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Storm surges during hurricanes Isaac and sandy in 2012: Verifications of the wind stress tide formula

S. A. Hsu
Louisiana State University, USA

Abstract

From August 27 through 30, 2012, when Hurricane Isaac was over the Gulf of Mexico, storm surges occurred along most U. S. Gulf coast. It is shown that on the right-hand side of the storm track from Florida to the mouth of Mississippi River, positive surges or setups prevailed whereas from southwest coast of Louisiana to the upper Texas coast, negative surges or set-downs occurred. It is found that these surges can be explained physically by the wind stress forcing or the wind speed squared. Verifications of these relationships indicate that the correlation coefficient for the setup is 0.97 in the Mississippi Sound and for the set-down 0.84 along the southwest coast of Louisiana, respectively. In October 2012 Hurricane Sandy devastated New York City and its vicinity caused mainly by the storm surge. The meteorological conditions were: minimum central pressure, 962 hPa, highest sustained wind speed 27.1 m s^{-1} and maximum gust 37.8 m s^{-1}. The peak storm surge was at 3.9 m and the peak storm tide at 4.4 m. The wind-stress tide formula shows that $S = K V^2$, where S is the storm surge, V is the wind speed and K is the coefficient depending on local geography and bathymetry. It is found that when S is in meters and V in m s^{-1}, K = 0.0051 with $R^2 = 0.91$, indicating that 91% of the total variation of the storm surge in the New York area can be explained by the wind stress forcing, which is represented by V^2. Similar results were obtained during Hurricane Irene in 2011, which also affected the New York area. Therefore, this simple wind-stress tide formula should be useful in coastal oceanography and engineering, urban planning, and emergency management.

Biography

S. A. Hsu is Professor of Oceanography and Coastal Sciences (Emeritus), Louisiana State University (LSU) since 1969 after he completed his M.S. in Environmental Health Engineering and Ph.D. in Atmospheric Sciences (specializing in the physics of air-sea-land interaction and engineering meteorology), Department of Civil and Environmental Engineering, the University of Texas. He published world-first textbook entitled "*Coastal Meteorology*" by Academic Press in 1988 and over 120 refereed journal articles in the fields of coastal and marine meteorology, air-pollution meteorology, air-sea interaction, and hydro- and engineering meteorology. Dr. Hsu is a Certified Consulting Meteorologist (certified by American Meteorological Society in 1979) for numerous corporations and law firms. Prof. Hsu is also the Co-Editor-in-Chief for "The Open Ocean Engineering Journal".