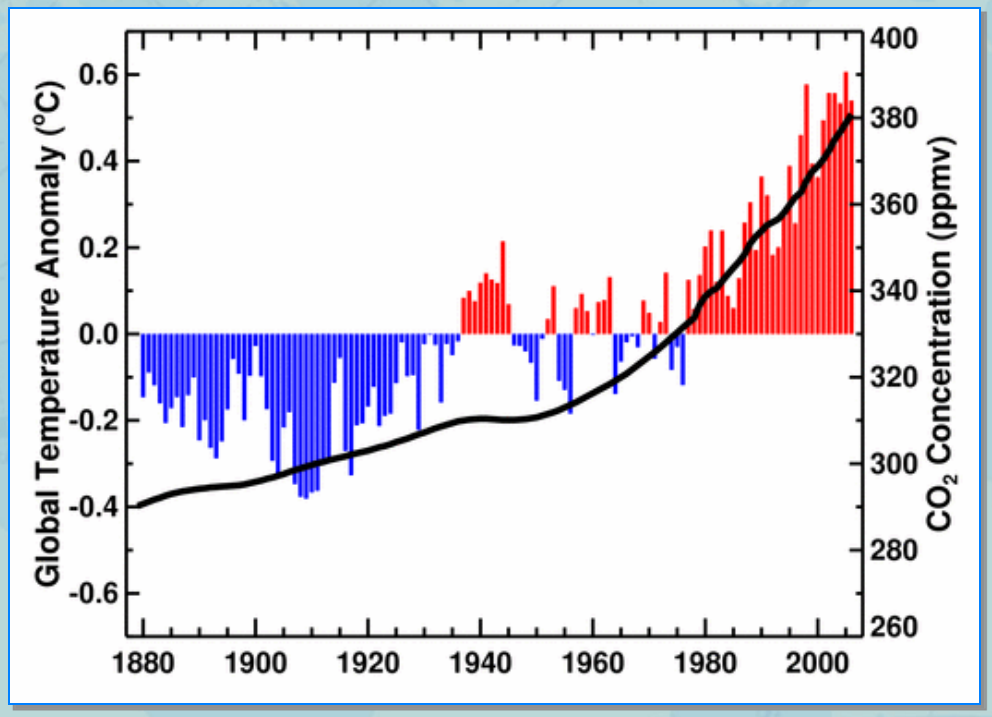
Weather and Climate Extremes: Uses and Applications



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The Problem:
Global Warming produces violent weather
One Solution:
S.U.V. Levees!

Who Needs Information on Extremes and Why?

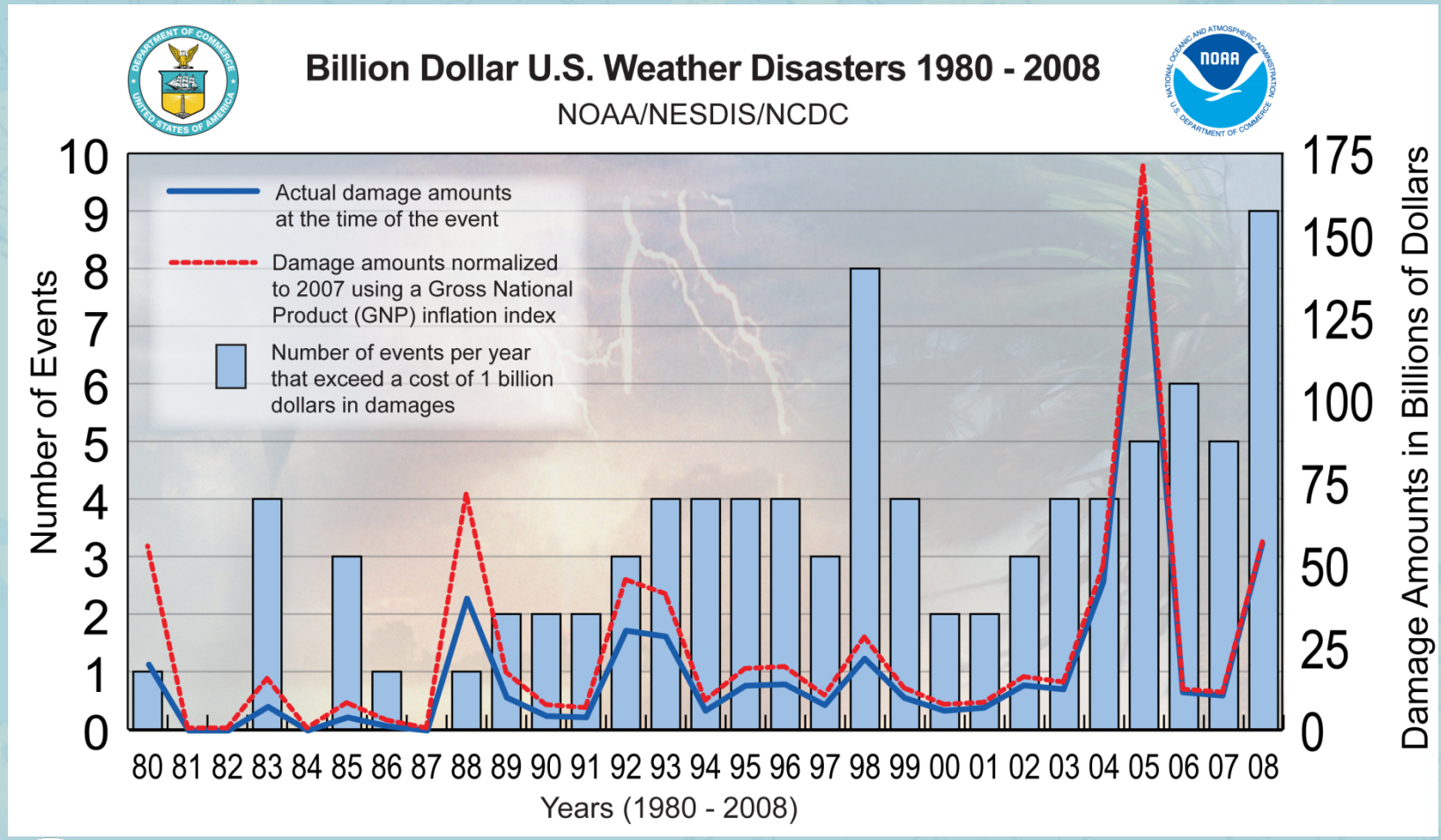
- Increased interest in regional and local changes (occurrences) in extremes
  - More relevant to people,
  - Largest impact on society
- But, we cannot *confidently* attribute any specific extreme event to human-induced climate change.
- We can make informed scientific statements about the influence of human activities on the *likelihood* of extreme events.

Health Community

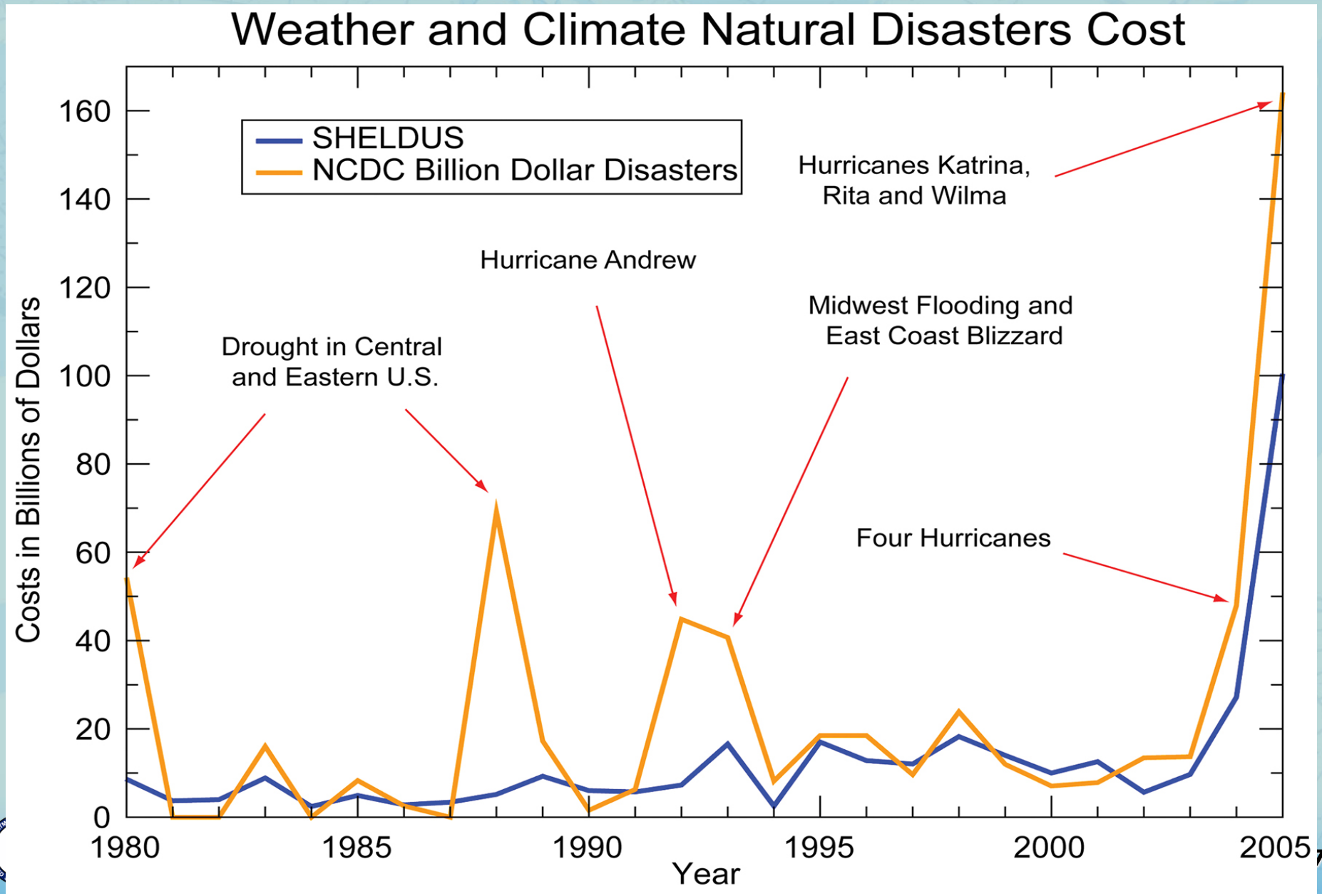
- Heat wave mortality
- Respiratory diseases and poor air quality.
- Vector-borne disease

Estimating Costs of Climate Extremes

Weather and climate extremes are among the most serious challenges to society in coping with global warming



Differences in Cost Estimates

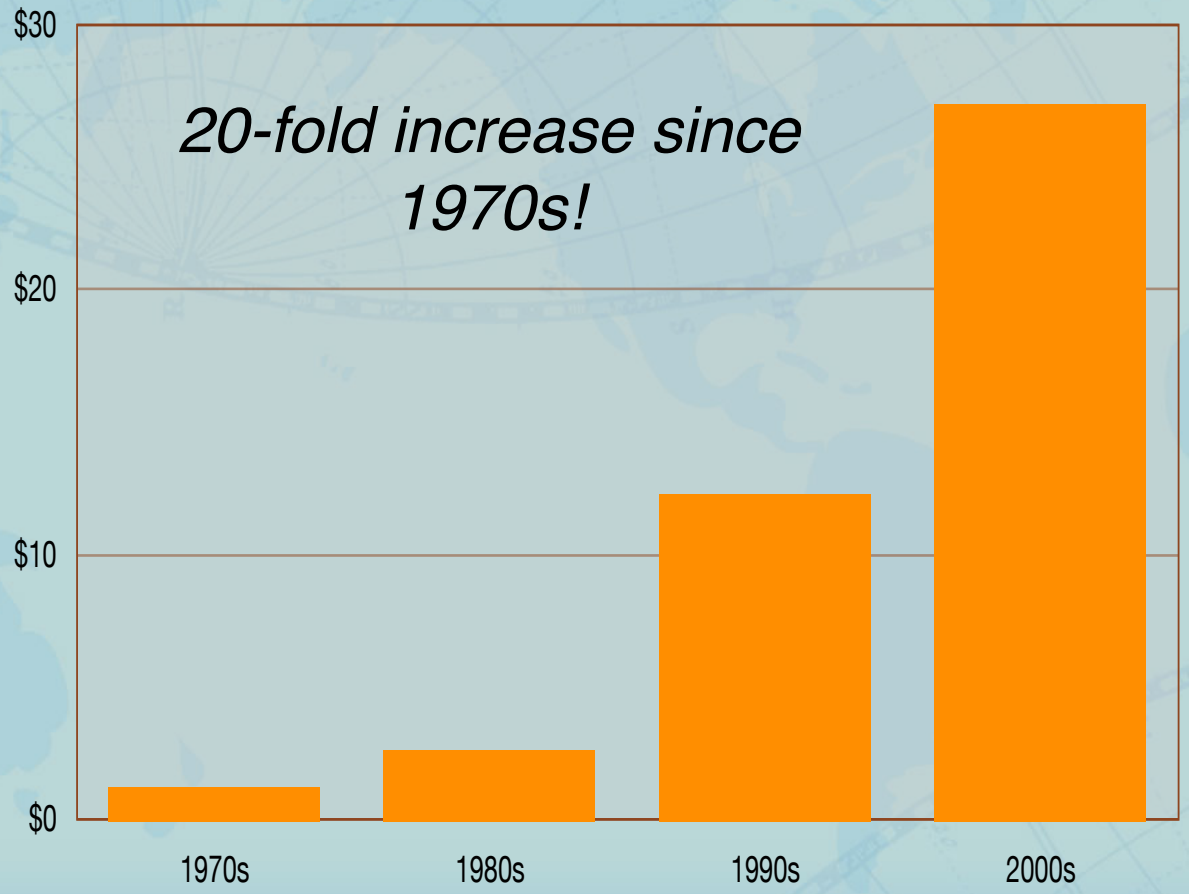


Insurance

- **Insurance has long been about the collective management of risk – RISK MANAGEMENT**
  - **Chinese marine transport from 3,000 BC**
  - **Great urban fires of the 1600s and 1700s**
- **Managing the catastrophic risk**
  - **Pooling modest premiums collected from many that reflect individual risk to pay for the catastrophic losses of a few.**
  - **Long-standing focus on promoting adaptation to prevent loss of life and property damage.**
  - **Now SEVERE WEATHER damage is growing much faster than other claims. Over the past 30 years global severe weather insurance claims have increased 20 fold.**

Severe weather claims paid

Annual global insurance disaster claims, US$B



More people and infrastructure at risk

Aging infrastructure

Changing climate

Institute for Catastrophic Loss Reduction

Building resilient communities

Food and Agriculture

- Managed systems cover ca. 40% of the earth
- Agriculture, fisheries, ecosystems feed produce enough food, but this is not accesible to all (800 M food-insecured; 200 M children malnourished)
- Food emergencies are related to climate hazards and some are particularly vulnerable
- Additional production will be required by growing population and changes in diet (more protein)
- Increasing pressures on resources (land, water, pollutants) challenges systems integrity under evolving climate

Regions

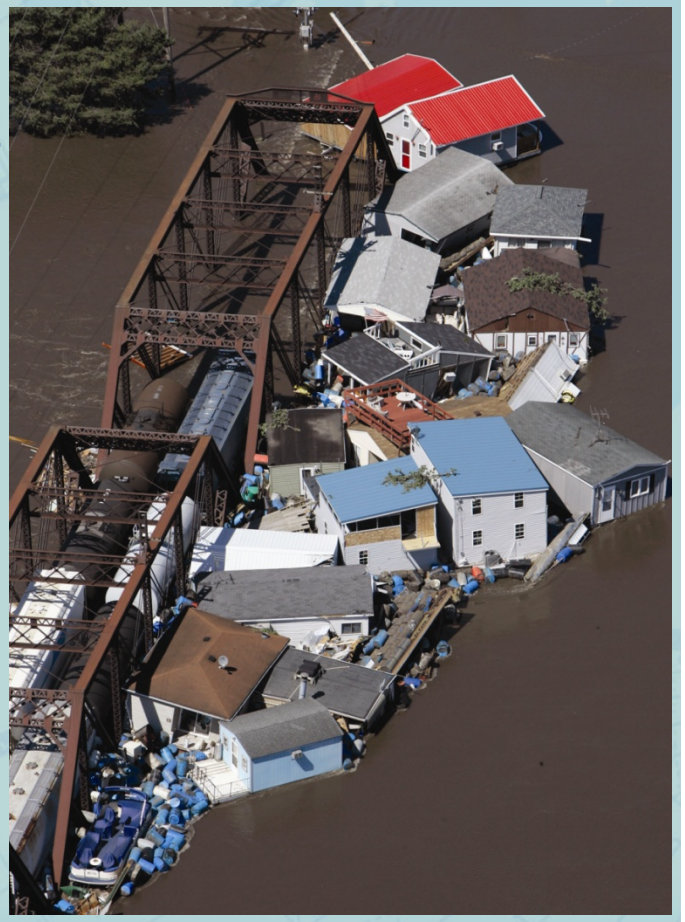
- **Africa:** … access to food, in many African countries and regions is projected to be severely compromised by climate variability and change
- **Asia**: …the risk of hunger is projected to remain very high in several developing countries
- **Latin America**: …Productivity of some important crops [and livestock] is projected to decrease with adverse consequences for food security

Water Planning

- Need to know about heavy precipitation for infrastructure planning.
- Drought

Vulnerability and Risk: Moderate vs. Extreme Events.

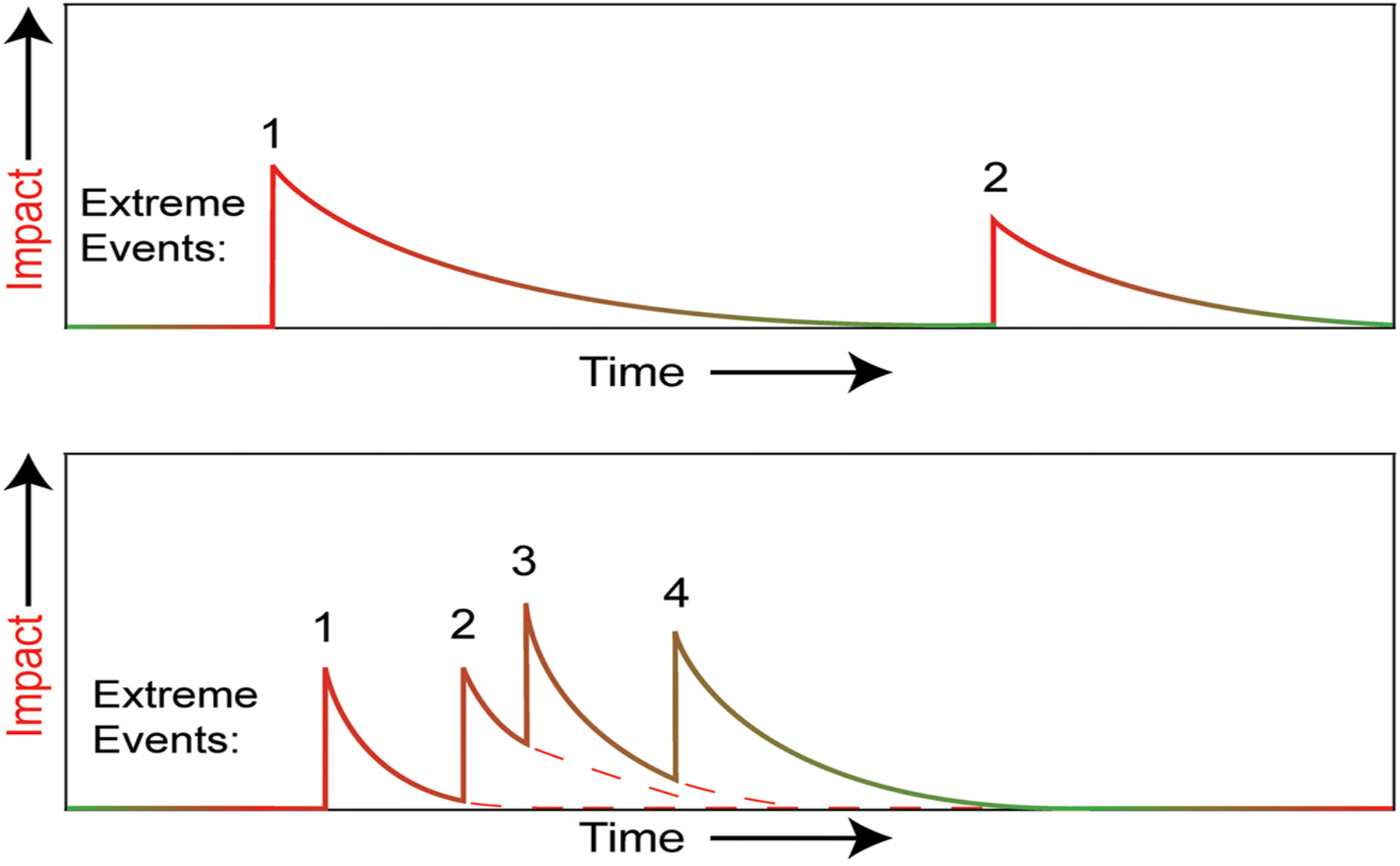
- Efforts to reduce risk for moderate events may lead to larger risk for extreme events
  - Levees control moderate floods,
  - Leads to more development in flood plains and false sense of security,
  - Major flood inflicts much larger damages than would have occurred without flood control measures.



Multiple and Compound Extreme Events

- Multiple events: when additional events occur before a system has fully recovered.
- Compound events: when two or more events occur simultaneously in the same location.

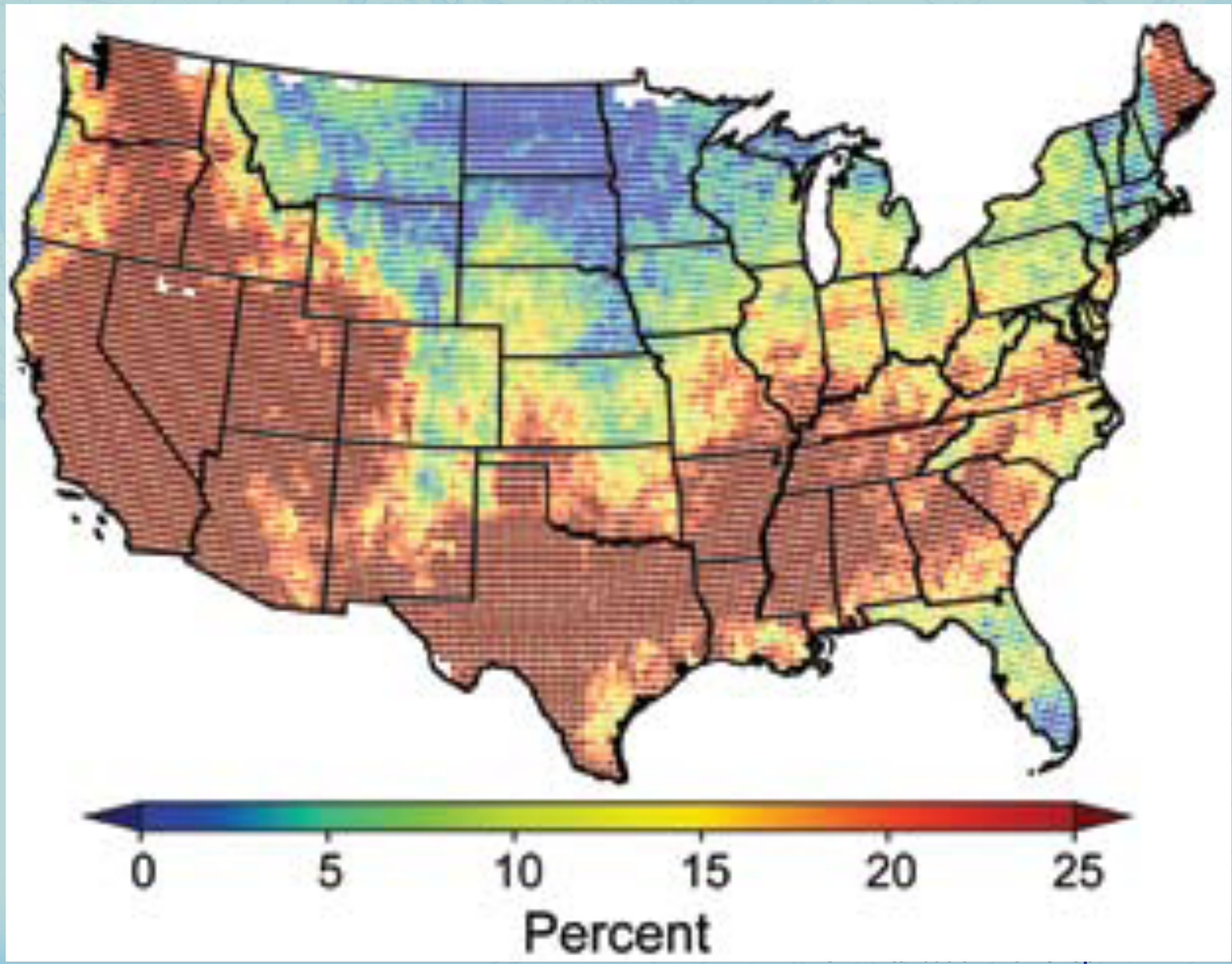
Extreme Events and Recovery of a System



September 8, 2004

September 19, 2004

Simultaneous Occurrence of Heat Wave and Extreme Air Stagnation



IMPACTS

Calculate thresholds

Crossing certain thresholds can lead to dramatic effects. Are there other thresholds we should be watching for?

Understand multiple stresses

Multiple stresses are common in society and the environment. And so we need to be prepared to deal with multiple stresses. Is climate change likely to produce other complex stresses that we should know about?

Quantify natural benefits

Nature provides us with many benefits such as food, fuel and fiber as well as many services we take for granted such as the cleansing of air and water. Are there benefits that we depend upon that are in jeopardy?

IMPACTS

Assess impacts on human health and well being

Climate change is going to impact many aspects of human health and well being. Are these impacts being adequately measured and projected so we can take action before a problem gets too serious?

Determine reversibility of impacts

Some aspects of climate change appear to be irreversible. Are the irreversible impacts being monitored adequately so that we can take precautions?

ADAPTATION

Incorporate climate change in planning

Some say we didn't pay much attention to climate change in the past and our country developed just fine. Why do we need to pay so much attention to it now?

Better understanding of evolving nature of adaptation

Climate is not constant. It will now continuously evolve so adaptation must also be dynamic. How can this adaptation be most effective?

ADAPTATION

Determine unintended consequences

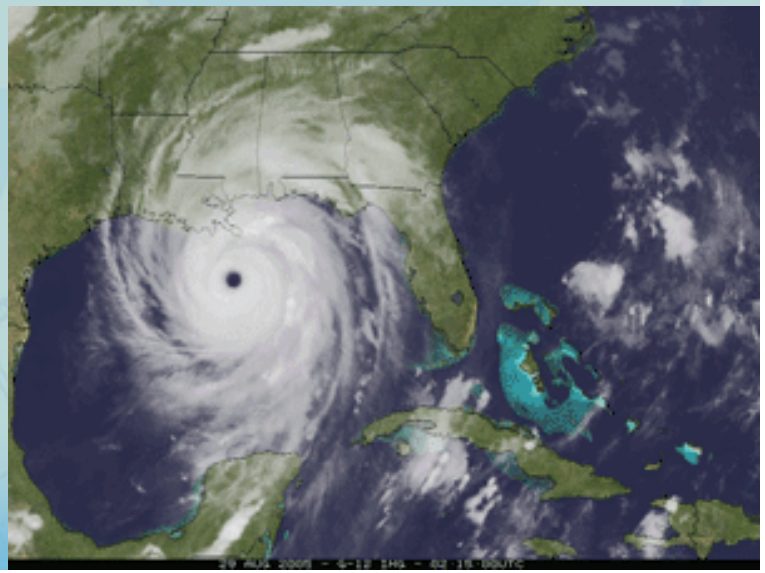
We've seen food prices sky rocket around the world while more corn is being turned into fuel forcing corn growth for food onto more marginal land. This consequence was not widely discussed when ethanol policy was being debated. Are there other unintended consequences awaiting us?

Estimating costs and benefits of adaptation actions

The Unified Synthesis Product outlines a number of adaptation strategies to help society cope with climate change in the context of other stresses. Do we have adequate methods to carry out cost-benefit analyses for such adaptation strategies?

Question

- What would change, policy-wise, if we can attribute extreme events to human-induced climate change?
  - For example, hurricanes, would attribution of Katrina make a difference in the post-Katrina response?



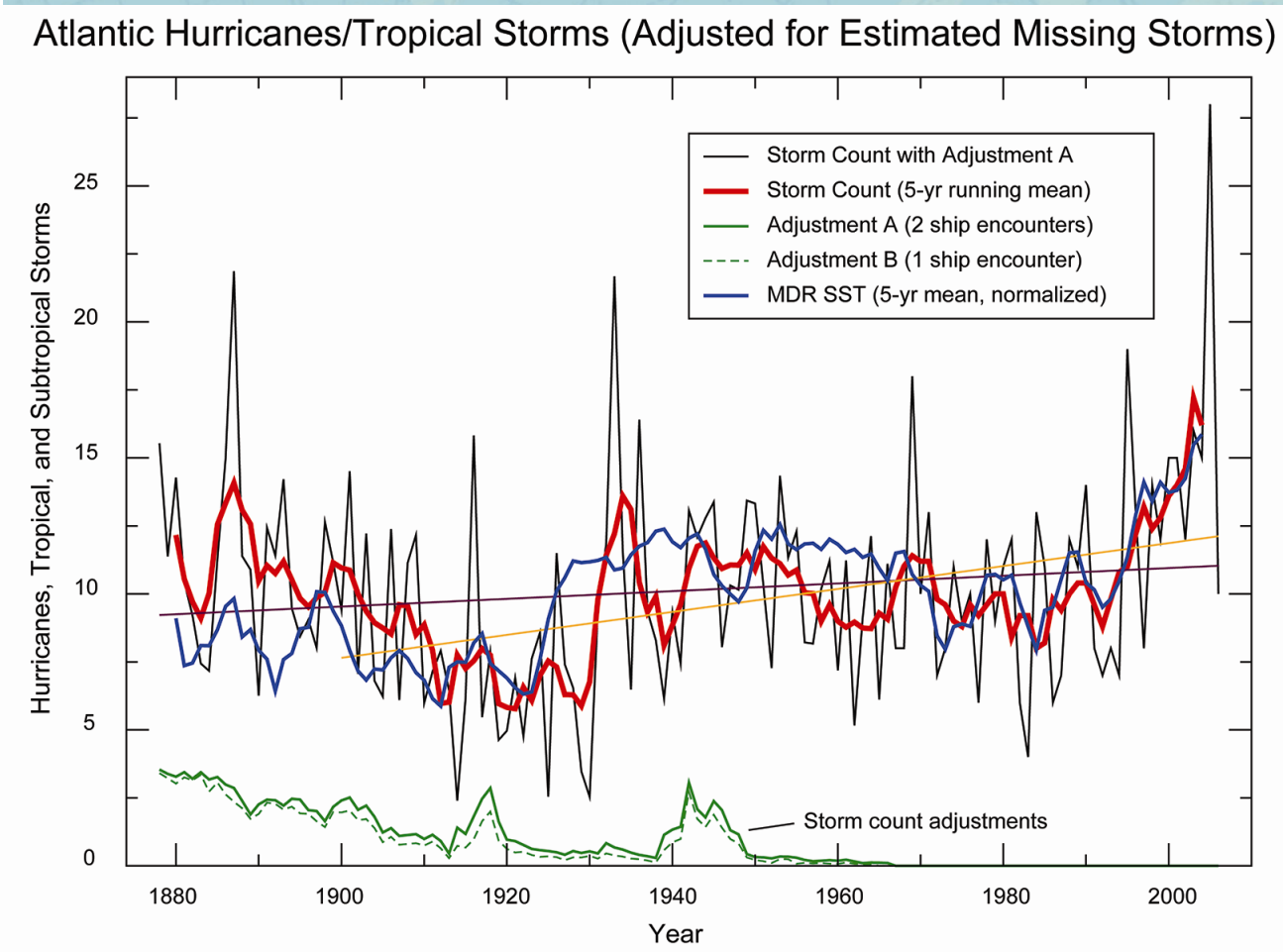
...and that concludes my federal report on the status of global warming. Now, special agent Coffield here will be placing you all under arrest for having classified information.

Questions?

Uncertainty Issues

STORMS & HURRICANES

Observed Changes and Uncertainty

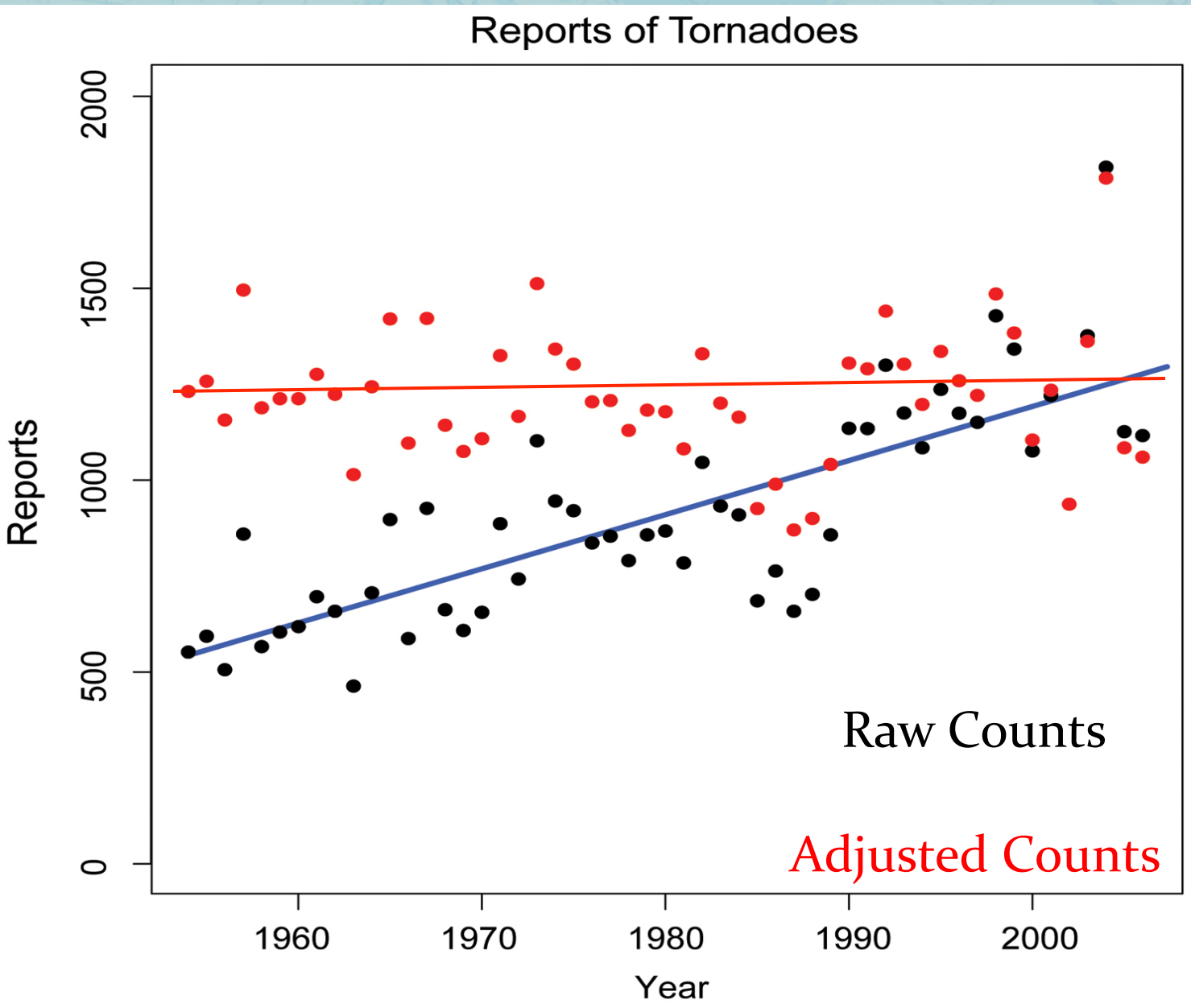


Atlantic hurricanes and tropical storms for 1878-2006, adjusted for missing storms.

Black curve is adjusted annual storm count,

Red curve is 5-year running mean, and

Blue curve is a normalized 5-year running mean SST index for Main Development Region


Reports of Tornadoes
Reports
0
500
1000
1500
2000
1960
1970
1980
1990
2000
Year
Raw Counts
Adjusted Counts

How do we examine changes in tornadoes?

- Must use large-scale storm environment changes rather than direct observations of storms.
  - Changes in thermodynamic parameters due to increased atmospheric water vapor and temperature.
  - Can also be done for model simulations.

How Do We Deal with Uncertainty Issues Like These?

Multiple independent experts and analyses

- Digitize and homogenize observational data sets by multiple groups.
- Multiple analyses by independent groups.
  - This approach helped reconcile the tropospheric temperature trends issue.
  - Would be very useful for extremes such as tropical storms or thunderstorms/ tornadoes.