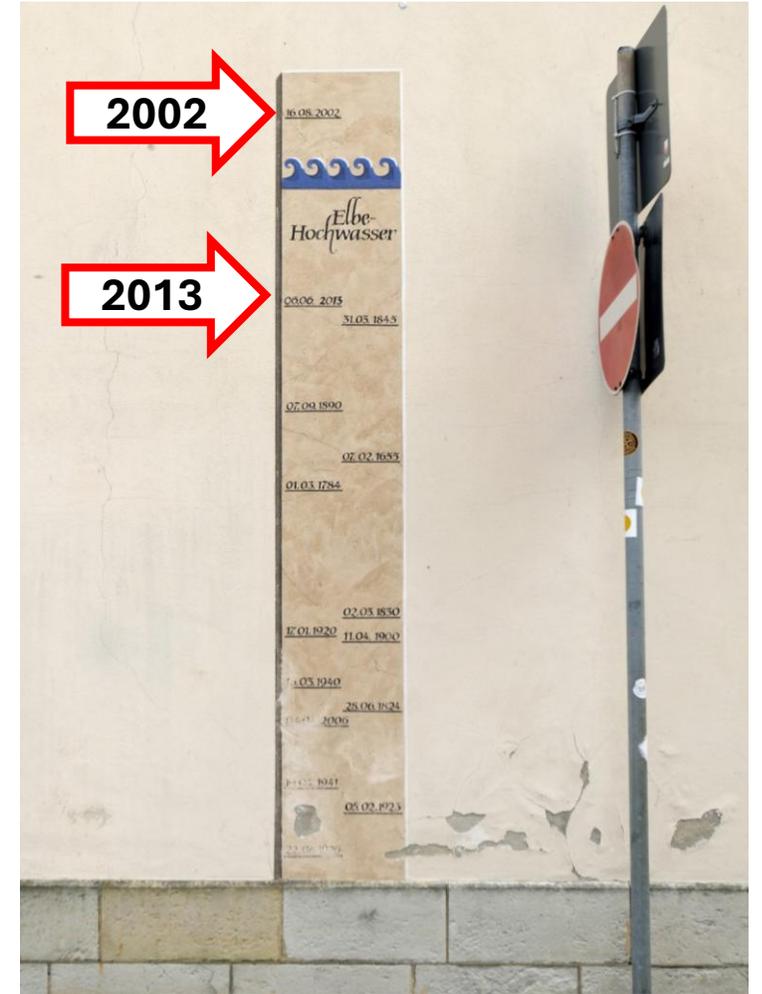


# Exploring the best available California climate model data for civil engineering use

Malter Dam 2002 (Lysippos via Wikimedia Commons, 18 Feb 2011)



Water level markers in the city of Pirna  
(Veit Schagow via Wikimedia Commons, 22 July 2021)



Main Station (LVZ)



Downtown (Micheal Kappeler ddp)

# Research Question

- What is the range of possibility when using best available climate model data products to calculate environmental loads projections as used for engineering design?

Looking for:

- 100-year precipitation
- 50-year ground snow loads (annual max swe)

In the best available spatial and temporal resolution.

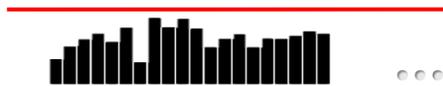


# Background

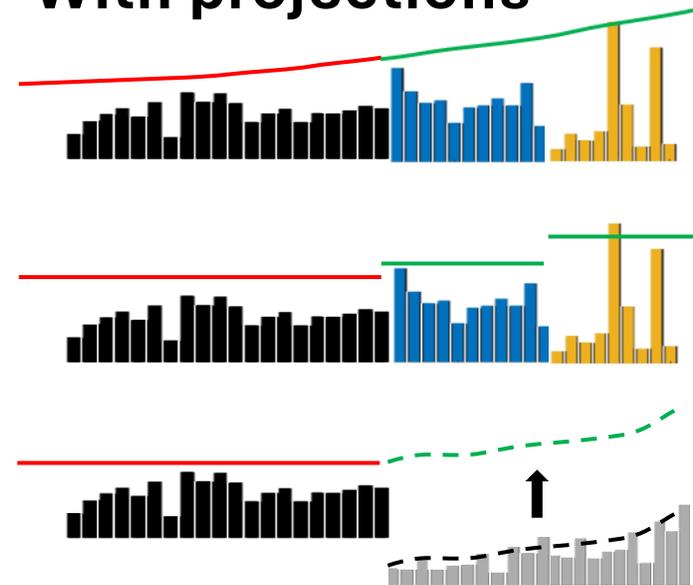
- Previous work to incorporate climate projections into updated load maps (New York, Virginia, Montana)
- GCM in high resolution do not do well with temporal extremes (Bjarke et al 2024)
- California has very nice downscaled data 😊

# Methods for incorporating climate model data

## Traditional



## With projections



Generally: extreme value analysis based on Block Maxima and Maximum Likelihood Fitting (Python, MATLAB used for processing)

# Data

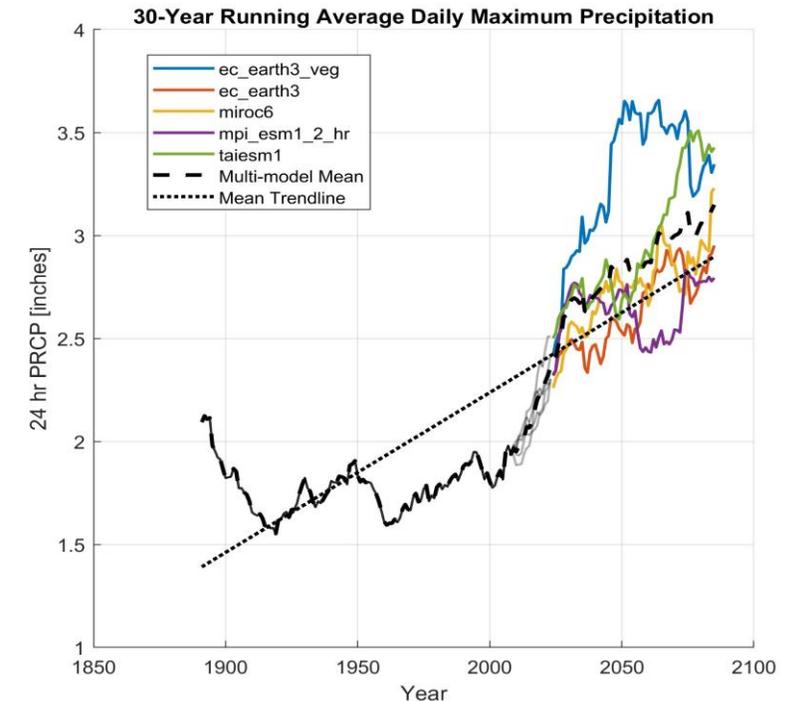
- Locav2 hybrid downscaling
  - 15models, 30-60 runs
  - 3kmx3km
  - 24hr
- WRF dynamically downscaled
  - 8 models, 5(4) bias corrected, 1 run each
  - 3kmx3km
  - 1hr

(Cal Adapt and Analytics Engine)

**READ DATA JUSTIFICATION MEMO!**

# 24hr 100-yr precipitation Sacramento SSP3-7.0

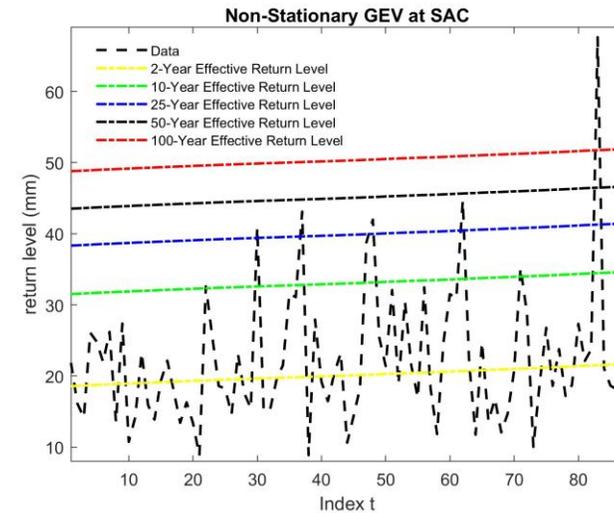
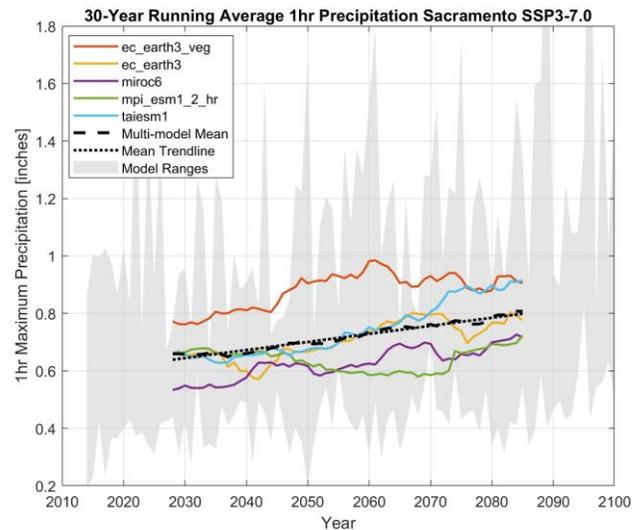
Method	Now - 2040	2041-2070	2071-2100
Atlas 14 (current min requirement) -1-	5.38	X	X
CMIP5 nonstationary (from AR4 report) BCCAv2 4 model mean -2-			6.35 (RCP4.5) 6.64 (RCP8.5)
Local Temperature Scaling $1.07^{\Delta T}$ -3- $pr_{1950} = 4.46in, t_{1950} = 16.25C$	5.16 ( $\Delta T=2.16$ )	5.63 ( $\Delta T=3.45$ )	6.01 ( $\Delta T=4.41$ )
CMIP6 stationary WRF SSP3-7.0	6.43	7.20	8.45
CMIP6 + historic nonstationary WRF SSP3-7.0 -4-	6.12	6.24	6.36



- 1- NOAA IDF data
- 2- Ragno et al 2018
- 3- Clausius-Clapeyron Scaling
- 4- NEVA Toolbox Cheng et al 2014

# 1hr 100-year precipitation Sacramento SSP3-7.0

Method	Now-2040	2041-2070	2071-2100
Atlas 14	1.19	X	X
Local Temperature Scaling $1.07^{\Delta T}$ based of Atlas	1.38 (+15.7%)	1.51 (+26.5%)	1.60 (+34.7%)
CMIP 6 stationary AMS WRF GEV	1.46	1.70	2.02
CMIP 6 nonstationary AMS WRF NEVA	1.80	1.86	1.92

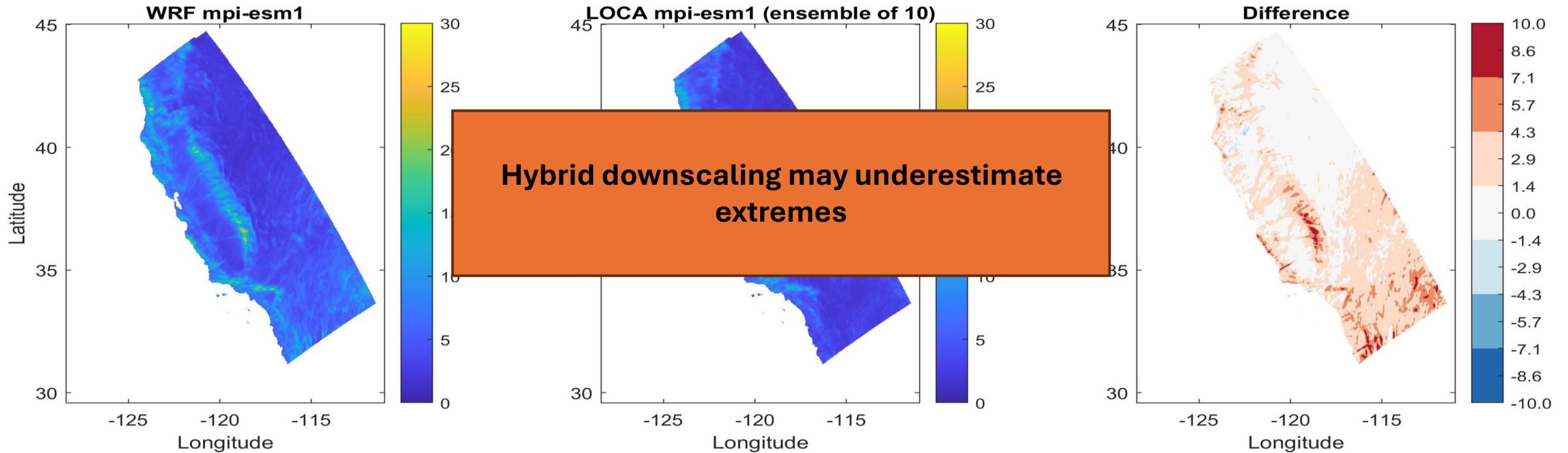


# A bit more context



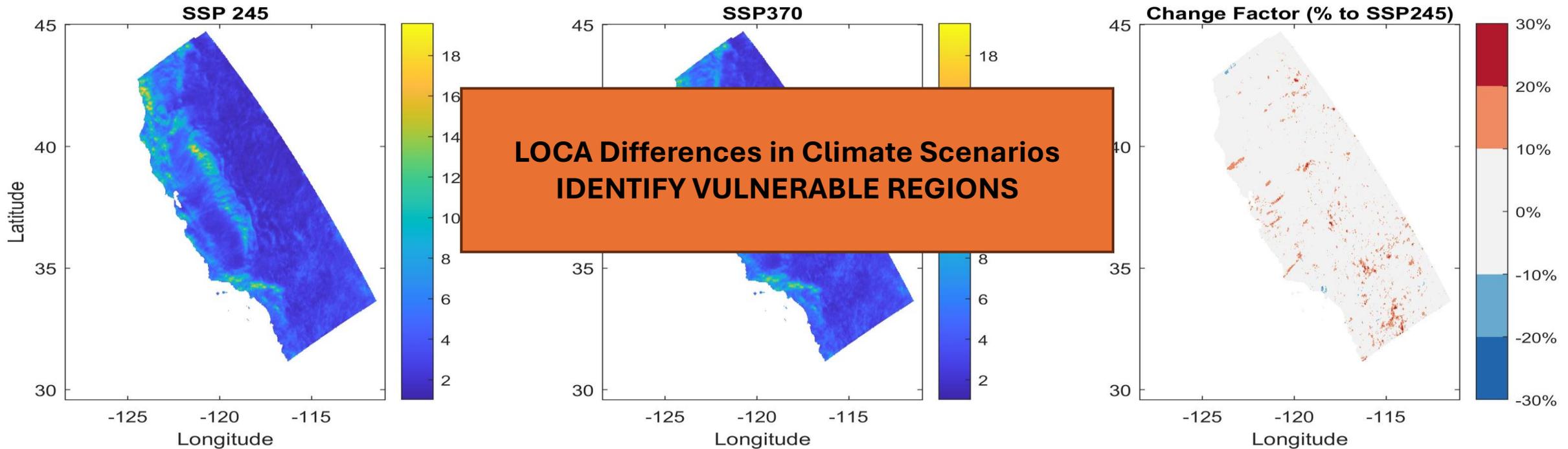
# 24hr 100-yr precipitation WRF vs. LOCA2 SSP3-7.0

24hr 100yr precipitation depth in California comparison of mpi-esm1 downscaling [inches]



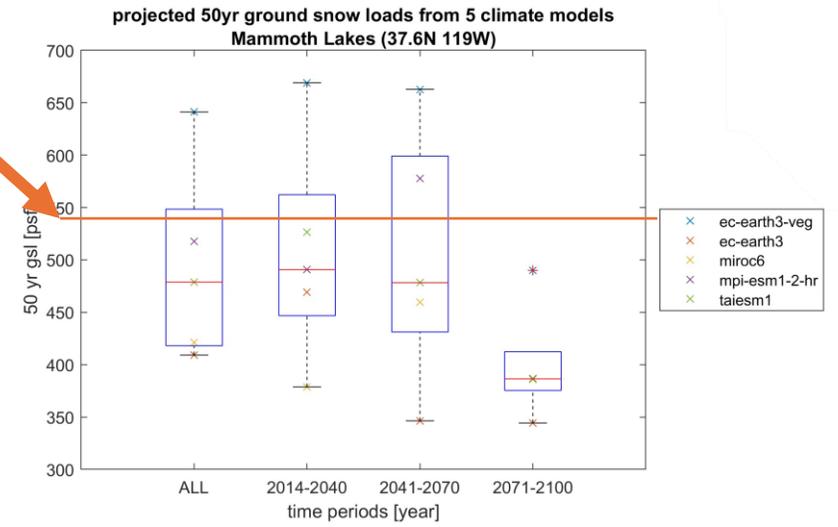
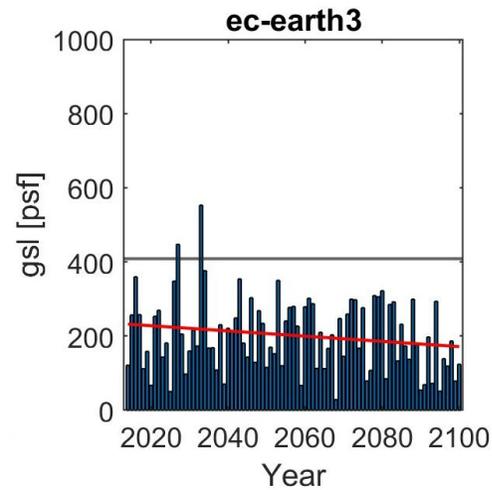
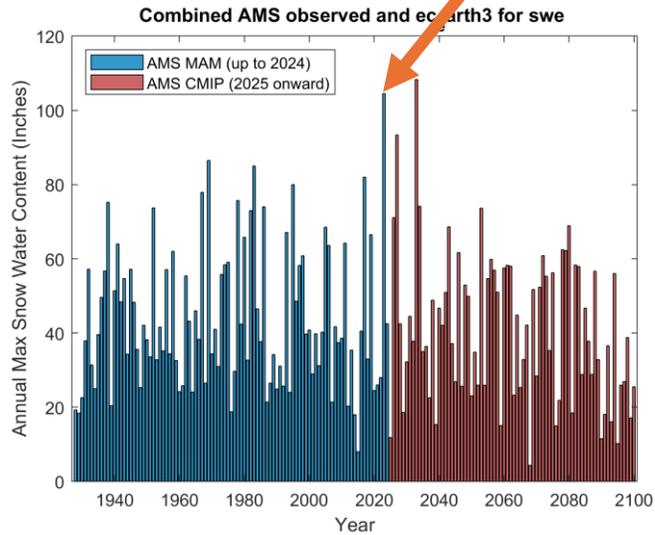
# 24hr 100-yr precipitation LOCA2 SSP245 vs. SSP370

24hr 100yr precipitation depth in California SSP245 and SSP370 [inches]



# 50-yr maximum ground snow SSP3-7.0

Mammoth Lakes 2023  
Snowpack 104.5'' (~540psf)

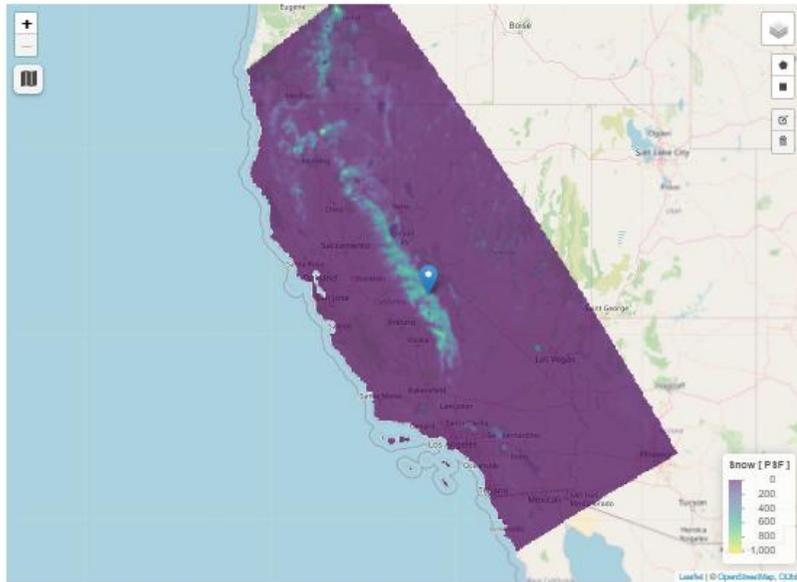


## California Future Climate Projections for Engineering Planning

Extreme event frequency for snow, precipitation, and wind, precipitation from CMIP6 downscaled climate model data.

Climate change is impacting magnitude and frequency of extreme weather events. Engineers depend on estimations of these values to plan and design resilient infrastructure. Based on CMIP 6 (WRF and Loca2) a priori bias corrected downscaled climate projections provided for California (see [Cal-Adapt](#)) values for ground snow loads, mean wind speeds, and precipitation intensities were calculated with the MLE extreme value fitting of annual maxima. Values are available for relevant return periods (50- or 100 year), future time periods (mid-century, end-century), and climate scenarios (SSP 245, SSP 370) as available from the data source. SSP are shared socioeconomic pathways as defined by the IPCC in the Sixth Assessment Report. Values displayed in this map are multiple climate model and model ensemble means, at minimum 5 different models. Grid resolution is 3km x 3km.

How To Use Map Tool



Reset Selection

### Snow ❄️

California 50yr Ground Snow Load  
📍 2014-2100 (All)

**489.39 PSF**  
(pounds per square ft)

Time Period	PSF
2014-2040	504.98
2042-2070	499.80
2070-2100	390.52
2014-2100 (All)	489.39
Highest Annual Maxima	612.64

Manual Coordinate Search | History

**Search Criteria:**

- Select weather hazard: Ground Snow Load [psf]
- Select Scenario: SSP 3-7.0
- Select Metric: 50yr MRI
- Select Time Period: 2014-2100 (All)

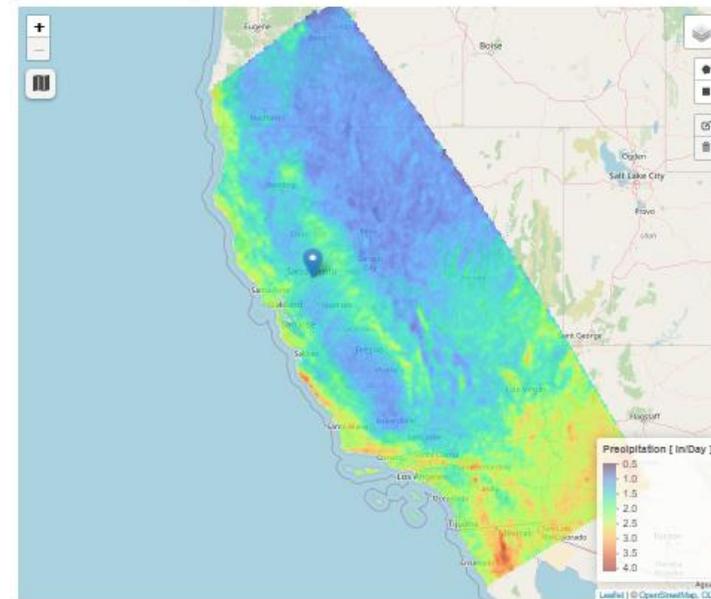
**Mammoth Lakes City Code:  
100 to 300psf**

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How To Use Map Tool



Reset Selection

### Precipitation ☁️

California 1hr 100yr precipitation  
📍 2014-2100 (All)

**1.62 In**  
(inches per day)

38.5762 | -121.4931

Time Period	In/Day
2014-2040	1.22
2042-2070	1.37
2070-2100	1.85
2014-2100 (All)	1.62
Highest Annual Maxima	2.15

Manual Coordinate Search | History

**Search Criteria:**

- Select weather hazard: Precipitation Depth [in]
- Select Scenario: SSP 3-7.0
- Select Metric: 1hr - 100yr MRI
- Select Time Period: 2014-2100 (All)

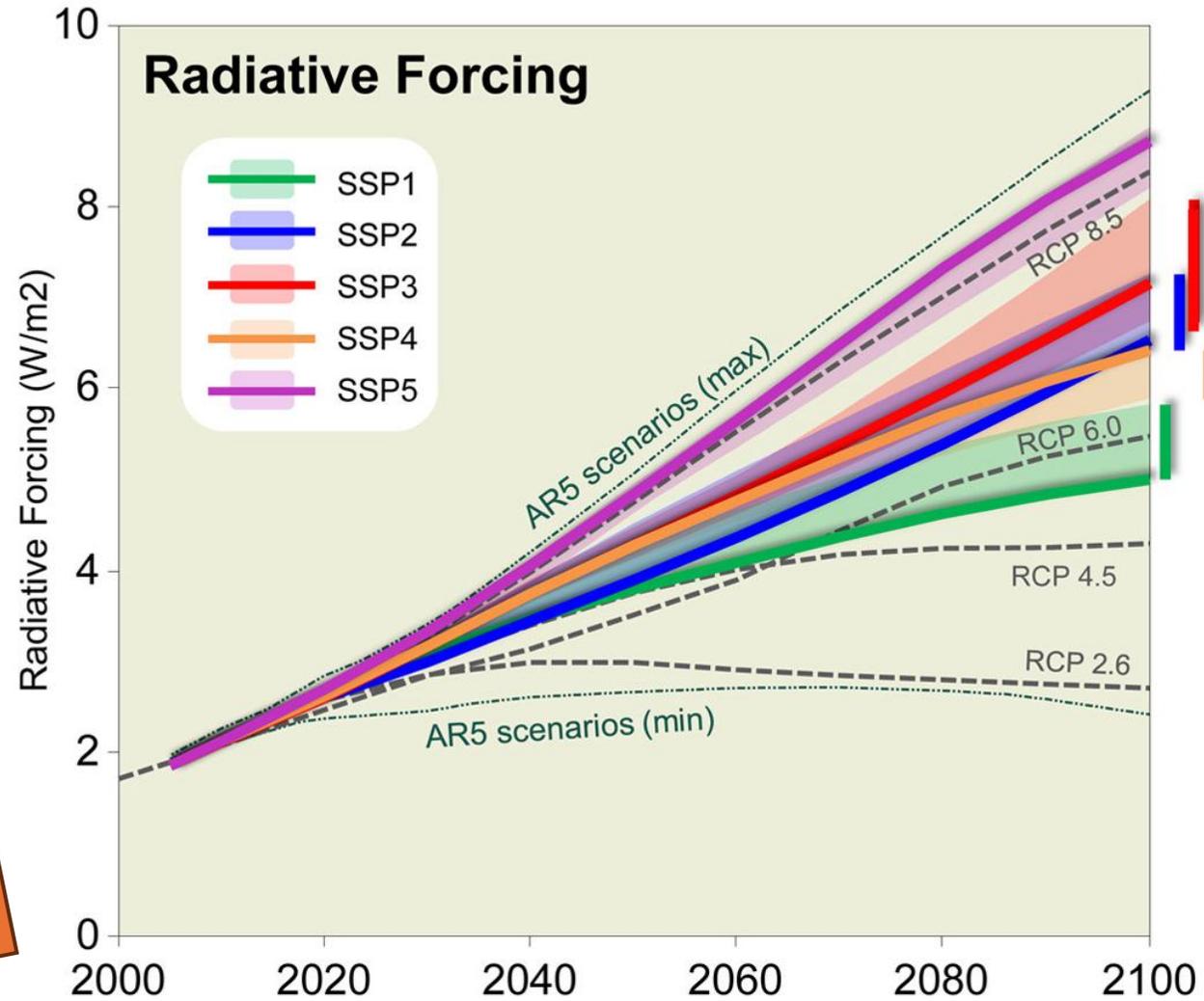
**Sacramento Atlas 14 for a 1hr 100-  
year event:  
1.19 inches**

# Takeaway

- Do trust the data. Do not trust the data.
- Uncertainty caused by approaching model data differently.
- Need for design solutions that can deal with high uncertainty.
- Management! Monitoring! Flexibility!

# Thank you!

Questions?



**PSA**  
Only RCP8.5 or SSP5-8.5 if  
you have a good reason

<https://doi.org/10.1016/j.gloenvcha.2016.05.009>