

# Hurricane Risk in NY City & Long Island

## Towards a More Realistic Appraisal of Extreme Weather Risk in the Northeast United States

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# Presentation Outline

- Recent Assertions Concerning Hurricane Risk Exposure for New York City and Long Island
- Hurricane Risk in the Northeast United States: Current Scientific Understanding
  - A look at NOAA's hurricane return period estimates for NY City and Long Island
  - Relevant background on the NOAA hurricane risk data
  - What the NOAA hurricane risk data says – and doesn't say
  - Are hurricane return period estimates reliable predictors of future hurricane activity?
- Towards a More Robust and Realistic Appraisal of Extreme Weather Risk for New York City and Long Island
  - Key components of a complete risk characterization
  - Relevant history of extreme weather events in New York City
  - Other potential hazards: Northeasters
- Global Warming and Extreme Weather
  - Potential implications for the Northeast United States
- Summary and Conclusions



## Recent Assertions Concerning Hurricane Risk Exposure for New York City and Long Island

- In recent weeks, it has been asserted that concerns about hurricane risk exposure in New York City and Long Island are “bogus”
- In support of these claim, several NOAA statistics have been cited:
  - “Recent statistics from the National Oceanic and Atmospheric Administration (NOAA) show that the odds of a category 4 or higher hurricane hitting New York City is *once every five hundred years* and on Montauk Long Island *once every 130 years*” [emphasis added]
- On the basis of these values, some have concluded that “[t]he hurricane data hardly demonstrates a risk [to New York City and Long Island]”

- The “1-in-500 year” and “1-in-130 year” values for New York City and Long Island that have been cited in recent press releases are actually *expected return periods* – they are not probabilistic *projections* of future hurricane activity for the region
- In simple terms, *hurricane return period* values are interpreted as the expected long-run frequency with which hurricanes of a specified intensity (e.g., Category 3, etc.) may be expected to occur within 75 NMI of New York City or Long Island
- Estimates of hurricane return periods are derived from *historical* data:
  - For example, a return period of 20 years for a Category 3 hurricane means that, on average, during the previous 100 years, a category 3 hurricane passed within 75 miles of that location approximately 5 times

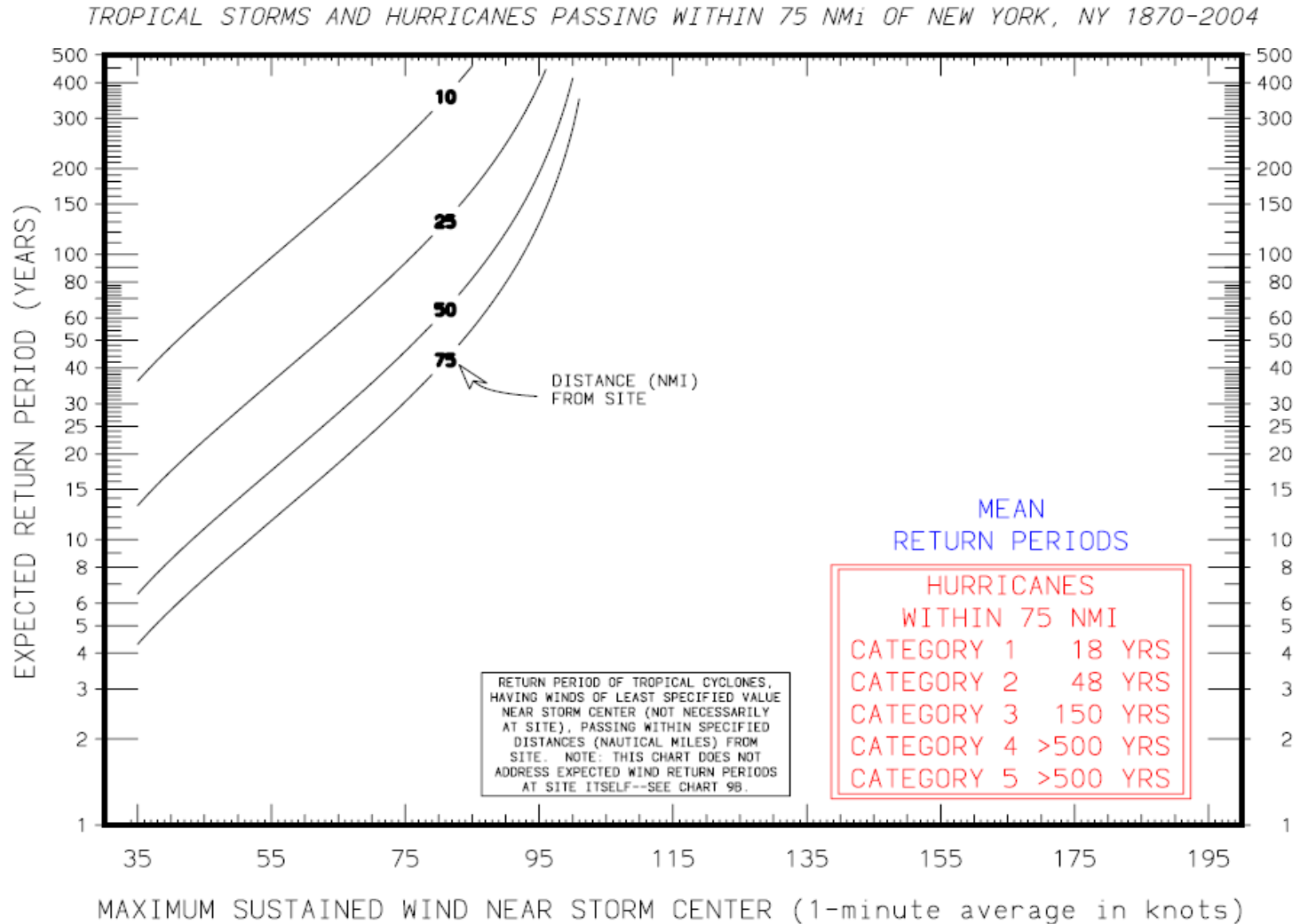


## Relevant Background on the NOAA Hurricane Risk Data

- The NY City and Long Island hurricane risk data cited in recent press releases is produced by NOAA's National Hurricane Center Risk Analysis Program, HURISK
- HURISK estimates the *expected return period* for hurricanes of varying intensities
- Key elements of HURISK's estimation procedure:
  - A population of tropical cyclones falling within a 75mi circle of a given location (e.g., New York City) is obtained from NOAA's best-track file
  - For that particular set of storms, the maximum wind within the 75mi circle is found
  - A count is then conducted to determine how many systems had winds of 30-34 kts, 35-39 kts, etc.
  - A probability distribution is then fit to this distribution of historical values (e.g., Weibel distribution)
  - From the fitted distribution, the probability  $p$  of *exceeding* a specific wind speed is computed
  - The return period value in years is simply the reciprocal,  $1/p$
  - This value gives an indication of the number of systems that may occur in the future



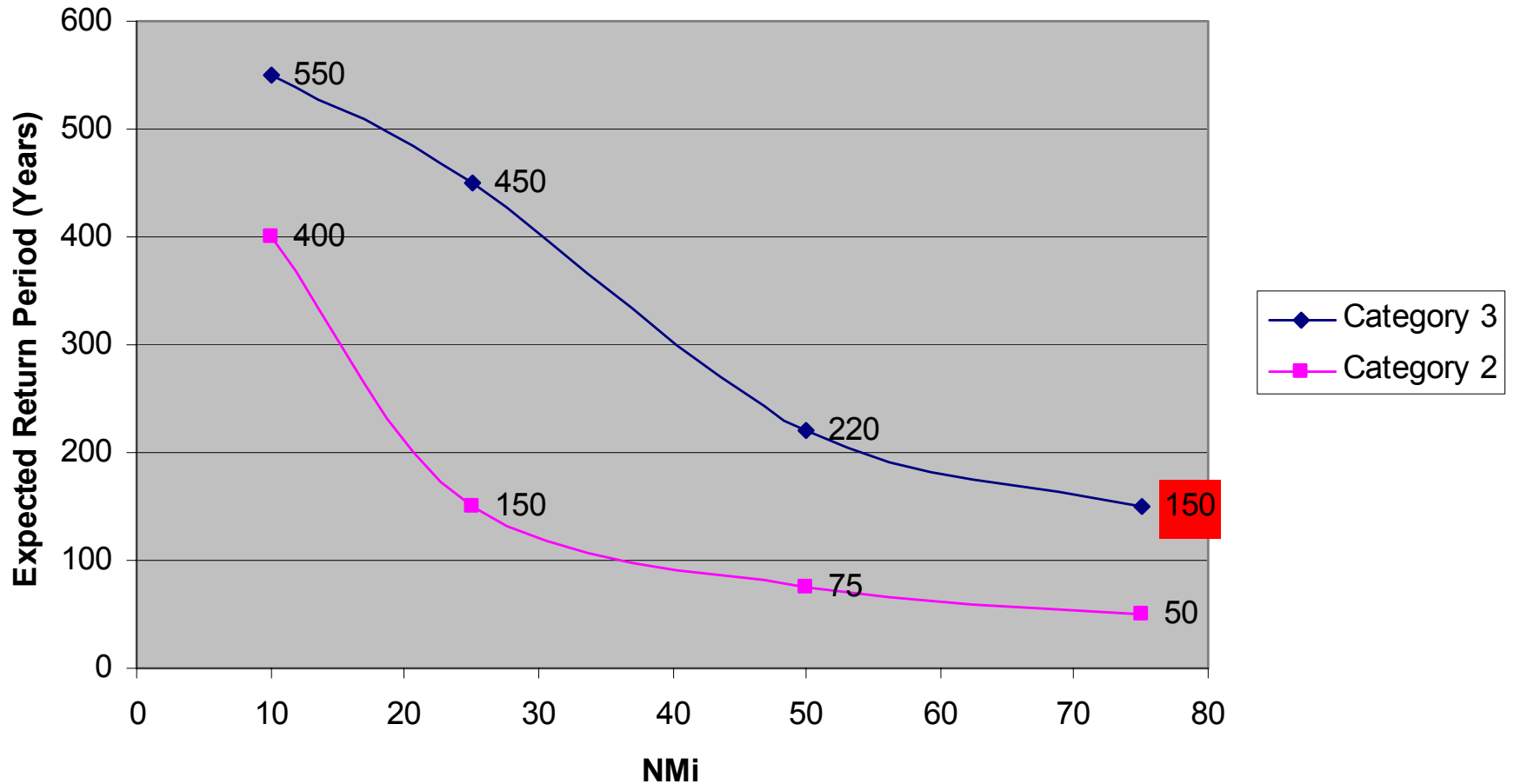
# HURISK Results for Hurricanes Passing Within 75 NMI of New York City: 1870 - 2004





# NOAA Hurricane Risk Data in a More Realistic Context

## Expected Return Periods for a Categories 2 & 3 Hurricanes in NY City as a Function of Distance from Storm Center: 1870-2004



Source: Based on data provided by the NOAA Tropical Prediction Center

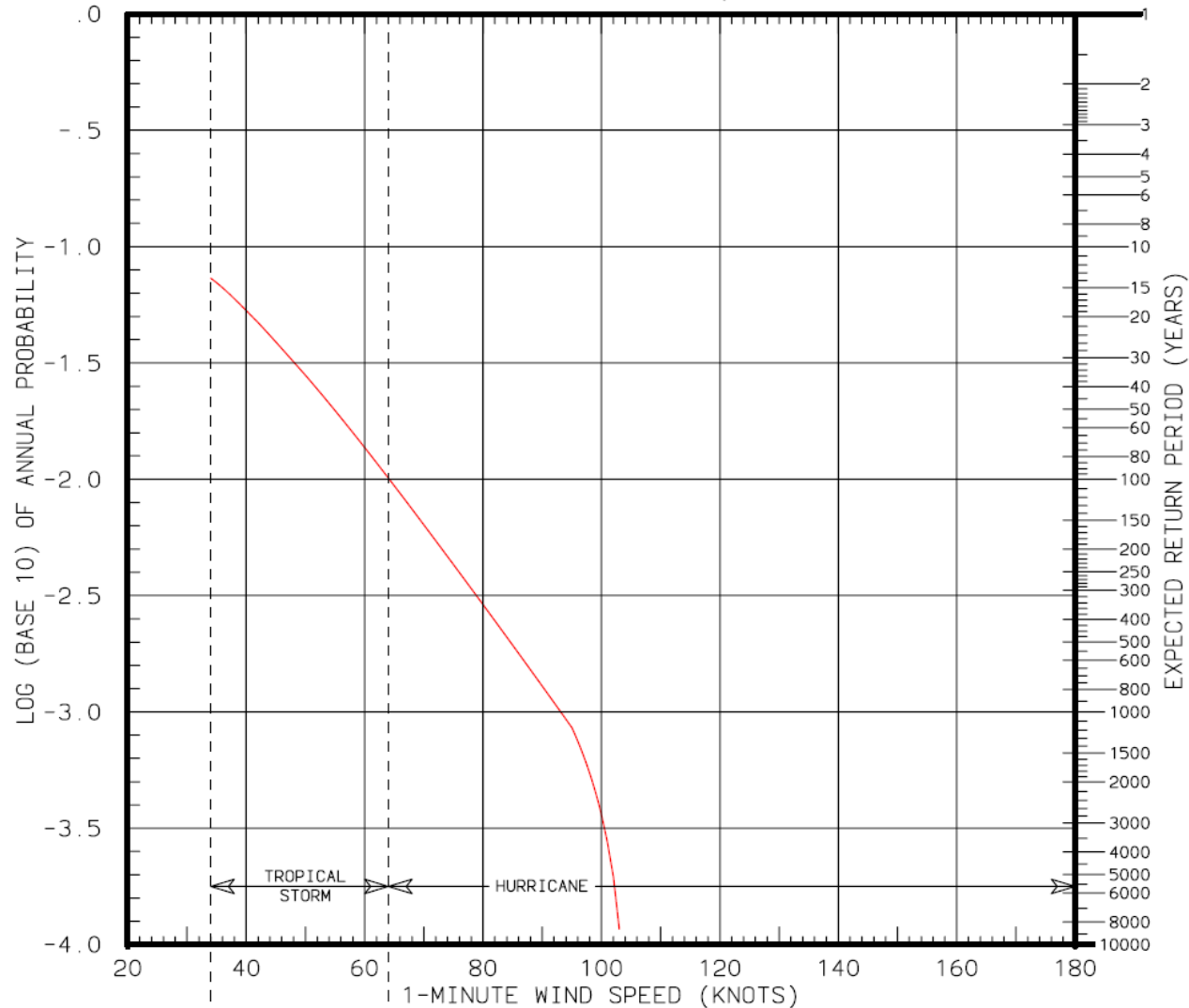


- The expected return period estimates for Category 2 and Category 3 hurricanes passing within close proximity to New York City are commensurate with return period estimates for the Gulf Coast and the Southeast
- Estimates of expected return periods for Category 4 and Category 5 hurricanes affecting New York City are compromised by limitations / deficiencies in the available historical record of hurricane activity for the region



# Long-Run Return Period Estimates for Tropical Cyclone Winds: New York City, 1870 - 2004

**HURISK MODEL: RETURN PERIODS OF SPECIFIED TROPICAL  
CYCLONE WINDS BASED ON PERIOD OF RECORD, 1870 - 2004.  
SITE IS: NEW YORK, NY**





## Implications of the NOAA Long-Run Data

- Tropical cyclone winds consistent with Category 4 and Category 5 hurricanes are not realized in NOAA's long-run (10,000 years) simulations for NY City
  - This result is purely an artifact of the available historical record
  - This result can easily be misinterpreted to mean that such events are impossible for the region
- Characterizations like this of long-run likelihoods are highly-dependent on geographic location
  - Miami is much more likely to be affected by Category 4 & 5 hurricanes – a fact that is well reflected in the historical record
  - As a consequence, the long-run return period data for that region of the country is more reliable than that for the Northeast U.S.
- Uncertainty in return period estimates is *greatest* for severe hurricanes (Category 4 & 5) affecting NY City and Long Island, as these extreme weather events are seen to occur much less frequently in the historical record



# Are Hurricane Return Period Estimates Reliable Predictors of Future Hurricane Activity?

- Hurricane return period estimates are based on historical data (e.g., historical tropical storm activity from 1851-2004)
  - The data may be incomplete, missing, or unreliable
  - The data may not be representative, or perhaps not large enough to yield statistically significant estimates and inferences
- Detailed historical records for hurricane activity in the Atlantic Basin is ~100 years
  - Complicates efforts to arrive at reliable return period estimates of “storm-of-the-century” effects
- Estimates of hurricane return periods presume that *the future will look like the past*
  - “If all things were equal...”
- Mean return period estimates are not truly *predictive*, but rather, *conditionally indicative* of what the future might bring, given what has happened historically in terms of extreme hurricane phenomena
- Most useful in preparedness and response contexts:
  - Structural design
  - Building codes
  - Land-use planning
  - Can aid in the development of flexible and robust catastrophe management systems



## Towards a More Robust and Realistic Appraisal of Extreme Weather Risk for New York City and Long Island

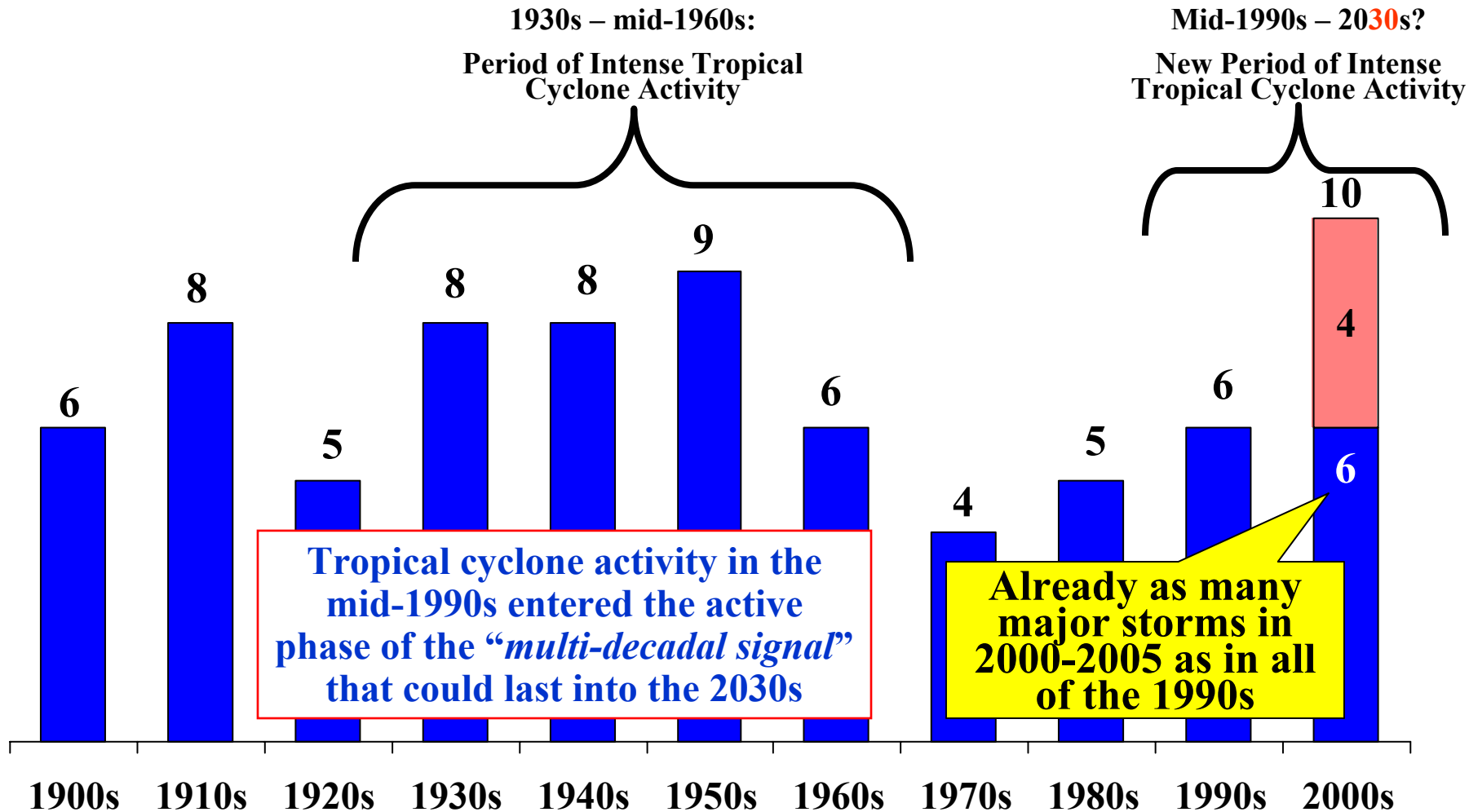
- Focusing solely on the potential *frequency of occurrence* and *severity* of future hurricane activity for the region is misleading
- It is important, also, to characterize and evaluate two other components that – together with frequency and severity of occurrence – comprise extreme weather risk:
  - The intrinsic *vulnerability* of a specific region or location (e.g., New York City and Long Island) to hurricanes and other extreme weather events
  - Given these vulnerabilities, the potential *losses* – both *economic* and *insured* – that are likely to result from an extreme weather event



## Hurricane Risk in Context

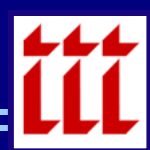


# Number of Major (Category 3, 4, 5) Hurricanes Striking the US by Decade



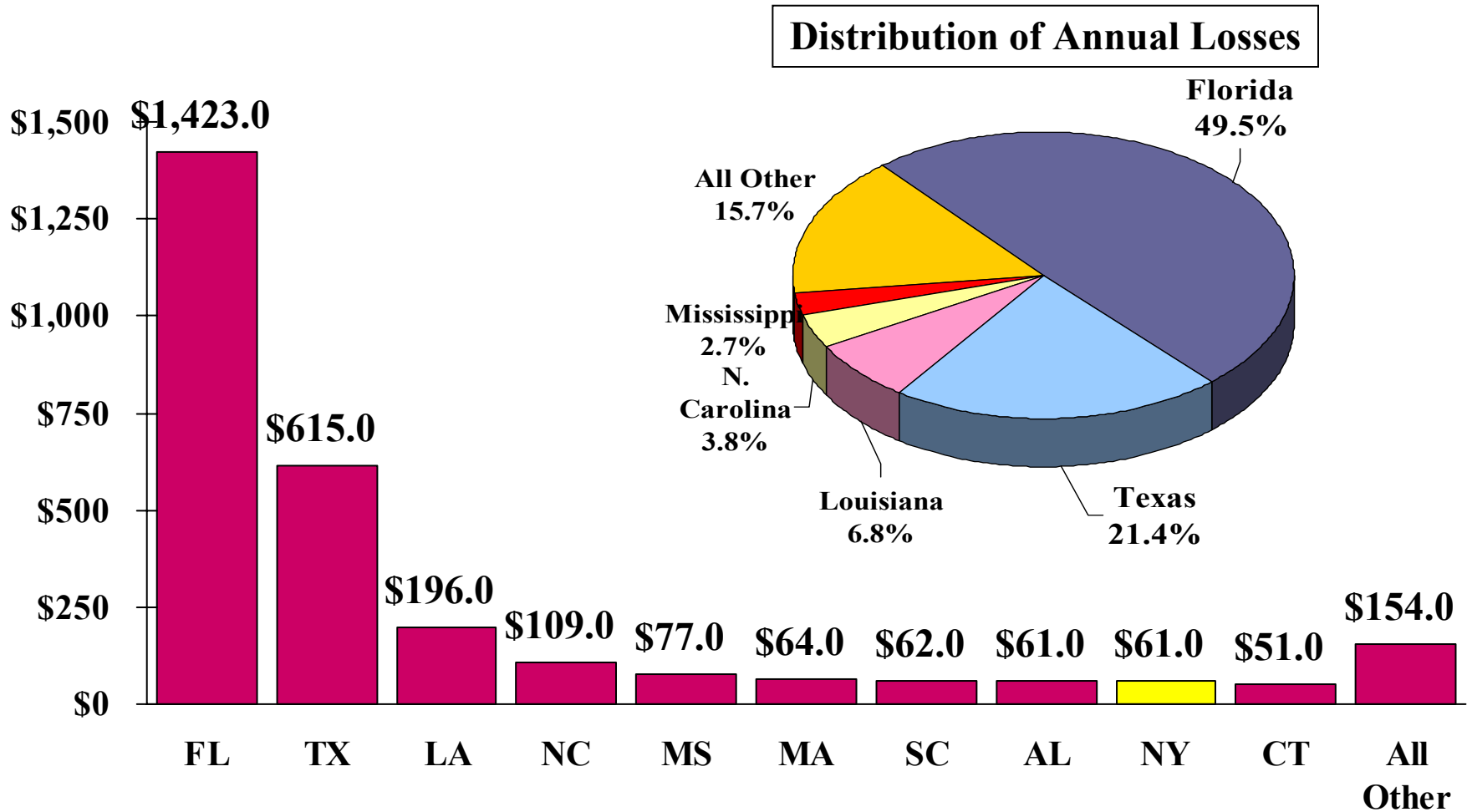
\*Figure for 2000s is extrapolated based on data for 2000-2005 (6 major storms: Charley, Ivan, Jeanne (2004) & Katrina, Rita, Wilma (2005)).

Source: Tillinghast from National Hurricane Center: <http://www.nhc.noaa.gov/pastint.shtm>.



# Average Annual Tropical Cyclone Insured Losses\*

(Top 10 States, \$ Millions)

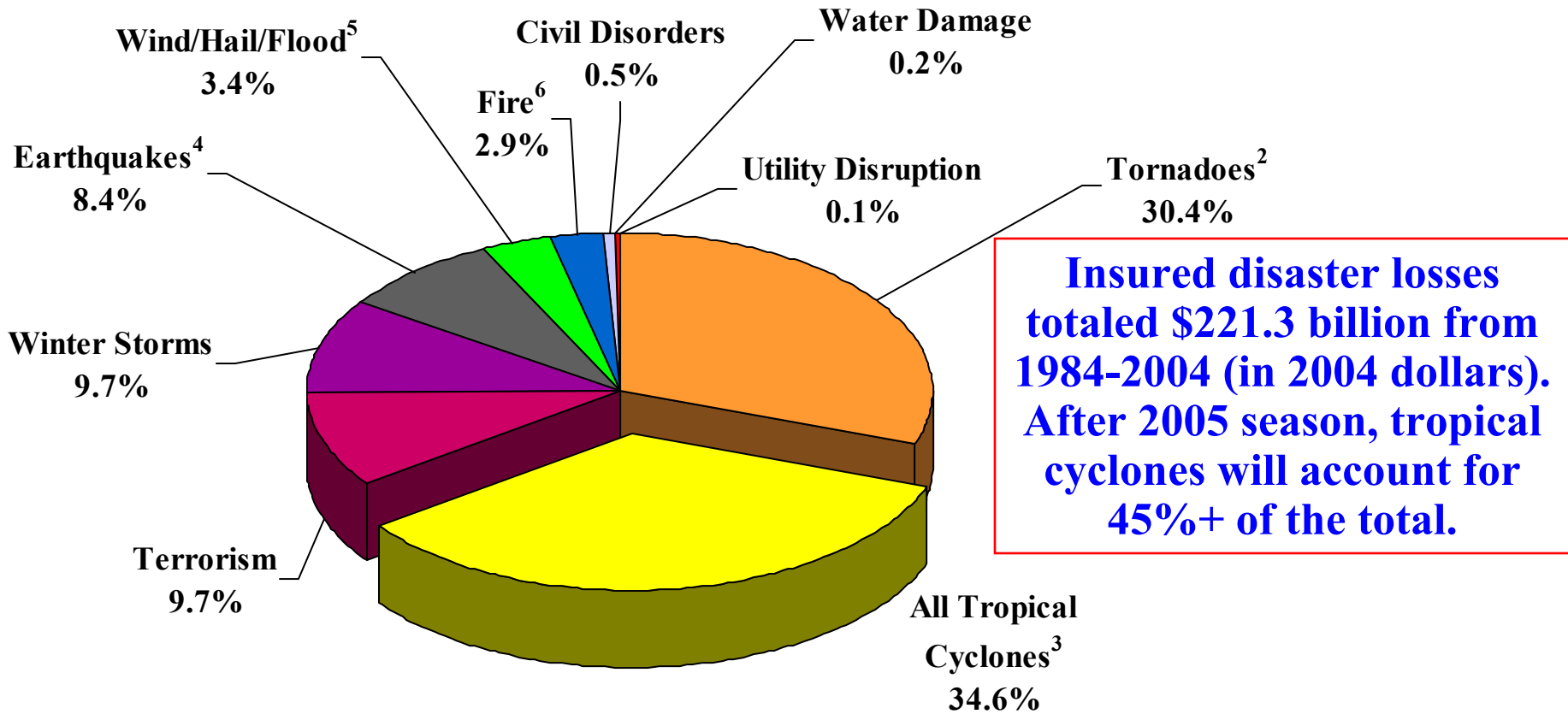


\*Normalized losses adjusted for inflation, housing density, wealth and wind insurance coverage, based on historical data for 100-year period 1900-1999.

Source: Tillinghast-Towers Perrin

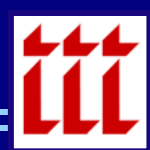


# Inflation-Adjusted U.S. Insured Catastrophe Losses By Cause of Loss, 1985-2004<sup>1</sup>

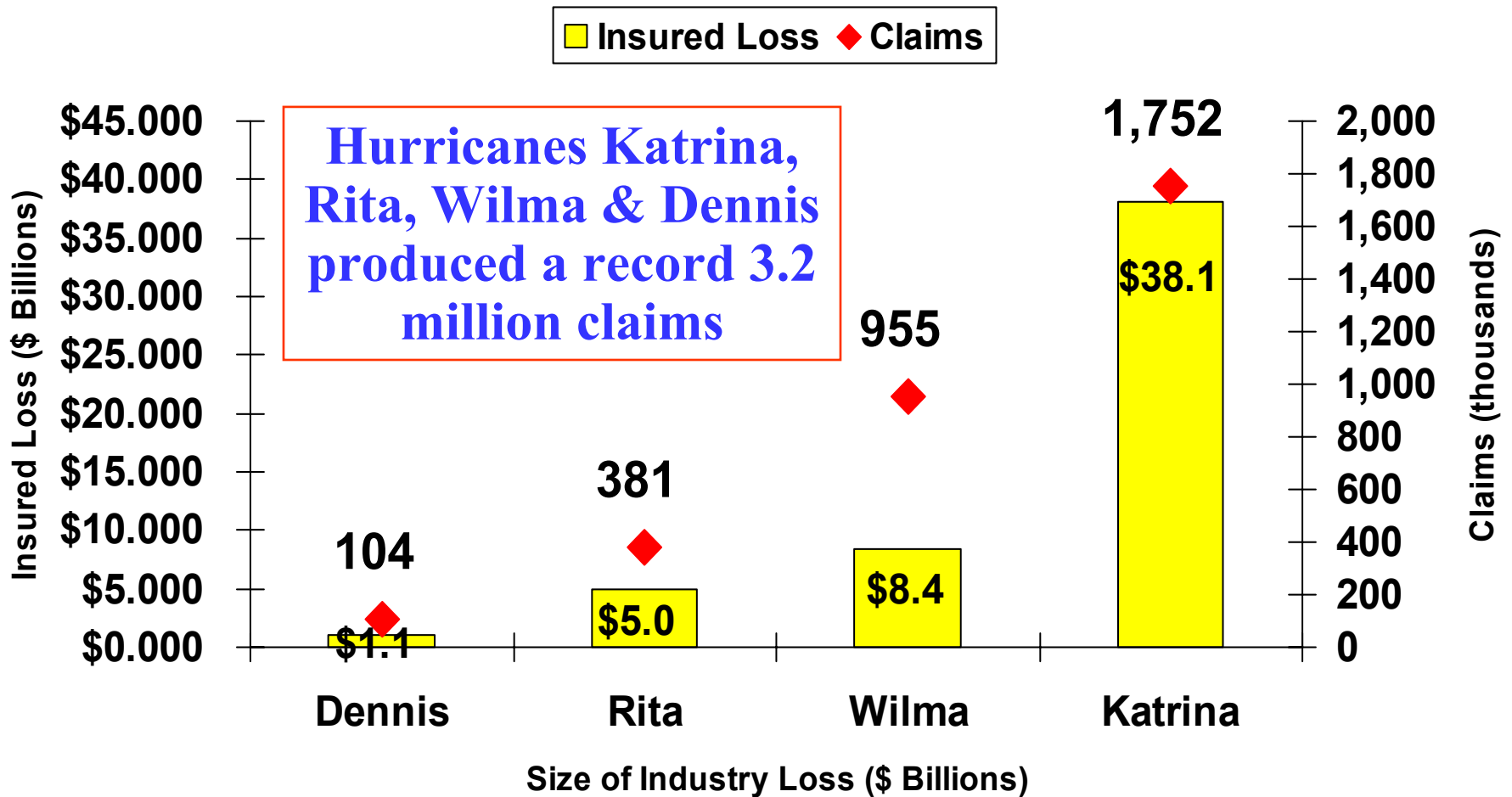


<sup>1</sup> Catastrophes are all events causing direct insured losses to property of \$25 million or more in 2004 dollars. Catastrophe threshold changed from \$5 million to \$25 million beginning in 1997. Adjusted for inflation by the III.

<sup>2</sup> Excludes snow. <sup>3</sup> Includes hurricanes and tropical storms. <sup>4</sup> Includes other geologic events such as volcanic eruptions and other earth movement. <sup>5</sup> Does not include flood damage covered by the federally administered National Flood Insurance Program. <sup>6</sup> Includes wildland fires.



# Insured Loss & Claim Count for Major Storms of 2005\*

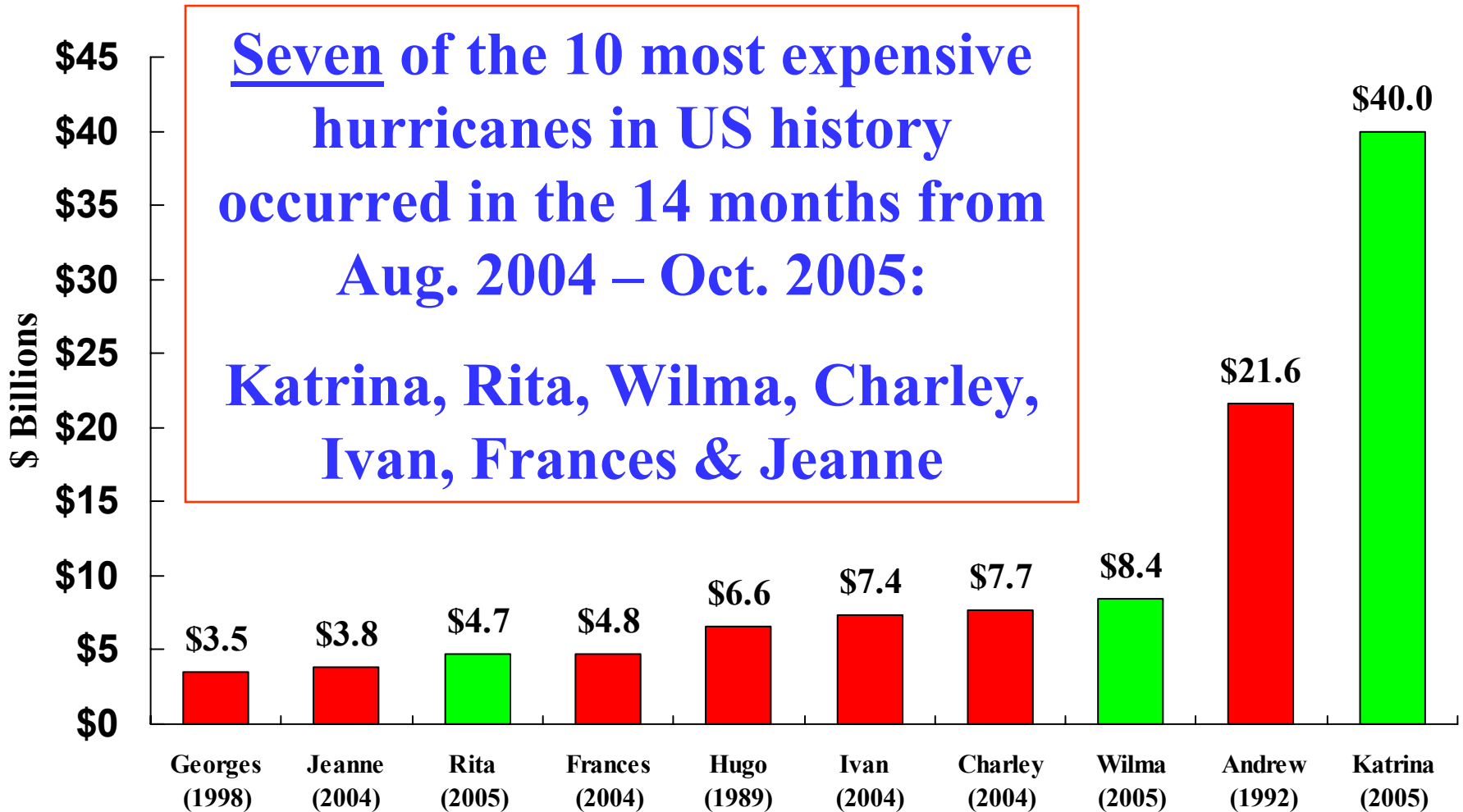


\*Property and business interruption losses only. Excludes offshore energy & marine losses.

Source: ISO/PCS as of February 8, 2006; Insurance Information Institute.

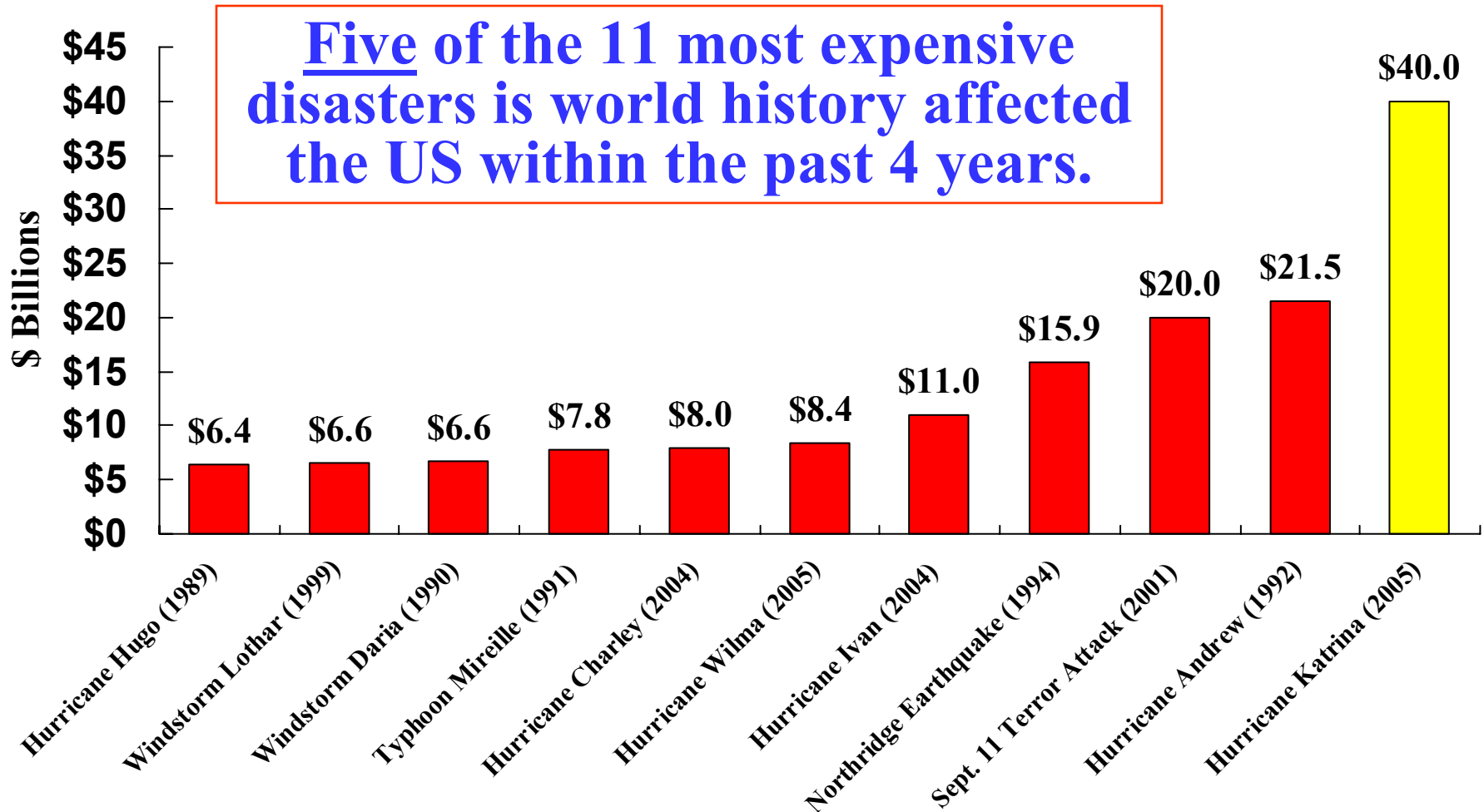


# Top 10 Most Costly Hurricanes in US History (Insured Losses, \$2005)





# Top 11 Insured Property Losses Worldwide, 1970-2005 (\$2005)\*



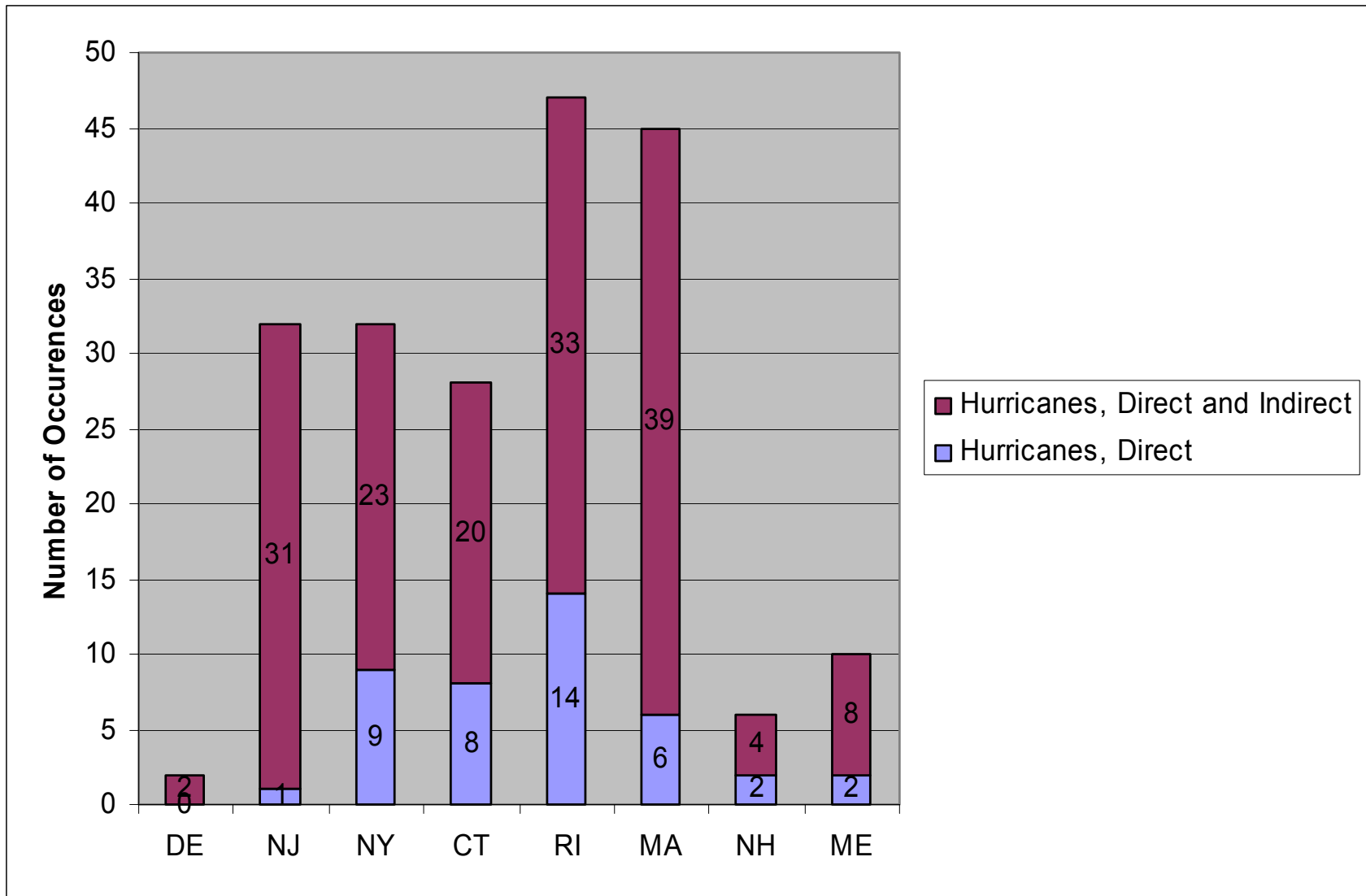
\*All figures are for total losses across all locations, not just US. Katrina losses are a preliminary III estimate.

Sources: ISO/PCS; Swiss Re, "Natural Catastrophes and Man-Made Disasters in 2003," *Sigma*, no.1, 2004



Extreme Weather in the Northeast United States:  
A Look at New York City and Long Island

# Number of Hurricanes Directly and Indirectly Affecting the Northeast United States Since 1900



Source: New Hampshire Office of Emergency Management

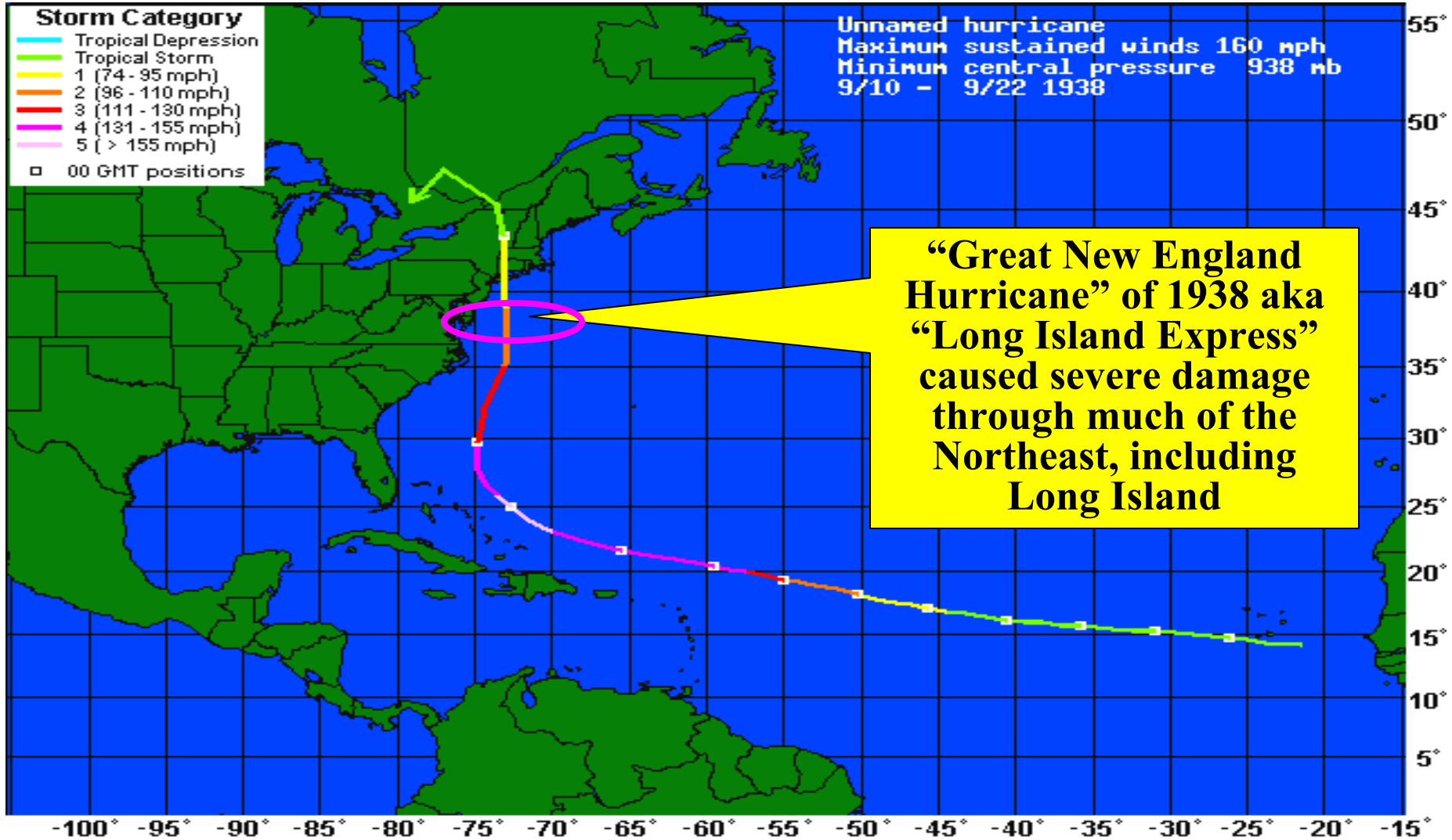


## Relevant History of Extreme Weather Events in New York City

- Extreme weather in New York City and surrounding regions is not without significant historical precedent:
  - *Hurricane of 1821*. Produced sea-level rise of 13ft in one hour in what is now Battery Park City
  - "*West Indian Monster*" of 1893. Triggered a 30ft storm surge that bore a destructive path through South Brooklyn and Queens
  - "*Long Island Express*" of 1938. Severe tidal surge hit Bayport, LI, causing 690 deaths and much damage to property and infrastructure
  - *Hurricane Agnes, 1972*. Caused record inland flooding across the Northeast. Prior to Hurricane Andrew in 92', the United States' most costly natural disaster
  - *Tropical Storm Floyd, 1999*. New York state and upstate NJ received 10-15 inches of rain during a 24-hour period. Caused massive flash flooding in New York City.



# Long Island Express of 1938





## Damage Caused by the “Long Island Express” Hurricane of 1938

- 700 deaths; 708 injured
- 4,500 homes, cottages, and farms destroyed; 15,000 damaged
- 26,000 destroyed automobiles
- 20,000 miles of electrical power and telephone lines downed
- 1,700 livestock and up to 750,000 chickens killed
- \$2,610,000 worth of fishing boats, equipment, docks, and shore plants damaged or destroyed
- Half the entire apple crop destroyed at a cost of \$2 million



# Catastrophe Loss Management



# Hurricanes and Tropical Storms Are Not the Only Potential Hazards: The Case of Northeasters

- In addition to hurricanes and tropical storms, *northeasters* also hold the potential to cause significant damage to New York City and its surrounding regions:
  - The damage they cause can be more widespread than for hurricanes
  - They can inflict greater damage than hurricanes since they often maintain their strength over several tidal cycles at a particular location
- Relevant historical events include:
  - *Blizzard of 1888*. 40 inches of snow fell in New York City; ~400 people died.
  - *Northeaster of December 1992*. Prompted the closing of all transportation infrastructure; caused significant beach and dune erosion
  - "*Storm of the Century*", *March 1993*. Killed 270 people and damaged more than 12,000 homes on Fire Island; economic costs exceeded \$3B



## Probability of Major Hurricane Landfall (CAT 3, 4, 5) in 2006

	Average*	2006F
Entire US Coast	52%	81%
US East Coast Including Florida Peninsula	31%	64%
Gulf Coast from FL Panhandle to Brownsville, TX	30%	47%

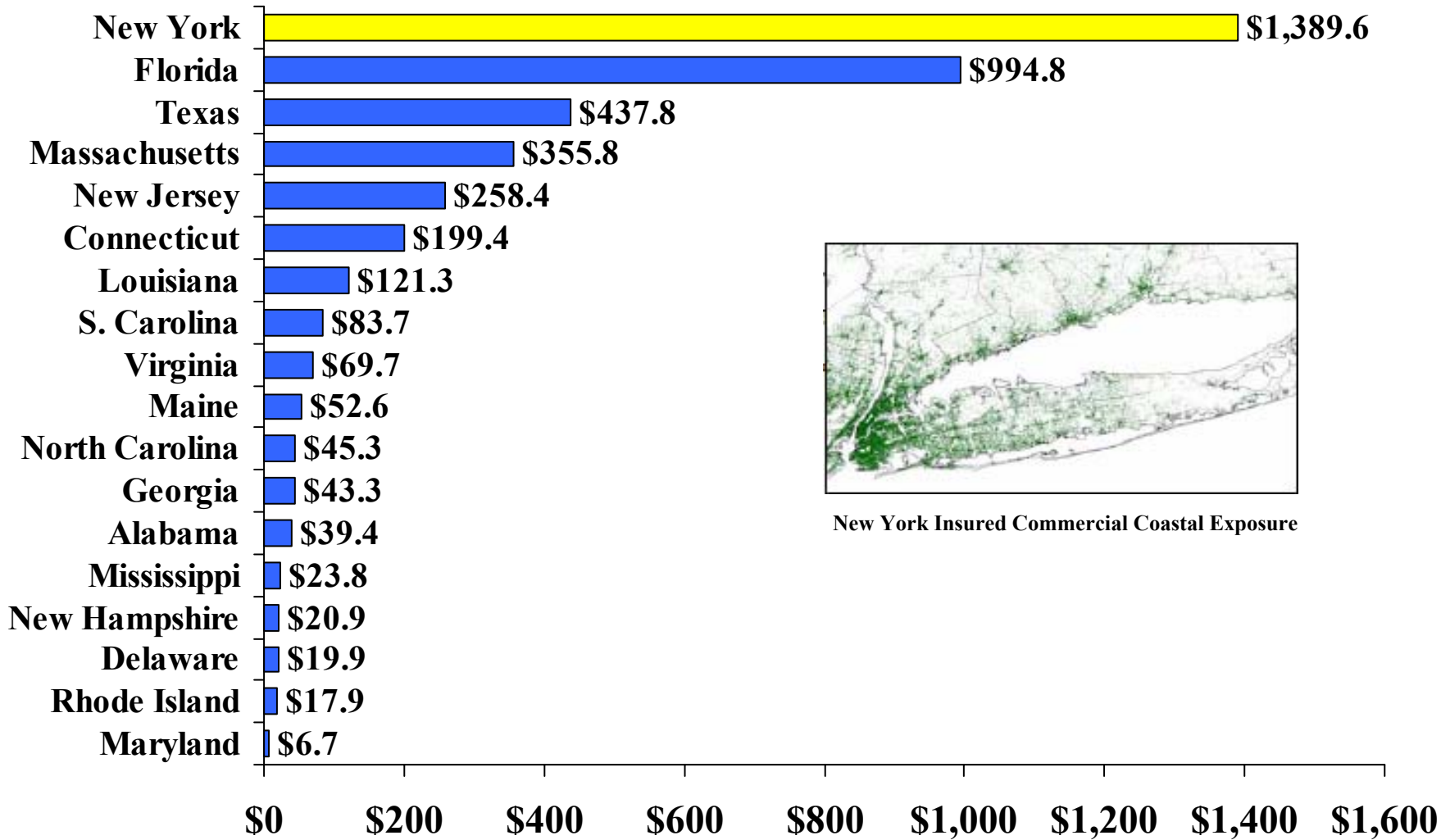
***Also, above-average major hurricane landfall risk is expected in the Caribbean for 2006***

\*Average over past century.

Source: Dr. William Gray, Colorado State University, December 6, 2005.



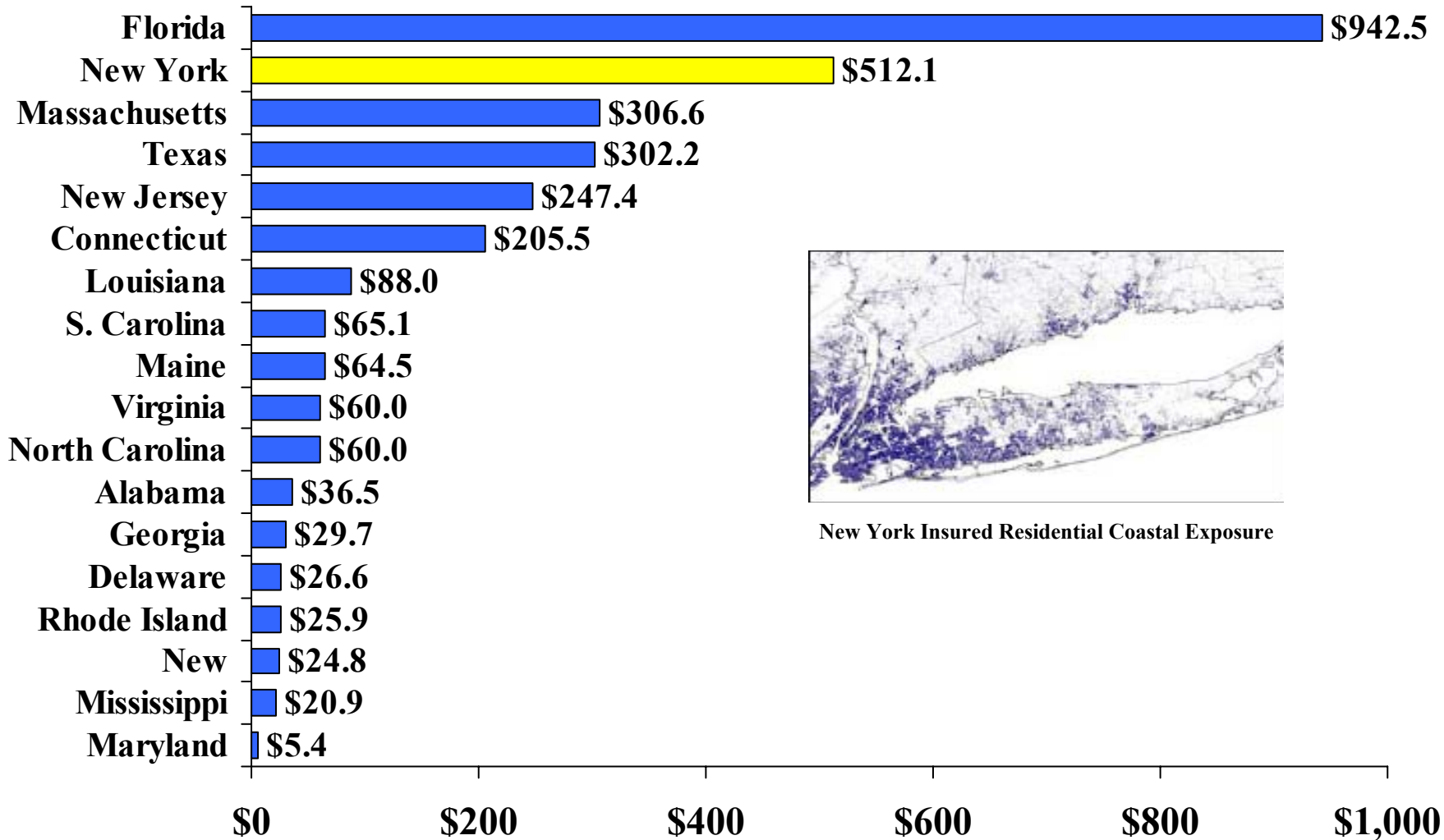
# Value of Insured Commercial Coastal Exposure (2004, \$ Billions)



Source: AIR

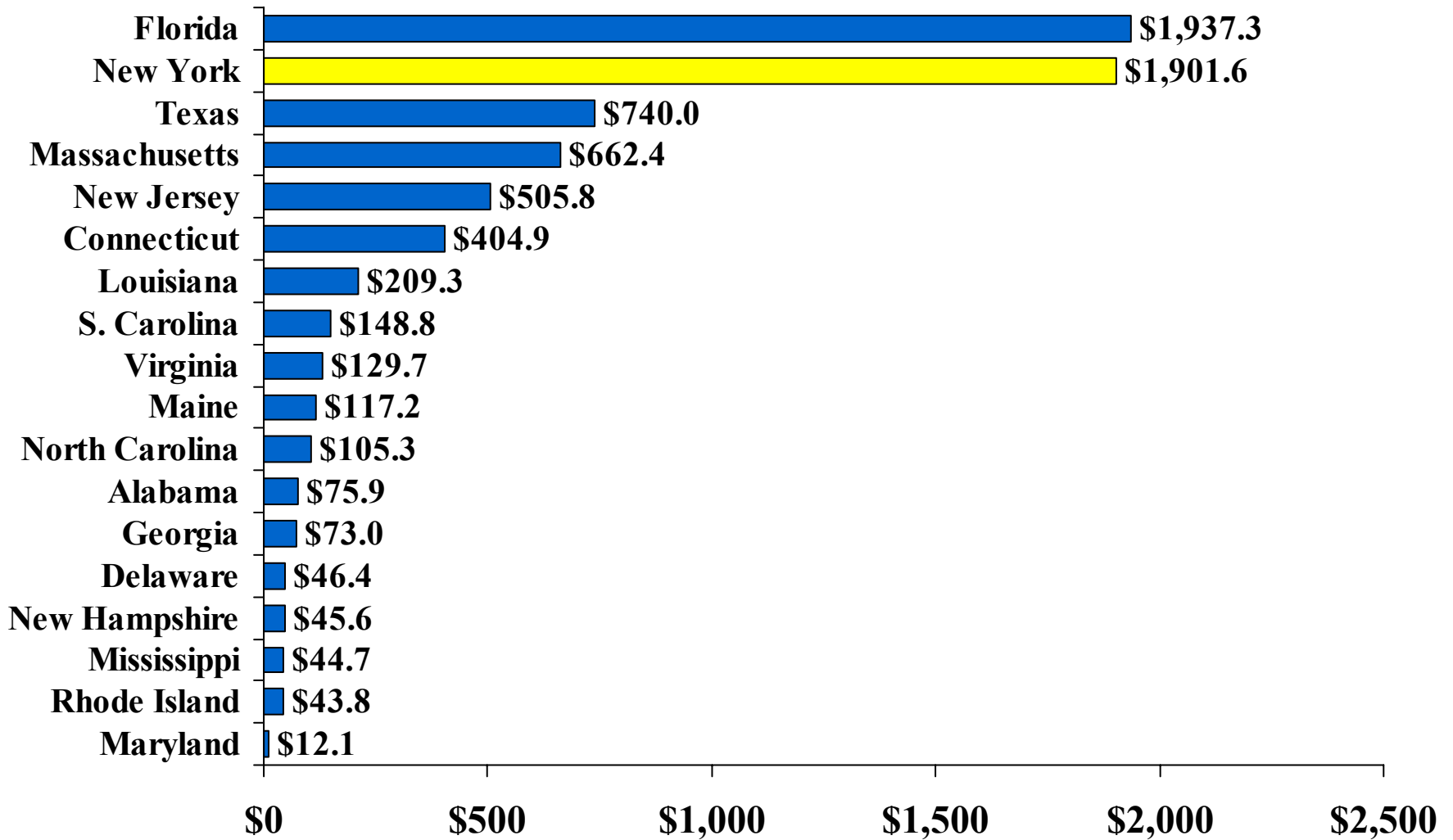


# Value of Insured Residential Coastal Exposure (2004, \$ Billions)





## Total Value of Insured Coastal Exposure (2004, \$ Billions)





# Global Warming and Extreme Weather: Potential Implications for the Northeast United States

- Many credible experts believe that hurricane activity in the Atlantic Ocean may be on the rise
  - There is growing concern that a *frequency shift* has occurred in the past decade for Atlantic tropical system
    - Long-term effects of the multi-decadal oscillation
    - Periodic effects of El Nino and La Nina
  - The Atlantic and Caribbean Oceans are currently in a heightened period of hurricane activity; this activity increase may continue for several more decades
- The U.S. Global Change Research Program reports that the minimum and maximum temperatures in NY City ave shown a long-term warming trend during the past century
- Global climate models project that the region's temperatures could increase by about 1°–4°F by 2030 and by about 5°–10°F by 2100
  - Most scientists believe that a warmer atmosphere increases the potential for extreme weather events
- The latest trends and events suggest that, looking forward, hurricanes may be more destructive due to increases in frequency, intensity, duration, and coastal property exposure



# The Need for Dynamic Hurricane Risk Estimation

- Most attempts to characterize hurricane and extreme weather risk are *static*, in that they do not attempt to estimate or model hurricane risks over time:
  - Loss estimate models do not account for *changes in building inventory*
  - Number, locations, types, and vulnerabilities of buildings in a region *vary with time*
  - Not taking these factors into account *compromises the accuracy* of loss estimates
  - It also complicates efforts to reliably appraise the *potential effectiveness* of possible mitigation strategies
- Hurricane risk stakeholders need to work towards flexible and robust measures of risk and vulnerability:
  - Need to be able to compute *changes* in expected annual hurricane losses over time
  - Need, also, to understand the key factors that *influence* and drive those changes



# Summary and Conclusions

- Major hurricanes – many with considerable destructive power – have historically affected New York City and LI, and will continue to pose a ongoing threat to the region
- The region is highly vulnerable to many of the potential consequences that are associated with extreme weather events:
  - Sea-level rise
  - Flooding
  - Storm surge
  - Coastal erosion and potential loss of wetlands
- A realistic appraisal of the risks that extreme weather poses to the region must look at:
  - Frequency and severity of occurrences
  - Intrinsic vulnerability of the region
  - Loss Estimation
- 1995 started a period of substantially more tropical storm systems and hurricanes in the Atlantic Basin
- Global warming may increase the potential for –and the destructive capability of – extreme weather events:
  - Frequency
  - Intensity
  - Duration
  - Coastal Exposure



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