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On the helicity estimation in the atmospheric boundary layer

Natalia Victorovna Vazaeva (1), Valeriy Feodosevich Kramar (1), Rostislav Dmitrievich Kouznetsov (1), Vasily Sergeevich Lyulyukin (1), Otto Guramovich Chkhetiani (1,2)

(1) A.M. Obukhov Institute of Atmospheric Physics, Russian Academy of Science, Moscow, Russian Federation (ifanataly@gmail.com, vkramar@list.ru, roux@ifaran.ru, lyulyukin@gmail.com, ochkheti@gmail.com), (2) Space Research Institute, Russian Academy of Science, Moscow, Russian Federation (ochkheti@gmail.com)

Large-scale motions in the atmospheric boundary layer (ABL) are sustained by the cooperative effect of friction and Earth rotation. This flows have a non-zero helicity [1,2]. Consequently, turbulence in the ABL is also characterize by the non-zero helicity [3]. This property has been observed in the atmospheric experiments [4] and the DNS modeling [5]. The role of helicity in the atmospheric and ocean large-scale dynamics and its possible prognostics sense attracts permanent interest.

The purpose of the present investigation is to determine the helicity in terms of experimental data and to check the possibility of the ABL helicity estimation. The integral helicity in the Ekman layer is given by

$_0\int^{\infty} \mathrm{H} = \mathrm{U}_G^2 + \mathrm{V}_G^2$ [1],

where U_G^2, V_G^2 is the geostrophic wind velocity component.

The ABL acoustic sounding experiment data obtained in expeditions of the A.M. Obukhov Institute of Atmospheric Physics in the arid-steppe zone of the South of Russia in the Chernozemelski district of Kalmykia (2007) [6] and in the Tsimlyansk (the Rostov region) (2012), enabling to get the wind profiles at heights of 400 to 800 m with resolution of 10-30 m and timing interval of 5-10 sec have been applied.

The helicity horizontal components would dominate in the total ABL helicity under ordinary conditions. It is also true for the turbulent data. The mean value for the large-scale motions helicity density were obtained (0.3-0.6 m/sec^2), an order of magnitude greater than its independently measured turbulent value [4,7].

Note that there are the significantly higher values of helicity during the nocturnal low-level jet events.

The layer average helicity in the ABL is close to the theoretical and empirical estimates of turbulent helicity and is equal to about 0.02-0.12 m/sec^2.

There is a good correlation between the integral helicity with the square of the wind velocity on the higher sounding levels (400-800 m) in slightly unstable or neutral stratification conditions. This fact allows to use the geostrophic wind data to build the regional and global helicity fields.

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