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Assessing the projection of soil moisture in the Canadian Prairie region relative to tree-ring reconstructions

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Natural (unforced) climatic variability is the dominant source of uncertainty in the projection of future regional hydroclimates. Information on past climate is of crucial importance for ascertaining the background natural climate variability, in order to understand recent climate changes in light of possible human impacts. Tree rings are a source of hydroclimatic data, and an absolute annual chronology, for the time intervals spanned by living trees and cross-dateable dead wood. Climate reconstruction using tree rings has revealed both fine and coarse scale climatic change.

In this study, we will reconstruct annual and seasonal soil moisture and streamflow for the past 300-900 years from tree rings collected in the southern prairie watersheds and stochastically downscale these proxy data to weekly estimates, to examine both long-term climate variability and anthropogenic contributions to change in soil moisture and streamflow. These spatial variations in soil moisture properties may be useful in differentiating between local and regional climate signals.

We investigate the current and future water supplies in these watersheds using the MESH modelling system (Modélisation Environmentale Communautaire Surface and Hydrology), which embeds the Canadian Land Surface Scheme and the distributed hydrological routing scheme of WATFLOOD to analyze the regional effect on water and energy budgets and for land–atmosphere interactions. The impacts of climate change will be assessed by forcing the MESH model with the bias-corrected dynamically downscaled meteorology from the CRCM5 (fifth-generation Canadian RCM developed by the Université du Québec à Montréal (UQÀM)) ensembles for the current (1980 – 2000) and future periods (2030 – 2050, 2080 – 2100). Finally, we will compare the tree-ring reconstructed soil moisture and streamflow to the model projections and thereby analyze the impact of anthropogenic climate change on hydroclimatic variables by determining the extent to which future variability in soil moisture and streamflow exceed that natural variability captured by the tree rings.

These proxy records allow the exploration of linkages between atmospheric circulations, precipitations and streamflow over longer intervals than instrumental records providing critical information for long-term planning of water recourses that are vital to many economic activities and stakeholders.