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Dynamical response of the Arctic atmospheric boundary layer to sea ice in Polar WRF model

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Impact of sea ice concentration (SIC) on the Arctic atmospheric boundary layer (ABL) is investigated using a Polar-optimized version of the Weather Research and Forecasting (Polar WRF) model. A detailed comparison of the simulations forced with various SIC datasets to historical ship and ice station based data are presented demonstrating the reasonable representation of the observed ABL evolution by the Polar WRF. Further, two dynamically distinctive effects of sea ice on the surface wind were found, which act on different spatial scales. Reduced SIC lowers ABL stability, thereby increasing surface wind (W10) speeds. The spatial scale of this response is comparable to the basin-scale of the SIC difference. In contrast, near-surface geostrophic wind (Wg) shows a strong response in the MIZ, where, a good spatial correspondence exists among the Laplacian of the sea level pressure (SLP), the surface wind convergence, and the vertical motion within the ABL. This indicates that SIC affects Wg through variation in SLP but on a much narrower scale. Larger-amplitude and broader-scale response in W10 implies that surface wind stress derived from Wg to drive ice-ocean models may not fully reflect the effect of SIC changes.