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Projected changes to rain-on-snow events over North America

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Rain-on-snow (ROS) events have significant impacts on cold region ecosystems and water-related natural hazards, and therefore it is very important to assess how this hydro-meteorological phenomenon will evolve in a changing climate. This study evaluates the changes in ROS characteristics (i.e. frequency, amounts, and runoff) for the future 2041-2070 period with respect to the current 1976-2005 period over North America using six simulations, based on two Canadian RCMs, driven by two driving GCMs for RCP4.5 and 8.5 emission pathways. Projected changes to extreme runoff caused by the changes of the ROS characteristics are also evaluated. All simulations suggest general increases in ROS days in late autumn, winter, and early spring periods for most Canadian regions and northwestern USA for the future period, due to an increase in rain days in a warmer climate. Increases in the future ROS amounts are projected mainly due to an increase in ROS days, although increases in precipitation intensity also contributes to the future increases. Future ROS runoff is expected to increase more than future ROS amounts during snowmelt months as ROS events usually enhance runoff, given the land state and asociated reduced soil infiltration rate and also due to the faster snowmelt rate occuring during these events. The simulations also show that ROS events usually lead to extreme runoff over most of Canada and north-western and -central USA in the January-May snowmelt months for the current period and these show no significant changes in the future climate. However, the future ROS to total runoff ratio will significantly decrease for western and eastern Canada as well as north-western USA for these months, due to an overall increase of the fraction of direct snowmelt and rainfall generated runoff in a warmer climate. These results indicate the difficulties of flood risk and water resource managements in the future, particularly in Canada and north-western and -central USA, requiring more in depth studies for these regions to facilitate appropriate adaptation measures.