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Wavelet analysis of the streamflow variability in the Inn catchment and inter-annual to inter-decadal coherence with dominant large-scale climate indices

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Understanding the temporal and spatial variability of river discharge and the impacts of large-scale climate oscillations on Alpine hydrological systems is of particular interest in Europe due to their relevance in water provisioning. Moreover, river discharge in Alpine catchments is very sensitive to climatic drivers, although it may show a delayed response and hence the correlation between climatic drivers and streamflow is challenging to be properly identified and modelled. For this purpose, wavelet transform (WT) is recognized as a suitable tool, since it is able to determine the crucial scales of variability and localized variations in the modes of variability within time series. In this work, we decomposed the streamflow signals in various levels using Discrete Wavelet Transform and we compute the correlation between these levels for eight gauging stations located along the Inn River. In addition, we use the same method to investigate the correlation with three climatic indexes: the North Atlantic Oscillation Index (NAOI), the Artic Oscillation Index (AOI) and the Mediterranean Oscillation Index (MOI). These analyses are performed for yearly and seasonal time series. Finally, the analysis is completed considering the Wavelet Coherence between streamflow time series and climatic indexes. Wavelet coherence analyses show four different behaviors of the eight analyzed gauging stations, related with the mean elevation of the catchment and the catchment area. A loss of coherence between the time series located at different elevations becomes significant at 2-4 years scales starting around 1980. Our analysis also highlights the heterogeneous response of the streamflow time series towards changes in climatic indexes depending on the mean elevation of the catchment. This research contributes to our understanding of streamflow variability over the Eastern Alps, and the role of NAO, AO and MO phenomena on this variability. These relationships can be also used to improve hydrological forecasting and water resources management in the Alpine region.