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INTENSIVE PROLONGED RAINS IN BELARUS AND BALTIC STATES 22-24 AUGUST 2017

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Abstract

Intensive prolonged rains started 22 of August, 2017 over the east regions of Belarus and 55 mm of precipitation was observed for the period of 12 h. From 23 to 24th of August the area of intensive precipitation spread to the most part of Belarus and Baltic States due to with the sharp deepening and movement of the cyclone to the north-western regions of Belarus. For the period of 24th of August from 50 to 130 mm of precipitation was observed, which is 1-2 of the monthly normal amount of precipitation. Such heavy rains are not common for these regions. As a result, vast areas of the region were flooded which caused significant economic damage.

INTRODUCTION

As known, the cyclonic formations of different trajectories of movement influence for the territory of Baltic region. The predominant are Atlantic cyclones shifted from the Central Atlantic and the cyclones which formed over Iceland and the Norwegian Sea. Besides, the weather conditions of Baltic Basin can determine the cyclones generated over south seas (Mediterranean, Black and Caspian). At the same time, if from the Mediterranean the cyclones exit to the Baltic region very often, the cases of movement cyclones from the Black Sea and especially from it eastern part or from the Caspian Sea are rare and make up no more than 5% of all cyclones during the year.
The aim of this study is complex analysis of evolution of intensive cyclone, which moved from the eastern part of Black Sea to the territory of Belarus and Baltic States 22-24 of August, 2017.

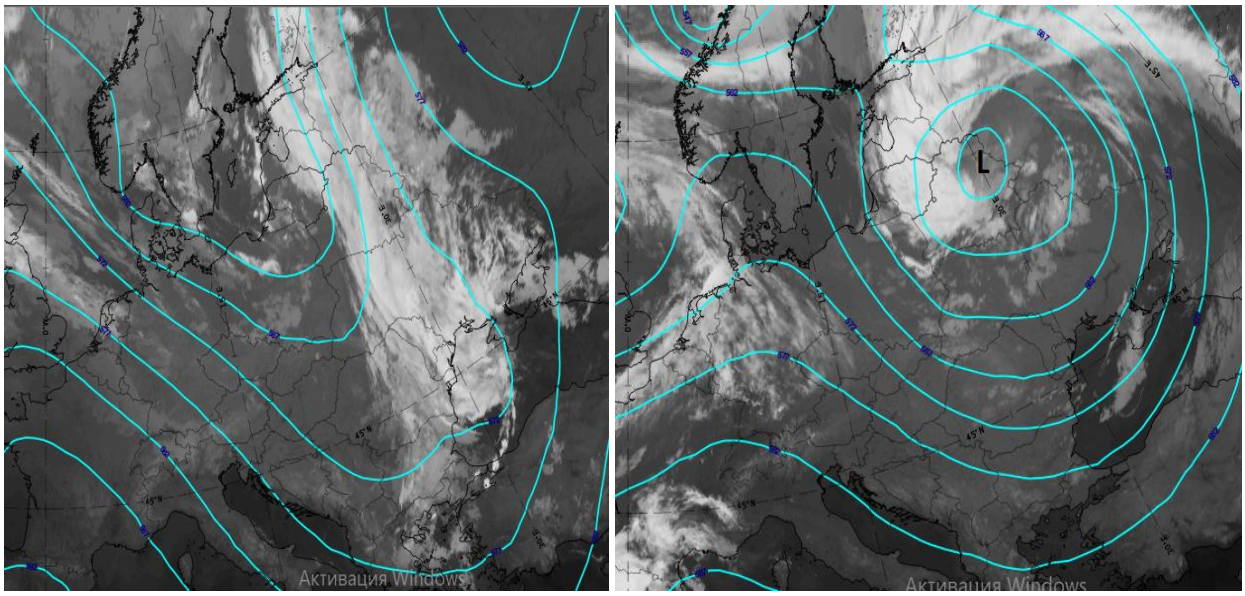
MATERIALS AND METHODS

The synoptic charts and the database of observations from the meteorological stations of Belarus, Latvia and Lithuania was used for the analysis of evolution of cyclone.
The materials of satellite analysis and the field of hydrodynamic characteristics (advection of temperature, divergence, relative vorticity) from ECMWF was used for the analysis of quantitative characteristics and assessment of their role in the evolution of cyclone (http://212.232.25.232/MapViewer.html).

DIAGNOSIS

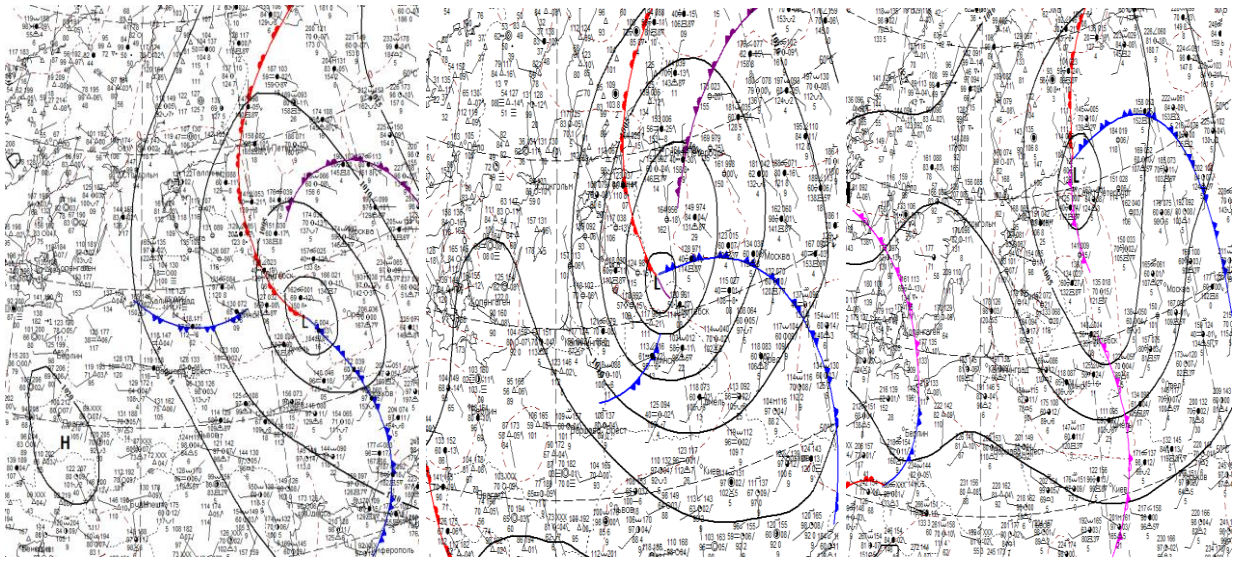
The first signs of cyclogenesis within the lower layers of the troposphere could already be observed on the 00 UTC 22 August over the eastern part of Black Sea. The Upper level trough was located over Europe at 500 hPa, the axis of it was observed from Scandinavia to eastern part of Mediterranean Sea (Fig. 1). The cyclone was formed in cyclogenetic region - in front of upper level trough. Further, the low system shifted in north direction and it came out to the eastern regions of Belarus at 06 UTC 23 August (Fig. 2). Pressure drop was 2-3 hPa/3h at the top of the wave. Due to the inflow of cold air masses, the upper level trough was deepened in next half a day and the upper cyclone was formed over Belarus at 500 hPa (Fig.1). The surface center joined in circulation of the upper level cyclone and shifted to the north-western regions of Belarus deepened to 994 hPa (03 UTC 24.08) and having reached the developed stage (Fig. 2). In next half a day the surface center stayed stationary and then filled. The

precipitation gradually stopped. But the new surface center was formed at the point of occlusion over the Leningrad region (Fig. 2) and it determined the weather conditions over the north-western regions of Russia for several days.



a ***b***

Figure 1: **IR 10.8 μm and ECMWF geopotential height at 500 hPa (blue lines, in decametres). Black L denotes the location of the upper level low centre. (a) 22 August 06 UTC. (b) 24 August 00 UTC.**



a ***b*** ***c***

Figure 2: **The synoptic observations, frontal analysis, mean sea level pressure (black line, mb) and low pressure centre. (a) 23 August 06 UTC. (b) 24 August 03 UTC. (c) 24 August 15 UTC.**

The positive cyclonic vorticity advection in mid-and upper level, observed over the surface center during the whole period of the cyclone deepening fostered of this (Fig. 3). The most intensive zone of the vorticity advection corresponded to the intense advection of cold air masses in the rear part of cyclone. This process caused the deepening of the upper level trough and the increasing of cyclonic circulation near the surface level. As a result, the cyclone has reached developed stage.

The field of temperature advection attracts the special attention. The intensity of it was increased during the deepening of cyclone. The most intensity of warm and cold advection at 700 hPa in front and rear parts of cyclone was observed during the developed stage of it (Fig. 3).

As known, the favorable conditions for the development and deepening of cyclones are the presence of divergence at the upper layers. In our case the field of divergence is very difficult and variable (Fig. 3). However, we can see the intensive divergence velocity over the surface center at level 300 hPa during the developed stage of cyclone.

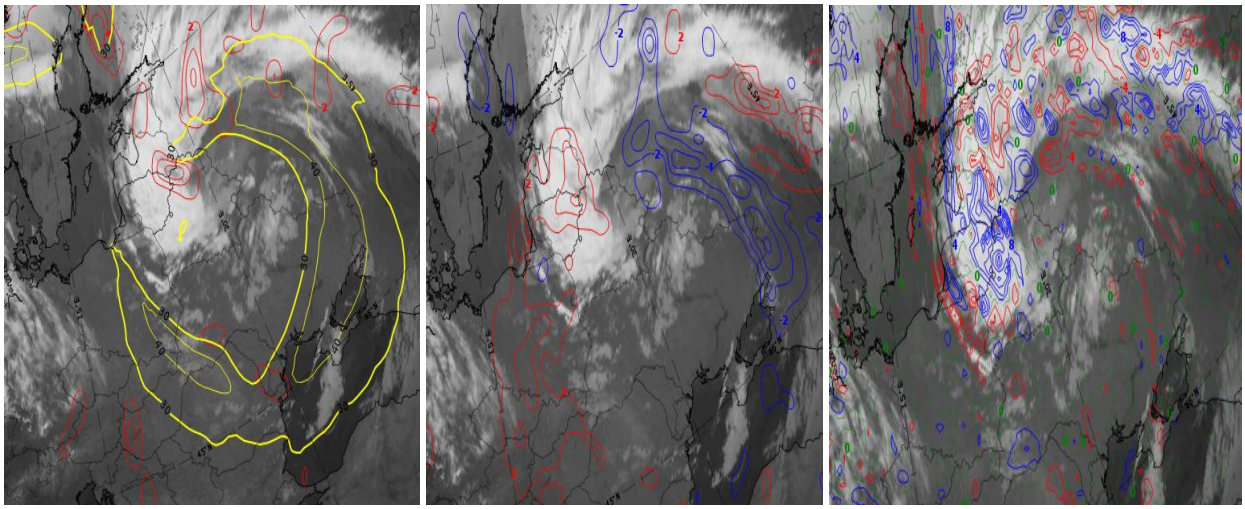


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Figure 3: **IR 10.8 μm and ECMWF hydrodynamic characteristics, 24 August 00 UTC. (a) cyclonic vorticity advection (red lines) and izotahs at 300 hPa (yellow lines). (b) temperature advection at 700 hPa (positive – red lines and negative – blue lines). (c) divergence (blue lines) and convergence (red lines) at 300 hPa.**

MSG RGB PRODUCTS

The MSG images were used to monitor the clouds during the whole period. The images below (Fig. 4) show the cloud spiral over Belarus and Baltic States 24 August 00 UTC. At this stage the low was beginning to occlude.

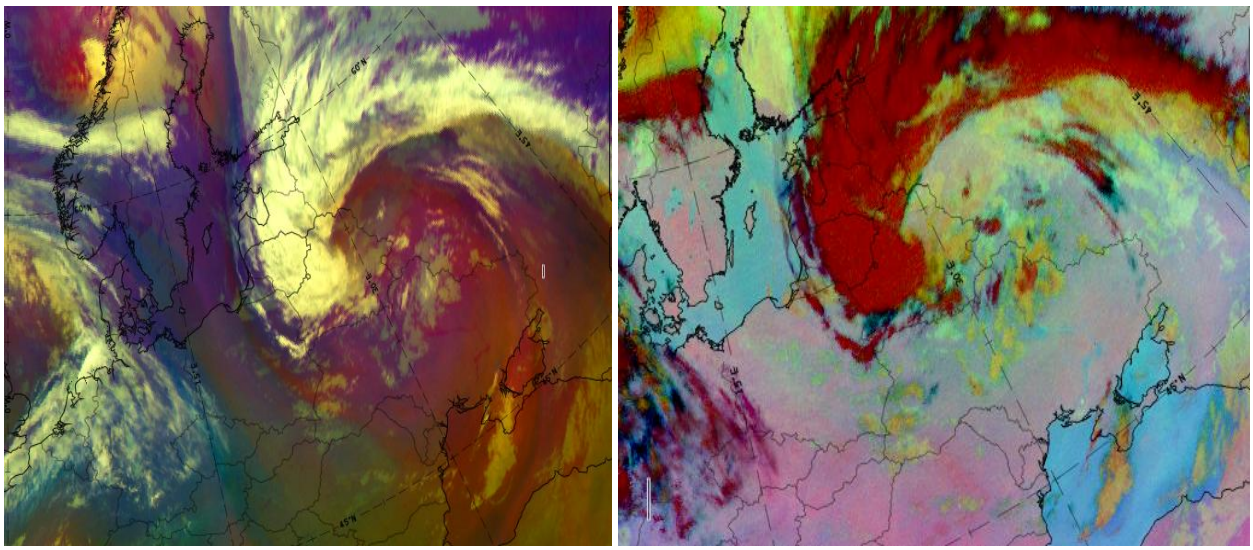

Figure 4: **MSG RGB Airmass (left) and 24h Microphysics (right), 24 August 00 UTC.**

The information from RGB composites can be summarized as follows:

- 24h Microphysics shows that cloud spiral consists of thick, precipitating clouds with mostly large ice particles and cold cloud tops;
- Airmass product: intensive red colour in the rear part of cyclone indicates high upper tropospheric PV values. We can see also the position of jet stream.

CONCLUSIONS

The analysis of the evolution of this summer cyclone using the complex of hydrodynamic parameters showed that space-time distribution of the dynamic and thermal characteristics of atmosphere conformed to the theoretical concepts about it role in the evolution of cyclone and the quantitative indicators didn't exceed the characteristic values which corresponds to the average intensity of the development of this cyclone. Thus, use of hydrodynamic characteristics, such as advection of temperature, divergence, relative vorticity, obtained as a result of an objective analysis of the fields of meteorological quantities in combination with satellite images is a reliable tool both qualitative and quantitative evaluation of intensity and tendency of development of atmospheric processes in operational synoptic practice.

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