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Evaluation of meteorological drought indices for streamflow modeling

Klaus Haslinger (1), Daniel Koffler (2), Günter Blöschl (3), Juraj Parajka (3), Wolfgang Schöner (1), and Gregor Laaha (2)

(1) Central Institute for Meteorology and Geodynamics, Climate Research Department, ZAMG, Vienna, Austria (klaus.haslinger@zamg.ac.at), (2) Institute of Applied Statistics and Computing (IASC), University of Natural Resources and Life Sciences, BOKU, Vienna, Austria (gregor.laaha@boku.ac.at), (3) Institute of Hydraulic Engineering and Water Resources, Centre for Water Resource Systems, Vienna University of Technology, TU-Wien, Vienna, Austria (bloeschl@hydro.tuwien.ac.at)

In this paper we present a comprehensive analysis which aims to link various meteorological drought indices to streamflow data in Austria and Central Europe. The motivation arises from the fact that discharge time series are usually shorter (beginning in the middle of the 20th century) than meteorological time series. In the European Greater Alpine Region we are fortunate of having a gridded dataset for temperature and solid/liquid precipitation on a monthly time scale that spans from 1801 to 2003 – the HISTALP database. If there is a link between meteorological drought indices and streamflow, a reconstruction of streamflow, with emphasis on low flows, will be possible for the last 200 years.

As meteorological drought indices the self-calibrating Palmer Drought Severity Index (scPDSI), the Standardized Precipitation Index (SPI) on various time scales as well as the moisture departure value d from the soil moisture modeling procedure of the scPDSI are used. The analysis focuses on three aspects, (i) temporal co-evolution of meteorological drought and streamflow indices, (ii) their at-site correlation at gauges, and (iii) their regional correlation structure depending on different climate and catchment conditions. The whole analysis is stratified by seasons, what allows us to explore the strength of the link for the dominant low flow generating process.

In order to show a connection between these indices and streamflow data the drought event of 2003 serves as a reference. We will show the temporal evolution of the drought indices parallel to streamflow indices like MQ, Q95 and MAM(7) for the period from summer 2002, which encompasses a major flood event in the northern parts of Austria, to fall 2003 when the streamflow drought was most severe. This is carried out for different regions in Austria, representing different climatic and soil-specific characteristics.

To quantify the link between drought indices and streamflow indices for the whole time series from 1801-2003, rank correlations are calculated, stratified by three different approaches. First, as mentioned above, a regional assessment is carried out. Second, the correlations are calculated separately for seasons (DJF, MAM, JJA, and SON). Third, different quantiles of the streamflow-data, ranging from Q50 to Q95, will be correlated with the drought indices.

The results show that there is definitely a strong connection between the MQ and the scPDSI in one target region in the Northwest of Austria. The results are encouraging for further attempts to reconstruct extreme low flow events from meteorological data only. A statistical model for linking meteorological drought indices with streamflow under dry conditions is currently under development and results will be presented in the near future.