

On turbulence closure problem for geophysical stably stratified flows

S. S. Zilitinkevich (1,2,3), T. Elperin (4), N. Kleerorin (4), I. Rogachevskii (4), I. Esau (2), and T. Mauritsen (5)

(1) Division of Atmospheric Sciences, University of Helsinki, Finland, (2) Nansen Environmental and Remote Sensing Centre / Bjerknes Centre for Climate Research, Bergen, Norway, (3) Finnish Meteorological Institute, Helsinki, Finland, (4) Department of Mechanical Engineering, Ben-Gurion University of the Negev, Beer-Sheva, Israel, (5) Department of Meteorology, Stockholm University, Sweden

There is a world-wide opinion that at Richardson number, Ri , larger than some critical value the velocity shear becomes insufficient to maintain turbulence. The budget equation for the turbulent kinetic energy (TKE) used solely seemingly supports this conclusion. In this paper we consider, besides the TKE, the turbulent potential energy (TPE) and the turbulent total energy ($TTE=TKE+TPE$), derive their budget equations, and demonstrate that sheared flows can be turbulent at any Ri . These results, confirmed by experimental and numerical-simulation data, disapprove the concept of critical Ri . The TTE budget equation together with refined flux-budget equations are used to develop a new hierarchy of turbulence closure schemes applicable to the whole range of stably stratified flows in the atmosphere and hydrosphere.