

A Reality Check: Climate Change and Weather

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What We Know

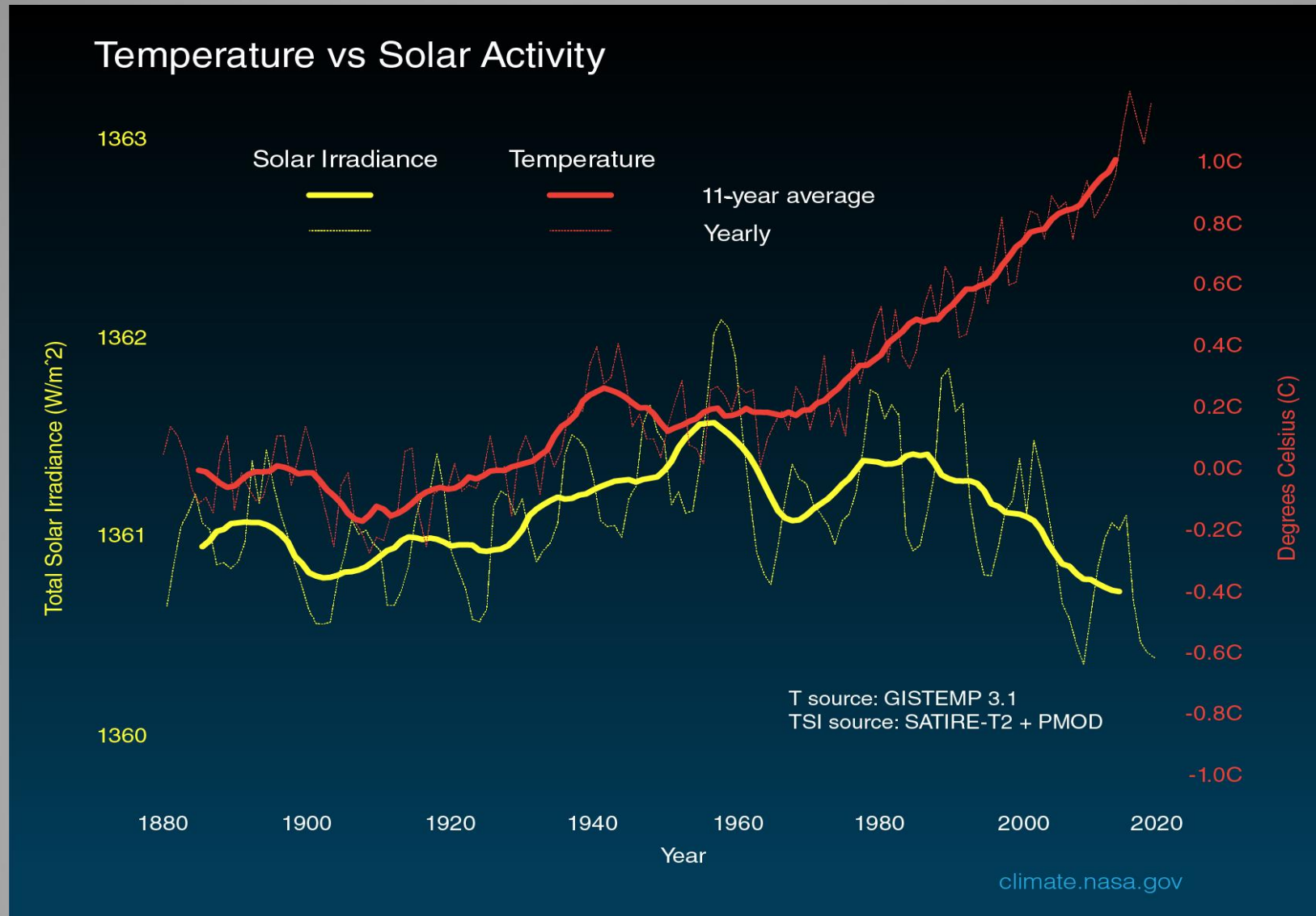
- Anthropogenic Global Warming (AGW) has been thoroughly scientifically documented.
- We begin to see the effects of AGW around 1950.
- Weather is events. Climate is trends.
- The relationship between AGW and weather is not well defined.

Causes of Climate Change

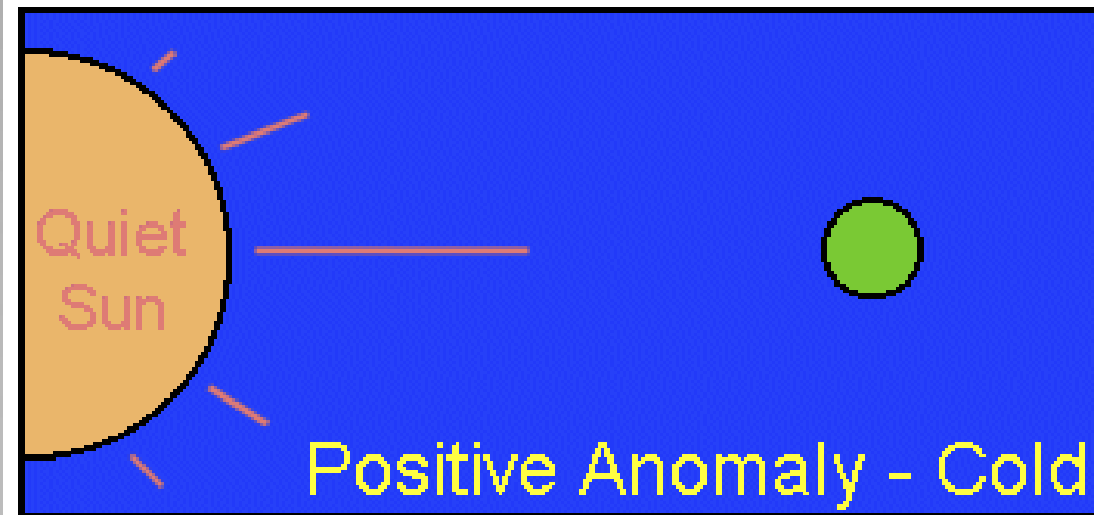
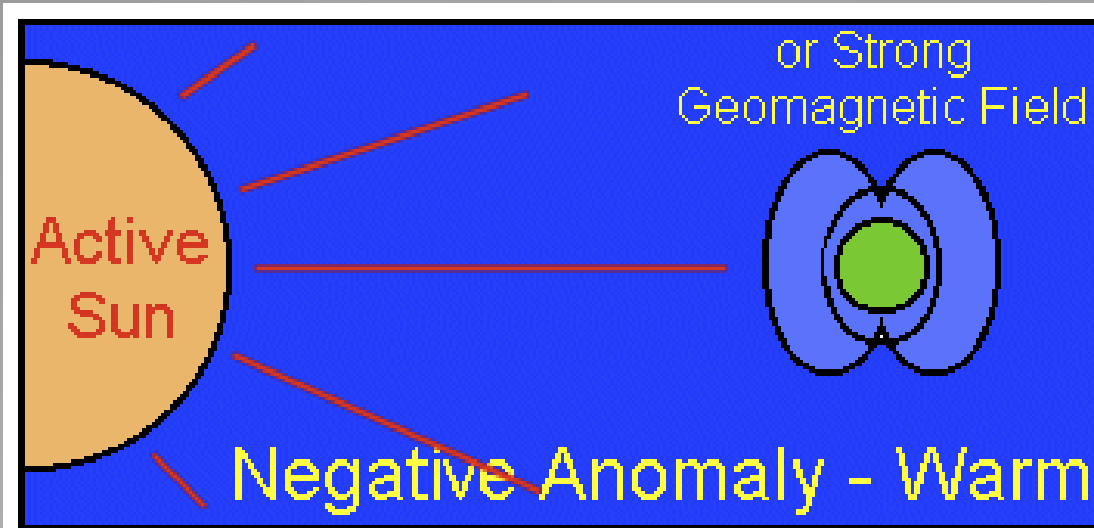
- Variations in the rate of sea-floor spreading ~100's of Millions of years
- Development of new continental masses ~10's of Millions of years.
- Mountain building events ~millions of years
- Glacial Episodes (Milankovitch Cycles) ~100,000's and 10,000's of years.
- Absolute variations in sun's energy ~tens to thousands of years
- Anthropogenic global warming ~100's of years
- Changes in oceanic currents ~ years to tens of years
- Weather – Minutes to weeks.

How these causes interact with each other is not always clear

We Begin to See Evidence of a Greenhouse Effect Around 1950

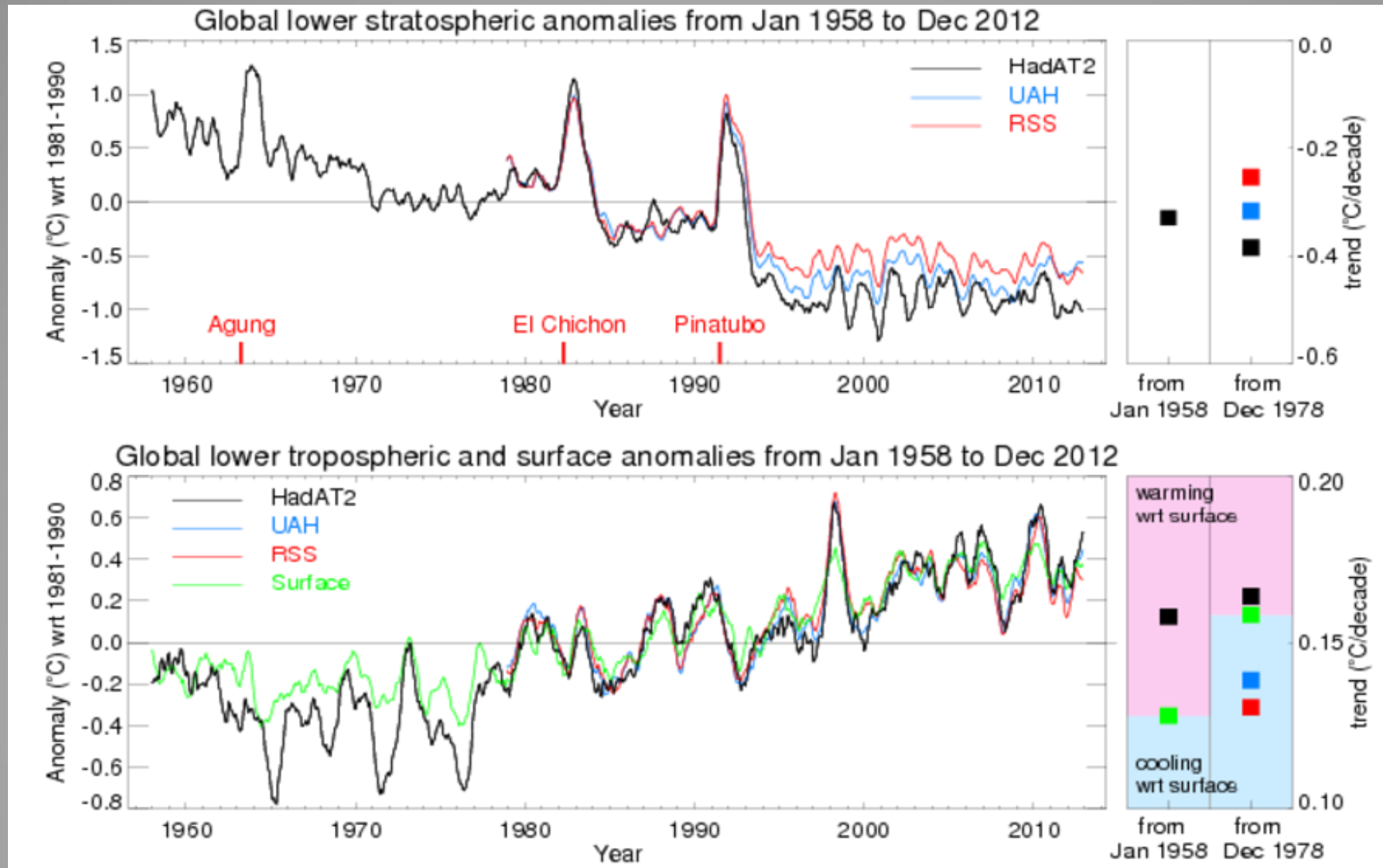


Relationship Between C^{14} and Solar Irradiance



Similar relationship exists for Be^{10} and Sr^{88} anomalies

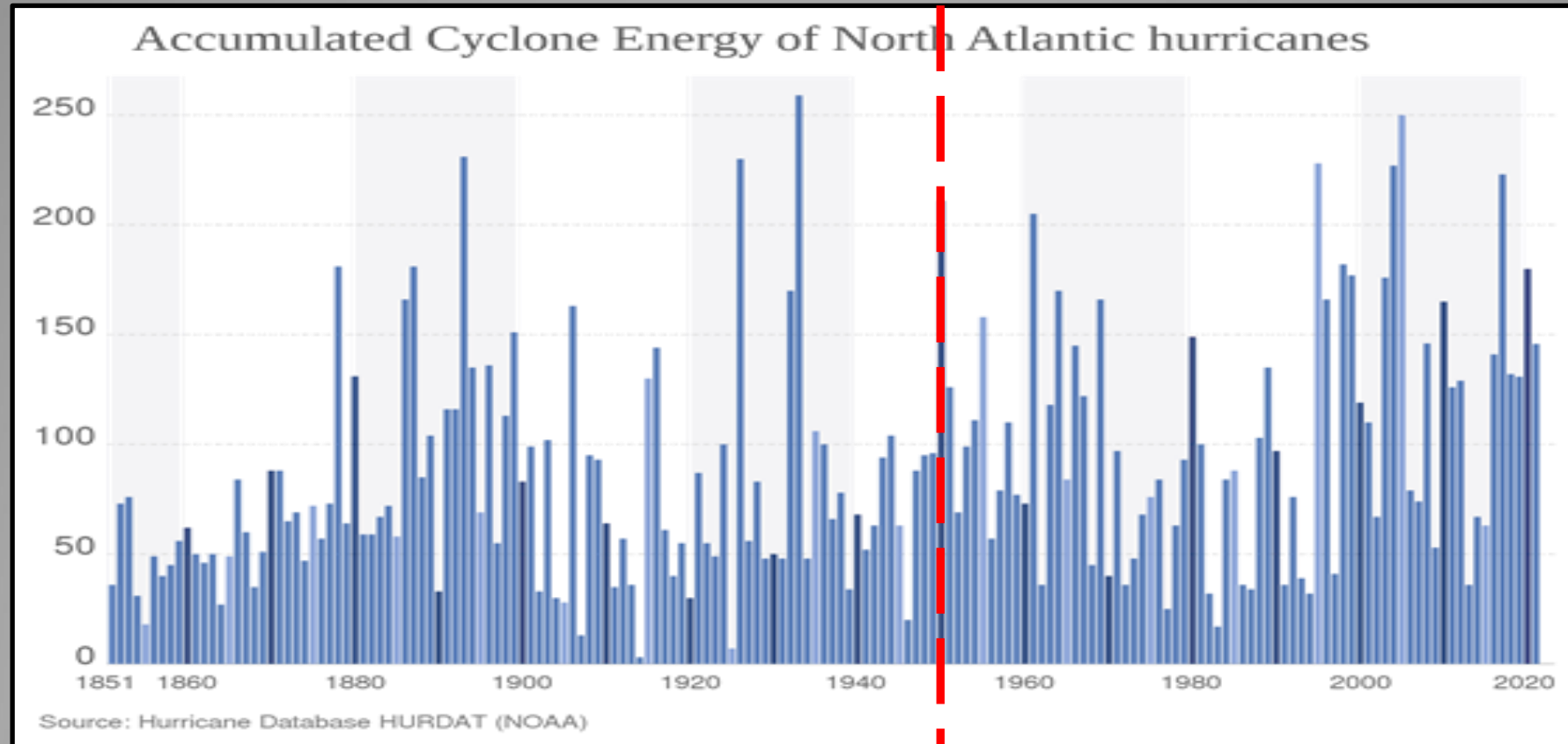
Stratosphere Cools as Troposphere Warms



In order to attribute changes in weather events to AGW we need to see a change in the trend of those events after 1950

So, Let's Look at Some of Them

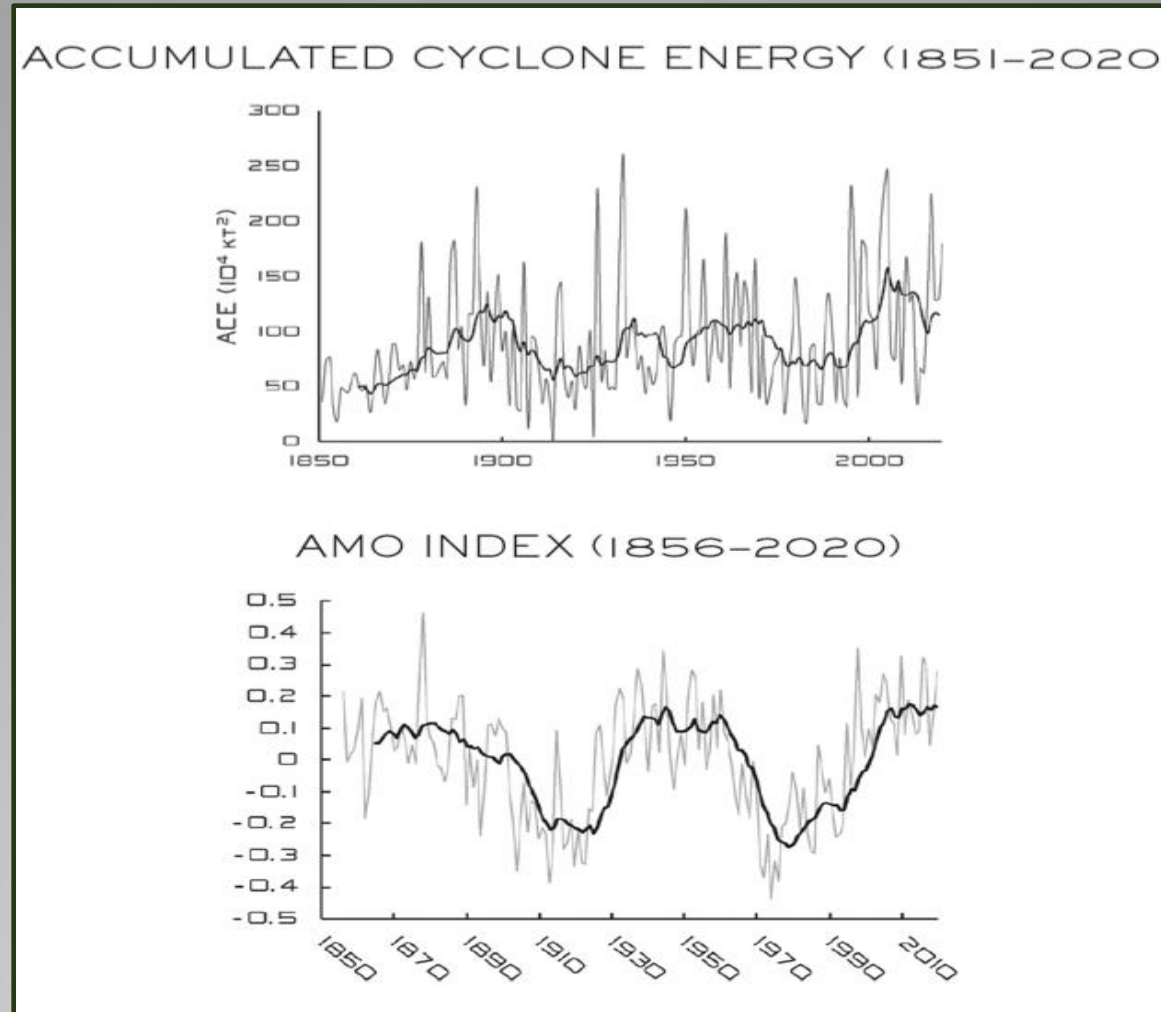
Hurricane: Accumulated Cyclonic Energy



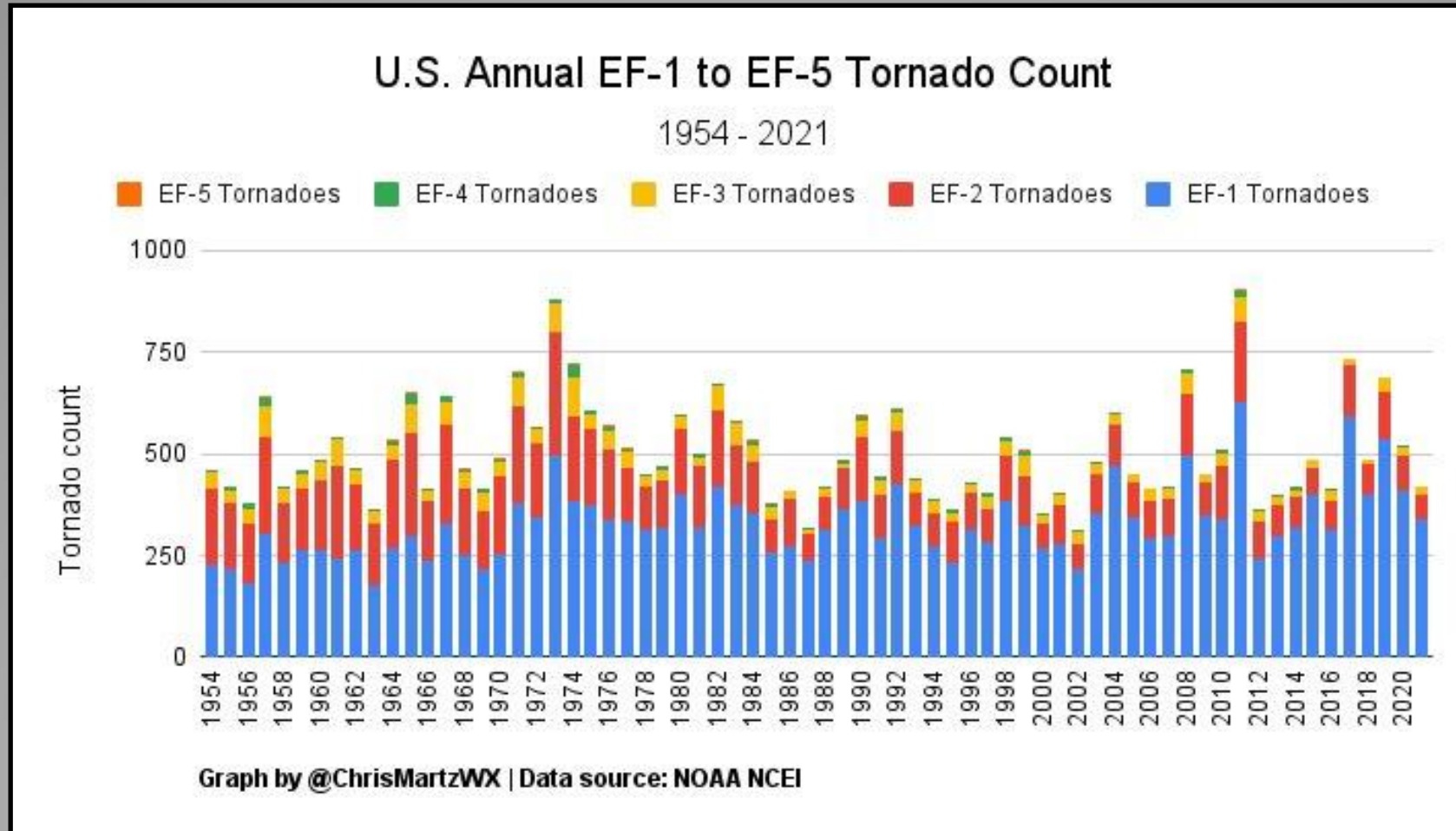
Changes in observation methods over time make it difficult to know whether tropical storm activity has shown an increase over time. EPA, 2015

“There is low confidence in most reported long-term (multidecadal to centennial) trends in [hurricane] frequency- or intensity-based metrics. IPCC, 2021

Oceanic Current Fluctuations appear to Control Hurricane Energy not AGW

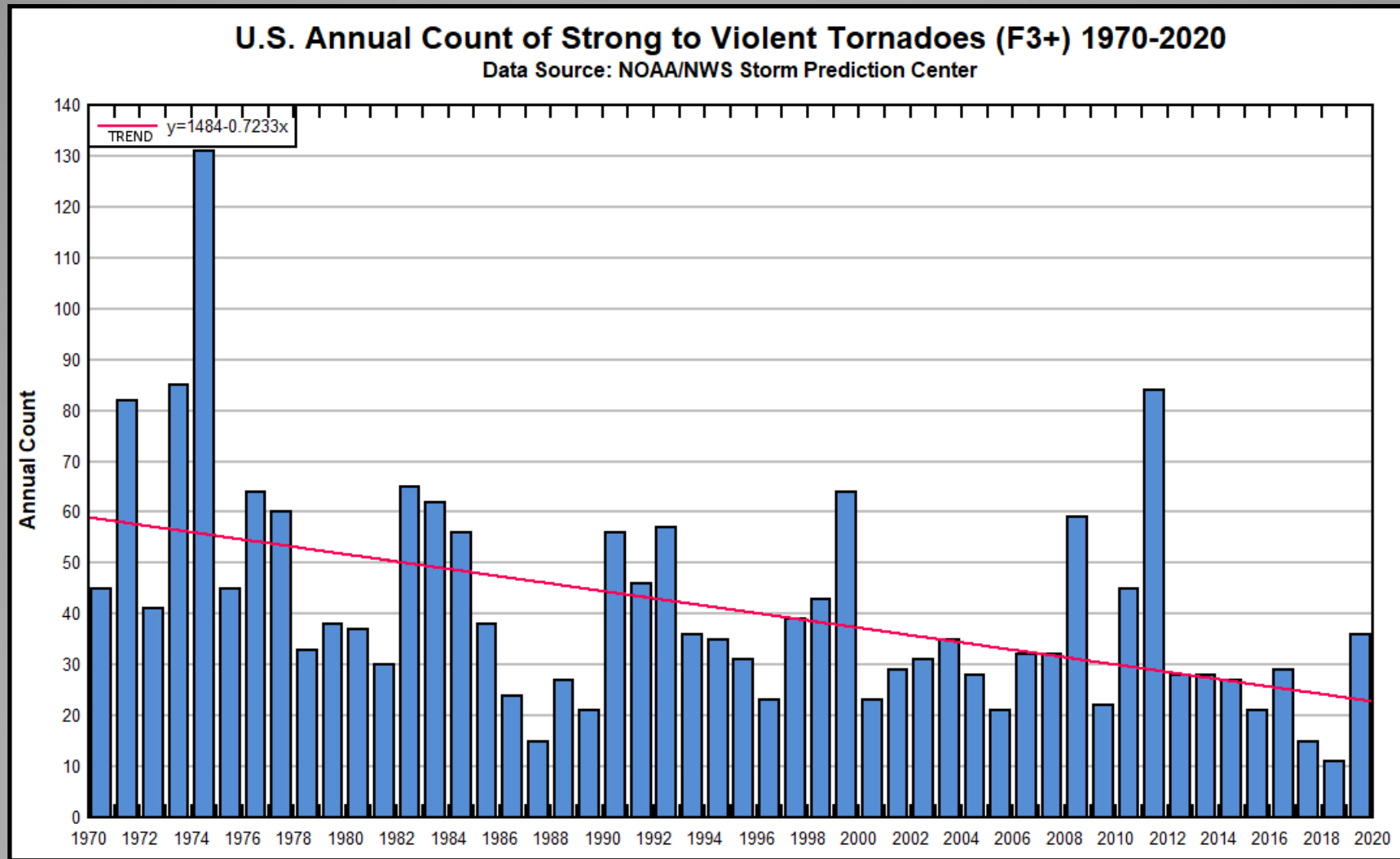


What About Tornadoes?

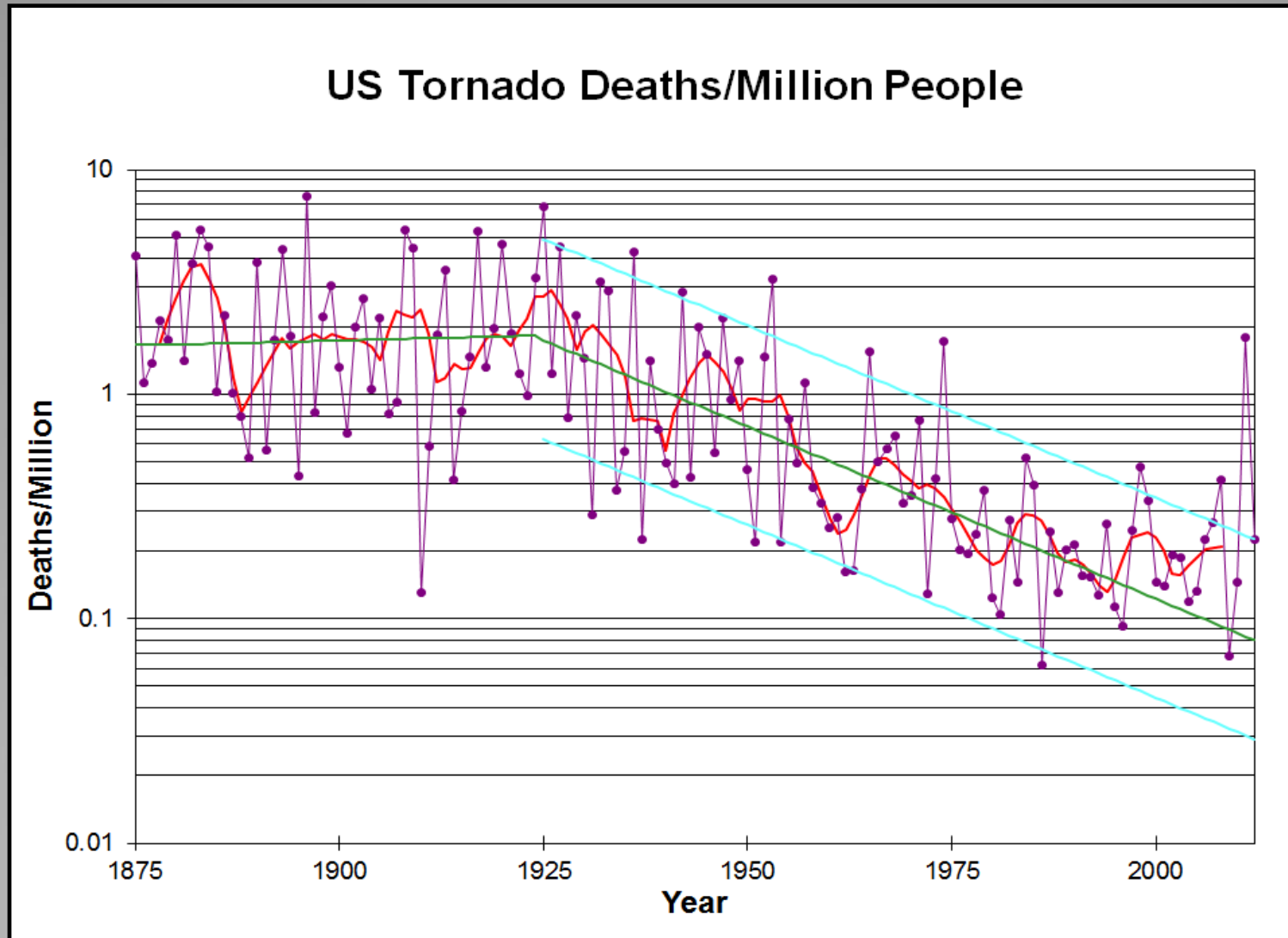


Number of EF 1 and greater tornados has remained stable since 1954

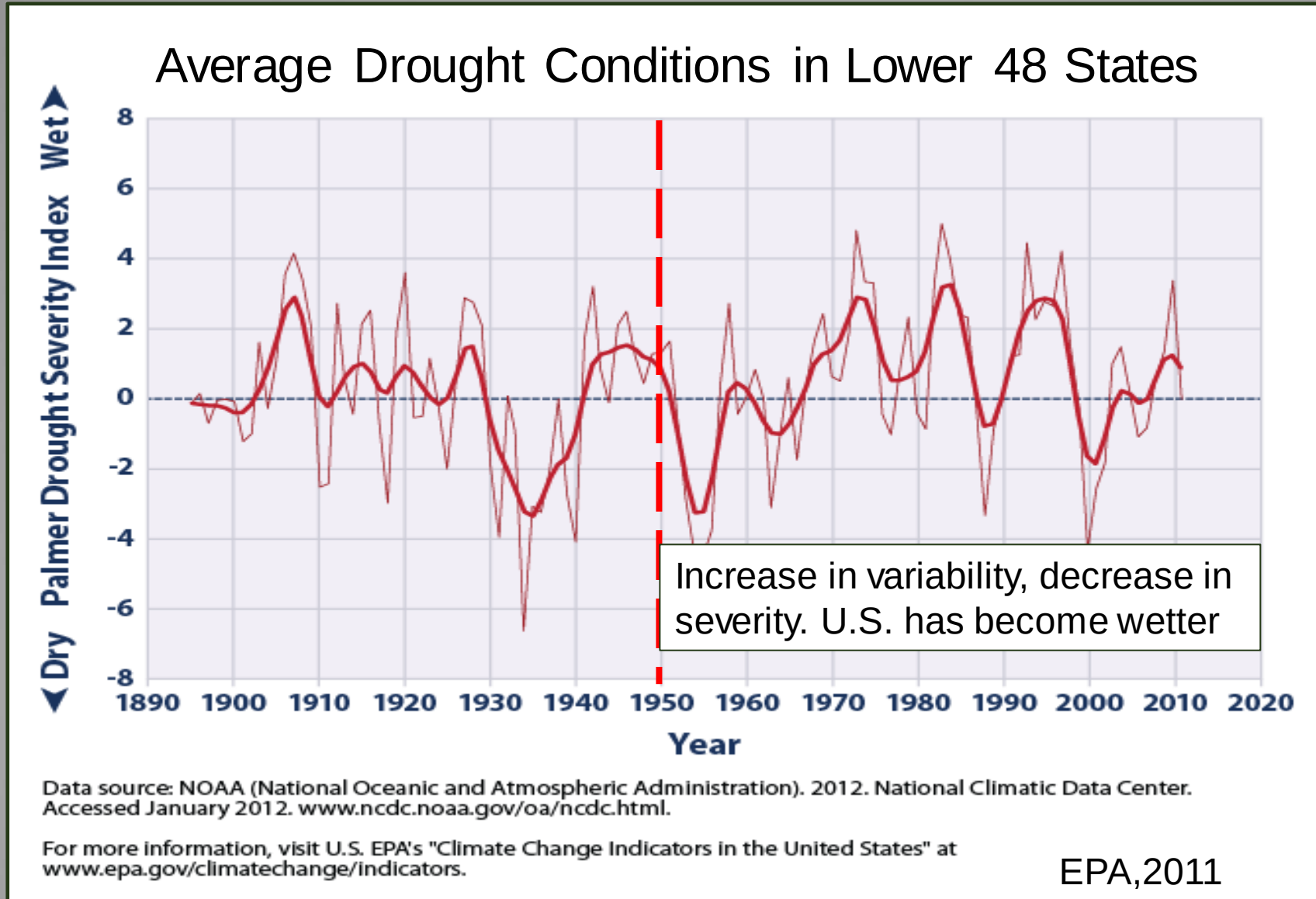
EF3 and Greater Tornadoes Have Declined



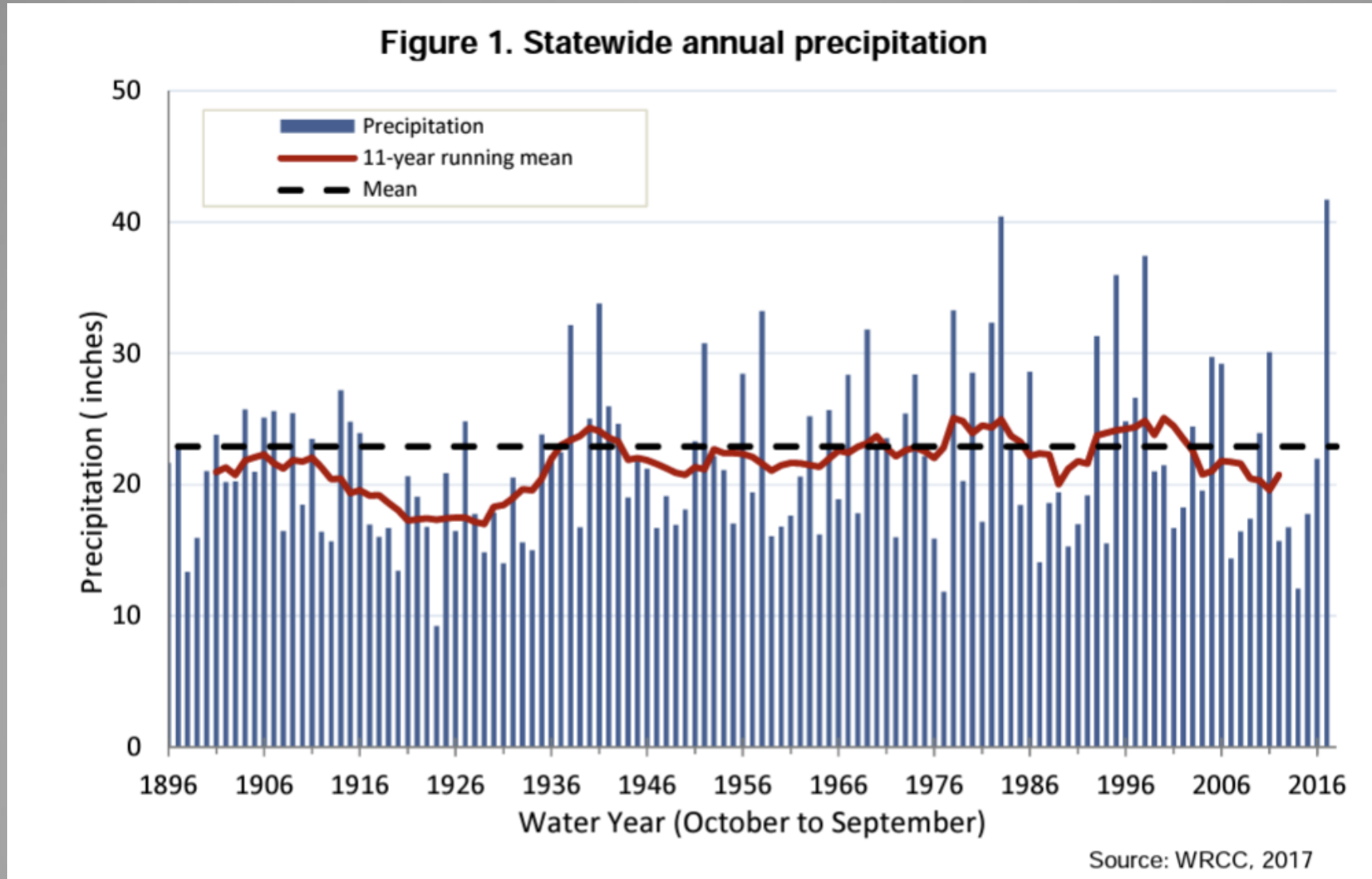
Tornado Deaths Have Declined Since 1925



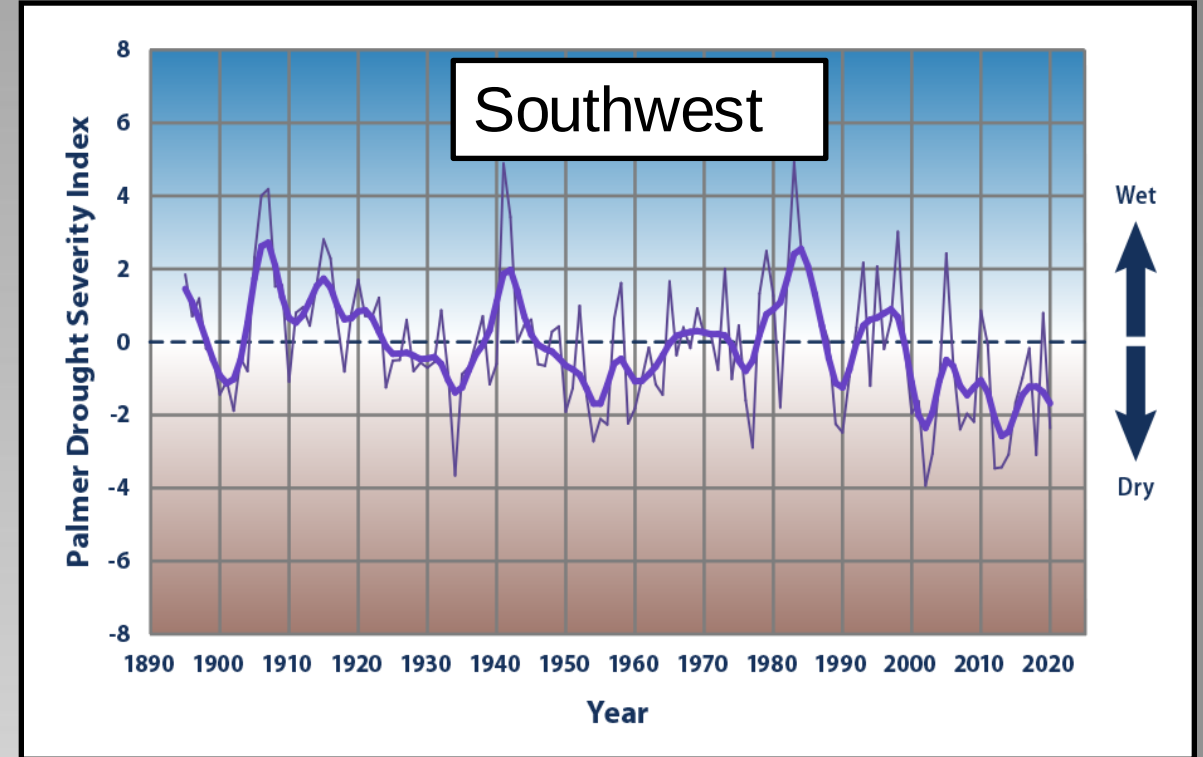
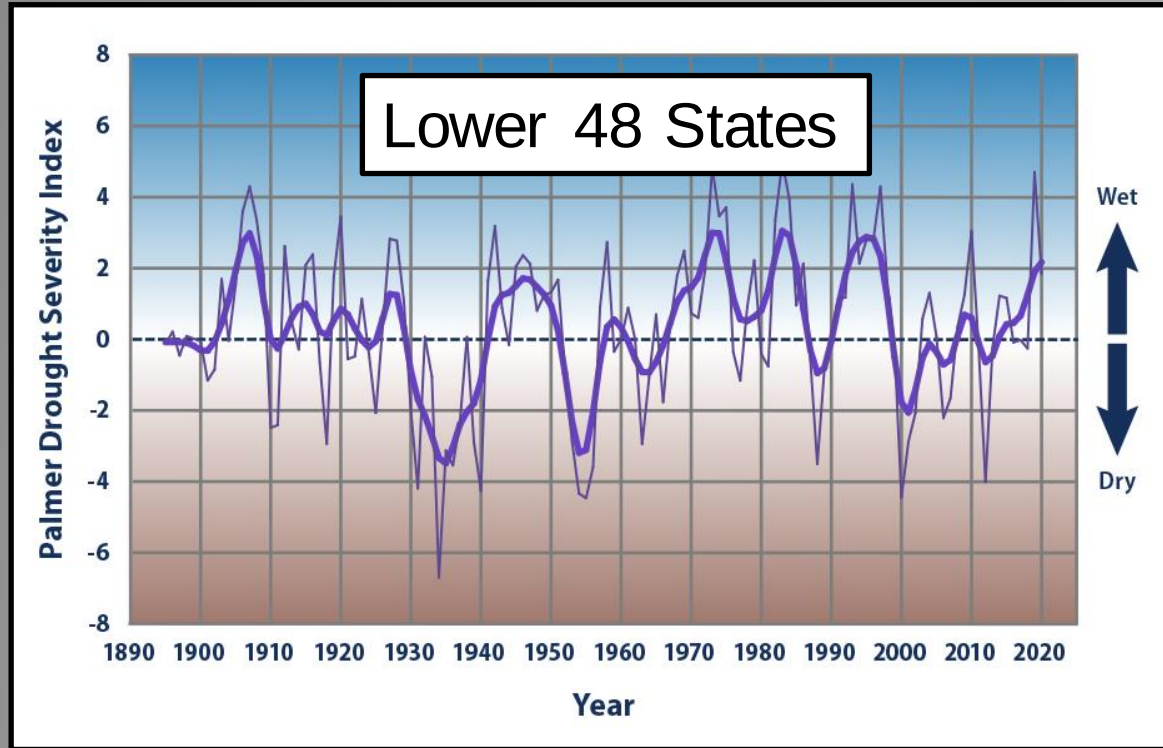
How about Droughts?



What about Droughts in California?

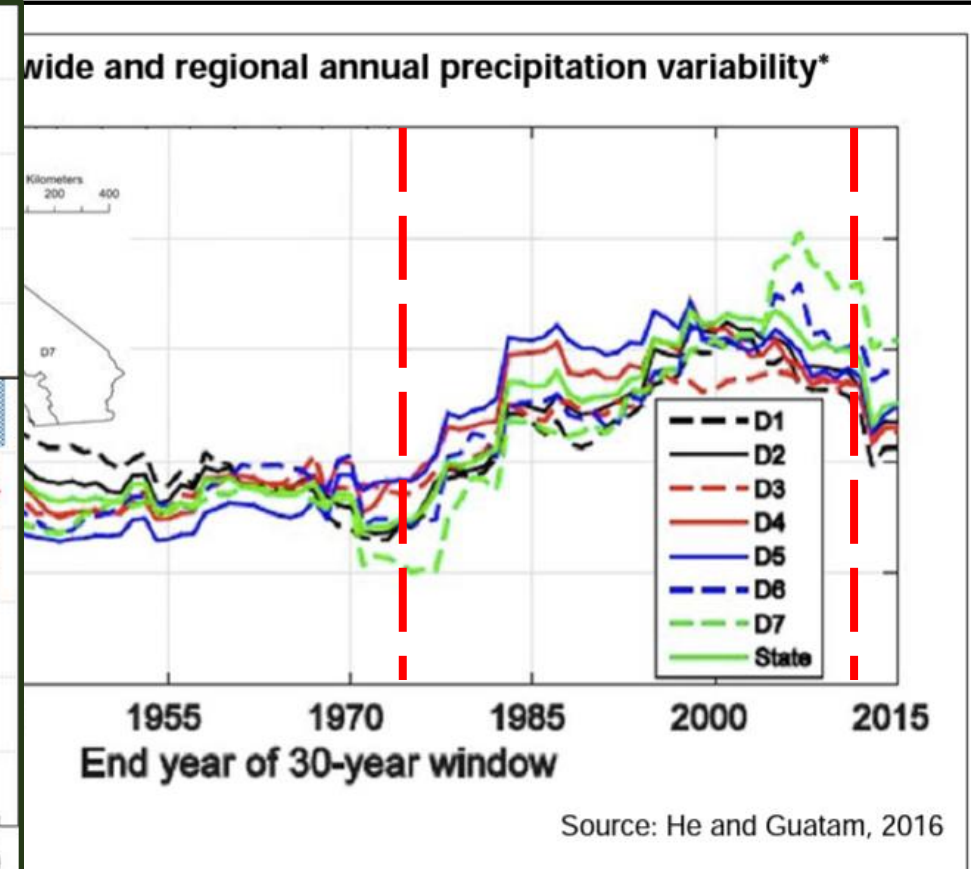
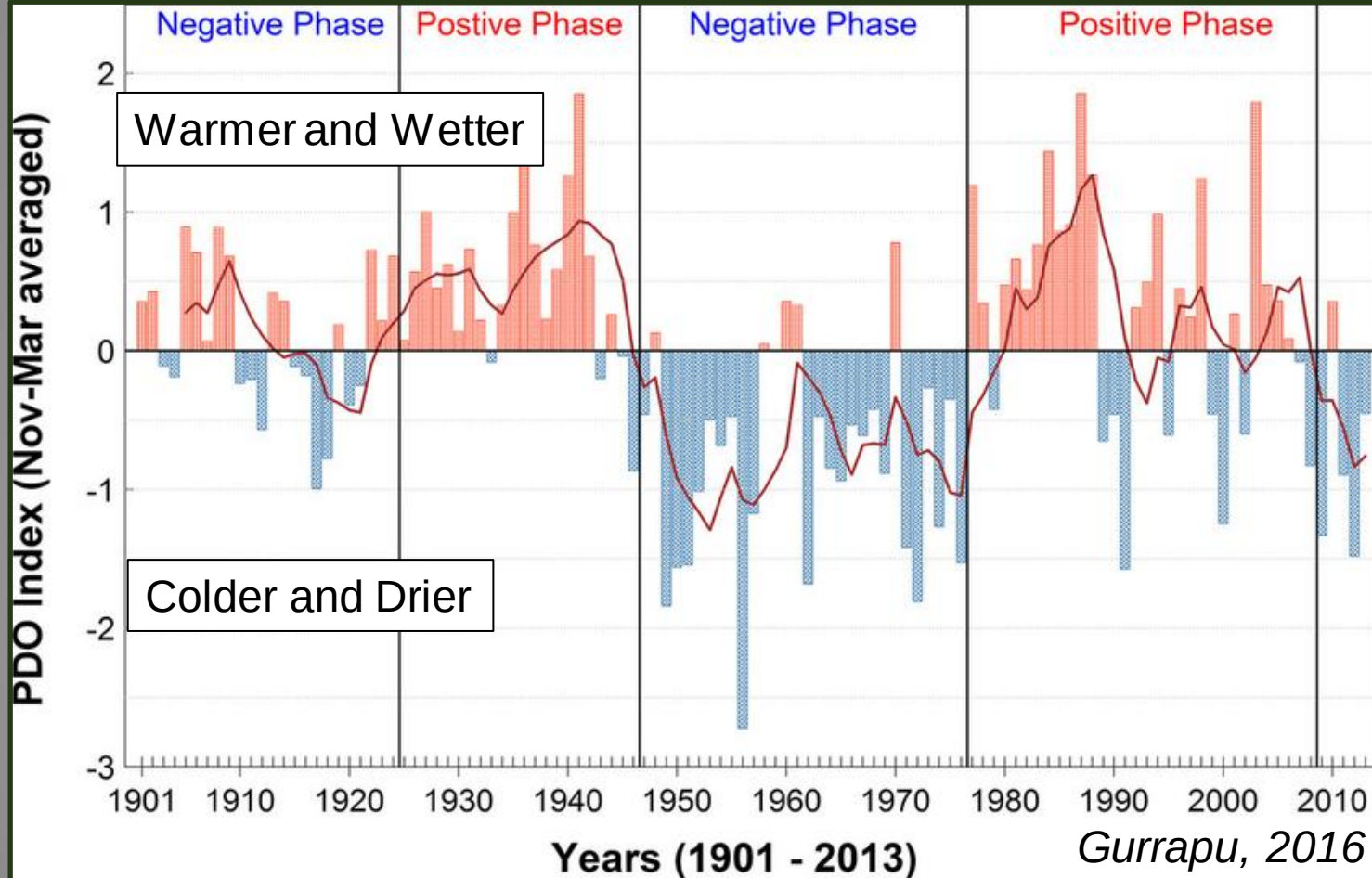


Rainfall is Flat But Temperature is Increasing

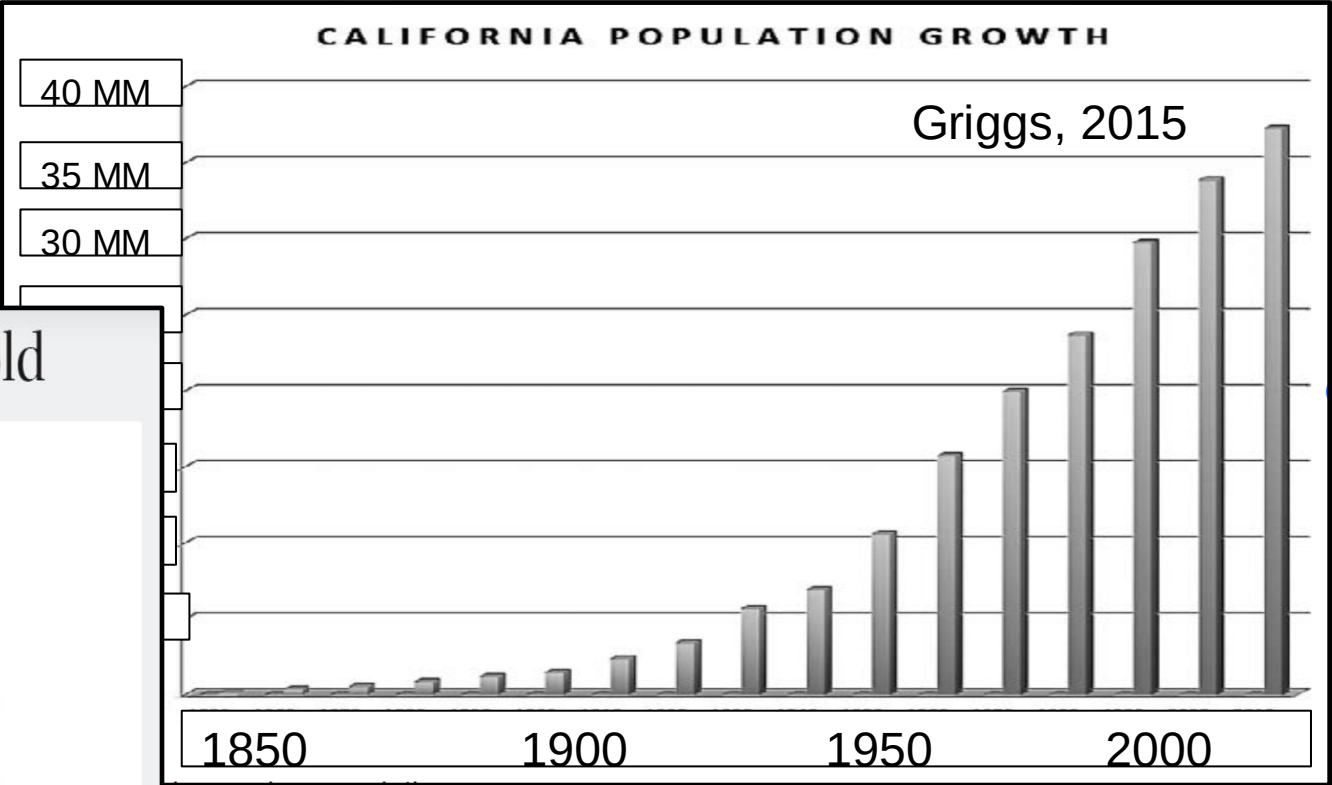
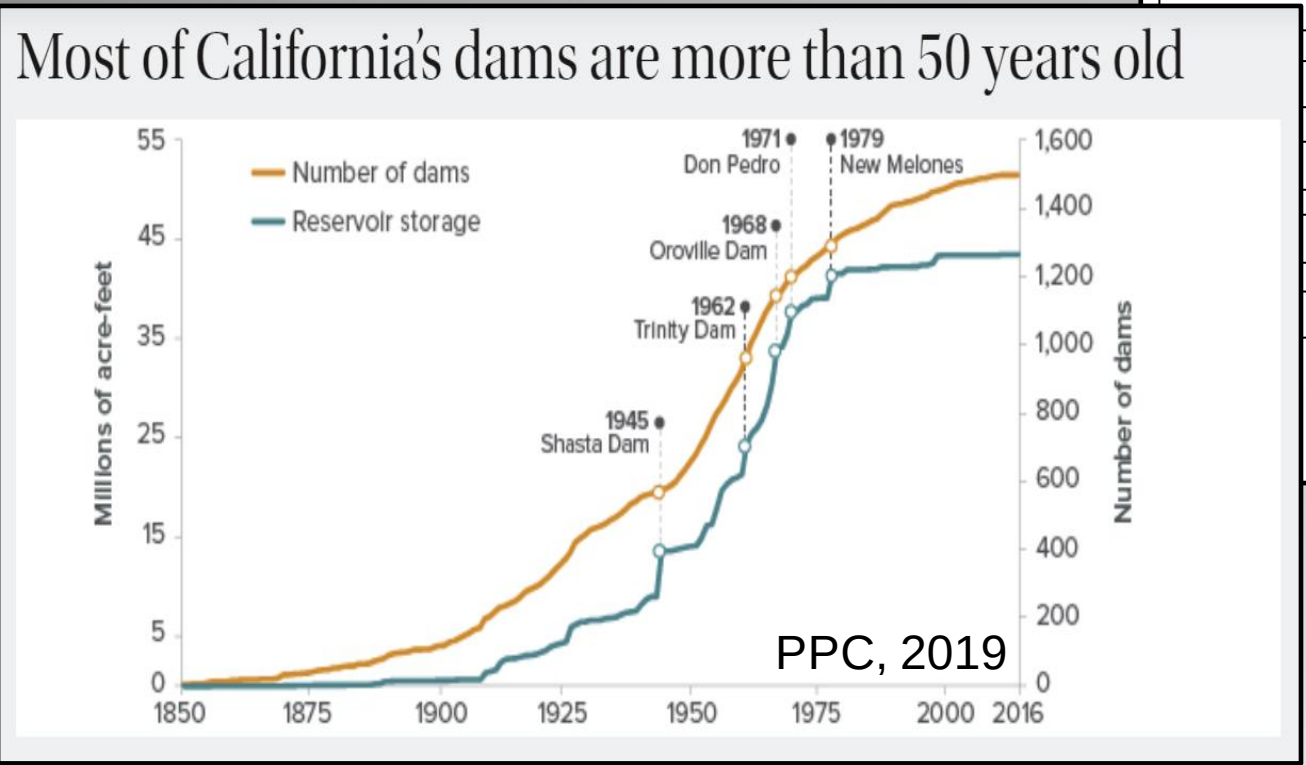


In terms of scale and duration, the droughts of the 1930s Dust Bowl era remain the most extreme in the historical record; EPA, 2020

Precipitation Variability In California Has Increased Since ~1975, But Why? Oceanic Currents or AGW?



Is What is Being Called a Drought, In Part, a Water Shortage?



Lake Mead Water Levels

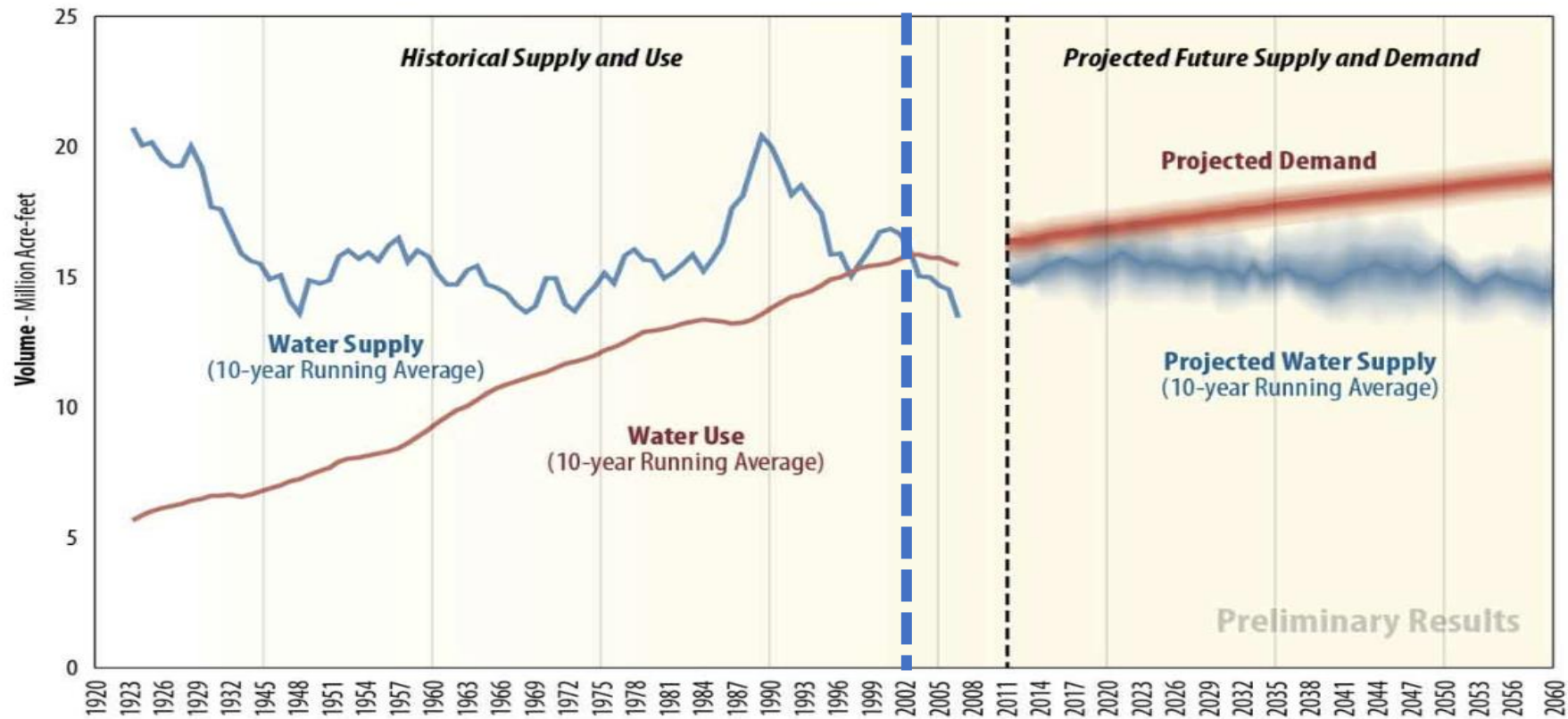
Lake Mead, July 2015

Climate.gov, 2015



1040', 2022

Colorado River Basin Water Usage



Recent data show that water usage has exceeded water supply for 75% of the years between 2000 and 2020; Richter et al.,2020

But Surely Polar Bears are Going Extinct?



Sandhills Sentinel, 2019

They are Not!

Polar Bear Count by Region	
Population Likely Increasing	3
Population Likely Decreasing	3
Population Likely Stable	4
Data Deficient	9
Regions	19

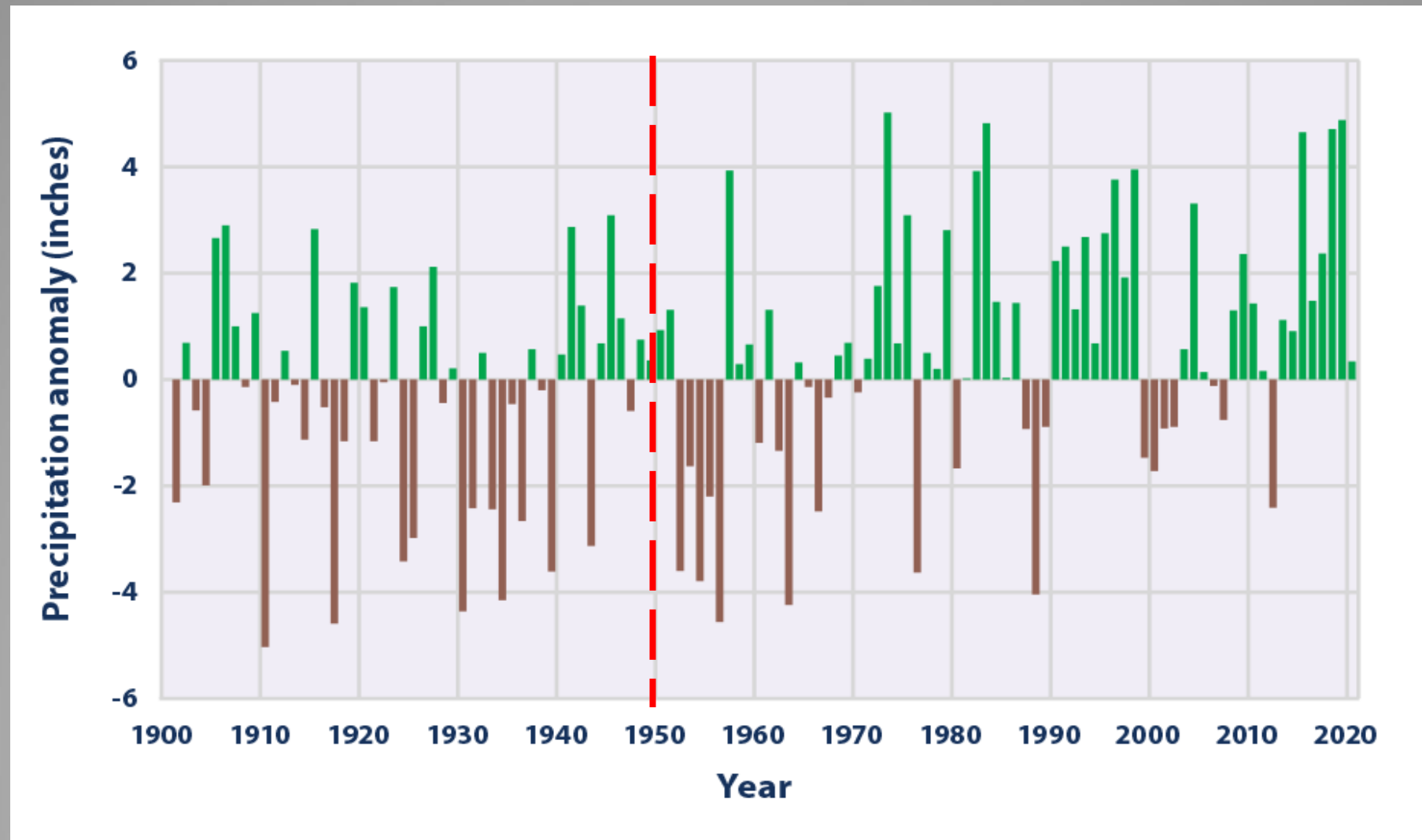
IUCN/SSC Polar Bear Specialist Group, 2021

- The idea that polar bear populations would decline was based on an assumption about the relationship between summer sea ice and polar bear hunting habits. It was never based on data.
- Polar Bears are hard to count, but available data show a stable population.

**Has Global Warming Had
Any Effect At All???**

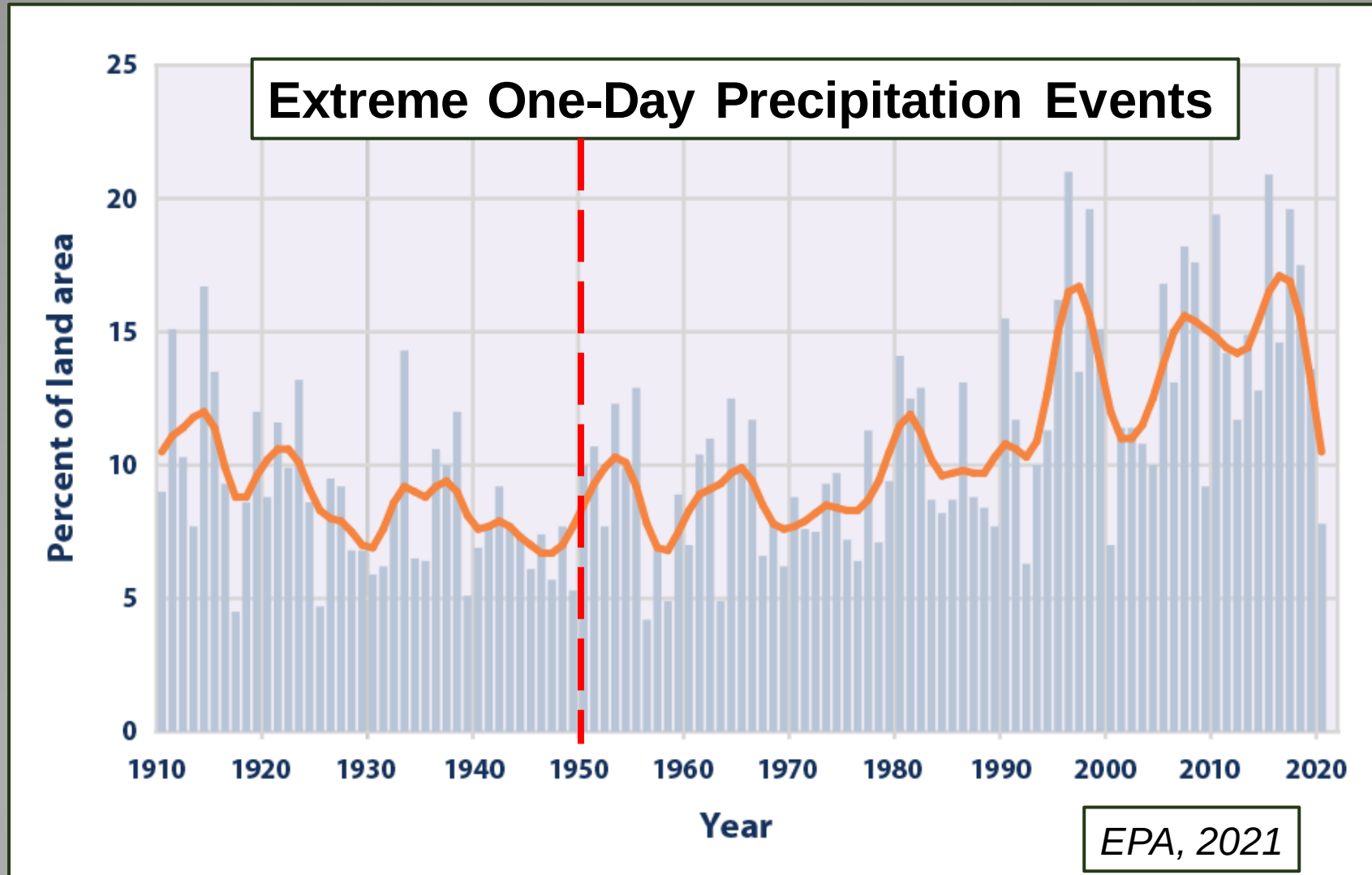
Yes!

Annual Precipitation Has Increased

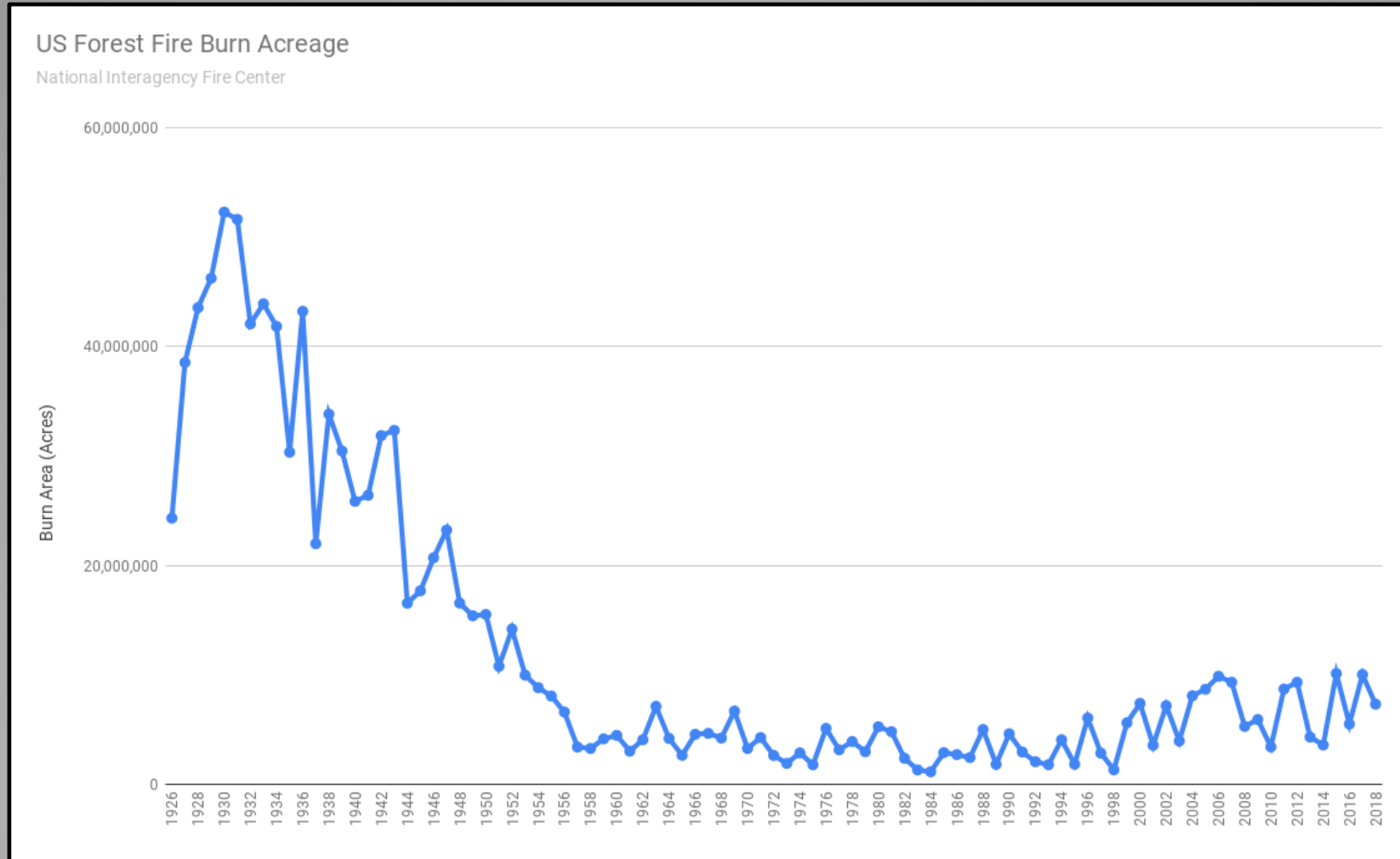


NOAA, 2021

Precipitation Has Become “Lumpier”



Forest Fires Have Declined 80% Since the Early 1900's –We Learned How to Fight Them

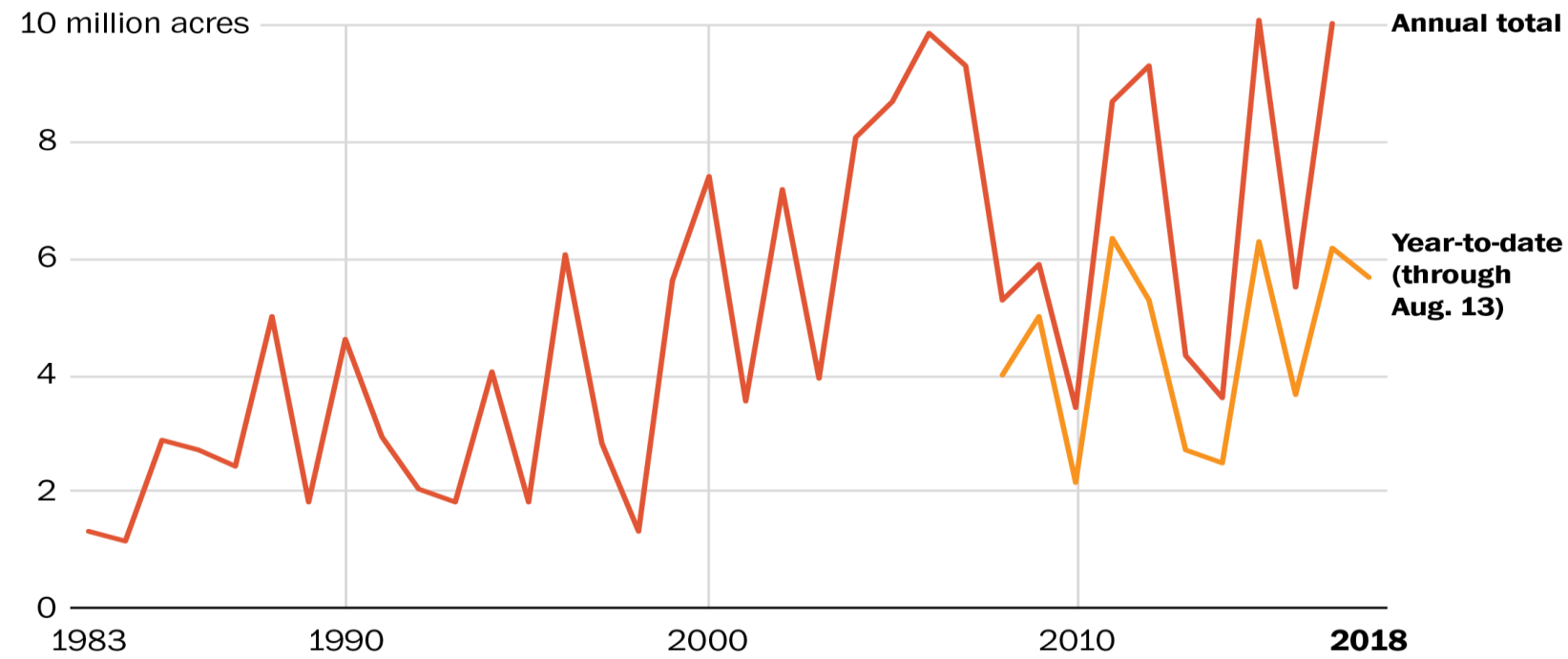


National Interagency Fire Center. 2019

But they Have Increased in Numbers Recently, and They Have Become Larger: Why?

A growing threat from wildfires

Annual and year-to-date acres burned by wildfires, 1983 through 2018



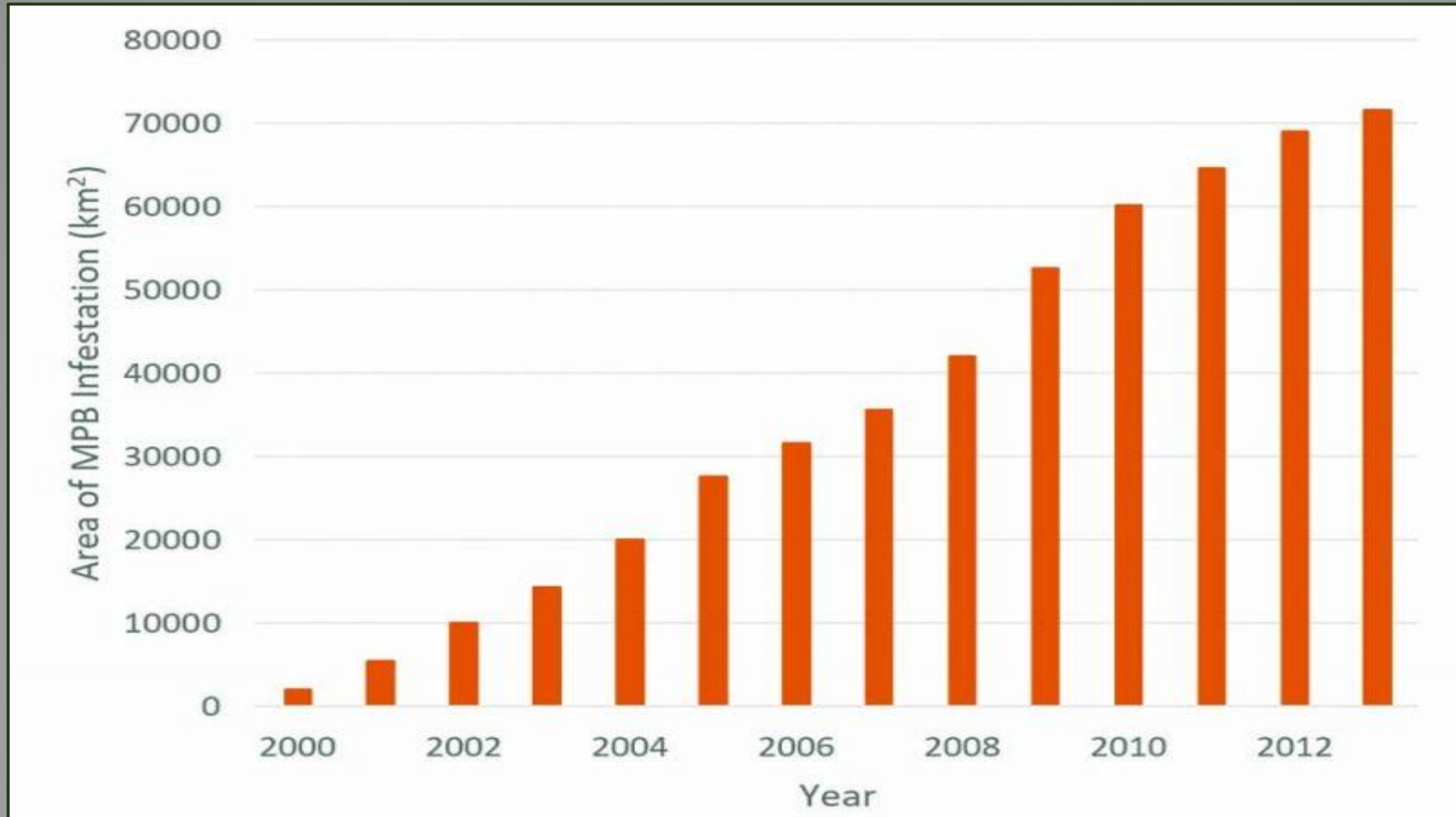
Source: National Interagency Fire Center

WAPO.ST/WONKBLOG

But They Have Increased Recently, and They Have Become Larger: Why?

- According to the NFS, 85% of forest fires are human-caused. More people means more fires. More people also means more damage from forest fires.
- Many states, particularly California and Oregon, have moved away from good forest management practices such as controlled burns and building of fire breaks. We learned how to fight fires. Then we stopped doing it.
- California introduced legislation in 2021 to increase prescribed burns.
- But the increase in temperature has also increased resulting in increased evapotranspiration in some areas. Has this offset the greater precipitation we observe? In some areas, probably yes. In others, no.

Then There is the Pine Bark Beetle



Pine Bark Beetle and Temperature

- The Pine Bark Beetle generally dies off in temperatures of less than 10 degrees Centigrade. Warmer winters mean greater survival.
- Longer summers associated with climate change mean that the Pine Bark Beetle has not one, but two breeding seasons in some areas.

This Means More Dead Pine Trees



And More Fires

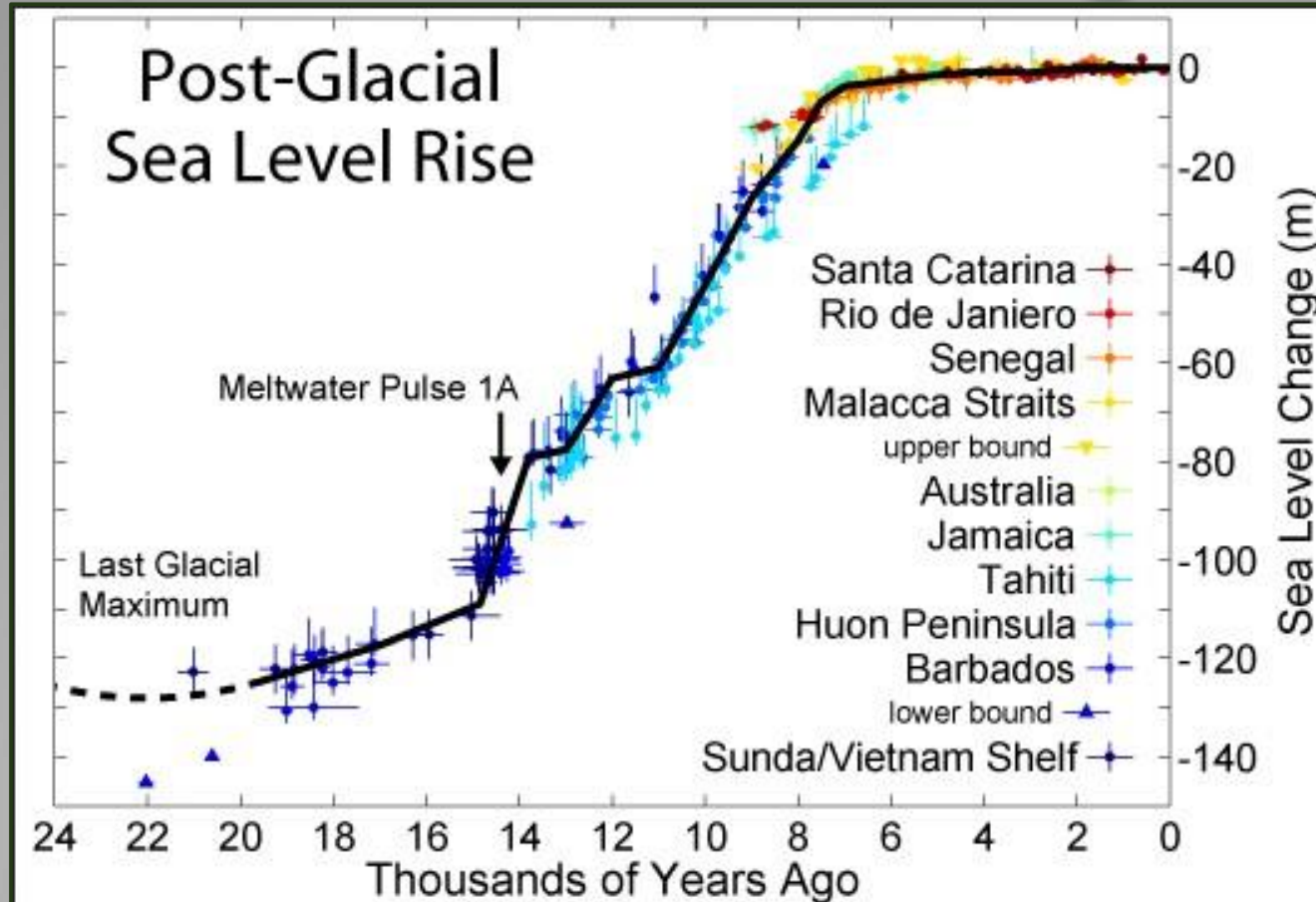
Sea Level Rise and Coastal Encroachment

These are NOT synonyms

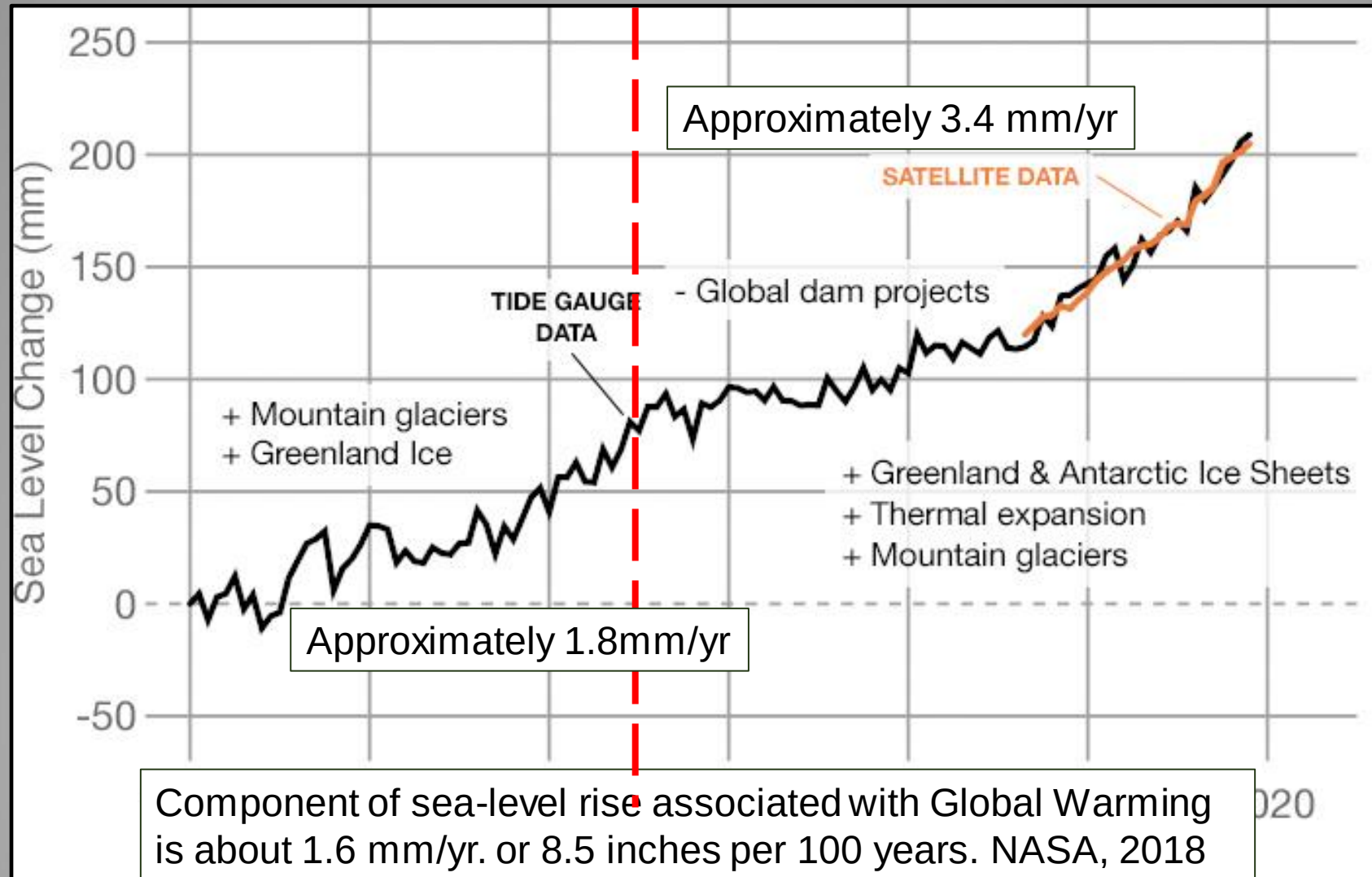
Coastal Movement: Landward or Seaward?

- Eustatic Sea-Level Rise (3.4 mm/yr.)
- Sediment Supply
- Subsidence or Uplift

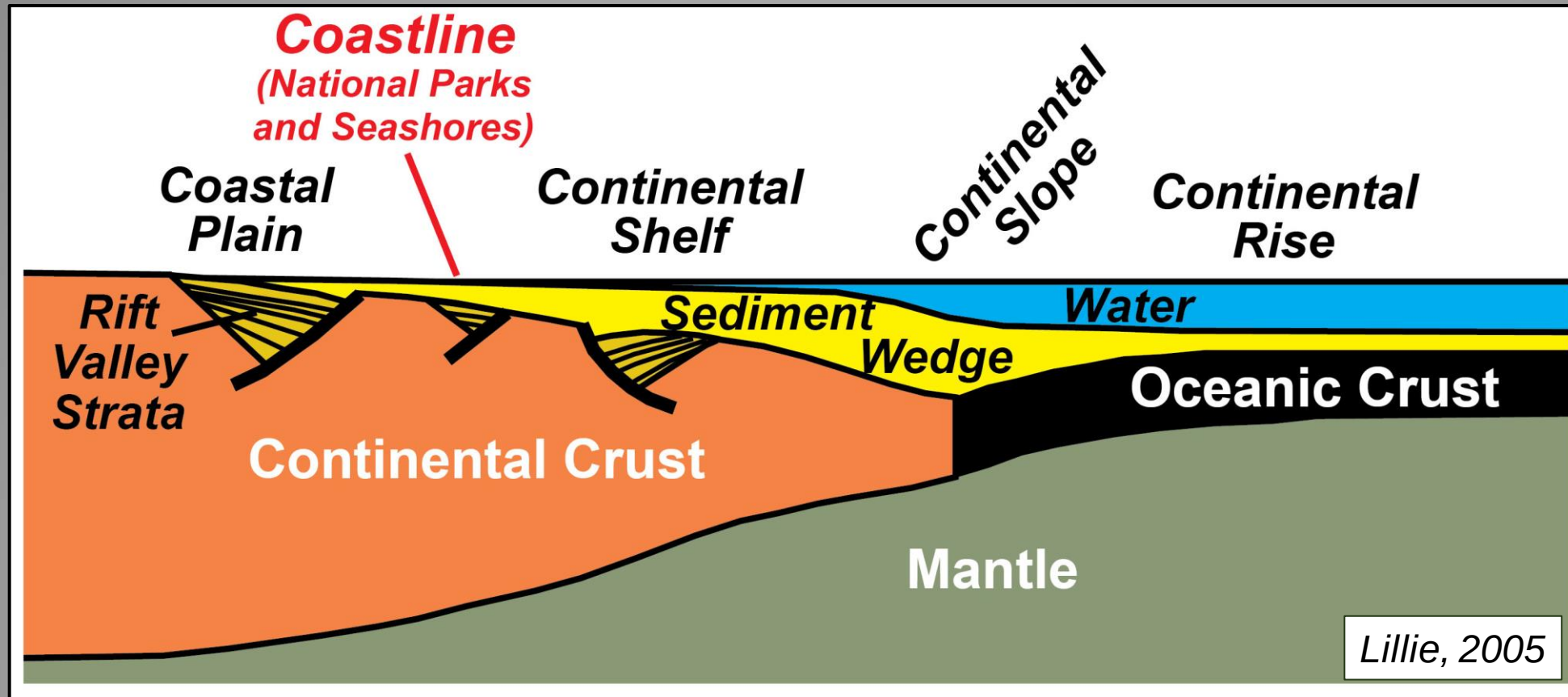
Sea-Level Has Been Rising for the Past 21,000 Years Due to Deglaciation



What Component of Sea-Level Rise is due to AGW and what Component to Deglaciation?



Passive Continental Margins



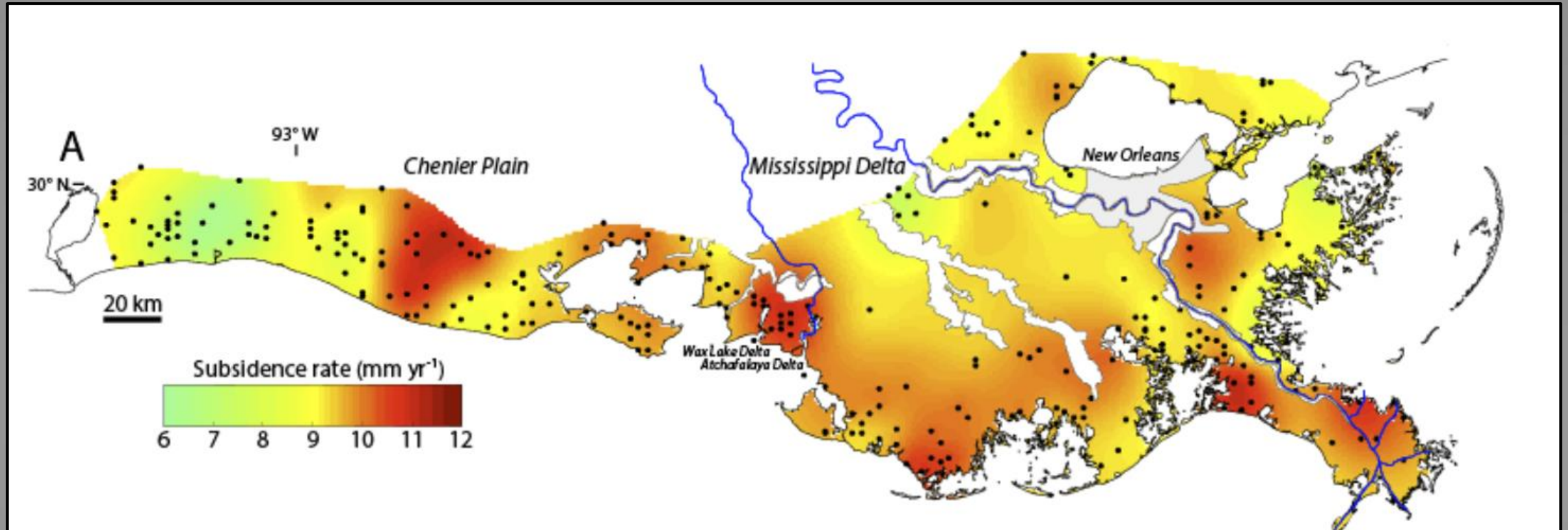
Passive margins subside largely due to the weight of overlying sediment
If sediment supply > Subsidence + eustatic rise, then the shoreline moves seaward
If sediment supply < Subsidence + eustatic rise, then the shoreline moves landward

In Bangladesh, Sediment Supply Overrides Eustatic Rise and Subsidence. Therefore, the Shoreline Moves Seaward



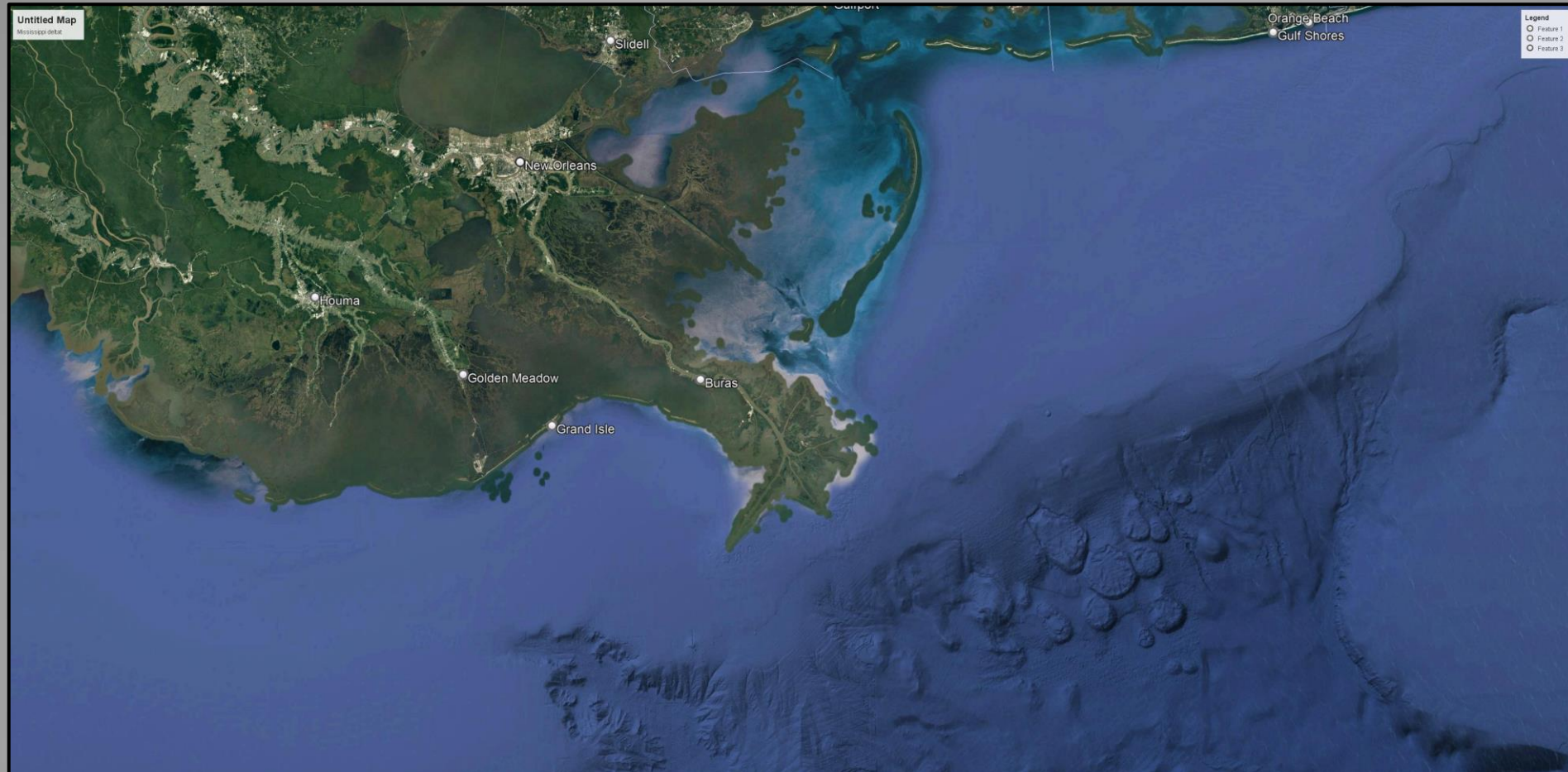
Bangladesh adds 20 sq. km of new land every year.
This is a wave-dominated delta: Sarker, 2008

The Coast of Louisiana is Subsiding at an Average Rate of 9 mm/yr.



Nienhaus et al., 2017

Mississippi Delta



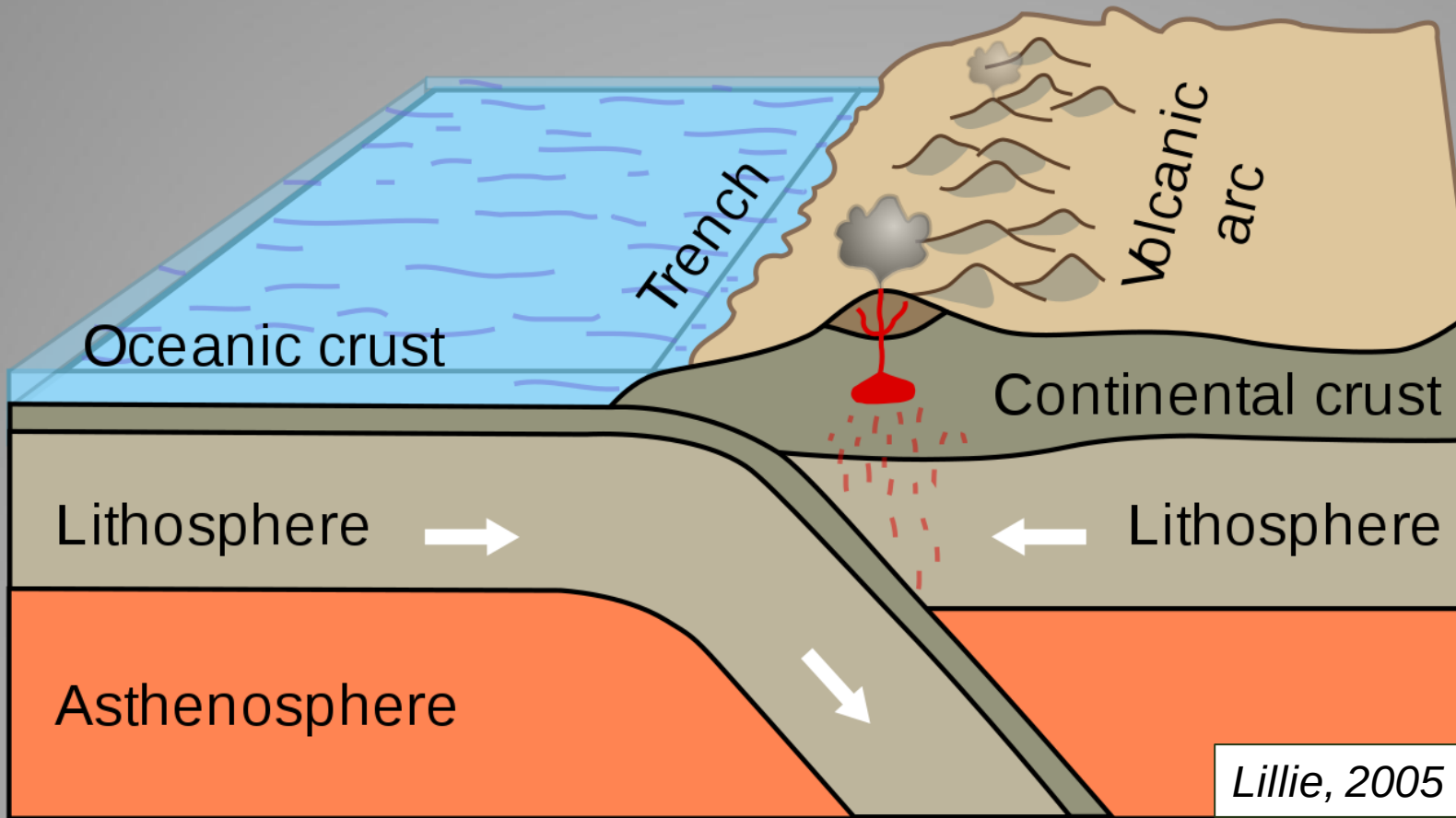
Unlike Bangladesh, sediment from the Mississippi is delivered directly to the continental slope so sediment supply along the coast cannot keep up with subsidence and eustatic rise. This is a river dominated delta. The shoreline moves landward

Isostatic Rebound

Name	Location	Uplift Rates (mm/yr)
ALGO	Algonquin Park, Canada	$2.4 \pm .7$
BRU1	Brunswick, ME	$3.2 \pm .9$
CHA1	Charleston, SC	$1.3 \pm .9$
CHL1	Cape Henlopen, DE	$1.2 \pm .9$
CHT1	Chatham, MA	$0.5 \pm .8$
CHUR	Churchill, Canada	13.0 ± 1.0
DUBO	Lac du Bonnet, Canada	0.9 ± 1.2
FLIN	Flin Flon, Canada	$5.8 \pm .9$
GAIT	Gaithersburg, MD	$2.4 \pm .9$

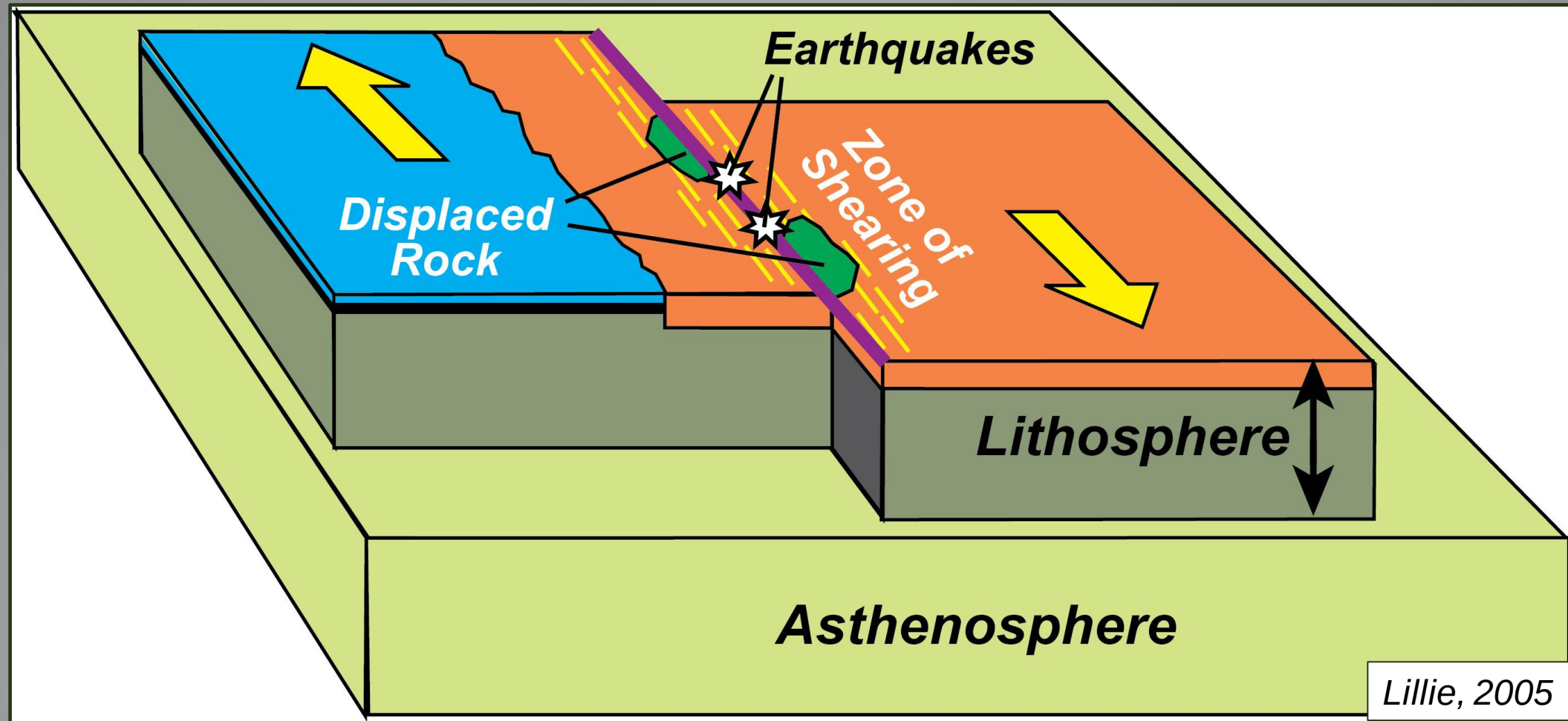
Kwan-Dong et al., 2002

Convergent Continental Margins - Oregon and Washington



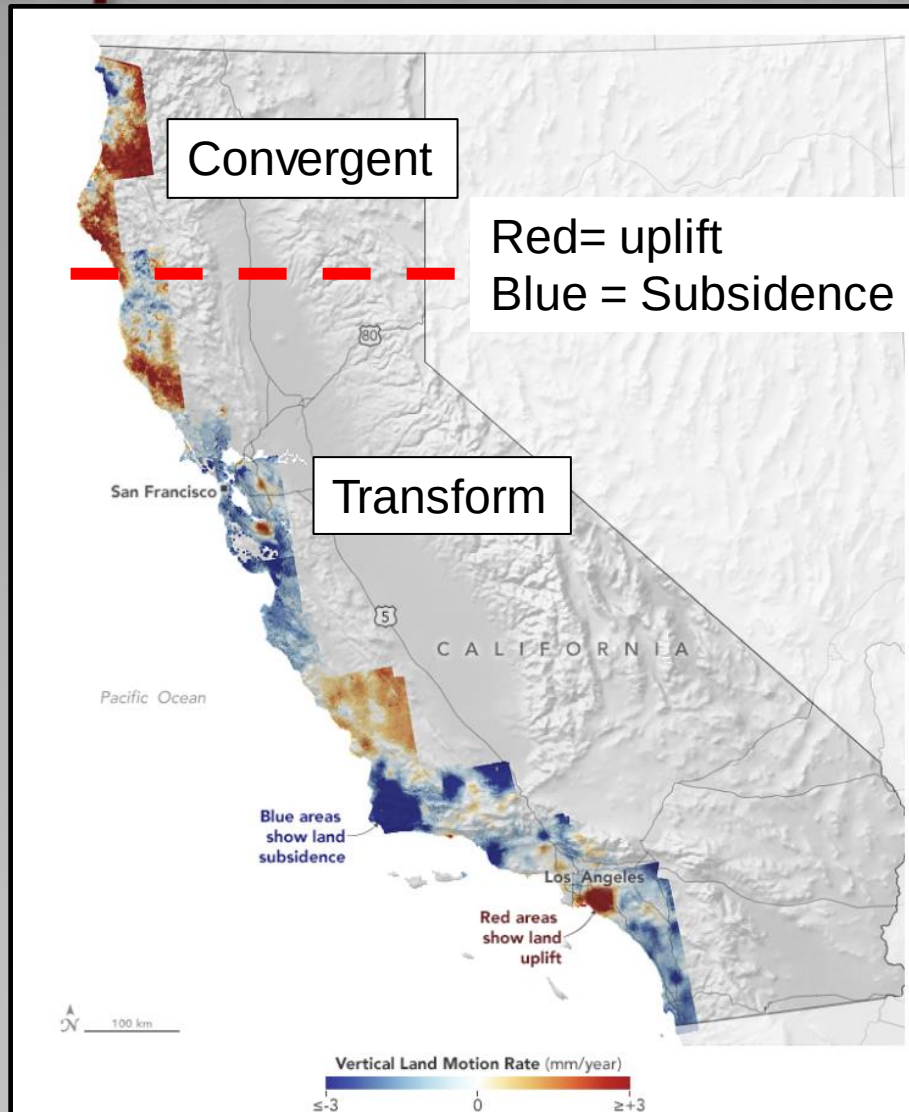
Active: Convergent Continental Margins – Mountain building results in the shoreline moving landward as uplift is commonly $>$ eustatic sea-level rise. Sediment supply is a minor factor due to a deep trench at the continental margin.

Transform Continental Margins - San Andreas Fault



Active: Transform Margin: Basins and Mountains are created along the fault zones due to friction

Coastal Areas of California Are Rising or Falling Independent of Eustatic Sea-Level Rise



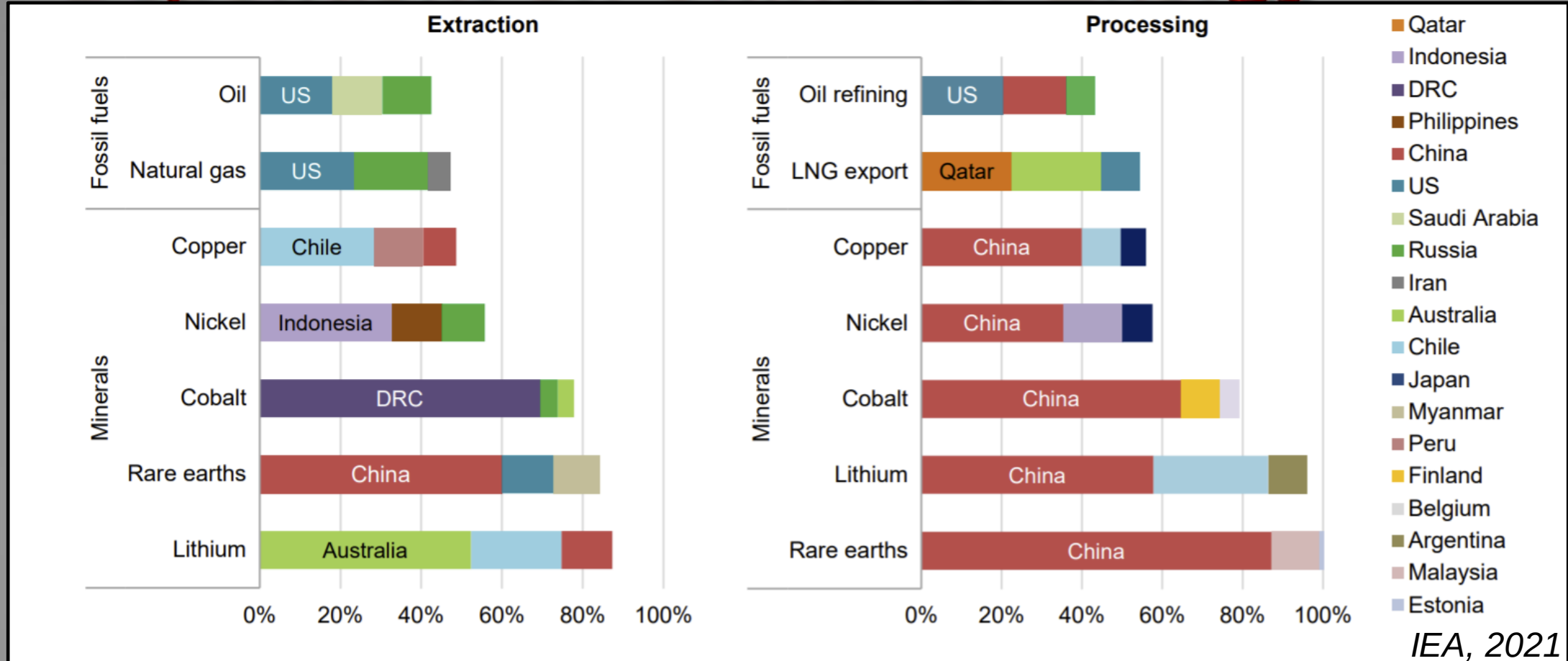
NASA, 2020

Presentism

We perceive events that happen in our lifetimes as being more significant than those that happened in the past.

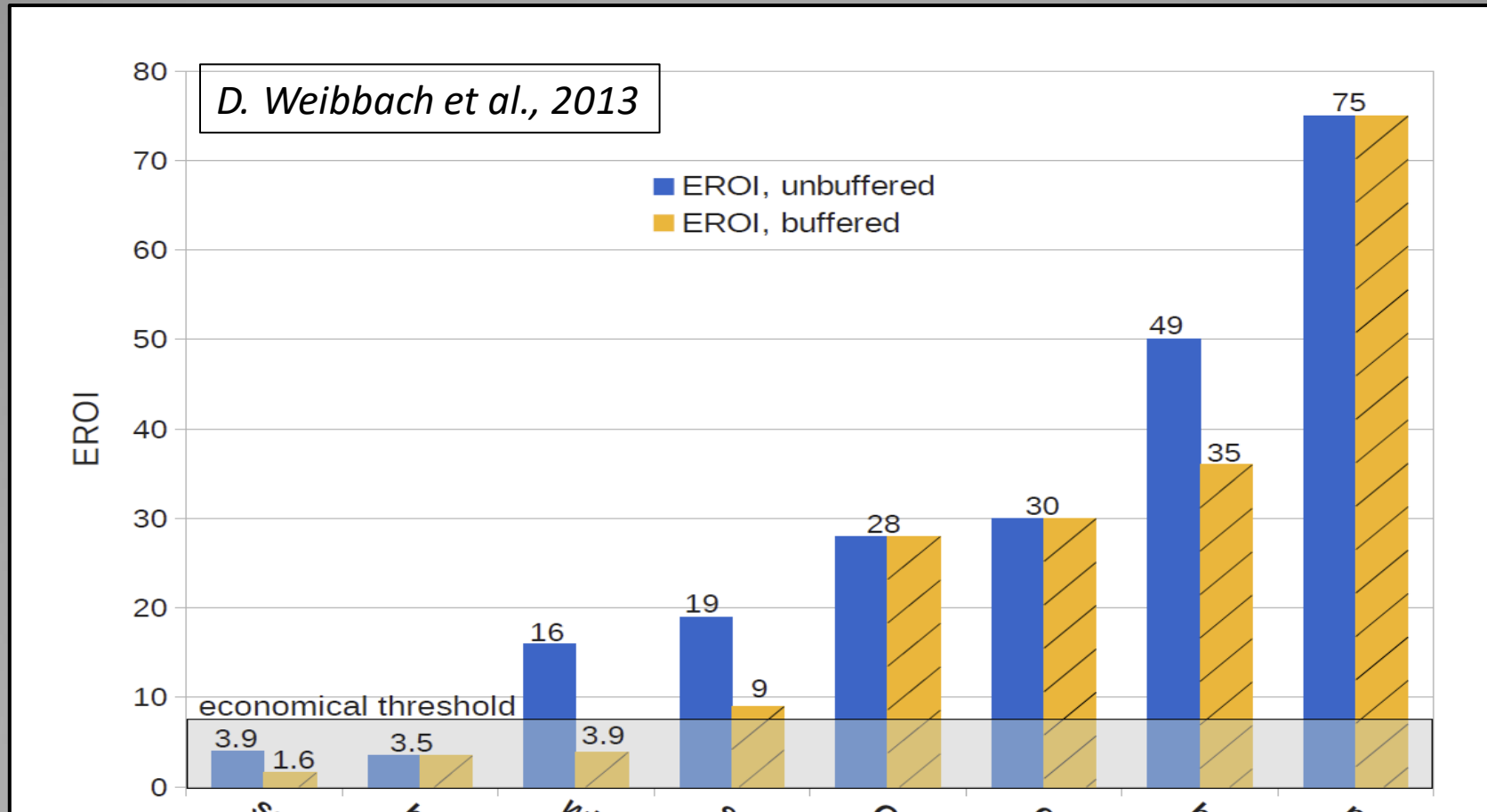
**Should we Make Policy
Decisions that Increase the
Cost of Energy Based on
These Data?**

A Switch to Wind and Solar Makes us Dependent on China for Energy



Over 50% of the coal used for energy in the world is used by China and they are the largest emitter of CO2 in the world. India is also rapidly increasing use of coal. A switch to wind and solar here results in more coal burned in China.

Energy Returned Versus Energy Invested



Ferroni and Hopkirk, 2016, using a more sophisticated method to calculate EROI noted that it was 0.82 for buffered PV solar in areas of moderate solar energy

Unbuffered = Energy delivered; Buffered = Includes cost of backup capacity

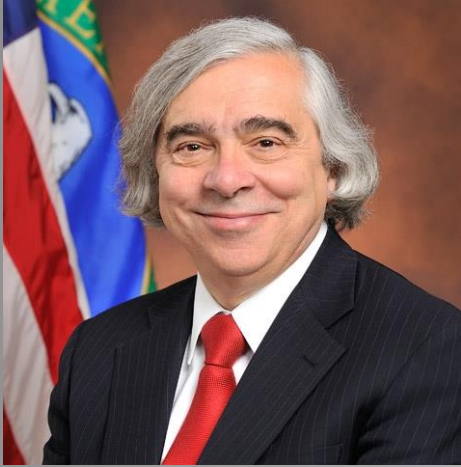
What Does a Value of 0.82 Mean?

- To mine and refine the raw materials, build the solar panels and batteries, transport, install, maintain and dispose of them takes more energy than they produce in moderate solar environments.
- Since most of these products are manufactured in China, much of that energy is generated using coal.
- Outsourcing our CO₂ to China does not reduce it.

We Should Be Aware of Climate Change But Not Use It as an Excuse

- Prescribed burns are unpopular. They kill animals and put CO₂ and particulate material in the atmosphere.
- Building fire breaks and clearing timber around power lines is unpopular.
- Building dams is unpopular.
- Flood control projects are popular, but they cost a lot of money and NIMBY. People lose homes and they litigate. There are significant *Eminent Domain* issues.
- If the world went to zero CO₂ emissions today it would take 75 -100 years to see any effect (Konin, 2020)

The Bottom Line



“The earth will get hotter, and we will adapt”: Dr. Ernest Moniz, DOE Secretary under Obama

Just Like the Polar Bears!!!!