Surface wind prediction by the boundary layer model

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The reliable surface wind prediction plays an important role in the meteorological service of the atmospheric pollution, take off and landing of the airplanes.

The most of operational schemes of surface wind prediction apply the models of surface layer based on the Monin-Obukhov similarity theory which uses the set of constrictions and empirical formulas. It reduces the quality of the forecasts.

The distinguishing feature of the approach used in Russian Hydro-meteorological Center (RHMC) is refusal of the surface layer separation and spreading the algorithm of the advanced atmospheric boundary layer (ABL) model (Shnaydman and Berkovich) to entire calculation area from the underlying surface to the top of ABL with the lower no-slip vertical condition on the level of roughness. It allowed to calculate the characteristics of the surface layer by taking into account the main physical mechanisms of space distribution of turbulence parameters and meteorological variables including the surface wind on the level of 10m.

The prediction of the surface wind was carried out by Forecasting System of RHMC which combine the scheme of forecasting the large scale atmospheric processes and the ABL formation. Here it was shown the results of near surface transfer reconstruction for the Europe, where the dense meteorological network and advanced ABL model gave the possibility of wind reconstruction with the good comparison of the predictions and objective analysis (OA) data. The comparisons done (non published results) showed that the wind measurements and OA data were close if the forecasting scheme had the horizontal resolution by the order of mean distance between the meteorological stations.

The brief description of the transfer near the underlying surface for Europe is given for 00 UTC 12 April 2005. The main peculiarities of the near surface transfer were the flows from west to east in the belt 70-75N, from south and south-west to north and north-east from 52-70N one. The wind between the lines connecting the points 57N and 70N at the west boundary, 42N and 59N at the east boundary got 12m/s. This zone was the most evidently expressed during the initial 12 hours. Then it weakened and shifted to the north as far as the prediction period increased to 36 hours.

The comparisons of the predictions and OA data were given by the mapping of the module and direction surface winds, the table of errors and the correlation coefficients. The predicted fields of surface wind represented the main straits of actual horizontal distributions of the module and direction of the near surface transfer. The predicted wind directions were in good agreement with the OA data especially in the areas where the wind speed is more than 2m/s.

The wind direction error was 4 deg and the coefficient of correlation was equal 0.84 for entire calculation area when the prediction time period was 24 hour. The best accuracy of module wind was got in the areas where the wind velocity was more than 4m/s. But for the entire calculation domain the prediction accuracy was high too: the error was 0.32m/s and the correlation coefficient was 0.88 when the prediction time period was 24 hour.

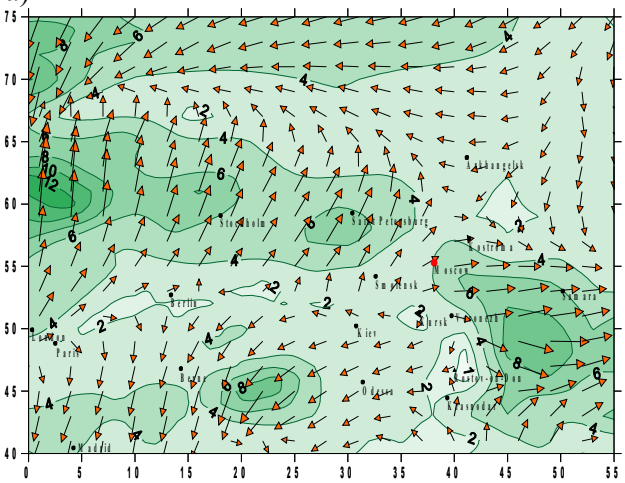
So small errors for the surface wind prediction are an achievement of atmospheric boundary layer modeling in the numerical prediction operations conducted for the operational meteorological service.

Time period of prediction	Absolute error	Relative error	Correlation coefficient

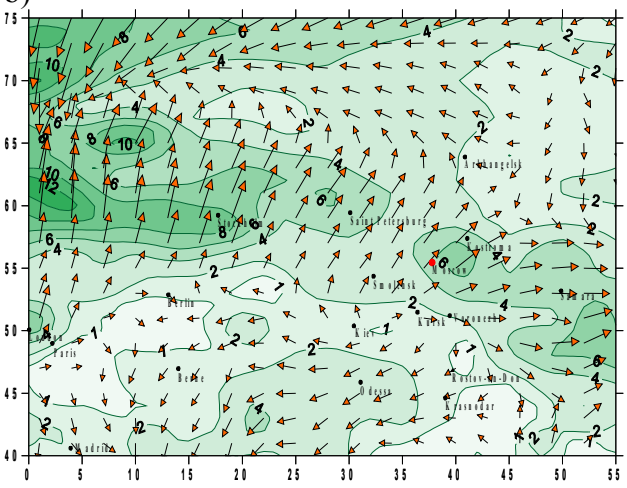
Module of surface wind			
12 h 24 h 36 h	0,77 m/s 0,32 m/s 0,97m/s	0,86 0,48 0,57	0,69 0,88 0,89
Direction of surface wind			
12 h 24 h 36 h	3 deg 4 deg 11deg	0,16 0,16 0,26	0,64 0,84 0,69

12-hour prediction (a) and objective analysis (b) data of surface wind

a)

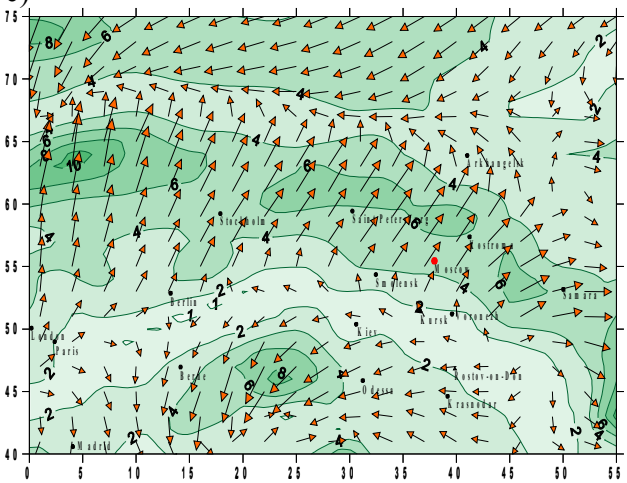


b)

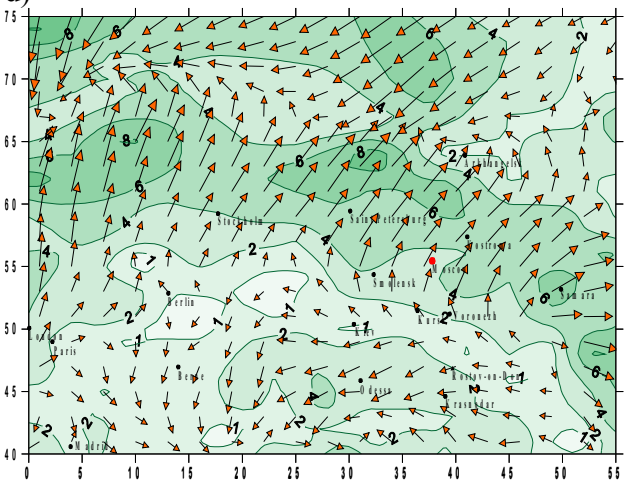


24-hour prediction (c) and objective analysis (d) data of surface wind

c)



d)



References

Shnaydman, V., Berkovitch, L.,2006: Atmospheric Boundary Layer Modeling in the Numerical Prediction Operations, Research Activity in Atmospheric and Oceanic Modeling, No 36, 5.57-5.58