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Polar climatepPredictability seasonal to multi-decadal: assessing the roles of initial conditions and boundary forcing on Arctic predictability

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The recent sharp decline in Arctic sea ice, particularly during summer months, has triggered an increase in the interest of Arctic sea ice predictability, not least driven by the potential of significant human industrial activity in the region that would benefit from such predictability. This work assesses the predictability of Arctic sea ice in a state-of-the-art GCM and considers the relative contributions to predictability by both initial value conditions and changing boundary conditions under a 'perfect model' assumption. The predictability of Arctic sea ice area and volume is estimated using both traditional measures of predictability, and relative entropy from information theory. Continuous initial value predictability of sea ice area lasts for about 1 to 2 years, whereas for volume it lasts about 3 to 4 years. There is seasonal predictability of sea ice area in the 2-4 year range which is a result of area-volume coupling in the summer season. Predictability from the forced response becomes significant for volume after about 3 years, but is only apparent in area in the 5th year of the ensemble experiments. Initial value predictability is mostly due to the distribution about the mean than from differences in the mean between ensemble and control for volume, while the opposite is true for area. Thus predictability of Arctic sea ice beyond a 3 year timescale is a boundary condition problem rather than initial-value problem.