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Evaluation of the Regional Arctic System Model (RASM) - Process-resolving Arctic Climate Simulation

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The Regional Arctic System Model (RASM) has been developed to better understand the past and present operation of Arctic System at process scale and to predict its change at time scales from days to decades, in support of the US environmental assessment and prediction needs. RASM is a limited-area, fully coupled ice-ocean-atmosphere-land model that uses the Community Earth System Model (CESM) framework. It includes the Weather Research and Forecasting (WRF) model, the LANL Parallel Ocean Program (POP) and Community Ice Model (CICE) and the Variable Infiltration Capacity (VIC) land hydrology model. The ocean and sea ice models used in RASM are regionally configured versions of those used in CESM, while WRF replaces the Community Atmospheric Model (CAM). In addition, a streamflow routing (RVIC) model was recently implemented in RASM to transport the freshwater flux from the land surface to the Arctic Ocean. The model domain is configured at an eddy-permitting resolution of 1/12° (or ∼9km) for the ice-ocean and 50 km for the atmosphere-land model components. It covers the entire Northern Hemisphere marine cryosphere, terrestrial drainage to the Arctic Ocean and its major inflow and outflow pathways, with optimal extension into the North Pacific / Atlantic to model the passage of cyclones into the Arctic. In addition, a 1/48° (or ∼2.4km) grid for the ice-ocean model components has been recently configured. All RASM components are coupled at high frequency (currently at 20-minute intervals) to allow realistic representation of inertial interactions among the model components.

In addition to an overview of RASM technical details, model results are presented from both fully coupled and subsets of RASM, where the atmospheric and land components are replaced with prescribed realistic atmospheric reanalysis data to evaluate model skill in representing seasonal climatology as well as interannual and multidecadal climate variability. Selected physical processes and resulting feedbacks will be discussed to emphasize the need for fully coupled climate model simulations, high model resolution and fine-tuning of many present parameterizations of sub-grid physical processes when changing model spatial resolution. We also investigate sensitivity of simulated sea ice states to scale dependence of model parameters controlling ice dynamics, thermodynamics and coupling with the atmosphere and ocean.