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Coastal Ocean Current Response to Hurricane Jeanne Using High Frequency Radar

Lynn (Nick) Shay and Jorge Martinez
RSMAS, University of Miami, Miami, United States (nshay@rsmas.miami.edu)

The coastal current response was observed by a pair of high frequency radars (known as Wellen Radar-WERA) during the passage of hurricane Jeanne in 2004 between Miami and North Key Largo, Florida. These real time measurements, acquired every 15 minutes, revealed a fairly complex coastal ocean current response. Since the measurements were acquired on the "clean" side of Jeanne, an eastward current response of 1 m/s emanated from the Biscayne Bay (depths < 20 m) where offshore surface winds approached 22 m/s with gusts up to 25 m/s. This current response forced an eastward bulge of $\approx$ 100 square kilometers resulting in an apparent offshore Florida Current meander. The Florida Current velocities decreased in response to the hurricane since the winds were generally orthogonal to the current. As Jeanne moved inland, the cyclonic rotating winds were in phase with the Florida Current resulting in a stronger coastal surface flow to the north of more than 2 m/s.

Comparison of the WERA data to the 10-m winds observed at the NOAA CMAN station at Fowey Rocks suggests that during the period of strong forcing, the radar inferred wind direction follows that measured at Fowey (slope of $\sim$1). Inferred surface winds, derived from the 2nd order returns in the Doppler spectra, indicate a bias of 2 m/s and a slope of $\sim$0.8 between the observed and inferred wind speeds. The correlation coefficient exceeds 0.7 over this domain where the WERA winds look reasonable. Using the forced surface currents and winds at Fowey Rocks, the surface drag coefficient is estimated from the forced shallow water equations with constant bottom topography. In the present case of shallow water (< 80 m), a scaling of the dominant terms reveals that the observed forced response can be described to first order by the time-dependent depth-integrated horizontal momentum equations. These types of HF radar measurements have implications for improving storm surge predictions.