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Evaluation of the Arctic sea-ice drift and its dependence on near-surface wind and sea-ice concentration in a coupled regional climate model

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We evaluate the Arctic sea-ice drift speed and its dependency on near-surface wind and sea-ice concentration during 2003-2014 in the coupled regional model HIRHAM-NAOSIM (Dorn et al., 2018). As observational/reanalysis data, we use 10-meter wind speed from ERA-Interim, NSIDC bootstrap sea-ice concentrations, and KIMURA ice drift data (Kimura et al., 2013). We focus our study on the month of minimum and maximum sea-ice extent, namely September and March. Both the observational/reanalysis data and the model show that the sea-ice drift speed increases with increasing near-surface wind speed. Further, the wind factor (ratio between sea-ice drift speed and wind speed) decreases with increasing wind speed. In the observational data, the increase of the ice drift with increasing wind speed is stronger when the wind speed passes a threshold (ca. 4 m/s), compared to lower wind speed classes. In the model, however, the response of the ice drift speed to the wind speed is generally linear and stronger than in observations. Statistically, the observations show no clear dependency of sea-ice drift speed on sea-ice concentration in September, while in March, the high-concentration (>90%) sea ice shows a lower drift speed compared to lower-concentration ice. In the model, however, sea ice with higher concentration has significantly lower median sea-ice drift speed when the concentration is larger than 30%, both in September and March. Meanwhile, the model overestimates the occurrences of low-concentration sea ice in March. A sensitivity experiment with respect to an improved parameterization of the transfer coefficients for momentum and heat over sea ice (Lüpkes and Gryanik, 2015) has been performed. Compared to the control simulation, the decrease of sea-ice drift speed with increasing sea-ice concentration is stronger. This is because the new parameterization changes the drag coefficient between air and sea ice differently depending on the sea-ice concentration; the drag coefficient over low-concentration sea ice is mostly affected (increased). The results show a pronounced impact on e.g. surface turbulent fluxes, sea-ice drift speed and wind factor over the whole Arctic domain, but this does not mean an overall model improvement.

References

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