Simulation of storm surges by improving the cyclonic wind formulation

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Coastal regions of India are highly prone to sea level rise during tropical cyclones. Storm surges due to cyclones can produce high sea levels, especially when their occurrence coincide with the high tides. Storm surges, tides and wind waves are the main factors responsible for the variation in the total water elevation (TWE) near the coast. The accuracy in simulation of storm surges depends not only on the cyclonic track and its intensity, but also on the spatial distribution of winds which include its speed and direction. In the present study, the cyclonic winds are validated using buoy winds for the recent cyclones formed in the Bay of Bengal since 2010 using Jelesnianski wind scheme. It is found that the cyclonic winds computed from the scheme show an underestimate in the magnitude and also a mismatch in its direction. Hence, the wind scheme is suitably modified based on the buoy observations available at different locations using a power law which reduces the exponential decay of winds by about 30%. Moreover, the cyclonic wind direction is also corrected by suitably modifying its inflow angle. The significance of modified exponential factor and inflow angle in the computation cyclonic winds is highlighted using statistical analysis.
In the present study, simulation of storm surges for the recent cyclonic cases along the east coast of India are carried out using both stand-alone hydrodynamical depth integrated ADCIRC model and coupled ADCIRC+SWAN model. The coupled ADCIRC+SWAN model is used to incorporate the contribution of wind waves in the simulation of TWE near the coast. The cyclonic wind distribution is computed using both modified and unmodified Jelesnianski wind scheme. The experiments are performed to validate the TWE generated from the cyclones through computation of surge residuals with the available tide gauge data. On comparison of observed surge residuals with the simulations using modified winds from the uncoupled and coupled models, it is found that the simulated surge residuals are better compared, especially with the inclusion of wave effect through the coupled model.

Keywords: total water elevations, storm surge, cyclonic winds, ADCIRC MODEL

