

# Probabilistic Flood Hazard Assessment

## Storm Surge

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**3<sup>rd</sup> NRC External Flooding Research  
Workshop**  
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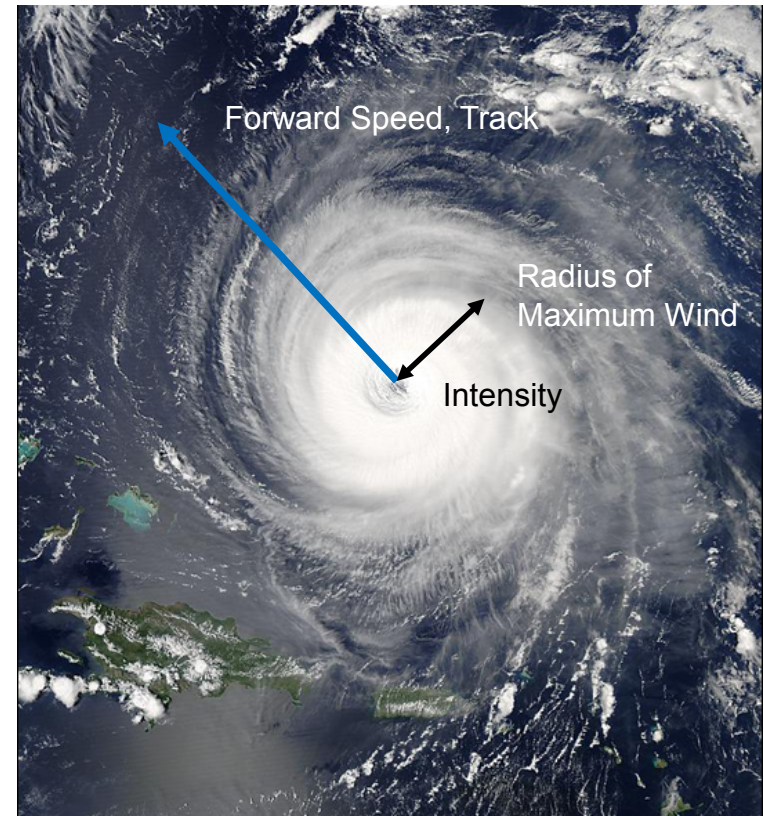
# EPRI Report on Storm Surge

- EPRI report [3002008111](#), Probabilistic Flooding Hazard Assessment for Storm Surge with an Example Based on Historical Water Levels
- Provides generic PFHA process as applied to Storm Surge
- Available data and storm type that leads to storm surges for site of interest determines the simulation approach
  - Controlling storm is a hurricane: atmospheric parameters such as central pressure deficit, radius of maximum wind, and maximum wind speed as well as tidal levels can be modeled in the Monte Carlo simulation
  - Controlling storm is not hurricane: historical water levels can be utilized to determine mean sea level or average lake level, storm surge level, and wind-wave effects using Monte Carlo simulation techniques

# Modeling Hurricane-Driven Storm Surge

- Hurricanes can be numerically simulated through a Monte Carlo analysis evaluating a number of parameters
  - Central pressure deficit
  - Radius of maximum wind
  - Maximum wind speed
  - Storm track
  - Forward speed
- Other parameters can be treated probabilistically, such as the tidal height

## Storm Meteorological Parameters



Source: NASA Earth Observatory  
Image

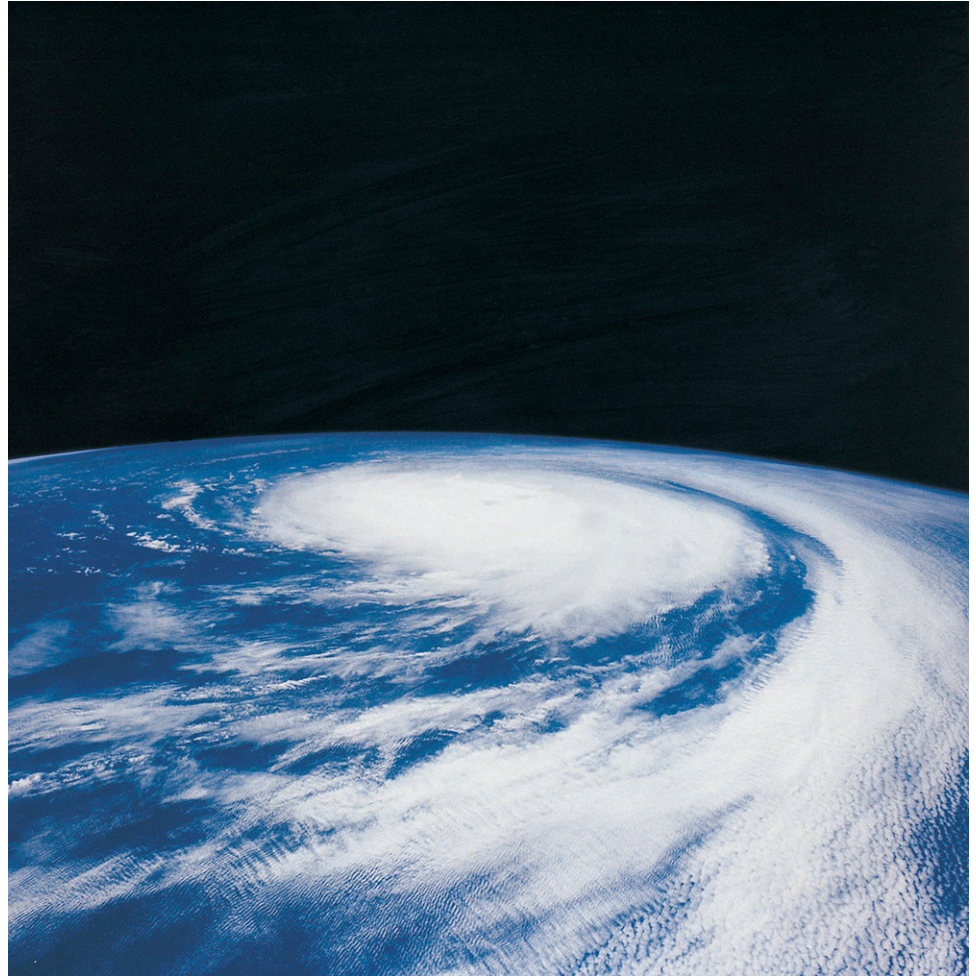
# Joint Probability Method

- The Joint Probability Method (JPM) combines the simulated hurricanes with a model for the storm surge produced by the storms
- Monte Carlo analysis performed selecting hurricane parameters for each simulated hurricane
- Range of parameters based on expert judgement from historical hurricane data
  - Correlation between parameters can be explicitly included
- Time point on tidal curve chosen randomly
- Result of the Monte Carlo and storm surge modeling leads to a flood-frequency curve for the site



# EPRI Research on JPM

- EPRI is currently conducting research on the use of the JPM to develop a storm surge flood-frequency curve for a site
- This research will be published in 2018



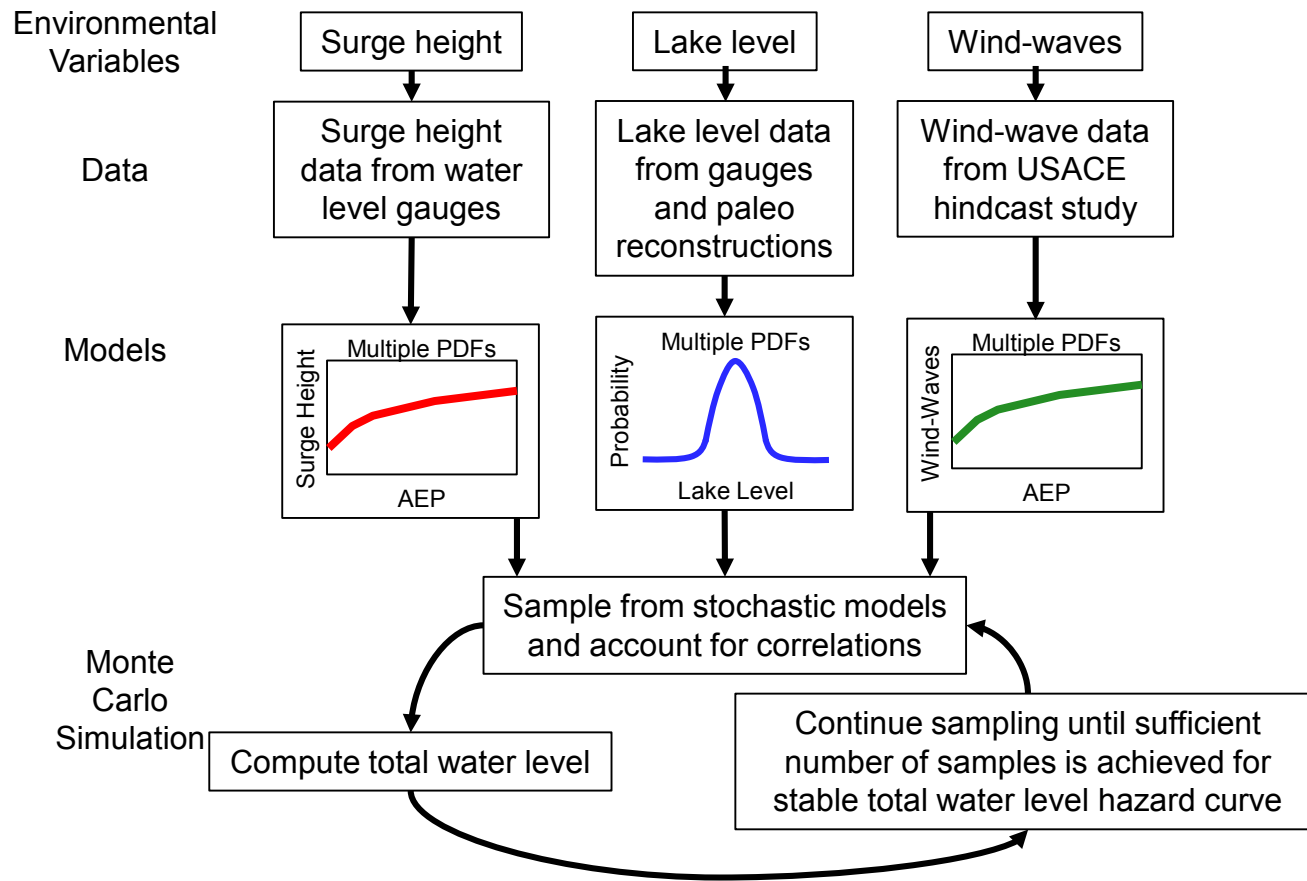
# Using Historical Water Levels to Assess Storm Surge

- Example site from EPRI Report [3002008111](#) located on the Great Lakes
- Site is not subject to fully formed hurricanes, so using a Joint Probability Method that models the atmospheric parameters is not applicable
- Long history (greater than 100 years) of lake levels is available including paleo data that can extend the record to 4000 years
- Lake buoys provide water level data
- Wave height, period, and direction determined by U.S. Army Corps of Engineers hindcast datasets

# Monte Carlo Simulation for Storm Surge

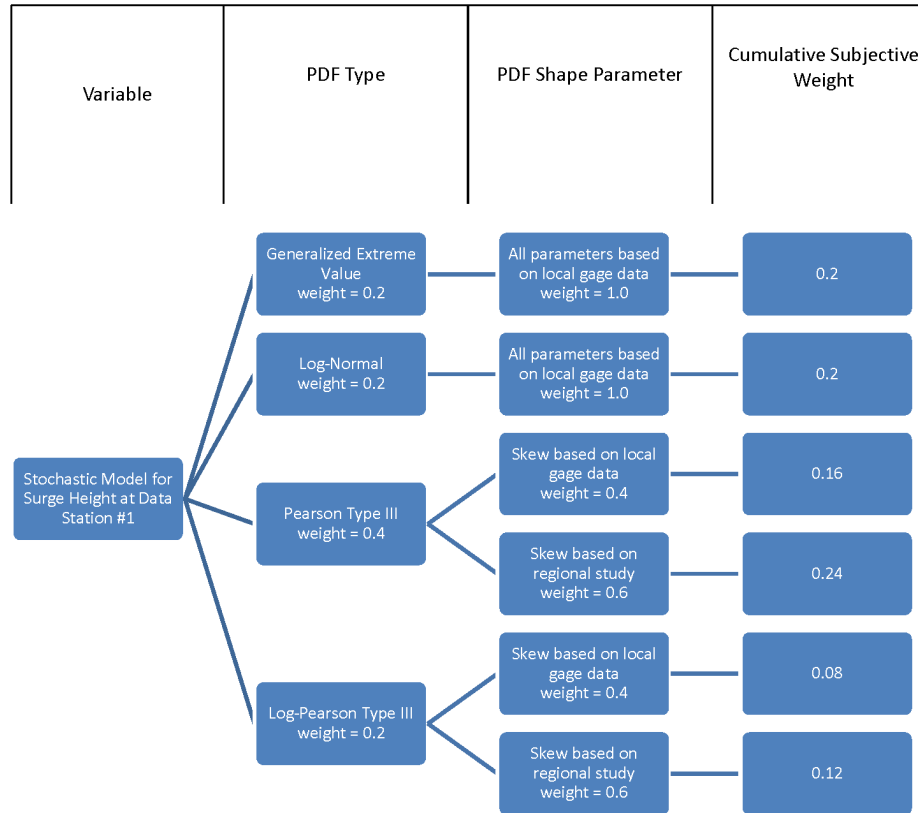
- Probability density functions (PDFs) created to represent:
  - Initial lake level
  - Storm surge height
  - Wind-wave parameters
- It is not always obvious which PDF provides the best fit to the existing data and which data source is most applicable
  - Logic trees used to weight alternative PDFs and data sources to each parameter
  - Process is similar to what is used by the Senior Seismic Hazard Analysis Committee (SSHAC)
- Monte Carlo simulations used to develop still water level hazard curve and total water level (including wave run-up) hazard curve
  - Sensitivity studies can be run to determine the sensitivity of the analysis results to particular assumptions

# Probabilistic Storm Surge Hazard Assessment Example



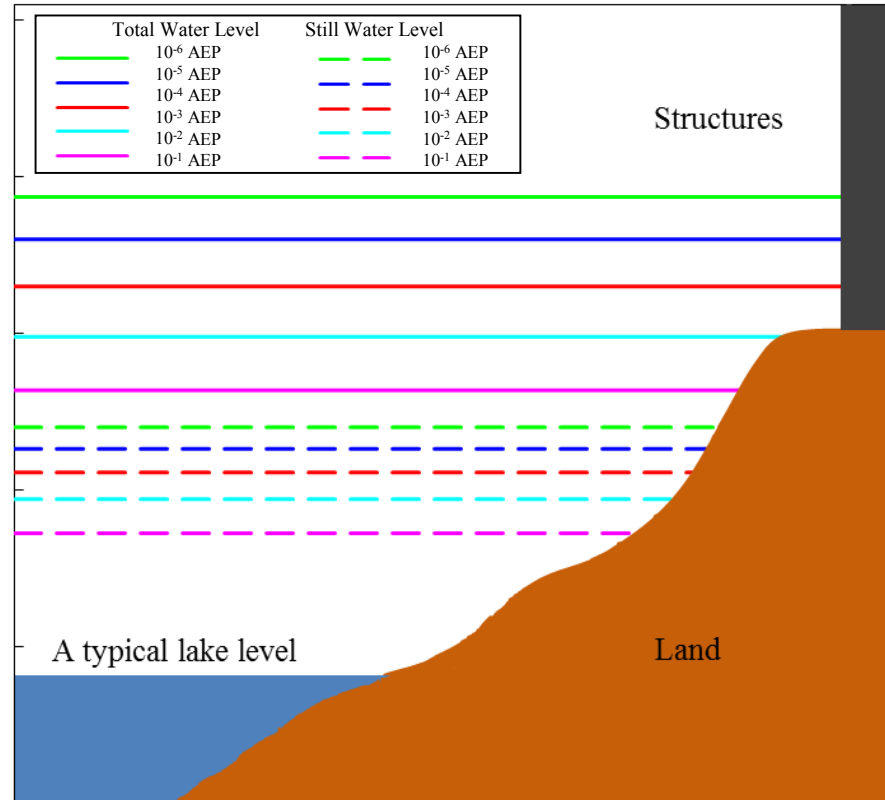


# Example Logic Tree to Determine Weighted PDF



Expert judgement and objective criteria used to set weighting parameters

# Example Still Water and Total Water Levels



Structures may be impacted by waves at a frequency of about  $1 \times 10^{-3}$ /year



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