Extreme Rainfall Statistics Past, Present and Future

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Cast

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Credits

Chesapeake Bay Trust

Virginia Transportation Research Council (VTRC)

The Commonwealth Center for Recurrent Flooding Resiliency (CCRFR)

State of New Jersey

NYS Energy Research and Development Authority (NYSERDA)

NOAA

Cornell University

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The Washington Post

Democracy Dies in Darkness

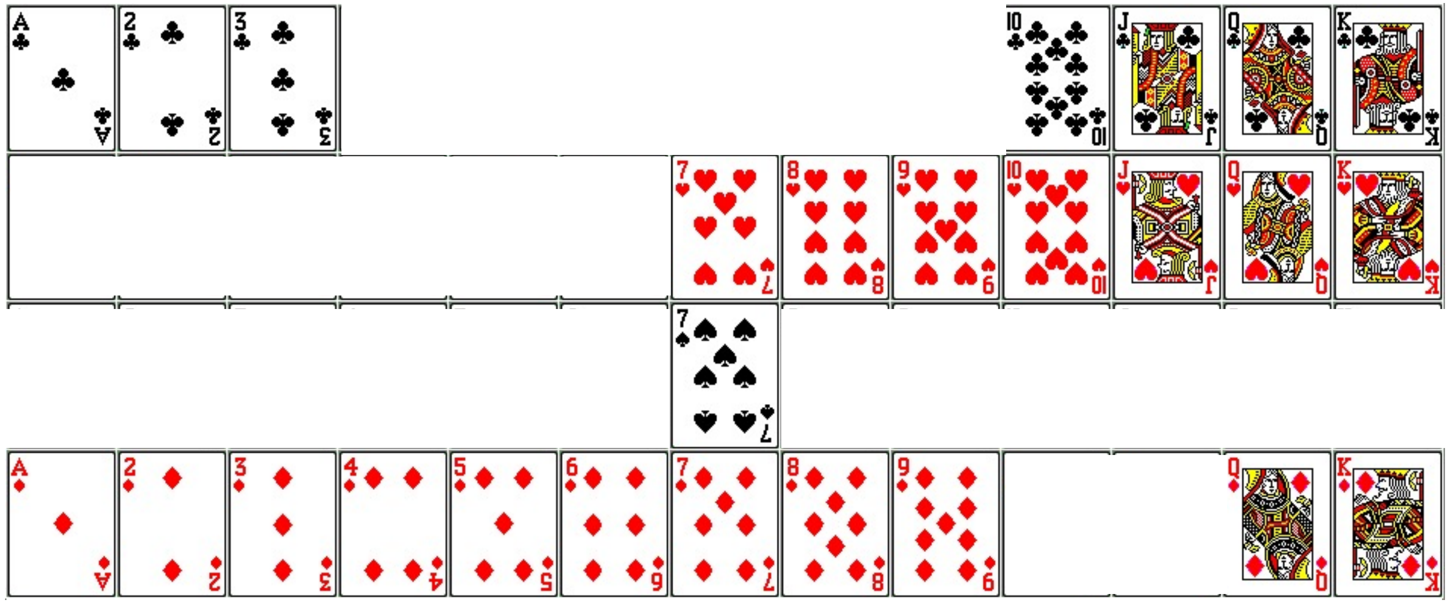
Climate and Environment

As rainstorms grow more severe and frequent, communities fail to prepare for risks

Lack of a current, national rainfall database means some states use 60-year-old statistics as they design roads, bridges and dams that are supposed to last 50 years

People walk through flood water near Interstate 10 in Houston after Hurricane Harvey hit Texas in August 2017. (Jabin Botsford/The Washington Post)

Estimating Current Rainfall Extremes is like…..



Estimating the probabilities of poker hands

Without knowing the values and suits of all the cards!

Partial Duration Series

Boston Logan Internation Airport (#190770) – 1936-2008 (72 complete years)						
7.06"	3.84"	3.11"	2.81"	2.64"	2.52"	2.42"
6.11"	3.77"	3.00"	2.80"	2.64"	2.52"	2.40"
5.69"	3.58"	2.98"	2.77"	2.63"	2.50"	2.40"
5.63"	3.51"	2.95"	2.77"	2.60"	2.50"	2.40"
4.88"	3.49"	2.94"	2.76"	2.59"	2.49"	2.39"
4.71"	3.36"	2.91"	2.76"	2.59"	2.49"	2.38"
4.47"	3.34"	2.90"	2.71"	2.58"	2.47"	
4.29"	3.32"	2.89"	2.67"	2.55"	2.46"	
4.21"	3.31"	2.89"	2.66"	2.54"	2.46"	
4.12"	3.16"	2.87"	2.64"	2.54"	2.46"	
4.00"	3.15"	2.82"	2.64"	2.53"	2.42"	

Atlas 14: The estimates are based on the analysis of annual maximum series and then converted to partial duration series results.

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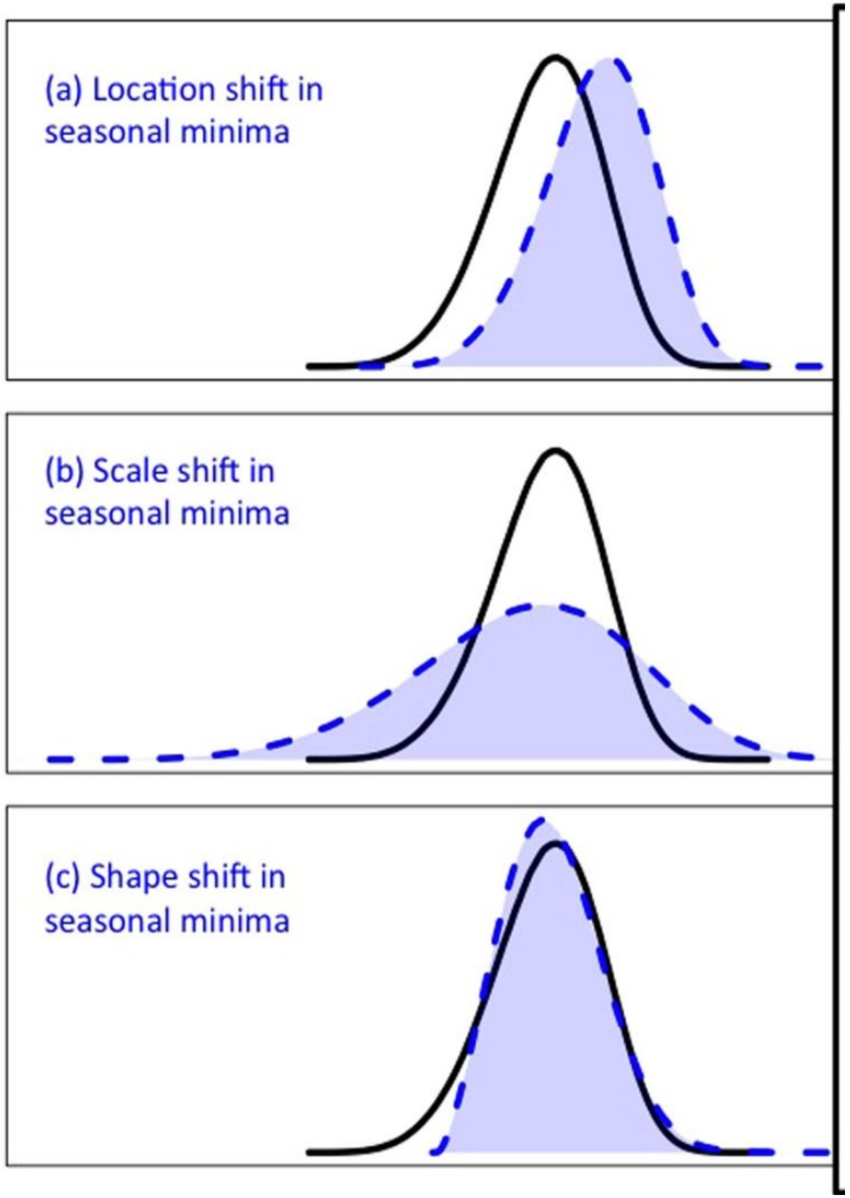
The GEV Distribution



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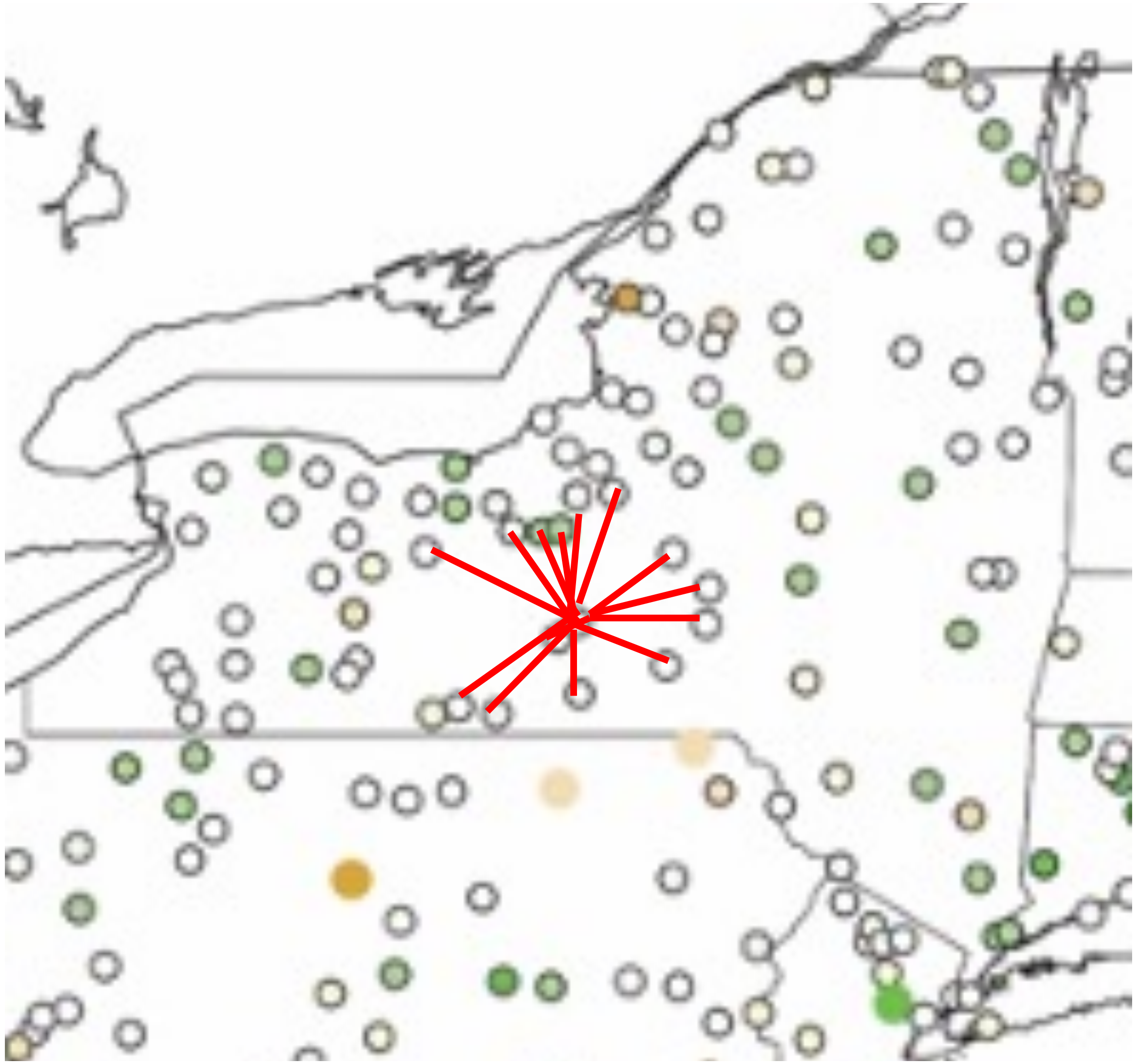
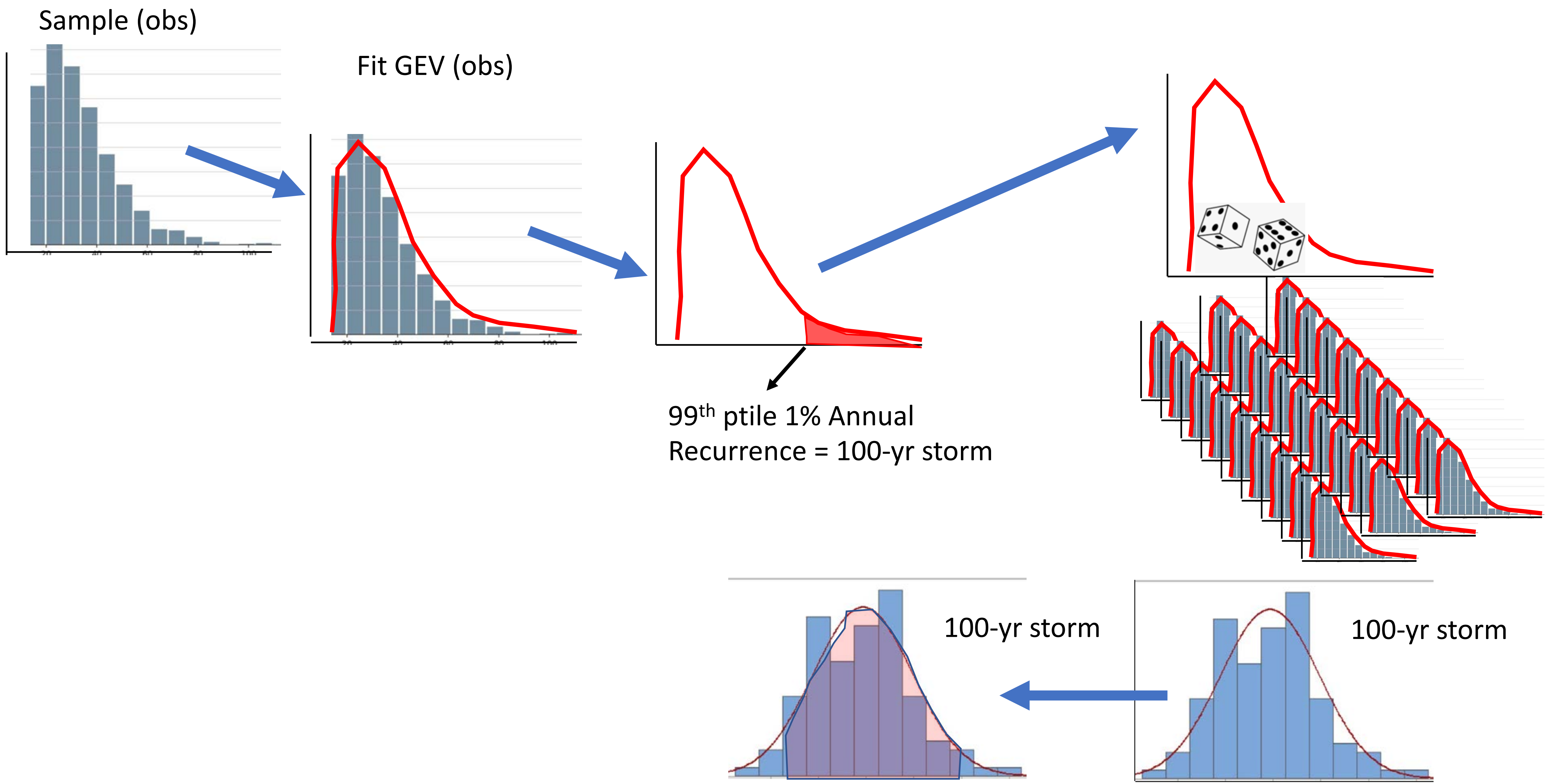
Regional L-moments Fitting

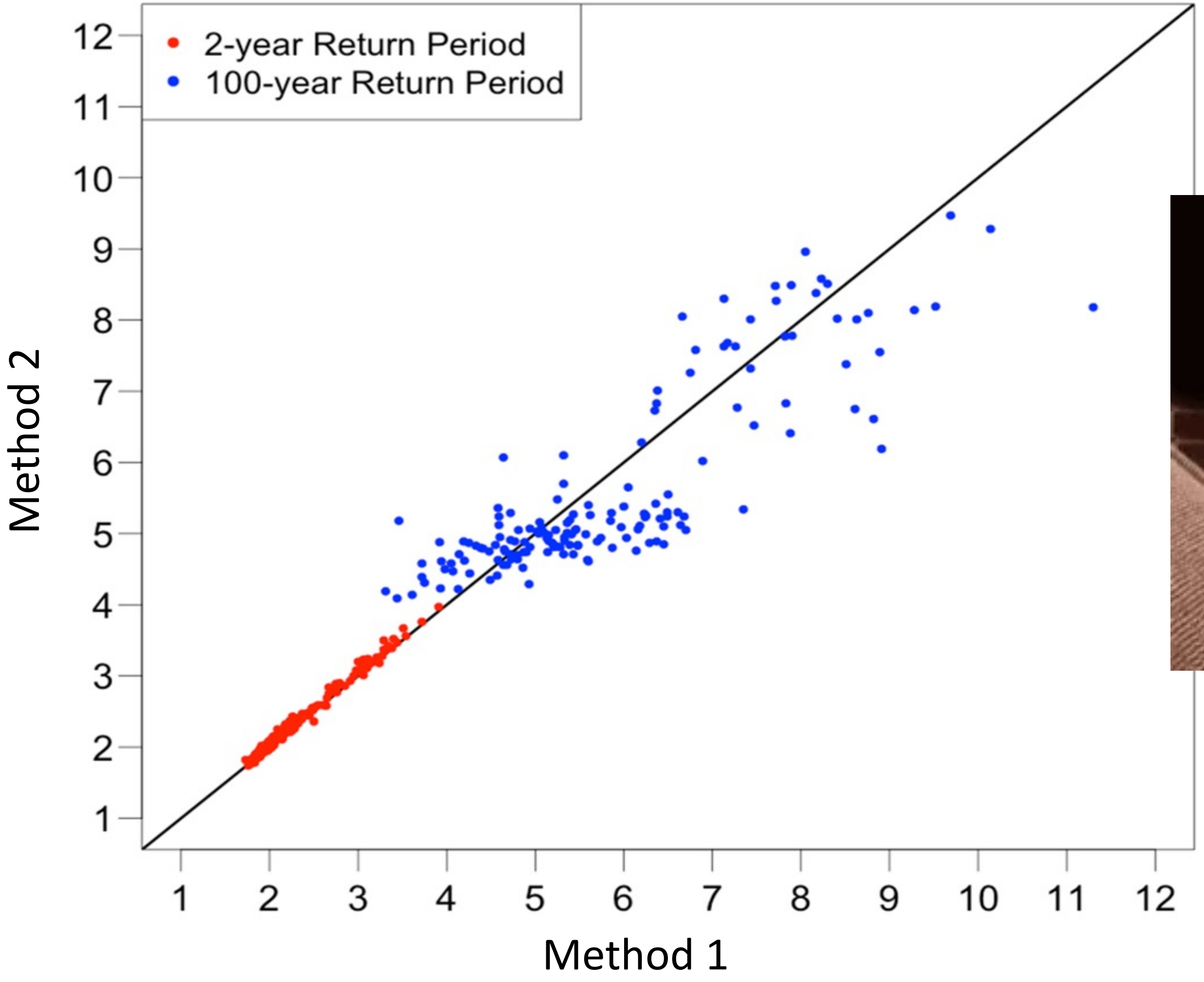
Average higher order moments of surrounding stations.



Resampled Confidence Intervals

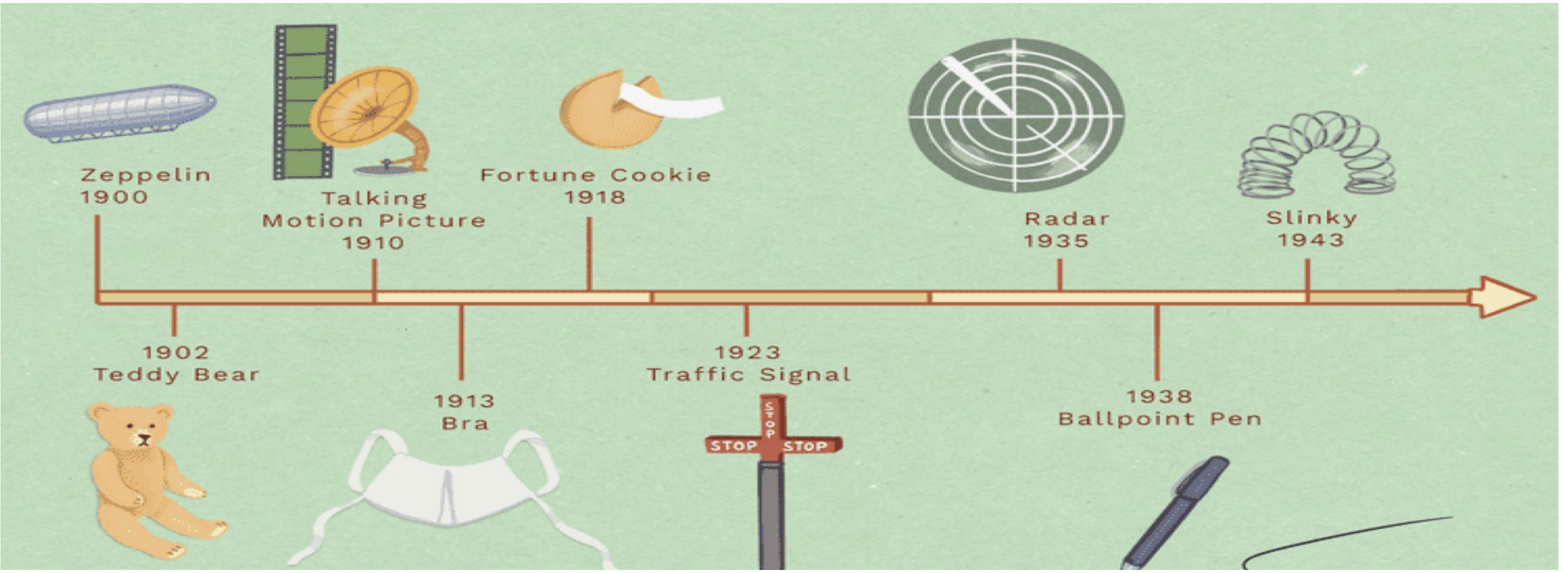


A Happy Dog!



2-year Return Period
100-year Return Period
Method 2
Method 1
1
2
3
4
5
6
7
8
9
10
11
12

Q1: Are the Longest Record Lengths the Holy Grail?



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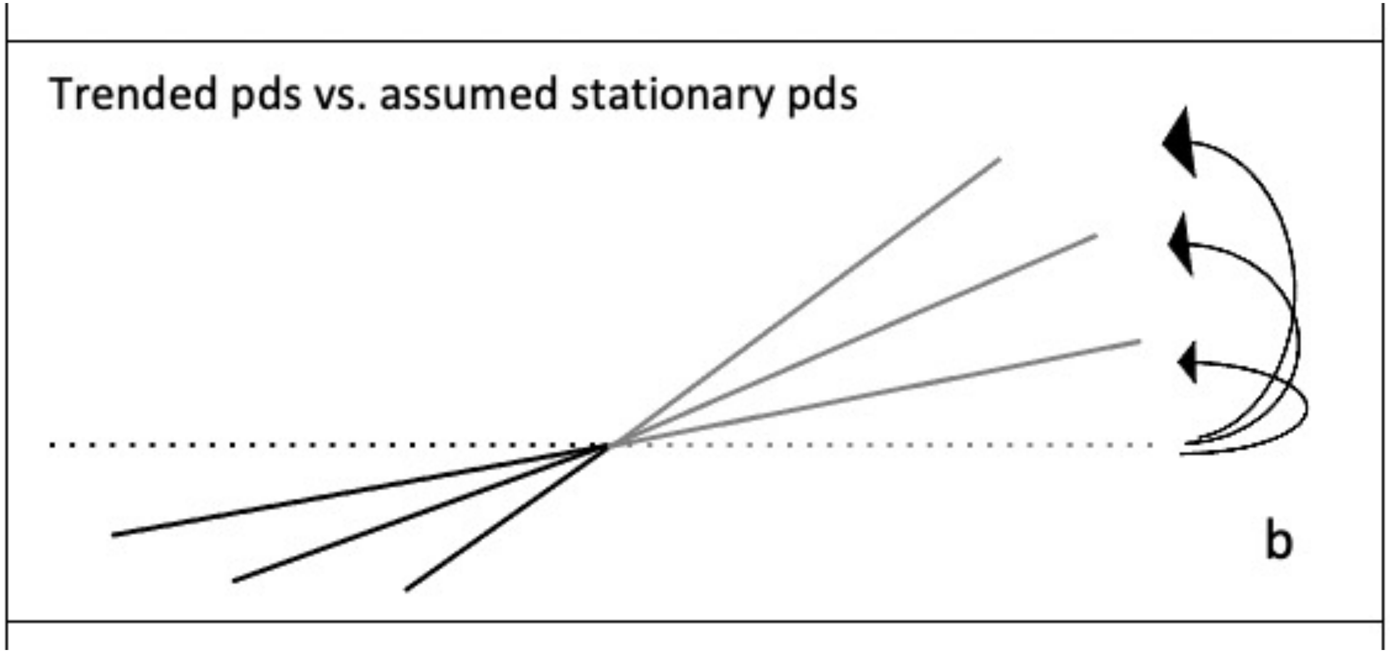

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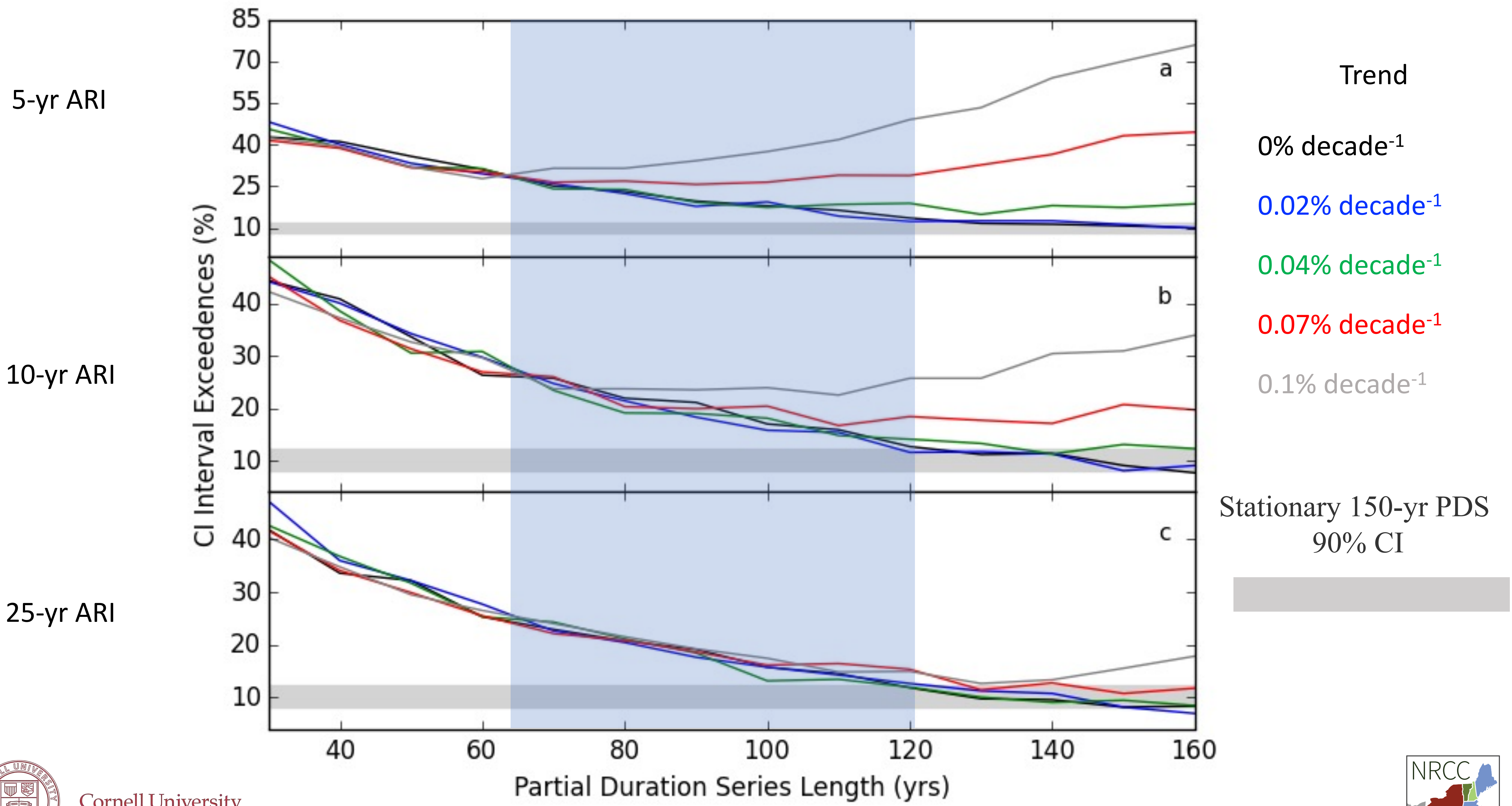

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Q1: Are the Longest Record Lengths the Holy Grail?

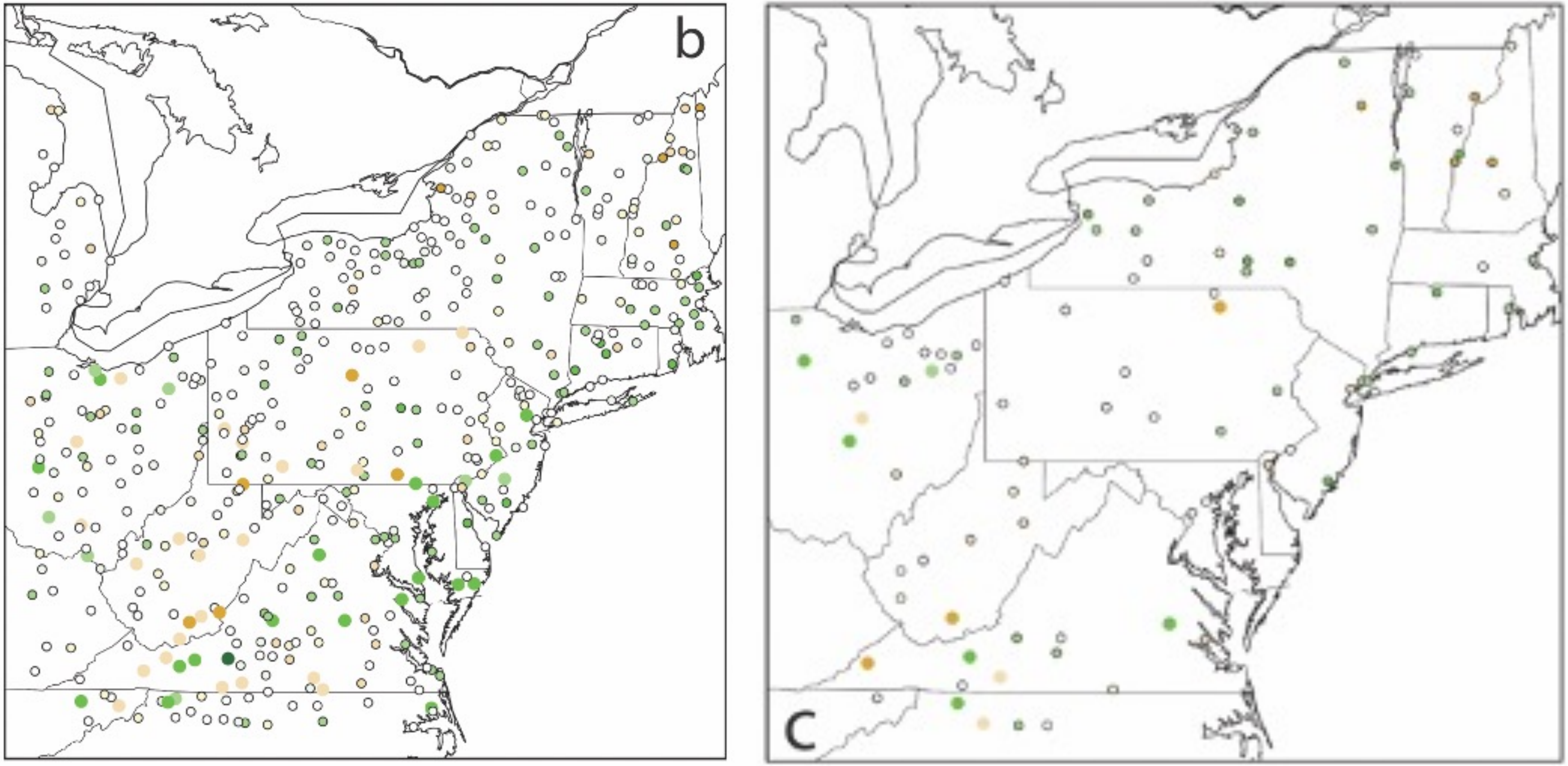
A1: Not when they have a trend

Sweet spot 70-120 years

Q2: How often should extreme rainfall atlases be updated?

Is NOAA Atlas 14
(circa 2000) out of date?

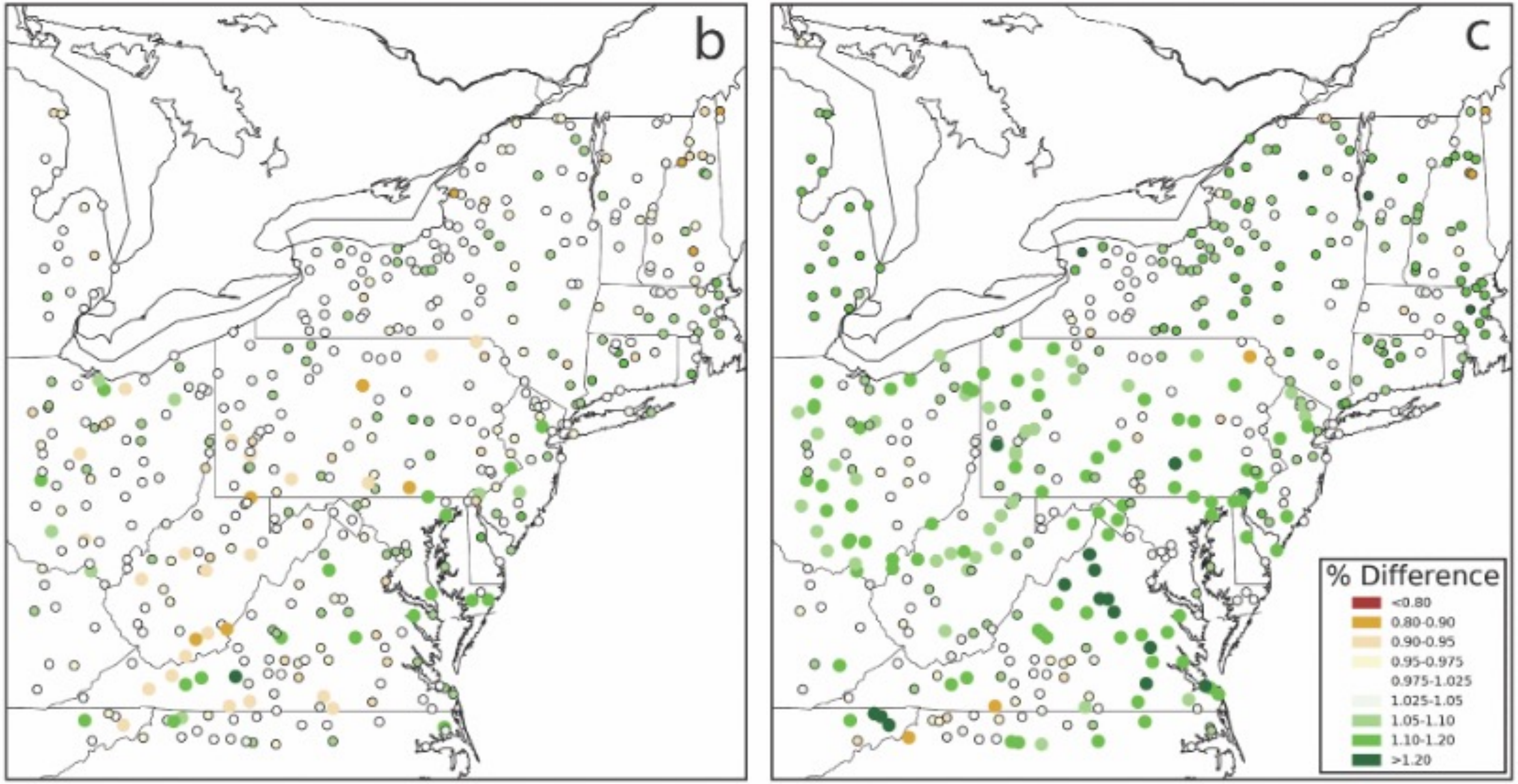
Study Domain



Daily

Hourly

Simulation of Atlas 14 Methods



2-year ARI

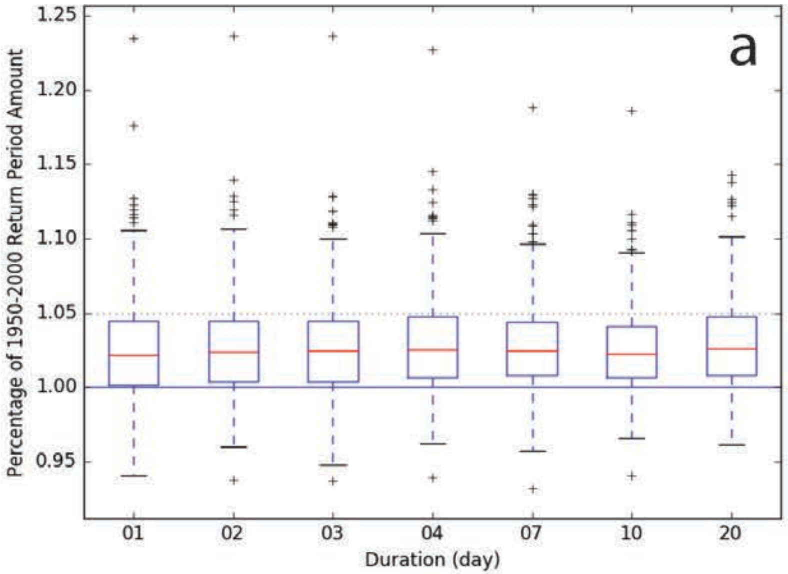
100-year ARI

Differences

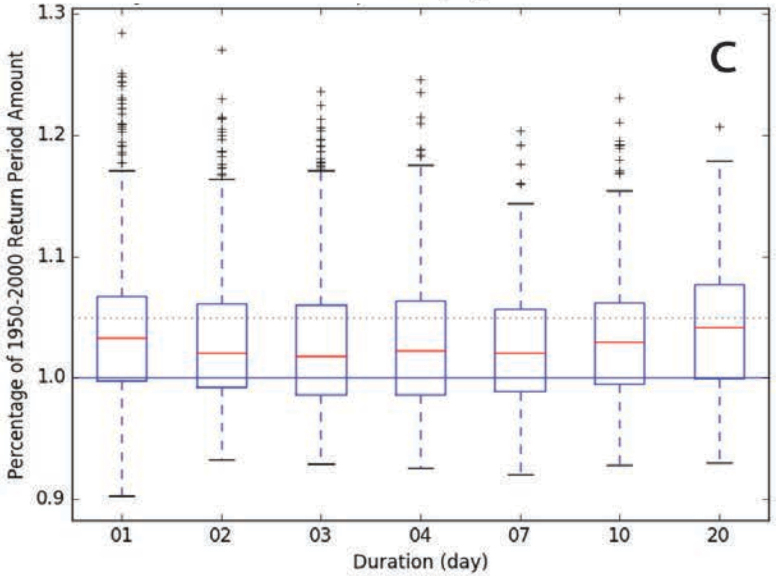
- Period of record
- AMS-PDS
- PA-NY regionalization
- PA-NY GEV
- Station vs grid

1950-2019 vs 1950-2000: Atlas 14 Update vs Original

2-year ARI



100-year ARI



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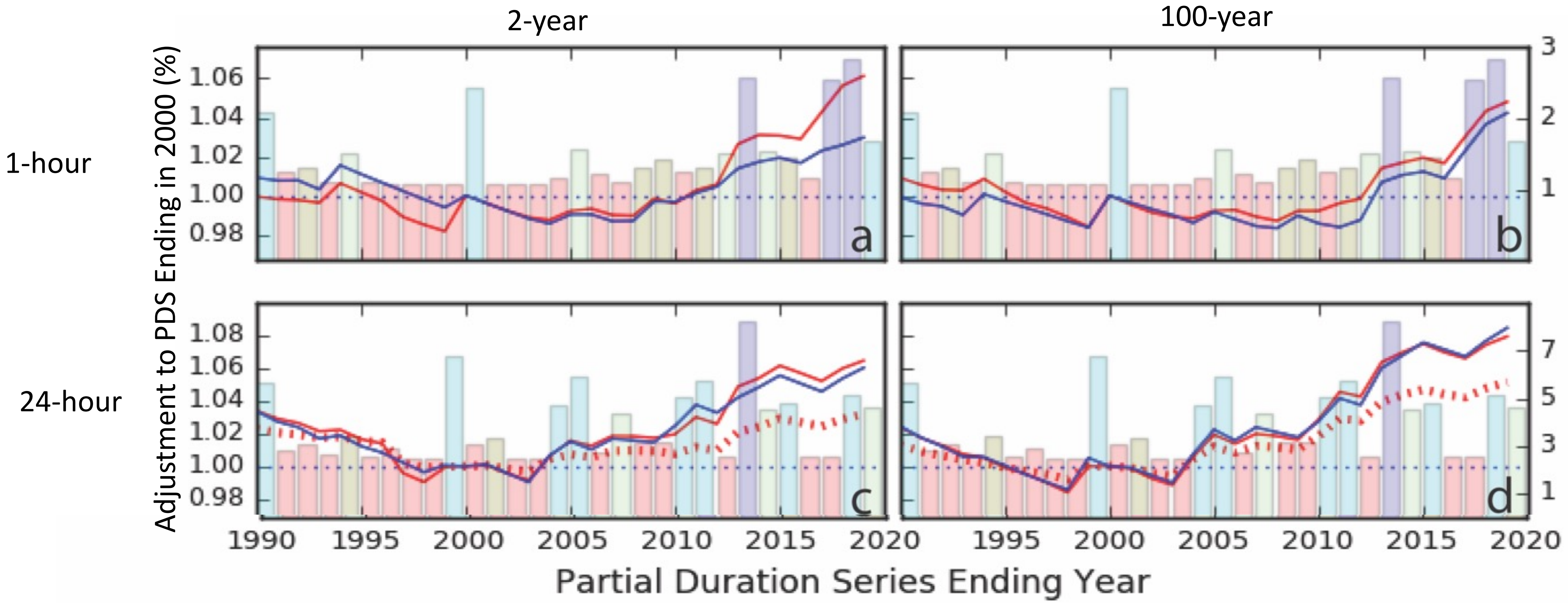
Why the Changes and Differences?



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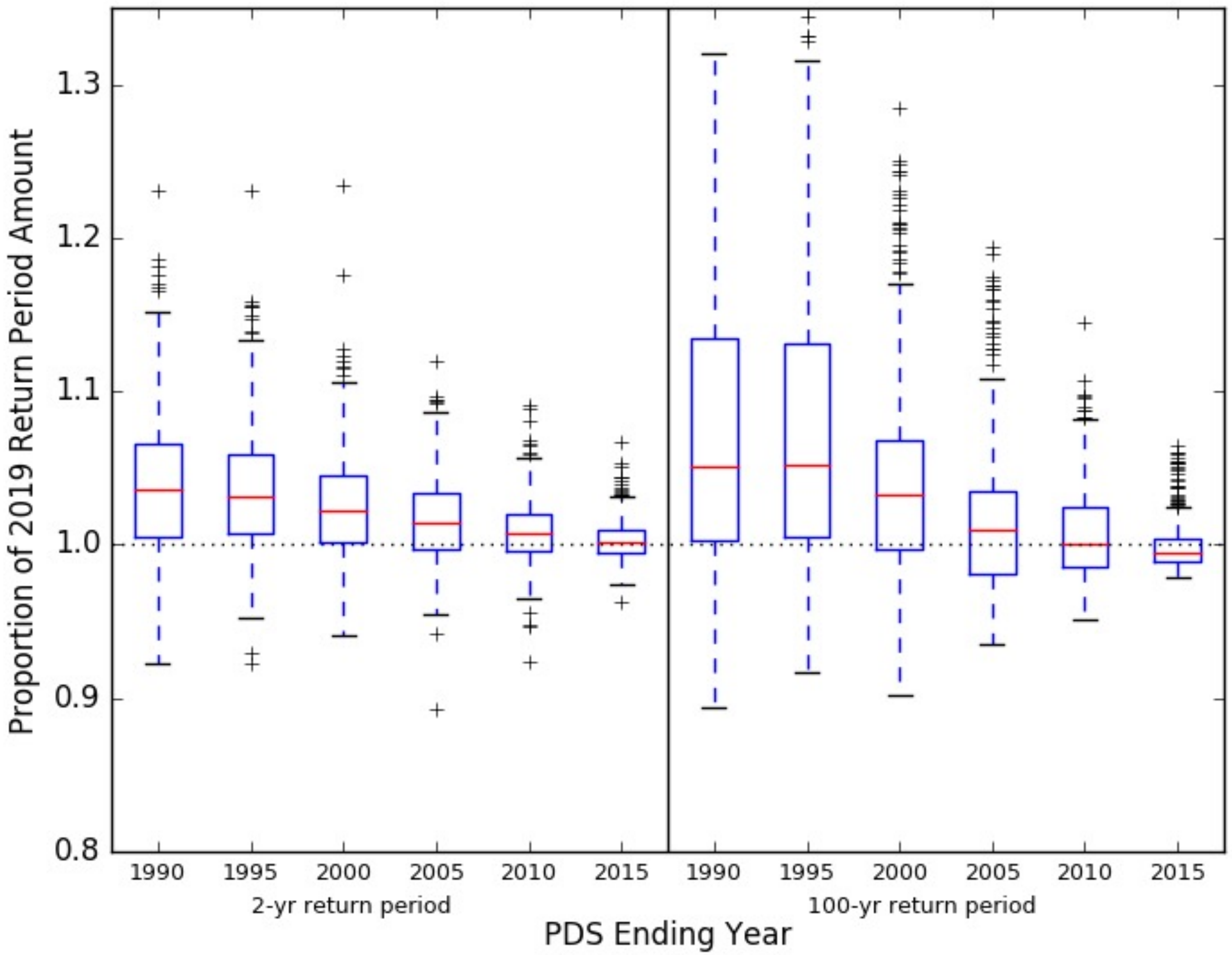
https://precipchange.nrcc.cornell.edu

Influence of Ending Year



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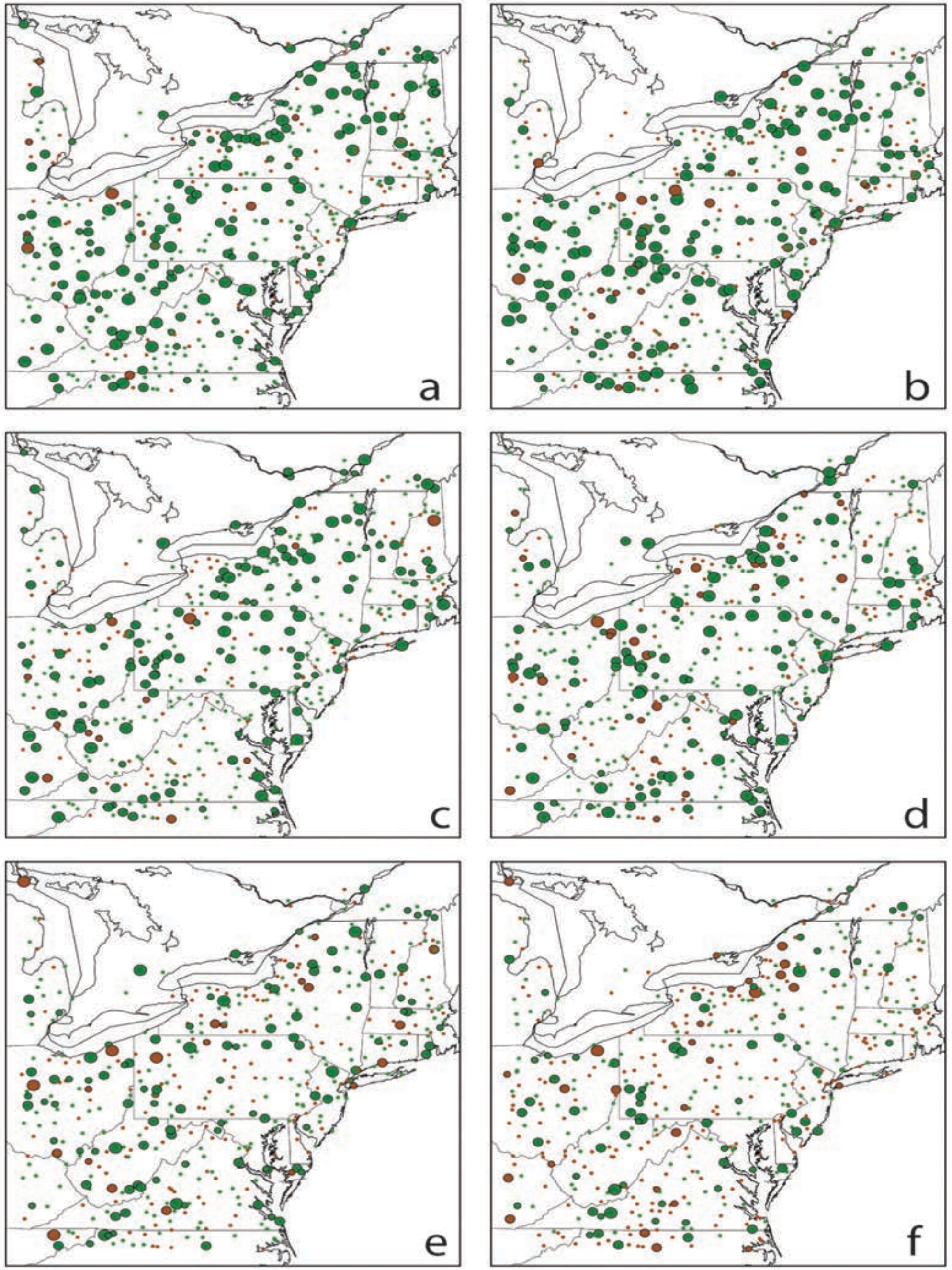
Significant?

- 2019 PDS at each station (70 years)
- Fit GEV
- Resample selecting 61, 51 and 41 values (2010, 2000,1990)
- Fit GEV, compute RI, calculate proportion (2019/base)
- Compare observed to resampled



Q3: How will Design Storms Change in the Future?

2020

1950-2020 PDS

2070

1950-2020 PDS?

Projections

Localized Constructed Analogs (LOCA)

- Statistically Downscaled
- 1/16th ° Spatial Resolution (7 km)
- 31 CMIP5 models
- Daily resolution
- RCP 8.5 and 4.5
- NCA method of choice

Coordinated Regional Climate Downscaling Experiment (CORDEX)

- Dynamically Downscaled
- 0.22° Spatial Resolution (25 km)
- 16 CMIP5 model-RCM combos
- Daily and sub-daily resolution
- RCP 8.5 and 4.5 (3 combos)

Excluded MACA and BCSD (two other common statistical downscaling techniques)

Methods (per model and grid point)

Extract 50-yr PDS:

- 1950-1999 (model hist)
- 2020-2069
- 2050-2099

Fit GEV to PDS to obtain ARIs:

- single grid
- regional (20 grids)

Compute Change Factor CF_{ARI}:

$$\frac{ARI\ Future}{ARI\ Historical}$$

Resample (1000 x):

- select PDS from original future
  fit GEV
- fit new GEV and obtain ARI
- compute

$$\frac{ARI\ Future\ (resampled)}{ARI\ Historical}$$

For each LOCA grid (31 x 1000) CF_{ARI} values
For each CORDEX grid (16 x 1000) CF_{ARI} values

Interpolate to common 0.1° grid
Compute median and percentiles

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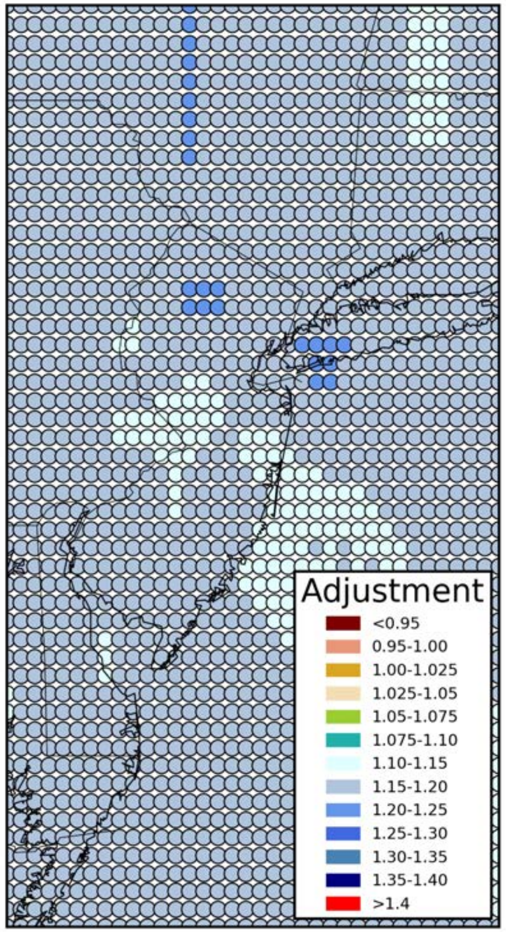
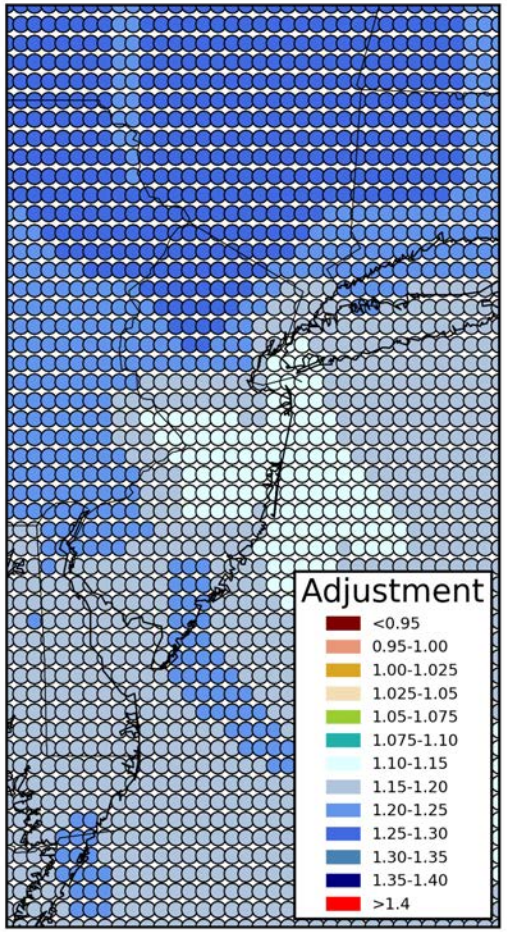
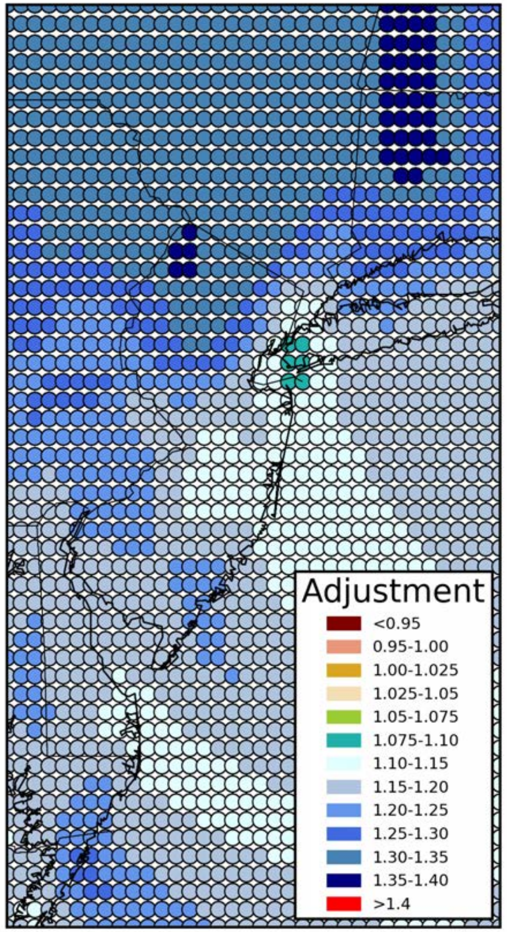
Ensemble Median Change Factor (RCP8.5 2050-2099)



2-yr



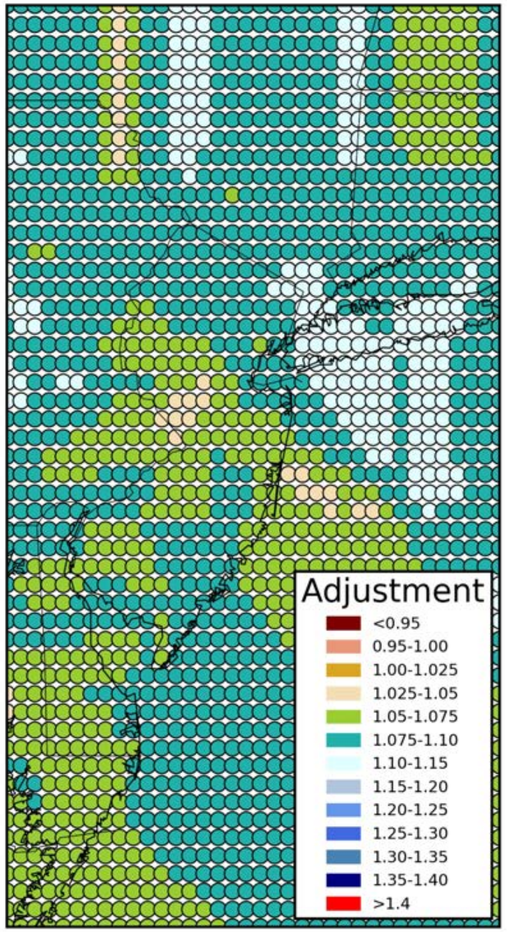
25-yr



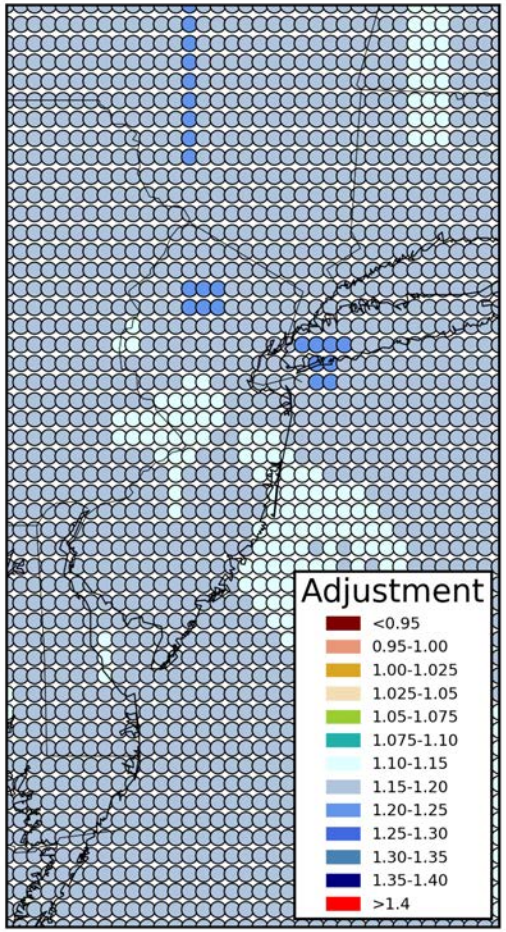
100-yr

Ensemble Change Factor 17th-83rd percentile range

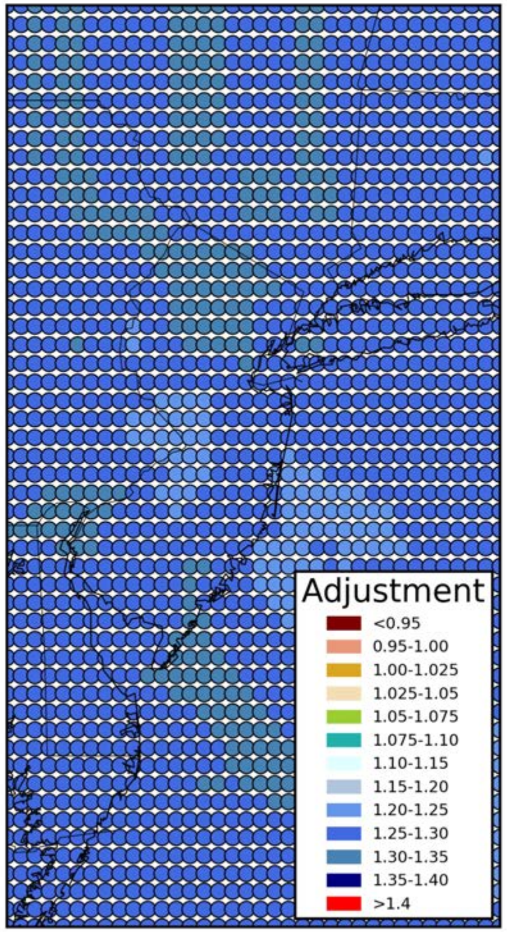
2-year ARI



17th



median



83rd

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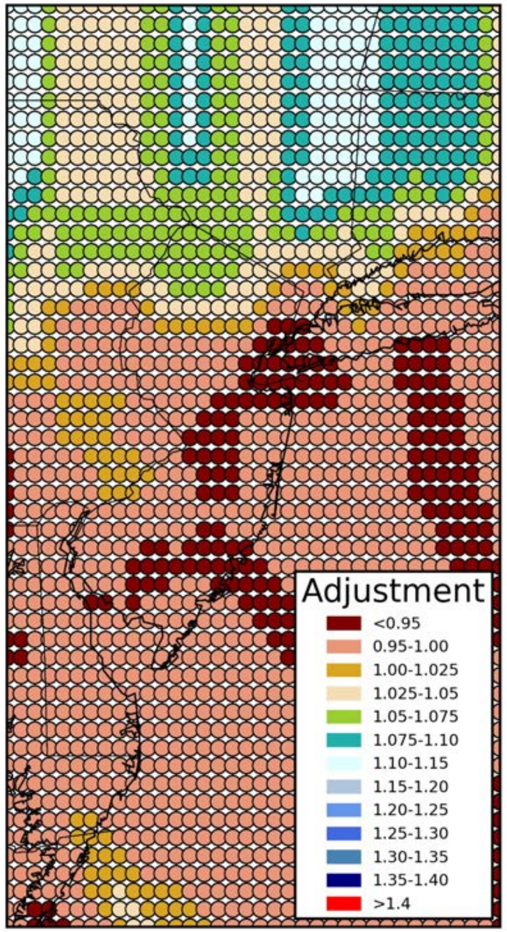
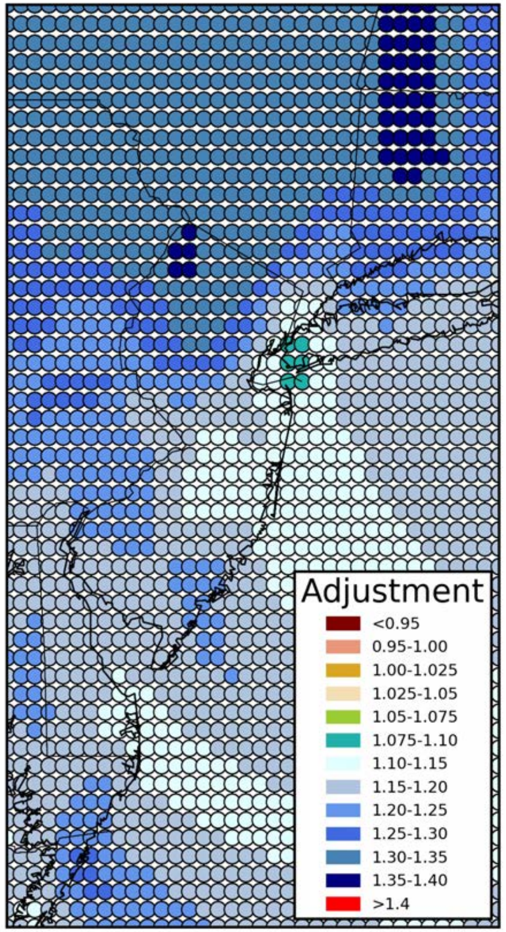
Ensemble Change Factor 17th-83rd percentile range

100-year ARI

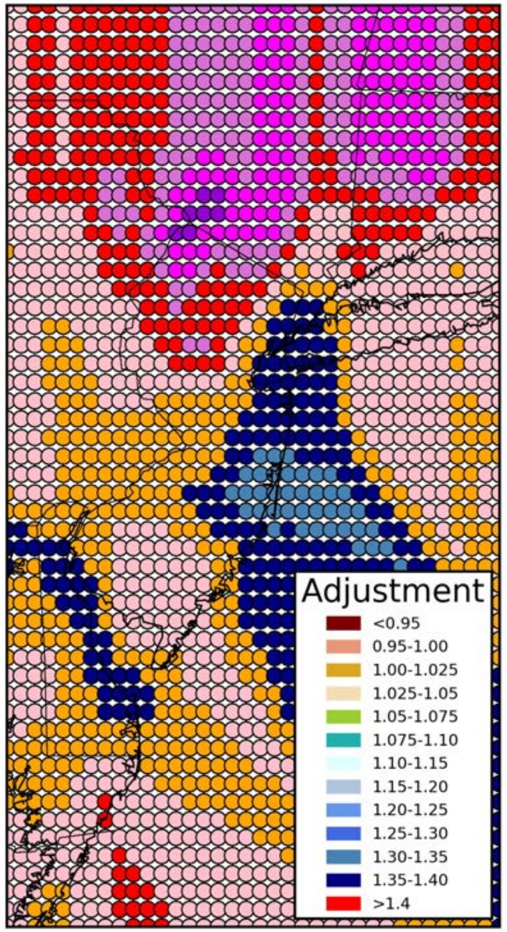
Orange 1.40-1.45
Pink 1.45-1.5
Red 1.5-1.55



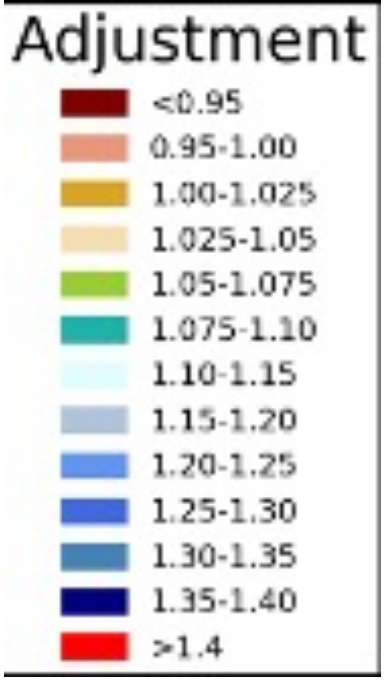
17th



median

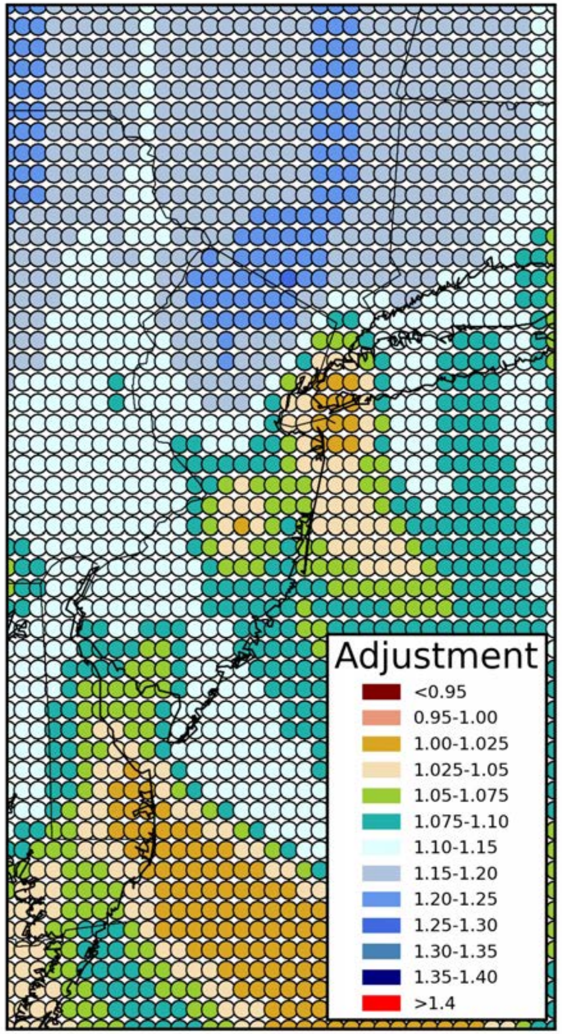


83rd

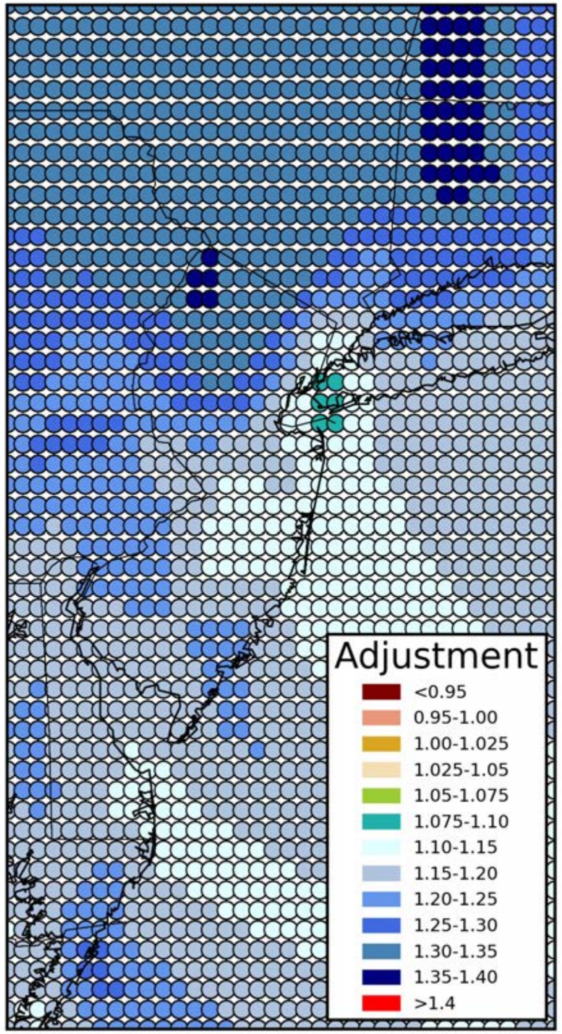


Median Ensemble Change Factors RCP 4.5 vs RCP 8.5

100-yr RCP 4.5. 2050-2099



100-yr RCP 8.5. 2050-2099



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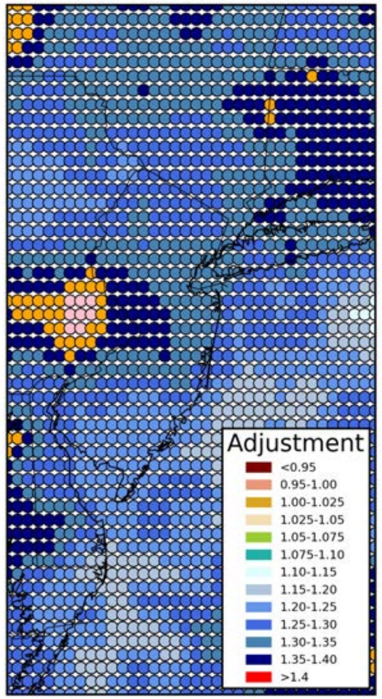
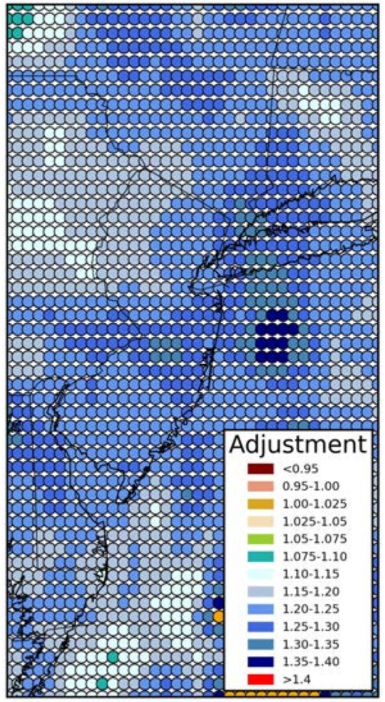
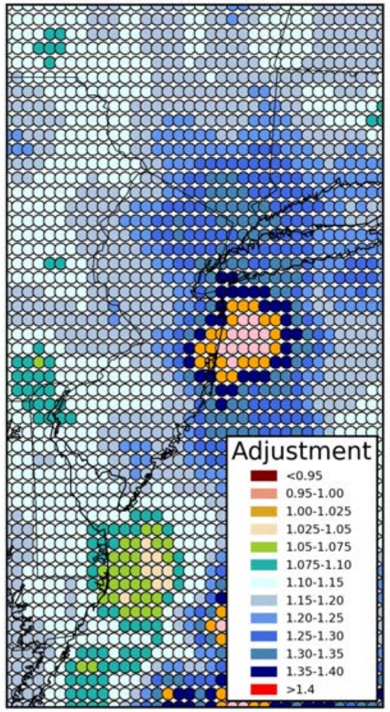
Median Ensemble 100-yr Change Factors RCP 8.5 2050-2099



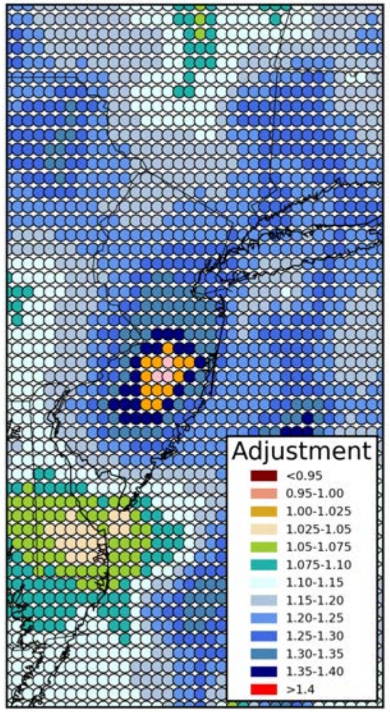
1 –hr



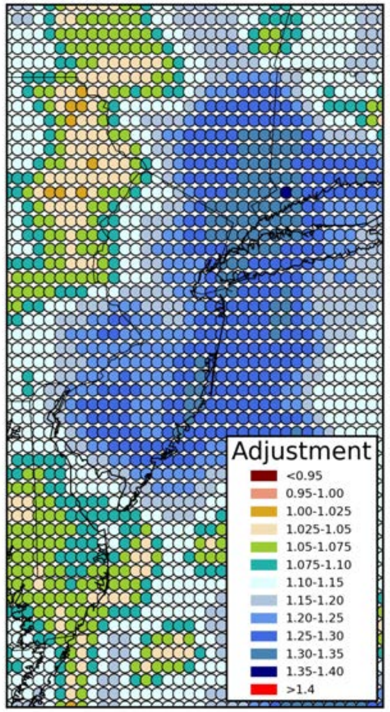
3-hr



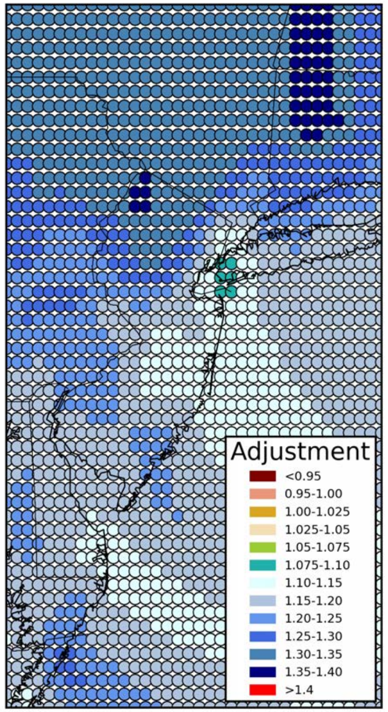
6-hr



12-hr



24-hr



1-day

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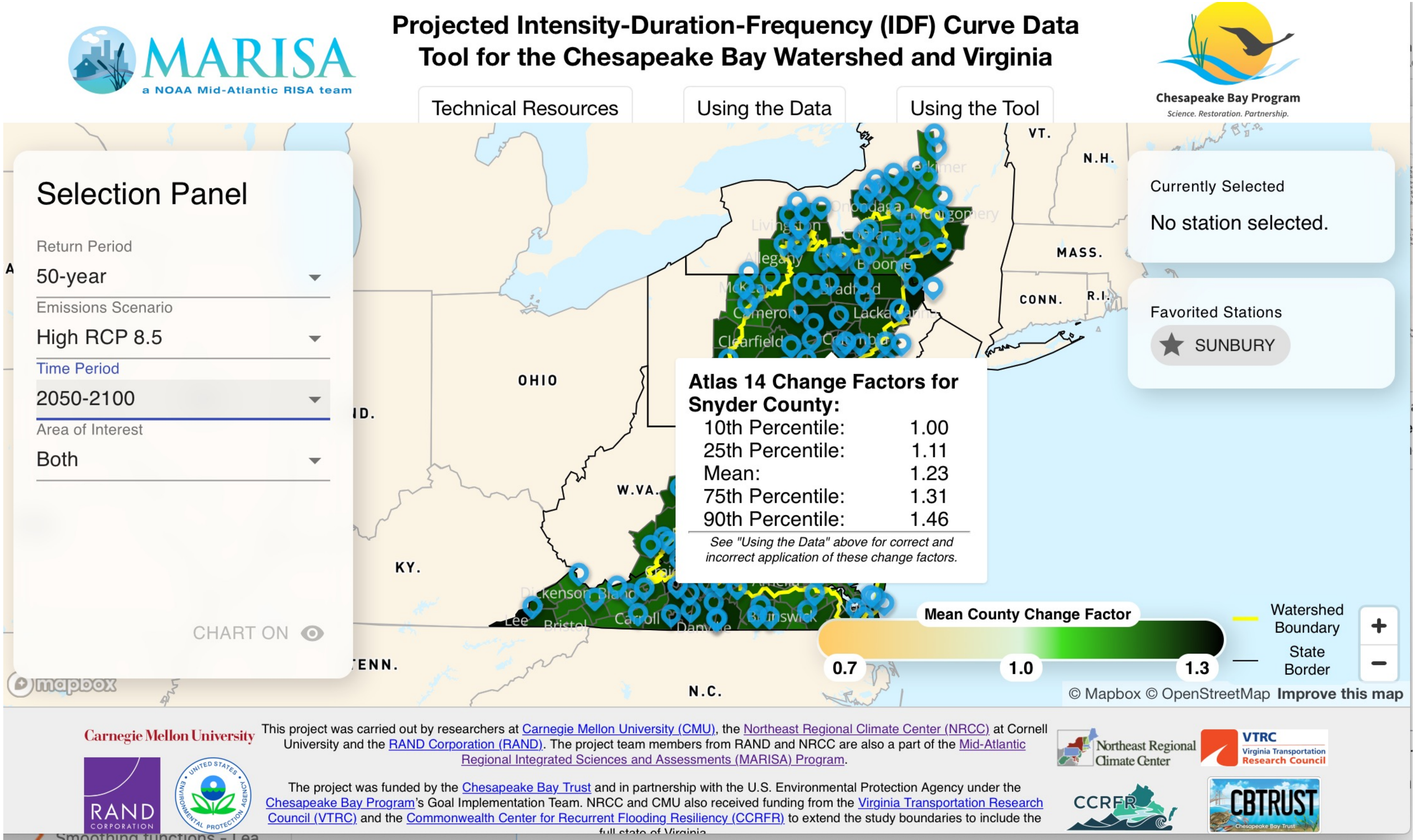
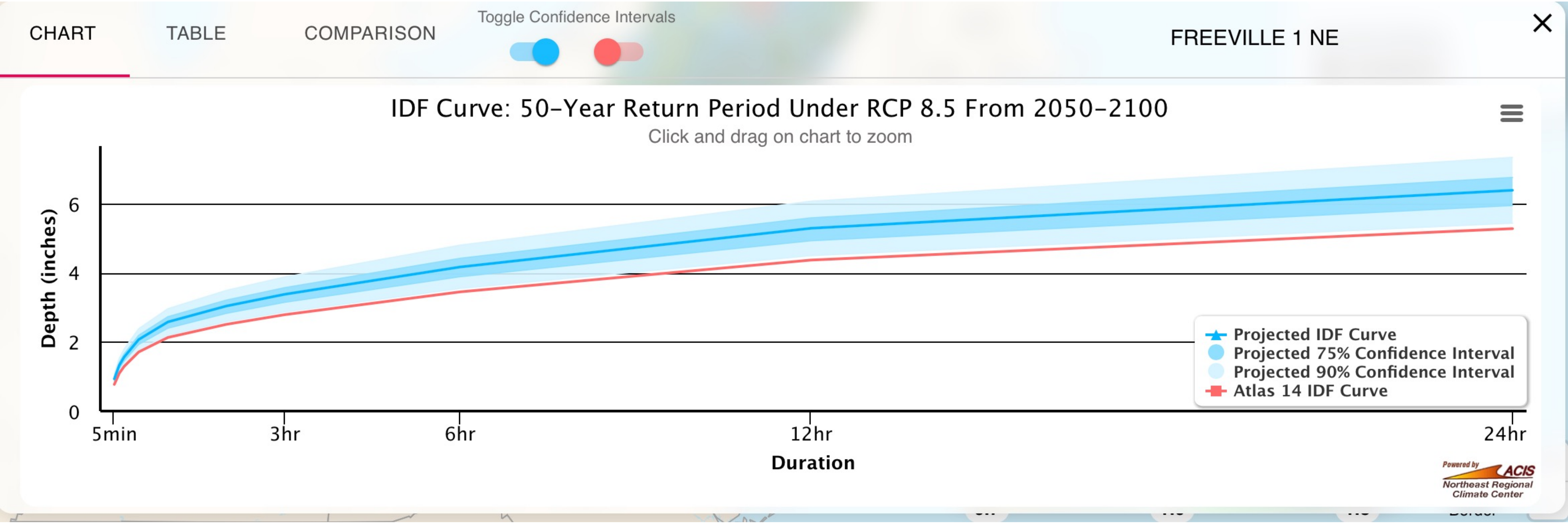
Final Product: https://midatlantic-idf.rcc-acis.org



Final Product: https://midatlantic-idf.rcc-acis.org



Final Product: https://midatlantic-idf.rcc-acis.org

CHART | TABLE | COMPARISON | DOWNLOAD CSV

FREEVILLE 1 NE

County Change Factors:	1.03	1.1275	1.21	1.28	1.39	
	Projected 2050-2100 Depth (inches)					Atlas 14 Depth (inches)
Duration	10th	25th	Mean	75th	90th	
12 hr	4.50	4.93	5.29	5.59	6.07	4.37
24 hr	5.44	5.95	6.39	6.76	7.34	5.28
2 day	6.17	6.75	7.25	7.67	8.33	5.99


Thank You!
Questions??