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An Assessment of Historical and Future Hydro-Climatic Extremes over Key Watersheds within Western Canada

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Since human activities and ecosystem health are dependent on adequate, reliable water supplies, hydro-climatic extremes, including the occurrence of severe droughts and excessive moisture pose a serious threat to society and the environment. Western Canada is a region with high natural hydro-climatic variability, including the periodic occurrence of drought and excessive moisture conditions, however, recent dramatic shifts between extreme drought and extreme wet conditions have suggested that this variability may be increasing. This investigation assesses the occurrence and atmospheric causes of both the past and projected future hydro-climatic variability and extremes over key watersheds within western Canada. Incorporation of the Standardized Precipitation Evapotranspiration Index (SPEI) reveals considerable decadal-scale variability in hydro-climate over many regions of western Canada with no discernible long-term trends. In addition, an assessment of the mid-tropospheric (500 hPa) circulation patterns associated with identified hydro-climatic extremes indicate that major drought episodes were associated with significantly higher frequencies of circulation types that included distinctive ridging patterns over the Prairie region, and lower incidences of zonal and mid-tropospheric troughing patterns. Excessive moisture conditions had opposite responses. Model output from a suite of Regional Climate Models (RCMs) from the North American Regional Climate Change Assessment Program suggests a drier summer climate in the region with likely increases to inter-annual hydro-climatic variability. In addition, preliminary results indicate that those atmospheric circulation patterns associated with extreme dry and wet conditions will continue to occur in the future and in some cases, increase in frequency. Results from this analysis have increased the understanding of historical synoptic-scale controls of hydro-climatic extremes in western Canada and have provided insight into potential future changes to these extremes as driven by changes to key, synoptic-scale atmospheric circulation patterns.