Precipitation and Temperature Extremes in the U.S.: Trends and Causes

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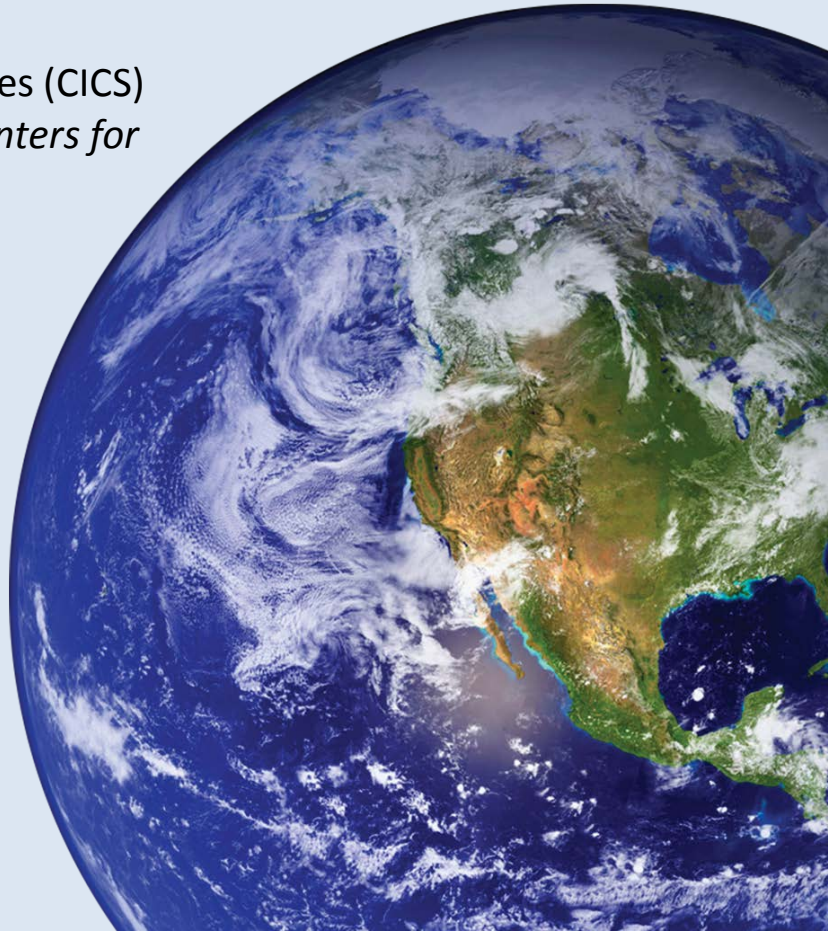
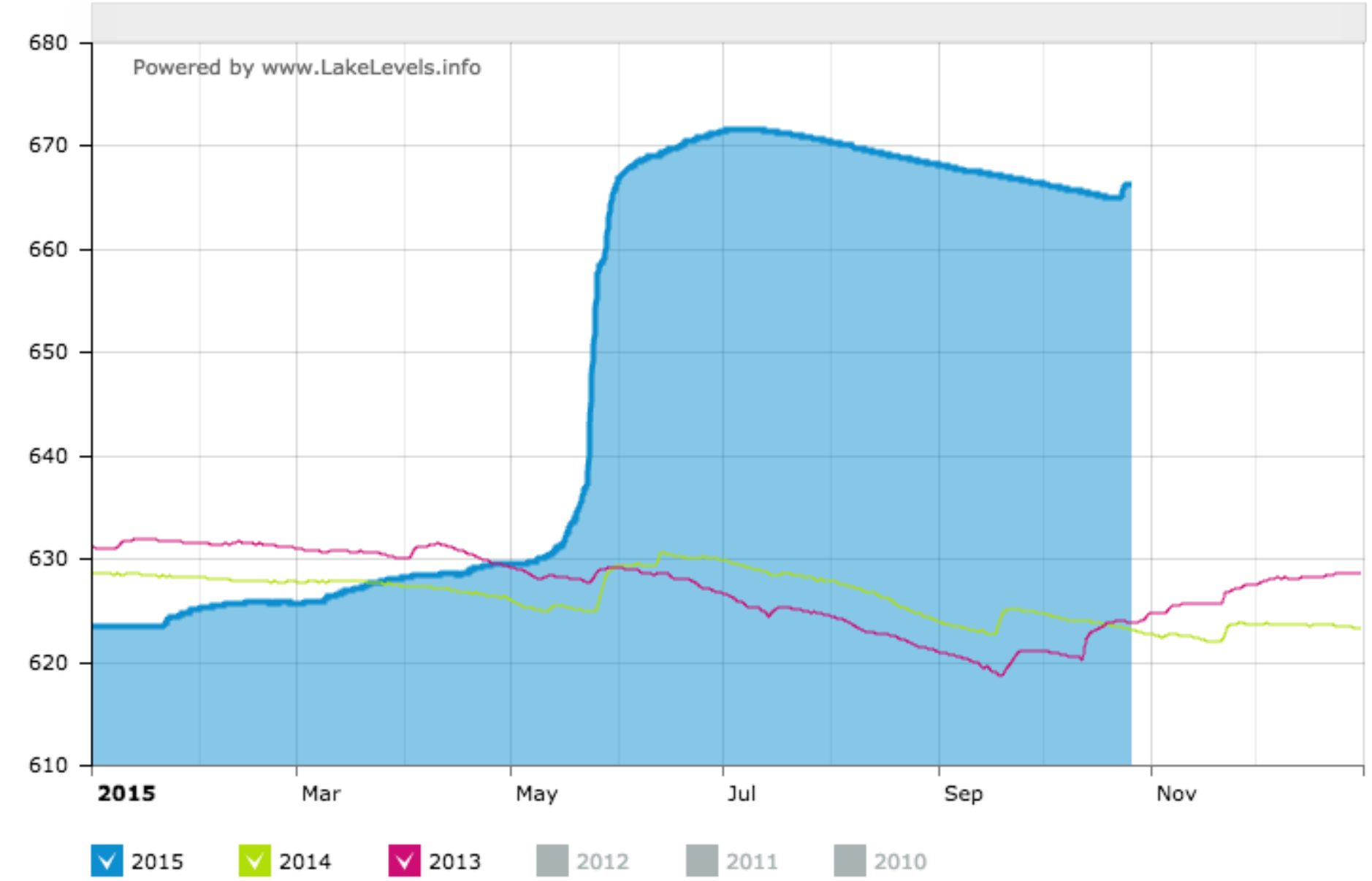
North Carolina State University and National Centers for Environmental Information

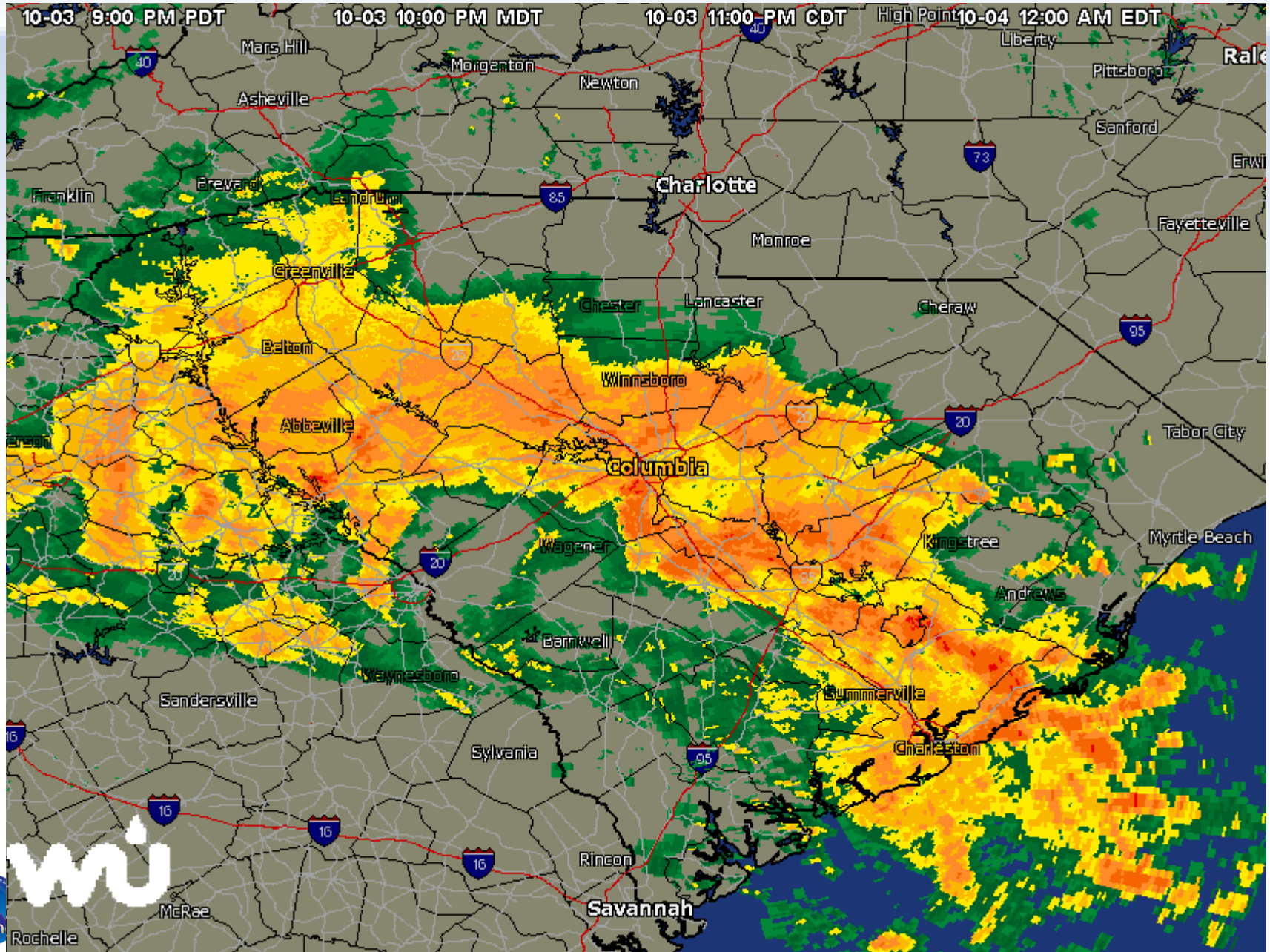
October 26, 2015



May, Texas, Lake Travis (Austin)



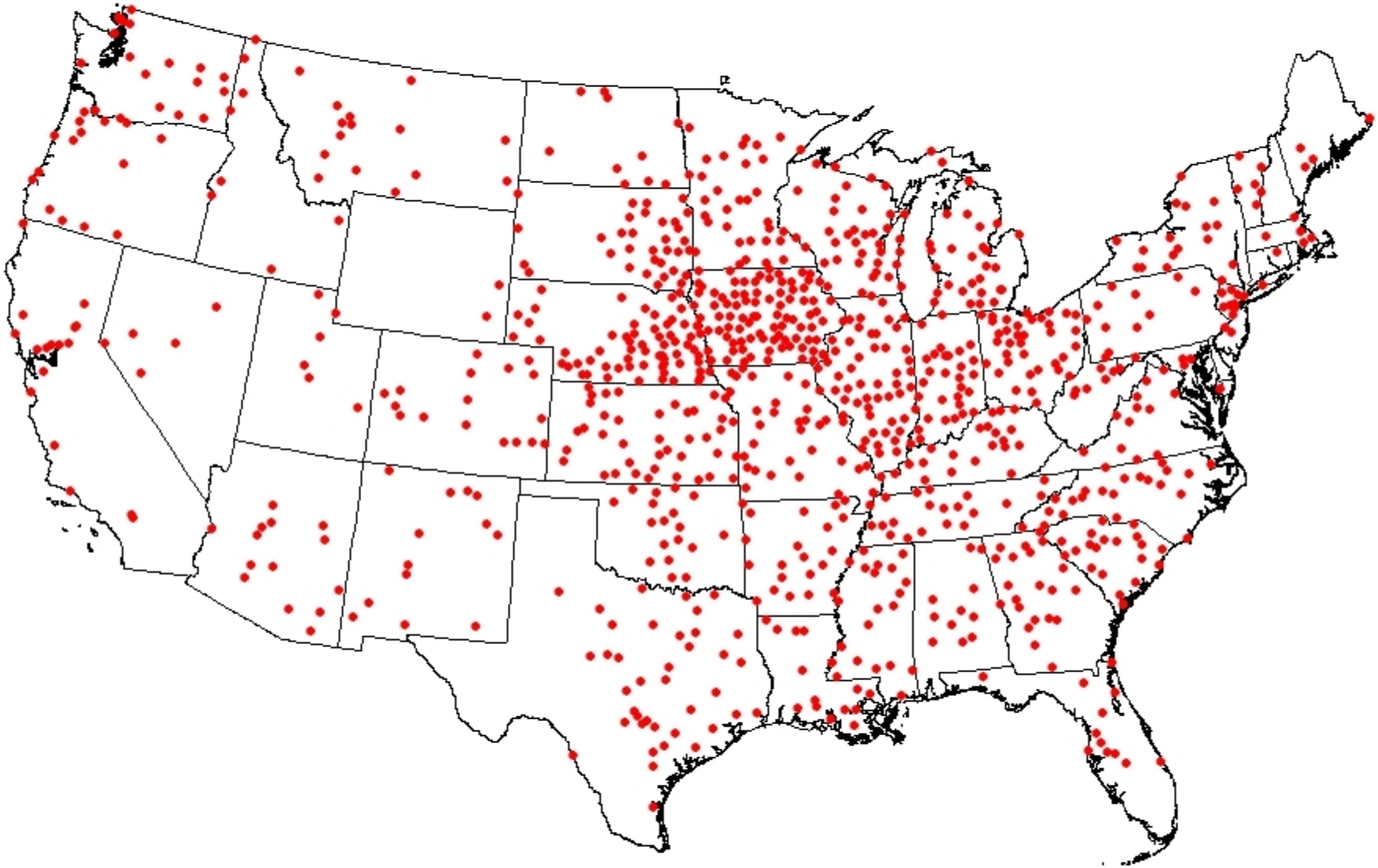
October 3, South Carolina



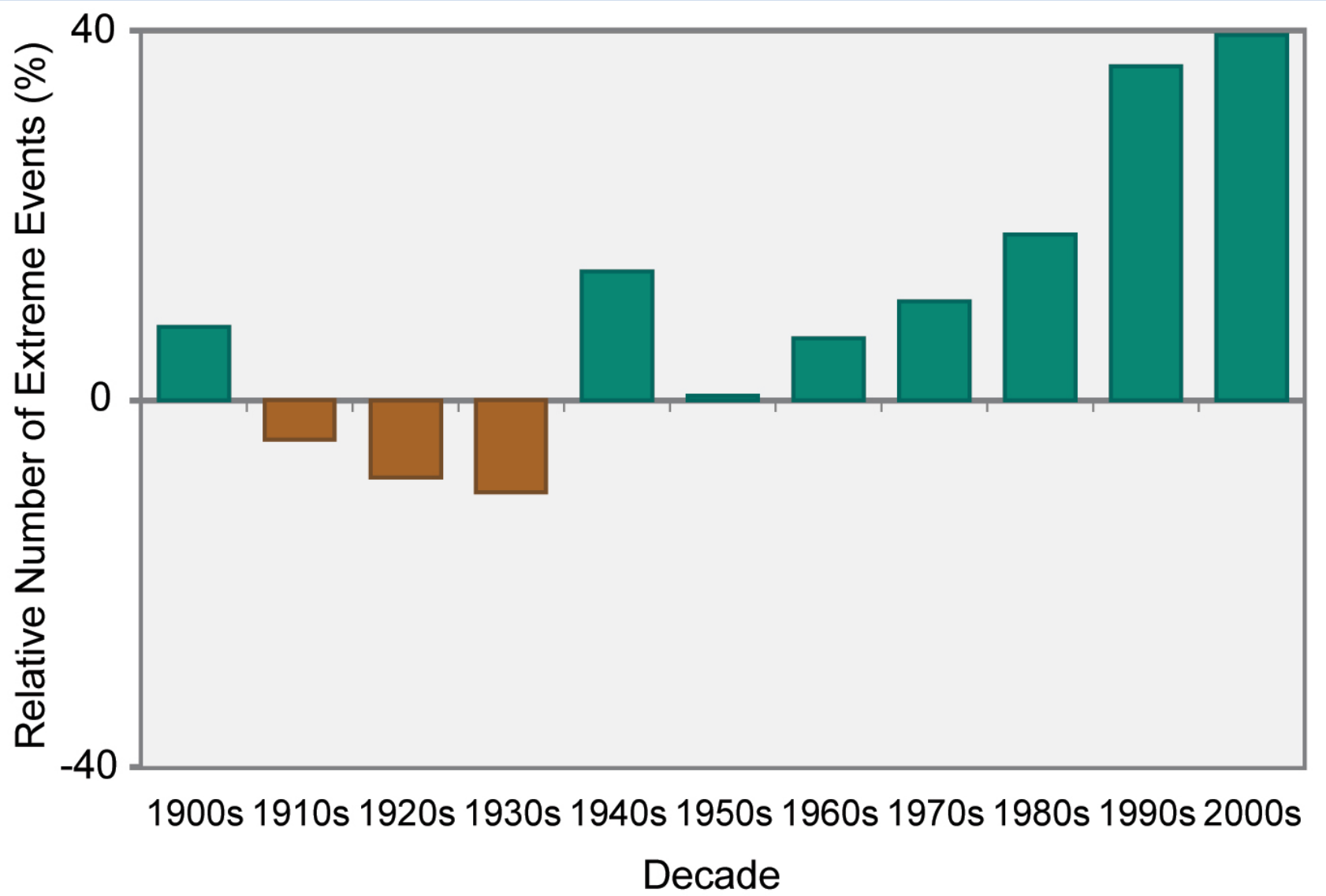
Oct. 24, Texas

Extreme Precipitation Analysis

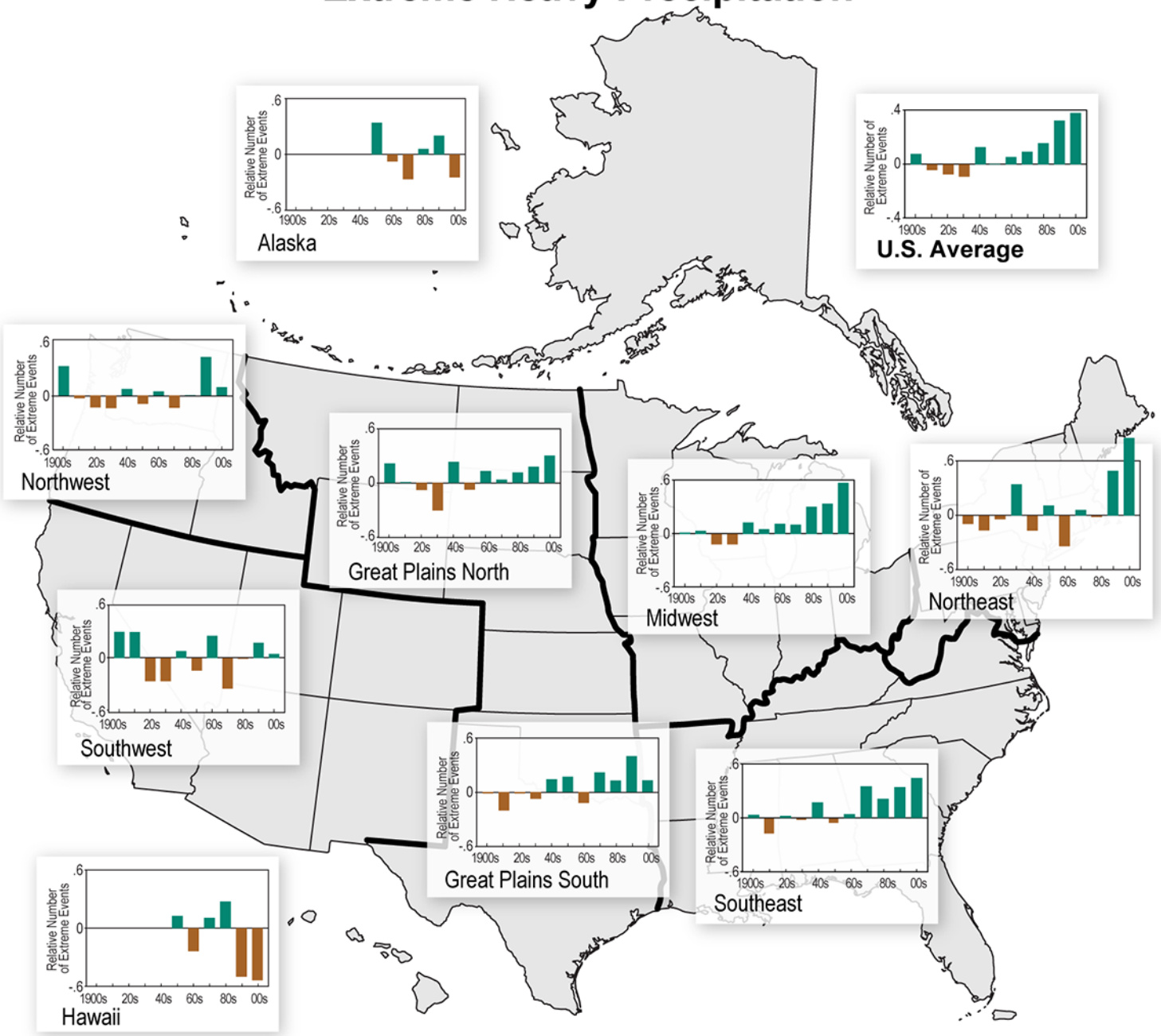
- Definition
  - Events exceeding a threshold amount for a specified average recurrence interval and duration: 2-day, 1-in-5yr, 1-day, 1-in-1yr
  - Amount of precipitation exceeding 99th %ile
  - Fixed threshold: 2 inches
- Periods: 1901-2012/2015, 1951-2014



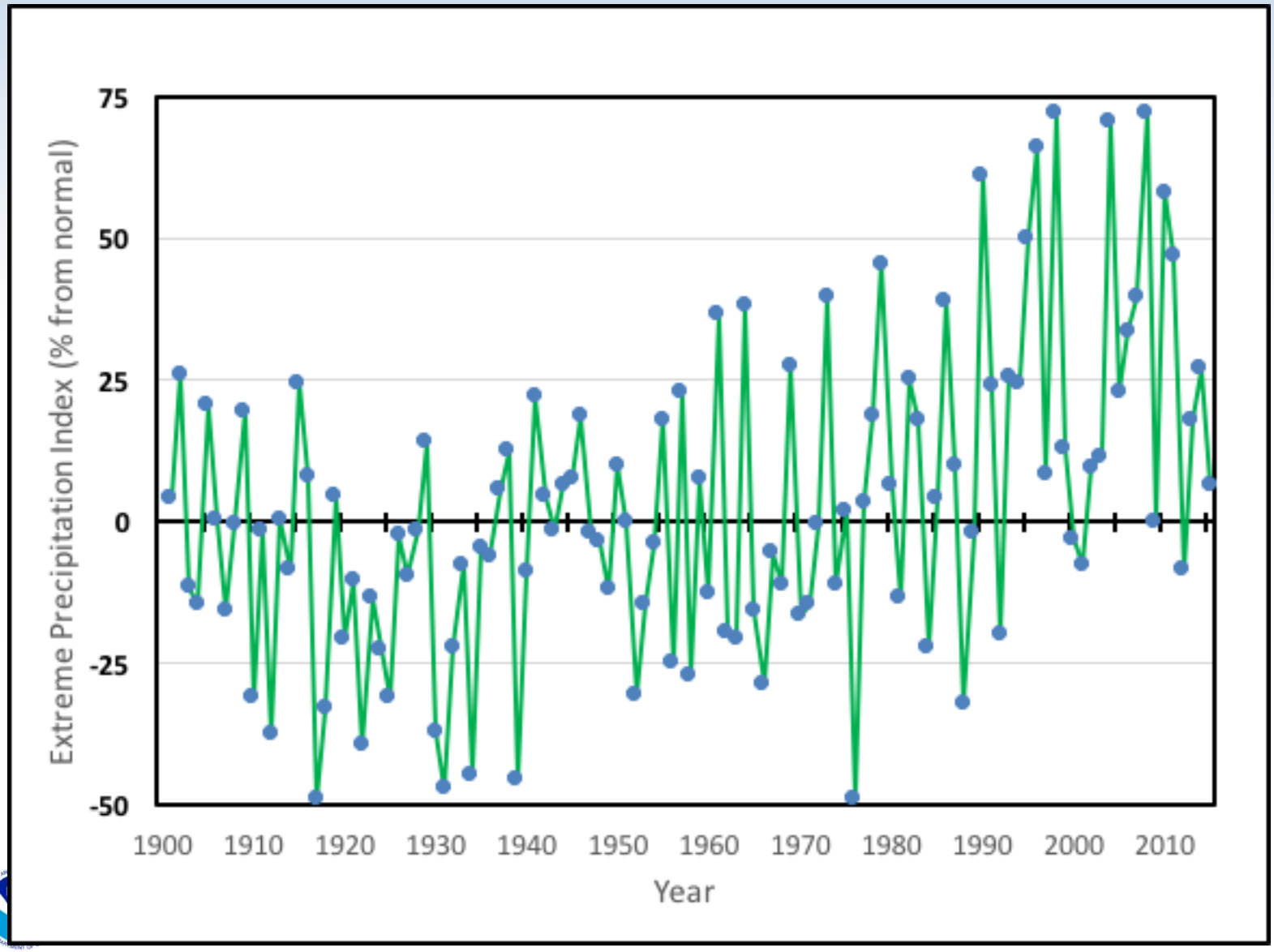
Number of 2-day, 1-in-5yr: U.S.



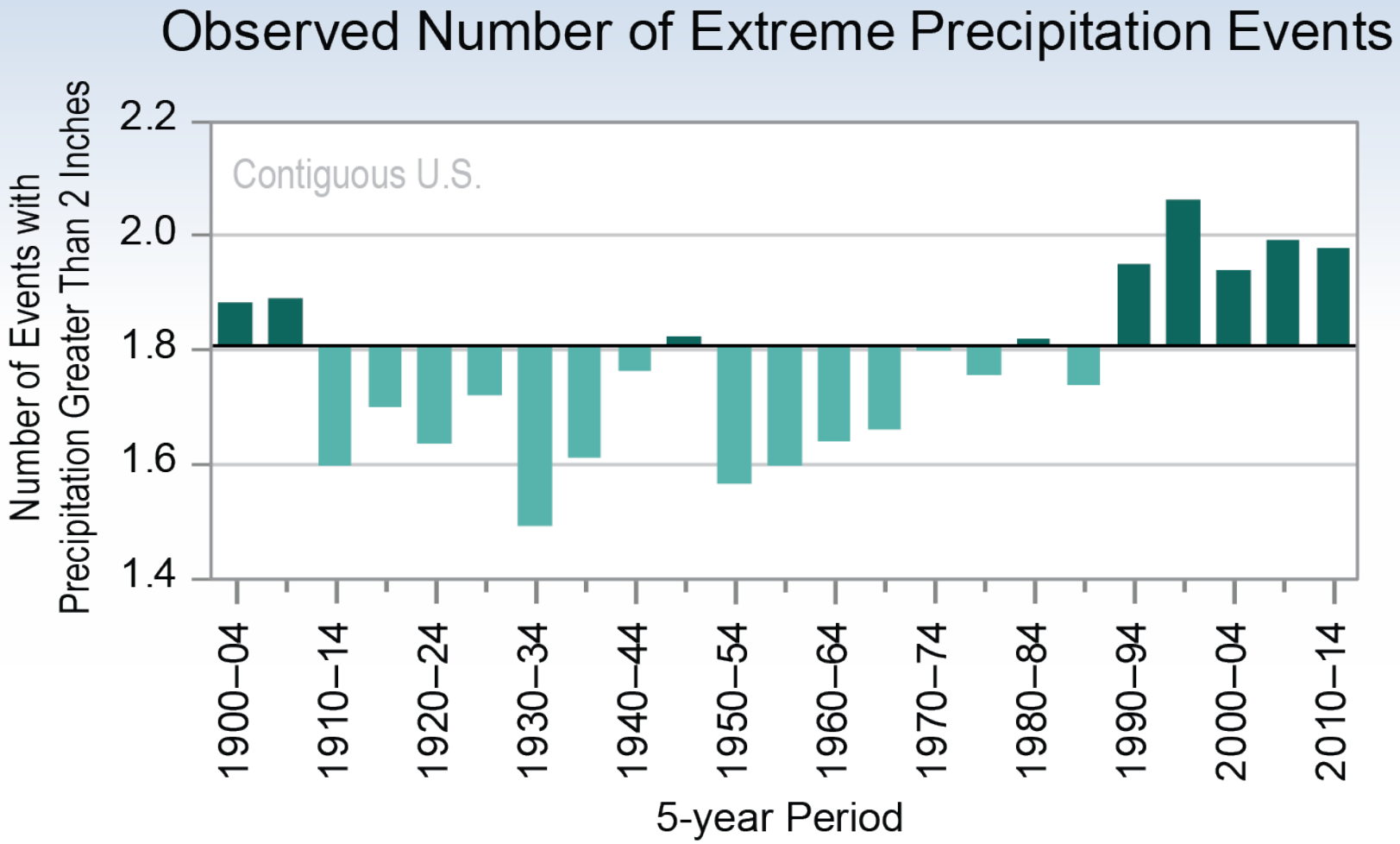
Extreme Heavy Precipitation



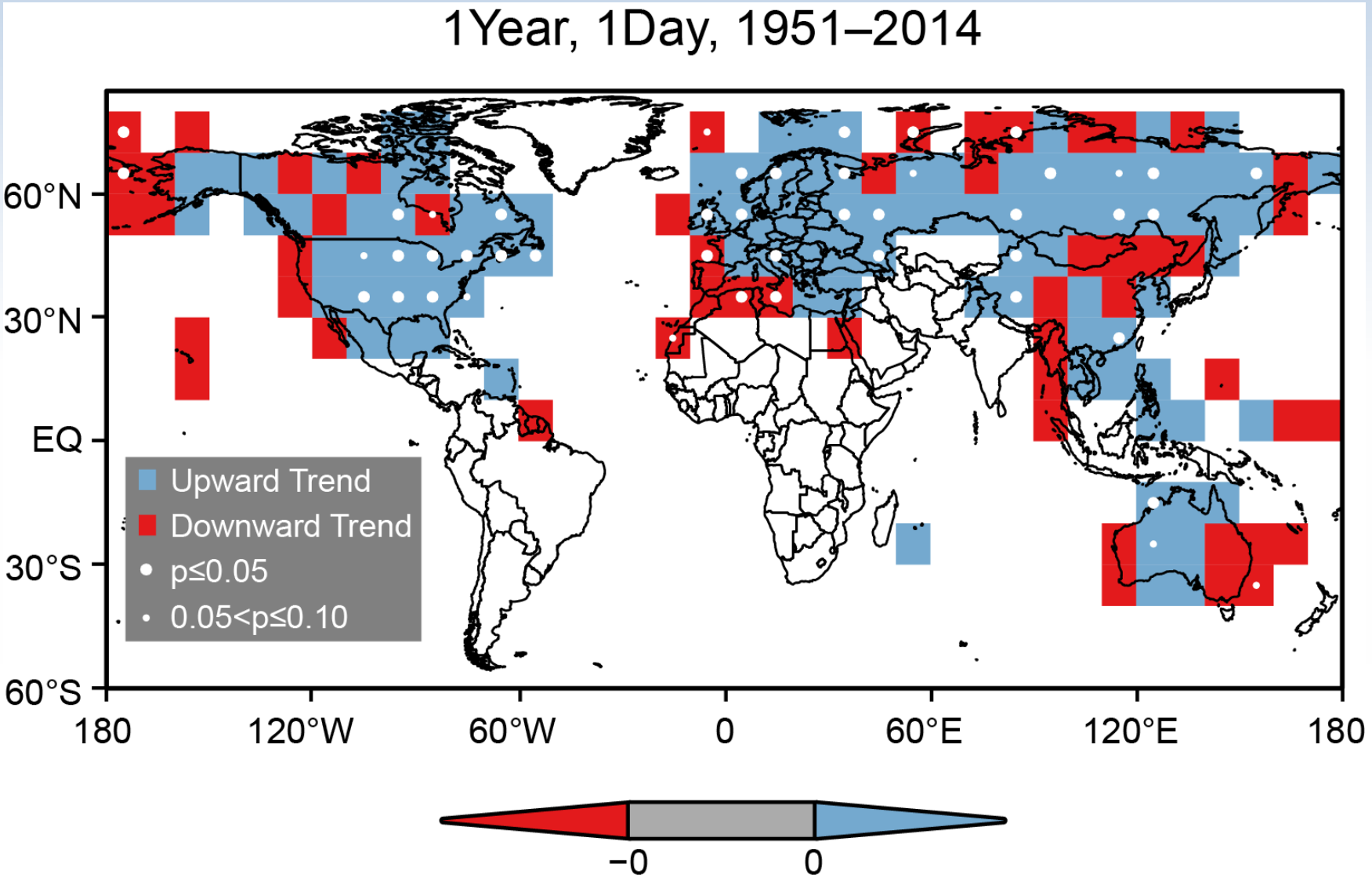
Number of 2-day, 1-in-5yr: U.S.



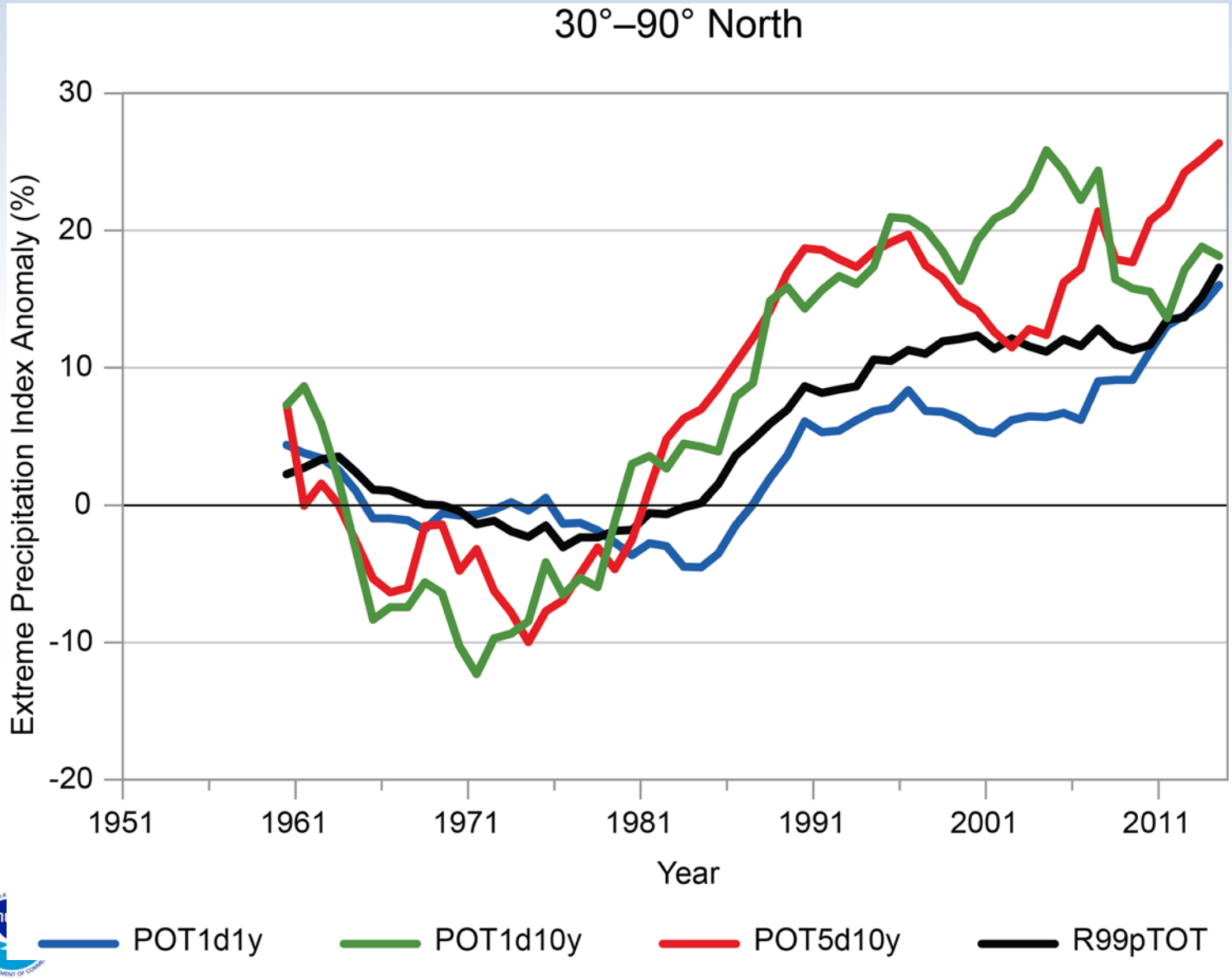
Daily 2 inch Precipitation Trends



Global Extreme Precipitation Trends



N.H. Mid and High Latitudes

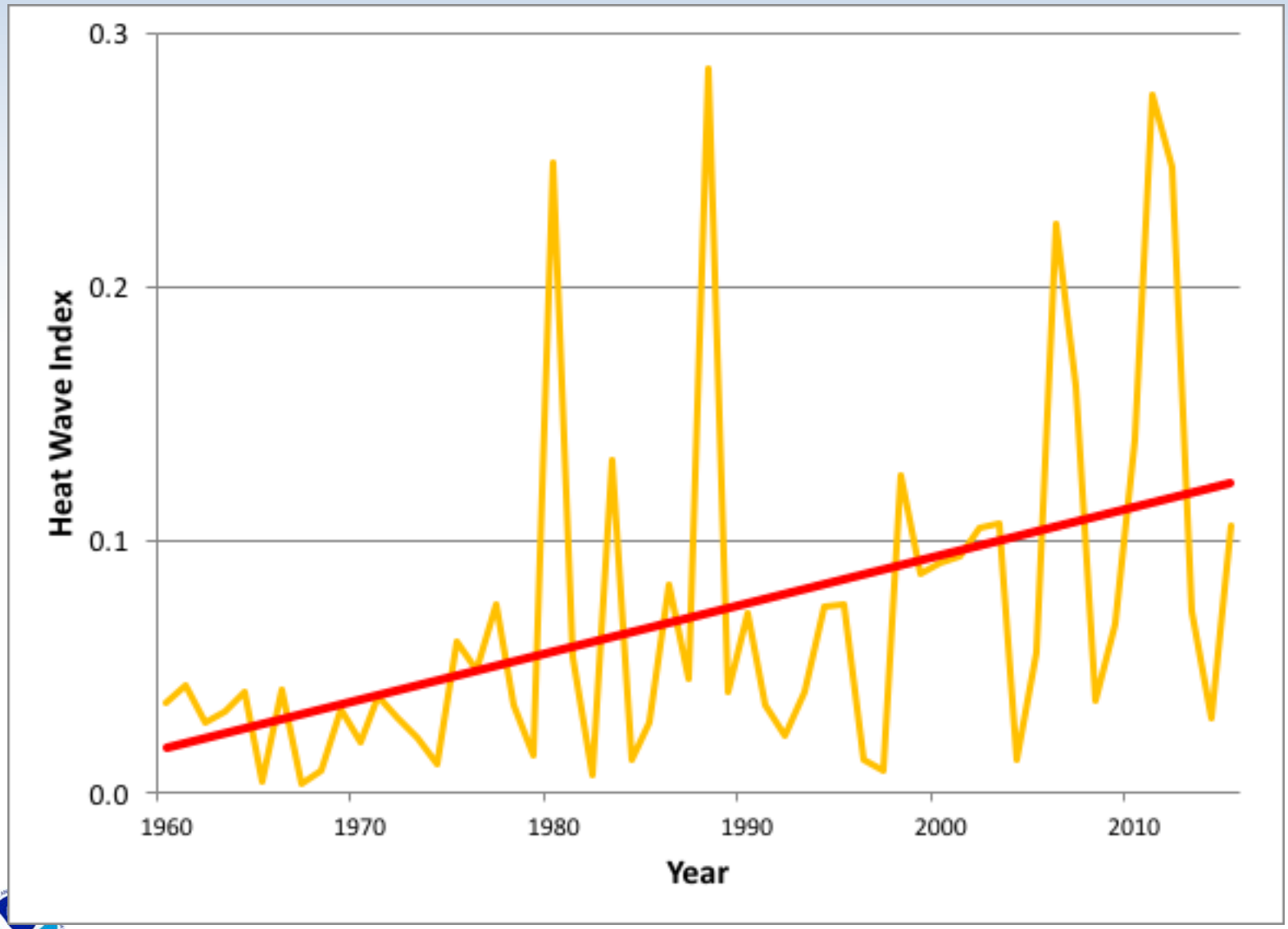


Heat and Cold Waves

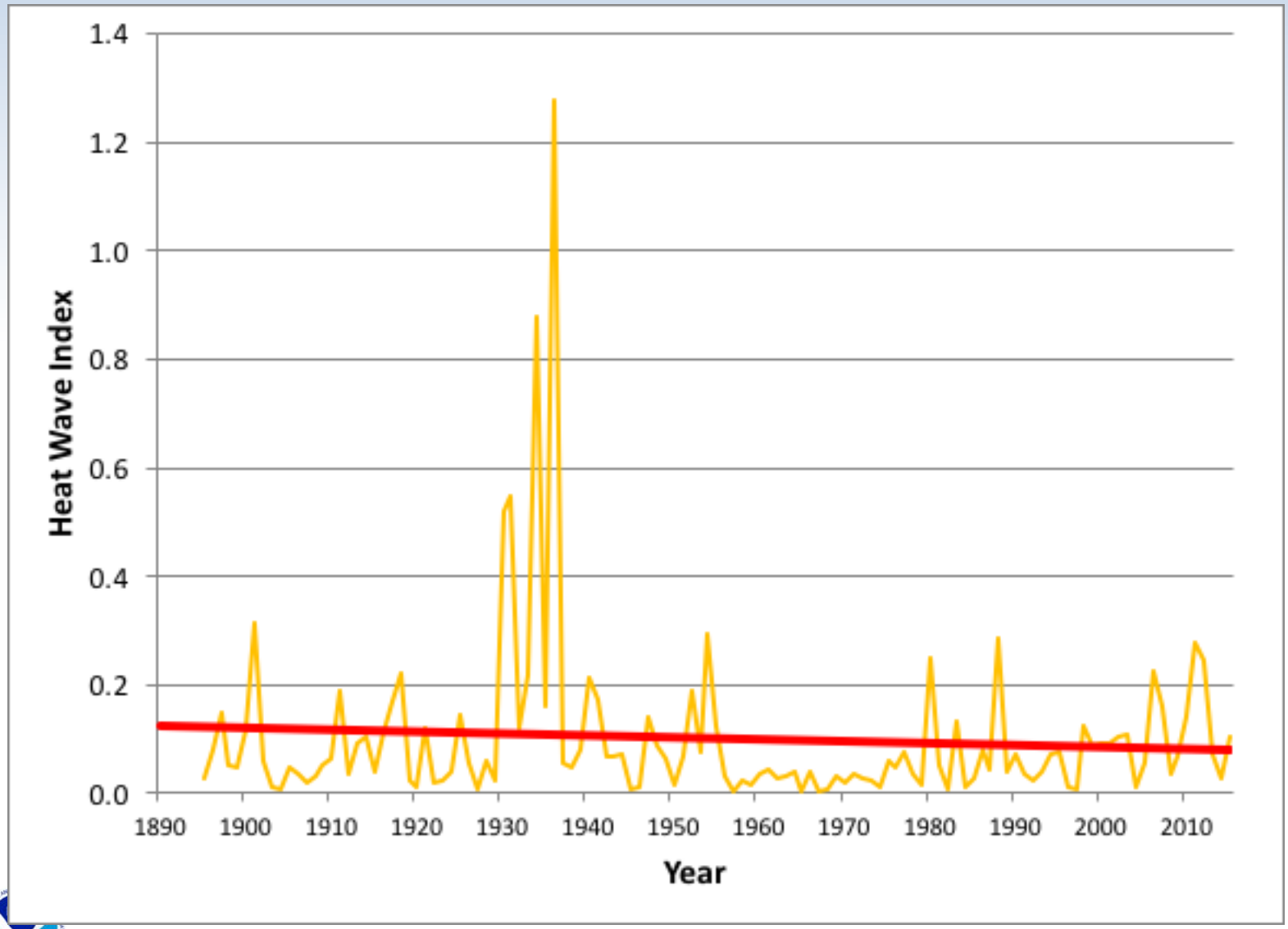
Observed Extreme Temperature Episodes

- 4-day, 1-in-10yr hot spells
- 5-day, 1-in-5yr hot spells
- Days with Tmin < 0F
- Days with Tmin > 75F
- Record hot and cold temperatures
  - Daily records
  - Monthly temperature records

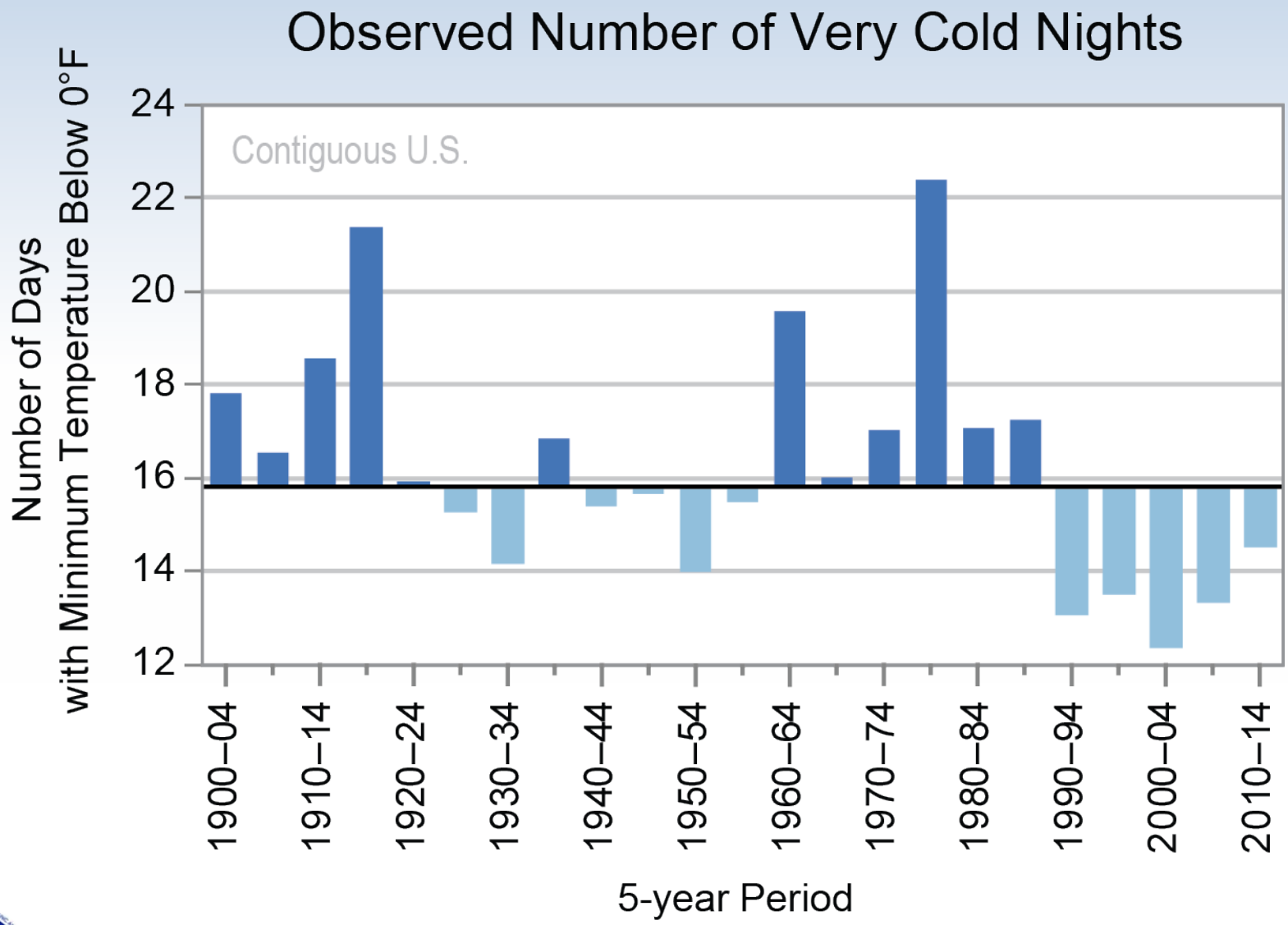
U.S. Hot Spells (4-day, 1-in-10yr)



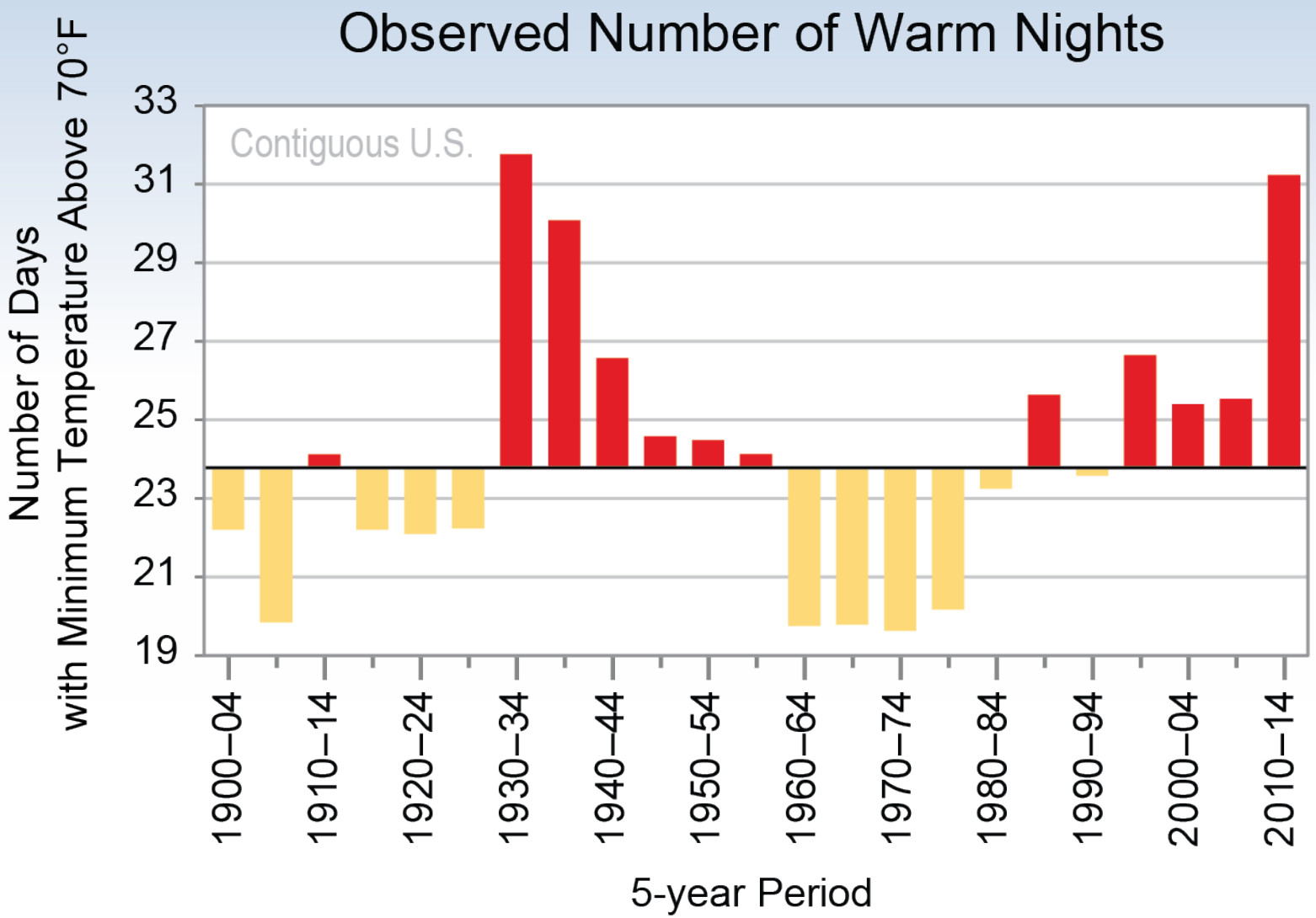
U.S. Hot Spells (4-day, 1-in-10yr)



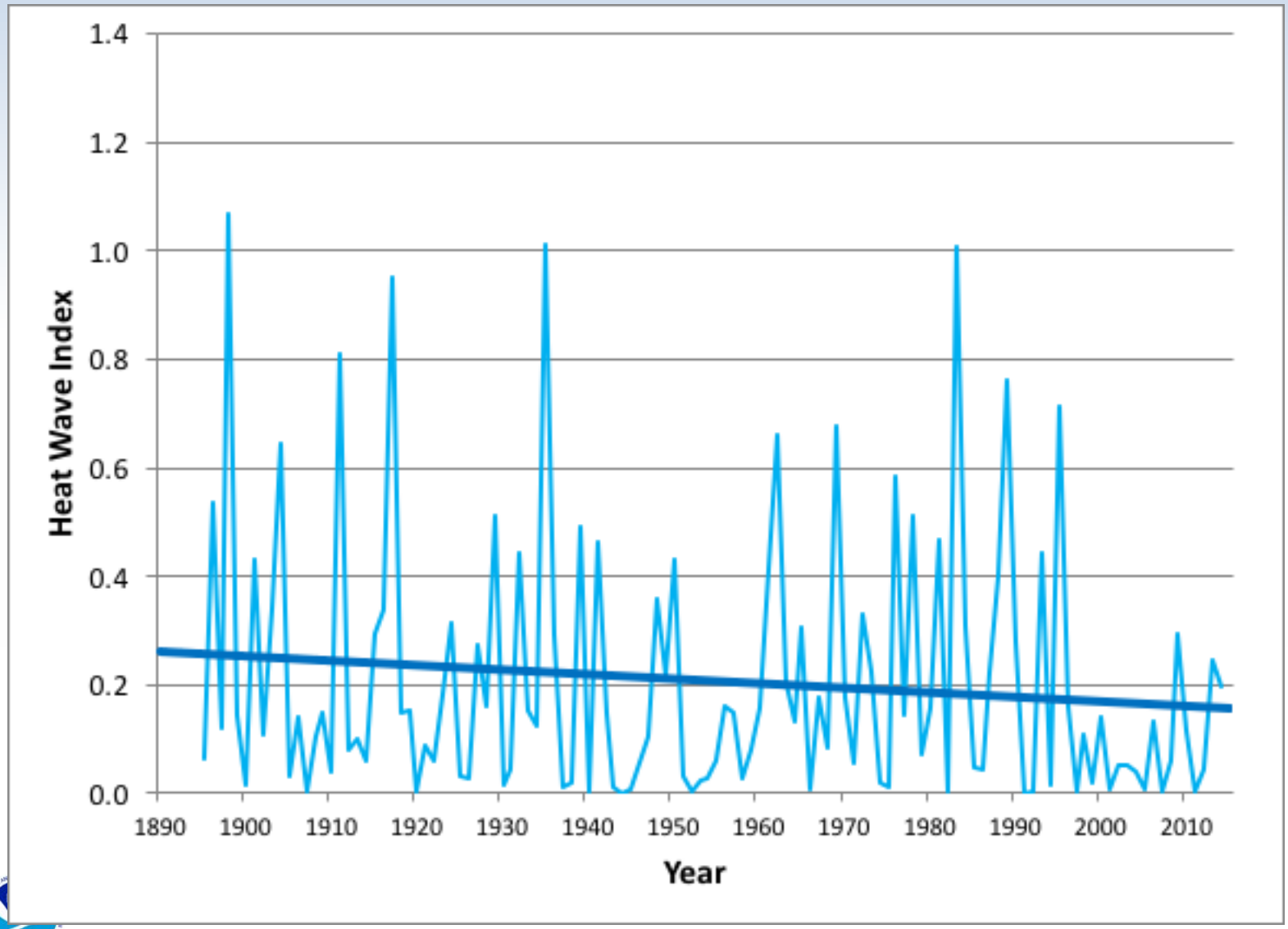
U.S. Very Cold Nights (T_{min} < 0F)



U.S. Warm Nights(T_{min} > 70F)

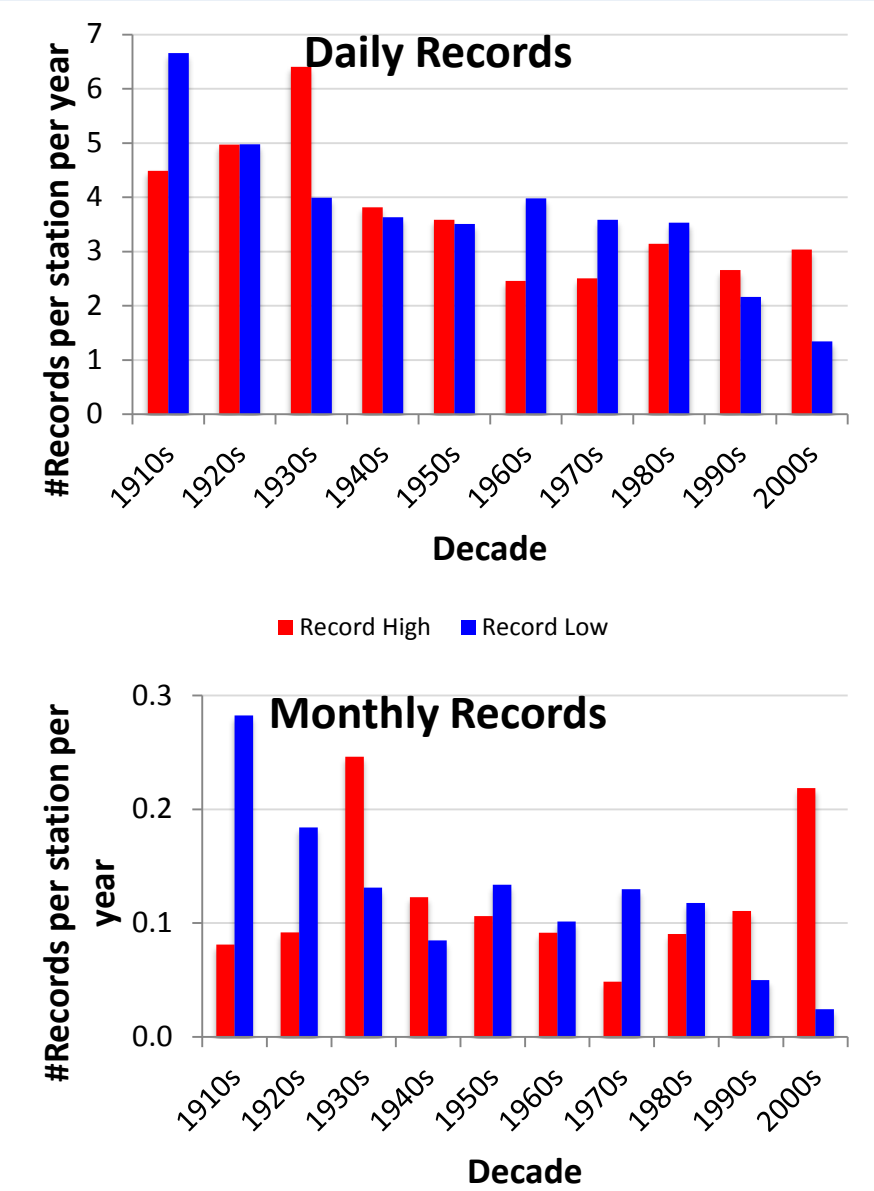


U.S. Cold Spells (5-day, 1-in-5yr)

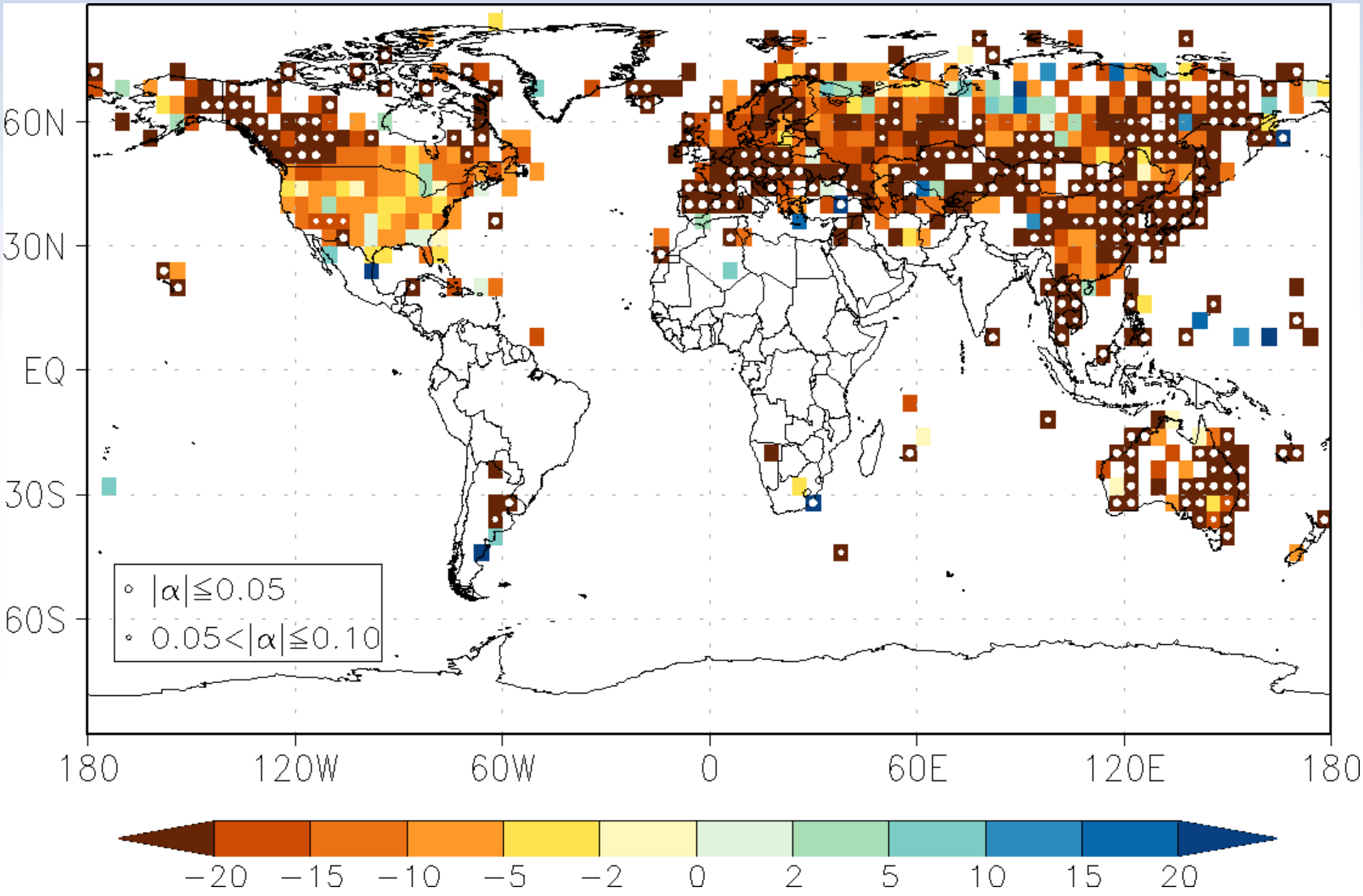


Extreme Temperature Episodes

- Record hot and cold temperatures
  - Daily records
  - Monthly temperature records



5-day, 1-in-5yr cold spells trend, 1951-2014



Causes of U.S. extreme precip trends

- Have there been secular changes in the frequency, intensity, and other characteristics of the meteorological phenomena producing heavy precipitation?
- Are the recent increases primarily a result of increases in atmospheric water vapor concentrations?

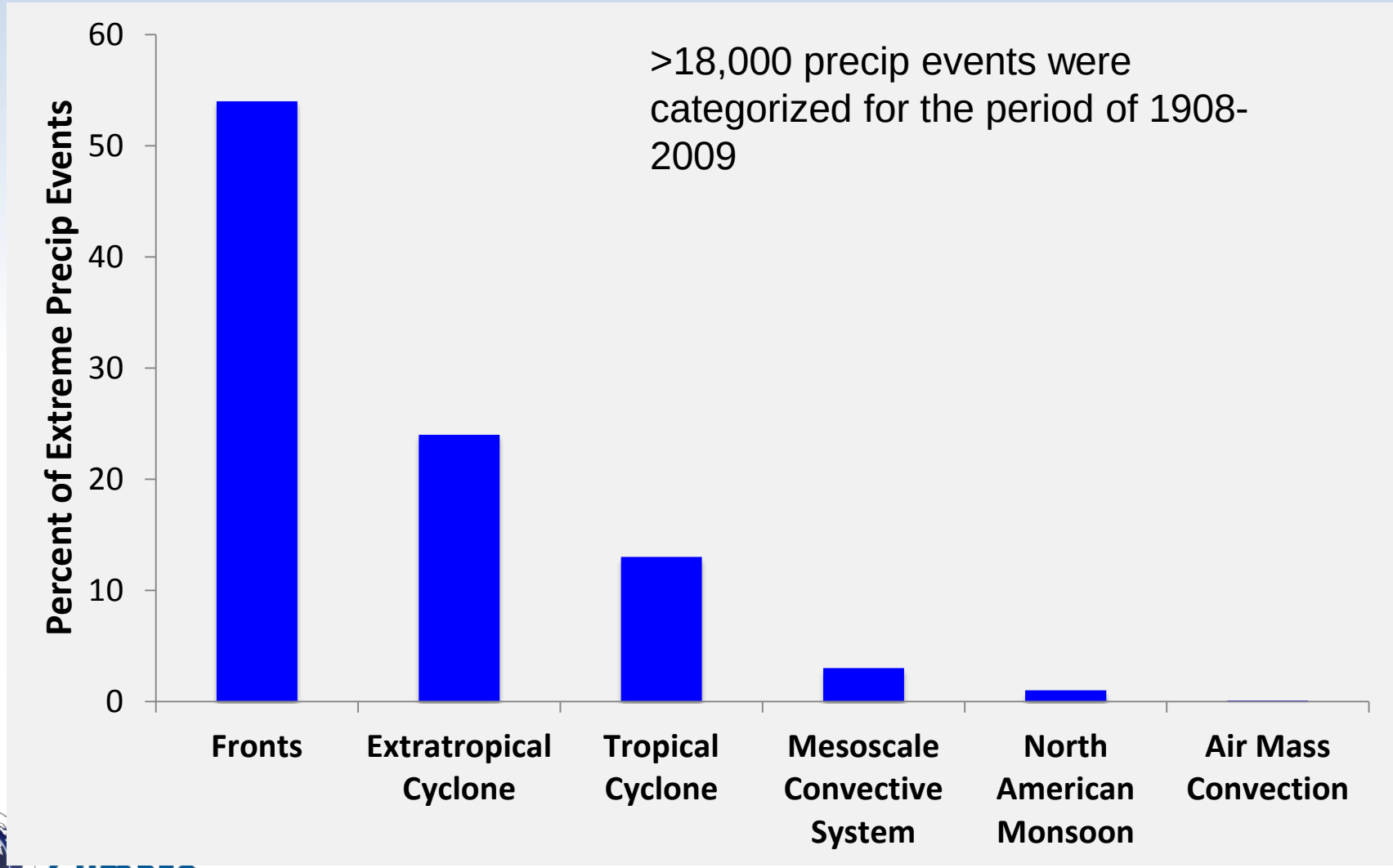
Causes

- Have there been secular changes in the frequency, intensity, and other characteristics of the meteorological phenomena producing heavy precipitation?

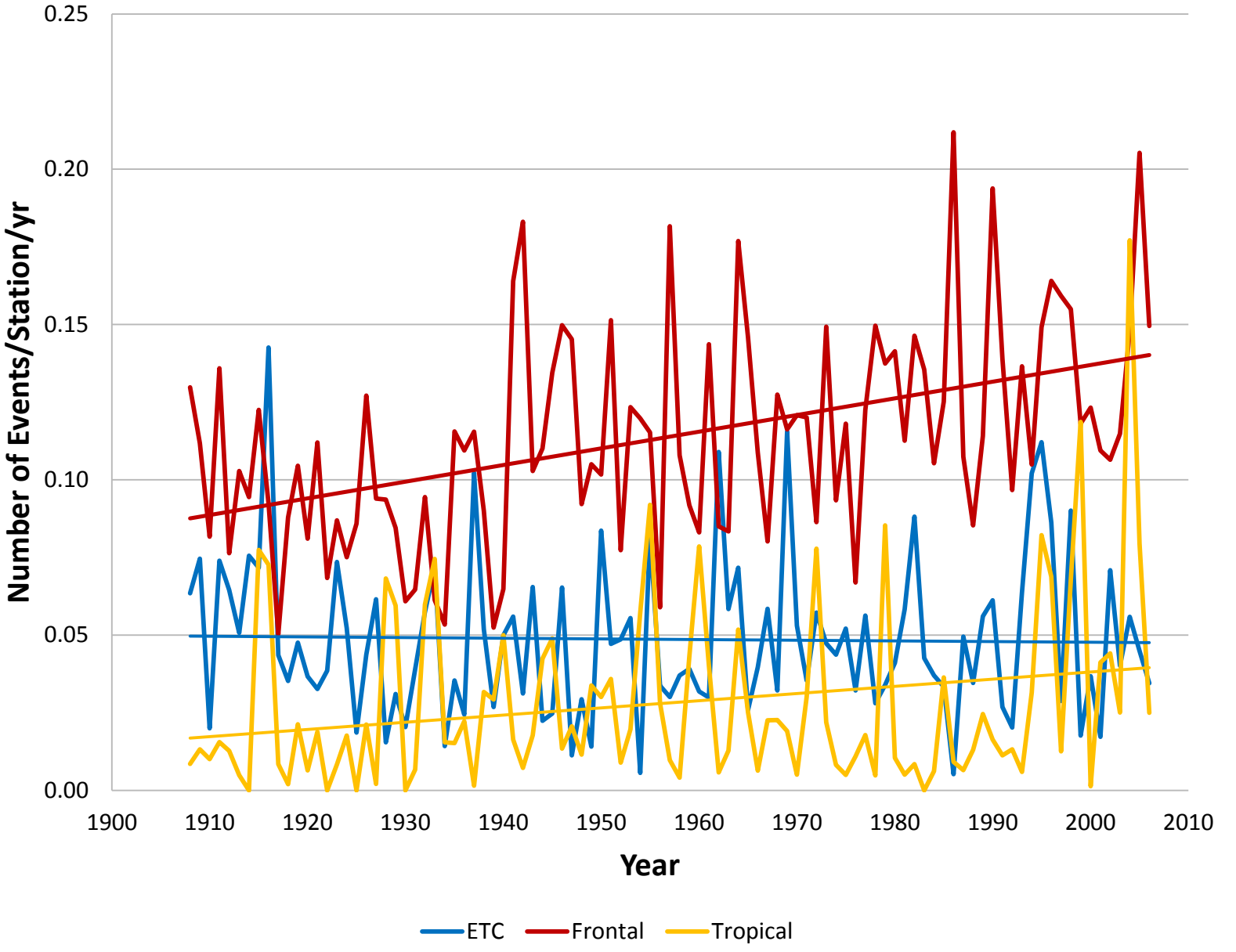
Meteorological Types

- Extratropical Cyclones
  - Frontal (at least ~300 km away from center of surface or upper low)
  - ETC (near surface or upper low center)
- Tropical Cyclones
- Mesoscale Convective Systems
- Air Mass Convection
- North American Monsoon
- Upslope

Contribution by Type



Fronts (red), ETC (blue), TC (yel)



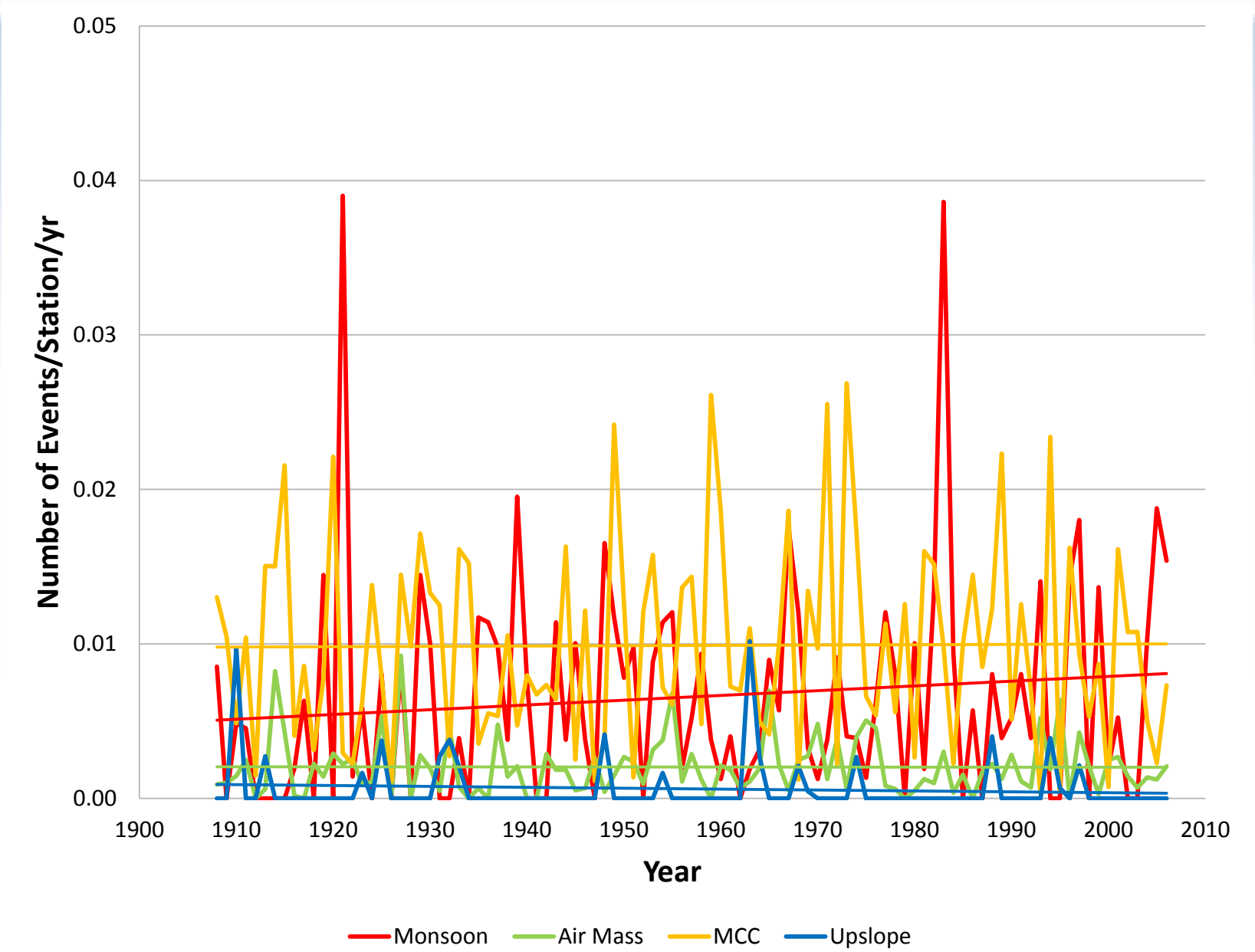
Causes

- The U.S. upward trend in extreme precipitation is associated with an increase in the number of events associated with **fronts** and **tropical cyclones**. There is no trend in the number associated with the other meteorological types.
- There is not any trend in the number of landfalling tropical cyclones. More extreme precipitation events per tropical cyclone. **Does this mean higher water vapor is the cause?**
- We have not investigated (yet) whether there are more fronts or the fronts have characteristics more conducive to extreme precipitation.

Conclusions

- 2015 preliminary extremes assessment
  - Above average extreme precipitation
  - Near average extreme heat and cold
- Recent above average occurrence of extreme precipitation events continues long-term trend
- Cold temperature extreme decreases
- Hot temperature extreme increases for nighttime minima

NAM, MCC, Air Mass, Upslope



99%ile precipitation change: 1958-2012