ACTUARIES CLIMATE INDEX
INDICE ACTUARIEL CLIMATIQUE

A PRESENTATION BY THE AMERICAN ACADEMY OF ACTUARIES TO THE NAIC'S CLIMATE CHANGE AND GLOBAL WARMING (C) WORKING GROUP

MARCH 24, 2018 – MILWAUKEE, WISCONSIN

American Academy of Actuaries
Objective. Independent. Effective.™

Actuaries Climate Index
&
Actuaries Climate Risk Index

March 24, 2018

ACTUARIES CLIMATE INDEX
INDICE ACTUARIEL CLIMATIQUE

ACTUARIES CLIMATE RISK INDEX
INDICE ACTUARIEL
DES RISQUES CLIMATIQUES

Agenda for this presentation

- Overview
- Highlights of the ACI
  - Components
  - Regions
- Latest Findings
- ACRI Preview
- Q&A

Goals of the Actuaries Climate Index (ACI) and the Actuaries Climate Risk Index (ACRI)

- Create indices that reflect an actuarial perspective, are objective, and are easy to understand without being overly simplistic
- Create one index that measures changes in climate extremes, and a second index that relates those climate extremes to economic and human losses
- Use the indices to inform policymakers, insurance professionals, and the general public on the incidence and impact of extreme events
- Promote the actuarial profession by contributing constructively to the climate change debate

Research Sponsors:

American Academy of Actuaries
Objective. Independent. Effective.™

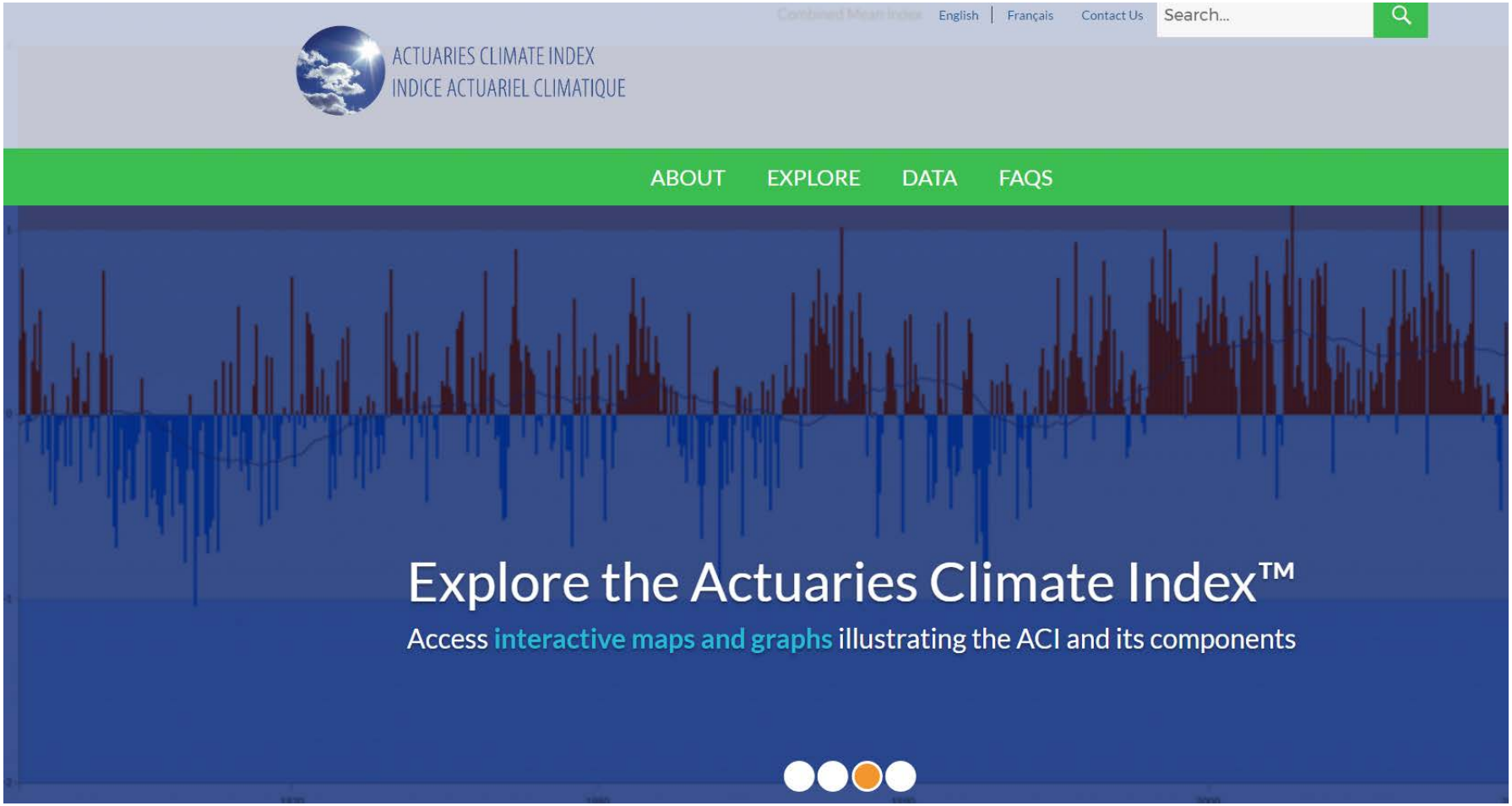
Canadian Institute of Actuaries / Institut canadien des actuaires

CAS

Society of Actuaries

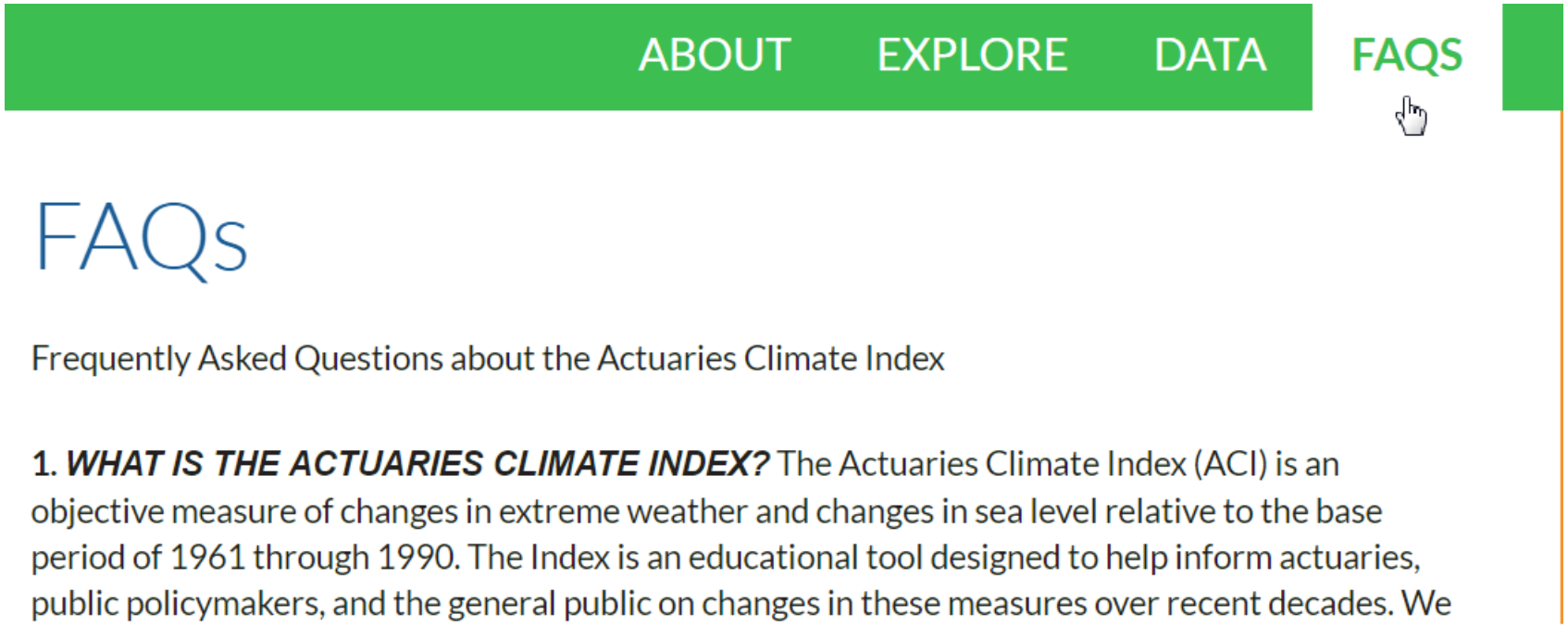
ACI-ACRI – A Web-based Tool

www.actuariesclimateindex.org www.indiceactuarielclimatique.org



Website - FAQs

www.actuariesclimateindex.org



FAQs

Frequently Asked Questions about the Actuaries Climate Index

1. ***WHAT IS THE ACTUARIES CLIMATE INDEX?*** The Actuaries Climate Index (ACI) is an objective measure of changes in extreme weather and changes in sea level relative to the base period of 1961 through 1990. The Index is an educational tool designed to help inform actuaries, public policymakers, and the general public on changes in these measures over recent decades. We intend to update the index quarterly, as data for each meteorological season is available. We also intend to publish a second index, the Actuaries Climate Risk Index (ACRI), based on the historical correlations of economic losses, deaths and injuries to the ACI data.

2. ***WHY ARE ACTUARIES WEIGHING IN ON CLIMATE CHANGE DISCUSSIONS?*** Actuaries are experienced in the assessment and mitigation of financial consequences of risks and in the

Website - Data

www.actuariesclimateindex.org

ABOUT EXPLORE DATA FAQS

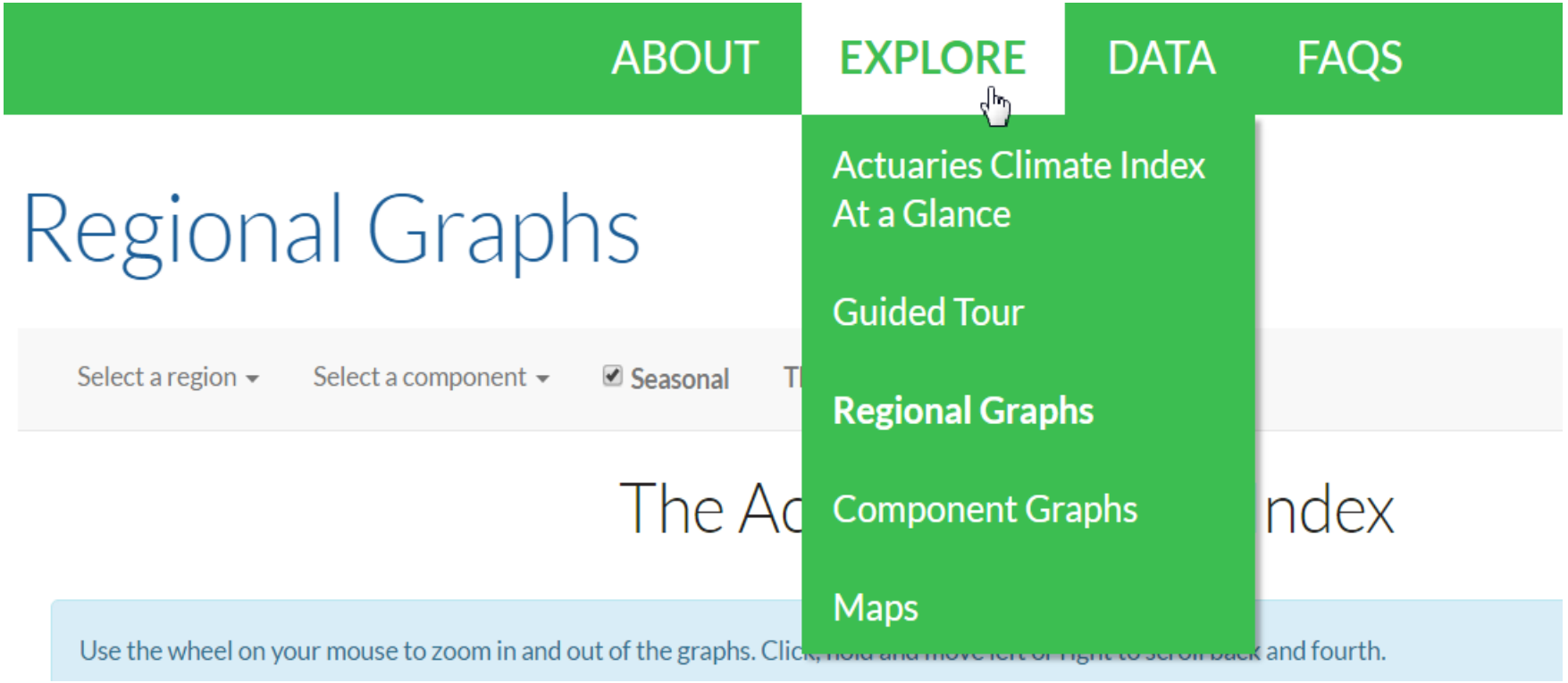
Data Disclosure

Data Disclosure for the Actuaries Climate Index™

In performing the work for this project, the American Academy of Actuaries (Academy), Casualty Actuarial Society (CAS), Canadian Institute of Actuaries (CIA), and Society of Actuaries (SOA) relied upon data and information provided by Solterra Solutions and a number of publicly available data sources: the National Oceanic and Atmospheric Administration (NOAA), CLIMDEX*, and Permanent Service for Mean Sea Level. We reviewed the data and information provided for reasonableness but did not perform detailed audits. We have, therefore, relied upon each of these sources to provide accurate and complete data and information.

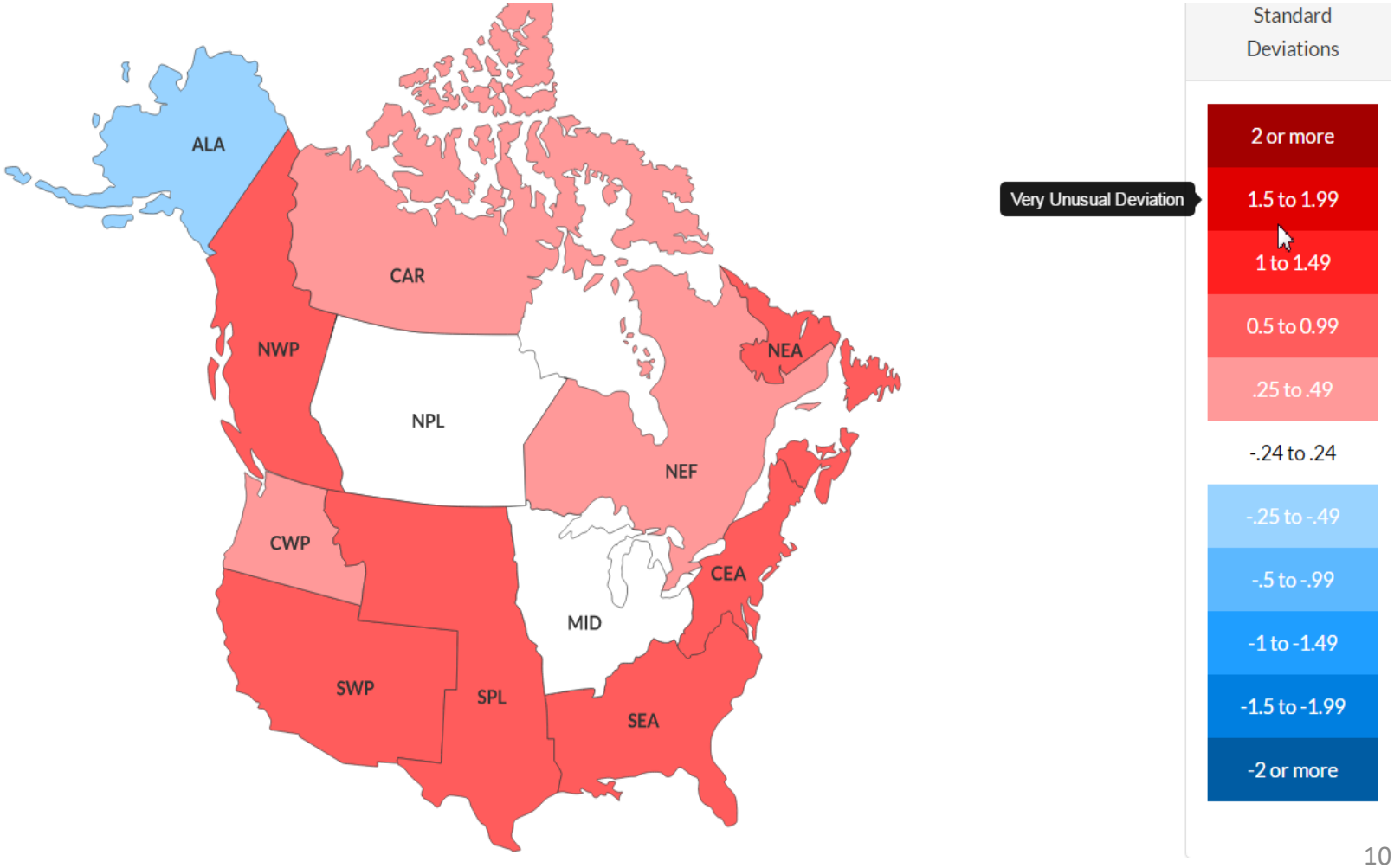
Website - Explore

www.actuariesclimateindex.org

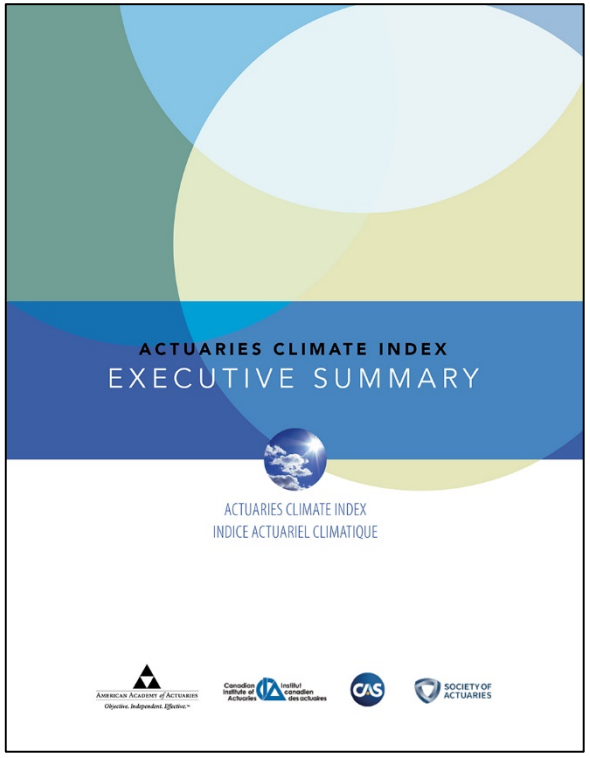


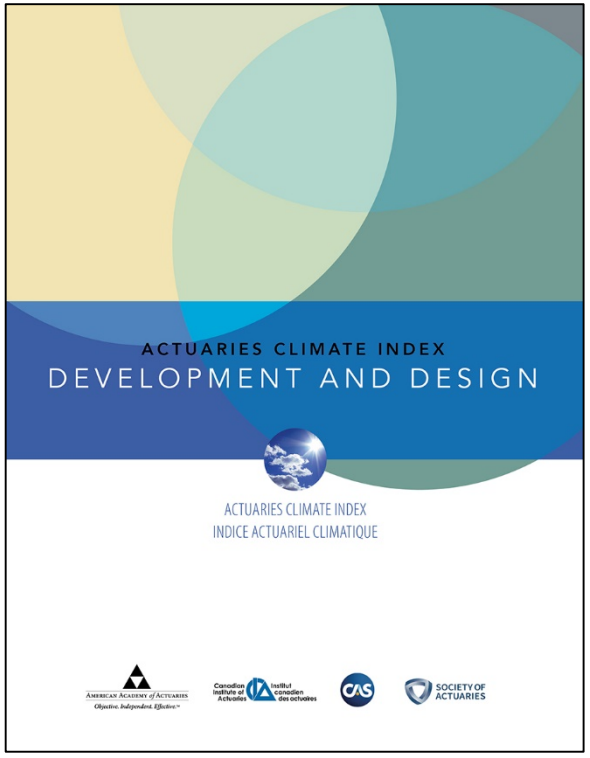
Website – Explore – Maps

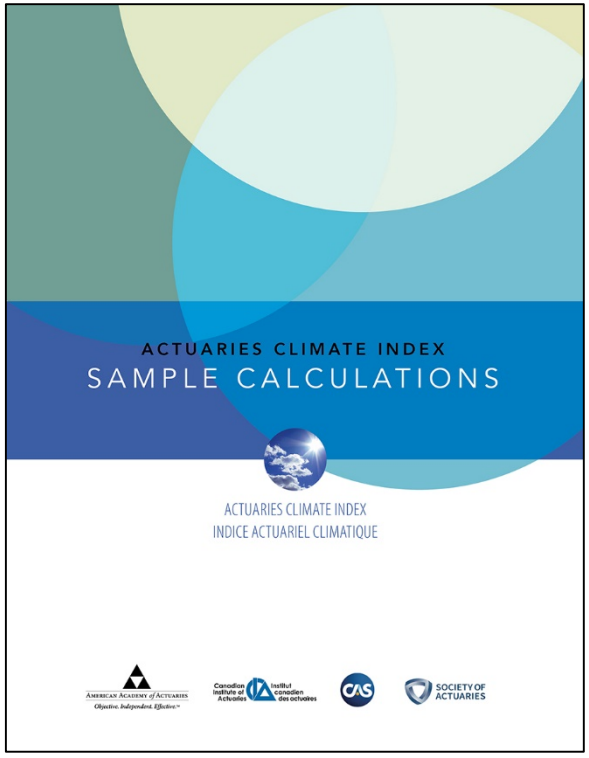
www.actuariesclimateindex.org



Three Foundational Documents on the ACI Website

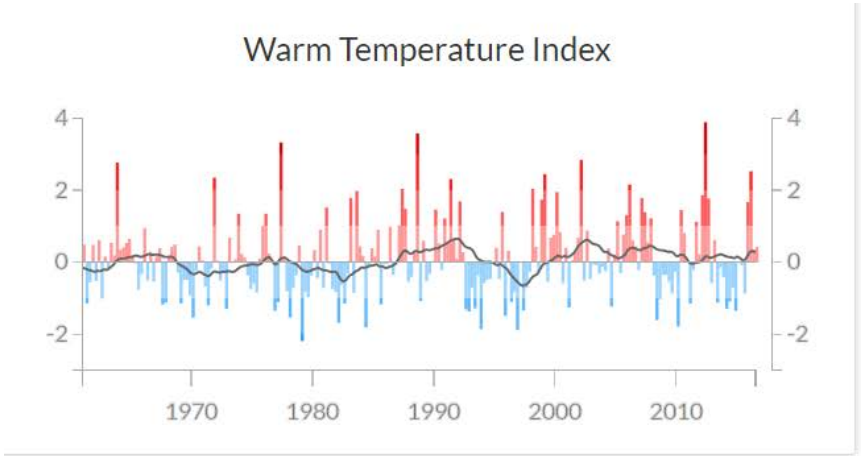


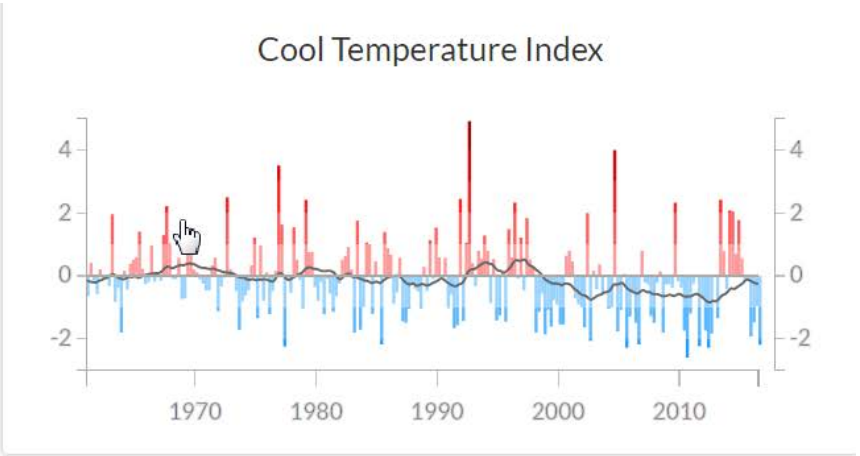


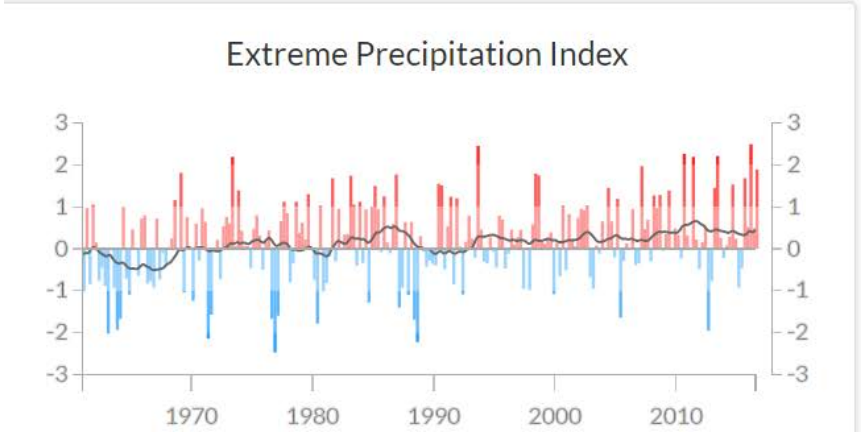


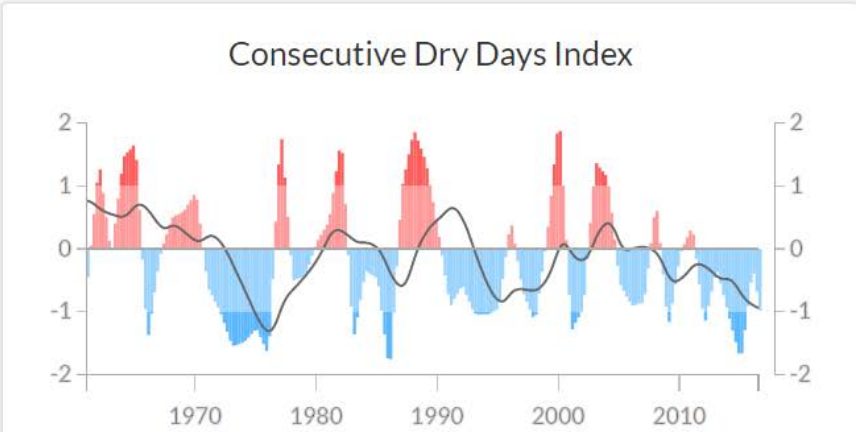
Website – Explore – Component Graphs

www.actuariesclimateindex.org



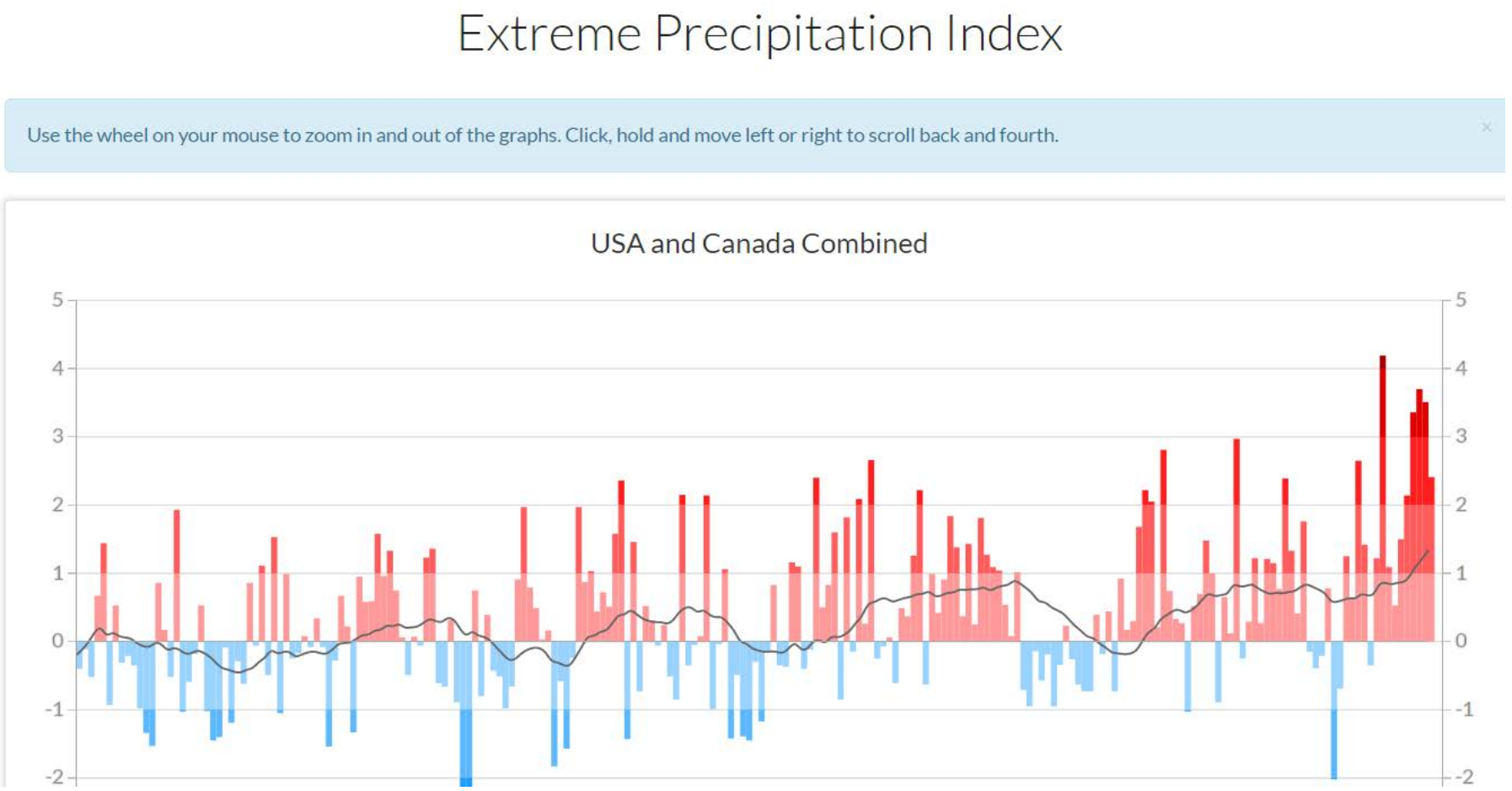






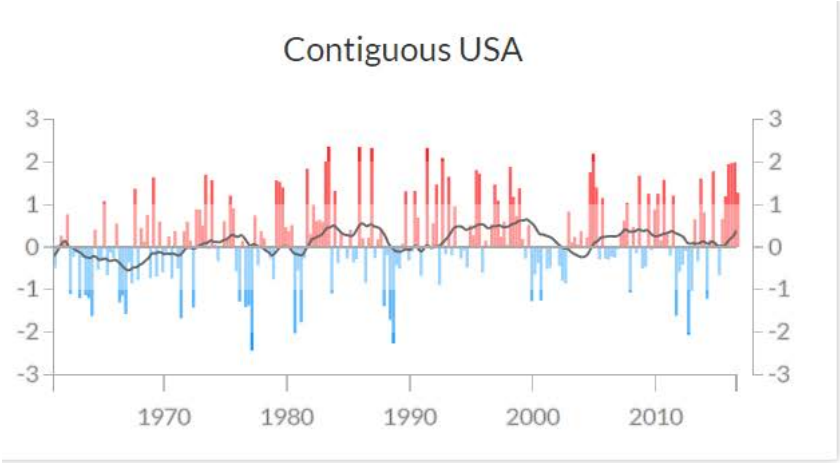
Website – Explore – Regional Graphs

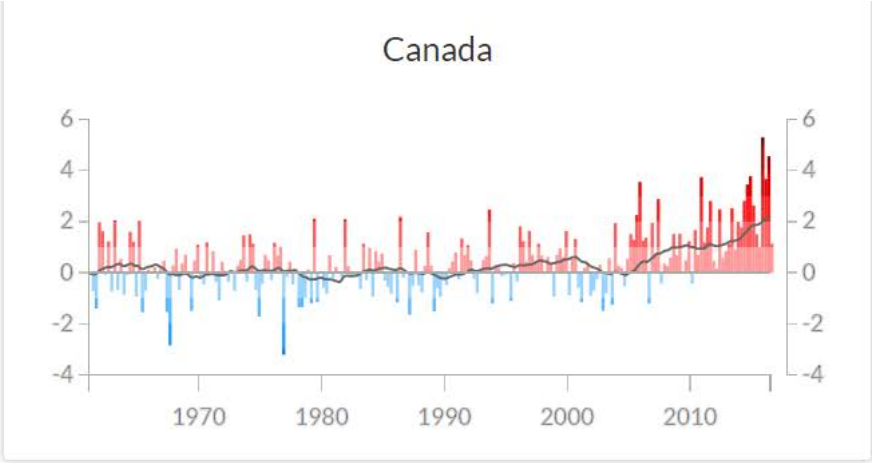
www.actuariesclimateindex.org

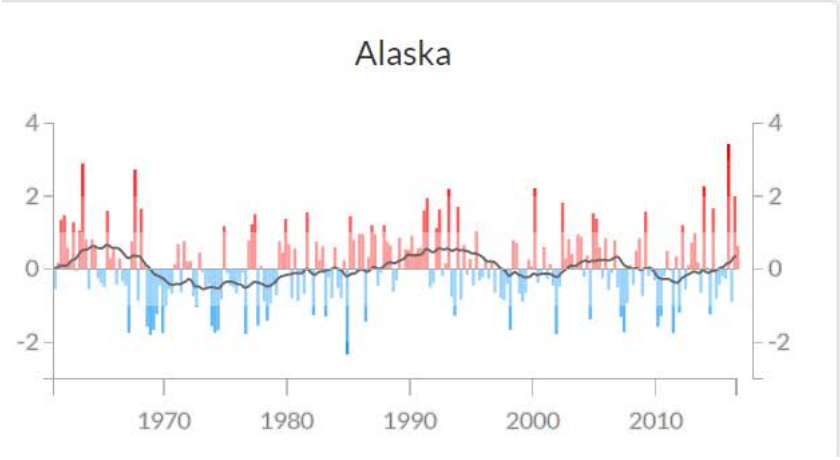


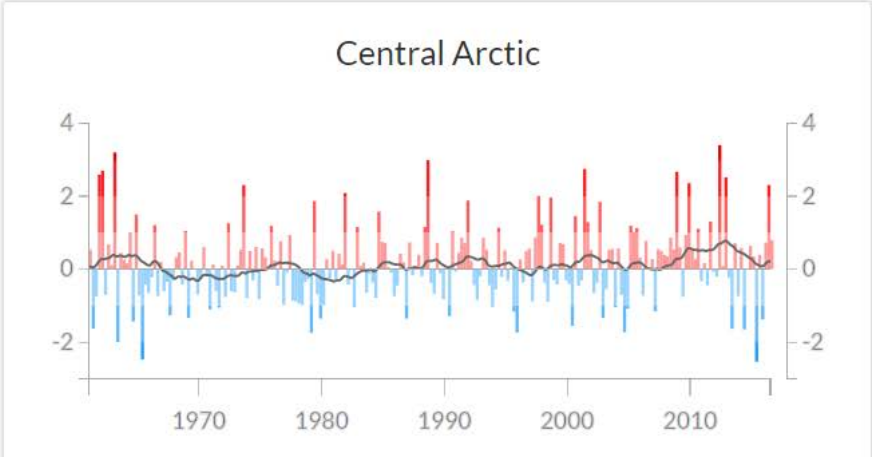
Website – Explore – Regional Graphs

www.actuariesclimateindex.org









ACI/ACRI Website

- ACI information publicly available on the dedicated website, as a resource for use in further research (ACRI will be added)
- Website includes commentary, documentation, charts of index components, maps showing variation by region, index data for download, and links to other information
- Commentary provided in English and French
- ACI data are updated quarterly on the website, based on data for each meteorological season (3 months ending February, May, August, and November)
- A news release is distributed to the media with each new update and to 600+ individuals who have subscribed to email updates
- Since launch, more than 22,000 visitor sessions from 134 countries have been tracked, and more than 1,600 data downloads have been made

The Actuaries Climate Index (ACI)

- The Actuaries Climate Index (ACI) was launched November 2016. It is intended to provide a useful monitoring tool—an objective indicator of the frequency of extreme weather and the extent of sea level change.
  - Website provides graphics and data for download
  - The ACI is available for the United States and Canada and 12 sub-regions thereof.
  - Six component sub-indices for hot temperatures, cold temperatures, high precipitation, drought, high wind, and coastal sea level

- It does not address causes or likely impact of climate change

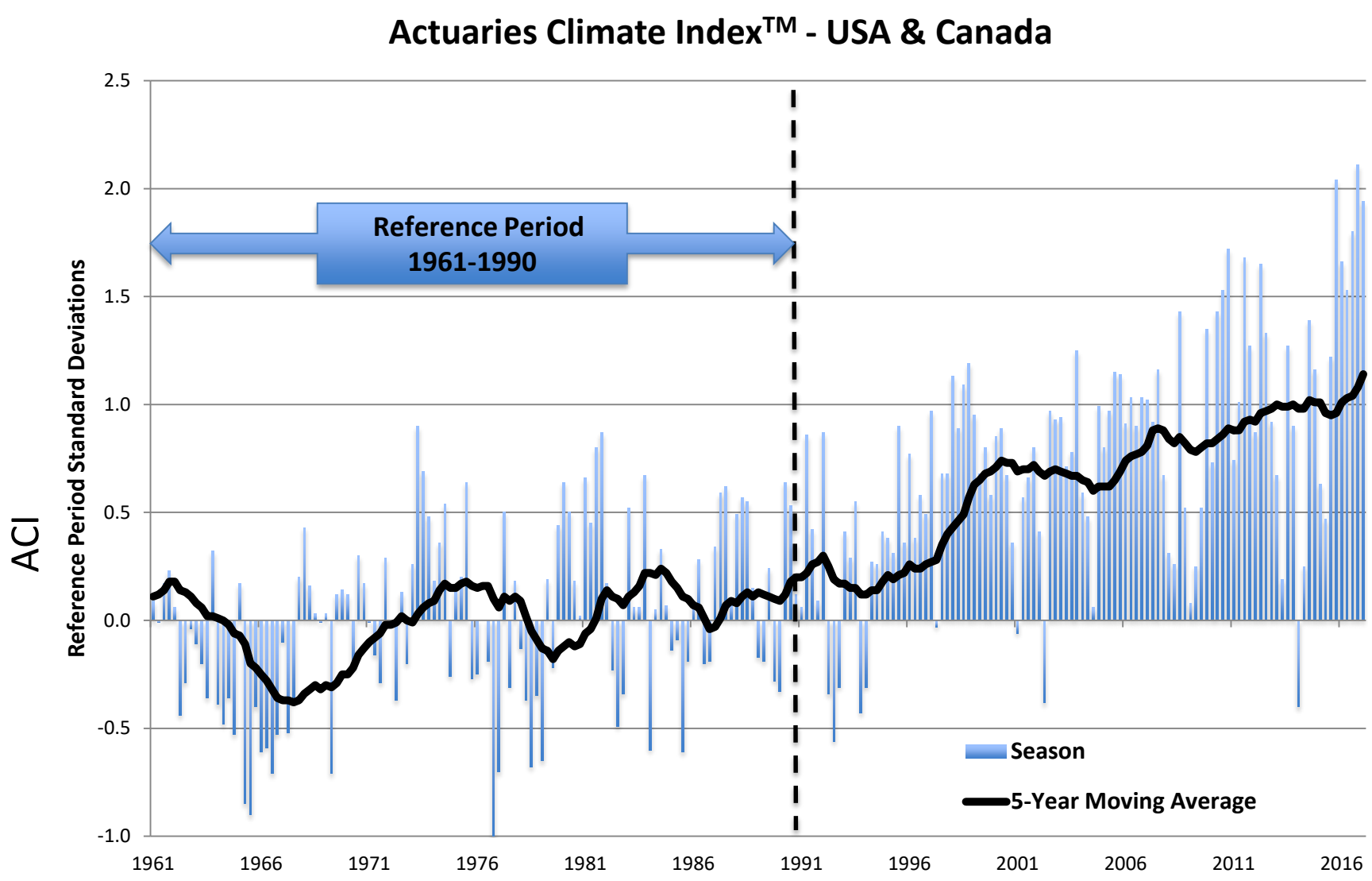
- It does not provide projections of future effects of climate change

ACI Measurements

- The six components of the Actuaries Climate Index are:
  - High temperatures;
  - Low temperatures;
  - Heavy rainfall;
  - Drought (consecutive dry days);
  - High wind; and
  - Sea level.

The Actuaries Climate Index (ACI) focuses on the frequency of severe weather

- Example: "How often is the temperature in a given month at or above the 90th percentile?"
- The 90th percentile is based on the 1961-1990 base reference period
- Average of six component sub-indices for hot temperatures, cold temperatures, high precipitation, drought, high wind, and coastal sea level


Actuaries Climate Index™ - USA & Canada
ACI
Reference Period Standard Deviations
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
Reference Period
1961-1990
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011
2016
Season
5-Year Moving Average

Temperature: T90 and T10

- The temperature components are defined as the change in frequency of warmer temperatures above the 90thpercentile (T90) and of colder temperatures below the 10th percentile (T10), relative to the reference period of 1961 to 1990.

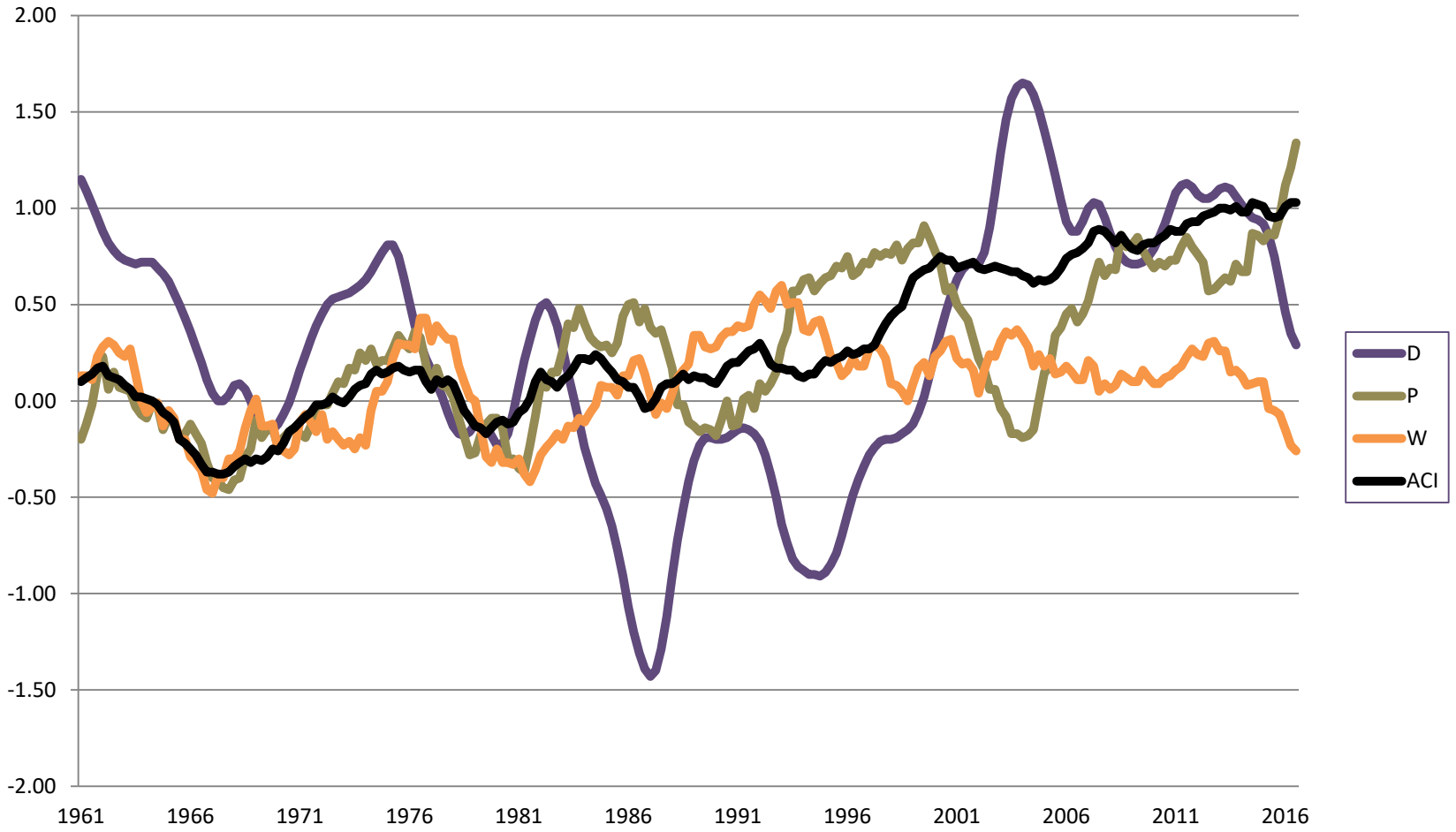
Temperature: T90 and T10

- T90: "How often is the temperature in a given month at or above the 90th percentile, based on the 1961-1990 base reference period?"
- T10: "How often is the temperature in a given month below the 10th percentile, based on the 1961-1990 base reference period?"
- T90 is calculated for both daily maximum temperatures (TX90) and the daily minimum temperatures (TN90); T90 is the average of TX90 and TN90
- Similar for T10, with T10 = (TX10 + TN10)/2
- TX90, TN90, TX10, TN10 come from GHCNDEX, which provides monthly data on a gridded dataset (2.5 degrees latitude and longitude)
- GHCNDEX is from the National Center for Atmospheric Research and the University Corporation of Atmospheric Research, headquartered at the University of Colorado

Precipitation and Drought

- Precipitation is measured as the maximum 5-day precipitation amount in a month
- It comes as a gridded dataset from GHCNDEX
- Drought is based on the maximum number of GHCNDEX Continuous Dry Days (a dry day is defined as less than 1 mm of precipitation)
- For each grid point, Continuous Dry Days is a single annual value
- We are looking to improve the frequency of this data measure

Wind Power, Precipitation, and Drought - USA and Canada

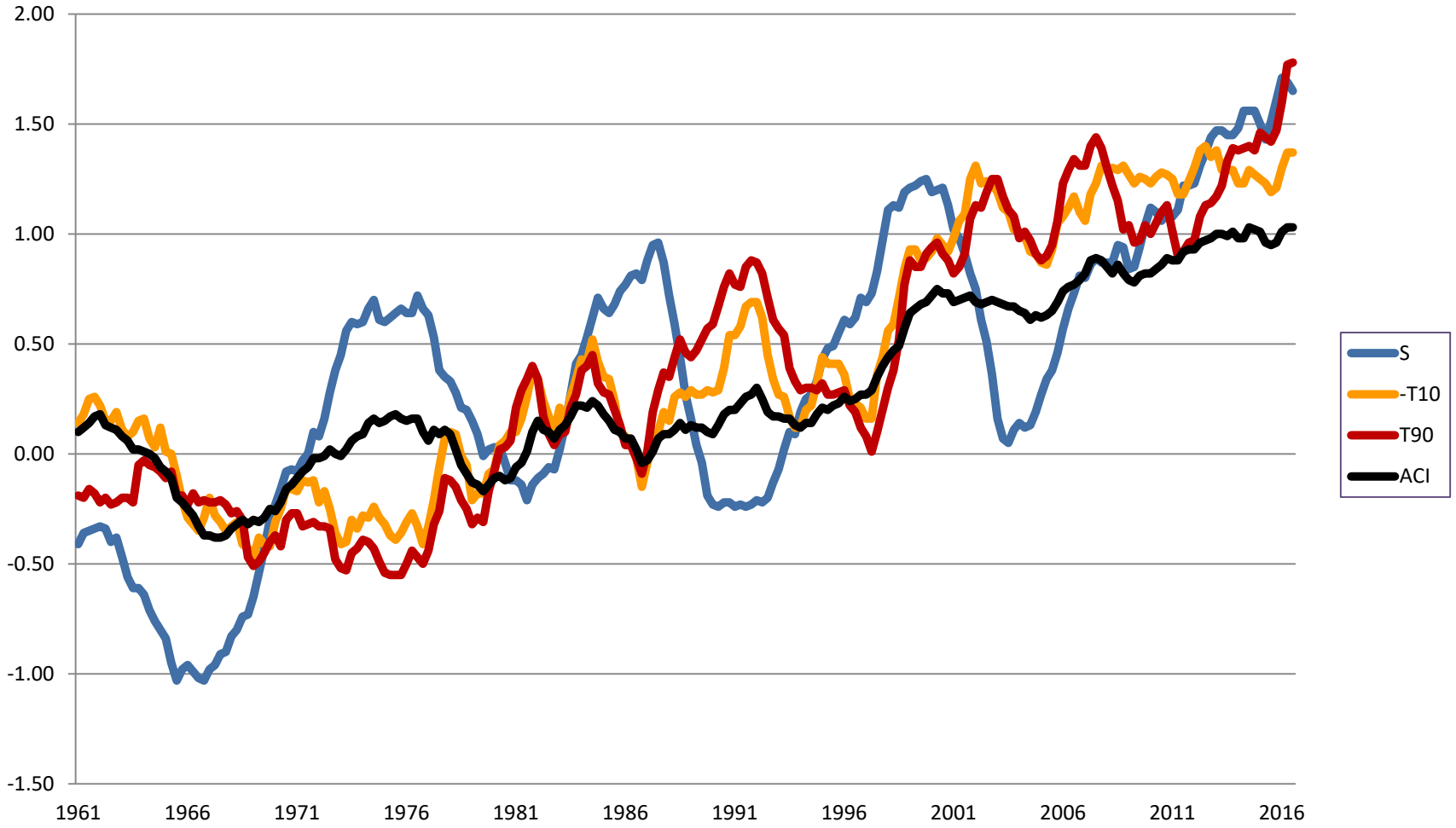


Baseline reference period

Wind Power and Sea Level

- Wind Power is calculated as the 90th percentile of the average Wind Speed from the National Centers for Environmental Protection (NCEP)
- Wind Power is equal to a constant x Wind Speed^3
- Wind Power is used, as damages have been found to be proportional to Wind Power
- Sea Level is our only component that is not based on a gridded dataset
- It comes from a worldwide database (Permanent Service for Mean Sea Level) from Liverpool, UK
- Based on mean monthly Sea Level at 76 coastal tidal stations; the stations within each region are averaged to produce a regional result

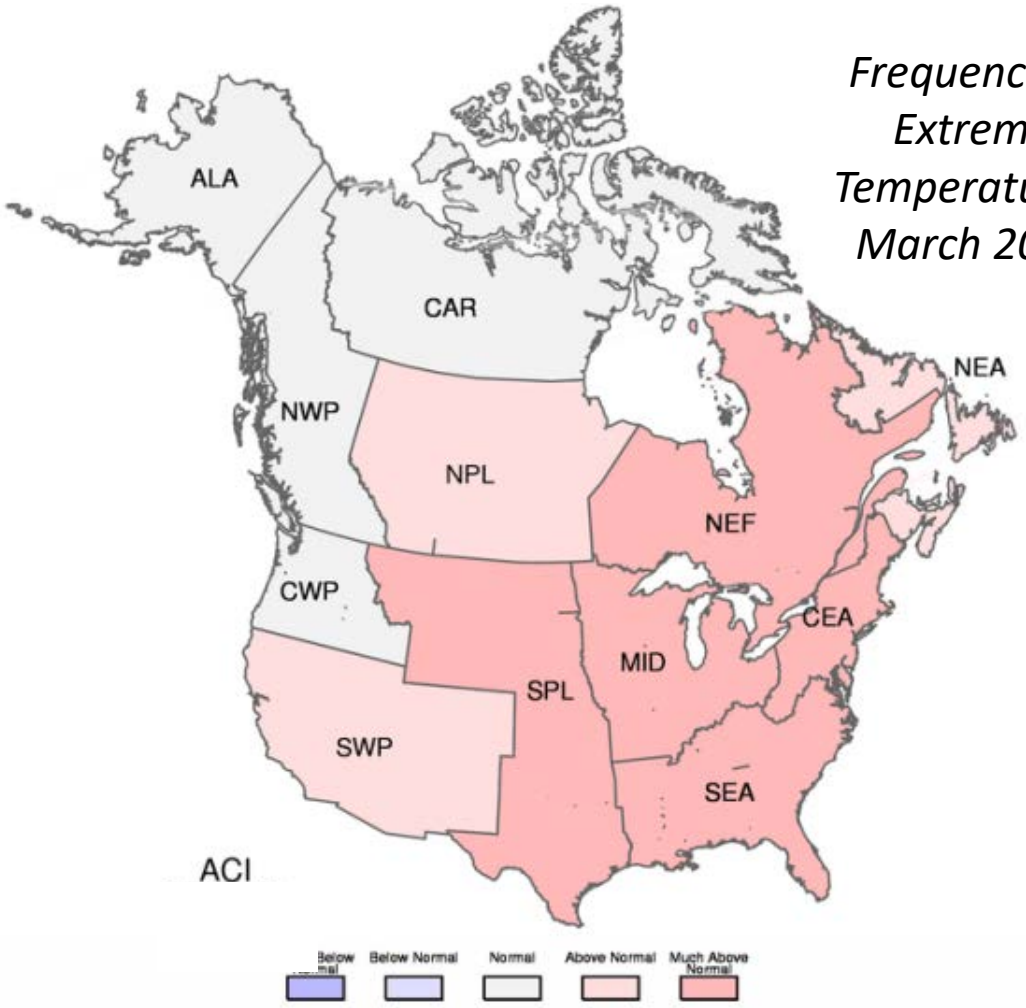
Temperature and Sea Level Components - USA and Canada



Baseline reference period

ACI data is constructed for geographic grids, then summarized to regions, countries, and in total

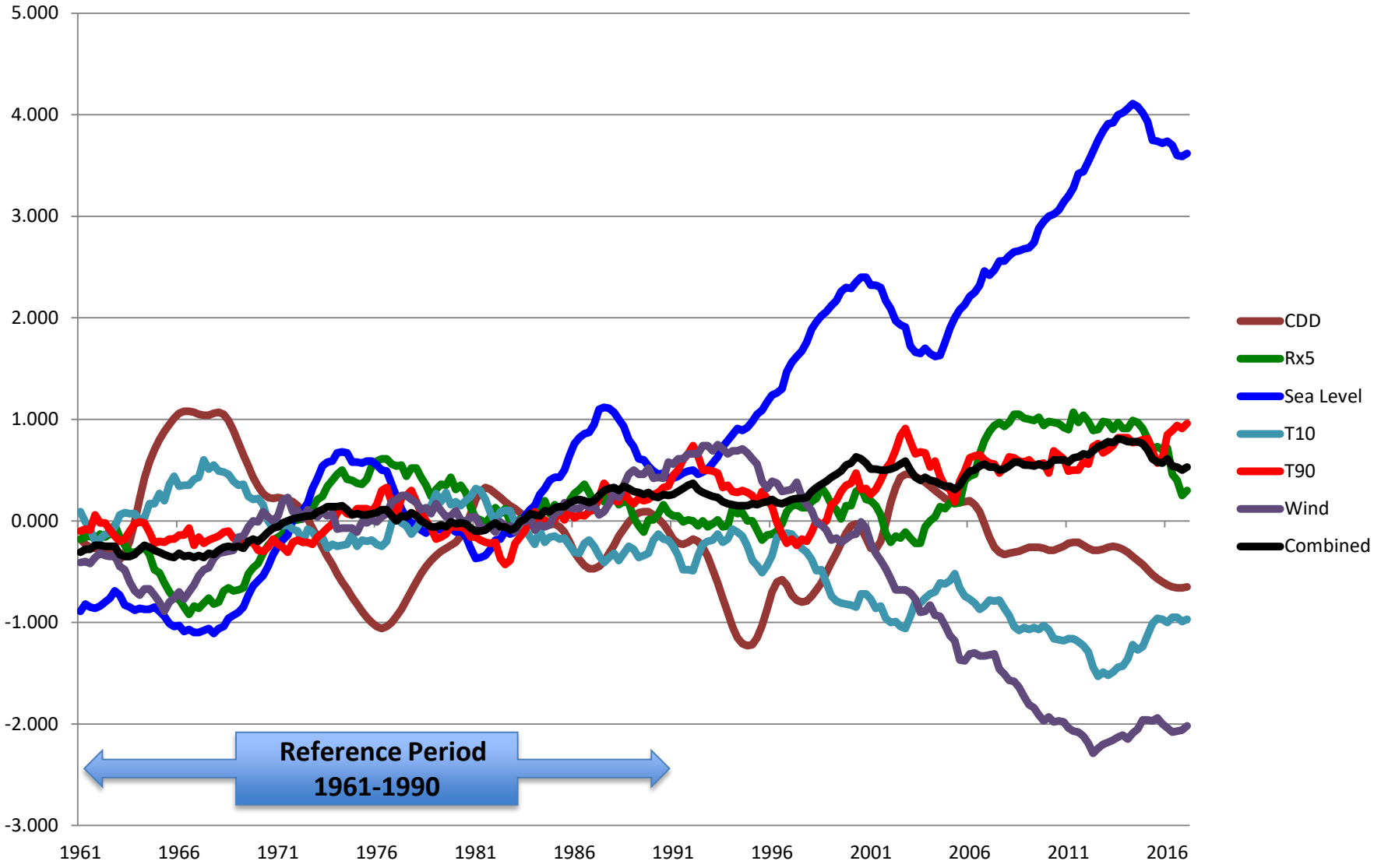
- ACI components are constructed in a uniform 2.5° grid across the USA and Canada
  - 275km by 275km at equator
- Grid components for each climate variable are summarized into indices for 12 natural regions, two countries and U.S. and Canada in total
- Summarized indices are unweighted averages of grid components
  - Each climate change component is equally important

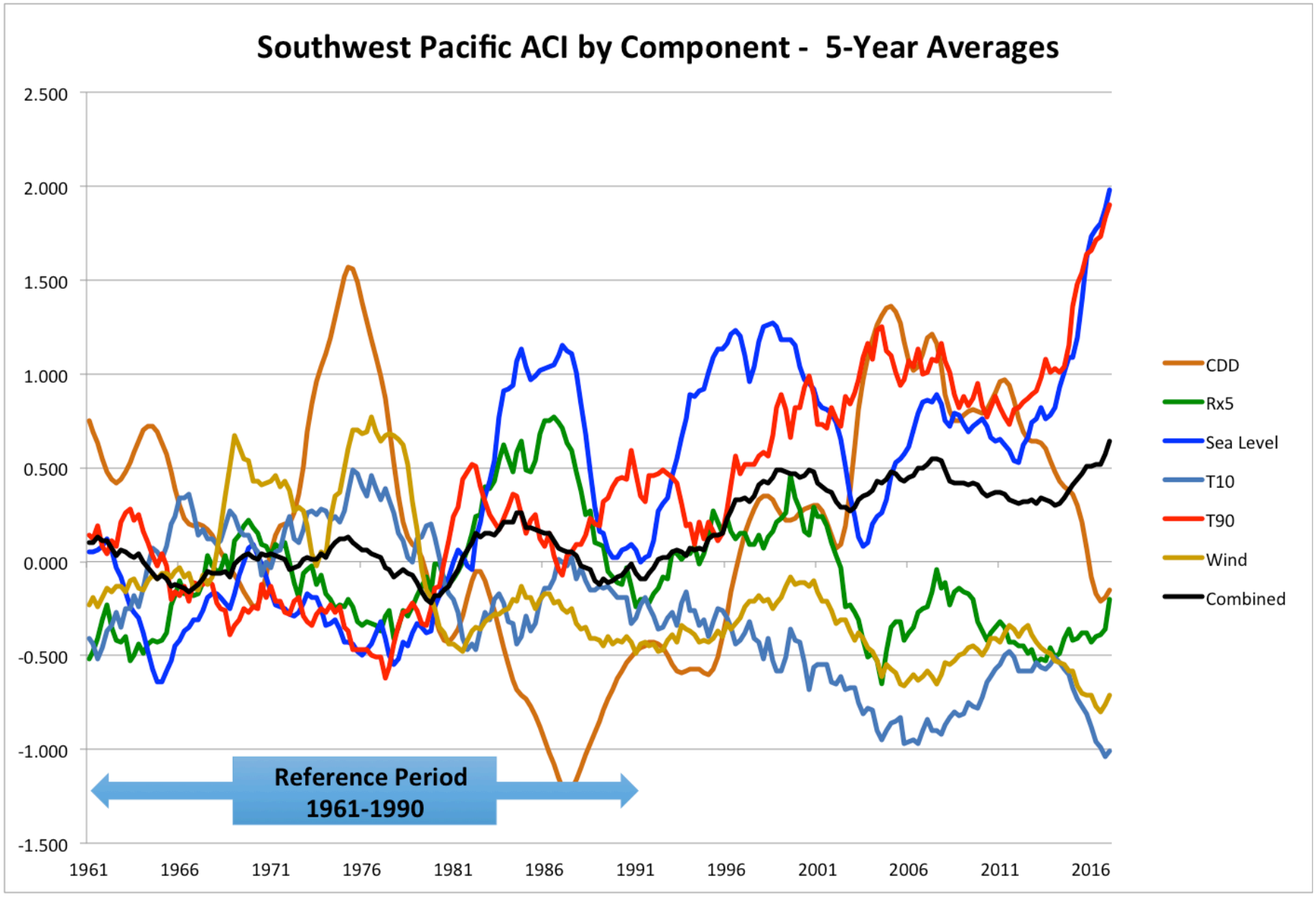


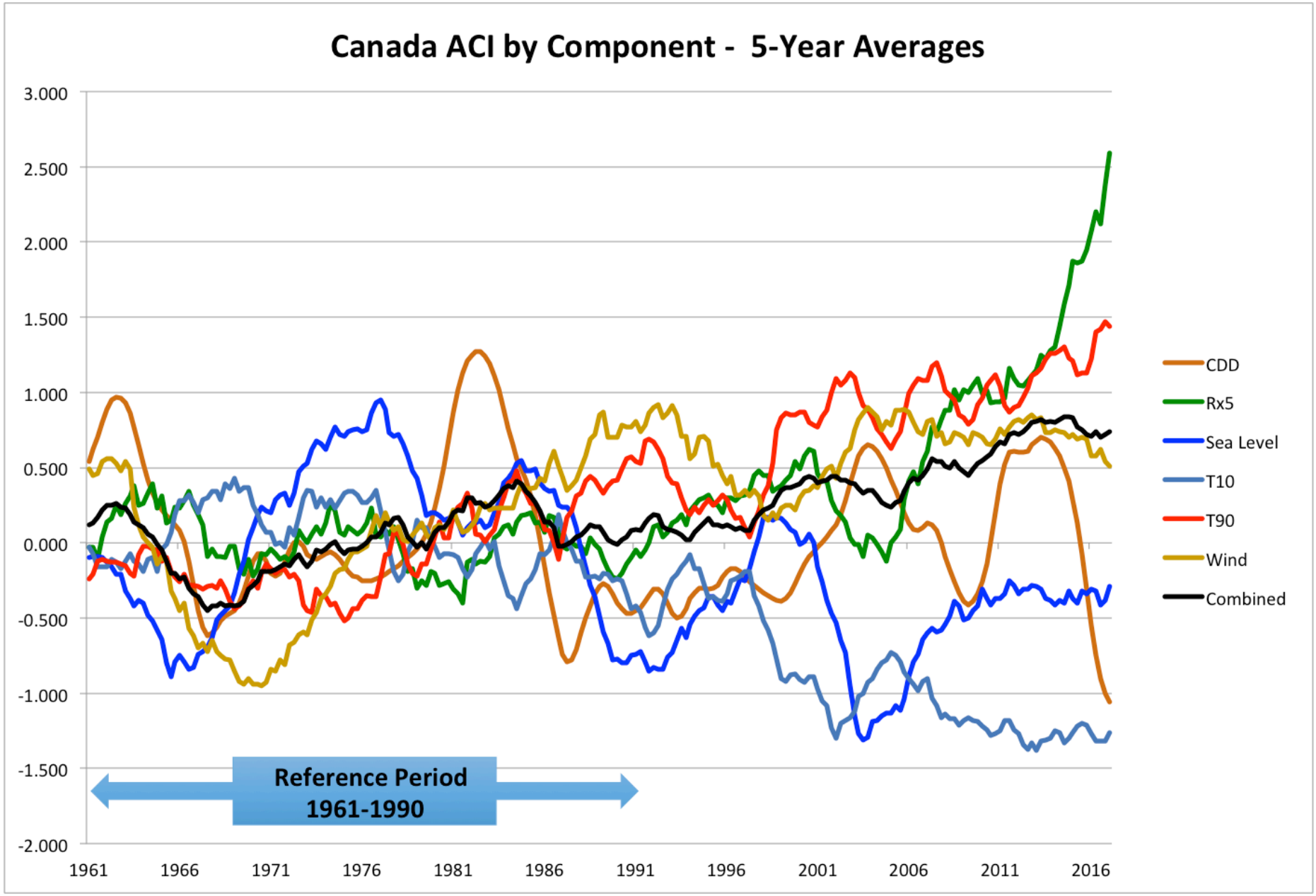
Frequency of Extreme Temperatures: March 2012

26

Central East Atlantic ACI by Component - 5-Year Averages




Southwest Pacific ACI by Component - 5-Year Averages
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
-1.500
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011
2016
Reference Period
1961-1990
CDD
Rx5
Sea Level
T10
T90
Wind
Combined


Canada ACI by Component - 5-Year Averages
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
-1.500
-2.000
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011
2016
Reference Period
1961-1990
CDD
Rx5
Sea Level
T10
T90
Wind
Combined

Latest Findings from the ACI

- Spring 2017 data were posted in January 2018
- Spring 2017 seasonal ACI value* of 1.66 is the seventh consecutive seasonal value above 1.5
- Five-year moving average index value of 1.14 remains at same record-high level as was first seen in Winter 2016

*Index of 0 corresponds to the baseline 30-year reference period of 1961-1990

Rising Sea Level

- Sea Level is now the biggest factor in measured climate extremes

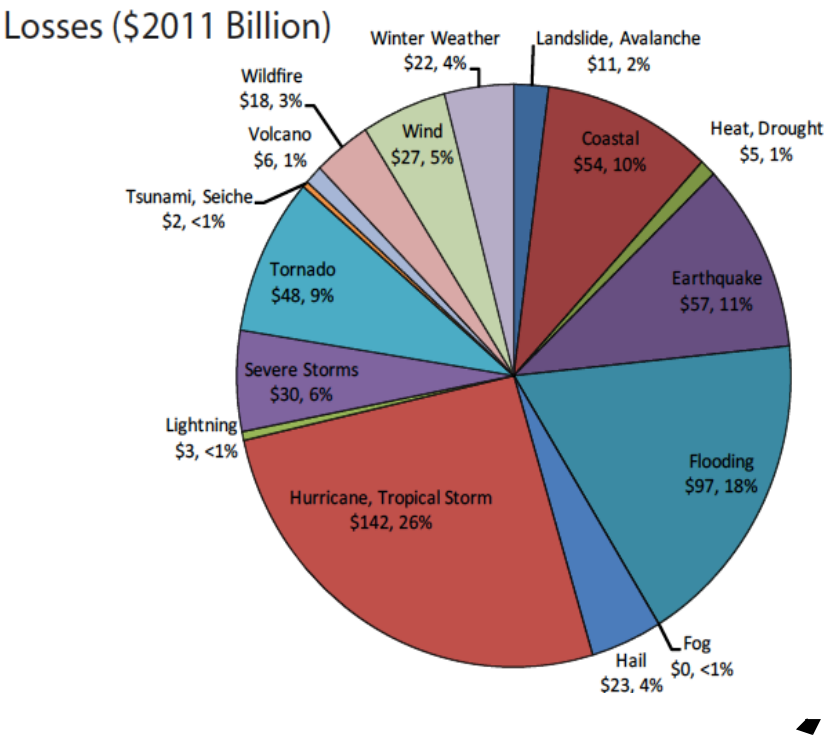
- Change in sea level is particularly notable in the Atlantic and Gulf Coast Regions

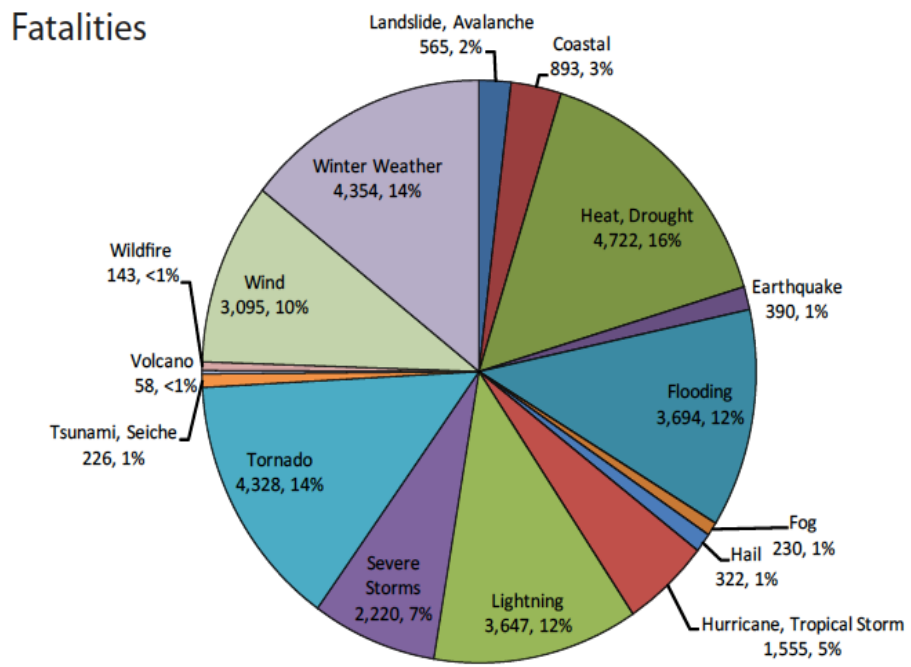
Preview: Actuaries Climate Risk Index

- Measure correlation of economic and human losses by peril to the relevant climate variable
  - Using SHELDUS (Spatial Hazard Events and Losses Database for the United States) data for economic losses, mortality and injuries in the U.S.
  - Canadian Disaster Database, compiled by Public Safety Canada
- Goal is to produce an index useful to actuaries and insurance professionals, policymakers and the public.

SHELDUS Data Summary

MONETARY & HUMAN LOSSES BY HAZARD TYPE





Source:
http://hvri.geog.sc.edu/SHELDUS/docs/Summary_1960_2015.pdf

Actuaries Climate Risk Index - Methodology

- Regression analysis of damages and ACI components taking into account regional differences (statistically significant relationships found)
- Currently examining Property Damage, Crop Losses, Fatalities and Injuries as separate analyses, each related to ACI components.

Actuaries Climate Risk Index – Next Steps

- Original design for ACRI, based on modeling on the work underlying the UN Development Programme's Disaster Risk Index.
- Now incorporating changes based on peer review by the Institute and Faculty of Actuaries (IFoA), developing a revised methodology using same data and similar modeling.
- Supplement the ACI website with ACRI content
- Expected launch by end of 2018

ACTUARIES CLIMATE RISK INDEX

INDICE ACTUARIEL
DES RISQUES CLIMATIQUES

For More Information

For more information about this presentation, contact:

Marc Rosenberg, senior casualty policy analyst
American Academy of Actuaries
(202) 785-7865 or rosenberg@actuary.org