Global warming, U.S. hurricanes, and insured losses

Anticipating the hurricane peril in the United States

American Meterological Society
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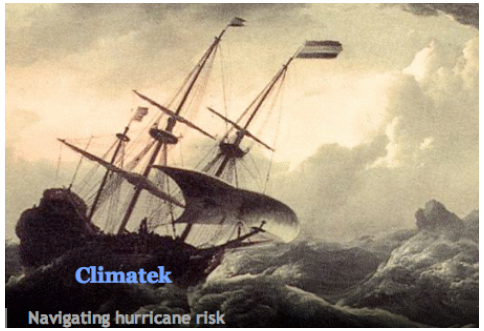
New Orleans



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Support: NSF, RPI

Take Home Points

Hurricane activity responds to variations in climate. On the seasonal time scale, and to a first order, a warm ocean fuels hurricanes, a calm atmosphere allows them to intensify and the position and strength of the subtropical high paves the tracks.

Theory and evidence supports a connection between climate change and Atlantic hurricanes through oceanic warmth.

Observations and models agree on the magnitude of the effect. Inhibiting factors include the possibility of greater wind shear and atmospheric stability. Evidence is ambiguous in other tropical cyclone basins, but all basins (except the IO) show positive trends in the intensity of the strongest tropical cyclones.

The next generation of hurricane risk models should make use of this new science & technology.

- Problem:

  Today's hurricane risk models are based on a large set of hypothetical storms (catalogue) generated from historical data and based on random sampling, but it is difficult to condition the large amount of sampling on climate variability & climate change.

- Solutions:

  Expert elicitation: panel of experts determine short-term (next 5 yr) activity.

  - Pros: easy, cheap, no need to scrap the catalogue.
  - Cons: who/how many experts, lack of coherency, basin-wide activity rather than landfall activity, uncertainty quantification.

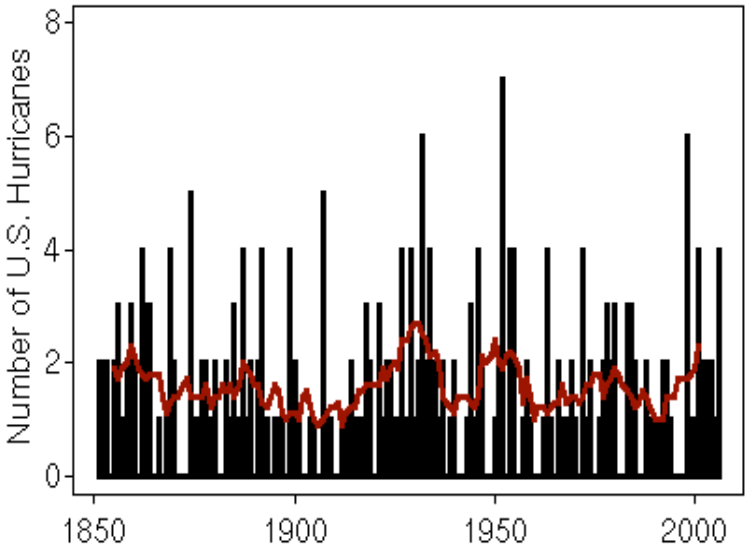
  Numerical models: Capable of resolving hurricanes.

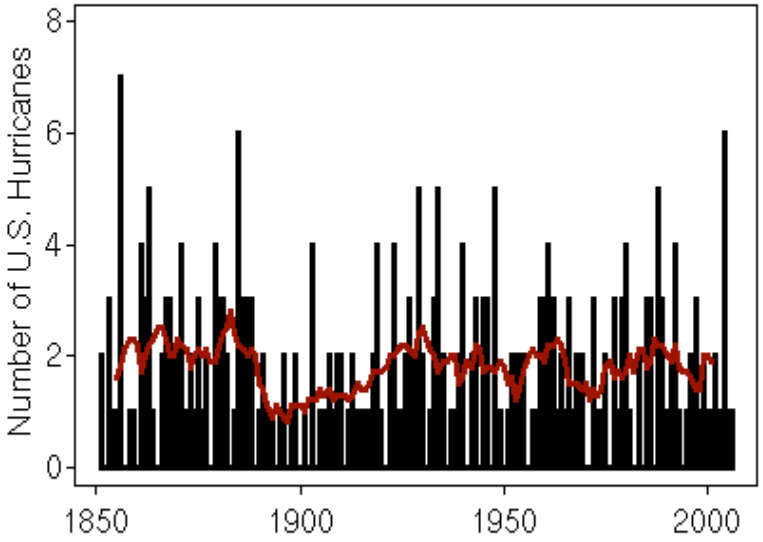
  - Pros: directly predict number, intensity hurricanes under various climate scenarios.
  - Cons: expensive, resolution too low for seasonal or multi-year forecasts.

  Data models: theoretical statistical distributions for activity (frequency, intensity, etc).

  - Pros: easy, cheap, climate conditioning on the distributional parameters, Bayesian methods can incorporate less precise data, uncertainty is easily included.
  - Cons: statistically sophisticated.

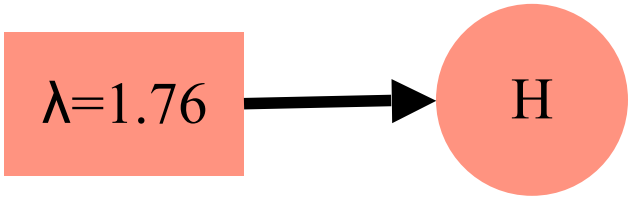
Data Models vs Data Analysis

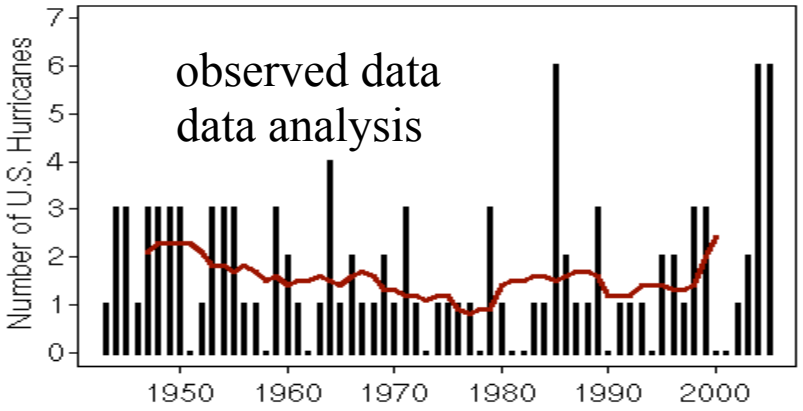


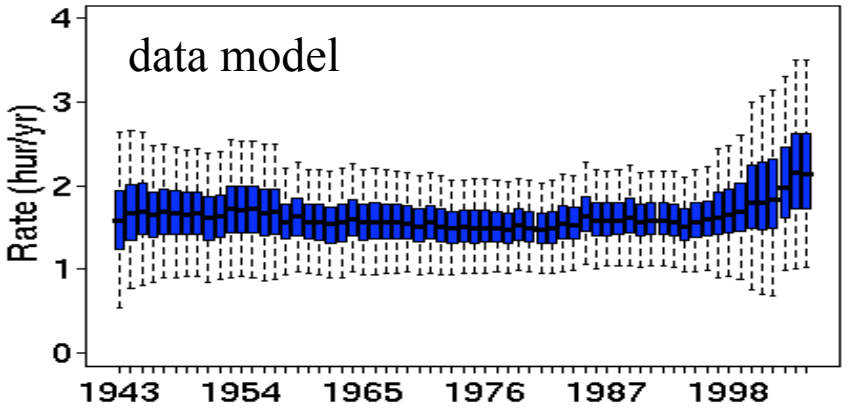


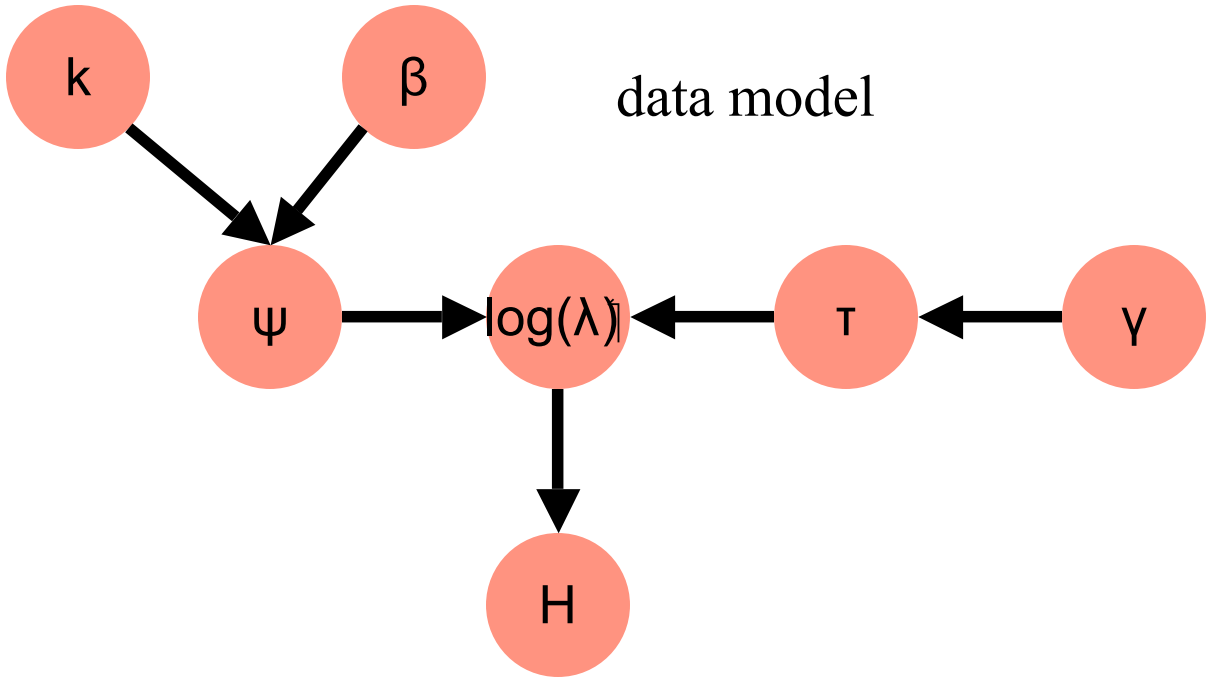
data analysis
(fooled by randomness)

data model

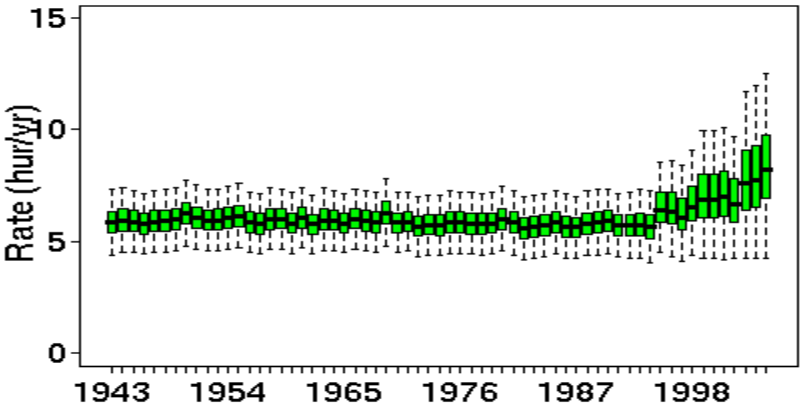



observed data
data analysis
Number of U.S. Hurricanes
0
1
2
3
4
5
6
7
1950
1960
1970
1980
1990
2000

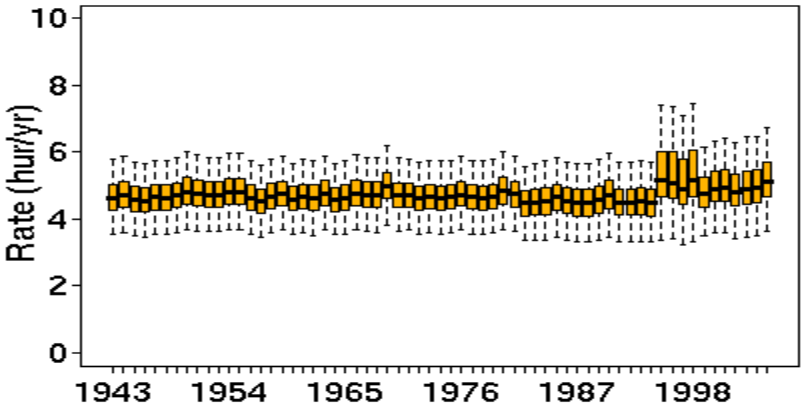

data model
Rate (hur/yr)
0
1
2
3
4
1943
1954
1965
1976
1987
1998


k
β
data model
ψ
log(λ)
τ
γ
H

Basin wide, Cat 1-5

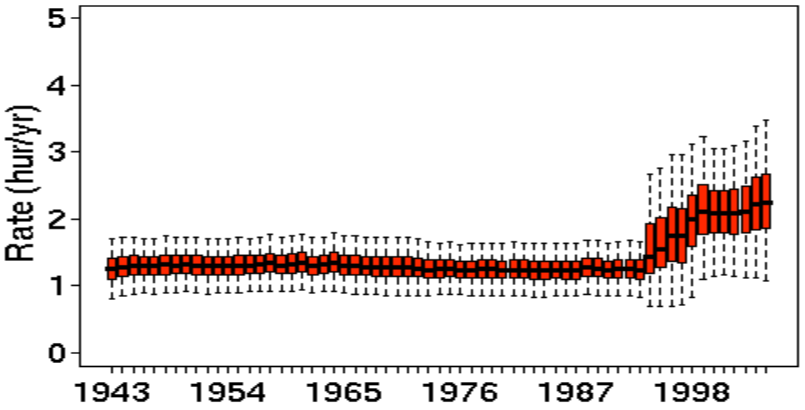


Basin wide, Cat 1-3

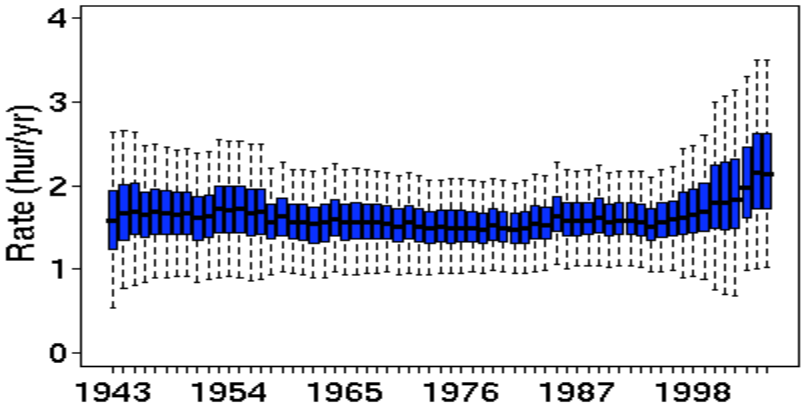


Note the lack of decadal variation. Why?

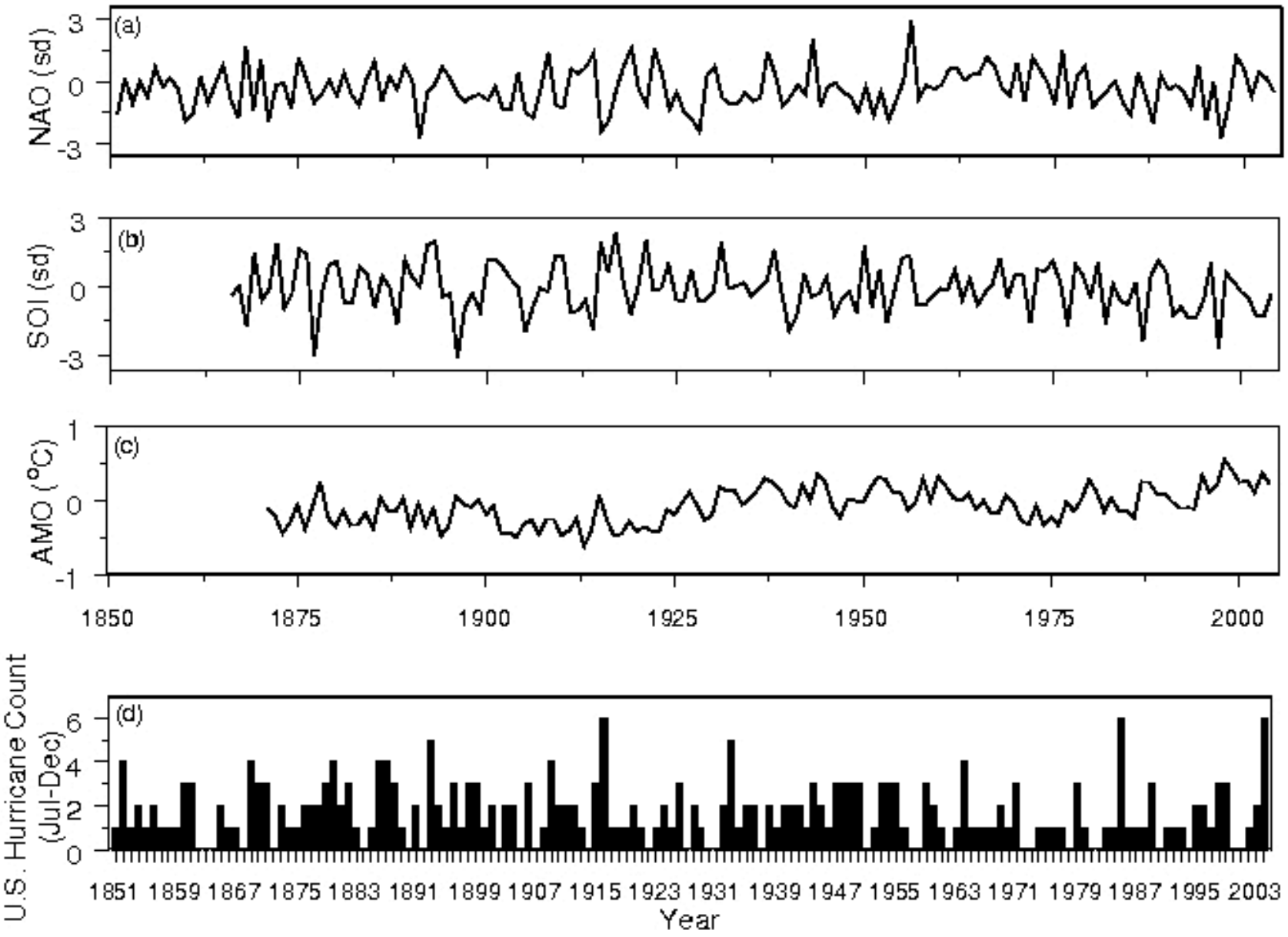
Basin wide, Cat 4-5

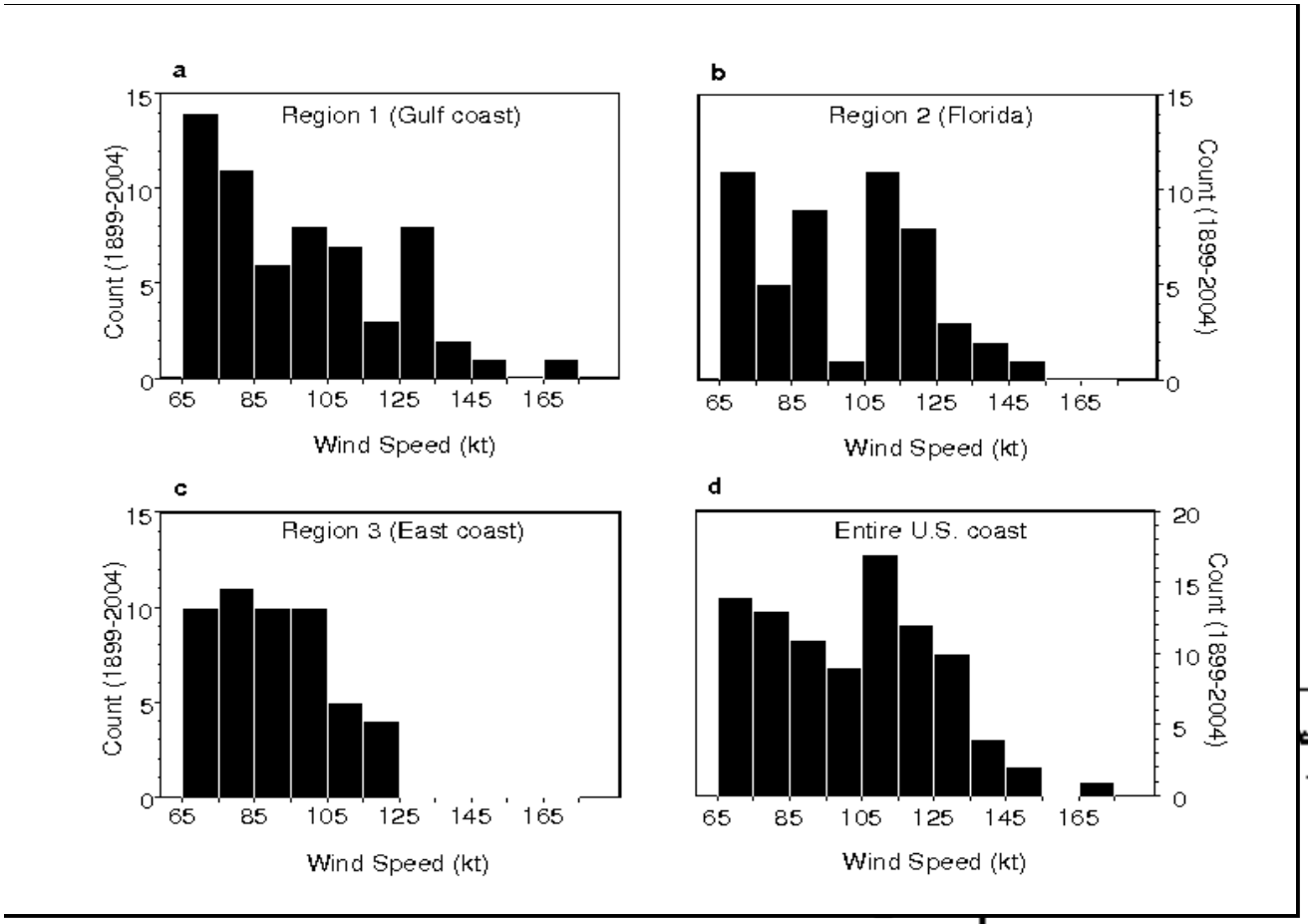


U.S. Landfalls, Cat 1-5

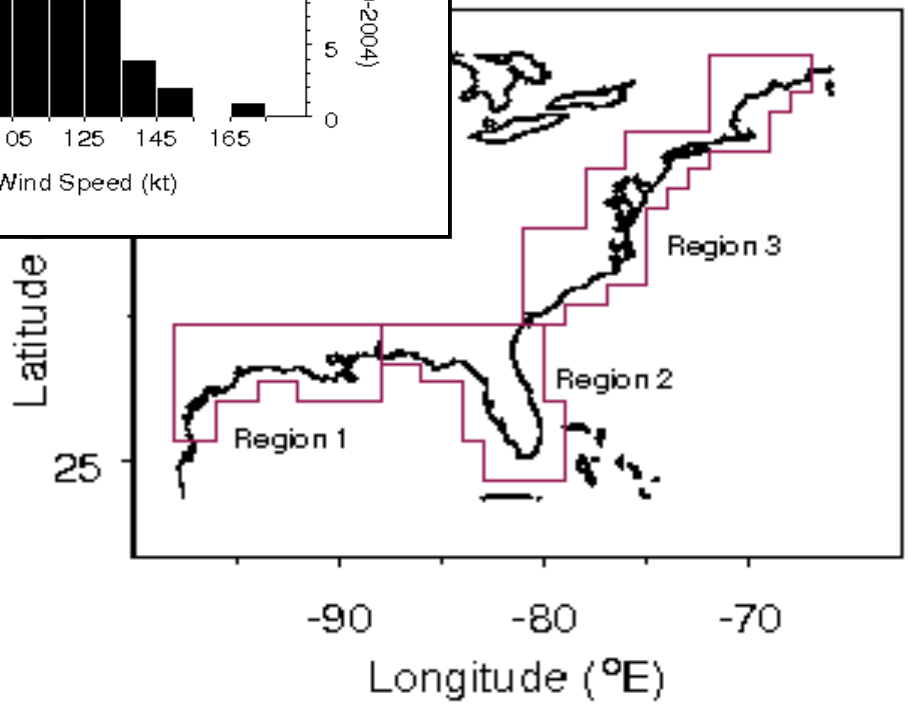


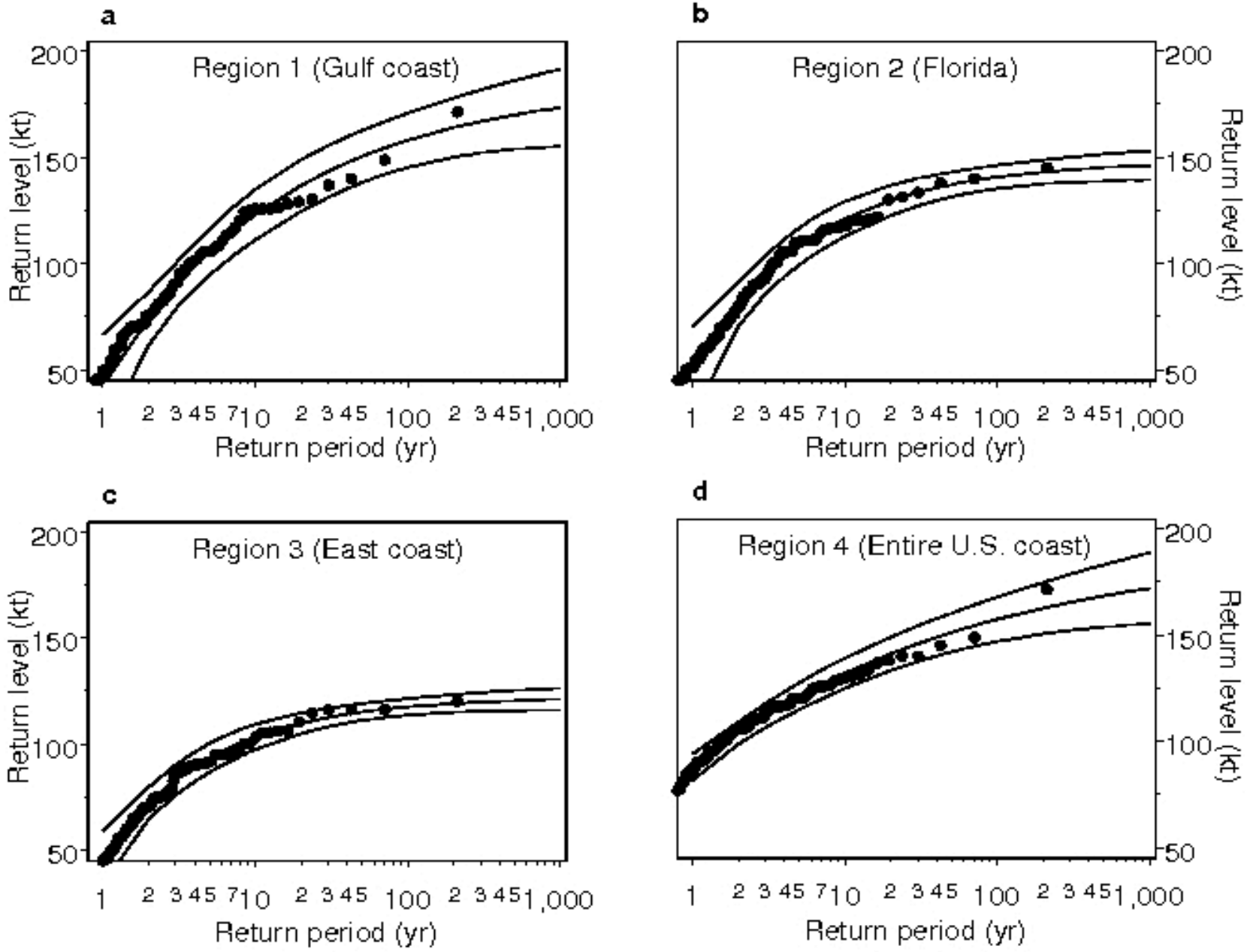
May-June values

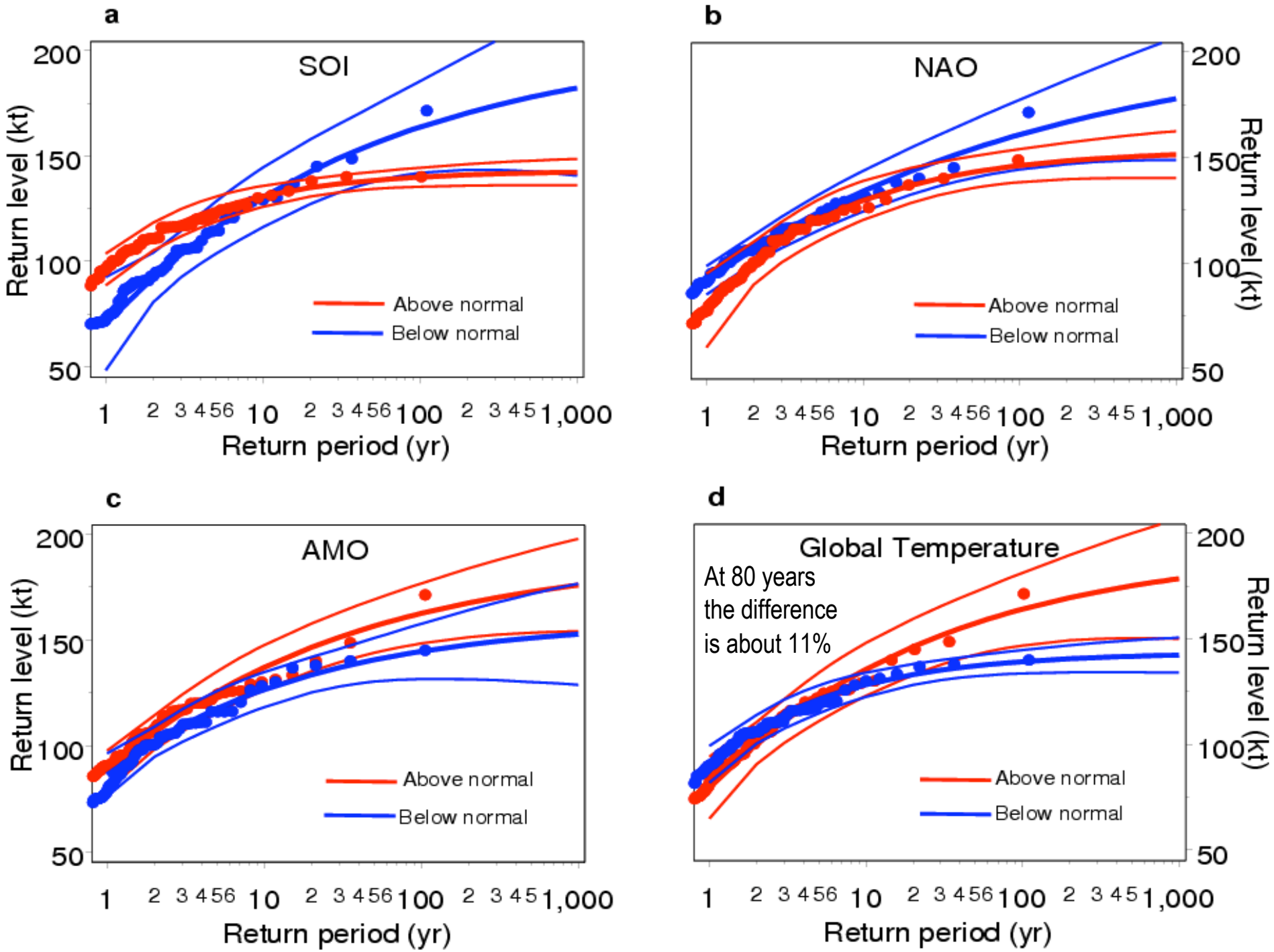




Too few strong storms to make meaningful empirical estimates of changes. But data models are useful.

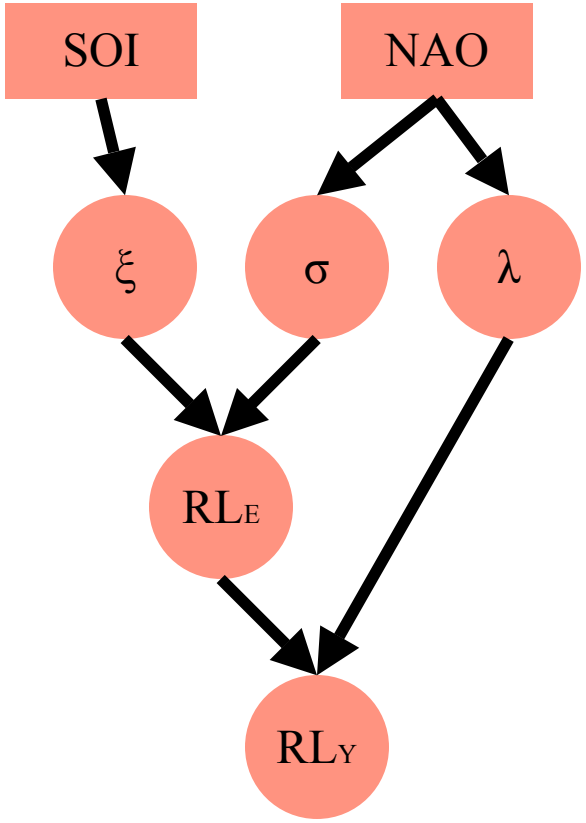


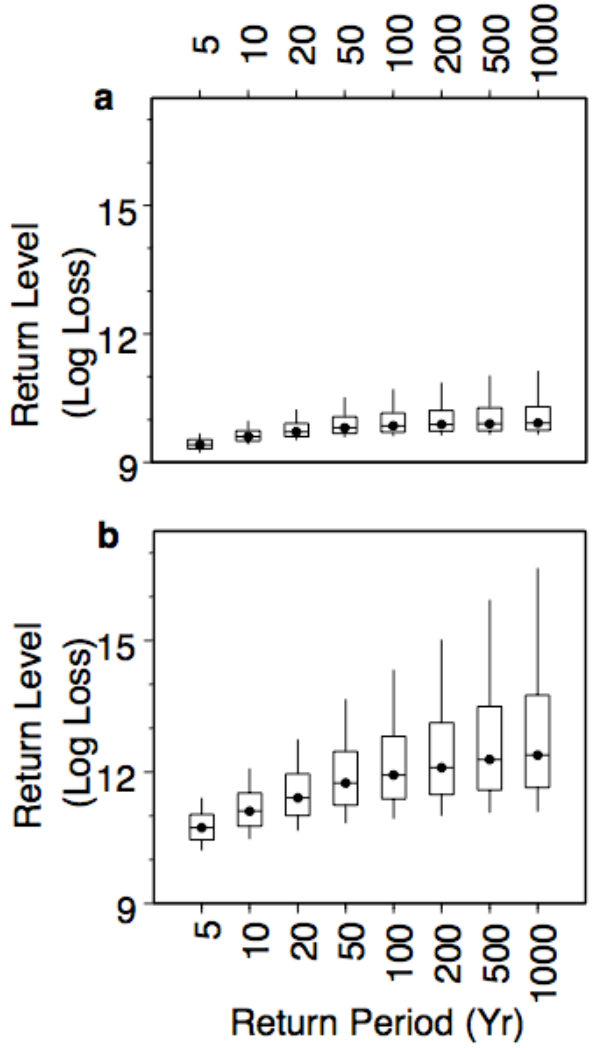

a
Region 1 (Gulf coast)
Return level (kt)
200
150
100
50
1
2 3 4 5 7 10
2 3 4 5 100
2 3 4 5 1,000
Return period (yr)
b
Region 2 (Florida)
Return level (kt)
200
150
100
50
1
2 3 4 5 7 10
2 3 4 5 100
2 3 4 5 1,000
Return period (yr)
c
Region 3 (East coast)
Return level (kt)
200
150
100
50
1
2 3 4 5 7 10
2 3 4 5 100
2 3 4 5 1,000
Return period (yr)
d
Region 4 (Entire U.S. coast)
Return level (kt)
200
150
100
50
1
2 3 4 5 7 10
2 3 4 5 100
2 3 4 5 1,000
Return period (yr)


a
SOI
Return level (kt)
200
150
100
50
Above normal
Below normal
1
2 3 4 5 6 10 2 3 4 5 6 100 2 3 4 5 1,000
Return period (yr)
b
NAO
Return level (kt)
200
150
100
50
Above normal
Below normal
1
2 3 4 5 6 10 2 3 4 5 6 100 2 3 4 5 1,000
Return period (yr)
c
AMO
Return level (kt)
200
150
100
50
Above normal
Below normal
1
2 3 4 5 6 10 2 3 4 5 6 100 2 3 4 5 1,000
Return period (yr)
d
Global Temperature
At 80 years
the difference
is about 11%
Return level (kt)
200
150
100
50
Above normal
Below normal
1
2 3 4 5 6 10 2 3 4 5 6 100 2 3 4 5 1,000
Return period (yr)

Data Models for Insured Losses

Combining a model for frequency with a model for intensity and applying it to normalized insured loss data aggregated over the entire U.S. coast produces a model that can be used to predict the maximum possible loss before the season begins.





Summary

Evidence indicates that the North Atlantic basin is responding to climate change with stronger and perhaps more frequent hurricanes. No conclusive evidence exists elsewhere.

Continued ocean warming will likely lead to stronger hurricanes threatening the US. From year to year the warming effect will be minor relative to the NAO, ENSO, and SST fluctuations, but averaged over many years (>20), the warming effect will be significant.

Climate conditions before the season provide clues as to the nature of the season and to the probability of catastrophic losses. This past year? Above normal NAO (Oct06-Jan07) indicated a lower probability of a catastrophic loss.

New research in the coming months and years will continue to shed light on some of the issues mentioned here. Advances in the field of paleotempestology. Incorporation of proxy and historical records into models of risk assessment. New, more flexible, risk assessment tools based on parametric and Bayesian statistics.

More Information

Google hurricane climate

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