Hurricane Storm Surge Hazards Assessment

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We are applying the methodology of Lin et al (2012) with the goal of assessing the risk of coastal inundation due to hurricane storm surge at each of the Structures of Coastal Resilience (SCR) project sites. In consideration of the changing climate, we seek to assess the risk for both current and projected future climate conditions. Using this methodology, we estimate storm surge return levels by forcing a hydrodynamic model with estimated wind and pressure fields of thousands of hurricanes under a given climate (e.g., Figure 1). The synthetic hurricanes (Figure 2) are generated from a statistical-deterministic model (Emmanuel et al 2006). This hurricane model uses large-scale atmospheric and oceanic data as input, which can be observed or generated from global general circulation models (GCMs). Thus to assess the current risk of storm surge, we use large-scale data of the observed climate as estimated by the NCEP/NCAR reanalysis (Kalnay et al 1996). To assess the risk for projected climate scenarios, we use large-scale data modeled by four GCMs informed by the RCP8.5 emissions scenario from the Intergovernmental Panel on Climate Change fifth assessment report (Stocker et al 2013). The estimated change of surge risk (due to the change of storm climatology) is then combined with the projected sea level rise probabilities to estimate how the inundation risk will change over the 21st century.

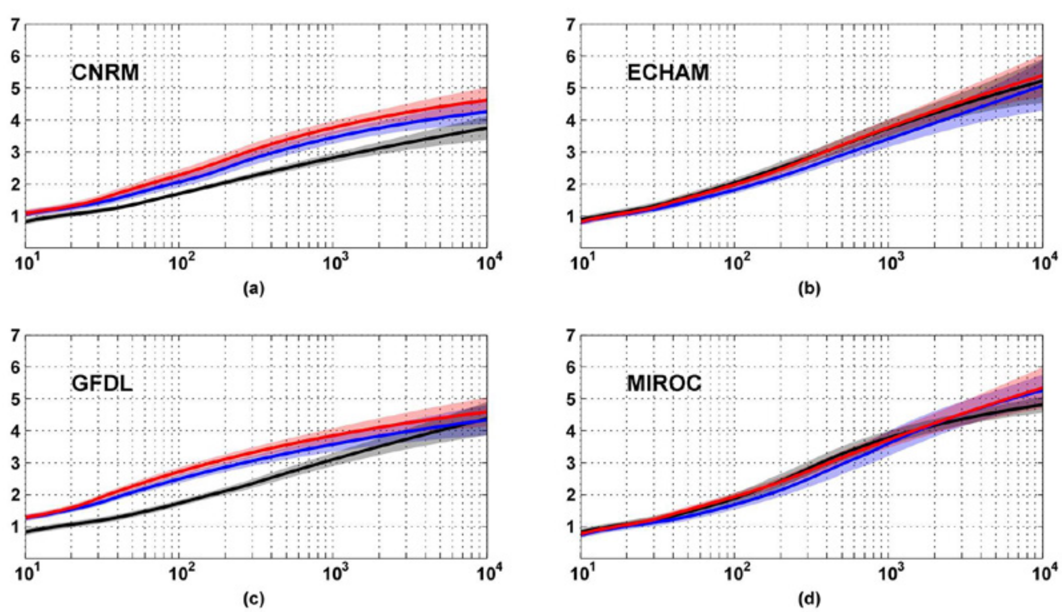

Figure 1: Return levels computed in Lin et al (2012) for the Battery Park in NY

The hydrodynamic model used in this study is the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) (Jelesnianski et al 1992). This model is the official operational forecast model of the National Oceanic and Atmospheric Administration. The National Weather Service, the National Hurricane Center, and the Federal Emergency Management Agency also use this model for emergency planning and response. It numerically solves the shallow water equations (SWE) on predefined numerical domains (i.e. basins, Figure 3), computing estimates of stillwater elevations at user-specified locations given the wind and pressure fields of an associated hurricane.

The model has several limitations, including the small size and course resolution of the basins and simplified physics. However, the SLOSH model is able to simulate storm surge very quickly with few computational recourses, a prerequisite for the large number of simulations over various sites required for this study. Additionally, we have simulated surges induced by recent historical storms (1988-2012) for all the study sites; the simulated surges compare well with tidal gauge observations, warranting the use of SLOSH for our risk assessment. In later phases of this research, we will use a higher fidelity hydrodynamic model, the Advanced Circulation model (Luettich et al 1992), to assess the risk at one study site. The ADCIRC model is able to solve the SWE on unstructured meshes, allowing greater numerical resolution in areas of interest. We will compare the results obtained from the two models to assess the impact of these variables.

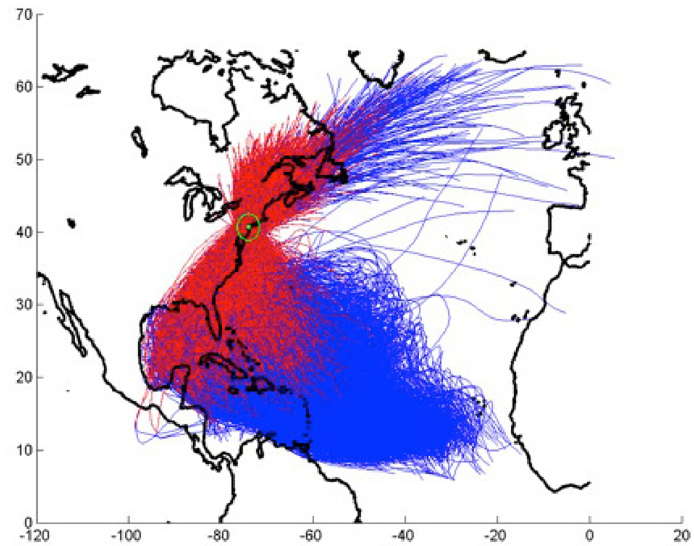

Figure 2: Hurricane tracks of synthetic storms generated for the NY area

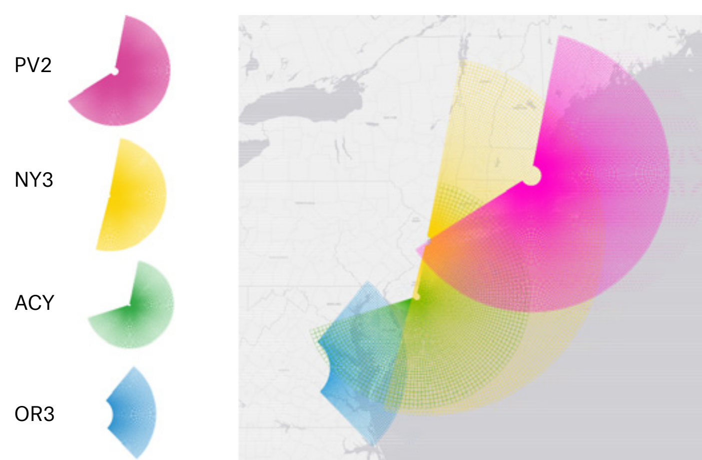

Figure 3: SLOSH model numerical domains (i.e. basins)

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