Developing and validating a model for the statistical downscaling of UK daily extreme precipitation

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Weather in the United Kingdom is dominated by the large scale atmospheric circulation. To describe the relationship between the large scale airflow and local scale extreme daily precipitation, we developed a vector generalised additive model. This model uses airflow strength, vorticity and direction to predict the extreme value distribution of monthly maxima of daily precipitation at 689 rain gauges across the UK. To avoid over-parameterisation, and to ensure a high predictive power, we cross validated different versions of the model based on quantile verification scores. We compared linear and nonlinear versions, separate models for each season versus a model for the whole year, a model without an explicit annual cycle versus a model with an explicit annual cycle, and models with only one predictive airflow variable instead of all three, and investigated the spatial patterns of the cross validation for all seasons. We found that relationships are considerably stable throughout the year so that we could model the whole year using the same statistical model including an additive annual cycle. Nevertheless, the relative importance of the different air flow variables changes throughout the year and spatially. Depending on location and season, linear trends help to improve the model.