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Importance of variable neutral drag coefficients for ocean-ice and air-ice fluxes in polar regions

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Sea ice features a variety of obstacles to the flow of air and seawater at its top and bottom surfaces. Sea ice ridges, floe edges, ice surface roughness and melt ponds, lead to a form drag that interacts dynamically with the air-ice and ocean-ice fluxes of heat and momentum. In most climate models, surface fluxes of heat and momentum are calculated by bulk formulas using constant drag coefficients over sea ice, to reflect the mean surface roughness of the interfaces with the atmosphere and ocean. However, such constant drag coefficients do not account for the subgrid-scale variability of the sea ice surface roughness. To study the effect of form drag over sea ice on air-ice-ocean fluxes, we have implemented a formulation that estimates drag coefficients in ice-covered areas comprising the effect of sea ice ridges, floe edges and melt ponds, and ice surface skin (Tsamados et al., 2013) into the NEMO3.6-LIM3 global coupled ice-ocean model. In this work, we thoroughly analyse the impacts of this improvement on the model performance in both the Arctic and Antarctic. A particular attention is paid to the influence of this modification on the air-ice-ocean fluxes of heat and momentum, and the characteristics of the oceanic surface layers. We also formulate an assessment of the importance of variable drag coefficients over sea ice for the climate modelling community.