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

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

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

SeaBreeze/Upwelling Days/Month + PJM MidAtl Dai

Maximum Upwelling Extent SST(°C)
NOAA-19 AVHRR 20130707 07:32UTC

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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

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

48% to 55%

One Hour Sample

Hourly winds

Modeling at 3km grid spacing, 10m height

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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

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**.

Goal: Better Inform and Engage Key Stakeholders

Social Values
Policy Analysis
Business Strategy

Environment

- Metocean Observations and Model Forecasts
- Air Emission Reductions
- Structural Design
- Energy Storage and EVs

Fisheries Impacts

Economy

- Electricity Markets
- NJ Economic Impacts
- Grid Operations
- Distributed and Grid-Scale Generation Models

Engineering

- Energy Markets
- Economic Impacts
- Grid Operations
- Distributed Generation Models

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

Satellite Receivers

46 Site CODAR Network

468 Glider Deployments

Ocean Modeling

Glider Lab

Ocean Information for a Changing World
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

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North Atlantic Right Whale: Monthly Distribution

Mid-Atlantic Peak Season

MAR

APR

MAY

JUN

Mid-Atlantic Low Season

JUL

AUG

SEP

OCT

Mid-Atlantic Coastal Season

NOV

DEC

JAN

FEB

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.

Web: http://rucool.marine.rutgers.edu
Email: jbrodie@marine.rutgers.edu