

# Projections of Extreme Precipitation Amounts for Climate Adaptation Planning in New York State

**Art DeGaetano**

**Northeast Regional Climate Center  
Department of Earth and Atmospheric Science, Cornell**

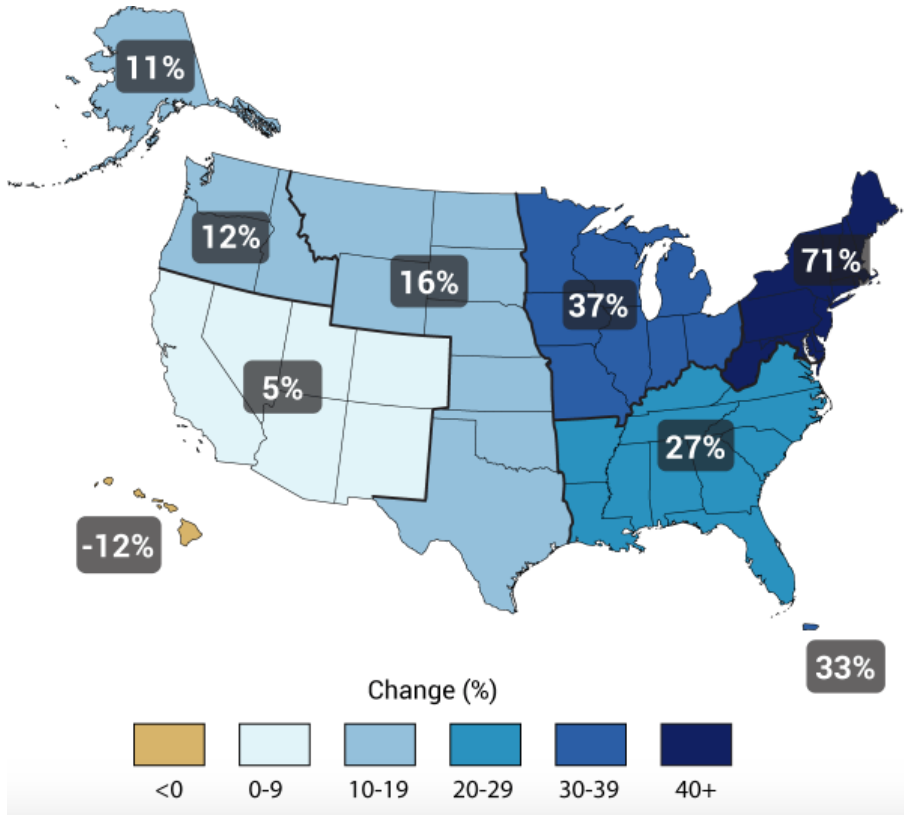


Cornell University



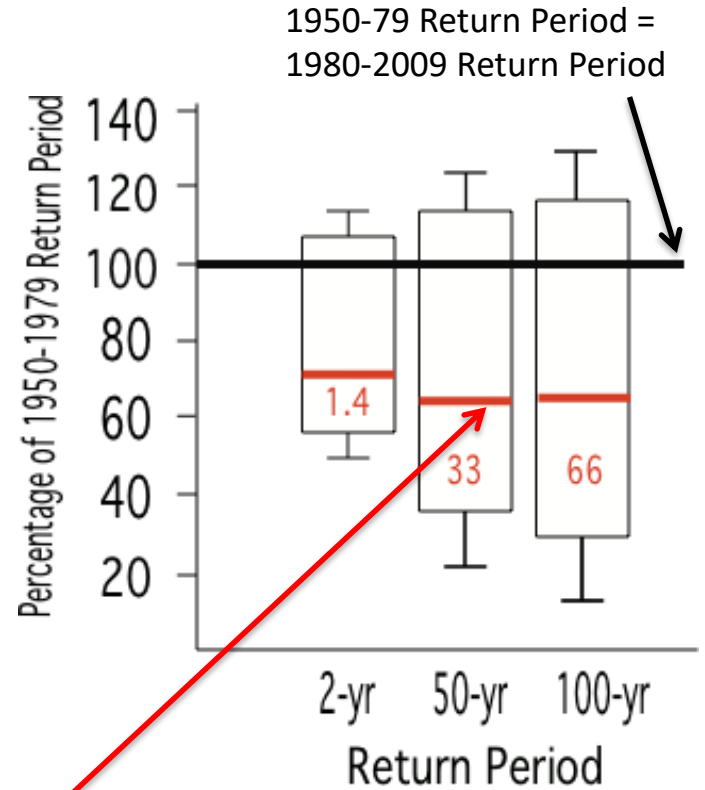
Northeast Regional  
Climate Center

# Motivation



## Change in heaviest 1% of all daily events 1958-2012

*from Karl et al. 2009*



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

DeGaetano, 2009

# Motivation

## NY Climate Risk and Resiliency Act CCRA

- Applies to **permitting, funding and regulatory decisions**

For example

Smart growth assessments

Wastewater treatment plant funding

Hazardous waste facilities siting

Design and construction of petroleum and chemical storage facilities

Oil and gas drilling

State acquisition of open space

- Applicants must **demonstrate** that they have taken into account **future** physical climate risks caused by storm surges, sea-level rise or **flooding**.



# History

## Extreme Precipitation in New York & New England An Interactive Web Tool for Extreme Precipitation Analysis

About this Project

Data & Products

Daily Monitoring

Documentation

### Select Product ?

Extreme Precipitation  
Tables - HTML ?

Extreme Precipitation  
Tables - Text/CSV ?

Partial Duration Series -  
by Point ?

Partial Duration Series -  
by Station ?

Distribution Curves -  
Graphical ?

Distribution Curves -  
Text/TBL ?

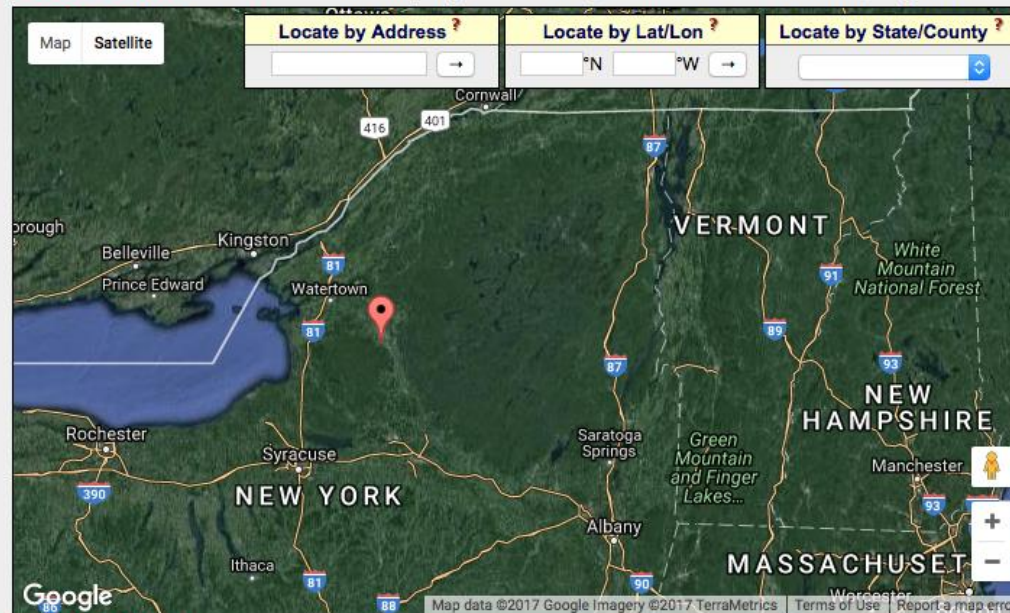
Intensity Frequency  
Duration Graphs ?

Precipitation Frequency  
Duration Graphs ?

GIS Data Files ?

Regional/State Maps ?

Select Location ? Double-click the map to place a marker, or enter address or latitude/longitude.



Select Options ?

Smoothing ?

Yes

Delivery ?

Popup

Submit

Version 1.12 Copyright 2010-2017.  
This project is a joint collaboration between:

Northeast Regional Climate Center (NRCC)



Natural Resources Conservation Service (NRCS)



Contact: [precip@cornell.edu](mailto:precip@cornell.edu)

- NRCS funded
- Pre Atlas 14
- Tendency for  
*Higher 100-yr*  
*Lower 2-yr*
- Promoted  
beyond NRCS
- Early adaptation  
in New England  
States



# Monitoring Extreme Precip Changes

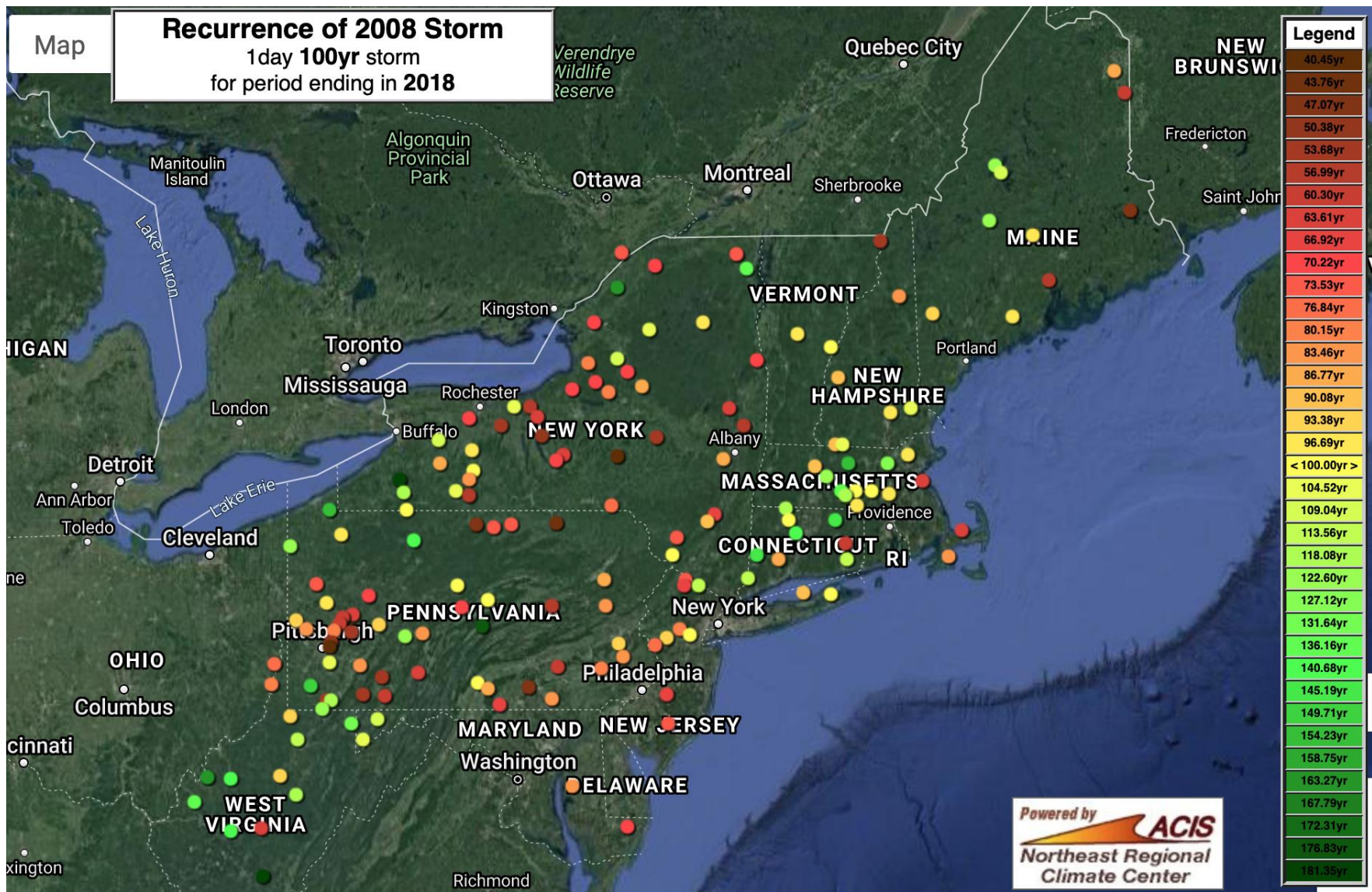
Automated ANNUAL generation of updated extreme rainfall products.



Cornell University



Northeast Regional  
Climate Center

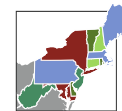
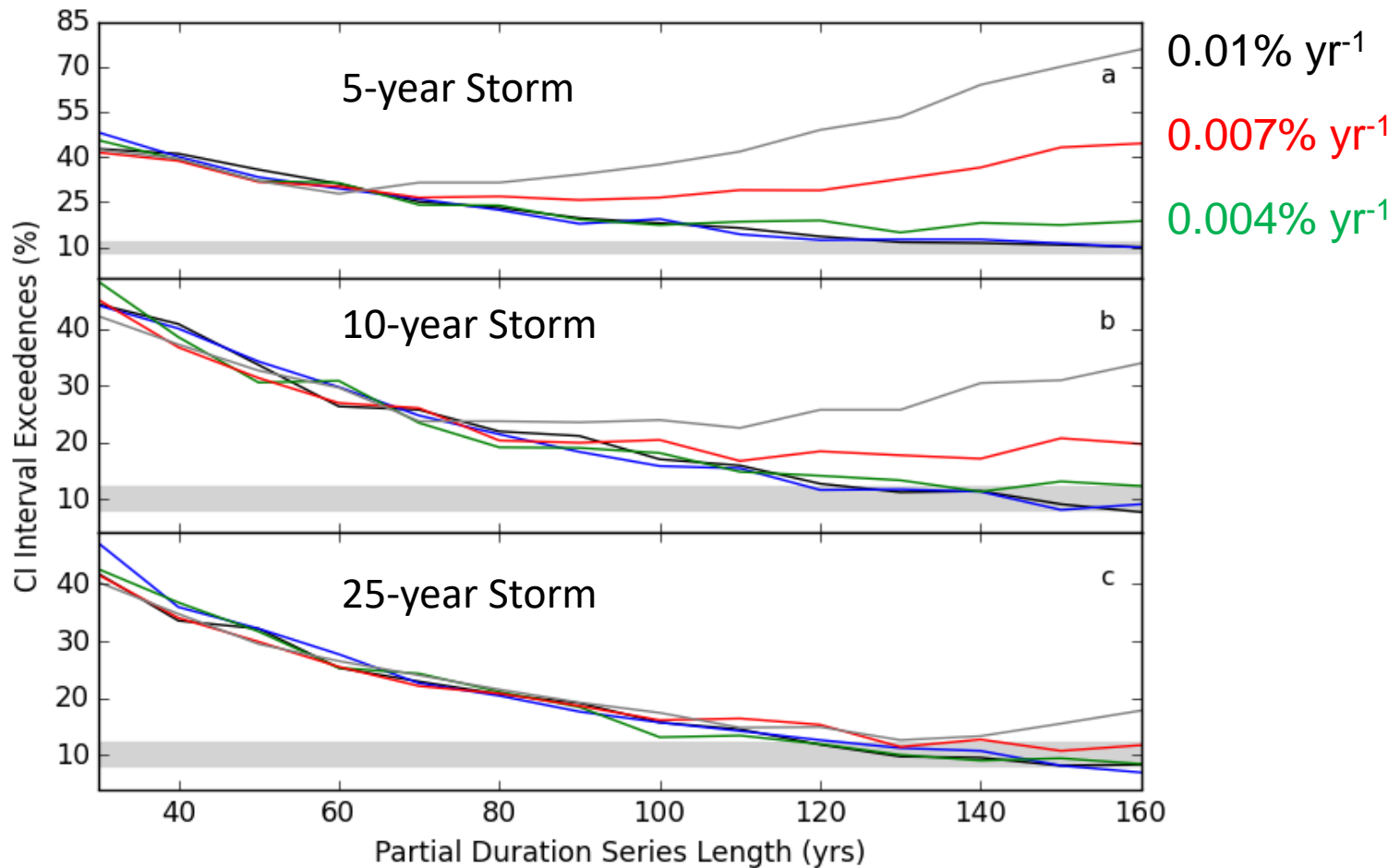


Cornell University

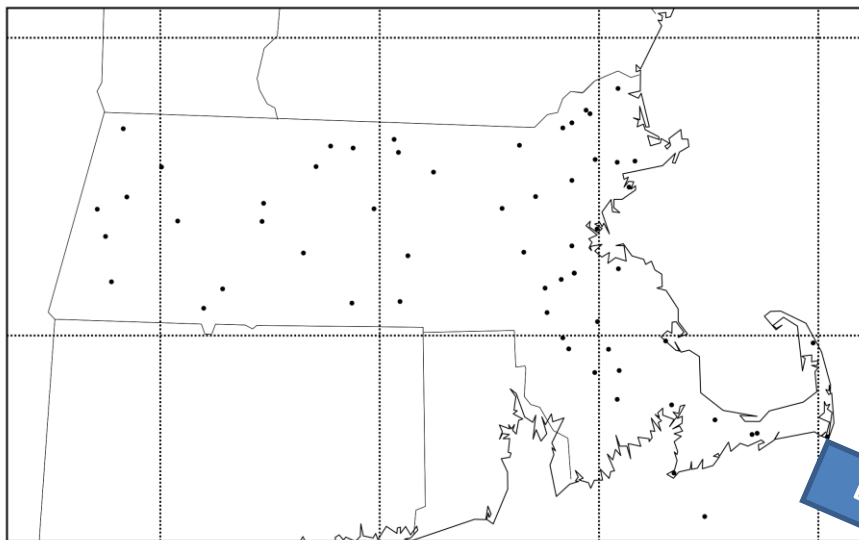


Northeast Regional  
Climate Center

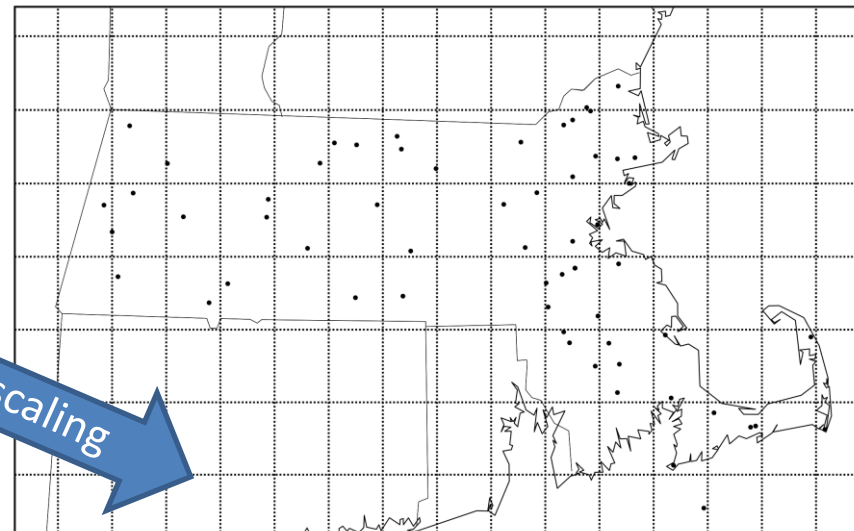
# Record Length??



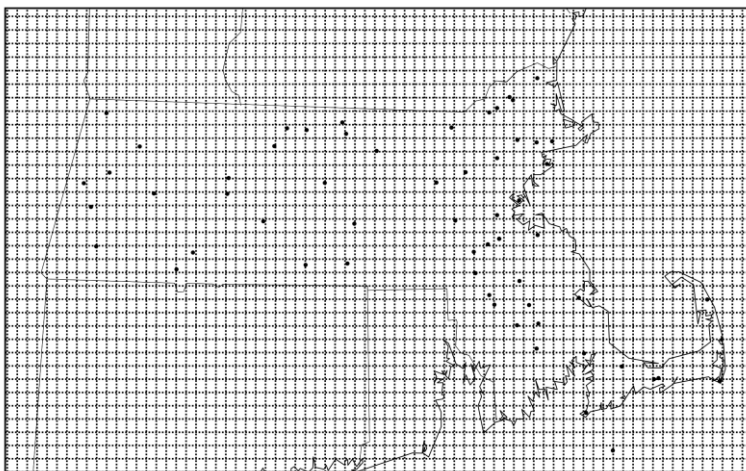
# Downscaling



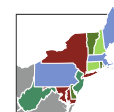
Downscaling



Downscaling



Cornell University



Northeast Regional  
Climate Center



# Downscaling Approaches

- 1) Dynamical Downscaling (CORDEX) (also NARCCAP)
  - Regional climate models (RCMs) run at 50-km resolution and driven by atmosphere–ocean general circulation (AOGCM) models
- 2) “Statistical” Downscaling – Delta Method (CMIP5)
  - Compares model-simulated precipitation extremes between historical and future periods (at GCM resolution)
- 3) Statistical Downscaling – Analog Method (CMIP5)
  - Uses historical weather map analogues to predict the occurrence of extreme precipitation on a given day



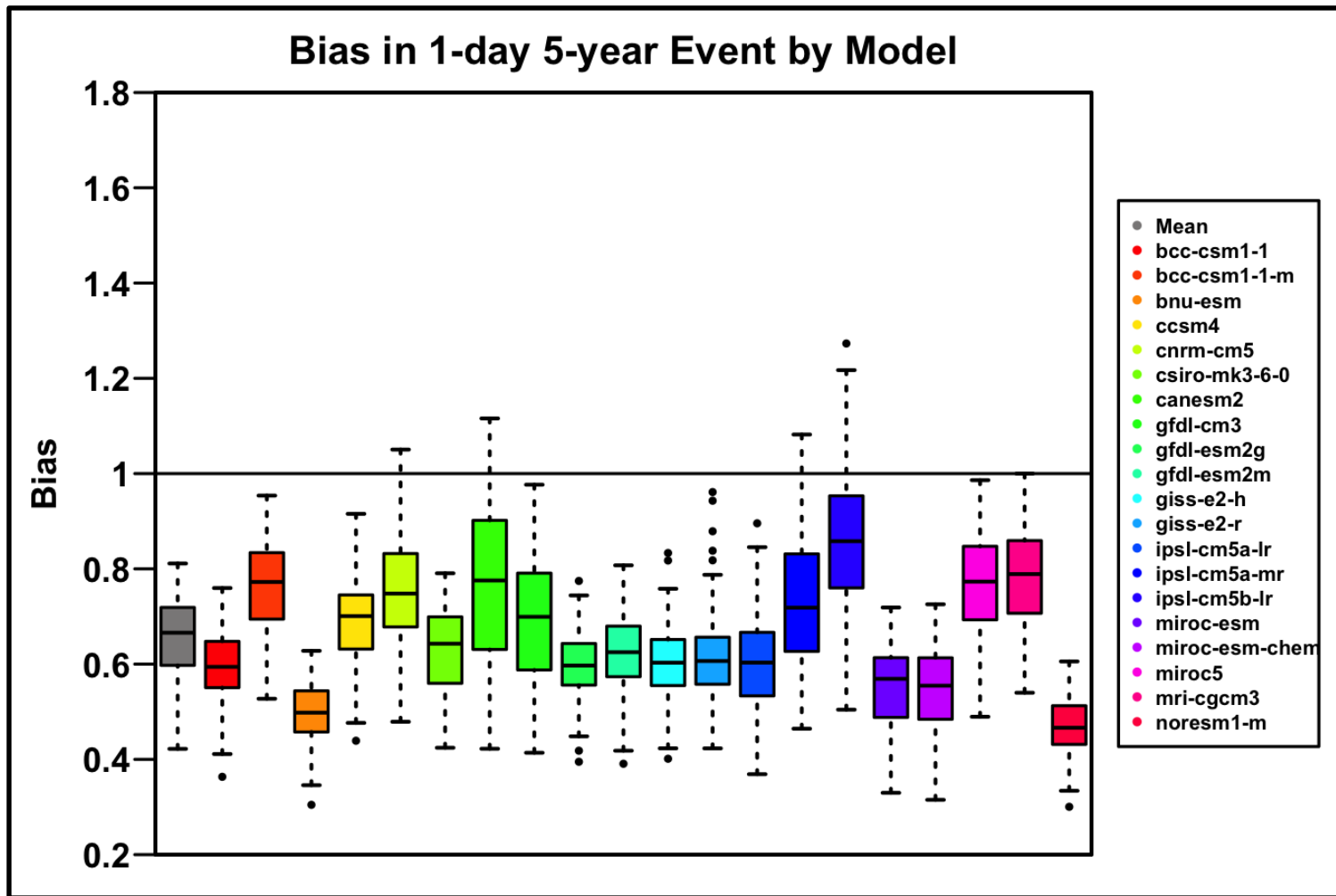


Cornell University

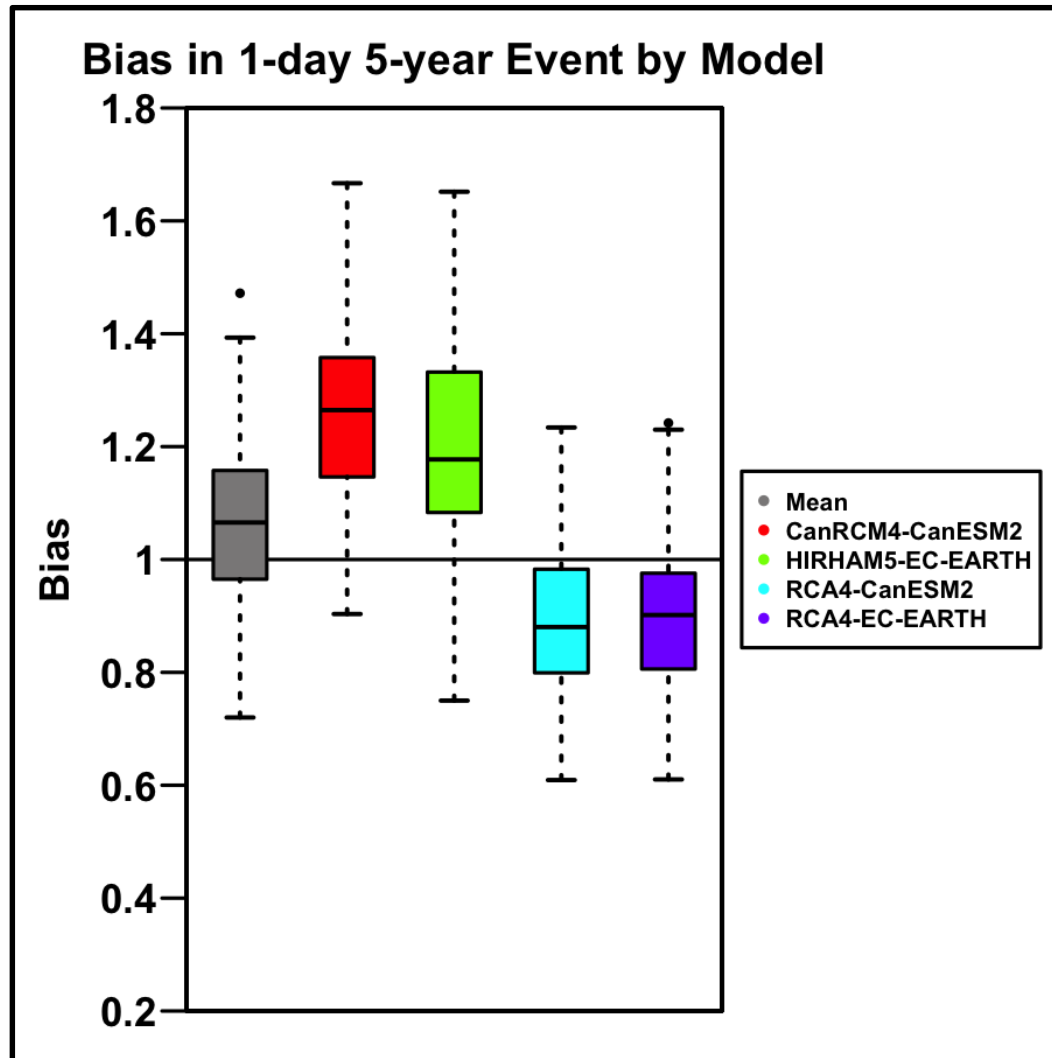


Northeast Regional  
Climate Center

# Raw CMIP5 No Downscaling vs Obs.



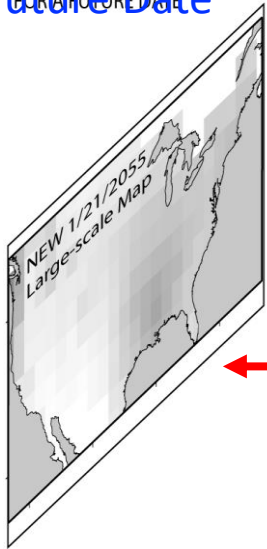
# CORDEX vs. Observed





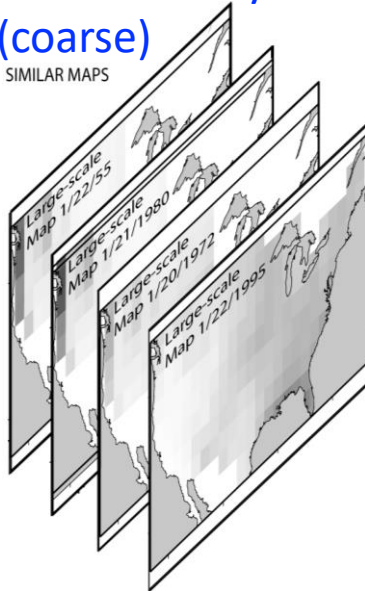
# Analog Downscaling

Coarse  
Resolution  
Future Date

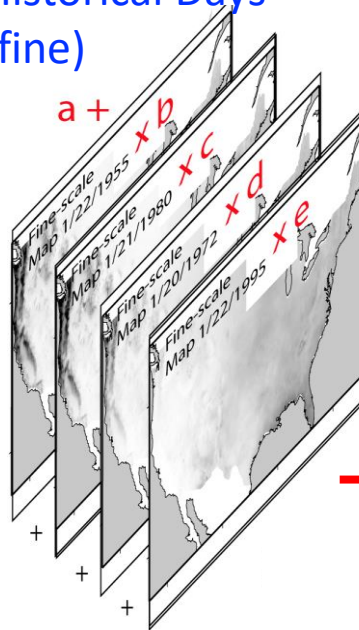


Similar Historical  
Observed Days  
(coarse)

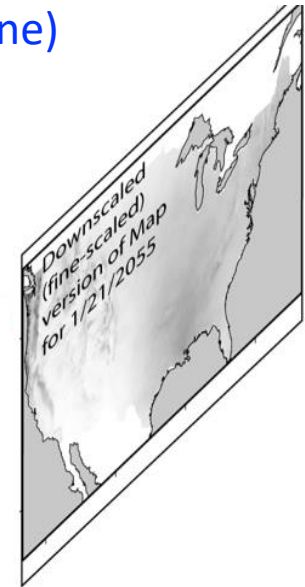
SIMILAR MAPS



Observed  
Historical Days  
(fine)



Future Day  
(fine)



$$F_{\text{Low}} = b(H1_{\text{Low}}) + c(H2_{\text{Low}}) + d(H3_{\text{Low}}) + d(H4_{\text{Low}}) + a$$

Develop statistical relationship  
between analog cases

$$b(H1_{\text{High}}) + c(H2_{\text{High}}) + c(H3_{\text{High}}) + c(H4_{\text{High}}) + a = F_{\text{High}}$$

Apply statistical relationship high resolution  
historical analogs

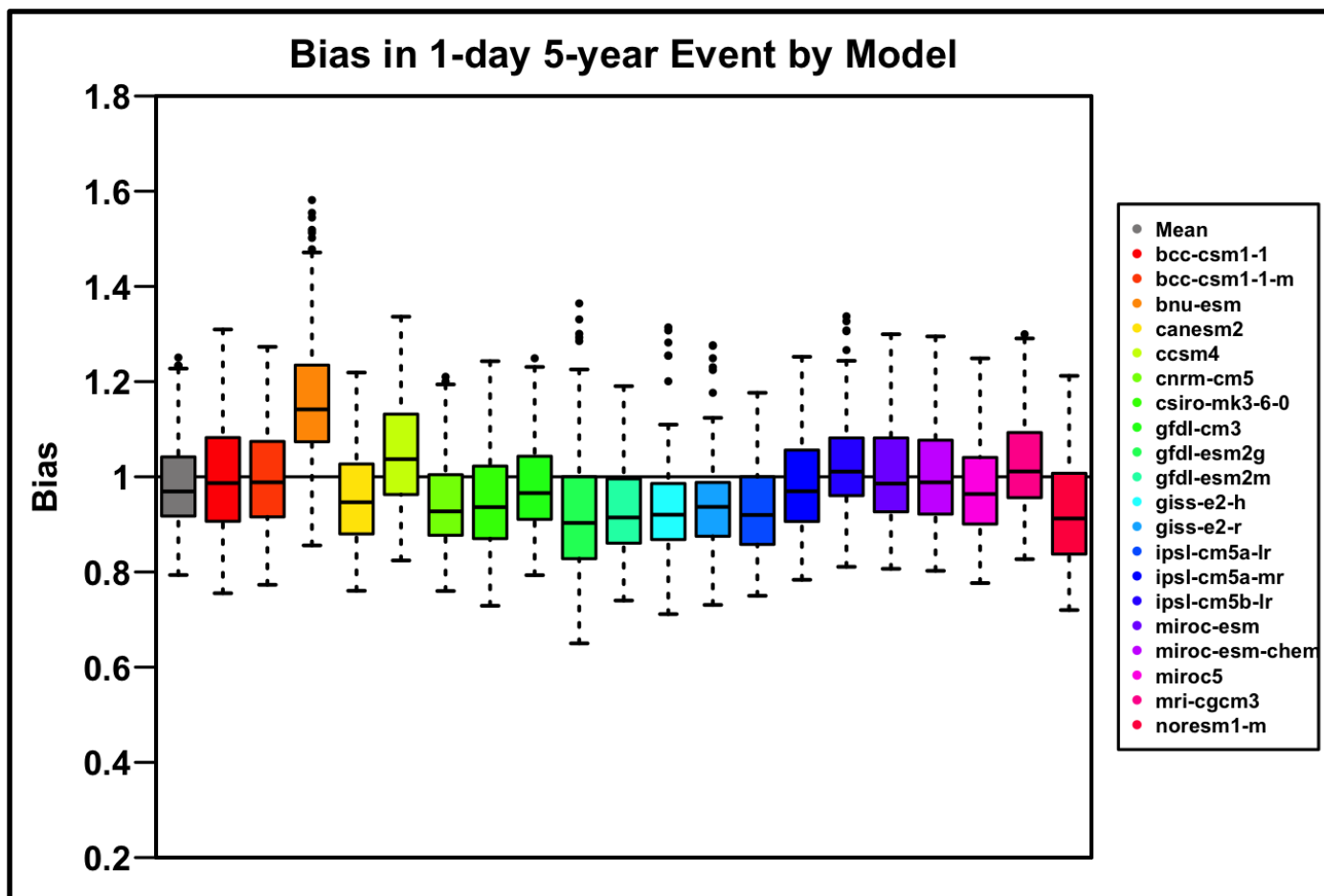


Cornell University

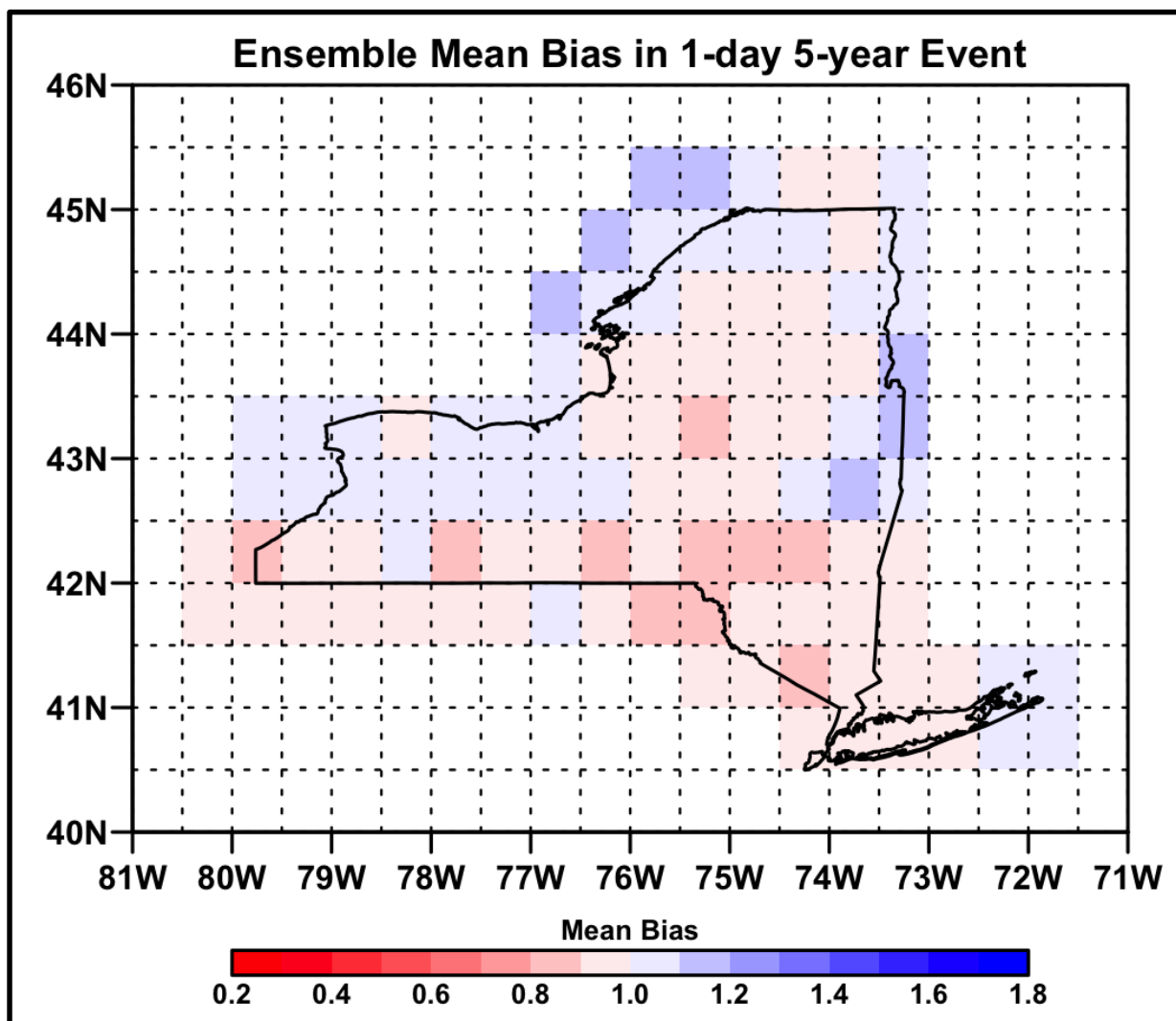


Northeast Regional  
Climate Center

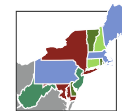
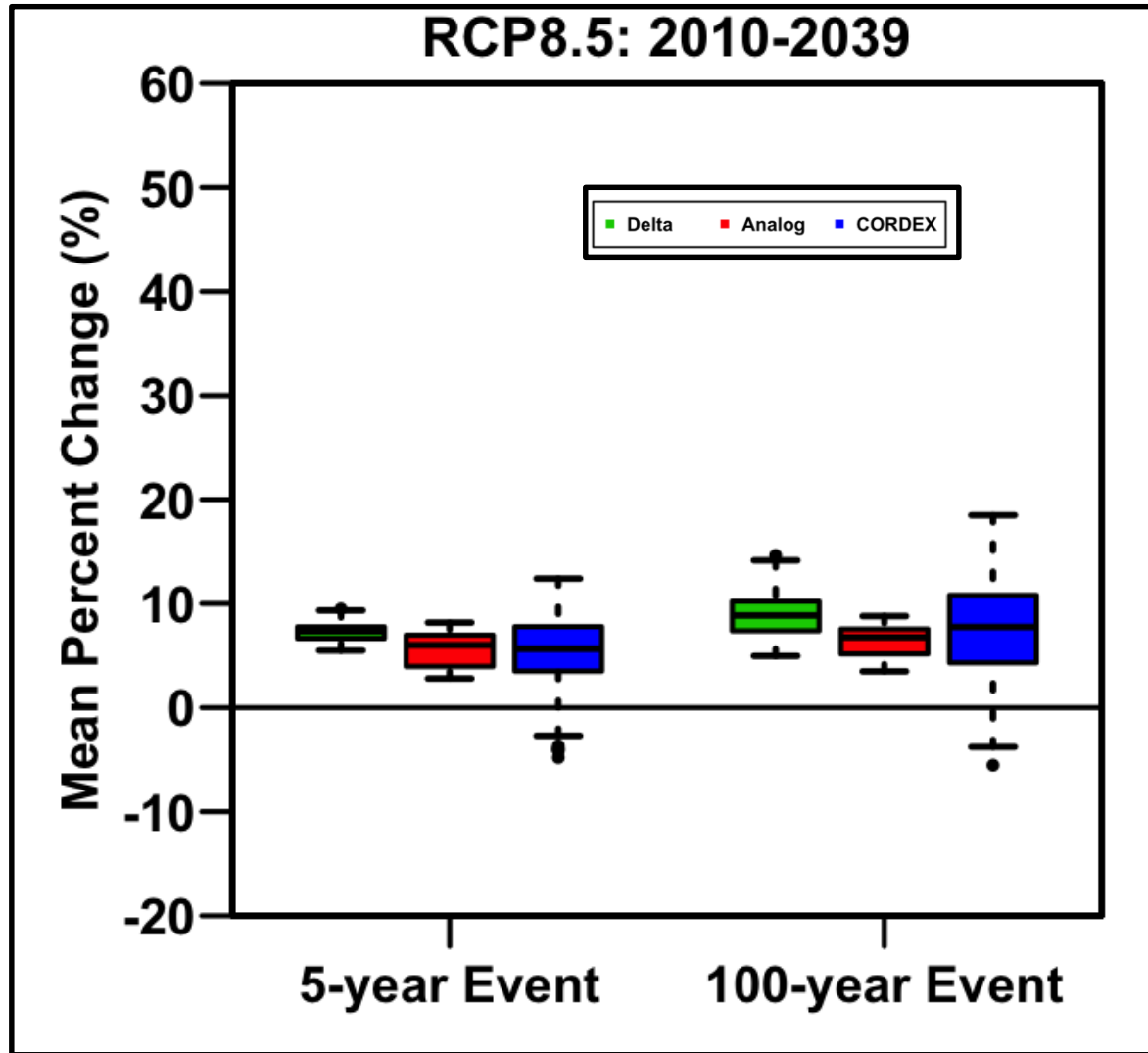
# Analog Method vs. Observed



# Analog vs Observed Ensemble Mean Bias

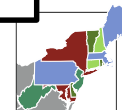
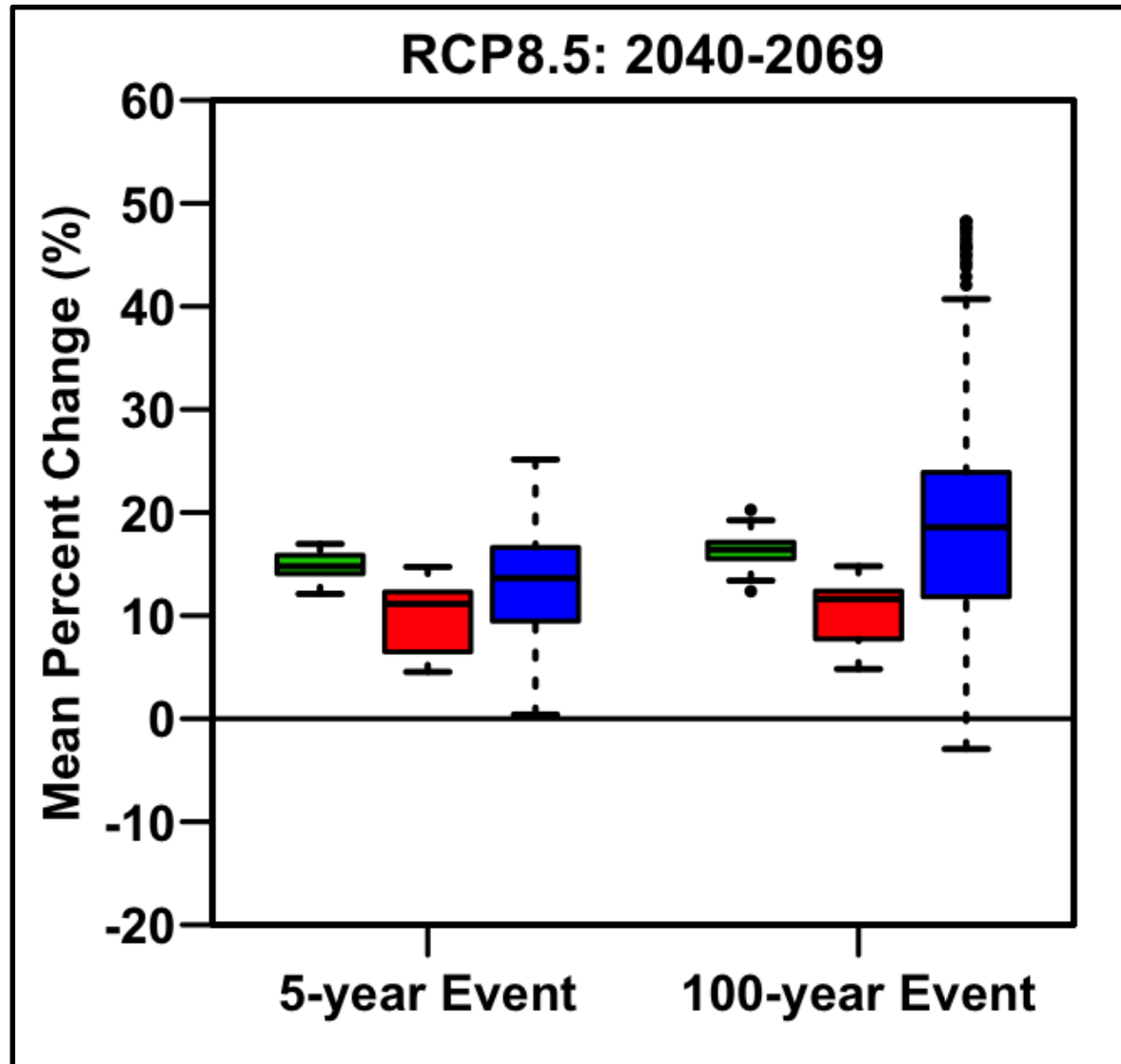


# Projected Changes in 1-day 5- and 100-Year Rainfall Amounts Relative to 1970–1999

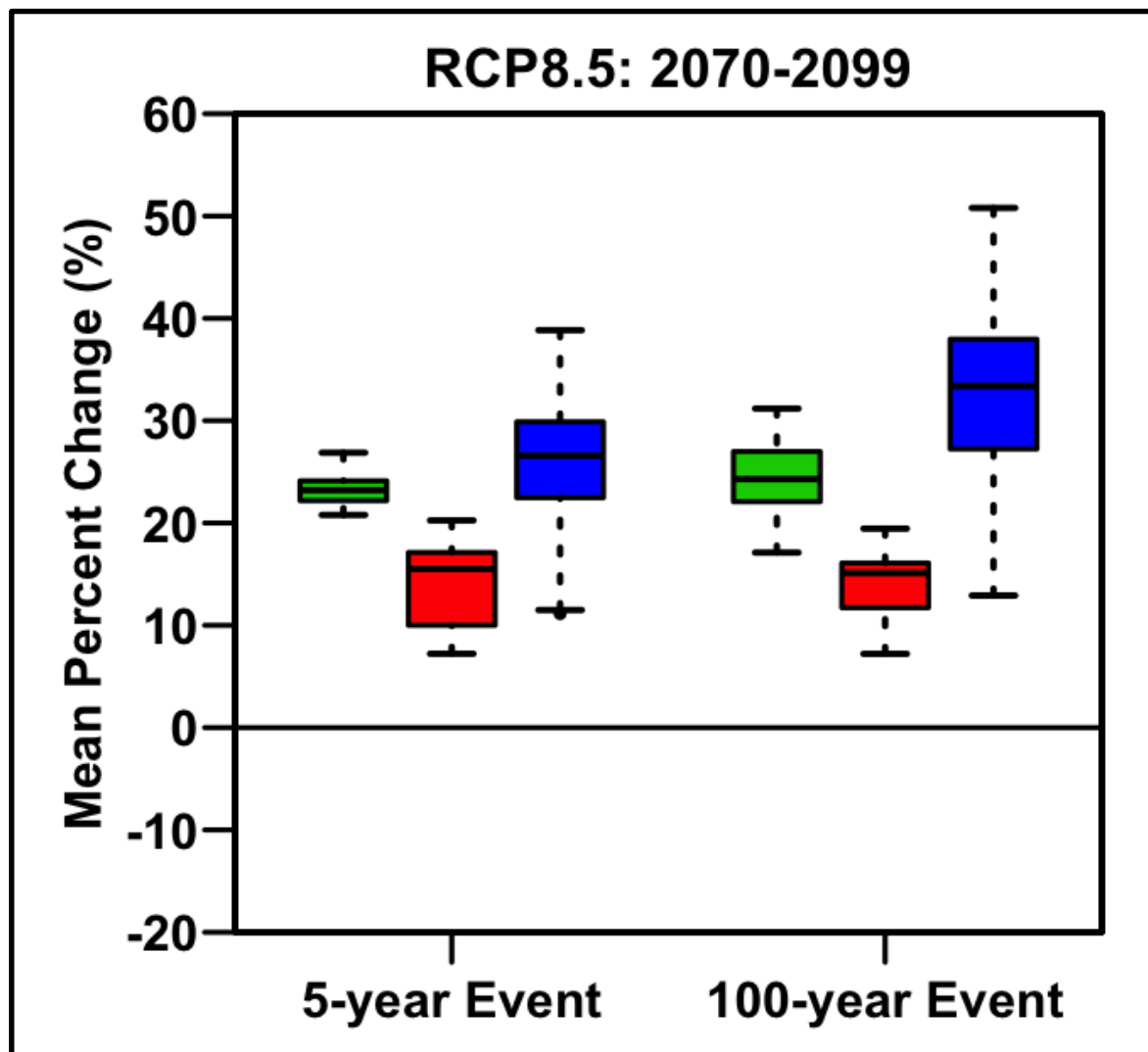




# Projected Changes in 1-day 5- and 100-Year Rainfall Amounts Relative to 1970–1999

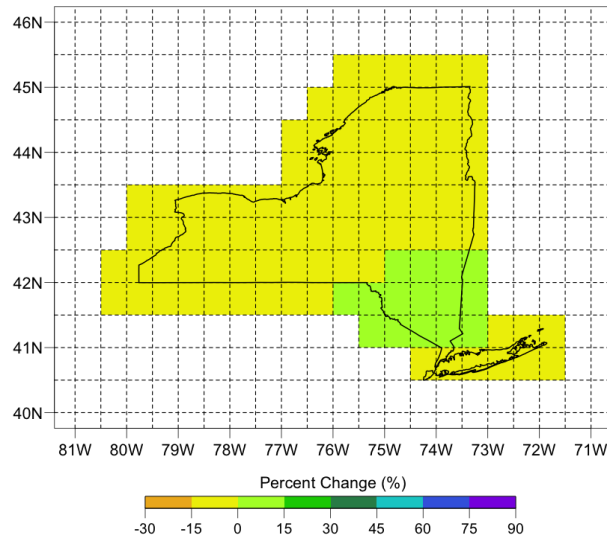


# Projected Changes in 1-day 5- and 100-Year Rainfall Amounts Relative to 1970–1999

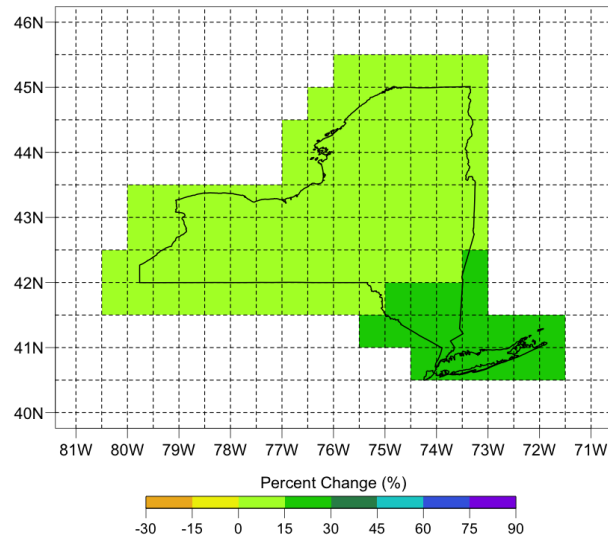


# Projected Changes in 1-day 100-year Rainfall Amounts 2070–2099 vs. 1970–1999

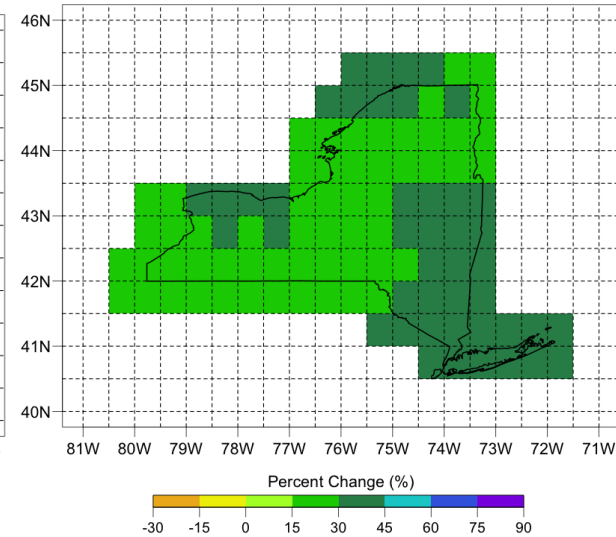
## 10<sup>th</sup> Percentile



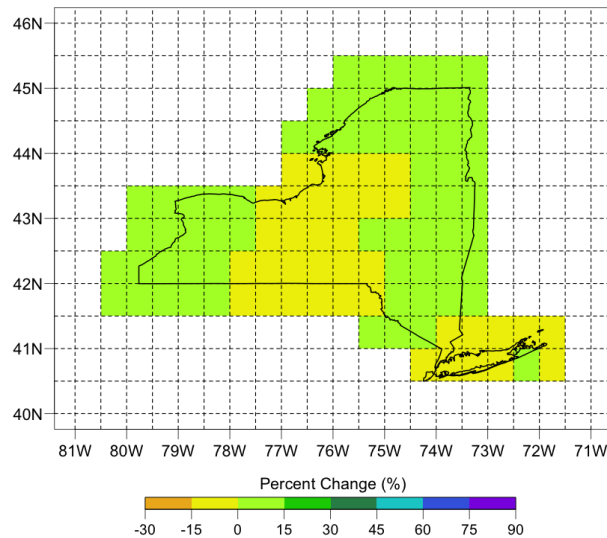
## Mean



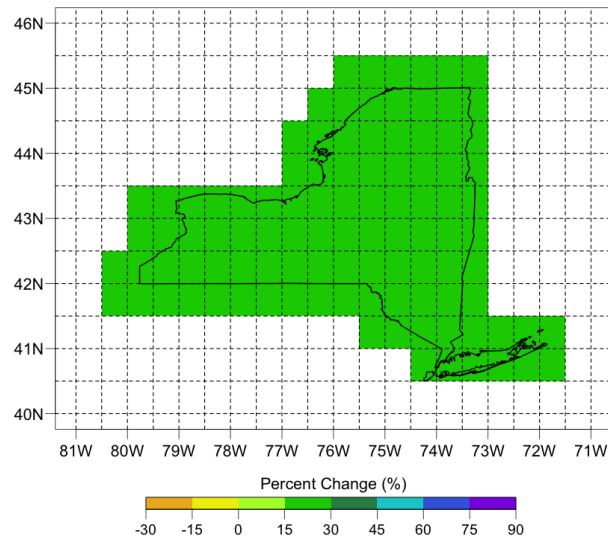
## 90<sup>th</sup> Percentile



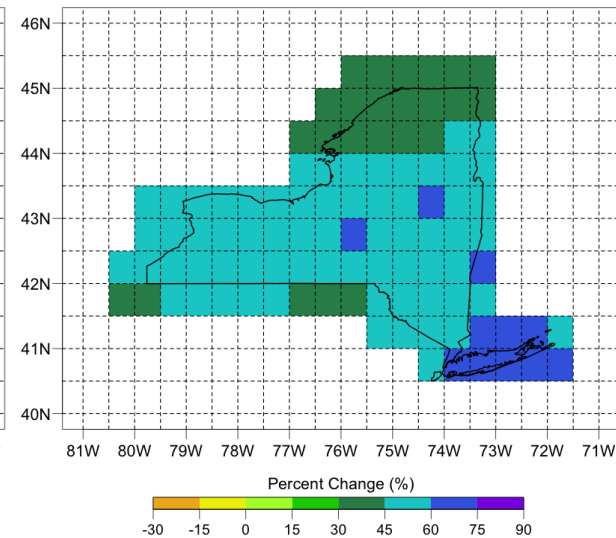
## 10<sup>th</sup> Percentile



## Mean



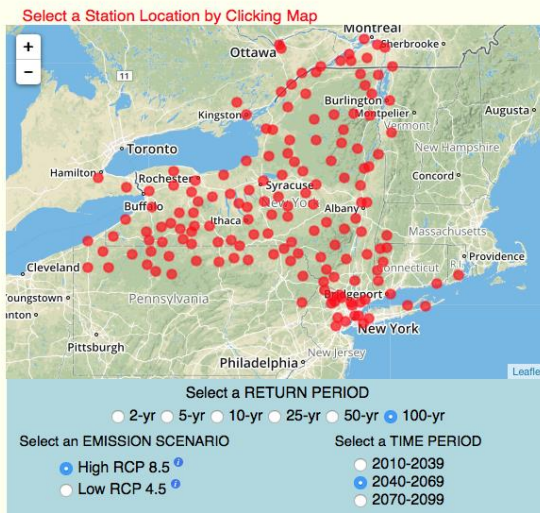
## 90<sup>th</sup> Percentile



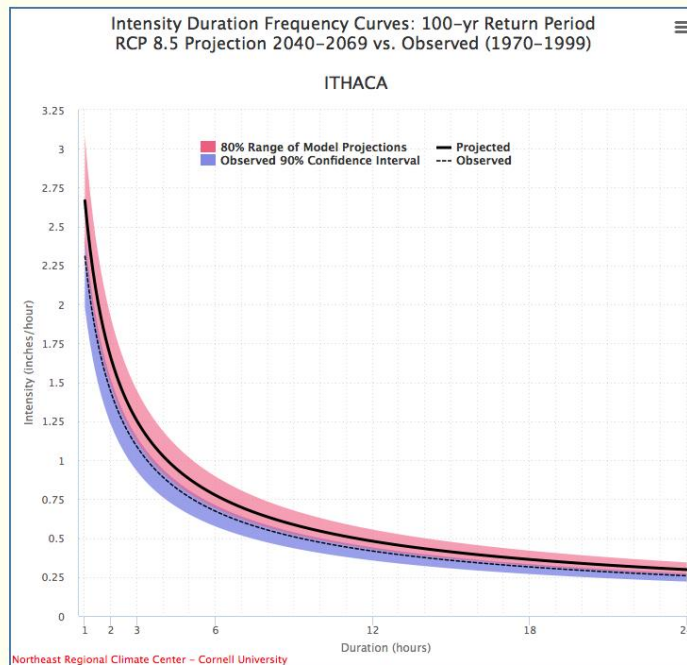
# Intensity Duration Frequency Curves for New York State *Future Projections for a Changing Climate*

Station-specific IDF Graphs

Statewide Maps of Projected Changes



**About this Project** Numerous studies have documented significant increases in both the frequency and magnitude of extreme precipitation in the northeastern U.S. since the mid-to-late 20th century. The most recent assessment from the Intergovernmental Panel on Climate Change (IPCC) suggests that the frequency and magnitude of extreme precipitation in this region will likely continue to increase throughout the 21st century. Such changes could greatly exacerbate the societal impacts of extreme precipitation in the future. In consideration of these impacts, the Northeast Regional Climate Center (NRCC) has partnered with the New York State Energy Research and Development Authority (NYSERDA) to downscale global climate model output and create extreme precipitation projections that will ultimately be incorporated into climate change adaptation planning for New York State. [Read more...](http://ny-idf-projections.nrcc.cornell.edu)



Northeast Regional Climate Center – Cornell University

Duration (hrs)	Projected 2040-2069 Intensity			Observed 1970-1999 Intensity		
	10 <sup>th</sup>	Mean	90 <sup>th</sup>	Low CI	Mean	High CI
1	2.38	2.67	3.08	1.98	2.31	2.45
2	1.47	1.65	1.91	1.23	1.43	1.52
3	1.11	1.25	1.44	0.93	1.08	1.15
6	0.69	0.77	0.89	0.57	0.67	0.71
12	0.43	0.48	0.55	0.36	0.42	0.44
18	0.32	0.36	0.42	0.27	0.31	0.33
24	0.27	0.30	0.34	0.22	0.26	0.27

<http://ny-idf-projections.nrcc.cornell.edu>



Cornell University



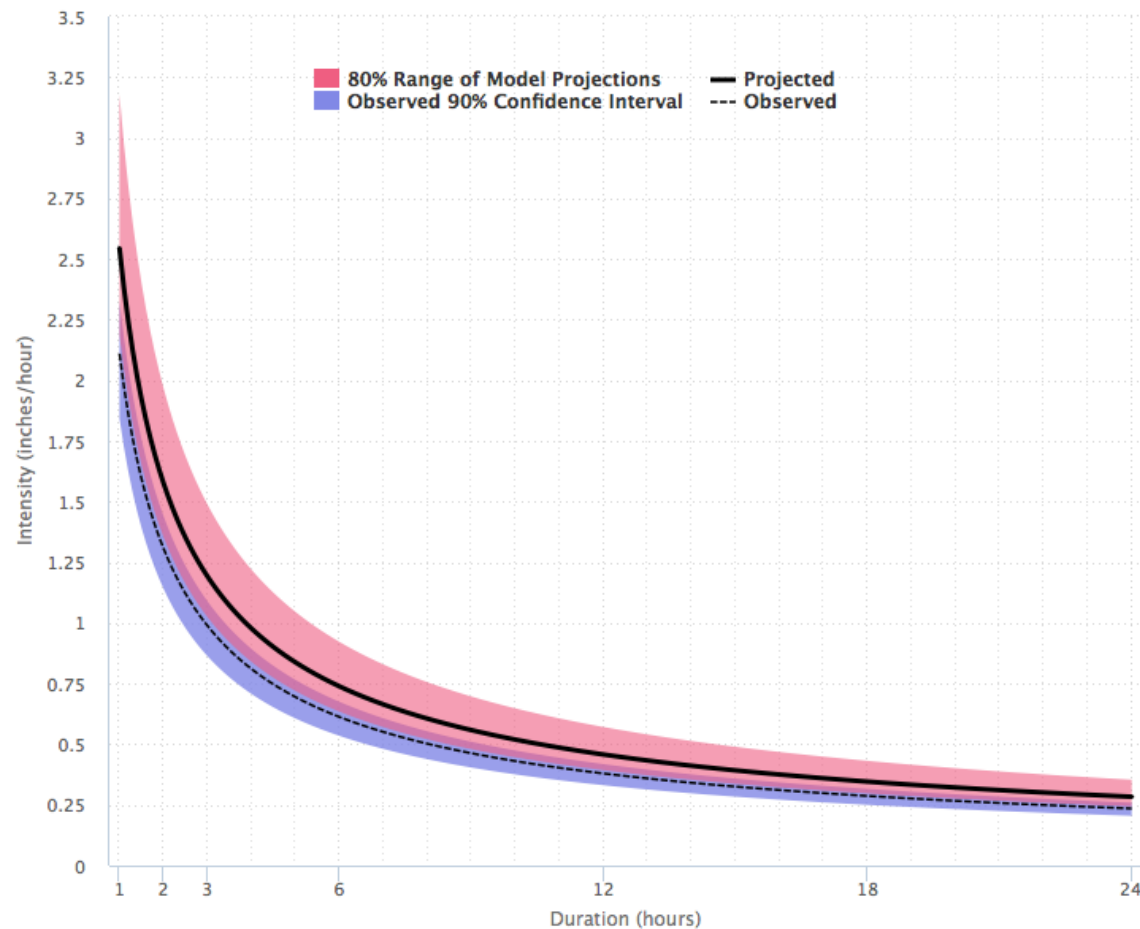
Northeast Regional  
Climate Center



# Intensity Duration Frequency Curves: 100-yr Return Period RCP 8.5 Projection 2070–2099 vs. Observed (1970–1999)



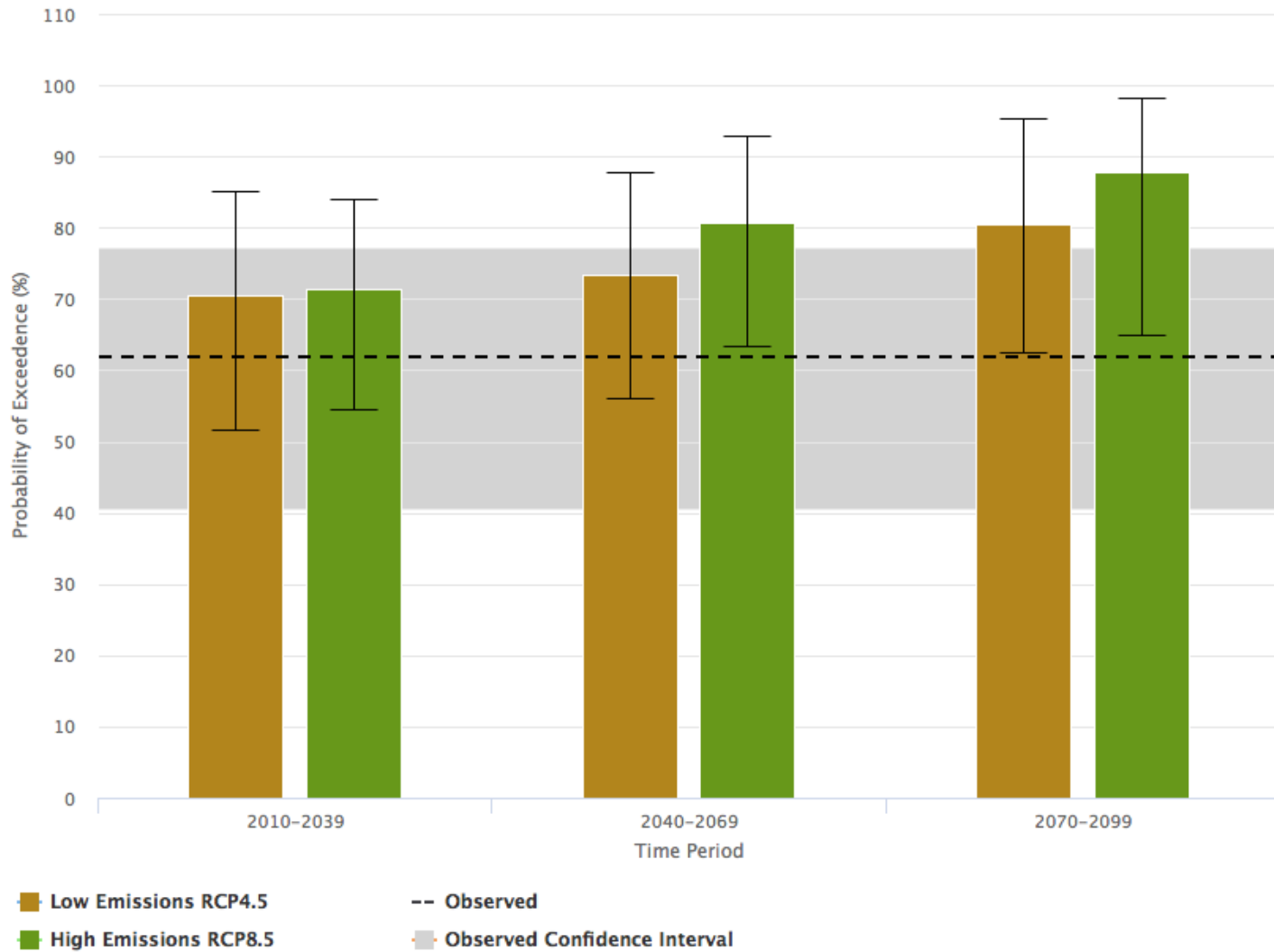
## ALBANY AP



Northeast Regional Climate Center – Cornell University

Duration (hrs)	Projected 2070-2099 Intensity Ensemble Member <a href="#">?</a>			Observed 1970-1999 Intensity with Confidence Interval (CI) Bounds <a href="#">?</a>		
	10 <sup>th</sup>	Mean	90 <sup>th</sup>	Low CI	Mean	High CI
1	2.19	2.54	3.18	1.84	2.11	2.32
2	1.35	1.58	1.97	1.14	1.31	1.44
3	1.02	1.19	1.49	0.86	0.99	1.09
6	0.63	0.74	0.92	0.53	0.61	0.67
12	0.39	0.46	0.57	0.33	0.38	0.42
18	0.30	0.35	0.43	0.25	0.29	0.32
24	0.24	0.28	0.35	0.21	0.24	0.26

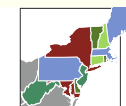
Probability of Exceeding 7.00 Inches of Precipitation in 24 Hours at NEW YORK CNTRL  
PK TWR During Specified 30-Year Periods (%)



Northeast Regional Climate Center – Cornell University



Cornell University



Northeast Regional  
Climate Center



THANK YOU!