Geophysical Research Abstracts
Vol. 20, EGU2018-2942, 2018
EGU General Assembly 2018

A new bulk parametrization of turbulent fluxes in the stably stratified surface layer over sea ice for climate models

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In climate and weather prediction models the near-surface turbulent fluxes of heat and momentum and related transfer coefficients are parametrized on the basis of Monin Obukhov similarity theory (MOST). Its application requires an iterative solution of the MOST equations. To avoid this iteration many models determine the transfer coefficients using the Louis method which relates the stability parameter z/L (L is the Obukhov length and z is height) to the bulk Richardson (Rib) number. However, the presently used methods are valid only for larger surface roughness and weaker stability than observed over the polar oceans. In contrast to the popular methods of polynomial fitting we propose an approximate solution of the MOST equations that results in z/L as a function of Rib and of the surface roughness. As an example of our general approach (Gryanik and Lüpkes, 2017) we use stability functions based on SHEBA data (suggested by Grachev et al., 2007). Bulk transfer coefficients for momentum and heat are obtained without iteration depending on stability and surface roughness. These coefficients reproduce the coefficients obtained by the classical, iteration based solution of the MOST equations with a mean accuracy of 5 % for Rib between 0 and 0.3 for a large range of surface roughness. At large Rib the new bulk transfer coefficients are much smaller than those currently used. The new non-iterative parametrization can be easily implemented in climate and weather forecast models. Finally, the impact of other stability functions is discussed.

References:
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Gryanik, V.M. and Lüpkes C. (2017) An Efficient Non-iterative Bulk Parametrization of Surface Fluxes for Stable Atmospheric Conditions Over Polar Sea-Ice,Boundary-Layer Meteorol, DOI 10.1007/s10546-017-0302-x