WAVE EFFECTS ON STORM SURGE IN A SMALL TWO-INLET BAY

Mara M. Orescanin, Naval Postgraduate School, msoresca@nps.edu
Thomas Chris Massey, USACE ERDC-CHL, chris.massey@usace.army.mil
Matt Reffitt, Naval Postgraduate School, mreffitt@nps.edu
Britt Raubenheimer, Woods Hole Oceanographic Institution, britt@whoi.edu
Steve Elgar, Woods Hole Oceanographic Institution, elgar@whoi.edu

BACKGROUND AND MOTIVATION

Storm surge resulting from oceanic extreme events, commonly tropical cyclones, is a major contributor to coastal flooding and property damage. Thus, there is significant investment in accurate predictions. However, forecasts of storm surge often are focused on regional scales, and are unable to resolve complex nearshore bathymetry and small tidal inlets (Yin et al. 2016) that can be critical to local surge magnitudes and timing.

Here, model simulations with a regional wave-flow coupled model (NACCS), a high bathymetric resolution uncoupled flow model (ADCIRC), and a high resolution coupled model (CSTORM) are compared with observations of storm surge during Hurricane Irene (Atlantic Storm 09, 2011) within Katama Bay, Martha's Vineyard, Massachusetts (Figure 1). Katama Bay (Orescanin et al., 2014; Orescanin et al., 2016) is a small (<7 km^2) bay that is connected by Edgartown Channel to Vineyard Sound to the north and by Katama Inlet to the Atlantic Ocean to the south. The bathymetry and geometry of the larger region (Figure 1a) modify the M2 tide so that the Vineyard Sound tides are delayed by three hours relative to those in the Atlantic. High (10 m) resolution bathymetry of Katama Inlet and the ebb shoal collected before and after Hurricane Irene was integrated with the coarse NACCS grid in the ADCIRC and CSTORM models.

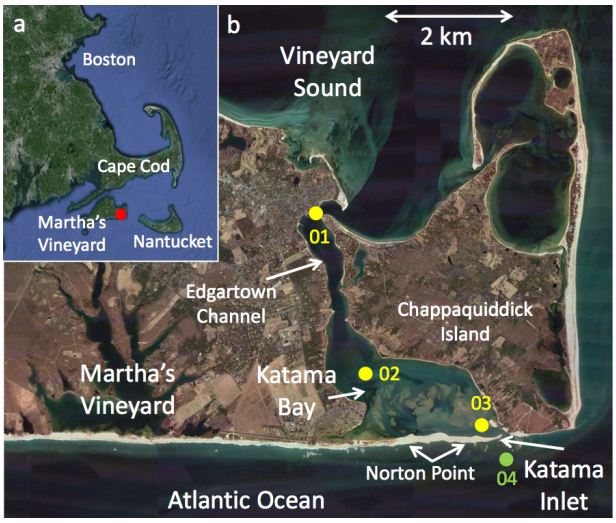

Figure 1 - a) Location of Katama Bay, Martha's Vineyard, MA and b) Katama Bay features and observation locations (numbered circles).

MODEL CONFIGURATION

To assess the threat of storm surge from tropical cyclones (including Hurricane Irene), the United States Army Corps of Engineers (USACE) compiled regional-scale model results from the circulation model ADCIRC, coupled with the wave model STWAVE into the North Atlantic Comprehensive Coastal Study (NACCS). NACCS includes risk assessments along the entire east cost of the United States, which have been validated by observations in some areas. However, owing to computational limitations, the grid resolution in the Katama Bay area is on the order of 200 m, insufficient to resolve the small (< 300 m wide) Katama Inlet.

The effects of bathymetric resolution and wave-flow model coupling on the accuracy of storm surge predictions are investigated by comparing model simulations with observations. Specifically, root mean square errors between each model's predictions and the observations of water levels at stations 01-03 (Figure 1b) are calculated. Effects of bathymetric-resolution are evaluated by comparisons of the model outputs.

CONCLUSIONS

The model-data comparisons suggest that:

- Wave forcing caused increased surge water levels within Katama Bay during Hurricane Irene
- High-resolution models indicate a focused nearshore alongshore coastal jet (2 m/s).
- Surge water-level prediction errors are reduced by 30% for the high-resolution coupled model compared with those for the coarse-resolution coupled NACCS.

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