NOAA's National Weather Service
Colorado Basin River Forecast Center

Developing Climate-Informed Ensemble Streamflow Forecasts over the Colorado River Basin

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Colorado Basin River Forecast Center

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Acknowledgements

John Lhotak – Development and Operations Hydrologist

Kevin Werner – NOAA Western Regional Climate Services Director

Michelle Stokes – Hydrologist in Charge

Overview

Points to Take Away

Background

Data and Methodology

Provisional Results

Next Steps

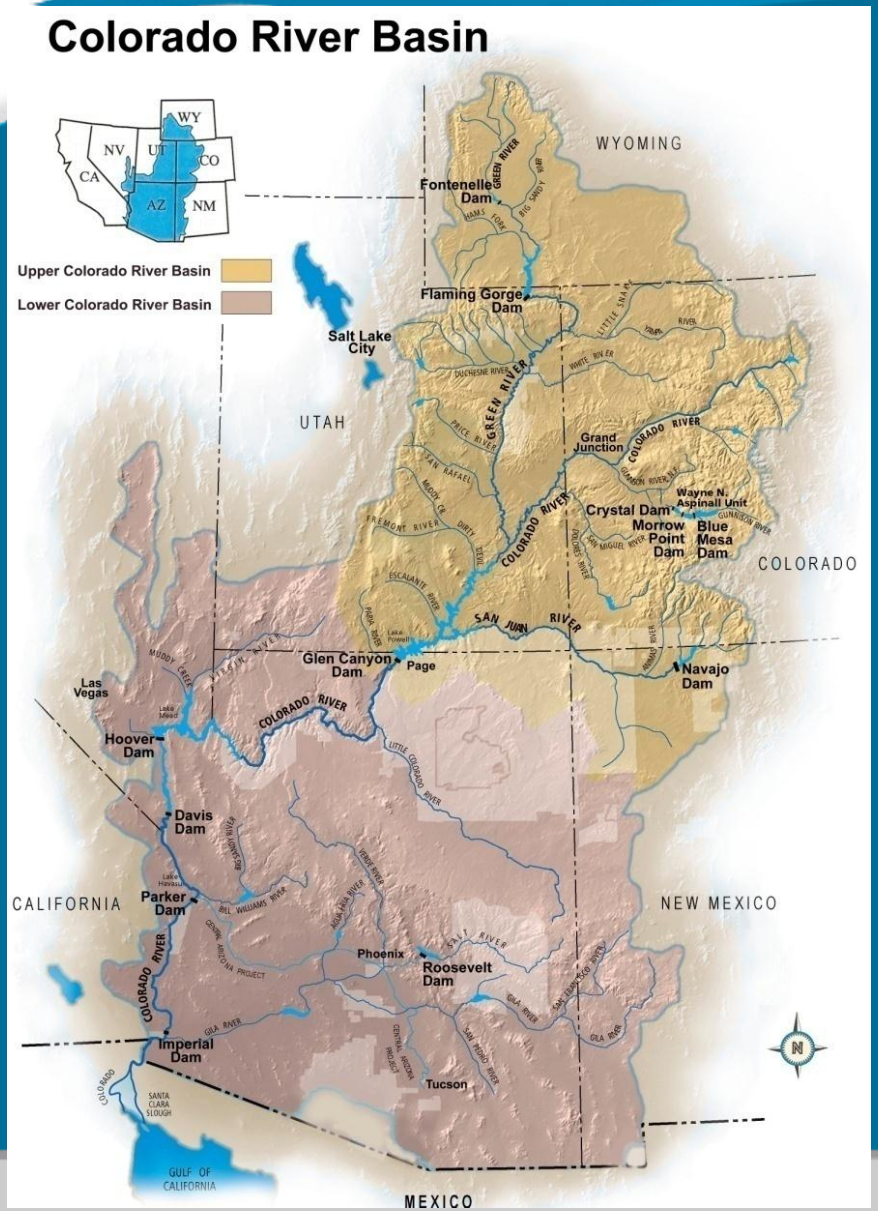
Points to Take Away

In response to needs of our stakeholders, the CBRFC is attempting to utilize contemporary climate information to inform long term streamflow forecasts

- **Utilize projections of precipitation and temperature change from BCSD CMIP3 and CMIP5 data to inform historical inputs driving ESP products**
- **Current analysis is limited, but indicates earlier streamflow runoff and decreased seasonal (April – July) runoff**

Further efforts will attempt to incorporate changes to ET, and application with a reservoir operations model

Background



In 2007, Reclamation developed interim guidelines to operate Lakes Powell and Mead

- **Operational tiers are determined by a model driven by CBRFC forecasts of unregulated streamflow**
- **Guidelines developed using ISM and historical streamflow, development of new guidelines must utilize climate information**

CBRFC would like to provide decision support

Background

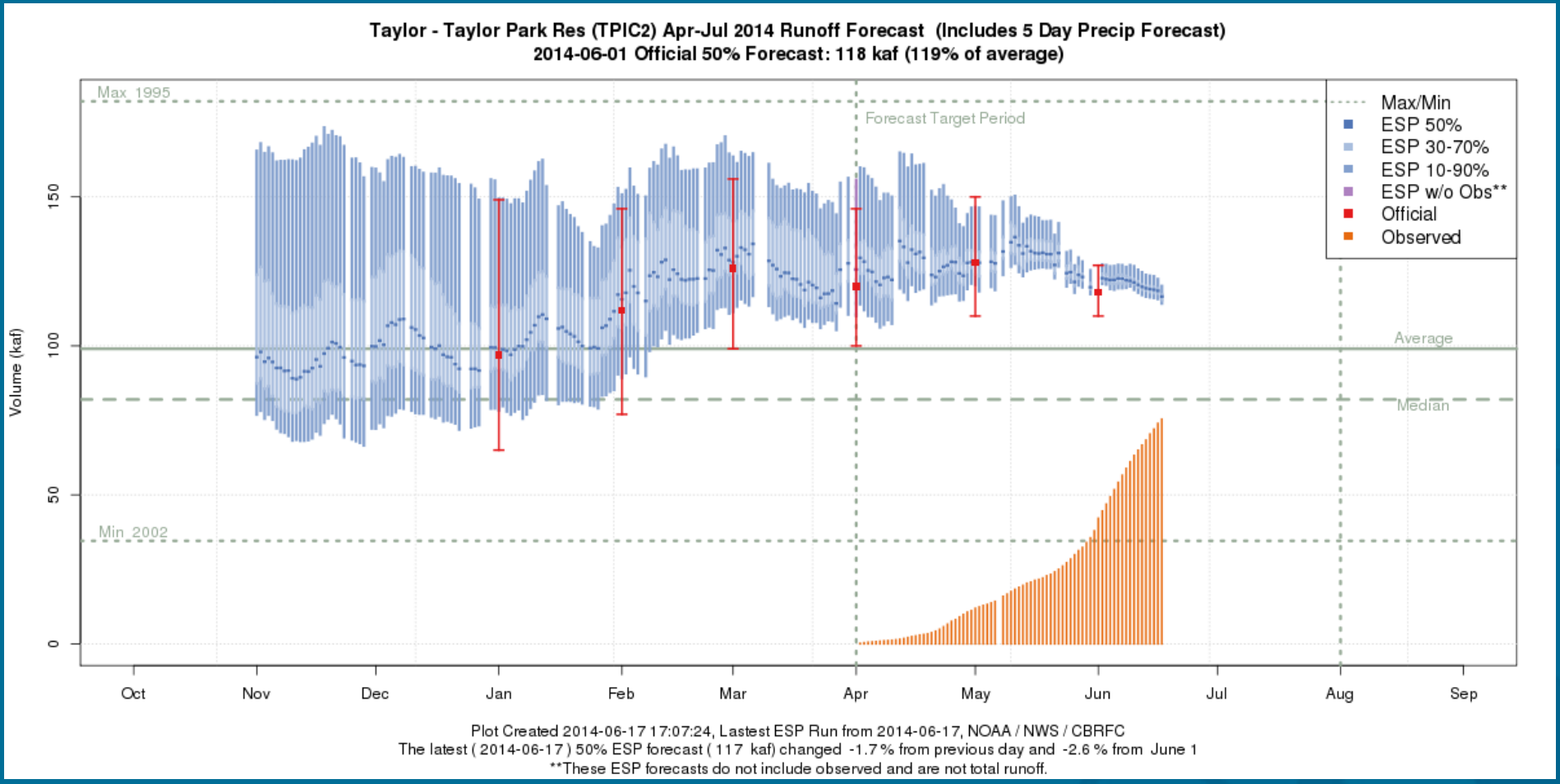
Photos by John Dohrenwend

Currently, CBRFC ensemble forecasts rely on current initial conditions and future climate (precipitation and temperature) as defined over a historical period spanning 1981-2010

- **Can also include 5-day QPF and 10-day QTF**
- **Limited by sequencing and magnitude of precipitation (and temperature) events in the historical period**

Past is no longer representative of the future

Ensemble Streamflow Prediction



How can we help?

Providing decision support for policy makers means making projections at a policy scale

- **Incorporate information from the latest climate projections**
- **Work to develop innovative ways to develop precipitation and temperature patterns outside of the historical record**
  - *Currently working with colleagues at the University of Colorado on an advanced weather generator*
  - *Incorporation of other climatic indicators (e.g., ENSO, CPC projections)*

Partnering with stakeholders to understand their needs

Data and Methodology

To "inform" our current historical input of precipitation and temperature data we utilized projected changes from BCSD CMIP3 and CMIP5 data

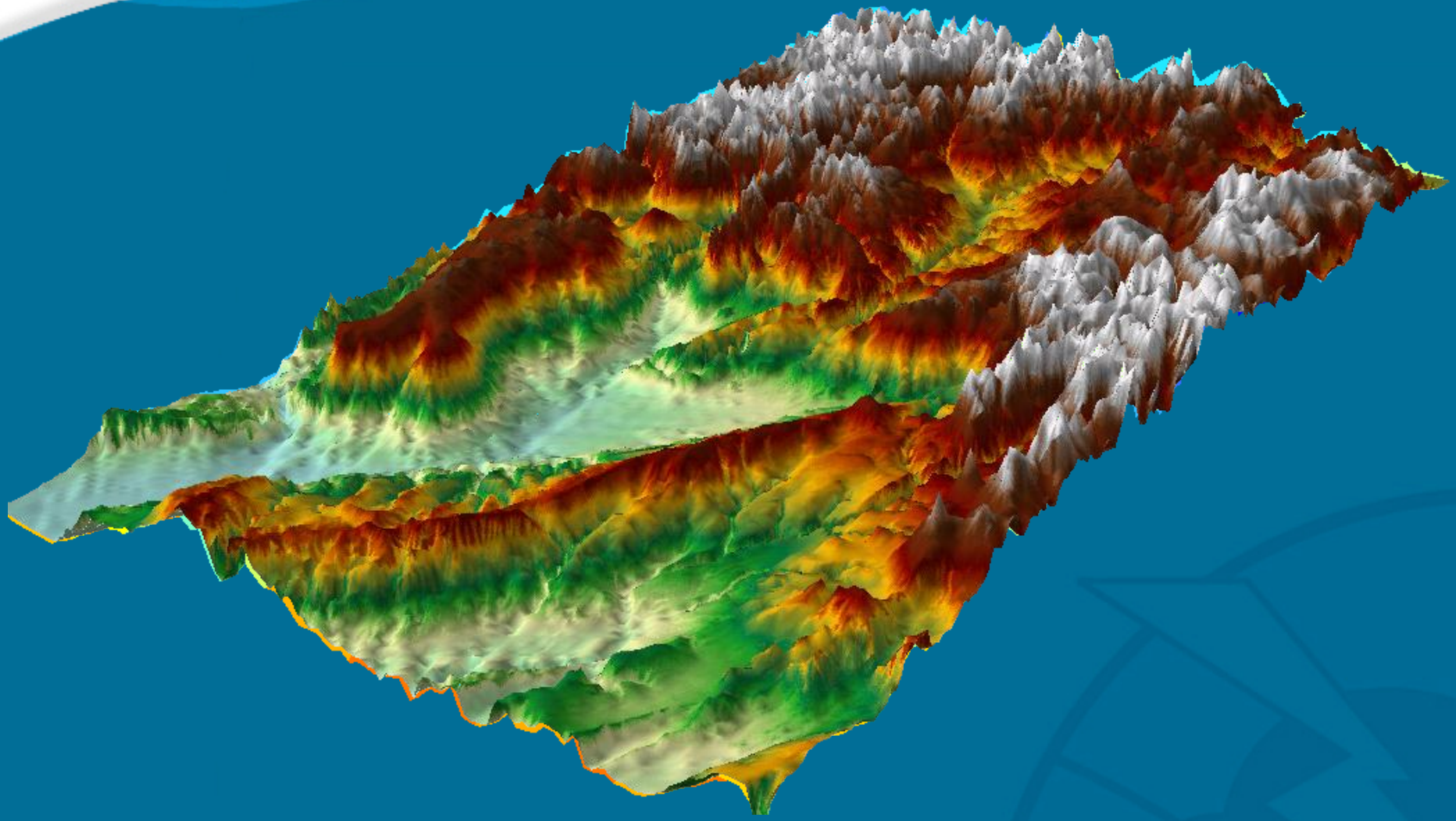
- **BCSD CMIP data is made available by Reclamation, LLNL, and other at:**

http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html

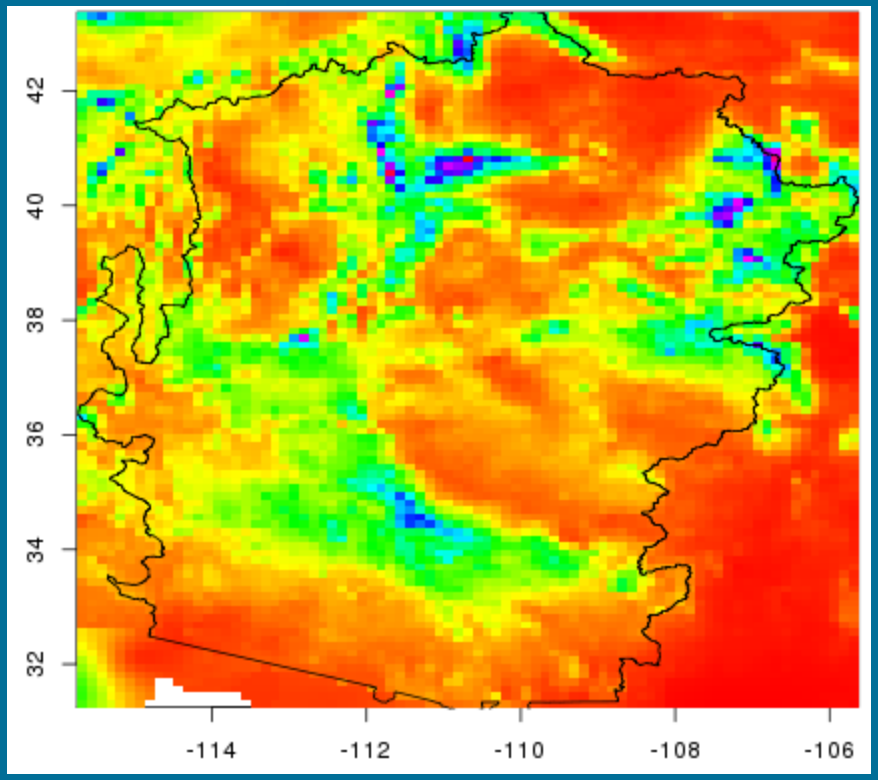
- **Gridded projections of climate need to be averaged over spatial zones defined in the CBRFC's lumped hydrologic model**

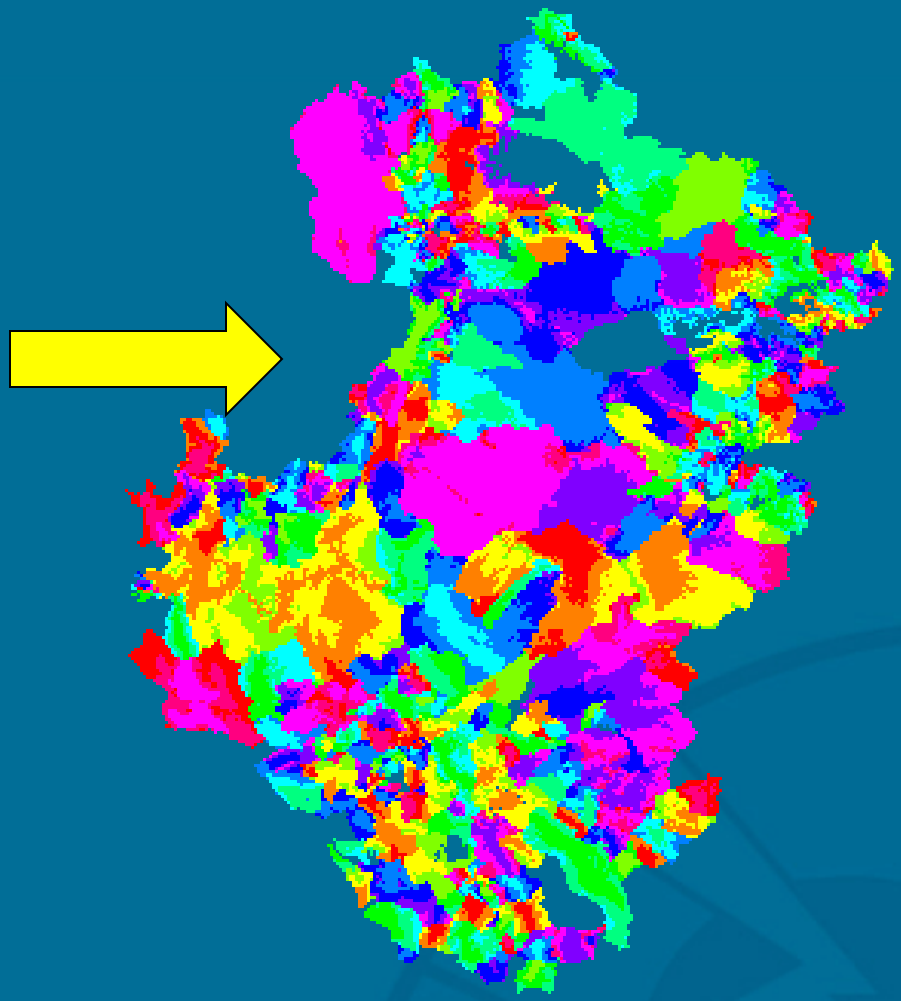
Currently averaged over all model runs, but we do have the ability to filter by emissions scenarios

Need for downscaling



Gridded to Lumped Inputs





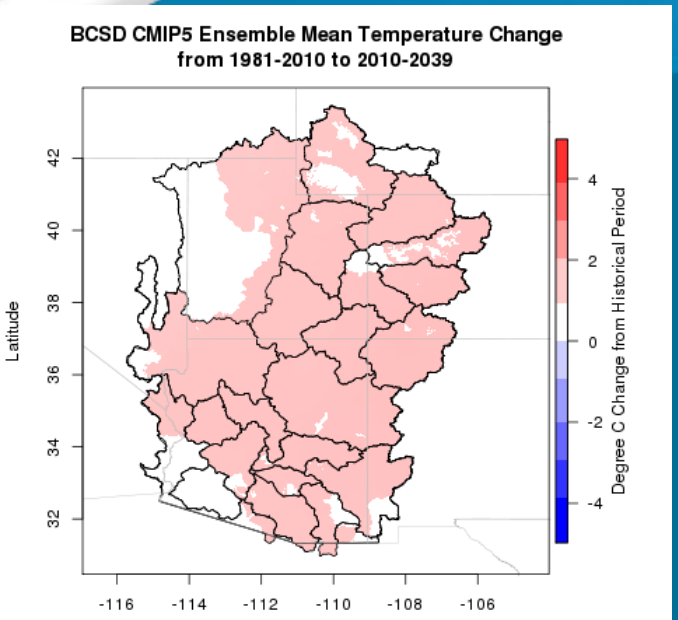
Data and Methodology

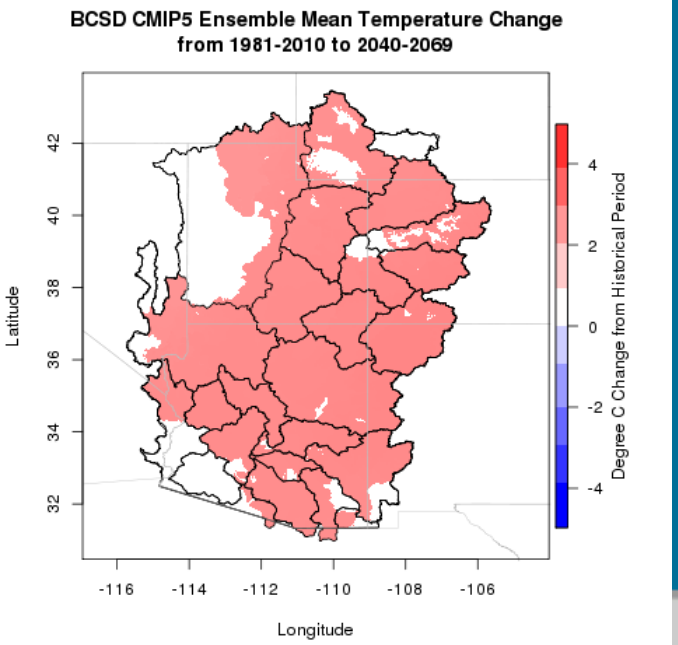
Average, relative modeled change from 1981-2010 to three future periods is derived

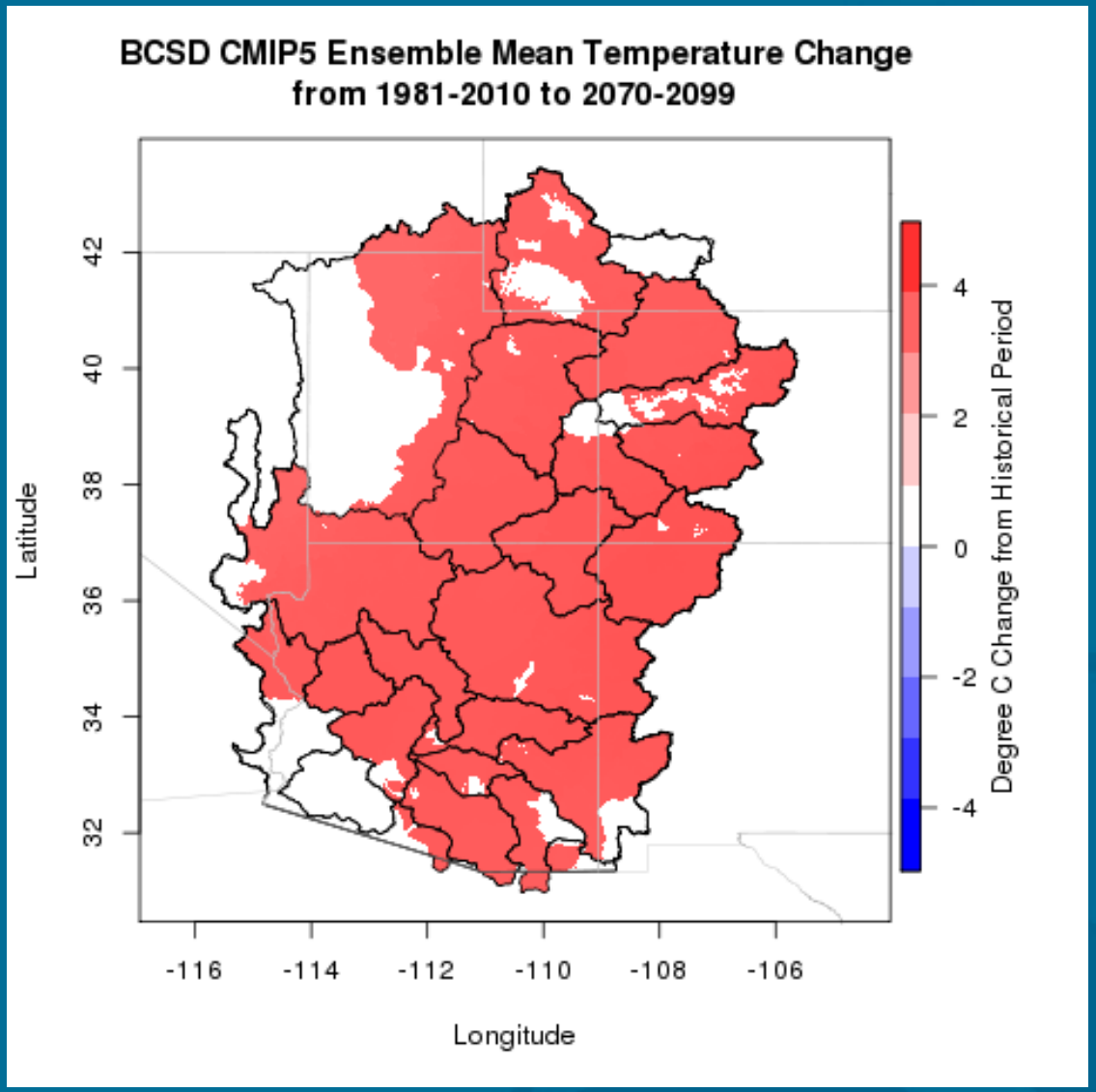
- **2010 – 2039, 2040 – 2069, 2070 – 2099 are each considered**
- **Gridded values are averaged over each defined and modeled zone in the CBRFC's modeling framework**
- **Percent change in precipitation is considered**
- **Degrees Celsius change in temperature is considered**

Historical input cards are perturbed by derived factors to develop "climate informed" inputs

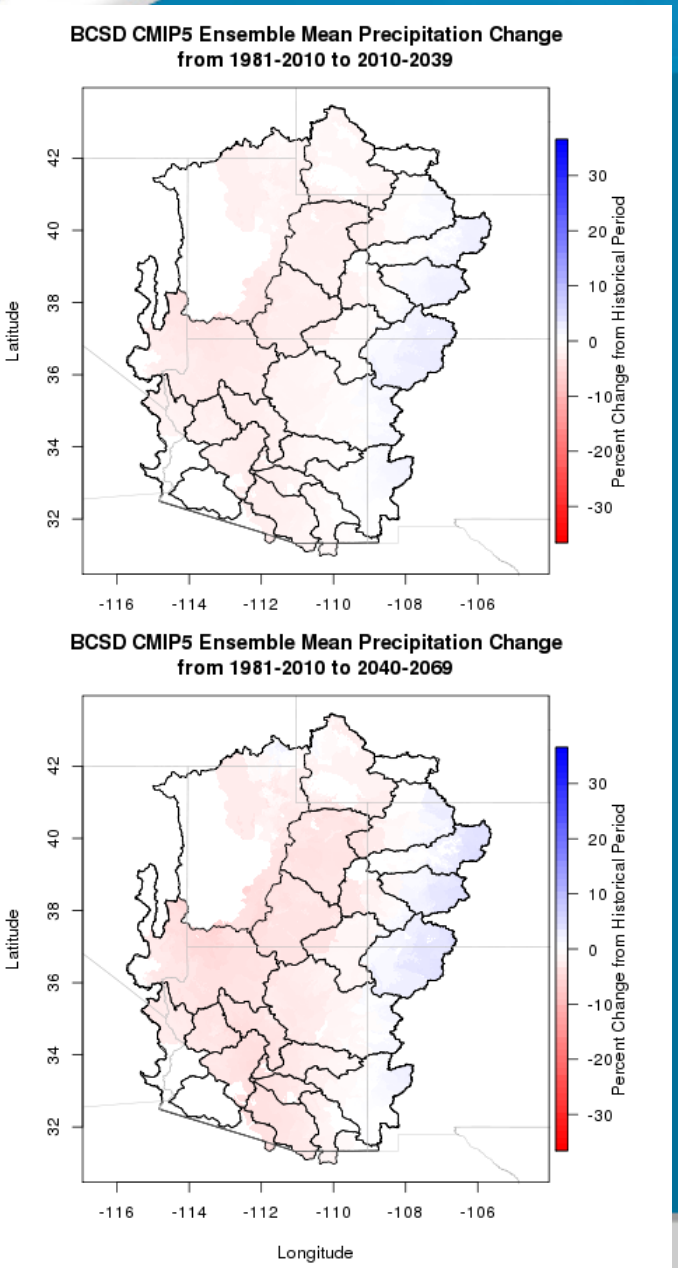
Results - Temperature

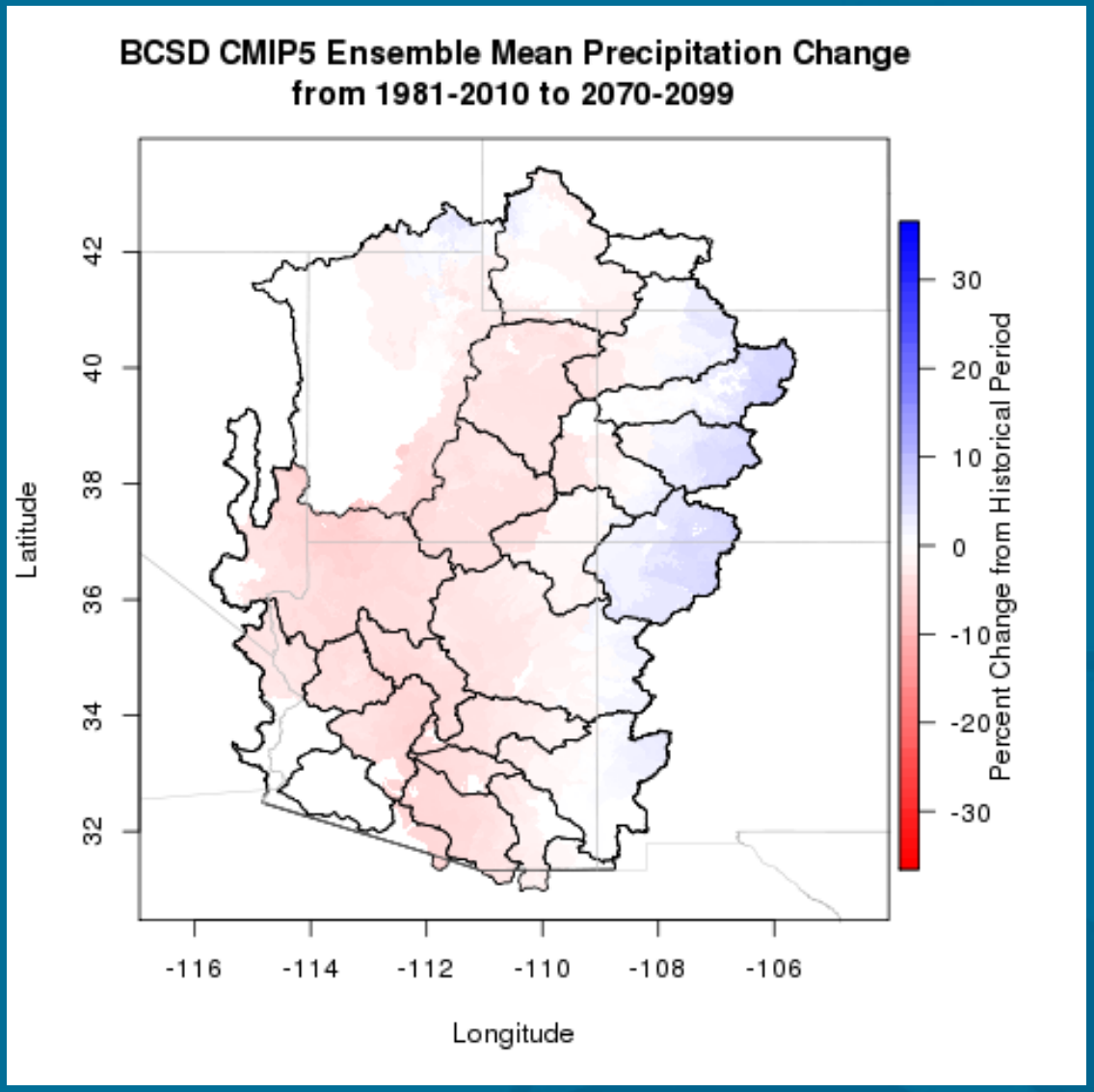




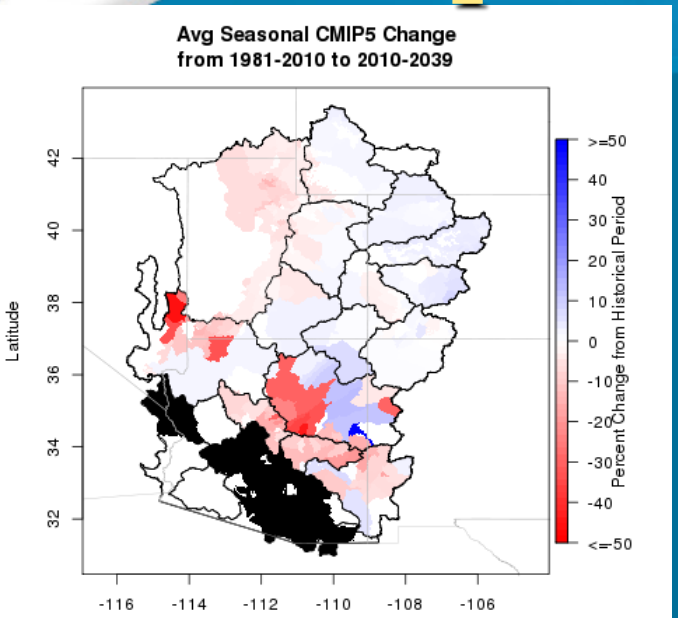


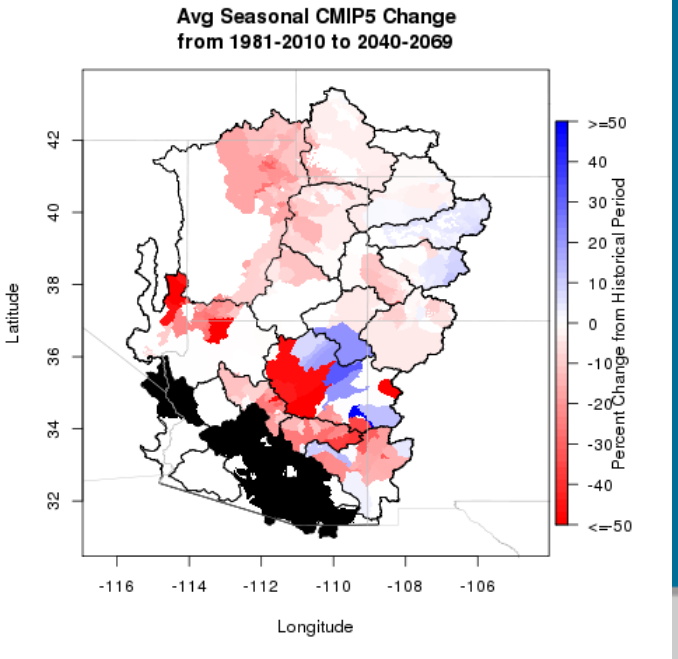
Results - Precipitation

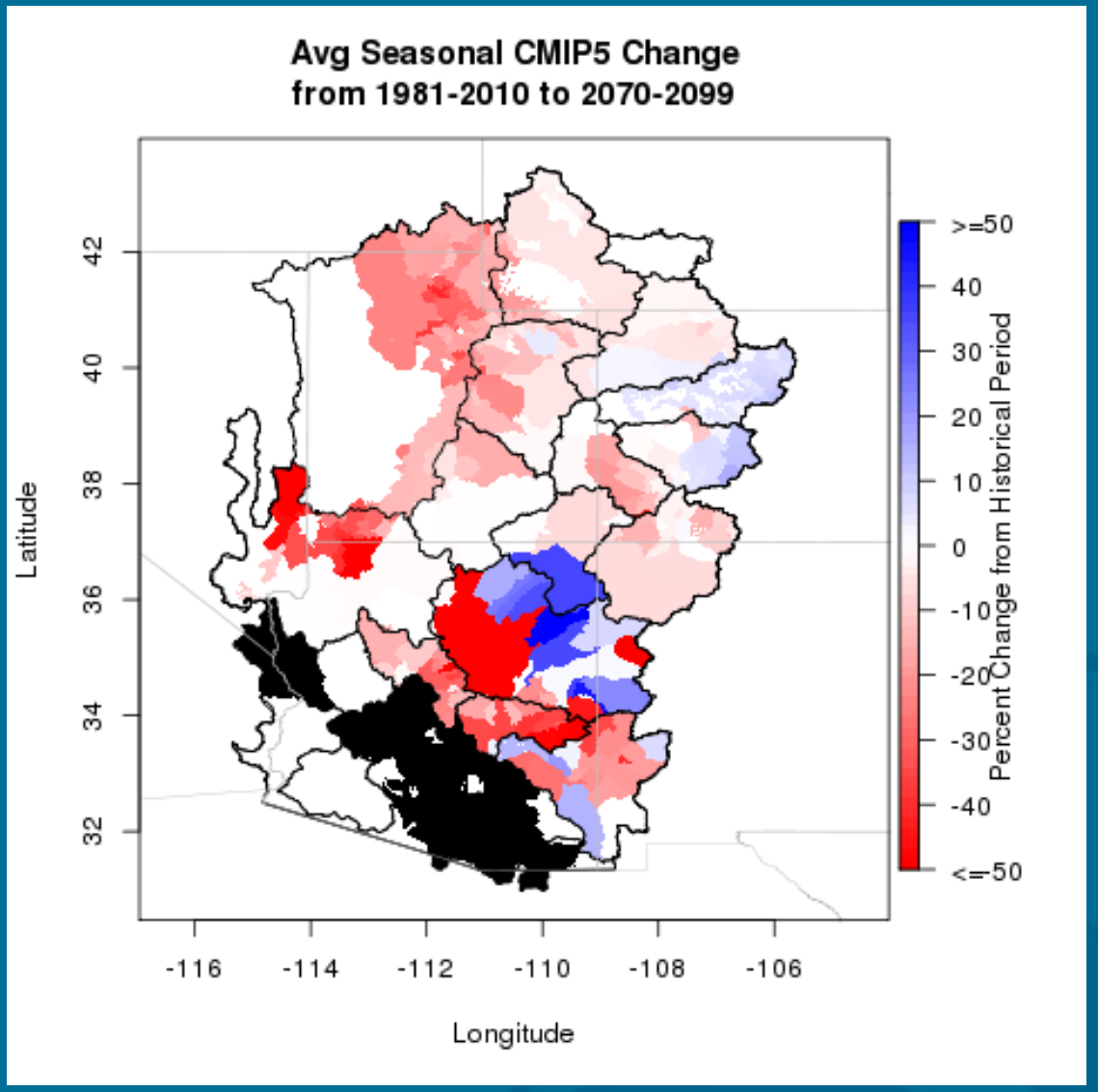




Impacts to Streamflow







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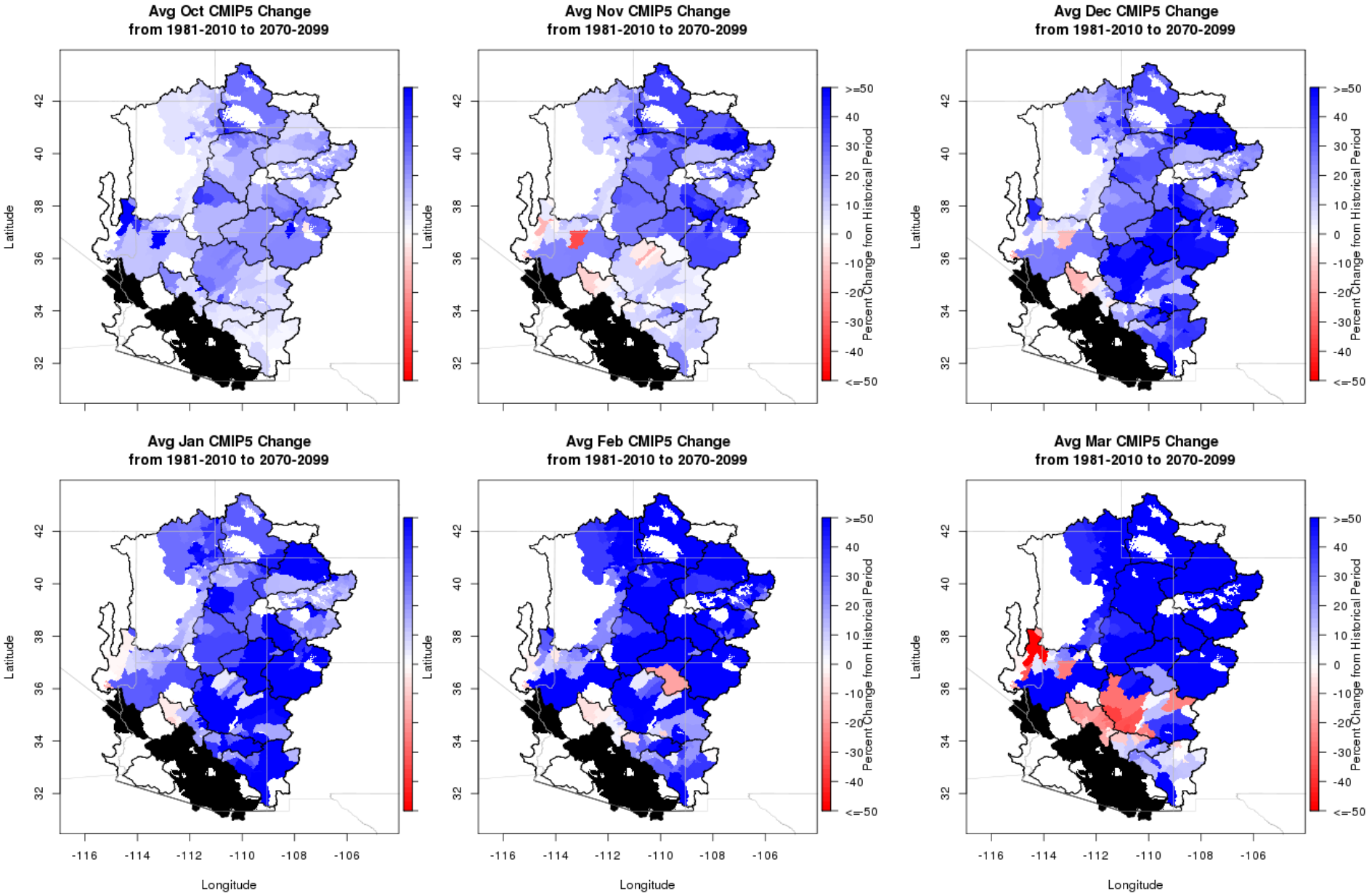

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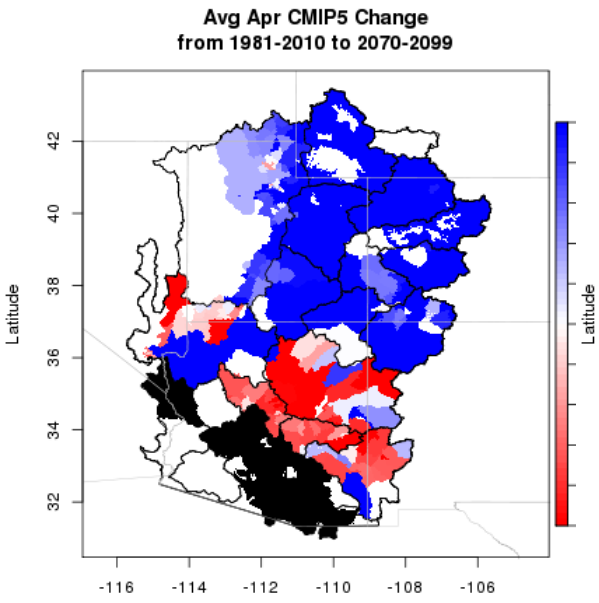

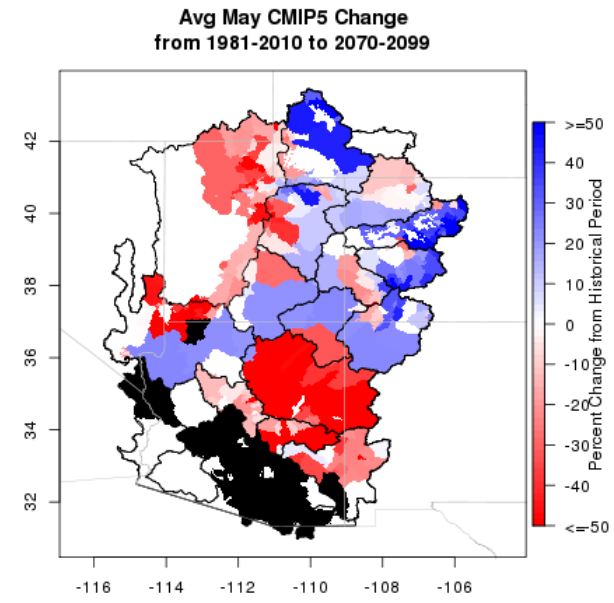

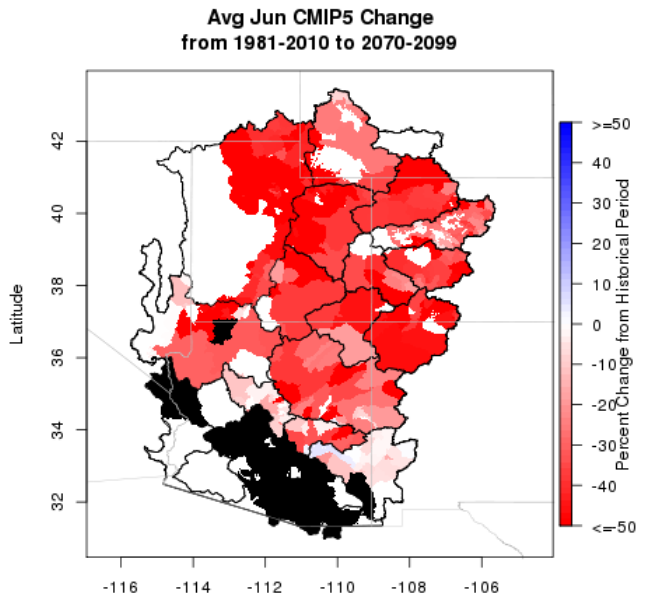

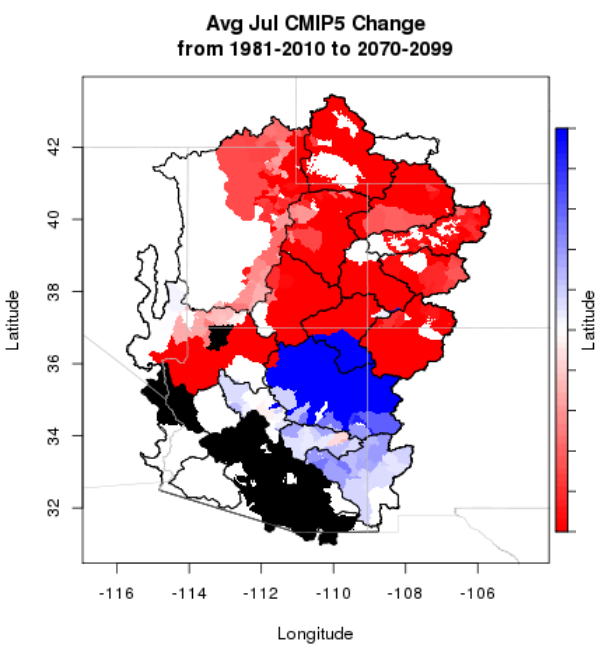

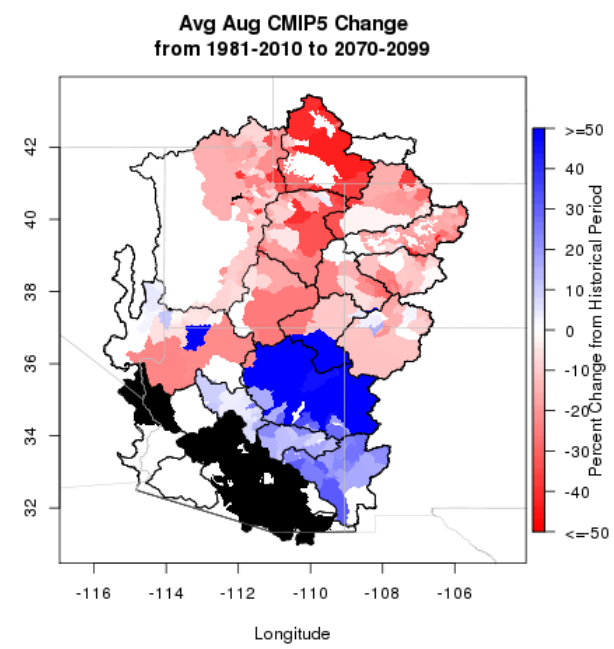

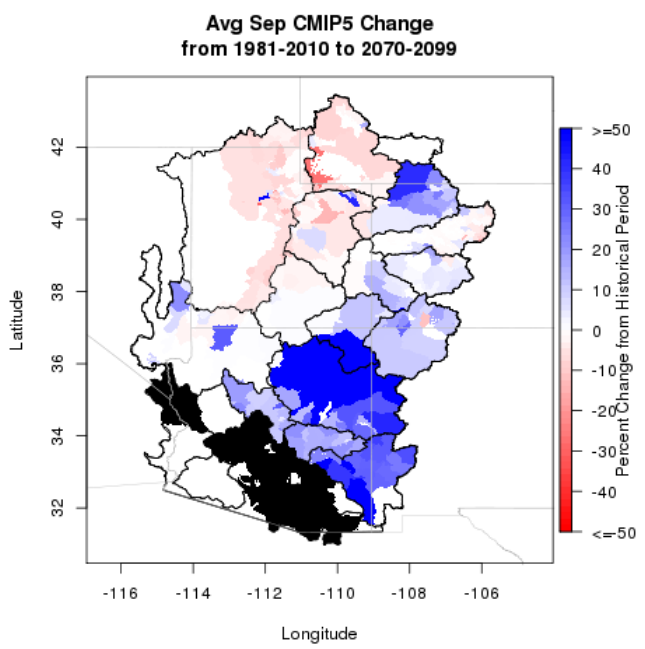

Limitations

Process is still dependent on historical sequences of precipitation and temperature

Process does not incorporate a dynamic ET component. ET is derived using a monthly coefficient that remains static throughout time

Possible wet bias introduced during the BCSD process?

Next Steps

Working with colleagues at the University of Colorado to further develop a stochastic weather generator

- **Capable of producing weather sequences not observed in the historical record**
- **Can be weighted to incorporate other climate information (e.g., teleconnections, CPC forecasts, etc…)**
- **Latest results show increased reliability and accuracy using “Above”, “Normal”, and “Below” probabilities for precipitation from forecasts made by Columbia University**

Next Steps Continued

Would like to partner with stakeholder to see impacts to reservoir operations

- **Short term forecasts still highly dependent on initial conditions**
- **Inform long-term policy development**

Build on past work done in our office to incorporate dynamic evapotranspiration

Questions?

Feel free to contact me at paul.miller@noaa.gov

More information about the CBRFC at www.cbrfc.noaa.gov