Abstract View

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Near-Inertial Ocean Current Response to Hurricane Frederic

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ABSTRACT

Hurricane Frederic passed with 80 to 130 km of the U.S. Naval Oceanographic Office current meter arrays in water depths ranging from 100 to 470 m near the DeSoto Canyon region, and within 150 km of an Ocean Thermal Energy Conversion (OTEC) mooring in 1050 m of water. Excitation of near-inertial waves by the moving hurricane was observed throughout the water column along the canyon walls and at the OTEC site. The frequencies of the waves were blue-shifted between 1% to 6% above the local inertial frequency. The horizontal wavelength of 250 km is consistent with an energetic first baroclinic-mode response, but is considerably below the linear theory prediction of 550 km. The inferred vertical wavelengths of the immediate response exceeded 1000 m along the northern and eastern sides of the canyon since the currents throughout the water column increased within hours of the hurricane passage. Later, the vertical wavelengths were about equal to the water depth. The vertical group velocities associated with the first and second baroclinic modes were 0.15 and 0.03 cm s^{-1} within 2 and 7 inertial period (IP) following storm passage.

The vertical modes of the ocean current field are determined using a constant Brunt–Väisälä frequency based on AXBT data. Solutions with a flat bottom and with a sloping bottom are compared to illustrate the effect due to bottom topography in the DeSoto Canyon region. The horizontal velocity eigenfunctions are fit to the velocity amplitudes derived from the ocean current time series to estimate the time-dependent modal amplitudes. The time evolution of the first two baroclinic modes, viz. the large vertical scale modes, agrees well with the predictions from a linear, inviscid model. At all of the arrays, the summation of the depth-averaged flow and the first two flat-bottom modes explain 52%–62% of the near-inertial variance averaged over 7 IP following storm passage. The inclusion of the sloping bottom effect contributed an additional 5–6% of the variance for the baroclinic modes. The depth-averaged flow contributed about 20% to the near-inertial variability along the periphery of the DeSoto Canyon.

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