

October 2018



RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY



New Jersey Offshore Wind Resource Modeling and Observations at RUCOOL

Dr. Scott Glenn

Dr. Josh Kohut

Dr. Travis Miles

Dr. Joseph Brodie

Dr. Rich Dunk

And Many Others!

Center for Ocean Observing Leadership
Department of Marine and Coastal Sciences
School of Environmental and Biological Sciences

The RUCOOL Offshore Wind Team

>100 Years Core Team Experience



Scott Glenn

Distinguished Professor, RUCOOL
Oceanographer with decades of experience observing and studying the Mid-Atlantic.

Joseph Brodie

Director of Atmospheric Research, RUCOOL
Meteorologist focusing on Mid-Atlantic offshore wind research for past 7+ years at RU and UD.

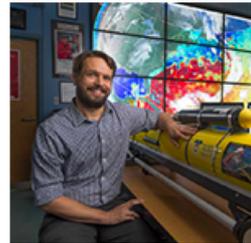


Josh Kohut

Associate Professor, RUCOOL
Interdisciplinary oceanographer bridging ocean physics with marine wildlife.

Travis Miles

Assistant Professor, RUCOOL
Marine meteorologist studying hurricanes, storms, and impacts for offshore wind.



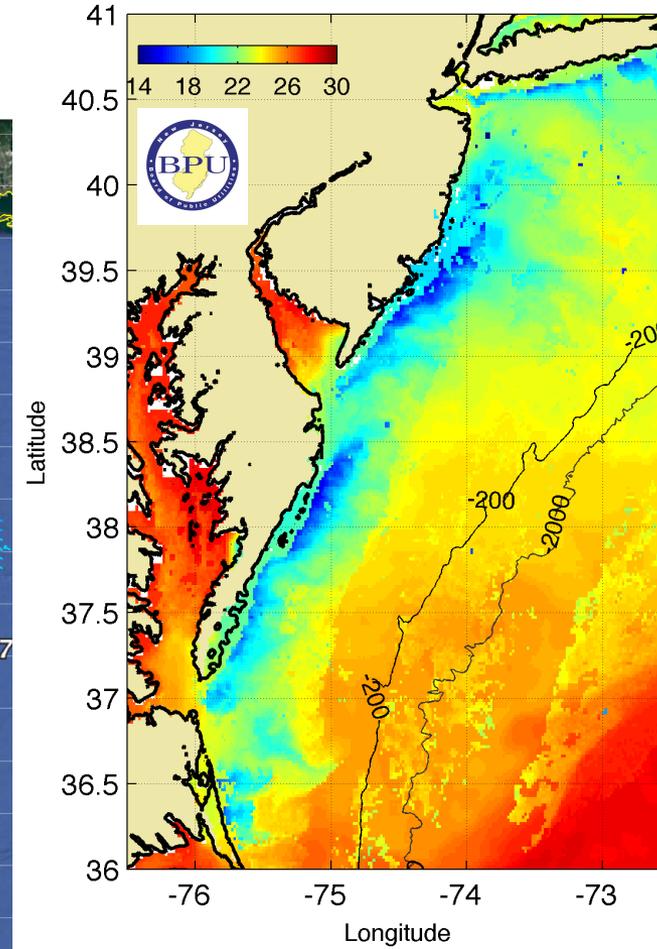
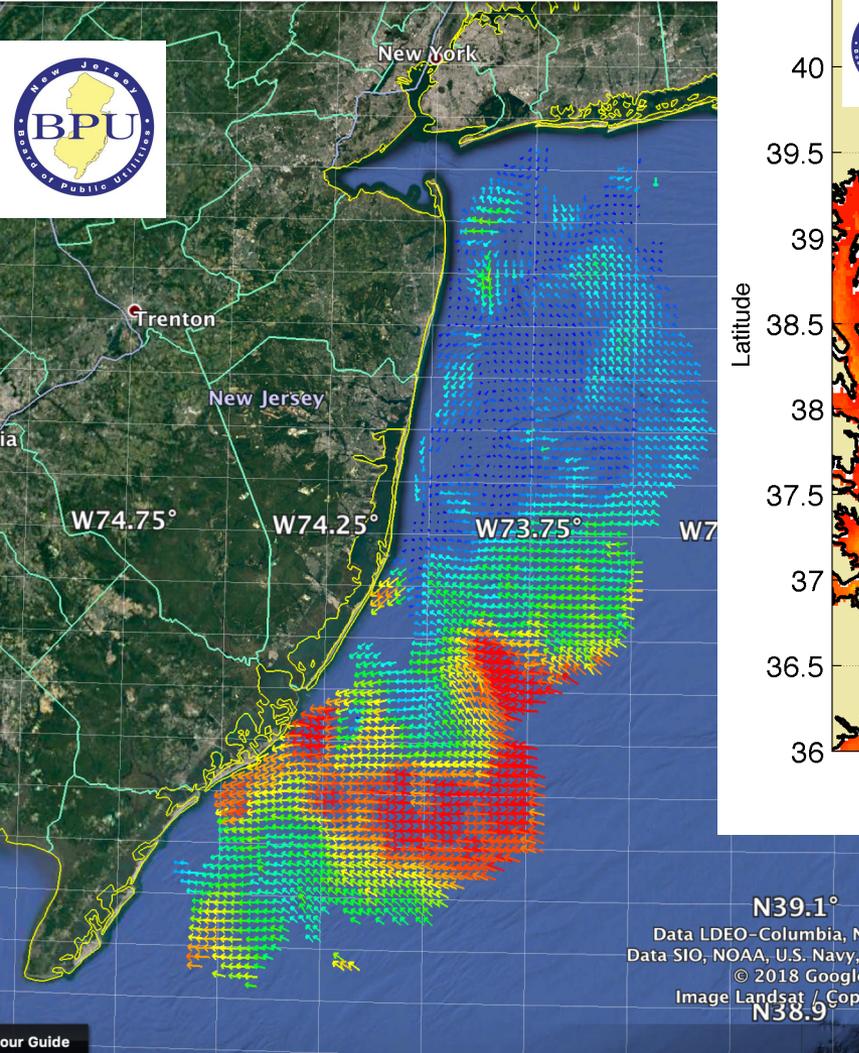
Rich Dunk

Principal Meteorologist/Owner, AquaWind LLC
Certified Consulting Meteorologist (CCM) with decades of experience in the NJ energy sector.

<http://rucool.marine.rutgers.edu>

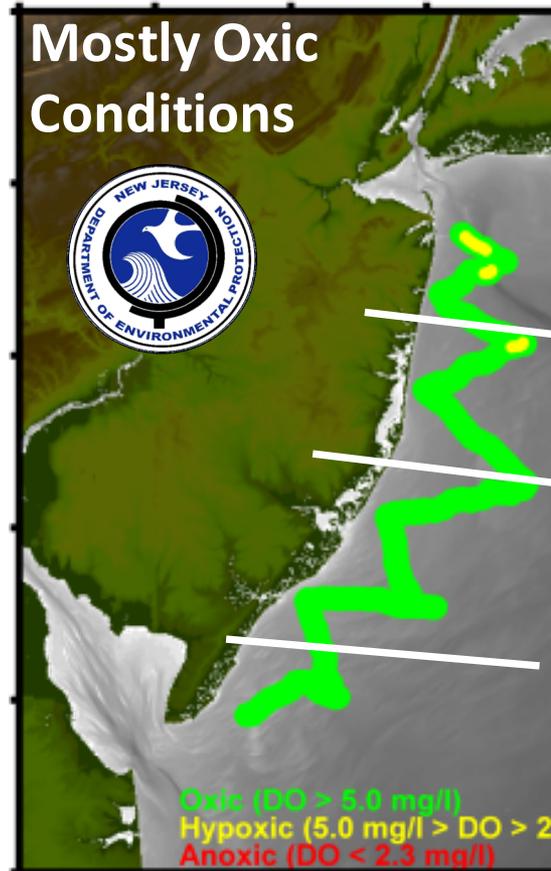
NJ BPU & NJ DEP State Ocean Observing System

Medium Range (13 MHz)
HF Radar Network



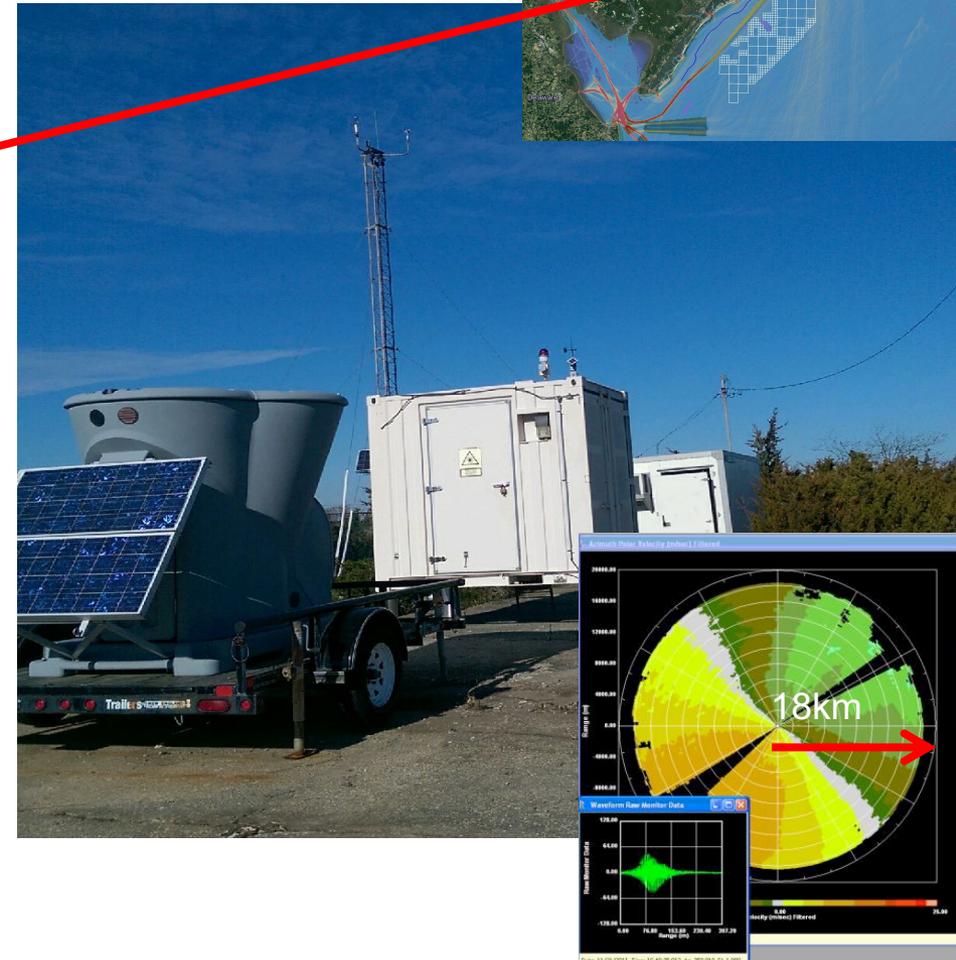
Nearshore
Glider
Surveys

Coldest Dark Pixel
SST Product
Development



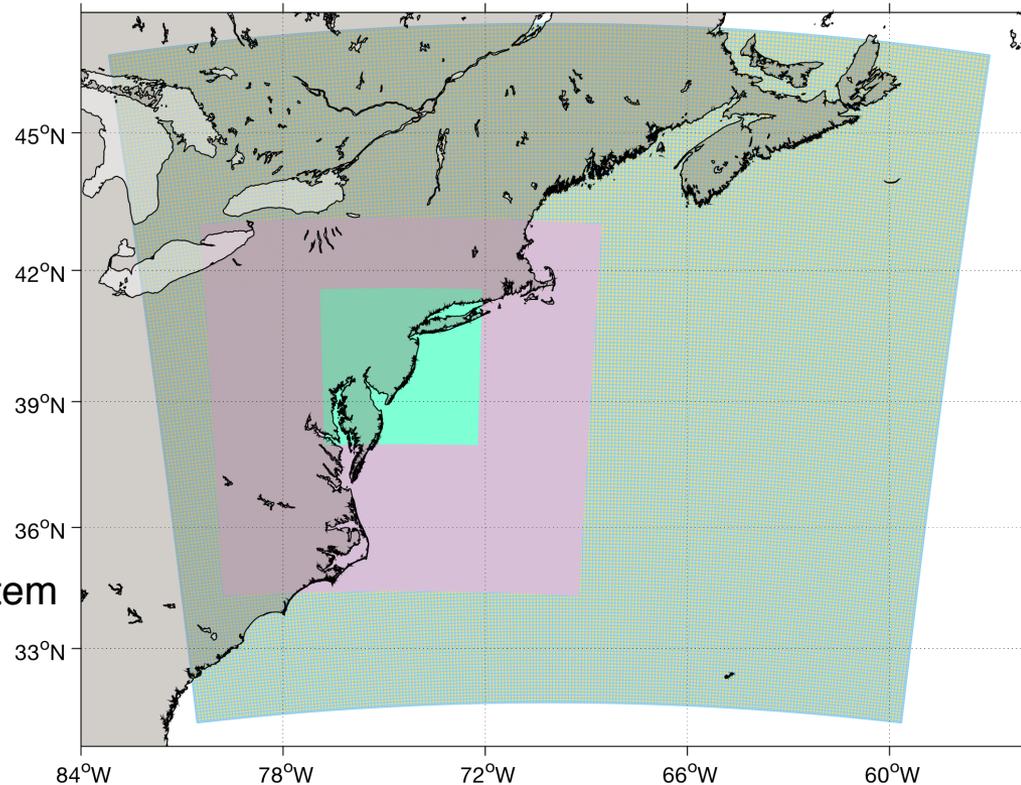
Coastal Met-Ocean Monitoring Station

- Located at the RU Marine Field Station in Tuckerton, NJ
- 12 m meteorological tower
- Triton SODAR
- Lockheed WindTracer scanning lidar



Real-Time Weather Modeling RU-WRF

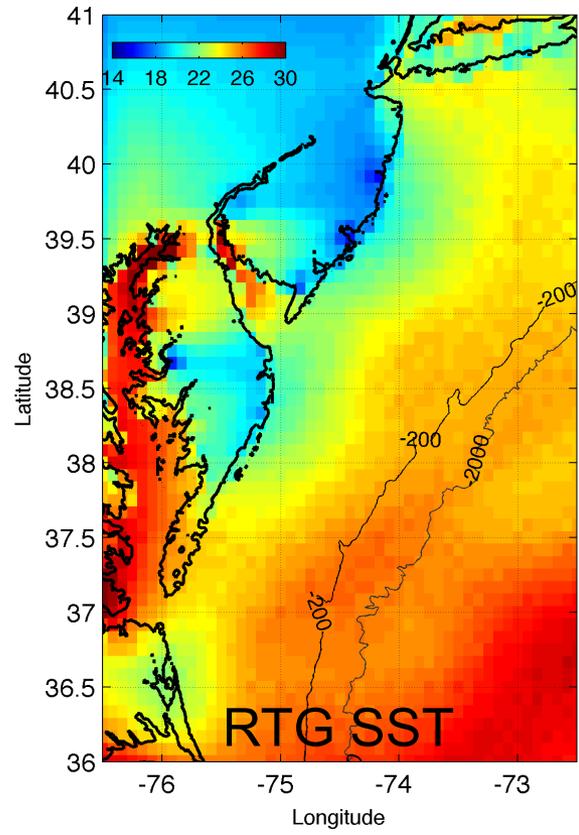
- Run Continuously 2011 – Present
- Triple nested: 9km-3km-1km
 - 9km: 0, 6, 12, 18Z cycles
 - 3km: 0, 12Z cycles
 - 1km: 0Z cycle (Research Mode)
- Hourly forecast:
 - 9km: out 5 days
 - 3km: out 2 days
 - 1km: out 1 days
- Lateral Boundary Conditions:
 - 9km: 0.25 degree Global Forecast System
 - 3km: RU-WRF 9km
 - 1km: RU-WRF 3km
- Vertical Levels:
 - 40 levels more tightly packed near the surface.
- Surface Boundary Condition:
 - RUCOOL Coldest Dark Pixel Composite



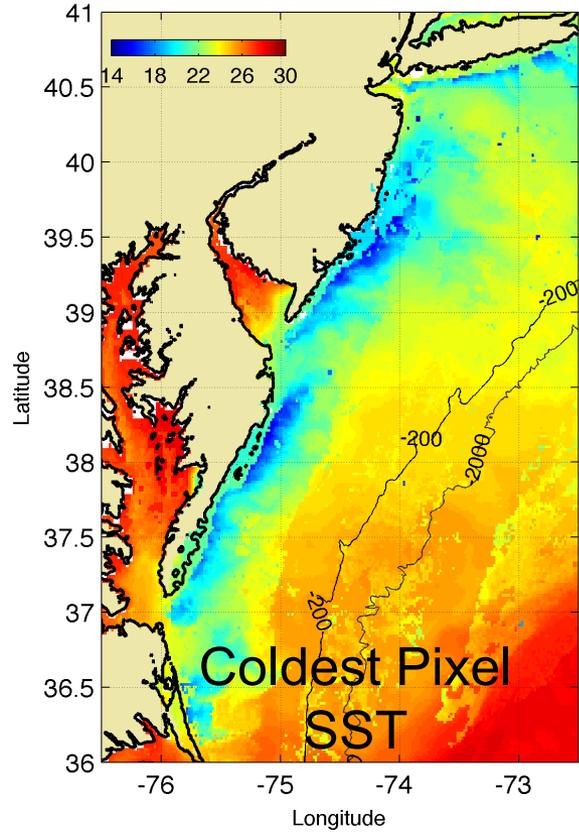
Regional Coldest Dark Pixel Composite SST Captures Coastal Upwelling

Example:
8 July 2013 Upwelling

Standard
National
Satellite
Sea Surface
Temperature
(SST) Product



Rutgers
Regional
Satellite
Sea Surface
Temperature
(SST) Product

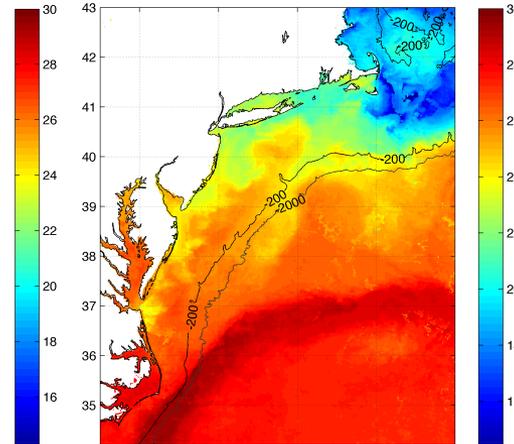
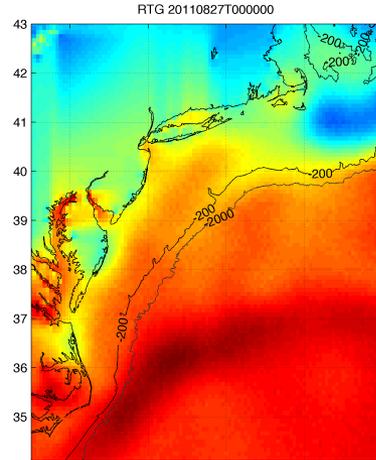


Coldest Dark Pixel SST Also Captures Hurricane-Driven Cooling

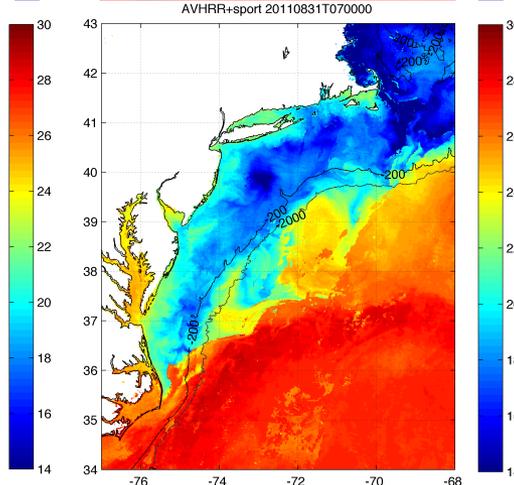
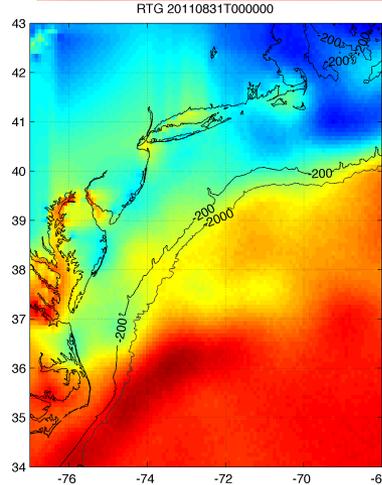
Standard
National SST

Rutgers
Regional SST

BEFORE
IRENE



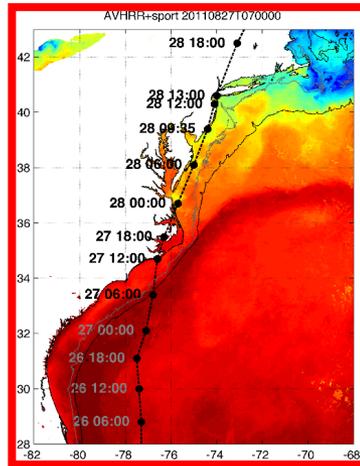
AFTER
IRENE



Example:
Hurricane Irene
August 2011

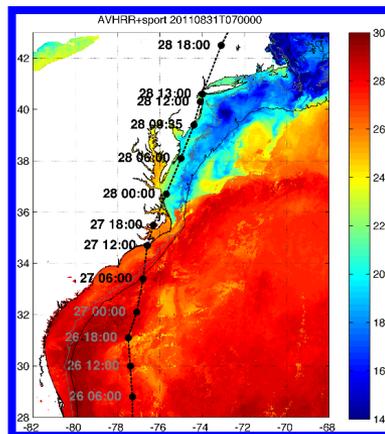
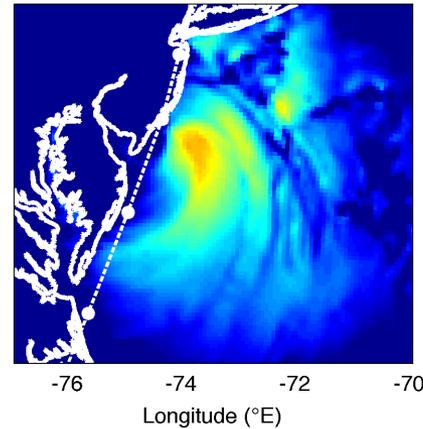
Cold Water Influences Coastal Storms

Hurricane Irene – Aug 2011



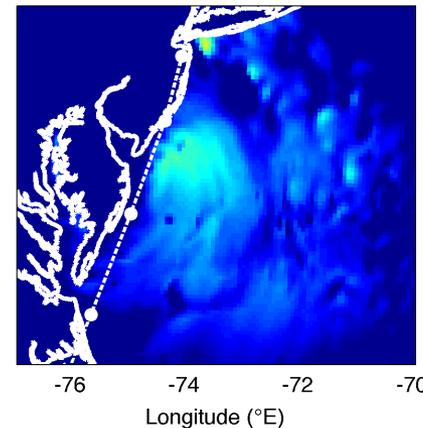
Warm
Ocean
→
Cat I
Hurricane

WRF Warm SST W Spd (kts)



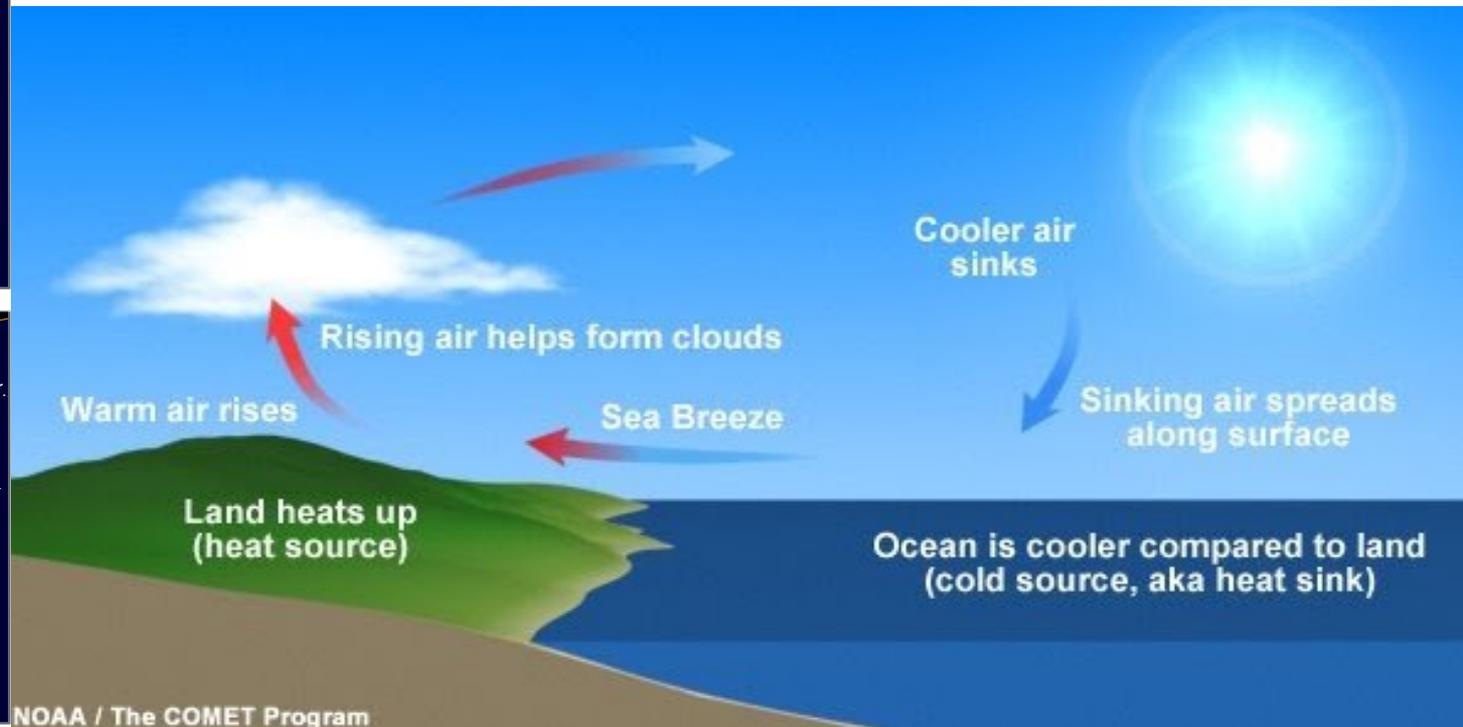
Cold
Ocean
→
Trop
Storm

WRF Cold SST W Spd (kts)

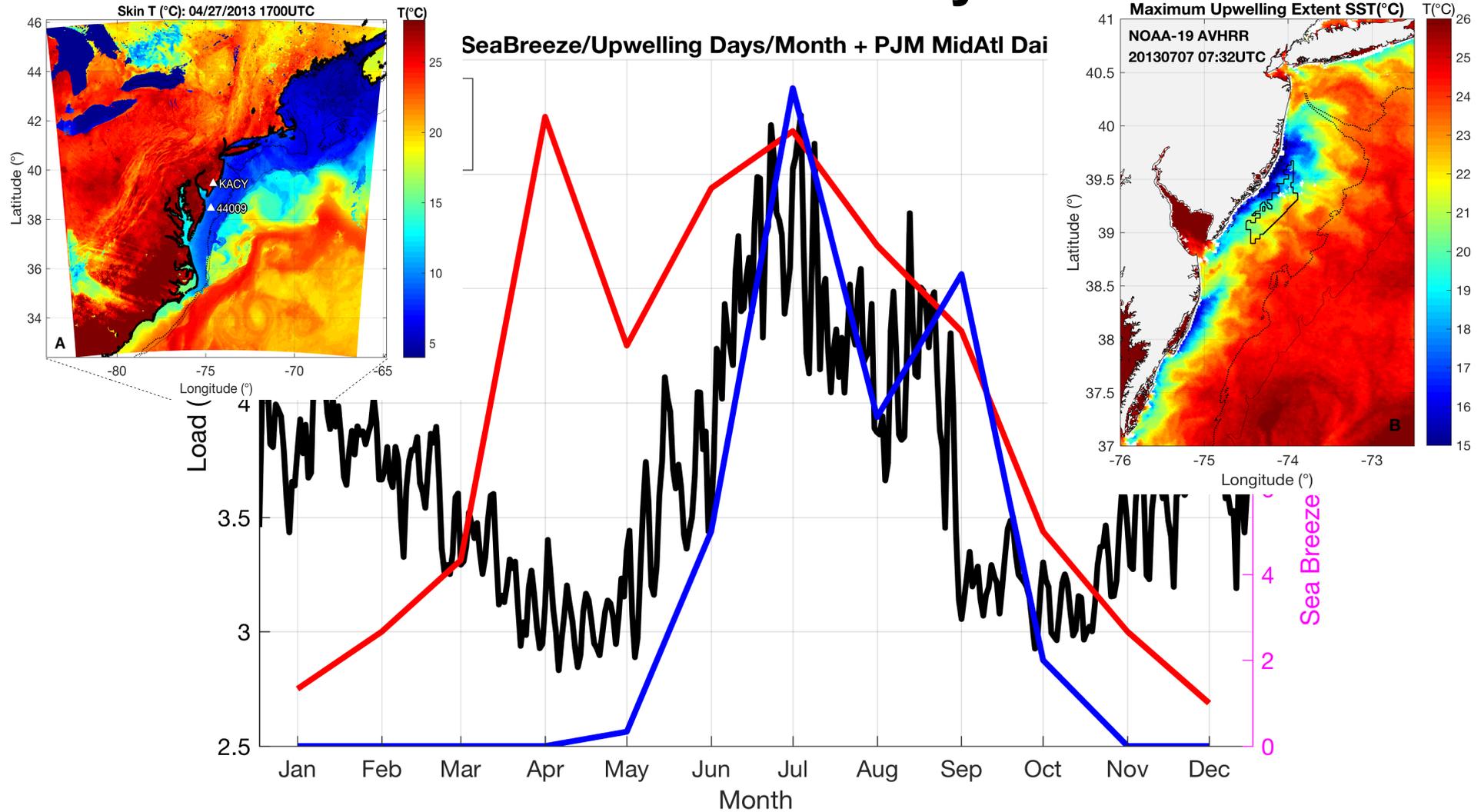


Sea breezes are common; Driven by land-sea temperature difference

Depending on height and strength of the return flow, and the location of the subsidence zone, turbines could experience different winds throughout the rotor layer

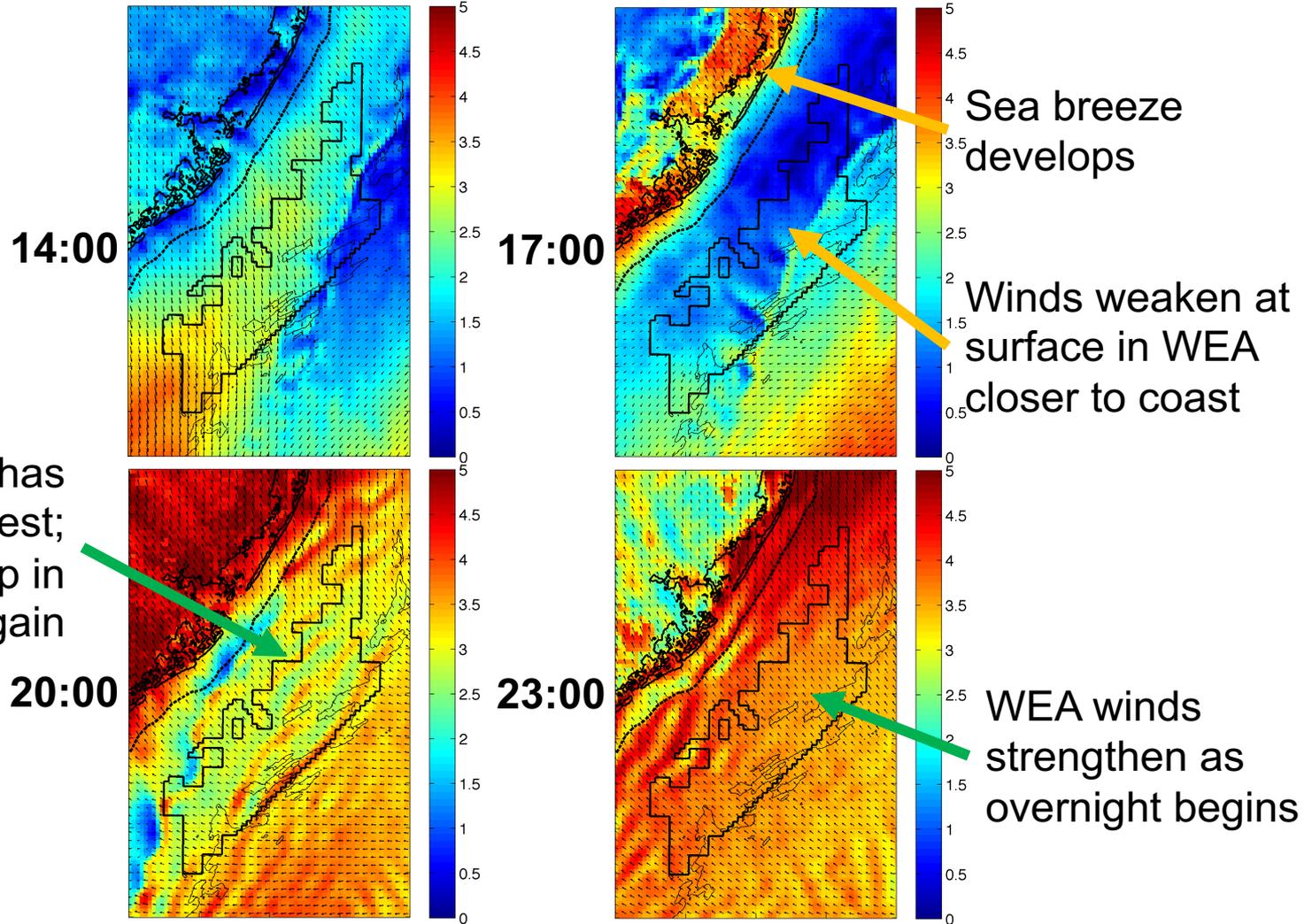


Sea Breezes & Upwelling Coincident with Electricity Demand



RU-WRF Capturing Sea Breeze Evolution

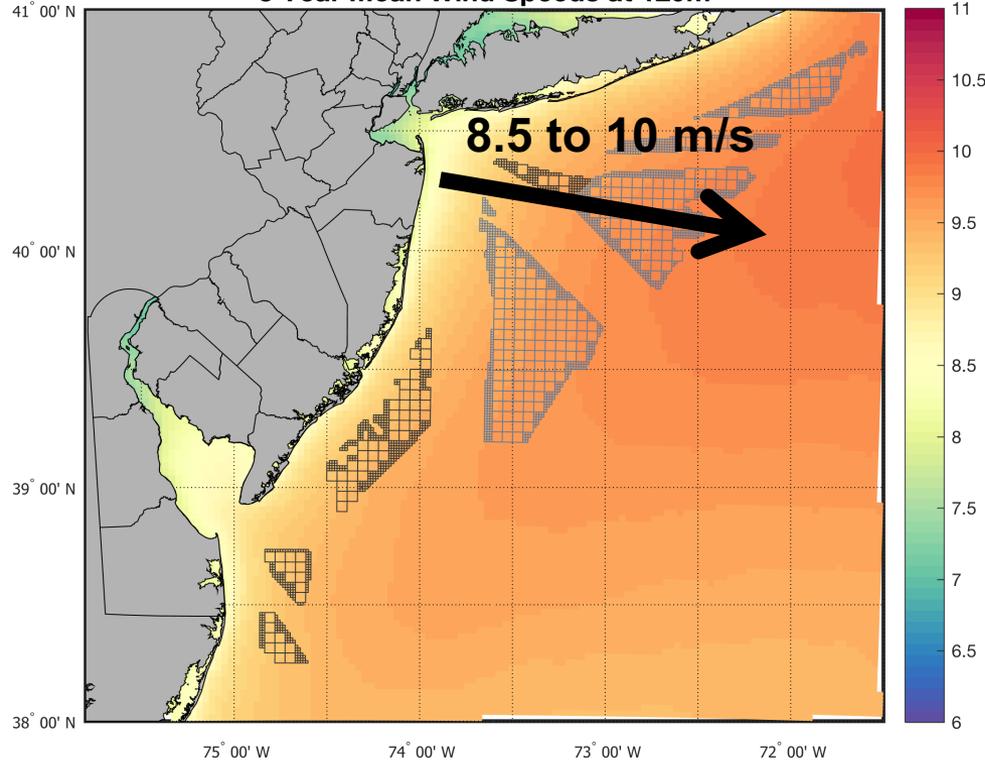
September 12, 2012 10m Winds



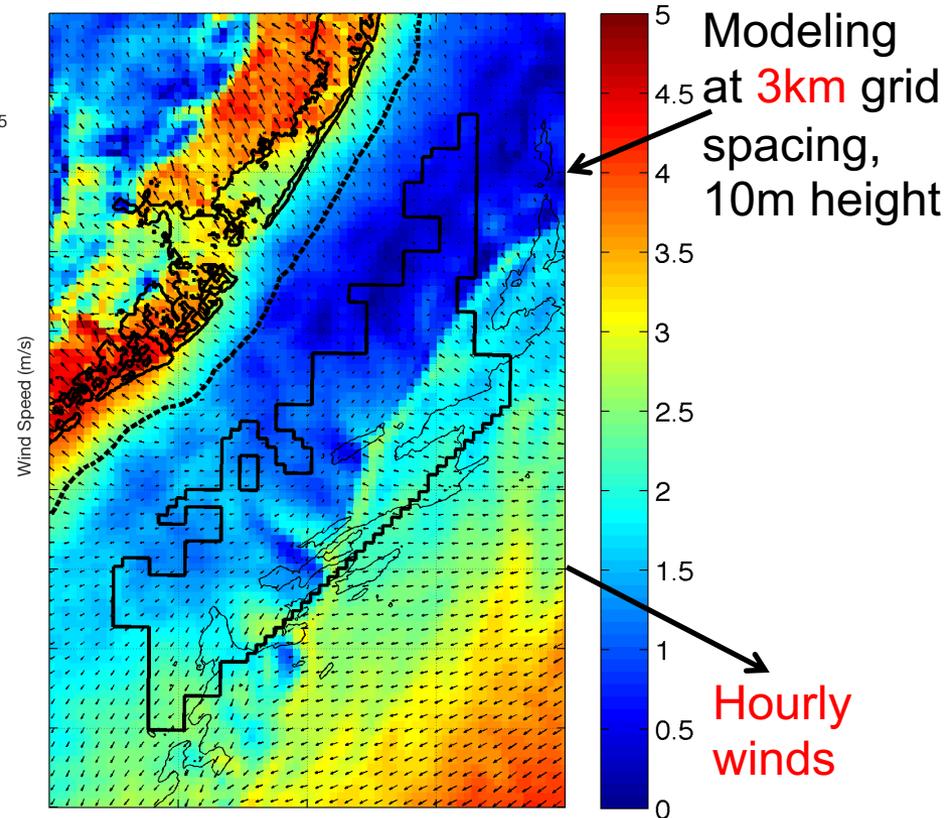
RU-WRF Wind Resource

3 Year Mean

3 Year Mean Wind Speeds at 120m



One Hour Sample

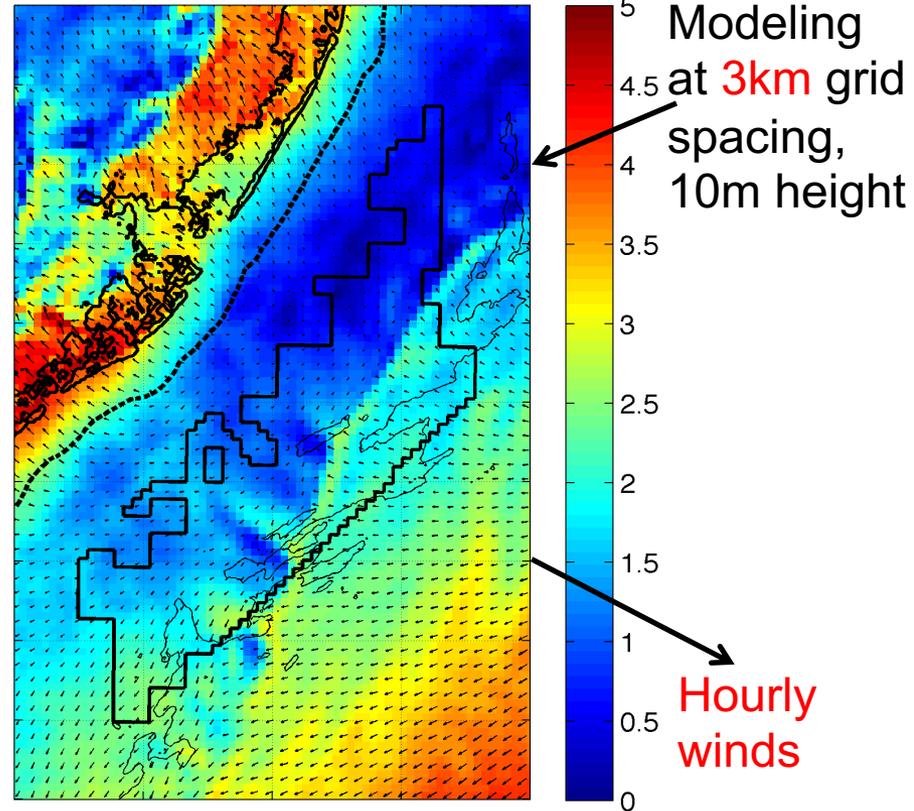
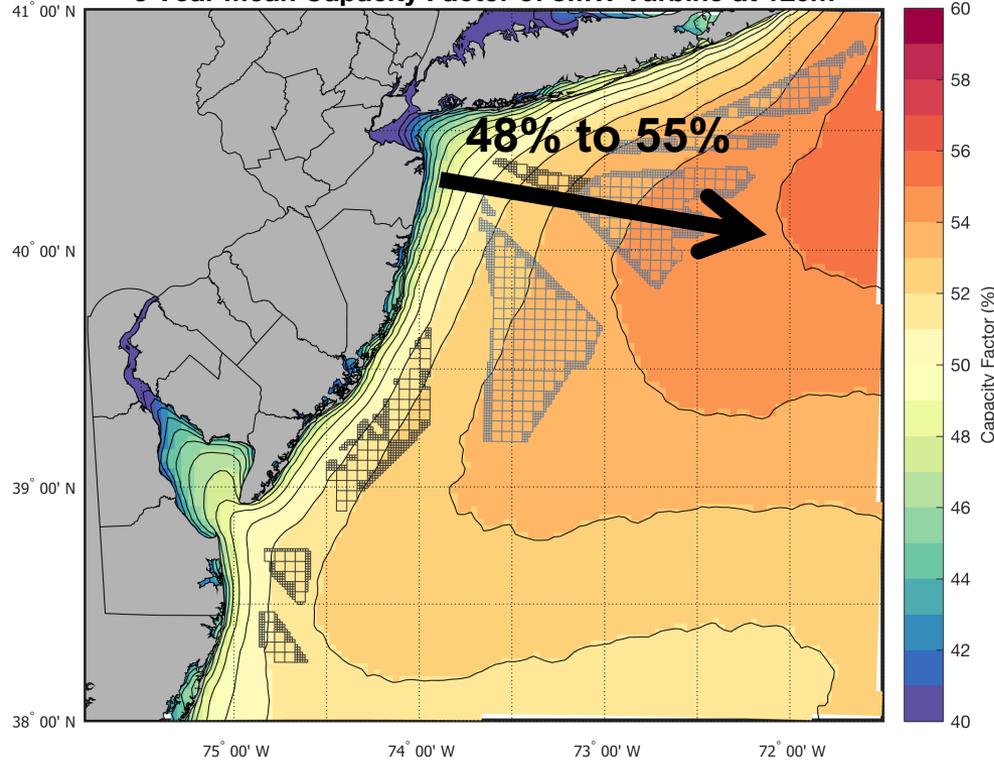


RU-WRF Wind Resource

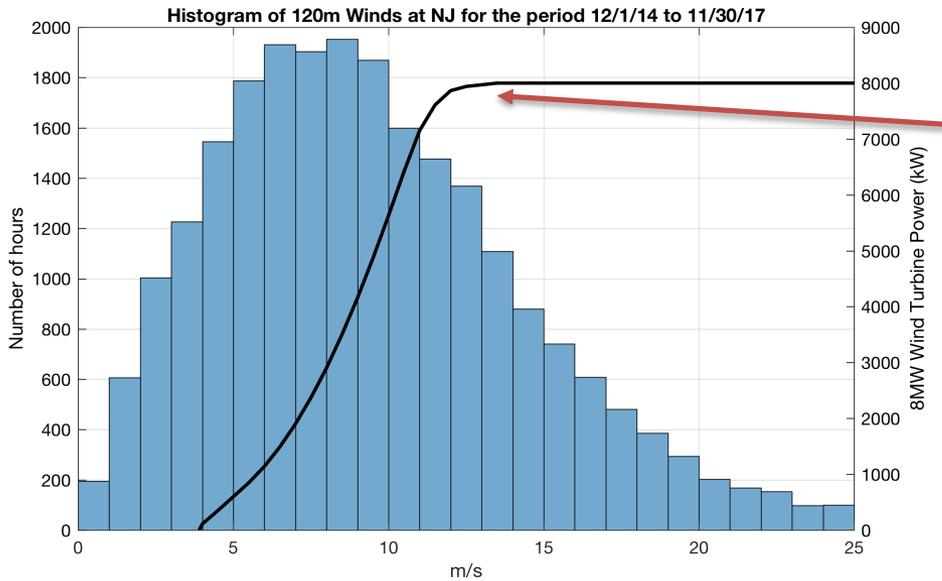
3 Year Mean

One Hour Sample

3 Year Mean Capacity Factor of 8MW Turbine at 120m



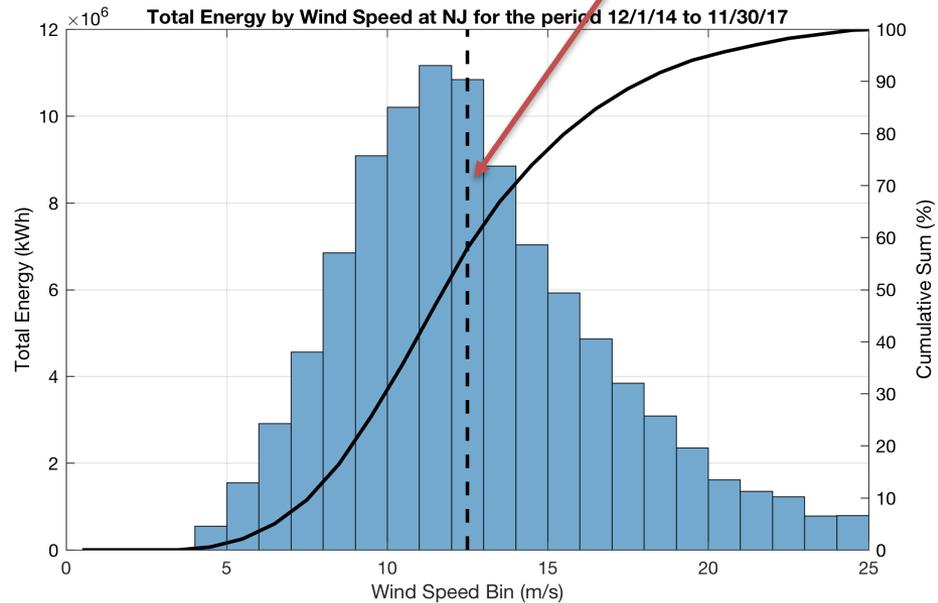
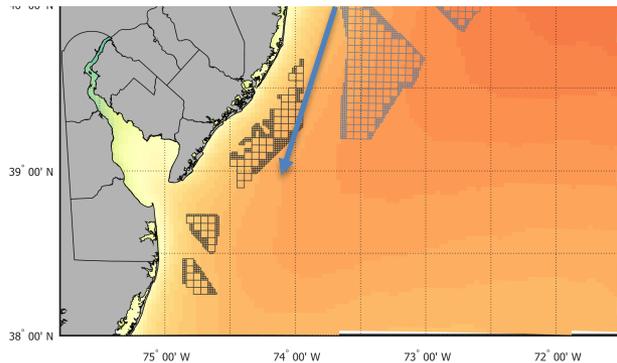
RU-WRF Wind Resource



8 MW wind turbine
12.5 m/s rated speed

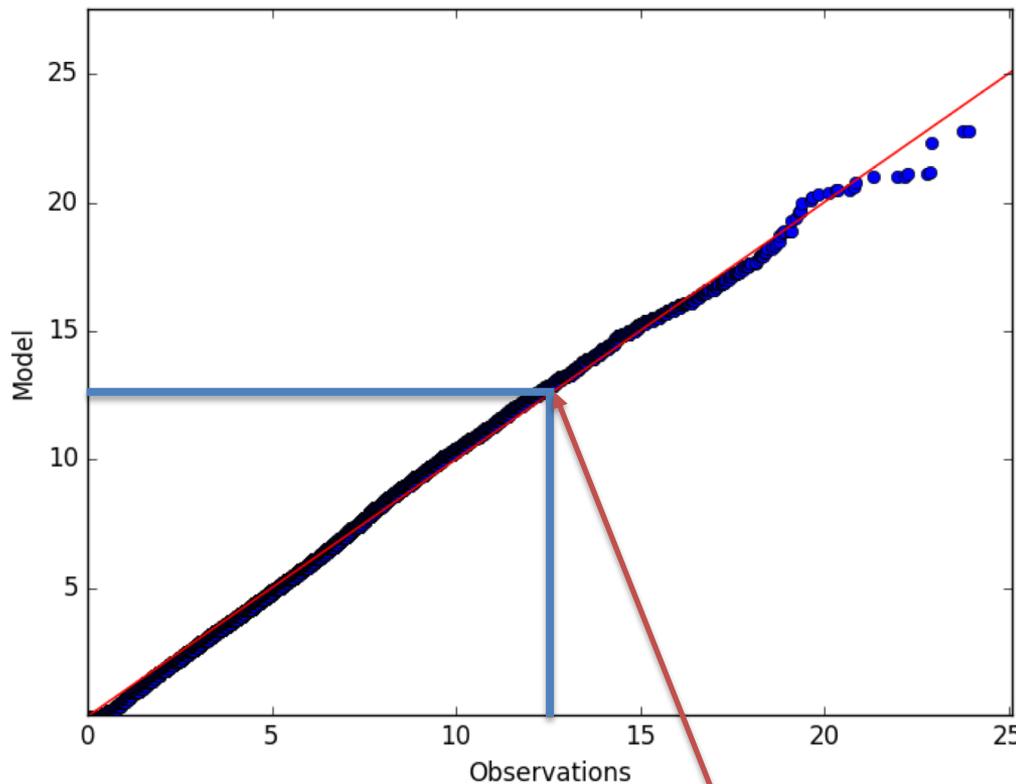
60% of energy extracted
below turbine rated speed

Virtual Met Tower



RU-WRF Captures Observed Wind Distribution

Q-Q Plot, 2012-2016



12.5 m/s turbine rated speed

- Accurate resource assessments rely on correctly capturing the wind distribution (quantile-quantile plot)
- RU-WRF effectively captures the distribution of wind speeds off of NJ
- At speeds above 12.5 m/s, our sample turbine is at full power

RU-WRF Data Portal – Beta Version



Main People Research Data Challenger Academics Outreach Center Facilities How to Help Search

RU-WRF Data Portal for NJ Offshore Wind Energy

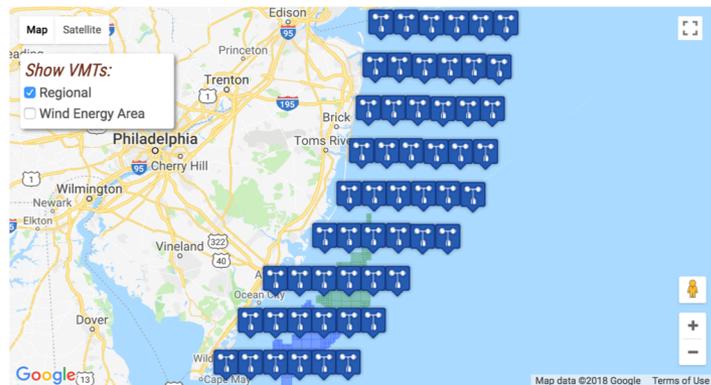
Map Graphing Download

The Rutgers University Center for Ocean Observing Leadership (RU-COOL) operates a real-time version of the Weather Research and Forecasting (WRF) model daily. This model, RU-WRF, includes a unique surface boundary condition derived from our internally-produced coldest-pixel sea surface temperature (SST) product.

This site features RU-WRF model output of winds at selected Virtual Meteorological Towers (VMTs) located both within and surrounding the New Jersey Offshore Wind Energy Areas. These towers can be selected on the map ("Wind Energy Area" for those within the two designated WEAs; "Regional" for those in the surrounding waters). Data from these VMTs can then be graphed or downloaded using the additional tabs.

Support for this site and the data herein has been provided by the State of New Jersey Board of Public Utilities (NJBP) Division of Economic Development & Emerging Issues Office of Clean Energy.

PLEASE NOTE: This interactive data portal is currently in development, and is for informational purposes only. This data portal should not be used for decision-making purposes.



Selected VMTs: Clear All

No selected VMTs

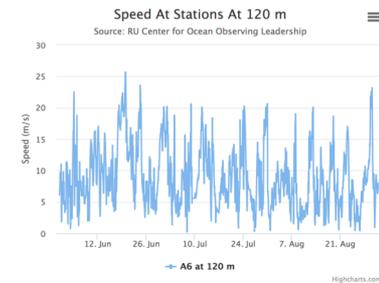
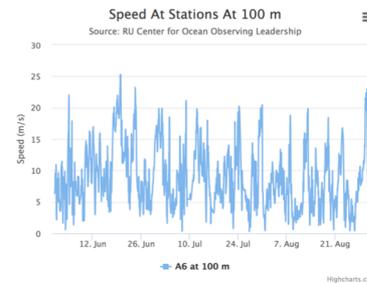
- Contains RU-WRF wind data for about 60 VMTs
 - Hourly data
 - 4 heights: 10, 100, 120, 140 m
- Input wanted!
 - Additional variables?
 - More locations/heights?
 - Data download formats?

From: 2017-06-01T00:00:00Z To: 2017-09-01T00:00:00Z Selected VMTs: A6

10 Meters 100 Meters 120 Meters 140 Meters

Change Station Selection Download (CSV Single File)

Line Graph - Wind Speed: Time Series By Height



<http://mosaic.njaes.rutgers.edu/rucool-bpu/>

RU-WRF: A Multi-Use Atmospheric Model

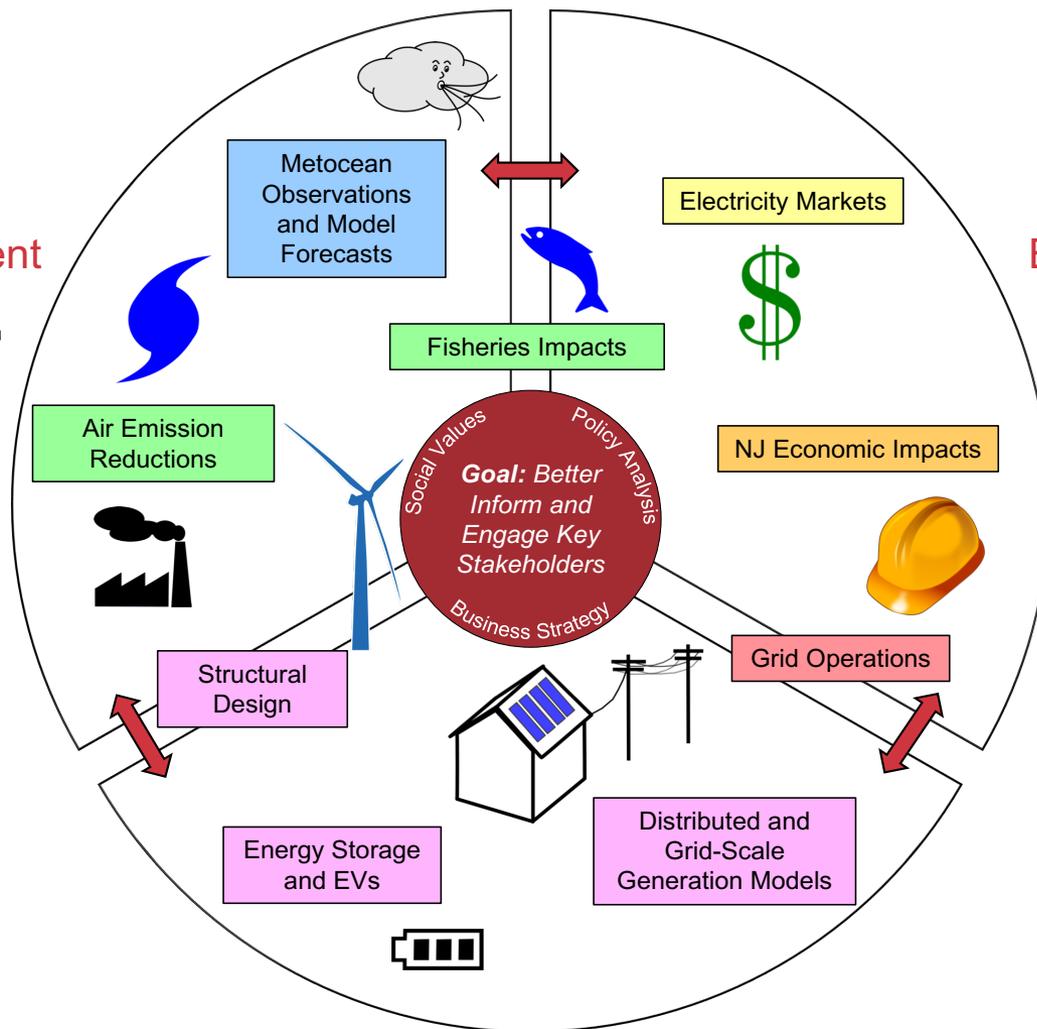
- **Hourly met variable output:** includes winds at multiple heights, which can be used for power resource assessment.
 - Useful tool for developers to combine with their existing resource data (i.e. flidar data, company models)
- Model can also be used for operational forecasting applications:
 - ✓ **Severe weather forecasting** for construction, O&M procedures.
 - ✓ **PJM grid management.**
 - ✓ **Energy market trading.**



Rutgers Energy Institute – Wind Working Group: “Triple-E” Multidisciplinary Expertise

Environment

RUTGERS
School of Environmental
and Biological Sciences



Economy

RUTGERS
Edward J. Bloustein School
of Planning and Public Policy

Engineering **RUTGERS**
School of Engineering

rei.rutgers.edu

Rutgers University - Center for Ocean Observing Leadership MARACOOS – A forum to bring forward the best science & technology



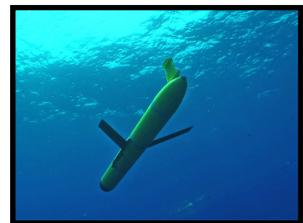
Satellite
Receivers



46 Site CODAR
Network

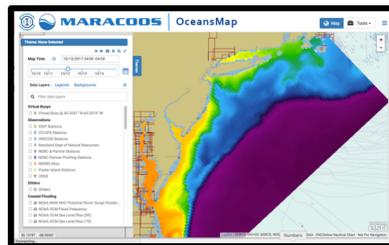


Glider Lab



468 Glider
Deployments

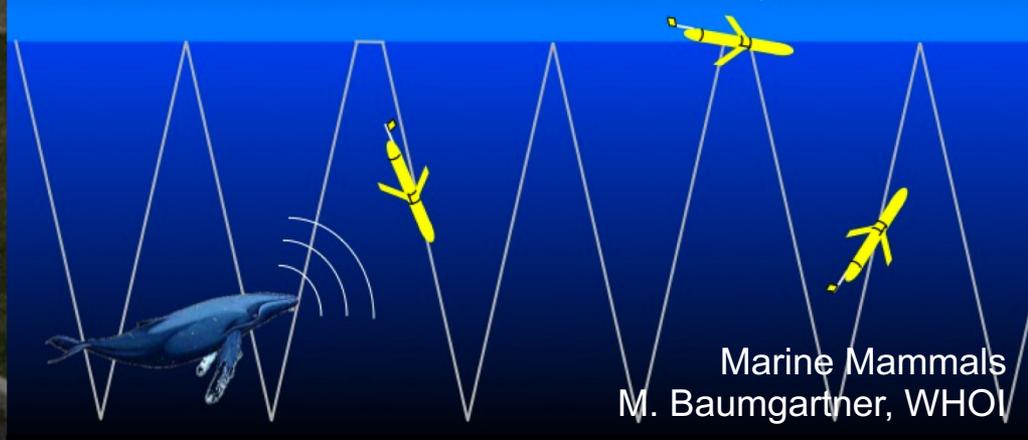
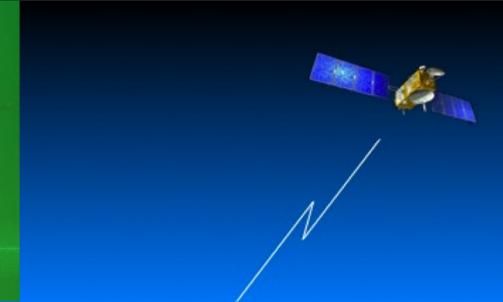
Ocean
Modeling



Tools for Offshore Wind: Glider Testbeds for Marine Organism Detection

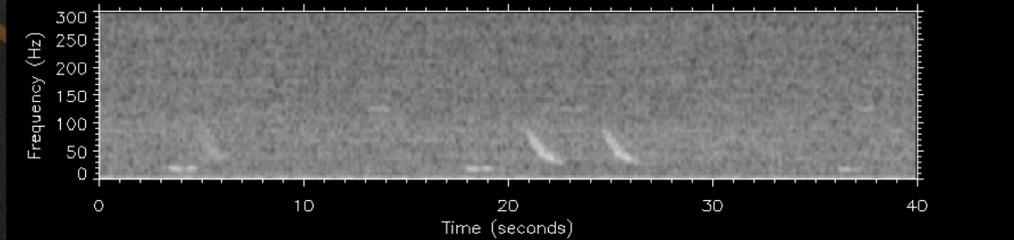
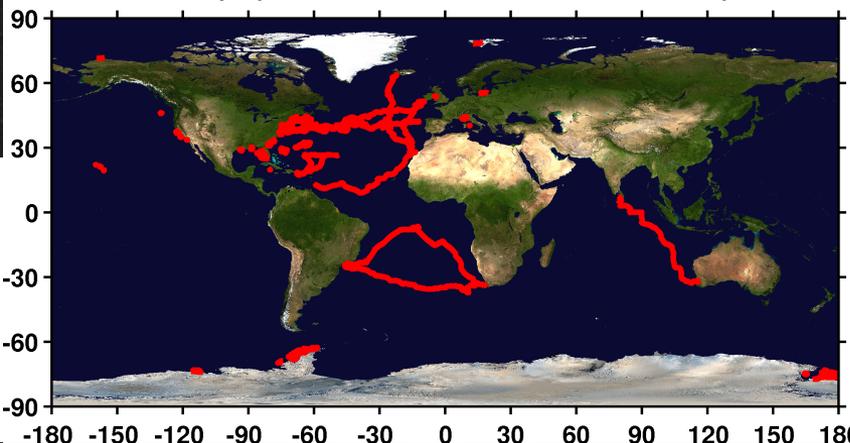


Krill & Fish
G. Saba, Rutgers



Marine Mammals
M. Baumgartner, WHOI

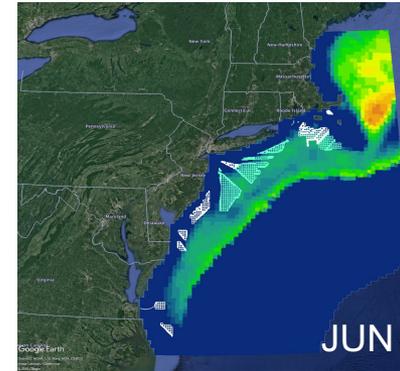
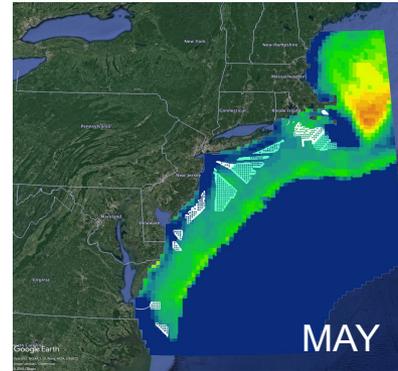
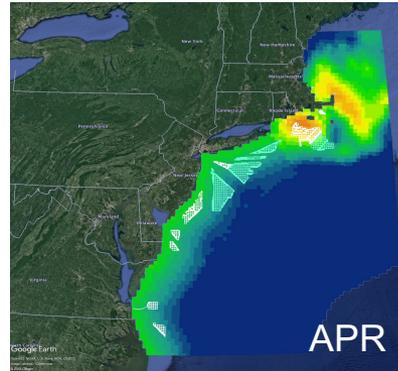
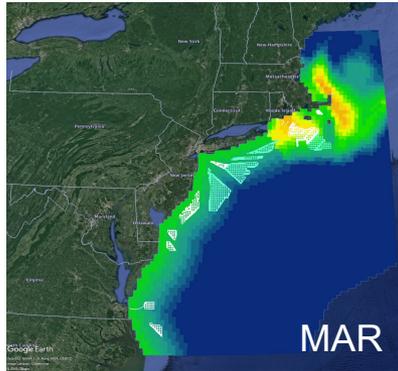
468 deployments - 225478.13km flown - 11626 days



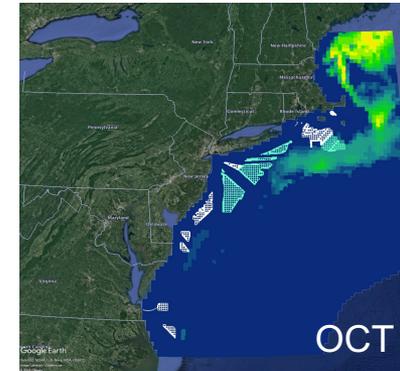
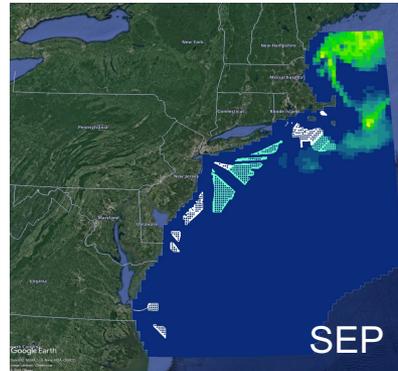
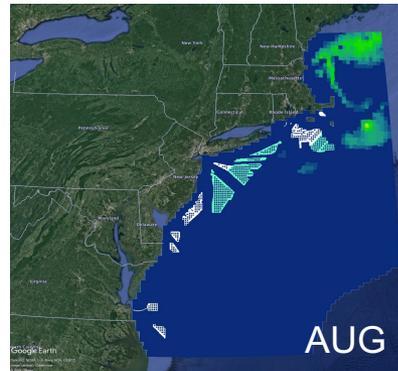
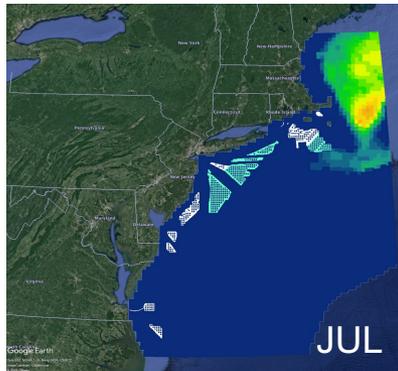
Sharks & Sturgeon
M. Oliver, UDel

North Atlantic Right Whale: Monthly Distribution

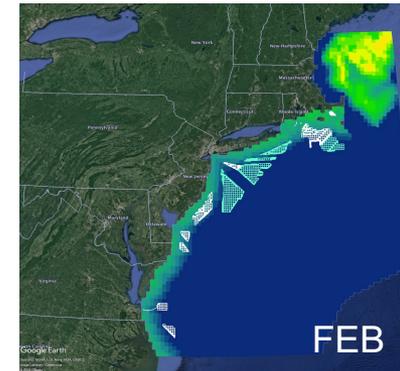
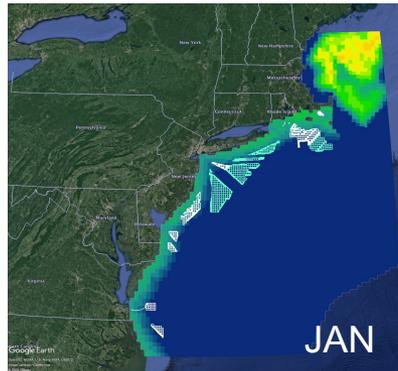
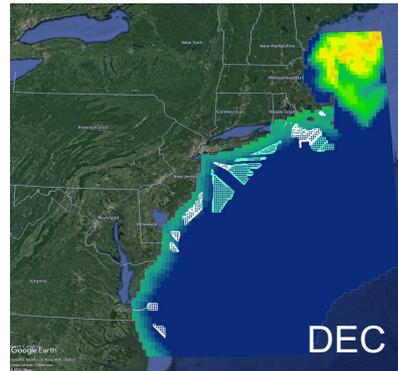
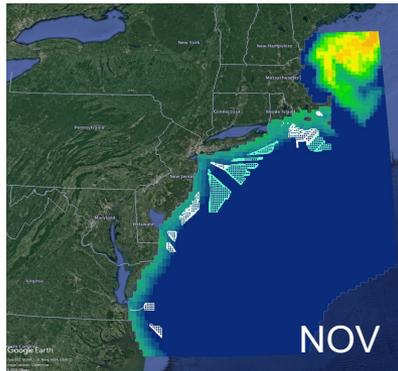
Mid-Atlantic Peak Season



Mid-Atlantic Low Season



Mid-Atlantic Coastal Season



Masters in Operational Oceanography



Training a workforce – Based on lessons learned:

- Residency in an operational ocean observatory – build community through grand challenges
- Work together as a team to operate new observing technologies in frontier areas
- Curate the data flow from collection to use in forecasts that inform decisions makers
- Senior students mentor junior students

Masters Program (Lecture and Research Credits)

- Introductory Classes, Physical Oceanography and Biological Oceanography (from Undergrad)
- Software Bootcamp (Analysis Tools, Common File Formats, and QA/QC)
- [Integrated Ocean Observing](#) (Platforms and Sensors)
- [Ocean Observing Field Lab](#) (hands-on opportunities within an operating ocean observatory)
- [Ocean Observing Cyber Lab](#) (data analysis techniques, model operation and validation)
- Thesis – (conference presentation/paper, mentor new students, contribute to shared software)

DISCUSSION AND QUESTIONS

Come visit us! We're happy to arrange a visit for more detailed discussions on how our data and expertise can inform your projects.

Web: <http://rucool.marine.rutgers.edu>

Email: jbrodie@marine.rutgers.edu