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Analysis of NARCCAP Multi- RCM Hydro-Climate Scenarios in the Lake Winnipeg Watershed

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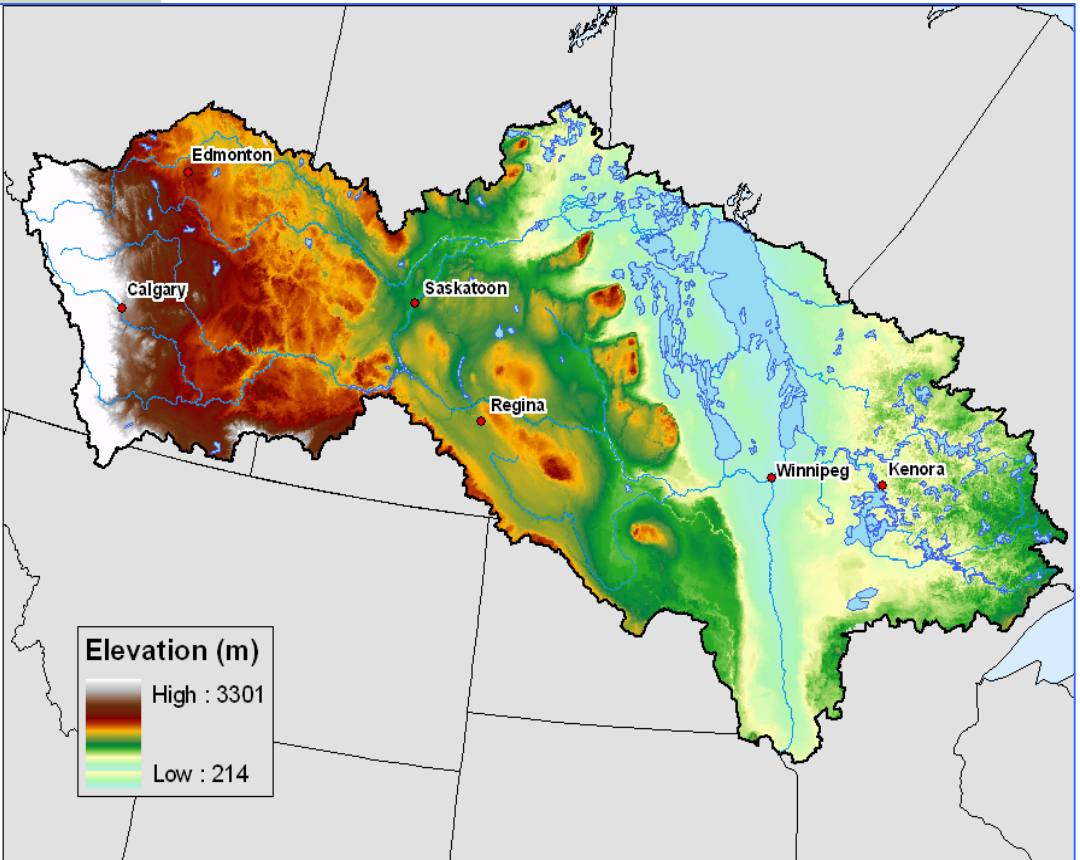
W-CIRC
Water & Climate Impacts Research Centre

Research Project: The Lake Winnipeg Basin Initiative (LWBI)

LWBI Science Objective supported:

- Assess the impact of climate variability and change on non-point source nutrients contribution in the Lake Winnipeg watershed



•Lake Winnipeg is Canada's sixth-largest freshwater lake

•The catchment area is about 953,000 km2

•Drainage Systems: Red, Assiniboine, Saskatchewan and Winnipeg rivers

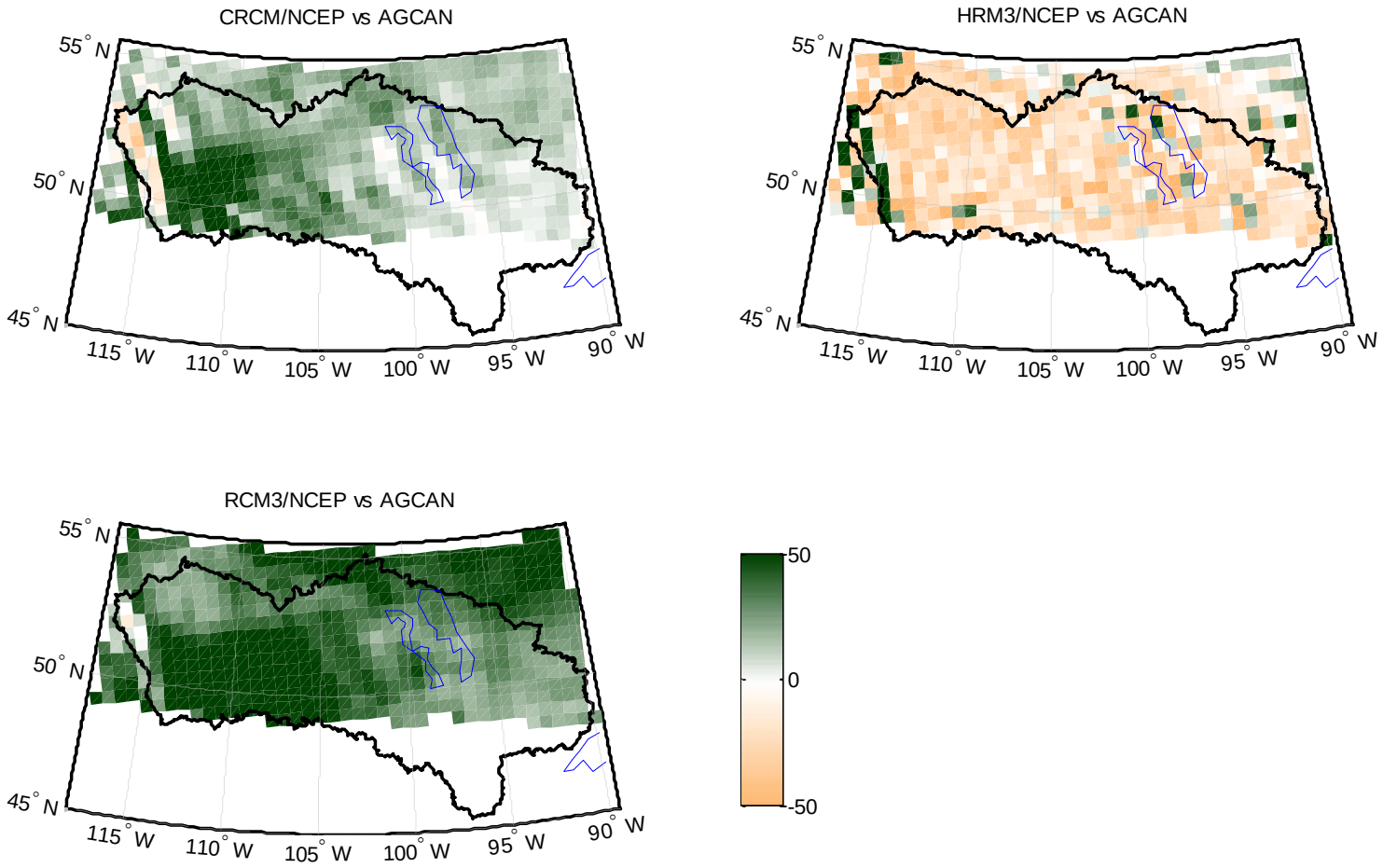
Canada

Observed Temperature and Precipitation Data for the Lake Winnipeg Watershed

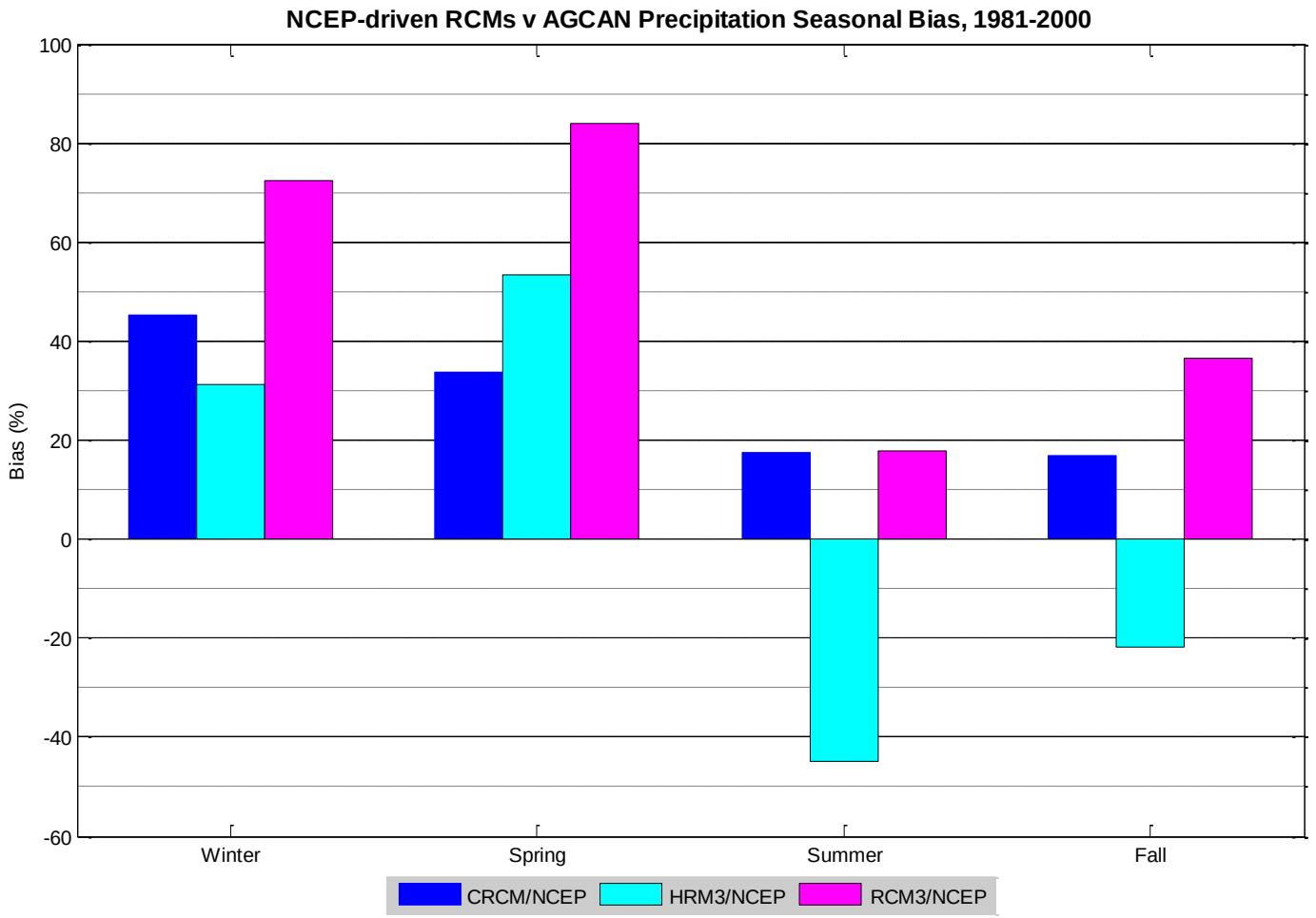
- Comparison is based on the daily 10km Gridded Climate Dataset for Canada (1961-2003) (Hutchinson, et. al. 2009) - AGCAN
- Based on EC daily observations, and has been interpolated to a high-resolution 10km grid using the thin-plate spline surface fitting method
- Contains 43-year daily precipitation, maximum temperature and minimum temperature

NCEP/RCMs vs Gridded Observed Precipitation

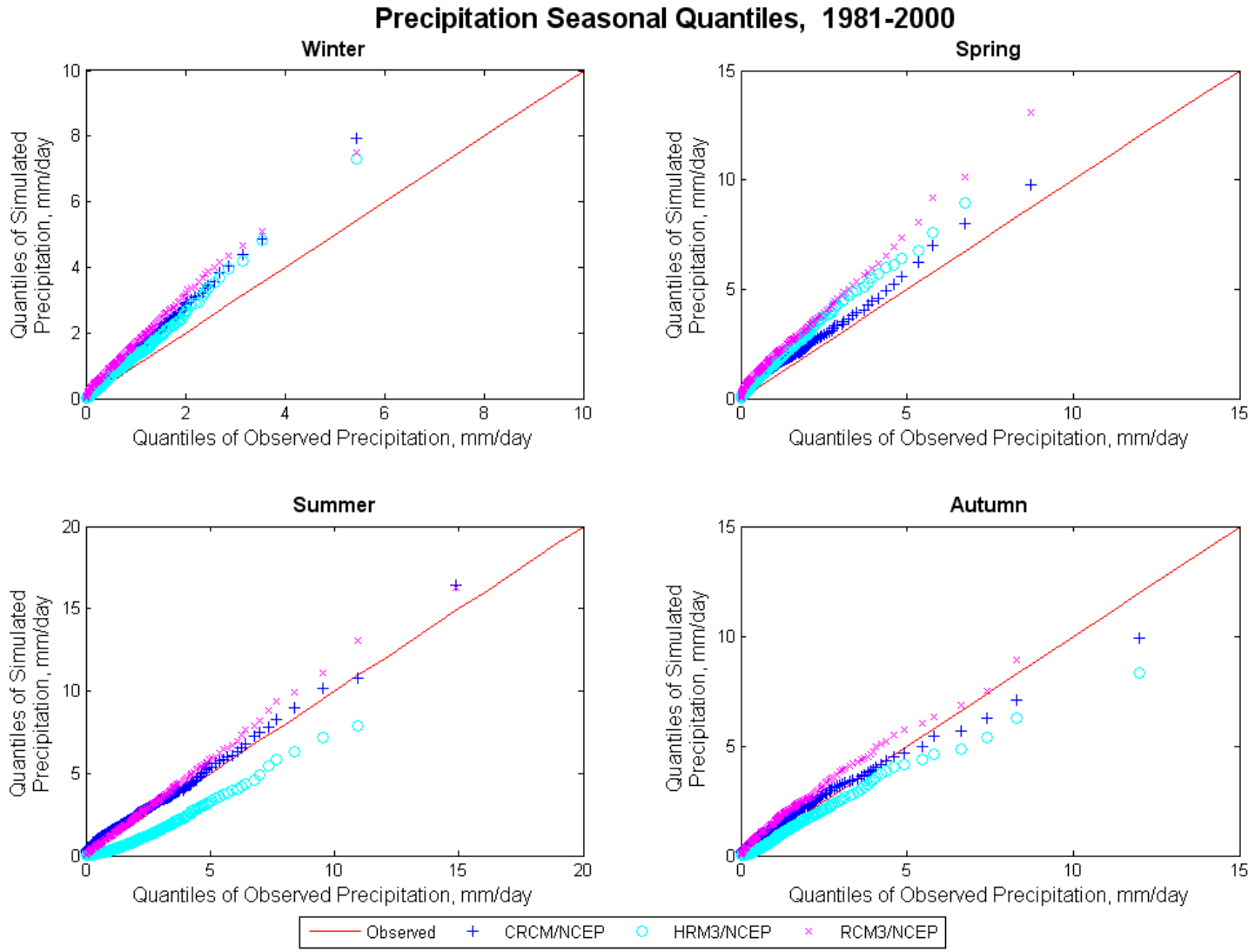
NCEP-driven RCMs Vs AgCan Annual Total Precipitation (% Difference), 1981-2000



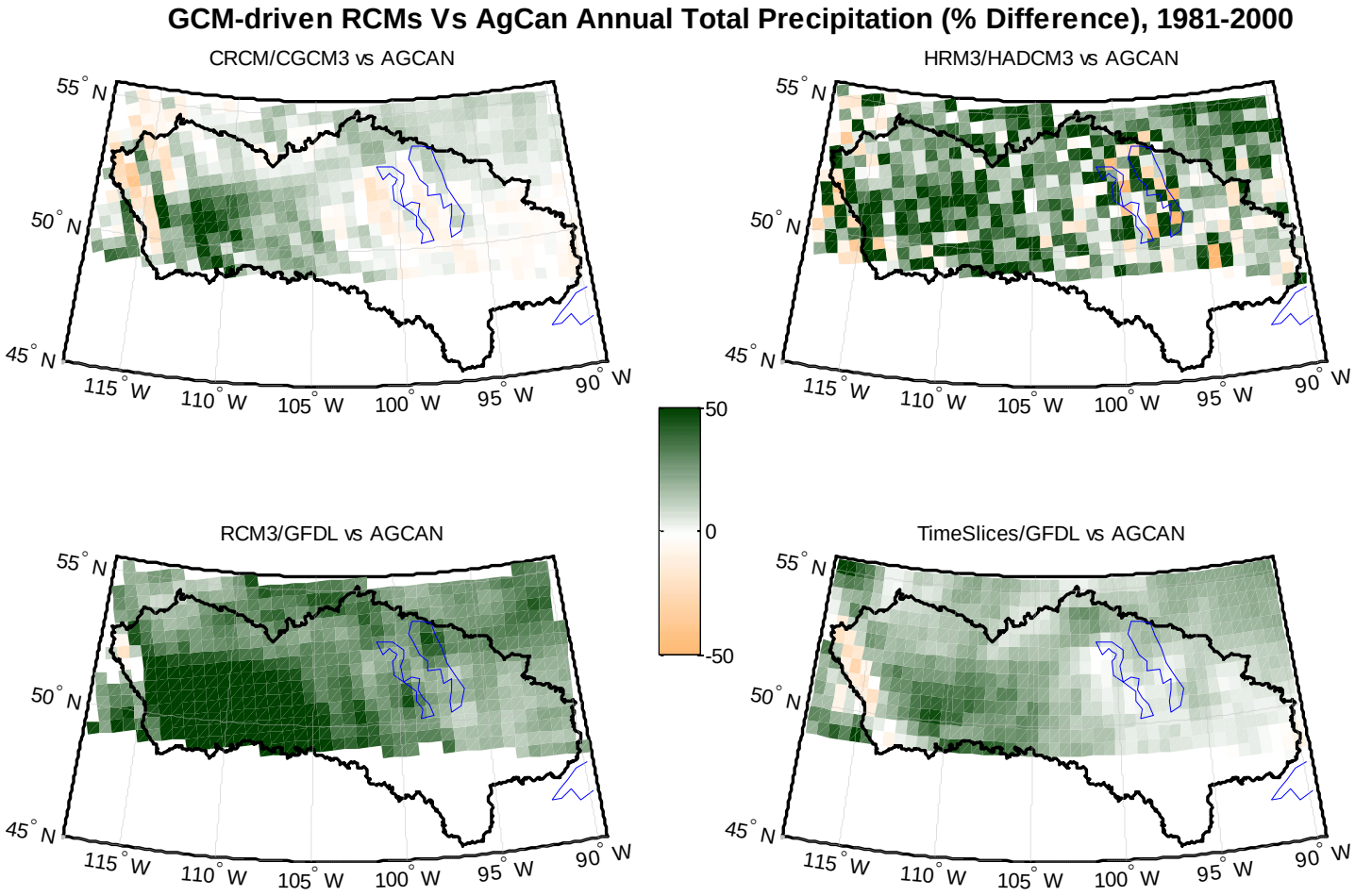
NCEP/RCMs vs Observed Precipitation Bias (%)



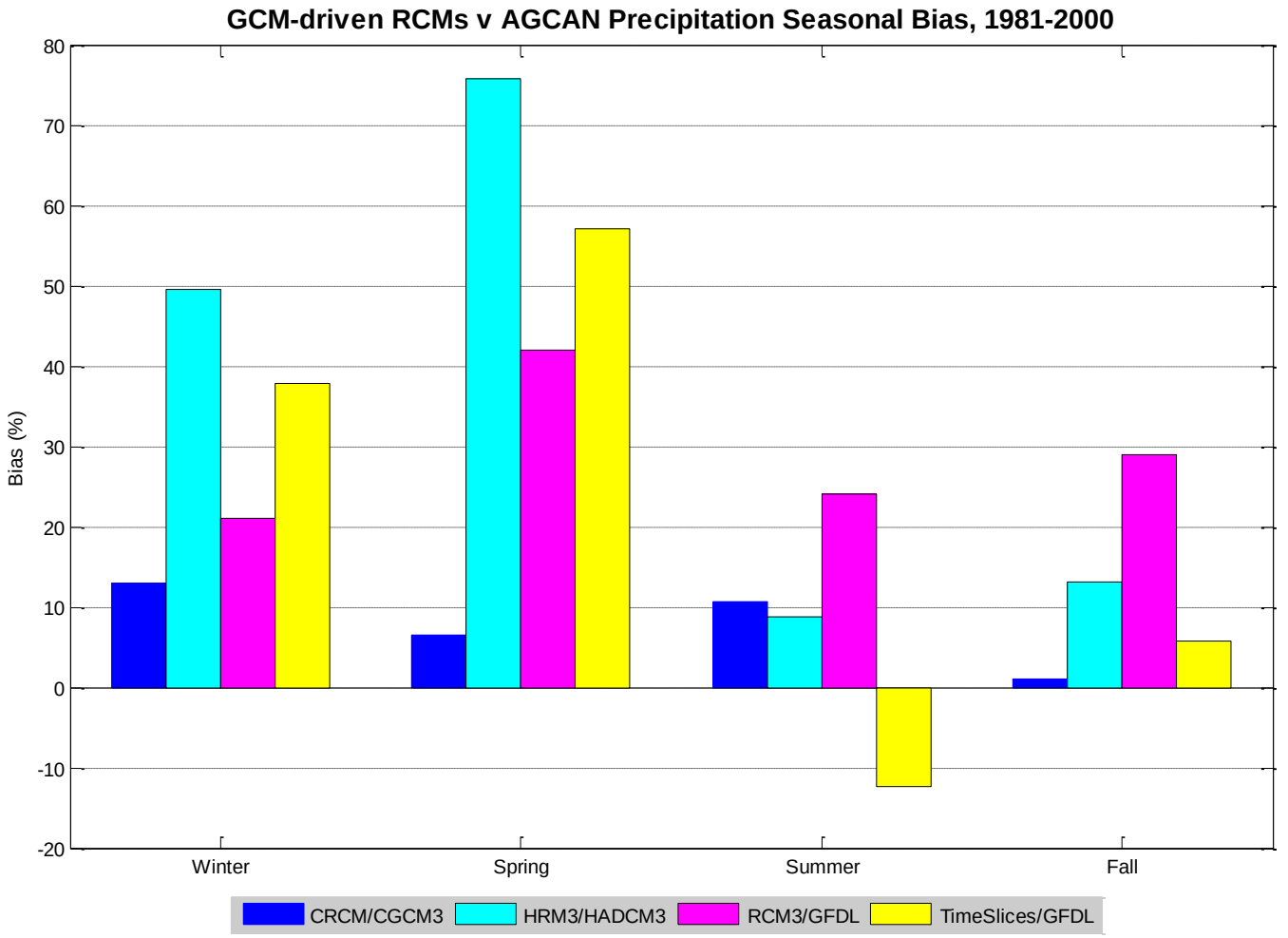
Q-Q plot of NCEP/RCMs vs Observed Precipitation



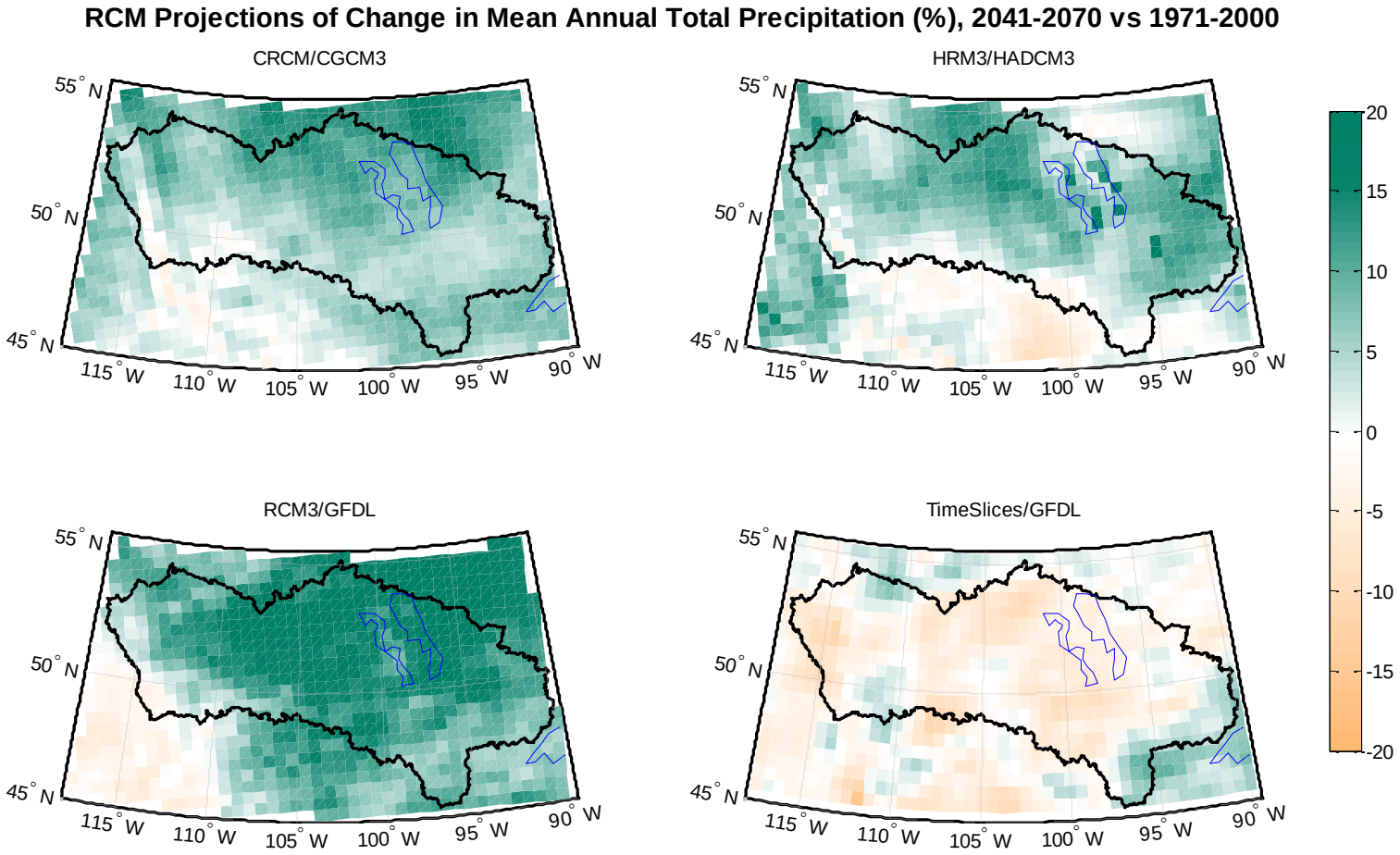
GCM/RCMs vs Gridded Observed Precipitation



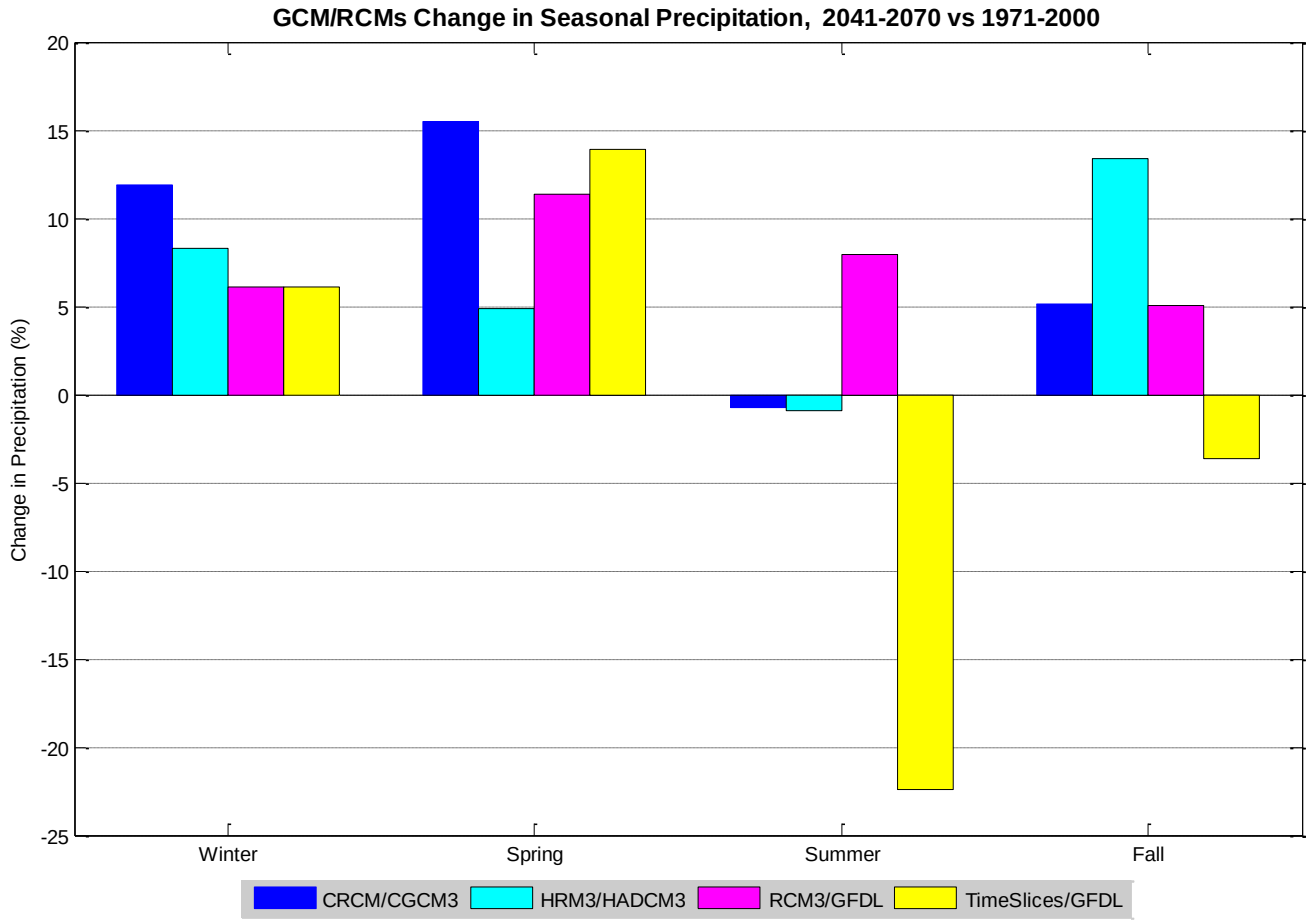
GCM/RCMs vs Observed Precipitation Bias (%)



Comparison of RCM Projections of Change in Mean Annual Precipitation (%) 2041-2070 vs 1971-2000

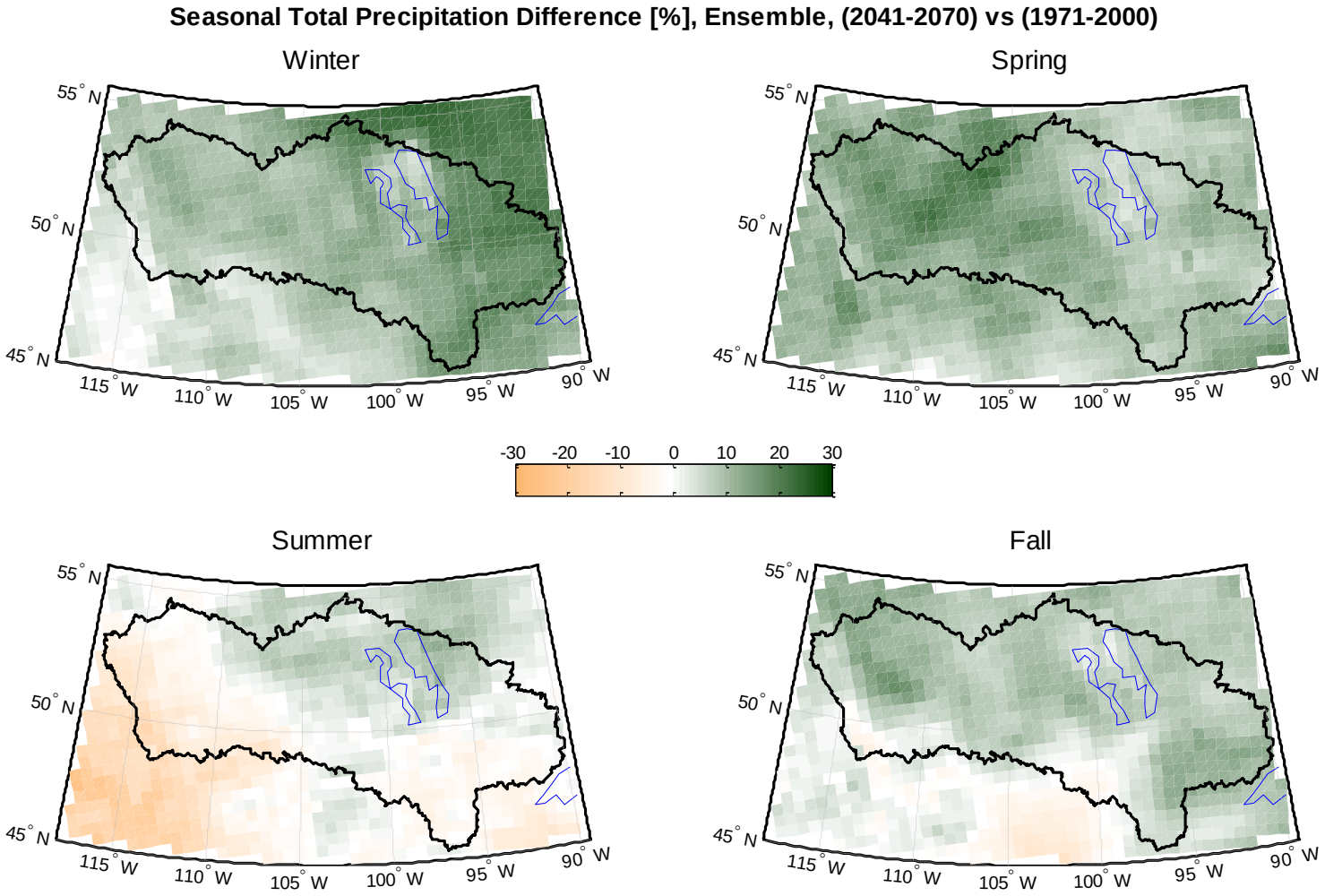


Comparison of RCM Projections of Change in Mean Seasonal Precipitation (%) 2041-2070 vs 1971-2000



RCM Ensemble

Change in Seasonal Precipitation (%) (2041-2070 vs 1971-2000)

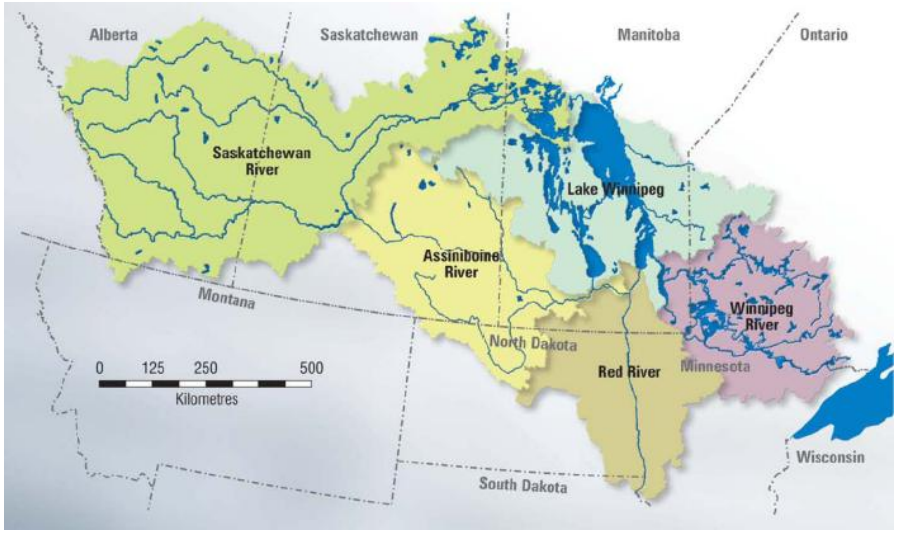


RCMs Precipitation Scenarios

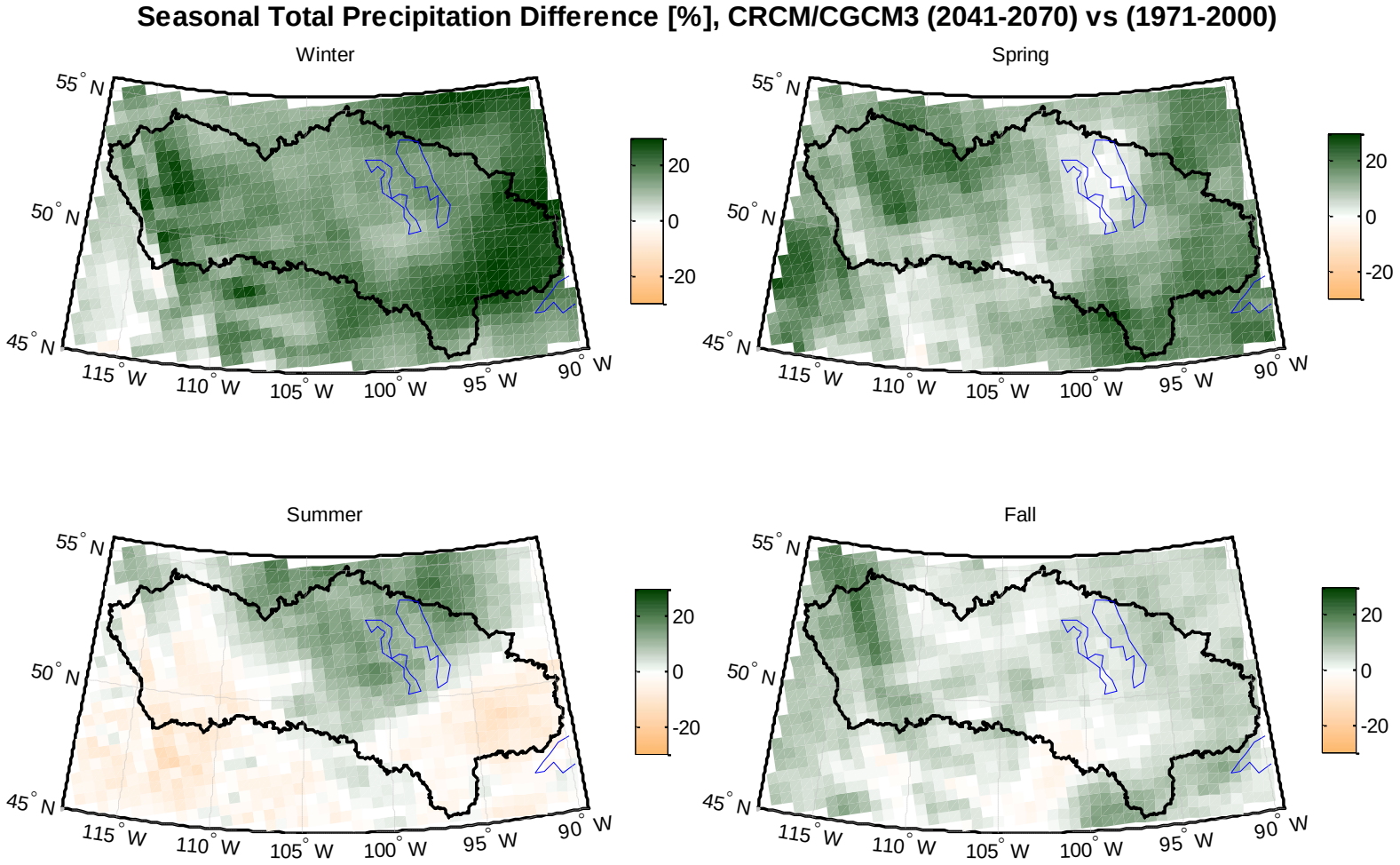
- Compared to 1981-2000 observed precipitation data over the Lake Winnipeg watershed:
  - NCEP driven CRCM and RCM3 has wet biases while HRM3 has a dry bias
  - While GCM driven RCM3 has a wet annual bias, the remaining three GCM/RCMs has a relatively small annual biases
  - CRCM/CGCM3 has less seasonal biases compared to the other three RCM/GCM
- Based on the A2 emission scenario of future climate:
  - All RCM/GCMs except TimeSlice/GFDL projected an increase in total annual precipitation by 5 - 7 % for the 2041-2070 compared to 1971-2000 while the later projected a decrease and the highest increase projected by RCM3/GFDL
  - Seasonally, all RCM/GCMs except RCM3/GFDL has projected increase in winter and spring and a decrease in summer precipitation while the later shows an increase in summer precipitation too.

Climate Impacts on Snow Depths and Discharges In the LWW

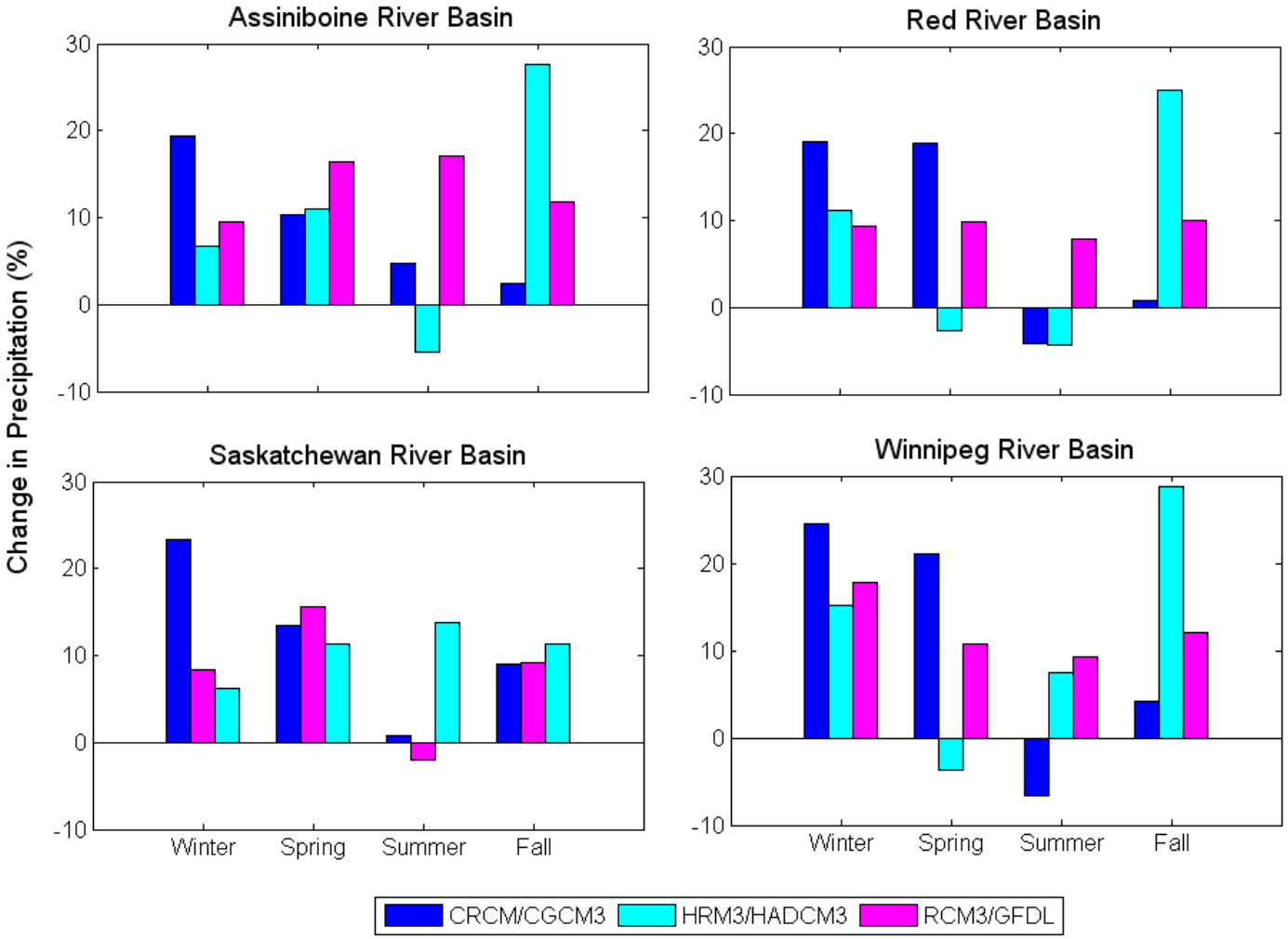
- Analyses of CRCM4 future projections of maximum snow depth, snow cover duration and snowmelt runoff
- Five river (and lakes) basins are identified in the LWW and snow and runoff analysis are performed and presented for each of these.



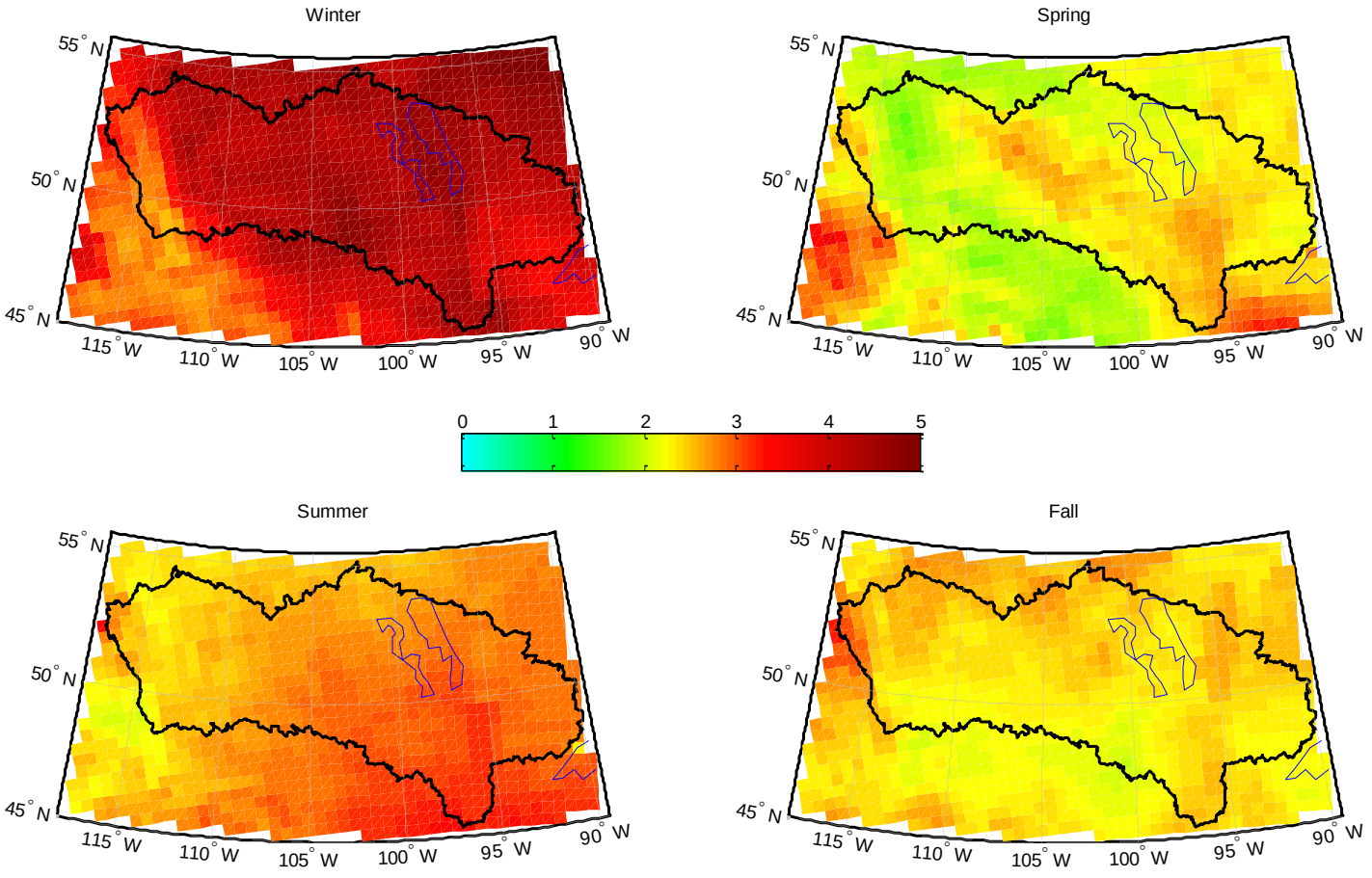
CRCM/CGCM3 Change in Seasonal Precipitation (%) (2041-2070 vs 1971-2000)



Comparison of RCM Projections of Change in Mean Seasonal Precipitation (%) 2041-2070 vs 1971-2000

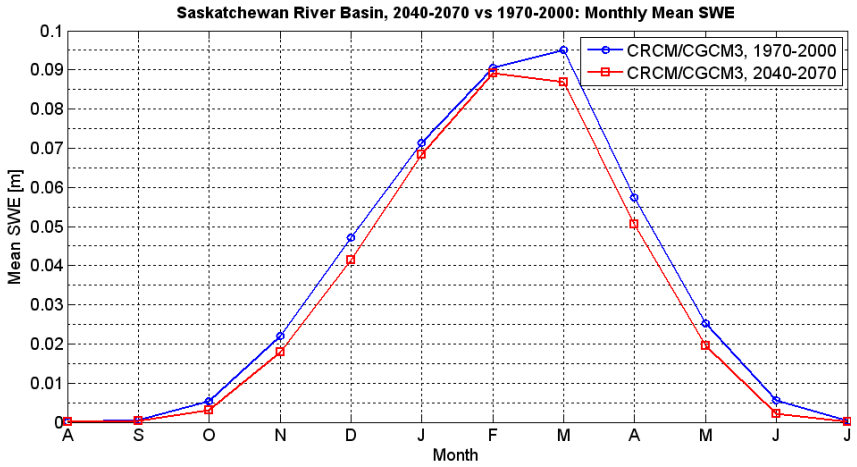


CRCM/CGCM3 Change in Seasonal Mean Tmin (2041-2070 vs 1971-2000)

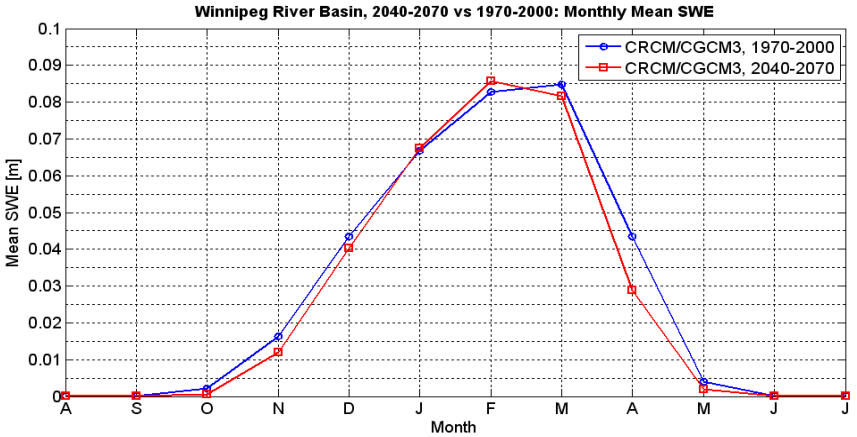


Projected Climate Change Impact on SWE

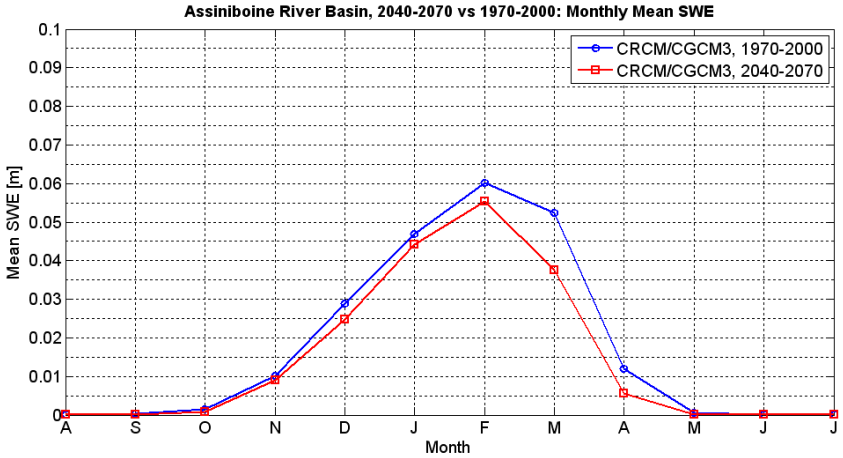
Saskatchewan River Basin



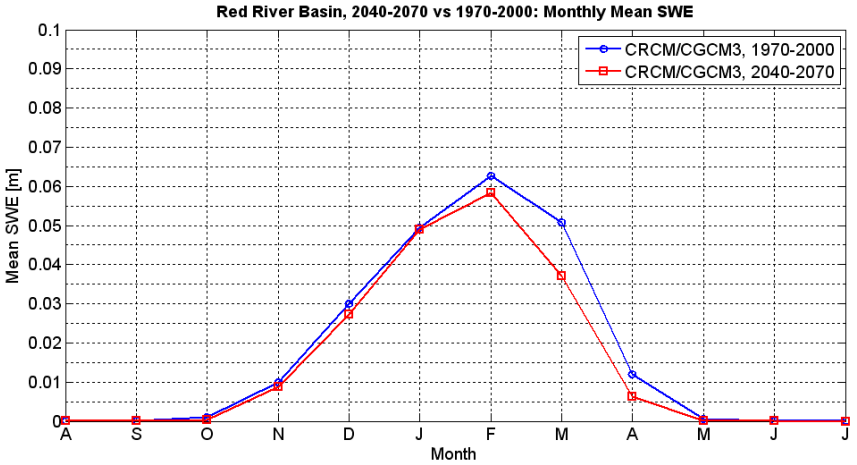
Winnipeg River Basin



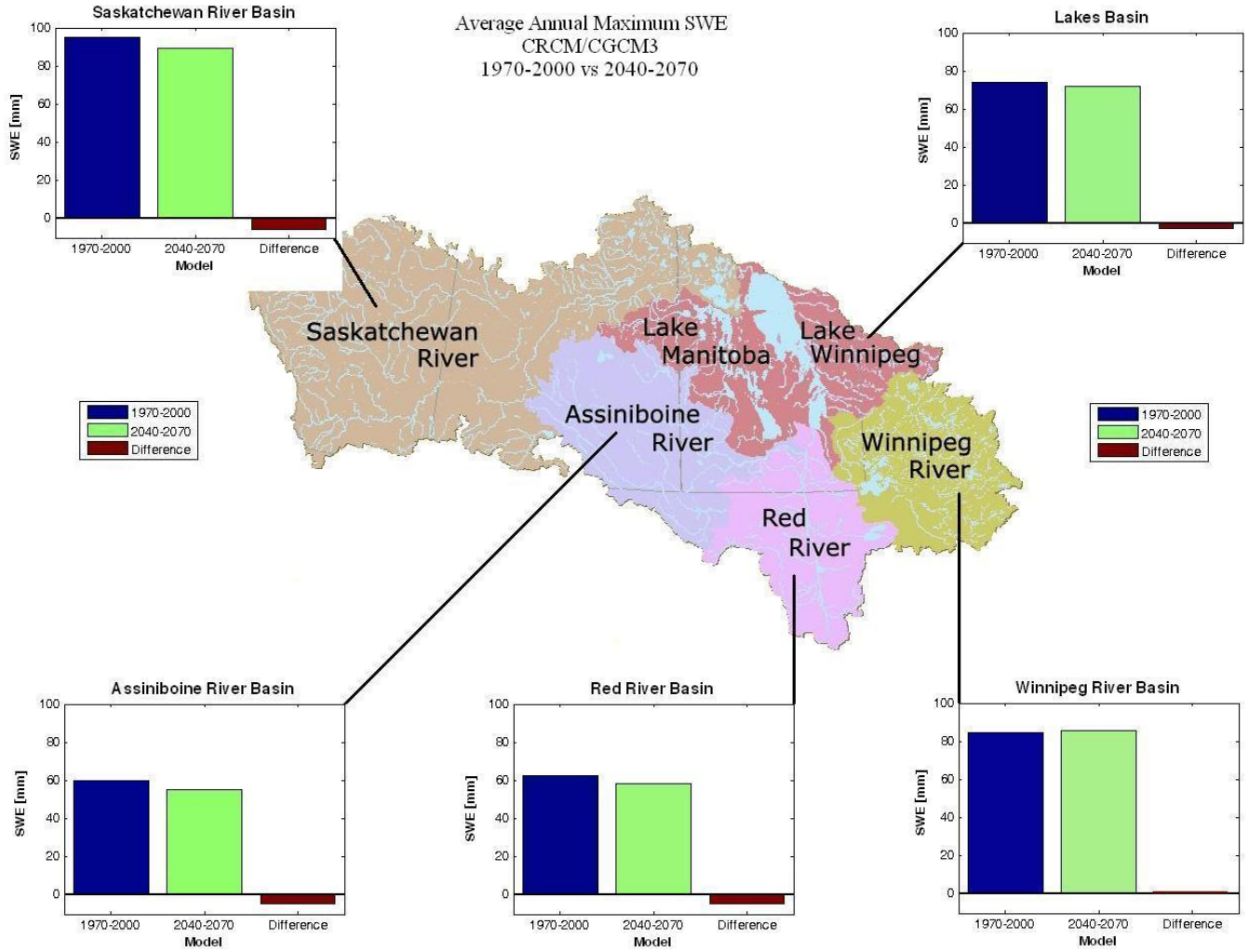
Assiniboine River Basin



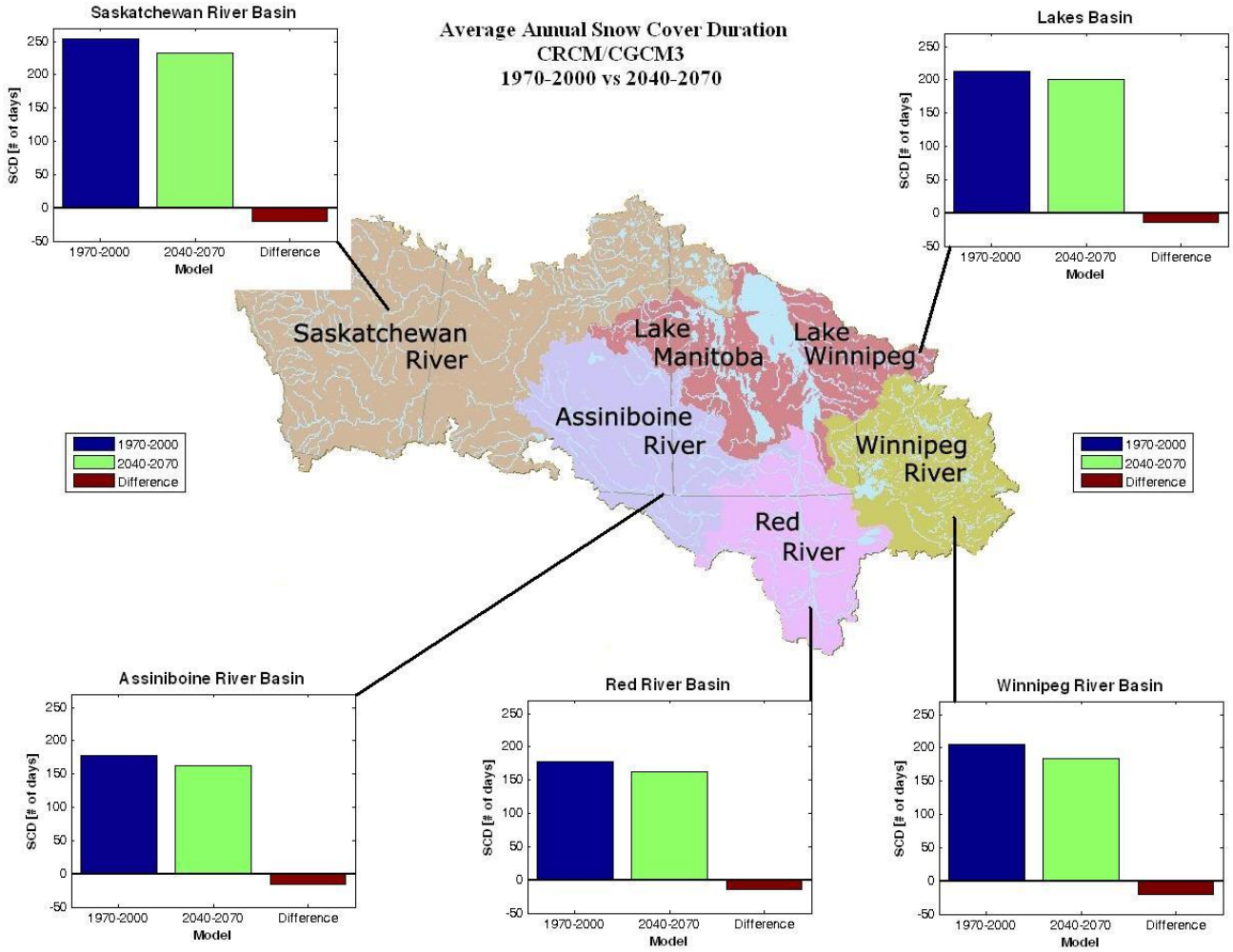
Red River Basin



Impact on Annual Maximum SWE

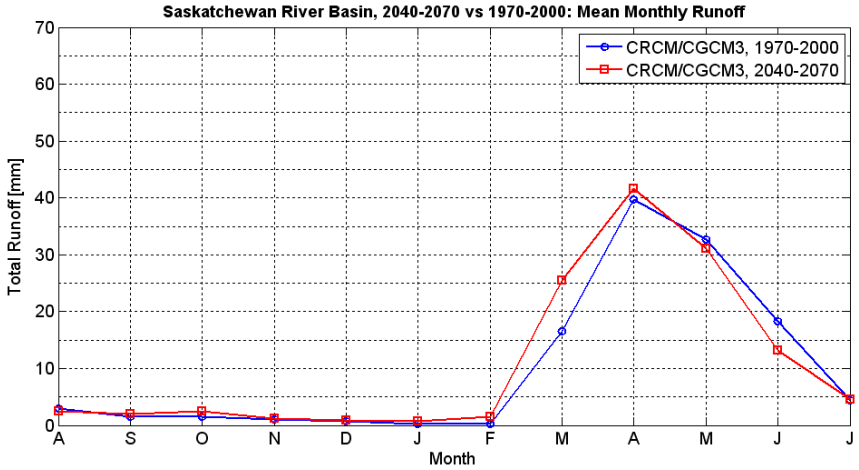


Impact on Mean Annual SCD

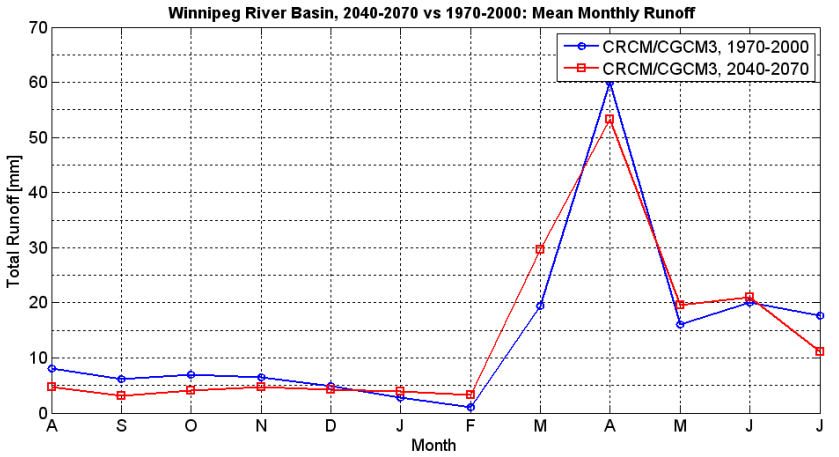


Projected Change in Mean Monthly Runoff

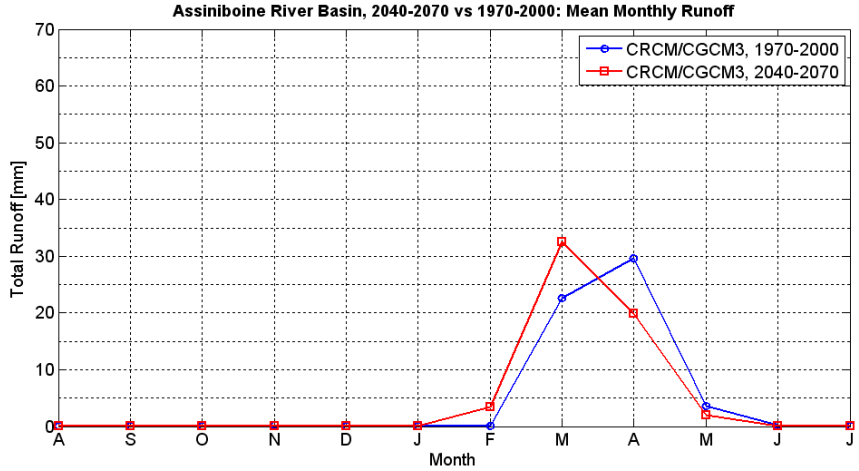
Saskatchewan River Basin



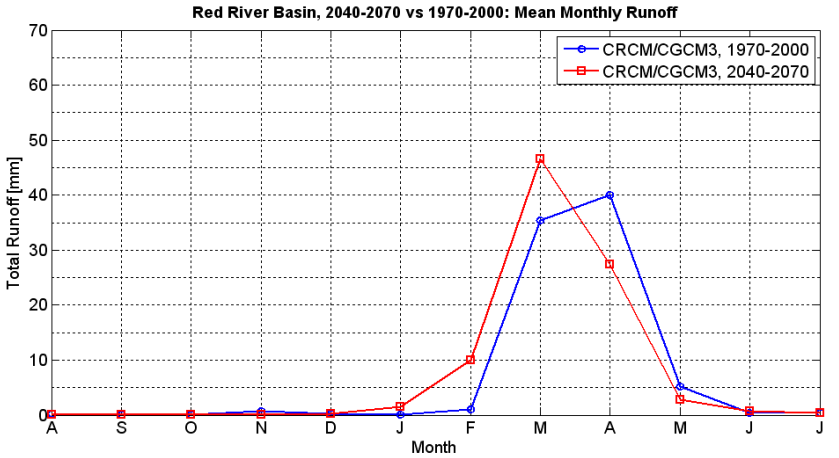
Winnipeg River Basin



Assiniboine River Basin



Red River Basin



Summary: Projected Changes in Snow and Runoff:

- There is an over all reduction in the mean SWE values for the 2041-2070 period compared to the 1971-2000
- The mean annual maximum SWE is expected to decrease in the range of 2.6 to 5.7 mm over most river basins
- The timing of the maximum SWE is projected to be earlier by about a month (from March to February)
- The mean annual SCD is projected to be reduced in all river basins by 14 to 21 days
- There will be a shift in spring runoff to earlier periods with increasing runoff in February and March and a corresponding decrease in April for most river basins
- The mean annual runoff is projected to increase in the range of 2.2 to 10.4 mm for most river basins except the Winnipeg River basin which shows a decrease of about 6.9 mm
- The projected climate also show a slight increase in annual peak monthly flow for most river basins except the Winnipeg River basin

Acknowledgment

We wish to thank the North American Regional Climate Change Assessment Program (NARCCAP) for providing the data used in this Presentation

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