Hurricane Wind and Inundation Risk on the US Northeast and New York City

NASA Centers Call award for NCA Support

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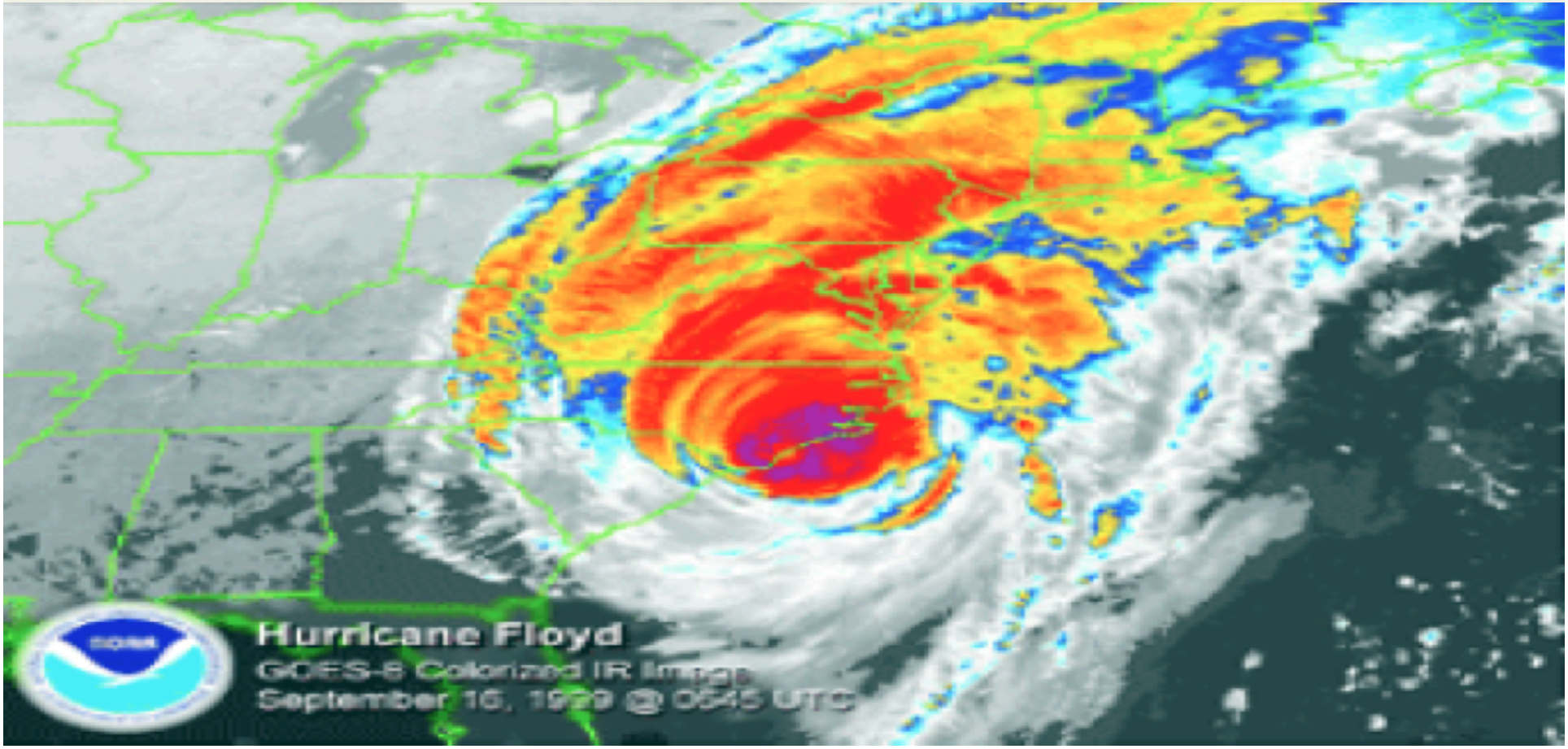


Motivation

- Hurricanes deadly and costly natural disasters, wind and surge & rainfall flooding.
- Huge vulnerability increase recent decades due to increased exposure.
- Climate change effects: uncertain changes in frequency and intensity, more certain increases in sea-level and rainfall.
- Range of estimates of 500-year event NYC surge: 3 to 8 meters.
- Given huge value of NYC-area property between 3 and 8 meters sea-level, work to further clarify of hazard crucial.

Deliverables

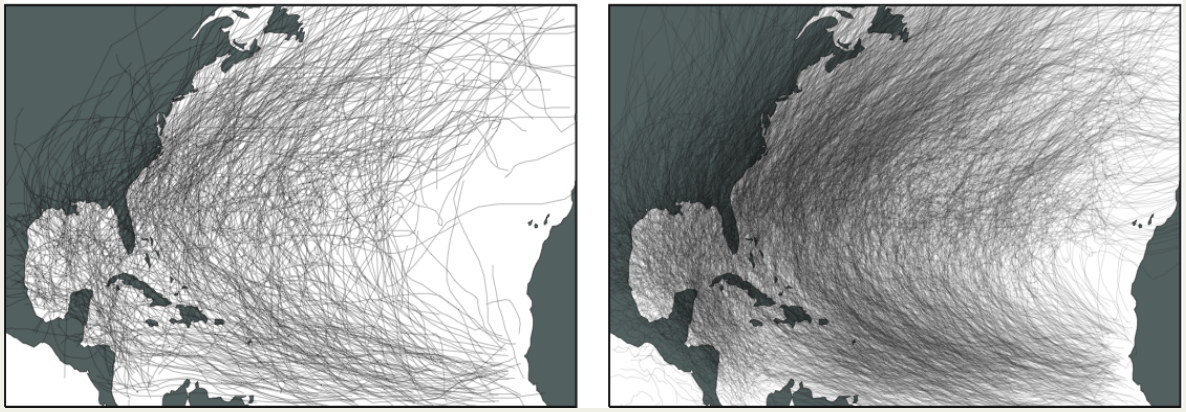
- Hurricane landfall probabilities on US northeast regions as function of hazard variables
- Storm surge probabilities on NYC area in current climate.
- Storm surge probabilities on NYC area in future sea-level and rainfall rates.
- Publication in peer-reviewed journals, on-line, and as part of NCA.

Schedule

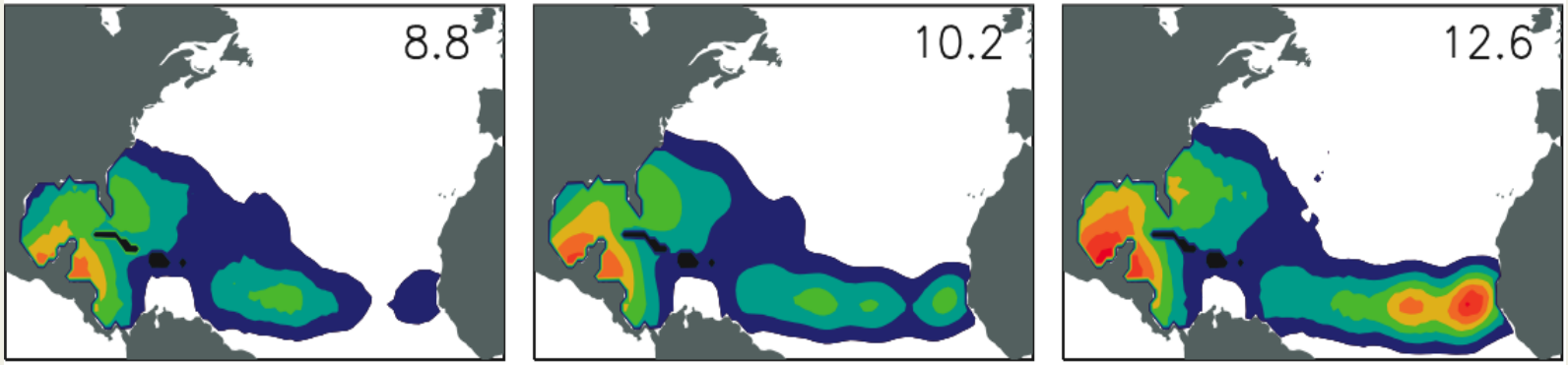
- 2011-2012: Implement & evaluate stochastic rainfall in TC model.
- 2011-2012: Develop & evaluate new NYC-area overland grid for surge model.
- 2012: Use TC model to generate ~10^7 synthetic TCs, compute landfall rates.
- 2012: From synthetic set built landfall probability tables (annual landfall probability as function of intensity, size, tidal phase, incidence angle, track speed).
- 2012: Drive 2D surge model for each variable combination (~10^3 2D simulations).
- 2012: Drive 3D surge model for most hazardous subset (~10^2 3D simulations).
- 2013: Repeat analysis for climate-model projections of future sea-level and rainfall (from empirical SST-storm rainfall relationships).
- 2013: Document results, prepare publications, participate in NCA.

Model Components: Statistical Tropical Cyclone Model

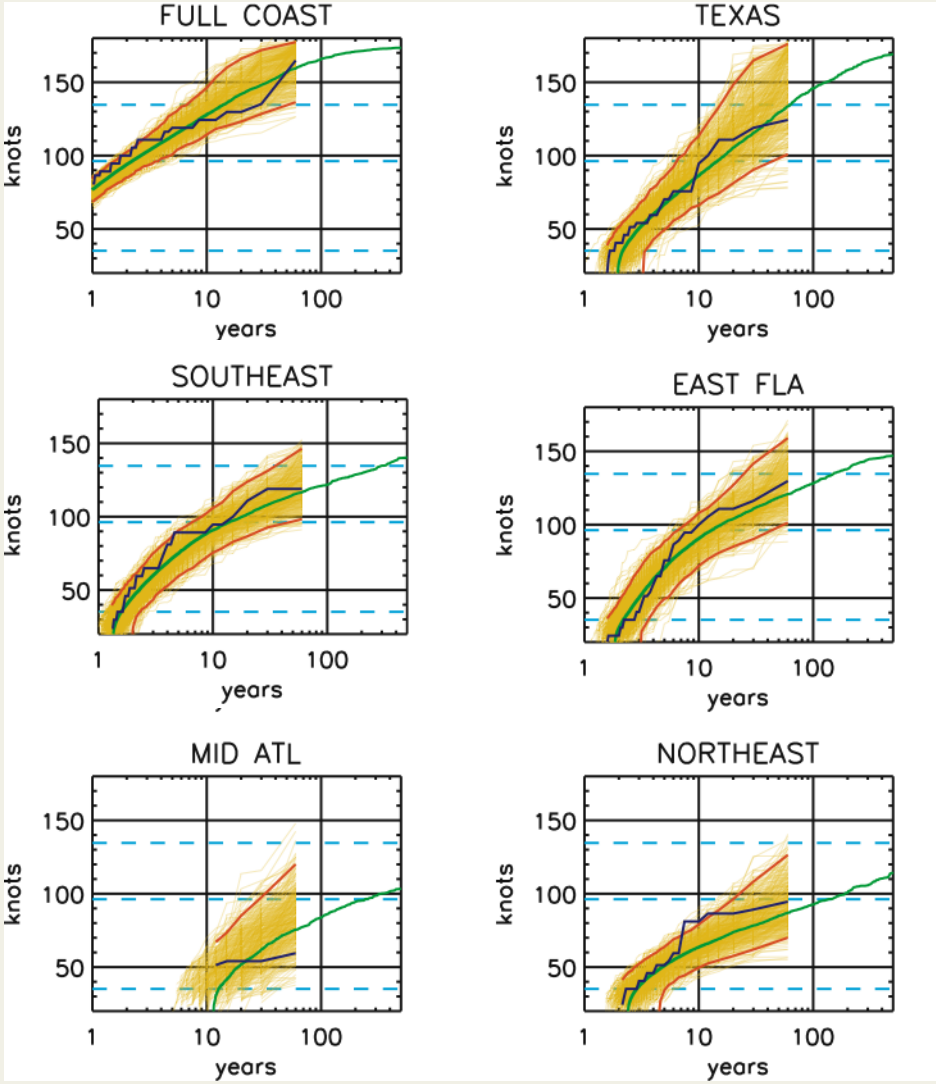
Statistical model built on NOAA NHC HURDAT on NA TCs, 1950-2010. Extract statistical properties of historical TCs (genesis, tracks, intensity, size). Generate arbitrarily many stochastic TCs that have these properties. Use stochastic set to compute landfall hazard. Stochastic set much larger than historical set.



Historical tracks (left), 1000 years stochastic tracks (right)



TC formation rates as function of SST (cold, neutral, hot)



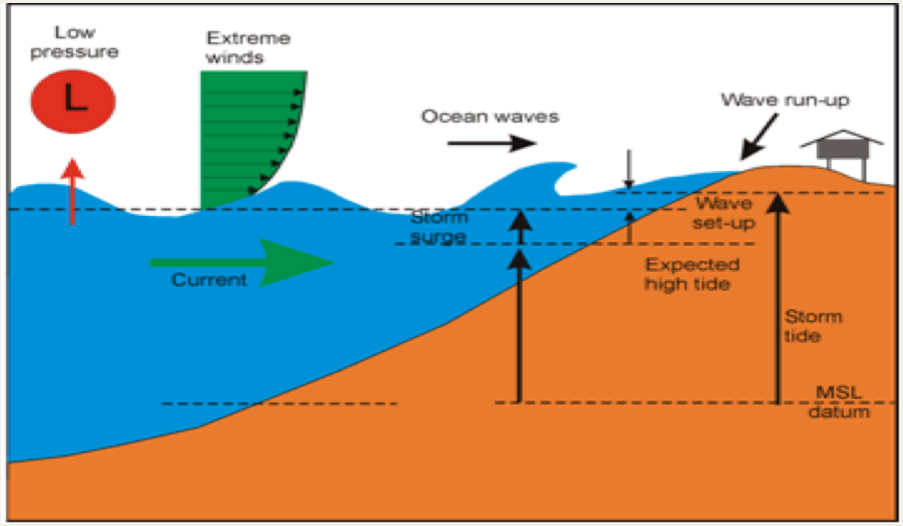
TC model evaluation:
Model performs well on a diagnostic if historical value of diagnostic looks like typical member of diagnostic value from stochastic simulation set.

Focus on landfall:
Range of stochastic wind-speed return period curves for regions along US Atlantic coast bound historical return period curves. Confidence to use model to estimate return periods much longer than historical period.

Hall and Jewson (2007; 2008) for description, evaluation of early version

SECOM Hydrodynamic Model:

High-resolution 2D and 3D of near-coast and harbor (e.g., NYC, Boston under development), long off shore fetch region (400km), coupled to improved wave model. Accounts for rainfall and evaporation over water and land, thereby allowing for surge and rainfall flooding. Overland NYC grid currently being developed to accommodate inland, as well as coastal flooding. Extensively evaluated on NYC as part of New York Harbor Observing and Prediction System (NYHOPS)



SECOM: *Blumberg et al* (1999),
Blumberg and Georgas (2008)

TC rainfall increase 7% per degree SST (range of climate-model results).

Preliminary simulation of rainfall flooding on Wreck Pond, NJ.

Manpower, NASA and Stevens Institute

FTEs

Budget Item	FTEs FY11	FTEs FY12	FTEs FY13	FTEs Total
FTEs, Civil Servant-GSFC	0.08	0.25	0.25	0.58
FTEs, Contractor-GSFC				
FTEs, Subaward, GSFC	0.10	0.50	0.62	1.22
Subaward, Other NASA Center (*)				
FTEs, Subaward, JPL (*)				
Total FTEs	0.18	0.75	0.87	1.80