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Evaluating Physical Processes during the Freeze-Up Season using a Coupled Sea Ice-Ocean-Atmosphere Forecast Model

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Improved sea ice forecasting must be based on improved model representation of coupled system processes that impact the sea ice thermodynamic and dynamic state. Pertinent coupled system processes remain uncertain and include surface energy fluxes, clouds, precipitation, boundary layer structure, momentum transfer and sea-ice dynamics, interactions between large-scale circulation and local processes, and others. In this presentation, we use a fully-coupled ocean-sea ice-atmosphere forecast system as a testbed for investigating biases in 0-10 day forecasts, with a focus on processes that determine fluxes at the ocean-ice-air interface.

Model results and validation examples from an experimental, weather-scale, coupled ice-ocean-atmosphere model for 2015 and 2016 fall, sea ice freeze-up season will be presented. The model, a limited-area, fully-coupled atmosphere-ice-ocean model (named, RASM-ESRL), was developed from the larger-scale Regional Arctic System Model (RASM) architecture. RASM-ESRL includes the Weather Research and Forecasting (WRF) atmospheric model, Parallel Ocean Program (POP2) model, Community Ice Model (CICE5) and the NCAR Community Land Model. The domain is limited to the Arctic and all components are run with 10 km horizontal resolution. Components are coupled using a regionalized version of the CESM flux coupler (CPL7), which includes modifications important for resolving the sea ice pack's inertial response to transient (i.e. weather) events. The model is initialized with a GFS atmosphere, satellite-derived sea ice analyses using AMSR-2, and forced by 3-hourly GFS forecasts at the lateral boundaries.

Experimental forecasts were run daily from late-July through mid-November in 2015 and 2016. These daily forecasts have been compared with observations of surface fluxes and vertical atmospheric profiles at the International Arctic Systems for Observing the Atmosphere (IASOA) stations, and with atmospheric and oceanic observations obtained within the sea ice from measurement campaigns in 2015 (from ONR-supported SeaState cruise) and 2016 (from NOAA-supported Arctic Heat experiment). Examples of how modeled coupled processes compare to this variety of observations will be presented.