Geophysical Research Abstracts
Vol. 18, EGU2016-6394, 2016
EGU General Assembly 2016

Monthly to seasonal trends of streamflow in Romania and their connection with large-scale atmospheric circulation

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Water resources management has become a challenging issue in the southern Europe, an area under a recurrent water stress. It is widely known that hydrologic variables, such as streamflow, are significantly influenced by various large-scale atmospheric circulation patterns. The identification of relationships between the climate conditions given by these patterns and the seasonal streamflow may provide a valuable tool for long-range streamflow forecasting, adding helpful information for developing efficient water-management policies. As such, the aim of this study is to detect the trends in observed hydrological data and to look for the physical mechanisms responsible for the seasonal modes of inter-annual variability of mean streamflow over Romania in connection with teleconnections indices and atmospheric circulation patterns.
The trend detection is performed for the monthly, seasonal and annual mean streamflow and the Standardized Streamflow Index (SSI) for an accumulation period of 1 month at 46 stations located over the whole Romanian territory, over the period 1935 - 2010. The results of the trend analysis show increasing trends (95% confidence level) in winter, spring, autumn and at annual time scale over the north-western part of the country and decreasing trends (95% confidence level) in spring over the southern part of the country.
To identify the physical mechanisms responsible for the relationships between the annual and seasonal time series of the mean streamflow and large-scale atmospheric circulation patterns, the potential impact of large-scale climate patterns of the Arctic Oscillation (AO), North Atlantic Oscillation (NAO), El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO) and Atlantic Multidecadal Oscillation in modulating streamflow variability at country level is assessed. The correlation map analysis between the annual and seasonal streamflow time series and the Northern Hemisphere teleconnection patterns emphasize that AO and NAO show the highest correlations with the mean streamflow for winter, spring and autumn seasons. For the winter and summer seasons, high correlations between the mean streamflow and PDO are also found, especially over the north-western part of the country. Due to the fact the is has been shown that the relationship between the pre-defined teleconnection patterns (e.g. NAO, ENSO) and climate and hydrological variables is non-stationary, we also test the relationship between the seasonal and annual mean streamflow variability in connection with daily circulation patterns in the North Atlantic regions, as defined in the EMULATE project. Using the EMULATE long-term reconstruction of daily circulation patterns in the North Atlantic region, we show that the interannual streamflow variations over Romania are related with different circultion patterns specific to each season, which do not necesarrly project onto well know climate modes of variability (e.g. NAO, AO).