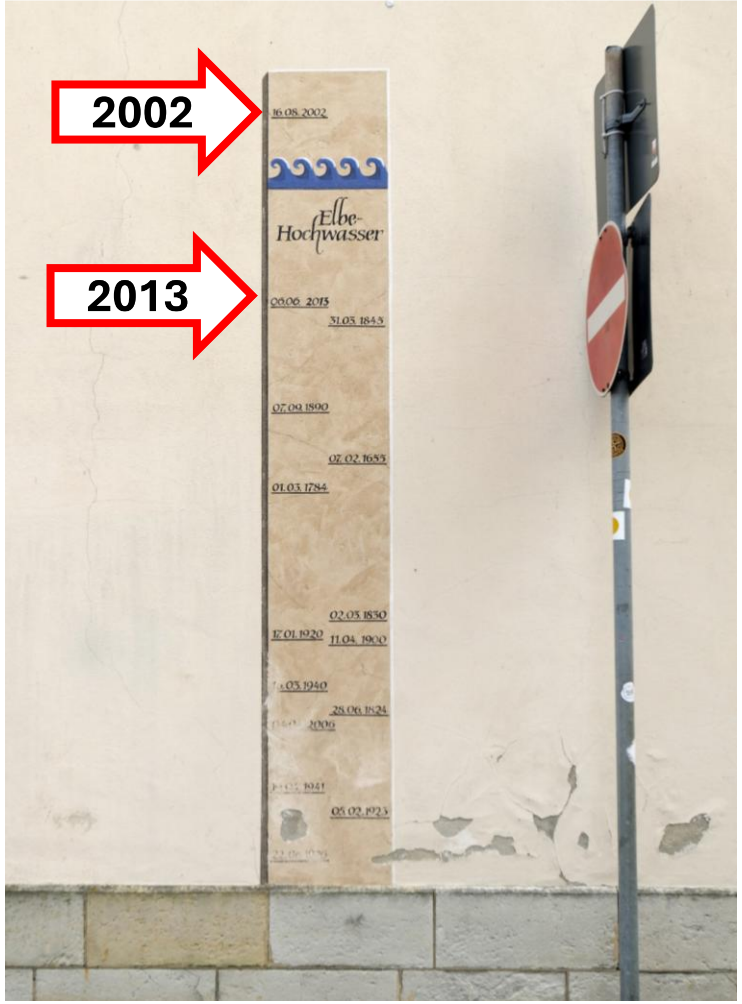
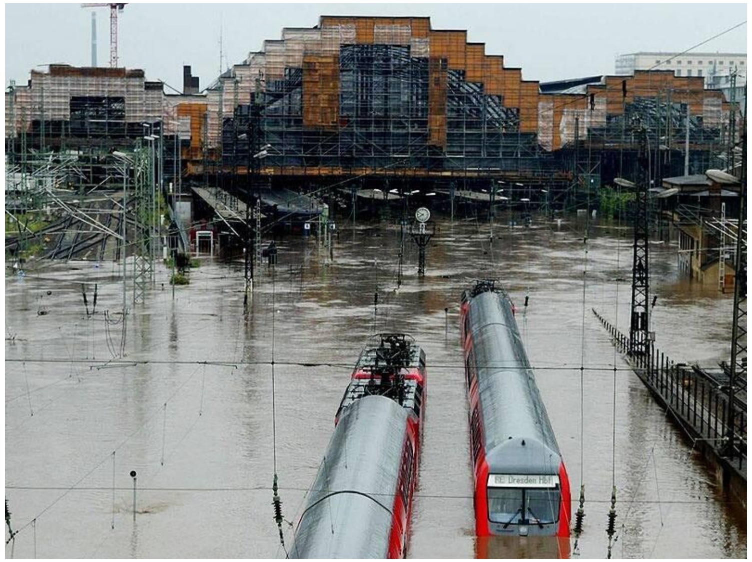
Exploring the best available California climate model data for civil engineering use

Marie Buhl, Markolf Lab, Environmental System Graduate Group

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)

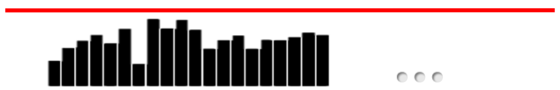
In the best available spatial and temporal resolution.

Background

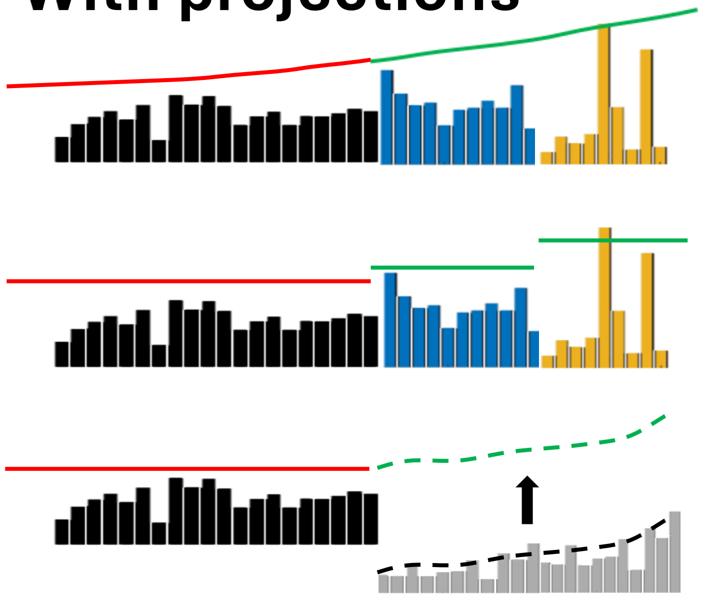
- Previous work to incorporate climate projections into updated load maps (New York, Virginia, Montana)
- GCM in high resolution do not do well with temporal extremes (Bjarke et al 2024)
- California has very nice downscaled data ☺

Methods for incorporating climate model data

Traditional



With projections



- **Past timeseries**
- **Projected data**
- **Load Value**
- **Updated Load**

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

Data

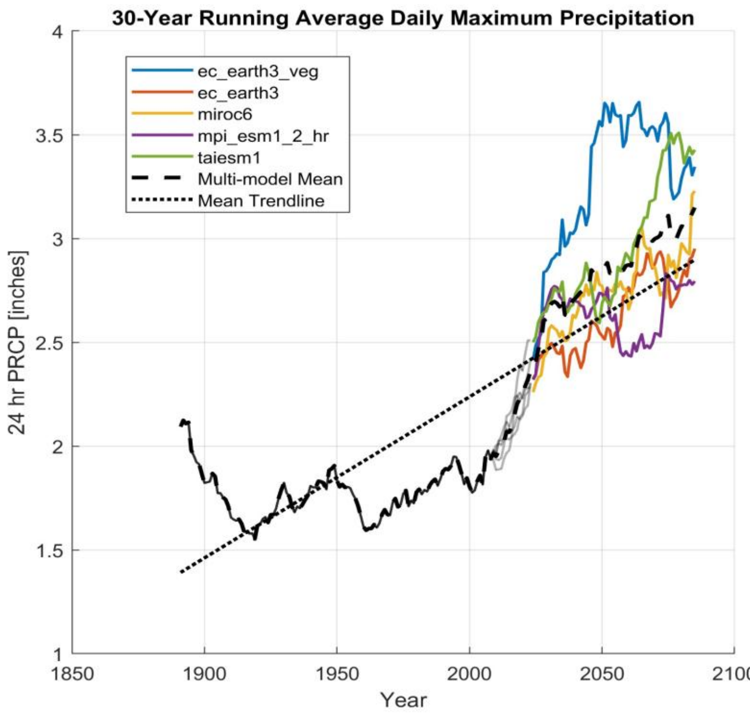
- Locav2 hybrid downscaling
  - 15models, 30-60 runs
  - 3kmx3km
  - 24hr
- WRF dynamically downscaled
  - 8 models, 5(4) bias corrected, 1 run each
  - 3kmx3km
  - 1hr

READ DATA JUSTIFICATION MEMO!

(Cal Adapt and Analytics Engine)

24hr 100-yr precipitation Sacramento SSP3-7.0

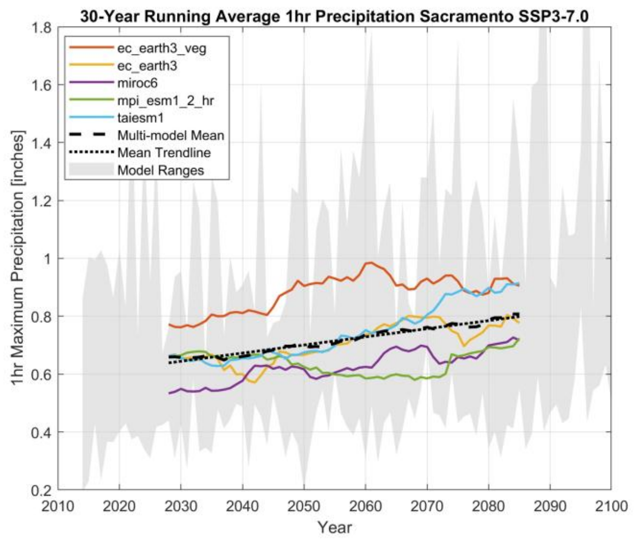
Method	**Now - 2040**	**2041-2070**	**2071-2100**
Atlas 14 (current min requirement) -1-	5.38	x	x
CMIP5 nonstationary (from AR4 report) BCCAv2 4 model mean -2-			6.35 (RCP4.5) 6.64 (RCP8.5)
Local Temperature Scaling $1.07^{\Delta T}$ -3- $pr_{1950} = 4.46in, t_{1950} = 16.25C$	5.16 (ΔT=2.16)	5.63 (ΔT=3.45)	6.01 (ΔT=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

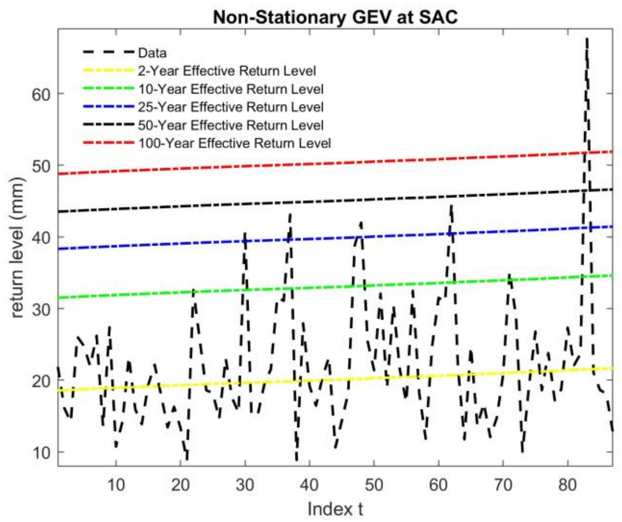


-1- NOAA IDF data
-2- Ragno et al 2018
-3- Clausius-Clapeyron Scaling
-4- NEVA Toolbox Cheng et al 2014

1hr 100-year precipitation Sacramento SSP3-7.0

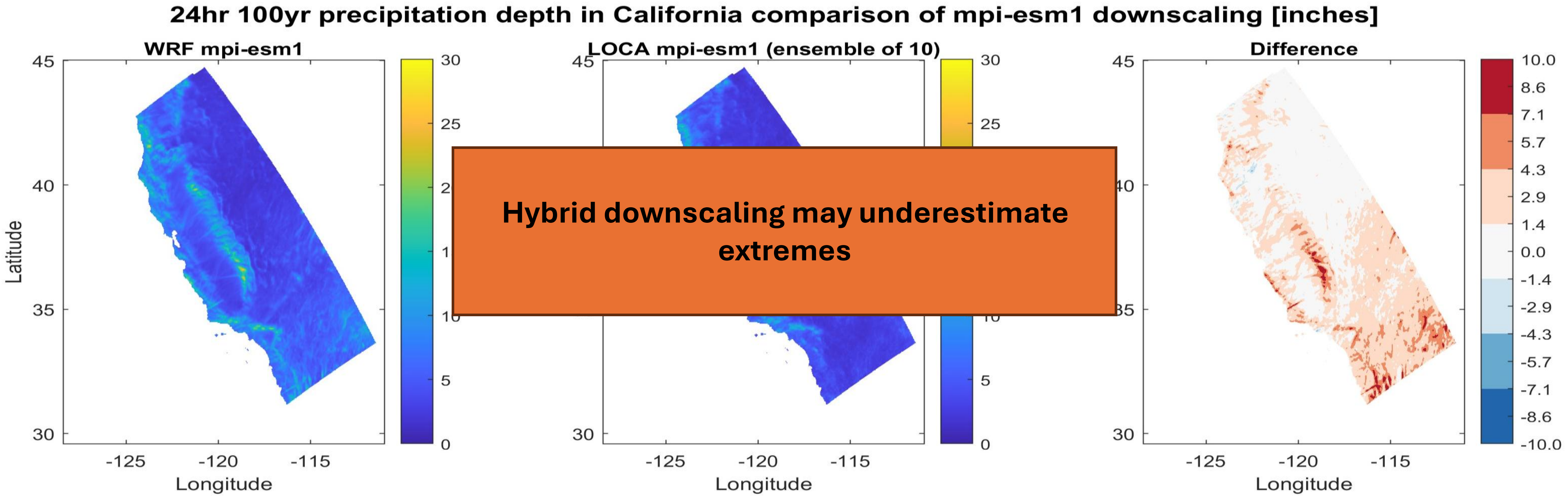
Method	Now-2040	2041-2070	2071-2100
Atlas 14	1.19	x	x
Local Temperature Scaling $1.07^{\Delta T}$ based of Atlas	1.38 (+15.7%)	1.51 (+26.5%)	1.60 (+34.7%)
CMIP 6 stationary AMS WRF GEV	1.46	1.70	2.02
CMIP 6 nonstationary AMS WRF NEVA	1.80	1.86	1.92





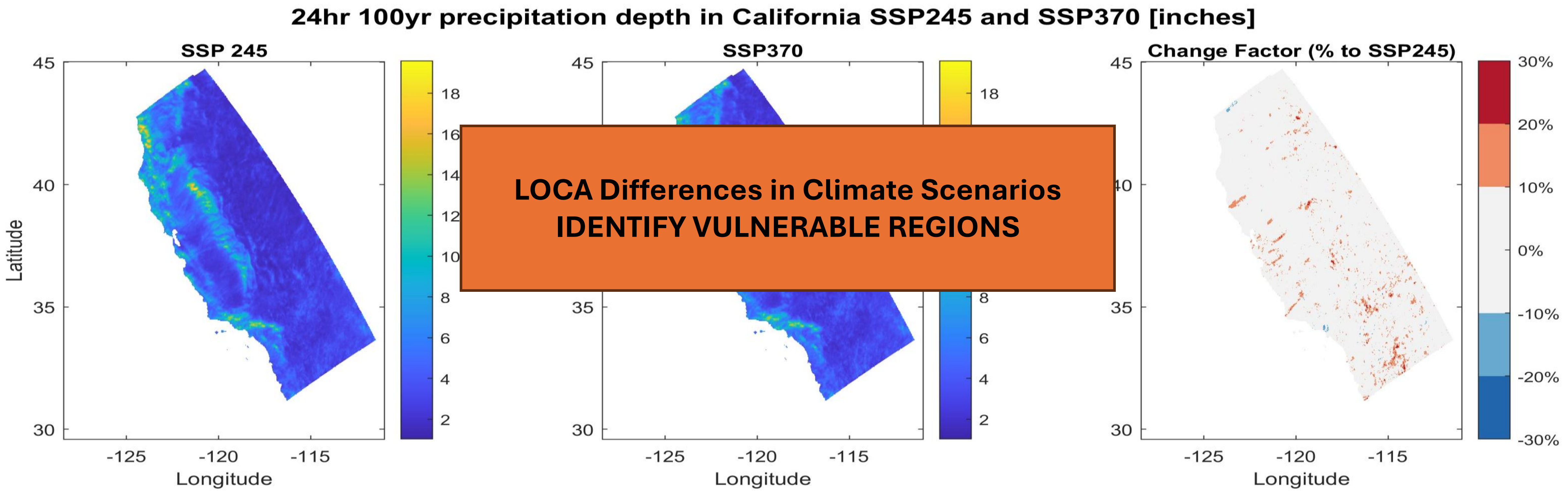
A bit more context

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



Hybrid downscaling may underestimate extremes

24hr 100-yr precipitation LOCA2 SSP245 vs. SSP370

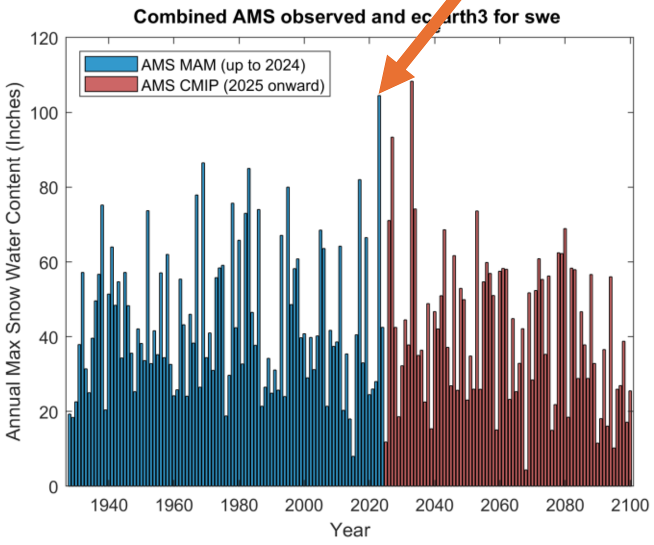


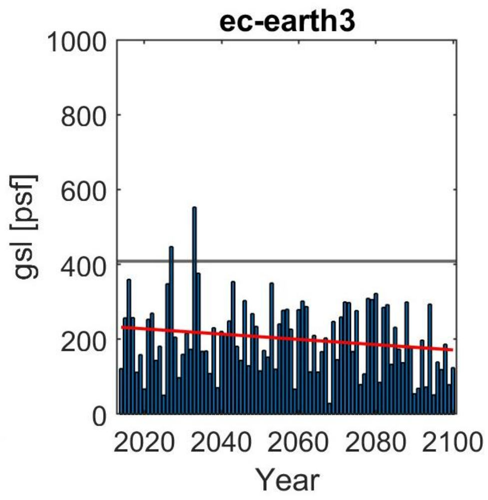
LOCA Differences in Climate Scenarios
IDENTIFY VULNERABLE REGIONS

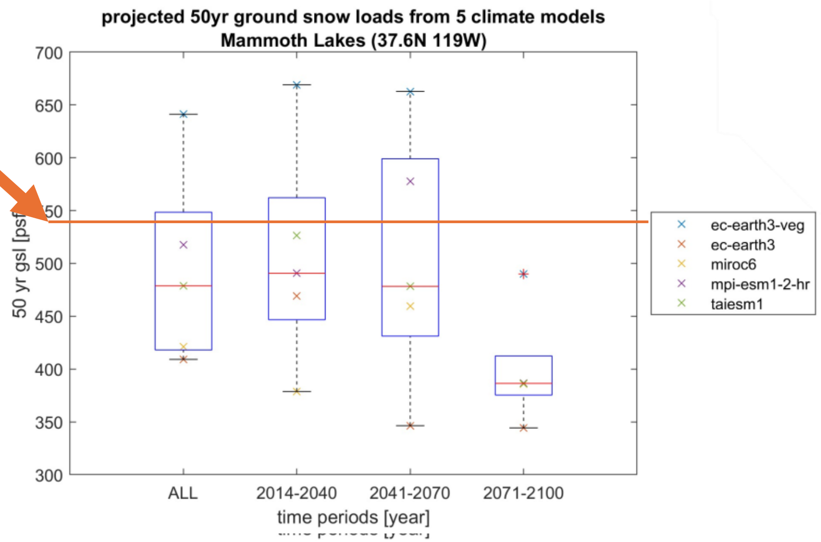
50-yr maximum ground snow SSP3-7.0

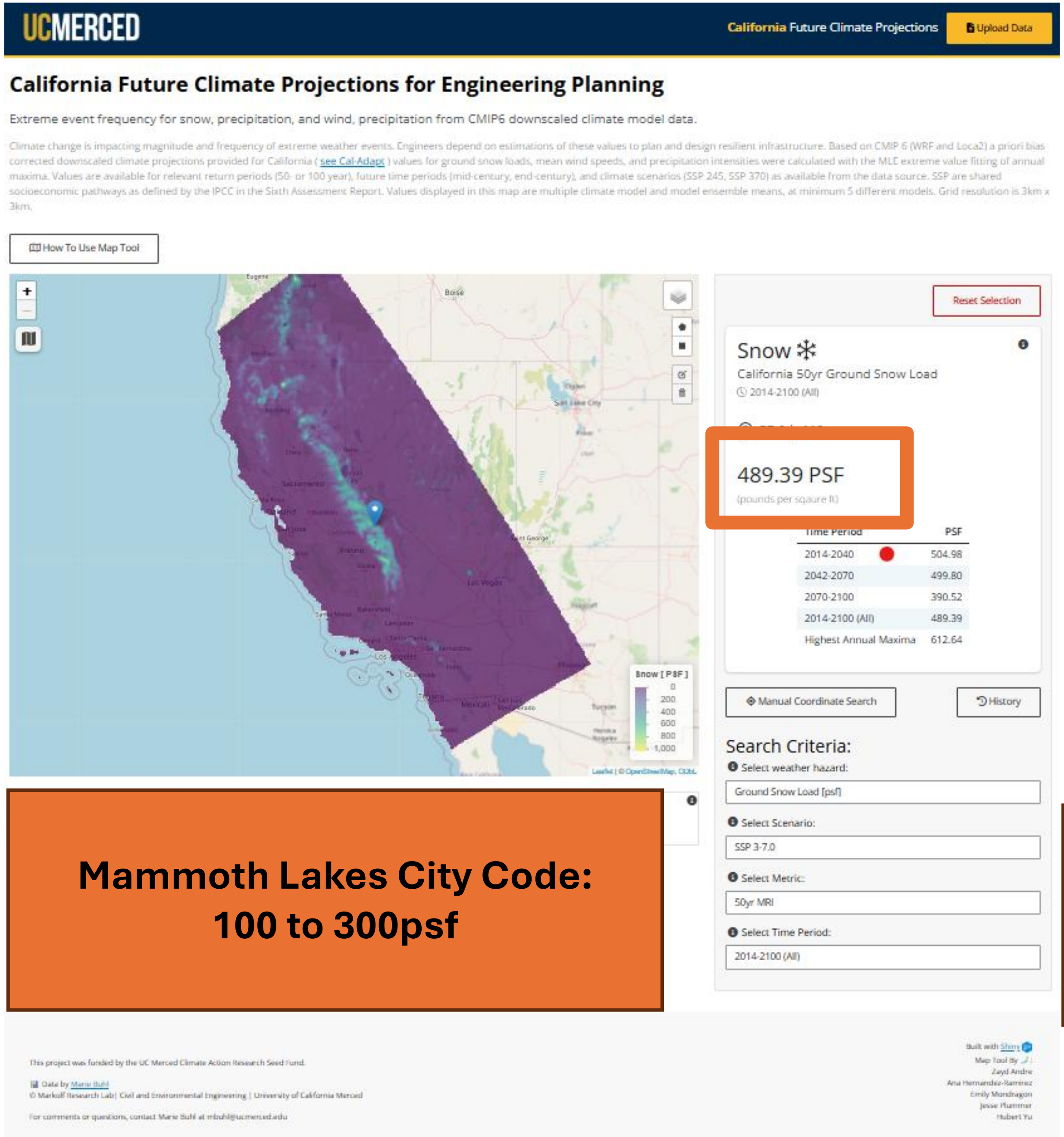
Mammoth Lakes 2023

Snowpack 104.5'' (~540psf)

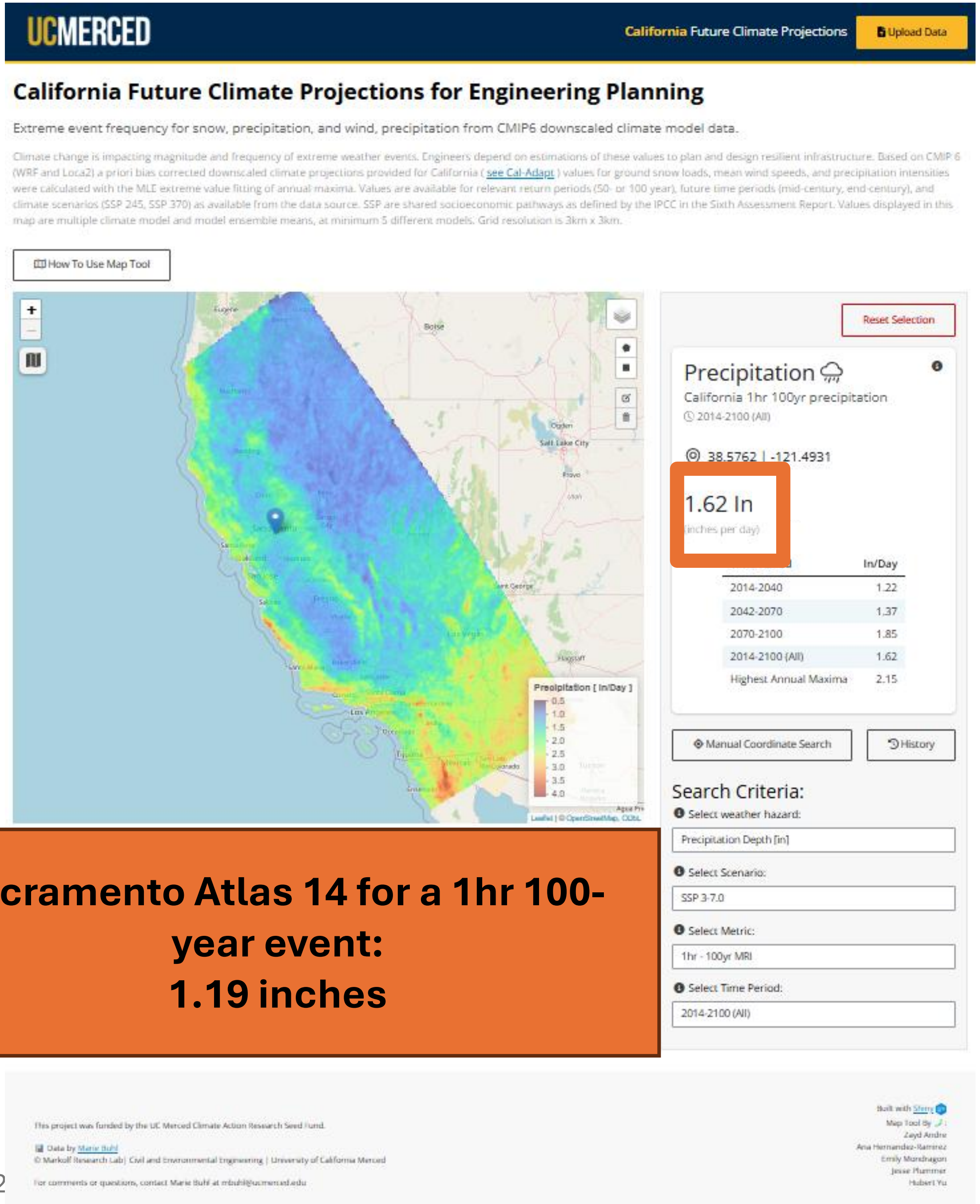








Mammoth Lakes City Code: 100 to 300psf



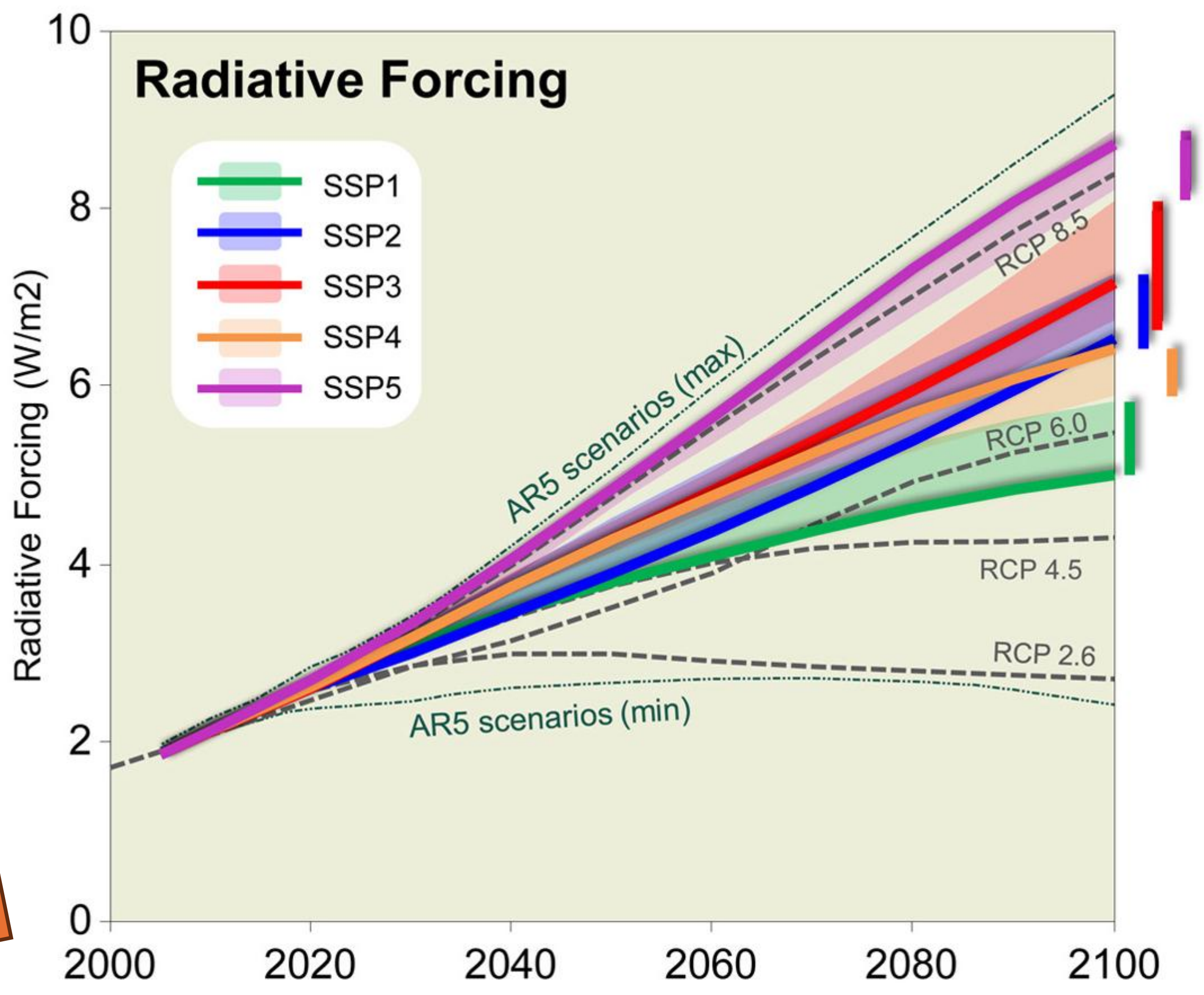
Sacramento Atlas 14 for a 1hr 100-year event: 1.19 inches

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