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Drivers of meteorological drought severity in the European Greater Alpine Region during the last two centuries

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Sustained dryness as a consequence of precipitation deficit can lead to serious impacts along many aspects of human society. From a meteorological/climatological point of view drought is typically either analyzed through event based case studies or precipitation variability is investigated in general, where drought is only one tail of the distribution, not considering its rather complex space/time characteristics (duration, size, intensity...). In this study we make use of a newly derived dataset of the spatiotemporal features of drought events in the Greater Alpine Region of Europe during the last 210 years (Haslinger and Blöschl, 2017) and aim to identify the relevant atmospheric processes using a Circulation Type (CT) reconstruction tailored for the Alpine Region with precipitation as the focus variable (Schwander et al. 2017).
In general, drought intensity is higher during periods with increased frequency of anticyclonic (dry) CTs in expense of cyclonic (wet) CTs, as would be expected. However, this relationship is not stable over time. 30-year moving linear regressions of annual CT frequency anomalies against annual drought intensity shows explained variances ranging between zero (late 19th century) and 0.5 (middle of the 20th century), indicating that CT anomalies only explain parts of the phenomenon of drought. Considering the driest decades during the last two centuries, the 1860s and the 1940s we demonstrate that these are not necessarily forced solely by higher frequencies of anticyclonic CTs, but rather through increased northeasterly to easterly flow towards the Alps in expense of westerly flow, reducing the amount of moisture transport from the Atlantic.
Using a subsample of the 30 most severe events we furthermore investigated the relationship of observed precipitation versus precipitation expected from the succession of the CTs during these events. We are able to show that the precipitation deficit of recent cold season events is reasonably well captured by using the expected precipitation from the CTs, whereas events in the 19th century show even less precipitation as would be expected. Furthermore, we found out that precipitation efficiency of CTs during warm season droughts is steered substantially by preceding soil moisture conditions, where already established drought conditions lead to decreasing precipitation efficiency. This is particularly the case for low air pressure gradient, and therefore local convection permitting CTs which are not able to generate sufficient rainfall due to a negative soil moisture-precipitation feedback.

Haslinger, K., and Blöschl, G. (2017). Space-time patterns of meteorological drought events in the European Greater Alpine Region over the past 210 years. Water Resources Research, 53, 9807–9823. https://doi.org/10.1002/2017WR020797

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