The modeling of dynamics of centimeter radio waves refraction index in bottom layer of atmosphere in East European area of Russia with using WRF model

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The Weather Research and Forecasting (WRF) Model is a next-generation mesocale numerical weather prediction system. The effort to develop WRF has been a collaborative partnership, principally among the National Center for Atmospheric Research (NCAR), the National Centers for Environmental Prediction (NCEP) and others. The model is open to general use for scientific purposes [1]. The model gives ample capabilities for three-dimensional modeling of dynamics of meteorological parameters in bottom layer of atmosphere (up to altitudes of the order of 20 km.). The wide spectrum of modes of a parametrization of various atmospheric physical processes (microphysics, transport processes, interaction terms with ground surface, etc.) is built in model. The model is in persistent development, the new possibilities are added in it and so on. WRF is suitable for a broad spectrum of applications. It is possible to use the model as for research of experimental outcomes and for prediction of a meteorological situation.

On the basis of WRF model have been explored the mesoscale meteorological processes in East European area of Russia (the centre of area is point of 51deg. e. long., 55.6deg. n. lat., the dimension of area is 300km x 200 km). Atmospheric dynamics was modeled for the real geographical region in view of the relief, the type of the underlaying surface, daily variations, microphysics processes (phase changes, cloudiness, etc.). The modeling was made for actual meteorological situation. The outcomes of the final analysis of global atmospheric model operation (EMC Model [2]) were used as initial and boundary conditions. These data are submitted by national centre of atmospheric examinations of the USA. The data are in the open access [3]. The outcomes of our modeling include the dynamics of the inhomogeneous 3-D fields of wind velocity, temperature, moistures (including phase states), etc.

We have available the long-term series (9 years) of every minute measurements of a meteorological situation (wind velocity, pressure, temperature, humidity) at the set of stations in area of modeling. On the basis of these data we have yielded examination of modeling outcomes to adequacy to actual observations.

The gained outcomes of modeling submitive the ample opportunities for detailed space-time researching of the lower aerosphere. On basis of these we had been gained the three-dimensional maps of centimeter radio waves refraction index n. In the elementary case the following equation [4] may be used (T is temperature (K), P is air partial pressure (mbar), e is moisture partial pressure (mbar)):

$$n = \left(\frac{155.2 \cdot 10^{-6}\ P}{T} + \frac{7.45 \cdot 10^{-1}\ e}{T^2 + 1} \right)^{1/2}$$

The gained outcomes can be useful to wide use in problems of earth remote sensing, researching of a climate and meteorology.

The modeling was carried out in the cluster of physical faculty of Kazan State University (Russia).

1. The WRF model site. http://wrf-model.org
2. EMC Model Documentation. http://www.emc.ncep.noaa.gov/modelinfo/index.html
3. NCEP Global Tropospheric Analyses datasets. http://dss.ucar.edu/datasets/ds083.2/
4. F.B. Cherniy. Rasprostranenie radiovoln. Moscow, “ Sovetskoe radio ”. 1962. 475p.