The predicted quantitative relations between the thermal stratification, wind shear and turbulence parameters

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The fields of the wind, temperature, specific humidity and the geopotential on the basic isobaric surfaces, as well as TKE, dissipation rate and turbulence coefficients are predicted in the numerical operational forecasting system of Hydro-meteorological Centre of Russia. The numerical algorithm given in /1/ are used The prediction was carried out for Northern hemisphere using 75km horizontal step and bottom 3-km layer handling the vertical steps of 50m. The initial information is obtained from the objective analysis at 0000UTC 27 June 2010 /2/.

The vertical distribution of meteorological variables and turbulence parameters in two selected points for Moscow (55.8 N, 37.6 E) and Landeck (46.5 N, 10.3 E) which are located in hilly (217m) and mountainous (2444m) areas are represented. The two-day forecasting results given reconstructed the quantitative relations between the thermal stratification, wind shear and turbulence parameters.

The short- term forecasting reconstructed the quantitative relations between the thermal stratification, wind shear and turbulence parameters in the hilly and mountainous areas. At day hours the same meteorological conditions defined the turbulence intensity in both areas. The strong turbulence is predicted from 10m to 1400m with the maximal gradient 60 m^2/s when the potential temperature gradient was less than –0. 02 deg/100m, and wind module vertical derivatives were small. The strong unstable stratification is a dominant mechanism of the intensive turbulent mixing.In the mountainous area at the nighttime the turbulence is missing when the potential Temperature vertical gradient is more than 0,2 K/100m and the module wind vertical derivative is less than 0.2m/s/100m. The comparison of the meteorological conditions of the turbulence structure in night hours showed that in the mountainous area the turbulence disappeared when the thermal stable stratification is less intensive than in hilly area but the main forcing mechanism remains the influence of stable stratification.In the hilly area the turbulence missing at the nighttime when the potential temperature vertical gradient is more than 0,5 K/100m and the module wind vertical one is less than 0.2m/s/100m. But above the strong stable stratified lowest layer of the 500m height the turbulence coefficient is more than 1 m^2/s in the layer from 500m to 1500m with

the maximum of 4 m^2/s -23 m^2/s on 700-800m when potential temperature vertical gradient is less 0.5 K /100m and the wind module derivative is more than 1m/s/100m.

The large-eddy simulation studies showed that during late afternoon and early morning (the transition periods) the decoupled residual layer, where turbulence is still active, developed above the stably stratified lower part of boundary layer /3/. In a concerted effort to learn more, the project is gathering the scientists from the European Union and the United States to work on this issue and to make observations for better understanding the physical processes that control the role of this transition in the turbulence structure /4/.

This study reveals the transition time of the turbulence activity development. It confirms the existence of residual turbulent layers and gives the quantities description of meteorological variables and turbulence parameters in these layers.

The results obtained allowed to estimate the horizontal distribution of the turbulence parameters. As an example the maximal vertical coefficients represented the turbulence strength at 1200UTC of 27/06 and 28/06 are given below for different latitudes and longitudes.

65-61N 1- 55 m^2/s^2, 0-42E.

61-56N 5-25 m^2/s^2, 0-8E 26 m^2/s^2 -55 m^2/s^2, 9-42E.

56-51N 30 m^2/s^2 - 5 m^2/s^2, 0-25E, 6 m^2/s^2 - 47 m^2/s^2, 26-42E.

51-46N, 18-35 m^2/s^2, 0-22E, 36 -56 m^2/s^2, 23-42E.

46-42N, 21-45 m^2/s^2, 0-18E, 46-57 m^2/s^2, 19-42E.

65-61N, less than 1 m^2/s^2, 0-10E, 1-65 m^2/s^2, 11-42 E.

61-56N, 45 m^2/s^2 -25 m^2/s^2,0-8 E, 26 m^2/s^2 -55 m^2/s^2. 9-42 E.

56-51N, 30 m^2/s^2 -5 m^2/s^2, 0-25 E, 6 m^2/s^2 -47 m^2/s^2, 26-42 E.

51-46N, less than 1 m^2/s^2, 0-11 E, 1-33 m^2/s^2, 12-22 E, 32-8 m^2/s^2, 23-32 E, 9 m^2/s^2 -34 m^2/s^2, 33-42 E.

46-42N, 30-1 m^2/s^2, 0-10 E, 2-53 m^2/s^2, 12-36 E, 52-28 m^2/s^2, 37-42 E.

At the noon the maximal turbulence coefficient had the large diversity. Its values got 65 m^2/s^2. At the night the turbulence is missing in the most points of calculation net. But the turbulence coefficients got 5-10 m^2/s^2 in the points where the predicted coefficients in noon were more than 50 m^2/s^2. It's related with the existence of the residual above the strong stable stratification.

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