)



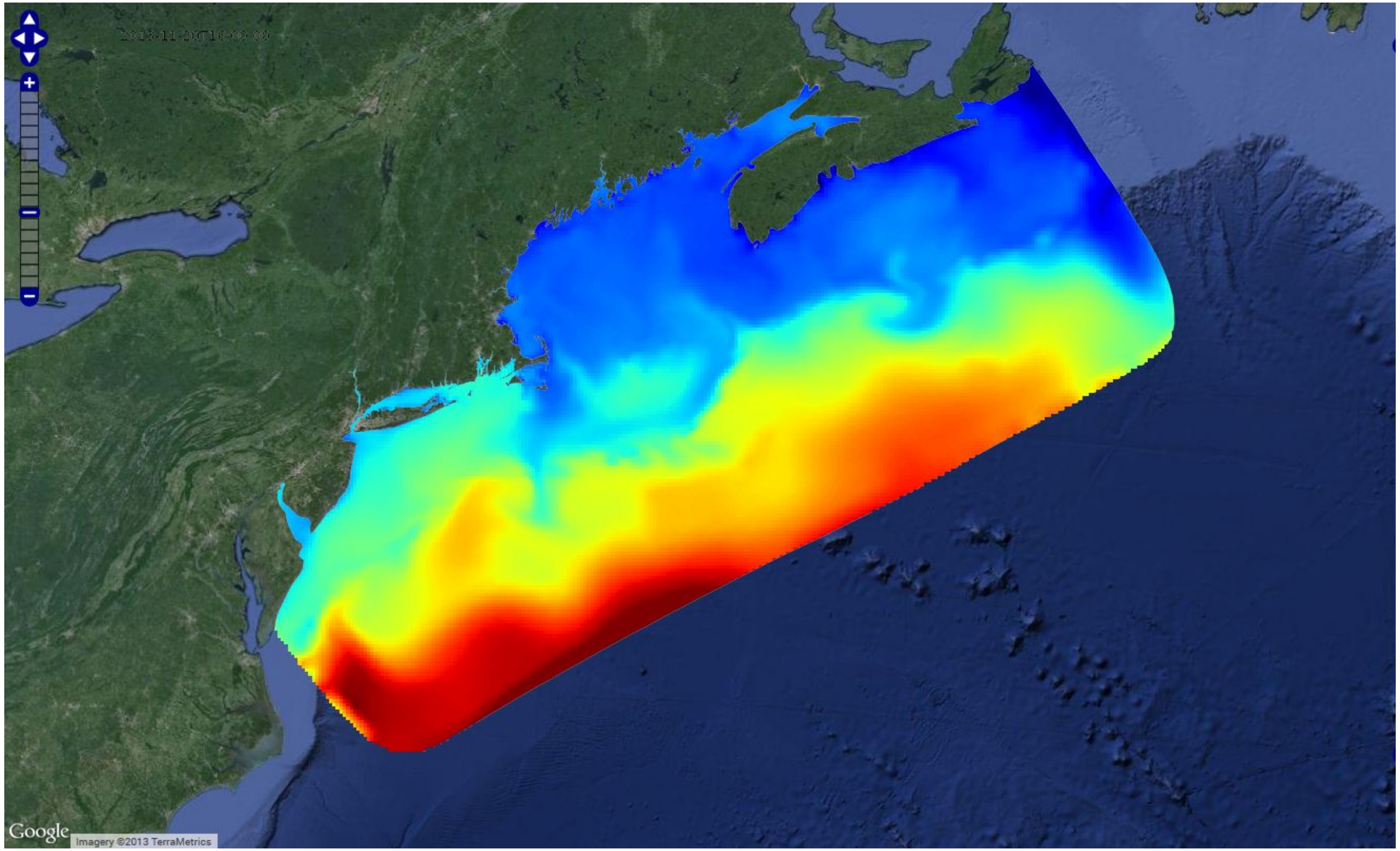

BUOYS FROM HEAD TO TOE
ABOVE THE WATER & BELOW
Lightning rod
Wind direction
Humidity
Wind speed
Air pressure
Cell/GPS antennae
Safety light
Air temperature
Solar panels
Control & battery box
NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS
NERACOOS.org
0' DEPTH IN FEET
3'
5'
Chlorophyll
(Detects algae & tracks harmful algal blooms, AKA "red tides")
Surface temperature, salinity
*Sub-surface sensors not to scale
Near-surface ocean currents
Dissolved oxygen
(This kind of sensor can be customized to measure different parameters, including dissolved oxygen, temperature, salinity, & pressure)


this order; the technology used varies by location and operator.
50'
100'
300'
At-depth temperature & salinity
Acoustic Doplar Current Profiler (ADCP)
(Measures ocean current speed using sound waves)
At-depth temperature & salinity
Wire rope assembly
(Very strong mooring line that also acts as a data transmission line to transmit info from underwater sensors to the buoy data logger)
"Compliant elastic tether"
(Allows the mooring line to stretch so buoy can ride the waves & more accurately record wave height)
Float
(Prevents too much slack in the mooring line/keeps sensors upright)
"Acoustic release"
(When the buoy needs to be retrieved for maintenance, a signal sent to the acoustic release triggers the separation of the mooring line from the anchor)
2,500-3,000 lb anchor weight

HF Radar – Surface Currents



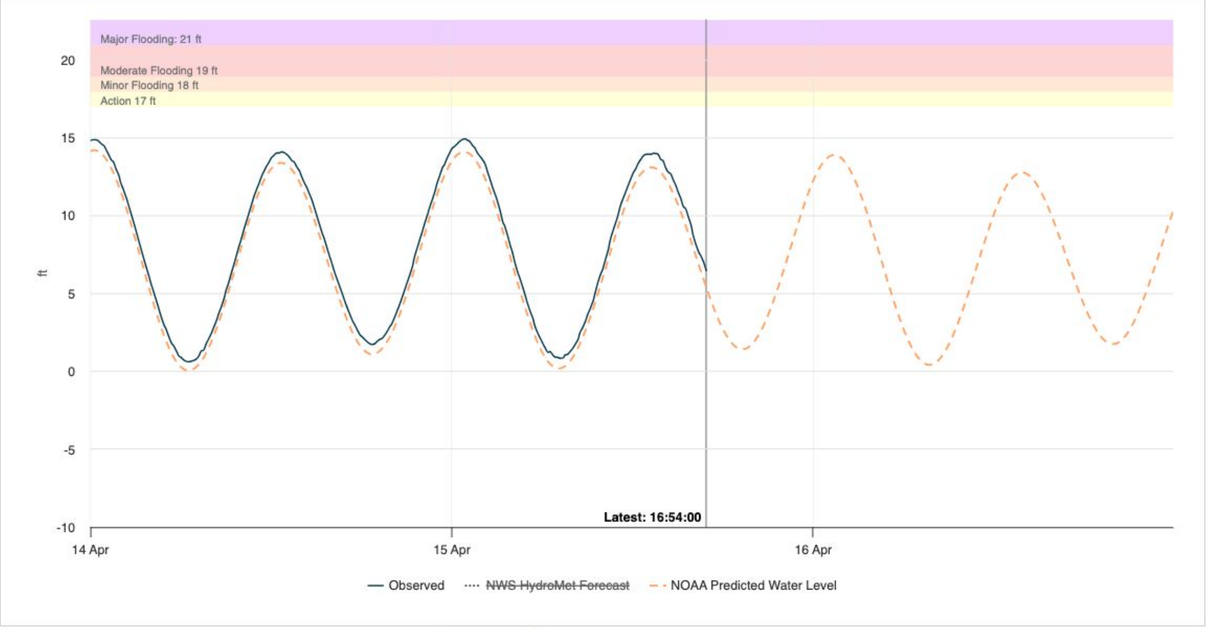
Oceanographic Models



Tide Gauges

Mean Low Low Water for Station: CFWM1

Mon Apr 14 2025 00:00:00 EST - Wed Apr 16 2025 23:54:00 EST



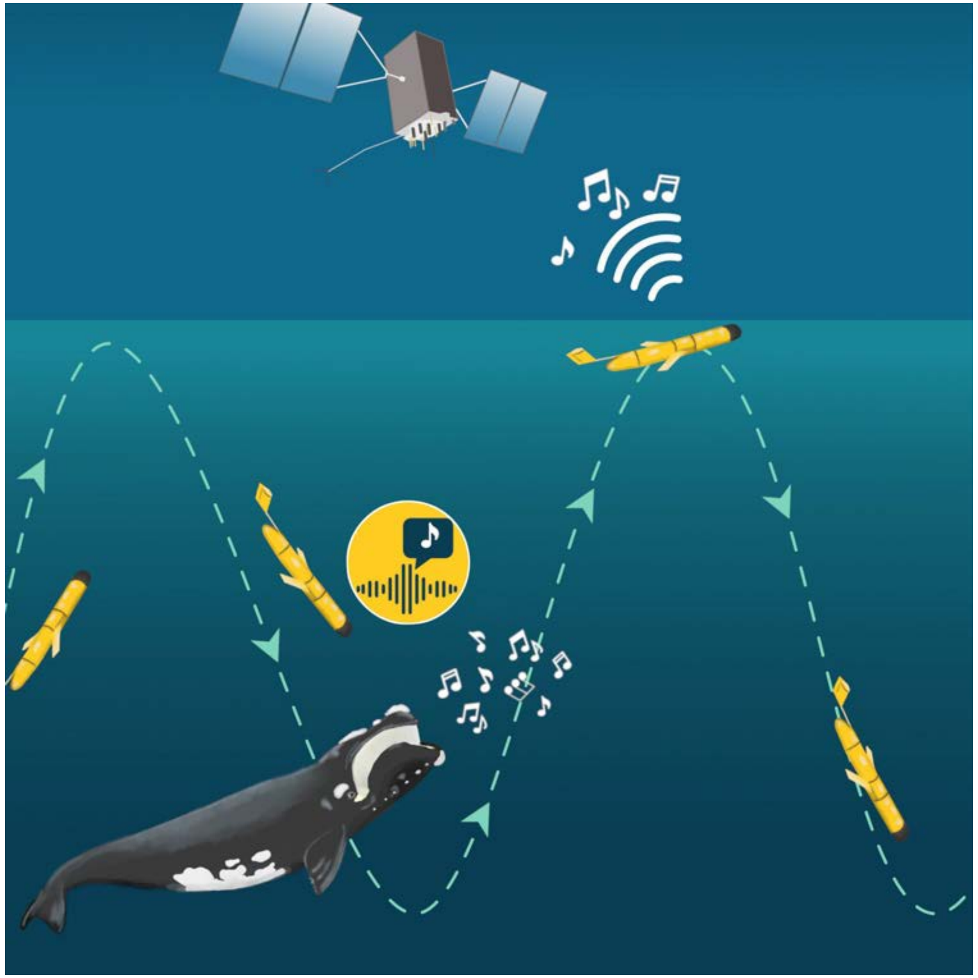
Start: 04/14/2025 End: 04/16/2025 Plot Dates

Upcoming Tides

NOAA Predicted Water Level

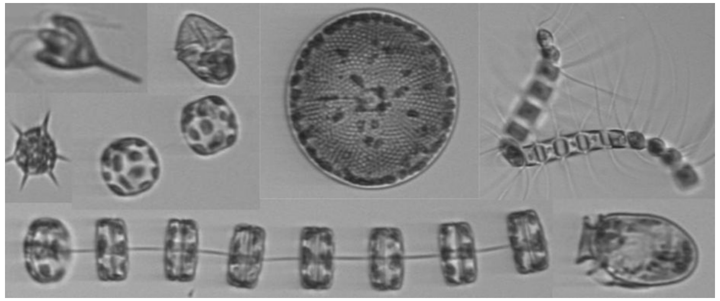
Tide	Value	Time
low	1.44 ft	4/15/2025, 7:18:00 PM
high	13.93 ft	4/16/2025, 1:24:00 AM
low	0.43 ft	4/16/2025, 7:42:00 AM

Gliders – Whale Detection

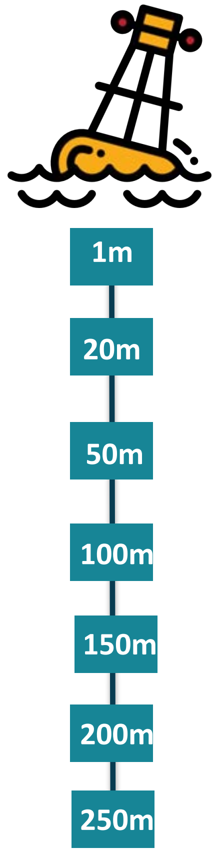


Biological Monitoring

Plankton and Harmful Algae Bloom Surveys



Data to Information



THE UNIVERSITY OF MAINE

1865

NERACOOS

NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS

station	time	mooring_site_desc	temperature	temperature_qc	salinity	salinity_qc	longitude	latitude	depth
	UTC		celsius	1	psu	1	degrees_east	degrees_north	m
M01	2022-05-27T00:00:00Z	Jordan Basin	10.66	0	32.145405	0	-67.880295	43.490414	10.0
M01	2022-05-27T01:00:00Z	Jordan Basin	10.6	0	32.098545	0	-67.880295	43.490414	10.0
M01	2022-05-27T02:00:00Z	Jordan Basin	10.75	40	32.155777	40	-67.880295	43.490414	10.0
M01	2022-05-27T03:00:00Z	Jordan Basin	10.58	0	32.15606	0	-67.880295	43.490414	10.0
M01	2022-05-27T04:00:00Z	Jordan Basin	10.31	0	32.134235	0	-67.880295	43.490414	10.0
M01	2022-05-27T05:00:00Z	Jordan Basin	10.27	0	32.129444	0	-67.880295	43.490414	10.0
M01	2022-05-27T06:00:00Z	Jordan Basin	10.17	0	32.137527	0	-67.880295	43.490414	10.0
M01	2022-05-27T07:00:00Z	Jordan Basin	10.09	0	32.107624	0	-67.880295	43.490414	10.0
M01	2022-05-27T09:00:00Z	Jordan Basin	10.25	0	32.12704	0	-67.880295	43.490414	10.0
M01	2022-05-27T10:00:00Z	Jordan Basin	10.3	0	32.122993	0	-67.880295	43.490414	10.0
M01	2022-05-27T11:00:00Z	Jordan Basin	10.28	0	32.120594	0	-67.880295	43.490414	10.0
M01	2022-05-27T12:00:00Z	Jordan Basin	10.29	40	32.111748	40	-67.880295	43.490414	10.0
M01	2022-05-27T14:00:00Z	Jordan Basin	10.29	0	32.111748	0	-67.880295	43.490414	10.0
M01	2022-05-27T15:00:00Z	Jordan Basin	10.32	0	32.11535	0	-67.880295	43.490414	10.0
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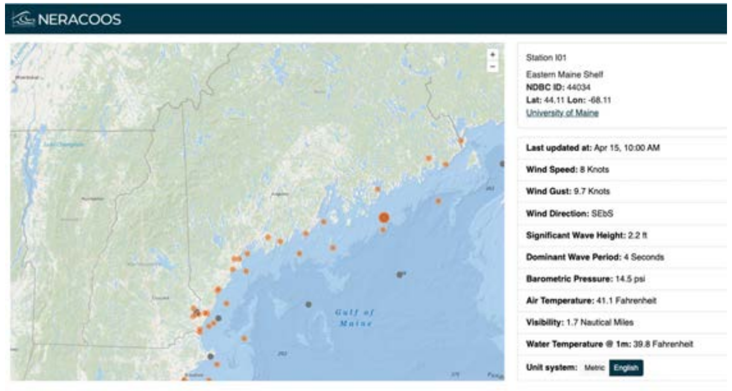
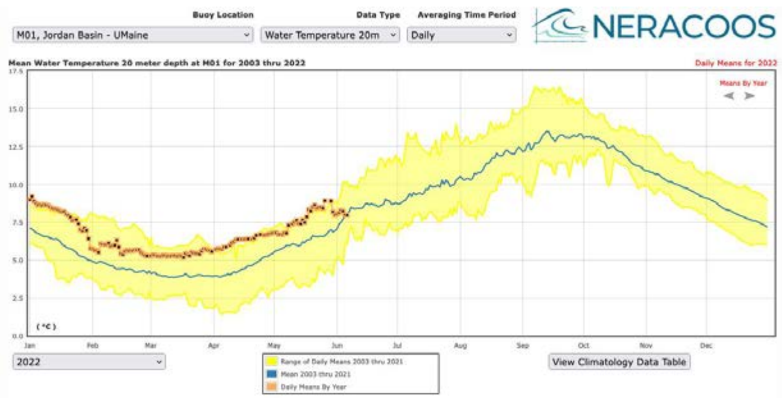
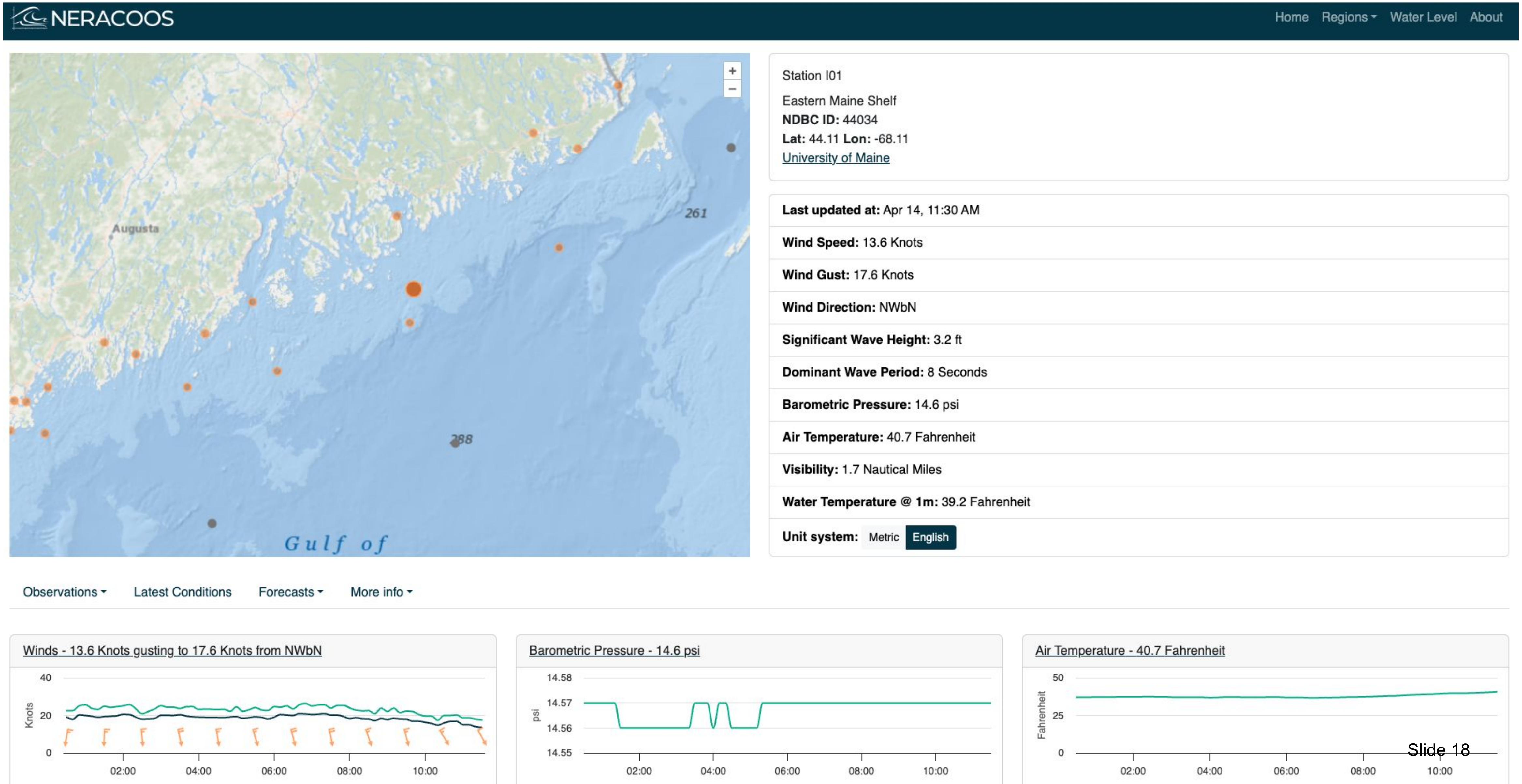




Mariners’ Dashboard



Climatology Tool

Daily Climatology

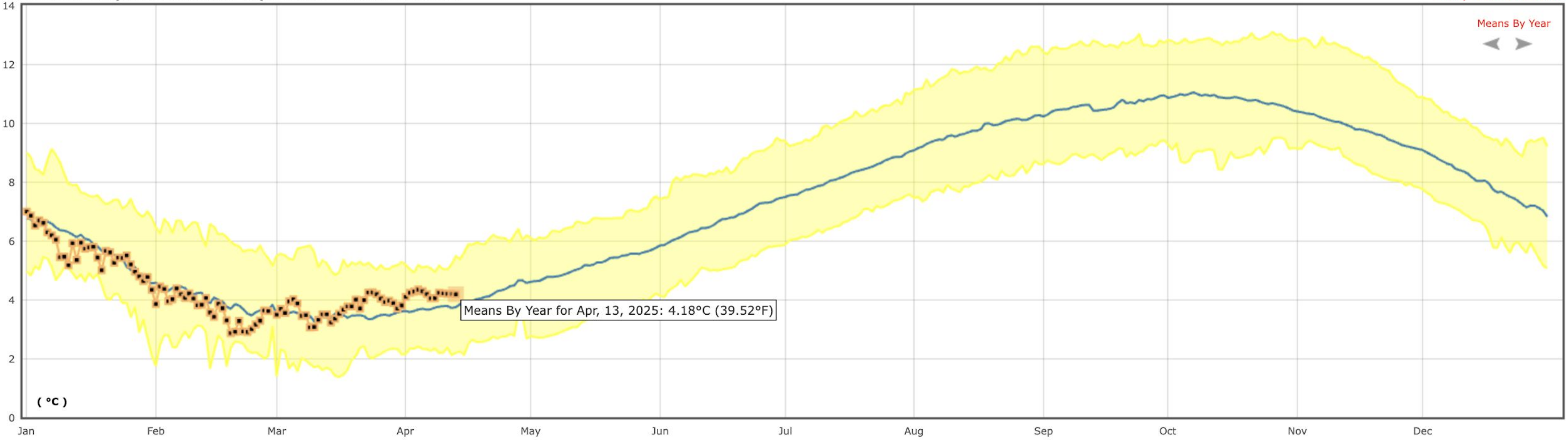
To view different plots, select buoy, data type and the averaging time period from the selections below. For more information on the product, view the information page. For an overview of how to use the display, or if you are having problems viewing the page, go to the How To Guide.

Buoy Location	Data Type	Averaging Time Period
I01, Eastern Maine Shelf - UMaine	Water Temperature 50m	Daily

NERACOOS

Mean Water Temperature 50 meter depth at I01 for 2001 thru 2025

Daily Means for 2025



2025

Range of Daily Means 2001 thru 2024
Mean 2001 thru 2024
Daily Means By Year

View Climatology Data Table

Data Access

ERDDAP
Easier access to scientific data

ERDDAP

ERDDAP (the Environmental Research Division's Data Access Program) is a data server that gives you a simple, consistent way to download subsets of scientific datasets in common file formats and make graphs and maps. This particular ERDDAP installation has oceanographic data (for example, data from satellites and buoys).

Easier Access to Scientific Data

Our focus is on making it easier for you to get scientific data.

Different scientific communities have developed different types of data servers.

For example, OPeNDAP, WCS, SOS, OBIS, and countless custom web pages with forms. Each is great on its own. But without ERDDAP, it is difficult to get data from different types of servers:

- Different data servers make you format your data request in different ways.
- Different data servers return data in different formats, usually not the common file format that you want.
- Different datasets use different formats for time data, so the results are hard to compare.

Start Using ERDDAP: Search for Interesting Datasets

- **Do a Full Text Search for Datasets**

  Search

- **View a List of All 205 Datasets**
- **Search for Datasets by Category**

  Datasets can be categorized in different ways by the values of various metadata attributes. Click on an attribute (cdm_data_type, institution, ioos_category, keywords, long_name, standard_name, variableName) to see a list of categories (values) for that attribute. Then, you can click on a category to see a list of relevant datasets.

Thank you!

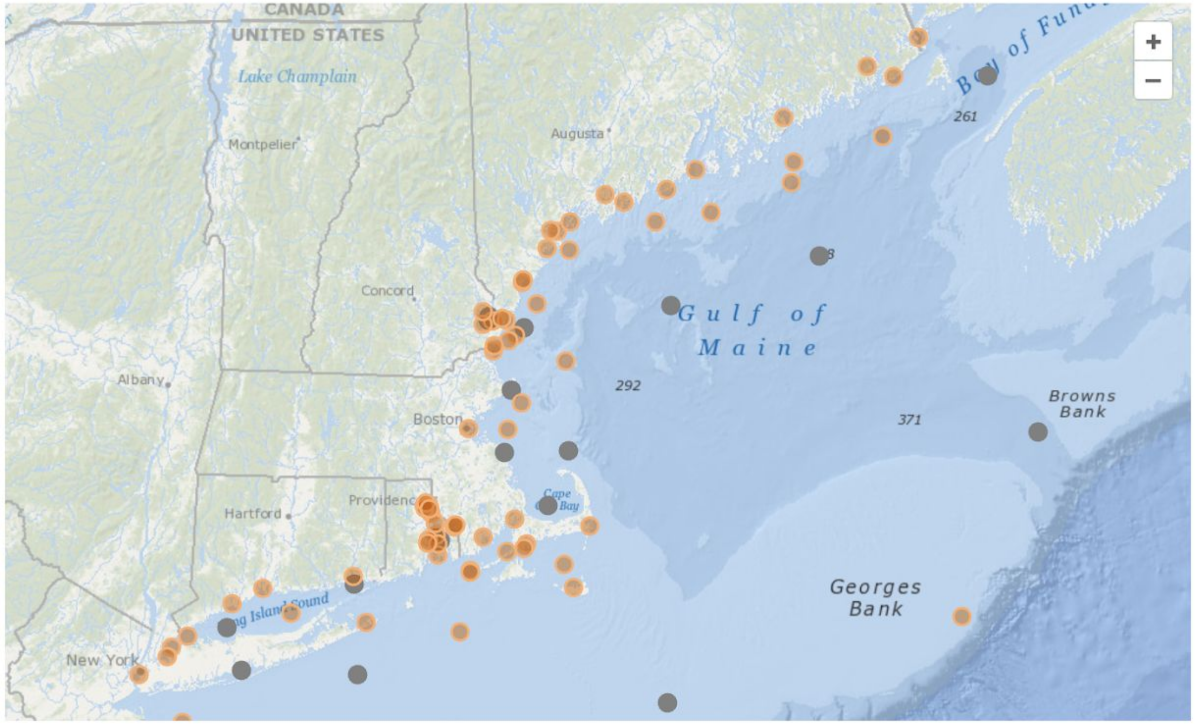
Tom Shyka

tom@neracoos.org

neracoos.org

Mariners’ Dashboard

NERACOOS | Home | Regions | Water Level | About



NERACOOS Mariners' Dashboard

Welcome to the NERACOOS Mariners' Dashboard, which delivers high-quality, timely data from a growing network of buoys and sensors into the hands of mariners heading to sea.

If you encounter a bug or have feedback regarding your experience, please use this form to submit a report.

GET STARTED:

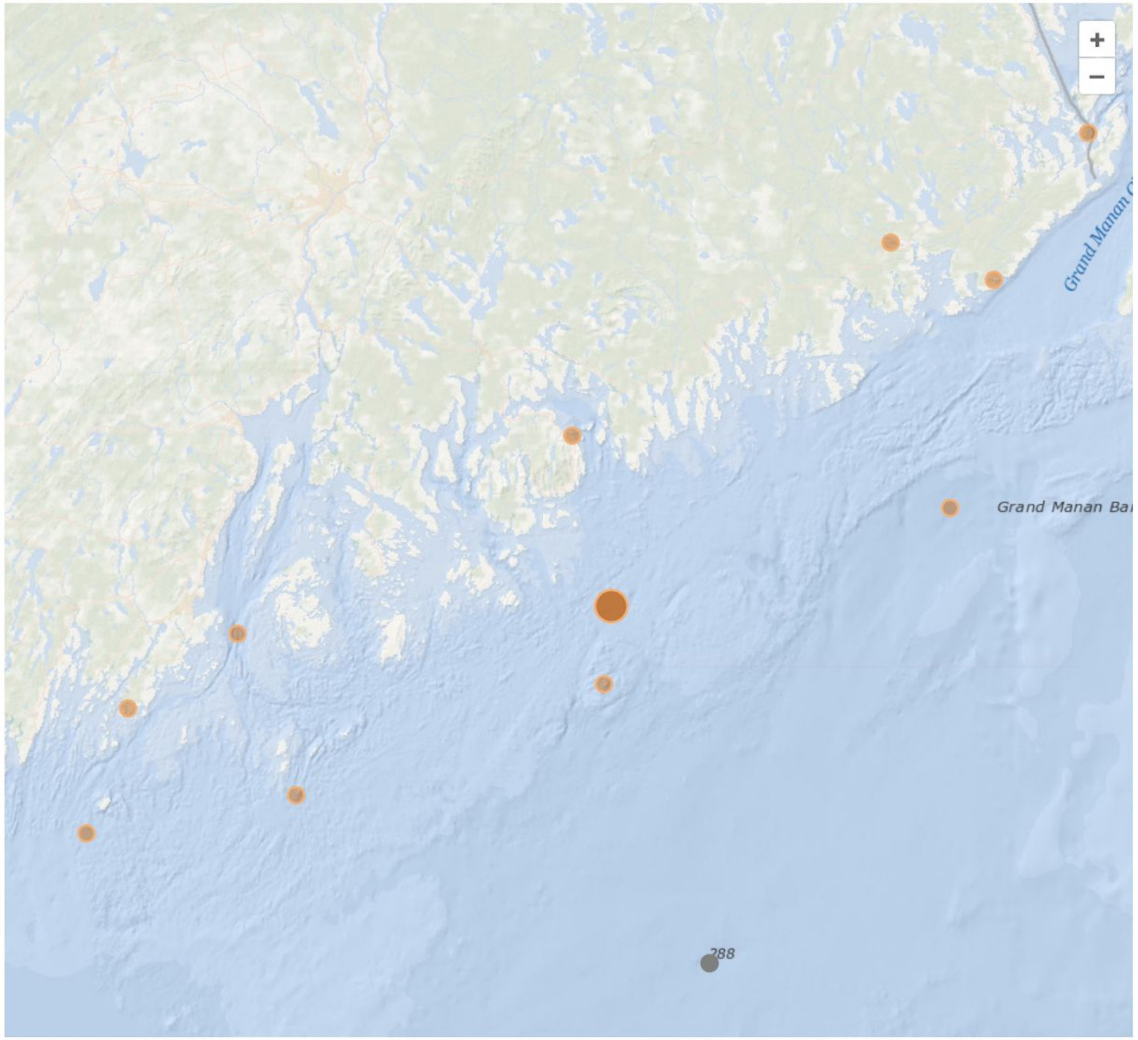
- To view the current conditions at a station, click a circle on the map
- You can also filter stations for a specific area of the Northeast by clicking the **Regions** dropdown menu located in the upper right-hand corner of the page
- Use the “Observations” tab to view the most recent data for the station’s available variables
- Select the “Forecasts” tab to view predicted conditions at the location

Latest Conditions

Highest Winds	Biggest Waves
21.4 Knots	5.6 ft
44065	44025

Mariners’ Dashboard

NERACOOS Home Regions Water Level About



Station I01

Eastern Maine Shelf
NDBC ID: 44034
Lat: 44.11 **Lon:** -68.11
University of Maine

Last updated at: Apr 16, 11:00 AM

Wind Speed: 14.5 Knots

Wind Gust: 17.4 Knots

Wind Direction: SWbW

Significant Wave Height: 3.4 ft

Dominant Wave Period: 5.4 Seconds

Barometric Pressure: 14.5 psi

Air Temperature: 40.8 Fahrenheit

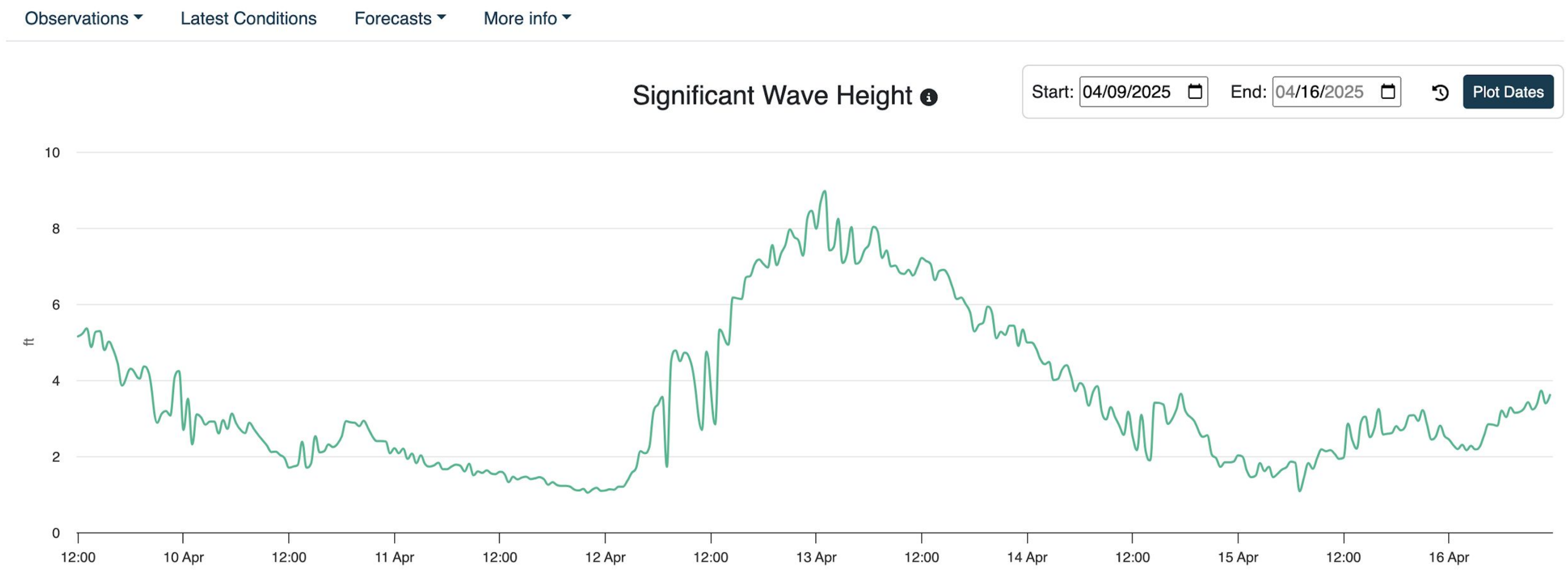
Visibility: 1.7 Nautical Miles

Water Temperature @ 1m: 39.3 Fahrenheit

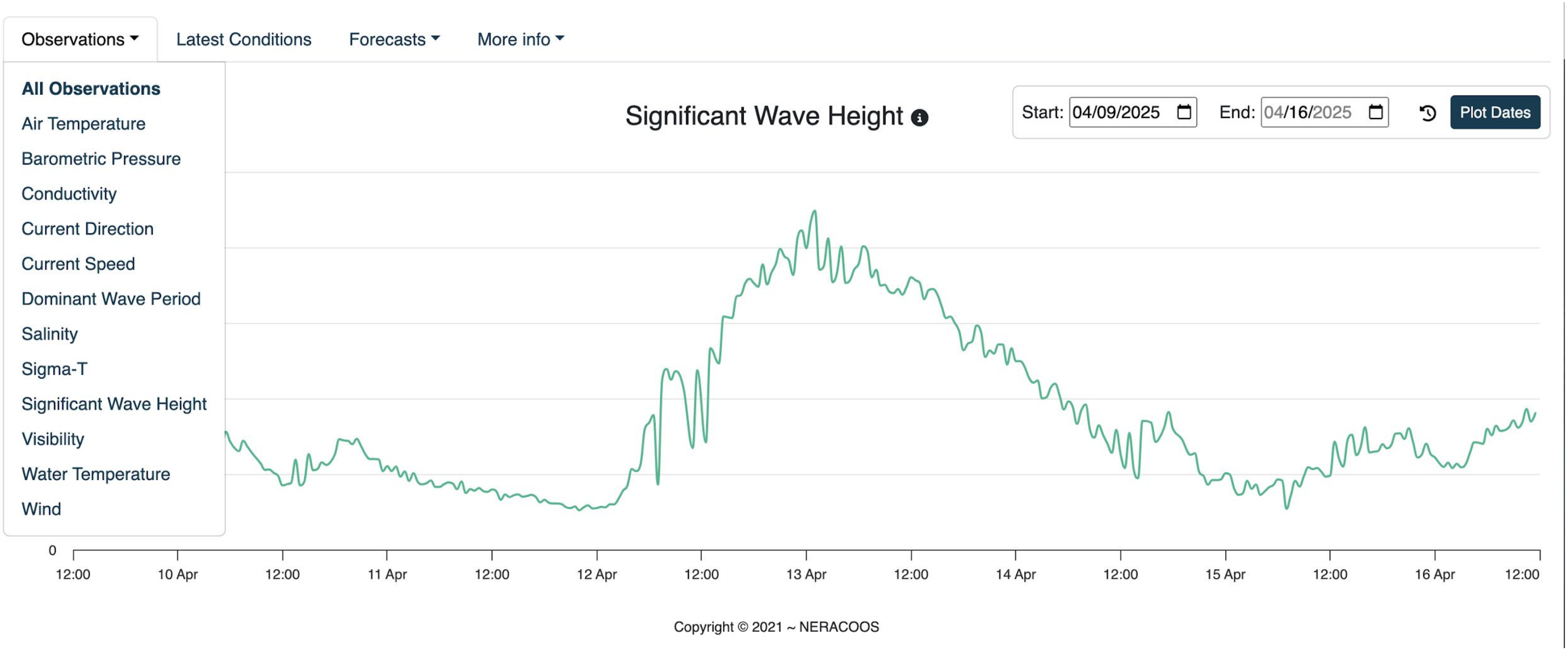
Unit system: Metric English

Mariners' Dashboard

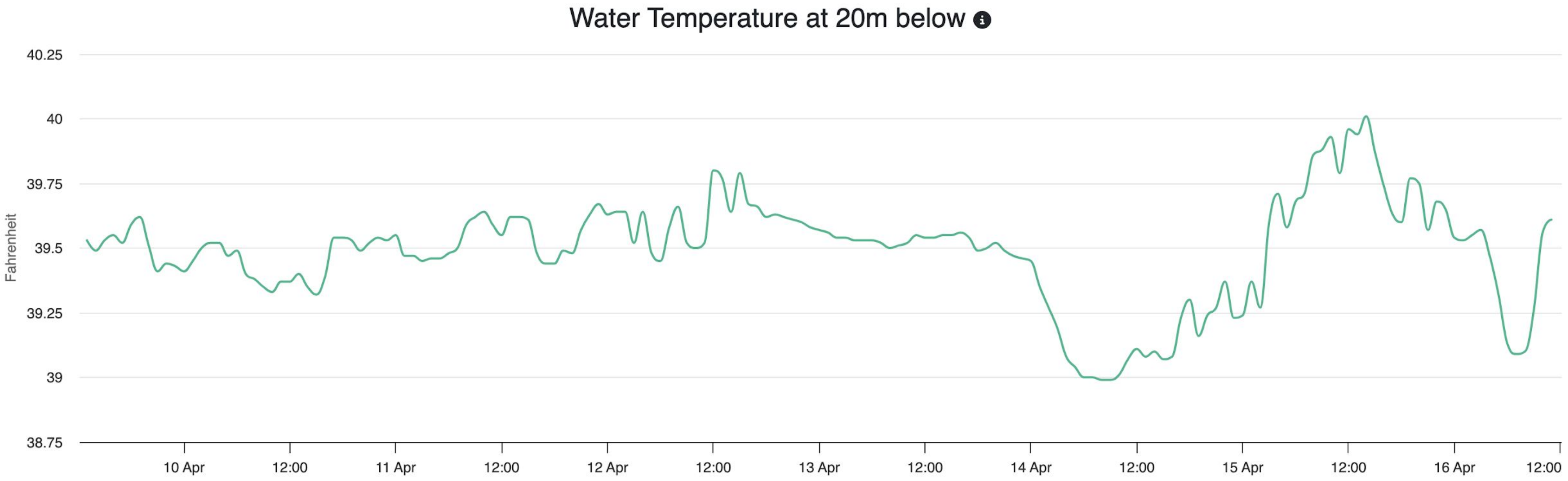
Mariners' Dashboard

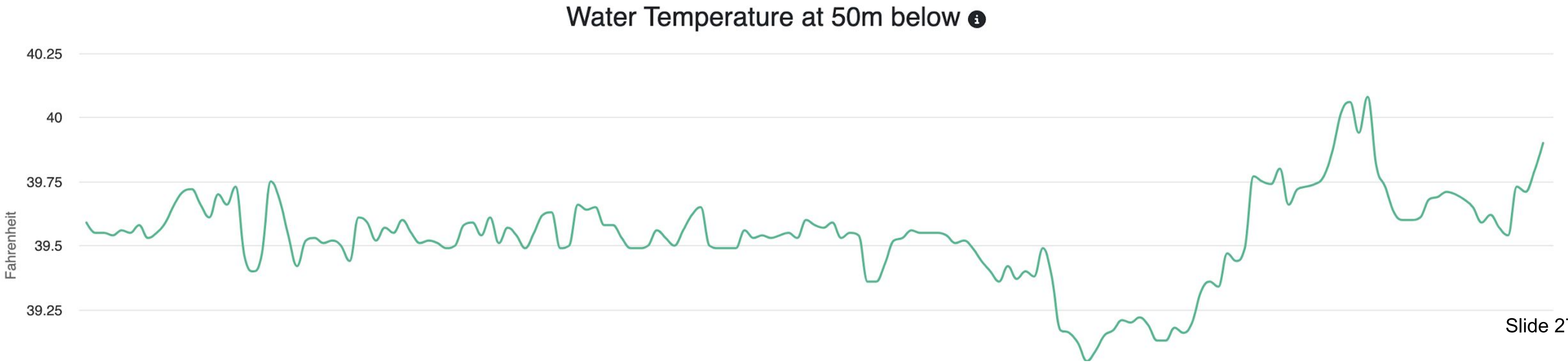


Mariners’ Dashboard

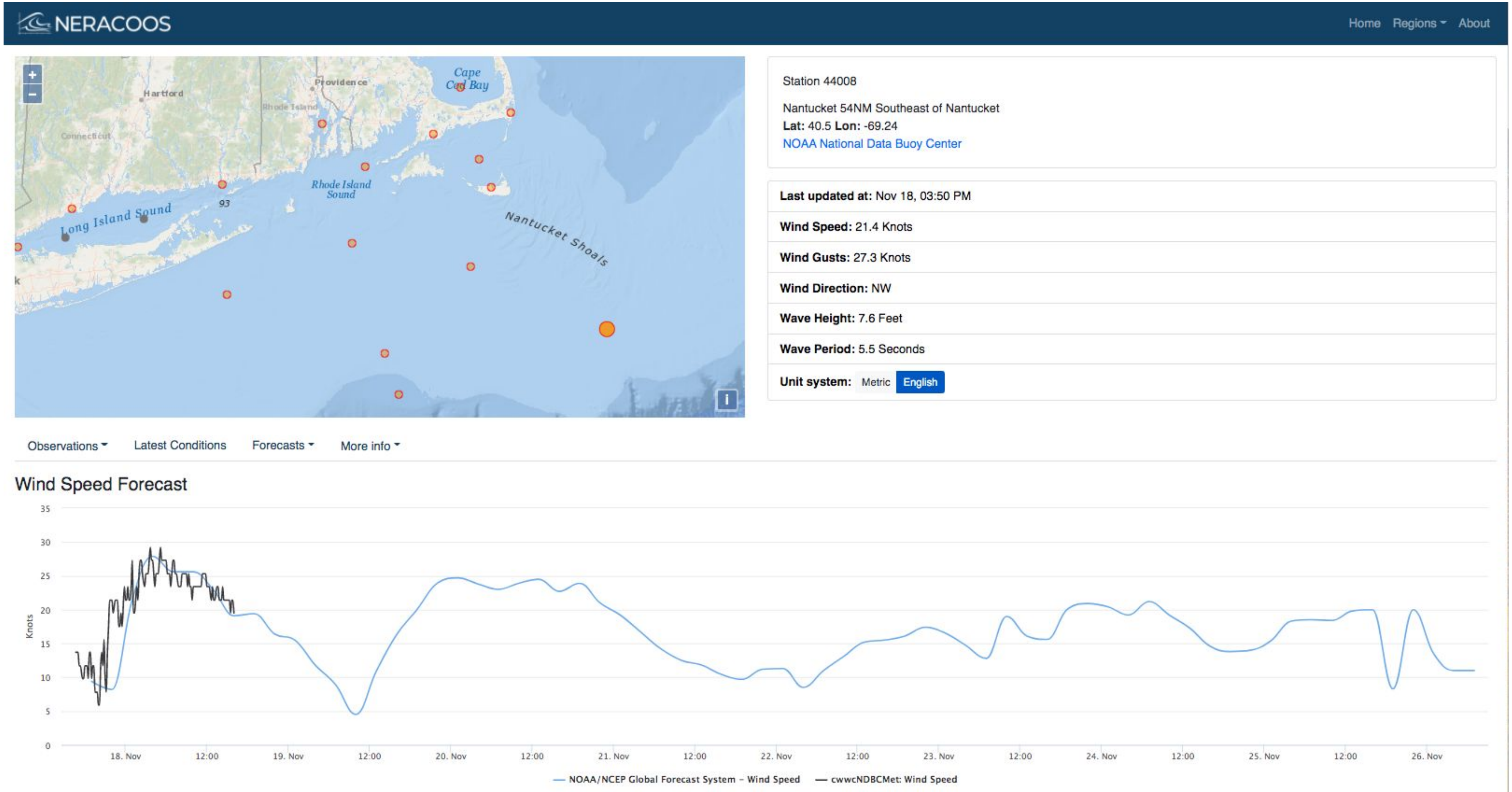


Mariners' Dashboard

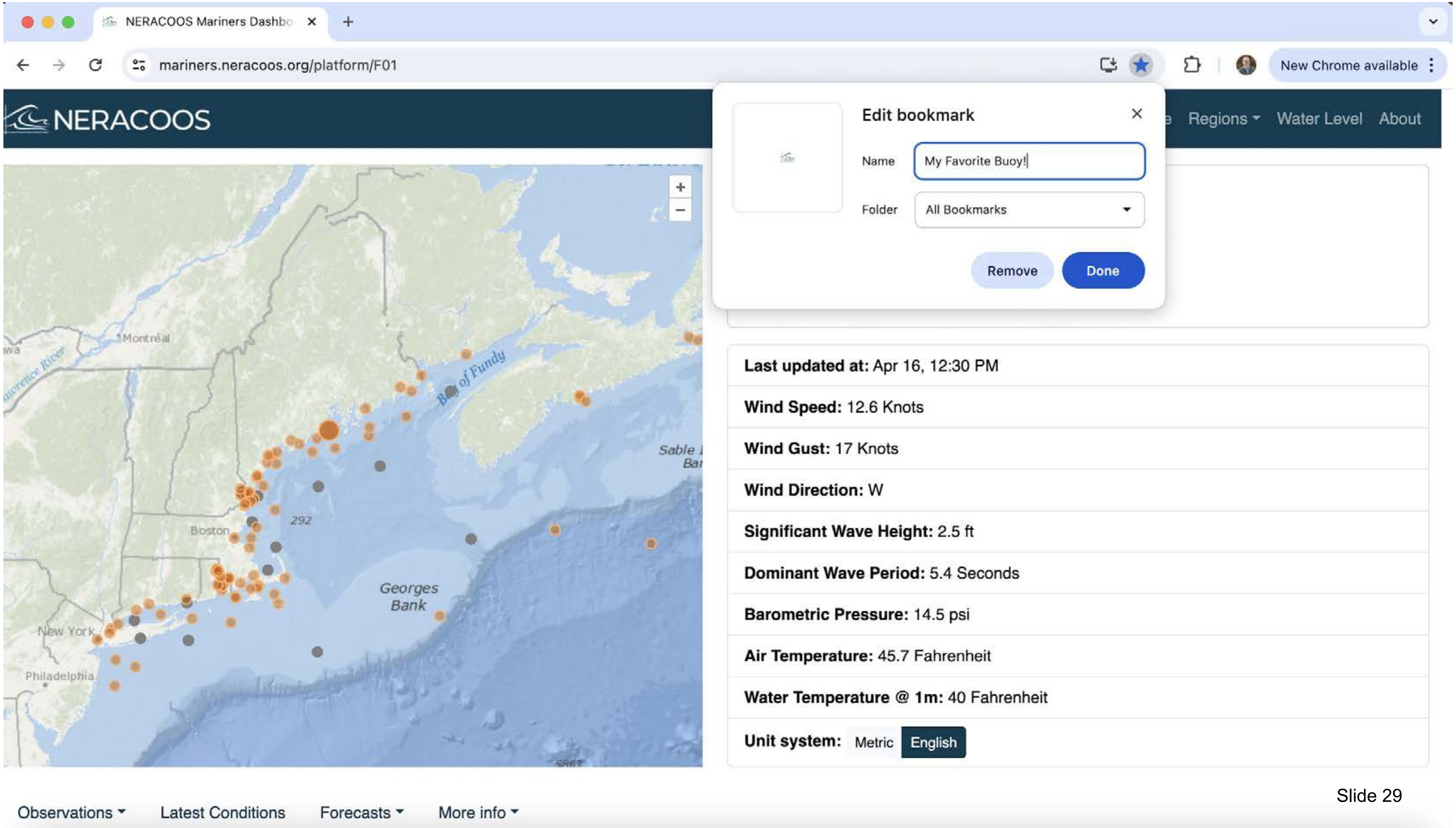




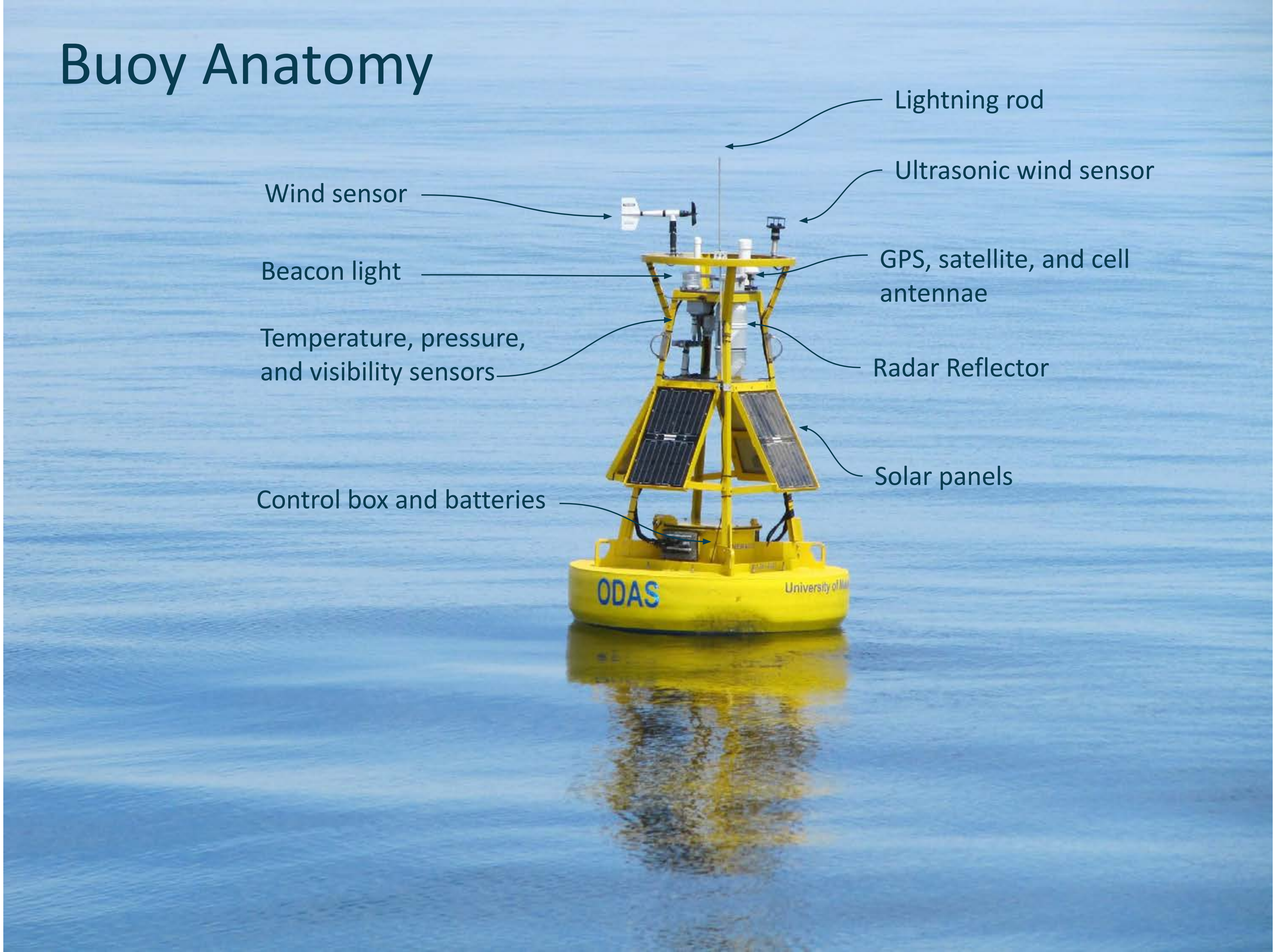
Mariners’ Dashboard



mariners.neracoos.org

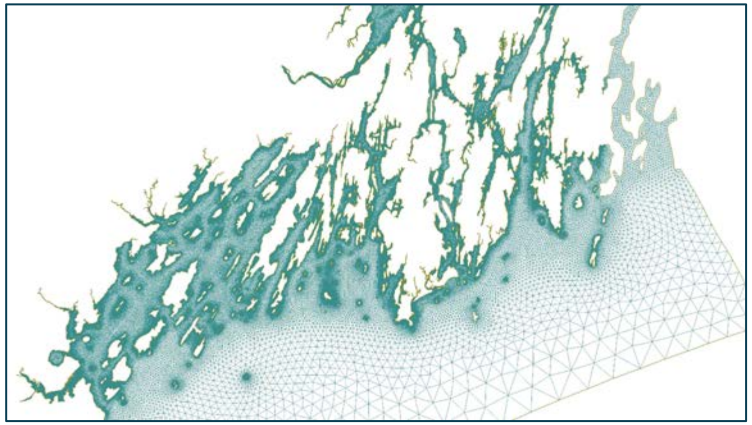


Buoy Anatomy



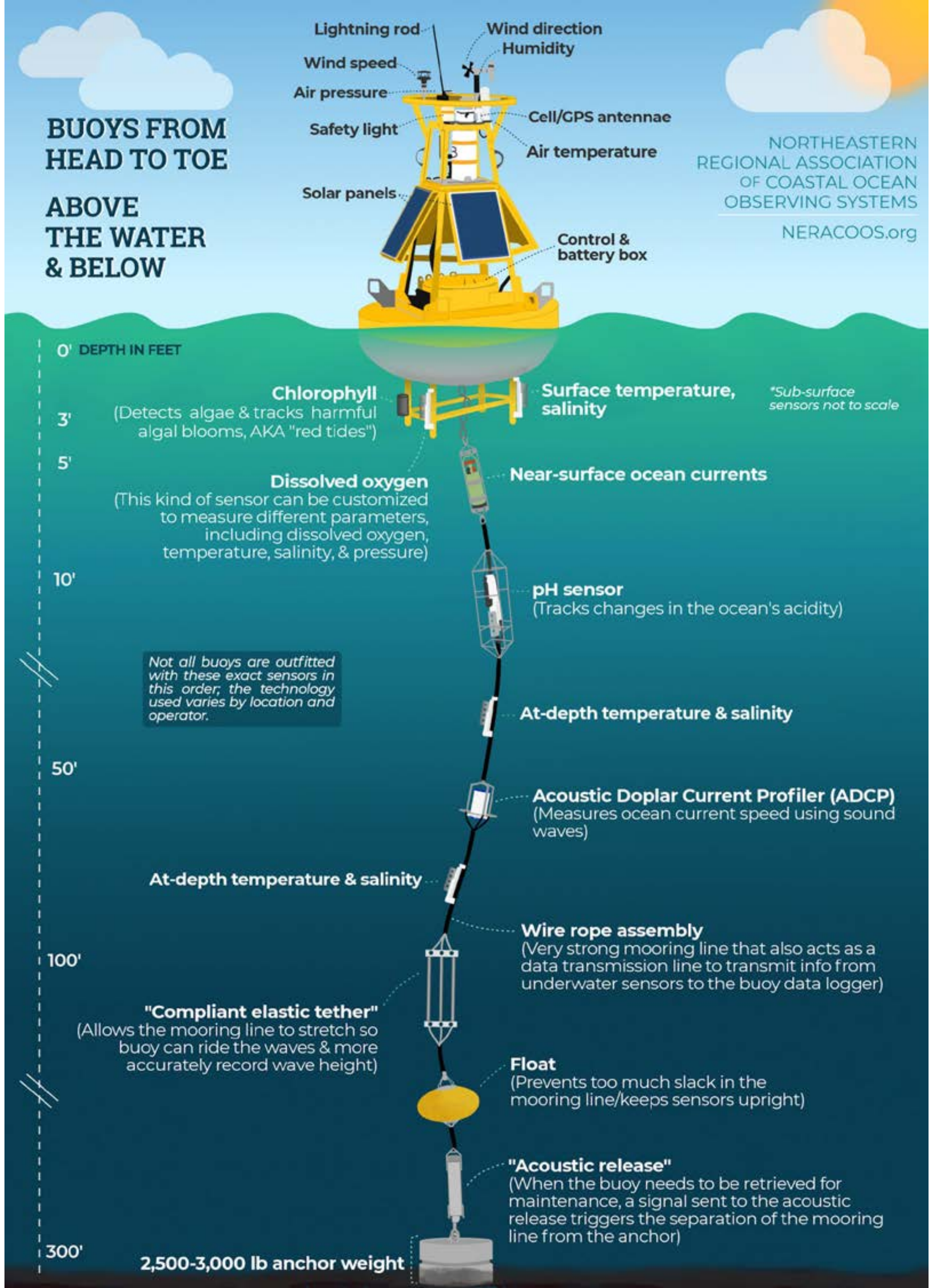
Challenges and Opportunities

- Increasing data demands - resulting from rapid changes in the coastal environment
- Demand for lower-cost observing capabilities
- Improving/evolving observing, modeling and data management technology
- Increasing volume of data being collected




NERACOOS
NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS
NORTHEAST OCEAN OBSERVING SYSTEM
U.S. Geological Survey
Water level station
Gulf of Maine Research Institute
Data integration & products
Website development
Wells National Estuarine Research Reserve
Water level station
Cowasuck Band of the Pennacook-Abenaki People
Indigenous ecological knowledge
Northeastern University
Temperature microsensors
Charybdis Group
3 Water level stations
Woods Hole Group
2 Buoys
Currents sensor
Water level station
Mashpee Wampanoag Tribe
Indigenous ecological knowledge
University of Connecticut
3 Buoys
Short-term prediction system
Block Island SLR Committee
Water level station
University of Massachusetts Dartmouth
Regional ocean modeling
University of Rhode Island
Nutrient monitoring
Regional satellite imaging
RPS
Data integration
Bedford Institution of Oceanography
Regional wave forecast
Biological data integration
Maine Center for Coastal Fisheries
Passamaquoddy at Pleasant Point Peskotomuhkati Nation
2 Coastal monitoring stations
University of Maine
6 Buoys
Harmful algal bloom monitoring
Nutrient monitoring
Plankton monitoring
Regional satellite imaging
eDNA
University of New Hampshire
4 Buoys
Harmful algal bloom monitoring
3 Coastal monitoring stations
eDNA
Nutrient monitoring
Regional ocean modeling
Plankton monitoring
5 Water level stations
Woods Hole Oceanographic Institution
4 High-frequency radar stations
Marine mammal monitoring
Harmful algal bloom monitoring
Acoustic Products
Marine Biological Association - Plymouth, UK
Plankton monitoring

NERACOOS


BUOYS FROM HEAD TO TOE
ABOVE THE WATER & BELOW
Lightning rod
Wind speed
Air pressure
Safety light
Solar panels
Wind direction
Humidity
Cell/GPS antennae
Air temperature
Control & battery box
NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS
NERACOOS.org
0' DEPTH IN FEET
3'
5'
10'
50'
100'
300'
Chlorophyll
(Detects algae & tracks harmful algal blooms, AKA "red tides")
Surface temperature, salinity
*Sub-surface sensors not to scale
Near-surface ocean currents
Dissolved oxygen
(This kind of sensor can be customized to measure different parameters, including dissolved oxygen, temperature, salinity, & pressure)
pH sensor
(Tracks changes in the ocean's acidity)
Not all buoys are outfitted with these exact sensors in this order; the technology used varies by location and operator.
At-depth temperature & salinity
Acoustic Doplar Current Profiler (ADCP)
(Measures ocean current speed using sound waves)
At-depth temperature & salinity
Wire rope assembly
(Very strong mooring line that also acts as a data transmission line to transmit info from underwater sensors to the buoy data logger)
"Compliant elastic tether"
(Allows the mooring line to stretch so buoy can ride the waves & more accurately record wave height)
Float
(Prevents too much slack in the mooring line/keeps sensors upright)
"Acoustic release"
(When the buoy needs to be retrieved for maintenance, a signal sent to the acoustic release triggers the separation of the mooring line from the anchor)
2,500-3,000 lb anchor weight

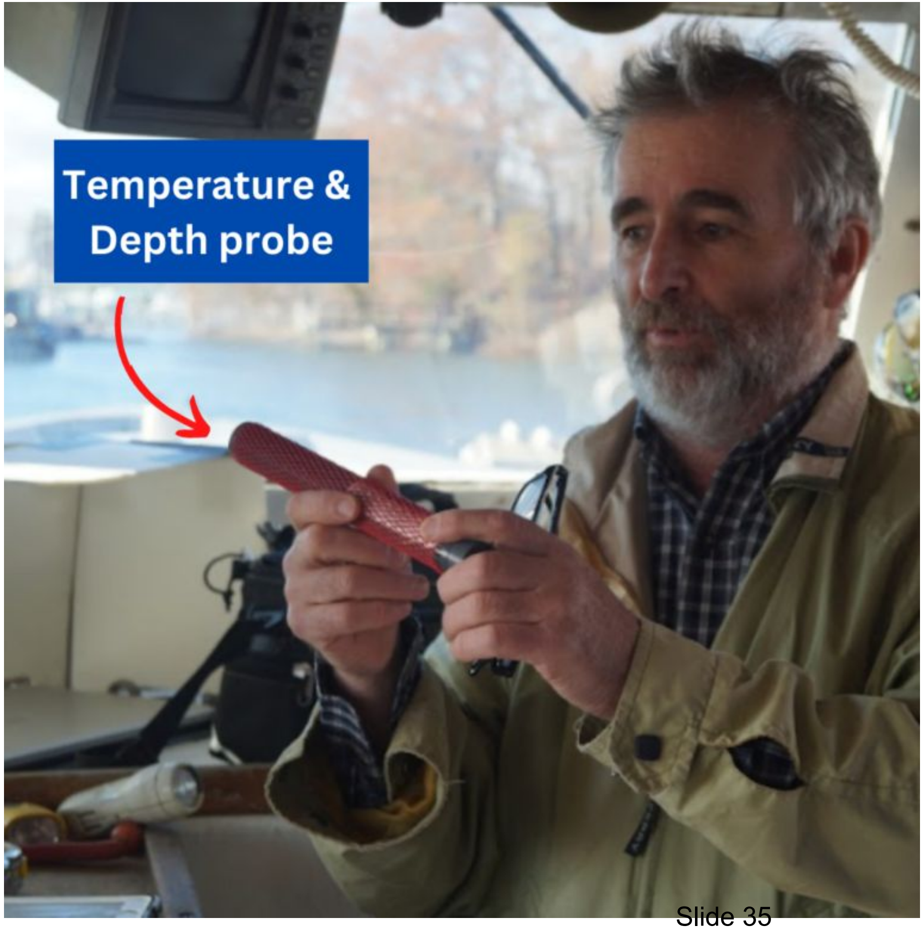
eMOLT

The Environmental Monitors on Lobster Traps and Large Trawlers Program

Democratizing Ocean Observing Since 1996

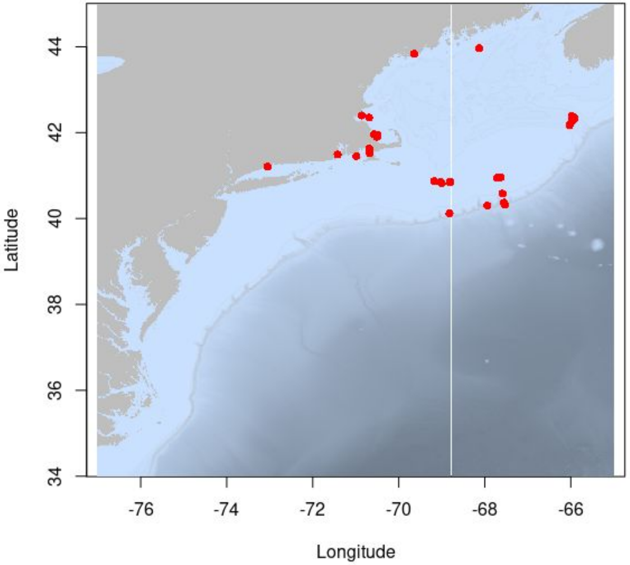
"I wondered what they were doing and I'm sure they wondered what we were doing. Eventually, I started going to the docks and chatting with the captains and crew and I realized they were very interested in the wild oceanography they had been observing week after week for many years. I started handing them little probes to tie-wrap to their traps and student-built drifters to toss over the side."

- JiM Manning



In the beginning…1996-2000

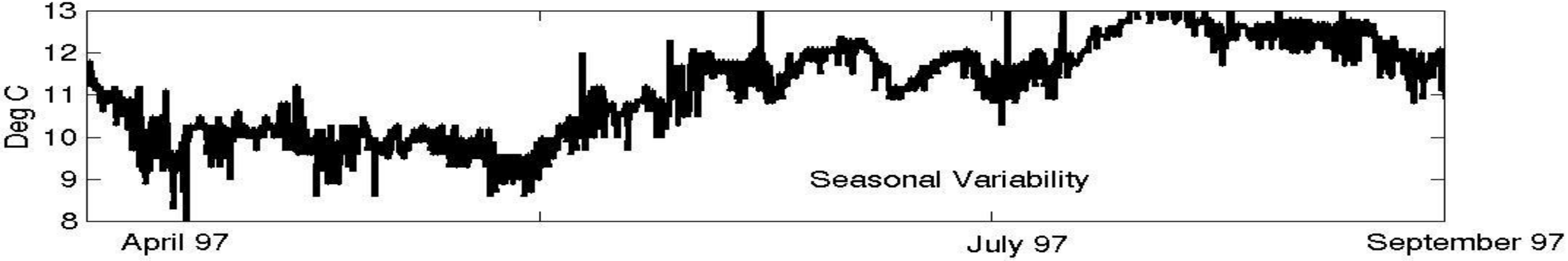
- Low cost loggers
- Accuracy +/- 0.2 °C
- Deployed by lobstermen, primarily fishing out of Massachusetts ports
- 37 sites
- ~ $3700 worth of sensors



Bottom Temp: ONSET Tidbit

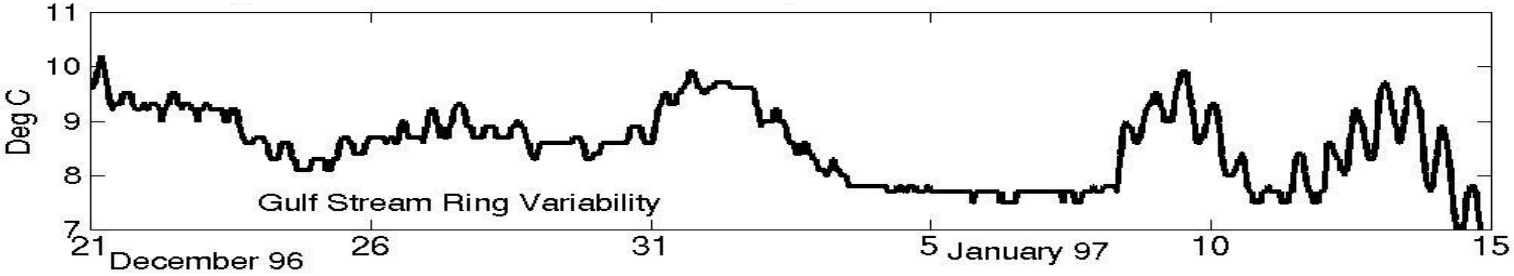
In the beginning…1996-2000

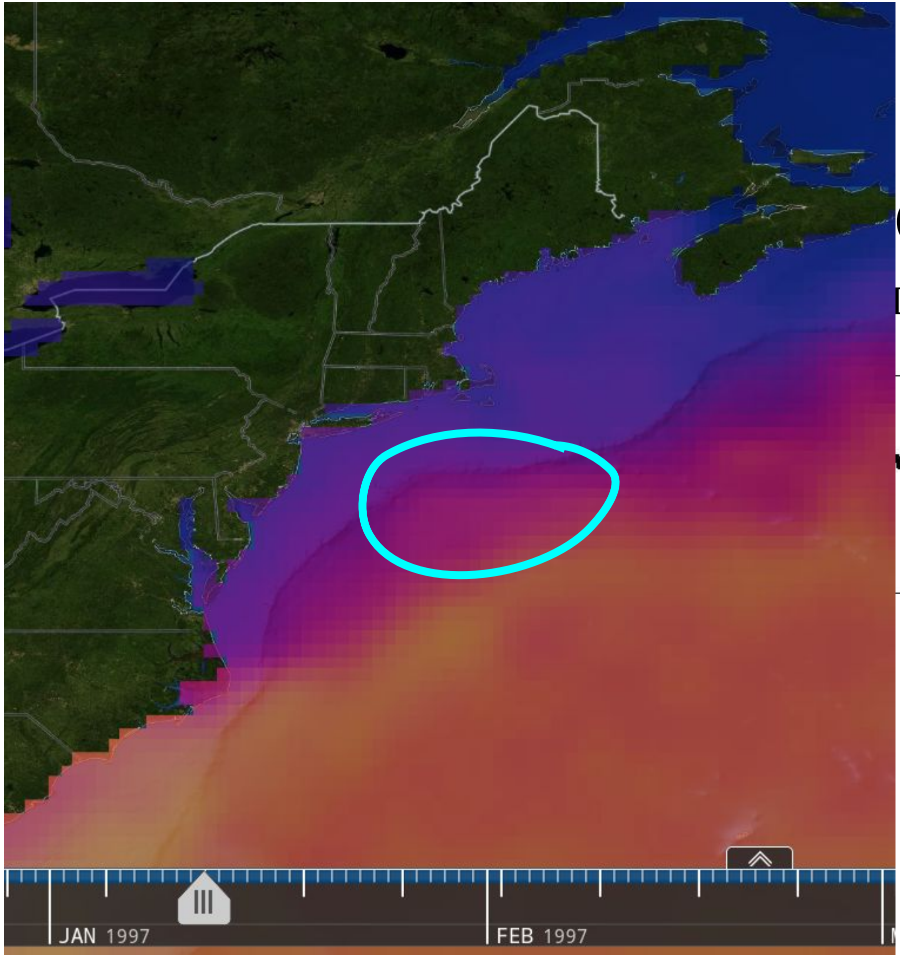
Bottom temperatures increasing over the course of the fishing season, 1997



In the beginning…1995-2000

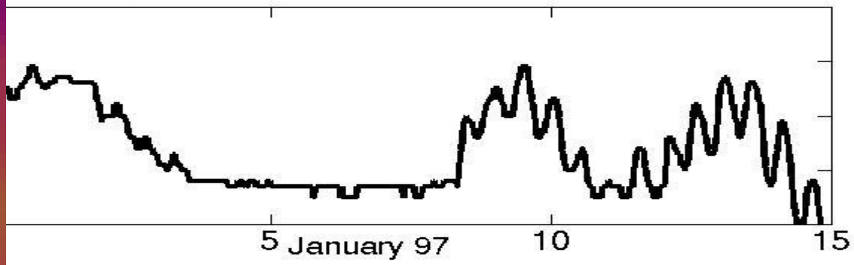
Intrusion of warmer waters in December 96 and January 97





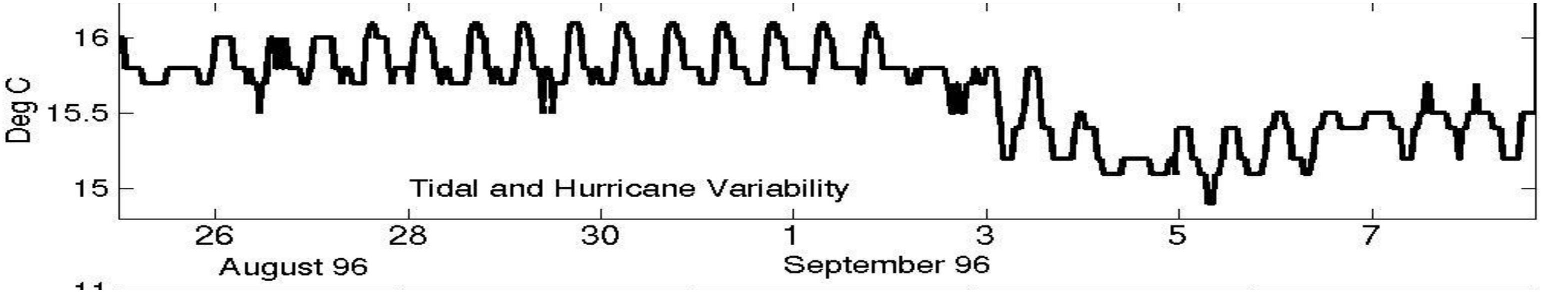
eginning…1995-2000

December 96 and January 97



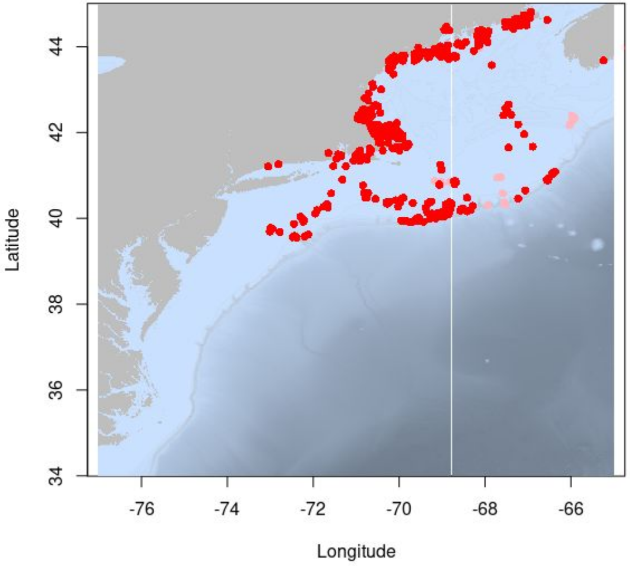
In the beginning…1995-2000

Tidal variability and changes in temperature during Hurricane Edouard



eMOLT expands…2000-2014

- Low cost loggers
- Accuracy +/- 0.1 °C
- Deployed by lobstermen, throughout New England
- 402 sites
- ~ $52,000 worth of sensors



Manning and Pelletier 2009

Journal of Operational Oceanography >
Volume 2, 2009 - Issue 1

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Original Articles

Full access

Environmental monitors on lobster traps (eMOLT): long-term observations of New England's bottom-water temperatures

J Manning & E Pelletier

Pages 25-33 | Published online: 01 Dec 2014
Download citation https://doi.org/10.1080/1755876X.2009.11020106

References | Citations | Metrics | Reprints & Permissions | View PDF

Abstract

Nearly one hundred New England lobstermen have installed temperature sensors on their traps to record hourly values at fixed locations since 2001. These moorings are distributed primarily along the shelf edge in the northern Mid-Atlantic Bight and along the entire western edge of the Gulf of Maine in a range of water depths (1–300m). Variability associated with tidal, wind, seasonal, and inter-annual processes can be depicted at nearly all sites. Tidal variation, for example, at certain times of the year in many locations can be significant (>10°C). Wind forcing is shown to significantly modify the seasonal cycle at many locations such as in Massachusetts Bay where a dramatic turnover occurs in the Fall. Inter-annual anomalies are derived by removing seasonal cycles. Comparisons between sites and between years are made. The years 2002 and 2006, for example, are documented as warmer in general than other years at nearly all sites. While a direct

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B. Patti et al.
Journal of Operational Oceanography
Published online: 10 Jun 2016

Gawarkiewicz et al. 2012

SCIENTIFIC REPORTS

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Scientific Reports **2**, Article number: 553 (2012)
doi:10.1038/srep00553
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Atmospheric science Biooceanography

Received: 22 May 2012
Accepted: 19 July 2012
Published online: 02 August 2012

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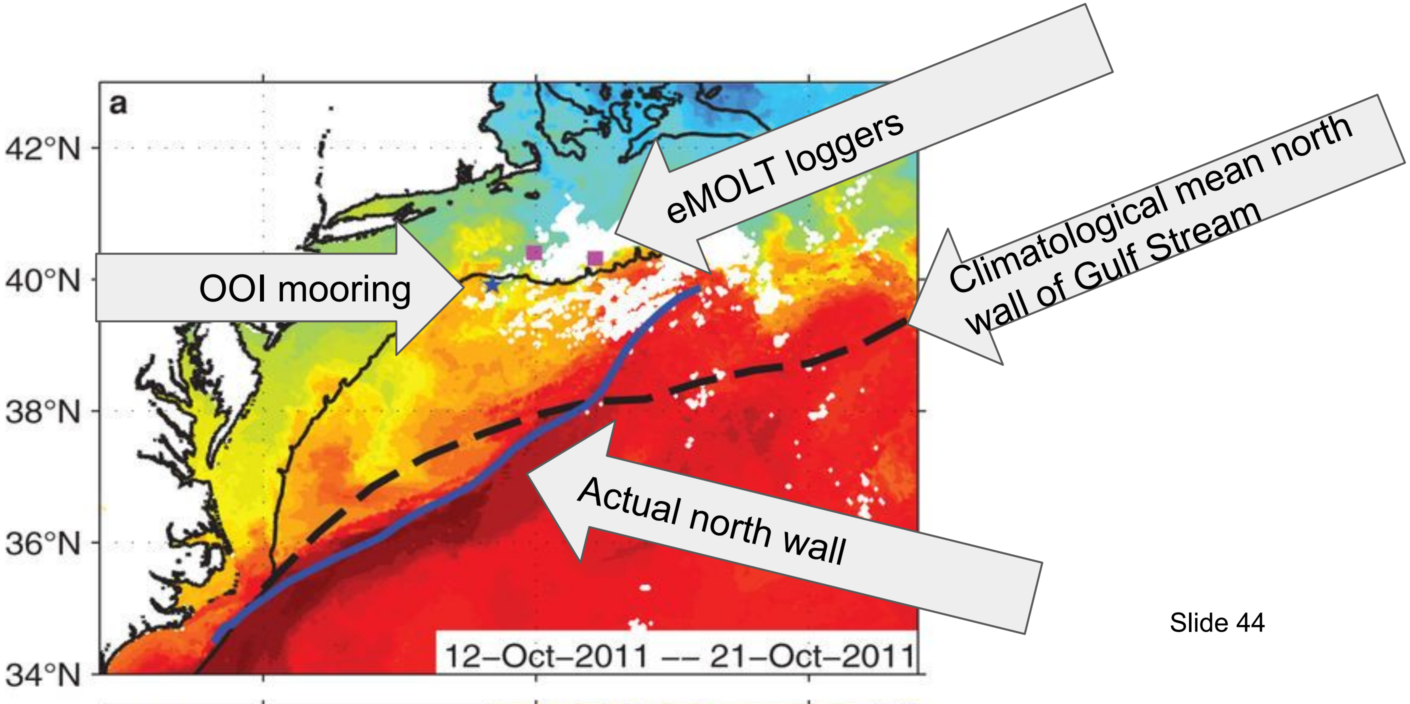
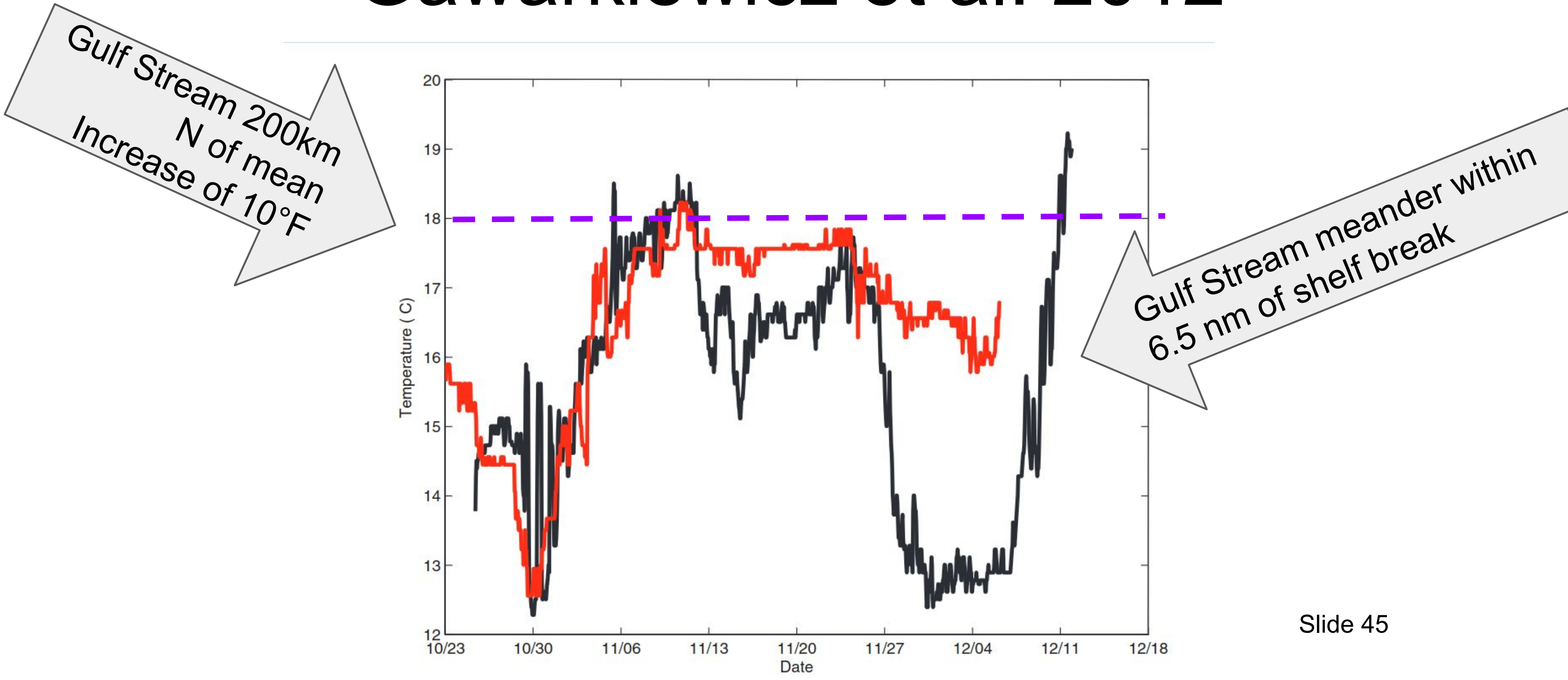


Gawarkiewicz et al. 2012



Tanaka and Chen 2016

ELSEVIER

Fisheries Research

Volume 177, May 2016, Pages 137-152

Modeling spatiotemporal variability of the bioclimate envelope of *Homarus americanus* in the coastal waters of Maine and New Hampshire

Kisei Tanaka, Yong Chen

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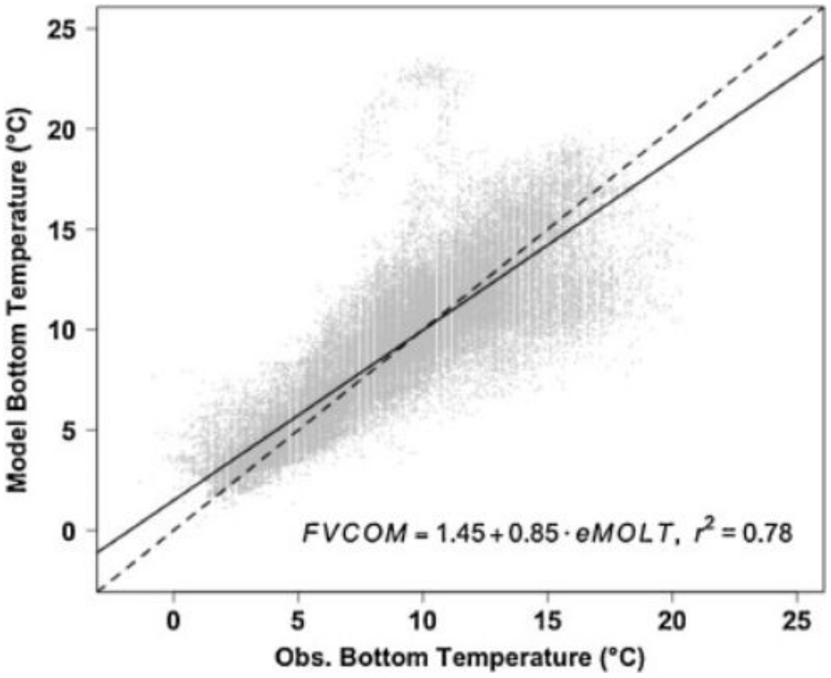
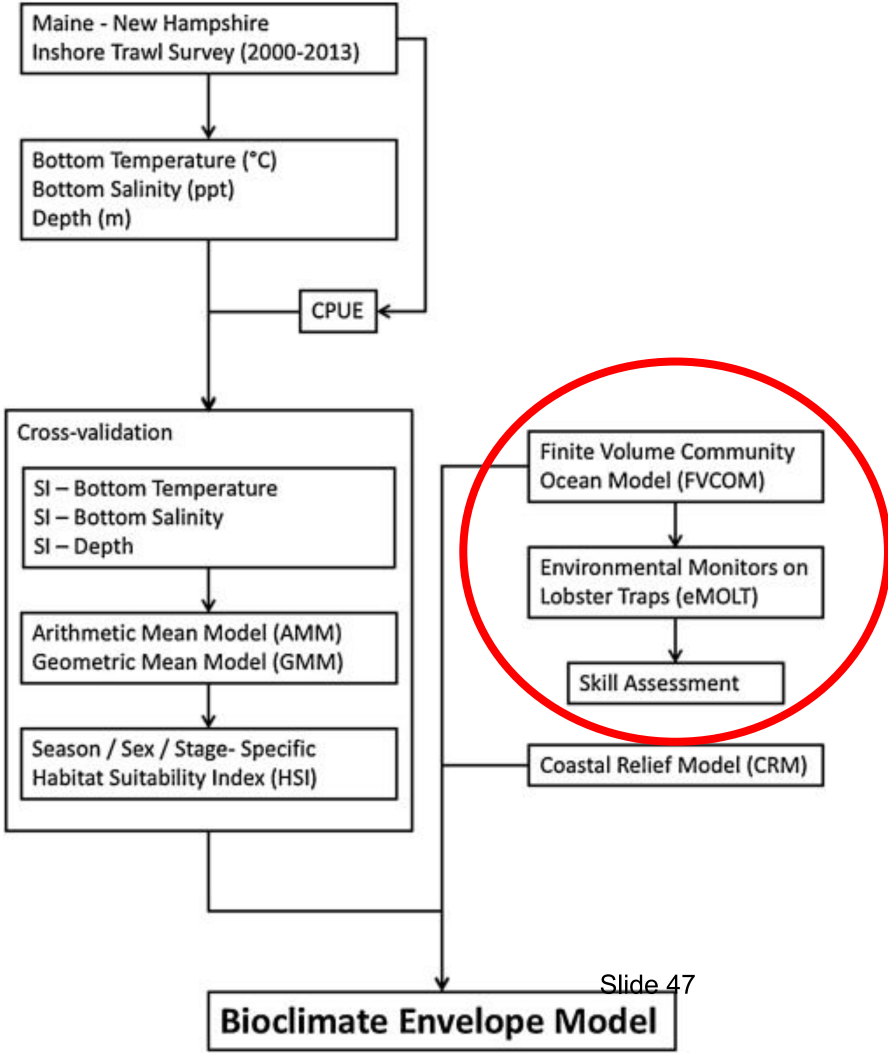
https://doi.org/10.1016/j.fishres.2016.01.010

MAINE

Tanaka and Chen 2016





Li et al 2017

ELSEVIER

Journal of Marine Systems

Volume 173, September 2017, Pages 21-30

Assessing the quality of bottom water temperatures from the Finite-Volume Community Ocean Model (FVCOM) in the Northwest Atlantic Shelf region

Bai Li [1], Kisei R. Tanaka [1], Yong Chen, Damian C. Brady, Andrew C. Thomas

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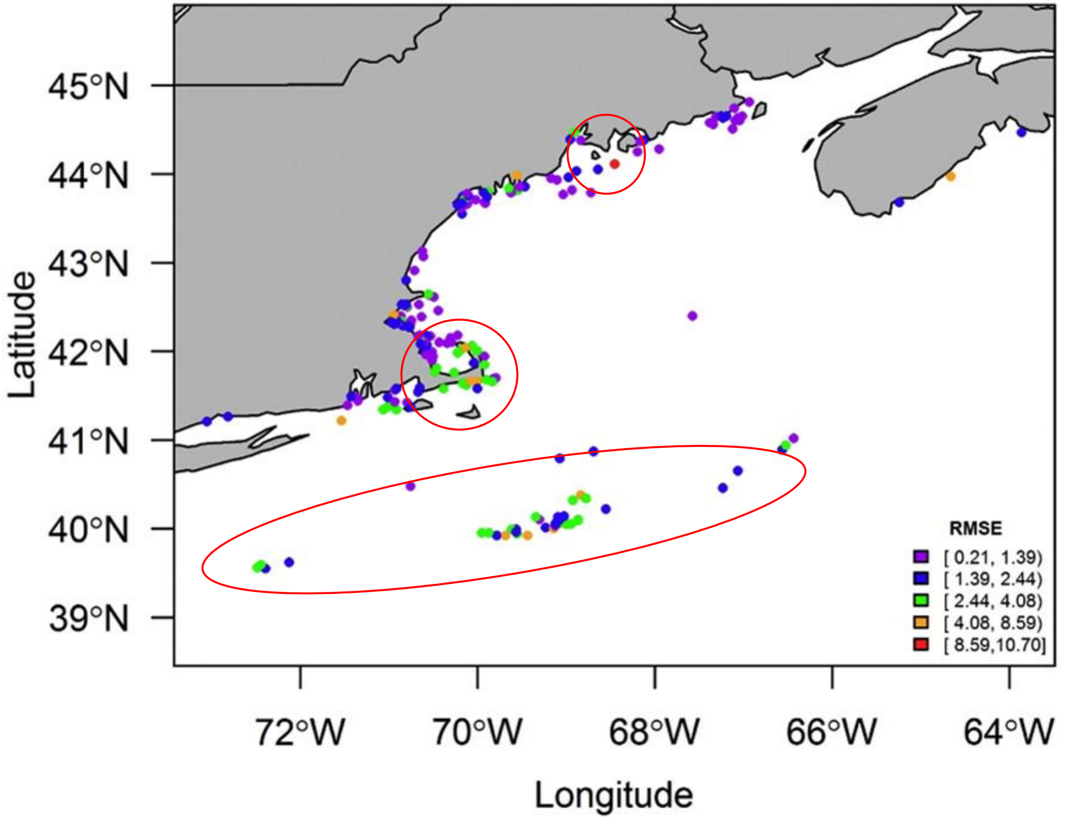

45°N
44°N
43°N
42°N
41°N
40°N
39°N
Latitude
72°W
70°W
68°W
66°W
64°W
Longitude
RMSE
[0.21, 1.39)
[1.39, 2.44)
[2.44, 4.08)
[4.08, 8.59)
[8.59,10.70]

Li et al 2017

Volume 76, Issue 4
July-August 2019

Article Contents

JOURNAL ARTICLE

A model-based approach to incorporate environmental variability into assessment of a commercial fishery: a case study with the American lobster fishery in the Gulf of Maine and Georges Bank

Kisei R Tanaka ✉, Jie Cao ✉, Burton V Shank, Samuel B Truesdell, Mackenzie D Mazur, Luoliang Xu, Yong Chen

ICES Journal of Marine Science, Volume 76, Issue 4, July-August 2019, Pages 884–896, https://doi.org/10.1093/icesjms/fsz024
Published: 22 February 2019 **Article history ▾**

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Abstract

Changes in bottom-up forcing are fundamental drivers of fish population dynamics. Recent literature has highlighted the need to incorporate the role of dynamic environmental conditions in stock assessments as a key step towards adaptive fishery management. Combining a bioclimate envelope model and a population dynamic model, we propose a model-based approach that can incorporate ecosystem products into single-species stock assessments. The

Slide 50

Volume 76, Issue 4
July-August 2019

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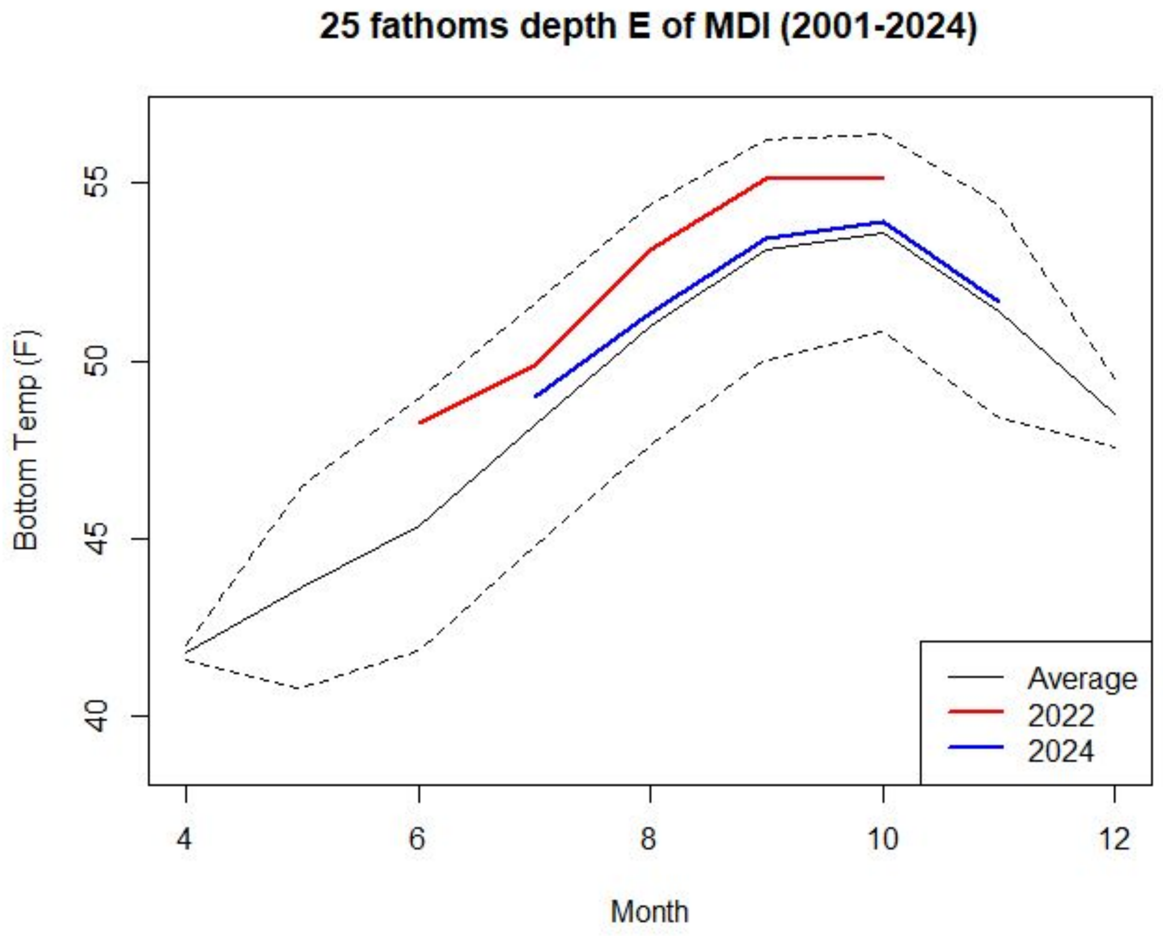
Atlantic States Marine Fisheries Commission

2020 American Lobster Benchmark Stock Assessment and Peer Review Report

Accepted for Management Use by the American Lobster Management Board October 19, 2020

Sustainable and Cooperative Management of Atlantic Coastal Fisheries



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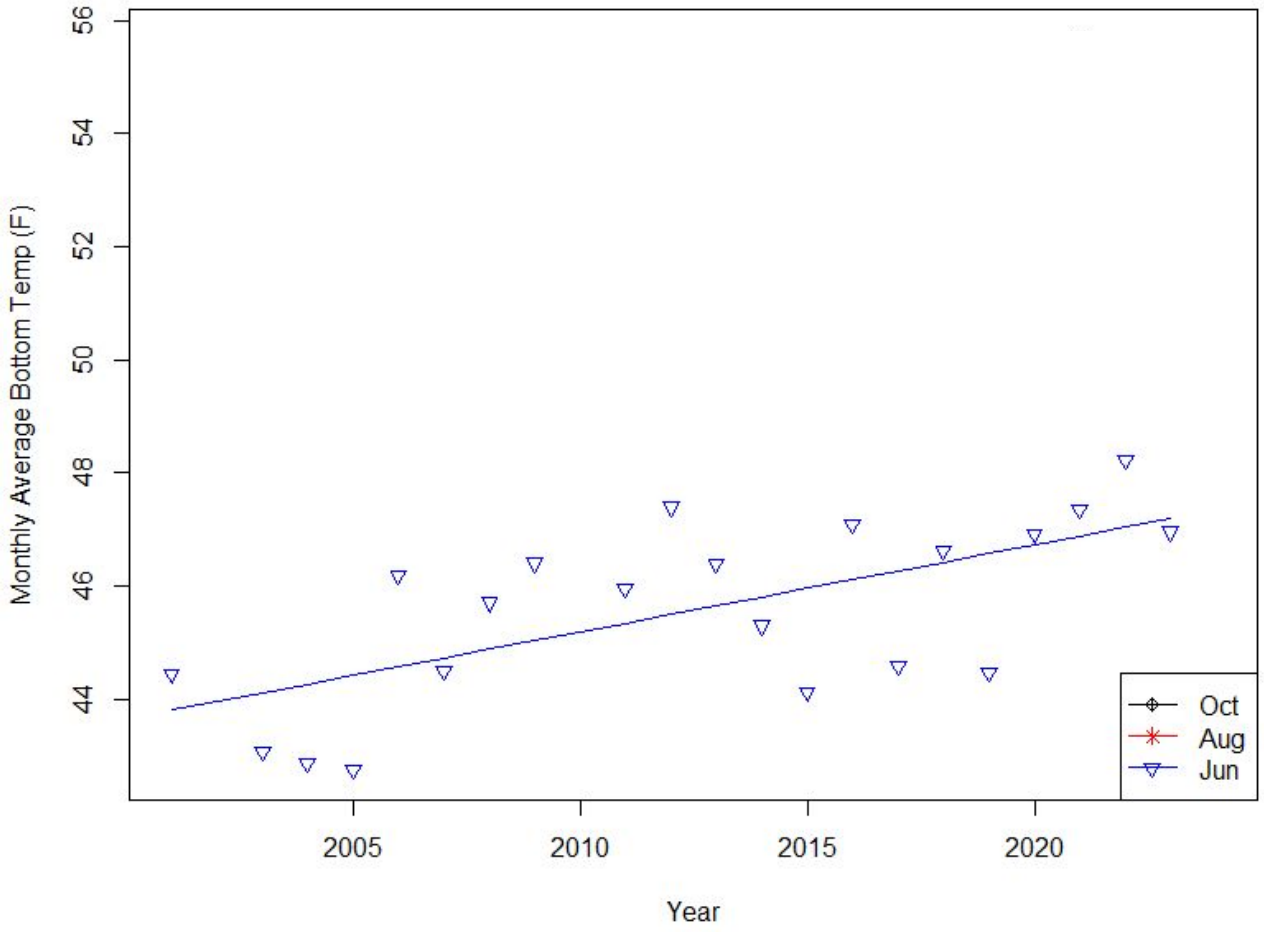
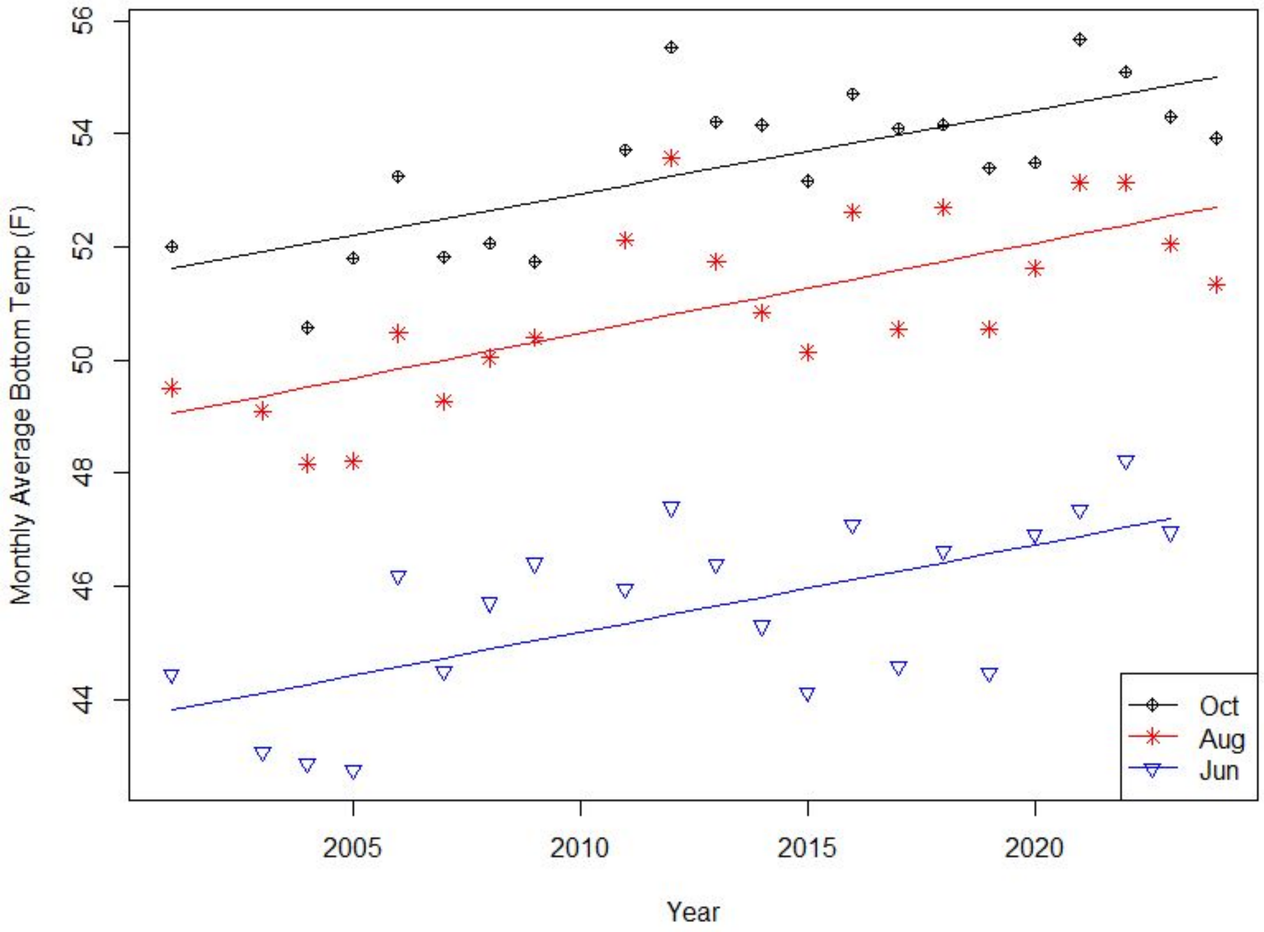
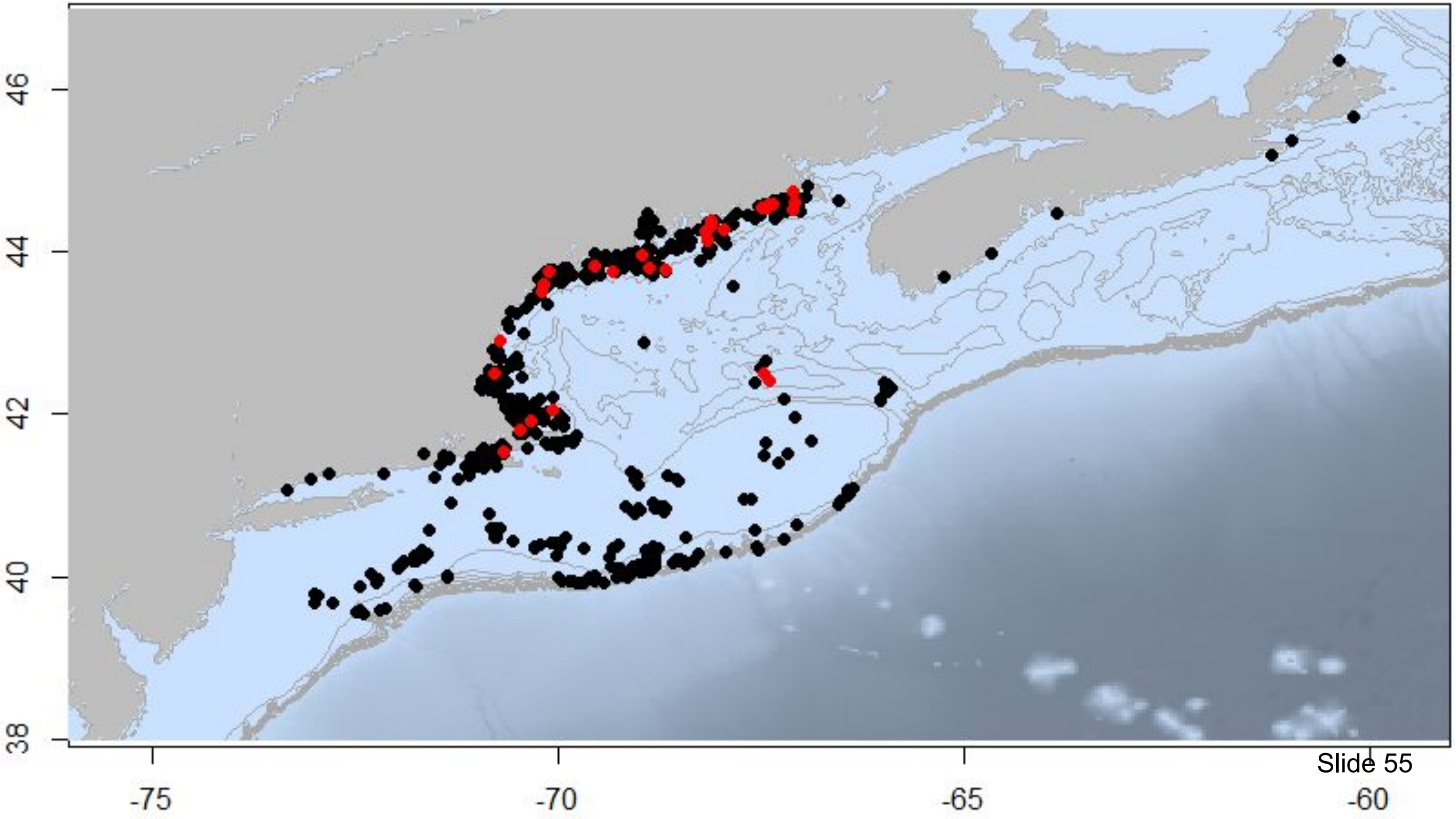


- Capt. Jon Carter
- 25 fathoms deep
- East of MDI

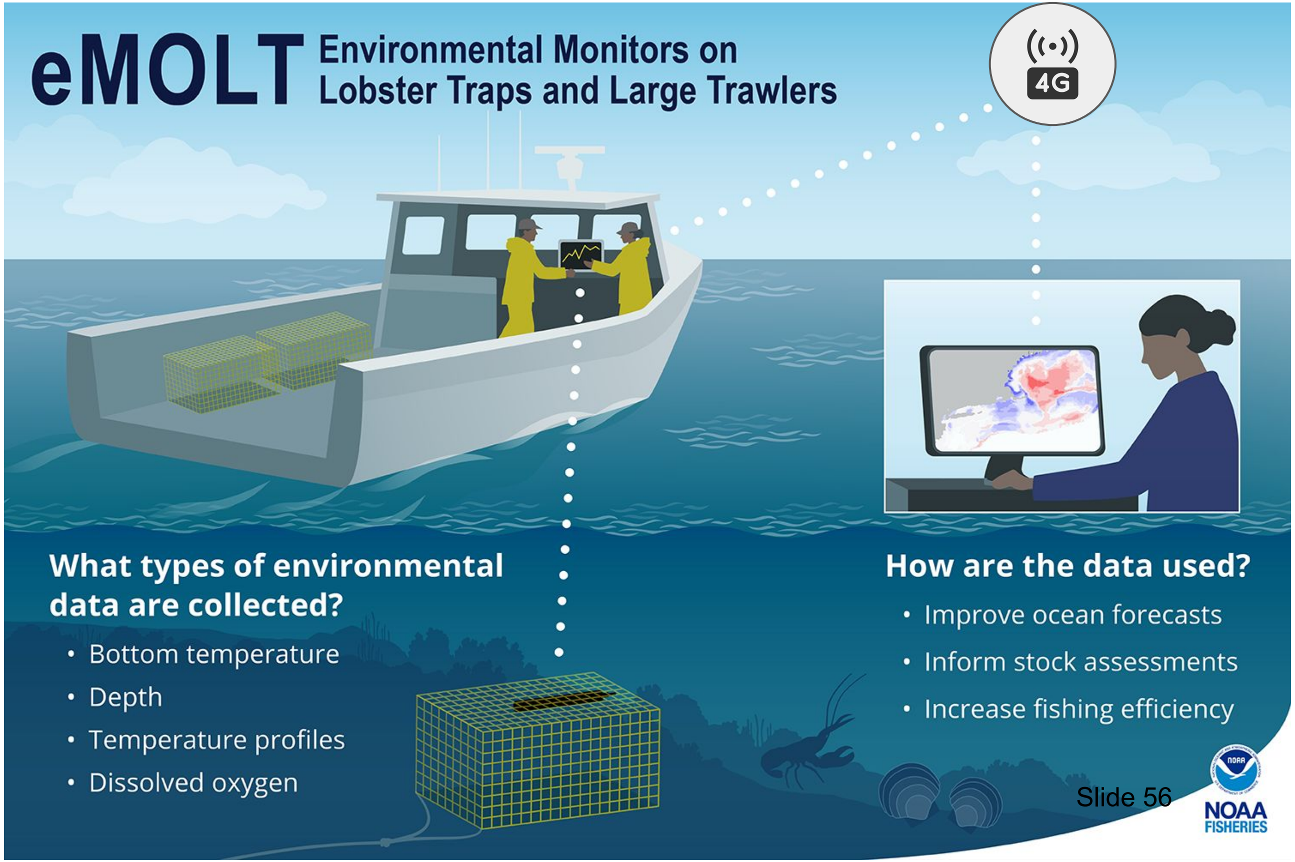


- Capt. Jon Carter

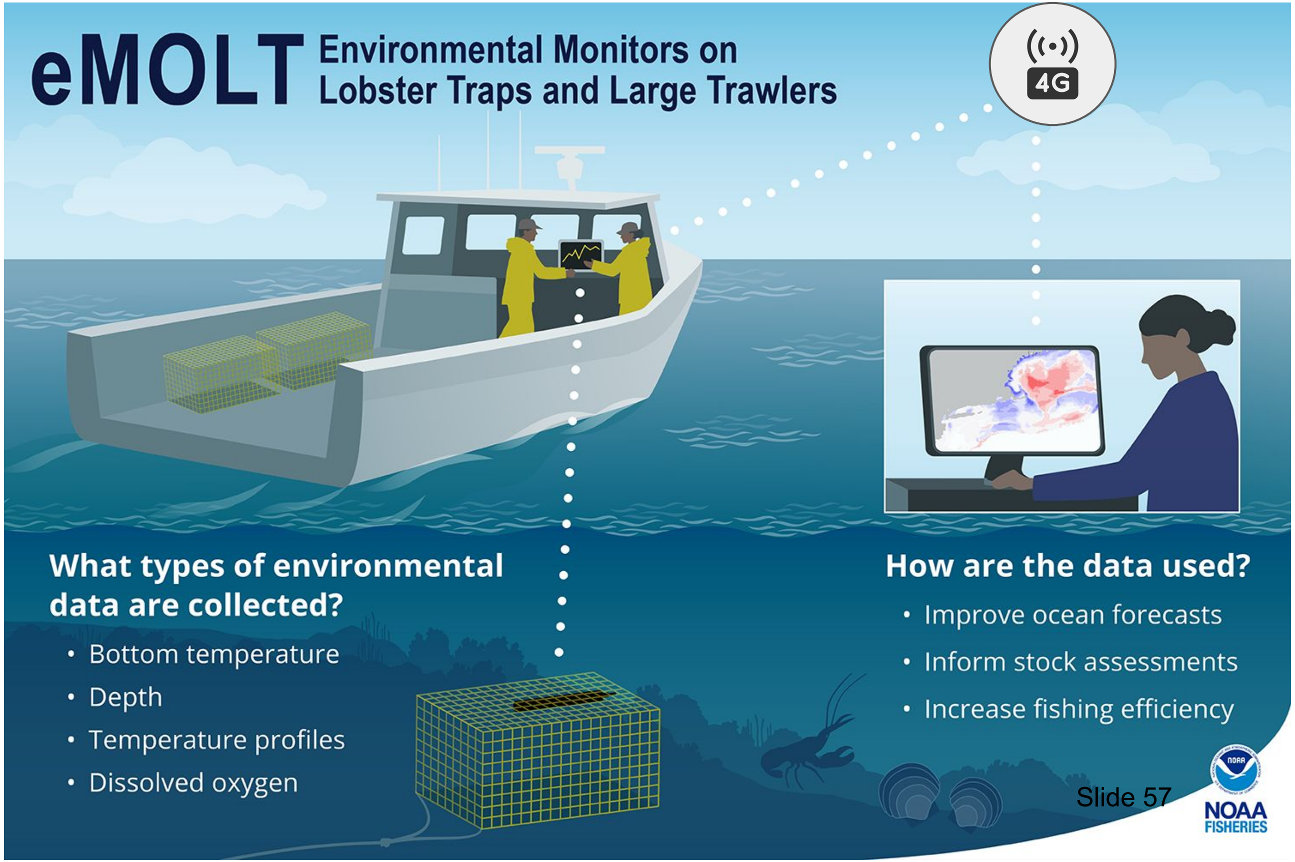
Declining participation in the non-realtime program



Realtime system development 2015 - Present



Realtime system development 2015 - Present



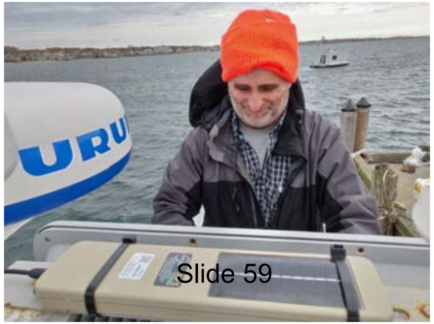
Realtime system development 2015 - Present

Photo: Crew of the F/V Dawn T, Chatham, MA

Realtime system development
2015 - Present

Tech Advances

- Low-cost deckboxes
- Wireless loggers
- Wireless ship to shore communication



eMOLT

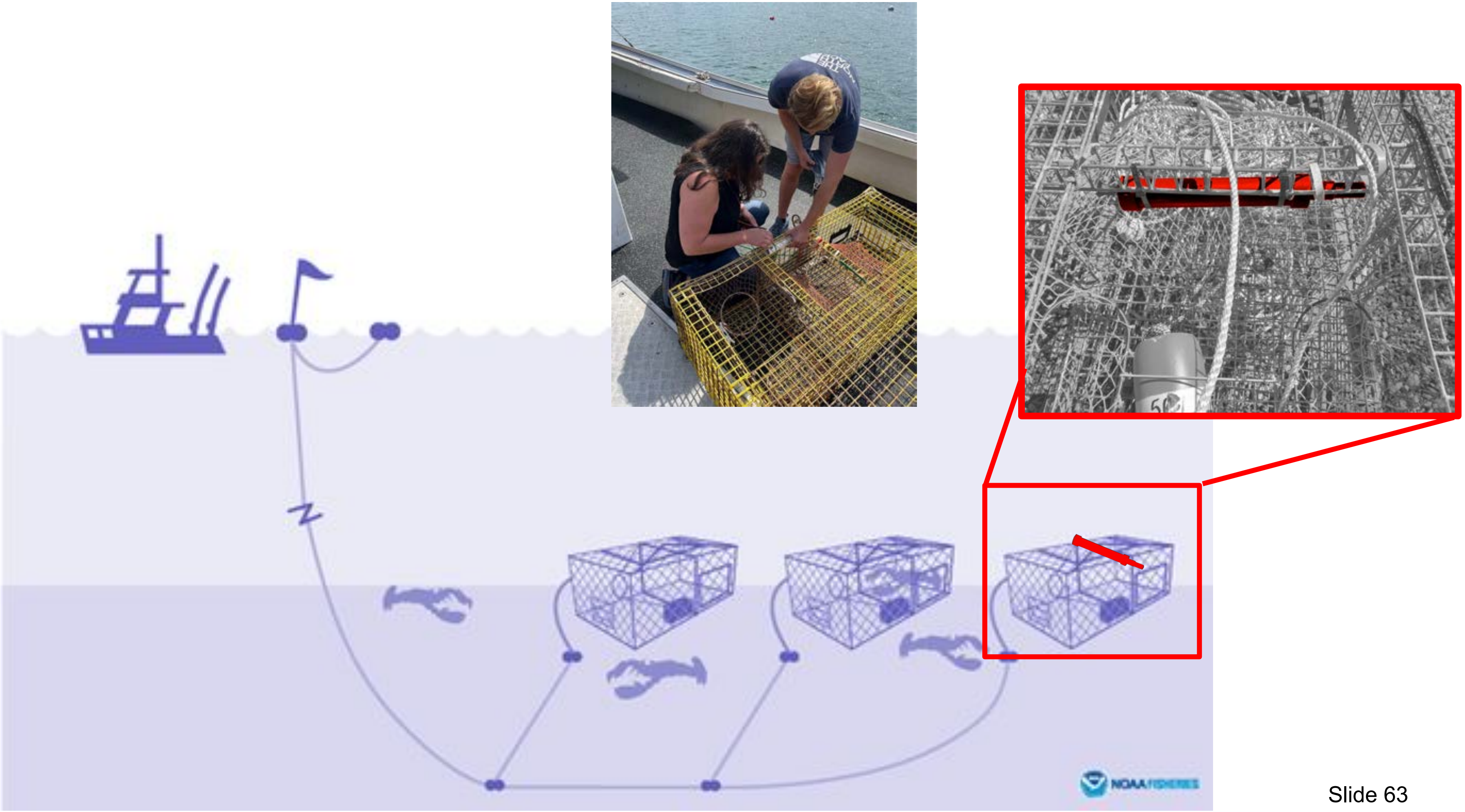
The Environmental Monitors on Lobster Traps and Large Trawlers Program

Democratizing Ocean Observing Since 1996

eMOLT Environmental Monitors on Lobster Traps and Large Trawlers

Temperature / Depth Profiling Loggers

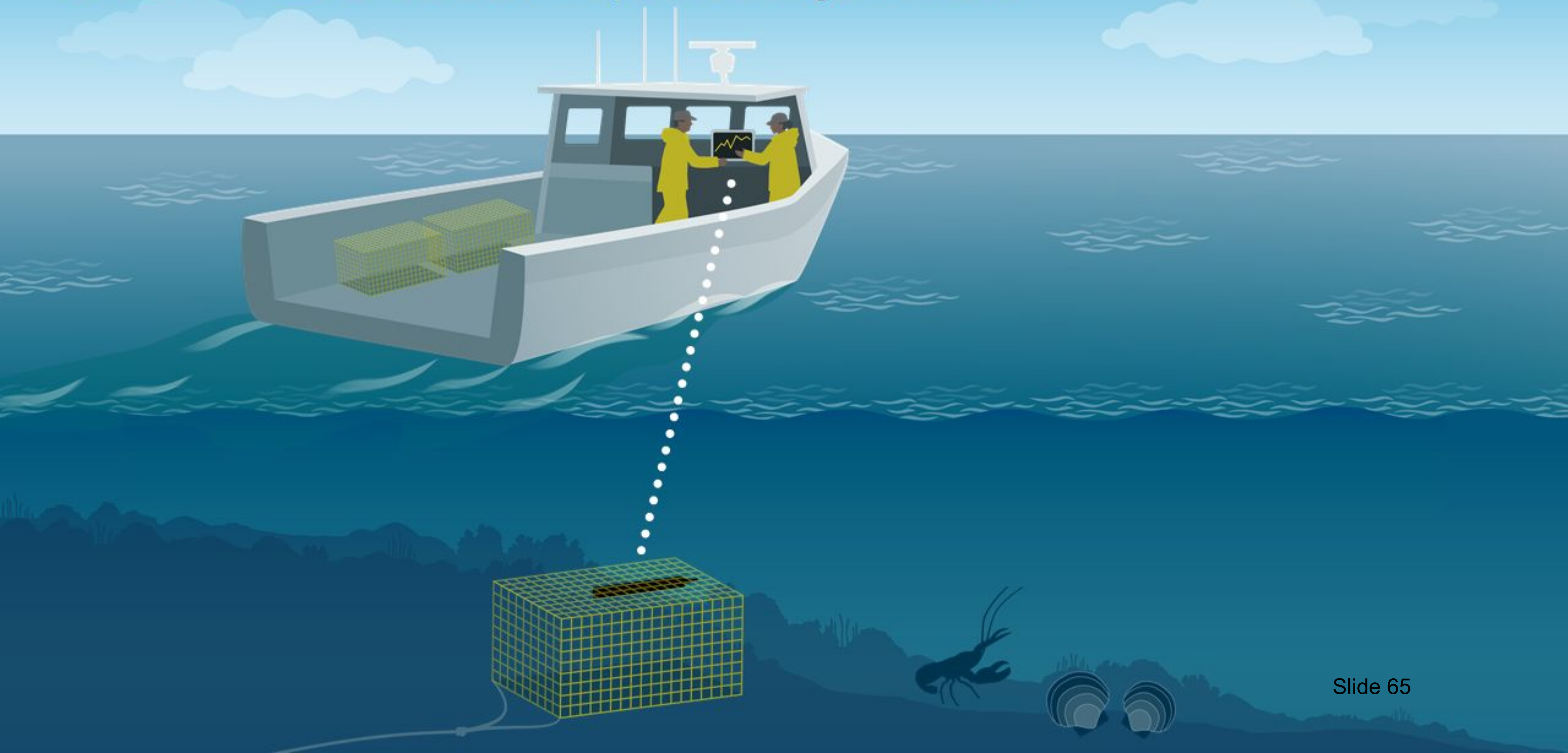
Dissolved Oxygen / Temperature Logger (no profiles)

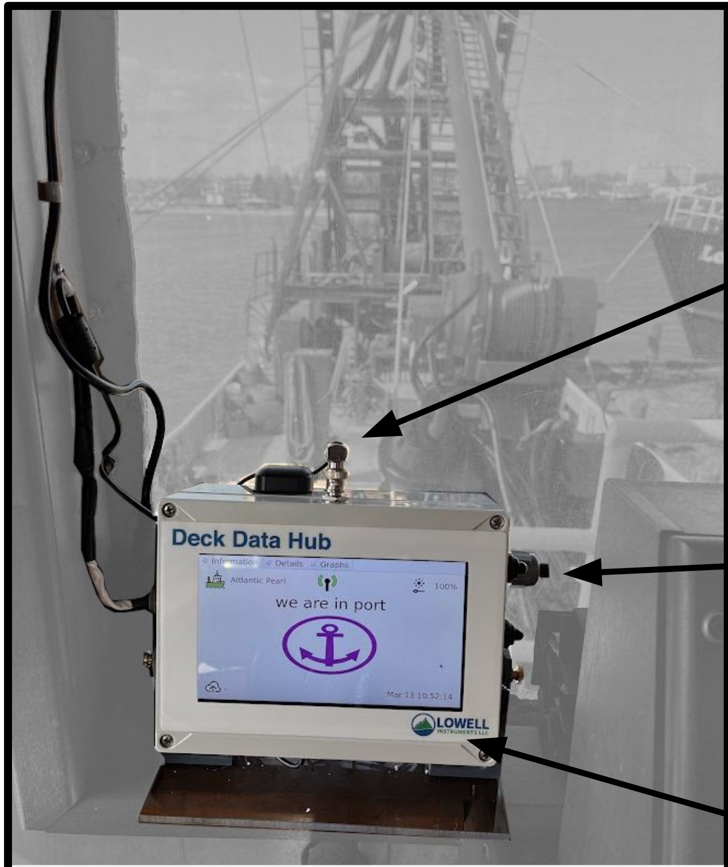


Huanxin and George aboard the
F/V Donna Marie in Provincetown, MA

Huanxin aboard the F/V Atlantic
in New Bedford, MA

eMOLT Environmental Monitors on Lobster Traps and Large Trawlers





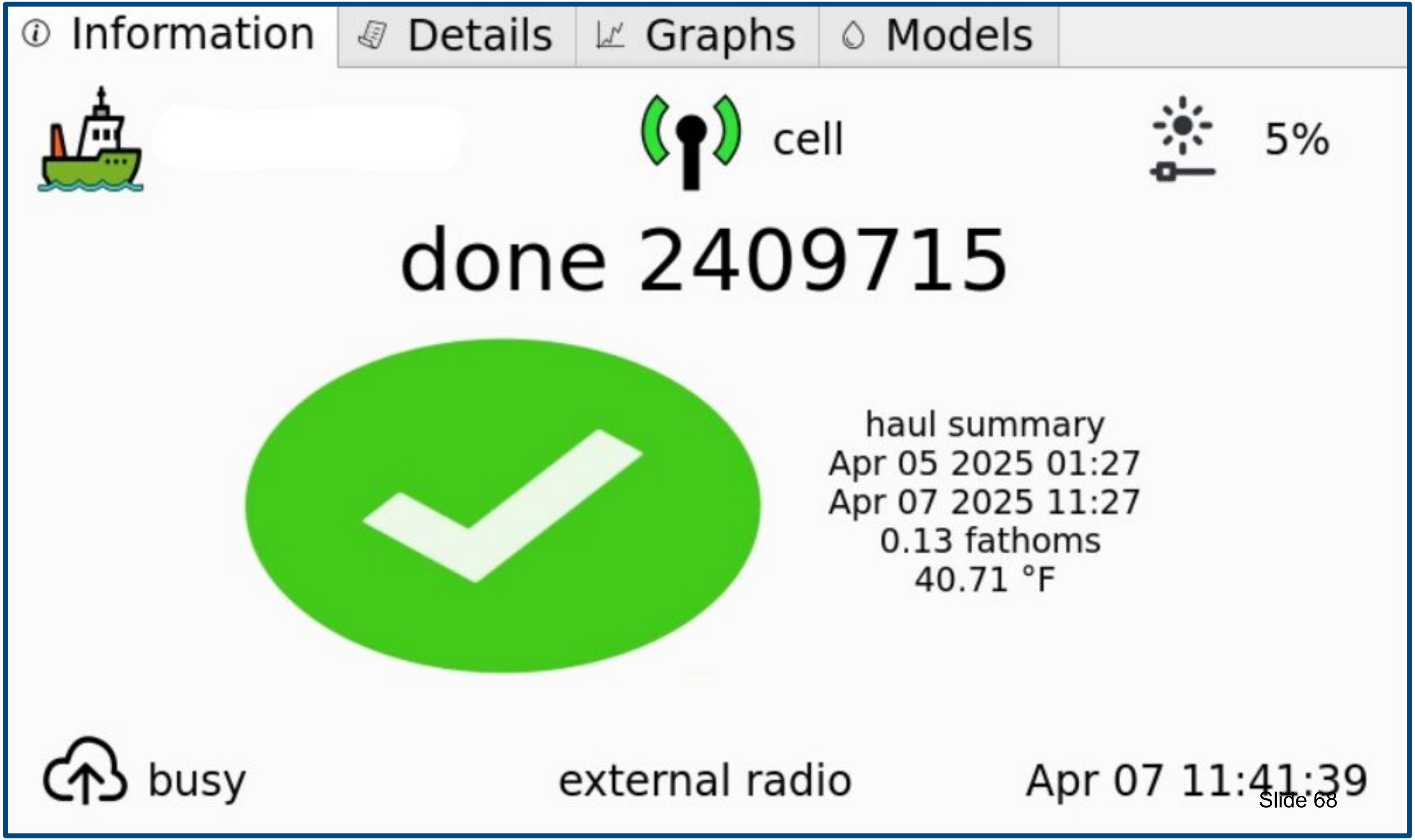
F/V Atlantic Pearl

GPS Receiver

Optional Bluetooth Extension

Touchscreen Deck Box


Information
Details
Graphs
Models
Miss Linus
100%
searching for loggers
checking
internal radio
Apr 10 09:07:32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Graphs
Models
cell
5%
done 2409715
haul summary
Apr 05 2025 01:27
Apr 07 2025 11:27
0.13 fathoms
40.71 °F
busy
external radio
Apr 07 11:41:39

Information | Details | Graphs | Models

	logger	result	rerun
1	2406607	ok TDO Apr 09 16:06 at +0.0000, +0.0000	True
2	2406614	success Jul 29 22:28 at +41.7138, -70.6053	True
3			
4			
5			
6			
7			
8			

-

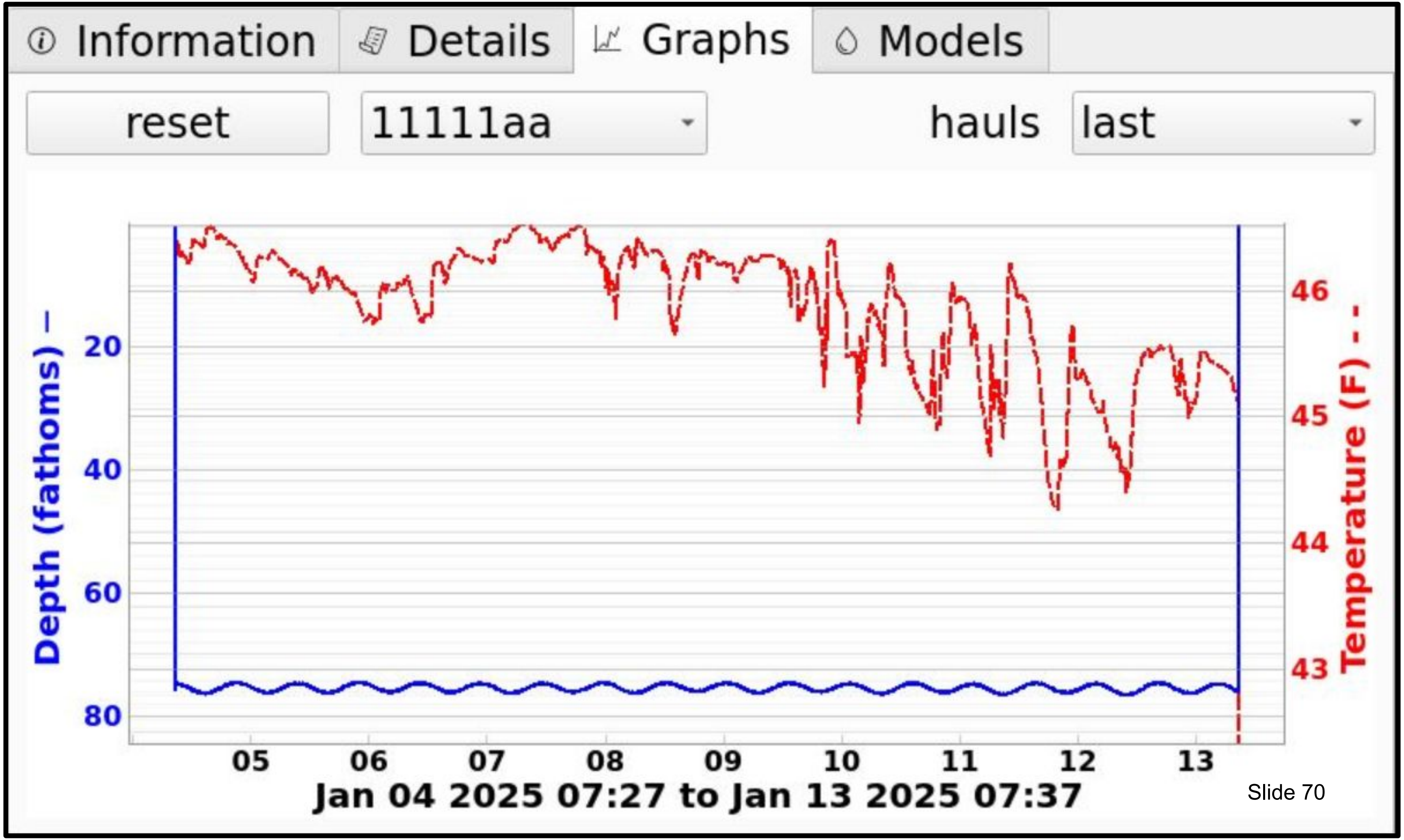
-

DDH 9999999

uptime 0:02:08

tech support

v. 4.0.88



Information
Details
Graphs
Models
reset
11111aa
hauls
last
Depth (fathoms) –
20
40
60
80
Temperature (F) - -
46
45
44
43
05
06
07
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09
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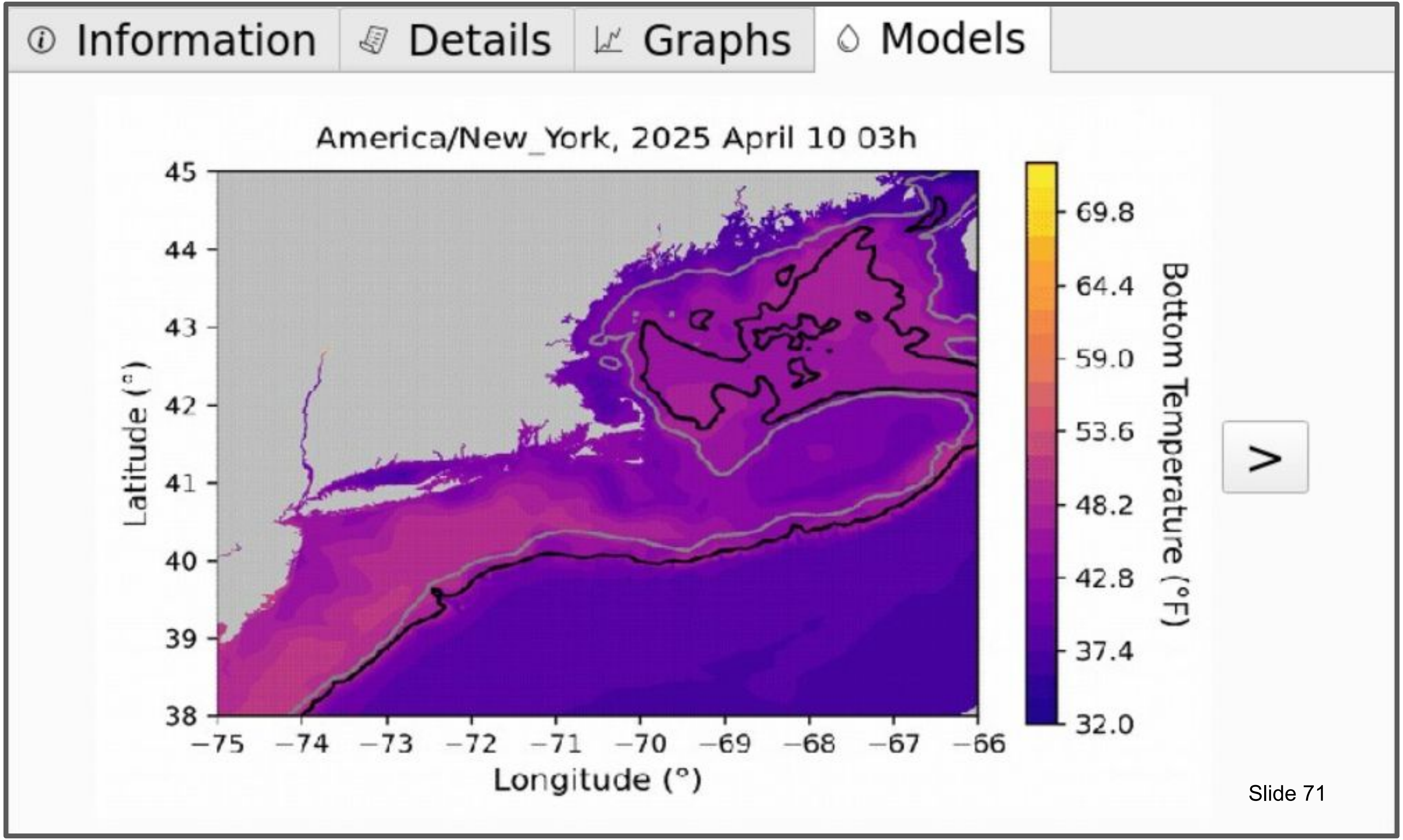
11
12
13
Jan 04 2025 07:27 to Jan 13 2025 07:37



Information
Details
Graphs
Models
America/New_York, 2025 April 10 03h
45
44
43
42
41
40
39
38
Latitude (°)
−75
−74
−73
−72
−71
−70
−69
−68
−67
−66
Longitude (°)
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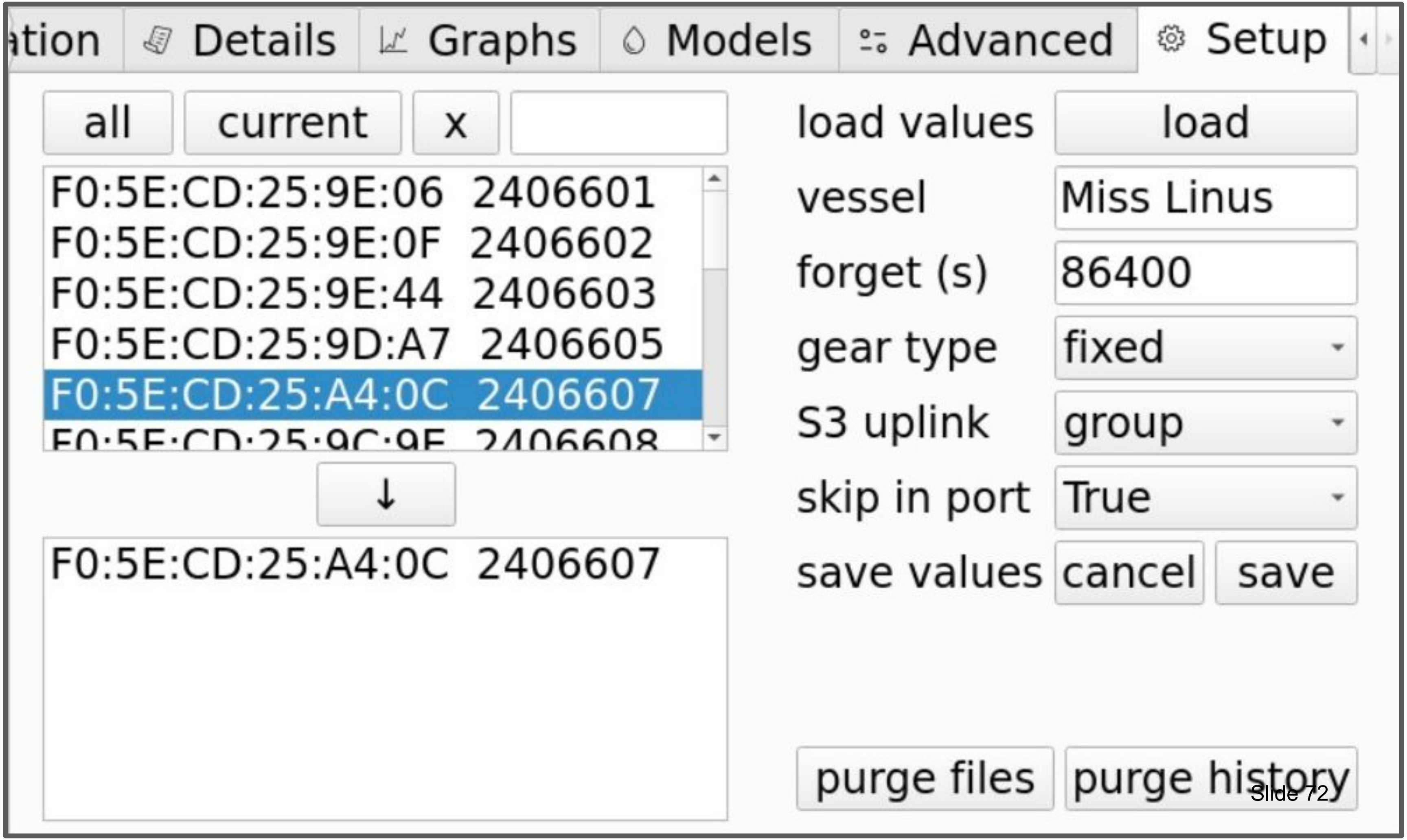
64.4
59.0
53.6
48.2
42.8
37.4
32.0
Bottom Temperature (°F)
>


ation
Details
Graphs
Models
Advanced
Setup
all
current
x
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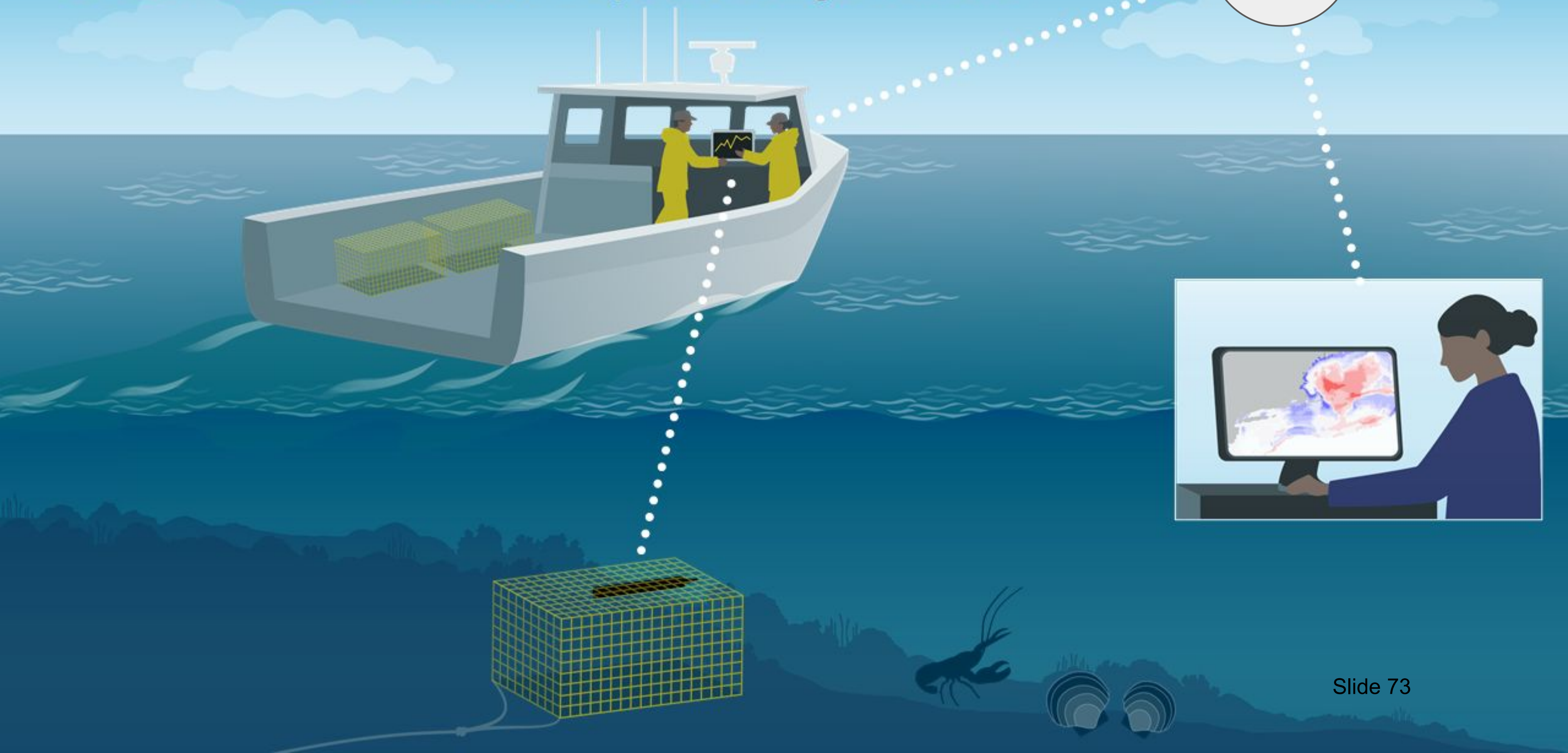
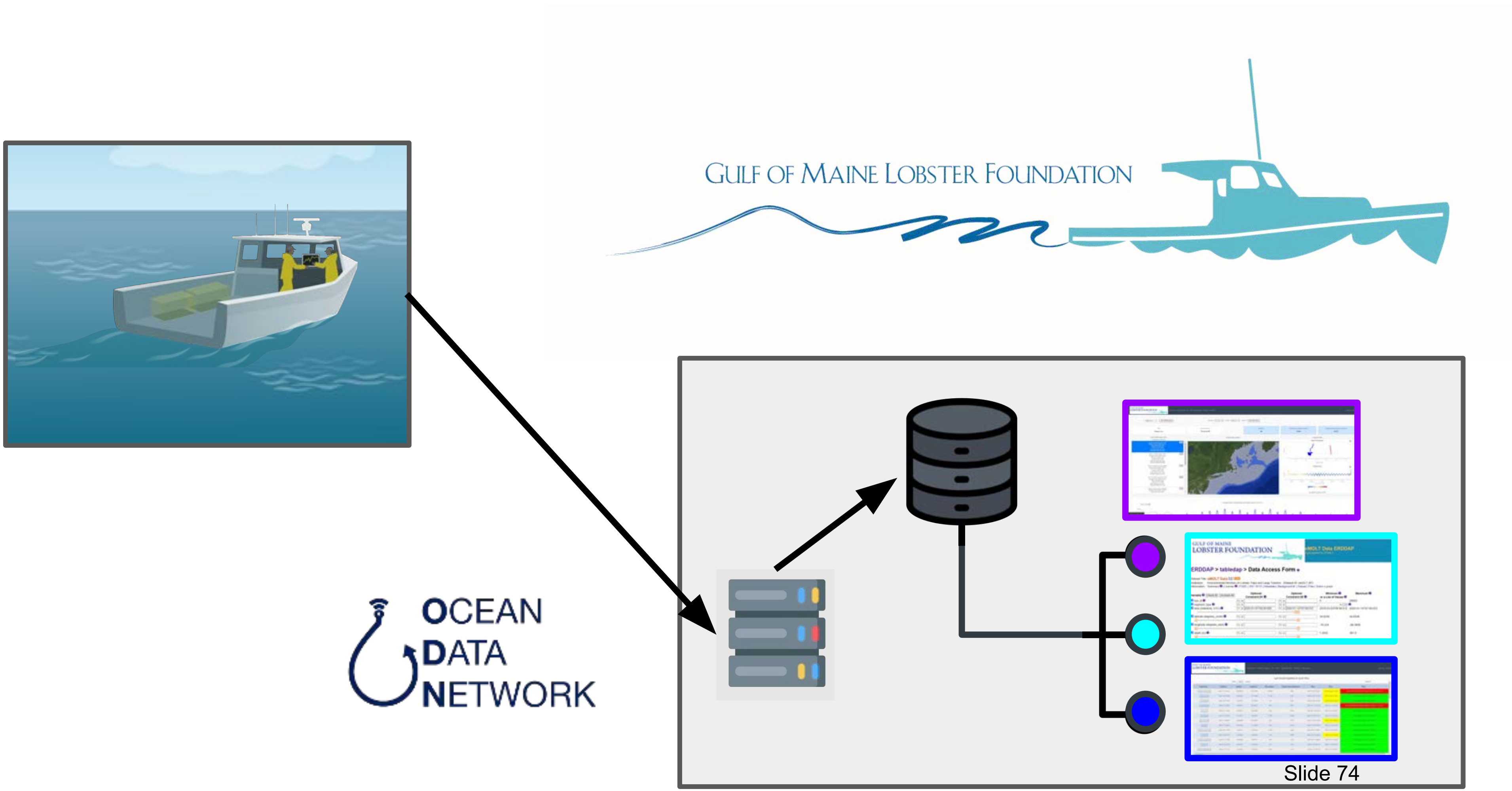
F0:5E:CD:25:9E:44 2406603
F0:5E:CD:25:9D:A7 2406605
F0:5E:CD:25:A4:0C 2406607
↓
F0:5E:CD:25:A4:0C 2406607
load values
load
vessel
Miss Linus
forget (s)
86400
gear type
fixed
S3 uplink
group
skip in port
True
save values
cancel
save
purge files
purge history

eMOLT Environmental Monitors on Lobster Traps and Large Trawlers




GULF OF MAINE LOBSTER FOUNDATION
OCEAN
DATA
NETWORK
Slide 74

Maine Expansions: Partnerships

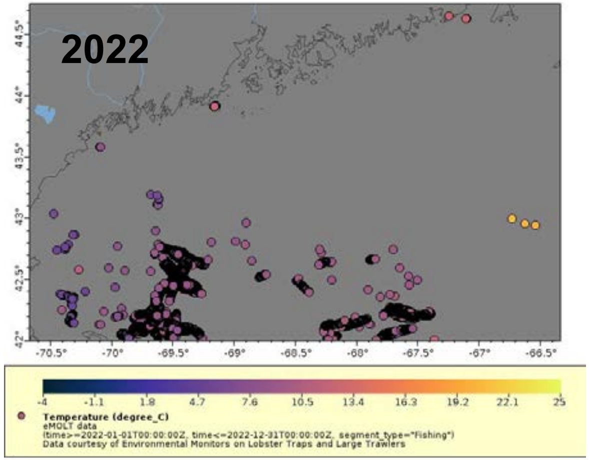
GULF OF MAINE LOBSTER FOUNDATION

THE UNIVERSITY OF MAINE
LOBSTER INSTITUTE

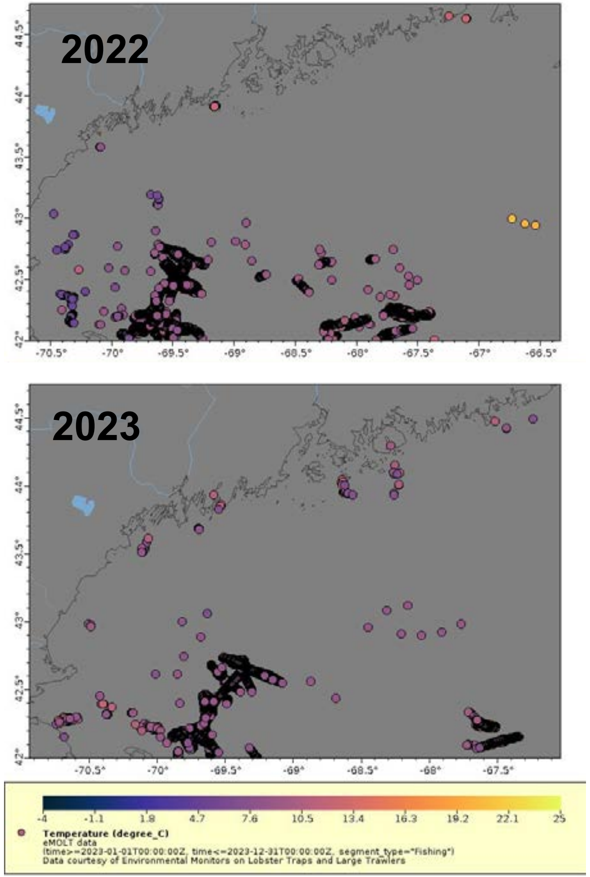
OCEAN
DATA
NETWORK

NERACOOS

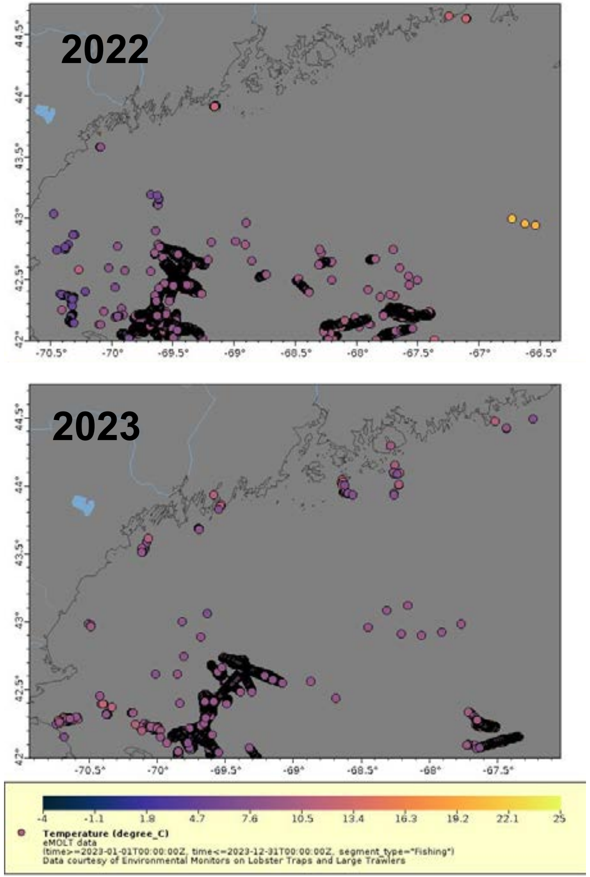
Maine Expansions: New Data Collection

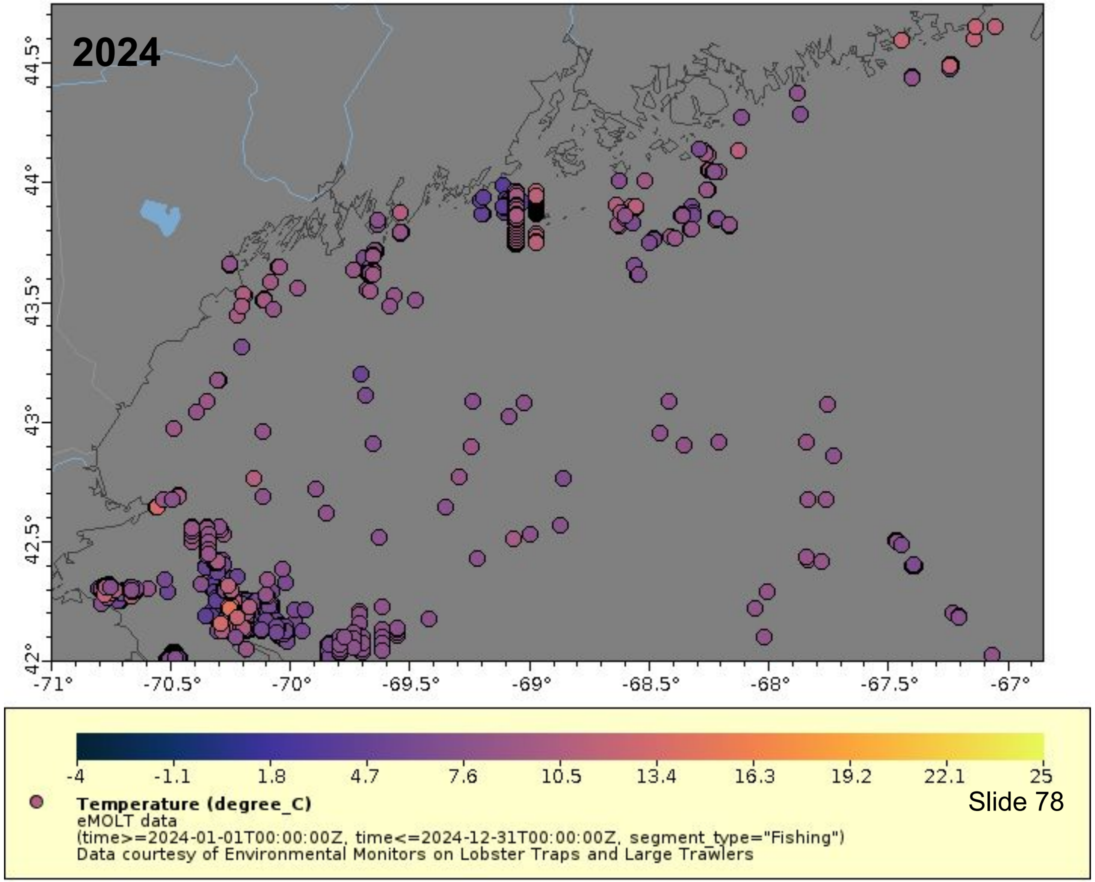


Maine Expansions: New Data Collection



Maine Expansions: New Data Collection





Maine Expansions: Funders

MASSACHUSETTS TECHNOLOGY COLLABORATIVE

Sea Grant MAINE

NATIONAL SCIENCE FOUNDATION

Maine Community Foundation
Broad Reach Fund

Woods Hole Sea Grant

NORTHEAST FISHERIES SCIENCE CENTER
COOPERATIVE RESEARCH

Maine Expansions: Funders

MASSACHUSETTS TECHNOLOGY COLLABORATIVE

Maine Community Foundation
Broad Reach Fund

Uses of the Data

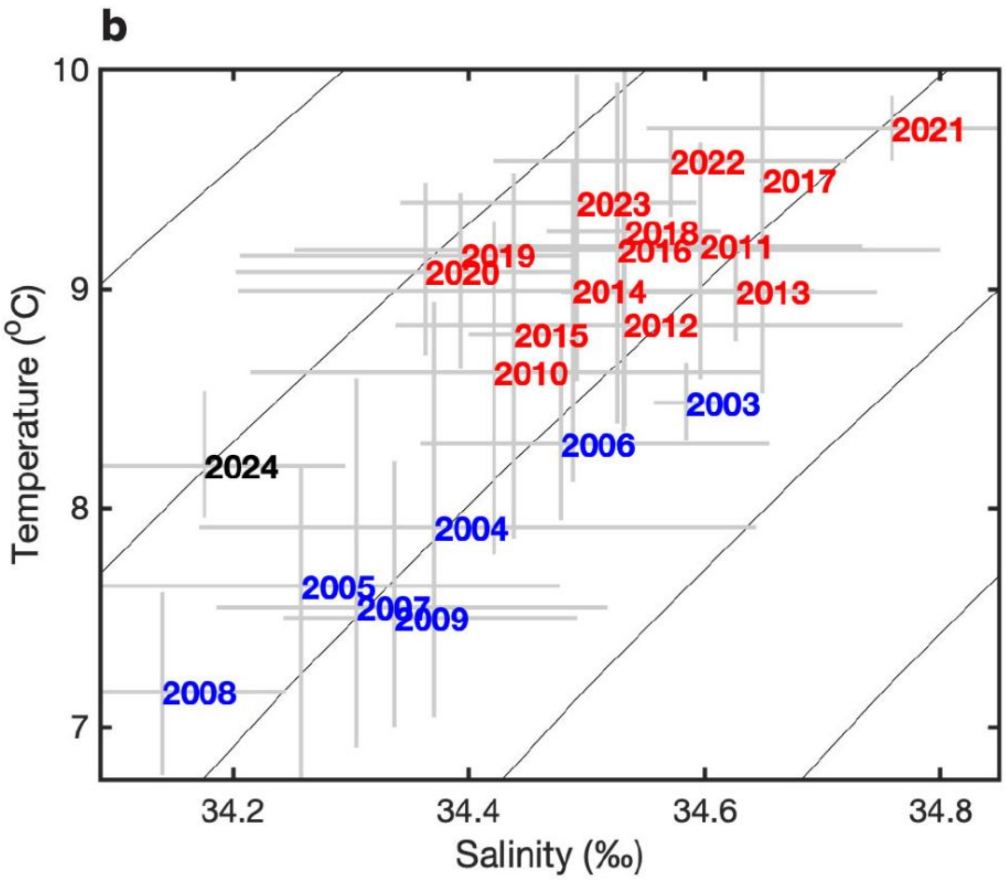
EARLY WARNING
OF A COLD WAVE IN THE GULF OF MAINE

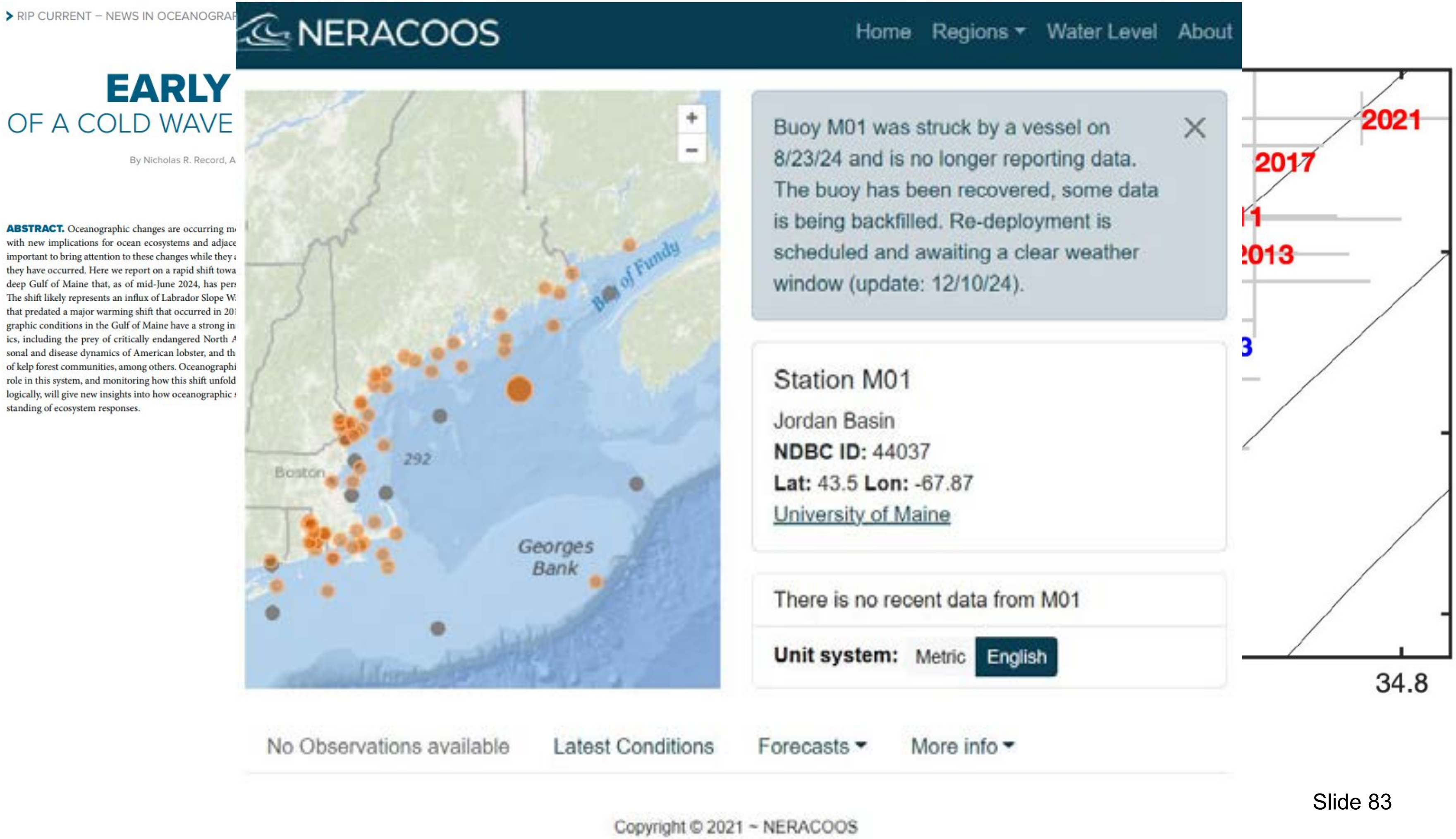
By Nicholas R. Record, Andrew J. Pershing, and Douglas B. Rasher

ABSTRACT. Oceanographic changes are occurring more rapidly in recent decades, with new implications for ocean ecosystems and adjacent human communities. It is important to bring attention to these changes while they are unfolding rather than after they have occurred. Here we report on a rapid shift toward colder, fresher water in the deep Gulf of Maine that, as of mid-June 2024, has persisted for at least six months. The shift likely represents an influx of Labrador Slope Water and resembles conditions that predated a major warming shift that occurred in 2011–2012. Deep-water oceanographic conditions in the Gulf of Maine have a strong influence on ecosystem dynamics, including the prey of critically endangered North Atlantic right whales, the seasonal and disease dynamics of American lobster, and the distribution and abundance of kelp forest communities, among others. Oceanographic surprises have an important role in this system, and monitoring how this shift unfolds, oceanographically and ecologically, will give new insights into how oceanographic signals can inform our understanding of ecosystem responses.

the Gulf of Maine ecosystem (Greene and Pershing 2007; Meyer-Gutbrod et al., 2021). Oceanographers have suggested the potential for early warnings of major changes based on upstream dynamics (Greene and Pershing, 2003; Gonçalves Neto et al., 2021). Because of the importance of subsurface currents to this process, focusing on surface conditions can mask important dynamics.

After more than a decade of consistently warming conditions, the deep water in the Gulf of Maine has a thermohaline regime not detected since before





RIP CURRENT – NEWS IN OCEANOGRAP
EARLY
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Jordan Basin
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Lat: 43.5 Lon: -67.87
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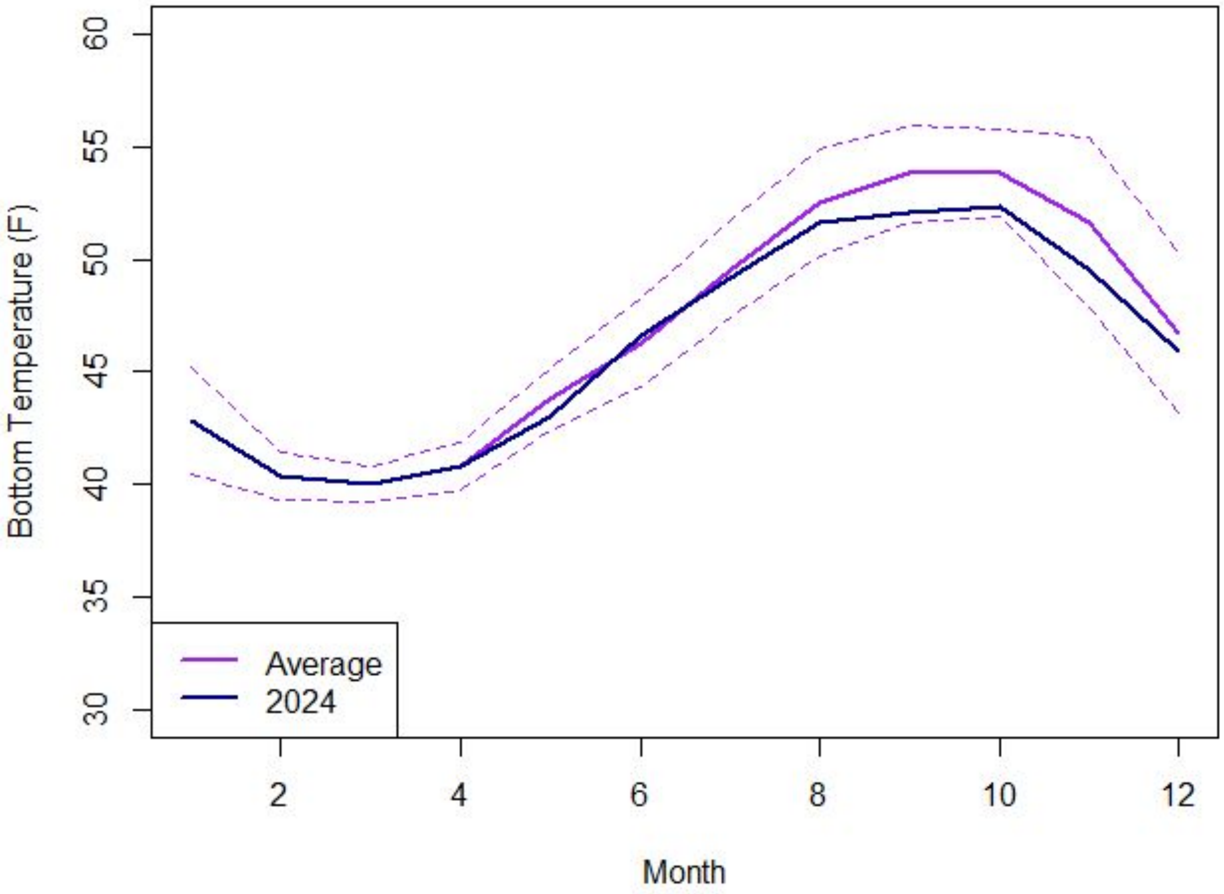
Unit system: Metric English
No Observations available
Latest Conditions
Forecasts
More info
Copyright © 2021 ~ NERACOOS
2021
2017
2013
34.8



Bottom Temperature (F)
60
55
50
45
40
35
30
Average
2024
2
4
6
8
10
12
Month

GOM *Tripos* Bloom 2023

Review of Oxygen Depletion and Associated Mass Mortalities of Shellfish in the Middle Atlantic Bight in 1976

FRANK W. STEIMLE and CARL J. SINDERMANN

ABSTRACT–In summer and autumn of 1976, mass mortalities of shellfish occurred in a 165-km long corridor of severe oxygen depletion paralleling the New Jersey coast from 5 to 85 km from shore. Mortalities of surf clams, Spisula solidissima, *the most severely affected species, were estimated in excess of 140,000 t. Alteration of normal migration patterns of lobsters and several species of finfish was also noted. A series of anomalous meteorological and hydrological events (particularly early warming of surface waters resulting in early thermocline development, and a massive shelf-wide phytoplankton bloom) superimposed on an already stressed coastal area, was considered to be responsible. The occurrence is particularly significant because the continental shelf of the Middle Atlantic Bight, from Cape Cod to Cape Hatteras on the east coast of the United States, contains the largest known stocks of ocean shellfish of any comparable coastal area of North America.*

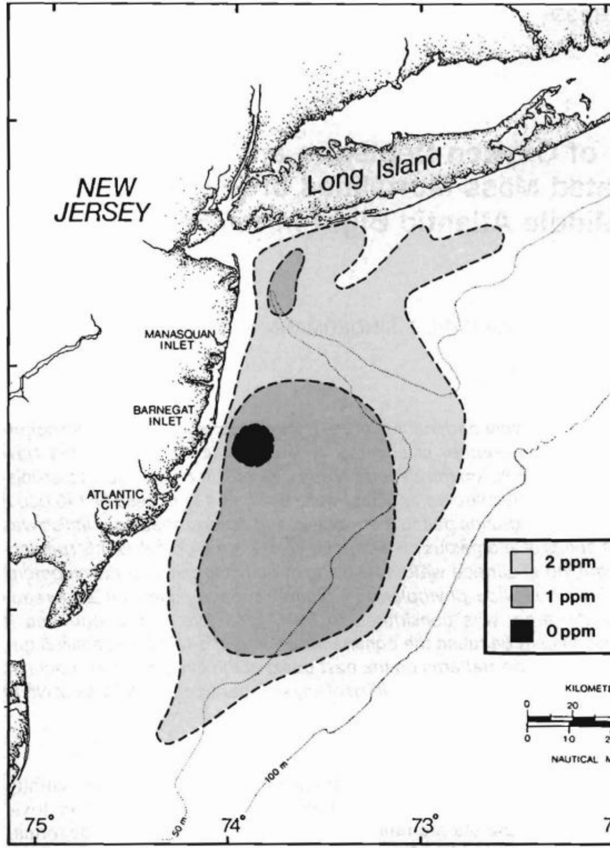
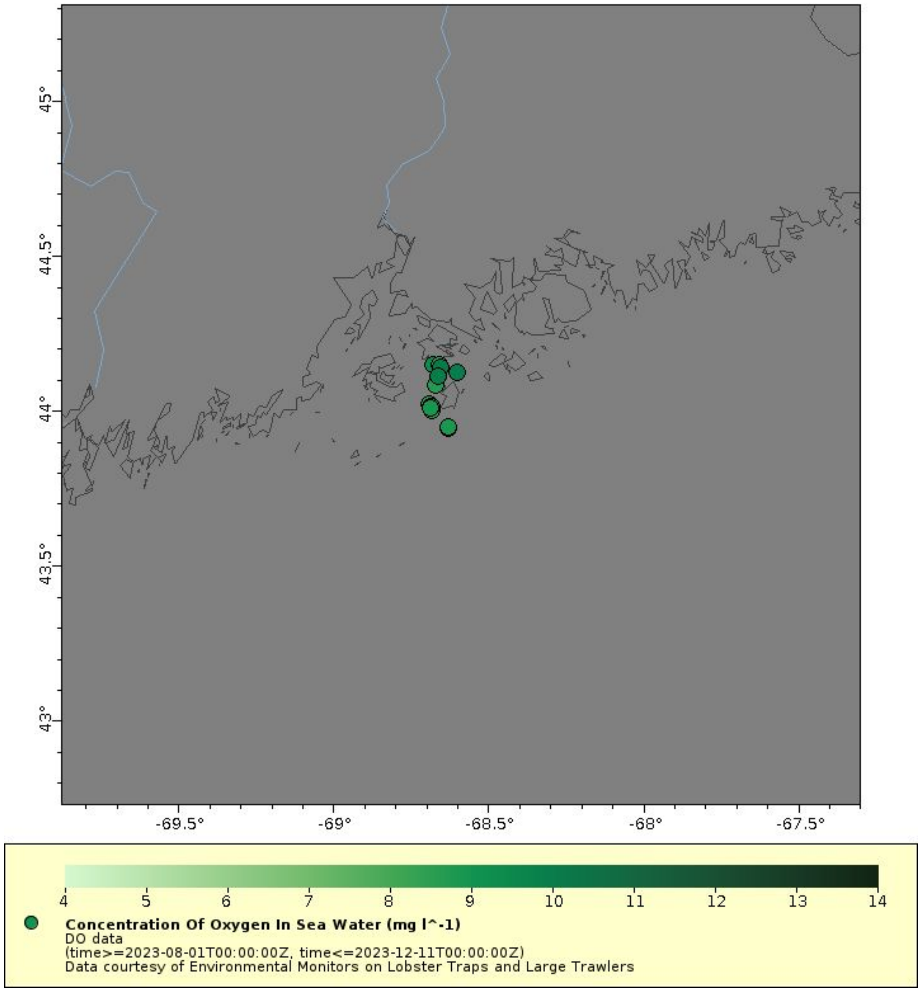
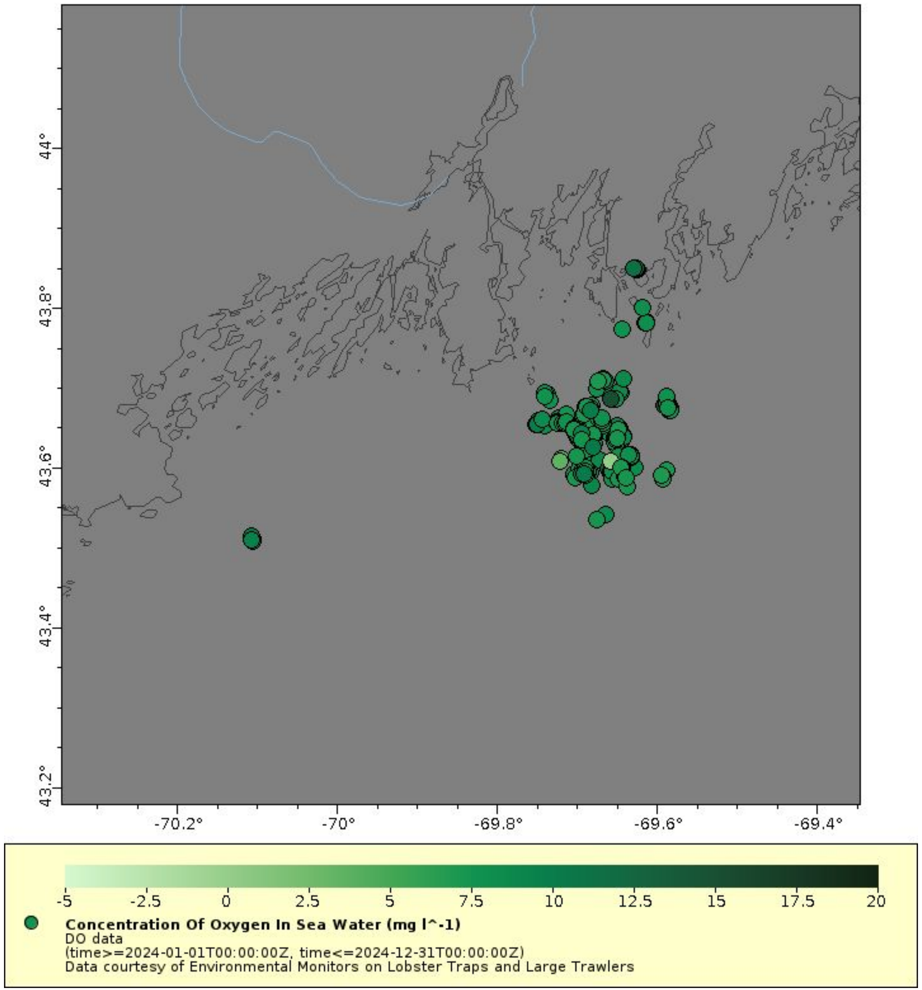
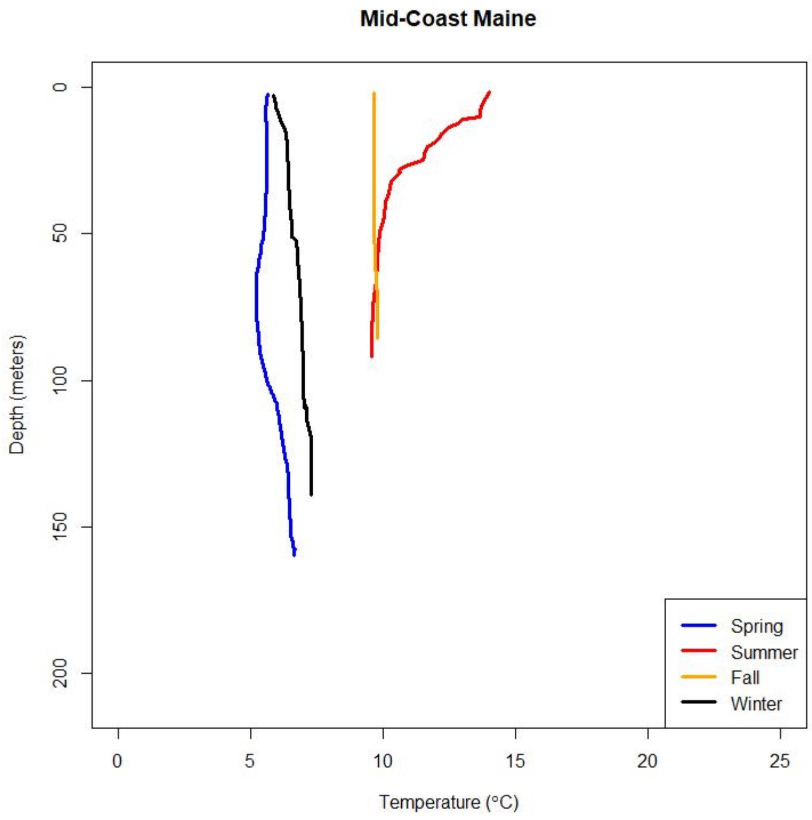


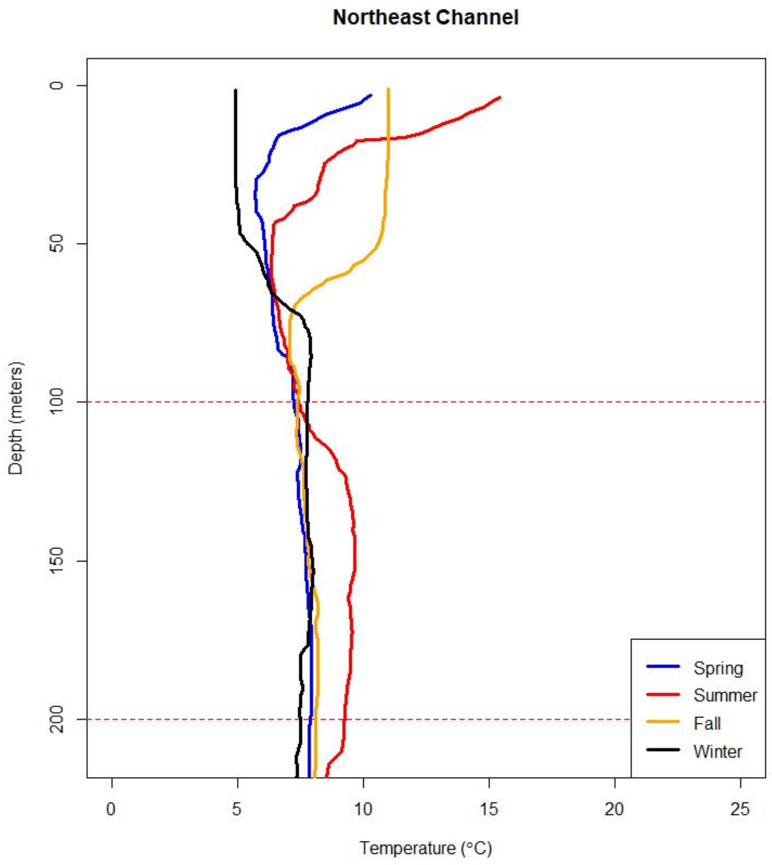
Figure 1.—The bottom oxygen levels in the New York Bight at period of greatest dist... late September 1976.

Slide 86

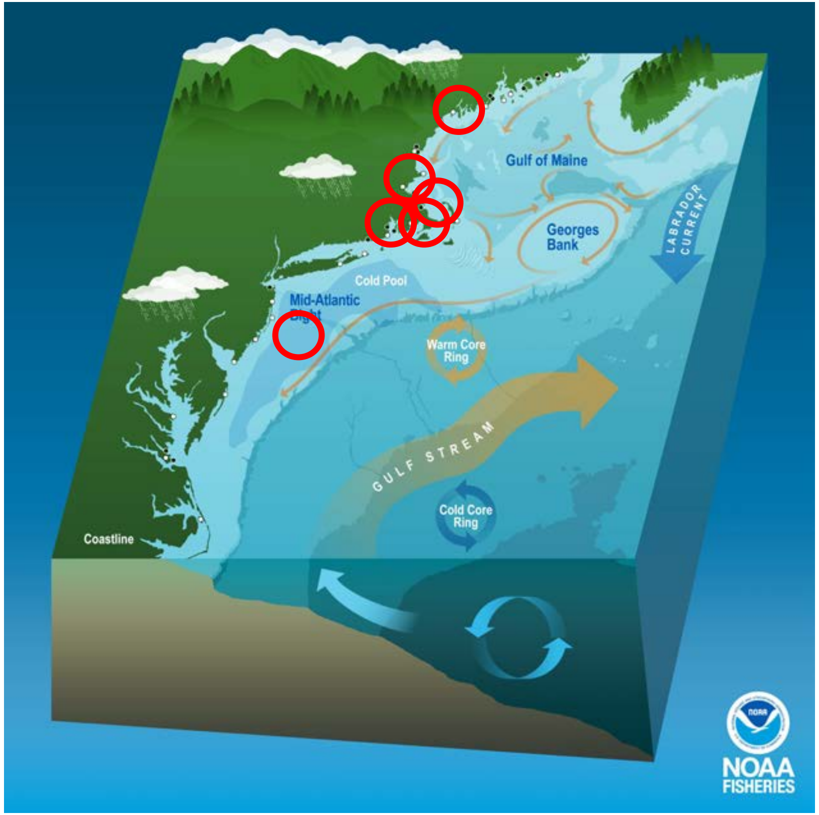

45°
44.5°
44°
43.5°
43°
-69.5°
-69°
-68.5°
-68°
-67.5°
4
5
6
7
8
9
10
11
12
13
14
Concentration Of Oxygen In Sea Water (mg l^-1)
DO data
(time>=2023-08-01T00:00:00Z, time<=2023-12-11T00:00:00Z)
Data courtesy of Environmental Monitors on Lobster Traps and Large Trawlers


44°
43.8°
43.6°
43.4°
43.2°
-70.2°
-70°
-69.8°
-69.6°
-69.4°
-5
-2.5
0
2.5
5
7.5
10
12.5
15
17.5
20
Concentration Of Oxygen In Sea Water (mg l^-1)
DO data
(time>=2024-01-01T00:00:00Z, time<=2024-12-31T00:00:00Z)
Data courtesy of Environmental Monitors on Lobster Traps and Large Trawlers


Mid-Coast Maine
Depth (meters)
0
50
100
150
200
0
5
10
15
20
25
Temperature (°C)
Spring
Summer
Fall
Winter


Northeast Channel
Depth (meters)
0
50
100
150
200
0
5
10
15
20
25
Temperature (°C)
Spring
Summer
Fall
Winter

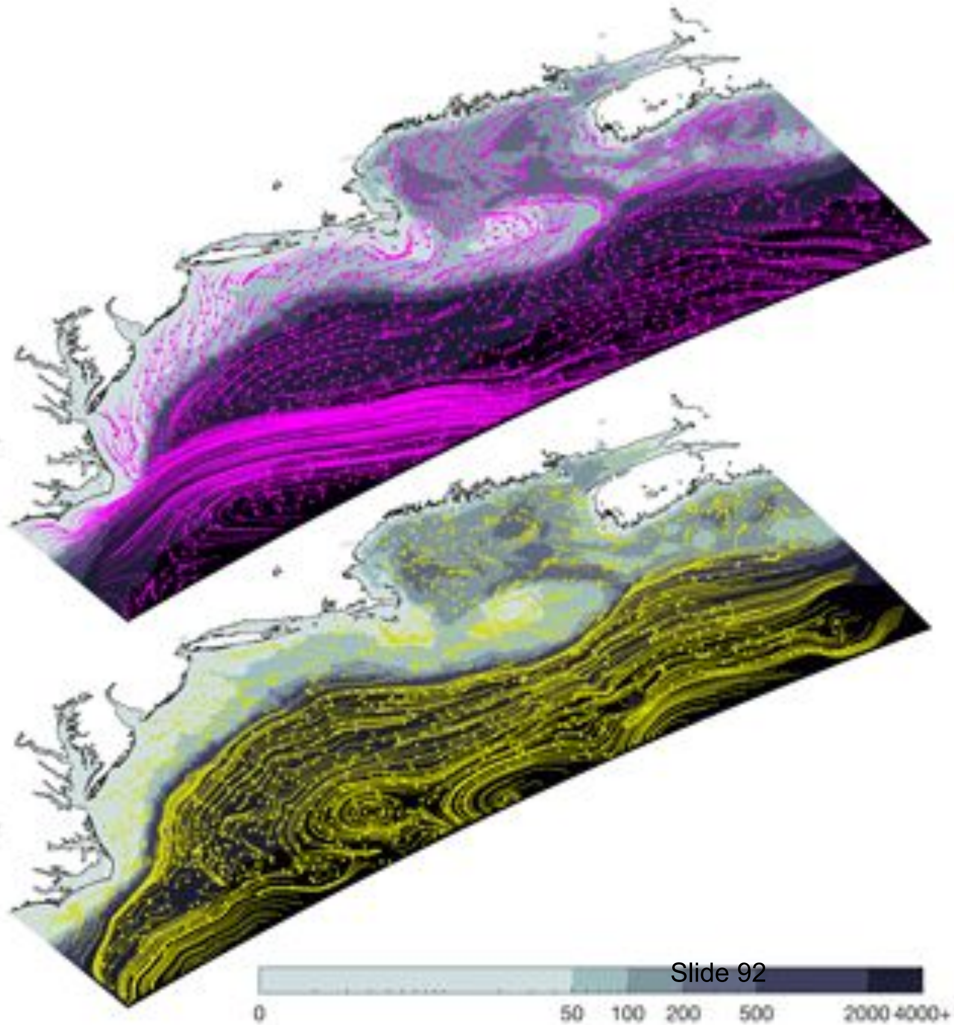
More DO Monitoring and Data Tools in the works for 2025



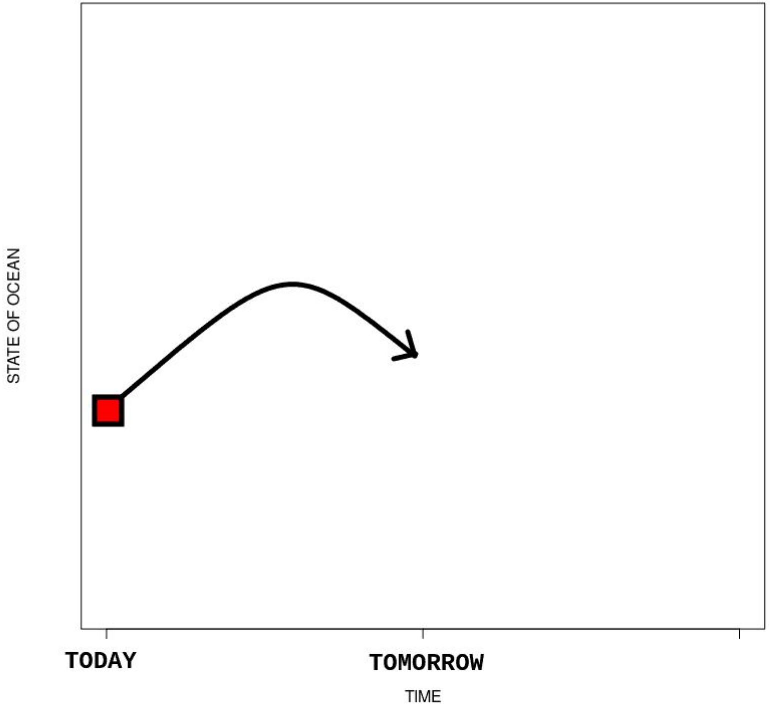
- Boothbay, Maine
- **Salem Sound, Massachusetts**
- Cape Cod Bay, Massachusetts
- **Buzzards Bay, Massachusetts**
- **Narragansett Bay, Rhode Island**
- **Mid-Atlantic Cold Pool, New Jersey**

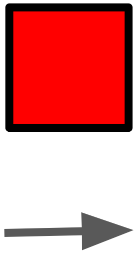
Ocean Forecast Assimilation

What is an Oceanographic Forecast?



Slide 92

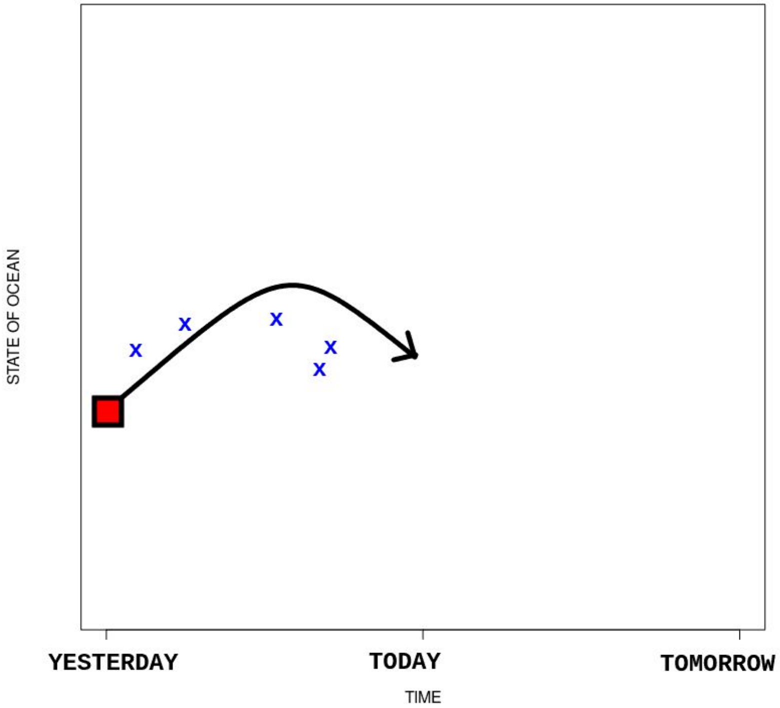




= Model estimate of the current state

= Forecast changes over time until tomorrow

Credit: John Wilkin

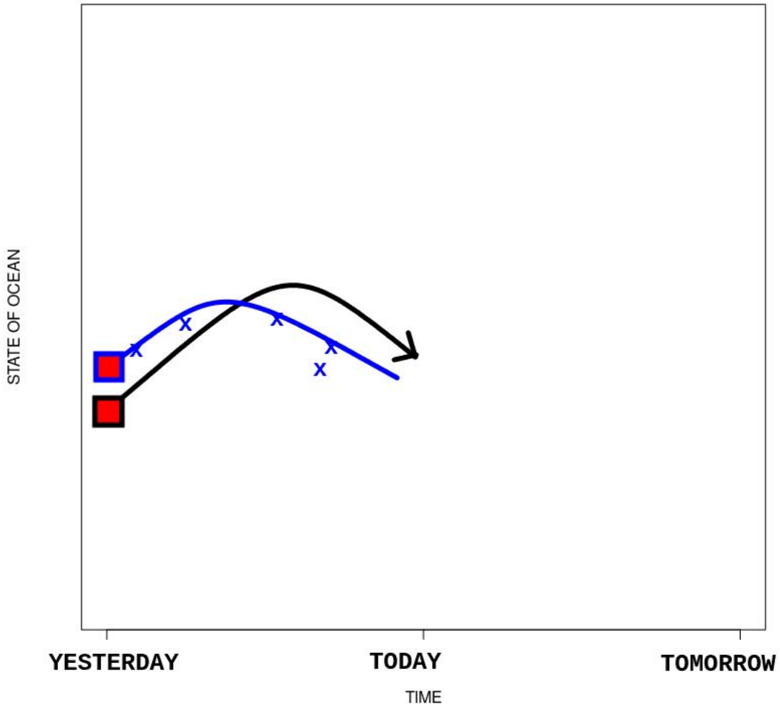


= Model estimate of the current state

= Forecast changes over time until tomorrow

X = Observations from the real world

Credit: John Wilkin



= Model estimate of the current state

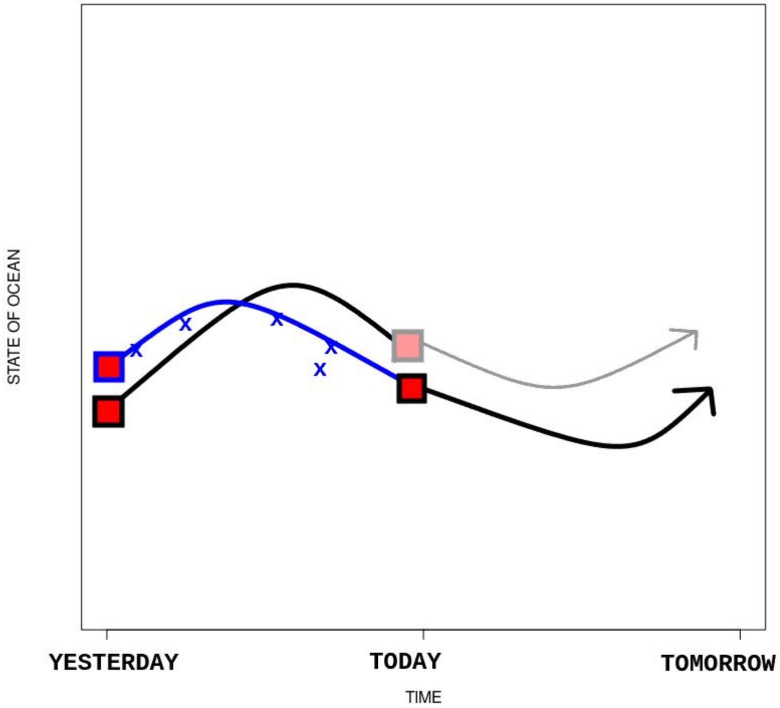
= Forecast changes over time until tomorrow

X = Observations from the real world

= Revised estimate of the starting state

= New version of model informed by more real world observations

Credit: John Wilkin



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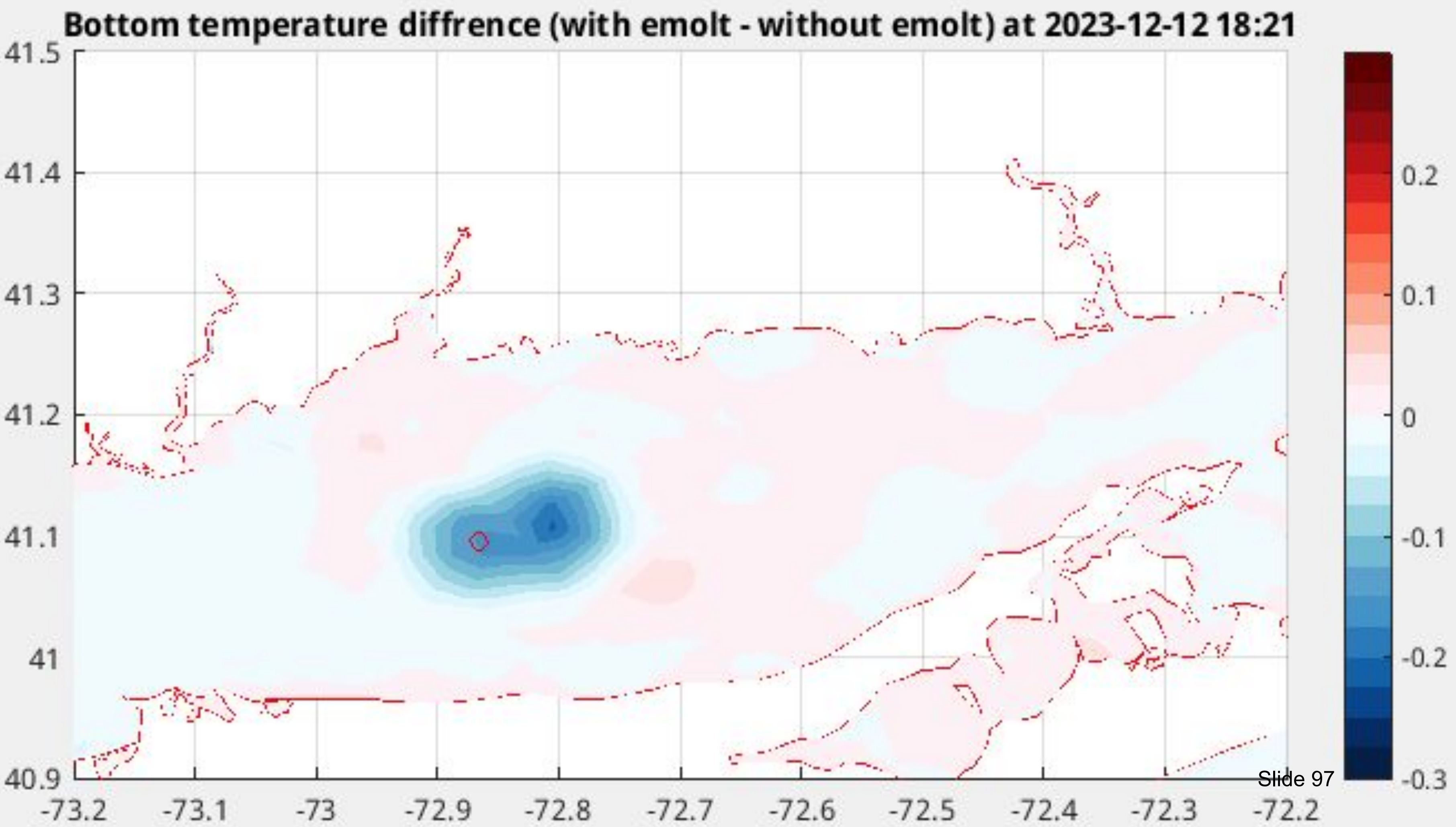
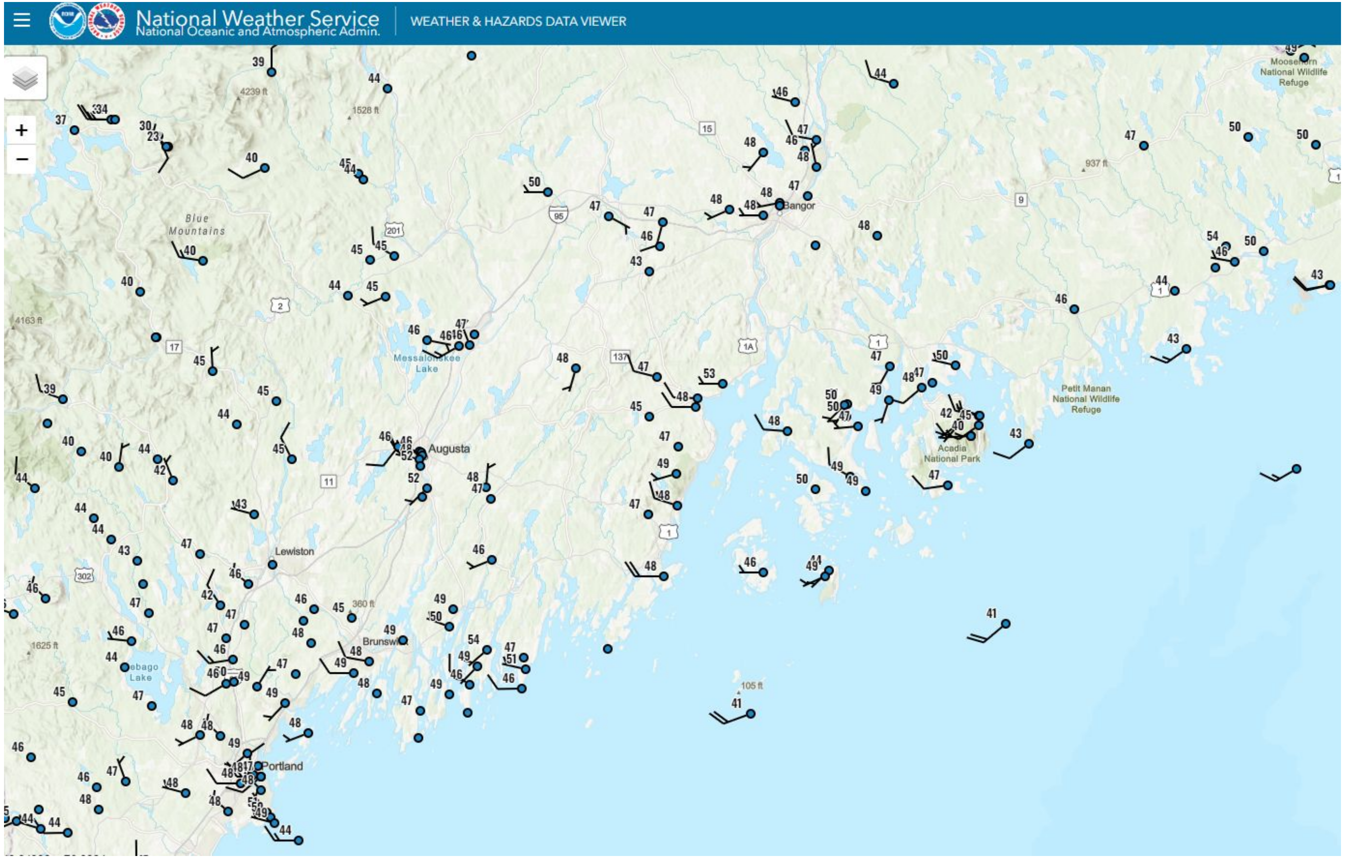
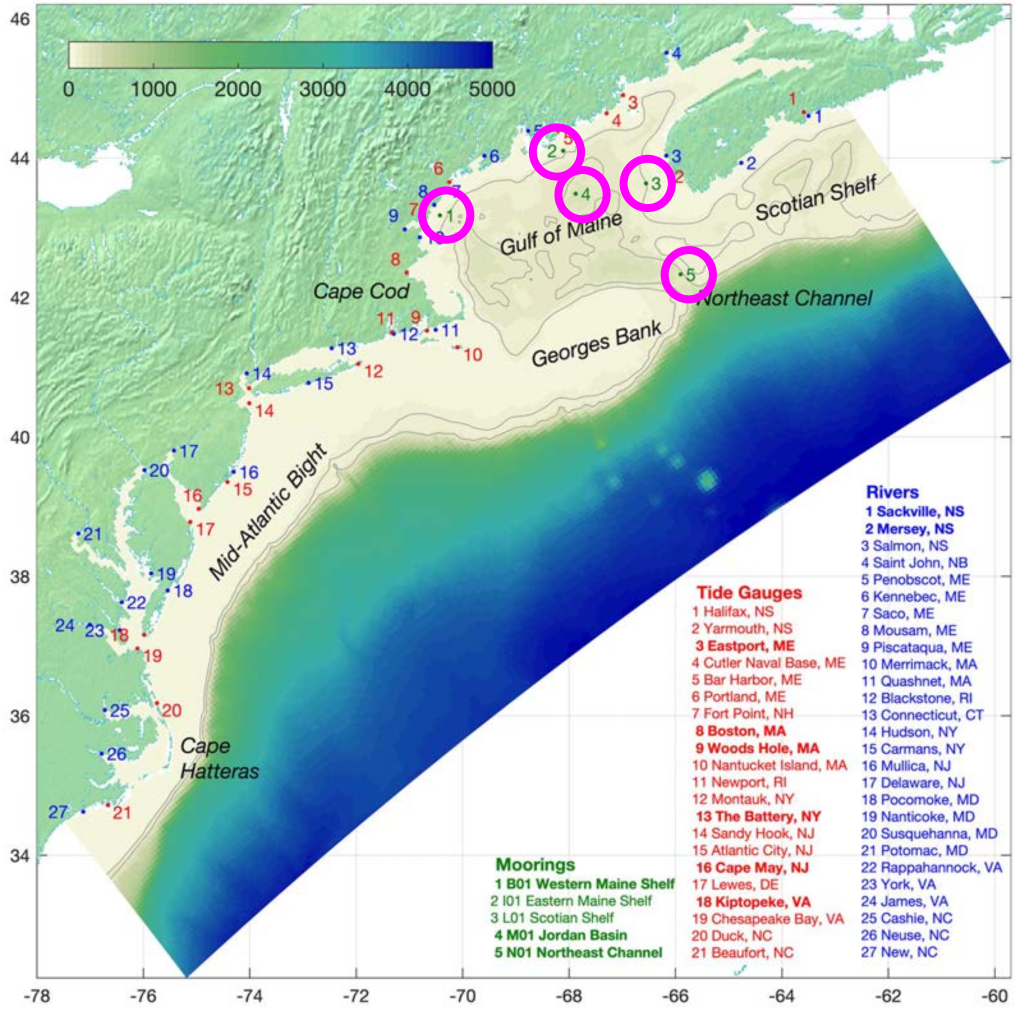
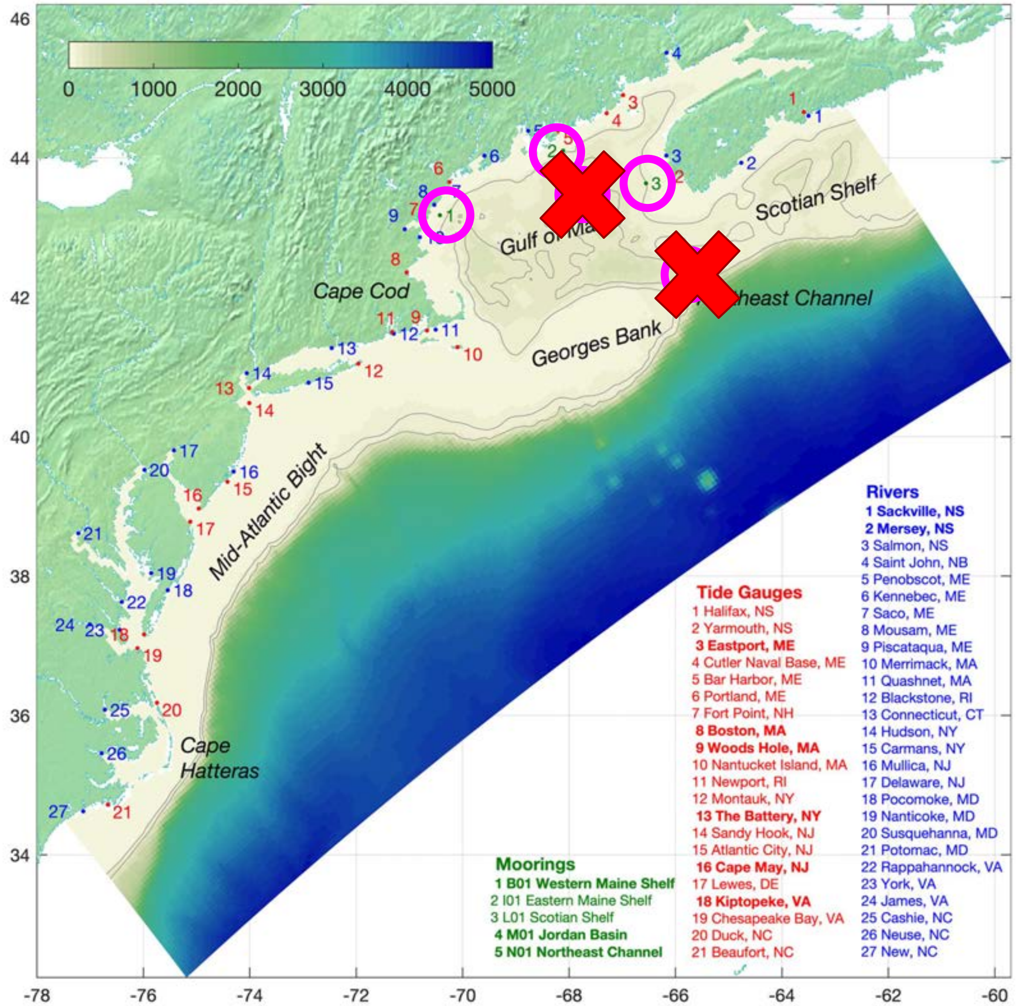

Bottom temperature diffrence (with emolt - without emolt) at 2023-12-12 18:21
41.5
41.4
41.3
41.2
41.1
41
40.9
-73.2
-73.1
-73
-72.9
-72.8
-72.7
-72.6
-72.5
-72.4
-72.3
-72.2
0.2
0.1
0
-0.1
-0.2
-0.3



Hundreds of temperature monitoring sites throughout Maine


0 1000 2000 3000 4000 5000
Gulf of Maine
Scotian Shelf
Cape Cod
Northeast Channel
Georges Bank
Mid-Atlantic Bight
Cape Hatteras
Rivers
1 Sackville, NS
2 Mersey, NS
3 Salmon, NS
4 Saint John, NB
5 Penobscot, ME
6 Kennebec, ME
7 Saco, ME
8 Mousam, ME
9 Piscataqua, ME
10 Merrimack, MA
11 Quashnet, MA
12 Blackstone, RI
13 Connecticut, CT
14 Hudson, NY
15 Carmans, NY
16 Mullica, NJ
17 Delaware, NJ
18 Pocomoke, MD
19 Nanticoke, MD
20 Susquehanna, MD
21 Potomac, MD
22 Rappahannock, VA
23 York, VA
24 James, VA
25 Cashie, NC
26 Neuse, NC
27 New, NC
Tide Gauges
1 Halifax, NS
2 Yarmouth, NS
3 Eastport, ME
4 Cutler Naval Base, ME
5 Bar Harbor, ME
6 Portland, ME
7 Fort Point, NH
8 Boston, MA
9 Woods Hole, MA
10 Nantucket Island, MA
11 Newport, RI
12 Montauk, NY
13 The Battery, NY
14 Sandy Hook, NJ
15 Atlantic City, NJ
16 Cape May, NJ
17 Lewes, DE
18 Kiptopeke, VA
19 Chesapeake Bay, VA
20 Duck, NC
21 Beaufort, NC
Moorings
1 B01 Western Maine Shelf
2 I01 Eastern Maine Shelf
3 L01 Scotian Shelf
4 M01 Jordan Basin
5 N01 Northeast Channel
46
44
42
40
38
36
34
-78 -76 -74 -72 -70 -68 -66 -64 -62 -60


0
1000
2000
3000
4000
5000
Scotian Shelf
Gulf of Ma
Cape Cod
heast Channel
Georges Bank
Mid-Atlantic Bight
Cape
Hatteras
46
44
42
40
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-68
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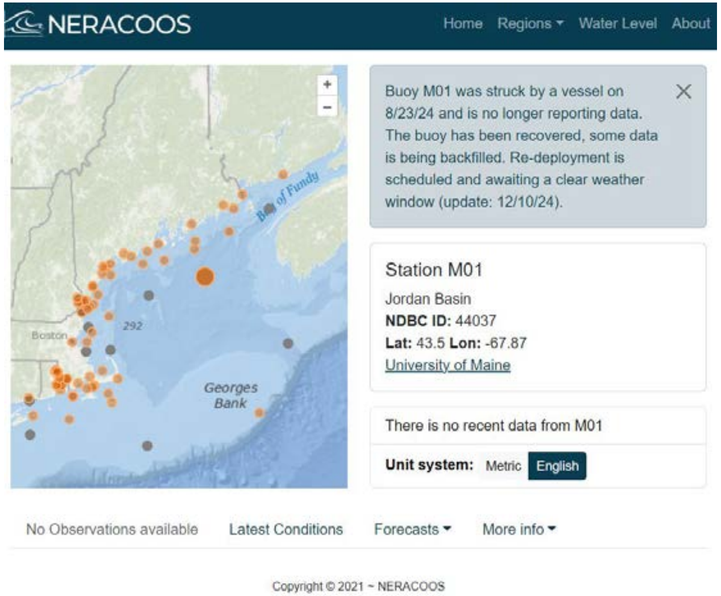
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University of Maine
There is no recent data from M01
Unit system: Metric English
No Observations available
Latest Conditions
Forecasts
More info
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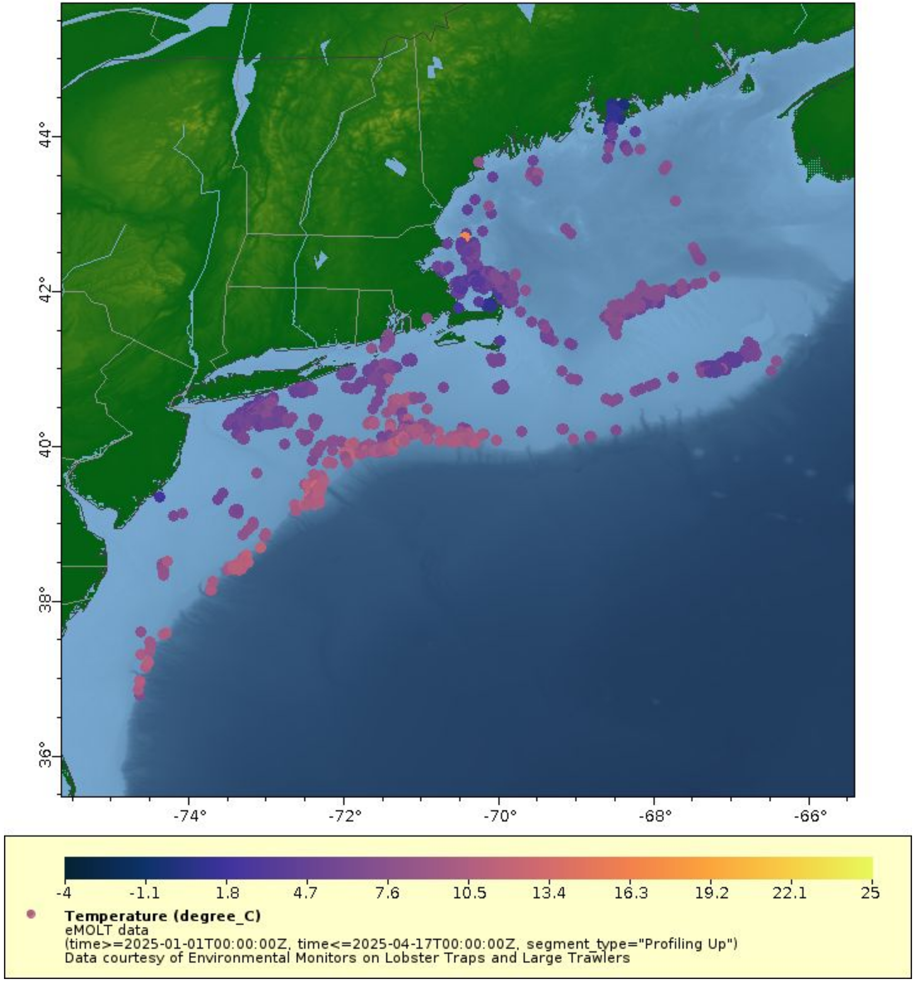

44°
42°
40°
38°
36°
-74°
-72°
-70°
-68°
-66°
-4
-1.1
1.8
4.7
7.6
10.5
13.4
16.3
19.2
22.1
25
Temperature (degree_C)
eMOLT data
(time>=2025-01-01T00:00:00Z, time<=2025-04-17T00:00:00Z, segment_type="Profiling Up")
Data courtesy of Environmental Monitors on Lobster Traps and Large Trawlers

Ground Truthing Models

Progress in Oceanography
Volume 209, December 2022, 102919

A data-assimilative model reanalysis of the U.S. Mid Atlantic Bight and Gulf of Maine: Configuration and comparison to observations and global ocean models

John Wilkin [a], Julia Levin [a], Andrew Moore [b], Hernan Arango [a], Alexander López [a], Elias Hunter [a]

Show more

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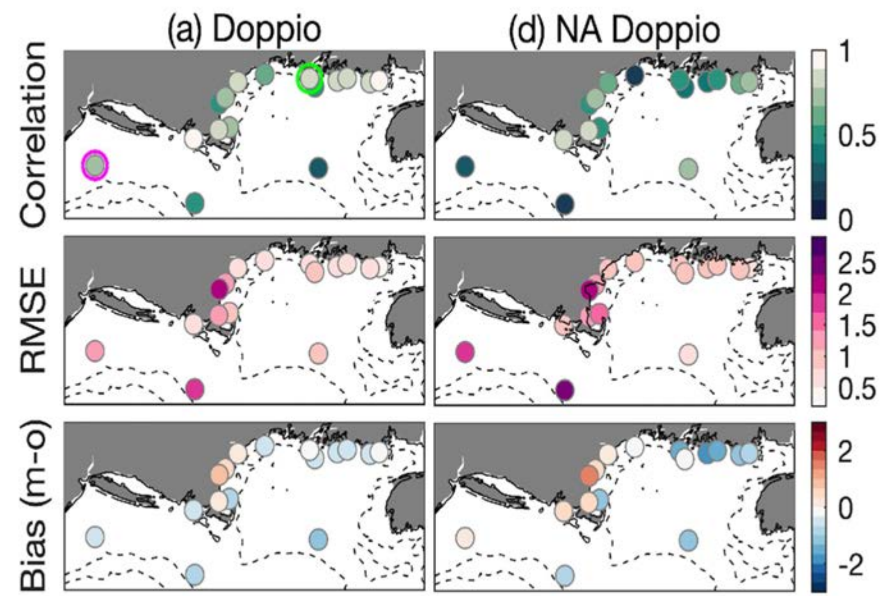
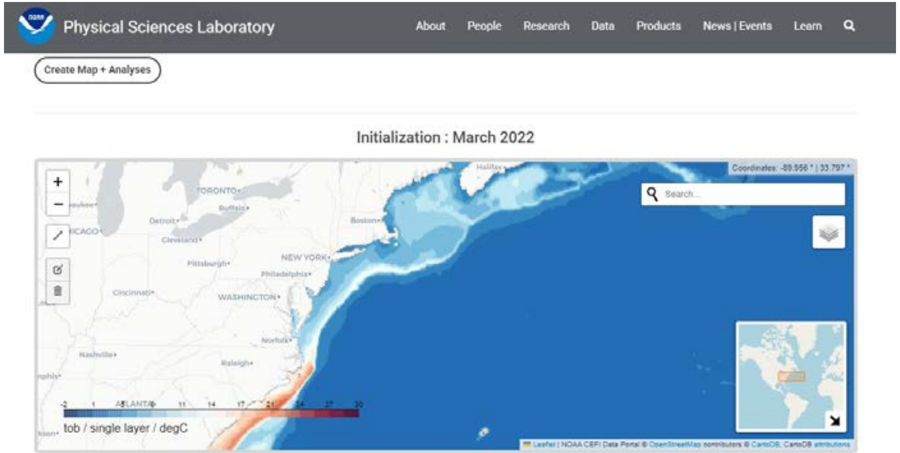
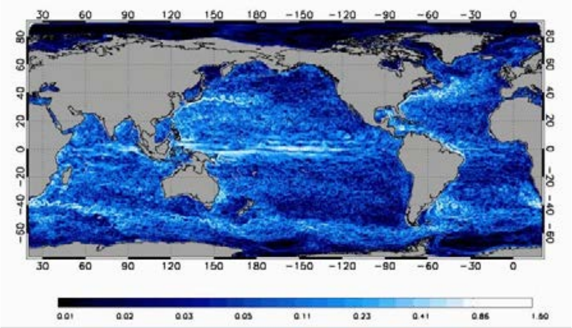


Assimilation of real time data (eMOLT, buoys, gliders, etc.) → better model performance

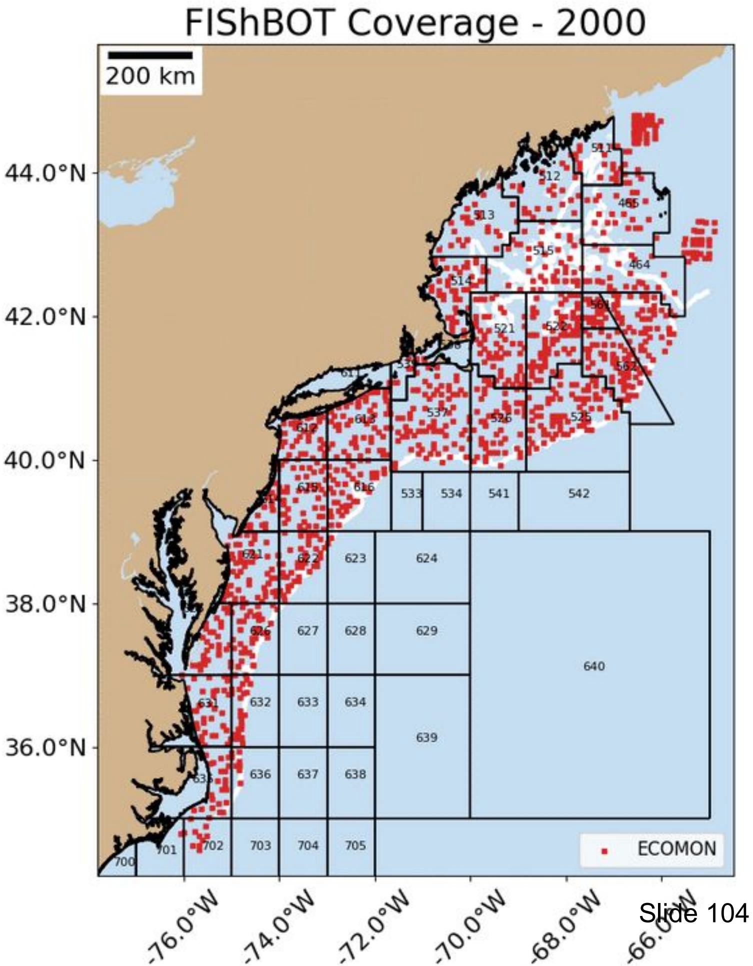
Ocean Hindcast Evaluation

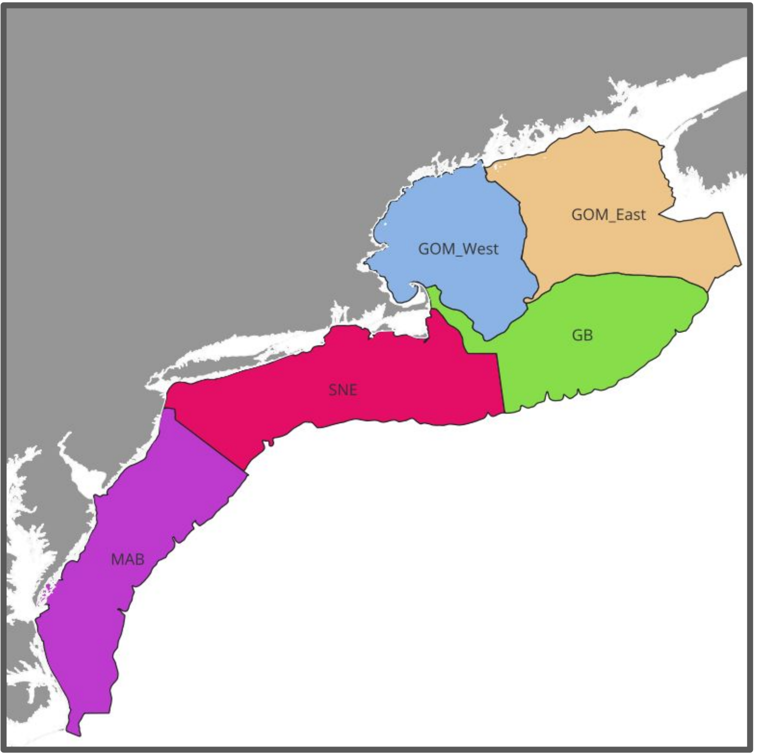
Ground Truthing Models

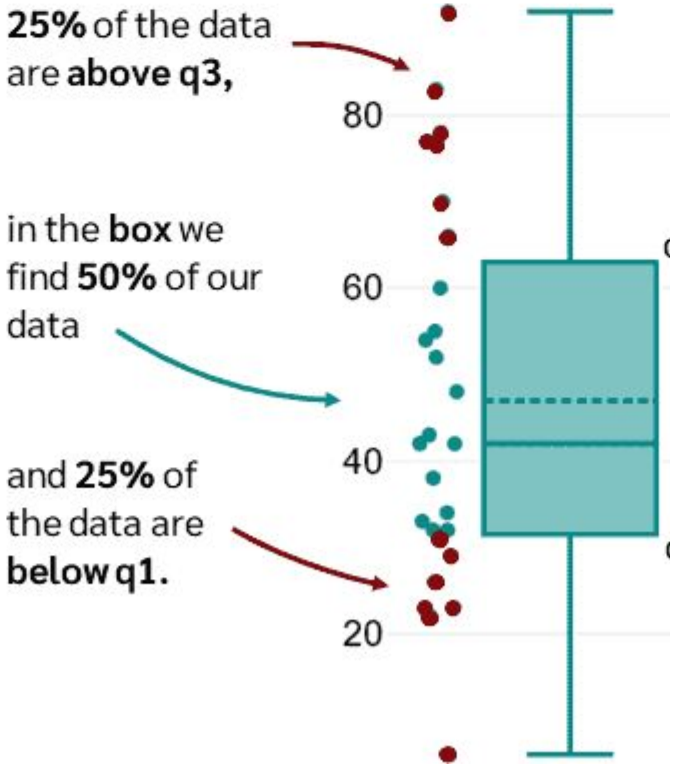


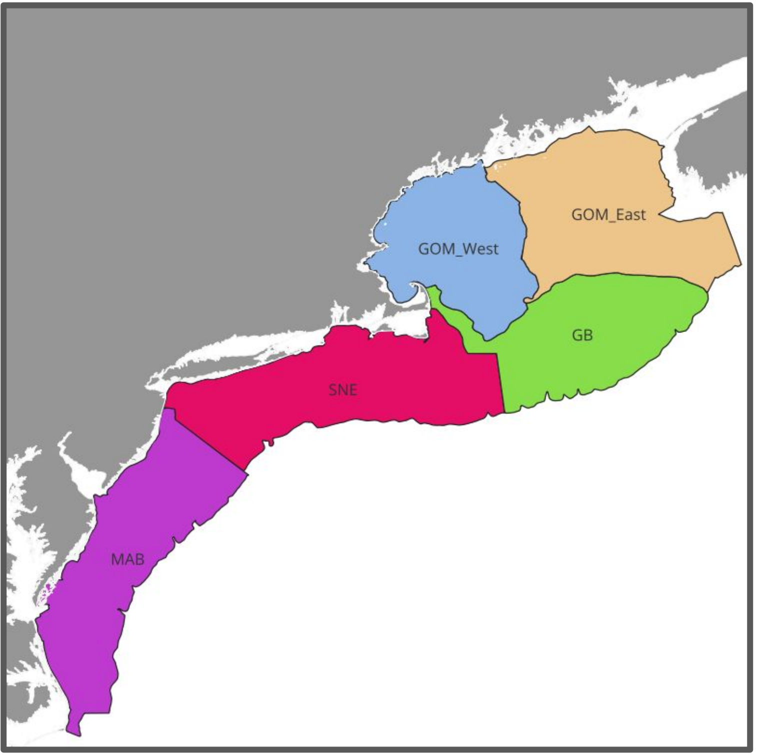


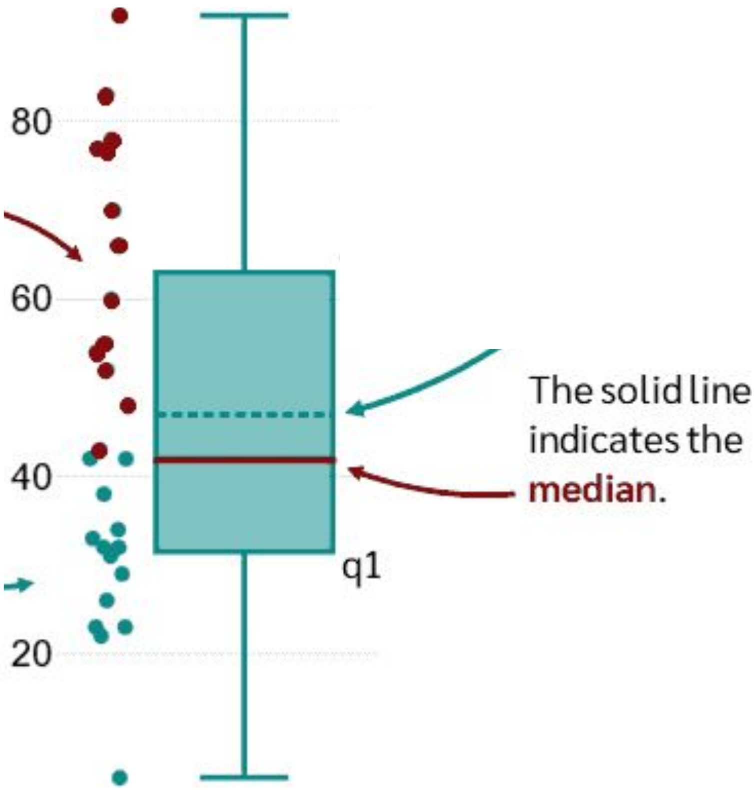
Reanalysed current speed (m/s) at 97 m depth on 3 may 2003 in GLORYS2V1

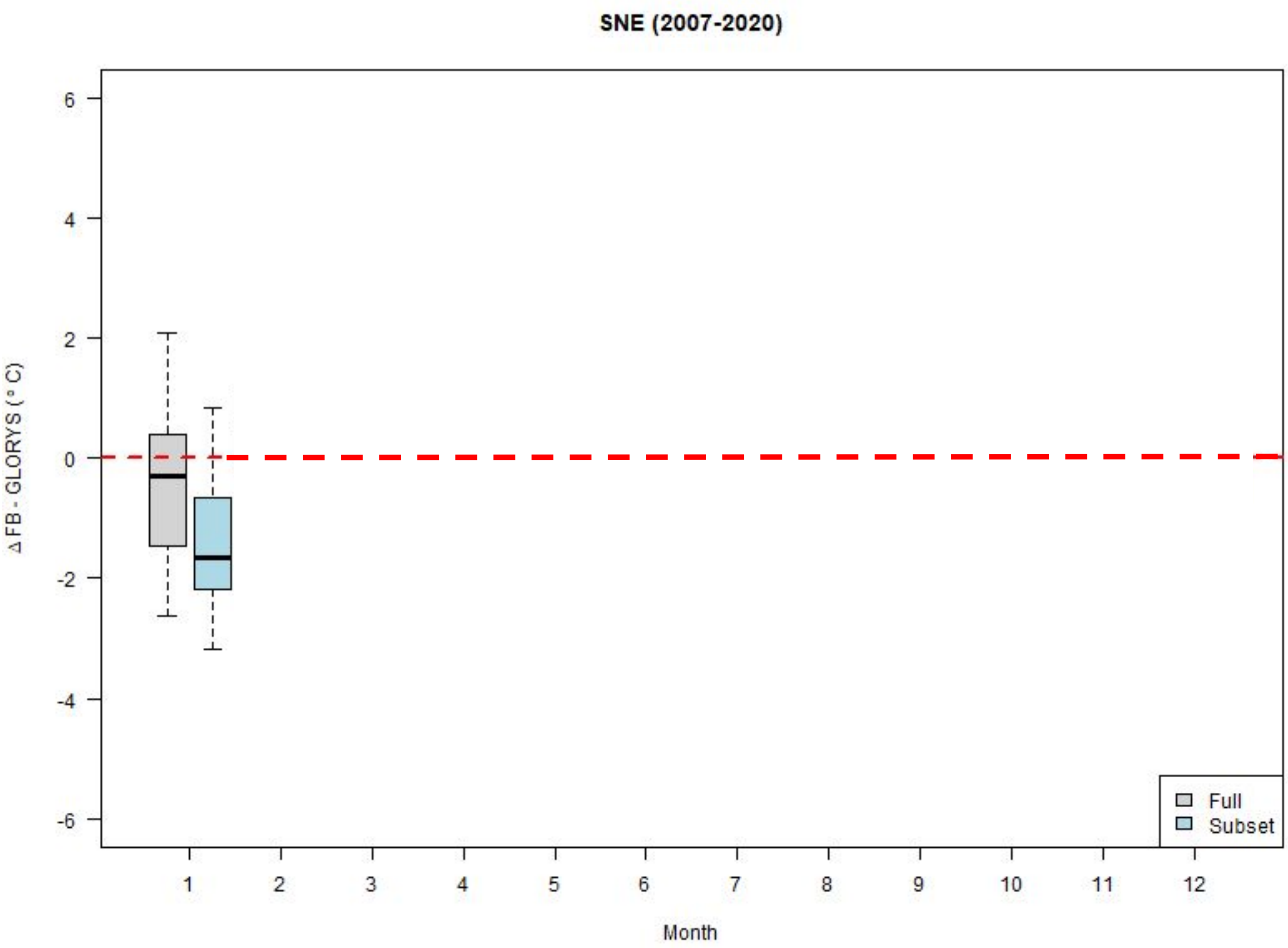



GOM_East
GOM_West
GB
SNE
MAB


25% of the data are **above q3,**
in the **box** we find **50%** of our data
and **25%** of the data are **below q1.**
80
60
40
20

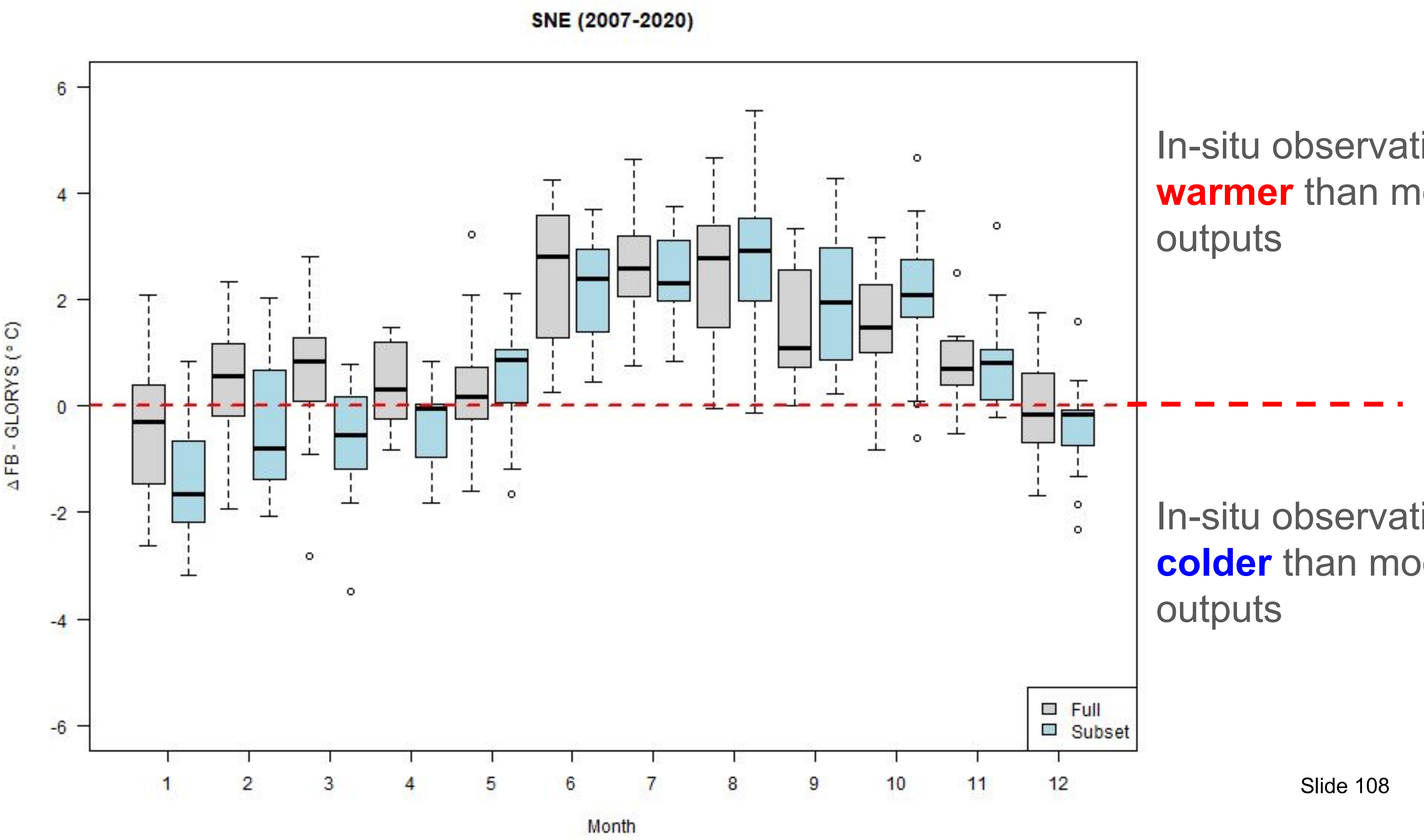

GOM_East
GOM_West
GB
SNE
MAB


80
60
40
20
q1
The solid line
indicates the
median.



In-situ observations **warmer** than model outputs

In-situ observations **colder** than model outputs



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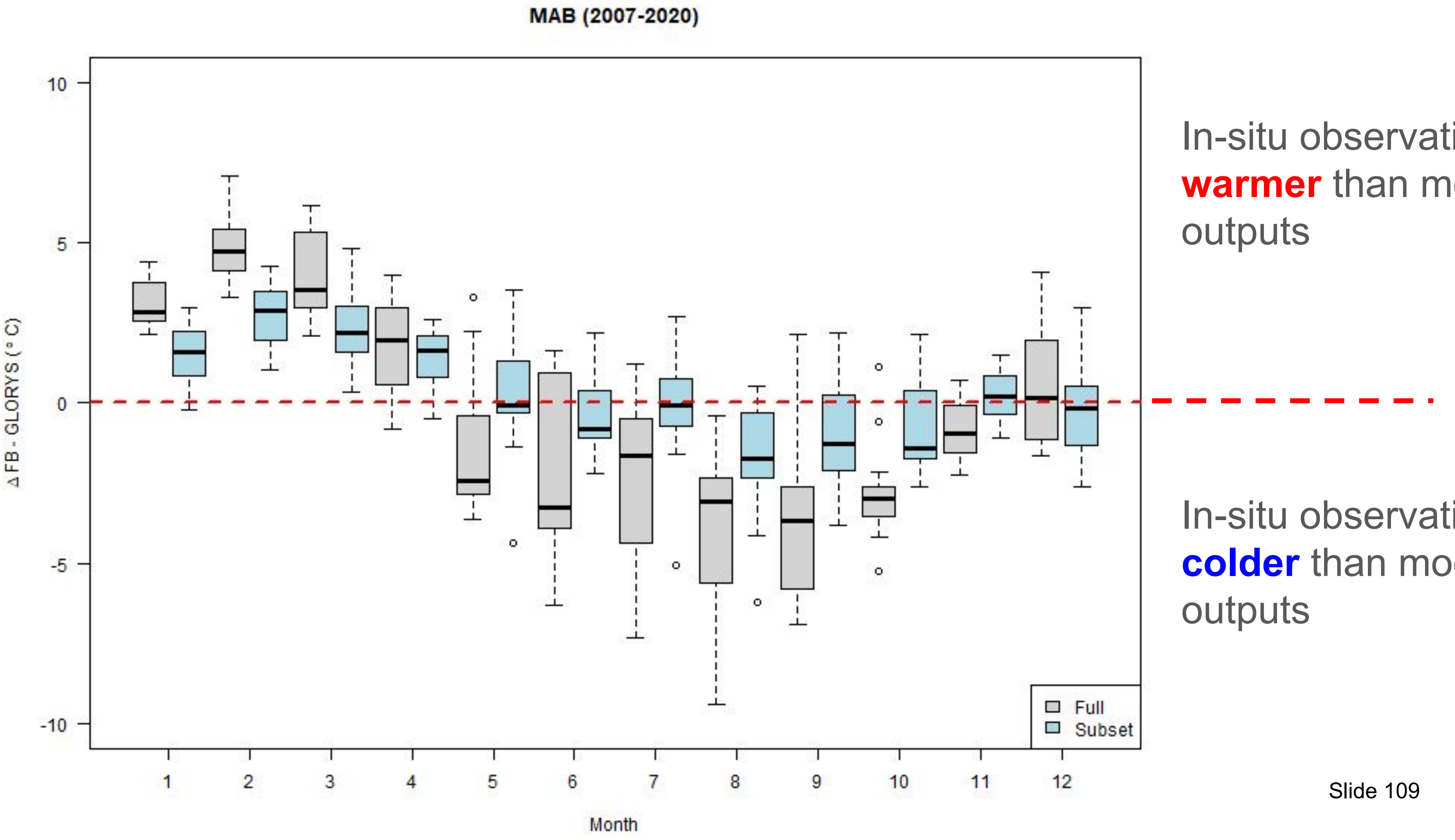

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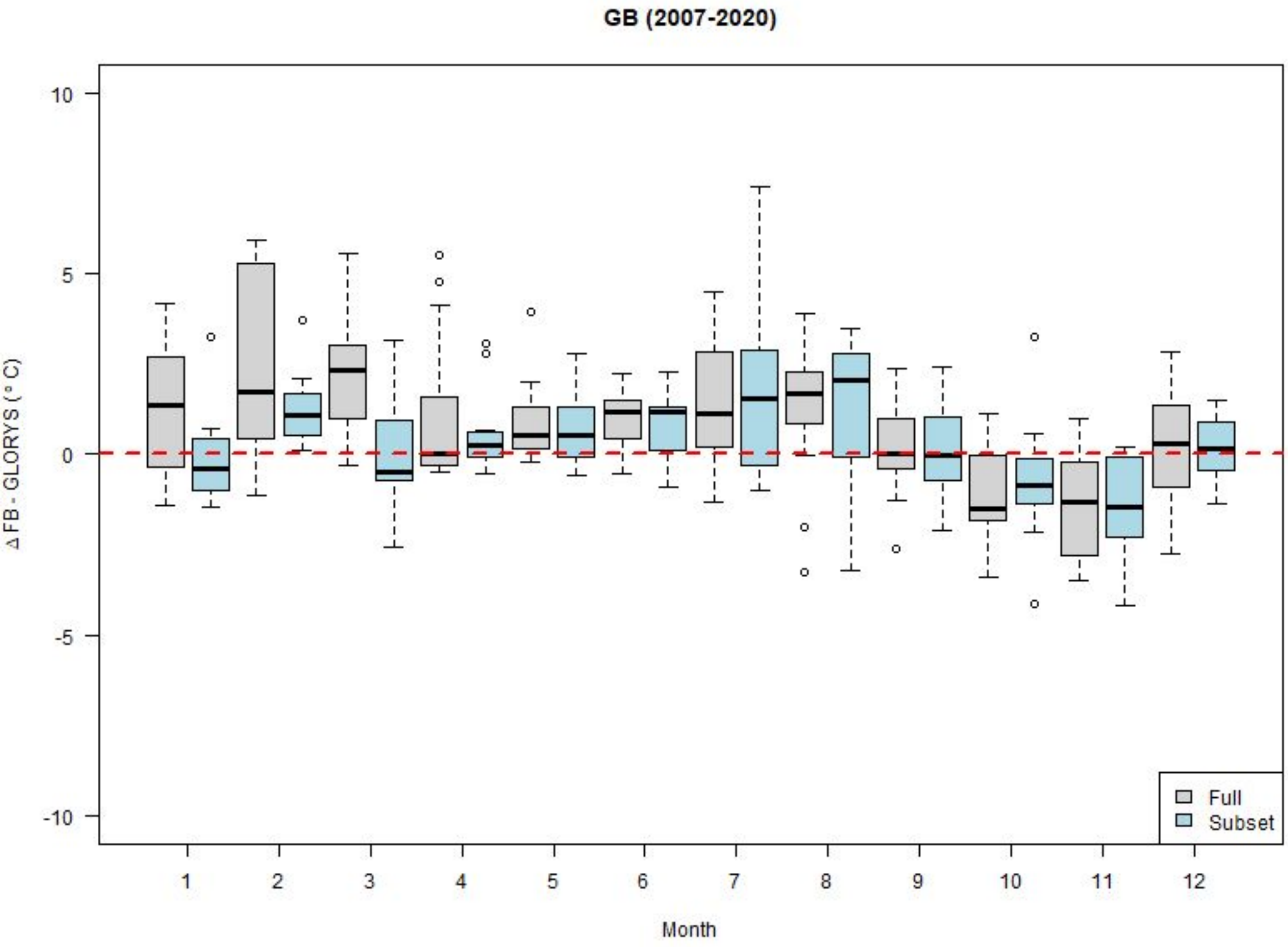


In-situ observations **warmer** than model outputs

In-situ observations **colder** than model outputs

Questions?

Discussion Prompts

CHANGES OVER TIME

- What kind of changes have you seen and has that changed how you work

- How are your data needs shifting over time? Are these different across seasons?

SCALE

What space and time scales are important & interesting to you?

- Just your fishing ground? Your lobster zone? Entire Gulf?
- tidal, daily, weekly, monthly, seasonal, annual, decadal?

TOOLS & DELIVERY FORMATS

- How do you most **prefer** to get information about ocean conditions?
  - Websites/Portals, Apps, Email updates, Newsletters mailed to you, Texts, Social media

INFORMATION USE PURPOSES

- What kind of information do you rely on before heading out and when you are out on the water—and what do you wish you had more of?

- How does the ocean data provided influence your on-water decisions?

- What data do you wish existed?

- How do your data needs shift under different regulations (e.g., if the gauge increase had gone into effect, would that change any ocean data needs)?

- What models do you rely on?

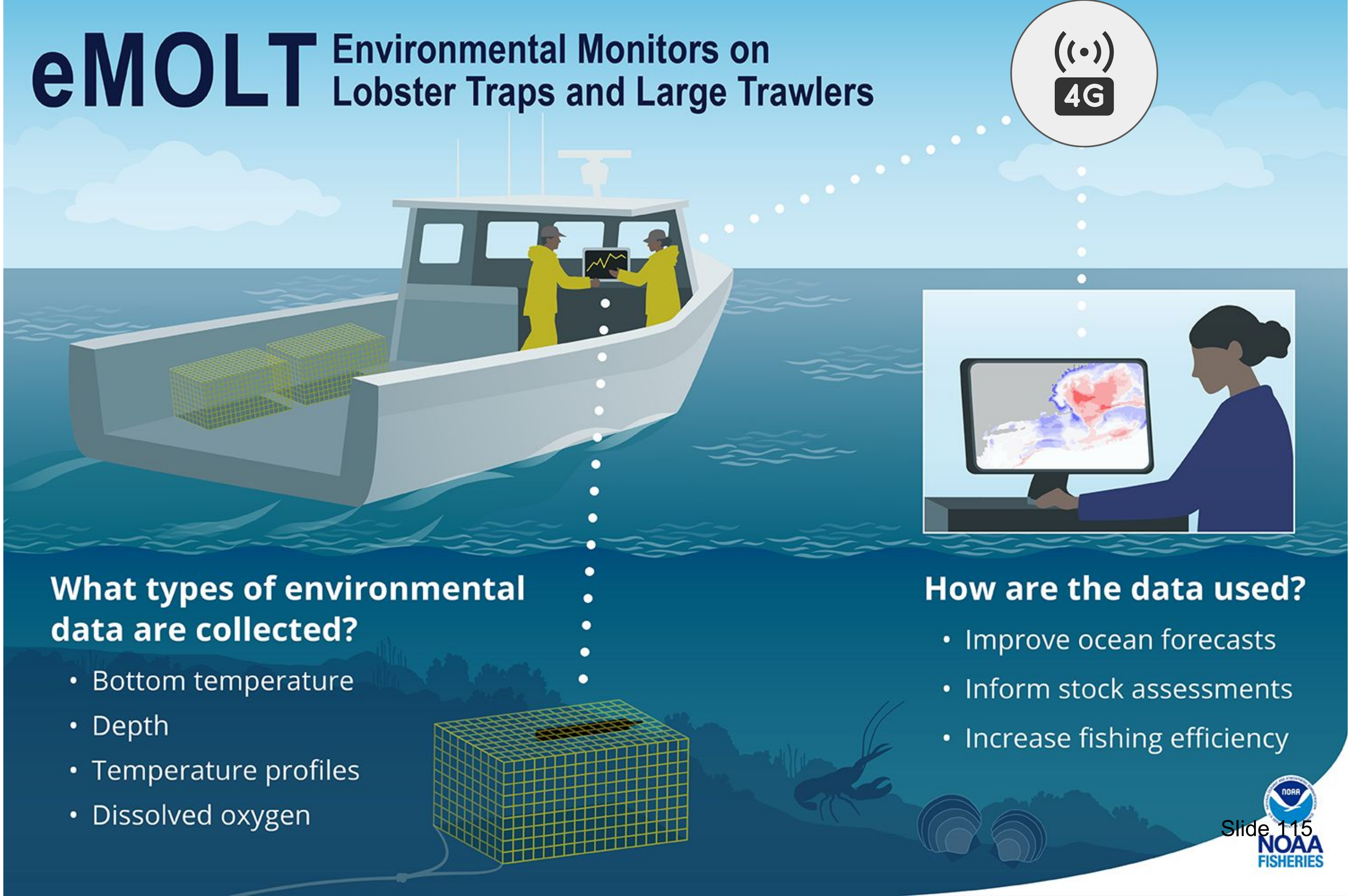
- Are there examples of when ocean data confirmed something you had previously thought was happening? What about vice versa, where the data was different than you thought it would be.

We are breaking for Lunch - See you all at 1:00 PM

eMOLT

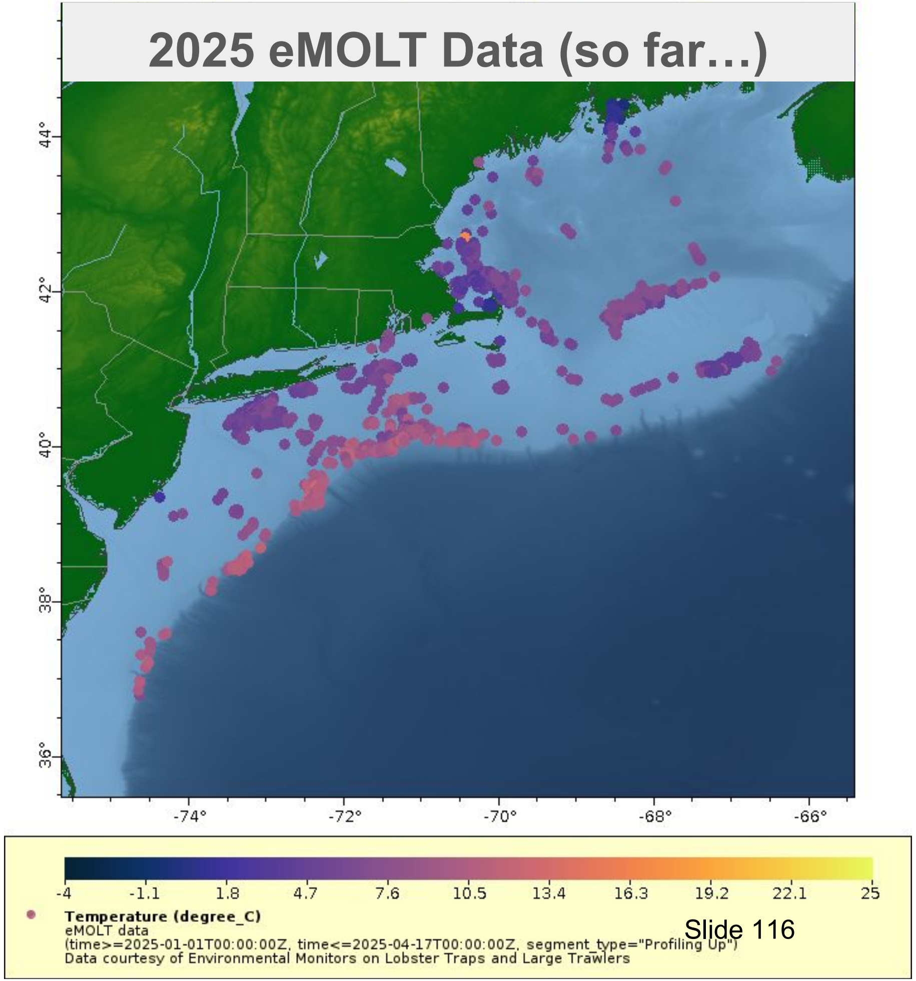
The Environmental Monitors on Lobster Traps and Large Trawlers Program

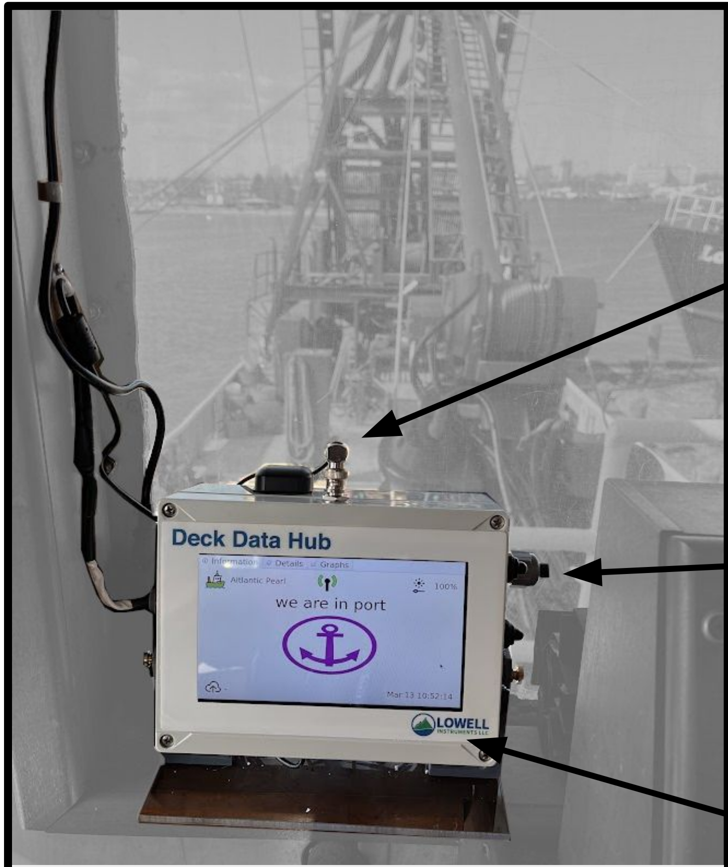
Democratizing Ocean Observing Since 1996


eMOLT
Environmental Monitors on Lobster Traps and Large Trawlers
4G
What types of environmental data are collected?
• Bottom temperature
• Depth
• Temperature profiles
• Dissolved oxygen
How are the data used?
• Improve ocean forecasts
• Inform stock assessments
• Increase fishing efficiency
NOAA
NOAA FISHERIES

Program Stats

- 95 vessels contributed data so far this year
- Home ports from Maine to Maryland
- Nearly every commercial fishery in the Northeast is represented
    - Lobster
    - Gillnet
    - Longline (tub-trawl, tilefish, pelagic)
    - Fish pots
    - Bottom trawl
    - Scallop dredge
    - Clam dredge
- Over 30,500 instrumented tows since 2018
- Nearly 22 million individual data points since 2018



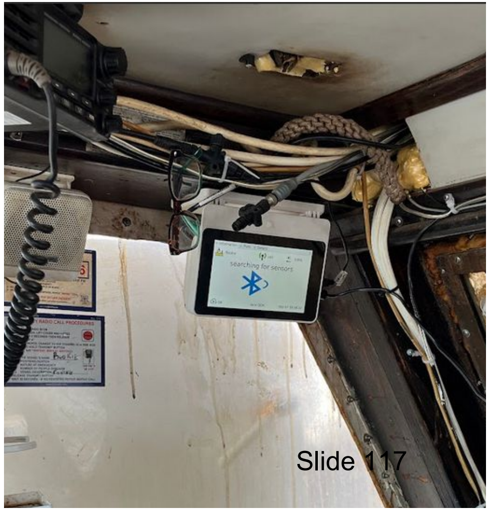


F/V Atlantic Pearl

GPS Receiver

Optional Bluetooth Extension

Touchscreen Deck Box



Extensive Partner Network

The eMOLT program relies on over 100 participating vessels to collect data at sea. These vessels are supported by field teams at organizations around the region, hardware built in Massachusetts and New Zealand, and computer infrastructure hosted by the Gulf of Maine Lobster Foundation with technical support from Ocean Data Network in Portland, ME.









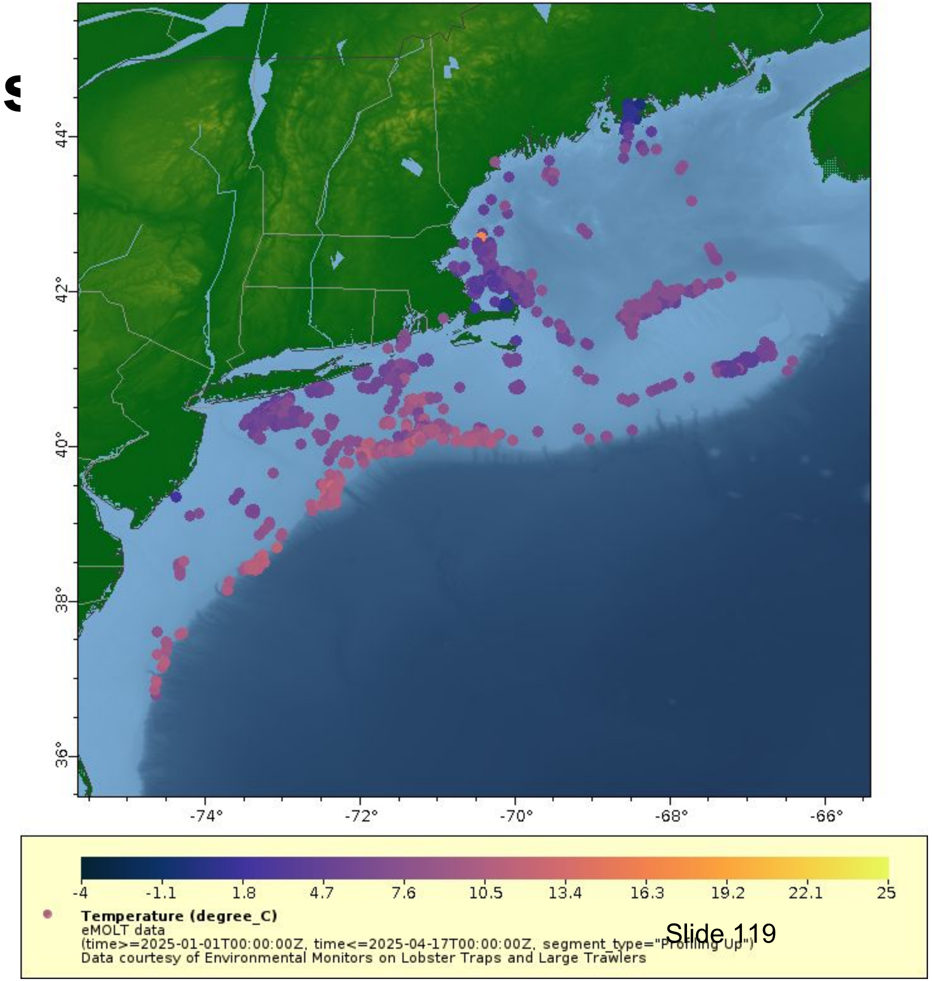


Frequently Asked Questions

- **Doesn't eMOLT just work with lobstermen?**
  Although the eMOLT program initially worked exclusively with lobstermen, we now work with vessels in almost every fishery in the region using a variety of mobile and fixed gear.

- **What data are made public?**
  We provide location and environmental data to scientists (see example to the right). On request, we will also provide information about the sensor used to collect the data. We do not make vessel information, gear type, or contact information public. Fishermen are always allowed access to all data collected aboard their own vessel and can share it with whomever they wish.

- **What does it cost?**
  We provide the instruments and data free of charge to our fishing industry partners. Data are made publicly available free of charge. The eMOLT program is supported by grants and Federal funding through the Northeast Fisheries Science Center.



NERACOOS

NORTHEASTERN REGIONAL ASSOCIATION OF COASTAL OCEAN OBSERVING SYSTEMS

April 17, 2025

Climatology Data Products

Riley Young Morse

Gulf of Maine Research Institute

NERACOOS DMAC

Are water temperatures warmer this year?

March 30

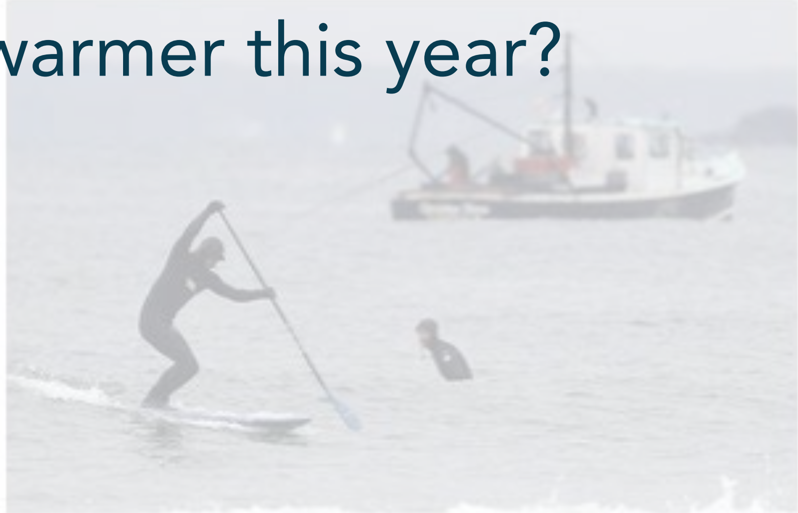
Gulf of Maine warming worries scientists

Rising water temperatures in the Gulf of Maine have some scientists concerned about the impact on ocean life -- and the ripple effects.

CLARKE CANFIELD / The Associated Press

This winter's warmth has helped drive up water temperatures in the Gulf of Maine, and the warm waters could lead lobsters to molt their shells and ocean algae to bloom earlier than usual.

The continuing trend raises long-term questions about how rising ocean temperatures might affect the growth and reproduction cycles and distribution of fish and shellfish, whales, zooplankton and other marine life throughout the gulf.



click image to enlarge

A paddle surfer prepares to catch a wave while lobster fishermen work in the background Thursday at Higgins Beach in Scarborough. Water temperatures in the Gulf of Maine have been rising in a way that is similar to a spike that occurred in the 1950s, though scientists are not certain if the rapid warm-up will be followed by cooling as it did six decades ago.

Temperature affects all life processes, but it's too soon to say whether changes brought on by rising water temperatures will be good or bad, said Jeffrey Runge, a biological oceanographer at the University of Maine and a researcher at the Gulf of Maine Research Institute in Portland.

We look at two decades of hourly observations

How do we approach this?

- The buoys have two decades of continuous observations from multiple parameters, depths, and locations
- We can look at the full dataset to understand what "normal" looks like
- We can then compare recent conditions to the "normal" or expected range (or **Climatology**)
- And visualize the information into a data product
- And answer that question…and more…

Is the water warmer this year than last year?

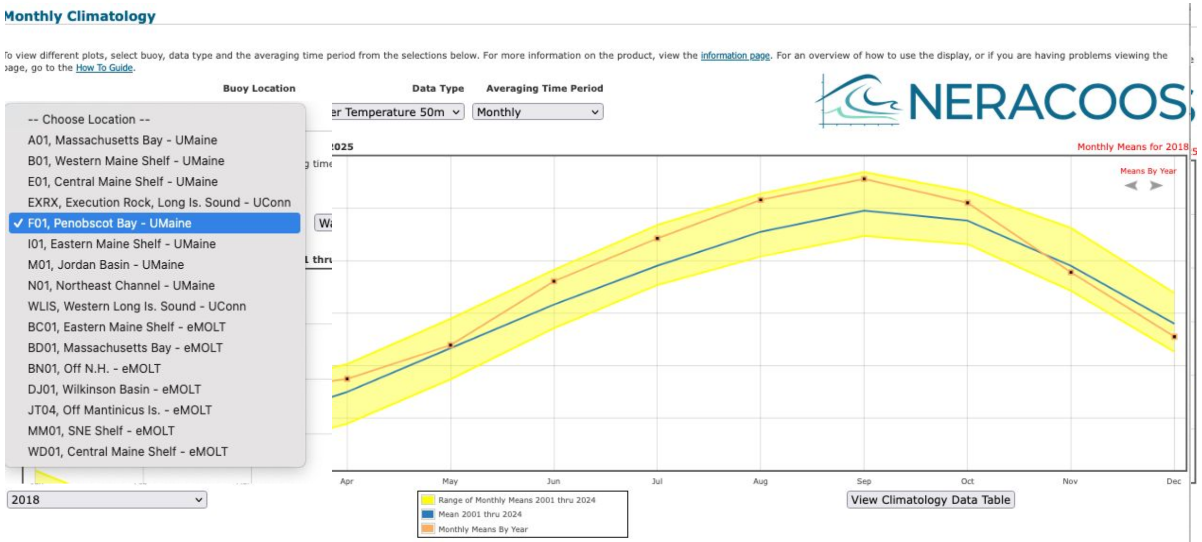
What do we mean by Climatology?

Climate in a narrow sense is usually defined as the **"average weather,"** or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years. (WMO definition)

Original Climatology Product

- Developed in 2013 with data partners at UMaine and UConn
- Adapted a standard procedure from WMO for data preparation and statistical calculations
- Buoys were limited to ~10 years of data, so the normal periods are continuously recalculated
- Can look at daily or monthly scale
- Change location, variable, depth

https://p5.neracoos.org/products/clim_test/drupal_clim.html

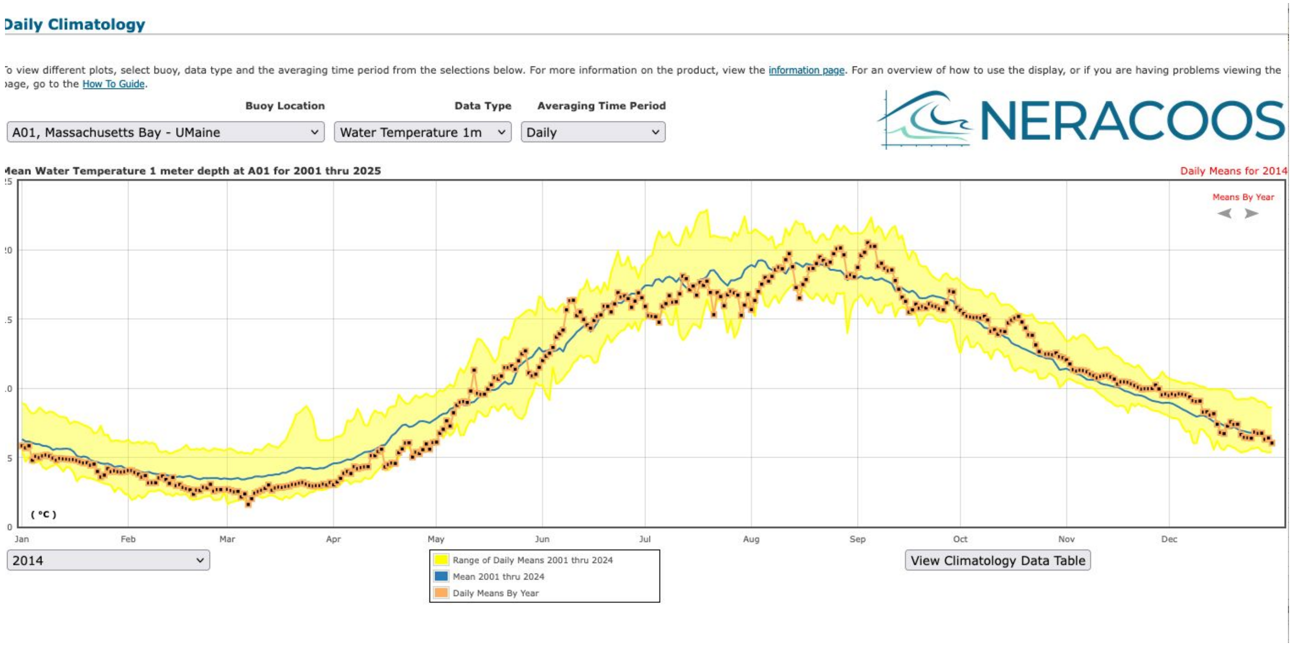


Daily Climatology Values for 2001 - 2025 (°C)

Month	Day	Mean (2001 - 2025)	Min (2001 - 2025)	Max (2001 - 2025)	Daily Means for 2012
Jan	1	4.9042	3.1065	6.3423	6.3423
Jan	2	4.8408	3.3706	6.4057	5.9405
Jan	3	4.7256	3.1685	6.427	5.8745
Jan	4	4.4563	2.3808	6.573	5.5695
Jan	5	4.3166	2.1554	6.5551	4.3424
Jan	6	4.1854	2.42	6.7284	4.5789
Jan	7	4.2252	2.8298	6.7977	4.8943
Jan	8	4.1425	2.4706	6.7588	4.8594
Jan	9	4.1626	2.6477	6.6975	4.6447
Jan	10	3.9545	2.4533	6.2175	4.7105
Jan	11	3.9457	2.2918	5.8576	5.0975
Jan	12	4.0046	2.5398	5.6585	5.3018
Jan	13	3.9771	2.504	5.7761	5.2107
Jan	14	4.0023	2.603	5.8959	5.0766
Jan	15	3.9195	2.263	5.7604	4.9559
Jan	16	3.6473	1.6041	5.3697	4.7352
Jan	17	3.3333	1.5312	4.8754	4.6727
Jan	18	3.2433	1.4938	4.7302	4.7302
Jan	19	3.2885	0.7874	5.1456	4.5297
Jan	20	3.2054	1.3114	5.0526	4.5148
Jan	21	2.9828	1.6885	4.8747	4.2404
Jan	22	2.7821	0.6319	4.7804	4.0804
Jan	23	2.8292	0.4133	4.9196	3.7556
Jan	24	2.7605	0.5464	4.6245	3.9269
Jan	25	2.6588	1.2057	4.5248	3.8395
Jan	26	2.5056	0.9551	5.0265	3.7859

Climatology - Old Methodology

- For each site/sensor/depth
  - Daily Climatology (min/max/mean)
  - Monthly Climatology (min/max/mean)
  - Daily Average
  - Monthly Average
- Creates individual files for each site/sensor/depth
  - Set constraints for data thresholds (from WMO)
    - Daily – 18 observations per day to count (3/4 of hourly)
    - Monthly – 20 complete days (2/3 of daily observations)
    - This removes incomplete days or months from gaps in the data



Limitations to Old Climatology

- Relies on data provider to produce climatology files and send to us
- Viewer running on legacy code/server and limited updating capability
- Data processing and file management doesn't scale (add new stations)
- Except for UMaine, data is not updated
  - UMaine data
    - UMaine continues to run the daily/monthly climatology files for all the buoys
      - ~450 files to maintain/transfer in addition to RT/historical data
  - UConn
    - One pilot station (WLIS) haven't maintained
  - UNH, URI
    - No climatology data being produced, active project to produce CO_2 and WQ climatologies
  - eMOLT (7 Sites)
    - Data from 2012-2017, sites identified in GOMLF project are not the same

New Methodology

- Developed process to generate climatology data at NERACOOS
- Source data from common platform – ERDDAP (data server)
- Makes adding and configuring stations easier to manage
  - Set up platform, time series, constraints (QC flags, variable, location)
- Lightweight visualization tool that can retrieve/process data quickly
- Calculations are done on the fly based on user selection
  - By platform, data type, depth, year, average time period (daily/monthly)
- Additional features
  - Adjust year range of normal period climatology
  - Adjust threshold configuration (# of obs to count for daily, useful for dataset that have fewer daily observations – CO_2 data)
  - Data table shows daily means (of selected year), Mean/Max/Min of date range, date when Min or Max daily value occurred, can download data and plots

New Beta Climatology Viewer

Platform: eMOLT_PTW

Data Type: Water Temperature

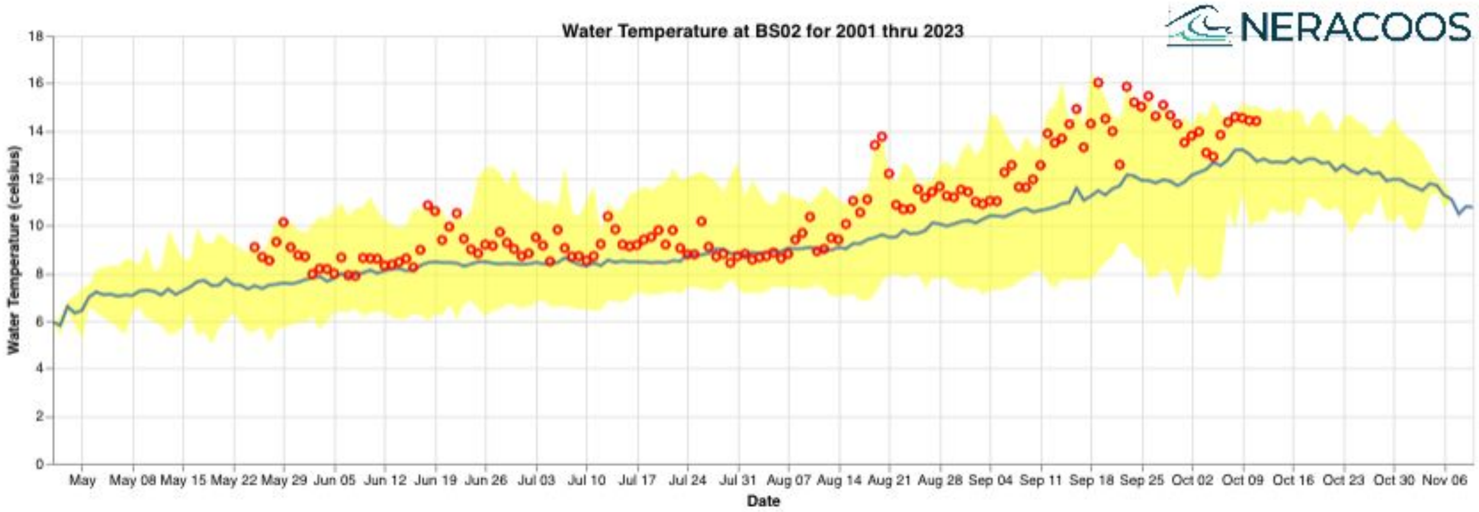
Select a year to display: 2022

Select a year to start generating the climatology: 2001

Select an end year for the climatology: 2023

Averaging Time Period: Daily

Threshold configuration



Platform on Mariners Dashboard

Dataset on ERDDAP

Climatology calculated from 2001 to 2023

Show data

2025-01-01	7.52	6.68	8.53	6.04	2009-01-01	2007-01-01
2025-01-02	7.51	6.62	8.42	5.67	2009-01-02	2012-01-02
2025-01-03	7.48	6.56	8.2	5.59	2009-01-03	2012-01-03
2025-01-04	7.18	6.37	7.8	5.3	2008-01-04	2007-01-04
2025-01-05	6.89	6.36	7.83	5.04	2008-01-05	2007-01-05
2025-01-06	6.68	6.35	8.01	5.28	2009-01-06	2007-01-06

.org/climatology

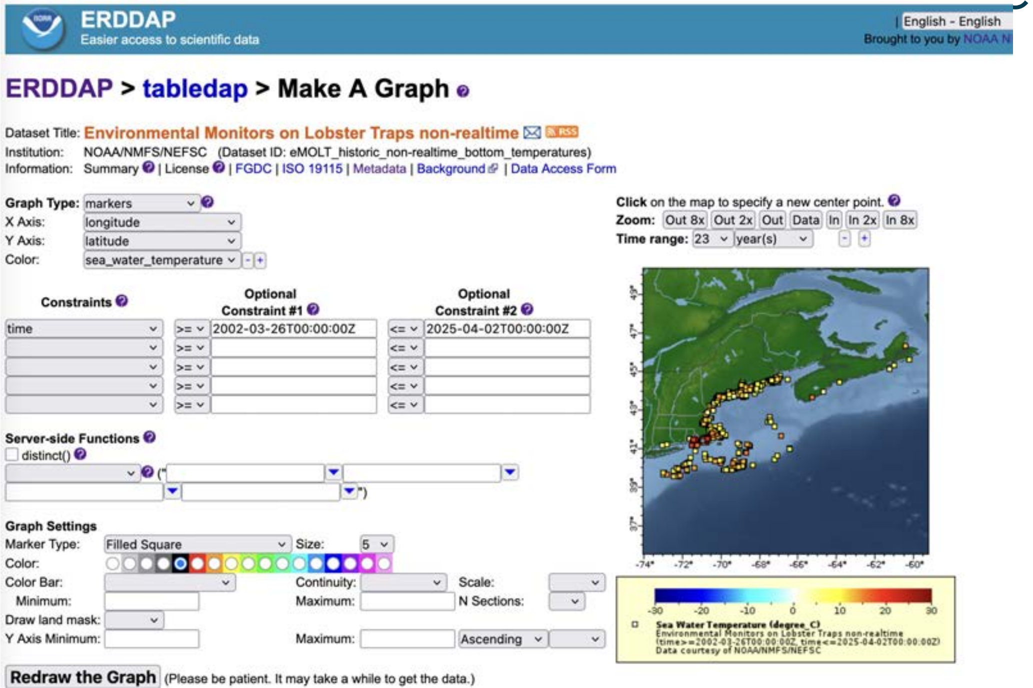
NERACOOS

Next steps

- Add and configure additional stations/platforms
- Refine product feature enhancements and implement additional functionality (with users!)
- Develop processing and visualization approach for directional data types (e.g., wind, wave, and current direction)
- Develop additional calculations
  - e.g., heat and cold waves – when daily average temps are above/below a known threshold and persist

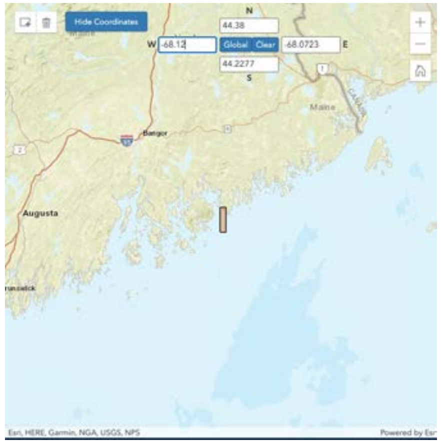
Adding eMOLT Sites

- The full historic record of eMOLT bottom temperature data is managed by the Northeast Fisheries Science Center
- It's available publicly through a data server - NEFSC ERDDAP
  - https://comet.nefsc.noaa.gov/erddap/tabledap/eMOLT_historic_non-realtime_bottom_temperatures.html
- In 2021 the station/vessel ID was removed from the dataset
- Jim Manning identified 6 long term (ongoing) sites as candidates for climatology

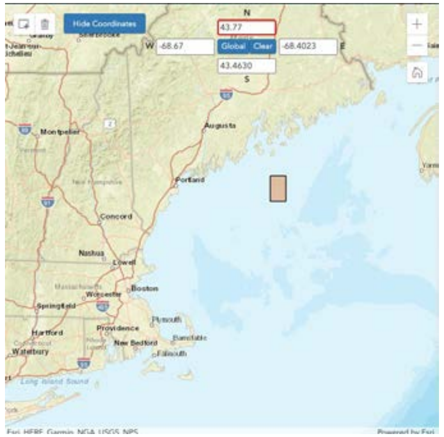


eMOLT Sites – Bounding Boxes associated with sites

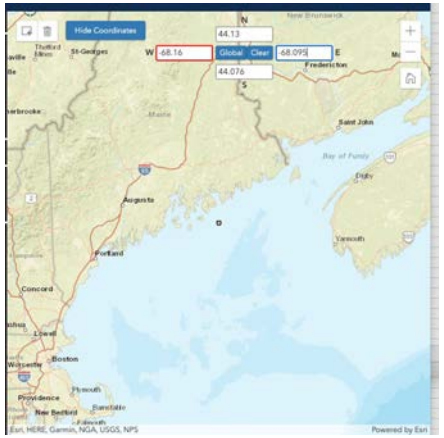
BF01 – Downeast ME



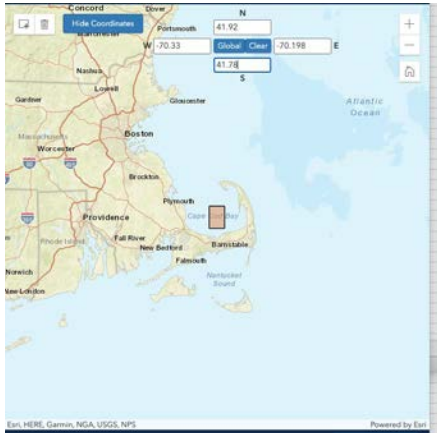
JT04 – Midcoast ME



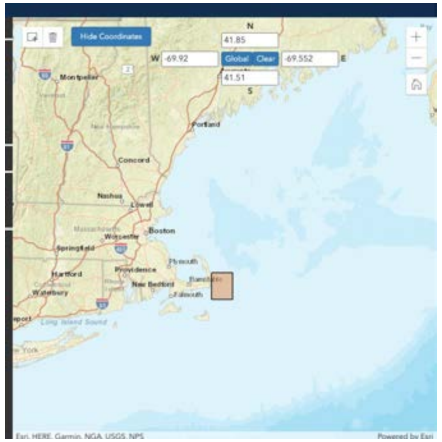
CJ01 - Downeast ME site 2



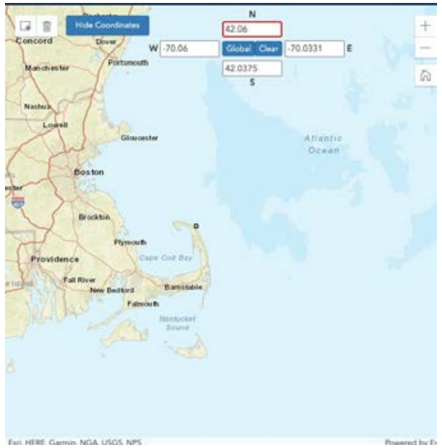
DK01 – Cape Cod Bay



JA01 – Outer Cape Cod



BS02 – Off Provincetown MA



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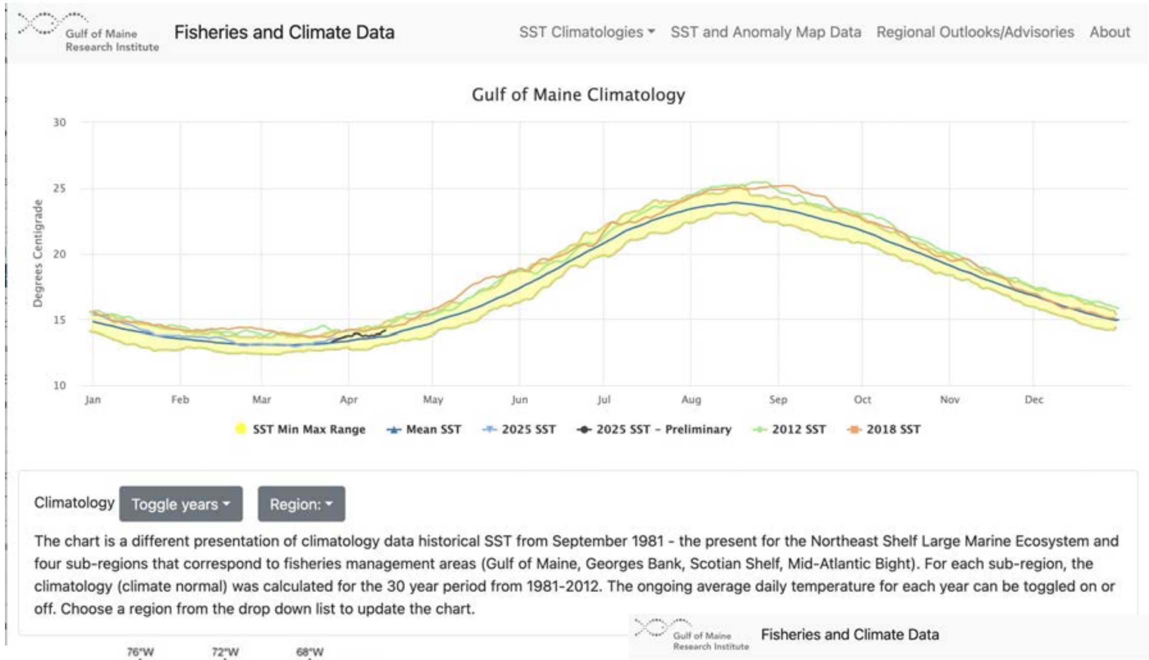
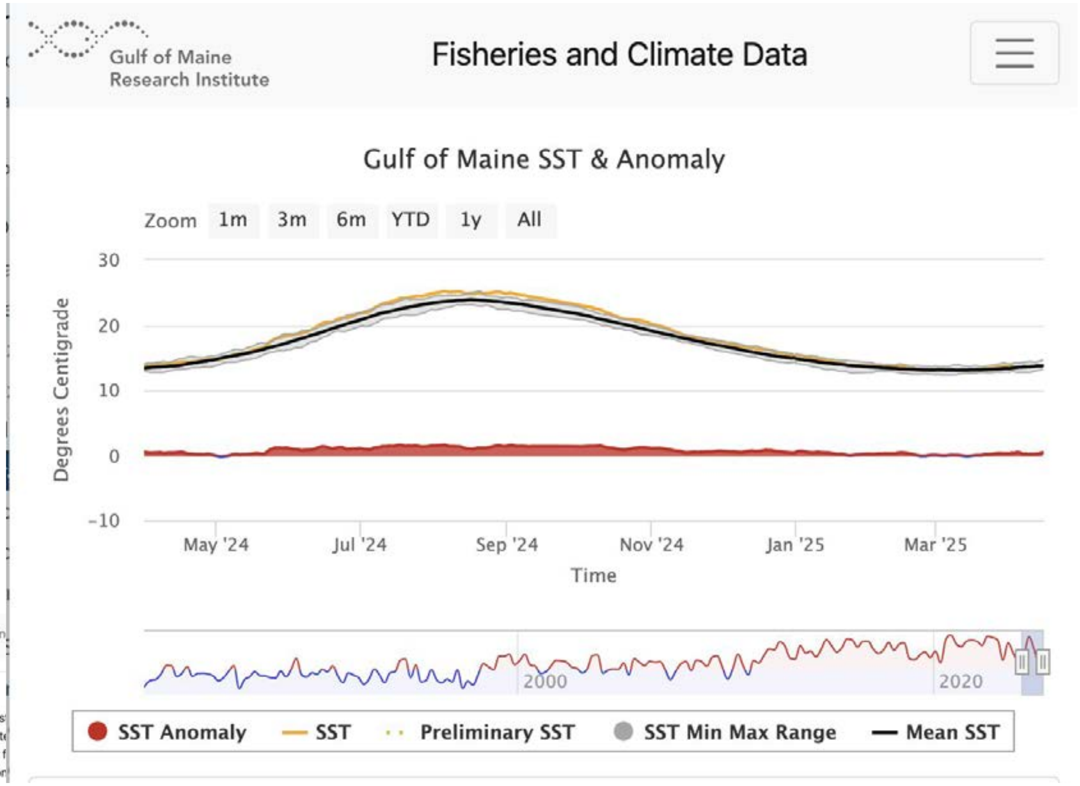
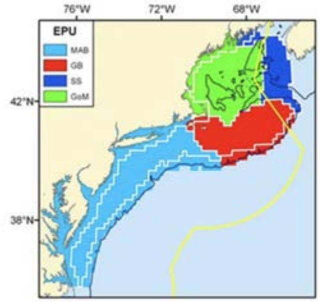
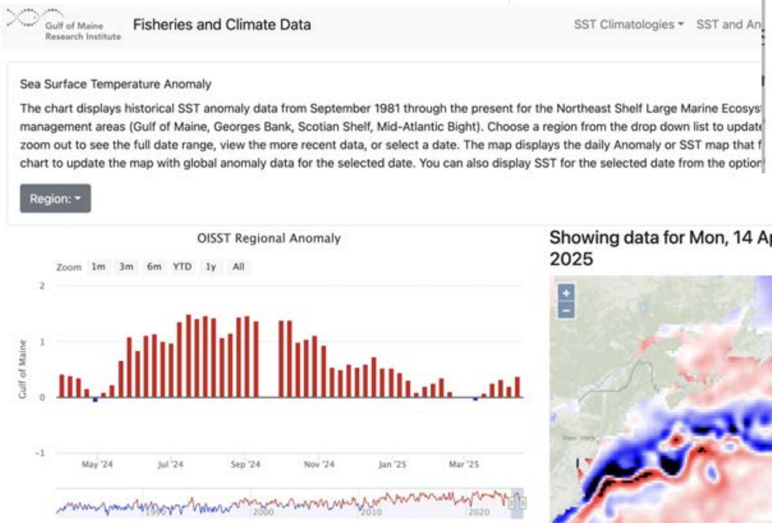
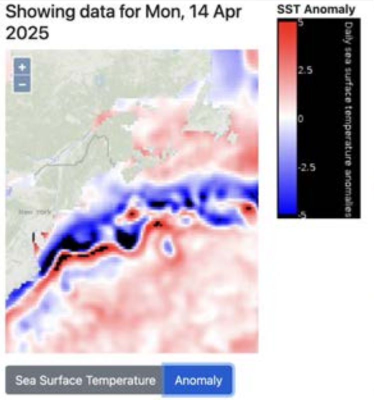


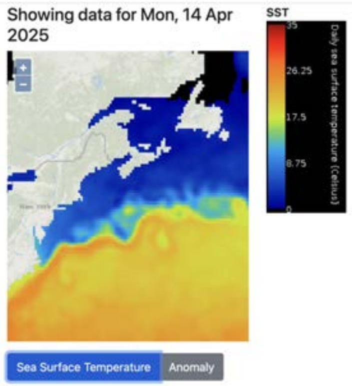




Ecological Production Units for the NE U.S. Continental Shelf







Climatology of Gulf of Maine and sub regions from NOAA OISST satellite daily sea surface temperature

Thank you!

Bring questions to the breakout session!