# When it Rains it Pours!
# Extreme Rainfall Change Factors Based on CMIP6 Model Output

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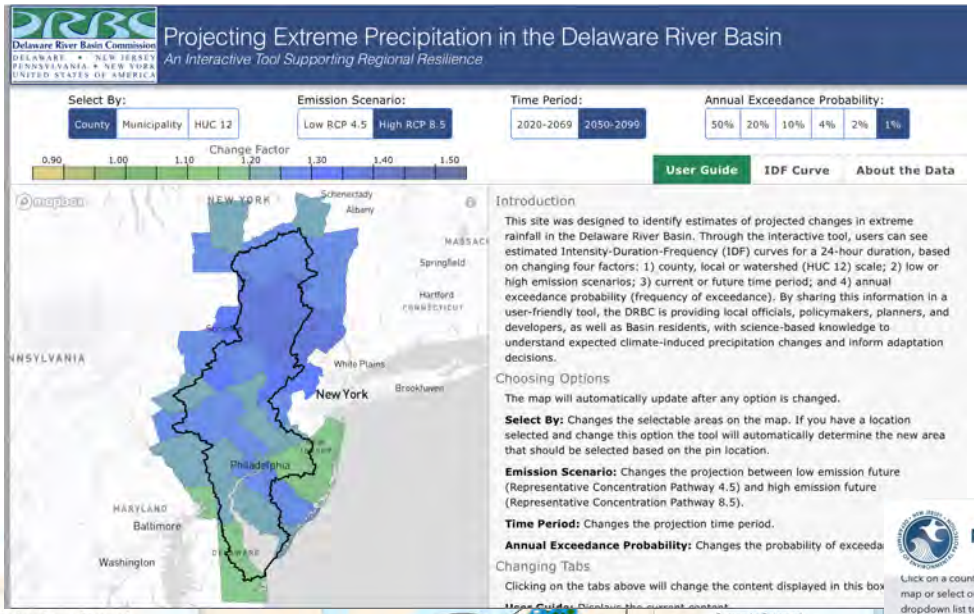
Climate and Environment

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

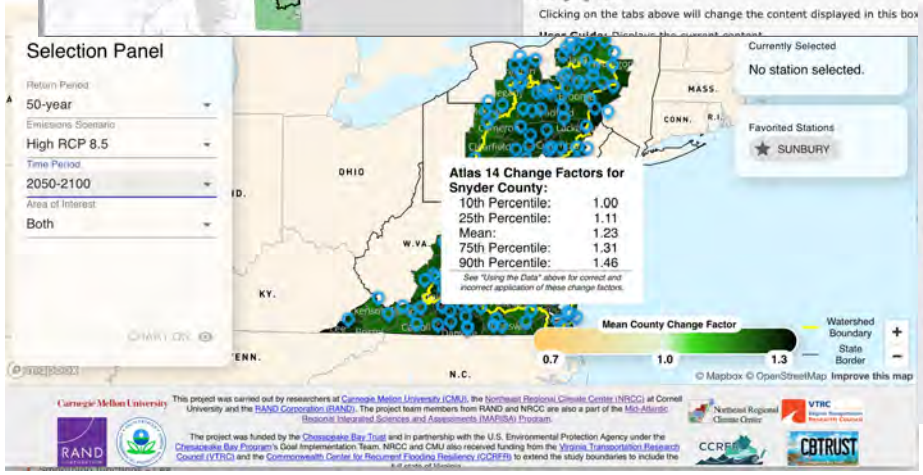
Lack of a current, national rainfall database means some states use 60-year-old statistics as they design roads, bridges and dams that are supposed to last 50 years

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

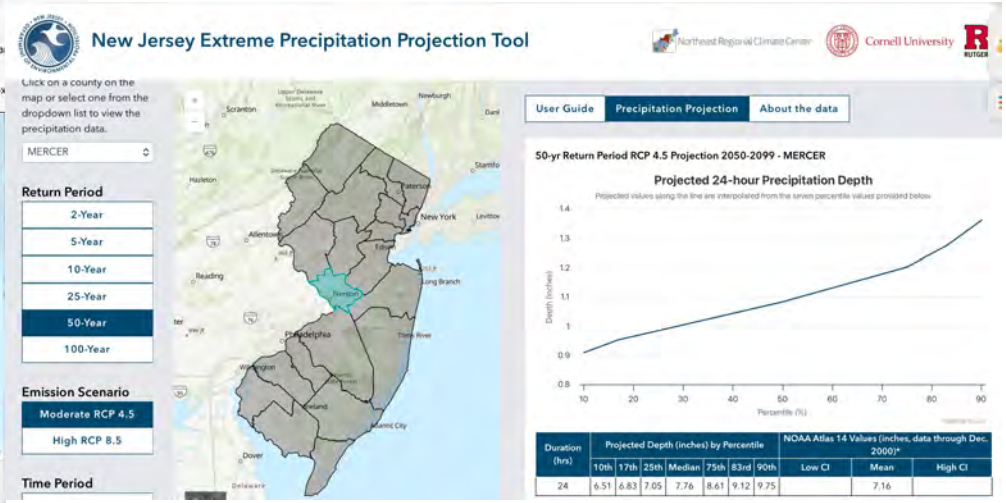
# Existing NRCC Extreme Precipitation Projection Tools




https://drbc-idf.rcc-acis.org

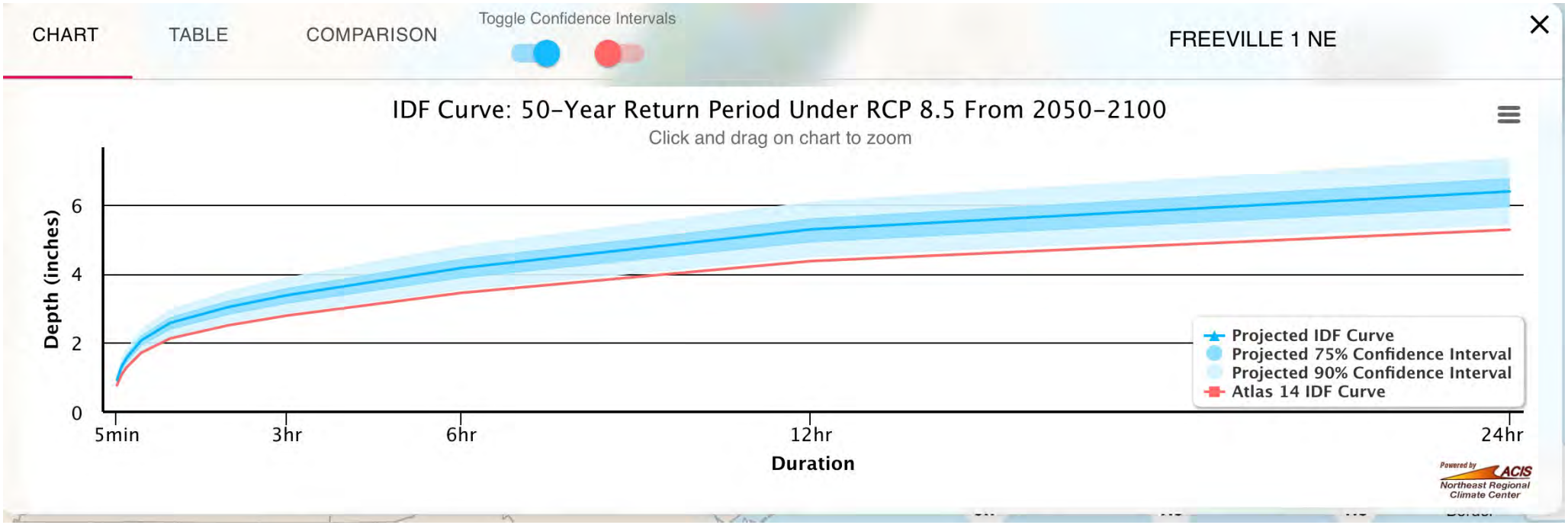



https://midatlantic-idf.rcc-acis.org




https://njprojectedprecipitationchanges.com

# Tool Functionality




NOAA Atlas 14 → Future Extreme Rainfall

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# Tool Functionality

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 |

$$5.28 \times 1.21 = 6.39$$

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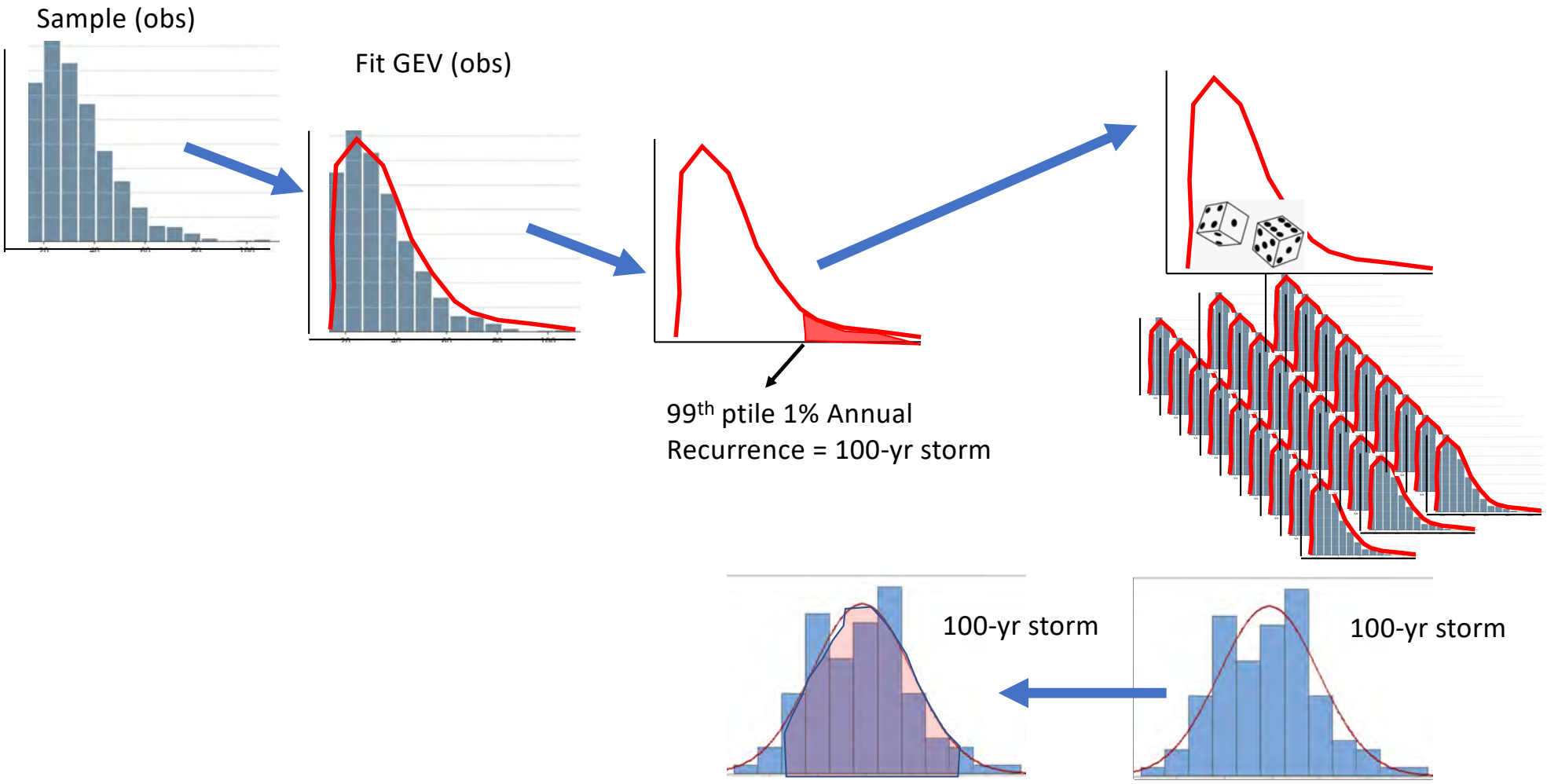
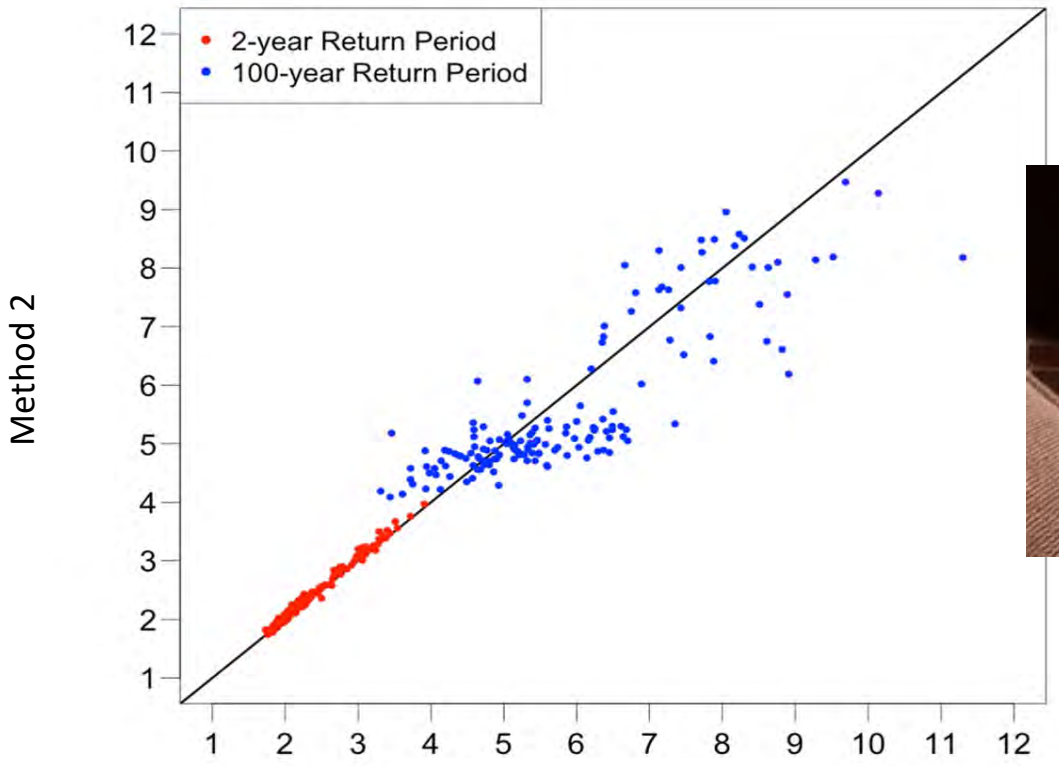
# Resampled Confidence Intervals



# A Happy Dog!

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# 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 LOCA2 grid (16 x 1000) $CF_{ARI}$ values

Compute median and percentiles

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# Projections CMIP5

## Localized Constructed Analogs (LOCA)

- Statistically Downscaled
- 1/16$^{th}$ ° 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)

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# Projections CMIP6

## Localized Constructed Analogs V2 (LOCA2)

- Statistically Downscaled
- 1/16$^{th}$ ° Spatial Resolution (7 km)
- 16 CMIP6 models used in NCA5
- Daily resolution
- SSP2-4.5, SSP3-7.0 SSP5-8.5
- One of two NCA5 methods

## 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)

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# LOCA2

| Climate Model | Affiliated Institution | Original Spatial Resolution |
|---|---|---|
| ACCESS-CM2, ACCESS-ESM1-5 | CSIRO, Bureau of Meteorology (Australia) | ~250 km |
| BCC-CSM2-MR | Beijing Climate Center (China) | ~100 km |
| CanESM5 | Canadian Centre for Climate Modelling and Analysis | ~200 km |
| EC-Earth3 | Multiple European Institutions | ~80 km |
| FGOALS-g3 | Institute of Atmospheric Physics, Chinese Academy of Sciences (China) | ~100 km |
| GFDL-ESM4 | Geophysical Fluid Dynamics Laboratory (USA) | ~100 km |
| INM-CM4-8, INM-CM5-0 | Institute for Numerical Mathematics (Russia) | ~140 km/~200 km |
| IPSL-CM6A-LR | Institut Pierre-Simon Laplace (France) | ~250 km |
| MIROC6 | Multiple Japanese Institutions | ~100 km |
| MPI-ESM1-2-HR, MPI-ESM1-2-LR | Max Planck Institute for Meteorology (Germany) | ~60 km/~200 km |
| MRI-ESM2-0 | Meteorological Research Institute (Japan) | ~130 km |
| NorESM2-LM, NorESM2-MM | Norwegian Climate Centre (Norway) | ~100 km/~60 km |

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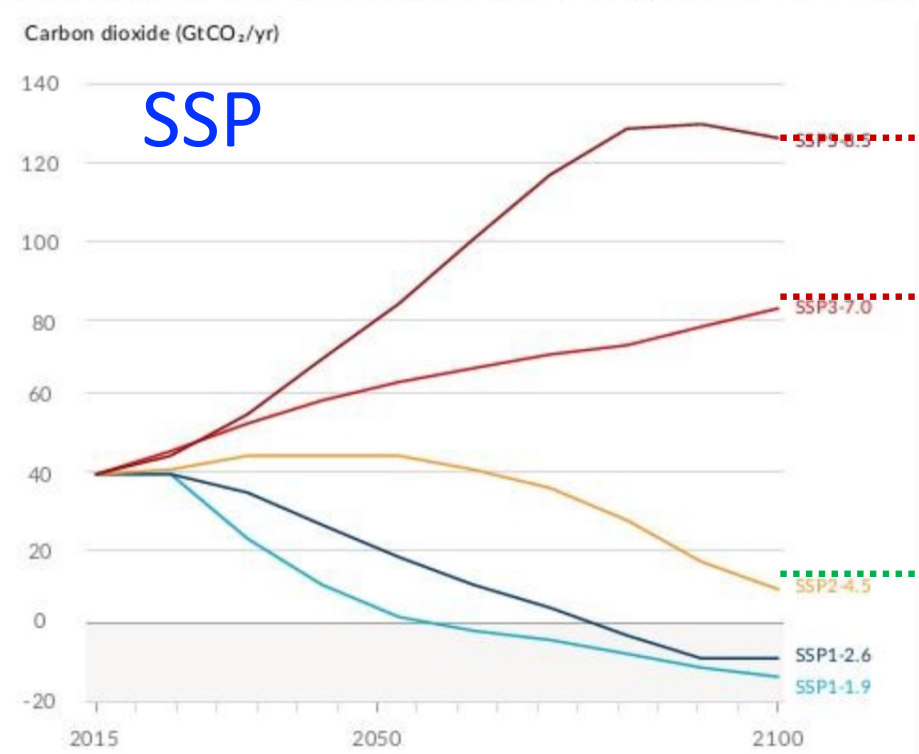
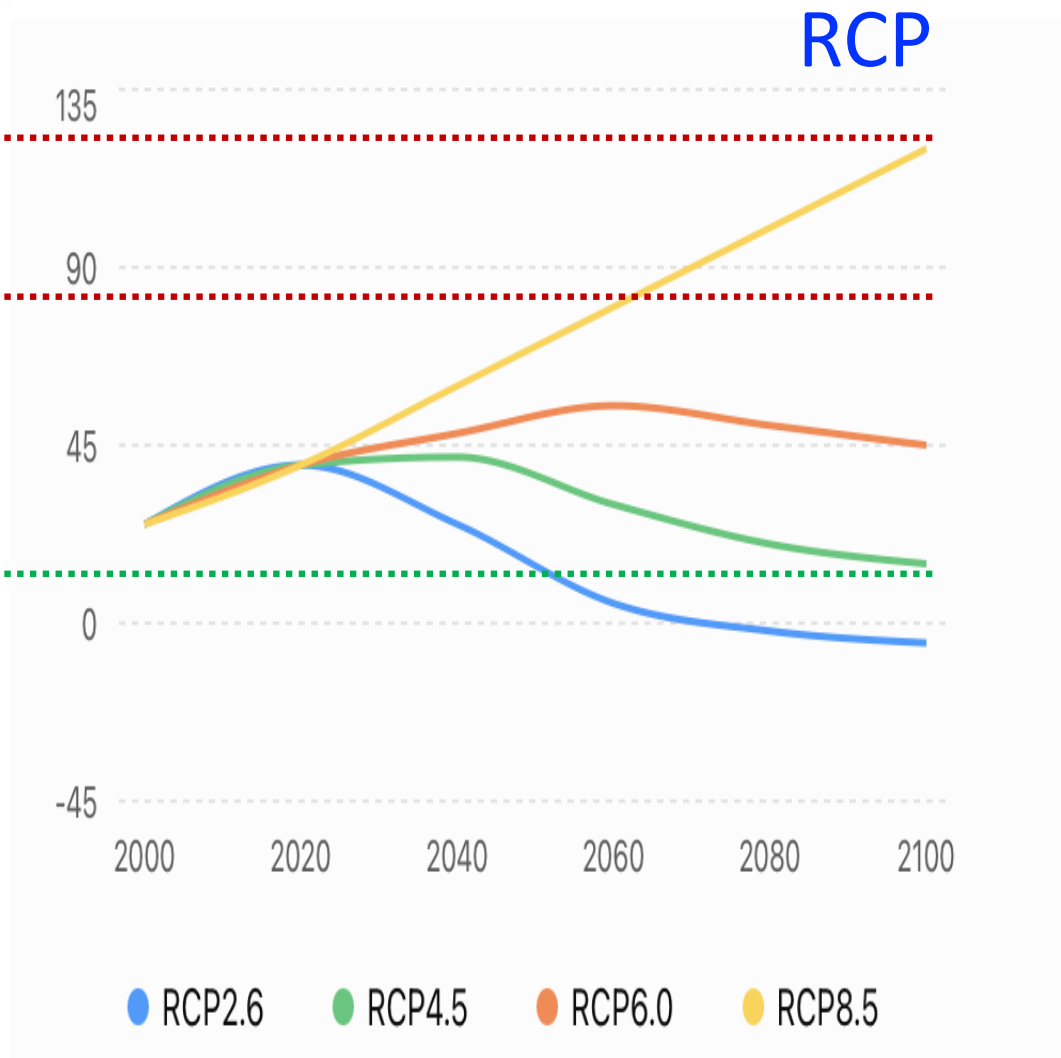

Carbon dioxide (GtCO₂/yr)
SSP
140
120
100
80
60
40
20
0
-20
2015
2050
2100
SSP3-7.0
SSP2-4.5
SSP1-2.6
SSP1-1.9

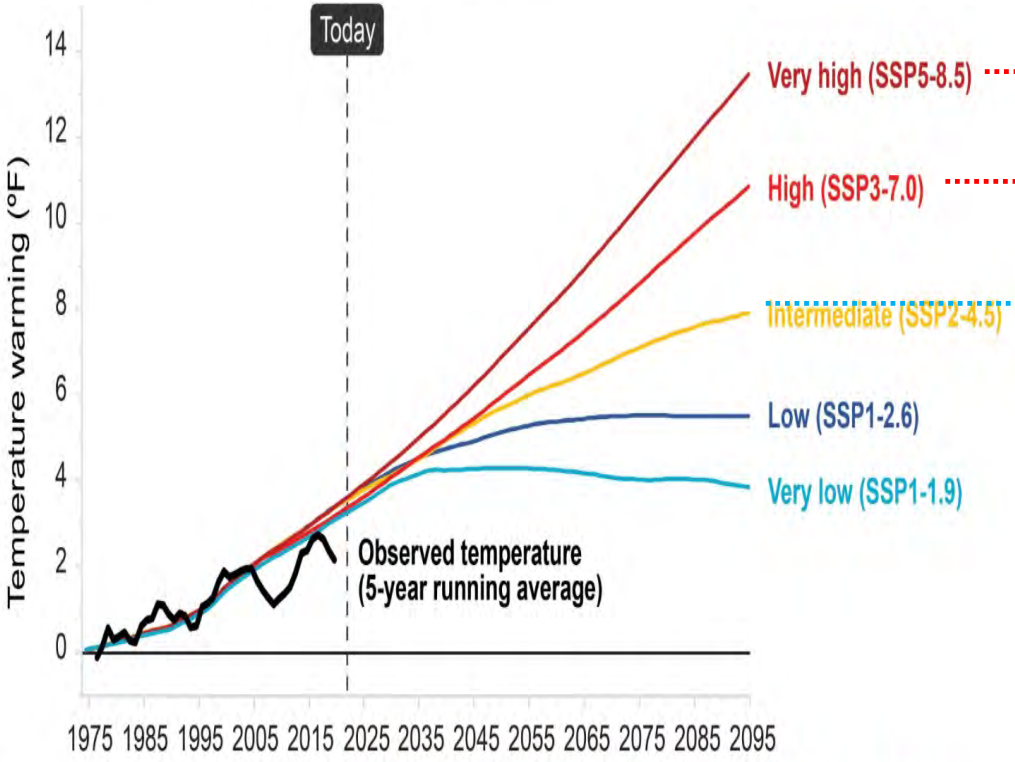

RCP
135
90
45
0
-45
2000
2020
2040
2060
2080
2100
RCP2.6
RCP4.5
RCP6.0
RCP8.5

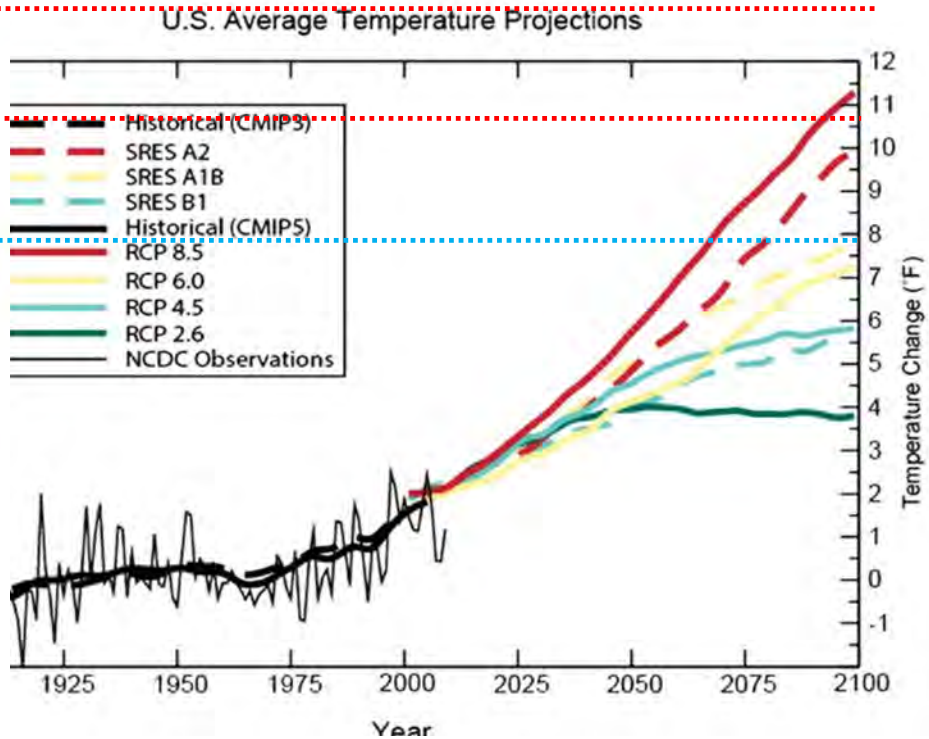
SSP

RCP

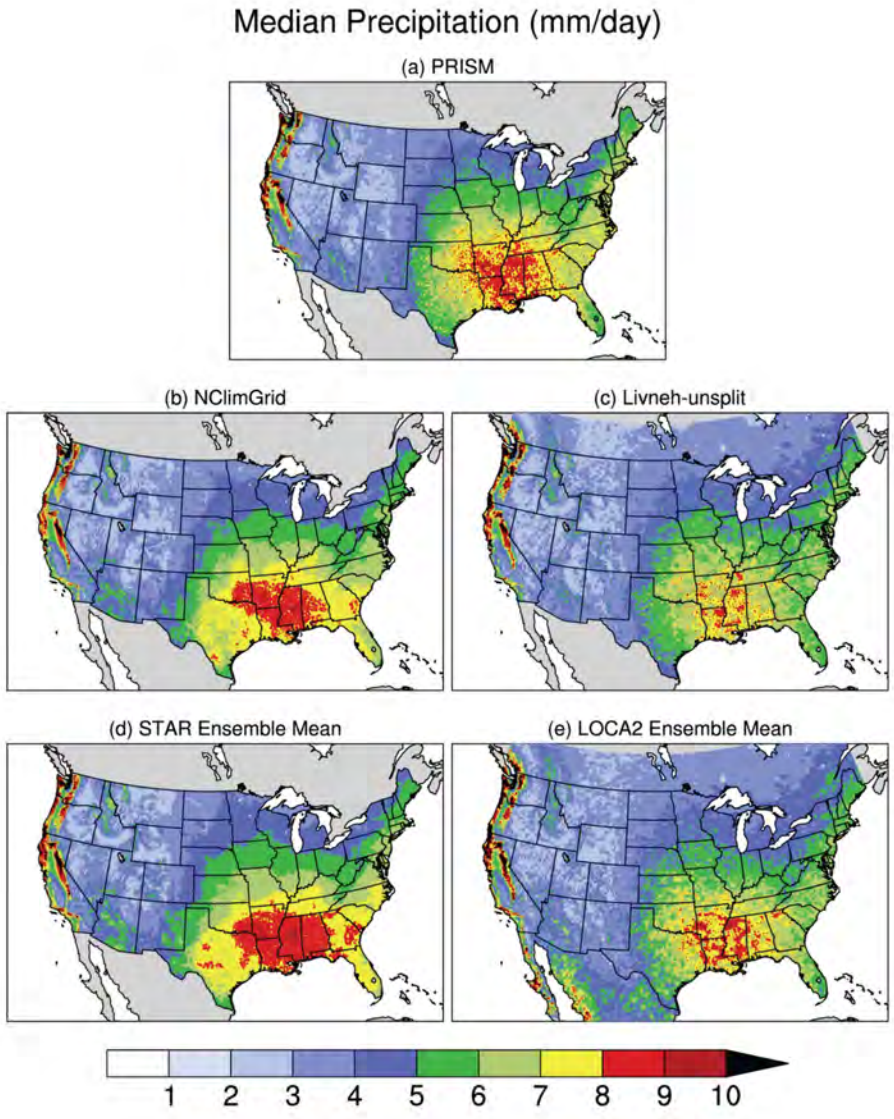
**Future Warming**

Future warming in the United States will depend on the total amount of global greenhouse gas emissions.




US Warming

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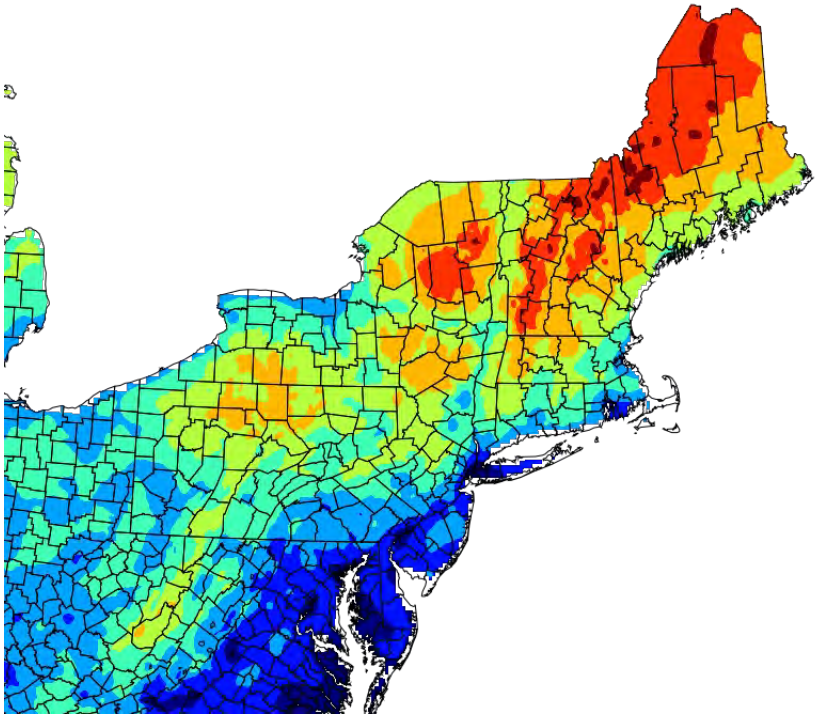
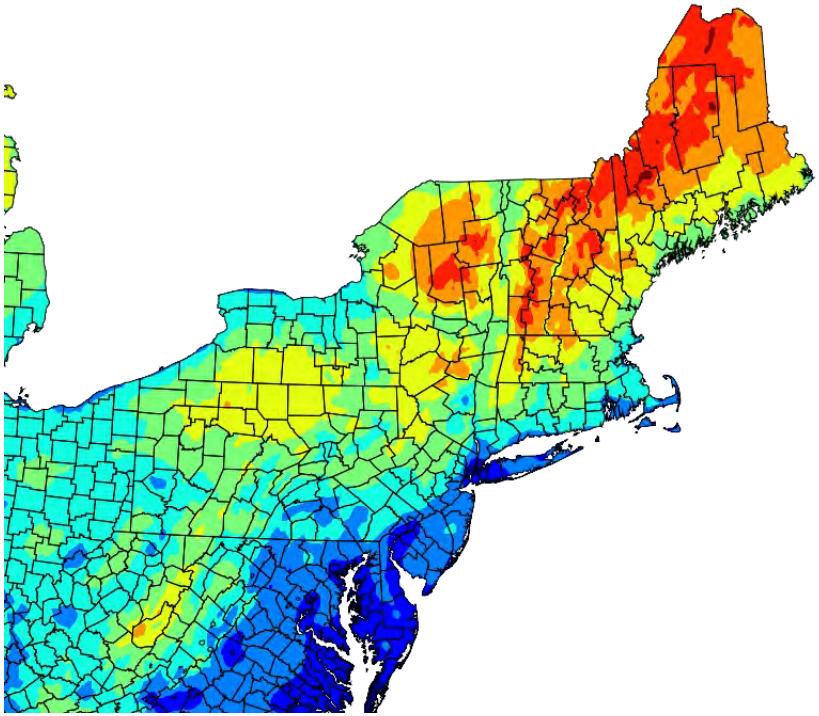
## LOCA



## LOCA2



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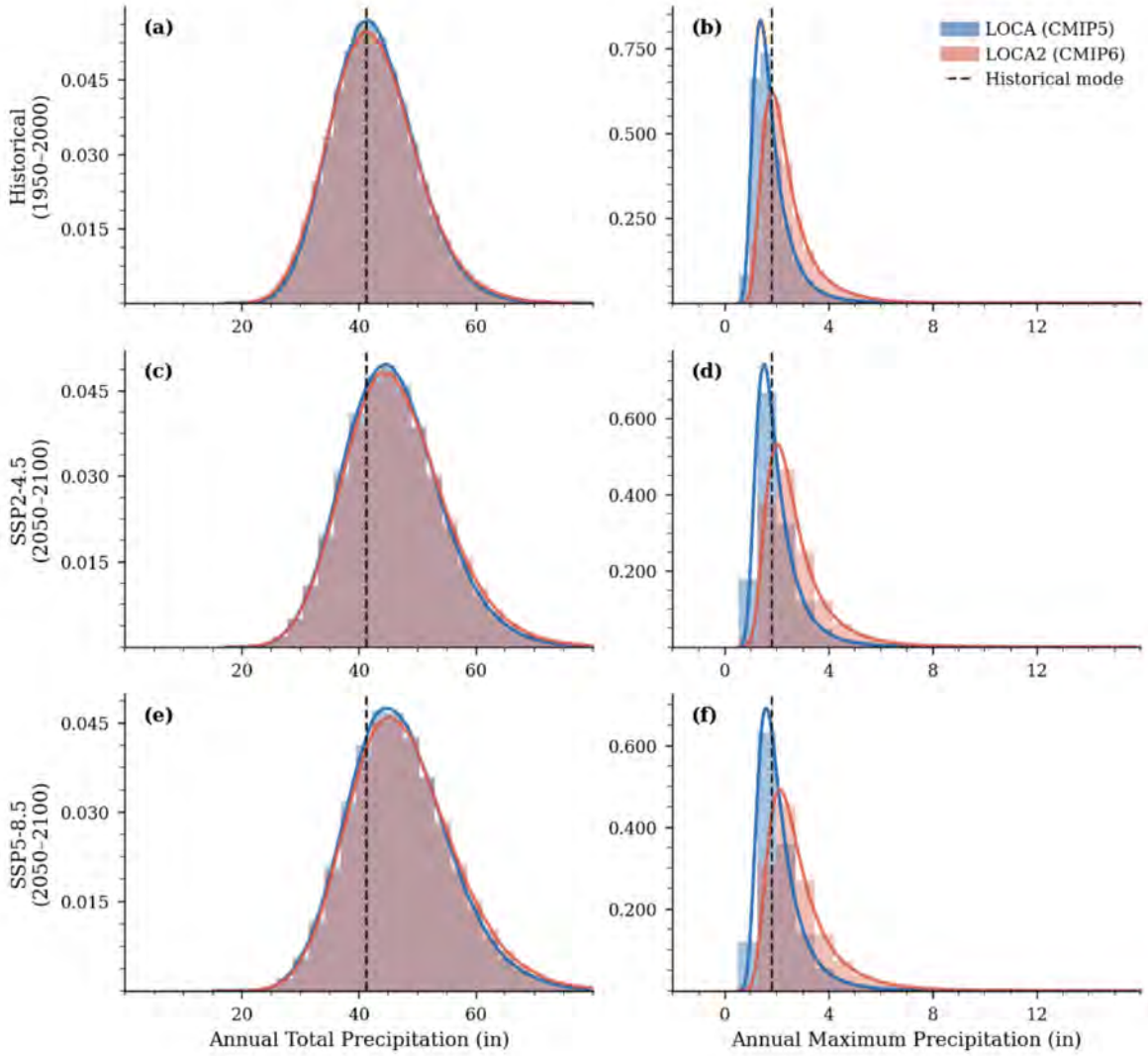
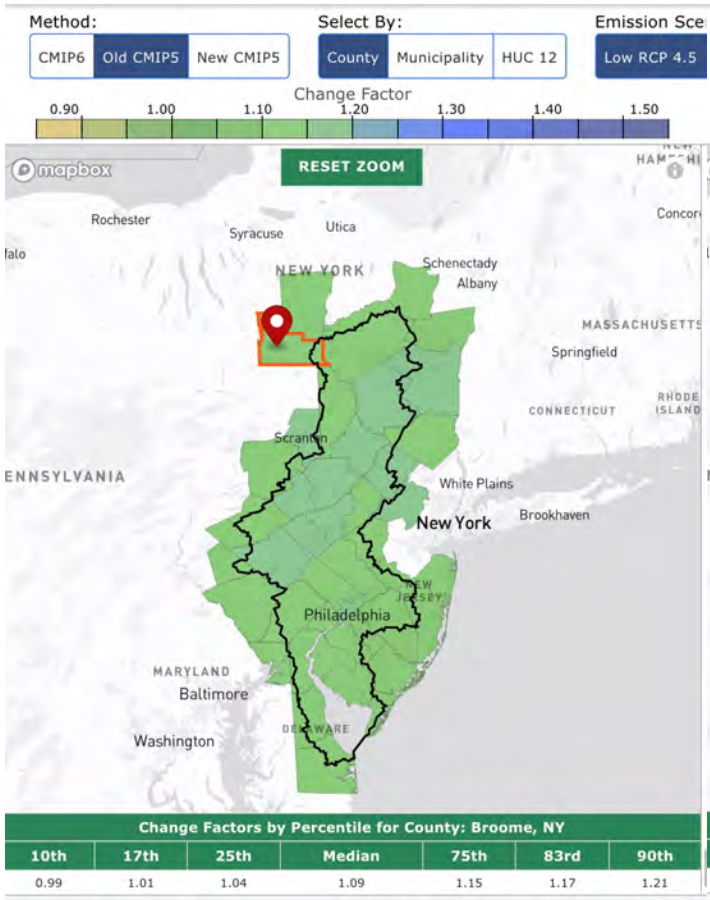
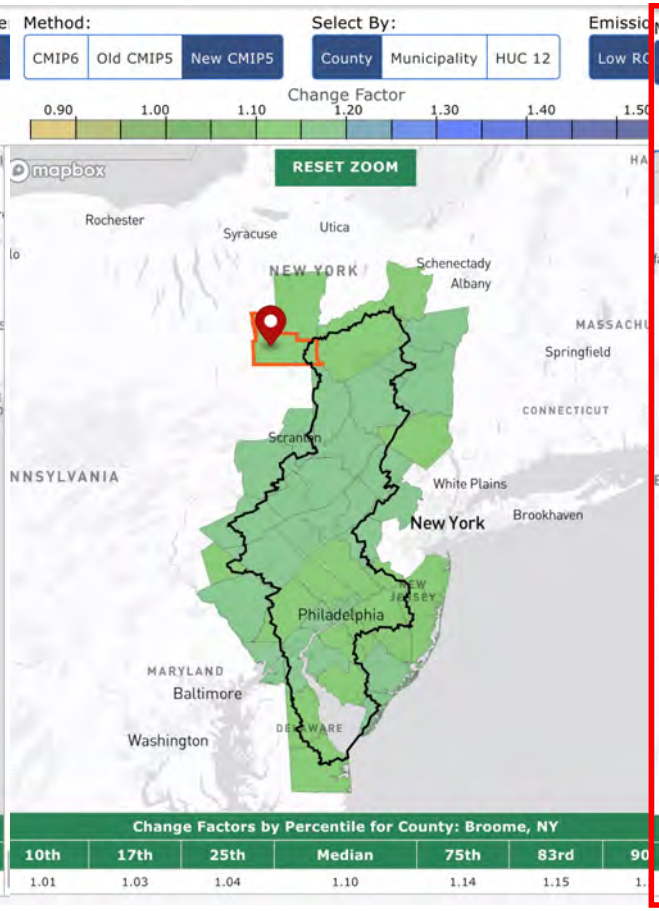
**Days <32°F**

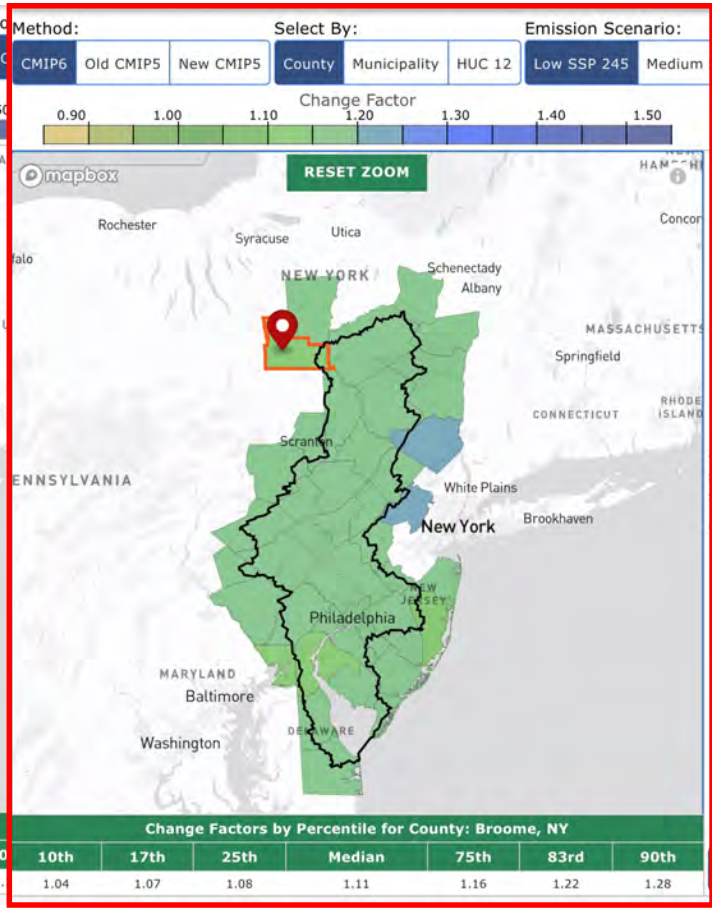
NRCC


(a)
(b)
(c)
(d)
(e)
(f)
LOCA (CMIP5)
LOCA2 (CMIP6)
Historical mode
Historical (1950–2000)
SSP2-4.5 (2050–2100)
SSP5-8.5 (2050–2100)
0.045
0.030
0.015
0.750
0.500
0.250
0.600
0.400
0.200
20
40
60
0
4
8
12
Annual Total Precipitation (in)
Annual Maximum Precipitation (in)

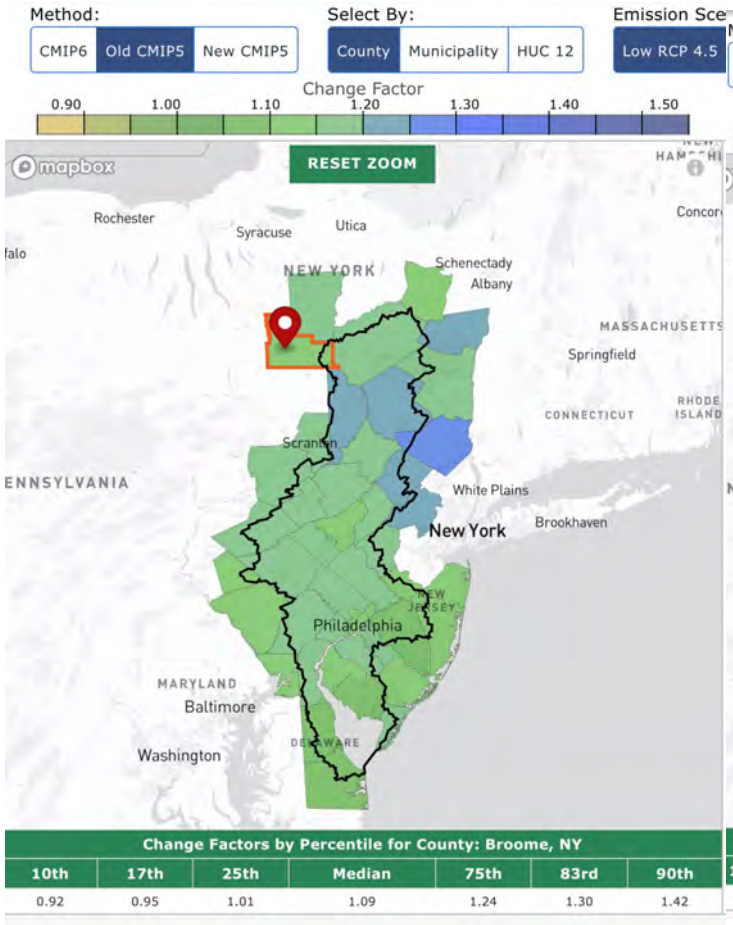
# SSP2-4.5 2-year Storm 2050-2099

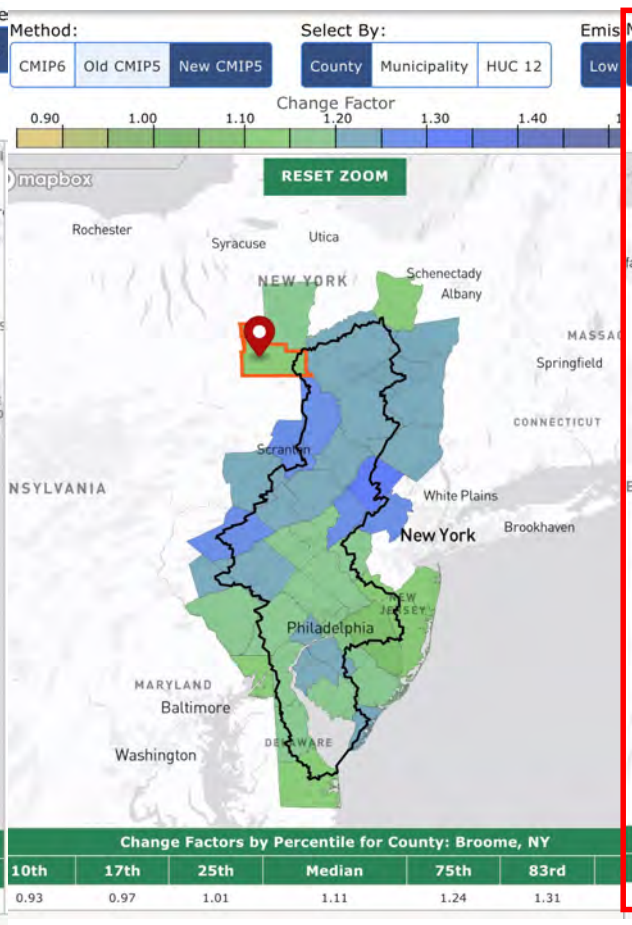


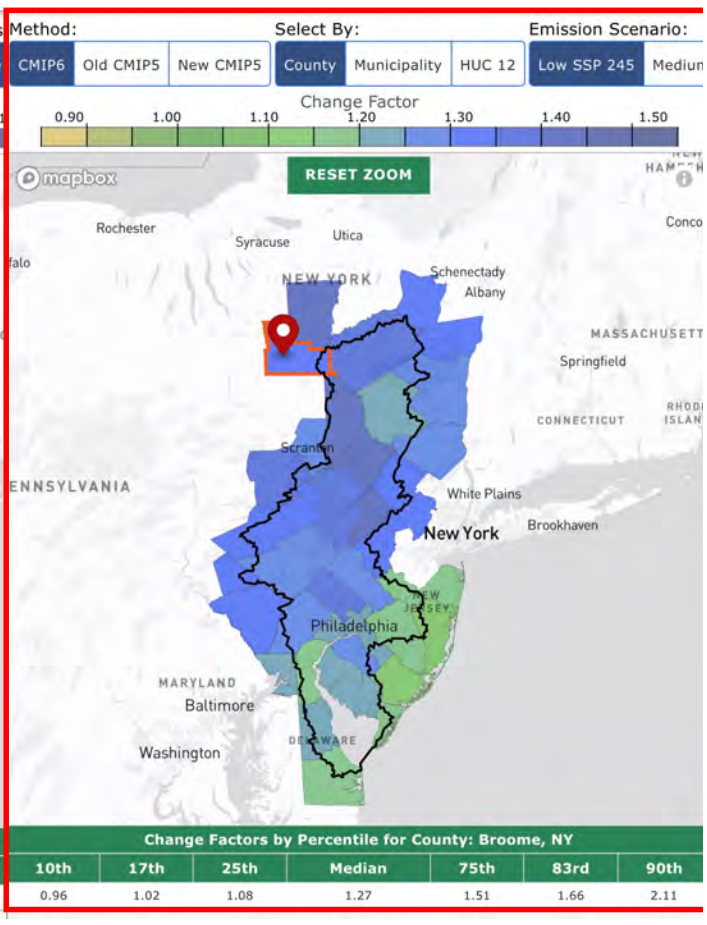



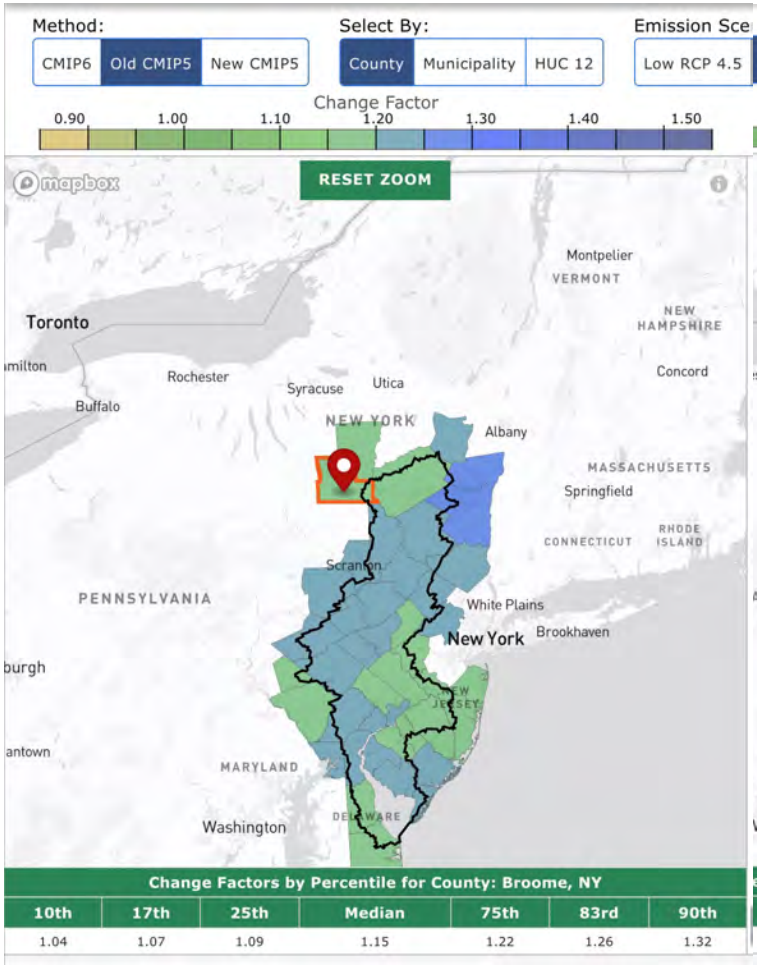
# SSP2-4.5 100-year Storm 2050-2099

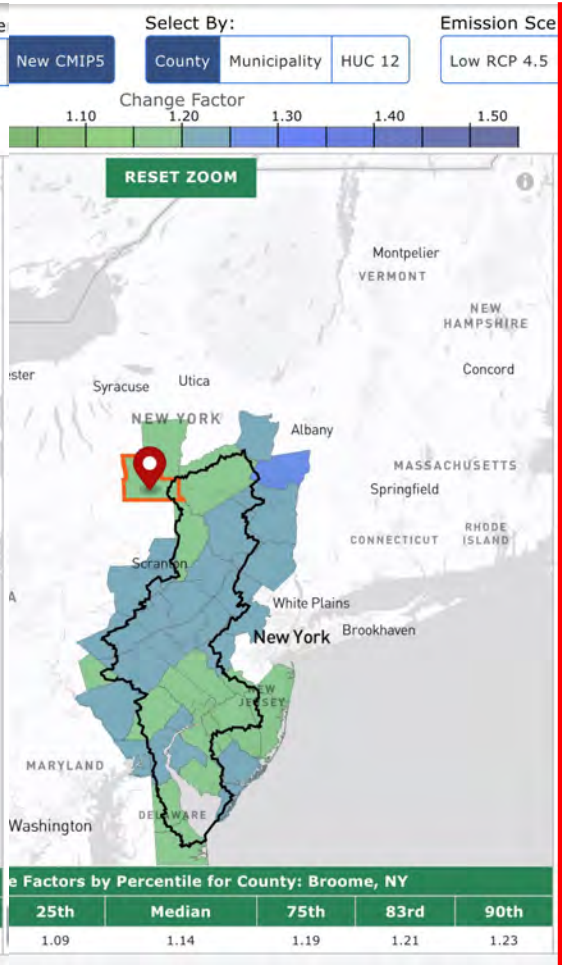


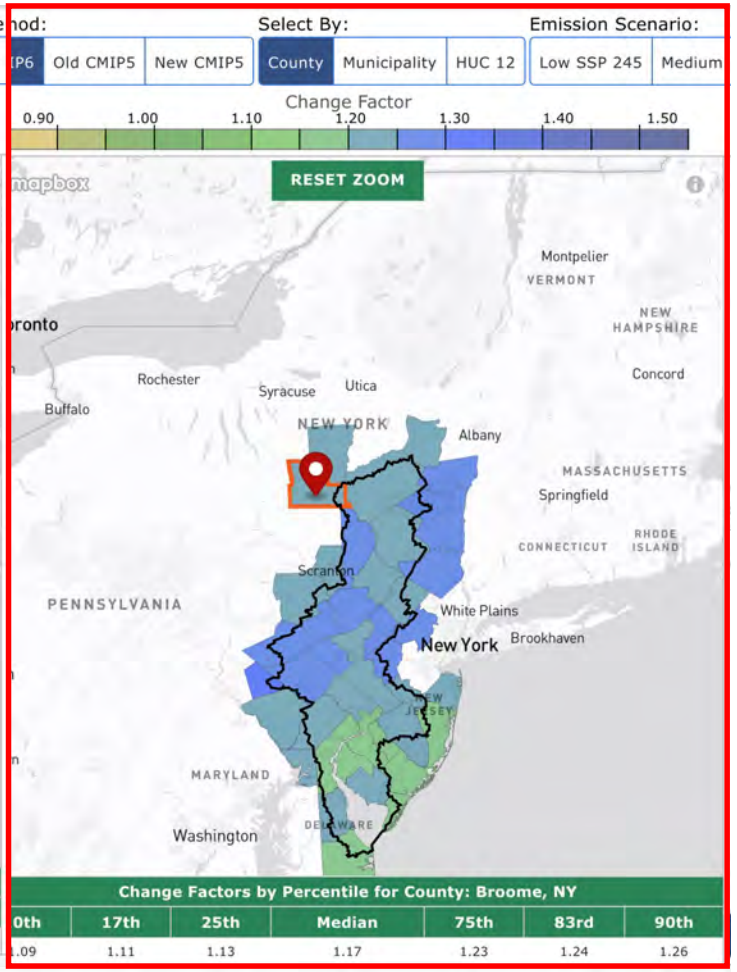



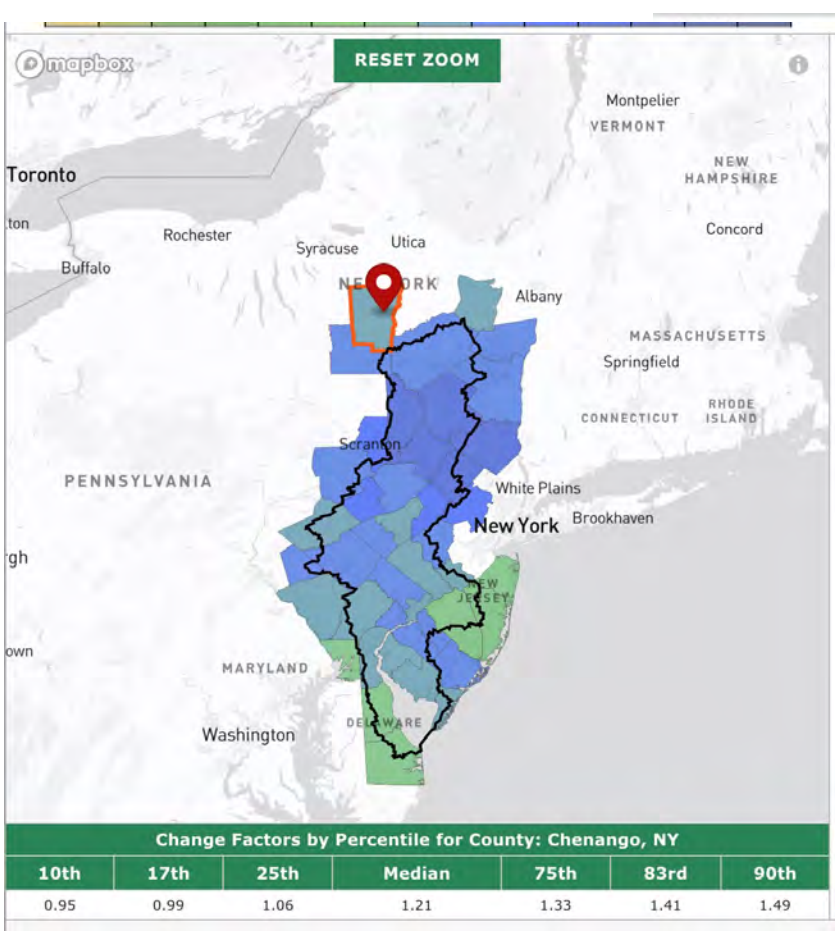
# SSP5-8.5 2-year Storm 2050-2099



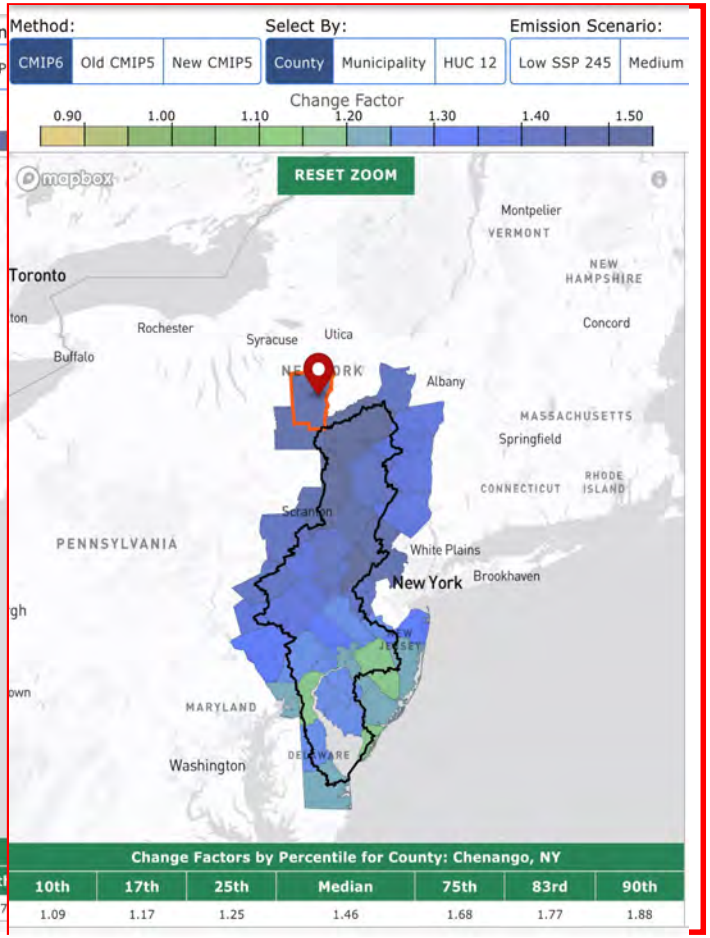



# SSP5-8.5 100-year Storm 2050-2099



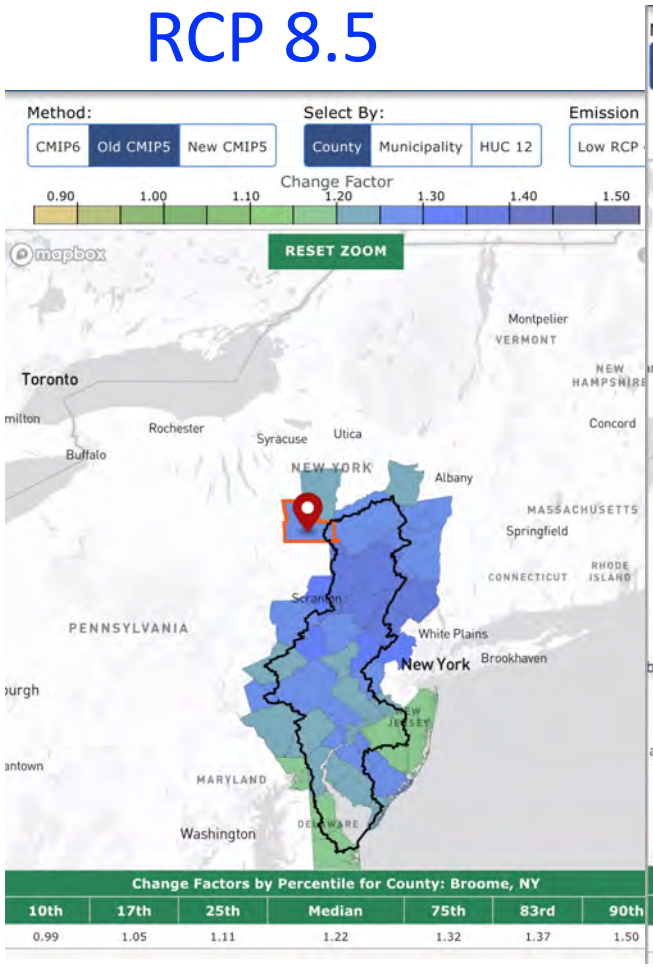


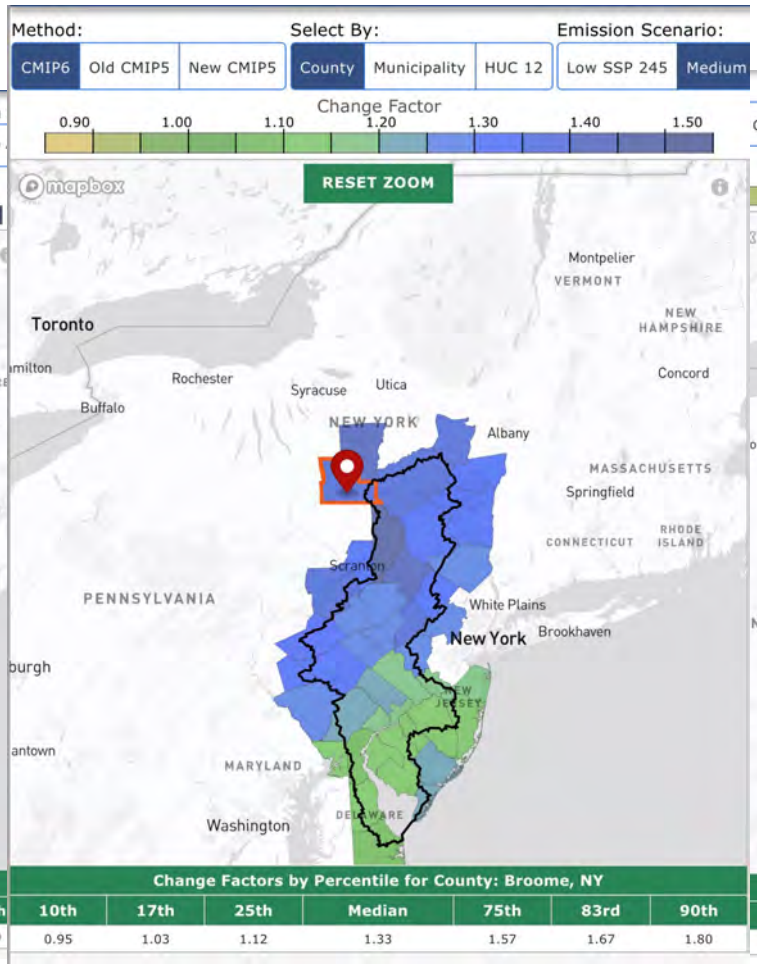


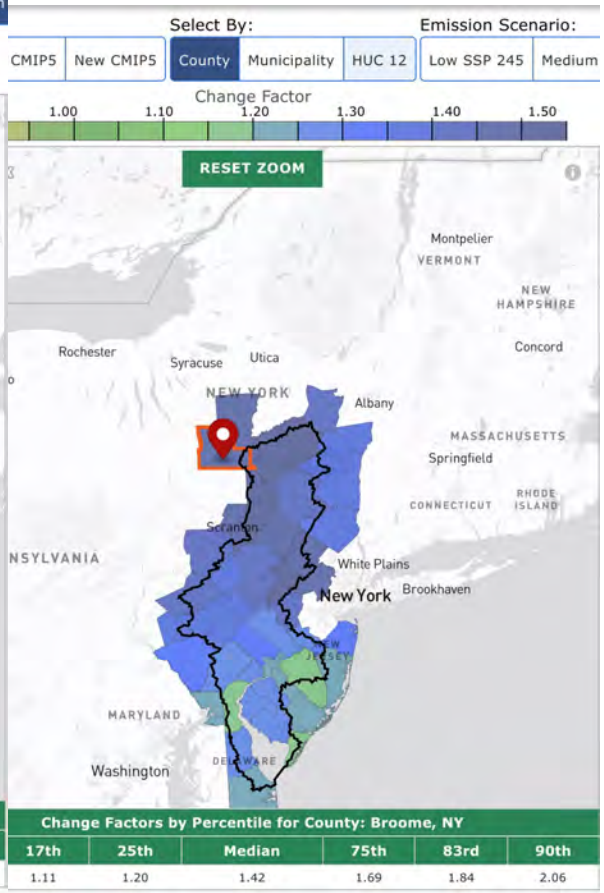
RCP 8.5

SSP3-7.0

SSP5-8.5

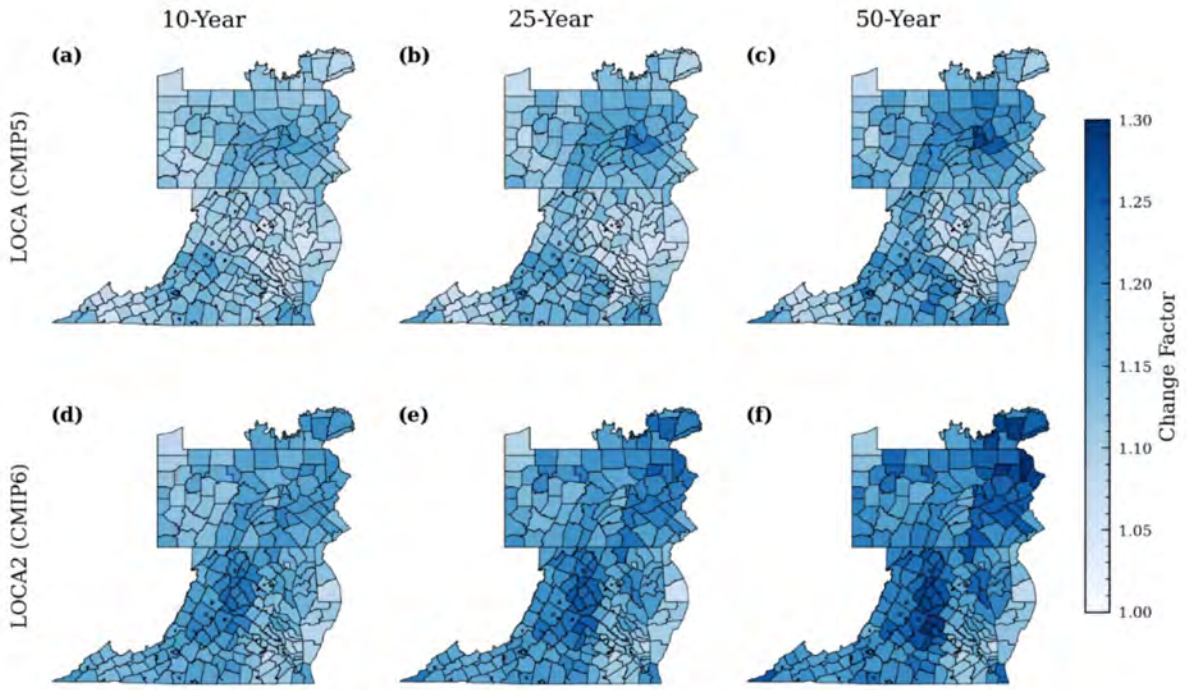



100-year Storm

2050-2099


10-Year
25-Year
50-Year
(a)
(b)
(c)
(d)
(e)
(f)
LOCA (CMIP5)
LOCA2 (CMIP6)
1.30
1.25
1.20
1.15
1.10
1.05
1.00
Change Factor


Thank You!
Questions??