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On the subseasonal clustering of European extreme precipitation events and its relationship to large-scale atmospheric drivers

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Extreme precipitation events that occur in close succession can have important societal and economic repercussions. Few studies have investigated the link between large-scale atmospheric drivers and temporal clustering of extreme precipitation events on a subseasonal scale, i.e. 20-day time scale. Here we use 40 years of reanalysis data (ERA-5) to investigate the link between possibly influential atmospheric variables and the temporal clustering of catchment-averaged extreme rainfall events in Europe. We define extreme events as exceedances above the 99th percentile and runs of consecutive days are declustered. We then explicitly model the seasonal rate of extreme occurrences using penalized cubic splines. The smoothed seasonal rate of extremes is then used to (i) infer the significance of subseasonal clustering and (ii) serves as the baseline rate for the subsequent modelling step. We use a Poisson generalized linear model with the baseline rate set as an offset to model the relationship between the temporal clustering and predictor variables. These variables are the North Atlantic Oscillation (NAO), the Arctic Oscillation (AO), atmospheric blocks, and a measure of the recurrence of synoptic-scale Rossby wave packets (RRWPs).

Initial results from four carefully selected catchments reveal the following patterns: for south-western Spain, the NAO, and AO indices tend to be notably lower on significantly clustered extreme rainfall days, whereas for northern Scotland the opposite effect is observed. Also, for south-western Spain, the Greenland atmospheric blocking frequency is significantly enhanced on clustering days. Last, on clustering days in north-western France, Scandinavian blocks are significantly more frequent.

For a complementary study on a methodology to identify subseasonal clustering episodes of extreme precipitation events and their contribution to large accumulations please refer to Kopp et al.