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The New Jersey Shelf Observing System (NJSOS) is a coastal observing network consisting of satellites, shore-based Coastal Ocean Dynamics Application Radars (CODAR), and autonomous fleet of underwater gliders (AUVs) used to monitor coastal upwelling and other oceanographic processes along the New Jersey coast. Recent research activities have come to include coastal meteorology and the interaction of the coastal ocean and the New Jersey sea breeze.

The sea breeze is a well-known phenomenon, which affects coastal areas primarily during the warm season. It is driven by the temperature difference between land and sea, which typically peaks during the afternoon hours with maximum diurnal heating of the land. Effects of the sea breeze include local changes in temperature, humidity, wind speed, wind direction, cloud cover, and sometimes precipitation. The occurrence of a sea breeze, its intensity, and its landward penetration are of interest to power utilities for load forecasting and design studies for renewable energy sources, the health care industry due to its effect on pollen distributions, and to specialized users in the marine and aviation communities.

During the Spring and Summer months in New Jersey, the leading edge of the sea breeze is often observed by the National Weather Service's WSR-88D operational radar at Ft. Dix, NJ (KDIX) as a fine line of higher reflectivity in clear-air mode. The shape and movement of this sea breeze "front" can vary considerably from day to day, and are observed to penetrate rapidly inland, at times crossing the entire state of New Jersey and moving into eastern Pennsylvania in a matter of hours.

One less recognized factor that may be important in the daily evolution of the sea breeze is the distribution of sea surface temperature along and near the shore. During prolonged periods of southwesterly synoptic-scale flow, it is common to observe the "upwelling" of colder water from below the ocean surface. This upwelling can produce near-shore pockets of water that are 5 to 10 °C (or more) colder than the surrounding ocean. Southwesterly winds are associated with the large scale Bermuda high which can lock in hot and hazy weather for several days, resulting in high land temperatures. Thus the potential for the strongest sea breezes exists during coastal upwelling events. Additionally, research has shown that there are

several recurrent upwelling centers located off the coast of New Jersey. Observational and modeling research has shown that these upwelling centers are related to topographic features located just off the Central and Southern New Jersey coastline (Song et al., 2001). Therefore variations in the development and the strength of the sea breeze are expected adjacent to these regions during upwelling conditions compared to other areas of the New Jersey shoreline.

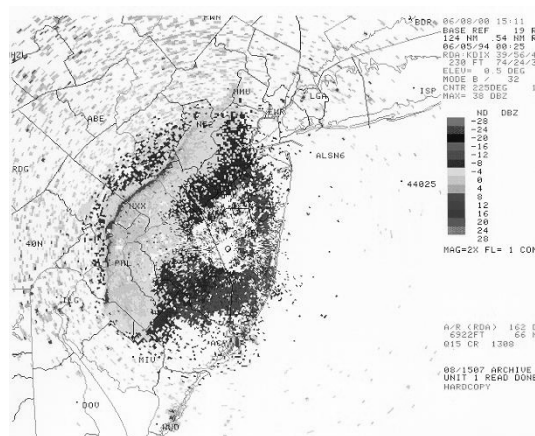


Figure 1. Radar image showing sea breeze penetrating across NJ into PA (from June 1994).

For the past year, the National Weather Service Office at Mount Holly, New Jersey (NWS-PHI) and the Rutgers University Institute of Marine and Coastal Sciences (RU-IMCS) have been collaborating on a COMET Partners' Project, "The New Jersey Sea-Breeze and Its Relationship to Coastal Upwelling." The purpose of this project was to test the hypothesis that the afternoon sea breeze along the New Jersey shore can be enhanced by cooler near-shore ocean water associated with coastal upwelling during the Summer. This hypothesis was tested by running the Regional Atmospheric Modeling System (RAMS) on selected cases from Summer 2000. Parallel runs used (1) the observed sea-surface temperature (SST) analysis including cold water upwelling, and (2) a warmer SST analysis from a different day. The results of this study showed a slight but significant increase in the strength of the model's forecast sea breeze when cold-water upwelling was present. More information is available on the Internet at <http://marine.rutgers.edu/cool/seabreeze/>.

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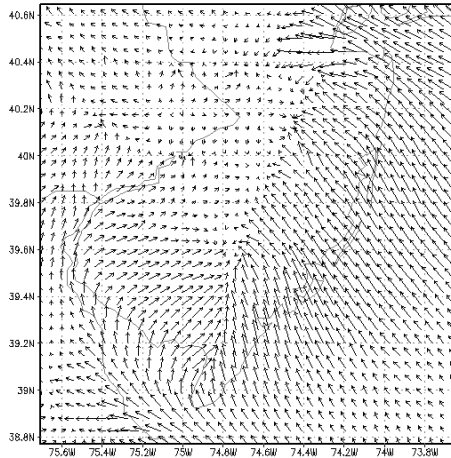


Figure 2. RAMS surface wind forecast for a selected sea breeze study case (from July 2000).

Future modeling studies are planned to investigate upwelling enhanced sea breeze development along the New Jersey coast. The Weather Research and Forecasting (WRF) Model is a state-of-the-art mesoscale weather forecast model and data assimilation system (More information is available at Michalakes et al. (1999) and <http://www.wrf-model.org>). WRF can be run at high spatial and temporal resolutions similar to that of the sea breeze phenomenon. The Regional Ocean Modeling System (ROMS) (<http://marine.rutgers.edu/po/models/roms/index/php>) has demonstrated skill in predicting the occurrence of coastal upwelling and downwelling, with data assimilation experiments indicating there is significant research required to find the optimal way in which to assimilate CODAR observations. Data from the NOAA weather radars and a statewide network of weather stations is used for comparison. Efforts to couple the high-resolution atmospheric model with the data assimilative coastal ocean model are ongoing.

References

- Michalakes, J., J. Dudhia, D. Gill, J. Klemp, and W. Skamarock, 1998: Design of a next- generation regional weather research and forecast model. *Towards Teracomputing*, World Scientific, River Edge, New Jersey, 117-124.
- Song, Y.T., D.B. Haidvogel, and S.M. Glenn, 2001: Effects of topographic variability on the formation of upwelling centers off New Jersey: A theoretical model. *J. Geophys Res.*, **106**, 9223-9240.