Catchment-based climatological rainfall distributions for hydrometeorological verification

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1. Background

Catchment area mean precipitation is used as the unit for precipitation verification for hydrological purposes alongside a joint precipitation and river-flow ensemble verification framework (Anderson et al., 2019). This is applied (Cole et al., 2021) to ~16 months to operational ensemble forecasts. A further enhancement was the calculation of time-window probabilities (TWPs). Which are intended to mirror what a hydrometeorologist does: scanning for the likelihood of a precipitation threshold exceedance at any time within a 24-, 48- or 72-hour period (time window). This allows for the objective evaluation of the quality of the ensemble precipitation guidance. TWPs, at the very least, mitigate against the impact of timing errors in the precipitation forecast, whilst increasing the detection of threshold-exceedance events. TWPs are derived by examining the precipitation across all the grid-cells in a catchment, not just the catchment-mean or –median precipitation. The probability for the time window is then derived by counting the number of ensemble members that have any exceedances (that also meet a coverage criterion) at any time during the time-window.

2. Climatology derivation

Previous work has shown that the use of fixed thresholds to define hydrological events of interest is unsatisfactory. Using a climatological distribution of precipitation for each catchment to identify events of hydrological interest provides better guidance on the variability of precipitation across the UK. This way more "extreme" precipitation values for a given catchment can be examined, since what is extreme for a low-rainfall catchment may be normal for a high-rainfall catchment. To create these climatological catchment-precipitation thresholds, ten historical years of gridded 1-km rain gauge-rainfall data from 2007--2016 were analysed to compute hourly and daily precipitation values corresponding to the 90, 95 and 99th percentiles of their respective. Figure 1 provides a snapshot of the catchment-based annual 99th percentile thresholds over England & Wales (E&W) for daily and hourly accumulations. For the annual all days-in-the-year are used, and a rolling 91-day window is applied to each day to provide a seasonal perspective. The 99th percentile is 4 mm/h or less for most of E&W away from high ground.

3. Application

The verification framework, TWPs and climatologies are applied to evaluate the operational Best Medium Range (BMR) precipitation ensemble forecasts, which extend out to over six days and issued four times a day with 24 ensemble members. The BMR combines data from the STEPS extrapolation nowcasting system, the 2.2 km convection-permitting MOGREPS-UK ensemble, and the ~20 km MOGREPS-G ensemble. All data are downscaled onto the fixed 2 km fixed grid over the UK. To illustrate the use. Figure 2 provides the Brier Skill Score (BSS) for a summer season (JJA) with catchments coloured dark red indicate negative skill scores. Here forecasts (on average) are worse than the sample climatology. The 4 mm/d threshold is shown to be very extreme with very little skill here. The seasonal and annual thresholds are much lower as per Fig 1 and show more skill. Generally, TWPs show more skill. Figure 3 shows the same results but for daily accumulations with a fixed threshold of 8 mm/d. Figure 3 shows the results for the daily accumulations, where a larger threshold of 8 mm/d is used as the fixed threshold. In this instance there is only low skill but some increase in skill when TWPs are used and the climatological thresholds, which also tend to be lower than 8 mm/d in many instances.

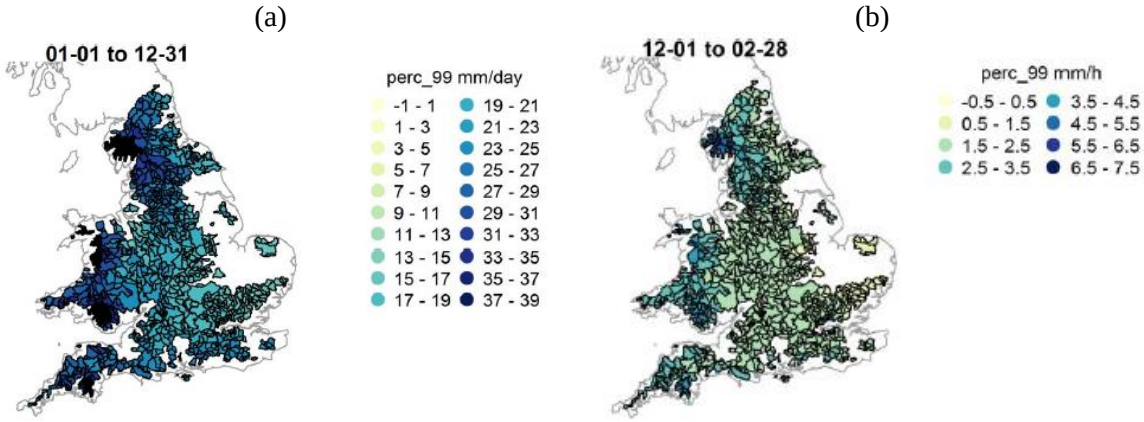

Figure 1 Examples of annual daily and seasonal hourly 99th climatological percentile thresholds for each of the catchments in England & Wales.

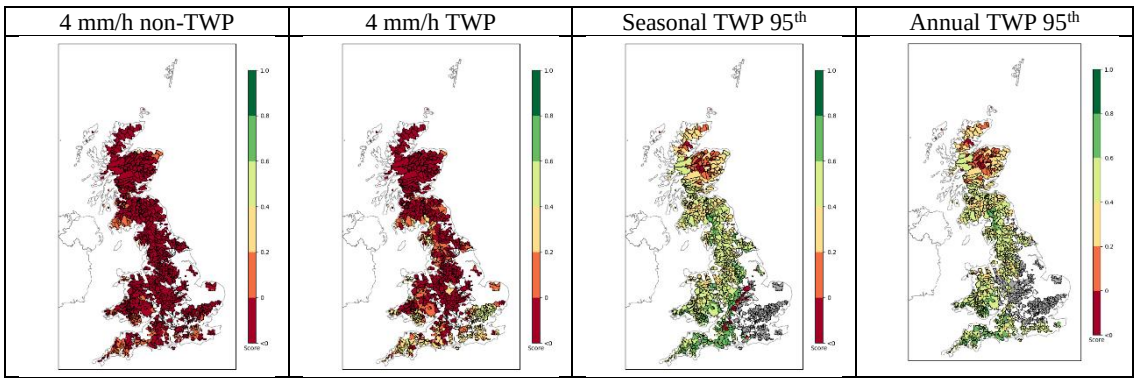

Figure 2 BSS for the fixed 4 mm/h threshold with and without time windows, as well as seasonal and annual climatological thresholds.

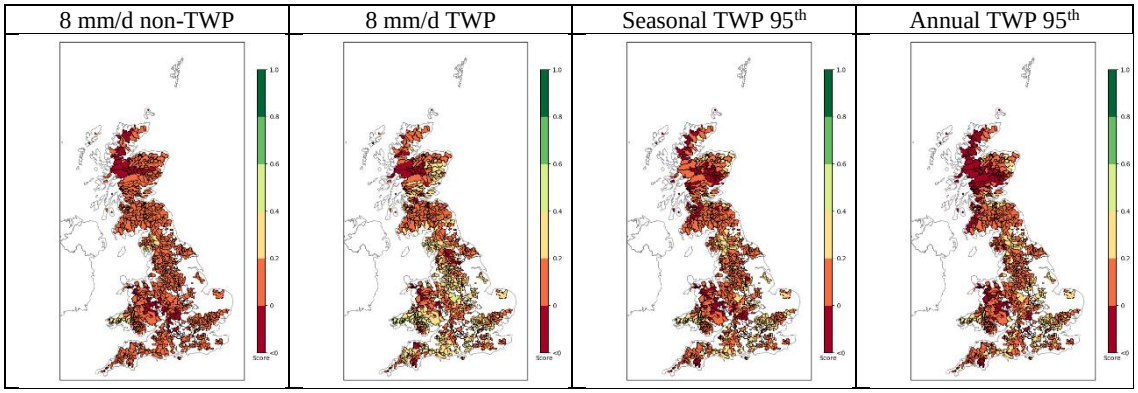

Figure 3 As for Fig. 2 but for daily accumulations, with fixed thresholds of 8 mm/d.

References

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