Geophysical Research Abstracts
Vol. 16, EGU2014-2255, 2014
EGU General Assembly 2014

Air-surface interaction processes in the polar and sub-polar regions under stable condition

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Stable atmospheric boundary layer investigations are important for monitoring atmospheric pollution and biogeochemical cycle. This is especially important for the northern regions, where stable boundary layer with strong inversion is typical for winter time.Transfers of heat, gas and momentum under strongly stable conditions in the atmospheric boundary layer have been studied through measurements of the turbulent fluctuations and vertical mean profiles of wind velocity and air temperature in the northern part of the Russia. As the local gradient Richardson number increases, intermittent turbulence appears, especially in temperature fluctuations. The ratio of the eddy conductivity to the eddy viscosity decreases with increasing Richardson number and tends to zero at high stabilities. Radiative effects are greatest above the boundary layer where large gradient Richardson numbers are generated. Consequently, turbulence in this region decays rapidly after transition, while in the absence of such effects a much slower decay occurs. The structure and evolution of the marine boundary layer above the pack ice is described. A stable layer, 300–1700 m high, grew in height proportionally to the square root of the distance from the ice edge, the fetch, up to 3000 km. After 400 km, a mixed layer formed, typically 100–250 m thick, related to the presence of low level jets in 60–90% of the profiles. The influence of thermal stability at the air-surface interface on computed values of the transfer velocities of trace gases is examined. New transfer velocity coefficients are suggested that bring the low wind speed results into better agreement with observations and other models. The calculations described here suggests that gas exchange with the atmosphere is sensitive to thermal stability at the air-surface interface. This specific, turbulence-related geophysical forcing may account for a portion of the observed scatter in previously obtained experimental data that has been correlated with wind speed alone. The work was sponsored by RFBR grants 14-05-00038, 13-05-41443.