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The role of internal variability in climate change projections of North American surface air temperature and temperature extremes in CanESM2 large ensemble simulations

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Recent studies indicated that the internal climate variability plays an important role in various aspects of projected climate changes on regional and local scales. Here we present results of the spreads in projected trends of wintertime North American surface air temperature and extremes indices of warm and cold days over the next half-century, by analyzing a 50-member large ensemble of climate simulations conducted with CanESM2. CanESM2 simulations confirm the important role of internal variability in projected surface temperature trends as demonstrated in previous studies. Yet the spread in North American warming trends in CanESM2 is generally smaller than those obtained from CCSM3 and ECHAM5 large ensemble simulations. Despite this, large spreads in the climate means as well as climate change trends of North American temperature extremes are apparent in CanESM2, especially in the projected cold day trends. The ensemble mean of forced climate simulations reveals high risks of warm days over the western coast and north Canada, as well as a weakening belt of cold days extending from Alaska to the northeast US. The individual ensemble members differ from the ensemble mean mainly in magnitude of the warm day trends, but depart from the ensemble mean in conspicuous ways, including spatial pattern and magnitude, of the cold day trends. The signal-to-noise ratio pattern of the warm day trend resembles that of the surface air temperature trend; with stronger signals over north Canada, Alaska, and the southwestern US than the midsection of the continent. The projected cold day patterns reveal strong signals over the southwestern US, north Canada, and the northeastern US. In addition, the internally generated components of temperature and temperature extreme trends exhibit spatial coherences over North America, and are comparable to the externally forced trends. The large-scale atmospheric circulation-induced temperature variability influences these trends. Overall, our results suggest that climate change trends of North American temperature extremes are likely very uncertain and need to be applied with caution.