Rhode Island Research Alliance Grant Application
RIRA-CA-2015
Project Overview

Project P.I. and Institution: Asst. Prof. Baylor Fox-Kemper (Brown Dept. of Earth, Environmental, & Planetary Sciences), Prof. Lew Rothstein, Prof. Christopher Kincaid, & Assoc. Marine Research Scientist David Ullman (U. Rhode Island Graduate School of Oceanography), Assoc. Prof. Dale Leavitt & Assoc. Prof. David Taylor (Roger Williams U. Dept. of Biology)

Project Title*: Pushing to New Limits for Models of Rhode Island Bays & Sounds

Relation to research themes or Centers of RI NSF EPSCoR: This multidisciplinary collaborative project between three Rhode Island institutions will support innovative technology development and capacity building in all three of the State's niches: Marine Science; Life Sciences; and Energy & Environment. Existing EPSCoR investments in the Brown supercomputer will be utilized.

Brief Description: Development and validation of circulation modeling systems for all Rhode Island coastal waters, with capability for high-resolution sub-regions.

Catalytic Nature of the Project: Core development of state capabilities in modeling the region. These will be useful tools in future investigations of marine resources, biology, and marine environment.

Project Summary (1 pg.)

SUMMARY OF PROPOSED ACTIVITY: How well can the climate and fundamental physics of RI's coastal waters be modeled ?
Rhode Island's bays and coastal waters have been modeled for limited applications (e.g., the figure shows tidal potential energy flow from two different regional models created by the investigators, hereafter called here the Narragansett Bay Model (NBM) and the Block Island Sound/Rhode Island Sound Model (RISM), (Fig. 1). How capable are these model setups for the purposes of *reevaluating*, *monitoring,* and *projecting* the coastal and marine environment of Rhode Island, including the **impacts of climate change on marine life**? In particular, how well do these models capture biologically and environmentally relevant physical processes, such as those that flush, ventilate, and dilute regions prone to anoxia or those in danger of hazardous pollutant spills? What challenges in modeling the circulation of the region limits the models' utility for simulating the environment and marine life distribution in the region?

Two physical modeling frameworks will be developed (code, forcing variables, grids, validation data) for the coastal waters of Rhode Island, from Block Island and Rhode Island Sounds through Narragansett and Mt. Hope Bays. The first physical modeling framework, the **Ocean State Ocean Model (OSOM),** builds on previous proven models for the region, but provides a single model with a larger domain and clearer physical linkages between the subregions. The simpler setup of the OSOM will improve both model fidelity and ease of understanding. The project will then use the OSOM to estimate the ocean circulation in the region over the last 30 years—a hindcast simulation. The hindcast will be directly evaluated against observations—physical, environmental, and biological—from historical measurements and extreme events. The biologists on the team will identify particular instances of ecosystem and societal importance (e.g., transport of larval fish and invertebrates and their subsequent effects on local fisheries; distribution of environmental contaminants that pose risk to wildlife and human health). The team will examine whether the OSOM is capable of acting as a base circulation model to study these phenomena (which might require additional model components, such as biological tracers to be added in future experiments).

The second modeling framework will be a first-of-its kind turbulence-resolving model, the **PRICLES (Prototype Rhode Island Coastal Large Eddy Simulator)**. Regions and events within the OSOM hindcast where historical measurements were particularly good, but the OSOM was unable to reproduce, will be chosen. For a few such junctures, a model with horizontal and vertical resolution of better than 5m will be developed to directly resolve the turbulent mixing and transport. This aspect of the problem will bring the high-resolution turbulence modeling of the Brown group to bear on the coastal problem. Such a model will clearly improve simulations and understanding of turbulent processes, such as the breakup of hypoxic waters during mixing, the dispersal of pollutants and larvae, and can act in the future to support application-driven projects, such as tidal power site characterization.

Intellectual Merit: This project will combine proven models of physical phenomena in the region and extend their capabilities. A new class of model will be developed and prototyped. Evaluation against observations will occur at each stage.
Broader Impacts: This new collaboration will synergize existing expertise and provide a modeling framework and hindcast simulations suitable for addressing future physical, biological, and environmental changes in the region and suitable for design and analysis of future observations in the region. Students (2 graduate, 1 undergraduate) and young scientists (1 postdoctoral) will participate and learn in this collaboration.