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Sensitivity study on decadal prediction skill to Arctic sea ice initialization in an Earth system model with a multi-category sea ice module

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A climate forecast system needs realistic ocean-ice initial states. Some recent studies have proposed that initializing sea ice with multi-category instead of the aggregated ice state variables has potential to increase prediction skill by reducing the sea ice bias. In this study the decadal prediction skills are investigated using the climate model EC-Earth initialized with anomaly initialization for the ocean and sea ice components with a 5-category sea ice module. We introduce three methods to split the sea ice from observation into the different sea ice categories with (1) a fixed ratio of 20% among the 5 categories, (2) a weighting function or (3) a likelihood function, based on the knowledge from multi-centennial climate simulations with EC-Earth. We find that the near surface atmosphere is more sensitive to the categorized sea ice initialization in the first two years of simulations, afterwards the memory held by the ocean states play a major role. Experiments with sea ice initialized only in parts of the Arctic region are also performed to assess the relative importance of regional sea ice initialization (i.e. sea ice removal) to decadal prediction. We also present results from a case study on whether the downward turbulent heat flux or the Arctic sea ice loss takes place first, that causes severe mid-latitude winters.