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CLIMATE VARIABILITY IN BULGARIA DURING THE 20TH CENTURY

Abstract: Climate variability and trends in Bulgaria during 20th century (1901-1997) were studied. Generally, there is no significant overall trend of mean annual air temperature in Bulgaria for that century. Bulgaria has experienced several drought episodes during the 20th century, most notably in the 1930s, 1940s and 1980s due to precipitation reductions. The variations of mean annual precipitation in Bulgaria showed a decreasing overall trend. A decreasing trend in precipitation during the period from April to September from the end of 1970s was found. There is a strong tendency to precipitation deficit of about 10% during the crop growing season above both 5° and 10°C.

Key words: Bulgaria, 20th century, temperature, precipitation, variability, trends.

1. Introduction

During the recent decade the issues of climate variability have been at the centre of many scientific studies. Global climate variability caused by natural processes as well as anthropogenetic factors, are major and important environmental issues that will affect the world at the beginning of the 21st century. The earth's climate has exhibited marked „natural” variations and changes, with time scales varying from many millions of years down to a few years. Over periods of one or two years, fluctuations in global surface temperatures of a few tenths of a degree have been recorded. Climate variability in Bulgaria has been investigated by several scientists, especially by Ek. Koleva (1993, 1994).

2. Experimental Material and Method

Daily data for mean air temperature and precipitation from 16 weather stations across the country with elevations below 800 m were gathered for the period 1901-1997. Weather data had been previously evaluated for erroneous and missing values.

All observed meteorological data that were used in this study were provided by the weather network of the Bulgarian National Institute of Meteorology and Hydrology.

A method suggested by Fedorov (Gulinova 1974) was used in order to simulate the beginning, end and duration of the potential crop growing season as well as the accumulated temperature sums above a base of 5° and 10°C. Obtained time series of air temperature and precipitation anomalies were smoothed by a 5-year running average. Two non-parametric tests were used in most cases in order to determine the possible existence of statistically significant trends of air temperature and precipitation assuming a 5% probability level Mann-Kendall and Spearman rank statistics (WMO 1990).

3. Results and Discussion

The current climatic conditions are based on the period 1961-1990, according to the recommendations by the World Meteorological Organization. A minimum of annual temperature in the country appears in the first decade of the current century. After that temperature rose up to about 1925. In the earlier 1940s there was also a cold spell. There are no significant air temperature fluctuations in the 1970s and 1980s. A slightly warming is observed from the middle of 1980s till 1994 which has been the warmest year in the country since the late 19th century - the annual air temperature was approximately 1.5°C above the current climate. However, annual temperature in Bulgaria in 1996 and 1997 was below the normal. Generally, there is no significant overall trend of mean annual air temperature in Bulgaria for the 20th century (Fig. 1a). The period from the 1920s to 1950s is characterized as a warmer period during the warm-half of the year (April-September) taking into account the positive anomalies in air temperature. There has been an obvious increasing trend in air temperature during this season since the end of the 1970s despite of lower air temperature in 1991 and 1997 (Fig. 1b). A slight increasing trend in air temperature during the cold-half of the year (October-March) is observed (Fig. 1c). This trend is most obvious in winter (January-March) due to significant warming in January and February. Spring (April-June) is also tending to be warmer at the end of the 20th century, however summer air temperatures (July-August) tended to be a little bit lower. Air temperature in June has an increasing trend. On the other hand, air temperatures in July and August have an overall decreasing trend mainly due to a significant cooler spell in the 1970s. Air temperature in autumn (October-December) varied around current climatic values without any concrete changes.

Annual precipitation in Bulgaria varied considerably from year to year during the study period. In some years, very low annual precipitation ushered in droughts of different intensities. The country has experienced several drought episodes during the 20th century, most notably in the 1930s, 1940s and 1980s (Fig. 2a). Drought spells in the 1940s and 1980s were observed everywhere across the country. Drought in Bulgaria was most severe in 1945 with precipitation less than 30% of current (1961-1990) climatic values. The most significant wet spell occurred in the 1950s. It was followed also by relatively high precipitation values in the 1960s and 1970s. Generally,

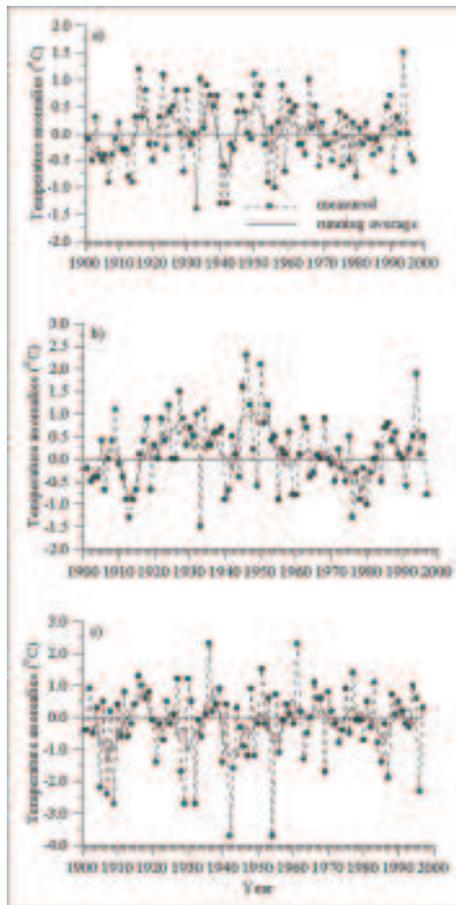


Fig. 1. Anomalies of annual (a) and seasonal (b: April-September; c: October-March) mean air temperature in Bulgaria, relative to the period 1961-1990.

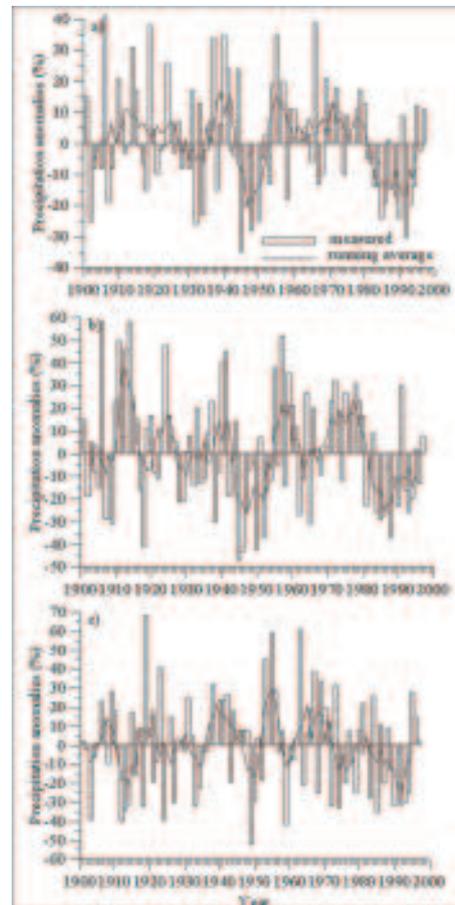


Fig. 2 Anomalies of annual (a) and seasonal (b: April-September; c: October-March) precipitation in Bulgaria, relative to the period 1961-1990.

the variations of mean annual precipitation in Bulgaria showed a decreasing overall trend (Fig. 2a). The filtered curve in Figure 2b suggests that there was a decreasing trend in precipitation during the period from April to September from the end of 1970s. Precipitation was below the 30-year (1961-1990) average for 13 of the last 17 years of investigation. 1985, 1988 and 1993 are among the driest warm-half years. There is no significant overall trend in precipitation during the cold half of the year despite of the relatively decreasing trend which has been observed since the end of 1960s (Fig. 2c). Winter precipitation deficit was observed during the last decade. Both spring and summer and also autumn precipitation have a tendency to decrease

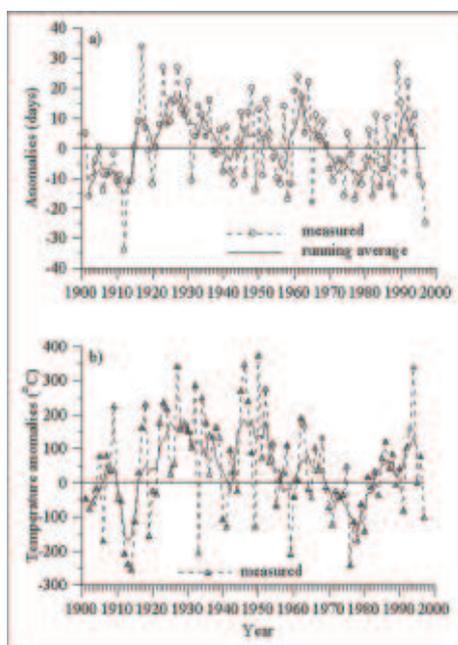


Fig. 3 Anomalies of duration of the period (a) and accumulated air temperatures (b) above a base of 10°C, relative to the period 1961-1990.

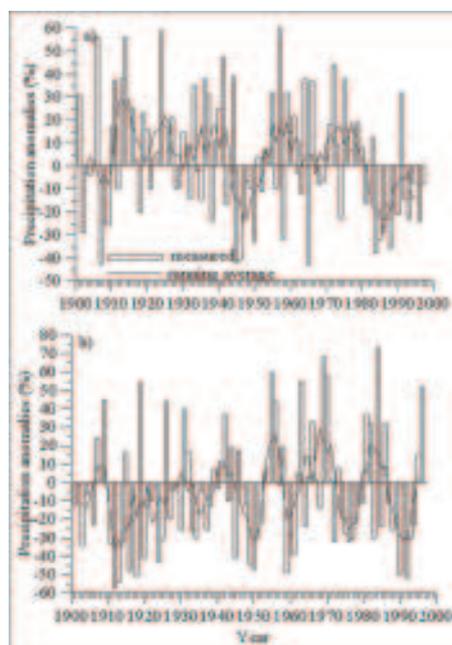


Fig. 4 Anomalies of precipitation during the period above a base of 10°C (a) and the period below a base of 5°C (b), relative to the period 1961-1990.

during the 20th century. February, April, August and December have an increasing trend in precipitation, while all other months have had precipitation reductions during the study period.

As a part of the climate variability study, long-term variations of agroclimatic indexes (beginning, end and duration of the periods above a base of 5° and 10°C; accumulated temperatures and precipitation during above periods) in Bulgaria were also determined. The beginning of the periods above bases of 5° and 10°C usually occurred in March and April, while the end of these periods can be observed in November and October, respectively. Potential crop growing seasons above the two thresholds started earlier in the 1910s and 1920s, 1940s and during the last decade except 1996 and 1997. On the other hand the beginning of the above periods occurred later in the 1900s, 1950s and 1970s. As a result of these variations, a slight trend to a later start of the period above a base of 5°C was found. The variations of the end of the period above bases of 5° and 10°C showed a 2-3 days shift back to the summer season. That is why the overall trend of the duration of potential crop growing season both above 5° and 10°C is slightly negative despite of the last positive trend in the

1980s. A shorter duration above a base of 10°C was observed during the last 3 years of investigation – the reductions of the potential crop growing season are between 9 and 25 days (Fig. 3a). Naturally, the long-term variations of the accumulated temperatures during the season above bases of 5° and 10°C were similar to the long-term variations of the mean air temperature during the warm half-year (Fig. 1b and 3b). There is a significant decreasing trend in accumulated temperatures from the middle of the 1920s till the end of 1970s. Since then an increasing trend has been observed.

Precipitation is a major factor during the growing season and has a significant impact on the crop yield potential. Precipitation during the non-growing period is also important for soil moisture accumulation and water reservoirs recharge. That is why long-term variations of precipitation during the seasons above or below bases of 5° and 10°C were also analyzed. There is a strong tendency to precipitation deficit of about 10% during the potential growing season above both 5° and 10°C. It could be seen in Figure 4a that such long drought term as that one during the potential crop growing season above a base of 10°C in the 1980s and 1990s was not observed during the 20th century. The relevant precipitation reductions during the last 2 decades were in some cases higher than 20% in the country. On the other hand, precipitation variations during the period below 10° and especially 5°C showed an overall increasing tendency (Fig. 4b).

4. Conclusions

Generally, there is no significant overall trend of mean annual air temperature in Bulgaria for the 20th century. This result is different in comparison with the trend of the global mean surface air temperature, which have increased. It confirms that local or national climate can have different variability or trends, relative to regional, continental and especially global climate variability and trends. The variations of mean annual precipitation in Bulgaria showed a decreasing overall trend. A decreasing trend in precipitation during the period from April to September from the end of 1970s was found. There is a strong tendency to precipitation deficit of about 10% during the potential growing season above both 5° and 10°C. It is difficult to predict precipitation variations during the next century. However, drought occurrences in the 1980s and 1990s have persisted for a long time, prompting one to ask if precipitation deficit is becoming more frequent or extensive. The obtained averages and trends of climate variability can be used by researchers to assess current climatic fluctuations and variability and the expected climate change for the 21st century.

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