Operational Forecasting of Winds and Waves at the NOAA Ocean Prediction Center

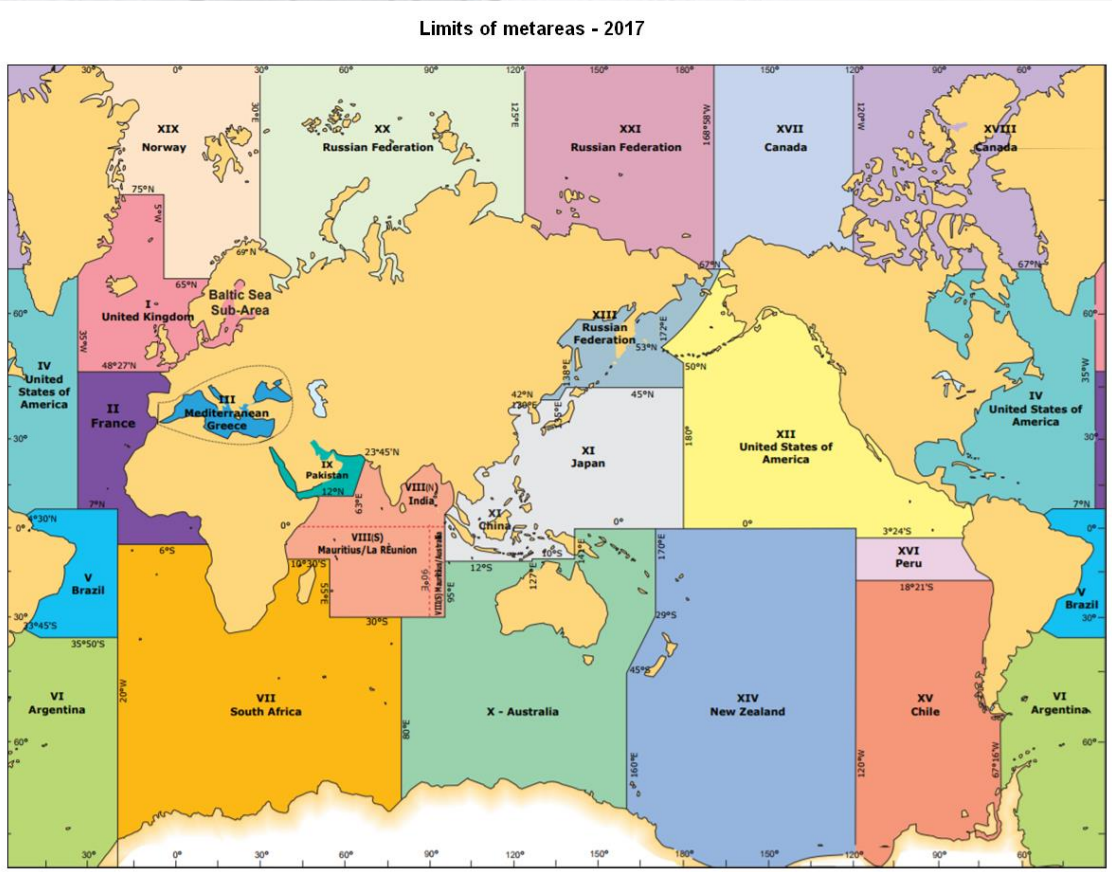
Outline

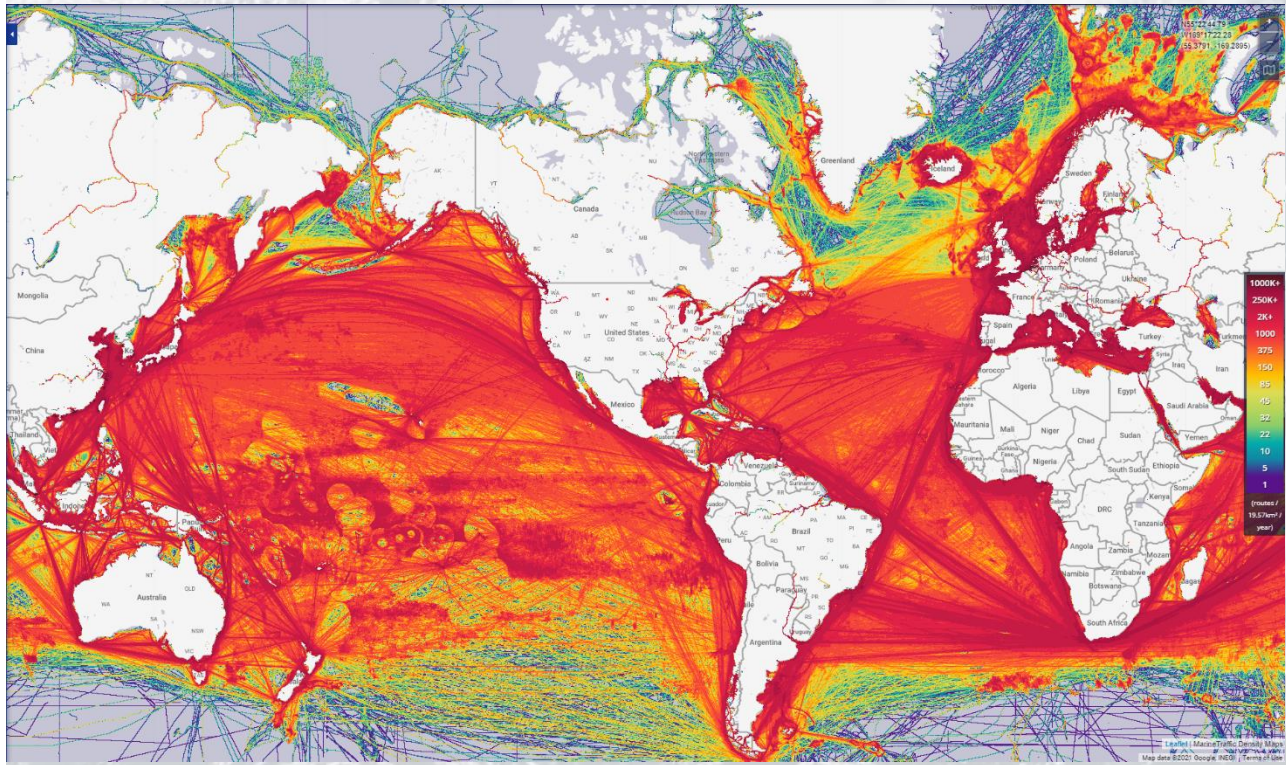
NOAA/NWS Mission
Situational Awareness
- Environmental
- Vessel Locations

Challenges
- Impactful scales, interactions
- “Dangerous seas”
- Modernizing marine weather services

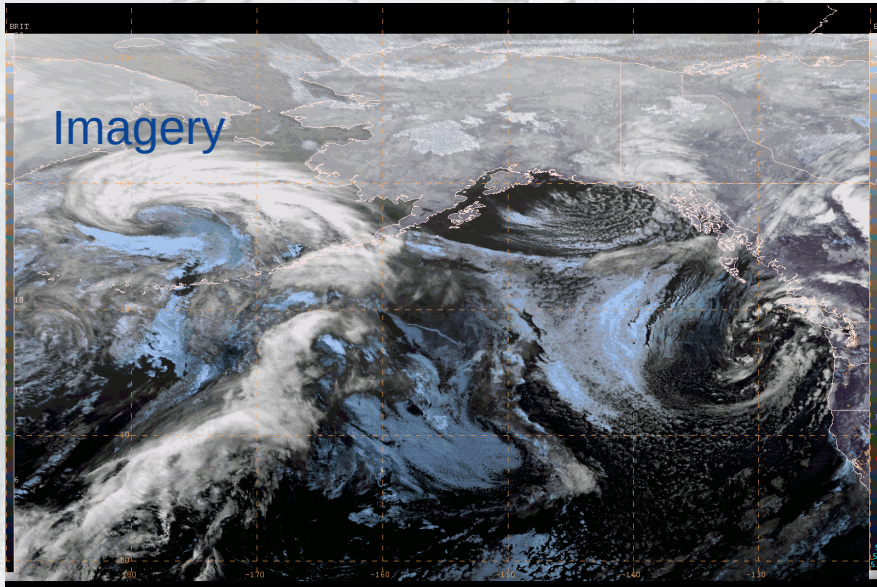
Ocean Prediction Center
Joseph M. Sienkiewicz
Frances T. Achorn

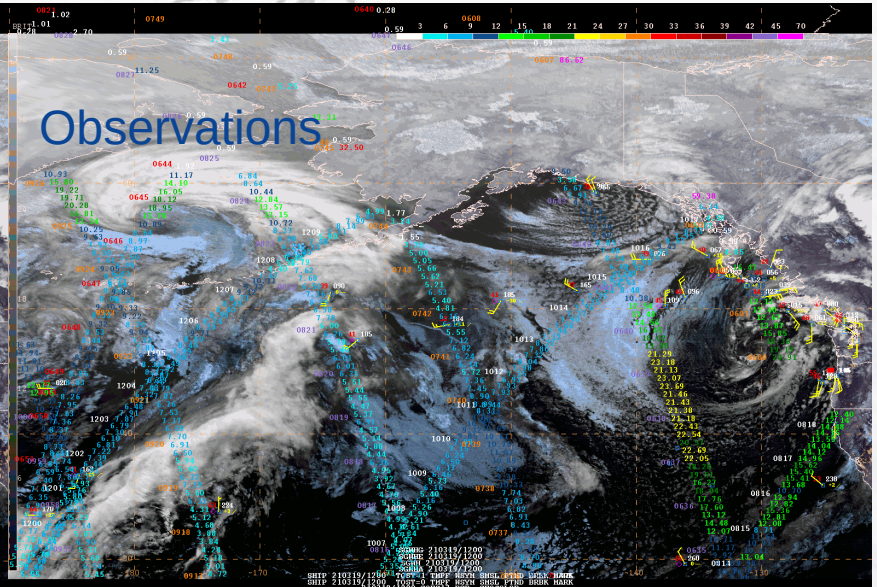
NOAA/NWS Mission: Provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.

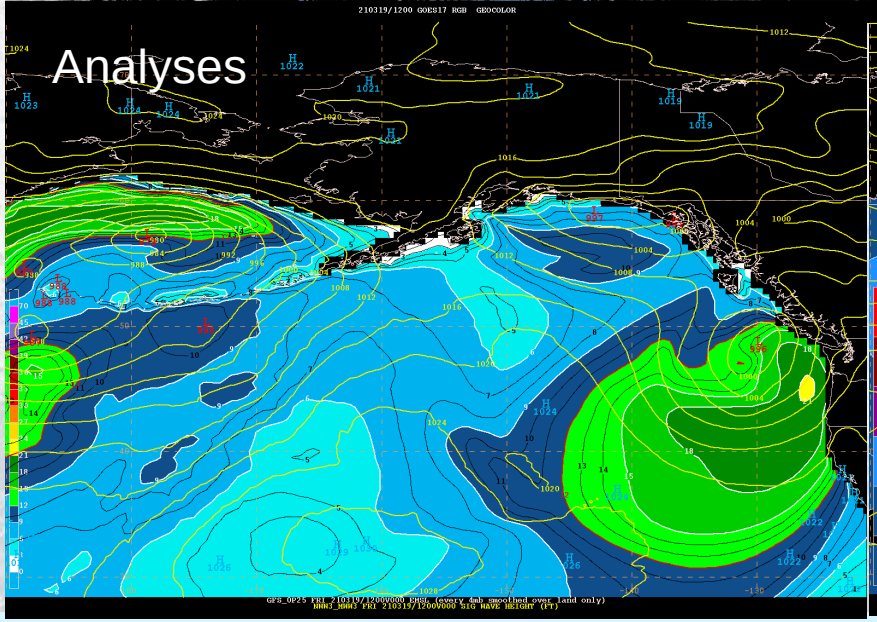


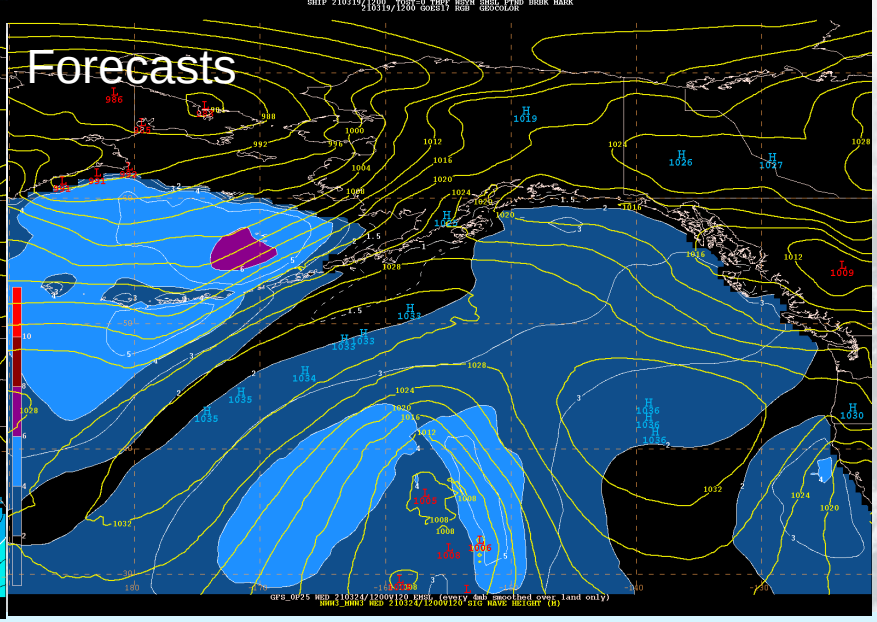


Situational Awareness - Environmental

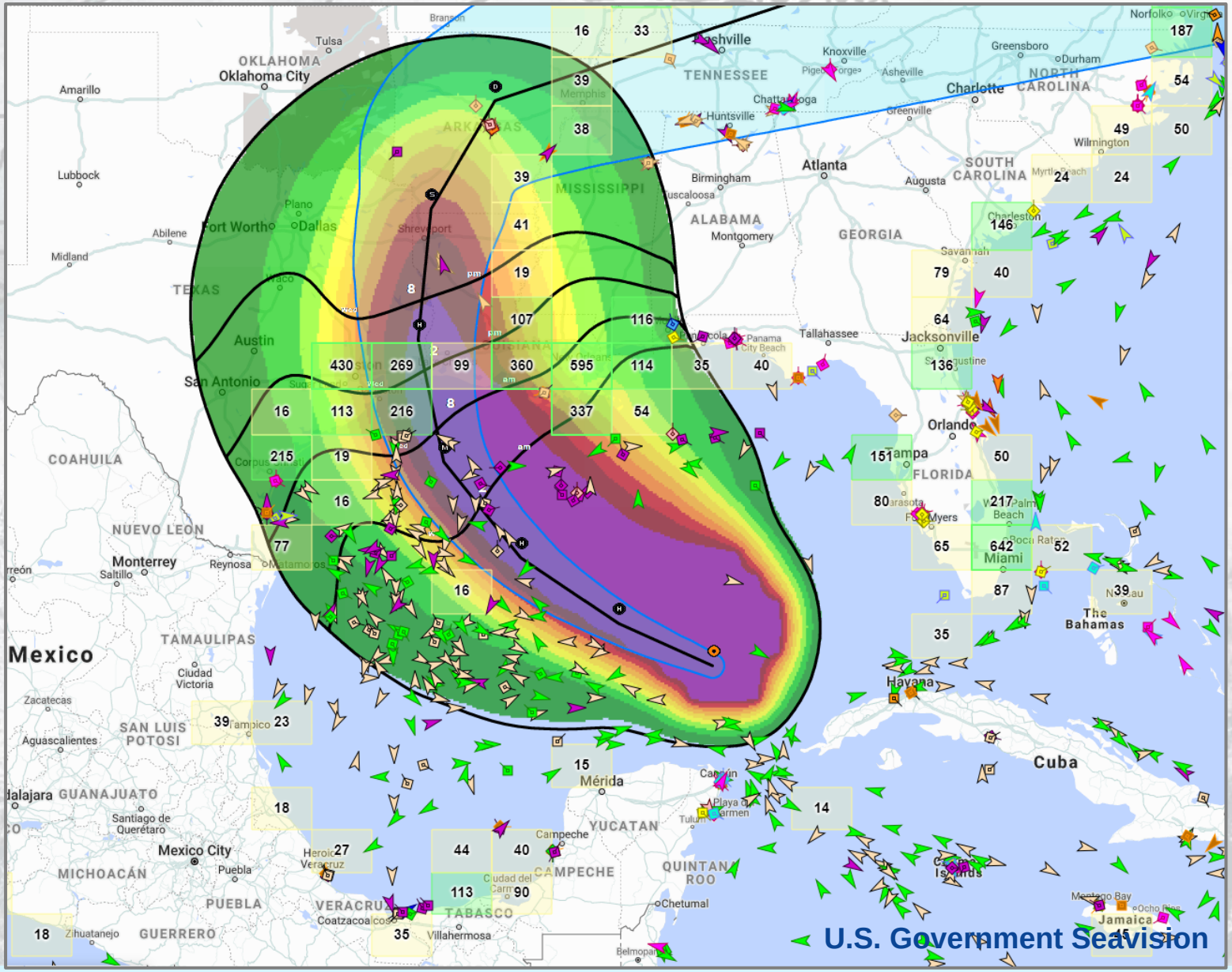




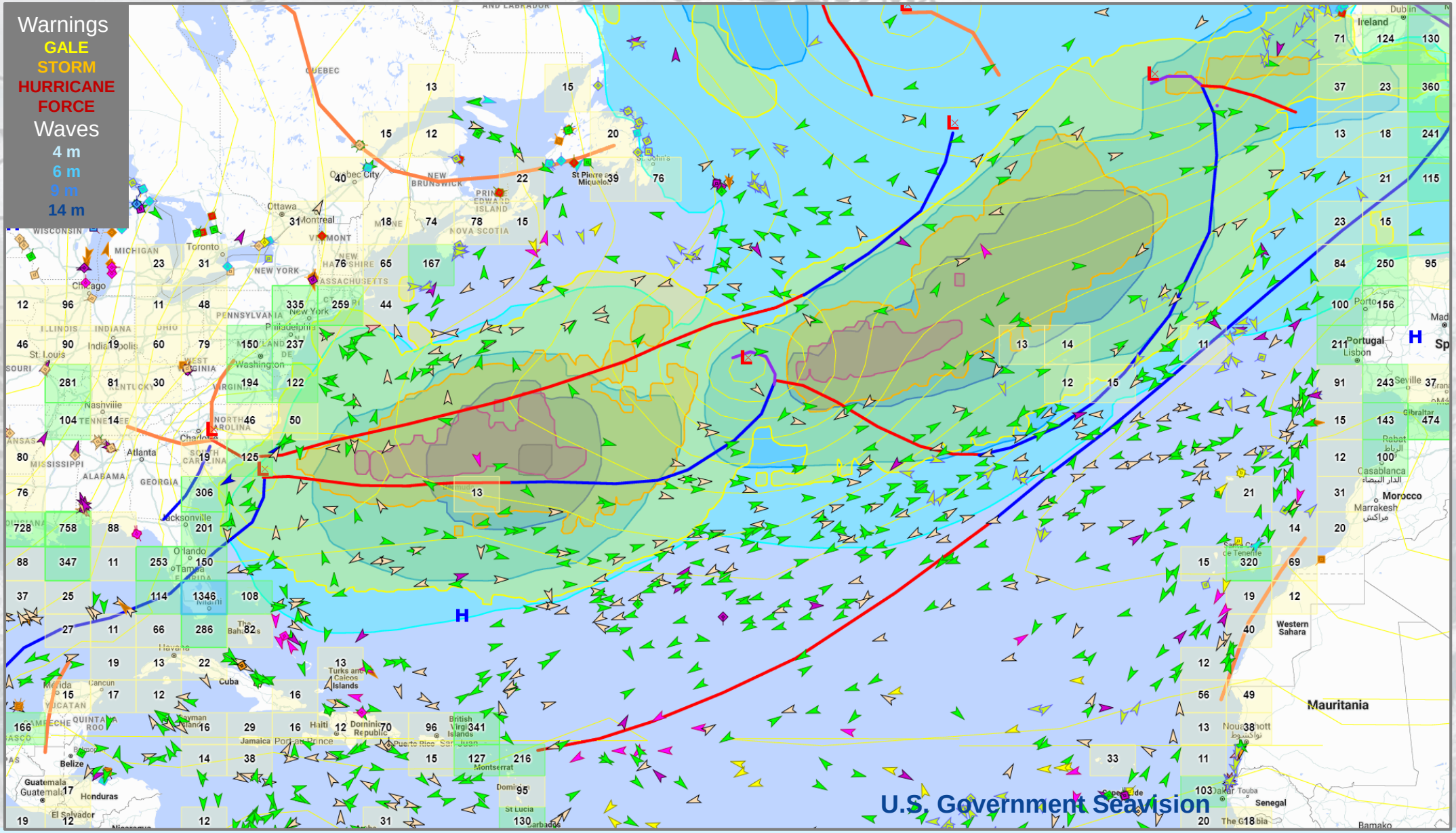




Situational Awareness - Vessel Locations

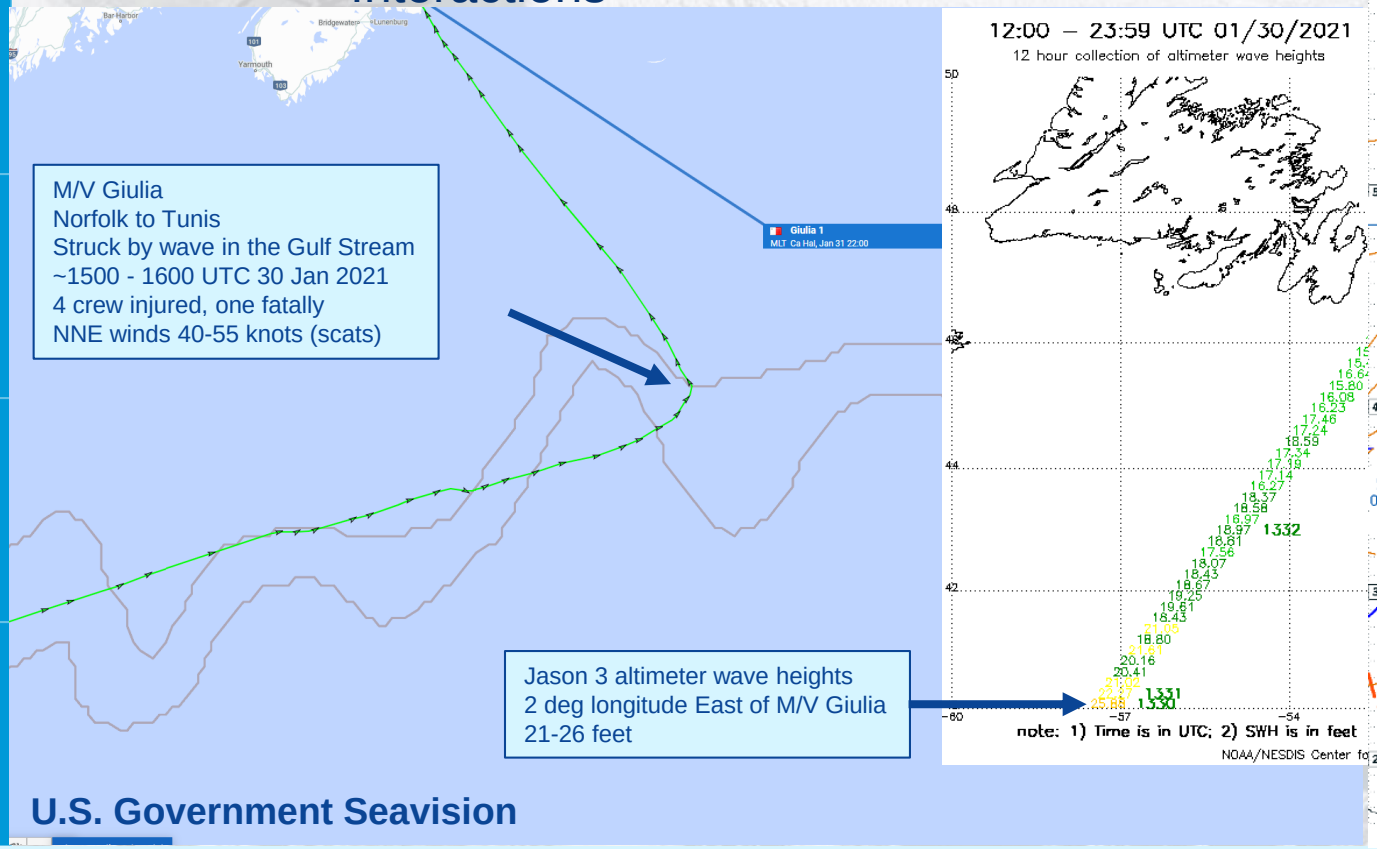


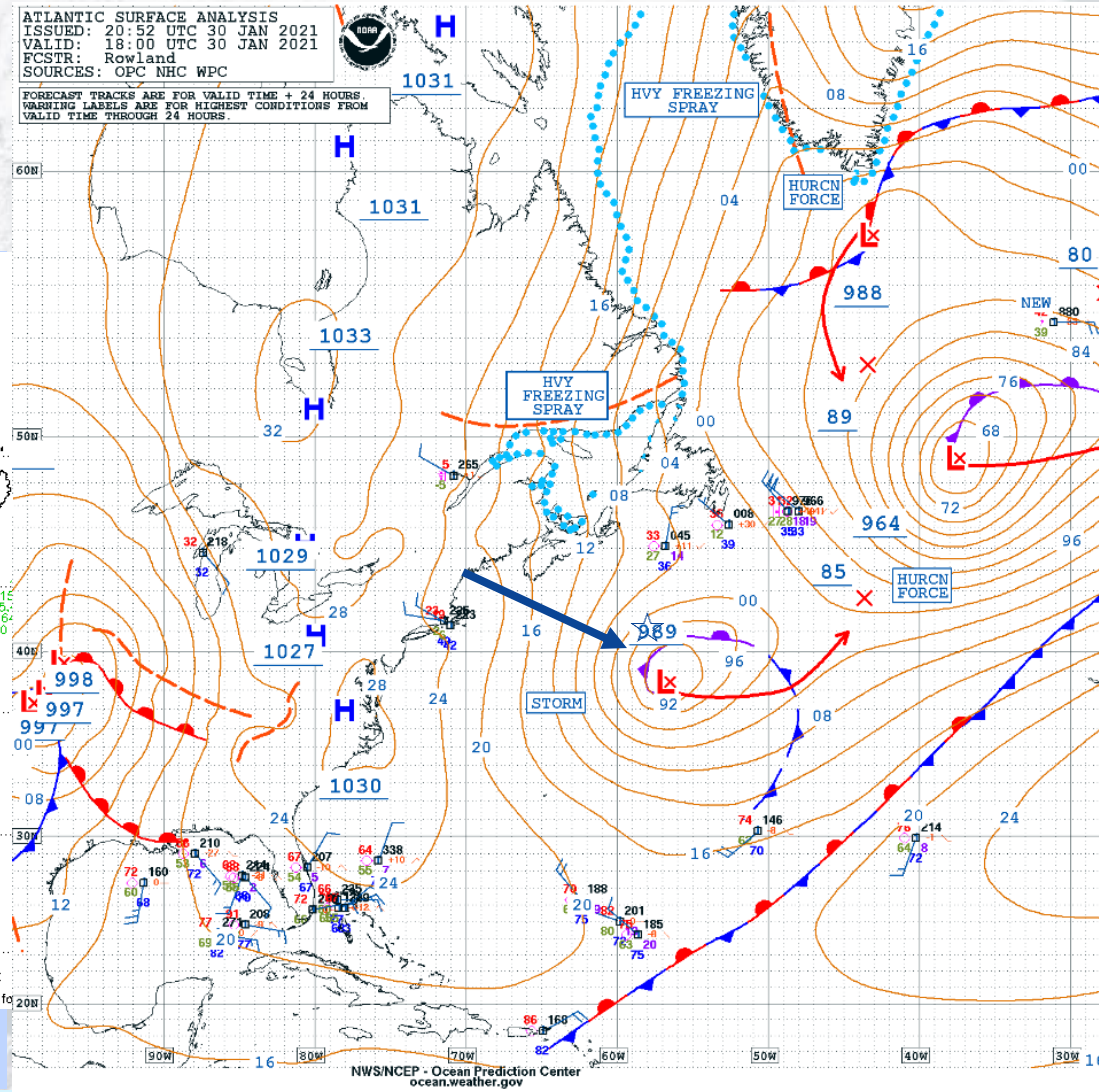
Situational Awareness - Vessel Locations



Challenges – wind, wave, current interactions

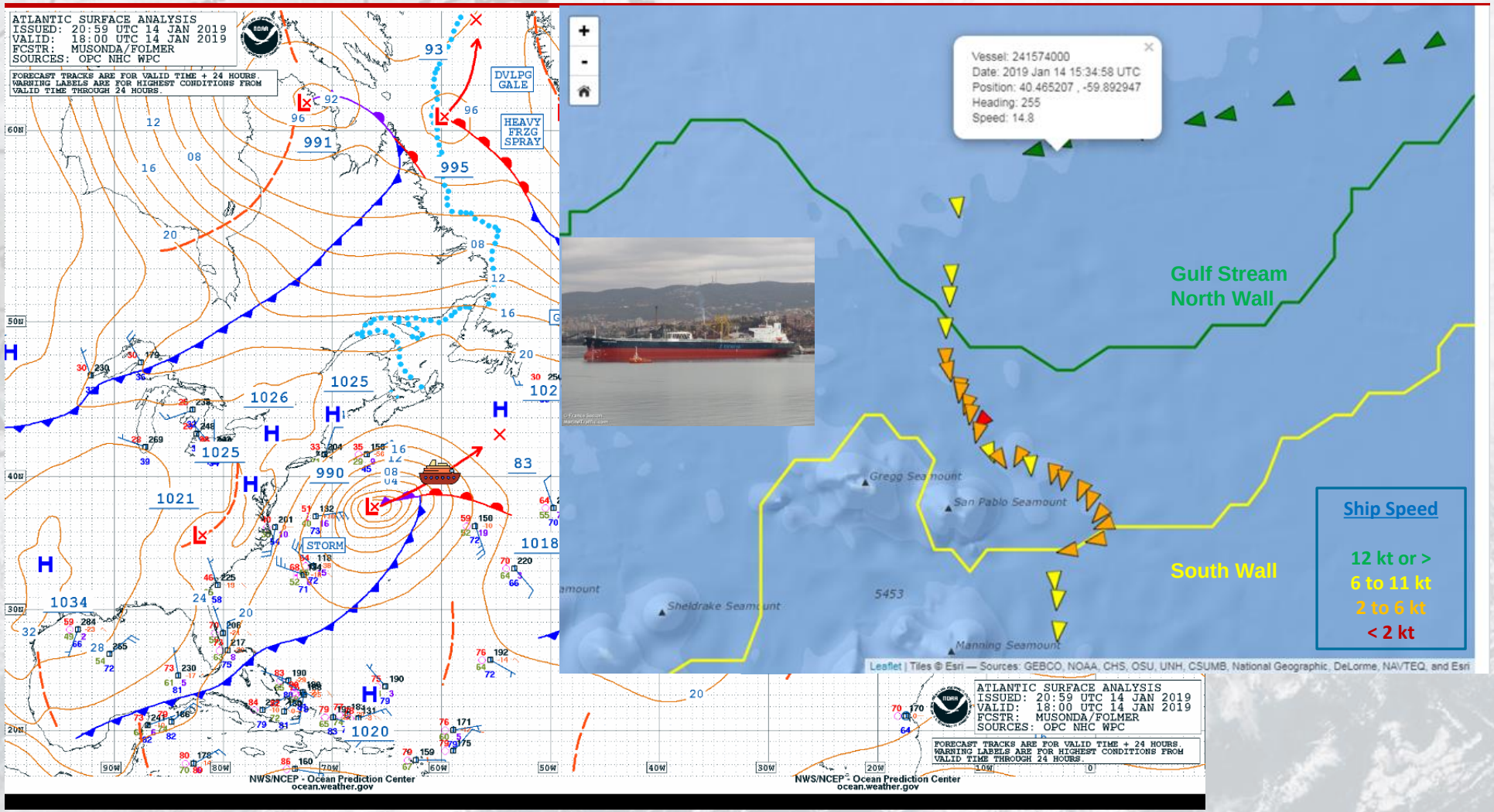
- Scales (observing and prediction)
- Representative current
  - Resolution, gradients, location
  - Interactions



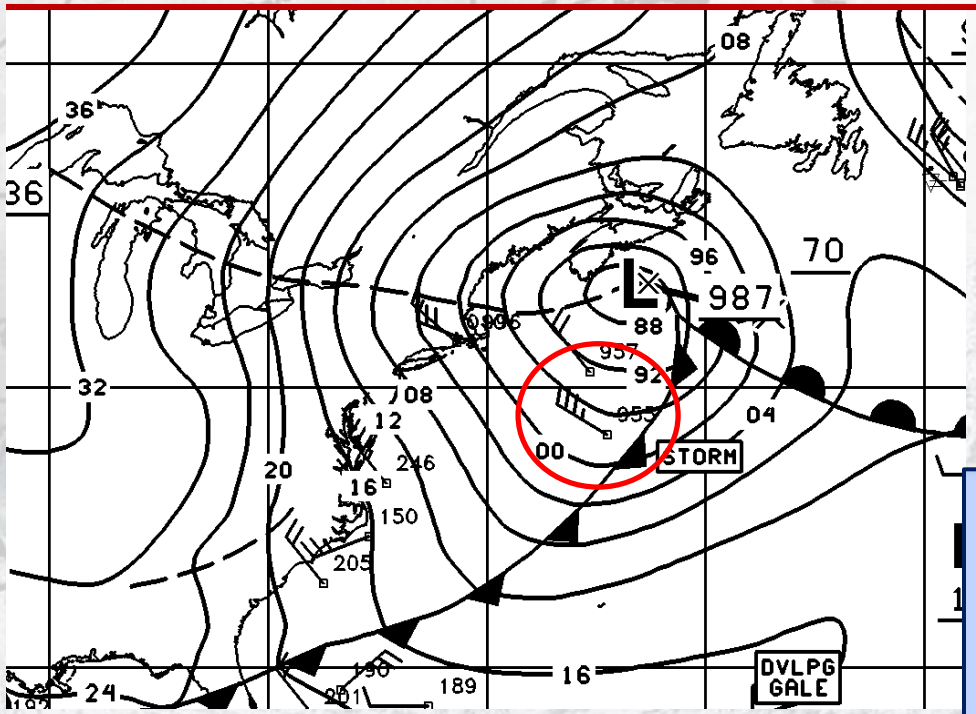


U.S. Government Seavision

Challenges – wind, wave, current interactions

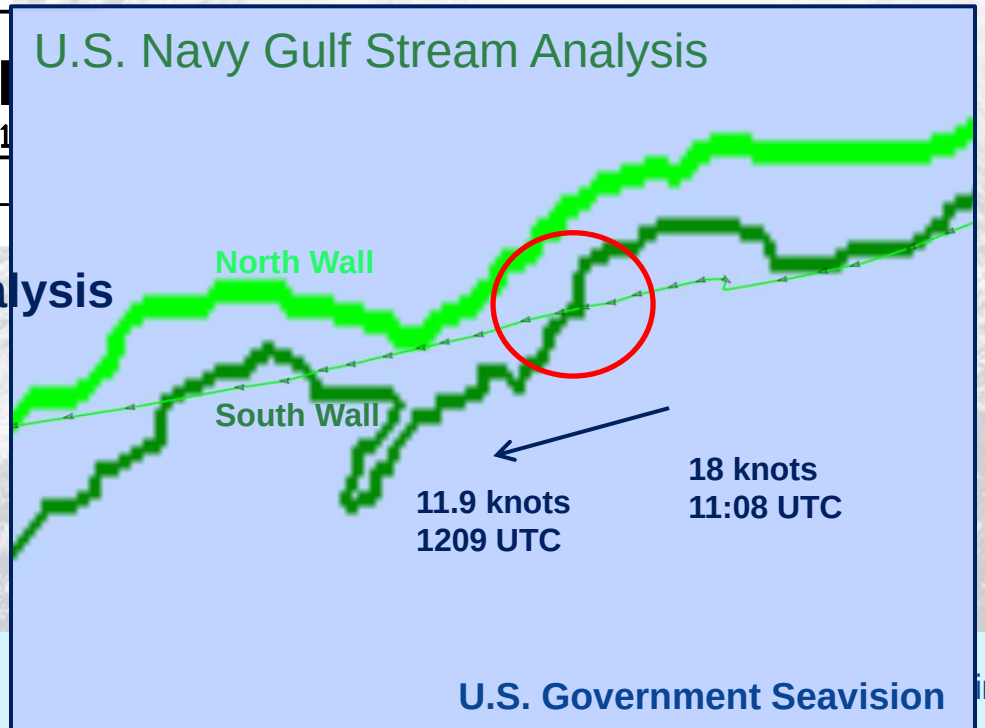


Extreme Maritime Weather – Challenge – Observations, Prediction



1200 UTC 28 Nov 2019 OPC Surface Analysis

***C/V Maersk Ohio* track 28 Nov 2019**



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Extreme Maritime Weather – Challenge – Observations, Prediction

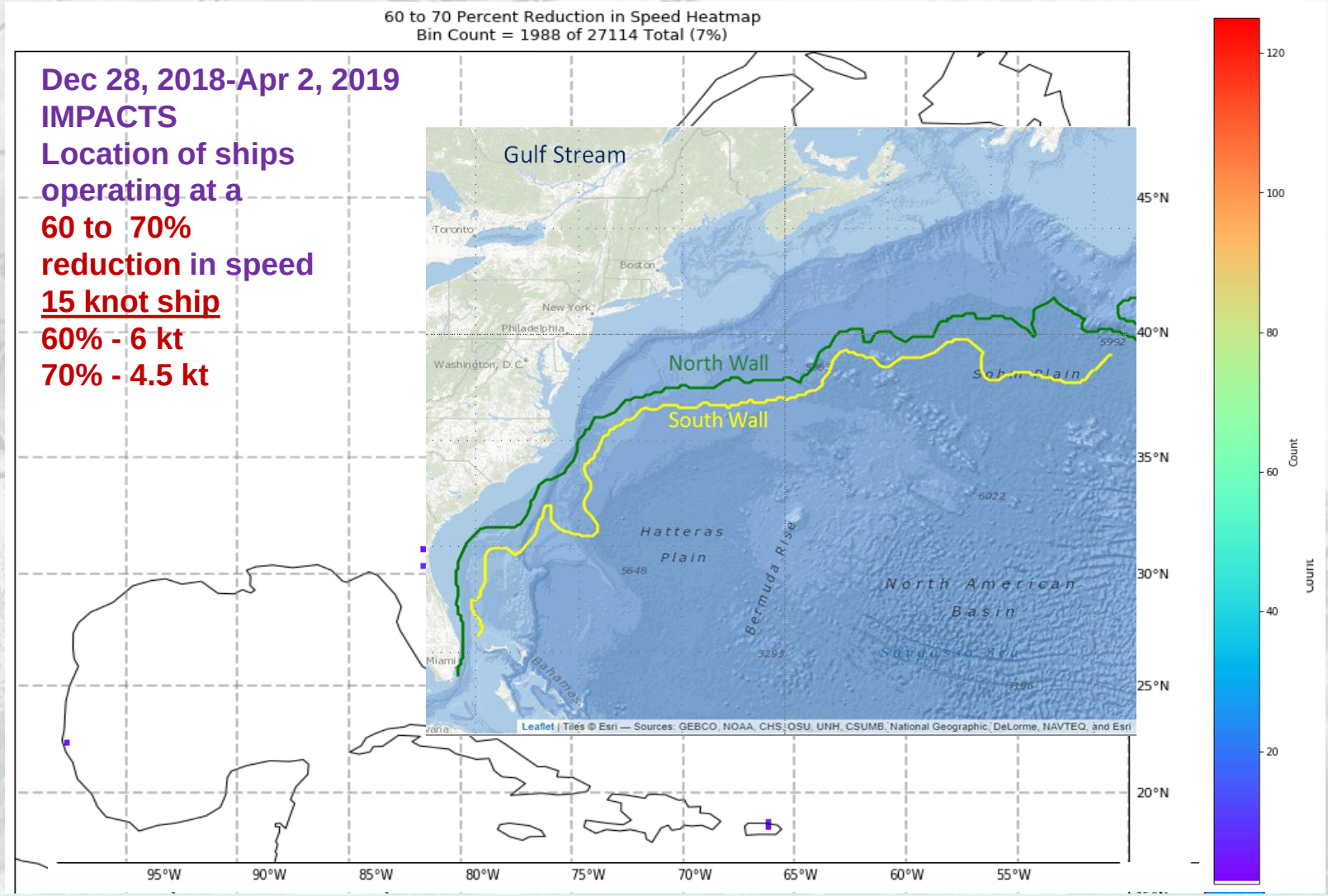
"We encountered the Gulf Stream around 28 Nov/ 11:00UTC (around 38-30 N / 64-13 W),

and the swells were confused and massive.

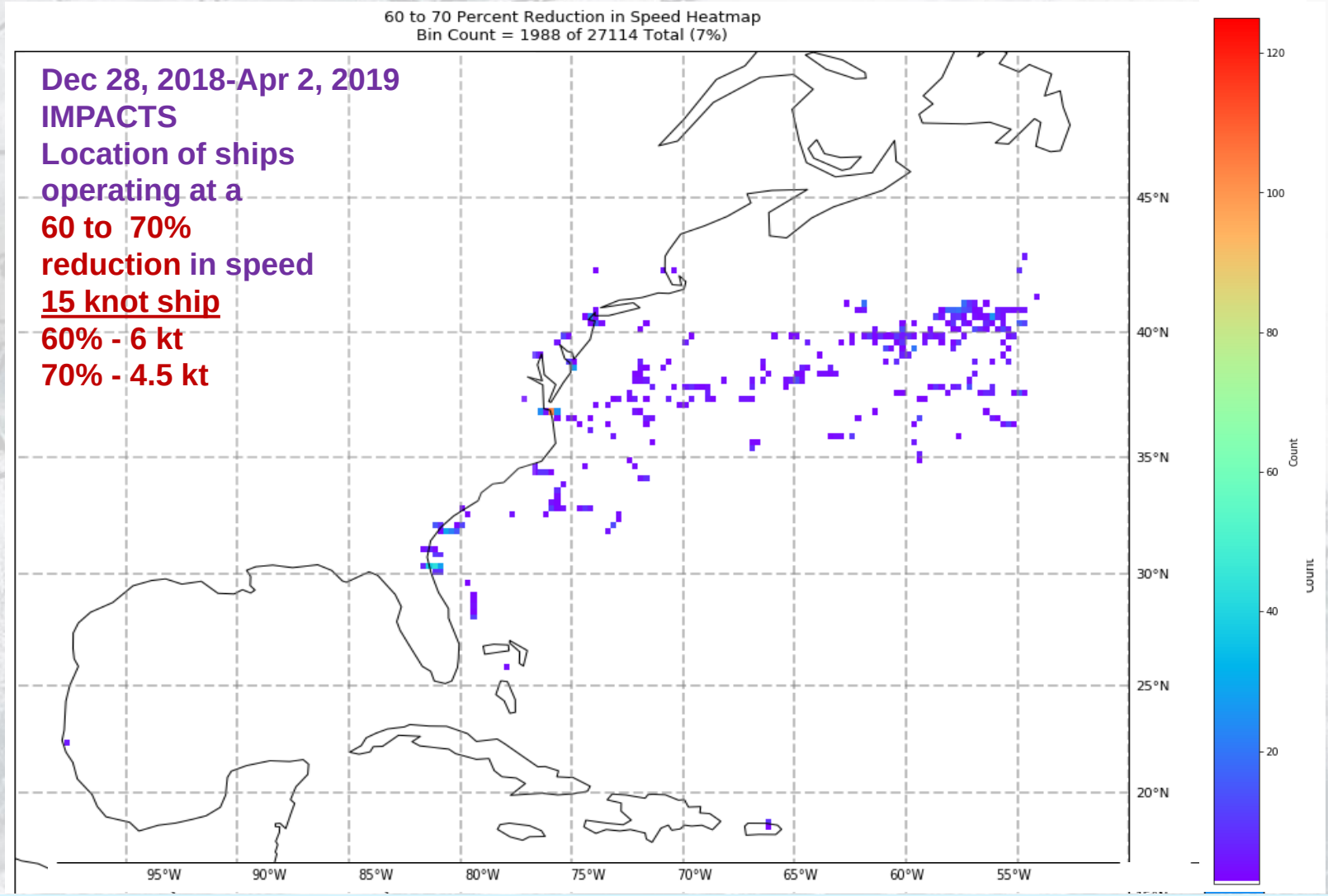
Water temp was around 24c. Once we got thru the South Wall and into the Gulf Stream, the sea became more predictive and uniform. Winds were a steady Beaufort Force 10-12, and at times exceeding 100kts , veering from SSW to N."

- Captain Chris Kavanaugh, C/V *Maersk Ohio*

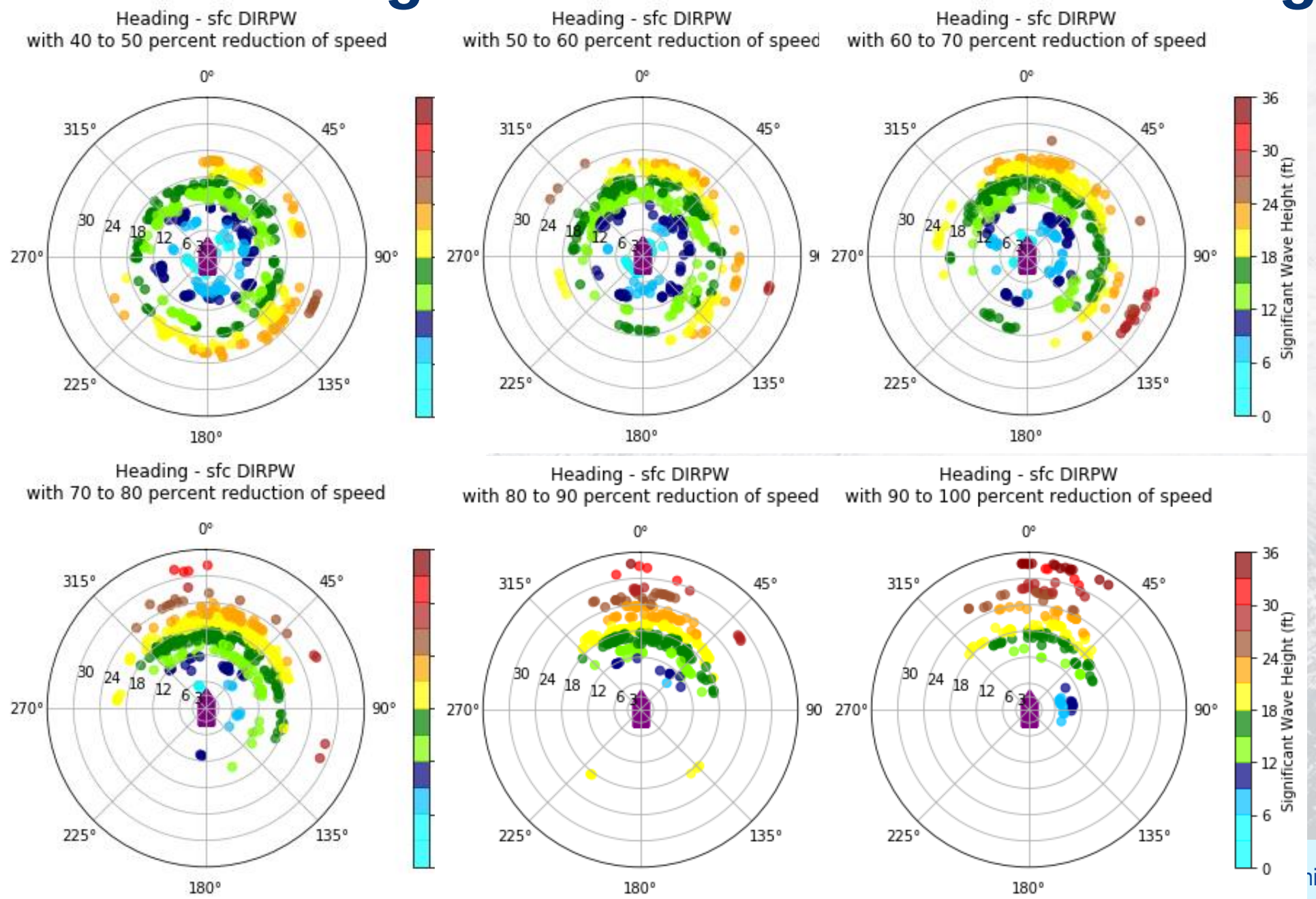
Challenge – Observations, Prediction



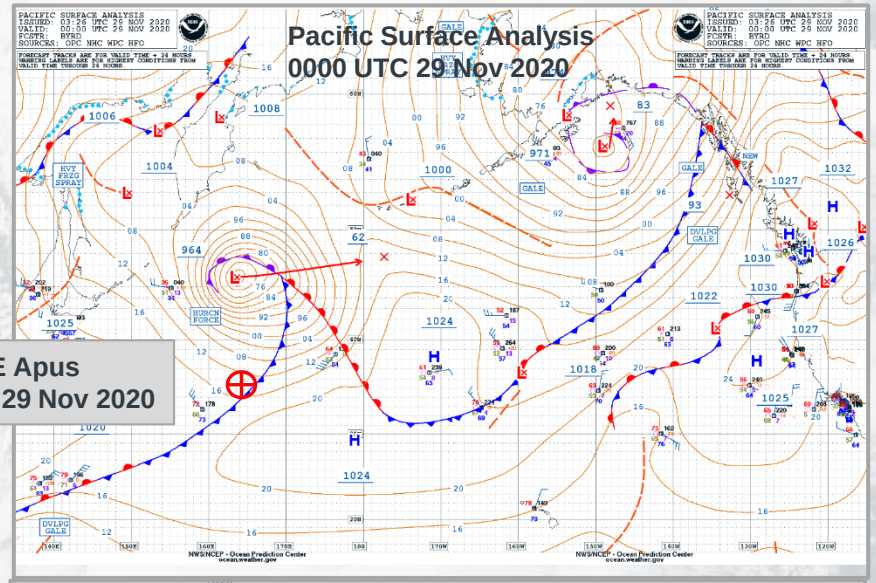
Challenge – Observations, Prediction

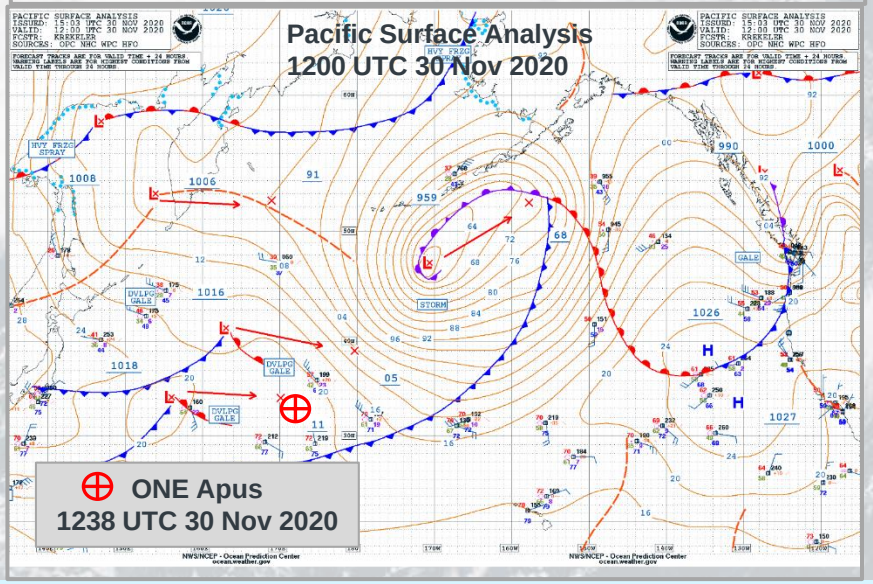


Vessel Heading vs. Wave Direction and Height



Challenge – Vessel Specific Conditions





"Today's update from Chidori Ship Holding LLC and NYK Shipmanagement Pte Ltd, the owner and manager, respectively, provides some additional details about the incident and what will happen moving forward.

The update said weather at the time was reported as wind force 4 on the Beaufort Wind Scale, corresponding to 13-18 mph winds, with north-westerly seas of 5 to 6 meters and a "long high swell"."
gcaptain.com ONE Apus update - 04 Dec 2020

North Pacific Container Loss

Report of containers lost overboard – 16 Jan

- NAVSAFETY Bulletin (NGA) 2238Z 16 Jan
  - 50-100 Containers adrift 28-24.7N 154-07.6W

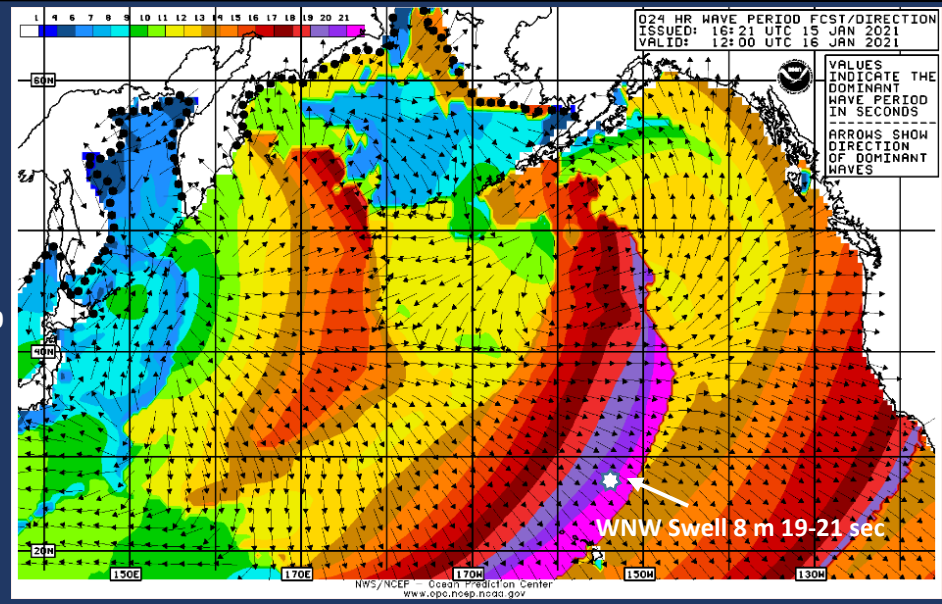
gCaptain media article – 20 Jan

- Maersk Essen reportedly lost ~750 containers
  - En route Xiamen, China – LA, now diverted to Mexico
  - Departed Xiamen 12/25/20, transit well S of storm track

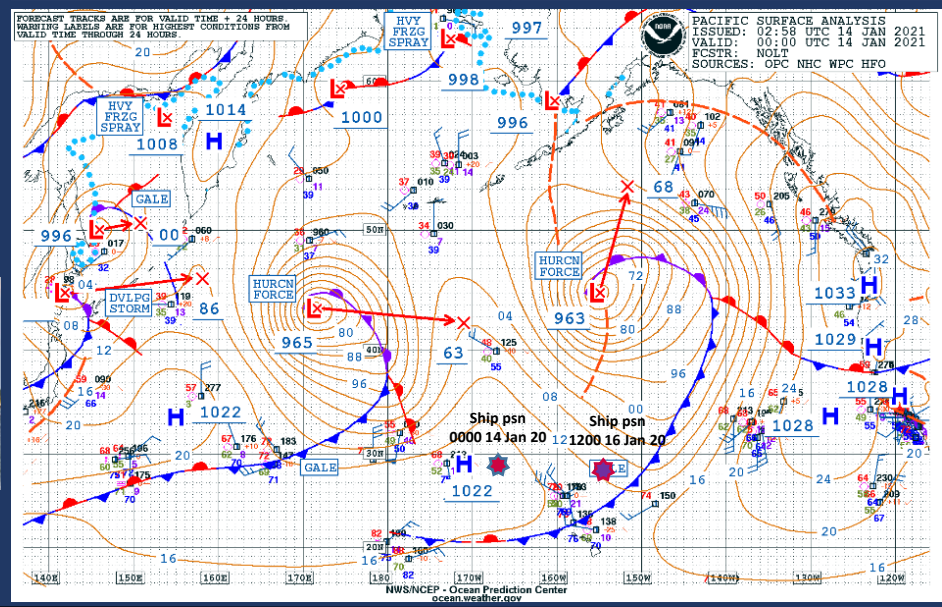
Weather

https://gcaptain.com/los-angeles-bound-maersk-containership-loses-750-boxes-overboard

- Long period swell 19-21 sec / 8 m per WW3 vicinity loss
- Swell source – HF Low 00Z 14 Jan – 965 mb



24 hr Wave Period/Dir
Valid 1200 UTC 16 Jan2020



Unified Analysis
0000 UTC 14 Jan2020

- 2nd largest container loss – globally
- 1st - ONE Apus 11/30/20
  1,816 containers
- 4th loss since 30 Oct 2020
- 7th large container loss North Pacific Oct 2020 – March 2021

Hurricane Lorenzo – Waves, Rip Currents

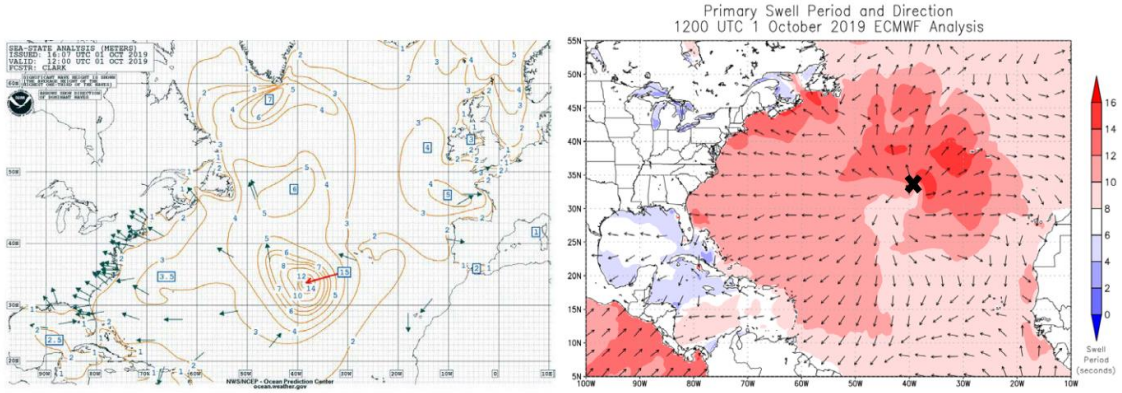
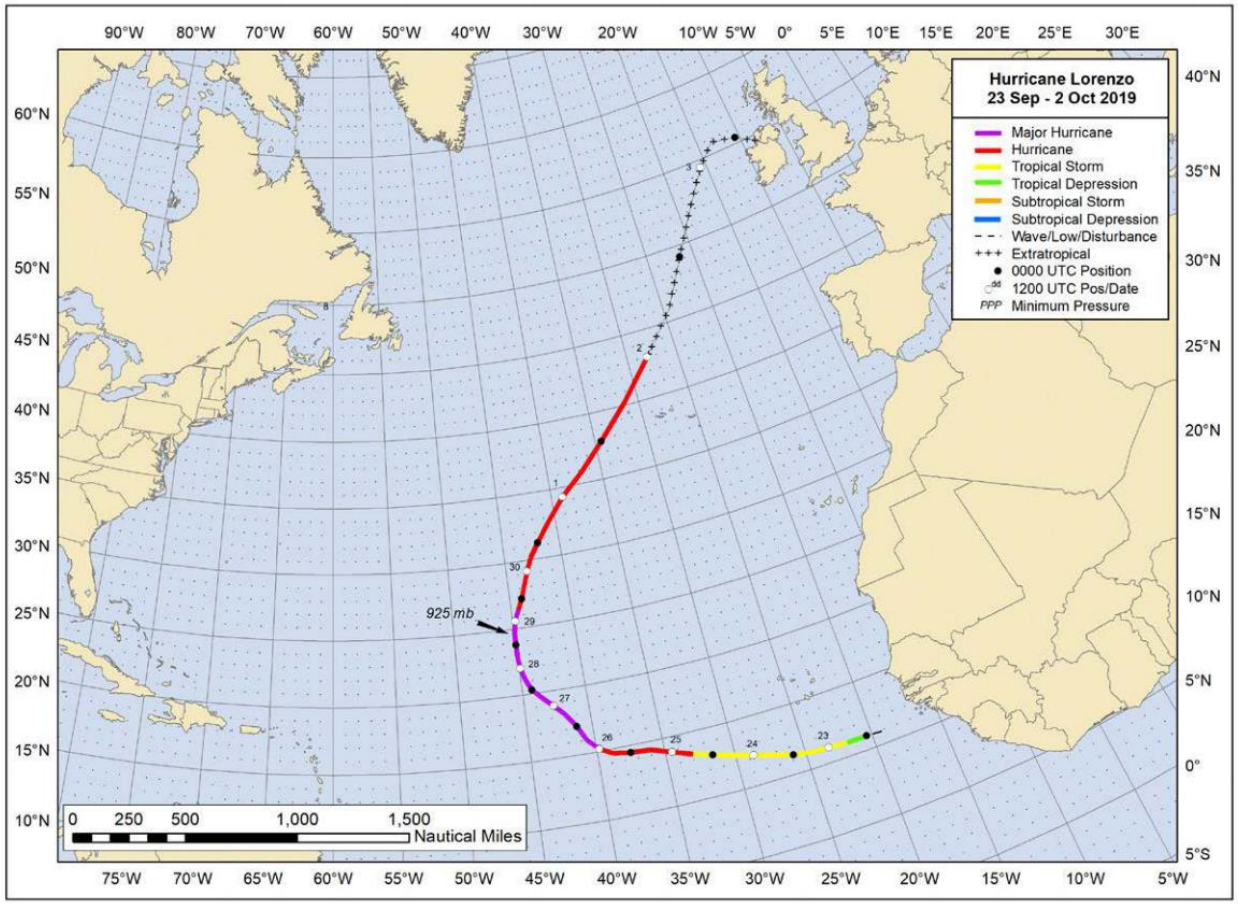


Figure 4. Waves and swell associated with Hurricane Lorenzo, valid at 1200 UTC 1 October 2019. The image on the left is the North Atlantic sea state analysis from the Ocean Prediction Center. The orange contours show significant wave height (average height of the highest one-third of the waves) in meters and the arrows show the direction of the dominant waves. The image on the right shows the mean total swell period (seconds) and direction in the ECMWF wave model analysis at the same time. The black X shows the approximate location of Lorenzo at the time of the model analysis. Large waves and long-period swells from Lorenzo affected most of the North Atlantic basin in late September and early October. Rip currents and rough surf caused 8 deaths along the east coast of the United States between 30 September and 3 October.

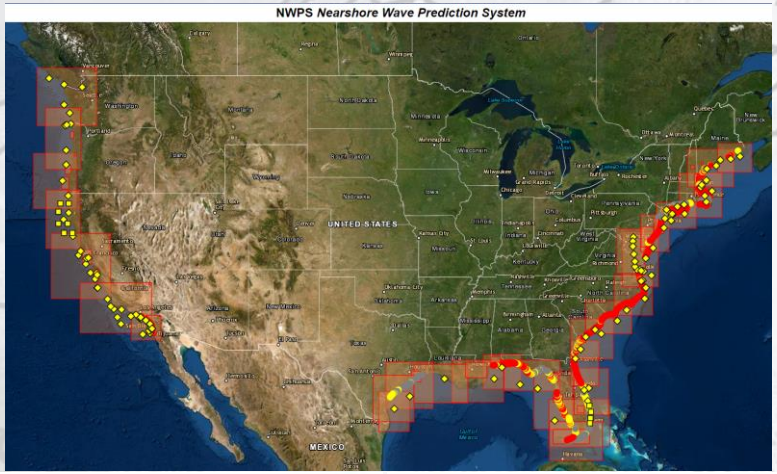
" Lorenzo was the second deadliest hurricane of the 2019 hurricane season and caused 19 deaths, including 11 crewmembers of the Bourbon Rhode, which sank near the eyewall of the hurricane on 26 September. Eight people also died along the U.S. east coast due to dangerous surf conditions generated by the hurricane."

Dave Zelinsky, National Hurricane Center
[NHC Lorenzo report]



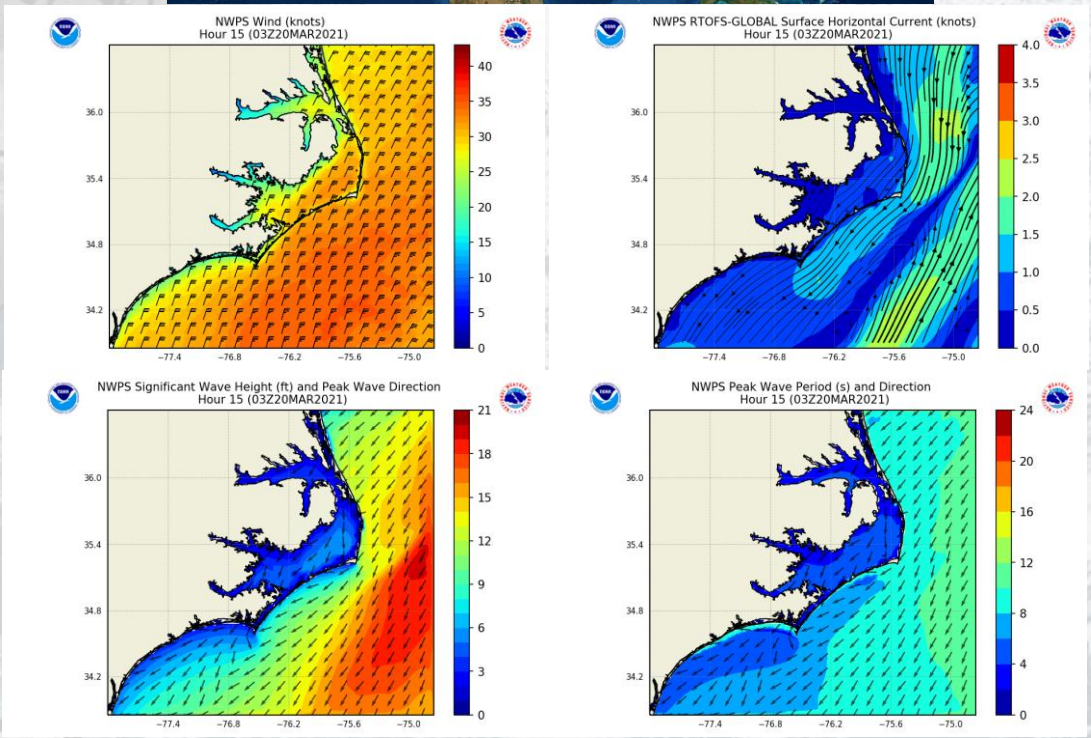
Best track positions for Hurricane Lorenzo 23 September–2 October 2019.

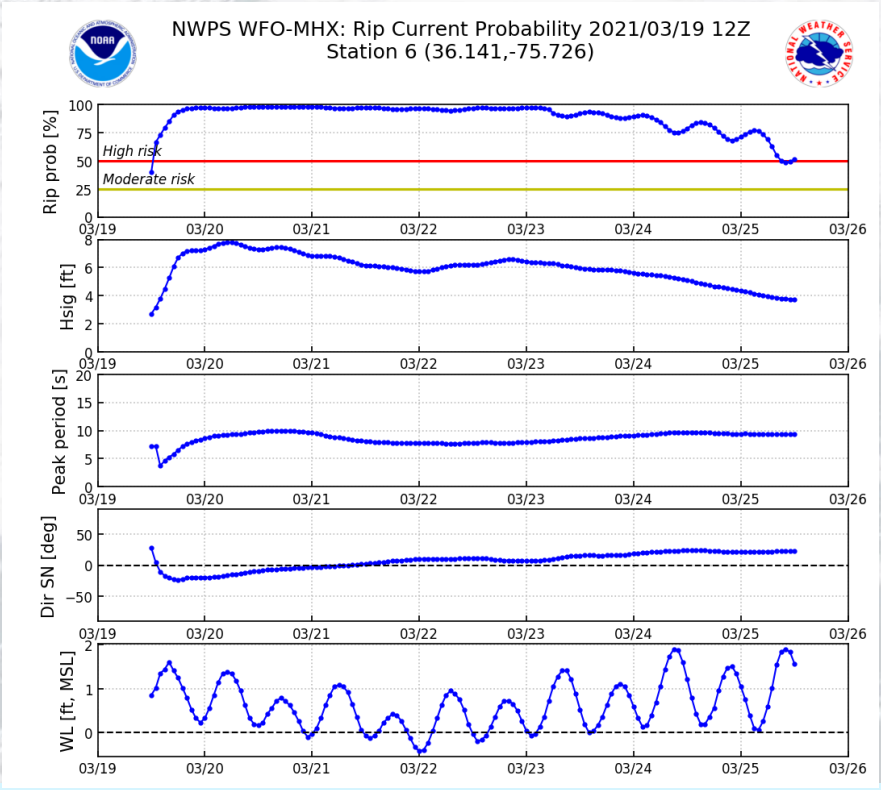
Nearshore Waves, Surf zone, Rip Currents



[Nearshore Wave Prediction System]

- SWAN based
- 36 domains
- Forecaster edited winds
- Run on demand
- Coupled with ESTOFS, Global RTOFS
- Probabilistic rip current





Challenges - Dangerous Seas

WMO Pub 558 MANUAL ON MARINE METEOROLOGICAL SERVICES

P.8 – preparation and issue of warning content

2.2.37 Warnings **should** be provided for the following phenomena:
(a) Unusual and hazardous sea-ice conditions;
(b) **Dangerous sea states**.

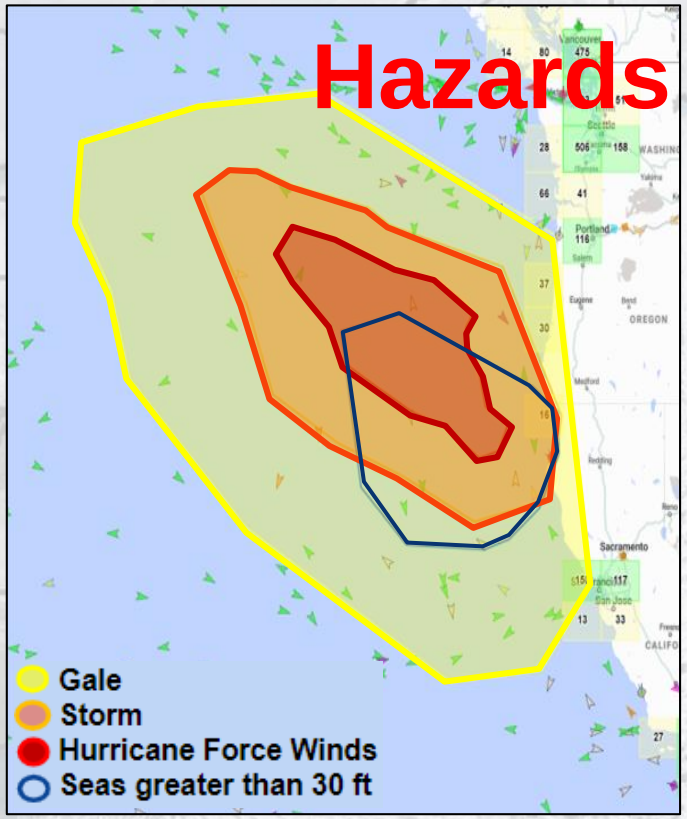
- Definition – NOAA working with ECCC for possible definition
  - Threshold of significant wave height
  - Crossing/confused seas
  - Breaking waves
  - Extreme waves
  - Wave, current, wind interactions
  - Deterministic and probabilistic
  - Vessel dependent or specific sea state?
    - Period dependence

S-41X

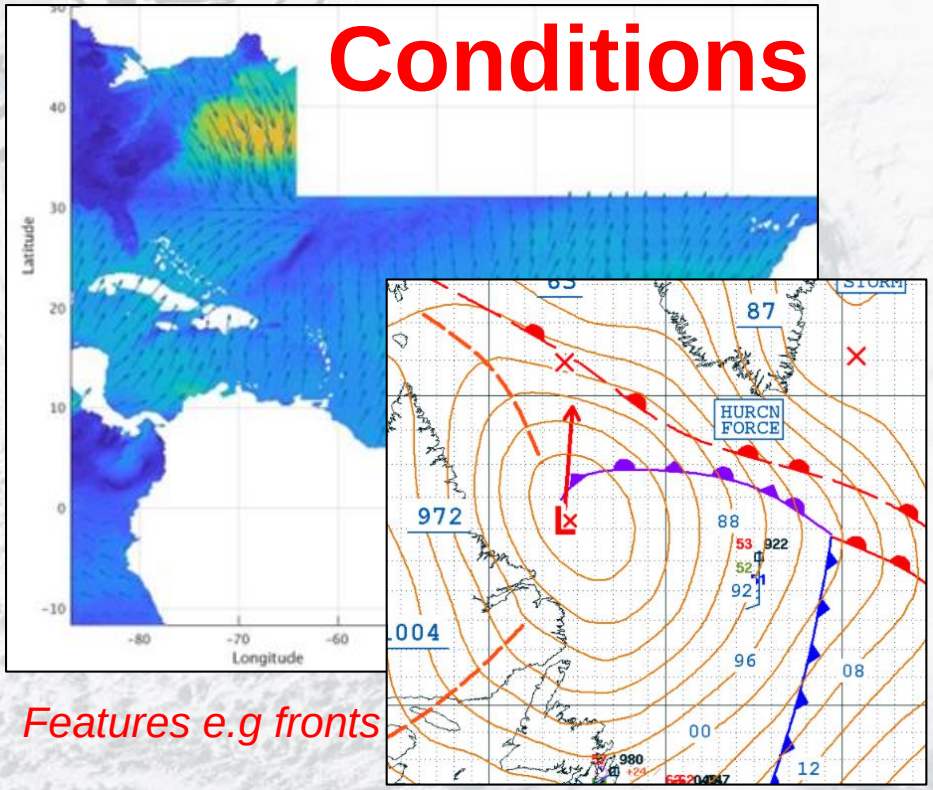
Modernizing Marine Weather Services

S-100 Weather Portrayals

Hazards

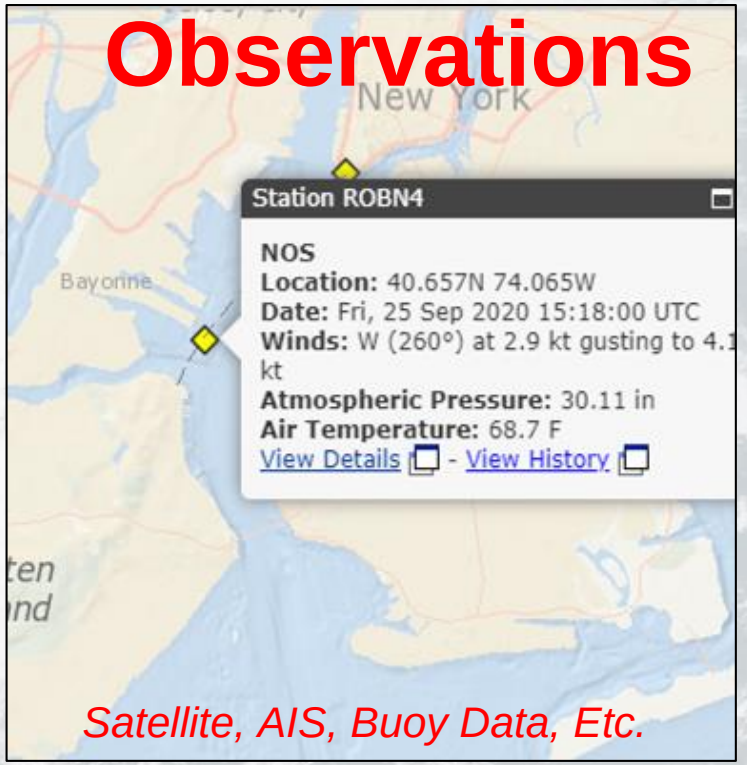


Conditions



Features e.g fronts

Observations

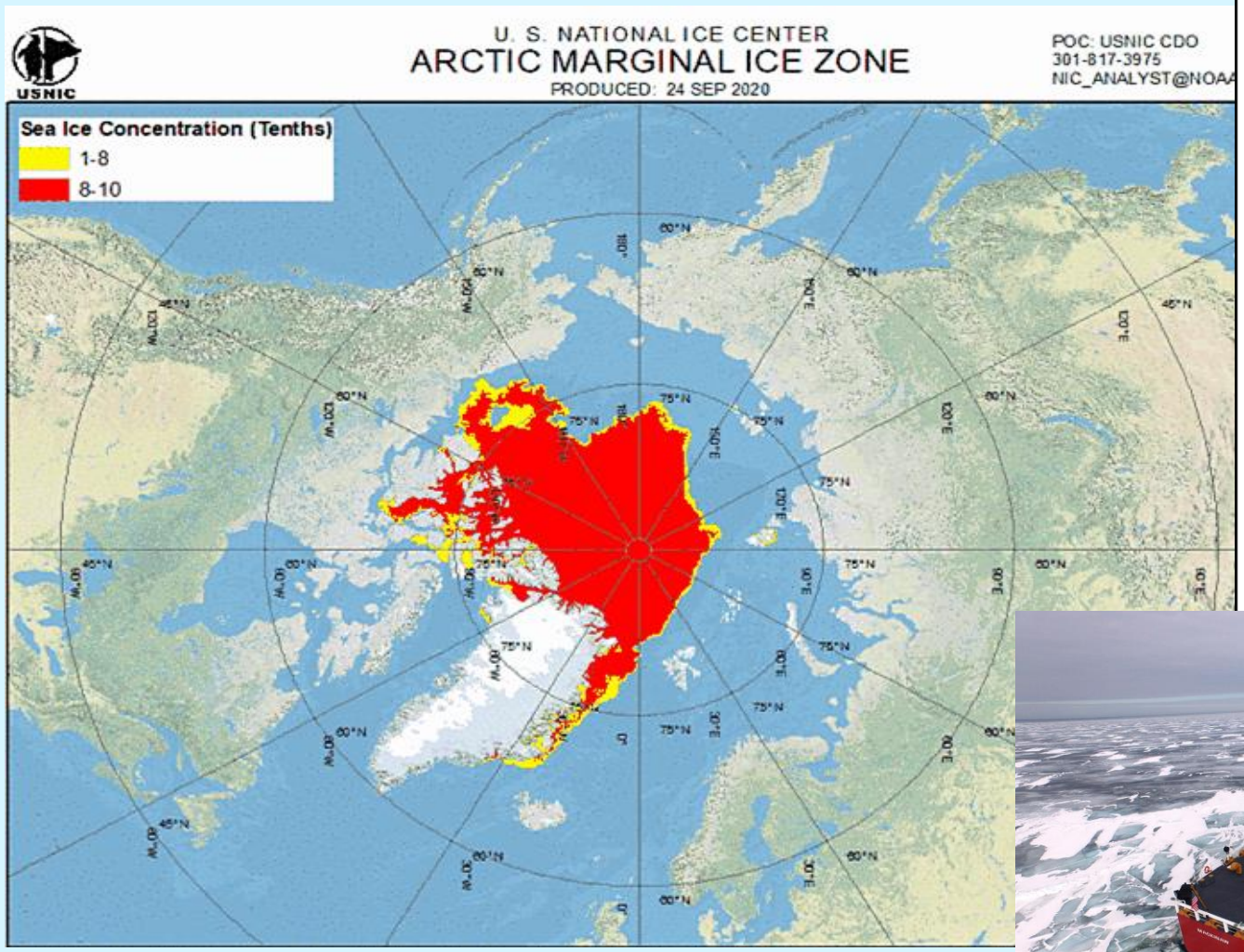


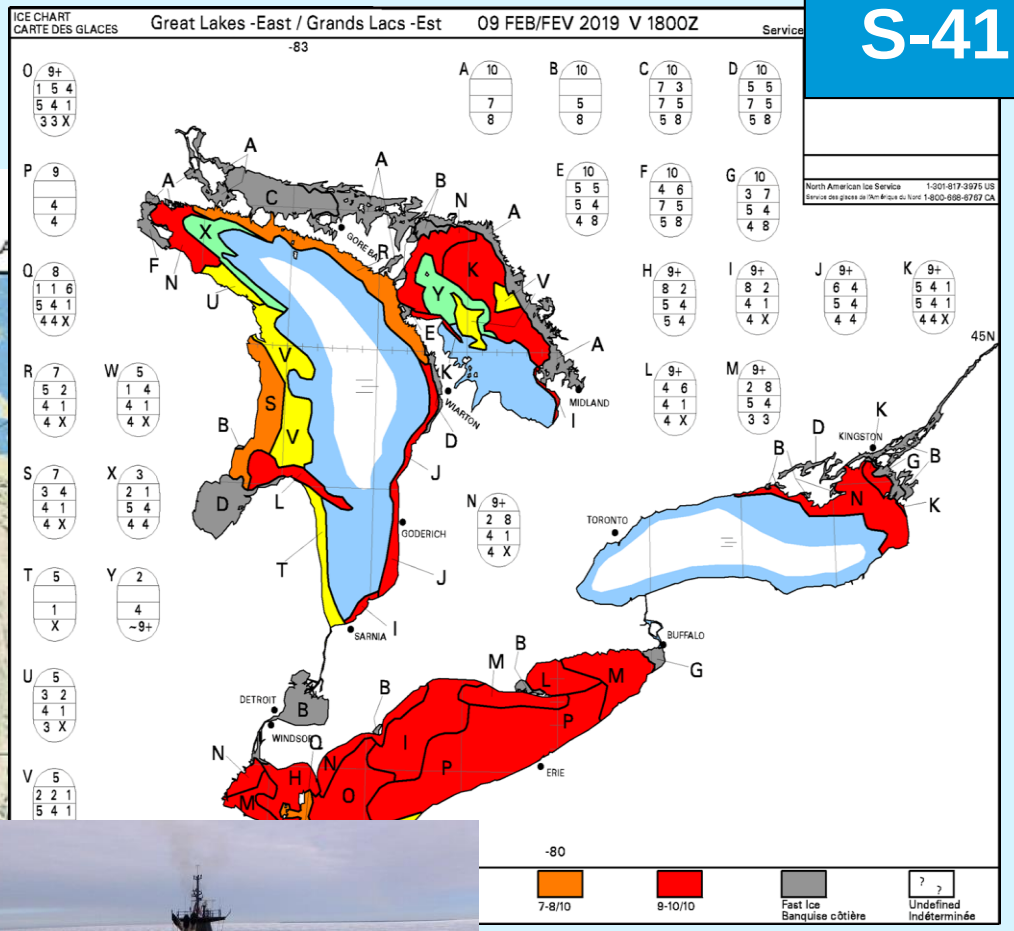
Satellite, AIS, Buoy Data, Etc.

S-412	S-413	S-414
Wave and Weather Hazards	Wave and Weather Conditions	Wave and Weather Observations
Polygons	Graphics and Gridded Data	Point Based Data

S-41X Ice Analysis

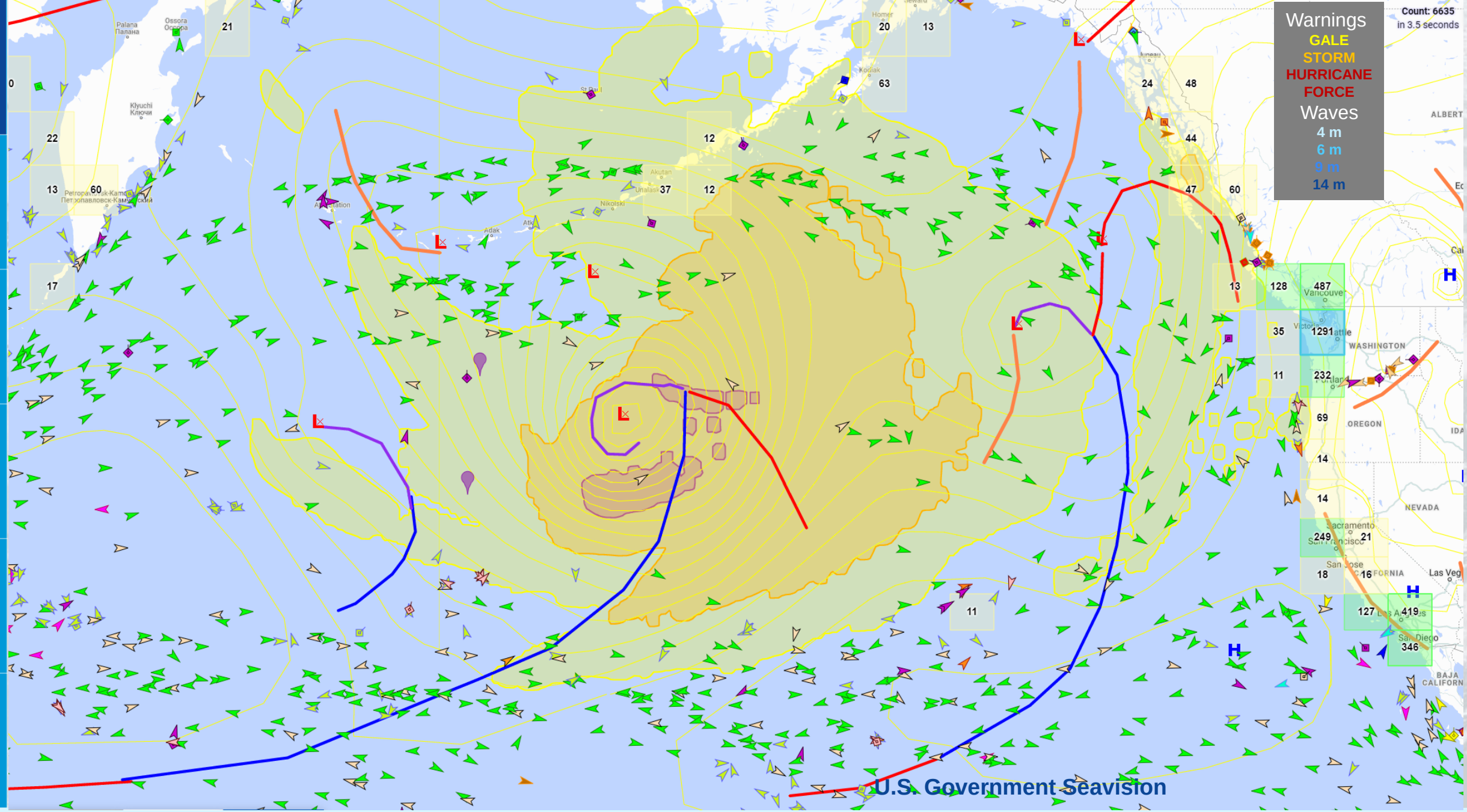
S-411

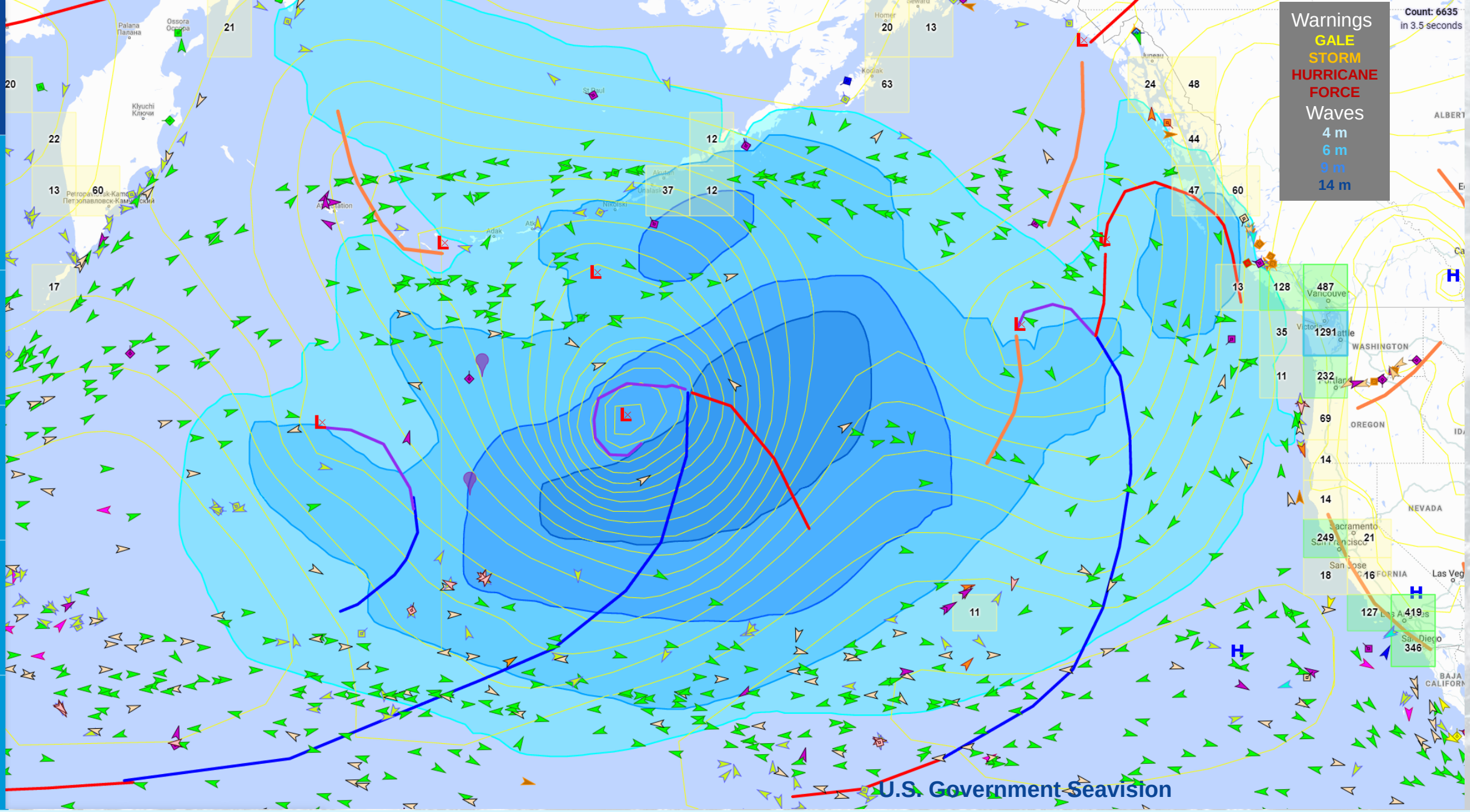




U.S. National Ice Center

S-411 Standard developed by German Bundesamt Seeschifffahrt Und Hydrographie (BSH)


Warnings
GALE
STORM
HURRICANE
FORCE
Waves
4 m
6 m
9 m
14 m
Count: 6635
in 3.5 seconds
U.S. Government Seavision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