

Rainfall Extremes in a Changing Climate

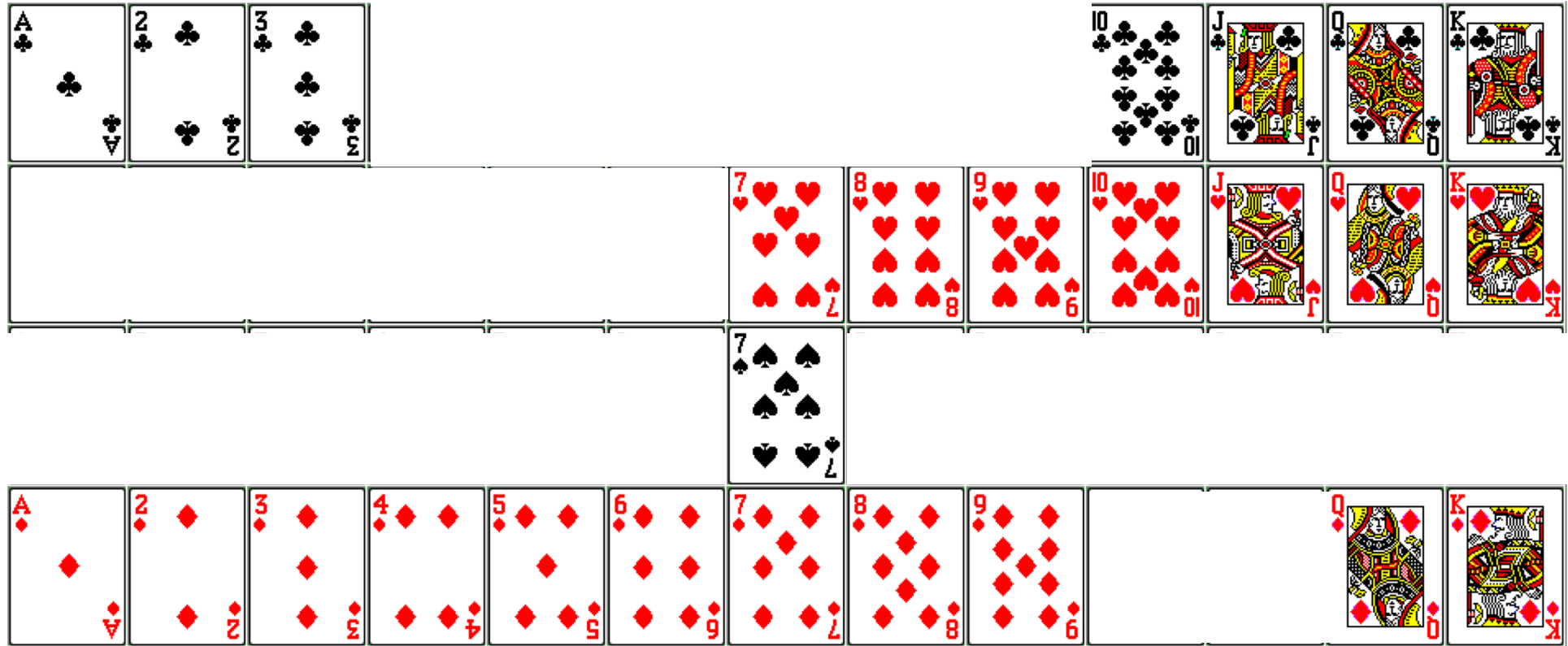
Art DeGaetano

Northeast Regional Climate Center

Department of Earth and Atmospheric Science, Cornell



Estimating Current Rainfall Extremes is like....

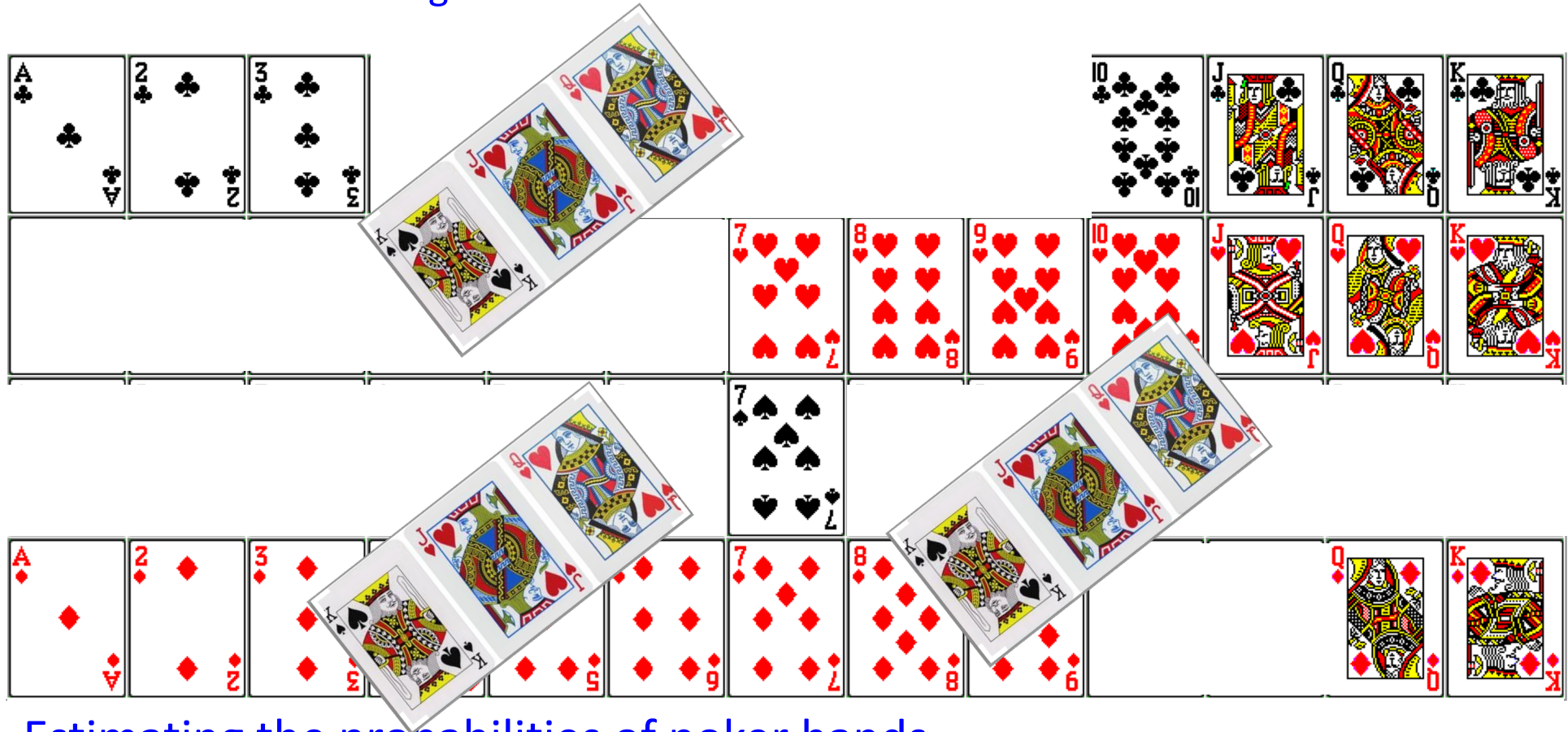


Estimating the probabilities of poker hands

Without knowing the values and suits of all the cards!



Estimating **FUTURE** Rainfall Extremes is like.....



Estimating the probabilities of poker hands

Without knowing the values and suits of all the cards

AND

Adding more face cards to the deck at an unknown rate



Precipitation Extremes 101

- Partial Duration Series (PDS)

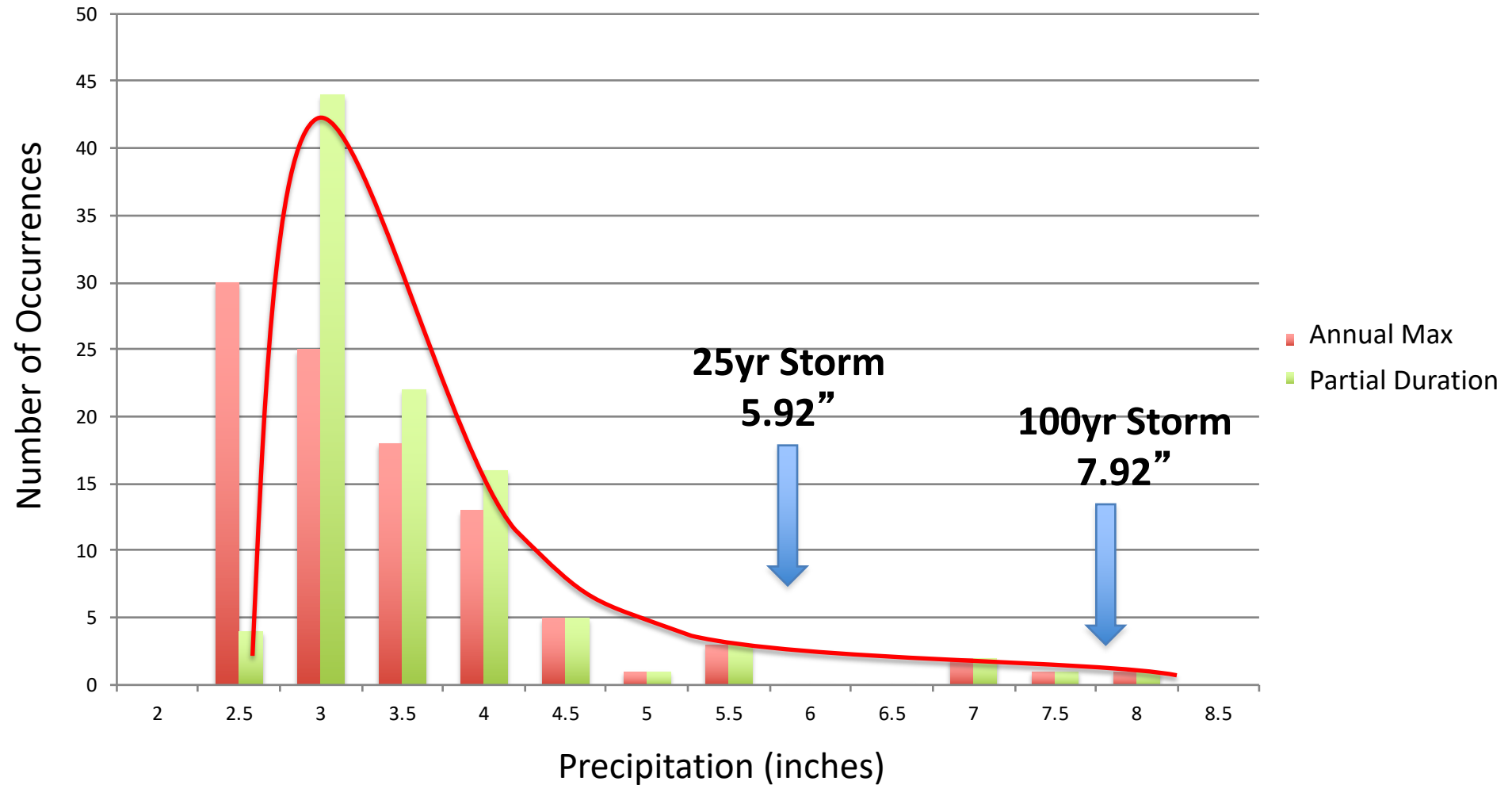
***n* highest** independent daily rainfalls in ***n* year** period

Boston Logan International 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"	



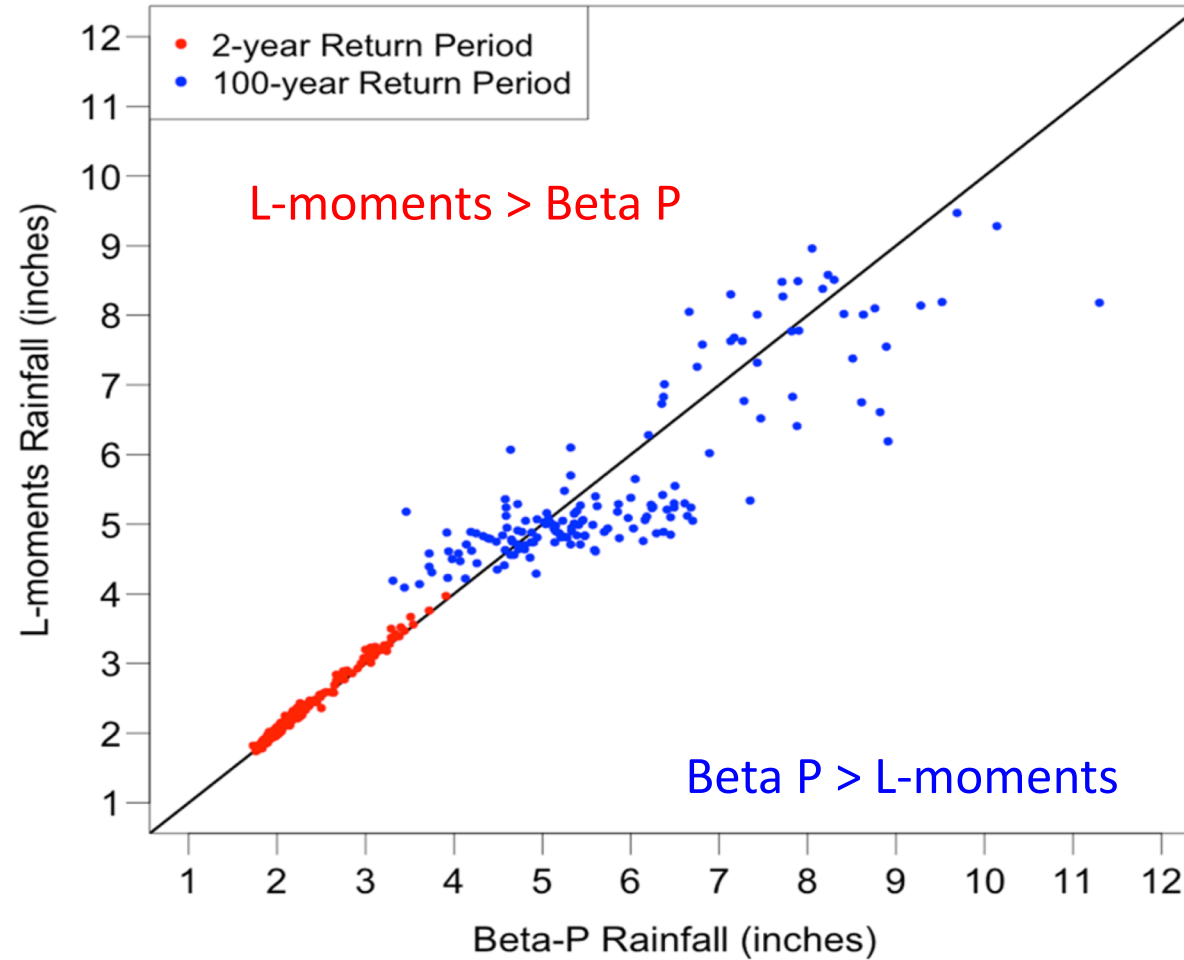
Precipitation Extremes 101

- **Fitting the Distribution**



Precipitation Extremes 101

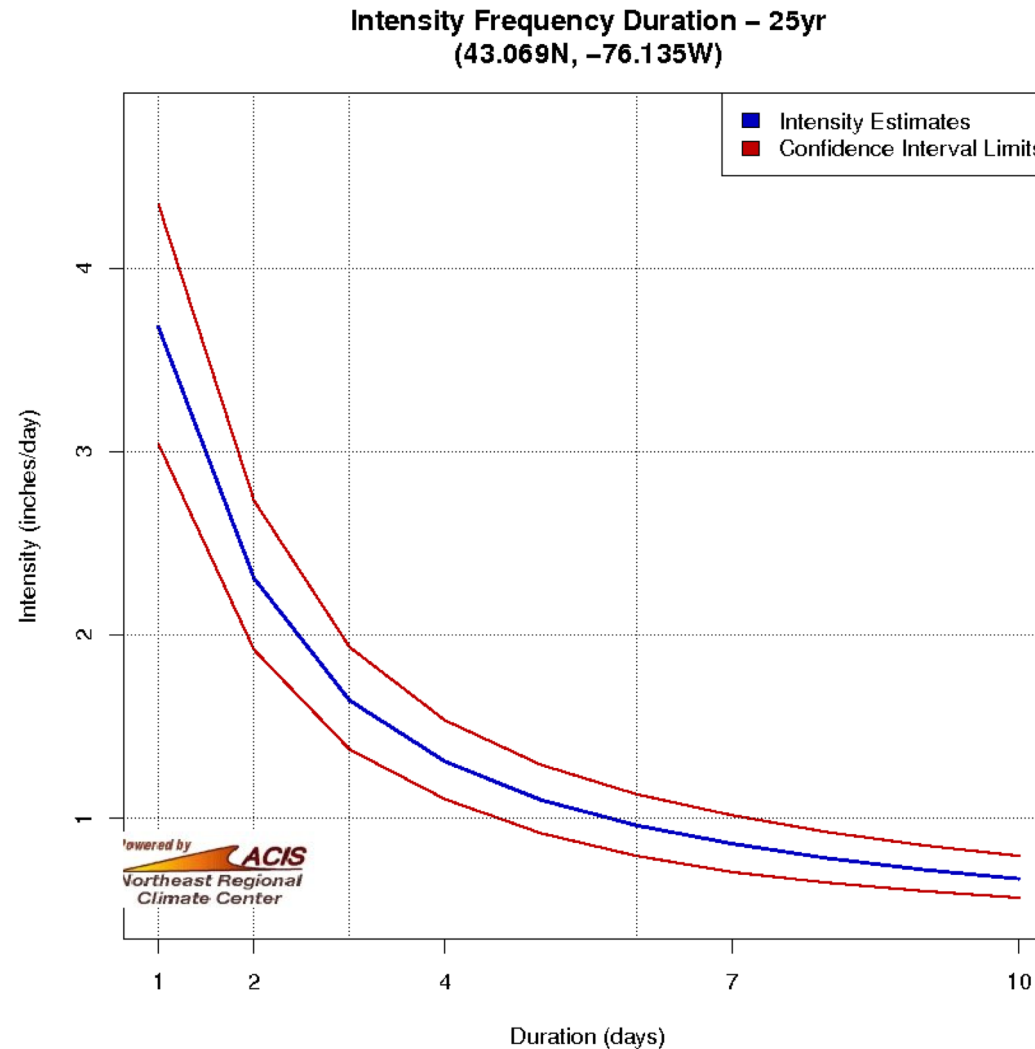
- **Fitting Introduces Uncertainty**



Precipitation Extremes 101

- Quantify Uncertainty

Randomly Draw 1000x
Refit Distribution
Retain 5th and 95th Percentiles



Precipitation Extremes 101



Stationary

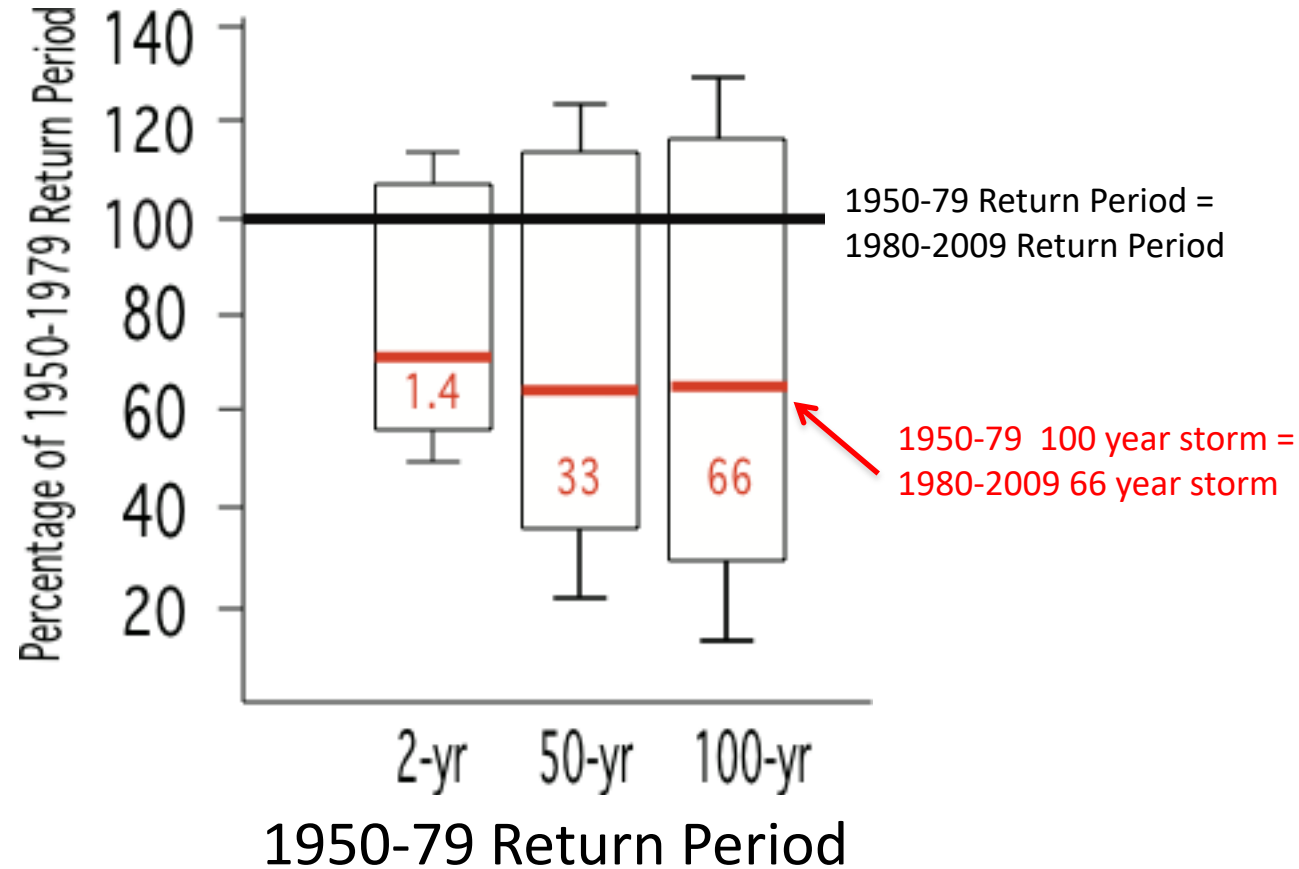
This is the assumption

Not Stationary

This is the reality



Extreme Rainfall 1950-79 vs 1980-2009

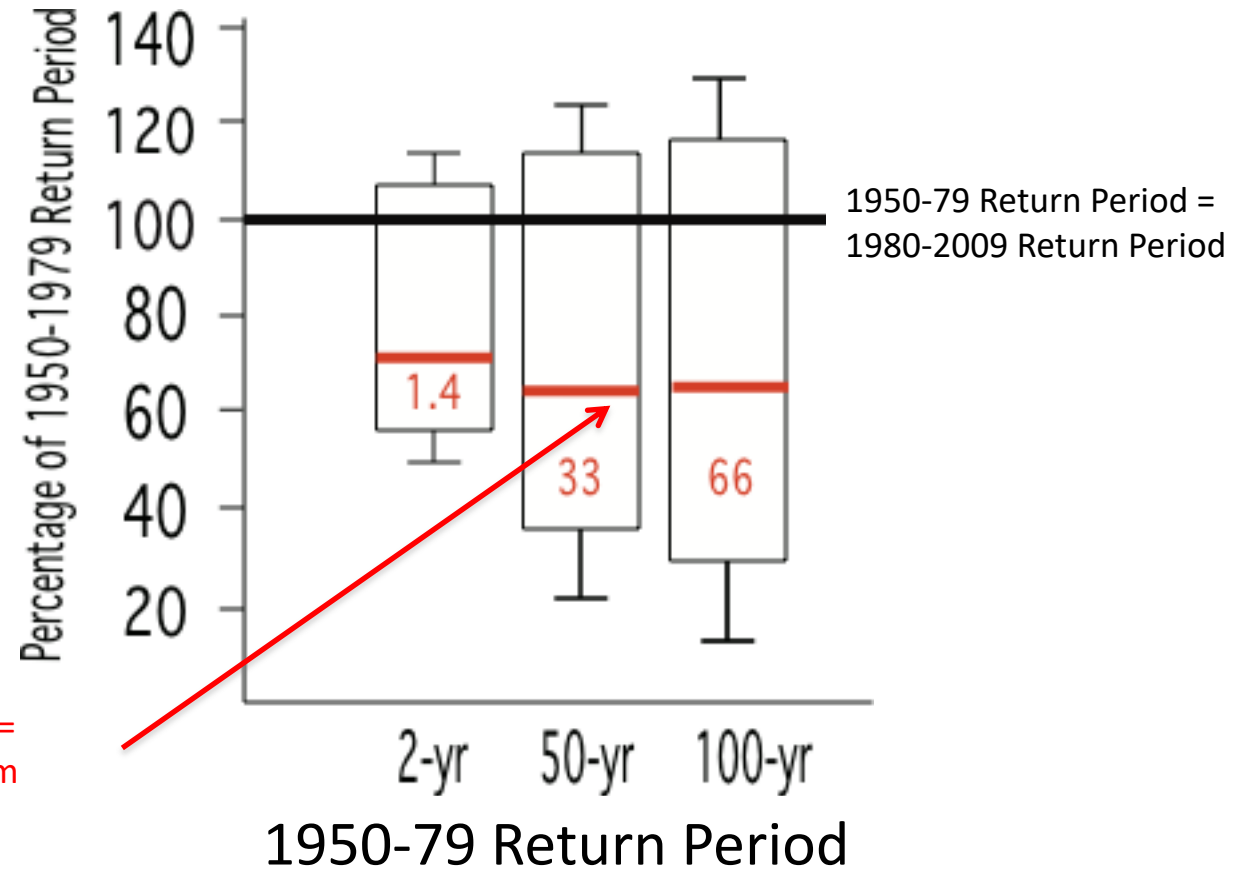


The 100-year storm has become the 66 year storm!

DeGaetano, Arthur T., 2009: Time-Dependent Changes in Extreme-Precipitation Return-Period Amounts in the Continental United States. *J. Appl. Meteor. Climatol.*, **48**, 2086–2099.



Extreme Rainfall 1950-79 vs 1980-2009



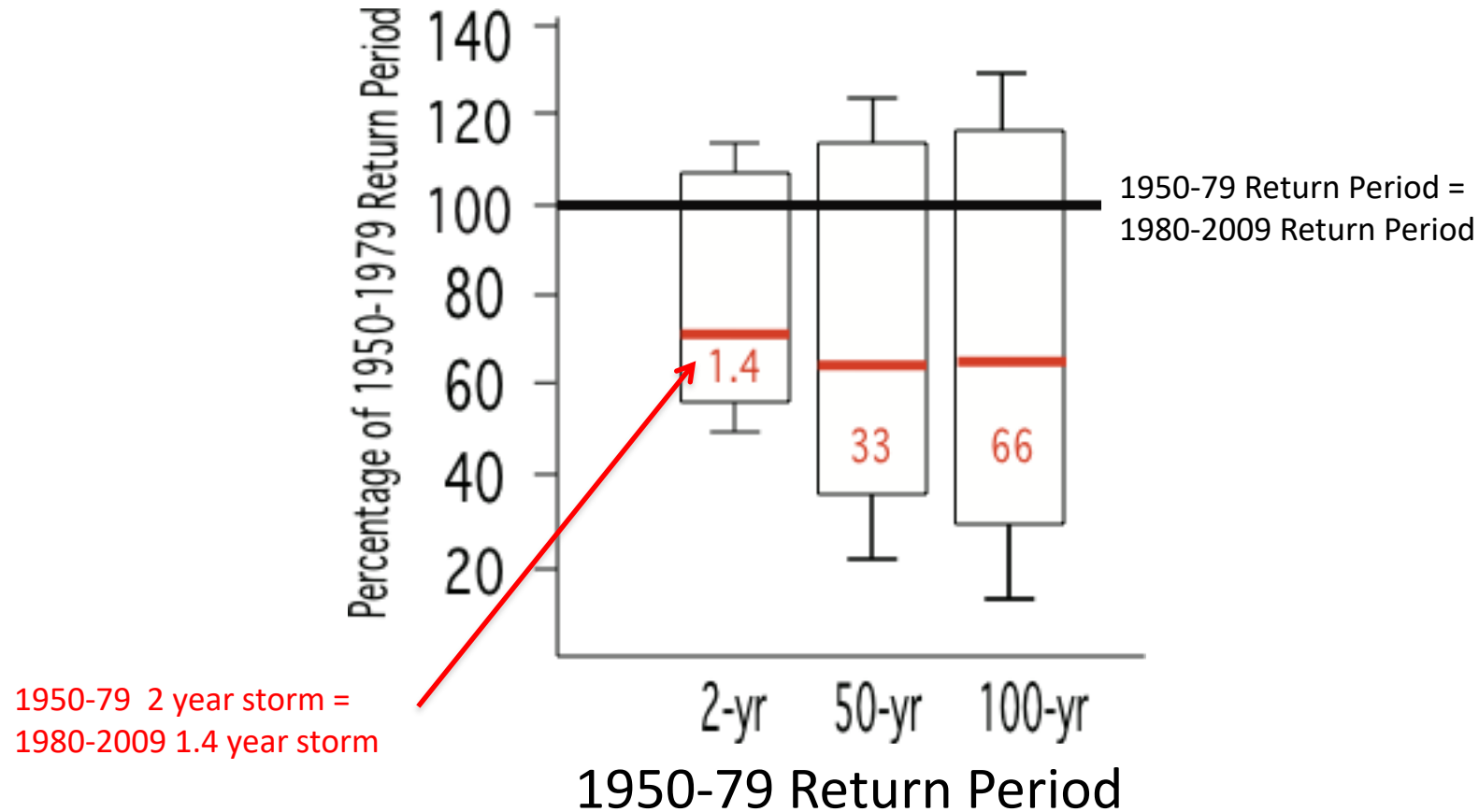
1950-79 50 year storm =
1980-2009 33 year storm

The 50-year storm has become the 33 year storm!

DeGaetano, Arthur T., 2009: Time-Dependent Changes in Extreme-Precipitation Return-Period Amounts in the Continental United States. *J. Appl. Meteor. Climatol.*, **48**, 2086–2099.



Extreme Rainfall 1950-79 vs 1980-2009

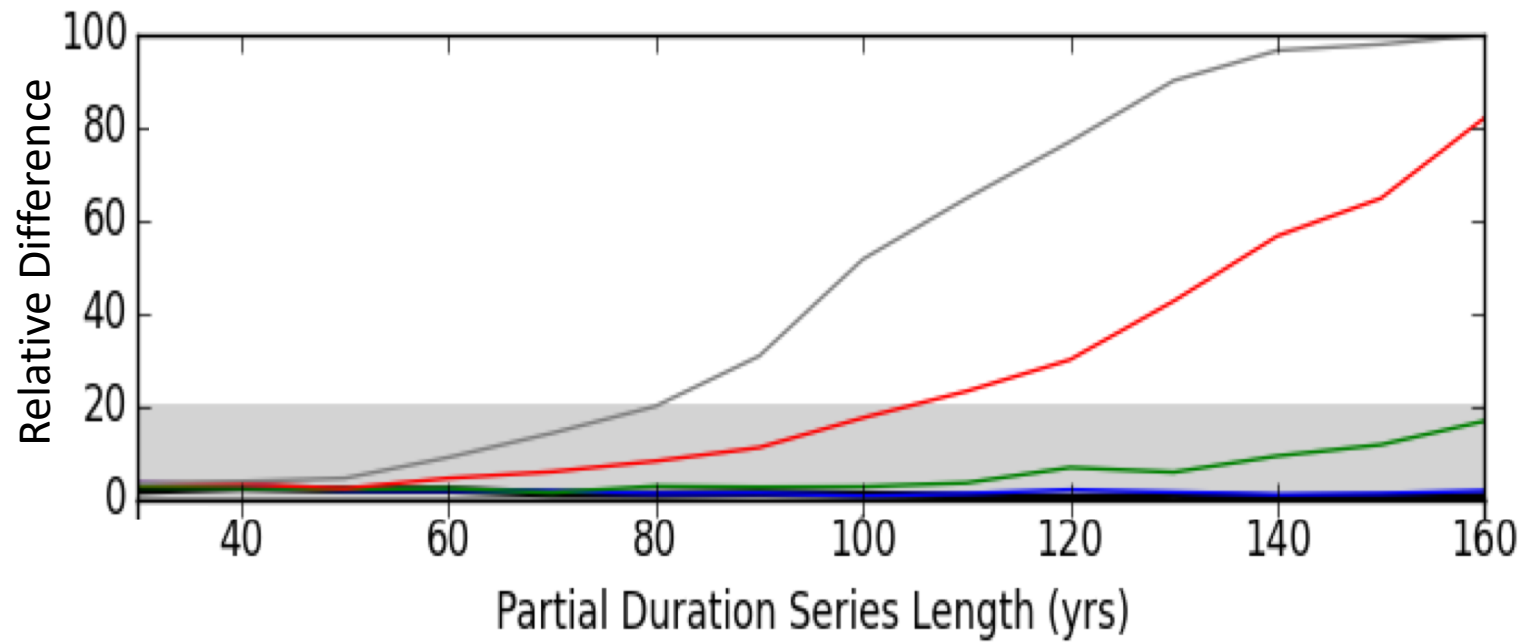


The 2-year storm has become the 1.4 year storm!

DeGaetano, Arthur T., 2009: Time-Dependent Changes in Extreme-Precipitation Return-Period Amounts in the Continental United States. *J. Appl. Meteor. Climatol.*, **48**, 2086–2099.



Long PDS are Inappropriate for Non-Stationary Series



Extreme Precipitation in a Changing Climate

Info

Map

Graph



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Options:

Recurrence: 100yr (1%)

State: NY - New York

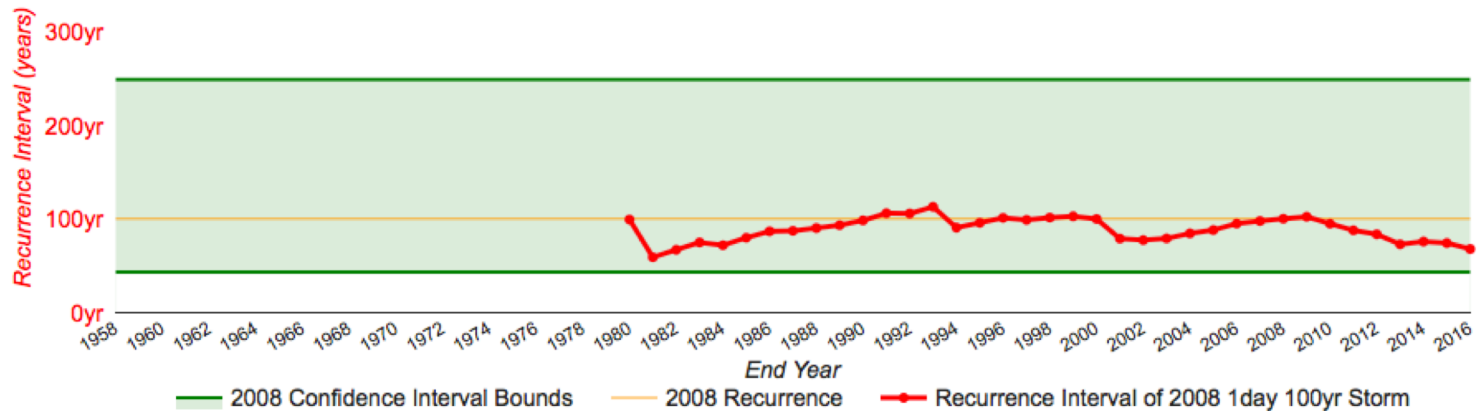
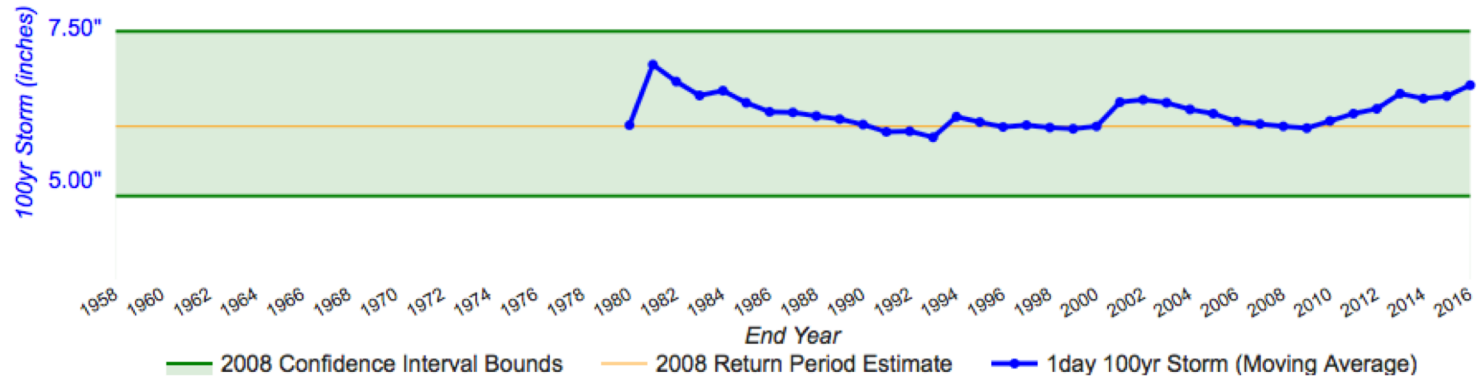
Station: [dropdown]

[dropdown]

Refresh Graph

Extreme Precipitation Statistics: #303050 FREEVILLE 1 NE (NY)

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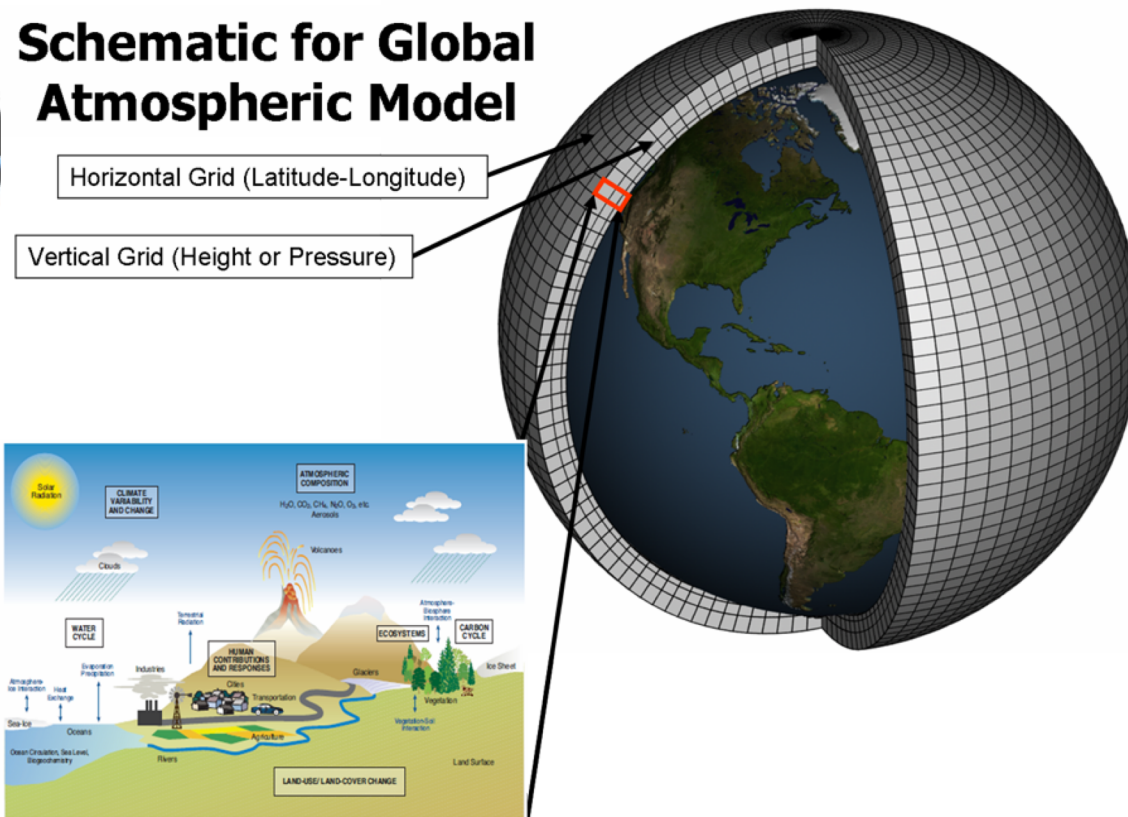


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What Does the Future Hold?

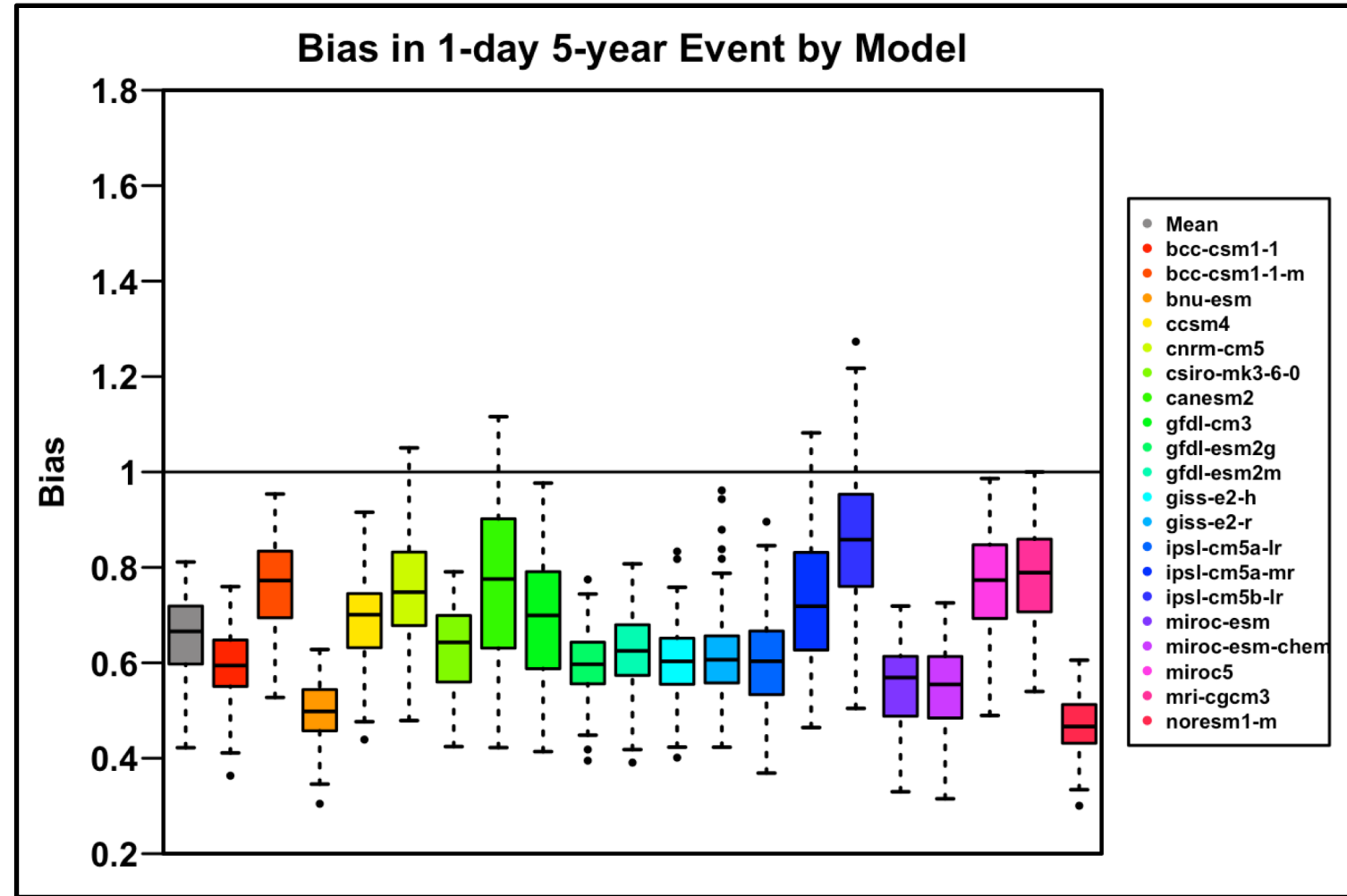
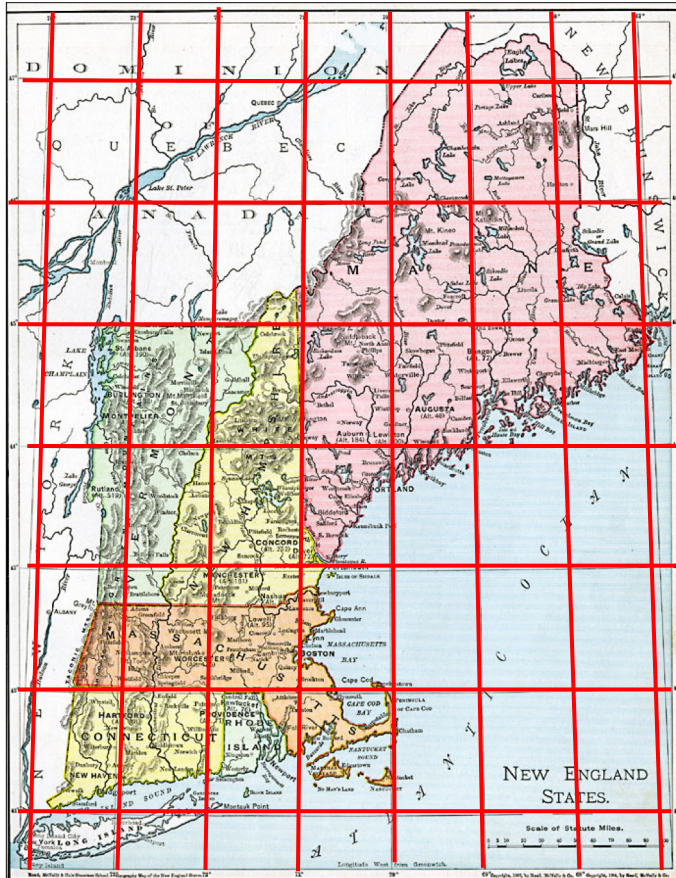


Schematic for Global Atmospheric Model





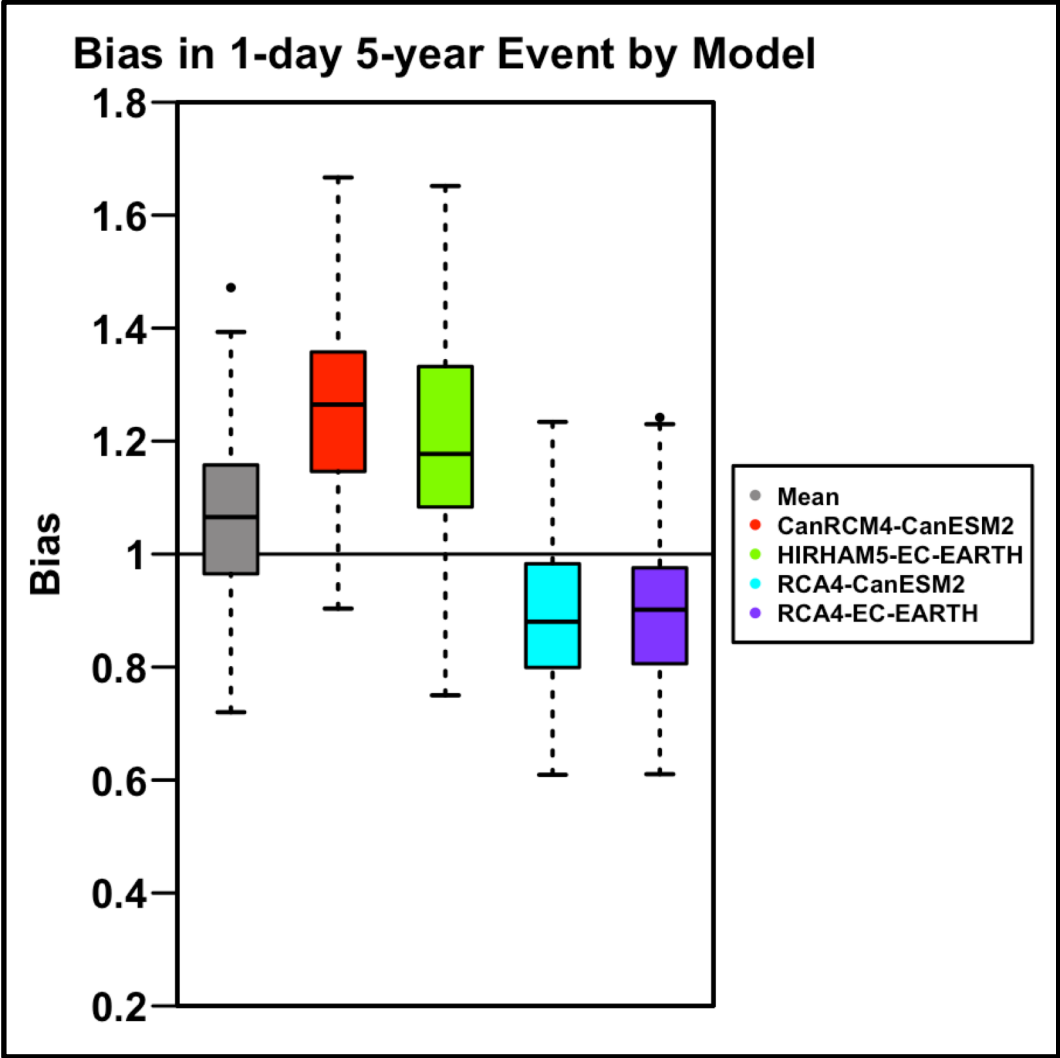
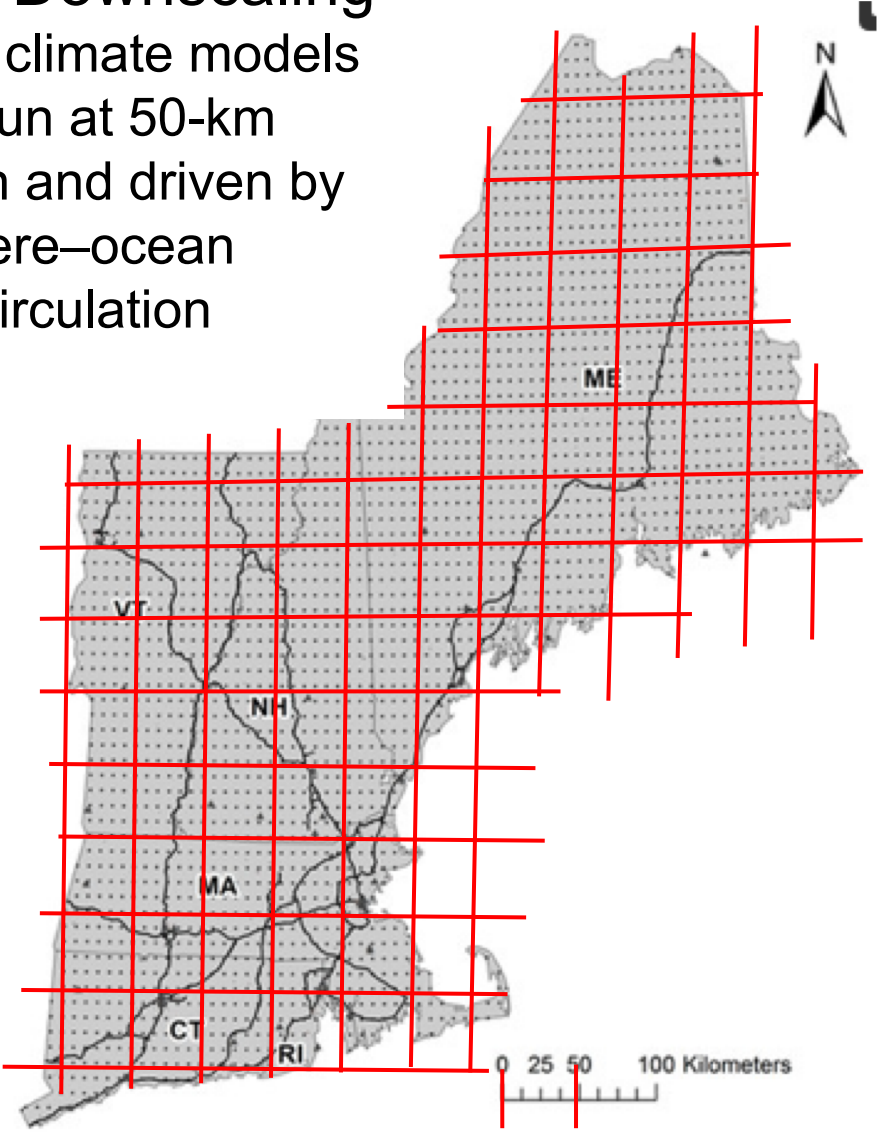
Raw CMIP5 No Downscaling vs Obs.



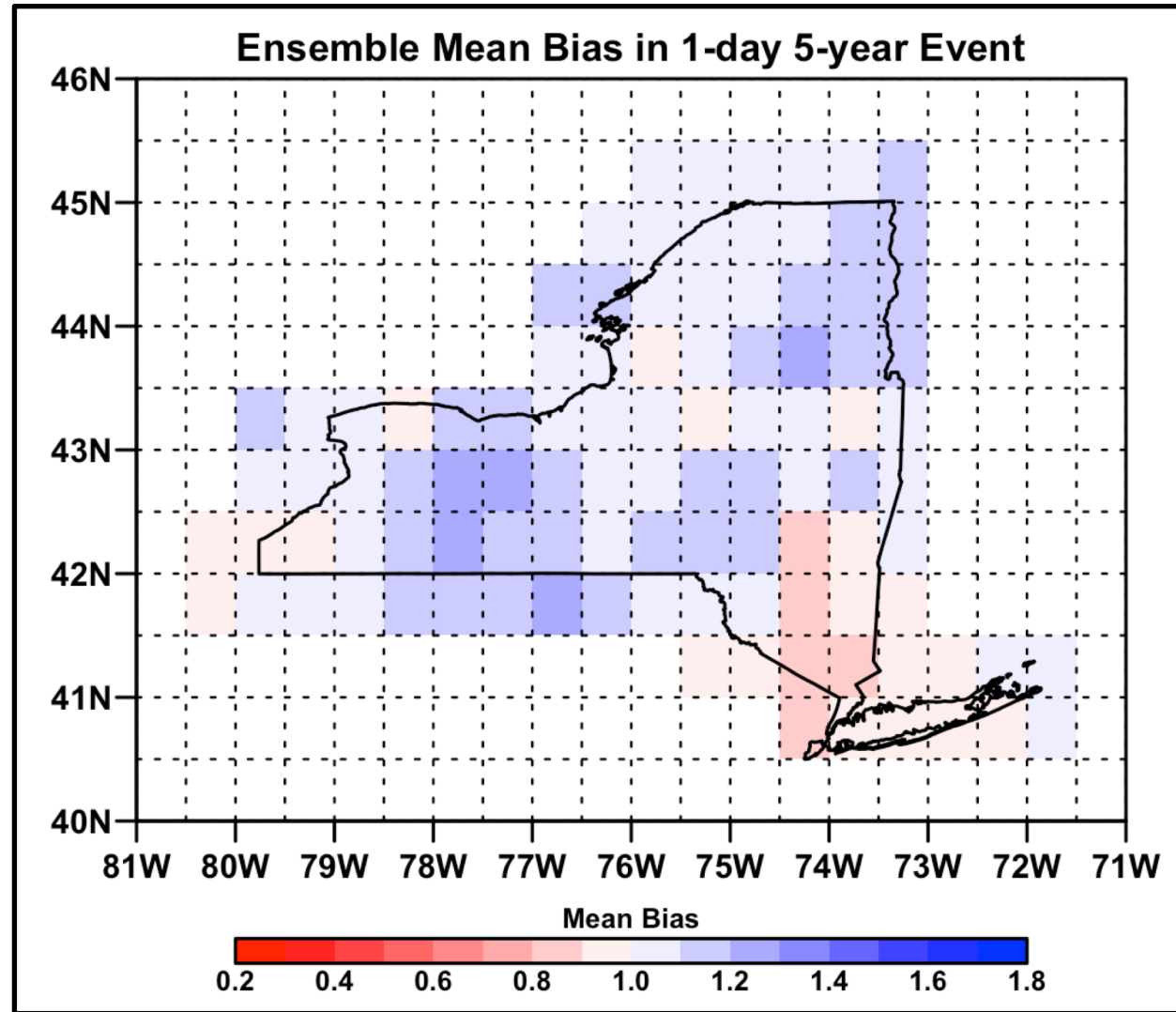
CORDEX vs. Observed

Dynamical Downscaling

Regional climate models (RCMs) run at 50-km resolution and driven by atmosphere-ocean general circulation models

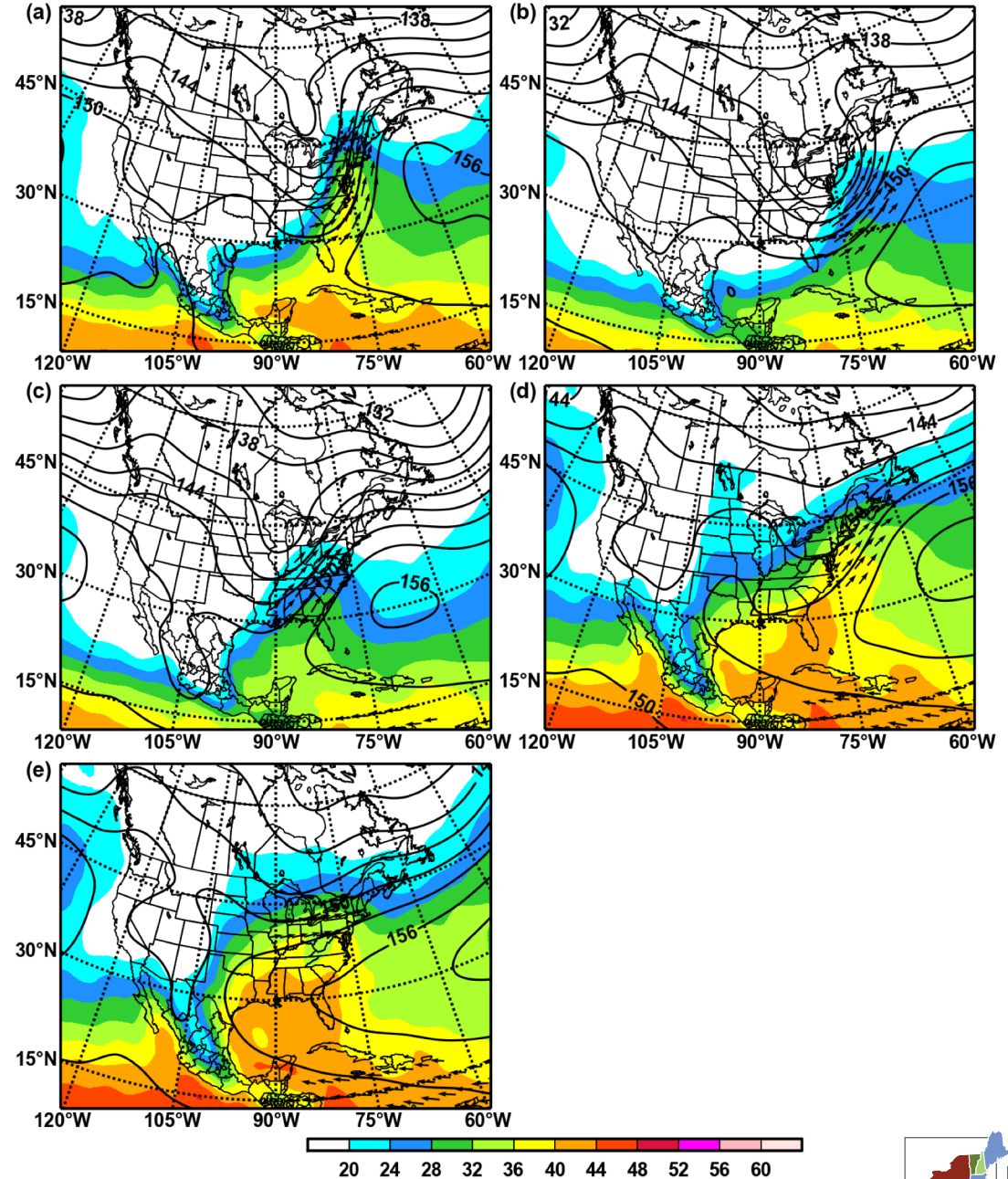
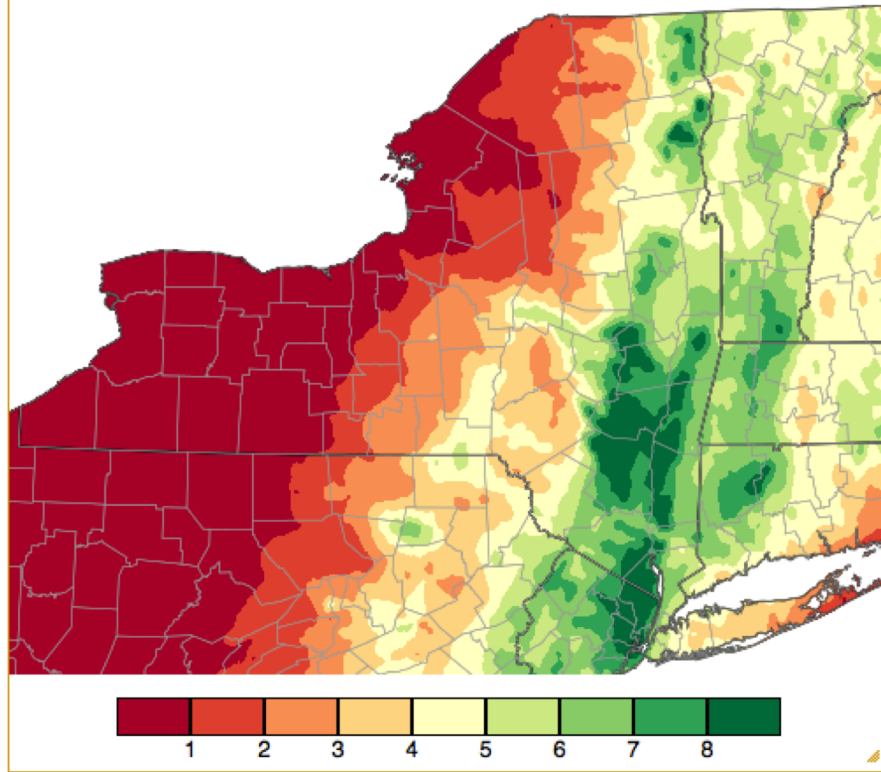


CORDEX vs Observed Ensemble Mean Bias

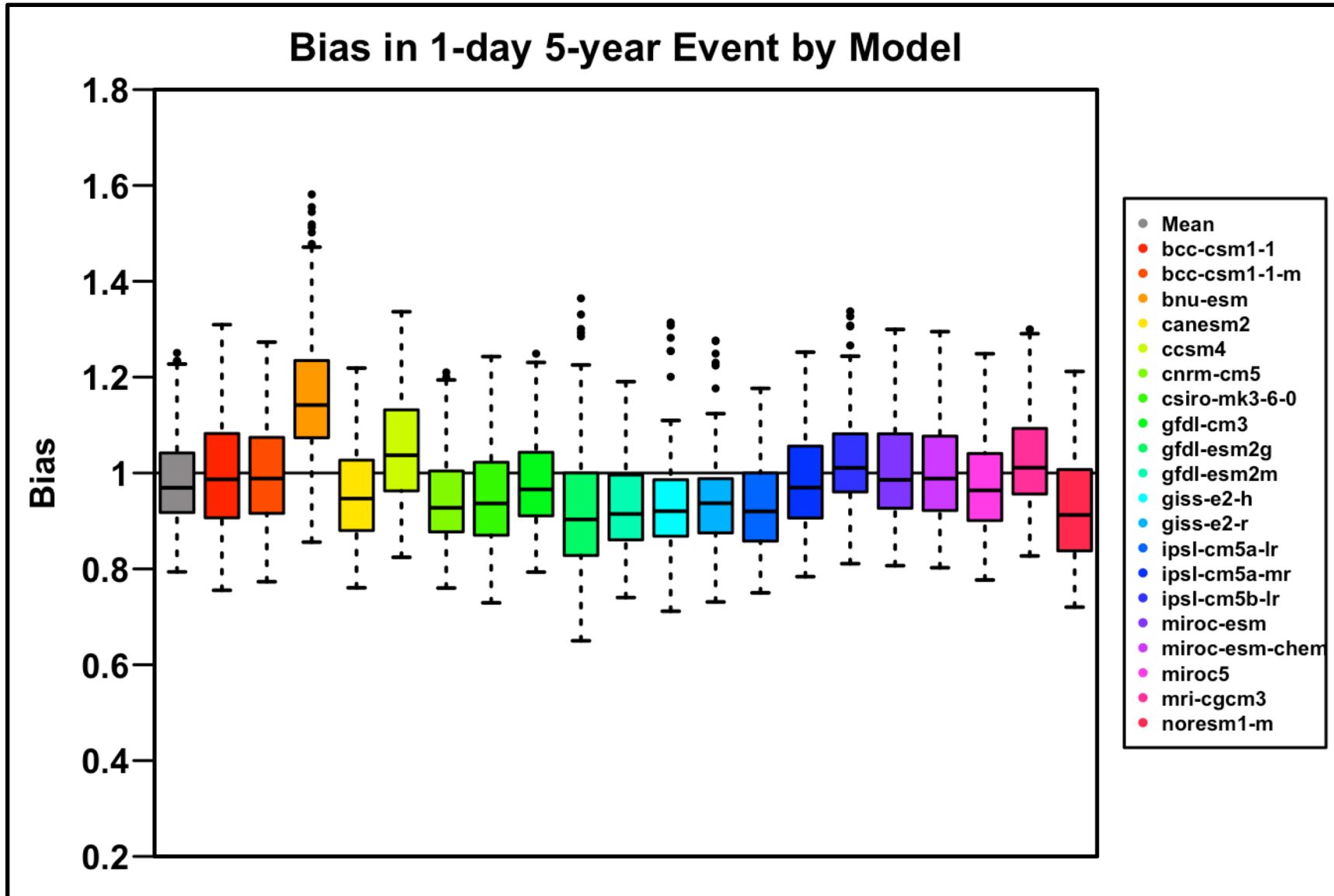


Analog Downscaling

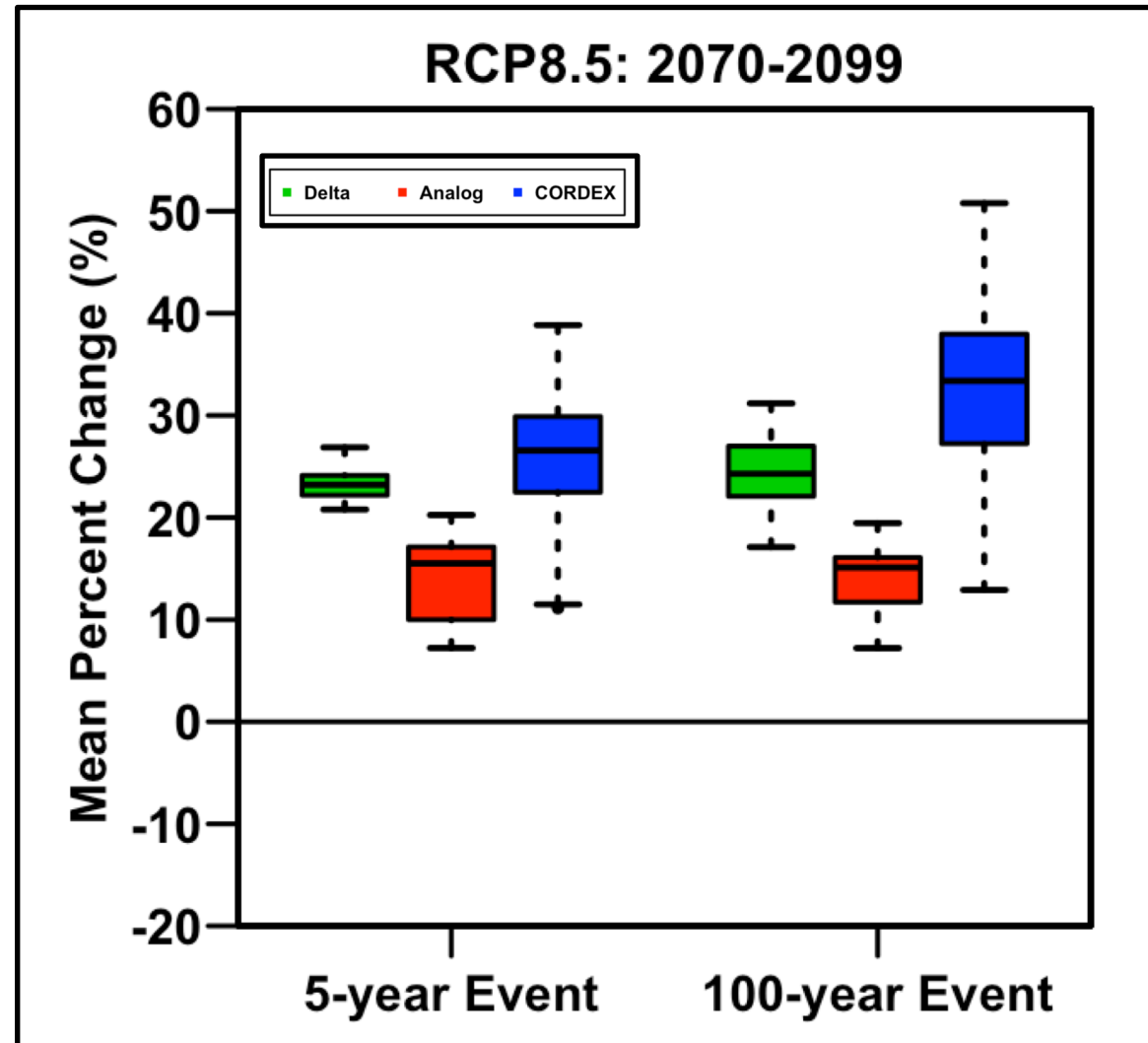
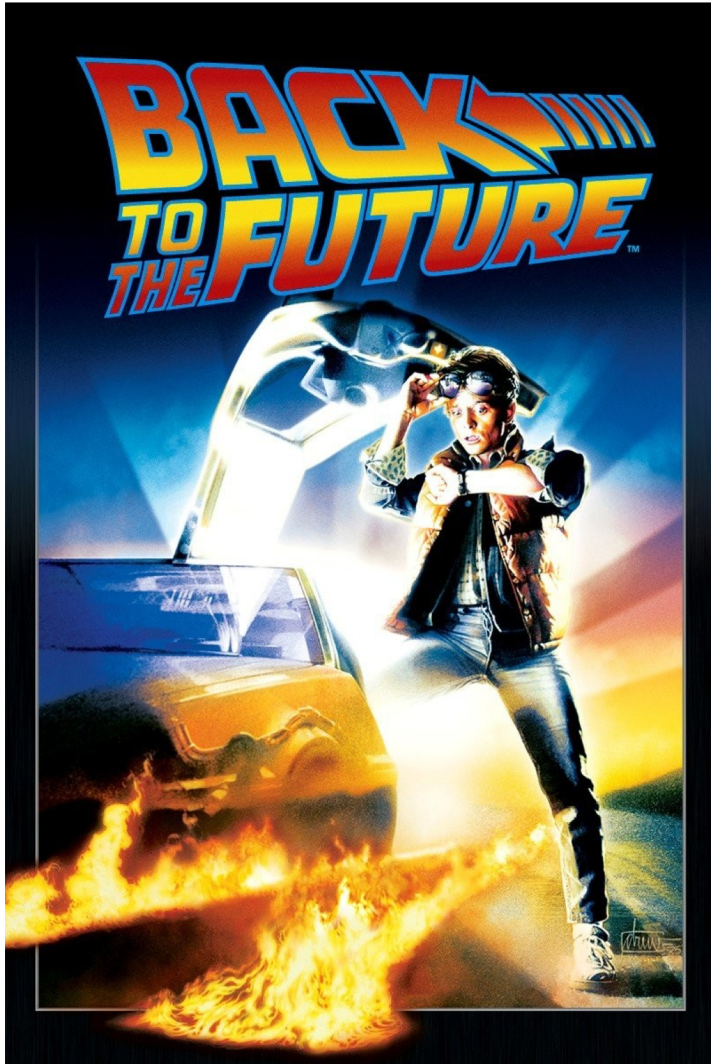
Total Precipitation - August 28, 2011 through August 29, 2011



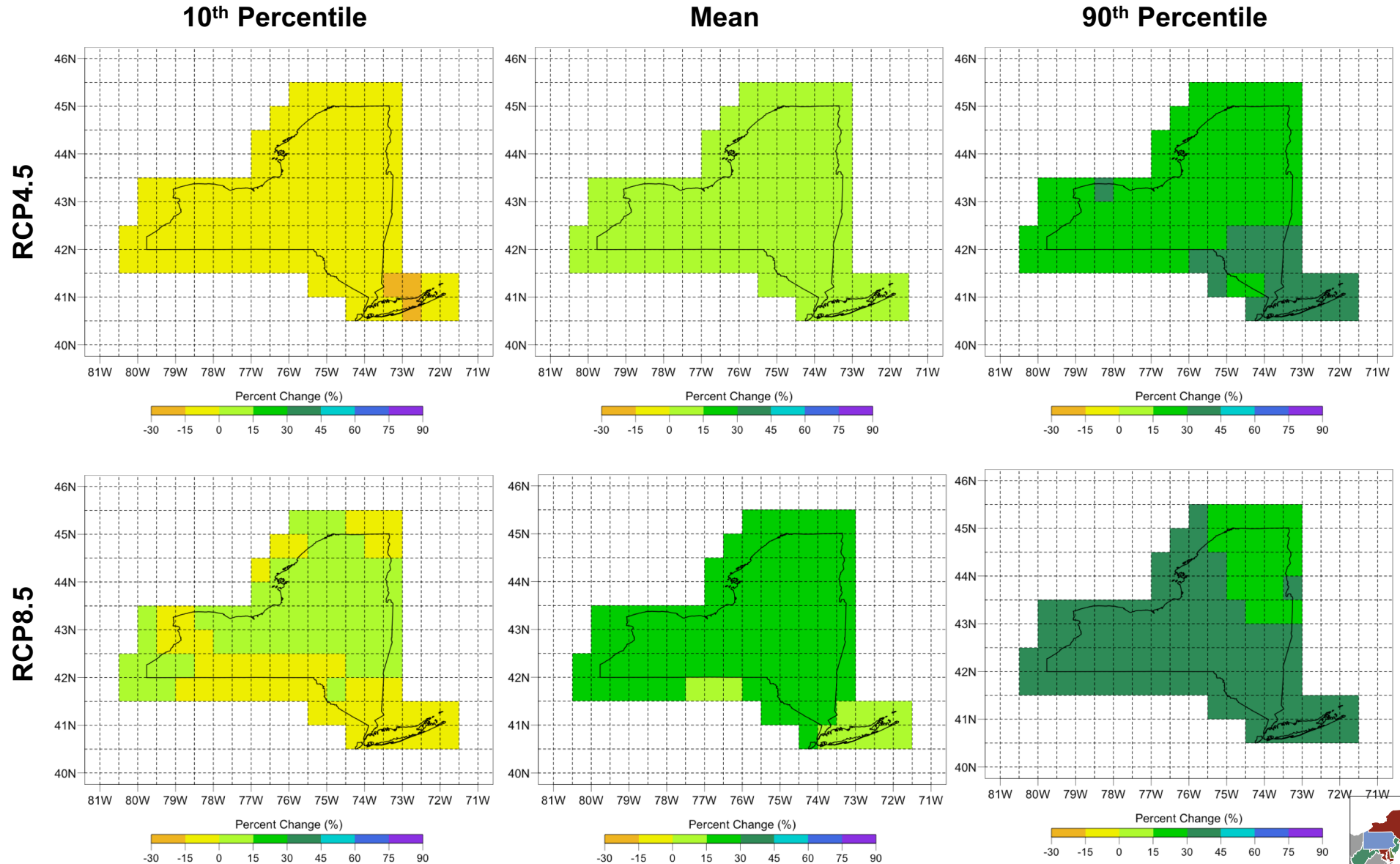
Analog Downscaling



Projected Changes in 1-day 5- and 100-Year Rainfall Amounts Relative to 1970–1999



Projected Changes in 1-day 100-year Rainfall Amounts 2040–2069 vs. 1970–1999



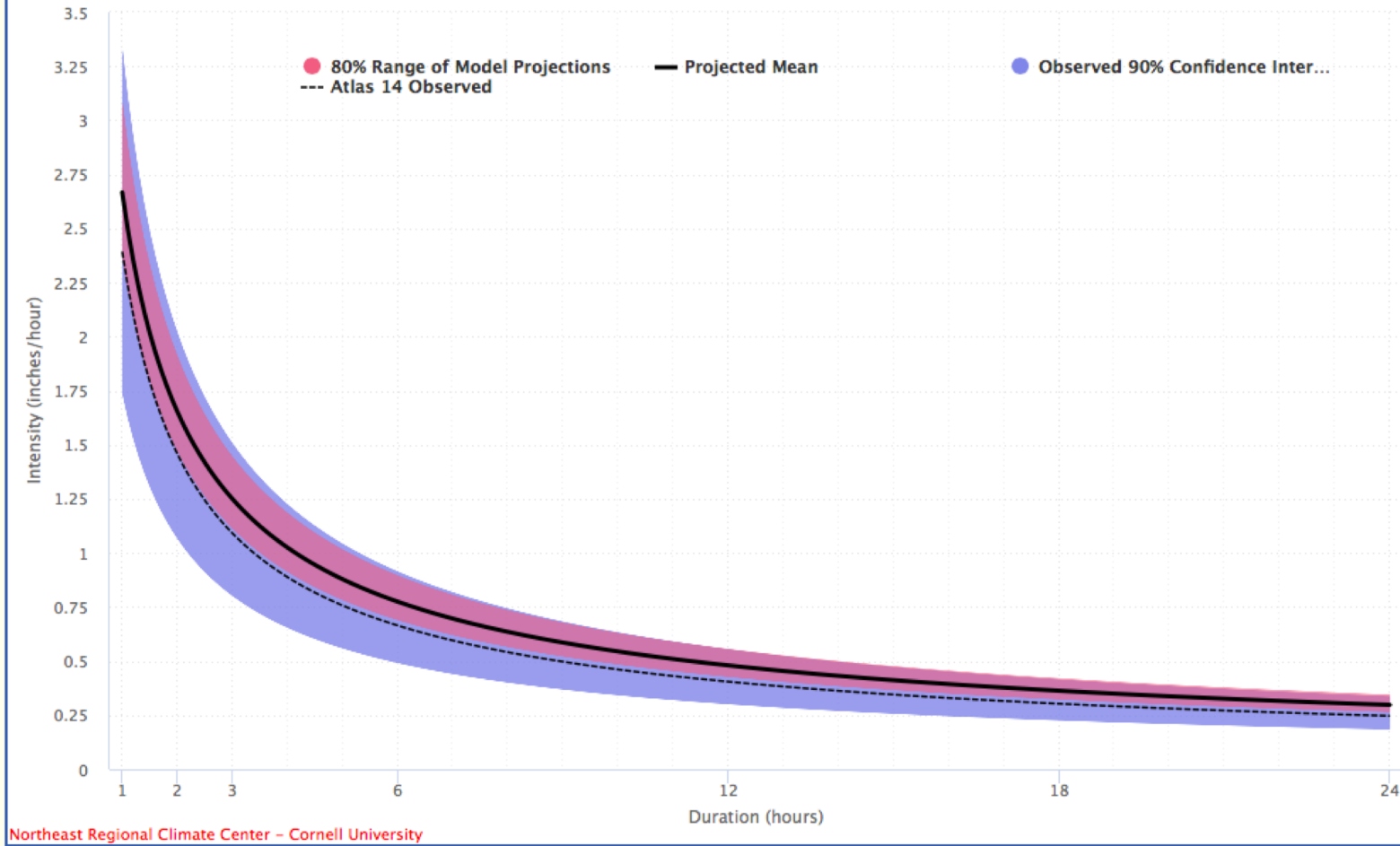
What About < 1 Day Extremes??

	<u>Wilks & Cember (1995)</u>	<u>TP 40 (1961)</u>
1-hour	0.43	0.41
2-hour	0.54	0.51
3-hour	0.62	0.58
6-hour	0.79	0.65
12-hour	0.97	0.80
24-hour	1.13	1.13



Intensity Duration Frequency Curves: 100-yr Return Period RCP 8.5 Projection 2040-2069 vs. NOAA Atlas 14

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Duration (hrs)	Projected 2040-2069 Intensity Ensemble Member [?]			Observed NOAA Atlas 14 Intensity with Confidence Interval (CI) Bounds [?]		
	10 th	Mean	90 th	Low CI	Mean	High CI
1	2.38	2.67	3.08	1.74	2.39	3.33
2	1.47	1.65	1.91	1.07	1.46	2.02
3	1.11	1.25	1.44	0.80	1.09	1.51
6	0.69	0.77	0.89	0.49	0.66	0.91
12	0.43	0.48	0.55	0.30	0.40	0.55
18	0.32	0.36	0.42	0.23	0.30	0.41
24	0.27	0.30	0.34	0.19	0.25	0.34



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THANK YOU!