



European-scale drought: understanding links between atmospheric circulation and climatological drought indices

Daniel Kingston (1), James Stagge (2), Lena Tallaksen (2), and David Hannah (3)

(1) Department of Geography, University of Otago, Dunedin, New Zealand (daniel.kingston@geography.otago.ac.nz), (2) Department of Geosciences, University of Oslo, Oslo, Norway, (3) School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, UK

Currently no seasonal drought forecasts exist for Europe and there is a need to advance our understanding of the main drought controlling mechanisms. This study aims to identify continental and regional scale climatological drivers of European-scale drought. Drought events are identified using two indices, the 6-month cumulative Standardised Precipitation Index (SPI) and Standardised Precipitation-Evapotranspiration Index (SPEI), and their relationships to large-scale atmospheric circulation are investigated. The SPI, recognised as a universal meteorological drought index, measures anomalies in precipitation, whereas the more recently proposed SPEI measures anomalies in climatic water balance (precipitation minus potential evapotranspiration) and thus provides a more comprehensive measure of water availability. Using the Watch Forcing Dataset (a bias-corrected version of the ERA-40 reanalysis data set), we develop a monthly time series for 1963-2001 of the percentage of the European continent in drought, defined here as where SPI-6 and SPEI-6 values are below the q20 threshold (i.e. 20% non-exceedence frequency) for a given month. Correlation of the SPI and SPEI drought time series with ERA-40 geopotential height fields indicates a consistent year-round relationship with hemispheric circulation, which is strongest in the winter half-year. Spatial patterns of correlation coefficients show the controlling influence of the westerly circulation on the development of European drought, with weak westerly circulation associated with drought onset. At the hemispheric scale, these patterns resemble the geopotential height signature of the East Atlantic/Western Russia (EA/WR) mode of atmospheric circulation. Composite and event-based analyses are used to examine the relationship between atmospheric circulation and the most widespread European droughts, as defined by spatial extent. For SPI-6, the most severe droughts begin typically in March, and are centred in northern Europe. The North Atlantic Oscillation (NAO) is the most important mode of atmospheric circulation for SPI drought development. A higher number of large-scale SPEI-6 events occur in comparison to SPI-6, with a greater variety in both spatial location (i.e. northern, southern and pan-European scale) and start date. Correspondingly, atmospheric circulation patterns associated with SPEI-6 events are more variable than for SPI-6 events, with the EA/WR, NAO and Scandinavian circulation modes all implicated to varying extents. These results indicate the complexity of climate drivers of European scale drought, but that there is also some inter-event consistency in forcing mechanisms. Differences between the atmospheric drivers identified for droughts defined by SPI or SPEI may be explained partially by differences in the underlying drought type, location, seasonality and regional factors implied by these indices, as discussed further in the presentation.