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FORECASTING THE DROUGHT INTERVALS IN THE SOUTH-WESTERN PART OF ROMANIA

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Abstract *The study presents a mathematical interpretation of the drought periods from 2010 to 2015 and the relationship between the drought periods and the associated baric structures at the European level. There is an increase compared to the climatological norm of positive temperature anomalies at the level of 500 hPa for almost the entire frame of the year, the only exception being the winter period. The maximum period of time characterized by a positive temperature anomaly at the level of 500 hPa is found during the summer months, when a sustained transport of air masses of tropical origin to the western area of Romania is noted. Periods of positive temperature anomaly at the 500 hPa level range from a minimum of 10 days to nearly 50 days during the summer. The period of negative anomalies varies between 7 days and approximately 40 days, the longest duration being during the winter months. From the analysis correlated with the arrangement of the baric centres, certain trends of the drought installation periods can be established, especially in the case of interpolation between the meteorological data and the analyses at the synoptic level. Although there may be short periods characterized by atmospheric instability during the summer, there is an accentuated humidity deficit that cannot compensate for the increased rate of potential evapotranspiration. The present study represents an intermediate analysis of the situation from a longer period.*

Keywords: *drought, agrometeorology, western Romania, mathematical modelling, agriculture*

INTRODUCTION

The territory of Romania presents a remarkable climate variability. This fact is due to the presence and orientation of the Carpathian Mountains chain, which constitutes a barrier to the advection of air masses from the west. (BÂZÂC, 1980) and which often generate specific orographic phenomena (DRĂGHICI, 1984). As a result, the climatic regime is more humid and moderate in the regions located west of the Carpathians, where the average annual temperature range is between 21° and 24°C, and the annual amounts of precipitation do not fall below 550 mm and have a more continental character in the southern and eastern part of the country, where the average annual amplitude of air temperature exceeds 25°C, and the annual amount of precipitation falls below 400 mm (SANDU ET AL., 2010).

Recent studies on extreme phenomena (MĂRĂZAN, 2018) in the continental area of the northern hemisphere highlighted an area of drought formation that also includes southern Romania. This fact, as well as the importance of this territory for agricultural production, led us to try drought forecasting in the growing season. Drought represents an active threat to economic, social security and also a risk to the well-being of a country. In the increasingly pronounced context of climate change, it is considered essential to study these extreme meteorological phenomena that have a significant impact on agriculture in the western part of Romania (ŞERBAN, 2010; MĂRĂZAN ET AL., 2020).

MATERIALS AND METHODS

Forecasting droughts for the growing season by analogy with previous seasons is an effective way to estimate the duration and intensity of a drought. It should be noted that the analogy and collaboration with operational meteorology. Seasonal forecasts in Romania can be treated to a good extent considering as the initial state the data from the Atlantic-European region for a time interval shorter than one year (BLUESTEIN, 1993). This is due to the relatively limited interannual variability of the climate in the Atlantic Ocean area and the lack of some: significant teleconnections for south-eastern Europe with pronounced interannual variability phenomena such as the Southern Oscillation. Of great importance in this sense is the arrangement at the synoptic level of the semi-permanent pressure centres. The synoptic archives for the advection temperature (TA) at the level of 500 hPa in the entire Atlantic-European region were used as materials for the preparation of this paper (CHEVAL, 2003; ION-BORDEI, 1983).

The year was divided into six homogeneous seasons, consisting of December-March, April, May, June-August, September-October and November. During these seasons, the advection temperature field at the level of 500 hPa shows relatively homogeneous variations in the nine districts of the Atlantic-European region. The range of variation of the advection temperature field at the level of 500 hPa for each season and district was divided into three ranges: the range of negative anomalies (-), the range of values located close to the multiannual mean (n), and the range of positive anomalies (+). Time intervals of approximately five days (during which synoptic macro-processes show homogeneity) called natural synoptic periods were considered (ENACHE, 2009; BERBECEL & STANCU, 1970).

The advection temperature field at the level of 500 hPa in the Atlantic-European region from 2010 to 2015 was averaged in time for each natural synoptic period and fitted into the characteristic structures, denoted hereafter with Roman numerals. A characteristic structure is described by a vector with nine components, each component expressing the sign of the advection temperature anomaly at the level of 500 hPa averaged over the natural synoptic period in one of the nine districts. Each season has a number of distinct characteristic structures, compatible with synoptic situations in the Atlantic-European region. Thus, the December - March interval includes 16 structures, June - August 9 structures, April and May each with 4 structures and September - November 9 structures (LACKMANN ET AL, 2017).

RESULTS AND DISCUSSIONS

From the analysis of synoptic data and geopotential maps, it is possible to observe the baric topography in the altitude, the temperature on the different levels of the troposphere and the variation of the baric centres in relation to the atmospheric dynamics at the European level. Table 1 shows a persistence of positive temperature anomalies in all analysed periods, but there is only one exception, namely the period December - March. The explanation in this case is given by the fact that spring is a season of transition between the persistent disposition of the Siberian Anticyclone and the activation of the Icelandic Depression and its action on the western area of Romania. Geopotential anomalies in altitude and their persistence indicate air advections of tropical origin. Thus, due to the penetration of warm and dry air from the area of the African continent, due to the extension of the Azorean Anticyclone to the areas close to Romania, there is a sharp decrease in cloudiness, a decrease in the amount of precipitation, an increase in potential evapotranspiration and implicitly an increase in temperature (AUSTIN, 1980). The decrease in relative air humidity is also noted, this fact being due to the characteristics of tropical air masses. During the winter seasons and until the beginning of spring, the highest value of the time intervals characterized by temperature values close to the multiannual average values is also noted (NIETO ET AL., 2005; HOFSTATTER ET AL., 2017).

The increasing trend of time periods characterized by positive anomalies is noticeable since the beginning of April, where these positive anomalies represent approximately 50% of the period of the entire month. In the month of May, the situation is similar, but the period characterized by positive temperature anomalies is more than half of the duration of the entire month. The maximum value during the year is reached during the summer months, where approximately 80% of the time is characterized as having positive temperature anomalies at the 500 hPa level.

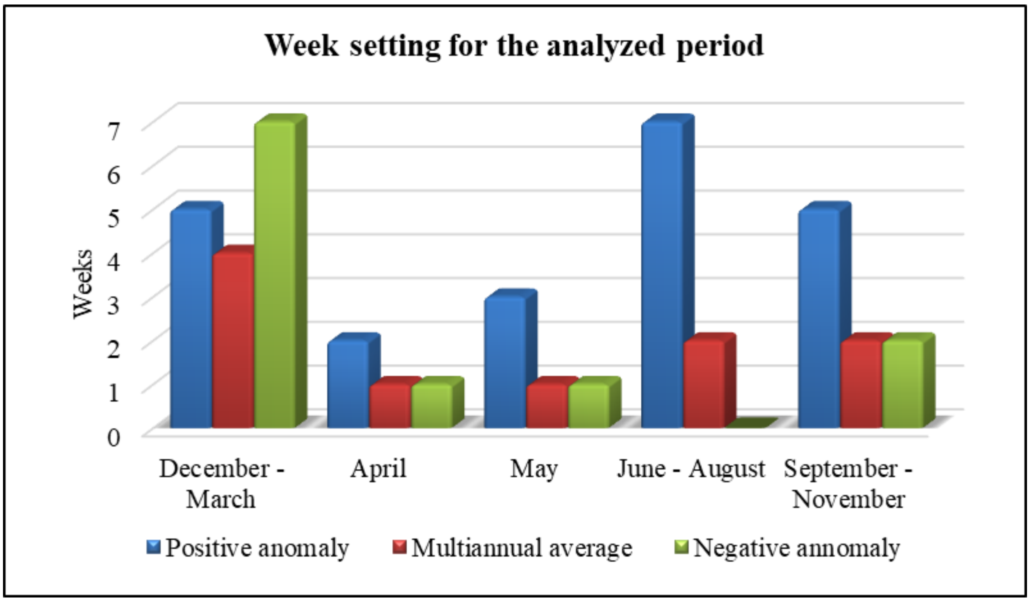

Figure 1. Duration of temperature anomalies at 500 hPa altitude

The main connection between the data presented in figure 1 above and the synoptic situation in the figures below is the exemplification of the advection of air masses of different origin.

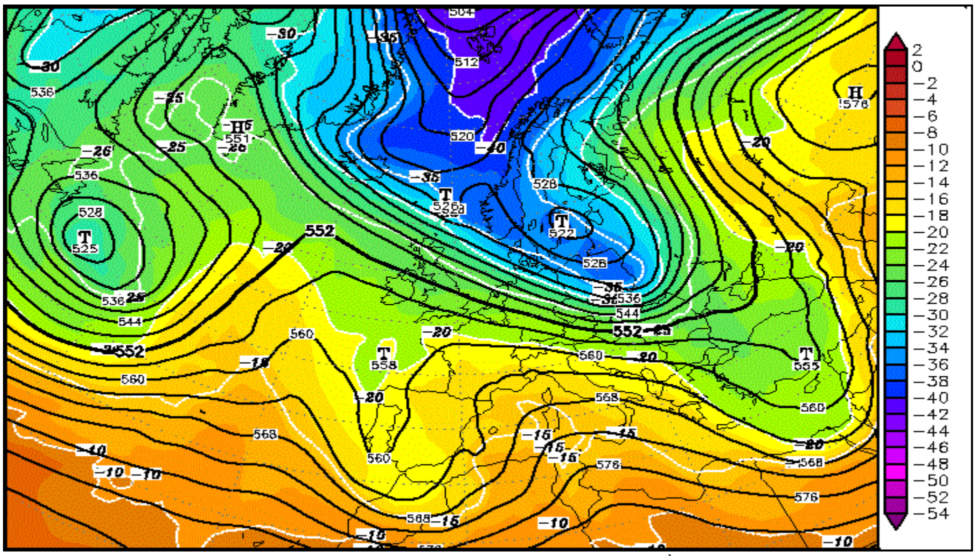

Figure 2. Temperature at 500 hPa height for the 22nd of April 2010

Figure 2 shows the temperature at the geopotential height of 500 hPa for April 22, 2010. It is noted that a mass of cold air, of polar origin, is being transported to the Romanian territory, this being an extension of the Icelandic Cyclone. The geopotential height at the level of 500 hPa is also presented, and for the northern part of Romania a strong penetration of an air mass of polar origin is observed.

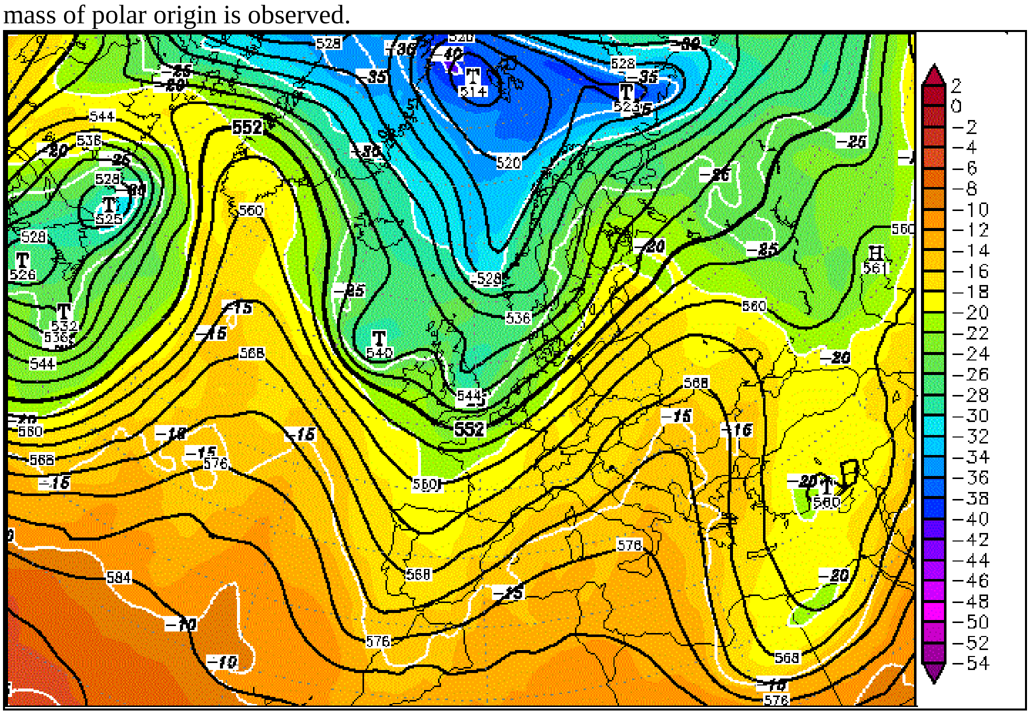

Figure 3. Geopotential height and temperature at 500 hPa height for the 1st of May 2010

Figure 3 shows the layout of the geopotential field for May 1, 2010. In this case, an air mass with tropical characteristics has advected, a fact indicated by the temperatures at the 500 hPa level. The topographic structure associated with the anticyclonic ridge accentuates the transport of tropical air masses and practically inhibits the penetration of air masses with moisture content. The distribution of semi-permanent pressure centres is narrower towards the north of the continent, and the Azoric Anticyclone shows its northern displacement, until in the southern area of Greenland a deepening of the Icelandic Cyclone is indicated.

CONCLUSIONS

The purpose of the present study was to analyse the synoptic periods from January 2010 to December 2015 and to perform a mathematical modelling to establish certain periods prone to drought.

From the obtained results, it is noted that the drought periods are closely related to the disposition of the main semi-permanent baric centres in the northern hemisphere. The predominance of positive temperature anomalies at the height of 500 hPa is noted throughout the investigated interval. A single exception appears in this regard, during the winter months and at the beginning of spring, when a period of more than 6 weeks of negative anomaly is noted. This fact is normal given the disposition of the Siberian Anticyclone during the respective period of the year. The present research is part of an extended research over a longer period.

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