Impact of major hurricanes on the deep ocean

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Hurricanes have well-established physical and biogeochemical impacts on the surface ocean, generating intense upper ocean mixing and upwelling of nutrient-rich waters that induces transient phytoplankton blooms. However, how hurricanes impact the deep ocean remains unknown. Using molecular and isotopic tools to trace particle flux processes, in this talk we present direct evidence of the impacts that major hurricanes have on the biological pump and carbon export to the deep ocean. Here we focus on the coupling between the physical and biological responses in surface waters and the carbon export flux to the deep ocean after the passage of two major (Category 3) hurricanes over the Bermuda Time Series site in the NW Atlantic Ocean: Fabian (Sept. 2003) and Nicole (Oct. 2016). Fabian and Nicole differed in track and translational speed and generated distinct ocean responses. Fabian was particularly noteworthy in that it resulted in both a transient phytoplankton bloom and in extensive resuspension of deep Bermuda platform detrital carbonate sediments, which were subsequently advected offshore and reached the Bermuda time series site 75 km distant. The deep flux of advected carbonates, measured by the Oceanic Flux Program sediment traps at 1500 m and 3200 m depths, during the two weeks following Fabian was comparable to the annual open ocean carbonate flux for this region. Nicole also induced a transient phytoplankton bloom, and suspended lipid concentrations in mesopelagic waters two weeks after Nicole evidenced the rapid export of bloom-derived materials to depths of at least 1700 m. In both cases, the lipid fluxes at 1500 m and 3200 m depths increased 200-400% following hurricane passage, providing direct evidence for hurricane-induced episodic flux of labile carbon to the deep ocean. These observations indicate that hurricanes have a major effect on the carbon cycle in the oligotrophic ocean by generating transient blooms and pulsed export of labile organic carbon (and associated bioreactive elements) to the ocean interior which, in turn, significantly affect deep ocean ecosystem activity.