

RECLAMATION

# Summary of Climate and Surface Water Analyses

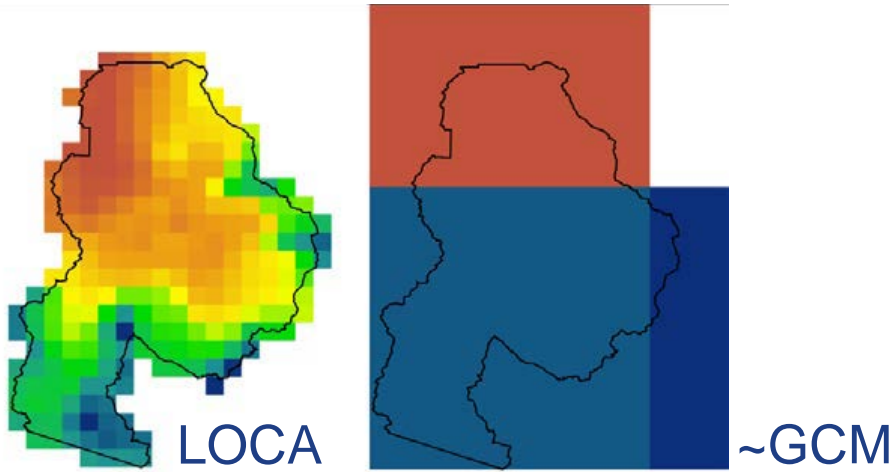


Lindsay Bearup

Bureau of Reclamation, Technical Service Center

October 22, 2019

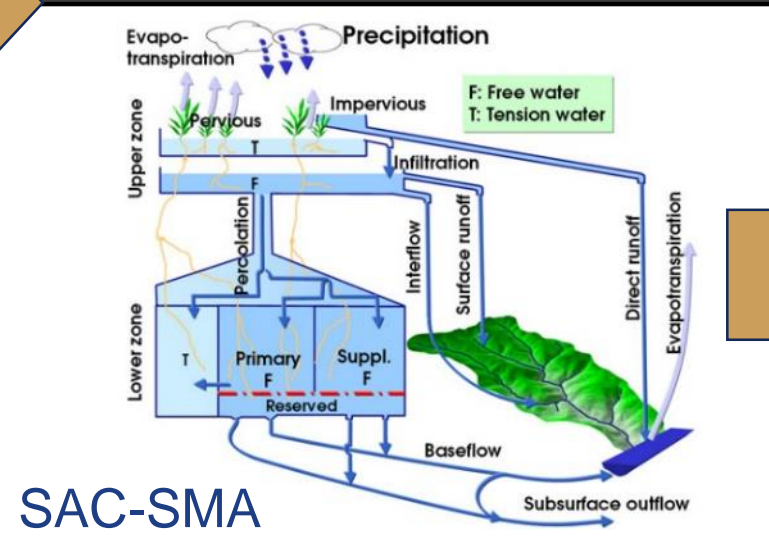
## 1. Downscaled Climate Projections



# Process Overview

Precipitation  
& Temperature

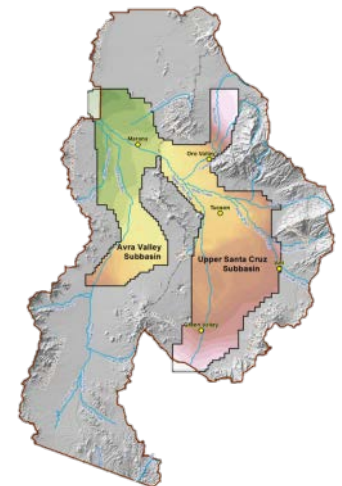
## 2. Surface Water Modeling



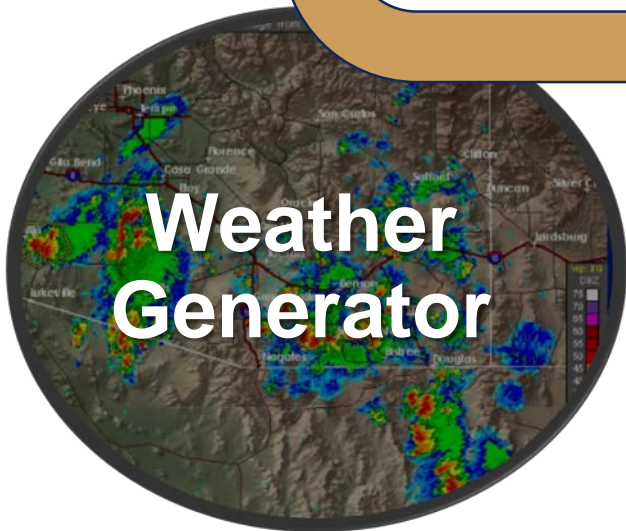
## 3. Groundwater Modeling

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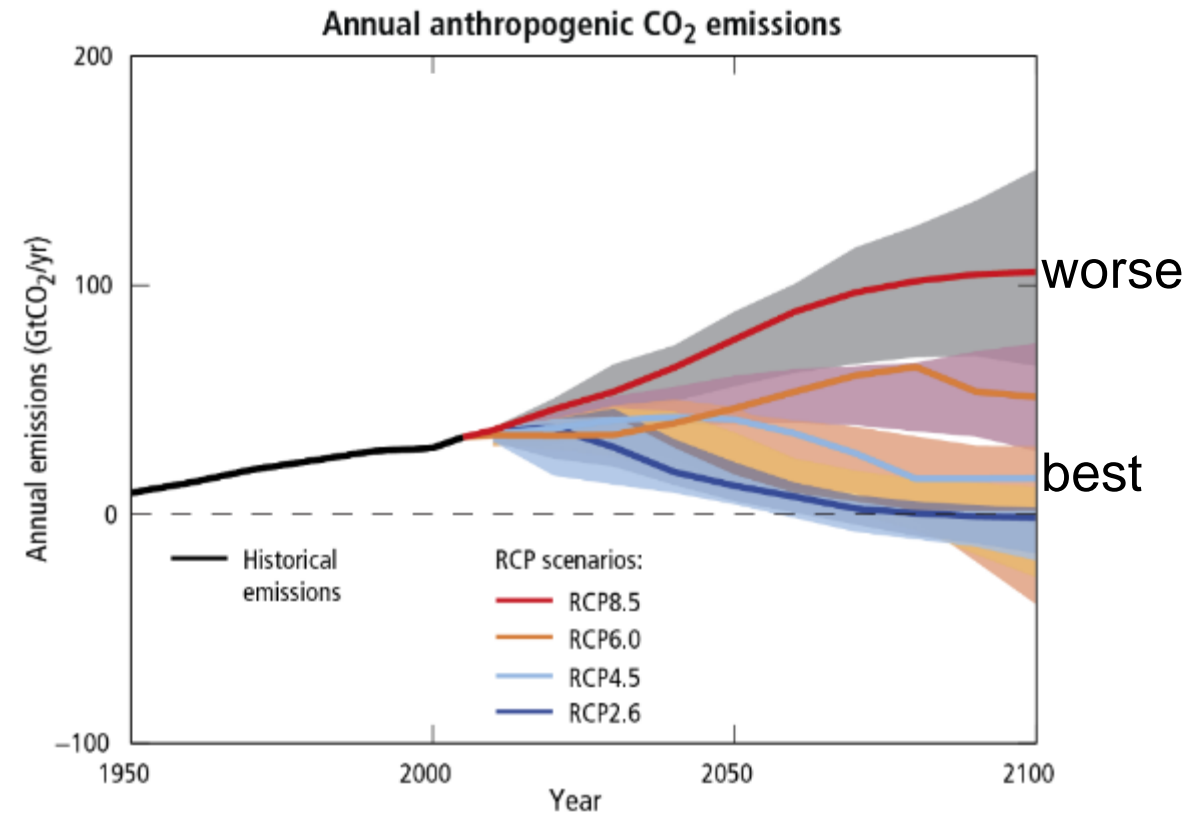


Weather  
Generator



# Future Climate - Analysis Periods

- *Historical: 1970-1999*
  - SAC-SMA calibration period
  - Prior to 2006 start of GCM “Futures”
- *“2030’s” Future: 2020-2049*
  - Near future
- *“2060’s” Future: 2050-2079*
  - Far future
  - Lower Santa Cruz study through 2060
  - Aligns with Colorado River Basin Study analysis through 2060

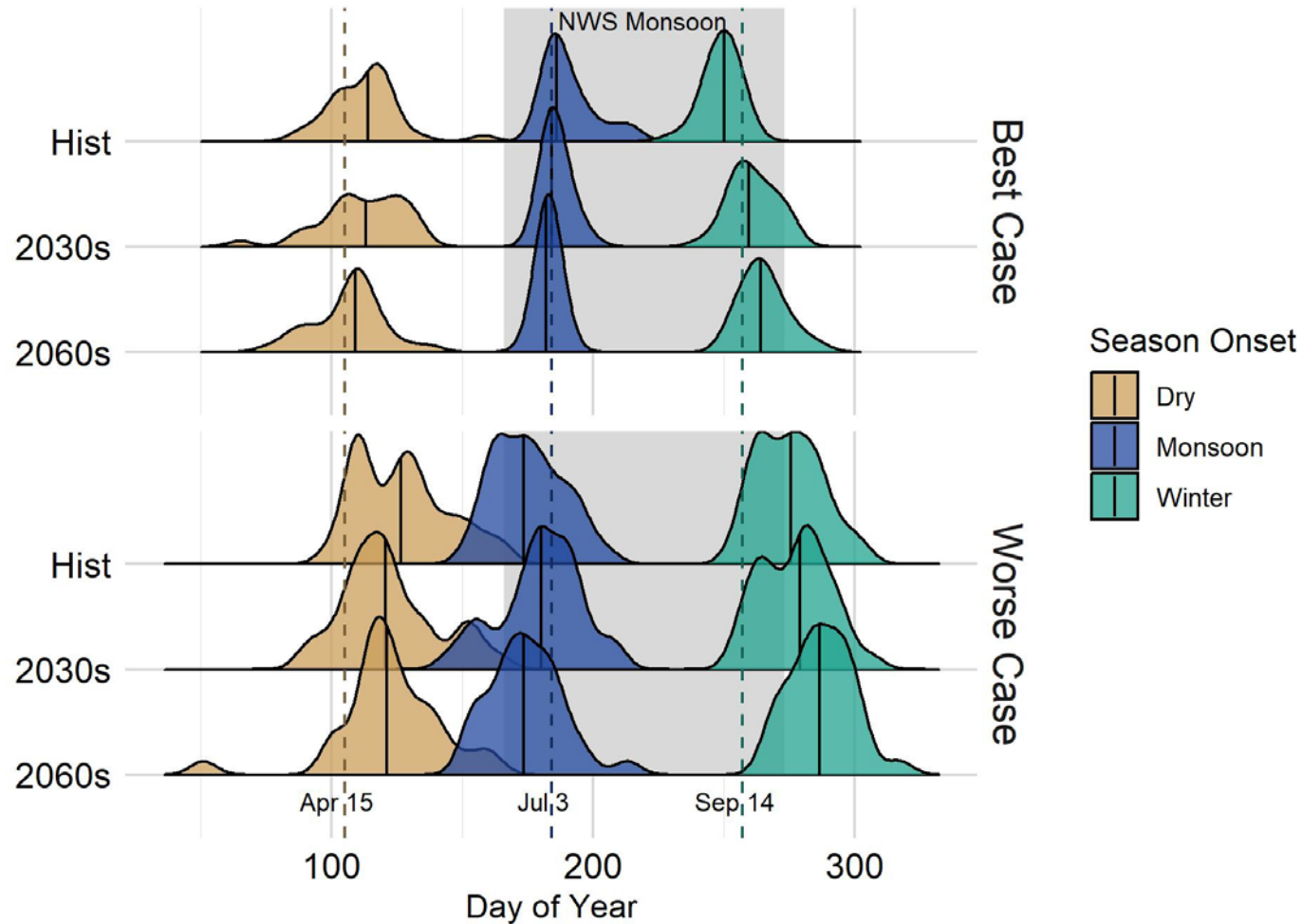


# Future Climate Scenarios

	DOWNSCALING	RCP	DOWNSCALED RESOLUTION	DATE RANGE
<b>HISTORICAL</b>	Statistical & Dynamical	-	6km / 25km	1971-1998
<b>2030'S BEST CASE</b>	Statistical (LOCA)	4.5	6km	2020-2049
<b>2030'S WORSE CASE</b>	Dynamical (WRF)	8.5	25km	2020-2049
<b>2060'S BEST CASE</b>	Statistical (LOCA)	4.5	6km	2050-2079
<b>2060'S WORSE CASE</b>	Dynamical (WRF)	8.5	25km	2050-2079

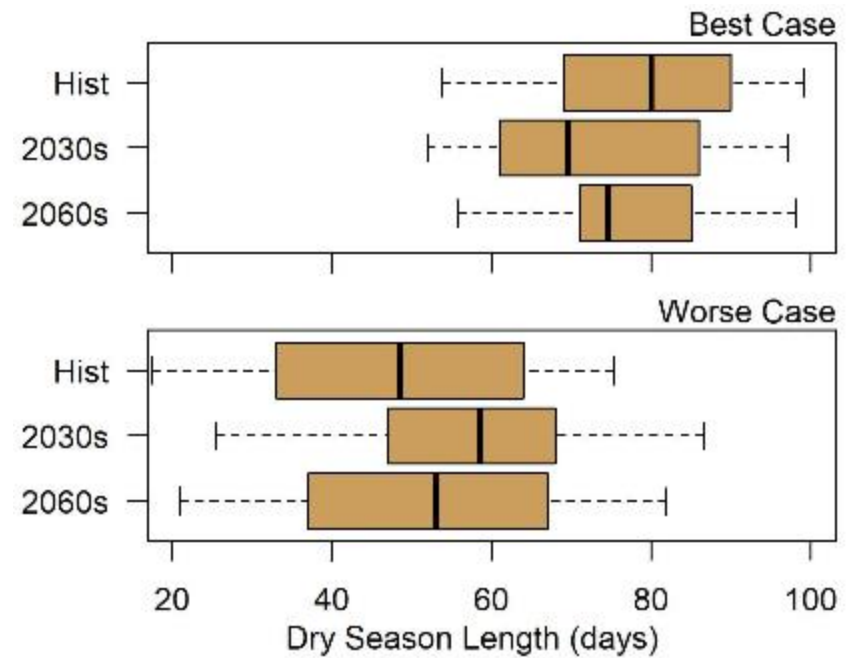
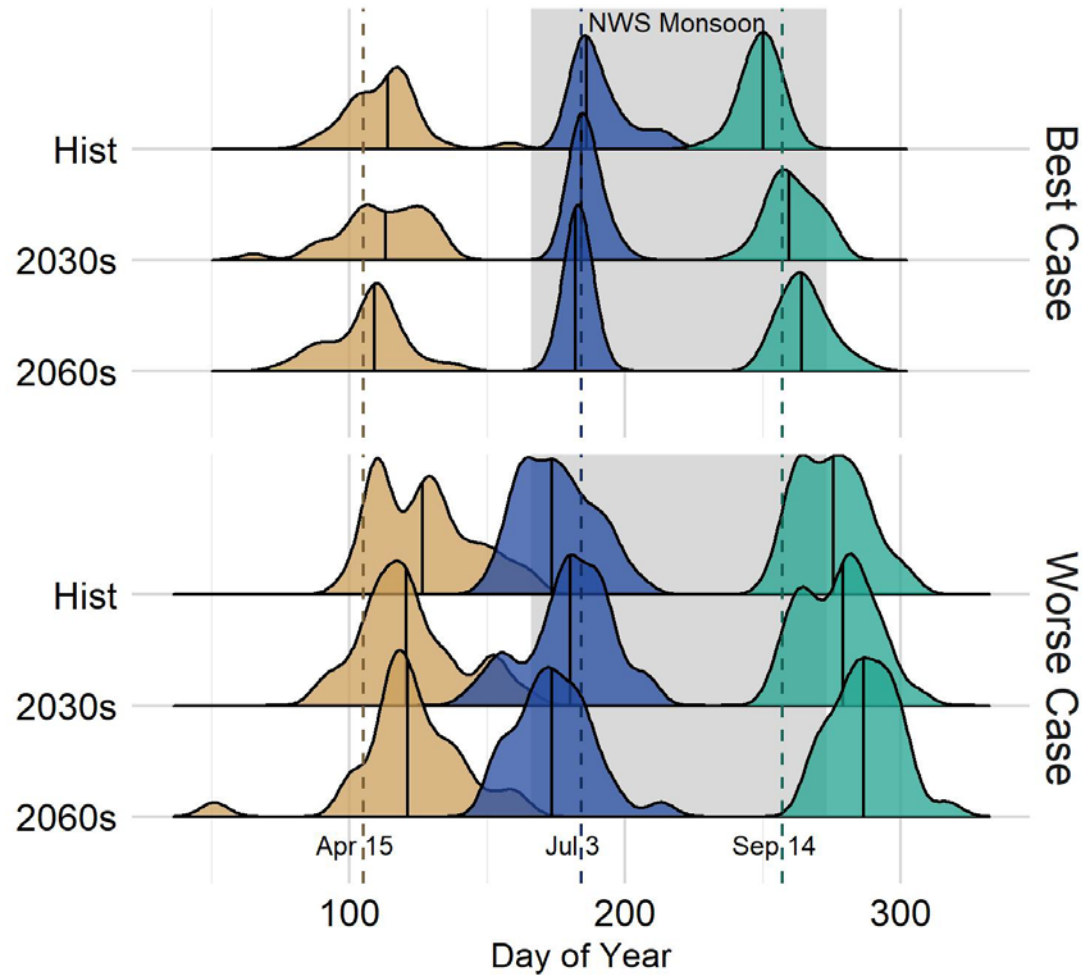


# Future Changes in Seasonality 1.1



- Later demise leads to longer monsoon season
- More variability in seasonal timing under worse case scenario
- Longer dry season in worse case scenario futures

# Future Changes in Seasonality 1.2



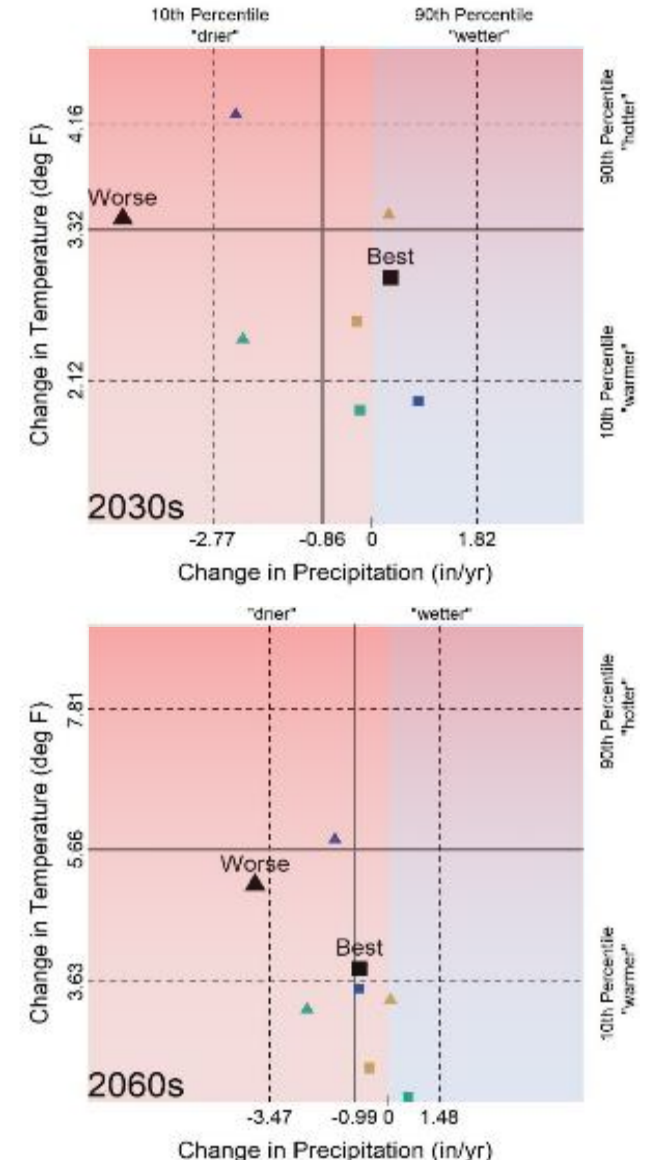
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## Variable Precipitation, Warmer Temperature

	Best 2030s	Best 2060s	Worse 2030s	Worse 2060s
Change in Total Annual Precipitation	0.32"	-0.85"	-4.34"	-3.90"
Change in Average Monsoon Precipitation	0.80"	-0.87"	-2.38"	-1.57"
Change in Average Winter Precipitation	-0.21"	0.57"	-2.25"	-2.38"
Precipitation RSD* Historical - B: 20.3% W: 17.3%	21.6%	28.5%	18.9%	30.4%
Change in Average Annual Temperature	2.94°F	3.83°F	3.41°F	5.12°F
Change in Average Dry Season Temperature	2.59°F	2.31°F	3.44°F	3.34°F
Change in Average Monsoon Temperature	1.96°F	3.52°F	4.24°F	5.81°F
Change in Average Winter Temperature	1.88°F	1.85°F	2.45°F	3.20°F

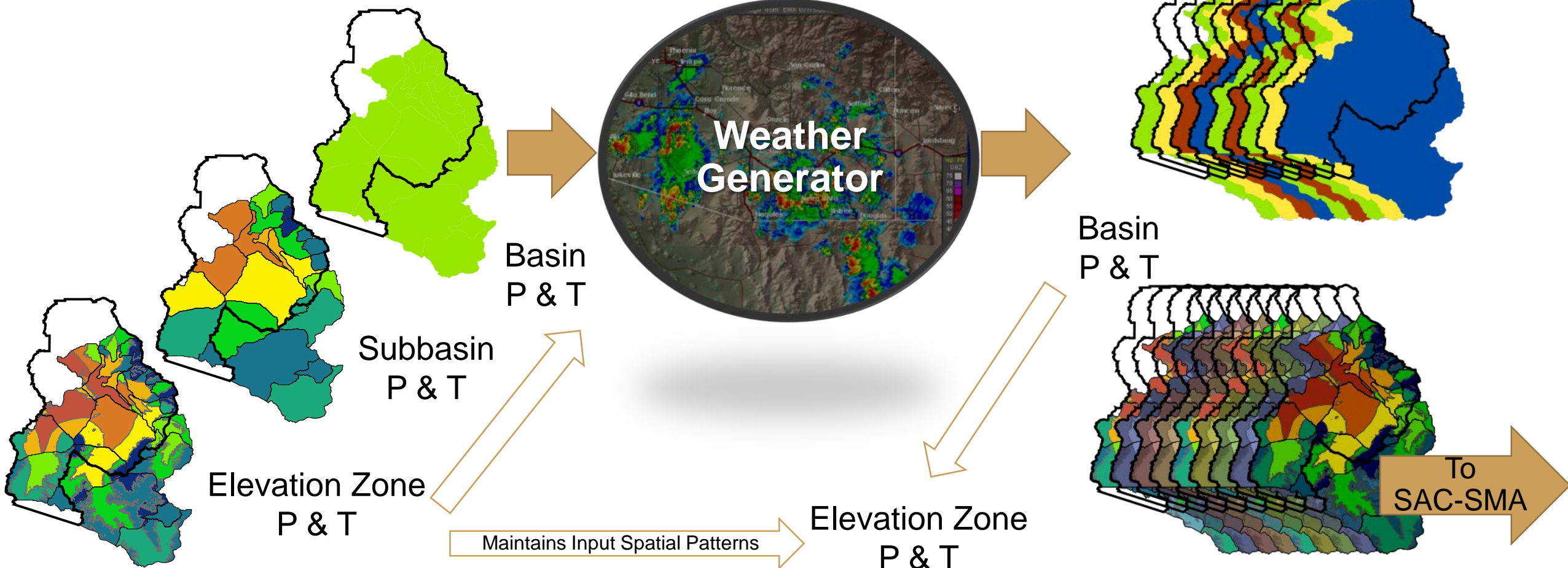
\*RSD = Relative Standard Deviation

The variability in temperature increases but the rsd is small ( $\leq 2\%$ ) relative to precipitation



# Weather Generator

For each day of  
each scenario...





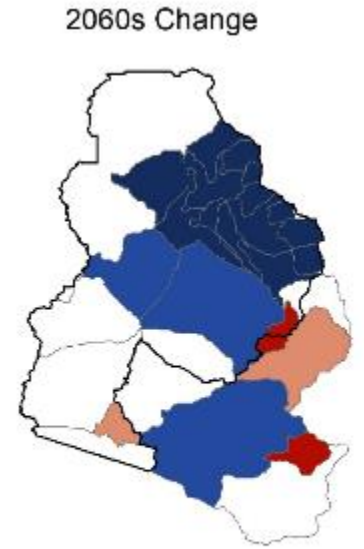
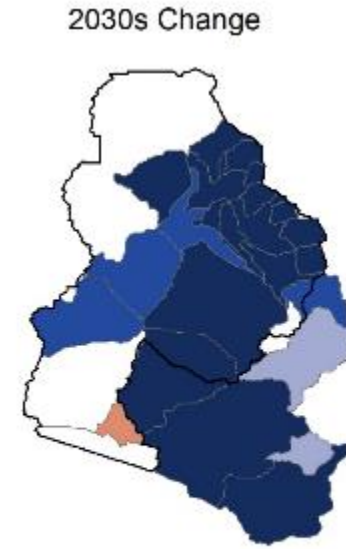
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## Surface Water Modeling Domain

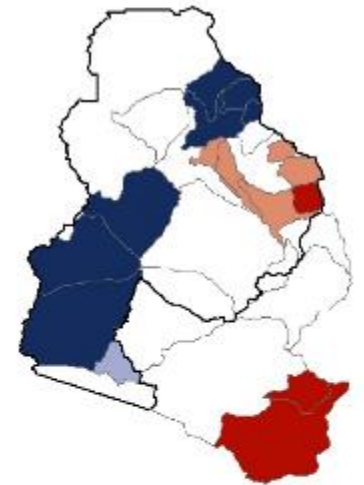
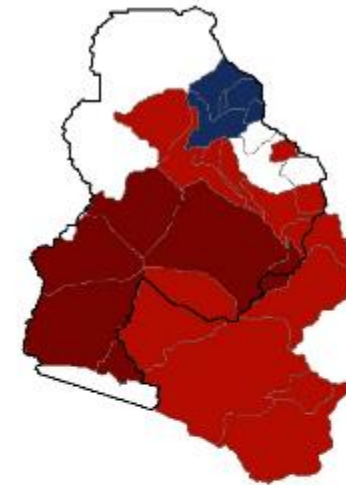


## Monsoon Season Spatial Streamflow

**Best Case Climate**  
results in more  
streamflow



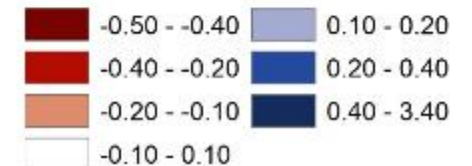
**Worse Case Climate**  
results in less  
streamflow



**Streamflow (ac-ft/season)**

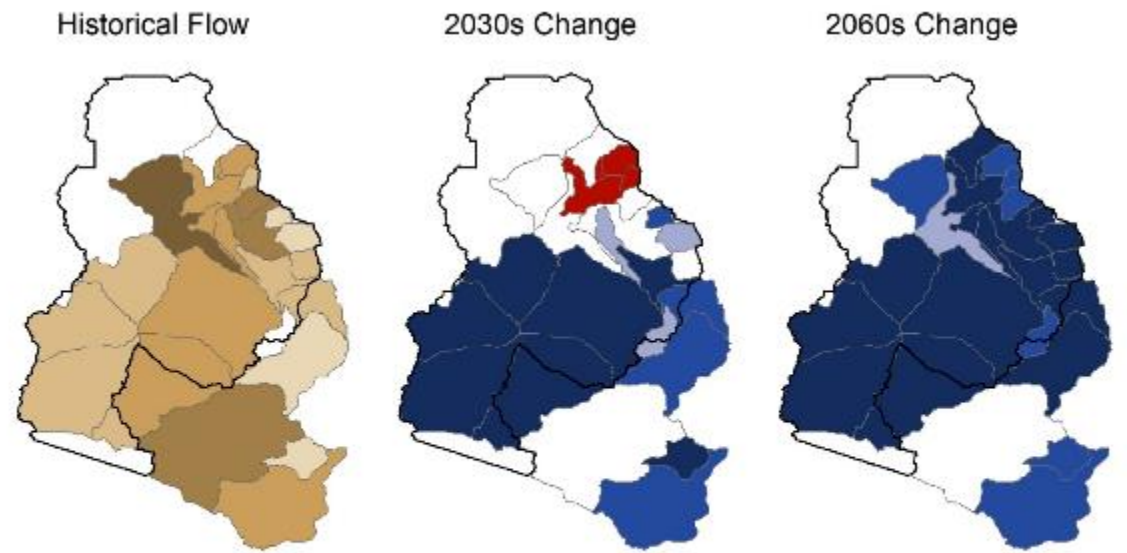


**Fractional Change in Streamflow**

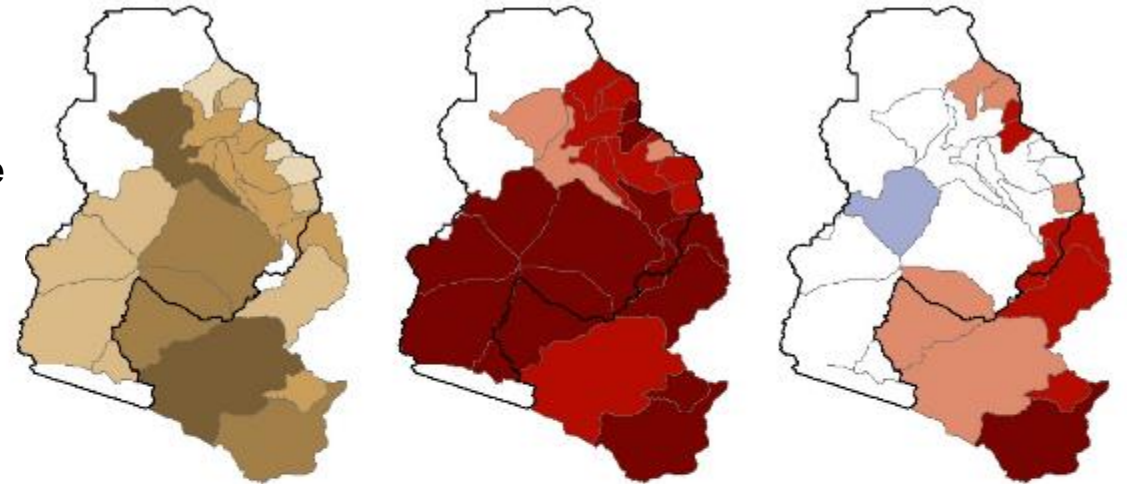


# Winter Season Spatial Streamflow 1.1

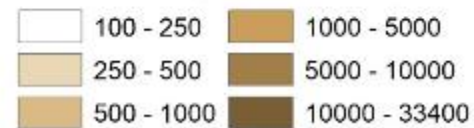
**Best Case Climate**  
results in more  
streamflow



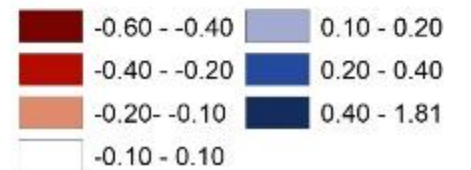
**Worse Case Climate**  
results in less  
streamflow



**Streamflow (ac-ft/season)**



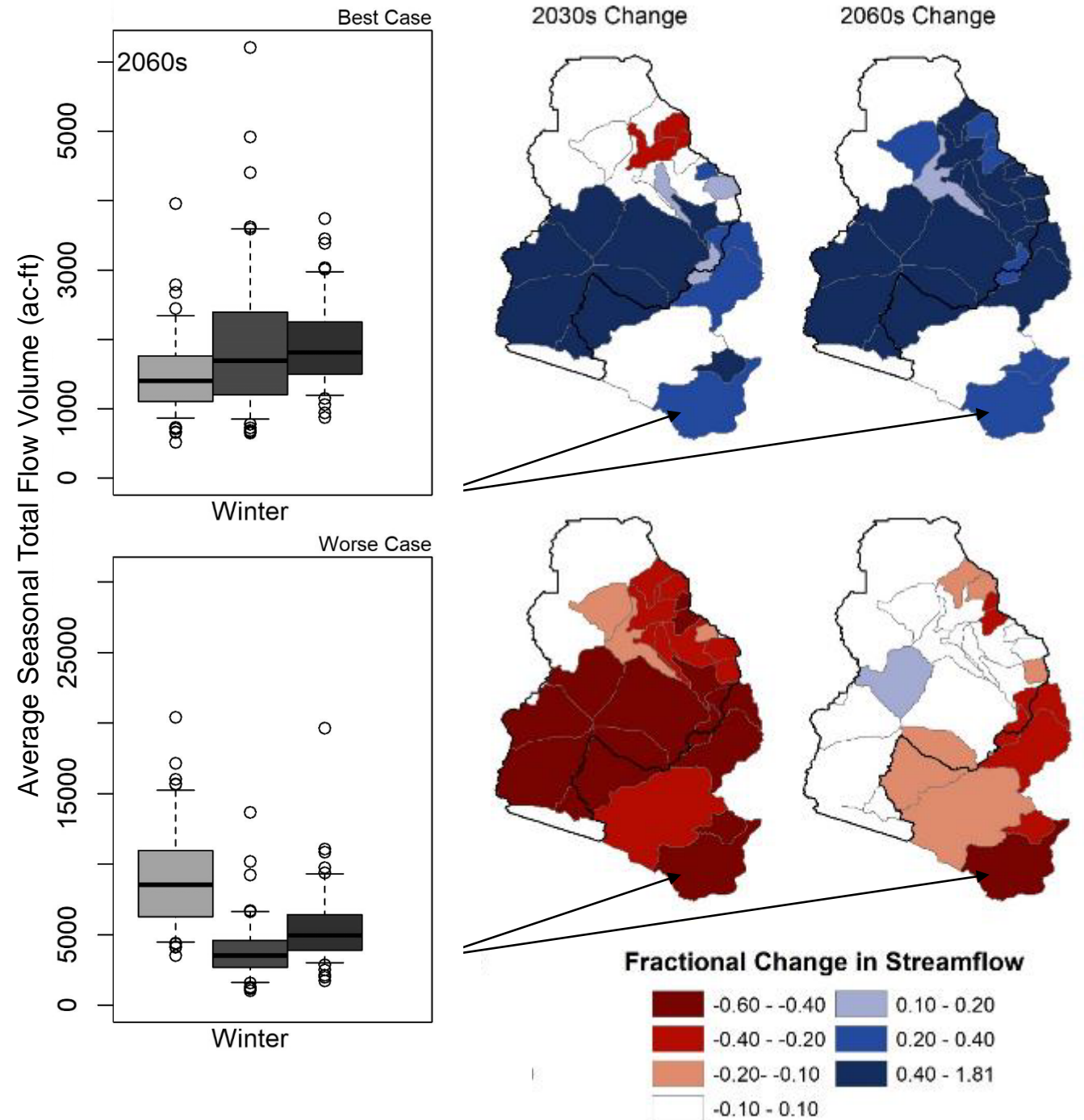
**Fractional Change in Streamflow**



# Winter Season Spatial Streamflow 1.2

But this map is just a  
change in the median of a  
range of possible futures!

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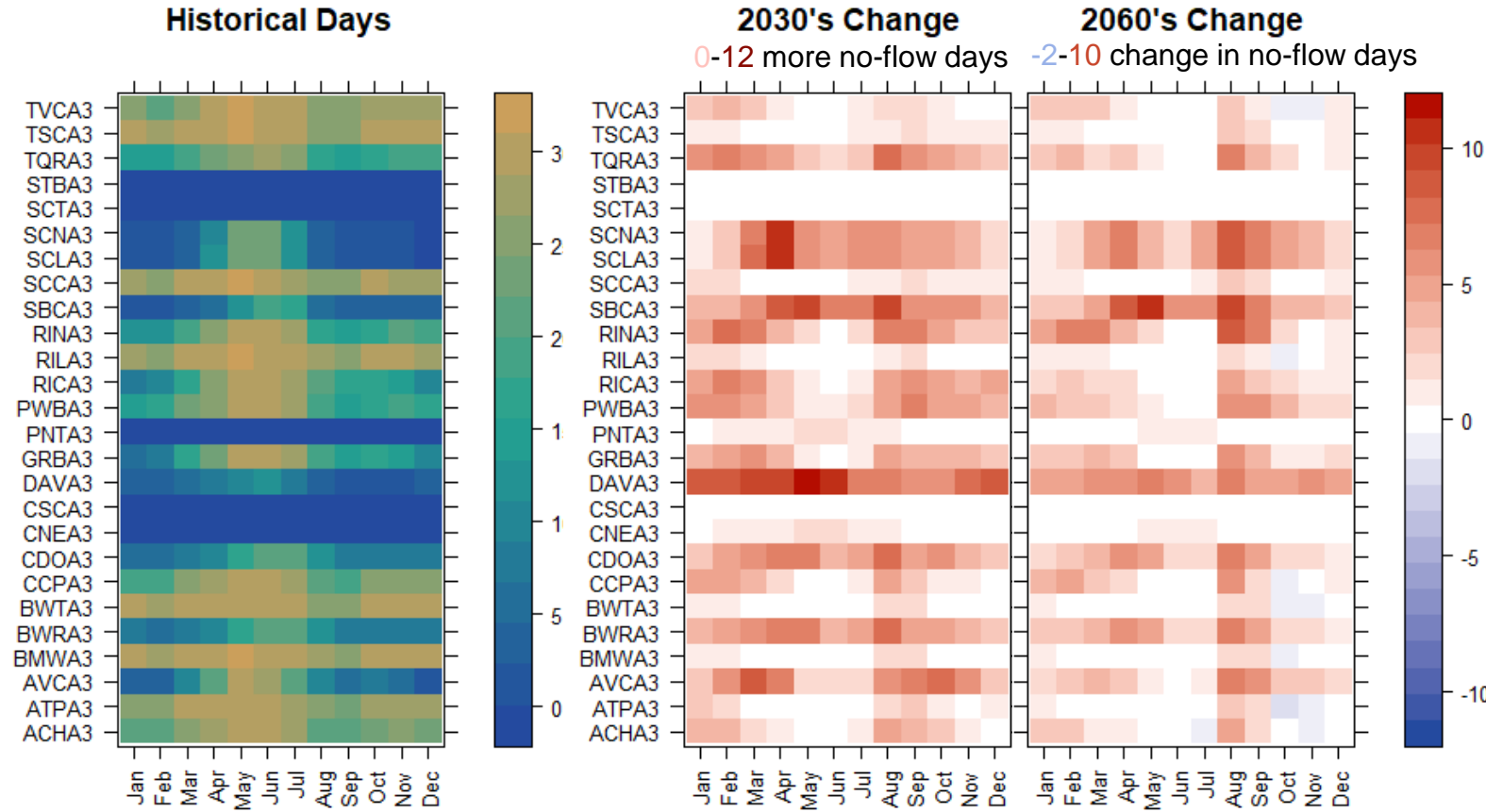




# Consistent Increase in No-Flow Days 1.1 (Worse Case Shown)

## 2030's – Top 5 Increase in dry days (#)

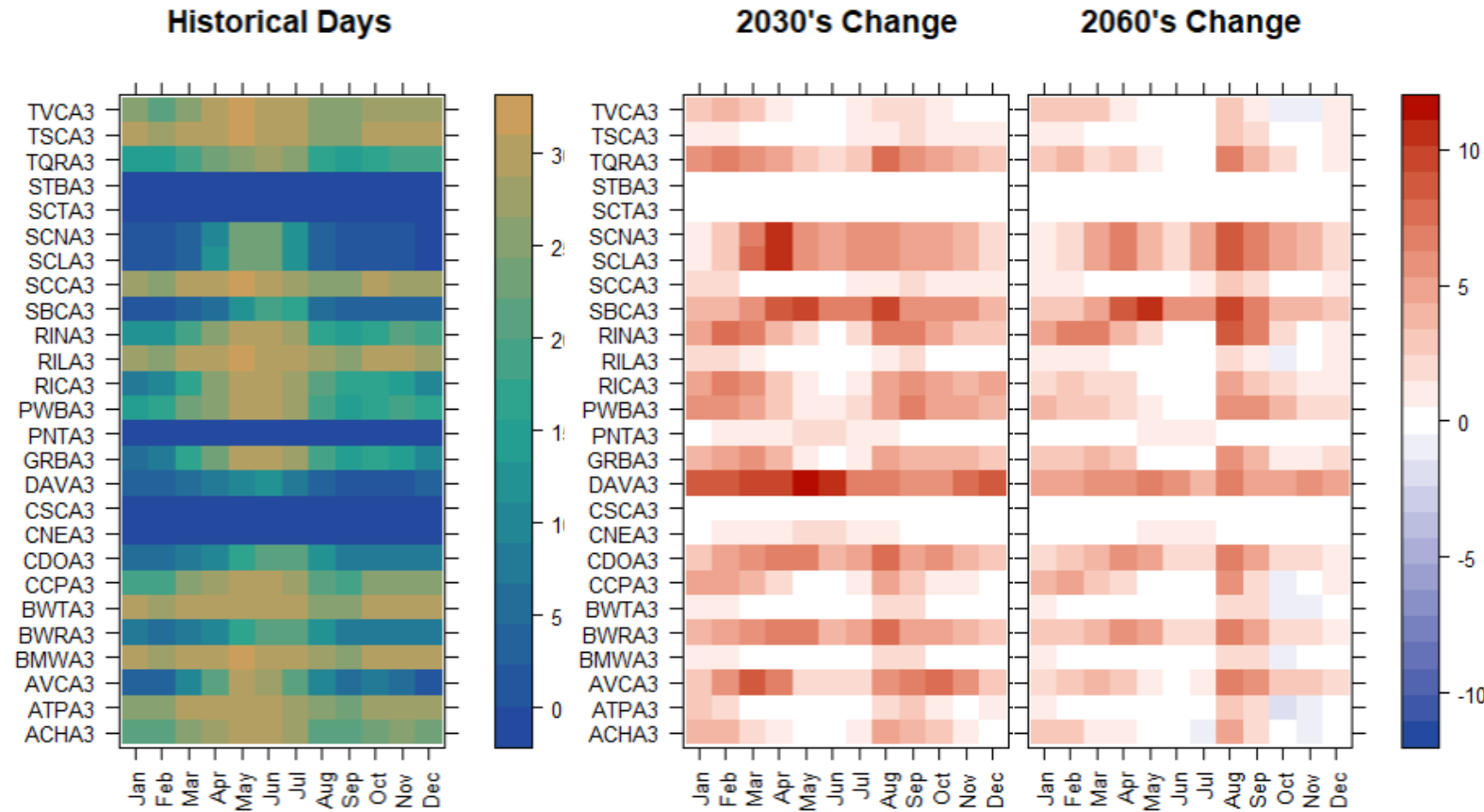
Davidson Canyon (DAVA3)	May	12
Davidson Canyon (DAVA3)	June	11
Santa Cruz nr Nogales (SCNA3)	April	10
Santa Cruz nr Lochiel (SCLA3)	April	10
Sabino Creek (SBCA3)	May	10



# Consistent Increase in No-Flow Days 1.2 (Worse Case Shown)

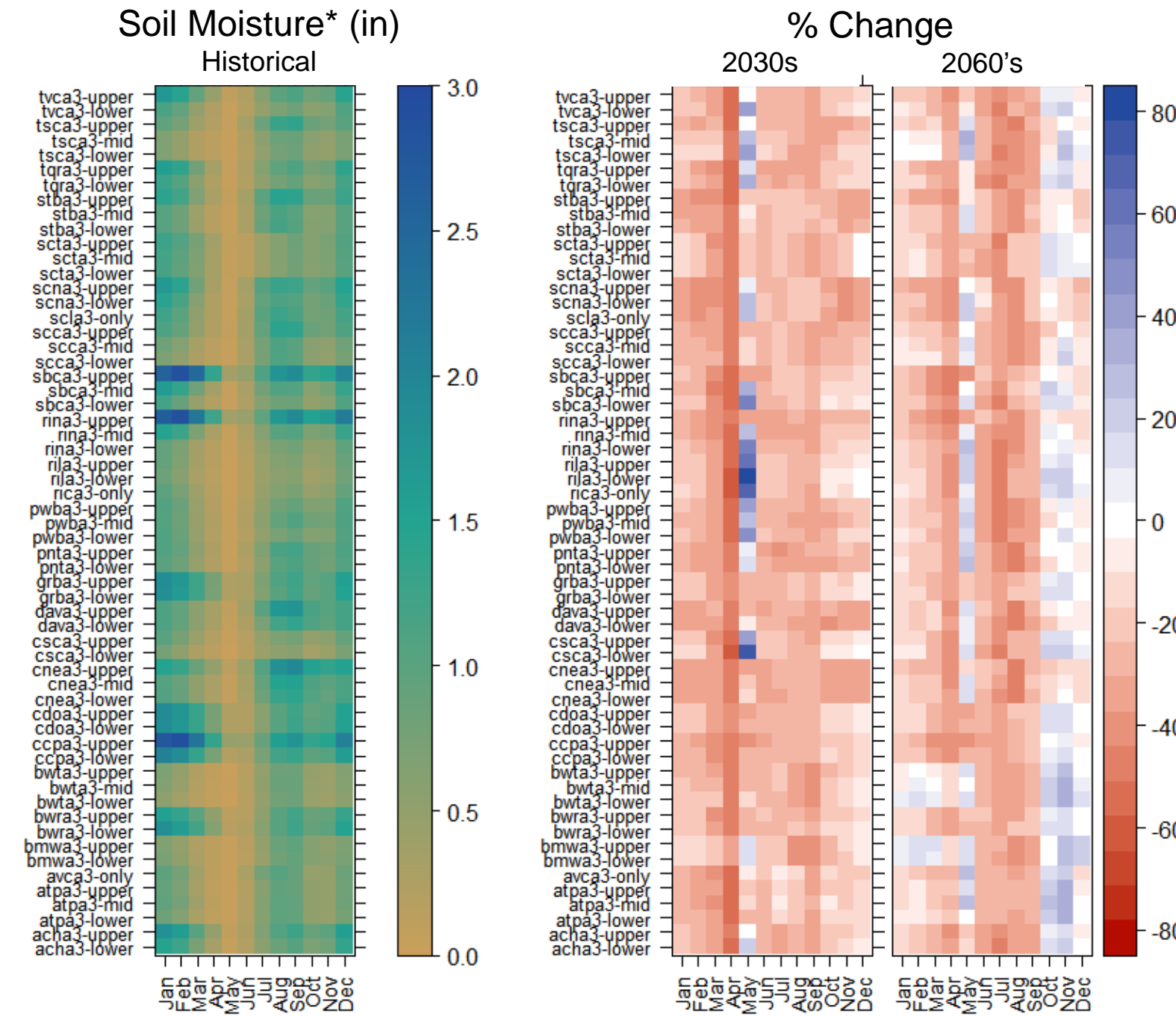
## 2060's – Top 5 Increase in dry days (#)

Sabino Creek (SBCA3)	May	10
Sabino Creek (SBCA3)	August	10
Sabino Creek (SBCA3)	April	9
Santa Cruz nr Lochiel (SCLA3)	August	9
Santa Cruz nr Nogales (SCNA3)	August	9



Soil Moisture  
generally  
decreases  
(Worse Case Shown)

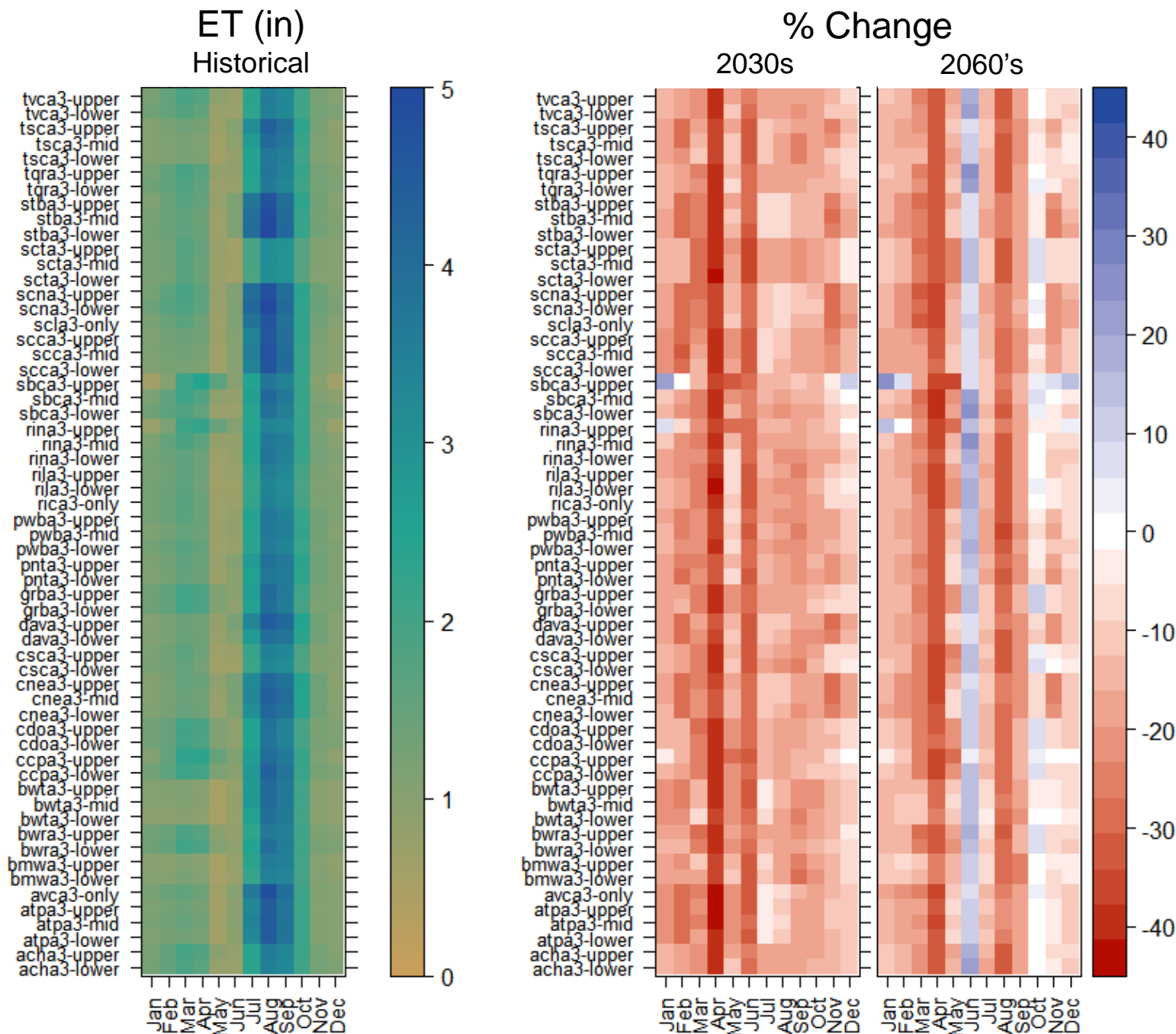
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\*As tension water, the largest component of soil water in this model

Evapotranspiration  
reflects lower soil  
moisture despite  
increased  
temperature

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# Summary

- Models and scenarios consistently identify increases in temperature, with larger increases in the worse scenario.
- The best case provides a scenario with relatively minimal change in seasonal precipitation; in the worse case scenario, total precipitation decreases in the monsoon and winter wet seasons.
- The number of no-flow days per month consistently increases in the worse case.
- Soil Moisture decreases are most pronounced in the months preceding the dry season.
- Evapotranspiration decreases, as limited by soil moisture.