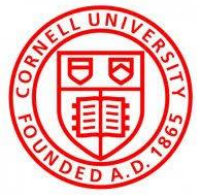
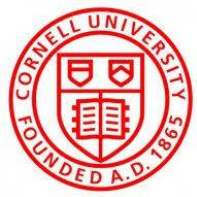

A stochastic weather generator for process-informed climate risk assessments of water resource systems in California

Climate Scenario Development



SPECIFYING CLIMATE SCENARIOS



Edit ./ClimateChangeScenarios.csv

Name	Date modified	Type	Size	
File (1)				
LICENSE	11/10/2022 11:06 AM	File	2 KB	
File folder (4)				
Data	12/4/2023 12:22 PM	File folder		
docs	11/8/2022 1:58 PM	File folder		
Figures	12/4/2023 5:57 PM	File folder		
Programs	12/4/2023 12:23 PM	File folder		
MD File (1)				
README.md	12/4/2023 1:10 PM	MD File	13 KB	
Microsoft Excel Comma Separated Values File (2)				
ClimateChangeScenarios	12/4/2023 12:24 PM	Microsoft Excel C...	1 KB	
SimulationLength	12/4/2023 12:24 PM	Microsoft Excel C...	1 KB	
R Project (1)				
WGEN-v2.0	12/4/2023 12:27 PM	R Project	1 KB	
Text Document (1)				
R_sessionInfo	8/22/2023 10:08 AM	Text Document	2 KB	

10 items



User inputs for climate change scenarios. These should be adjusted prior to model run.



Edit ./ClimateChangeScenarios.csv

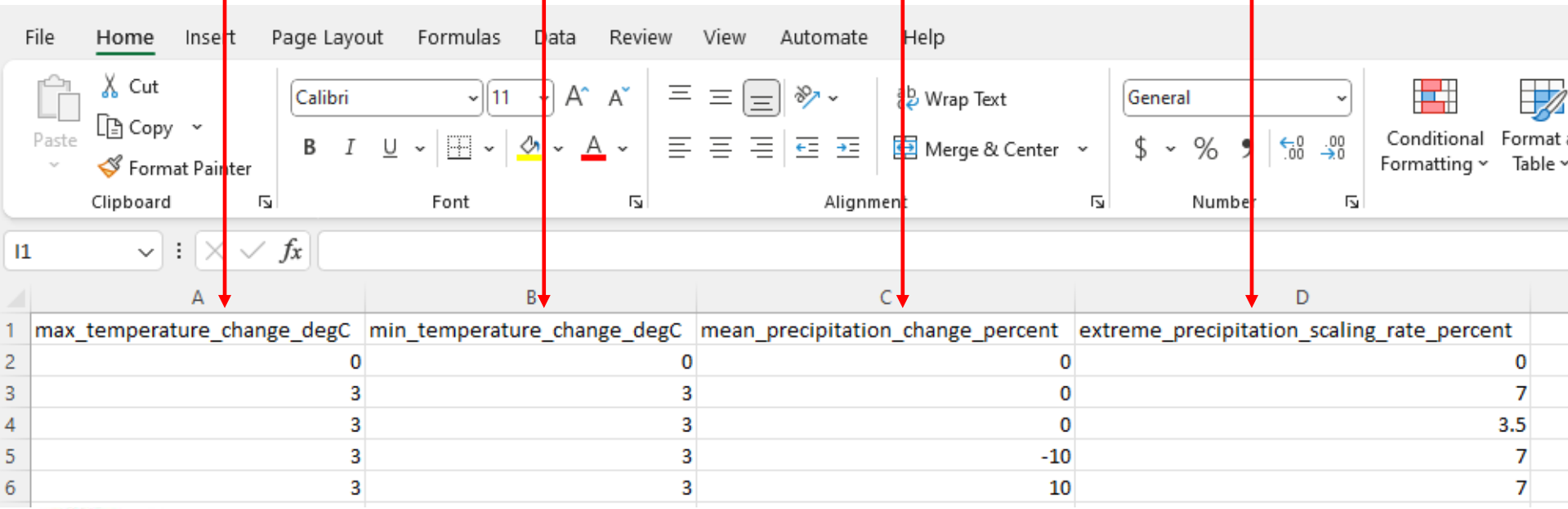
Primarily thermodynamic mechanisms of climate change

Temperature
change [in °C]
for Tmax

Temperature
change [in °C]
for Tmin

Mean
precipitation
change [in %]

Extreme
precipitation
scaling [in %]



The screenshot shows the Microsoft Excel interface with the 'Home' tab selected. The ribbon includes options for Clipboard, Font, Alignment, and Number. The spreadsheet data is as follows:

	A	B	C	D
	max_temperature_change_degC	min_temperature_change_degC	mean_precipitation_change_percent	extreme_precipitation_scaling_rate_percent
1				
2	0	0	0	0
3	3	3	0	7
4	3	3	0	3.5
5	3	3	-10	7
6	3	3	10	7

Edit ./ClimateChangeScenarios.csv

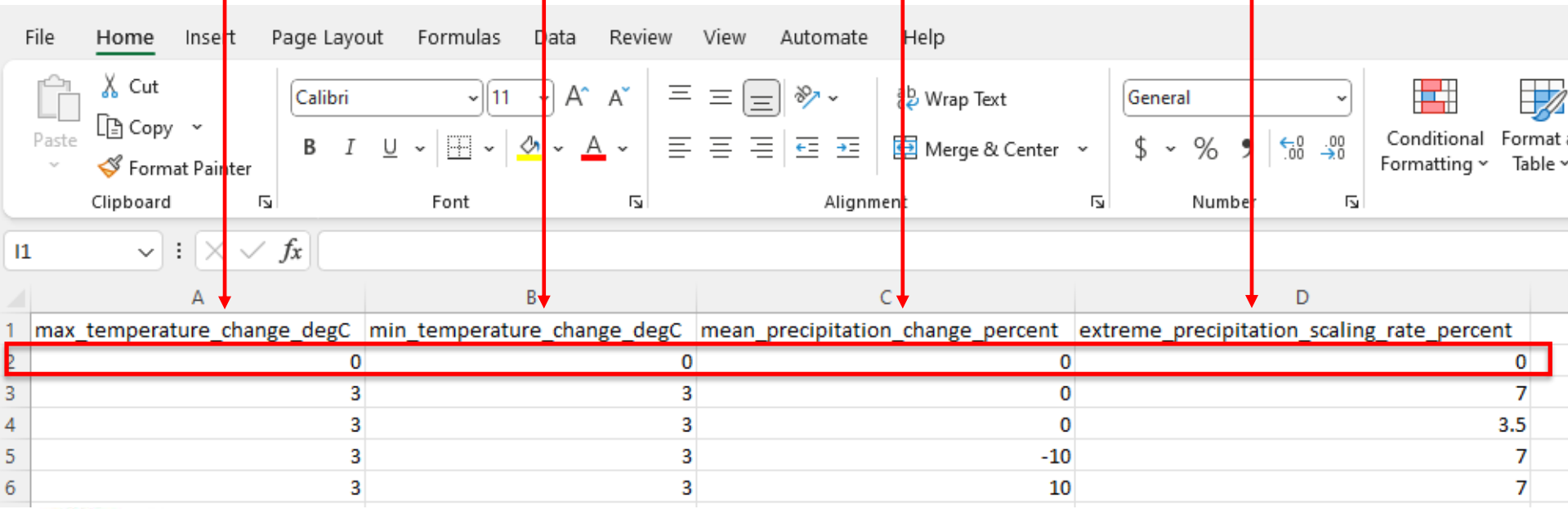
Primarily thermodynamic mechanisms of climate change

Temperature
change [in °C]
for Tmax

Temperature
change [in °C]
for Tmin

Mean
precipitation
change [in %]

Extreme
precipitation
scaling [in %]



The screenshot shows the Microsoft Excel interface with the 'Home' tab selected. The ribbon includes options for Clipboard, Font, Alignment, and Number. The spreadsheet displays a table with 6 rows and 4 columns. The first row contains headers for temperature change (Tmax and Tmin) and precipitation change (Mean and Extreme). The subsequent rows contain numerical data. A red rectangle highlights the first row of data (row 2), and red arrows point from the labels above to the corresponding columns.

	A	B	C	D
	max_temperature_change_degC	min_temperature_change_degC	mean_precipitation_change_percent	extreme_precipitation_scaling_rate_percent
2	0	0	0	0
3	3	3	0	7
4	3	3	0	3.5
5	3	3	-10	7
6	3	3	10	7

Edit ./ClimateChangeScenarios.csv

Primarily thermodynamic mechanisms of climate change

Temperature
change [in °C]
for Tmax

Temperature
change [in °C]
for Tmin

Mean
precipitation
change [in %]

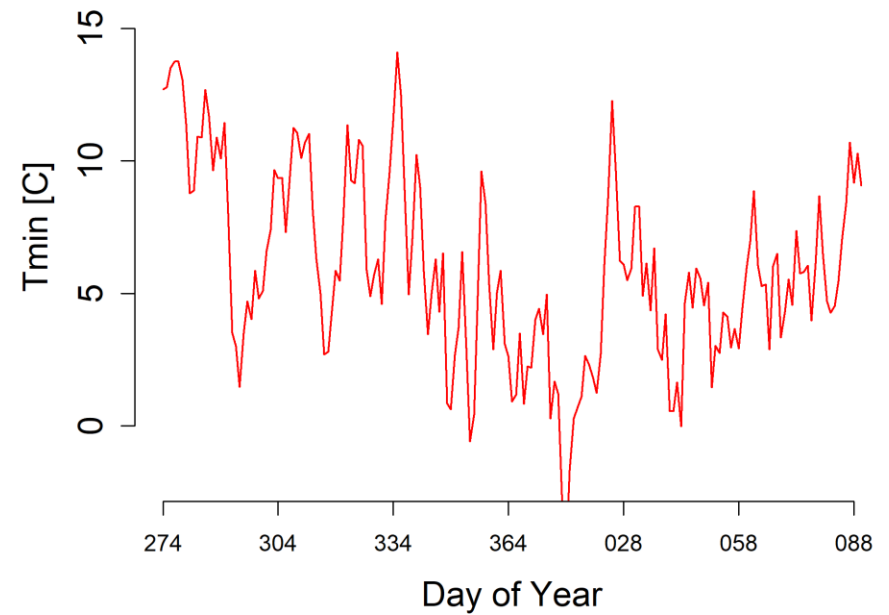
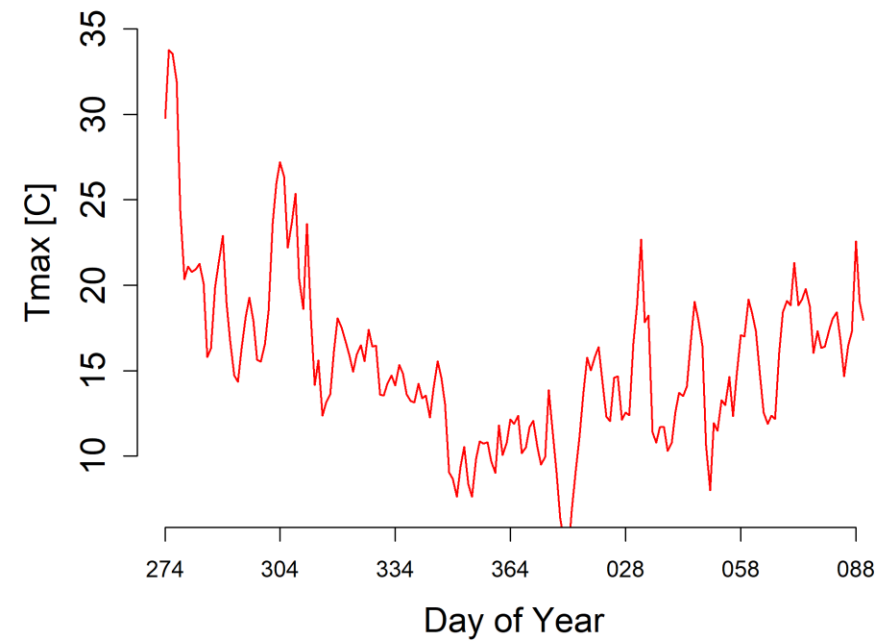
Extreme
precipitation
scaling [in %]

The screenshot shows the Microsoft Excel interface with the 'Home' tab selected. The ribbon includes options for Clipboard, Font, Alignment, and Number. The spreadsheet has four columns labeled A, B, C, and D. Column A is 'max_temperature_change_degC', Column B is 'min_temperature_change_degC', Column C is 'mean_precipitation_change_percent', and Column D is 'extreme_precipitation_scaling_rate_percent'. The data is as follows:

	A	B	C	D
1	max_temperature_change_degC	min_temperature_change_degC	mean_precipitation_change_percent	extreme_precipitation_scaling_rate_percent
2	0	0	0	0
3	3	3	0	7
4	3	3	0	3.5
5	3	3	-10	7
6	3	3	10	7

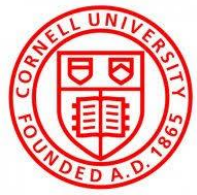
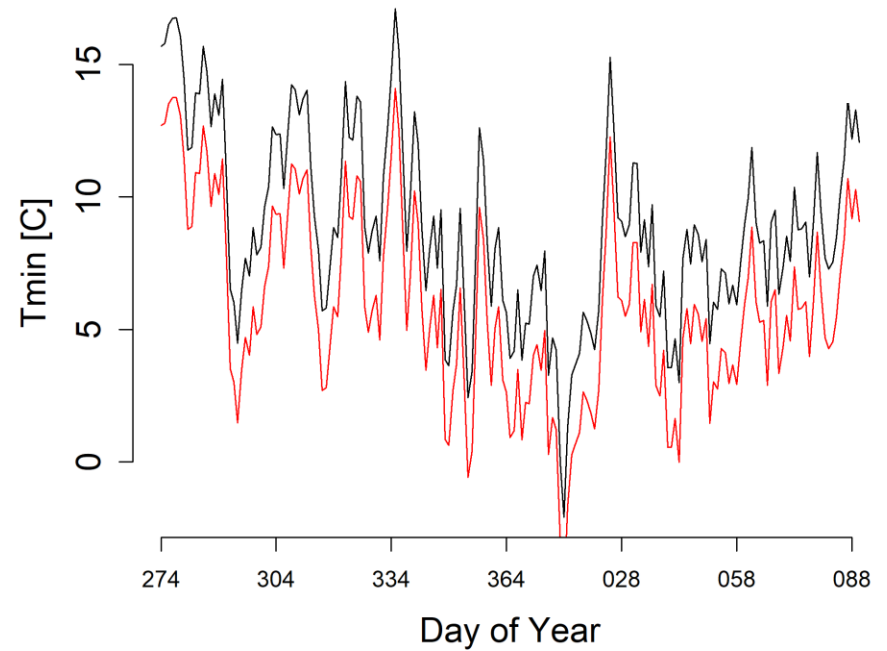
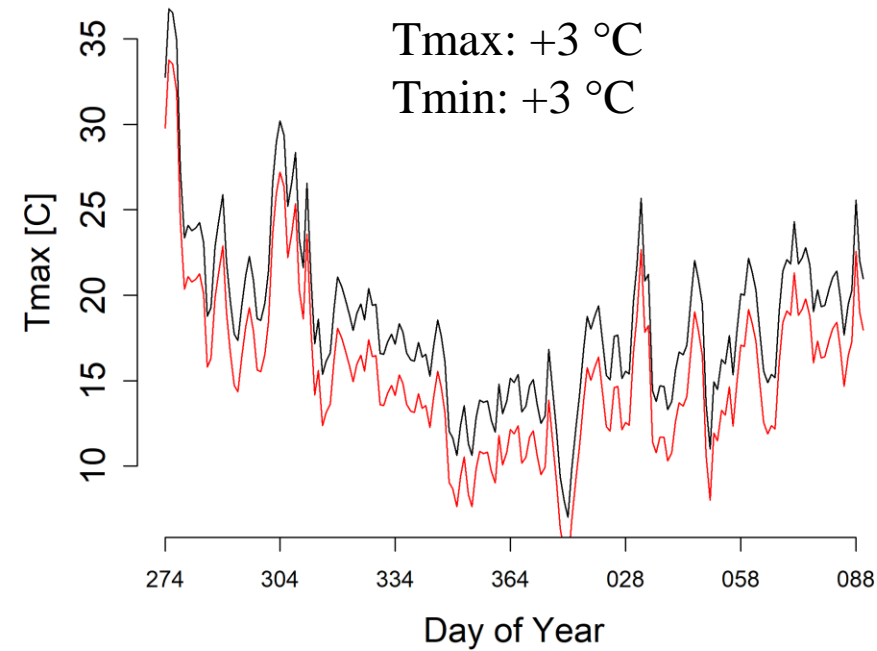
Temperature Warming

Original Simulation

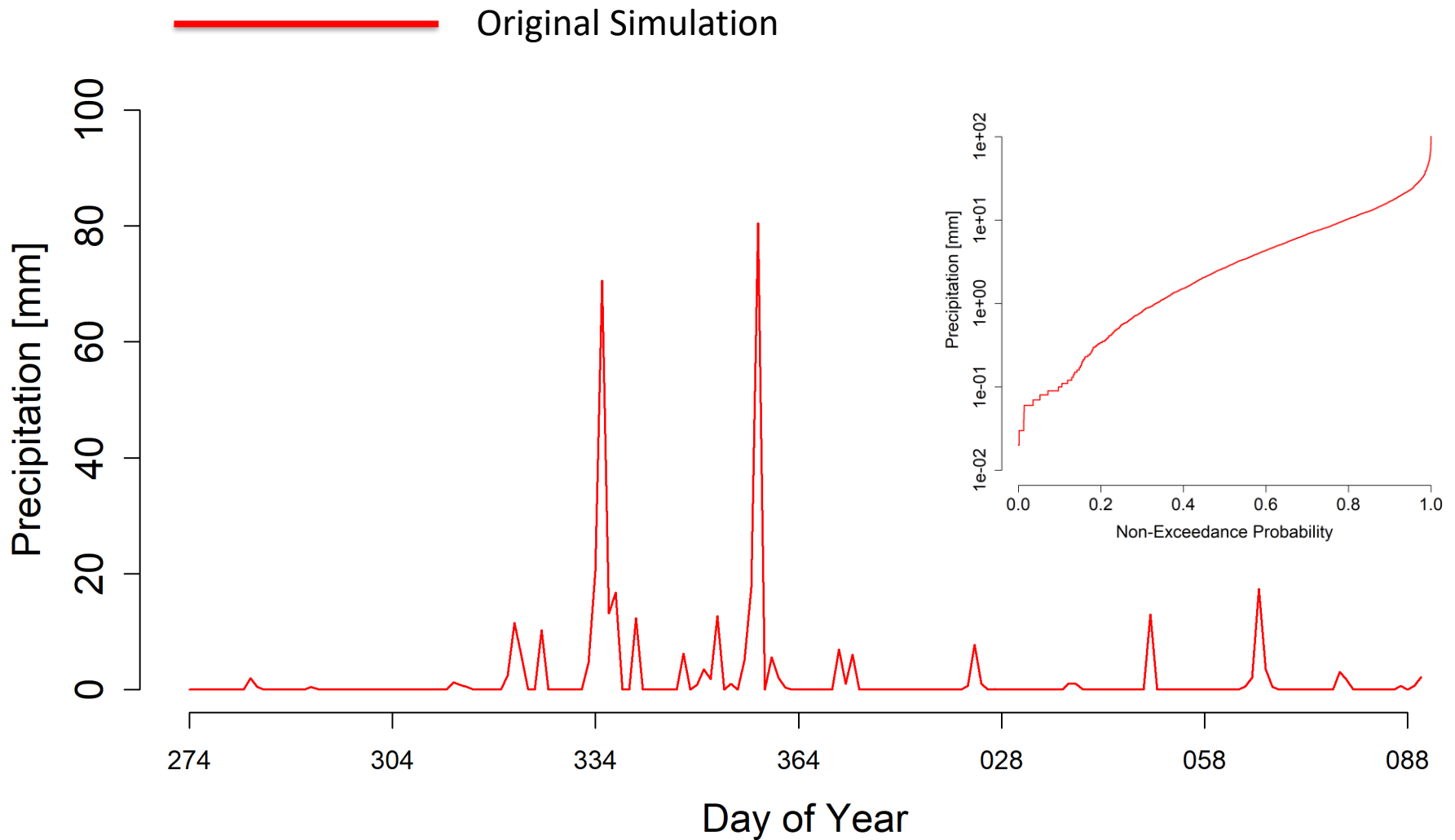


Temperature Warming

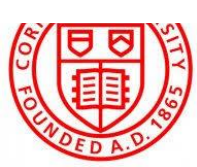
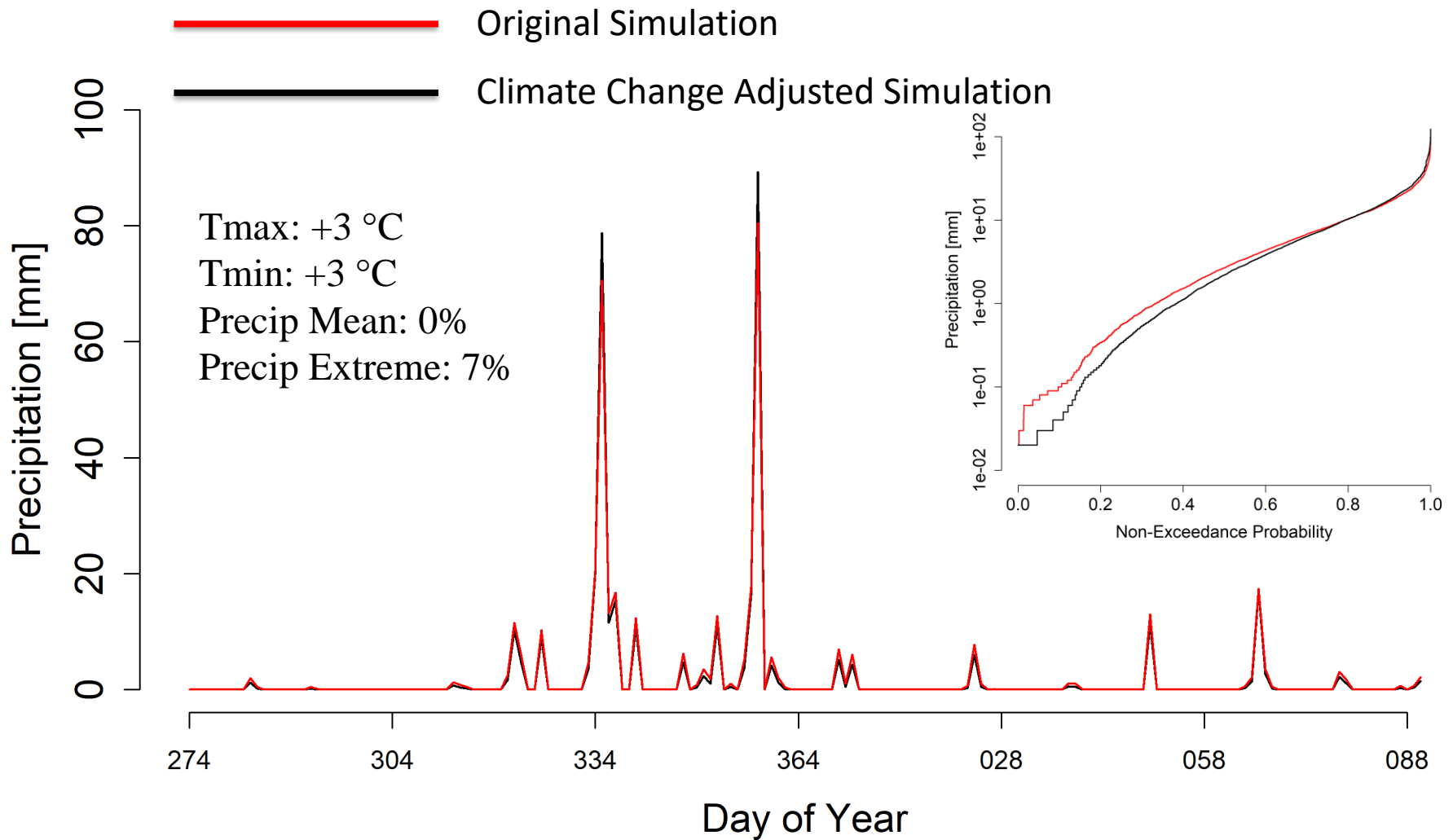
— Original Simulation
— Climate Change Adjusted Simulation



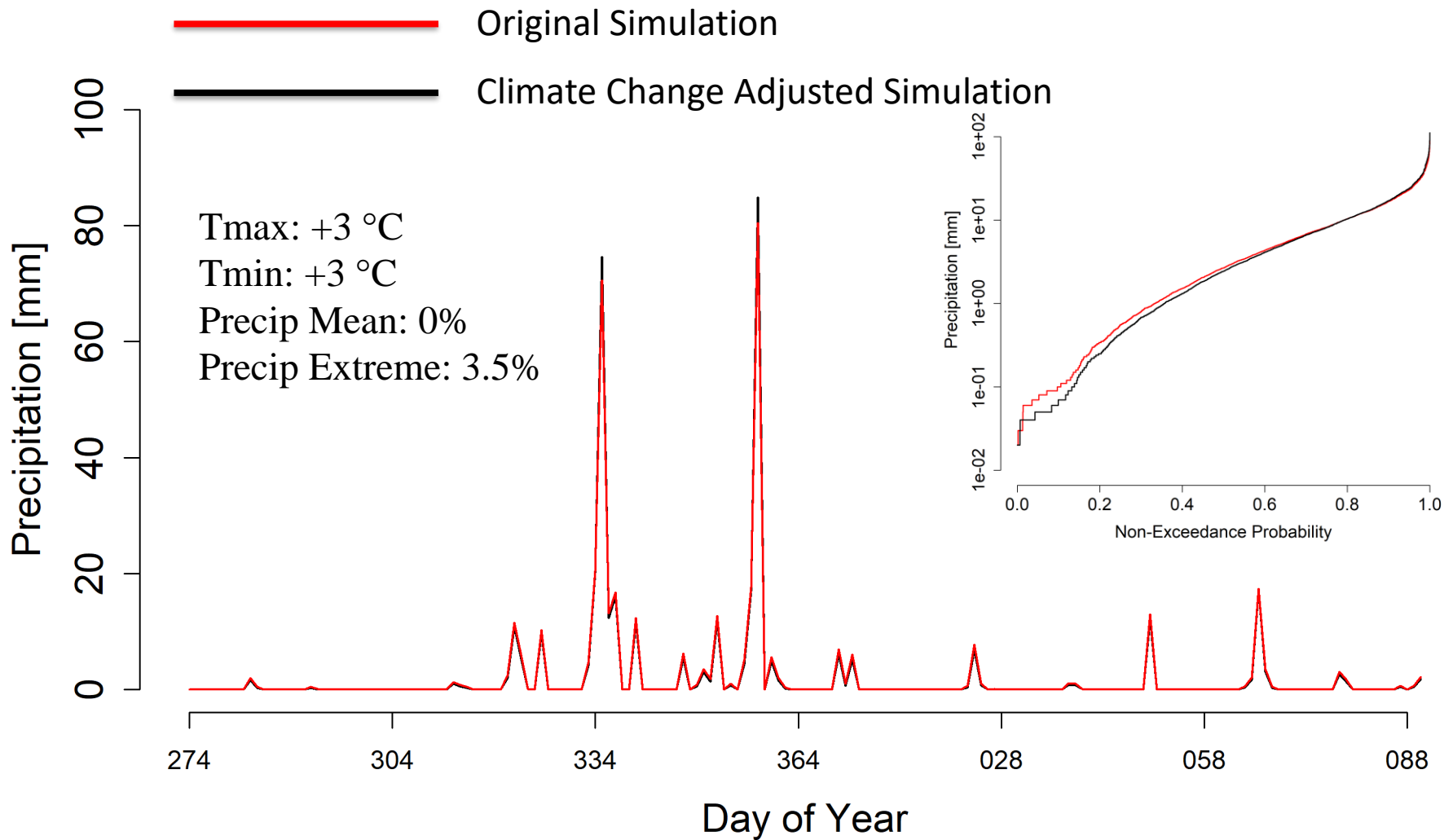
Extreme Precipitation Scaling



Extreme Precipitation Scaling



Extreme Precipitation Scaling



Edit ./ClimateChangeScenarios.csv

Primarily thermodynamic mechanisms of climate change

Temperature
change [in °C]
for Tmax

Temperature
change [in °C]
for Tmin

Mean
precipitation
change [in %]

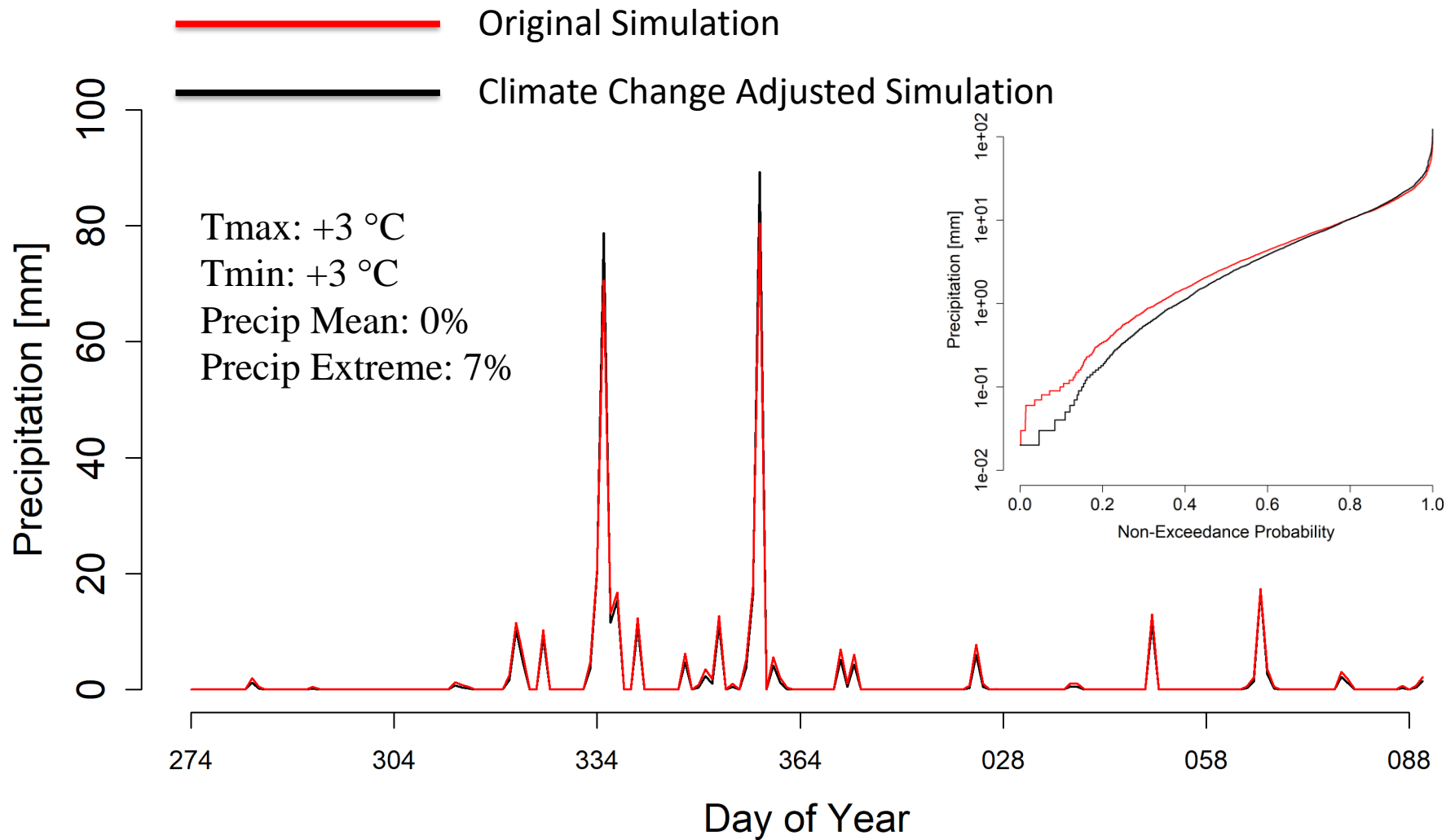
Extreme
precipitation
scaling [in %]

The screenshot shows the Microsoft Excel interface with the 'Home' tab selected. The ribbon includes options for Clipboard, Font, Alignment, and Number. The spreadsheet displays data from a CSV file with the following columns and rows:

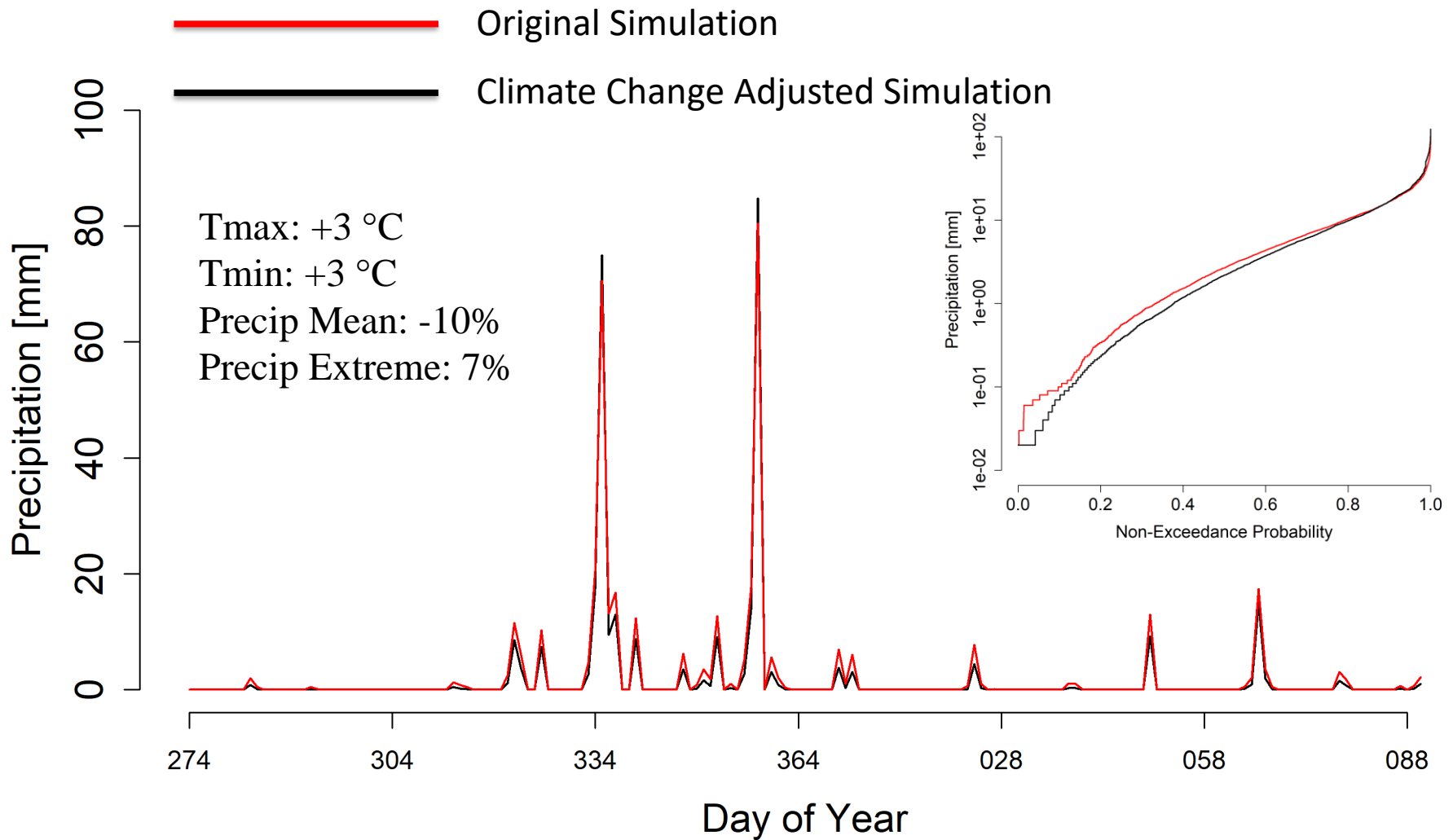
	A	B	C	D
	max_temperature_change_degC	min_temperature_change_degC	mean_precipitation_change_percent	extreme_precipitation_scaling_rate_percent
1				
2	0	0	0	0
3	3	3	0	7
4	3	3	0	3.5
	3	3	-10	7
	3	3	10	7

The last two rows of data are highlighted with a red border.

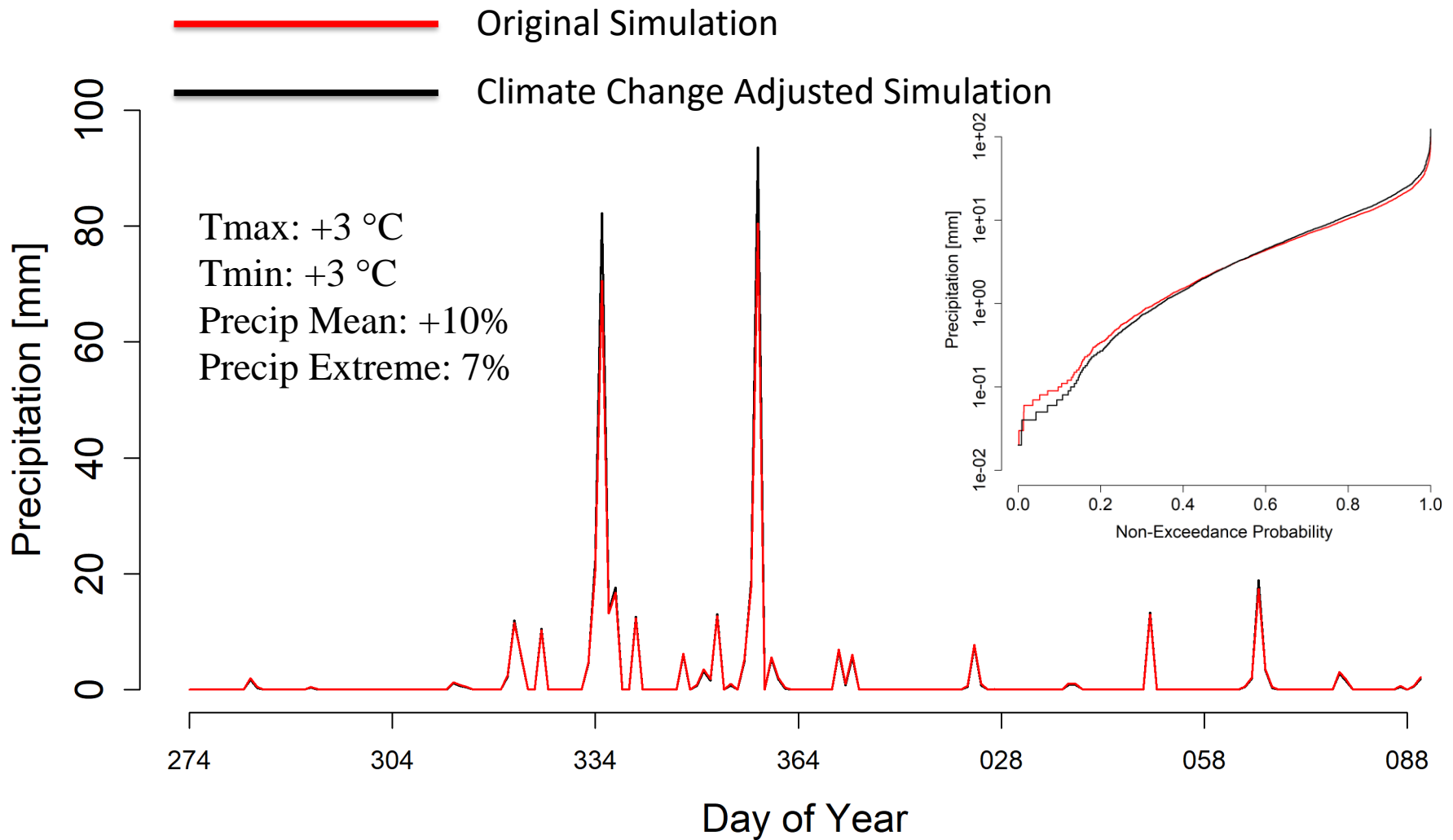
Changes in Mean and Extreme Precipitation



Changes in Mean and Extreme Precipitation



Changes in Mean and Extreme Precipitation



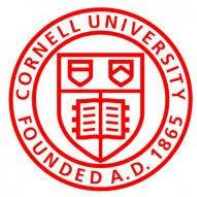
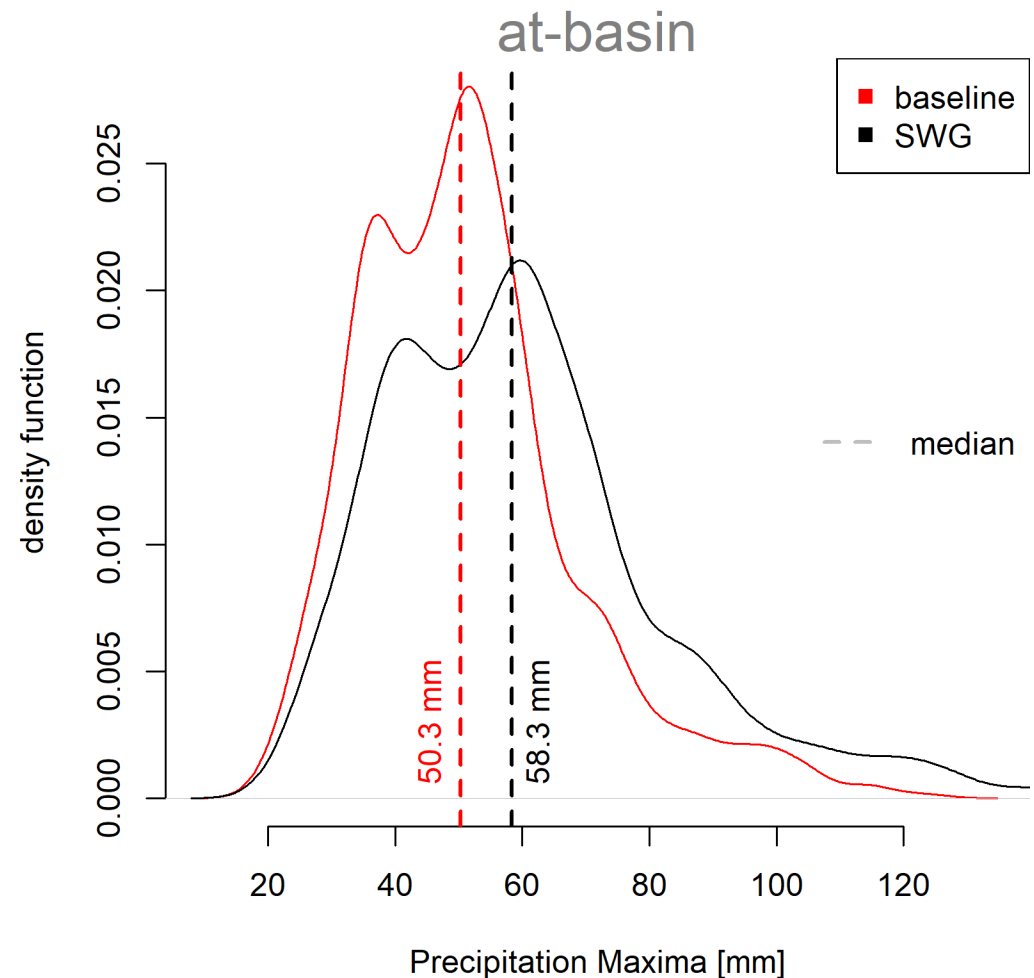
Resulting Changes in Annual Max Distribution

Tmax: +3 °C

Tmin: +3 °C

Precip Mean: 0%

Precip Extreme: 7%



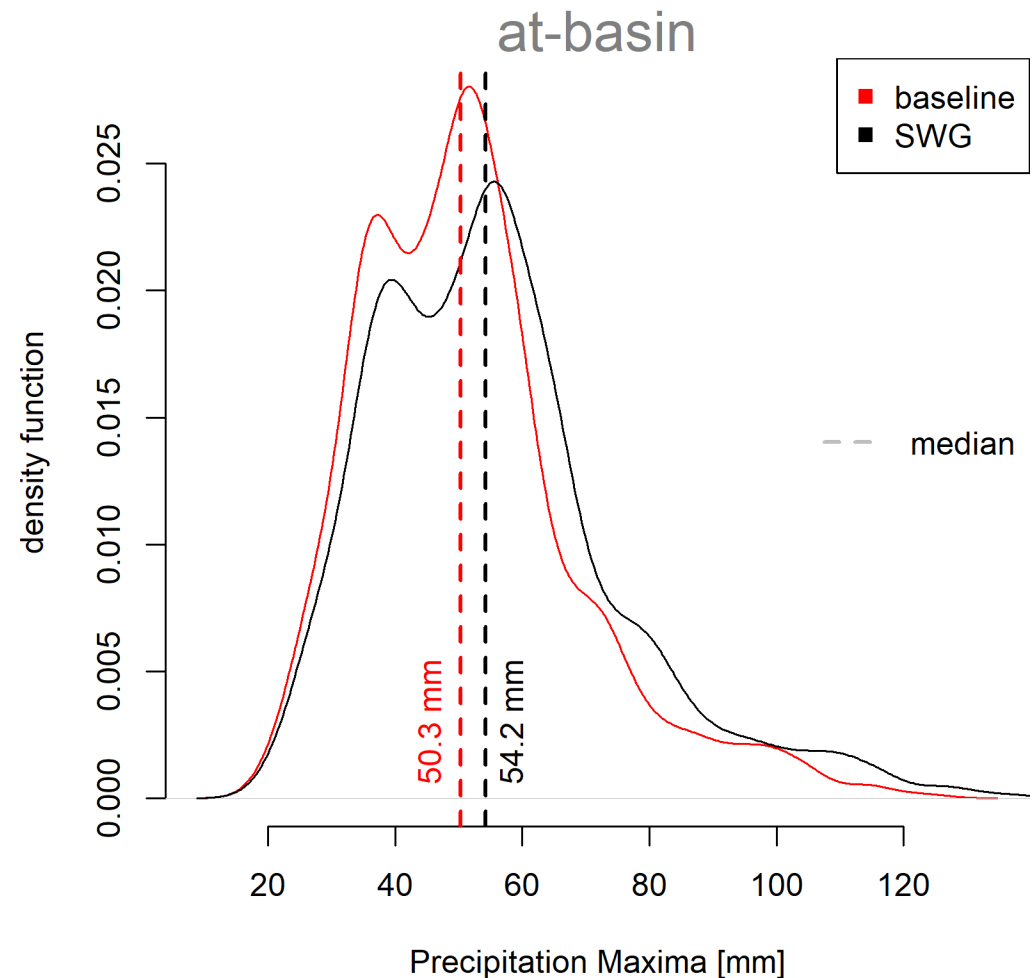
Resulting Changes in Annual Max Distribution

Tmax: +3 °C

Tmin: +3 °C

Precip Mean: 0%

Precip Extreme: 3.5%



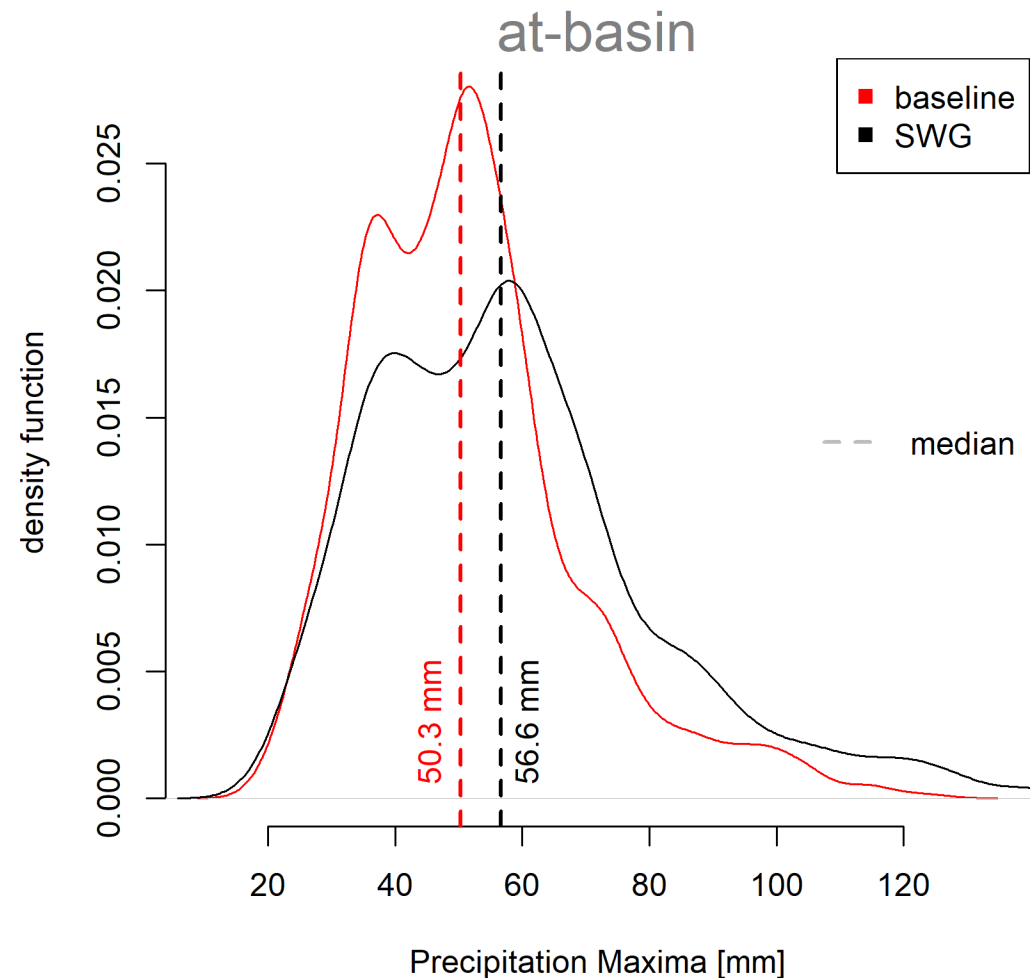
Resulting Changes in Annual Max Distribution

Tmax: +3 °C

Tmin: +3 °C

Precip Mean: -10%

Precip Extreme: 7%



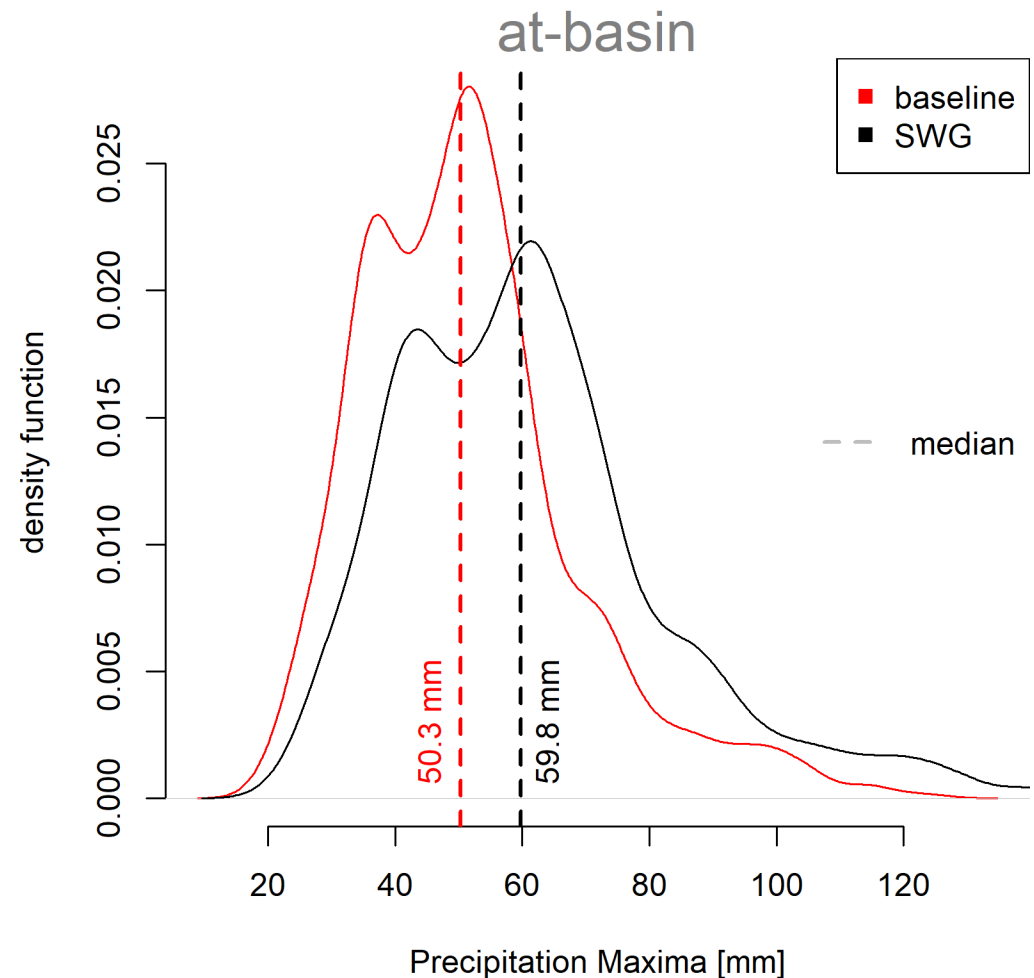
Resulting Changes in Annual Max Distribution

Tmax: +3 °C

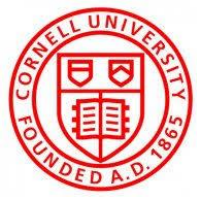
Tmin: +3 °C

Precip Mean: +10%

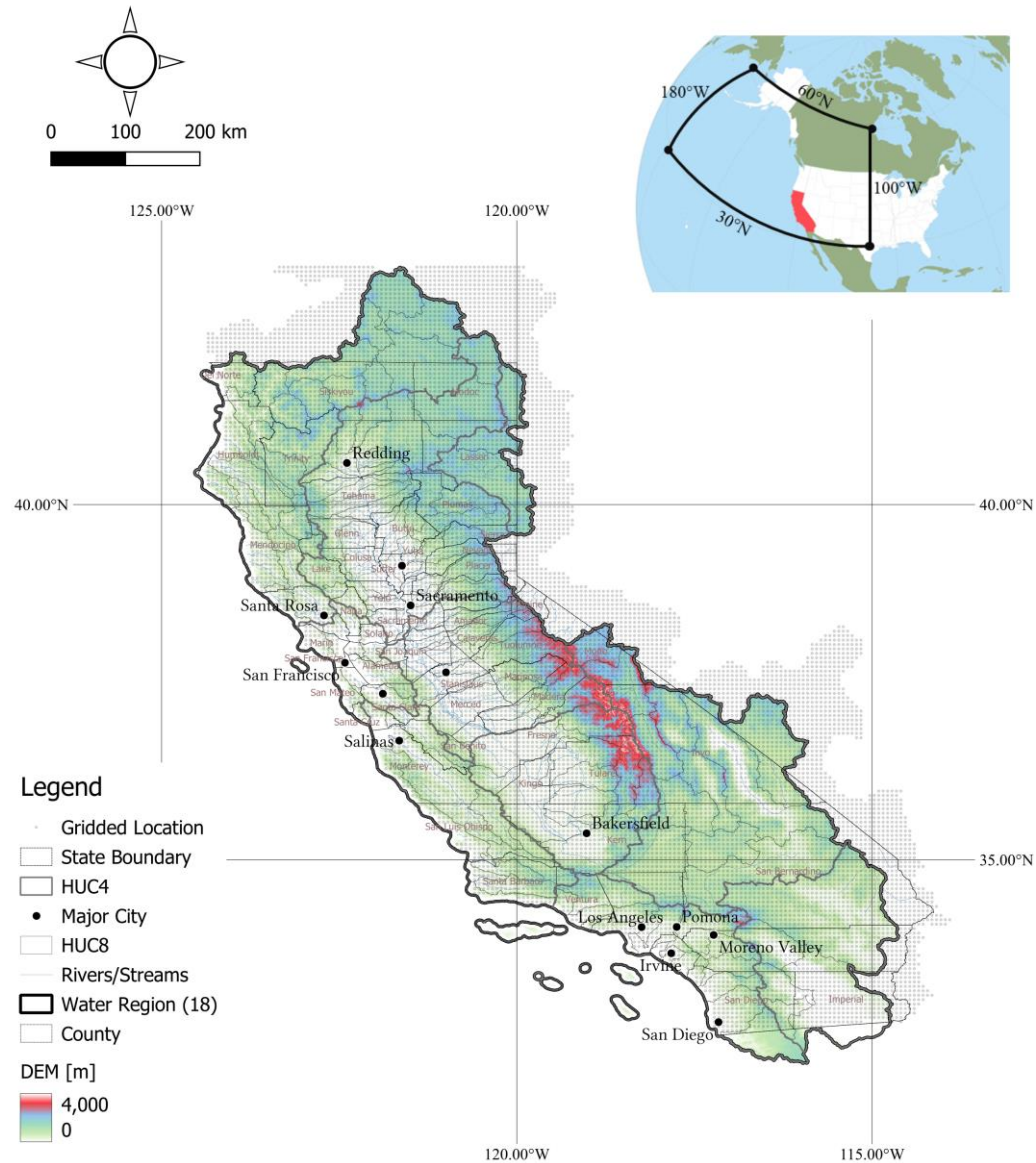
Precip Extreme: 7%



DESCRIPTION AND ANALYSIS OF STATEWIDE SCENARIOS



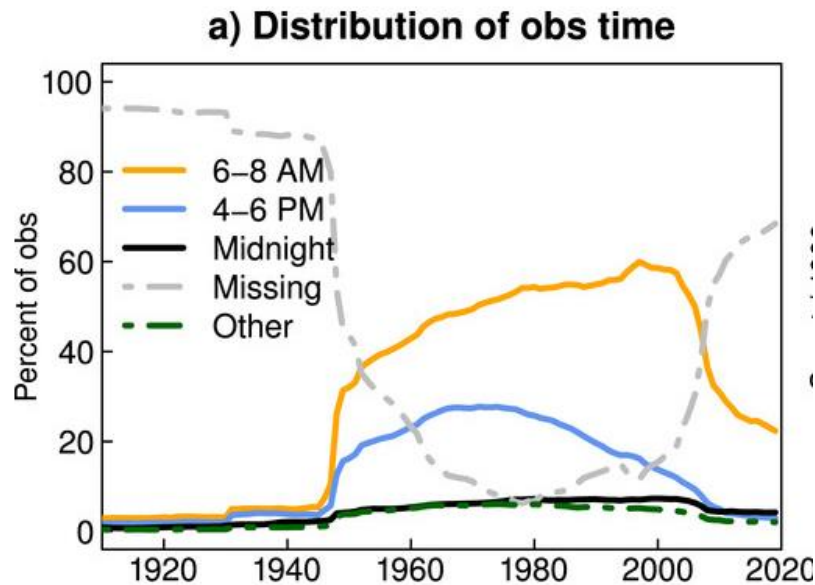
Data Coverage



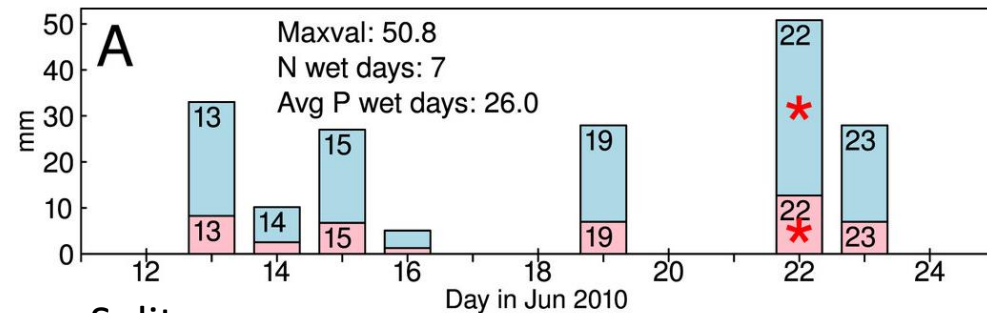
Data Products Used: Precipitation

An Extreme-Preserving Long-Term Gridded Daily Precipitation Dataset for the Conterminous United States (1915 – 2018)

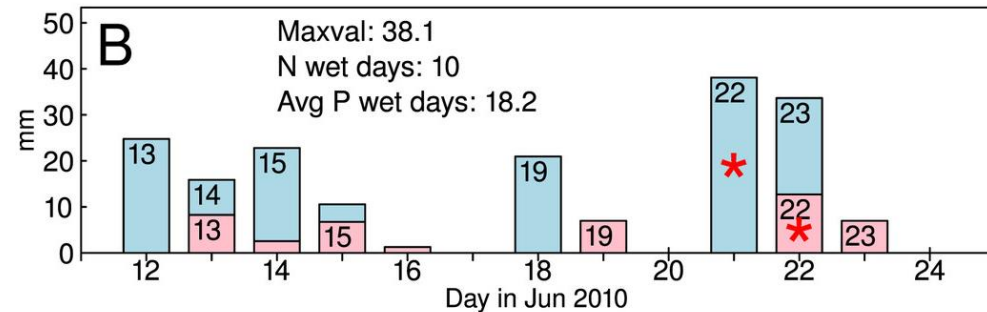
David W. Pierce, Lu Su, Daniel R. Cayan, Mark D. Risser, Ben Livneh, and Dennis P. Lettenmaier



Unsplit



Split



Data Products Used: Temperature

A Long-Term Hydrologically Based Dataset of Land Surface Fluxes and States for the Conterminous United States: Update and Extensions

Ben Livneh, Eric A. Rosenberg, Chiyu Lin, Bart Nijssen, Vimal Mishra, Kostas M. Andreadis, Edwin P. Maurer, and Dennis P. Lettenmaier

(1915 – 2013)

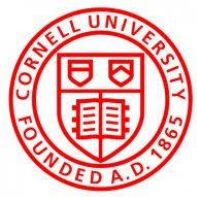
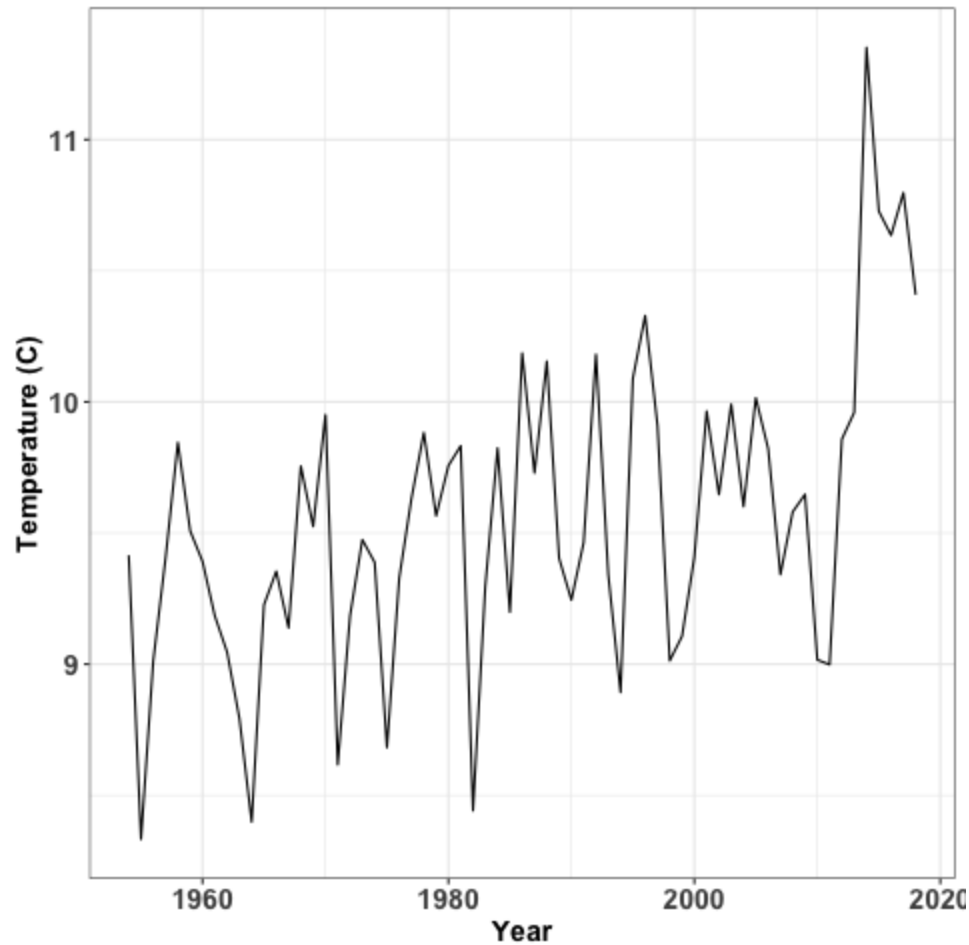


(2014 – 2018)

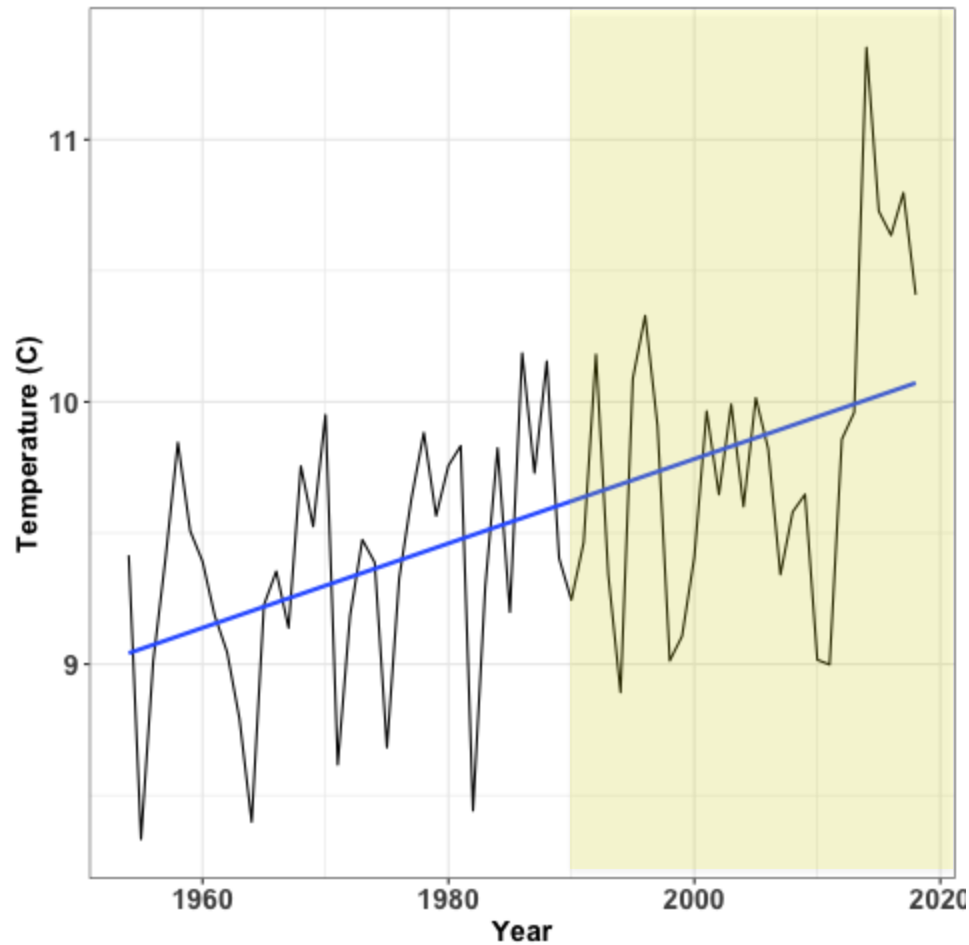
Monthly bias correction to
synchronize two products



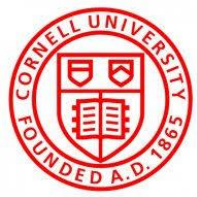
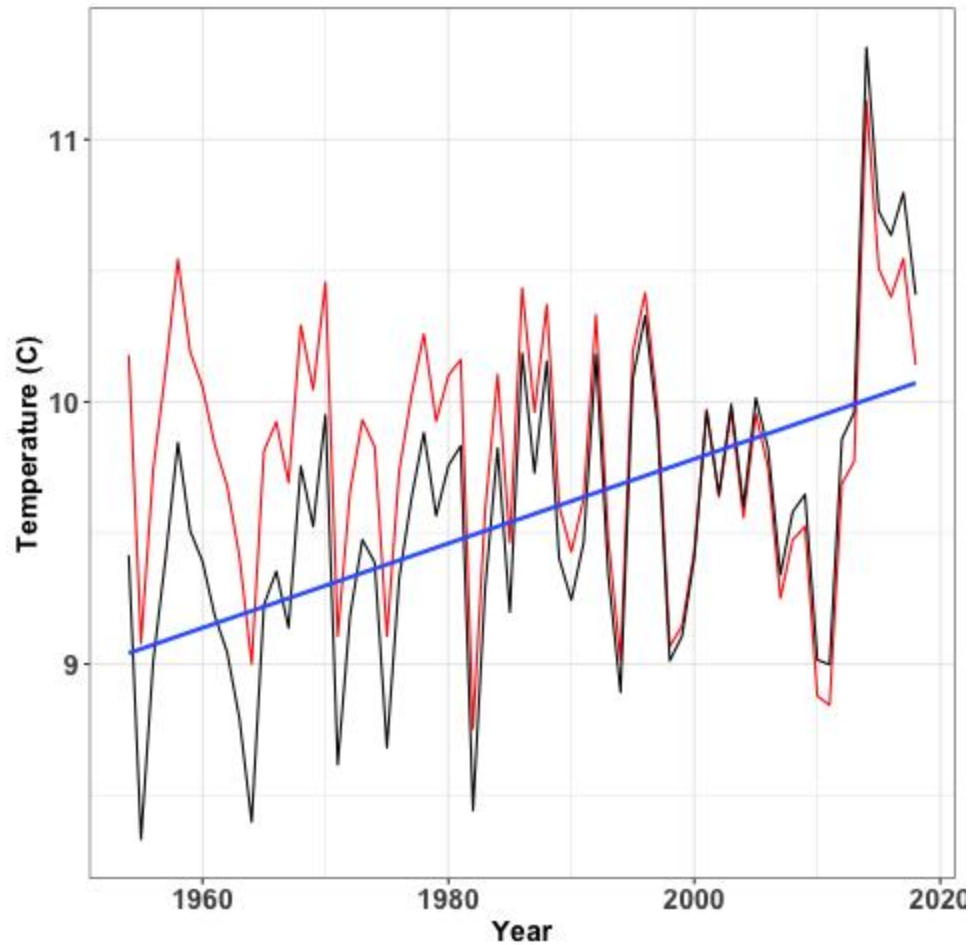
Data Products Used: Temperature Detrending



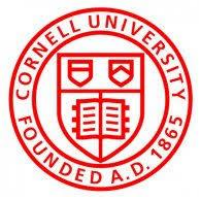
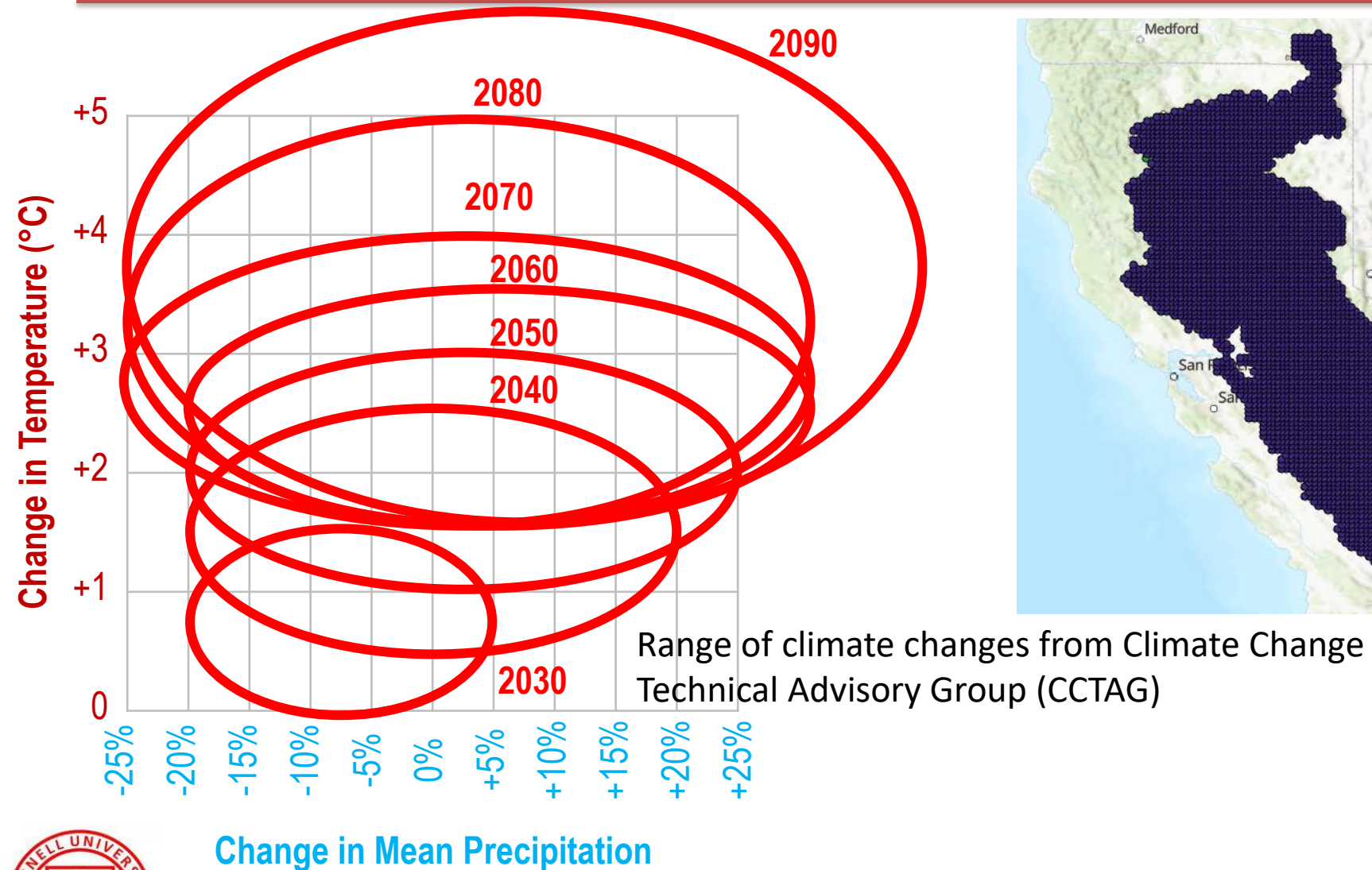
Data Products Used: Temperature Detrending



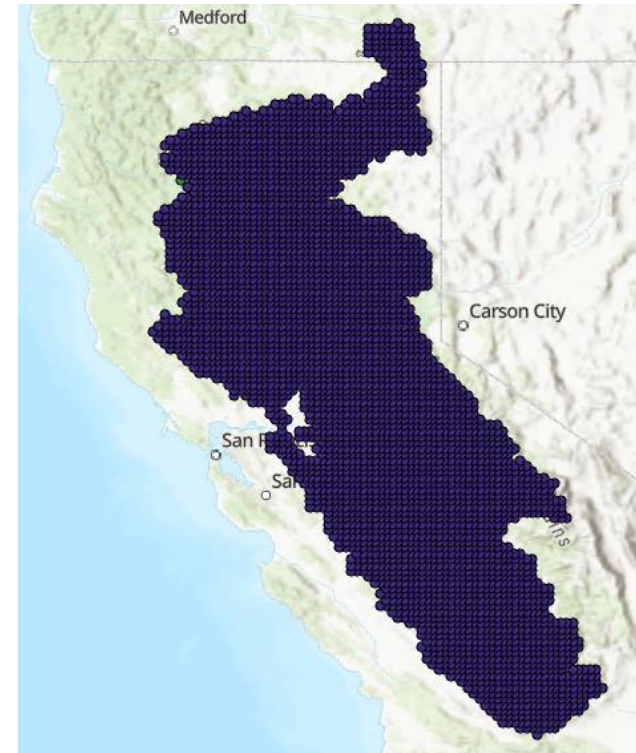
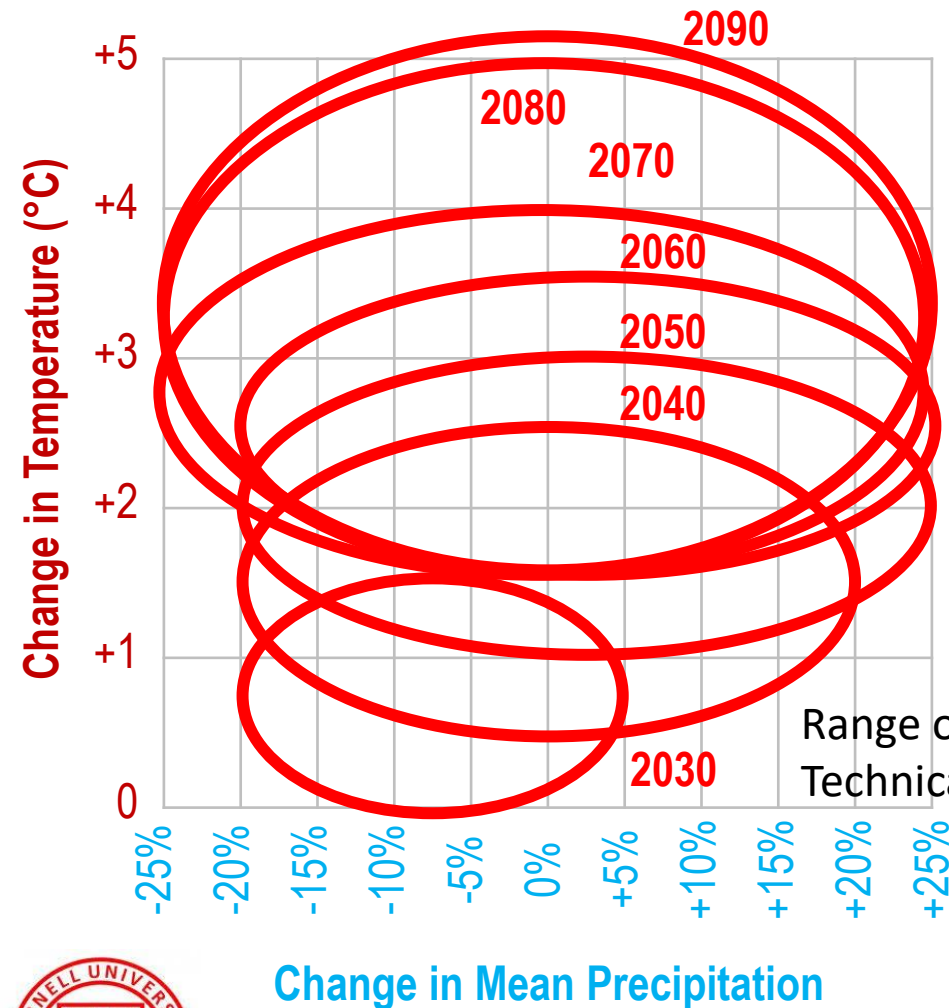
Data Products Used: Temperature Detrending



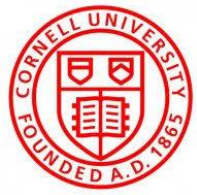
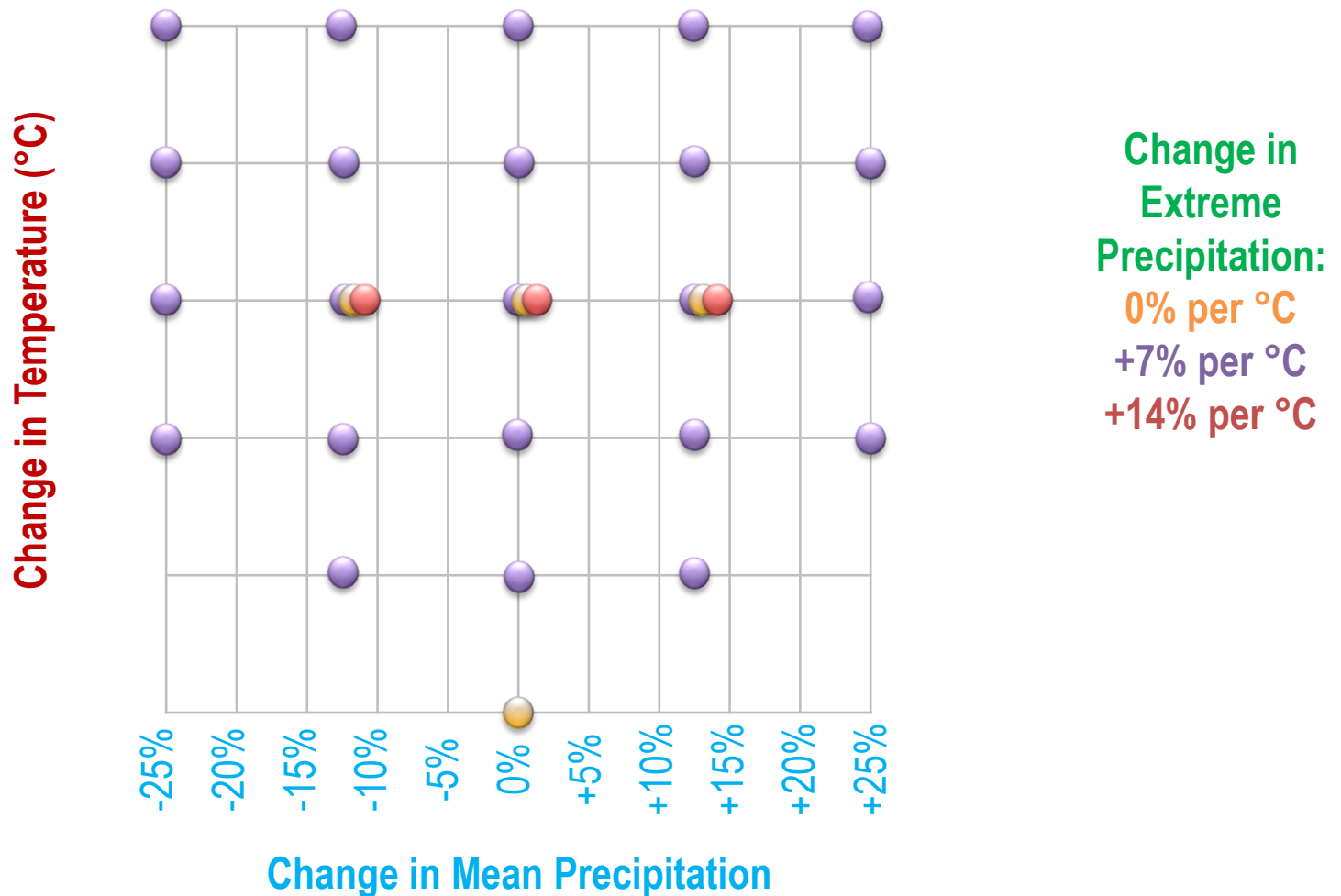
Climate Change Scenarios



Climate Change Scenarios



Climate Change Scenarios



Climate Change Scenarios



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Gridded Weather Generator Perturbations of Historical Detrended and Stochastically Generated Temperature and Precipitation for the State of CA and HUC8s


The Weather Generator Gridded Data consists of two products:

- [1] statistically perturbed gridded 100-year historic daily weather data including precipitation [in mm], and detrended maximum and minimum temperature [in degrees Celsius] (**ProductA_100yr**), and
- [2] stochastically generated and statistically perturbed gridded 1000-year daily weather data including precipitation [in mm], maximum temperature [in degrees Celsius], and minimum temperature [in degrees Celsius] (**ProductB_1000yr**).

The base climate of this dataset is a combination of historically observed gridded data including Livneh Unsplit 1915-2018 (Pierce et. al. 2021), Livneh 1915-2015 (Livneh et. al. 2013) and PRISM 2016-2018 (PRISM Climate Group, 2014). Daily precipitation is from Livneh Unsplit 1915-2018, daily temperature is from Livneh 2013 spanning 1915-2015 and was extended to 2018 with daily 4km PRISM that was rescaled to the Livneh grid resolution (1/16 deg). The Livneh temperature was bias corrected by month to the corresponding monthly PRISM climate over the same period. Baseline temperature was then detrended by month over the entire time series based on the average monthly temperature from 1991-2020. Statistical perturbations and stochastic generation of the time series were performed by the Weather Generator (Najibi et. al. 2023).

The repository consists of 30 climate perturbation scenarios that range from -25 to +25 % change in mean precipitation, and from 0 to +5 degrees Celsius for mean temperature. Changes in thermodynamics represent scaling of extreme events by a scaling factor per degree Celsius increase in mean temperature an consist primarily of 7%/degree-Celsius with 14%/degree-Celsius as sensitivity perturbations. Further insight for thermodynamic scaling can be found in Nasser et. al. 2023.


The data presented here was created by the Weather Generator which was developed by Dr. Scott Steinschneider and Dr. Nasser Najibi (Cornell University). If a separate weather generator product is desired apart from this gridded climate dataset, the weather generator code can be adopted to suit the specific needs of the user. The weather generator code and supporting information can be found here: <https://github.com/nassernajibi/WGEN-v2.0/tree/main>



California
Department of Water
Resources


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Data and Resources

**ProductA_100yr Text files**


This link is to the gridded climate repository for ProductA_100yr text files

[Explore](#)

**ProductB_1000yr Text files**

This link is to the gridded climate repository for ProductB_1000yr text files.

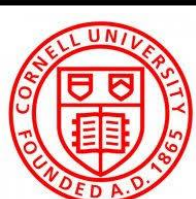
[Explore](#)

**Grid Cell Spatial Coverage 1/16th degree jpg**

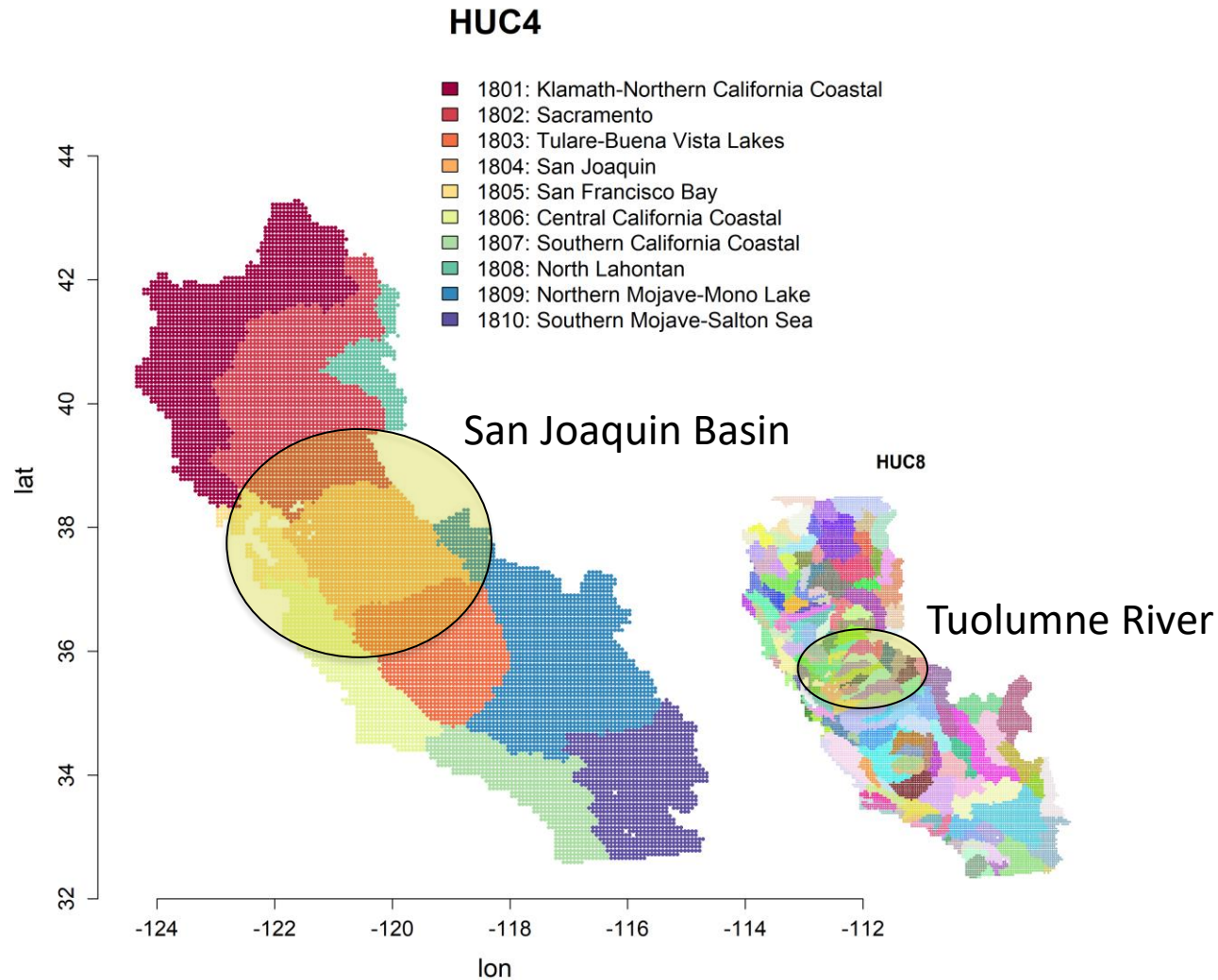
Shown are the 1/16th grid cell coverage across the CA domain. Coloration...

[Explore](#)

<https://data.cnra.ca.gov/dataset/ca-weather-generator-gridded-climate-pr-tmin-tmax-2023>



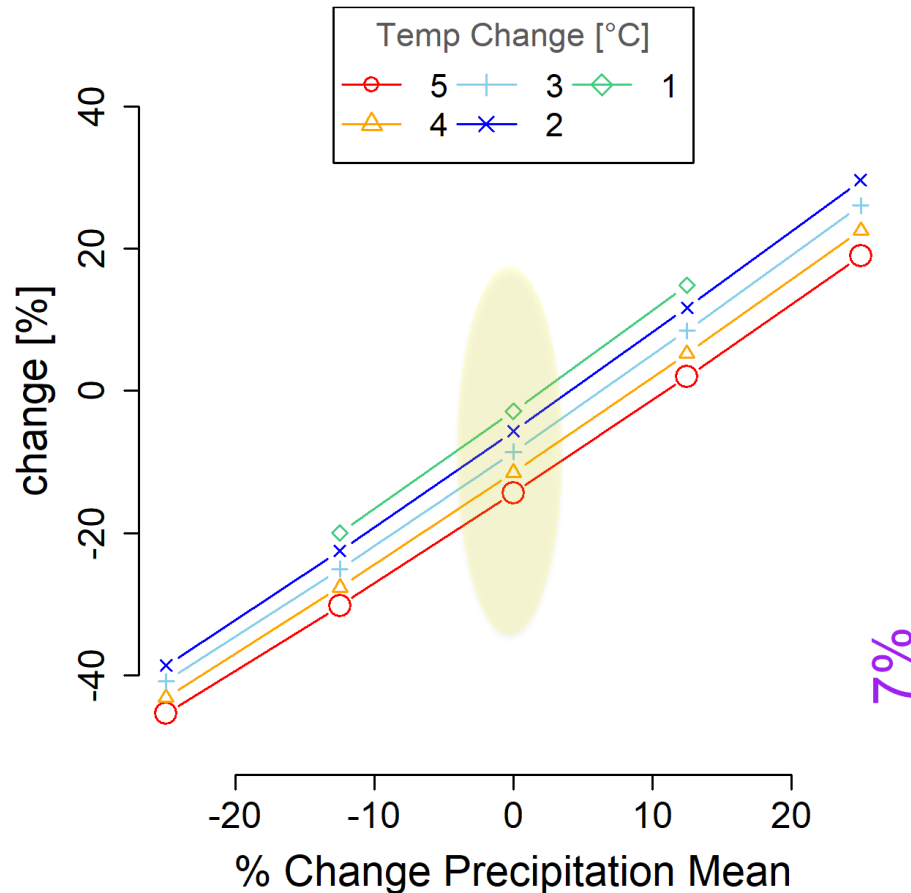
Evaluating Scenarios at the HUC4 and HUC8 Level



Basin-Wide Drought and Intensifying Precipitation Regime

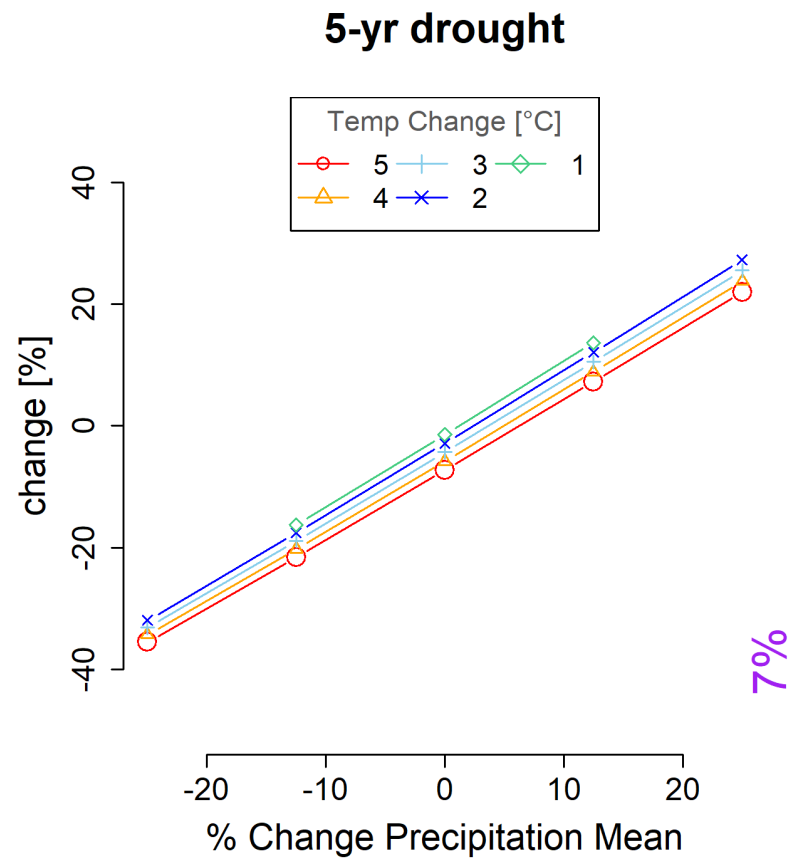
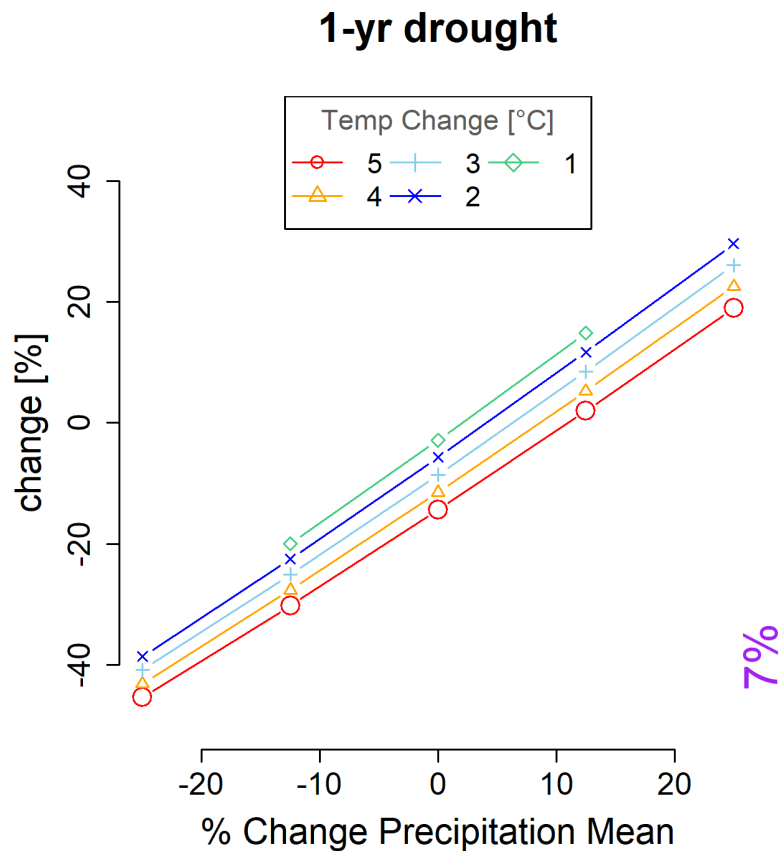
San Joaquin HUC 4 (1804)

1-yr drought



Basin-Wide Drought and Intensifying Precipitation Regime

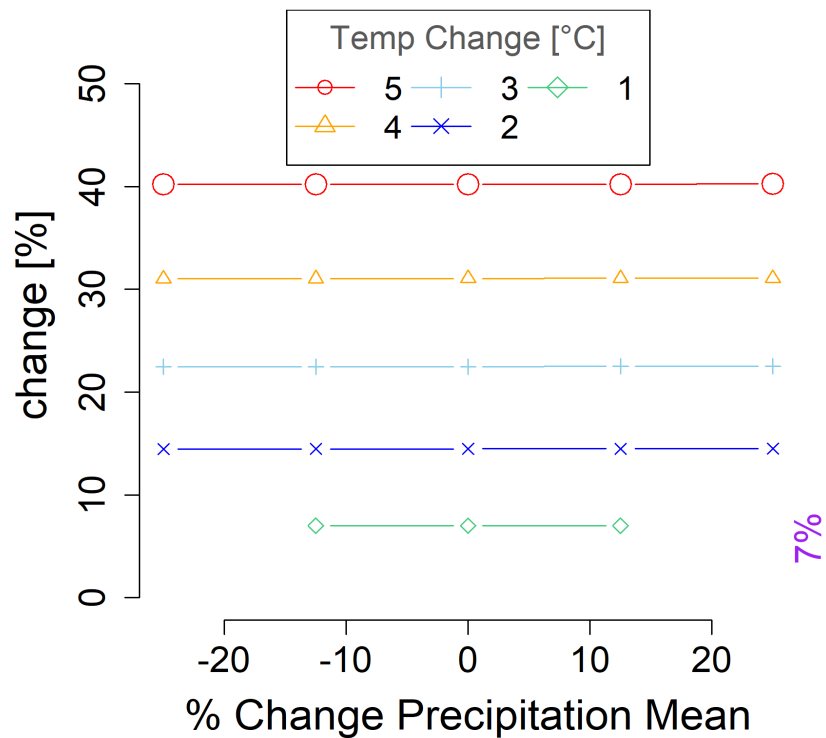
San Joaquin HUC 4 (1804)



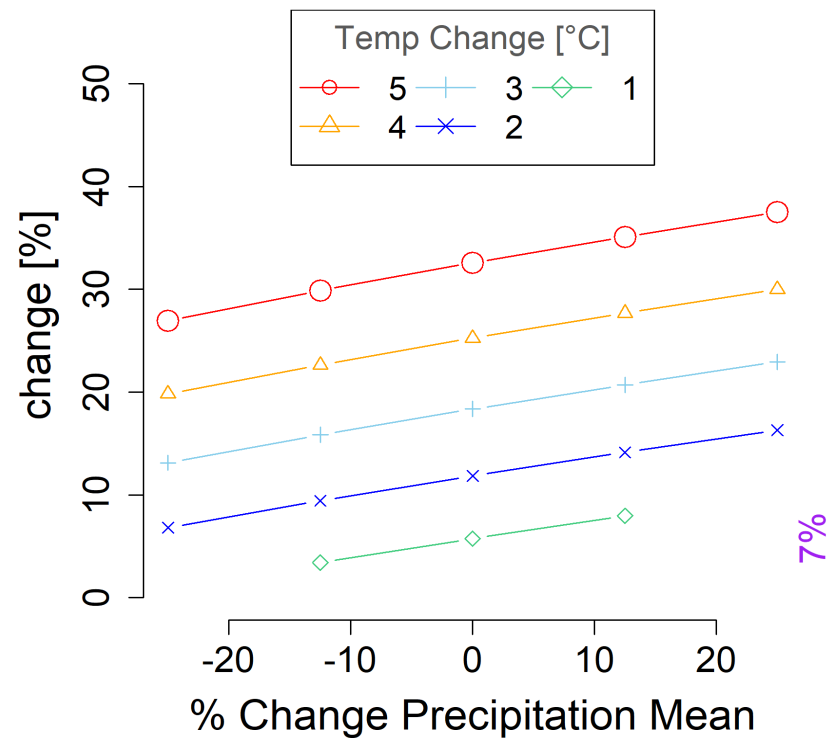
Extreme Precipitation Events

San Joaquin HUC 4 (1804)

1-day maxima



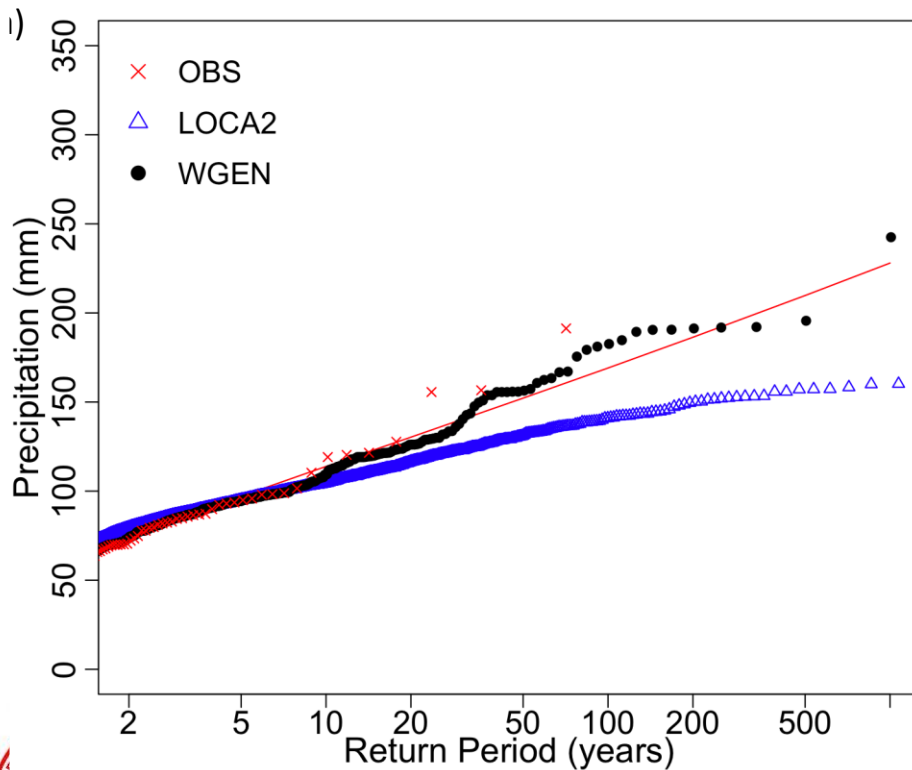
7-day maxima



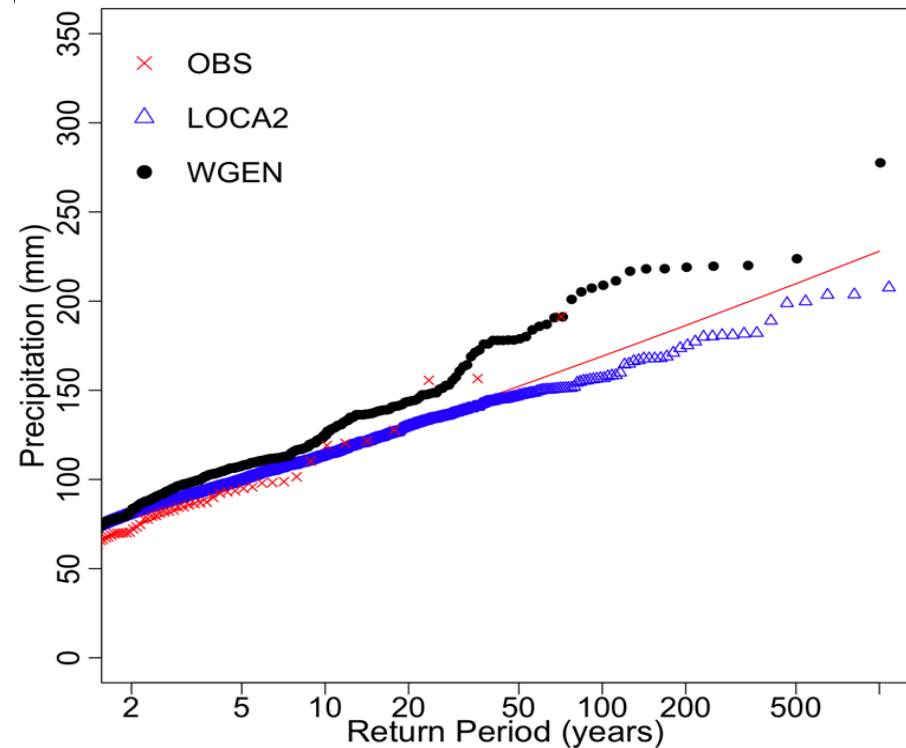
Extreme Precipitation Events

Upper Tuolumne River Basin

Historical



2°C Warmer



Extreme Heat

San Joaquin HUC 4 (1804)

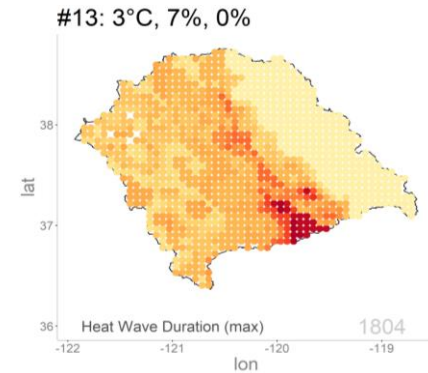
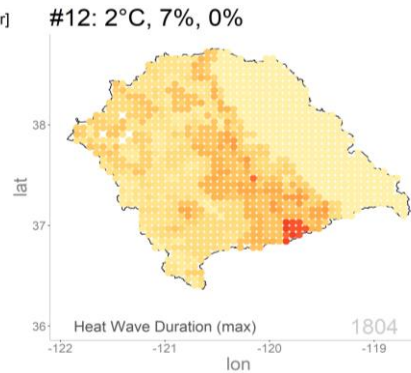
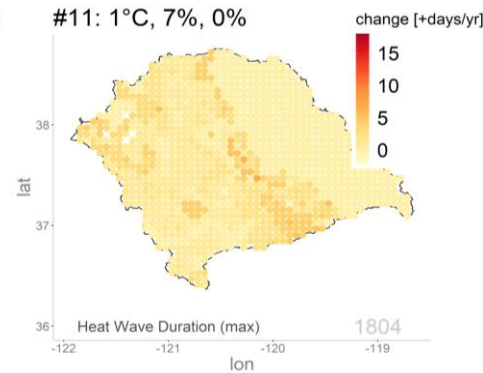
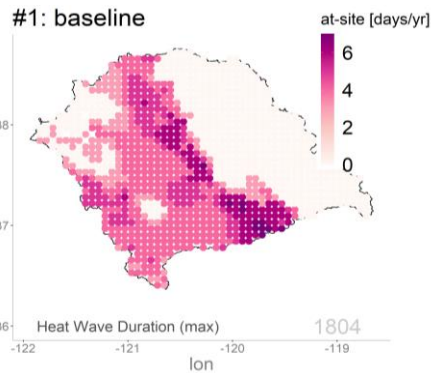
Heat Wave Duration

Baseline Values

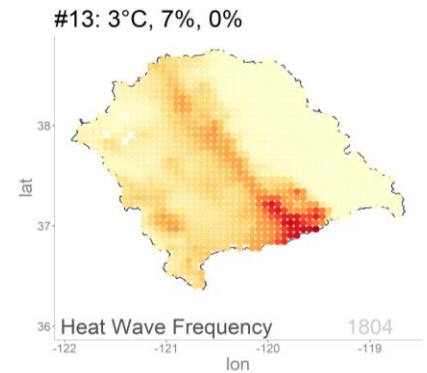
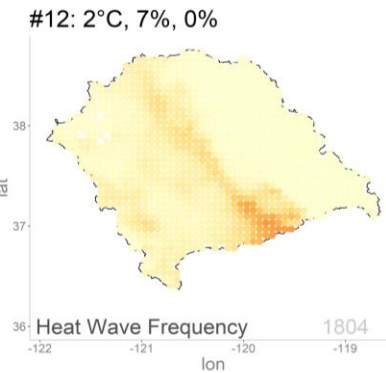
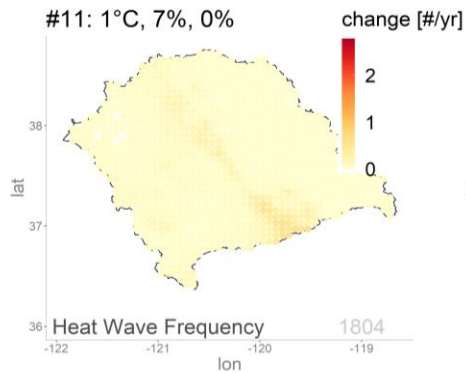
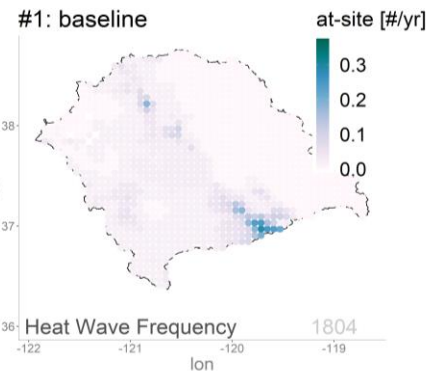
Change in Value (+1°C)

Change in Value (+2°C)

Change in Value (+3°C)



Heat Wave Frequency



THANK YOU

