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Improving daily-to-seasonal sea ice forecasts of the AWI coupled prediction system with sea-ice and ocean data assimilation and atmospheric large-scale wind nudging.

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Predictive skills of coupled sea-ice/ocean and atmosphere models are limited by the chaotic nature of the atmosphere. Assimilation of observational information on ocean hydrography and sea ice allows to obtain a coupled-system state that provides a basis for subseasonal-to-seasonal ocean and sea-ice forecast (Mu et al., 2022). However, if the atmosphere is not additionally constrained, the quasi-random atmospheric states within an ensemble forecast lead to a fast divergence of the ocean and sea-ice states, degrading the system's performance with respect to the sea ice forecasts. As reported previously, imposing an additional constraint by nudging large-scale winds to the ERA5 reanalysis data (Sánchez-Benítez et al., 2021; Athanase et al., 2022) improves predictive skills of the AWI Coupled Prediction System (AWI-CPS, Mu et al. 2022) with regard to sea ice drift (Losa et al., 2023). Here we provide results based on a much more extensive set of ensemble-based data assimilation experiments spanning the time period from 2002 to 2023 and a series of long forecast experiments over 2010 – 2023, initialized in four different seasons. We compare the performance of forecasts initialized from two sets of data assimilation experiments, with and without atmospheric wind nudging. The additional relaxation of the large-scale atmospheric circulation to the ERA5 reanalysis data for the initialization leads to reasonable atmospheric forecast skill on weather timescales: Despite the simple technique, the coarse resolution compared to NWP systems, and the limited optimization efforts, 10-day forecasts of the 500 hPa geopotential height are about as skillful as the best performing NWP forecasts were about 10 –15 years ago. Among other aspects, this leads to significantly improved subseasonal-to-seasonal sea-ice concentration and thickness forecasts.

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