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The impacts of land cover changes on local-scale evapotranspiration and precipitation, and hydrological processes in the Canadian prairies

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Land cover changes from perennial grasses to annual crops have changed the hydrological processes in the Canadian prairies since the arrival of European settlers in the early 20th Century. Almost 60% of the grasslands have been converted to croplands. The objective of this research is to study the effect of the land cover changes on convection and hydrological processes in the Canadian prairies. Three study sites near Calgary in western Canada including one grassland site (Spyhill) and two cropland sites (Woolimans and Zingler) were monitored by meteorological station and hydrological devices to measure air temperature, relative humidity, wind speed, long and shortwave radiation, precipitation, evapotranspiration, snow water equivalent, soil temperature and soil moisture. These observations enabled to investigate changes in evapotranspiration, soil moisture content, infiltration, snow redistribution, and deep convection under landscape conversion. High resolution weather and climate model outputs and land cover information from remote sensing imagery are used to separate frontal and convective precipitation events associated with local contribution of evapotranspiration from croplands and grasslands. The results show that the lower soil water content and higher soil porosity in grassland increases the air-filled porosity, which can greatly affect snowmelt runoff processes. Besides that, the macrospores effect, which is dominant in grassland soil compared to cropland, leads to increase the infiltrability of the soil beneath the grass in particular under frozen soil condition. Low infiltrability in croplands leads to high runoff and water input to wetlands in the Canadian Prairies. The evapotranspiration in croplands has a higher rate than grasslands during rapid foliage expansion (July), which can enhance the convection during this period. The results show that differences in the latent heat flux for two types of vegetation — grasslands and croplands as a result of changes in the seasonal and regional water use of the vegetation lead to large changes in the partitioning of the net radiation between latent and sensible heat, which increases the magnitude of the available buoyant energy for convection in croplands more than grasslands. This is because the latent heat flux raises the specific humidity and temperature of the convective boundary layer more in croplands than in grasslands. Findings of this research can be used to have better understanding of hydrological fluxes variability under land cover transformation and to estimate changes in patterns of the convective precipitation in other areas under land cover change.