

Drought Impact on Streamflow in Central-Southern Chile under Climate Change

Deniz Bozkurt, Maisa Rojas, Jonás
Valdivieso and Mark Falvey
Department of Geophysics
University of Chile

International Expert Eymposium “Coping with Droughts” 19th-21st November 2014, Santiago-Chile

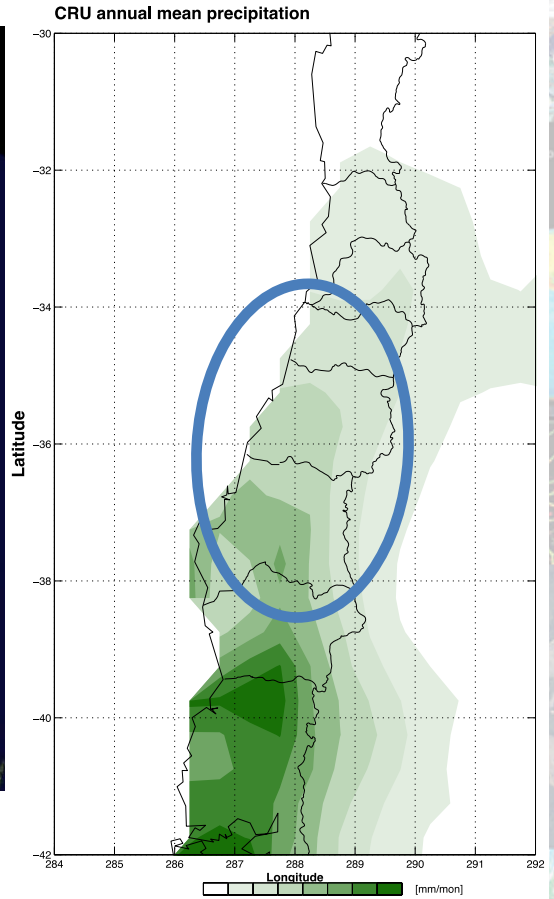
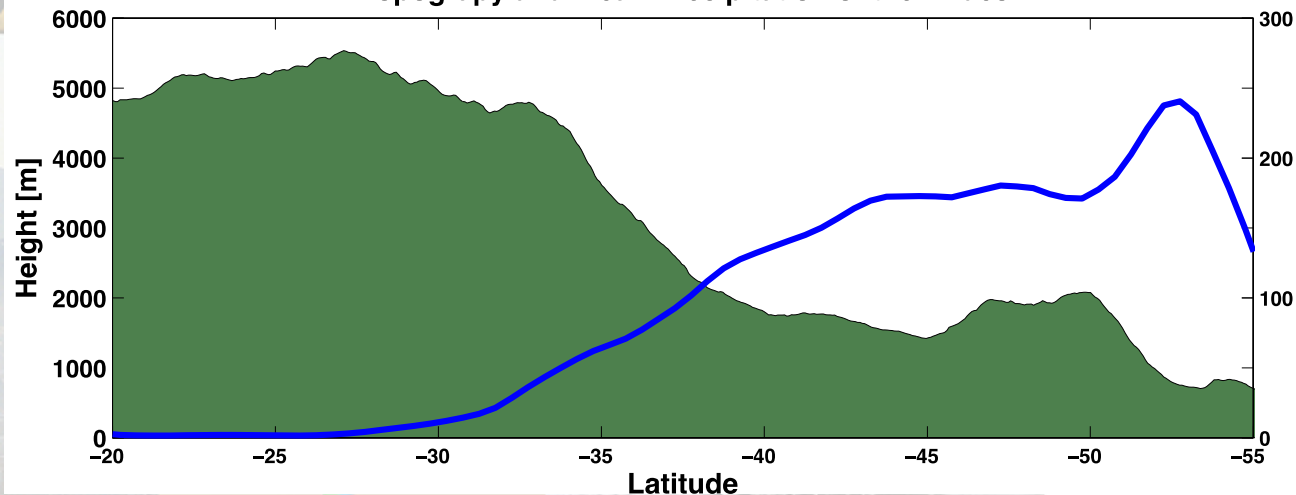
Overview

- Region / Motivation
- Climate context: present, CMIP5 RCP8.5 projections
- Data and method
- Runoff projections?

Regional context

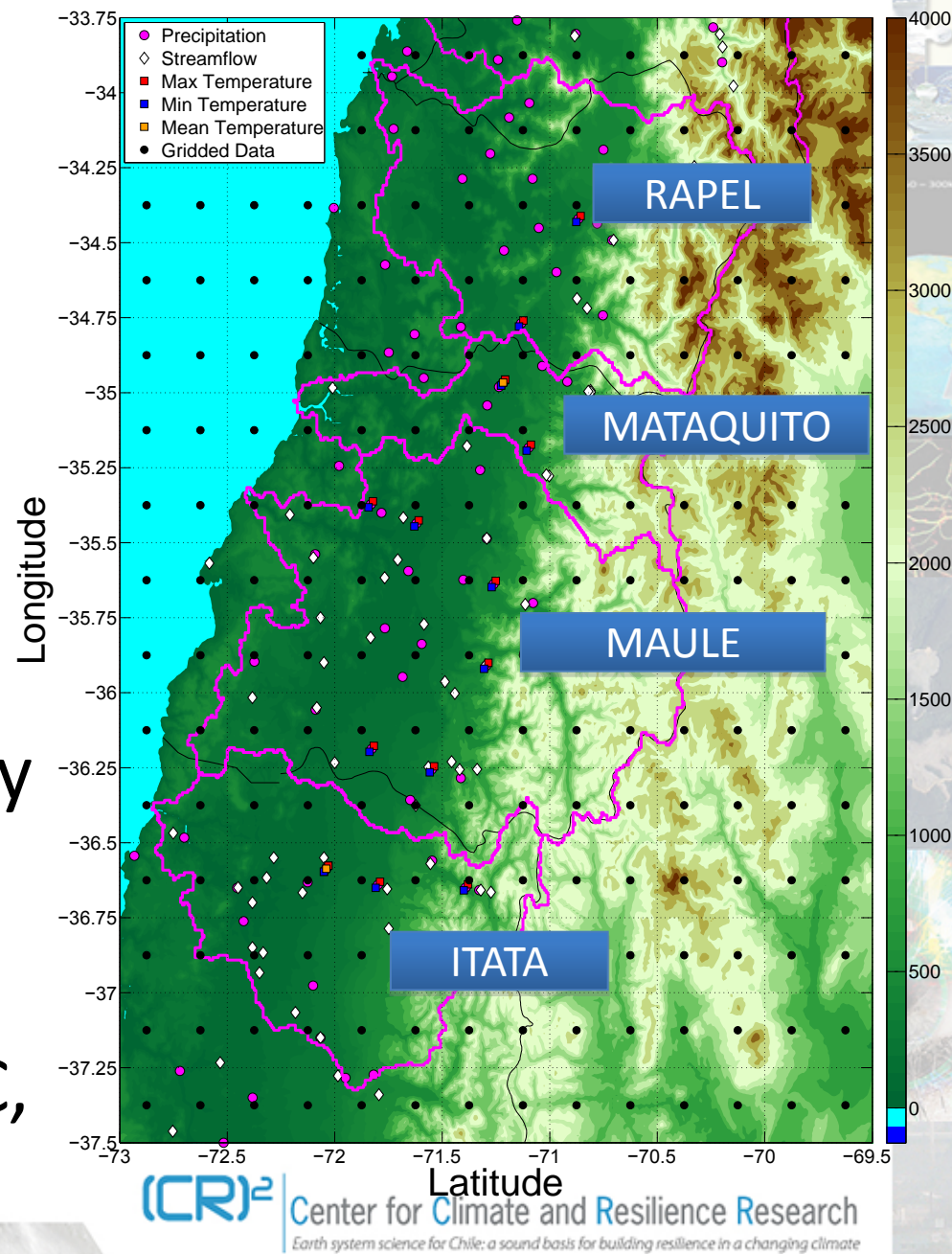


Topography and mean Precipitation of the Andes



Data Used

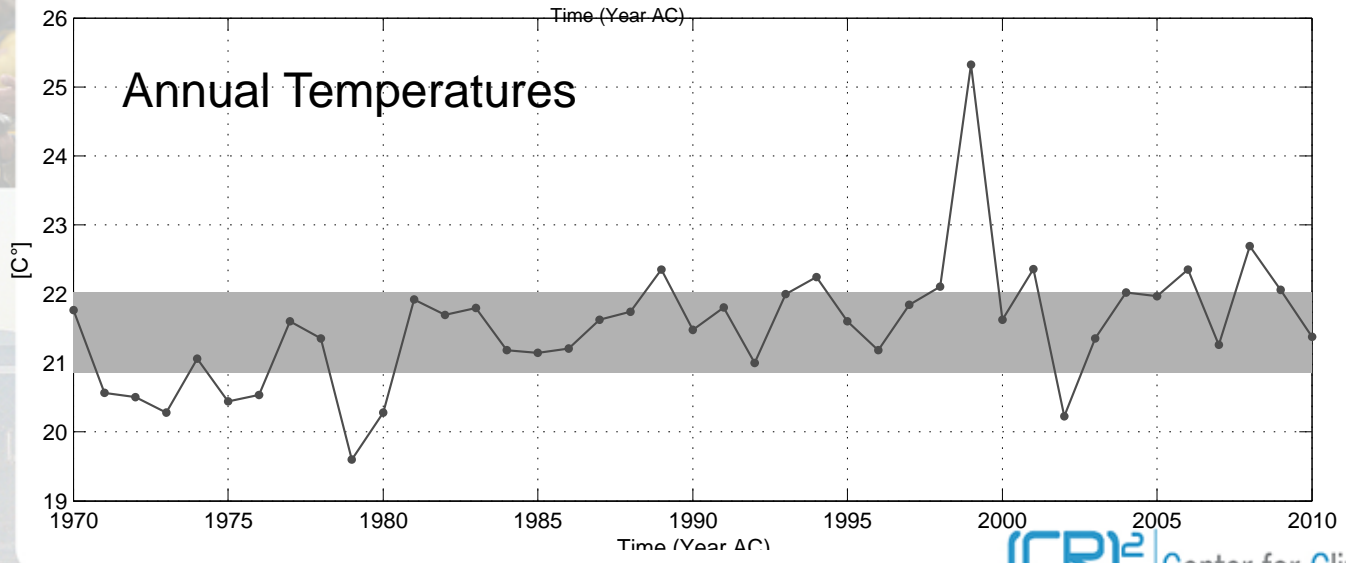
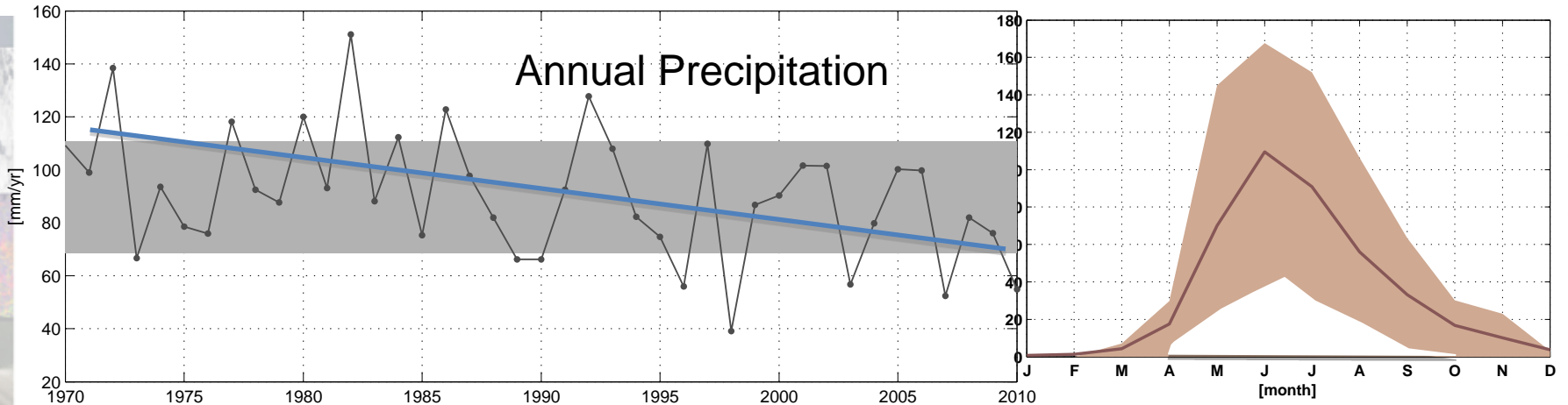
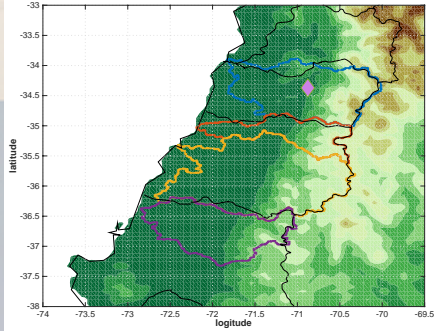
- 28 CMIP5 models, daily data: precip, tasmx, tasmin.
 - Historical simulation: 1960-2005
 - RCP8.5: 2006-2099
- Gridded data set of daily precip, temperatures (DeMaria, 2013)
- Daily Station data (DMC, DGA).



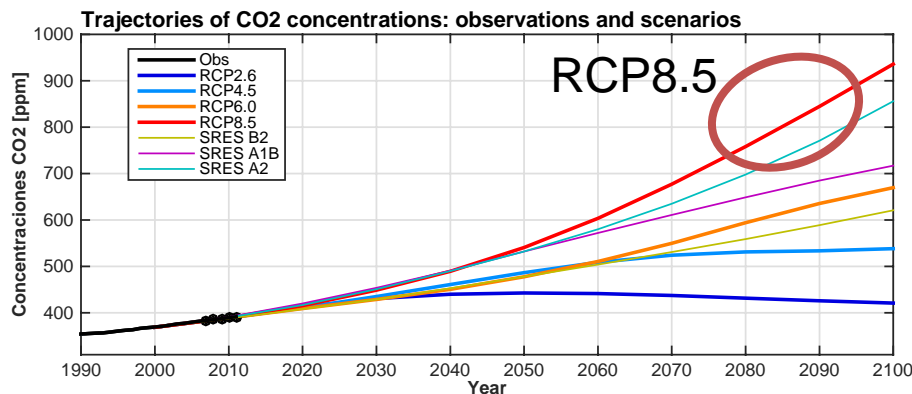
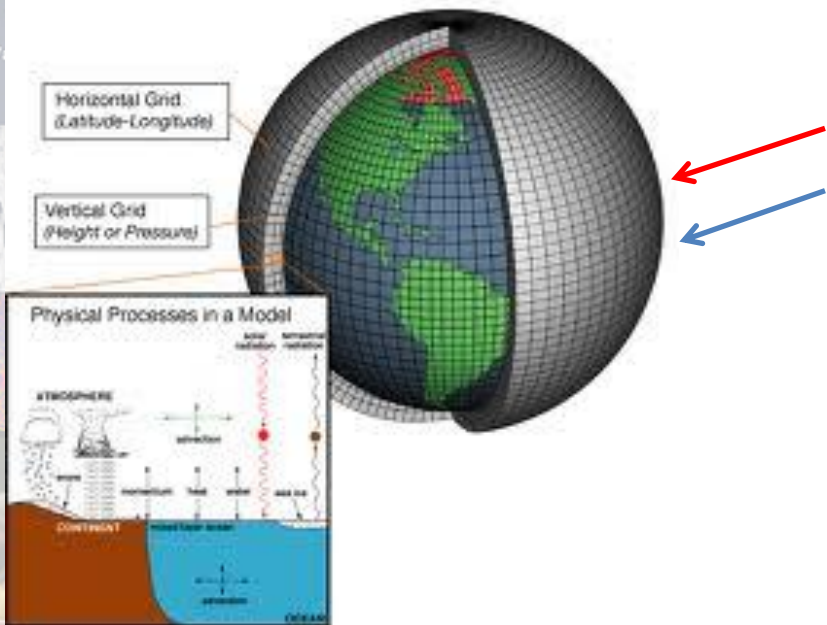
Methodology

- 28 CMIP5 Coupled models daily precipitation and temperature data are “adjusted” observations via a “Transfer function”.
- Adjusted timeseries are used to force VIC hydrological model
- Runoff changes are evaluated

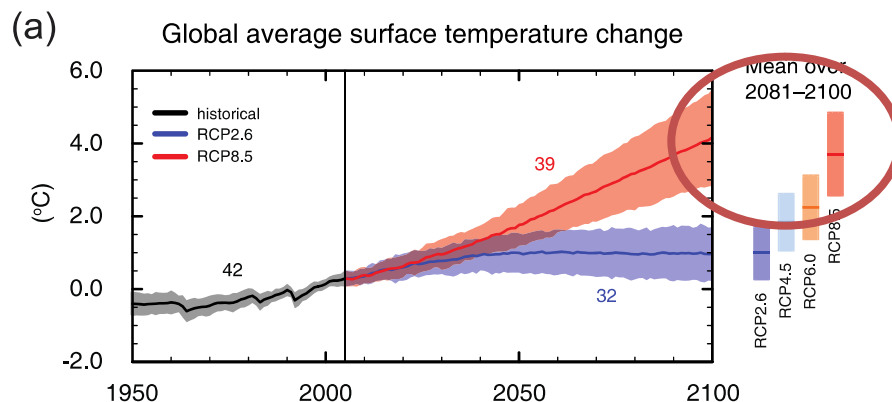
Climatology: Rapel Basin



RCP8.5: socio-economic development scenario used for climate projections.

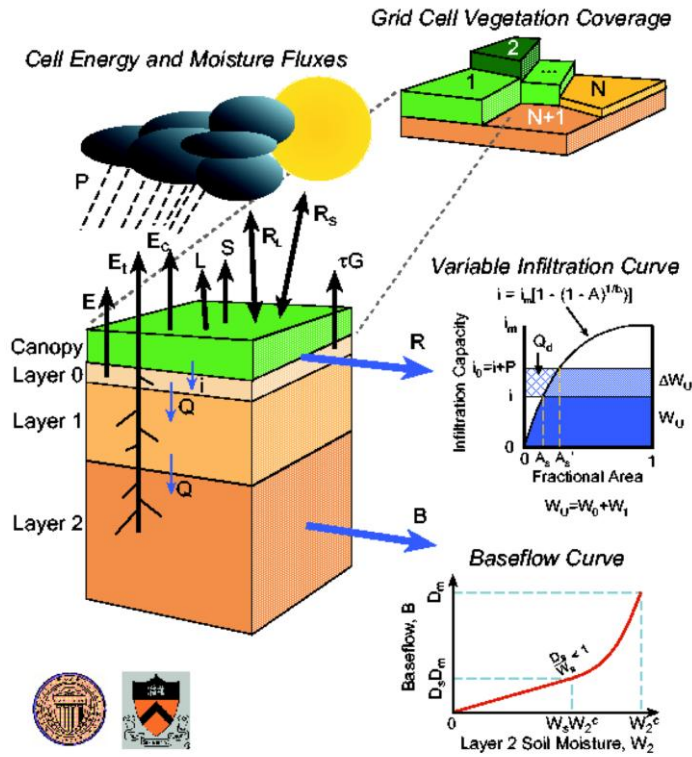


[NOAA 200th Celebration](#) diagram showing a climate model



VIC Model and Validation

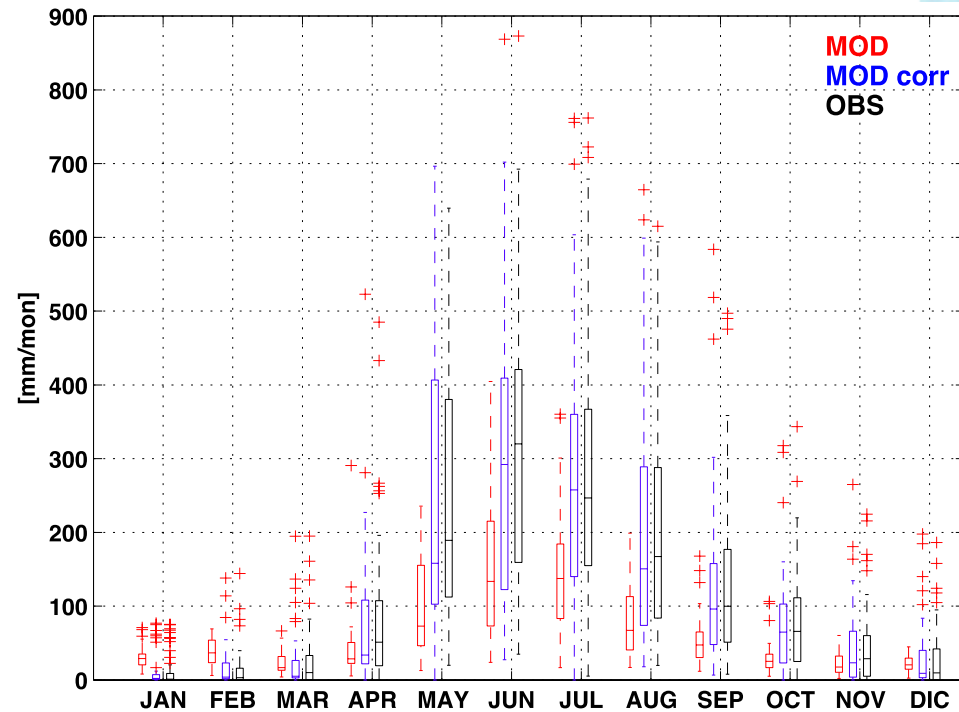
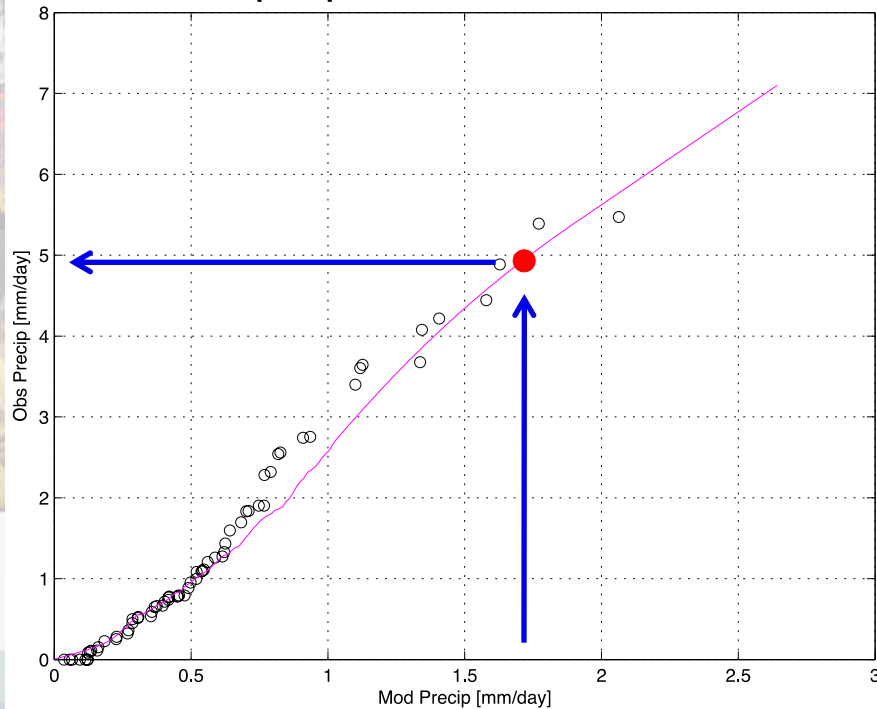
Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model



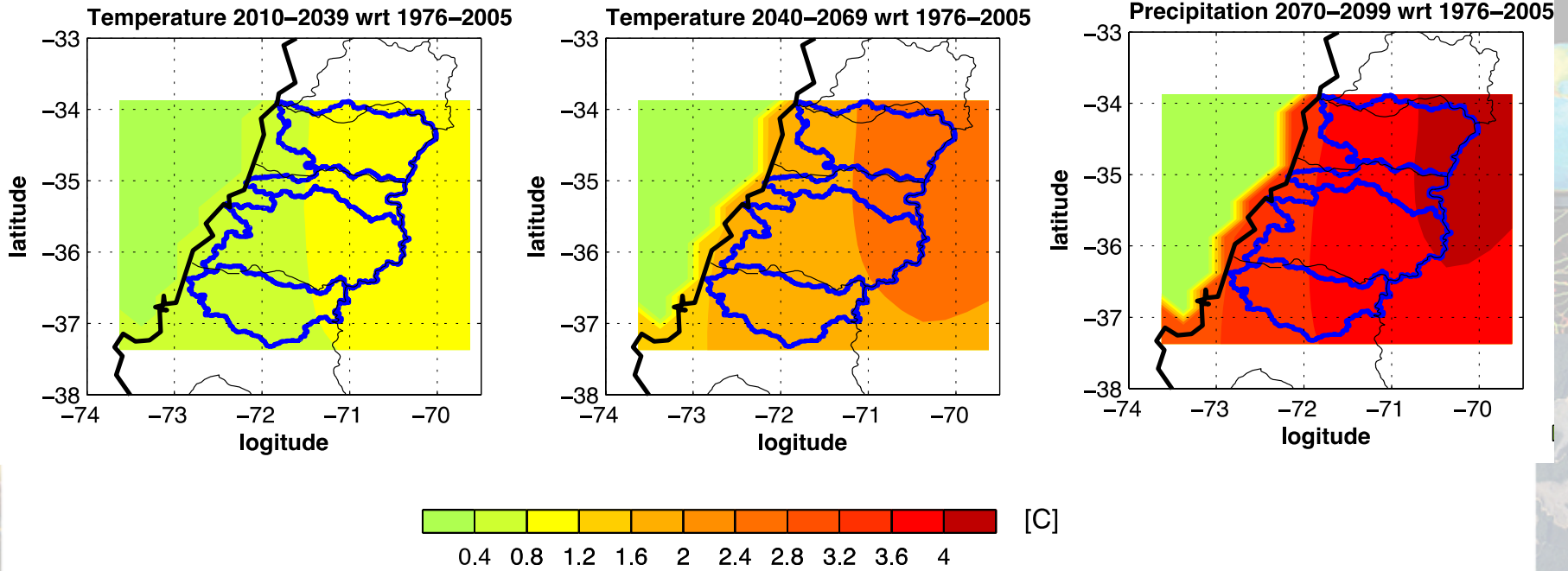
- Large-scale hydrologic model
- Simulates water & energy storages and fluxes
- Inputs:
 - Precipitation
 - Air temperature (Max. and min.)
 - Wind speed
- from DeMaria et al. (2013) as observed forcing and from 9 CMIP5 coupled models
- Model time step length = daily
- Model outputs: Total runoff (Surface runoff+sub-surface flow, precipitation, snowcover, SWE...)
- Model resolution: 0.25x0.25 degree
- Model validation (1976-2008) has been performed based on:
 - Long-term mean monthly runoff data (GRDC, 2013)
 - CRU precipitation
 - MODIS snowcover (2001-2008)

Transfer function for precipitation

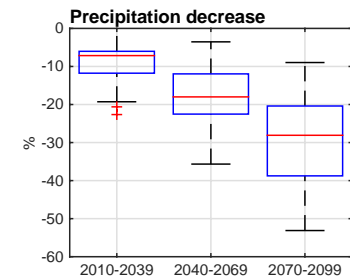
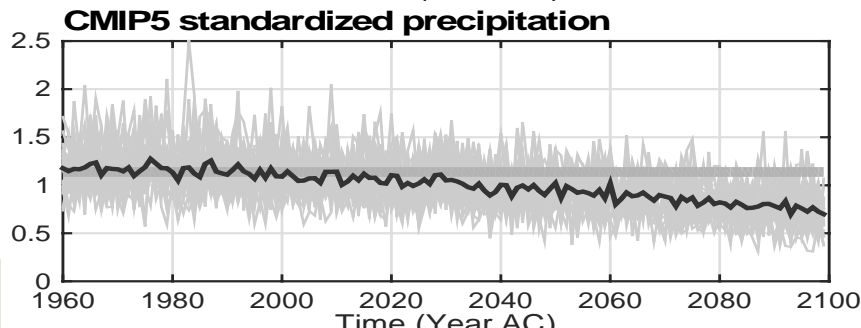
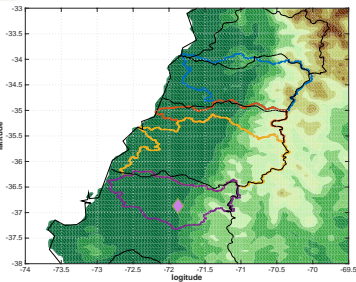
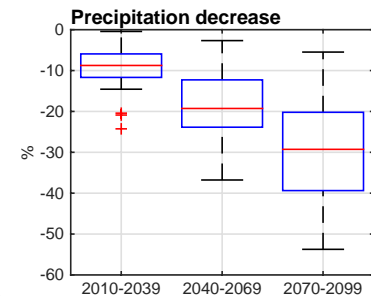
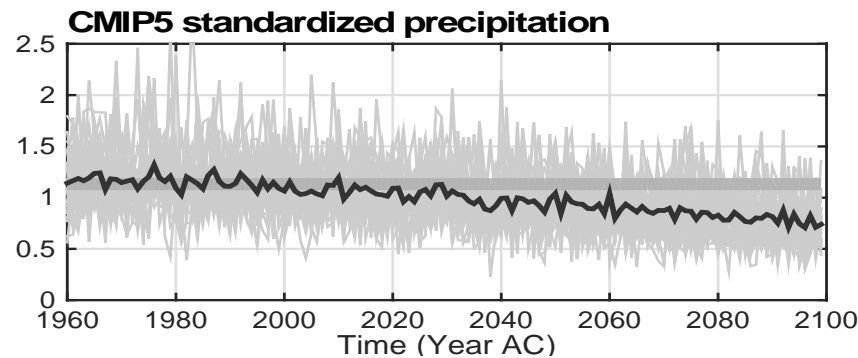
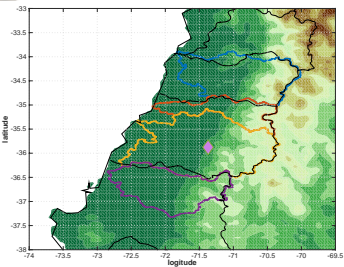
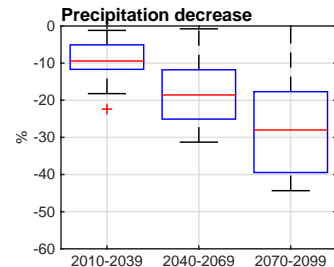
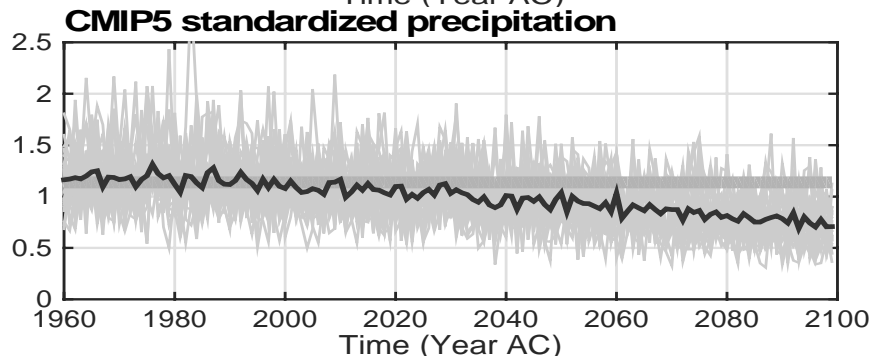
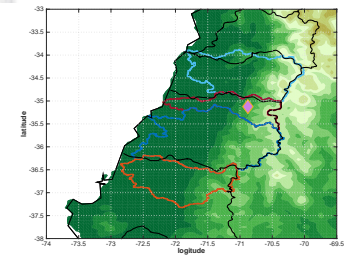
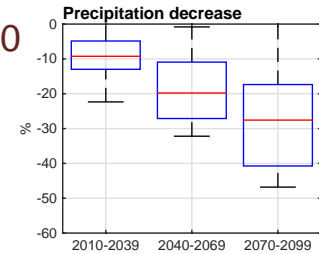
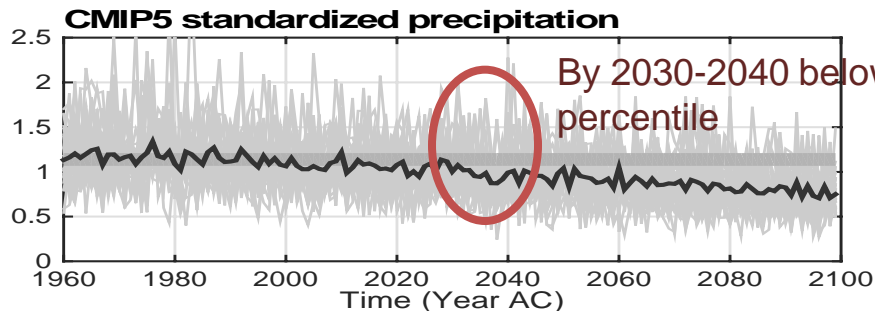
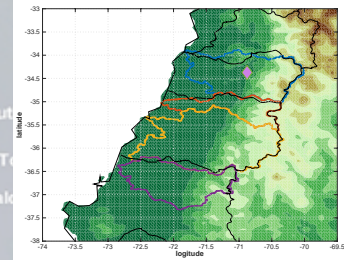
precipitation transfer function



Temperature projections

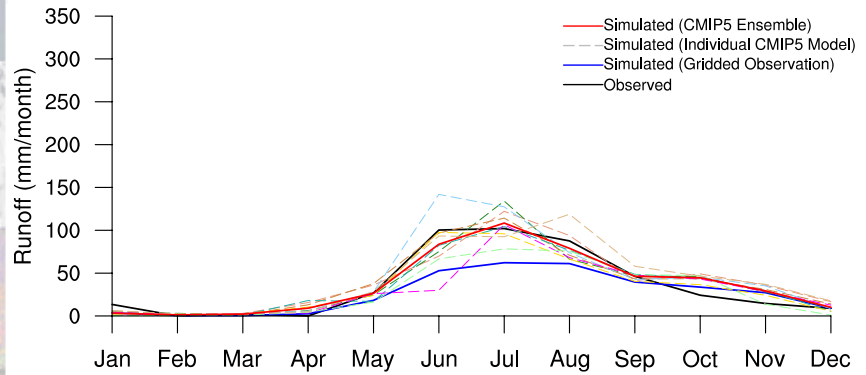


Precipitation projections

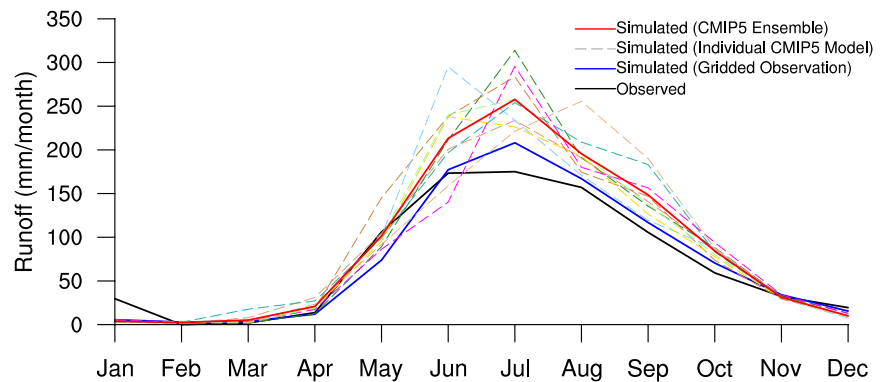


VIC Validation: mean annual runoff cycle

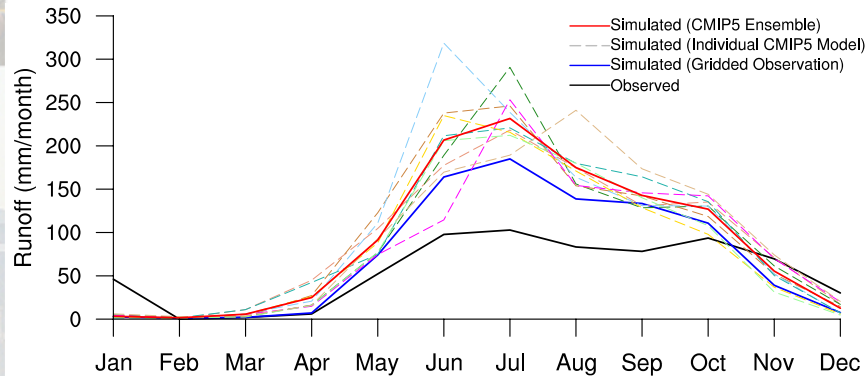
Rapel Basin



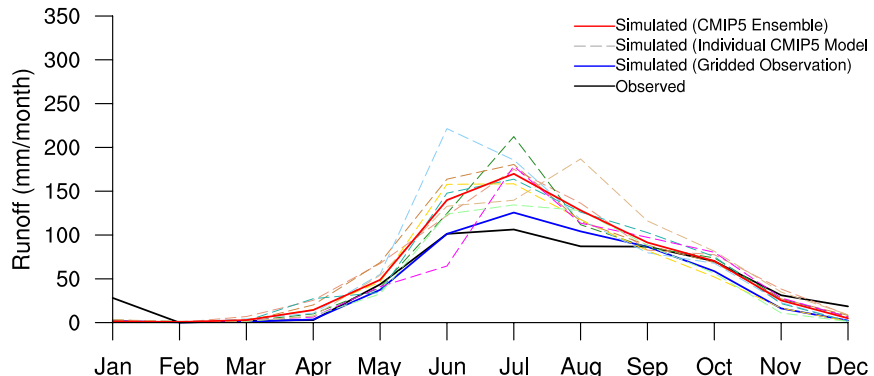
Itata Basin



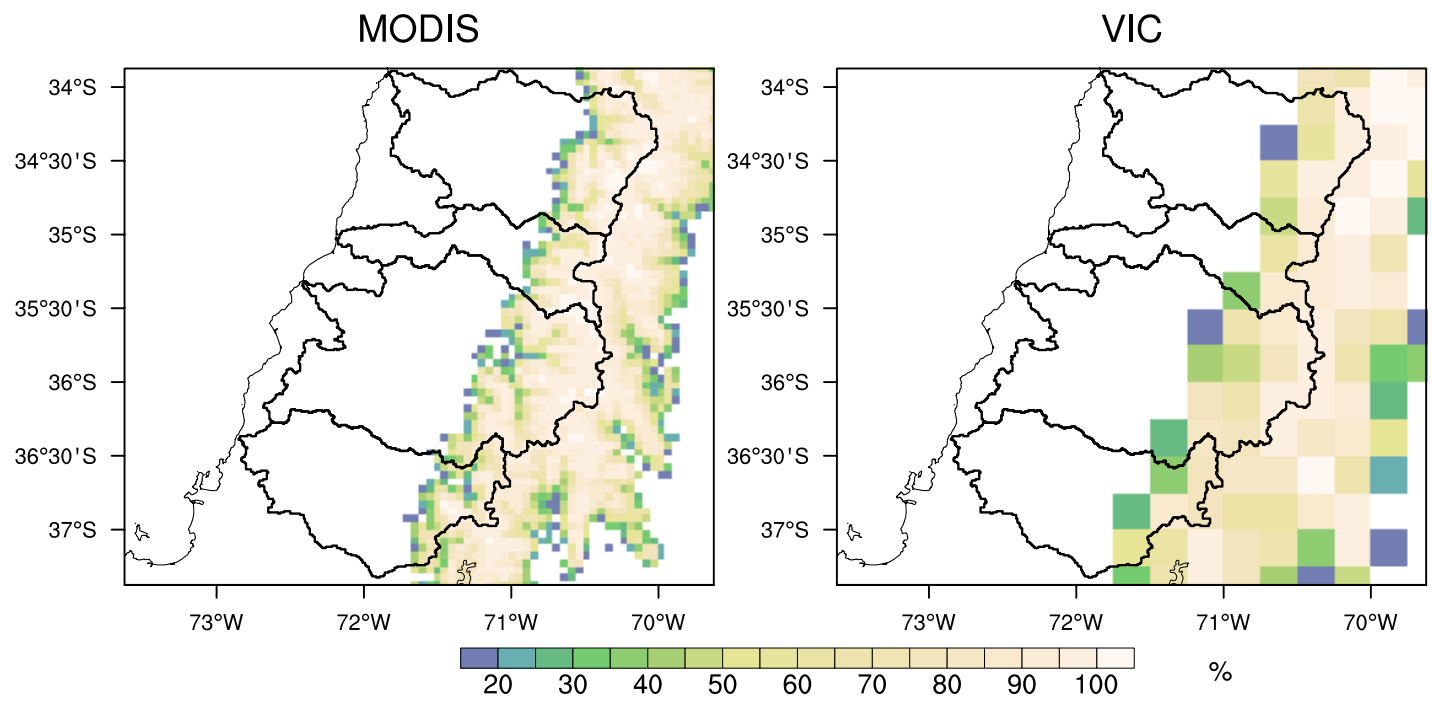
Maule Basin



Mataquito Basin

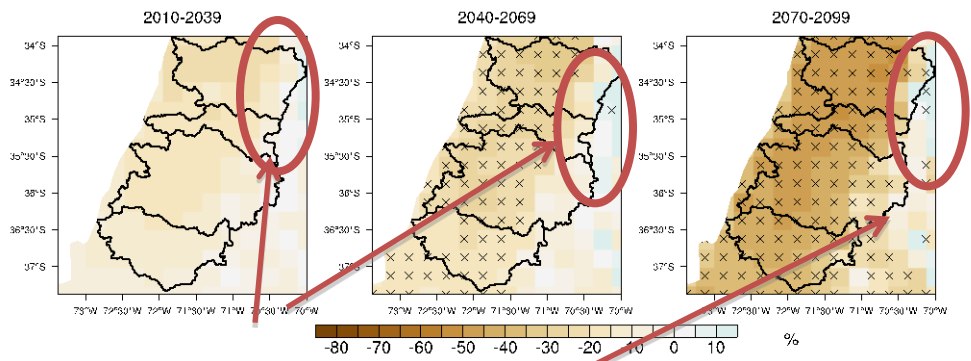


VIC Validation: winter (JJA) snowcover > 1000m



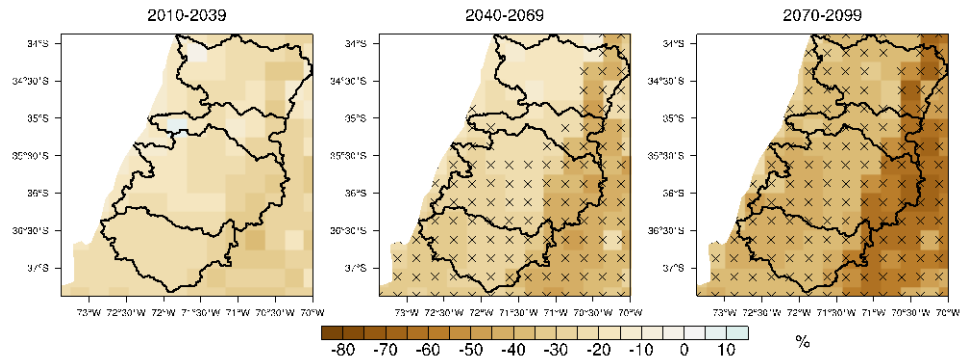
VIC Model Projections

JJA total runoff change

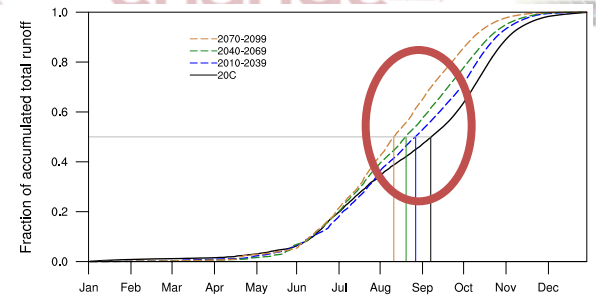


Winter increase in runoff

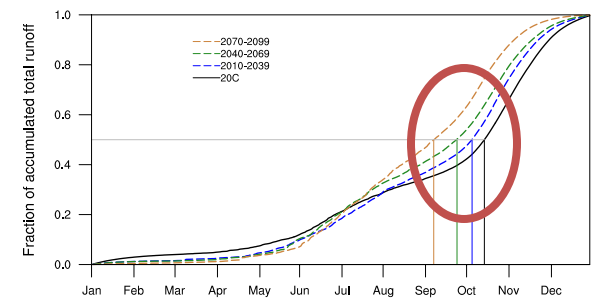
SON total runoff change



Rapel Basin

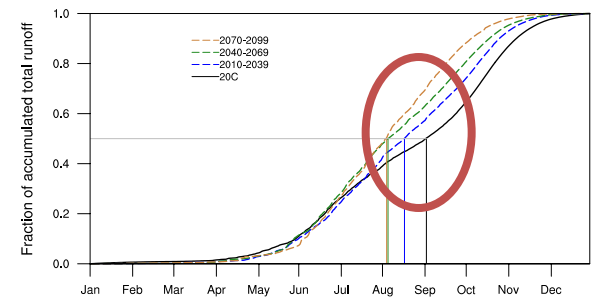


Mataquito Basin

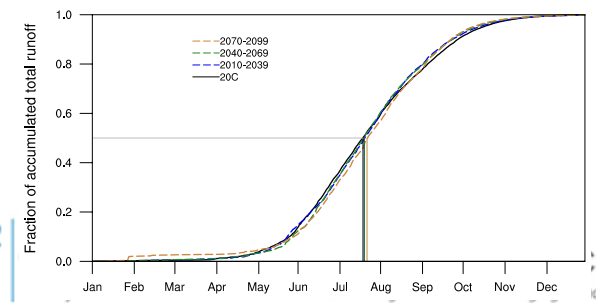


Shift in peak runoff

Maule Basin

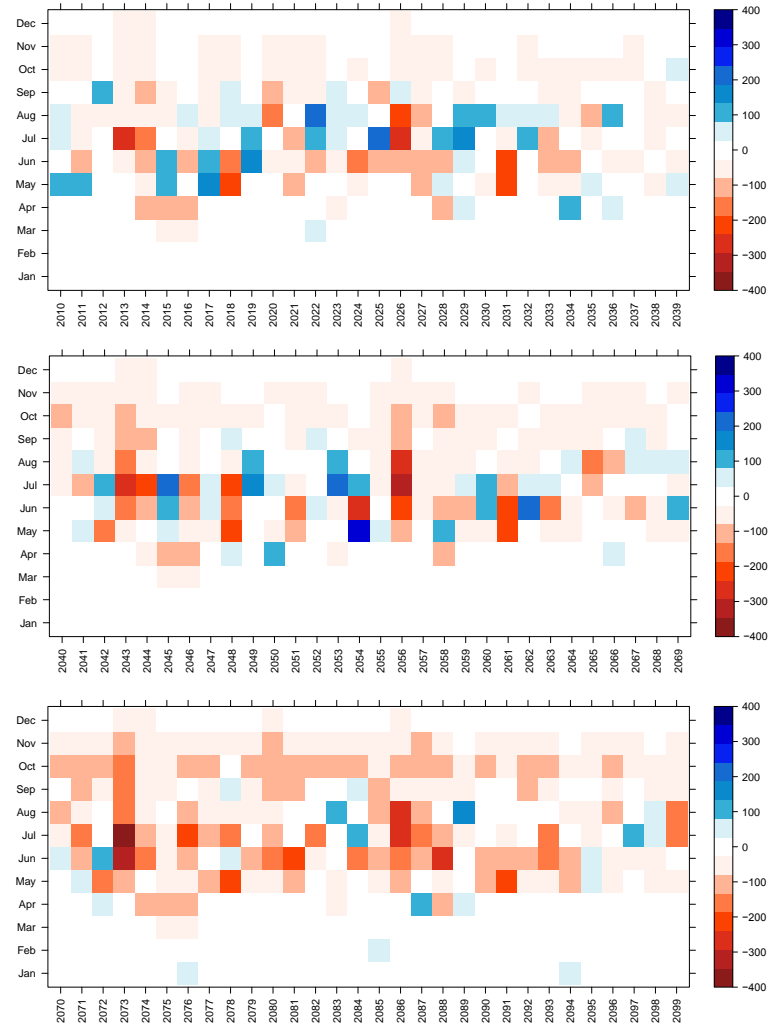


Itata Basin



VIC Model Projections

Maule Basin



Early-century

Mid-century

Late-century

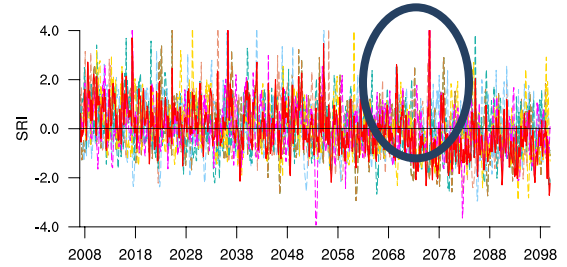
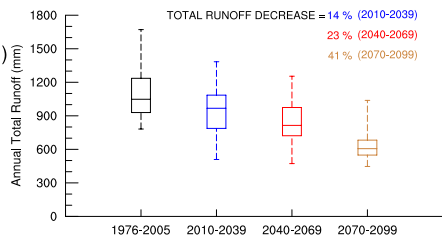
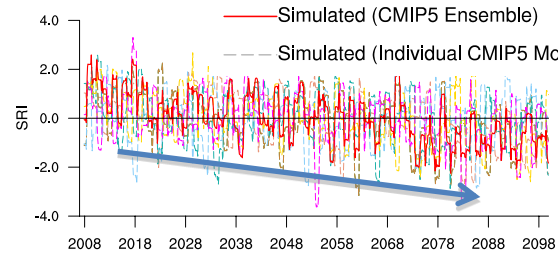
VIC Model Projections

SRI-12 month

Total runoff changes

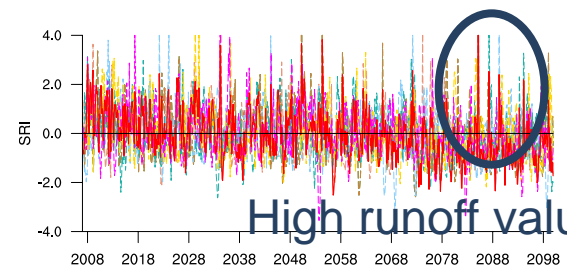
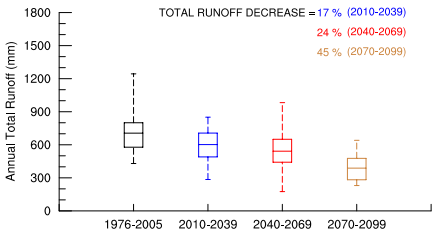
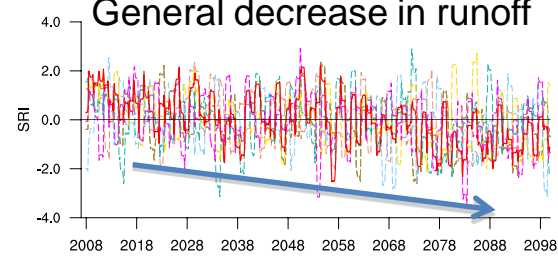
SRI-3 month

Itata Basin

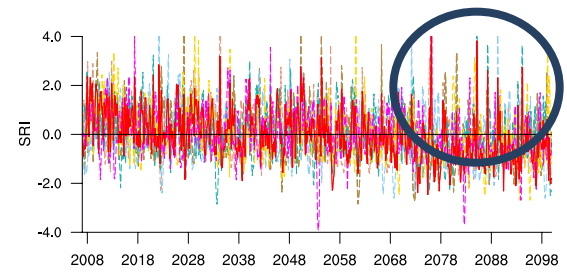
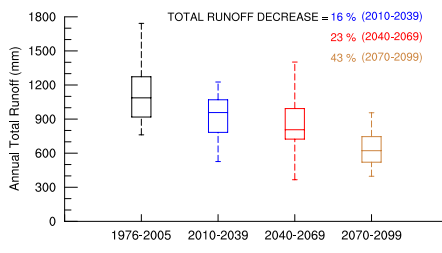
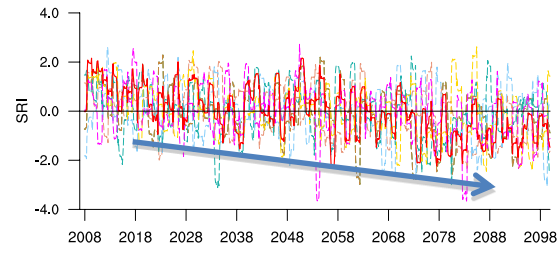


Mataquito Basin

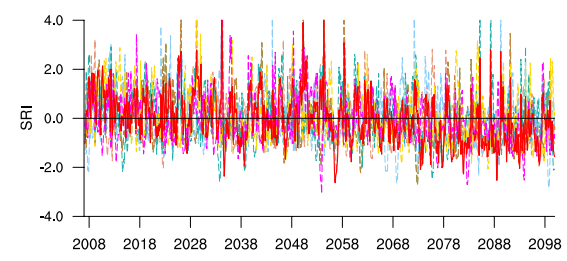
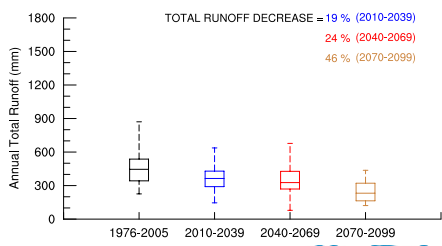
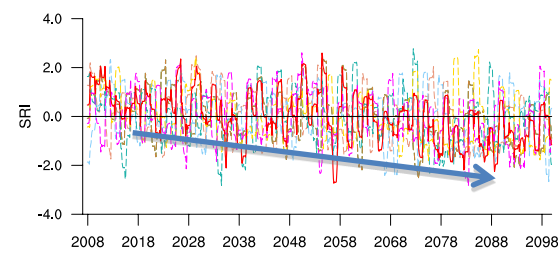
General decrease in runoff



Maule Basin



Rapel Basin



Conclusions

- Central/Southern Chile is projected to become warmer and drier under RCP8.5 scenario.
- Drying is robust (in the models) up to 30% by the end of the century.
- Results for 4 basins indicate overall less streamflow and temporal shifts to earlier days in the peak timing.
- In some areas winter runoff is projected to increase because of zero isotherm moving upward.

References

Global Runoff Data Centre (2013): Long-Term Mean Monthly Discharges and Annual Characteristics of GRDC Station / Global Runoff Data Centre. Koblenz, Germany: Federal Institute of Hydrology (BfG), 2013.

Demaria, E.M., Maurer, E.P., Sheffield, J., Bustos, E., Poblete, D., Vicuna, S., Meza, F. Using a Gridded Global Dataset to Characterize Regional Hydroclimate in Central Chile, Journal of Hydrometeorology, 2013, Vol.14, 251-265

Acknowledgement

We are thankful to Justin Sheffield and Edwin P. Maurer for providing the VIC model parameter files and gridded meteorological fields.