

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

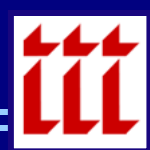
- Recent Assertions Concerning Hurricane Risk Exposure for New York City and Long Island
- Hurricane Risk in the Northeast United States: Current Scientific Understanding
 - A look at NOAA's hurricane return period estimates for NY City and Long Island
 - Relevant background on the NOAA hurricane risk 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 months, 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

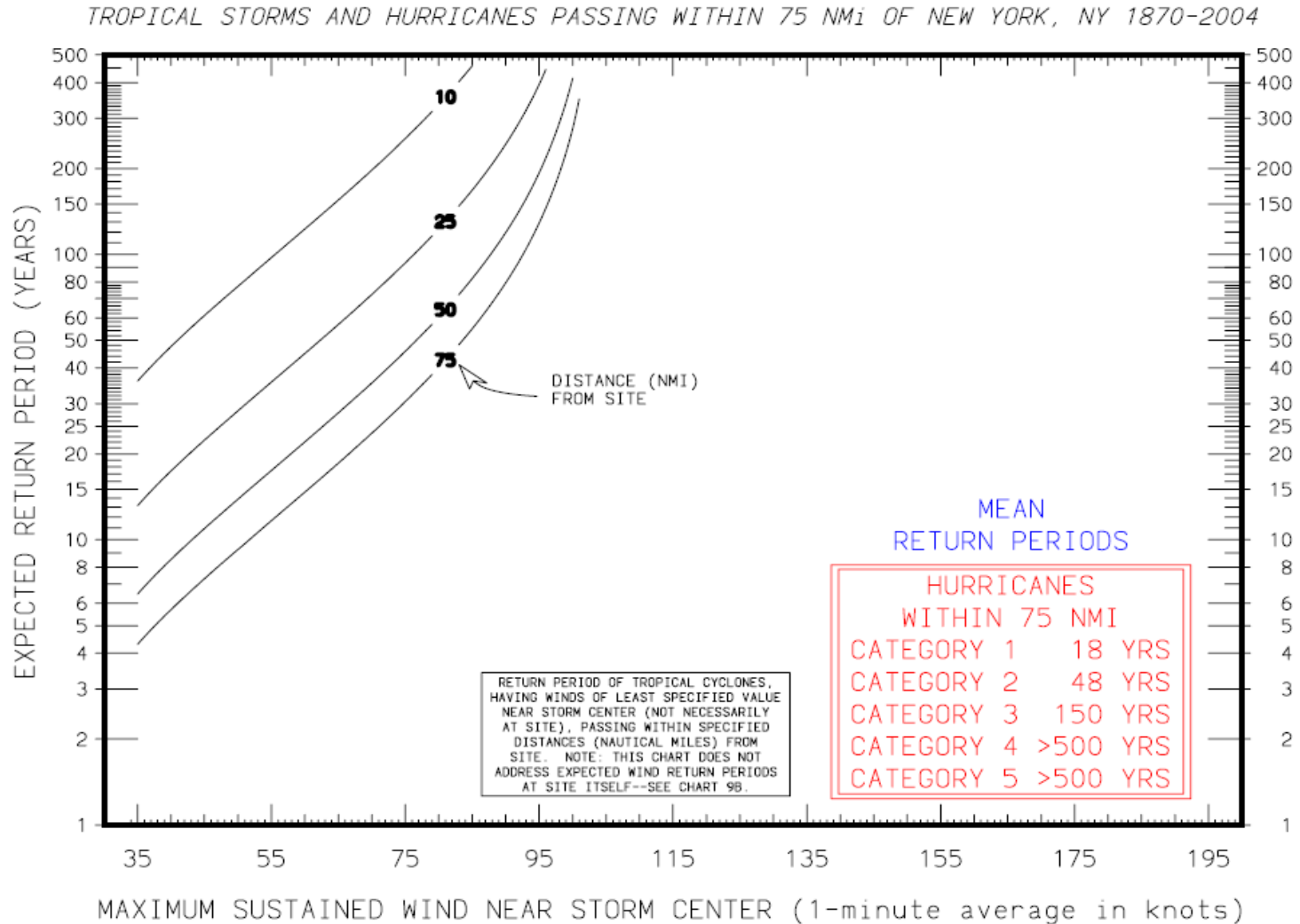


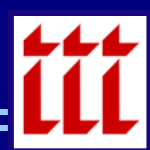
Relevant Background on the NOAA Hurricane Risk Data

- 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



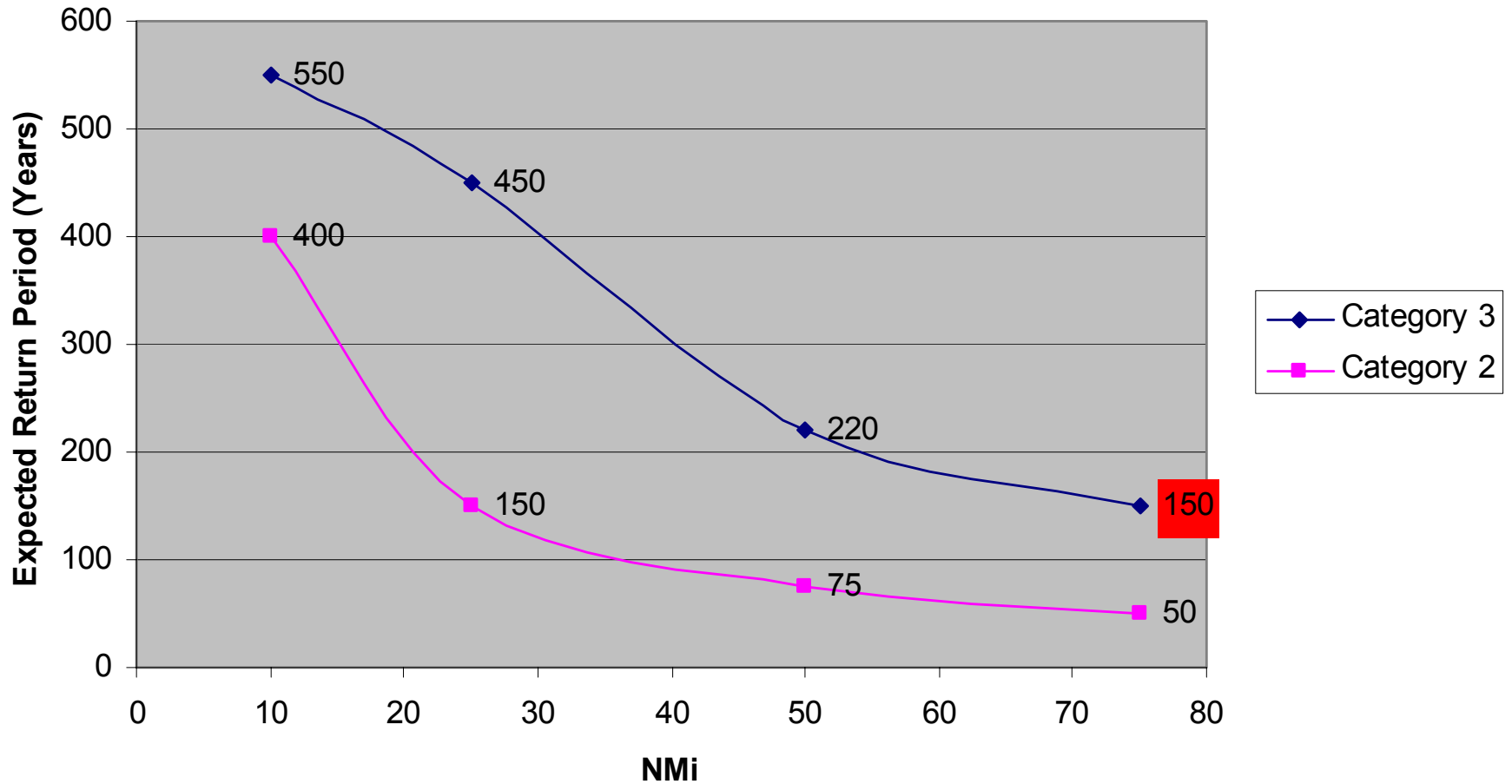
HURISK Results for Hurricanes Passing Within 75 NMI of New York City: 1870 - 2004





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



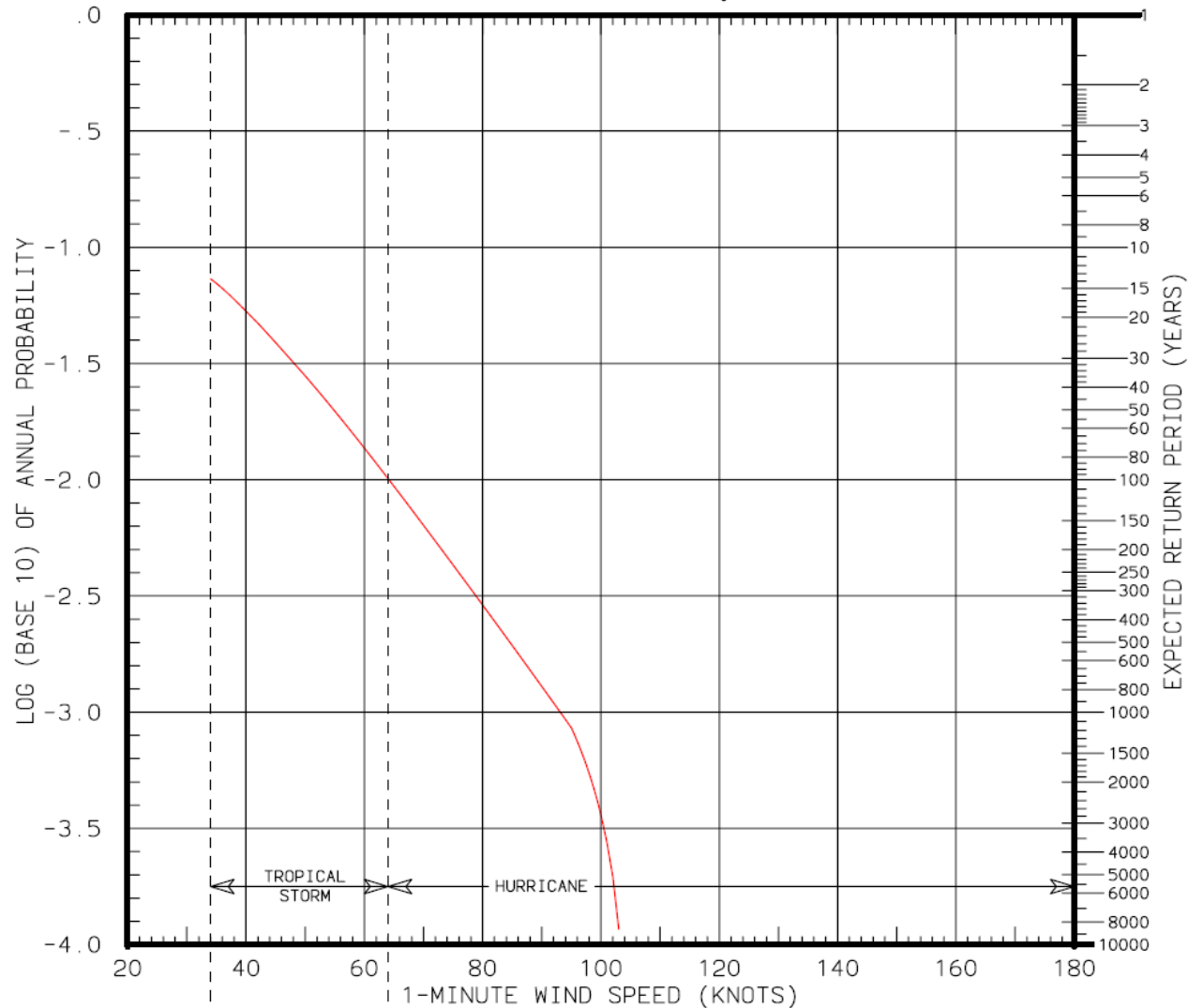
Source: Based on data provided by the NOAA Tropical Prediction Center



- 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**

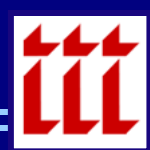


Source: Graph courtesy of Colin McArdie, NOAA Tropical Prediction Center



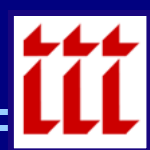
Implications of the NOAA Long-Run Data

- 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

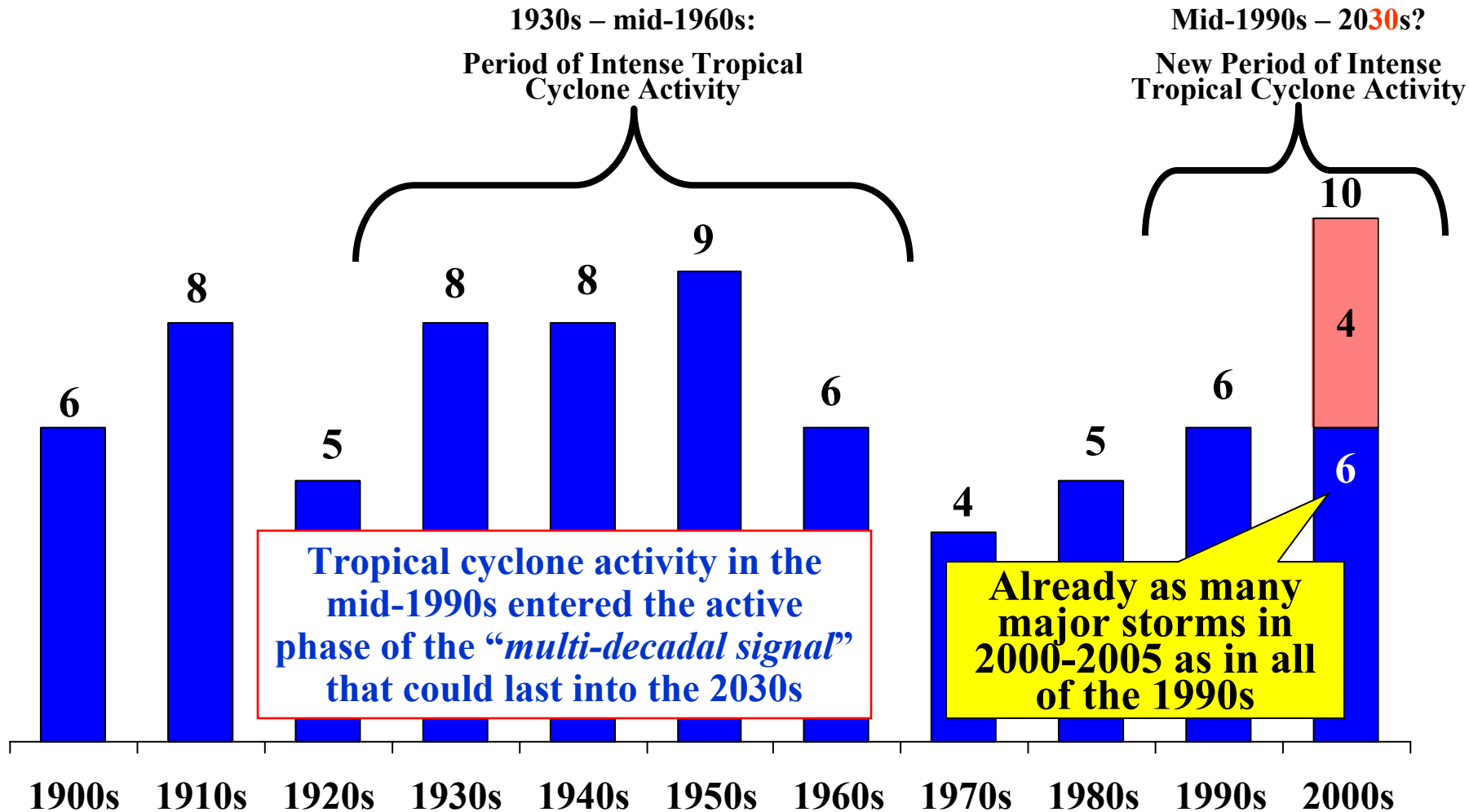
- Focusing solely on the potential *frequency of occurrence* and *severity* of future hurricane activity for the region is misleading
- It is important, also, to characterize and evaluate two other components that – together with frequency and severity of occurrence – comprise extreme weather risk:
 - 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

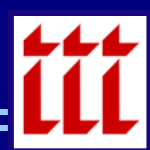


Number of Major (Category 3, 4, 5) Hurricanes Striking the US by Decade



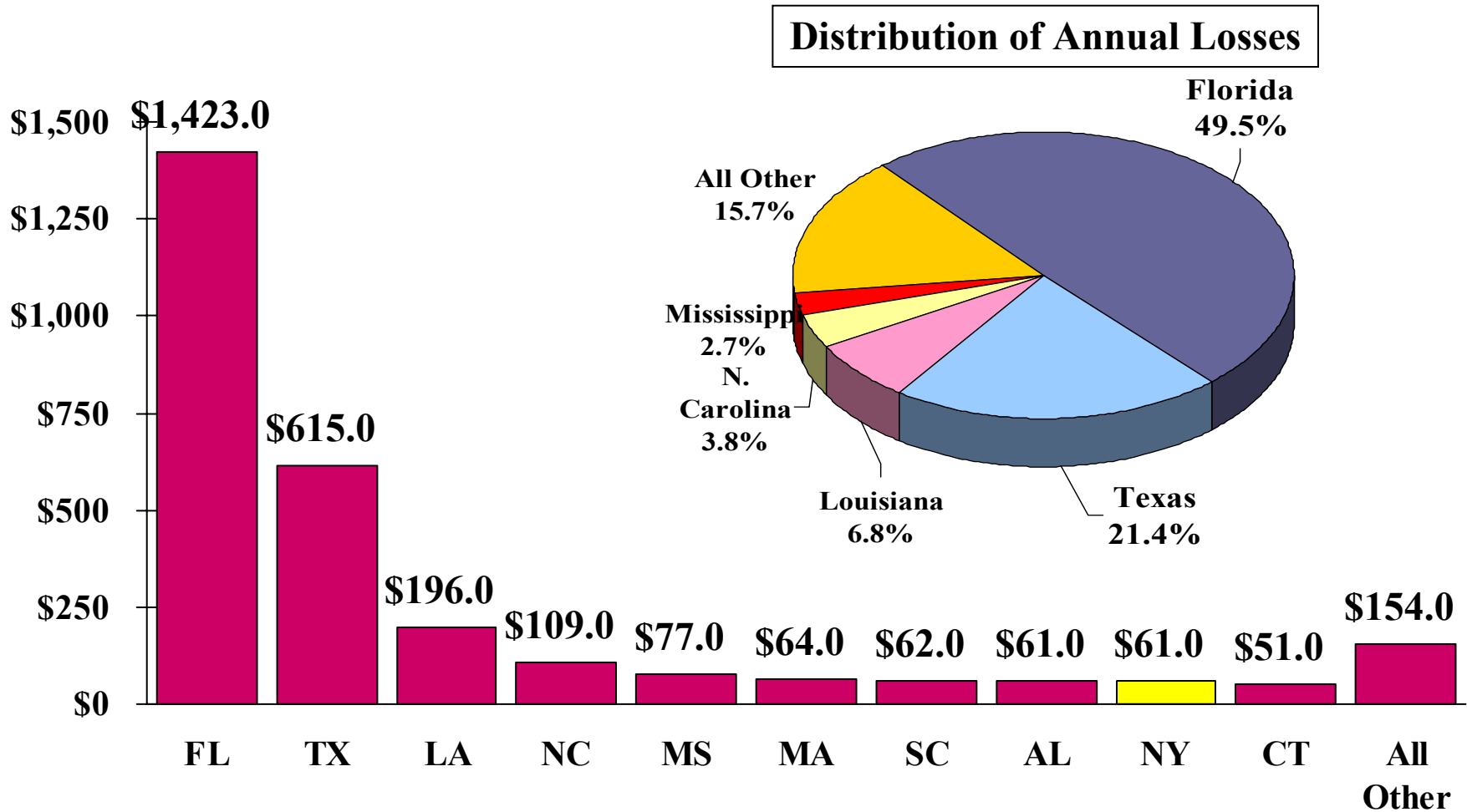
*Figure for 2000s is extrapolated based on data for 2000-2005 (6 major storms: Charley, Ivan, Jeanne (2004) & Katrina, Rita, Wilma (2005)).

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



Average Annual Tropical Cyclone Insured Losses*

(Top 10 States, \$ Millions)

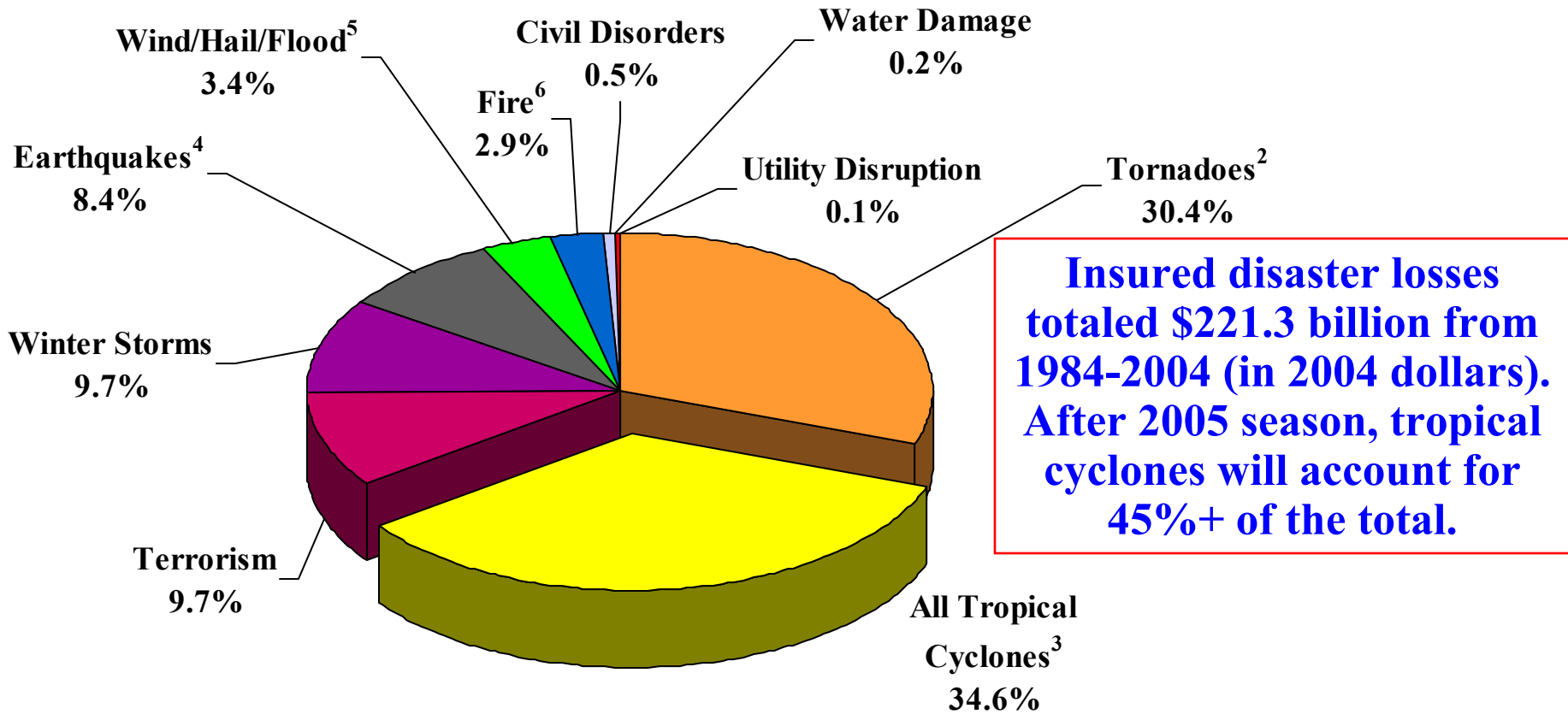


*Normalized losses adjusted for inflation, housing density, wealth and wind insurance coverage, based on historical data for 100-year period 1900-1999.

Source: Tillinghast-Towers Perrin



Inflation-Adjusted U.S. Insured Catastrophe Losses By Cause of Loss, 1985-2004¹

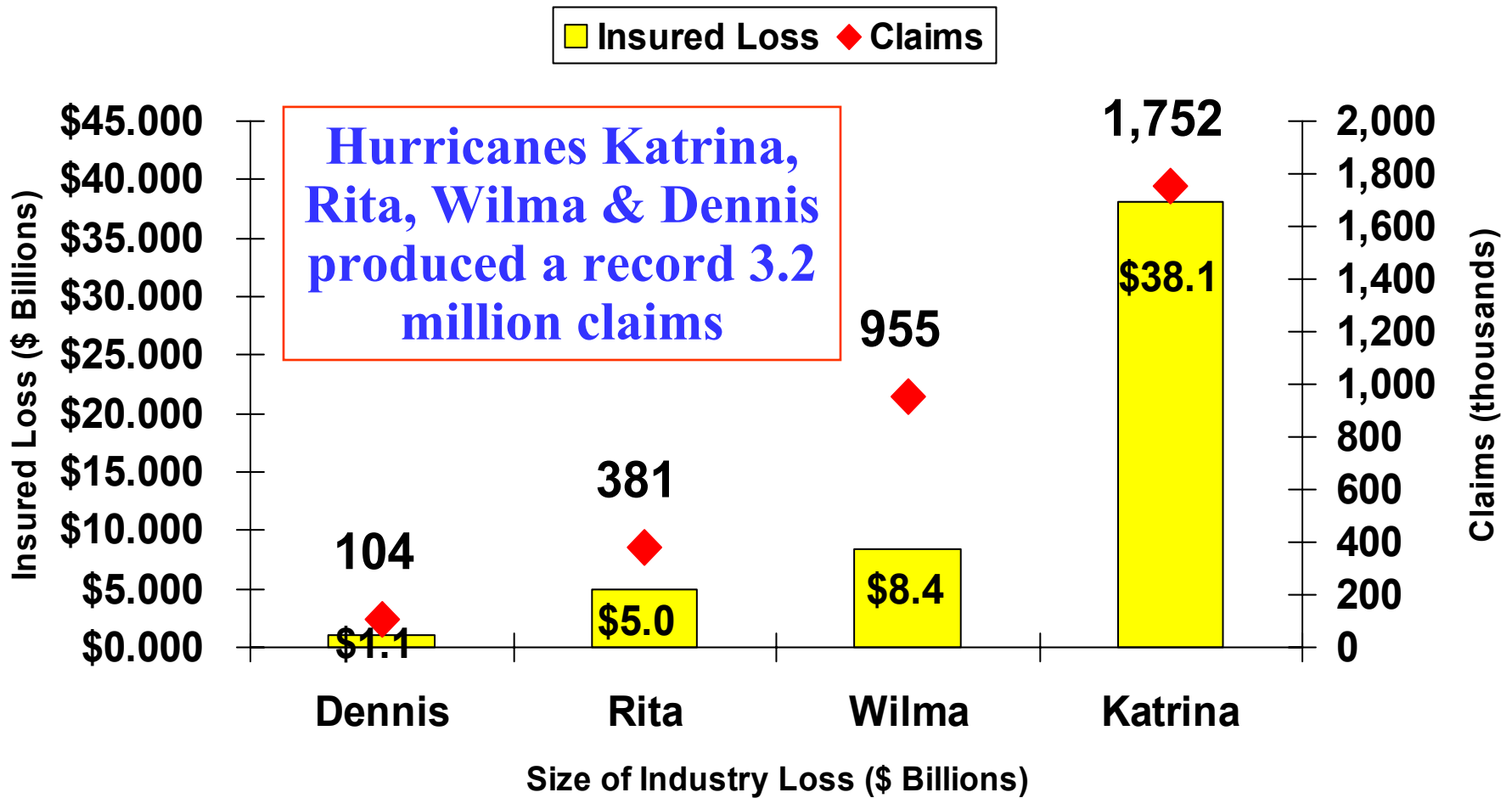


¹ Catastrophes are all events causing direct insured losses to property of \$25 million or more in 2004 dollars. Catastrophe threshold changed from \$5 million to \$25 million beginning in 1997. Adjusted for inflation by the III.

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



Insured Loss & Claim Count for Major Storms of 2005*

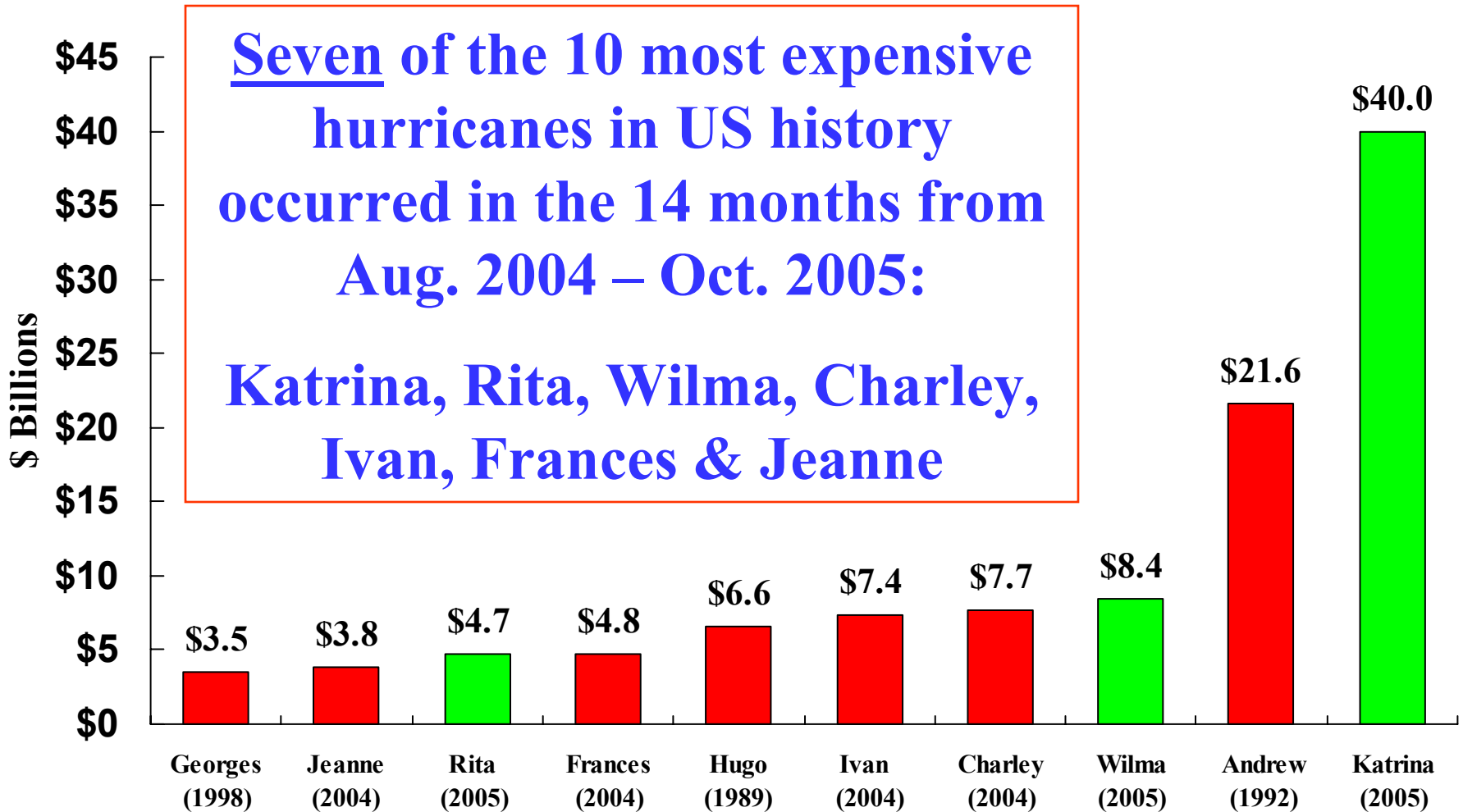


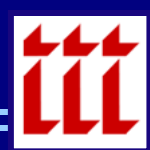
*Property and business interruption losses only. Excludes offshore energy & marine losses.

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

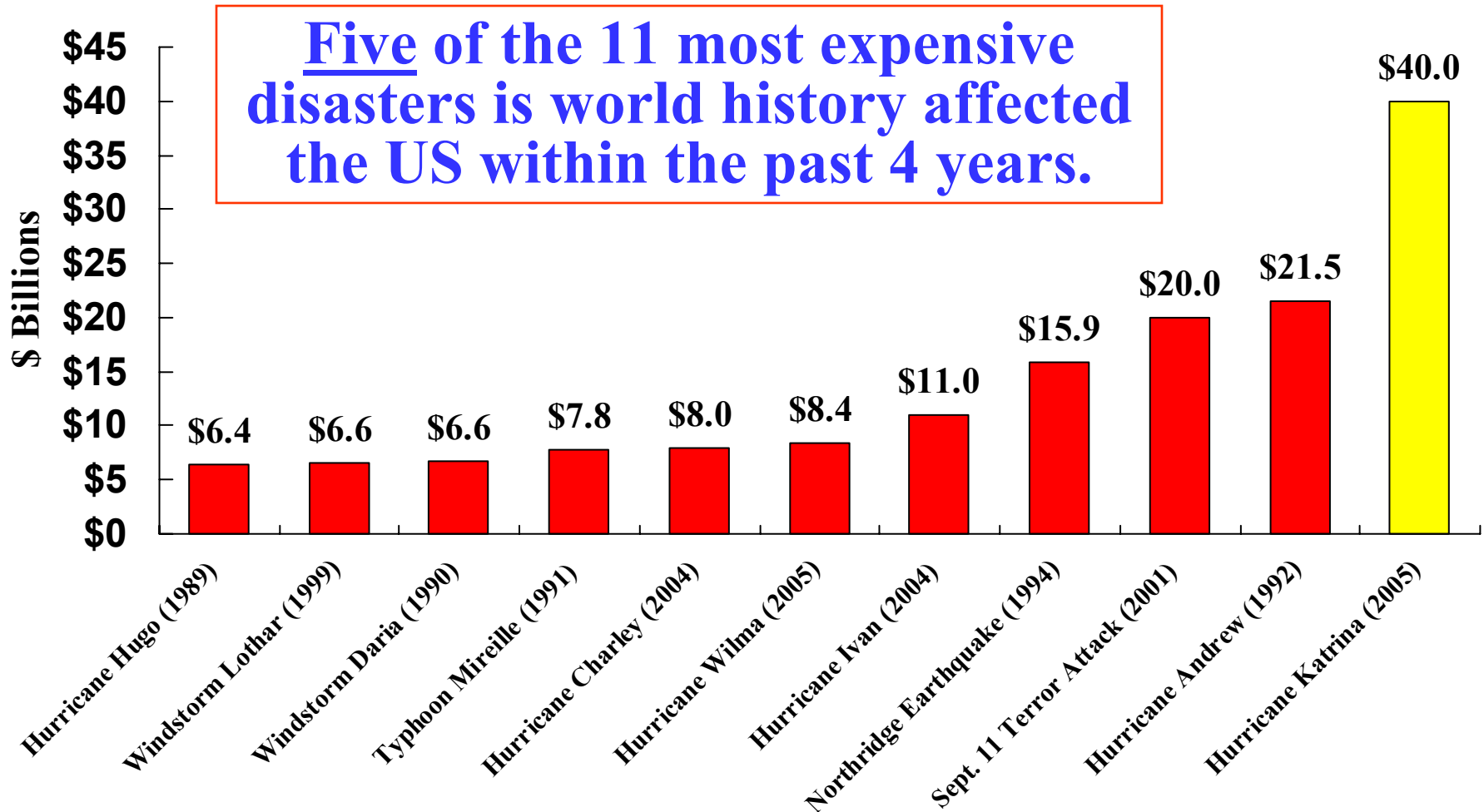


Top 10 Most Costly Hurricanes in US History (Insured Losses, \$2005)





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



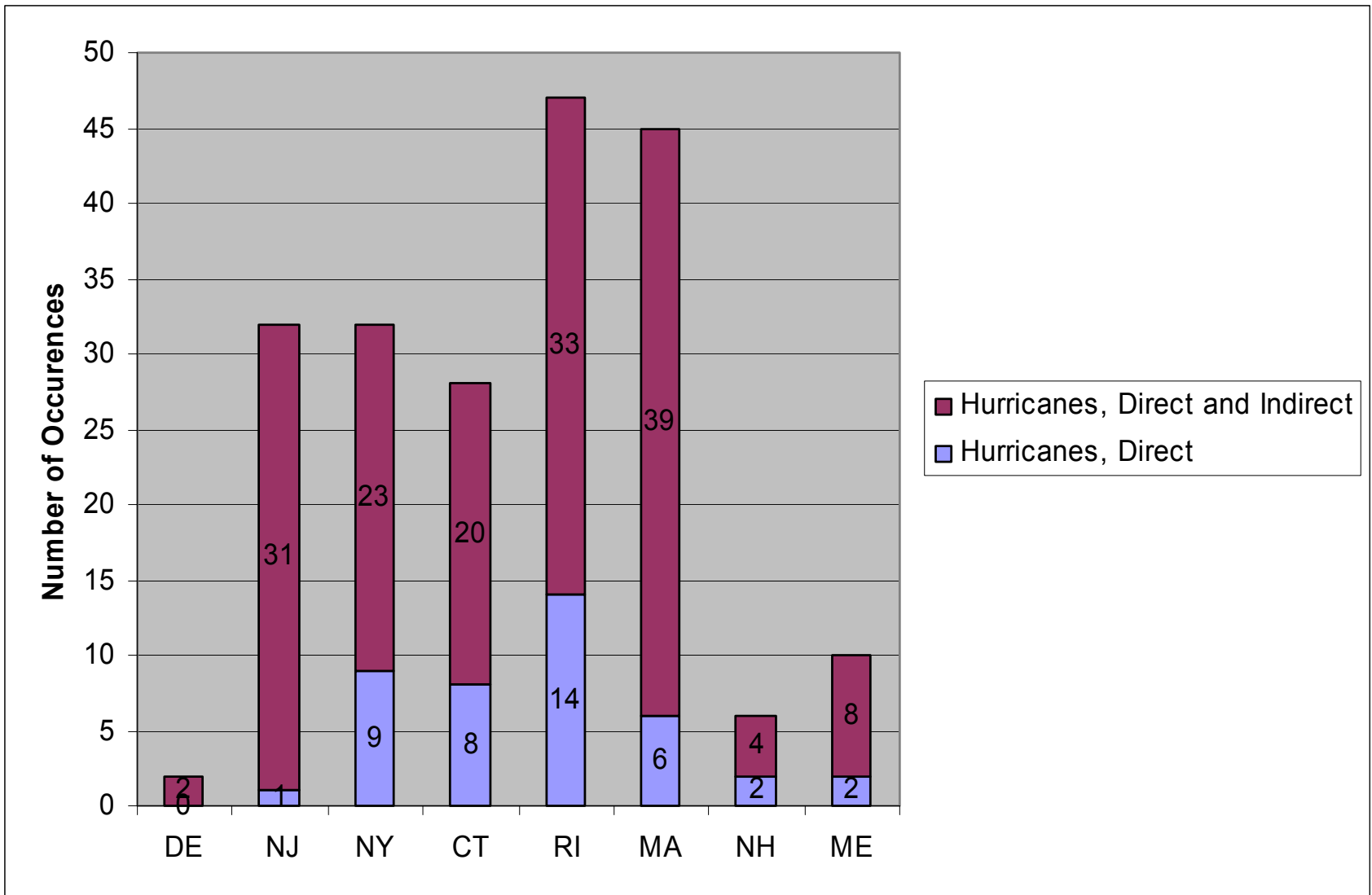
*All figures are for total losses across all locations, not just US. Katrina losses are a preliminary III estimate.

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

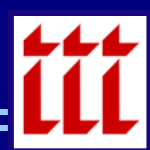
Number of Hurricanes Directly and Indirectly Affecting the Northeast United States Since 1900



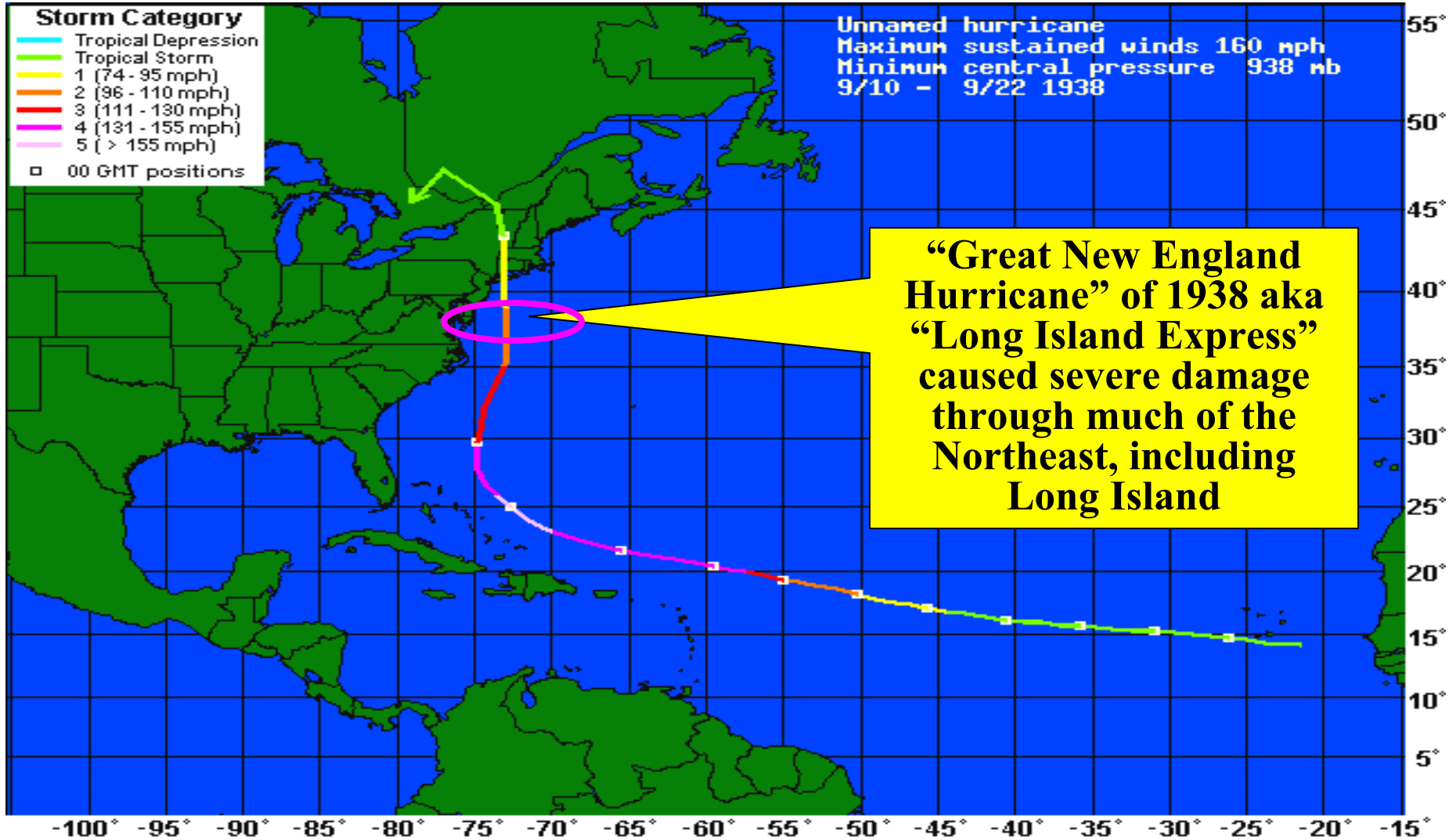


Relevant History of Extreme Weather Events in New York City

- 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



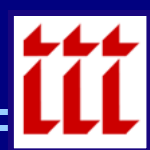
Probability of Major Hurricane Landfall (CAT 3, 4, 5) in 2006

	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%

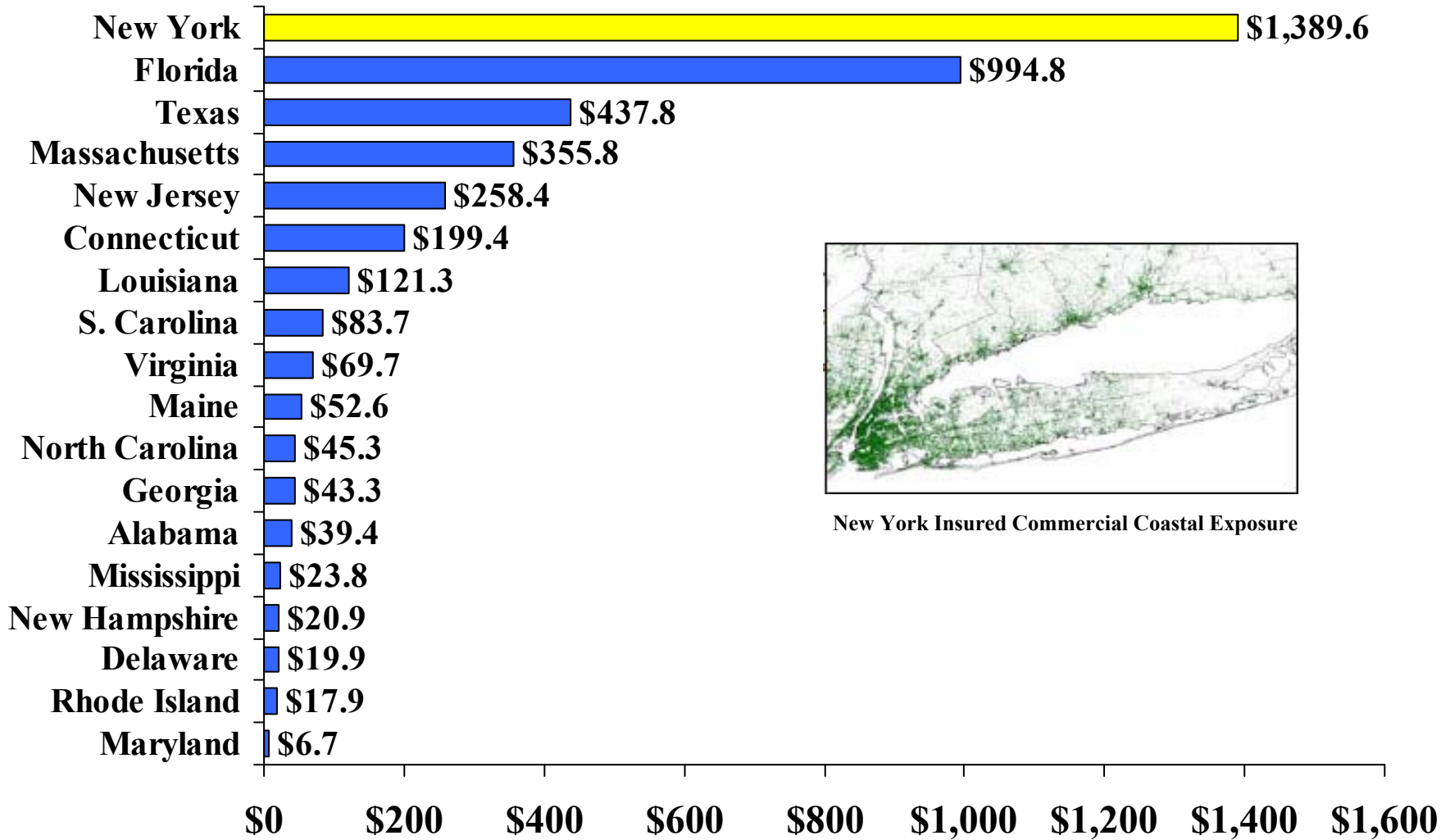
Also, above-average major hurricane landfall risk is expected in the Caribbean for 2006

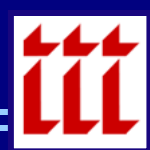
*Average over past century.

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

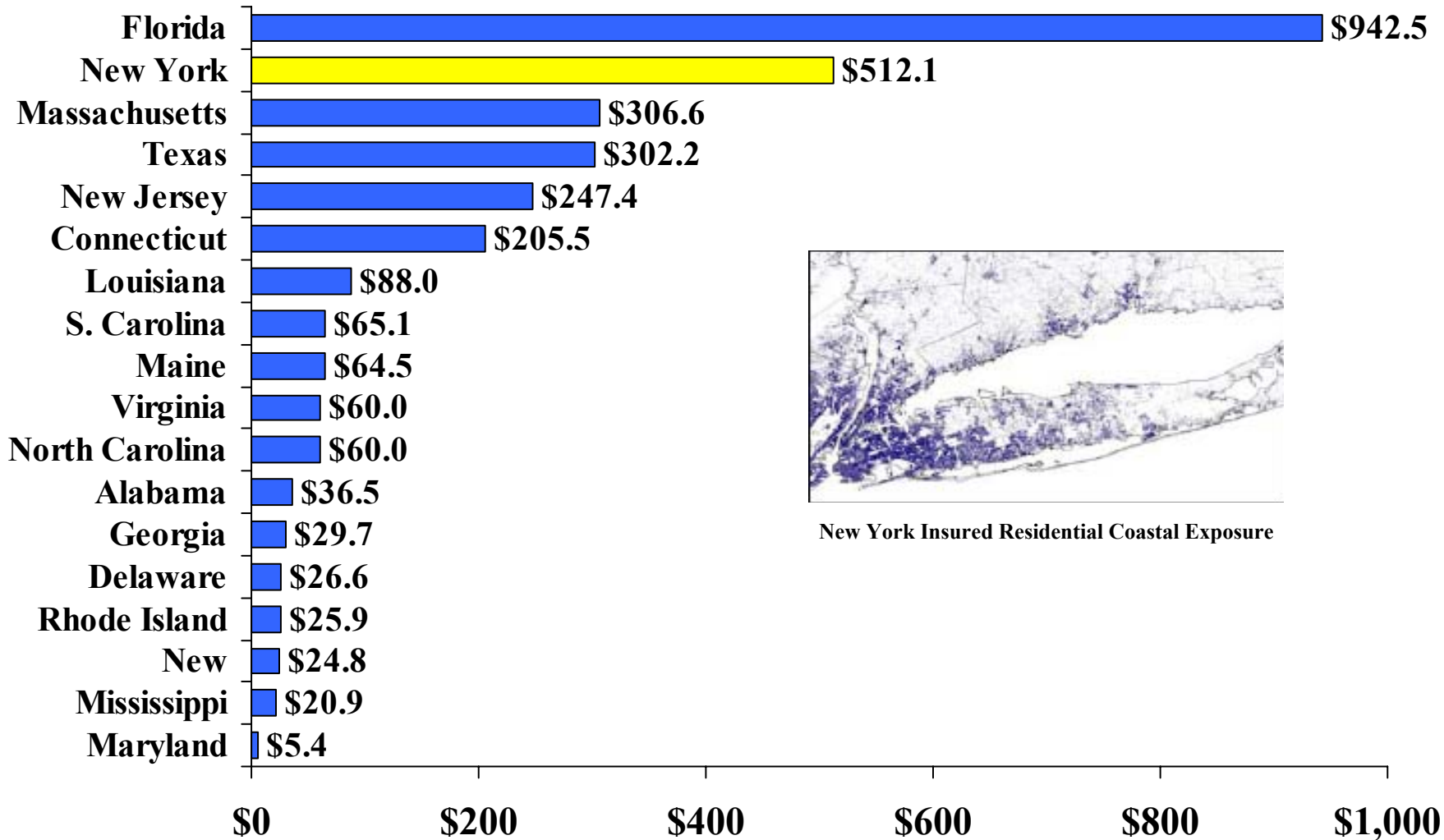


Value of Insured Commercial Coastal Exposure (2004, \$ Billions)



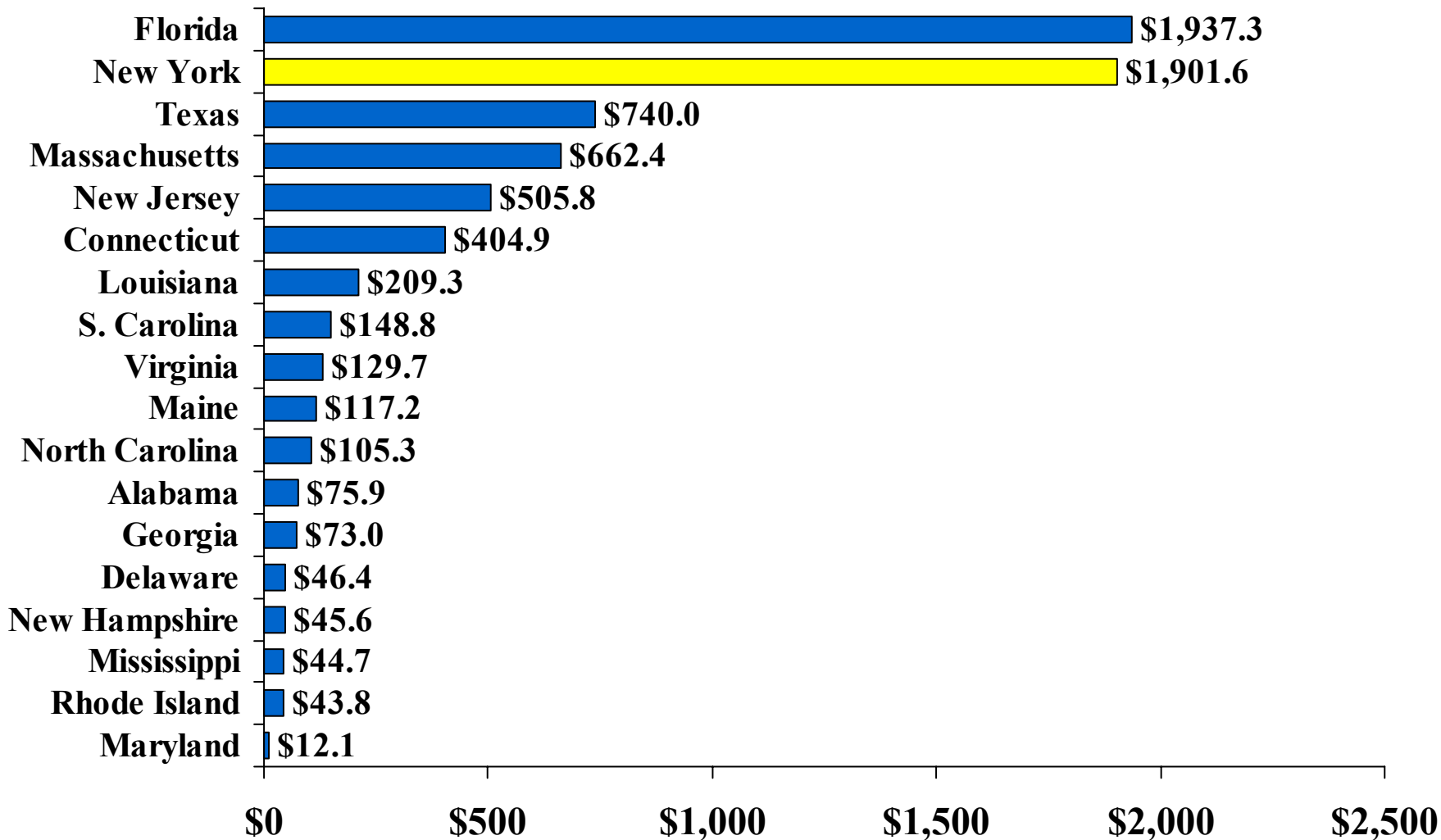


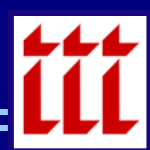
Value of Insured Residential Coastal Exposure (2004, \$ Billions)





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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