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Convection-Permitting Regional Climate Simulations over North America

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The NCAR Water System Program has been striving to improve the representation of the water cycle and its future changes in both regional and global models during the past decade. One of our efforts is conducting continental-scale convection-permitting simulations of the current and future climate of North America using the WRF model based atmospheric-hydrological coupling system. The major science objectives of these simulations are: 1) to evaluate the capability of convection-permitting WRF model in capturing orographic precipitation and snow mass balance over the western mountains of North America and convective precipitation in the eastern part of the continent; 2) to assess future changes in seasonal snowfall and snowpack and associated surface hydrological cycles under the CMIP5-projected global warming; 3) to investigate water cycle changes in response to climate warming, including the summertime convective precipitation and associated mesoscale convective storm tracks; and 4) to examine the impact of climate change on severe weather over North America. As such, two phases of convection-permitting climate modeling have been undertaken using 4-km horizontal grid spacing covering most of North America.

The phase-one effort involves two 13-year simulations as reported in Liu et al. (2017): 1) a historical simulation with initial and boundary conditions from ERA-interim, and 2) a future climate sensitivity simulation, called pseudo-global warming (PGW), with modified reanalysis-derived initial and boundary conditions by adding the CMIP5 ensemble-mean projected climate change. These WRF-downscaled climate change simulations provide a unique high-resolution dataset to the community for studying one possible scenario of regional climate changes and impacts.

Recognizing that only the thermodynamic future climate impacts can be adequately addressed in the PGW approach, the NCAR Water System team has started conducting a second set (phase II) of current and future simulations at 4-km grid spacing over North America. In these simulations, the WRF model is forced using the weather perturbations derived from the NCAR CESM model 6-hourly output plus the reanalysis-based bias-corrected CMIP5 ensemble mean climate as detailed in Dai et al. (2017). The model domain is also expanded northward to include Canada and the Canadian Arctic. Because storm track changes are permitted, these simulations complement the previous PGW simulations, allowing us to address the impact of dynamic changes in the future warmer climate. We will present some preliminary analysis results of these simulations, with focus on the evaluation of the historical simulation and the added value of convection-permitting

resolution and mean climate bias corrections.