



Learning from the Experts Webinar Series

Weather Impacts on Offshore Wind



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Director Energy and Shipping
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Project Manager Energy Division
Weather Routing Inc. (WRI)

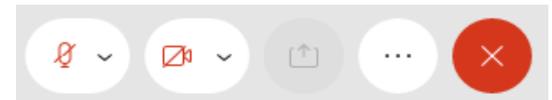
April 20, 2022

Meeting Procedures

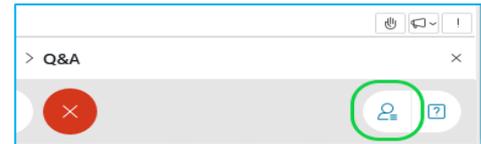
Webinar recordings and presentations will be available at:
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Participation for Members of the Public:

- > Members of the public will be muted upon entry.
- > Questions and comments may be submitted in writing through the Q&A feature at any time during the event.
- > If technical problems arise, please contact Sal.Graven@nyserda.ny.gov



You'll see  when your microphone is muted



Learning from the Experts

This webinar series is hosted by NYSERDA's offshore wind team and features experts in offshore wind technologies, development practices, and related research.

DISCLAIMER:

The views and opinions expressed in this presentation are those of the presenter and do not represent the views or opinions of NYSERDA or New York State.



NEW YORK
STATE OF
OPPORTUNITY.

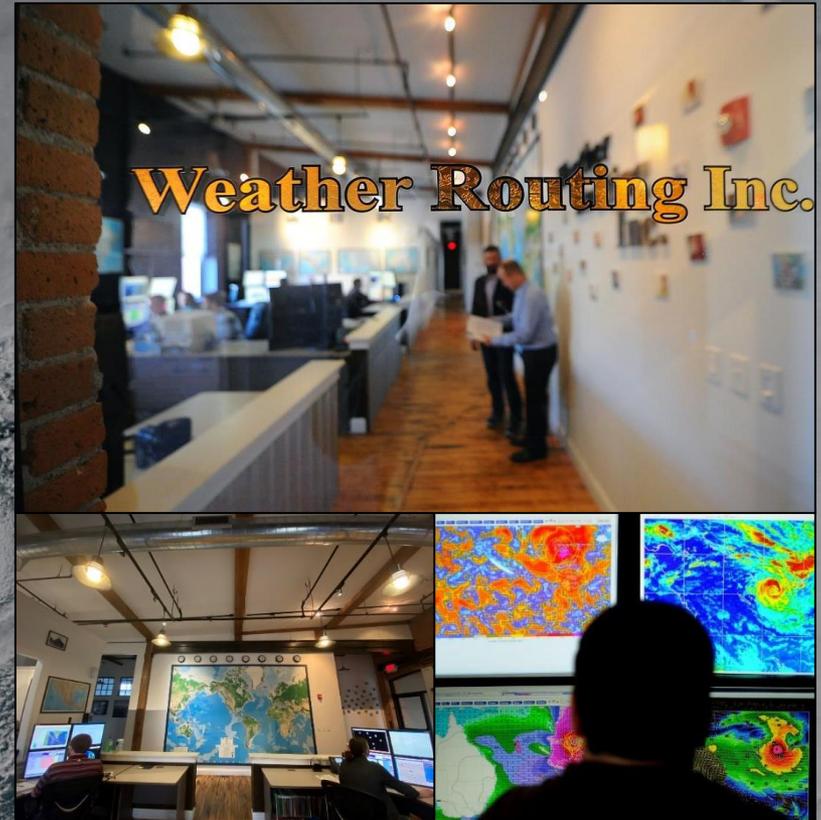
NYSERDA





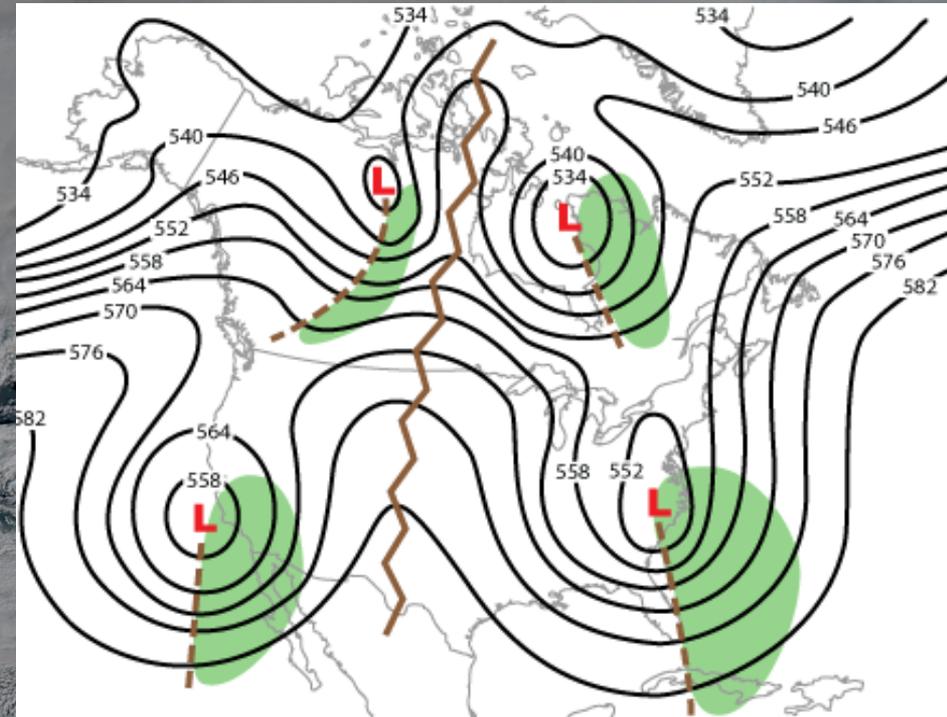
Introduction – About WRI

- WRI has been in business since 1961, and has been providing weather routing services, decision support, and vessel performance analysis for more than 60 years.
- We currently employ 45 Meteorologists, with all employees holding a minimum of a Bachelors Degree in Meteorology.
- WRI's Operations Center is staffed 24/7, and can be reached via phone, e-mail, or fax 24 hours a day, 365 days a year.
- Our office is located on the Hudson River in Glens Falls, New York.



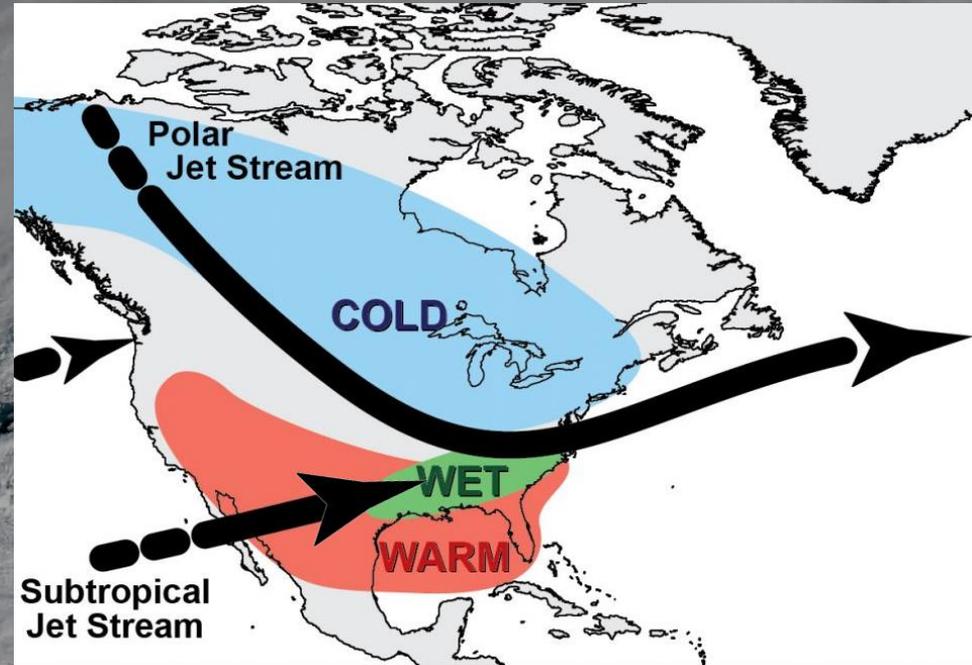
Rapid Cyclogenesis (Bomb Cyclones)

- Upper-level large scale trough approaching eastern U.S.
- Phased interaction between northern and southern jet stream
- Arctic airmass associated with upper trough.
- Warm ocean, Gulf Stream



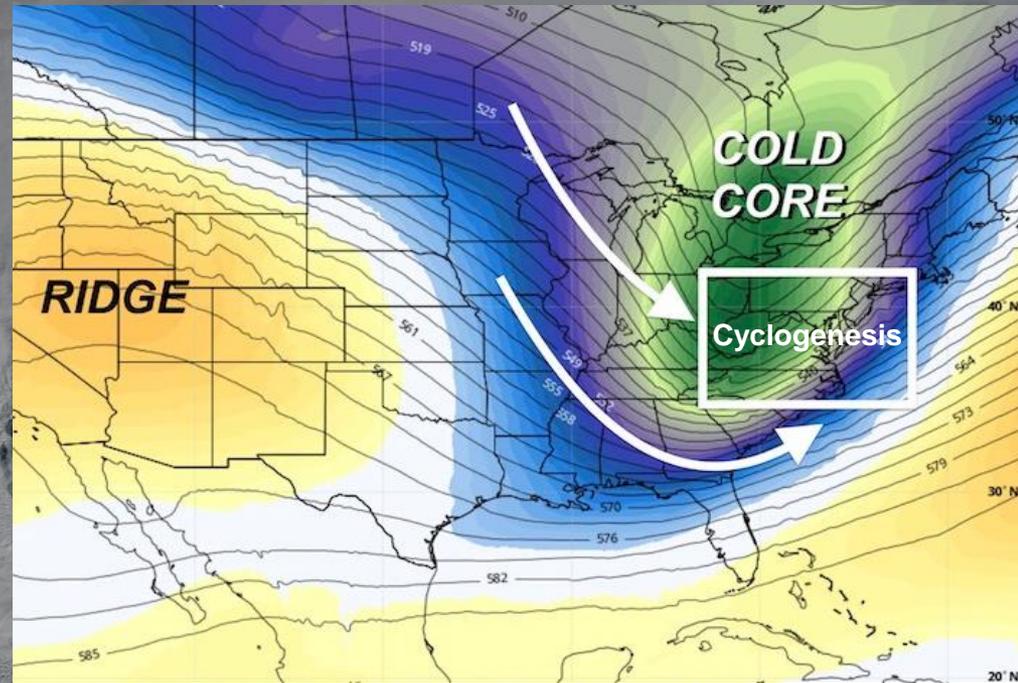
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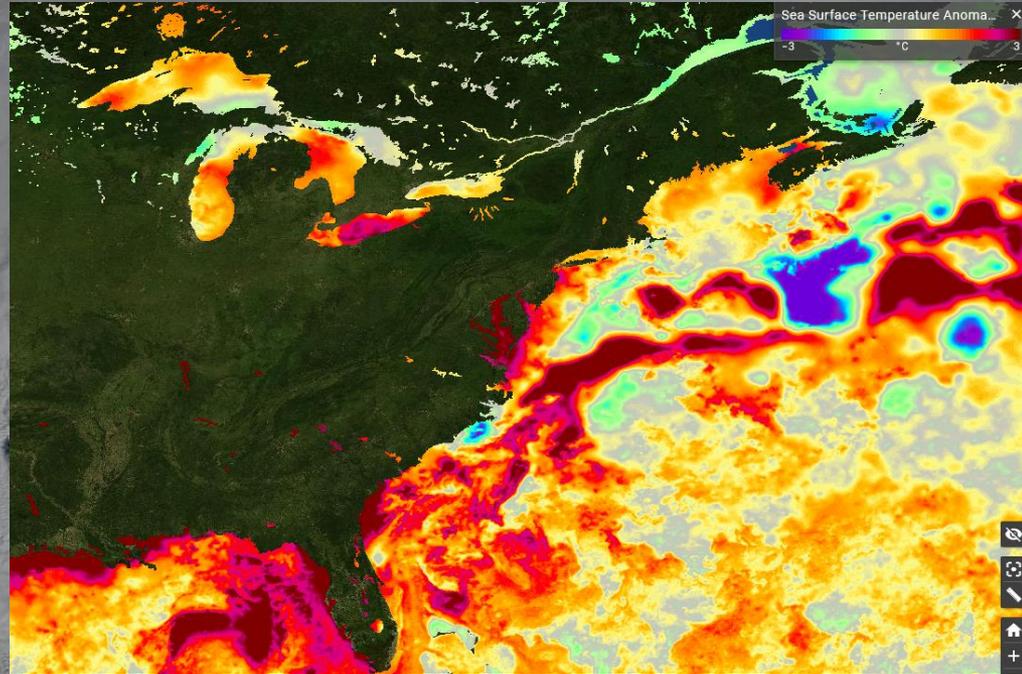
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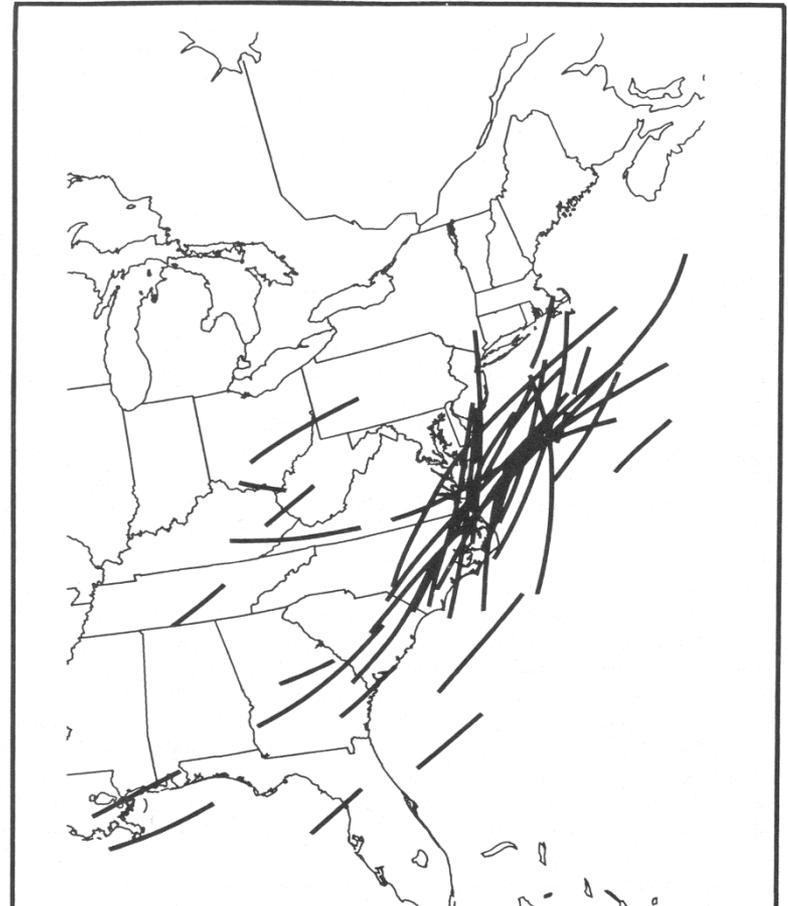


Storm Tracks with Rapid Intensification

- Rapid intensification most often occurs from eastern Carolinas north-northeast to offshore southern New England
- Most intense storms track from south to north
- This presents a significant hazard to most of the offshore wind farms planned and under construction off of the eastern United States

CYCLONE PATHS DURING PERIODS OF RAPID INTENSIFICATION

($>-3 \text{ mb (3h)}^{-1}$)

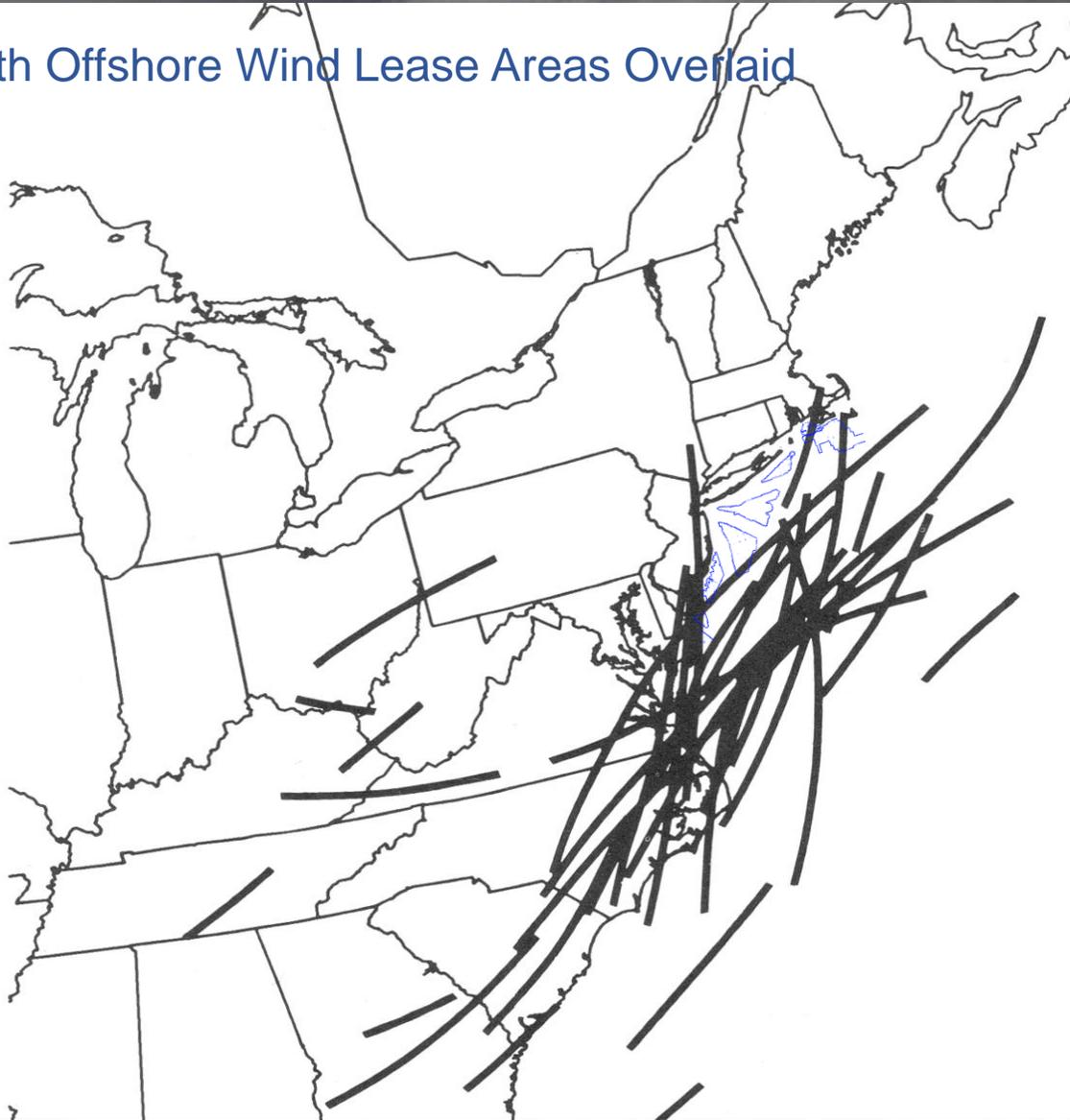




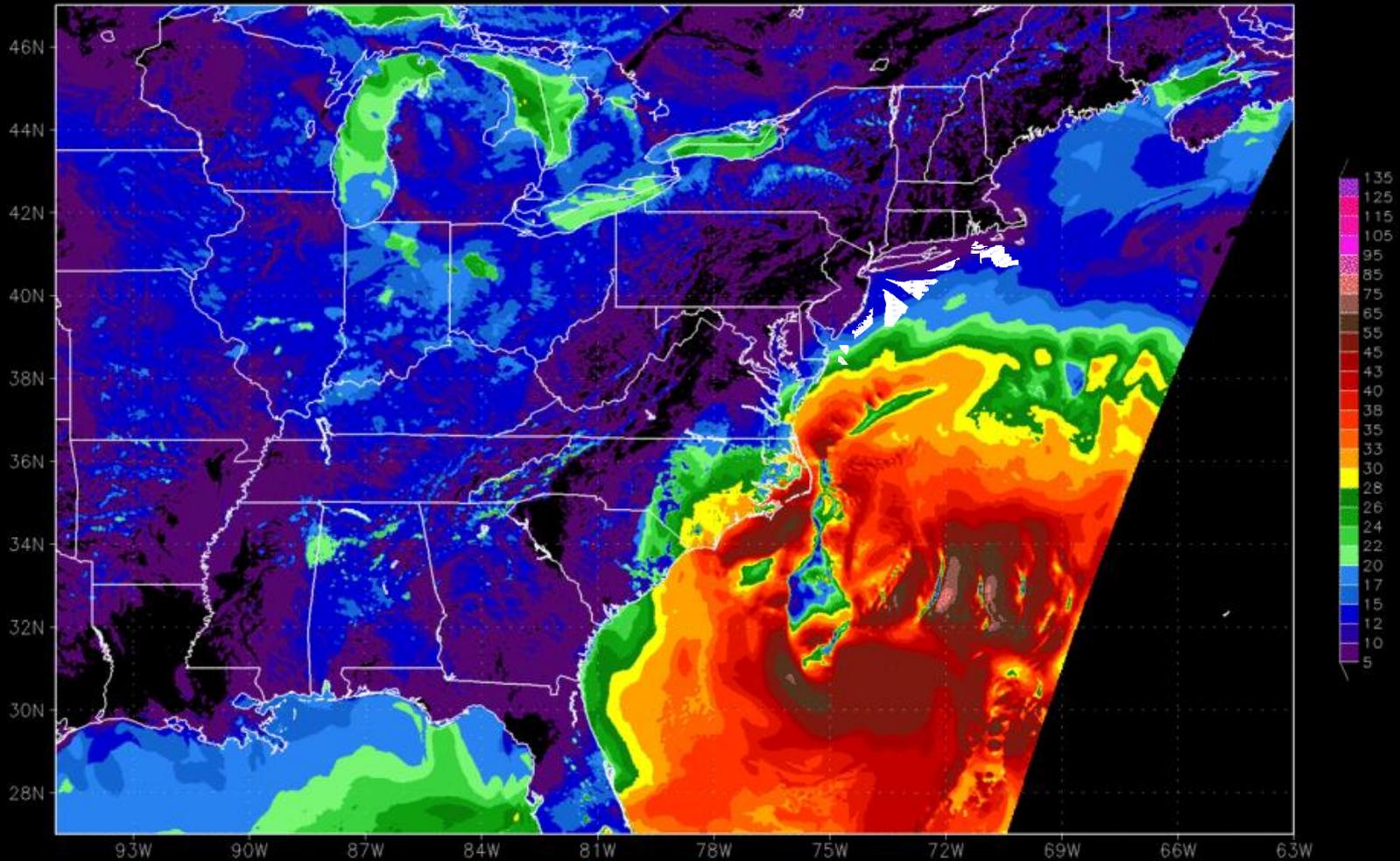
Weather Impacts Offshore New York & Southern New England

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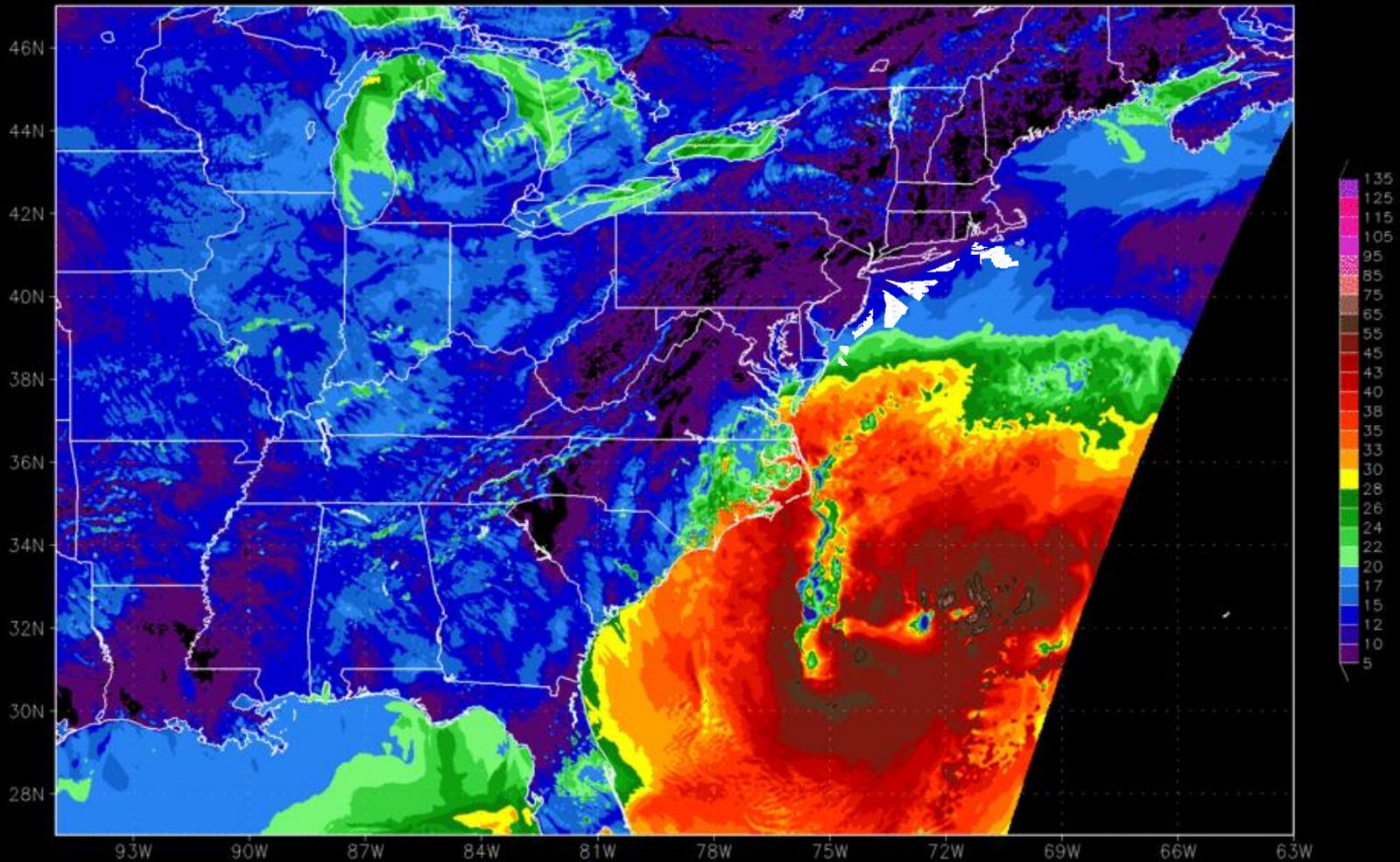
With Offshore Wind Lease Areas Overlaid



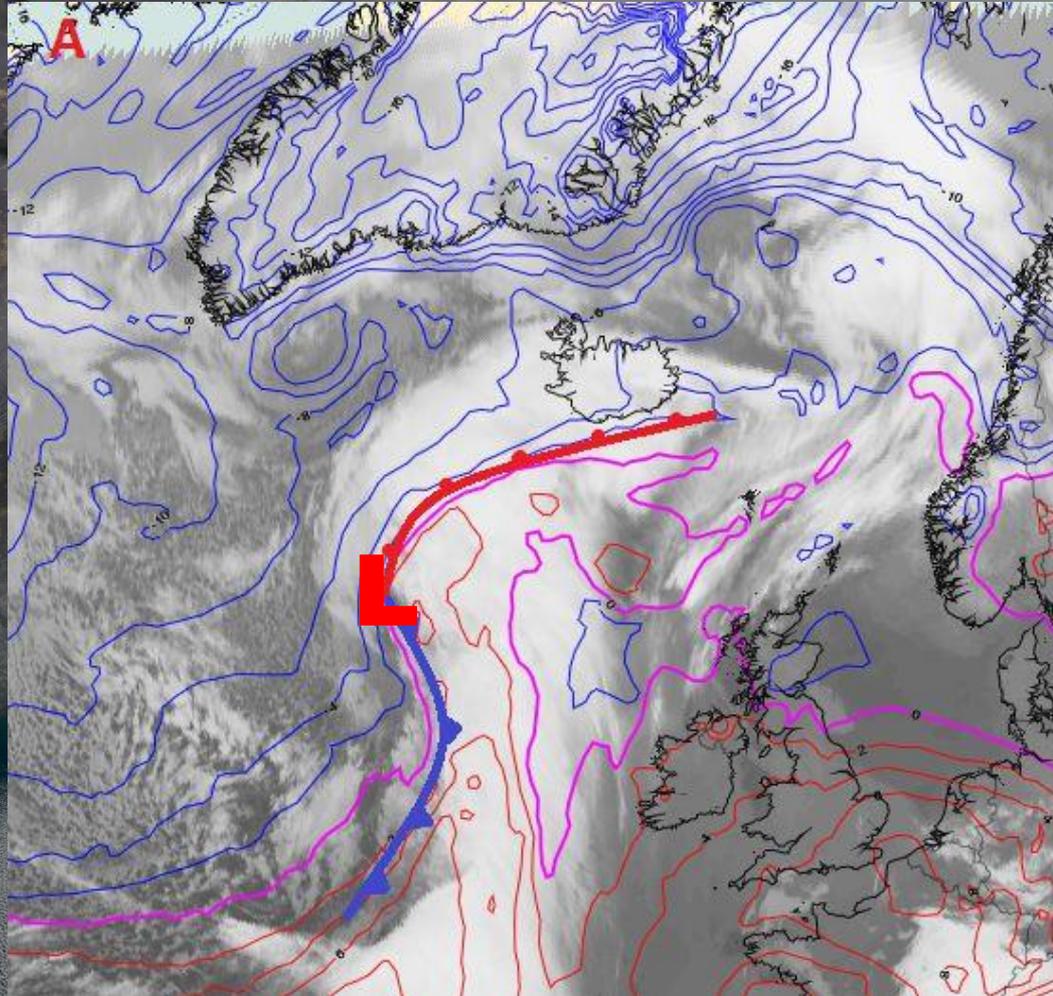
Jan 04th, 2018 Blizzard Max Wind Speed (kts)
15 minutes



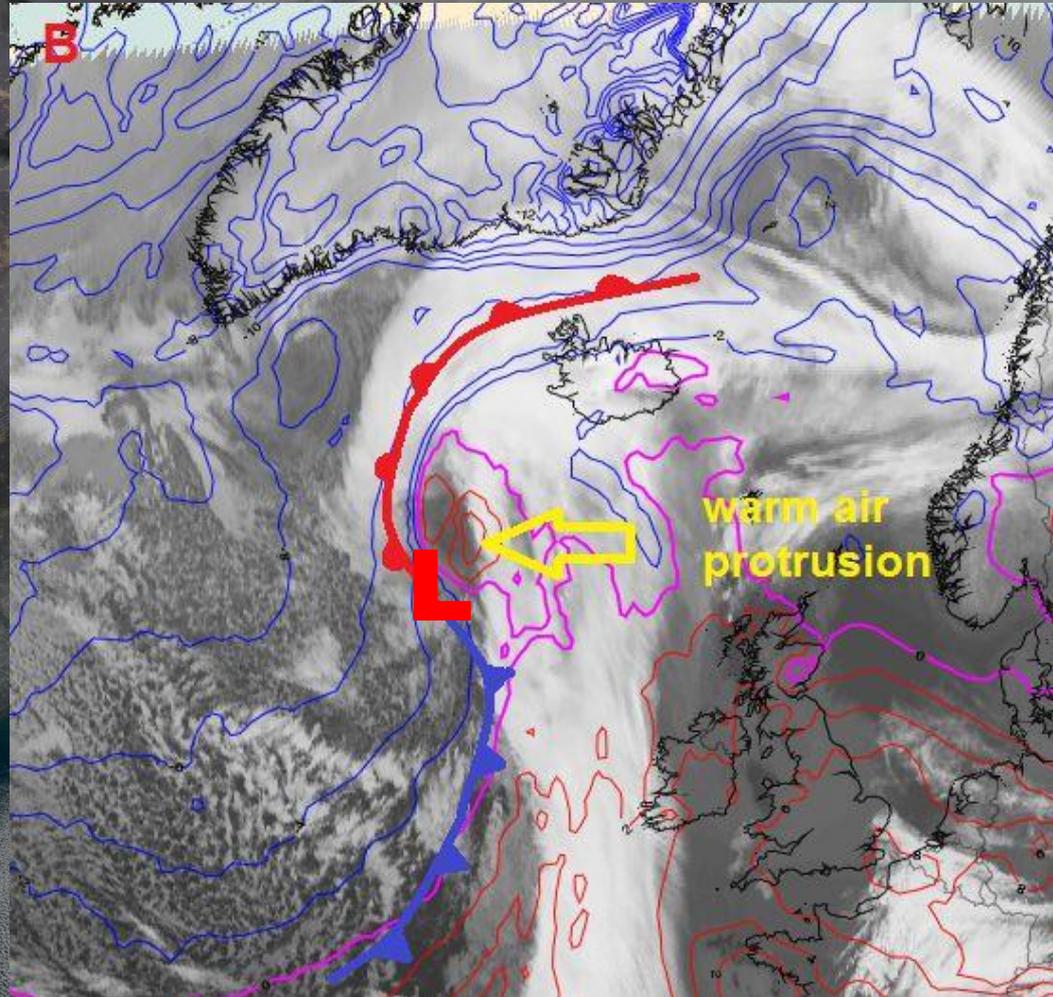
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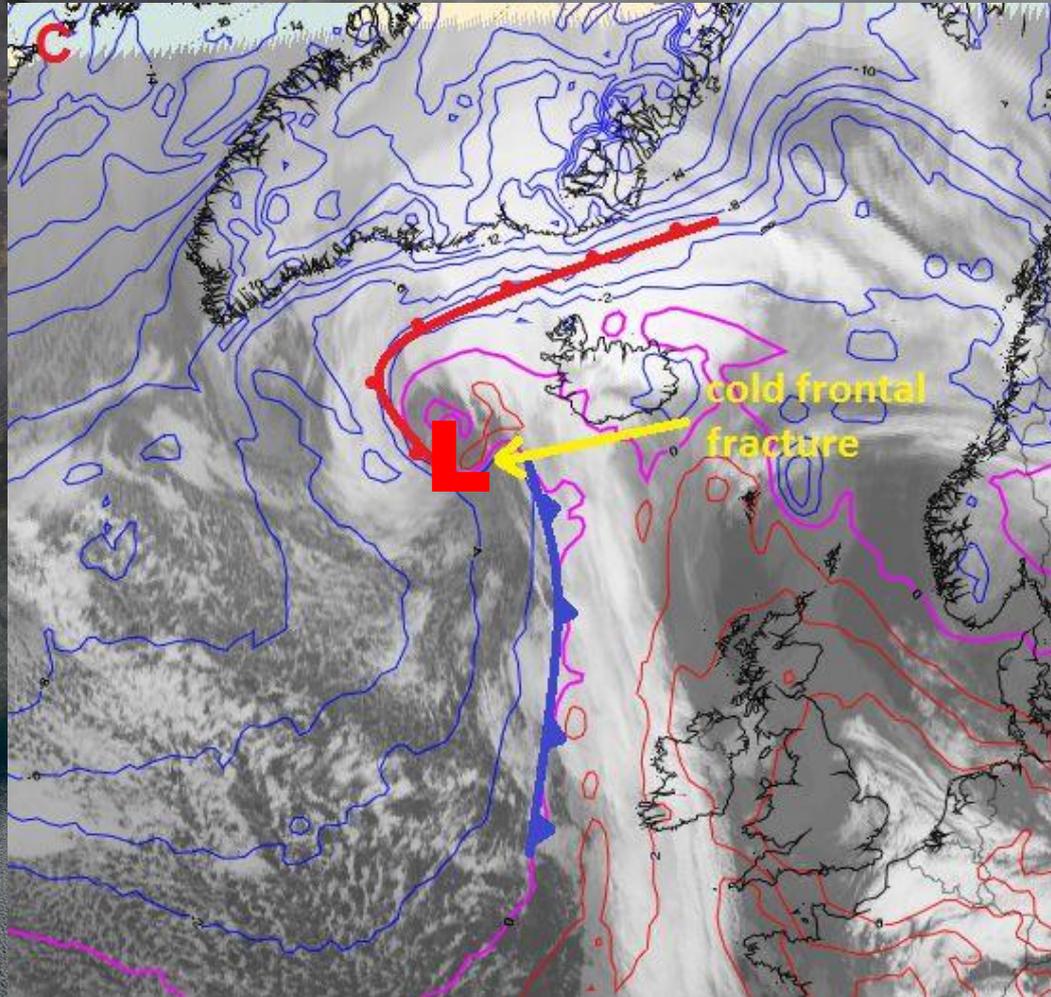
Evolution of a Warm Seclusion



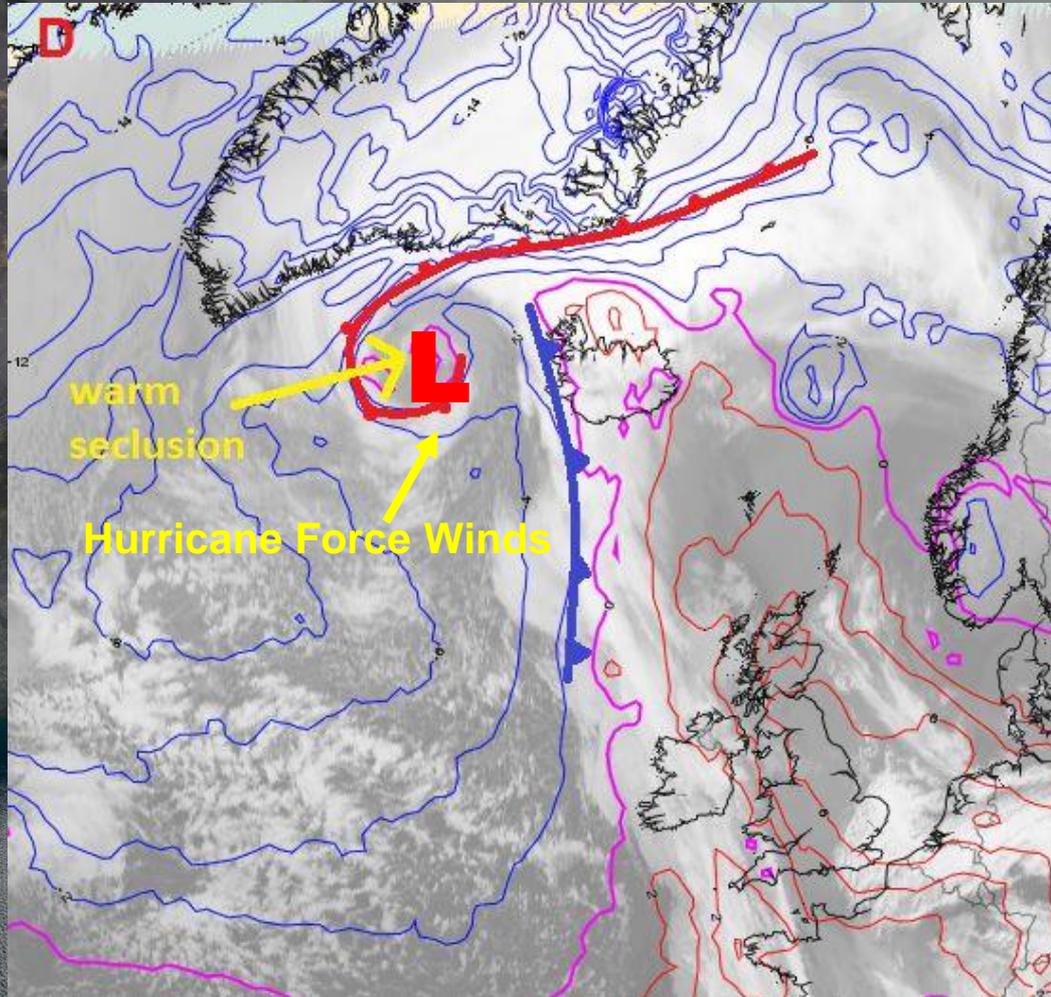
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Evolution of a Warm Seclusion



Evolution of a Warm Seclusion



Implications for Offshore Wind

- Safety of O&M, construction, transport, and any other working crew.
- Downtime for both crews and operational turbines.
- Accurately forecasting wind and sea conditions associated with these systems is crucial for both of the above points.
- Long range predictions can optimize scheduling of the above tasks.



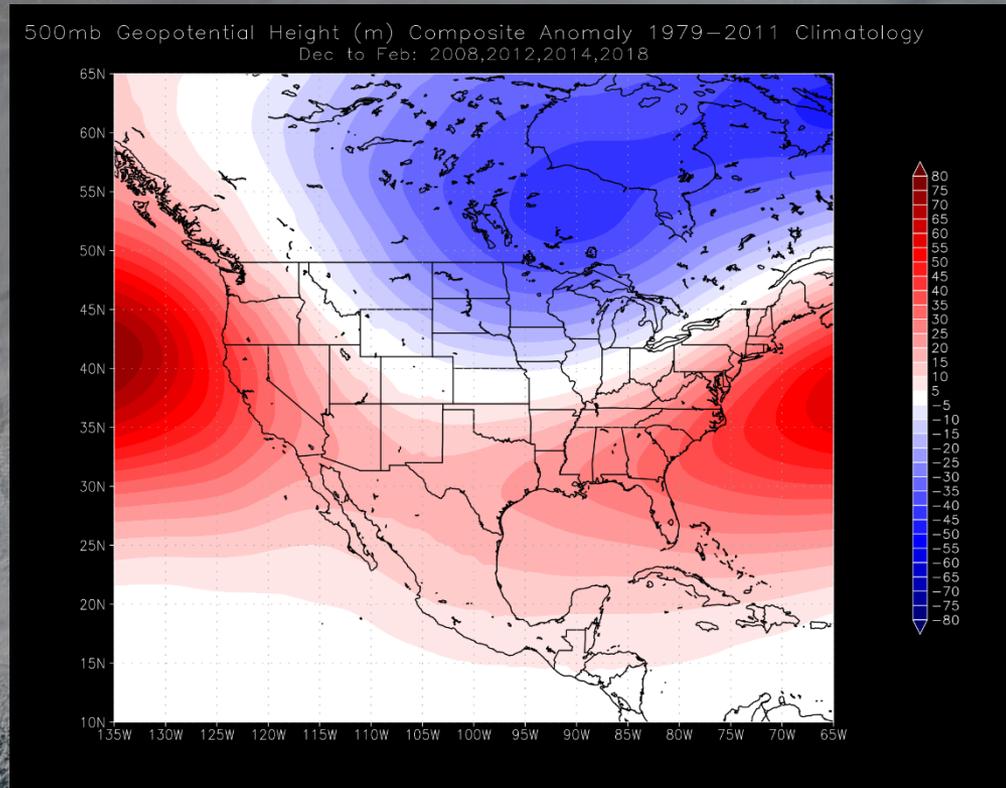
How are these storms predicted?

Long Range (2 - 10 weeks)

- Climate models (CFSRv2)
- 500mb Height Anomaly, trends
- Teleconnections

Mid Range (4 days – 2 weeks)

- Global models (GFS, ECMWF, GEM)
- Sea Surface Temperature Anomalies
- Teleconnections



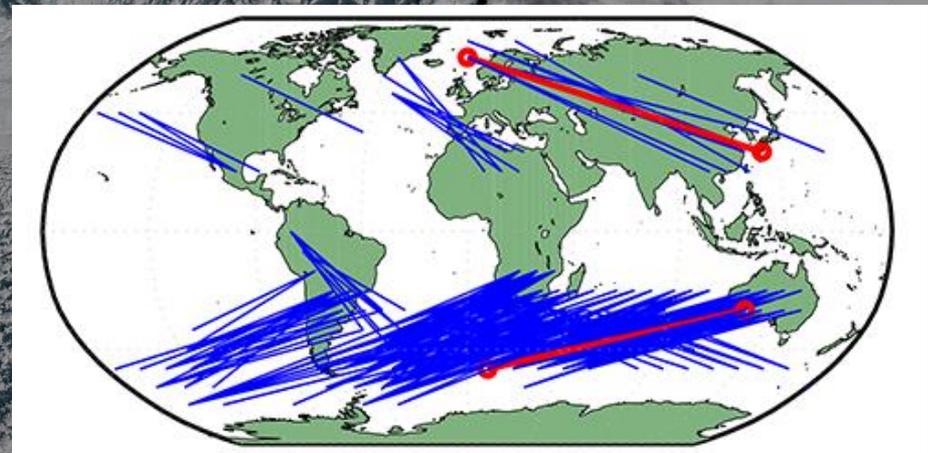
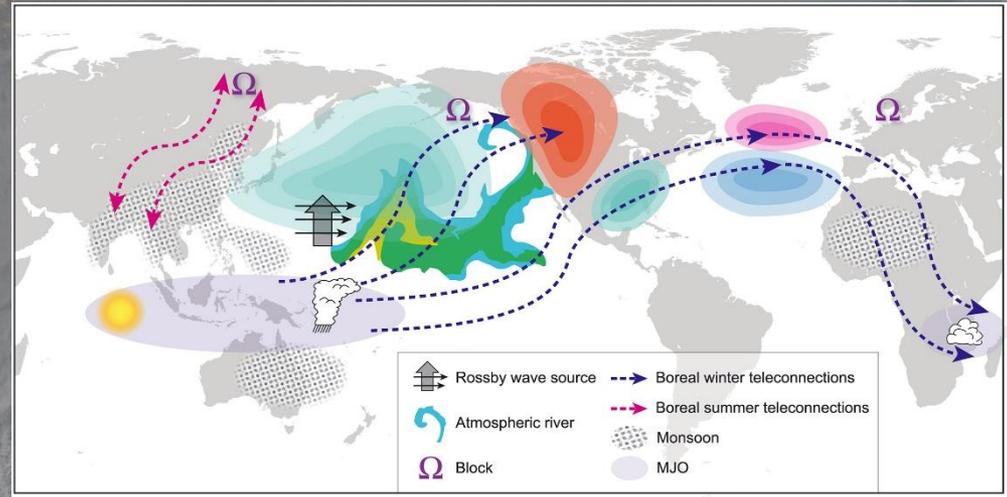
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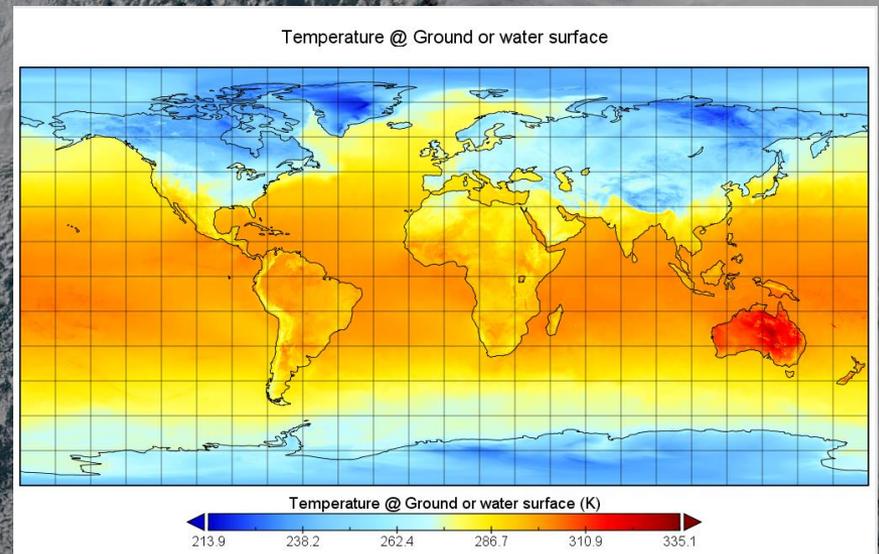
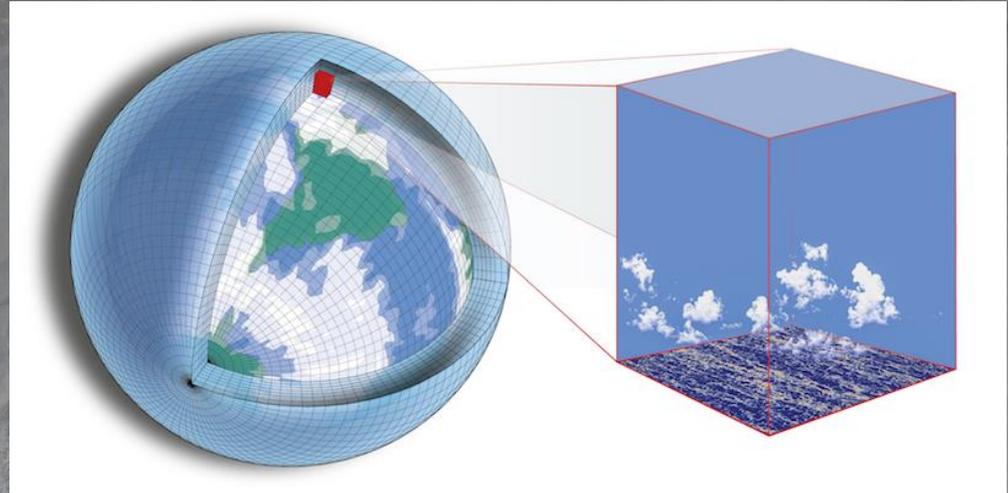
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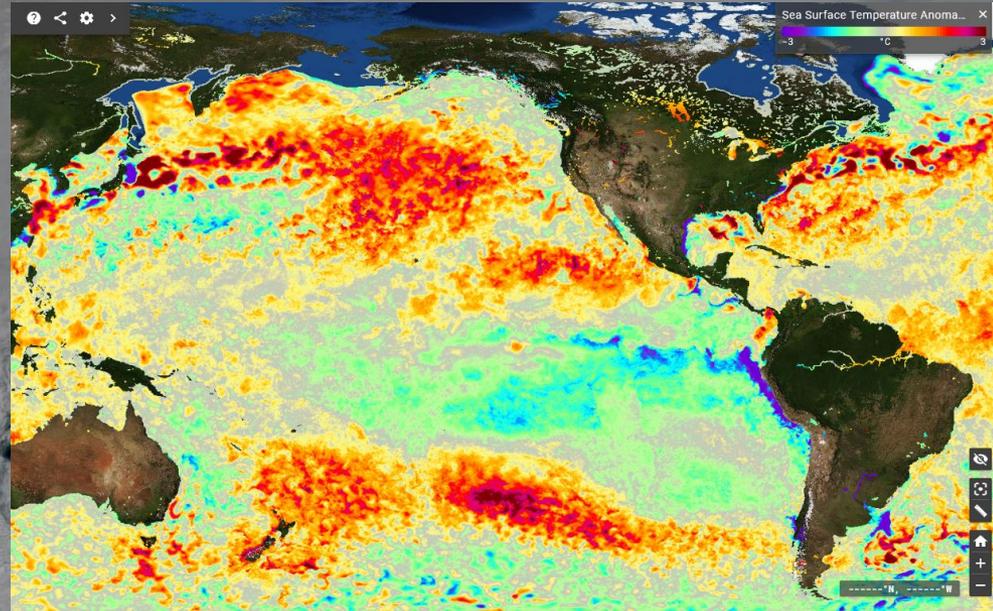
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NASA / PODAAC / JPL

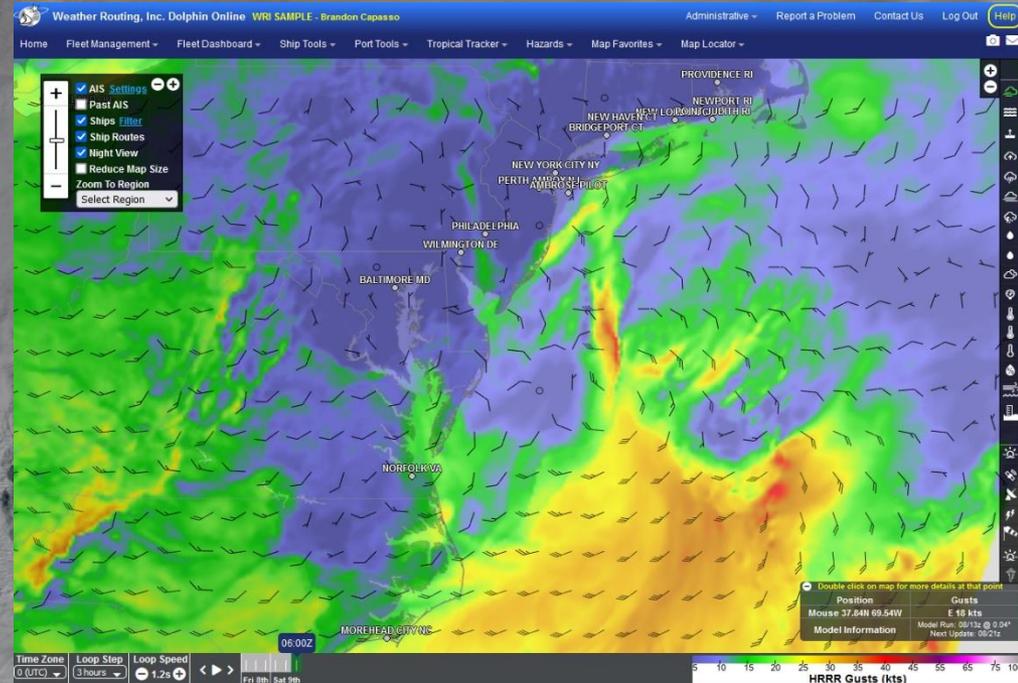
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Short Range - 6 hours – 4 days

- Meso/Microscale models (HRRR, WRF, NAMNST ICON, GEM-RDPS)
- Observations (surface, upper air, satellite, ship/buoy, aircraft)
- Forecast skill utilizing the above tools

Nowcasting – 15 min to 6 hours

- Radar/Satellite/Observations
- Microscale models



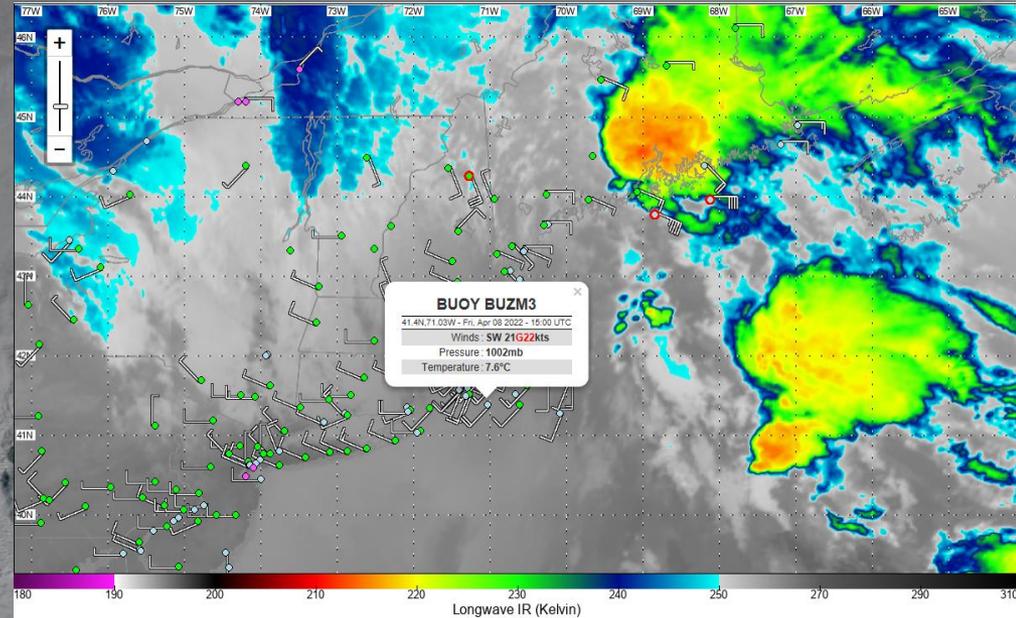
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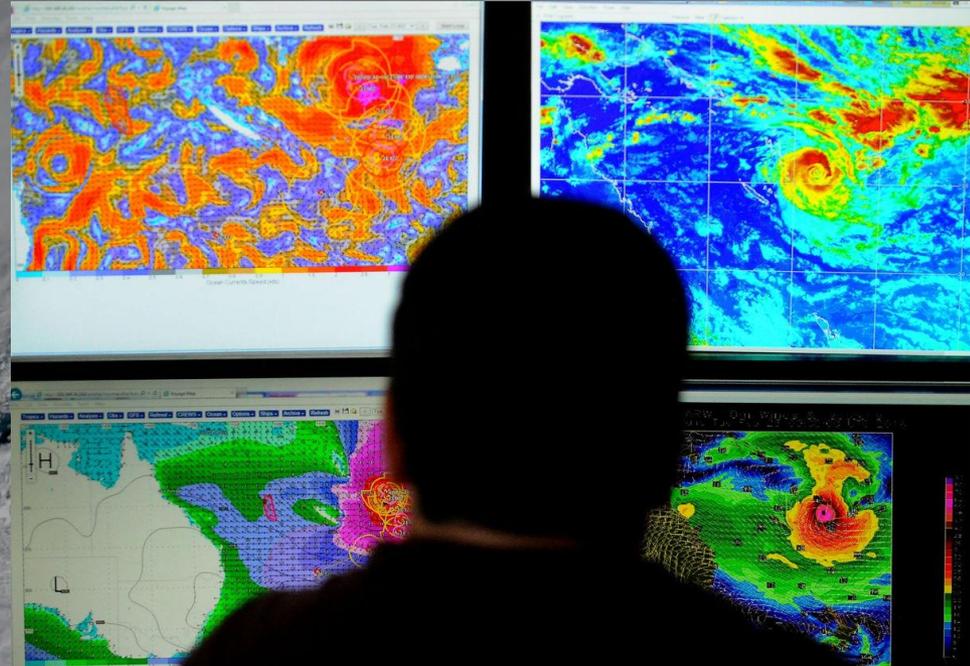
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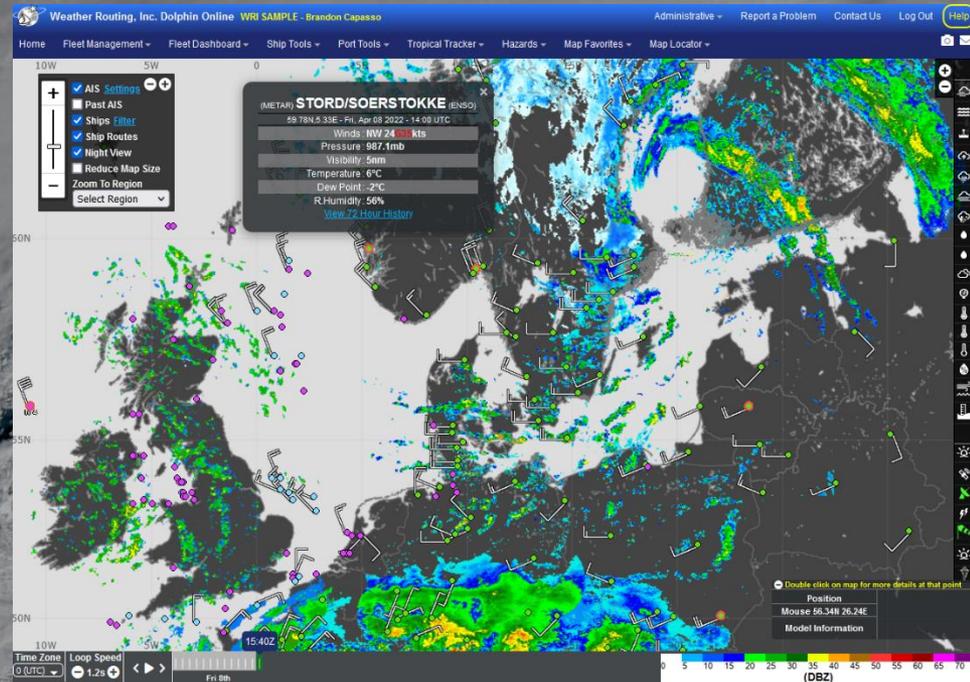
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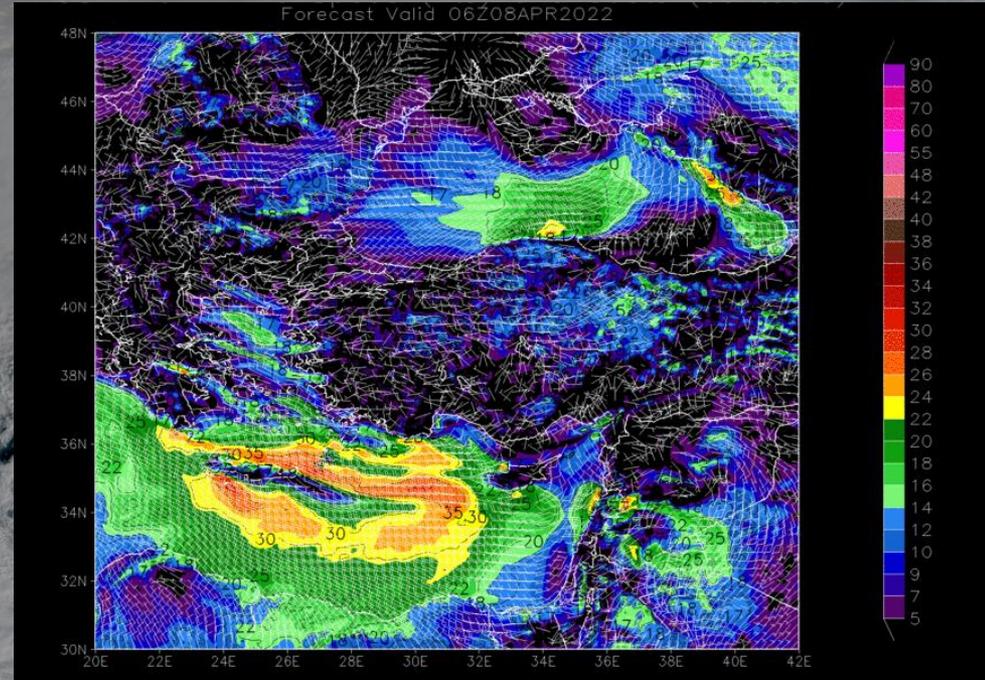
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Nowcasting – 15 min to 6 hours

- Radar/Satellite/Observations
- Microscale models
- **Look out the window!**



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Nowcasting – 15 min to 6 hours

- Radar/Satellite/Observations
- Microscale models
- **Look out the window!**
- **Webcams!**



Icing and Freezing Spray - Why here?

- Potential for very cold air temperature
- Warm ocean (40°-45° F), very cold air, and high winds provide mechanism for “airborne” supercooled water droplets (sea smoke).
- These supercooled droplets will freeze onto the first surface they come into contact with (i.e. wind turbine).

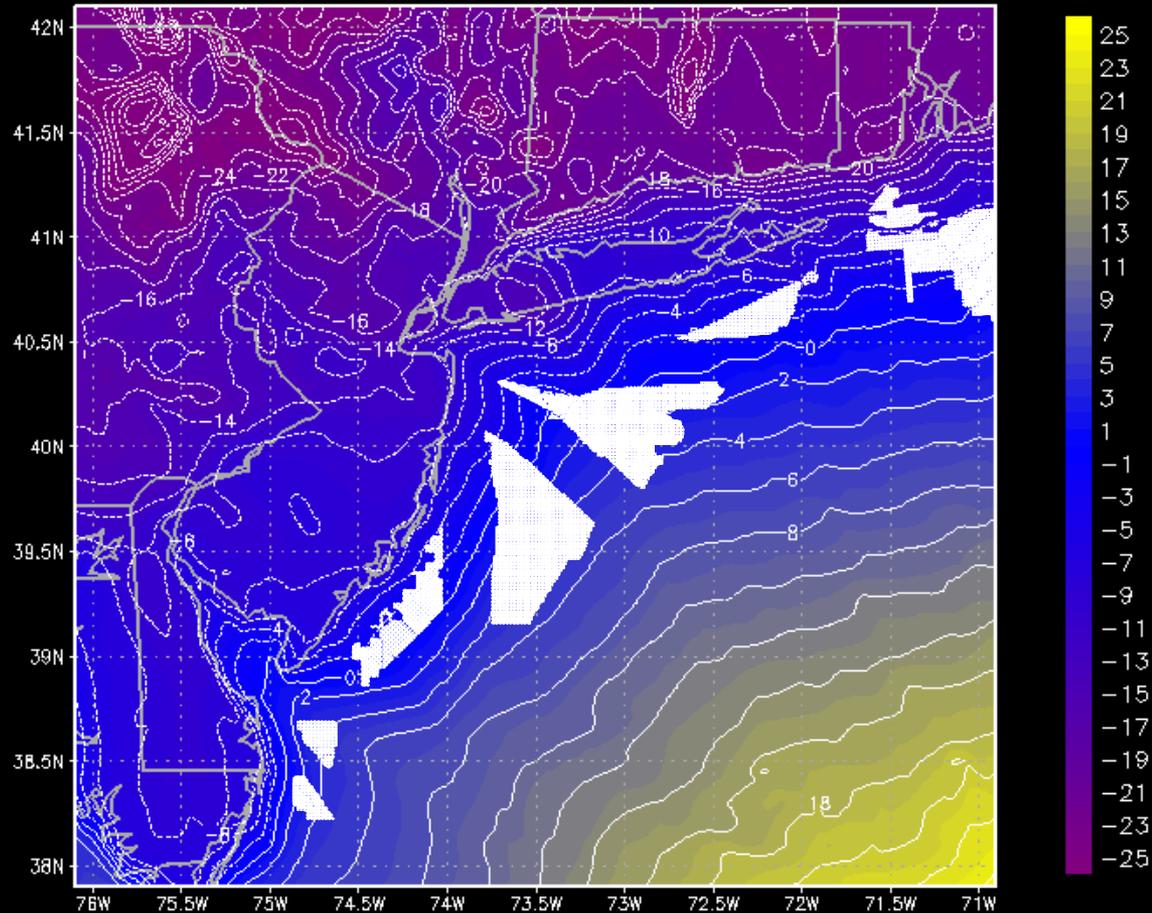




Weather Impacts Offshore New York & Southern New England

Icing and Freezing Spray

WRI-WRF 2013-2017 Minimum 100m Temperature (deg F)



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2017 Iowa State University
Email: huhui@iastate.edu

$t = 0 \text{ s}$

*Rime ice accretion over DU96-W-180 airfoil with airflow of
Wind Speed = 40 m/s, $T = -10.0 \text{ }^\circ\text{C}$, LWC = 0.3 g/m³*

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$t = 0 \text{ s}$

*Glaze ice accretion over DU96-W-180 airfoil with an airflow of
Wind Speed = 40 m/s, $T = -5.0 \text{ }^\circ\text{C}$, LWC = 3.0 g/m³*

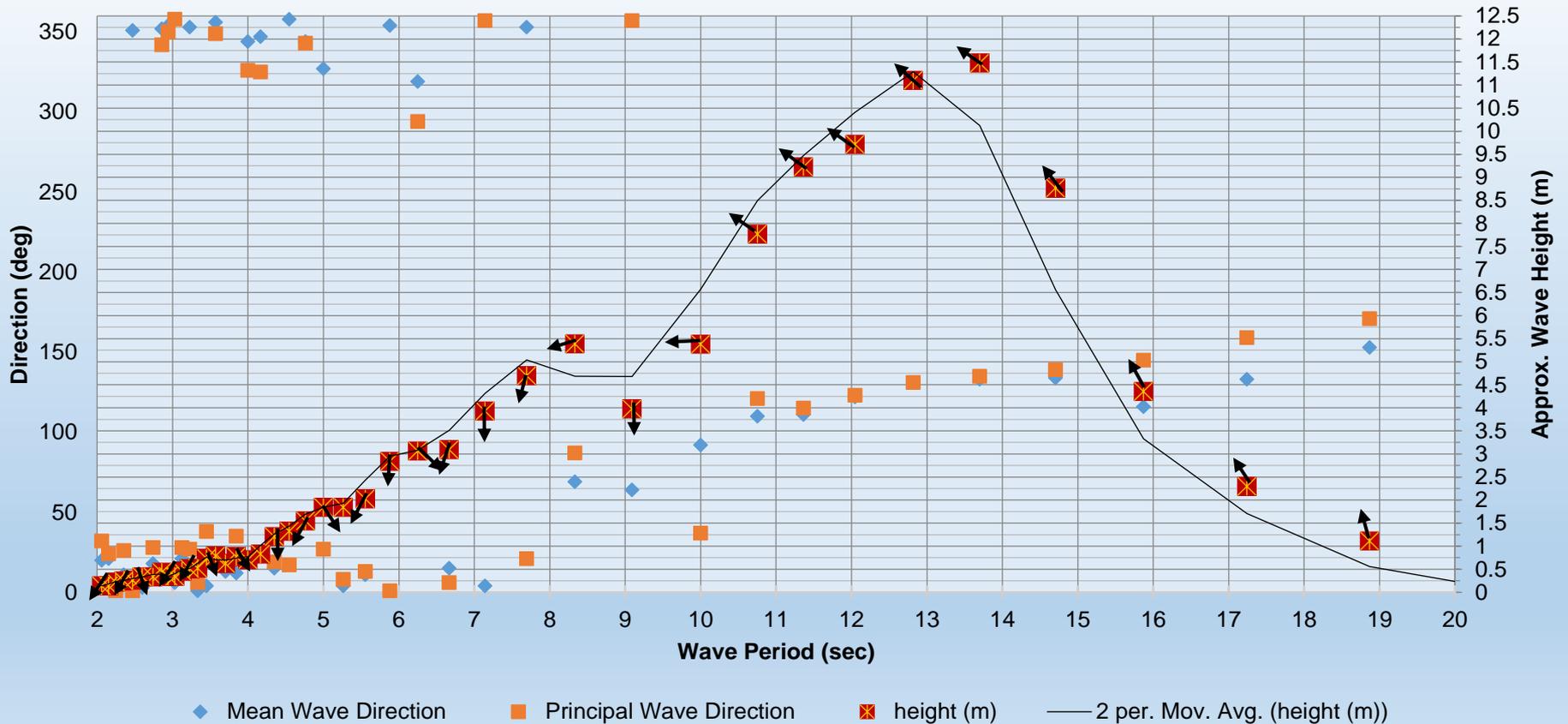
(Gao et al., Intl. J. Heat & Mass Transfer, 2019)

Confused Seas off NE U.S.

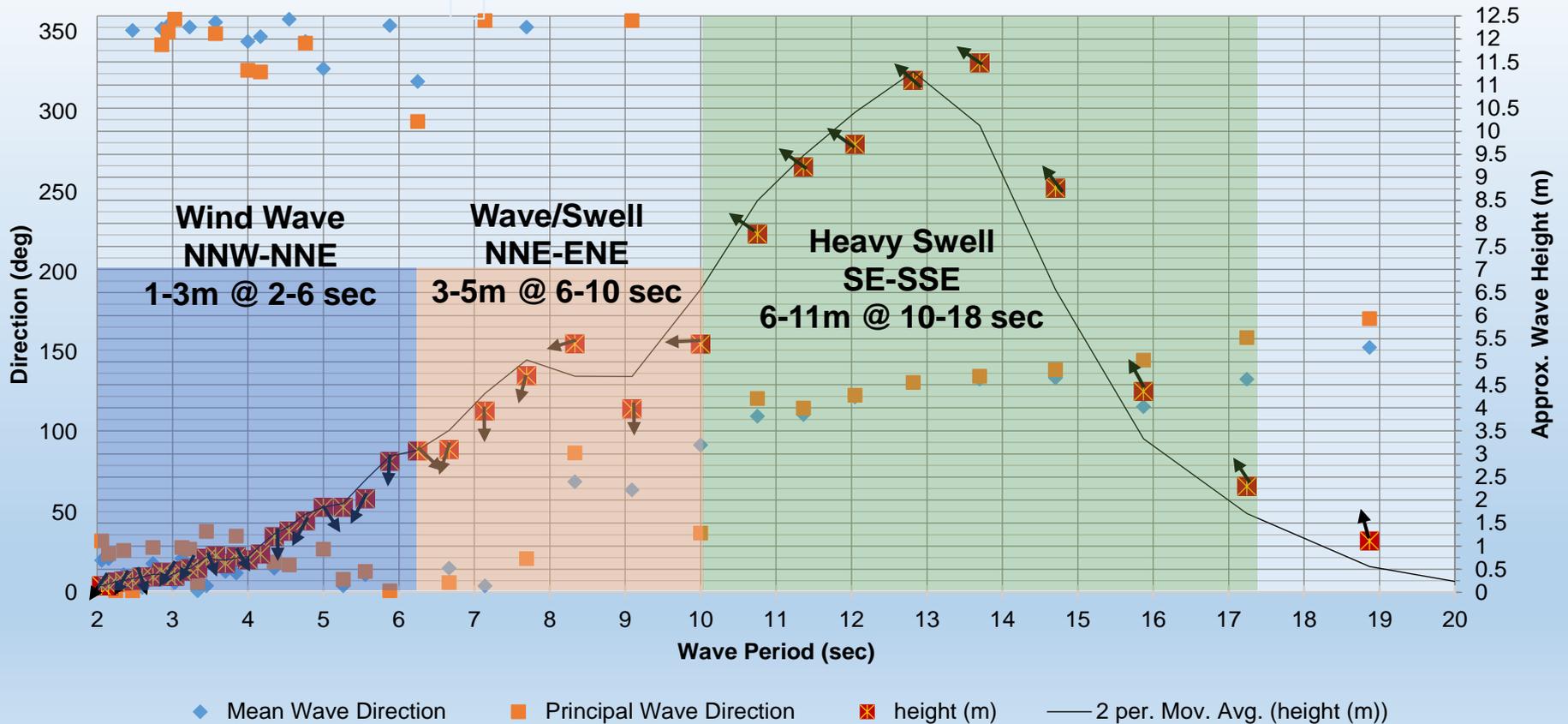
- Various swell systems can simultaneously impact areas around the Northeast U.S.
- Interaction with Gulf Stream/loops and tidal currents
- “Confused” sea states can be difficult to navigate, particularly with small/sensitive vessels.
- Increased likelihood of wave sets higher than the significant wave height, or even rogue waves.



Full Wave Spectrum at Buoy 44008 on 01/05/18 at 0000 UTC

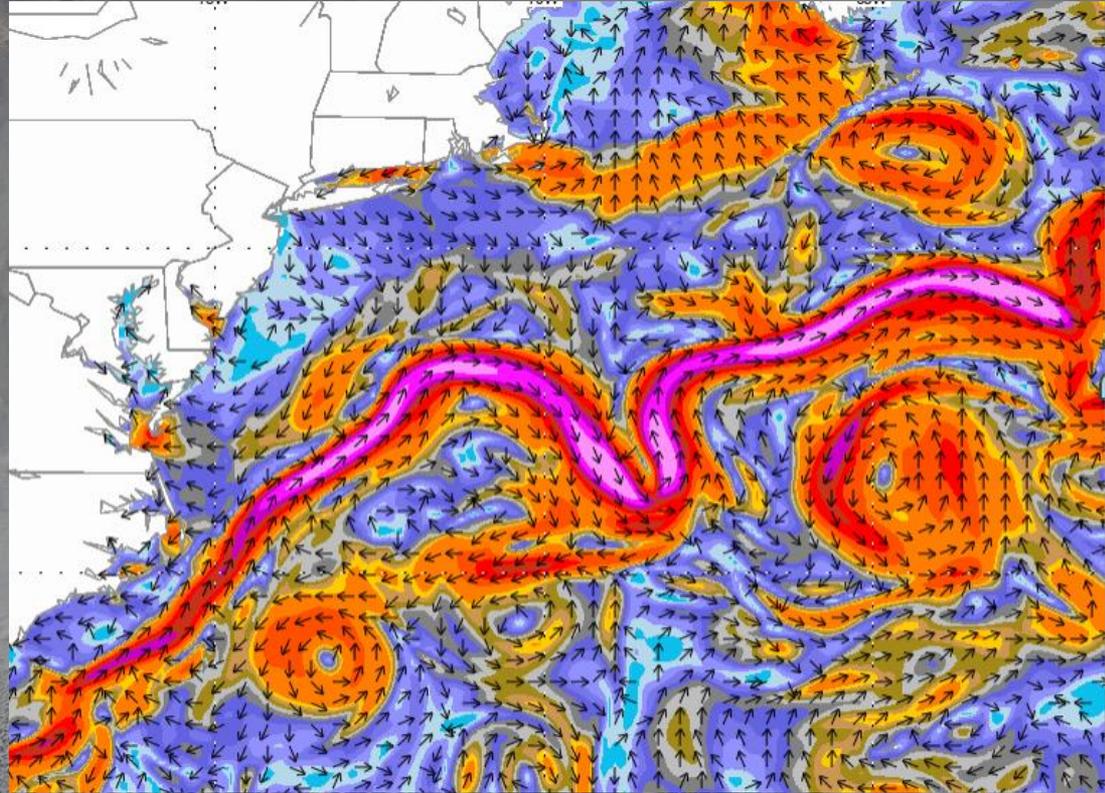


Full Wave Spectrum at Buoy 44008 on 01/05/18 at 0000 UTC



Gulf Stream/Tidal Currents

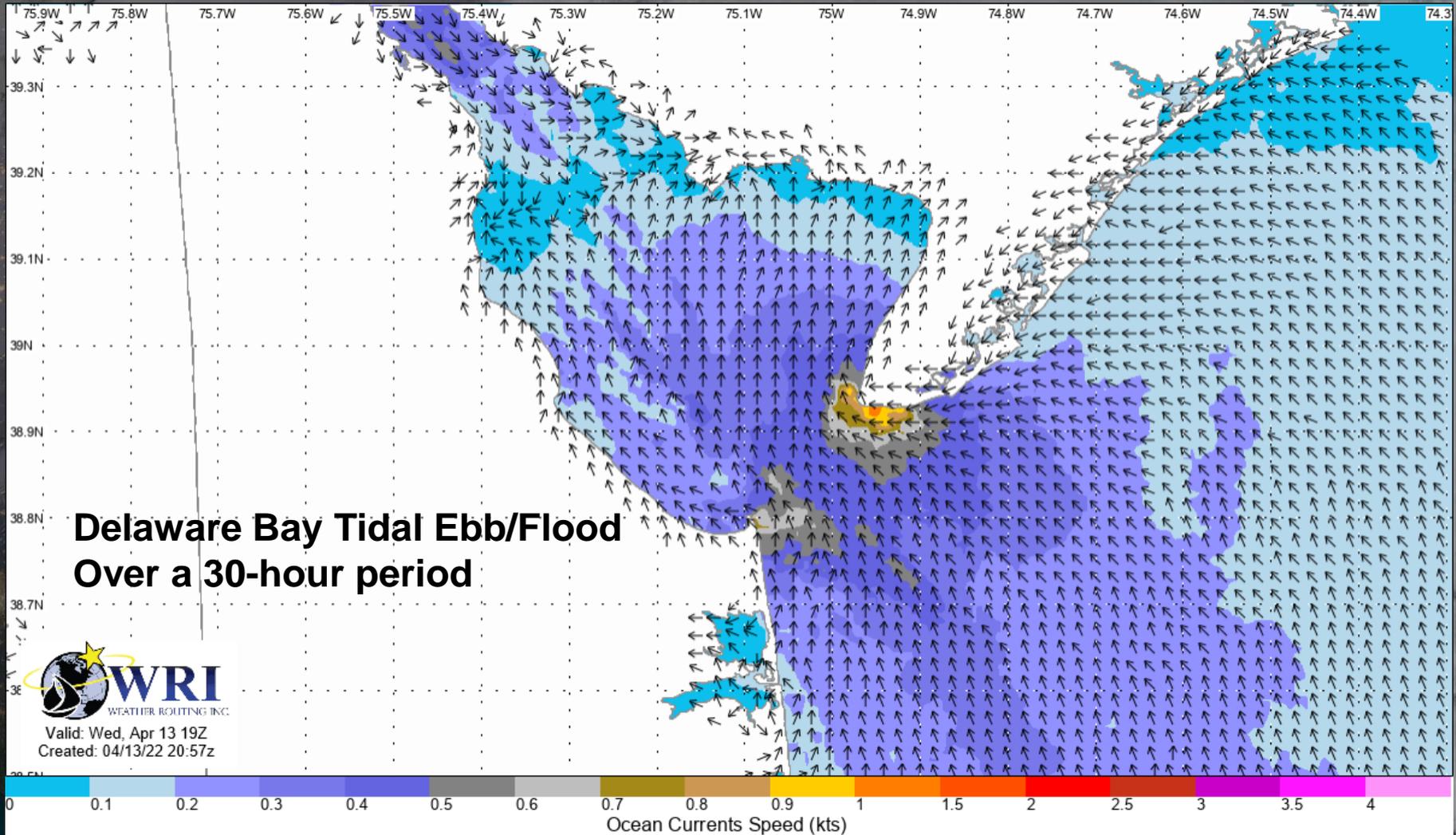
- Near-shore tidal currents/loop currents from the Gulf Stream can interact with swell/waves when opposite in direction.
- This interaction increases wave height and steepness.
- Tidal current can have a similar effect, particularly near/outside of bay entrances.





Weather Impacts Offshore New York & Southern New England

Multi-Directional Waves (Confused Sea State)



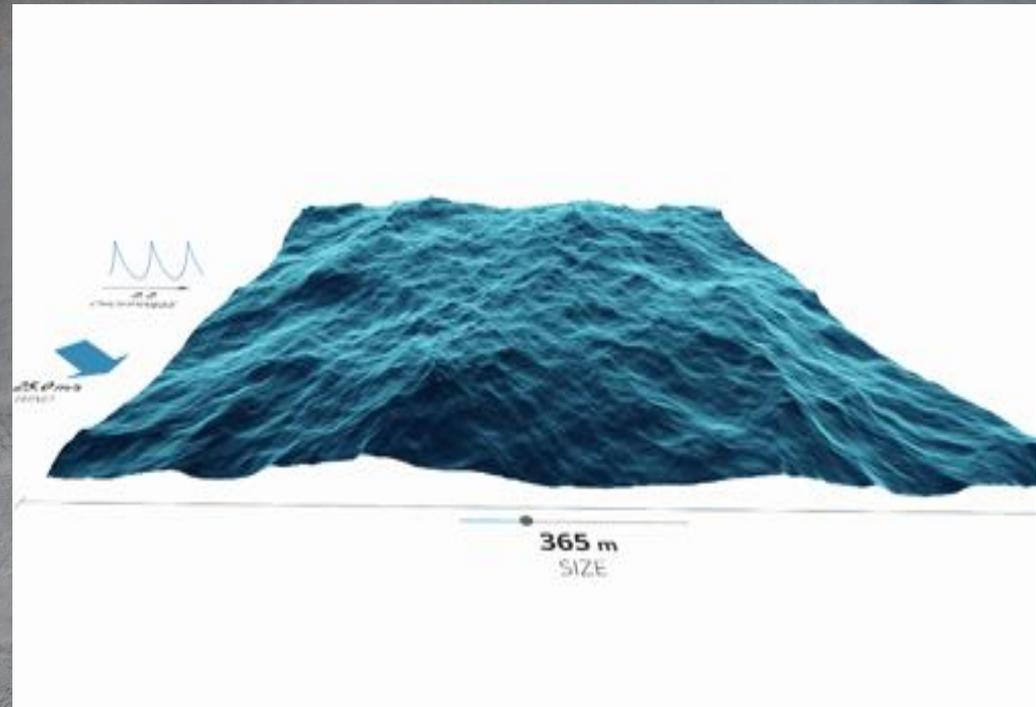
Wave/Current Interaction

- Can result in higher and steeper than expected waves, posing a hazard to O&M, construction, transport, etc.
- Increases the likelihood for a rogue wave to occur.
- Tidal current is not accounted for in most long-term model wave climatology



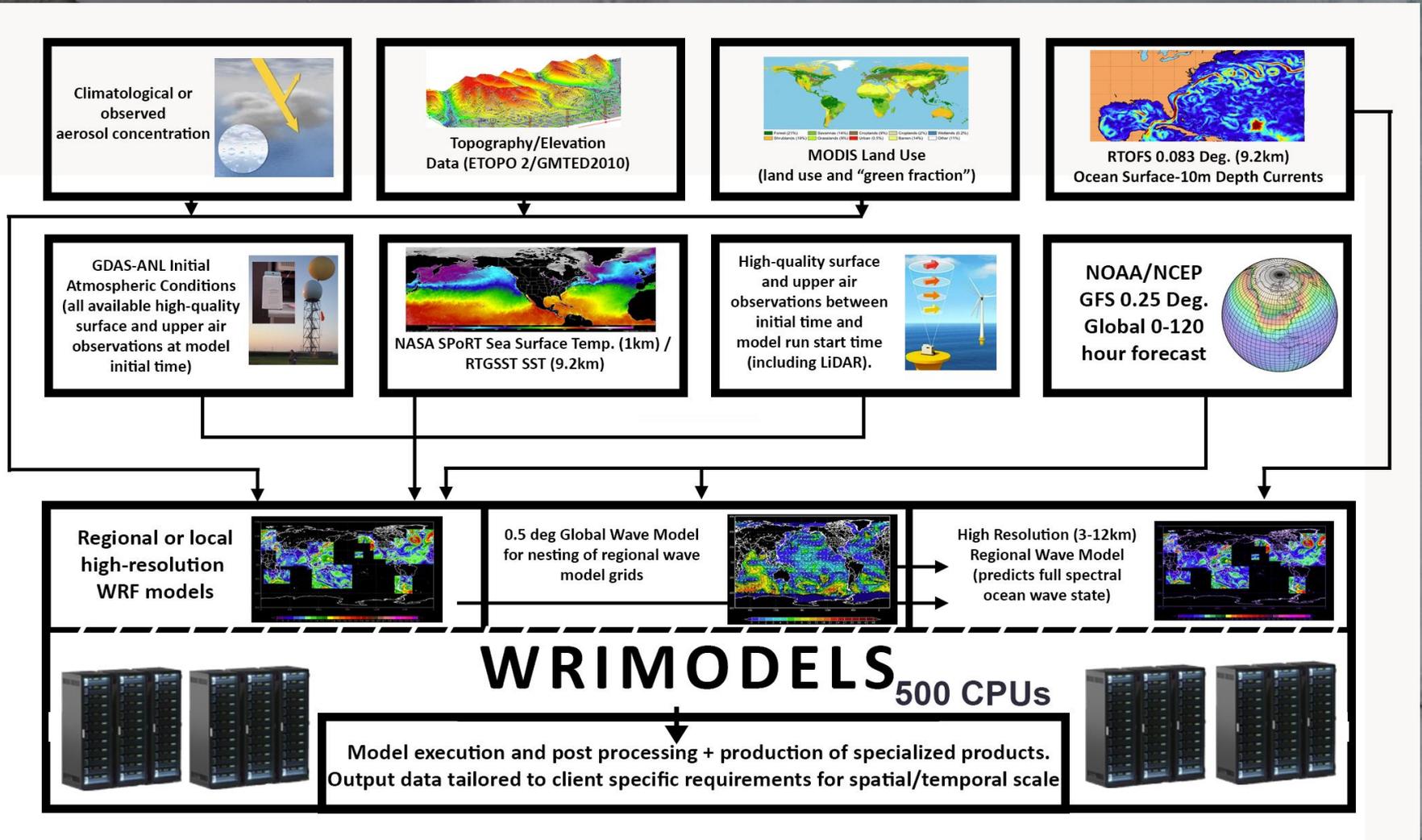
How do we forecast the sea state?

- WRI runs a state-of-the-art high resolution wave model that accounts for up to 25 wave spectra (wave sets) at any given location/time.
- The wave model is coupled with our in-house atmospheric weather model and high-resolution ocean current / tidal current model to produce an accurate digital representation and forecast of ocean waves.



Weather Impacts Offshore New York & Southern New England

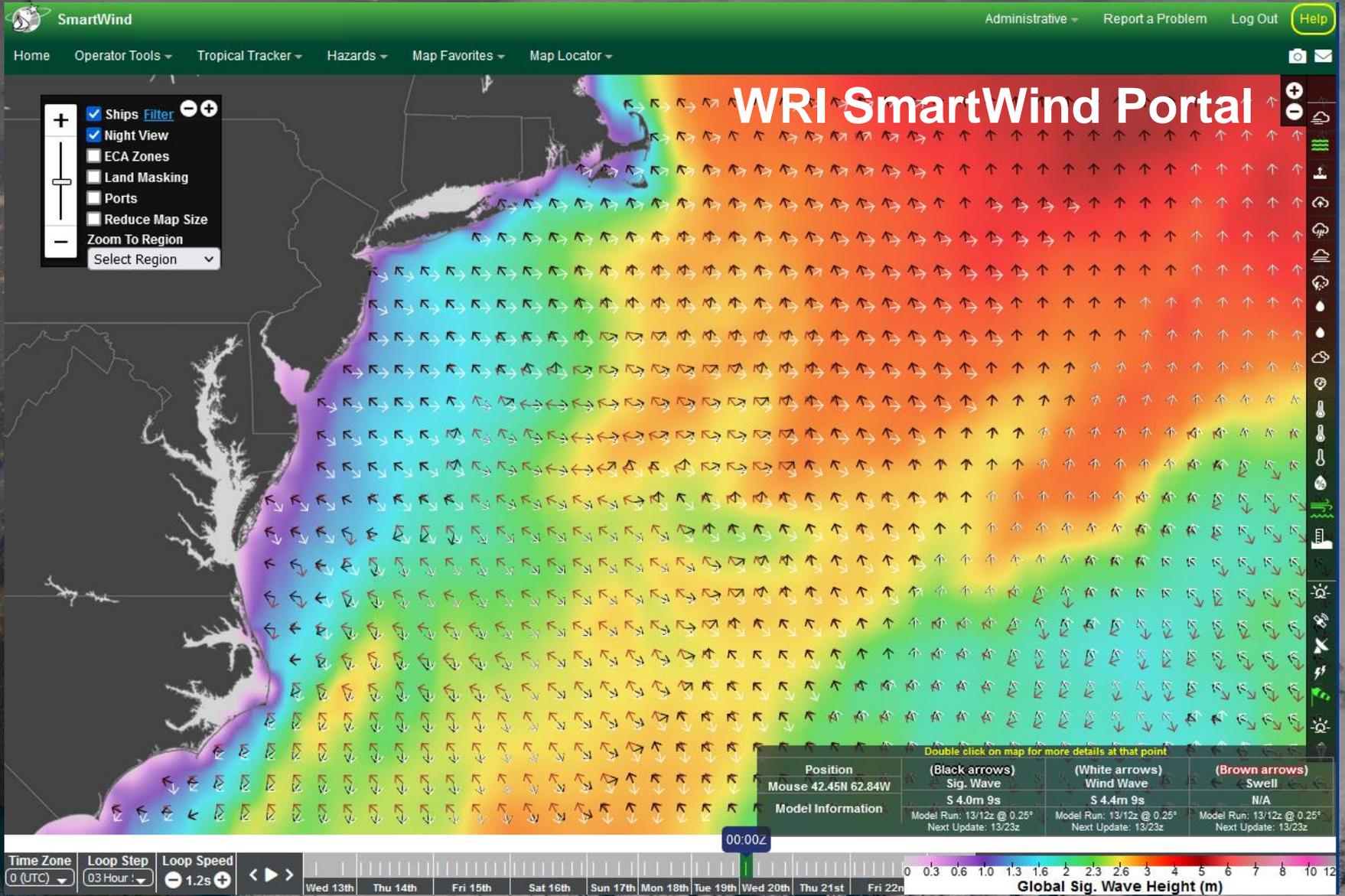
Multi-Directional Waves (Confused Sea State)





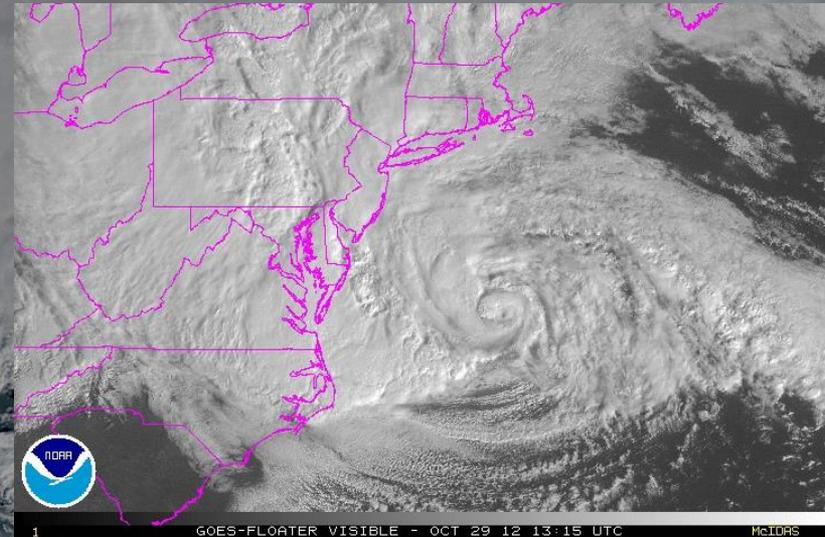
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Multi-Directional Waves (Confused Sea State)



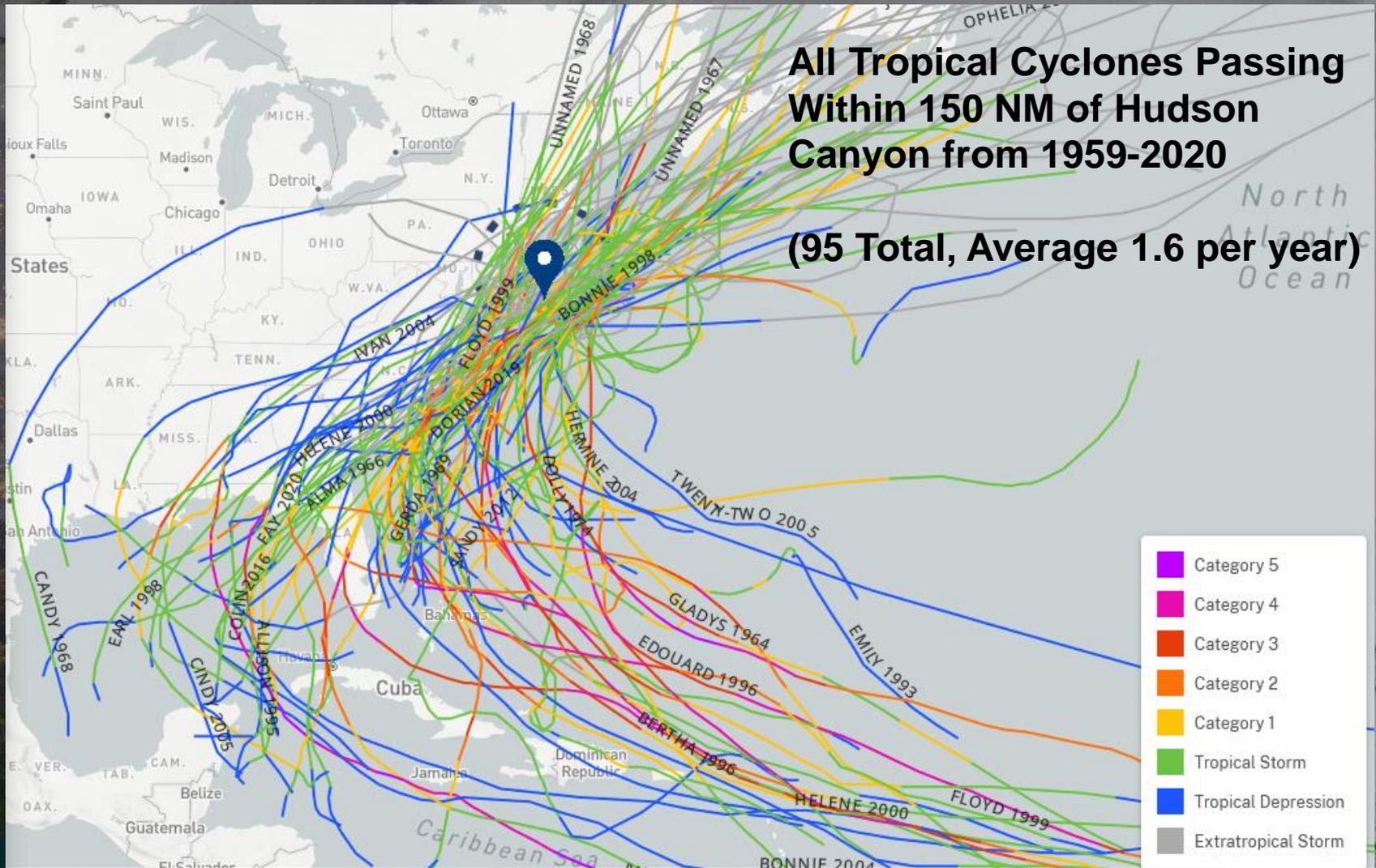
Tropical Cyclone Impacts

- Continental high pressure over U.S. mainland often blocks systems from moving inland and steers them northward along the East Coast.
- Late season systems can interact with arctic airmass from SE Canada to produce large/powerful storms (Hurricane Sandy).
- Average frequency of tropical or extratropical cyclones passing over majority of lease areas is 1.6 per year.



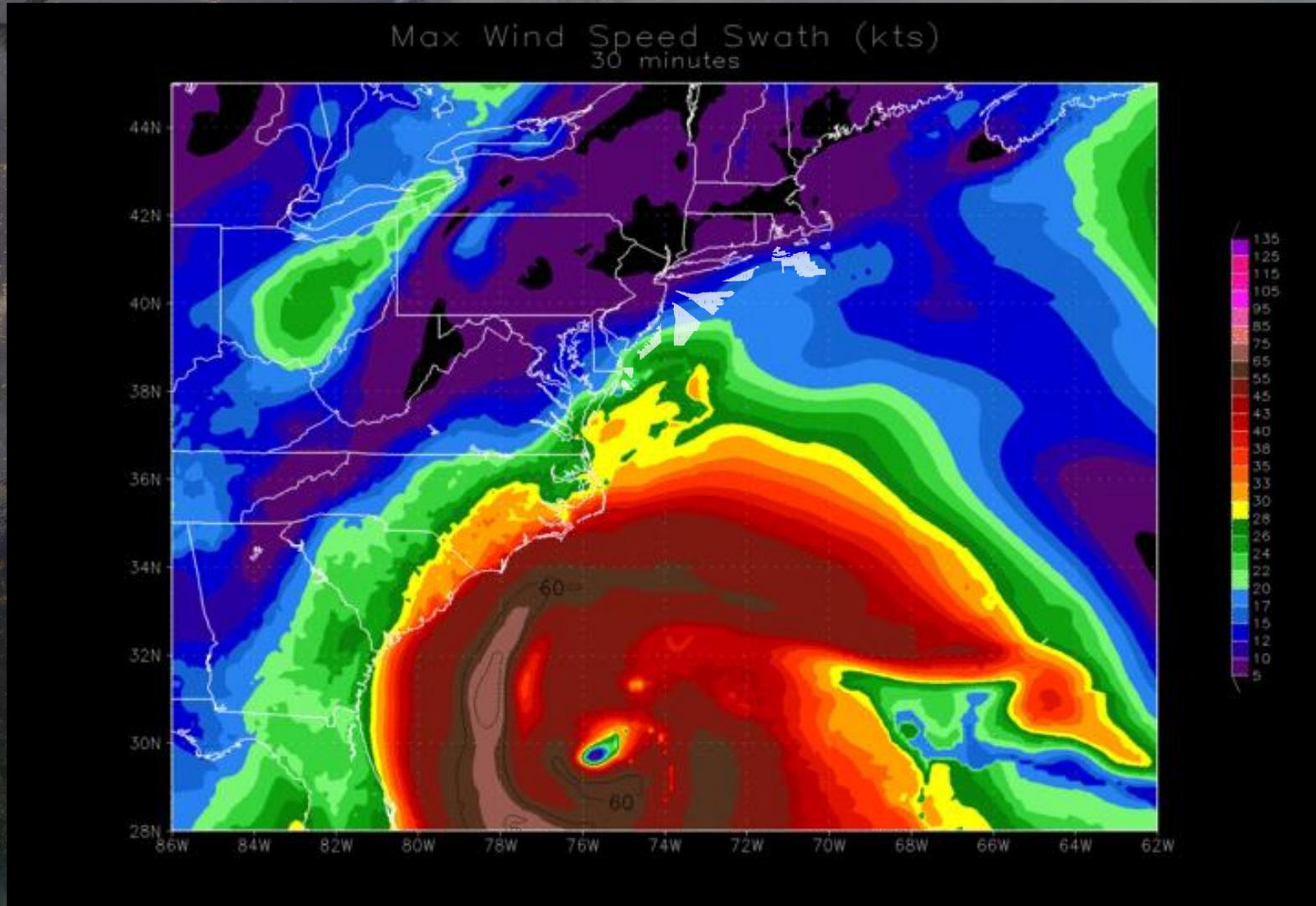
All Tropical Cyclones Passing Within 150 NM of Hudson Canyon from 1959-2020

(95 Total, Average 1.6 per year)



- Category 5
- Category 4
- Category 3
- Category 2
- Category 1
- Tropical Storm
- Tropical Depression
- Extratropical Storm

Hurricane Sandy



Tropical Cyclone Impacts

- Potential for wind speed to exceed design limits for turbines, resulting in damage/destruction.
- Potential for wave height to exceed foundation/tower design load limits.
- Significant downtime for O&M, construction, transport, and power production.



(a) WT No. 3



(b) WT No. 4



(c) WT No. 5



(d) WT No. 6

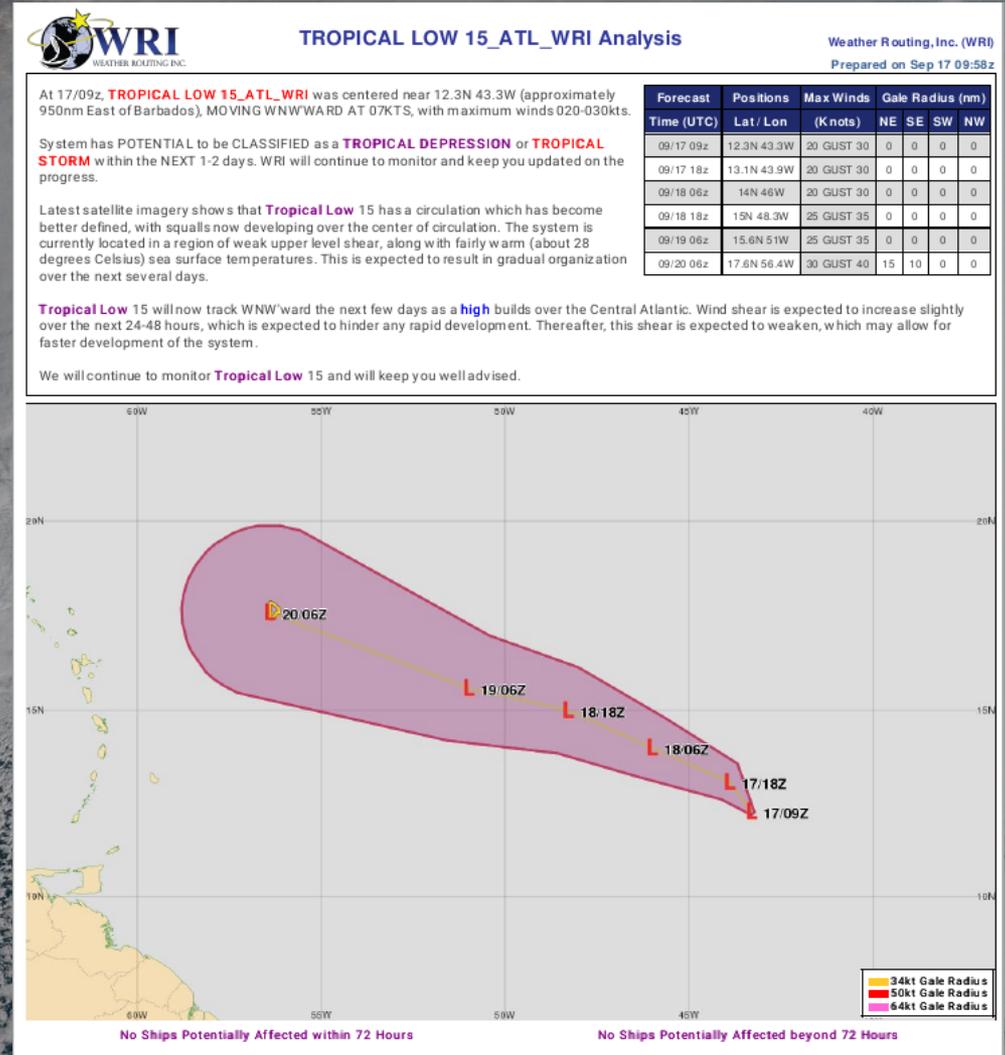


Weather Impacts Offshore New York & Southern New England

Tropical Cyclone Impacts

WRI Tropical Surveillance

- WRI issues track/intensity forecasts as much as 3-5 days prior to government advisories are issued.
- Consultation services: where/when to move, when is it safe to return, how will this impact operations.
- WRI has been providing Tropical Surveillance services to many companies/operators on a continuous basis for 10-15 years.

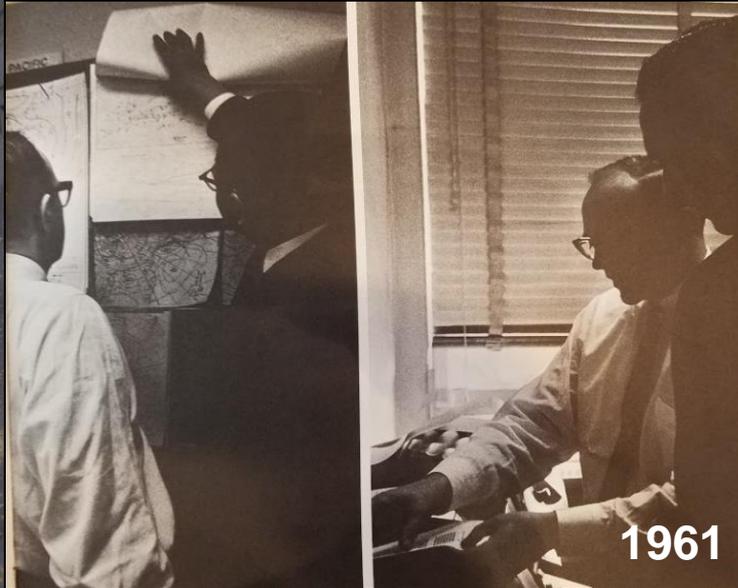


Conclusions

- A wide variety of weather hazards exist offshore from the Northeast U.S.
- Having a weather expert “involved in the discussion” is crucial for making productive decisions regarding O&M, construction, surveying, and component transport.
- Meteorologists understand complex weather factors such as “gust duration”, the ocean wave spectrum, depth of the marine boundary layer, etc.
- WRI services are customizable – we are equipped and prepared to meet your operational weather requirements.
- WRI’s has more than 50 meteorologists on staff around the clock.
- WRI’s Tropical Surveillance allows for advanced planning and avoidance of tropical cyclone impacts.



WRI Contact Information



Meteorologists are available 24 hours a day, 365 days a year

Weather Routing, Inc. (WRI)
Ph: 1.518.798.1110 (24 hour)
Ops E-mail: wri@wriwx.com
Energy E-mail: energy@wriwx.com
Website: www.wriwx.com

Coming Next:

May 11, 1:00 p.m. ET

Vessel Types

Noé Rouxel, DNV

May 25, 1:00 p.m. ET

Workforce Development

Philip Jordan, BW Research

Visit wind.ny.gov to register

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