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Climate variability of the hydro-meteorological extreme events in Romania

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The purpose of this study is to analyze climate extremes for monthly and seasonal values of temperatures, precipitation and discharges defined in 27 stations distributed relatively evenly throughout Romania. For the beginning, for each season a drought index was calculated from the difference between standardized temperature and precipitation (STPDI) for a period of 68 years (1931-1998) compared with self-calibrated Palmer Drought Severity Index (sc-PDSI). The sc_PDSI values with a resolution of 0.5 degrees longitude by 0.5 degrees latitude were extracted from Climate Research Unit (http://www.cru.uea.ac.uk/data/).
The analyses of histograms of the two indices for several stations in Romania revealed as values defining extremes depend on the season and location, but generally the values higher than 4 in the absolute value, indicate drastic extreme events, with the only difference that the two indices have reverse signs.
A negative value of sc_PDSI < - 4 indicates an extreme drought, while a value < - 4 of STPDI shows an extremely wet event and vice versa.
The sc-PDSI is more sensitive to location where is calculated, in comparison with classical PDSI and therefore it can give more accurate differentiation between different areas described by this index.
In the next step of our analysis we retained only STPDI for several reasons. First, STPDI is a better predictor for discharges in Romania than sc-PDSI (correlations are closer between STPDI and discharge than between sc_PDSI and discharge). Response to large-scale atmospheric circulation expressed here by North Atlantic Oscillation (NAO) is better and this index is easier to estimate from the values simulated by climate models (GCMs / RCMs). In addition, spatial climate differences can be outlined just as well as using sc-PDSI values by means of modes 2 and 3 of the EOF decompositions.
Climate variability of STPDI was analyzed both for the entire country by the EOF decomposition and separate for each of the 27 stations.
The time series of the STPDI have been analyzed using Pettitt and Mann-Kendall statistical non-parametric tests, in order to find the eventual climate change points, as well as the climate tendency. The quantification of the climate change intensity has been achieved by estimating the signal-to-noise ratio. The same procedures were applied for discharge values and the NAO index values. For the winter season, significant change points, were highlighted both in the principal component (PC1) of the EOF decomposition of STPDI, and in the NAO values around the year 1970.
Regarding the link between atmospheric circulation (NAO) and PC1 of STPDI, the most significant results were obtained for winter. Analyzing the influence of NAO on areas, the stations located within the Carpathian arch respond better to the NAO than those located in southern and eastern Romania.
Related to the spatial variability STPDI, the mode 2 has revealed five relatively homogeneous areas. Also by Pardé coefficients calculated for the monthly discharges from the 27 stations, were found homogeneous areas, especially for spring and early summer, areas vulnerable to occurrence the floods. The identification of these homogeneous areas is illustrated by the Hovmöller diagram. Also, to better highlight the impact of climate change on hydrological regime in Romania area, the information entropy theory was applied. The entropy concept was used to define the relationship of drought and flood sequences with the time series of the STPDI and Pardé coefficients.
For the 21-st century we estimated NAO by means of PC1 of sea level pressure from five GCMs: CNRM-CM3, ECHAM5-MPI, EGMAM, IPSL-CM4 and METO-HC-HADGEM2 (A1B scenario ENSEMBLES project).
From the models which reproduce well NAO in the 20-th century, we obtained the frequency of NAO events during winter, with positive and negative phases in the 21-st century. Frequency of both positive and negative phases of NAO in the 21-st century is higher compared to the 20-th century, which favors the occurrence of extreme events especially in the western part of Romania. The occurrence frequency of the positive phase of NAO index is greater than of the negative phase, favoring increased frequency of dry periods.