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Variability and changes of drought-relevant circulation types in southern central Europe

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The estimation of regional extreme events (heavy precipitation and droughts) in Central Europe under ongoing climate change especially includes an evaluation of the relationship between atmospheric circulation types and regional droughts taking place in the bilateral research project WETRAX+ (WEather Patterns, Cyclone TRAcks, and related precipitation EXtremes). The study area is located in the south of central Europe, including Austria, parts of Germany, Switzerland, and the Czech Republic.

For a precipitation-conditioned circulation type classification, atmospheric variable fields from gridded daily JRA55 reanalysis data (Japan Meteorological Agency 2018) and gridded daily precipitation data based on 1756 weather stations in the study area (Zentralanstalt für Meteorologie und Geodynamik 2018) were used for the observation period 1961 to 2017. Seven different regional climate model runs of the Euro-Cordex – Initiative and from ReKliEs-De (Regional Climate Projections Ensemble for Germany) as well as three runs of the global climate model ECHAM6 (greenhouse gas scenario RCP 8.5) were used to estimate future changes in two projection periods (2031-2060 and 2071-2100).

The large-scale atmospheric circulation types have been derived using a non-hierarchical cluster analysis provided in the COST733 Classification Software. The drought-relevant circulation types are determined according to relative frequencies of circulation type days under a particular percentile of precipitation: If at least 20 percent of the circulation type days are below the 20th percentile of precipitation, the circulation type is defined as drought relevant. Drought-relevant circulation types are examined in terms of trends, persistence, changes in monthly occurrence frequencies, and within-type variability. When transferring the circulation types to the climate model data, each single day of the projection period is assigned to the circulation type to whose centroid fields the respective single fields have the smallest Euclidean distance.

During the observation period, the trend analyses show that the occurrence of drought-relevant circulation types is significantly more often associated with higher temperatures and lower relative humidity. First results of the analysis for the future climate show an increase of central high-pressure areas over Central and Eastern Europe for the months April to September. Anticyclonic weather conditions with a resulting southwesterly flow occur less frequently.