Assessing the impact of projected climate changes on small coastal basins of the Western US

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Introduction

- *How will climate change impact streamflow of coastal basins in the Western United States?*
- Future water management will depend on understanding how streamflow is changing
- Modeling presents a method to better understanding future changes in hydrology

Coastal Basins

- Later streamflow timing as compared to mountainous basins
- Less exhaustively studied than mountainous basins in the Western US

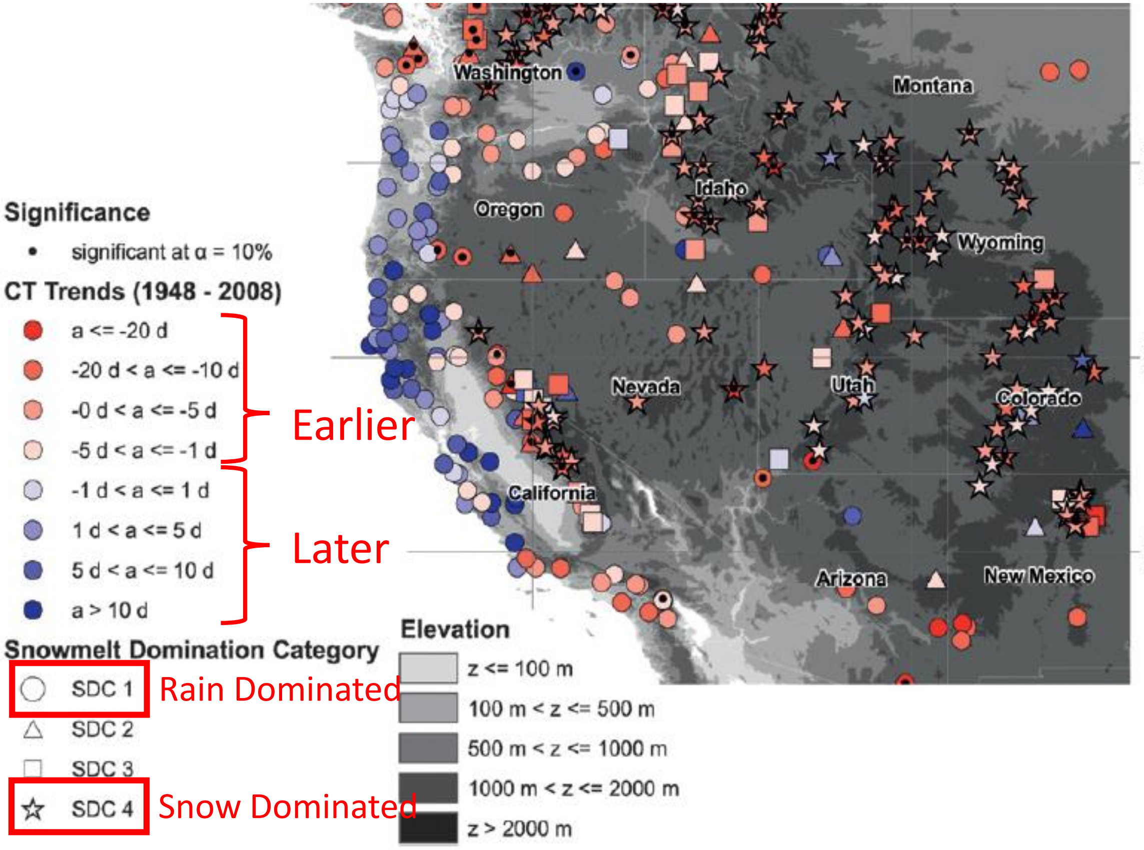
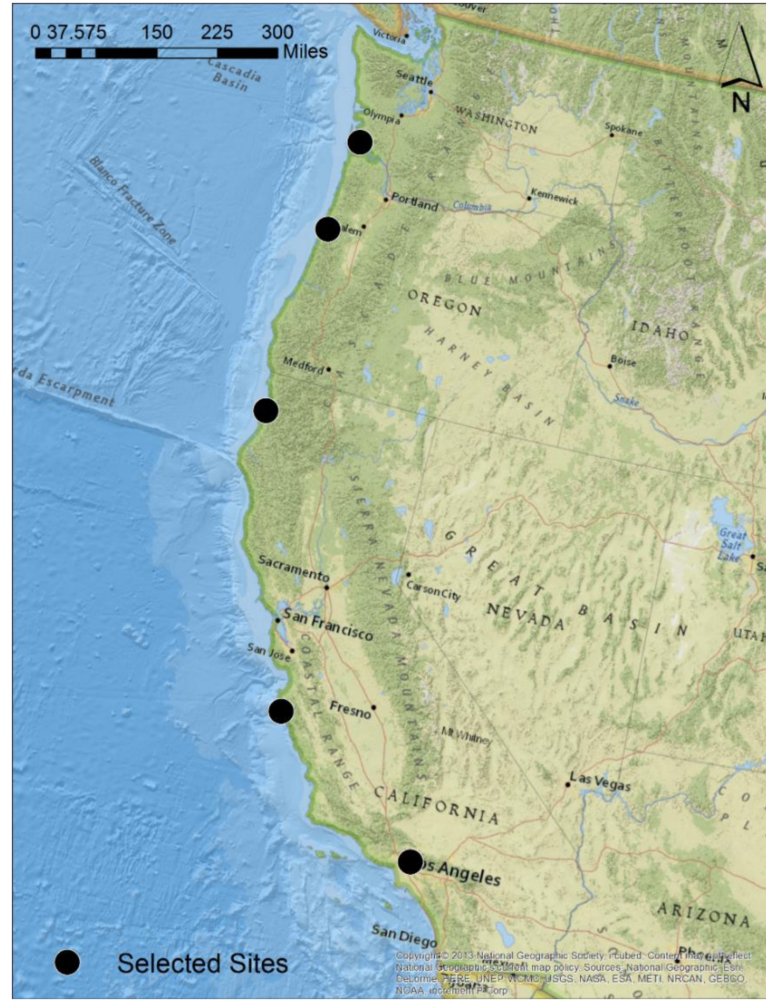


FIG. 3. Trends in CT for each SDC. Trend values are given in days over the 61-yr period.

Fritze et al. 2011

Sites

- Five sites along the West Coast
- WA, OR, and 3 in CA
- Chosen for proximity to the coast, geographic spacing, different climatic zones, and data availability



Site	River	Drainage (sq km)	Data Years
WA	Naselle River	142	80
OR	Siletz River	526	88
N. CA	Redwood Crk	718	58
Central CA	Big Sur River	121	59
S. CA	Arroyo Seco	42	95

Methods

- Soil and Water Assessment Tool (SWAT) (Neitsch, 2011)
- SWAT Calibration and Uncertainty Programs (CUP)
  - Calibration and validation using SUFI2
- Statistical analysis
  - Temperature and precipitation changes
  - Comparison of monthly means
  - GCM medians, 25^{th} & 75^{th} percentiles

Data

Data Type	Description	Source
Elevation	1/3 arc second (~30 ft) resolution digital elevation model	USGS National Elevation Dataset
Land Cover	30 meter resolution land cover data	National Land Cover Database (NLCD) 2011
Soil	High resolution soils data (AWC, K sat, bulk density, depths)	USDA Soil Survey Geographic Database - SSURGO
Streamflow	Daily streamflow gauge data from sites unaffected by human impacts	USGS Hydroclimatic Data Network - 2009
Observed Climate	1960-2011 at 1/8 degree spatial resolution gridded daily and monthly data	Livneh et al. 2013 (derived from NOAA Cooperative Observer Stations)
Projected Climate	Downscaled BCCA CMIP5 projected data for 2000-2099 at 1/8 degree spatial resolution gridded daily and monthly data -Representative Concentration Pathway (RCP) 8.5 (20 models) & 4.5 (19 models)	Reclamation, 2013

Parameters

- 24 parameters used at each site
- Run from 3x – 5x 1000 iterations depending on site
- Run at daily time step

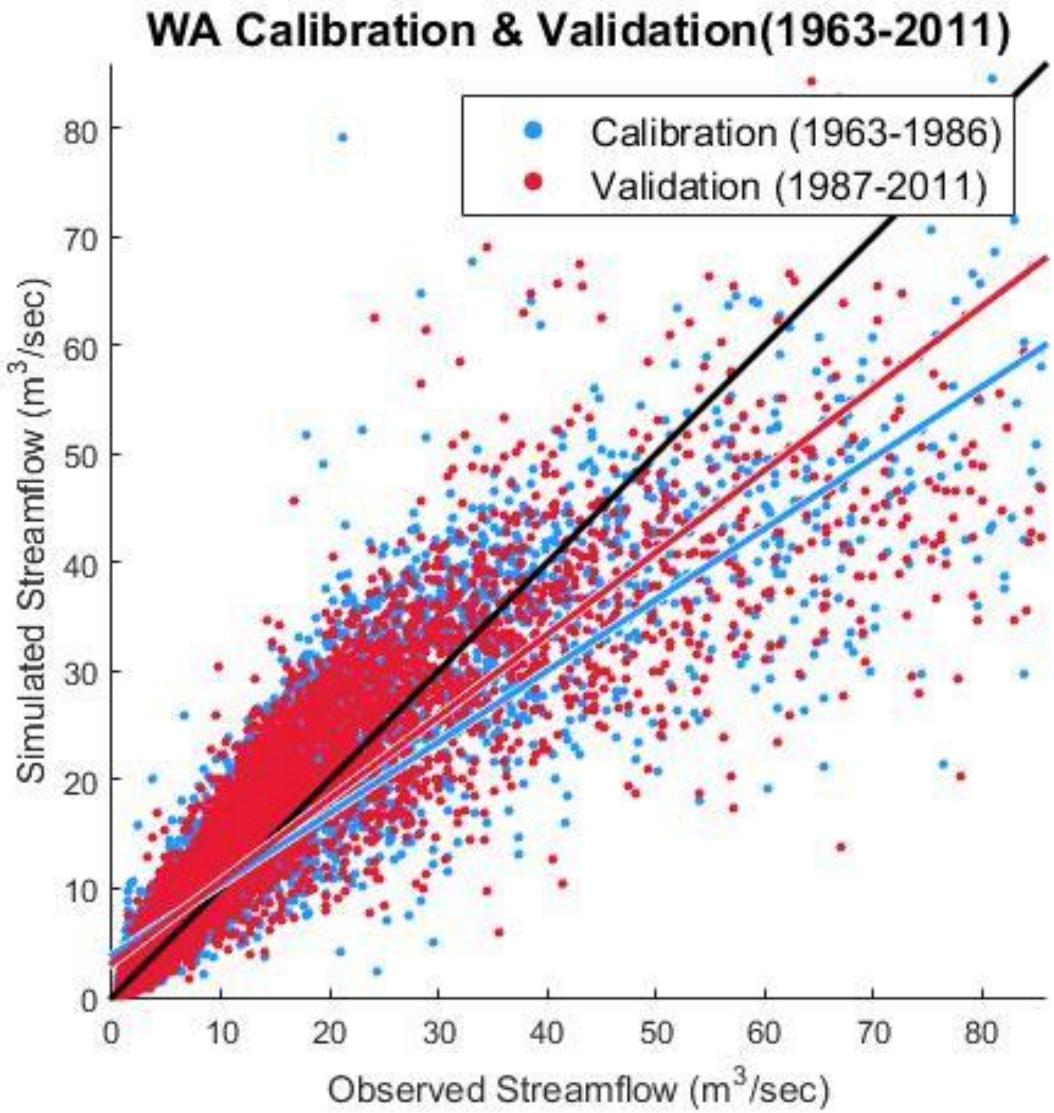
Parameter	Description
Groundwater	
ALPHA_BF	Baseflow alpha factor (days)
GW_DELAY	Groundwater delay (days)
GWQMN	Threshold depth required for return flow to occur (mm)
GW_REVAP	Groundwater "revap" coefficient
REVAPMN	Threshold depth for "revap" to occur (mm)
RCHRG_DP	Deep aquifer percolation fraction
GW_SPYLD	Specific yield of the shallow aquifer (m3/m3)
Soil	
SOL_BD	Moist bulk density
SOL_K	Saturated hydraulic conductivity
SOL_AWC	Available water capacity of the soil layer
SOL_Z	Maximum rooting depth of soil profile
Channel Flow	
ALPHA_BNK	Baseflow alpha factor for bank storage
CH_N2	Manning's "n" value for the main channel
CH_K2	Effective hydraulic conductivity in main channel alluvium
Surface Runoff	
CN2	SCS runoff curve number
ESCO	Soil evaporation compensation factor
EPCO	Plant uptake compensation factor
OV_N	Manning's "n" value for overland flow
LAT_TTIME	Lateral flow travel time
SLSOIL	Slope length for lateral subsurface flow
PLAPS	Precipitation lapse rate
TLAPS	Temperature lapse rate
SURLAG	Surface runoff lag time
RFINC	Rainfall adjustment

Calibration & Validation

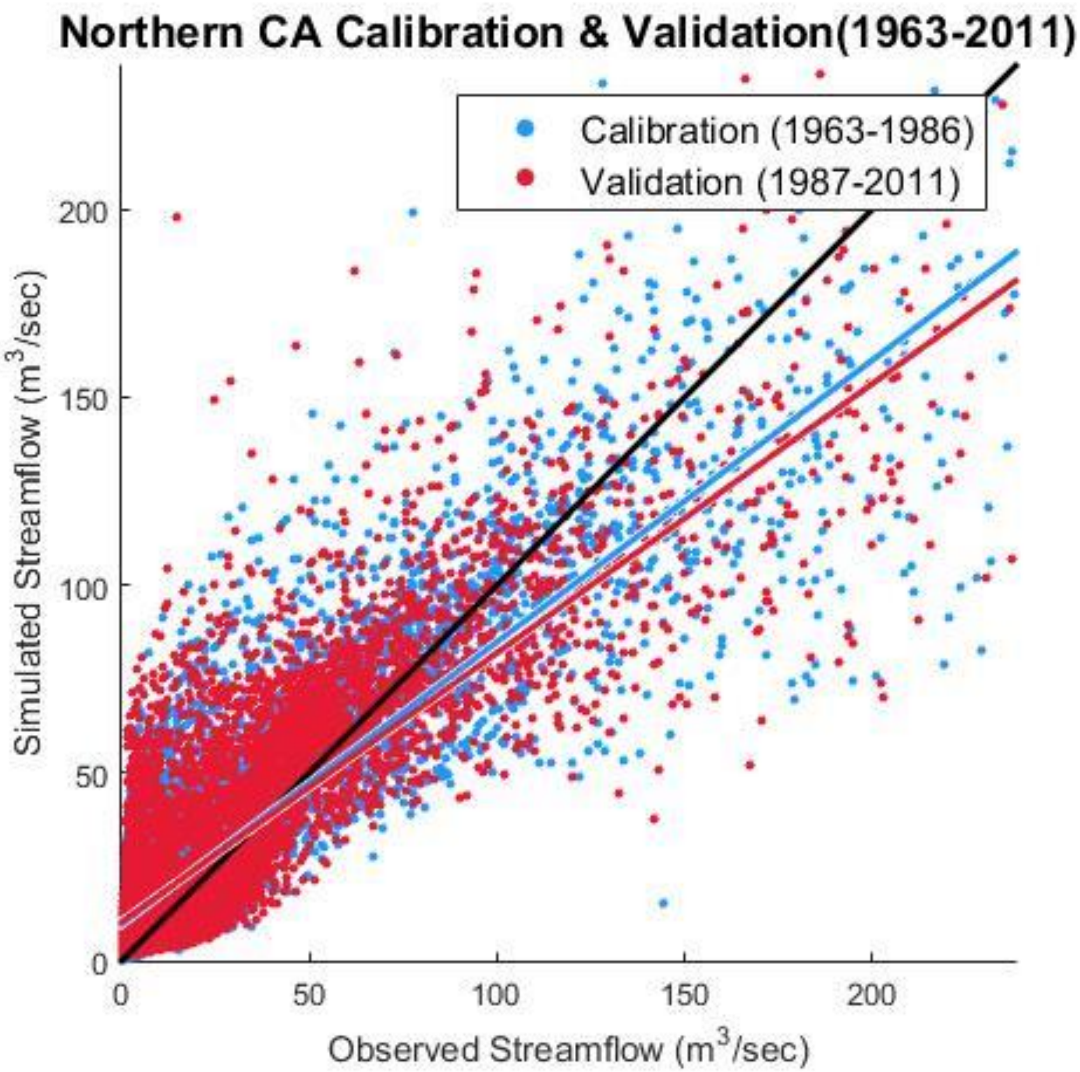
- Using evaluation guidelines from Moriasi et al. 2007
- Nash-Sutcliffe > **0.5**
- Percent bias +/- **25%**
- RMSE to standard deviation ratio (RSR) < **0.7**
- Calibration: 1963-1986   Validation: 1987-2011

	C. CA		N. CA		OR		So. CA		WA	
	Cal	Val	Cal	Val	Cal	Val	Cal	Val	Cal	Val
NSE	0.83	0.77	0.84	0.78	0.91	0.80	0.76	0.61	0.87	0.81
PBIAS	-5.0	-22.1	-13.0	-22.2	-7.0	6.8	-55.6	-54.0	-6.6	-4.8
RSR	0.42	0.48	0.40	0.47	0.31	0.45	0.49	0.63	0.37	0.43

Calibration & Validation



Calibration & Validation



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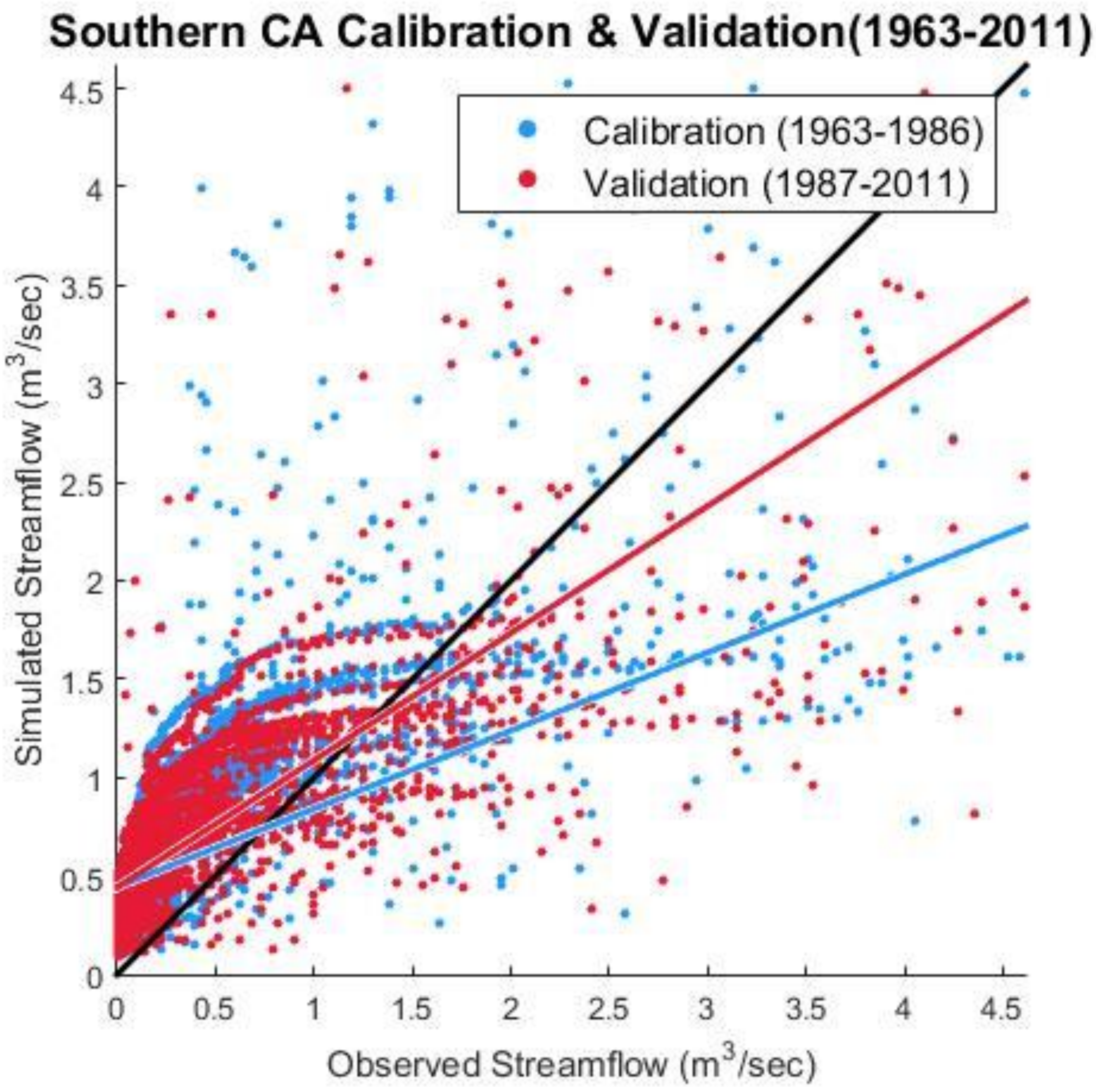
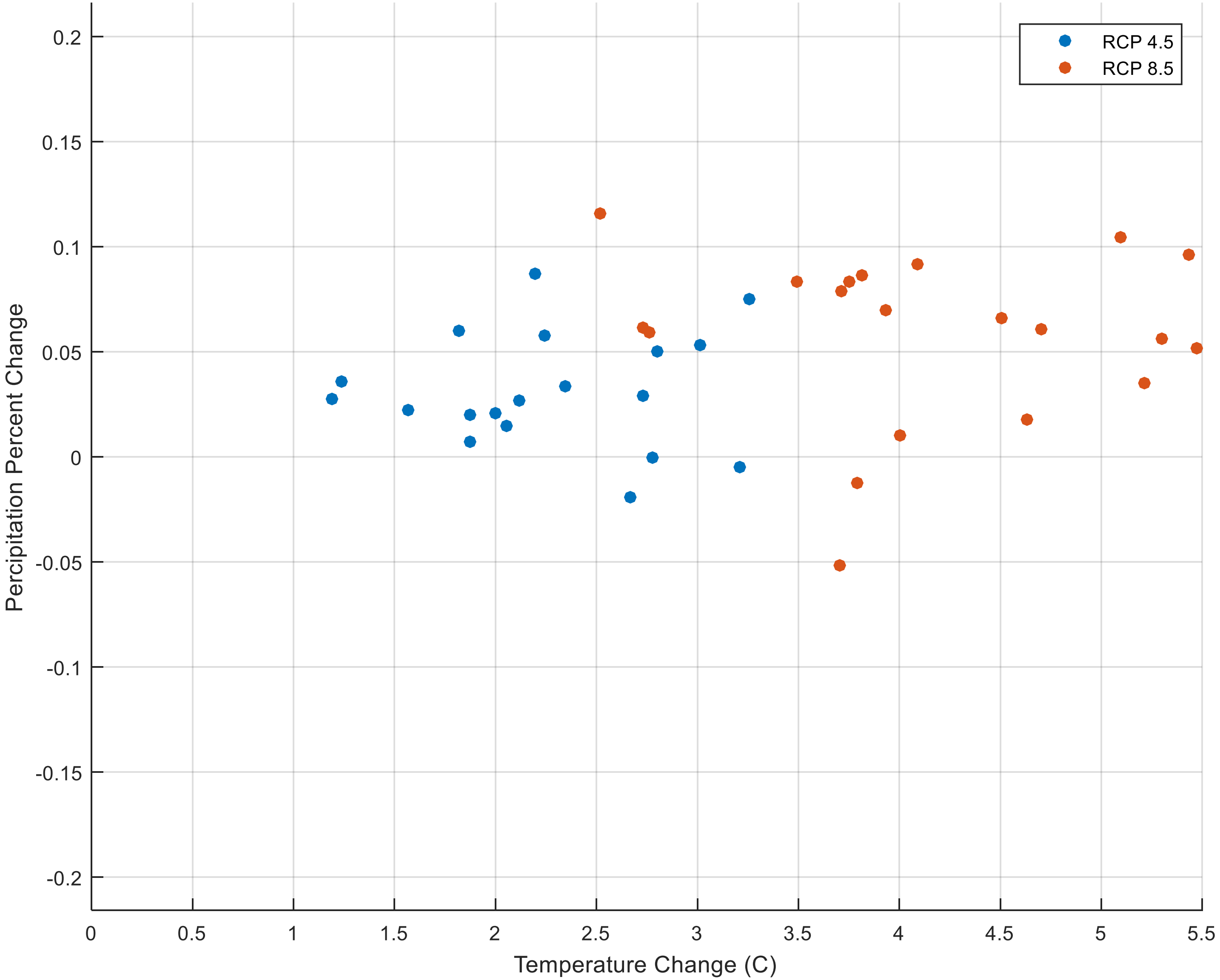
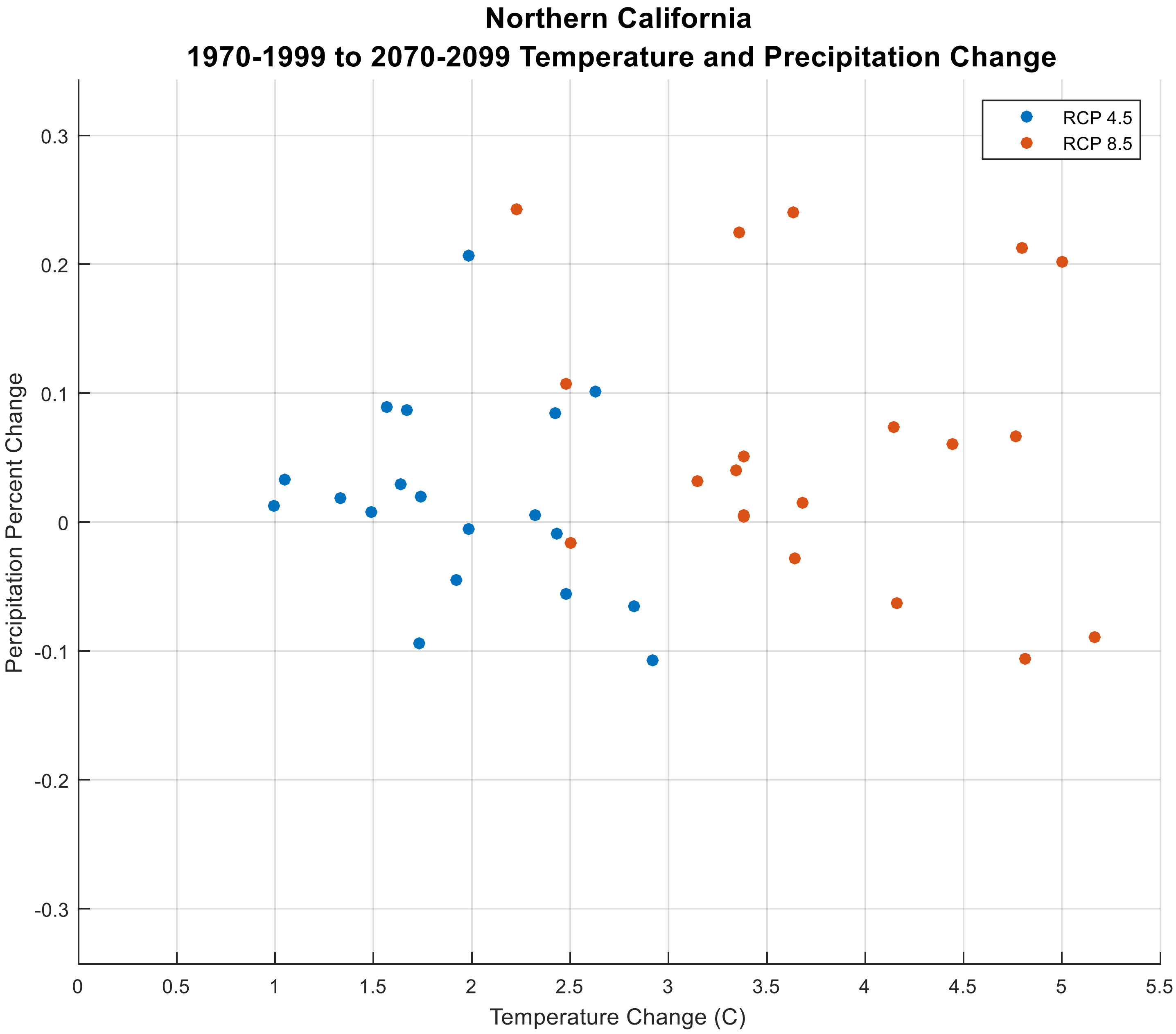


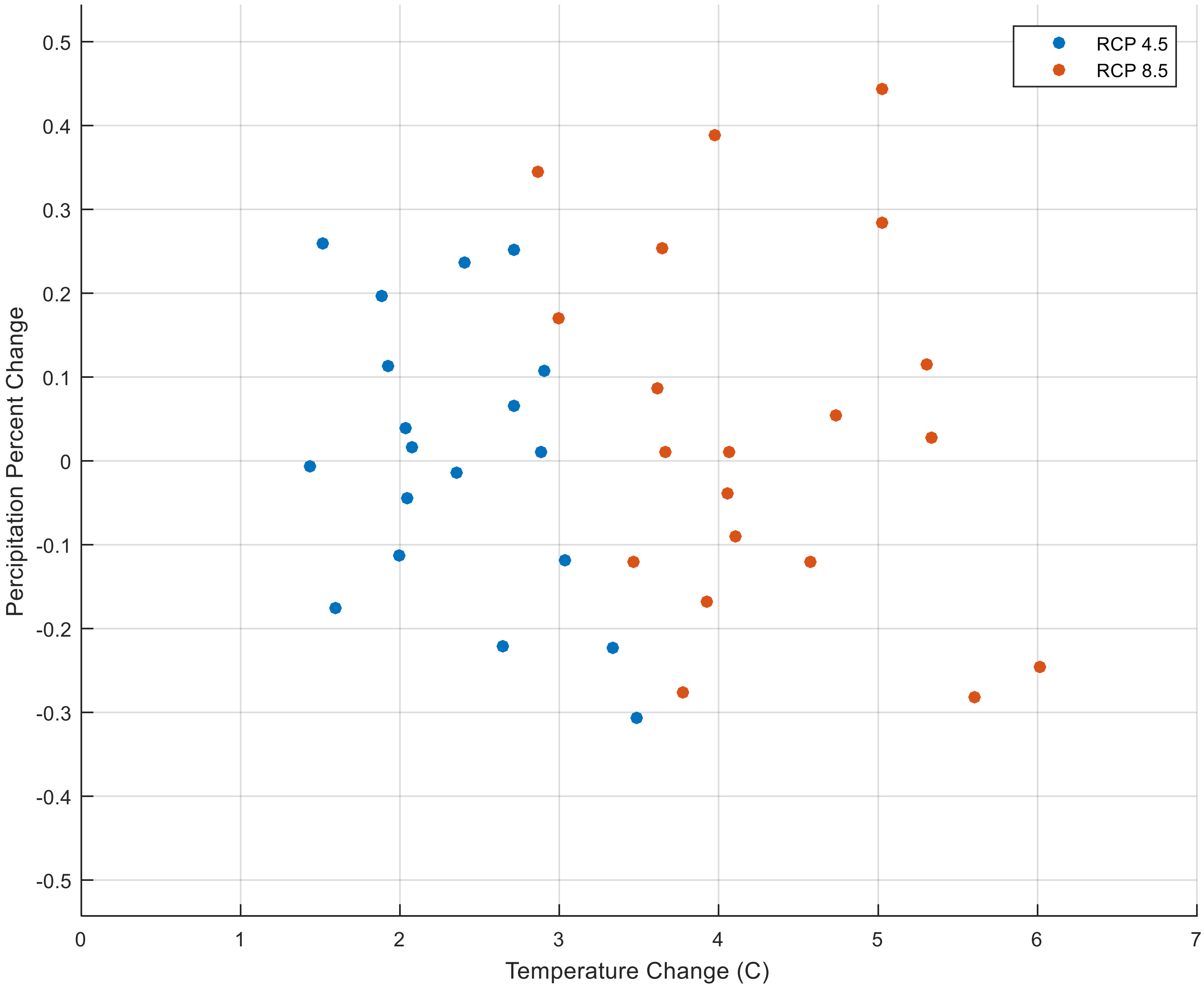
Washington
1970-1999 to 2070-2099 Temperature and Precipitation Change

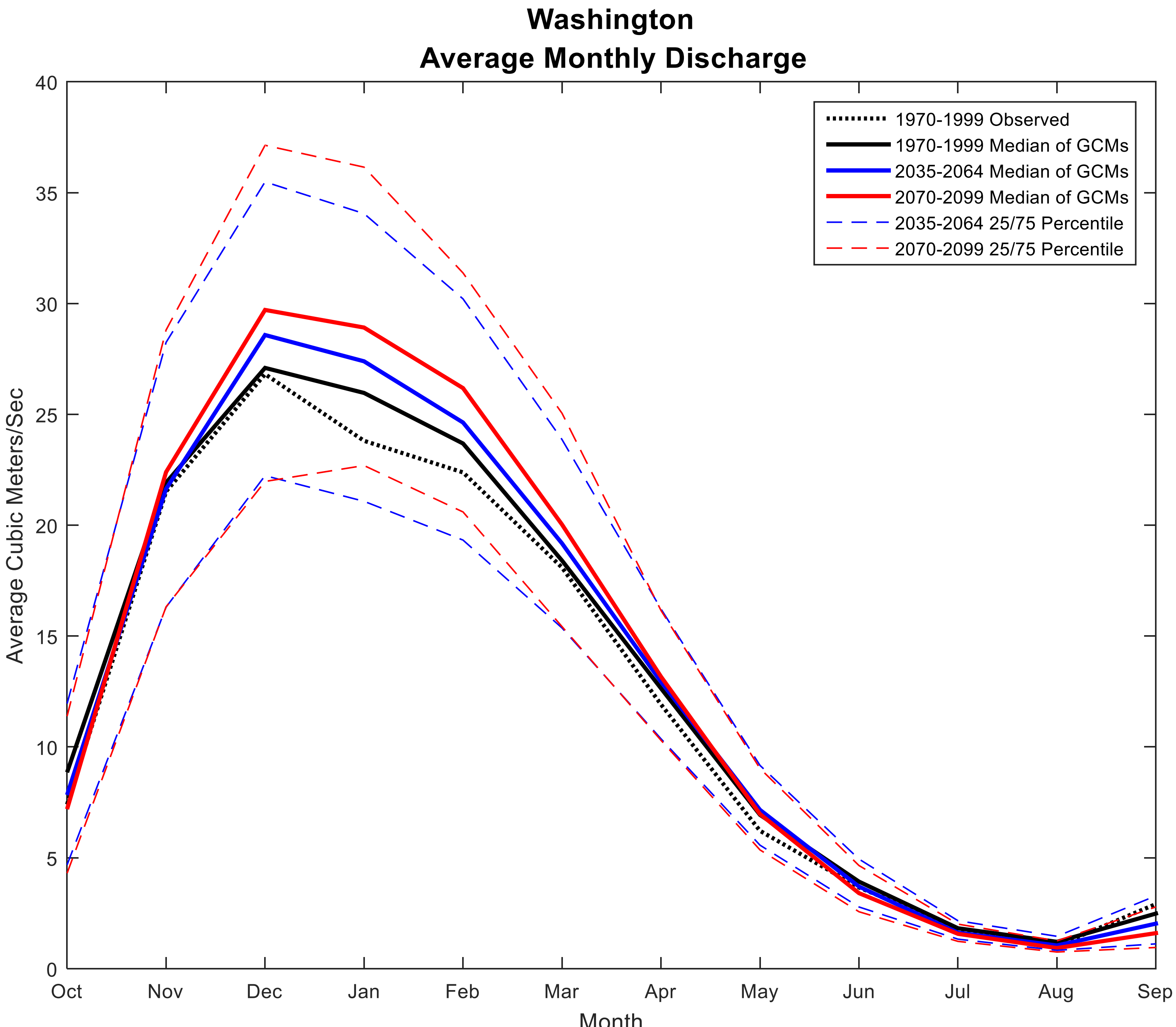


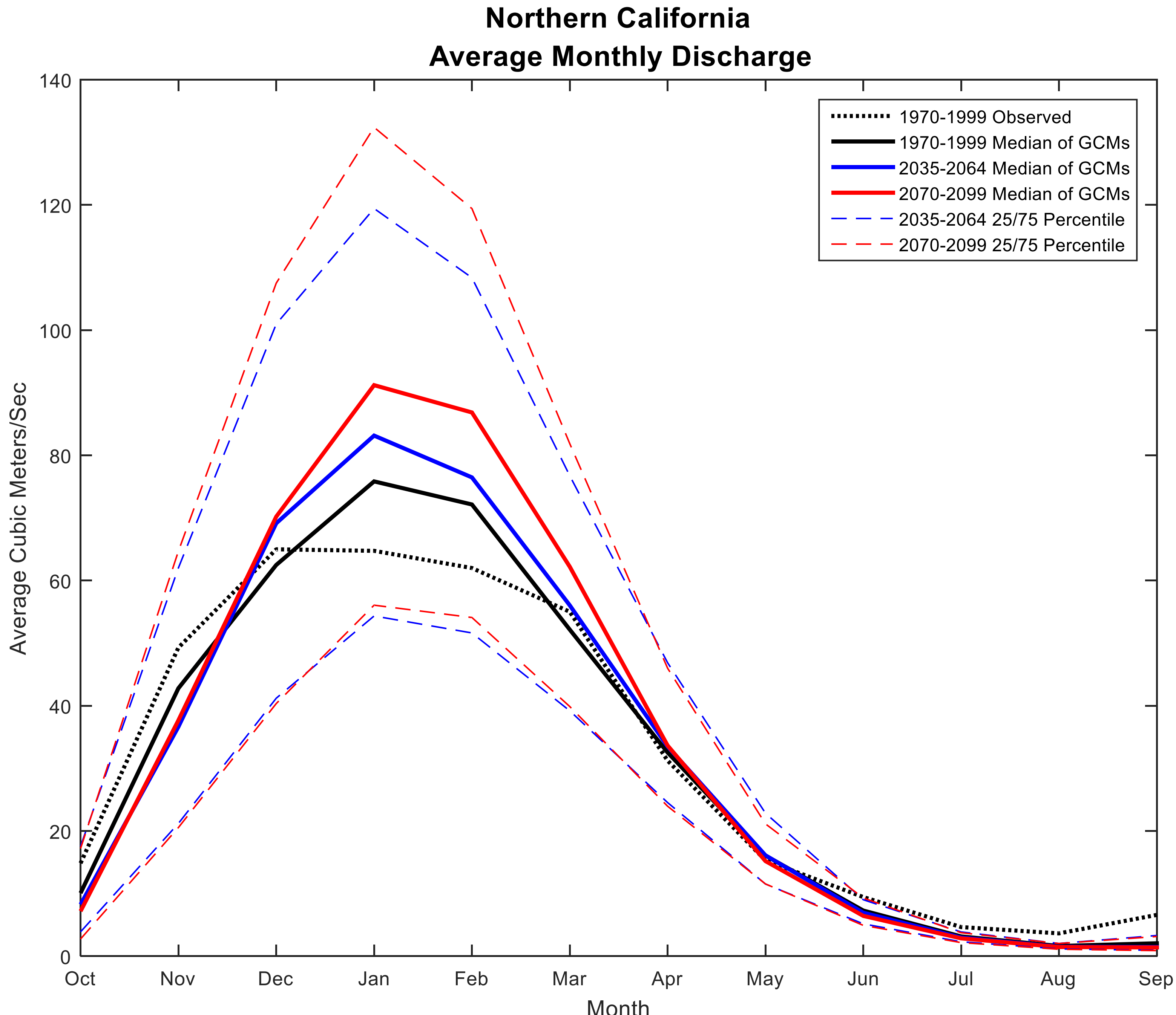


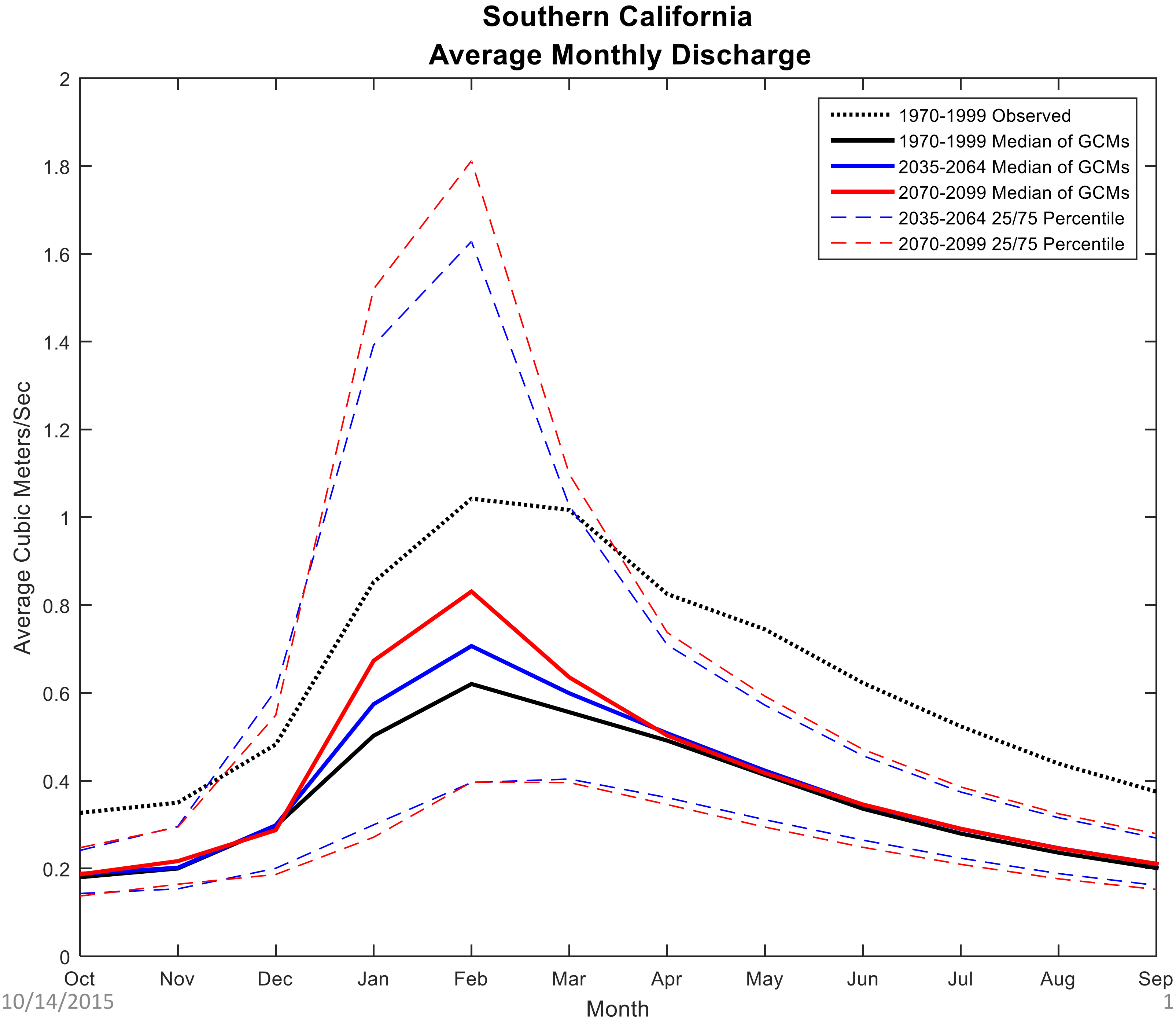
Northern California
1970-1999 to 2070-2099 Temperature and Precipitation Change
RCP 4.5
RCP 8.5
Percipitation Percent Change
Temperature Change (C)
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5

Southern California
1970-1999 to 2070-2099 Temperature and Precipitation Change




Washington
Average Monthly Discharge
Average Cubic Meters/Sec
0
5
10
15
20
25
30
35
40
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month
1970-1999 Observed
1970-1999 Median of GCMs
2035-2064 Median of GCMs
2070-2099 Median of GCMs
2035-2064 25/75 Percentile
2070-2099 25/75 Percentile


Northern California
Average Monthly Discharge
1970-1999 Observed
1970-1999 Median of GCMs
2035-2064 Median of GCMs
2070-2099 Median of GCMs
2035-2064 25/75 Percentile
2070-2099 25/75 Percentile
Average Cubic Meters/Sec
0
20
40
60
80
100
120
140
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month


Southern California
Average Monthly Discharge
1970-1999 Observed
1970-1999 Median of GCMs
2035-2064 Median of GCMs
2070-2099 Median of GCMs
2035-2064 25/75 Percentile
2070-2099 25/75 Percentile
Average Cubic Meters/Sec
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month

Results

- Small changes in overall discharge. Increases in peak flow at both mid and late century
- Slight shift towards later timing in N. CA, otherwise so changes in timing
- Notable variation across models-25th & 75th percentiles indicative of high variability
- Large changes in temperature particularly S. CA
- Variable changes in precipitation, highly dependent on climate model

Future Work

- Focus on longer time series analysis
- Analyze variability and extreme events
- Assess the relative influence precipitation and temperature on streamflow
- Compare trends across sites – are impacts in WA comparable to those in CA?

Thank You

References:

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Moriasi, D. N., Arnold, J. G., Van Liew, M. W., Bingner, R. L., Harmel, R. D., & Veith, T. L. (2007). Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. Trans. Asabe, 50(3), 885-900.

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