

RAINFALL EXCESSES ON THE REPUBLIC OF MOLDOVA TERRITORY. CASE STUDY

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Key words: rainfall excesses, Black Sea, Carpathian mountains, atmospheric circulation, izohypses, cyclonic center.

Abstract. The article is based on analyzing the pluviometric excesses from the territory of the Republic of Moldova, through the condition of regional atmospheric circulation. The role of the Black Sea basin and Carpathian mountains is highlighted as well. The study was focused on the following cases of pluviometric excesses: July 7-8, 1948; August 26, 1994; August 7, 2005; July, 28, 2008; June, 2010; June, 2011.

Introduction

Maximum diurnal rainfalls occur during the warm season, as a result of the Azores anticyclone increasing activity, and the Atlantic and the Mediterranean cyclonic activity. In the Republic of Moldova, rainfalls of the summer season, often have frontal features and occur more during the day, frequently as a brief downpour. A characteristic of territorial distribution of maximum diurnal rainfall (24 hours) is that in the summer months, the largest quantities on the Republic's territory can be registered in its south-eastern region, influenced by the local atmospheric circulation caused by the air masses above the Black Sea.

Features of general atmospheric circulation in the central-south-eastern Europe and its effects on rainfall in the eastern region of the Carpathians (which includes the Republic of Moldova), were presented by [1, 2, 3, 4, 5]. So, the country's position in the south-east of the continent and the „open territory” to the Black Sea, are the main characteristics of this area, which produce noticeable local changes in the atmosphere dynamics that influence the diurnal rainfall maximum regime.

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The intensity, the extension and the position of barometric centres on the Republic of Moldova's area, determine the forms, versions and types of atmospheric circulation, with results in the genesis of weather, and the maximum diurnal rainfall genesis respectively. At our country level, there are four main types of atmospheric circulation: western, polar, tropical and blocking air masses [5].

Western circulation is the main factor which influences the weather's state in the Republic of Moldova. It occurs under an anticyclone belt in southern Europe and a barometric depression in the northern part of the continent. In the Republic of Moldova, it determines mild winters with high amount of precipitation and unstable air masses during summer.

Polar movement occurs under the Azoric anticyclone towards the North of the Atlantic Ocean. The penetration of marine air from the polar latitudes to the Republic of Moldova area, determines the cooling of the weather, the increasing moisture, nebulosity, and high abundant rainfall of short duration. Winter is associated with strong wind and snow storm phenomena.

Tropical circulation occurs under the penetration of warm tropical air, from North Africa, enriched with moisture passing over the Mediterranean Sea, resulting in mild, rainy and mild winters and summers with unstable weather, or, respectively, the penetration of dry air from the Middle East determines very hot and dry summers.

The blocking movement occurs while the European continent is crossed by an axis of high pressure, between the Black Sea and the English Channel, which blocks the entry of North-Atlantic or Mediterranean cyclones into our country (Apostol, 1997).

On the Republic of Moldova territory, the Carpathian influence on the atmospheric circulation processes is felt at a very large extent. So, under the mountains' influence, the cyclone trajectories are changed, the atmospheric fronts are deformed, and as a result, significant changes in weather occur. This influence is also transmitted to the characteristics of diurnal rainfall maximum regime.

So, the general circulation of the atmosphere is due to non-periodic changes of the weather, sometimes quite sudden and intense. By its dynamic particularity, it gives the maximum diurnal rainfall regime a quite variable character.

1. Analysis of results

Following the analysis of mean monthly and diurnal baric fields over the Europe, and the surrounding areas, the high stretching, intensity and frequency barometric formations could be shaped, with relatively homogeneous properties, which have a crucial role on the atmospheric circulation in the Republic of Moldova area. Below, we will briefly present the main features of the action

barometric centers across Europe and how they are involved in rainfall genesis across the country's territory.

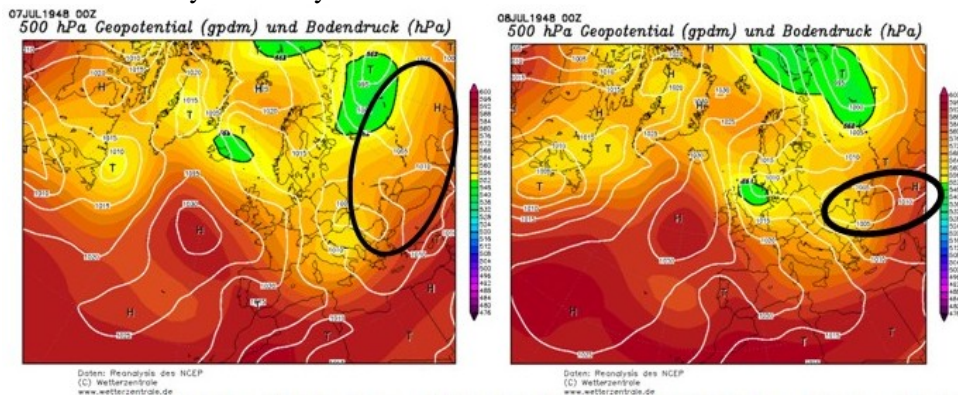


Fig.1 - Synoptic situations of July 7 to 8, 1948 (left and right) that caused heavy rainfall accompanied by catastrophic floods in small river basins

Although it appears that the year 1948 was normally hot and excessively dry, the summer was cool and rainy. The maximum rainfall of July 1948 was caused by the cyclones coming from the polar seas on the previous Azores anticyclone flank centered in the British Isles (Fig.1.). Following the heavy rains of July 7 to 8, 1948, the central regions of the country were catastrophically flooded.

The heavy rains of August 26 to 27, 1994, according to the radar data recorded by the "Antigrindina" Service. In 10 hours, there were 270 mm of precipitations in Hincesti, Calmatui. These had been formed by the channeling of the depression areas of the Atlantic up to our regions, favored by the Azores anticyclone, which withdraw from the continent, forming a dorsal to the Scandinavian Peninsula (Fig.2 a,b.).

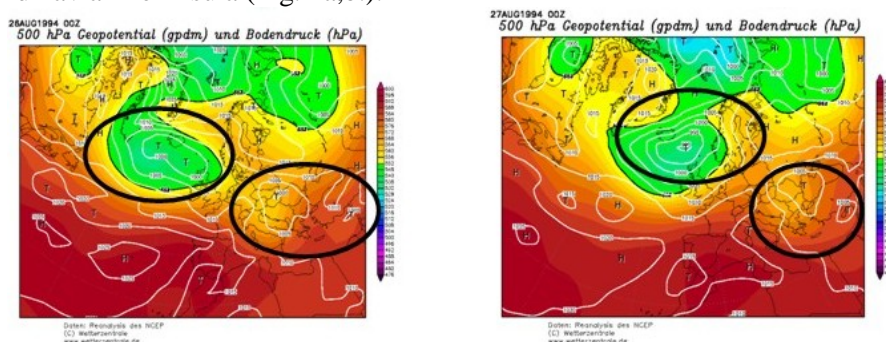


Fig. 2 - Synoptic situations of August 26 to 27, 1994 (left and right) that caused heavy rainfall

Depression areas of the Mediterranean Sea were pushed up into the Black Sea by the second dorsal of the Azores anticyclone, which fielded over North Africa by South. Usually, at their confluence on the Republic's territory, exceptional heavy rains occur.

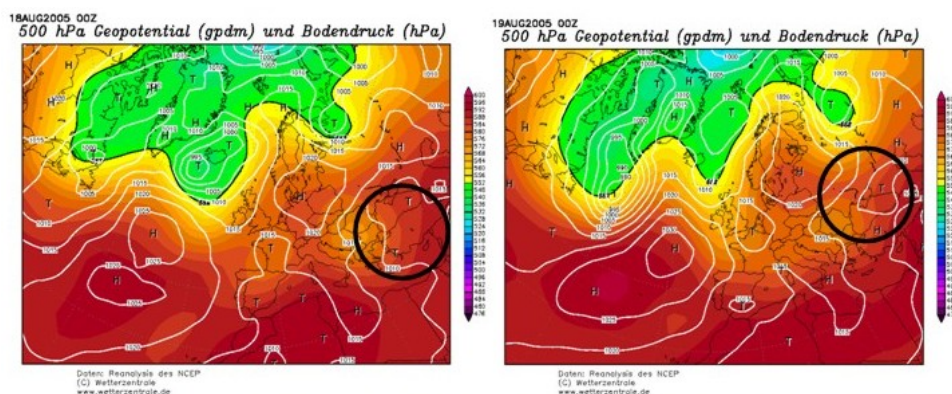


Fig.3 - Synoptic situation of August 18-19, 2005 (left and right), which caused heavy rainfall in the Northern part of the country

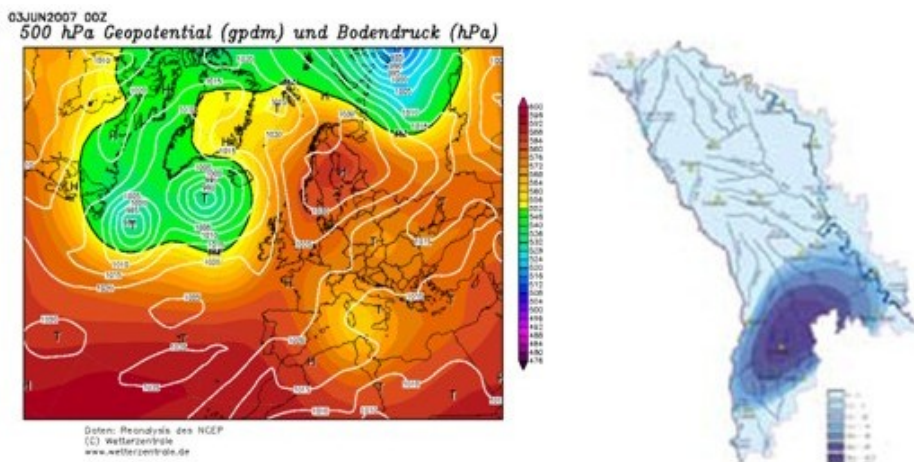


Fig.4 - Synoptic situation of June, 3, 2007 (left and right) which caused heavy rainfall in the South-East of the country

According to the State Hydrometeorologic Service, maximum daily precipitations were recorded in 2005 in May, 23, 25, 26 and 31, when for an hour

the maximum quantity was of 40mm. Rainfalls of an even higher intensity were registered in August 7, 18 and 18, 2005.

On the night of 18 to 19 August, in the Northern and Central regions, according to the data recorded by the hydrometeorological stations of Costesti, Riscani, Dumeni, 140-160 mm of rainfall or about 3 standard monthly norms fell. These precipitations were generated by a cold atmospheric front entering the country's territory from south-west and by its deepening when meeting the warm and very hot air masses coming from the Black Sea (fig.3 a,b).

A similar situation was created in the south-eastern region of the country during the night of June 3, 2007, when one monthly norm of precipitations fell in Comrat in the morning of 4th of June, on the background of a devastating drought settled in the region. (fig. 4 a,b).

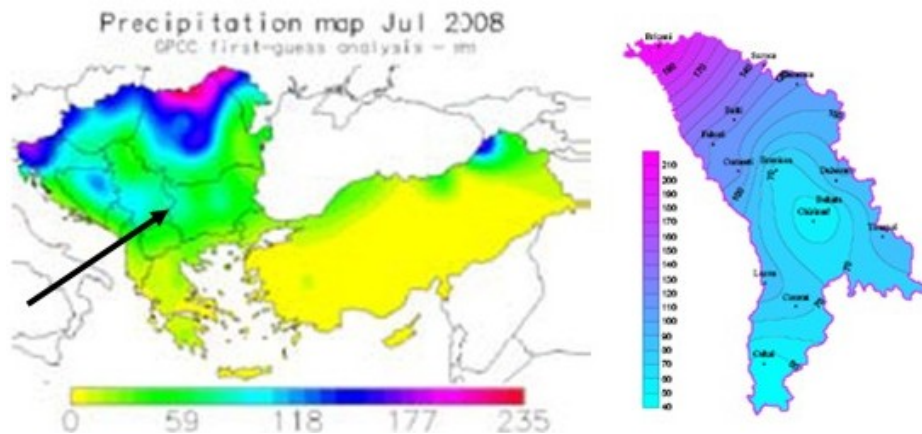


Fig. 5 - Spatial distribution of heavy rainfall in South-Eastern Europe (left) and its cartographic modeling (right) at regional level (July 2008); source: www.dmcsee.org

Such a synoptic situation, greatly influenced by the local circulation above the Black Sea, and causing rains, represents a climate's characteristic feature of the South-Eastern part of the country.

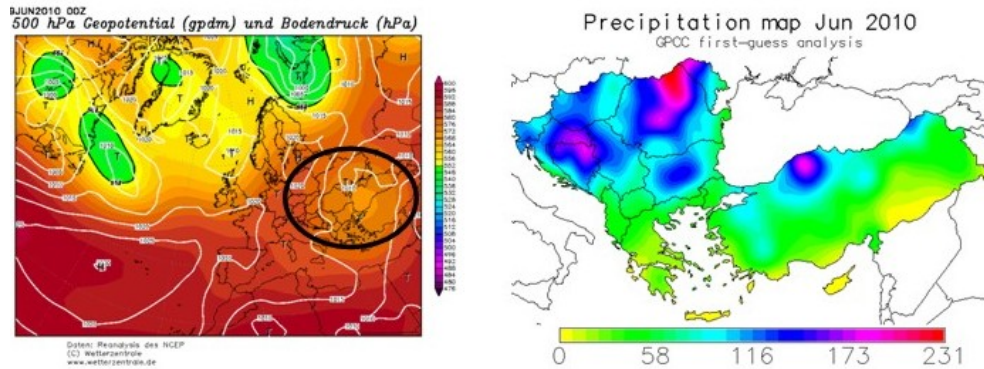


Fig.6 - Synoptic situation June, 29, 2010 (source: www.wetterzentrale.de) and heavy rainfall's spatial distribution of the South-East of the Europe, June, 2010

In July 2008, maximum monthly amounts of over 180 mm were recorded in Moldova in the North-Western part of the country. The cartographic modeling of the maximum rainfalls in July 2008, made in the Climatology laboratory, confirms the evolution of rainfall measured by the Southeast European Center for Drought Management in Southeastern Europe (fig. 5 a, b).

June 20, 2010 marks the start of long period of instability, marked by torrential rains and less by associated phenomena (hail and storms), which continued almost daily until the end of July. Affected regions: all the country, but the great magnitude and the extended character of both human and material damages, characterized the North and Central part of the Republic of Moldova (fig.6 a,b).

Floods on the large rivers (Prut, Dniester) occurred in this region, and flashflood type flooding occurred on the small rivers, as it happened on the night of 28th to 29th, and 29th of June in Briceni, Edinet and Soroca regions. The amounts fallen exceeded 2-3 times the climate norms for this period. In the Northern and Central part of the Republic of Moldova and the Eastern frame of the Eastern Carpathians, in just ten days in the last decade of June, the quantities of water exceeded 200 l/m², quantities that would have to fall in two months - June and July. But the big problem was that such amounts were recorded in only a few hours; therefore, in this work, we will try to identify the genetic causes which led to this situation. The cause of this pluviometric regime was the gradual installing of a block-structure above the continent - actually a double blocking – an atmospheric blocking, both in Western Europe over the North-Eastern Atlantic basin, and especially over the Russian Plain, where a high blockage was present and that persisted for more than two months.

The persistence of this type of atmospheric structure for such a long time, in our opinion, can also be associated with a persistence effect in terms of the polar vortex dynamics, which favored a “stationarity” of the Rosby planetary waves. The consequences were: heavy rainfall in the Central South-Eastern part of the continent, drought and heat in the Russian Plain.

Even since June, 18, through the frontal part of the baric maximum over the North Atlantic, there was an infiltration of cold air, which fielded during this period to Central Europe. This cold air penetrating the entire tropospheric column at 500 pPa was evidenced by a wide thalweg (and a closed cut-off type core in the Scandinavian Peninsula area), and a deeper depression thalweg (1005 mb) was outlined at the ground level, positioned slightly to the east depending on the altitude thalweg, where in the morning of June, 19, a Mediterranean Cyclone formed, sheltered by the Alps. This cyclone of the Northern Italy continued to be strengthened - increasing thermal asymmetry – by the cold air in the rear part (cold air came from the earth surface infiltrating through the Rhone corridor), but also by the increasingly cold tropospheric air (cut-off which reached this area). Thus, during the afternoon, our country was reached by the front warm systems associated with this atmospheric depression.

Since June 21, the Mediterranean cyclonic disturbance is placed on a trans-Balkan trajectory, and its slow progress towards the Black Sea causes heavy rainfalls, in the western half of the territory in the first day and then until June 25, in the eastern half, but especially in Moldova and the Eastern part of Eastern Carpathians. On June 25, the North-Eastern dorsal of the North Atlantic advanced to the center of the continent, and on the previous flank, air dynamics allowed a new mass refreshing, especially in the middle troposphere. As a result, cyclonic activity in the Black Sea was revived, the pressure decreased slightly in the western Black Sea basin, and as far as dynamics was concerned, the depression system had a retrograde movement, first, to the Republic of Moldova, and since June 28, to the south and south-east of the territory.

This development coincided with a new retrograde peak of front heavy rainfall, for the central part of Moldova and the eastern slopes of the Eastern Carpathians: as a result, the State Hydrometeorologic Service has managed the situation by issuing several yellow code warnings and an orange warning code for the period of 25 to 27 of June.

For the analyzed period (28-29 of June), the cyclonic center of the lower troposphere had a slight shift to the South and South-East, due to the increasing pressure over Central Europe, so that in the Northern part of Moldova, the baric gradient increased significantly – the intense isobaric component of the North, North-West to the Eastern part of Eastern Carpathians.

At the 850 hPa level, the intersection between the low South-East pressure system and the high pressure center was somewhere in the Northern part of Moldova; this time, the isohypses gradient was oriented from the North-East to South-West, thus, resulting in a wind component close to the geostrophic one, this time on a East, North-East direction. This component can be associated in this case, with a low level jet - a classic jet that involves hot air and humidification over the Russian Plain.

In the middle troposphere, airflow was imposed by the cool core development - cut off, which was centered in the South-Western part of the Black Sea basin, and the area of interest, the airflow direction was predominantly Eastern.

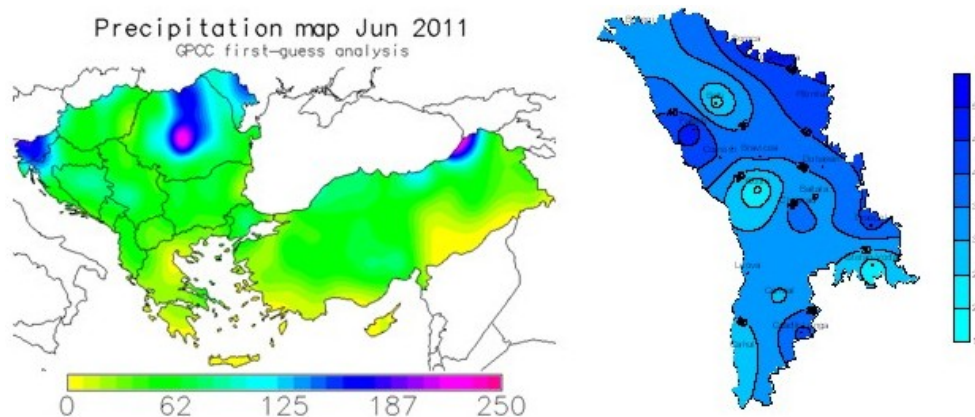


Fig.7 - Spatial distribution of heavy rainfalls in June 2011 in the South-Eastern Europe (left) and their cartographic modeling (right) at regional level

At the synoptic scale, there was a baroclinic area, initially associated with well-defined fronts, which quickly transformed into a stationary front. It was oriented from the North-East to South-West, over the Central part of Russia, South-Eastern Belarus and Poland, to the Carpathians in Ukraine, and separated a dry polar air mass, situated in the Northern part of a humid tropical air mass. This area with high baroclinicity coincided with the typical situation of the barocline areas within an altitude cyclone: one behind and another in front of the disturbance, and the third, as in our situation, in the North-Eastern sector.

In June 2011, in the North-East of the country (fig.7 a,b), the most essential rainfalls of that month were reported. In isolated areas, the rains fell as showers and exceeded the monthly average in South-Eastern and Central-Western part of the country. Therefore, torrential rains (rain showers) are characterized by a huge amount of fallen water in a very short time, which involves a high intensity and

possibly serious damages caused by the washing away of soil nutrients, by accelerated erosion processes, often resulting in a wide range of slope processes, destroying agricultural pastures and crops.

Daytime maximum rainfall exceeding 50 mm has a relatively high energy action, causing the formation of “rivers”, soil rain-wash and valleys flooding. But rainfalls exceeding 100 mm in 24 hours that cause catastrophic damages are particularly hazardous. Taking into account the rainfall devastating character, according to these falling limits, the diurnal maximum data recorded for 24 hours by the hydrometeorological stations of the Republic of Moldova have been analyzed and systematized. It should be emphasized that of the total number of observations points (65), only five meteorological stations have recorded statistical data for more than a century, which ultimately will form the basis for the analysis of trends change occurred in the extreme rainfall regime. It is worth mentioning that for these stations (Briceni, Soroca, Cornesti, Chisinau, Cahul), the number of cases with maximum diurnal rainfall exceeding 50 mm varies from 19 up to 24 cases, most of them recorded in Cahul and Chisinau (24 and 23 cases, correspondingly), and maximum diurnal rainfall exceeding 100 mm was recorded in the Central part (2 cases).

The above mentioned facts confirm the essentially variable character of diurnal maximum rainfalls in time and space on the Republic of Moldova territory.

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