Weather Trends

Insurance Industry Impacts

March 6th 2017

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Agenda

- Review of Extreme Weather Risk Perception
- Weather Scales, Variability and Volatility
- Objectively review weather data relevant to insurance industry
- What Can Insurance Companies Do?

Poll - 2016 North America Largest Insured Losses

- Hurricane Matthew
- Texas Hail Storms
- Wildfire Fort McMurray
- LA Flooding

Poll - 2016 North America Largest Insured Losses

Hurricane Matthew

- 2.2 Billions USD

Texas Hail Storms

- 7.9 Billion USD

Wildfire Fort McMurray

- 2.72 Billion USD - 3.58 Billion CAD

LA Flooding

- 1 Billion USD

Did you know its not all doom and gloom

- January has gotten off to an active start for US insurers as it relates to the weather related losses. Initial claims are already at 1.2 B. Highest since the start of the 2014 year and 230% above the last 10 year Insured loss average .

- Texas has accounted for 56% of the U.S. Severe Weather Loss in 2016. Which is 476% above the 10 year average.

- The U.S. is experiencing what some scientist call the "Great Depression of tornado activity."

- It will be at least 4,239 days (11 years, 7 months, 9 days) since a major hurricane made landfall in the U.S.

- In 2016 the number of wildfires is still below average by 5,561,000 fire with acres burned 78% below normal.

Media Use of Extreme Weather

Weather in the News

Top 5 Network News Topics of 2015

Crime	52 hours / 17% news
Terrorism	39 hours / 13% news
Weather	33 hours / 11% news
Politics	32 hours / 11% news
Accidents/Disasters	32 hours / 10% news

Source: MRC analysis of ABC, CBS and NBC evening newscasts, 1/1 to 12/31, 2015.

Top Weather Stories 2015

133 minutes was spent on the summer wildfires in several western states
88 minutes May's extensive flooding in Texas
67 minutes California drought
60 minutes Hurricane Joaquin
58 minutes North and South Carolina Flooding

Overall, the networks spent 97 minutes of airtime in 2015 opining about climate change, including 17 minutes for the climate summit in Paris in December.

TV – Gimmicks

NBC-Owned Stations Unveil ‘StormRanger’ Mobile Radar Trucks

Share Tweet More

By Kevin Eck on Aug. 1, 2016 - 10:46 AM 2 Comments

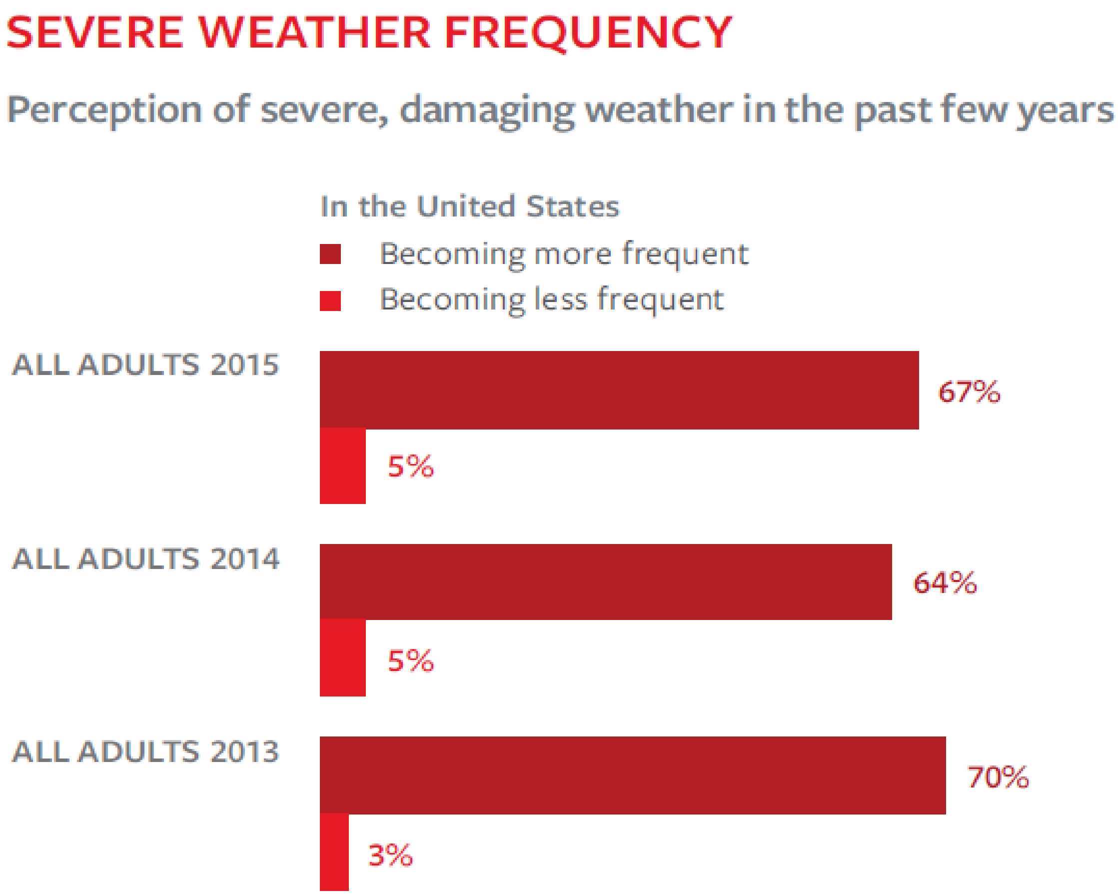
NBC-owned Television Stations is deploying a fleet of three mobile Doppler weather radar trucks for all of its NBC and Telemundo stations.

WCAU in Philadelphia got the first trucks called StormRanger, or CazaTormentas for the Telemundo stations.

Two more will arrive before the Olympics for KXAS in Dallas-Fort Worth, WMAQ in Chicago, KNBC in Los Angeles and KNTV in the San Francisco Bay Area.

Annual Survey of The Risks - Travelers

Two-thirds of households have consistently stated over the past three years that they believe severe weather is becoming more frequent in the U.S.; 40% believe that is the case in their local areas



Source: Travelers

Question

How many of you are NFL Football Fans?

How many of you follow the Super Bowl?

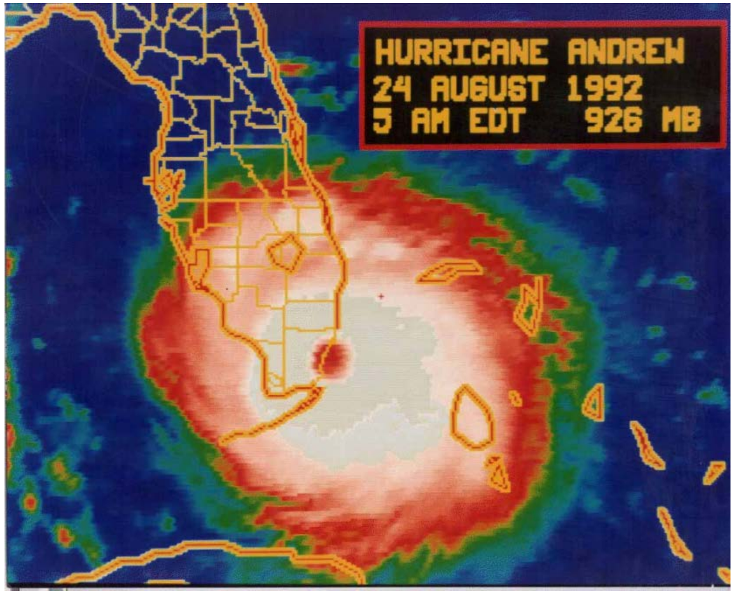
How many of you are Green Bay Packer Fans?

Who was in the Super Bowl in 2011?
Who won / Who lost?
What was the score?

31

25

Weather Memory Is Generational

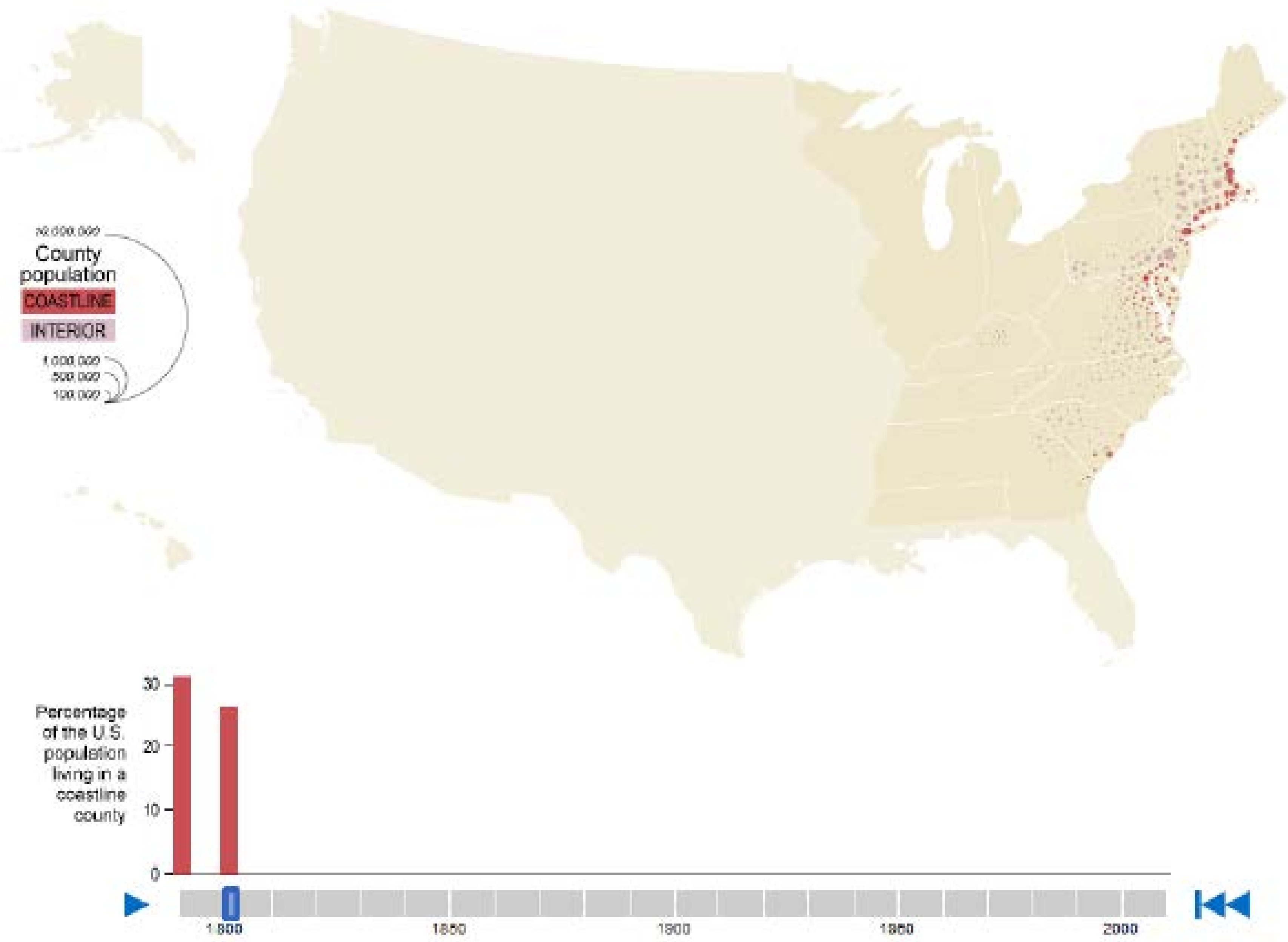


Hurricane Andrew Most recent category 5 hurricane.

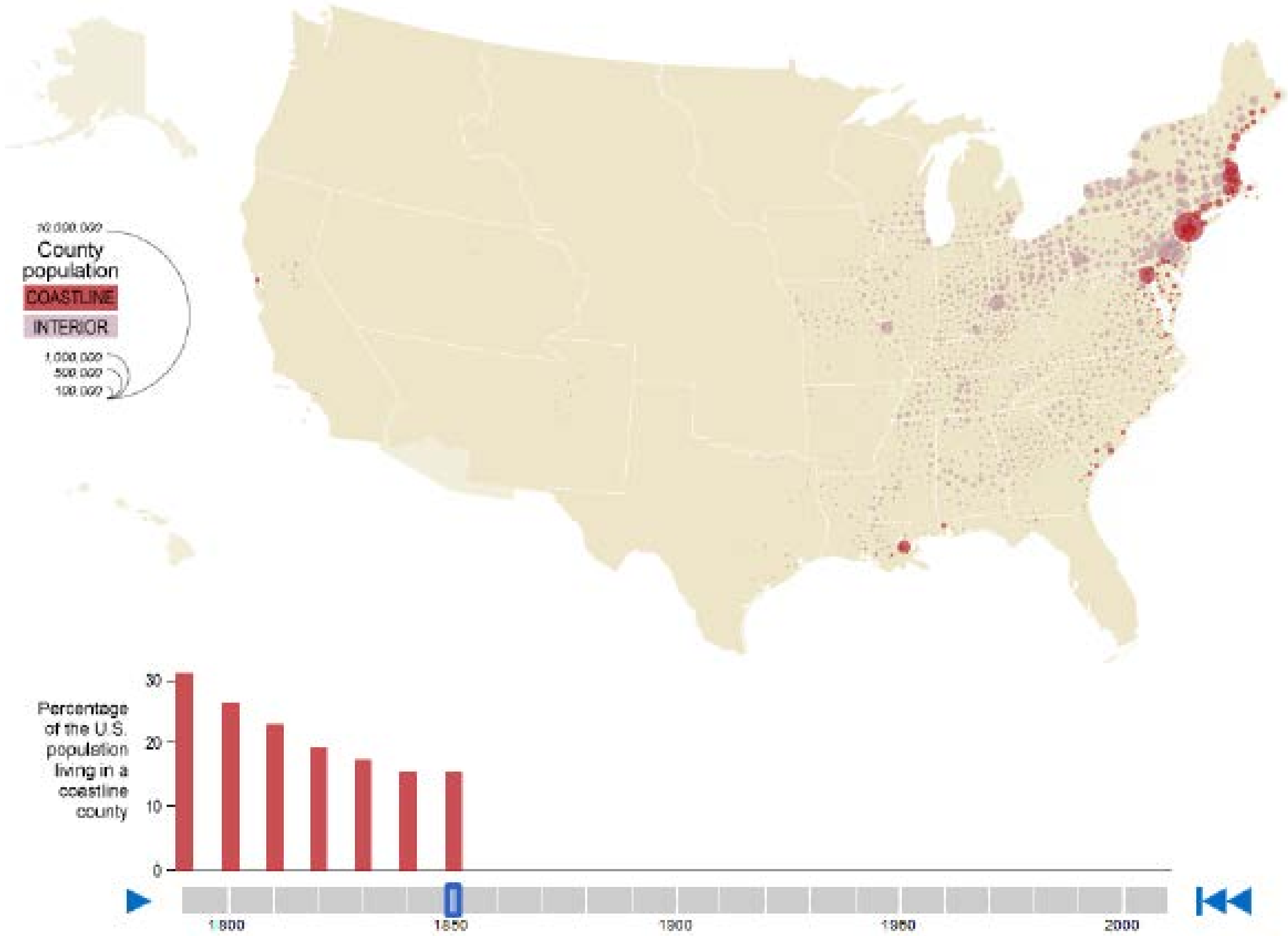
Few people are even alive even remember the 1926 Miami Hurricane

We only really remember last weather major event.

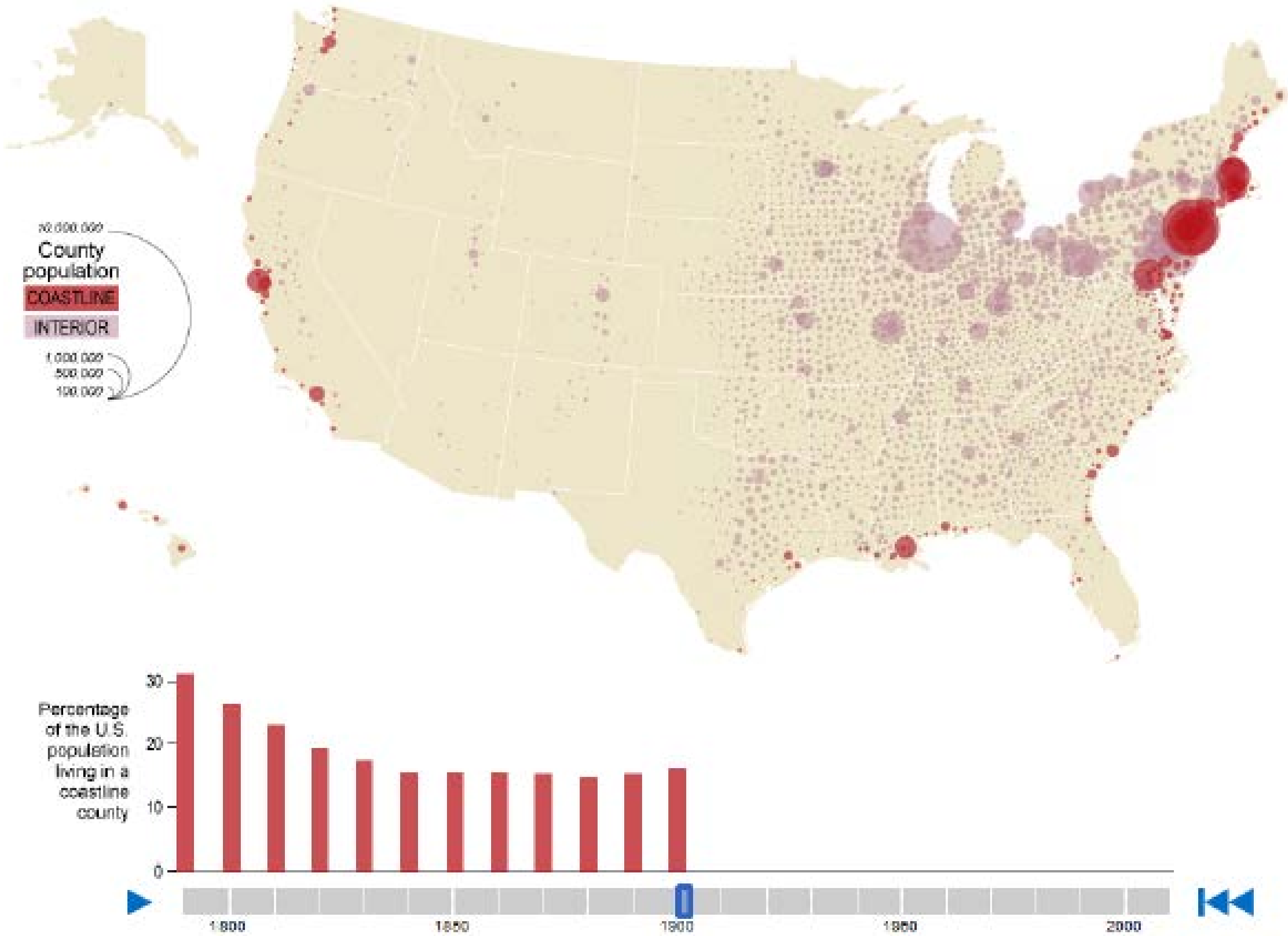
U.S. Population 1800



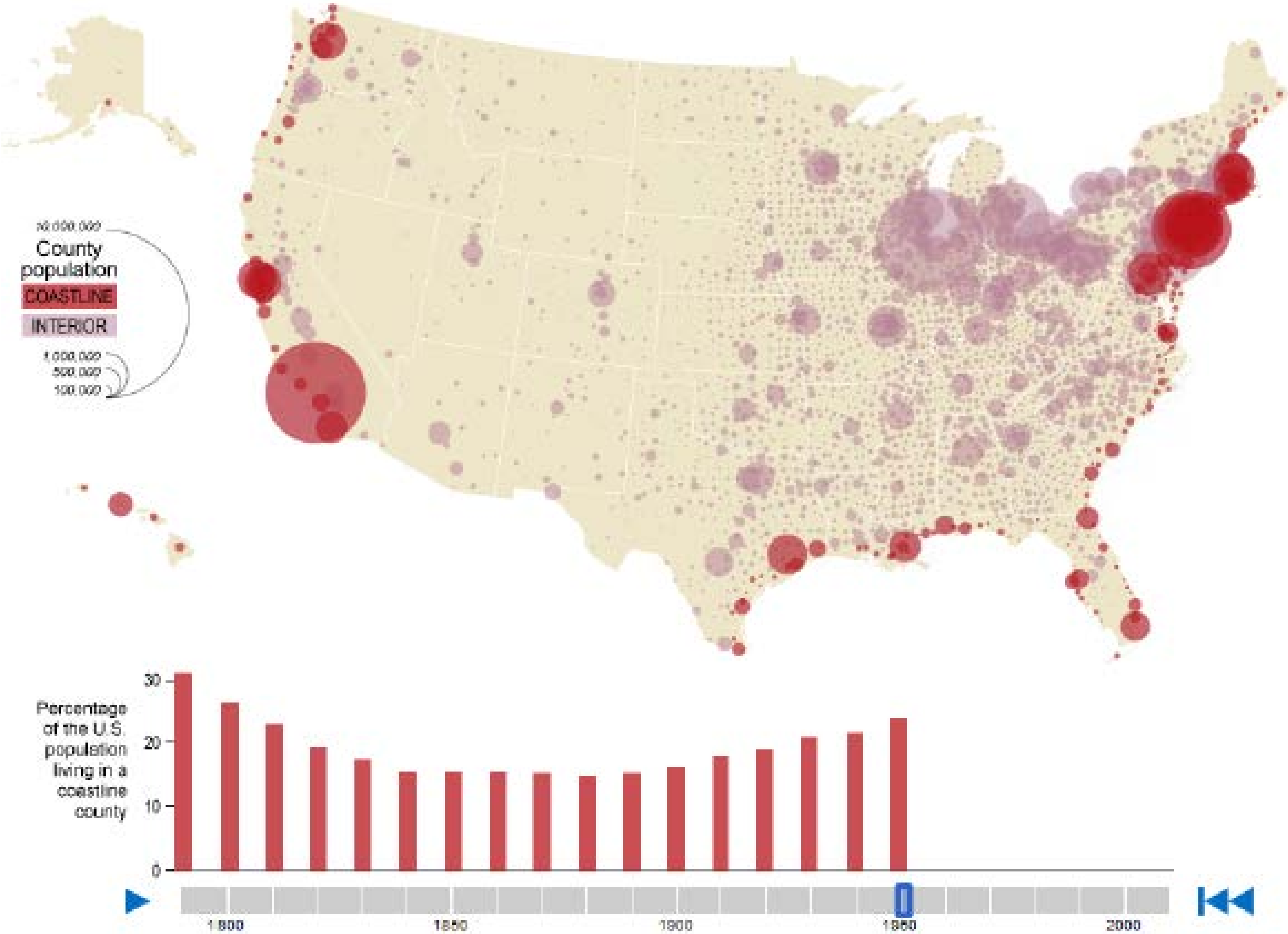
U.S. Population 1850



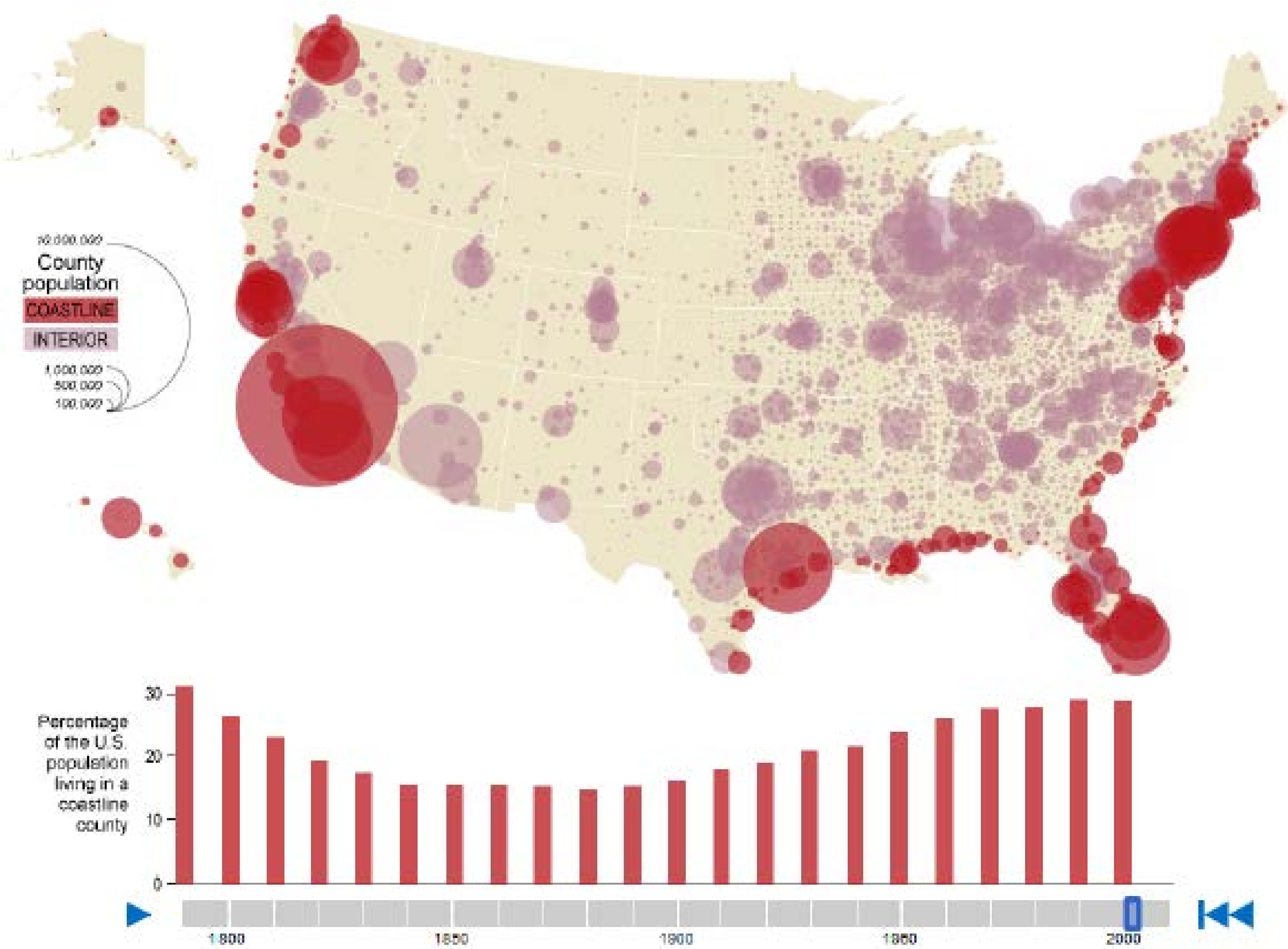
U.S. Population 1900



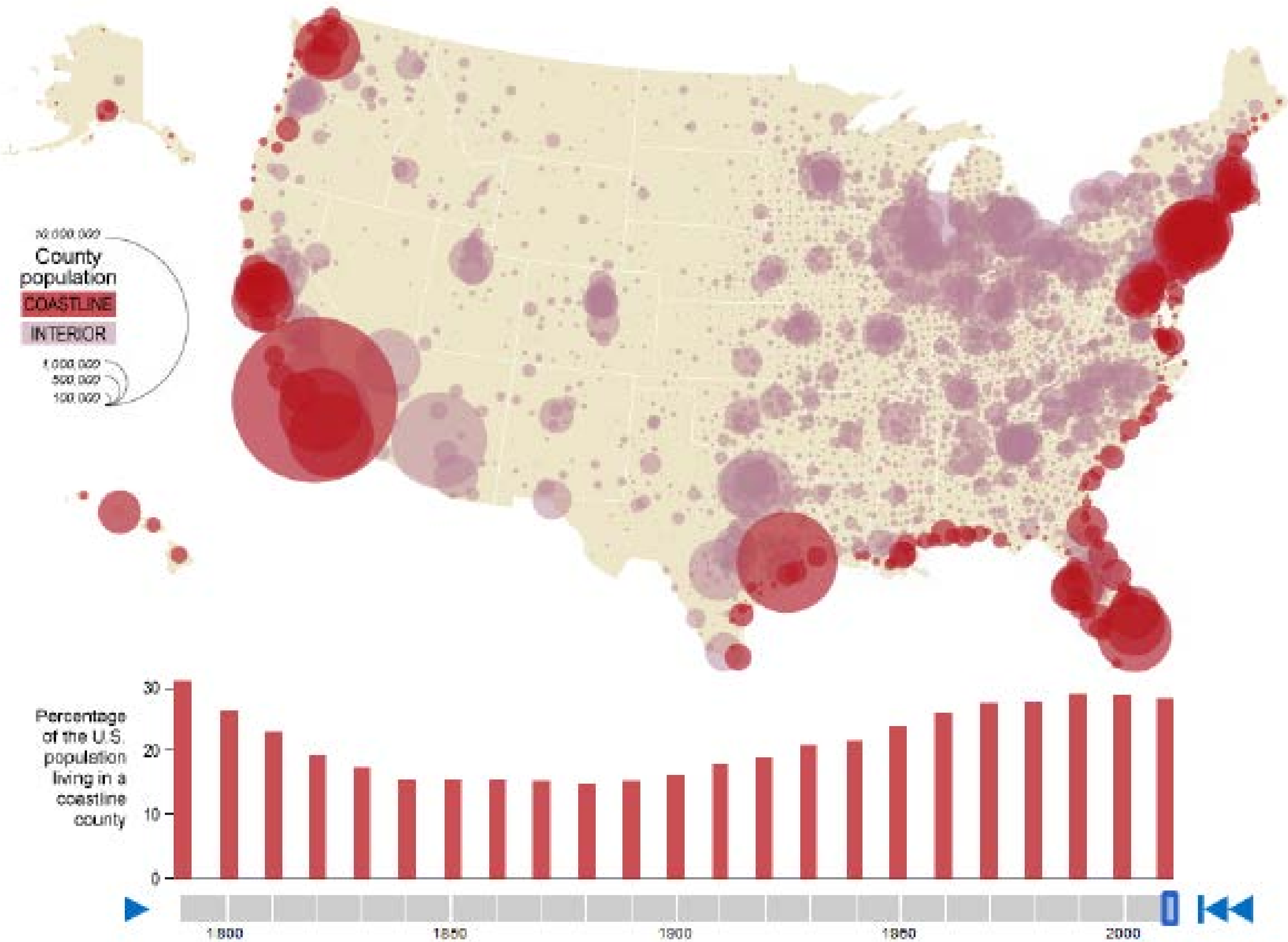
U.S. Population 1950



U.S. Population 2000



U.S. Population 2010

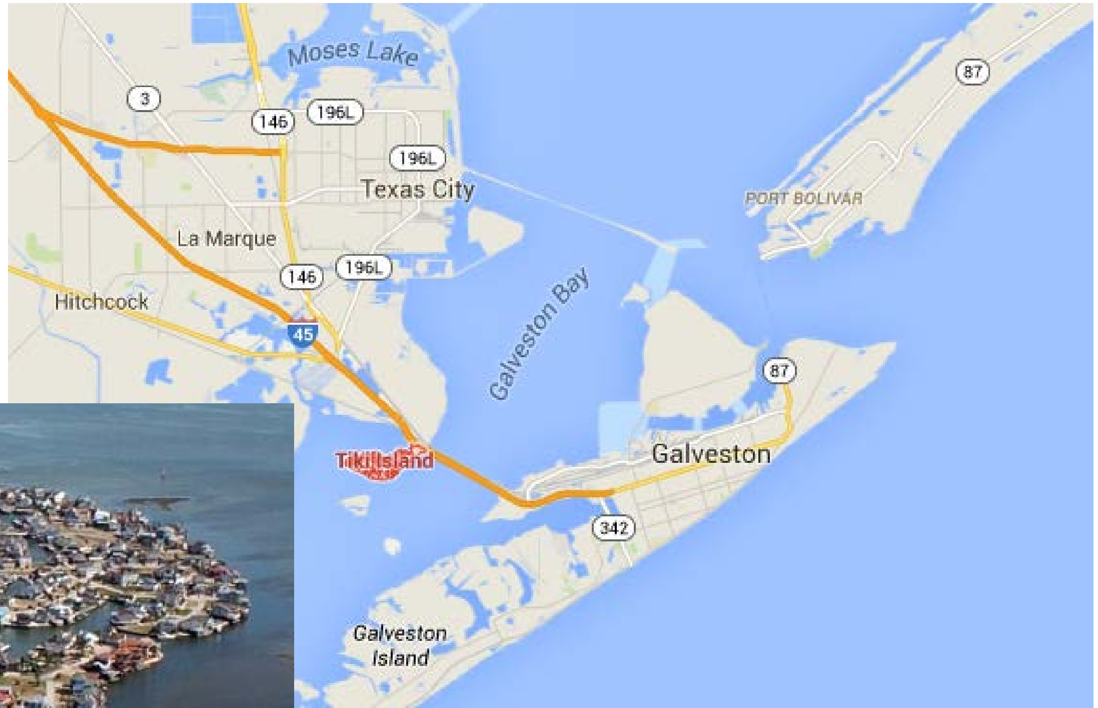


Disaster by Design

Thailand Floods of 2011 - This is the changing face of natural disasters

Size of Homes and Location, Location, Location

Tiki Island, TX - 1.39 sq miles (3.6 km²) with population of 968



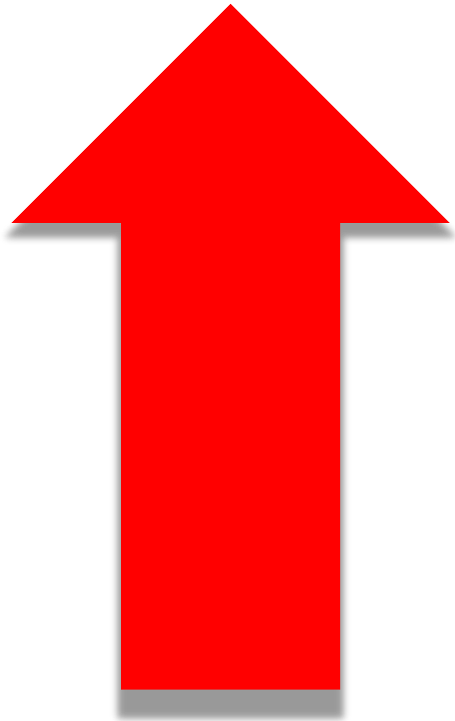
Natural Catastrophes Increasing?

Increasing Population

Increasing Values

Concentration In Exposed Areas

Insurance Penetration



Changing Hazards

Weather Scales, Variability and Volatility

Severe Weather

Know the Difference

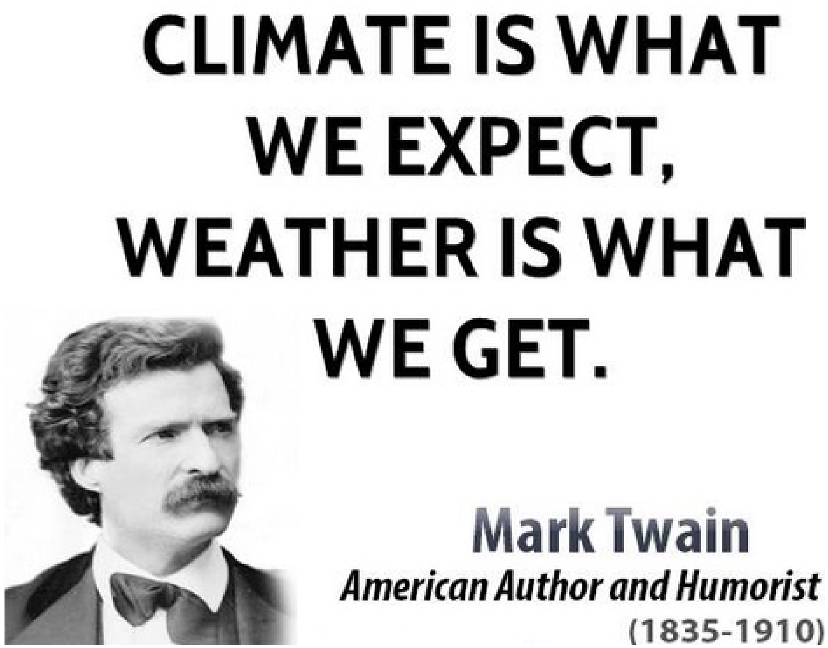
Climate and weather are not the same.

Weather :
is the particular set of abiotic conditions, such as rainfall, sunlight, temperature and humidity affecting a particular area at a particular time.

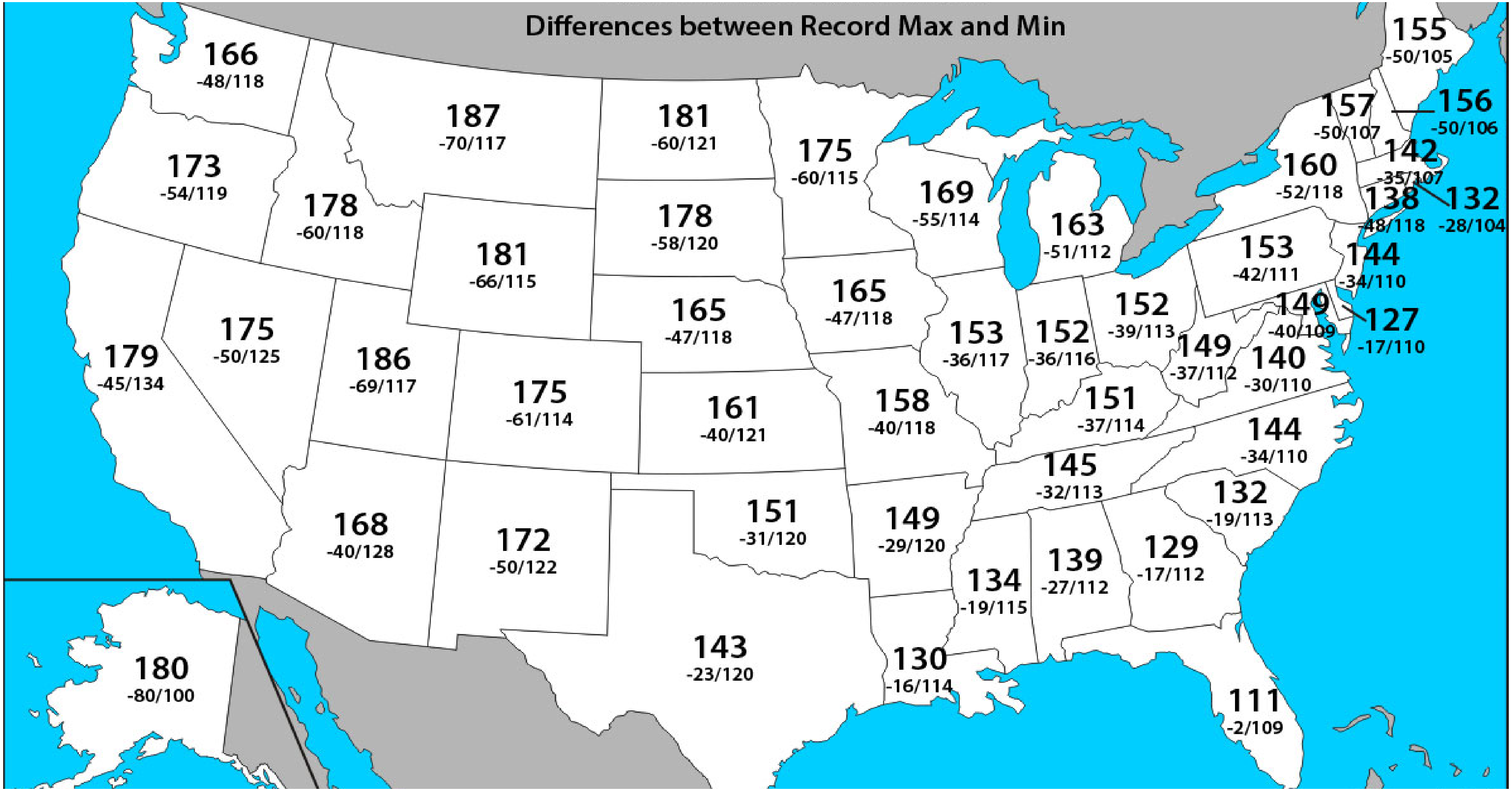
Climate:
is the overall pattern of weather at that area.

Weather changes daily.

Climate changes over decades, or hundreds or thousands of years.



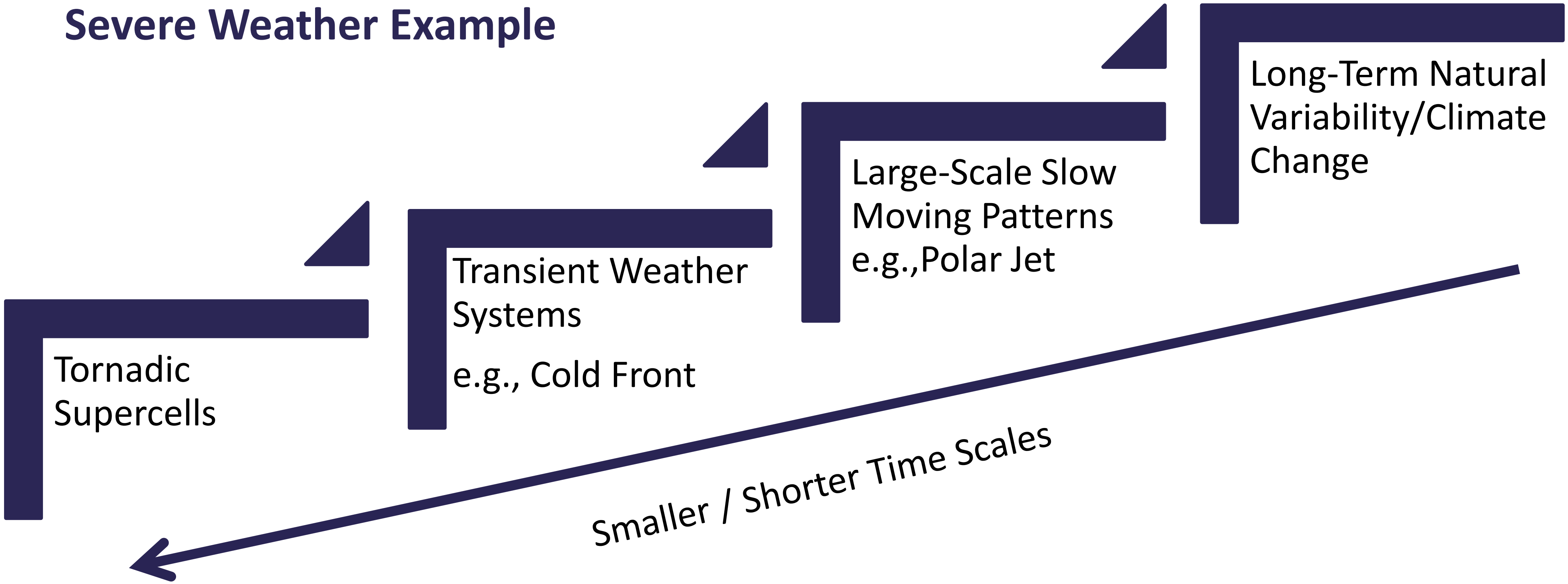
Weather Volatility



Scales of weather/climate variability

- The atmosphere – ocean system is naturally variable in time and space. Its is always in constant balance.
- Variability in time is apparent in a range of scales from days to many years.

Severe Weather Example

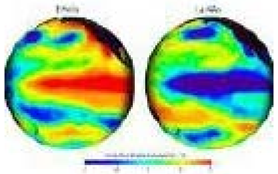


Complex Physical Problem

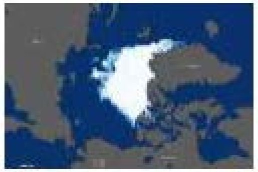
Changes in the atmosphere and/or ocean can trigger changes in the variability and overall state of the weather and climate locally in time and space.

Remote Forcing → **Changing Variability** → **Changing Risk**

Remote Forcing

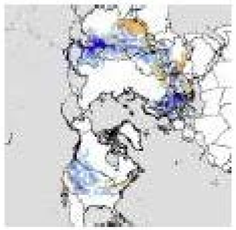


El Nino / La Nina



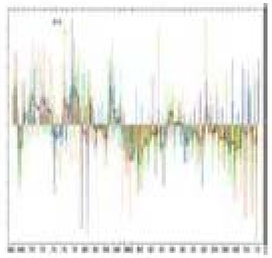
Sea Ice and Glaciers

Solar Energy



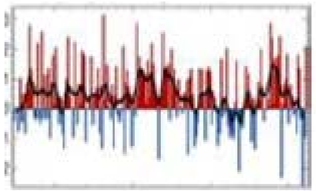
Snow Pack

Changing Variability



Upper Air Temperatures

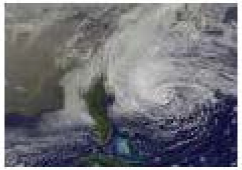
Sea Surface Temperatures



Surface Temperatures

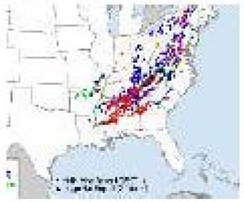
Changing Risk

Drought



Tropical Weather

Rainfall / Wind



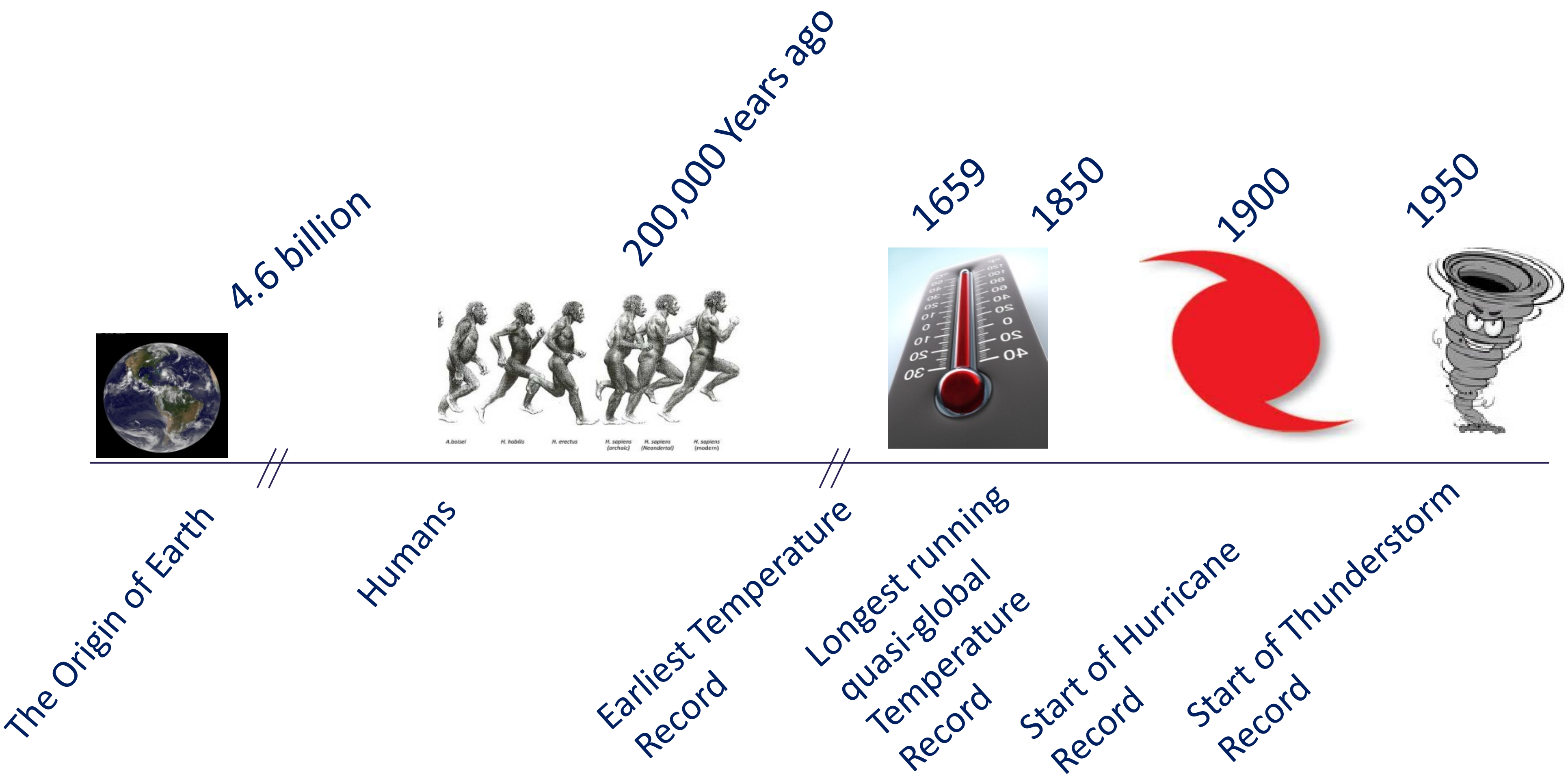
Severe Storms

Inconsequential to impactful

- Weather volatility is a measure of variability, dependent on the time and space scales
- High weather volatility = extreme variability = unexpected results
- Some volatility on smaller space and time scales in inconsequential
  - o Short – term temperature spikes
  - o Localized severe weather
- Volatility on larger scales can lead to significant, negative impactful events.
  - o Extended droughts
  - o Large scale floods
  - o More intense wind events
  - o Severe weather outbreaks

Time Scales of Weather Records

In the grand picture of time, we have a very short record of weather. Extreme weather requires very long return periods to properly understand the correct return period on severity.



bms.

Official Reports on the Weather Trends:

Evidence, and how it stacks up:

Rainfall – It is likely that since 1951 there have been statistically significant increases in the number of heavy precipitation events in more regions than there have been statistically significant decreases, but there are strong regional and sub-regional variations in the trends.

Flooding – Even though there has been an increase in what scientists call "extreme precipitation" events, there is very little evidence to suggest that this increase has been accompanied by an increase in floods.

Drought – There is medium confidence that since the 1950s, some regions of the world have experienced more intense and longer droughts, in particular in southern Europe and West Africa. But in some regions, droughts have become less frequent, less intense or shorter.

Tropical Cyclone - After accounting for past changes in observational capabilities, the current data indicates no significant observed trends in tropical cyclones.

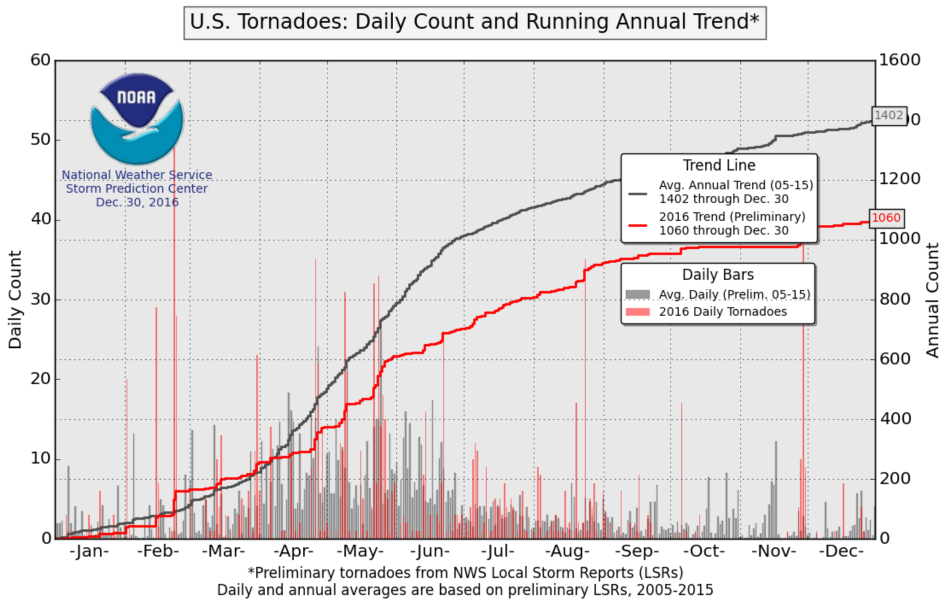
Severe Weather – The quality of data makes any conclusion about long-term trends problematic and, therefore, there is low confidence in observed trends in small spatial-scale phenomena such as tornadoes and hail.

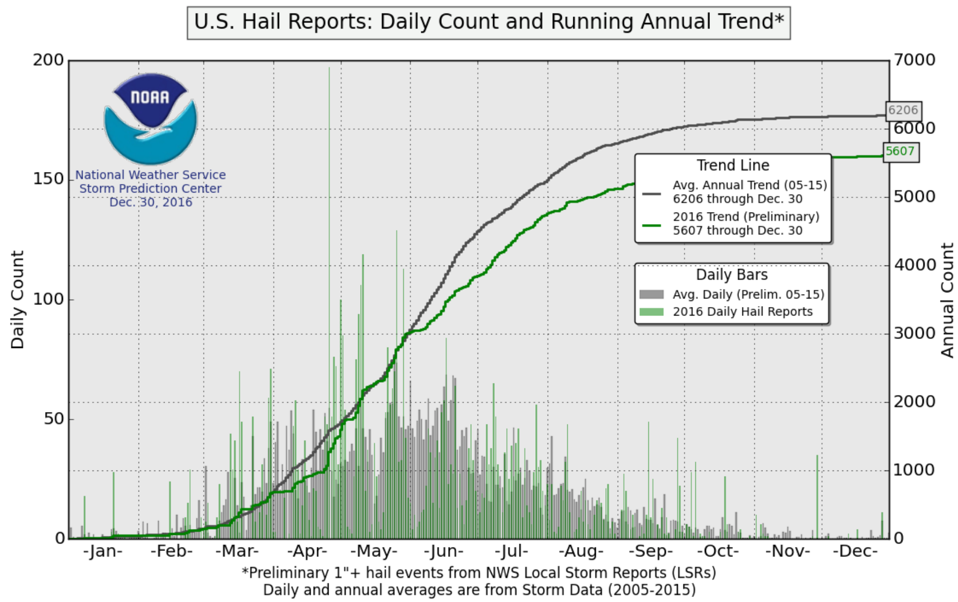
Source: IPCC SREX and AR5 Reports

Weather / Climate Data

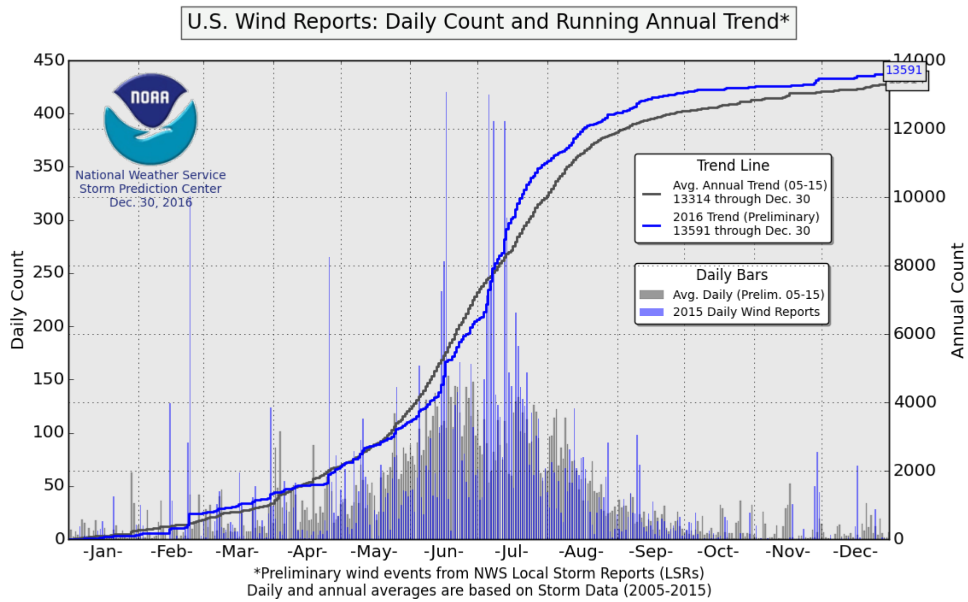
Severe Weather

2016 Severe Weather Reports





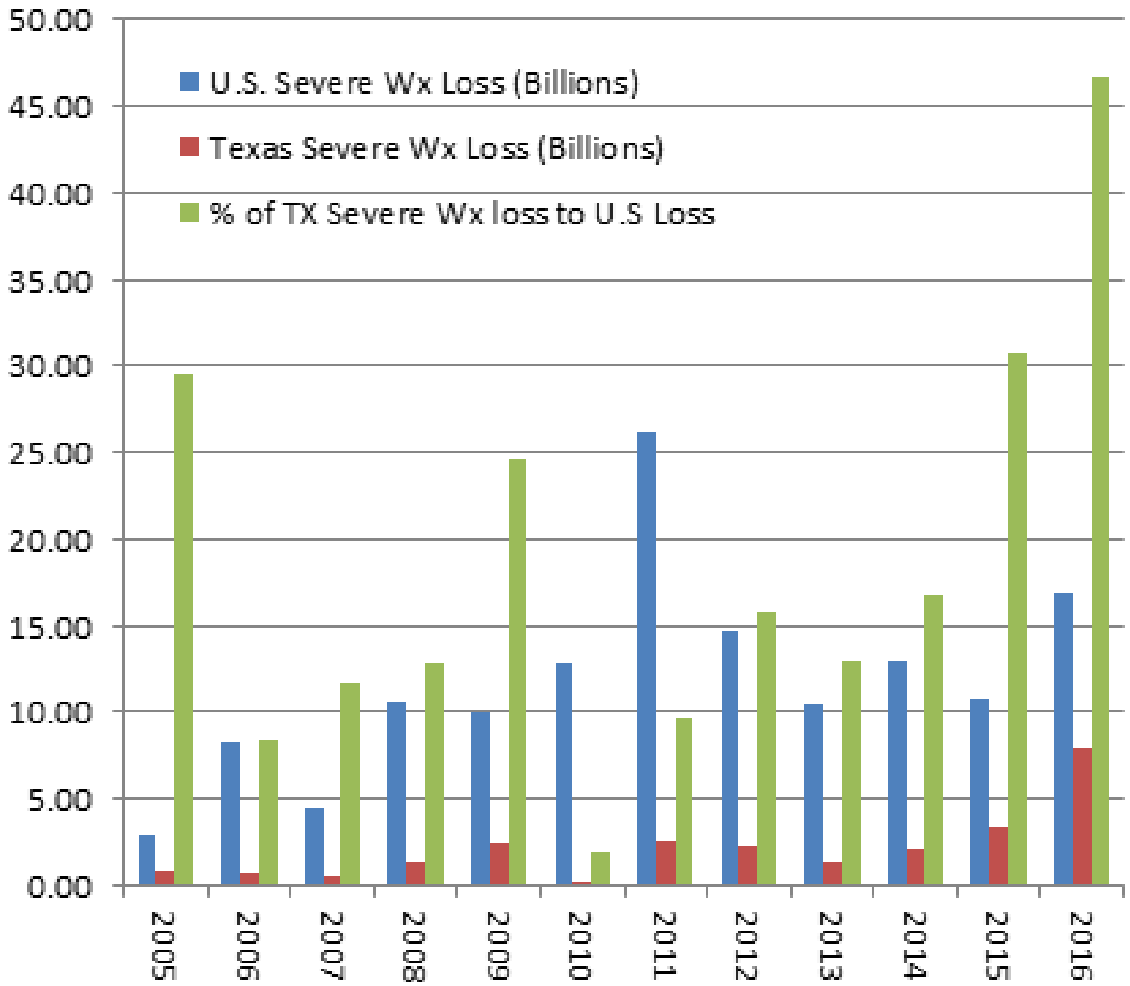
For the last four years tornado, hail and wind severe weather reports have been below the 2005 – present year average. This year wind reports were above this average slightly.



The historic tornado drought continues with historically low occurrence of tornados across U.S.A.

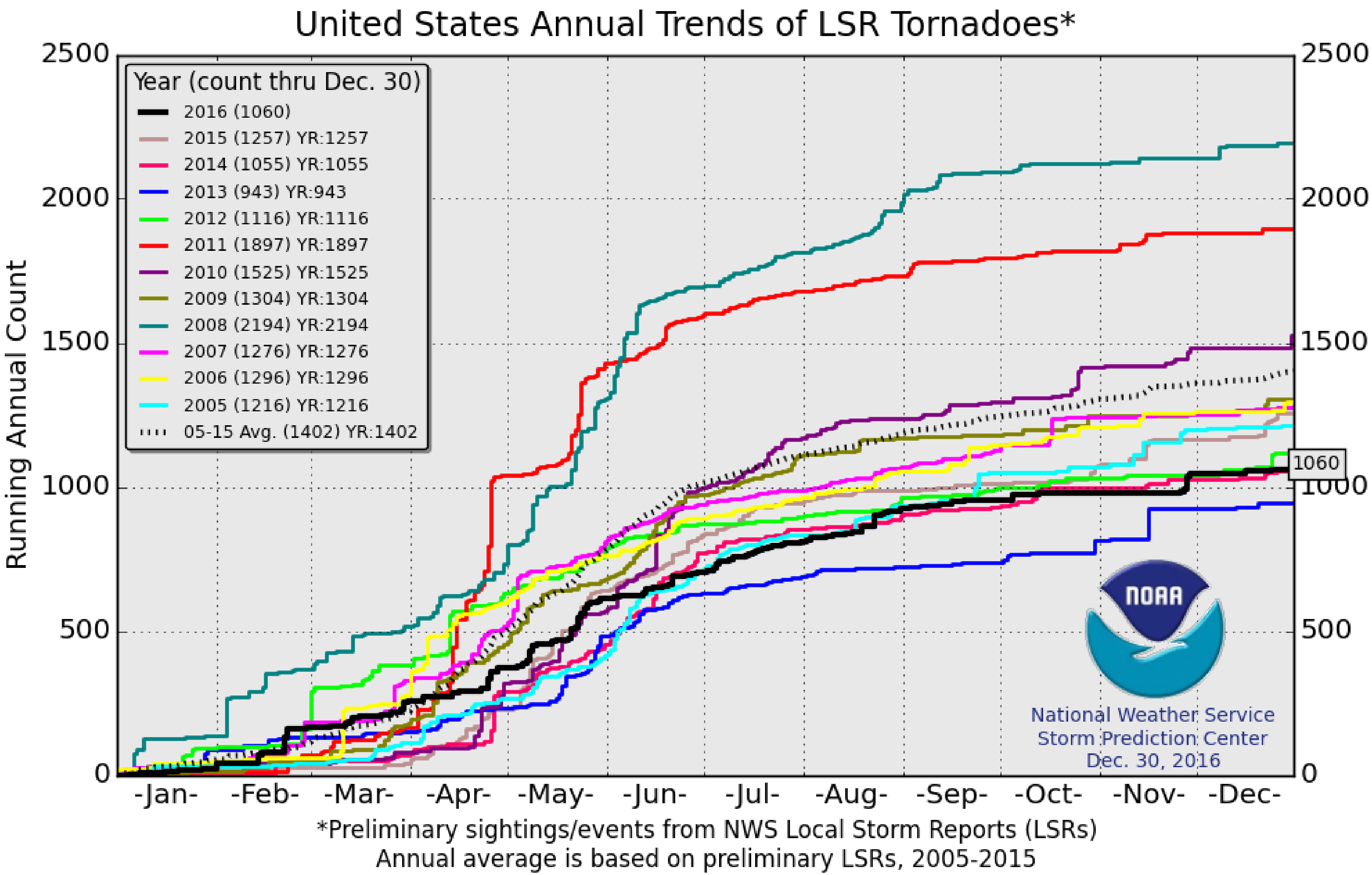
Severe Weather Losses

- U.S. Insured losses are at a multi-year high. Highest since 2011.
- Losses are driven by Texas which is 47% of the total reported losses
- Historically this percent is much higher then the 15% average.
- Unlike the high losses in 2011 this years losses are driven by hail and wind losses with no significant tornado losses across the U.S.
- Texas loss are driven by major hail events in major cities.



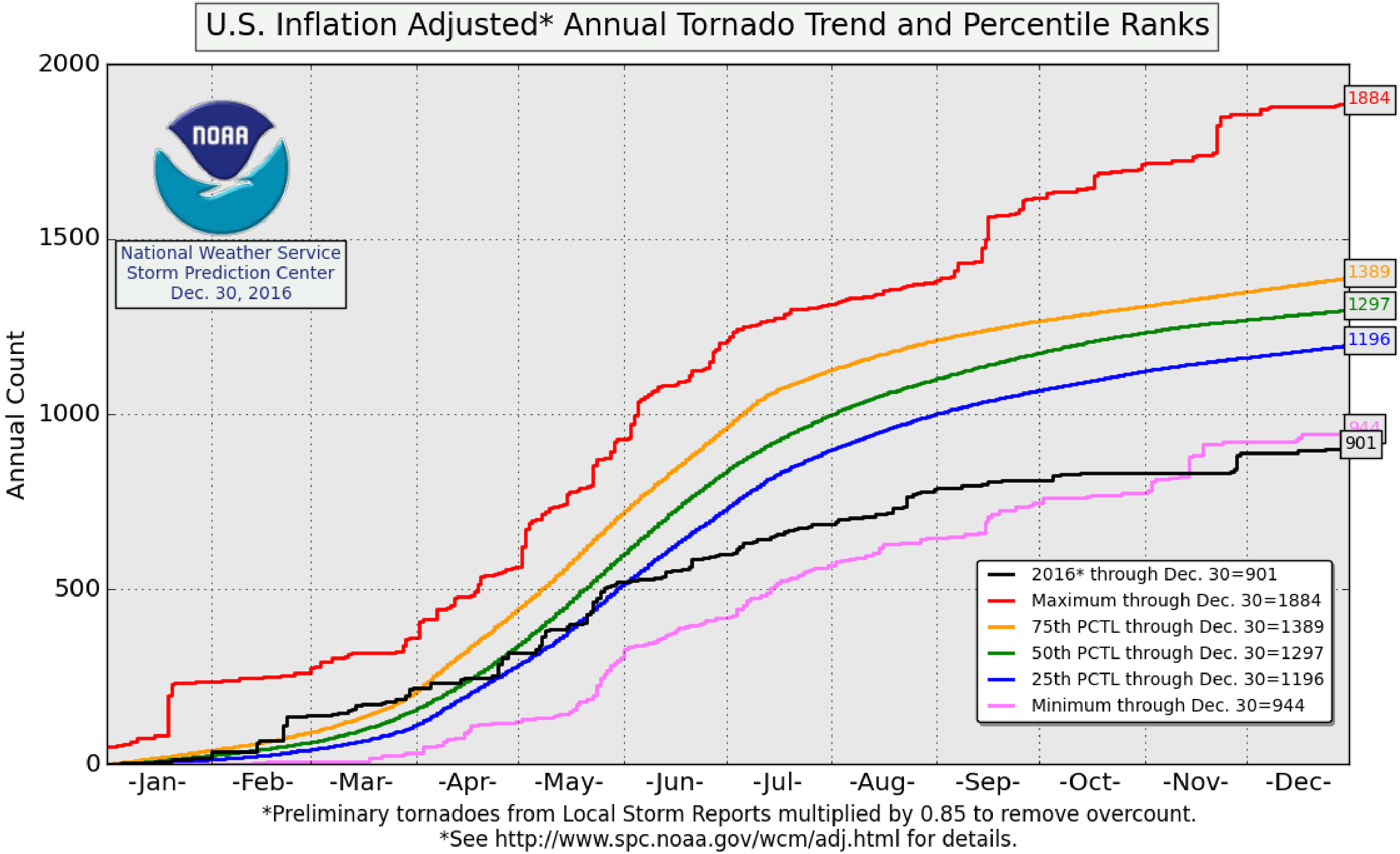
Source:PCS

Tornado Trends



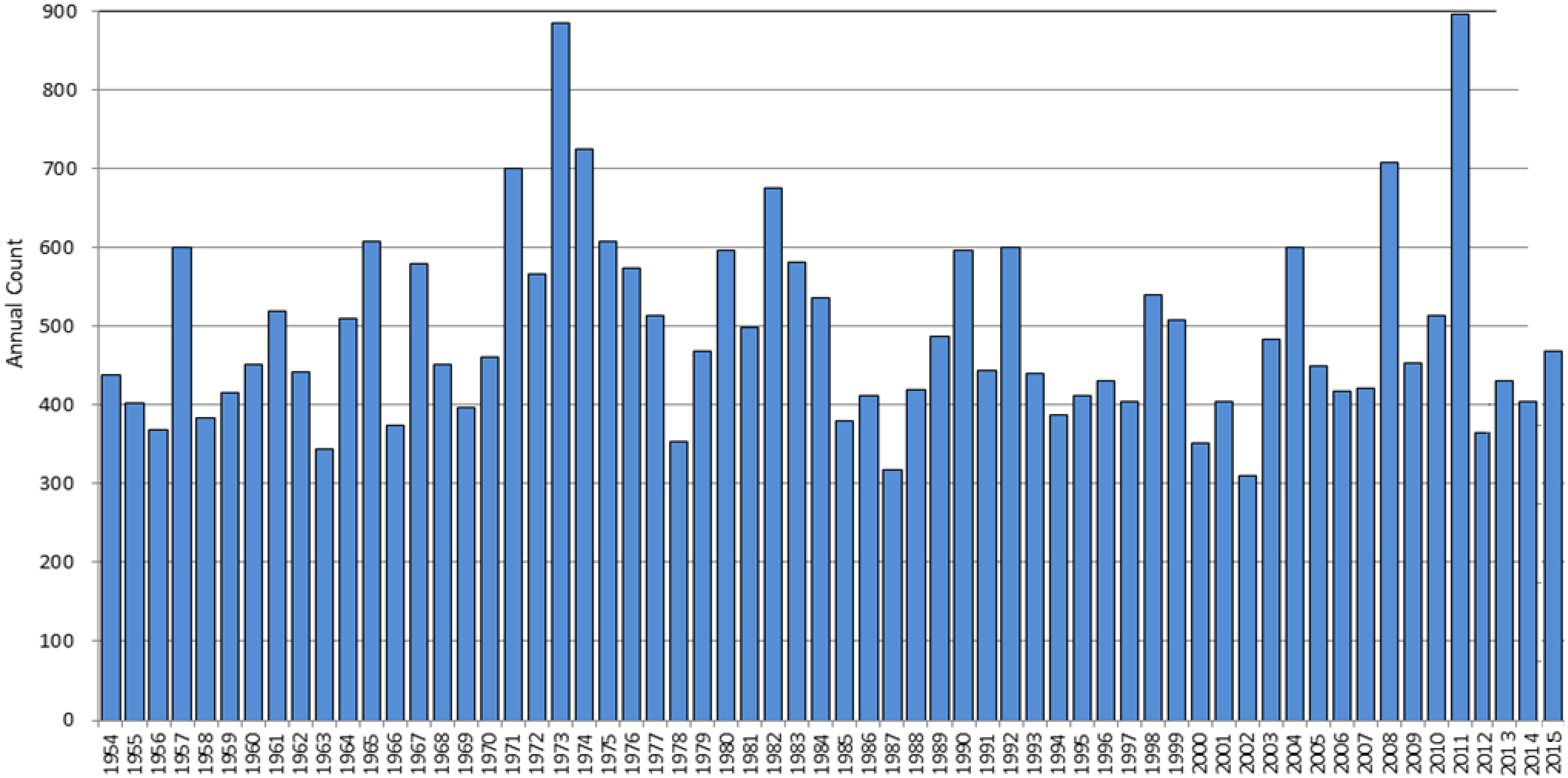
We have not had a year with above normal tornado activity since 2011. Last four years were some of the lower tornado report years in the period of record.

Tornado Trends Adjusted



When adjusting for the historical bias in reporting of tornadoes, 2016 is the lowest tornado count since 1950.

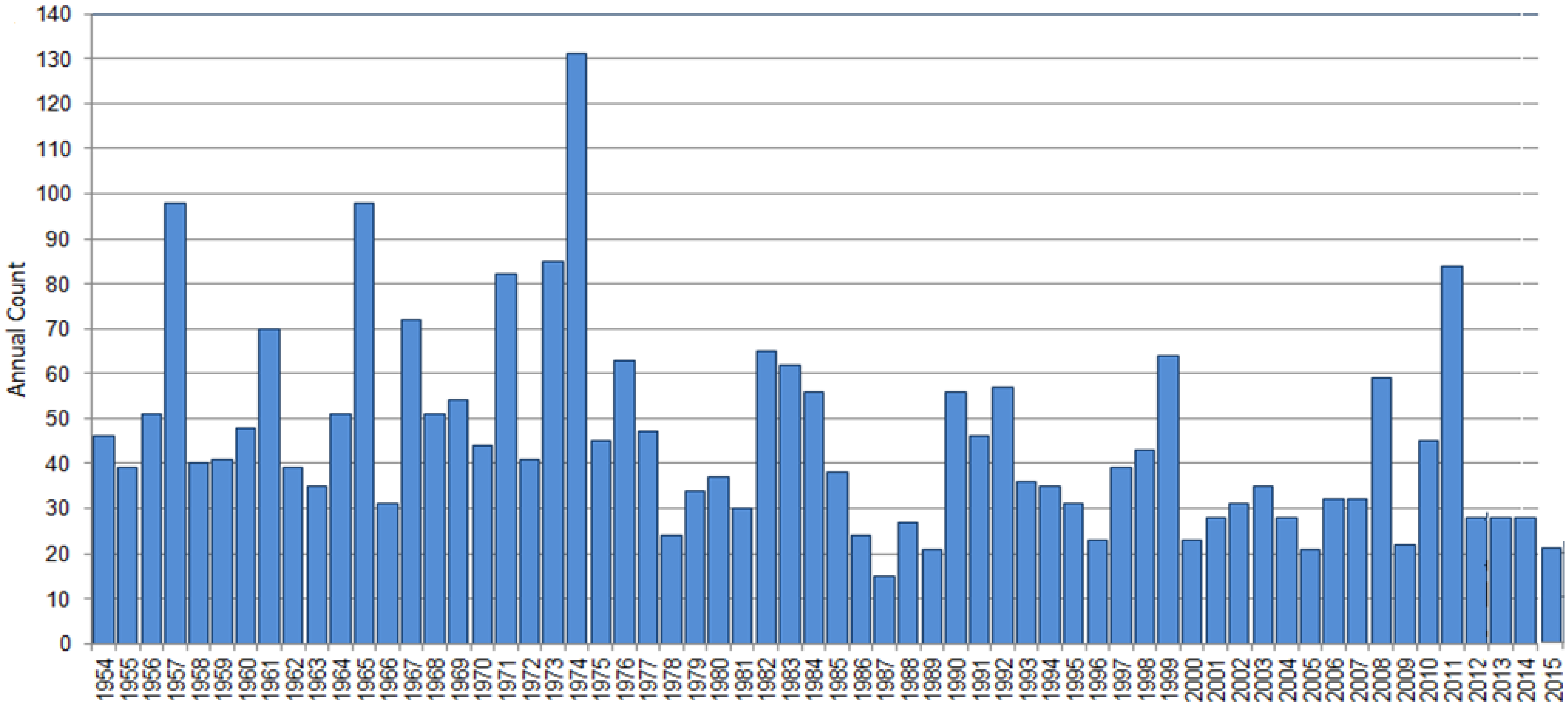
U.S. Annual Count of EF-1+ Tornadoes



Little to no trend in tornado counts of EF 1 and greater

Source: NOAA Storm Prediction Center

U.S. Annual Count of EF-3+ Violent Tornadoes



Downward trend in major tornado counts.

Source: NOAA Storm Prediction Center

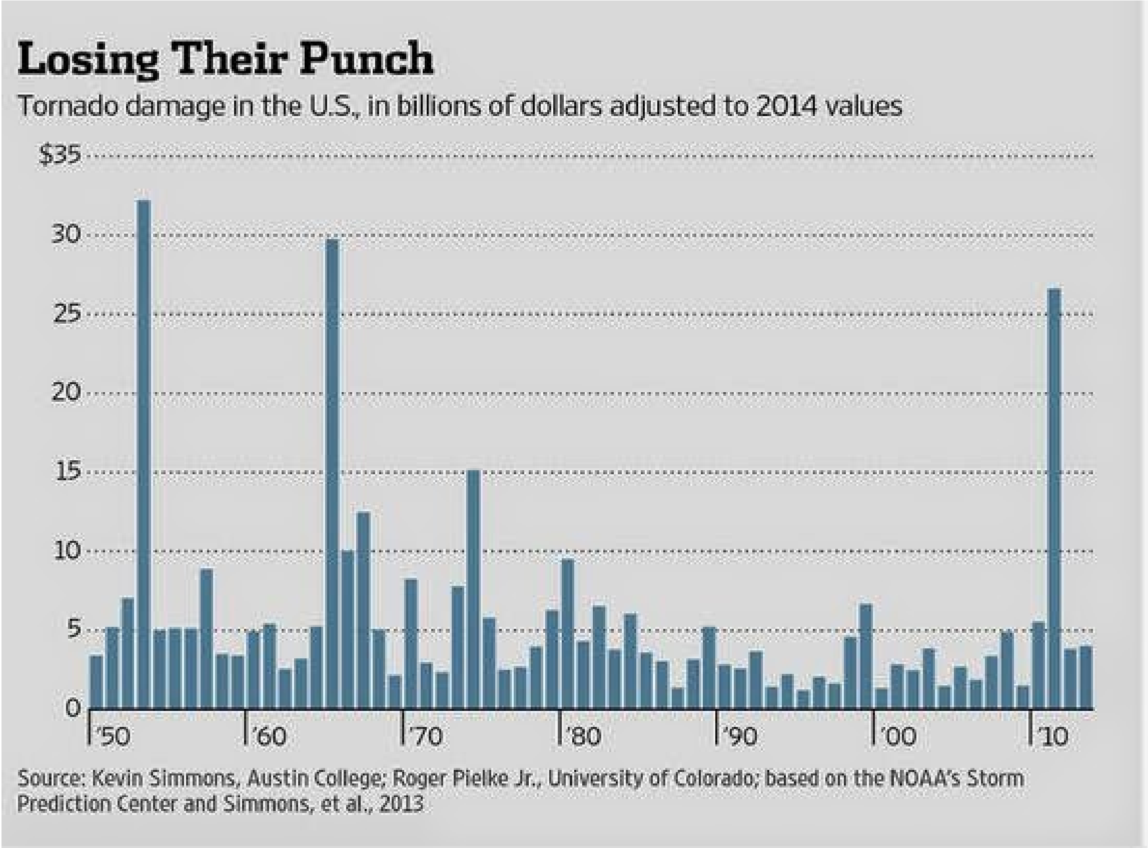
Tornado Damage Normalized

Estimation of how much tornado damage would occur in the U.S. if each year's tornadoes occurred with the levels of population and development of today.

Average annual losses from the entire 63-year period across the U.S. are $5.9 billion.

The first 32 years average annual loss is $7.6 billion.

Since 1982, a period of 31 years shows an average annual loss of $4.1 billion.



Source: WSJ

Matter of Luck

Source: Twin tornadoes are seen near Dodge City, Kansas, with Dodge City Raceway Park in the foreground on Tuesday, May 24, 2016. (Instagram/bradguay)

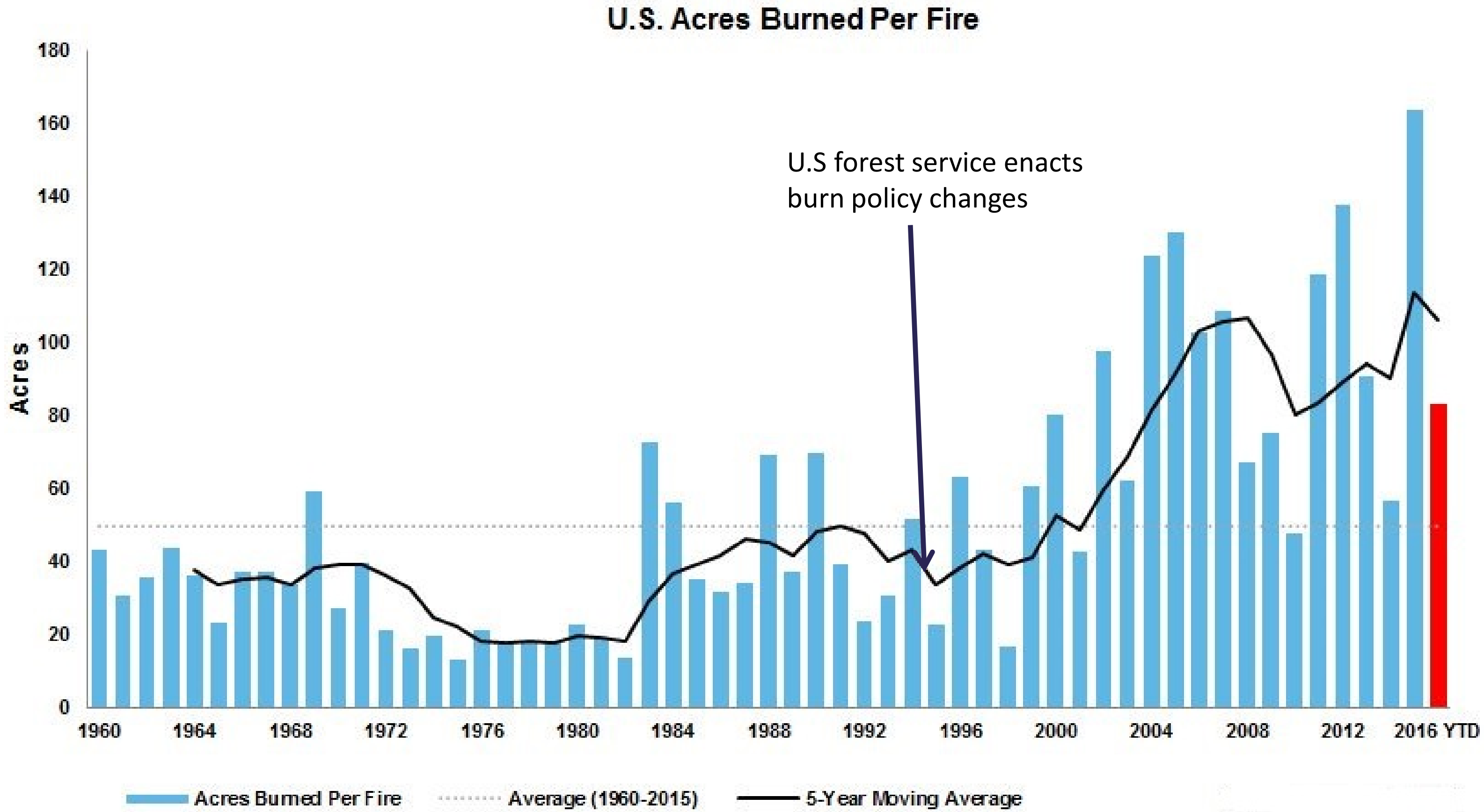
Severe Weather losses are often a matter of luck . There were many close calls in 2016 like this major tornado that occurred just 3 miles south of Dodge City, Kansas. Hail Storm in Texas made direct hit on major urban areas leading to high insured losses.

Weather / Climate Data

Wildfire

U.S. Wildfire Burn Frequency

The National Interagency Fire Center (NIFC) and National Interagency Coordination Center maintained wildfire records from 1960 to 1982 before the NIFC began their current method of data compilation from states and other agencies in 1983.



Reasons?

Larger Fires - Changing firefighting tactics & landuse

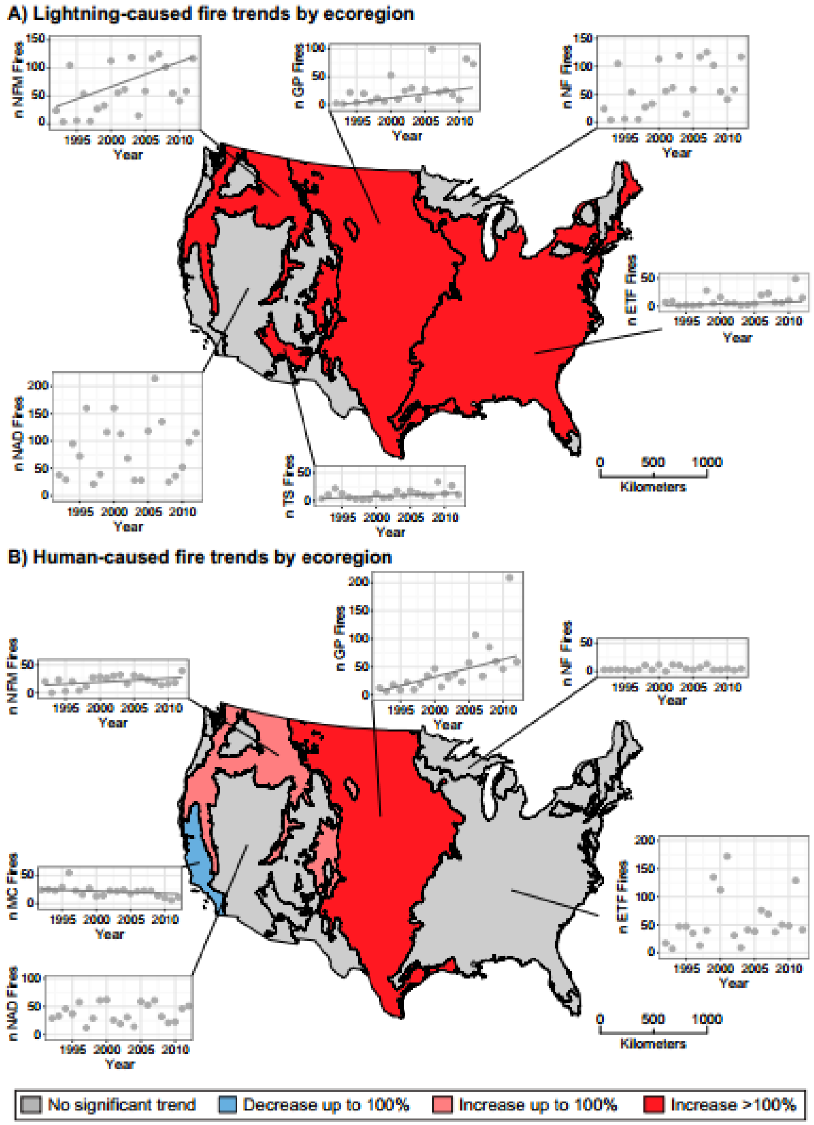
Extended fire season, more heat and fuel and shifts between wet and dry periods

Source: NIFC

bms.

Human Caused Fires

- 2016 was a large loss year for wildfires.
- Both the Fort McMurray and Gatlinburg Fires were human caused totaling 3.6B in insured losses.
-
- Humans cause 84% of wildfires in forests.
- Lightning accounts for rest mainly in mountainous, sparsely pop areas.
- Observations show climate change has extended fire season across US by 0-2 weeks, while human fire-starters increased length by 3-months!
- Humans extend fire season into colder parts of the season. Lighting fire season has changed very little and are still common in the warm season as expected

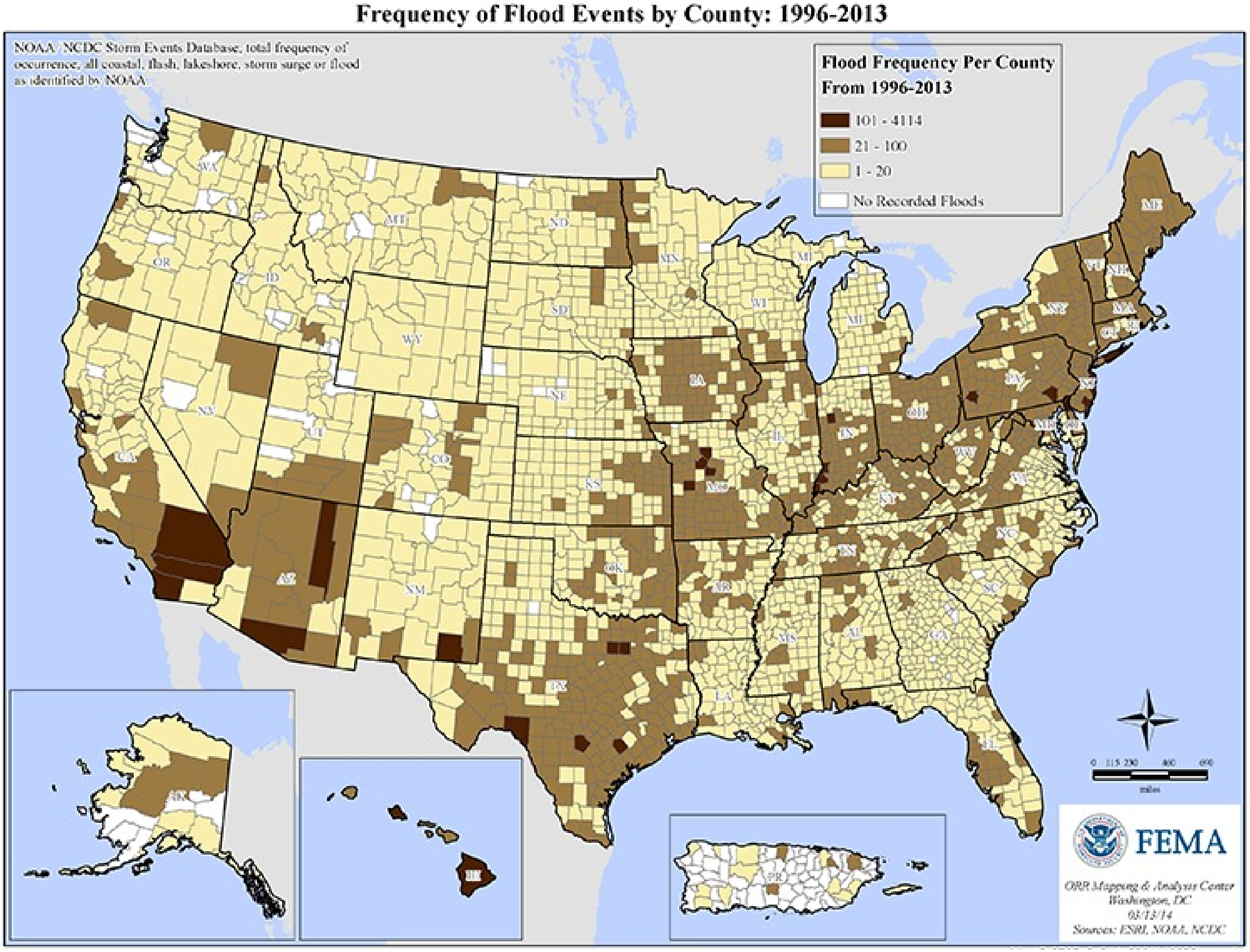


Source: Human-started wildfires expand the fire niche across the United States. http://www.pnas.org/content/early/2017/02/21/1617394114

Weather / Climate Data

Rainfall / Flood

Flood Events in 1996-2013



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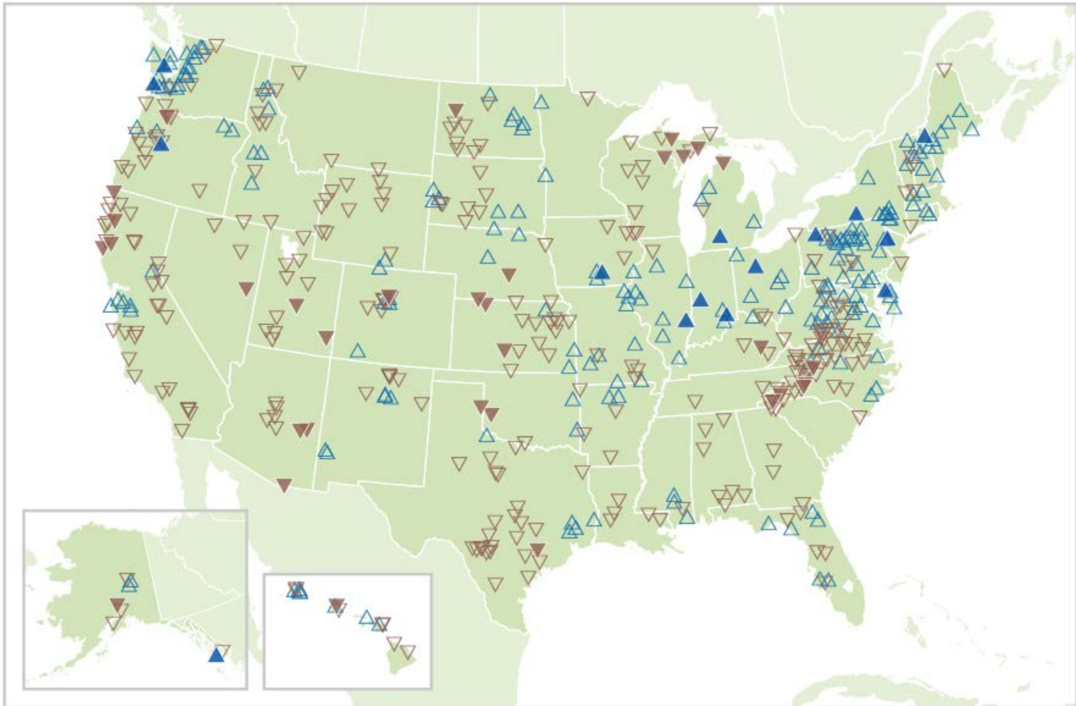
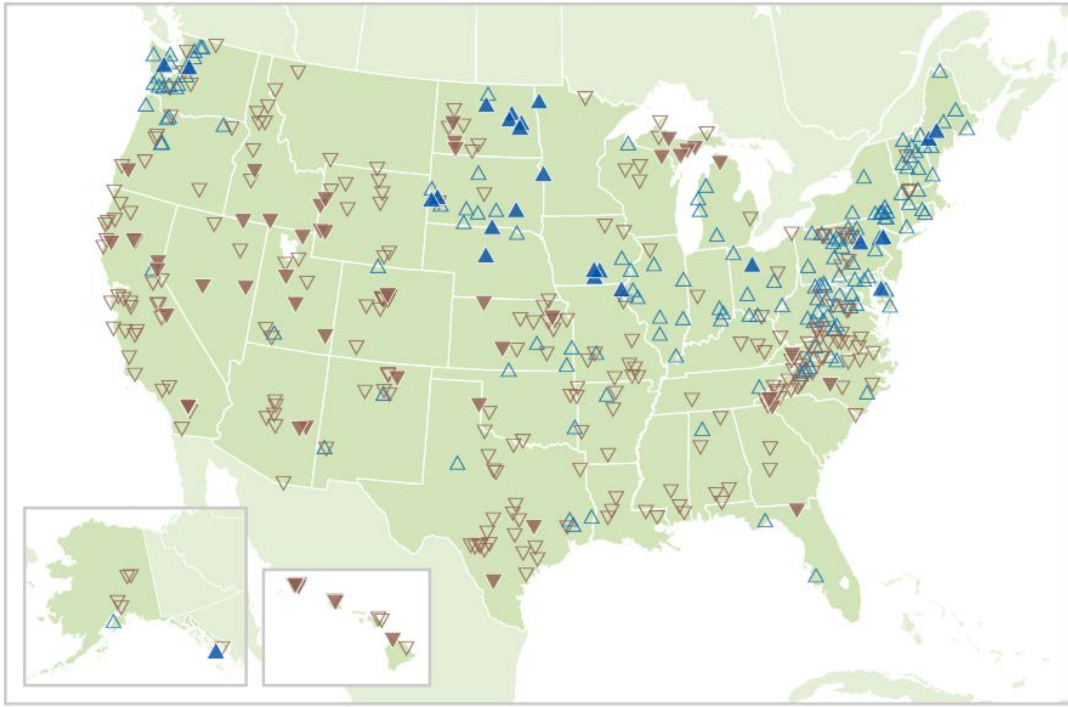
River Flood Frequency & Magnitude

Change in the Magnitude of River Flooding in the United States, 1965–2015



Change in the Frequency of River Flooding in the United States, 1965–2015



▼ **Significant decrease**

▽ **Insignificant decrease**

△ **Insignificant increase**

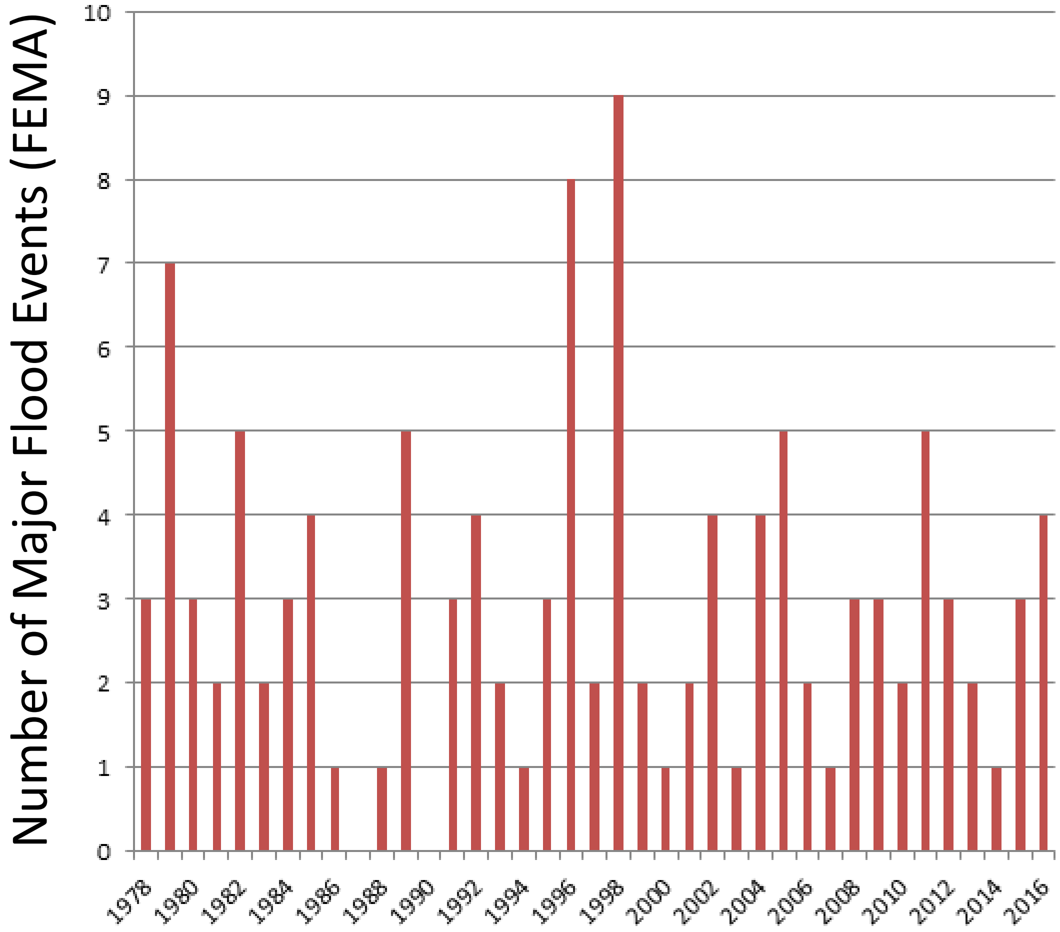
▲ **Significant increase**

Data source: Slater, L., and G. Villarini. 2016 update and expansion to data originally published in: Mallakpour, I., G. Villarini. 2015. The changing nature of flooding across the central United States. Nature Climate Change 5:250–254.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Flood Losses Continue

- Major U.S flood events continue be a major loss focus.
- 2016 had 4 major flooding event.
  - Late Winter Severe Storms – March
  - Torrential Rains – Texas - April
  - Louisiana Flooding - Aug
  - Hurricane Matthew – Oct (Pending Official Data)
- However, no real trend in flood event since 1978



*Major Flood Event = Flooding events with 1,500 FEMA claims.

The 1-in-1000 year rainfall / flood event

10 That is how many of these rainfall events have occurred across the U.S. since 2010.

2016 April - Houston, TX

June - Greenbrier, Kanawha and Nicholas Counties, WV

July - Ellicott City, MD

August – Louisiana Floods

A 1-in-1,000-year rain event is a statistical way of expressing the probability of such a massive rainfall occurring in any given year in a given location. Less than 0.1 percent chance of happening in any given year.

No New U.S. Extreme Rainfall Records

U.S. Record Point Rainfalls

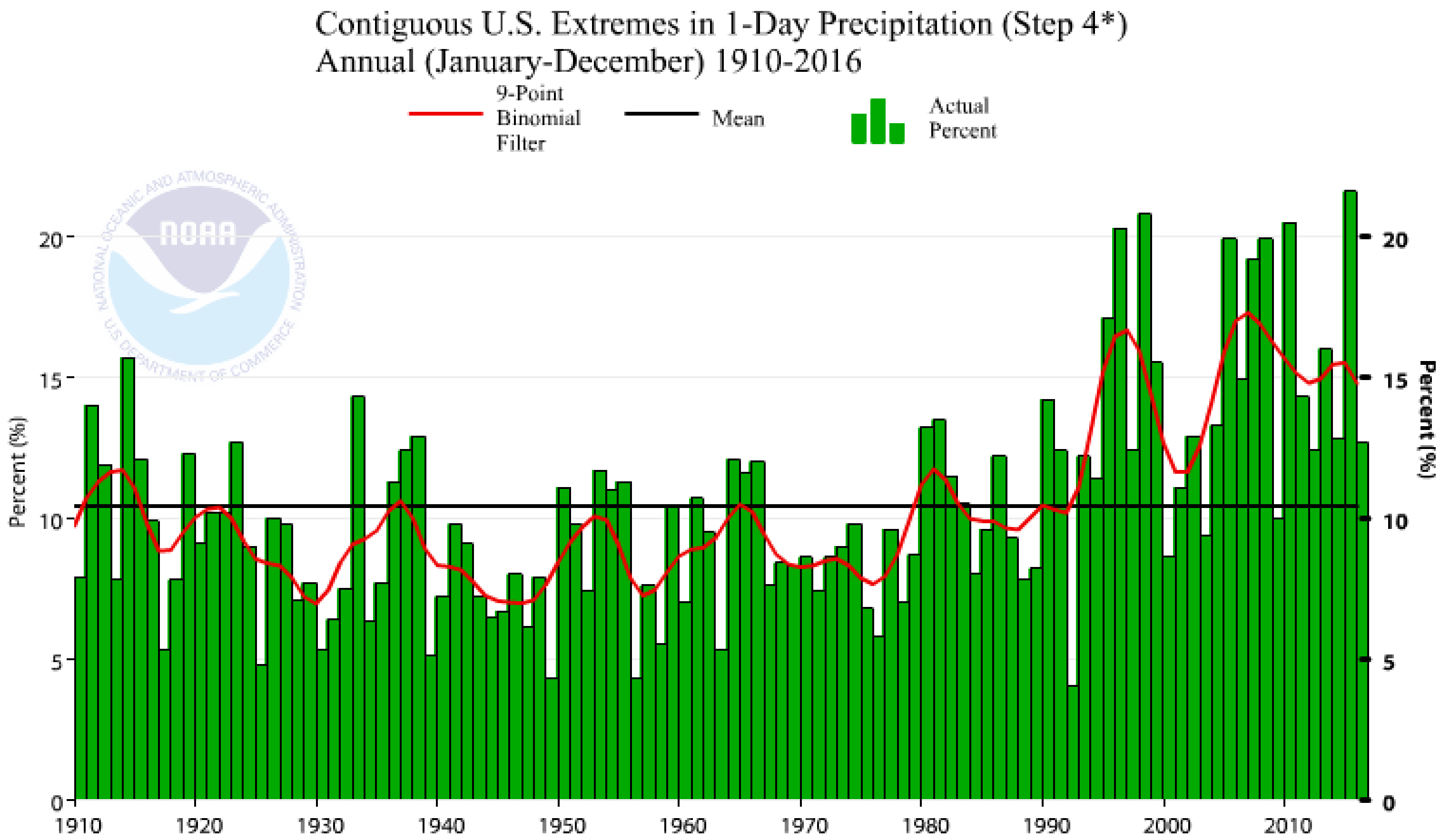
Time	Rainfall	Location	Date
1 minute	1.23″	Unionville, MD	7/4/1956
5 minutes	2.03″	Alamogordo Creek, NM	6/5/1960
12 minutes	2.30″	Embarrass, WI	5/28/1881
15 minutes	3.95″	Galveston, TX	6/4/1871
30 minutes	7.00″	Cambridge, OH	7/16/1914
40 minutes	9.25″	Guinea, VA	8/24/1906
42 minutes	12.00″	Holt, MO	6/22/1947*
1 hour	13.80″	Central WV	5/4-5/1943
1 hour 30 minutes	14.60″	Central WV	5/4-5/1943
2 hours	15.00″	Woodward Ranch, (D'Hanis) TX	5/31/1935
2 hours 30 minutes	19.00″	Rockport, WV	7/18/1889
2 hours 45 minutes	22.00″	Woodward Ranch, (D'Hanis) TX	5/31/1935*
3 hours	28.50″est.	Smethport, PA	7/18/42*
4 hours 30 minutes	30.70″	Smethport, PA	7/18/42*
12 hours	34.30″	Smethport, PA	7/17-18/1942
18 hours	36.40″	Thrall, TX	9/9/1921
24 hours	43.00″	Alvin, TX	7/25-26/1979
4 days	62.00″	Kukaiau, Hamakua, HI	2/27-3/2/1902
8 days	82.00″	Kukaiau, Hamakua, HI	2/27-3/6/1902
1 month	148.83″	Mt. Waialeale, Kauai, HI	3/1982
1 month (mainland)	71.54″	Helen Mine, CA	1/1909
1 year	704.83″	Kukui, Kauai, HI	1982
1 year	332.29″	MacLeeod Harbor, AK	1976
1 year (mainland)	204.12″	Laurel Mountain, OR	1996

*constitutes a world record

NO U.S. location has seen a record rainfall in terms of the amount of rain in a given amount of time. This suggests the rain rate has not increased.

Source: Wunderground.com Chris Burt

Extreme Precipitation



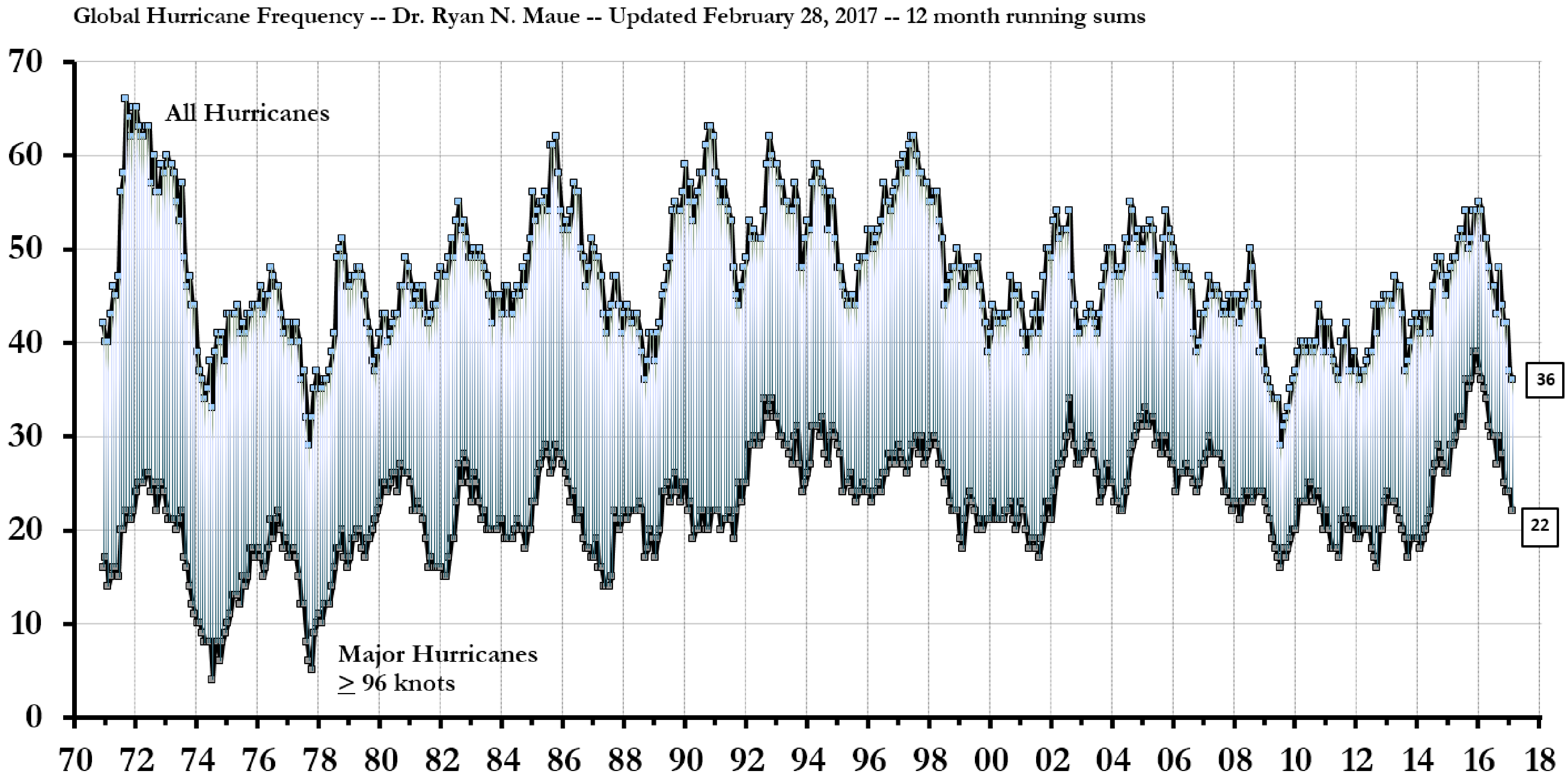
U.S. Climate Extreme Index quantifies the observed changes in one-day precipitation extremes across the U.S.

Since 1990, there has been an increase in the area of the U.S. that has seen one-day extreme rainfall.

Weather / Climate Data

Named Storm / Hurricane

Global Hurricane Frequency



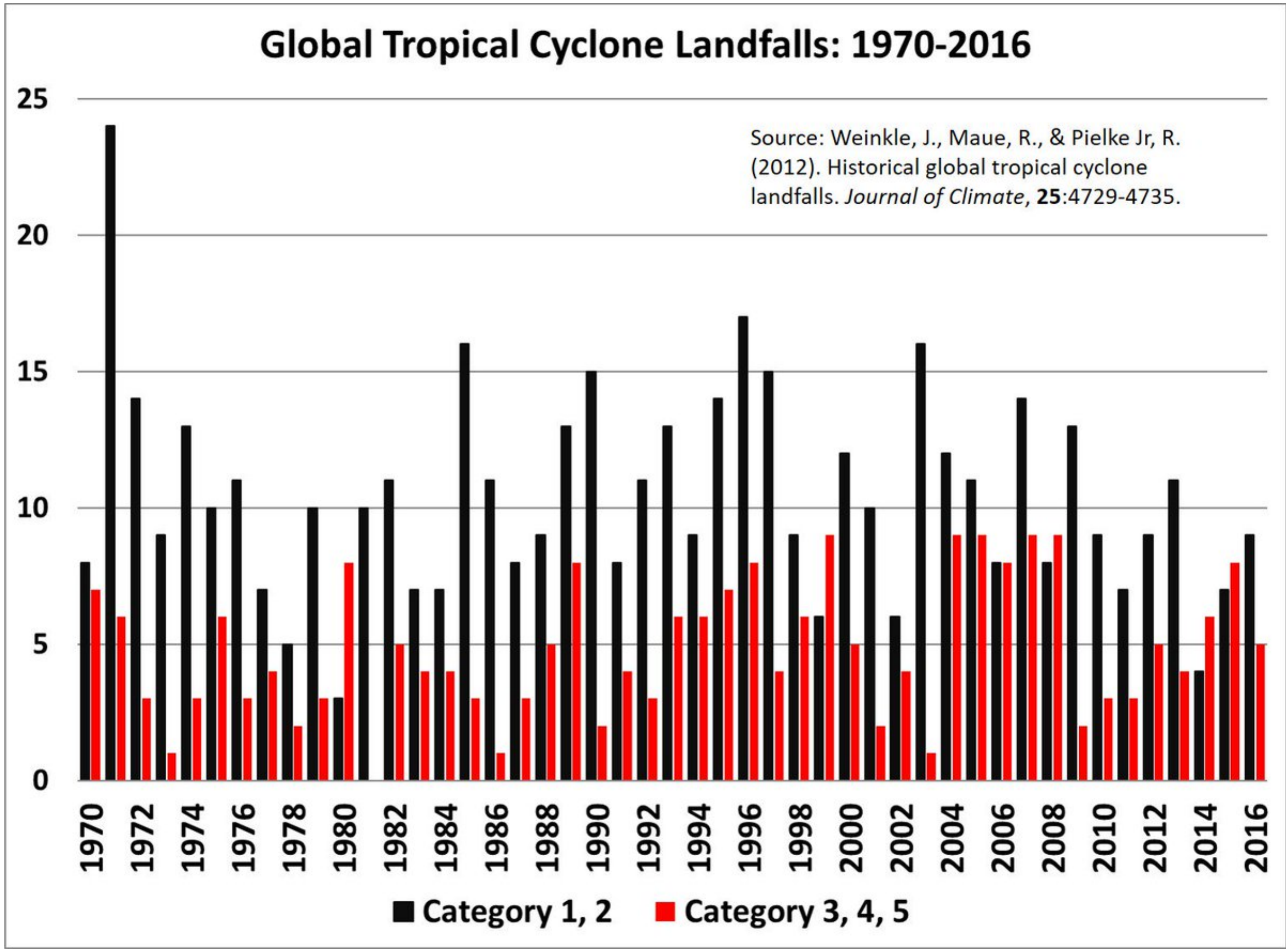
Is there a trend? 12-month running sums. The top time series is the number of global tropical cyclones that reached at least hurricane-force. The bottom time series is the number of global tropical cyclones that reached major hurricane strength.

Global Tropical Cyclone Landfalls

- How many tropical cyclones (of hurricane+ strength) have made landfall globally & how has that varied/changed?
- No simple trend, no evidence of increasing landfalls.
- 2009-2016 somewhat less than previous years
- 2016 had 6 total landfalls
  5 Category 3, 4, 5
  9 Category 1, 2

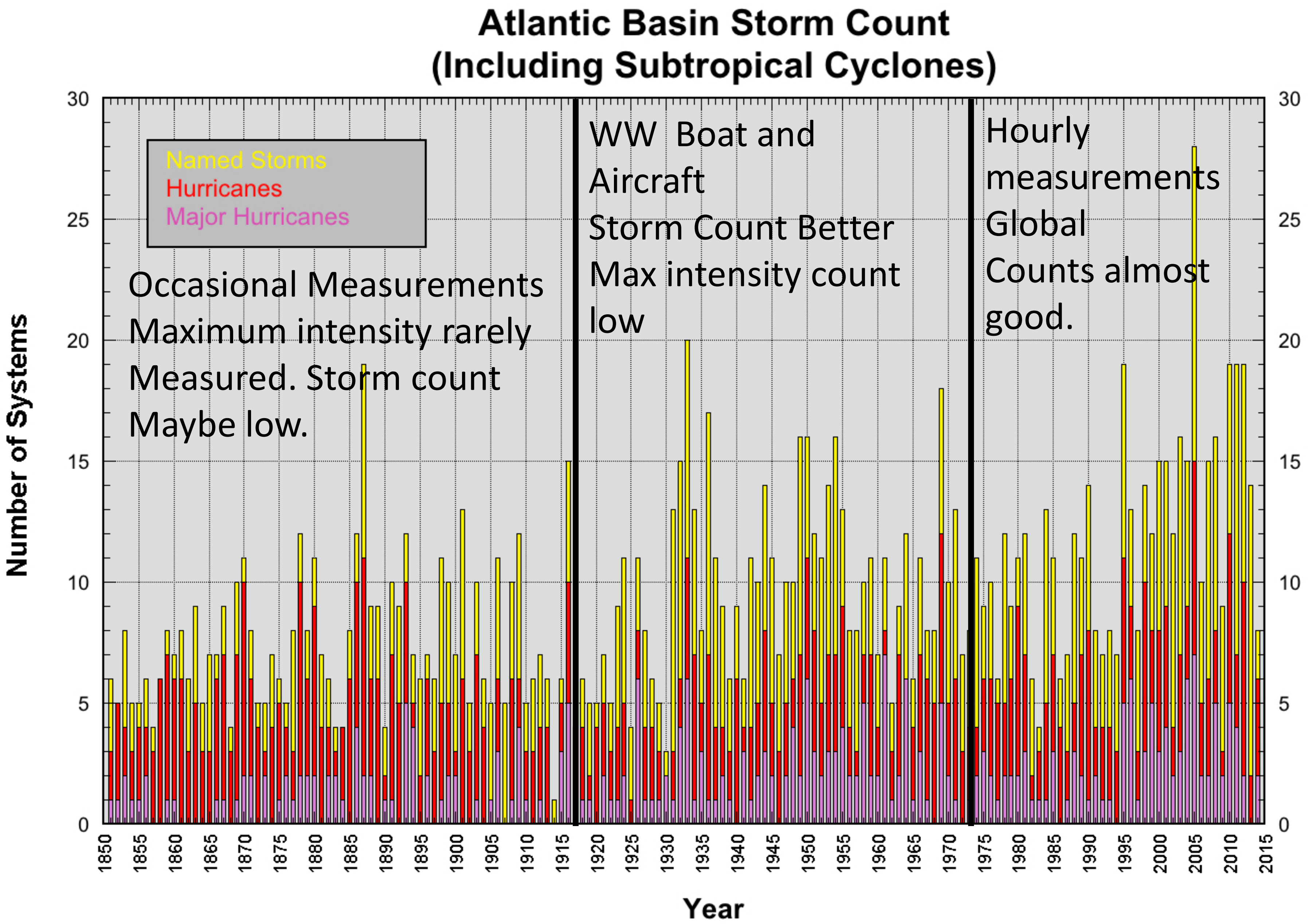
The annual averages between 1970-2015 are:

- 15.3 total
- 10.5 Cat 1 & 2
- 4.7 Cat 3+



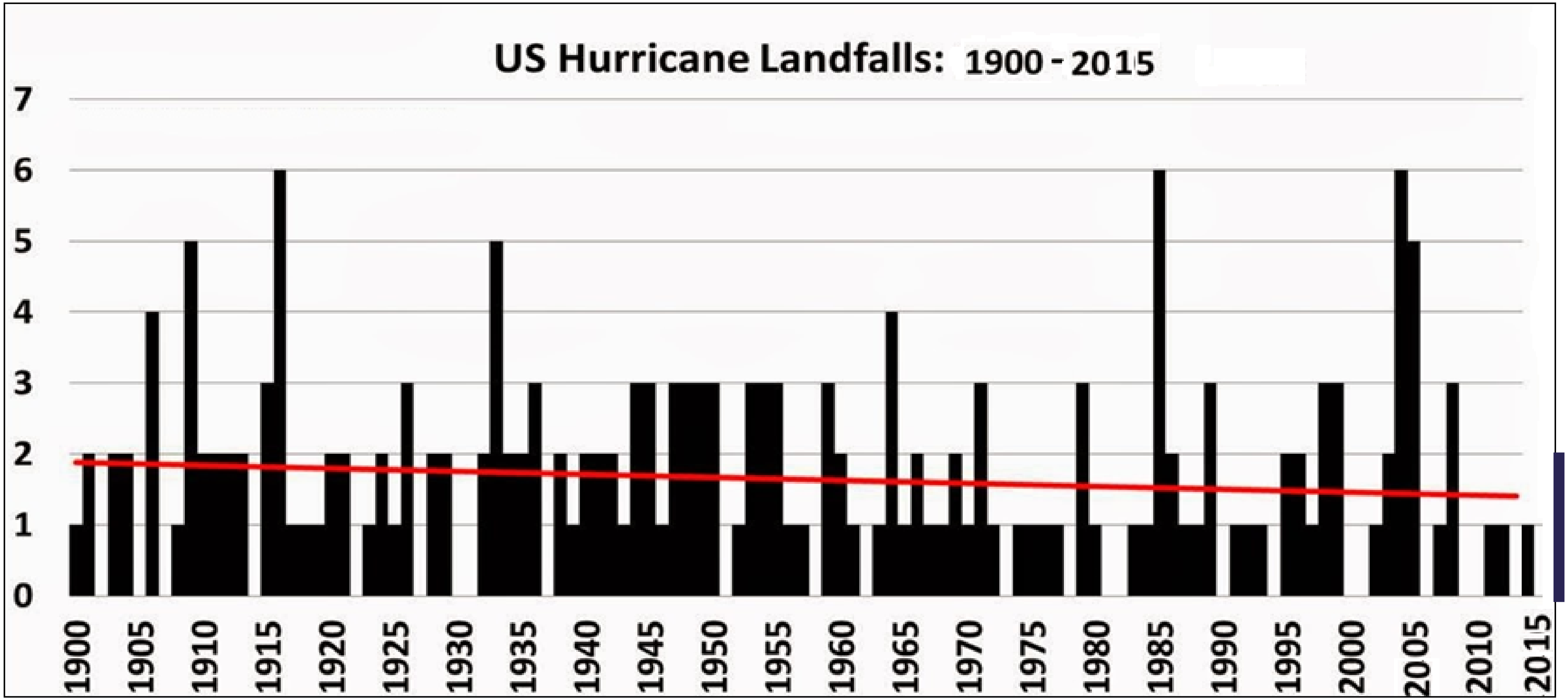
Source Weinkle et al 2013 and Ryan Maue Weatherbell.com

Atlantic Named Storm Activity



Source: NOAA NHC

U.S. Landfalls



The U.S. coast is in an unprecedented hurricane drought! This is Terrifying!
Population and wealth along parts of the U.S. coast have exploded since the last stormy period.

Source: NOAA NHC and Roger Pielke Jr.

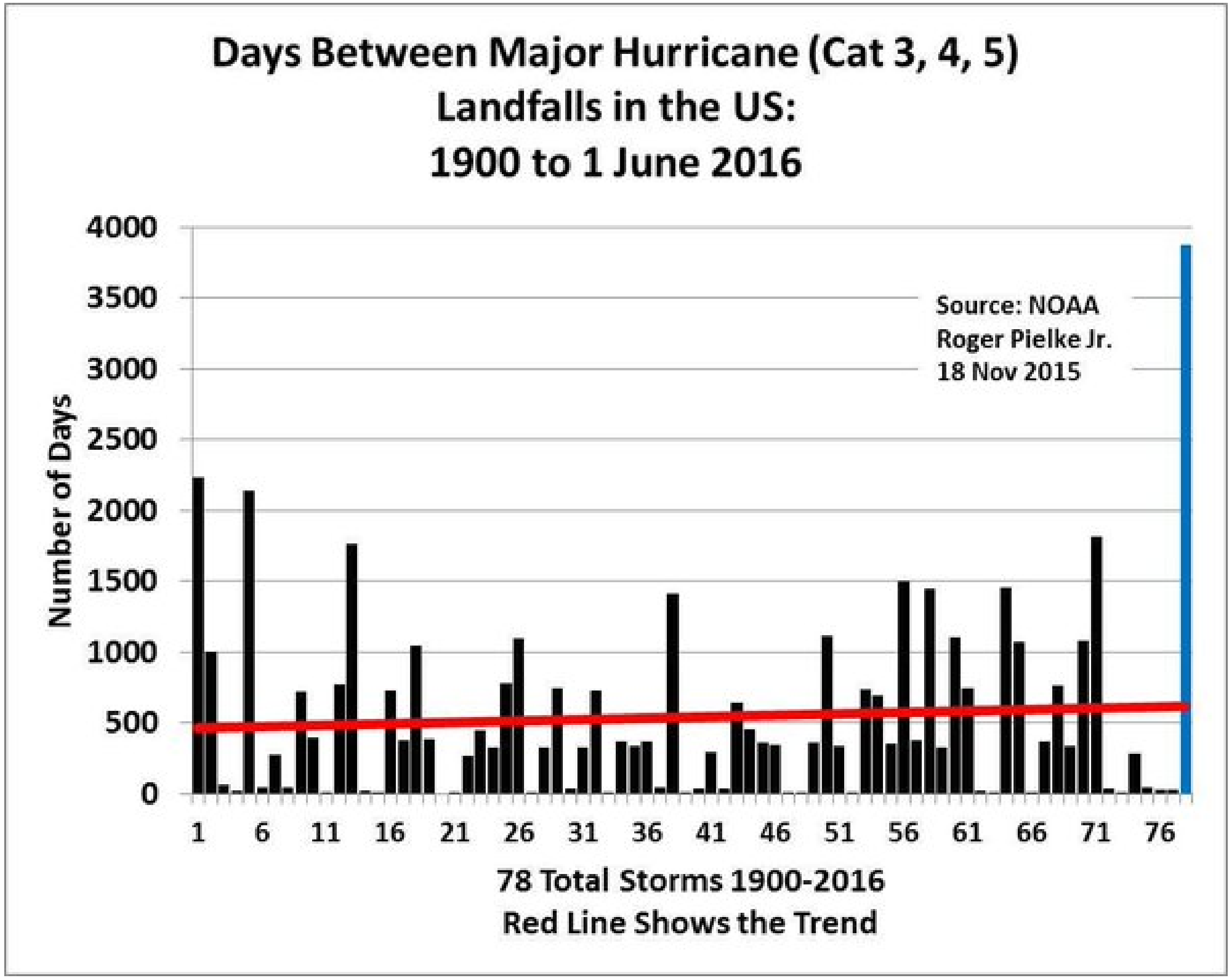
bms.

Unprecedented Drought in U.S. Major Hurricane Landfalls

In the 114 years of landfall records, never has there been an extended period lasting this long without a major hurricane landfall.

Twenty-seven major hurricanes have occurred in the Atlantic Ocean basin since the last one, Wilma, struck Florida in 2005

The odds of this are 1 in 2,300, according to Phil Klotzbach at CSU

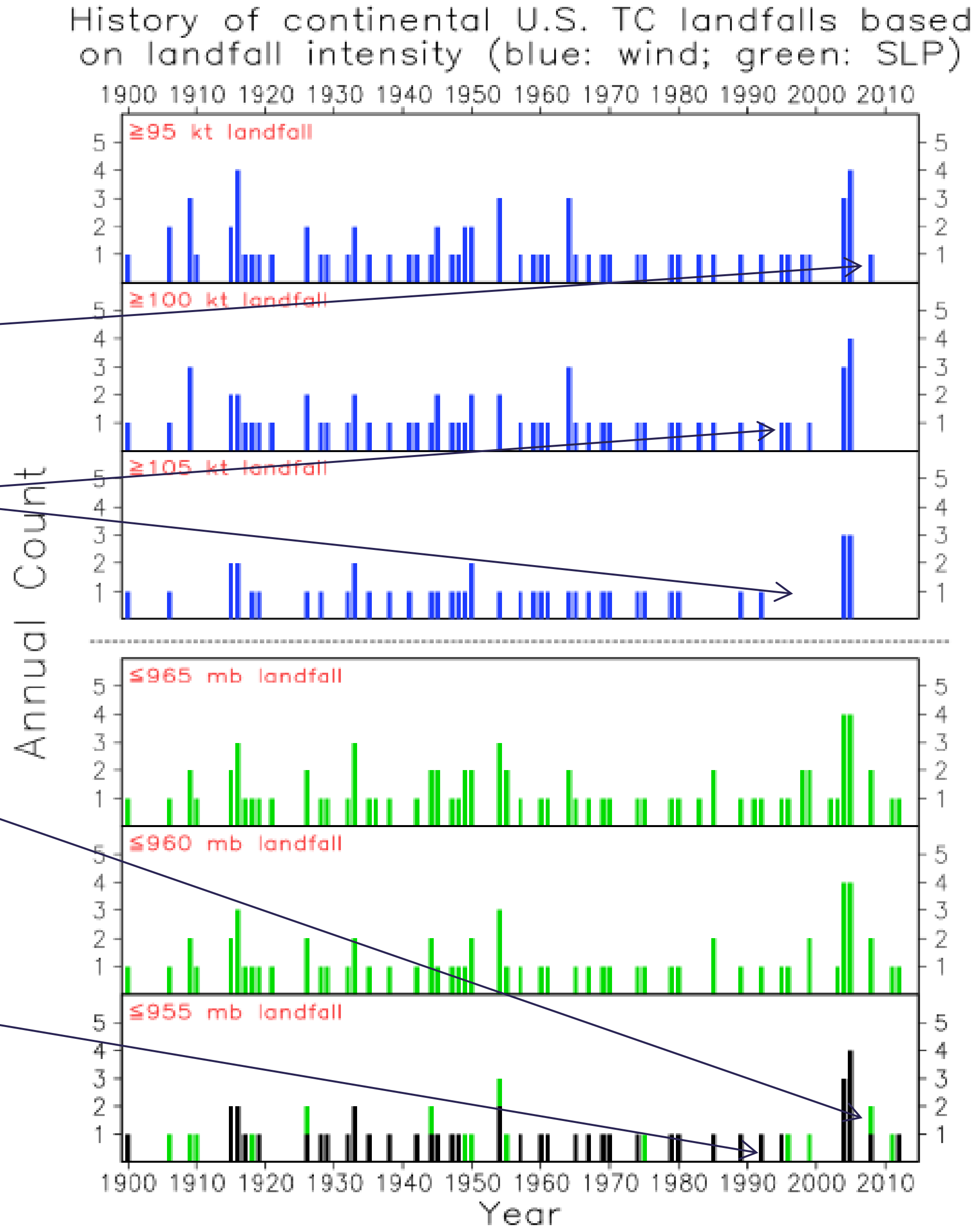


Source: NOAA NHC and Roger Pielke Jr.

Definition of landfall drought

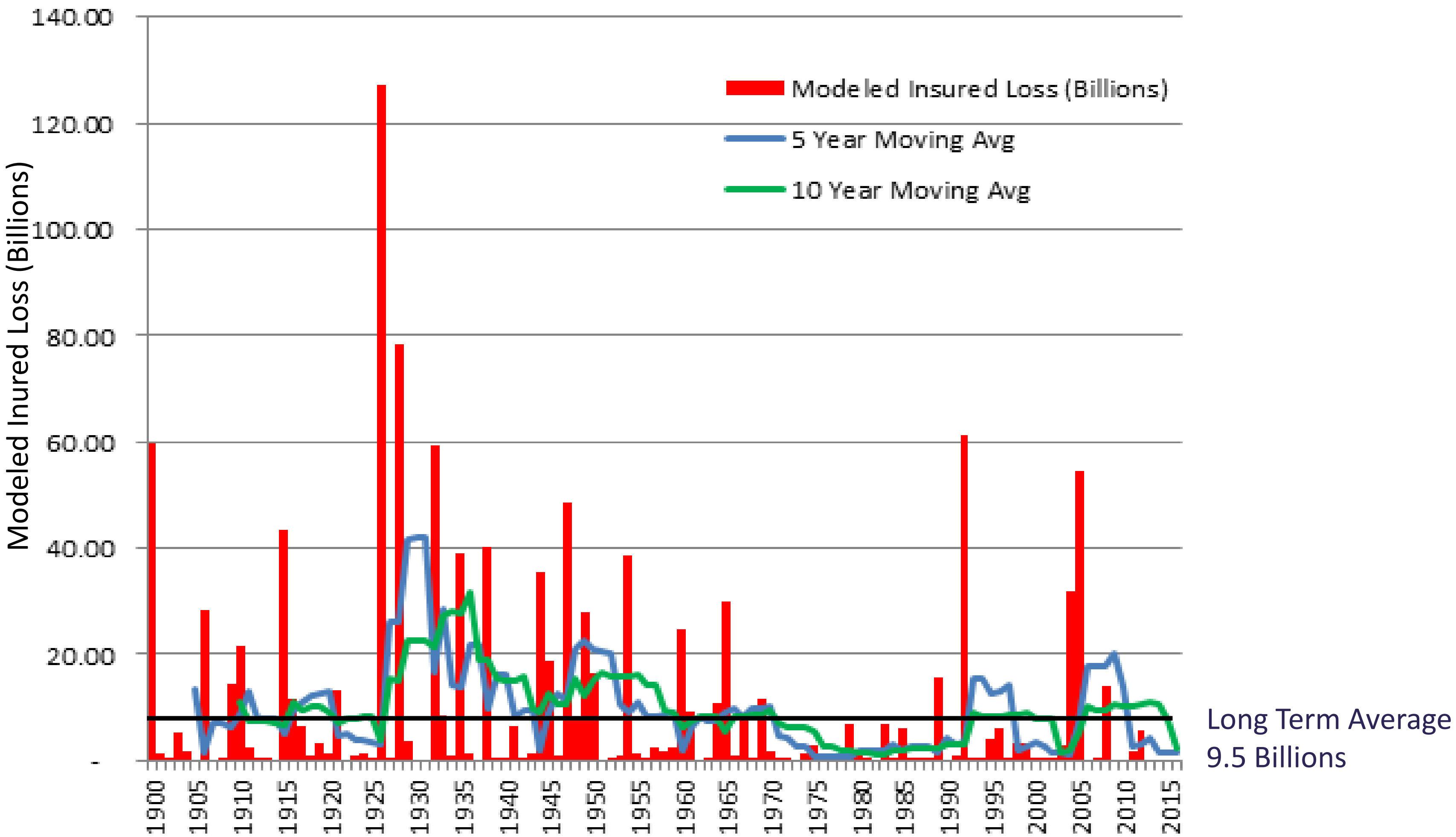
Although 11 years have passed since the last U.S. major hurricane landfall, the existence and relative significance of the current drought are largely due to the chosen metric and luck.

- Lower the threshold to 95 kt and the drought is reduced significantly due to Ike (2008)
- Increase the threshold to 105kt, and a record drought occurred from 1993-2003 – but no one apparently noticed because 105kt isn't noteworthy—and three 100kt landfalls occurred during this "drought."
- When minimum SLP thresholds from 965 (green) to 950mb (black) are used, there is no drought of any kind – due in part to Sandy and Irene.
- Note also that the 1993-2003 105kt drought period also disappears when pressure is used



Source: http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-15-00185.1

Named Storm Insured Loss Trend



- Using model losses removes the uncertainty of adjusting historical losses to account for socioeconomic factors.
- Insured losses are at multi-decadal lows with much higher insured loss occurring between 1930–1960.

Future Hurricane Landfalls

Hurricane Rate Activity – In the news

correspondence

Active Atlantic hurricane era at its end?

ARTEMIS
www.artemis.bm

Will an inactive phase change ILS investor appetite for hurricane risk?

TRADING Risk

ILS market cautious over changing hurricane assumptions

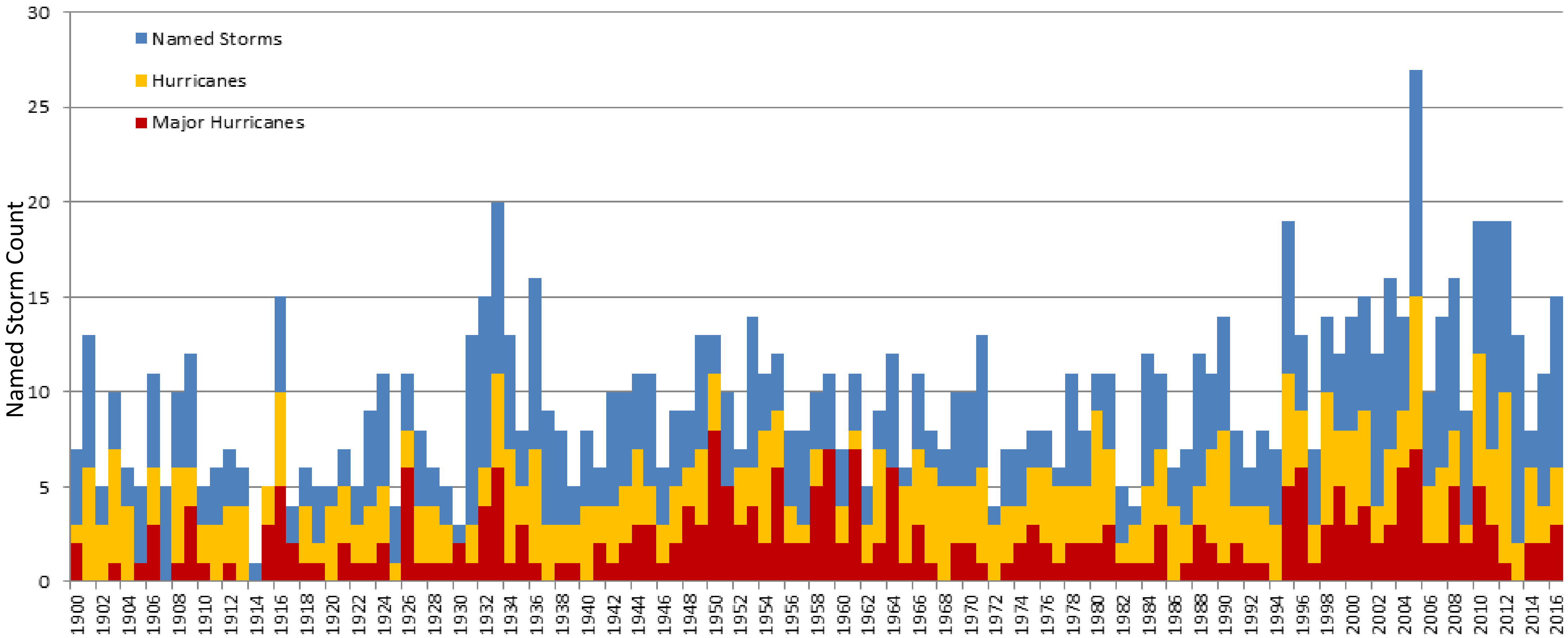
RMS

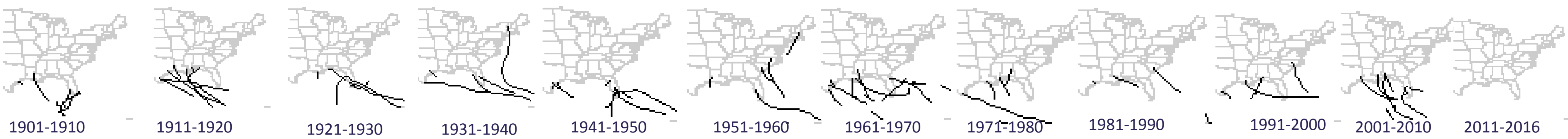
Are We Any Closer to Determining What's Going on in the Atlantic?

HORIZONS

North Atlantic Hurricane Activity: Multi-Decadal Variability and Medium-Term Rates

Atlantic Named Storm Activity

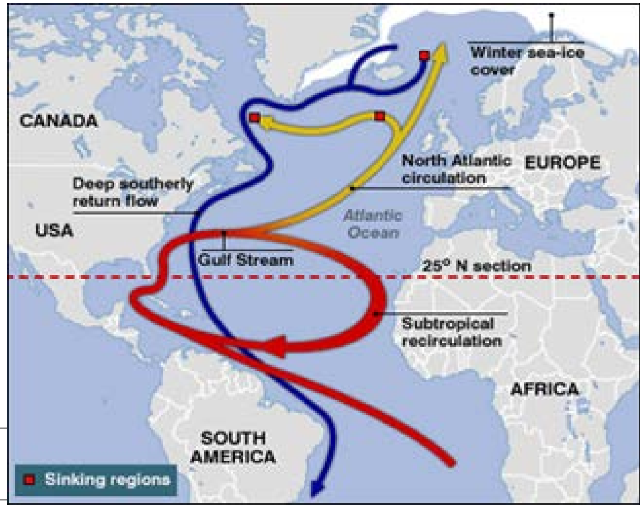


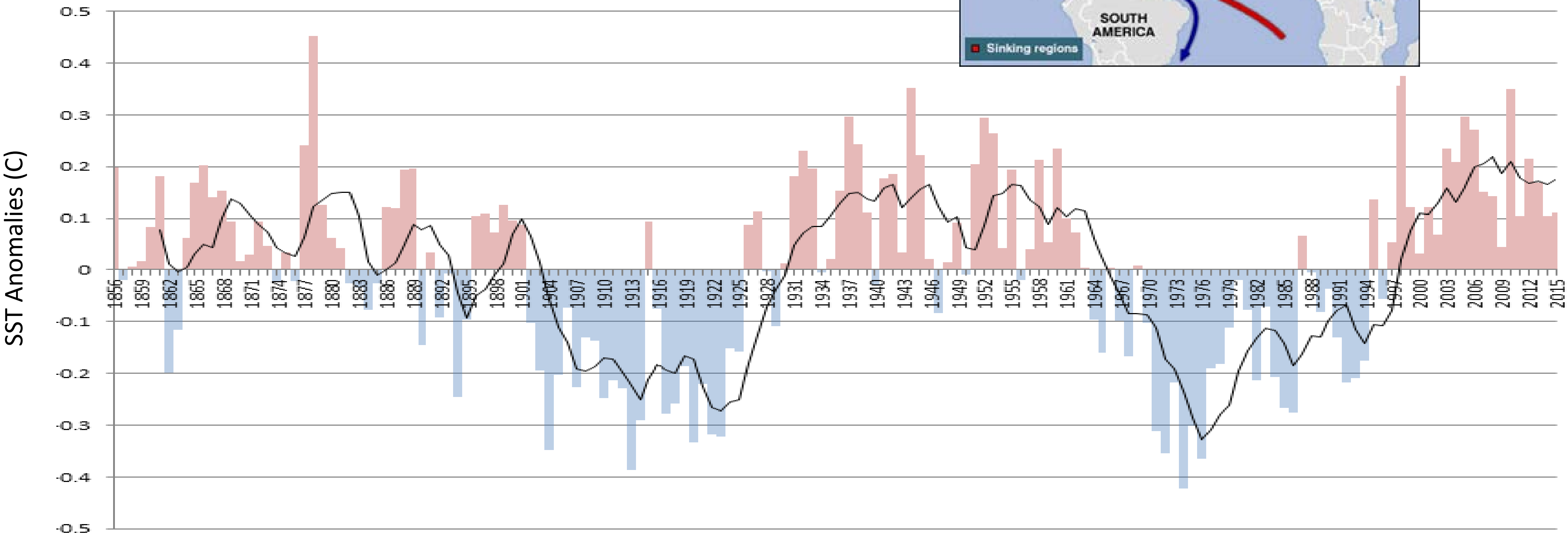


Major hurricane landfalls by decade

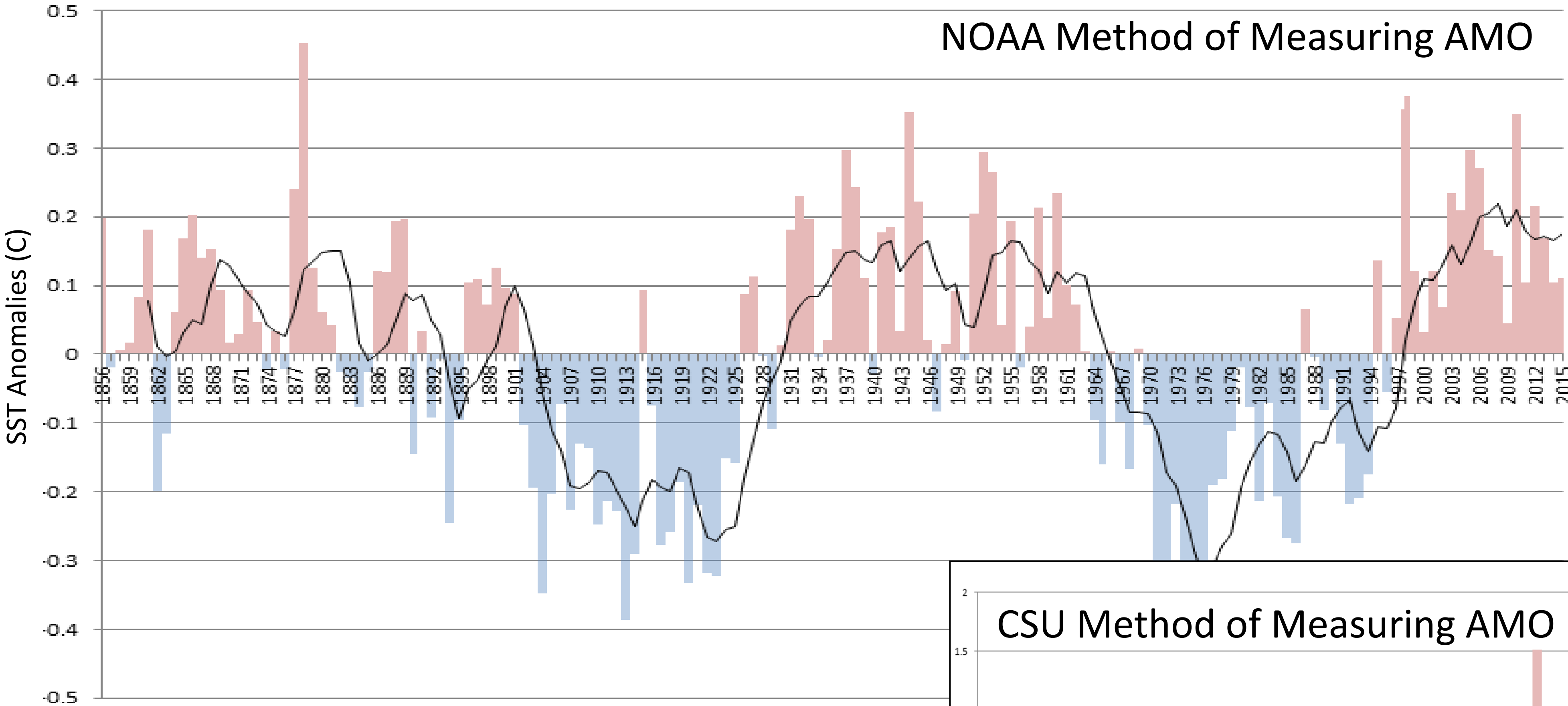
Atlantic Multi-decadal Oscillation (AMO)

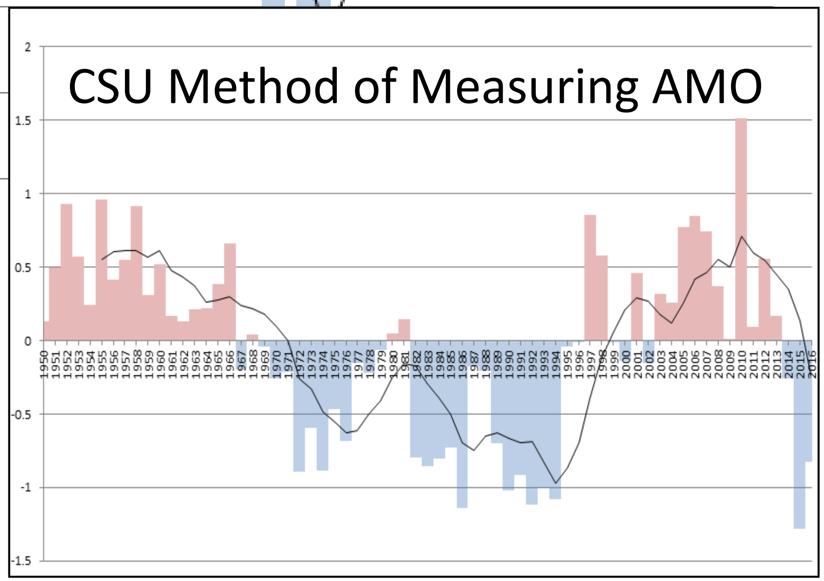
AMO is likely a variability that is associated with small changes in the North Atlantic branch of the thermohaline circulation, but limited data hinders our ability to understand what exactly causes the AMO.





AMO Slowly Fading?

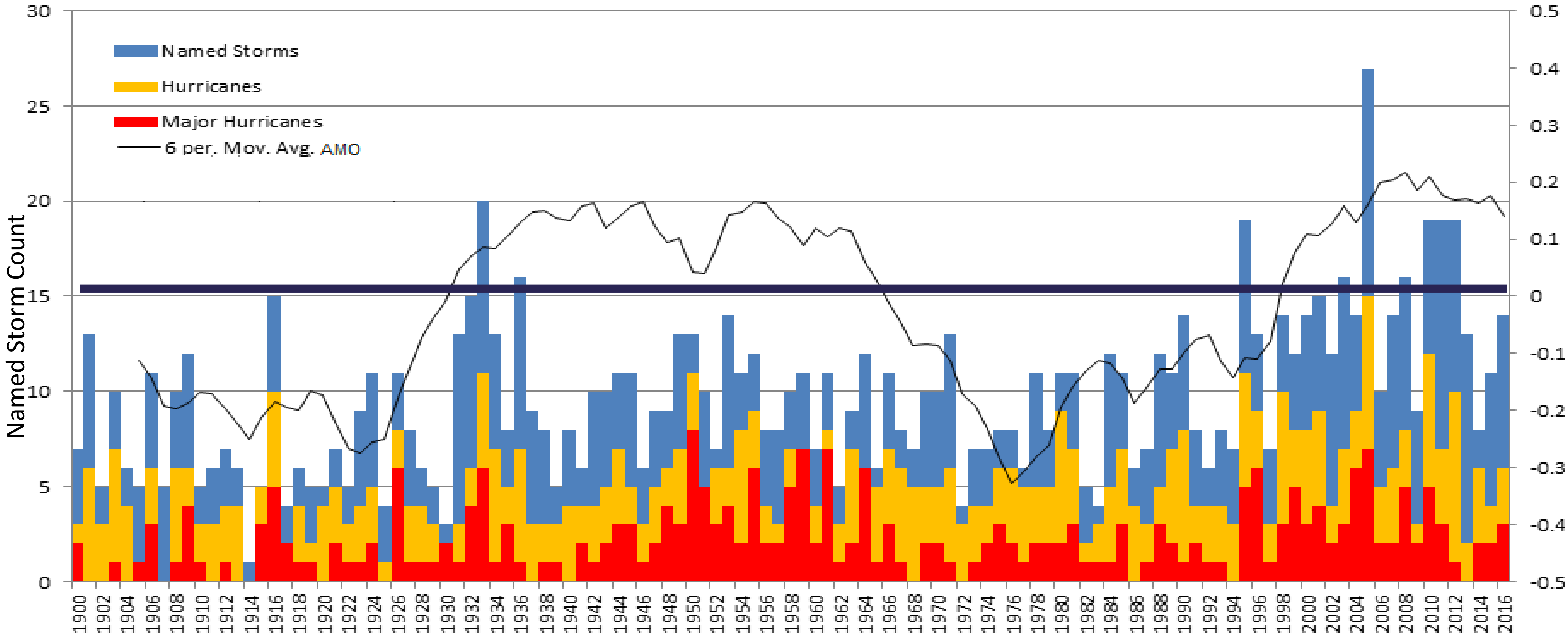


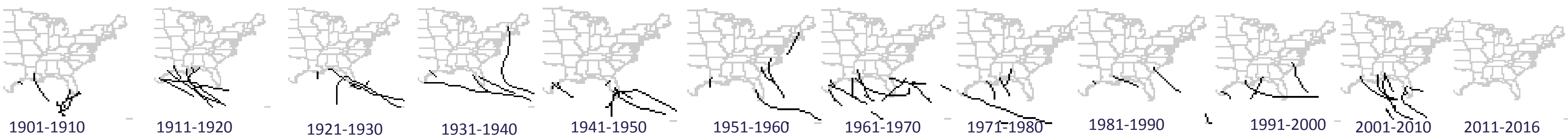


There are different ways to measure the AMO, and some of those methods suggest the warm phase of the AMO ended in 2012. Studies by Phil Klotzbach (Colorado State) suggest the AMO has switched to cold phase.

Source: Klotzbach, P., Gray, W., and Fogarty, C. (2015). Active Atlantic hurricane era at its end? Nature Geosci., 8, 737-738.

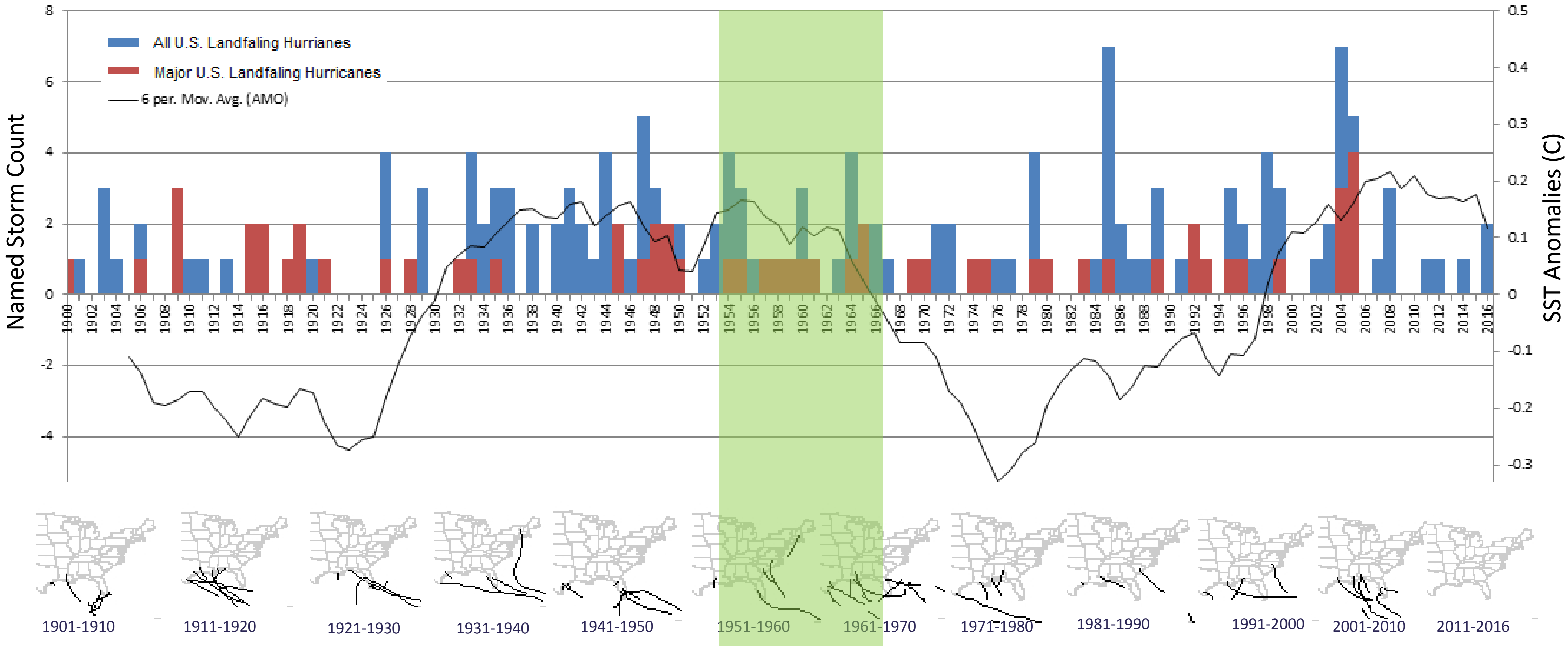
Atlantic Named Storm Activity





There is a good correlation between the warm and cold phases of the AMO and overall named storm activity in the Atlantic basin.

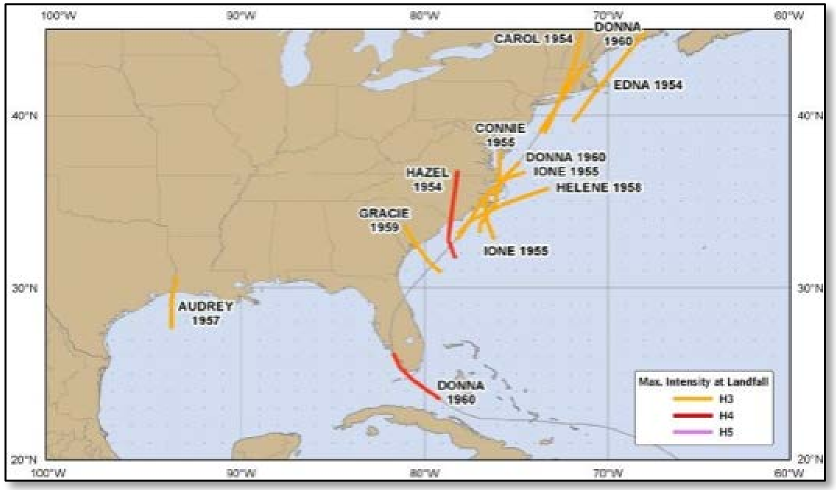
Major Hurricane Connection



- The insurance industry needs to start understanding what happens at the tail end of the AMO.
- The end of AMO is approaching: by 2020, we should be close to the end of the current warm AMO.

Historical Event Data Rate Adjustment

- Weather memory is generational
- Tail end of last warm AMO (1954-61) has major East Coast U.S. landfall activity
- Can this observation be used to create a new "near term" event loss rate within the models to increase frequencies along the northeast U.S.?



Map of Landfall Activity 1954-1961

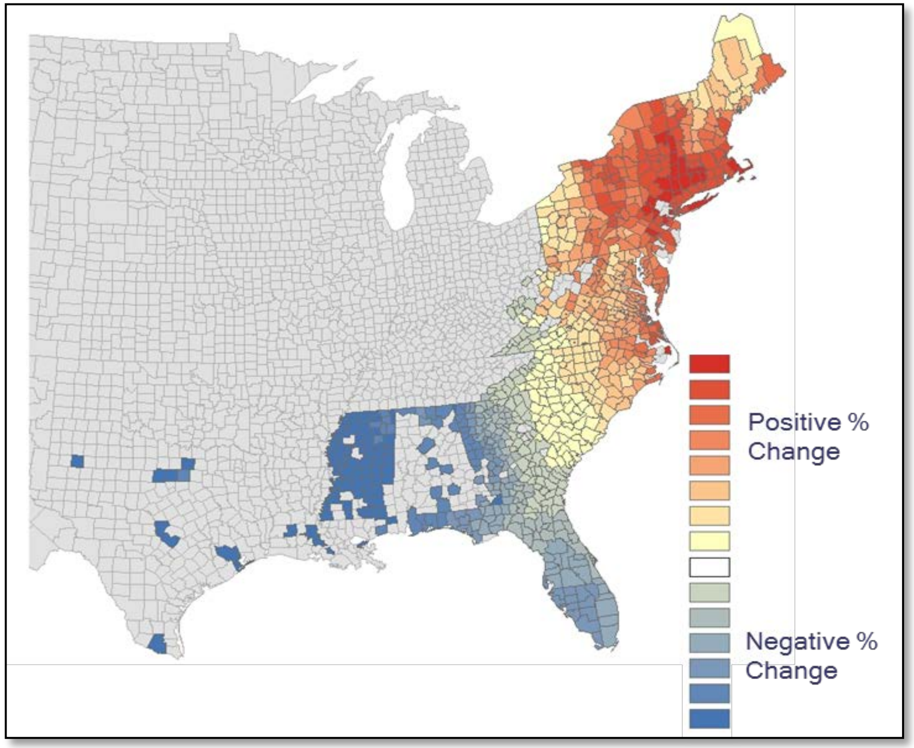
Last AMO shift from warm to cold phase

Recent Named Storm Activity

2010 Hurricane Earl Just Missed East Coast
2011 Hurricane Irene Hits East Coast
2012 Hurricane Sandy Hits East Coast
2013 – No Activity
2014 Hurricane Arthur East Coast – Two Bermuda Storms
2015 Hurricane Joaquin & Kate – East Coast Impacts
2016 Hurricane Matthew – East Coast

Event Rate Percent Change by County

Example of new "near term" rates given research

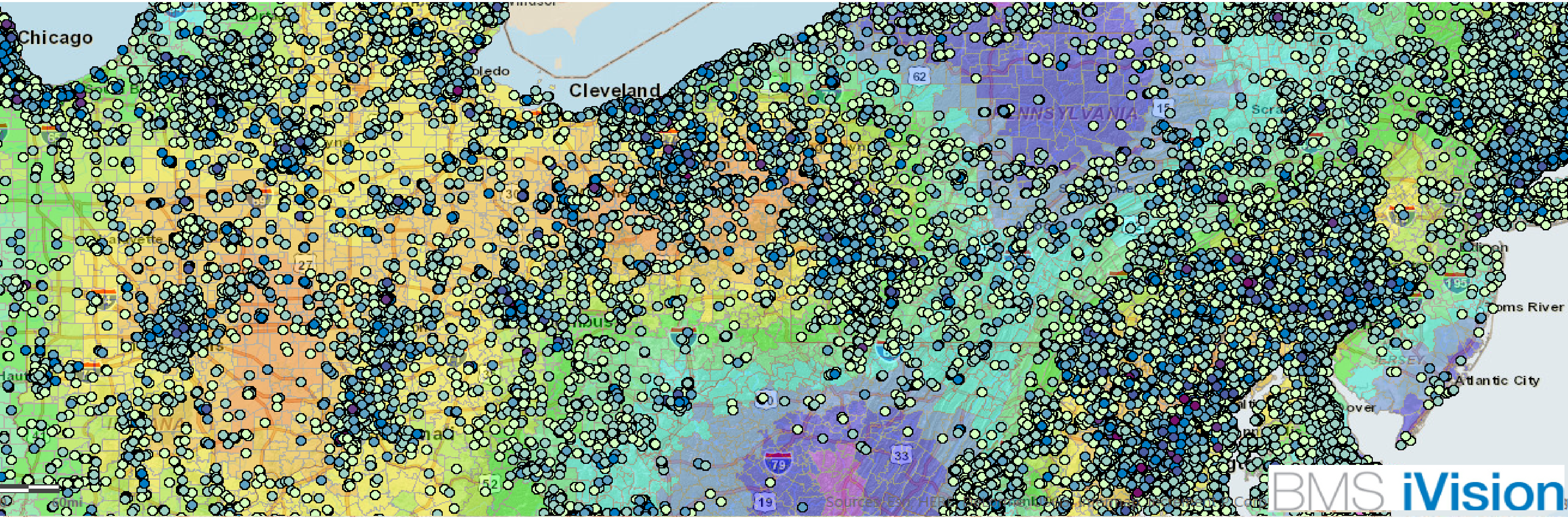


What can insurance companies do?

Sub-title (24pt Calibri)

Understanding where events can happen

- It's almost impossible to predict exactly when and where the next event is going to happen.
- If you can predict the location with the highest risk for an event, isn't that just as much or more important for setting a natural catastrophe plan/strategy?



BMS Severe Storm Relativity allows clients to understand severe weather risk across the U.S.

Don‘t overreact

- Fall-out from major extreme weather events often grab the headlines, but minor weather variances can still significantly impact the insurance industry.

- Don’t be mislead by one extreme weather event.
    - One event does not mean there is a change in the frequency or severity of that event.
    - To understand weather trends years of data are needed which we just don’t have.

- Insurance companies cannot control the weather but they can mitigate its financial impact

Take ownership and explore the link between weather and your business:

1. Identify direct causes of loss
2. Gather historical weather data at relevant locations
3. Use catastrophe modeling output wisely
4. Build a tailored weather index to match sensitivity in loss data
5. Structure alternative weather cover to smooth downside risk to these sensitivities

Thank You

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Blog - http://media.bmsgroup.com/?tag=andrew-j-siffert

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