

# Data, Analytics, Visualization

## *The Three -Legged Maritime Domain Awareness Stool*

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# Data, Analytics, Visualization

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*The Three -Legged Maritime Domain Awareness Stool*

**GIS provides us the universal visual language...**

**...to help make million dollar 'go/no go' decisions safely and efficiently.**

**Common Operating Picture**

*delivers*

**Maritime Domain Awareness**

*creates*

**Actionable Intelligence**

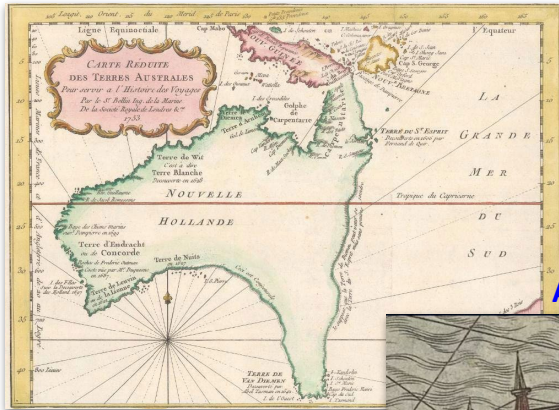
# Presentation Overview

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- Maritime Domain Awareness
- MetOcean Challenges in the Gulf of Mexico
- Eni Requirements
- Fugro: Loop Current Monitoring & Forecasting
- 40Geo: Raptor MetOcean Dashboard

# Maritime Domain Awareness

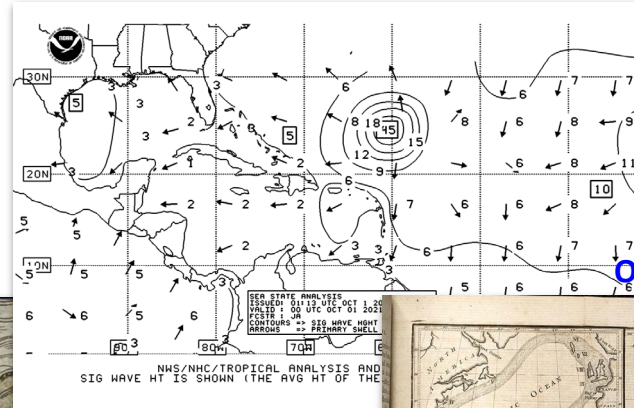
Discovery<sup>1</sup>



Aids to Navigation<sup>2</sup>



Meteorology<sup>3</sup>



Oceanography<sup>4</sup>



<sup>1</sup>Jacques-Nicolas Bellin (1703-1772)

<sup>2</sup>Chet Van Duzer - Sea Monsters on Medieval and Renaissance Maps

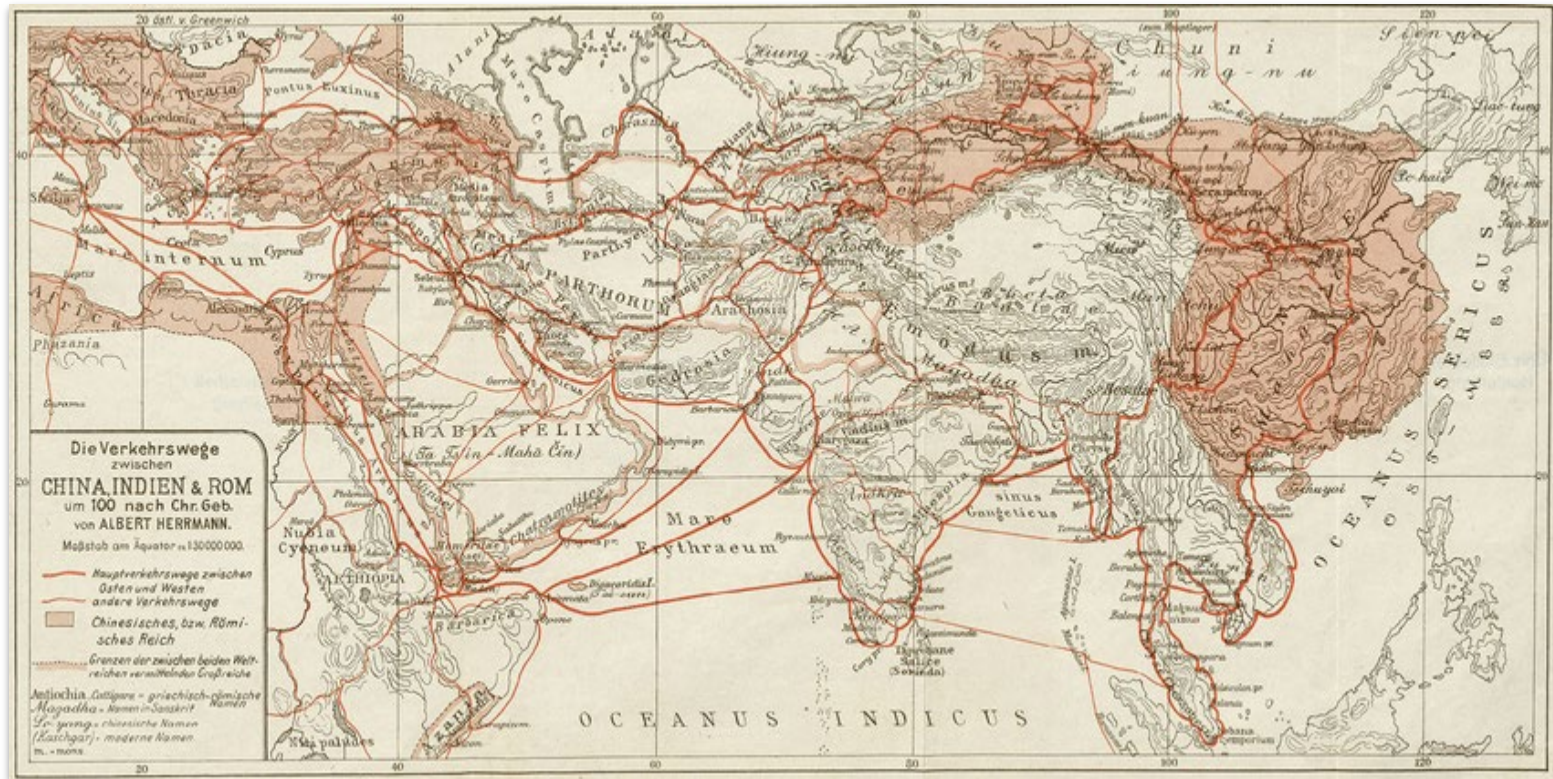
<sup>3</sup>NOAA National Weather Service Radiofax Chart

<sup>4</sup>Franklin-Folger chart of the Gulf Stream



# Maritime Domain Awareness

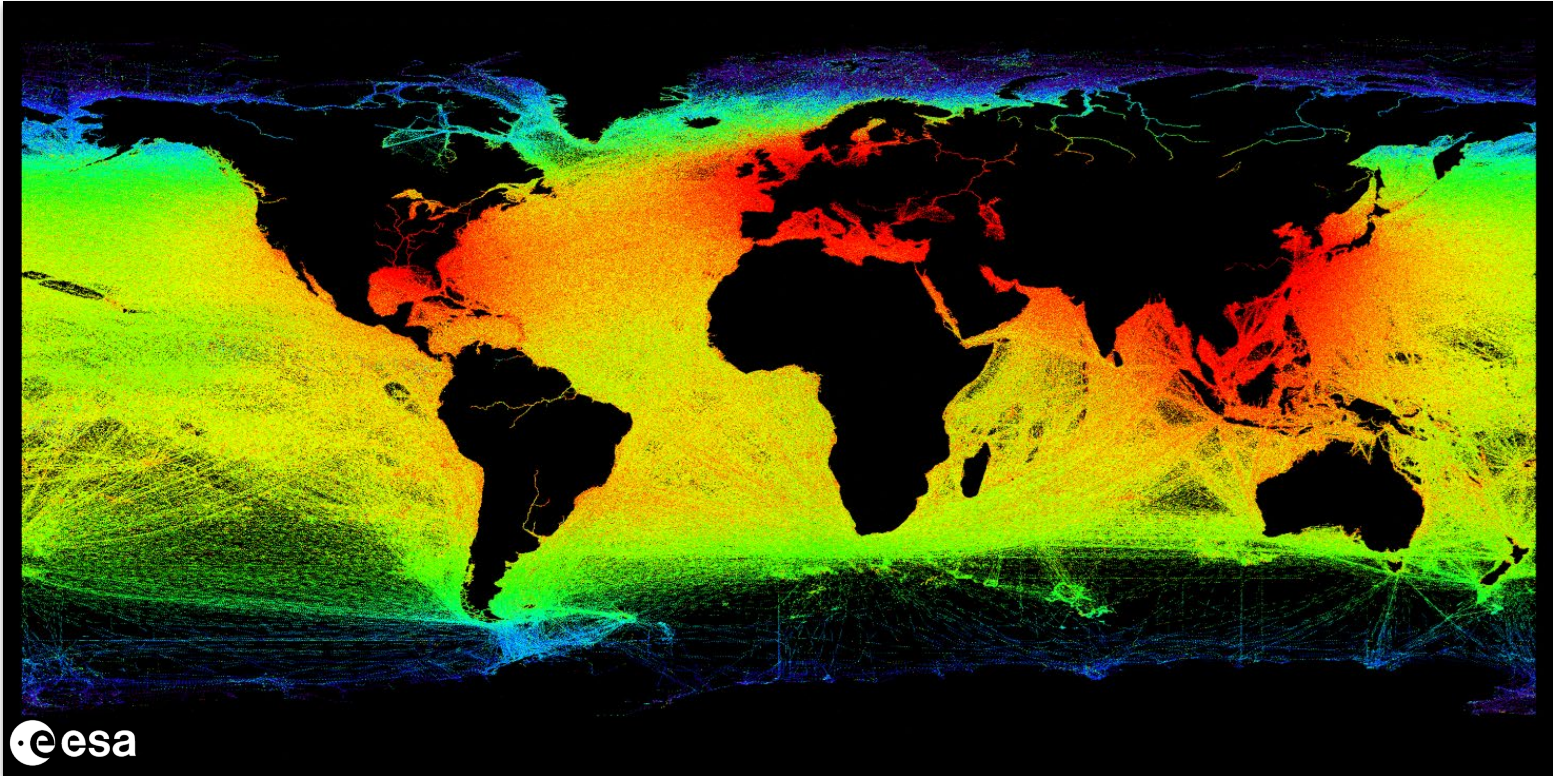
## Trade



Map of the Silk Roads (Herrmann, 1922)

# Maritime Domain Awareness

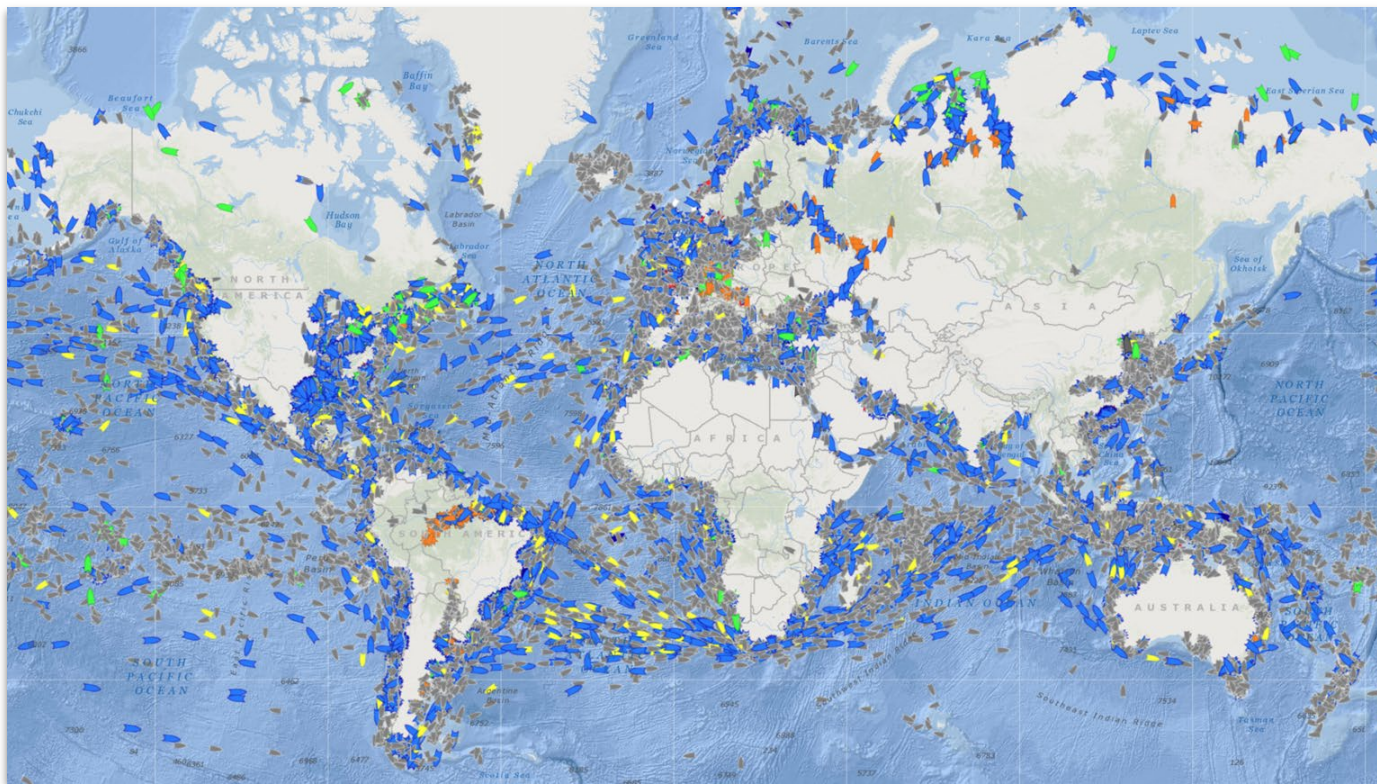
*~90% of goods are transported via water*





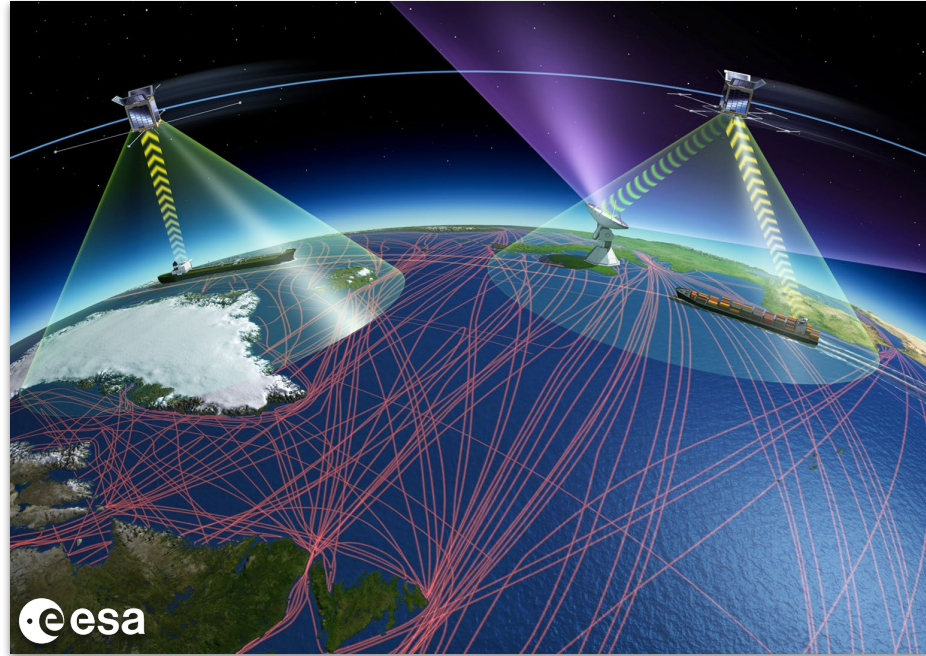
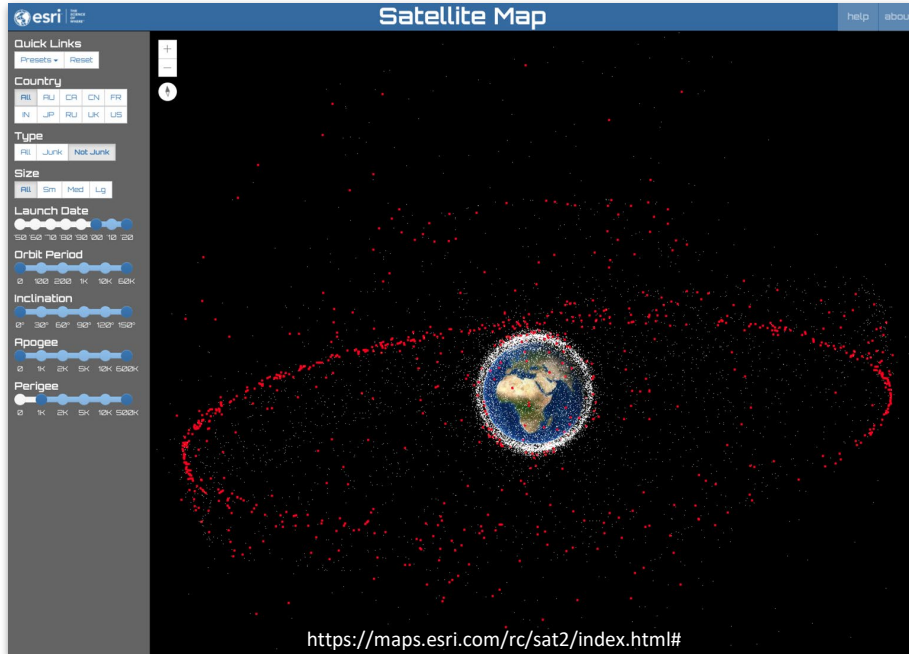
# Maritime Domain Awareness

*Location. Location. Location.*



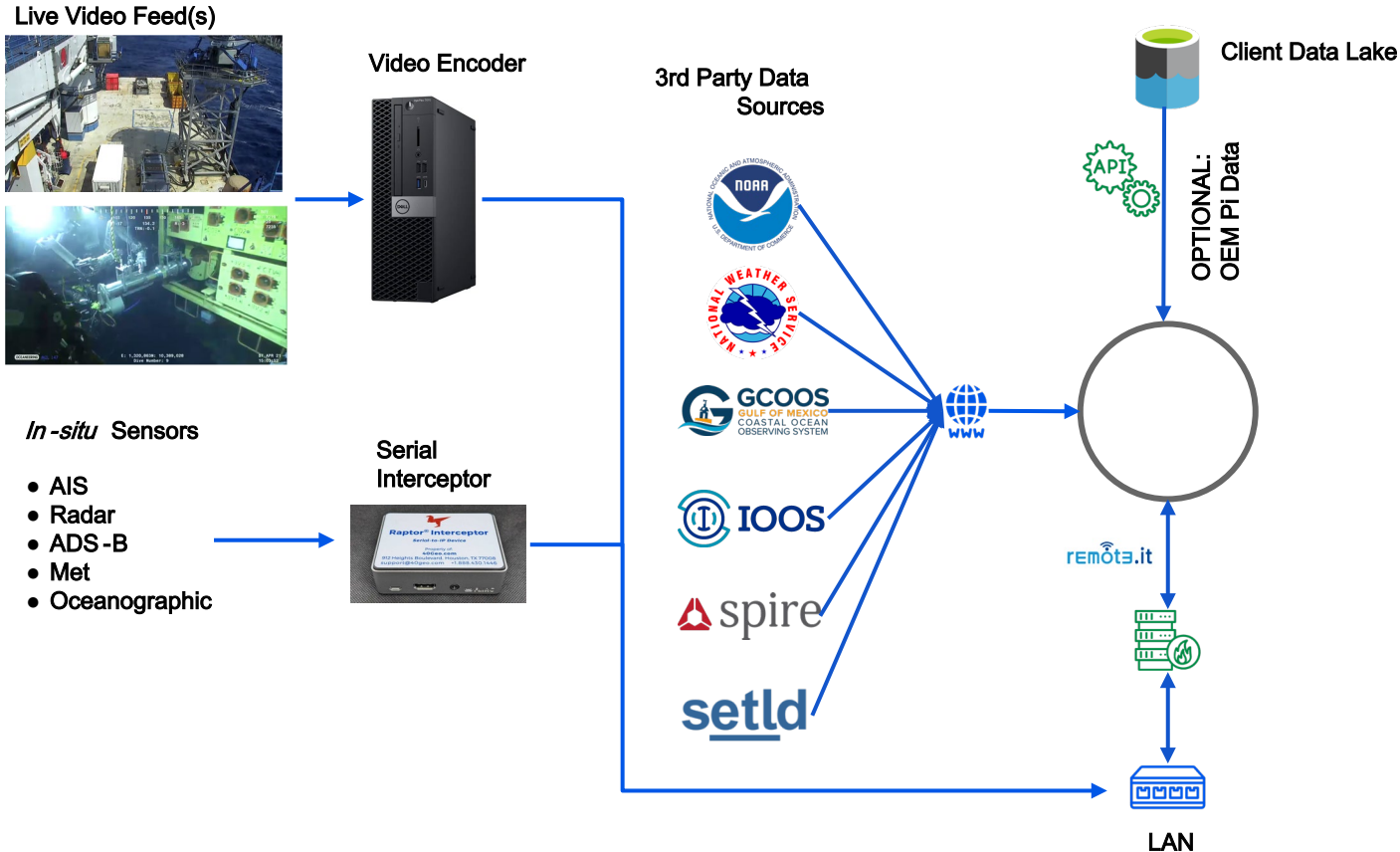
# Maritime Domain Awareness

*Global Positioning System + Automatic Identification System*



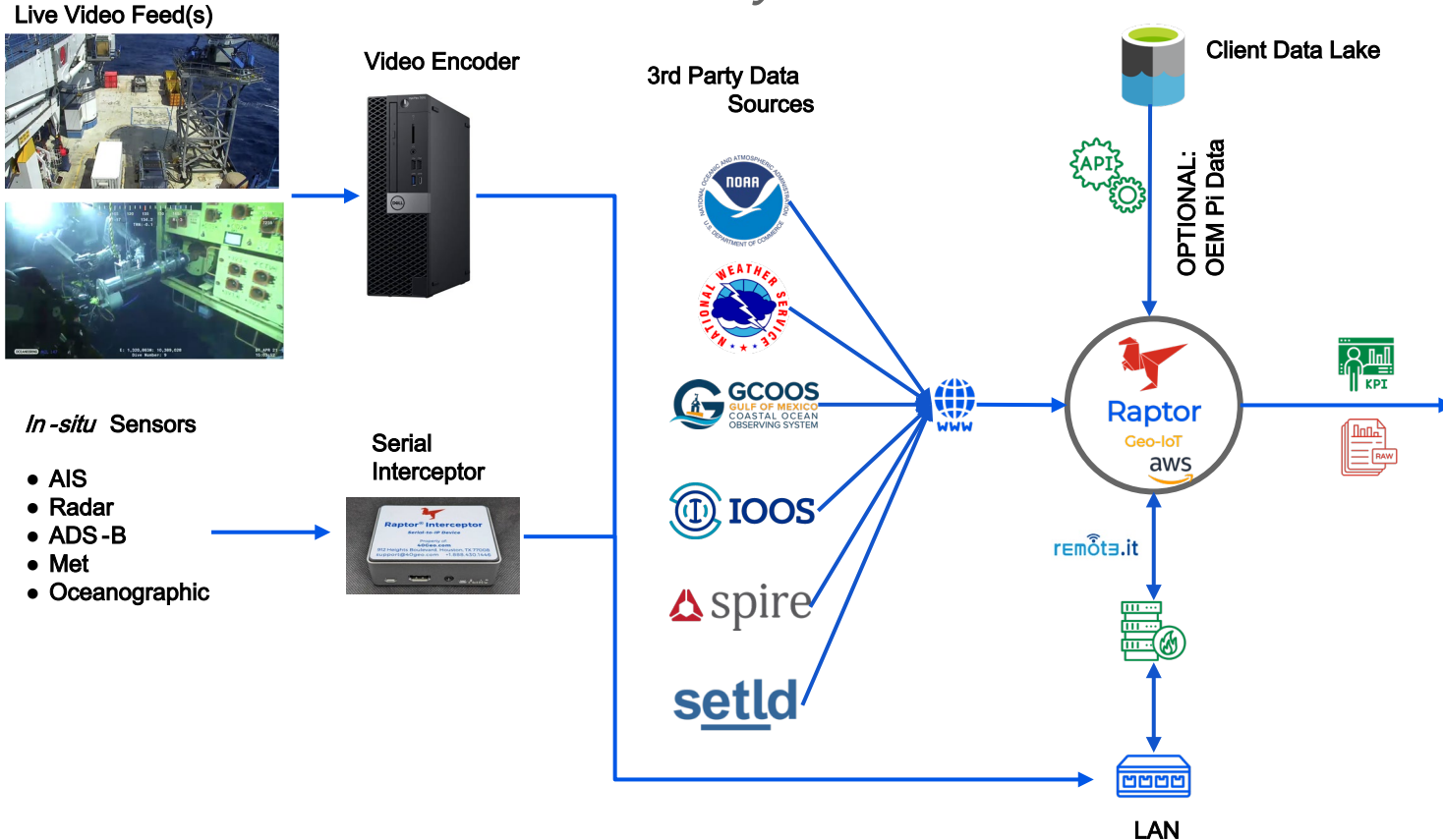
# Maritime Domain Awareness

## *Data.*



# Maritime Domain Awareness

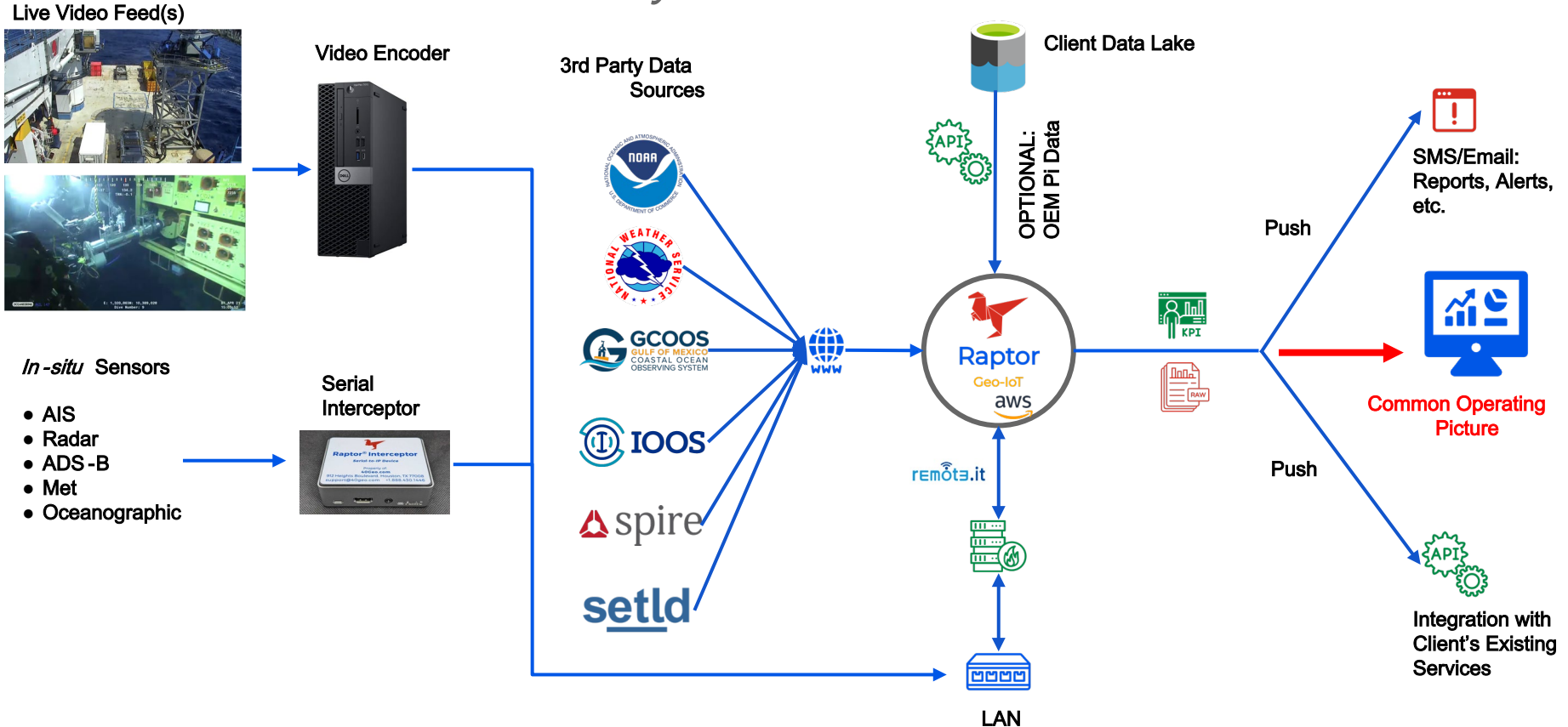
*Data. Analytics.*





# Maritime Domain Awareness

*Data. Analytics. Visualization.*



# Maritime Domain Awareness

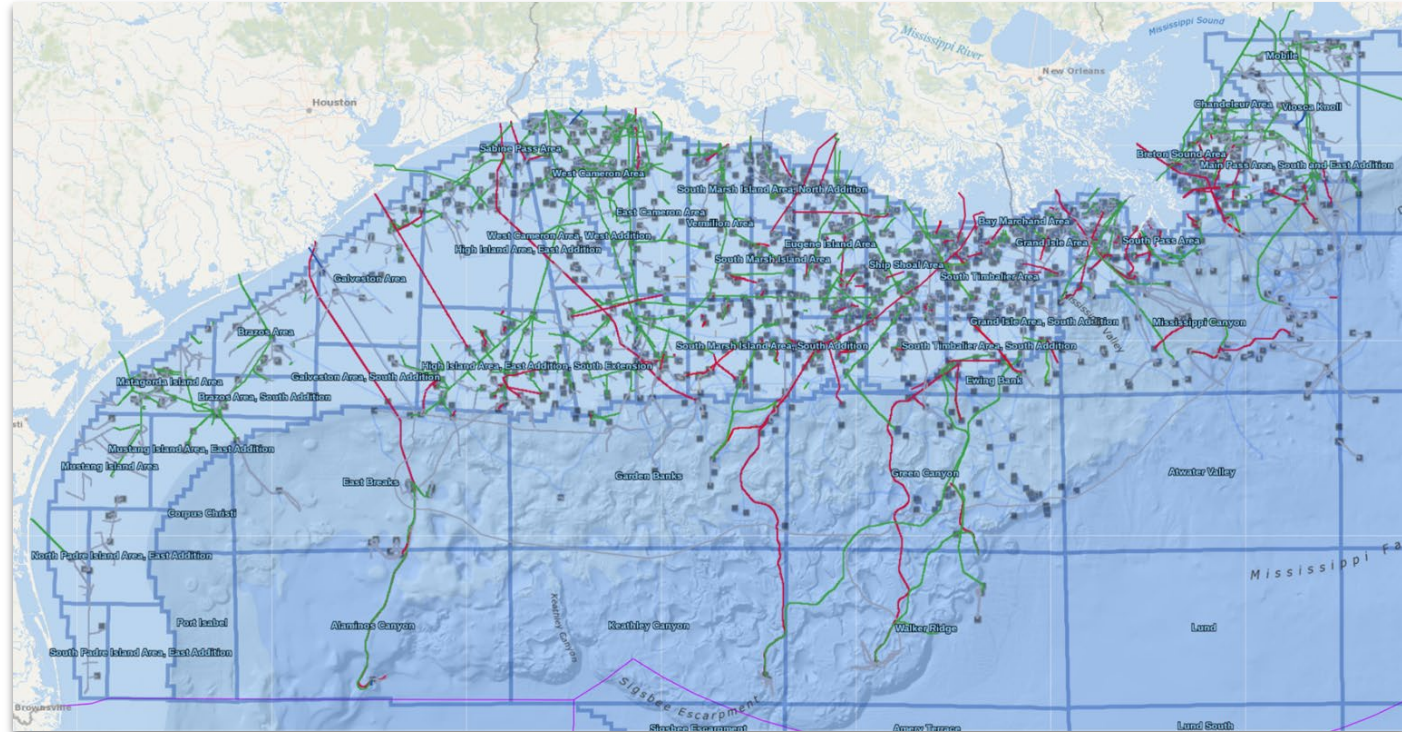
*Million dollar 'go/no go' decisions safely and efficiently*



*Captain Jan Berghuis*

# Gulf of Mexico

- 1,800+ production facilities
- 15% of U.S. oil production
- 5% of U.S. natural gas production
- 47% of U.S. petroleum refining
- 51% of total U.S. natural gas processing





# Gulf of Mexico - Harsh Environmental

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## Water Depth

- max: 14,000' (4,300m)
- Steep escarpment



# Gulf of Mexico - Harsh Environmental

## Intense Storms

- *Seacor Power* Tragedy

### Straight Winds Storm

- Winds: 70-80 kts (130-145 km/h)
- Max. Gust: 102 kts (188 km/h)
- Waves: rose 7-9' (2.1-2.7 m)

#### How a thunderstorm with the power of a hurricane capsized a ship

By Allison Chinchar, CNN Meteorologist

🕒 Updated 5:45 AM ET, Sat April 17, 2021



A Coast Guard boats heads toward a capsized commercial liftboat south of Port Fourchon, Louisiana, on Tuesday, April 13.

**(CNN)** — Nineteen people were on board a commercial ship when it capsized Tuesday during a thunderstorm off the Louisiana coast. But this was no ordinary storm.

# Gulf of Mexico - Harsh Environmental

## Catastrophic Storms

- 14 named storms
- 7 hurricanes / yr.
- 3x Cat. 3+ hurricanes / yr.

Cat. 1:  
74-95 mph | 64-82 kt | 119-153 km/h

Cat. 2:  
76-110 mph | 83-95 kt | 154-177 km/h

Cat. 3:  
111-129 mph | 96-112 kt | 178-208 km/h

Cat. 4:  
130-156 mph | 113-136 kt | 209-251 km/h

Cat. 5:  
157+ mph | 137+ kt | 252+ km/h





# Gulf of Mexico - Harsh Environmental

MENU



HART ENERGY

## Loop Current & Loop Current Eddies

- 3+ knot Ocean Currents
- “Predictably Unpredictable”
- No True Seasonality
- Weeks/Months of Impact
- 1,000s hours of NPT /year

DEEPWATER

## Loop Currents Blamed For Big Foot Failure

Subsea Engineering News Fri, 06/26/2015 - 03:13 AM

...Chevron executives identifies **strong loop currents as the likely cause of the failure of nine of 16 tendons** that were to comprise the Big Foot tlp's four tension legs...

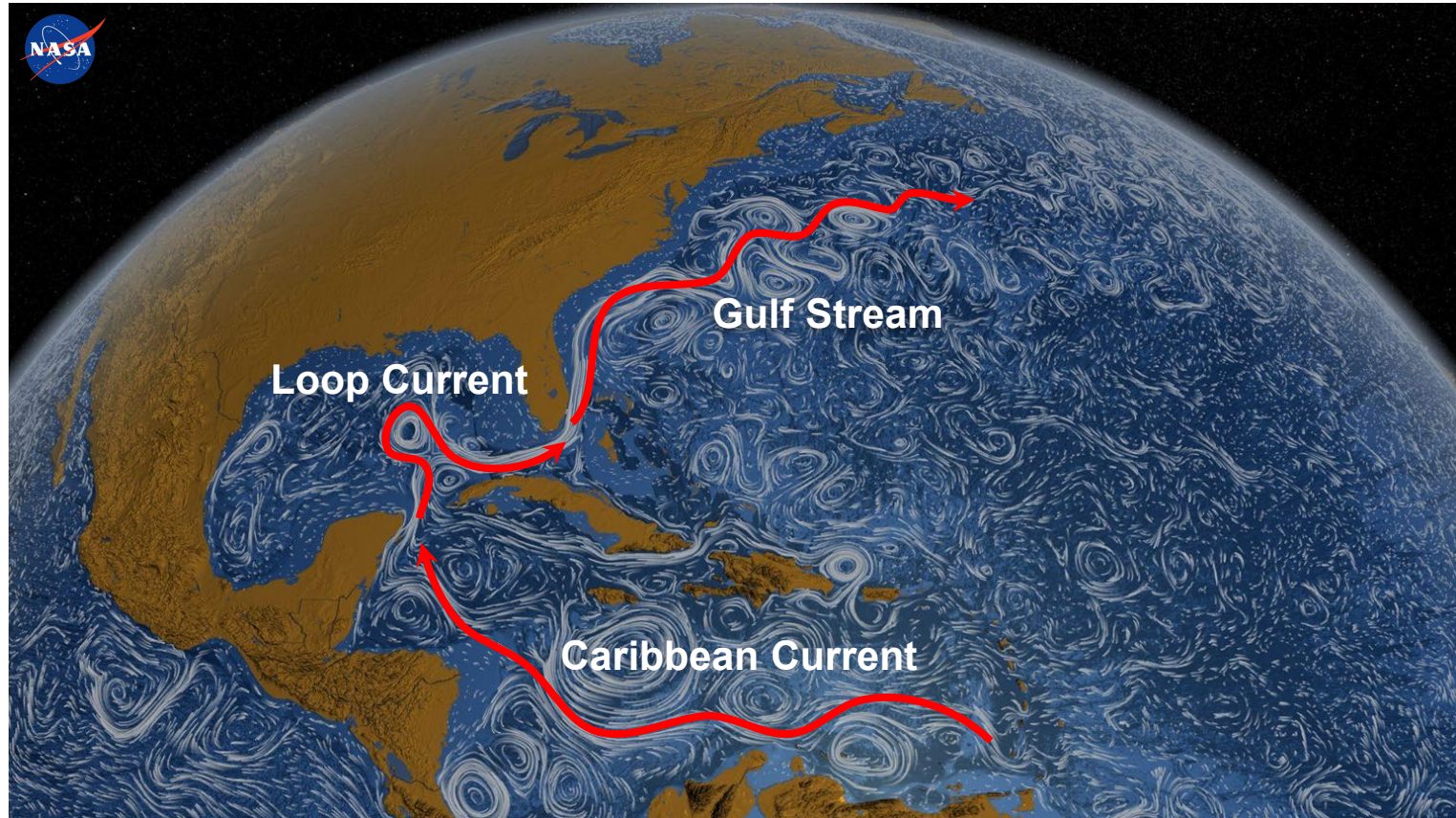


Image: <https://www.chevron.com/projects/big-foot>

Source: <https://www.hartenergy.com/news/loop-currents-blamed-big-foot-failure-104573>

# Intra -America Seas

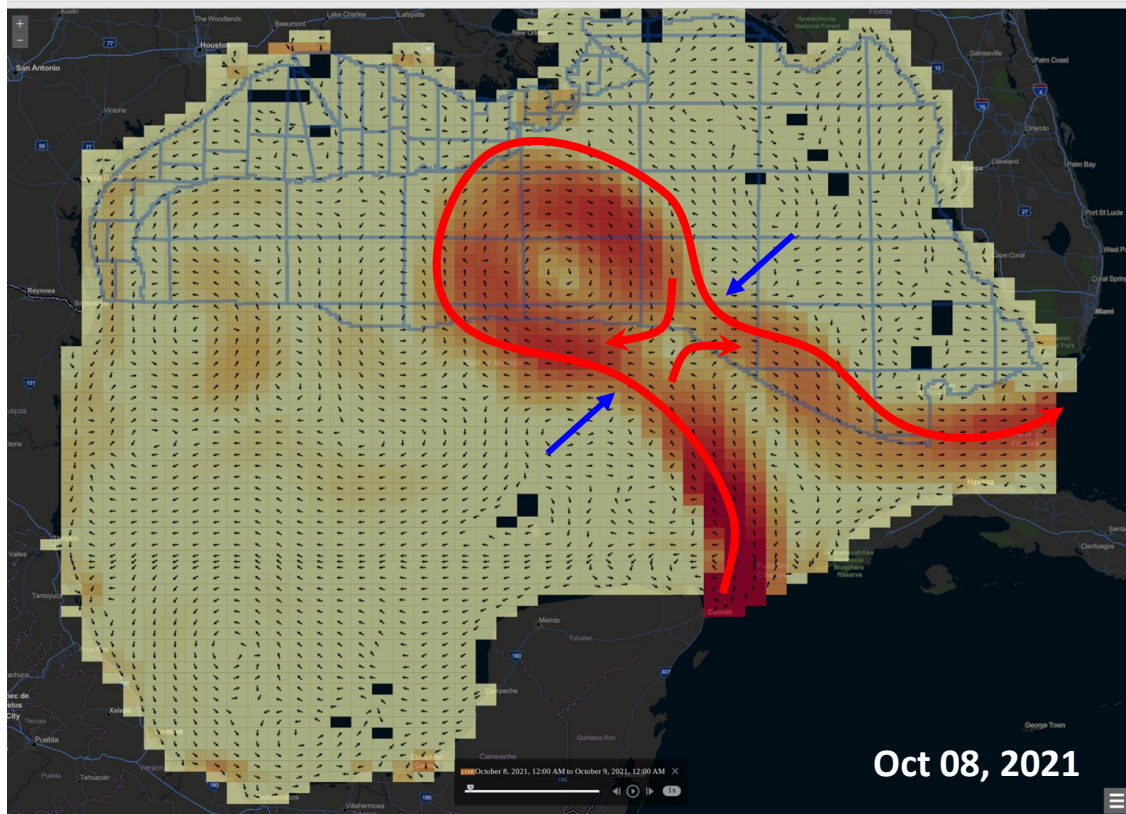
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# Loop Current System

Raptor® MetOcean Dashboard & Mapping Interface

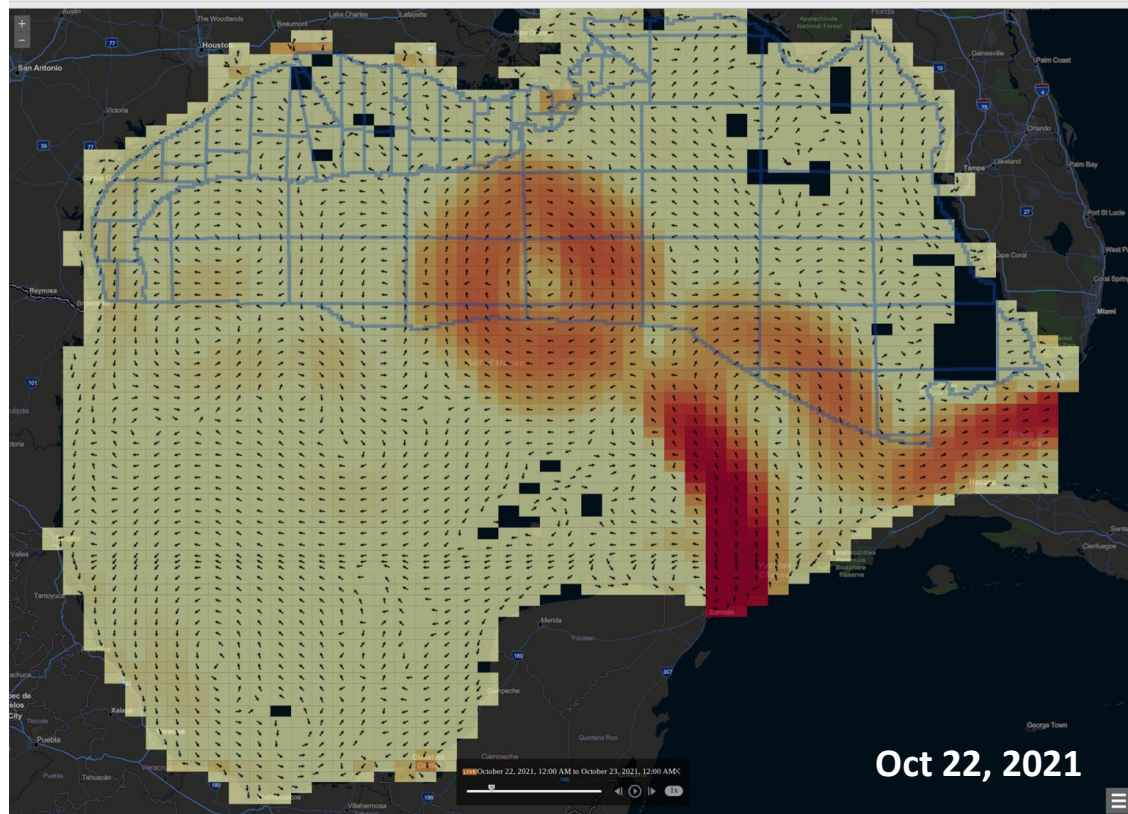


Oct 15, 2021

**Oct 15, 2021**

# Loop Current System

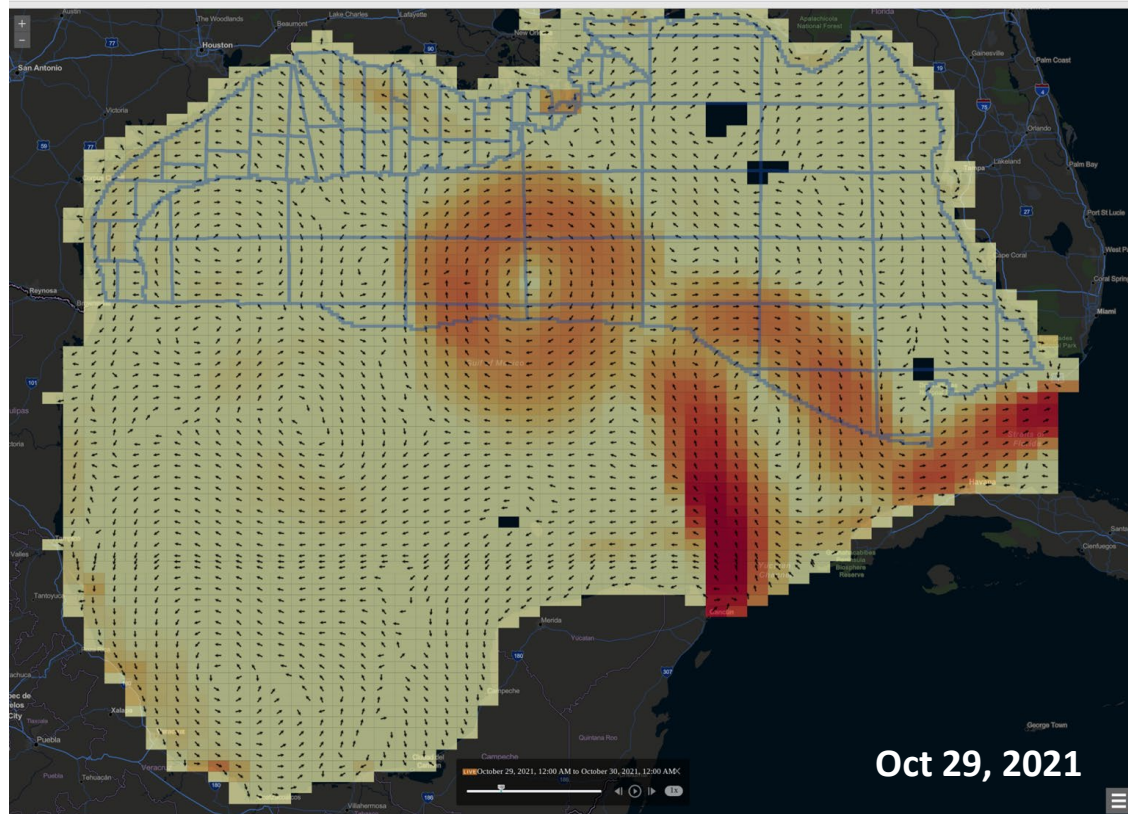
Raptor® MetOcean Dashboard & Mapping Interface





# Loop Current System

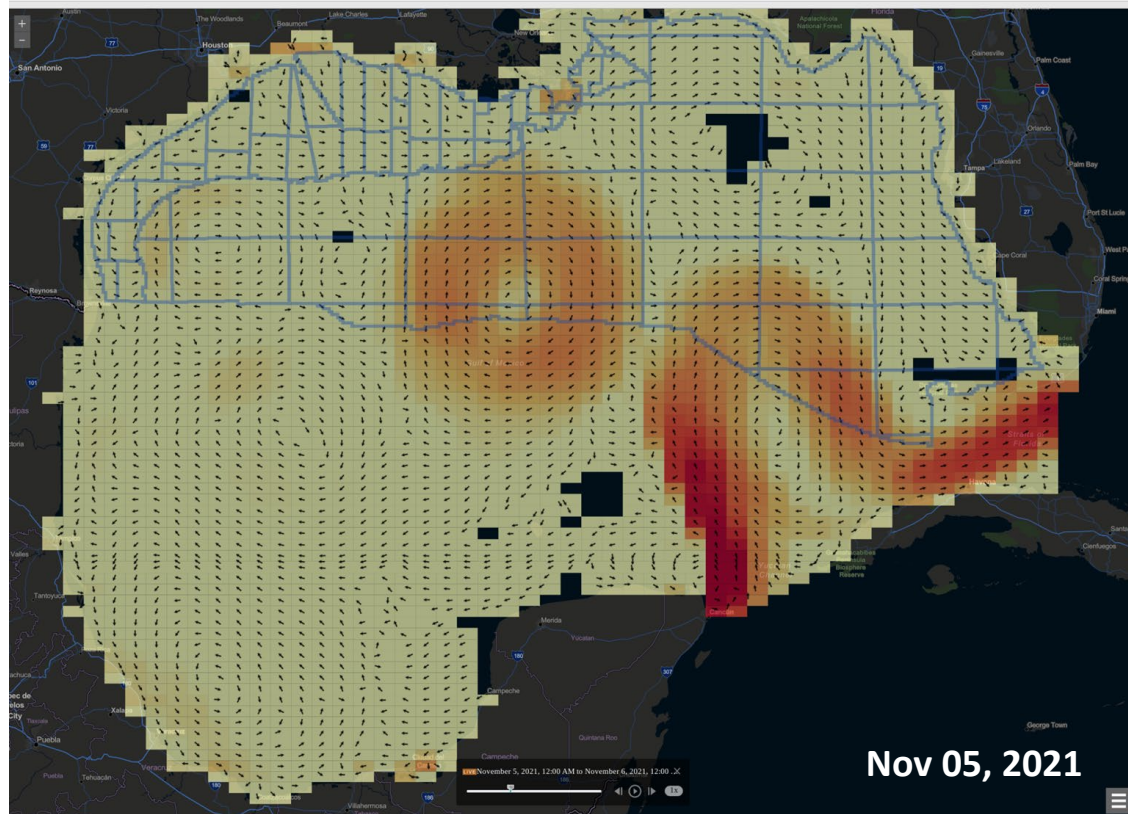
Raptor® MetOcean Dashboard & Mapping Interface





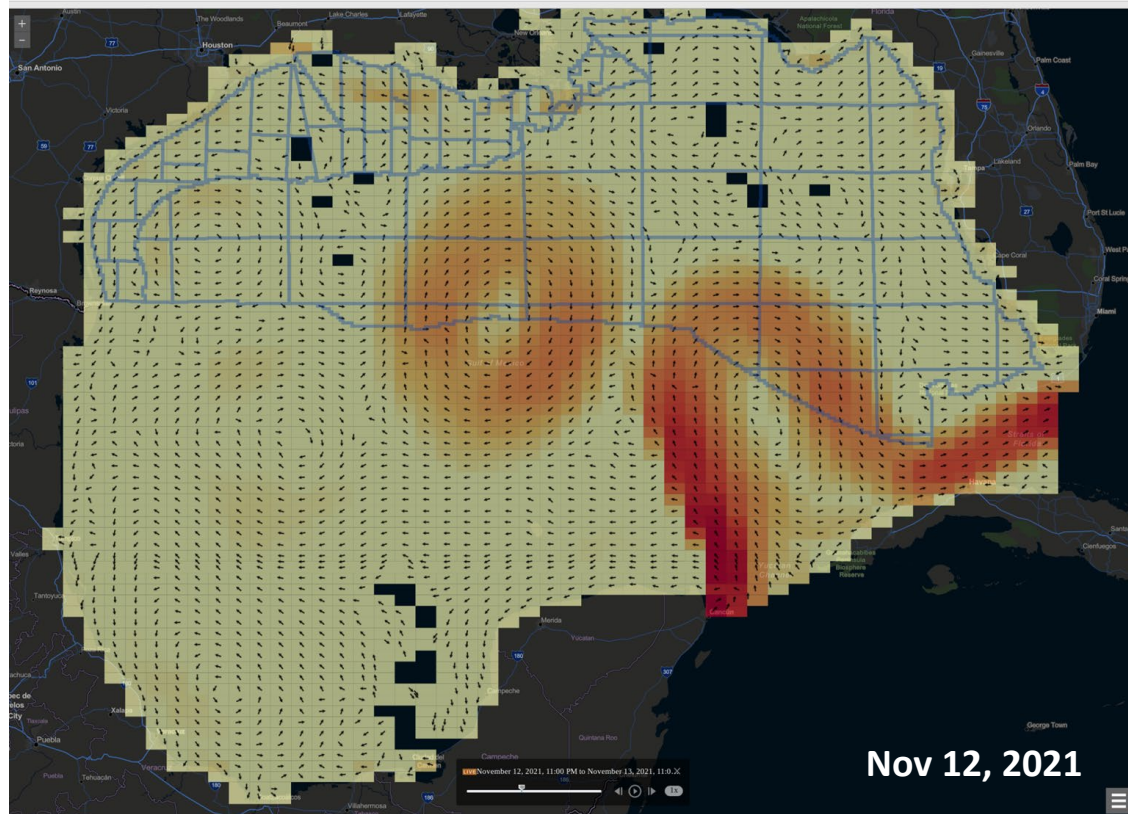
# Loop Current System

Raptor® MetOcean Dashboard & Mapping Interface



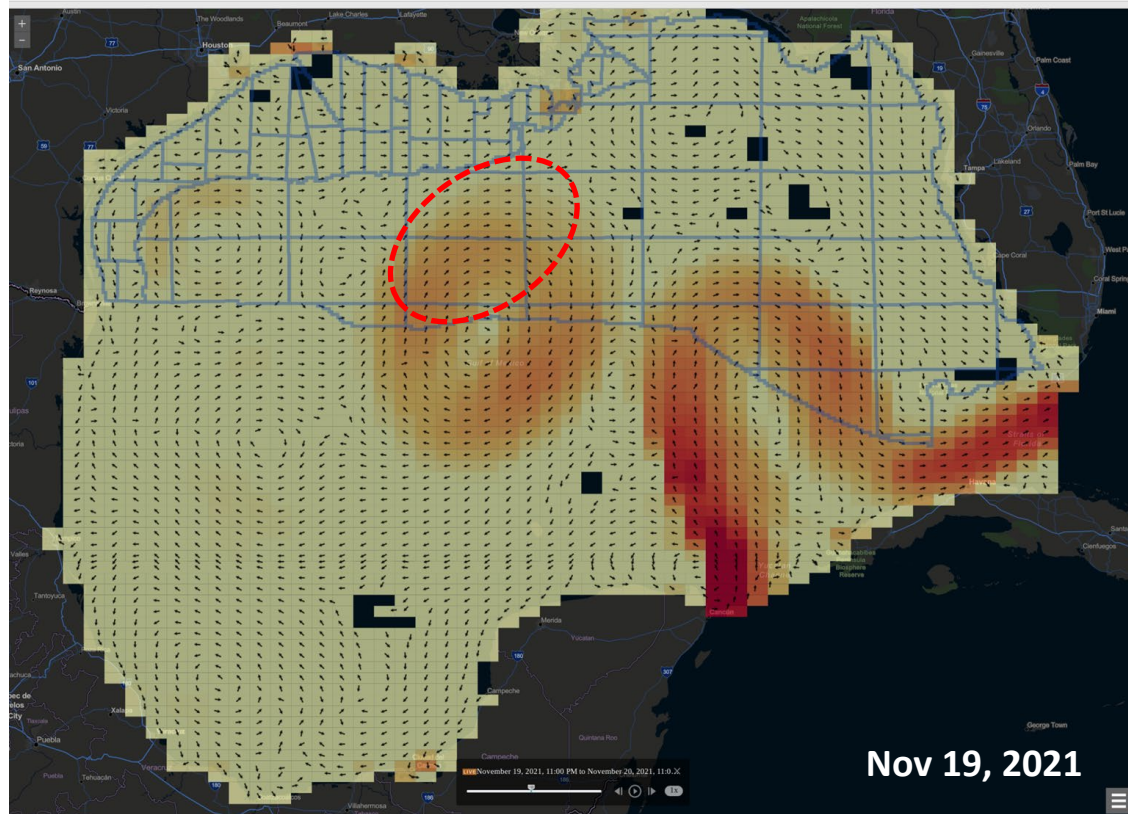
# Loop Current System

Raptor® MetOcean Dashboard & Mapping Interface



# Loop Current System

Raptor® MetOcean Dashboard & Mapping Interface



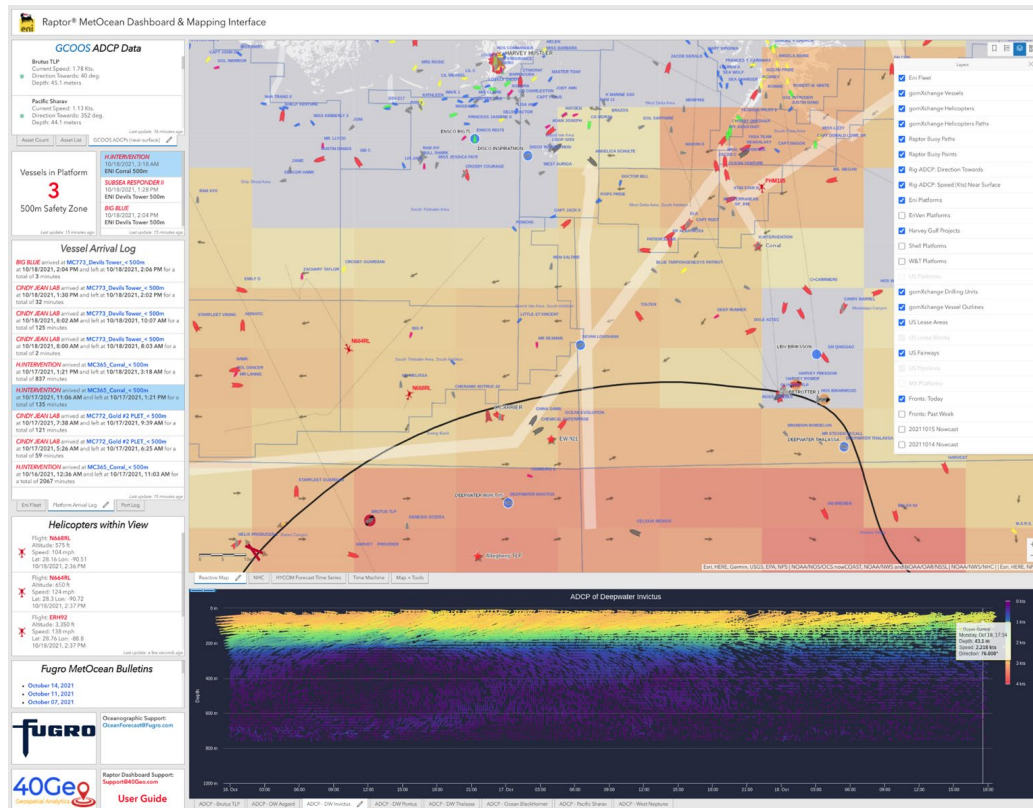


## Operations:

- 3x Production Platforms
- Decommissioning
- Drilling
- Inspection

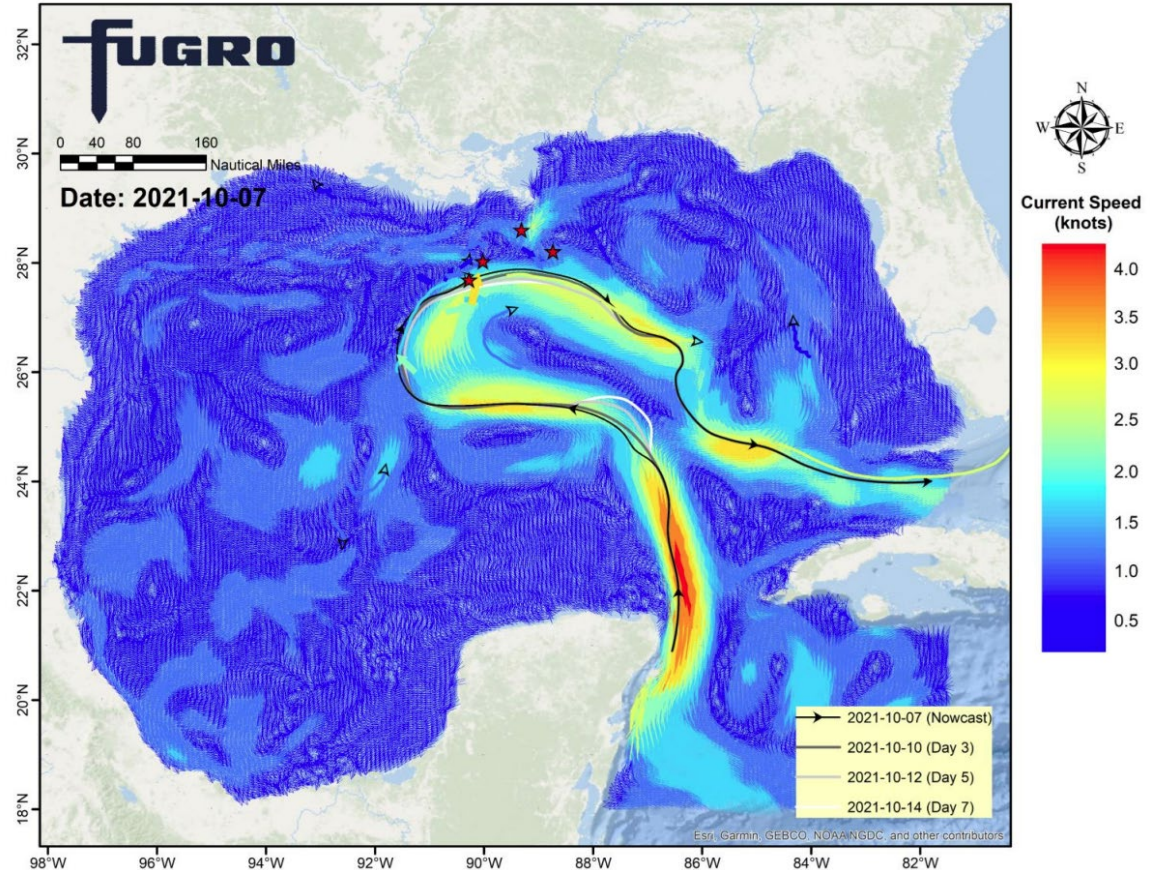
## Logistics:

- 6x Fleet vessels + adhoc fleet
- Crew change/Resupply
- Upto 4x helicopters

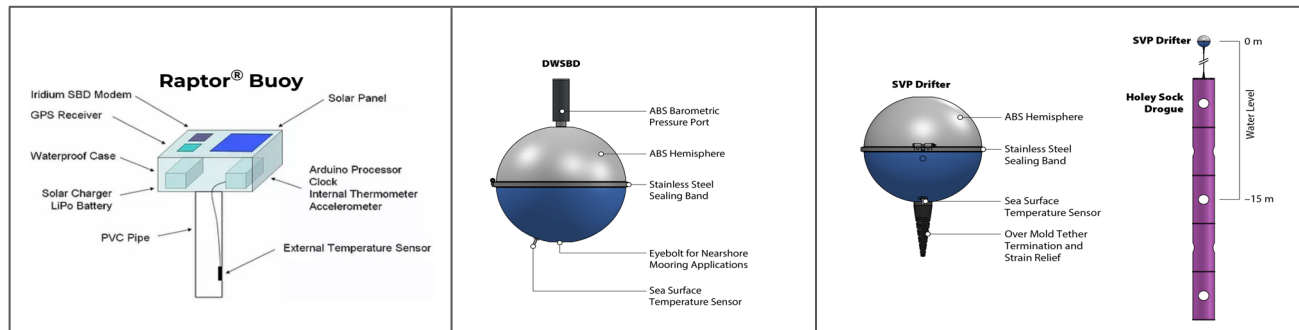


# Eni - Loop Current Monitoring Requirements

- Daily Frontal Analysis
  - In-situ Data
  - Remotely-sensed Data
- Twice Weekly Reports
  - Nowcast
  - 3-5 day Forecast
  - 7 day outlook
- Phone & Email Consultation
- Data & Analysis via COP
  - Frontal Analysis
  - Forecast
  - Vessel Tracking
  - Helicopter Tracking
  - Hurricane Tracking



# In-Situ Data



Scripps Institution of Oceanography's  
**LAGRANGIAN** DRIFTER  
LABORATORY

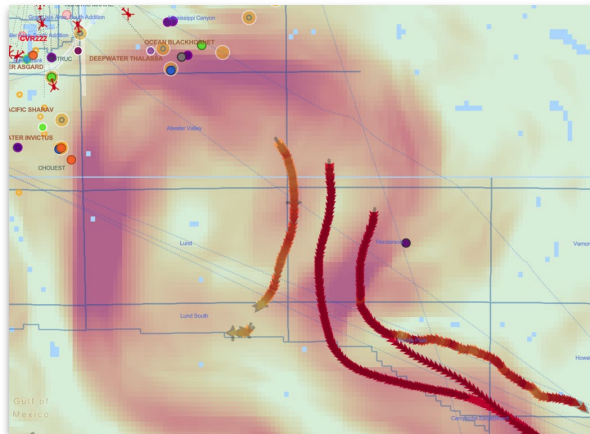
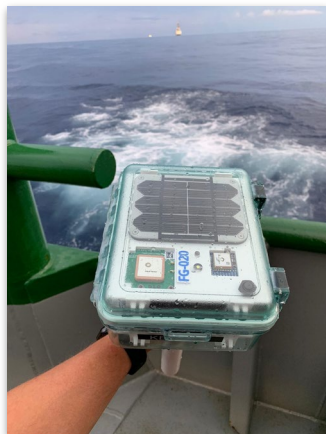


Global Ocean Monitoring and Observing  
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

**FUGRO**



*"...the instruments  
cannot be regarded as  
marine debris..."*

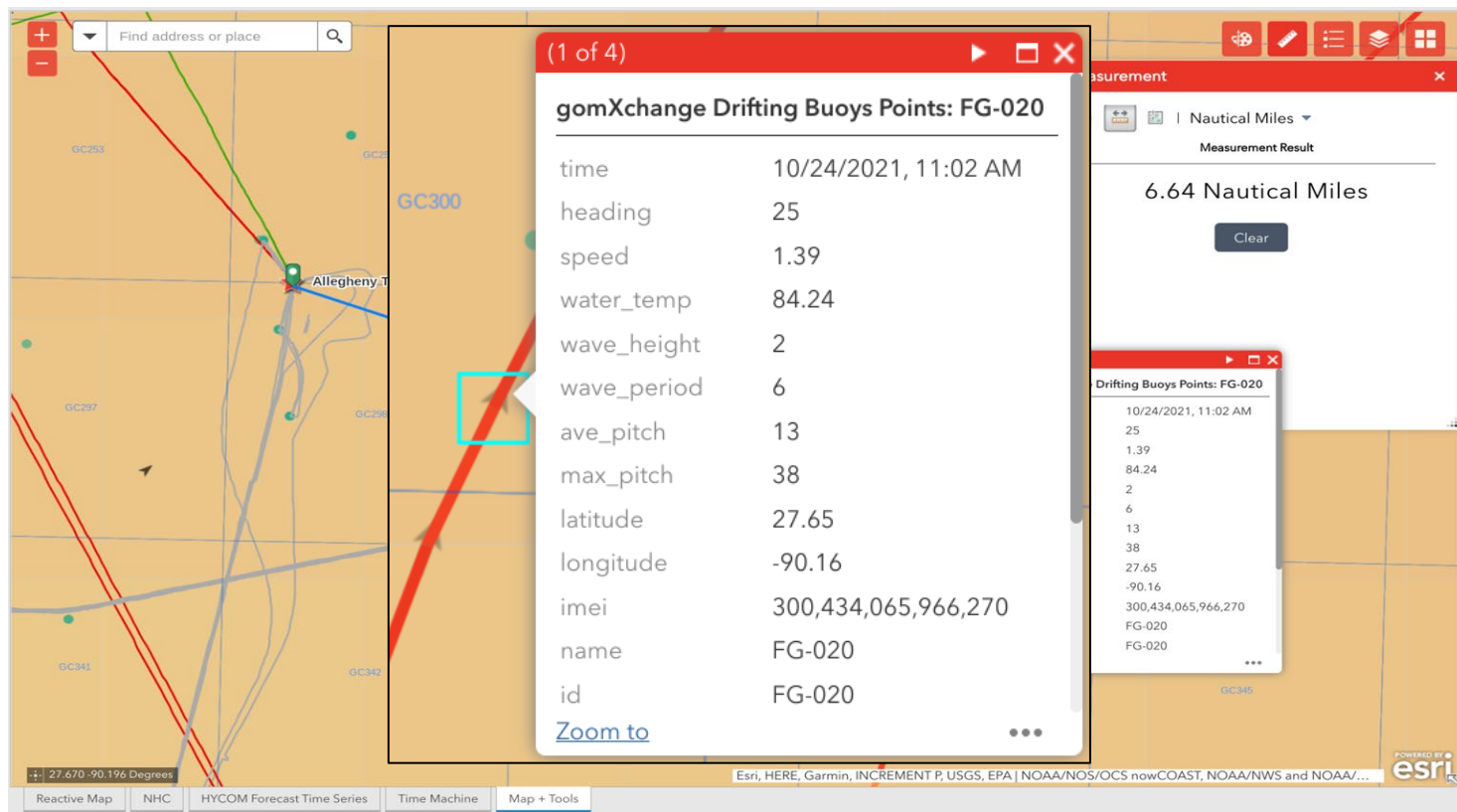
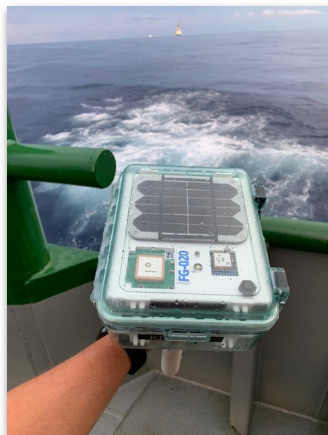




# In-Situ Data



fugro



# In-Situ Data



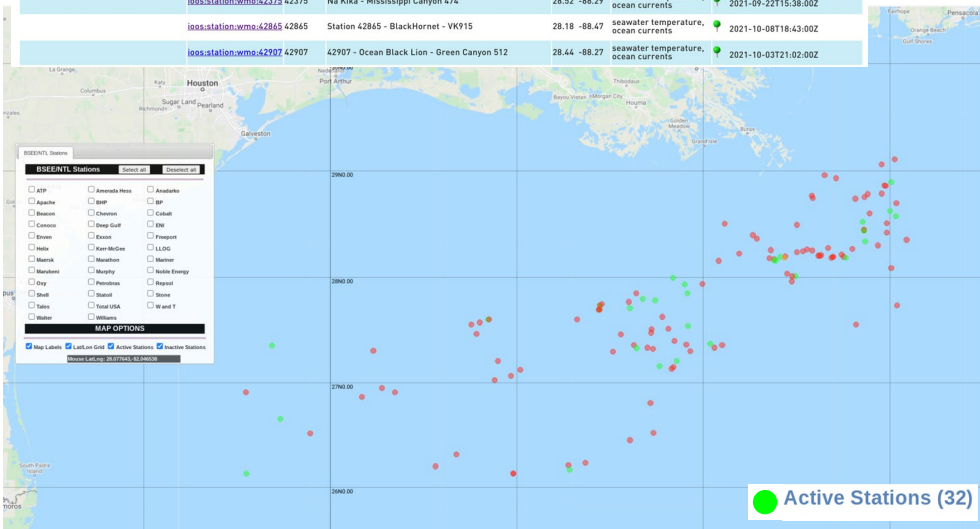
[HOME](#)
[LIST OF STATIONS](#)
[MAP OF STATIONS](#)
[WAF](#)
[DATA ON ERDDAP](#)
[CONTACT US](#)

NOTE: The following are the registered observing stations. Please contact [data@gcoos.org](mailto:data@gcoos.org) if you want to register a new observing station or noticed incorrect information.

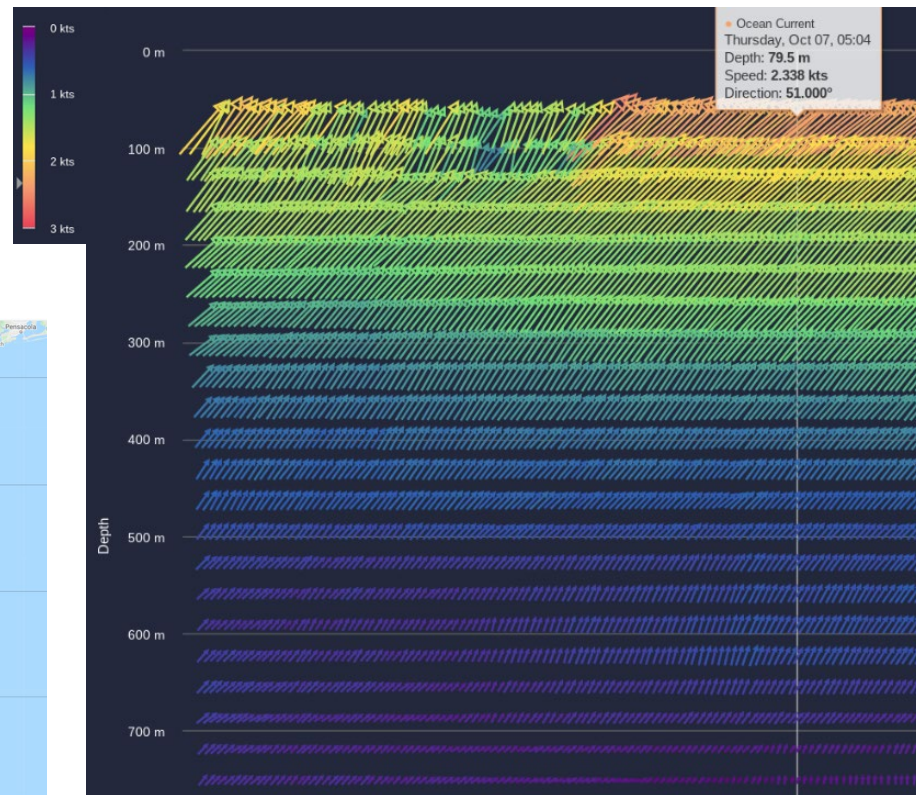
Generate a CSV file of the station inventory | Pre-generated [station\\_table.txt](#) | [?](#)

[ALL Stations \(130\)](#)
[Active Stations \(32\)](#)
[Inactive Stations \(98\)](#)

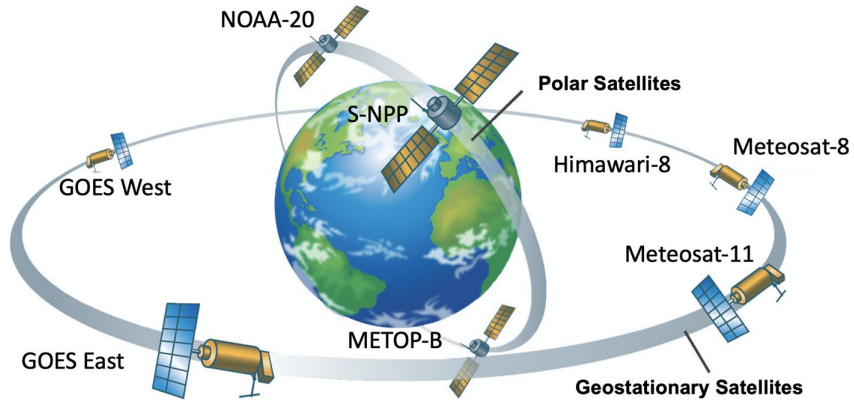
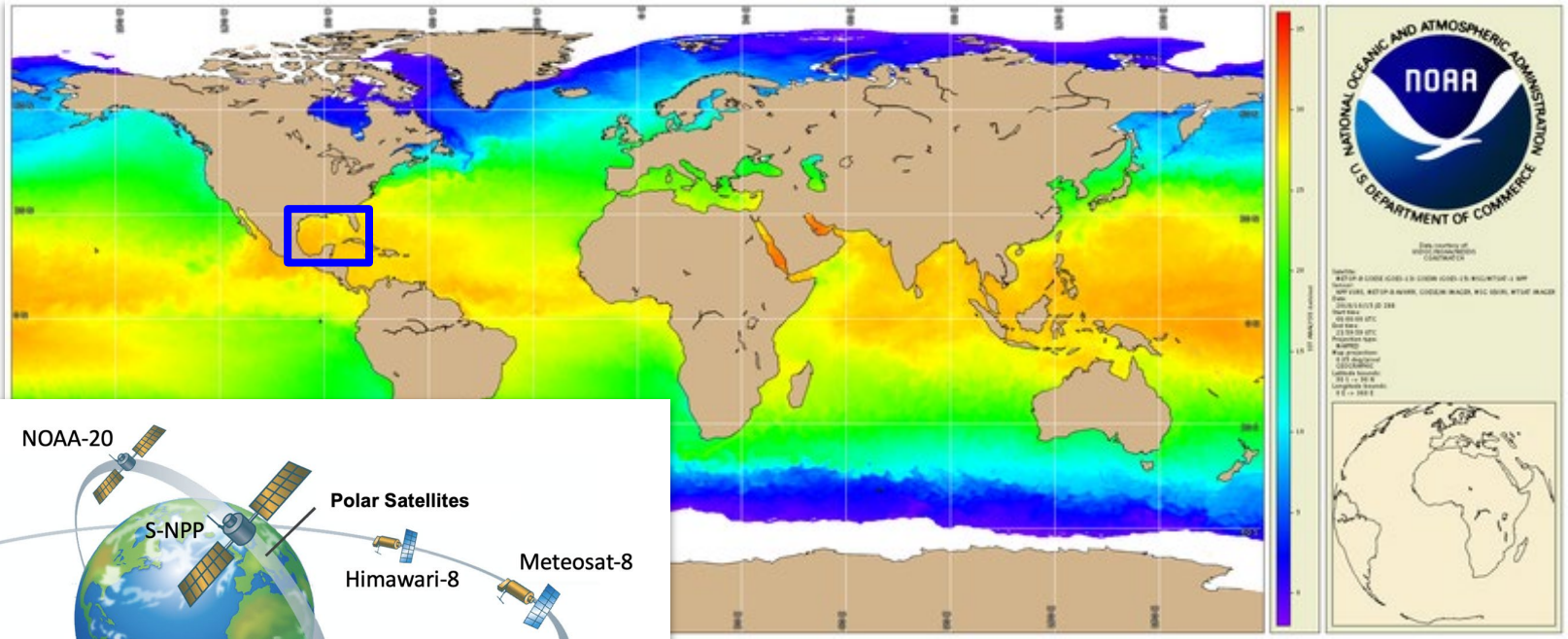
Data Provider	URN	WMO	Description	Location	Parameters Ingested	Last Reported
Beacon Offshore Energy	<a href="#">ioos.station.wmo-42876</a>	42874	42874 - Deepwater Asgard - Atwater Valley 23	27.93 -90.20	seawater temperature, ocean currents	2021-10-08T18:33:00Z
BHP Billiton	<a href="#">ioos.station.wmo-42932</a>	42932	42932 - Deepwater Invictus - Green Canyon 124	27.85 -90.17	seawater temperature, ocean currents	2021-10-08T18:42:00Z
BP Inc	<a href="#">ioos.station.wmo-42369</a>	42369	42369 - Mad Dog Spar - Green Canyon 782	27.21 -90.28	seawater temperature, ocean currents	2021-10-08T18:40:00Z
	<a href="#">ioos.station.wmo-42375</a>	42375	Na Kika - Mississippi Canyon 474	28.52 -88.29	seawater temperature, ocean currents	2021-09-22T15:38:00Z
	<a href="#">ioos.station.wmo-42865</a>	42865	Station 42865 - BlackHornet - VK915	28.18 -88.47	seawater temperature, ocean currents	2021-10-08T18:43:00Z
	<a href="#">ioos.station.wmo-42907</a>	42907	42907 - Ocean Black Lion - Green Canyon 512	28.44 -88.27	seawater temperature, ocean currents	2021-10-03T21:02:00Z



● Active Stations (32)



# Remotely -Sensed Data





# SST

Make NetCDF Raster Layer

Input netCDF File  
K:\02051-Consult\F194359\_ENI\20211008\nowcast\_forecast\SST.nc

Variable  
sst

X Dimension  
lon

Y Dimension  
lat

Output Raster Layer  
GOES\_SST\_1008

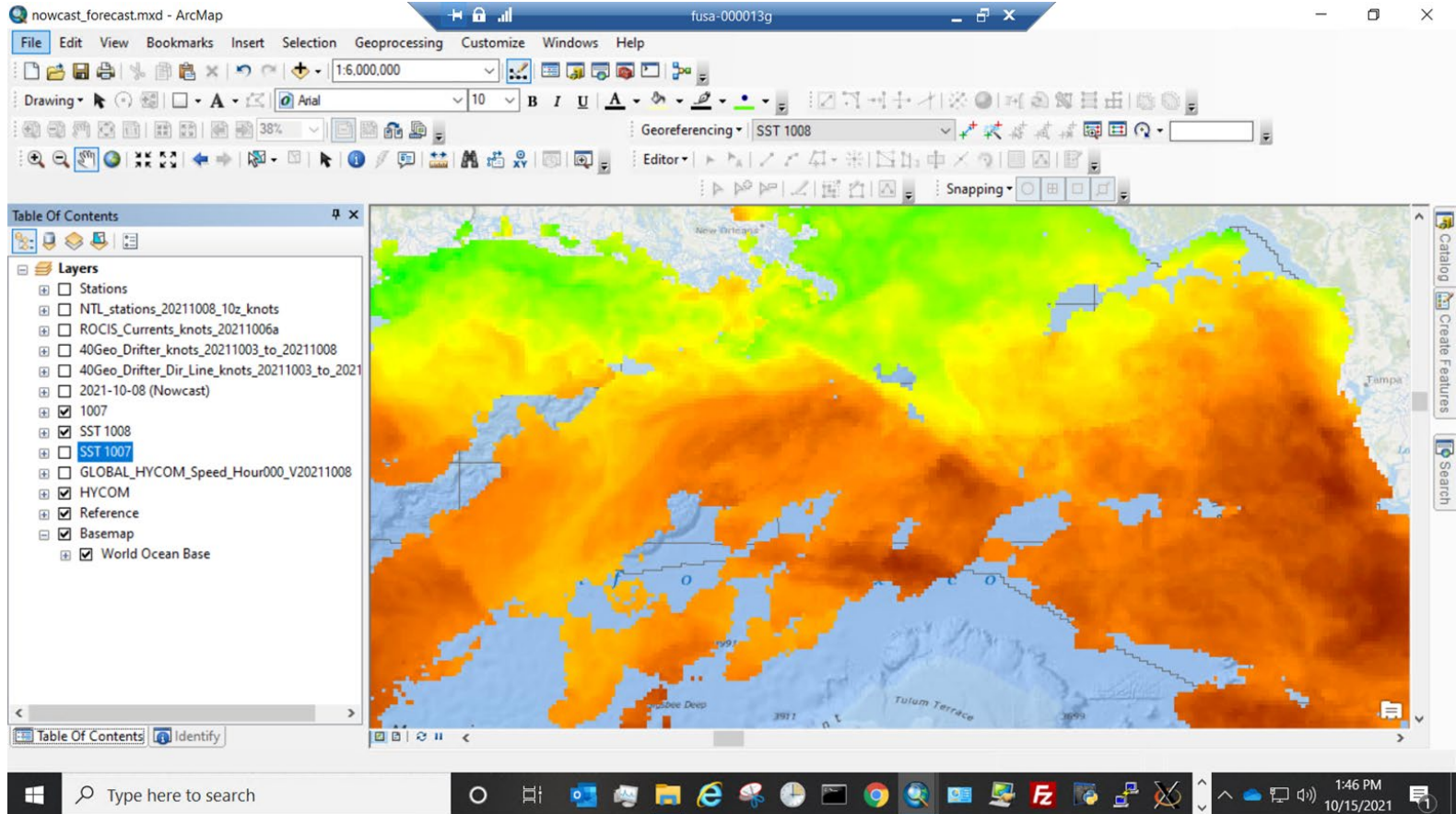
Band Dimension (optional)

Dimension Values (optional)

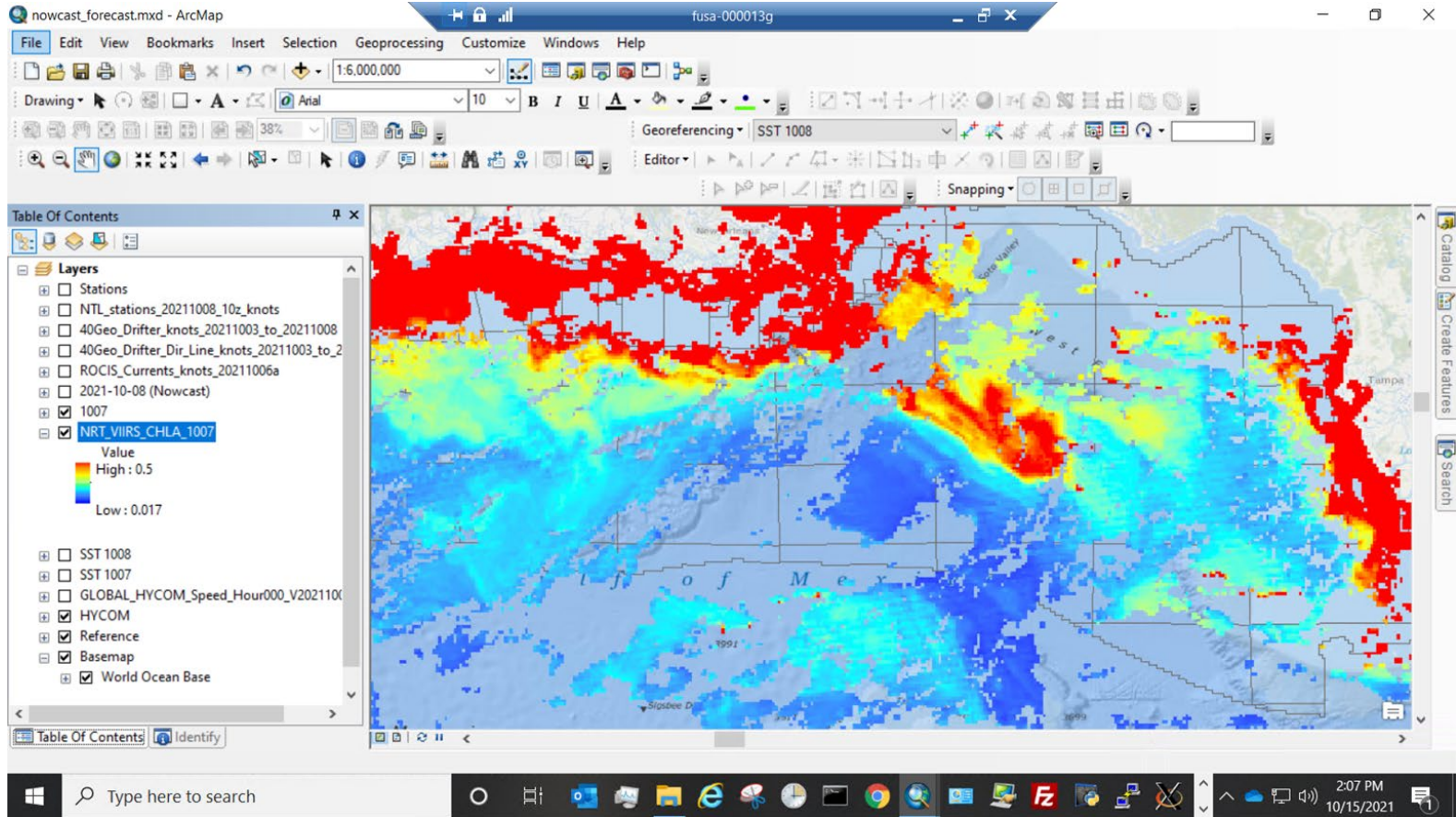
Dimension	Value
time	10/08/2021 12:00:00

OK Cancel Environments... Show Help >>

# SST

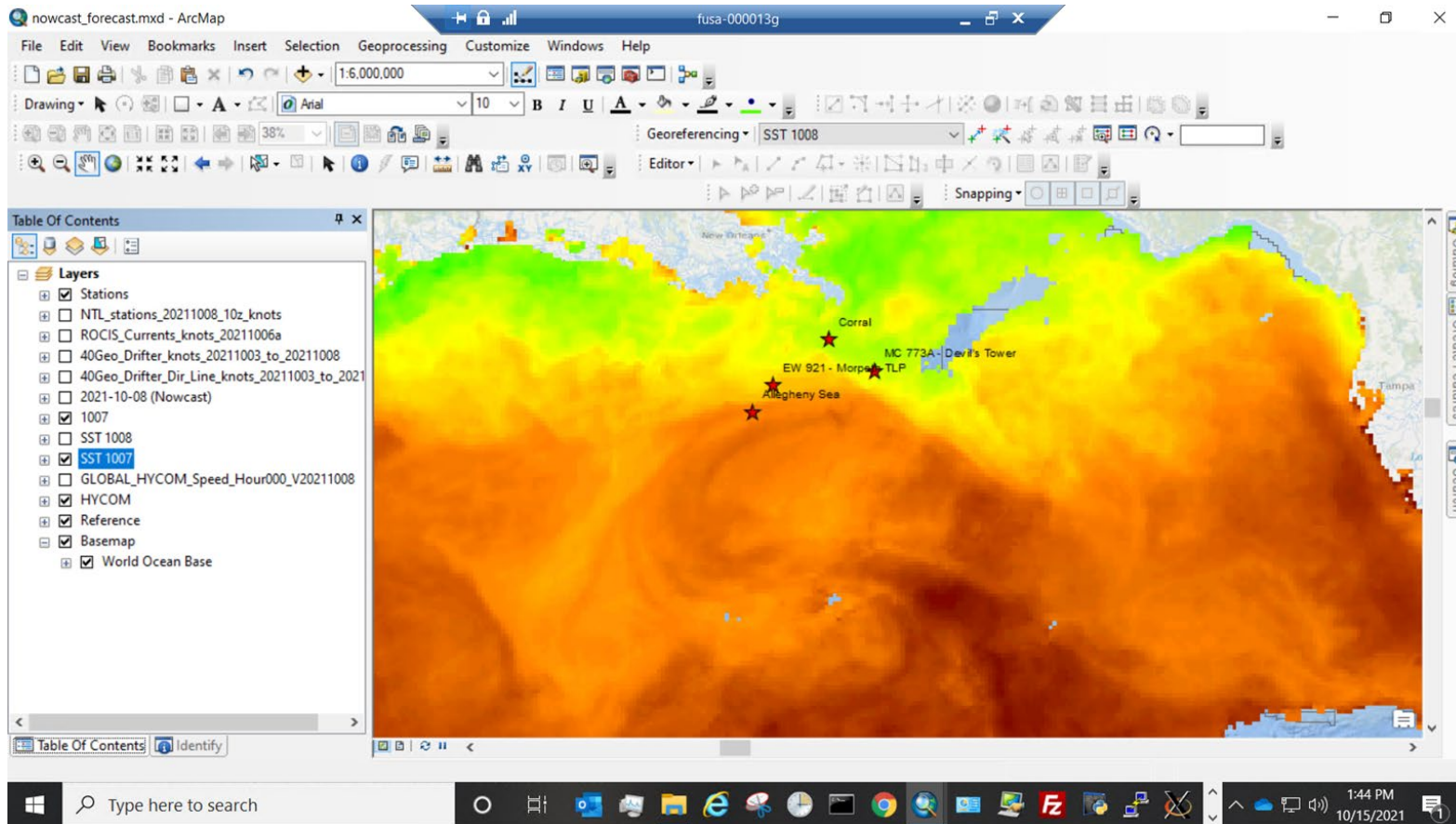


# Ocean Color

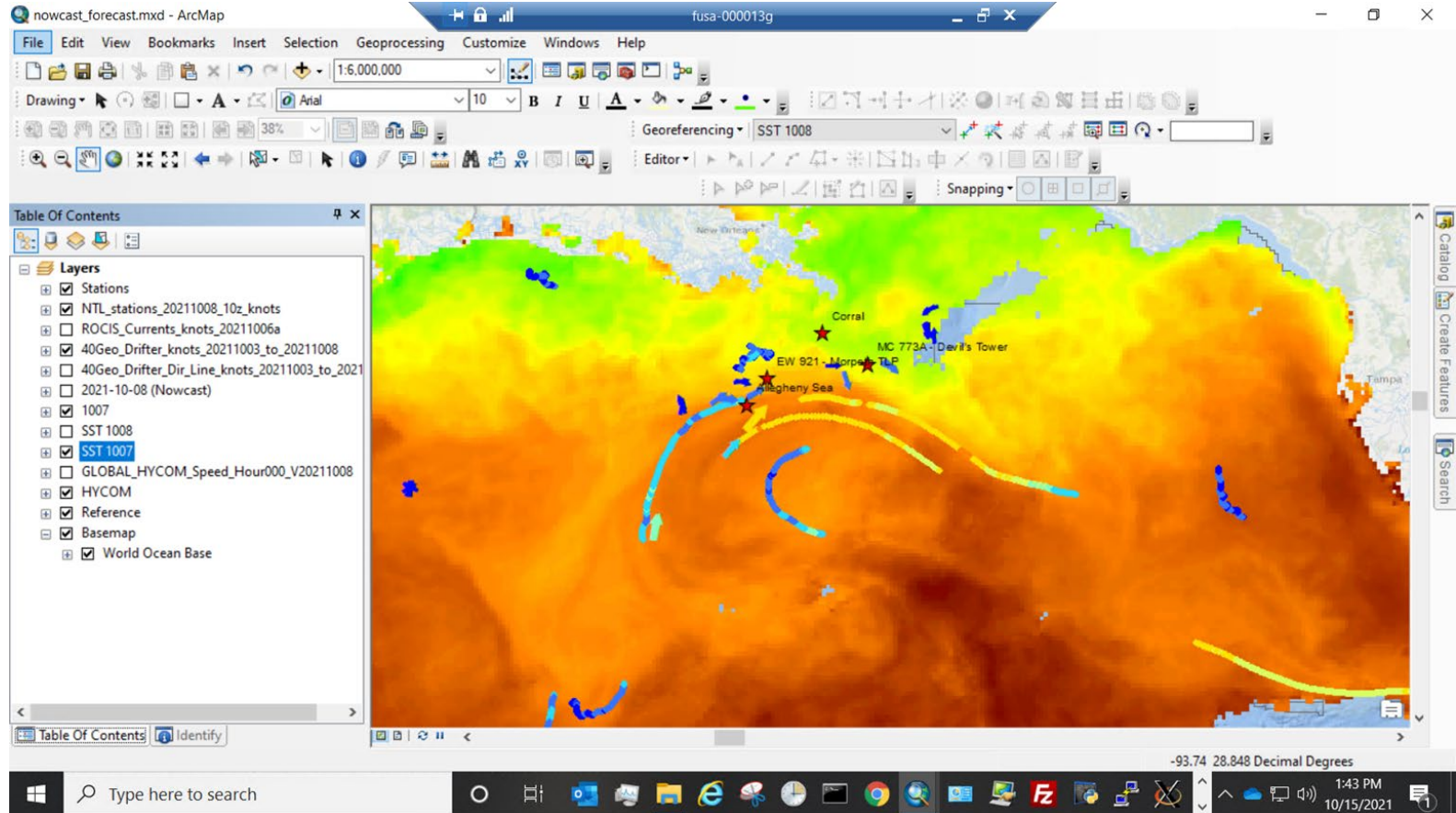




# 2-day SST



# 2-day SST + Buoys + ADCPs



# HYCOM Nowcast

The screenshot displays the ArcMap application window titled 'nowcast\_forecast\_zoom.mxd - ArcMap'. The interface includes a menu bar (File, Edit, View, Bookmarks, Insert, Selection, Geoprocessing, Customize, Windows), a toolbar, and a Python console on the left. The Python console contains a script for processing NetCDF data into a raster layer.

```
... #Sets mask to limit raster processing to the GOM
... GoM_mask = "GoM_mask"
... env.mask = env.workspace + "/Cdrive_eddy_forecast/GoM_mask.shp"
... shape

... #NC variables for speed
... inVariables = "water_u;water_v;lat;lon"
... SSH_NC_variables = "surf_el;lat;lon"
... inXVariable = "lon"
... inYVariable = 'lat'
... rowDimensions = "lat;lon"
... ZVariable = ''
... MVariable = ''
... dimensionValues = ''
... valueSelectionMethod = 'BY_VALUE'
... config_keyword = "#"
... speed = 'Speed'
... dir = 'Direction'
... nc = '.nc'

... # Description/Summary/Tag Info needed for package
... Summary_pkg = "We have used the Global " + model.upper() + "
forecast product to generate figures of surface current velocities,
locations of Loop Current (LC) & Loop Current Eddies (LCEs), &
areas of strong current speed. This package presents a nowcast
```

Overlaid on the right is the 'Make NetCDF Raster Layer' dialog box. It contains the following fields:

- Input netCDF File: K:\02051-Consult\F194359\_EN1\20211008\nowcast\_forecast\SST.nc
- Variable: sst
- X Dimension: lon
- Y Dimension: lat
- Output Raster Layer: GOES\_SST\_1008
- Band Dimension (optional):
- Dimension Values (optional):

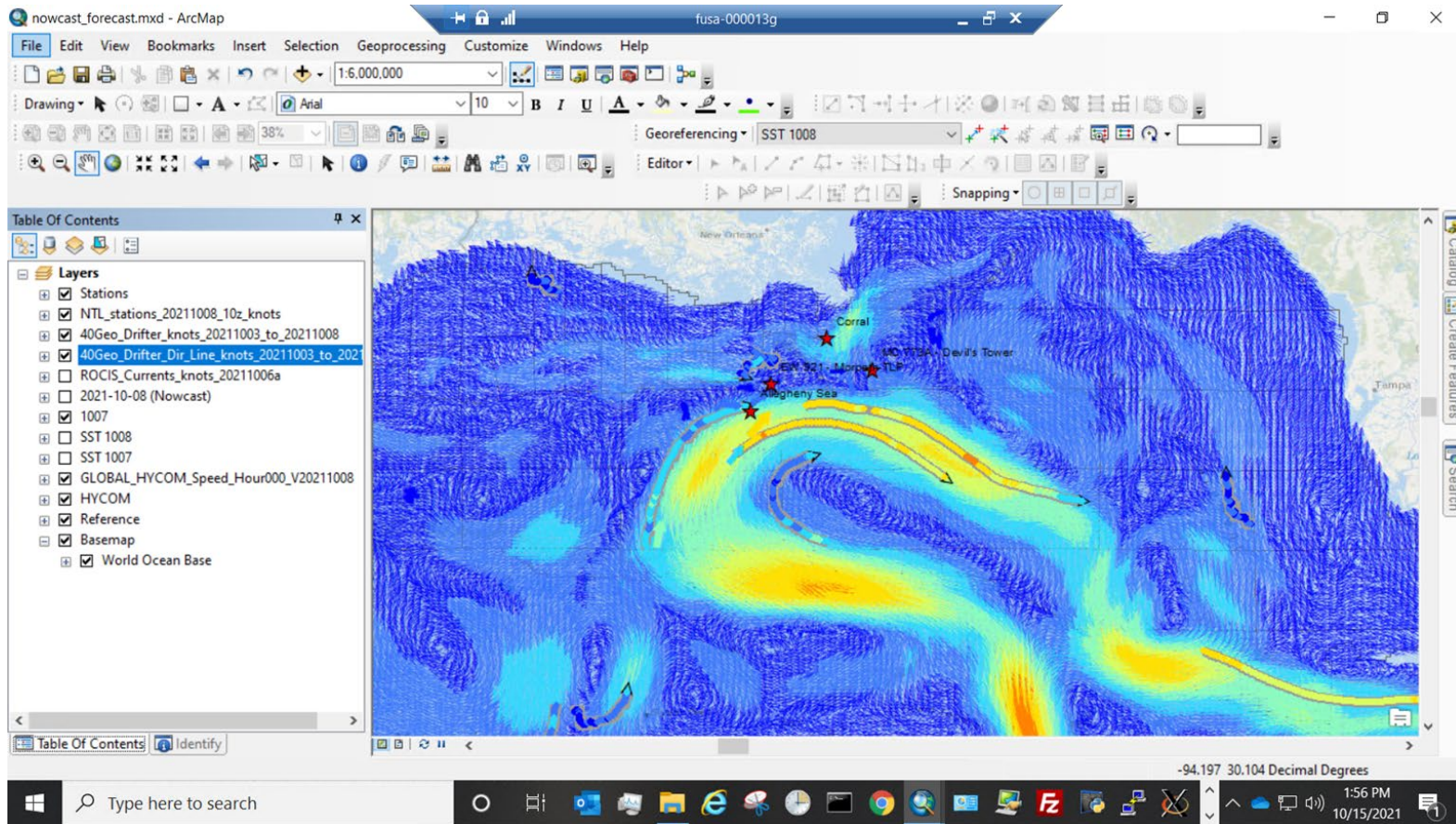
A table within the dialog shows the dimension values:

Dimension	Value
time	10/08/2021 12:00:00

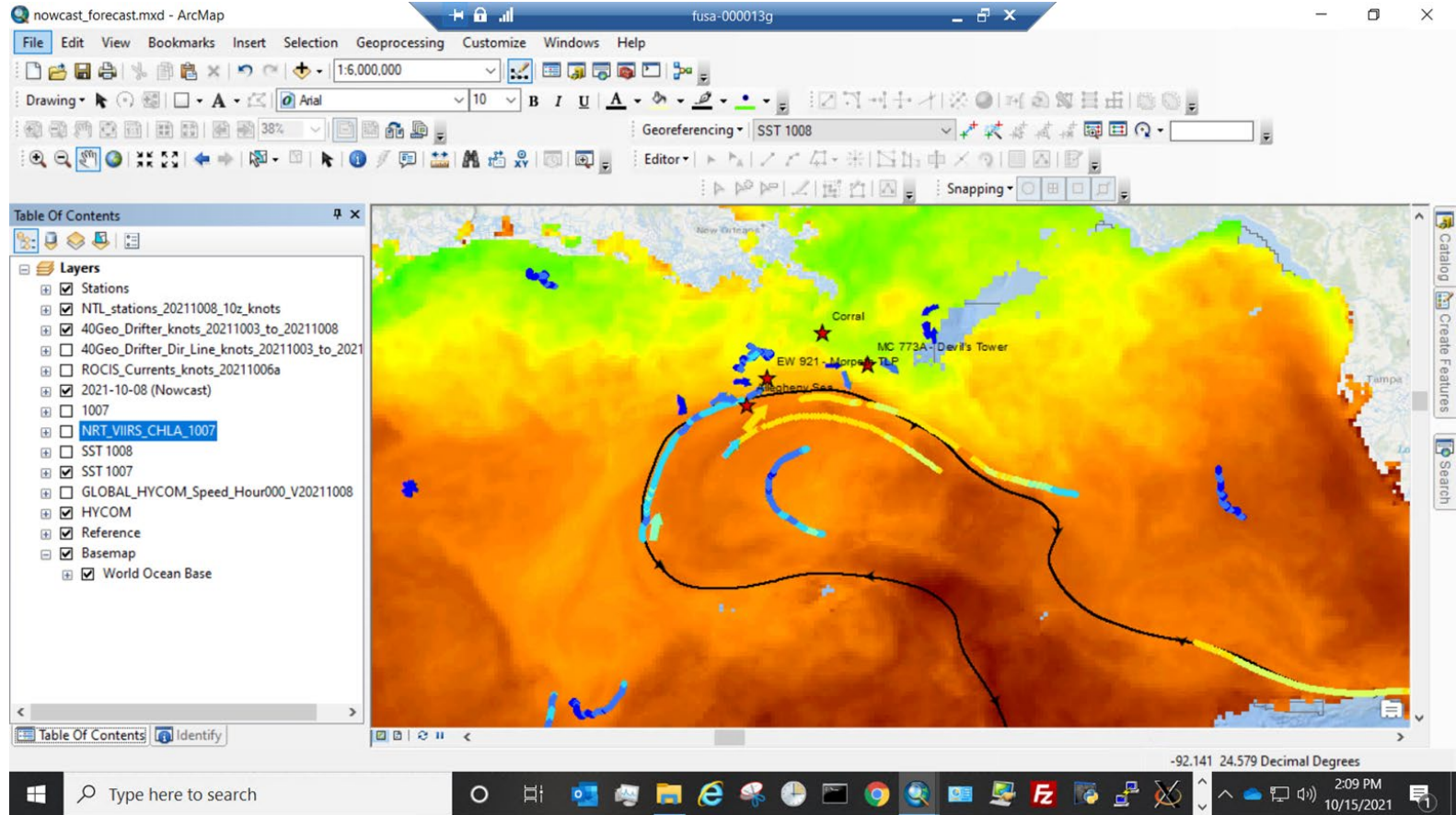
At the bottom of the dialog are buttons for OK, Cancel, Environments..., and Show Help >>. Below the dialog, a map view shows a coastal area with a red star labeled 'Allegheny Sea' and a yellow arrow pointing to a specific location. The map has a blue background with yellow and red lines indicating current paths. The status bar at the bottom shows coordinates: -90.907 27.804 Decimal Degrees, and the system clock shows 2:43 PM on 10/15/2021.



# HYCOM Nowcast

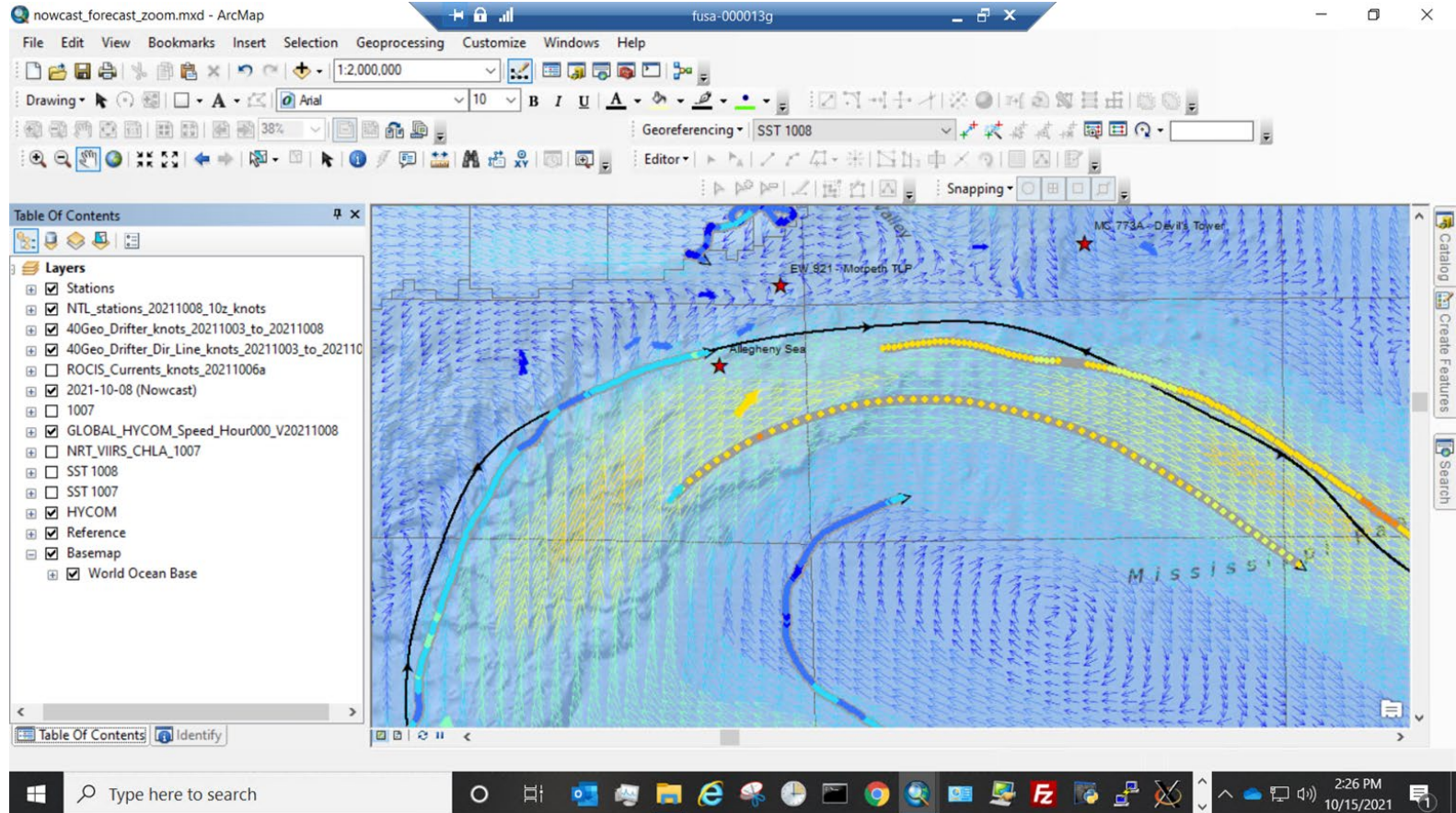


# Frontal Analysis



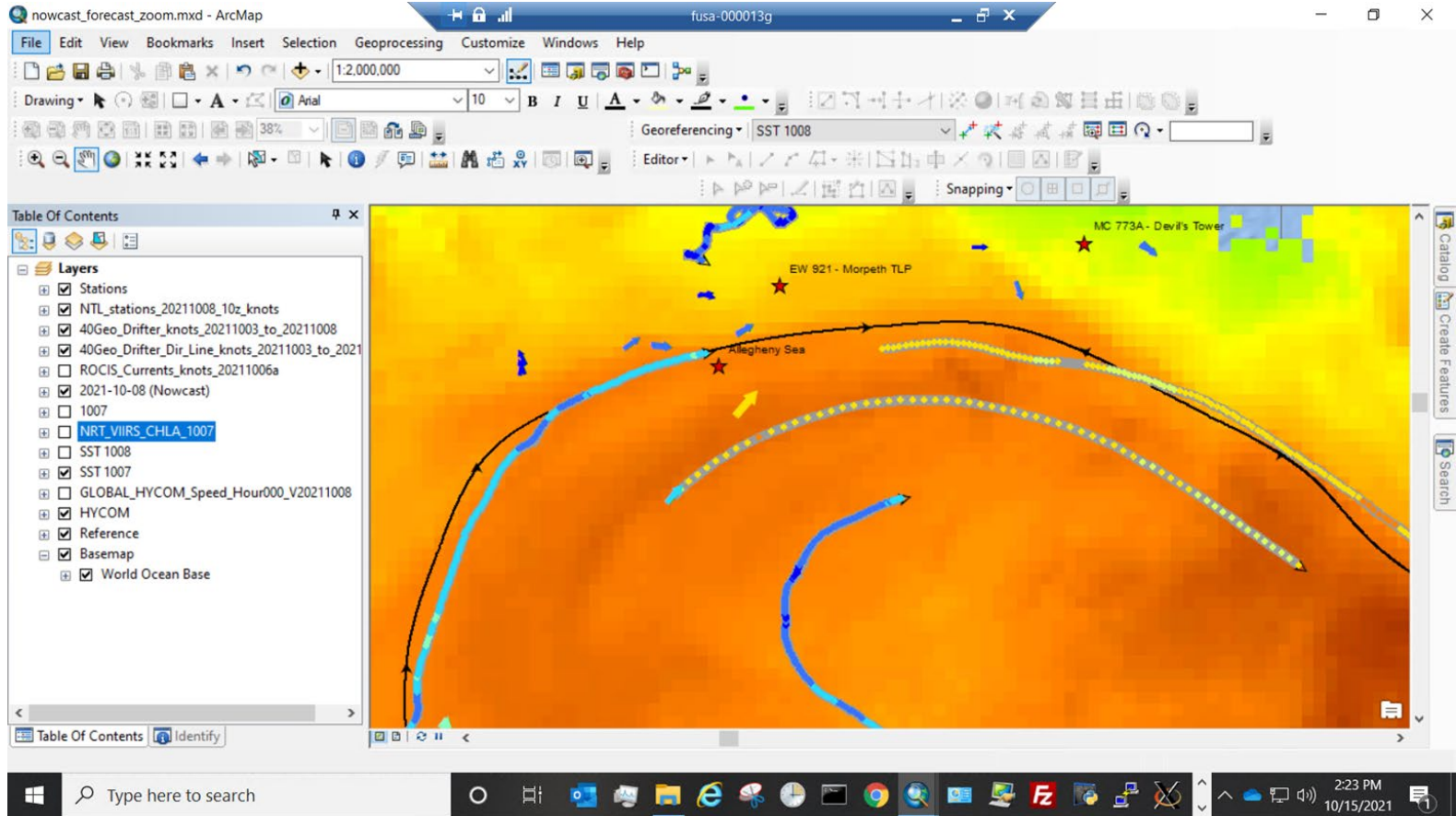


# Frontal Analysis

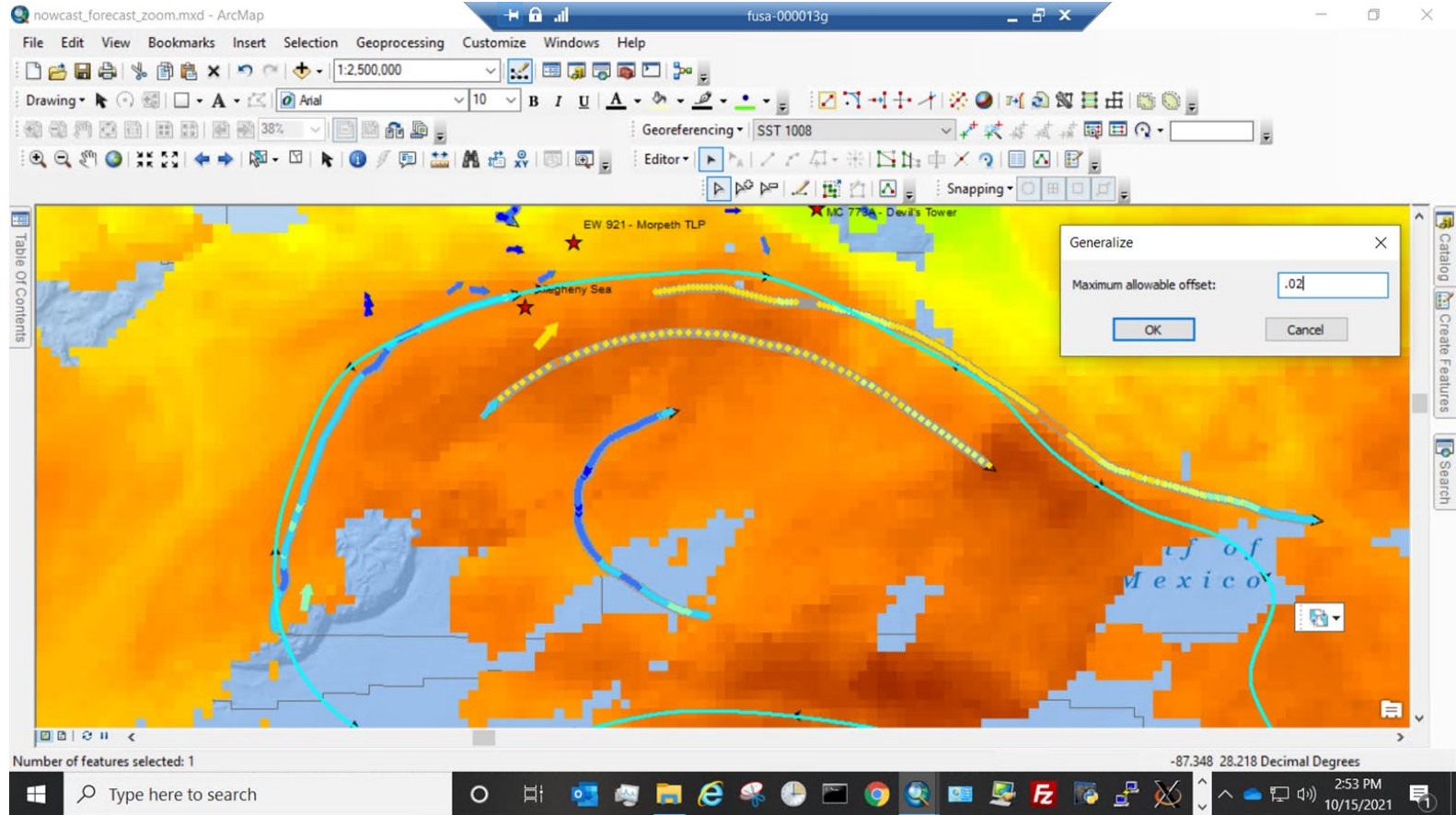




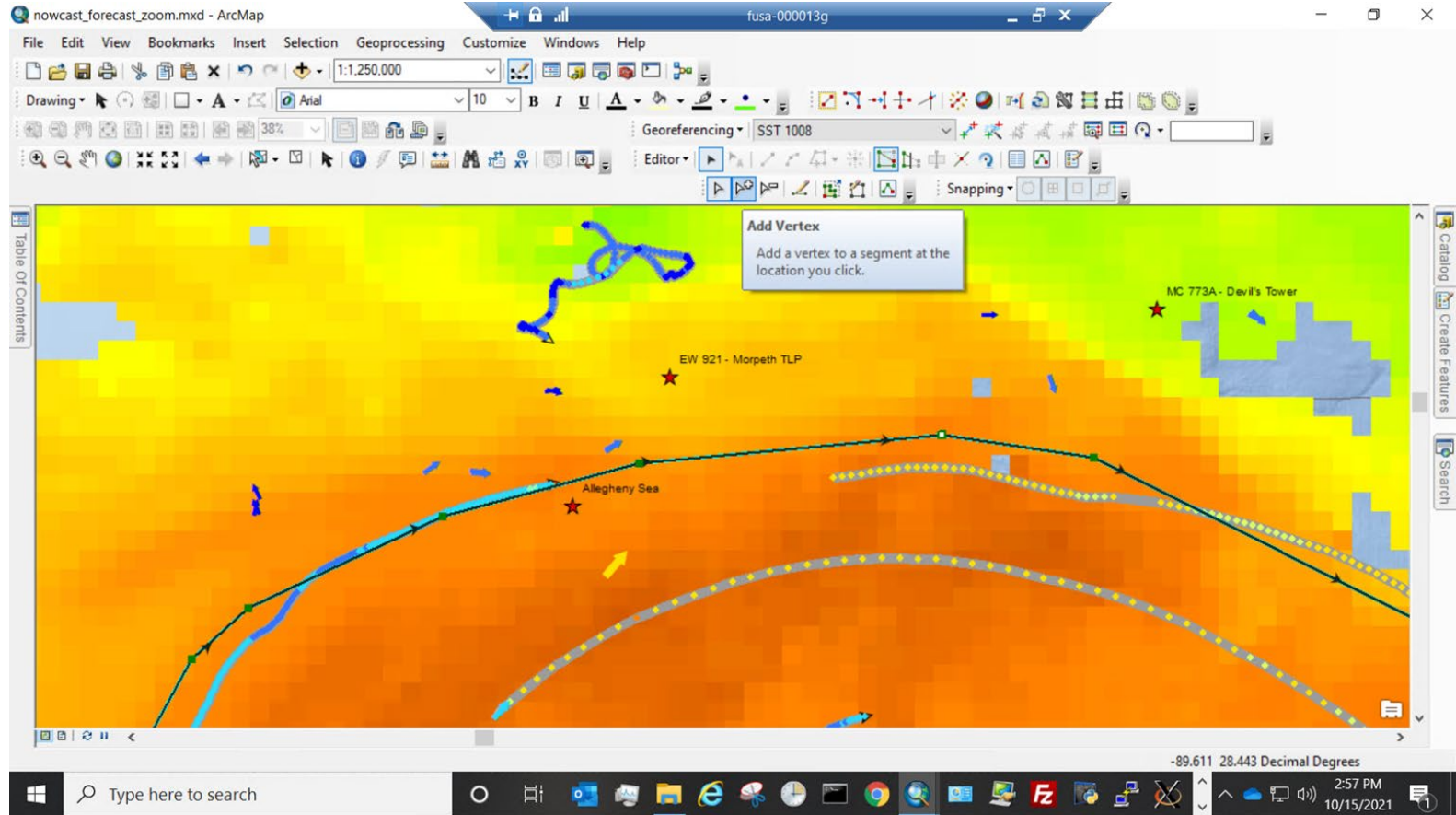
# Frontal Analysis



# Frontal Production

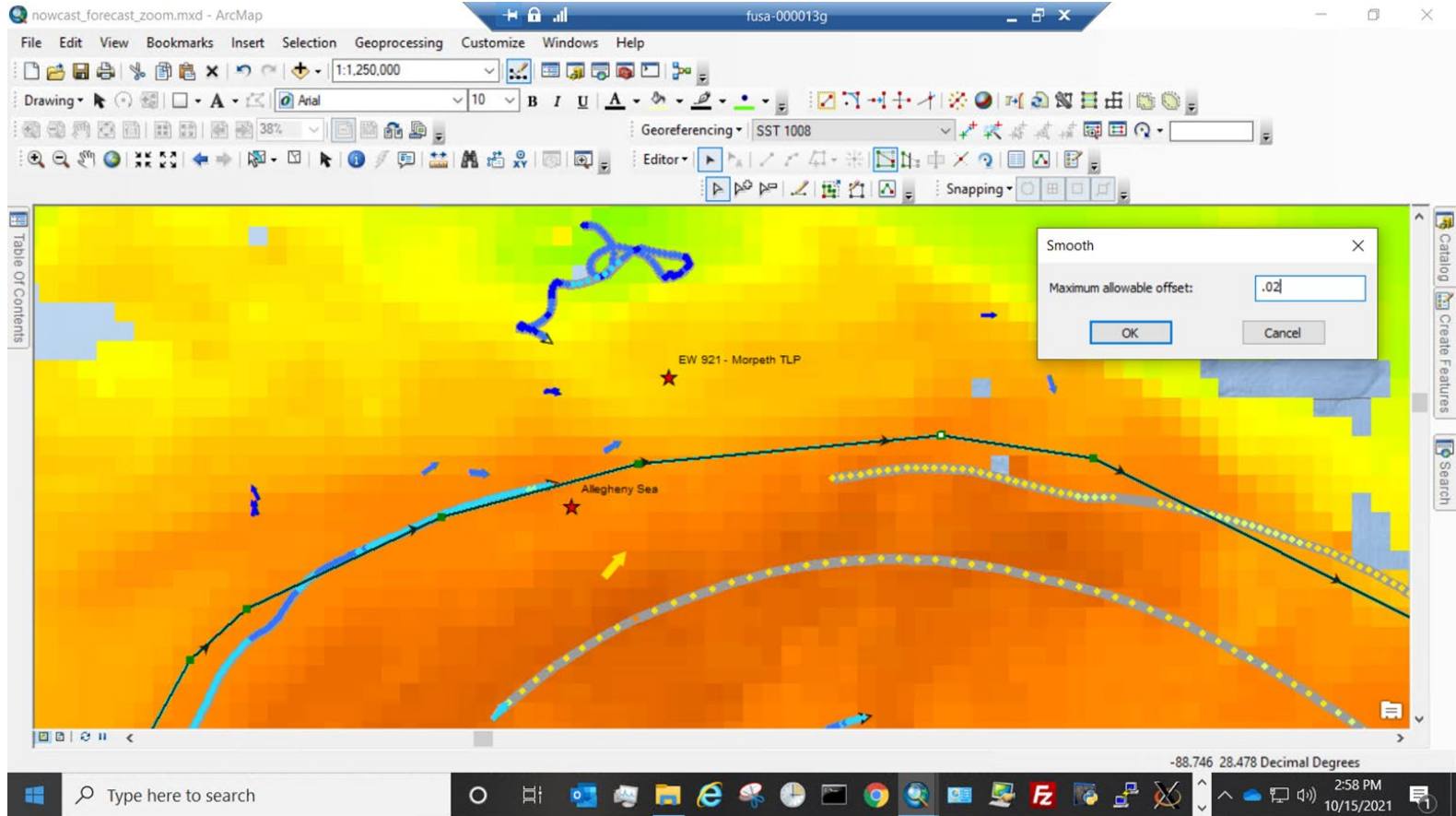


# Front Production

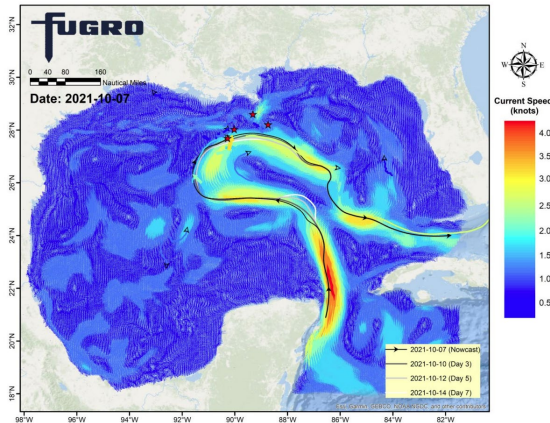




# Front Export



# Loop Current Bulletin



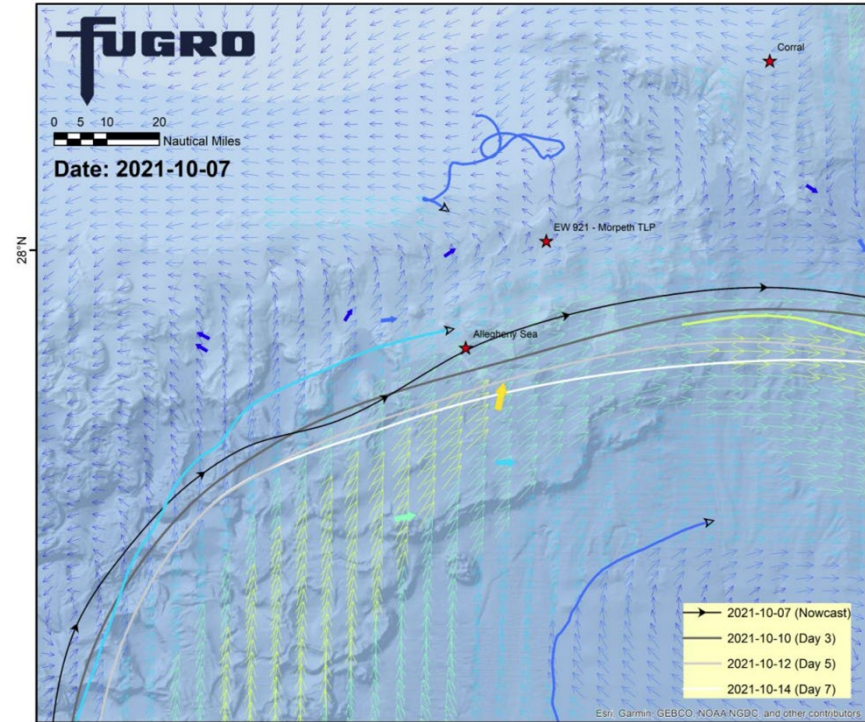
Oceanographer: J. Molina  
Technical Reviewer: R. Schiller

Ocean Model: Global HYCOM  
Region: Gulf of Mexico (GOM)  
Contract Number: F194359  
Client: ENI  
Positions: 28.2086°N, 88.7372°W (Devil's Tower)  
28.0300°N, 90.0200°W (Morpeth TLP); 27.6916°N, 90.2755°W (Allegheny TLP)

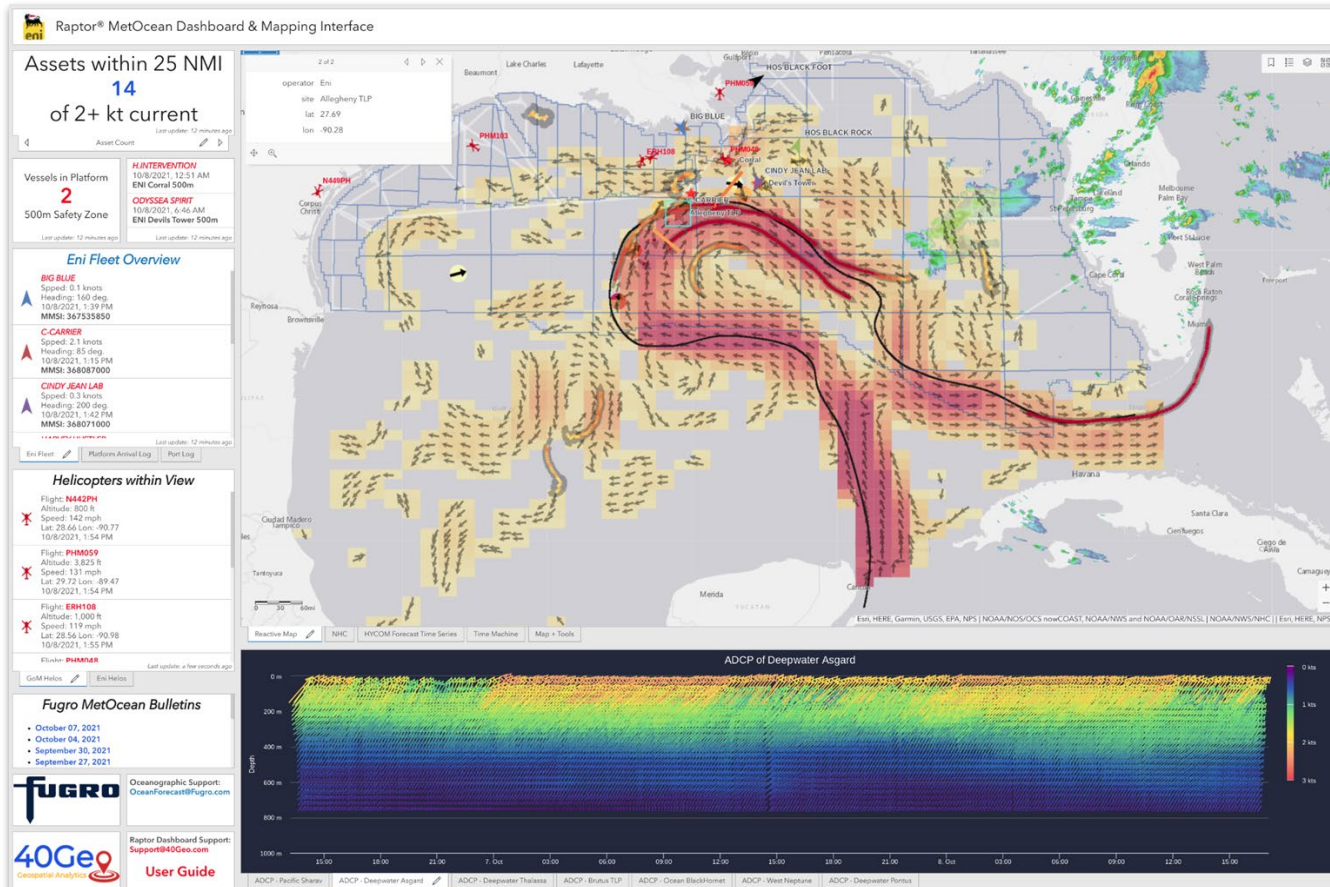
## Current Advisory Bulletin for Allegheny TLP – 7 October 2021

### Loop Current Advisory - Allegheny TLP - 7 October 2021

- The Allegheny TLP site is currently being affected by the Loop Current (LC).
- Based on the measurements in the area, the near-surface currents at the Allegheny TLP site are ~1.0 knot with a northeastward direction. Near-surface current speeds of ~1.0 knot to ~3.0 knots are being observed at nearby rigs.
- 3-day outlook
  - Depending on where the band of high currents are, current speeds near the Allegheny TLP site will remain above ~1.5 knot over the next 3 days.
- 5-day forecast
  - Depending on where the band of high currents are, current speeds near the Allegheny TLP site will remain above ~2.0 knots over the next 5-7 days.



# Common Operating Picture





# Data Aggregation & Analytics



Vessels of Interest: CINDY JEAN LAB

SPEED 0.50  
HEADING 91  
LAT 28.20  
LON -88.74  
COURSE 209  
STATUS under way u  
engine  
TIMESTAMP 10/19/2021  
PM  
SHIPNAME CINDY JEAN  
MMSI 368071000  
IMO 9421398  
CALLSIGN WDK4946  
SHIPTYPE 0  
TYPE\_NAME Passenger Ship

GENERAL\_CLASSIFICATION

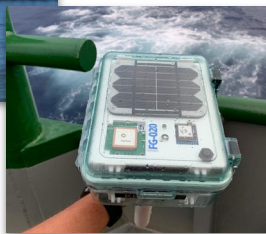
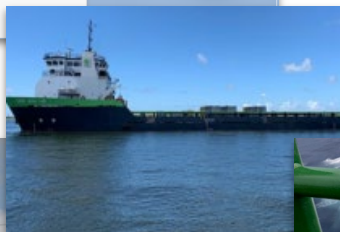
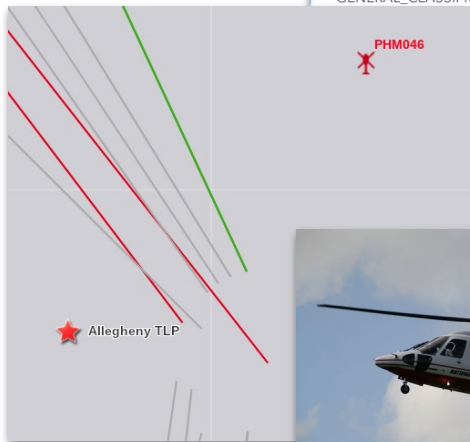


LOCATION  
LENGTH 0  
WIDTH 0

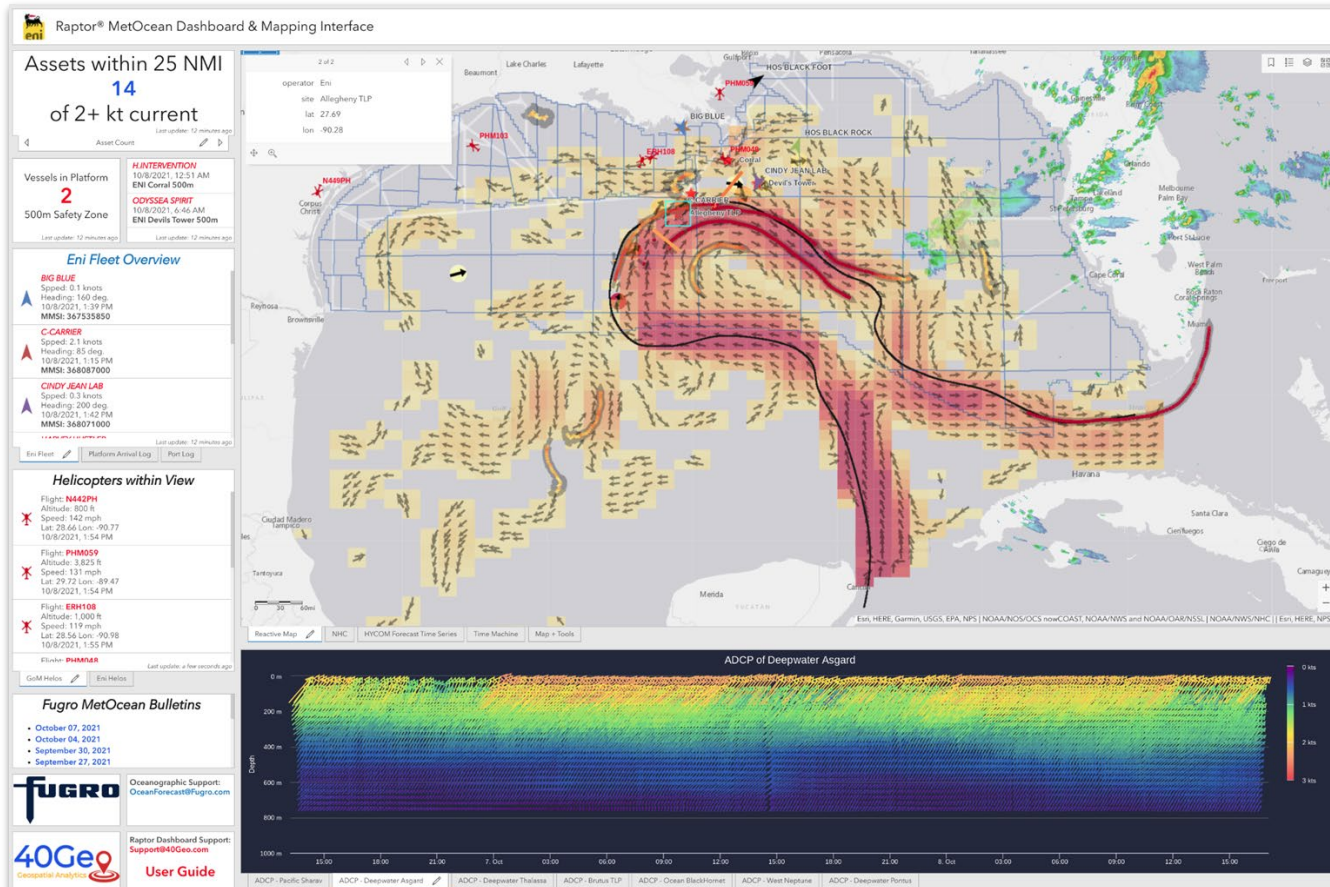


★ Devil's Tower

CINDY JEAN LAB



# Common Operating Picture

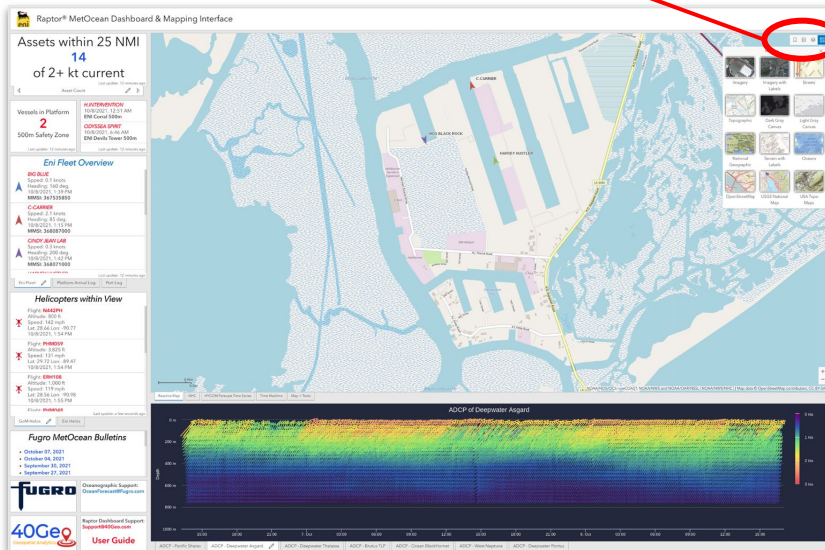
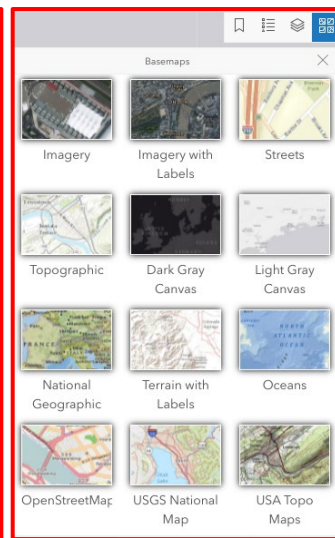
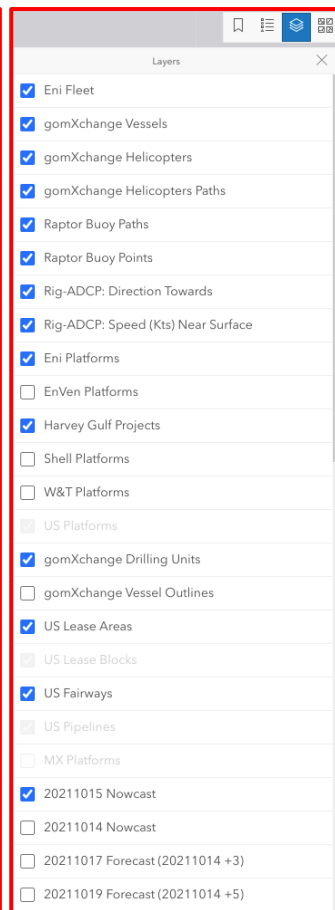
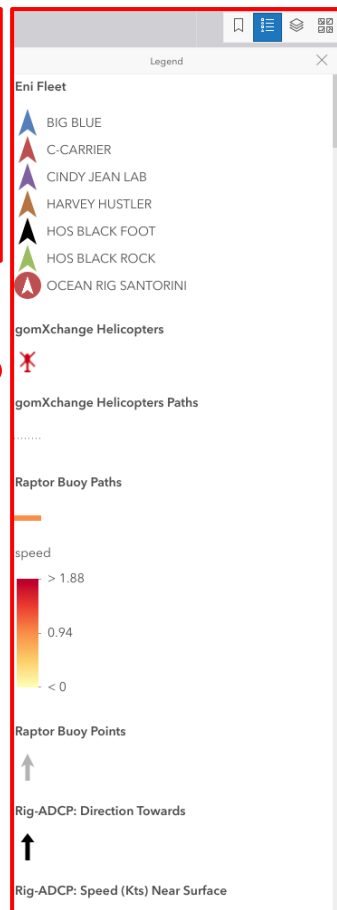
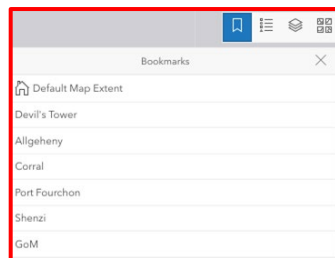




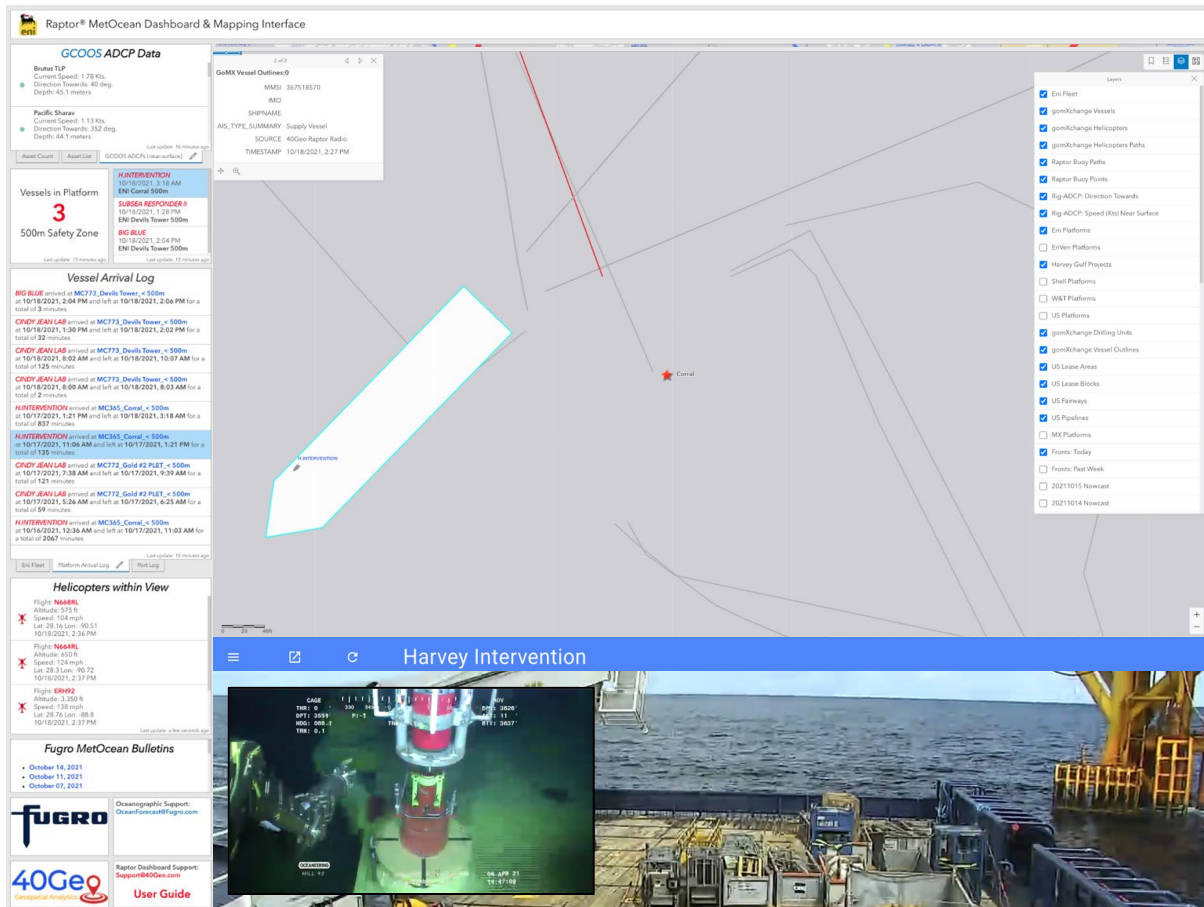
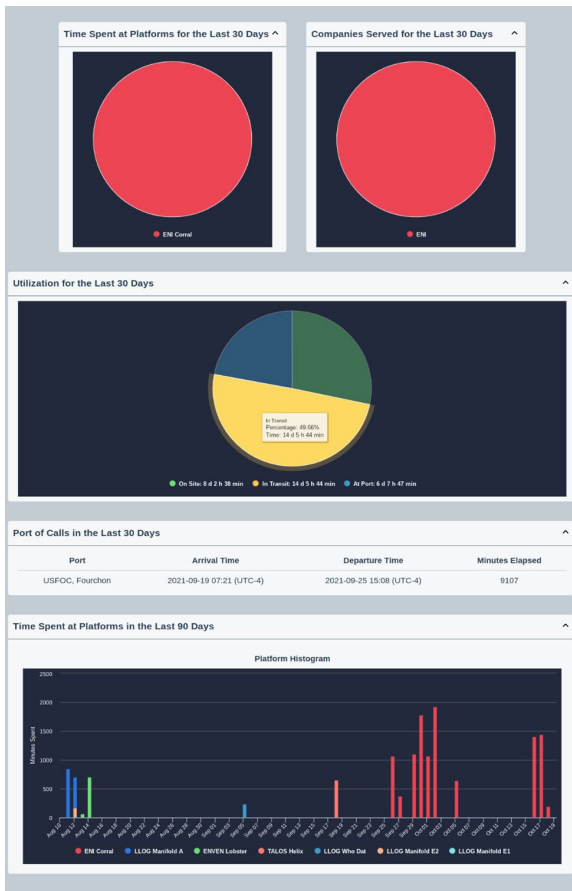
The collage displays various maritime monitoring and mapping software interfaces. The top row shows a dashboard for 'Assets within 25 NMI of 2+ kt current' with a large '28' and a '3' in a red circle. The middle row shows 'Vessels in Platform' with a large '3' and a '3' in a red circle. The bottom row shows 'Eni Fleet Overview' and 'Vessel Arrival Log' with a '3' in a red circle. Other screenshots include 'GCOOS ADCP Data', 'Fugro MetOcean Bulletins', '40Geo' login page, and 'Helicopters within View'.



# Map Features



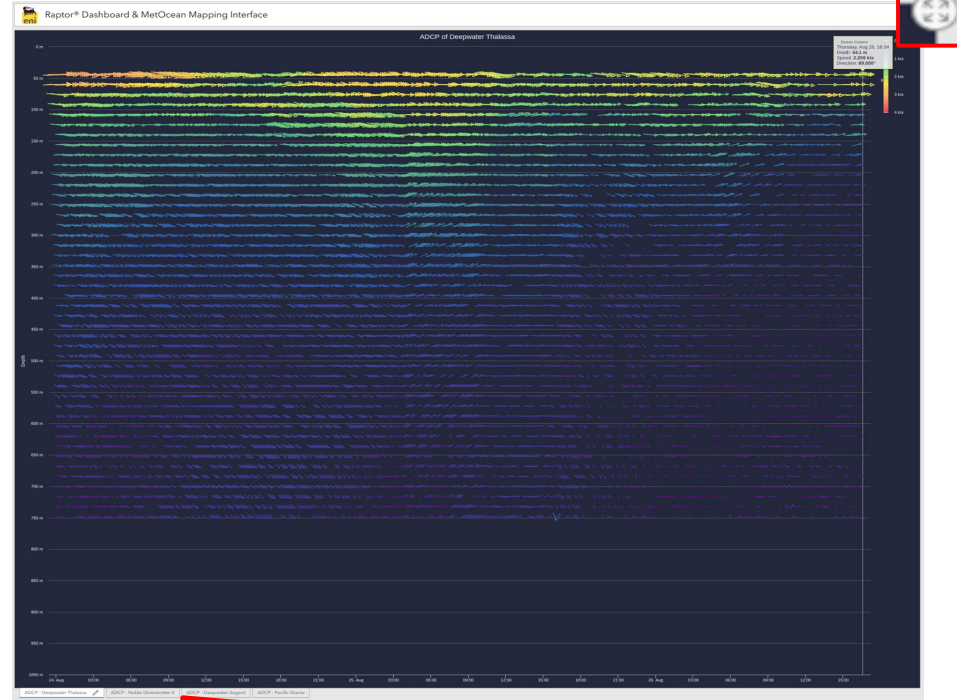
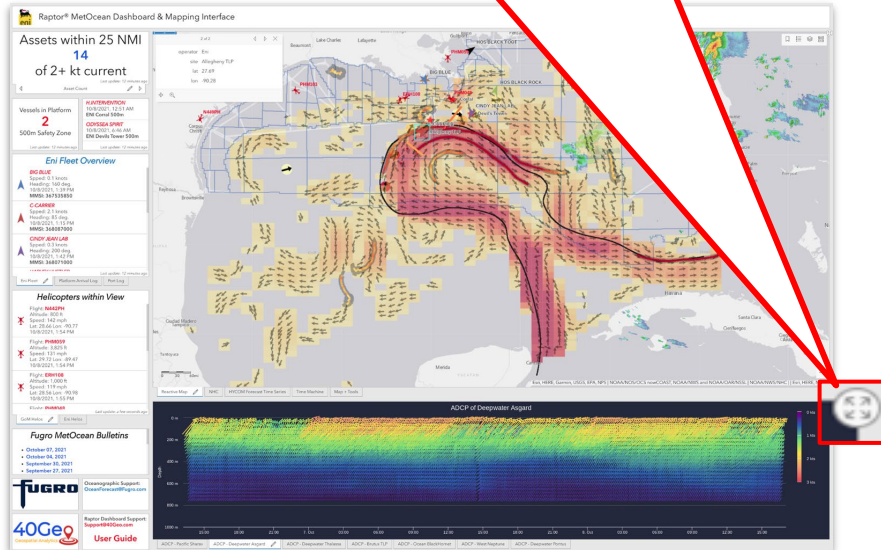
# Dynamic Mapping + Live Video + Vessel Analytics



# Data Rich Environment

Nearby Rig -ADCP data (in profile)  
are provided as a timeseries.

- Clicking top right button expands window.
- Clicking on the top right button will return the interface to standard configuration.



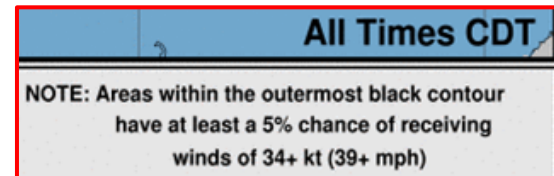
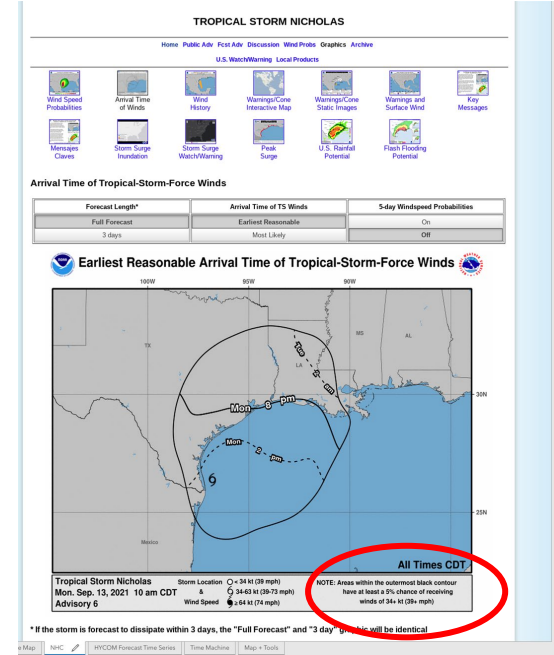
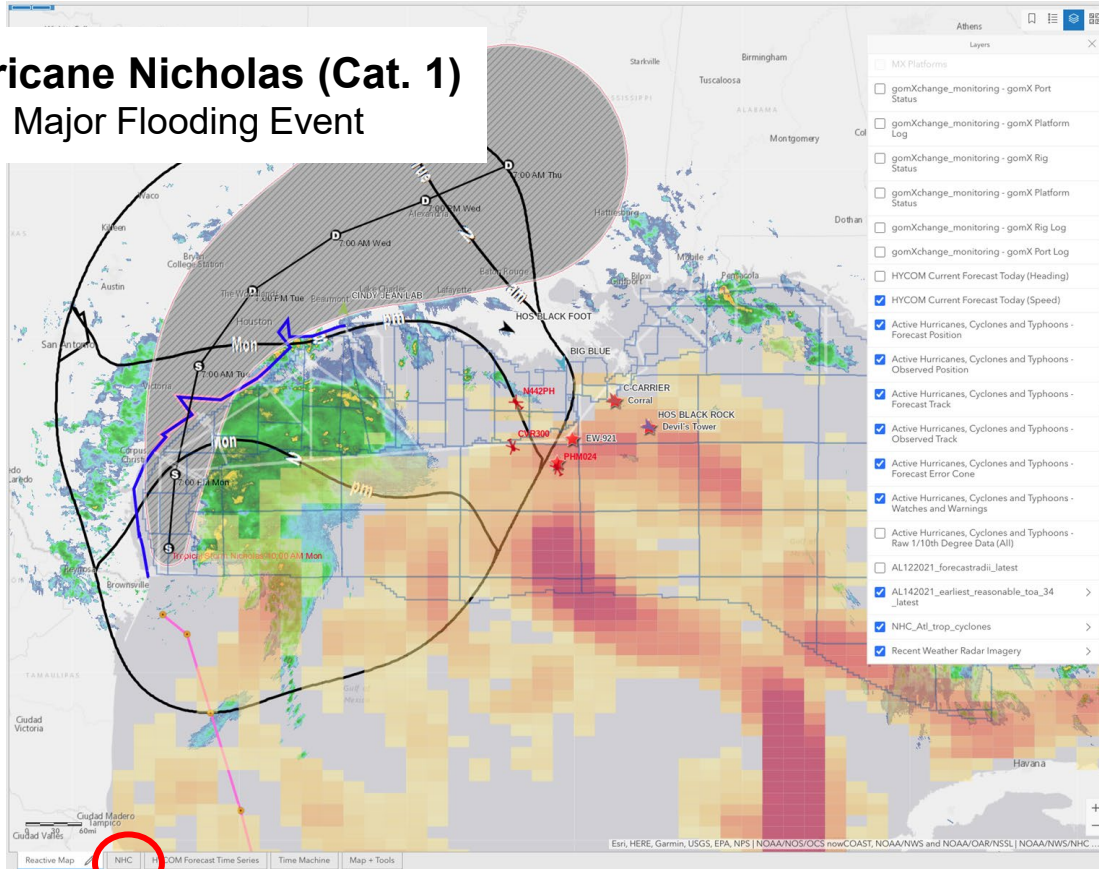
Tabs across the bottom of the window display ADCP data from other rigs.



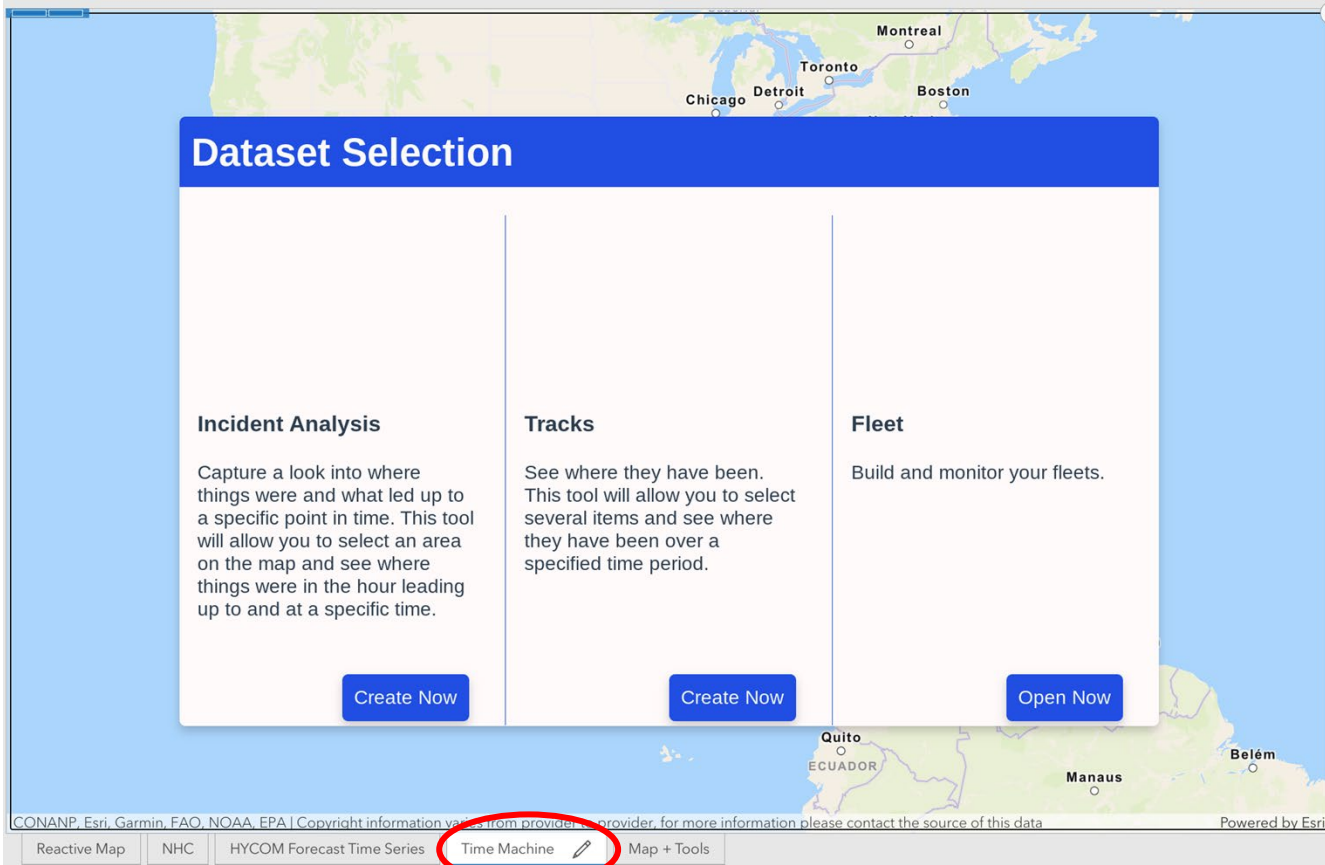
# Source Data

## Hurricane Nicholas (Cat. 1)

- Major Flooding Event



# AIS Data



The screenshot displays a web application interface for AIS Data. A map of North America is visible in the background, with cities like Chicago, Detroit, Toronto, Montreal, and Boston labeled. Overlaid on the map is a 'Dataset Selection' panel with a blue header. The panel contains three columns: 'Incident Analysis', 'Tracks', and 'Fleet'. Each column has a description and a button at the bottom. The 'Incident Analysis' and 'Tracks' columns have a 'Create Now' button, while the 'Fleet' column has an 'Open Now' button. At the bottom of the interface, there is a footer with copyright information and a navigation bar. The 'Time Machine' button in the navigation bar is circled in red.

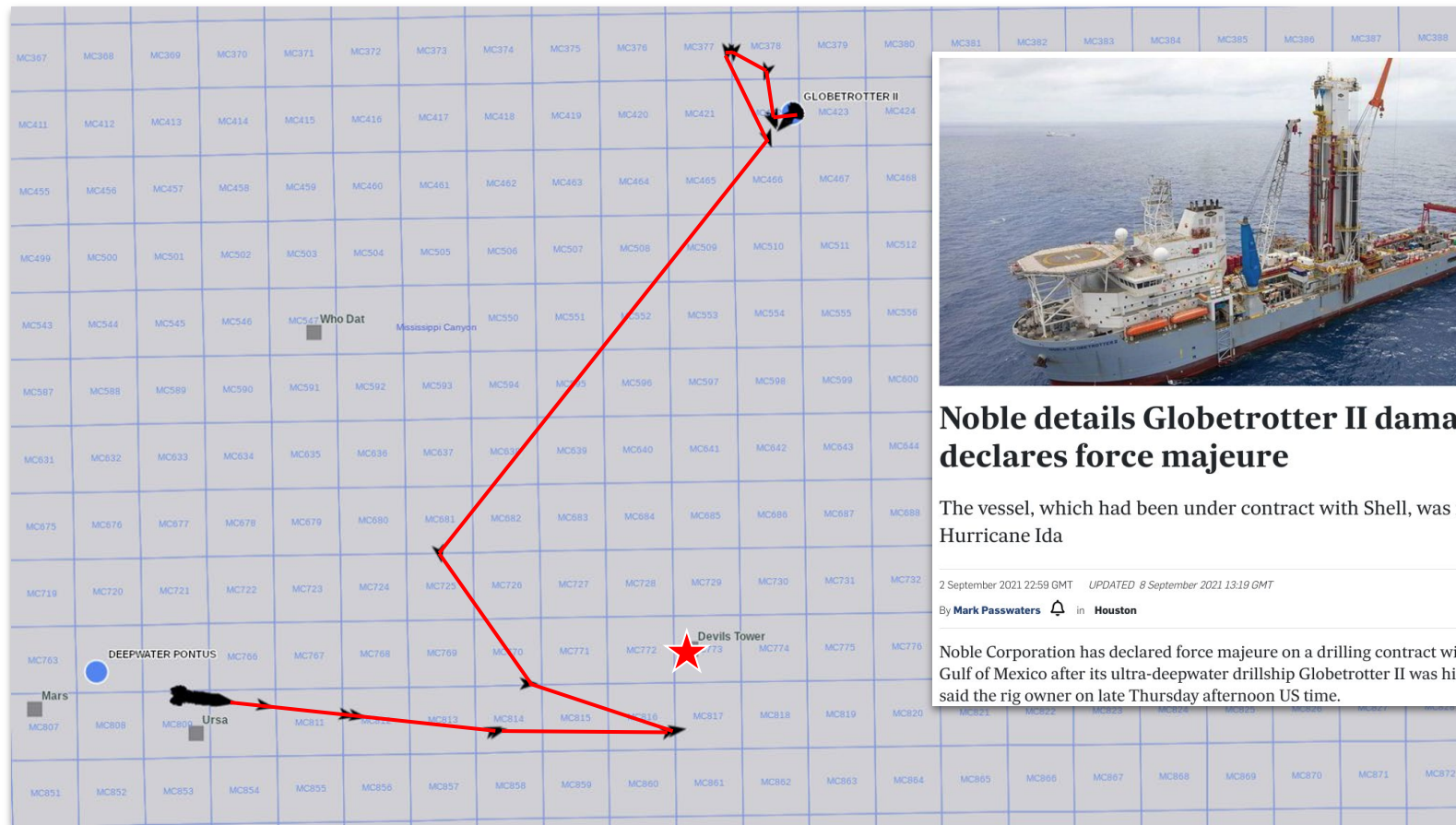
## Dataset Selection

Incident Analysis	Tracks	Fleet
Capture a look into where things were and what led up to a specific point in time. This tool will allow you to select an area on the map and see where things were in the hour leading up to and at a specific time.	See where they have been. This tool will allow you to select several items and see where they have been over a specified time period.	Build and monitor your fleets.
<a href="#">Create Now</a>	<a href="#">Create Now</a>	<a href="#">Open Now</a>

CONANP, Esri, Garmin, FAO, NOAA, EPA | Copyright information varies from providers. For more information please contact the source of this data. Powered by Esri

Reactive Map | NHC | HYCOM Forecast Time Series | **Time Machine** | Map + Tools

# AIS Data – Incident Analysis



## Noble details Globetrotter II damage, declares force majeure

The vessel, which had been under contract with Shell, was impacted by Hurricane Ida

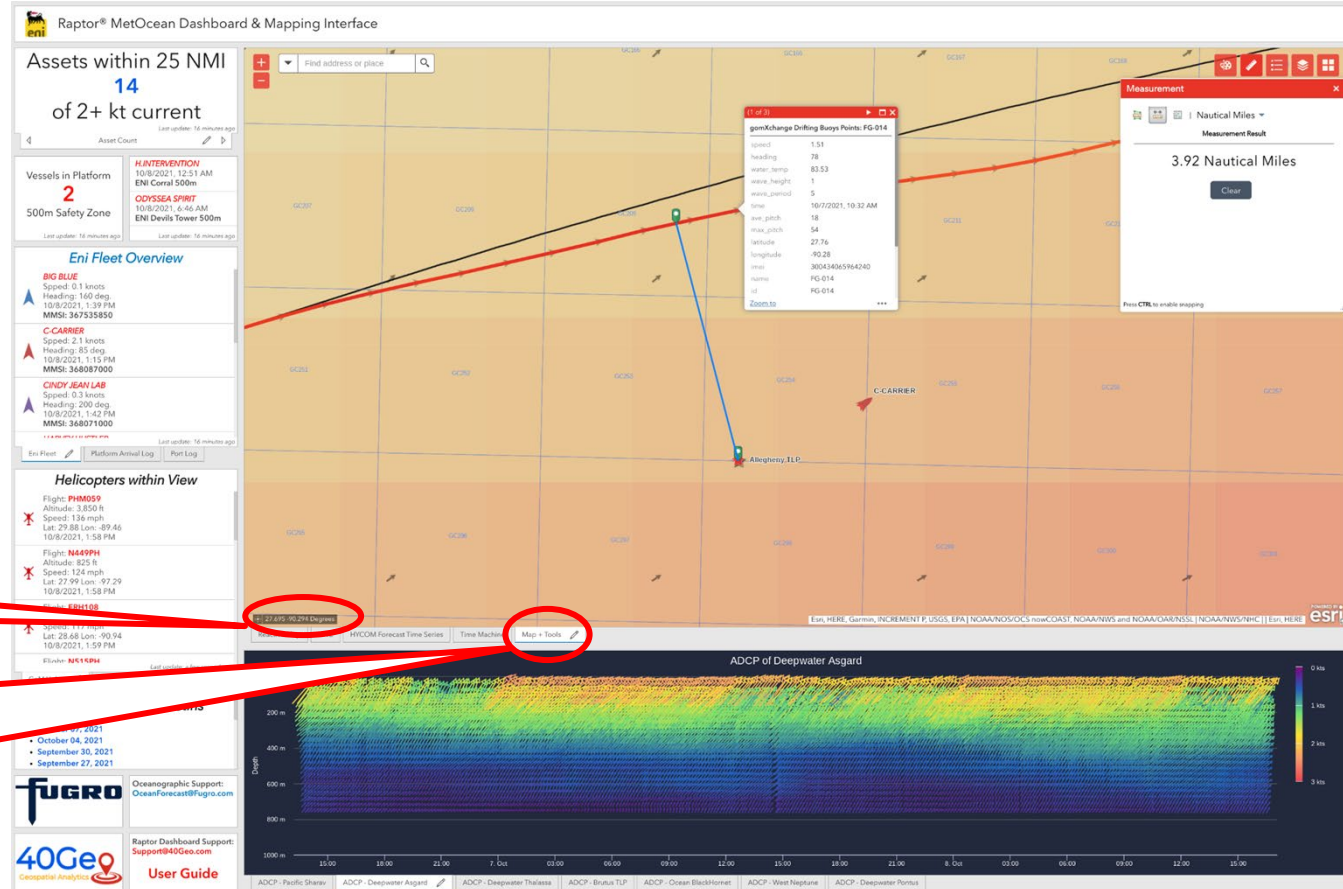
2 September 2021 22:59 GMT UPDATED: 8 September 2021 13:19 GMT

By **Mark Passwaters** in **Houston**

Noble Corporation has declared force majeure on a drilling contract with Shell in the US Gulf of Mexico after its ultra-deepwater drillship Globetrotter II was hit by Hurricane Ida, said the rig owner on late Thursday afternoon US time.



# Map Tools



Measure  
area &  
Distance

Layer  
Selection

Annotation

Map  
Background

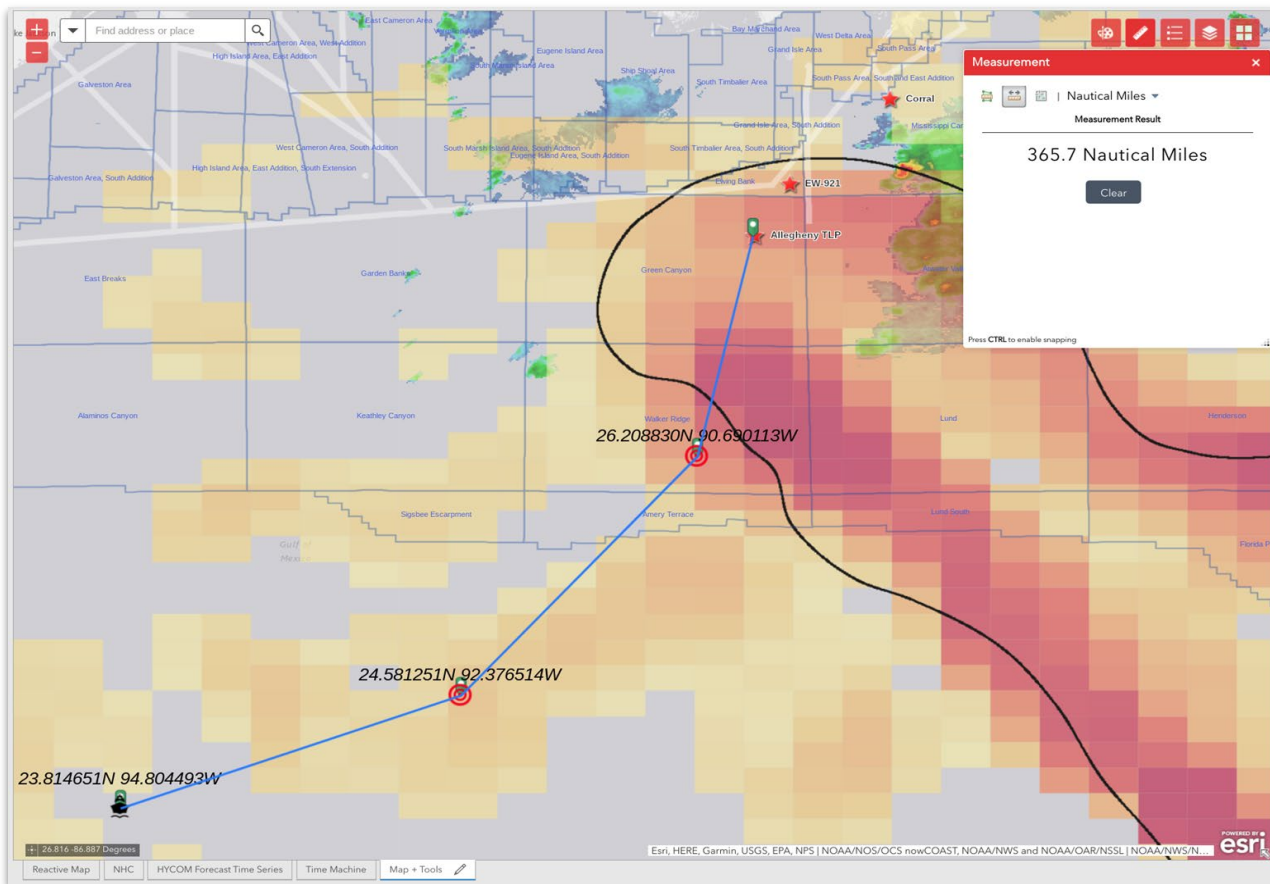
Layers  
Legend

Longitude &  
Latitude of cursor

Map + Tools\*

\*is *not* Dashboard  
'reactive'

# Map Tools – Plan & Communicate



The Draw tool panel is shown on the right side of the map. It includes a 'Select draw mode' section with icons for various drawing tools. A 'Preview' section shows a target symbol. Below this is a 'Basic' section with a grid of symbols. The 'Symbol size' is set to 30. The 'Show location measurement' toggle is turned on. The 'Unit' is set to Degrees. The 'Font color' is black. The 'Font size' is set to 24. At the bottom are 'Undo', 'Redo', and 'Clear' buttons.

Draw

Select draw mode

Preview:

Basic

Symbol size: 30

Show location measurement

Unit: Degrees

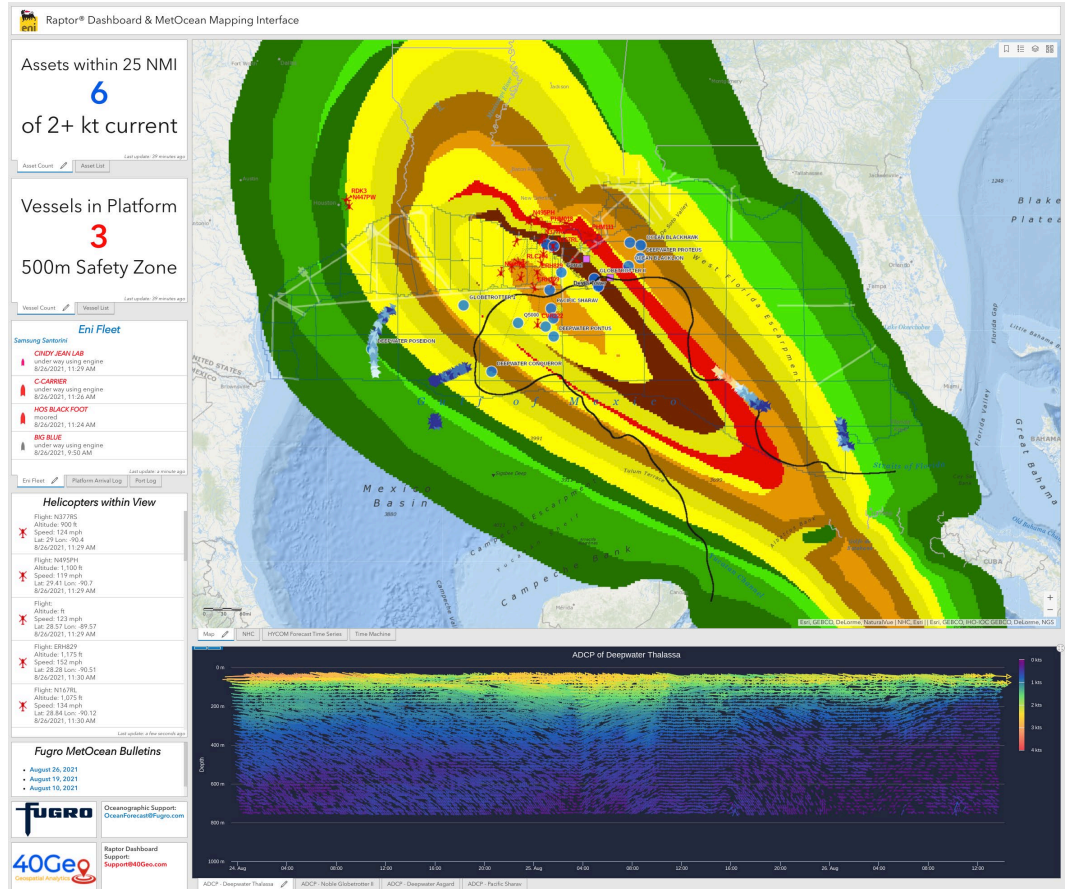
Font color:

Font size: 24

Undo Redo Clear

# Summary

**Common Operating Picture**  
*delivers*  
**Maritime Domain Awareness**  
*creates*  
**Actionable Intelligence**





# Data, Analytics, Visualization

## *The Three -Legged Maritime Domain Awareness Stool*

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