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Extreme climatic events in the precipitation time series in Romania and their impact in the Danube inferior basin

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The daily, monthly, seasonal and annual precipitation time series for several stations in Romania have been considered for the period 1901-2003.

For the daily precipitation, at five stations (Arad, Bucharest, Constanta, Iasi and Sibiu) the dry spells were defined as those with 20 subsequent days without precipitation. The periods with precipitation excess were considered as those for which the total precipitation over subsequent five days exceeded 85% of the threshold values of 50 mm. A transformation procedure was proposed for the probability of the concrete statistical distribution into one close to the Gaussian one. Interesting results, which depend on the season and station, have been obtained, calculating the occurrence probabilities of drought periods ($>$ 20 days) and the rainy ones (daily amounts $>$ 10 mm) and by estimating the mean return period. Details about the statistical methods used in the investigation of extreme events in daily precipitation and about the obtained results are found in Mares and Mares (1993).

For the monthly, seasonal and annual time scale, drought index (DI) time series were calculated by means of the standardized anomalies of temperature and precipitation (Mares et al., 2002a, b). This index is very similarly with the Palmer Drought Severity Index (PDSI). The DI time series were estimated both for four stations (Bucharest, Constanta, Timisoara and Sibiu) with long series of observations (over 100 years) and for the 33 stations in Romania for the period 1950-2003, filtered by the first principal components of empirical orthogonal functions (EOF) decomposition.

An analysis of the internal structure of the DI time series was achieved, testing homogeneity and climate change points both for seasonal and annual values.

In order to test the existence of common climate changes in the variables at the local scale and in the atmospheric circulation at large scale, an analysis of internal structure of geopotential field at 500 hPa over Atlantic-European region was carried out.

For the ***annual values***, over the European sector as well as over the European sector (excepting for the north-western part), the geopotential field presented a change-point in 1981, with higher values after this year. The year 1981 has been also found as a change-point to a drier period in the DI in Romania.

In the ***wintertime***, climate change in DI occurred in 1970/1971. The increases of the geopotential field after this date, especially over Europe, led to a diminution of the precipitation amounts and intensify of the drought event in the Romanian area. This result is in accordance with Beniston (2005), who shows that a change was occurred in the beginning of the 1970s in the North Atlantic Oscillation (NAO) index, a change reflected in the behaviour of the maximum temperature in the Alps.

The NAO index was found that is also a good predictor for temperature and precipitation time series in Romania and the Danube basin (Mares et al., 2002b).

During the **summer and autumn** time, the climate change points in the drought index time series in Romania occurred in 1969-1970 and in 1981. In the first case, the transition was to a wetter interval, while 1981, represents the transition to a drier period.

In the 500 hPa field, changes around 1968-1970 in the summer and autumn time, also occurred.

Due to the occurred changes mainly in the last 30 years; in some of our investigations we considered the reference period 1971-2000 instead of 1961-1990 both for the temperature and precipitation fields. From the comparison of differences between the two periods of total precipitation from 33 stations in Romania, the mean precipitation amounts decreased in all these months, except for September and October, where for some stations a slight increase was noted. The monthly temperature means for the period 1971-2000 are generally greater than in the period 1961-1990, except for autumn months where a slight decrease is evidenced. The greatest increase of temperature is remarked in January, where for some stations there is an increase greater than one Celsius degree.

The recent heat waves that affected many parts of Europe were investigated in Beniston and Diaz (2004) and Beniston and Stephenson (2004), where the principal extreme event was 2003 heat wave. In 2003, Romania was situated at the periphery of block-

ing high-pressure system and 2003 summer was very hot and it was exceeded only of summer 1946. For instance, for Bucharest, monthly mean temperature was 24, 13 C degree for summer of 2003, and of 24, 87 C degree in summer 1946.

Atmospheric circulation over Europe in 2003 led to the very low discharge level of the Danube on the Romanian territory. In September 2003, discharge level in the Danube inferior basin reached absolute minimum since 1840. This extreme event affected natural ecosystems, agriculture, water supply, energy demand, navigation, etc.

Concerning the simulations by global climate models, for the Romanian area the post-processing of time-slice experiments with ECHAM3-T42 indicated that the CO_2 increase leads to an increase of the drought frequency in the Romanian region (Mares et al., 2002c).

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