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An assessment of the changing nature of the winter hydroclimate in eastern North America and its impacts on risk management

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The winter hydroclimate of eastern North America is characterized by a complex and spatially varying combination of snow and rain. Much of this complexity stems from the presence of Great Lakes that are a source of heat and moisture during the winter months. Lake effect snowfall can result in heavy snowfall in highly localized regions downstream of the lakes. In addition the average mean winter temperature in the region is close to freezing and so there is enhanced sensitivity as to the phase of the precipitation. The region has warmed by 1-2.5 oC during the winter over the past 30 years and so there is concern that the character of the winter hydroclimate may be changing. Here we use reanalysis fields as well as the results of AMIP model runs, with horizontal resolutions ranging from 100 km to 16 km, to investigate the changes that have occurred in the winter hydroclimate of the region. It is shown that a horizontal resolution below $\sim$40 km is needed to resolve the observed spatial gradients in snowfall and rainfall in the region. Over the past 30 years, the mean and 95th percentile snowfall rates in the southern part of the region have decreased by as much as 20% with an increase of a similar magnitude in both these parameters in its northwest. There has also been an increase in the mean and 95th percentile rainfall rates across much the region that exceeds 100% in the vicinity of Lake Superior, the largest and most northern of the Great Lakes. These changes are attributed to the warming that the region has experienced and are expected to continue into the future. They have and will continue to impact a number of societal functions including winter road maintenance as well as influencing the management of property risks such as flooding.