Geophysical Research Abstracts
Vol. 17, EGU2015-4636, 2015
EGU General Assembly 2015

Changing summer sea ice roughness modifies momentum transfer into the Arctic Ocean

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The current shrinking of Arctic sea ice affects the transfer of momentum from the atmosphere into the ocean. While in winter a thinner and thus weaker sea ice cover enables a greater ocean surface stress than in previous decades, the enormous retreat of sea ice in recent summers reduced the surface roughness of the Arctic Ocean and hence causes a negative ocean surface stress trend in this season. The latter is related to a generally enhanced surface drag in the presence of sea ice. Martin et al. (2014, JGR) suggested that such amplification of momentum transfer by ice floes peaks at an optimal ice concentration of 80-90%—since higher concentrations damp momentum transfer due to ice internal stresses. However, this model study only considered a constant sea ice roughness in the calculation of the surface stress. Tsamados et al. (2014, JPO) recently implemented complex variable sea-ice drag coefficients into the sea ice model CICE also distinguishing between skin and form drag. They showed in stand-alone sea ice simulations that varying sea ice roughness due to, amongst others, pressure ridges and floe edges significantly impacts sea ice motion likely with implications for the ocean circulation underneath.

Here, we present the effect of variable sea ice drag on the ocean surface stress. A comparison of the CICE results with Martin et al. (2014, JGR) shows that on basin-wide average the ice concentration–ocean stress relationship still peaks at about 80-90% but stress increases more rapidly with increasing ice concentration forming a “plateau” at 40-70%. We find that pressure ridges contribute more to the 80-90% peak whereas floe edges and skin drag shape the plateau. Further, Tsamados et al. (2014, JPO) found for the summer season that floe edges dominate the ice-water drag magnitude and that an increase in the floe edge form drag dominates the overall ice-water drag trend over the past two decades. This hints at the possibility that a favorable floe size distribution associated with loose ice conditions may compensate the negative effect of increased ice-free areas on the basin-wide mean surface drag. To learn more about the consequences on ocean surface stress trends come to this presentation.