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Short-Range Prediction of Extreme Winds by Regional Mesoscale Numerical Model

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ABSTRACT. The present paper presents an assessment of the capacity of explicit short-range forecasting of extreme events, using the weather numerical mesoscale model WRF ARW, which was demonstrated with respect to the strong wind event case in Tbilisi on 9th January 2009. Model simulation is in very good agreement with process track and maximum intensity prediction. As for quantitative prediction of such variables as surface maximum wind speed the statistical calibration should be done additionally.

***Key words**: numerical weather prediction, frontal intrusion.*

In the present paper circulation process development is considered on the territory of Georgia, when sharp air masses intrusion occurred from the Black Sea, followed by strong winds in Tbilisi. According to observation, maximum wind intensity (>50m/s) was observed at 3 p.m. local time in Tbilisi during frontal motion above it. As the frontal line moved with high speed, extreme conditions lasted less than half an hour in Tbilisi.

The configuration of the real-time ARW model was the following: 15-km outer domain with the interactive nest on a 5-km mesh was fixed in space, containing 72X110 points in the north-south and east-west directions-, respectively. Both domains used the Kain-Fritsch cumulus parameterization (deep and shallow convection sub-grid scheme) [1-2], the WSM3 (WRF Single-Moment 3-class scheme) microphysics scheme that predicted only one cloud variable (water for T > 0ºC and ice for T < 0ºC) and one hydrometeor variable, either rain water or snow (again threshold at 0ºC). Both domains also used the Yonsei University (YSU) scheme for the planetary boundary layer [3].

The forecast was integrated beginning at 00 UTC, both domains were initialized directly from the National Centers for Environmental Prediction Global Forecast System (GFS) model with no additional data assimilation or balancing. Initial maps of surface pressure and high clouds fields for 9 January 2009 (00 UTC) are presented in Fig.1. As shown in the figure, the main trough of cyclone is directed south-west covering the eastern part of the Black Sea. South-west of the Caucasus is occupied by high pressure area, thus preventing eastward spread of the low atmosphere pressure trough. Surface pressure and high clouds prognostic maps for 12 UTC 9 January 2009 (Fig.2) indicate fast propagation of the low pressure area from the Black Sea in eastward direction. All upper air maps (AT-925, AT-850, AT-700, AT-500 hpa) also show the same. Examination of the above mentioned prognostic maps shows that the atmospheric front moving in the west to east direction passed Tbilisi latitude (45°E) in the afternoon of local time (12 UTC). For that period drastic changes of meteorological parameters were recorded in Tbilisi

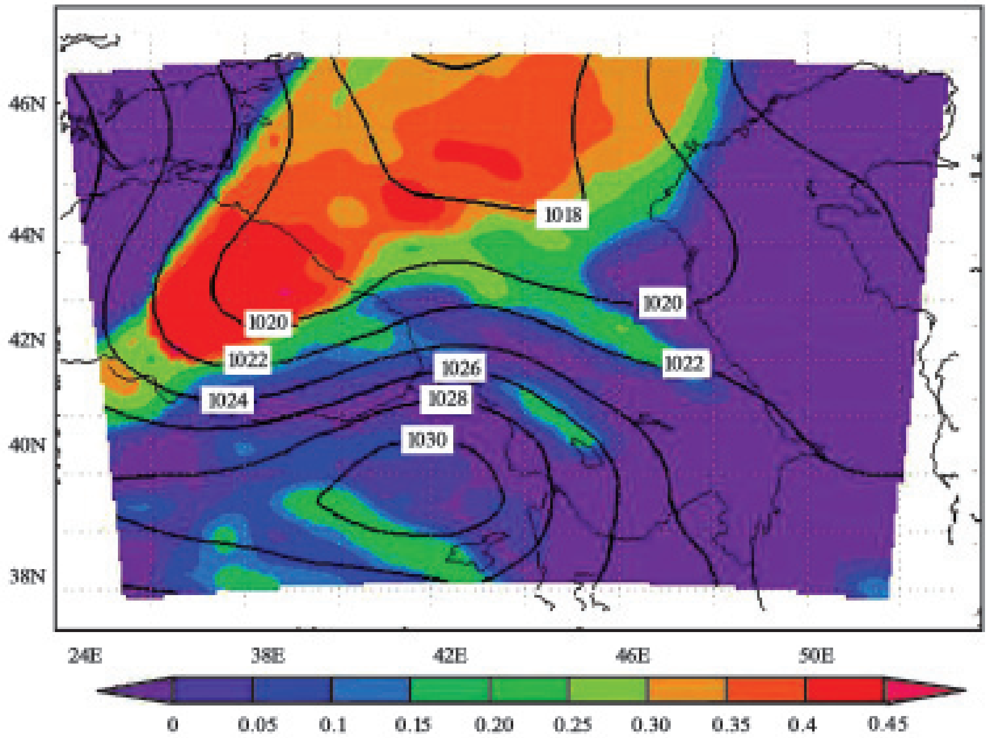

Fig. 1. Initial maps of sea level pressure and high clouds fields for 9 January 2009 (00 UTC) simulated for the main domain with 15 km resolution.

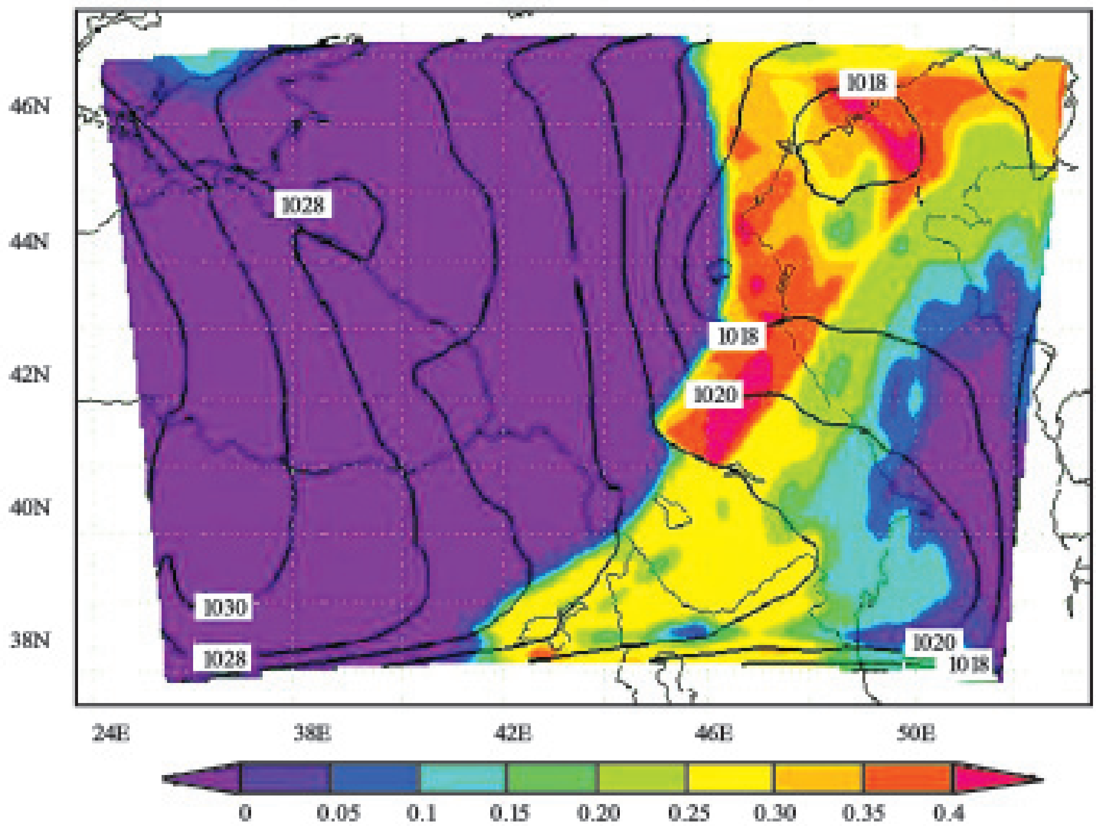

Fig. 2. Maps of sea level pressure and high clouds fields for 9 January 2009 (12 UTC) simulated for the main domain with 15 km resolution.

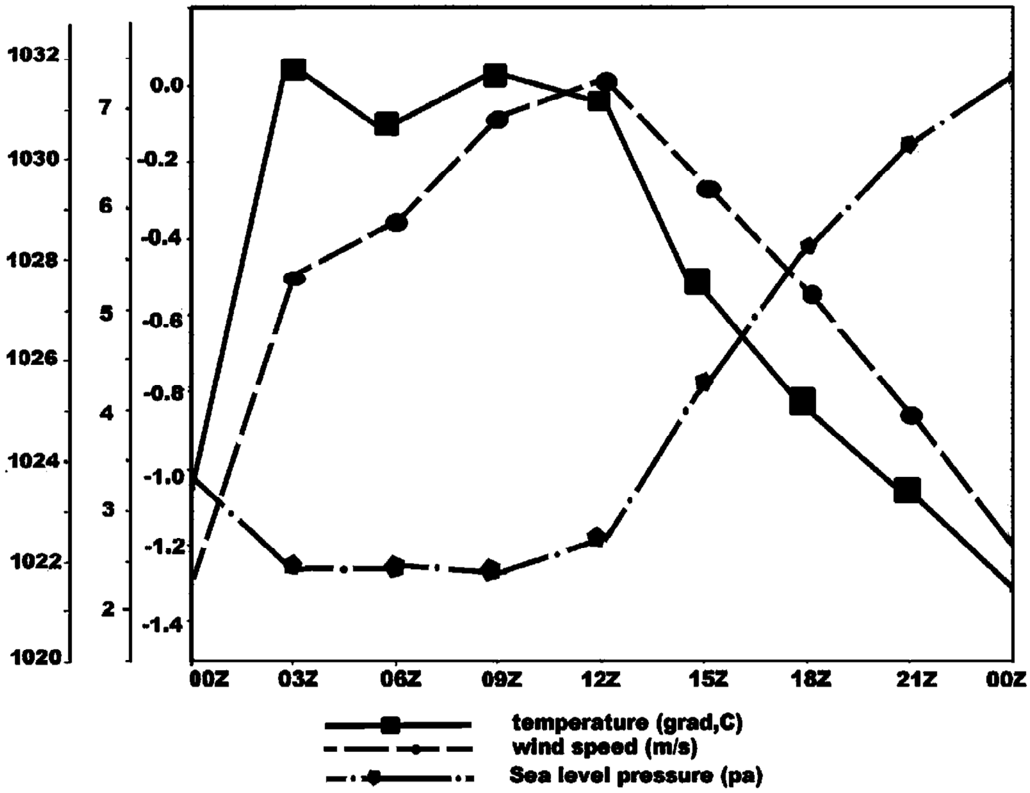

Fig. 3. Diurnal course of wind speed, sea level pressure and temperature in Tbilisi for 9 January 2009.

(Fig.3). This graph present the wind speed at 10m above ground (altitude of the weathercock), which was found to be almost twice less than factual and thus needs to be statistically corrected. This method [4] is generally accepted for quantity determination of some surface layer parameters both for global and for local area numerical modeling. Prognostic values of wind speed increase by height and reach 20-30m/s at AT-850 hpa. Therefore in Tbilisi wind velocity exceeds its limiting value for a short period of time (less than 1 hour). Despite quite strong frontal intrusion, as was shown by prognostic maps of precipitation, it is unlikely to foresee heavy rains in Georgia. The observed amount of rainfall was actually small.

In summary it can be said that the above-mentioned model can be successfully used for the prediction of local weather extremes. Though model results are more realistic in forecasting the prognostic variables of the course character for quantitative prediction of such variables as surface maximum wind speed, air temperature etc. statistical calibration should be done additionally.

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გეოფიზიკა

ექსტრემალური ქარების მოკლევადიანი პროგნოზირება ამინდის მეზომასშტაბური რიცხვითი მოდელის გამოყენებით

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