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NEVADA IRRIGATION DISTRICT

NID-PFW
Global Climate Projections and Unimpaired Hydrology

May 23, 2023

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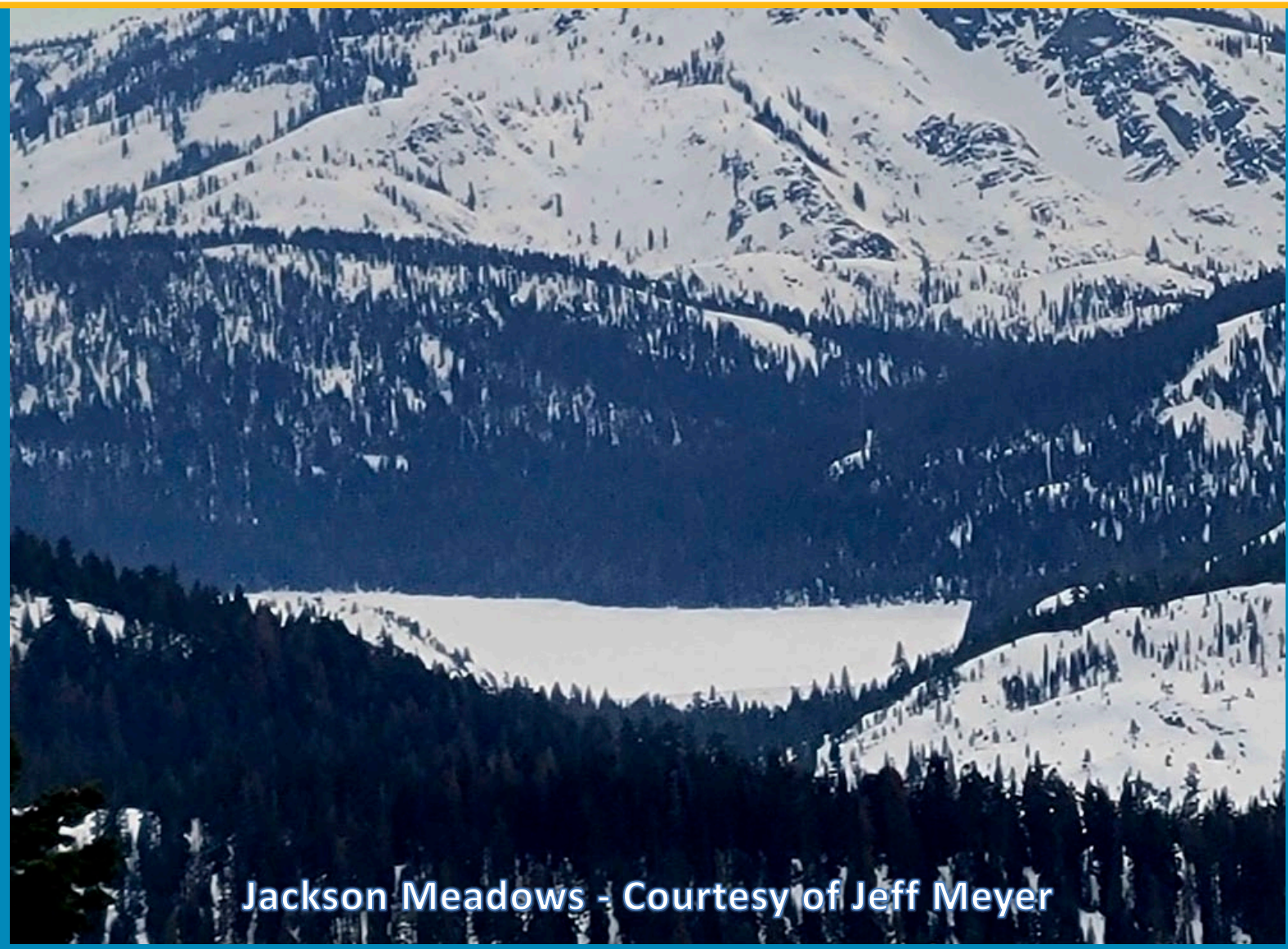
Agenda

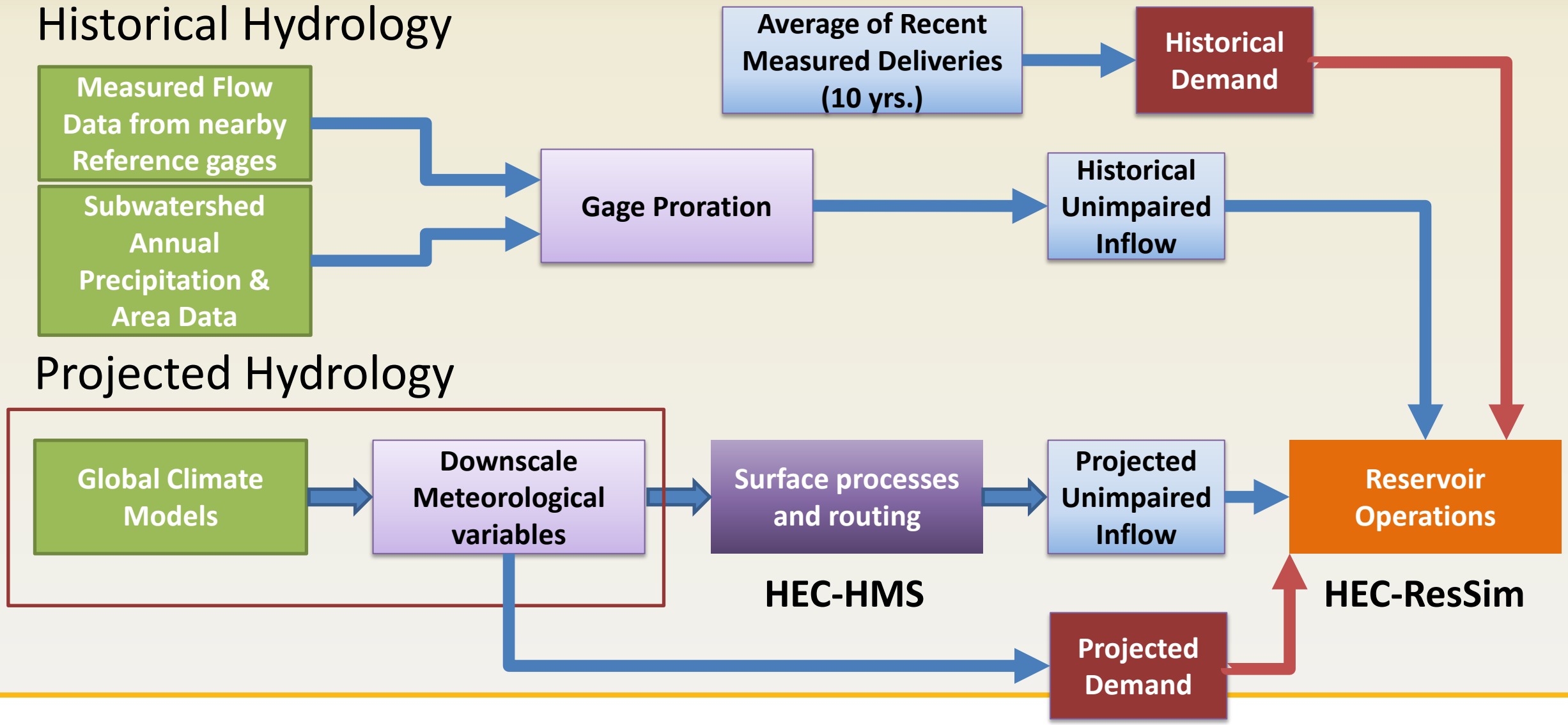
Global Climate Projections

- Introduction
- GCM – CMIP6
- Downscaled GCM
- Model Selection
- Emission Scenarios
- Data Processing/Examples
- Next Steps



Jackson Meadows - Courtesy of Jeff Meyer

Introduction



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GCM – CMIP6

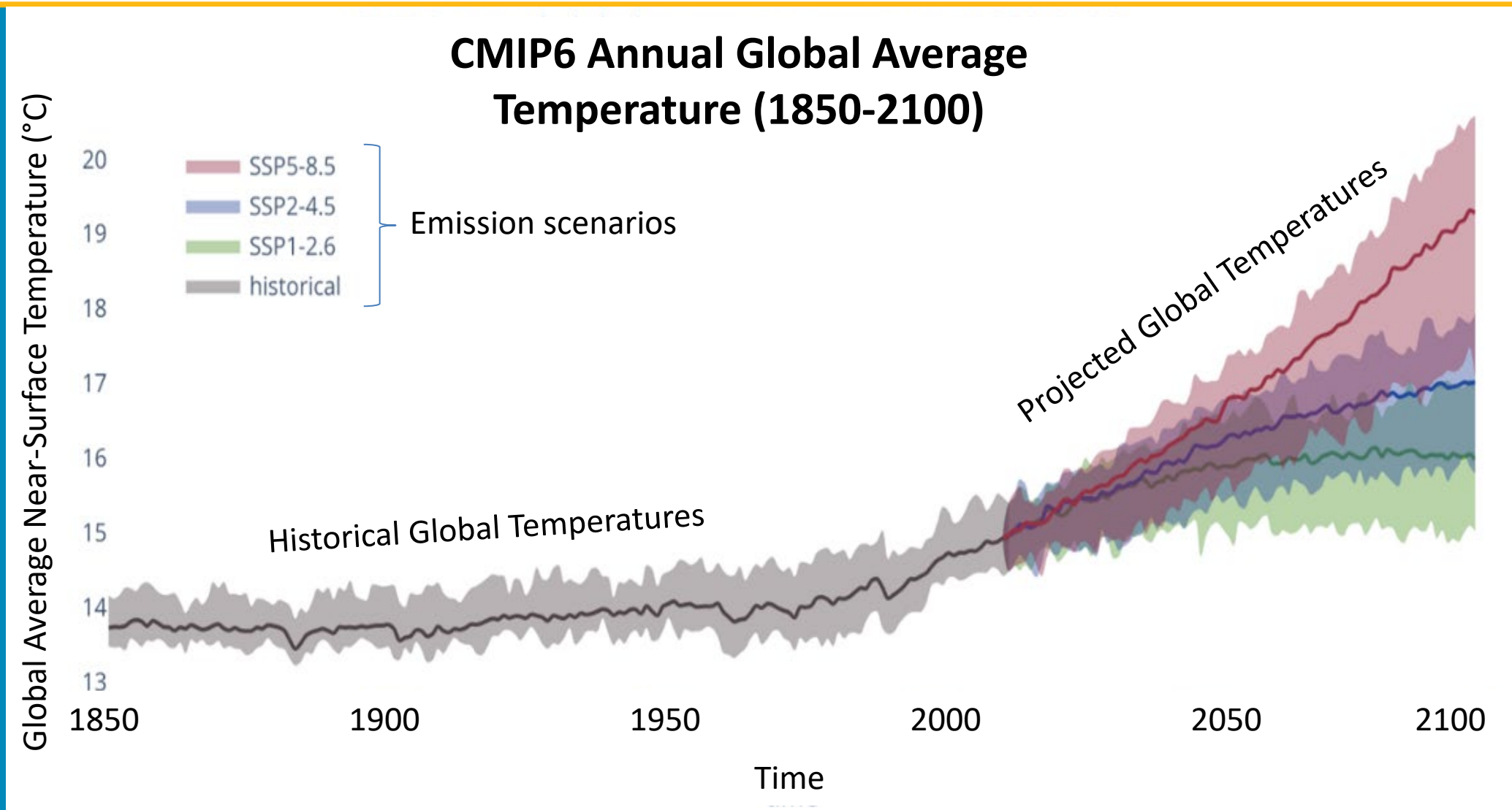
Coupled Model Intercomparison Project Phase 6

"The CMIP6 generation of models includes GCMs that improve the representation of continental-scale atmospheric circulation patterns that produce realistic weather and climate in California in both an average sense and in terms of variability compared to CMIP5 (Cannon, 2020; Simpson et al., 2020)."

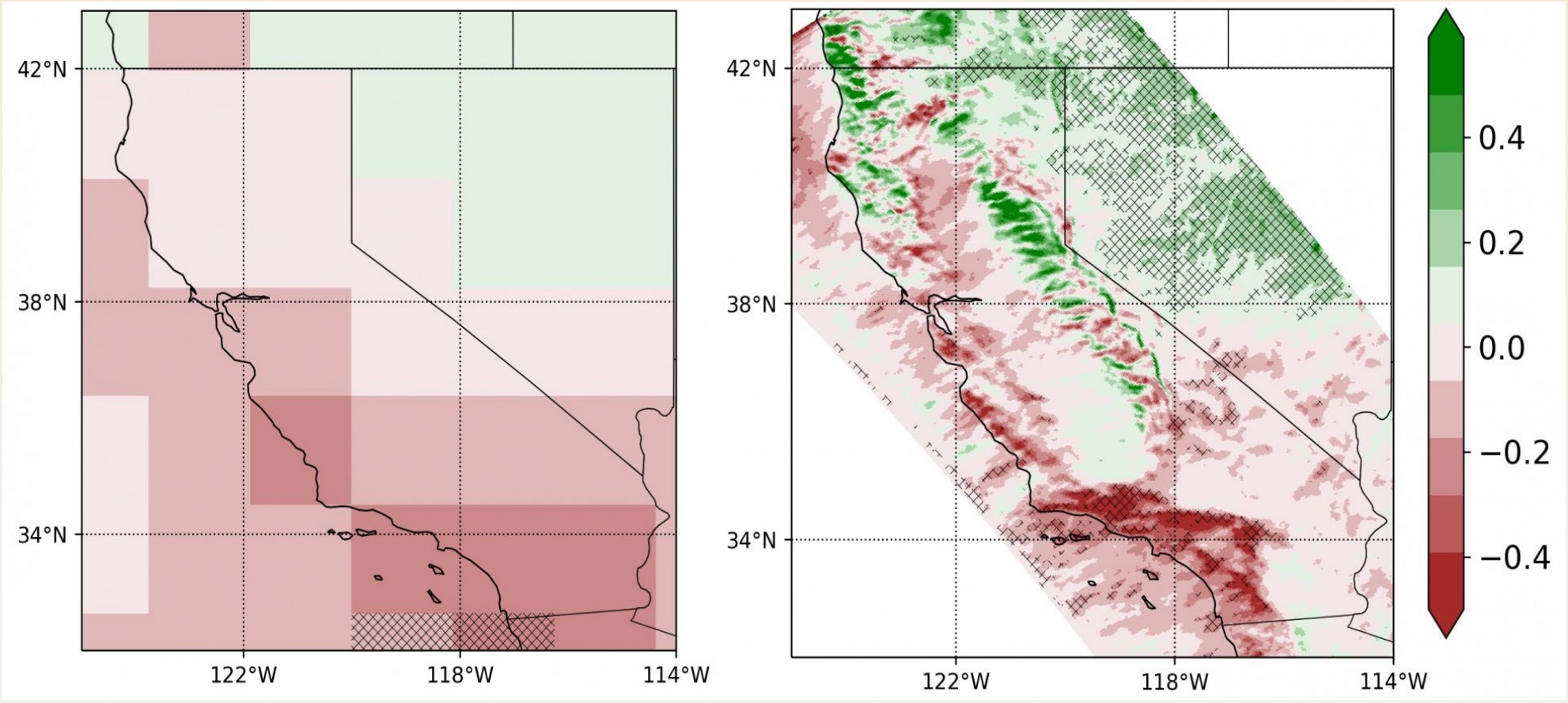
GCM – CMIP6

Coupled Model Intercomparison Project Phase 6

100 models - 50 modeling centers



Downscaled Climate Data



Future (2080-2100 average) minus historical (1980-2015 average) simulated precipitation anomalies [mm/d]. Source: [CMIP6 Downscaling Using WRF | Alex Hall's Research Group (ucla.edu)]

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Downscaling Datasets

1)Statistically downscaled (LOCA):

David Pierce

CW3E, California Energy Commission

1950-2100

27 models, 3 scenarios

Multiple Ensembles

2) Dynamically downscaled:

UCLA Alex Halls Group WRF

1980-2100

Limited models, scenarios

Still under review

Climate Model Selection

Models are not created equal

Model Ranking (Process-based)

- Large-scale patterns of circulation, pressure, and moisture transport

Model Ranking (Local climate)

- Seasonal and annual patterns
  - Temperature and precipitation
  - Mean and variability

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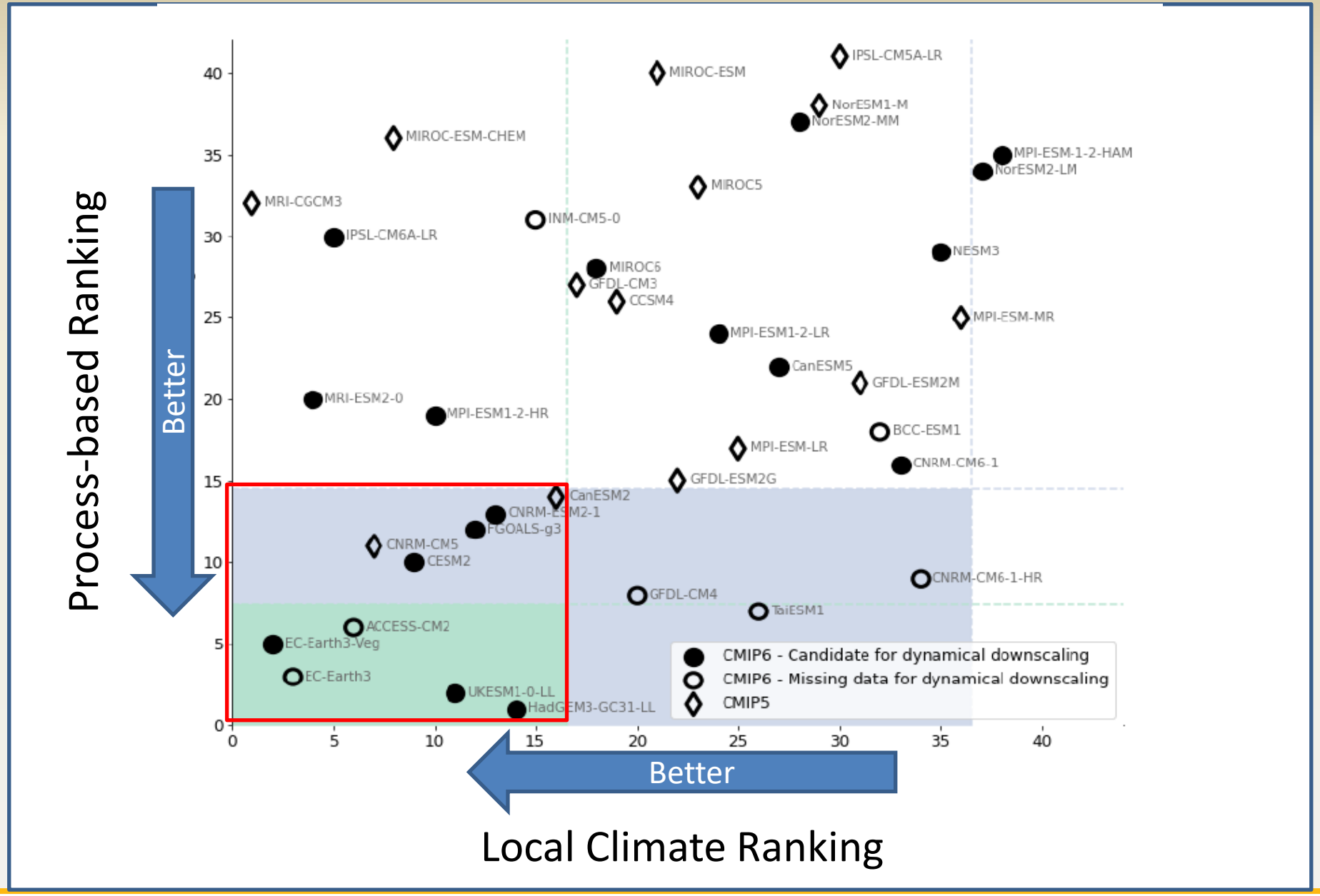
Source: Krantz, et al. Memorandum on Evaluating Global Climate Models for Studying Regional Climate Change in California (2021)



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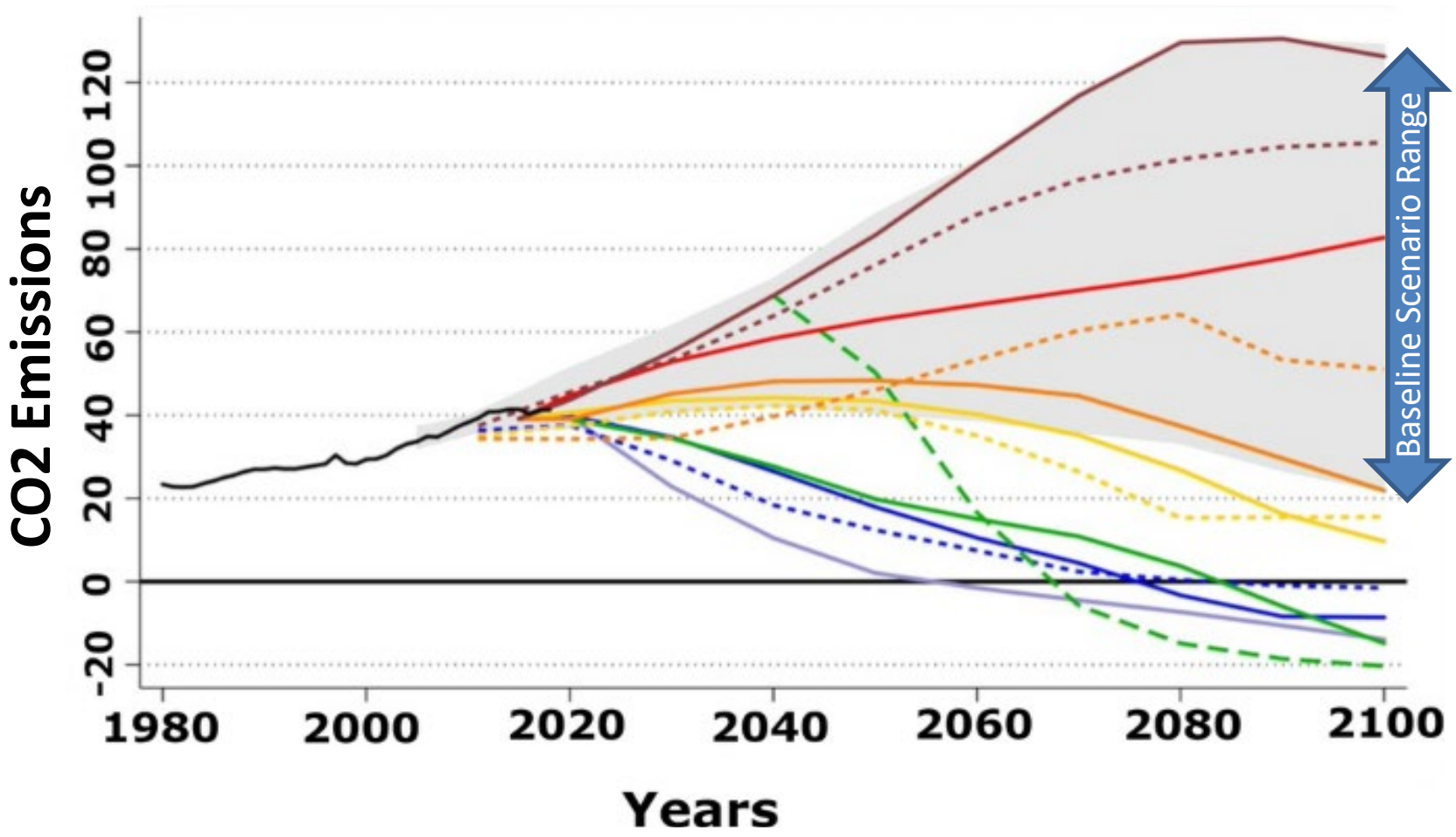
Source: Krantz, et al. Memorandum on Evaluating Global Climate Models for Studying Regional Climate Change in California (2021)

Emission Scenarios



Worst case

Middle of the road

Optimistic

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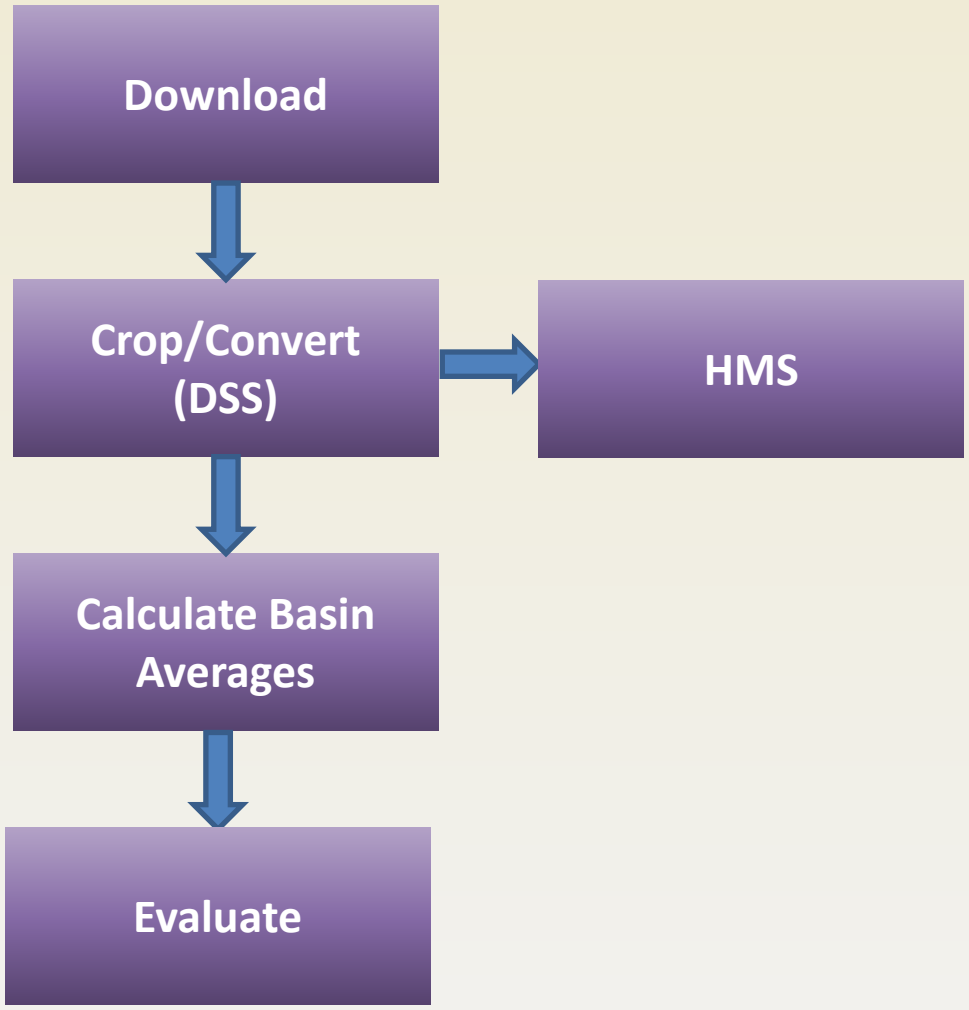
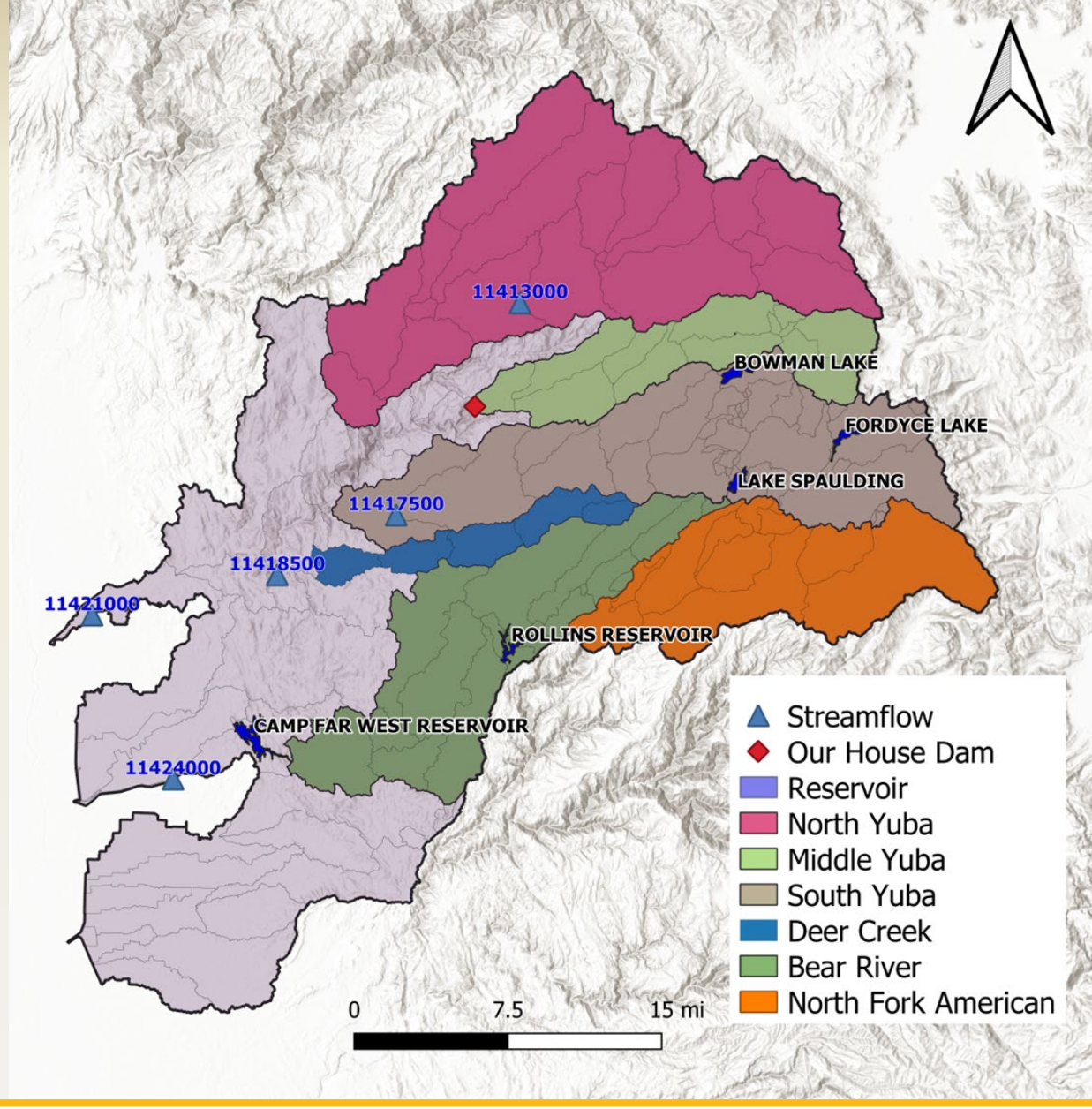
Data Processing/Examples





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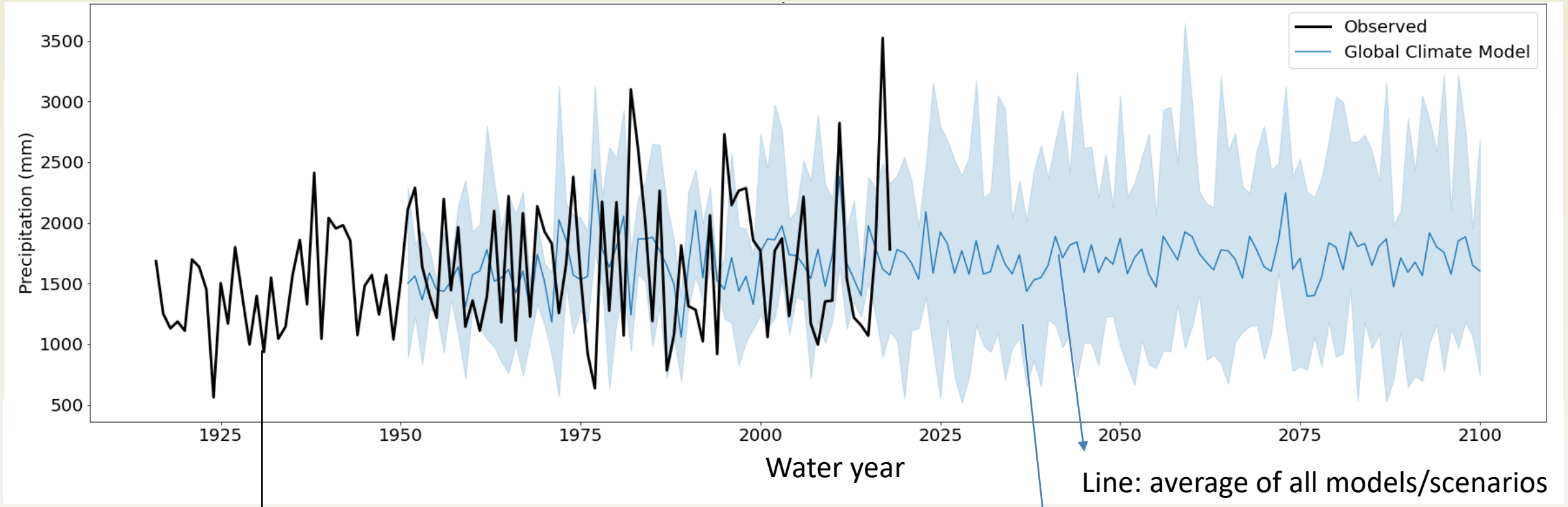
Middle Yuba River

Basin average total annual precipitation (mm):
observed and projected based on Global Climate Model



Observed: Livneh dataset

Line: average of all models/scenarios

Shaded area represents the ensemble of multiple climate models and scenarios (both observed and projected)

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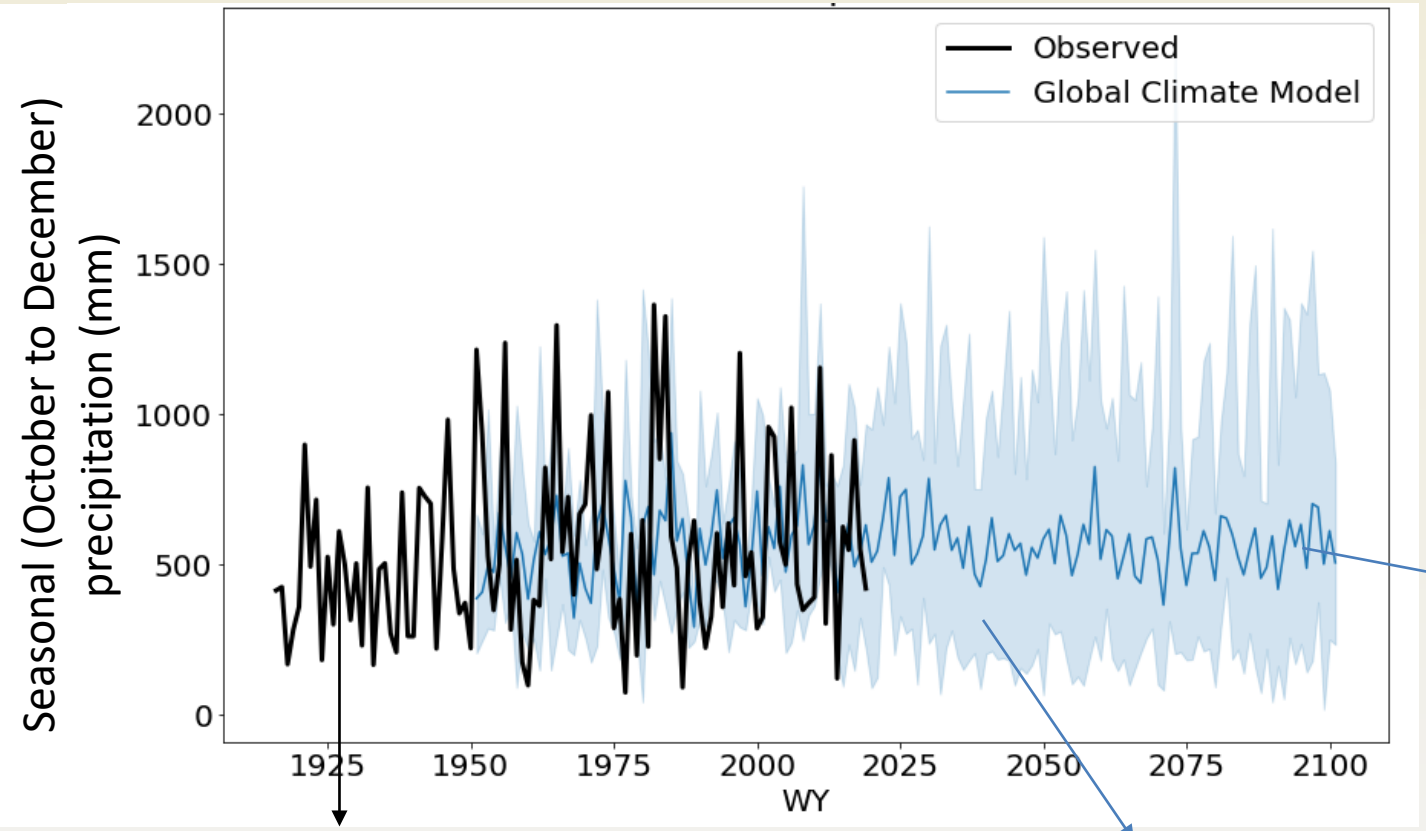
Middle Yuba River

Basin average seasonal (Oct to Dec) precipitation (mm):
observed and projected based on Global Climate Model



Line: average of all models/scenarios

Observed: Livneh dataset

Shaded area represents the ensemble of multiple climate models and scenarios (both observed and projected)

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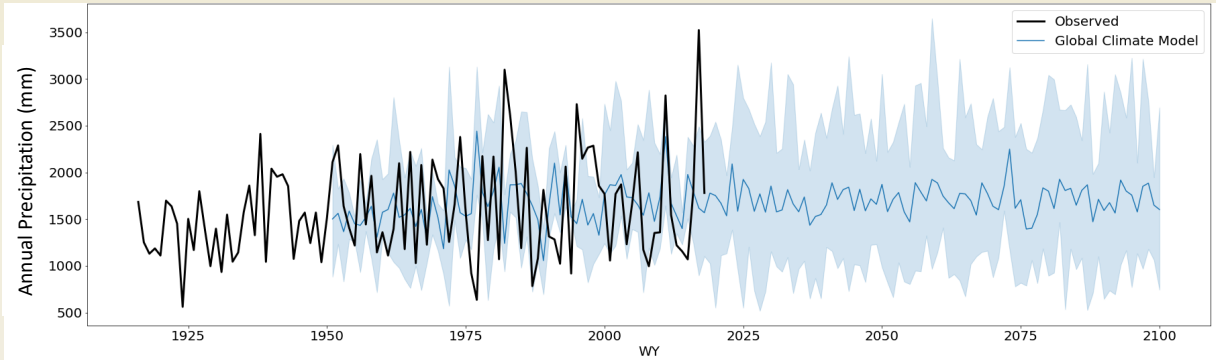
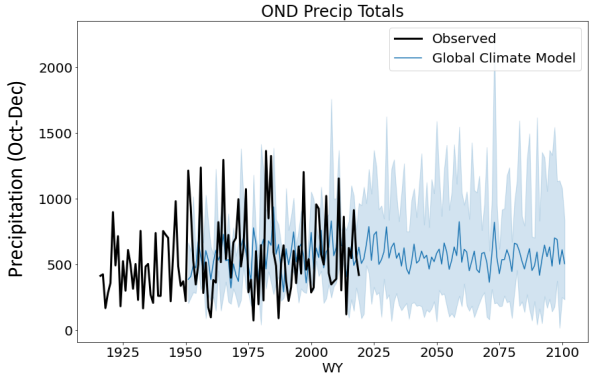
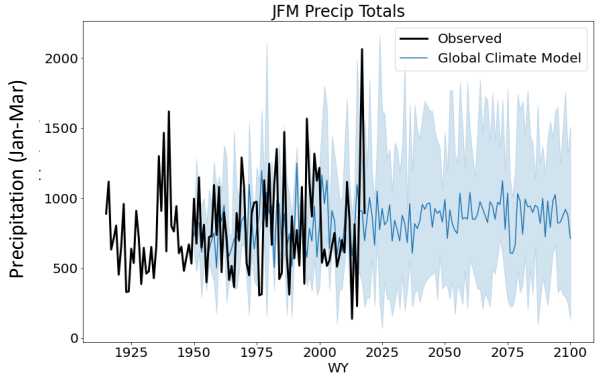
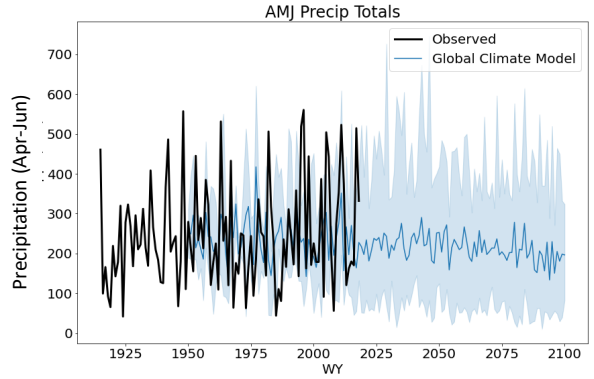
Middle Yuba River

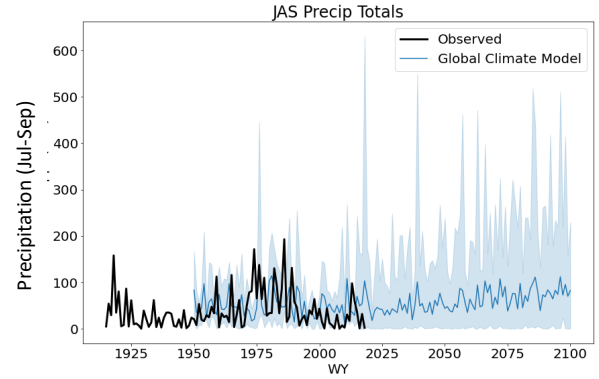
Annual and seasonal precipitation (mm)



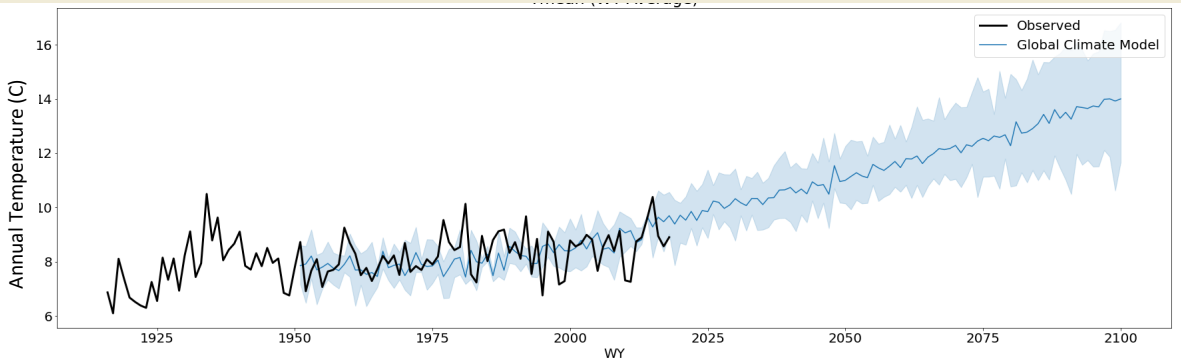


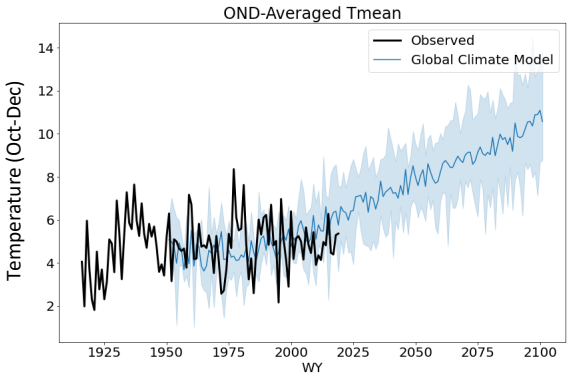


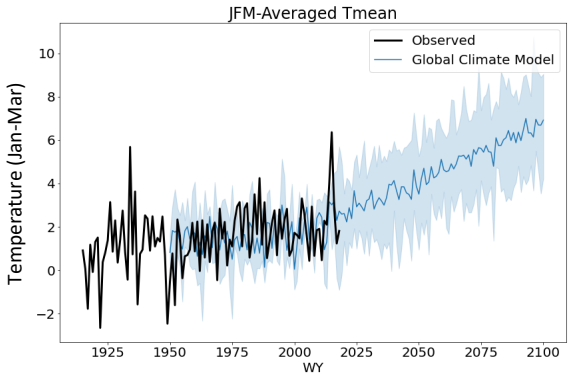


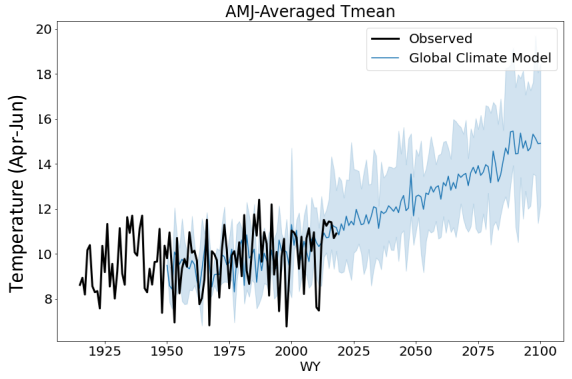


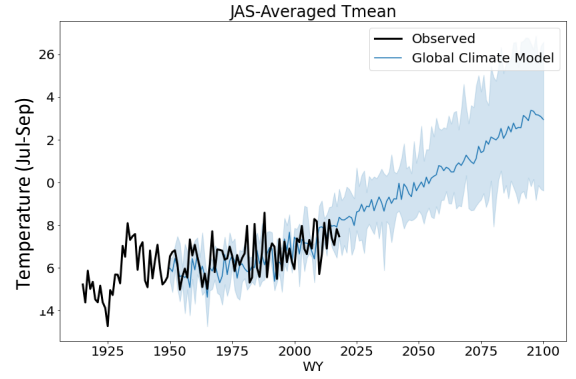
Annual and seasonal temperature (C)



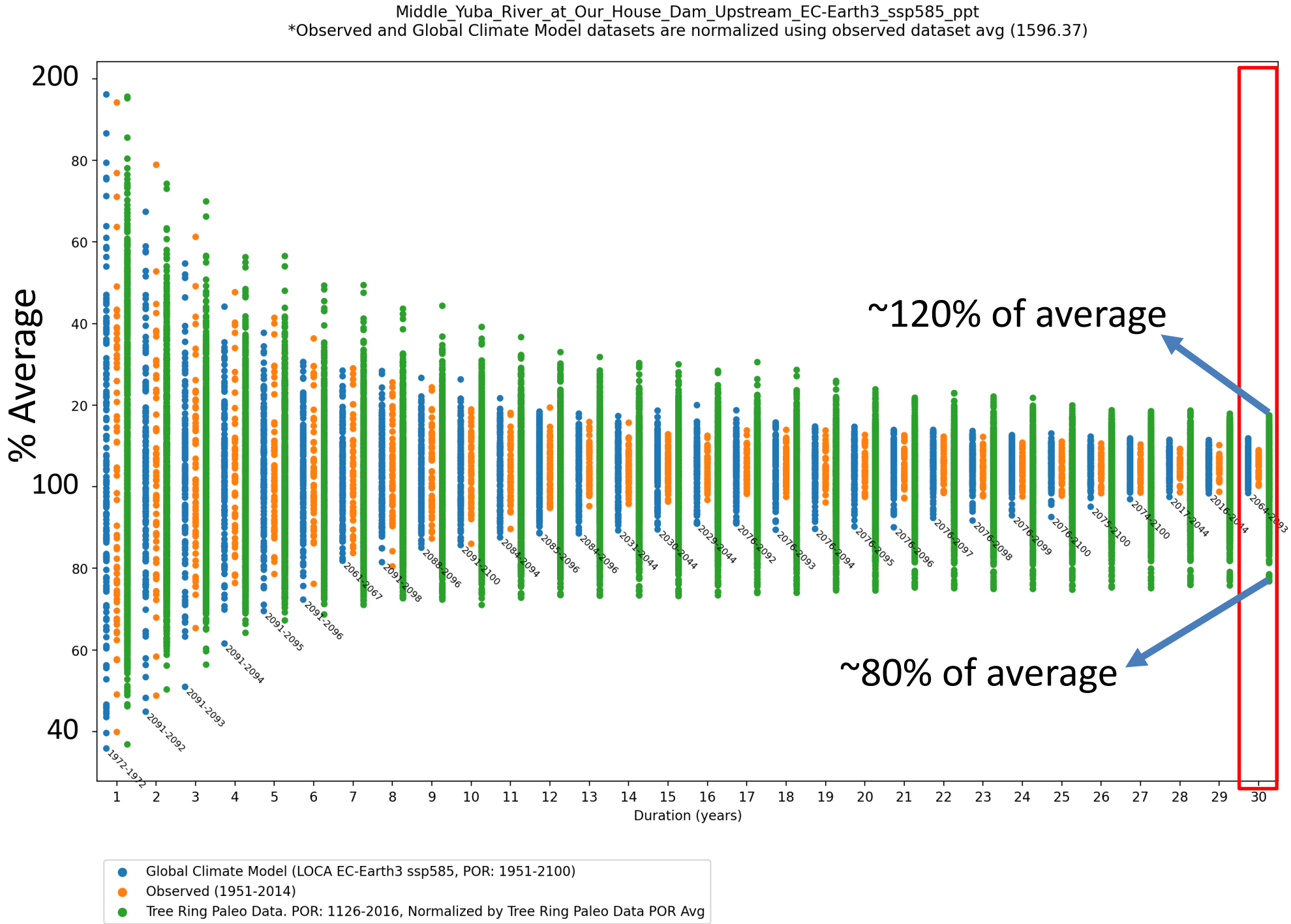








Paleo Data



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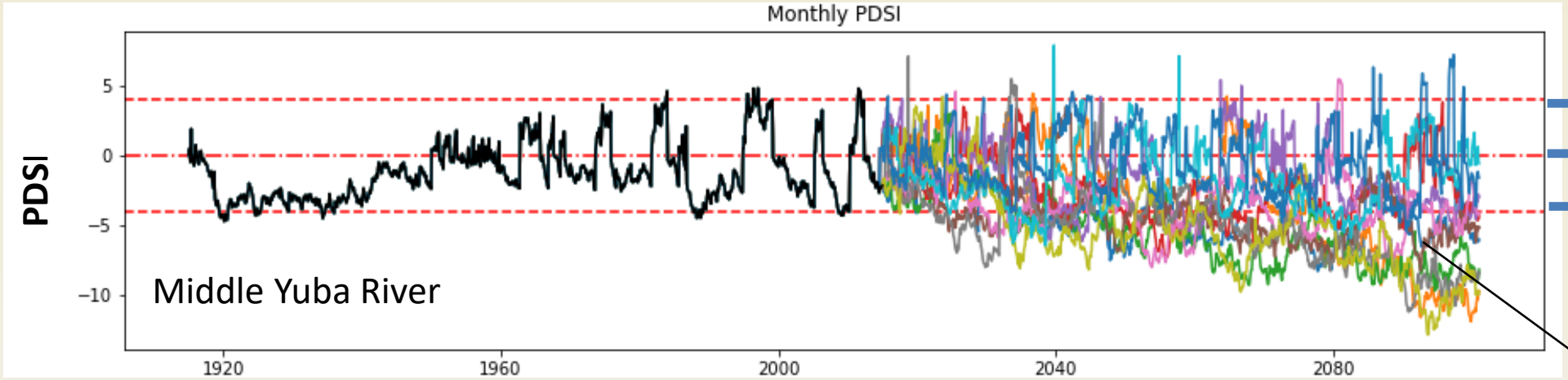
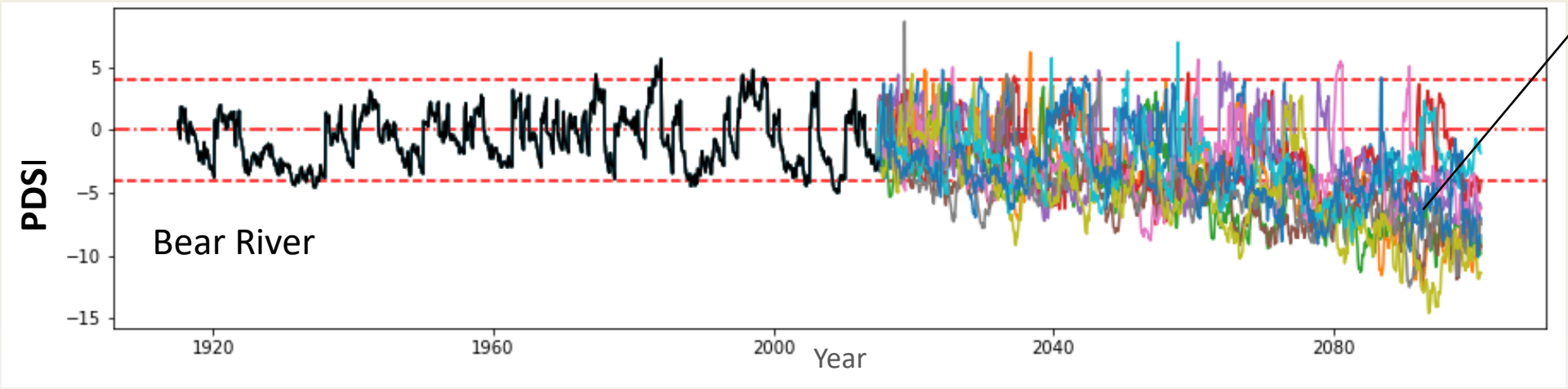
Precipitation and Temperature: Combined Effect

PDSI: Palmer Drought Severity Index





Extreme Wet Spell

Normal

Extreme Dry Spell

Multiple lines represent different climate models and scenarios

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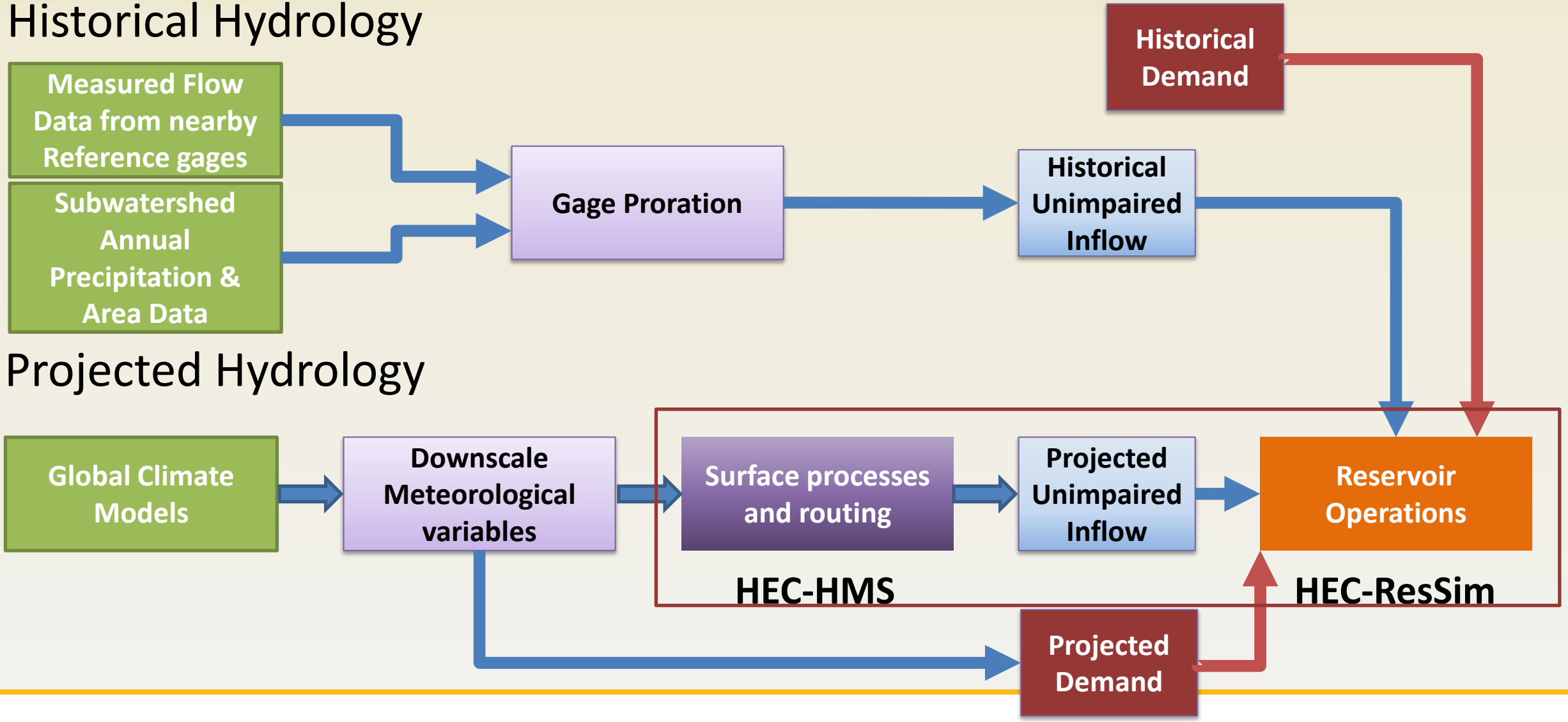
Reference: https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi

Next Step

Historical Hydrology



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Historical Unimpaired Hydrology

NID Plan for Water
May 18, 2023

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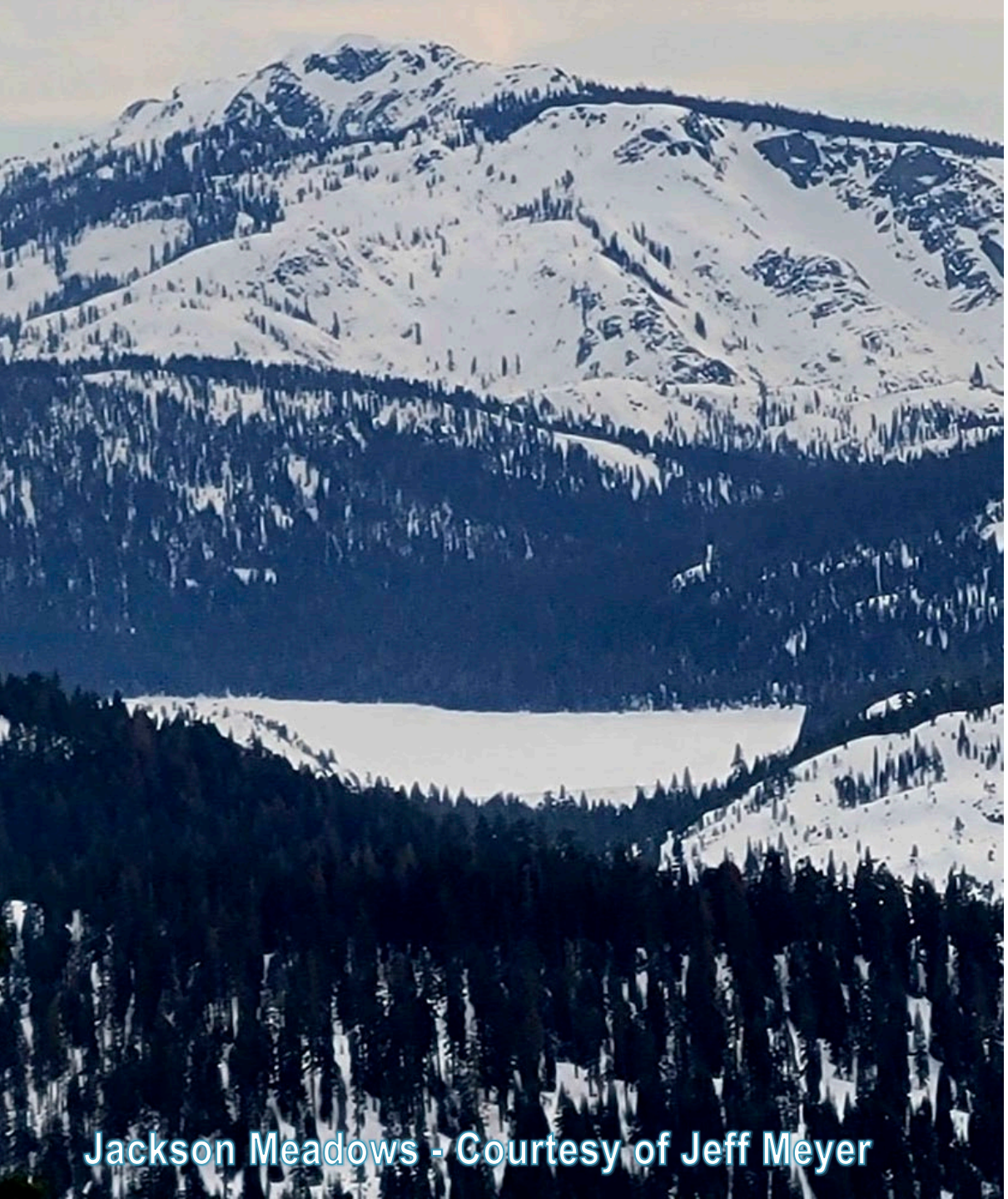


AGENDA

Historical Unimpaired Hydrology

- Objectives
- History
- Database & Hydrology Extension
- Validation

Objectives

- Develop unimpaired hydrology representative of historical conditions
- Compatible with HEC-ResSim
- Support NID's Plan for Water process

Plan for Water

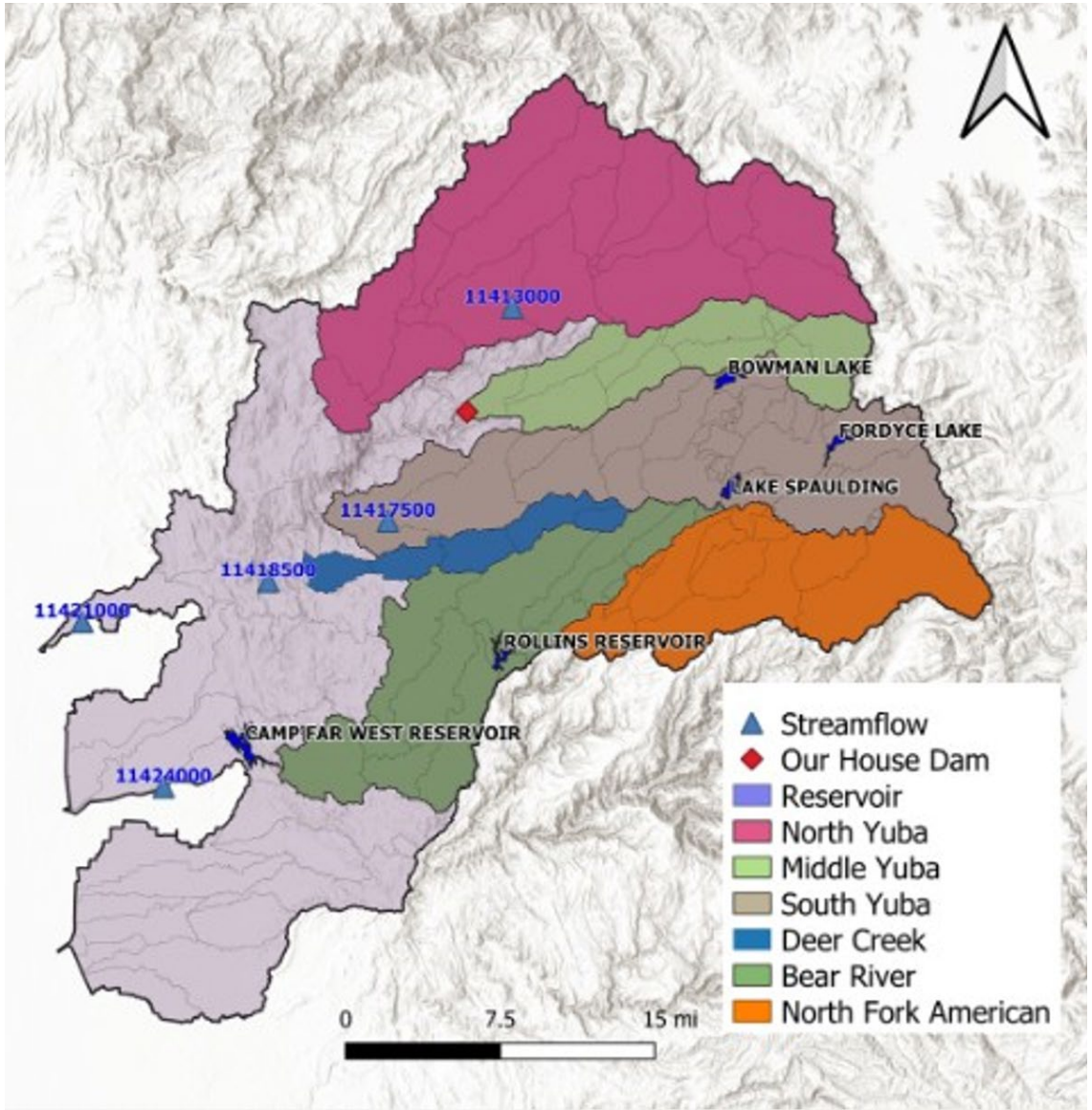
Timeline of Historic Unimpaired Hydrology Development

- 2010 FERC relicensing
  - WYs 1976-2008
- 2020 Raw Water Master Plan (RWMP) update
  - WYs 1976-2011
- 2023 Plan for Water
  - WYs 1976-2021
- All datasets were developed for compatibility with NID's HEC-ResSim model

Unimpaired Hydrology Database

82 Total Subbasins:

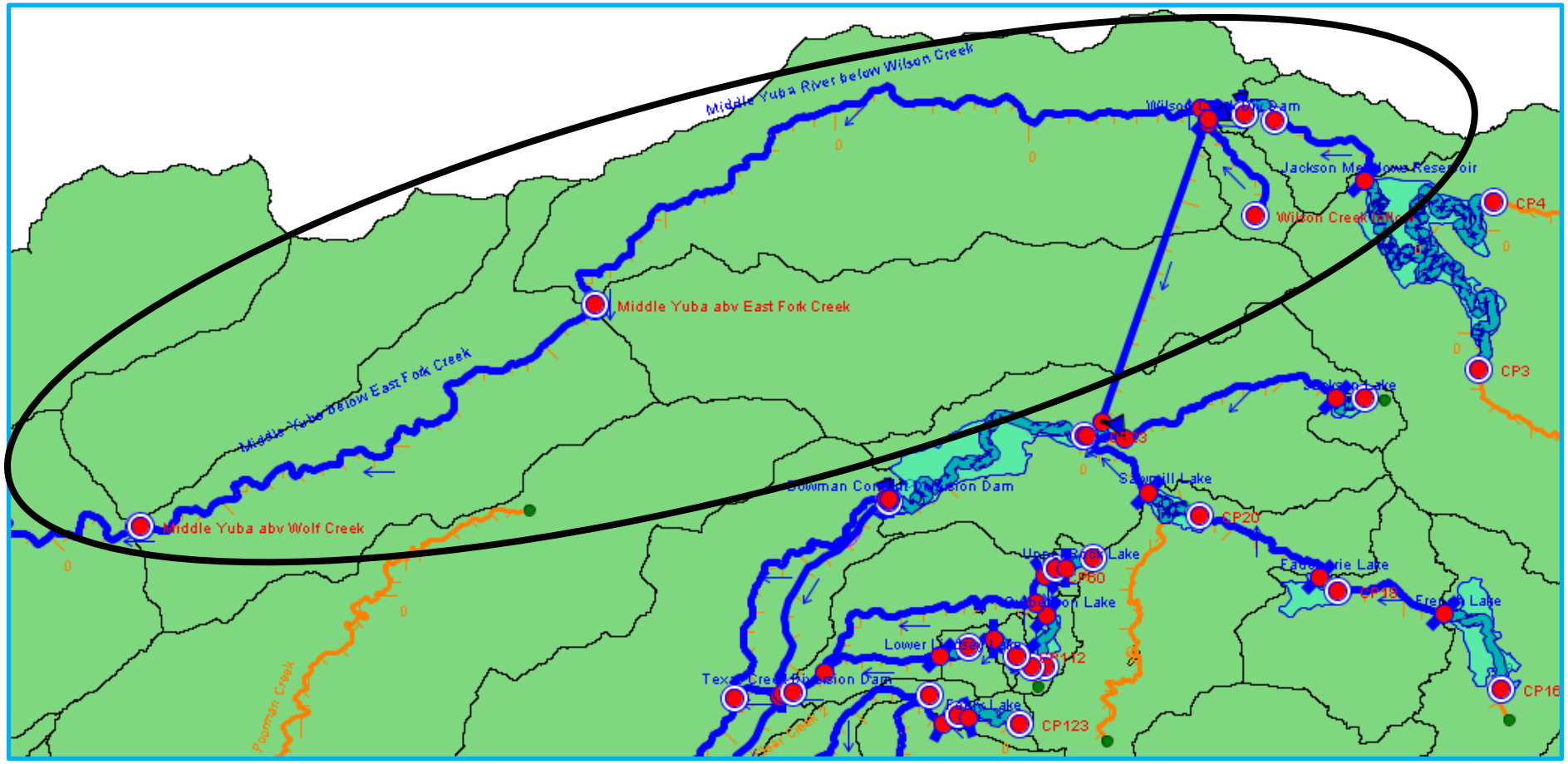
- Middle Yuba River
- South Yuba Rivers
- NF of NF American River
- Bear River
- Deer Creek
- Coon Creek
- Auburn Ravine



Hydrology Extension

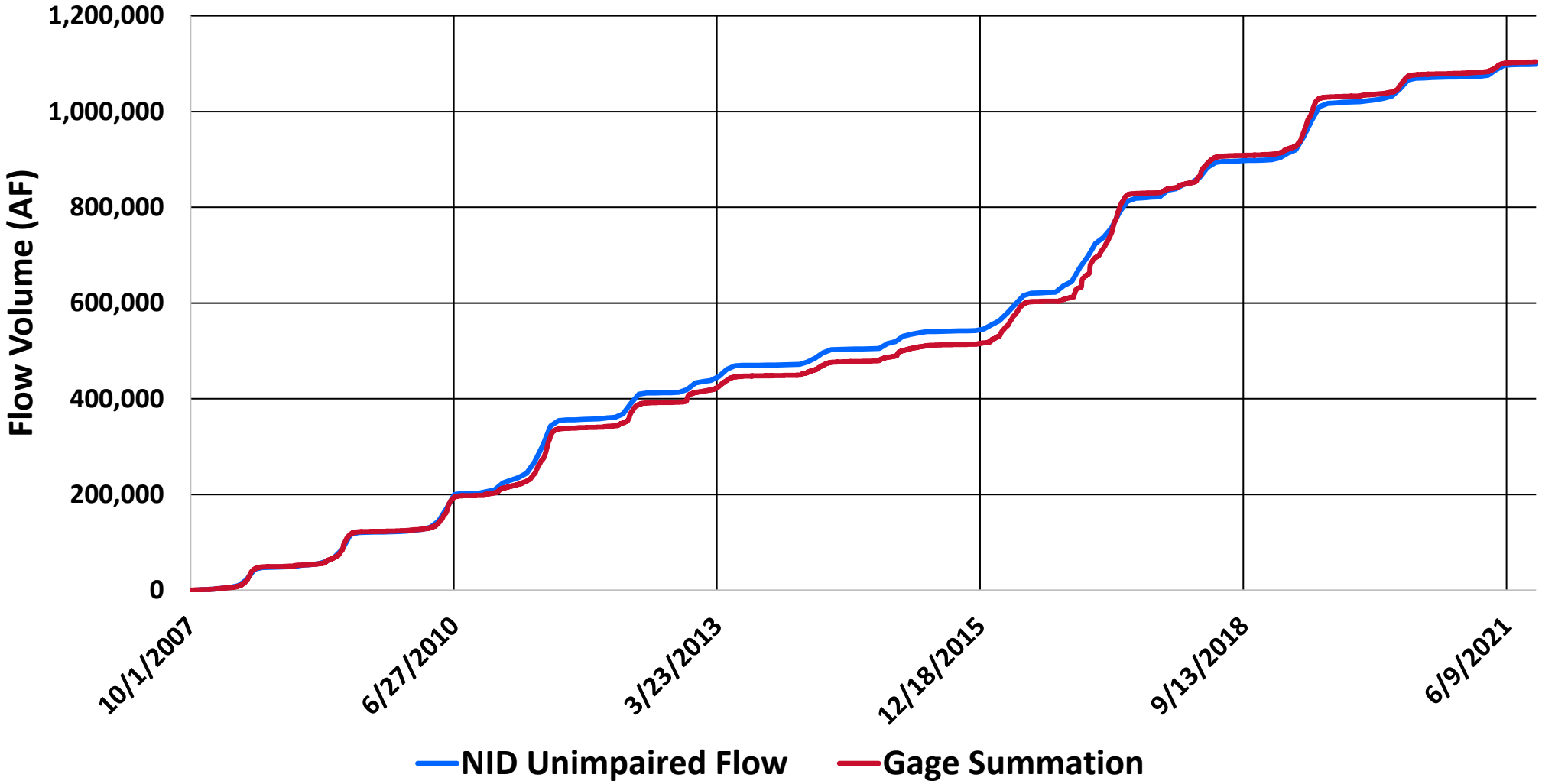
- WYs 2012 through 2021
- Used existing gage proration methods (HDR 2020)
- Gage proration assumes runoff is proportional to the drainage area and annual precipitation.

Example: Middle Yuba River



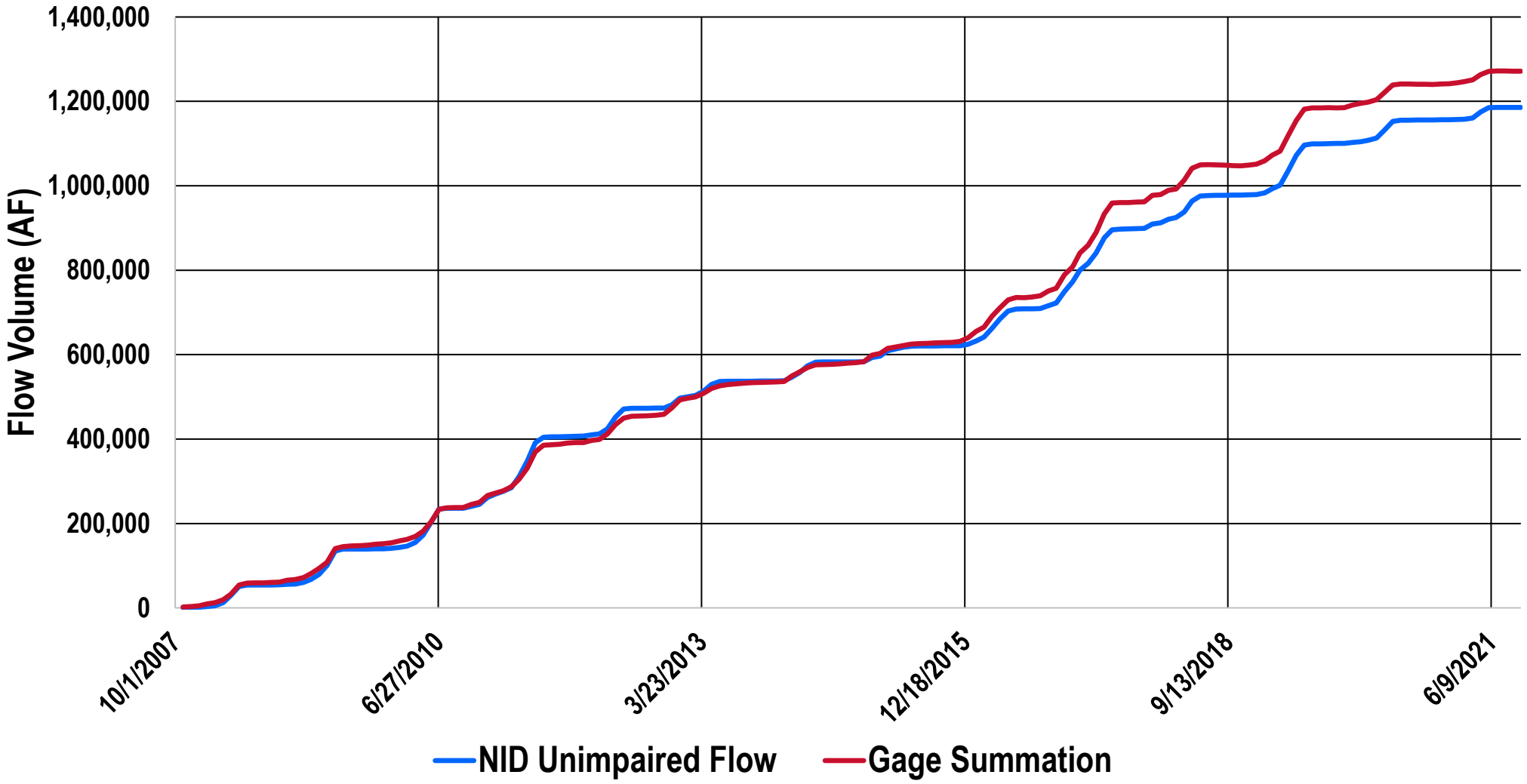
Middle Yuba River Flow Validation

Jackson Meadows Monthly Accumulation: 2008-2021



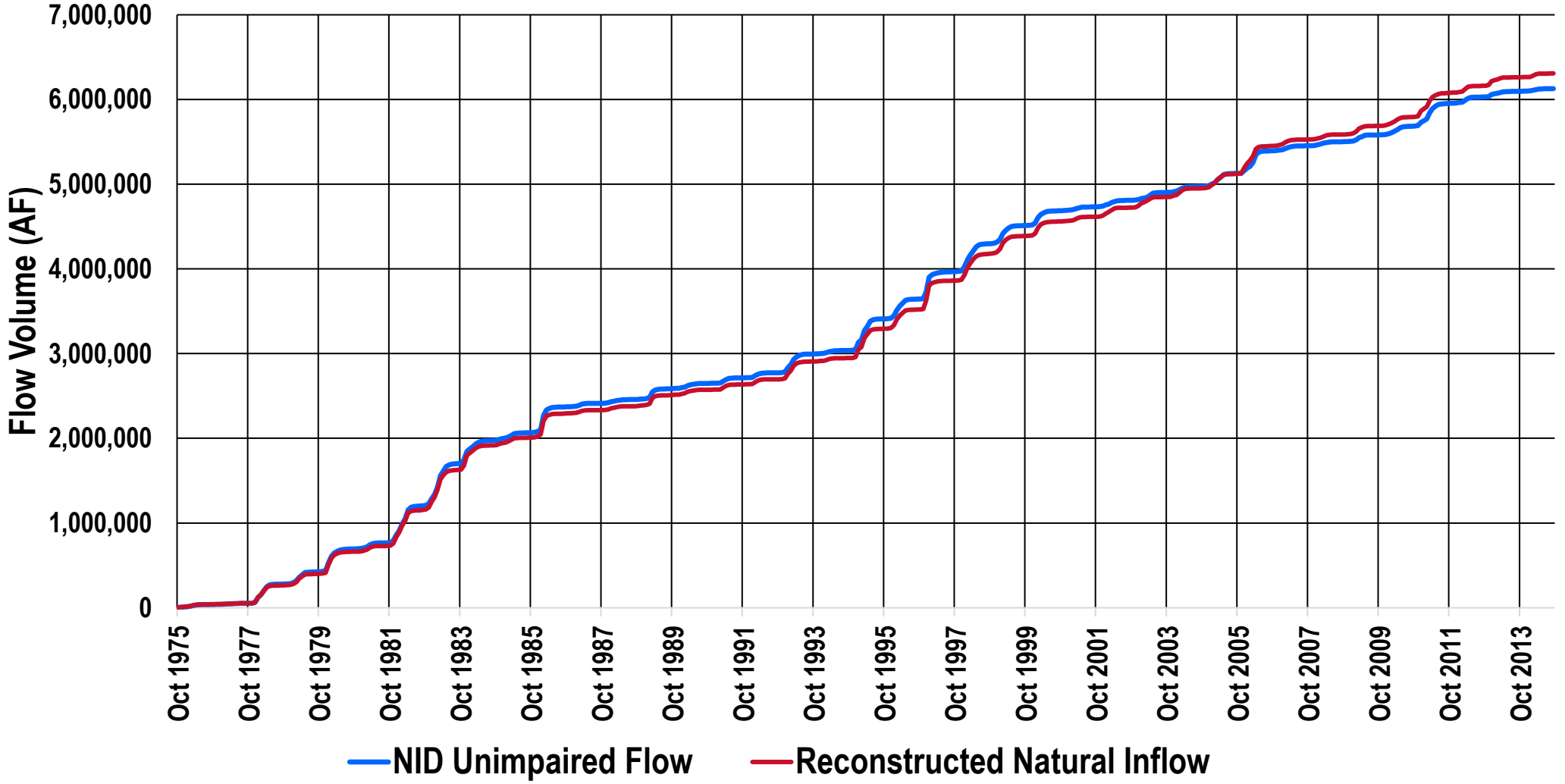
Canyon Creek Flow Validation

Bowman Lake Monthly Accumulation: 2008-2021



Bear River Flow Validation

Rollins Reservoir Monthly Accumulation 1976-2014



Next Steps

- Incorporate extended hydrology dataset into HEC-ResSim
- Validate regulated model output against regulated gage data

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Discussion and Questions

Global Climate Projections and Unimpaired Hydrology

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References

CMIP6

- https://pcmdi.llnl.gov/CMIP6/
- https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6
- CMIP6 Downscaling Using WRF | Alex Hall's Research Group (ucla.edu)

LOCA

- LOCA statistical downscaling - LOCA Statistical Downscaling (Localized Constructed Analogs) (ucsd.edu)
- Mean and Extreme Climate Change Impacts on The State Water Project
- Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development
- Cal-adapt

EXTRA SLIDES

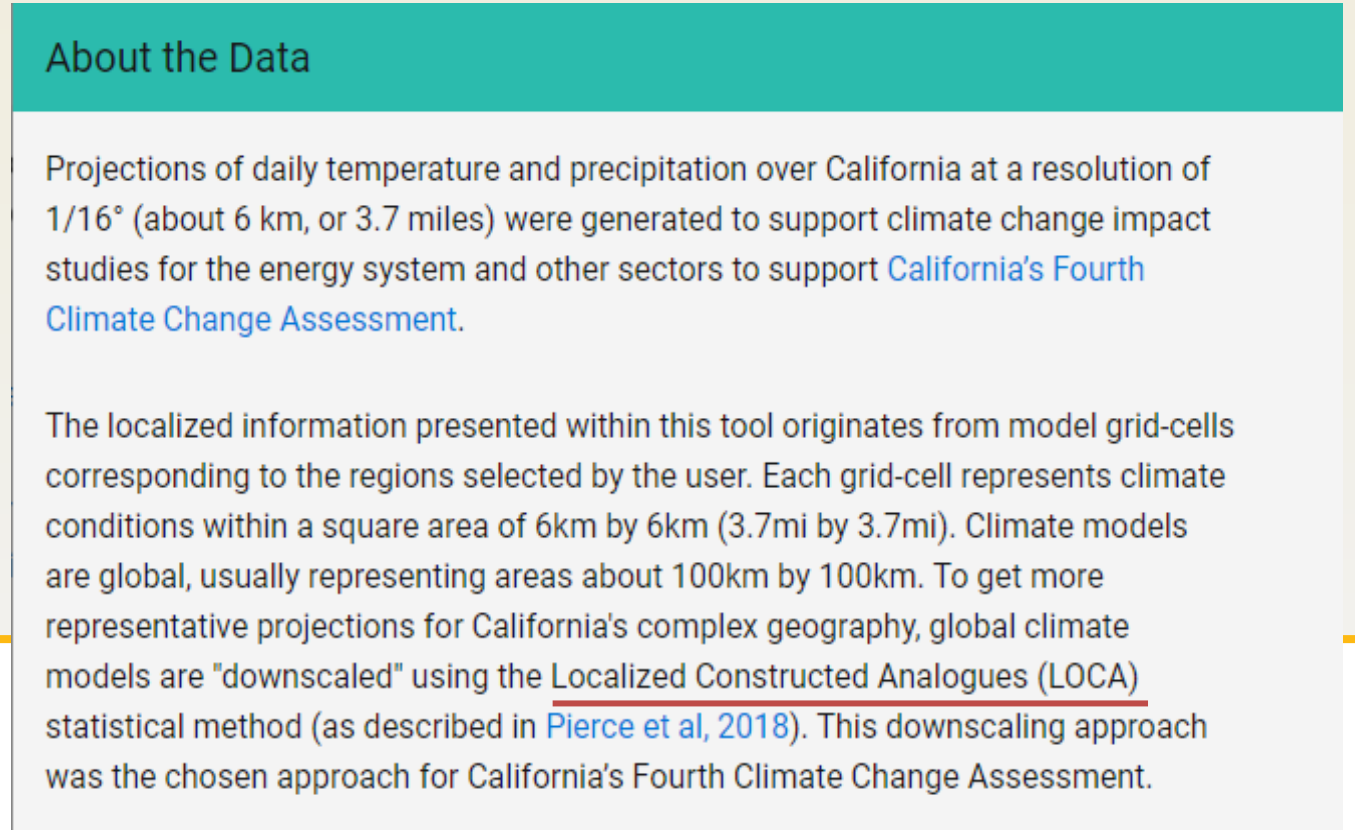
Statistically Downscaled (LOCA)

LOCA statistical downscaling - LOCA Statistical Downscaling (Localized Constructed Analogs) (ucsd.edu)

Mean and Extreme Climate Change Impacts on The State Water Project

Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development

Cal-adapt



About the Data

Projections of daily temperature and precipitation over California at a resolution of 1/16° (about 6 km, or 3.7 miles) were generated to support climate change impact studies for the energy system and other sectors to support California's Fourth Climate Change Assessment.

The localized information presented within this tool originates from model grid-cells corresponding to the regions selected by the user. Each grid-cell represents climate conditions within a square area of 6km by 6km (3.7mi by 3.7mi). Climate models are global, usually representing areas about 100km by 100km. To get more representative projections for California's complex geography, global climate models are "downscaled" using the Localized Constructed Analogues (LOCA) statistical method (as described in Pierce et al, 2018). This downscaling approach was the chosen approach for California's Fourth Climate Change Assessment.

Unimpaired Reference Streamgages

- South Yuba River at Cisco
  (elev. 5,520 ft, 51.8 sq. mi.)
- Pilot Creek above Stumpy Meadows Reservoir
  (elev. 4,280 ft, 11.7 sq. mi)
- Oregon Creek above Log Cabin Diversion
  (elev. 2,230 ft, 23.0 sq. mi)
- South Honcut Creek near Bangor
  (elev. 644 ft, 30.6 sq. mi.)
- Cosumnes River at Michigan Bar
  (elev. 168 ft, 536 sq. mi.)
- Deadwood Creek near Strawberry Valley
  (elev. 3,275 ft, 5.2 sq. mi.)

Gage Proration Methodology

$$Q_{target} = \left(\frac{A_{target}}{A_{reference}}\right)\left(\frac{P_{target}}{P_{reference}}\right) Q_{reference}$$

Where: Q_{target} is the flow for the subbasin of interest

$Q_{reference}$ is the flow for the reference basin

A_{target} is the drainage area for the subbasin of interest

$A_{reference}$ is the drainage area for the reference basin

P_{target} is the mean annual precipitation for the subbasin of interest

$P_{reference}$ is the mean annual precipitation for the reference basin

GCM Models	Emissions		
	ssp245	ssp370	ssp585
ACCESS-CM2	X	X	X
EC-Earth3	X	X	X
EC-Earth3-Veg	X	X	X
CNRM-ESM2-1	X	X	X
FGOALS-g3	X	X	X
HadGEM3-GC31-LL	X		X
CESM2-LENS		X	

Legend:		
	X	Best performing GCMs with accurate representation of California climate
	X	2nd best performing GCMs with accurate representation of California climate
		Downscaled data not available

NOTES:

1) Red items means downscaled emission scenario is not available.

2) Downscaled UKESM1-O-LL GCM is not available.

3) Missing data for dynamically downscaling GCMs do not adversely impact our analyses.