October 2018

RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

New Jersey's cleanenergy program™
njcleanenergy.com

New Jersey Offshore Wind Resource Modeling and Observations at RUCOOL

Dr. Scott Glenn
Dr. Travis Miles
Dr. Rich Dunk
Dr. Josh Kohut
Dr. Joseph Brodie
And Many Others!

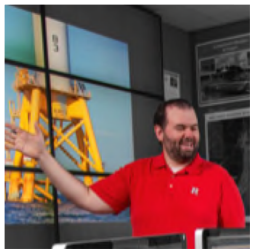
Center for Ocean Observing Leadership
Department of Marine and Coastal Sciences
School of Environmental and Biological Sciences

The RUCOOL Offshore Wind Team

>100 Years Core Team Experience

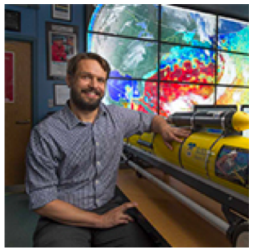
Scott Glenn
Distinguished Professor, RUCOOL
Oceanographer with decades of experience observing and studying the Mid-Atlantic.

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.

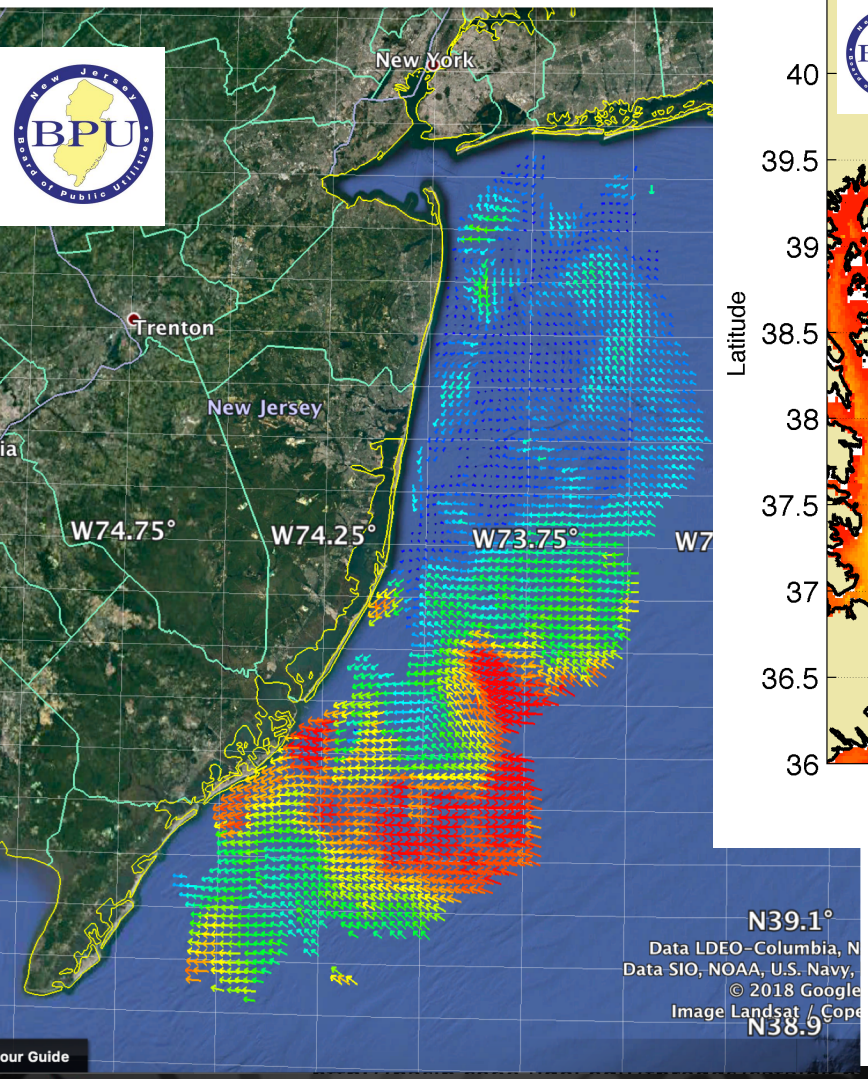


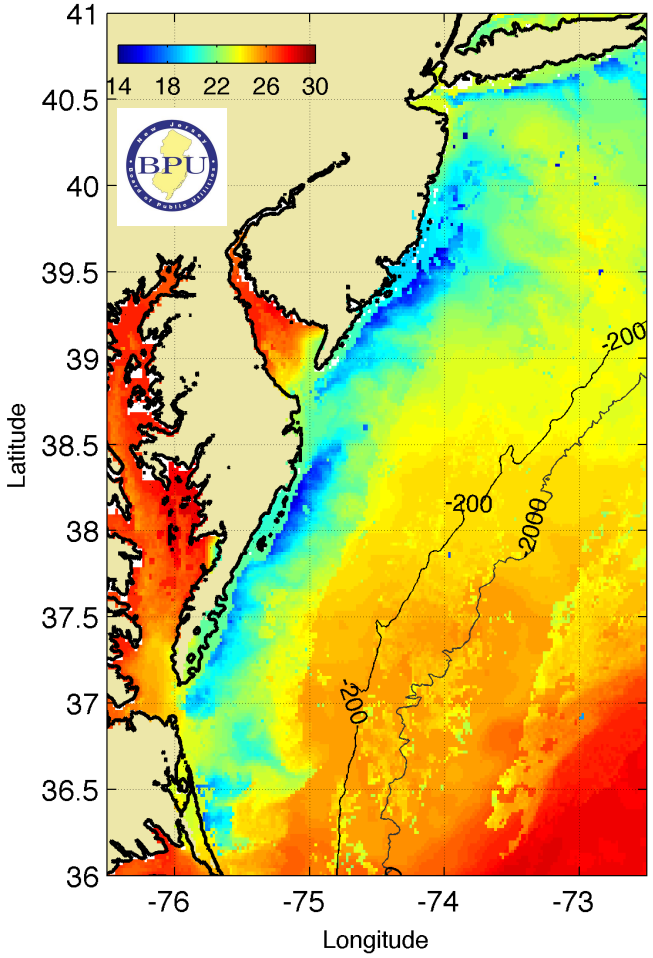
Rich Dunk
Principal Meteorologist/Owner, AquaWind LLC
Certified Consulting Meteorologist (CCM) with decades of experience in the NJ energy sector.

http://rucool.marine.rutgers.edu

NJ BPU & NJ DEP State Ocean Observing System

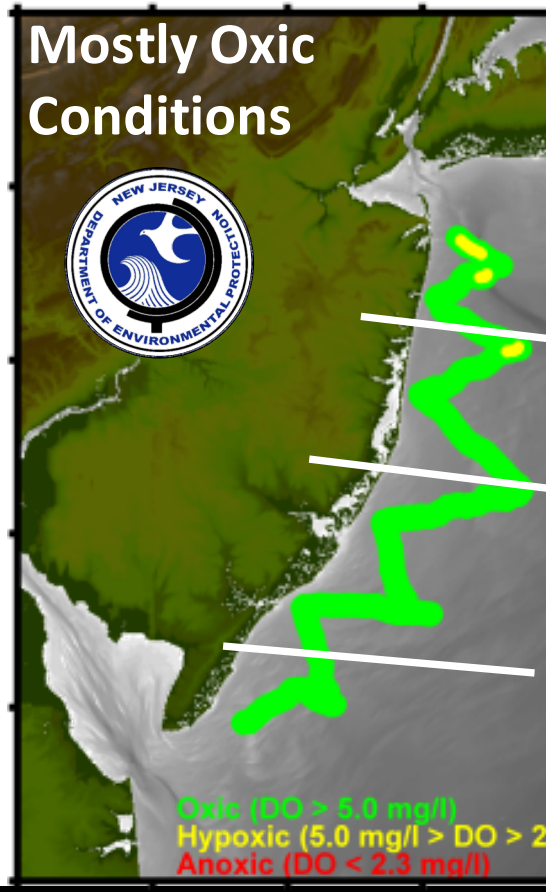
Medium Range (13 MHz)
HF Radar Network





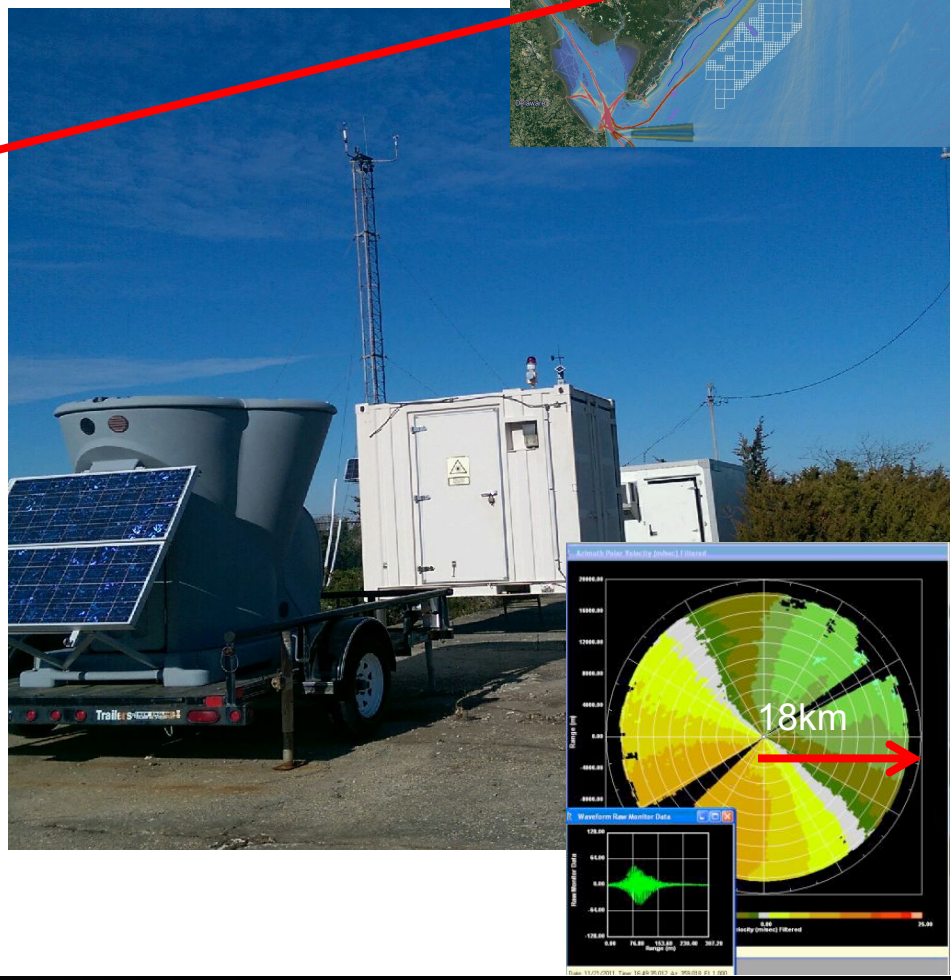
Coldest Dark Pixel
SST Product
Development

Nearshore
Glider
Surveys



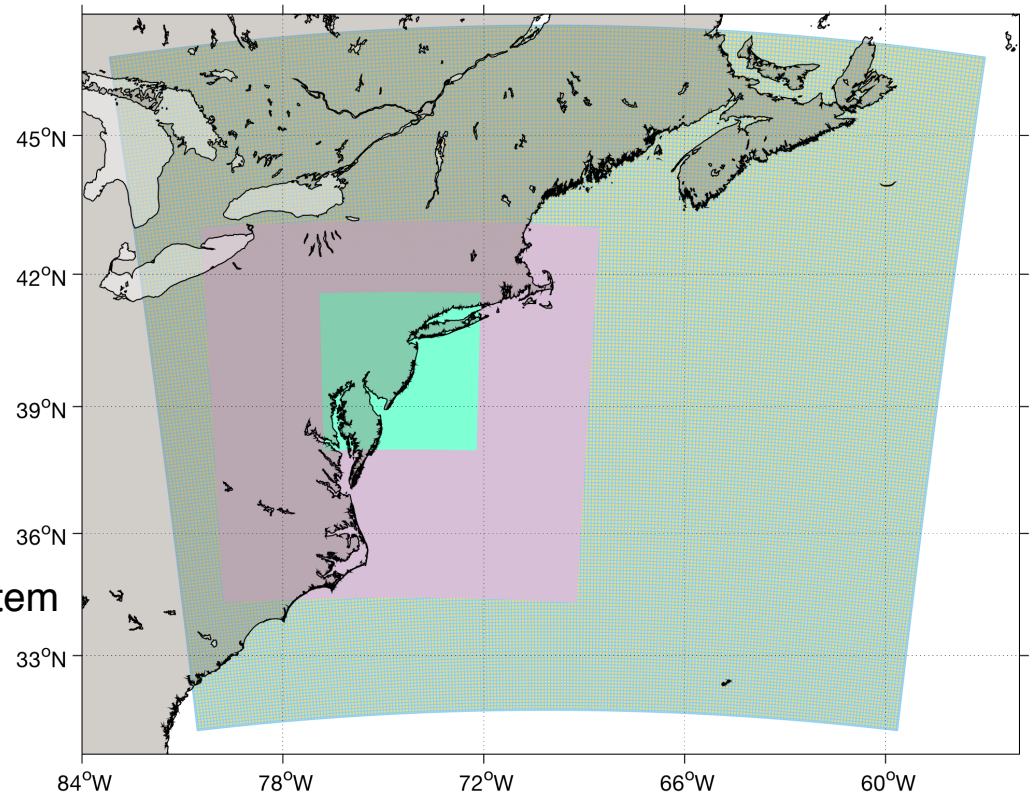
Coastal Met-Ocean Monitoring Station

- 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

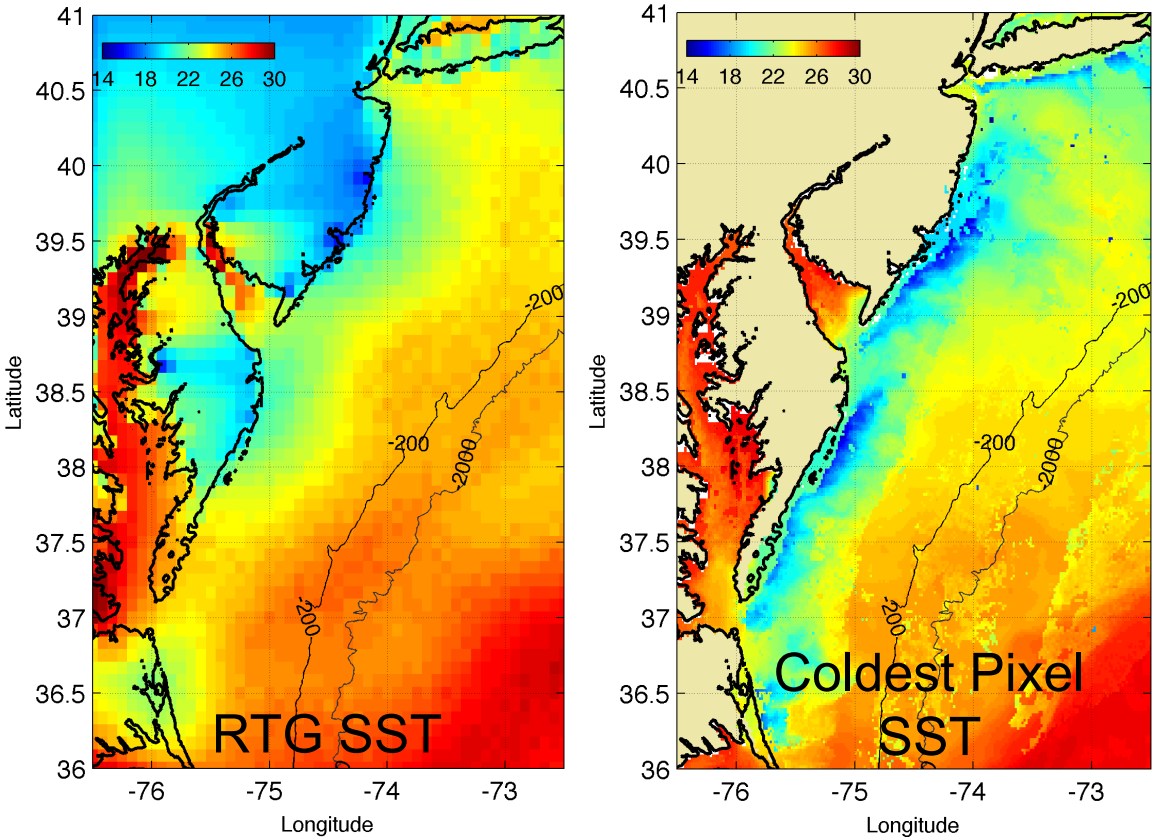


New Jersey's cleanenergy program™ njcleanenergy.com

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

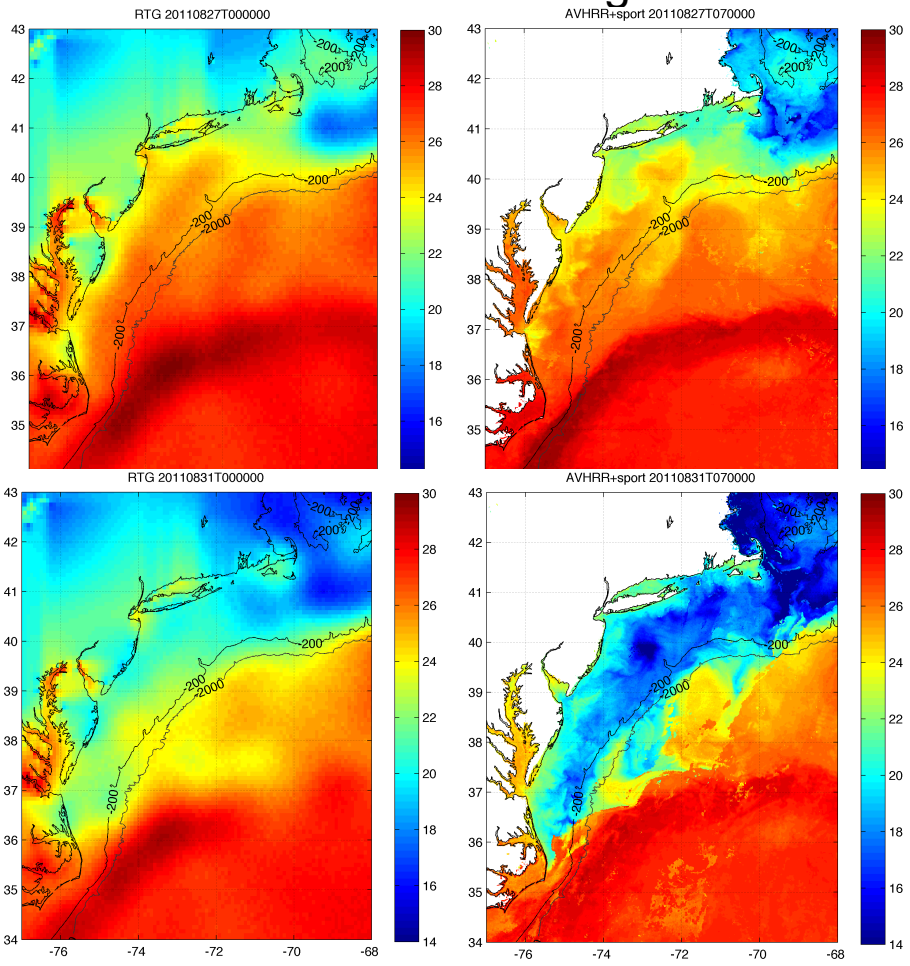
Coldest Dark Pixel SST Also Captures Hurricane-Driven Cooling

Standard National SST

Rutgers Regional SST

BEFORE IRENE

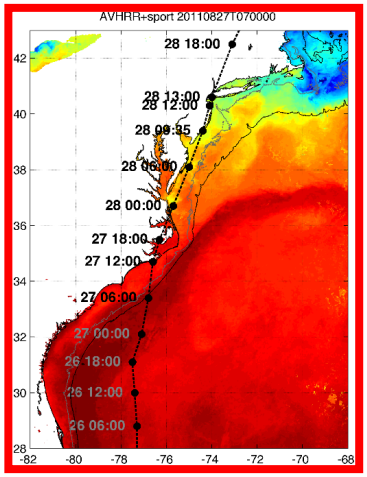
AFTER IRENE



Example: Hurricane Irene August 2011

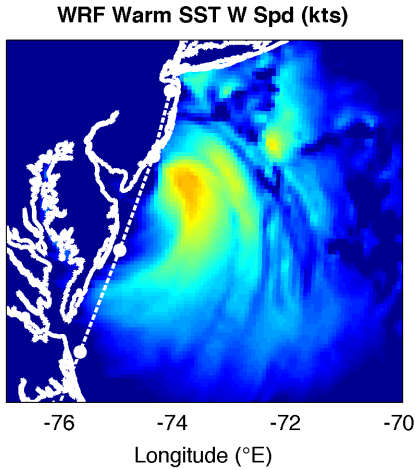
Cold Water Influences Coastal Storms

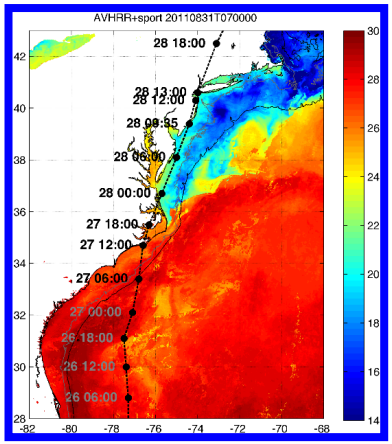
Hurricane Irene – Aug 2011



Warm Ocean

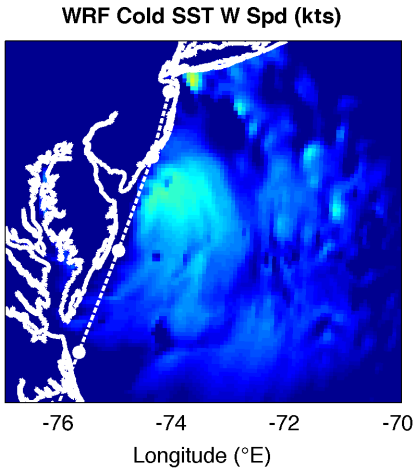
Cat I Hurricane

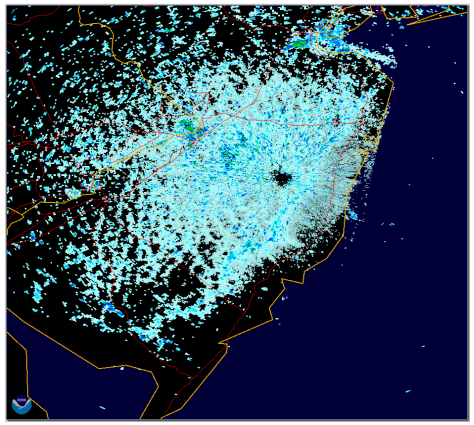


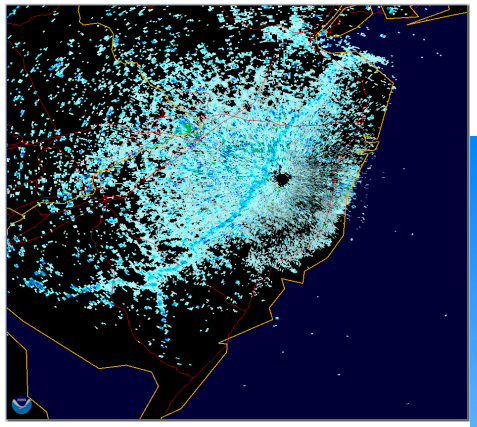


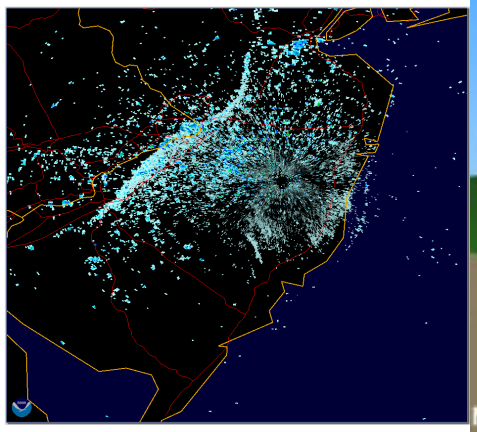
Cold Ocean

Trop Storm



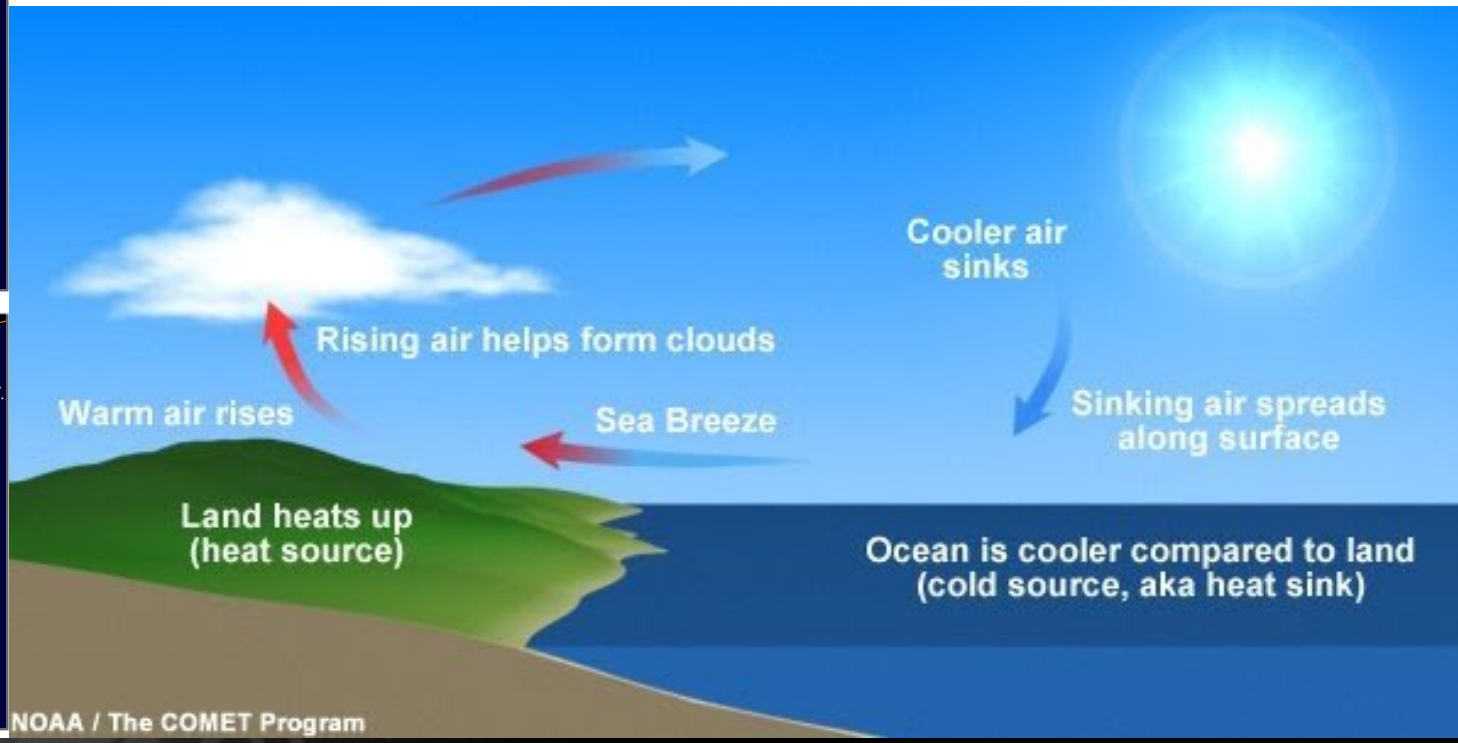




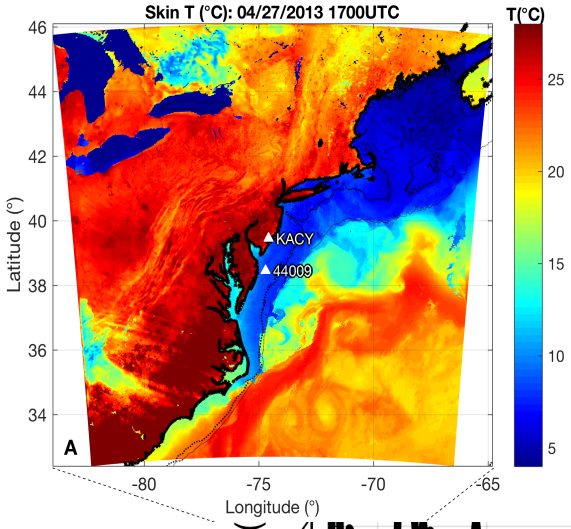


Sea breezes are common; Driven by land-sea temperature difference

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

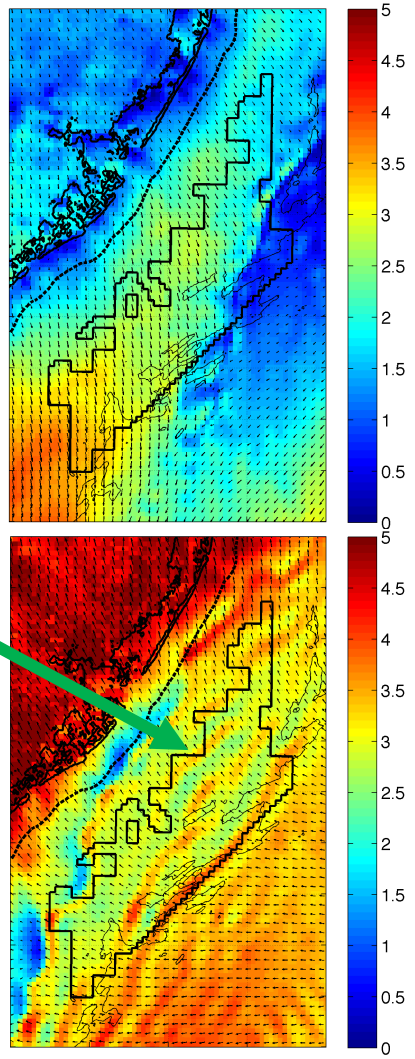


Sea Breezes & Upwelling Coincident with Electricity Demand



RU-WRF Capturing Sea Breeze Evolution

September 12, 2012 10m Winds



Sea breeze develops

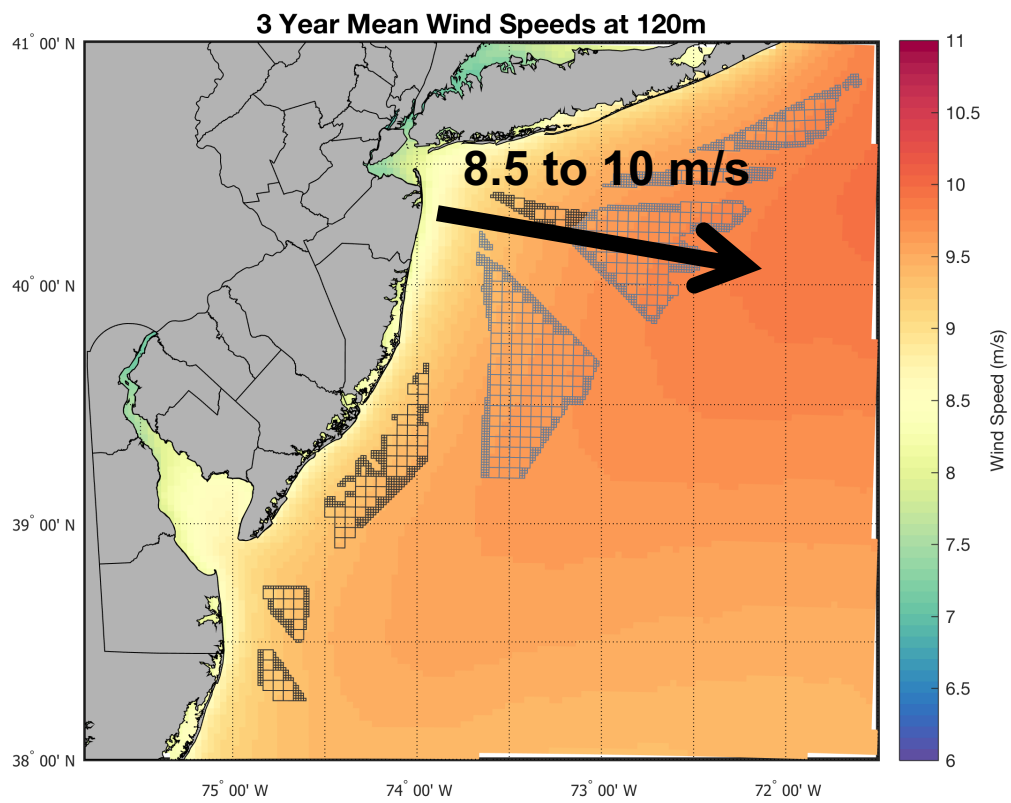
Winds weaken at surface in WEA closer to coast

Sea breeze has propagated west; winds pick up in WEA again

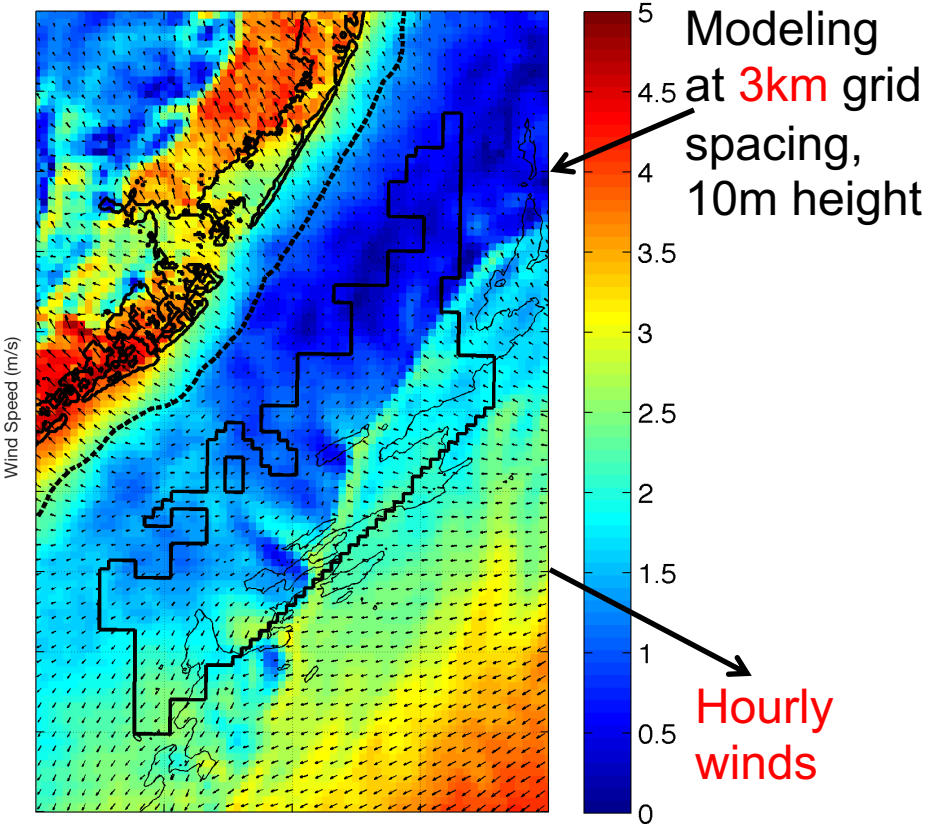
WEA winds strengthen as overnight begins

RU-WRF Wind Resource

3 Year Mean

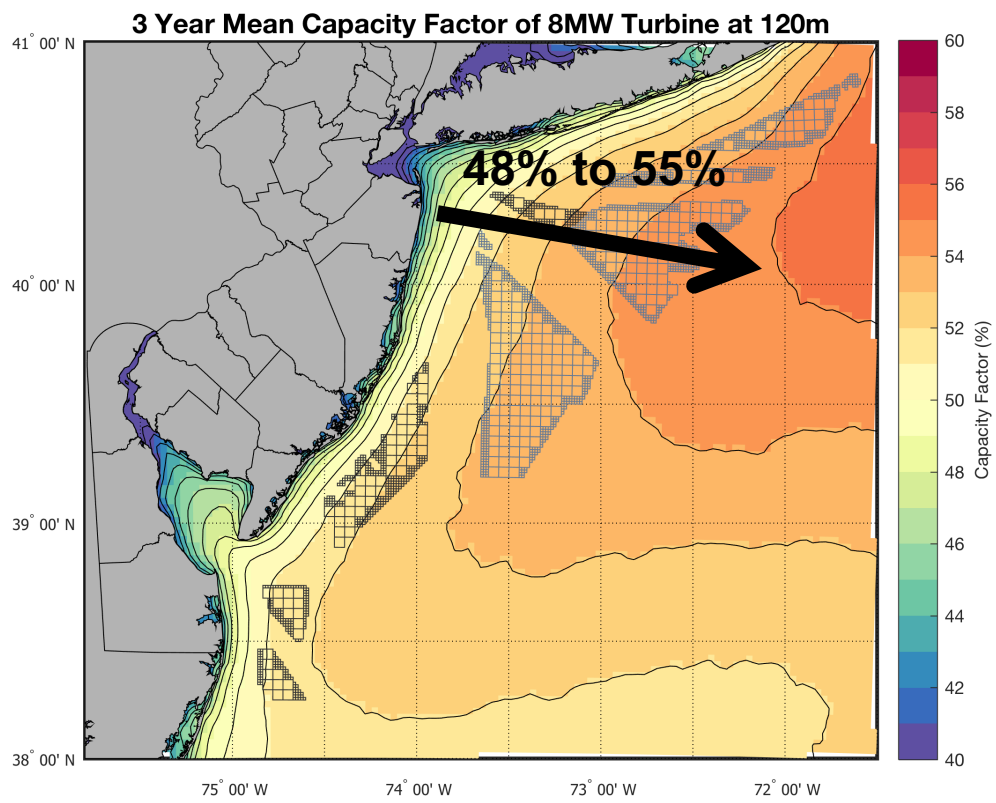


One Hour Sample

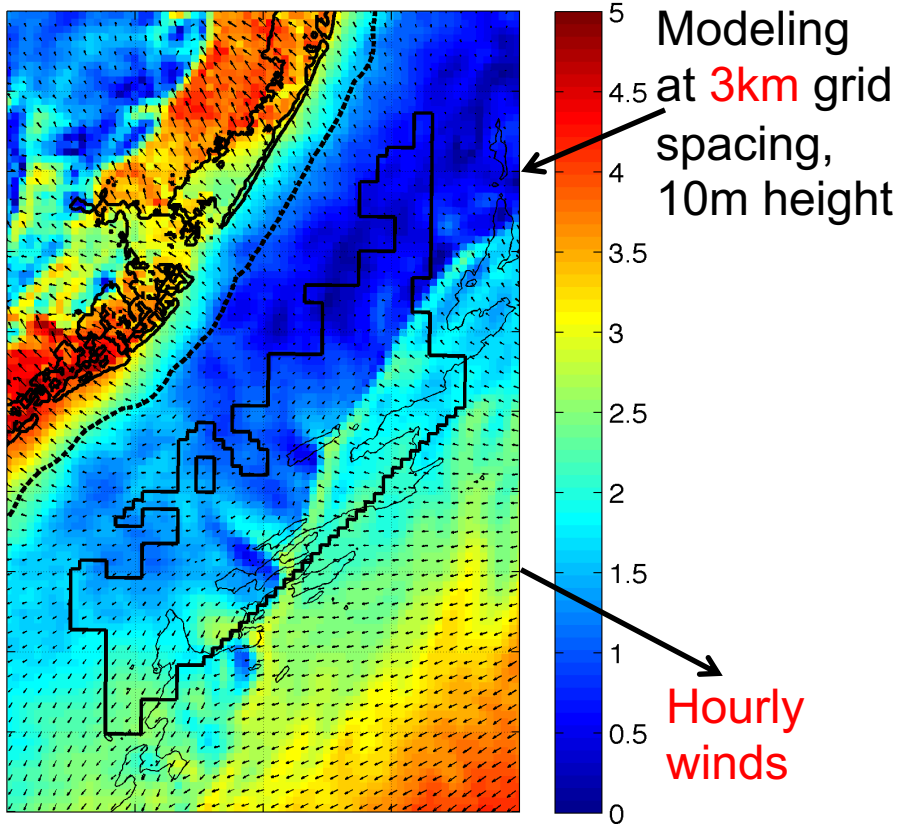


RU-WRF Wind Resource

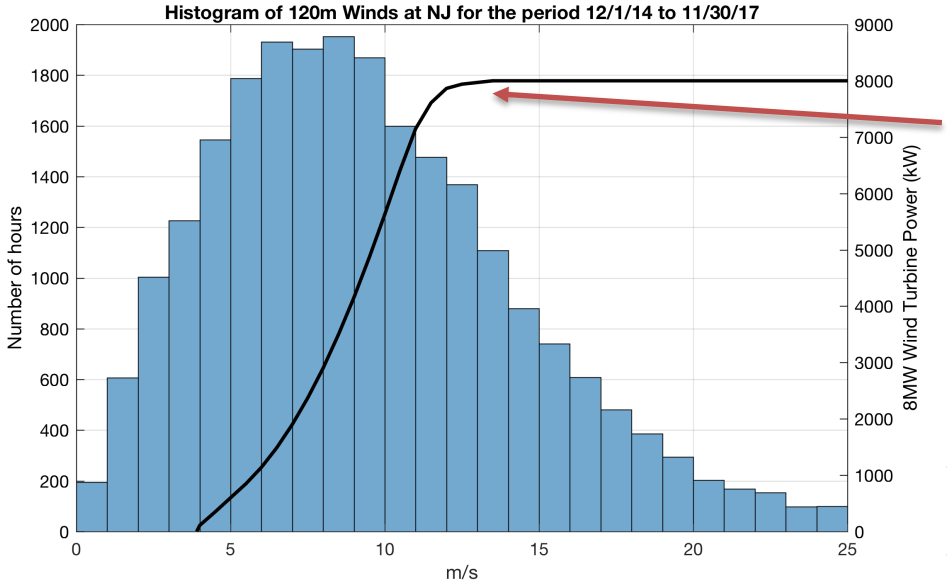
3 Year Mean



One Hour Sample

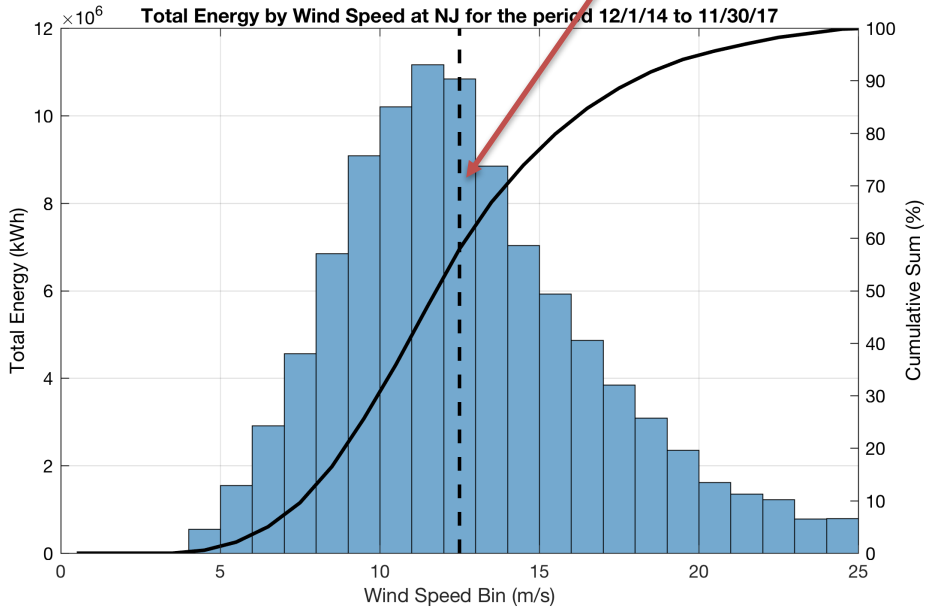


RU-WRF Wind Resource

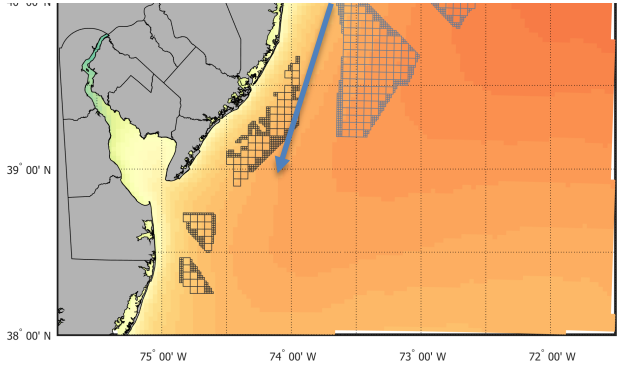


8 MW wind turbine
12.5 m/s rated speed

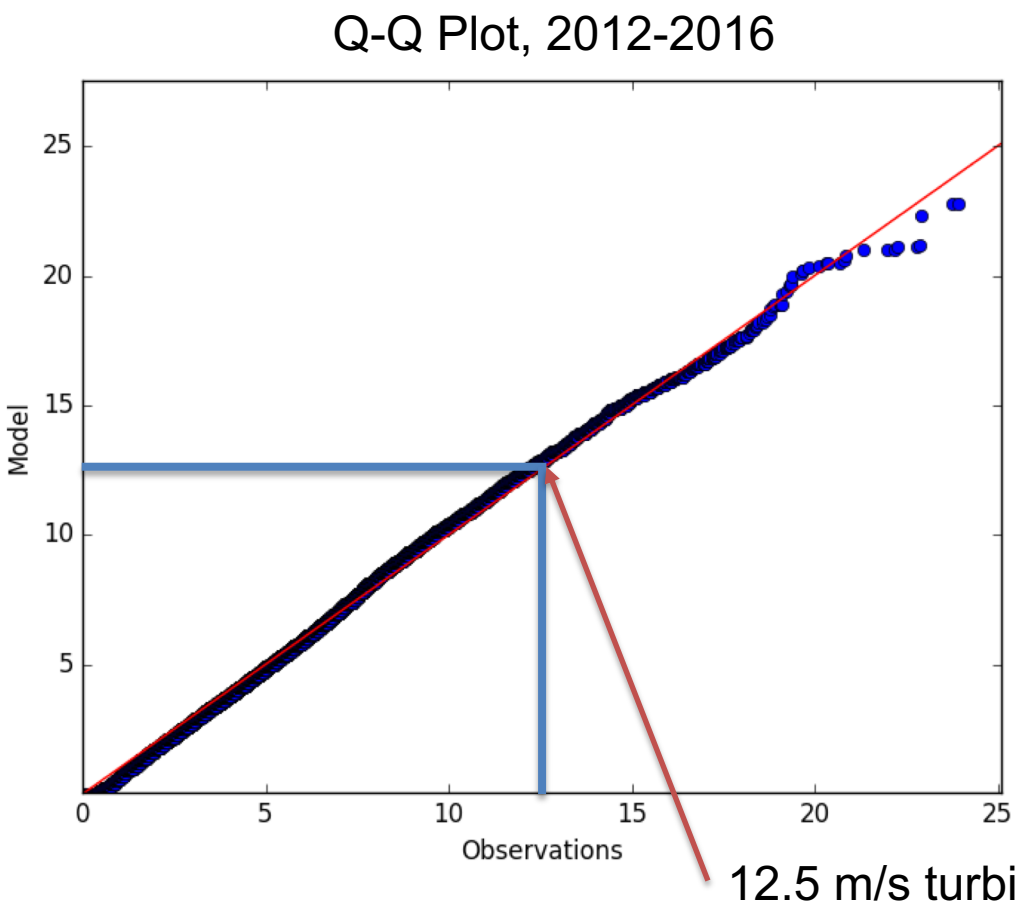
60% of energy extracted
below turbine rated speed



Virtual Met Tower

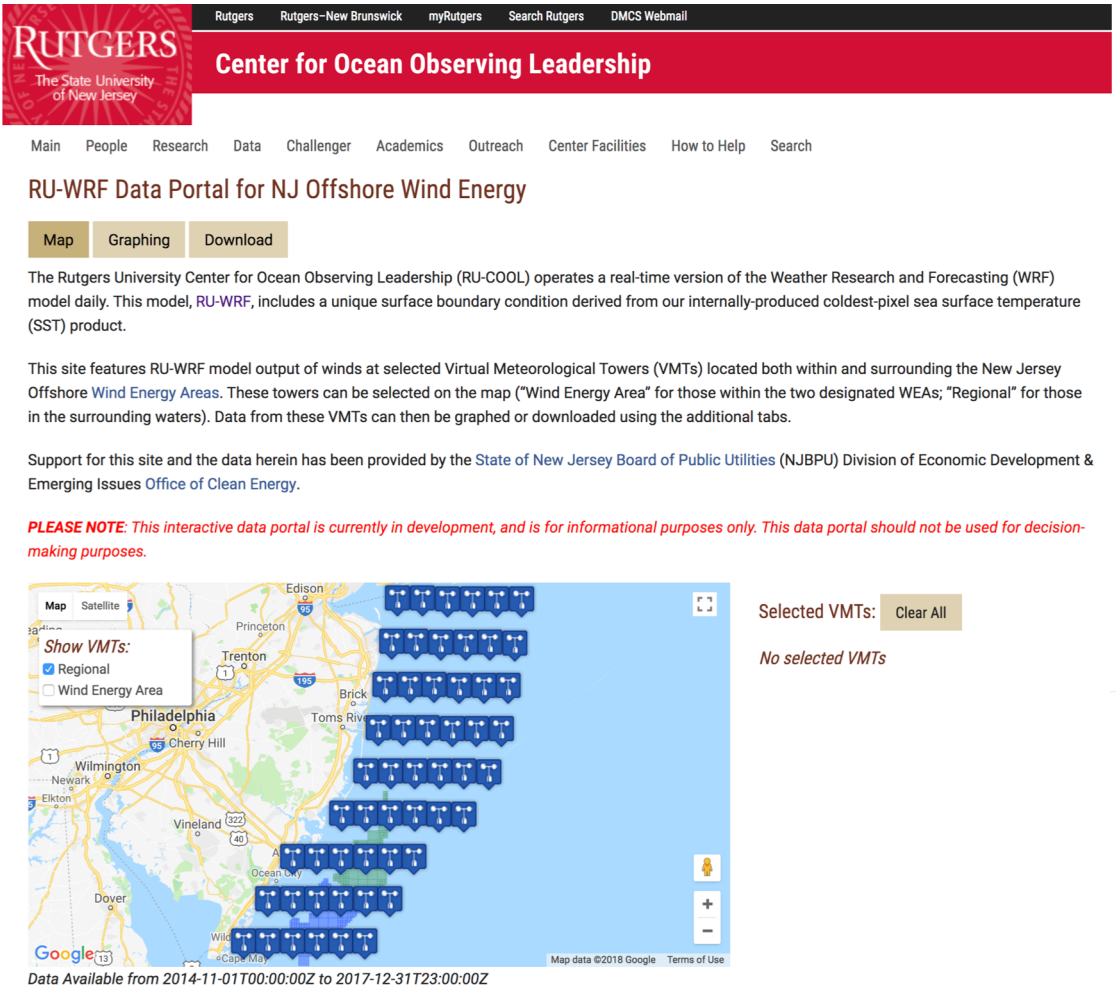


RU-WRF Captures Observed Wind Distribution



- 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



- 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?

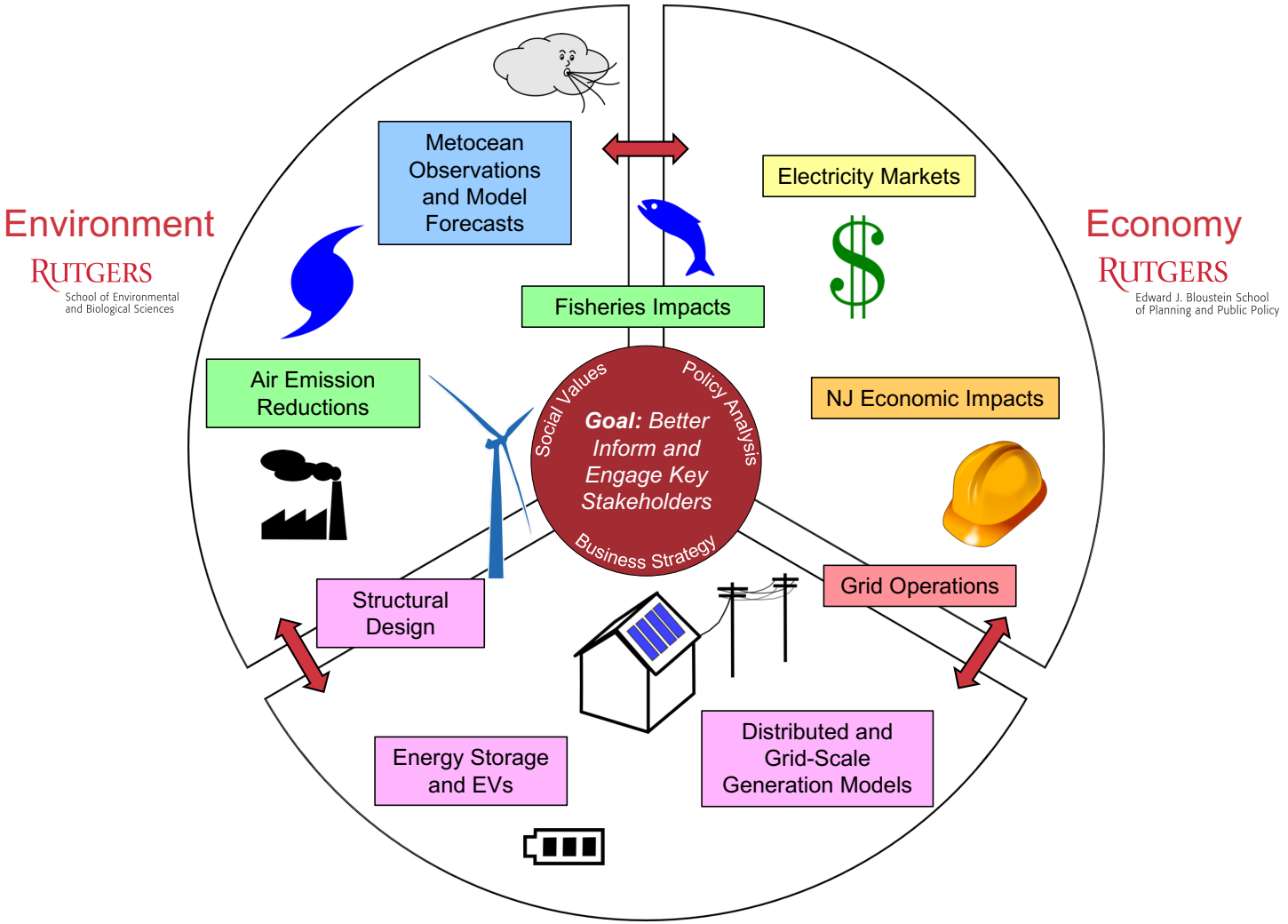
http://mosaic.njaes.rutgers.edu/rucool-bpu/

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

RUTGERS Energy Institute



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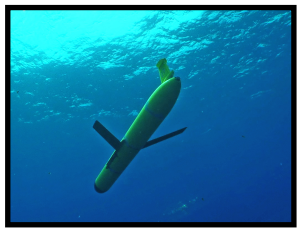
MARACOOS – A forum to bring forward the best science & technology

Satellite Receivers

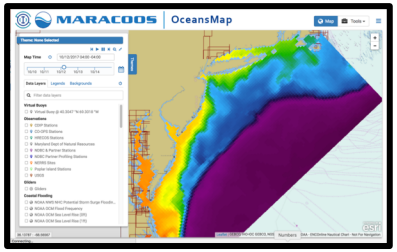
46 Site CODAR Network

Glider Lab

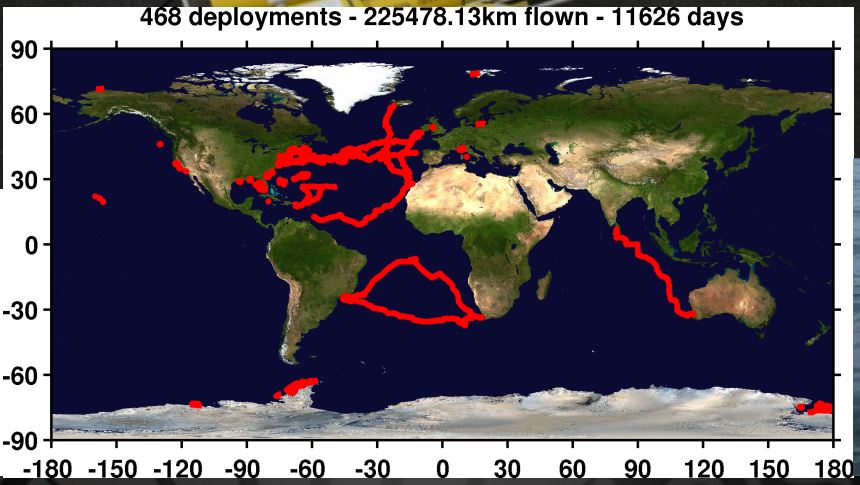


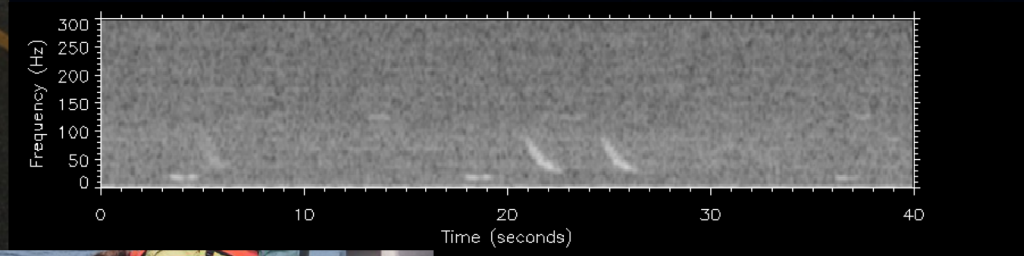
468 Glider Deployments

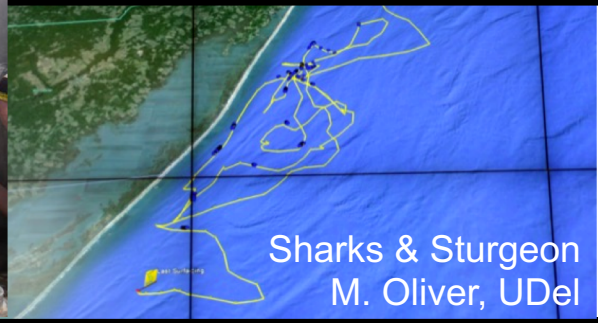
Ocean Modeling



Tools for Offshore Wind: Glider Testbeds for Marine Organism Detection

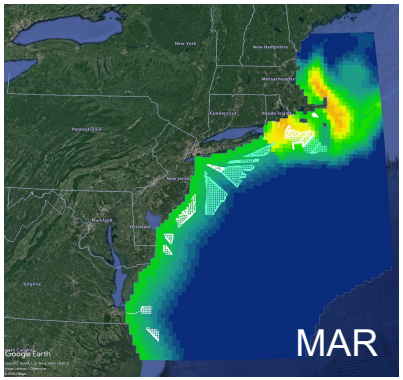


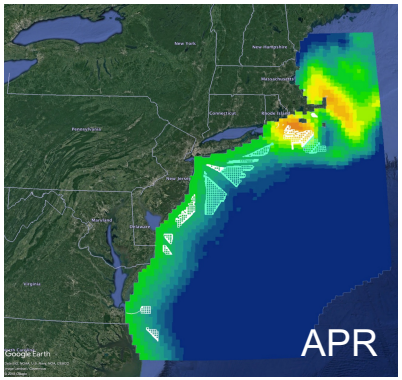


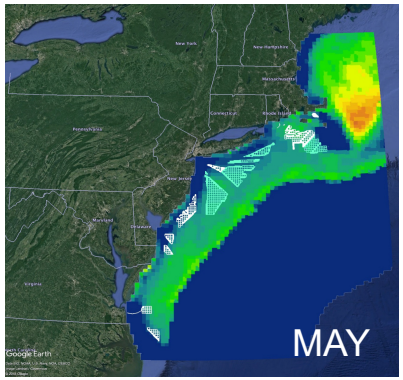


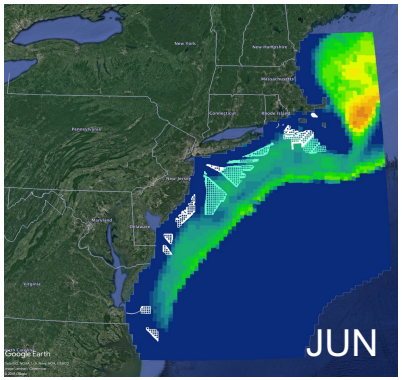
North Atlantic Right Whale: Monthly Distribution

Mid-Atlantic Peak Season

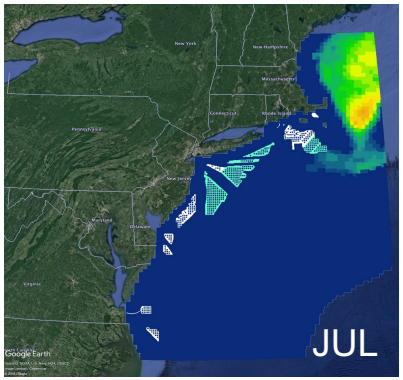


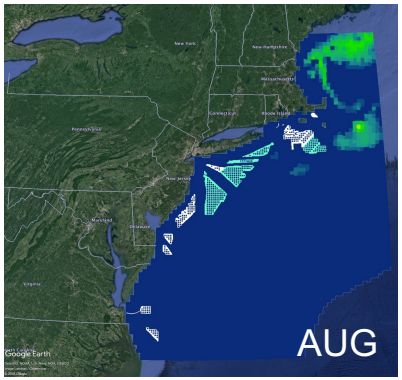


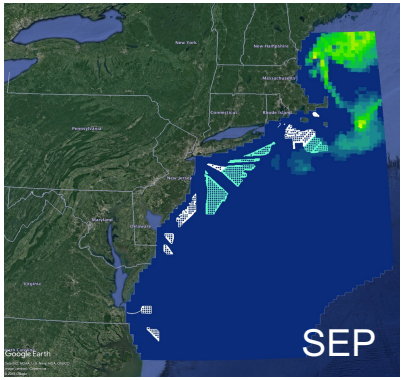


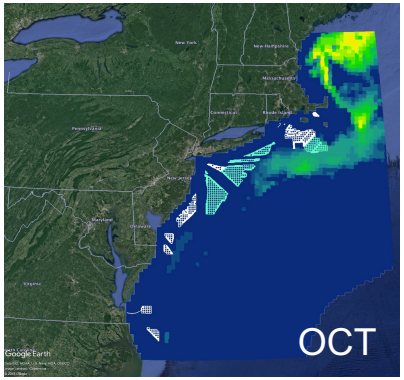


Mid-Atlantic Low Season

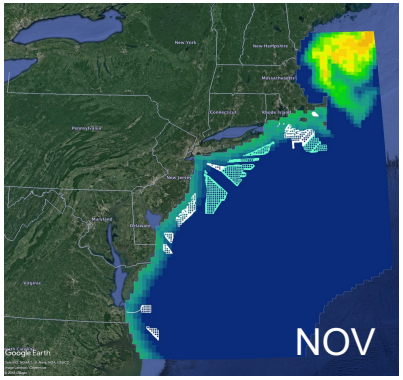


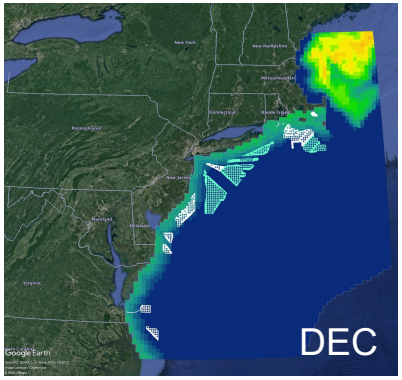


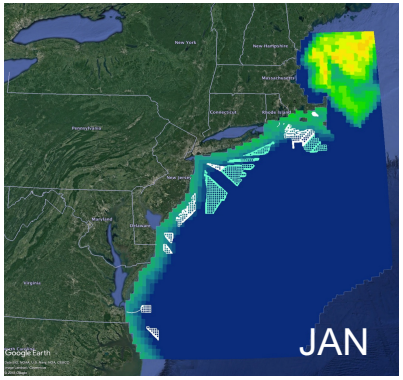


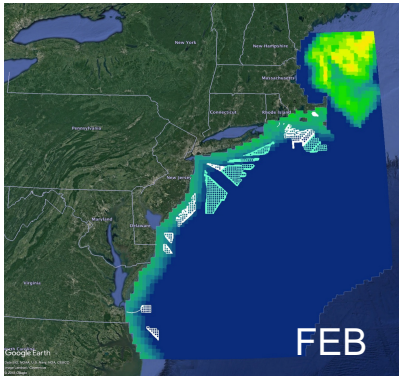


Mid-Atlantic Coastal Season









Data: Duke University
Marine Geospatial Ecology Lab

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.

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