NWS Precipitation Frequency Estimates and Whaddya Mean by Extreme Precip

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Topics

- Precipitation Frequency Estimates
  - What are they? How are they used?
  - NOAA Atlas 14
- Potential Impact of Climate Change on Precip Frequency
  - The semantic problem
  - Exceedances

Probabilistic Approach to Hydrologic Design

- Generally too costly to avoid failure all the time
  - *Therefore accept chance of failure based on situation*
- FLOOD FREQUENCY ESTIMATE: Peak discharge associated with annual chance of exceedance
- PRECIPITATION FREQUENCY ESTIMATE: Precipitation magnitude associated with annual chance of exceedance
  - *for a given duration*
- Both are used by Civil Engineers in the design of civil works, flood plain management, etc

Generalized precipitation frequency design criteria for water-control structures

(from Chow: Applied Hydrology)

Type of structure		Return period
Highway culverts		
Low traffic	5–10	—
Intermediate traffic	10–25	—
High traffic	50–100	—
Highway bridges		
Secondary system	10–50	—
Primary system	50–100	—
Farm drainage		
Culverts	5–50	—
Ditches	5–50	—
Urban drainage		
Storm sewers in small cities	2–25	—
Storm sewers in large cities	25–50	—
Airfields		
Low traffic	5–10	—
Intermediate traffic	10–25	—
High traffic	50–100	—
Levees		
On farms	2–50	—
Around cities	50–200	—
Dams with no likelihood of loss of life (low hazard)		
Small dams	50–100	—
Intermediate dams	100 +	—
Large dams	—	50–100%
Dams with probable loss of life (significant hazard)		
Small dams	100 +	50%
Intermediate dams	—	50–100%
Large dams	—	100%
Dams with high likelihood of considerable loss of life (high hazard)		
Small dams	—	50–100%
Intermediate dams	—	100%
Large dams	—	100%

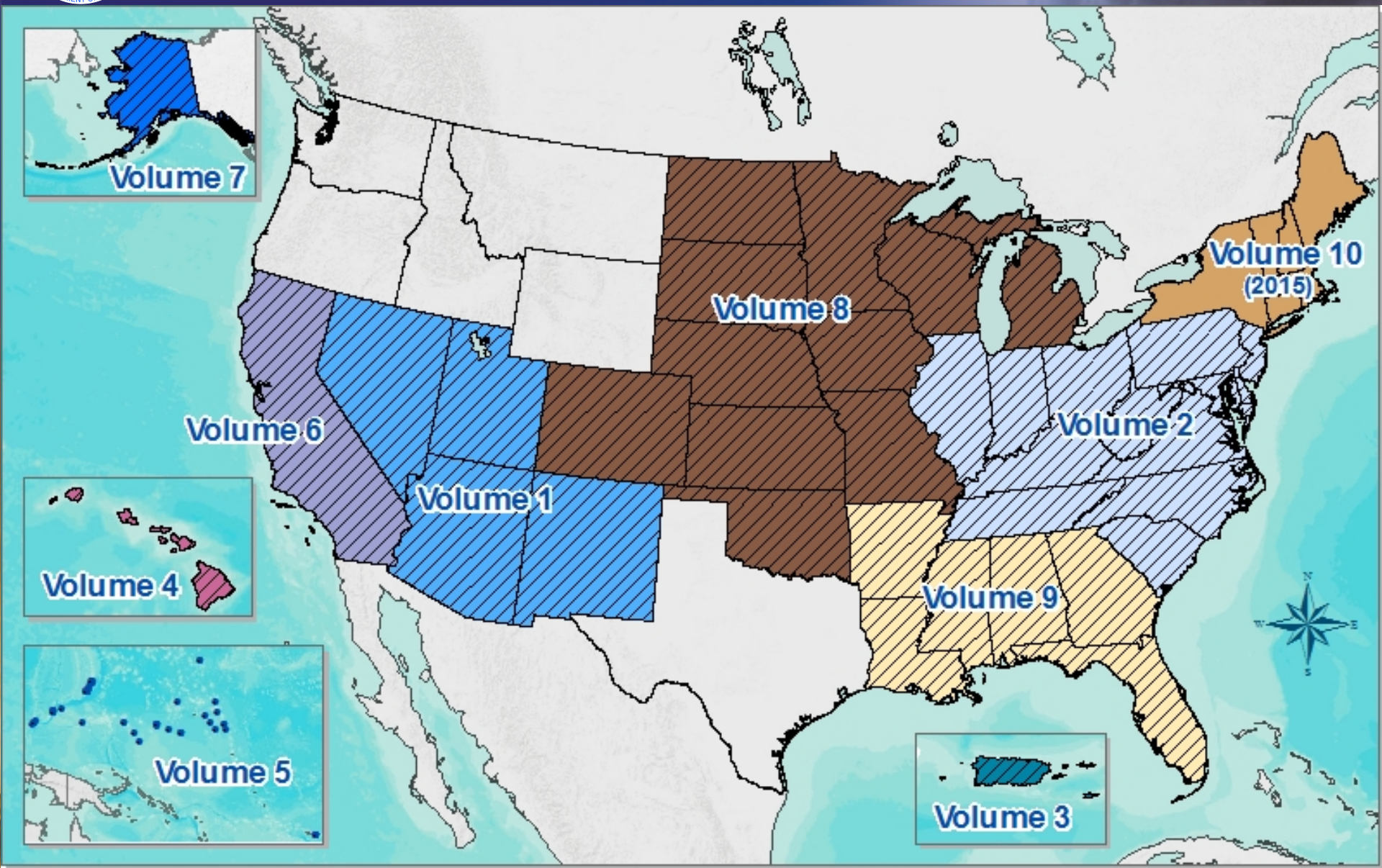
NOAA Atlas 14: Precipitation Frequency Atlas of the United States

- Produced by NWS on behalf of Federal Government
- NA14 is most recent document
  - *supersedes various publications developed since late 1940s*
- Defacto national design standard
- Ensure objective assessment of the probability of rare rainfall in planning and design
- Reimbursable funding

NOAA Atlas 14 Summary

- Begun in 2000
- Published as volumes by project area
  - *as funds become available*
- Annual Exceedance Probability: 1/2 – 1/1,000
- Durations: 5 minutes – 60 days
- Error Estimates: 90% confidence intervals
- Locally Relevant: 30 arc-sec resolution
- User Friendly: web based, interactive

NOAA Atlas 14 Status



Potential Impact of Climate Change

"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;*

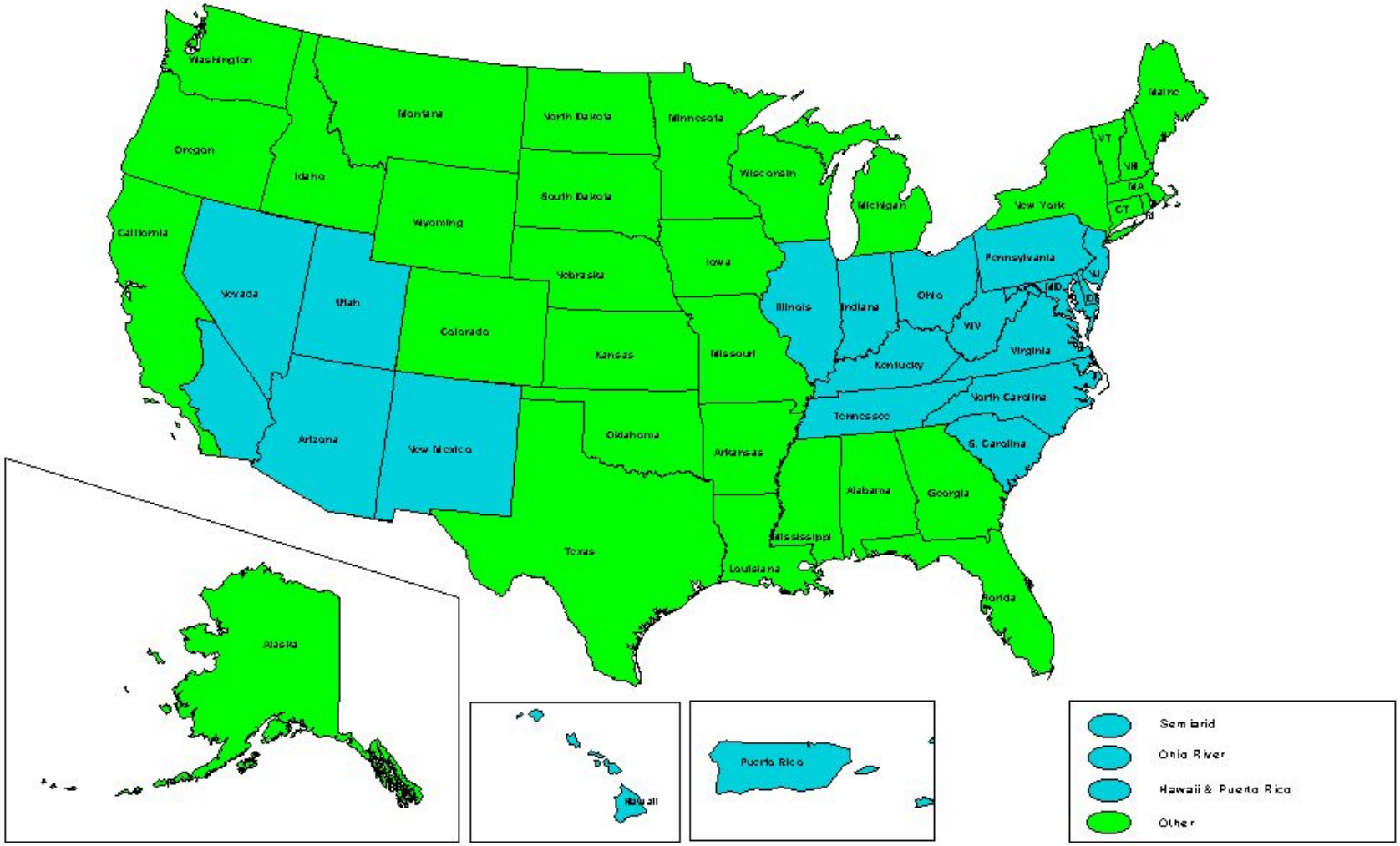
    *as **very heavy** when it falls into the upper 1% and/or 0.3% of precipitation events;*

    *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**

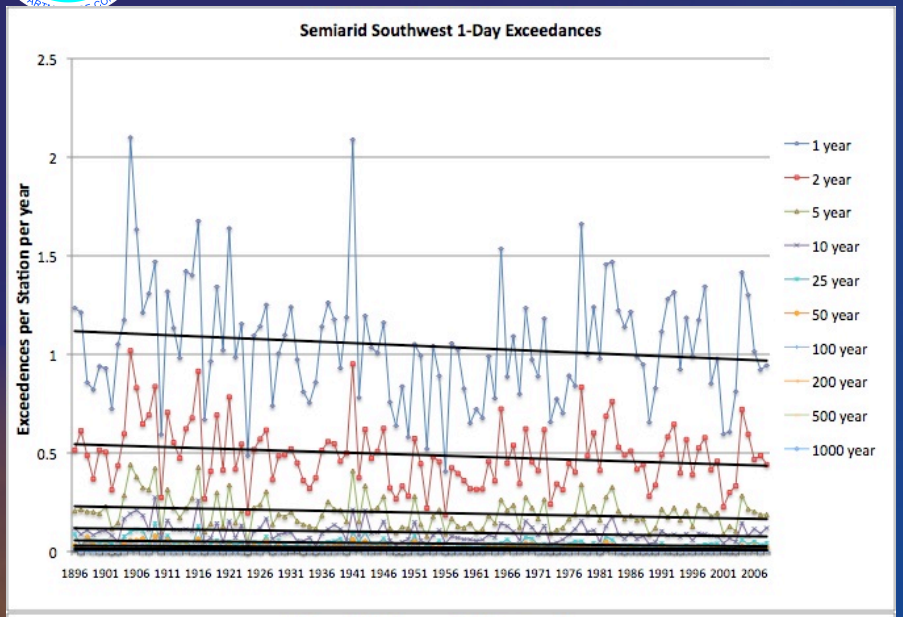
Civil Engineering Semantics

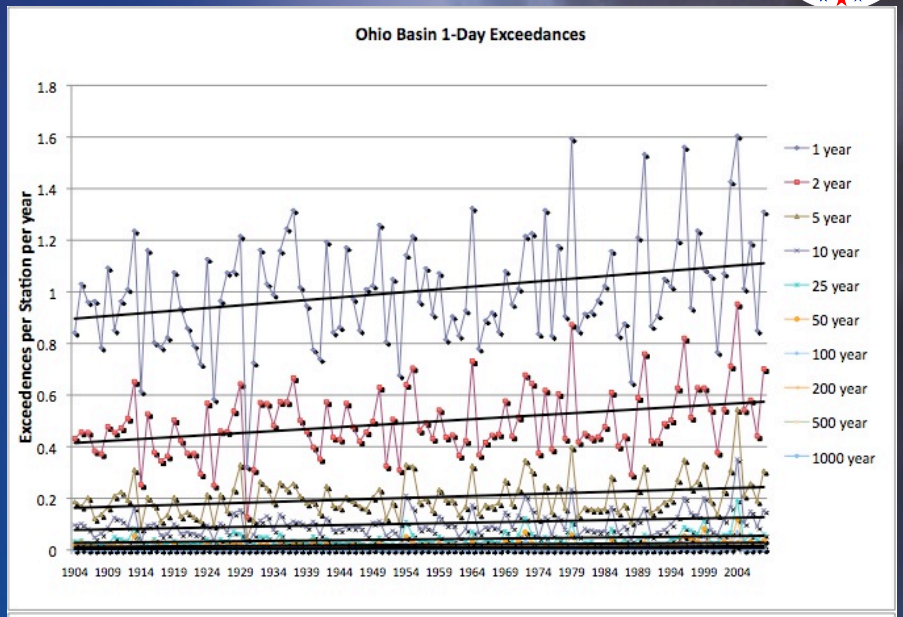
- **Use precipitation frequency estimates**
  - *annual exceedance probabilities (AEP) or*
  - *average recurrence intervals (ARI)*
- **Heavy, very heavy, and extreme rainfall:**
  - *generally subjective terms*
- **Use many durations; not just daily**
  - *NOAA Atlas 14 provides 5 min through 60 days*

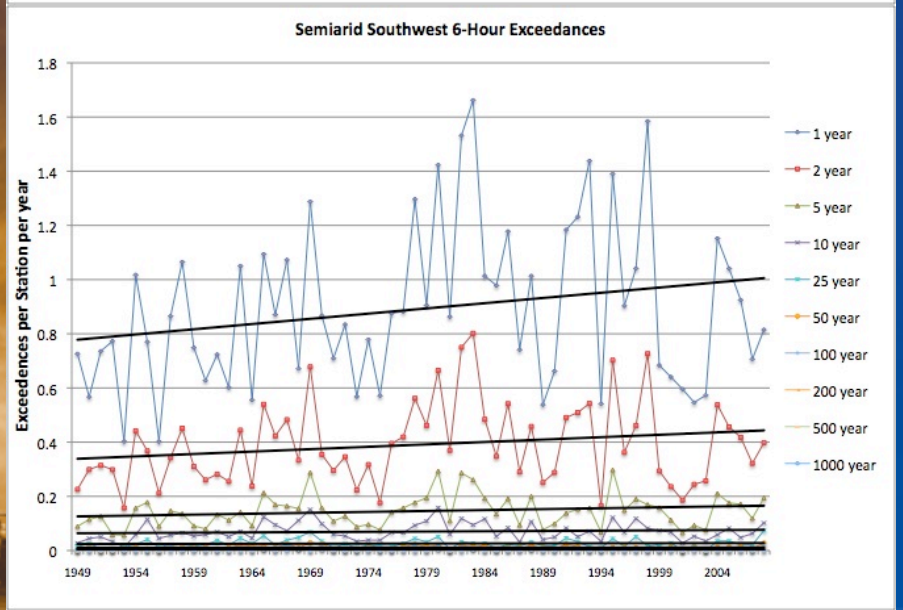
Trends in Exceedances

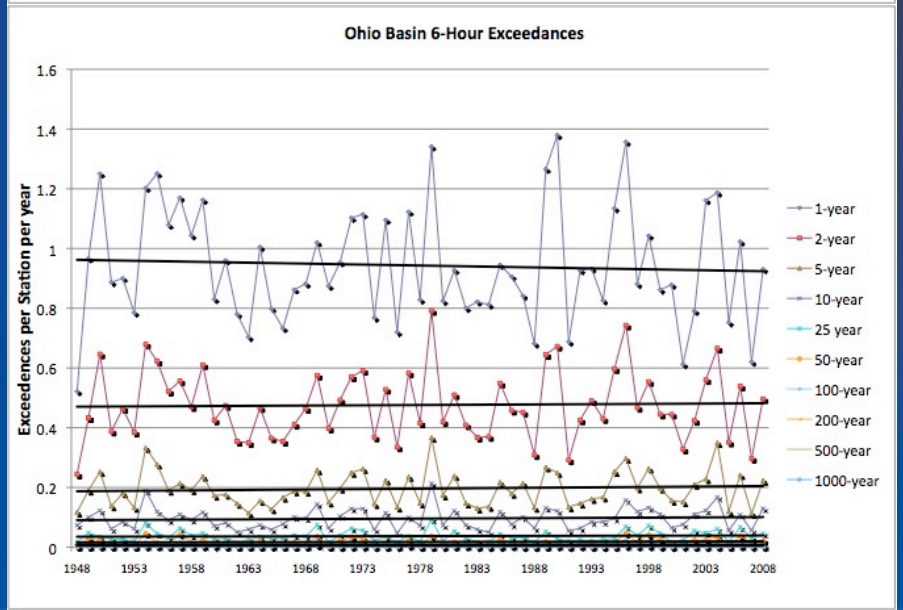


Example Trends in Exceedances









Trends in Exceedances

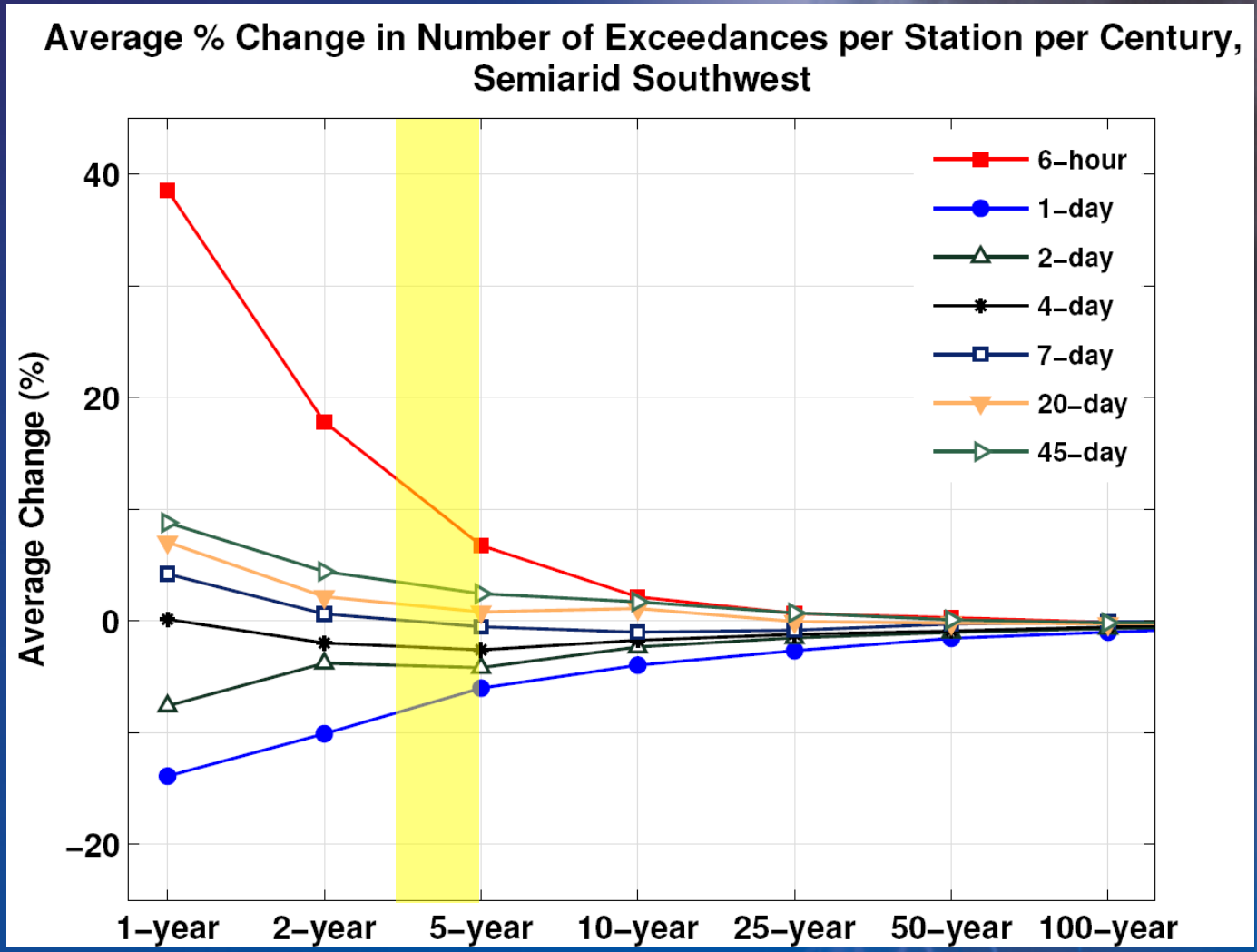
NA14, 90% confidence intervals

+/- 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)

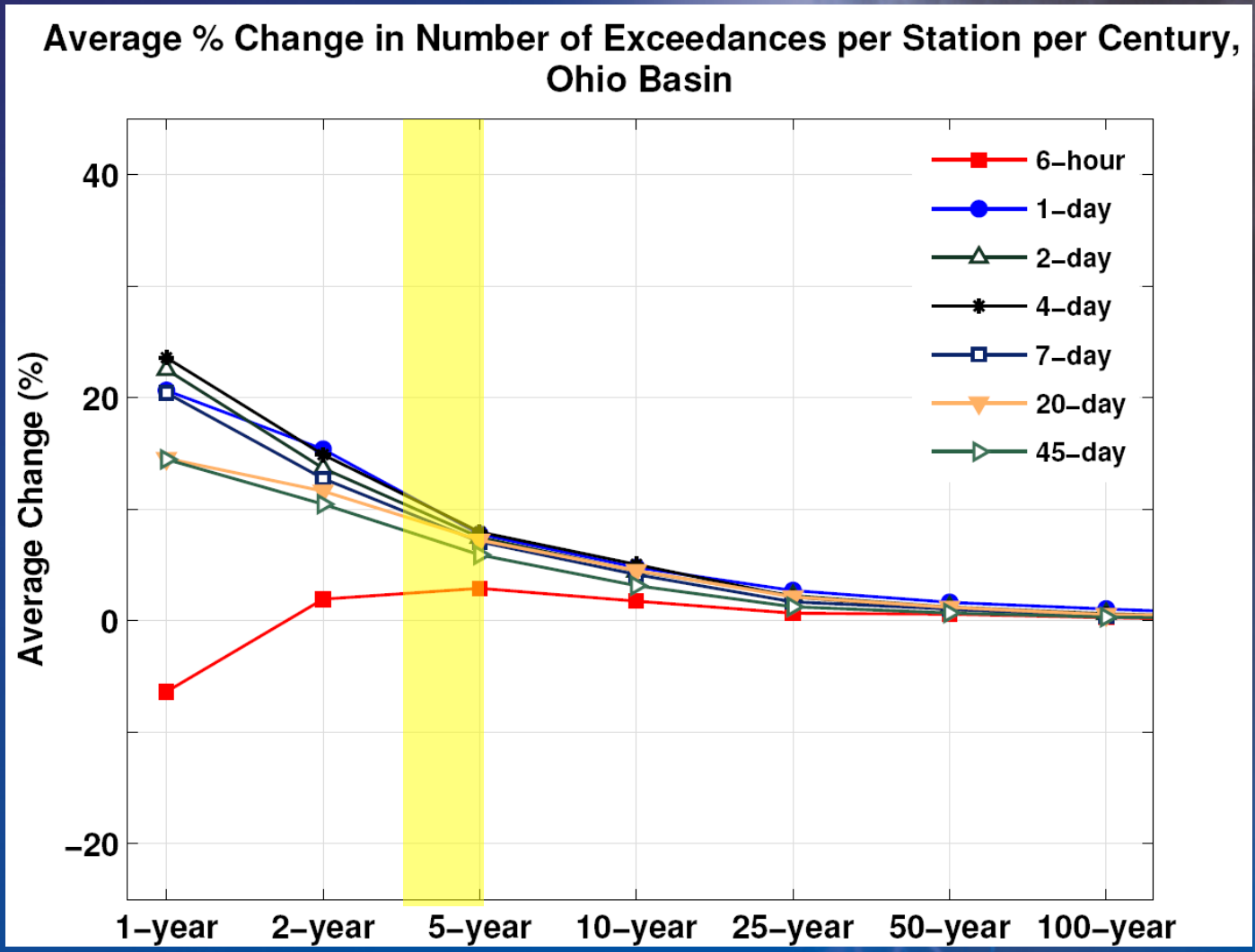
NA14, 90% confidence intervals

+/- 30%

- **sparsely instrumented, shorter record; to**

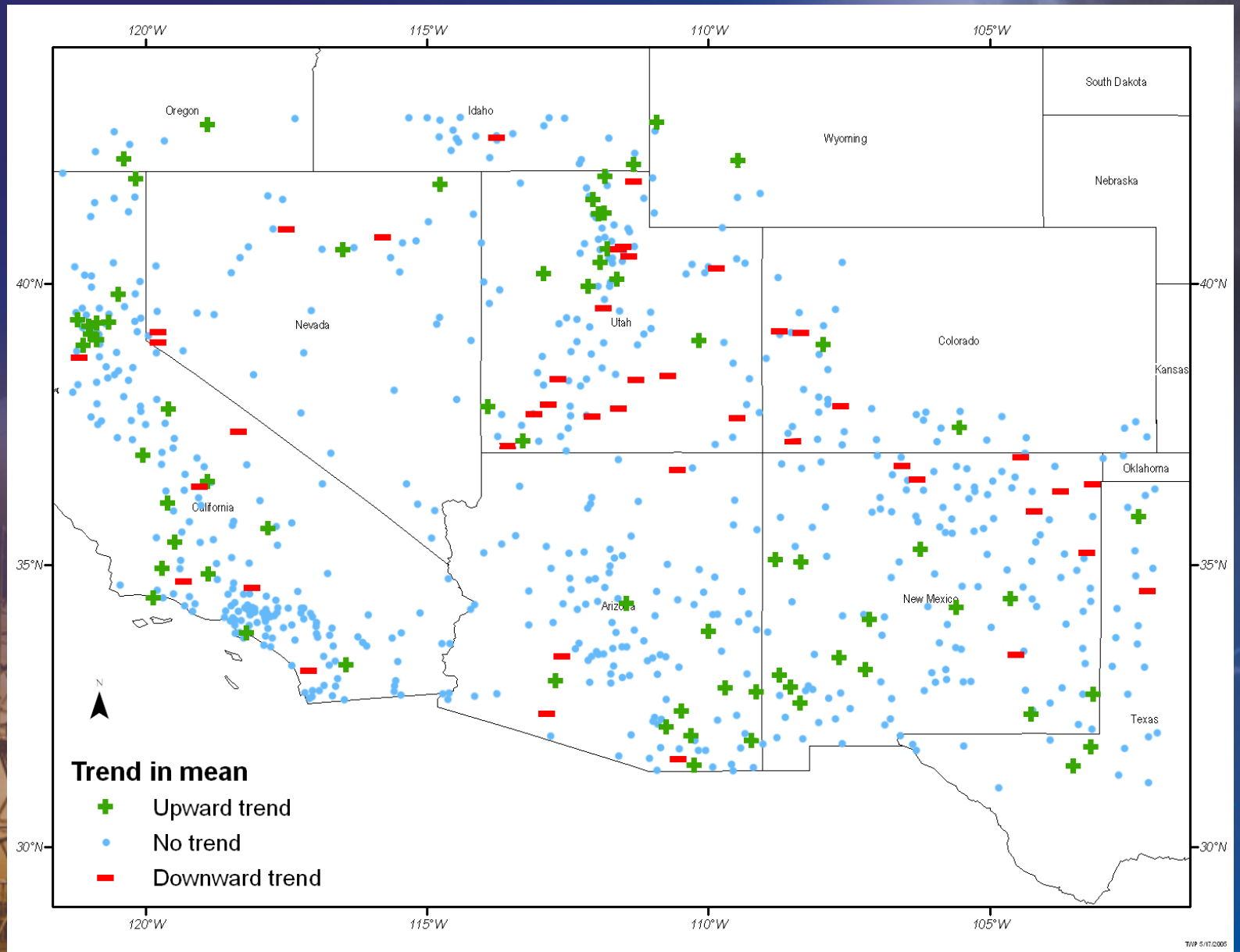
+/- 10%

- **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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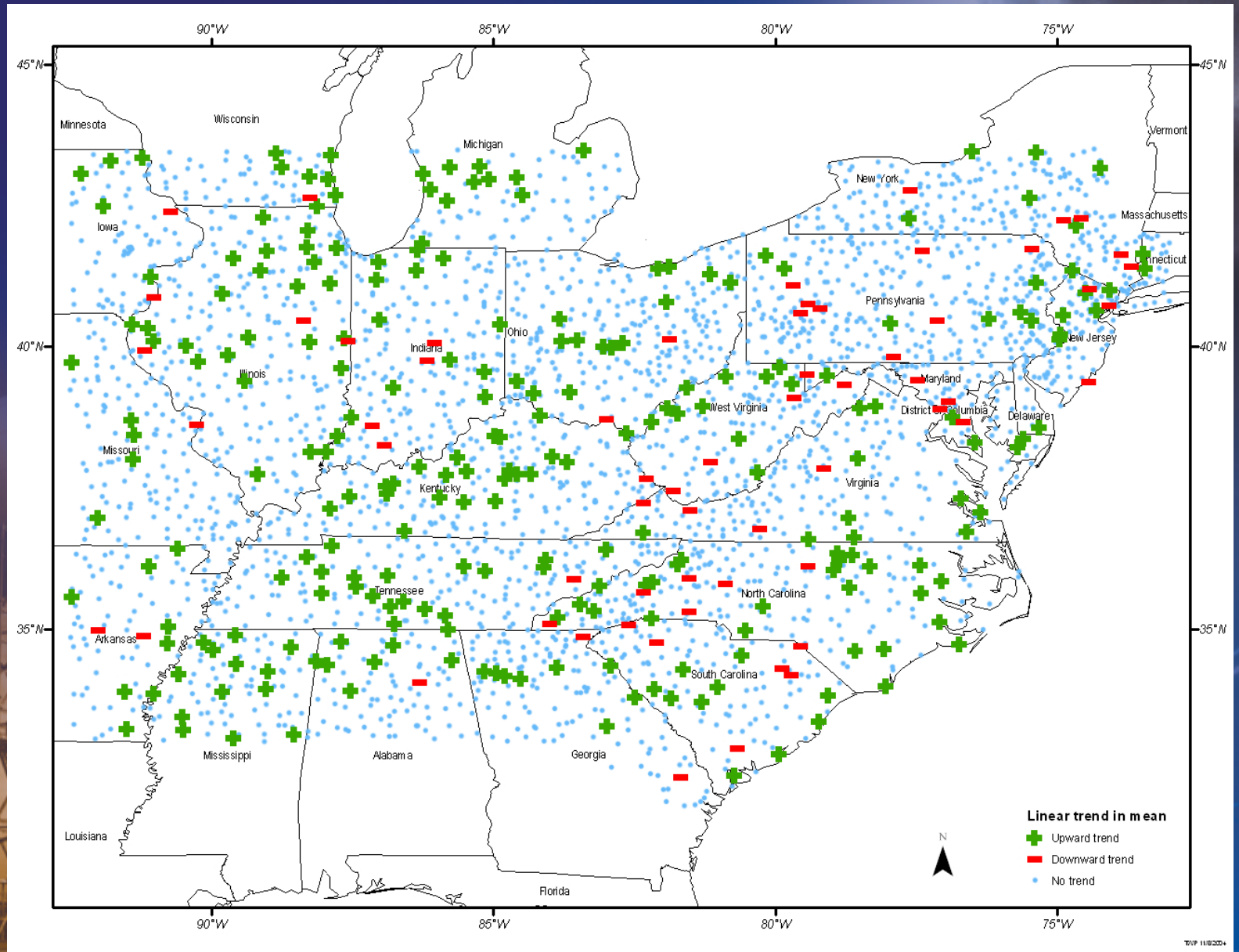

Conclusions

- **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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