CAS Severe Weather Workshop: Climate Risk and the P&C Industry

March 2016

Steve Kolk, ACAS, MAAA
Rita Zona, ACAS, MAAA

Agenda

- CAS Climate Change Committee Update
- NAIC Disclosure Update
- Potential Impacts of Climate Change on the P&C Industry
- Sustainability/Green Products
- Questions and Discussion

CAS Climate Change Committee Update

CAS Climate Change Committee

2008	2009	2010	2011	2012	2013	2014	2015
					I & II	III & IV	V

CAS Climate Change Task Force

Standing Committee established; Joined force to include AAA, CIA and SOA

Climate Index Working Group Phase 1

Determining the Impact of Climate Change on Insurance Risk and the Global Community

Climate Index Working Group Phase 2: **Stages I, II, III, IV & V**

Actuaries' Climate Index (ACI) developed
Actuaries Climate Risk Index (ACRI) developed

- The CAS Climate Change Committee was created to respond to the emerging risk of climate change.
  - ➢ To recommend, support, and perform research on climate change and assess the potential risk management implications for the insurance industry.
- It is our actuarial professional responsibility to understand the latest in climate change science and develop actuarially sound approaches to managing the potential implications of climate change risk factors.

CAS Climate Change Committee

- Initial areas of focus
  - Identify future climate scenarios and explore implications for our profession
    - Insurance products/services, reserving practices, contingency planning, and corporate strategy
  - Have a significant role in climate change modeling
    - Model development, assumptions, uncertainty, sensitivity, robustness, appropriate application, and interpretation of results
  - Understand reporting and disclosure requirements
  - Address public relations and policy issues that arise from climate change
    - Recommend position of CAS and how to work with other actuarial organizations around the world
  - Educate our membership
    - Facilitate background training for our membership to understand issues and implications

Climate Index Working Group

- The Actuaries' Climate Index has been developed by ***Climate Index Working Group*** (CIWG) to help raise awareness of the potential risks associated with climate change and the risk management implications within North America and globally.
- Phase 1 completed: a synthesis of the extensive and rapidly growing body of knowledge on climate change as it relates to possible impacts on human society.

  "*Determining the Impact of Climate Change on Insurance Risk and the Global Community. Phase 1: Key Climate Indicators*" (Nov 2012)
- Phase 2 in progress:
  - The CIWG finished developing the Actuaries' Climate Index (ACI)
  - » Essays on the Impact of Climate Change on the Insurance Industry were published in February 2014.
  - » The final formulation of the ACRI was completed in December 2015.

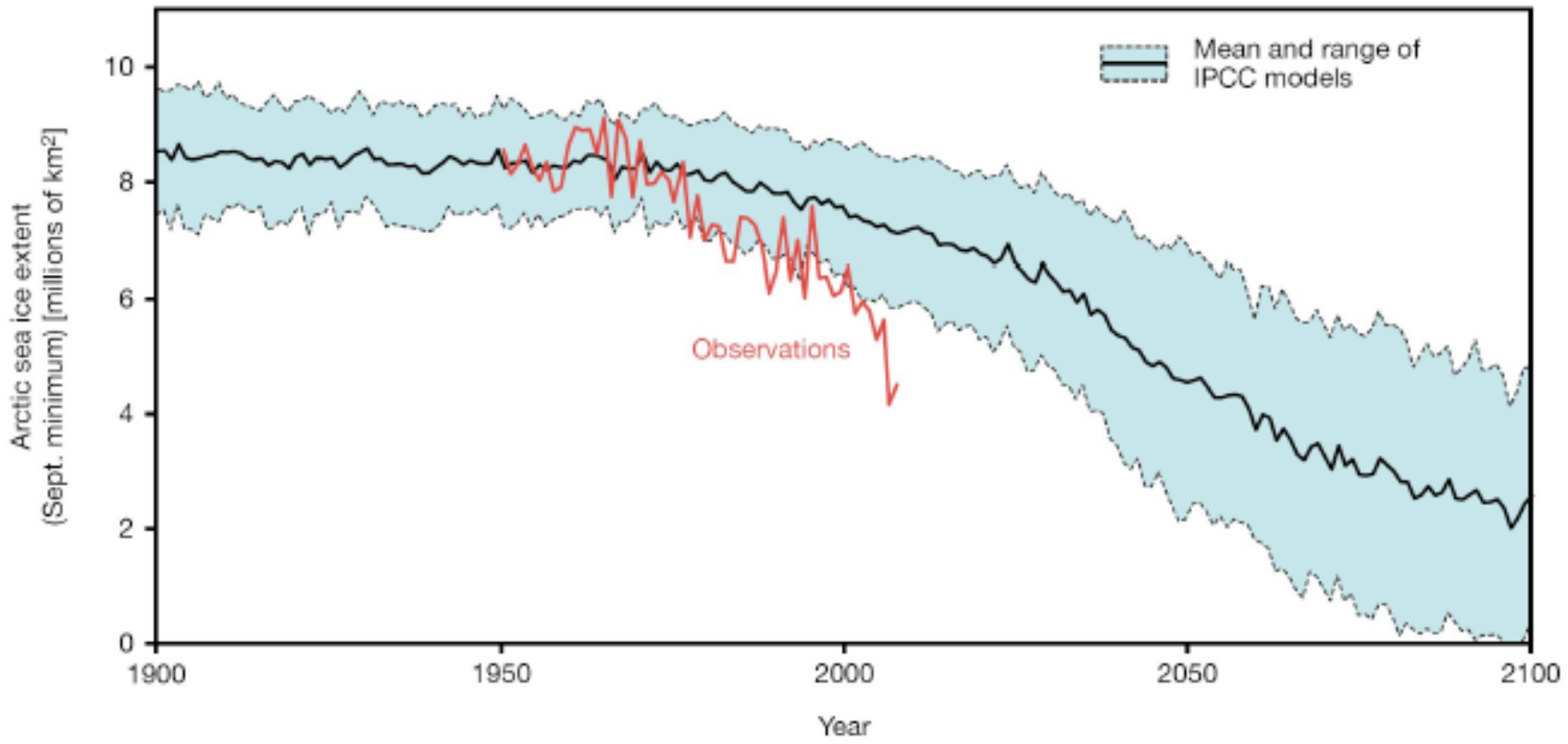
Phase 1 Report

- The report reviewed recently published scientific research in specific areas
  - The review laid the foundation for the development of an Actuaries Climate Index (ACI)
- Various indices were constructed, using carefully vetted data or model projections, which adequately reflect changes in the underlying climate variables.
- A composite index, carrying information from many individual climate variables and standardized with respect to climate variability, was formulated to suit the needs of both actuaries and the public at large. This is termed the Actuaries Climate Index™ (ACI™). This index carries information regarding the occurrence of climate extremes, as well as more gradual changes in mean quantities.
  - The index has been defined for individual regions, provided sufficient high-quality data are available.
  - Finally, by adding socioeconomic damage data, the ACI was extended to form the basis of a more targeted index to reflectsthe risk to populations and capital due to climate change (the Actuaries Climate Risk Index™, or ACRI™).

Source: "*Determining the Impact of Climate Change on Insurance Risk and the Global Community. Phase 1: Key Climate Indicators*"

Phase 1 Report: Climate Change

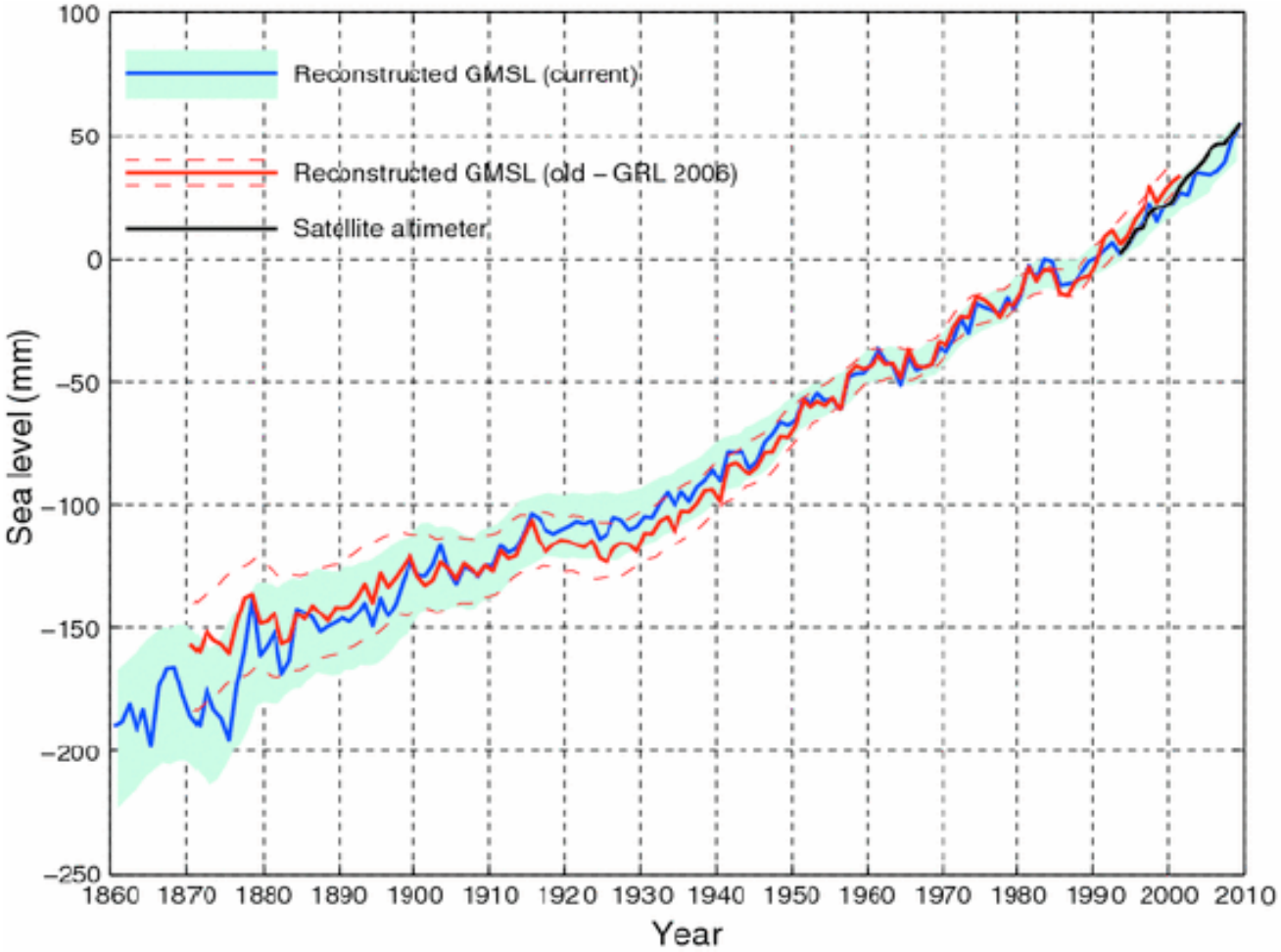
Observed rate of Arctic sea ice decline more than expected



Source: "*Determining the Impact of Climate Change on Insurance Risk and the Global Community. Phase 1: Key Climate Indicators*"

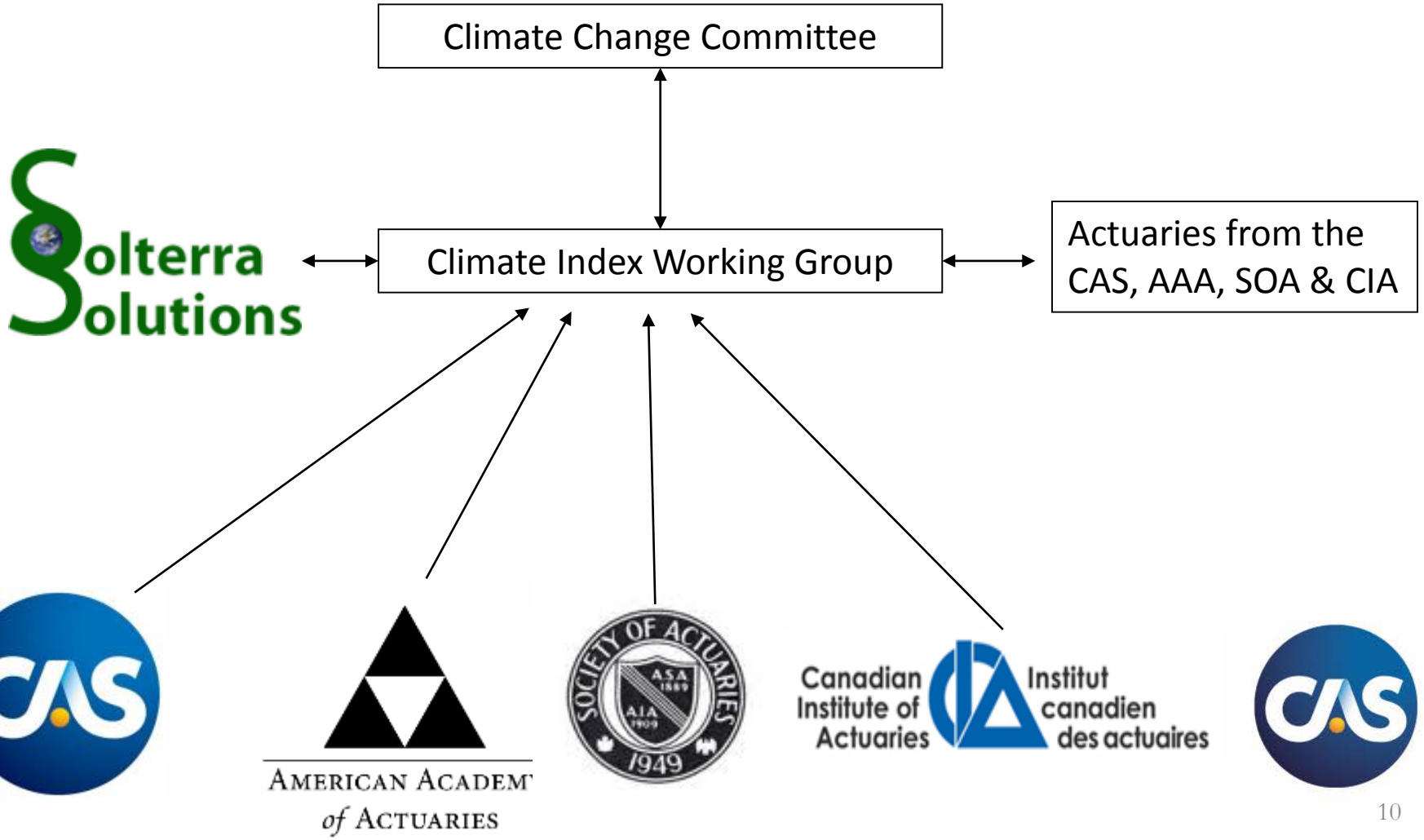
Phase 1 Report: Climate Change

Rising Sea Level – an instrumental record of 150 years



Source: "*Determining the Impact of Climate Change on Insurance Risk and the Global Community. Phase 1: Key Climate Indicators*"

Climate Index Development Structure



Actuaries Climate Index - Goals

- Create an objective index that measures changes in climate over recent decades
- Educate the insurance industry and the general public on the impact of climate change
- Easy to understand, but not simplistic
- Promote our profession

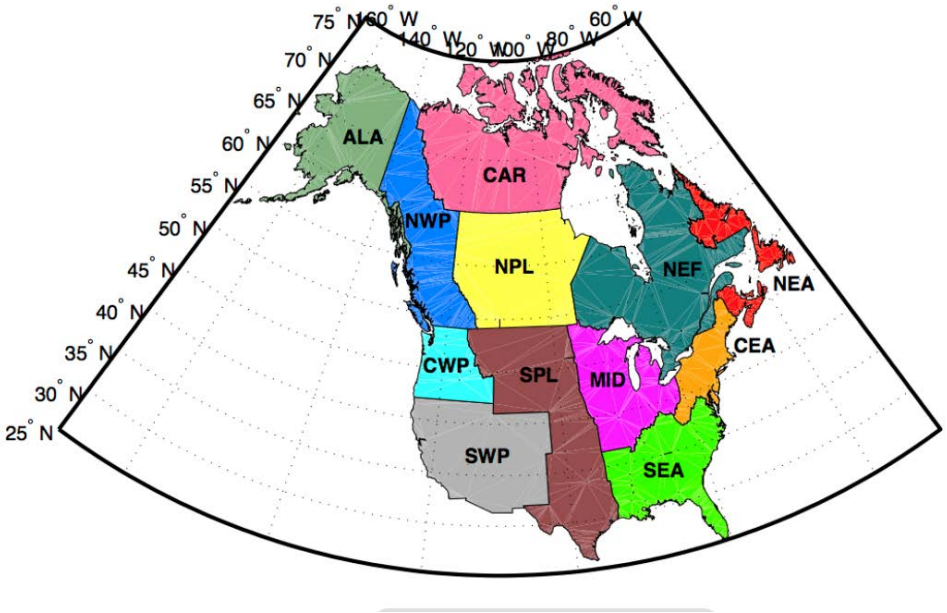
ACI Basics (1)

- The indices focus on the "frequency of severity" aka "f-s"
  - "How often is the temperature in a given month at or above the 90th percentile?"
  - Other indices tend to focus on change in the average over time, but it is the frequency of extreme weather that matters to us
- Indices are weighted averages of six "f-s" variables
  - High temperature
  - Low temperature
  - Heavy precipitation
  - Lengthy drought
  - High wind
  - Elevated sea level (for ocean coast only)

❖ The 90th percentile is based on the 1961-1990 reference period

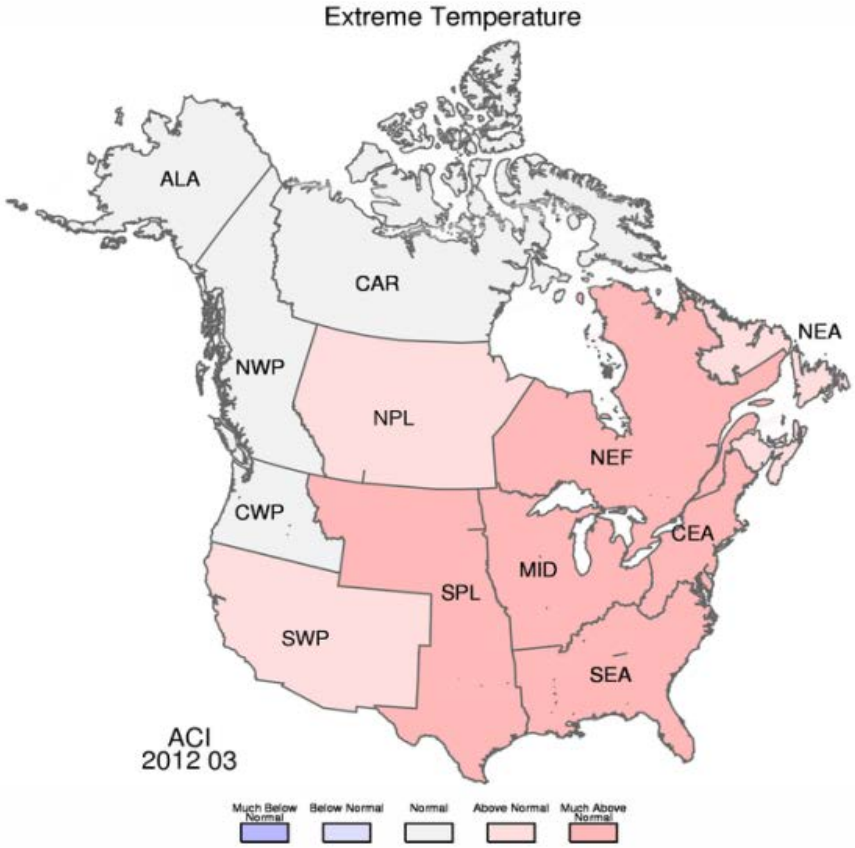
ACI Basics (2)

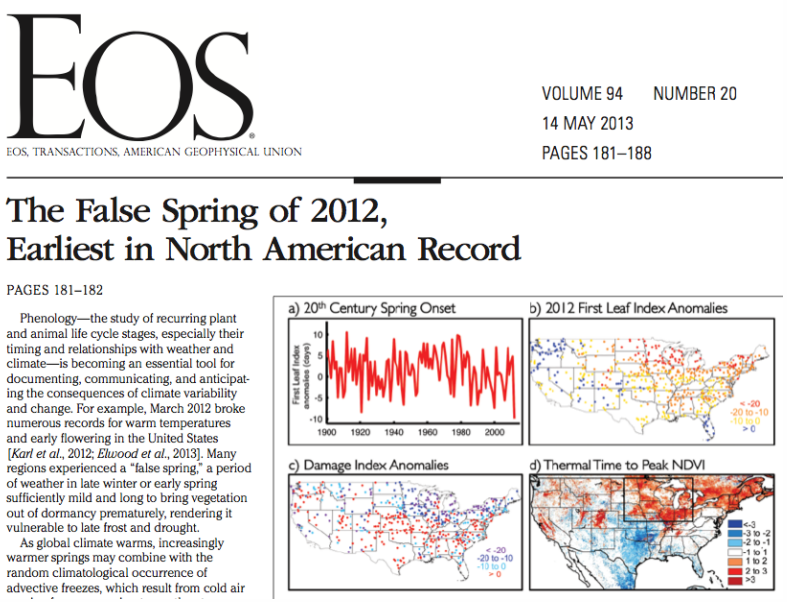
- Granularity of data – each variable is available for each 2.5° grid (275km x 275km at equator) in North America
  - While indices can be computed at this granularity, they would be volatile
- Grid indices are averaged across 12 natural regions
- Also averaged to produce indices for US, Canada and total US/Canada



Source: FINAL FORMULATION OF THE A.C.R.I. – *Solterra Solutions, December 4, 2015*

Region Map *Example from prototype website for March 2012*





EOS

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION

VOLUME 94 NUMBER 20
14 MAY 2013
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

Source: Overview of Actuaries Climate Index Research Project, presented to CIPR, 10/7/2014

ACI – additional details

- Initial focus US and Canada
  - Hope to gradually add other parts of world where good data is available – Mexico, Europe, Australia…
  - Publish index and related information on web
- Focus on measuring frequency and intensity of extremes rather than averages
  - Express changes as standardized anomalies, e.g.,

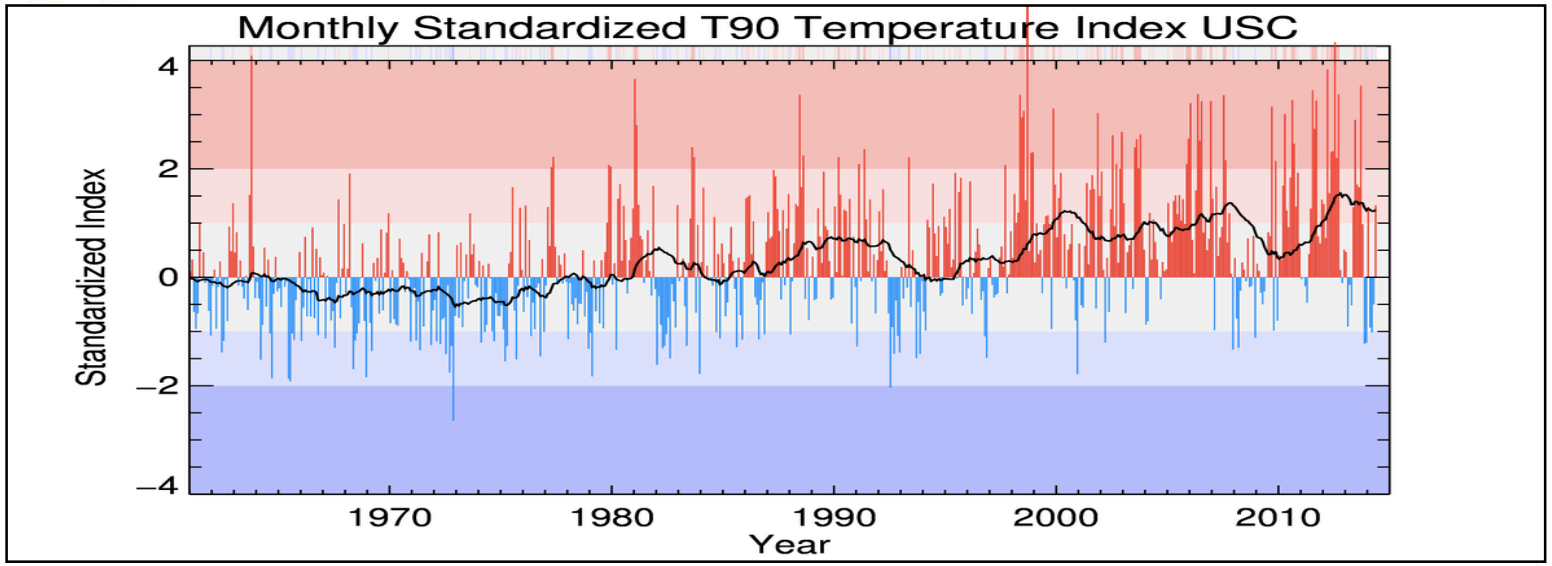
$$X' = (X - X_{ref}) / \sigma_{ref}(X) = \Delta X / \sigma_{ref}(X)$$

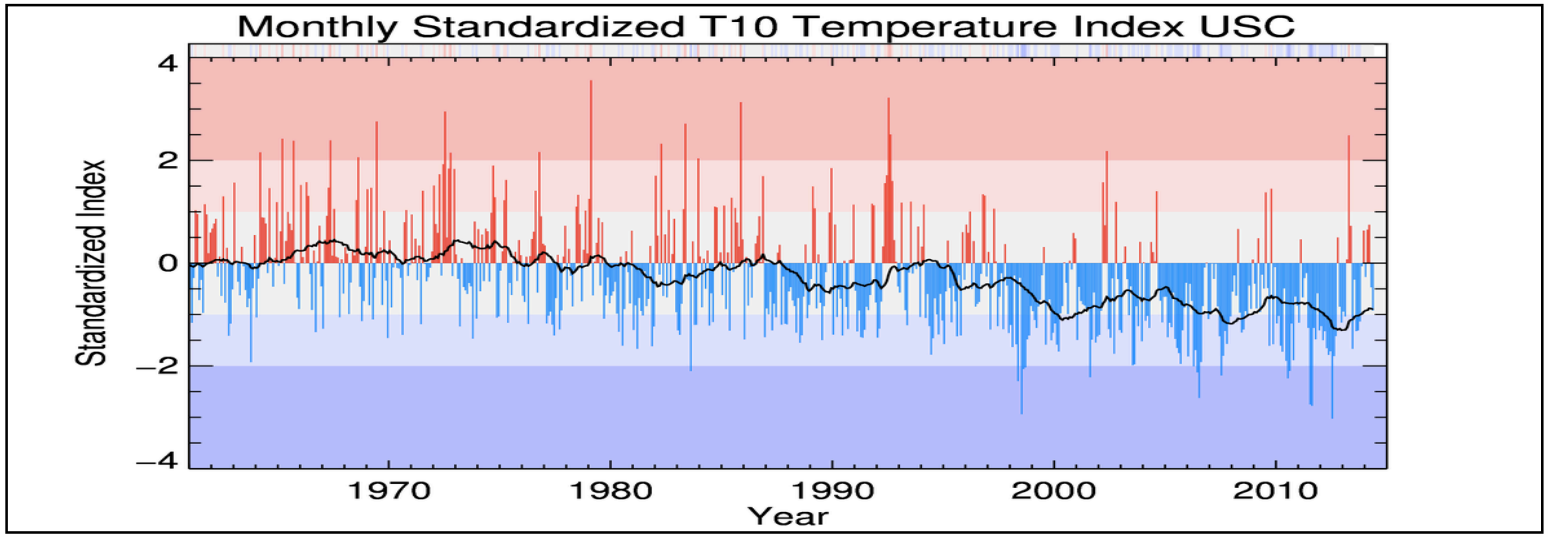
Extreme Temperatures Indices

- Global Historical Climatological Network (GHCN) – global, land station-based, gridded dataset, daily from 1950-present (GHCN-Daily)
- GHCNDEX indices* based on the above:
  - TX90 = 90%ile warm days
  - TN90 = 90%ile warm nights
  - TX10 = 10%ile cold days
  - TN10 = 10%ile cold nights
- The average of % anomalies relative to the 1961-1990 reference period for T90 and T10:
  - Standardized anomaly (T10′ similar): $T90' = \Delta T90 / \sigma_{ref}(T90)$

- Produced as part of the CLIMDEX project by the Climate Change Research Centre, at The University of New South Wales, Australia.

Standardized T90 and T10, US and Canada





Extreme Precipitation Indices

- GHCNDEX monthly maximum five-day precipitation data
  - Heavy precipitation index, P' = ΔRx5day / σ_{ref}(Rx5day)
- GHCNDEX, consecutive dry days (CDD) = Max days per year with <1mm precipitation
  - Drought index = 1 value of CDD/year
  - Linear interpolation to obtain monthly
  - D' = ΔCDD / σ_{ref}(CDD)

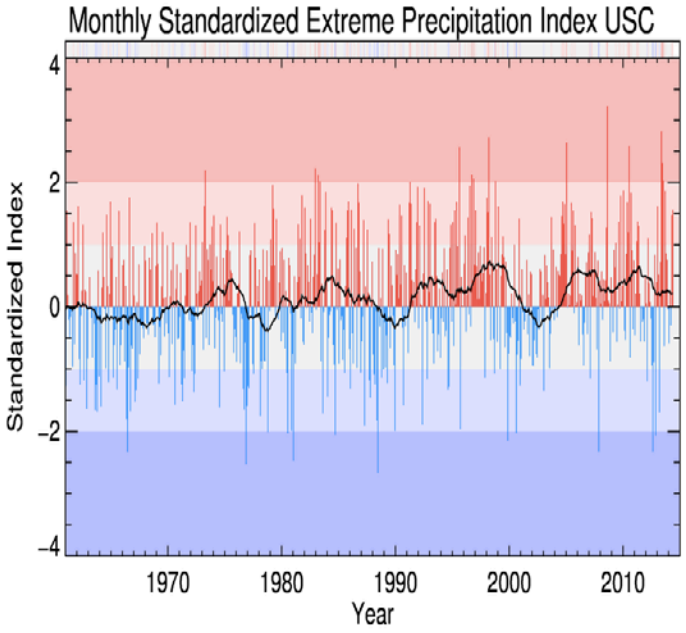
Wind Power Index

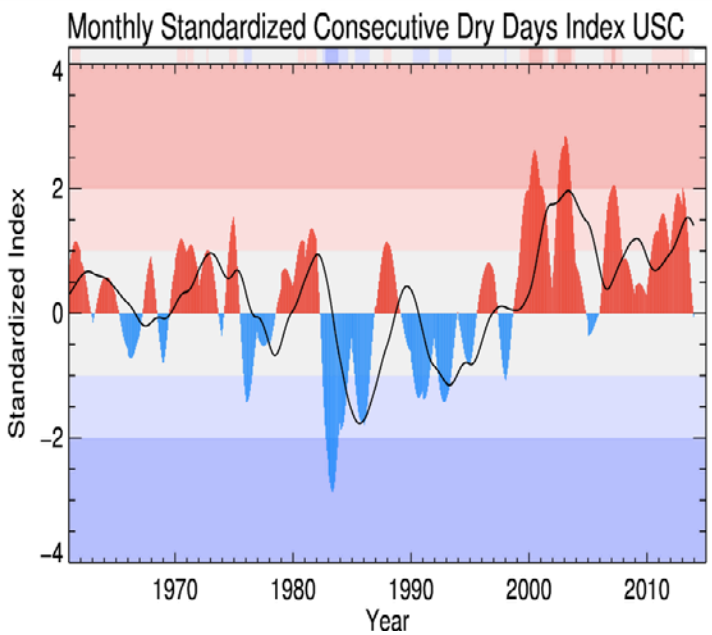
- Index derived from NOAA Earth System Research Laboratory data:
  - Daily mean wind speeds
  - $WP = (1/2)*\rho*w^3$
    Where ρ is air density, w is daily mean wind speed
- $W' = \Delta WP90 / \sigma_{ref}(WP90)$
  - Where WP90 is the monthly frequency of the 90th percentile or higher of daily wind power

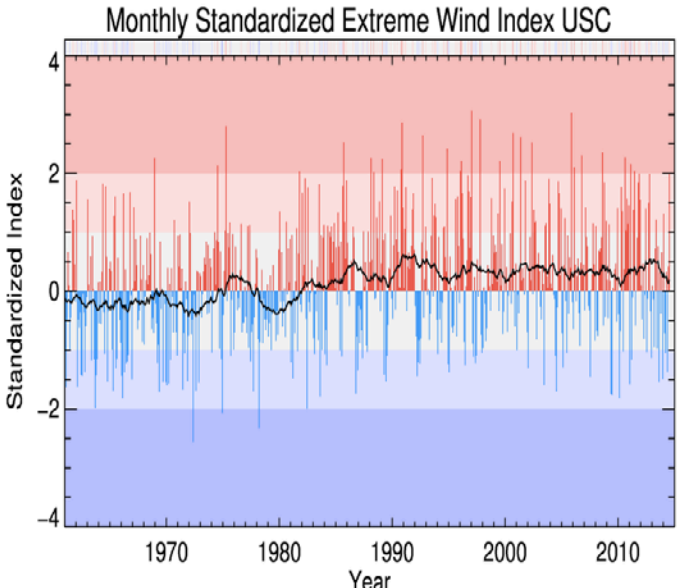
Sea Level Index

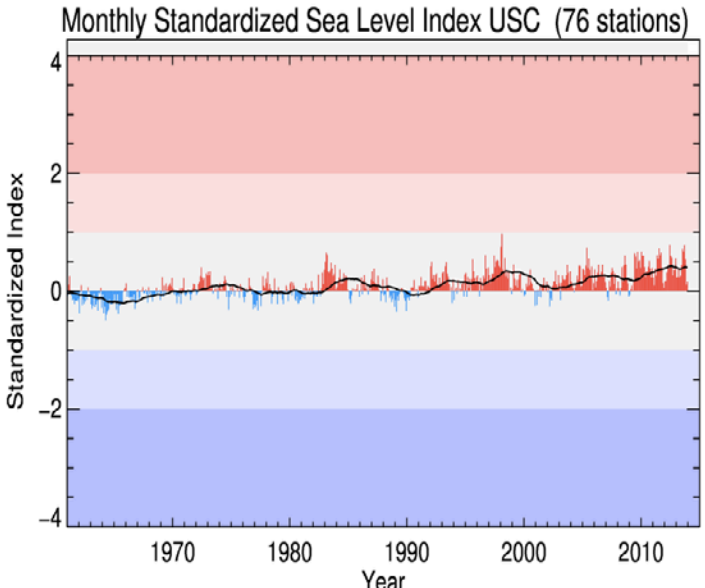
- At tide gauge stations along US and Canada coast
  - Data provided by Permanent Service for Mean Sea Level (PSMSL), part of the UK's National Oceanography Center
  - Data matched to grids used for other variables
    - Index reflects portion of each region represented by coastal grids
  - Land movements removed from tide gauge measurements to produce index reflecting sea movements only
  - $S' = \Delta S / \sigma_{ref}(S)$

ACI Precipitation, Wind and Sea Level Components



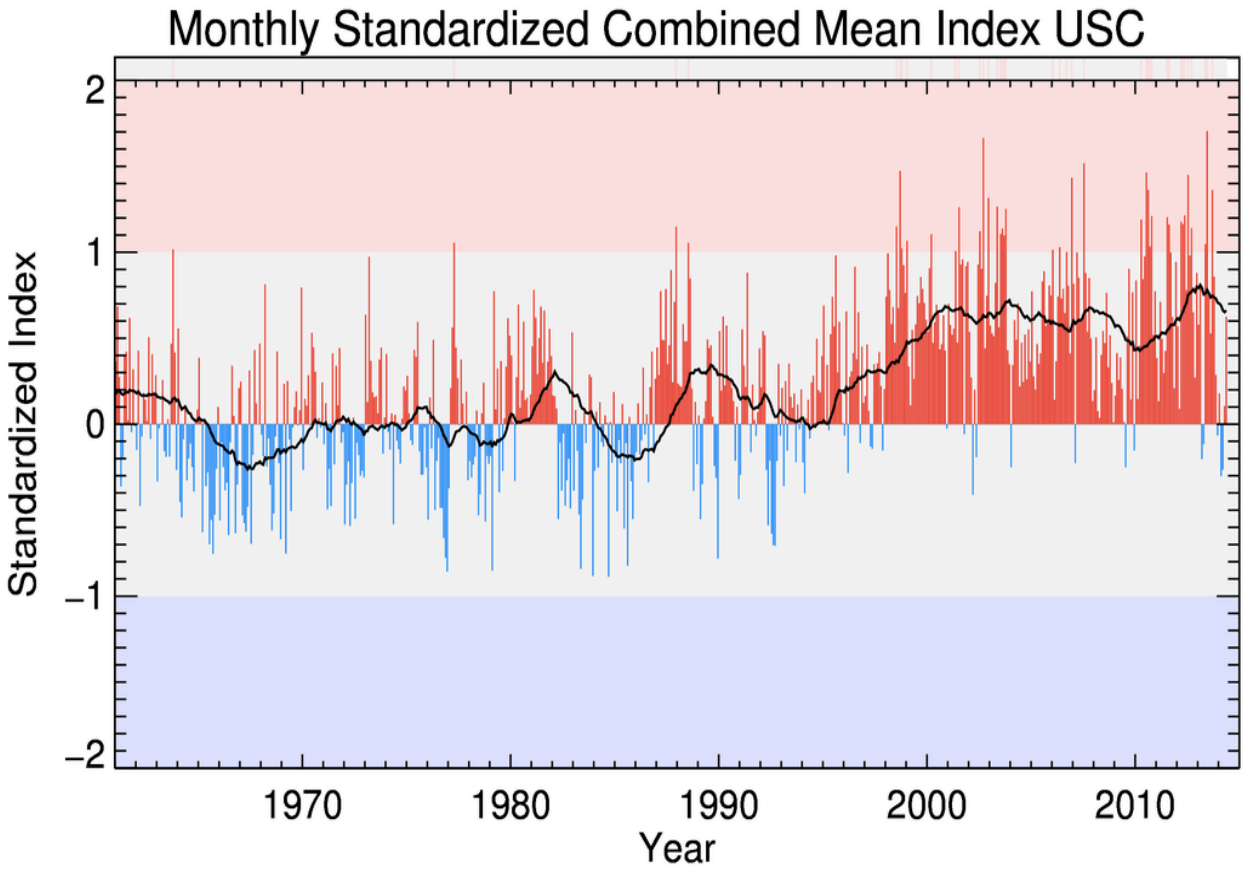




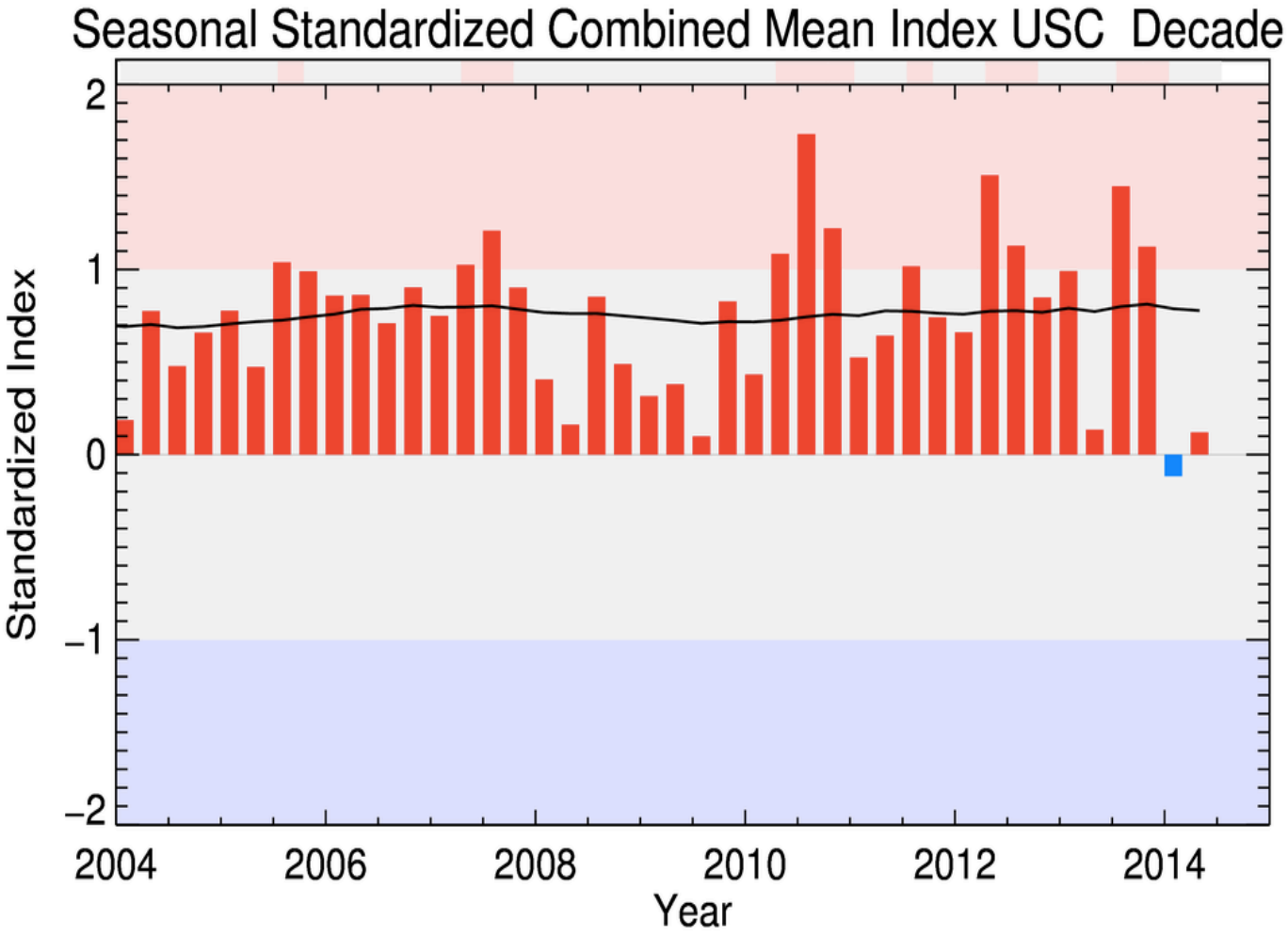


Composite ACI Index

- Unweighted average of standardized anomalies
  - $ACI = (T90' - T10' + P' + D' + W' + S') / 6$



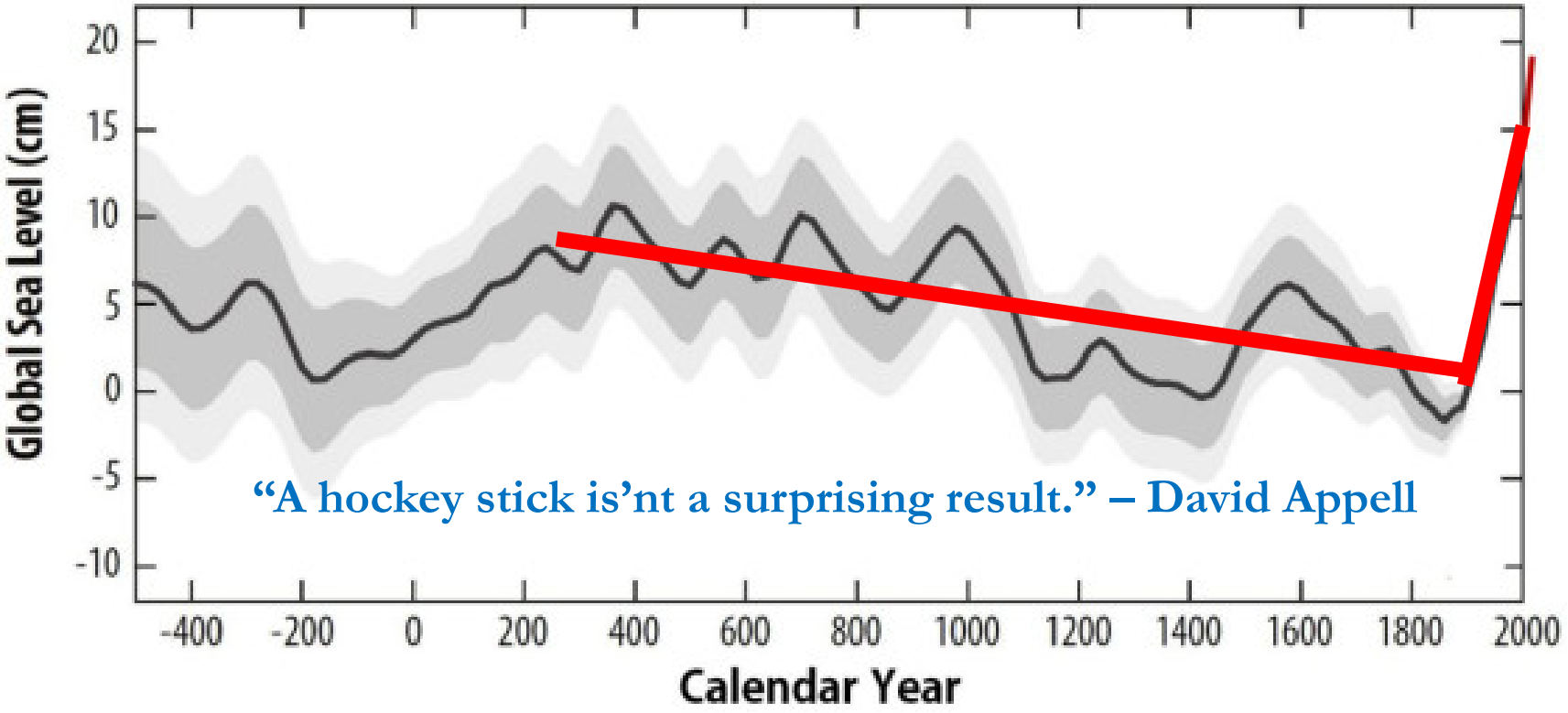
Composite ACI – Latest Decade by Season



Sea Level Rise Nature's 2500 Year Record

"sea level rise is a proxy for global temperature… [and] is a better measure of global warming than temperature"

Paul H. Carr, PhD *Rising Seas and Solutions,* slideshare 3/12/2015



Source: "And Then There's Physics" 2/26/2016 - **Credit: Kopp et al. (2016)**

Actuaries Climate Risk Index

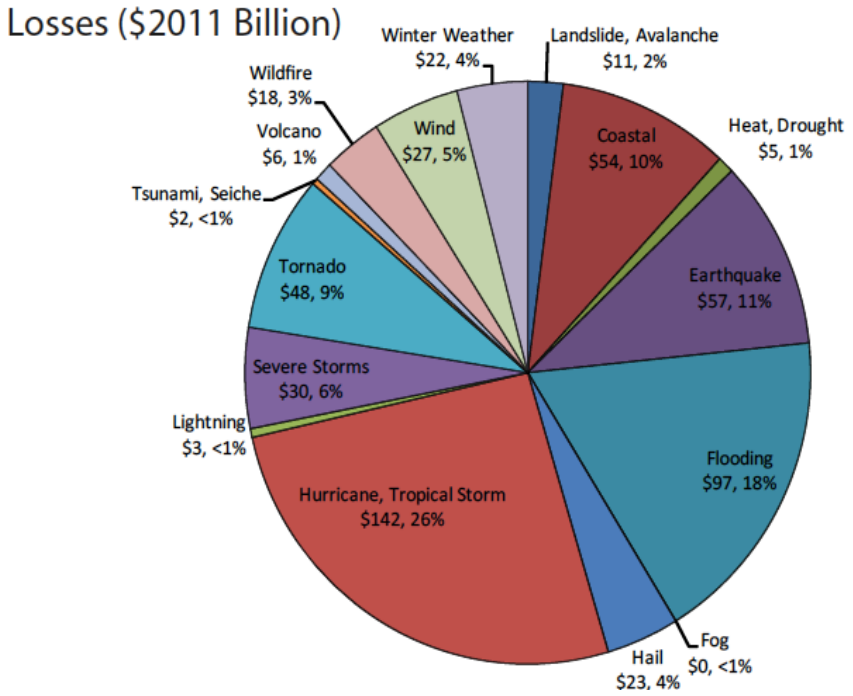
- Selected components of ACI that can be compared to damage information
- Using linear regression, significant relationships between economic losses by peril and climate variables were found in
  - SHELDUS data for economic losses, mortality and morbidity in the US
  - Canadian Disaster Database, compiled by Public Safety Canada
- These findings are being packaged in a risk index especially useful to the insurance industry

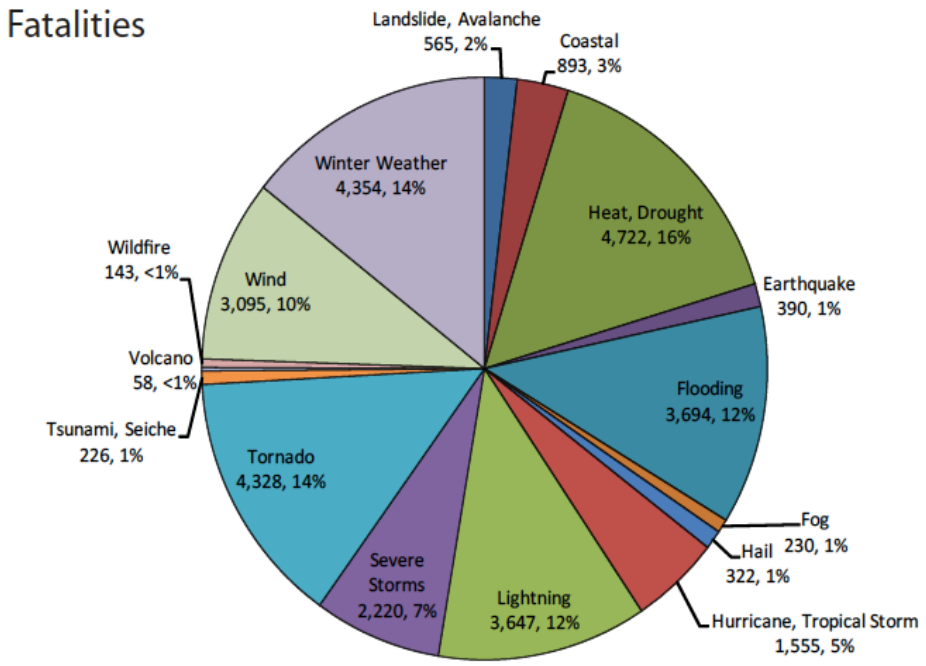
Actuaries Climate Risk Index - Methodology

- Regression analysis of damages and ACI components by region looked at:
  - Mortality and morbidity vs. heat
  - Flood damages vs. maximum 5-day precipitation
  - Crop damages vs. consecutive dry days
  - Wildfire damages vs. consecutive dry days
  - Wind damages vs. wind power
- Each of these became a historical impacts index (HII)
  - Scaled to an index ranging from 1-10
- Proxies or no index were used in a few regions with no finding of statistically significant relationships
- These are blended together to become the ACRI

SHELDUS Data Summary 1960-2011

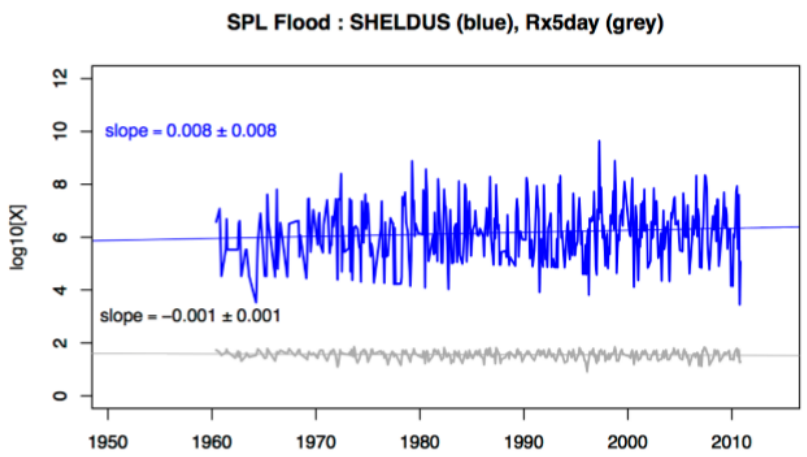
MONETARY & HUMAN LOSSES BY HAZARD TYPE

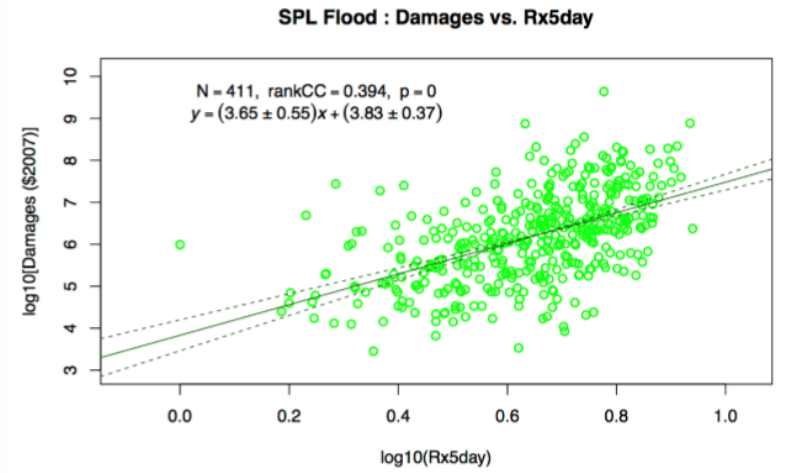




Source: http://hvri.geog.sc.edu/SHELDUS/docs/Summary_1960_2011.pdf

Phase 2 – Stage V - Regression





- A linear regression analysis was performed for all regions for the following damage categories: Flood, Wind, Heat, Drought and Wildfire.
- The example here is for Flood in which Rx5day precipitation was regressed against Sheldus monetary damages (in Billions US$2007)
- Relationships like this, together with their 95th confidence limits, were evaluated by hazard and region.

Source: Climate Index Work Group, *Stage V Summary*

Phase 2 – Stage V - Results

	PE			*H* alone				Both *H* & *P*				
Flood	***a***	C_0	R_{PE}^2	$a_H(a_P=0)$	C_0	R_H^2	τ_K	a_H	a_P	C_0	R_{HP}^2	p_P
Predictor: Rx5day ; Predictand: Monthly aggregated damages (2007$US)												
CEA	4.3	4.3	0.19	4.6	4.3	0.19	0.30	4.6	1.2	4.2	0.19	0.6
CWP	1.8	3.7	0.21	1.9	3.9	0.23	0.30	1.9	0.19	3.8	0.23	0.8
MID	3.6	4.5	0.19	3.5	4.5	0.18	0.32	3.5	5.1	4.1	0.20	0.01
SEA	4.2	4.3	0.22	5.0	3.6	0.19	0.34	5.2	2.9	2.9	0.24	$<10^{-7}$
SPL	3.4	4.1	0.30	3.7	3.8	0.29	0.40	3.8	1.9	3.4	0.31	$<10^{-3}$
SWP	2.1	4.8	0.15	2.4	4.5	0.17	0.24	2.5	0.84	4.2	0.17	0.1
NPL	1.5	6.2	0.16	1.3	6.3	0.12	0.23	1.0	5.1	-28.	0.22	0.02

- Linear regression results for U.S. and Canadian regions. Best-fit slopes (a) and intercepts (C0) from linear regression of estimated damages versus physical exposure PE (a; RPE2), climate hazard only (aH; RH2), and climate hazard and population together (aH, aP; C0; RHP2) as predictors of economic damage.
- Statistically significant correlations were found for 6 out of 7 U.S. regions in the Flood category (Rx5day). Far fewer statistically significant relationships were found using the Canadian data: only 1 of 4 regions displayed significant relations for Flood, The Canadian Arctic region, CAR, was omitted from the analysis due to lack of damage data.

Source: Climate Index Work Group, *Stage V Summary*

Phase 2 – Stage V - Relationships

	Region												
Hazard	ALL U.S.	ALA	CEA	CWP	MID	SEA	SPL	SWP	NEA	NEF	NPL	NWP	CAR
Flood(PE)		3.0, 4.3	3.4, 4.4	2.9, 3.9	2.8, 4.4	3.0, 4.3	3.6, 3.9	2.4, 4.6	1.4, 5.9	1.4, 5.9	1.3, 6.1	1.4, 5.7	-
Wind(PE)		1.1, 5.4	0.8, 5.6	1.1, 4.6	0.8, 5.9	1.6, 5.4	0.6, 6.0	1.2, 5.1	1.6, 5.5	1.6, 5.5	1.6, 5.5	1.6, 5.5	-
Heat(PE)		-	1.1, 0.08	1.1, 0.08	1.1, 0.08	1.3, 0.12	1.1, 0.11	0.94, 0.01	1.1, .08	1.1, .08	1.1, .08	1.1, .08	-
Drought	0.42, 7.1	-	2.0, 5.3	2.0, 5.2	2.0, 5.7	2.0, 5.4	2.0, 5.7	2.0, 5.1	2.0, 4.0	2.0, 4.7	2.0, 5.3	2.0, 4.2	-
Wildfire	2.6, 4.1	-	o	o	o	o	1.8, 3.9	1.7, 5.7	o	o	o	o	-

- Entries marked "-" do not show a statistically significant relationship.
- Entries in blue are *proxies,* equal to the mean value in all regions *within either US-only or Canada-only* having a significant relationship.

Source: Climate Index Work Group, *Climate Index Relationships*

ACI and ACRI Roll Out

- Complete formulation of ACI is Done
- Prototype website was built by Solterra Solutions
- ACI website is being built; launching May/June 2016
- Building the ACRI portion of actual website will follow
- Quarterly index releases in tandem with ACI
- Periodic articles in actuarial magazines
- Call for papers

Jeff Stahler's View...

Index Resources

- Donat, M. G., et al. 2013. Global land-based datasets for monitoring climatic extremes. Bulletin of the American Meteorological Society, July, 997-1006, doi:10.1175/BAMS-D-12-00109.1.
- Hansen J., et al. 1998, A Common Sense Climate Index: Is Climate Changing Noticeably? PNAS, 95, 4113-4120.
- Peduzzi, P., et al. 2009, Assessing global exposure and vulnerability towards natural hazards: the Disaster Risk Index. Natural Hazards and Earth System Sciences, 9, 1149-1159.
- Solterra Solutions, Determining the Impact of Climate Change on Insurance Risk and the Global Community, Phase I: Key Climate Indicators, November 2012. Available at: www.casact.org/research/ClimateChangeRpt_Final.pdf

- Data sources:
  - GHCNDEX: www.climdex.org
  - GHCN-Daily: www.ncdc.noaa.gov/oa/climate/ghcn-daily/
  - Sea Level: www.psmsl.org/data/obtaining/
  - Wind: www.esrl.noaa.gov/psd/data/gridded/datancep.reanalysis.html
  - Economic Losses: http://webra.cas.sc.edu/hvriapps/sheldus_setup/sheldus_login.aspx http://www.publicsafety.gc.ca/cnt/rsrcs/cndn-dsstr-dtbs/

Outside Reading (Homework)

- Al Gore, An Inconvenient Truth
- James Hansen, Storms of my Grandchildren
- James Hansen, Ice Melt, Sea Level Rise and Superstorms
- Robert Henson, The Rough Guide to Climate Change
- Elizabeth Kolbert, The Sixth Extinction
- Michael Mann & Lee Kump, Dire Predictions
- Roger Pielke, Jr., The Rightful Place of Science: Disasters & Climate Change
- Henry Pollack, A World Without Ice
- Henry Pollack, Uncertain Science… Uncertain World
- Matt Ridley, The Rational Optimist
- Andrew Weaver, Generation Us

NAIC Disclosure Update

NAIC Disclosure Survey Timeline

NAIC teamed with CERES and insurance representatives in developing disclosures

2006	2007	2008	2009	2010	2011	2012	2013	2014
NAIC Climate Change Task Force formed	Drafting of survey questions		NAIC approves Disclosure Survey	Individual States adopt own rules	Task Force dissolved CA, WA, NY (and PA) keep the survey. Working Group formed		CT, MN join the multi-state initiatives	IL, MD, and NM join the multi-state initiatives
			Mandatory and public reporting for insurer groups with DWP >500M	Voluntary and confidential	Mandatory and public reporting for individual companies who write >300M DWP in one of CA, WA and NY. For PA: Mandatory for insurer groups with DWP >300M		CA, WA, NY, CT and MN: >100M DWP PA: >300M DWP	

NAIC Disclosures Survey – State Disclosure Actions

Participating in Disclosures		
State	Mandatory?	Public?
California	Yes	Yes
New York	Yes	Yes
Washington	Yes	Yes
Pennsylvania	Yes	Yes
Minnesota	Yes	Yes
Connecticut	Yes	Yes
Maryland	Yes	No
Puerto Rico	Yes	No
Florida	No	Yes
Illinois	No	Yes
New Jersey	No	Yes
Oregon	No	Yes
Alabama	No	No
Colorado	No	No
Louisiana	No	No
Michigan	No	No
Missouri	No	No
Nebraska	No	No
Ohio	No	No
Oklahoma	No	No

Not Participating	
Alaska	Kentucky
Arkansas	Montana
Delaware	North Carolina
Georgia	North Dakota
Iowa	Nevada
Idaho	South Dakota
Indiana	Texas
Kansas	

N/A – No Response	
American Samoa	New Hampshire
Arizona	New Mexico
D.C.	Rhode Island
Guam	South Carolina
Hawaii	Tennessee
Massachusetts	Virginia
Maine	Vermont
	Wyoming

NAIC Disclosures Survey

Adopted Disclosure Survey – 8 Questions

Disclosure 1

Does the company have a plan to assess, reduce or mitigate its emissions in its operations or organizations? If yes, please summarize.

CDP: Performance Q21

Disclosure 2

Does the company have a climate change policy with respect to risk management and investment management? If yes, please summarize. If no, how do you account for climate change in your risk management?

Disclosure 3

Describe your company's process for identifying climate change-related risks and assessing the degree that they could affect your business, including financial implications.

CDP: Risk & Opportunities Q1-3

Disclosure 4

Summarize the current or anticipated risks that climate change poses to your company. Explain the ways that these risks could affect your business. Include identification of the geographical areas affected by these risks.

CDP: Risk & Opportunities Q1-3

Disclosure 5

Has the company considered the impact of climate change on its investment portfolio? Has it altered its investment strategy in response to these considerations? If so, please summarize the steps you have taken.

CDP: Risk & Opportunities
Q3 "Other Risks"
Q6 "Other Opportunities"

Disclosure 6

Summarize steps the company has taken to encourage policyholders to reduce the losses caused by climate change-influenced events.

CDP: Risk & Opportunities Q4-6

Disclosure 7

Discuss steps, if any, the company has taken to engage key constituencies on the topic of climate change.

CDP: Governance Q24, 26, 27

Disclosure 8

Describe actions your company is taking to manage the risks climate change poses to you business including, in general terms, the use of computer modeling.

CDP: Risk & Opportunities Q1-3

NAIC Disclosure Scoring Methodology

Scoring Framework

Thematic organization of the scoring approach is as follows:

- **Theme 1**: Climate Governance
- **Theme 2**: Enterprise-Wide Climate Risk Management
- **Theme 3**: Climate Change Modeling & Analytics
- **Theme 4**: Stakeholder Engagement
- **Theme 5**: Internal Greenhouse Gas Management
- **Theme 6**: Quality of Climate Risk Disclosure & Reporting

Rated Results

Ceres uses four-tier approach for rating insurers' responses to survey questions:

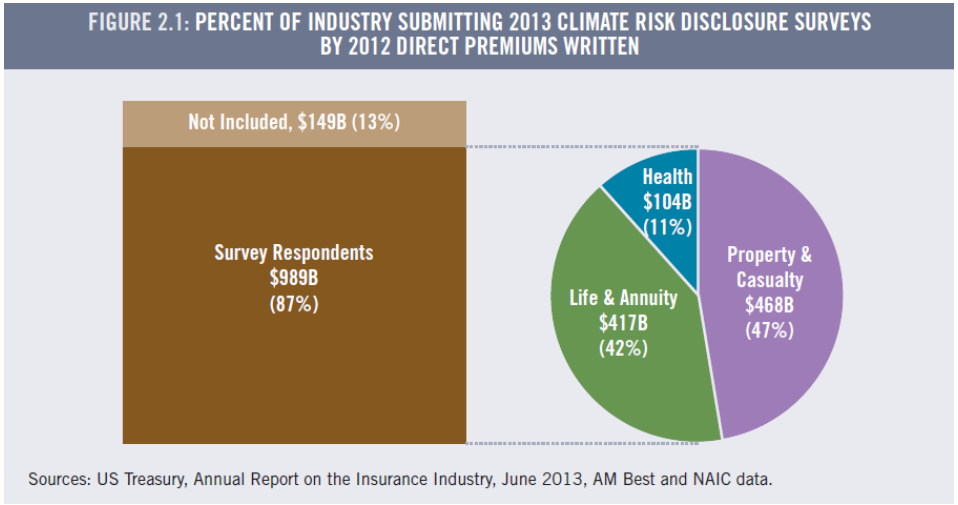
- **Top Quartile Rated Insurers =** Leading Practices
- **Second Quartile Rated Insurers** = Developing Practices
- **Third Quartile Rated Insurers** = Beginning Practices
- **Fourth Quartile Rated Insurers** = Minimal Information

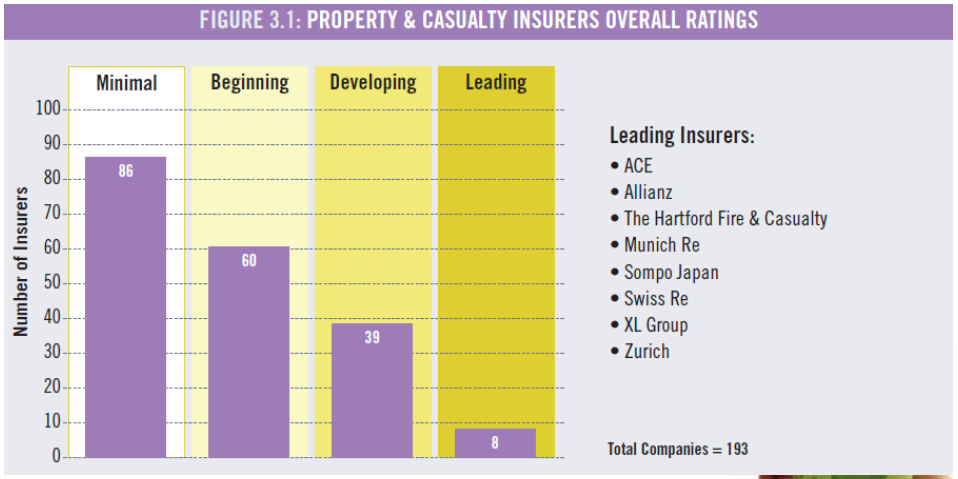
Source: Insurer Climate Risk Disclosure Survey Report and Scorecard – 2014 Findings and Recs.pdf

NAIC 2014 State Disclosures Survey Results

For the 2014 reporting year:

- Survey generated 330 distinct insurer responses, representing 87% of the U.S. insurance market
- The 2014 survey revealed that most of the companies responding to the survey reported a profound lack of preparedness in addressing climate-related risks and opportunities.
- Using a 100-point scale, only 4% of the P&C Segment surveyed earned an overall "Leading" rating (75 points or higher) while vast majority of insurers, 76%, earned "Beginning" or "Minimal" ratings (50 points or below)
- Nearly half of P&C insurers have taken positive steps in Climate Change Modeling & Analytics
- Link to survey database as of December 31, 2014
  - https://interactive.web.insurance.ca.gov/apex/f?p=201:1:0::NO





Source: Insurer Climate Risk Disclosure Survey Report and Scorecard – 2014 Findings and Recs.pdf

NAIC 2014 State Disclosures Recommendations

Develop Climate Risk Oversight at the Board and C-Suite Levels:

- Insurers' senior-level leadership will need to understand and align company policies with the risks associated with climate change.

Issue a Comprehensive, Public Corporate Policy on Climate Risk:

- All insurer should develop and issue a public climate risk management policy for the benefit of their shareholders, policyholders, and employees.

Integrate Climate Risk into ERM Frameworks:

- Incorporating climate change as an emerging risk will help insurers catalyze more effective responses across their enterprises.

Improve Climate Change Scenarios and Impact Assessments:

- Large-scale climate scenario project software and insurer underwriting data synergy will promote loss scenario developments that will directly feed into insurer product offerings and pricing.

Evaluate Climate Risks and Opportunities in Investment Portfolios:

- To remain competitive, companies will need to understand and invest in new opportunities such as green bonds which provide attractive returns and opportunities for diversification.

Engage with key Stakeholders on Climate Risk:

- Efforts include advocating for investments in resilient public infrastructure and climate research, educating policyholders regarding how they can mitigate climate risks in their homes and businesses, and promoting climate-smart insurance products.

Provide Comprehensive Climate Risk Disclosure to Regulators:

- In the interests of transparency and supporting evaluations of each specific insurance company's management of its climate risks, insurers should make every effort to provide comprehensive information publicly.

Participate in Joint Industry Initiatives on Climate Risk:

- Ceres' INCR, United Nations (UNEP FI PSI), ClimateWise.

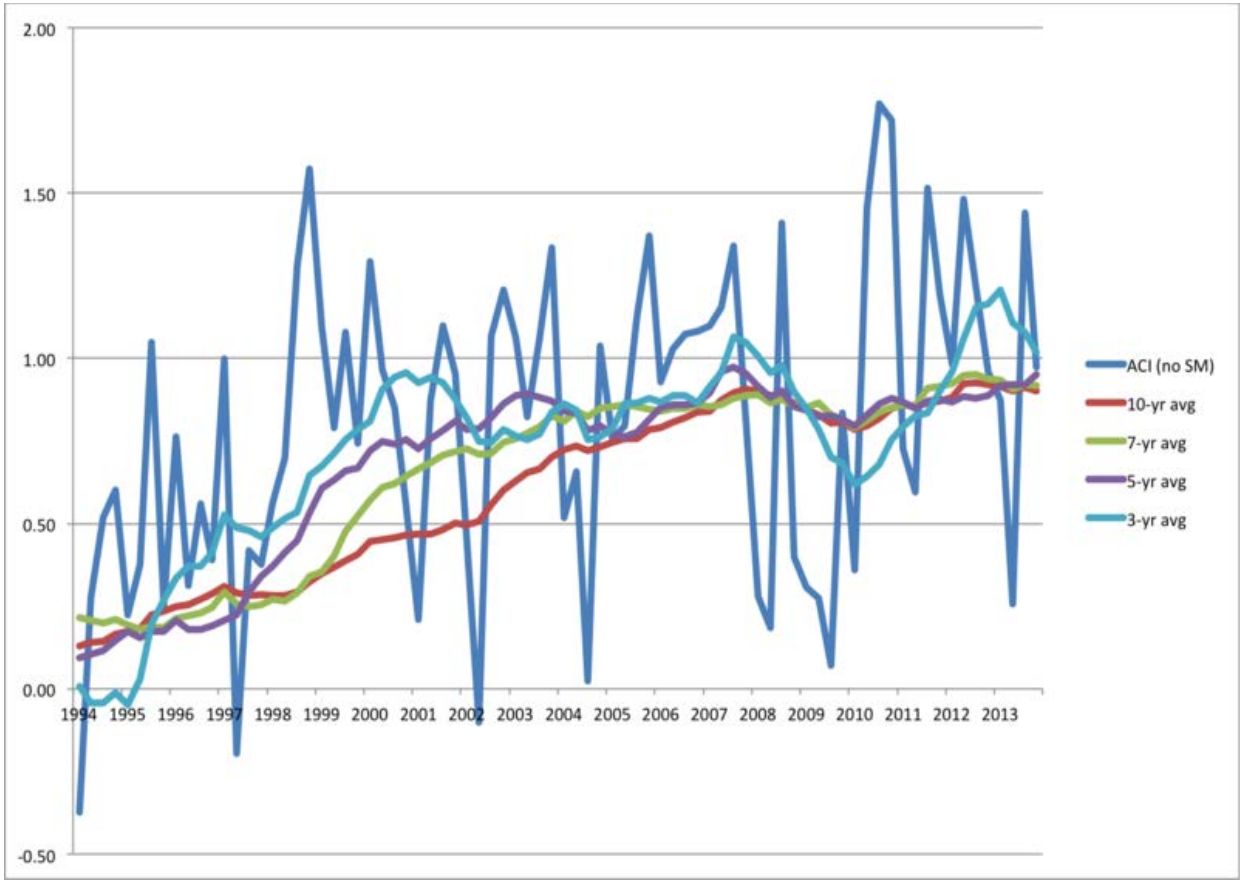
Potential Impacts of Climate Change on the P&C Industry

How might
the Actuaries Climate Index
impact Property & Casualty
actuarial work?

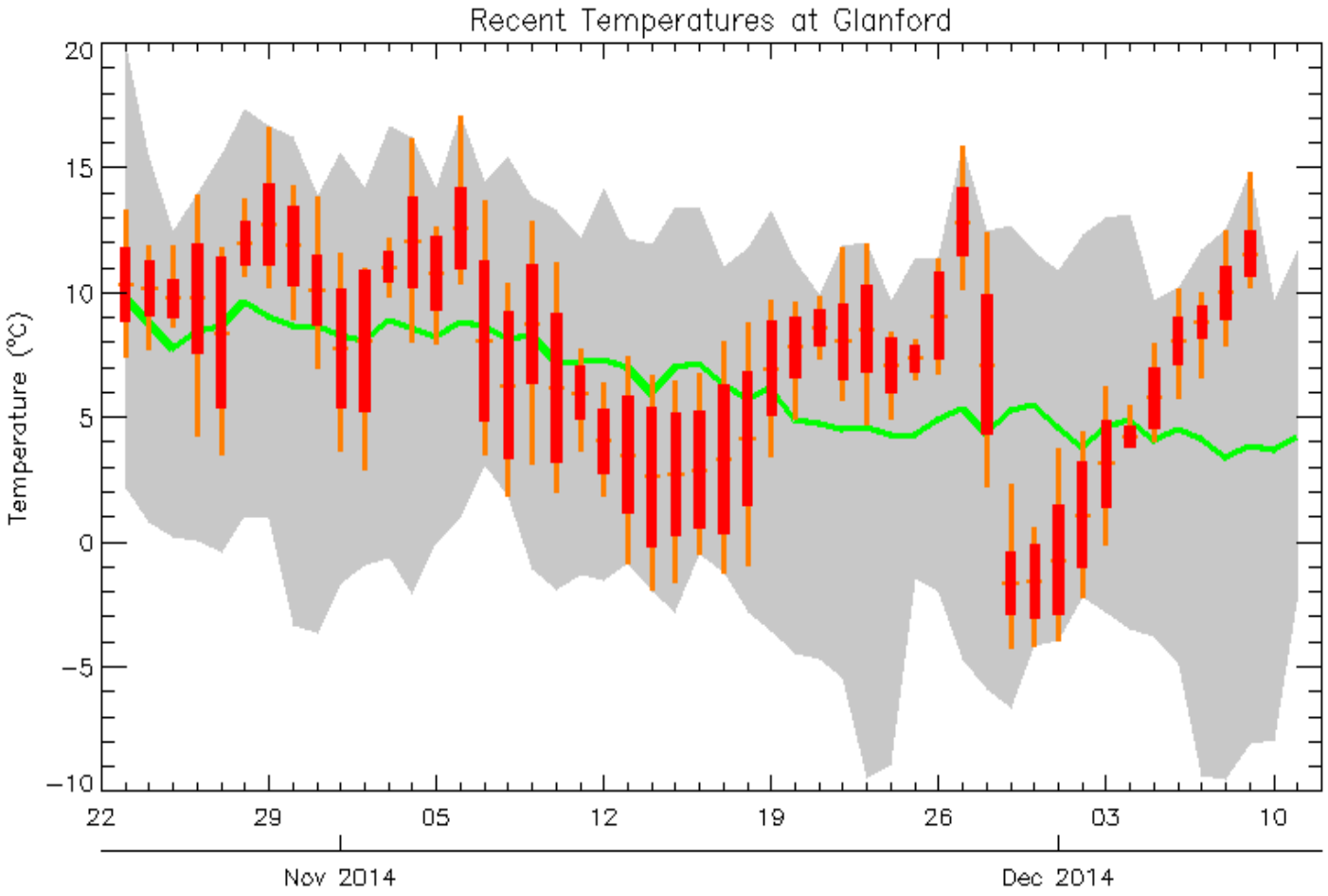
P&C Actuaries will need to

- Learn & follow measures of changing climate.
- Distinguish between changes in climate from changes in weather.
- Follow changes of climate over time and estimate how risk distributions change.
- Estimate changes in risk distributions
- Translate global risk distribution changes into their impact on local situations.
- Estimate the impacts of change on exposures at risk in various locations.

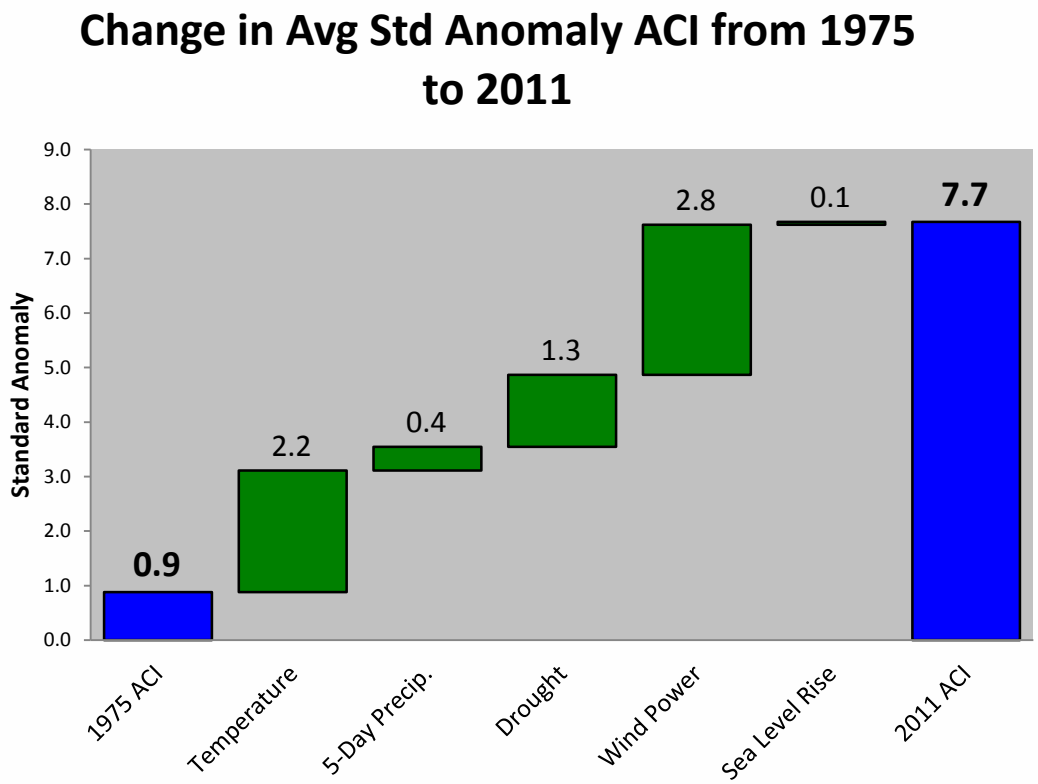
Measure change in extreme climate over time



Graph Weather vs Climate @EdWiebe Tweet 12/11/2014



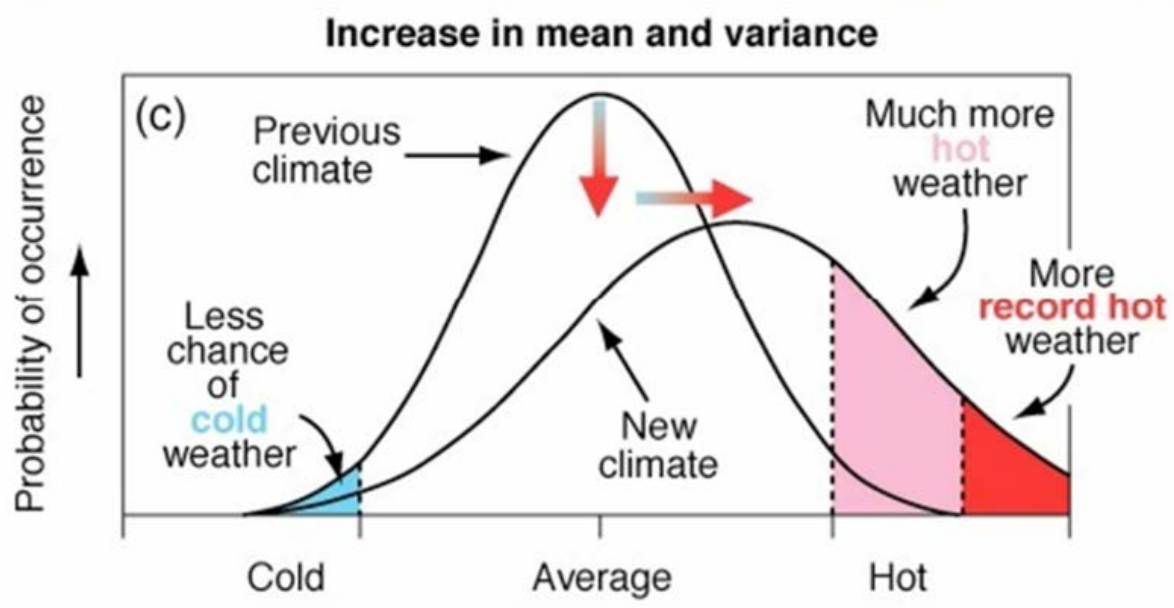
ACI is a risk lever measurement of Climate Extreme multipliers



"Climate change is a 'threat multiplier' making worse the problems that already exist."

- Senator John Warner, in testimony before the Senate Foreign Relations Committee as quoted by John Kerry, Secretary of State at Old Dominion University.

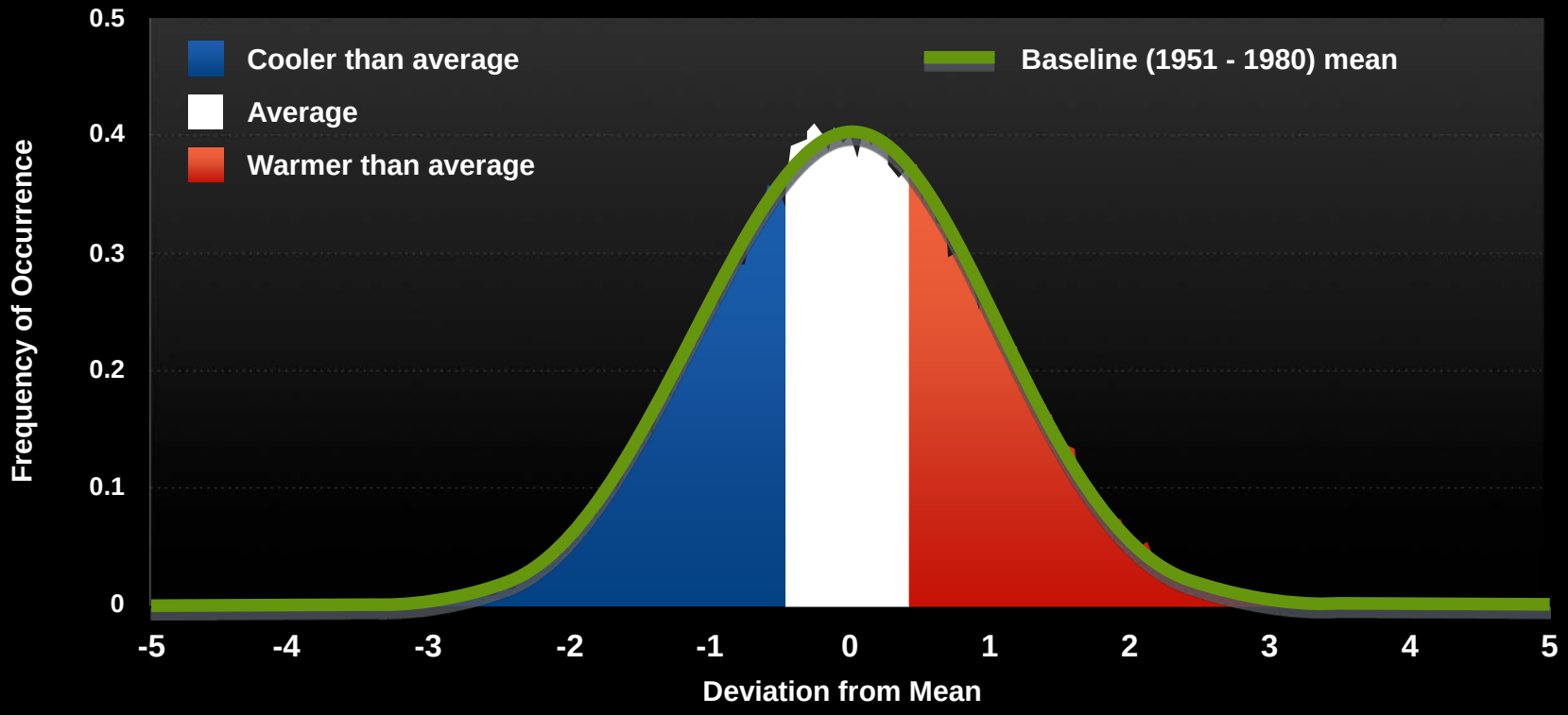
WHAT THE ACI DOES: ITS COMPONENTS MEASURE INCREASE IN MEAN AND VARIANCE



Source: Solterra Solutions: *Determining the Impact of Climate Change on Insurance Risk and the Global Community Phase 1: Key Climate Indicators*

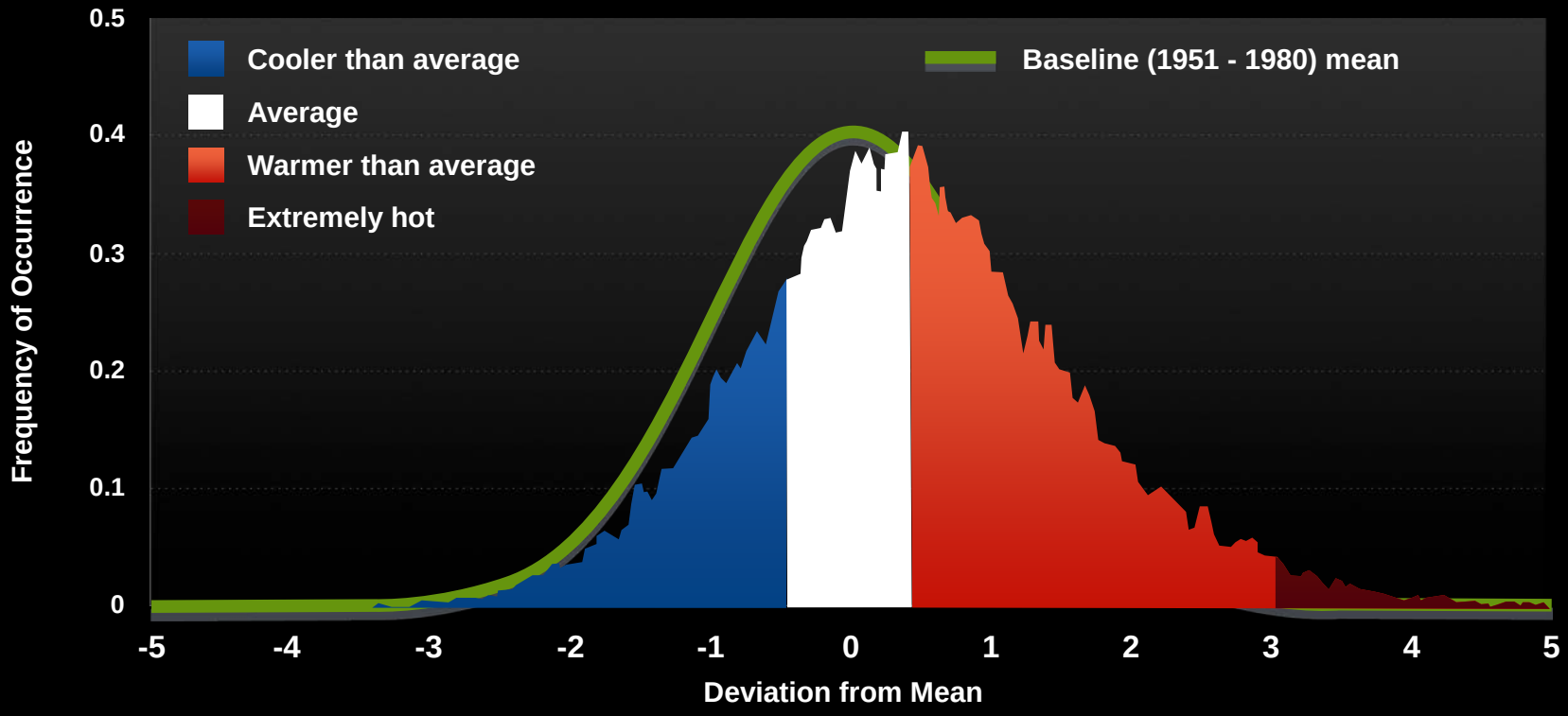
Summer Temperatures Have Shifted

1951 – 1980



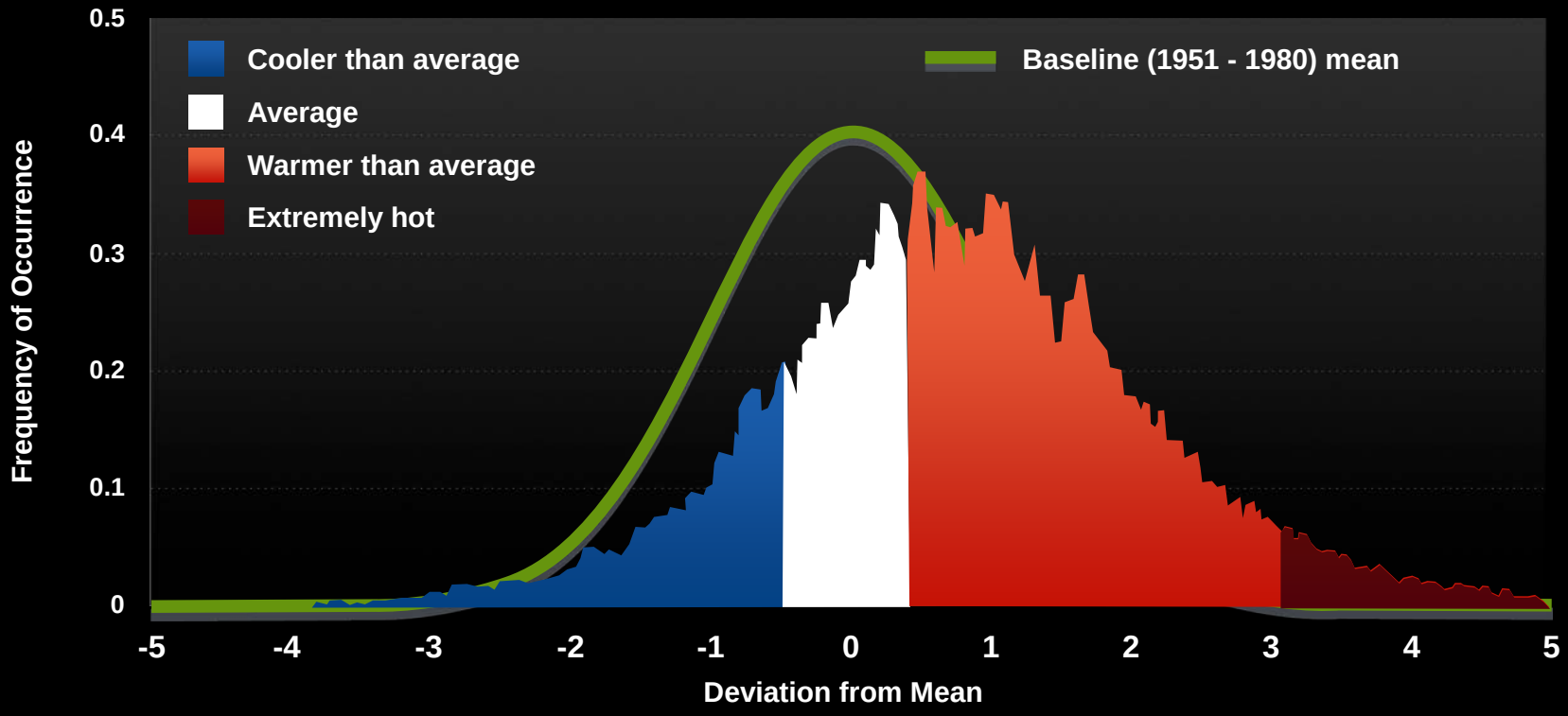
Source: NASA/GISS; Hansen, et al., "Perceptions of Climate Change," *Proc. Natl. Acad. Sci. USA* 10.1073, August 2012

1981 – 1991



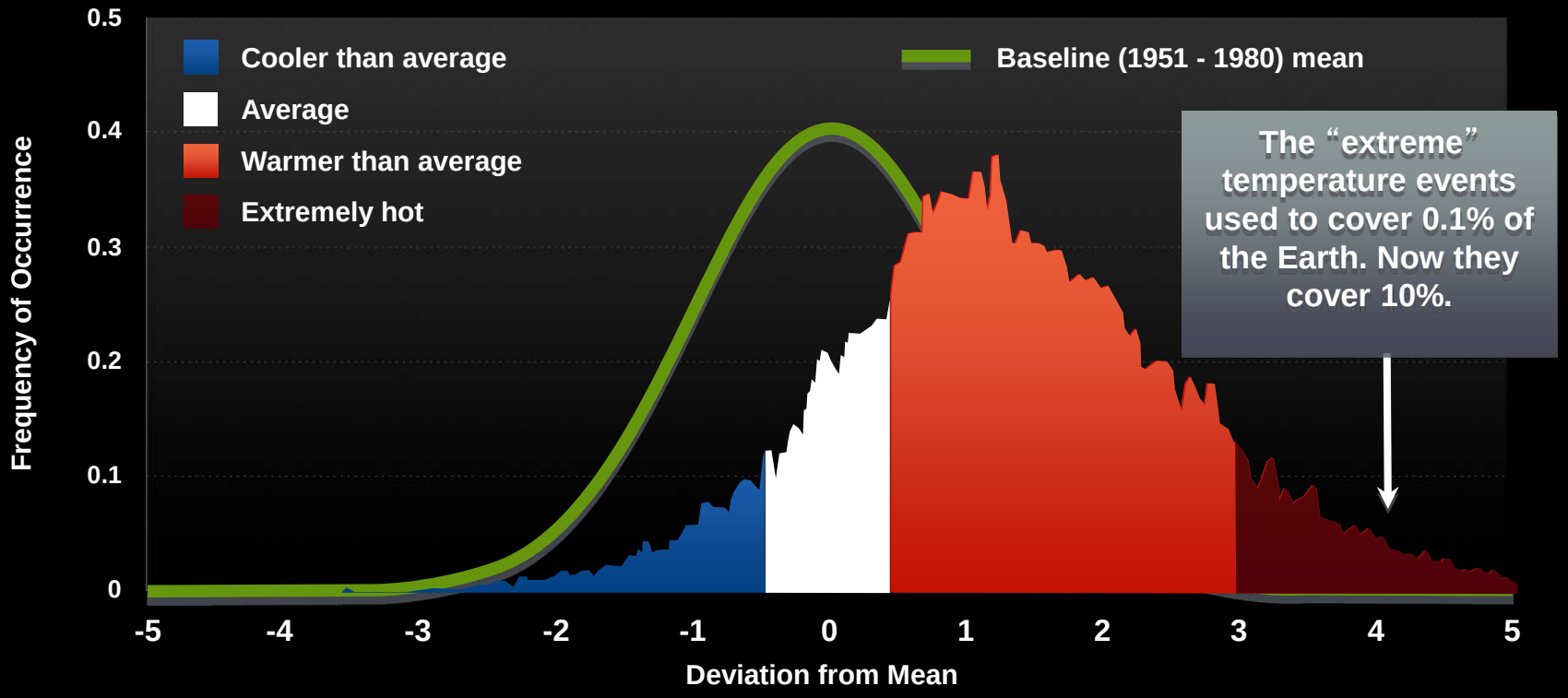
Source: NASA/GISS; Hansen, et al., "Perceptions of Climate Change," *Proc. Natl. Acad. Sci. USA* 10.1073, August 2012

1991 – 2001



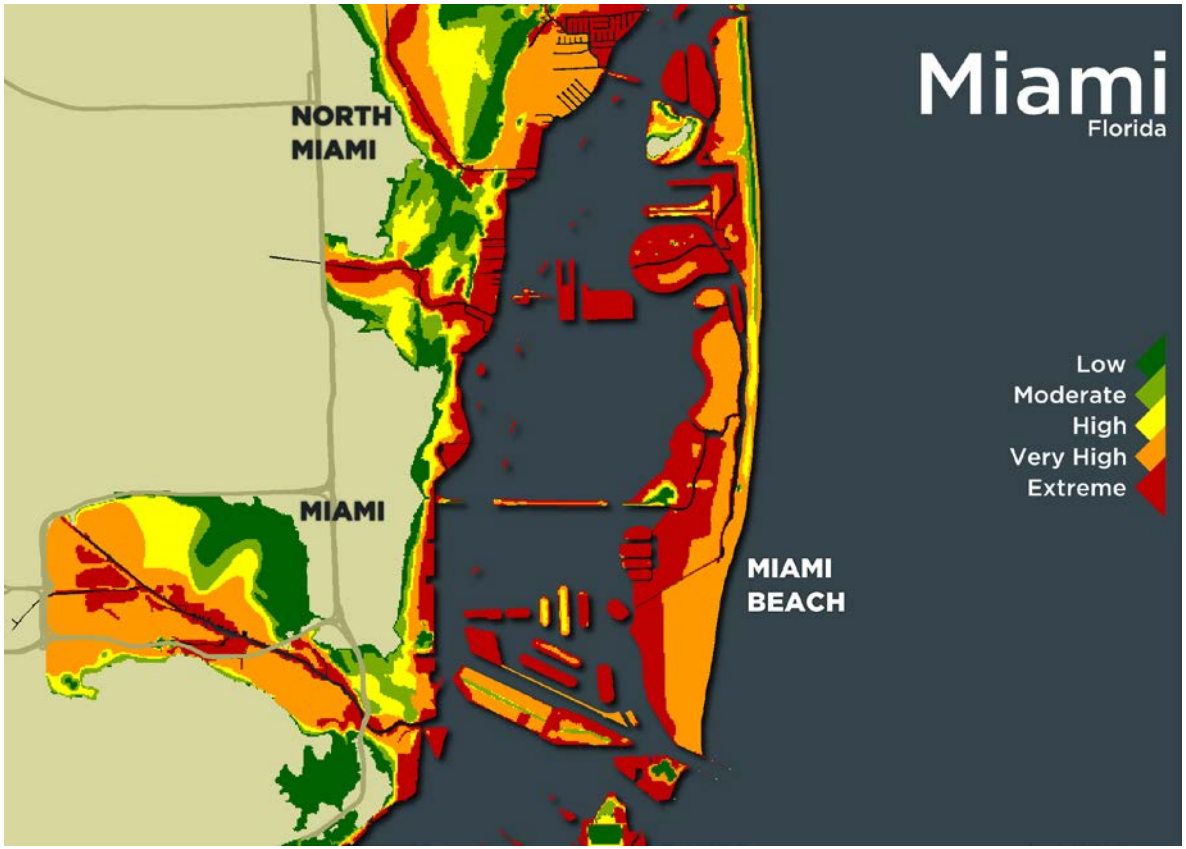
Source: NASA/GISS; Hansen, et al., "Perceptions of Climate Change," *Proc. Natl. Acad. Sci. USA* 10.1073, August 2012

2001 – 2011

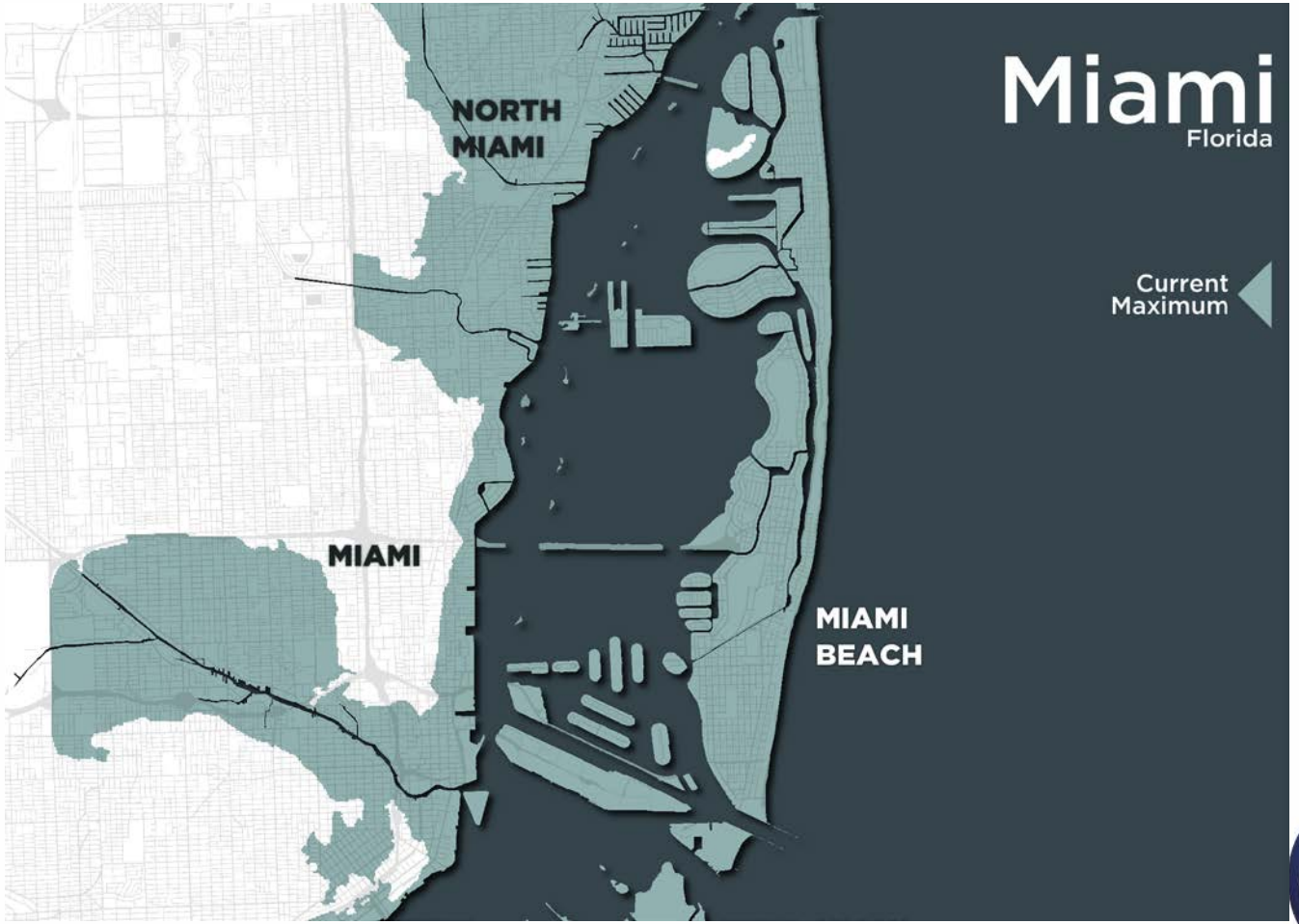


Source: NASA/GISS; Hansen, et al., “Perceptions of Climate Change,” *Proc. Natl. Acad. Sci. USA* 10.1073, August 2012

Current Estimated Storm Surge Extent – by risk level

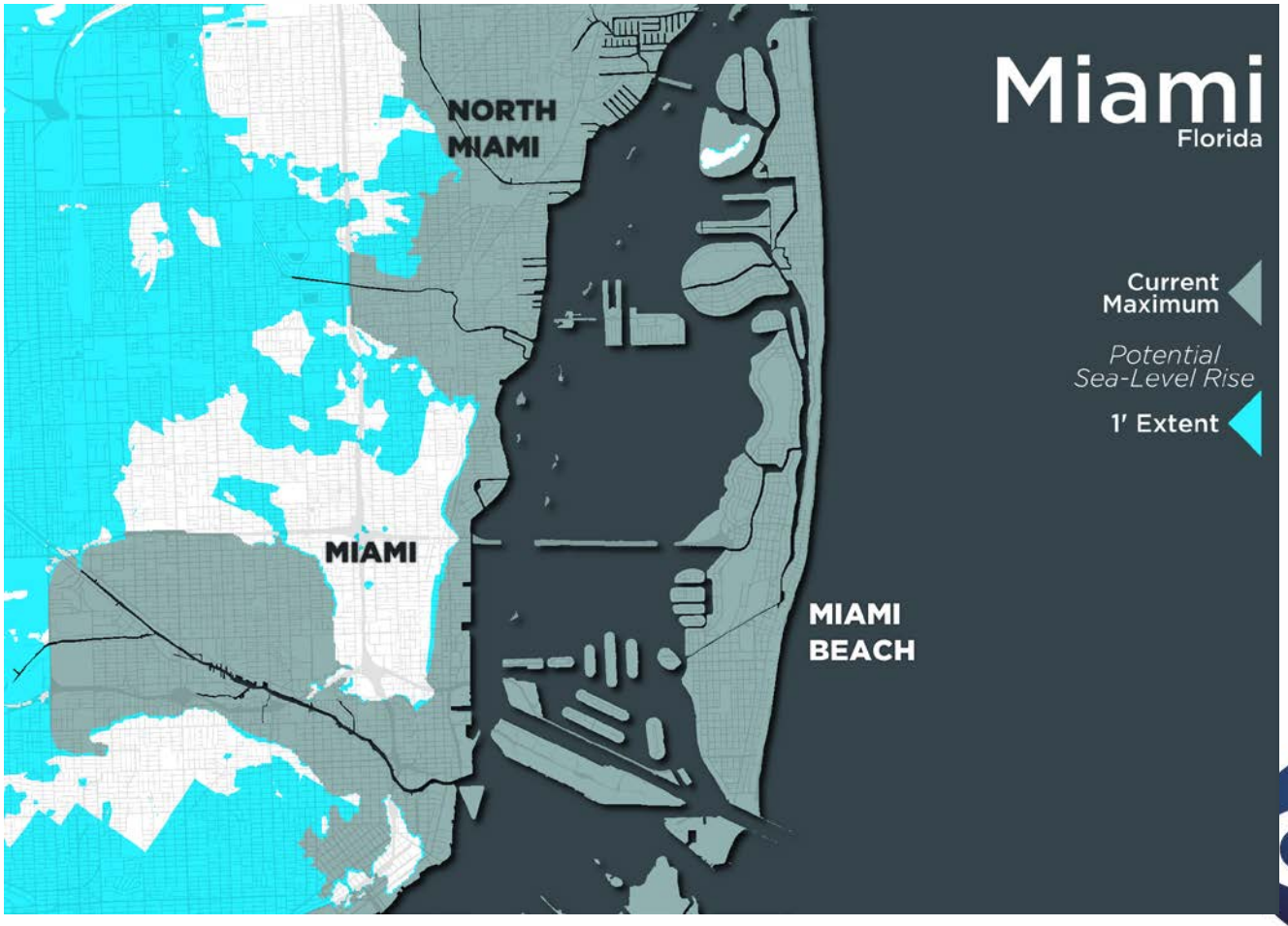


Current estimated MAXIMUM Storm Surge Risk Extent



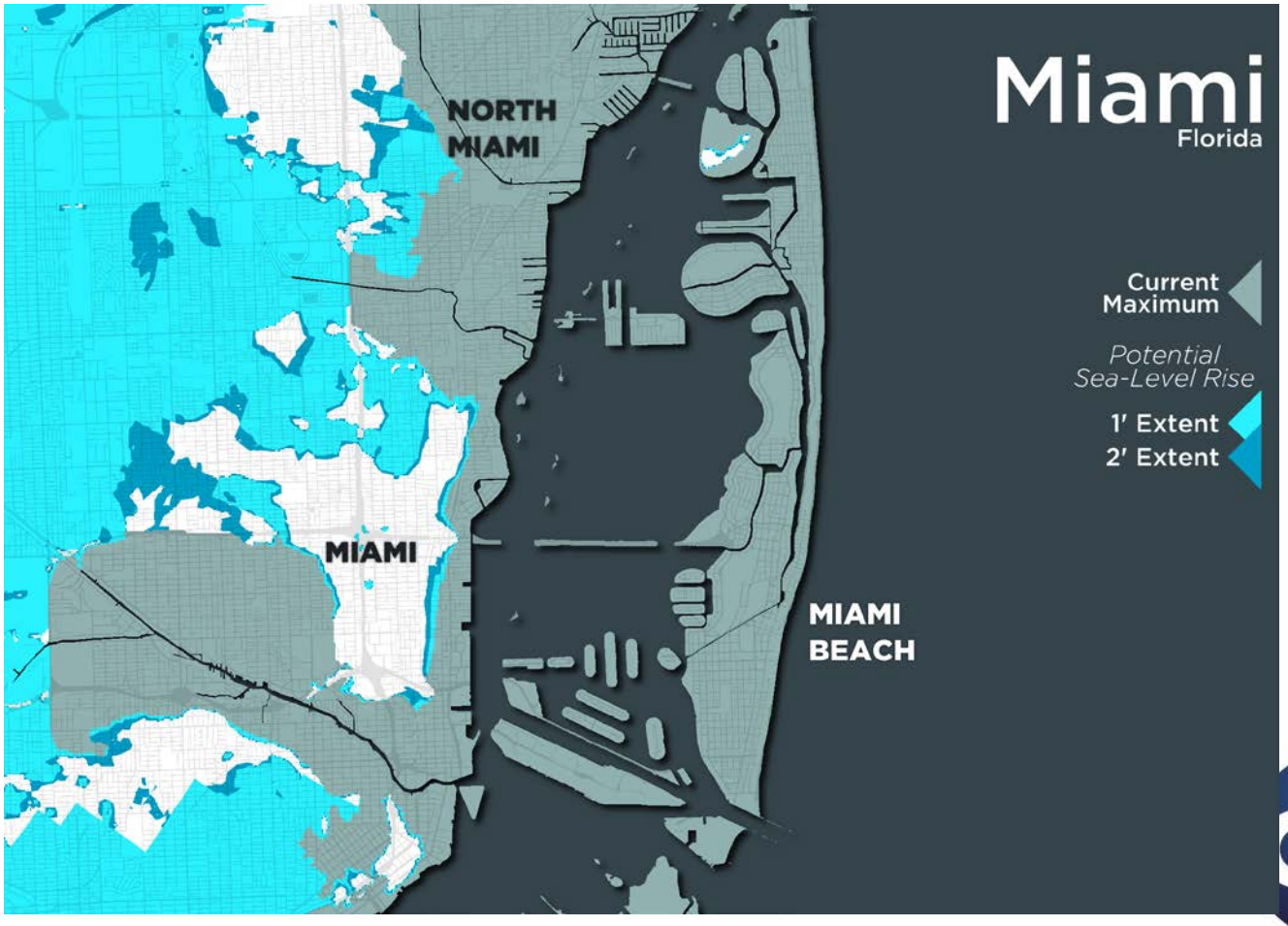
Source: CoreLogic Storm Surge Report, 2013

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



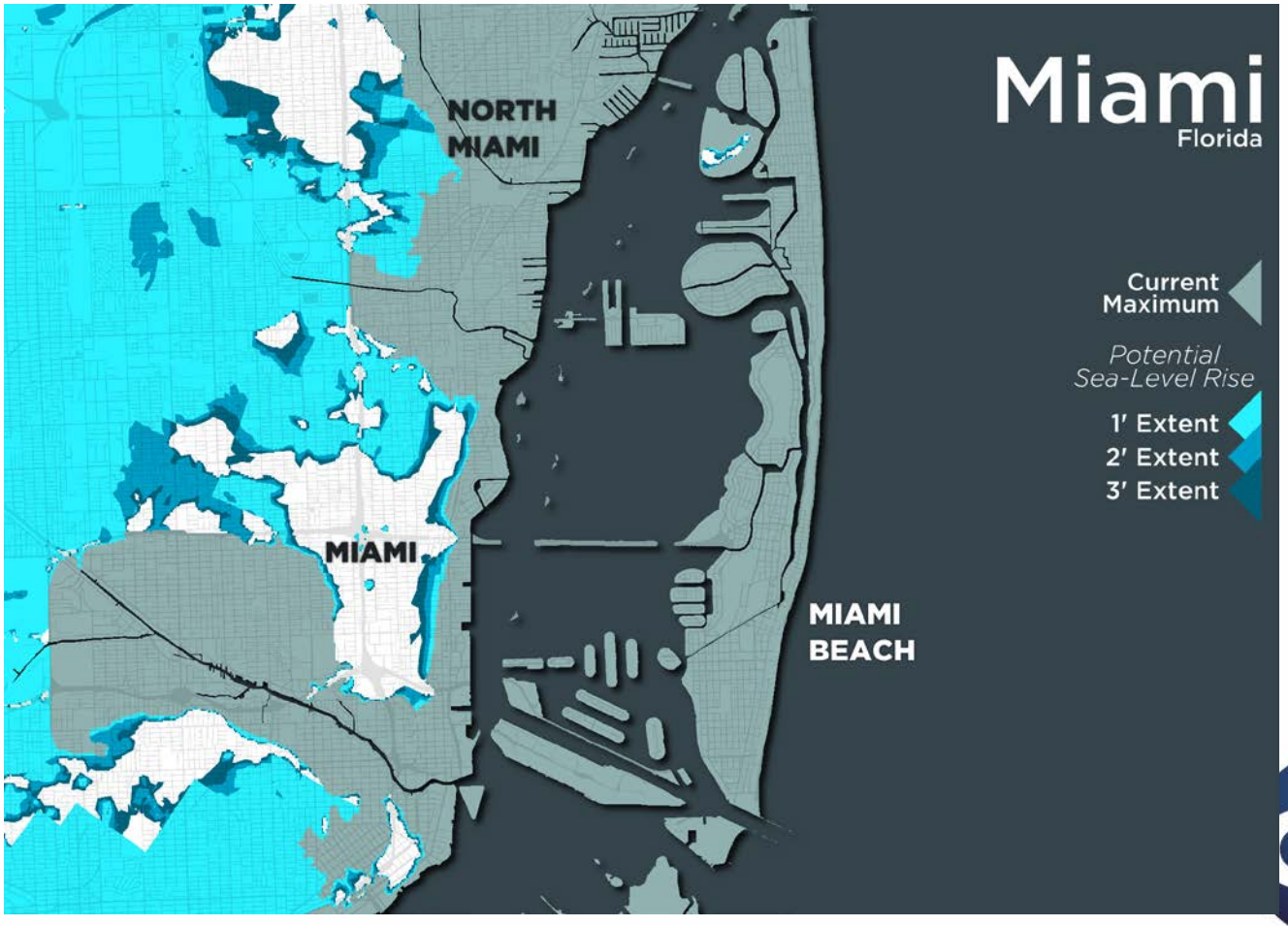
Source: CoreLogic Storm Surge Report, 2013

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



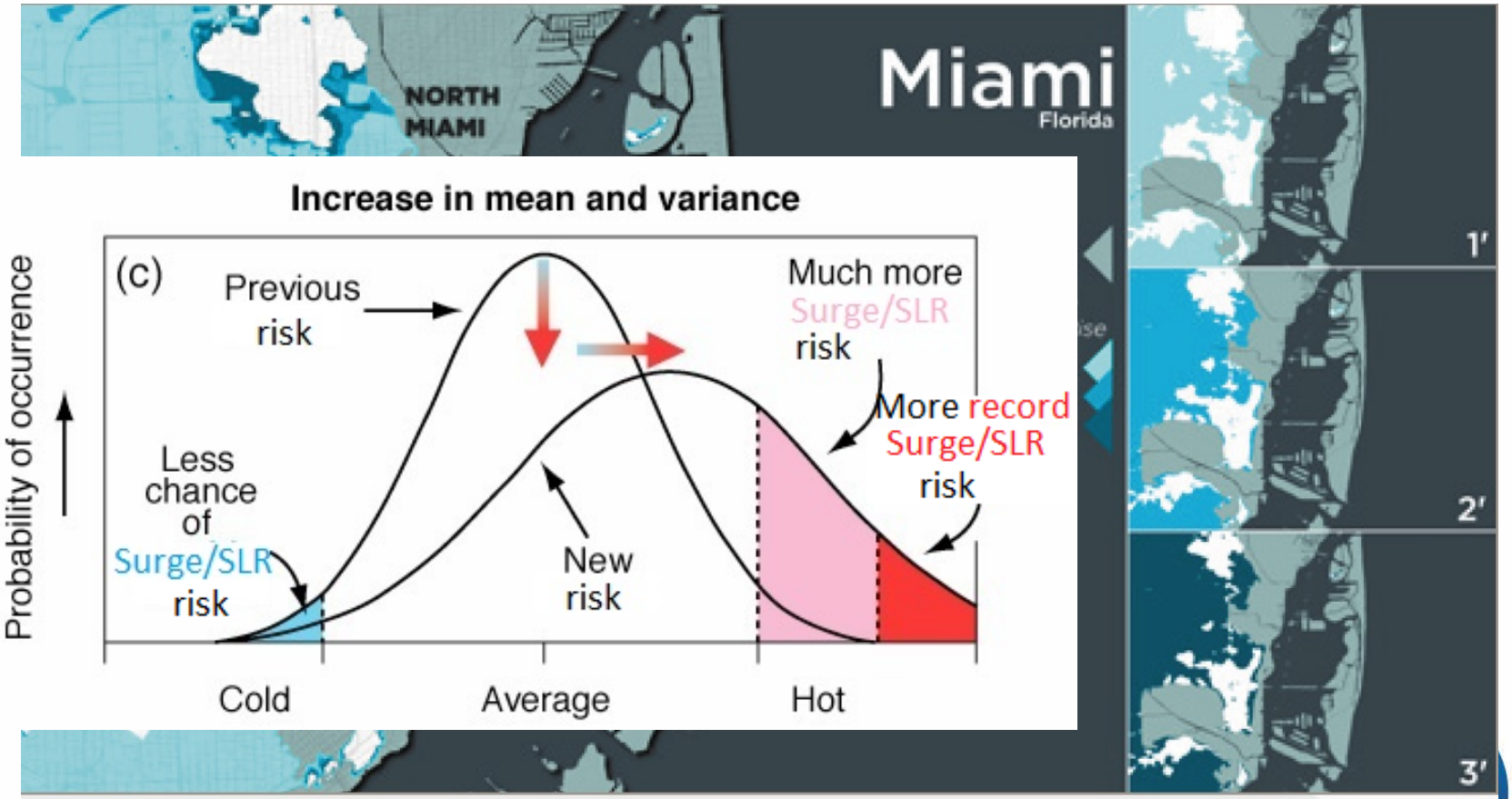
Source: CoreLogic Storm Surge Report, 2013

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



Miami 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

Potential additional Residences at risk of Sea-Level Rise

		Additional Properties at risk with Sea-Level Rise of		
Area Name	**Properties Affected**	**1 foot**	**2 feet**	**3 feet**
New York	447,428	16,487	32,238	49,023
Miami	239,910	207,986	218,109	223,485
Virginia Beach	305,943	3,457	7,925	11,075
Tampa	301,045	2,992	4,105	8,794
New Orleans	238,919	2,026	2,864	3,592
Houston	187,560	11,666	19,686	28,434
Mobile	27,515	1,527	3,043	6,718

Source: CoreLogic Storm Surge Report, 2013

What has been accomplished?

- By focusing carefully and thoughtfully on the past, the Climate Change Committee has finished a solid foundation of extreme climate risk data for the future.
- **The ACI** is a carefully curated index data that can be thought of as ***the footings of a new analytic home*.**
- **The ACRI** could be thought of as ***the solid foundation of a new home*.**

Carefully curated Indices: ACI & ACRI

Actuaries Climate Index: Solid footings!

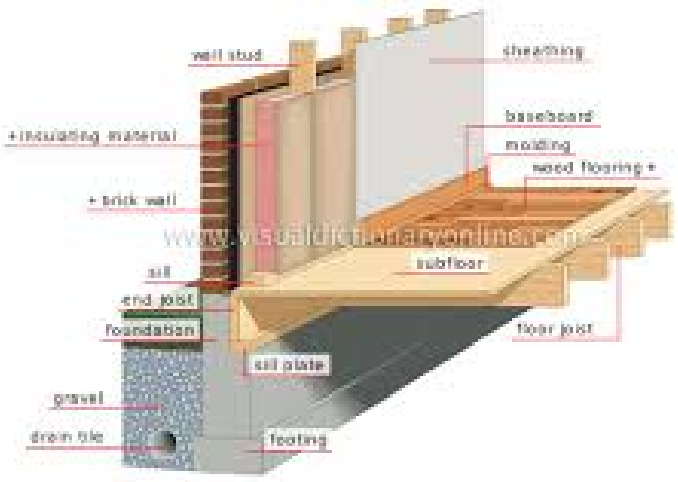
Actuaries Climate Risk Index: A Solid foundation!

What will the ACRI do?

- Economic damage data was gathered
  - (SHELDUS data in the US and a similar Canadian dataset).
- Historical relationships, Historical Hazard Indices were quantified between economic damages and population data and the ACI
- **Blending these predictive relationships is the ACRI, the Actuaries Climate *Risk* Index**
- The resulting ACRI will quantify changing level(s) of risk to economic assets and human population due to aspects of climate change described in the ACI, over the same North American (Canada-U.S.) domain.

Benefits of Actuarial/Scientist Collaboration using the ACI/ACRI

Opportunity to Build the 1st Floor!



Future Projects will then be ready to weather storms and stand firm!

Potential Uses, Further R & D

- Potential uses
  - Inform the debate
  - Compare weather and climate
  - Analysis of data
- Adding regions
  - Will actuarial organizations elsewhere take lead?
  - Had preliminary talks recently with IFoA in UK
  - Could link or add to our website
- Call paper program after launch
- Funded research

Benefits of Collaborative Refinement

- A refined ACI could be constructed for the US, by state and/or county. 3 benefits & A Big Result would follow:
  - BETTER GRANULARITY: It could improve the ACI giving Property Casualty with work by State. Further, the county detail would give necessary coastal reference points for measuring climate extreme impacts of Seal Level Rise (SLR).
  - BETTER USE OF DATA: Actuaries could help make best use of the wealth of data gathered to solve SLR problems
  - BETTER SCIENCE The analysis could be enhanced with expert modeling skills of NOAA scientists and others.
- REFINED CLIMATE ADAPTATION COST MODELS

Phase 2: Potential Uses – Impact by Line of Business

- Composite indexes by product line could be created based on an understanding of the relative impact of various climate driven natural hazards.
- Examples :
  - Property Climate Risk = f(Floods, Tropical Cyclone, Extra-tropical Cyclone Indices, Sea Level Rise)
  - Crop Climate Risk = f(Floods, Heat waves and Drought)

Hazards	Timeframe	Property (individual and commercial lines)	Engineering (EAR, CAR*)	Marine	Agricultural (crop and livestock)	Motor own damage	Aviation and space	Contingency risks (cancellation of event)	Life and health	Liability
Floods, storm surge	5-10 years									
	10-30 years									
Storms, flash floods	5-10 years									
	10-30 years									
Heatwaves and drought	5-10 years									
	10-30 years									
Less frost and cold weather	5-10 years									
	10-30 years									
Rising sea levels	5-10 years									
	10-30 years									
Tropical cyclones	5-10 years									
	10-30 years									
Extratropical storms	5-10 years									
	10-30 years									
Melting of polar icecaps	5-10 years									
	10-30 years									

* EAR = Erection All Risks, CAR = Contractors All Risks

generally positive
no
slightly negative
fairly negative
highly negative

Source: "Globe of Natural Hazards", Munich Re, 200

Sustainability/Green Products

Sustainability/Green Products

"Just as the industry has historically asserted its leadership to minimize risks from building fires and earthquakes, insurers have a huge opportunity today to develop creative loss-prevention solutions and products that will reduce climate change-related losses for consumers, government, and themselves."

– E. Mills, Ph.D.,
CERES “From Risk to Opportunity Insurer Responses to Climate Change”

Sustainability/Green Products

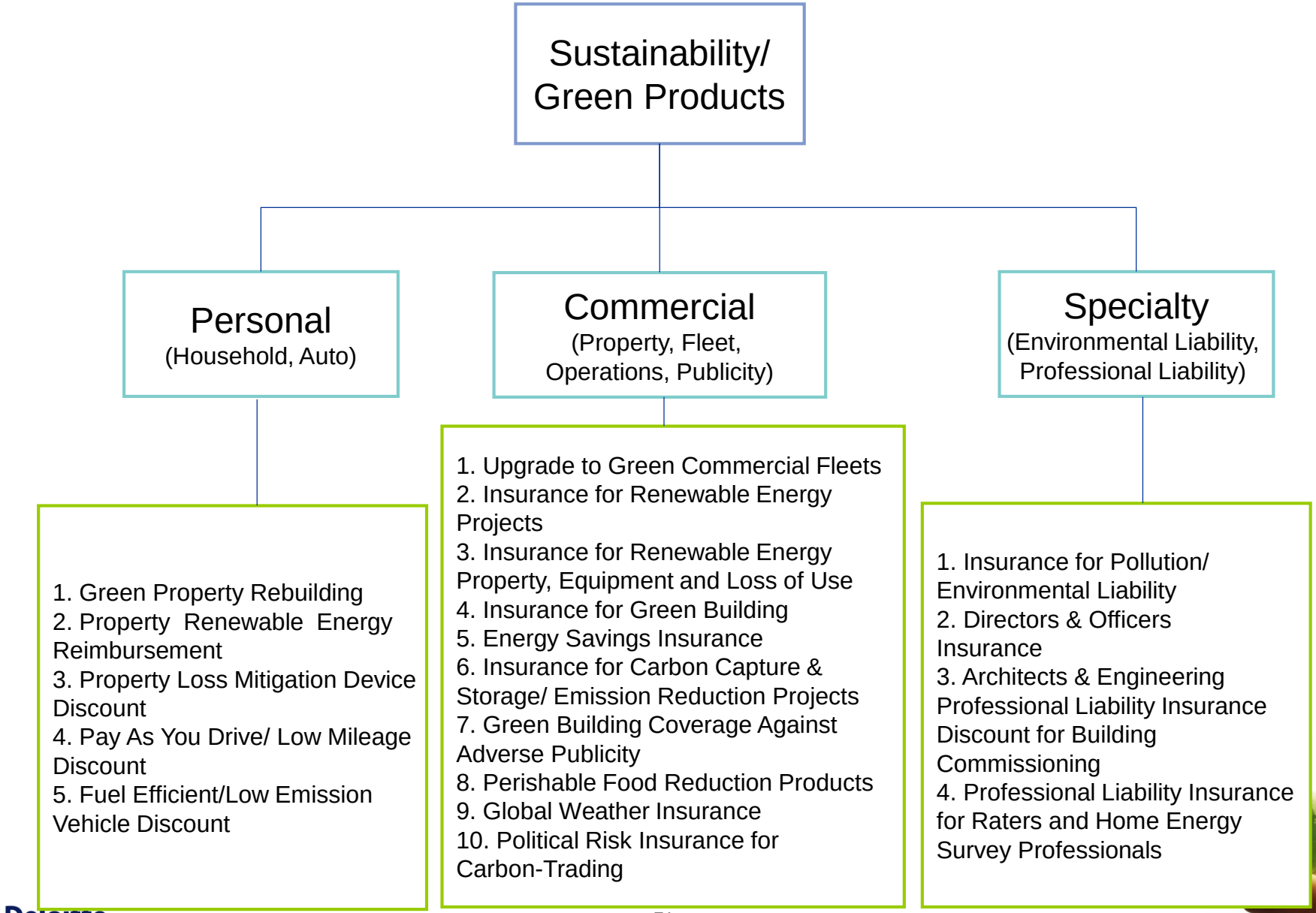
- Sustainable products are those products that provide environmental, social and economic benefits while protecting public health and the environment over their whole life cycle, from the extraction of raw materials used to produce the product until their final disposal

- Sustainable and green insurance products are those that cover the design, production and use of sustainable products, or the liability associated with their production and use.

- They also indemnify against the environmental consequence of potential climate change decisions (or indecisions) made by executives in Directors & Officers coverage.

- Also broadly covered in this definition of sustainable/green products would be policies where certain features promote sustainable or green behavior.

Sustainability/Green Products



Green Product Offerings: Personal Lines

Product	Description
Green Property Rebuilding	Repair and replace with more energy-efficient and sustainable materials, equipment or appliances
Property Renewable Energy Reimbursement	In case of power outage from the alternative-energy system, indemnify for loss of income generated, costs to purchase replacement electricity and re-connection costs
Property Loss Mitigation Device Discount	Premium credits are offered to homeowners who install mitigation devices or choose storm-resistant construction techniques
Pay As You Drive/Low Mileage Discount	Give incentives to drive less which leads to less pollution that may be contributing to global warming
Fuel Efficient/Low Emission Vehicle Discount	Provide discounts for hybrid or electric passenger vehicles

Green Product Offerings: Personal Lines Example 1

ISO Green Upgrades Coverage (HO 06 31 01 14)

1. Green Upgrades Property Coverage

The coverage is available for the increased cost due to green upgrades and is based on a percentage of the amount of the loss. This percentage is selected by the client (at the time the endorsement is added) with options of 10%, 20%, 30%, 40%, or 50% available.

One green option that is gaining popularity is a vegetated roof—also known as a green roof, a living roof, or an eco roof. The increased cost to upgrade to a vegetated roof is not automatically covered by this endorsement.

2. ISO Green Upgrades Related Coverage

Coverage is provided up to the limit shown in the Schedule for those expenses that are related to a loss covered under the Green Upgrades Property Coverage. Covered expenses are those incurred for:

- Waste Reduction and Recycling,
- Design And Engineering Professional Fees,
- Certification Fees And Related Equipment Testing, and
- Building Air-out And Related Air Testing.

Green Product Offerings: Personal Lines Example 2

Green Property Rebuilding

After a covered loss, it pays for the use of:

- Environmentally friendly or more energy-efficient materials when making repairs
- More energy efficient equipment or appliances.

For those policyholders who are already green, discounts are sometimes offered on their insurance premiums.

QUESTIONS
&
DISCUSSION

Potential Uses – Rate Making & Risk Management

- Integrate AC(R)I as parameters into predictive models
  - Capture climate sensitivity in underlying hazard
  - Capture both historical and projected trends explicitly
- ACRI can complement catastrophe risk models
- ACRI parameters can be used to create and assess future robust decision making scenarios
- ACRI can be used to calculate the Climate Change “Uncertainty or Ambiguity” load in pricing and capital management
- Regional and line of business ACRI can be used for portfolio diversification and strategic decisions

How Can We Leverage This Work?

- What significant issues does the insurance industry face due to climate change?
  - Varies for property, liability, life, health
  - Incorporating new trends into pricing
  - Incorporating higher risk into pricing and ERM
  - Coverage & availability
  - Underwriting, investment and claim strategy
- Timetable and urgency of mitigation, remediation
- Managing climate change risk using the ACI & ACRI
  - Education
  - Data analysis

CAS Climate Change Committee – CIWG – ACI/ACRI Timeline

2008 thru 2010		2011	2012	2013	2014	2015	2016
				I & II	III & IV	V	Publish!

"Phase 0" CAS Climate Change Task Force formed	Climate Index Working Group Phase 1	Climate Index Working Group Phase 2: **Stages I, II, III, IV & V**	**"Phase 3" What can we do together with the ACI and ACRI for society?**
	Determining the Impact of Climate Change on Insurance Risk and the Global Community	Actuaries' Climate Index (ACI) developed Actuaries Climate Risk Index (ACRI)	

- It is our actuarial professional responsibility to understand the latest in climate change science and develop actuarially sound approaches to managing the potential implications of climate change risk factors.