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Seasonal predictability of the Arctic sea-ice in a coupled GCM: a diagnostic approach

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Sea ice is a major component of the climate system. It acts as an insulator and regulates exchanges between the atmosphere and the ocean in the polar regions, and influences surrounding regions, especially through freshwater transport. As it is a slow-varying medium, sea ice may represent a source of predictability on seasonal or possibly decadal time scales in the mid to high latitudes.

The main patterns of sea ice predictability are investigated in the CNRM-CM3.3 coupled Global Climate model (roughly 2° horizontal resolution). A FP6/ENSEMBLES Stream 2 400-year pre-industrial simulation of CNRM-CM3.3 is studied. Such a simulation allows us to study the intrinsic variability of climate components, in particular sea ice, in the framework of a stabilized climate, devoid of any trend. Potential predictability of the pan-Arctic sea ice area is investigated, using several predictors. We quantified the predictive capability of the sea ice area itself, the sea ice volume and some areal predictors built from the subgrid ice thickness distribution (ITD). For all months of prediction, the ice area provides a potential delay of predictability of about 3 months. Sea ice volume predictive potential appears weak for all months prediction, with the exception of the summer months, for which sea ice volume is a better predictor than the sea-ice area. Using ITD-based predictors, we highlighted two regimes of predictability. The first one, a "persistence regime", applies to the winter (FMA) sea ice area predictability. The winter sea ice cover can be predicted in late fall/early winter with the amount of young ice formed from the beginning of the freeze-up in the margins. However, none of the predictors exhibits capability better than the persistence of the sea ice area. The second regime is a "memory regime". It applies to the summer (JJAS) sea ice area predictability. An anomaly of sea ice area in August or September is potentially predictable using the area covered by ice thicker than 0.9 – 1.5m up to 6 months in advance with good confidence. These results provide an insight into the importance of the thickness initialization for winter-spring to summer sea ice predictions, and also into the advantage of using multi-category sea ice models in coupled climate models.