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Consistency of extreme rainfall representation in numerical simulations and hydrological datasets

Ben Timmermans (bwtimmermans@lbl.gov)
Michael Wehner, Travis O'Brien, John O'Brien, Daithi Stone
Dan Cooley[1], Emeric Thibaud[1]

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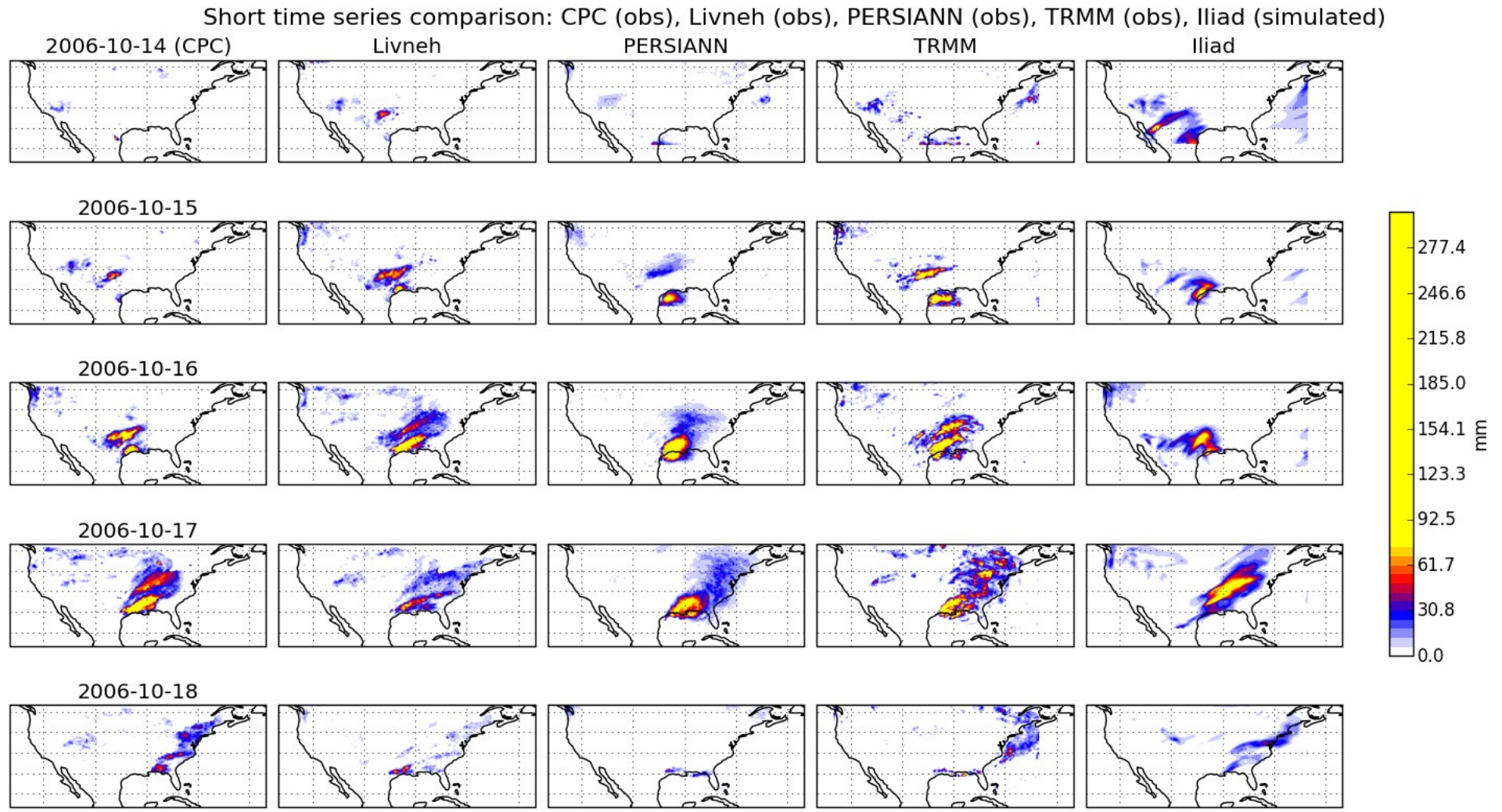
[1] University of Colorado

Motivation

- Studies suggest that in the future extreme weather may change disproportionately with the mean.
- Our models must therefore be validated against appropriate observations.
- However, to date there appears to have been little investigation of the consistency of precipitation datasets for the U.S. in the extremes.

Motivation



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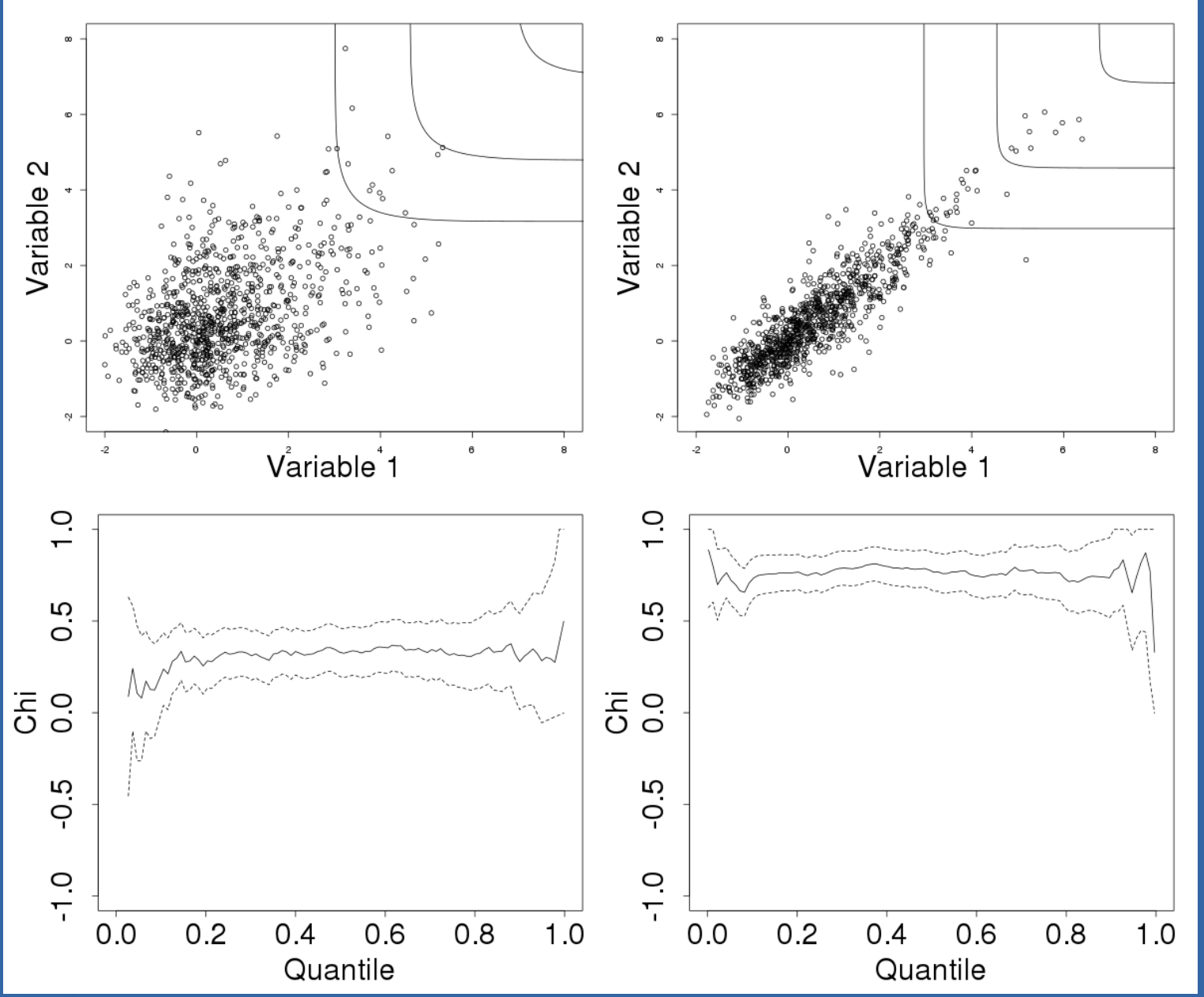
Precipitation observations for CONUS

- A number of precipitation observational datasets exist.
- Typically these are provided as gridded products for daily accumulated precipitation @ ~25 km resolution:
  - NOAA Climate Prediction Centre (~50 years, CPC)
  - Maurer et al. 2002 (~50 years, gauge based)
  - Livneh et al. 2013 (~65 years, extends Maurer et al.)
  - PERSIANN (~30 years, satellite derived)
  - TRMM (~20 years, satellite derived)

Analysis

- Similar to the approach used by Weller, Cooley & Sain (2012) “... pineapple express phenomenon ...”
- Use a “pairwise” approach.
  - Regard pairs of datasets as a sample from a bivariate extreme value distribution.
- Coles et al. (1999) describes dependence measures that can be used to examine for asymptotic dependence or independence...

$$\chi = \lim_{z \to z^*} \Pr(Y > z | X > z)$$



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Analysis: Maurer and CPC

- Obtained from the same rain gauge network, so we expect consistency.
- Approximately 50 years at 25km resolution.

Analysis: Maurer and CPC

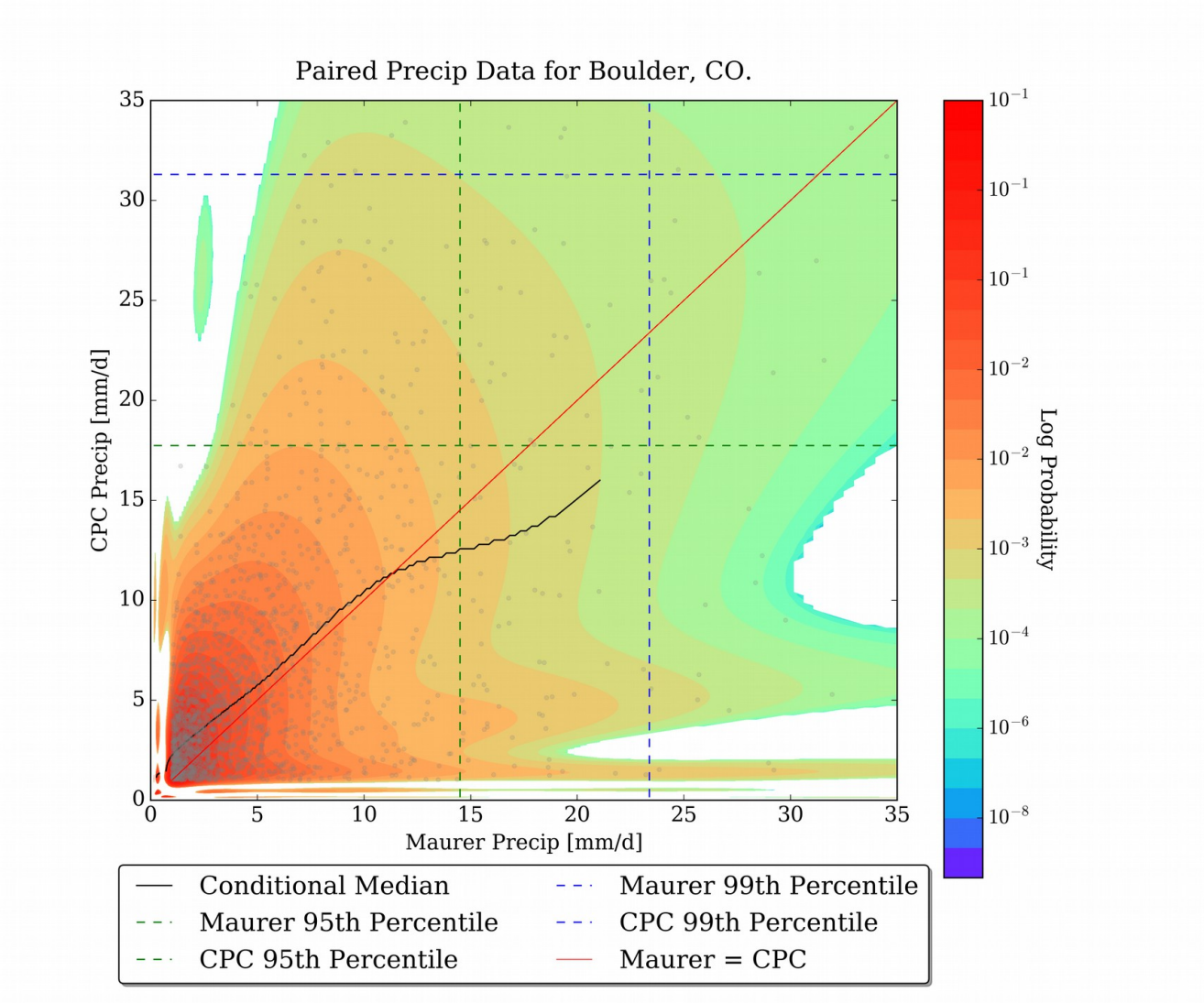
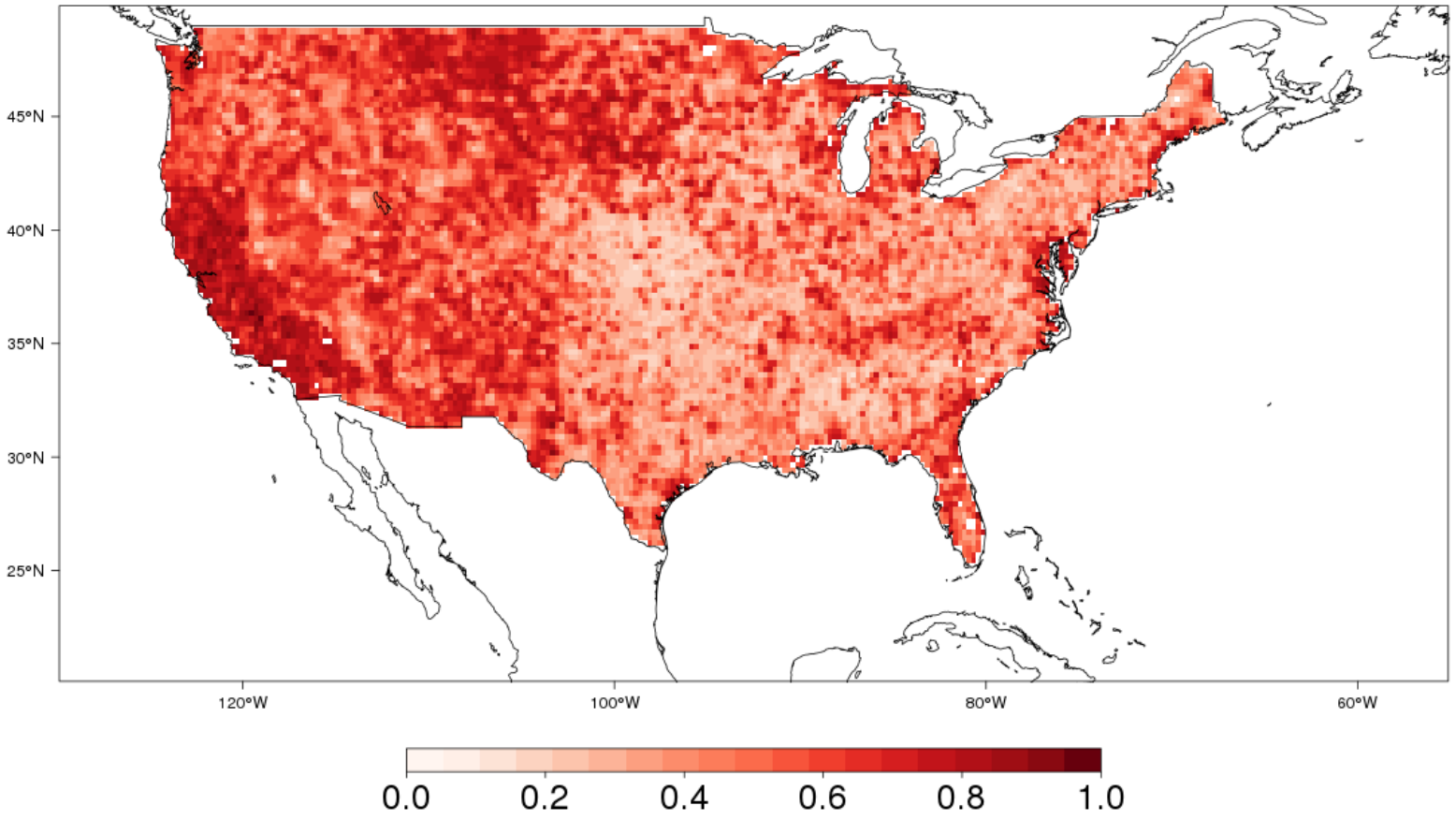


Figure using fastKDE, provided by John O'Brien

Analysis: Maurer and CPC



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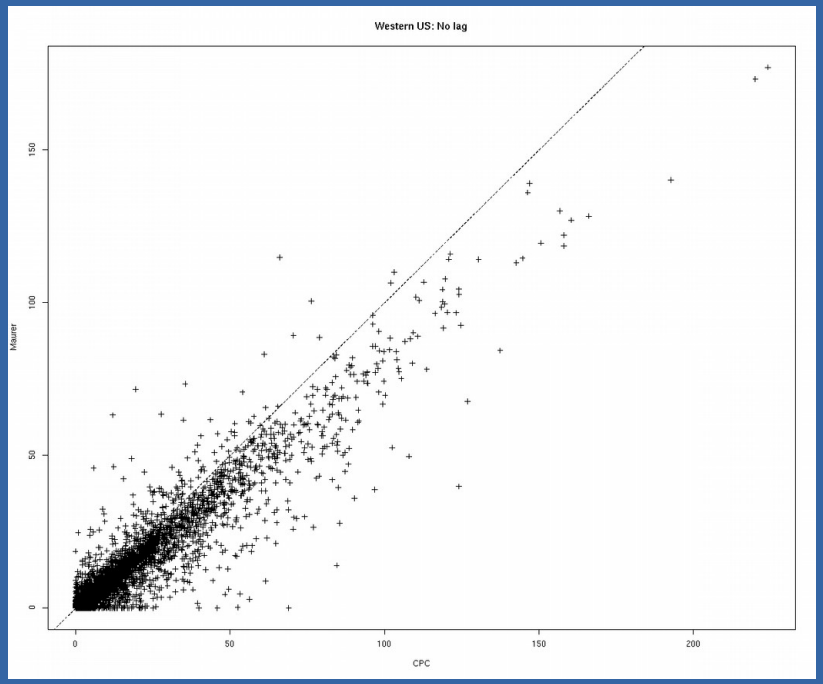
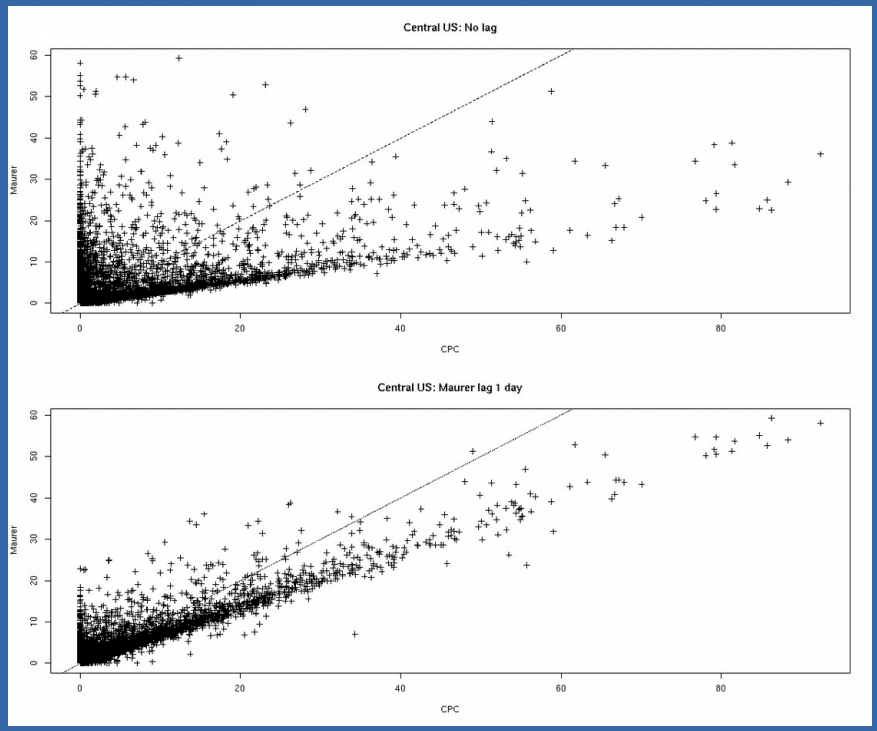
Findings: Maurer and CPC

- Point correlation in western U.S. and central U.S.





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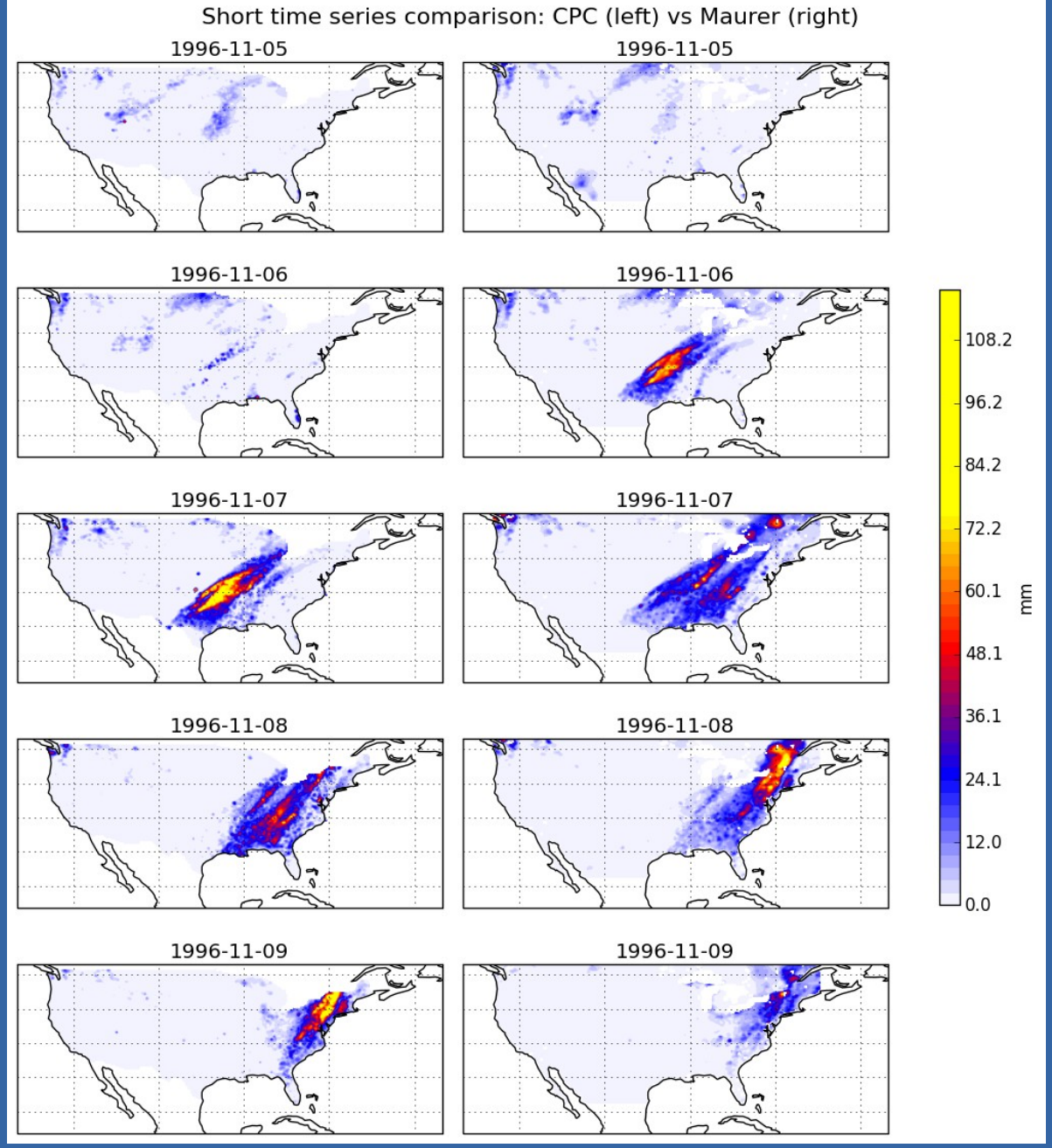

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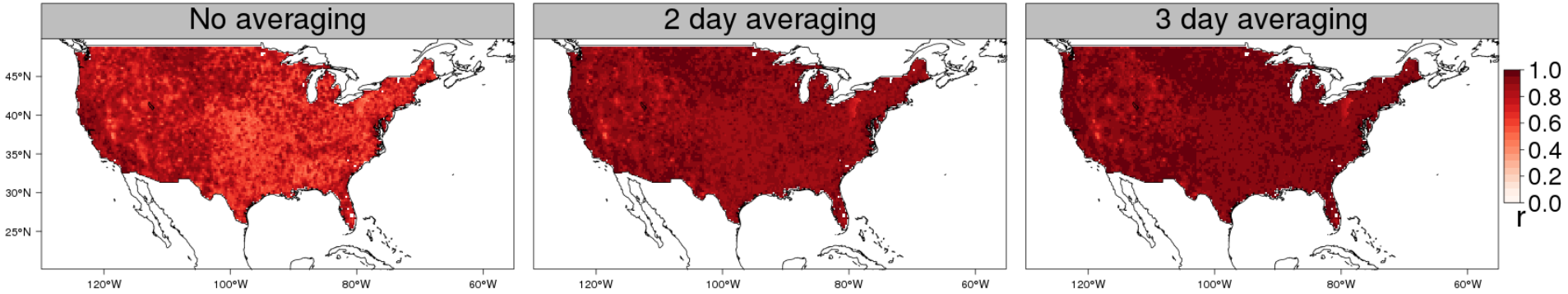
Problems:

- Using **daily data** for analysis on a daily timescale can be problematic!
- Integrating to longer timescales appears to be required.
- A similar approach may be required for spatial mismatches...

Correlation between CPC and Maurer for different averaging windows.



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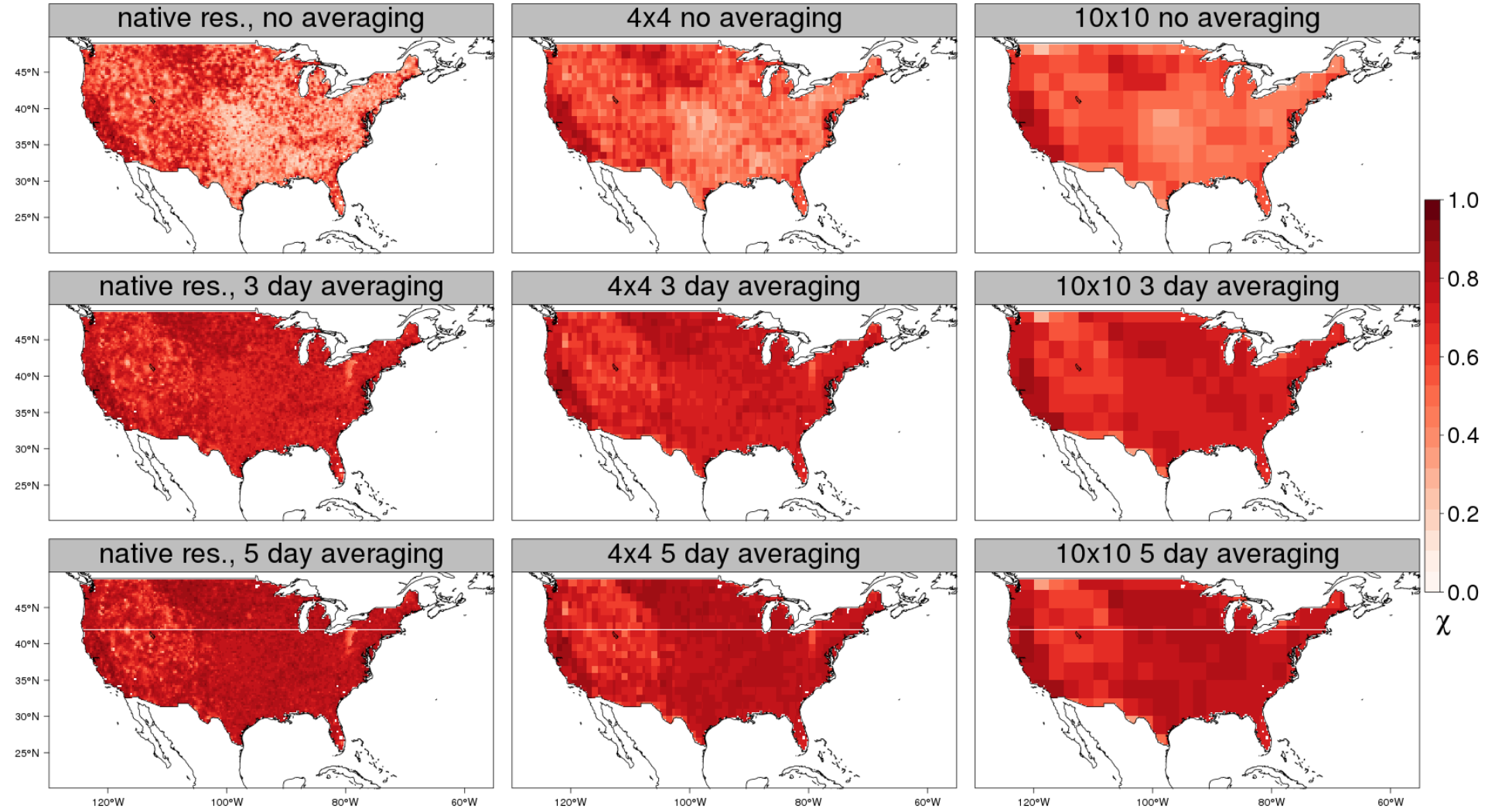
Tail dependence between CPC and Maurer: mean(χ (0.9 -> 0.95)) for blocks of cells



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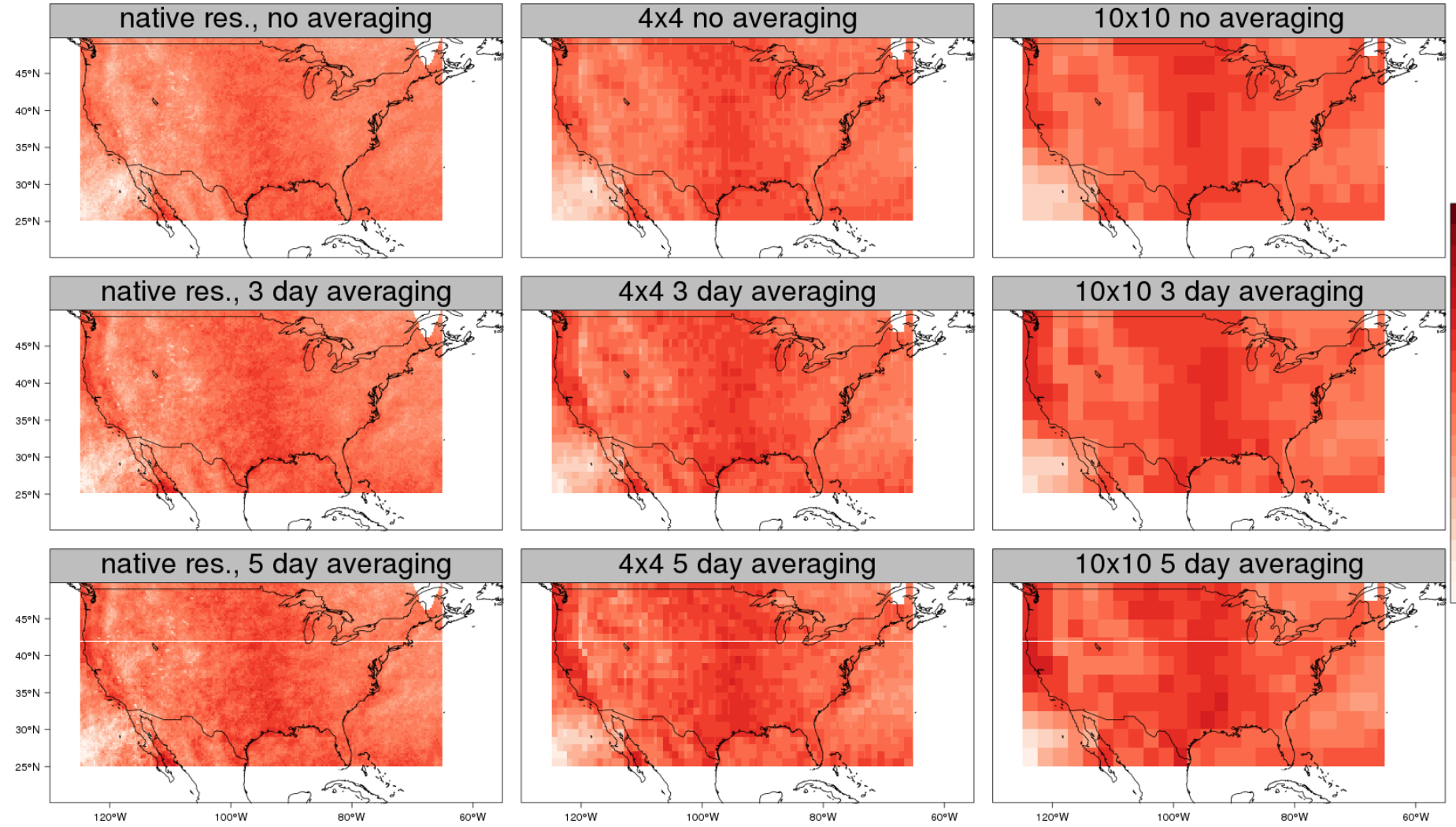
Tail dependence between PERSIANN and TRMM: mean(χ (0.9 -> 0.95)) for blocks of cells



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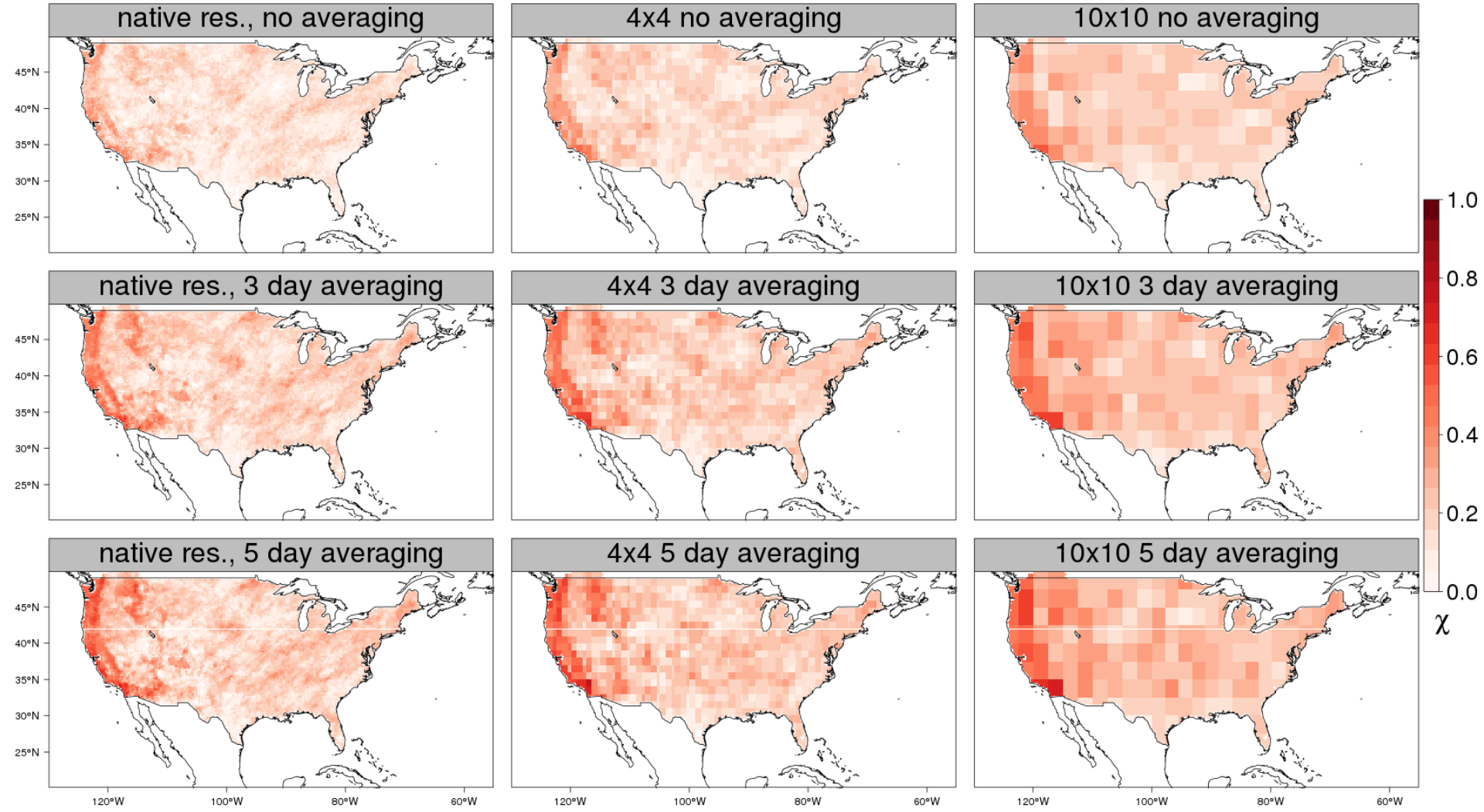
Tail dependence between Livneh and Iliad: mean(χ (0.9 -> 0.95)) for blocks of cells



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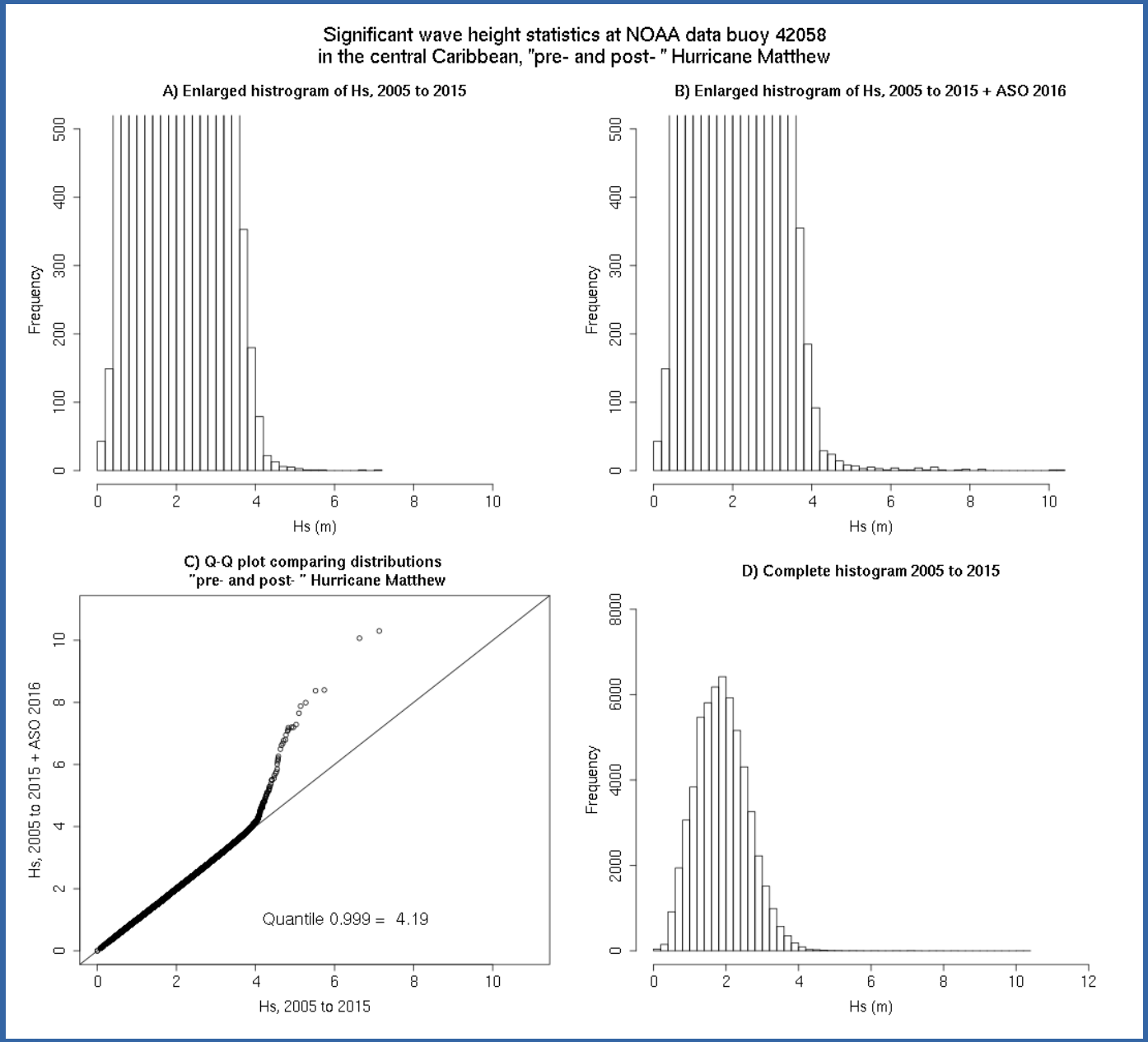
Conclusions (so far...)

- Use of **daily data** for **daily analysis** requires caution!
- Use of the dependence measure suggests that there is a quantifiable disagreement between observational datasets.
- **How to formalise?**
  - Measures require the specification of spatial and temporal “parameters” (e.g. averaging windows).
- Can we extend to a multivariate dependence measure?
- Parallelisation of R with pbd package provides excellent performance improvement.



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References

- “ILIAD simulations”, O'Brien et al., *JAMES* (2016) *in press*
- “Dependence Measures for Extreme Value Analyses”, Coles et al. (1999), *Extremes* 2
- “An investigation of the pineapple express phenomenon via bivariate extreme value theory”, Weller et al. 2012, *Environmetrics* 23
- R packages:
  - evd (Extreme Value Distributions)
  - pbd (Programming for Big Data), pbdNCDF4, pbdMPI