A new coupled modeling system developed for Arctic sea ice simulation and prediction

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Arctic sea ice has experienced dramatic changes for the past few decades. Recent changes in the properties of Arctic sea ice have posed significant challenges to the research community to provide sea ice predictions. To improve our capability to predict Arctic sea ice and climate, we have developed a coupled atmosphere-sea ice-ocean model configured for the Arctic with sufficient flexibility. The Los Alamos sea ice model is coupled with the Weather Research and Forecasting (WRF) Model and the Regional Ocean Modeling System (ROMS) within the Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) modeling system. A series of sensitivity experiments with different physics options have been performed to determine the ‘optimal’ physics configuration that provides reasonable simulation of Arctic sea ice.

It is well known that dynamic models used to predict Arctic sea ice at short-term periods strongly depend on model initial conditions. Thus, a data assimilation that integrates sea ice observations to generate realistic and skillful model initialization is needed to improve predictive skill of Arctic sea ice. Parallel Data Assimilation Framework has been implemented into the new modeling system to assimilate SSMIS sea ice concentration, and CyroSat-2 and SMOS sea ice thickness using a localized error subspace transform ensemble Kalman filter (LESTKF). We have conducted Arctic sea ice predictions for the melting seasons of 2017 and 2018. Predictions with improved initial sea ice states show reasonably accurate sea ice evolution and small biases in the minimum sea ice extent.

Storms-induced ocean surface waves are capable of breaking pack ice into smaller floes and changing the sea ice melting rate. We have also coupled the Simulating Wave Nearshore (SWAN) with above atmosphere-sea ice-ocean coupled system and examined the impacts of wave-ice interactions on sea ice simulation. Preliminary results suggest ocean waves have direct and indirect impacts on sea ice. Direct impacts are the fracturing of ice pack and indirect impacts the change of ocean thermo-structure through the wave breaking.