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Grease ice parameterisation in sea-ice ocean models

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The first ice formation in Arctic and Antarctic waters is often grease ice, a mixture of sea water and frazil ice crystals. Grease ice thus creates a gradual transition between water and solid ice, a transition previously not resolved in sea-ice ocean models. A simple way of modelling grease ice in large scale models is suggested here, capturing the basic grease ice properties: a surface temperature at the freezing point, a $\sim$25 % volume concentration of frazil ice, and a wind and current dependant grease ice thickness.

The open water heat loss governs the grease ice production, and the transition to a solid sea ice cover follows gradually over the next day when $\sim$50 % of the model grease ice area forms pancake ice. The new grease ice parameterisation delays the transition from open water to a solid ice cover, increasing ocean-to-air heat fluxes during freezing conditions.

A basic version of the grease ice parametrisation is tested in a column model showing that during mean winter Arctic conditions changes are moderate and heat fluxes increase by $\sim$1 W/m^2. Additional stronger heat fluxes are produced by the new parameterisation under significant ice divergence, such as in a polynya, or for large initial open water areas. As the effect of implementing grease ice becomes stronger with larger open water areas, it will have a significant impact on the freeze-up conditions in the simulations of the recent retreat of Arctic summer sea ice. The grease ice parameterisation may thus provide a negative feedback for the recent ice loss and contribute to a more robust model ice cover for both Arctic and Antarctic oceans.