AN HOURLY PRECIPITATION DATASET FOR THE UK: QUALITY CONTROL, CLIMATOLOGY, VARIABILITY AND TRENDS

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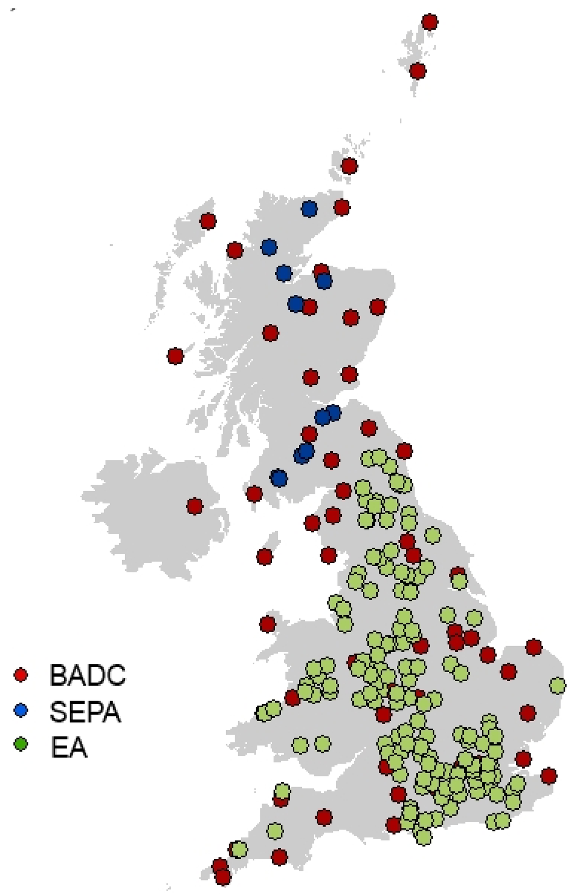
ABSTRACT

Extremes of sub-daily precipitation may be associated with flash flooding, particularly in urban areas, but have been studied relatively little in the UK. As part of the **CONV**ective **EX**tremes project a dataset of hourly precipitation for the UK has been constructed based on three different sources of rain gauge data.

DATA SOURCES & QUALITY CONTROL

CONVEX has combined observations of hourly rainfall from the UK Met. Office Integrated Data Archive System (MIDAS), the Scottish Environmental Protection Agency (SEPA), and tipping bucket rain gauge (TBR) data from ~1,300 gauges across England and Wales from the UK Environment Agency (EA). The TBR data was subjected to quality control checks and identified a range of issues including:

- obvious data recording errors producing implausible hourly totals
- accumulated totals
- periods of non-operation of TBRs
- unrealistic high-frequency tipping in the TBRs. These were identified on the assumption that rainfall rates change slowly and identified by the statistic $\lambda_k = |\log_e(\tau_k/\tau_{k-1})|$[1] where τ_k is the inter-tip time and $\lambda_k > 5$ is identified as a threshold for the rejection of a tip.
- accumulated 24h totals were also compared with a gridded daily dataset[2].



After quality control, a specific year/season is only included if it contains no more than 15% of missing data. Gauges were excluded from analysis if more than 15% of all years/seasons over the period of analysis were missing, see Fig 1.

Fig 1. Spatial coverage of rain gauges meeting selection criteria for autumn (SON) which provides the highest number of gauges (226).

CLIMATOLOGY OF EXTREMES

A climatology of extremes is being constructed based on:

- 1h R_{med} (median 1h annual maxima, Fig 2); summer (JJA) is identified as the period the annual maximum 1h rainfall is most likely to occur (Fig 3);
- Extreme Rainfall Alert (ERA) thresholds;
- extreme value analysis;
- peaks over threshold (POT).

Statistical tests for break points indicate a decrease in mean 1h precipitation intensity of around 50% since the year 2000 in the West Midlands.

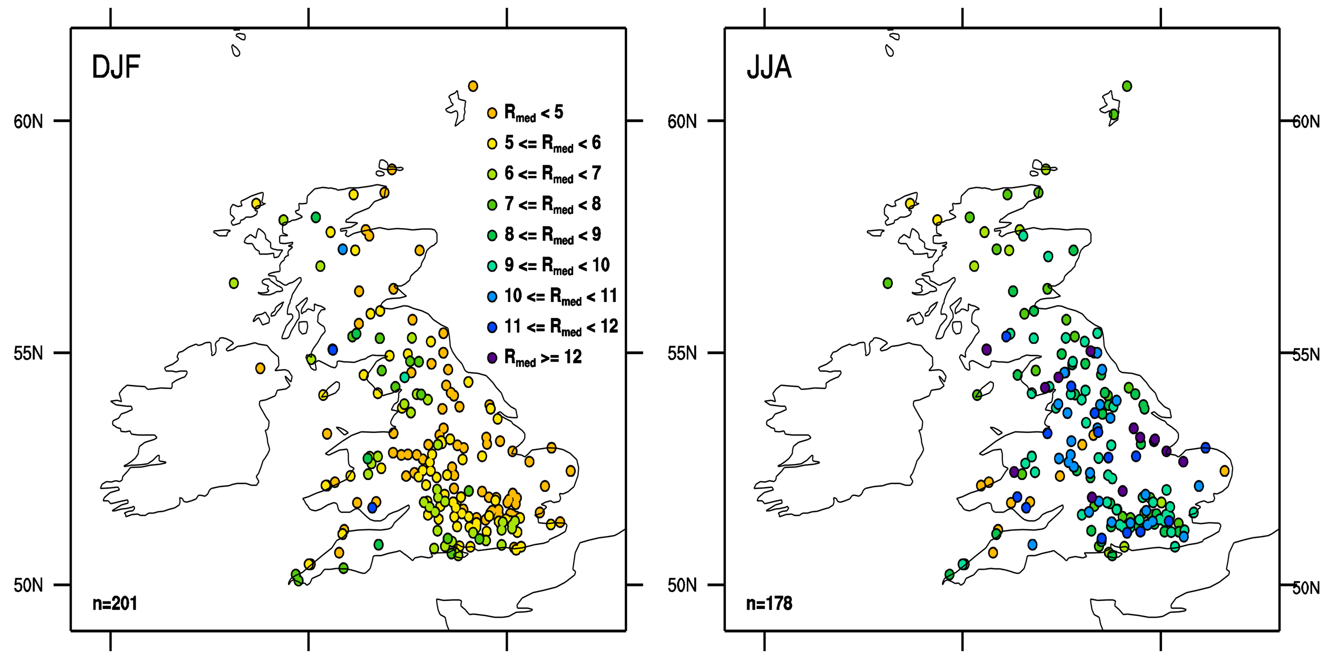


Fig 2. Seasonal 1h annual maxima (R_{med}; mm) for the period 1992-2011 for winter (left) and summer (right), n denotes the number of gauges.

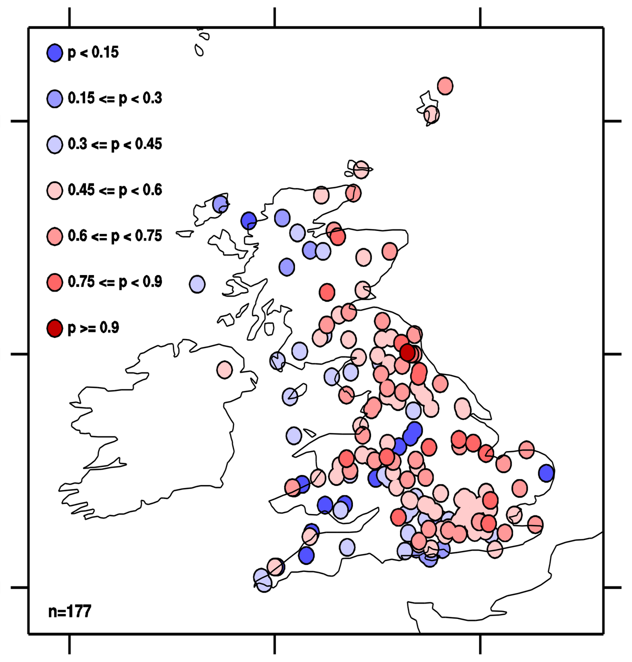


Fig 3. Proportion of annual maxima occurring in summer (JJA).

A general pattern of decreasing annual maxima (1982-2011) is noted over southern Britain in summer with small decreases over Scotland and northern England in winter.

RELATIONSHIP BETWEEN EXTREME HOURLY PRECIPITATION AND TEMPERATURE

It has been hypothesised that the amount of water in the atmosphere will increase at a rate of ~7% per °C of surface warming (the 'Clausius-Clapeyron' (C-C) relation), causing comparable rises in heavy precipitation events. Here, hourly precipitation – temperature scaling relationships for summer (JJA) are evaluated using maximum hourly intensities from each wet day (P_{max}), and comparing them with the daily mean temperature (T_{avg}). The values of P_{max} are binned according to T_{avg} with the *n*-th quantile (*q*) of each bin estimated[3]. An example of this for an individual site is shown in Fig 4.

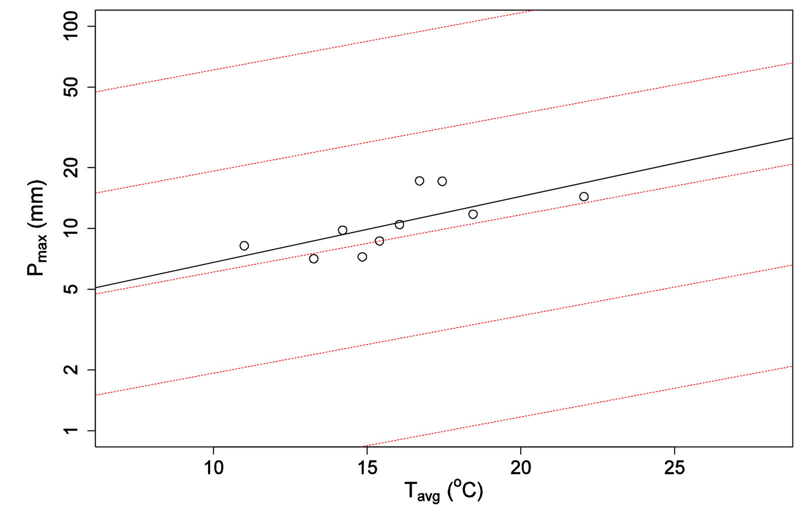


Fig 4. Relationship between JJA T_{avg} bins and q(P_{max}) for a single site, where *q*=0.99. The solid black line shows an exponential regression (least-squared linear regression fitted to the log of precipitation), the dashed red lines indicate C-C scaling.

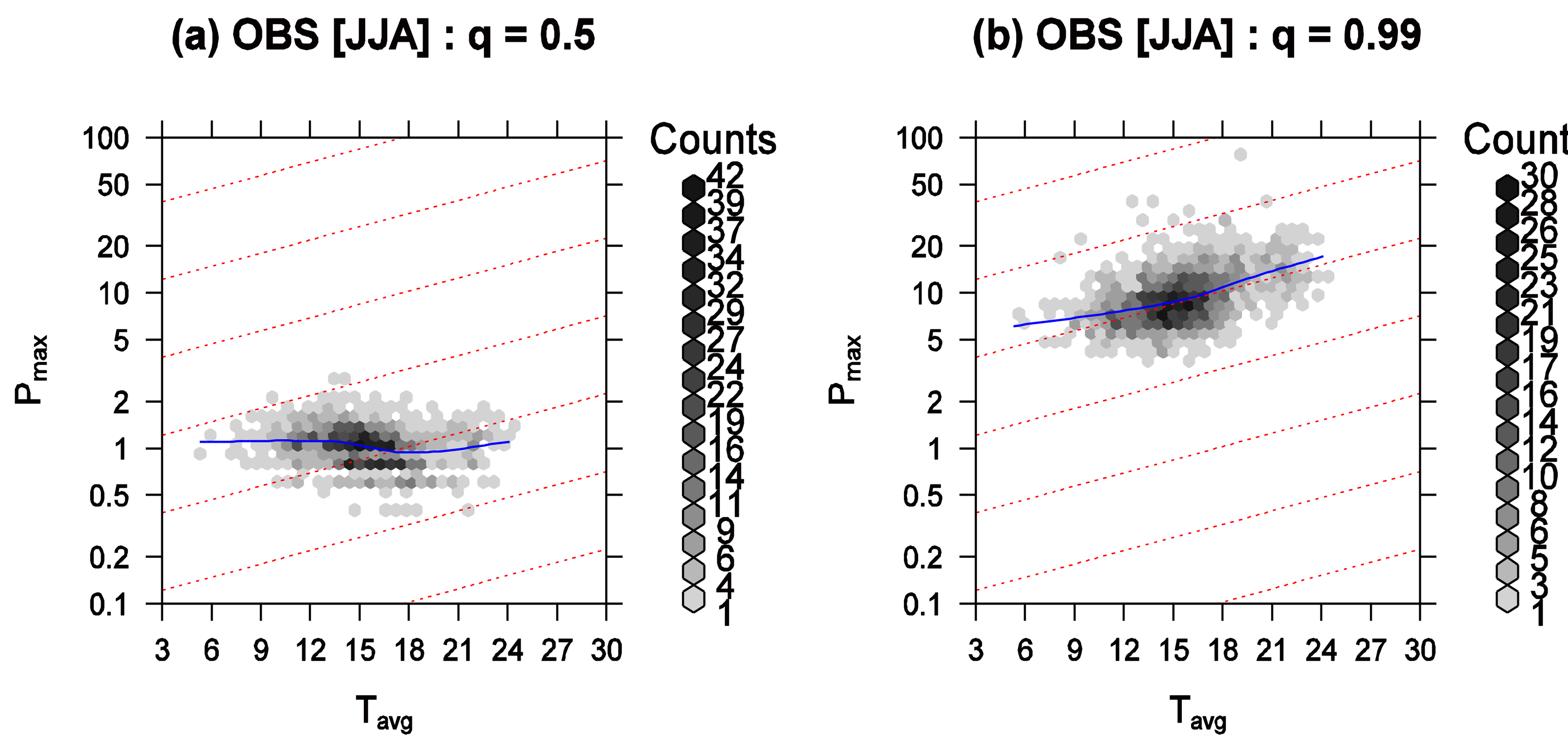


Fig 5. Density plots showing T_{avg} bins and q(P_{max}) for pooled UK gauges. Plots are shown for q50 (left) and q99 (right). Solid blue lines indicate the LOESS-estimated relationship between log10(q(P_{max})) and T_{avg}, the dashed red lines indicate C-C scaling.

The individually estimated T_{avg} and q(P_{max}) pairs for the UK are spatially pooled and plotted with density plots (Fig 5) indicating an approximate C-C scaling relationship for *q*=0.99. Fig 6 explores the spatial variation of this relationship for different UK rainfall regions[4] and shows a high degree of consistency between regions - a sub C-C scaling below a certain temperature and a slightly greater than C-C scaling above this threshold.

Ongoing work is examining these relationships further and investigating their presence in CONVEX's high resolution climate model experiments.

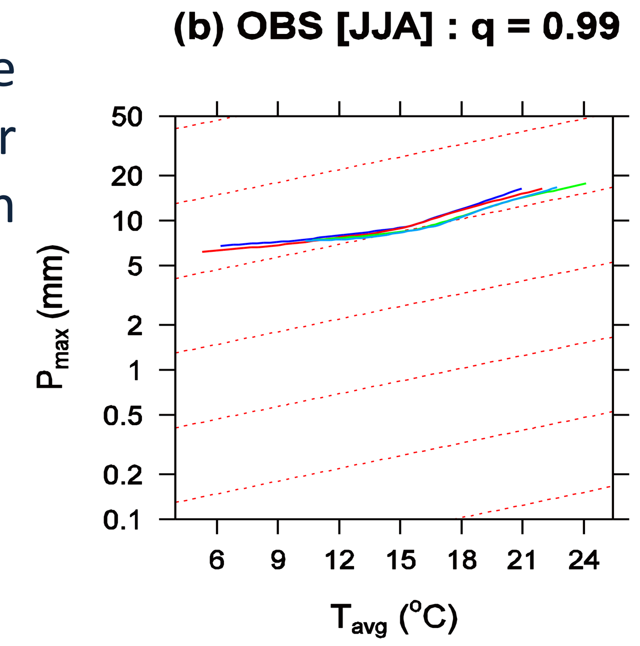


Fig 6. LOESS-estimated relationship between log10(q(P_{max})) and T_{avg}. Relationships are shown for Solway (red), NW England (blue), SE England (green) and West Country (orange) for q99. The dashed red lines indicate C-C scaling.

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