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Effects of initialization of sea ice properties on medium-range forecasts in the Korean Integrated Model

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The Korean Integrated Model (KIM) has been in operation at Korea Meteorological Administration (KMA) since April 2020 and its forecasting performance has been improved by updating model physical processes and data assimilation system. The model performance is comparable to that of the Unified Model run in parallel with the KIM at KMA during Boreal summer, but is relatively poor during the winter. One of the major biases in 5-day temperature forecasts for Norther Hemisphere winter is the low atmospheric cold bias over the Arctic region, and thus this study modifies the initialization of sea ice properties (sea ice thickness and temperature) to reduce the bias. First, the initial sea ice thickness data prescribed by climatology data produced using reanalysis data from the past 10 years (2000~2009) is replaced using the latest (2019~2021) reanalysis data. Second, the initial temperatures of the 1st and 2nd sea ice layers are set to the sea water freezing temperature instead of the currently applied first guess (background) sea ice temperatures. The effects of initialization modification on the medium-range forecasts of KIM are analyzed by performing two sets of experiments: cold start and warm cycle experiments without and with a data assimilation system in January 2022. The latest sea ice thickness initial data shows that sea ice thickness has decreased by about a factor of two. And its adoption by KIM increases surface and lower atmospheric temperatures in the Arctic sea ice region, alleviating cold biases in the region for both analysis and forecasts. In addition to sea ice thickness, sea ice temperature initialization modifications enhance Arctic warming and lead to greater improvement of cold bias. The warming effect in the lower Arctic is consistent in both cold start and warm cycle experiments. However, secondary effects induced by the Arctic warming occur significantly only in the warm cycle experiment and significantly affect forecasts fields not only in the polar region but also in the Southern Hemisphere and mid-latitude regions. Skill scores for medium-range forecasts in January 2022 are mostly improved (degraded) for the 12 UTC (00 UTC) initial conditions in the warm cycle experiment.