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Air- ice-snow interaction in the Northern Hemisphere under different stability conditions

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The traditional parameterizations of the atmospheric boundary layer are based on similarity theory and the coefficients of turbulent transfer, describing the atmospheric-surface interaction and the diffusion of impurities in the operational models of air pollution, weather forecasting and climate change. Major drawbacks of these parameterizations is that they are not applicable for the extreme conditions of stratification and currents over complex surfaces (such as sea ice, marginal ice zone or stormy sea). These problem could not be overcome within the framework of classical theory, i.e, by rectifying similarity functions or through the introduction of amendments to the traditional turbulent closure schemes. Lack of knowledge on the structure of the surface air layer and the exchange of momentum, heat and moisture between the rippling water surface and the atmosphere at different atmospheric stratifications is at present the major obstacle which impede proper functioning of the operational global and regional weather prediction models and expert models of climate and climate change. This is especially important for the polar regions, where in winter time the development of strong stable boundary layer in the presence of polynyas and leads usually occur.

Experimental studies of atmosphere-ice-snow interaction under different stability conditions are presented. Strong stable and unstable conditions are discussed. Parametrizations of turbulent heat and gas exchange at the atmosphere ocean interface are developed. The dependence of the exchange coefficients and aerodynamic roughness on the atmospheric stratification over the snow and ice surface is experimentally confirmed. The drag coefficient is reduced with increasing stability. The behavior of the roughness parameter is simple. This result was obtained in the Arctic from the measurements over hummocked surface. The value of the roughness in the Arctic is much less than that observed over the snow in the middle and even high latitudes of the Northern Hemisphere because the stable conditions above Arctic ice field dominate. Under such conditions the air flow over the uneven surface behaves in the way it does over the even one. This happens because depressions between ridges are filled with heavier air up to the height of irregularities. As a result, the air moves at the level of ridges without entering depressions. Increased heat and mass transfer over polynyas and leads through self-organization of turbulent convection is found. The work was sponsored by RFBR grants and funded by the Government of the Russian Federation grants.