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Recent Advances in High-Resolution Regional Climate Modeling at the U.S. Environmental Protection Agency

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The Regional Climate Modeling Team at the U.S. Environmental Protection Agency has been improving the quality of regional climate fields generated by the Weather Research and Forecasting (WRF) model. Active areas of research include improving core physics within the WRF model and adapting the physics for regional climate applications, improving the representation of inland lakes that are unresolved by the driving fields, evaluating nudging strategies, and devising techniques to demonstrate value added by dynamical downscaling. These research efforts have been conducted using reanalysis data as driving fields, and then their results have been applied to downscale data from global climate models. The goals of this work are to equip environmental managers and policy/decision makers in the U.S. with science, tools, and data to inform decisions related to adapting to and mitigating the potential impacts of climate change on air quality, ecosystems, and human health.

Our presentation will focus mainly on one area of the Team's research: Development and testing of a seamless convection parameterization scheme. For the continental U.S., one of the impediments to high-resolution ($\sim$3 to 15 km) climate modeling is related to the lack of a seamless convection parameterization that works across many scales. Since many convection schemes are not developed to work at those "gray scales", they often lead to excessive precipitation during warm periods (e.g., summer). The Kain-Fritsch (KF) convection parameterization in the WRF model has been updated such that it can be used seamlessly across spatial scales down to $\sim$1 km grid spacing. First, we introduced subgrid-scale cloud and radiation interactions that had not been previously considered in the KF scheme. Then, a scaling parameter was developed to introduce scale-dependency in the KF scheme for use with various processes. In addition, we developed new formulations for: (1) convective adjustment timescale; (2) entrainment of environmental air; (3) impacts of convective updraft on grid-scale vertical velocity; (4) convective cloud microphysics; (5) stabilizing capacity; (6) elimination of double counting of precipitation; and (7) estimation of updraft mass flux at the lifting condensation level. Some of these scale-dependent formulations make the KF scheme operable at all scales up to about sub-kilometer grid resolution.

In this presentation, regional climate simulations using the WRF model will be presented to demonstrate the effects of these changes to the KF scheme. Additionally, we briefly present results obtained from the improved representation of inland lakes, various nudging strategies, and added value of dynamical downscaling of regional climate.

Requesting for a plenary talk for the session: "Regional climate modeling, including CORDEX" (session number CL6.4) at the EGU 2014 General Assembly, to be held 27 April - 2 May 2014 in Vienna, Austria.