Development of Frameworks for Robust Regional Climate Modeling

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PROJECT DESCRIPTION

We propose a hierarchical approach to test the veracity of the global high resolution, global variable resolution, and nested regional climate model for regional climate modeling. We hypothesize that systematic evaluation of different modeling approaches, in the context of interactions across spatial/temporal scales and between the atmosphere, land, and ocean systems, will lead to better understanding of the relative merits of different dynamical approaches and improve the frameworks for robust simulations of regional climate. Our evaluation hierarchy has four stages: 1) idealized, no physics test cases, 2) idealized, full physics test cases, 3) real world, atmosphere-only and ocean-only simulations, and 4) real world, coupled atmosphere-ocean simulations for both current and future climate. We will use the regional hydrologic cycle as our scientific thrust for developing and evaluating frameworks for robust regional climate modeling. Since the regional hydrologic cycle can manifest differently in different climate regimes, we will use North and South America as our geographic focus to highlight several distinctive features.

SIGNIFICANCE

Predicting the regional hydrologic cycle at time scales from seasons to centuries is one of the most practical yet challenging goals of climate modeling. Water supports the ecosystems as well as a wide range of human activities such as energy, agriculture, and transportation. Climate models have projected increasingly uneven distributions of water both spatially and temporally and more frequent extremes, motivating the need for more research to improve regional predictions of the hydrologic cycle to address climate change impacts, adaptation, and mitigation.

A myriad of processes are responsible for the formation of clouds and precipitation, which provide the dominant forcing for the surface water budgets. To date, limitations in model simulations of clouds constitute a major uncertainty in climate predictions for the future. Thus, besides meeting societal needs, improving model skill in simulating the regional hydrologic cycle is an important benchmark for global and regional climate models. Because hydrologic cycle processes are inherently multi-scale, it has been postulated that increasing model resolution to more explicitly represent finer scale processes is a key to improving simulations of the hydrologic cycle.