Coastal Storms of the New Jersey Shore

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Overview

- Threats
- Historical Examples
  - Nor’easters
  - Tropical Cyclones
- Prospects for the Future
Threats

• Wind damage
  – From cyclones
  – From thunderstorms
What Drives the Winds? (Cyclone)
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What Drives the Winds? (Thunderstorm)

![Diagram of storm stages](image)

The three stages of an ordinary cell: (a) towering cumulus stage, (b) mature stage, and (c) dissipating stage. (Adapted from Byers and Braham [1949] and Doswell [1985].)

Temperature decreases with height faster
Wind changes with height faster → Stronger storm
Threats

• Wind damage
  – From cyclones
  – From thunderstorms

• Coastal flooding from storm surge
  – From tropical cyclones
  – From nor’easters
Coastal Flooding

NEW JERSEY ATLANTIC COAST AT ATLANTIC CITY (OCEAN FRONT)

Latest observed value: 6.31 ft at 9:18 PM EDT 18-May-2011. Flood Stage is 6 ft

Record Stage: 9.3 ft
Major Stage: 8.0 ft
Moderate Stage: 7.0 ft
Flood Stage: 6.0 ft
Stalling Stage: 5.5 ft

Site Time (EDT)
Graph Created (9:46PM May 18, 2011) - Observed - Forecast (issued 8:00PM May 18)

Mean lower low water (MLLW)
Lower low water
Cyclone Track and Position

Fig. 11. (a) Cyclone tracks from 48 h before the time of maximum minor surge (0.8–1.0 m) at the Battery to 24 h after maximum surge, every 6 h. (b) As in (a), but for the moderate-surge (>1.0 m) events. The NYC area is denoted by the white box.

Fig. 12. (a) Surface cyclone position at the time of maximum surge for the surge events between 0.6 and 1.0 m. The number of cyclones every 1.0° of latitude and longitude is given by the filled-circle sizes in the bottom key. (b) As in (a), but for the moderate-surge (>1.0 m) events.
Threats

• Wind damage
  – From cyclones
  – From thunderstorms

• Coastal flooding from storm surge
  – From tropical cyclones
  – From nor’easters

• Flooding from heavy rain
Notable Nor’easters

- Ash Wednesday Storm (1962)
- Five high tides
- Extensive damage from Outer Banks to Rhode Island
- Fifth highest tide at Atlantic City
December 1992

- Preceded by “Perfect Storm”
- Gusts to hurricane force
- Billions in damages
Last Week

Stationary
Full Moon (Spring Tide)
Hurricanes from the Distant Past

• September 1821
  – Estimated at Category 3
  – Flooded a large portion of southern Manhattan

• September 1903
  – Most recent hurricane to make landfall in NJ
  – Most piers and pavilions in Atlantic City destroyed

• September 1944
  – Remained offshore
  – Extensive damage from Barnegat Bay to Cape May
  – Boardwalks in Atlantic City and Ocean City heavily damaged
  – Many homes on LBI swept out to sea
  – Second-highest storm surge at Atlantic City
Gloria (1985)

- Paralleled coast just offshore as Category 2 hurricane
- Severe coastal flooding (8 ft above MLLW at Atlantic City)
- Quick movement
Bob (1991)

- Offshore track limits impact on NJ
- Last year’s Earl even further east
Floyd (1999)

- 5 to 10+ inches of rain across NJ
- Extreme river flooding inland
- Tidal flooding minimal
Prospects for the 21\textsuperscript{st} Century (Nor’easters)

- Development favored when horizontal temperature change is large
- Many studies consider hemisphere
- Midlatitude cyclones are complex
  - Different techniques applied to same data produce different results
- Consensus: Slight decrease

Ulbrich et al. (2009)
Prospects for the 21\textsuperscript{st} Century (Hurricanes)

- **Natural Variability**
  - 70 year cycle?
  - Active period from 1995 to about 2020

- **Climate Change**
  - No significant trend over last 100 years
  - SST expected to increase
  - Wind shear expected to increase
  - Fewer tropical cyclones, but 2x Category 4+??

- **Caveat:** Studies typically focus on Atlantic basin, not NJ
Sea Level Rise Is Main Threat

A 100-yr flood now would be a 30-yr flood with a two-foot SLR (Beevers 2005)

Gloria

Dec 1992

Moderate surge

Minor surge
(Becomes moderate surge with 16 in. sea-level rise)

FIG. 2. Time series of the daily maximum positive surge (water level minus astronomical tide) at the Battery (see Fig. 1 for location) between 1959 and 2007. The two dashed lines represent the minor (0.6 m) and moderate (1.0 m) surge thresholds used in this study.

Colle et al. (2010)
Thunderstorm Severity Could Increase

Trapp et al. (2007)
Conclusions

- Many historical examples demonstrate the Shore’s vulnerability to cyclone activity
- Thunderstorms present smaller threat
- Trends in storm activity are uncertain
- Even without changes in storm characteristics, sea level rise will increase impacts