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Impact of the atmospheric circulation on the Arctic snow cover and ice thickness variability

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The Arctic sea ice cover and thickness have significantly declined since the 1970s, while exhibiting large interannual variability. Snow cover on sea ice, acting as an insulating barrier, was shown to be instrumental in driving the variability and trends in sea-ice thickness. Yet, the Arctic snow depth remains scarcely measured and overlooked in climate models, which translates to “very limited predictive skill” according to the IPCC (Special Report on the Ocean and Cryosphere in a Changing Climate). Moreover, sea-ice thickness initialization has been shown to be an important element for skilful sea-ice forecasts, and it appears plausible that the same holds for the snow layer on top.

Here, we investigate the role of atmospheric circulation anomalies in shaping the Arctic snow-cover and sea-ice thickness anomalies. In this preparatory work, spectral nudging of the large-scale atmospheric circulation towards ERA5 reanalysis data is applied to the fully coupled AWI Climate Model (AWI-CM-3). We examine the variability and trends of Arctic snowfall, snow depth, sea ice cover and thickness over a 42-year period (1979-2021), and in particular the reproduction of observed anomalies. Two nudging configurations are used, differing in strength by their relaxation timescale τ and spectral truncation wavenumber T (namely τ=24 h, T20 and τ=1 h, T159). We demonstrate the importance of atmospheric circulation anomalies in shaping variations of snow and ice thickness at sub-seasonal to interannual scales, and discuss the potential of spectral nudging as a tool to improve the initialization of sea ice forecasts.