New Jersey Offshore Wind Resource Modeling and Observations at RU-COOL

Dr. Scott Glenn
Dr. Travis Miles
Dr. Rich Dunk

Dr. Josh Kohut
Dr. Joseph Brodie
And Many Others!
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.

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

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

**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

Mostly Oxic Conditions

Nearshore Glider Surveys

Oxic (DO > 5.0 mg/l)
Hypoxic (5.0 mg/l > DO > 2.3 mg/l)
Anoxic (DO < 2.3 mg/l)
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

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

[Graph showing SeaBreeze/Upwelling Days/Month + PJM MidAtl Dai]

[Map showing Skin T (°C): 04/27/2013 1700UTC and Maximum Upwelling Extent SST (°C) NOAA-19 AVHRR 20130707 07:32UTC]

RUTGERS Center for Ocean Observing Leadership
RU-WRF Capturing Sea Breeze Evolution

September 12, 2012 10m Winds

14:00

Sea breeze develops

17:00

Winds weaken at surface in WEA closer to coast

20:00

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

23:00

WEA winds strengthen as overnight begins
RU-WRF Wind Resource

3 Year Mean

8.5 to 10 m/s

One Hour Sample

Modeling at 3km grid spacing, 10m height

Hourly winds
RU-WRF Wind Resource

3 Year Mean

One Hour Sample

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

48% to 55%

Modeling at 3km grid spacing, 10m height

Hourly winds
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
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.

12.5 m/s turbine rated speed.
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

Goal: Better Inform and Engage Key Stakeholders

Social Values

Policy Analysis

Business Strategy

Environment

Rutgers School of Environmental and Biological Sciences

Meteorological Observations and Model Forecasts

Electricity Markets

Economy

Rutgers Edward J. Bloustein School of Planning and Public Policy

Fisheries Impacts

Air Emission Reductions

NJ Economic Impacts

Engineering

Rutgers School of Engineering

Structural Design

Energy Storage and EVs

Grid Operations

Distributed and Grid-Scale Generation Models

RUTGERS
Center for Ocean Observing Leadership

rei.rutgers.edu
Rutgers University - Center for Ocean Observing Leadership
MARACOOS – A forum to bring forward the best science & technology
Tools for Offshore Wind: Glider Testbeds for Marine Organism Detection

Krill & Fish
G. Saba, Rutgers

Marine Mammals
M. Baumgartner, WHOI

Sharks & Sturgeon
M. Oliver, UDel

468 deployments - 225478.13km flown - 11626 days

RUTGERS Center for Ocean Observing Leadership
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
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