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Hydrological response in the Danube lower basin to some internal and external forcing factors of the climate system

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The precipitation in the Danube upper and middle basin is the main indicator for the Danube discharge at the entry in the lower basin. Along with precipitation, from the category of internal factors, in the first stage, we tried to find other predictors from the fields of temperature, pressure and geopotential.
In the second phase, we considered external factors, taking into account the indices of solar/geomagnetic activity, represented by Wolf numbers, 10.7cm solar flux/aa geomagnetic index.
In the Danube upper and middle basin, were considered fields of precipitation (PP), and temperatures (T) at 15 meteorological stations. The large-scale atmospheric circulation was quantified by Greenland-Balkan-Oscillation index (GBOI), North Atlantic Oscillation index and by blocking indices. The hydrological state in the Danube lower basin was represented by the discharge at the Orsova station.
To estimate the discharge response in the Danube lower basin to various factors, developments in EOFs, cross correlations, power spectra, filters, composite maps were achieved.
For the atmospheric variables, taken simultaneously, the most significant results (confidence level of 95%) are related to the predictors, considering the difference between standardized temperatures and precipitation (TPP), except for winter season, when the best predictors are PC1 of precipitation field and GBOI.
In order to see the predictive hydrological response to the considered predictors, the correlative analyses with some lags were achieved. The significant results, were obtained for the winter/spring variables (PC1-precipitation and TPP), which can be considered good predictors for spring/summer discharge in the Danube lower basin. The hydrological response to the solar/ geomagnetic activity is given with a delay of two and three years.
Due to the important signal of GBOI in the Danube basin precipitation in winter (correlation coefficient of 0.83), a stochastic modeling was performed between GBOI and PC1-PP, by means of a nonhomogeneous hidden Markov model with five states. From the emission matrix, the probabilities of the discharge states, associated with the states of atmospheric circulation, were estimated.
From the preliminary tests on the links between discharge and internal and external factors, achieved by neural networks (NN), nonlinearity existence for some of the predictors was highlighted. In this case to increase the prediction skill, nonlinear regression equations were developed.