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On the Role of Arctic Sea Ice Deformations: An Evaluation of the Regional Arctic System Model Results with Observations.

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The atmosphere - sea ice - ocean fluxes and their contribution to rapid changes in the Arctic system are not well understood and generally are not resolved by global climate models (GCMs). While many significant model refinements have been made in the recent past, including the representation of sea ice rheology, surface albedo and ice-albedo feedback, other processes such as sea ice deformations, still require further studies and model advancements. Of particular potential interest here are linear kinematic features (LKFs), which control winter air-sea heat exchange and affect buoyancy forces in the ocean. Their importance in Arctic climate change, especially under an increasing first-year ice cover, is yet to be determined and their simulation requires representation of processes currently at sub-grid scale of most GCMs.

To address some of the GCM limitations and to better understand the role of LKFs in air-sea exchange we use the Regional Arctic System Model (RASM), which allows high spatio-temporal resolution and regional focus on the Arctic. RASM is a fully coupled regional climate model, developed to study dynamic and thermodynamic processes and their coupling across the atmosphere-sea ice-ocean interface. It consists of the Weather Research and Forecasting (WRF) atmospheric model, the Parallel Ocean Program (POP), the Community Ice Model (CICE) and the Variable Infiltration Capacity (VIC) land hydrology model. The sea ice component has been upgraded to the Los Alamos Community Ice Model version 5.1 (CICE5.1), which allows either Elastic-Viscous-Plastic (EVP) or a new anisotropic (EPA) rheology. RASM‘s domain is pan-Arctic, with the ocean and sea ice components configured at an eddy-permitting horizontal resolution of 1/12-degree as well as 1/48-degree, for limited simulations. The atmosphere and land model components are configured at 50-km grids. All the components are coupled at a 20-minute time step.

Results from multiple RASM simulations are analyzed and presented with different rheology options in CICE5.1 combined with varying horizontal resolution. They are inter-compared against each other and evaluated against observations with emphasis on model representation of sea ice deformations and their role in surface flux exchanges between the atmosphere, sea ice and ocean.