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Regional Arctic Climate System Model (RACM) - Development and selected results

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Global climate system models are limited and have significant errors in representing the current and past state of the Arctic, which undermines their predictions of future climate change in the region. Some of the most significant problems include northward fluxes of heat and moisture, sea ice area and thickness distribution, and export of freshwater into the North Atlantic. Such errors arise from many sources including errors propagating into the Arctic from lower latitudes, inadequate representation of polar climate processes, and coarse model resolution. On the other hand, the majority of existing regional Arctic models use higher resolution compared to global models but they do not account for important sea-ice-atmosphere-land hydrology feedbacks. They either simulate the atmospheric state using simplified lower boundary conditions for sea ice and ocean or predict sea ice-ocean variability using prescribed atmospheric forcing. However, many of these processes and feedbacks impose critical controls on both regional Arctic and on global climate variability and their realistic representation requires dedicated high-resolution modeling studies and it is critical to improved climate predictions. One way to address these shortcomings is through the use of an Arctic-focused regional climate system model. The use of an Arctic regional climate system model allows for increased horizontal and vertical resolution, use of improved model physics that are optimized for polar regions, as well as for retrospective simulations and the use of "perfect" lateral boundary conditions.

Following the above rationale, a state-of-the-art regional Arctic climate system model (RACM) has been developed to perform multi-decadal numerical experiments and to minimize uncertainties and fundamentally improve current predictions of climate change in the Arctic.. RACM includes a high-resolution atmosphere (polar WRF), ocean (POP), sea ice (CICE) and land hydrology (VIC) components. Its domain covers the pan-Arctic region and includes all sea-ice-covered regions in the Northern Hemisphere as well as all terrestrial drainage basins that drain to the Arctic Ocean. High resolution is defined as $\leq$10-km for ice/ocean and $\leq$50-km for atmosphere/land/hydrology models. RACM uses current "off-the-shelf" state-of-the-art four component models, which are coupled together using the NCAR CCSM/CESM flux coupler CPL7. This presentation will review details of model development and summarize selected results from stand-alone and fully coupled RACM simulations.