RU COOL Offshore Wind Energy Research Capabilities

Dr. Scott Glenn

Dr. Travis Miles

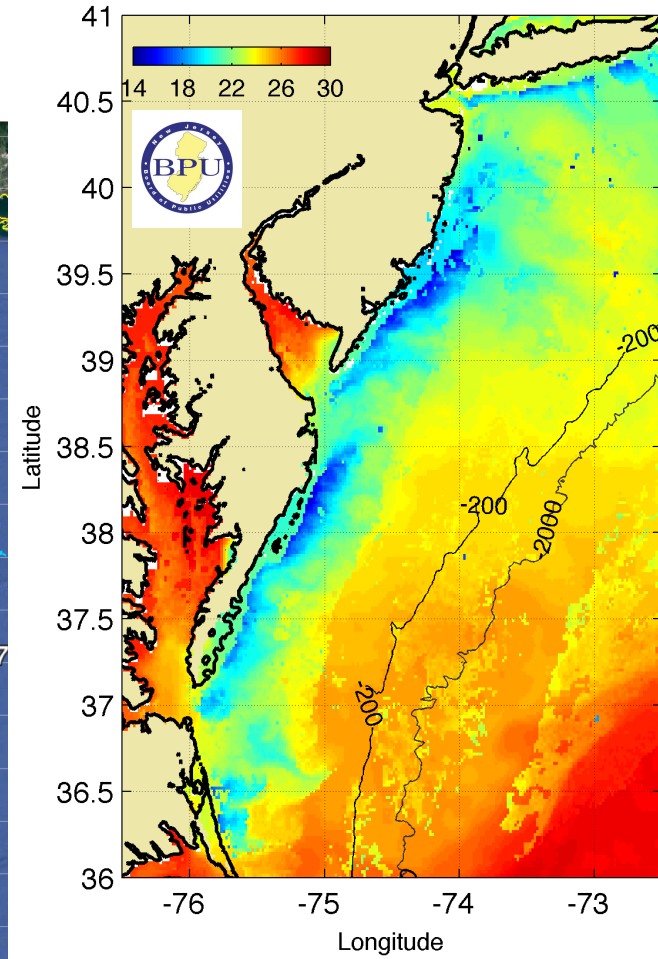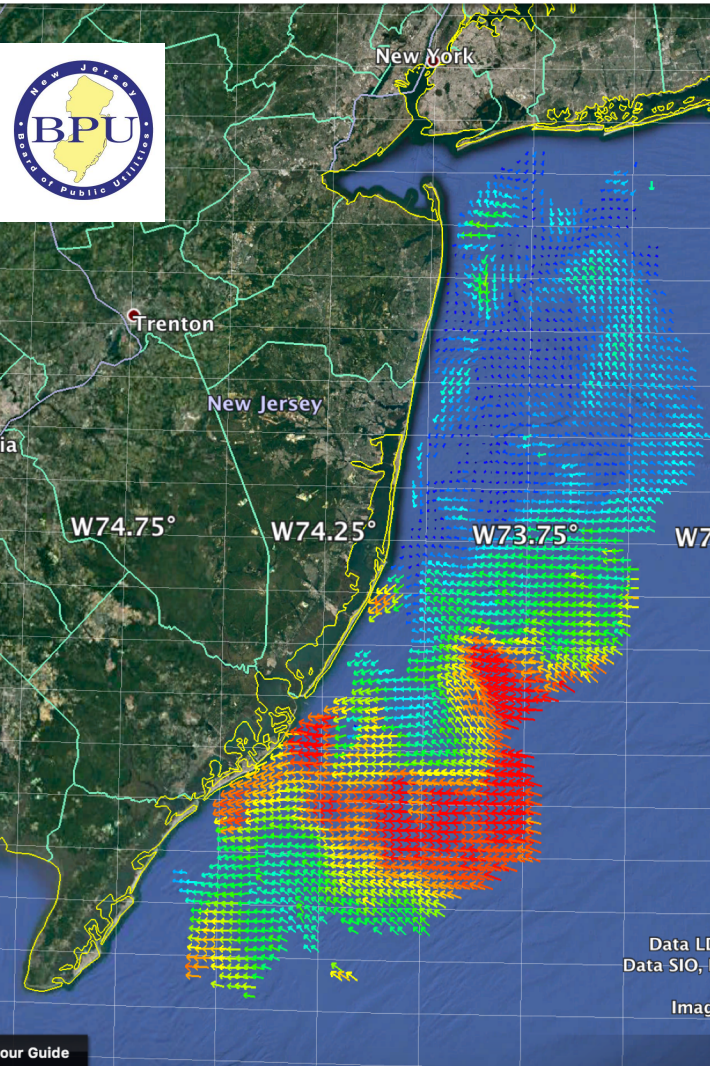Dr. Rich Dunk

Dr. Josh Kohut

Dr. Joseph Brodie

And Many Others!
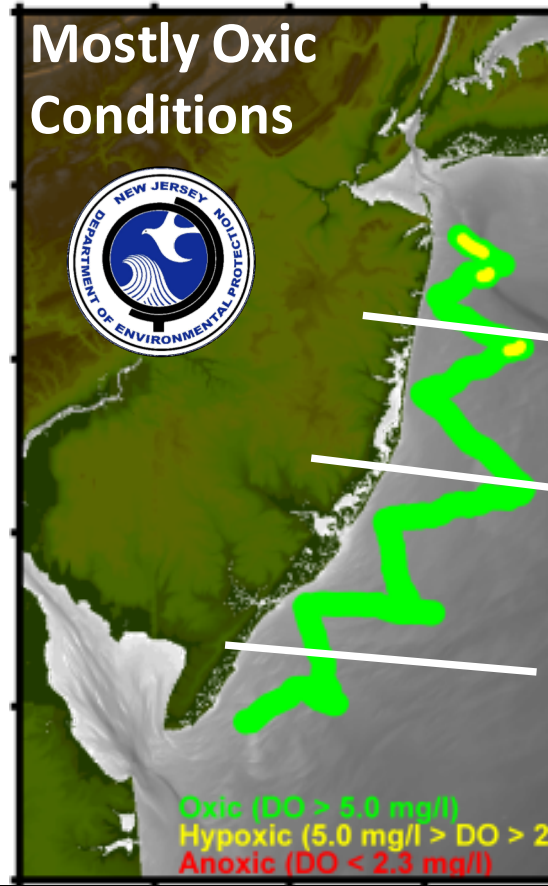
Center for Ocean Observing Leadership
Department of Marine and Coastal Sciences
School of Environmental and Biological Sciences

NJ BPU & NJ DEP State Ocean Observing System
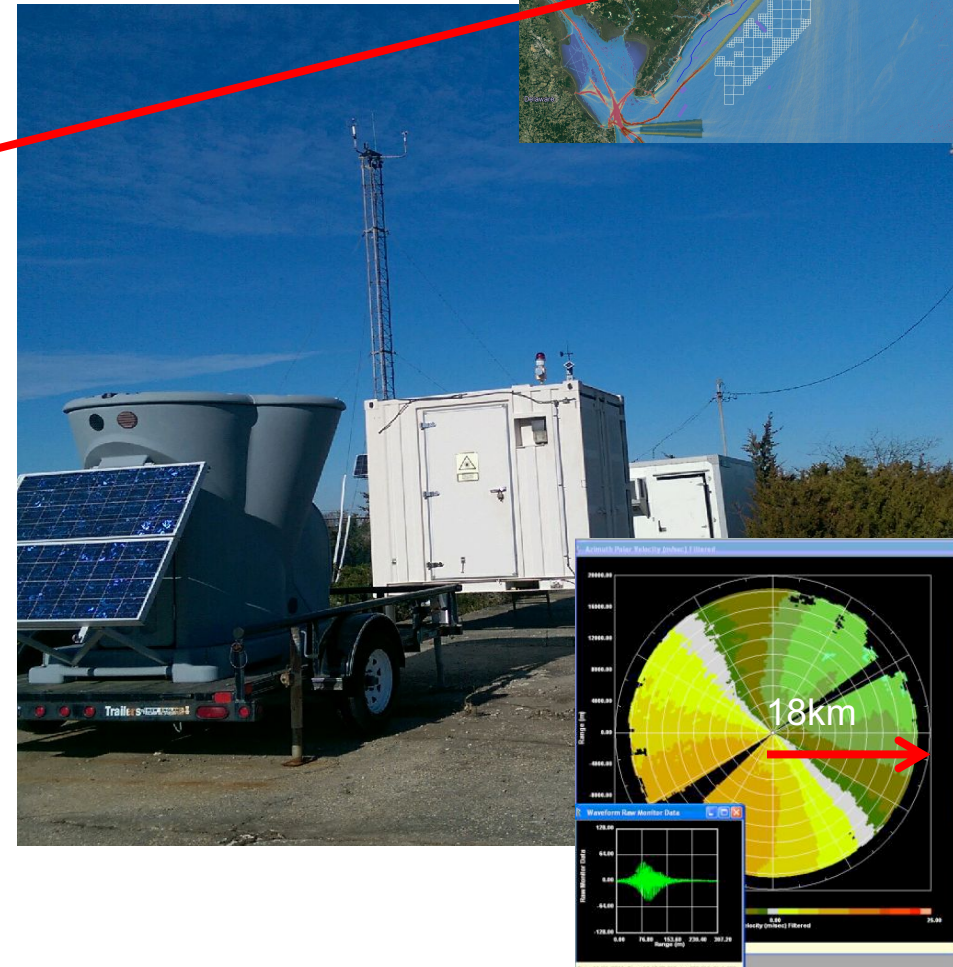
Medium Range (13 MHz)
HF Radar Network

Coldest Dark Pixel
SST Product
Development

Mostly Oxic Conditions

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 (coming soon)

18km

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
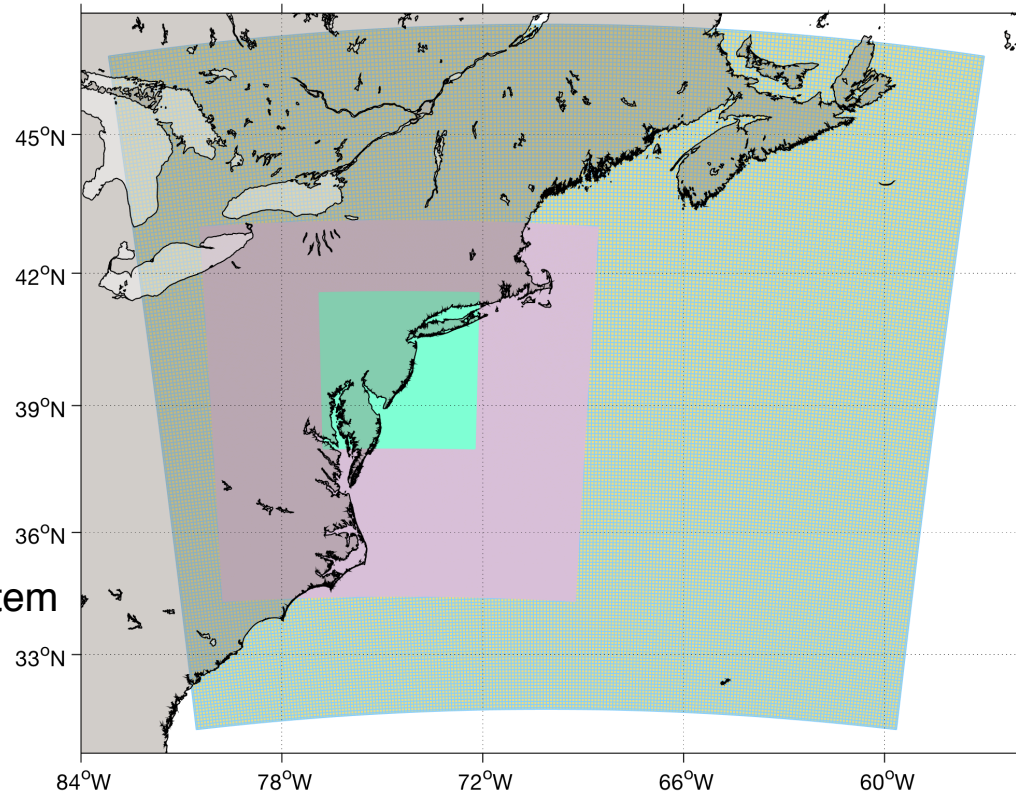

NOAA / The COMET Program
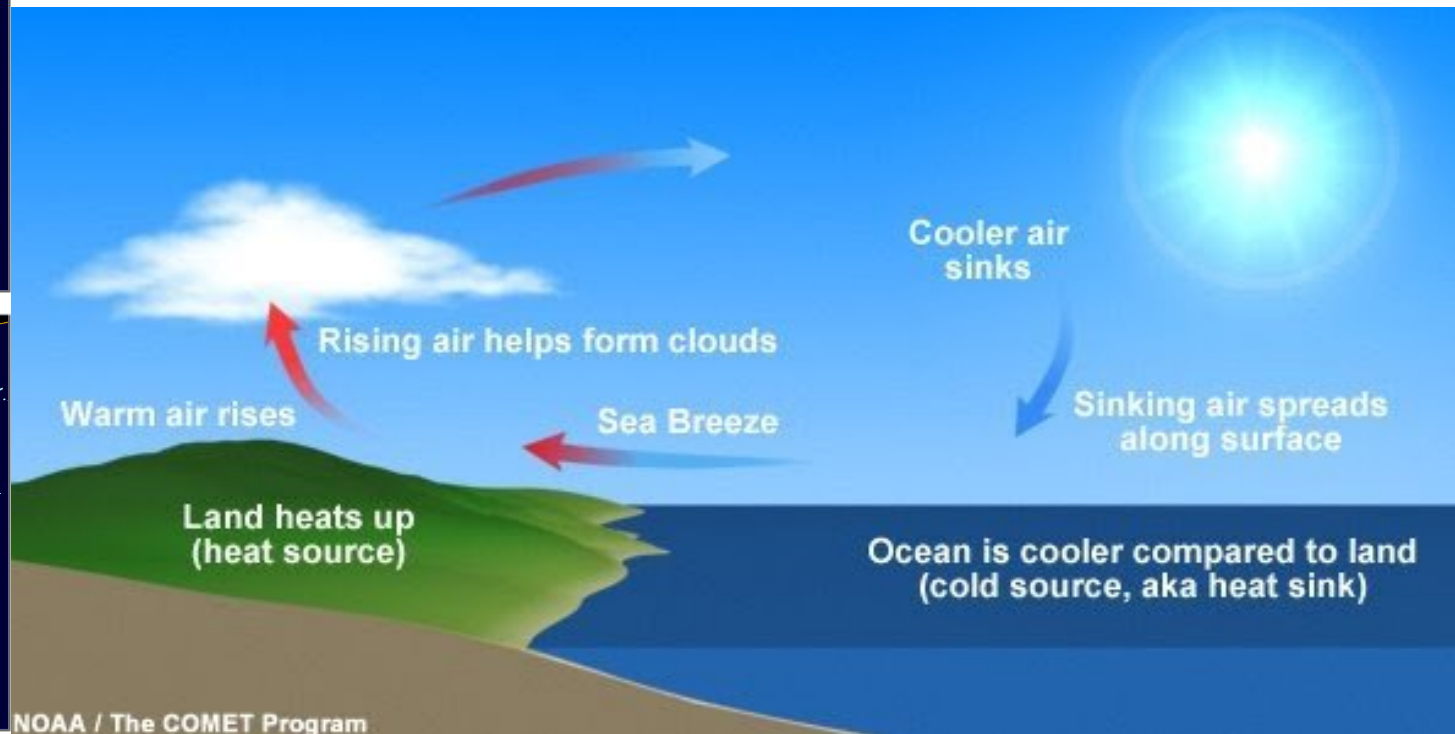
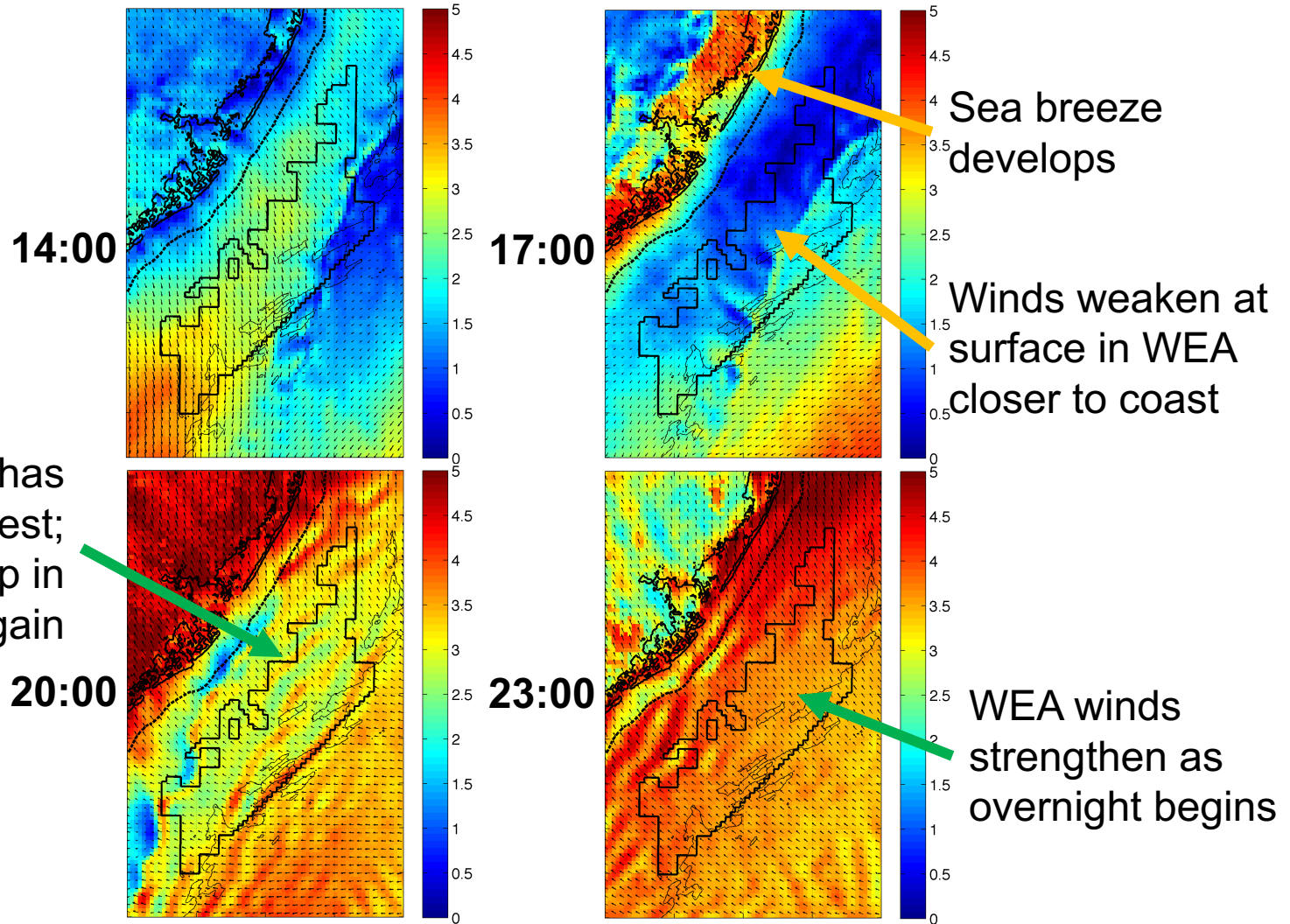# Sea breezes & upwelling, coincident with electricity demand
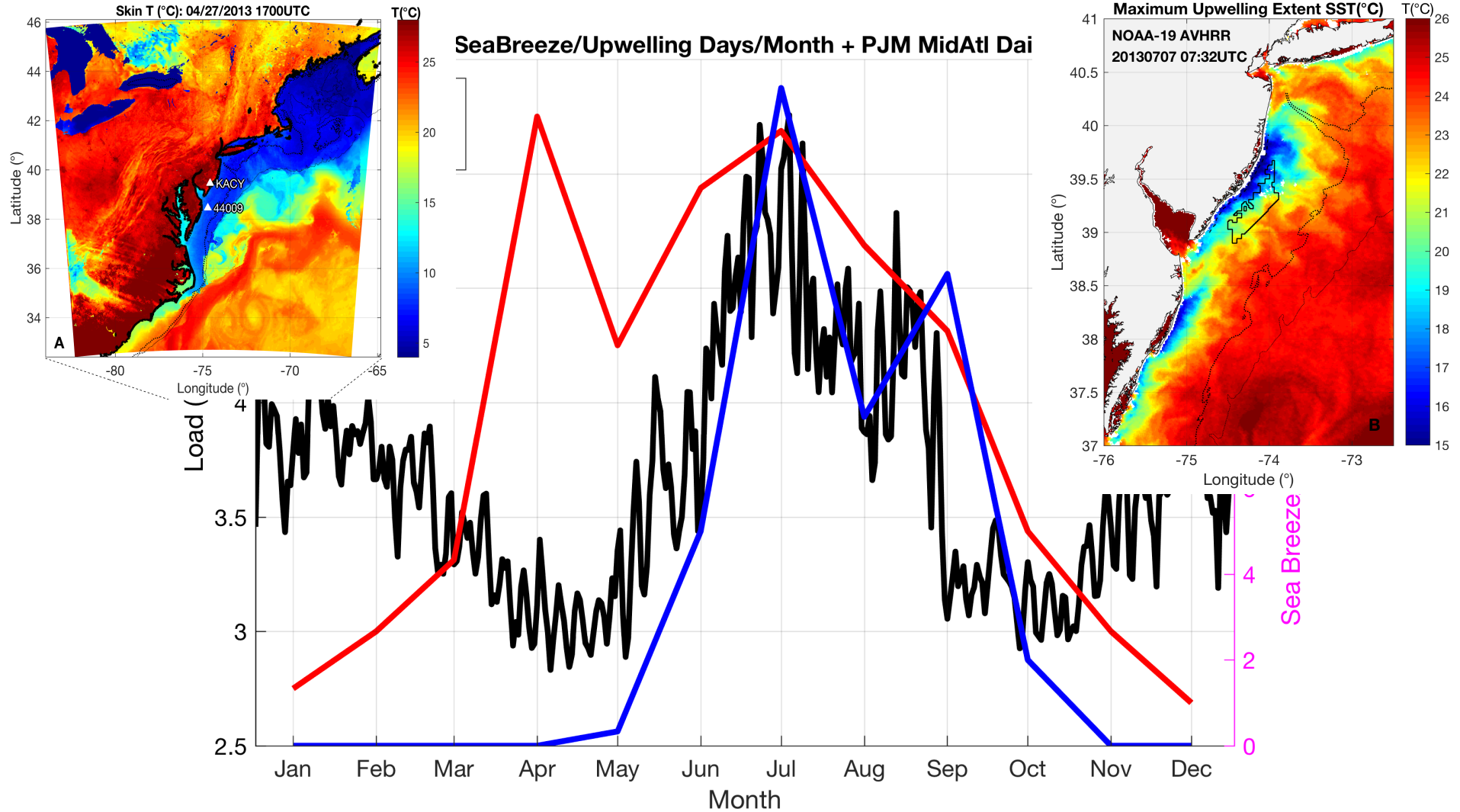
Real-Time Weather Modeling RU-WRF

- 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:
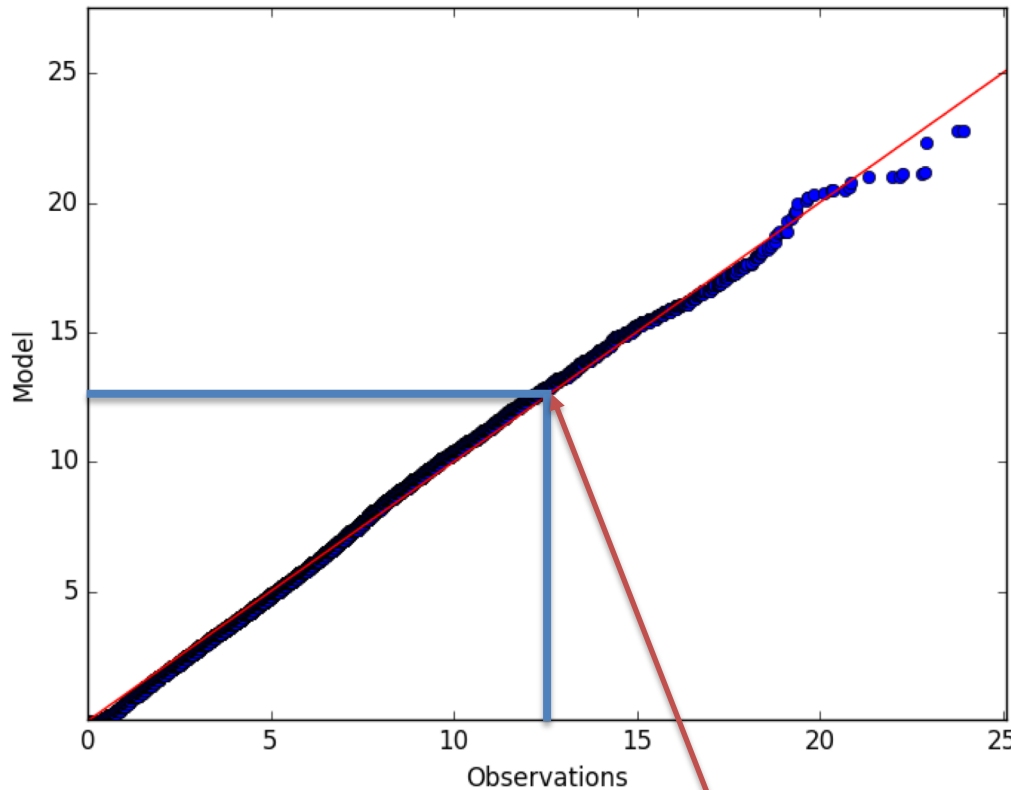 - RUCOOL Coldest Dark Pixel Composite (Details Later)

RU-WRF Capturing Sea Breeze Evolution

September 12, 2012 10m Winds

14:00

17:00

Sea breeze develops

Winds weaken at surface in WEA closer to coast

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

20:00

23:00

WEA winds strengthen as overnight begins

# RU-WRF Captures Observed Wind Distribution

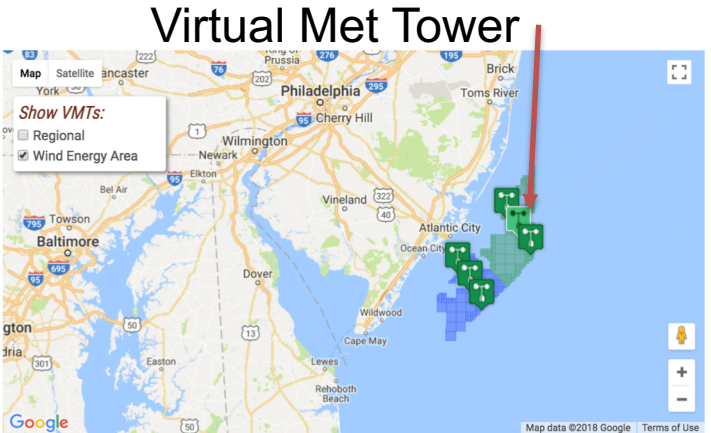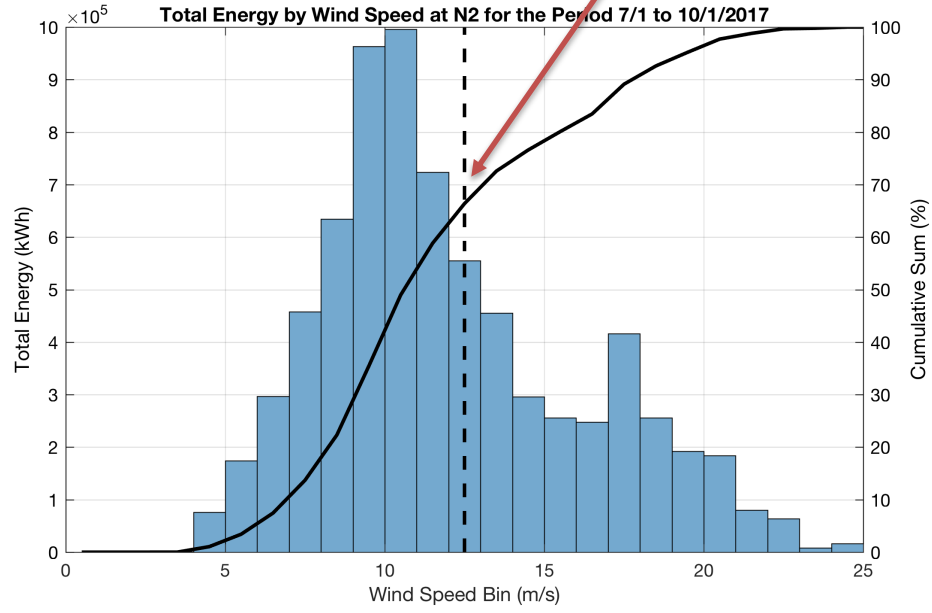Q-Q Plot, 2012-2016

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
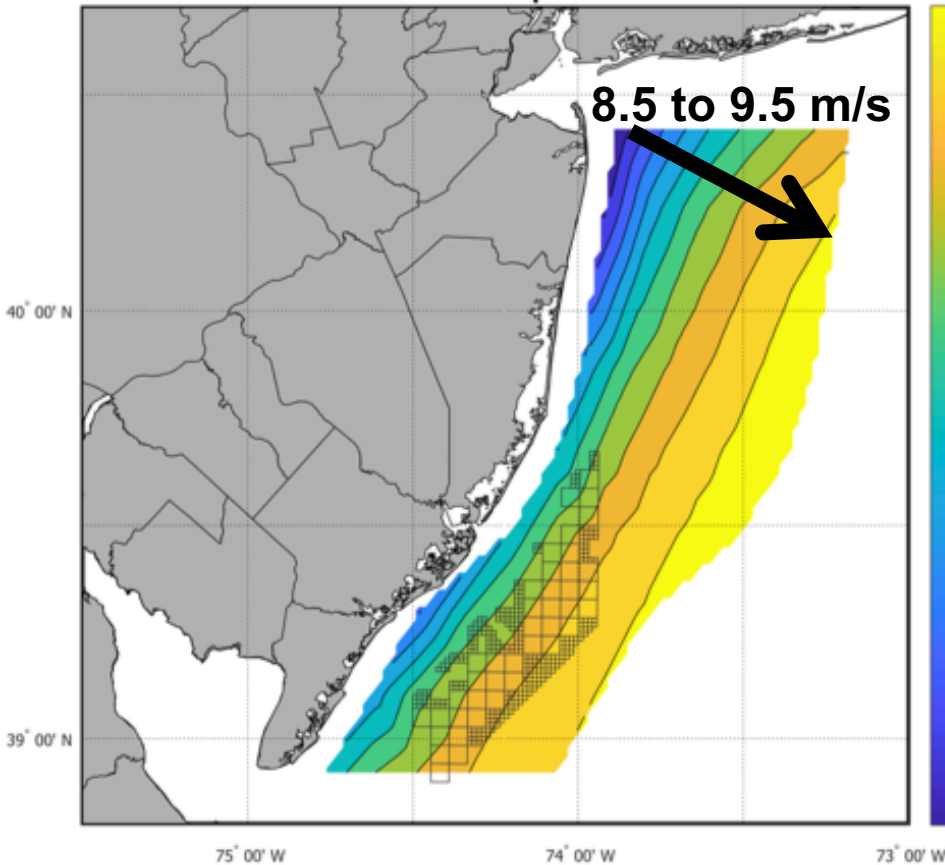
NJ WEA Wind Resource

Histogram of 120m Winds at N2 for the Period 7/1 to 10/1/2017
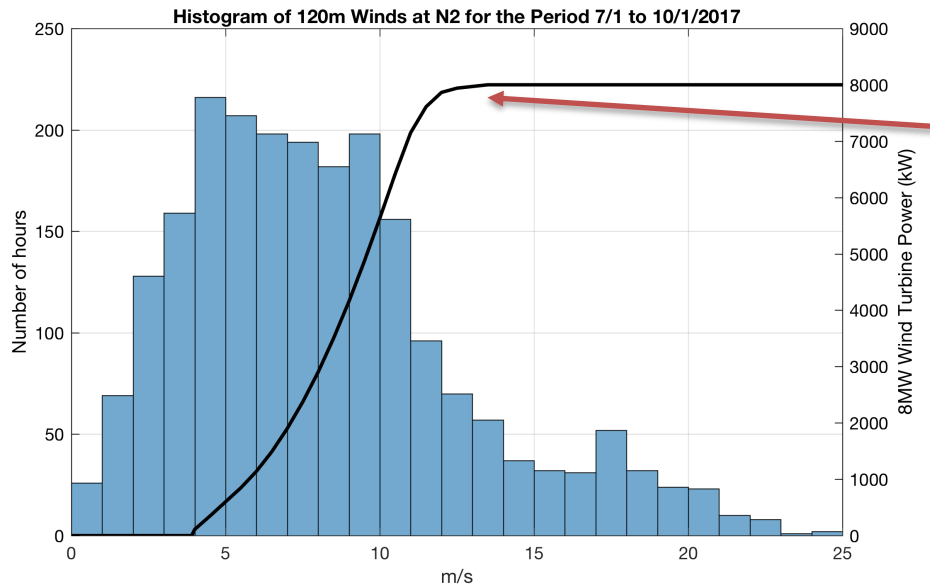
8 MW wind turbine
12.5 m/s rated speed

2/3 of energy extracted
below turbine rated speed

Total Energy by Wind Speed at N2 for the Period 7/1 to 10/1/2017

Virtual Met Tower

RU-WRF Wind Resource

3 Year Mean

8.5 to 9.5 m/s

One Hour Sample

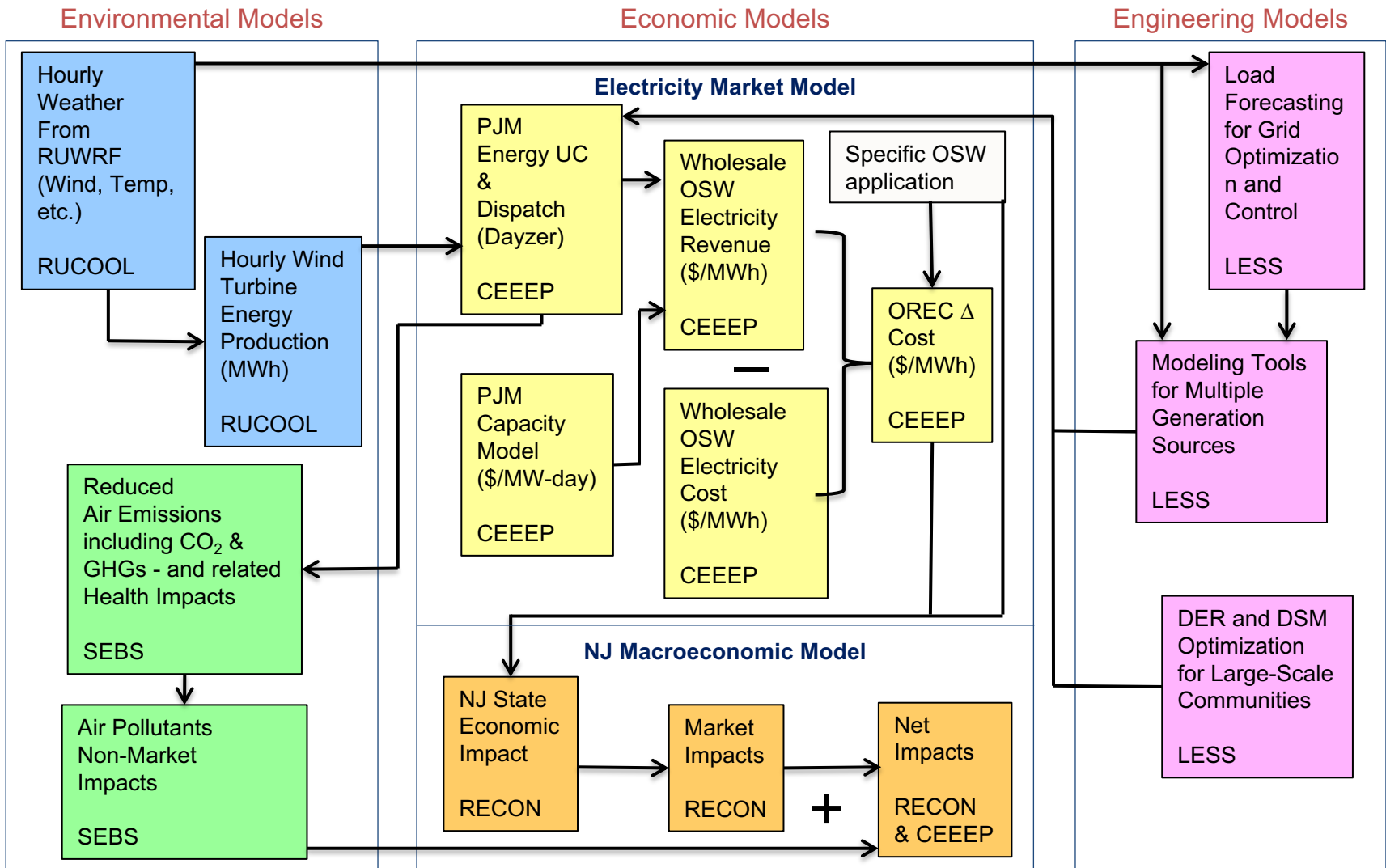Modeling at 3km grid spacing, 10m height
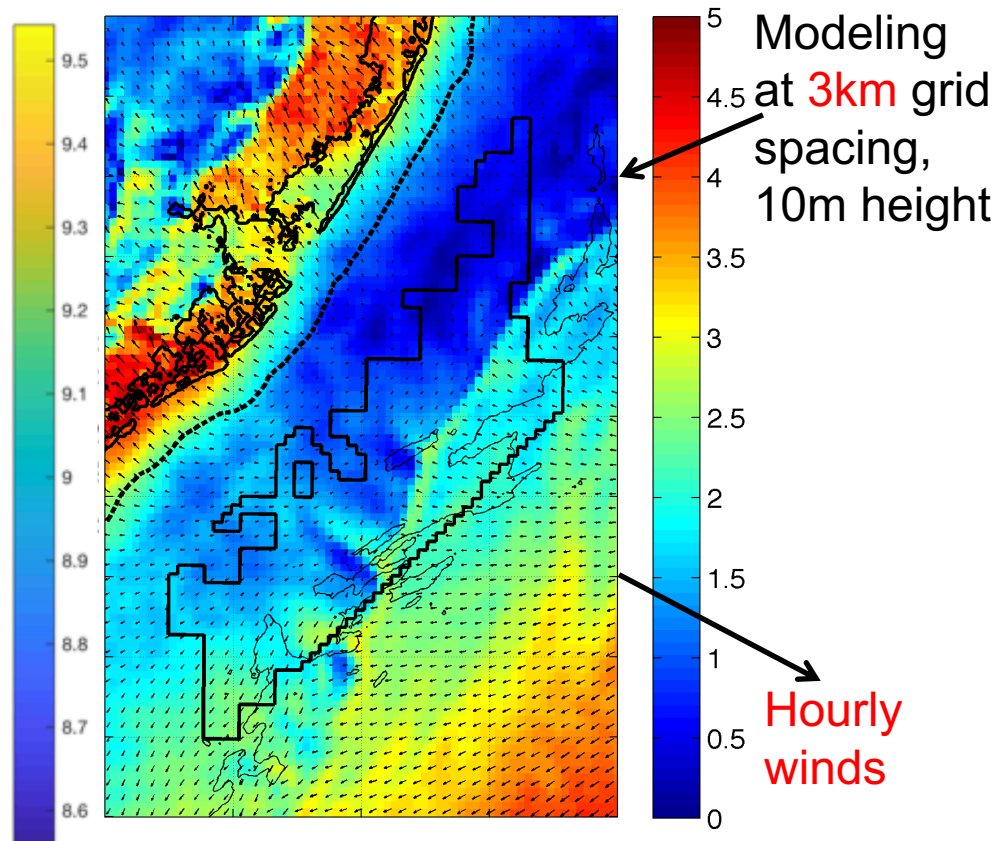
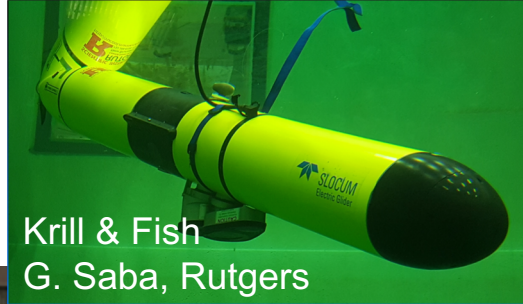Hourly winds

RU-WRF: A Multi-Use Atmospheric Model

- **Hourly met variable output**: includes winds at multiple heights, which can be used for power resource assessment.
- Model can also be used for operational forecasting applications:
    - ✓ **Severe weather forecasting** for construction, O&M procedures.
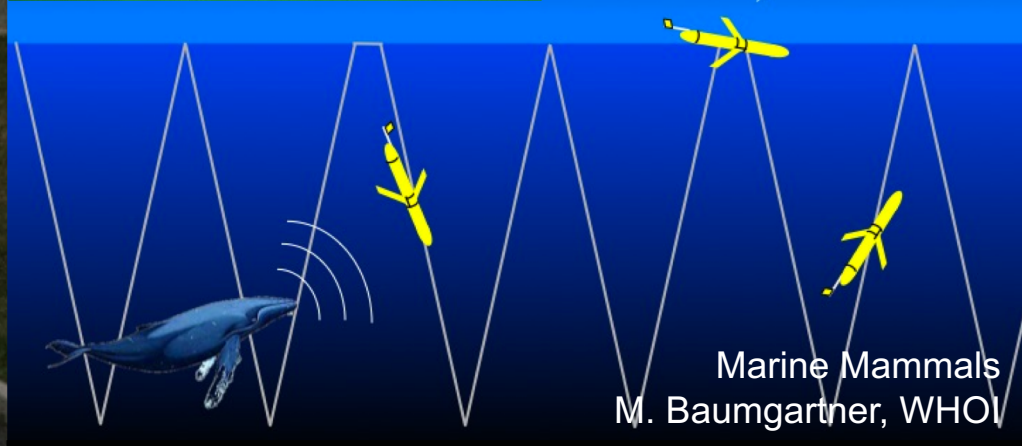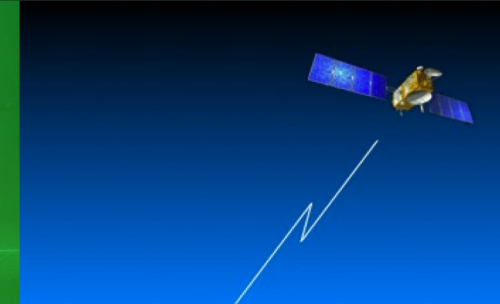   - ✓ **PJM grid management**.
    - ✓ **Energy market trading**.

Rutgers Energy Institute – Wind Working Group: Integrated Modeling Platforms & Experience Chain

RUTGERS
Energy Institute

Environmental Models

Economic Models

Engineering Models

Hourly Weather From RUWRF (Wind, Temp, etc.)

RUCOOL

Hourly Wind Turbine Energy Production (MWh)

RUCOOL

Reduced Air Emissions including CO_2 & GHGs - and related Health Impacts

SEBS

Air Pollutants Non-Market Impacts

SEBS

Electricity Market Model

PJM Energy UC & Dispatch (Dayzer)

CEEEP

Wholesale OSW Electricity Revenue ($/MWh)

CEEEP

PJM Capacity Model ($/MW-day)

CEEEP

Wholesale OSW Electricity Cost ($/MWh)

CEEEP

Specific OSW application

OREC Δ Cost ($/MWh)

CEEEP

NJ Macroeconomic Model

NJ State Economic Impact

RECON

Market Impacts

RECON

+

Net Impacts

RECON & CEEEP

Load Forecasting for Grid Optimization and Control

LESS

Modeling Tools for Multiple Generation Sources

LESS

DER and DSM Optimization for Large-Scale Communities

LESS

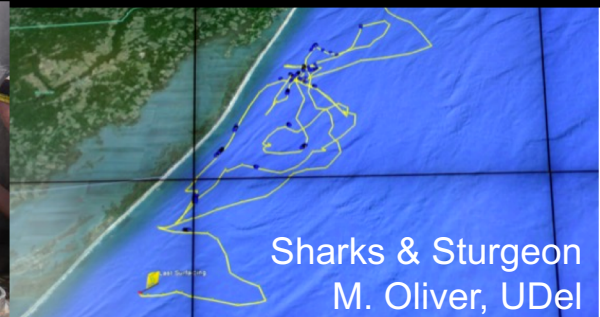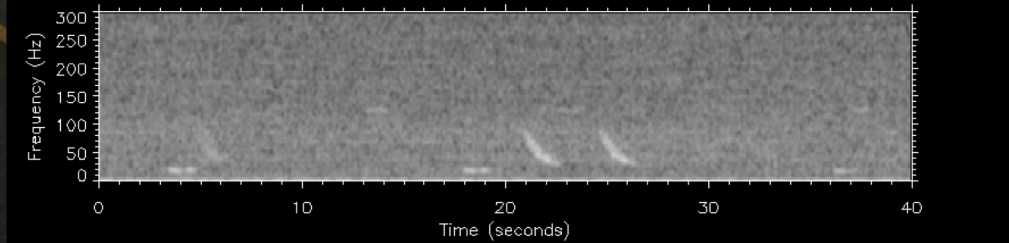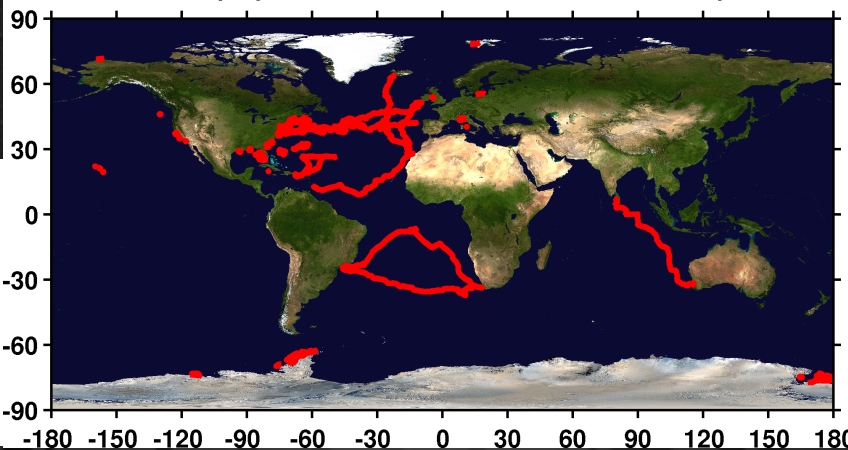# Tools for Offshore Wind: Glider Testbeds for Marine Organism Detection
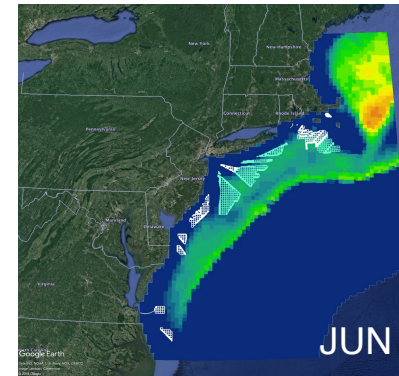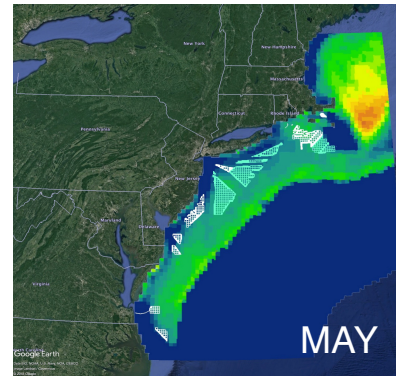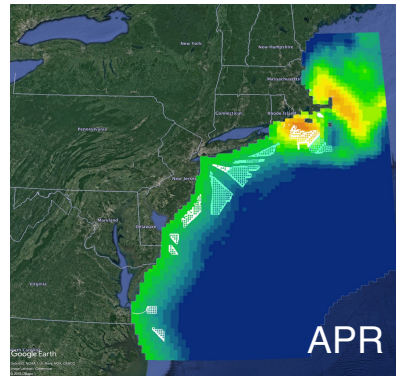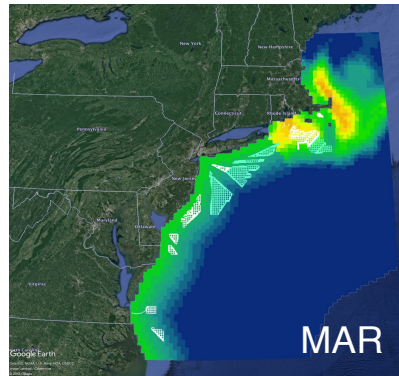
Krill & Fish
G. Saba, Rutgers

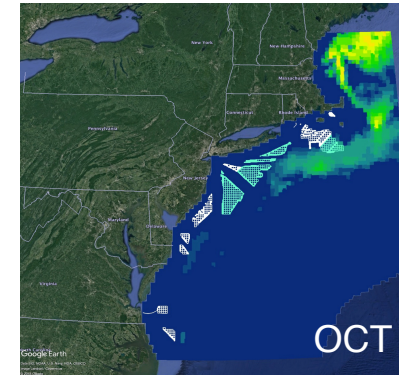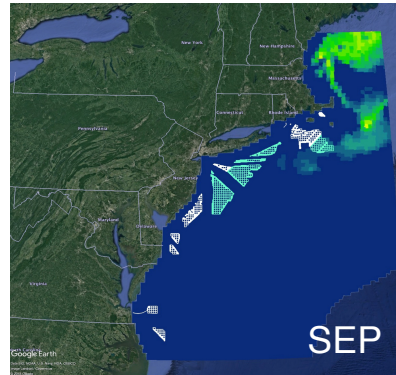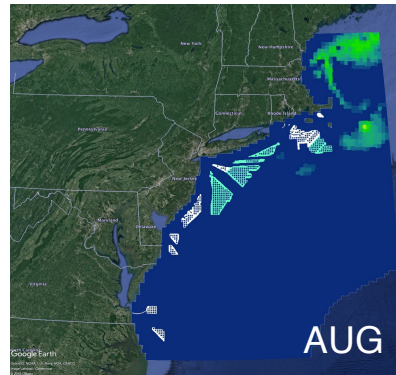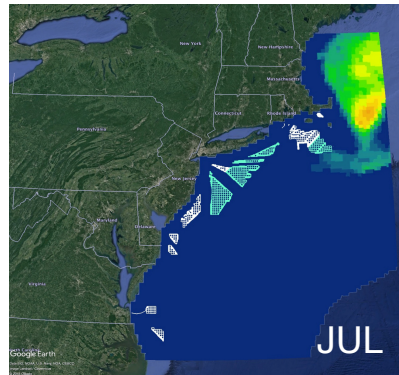Marine Mammals
M. Baumgartner, WHOI

468 deployments - 225478.13km flown - 11626 days

Sharks & Sturgeon
M. Oliver, UDel

RUTGERS Center for Ocean Observing Leadership

MARACOOS
Ocean Information for a Changing World

North Atlantic Right Whale: Monthly Distribution

Data: Duke University
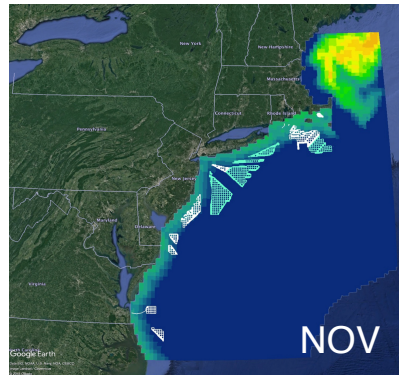Marine Geospatial Ecology Lab
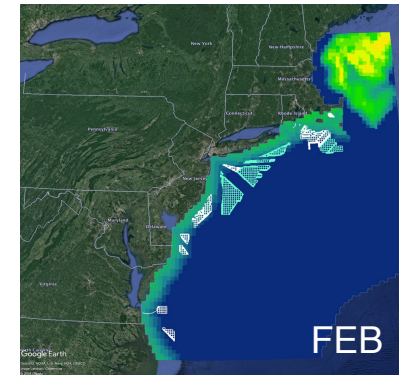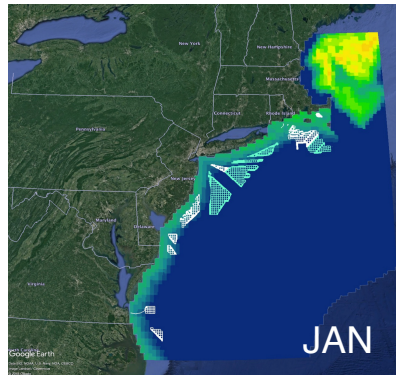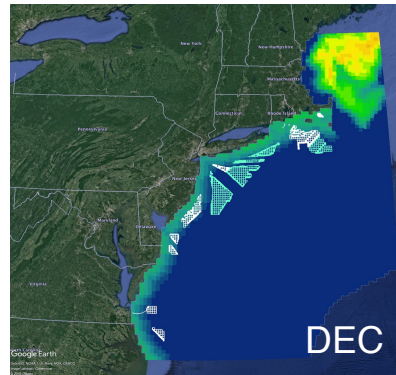
Masters in Operational Oceanography

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)