Geophysical Research Abstracts
Vol. 16, EGU2014-3568, 2014
EGU General Assembly 2014

A statistical forecast model for Tropical Cyclone Rainfall and flood events for the Hudson River

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Tropical Cyclones (TCs) lead to potentially severe coastal flooding through wind surge and also through rainfall-runoff processes. There is growing interest in modeling these processes simultaneously. Here, a statistical approach that can facilitate this process is presented with an application to the Hudson River Basin that is associated with the New York City metropolitan area. Three submodels are used in sequence. The first submodel is a stochastic model of the complete life cycle of North Atlantic (NA) tropical cyclones developed by Hall and Yonekura (2011). It uses archived data of TCs throughout the North Atlantic to estimate landfall rates at high geographic resolution as a function of the ENSO state and of sea surface temperature (SST). The second submodel translates the attributes of a tropical cyclone simulated by the first model to rainfall intensity at selected stations within the watershed of Hudson River. Two different approaches are used and compared: artificial neural network (ANN) and k-nearest neighbor (KNN). Finally, the third submodel transforms, once again, by using an ANN approach and KNN, the rainfall intensities, calculated for the ensemble of the stations, to the streamflows at specific points of the tributaries of the Hudson River. These streamflows are to be used as inputs in a hydrodynamic model that includes storm surge surge dynamics for the simulation of coastal flooding along the Hudson River. Calibration and validation of the model is carried out by using, selected tropical cyclone data since 1950, and hourly station rainfall and streamflow recorded for such extreme events. Four stream gauges (Troy dam, Mohawk River at Cohoes, Mohawk River diversion at Crescent Dam, Hudson River above lock one nr Waterford), a gauge from a tributary in the lower Hudson River, and over 20 rain gauges are used. The performance of the proposed model as tool for storm events is then analyzed and discussed.