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Role of wetlands in attenuation of storm surges using coastal circulation model (ADCIRC), Chesapeake Bay region

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The Chesapeake Bay, Virginia is subject to storm surge from extreme weather events nearly year-round; from tropical storms and hurricanes during the summer and fall, (e.g., hurricanes Isabel [2003] and Sandy [2012]), and from nor'easters during the winter (e.g., winter storms Nemo and Saturn [2013]). Coastal wetlands can deliver acute fortification against incoming hurricane storm surges. Coastal wetlands and vegetation shape the hydrodynamics of storm surge events by retaining water and slowing the propagation of storm surge, acting as a natural barrier to flooding. Consequently, a precise scheme to quantify the effect of wetlands on coastal surge levels was also prerequisite. Two wetland sites were chosen in the Chesapeake Bay region for detailed cataloging of vegetation characteristics, including: height, stem diameter, and density. A framework was developed combining these wetlands characterizations with numerical simulations. Storms surges were calculated using Coastal circulation model (ADCIRC) coupled to a wave model (SWAN) forced by an asymmetric hurricane vortex model using an unstructured mesh (comprised of 1.8 million nodes) under a High Performance Computing environment. The Hurricane Boundary Layer (HBL) model was used to compute wind and pressure fields for historical tropical storms and for all of the synthetic storms. Wetlands were characterized in the coupled numerical models by bathymetric and frictional resistance. Multiple model simulations were performed using historical hurricane data and hypothetical storms to compare the predicted storm surge inundation resulting from various levels of wetlands expansion or reduction. The results of these simulations demonstrate the efficacy of wetlands in storm surge attenuation and also the outcome will scientifically support planning of wetlands restoration projects with multi-objective benefits for society.