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The atmospheric boundary layer (ABL) is the transitional layer between the surface of different roughness (e.g. earth, water, ice, etc.) and the rest of the capping atmosphere. Life on Earth occurs mostly in boundary layers. Needless to say, the knowledge, better understanding and proper model description of different kinds of processes occurring within the ABL is the crucial objective of meso-meteorology. Regardless the fact that during the last 10-15 years detailed observational databases have been created and substantial progress in computer technology has been reached, the numerical simulation and forecast of the state of ABL and its characteristics still meet serious uncertainties and failures. For example, handling of rapid surface cooling and over-diffusion of the ABL are certain and common problems for most of climate and mesoscale models. These difficulties arise even more obvious in representation of the stable (SABL) and very stable (VSABL) atmospheric boundary layers, in which smaller eddies play significant roles. In contrast, the convective boundary layer (CABL) is determined by large scale turbulent eddies, which properties are reasonably well simulated in numerical models. Side by side with the CABL, the nature and behavior of the SABL, in space and time, is still not understood adequately.

Typically, the model vertical resolution in the lowest atmosphere is not satisfactory for illuminating the evolution of SABL which is usually a thin layer, sometimes extending to only a few tens meters. An improved description of the "z-less" mixing length for parameterization of turbulence length scale in the SABL is proposed in this work. The new mixing length-scale scheme is based on the turbulent kinetic energy equation and explicitly includes the vertical shear of horizontal wind [2, 5, 6]. The verification of obtained solutions is performed by intercomparison of two models. The first is the MIUU mesoscale model, which is a 3D fully nonlinear numerical model with a reliable higher order turbulence parameterization scheme [1,2]. The other is the analytical 1D model with a prescribed gradually varying vertical eddy diffusivity/conductivity profile, i.e. the modified Prandtl model [3,4]. As the simulation results showed, a newly proposed local generalized “z–less” mixing length scale scheme obviously repairs a large part of the over-diffusion problem. For example, the permanent katabatic flow over cooled sloped terrain, which is usually absent in over-diffused SABL (VSABL), is clearly seen in vertical profiles of the downslope wind components computed with the proposed mixing length-scale. The possible inclusion of generalized “z–less” mixing length scale to turbulence closure schemes between 1st and 2nd order for the VSABL are also suggested.

Tentative simulations of pure katabatic flows using the newly proposed mixing length scale display promising results. The scheme can be implemented and tested in current numerical weather prediction models after testing with detailed observational databases.

References

1. *Enger, L. and B. Grisogono*, (1998) The response of bora-type flow to sea surface temperature. Quart. J. Roy. Meteorol. Soc. **124**, 1227–1244.

2. *Grisogono, B. and D. Belušić*, (2009) Improving mixing length-scale for stable boundary layers. Quart. J. Roy. Meteorol. Soc. **134**, 2185–2192.

3. *Grisogono, B., A. Jeričević and L. Kraljević*, (2007) The low-level katabatic jet height versus Monin-Obukhov height. Quart. J. Roy. Meteorol. Soc. **133**, 2133–2136.

4. *Kavčič, I. and B. Grisogono*, (2007) Katabatic flow with Coriolis effect and gradually varying eddy diffusivity. Boundary-Layer Meteorol. **125**, 377–387.

5. *Mauritsen, T., G. Svensson, S. Zilitinkevich, I. Esau, L. Enger and B. Grisogono*, (2007) A total turbulent energy closure model for neutrally and stably stratified atmospheric boundary layers. J. Atmos. Sci. **64**, 4113–4126.

6. *Zilitinkevich, S., T. Elperin, N. Kleeorin, I. Rogachevskii, I. Essau, T. Mauritsen and M.W. Miles*, (2008) Turbulence energetics in stably stratified geophysical flows: strong and weak mixing regimes. Quart. J. Roy. Meteorol. Soc. **134**, 793–799.