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Estimating Romanian rainfall contribution to lower Danube discharge

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The lower Danube (Romania) irregularly experiences disastrous floods (e.g. 2006) and droughts (e.g. 2003). In the future, rainfall will become more intense over mid-latitudes under enhanced CO_2 concentrations. However, on regional to local scales considerable uncertainties about future rainfall intensity and frequency remain. It is thus essential to estimate future flood and drought frequencies for the lower Danube to ensure appropriate measures can be taken.

In a first step towards this goal, the contribution of Romanian rainfall to lower Danube discharge is investigated under present-day and historical conditions. Statistical downscaling is applied to attribute Romanian rainfall to surface pressure fields that are simulated with high reliability in Global Circulation Models (GCMs), using Circulation Weather Types (CWTs). The statistical downscaling is trained with measured rainfall at several stations in the lower Danube catchment. The method is applied to historical simulations and results are compared to discharge records from the lower Danube (SW Romania and Danube Delta).

CWT analysis for 25˚E, 45˚N shows significant positive (negative) correlation of rainfall with cyclonic (anti-cyclonic) days. During summer, rainfall originates for NE and N CWTs (low pressure over Black Sea), while during winter E and SE CWTs (low pressure over eastern Mediterranean) contribute the most rainfall days. Westerly (SW, W, NW) CWTs are negatively correlated with rainfall due to diffluence effects south of the Carpathians.

Hidden Markov Chain (HMC) analyses are conducted using daily Danube discharge at the station Orsova, (SW Romania), where the Danube enters Romania. Seven equally probable states are calculated, with the lowest discharge (state 1: $<$3140 m^3/s) correlated to the anti-cyclonic CWT and the highest discharge (state 7: $>$8126 m^3/s) correlated to the cyclonic CWT. The result is due to relatively large area of influence of the cyclonic and anti-cyclonic CWTs.

To integrate lower Danube basin rainfall contribution to Danube Delta floods, results from the CWT analysis are related to relative discharge deviation at Orsova and the Danube Delta. Results show that part of the Danube Delta discharge signal can be attributed to Romanian rainfall (or absence of it), but contributions of the upper Danube catchment are at least as important to estimate Romanian flood and drought conditions, as local precipitation. Therefore it would be necessary to include rainfall conditions in the upper and middle Danube basin to reliably estimate future floods or droughts in the lower Danube.