Modeling Water Exchange Between Rhode Island Sound and Southern New England Estuaries

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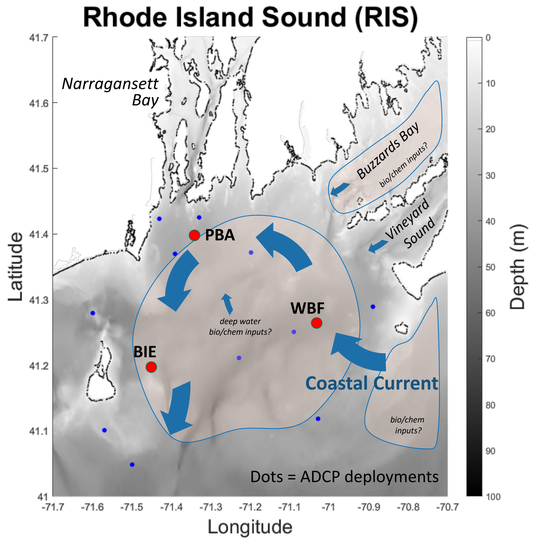
Abstract

- This study is the beginning of a larger effort to expand our understanding of circulation processes associated with Rhode Island Sound (RIS) and the estuaries of Southern New England.
- We know the summer water flux into NB from RIS through the East Passage is approximately 2500-4000 m^3/s, and that flux likely includes waters from the following sources:
  1. The coastal current
  2. Martha's Vineyard Sound
  3. Buzzards Bay (BB)
  4. Deep water RIS inputs
- We will use the Ocean State Ocean Model (OSOM) to understand how waters move into and between RIS, NB, and BB, but first we have to validate OSOM for RIS before we can use it to develop reliable conclusions.
- We report on results attempting to validate OSOM against real world data collected around RIS during past studies. Our preliminary results for summer/stratified periods are mixed, showing OSOM can represent time-averaged trends in the coastal current in some locations, but the model also misses some of the critical driving forces.

Methodology

We compare real world data collected during deployments of moored acoustic doppler current profilers (ADCP) sensors (2008 and 2010) and numerical model data generated using OSOM (an implementation of the Regional Ocean Model System, ROMS). We also compare real world drifter data with OSOM-modeled drifters. Current velocity for both ADCP data and model-generated data are converted to "residual," meaning the tidal movement is removed leaving water flow due to seasonal influences. This conversion makes it possible to compare data from the same time periods in different years.



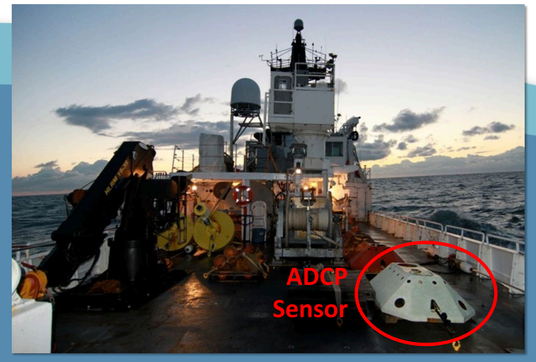
For model data, we start with 2006 because the necessary boundary condition and forcing files have already been created for that year. We generate data at the same locations as the ADCP deployments (marked as red and blue dots in the map above).

Plot Types:

A. Time series of currents

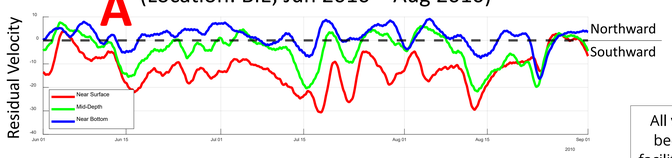
B. Period-averaged currents at different depths

C. Daily-averaged currents plotted against the daily tidal range

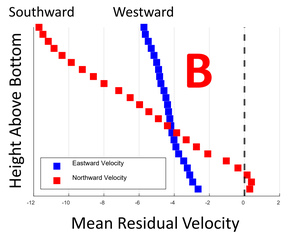


Real World Results

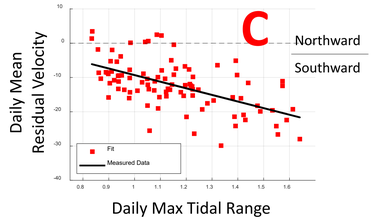
ADCP-Measured Northward Current
(Location: BIE; Jun 2010 – Aug 2010)



Velocity Profile



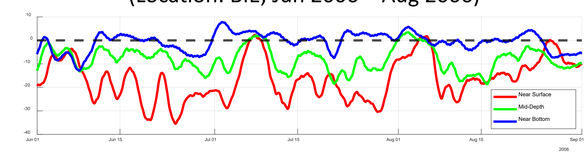
Northward Flow vs. Tidal Range



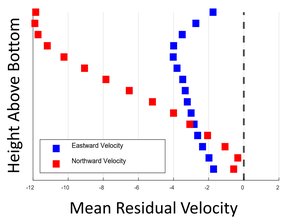
All velocities have been de-tided to facilitate comparison across years.

Computer Modeled Results

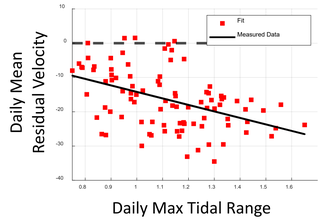
Computer-Modeled Northward Current
(Location: BIE; Jun 2006 – Aug 2006)



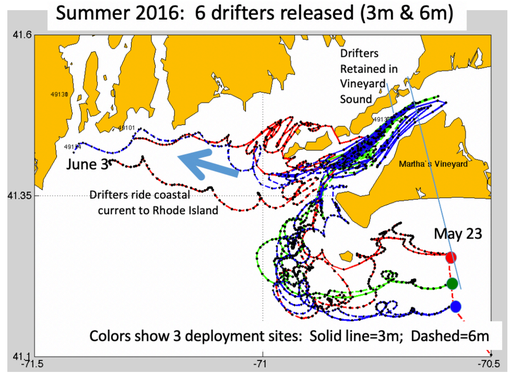
Velocity Profile



Northward Flow vs. Tidal Range



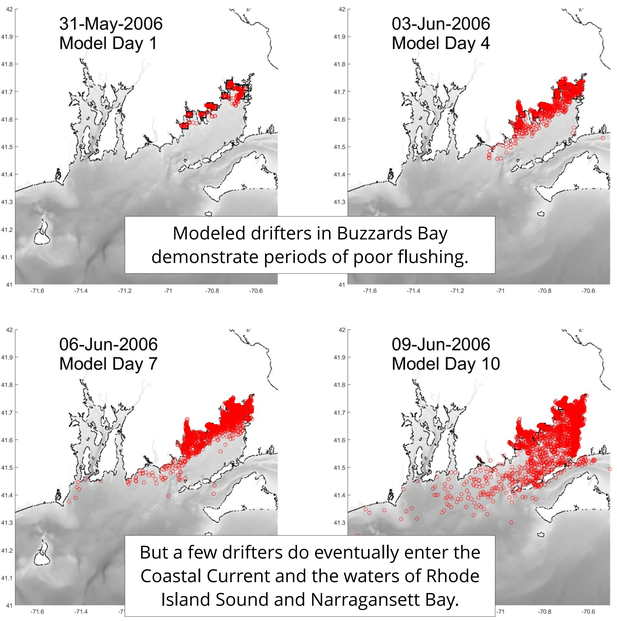
Real World Drifter Movements
(May 2016 – Jun 2016)



Drifter Sensor

A 2016 experiment tracking drifters deployed south of Martha's Vineyard suggest limited exchange between surface waters of Buzzards Bay and Rhode Island Sound.

Computer Modeled Drifter Movements
(May 20106– Jun 2006)



Conclusions

1. Preliminary model-validation results are mixed but promising. The model matches real world sensor data well in some locations, but poorly in others.
2. Experimental and computer-model results suggest periods of very slow flushing in Buzzards Bay and limited exchange of water between Buzzards Bay and Rhode Island Sound.
3. These preliminary results confirm that water movement within and between RIS, NB, and BB is a valid area for investigation using computer modeling and the results will have significant implications for the health of southern New England estuaries.

References & Acknowledgements

Pfeiffer-Herbert, A.J., et al., 2015. Dynamics of wind-driven estuarine-shelf exchange in the Narragansett Bay estuary. Continental Shelf Research, 105, pp 42-59.
Liu, Qianqian, 2015. Dynamics of Rhode Island Coastal Waters. Open Access Dissertations. Paper 373.

- This material is based upon work supported in part by the National Science Foundation under EPSCoR Cooperative Agreement #OIA-1655221. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.
- This material is based upon work conducted at a Rhode Island NSF EPSCoR research facility [Brown University Center for Computation and Visualization] supported in part by the National Science Foundation EPSCoR Cooperative Agreement #OIA-1655221.
- This material is based upon work supported by the Rhode Island Sea Grant and the Rhode Island Endeavor Program.