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Arctic Sea Ice Sensitivity to Ice Thermodynamic Formulations in a Sea Ice Model

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Abstract

We perform the sensitivity tests of Arctic sea ice to different thermodynamics components using the Los Alamos sea ice model version 5 (CICE5). The new mushy layer thermodynamics formulation (MUSHY) in which salinity evolves with time is compared to the previous thermodynamics (BL99) that assumes a fixed salinity profile. MUSHY exhibits larger simulated ice volume due to thicker ice. Comparison of the ice growth/melt rate reveals that MUSHY has the lower growth rate in cold season and the lower melt rate in warm season. The higher brine salinity in MUSHY may increase the thermal inertia of sea ice and ice temperature. Thus, the seasonal variation of sea ice volume is smaller in MUSHY. Although the change in thermodynamics formulation primarily modulate salinity and temperature of the ice, the other external processes become salient in warm season. In warm season, the lower melt rate in MUSHY is mostly due to the lower top melt rate, which originated from the more top snow volume persisting for the entire year, as well as the much less net shortwave flux and melt pond occurrence in MUSHY. The processes in warm season dominate the equilibrium ice thickness, leading to thicker ice in MUSHY.