Calculation of the tracks of typhoons threatening the coasts of Russia

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The typhoon Nabi, the 14th tropical cyclone (TC) moving in the northwest of the Pacific in 2005, originated on 29 August at 14.5^{o} N, 154^{o} W and reached the typhoon stage on the 1st of September. It was supposed that it would make landfall on the island Hokkaido, would cover the south of Sakhalin, then the South Kurile Islands and would reach Kamchatka. The cities of Russia in the coastal zone of said territories would have been threatened with storm winds, showers and a huge storm wave.

In the Hydrometeorological Center of Russia, in the laboratory of the dynamics of the atmosphere in the tropical zone of the World Ocean, the calculations of the motion and evolution of the TC were made on the basis of the regional ETA model.

The model is adapted for the global data of the Hydrometeorological Center of Russia. As a result a technology has been created that makes it possible to take the data of the objective analysis of the Hydrometeorological Center of Russia and the forecasts using the spectral model of the Hydrometeorological Center as the input data for the ETA model.

The input data for the ETA model are the fields of the geopotential, of the zonal and meridional components of the wind velocity, of temperature on 10 standard isobaric surfaces (1000 – 100 hPa). Initial data and lateral boundary conditions are taken every 6 h from operative analyses of ECMWF that were not subject to initialization. The model version used in the Hydrometeorological Center includes extra blocks responsible for the TC motion and strength.

Presently the mentioned technology enables us to make forecasts of fields of meteorological values over vast territories for the periods up to 48 h on the basis of the on-line data available in the Hydrometeorological Centre of Russia, to make calculations characterizing the forecasts verification score etc.

What is important, the ETA model designed for the forecast general purposes operates within the framework of a developed prognostic system implying not only the release of operative forecasts using this model, but also all the procedures associated with the collection, preliminary processing (pre-processing) of the input information, interpretation of the output information (post-processing). The system implies also tackling the problem of the dissemination of the prognostic data obtained using the above-mentioned) model, and the problem of creation of the database and archives.

The goal was building a certain “sub-system” meant for the TC operative forecasting achieving the stage of visualization of the calculated forecasts of both TCs themselves and the large-scale fields surrounding them.

The calculation of the tracks and the evolution of tropical cyclones is performed on the basis of the solution of a system of hydrodynamic equations, in incremental representation, with a horizontal step of 30 km and with 32 levels vertically. In the course of integration and tracking of the cyclone the point with the local maximum in the vorticity field is took as (/is assumed to be) the cyclone center.

In the problem under consideration the integration region is 116 - 164º E, 10 - 50º N. For the initial data the data of the on-line analysis and of real-time forecast made in the Hydrometeorological Centre of Russia for 00 UTC for 6 August 2001, as well as those of the re-analysis were taken.

The trajectory of Nabi was of parabolic character. The TC reached its utmost strength (P = 925 hPa, V = 42 m/s) on 2 September, in the open ocean. On 6 September the TC made landfall on the western coast of the island Kyushu and, further, moved in the Sea of Japan.

To estimate what threat the typhoon Nabi constituted to the Russian littoral, a forecast of the TC Nabi motion was performed using the ETA model for 2 days beginning from 6 August.

The results of the calculation have shown that in 24 hours from the beginning of the calculation, i.e. at 00 UTC 7 September, Nabi should have been located in the southern part of the Sea of Japan (37º N, 133º E) (actually its center turned out to be in the point 37.8º N, 134.6º E), and that within the following 24 hours it would move towards the island Hokkaido and further cover the South Kuril Islands (the island Kunashir and the island Shikotan). The coordinates of the calculated point of the TC center location are 43.5º N, 142º E (the actual one was located at 44º N, 144.5º E).

The comparison of the analysis fields built at the Hydrometcentre of Russia (Department of Global Analysis and Forecast of Weather) with the analysis and forecast of pressure fields based on the calculation using the ETA model shows that the latter ones do not rank below (as for the precision of the description of the real situation in the aquatory occupied by the TC) the analysis of the situation made on the basis of international data. The forecast of the mentioned fields for 24 and 48 h is close to the real situation.