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Actuaries : Striving for excellence, creating sustainable future

21st Global Conference of Actuaries

17th - 19th February 2020 | Mumbai, India

Measuring Climate Change

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18 February 2020

Outline of this Presentation

- Goals and genesis of the ACI & ACRI
- ACI Overview:
  - Components
  - Regions
- Highlights of the ACI website
- The ACI in Other Regions
- Worldwide Tropical Cyclone Activity measured using the ACI Methodology
- Other Measures of Climate Change

Goals of the ACI and 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:

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SOCIETY OF ACTUARIES

Canadian Institute of Actuaries / Institut canadien des actuaires

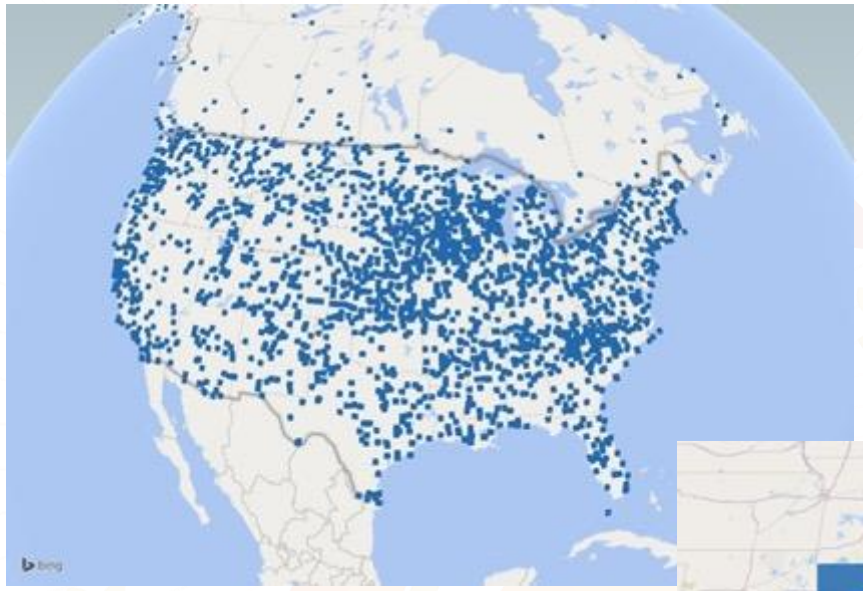
American Academy of Actuaries
Objective. Independent. Effective.™

The ACI focuses on Extreme 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 reference period
- Average of six component sub-indices for hot temperatures, cold temperatures, high precipitation, drought, high wind, and coastal sea level
- $ACI = (\Delta T_H - \Delta T_C + \Delta P + \Delta D + \Delta W + \Delta S) / 6$
- ACI components are of the form: $(x - \mu_{ref})/ \sigma_{ref}$

ACI data is built by geographic grid and region

- Station data summarized by 2.5° grid
  - 275km by 275km at equator
- Grid components for each climate variable are summarized into indices for 12 regions, two countries and U.S. and Canada in total



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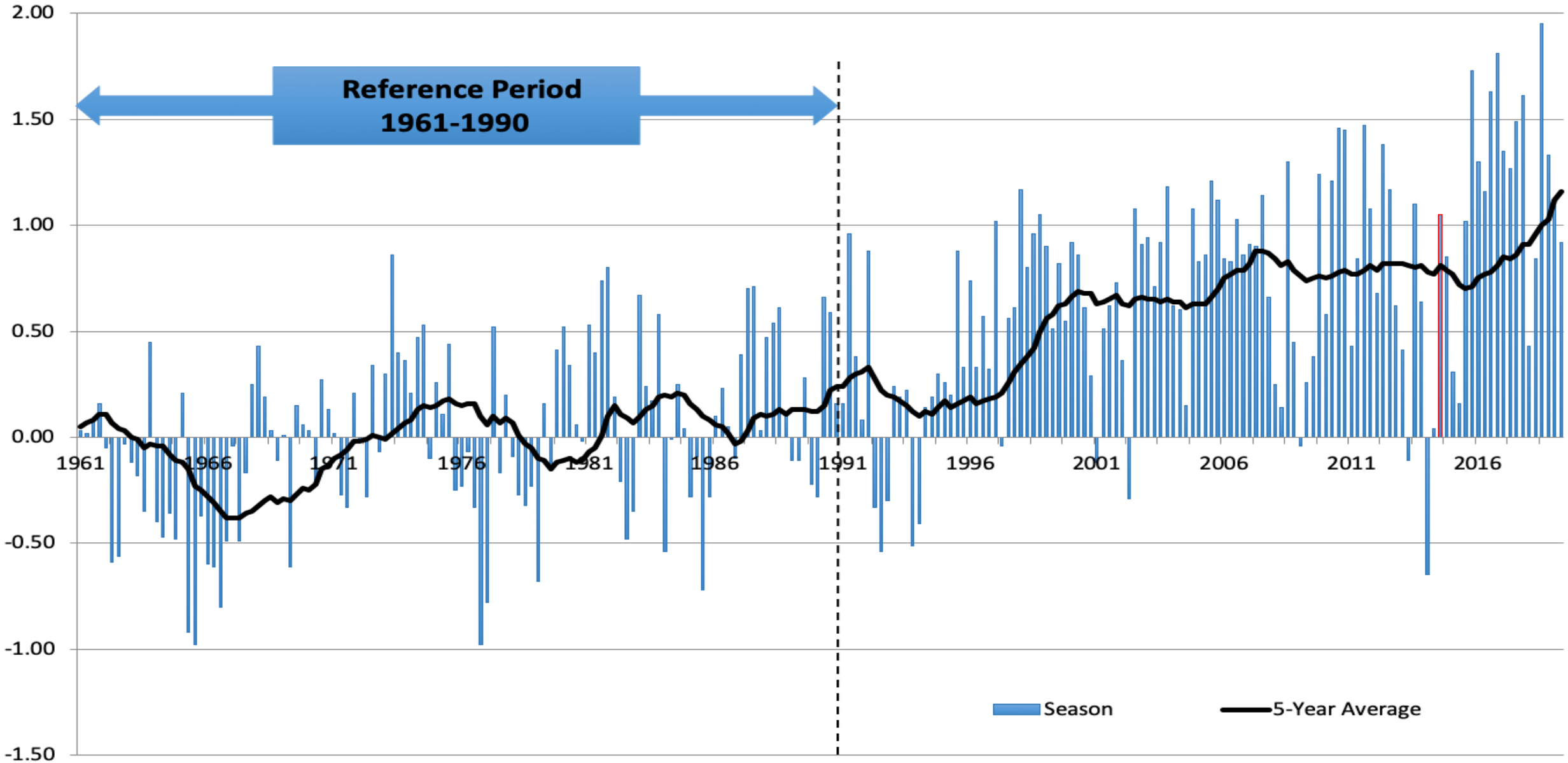
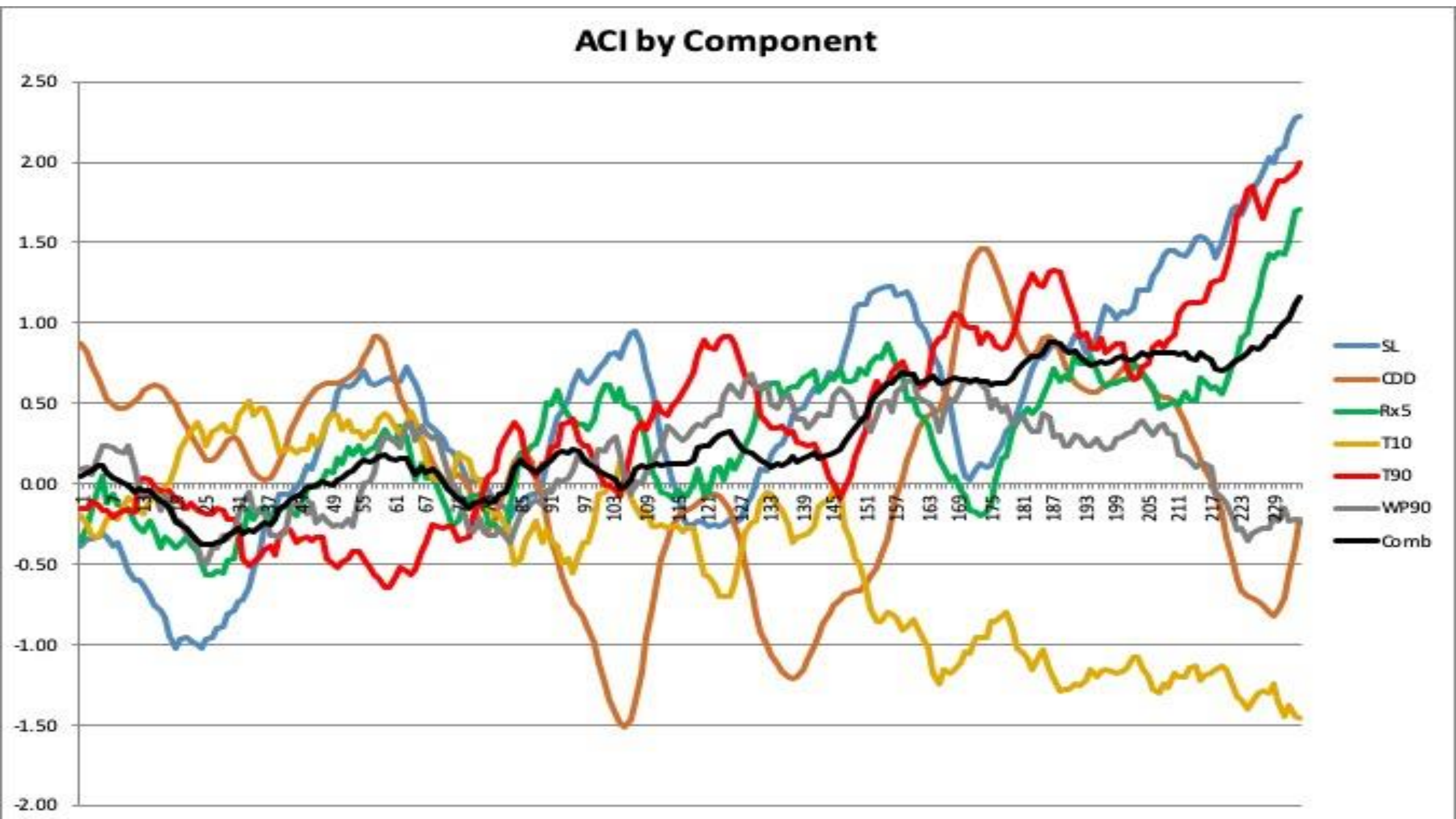
Actuaries Climate Index - USA & Canada



Red bar shows the first season in the latest 5-Year average.


ACI by Component
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
1
7
13
19
25
31
37
43
49
55
61
67
73
79
85
91
97
103
109
115
121
127
133
139
145
151
157
163
169
175
181
187
193
199
205
211
217
223
229
SL
CDD
Rx5
T10
T90
WP90
Comb

Highlights of the ACI Website

ACTUARIES CLIMATE INDEX
INDICE ACTUARIEL CLIMATIQUE

- ACI information publicly available on a dedicated website, as a resource for use in further research
  - actuariesclimateindex.org
- Website includes commentary, documentation, charts of index components, maps showing variation by region, index data for download, and links to other information
- ACI data updated quarterly on the website, based on data for each meteorological season (3 months ending February, May, August, and November)
  - Data Disclosure notes key reliances and limitations
- We send out a news release with each new update (800+ have subscribed to email updates)
- Tenth seasonal ACI update posted on November 21st. (Spring 2019)
  - Next update likely late February or March
- Since launch, more than 58,000 visitor sessions from 165 countries have been recorded, and more than 4,000 data downloads have been made

Top 20 Countries (# of sessions)

• United States	30,957	• Germany	552
• Canada	10,323	• South Korea	384
• Australia	1,586	• Malaysia	341
• United Kingdom	1,389	• Italy	316
• China	1,155	• Indonesia	288
• India	1,154	• Netherlands	270
• Denmark	837	• Spain	234
• Hong Kong	816	• South Africa	226
• France	722	• Belgium	224
• Japan	627	• Taiwan	223

ACI Data can be viewed in graphs or maps

Maps can show ACI movement over tin

(5-year averages 1965 – 1990)

1965

1975

1980

1990

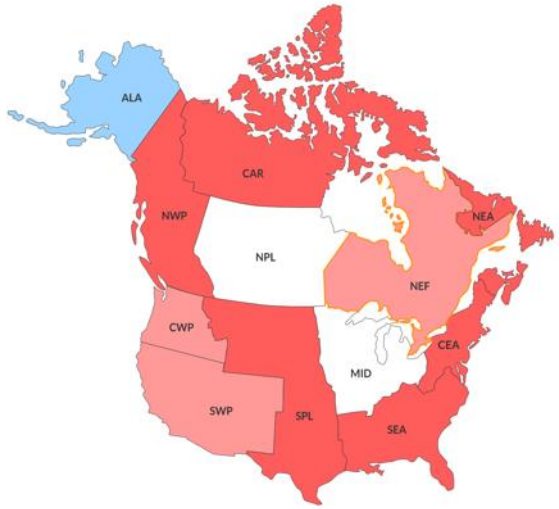
Maps can show ACI movement over tin

(5-year averages 1995 – 2019)

1995

2005

2010



2019

Changes under consideration for AC 2.0:

1. Use station data rather than gridded data
2. Alternative metrics/data for measuring precipitation, drought and wind
3. Separate daytime and nighttime temperatures
4. Alternative approaches for aggregating data from local to regional level
5. ACI measures that are more relevant for ACRI
6. Include other regions / oceans

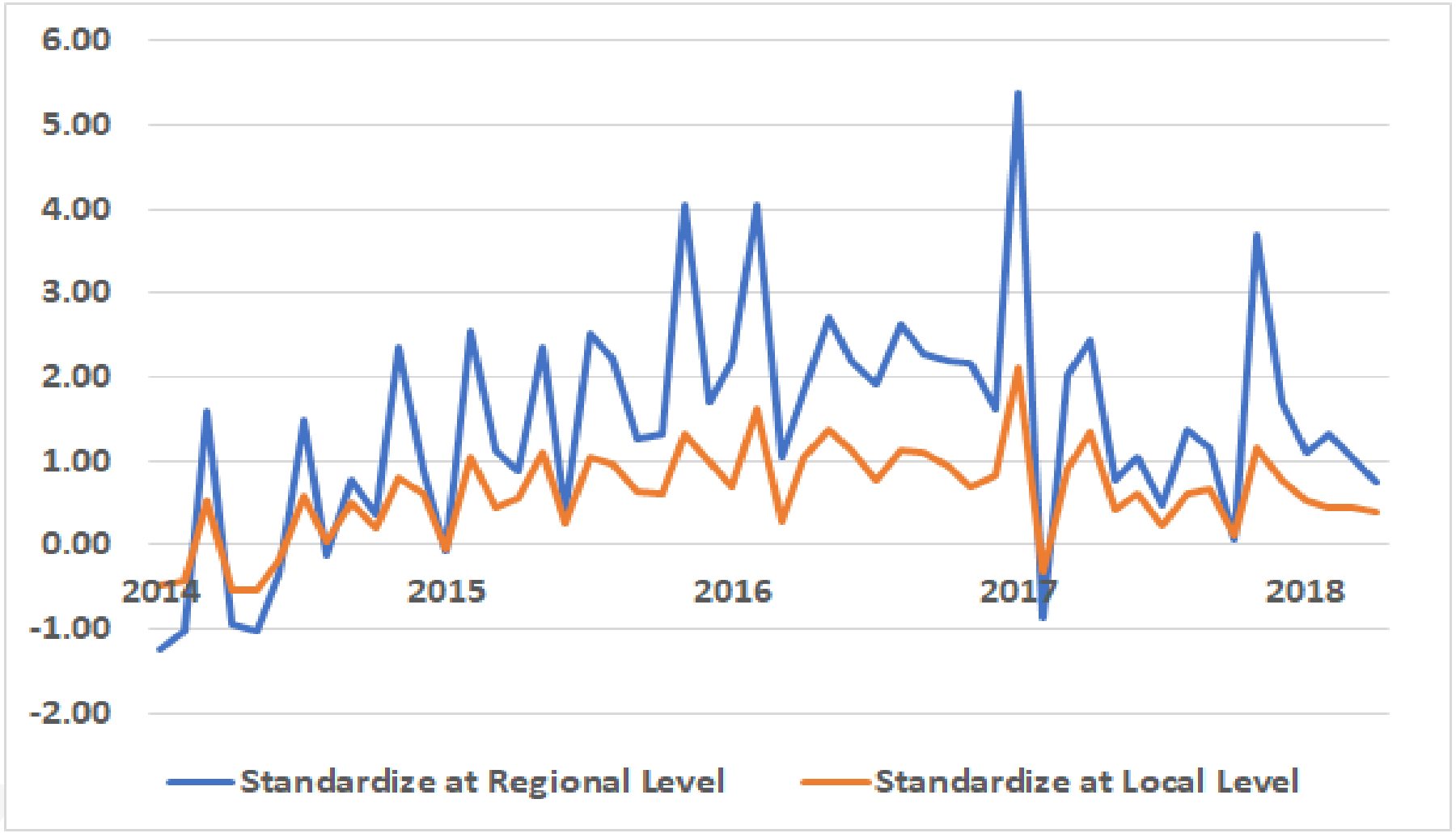
Australian ACI

- Different components than USA/Canada ACI
  - Temperature at 99% and 1%
  - Heavy precipitation at 99%
  - Wind at 99% wind gust
  - Maximum Seasonal Sea Level

- Different methodology
  - Reference period is 1981-2010 (except wind)
  - Index Composite is average of just high temperatures, heavy precipitation and sea level
  - Alternate order of geographic aggregation

https://www.actuaries.asn.au/microsites/climate-index

Impact of order of Geographic Aggregation



ACI Implementation Elsewhere?

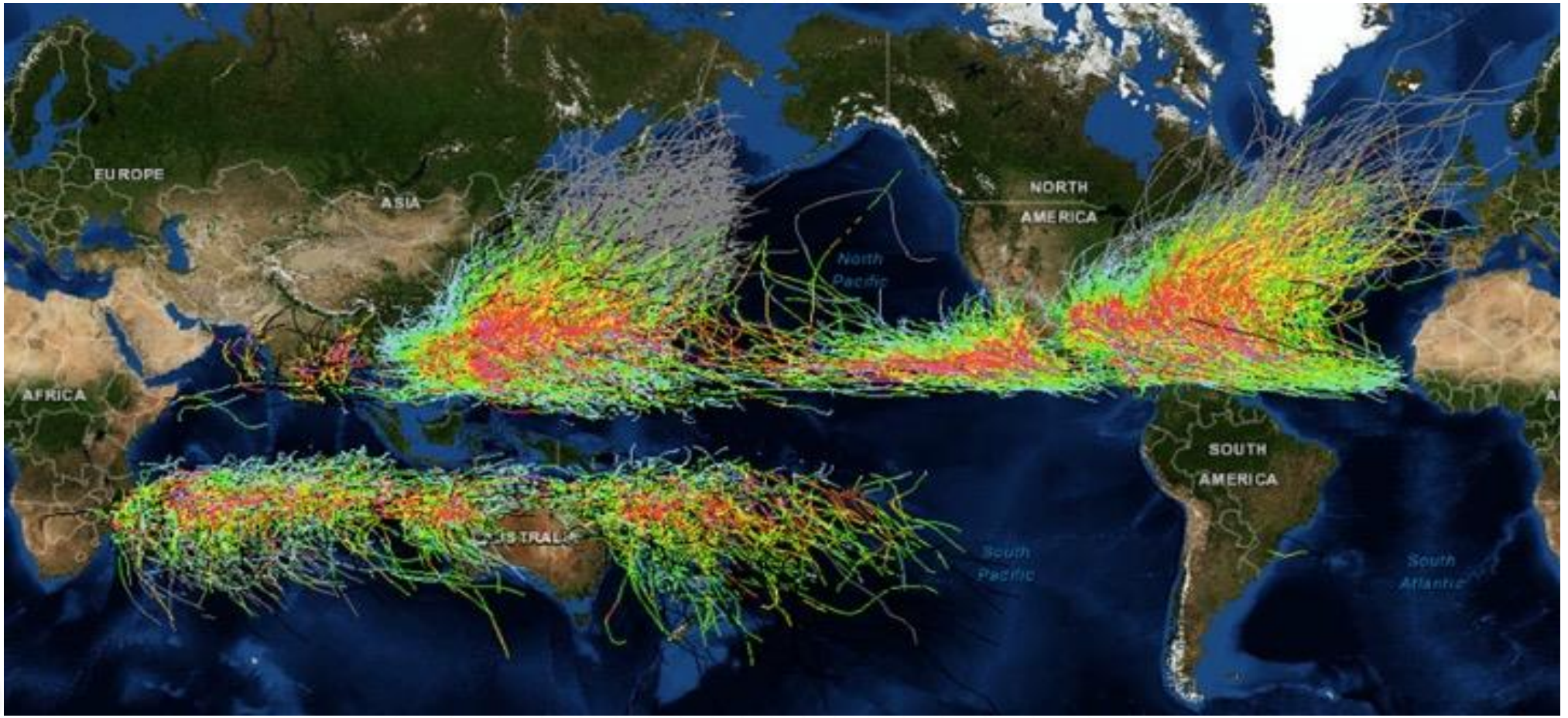
- Europe
- Caribbean
- Asia

Worldwide Accumulated Cyclone Energ using the ACI Method

- What is Accumulated Cyclone Energy?
  - Measures the strength and duration of tropical cyclones
    - ACE = $10^{-4} \Sigma v^2_{max}$
      - Where v_{max} is the estimated maximum sustained wind speed in knots at six-hour intervals over the life of the storm while it is at least at tropical storm strength
    - Divided by 10,000 for convenience
- ACE is Better measure than maximum wind speed
- Does it show an increasing trend?

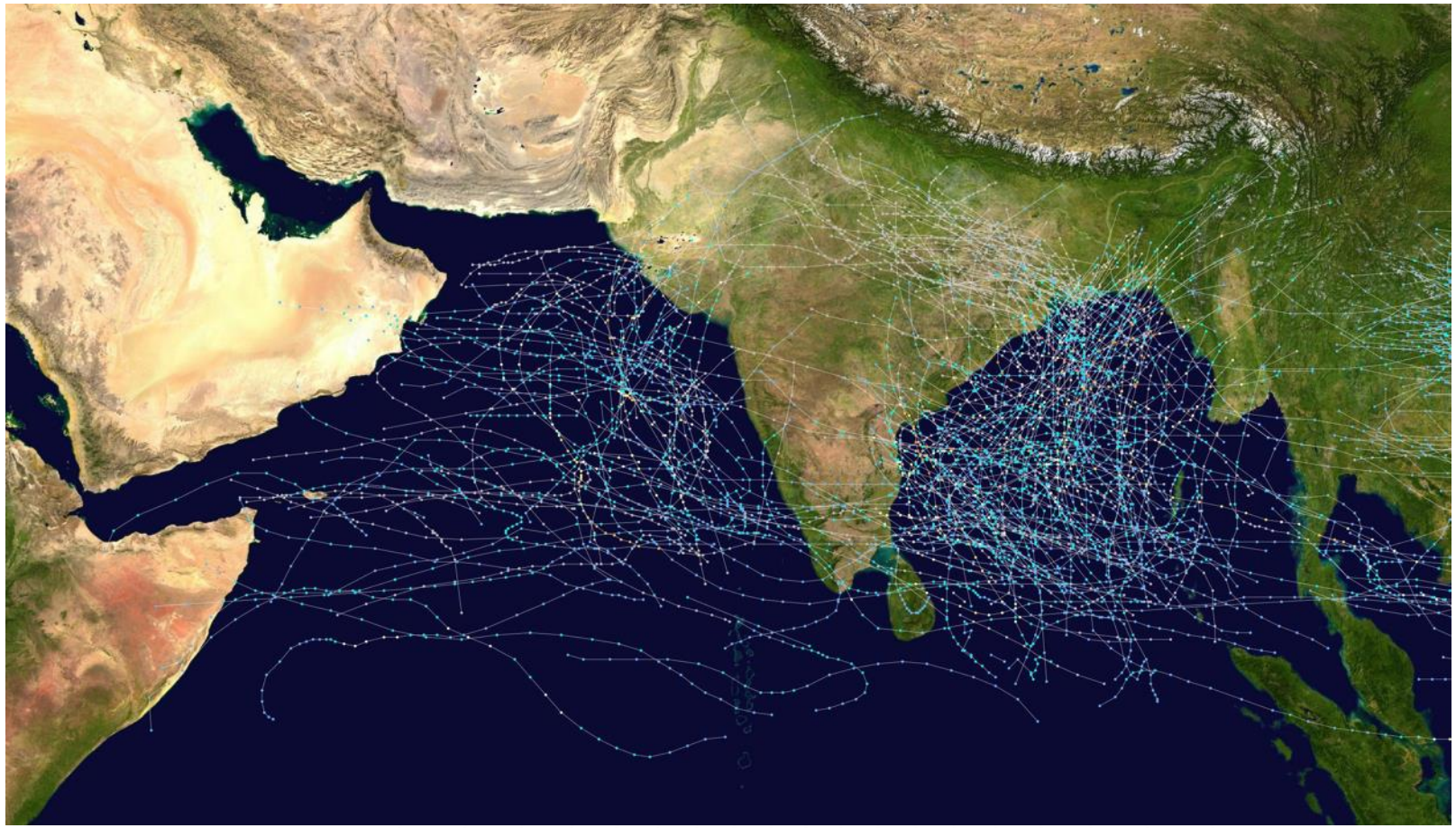
https://www.casact.org/pubs/forum/18spforumv2/05_Collins.pdf

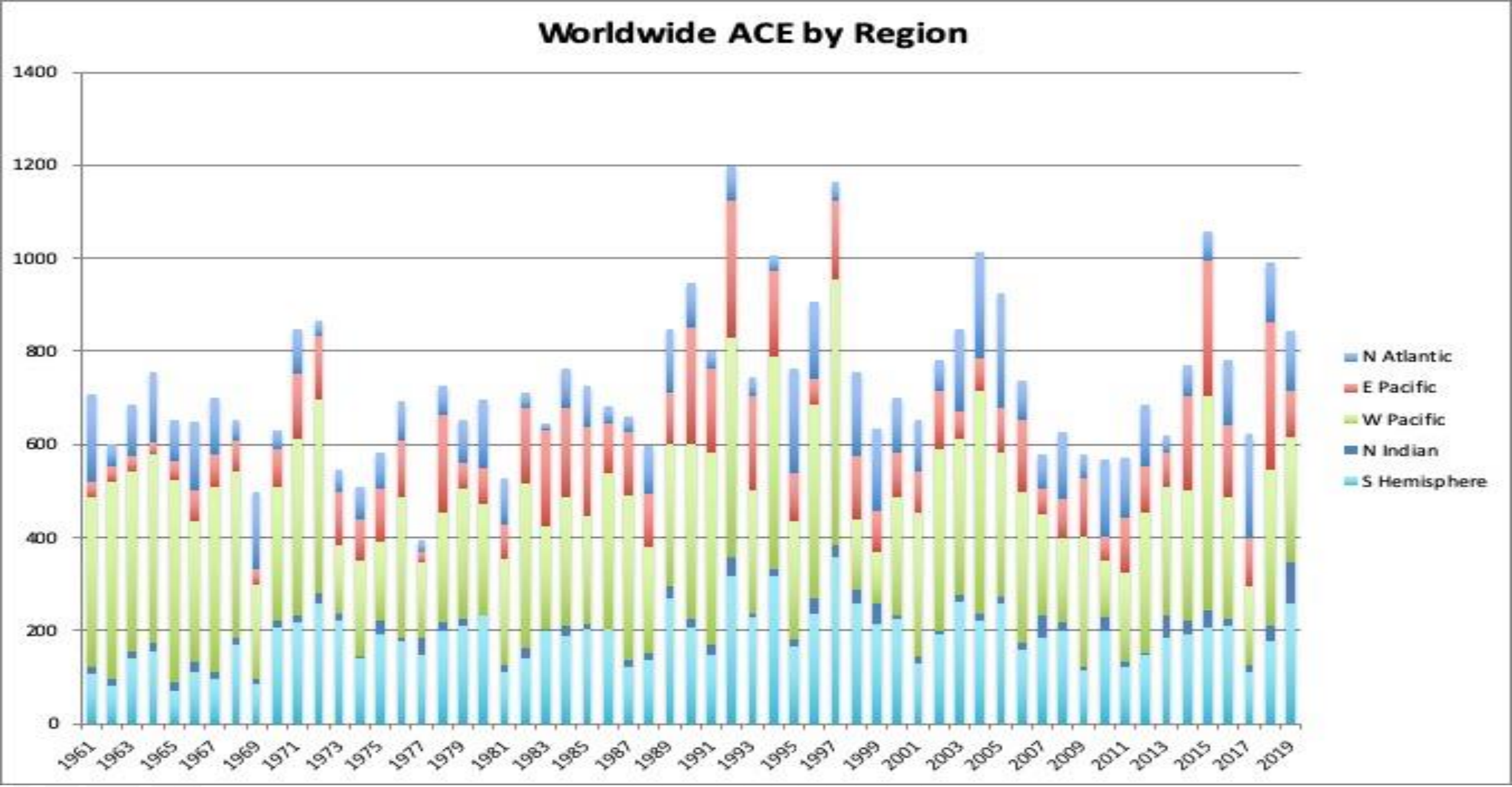
Worldwide Tropical Cyclone Tracks



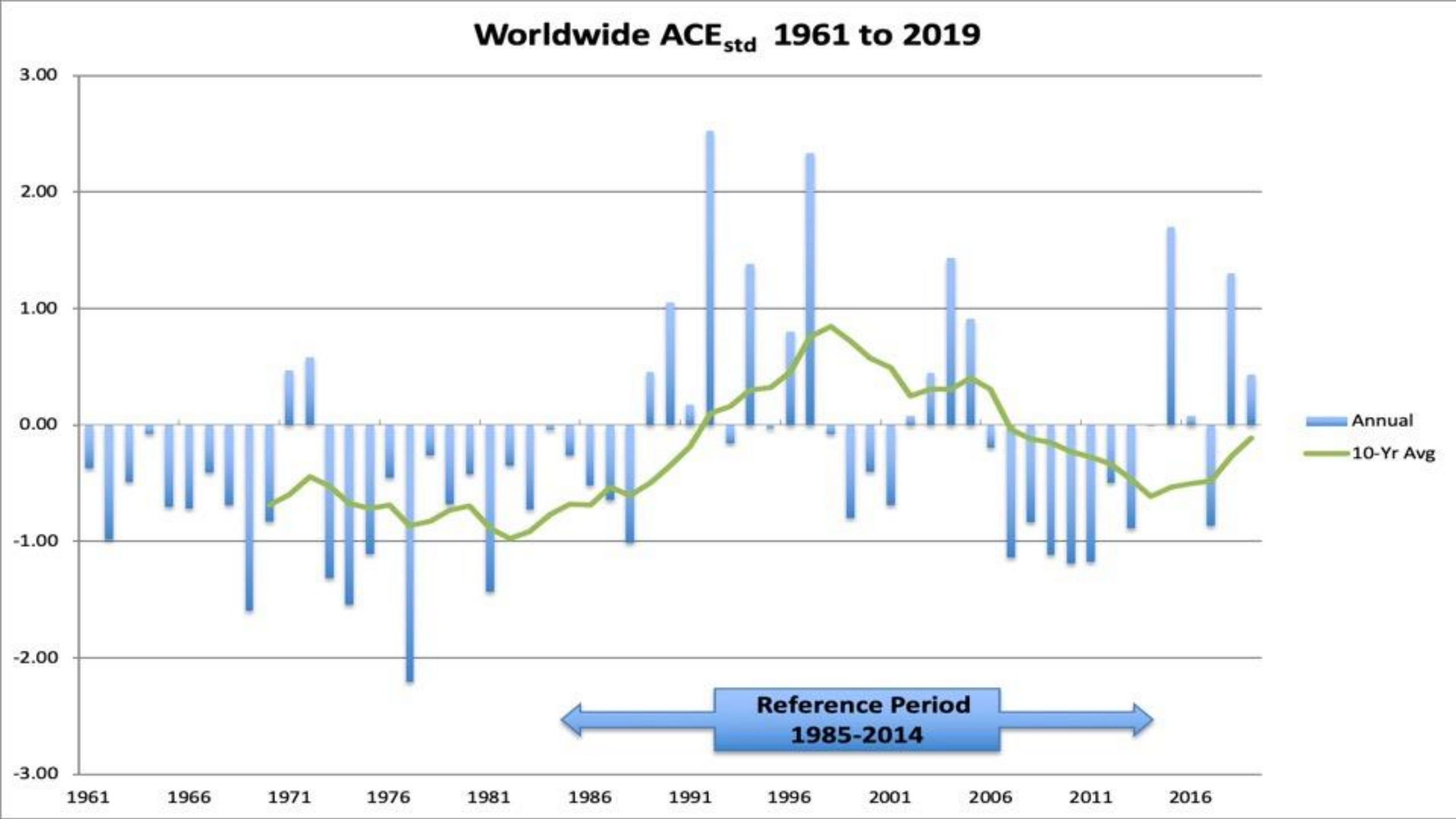
Credit: National Oceanic & Atmospheric Administration (NOAA)
Showing storms with hurricane force winds through 2016

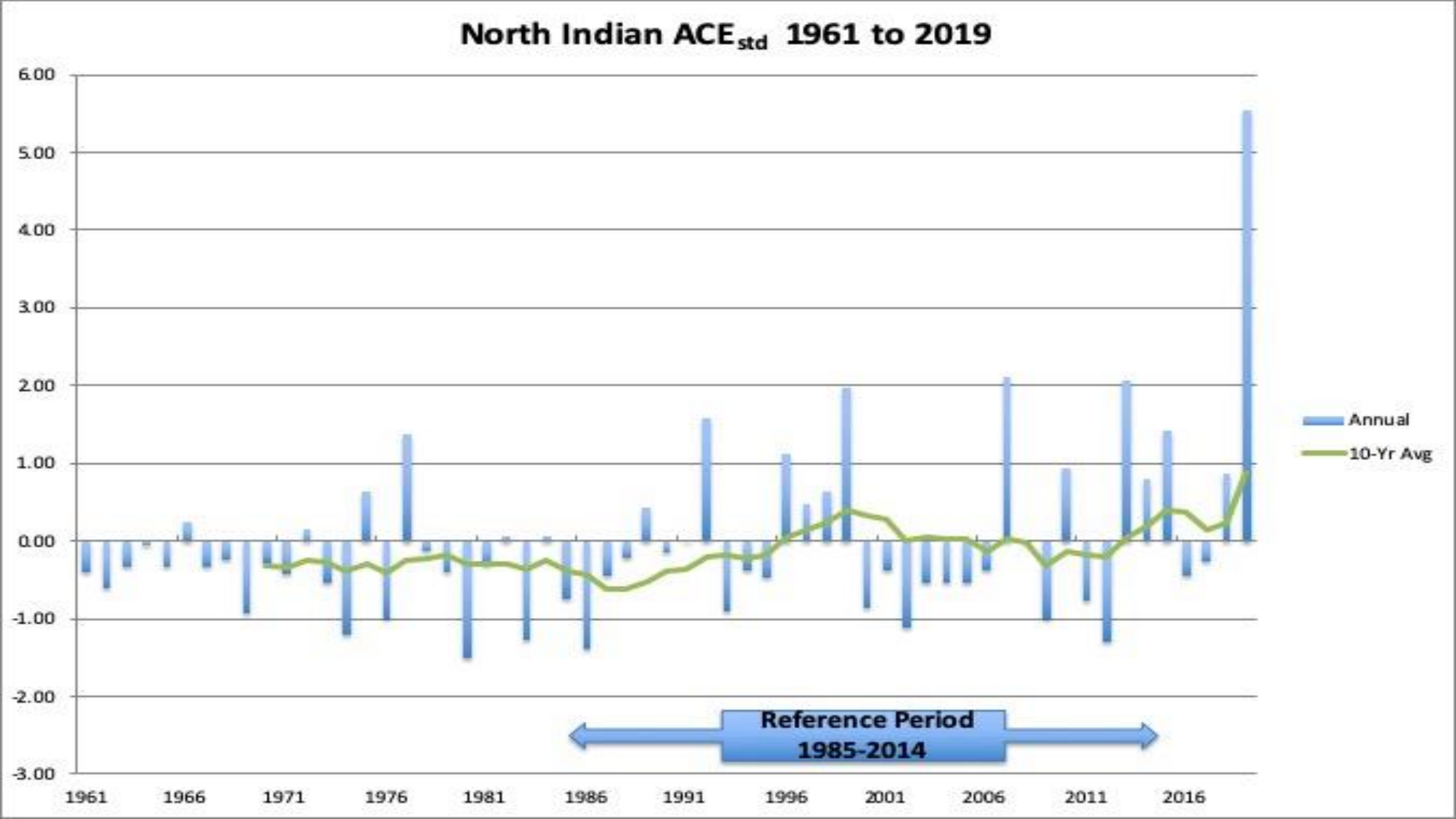
North Indian Ocean Tropical Cyclones

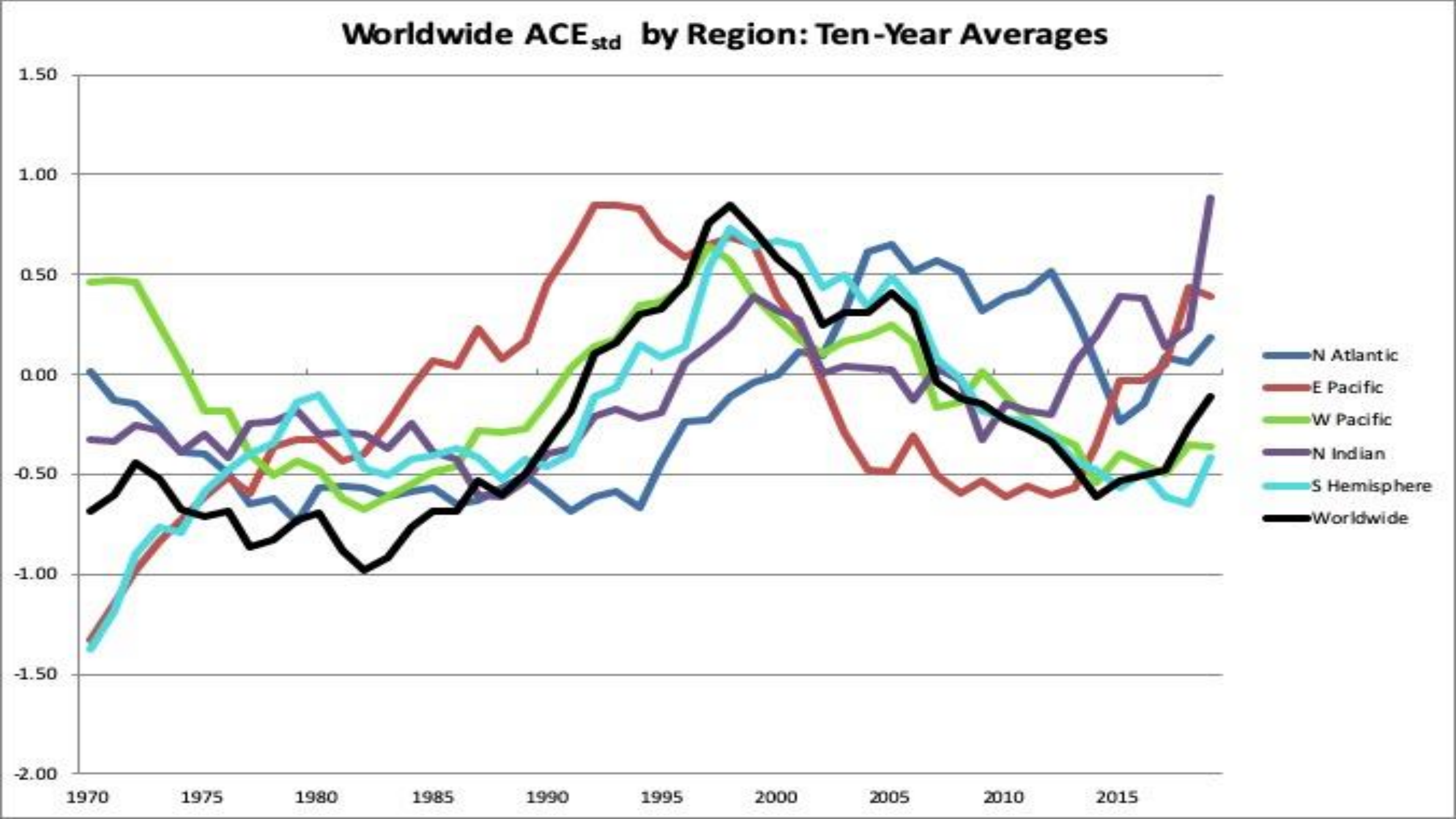




Sources: https://tropical.colostate.edu/real-time-cyclone-activity/ and climatlas.com/tropical/


Worldwide ACE$_{std}$ 1961 to 2019
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011
2016
Annual
10-Yr Avg
Reference Period
1985-2014


North Indian ACE$_{std}$ 1961 to 2019
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006
2011
2016
Annual
10-Yr Avg
Reference Period
1985-2014


Worldwide ACE$_{std}$ by Region: Ten-Year Averages
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
N Atlantic
E Pacific
W Pacific
N Indian
S Hemisphere
Worldwide

Some Very Useful Climate Websites

- Global average temperatures and sea level
  https://climate.nasa.gov/vital-signs/global-temperature/
  https://climate.nasa.gov/vital-signs/sea-level/

- Atmospheric CO_2 levels
  https://www.esrl.noaa.gov/gmd/ccgg/trends/full.html

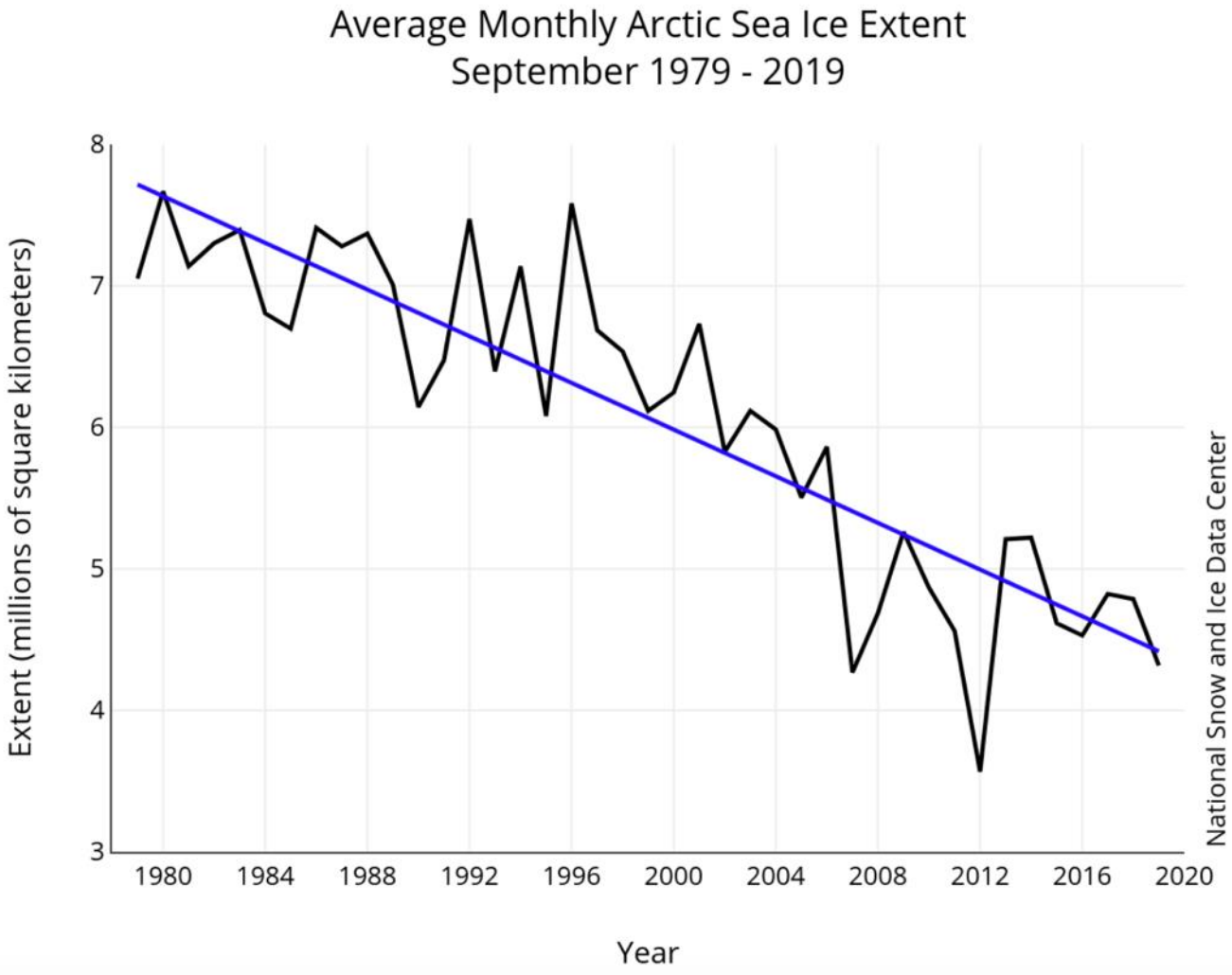
- Mass balance of Antarctic & Greenland Ice Sheets
  https://climate.nasa.gov/vital-signs/ice-sheets/

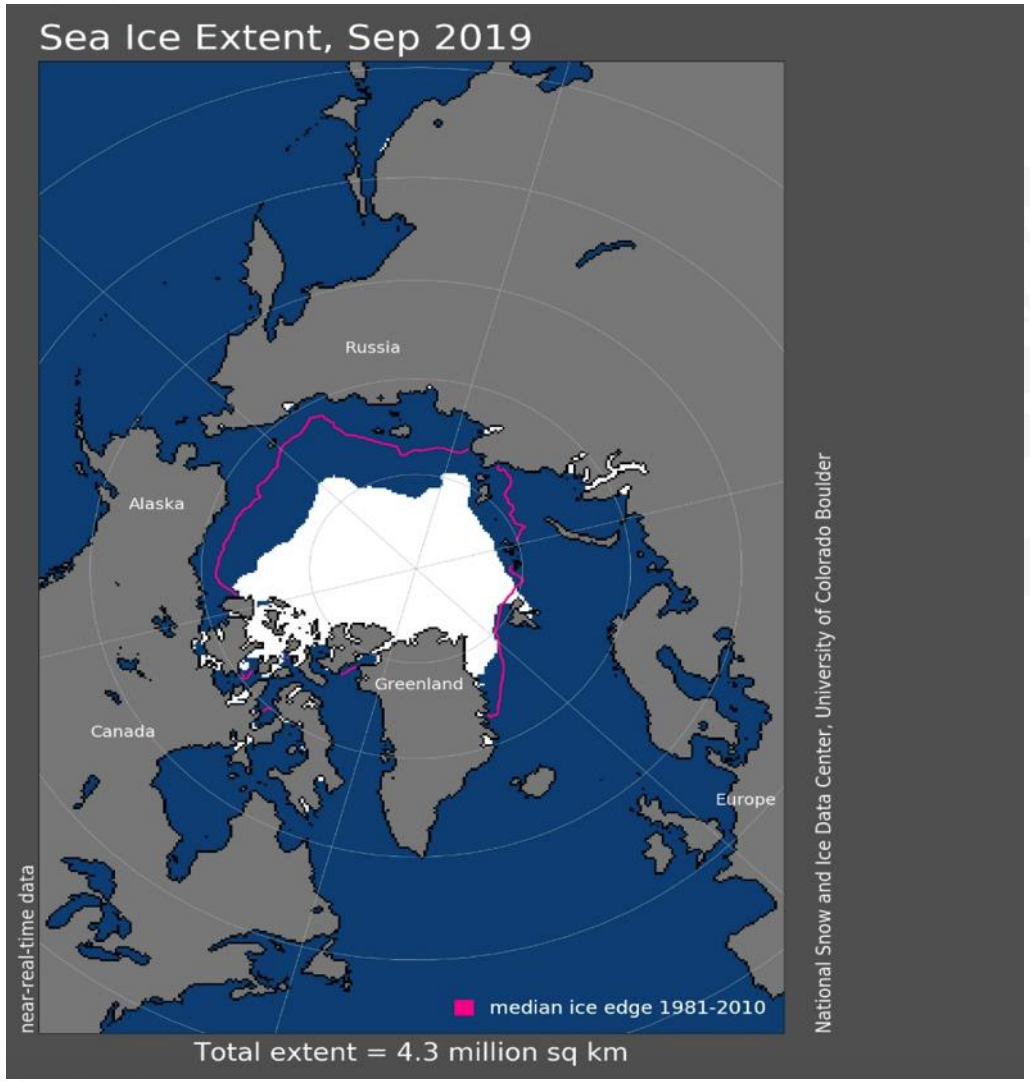
- Arctic sea ice extent
  https://nsidc.org/arcticseaicenews/

- Worldwide tropical cyclone activity
  http://tropical.atmos.colostate.edu/Realtime/index.php?arch&loc=global

- Costs of Climate Change?

Trends in Arctic Sea Ice Extent





Questions?

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Thank You