



University  
of Victoria

Graduate Studies

Notice of the Final Oral Examination  
for the Degree of Doctor of Philosophy

of

**BRANDI NEWTON**

MSc (University of Victoria, 2014)

BSc (University of Alberta, 2011)

**“An evaluation of winter hydroclimatic variables conducive to  
snowmelt and the generation of extreme hydrologic events”**

Department of Geography

Wednesday, June 27, 2018

9:00 A.M.

Clearihue Building

Room B017

Supervisory Committee:

Dr. Terry Prowse, Department of Geography, University of Victoria (Supervisor)

Dr. Thomas Edwards, Department of Geography, UVic (Member)

Dr. Barrie Bonsal, Department of Geography, UVic (Member)

Dr. Glenn McGregor, Department of Geography, Durham University (Outside Member)

External Examiner:

Dr. Stephen Déry, Natural Resources and Environmental Studies, University of Northern British  
Columbia

Chair of Oral Examination:

Dr. Jill Walshaw, Department of History, UVic

## **Abstract**

The frequency, magnitude, and atmospheric drivers of winter hydroclimatic variables conducive to snowmelt in western Canada were evaluated. These hydroclimatic variables were linked to the mid-winter break-up of river ice; a comprehensive database including 46 mid-winter river ice break-up events in western Canada (1950-2008) and 6 events in Alaska (1950-2014) was created. Widespread increases in above-freezing temperatures and spatially diverse increases in rainfall were detected over the study period (1946-2012), particularly during January and March. Critical elevation zones representing the greatest rate of change were identified for major river basins. Specifically, low-elevation (500-1000m) temperature changes dominated the Stikine, Nass, Skeena, and Fraser river basins and low to mid-elevation changes (700-1500m) dominated the Peace, Athabasca, Saskatchewan, and Columbia river basins while the greatest increases in rainfall were seen below 700m and between 1200-1900m in the Fraser and at mid- to high-elevations (1500-2200m) in the Peace, Athabasca, and Saskatchewan river basins. Daily synoptic-scale atmospheric circulation patterns were classified using Self-Organizing Maps (SOM) and corresponding hydroclimatic variables were evaluated. Frequency, persistence, and trajectory of identified synoptic types provided additional insight into characteristics of dominant atmospheric circulation patterns. Trend analyses revealed significant decreases in two dominant synoptic types: a ridge of high pressure over the Pacific Ocean and adjacent trough of low pressure over western Canada, which directs the movement of cold, dry air over the study region, and zonal flow with westerly flow from the Pacific Ocean over the study region. Conversely, the frequency and persistence of a ridge of high pressure over western Canada increased over the study period. However, step change analysis revealed a step decrease in zonal flow and a step increase in a ridge of high pressure over western Canada in 1977, coinciding with a shift to a positive Pacific Decadal Oscillation regime. A ridge of high pressure over western Canada was associated with a high frequency and magnitude of above-freezing temperatures and rainfall in the study region. This pattern is highly persistent and elicits a stronger surface climate response during persistent regimes. A ridge of high pressure and associated above-freezing temperatures and rainfall was also found to be the primary driver of mid-winter river ice break-up with rainfall being a stronger driver west of the Rocky Mountains and temperature to the east. These results improve our understanding of the drivers of threats to snowpack integrity and the generation of extreme hydrologic events.