Potential Impact of Climate Change on Rare Precipitation

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Topics

- Approaches to Hydrologic Design
- National Research Council Concern
- The Semantic Problem
  - Climate community semantics
  - Engineering community semantics
- Trends in Exceedances
  - From an engineering point of view

Approaches to Hydrologic Design

1 Generally too costly to avoid failure always
- Therefore accept chance of failure based on situation
  - *Flood Frequency Estimate*: Peak discharge associated with annual exceedance probability
  - *Precipitation Frequency Estimate*: Precipitation depth or intensity associated with annual exceedance probability for a given duration

1 Sometimes we must avoid failure always
- *Probable Maximum Precipitation*: worst case "perfect storm"
  - Unknown probability

National Research Council Concern

"Management and mission-oriented agencies with public-sector responsibilities have been provided with marginally useful scientific information about the likely manifestations of future climate change."

"There are insufficient interactions and knowledge exchange between climate scientists, water scientists, and engineers and practitioners to solve these challenges."

"Global Change and Extreme Hydrology: Testing Conventional Wisdom"
National Research Council, Water Science and Technology Board, 2011

Climatology Semantics

- "It is likely that the frequency of **heavy** precipitation events … has increased over most areas."

  IPCC AR4, Climate Change 2007: Synthesis Report

- "Groisman et al. (2005) found significant increases in the frequency of **heavy** and **very heavy** (between the 95th and 99.7th percentile of daily precipitation events)"

  IPCC AR4 Working Group I

- These and similar statements in the literature define terms such as
  - "**heavy**", "**very heavy**", and "**extreme**" precipitation
  - Sometimes differently!

For Example

- Groisman et al 2005
  - "… we define a daily precipitation event as **heavy** when it falls into the upper 10% and/or 5% of all precipitation events;

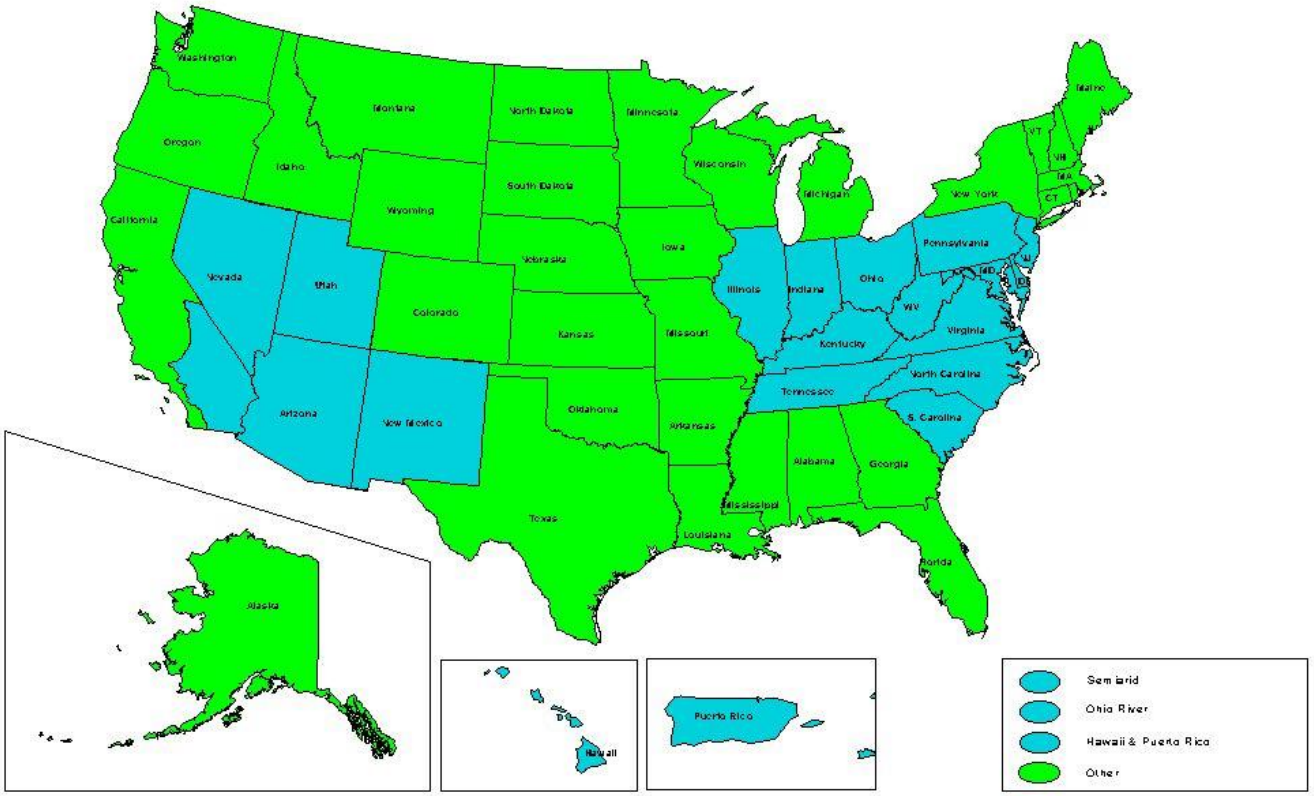
    as **very heavy** when it falls into the upper 1% and/or 0.3% of precipitation events;

    and **extreme** when it falls into the upper 0.1% of all precipitation events."
  - "The return period for such events … varies, for example, from 3 to 5 yr for … **very heavy** precipitation events."
- Generally consider just daily durations

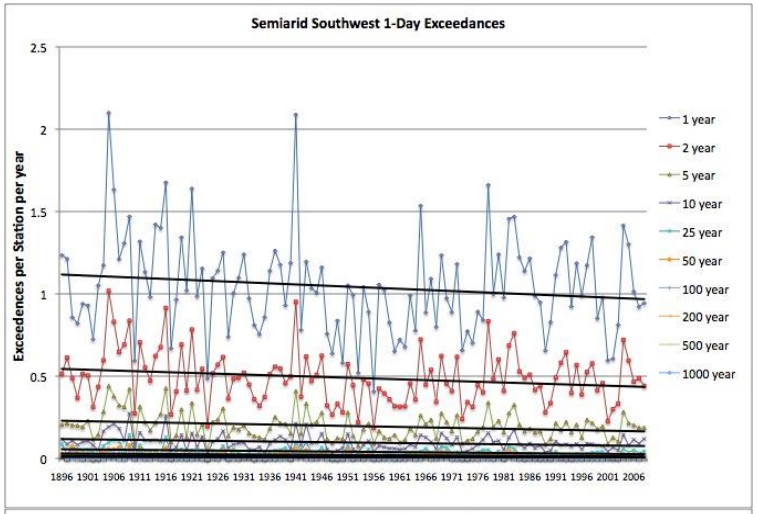
Civil Engineering Semantics

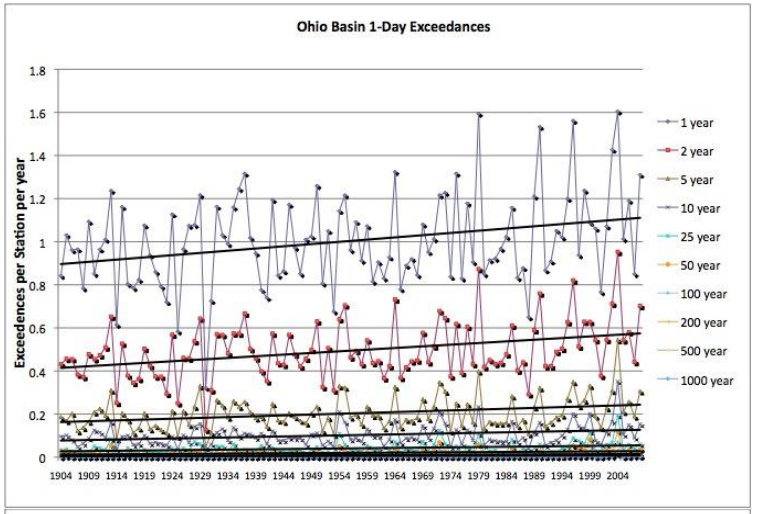
- Use precipitation frequency estimates
  - annual exceedance probability (AEP) or
  - average recurrence interval (ARI)
- Heavy, very heavy, and extreme rainfall:
  - are subjective terms
- Use many durations; not just daily
  - NOAA Atlas 14 provides 5 min through 60 days

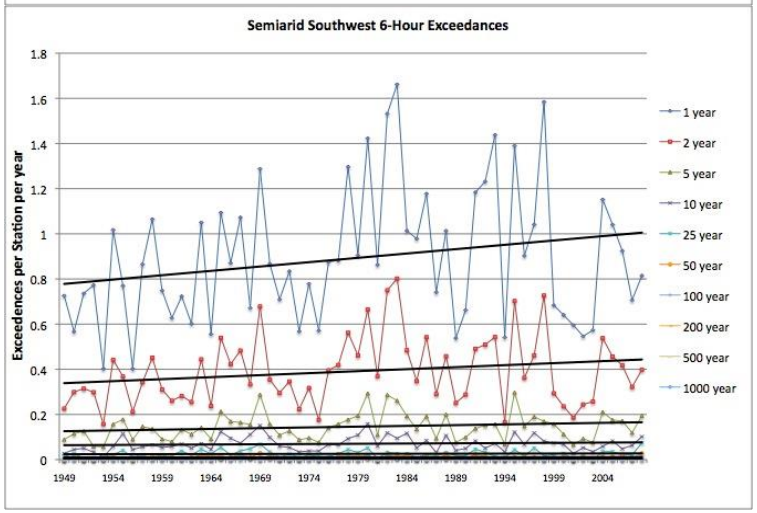
Trends in Exceedances Engineering Perspective

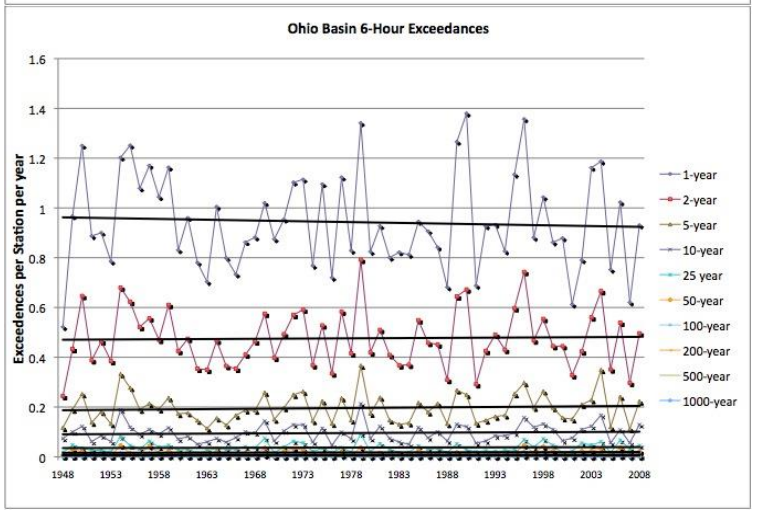


Example Trends in Exceedances







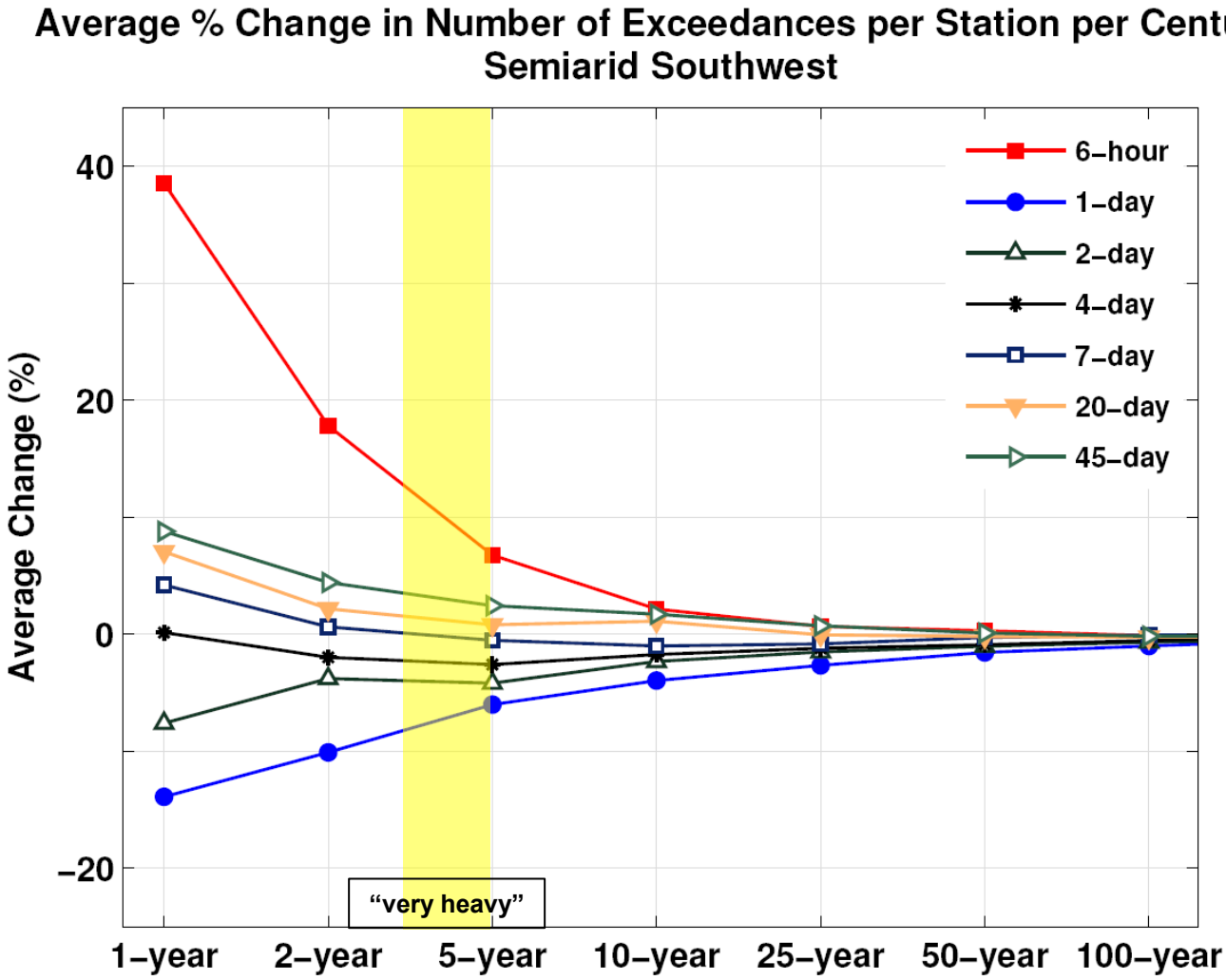


Trends in Exceedances

NA14, 90% confidence intervals

+/- 30%
sparsely instrumented, shorter record; to

+/- 10%
more densely instrumented, longer record



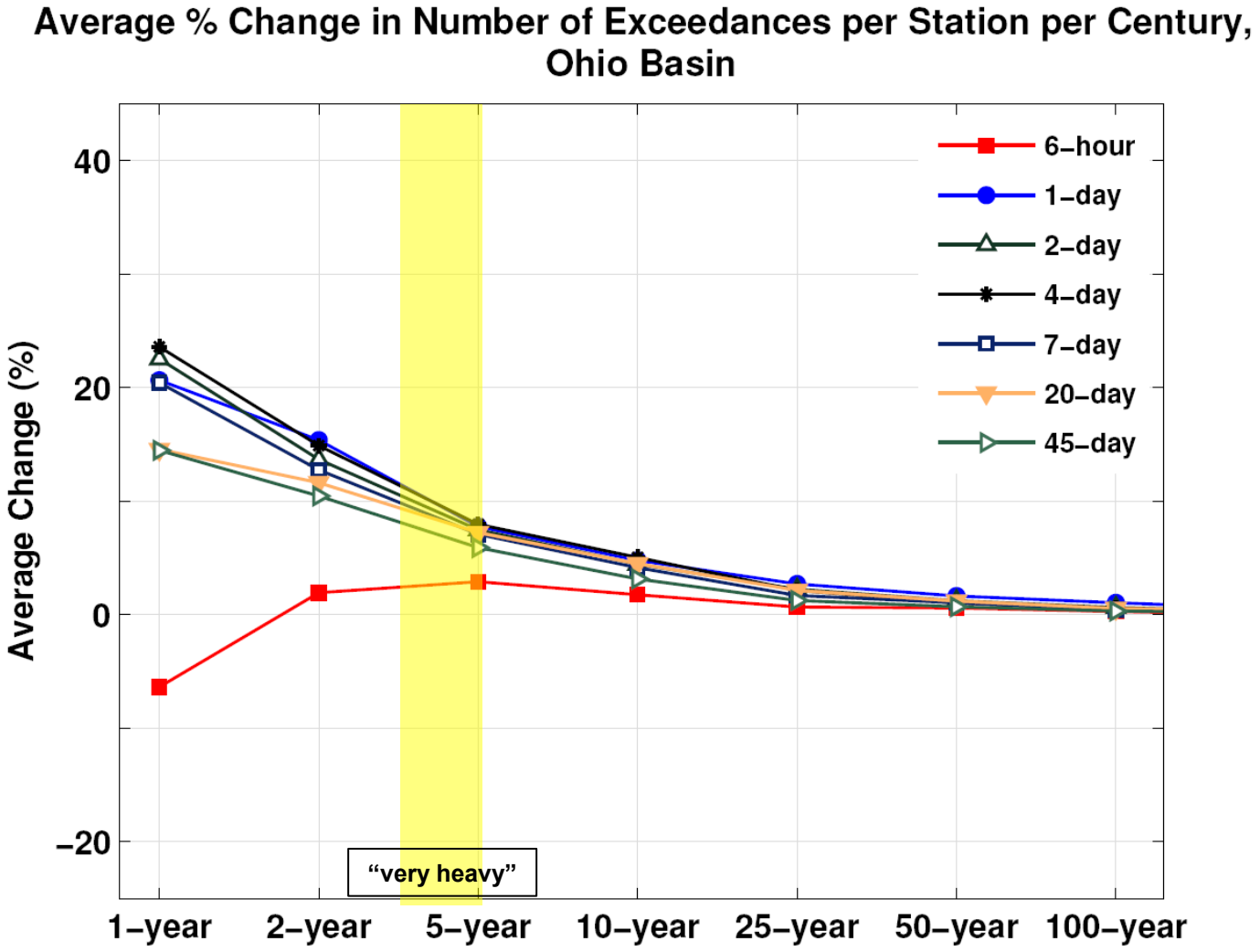
- Generally statistically significant except for 6 hour durations
  - *.05 level, T-test & Mann Kendall*

Trends in Exceedances (continued)

NA14, 90% confidence intervals

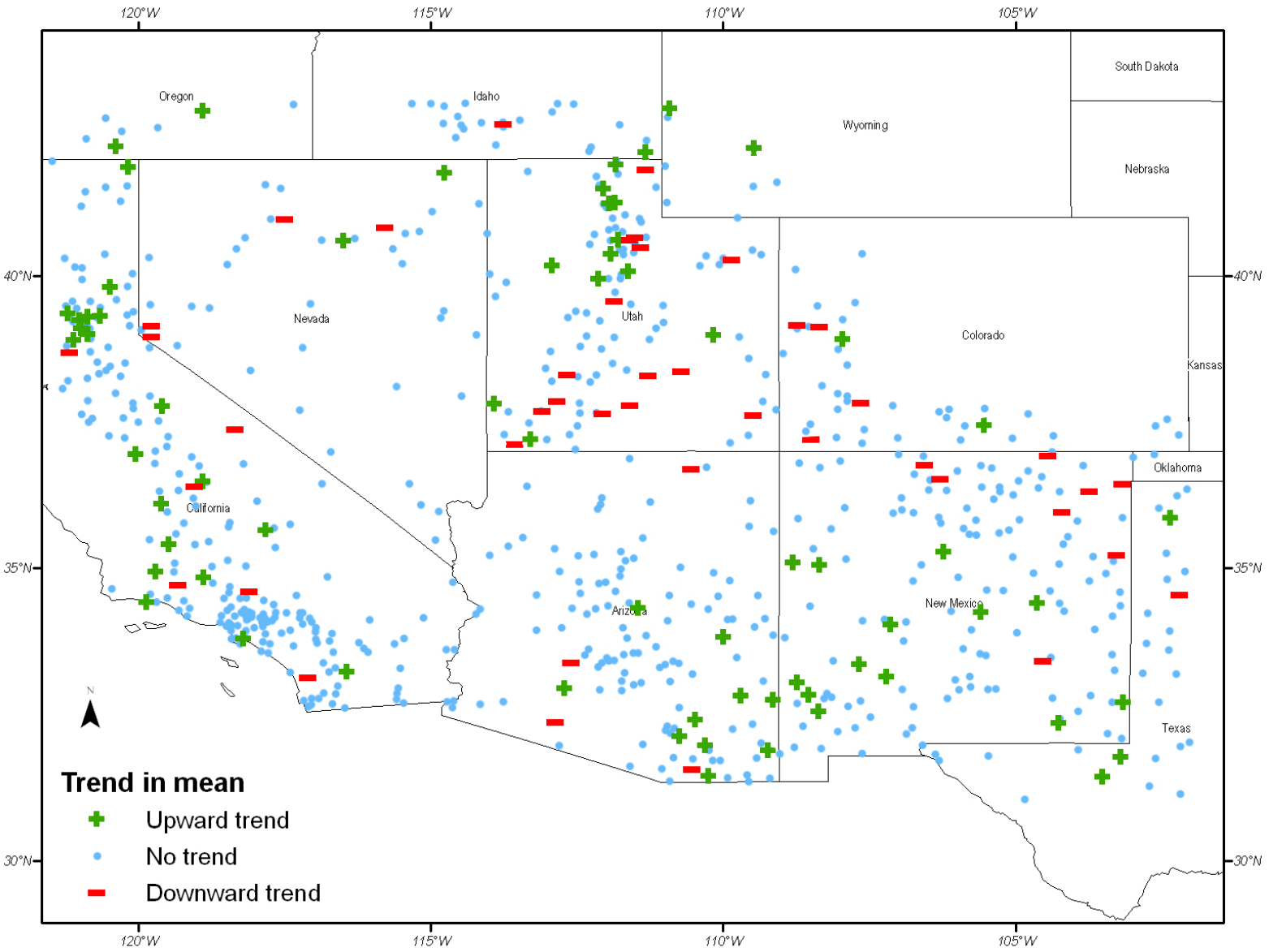
+/- 30% sparsely instrumented, shorter record; to

+/- 10% more densely instrumented, longer record



- Generally not statistically significant except for daily durations above 2 yr ARI
  - *.05 level, T-test & Mann Kendall*

Spatial Coherence of Trends in AMS Means



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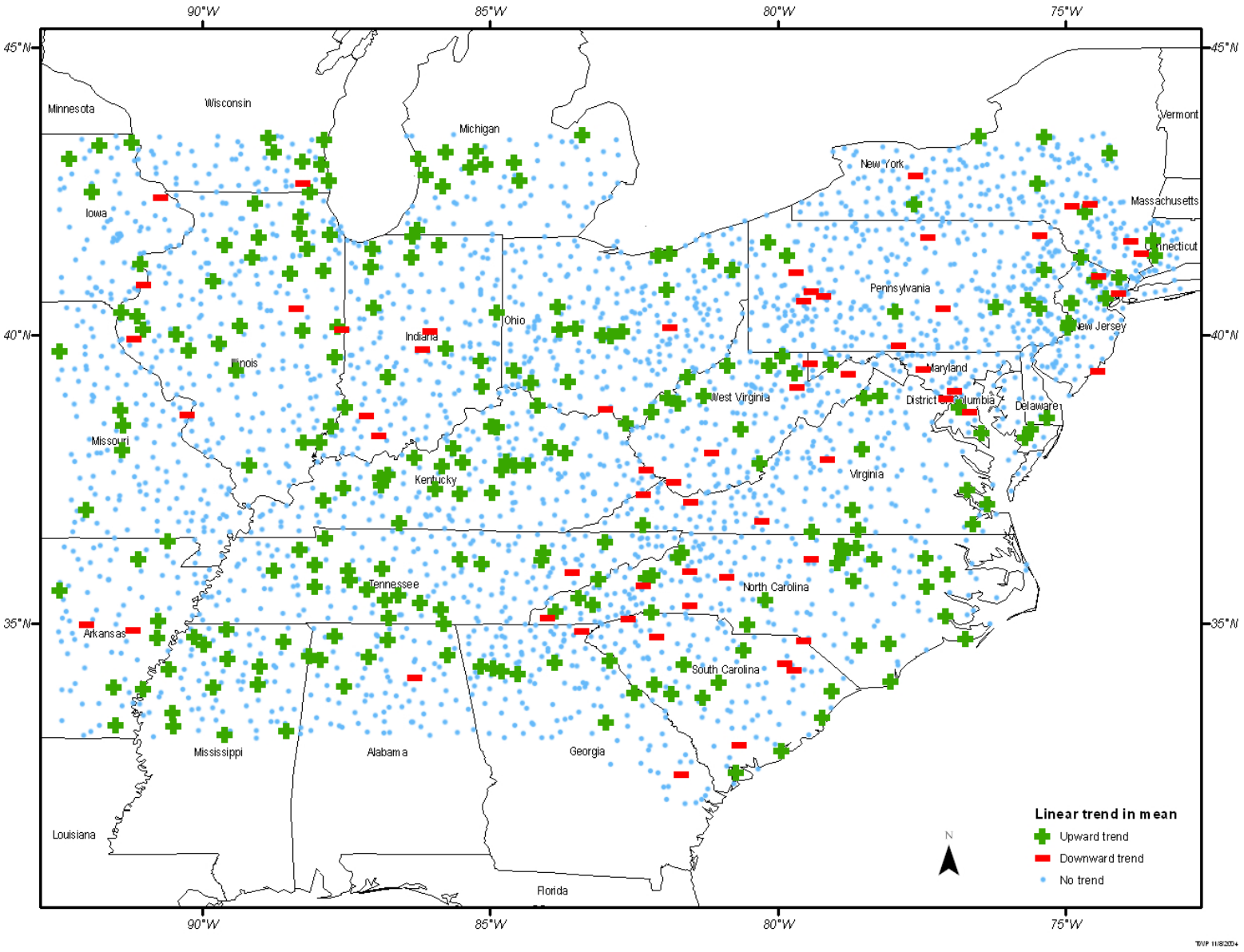

Conclusions

- Climate community statements on trends in rainfall exceedances
  - *Do not address frequencies and durations required for civil infrastructure*
- Climate community statements are being misinterpreted
  - *by Civil Engineers and probably the public*
- Historical trends in exceedances
  - *Are small compared to uncertainty of IFD values*
- We need better guidance on potential impact of climate change on IFD curves
  - *In range relevant to civil infrastructure*

Discussion

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