A new bulk flux algorithm to predict turbulent surface fluxes over summer sea ice and the marginal ice zone

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Summer sea ice in the Arctic shares morphological features with any marginal ice zone: Both surfaces are a mix of ice and open water. Though this diverse texture makes these surfaces appear heterogeneous, the vertical ice faces associated with the open water make the surface more aerodynamically homogeneous than compact, snow-covered winter sea ice. Here, we establish this conclusion with eddy-covariance data from SHEBA, the experiment to study the Surface Heat Budget of the Arctic Ocean. The homogenization is likely a consequence of form drag induced by the vertical ice surfaces. We also merge our SHEBA summer data, which represents sea ice in concentrations between 60 and 100%, with several data sets collected in marginal ice zones, where ice concentrations ranged from 0 to 95%, to develop a single parameterization for the drag coefficient over mixed ice and water surfaces. The only independent variable in this parameterization is ice concentration. We also use our SHEBA flux data to refine an algorithm for predicting the turbulent fluxes of sensible and latent heat over summer sea ice and the marginal ice zone. Our ultimate product is a bulk flux algorithm that provides a unified approach to estimating the turbulent surface fluxes in any sea ice region that features a significant concentration of open water.