Overview of Actuaries Climate Index Research Project

Actuaries Climate Index Committee

CIPR Symposium:

Implications for Increasing Catastrophe Volatility on Insurers and Consumers

October 7, 2014

CAS

American Academy of Actuaries
Objective. Independent. Effective.™

Society of Actuaries
A.S.A. 1889
A.I.A. 1909
1949

Canadian Institute of Actuaries
Institut canadien des actuaires

Agenda

- **Introduction**
  - Michael E. Angelina, MAAA, ACAS, CERA
- **About the Actuaries Climate Index (ACI)**
  - R. Dale Hall, FSA, MAAA, CERA, CFA
- **Possible Future Uses**
  - Stephen L. Kolk, ACAS

Actuaries Climate Index Committee Structure

- CAS Climate Change Committee

  - Climate Index Working Group
    - Caterina Lindman, Chair
    - Members include actuaries from the CIA, CAS, SOA, and the American Academy of Actuaries

- Climate scientists from Solterra Solutions have been collaborating with the Committee to develop the ACI

Actuaries Climate Risk Index Project Overview

- ACI
  - An Internet-based index to support scientific consensus on climate risk: frequency/intensity of extreme climate events has increased notably in recent decades
  - ACI will function as a useful monitoring tool for actuaries, policy makers, the public, and other interested parties
  - Website will host a variety of graphics depicting changes in ACI, its components, and regional distribution of changes
  - Quarterly updates with information provided in English and French

Actuaries Climate Risk Index Project Overview

- ACRI
  - Assessing risk due to changing ACI requires information on the human and built environment: *What/who is currently in harm's way?*
  - Goal is to provide an index that is especially useful to the insurance industry
  - Quantifying risk in the form of an ACRI requires establishment of relationships between climatic and socioeconomic factors
  - Investigation of these relationships in the North American context is underway

Background – Climate Change

- Since 2005, severe weather and climatological events accounted for 85 to 90 percent of natural hazards resulting in claims or property damage or personal injury, according to global totals (Munich Re 2012)

- A significant increase in the frequency of heavy precipitation events has been observed in the majority of locations where data are available
  - Particularly in the eastern half of North America and Northern Europe, where there is a long record of observations

- As expected, regionally, changes can be significantly higher or lower than the global average. For example:
  - In the SW Pacific Ocean, the rate of sea-level rise is 4x the global mean.
  - At 66 percent of measurement stations along the continental shores of the U.S., sea-level rising has led to a doubling in the annual risk of what were considered "once in a century" or worse floods

Background – Climate Change

- The main changes that have occurred are:

  - Global mean surface temperatures have risen by three-quarters of a degree Celsius over the last 100 years
    - The rate of warming over the last 50 years is almost double the rate over the last 100 years
  - The 16 warmest years on record occurred in the 17-year period from 1995-2011
  - Land regions have warmed at a faster rate than the oceans, which is consistent with the known slower rate of heat absorption by seawater
  - Over the past five decades, the frequency of abnormally warm nights has increased, and that of cold nights has decreased, at most locations on land
    - Fraction of global land area experiencing extremely hot summertime temperatures has increased approximately ten-fold over the same period

The Actuaries Climate Index

- Measures change in frequency of extreme events and/or magnitude of recent change relative to natural climate variability

- Focuses on measuring frequency and intensity of extremes in key climate indicators based on quality-controlled observational data

  - Temperature
  - Precipitation
  - Drought
  - Wind
  - Sea level
  - Soil moisture (means)

- Data observations via a 2.5° by 2.5°grid (275km x 275km at equator)

- Updatable on a frequent (seasonal) basis from publicly available data sources

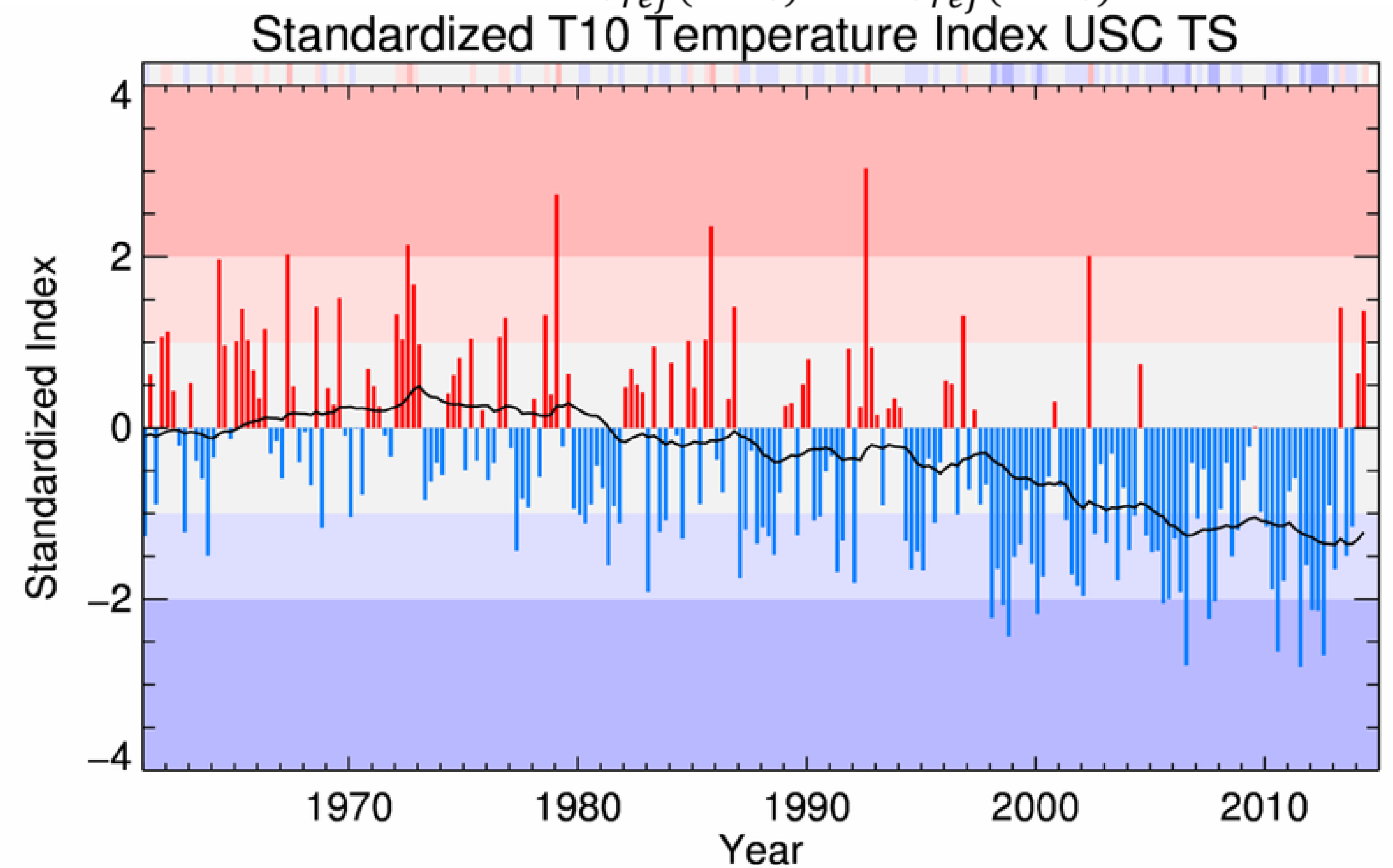
The Actuaries Climate Index

- Covers U.S. and Canada
- Also calculated for 12 North American sub-regions
- Hope to gradually add other parts of world where good data is available
- Publish Index and related information on website

- Could be readily extended to a more comprehensive Index containing socioeconomic information, serving the needs of actuaries, stakeholders, & the public more directly

Background of Climate Risk
Index T10: Excess frequency of cool days and nights

$$T10' = \frac{\Delta TX10}{2\times\sigma_{ref}(TX10)} + \frac{\Delta TN10}{2\times\sigma_{ref}(TN10)}$$

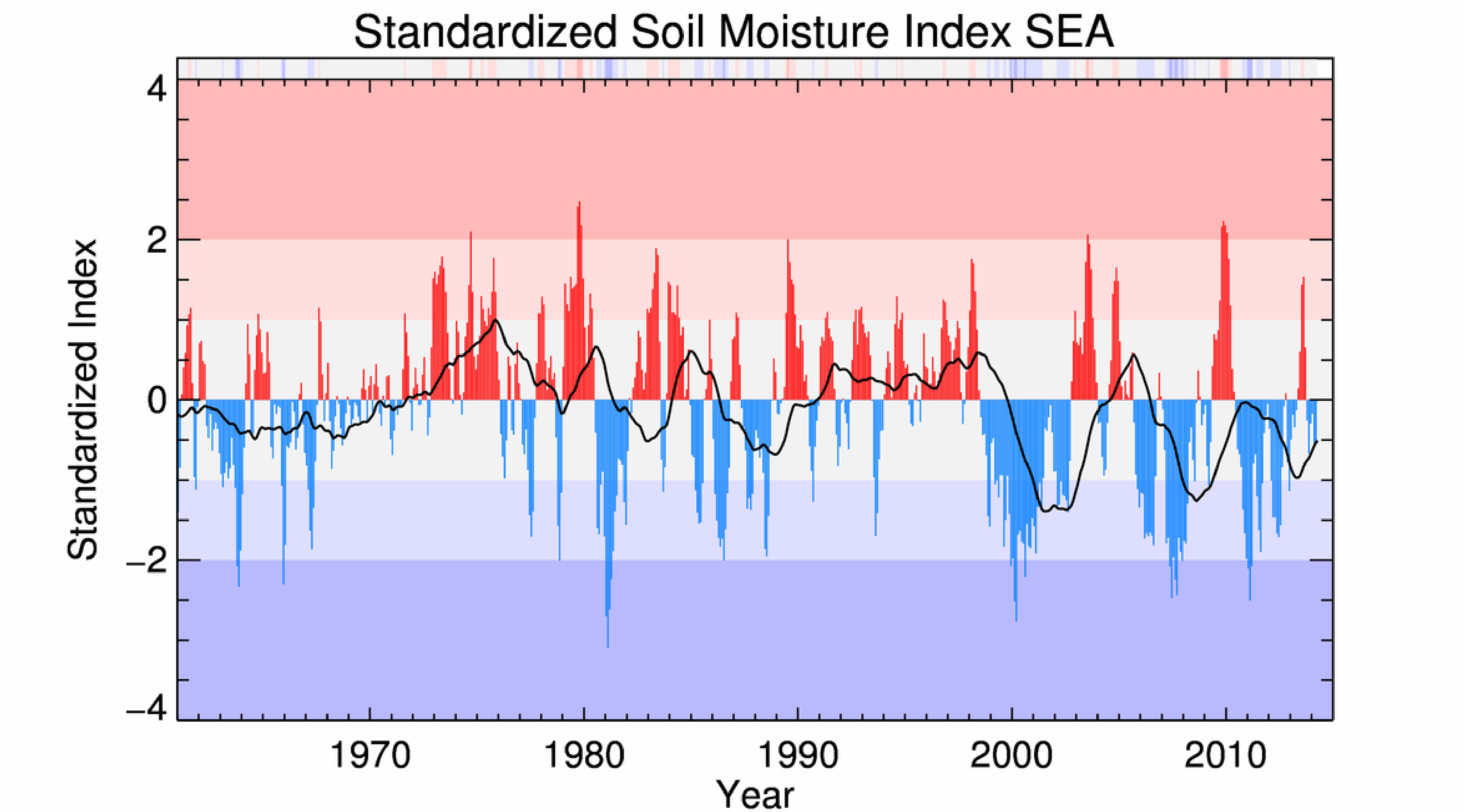


Winter 2013-14

Background of Climate Risk

Soil Moisture

Monthly soil moisture anomaly from NOAA Climate Prediction Center: *M′*



Solterra Solutions

Background of Climate Risk
Soil Moisture

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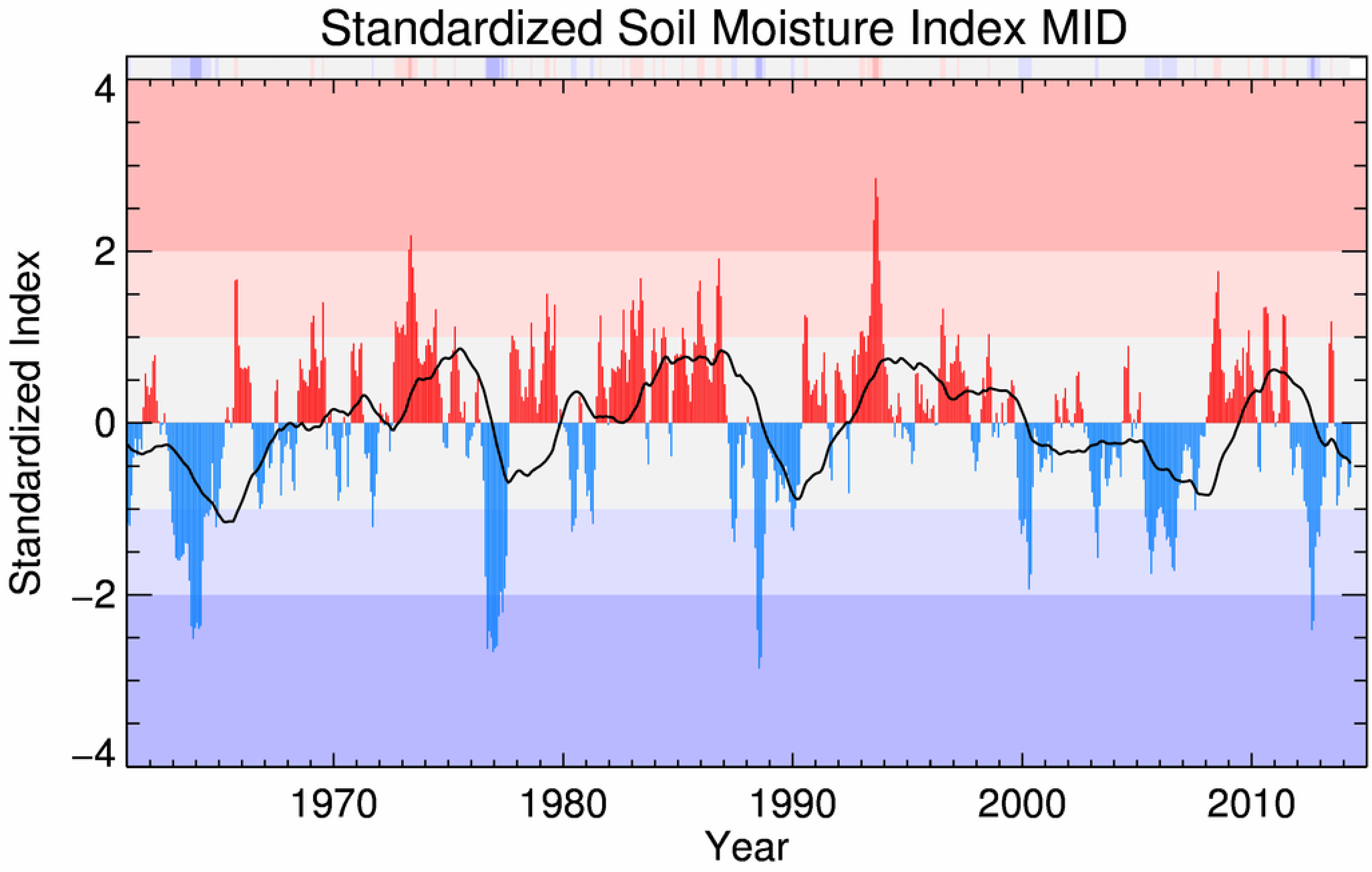

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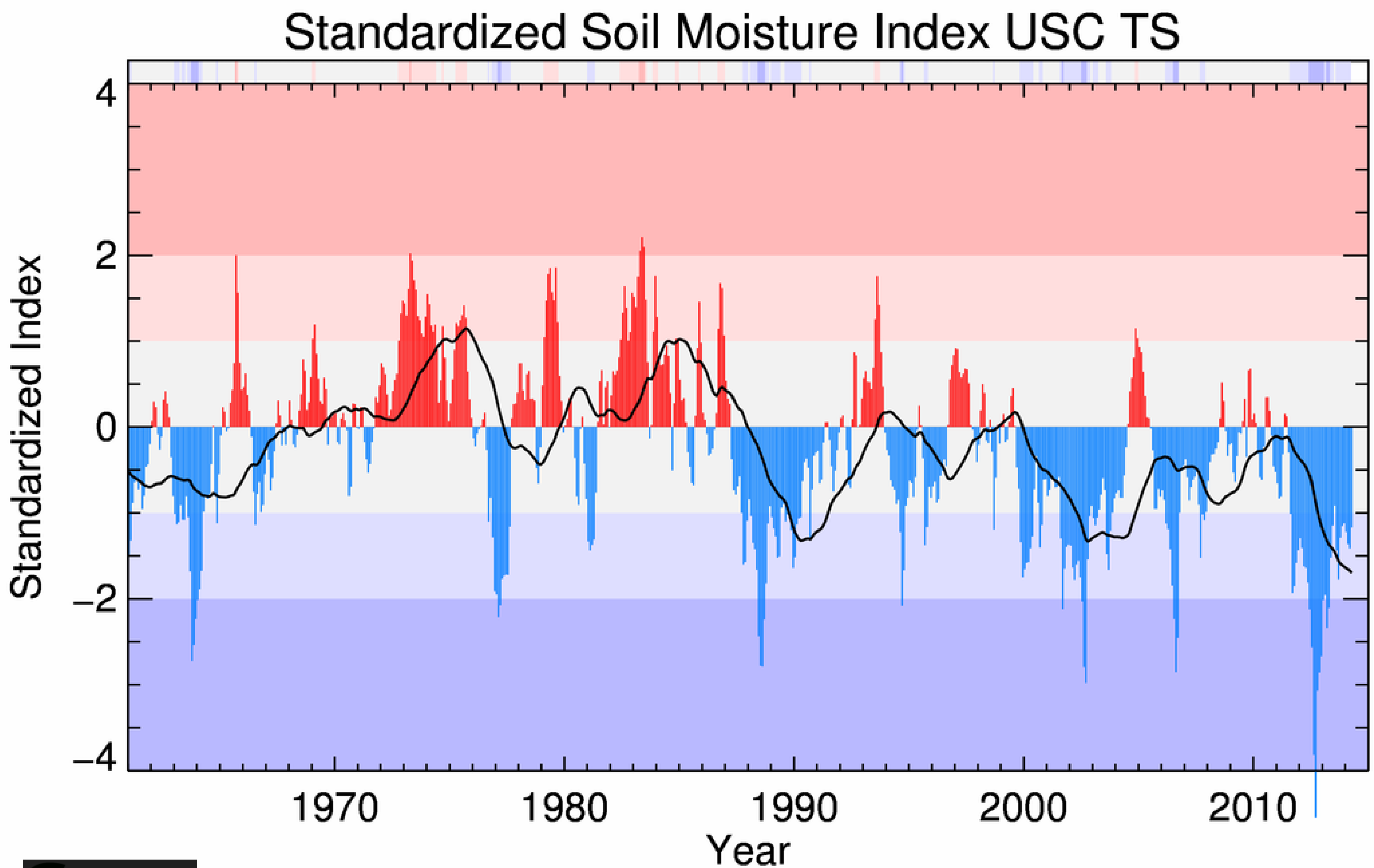


Composite ACI: Putting it all together

- Many ways to combine components (e.g., temperature, soil moisture, drought) into a composite ACI, and a couple of options will be available via final website

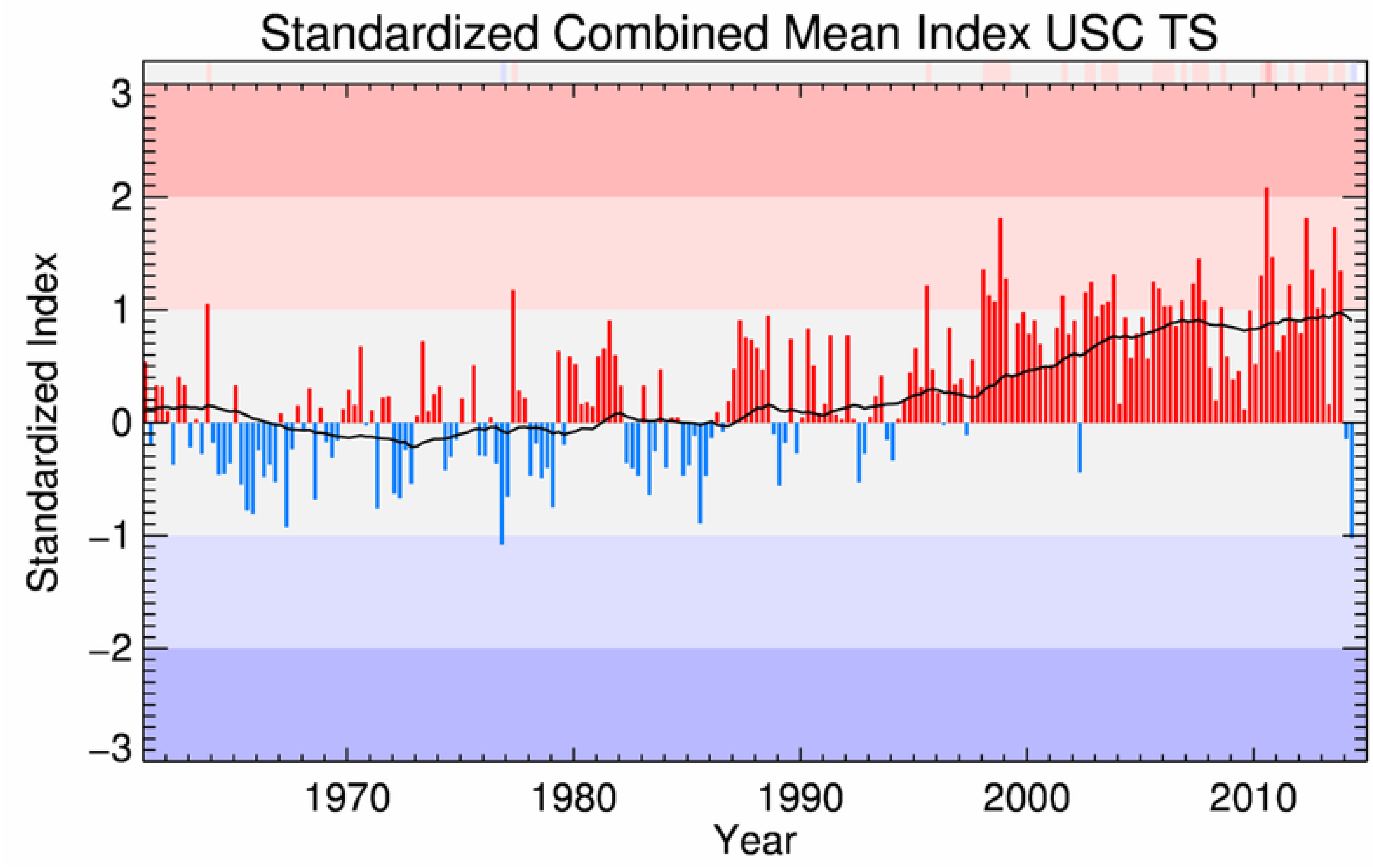
- Default form is a simple mean of components:

$$ACI = \text{mean}(T90' - T10' + P'_X + D'_X + W'_X + S')$$

(soil moisture omitted in this form due to its indirect connection to flooding; but available as an option)

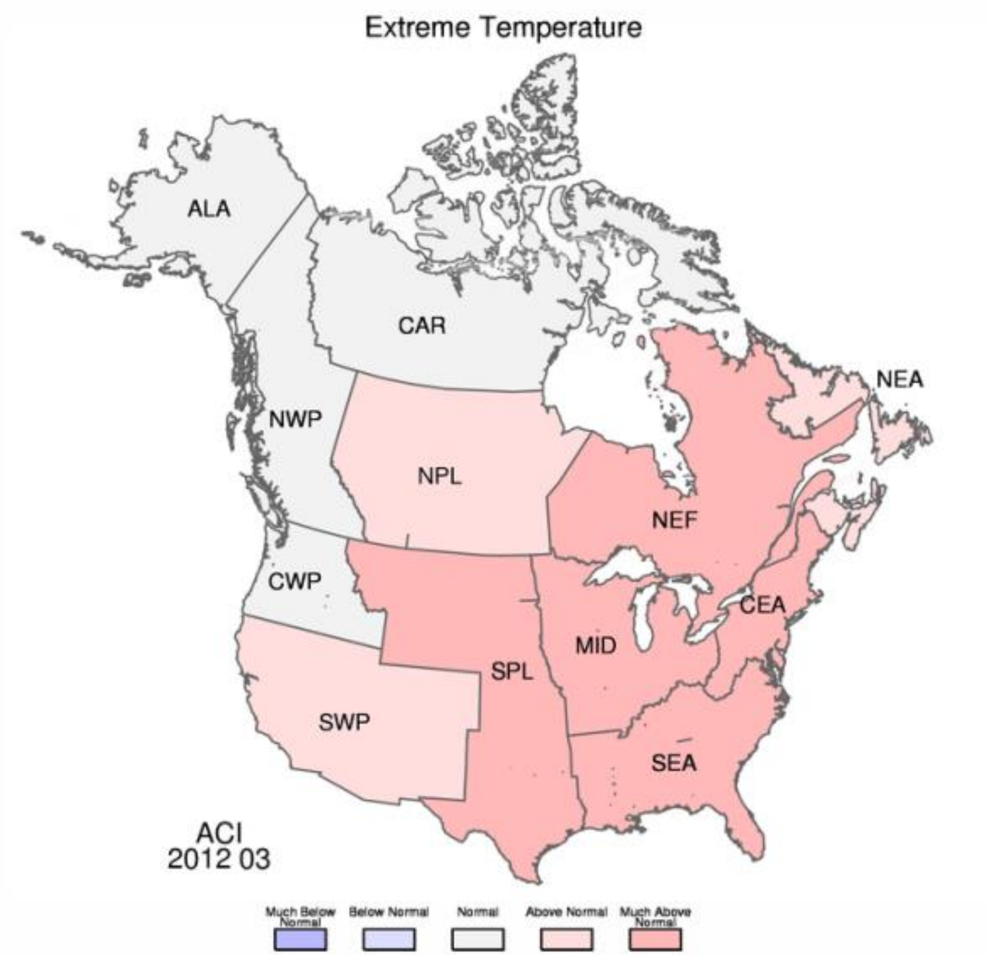
Solterra Solutions

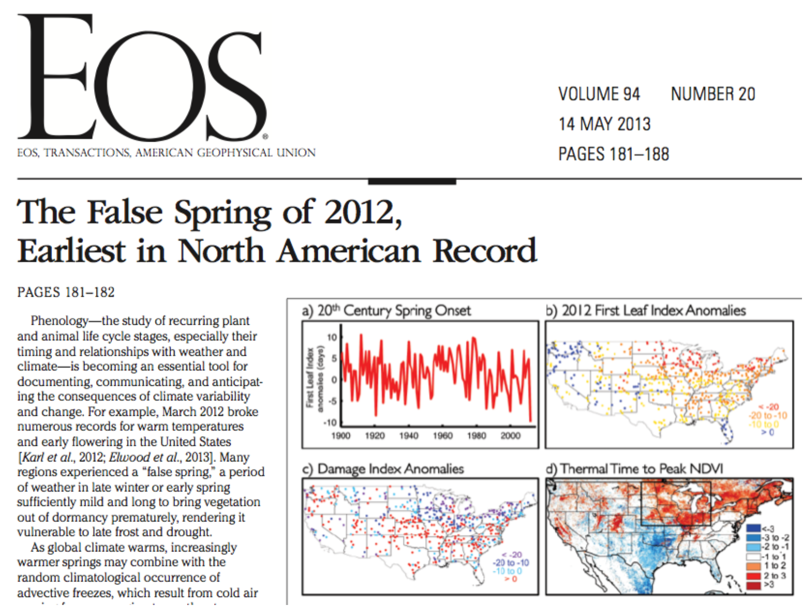
Composite seasonal ACI



ACI: Validation and regional breakdown

Example from prototype website for March 2012





EOS

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

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PAGES 181–188

The False Spring of 2012, Earliest in North American Record

PAGES 181–182

Phenology—the study of recurring plant and animal life cycle stages, especially their timing and relationships with weather and climate—is becoming an essential tool for documenting, communicating, and anticipating the consequences of climate variability and change. For example, March 2012 broke numerous records for warm temperatures and early flowering in the United States [*Karl et al.*, 2012; *Elwood et al.*, 2013]. Many regions experienced a "false spring," a period of weather in late winter or early spring sufficiently mild and long to bring vegetation out of dormancy prematurely, rendering it vulnerable to late frost and drought.

As global climate warms, increasingly warmer springs may combine with the random climatological occurrence of advective freezes, which result from cold air

a) 20th Century Spring Onset

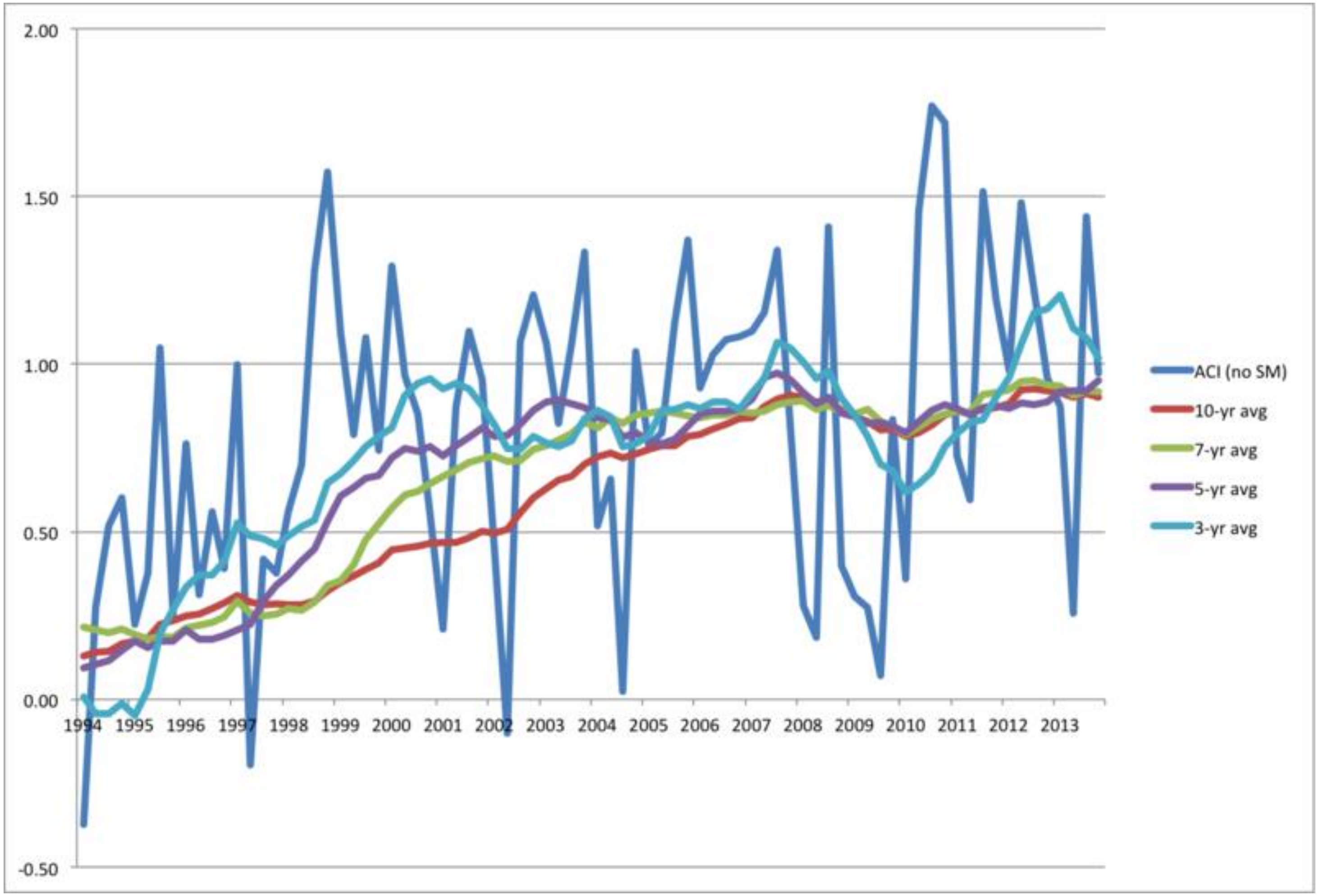
b) 2012 First Leaf Index Anomalies

c) Damage Index Anomalies

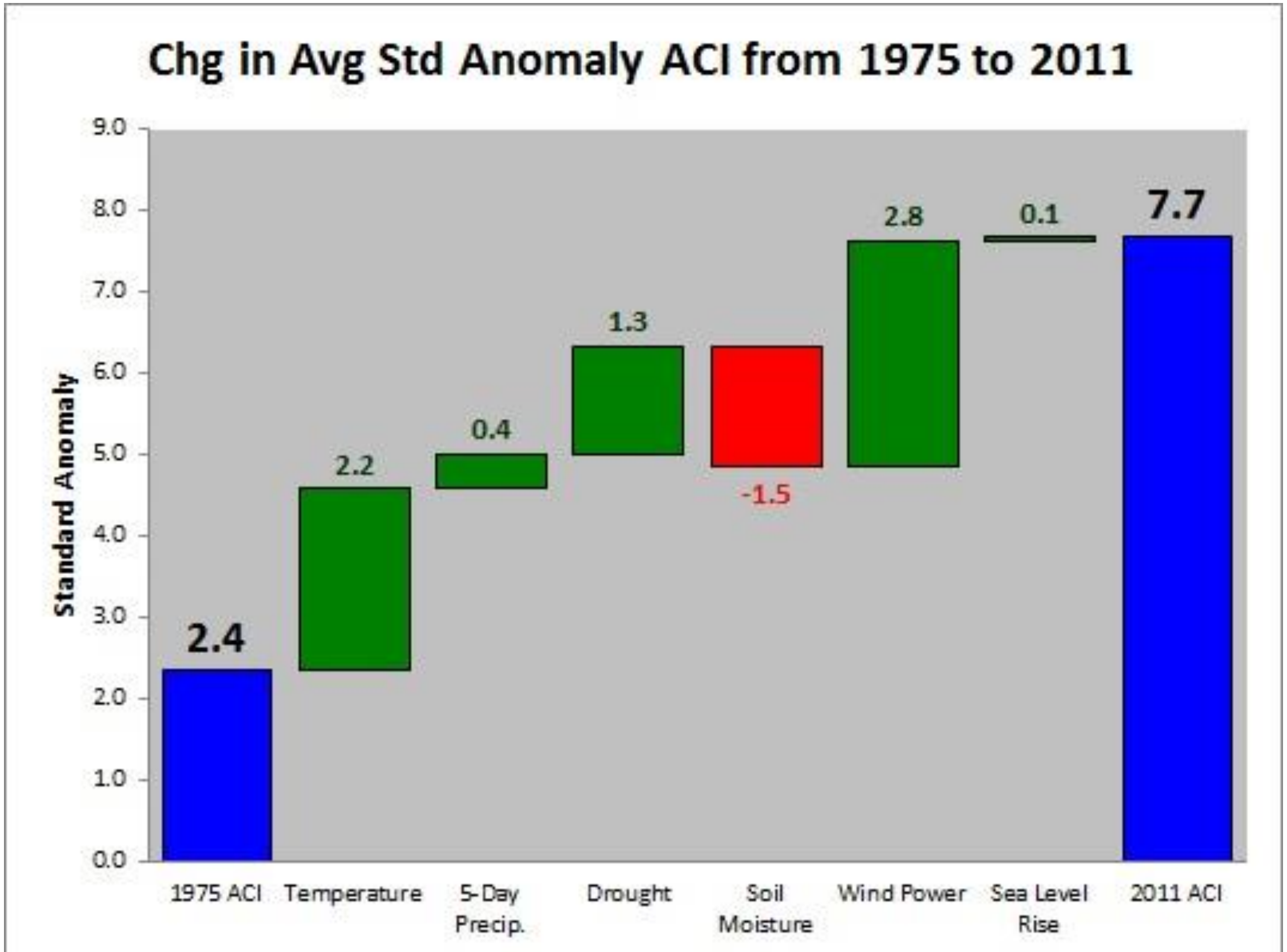
d) Thermal Time to Peak NDVI

What might actuaries and others do with the ACI (and the Actuaries Climate Risk Index)?

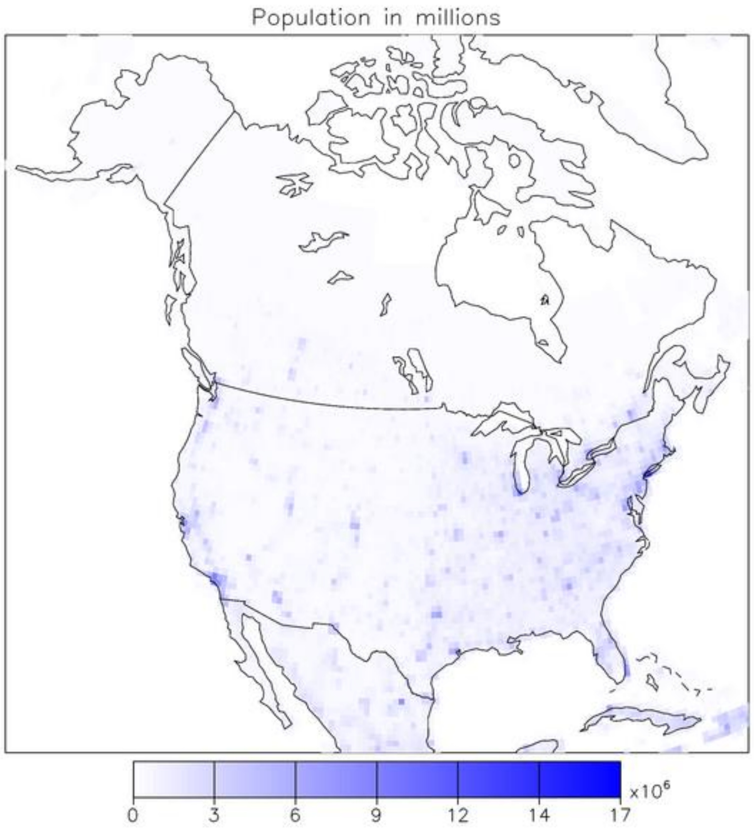
Measure change in extreme climate over time



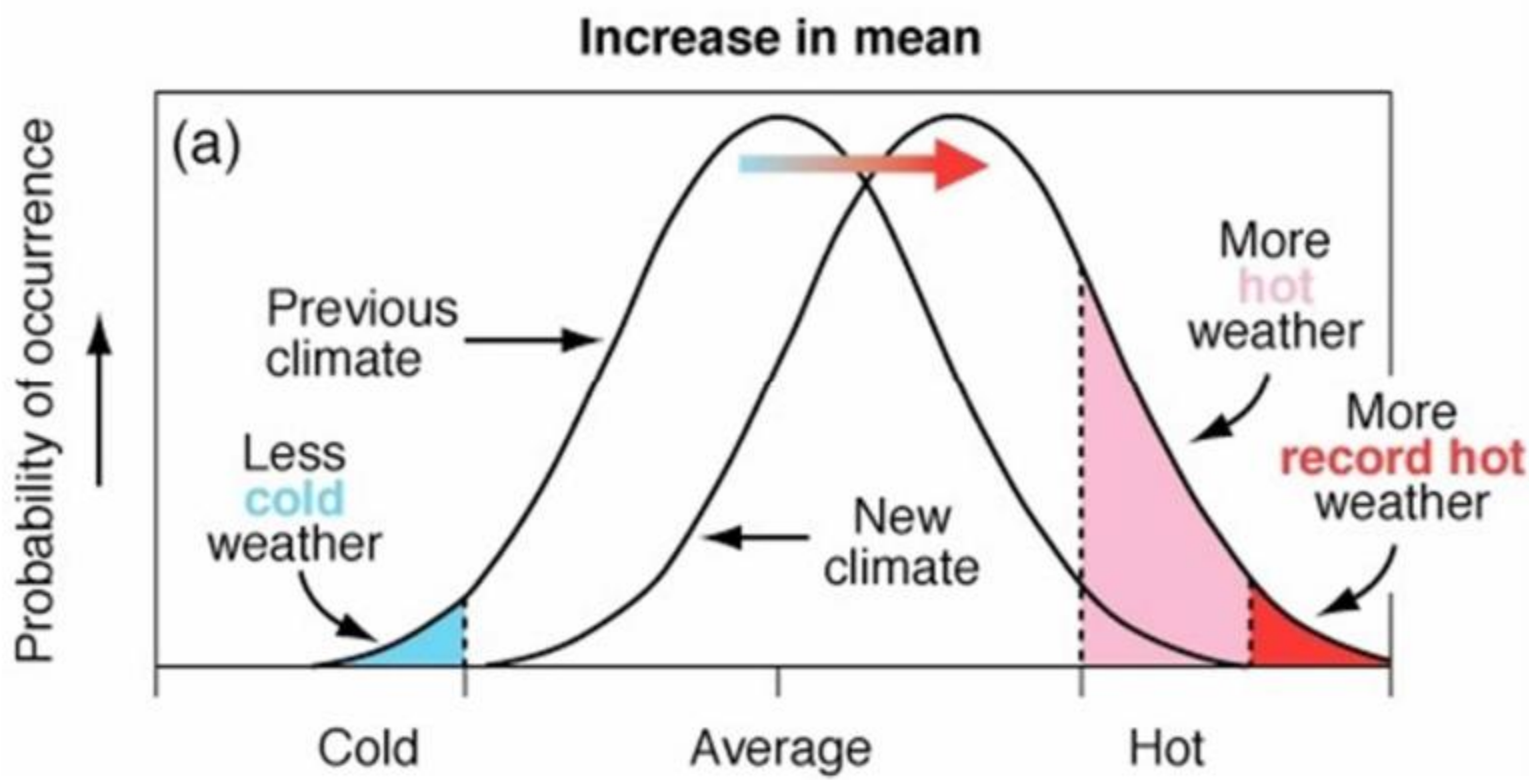
Measure change in extreme climate by component



Use ACI region data and ACRI exposure measures

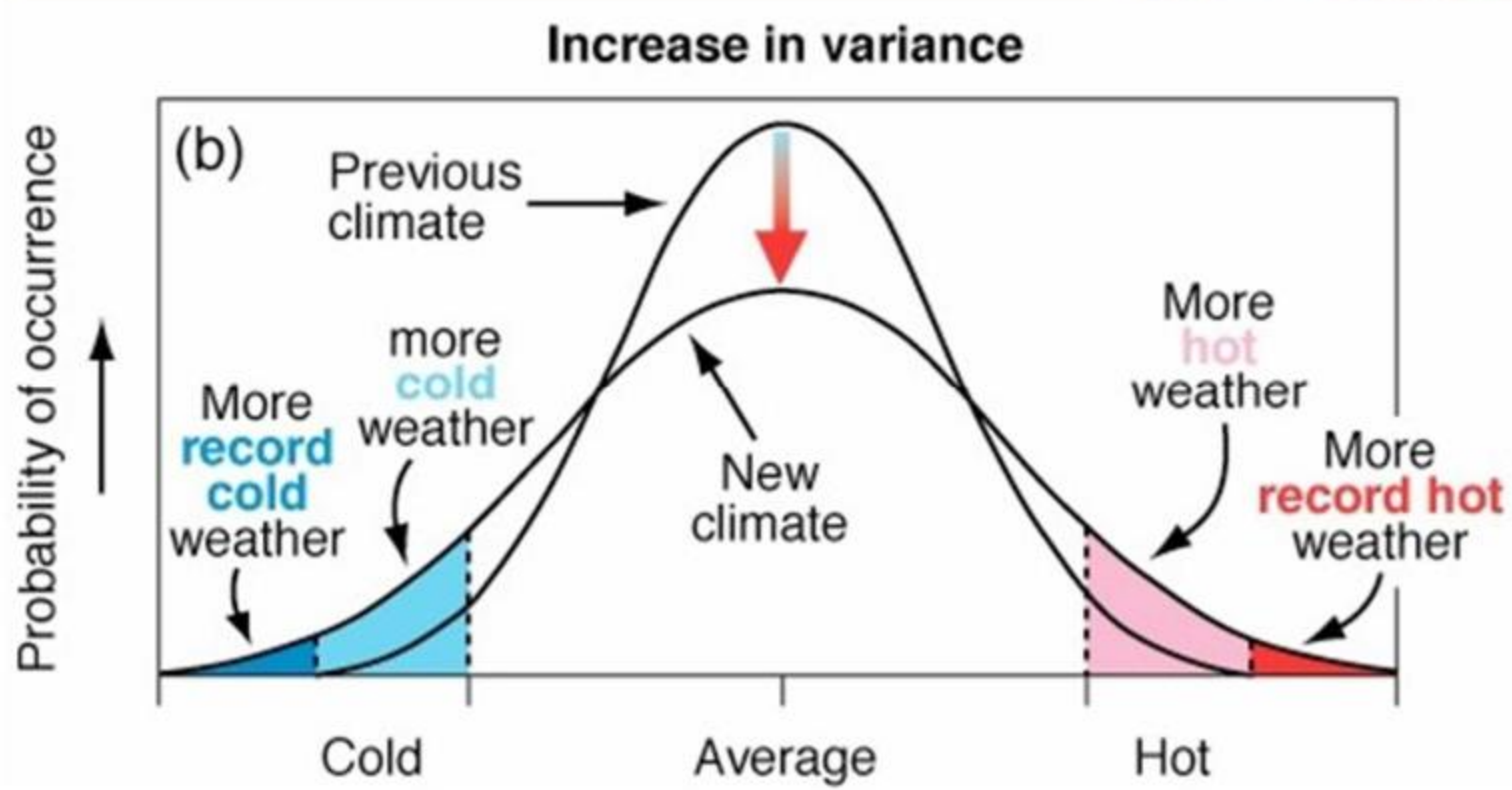


Climate Impact #1: INCREASE IN MEAN



Source: North American Climate Change Committee Report: *Climate Determining the Impact of Climate Change on Insurance Risk and the Global Community Phase 1: Key Climate Indicators*

Climate Impact #2: INCREASE IN VARIANCE



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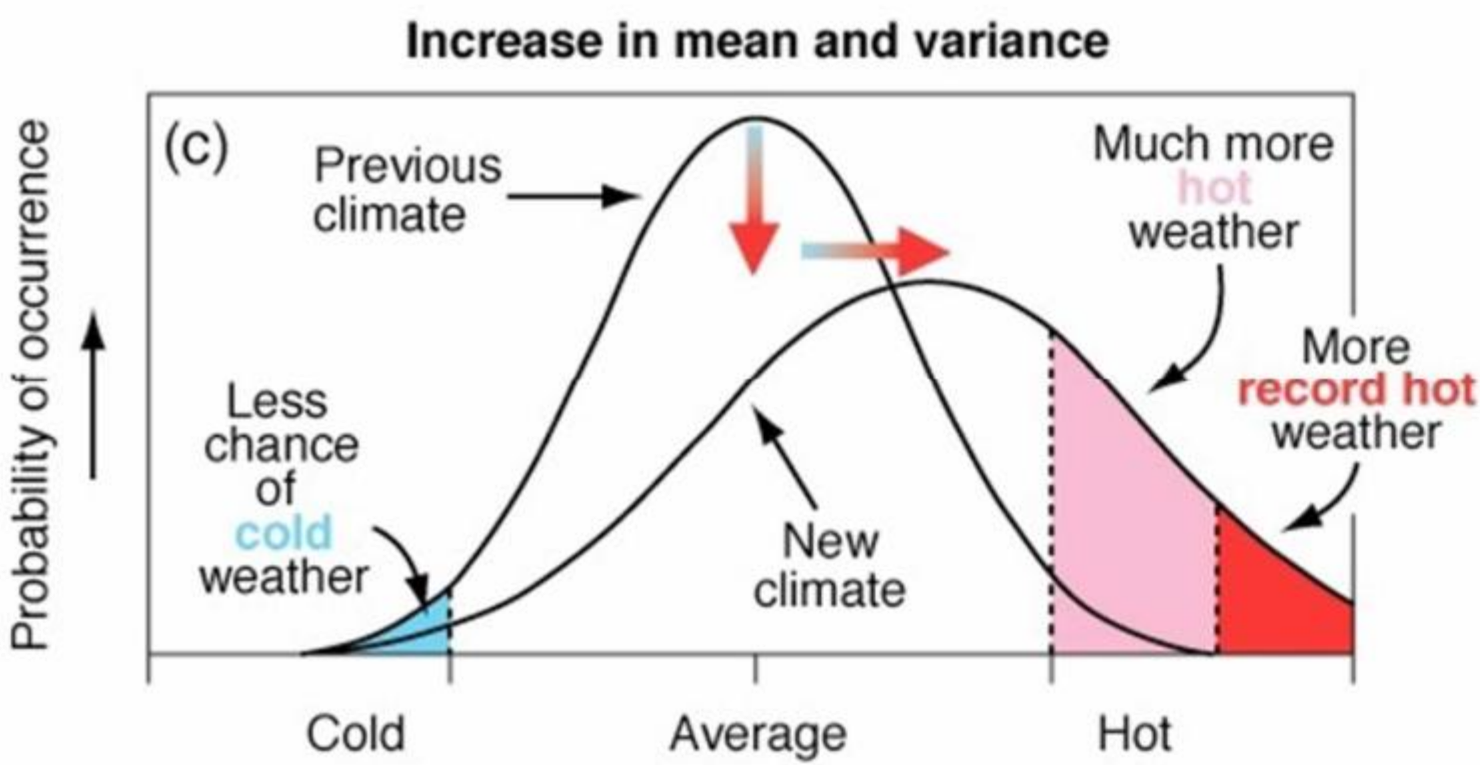
Climate Impact #3: INCREASE IN MEAN AND VARIANCE



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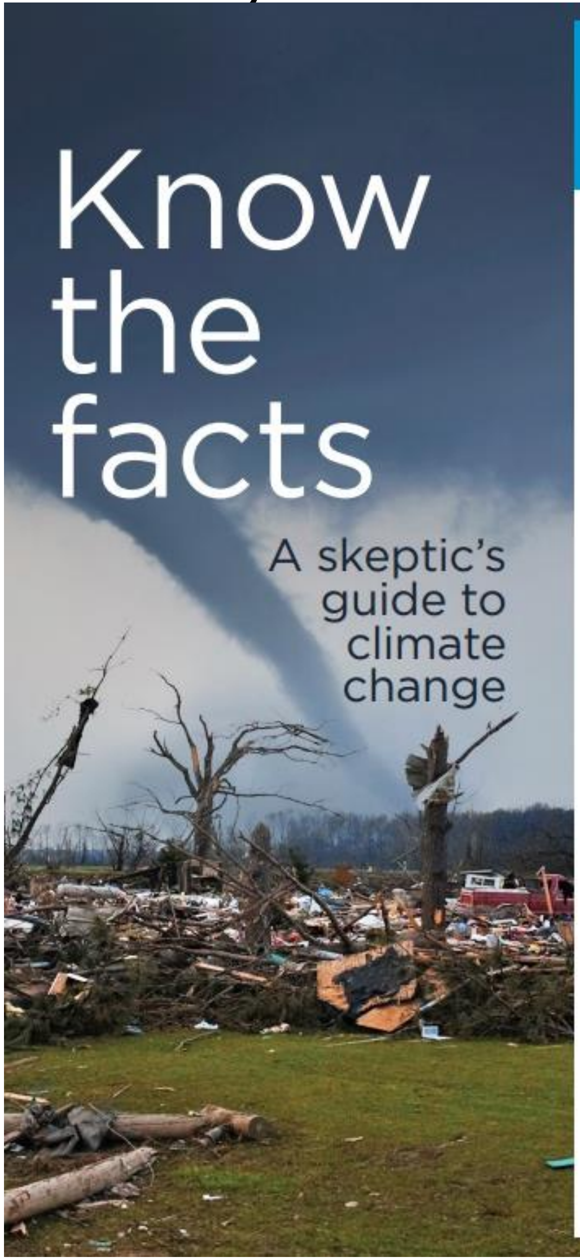
Extreme Events & Climate Change: Berkeley Earth – 9/23/14 Newsletter



Is the extreme weather we see today really caused by global warming?

These days, climate change is being blamed for everything, from Hurricane Sandy to tornadoes in Missouri. Claims are made that push beyond what science can tell us. Attributing cause-and-effect to individual weather events is fiendishly difficult.

This chart provides a quick assessment of which extreme weather events are not likely linked to global warming, which events might be linked, and which events have demonstrated (though often exaggerated) links.

Extreme weather event	No global warming link	May change with global warming but amount not established	Evidence of some global warming link
Hurricanes		X	
Tornadoes	X		
Droughts		X	
Forest fires		X	
Heatwaves			X
Coastal floods			X
Earthquakes	X		
Floods		X	

Extreme Events & Climate Change: Berkeley Earth -

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From An Infrastructure Study of the Gulf Coast

"While the focus of this project is on a portion of the U.S. Gulf Coast, the intent is to develop a conceptual framework that lays the groundwork for an assessment that links climate change and transportation and to focus this nexus by using a specific case as an illustration."

-Impact of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I

- The 2008 Conceptual Framework for Assessing Potential Impacts on Transportation reviewed:
  - Exposure
  - Vulnerability
  - Resilience, and
  - Adaptation

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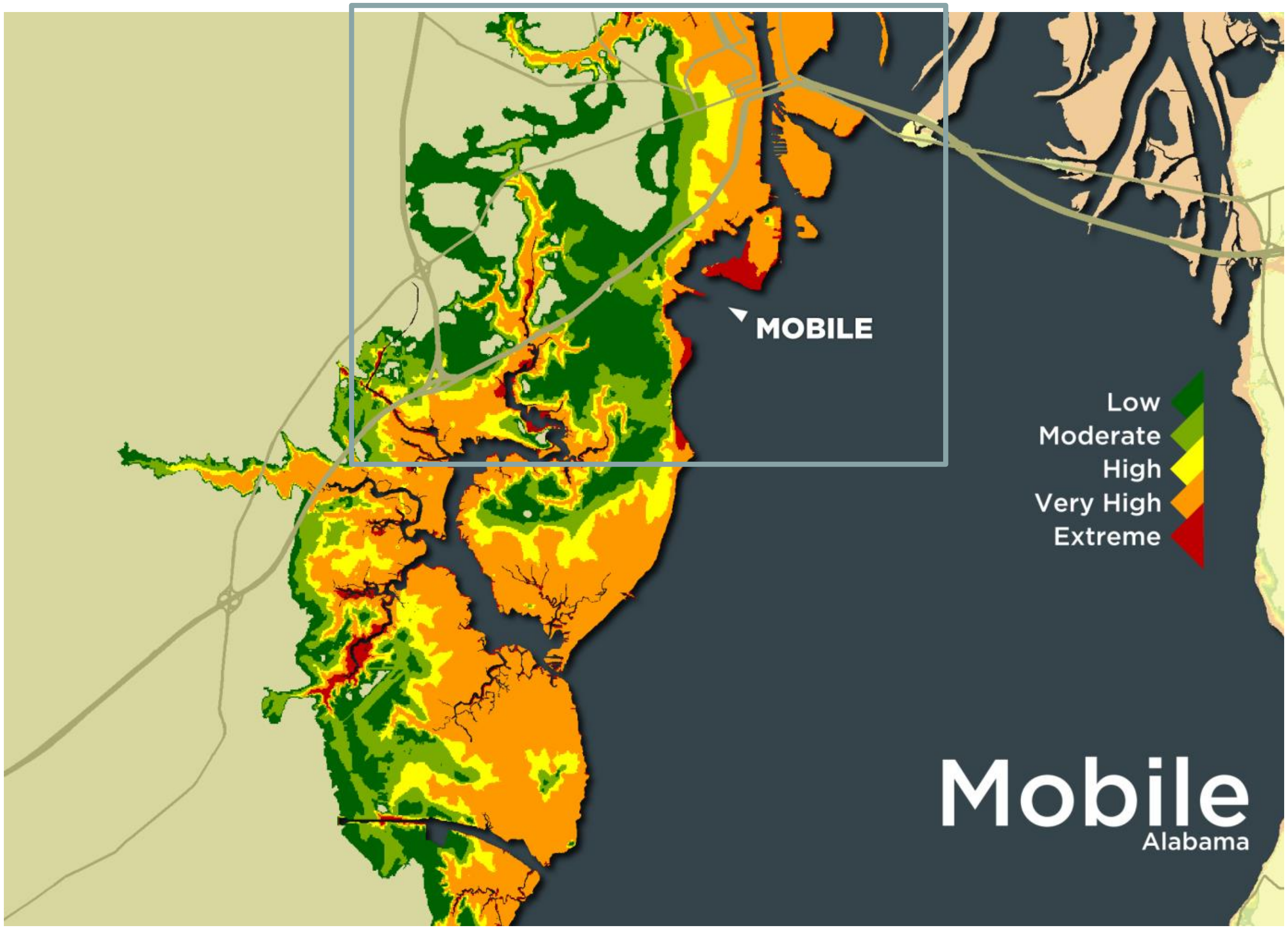
Here is where the ACTUARIES' CLIMATE INDEX (The ACI)

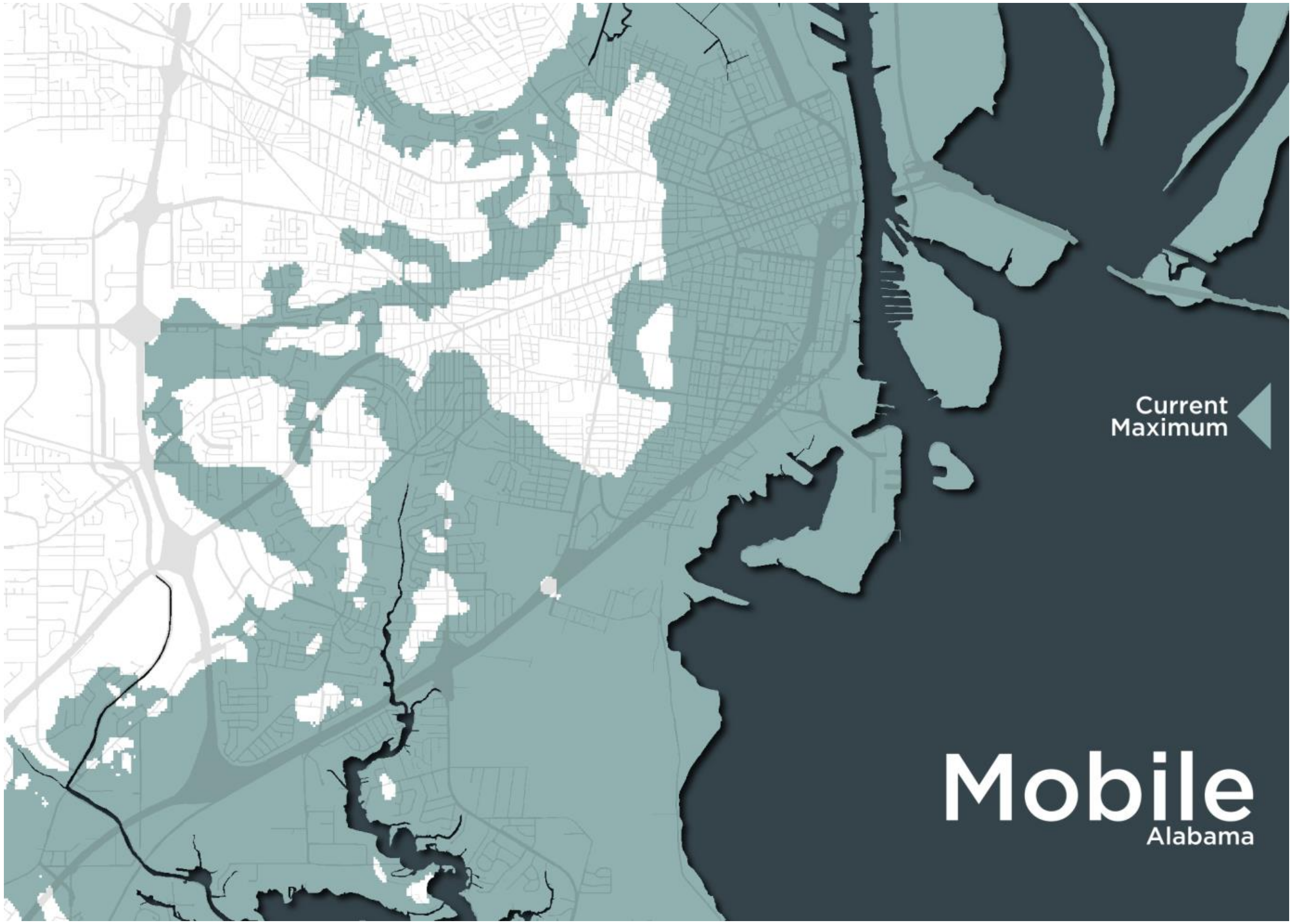
and the ACTUARIES' CLIMATE RISK INDEX (The ACRI) can add value

Current estimated Storm Surge Extent – by risk level



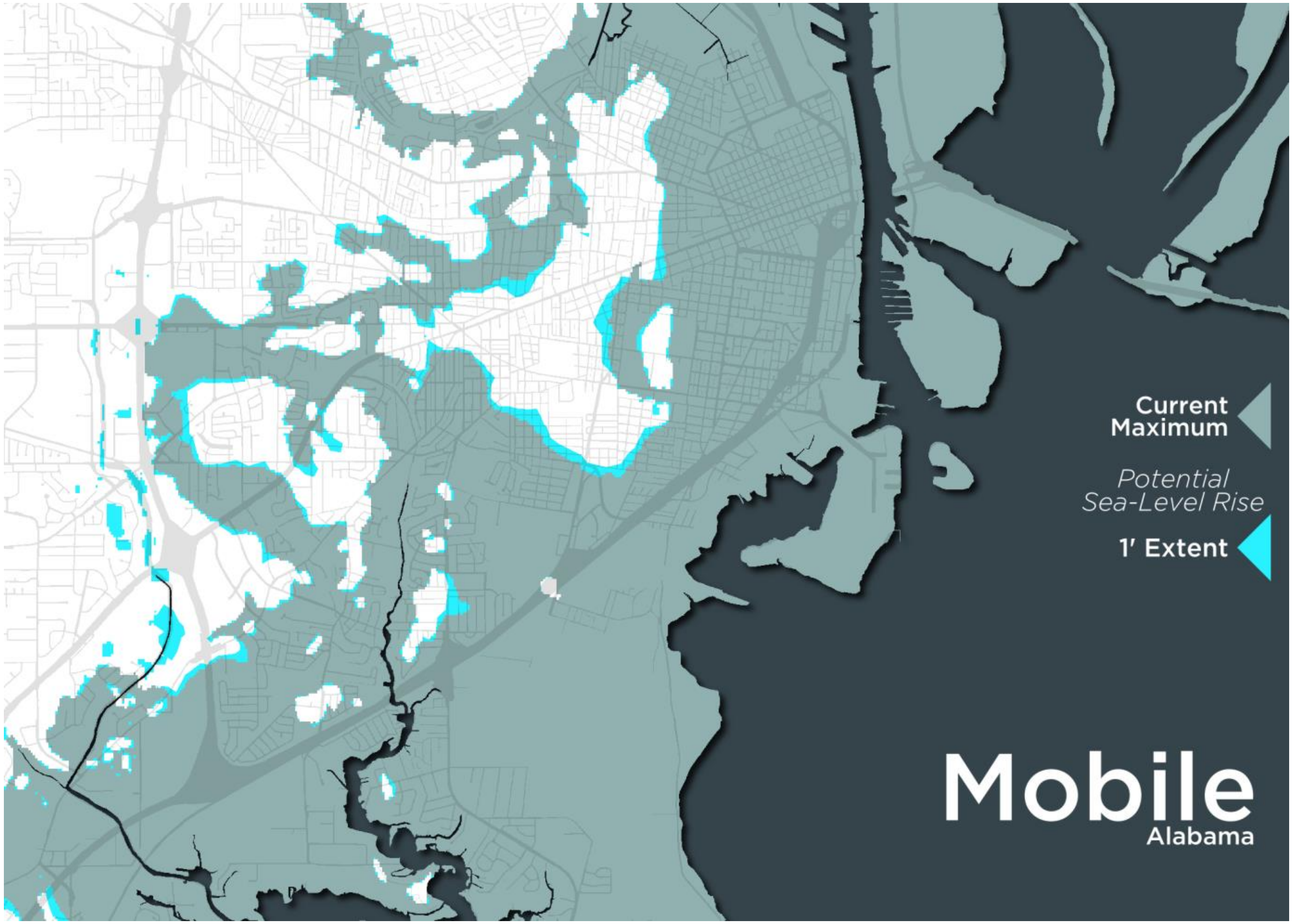
Source: CoreLogic Storm Surge Report, 2013

Current estimated MAXIMUM Storm Surge Risk Extent



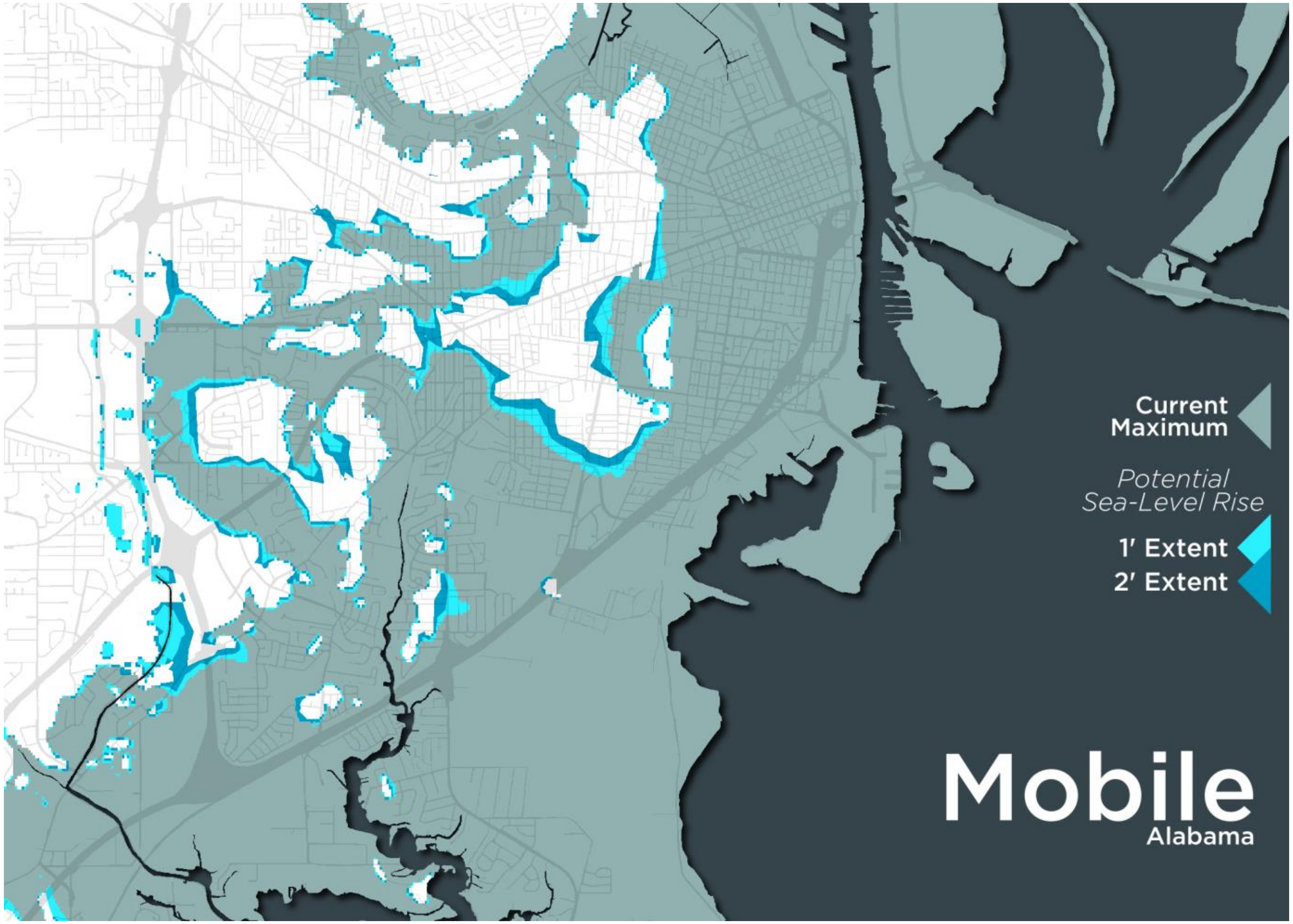
Source: CoreLogic Storm Surge Report, 2013

Estimated maximum surge risk extent after 1 foot Sea-Level Rise



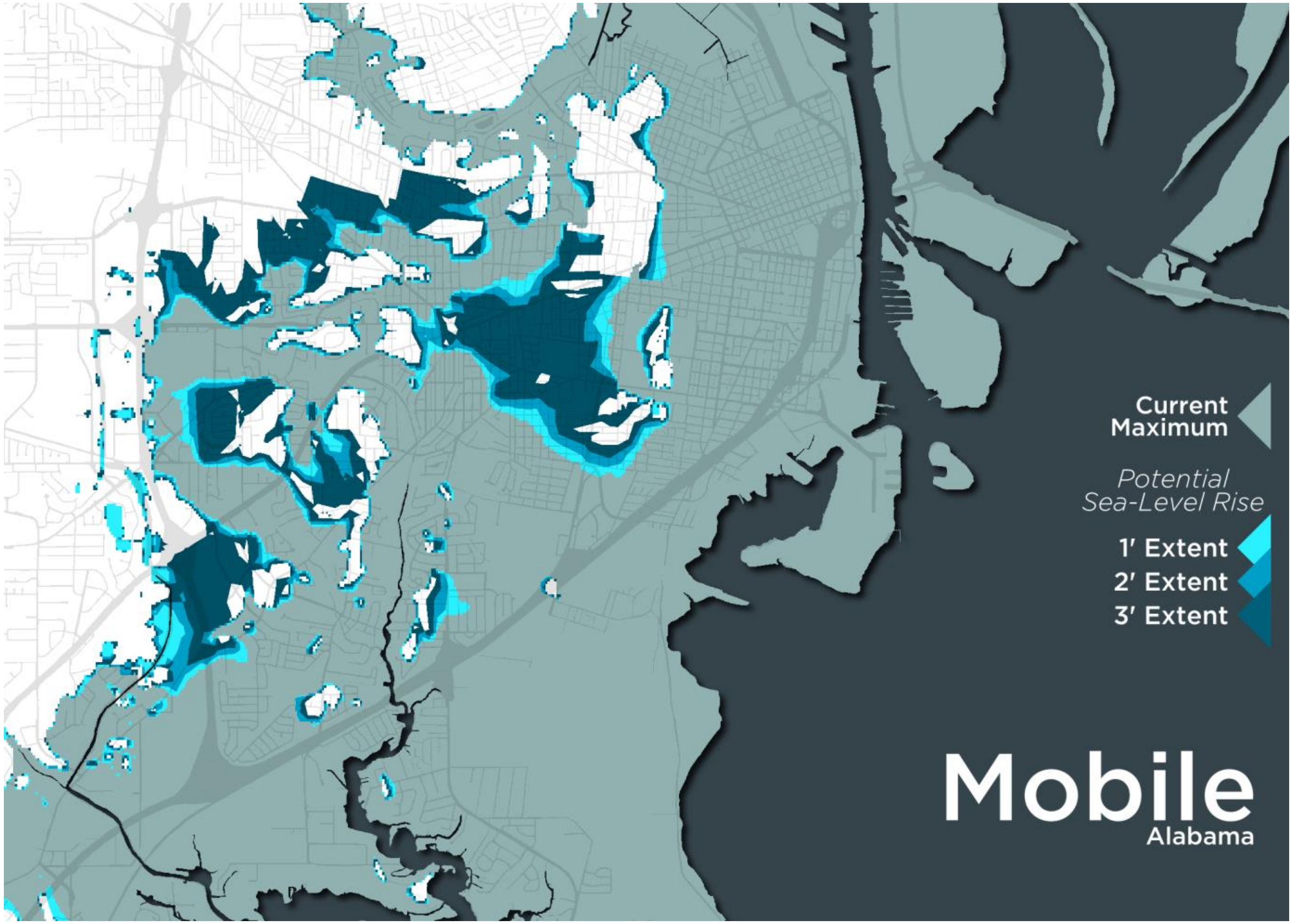
Source: CoreLogic Storm Surge Report, 2013

Estimated maximum surge risk extent after 2 foot Sea-Level Rise



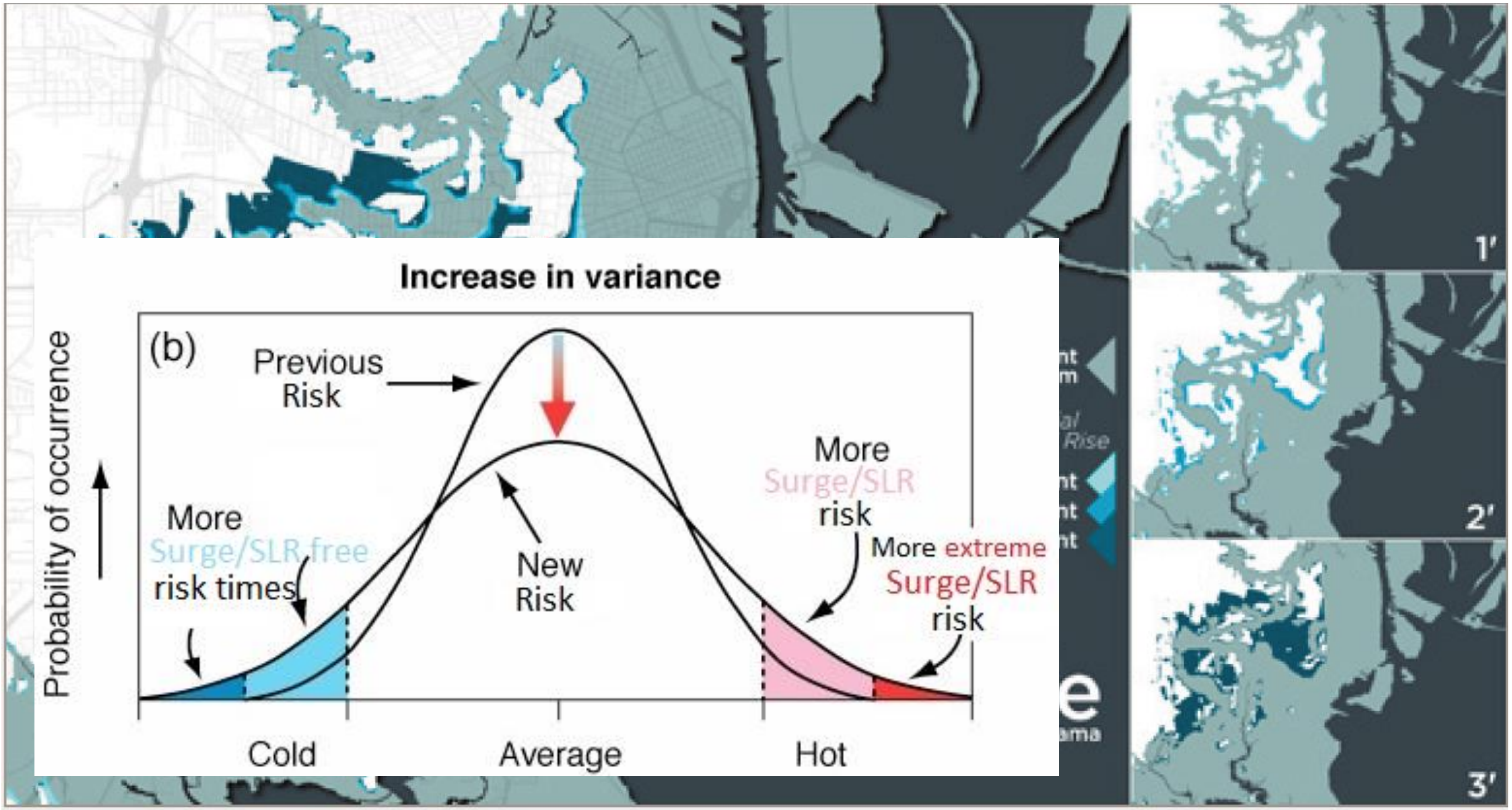
Source: CoreLogic Storm Surge Report, 2013

Estimated maximum surge risk extent after 3 foot Sea-Level Rise



Source: CoreLogic Storm Surge Report, 2013

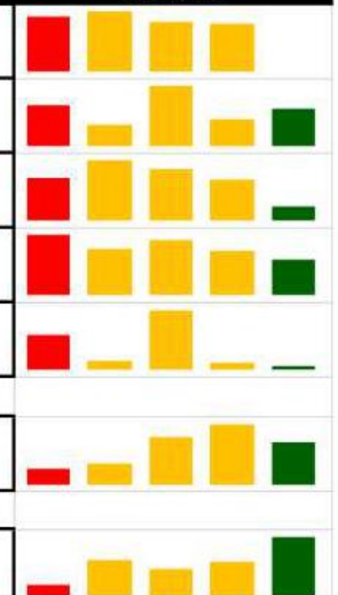
Storm Surge Risk extension
by Sea-Level Rise of 1 foot, 2 feet, & 3 feet



Mobile Regional Storm Surge Risk with Sea-Level Rise. Source: CoreLogic, 2013.

Residential Property Counts & Values at risk of Storm Surge

Rank	Area Name	Properties Affected	Total Structure Value	Property distribution by Surge Risk Level
1	New York	447,428	$205,712,837,261	
2	Miami	239,910	$100,132,133,476	
3	Virginia Beach	305,943	$73,033,753,064	
4	Tampa	301,045	$55,073,950,288	
5	New Orleans	238,919	$43,728,316,068	
12	Houston	187,560	$29,032,620,030	
42	Mobile	27,515	$3,231,380,600	



Source: CoreLogic Storm Surge Report, 2013

CoreLogic

Overview of Actuaries Climate Index Research Project

For more information, contact:

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