TRAJECTORIES OF THE MEDITERRANEAN CYCLONES INFLUENCING THE PRECIPITATION IN BULGARIA DURING THE MONTHS OF SEPTEMBER-APRIL

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Trajectoires des cyclones méditerranéens influençant les précipitations en Bulgarie pendant les mois de septembre-avril

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Introduction

The Mediterranean region is known for the formation of an area of low atmospheric pressure during the cold half of the year and the formation of cyclones. The cyclogenesis of this area is influenced by both cold air advections along the cold fronts of the Atlantic cyclones, the East European Maximum, and high-pressure ridges coming from the Azores Maximum located to the west. The formed cyclones over the waters of the Mediterranean Sea have an impact on a vast territory covering southern Europe, the Middle East and the northern parts of Africa, which defines the zone of Mediterranean climates. Their mode, trajectories, speed of movement and duration of retention over a given territory determine to varying degrees the intra-annual rainfall regime, as well as the individual economic activities related to them.

Pioneering studies that include climatology of cyclones and cyclogenesis in the Mediterranean (in the frame of hemispheric studies) are those by Pettersen (1956) and Klein (1957). Most of studies about Mediterranean cyclones have been focused on precipitation (Trigo *et al.,* 2000; Jansa *et al.,* 2001b; Kahana *et al.,* 2002; Maheras *et al.,* 2002, 2004).

1. Data and methods

For the purposes of this article, data from synoptic maps at a height of 500 hPa were used, as well as average monthly precipitation data for 10 meteorological stations - four located in Northern Bulgaria (Vidin, Pleven, Ruse, Varna) and six in Southern Bulgaria: Burgas, Sliven, Plovdiv, Sofia, Kyustendil and Sandanski. They are collected from NIMH (National Institute of Meteorology and Hydrology) monthly newsletters.

Pisarski's (1955) classification scheme was used as the basis for the types of trajectories of Mediterranean cyclones. The monthly, seasonal and annual total number of Mediterranean cyclones is calculated. The main areas of cyclogenesis and their percentage ratios in relation to the total number of formed cyclones have been established. For each trajectory, the shares of cyclone formation areas relative to the total number of Mediterranean cyclones formed were calculated. The monthly and seasonal distribution of cyclones passing along the different trajectories, as well as average, minimum and maximum duration, are presented.

To analyze the influence of Mediterranean cyclones on the precipitation in Bulgaria, the correlation coefficient (r) between the precipitation amounts for the 10 selected stations and the frequency of occurrence of the formed cyclones was used.

2. Results

The total number of Mediterranean cyclones that formed and passed through Trajectory 1, Trajectory 2, Trajectory 3.1 and Trajectory 3.2 for the period 2010–2020 is 215. With the largest share and as the main area of occurrence of Mediterranean cyclones is the Gulf of Genoa with 31% of the total number of cyclones formed during the period. It is followed by the Ionian Sea with 13%; Balearic Sea with 12%; Aegean Sea with 9%; Adriatic Sea with 8% and Tyrrhenian Sea with 8%. A high share (10%) has cyclones coming from Africa.

If we compare the results with the cited studies, the share of cyclones that occurred in the Gulf of Genoa (31%) is smaller by nearly 15% for the studied period. The share of cyclones that occurred in the region of

southern Italy (Ionian, Adriatic and Tyrrhenian Seas) is almost the same - 29%. More than half of the cyclones passing through trajectories 1 and 2 formed in the Gulf of Genoa region.

As a second center of cyclogenesis related to these trajectories is the Balearic Sea region. Nearly one-third (32%) of the cyclones passing through trajectory 3.1 formed in the region of southern Italy, and 29% originated in the Gulf of Genoa. The Aegean Sea is also the area of cyclogenesis for 11% of the cyclones moving along this route.

Nearly 40% of cyclones passing through trajectory 3.2 originate in southern Italy. One-sixth of the cyclones passing through this southernmost of the studied routes originate in the Gulf of Genoa region. Over 10% of the cyclones moving along trajectories 3.1 and 3.2, respectively, originate over Africa.

When comparing the total number of Mediterranean cyclones and precipitation in Bulgaria, the strongest correlation is for the month of December. For Sofia, it is over 0.8. We establish such a relationship for the precipitation in December over Sofia and regarding the cyclones passing along trajectory 1. According to trajectory 2, we register a strong correlation between Mediterranean cyclones and monthly amounts of precipitation for the eastern part of the country for the month of February. For the Northern part of the Black Sea coast, a very strong correlation was reported for the months of January and February. On trajectory 3.1, we report a strong positive correlation between the frequency of cyclones for the entire country in the month of December. In southern and southwestern Bulgaria, we register a strong negative correlation between precipitation and cyclones along this trajectory in the month of April.

Conclusion

The highest frequency of Mediterranean cyclones is in January and with the lowest is in September.

Decrease of cyclogenesis was found in the Gulf of Genoa, the Adriatic and the Tyrrhenian Sea for the period studied. The areas of the Balearic, Ionian and Aegean Seas have been registered as new centers.

When studying the correlation coefficients between the frequency of occurrence of Mediterranean cyclones and precipitation, the results show a very strong positive correlation for December for the Sofia region – 0.83. The highest values on correlation coefficients on trajectory 2 were recorded for Varna in January and February – 0.81 and 0.87. In October on trajectory 2, a significant and strong correlation was found for the region of Western Bulgaria.

The best-expressed positive correlation was found in the winter months, and negative - in the spring months.

Between the frequency of cyclones crossed on trajectory 3.1 and the rainfall amounts, there is a significant to strong positive dependence. There is a very strong positive correlation for Vidin (0.80) in February and for Sofia (0.85) in November.

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