Modeling the effects of climate change forecasts on streamflow in the Nooksack River basin

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Dr. Robert Mitchell

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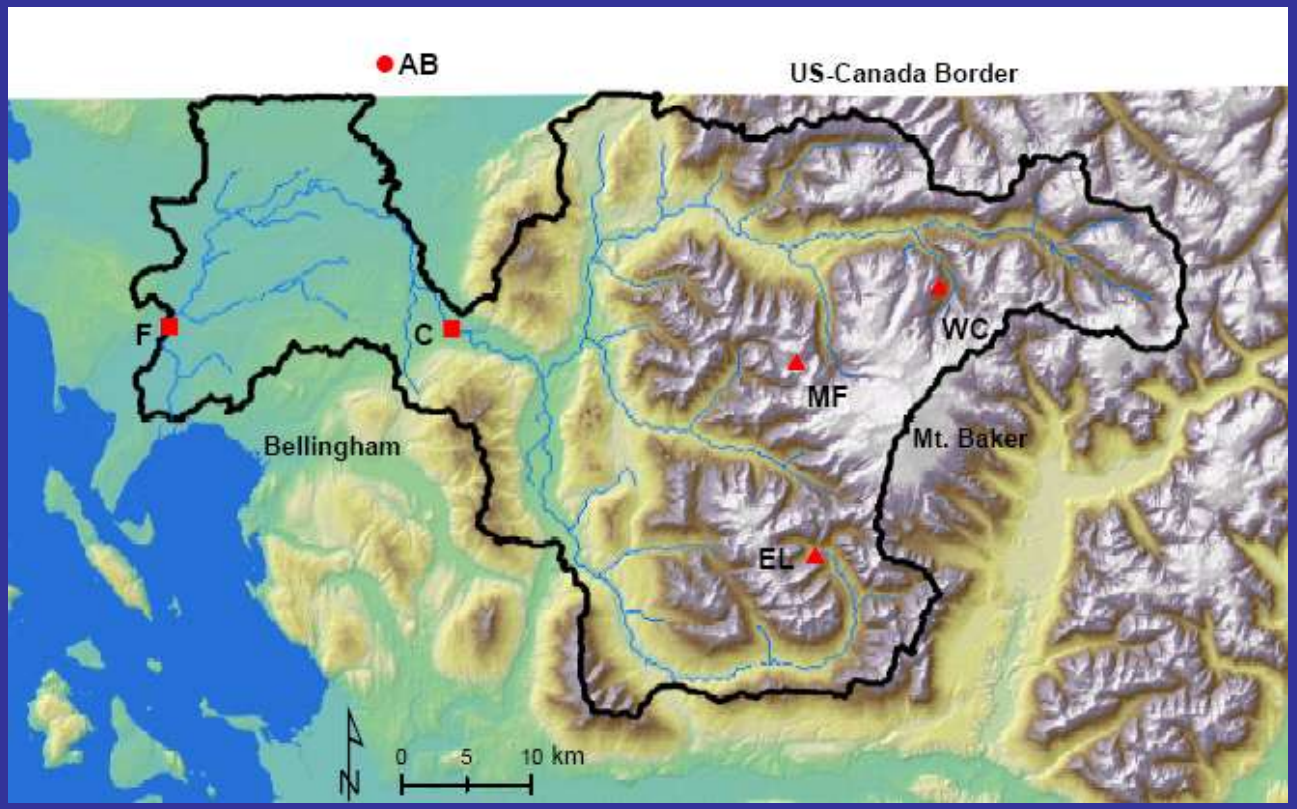
Assistance From:

Climate Change Technical Committee:

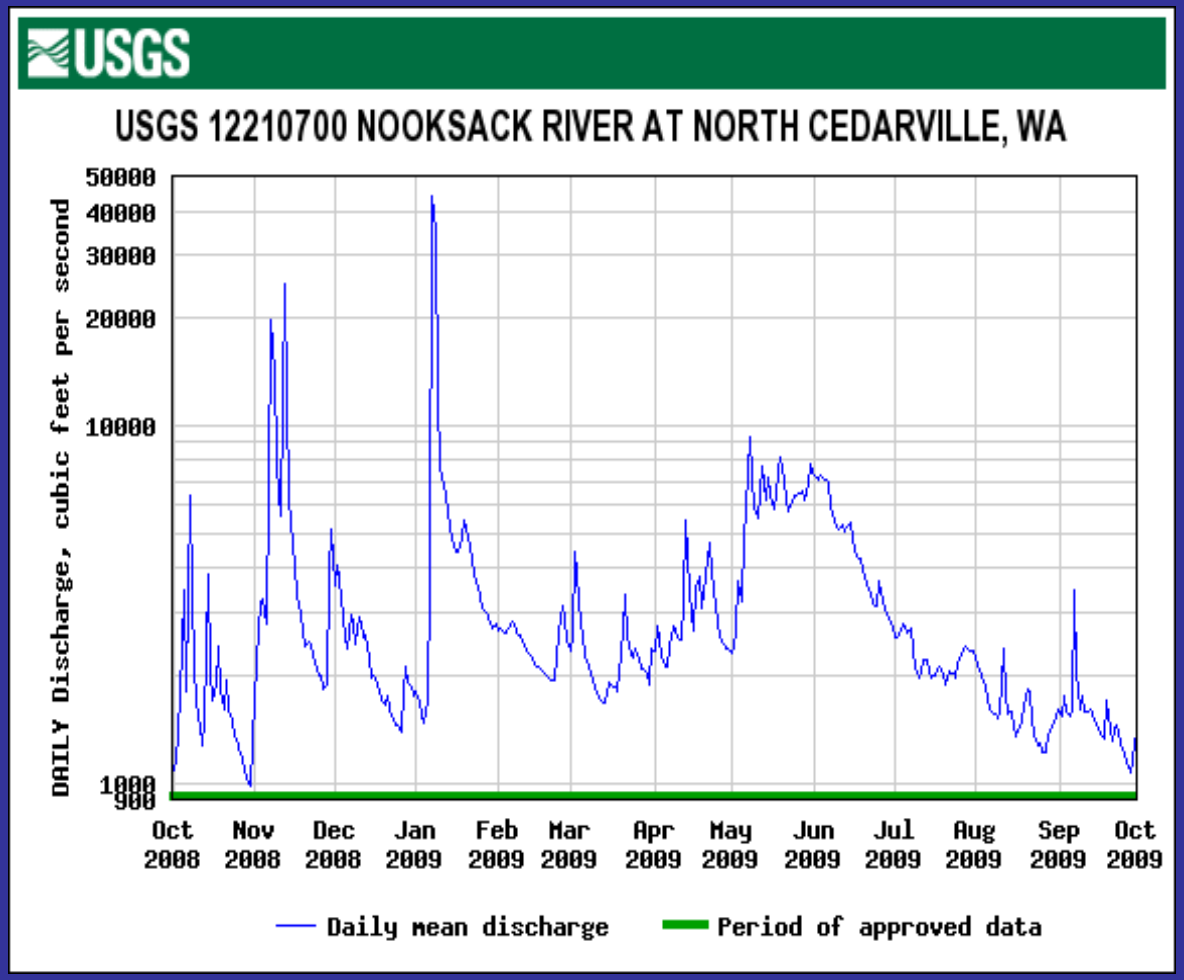
Matt Wiley & Austin Polebitski

Goal of Research

To predict the timing and magnitude of streamflow in the Nooksack River basin under changing climate conditions

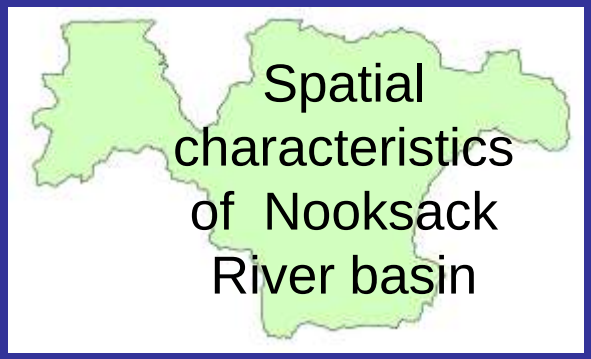


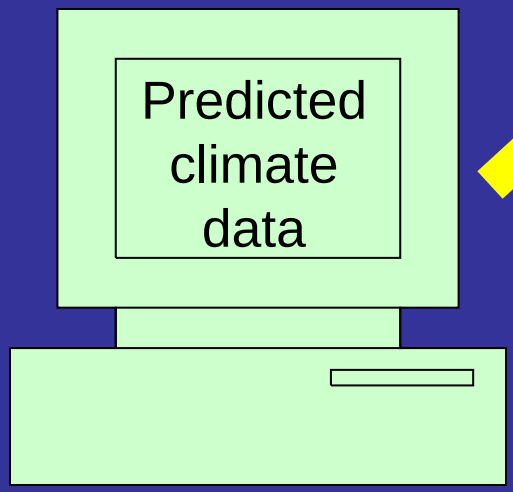
Background: The Nooksack River

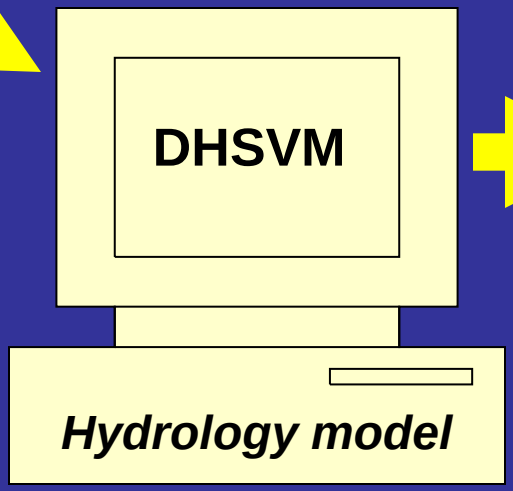


Streamflow at North Cedarville, WA
Water Year 2009 (Oct 2008 – Sept 2009)

Approach







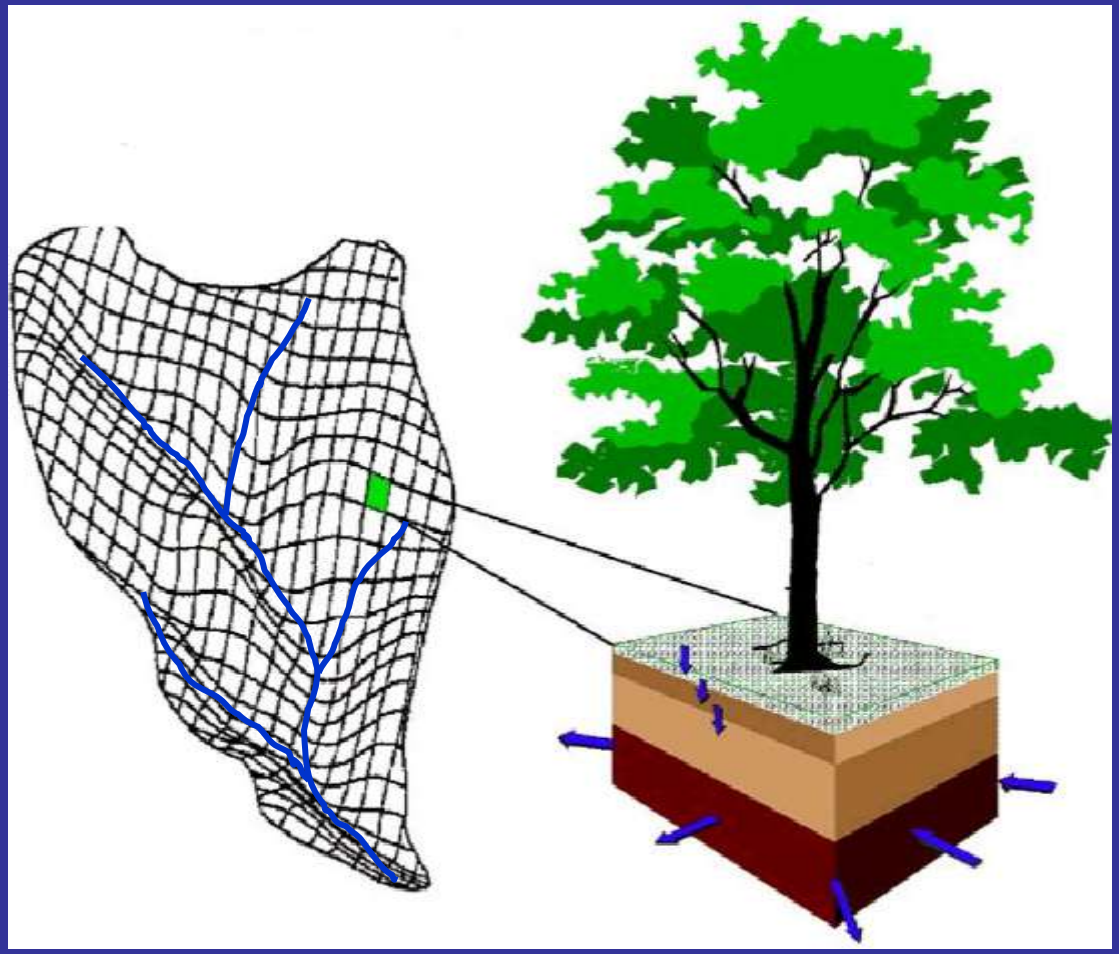
Predictions

Future Snowpack

Future Streamflow

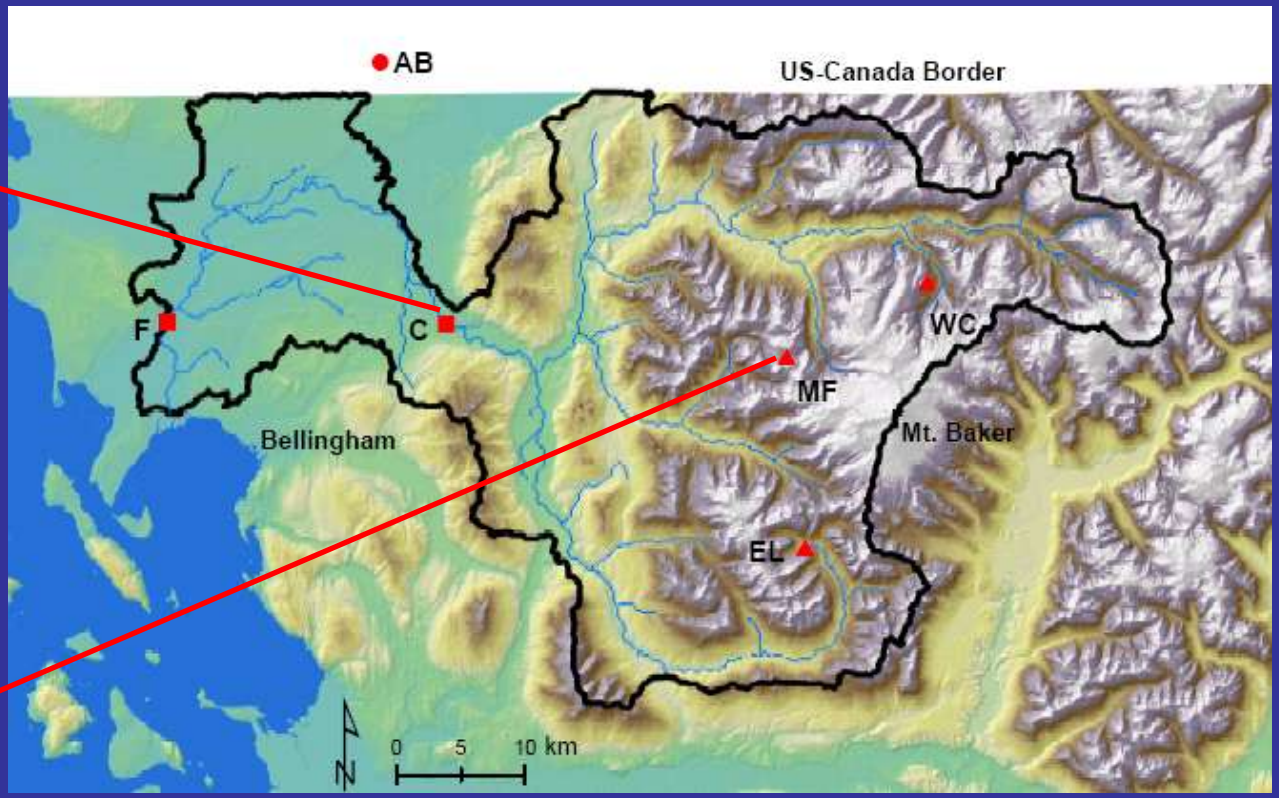
Future Peak Flows

Methods: DHSVM
Distributed Hydrology Soil Vegetation Model



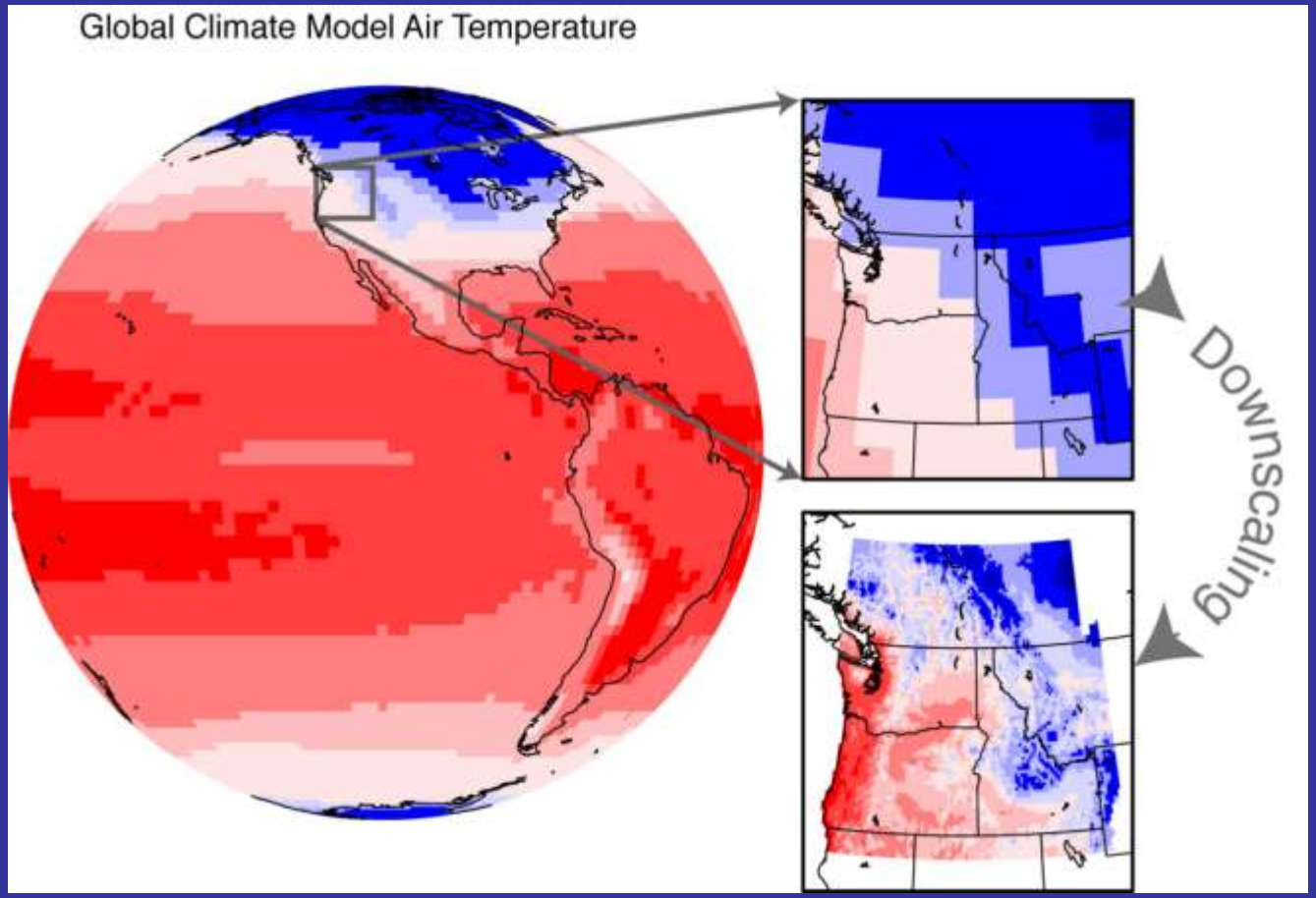
Pascal Storck

Methods: DHSVM Calibration



Methods: Forecast Downscaling

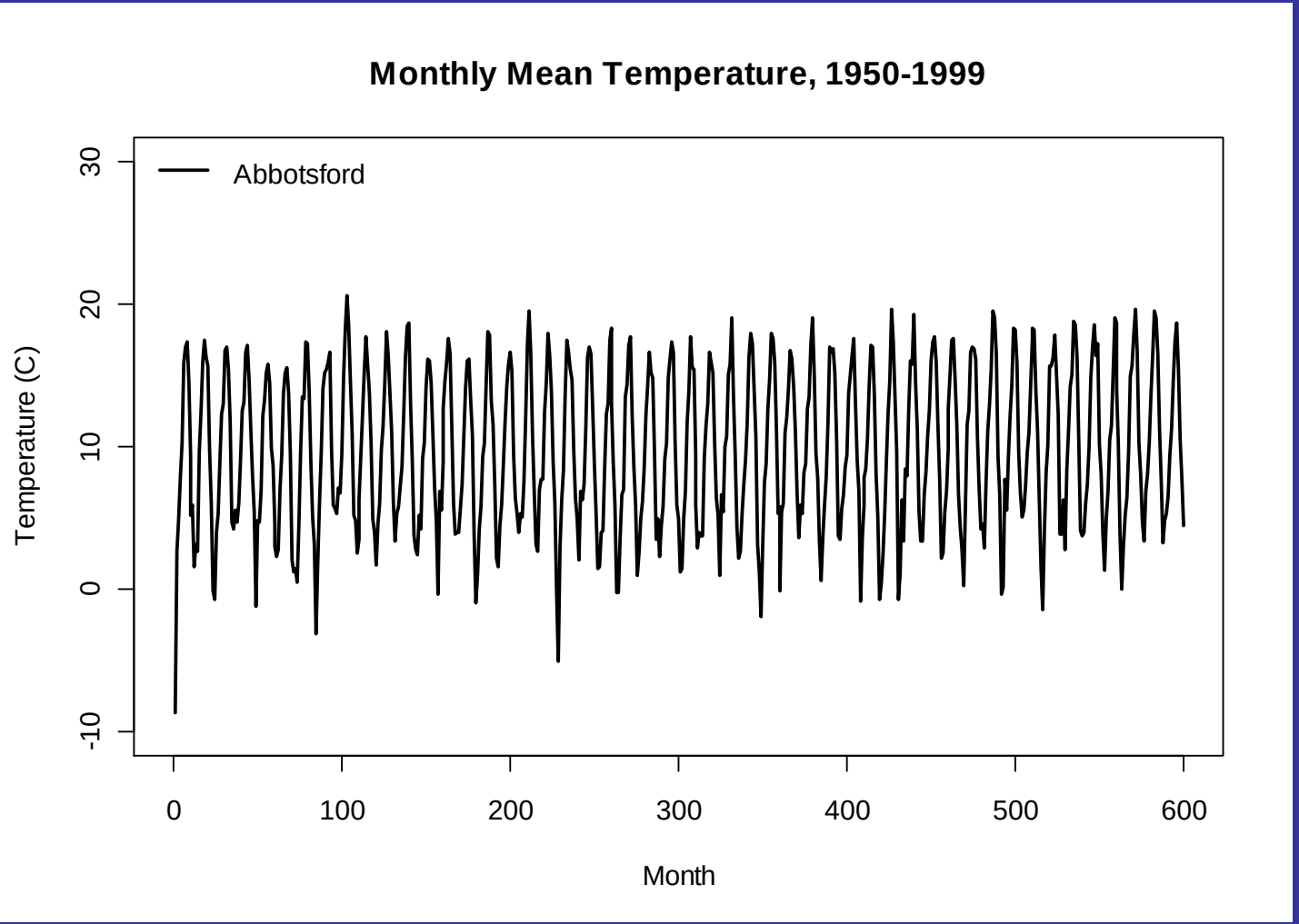
Forecast scale of 100s km → → local station



CIG, 2010

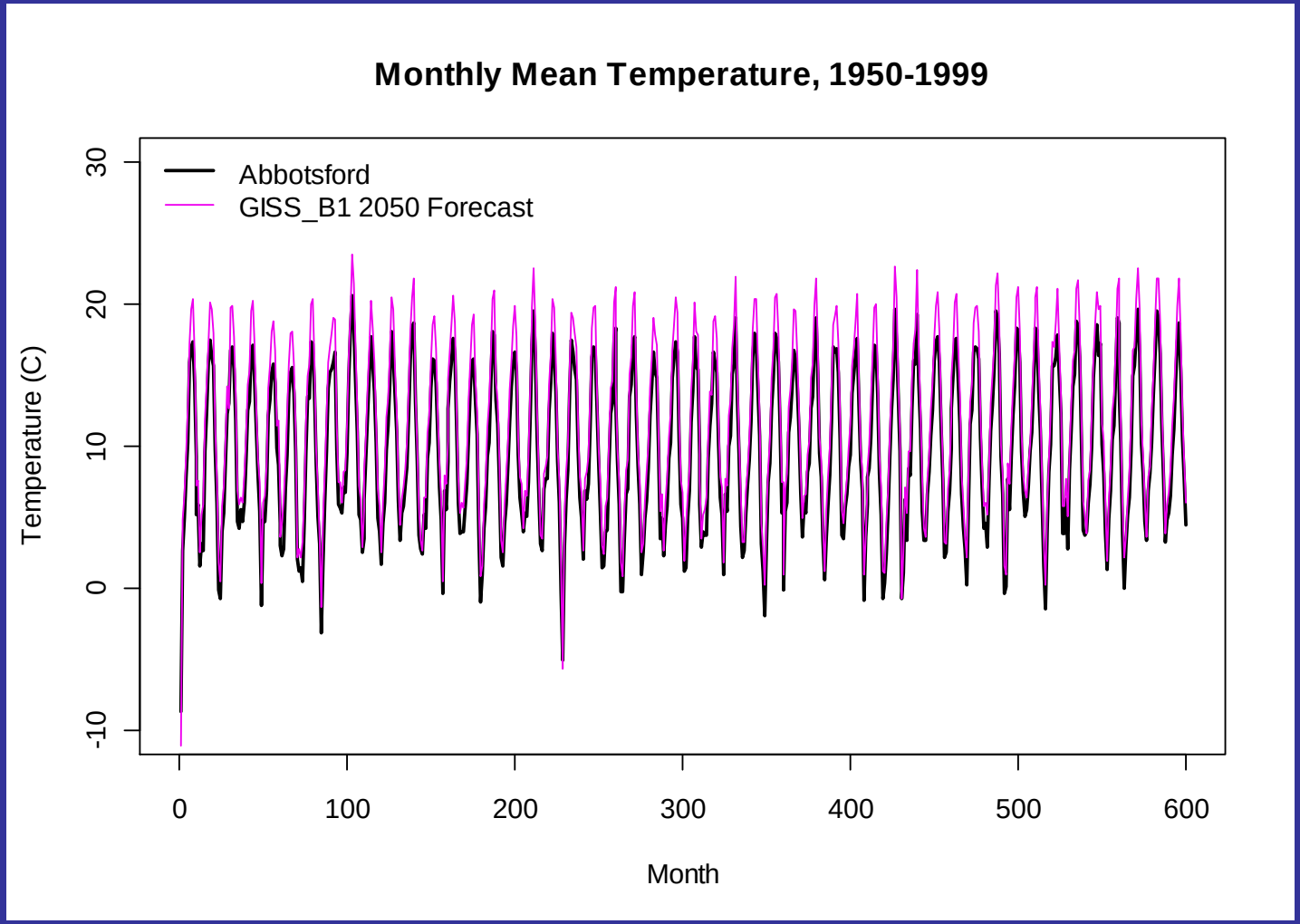
Methods: Local Climate Change Forecasts

Each forecast incorporates local variability



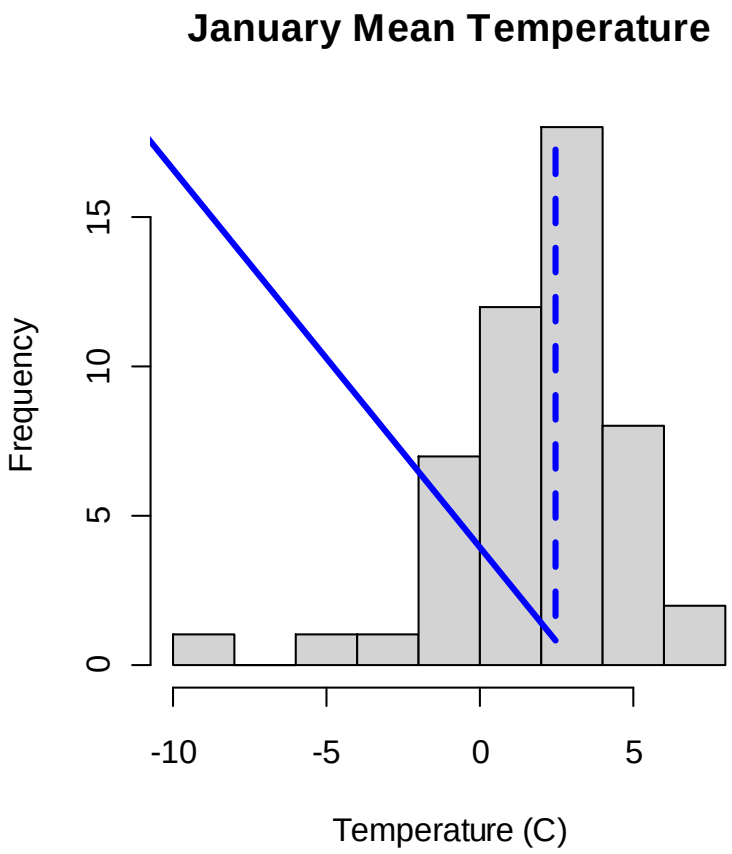
Methods: Local Climate Change Forecasts

Each forecast incorporates local variability **AND** **future climate trends**

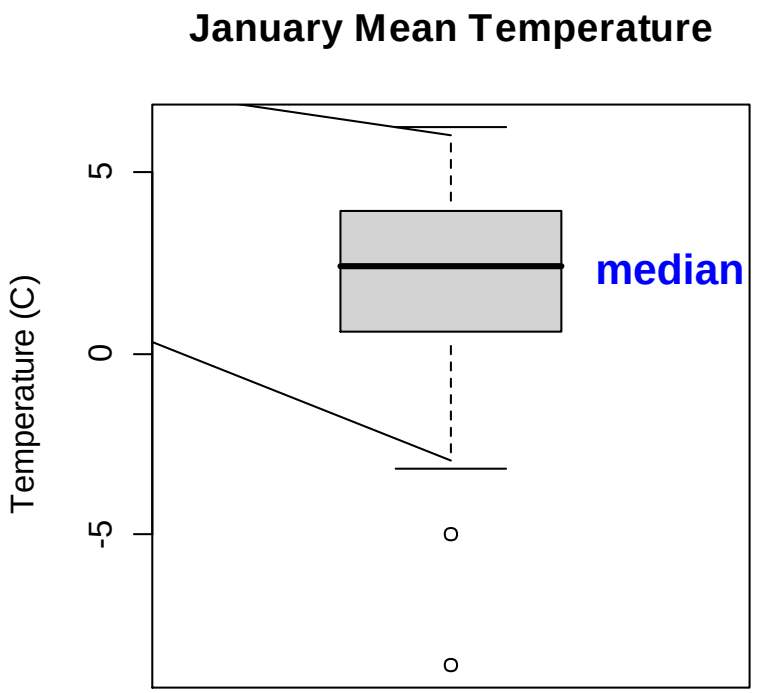


Methods: Local Forecasts

Histogram



Boxplot



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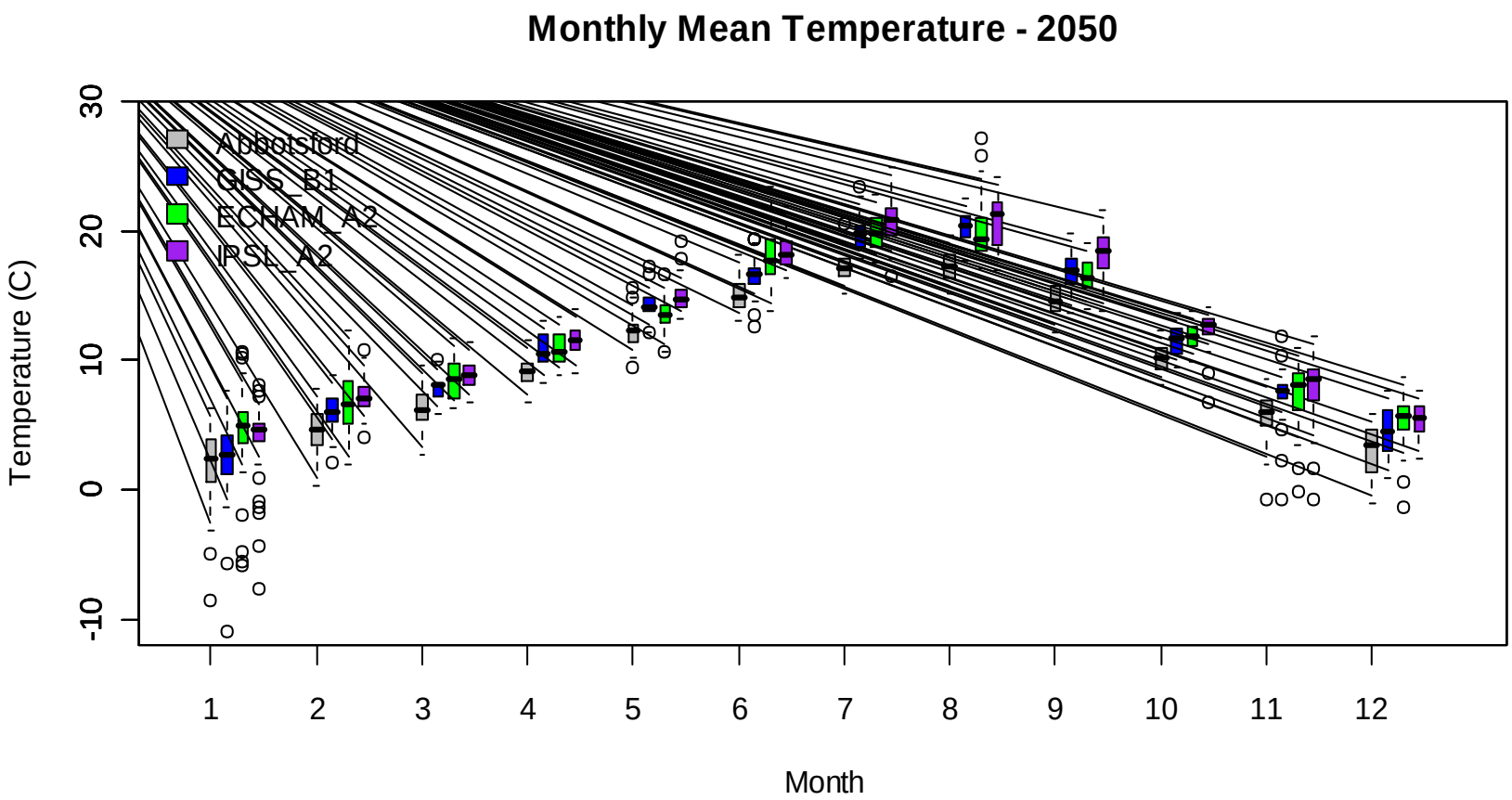

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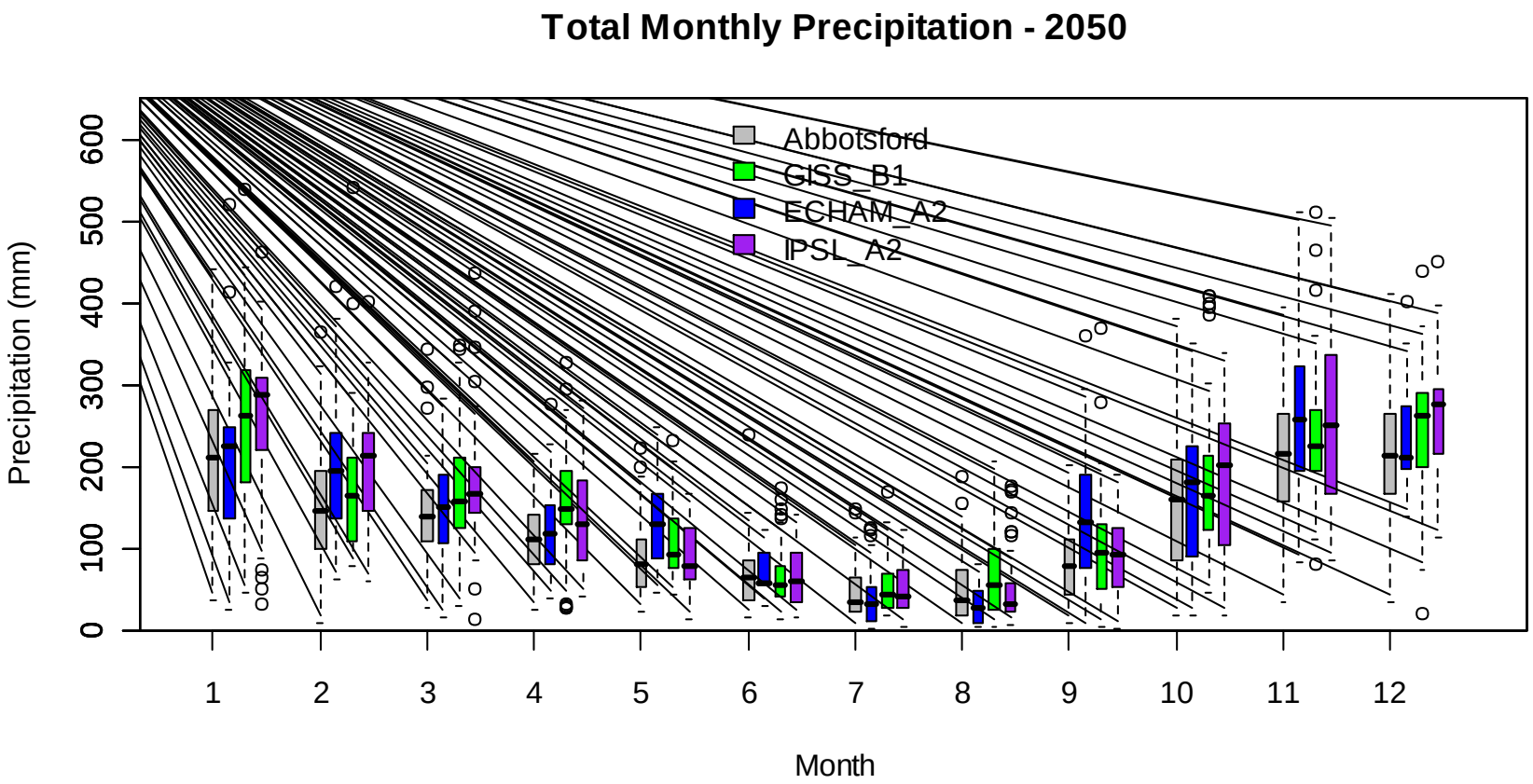
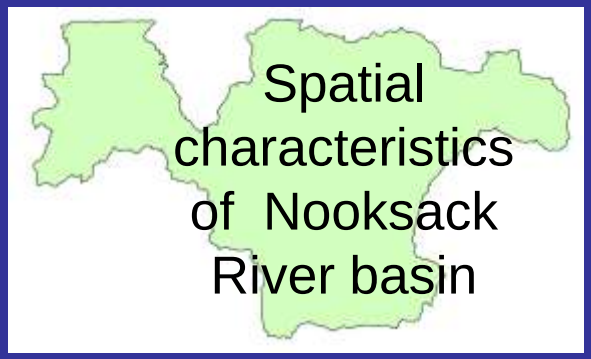
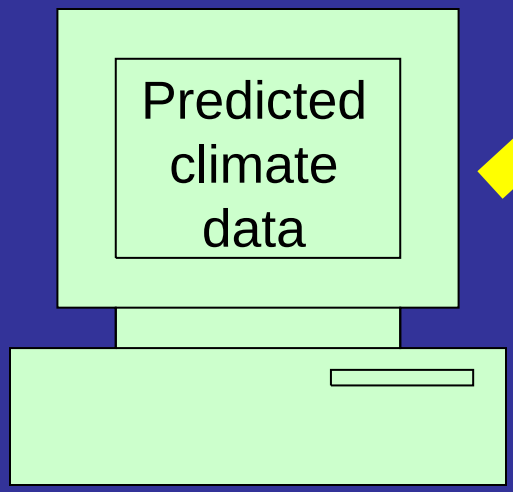
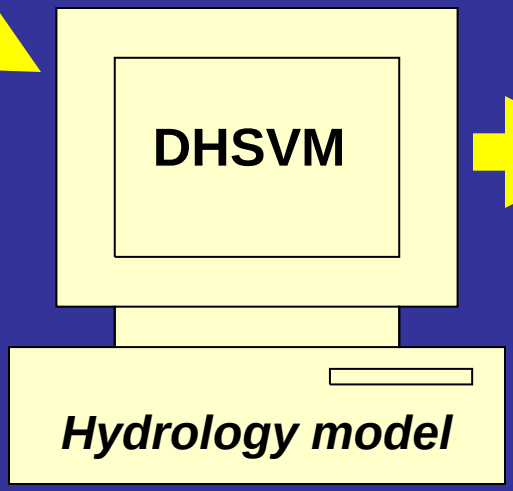


Approach







Predictions

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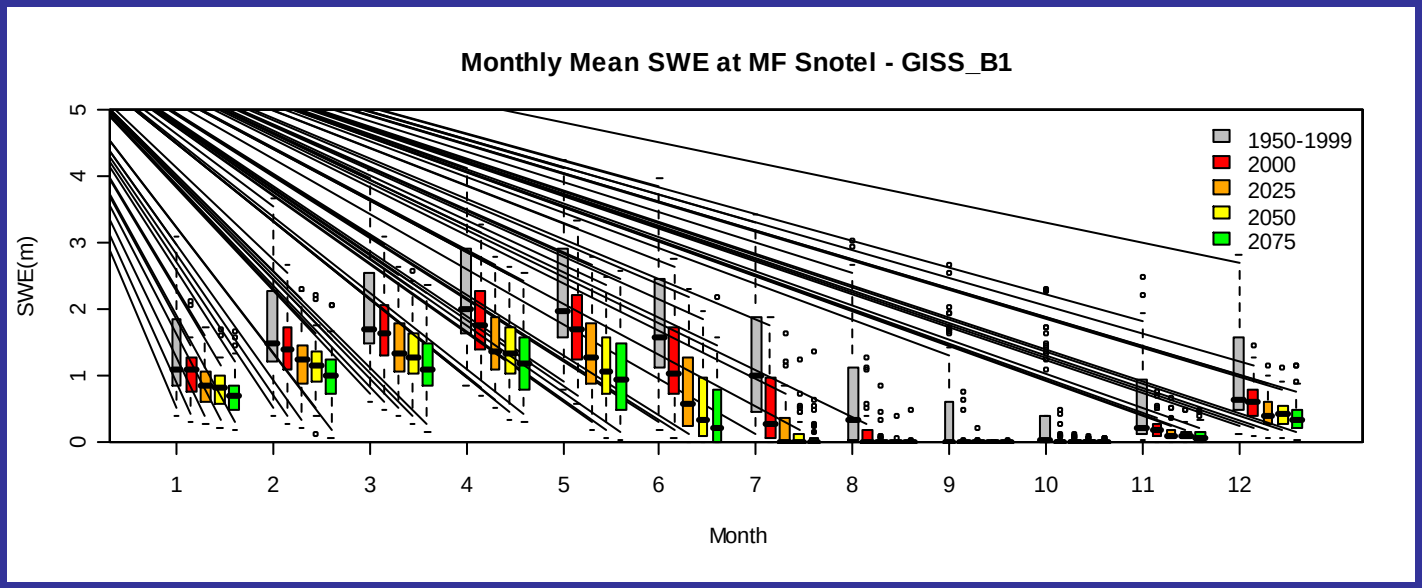
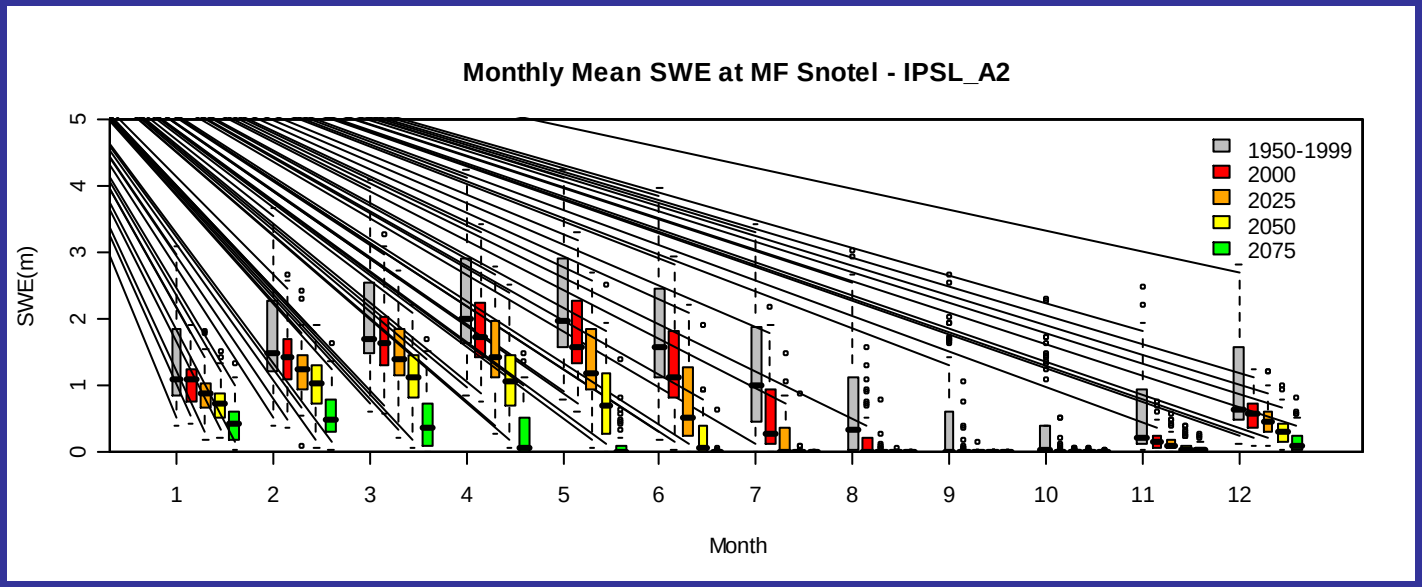
Future Streamflow

Future Peak Flows

Results: Snow Water Equivalent





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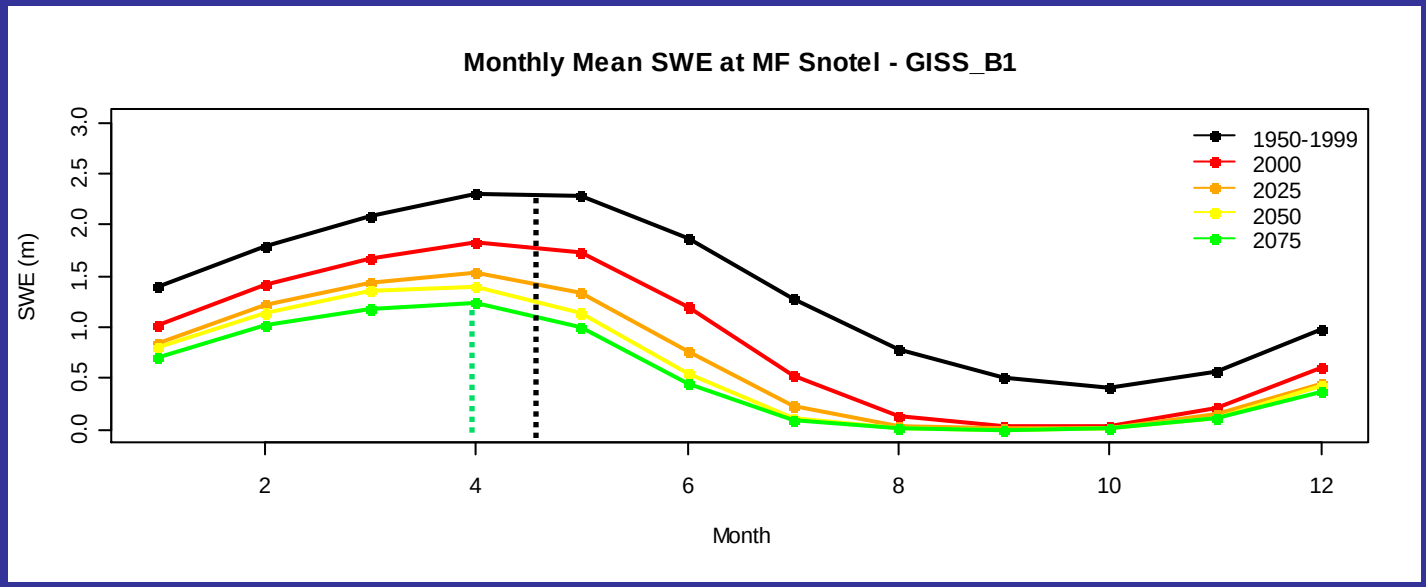
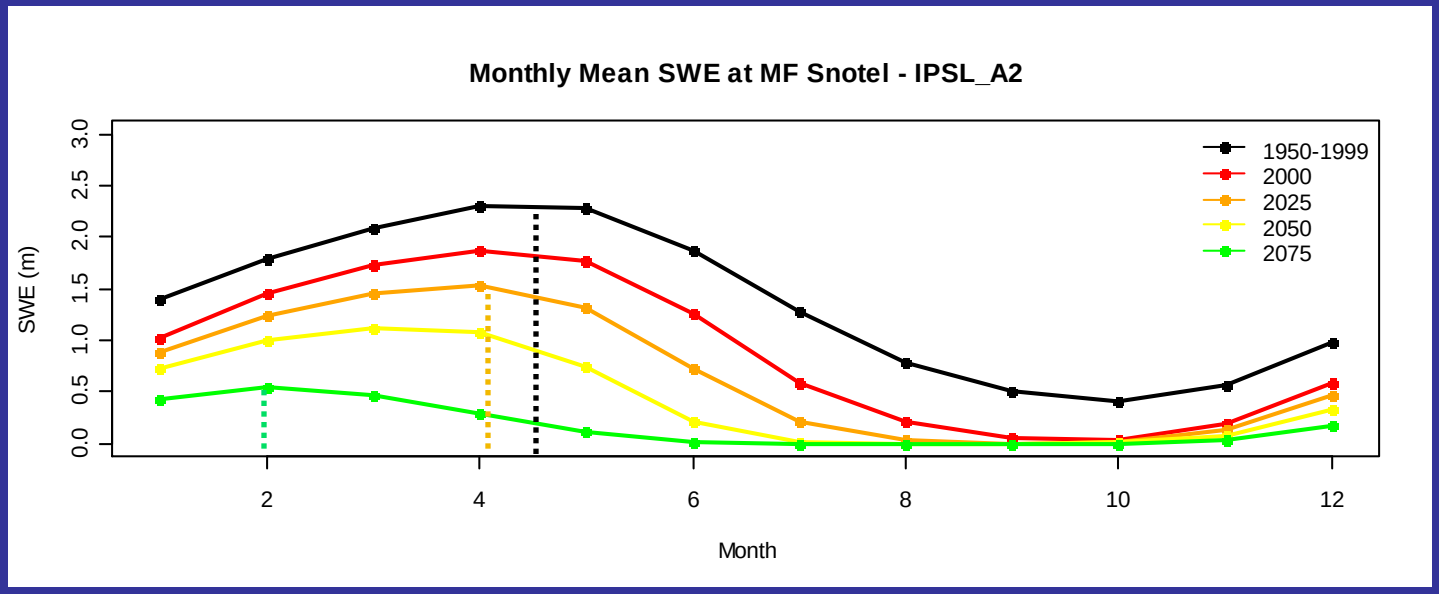
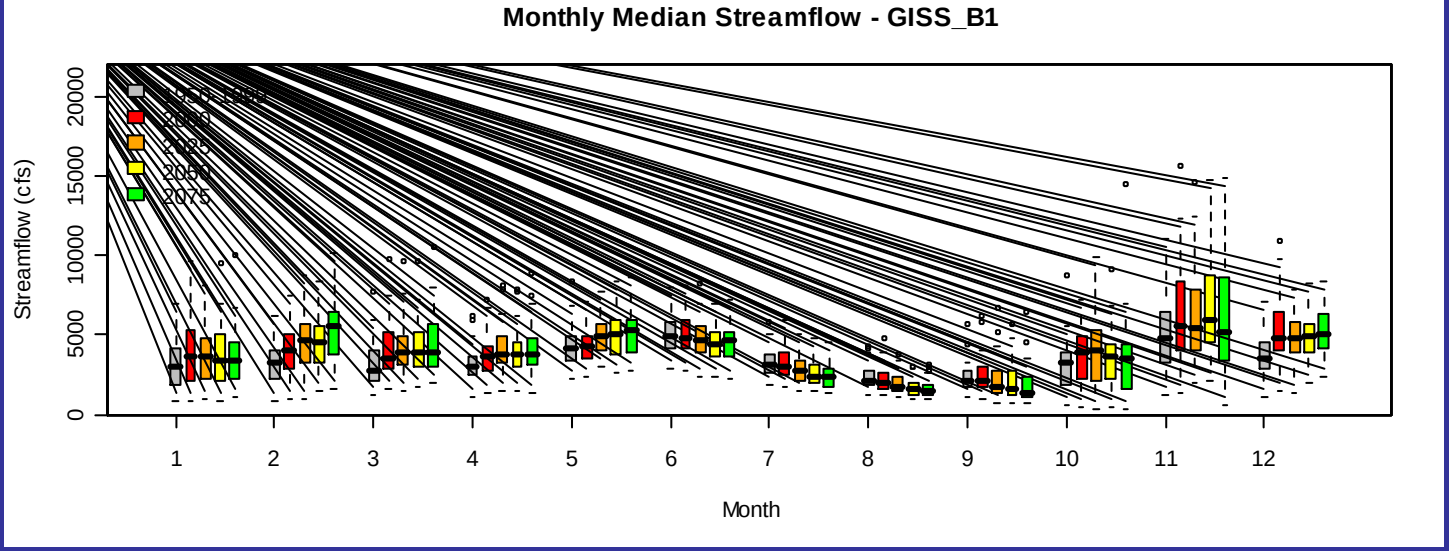
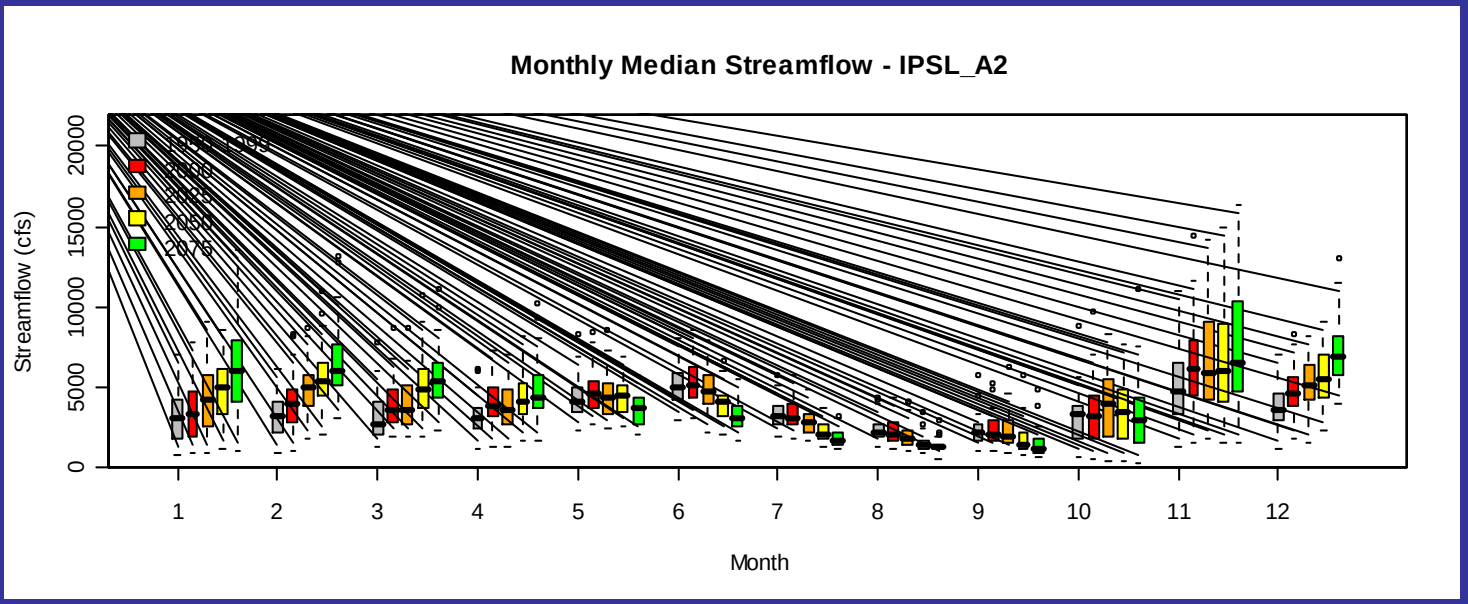


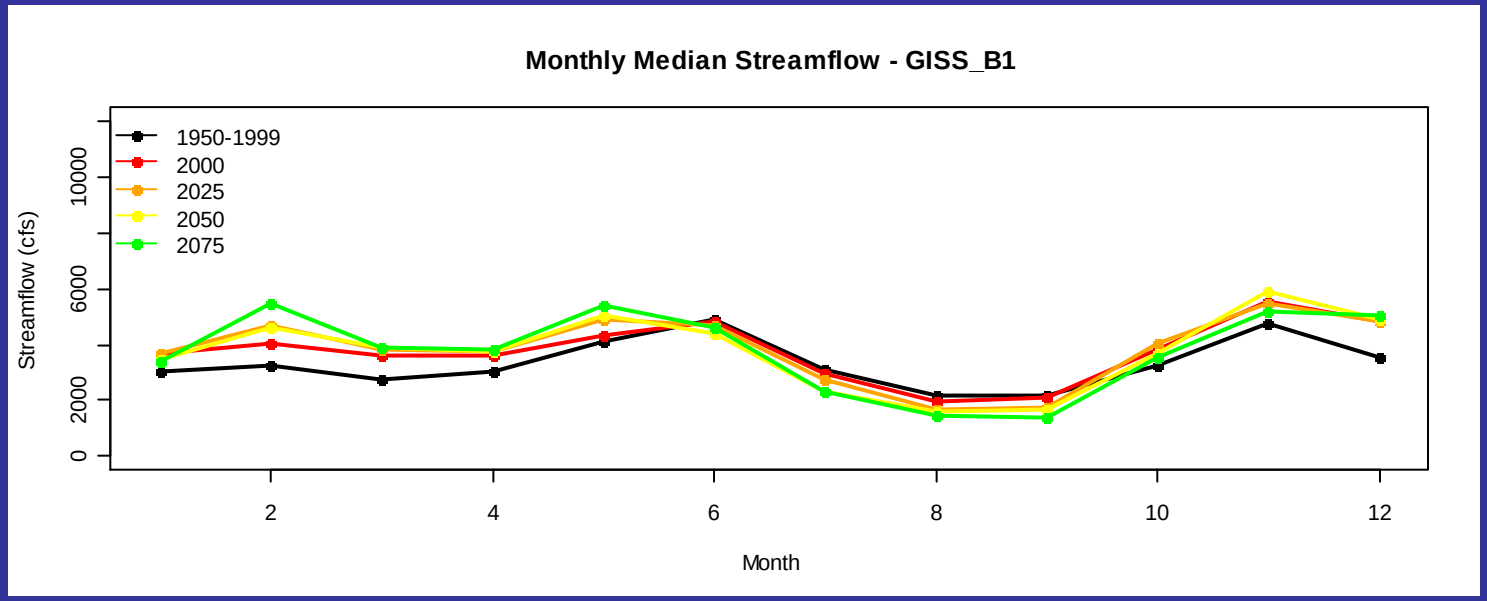


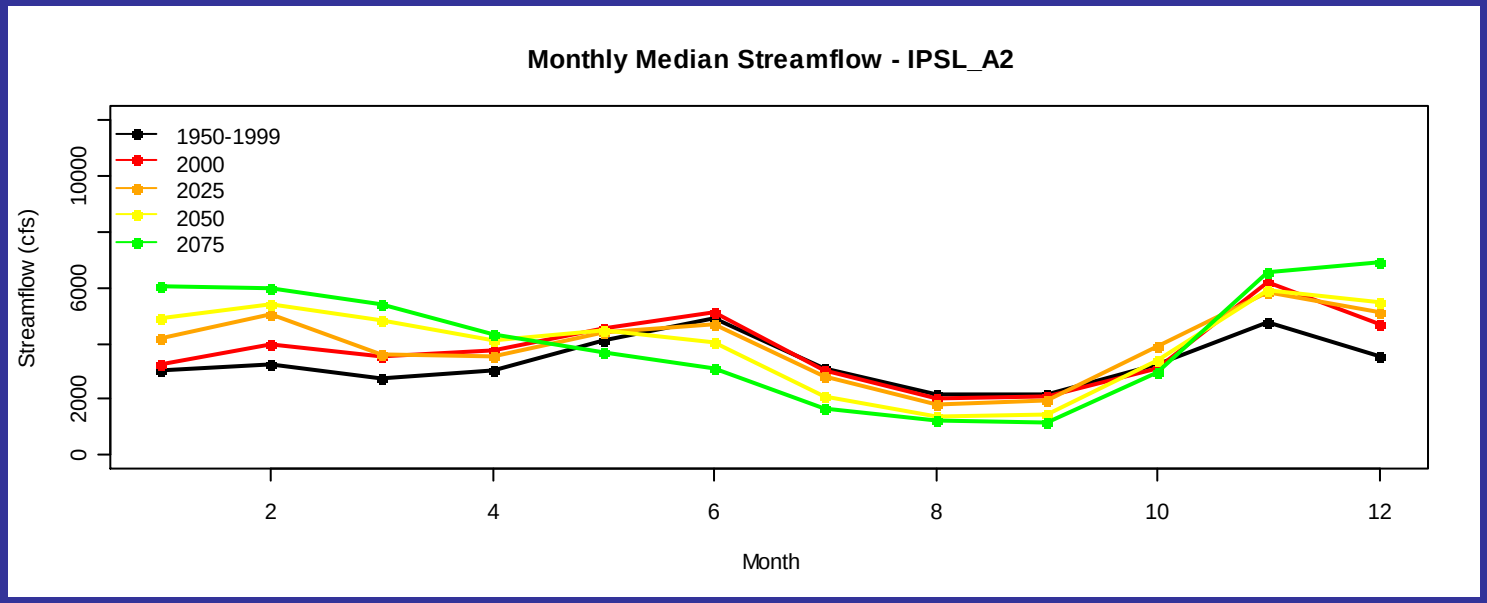
Results: Streamflow



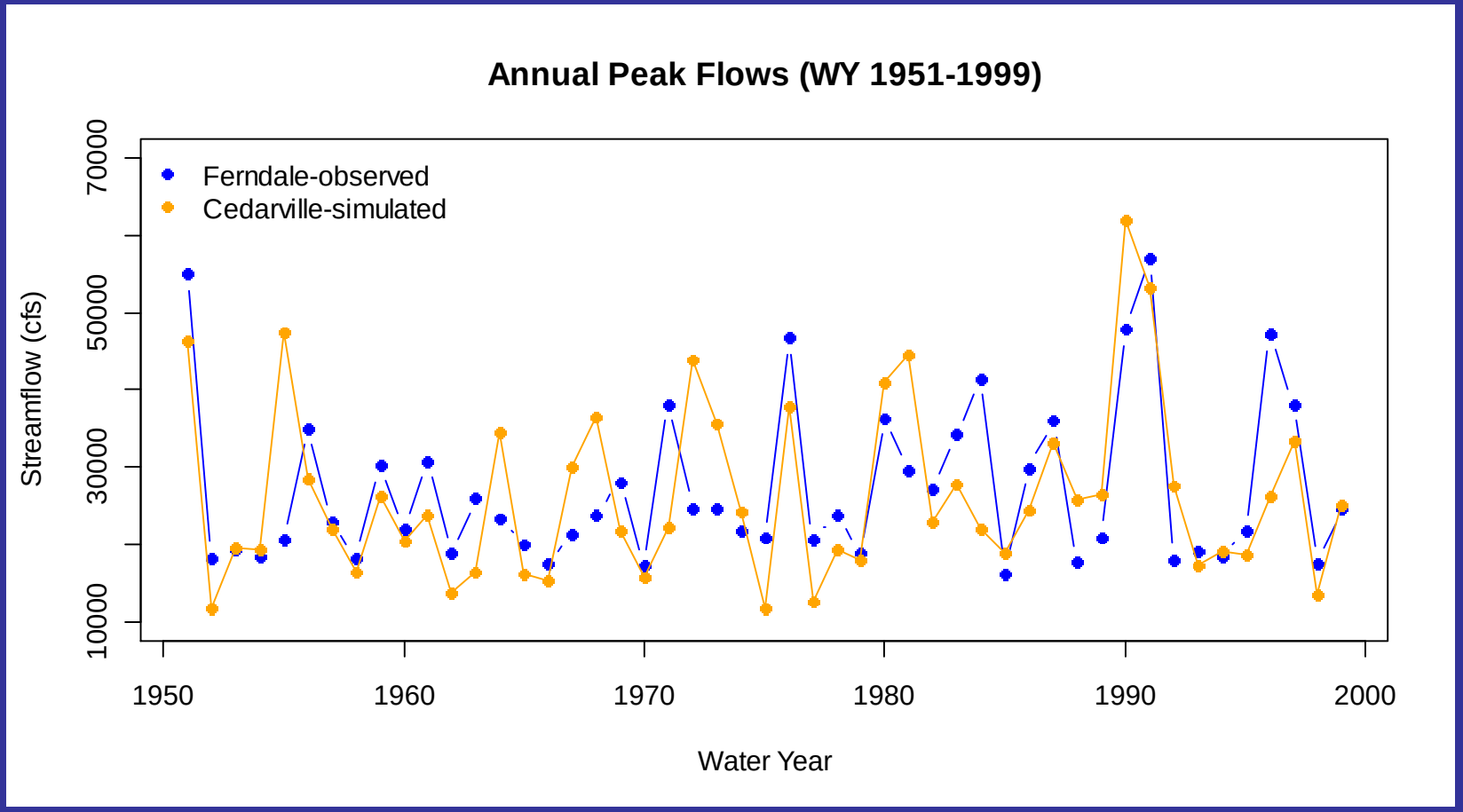


Results: Streamflow





Results: Peak Flow Events



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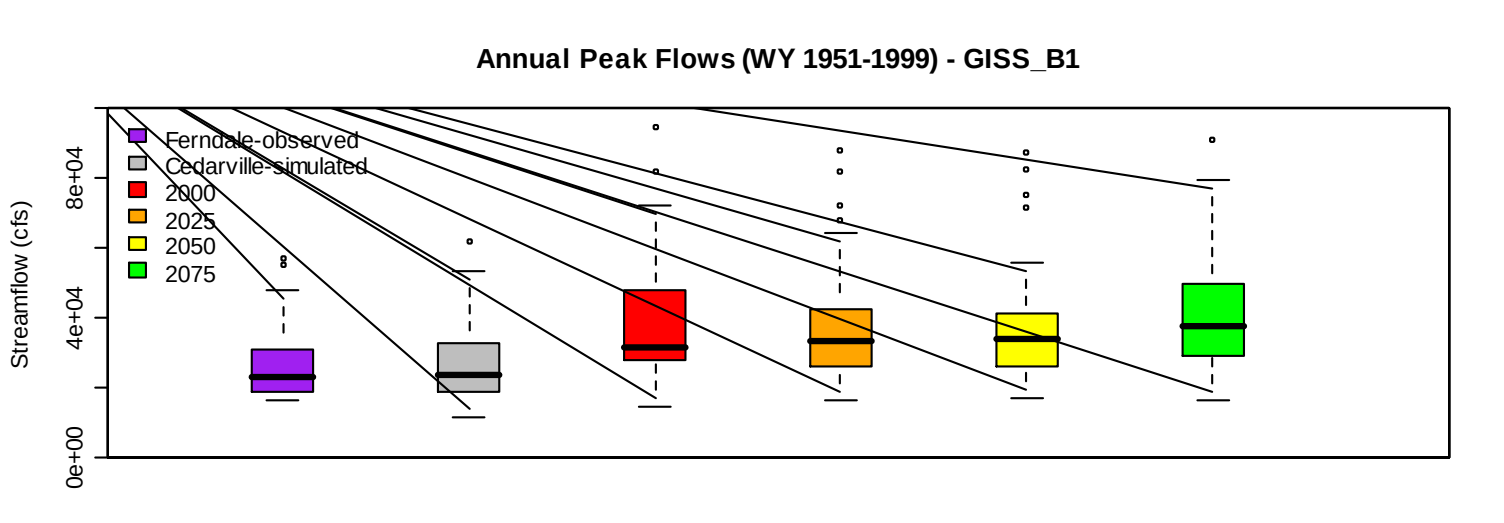
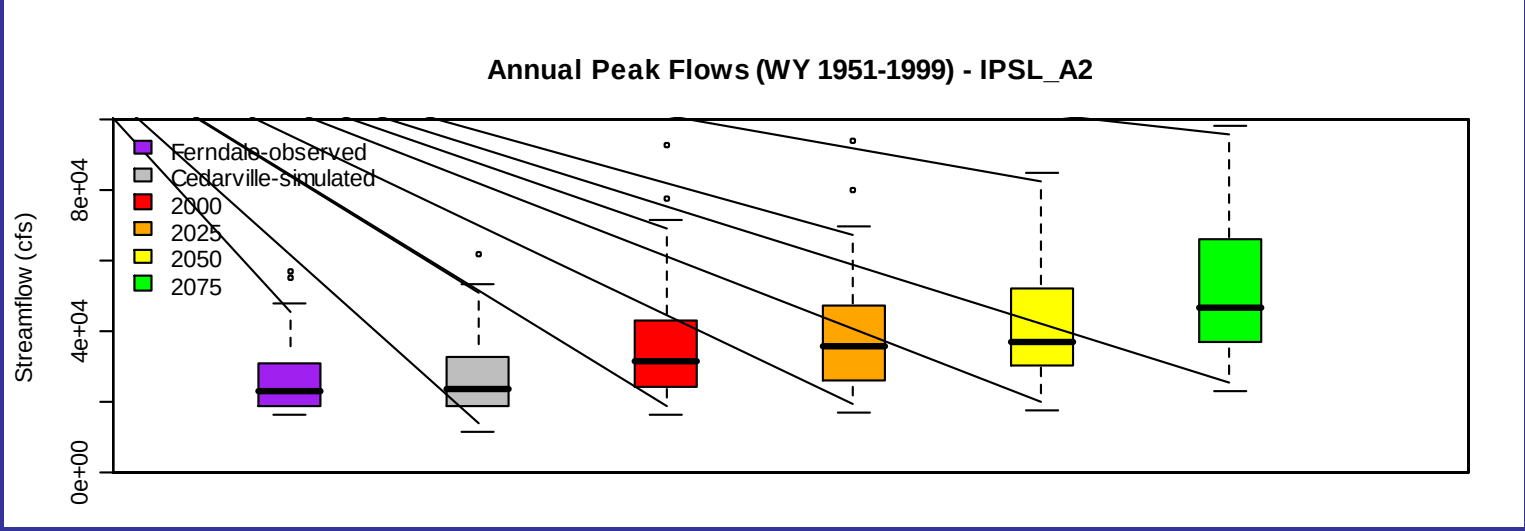
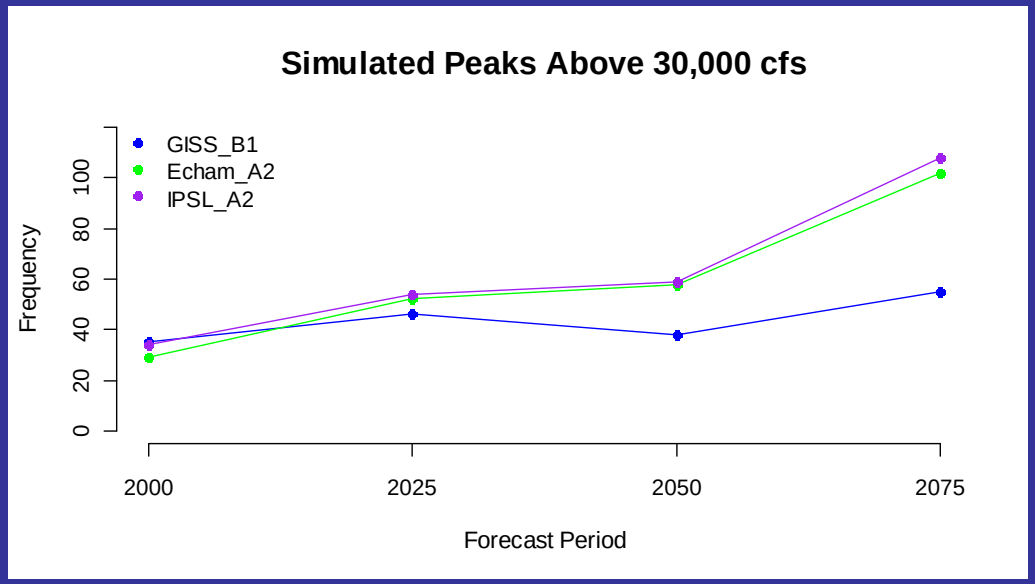
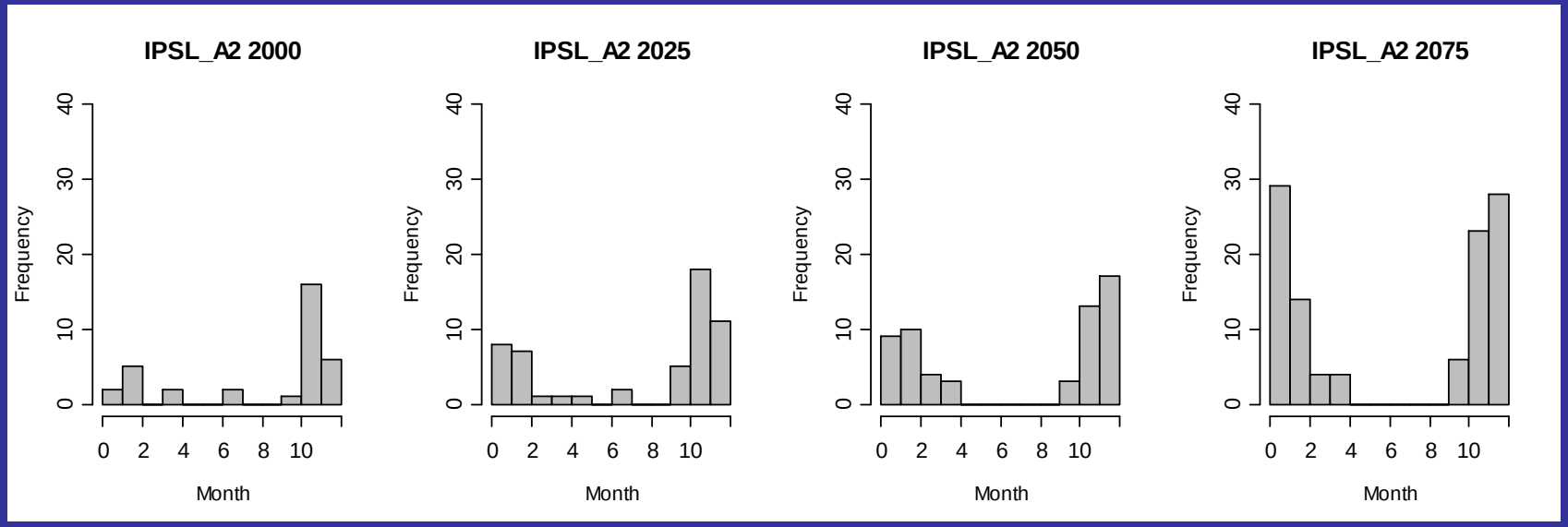




Results: Peak Flow Events

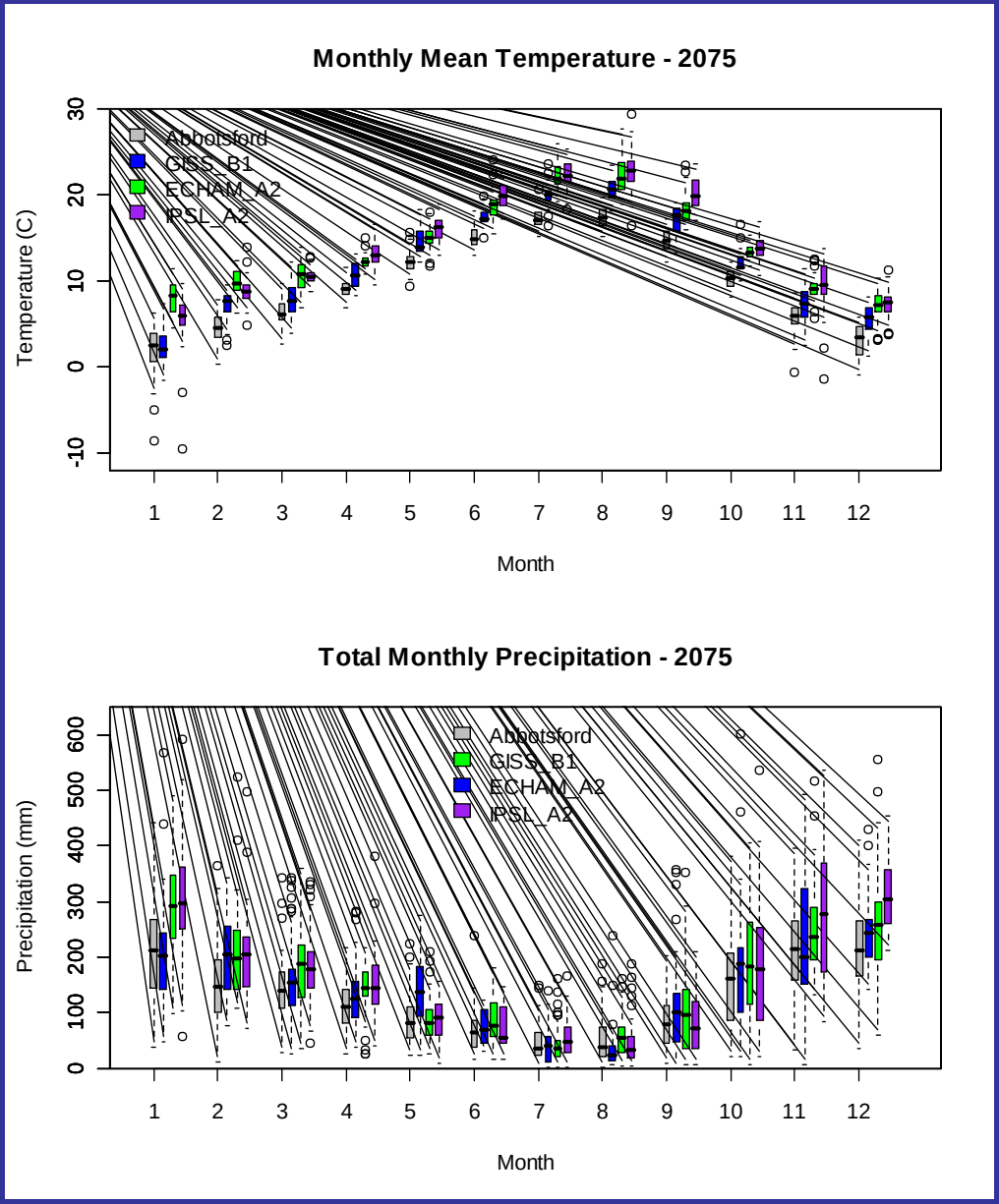




Temperature or Precipitation?

- Predicted increases in temperature and precipitation
- More agreement on temperature trends
- Previous regional studies indicate that temperature is the driving factor in changes to snowpack

(Hamlet et al., 2005, Mote et al., 2005, Mote et al., 2008)



Conclusions

- Snowpack will decrease
- Timing of peak snowpack and of the spring melting will move earlier in the year
- Winter streamflow will increase, summer streamflow will decrease
- Peak flow events will increase in magnitude and frequency
- Extent of change depends on temperature change

Thank you!

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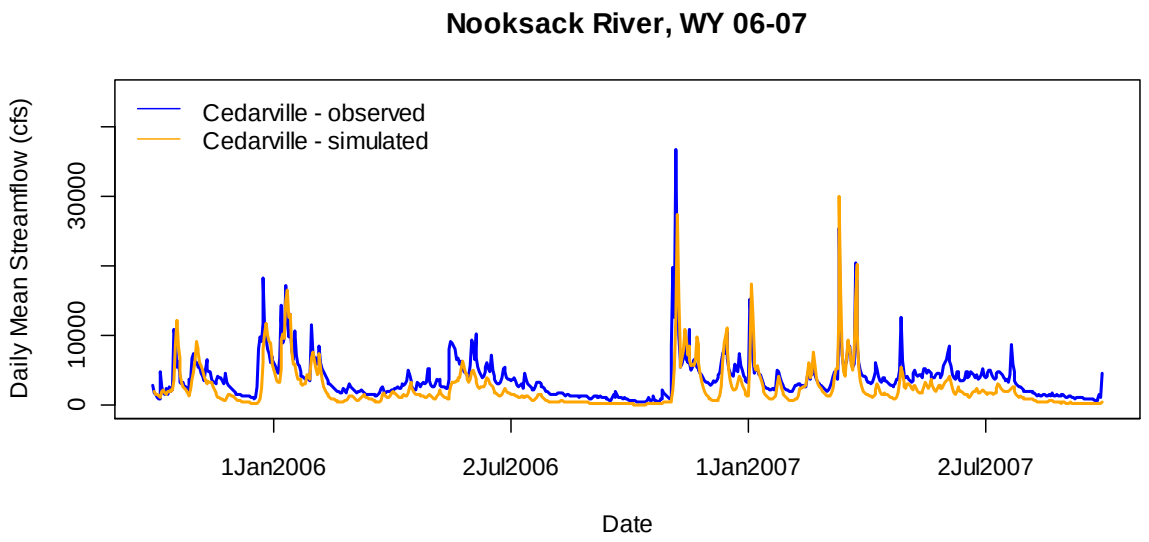
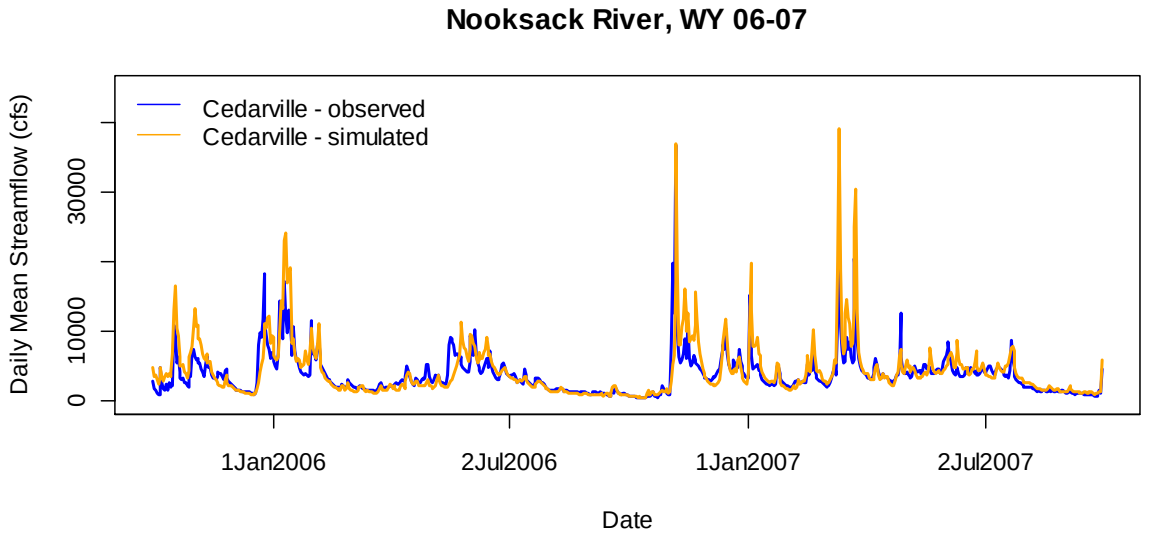
DHSVM: Calibration

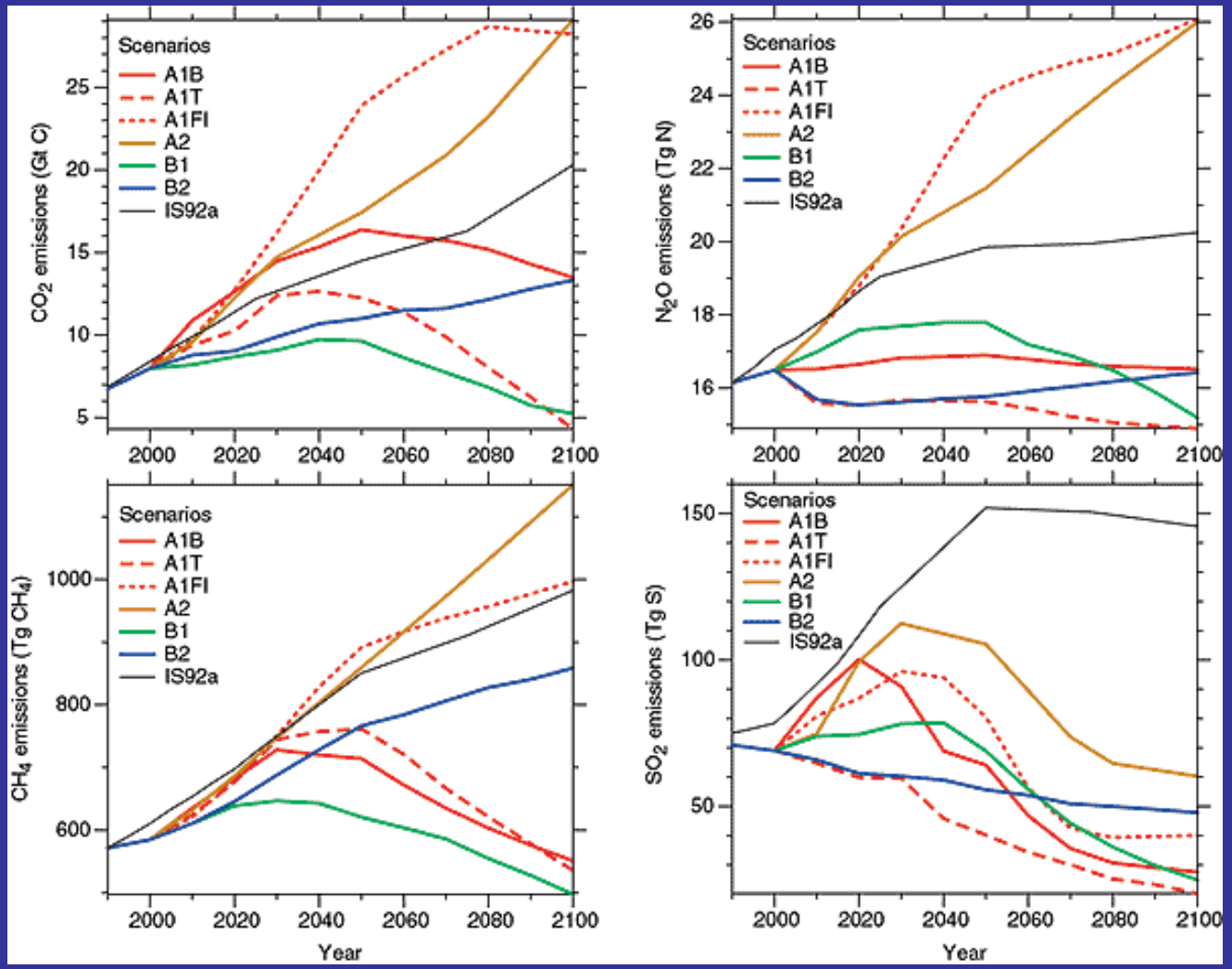
Initial Simulation



After Calibration

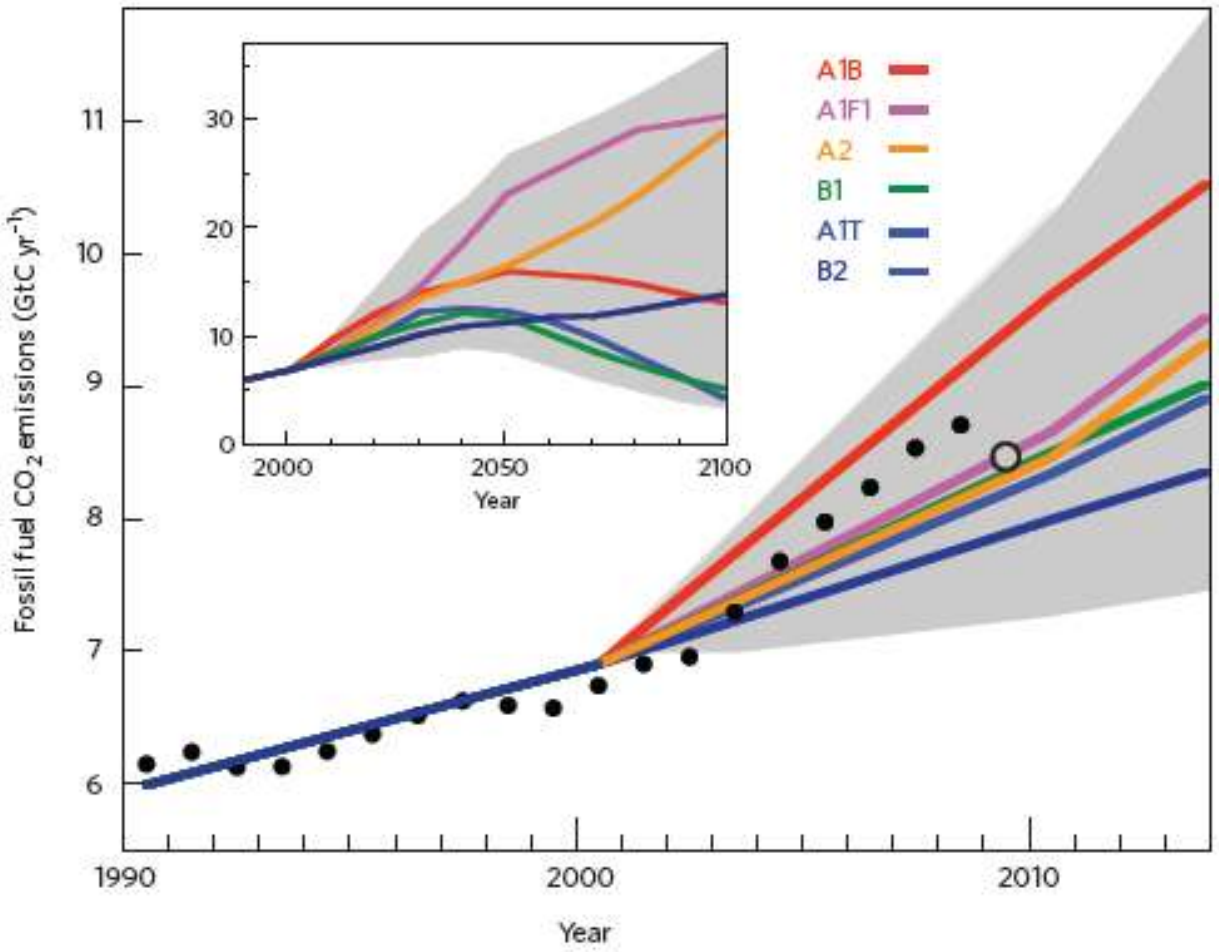


Emissions Scenarios



IPCC 2001

Emissions Scenarios



Manning et al., 2010

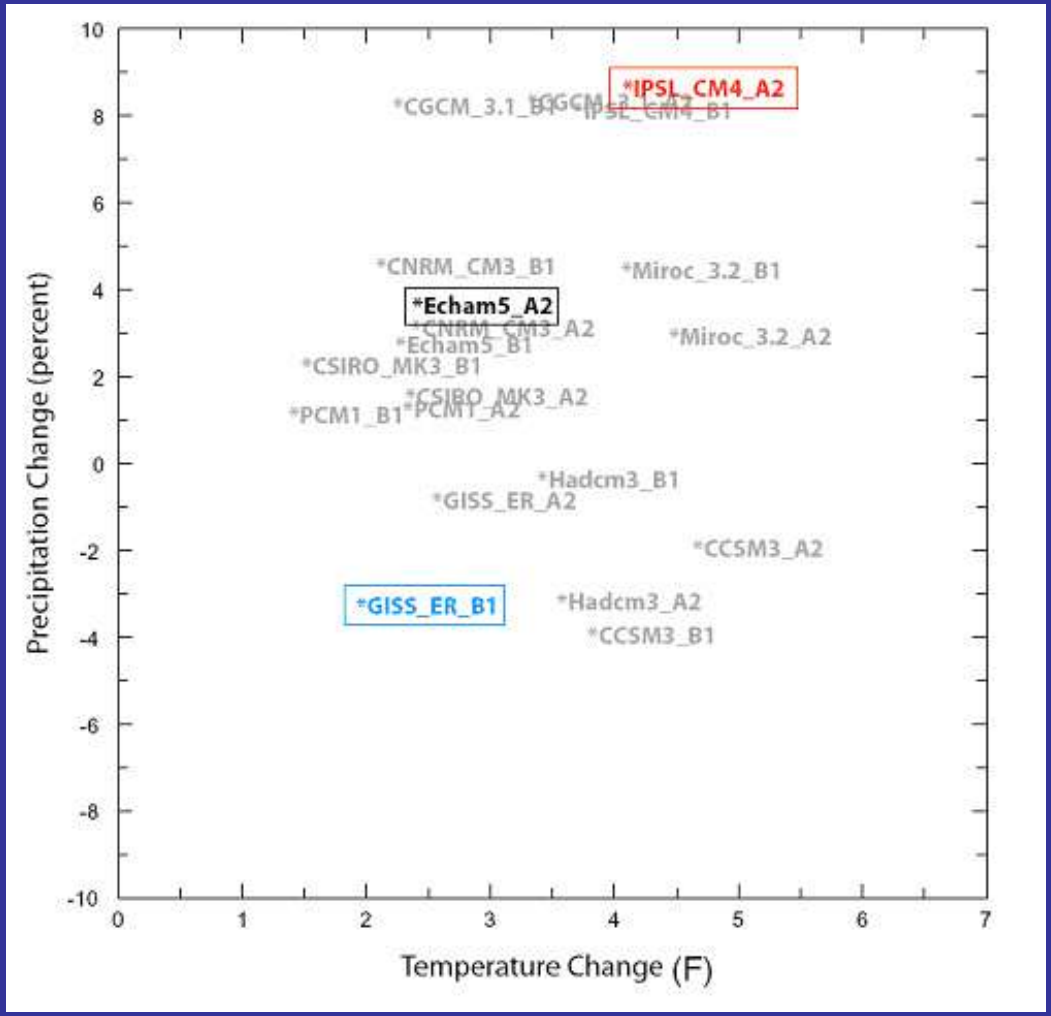
Methods: Climate Change Forecasts

Three General Circulation Models (GCMs) :

1. IPSL_CM4_A2
Institut Pierre Simon Laplace (with A2)

2. Echam5_A2
Max Planck Institute for Meteorology (with A2)

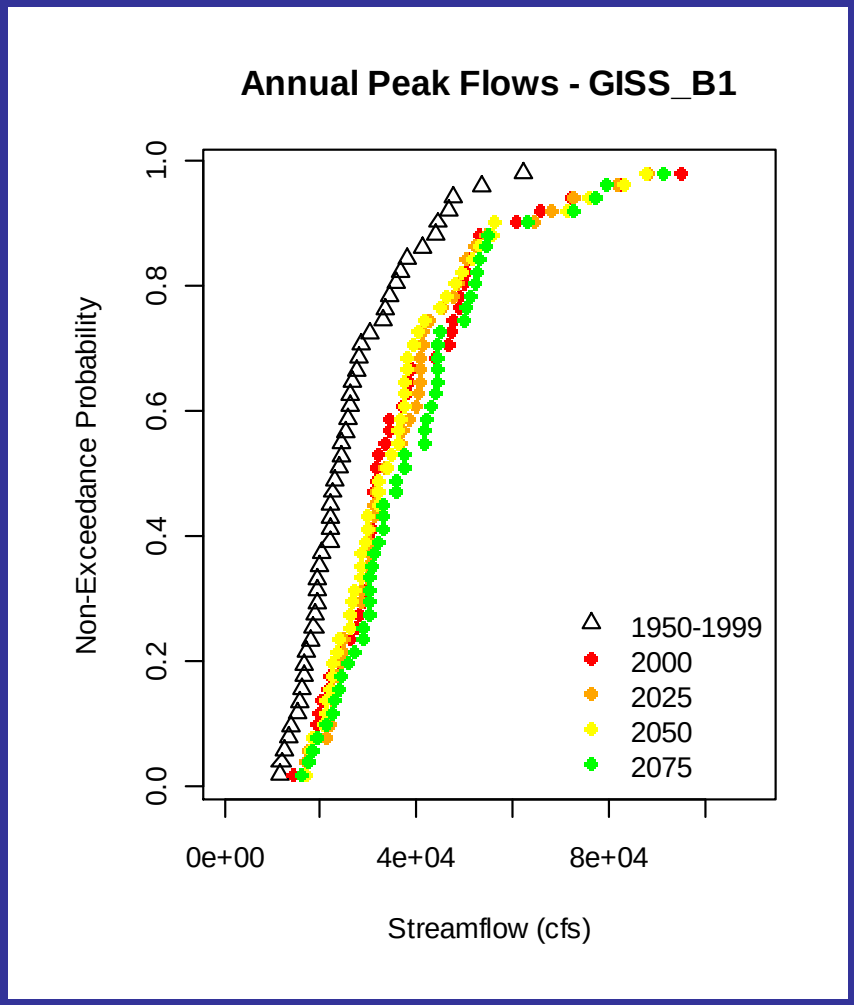
3. GISS_ER_B1
Goddard Institute for Space Studies (with B1)

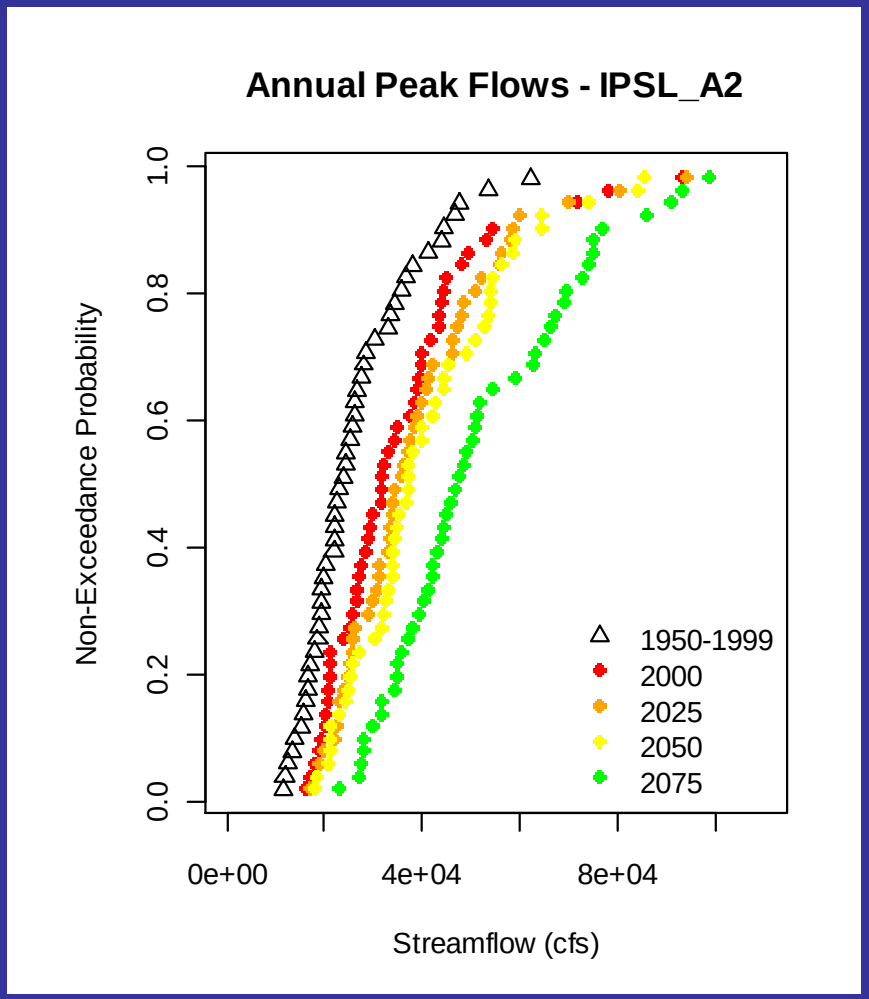


2040s Changes in Temperature and Precipitation

Mote and others, 2005

Results: Peak Flow Events





Results: Spring Peak Flow Events