# A spatial propinquity extreme-value model for assessing monsoon-type precipitation extremes in future climates


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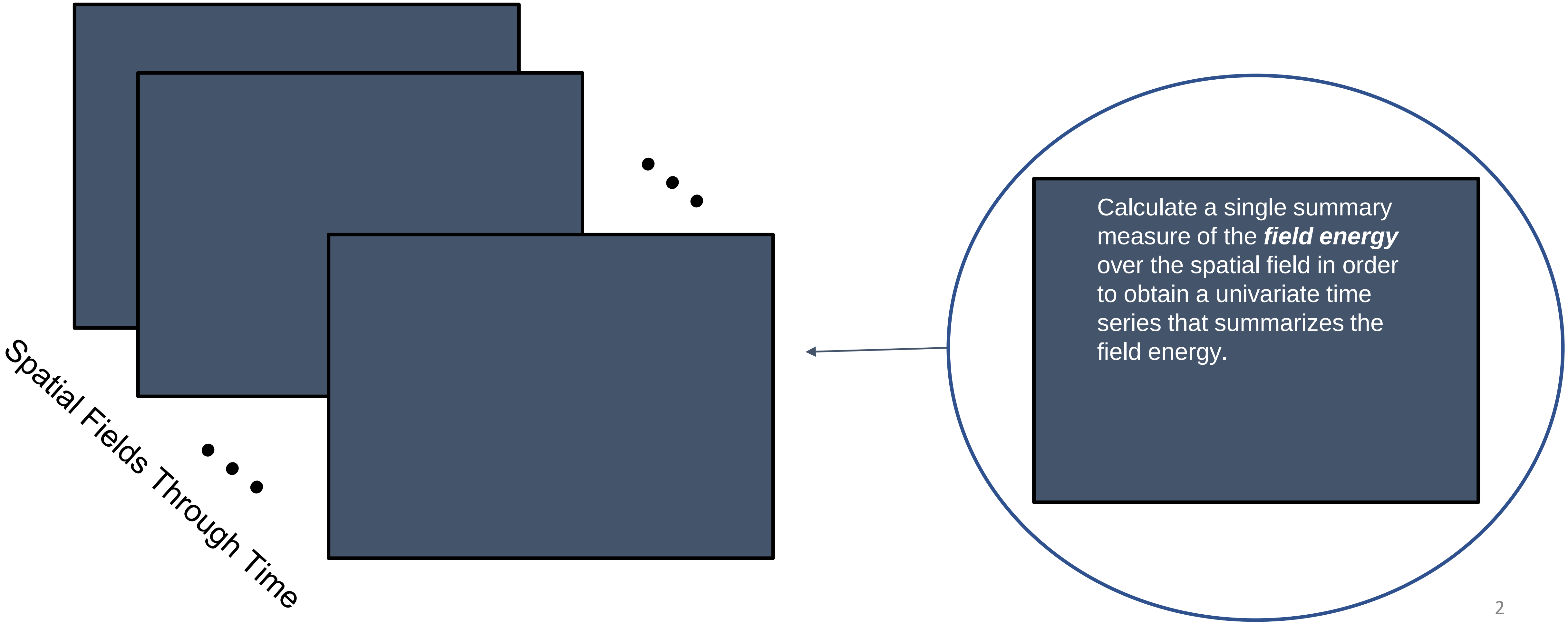
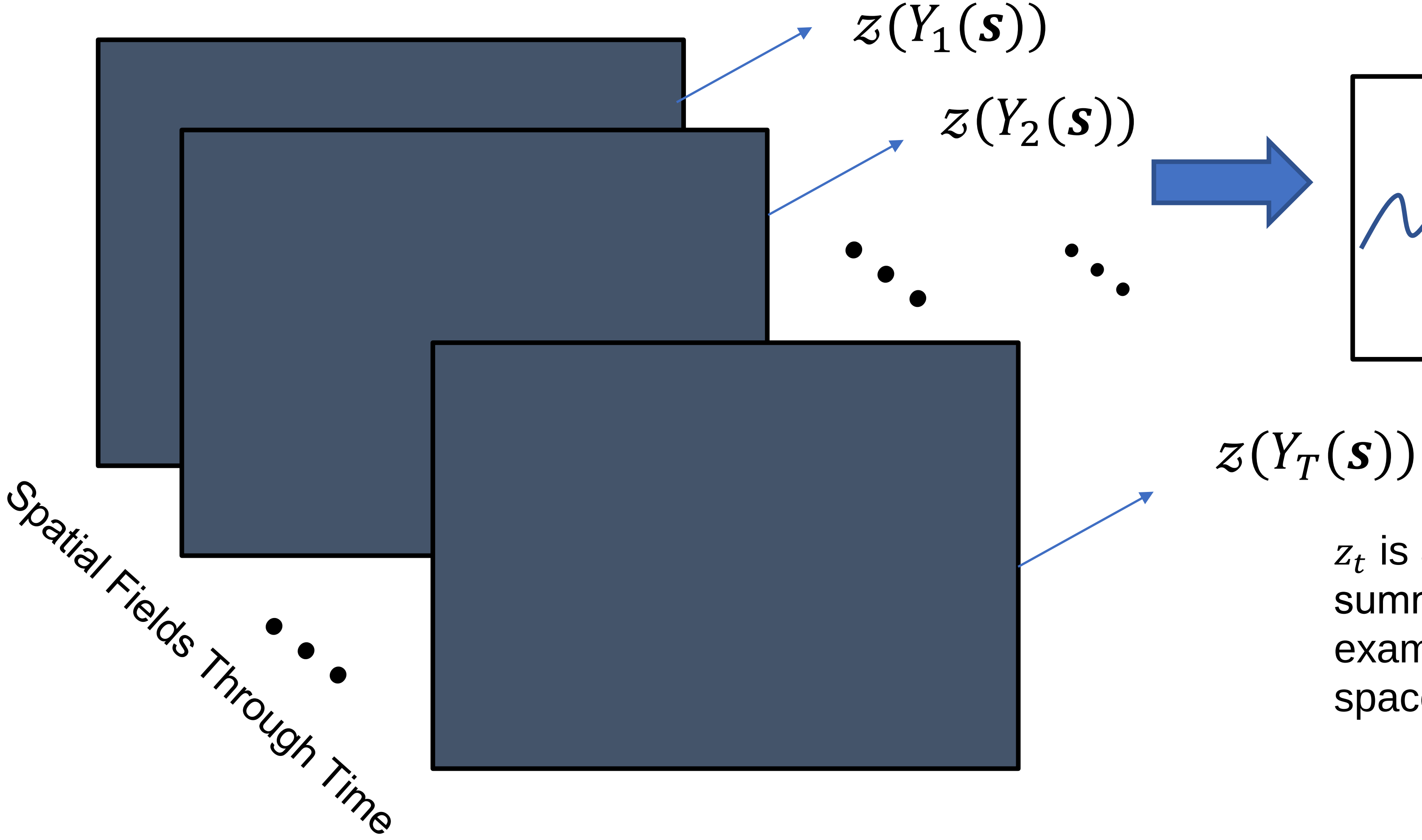
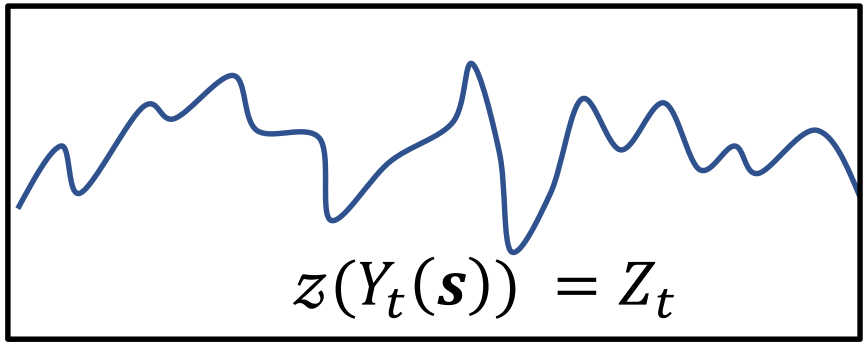
# Model Approach



# Model Approach

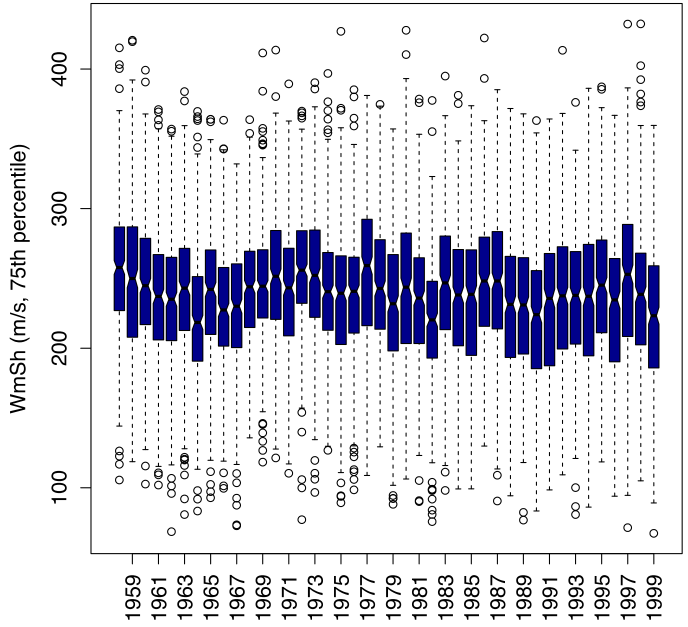


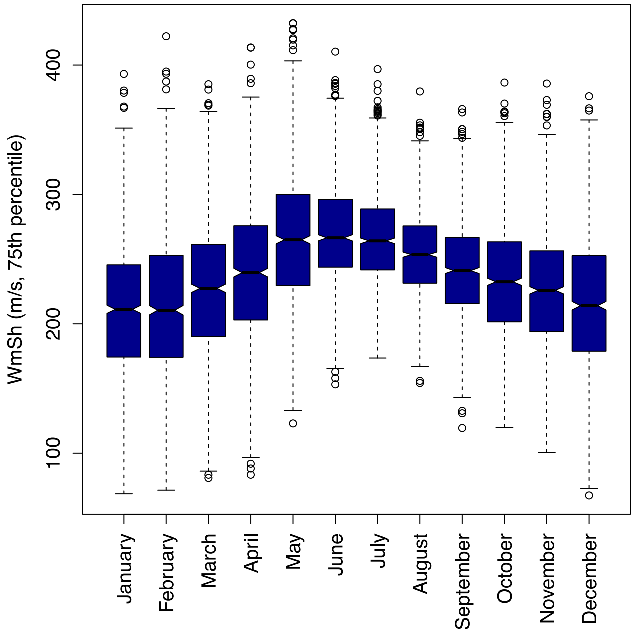




$z_t$ is a single univariate time series, summarizing the “energy” in the field. For example, could take the upper quartile over space, denote it by q75.

# Example: WmSh (a large-scale severe storm indicator variable)

The upper quartile over space, q75, is a univariate time series that gives a measure of high WmSh over, possibly a small area of, space.



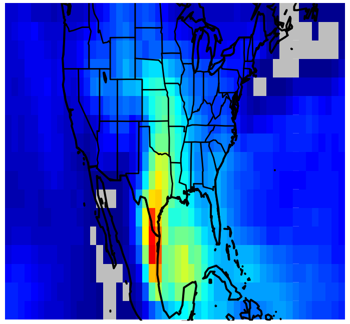

G. et al 2013. Spatial extreme value analysis to project extremes of large-scale indicators for severe weather. *Environmetrics*, **24** (6), 418 - 432, DOI: 10.1002/env.2234

# Example: WmSh (a large-scale severe storm indicator variable)

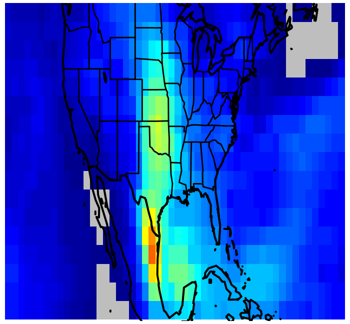
$$\left[\mathrm{WmSh}_1,\ldots,\mathrm{WmSh}_n \,\middle|\, \mathrm{q75} > u\right]$$

The mean of WmSh at each grid point conditioned on high q75. Using the Heffernan and Tawn (2004, [https://doi.org/10.1111/j.1467-9868.2004.02050.x](https://doi.org/10.1111/j.1467-9868.2004.02050.x)) conditional extreme value model. Henceforth HT2004.

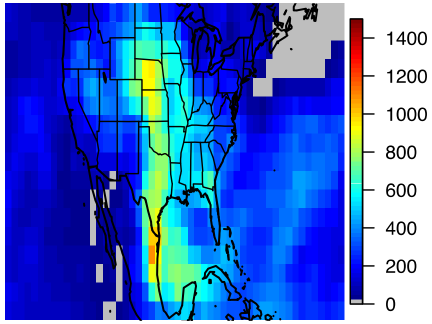
1958 – 1978



1979 – 1992



1993 – 1999




Spring
WmSh ($m^2s^{-2}$)

G. et al 2013. Spatial extreme value analysis to project extremes of large-scale indicators for severe weather. *Environmetrics*, **24** (6), 418 - 432, DOI: 10.1002/env.2234

The field-energy stairway

Photo of Endless stairway at KPMG, Munich, Germany by Oliver Raupach, Creative Commons Attribution-Share Alike 2.5 Generic

# The propinquity Model

From Wikipedia: In social psychology, **propinquity** (/prəˈpɪŋkwɪtiː/; from Latin *propinquitas*, "nearness") is one of the main factors leading to interpersonal attraction.

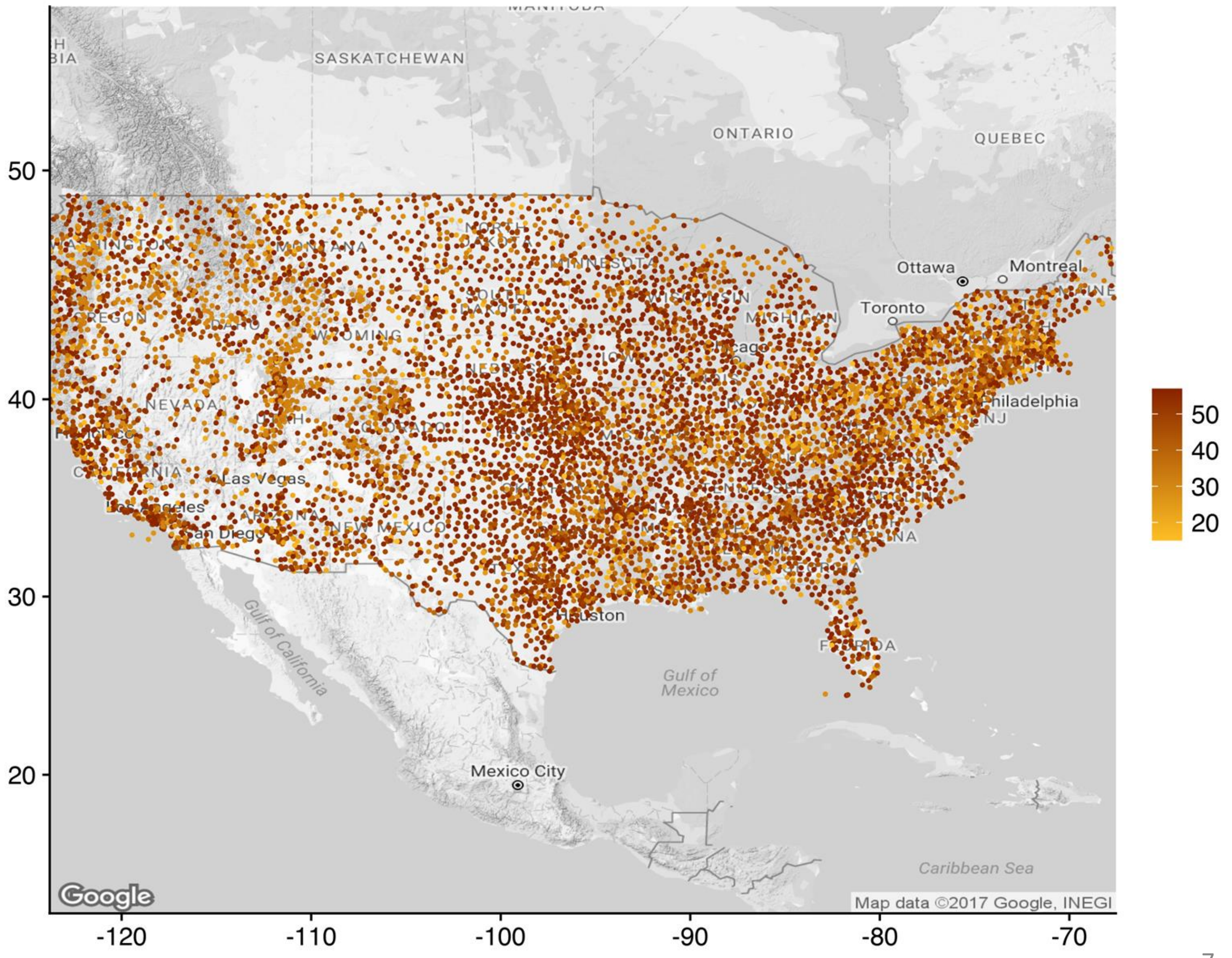
People who live on the same floor of a building have a higher propinquity than those who live on a different floor, unless they live near the staircase.

Using the term propinquity for the model from 2013 (also G. et al. 2016, DOI: 10.5194/ascmo-2-137-2016). Though it is a new term not used in those papers.

# Data

GHCN-Daily precipitation dataset

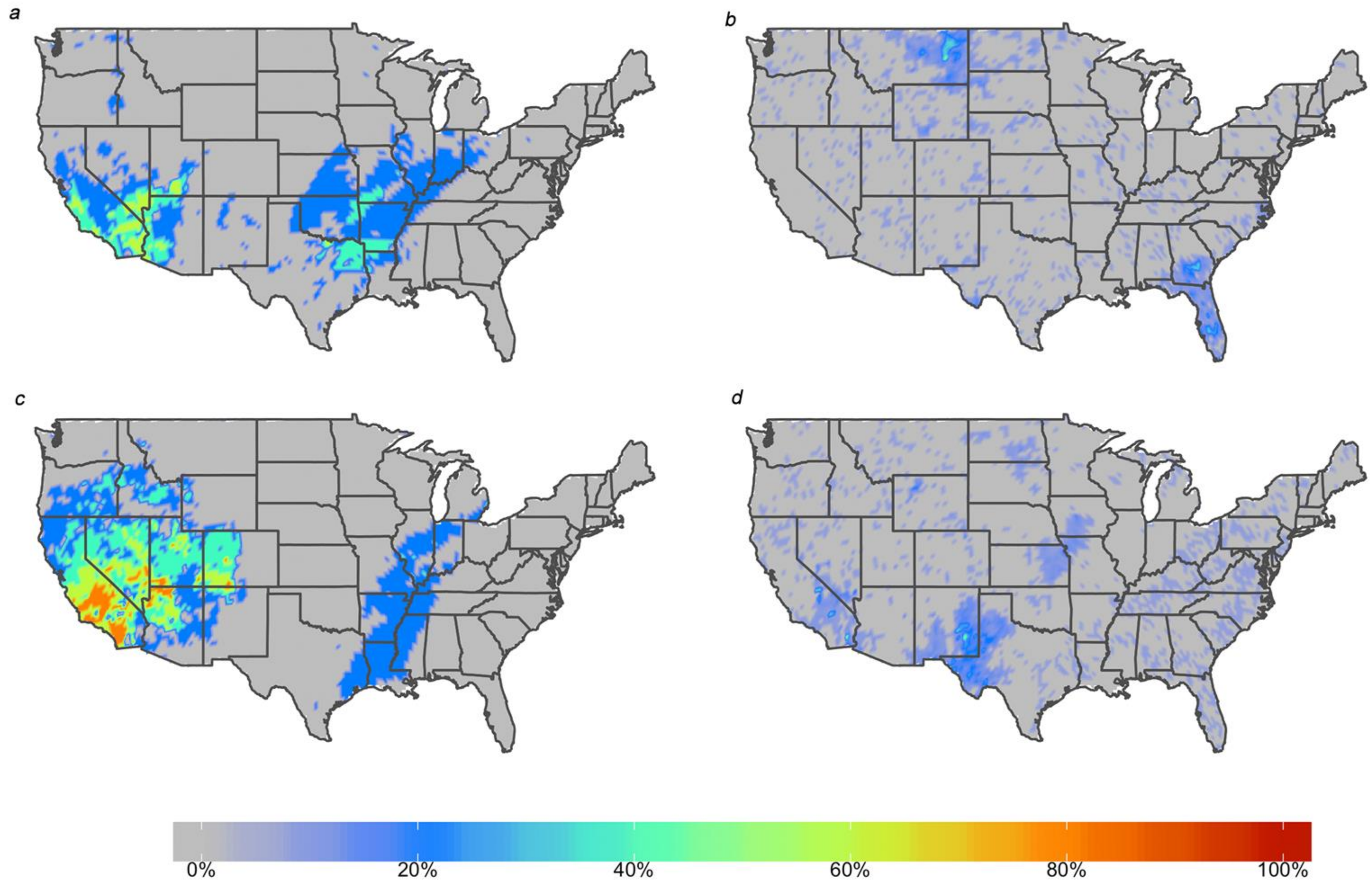
- Number of stations = 8516
- Stations are interpolated to a 30x30km grid.
- The color shade indicates the length of the observation period
- Generally, 56 years (1961 – 2016) of daily data in mm/day



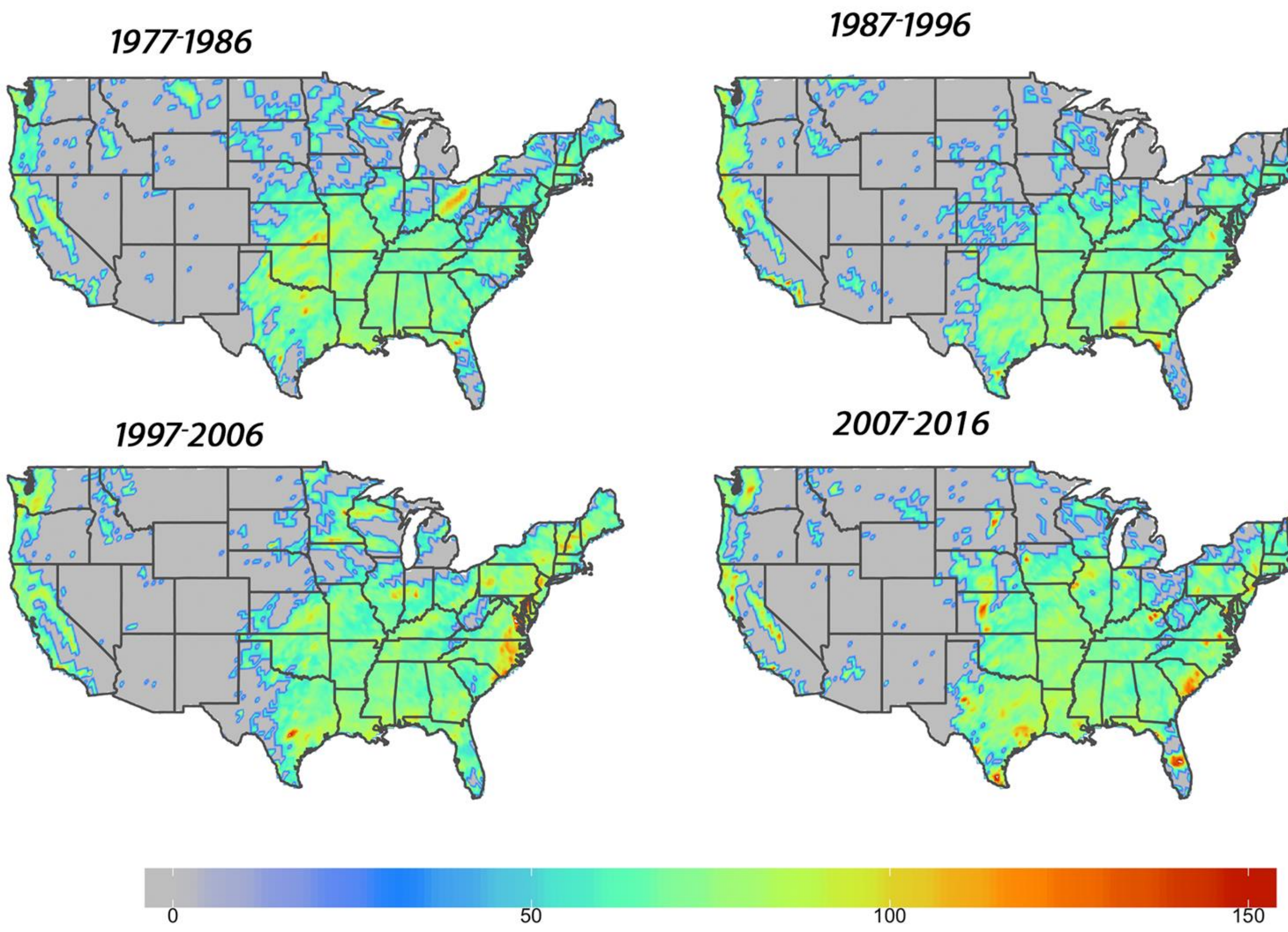
# Examples

Propinquity Model

Traditional (individual grid points)

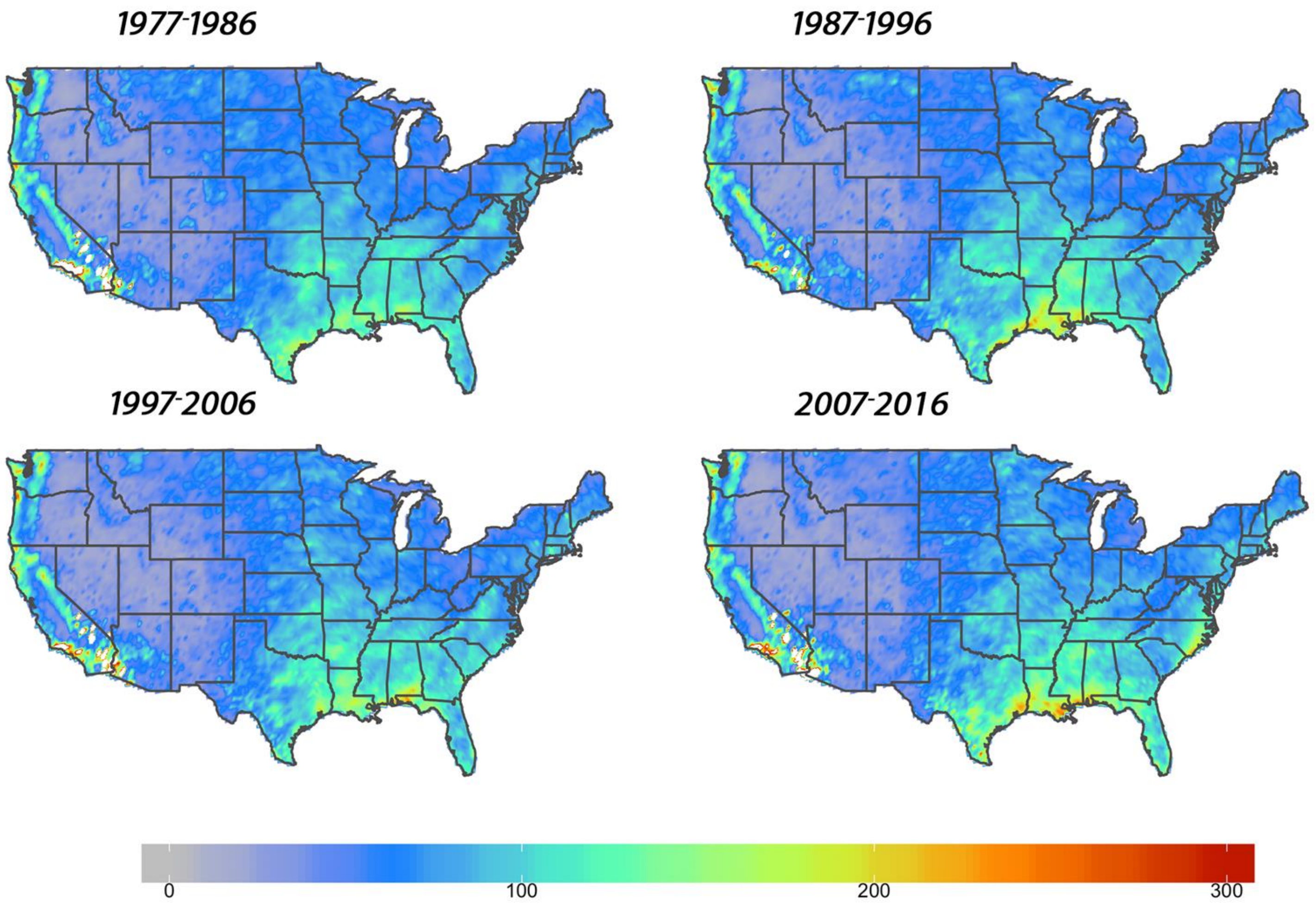


# Empirical Propinquity Model



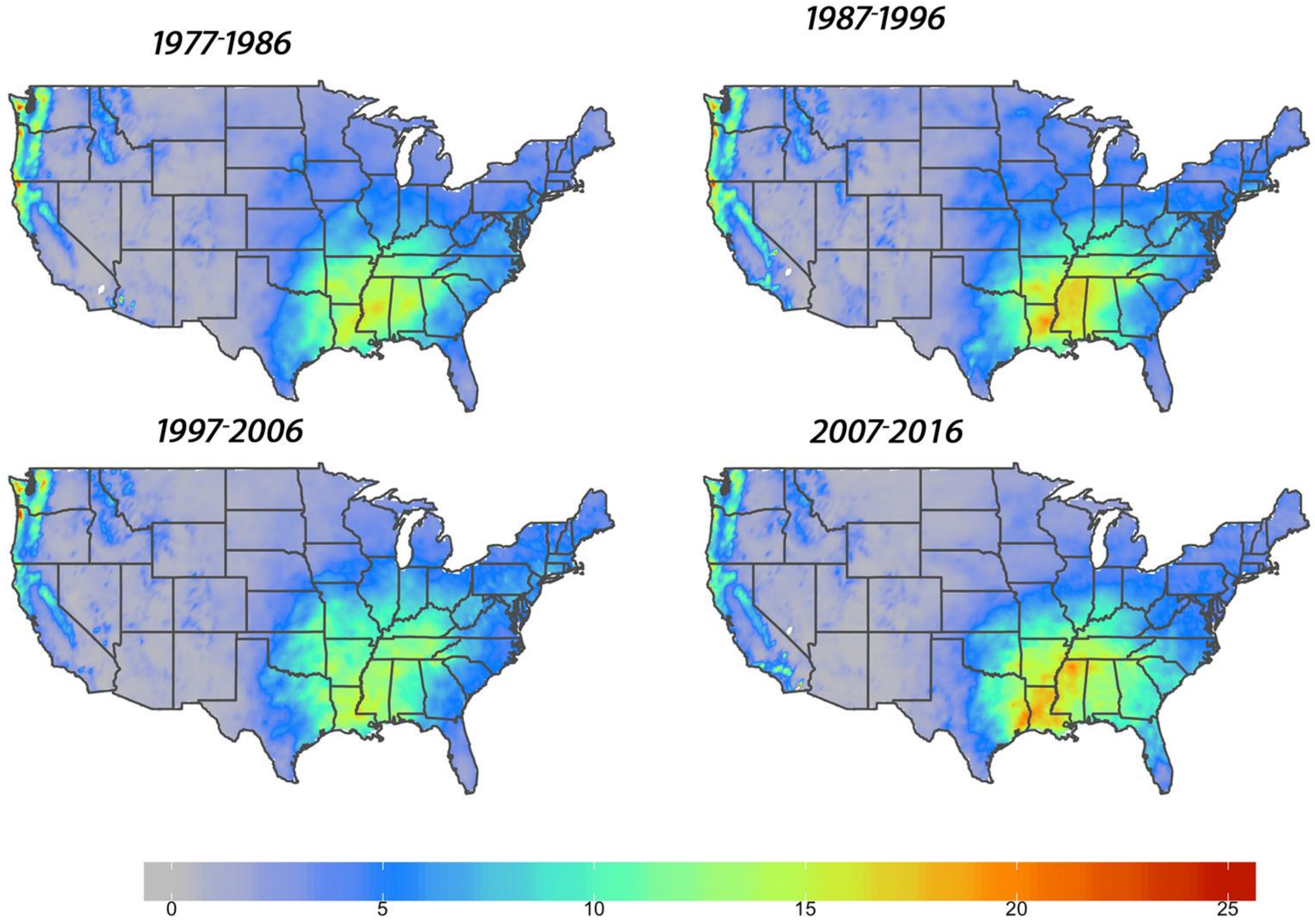
# Marginal GPD's fit to data at each grid point

Threshold is set at 90th percentile.
10-year return values.



# Propinquity Model with HT2004

Mean of simulated values conditioned on q75 = 10-year return level (based on its marginal GPD fit)



# Summary

- Propinquity Model is a spatial model where the dependence results from the degree of ***propinquity*** of the random variables at each grid point to an overall summary of spatial field energy.
- Results in spatially cohesive fields of statistics that represent large-scale, process-oriented behaviors rather than localized phenomena.
- Spatial verification measures can be employed to analyze differences, e.g., between time periods, which can help to determine if significant changes result from changes in intensity and/or large-scale processes that have "moved" over time.
- ***Field energy*** might be defined through any statistic of interest calculated across space, e.g., the mean, upper quartile, median, sum, sum of squares, etc.
- Can be employed empirically or with a model, e.g., HT2004 is a natural choice if interest is in projecting extreme values.

# Thank you

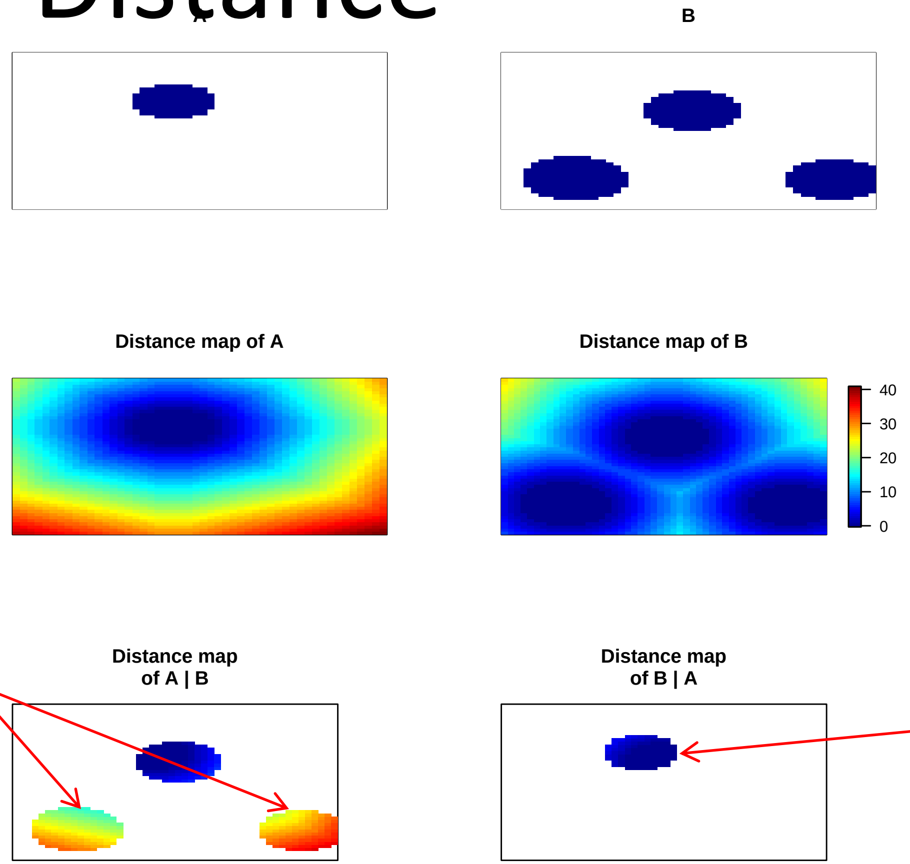
Questions?

Note: The R package **texmex** was used for fitting the HT2004 model in these slides.

Harry Southworth, Janet E. Heffernan and Paul D. Metcalfe (2018). texmex: Statistical modelling of extreme values. R package version 2.4.2.

# Mean Error Distance

d(x, A)




d(x, B)

Very large because much of B is very far from A

Very small because all of A is very close to B in space

$\text{MED}(A, B) = \Sigma_{x \text{ in } B}\, d(x, A)/N$

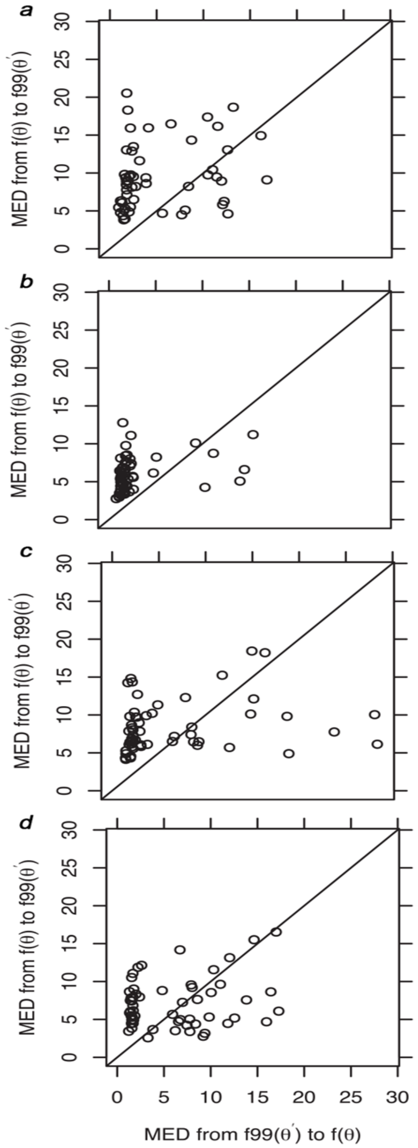
N is the size of the domain

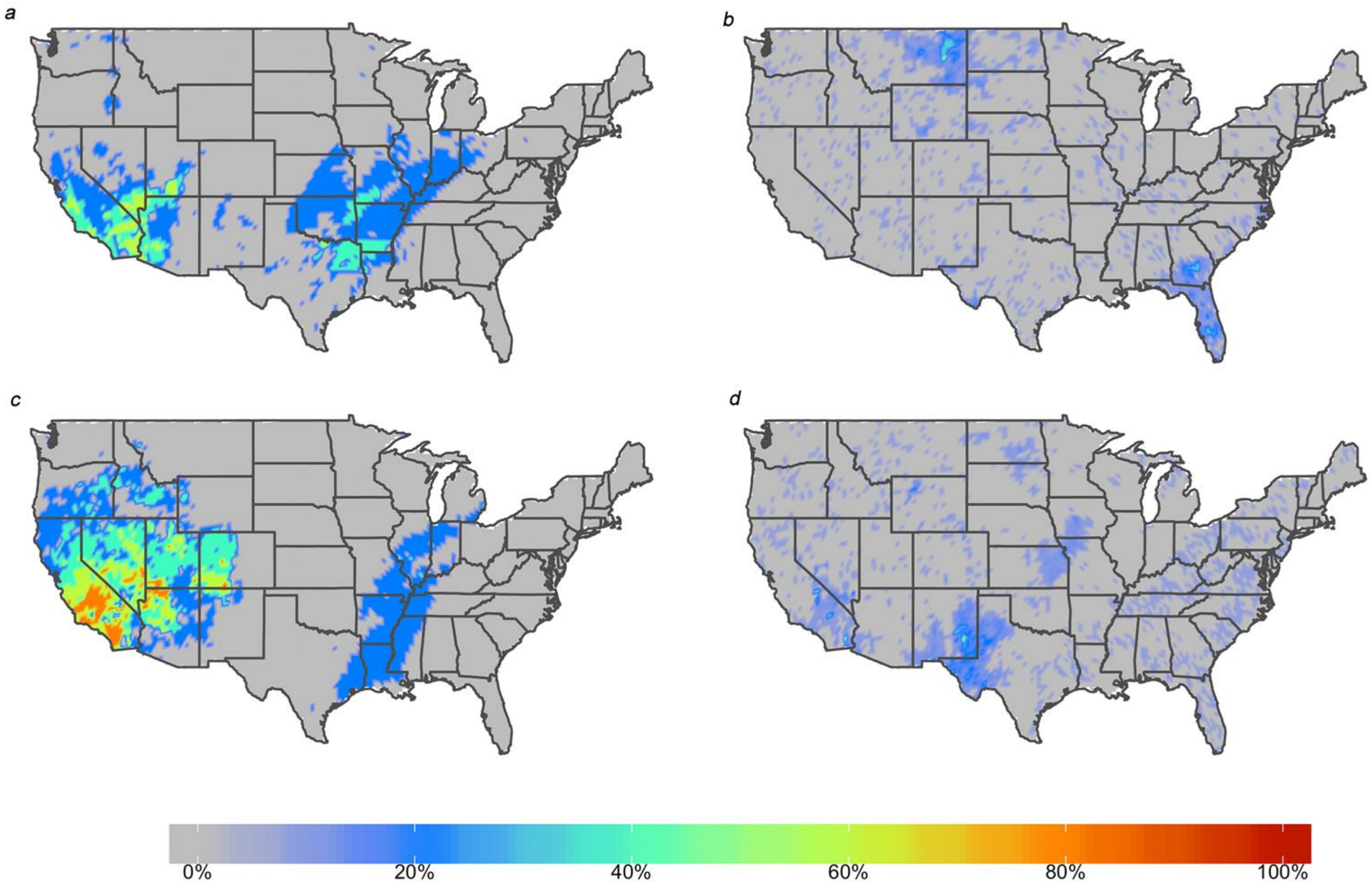
**Average distance from B to A.**

$\text{MED}(B, A) = \Sigma_{x \text{ in } A}\, d(x, B)/N$

**Average distance from A to B.**

# Examples

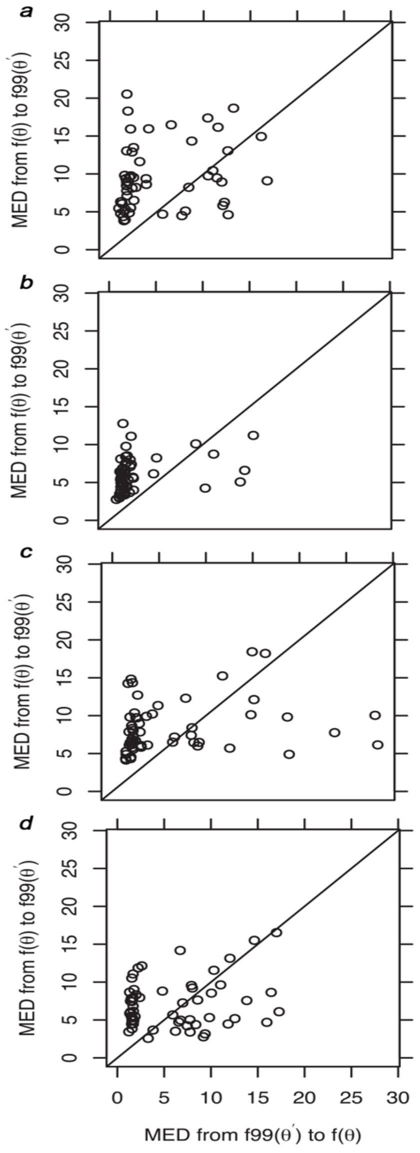


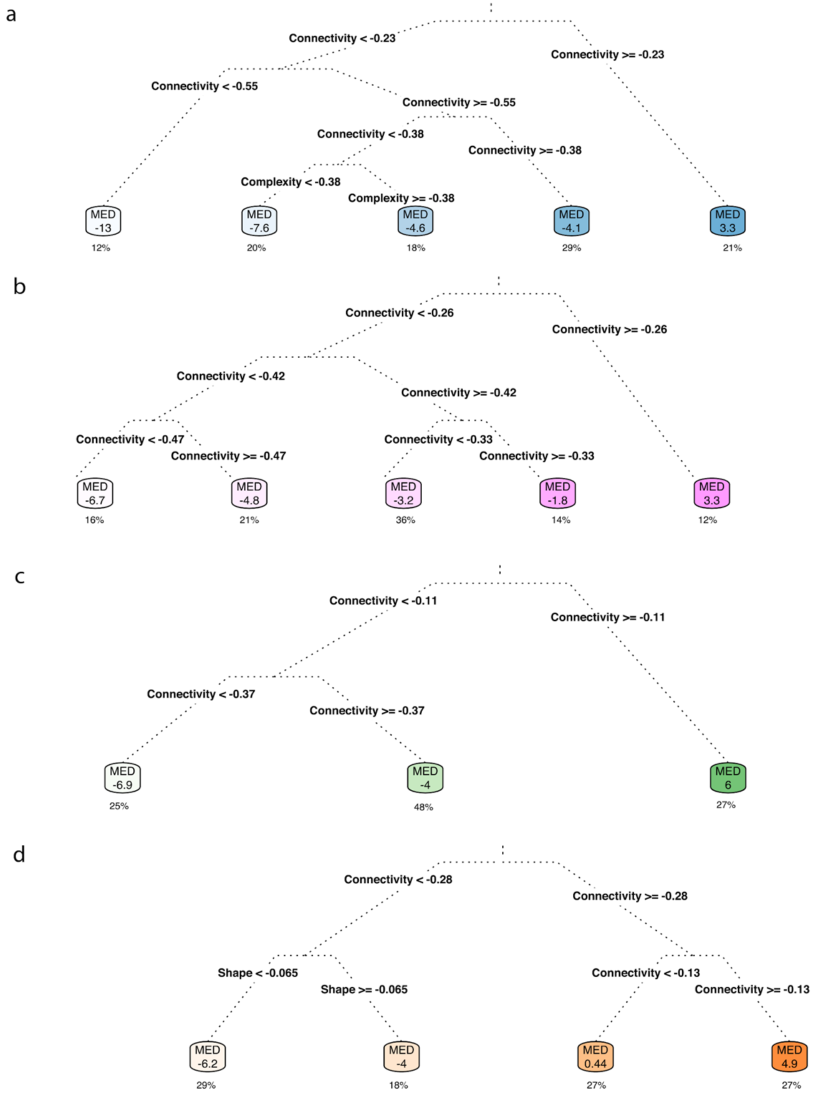



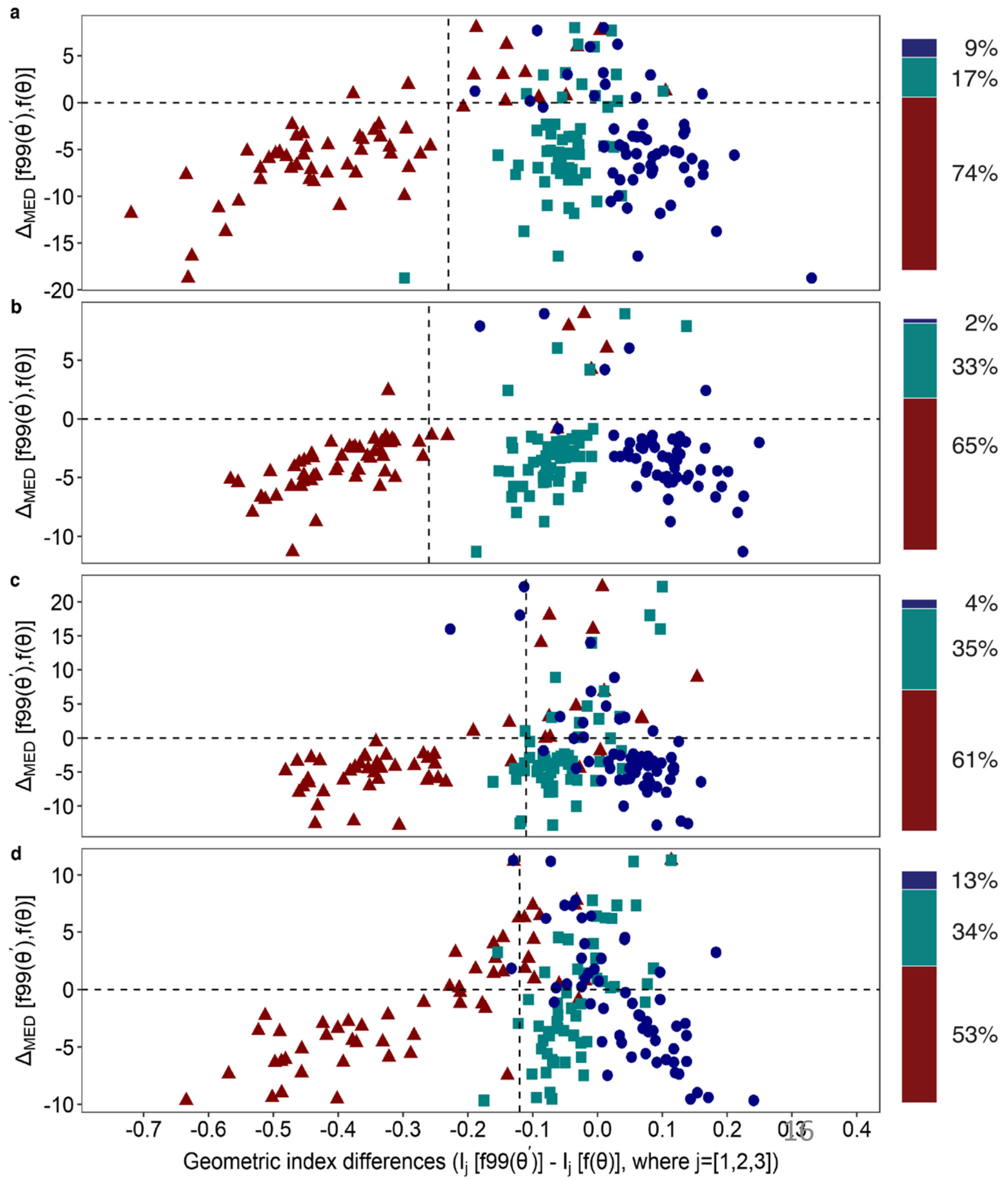

From univariate GP to (spatial) propinquity

From propinquity to univariate GPD

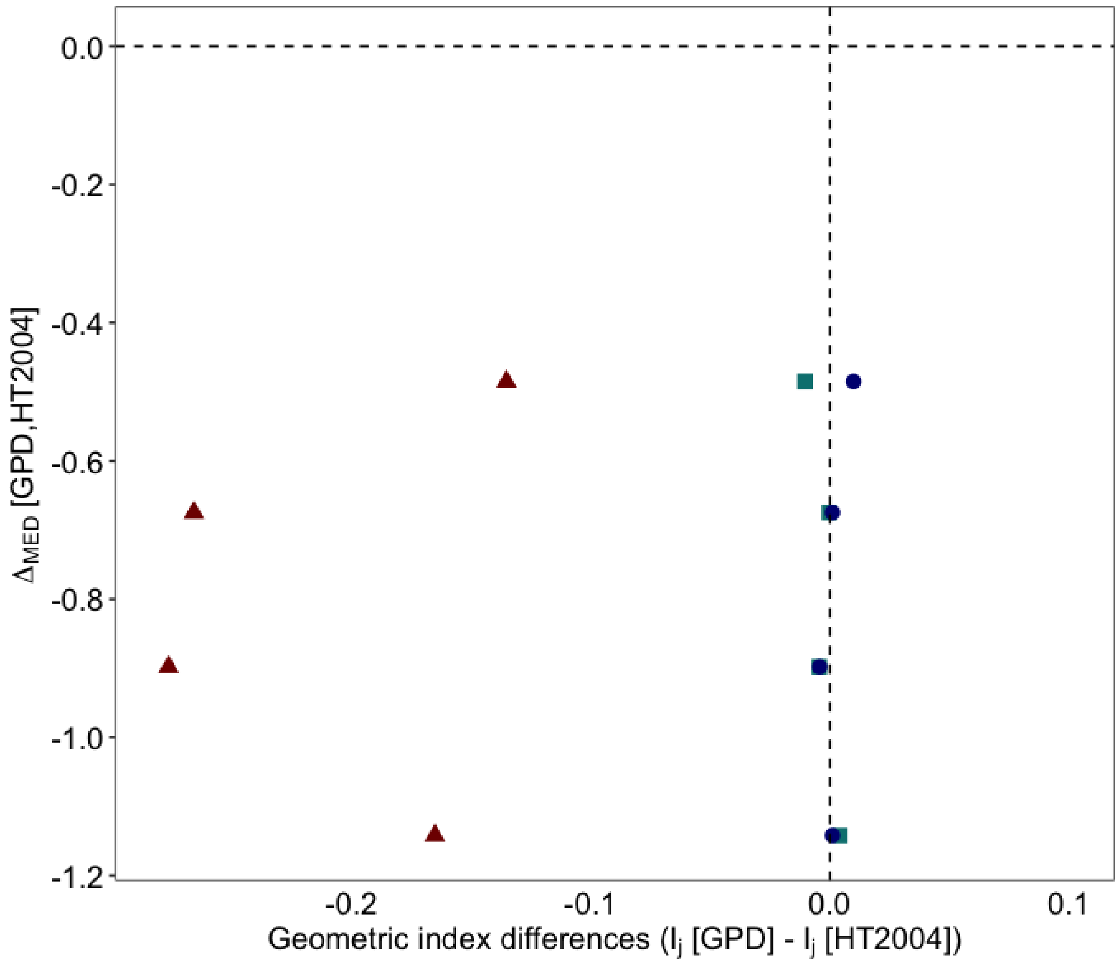
# Comparison (obs.)



# Comparison (GPD vs. HT2004)



# Threshold Selection Algorithm for Extremes

1. Essential Field Quantity (EFQ) is closely matched to the timeframe of interest
2. Dimension reduction based on statistical quantiles
3. Spatial domain mapping represented by geometric indices
4. Time series clustering and threshold selection

**“Extremeness” is determined by an underlying process in space and time!**