# A Climate Change Scenario Intercomparison Study for the Canadian Columbia River Basin

## *High Level Summary*

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**Abstract**

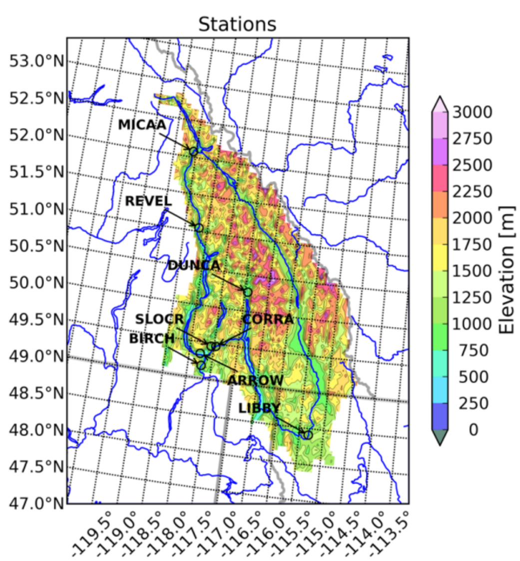
Currently, two different large-scale hydrologic modeling studies (conducted by the Climate Impacts Group (CIG) at the University of Washington and the Pacific Climate Impacts Consortium (PCIC) at the University of Victoria respectively) have projected the impacts of regional climate change for the Canadian Columbia River basin. This study evaluates key areas of convergence and divergence in the results of these studies for 18 hydroclimatic variables projected for the 2040s, including: cool-season (October – March) precipitation (P), cool-season P extremes, warm-season (April - September) P, warm-season P extremes, cool-season Temperature (T), cool-season T extremes, warm-season T, warm-season T extremes, April 1 snow water equivalent (SWE), SWE to P ratio, annual streamflow, cool-season streamflow, warm-season streamflow, July-September streamflow, August streamflow, center of timing of flow, high flow extremes, and low flow extremes. The consensus on qualitative impacts, and particularly the overall direction of change, was found to be strong for 16 of 18 variables when comparing different modeling approaches. Consensus on the percent change was strong for six variables, moderately strong for eight variables, and weak for four variables. Historical baselines were often substantially different for the two studies, and different aspects of the hydrologic cycle were better simulated by different studies.

## Introduction

Given the importance of the Canadian portion of the Columbia River basin to climate change impacts throughout the transboundary basin, and to local impacts in British Columbia, there is great interest in the hydrologic sensitivity of this region to climate change.

Hydrologic models are computer programs that simulate the water and energy balance of the land surface. These tools are commonly used to estimate changes in the water cycle in climate change studies. Currently, two different large-scale hydrologic modeling studies (conducted by the Climate Impacts Group (CIG) at the University of Washington and the Pacific Climate Impacts Consortium (PCIC) at the University of Victoria respectively) have quantified the impacts of regional climate change for the Canadian Columbia River basin.

In this study, we carried out a detailed intercomparison of the different hydrologic model projections from the existing CIG and PCIC hydrologic studies for the Canadian Columbia River basin for the 2040s. The primary objective of the study is to identify key areas of consensus and divergence in the climate change projections for 18 different hydroclimatic variables that are commonly used in assessing climate change impacts. Figure 1 shows the Canadian Columbia River basin and streamflow locations included in the intercomparison.




| **River Location:** | **Map ID** |
|---|---|
| Columbia River at Mica Dam | MICCA |
| Columbia River at Revelstoke Dam | REVEL |
| Columbia River at Keenleyside Dam (Arrow Lakes) | ARROW |
| Kootenay (Kootenai) River at Libby Dam | LIBBY |
| Kootenay River at Corra Linn Dam (Kootenay Lake) | CORRA |
| Duncan River at Duncan Dam | DUNCA |
| Columbia River at Birchbank (upstream of confluence with the Pend Oreille close to the international boundary) | BIRCH |

Figure 1. Map of study domain and streamflow locations included in the intercomparison.

***Summary of Key Study Conclusions:***

1) *The two modeling studies establish a strong consensus on the nature and overall direction of meteorological and hydrological change in the Canadian Columbia basin for the 2040s (Figure 2).*

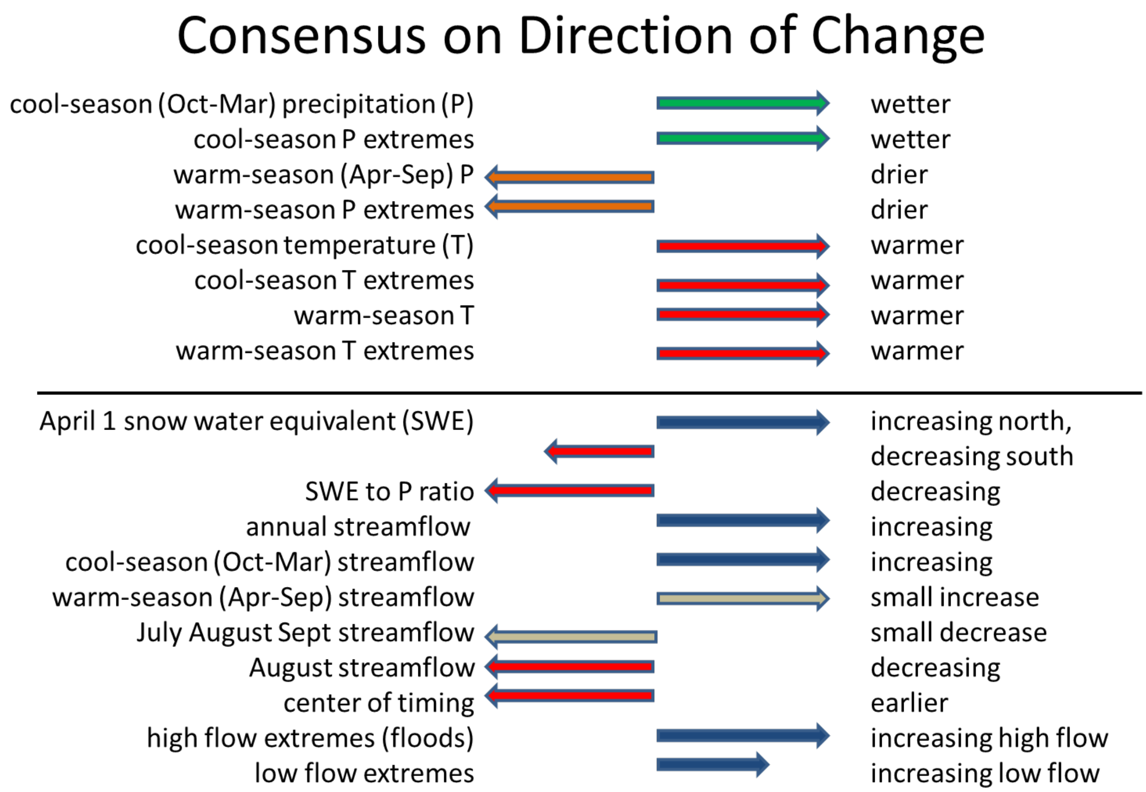
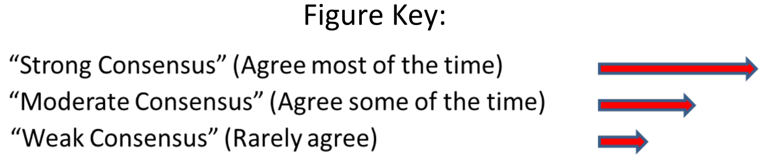



Figure 2. Degree of consensus between modeling studies on the **direction of change** for 18 hydroclimatic variables (left column), and the nature of the change (right column). Length of arrows indicates degree of consensus.



2) *The two modeling studies establish a strong consensus on the percent change of most meteorological variables, but consensus on the percent change of most hydrologic variables is weaker and limited to either moderate consensus (6 hydrologic variables) or weak consensus (5 hydrologic variables) (Figure 3).*

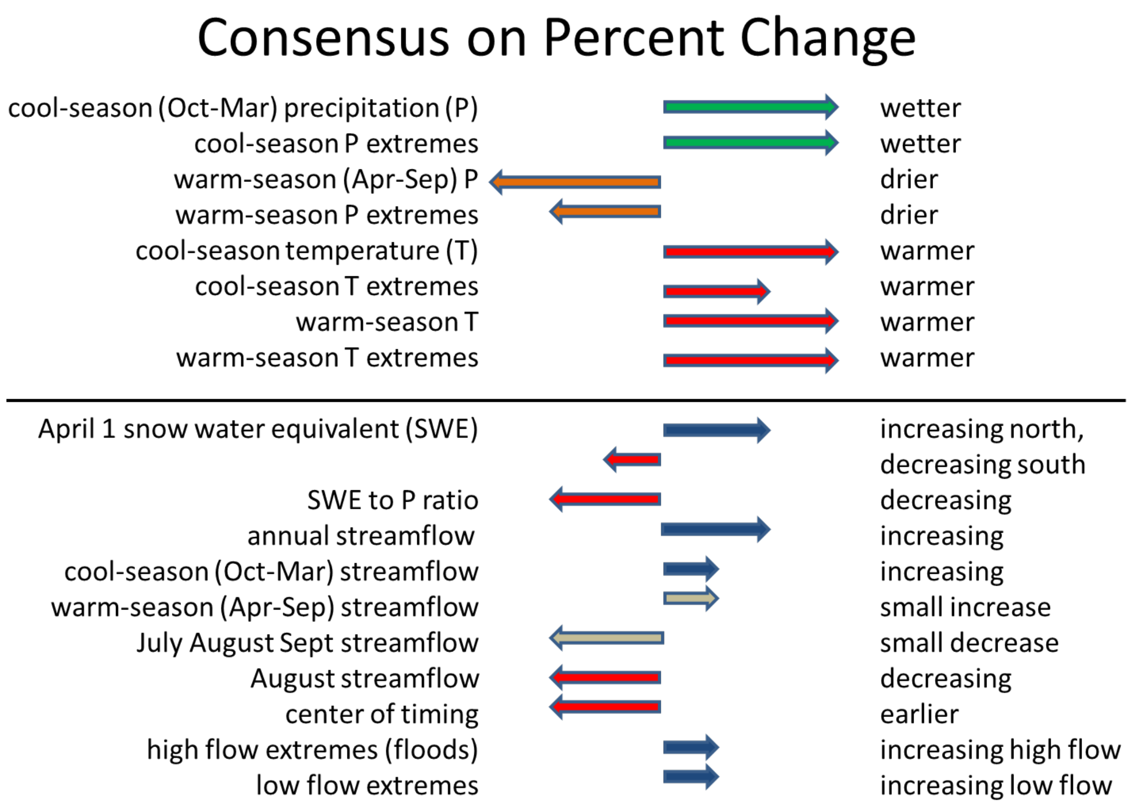
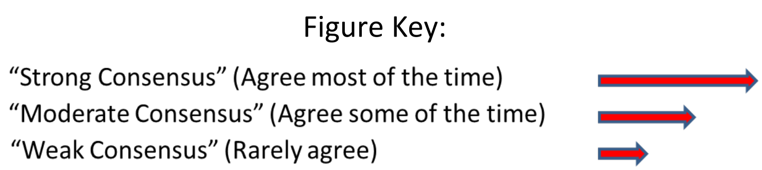



Figure 3. Degree of consensus between modeling studies on the **percent change** in 18 hydroclimatic variables (left column). Length of arrows indicates degree of consensus.



3) *The two modeling studies often show substantially different results for historical baseline simulations (Figure 4), and different aspects of the monthly hydrograph were better simulated by different studies (Figure 5). PCIC simulations, which incorporate the effects of glaciers on late summer flow, better mimic the actual streamflow behavior in late summer than the UW simulations. However, the two models frequently have comparable percent changes in flow in August, suggesting that changes in snowpack may be the most important factor.*

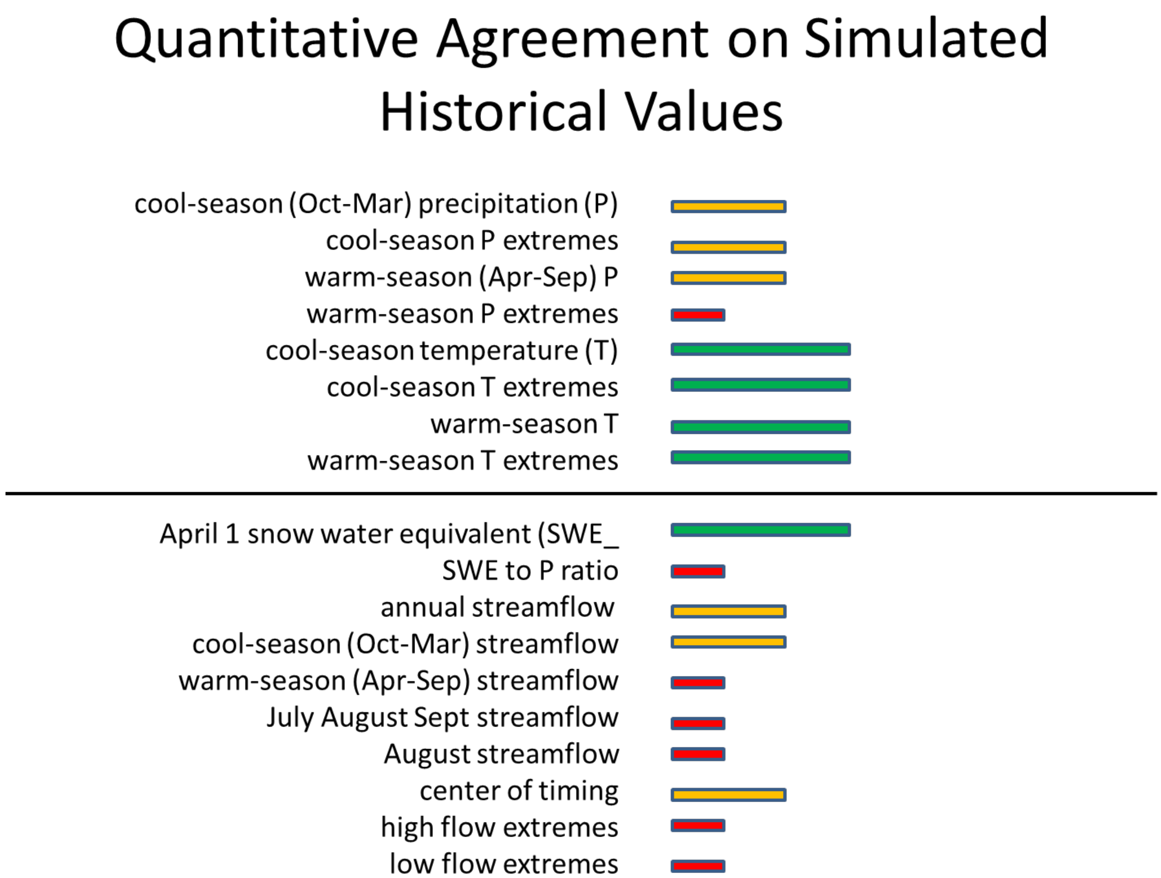
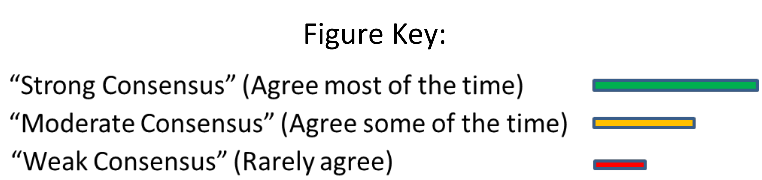



Figure 4. Quantitative agreement of historical baseline simulations of 18 hydroclimatic variables.



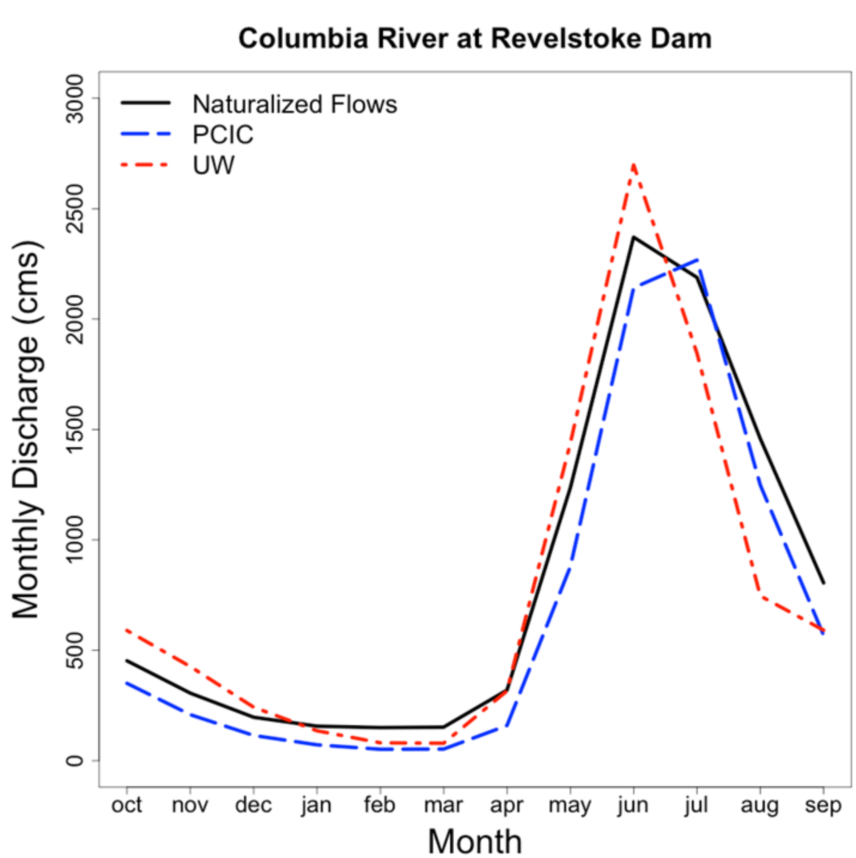



Figure 5. Comparison of monthly long-term average observed naturalized streamflow (black line) and simulated naturalized streamflow for the Columbia River at Revelstoke Dam for the PCIC (blue line) and UW (red line) hydrologic modeling studies.

4) *Interpretation of the differences between the hydrologic modeling studies may vary with context:*
    a. *Conclusions based on qualitative results (such as the direction of change) would likely draw very similar conclusions about the nature of impacts and identify a high level of consensus between the different modeling approaches.*
    b. *Engineering studies using these simulations as inputs (e.g. as inputs to reservoir simulation models predicting hydropower production) would likely show substantial differences in outcomes and a high level of divergence between the different modeling approaches.*

*c.*

*d.*

*e.* *p:\jah\fish\transb\2012 climate impacts comparison cig\hamlet_high_level_summary_final.docx*