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Large-scale teleconnection patterns associated to Rhine river streamflow variability in spring and autumn

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In this study we investigate the relationship between large-scale atmospheric patterns and Rhine river streamflow variability, for spring and autumn, respectively.

We show that the streamflow anomalies are correlated to different climate related patterns during the transition seasons (e.g. spring and autumn). In spring, the streamflow anomalies are related with a sea surface temperature (SST) pattern which resembles the El Niño - Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO) SST anomalies, while in autumn, the streamflow anomalies are related to SST anomalies just from the Atlantic Basin.

Associated with the SST anomalies, there are consistent atmospheric patterns which induce high (low) streamflow anomalies over Rhine catchment area. Regions with negative SST anomalies are associated with high vorticity and more dense air and the development of low-pressure systems, while the opposite happens in the case of positive SST anomalies. As a consequence, in agreement with the SST patterns, high streamflow anomalies over Rhine catchment area are associated with a strong and deep low-pressure system over the British Isla and the north-western part of Europe and a shift southward of the Atlantic Jet axis, in both seasons. The axis of the Atlantic and African Jet, as well as the advection of moist air from the ocean, plays a crucial role in the variability of Rhine streamflow.

Wavelet and cross spectra techniques are also used to identify the coherent cyclic and non-stationary modes in the Rhine streamflow time series for spring and autumn. In spring, the wavelet power spectra for Rhine flow reveals that the power is broadly distributed with peaks in the 2 to 8 years, 8 to 16 years and 16 to 30 years bands. The 95% confidence levels demonstrate that these peaks are not stationary in time, and that the Rhine streamflow variance has varied in time.

The wavelet power spectra for autumn Rhine flow is characterized by strong interannual variability as well as decadal variability. The power is distributed, like in the case of spring streamflow, in the 2 to 8 years band, as well as in the 8 to 16 years band. The main difference, when compared with spring streamflow, is the strong and significant peak in the 30 to 60 years band.

The research presented here contributes to a better understanding of how the interannual and the decadal climate phenomenon influence the streamflow variability.