BUREAU OF RECLAMATION

2021 LTO Climate Change Dataset Development

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DRAFT – SUBJECT TO REVISION

Collaborators

- Bureau of Reclamation
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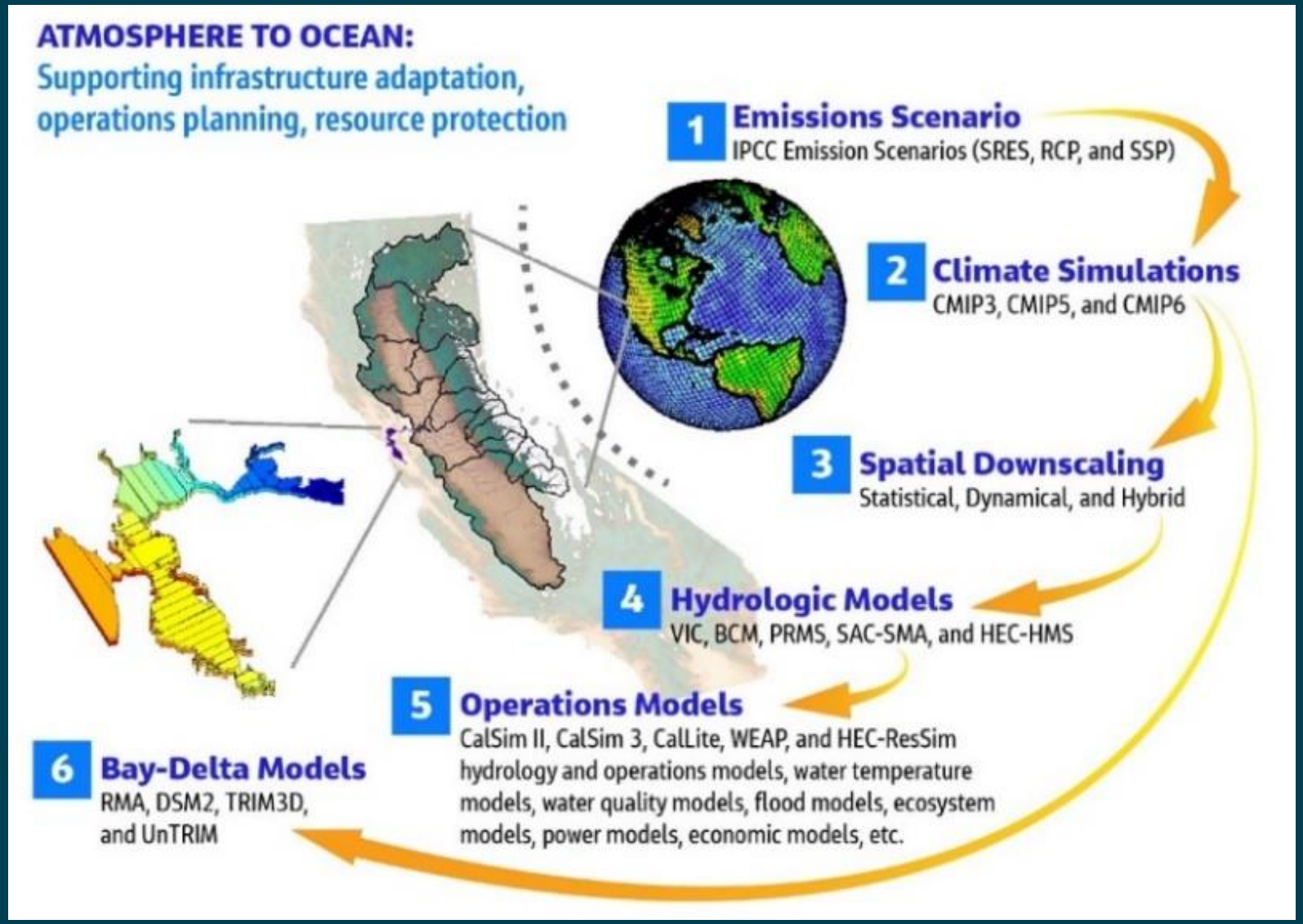
  - Michael Wright (Emeritus)
- California Department of Water Resources
  - Andrew Schwarz
- Jacobs Engineering
  - Steve Micko
  - Tapash Das
  - Rob Leaf

Motivation

- Climate change requires continuous learning
  - New data
  - Revised methods
- Relative importance of climate change variables shift among studies

- Since CCTAG:
  - 7 more years knowledge with climate science
  - Recognition of the impacts of downscaling on water management decision variables

Overview



- Identify likely representative climate models
- Investigate RCP & downscaling effects

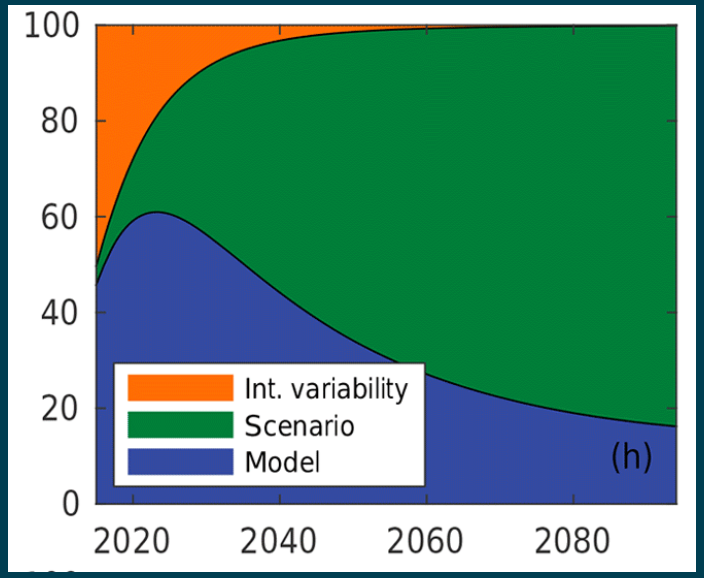
Initial analysis for remainder of climate change analysis workflow

Reclamation, 2021

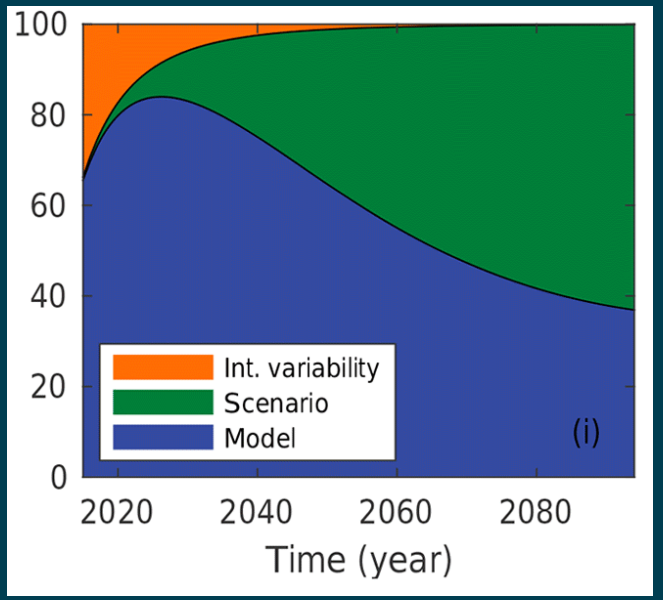
GCM Limitations

- GCMs represent numerical uncertainty
  - Model physical processes
  - Initial conditions
- RCPs/SSPs represent likelihood
- GCMs and RCPs/SSPs jointly contribute to the overall uncertainty
- GCM performance varies by how well they capture regional physical processes

CMIP5



CMIP6



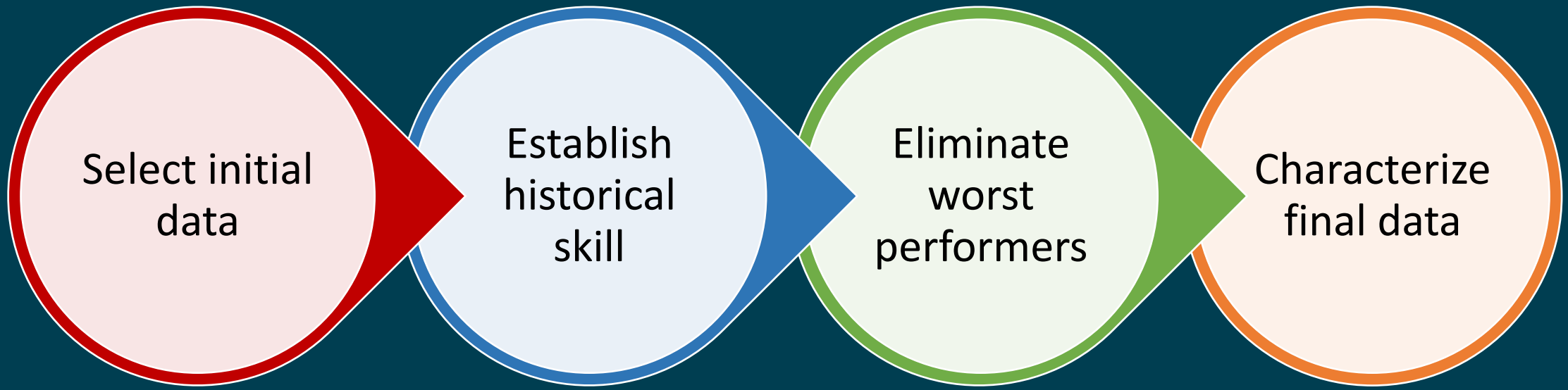
Lehner et al., 2020

Representativeness

- Cull GCMs based on study relevant, regional performance metrics
- Eliminates the worst performers while maintaining numerical uncertainty
- Resulting GCM subset is “credibly representative” of regional future conditions

- *Statistical evaluation over the reanalysis period can characterize GCM performance*
- *Downscaling must be included because it alters the statistical performance*

Process


Select initial data
Establish historical skill
Eliminate worst performers
Characterize final data

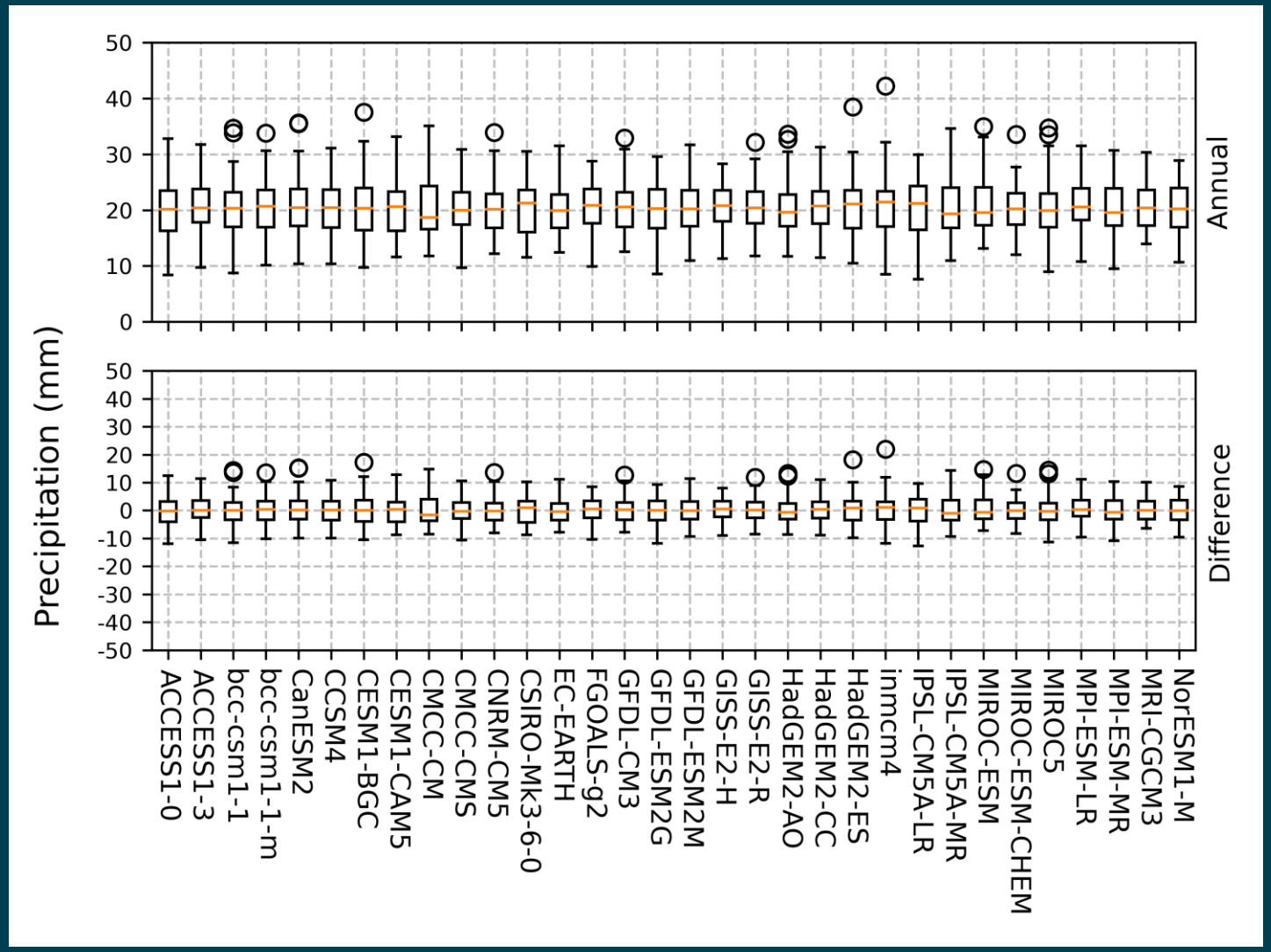
Process

- Extension of DWR CCTAG selection process for CMIP5
- Include downscaling in the selection
- Exclude worst models using water management criteria
  - Temperature performance similar across all models
  - Focus on precipitation as first order variable
- Metrics
  - Temporal distribution
  - Spatial distribution
  - Interannual variability
- Clip data to HUC2 California basin

Temporal Distribution

- Evaluates differences in precipitation timing over the full historical period
- Uses the PRISM 800m dataset as observed
- Monthly and full period statistics
  - Mean average error
  - Cumulative Rank Probability Score
  - Cumulative Rank Probability Skill Score
    - Compares the skill back to climatology

Temporal Distribution



- MAE in precipitation across the basin
- No strong differentiation across the GCMS

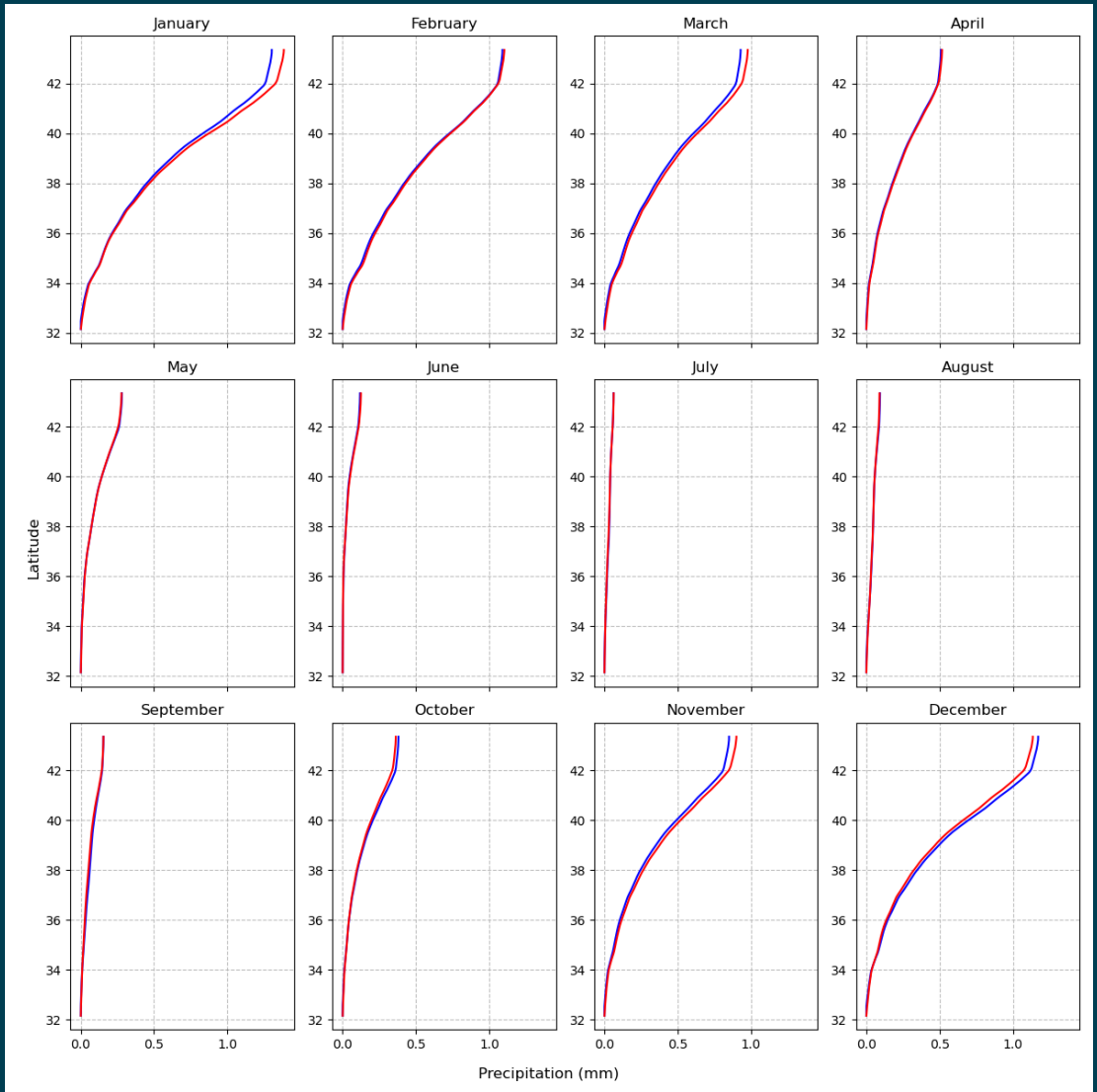
Spatial Distribution

- Evaluates the north/south distribution of precipitation
  - Driven by AR placement rather than orographic affects
- Mean annual/monthly precipitation across longitude
- Zonal (latitude) statistics as a function of mean

- Two Sample Kolmogorov-Smirnov (KS) test
  - Measures the difference in the cumulative precipitation from south to north

- No meaningful difference in performance

Spatial Distribution

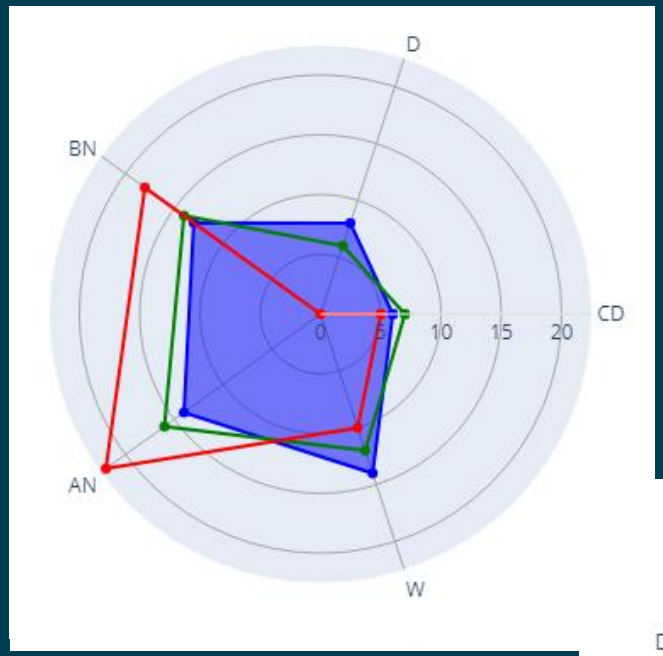


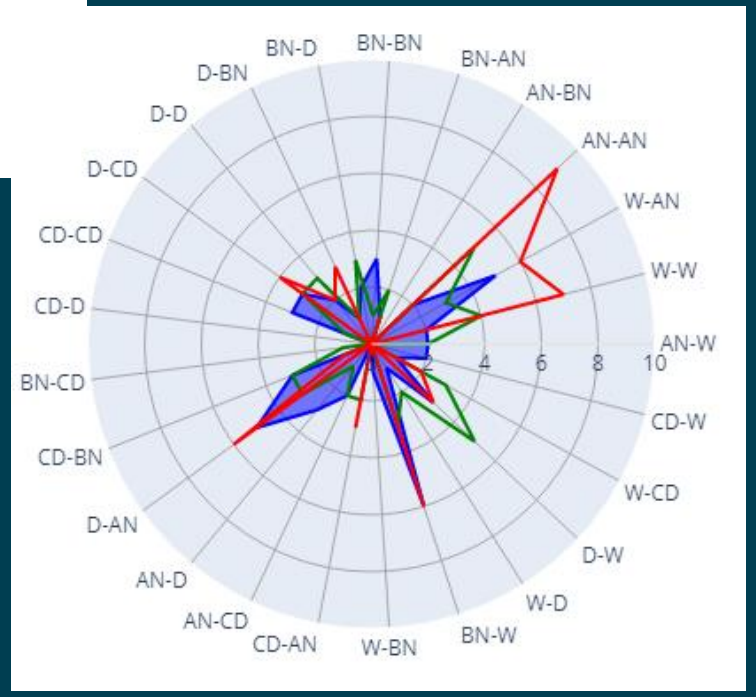
- Different monthly distributions that are not meaningful on annual scales
- No strong differentiation across the GCMs

Interannual Variability

- Captures resolution of interannual cycles
  - Timing and magnitude of transitions are both important
  - Driven by carryover considerations
- Define WY types based on percentiles from PRISM
  - Critical Dry: P <10%
  - Dry: 10%<P<25%
  - Below Normal 25%<P<50%
  - Above Normal 50%<P<75%
  - Wet 75%<P
- KS test on mean annual precipitation
  - No meaningful difference in performance

Interannual Variability





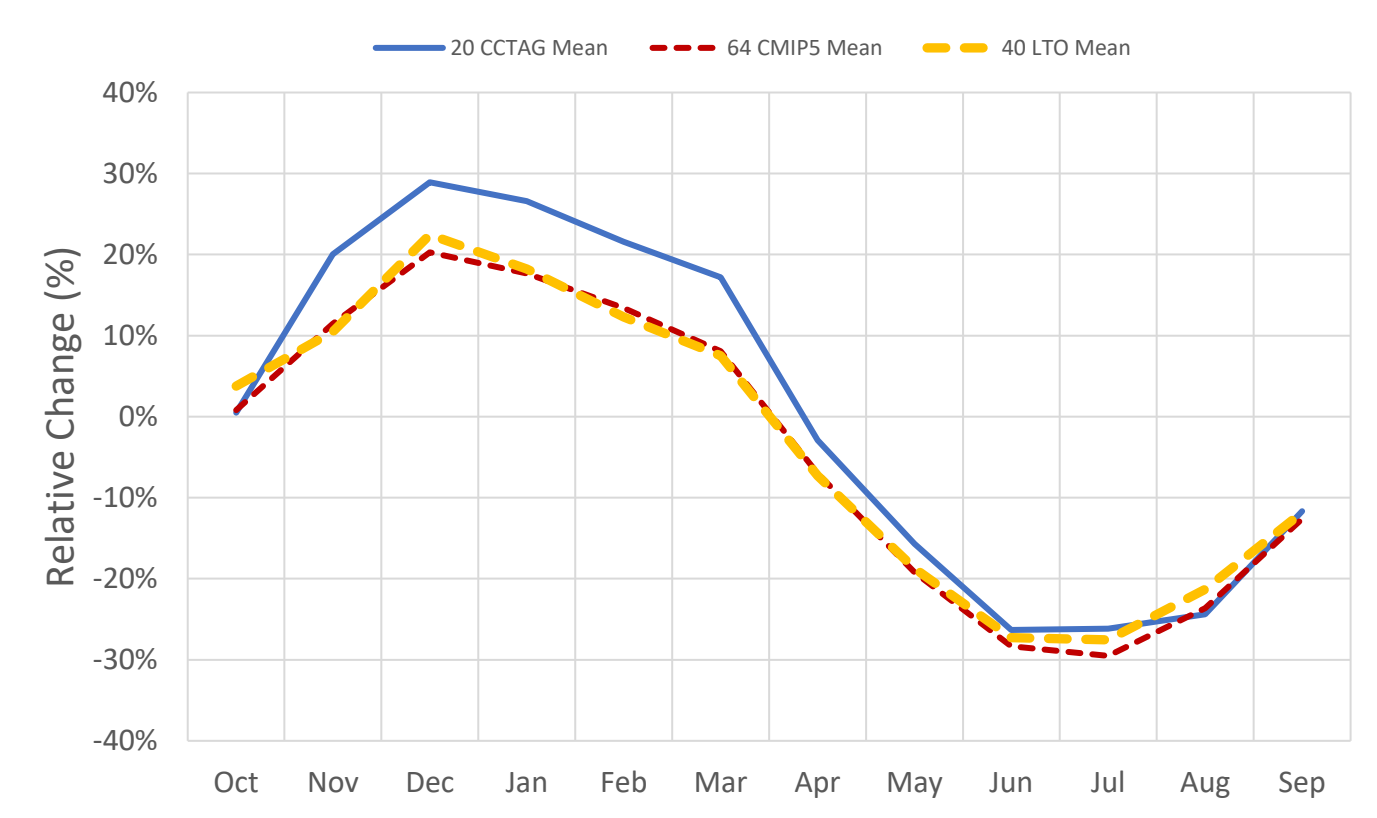
- Bin WY and transition rates
- Treat states as continuous for a KS test
  - Removed outliers greater than 1 std above the mean
- Contingent WY mean error
  - Binned GCM by WY type
  - Removed outliers with +/- 10% bias in any type
  - Enforces that the WY exists
  - Enforces no bias in types

GCM Selection Results

- 20 of the 32 GCMs remained after the selection
- Use both emissions scenarios assuming equal likelihood
  - Lower emission trajectory (RCP 4.5)
  - Higher emission trajectory (RCP 8.5)

- Use ensemble trends rather than features specific to specific GCMs
  - More confidence in trends across the GCMs than individual GCM results

Anticipated Change in Runoff - 8RI

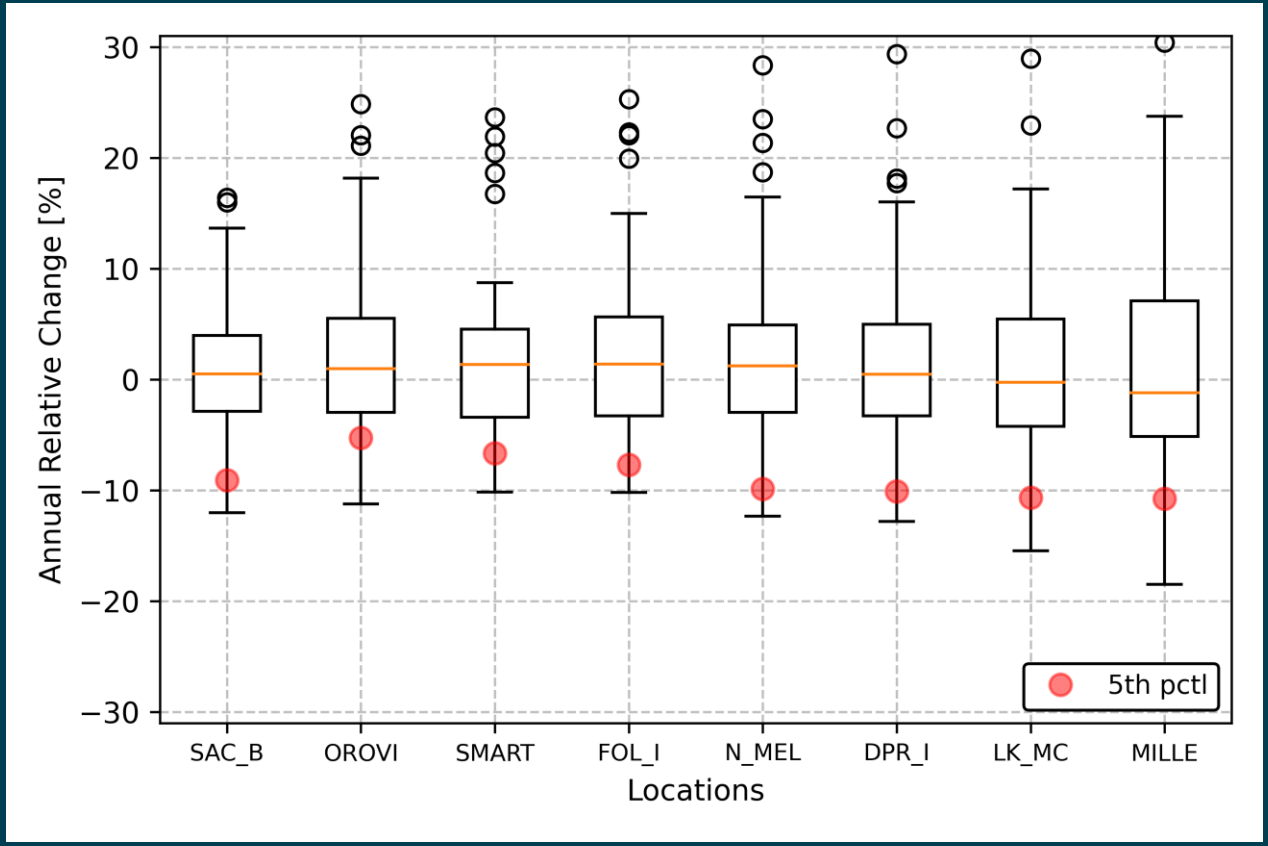


- Change in eight-river index
- Preliminary estimate
  - Calculated from a weighted average of each GCM used in rainfall/runoff model
- Modeling process
  - Treat selected GCMs as an ensemble
  - Calculate precipitation, temperature adjustment based on ensemble properties
  - Apply scenario adjustment factors individually to each grid cell

Selection	Relative Annual Change*
20 CCTAG CCTAG Mean	4.7%
64 CMIP5 Mean	-1.4%
40 LTO Mean	-1.0%

*Averages the preprocessed VIC routed data

Scenarios - Precipitation



- Intended to describe the likely range of numerical uncertainty
- Most likely
  - Median – 50th Percentile
- Sensitivity Analysis for T, P
  - Hot Dry – 25th Percentiles
  - Cool Wet – 75th Percentile
  - Very Dry – 5th Percentile

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