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Study of low-level jets based on a single-column model

Agnieszka Czerwinska (1) and Zbigniew Sorbjan (1,2)

(1) Institute of Geophysics PAS, Atmospheric Physics, Warsaw, Poland (aczerwinska@igf.edu.pl), (2) Department of Physics, Marquette University, Milwaukee, WI 53201-1881, USA

We present a study of low-level jets in the stable boundary layer using a single column model. Parametrization of turbulence within the model is based on the K-theory approach, with empirical functions of the Richardson number, evaluated by using the data collected during the Surface Heat Budget of the Arctic Ocean (SHEBA) experiment, and a semi-empirical form of the mixing length. Effects of the geostrophic wind velocity, cooling rate, baroclinicity, roughness, and the Coriolis parameters on low-level jets are investigated in the study. The results of the numerical simulations are compared with the wind profiles observed in the atmosphere over the U.S. Great Plains, using high-resolution Doppler lidar. This area is known of the presence of low-level jets and high wind energy potential.

The results show that the most influential parameters controlling the height and strength of low-level jets are the geostrophic wind velocity G, cooling rate Cr, roughness parameter zo, and baroclinity parameter Ty. The Coriolis parameter f, and baroclinity parameter Tx affect the shape of the wind profiles.

Referring to the three types of the wind profiles identified by Pichugina and Banta, we conclude that the ascending profiles of type III and descending profiles of type I of the wind velocity are most likely caused by baroclinicity effects.