A new sub-daily rainfall dataset for the UK

Dr. Stephen Blenkinsop, Liz Lewis, Prof. Hayley Fowler, Dr. Steven Chan, Dr. Lizzie Kendon, Nigel Roberts

Introduction & rationale

The aims of CONVEX include:

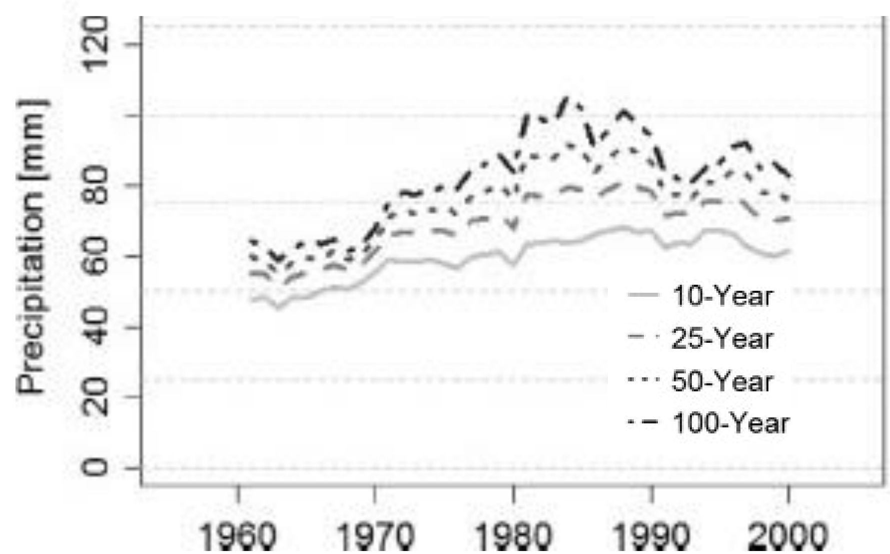
"improving understanding of:

- *how intense rainfall is produced in different locations;*
- *future changes in intense rainfall for the UK."*

A prerequisite of these is comprehensive and reliable data for the current and historical period.

UK precipitation on a daily timescale is well studied e.g. Jones et al., 2013 – increase in multi-day winter extremes, decrease in summer rainfall intensities.

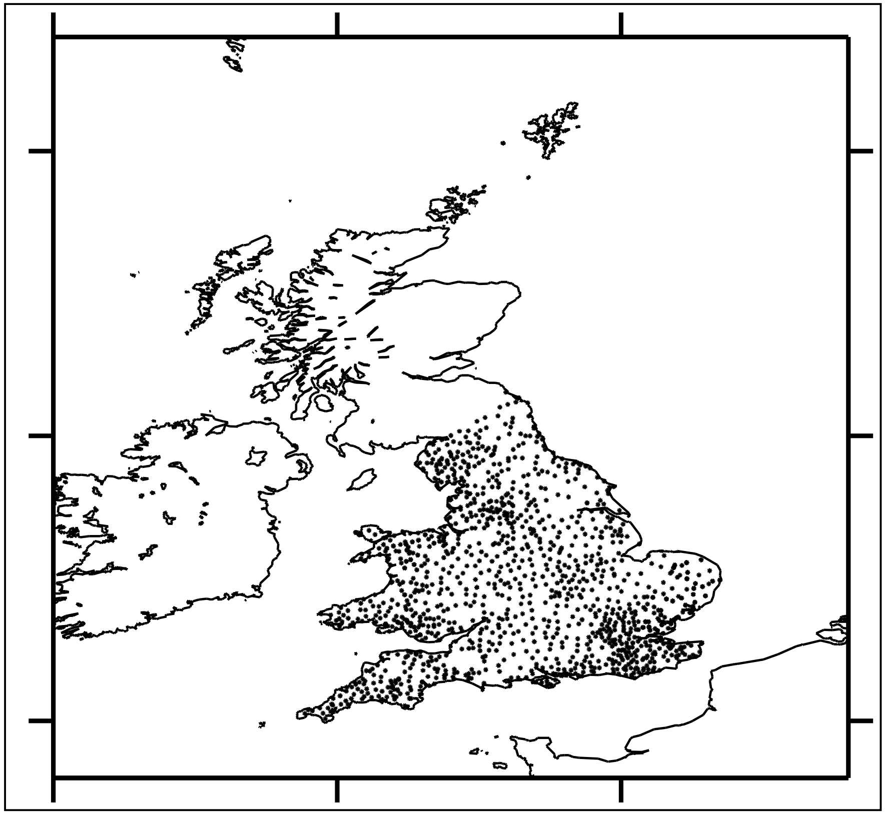
SE England winter 5-day rainfall



What data has been used?

We have used:

- Met Office Integrated Data Archive System (MIDAS);
- Scottish Environment Protection Agency (SEPA);
- Environment Agency (EA), ~1300 tipping bucket rain gauges (TBRs) across England & Wales.



Location of EA tipping bucket rain gauges before quality control procedures

How was the quality of the data checked?

Limited existing quality control/testing:

- data marked as good (G), suspect (S) and unchecked (U);

TBR totals less than (greater than) 25mm and are within ±2mm (± 8%) of a check gauge then data are classified as "good"

Data identified as 'suspect' in EA metadata are excluded.

Anomalously large values excluded unless identified as 'good' in EA metadata and are not accumulations.

The "frequent tipping" problem

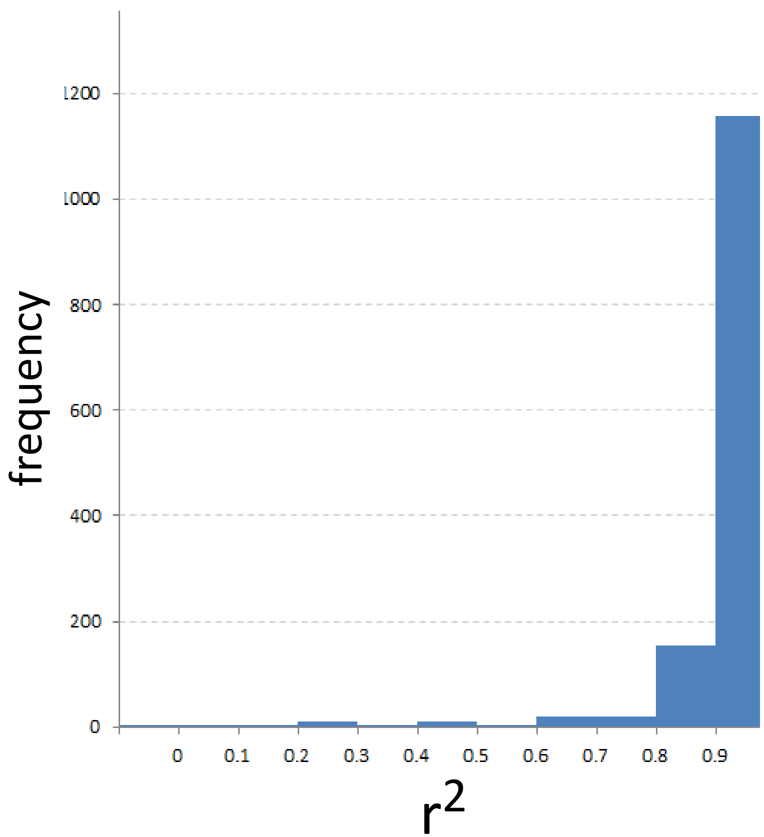
Long dry periods representing gauge malfunction are identified and excluded.

Comparison with other precipitation products – daily 5km gridded dataset

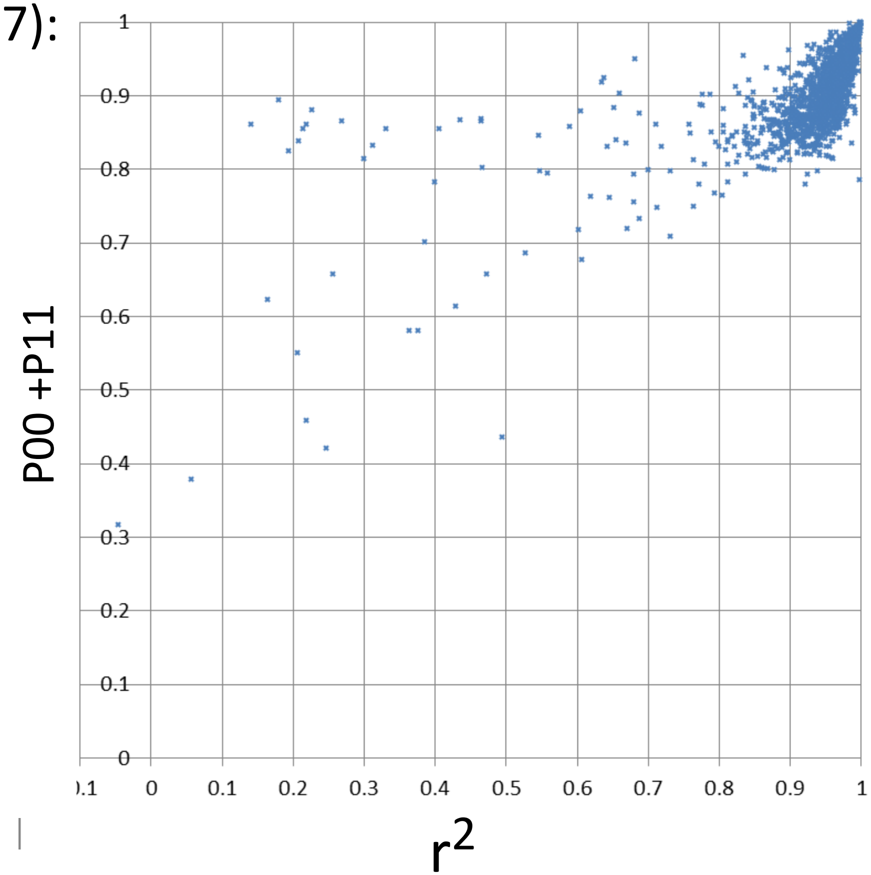
How good is the dataset?

Data aggregated to 24h and compared with UKCP09 gridded observations demonstrates quality of dataset.

Correlation:



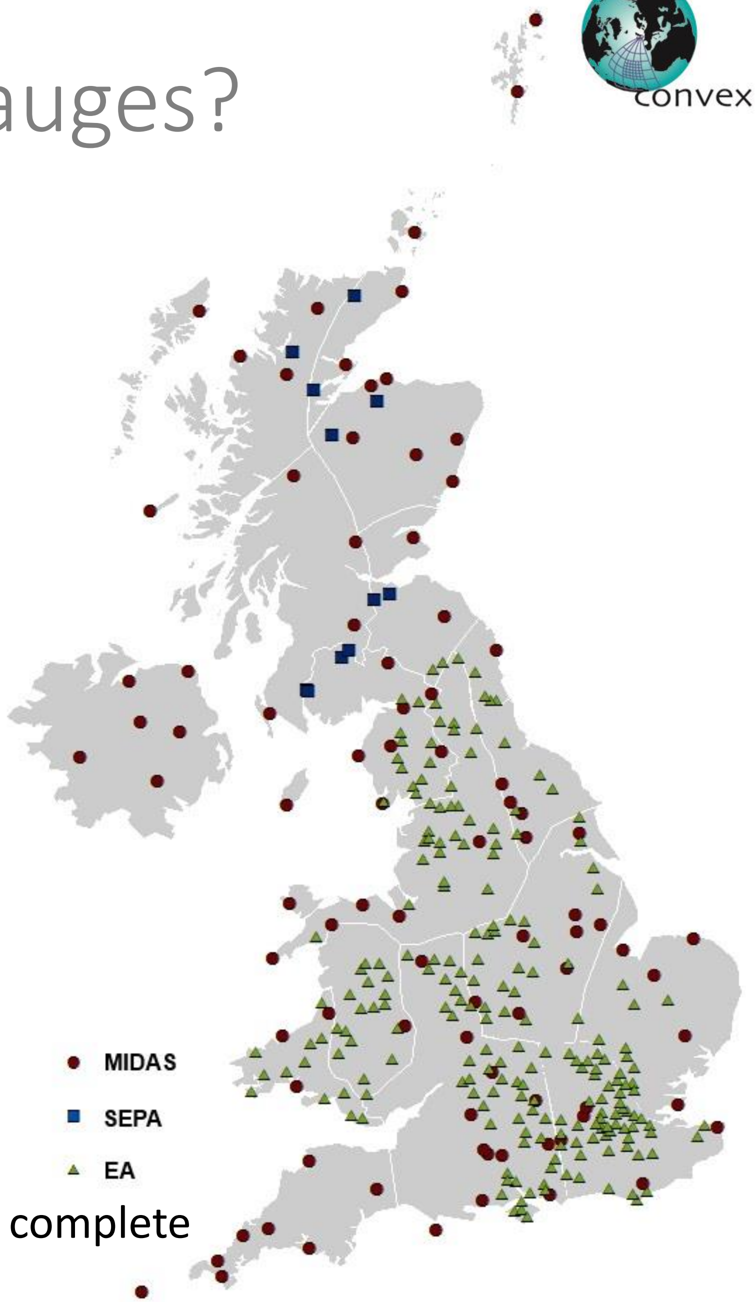
Matching statistics showing concordance of rainfall occurrence(based on Yoo and Ha 2007):



What was the final list of gauges?

To determine complete time series we applied the following rules:

- Must be no more than 15% missing in a given season/year.
- No more than 15% missing seasons/years in period of analysis.

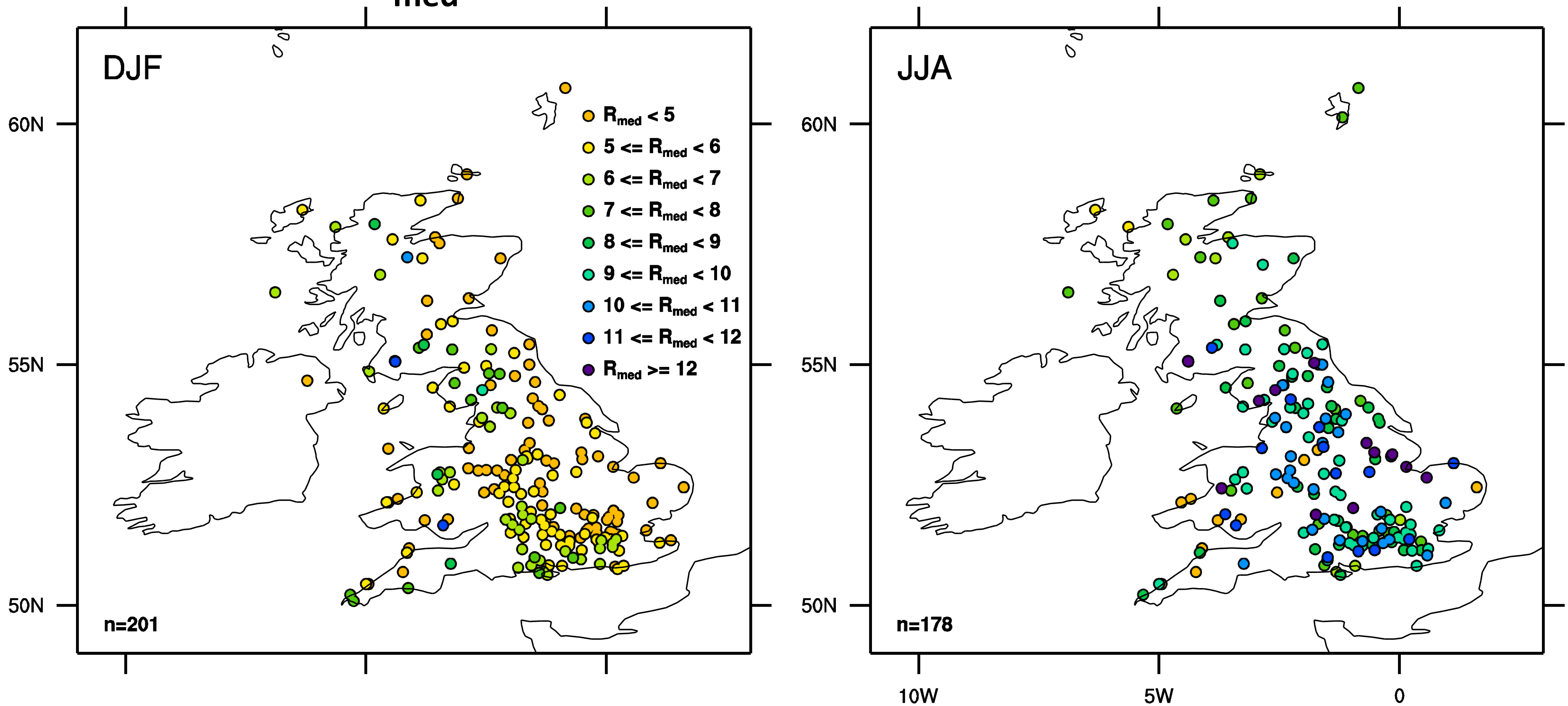


Stations with a reasonably complete record for 1992-2011

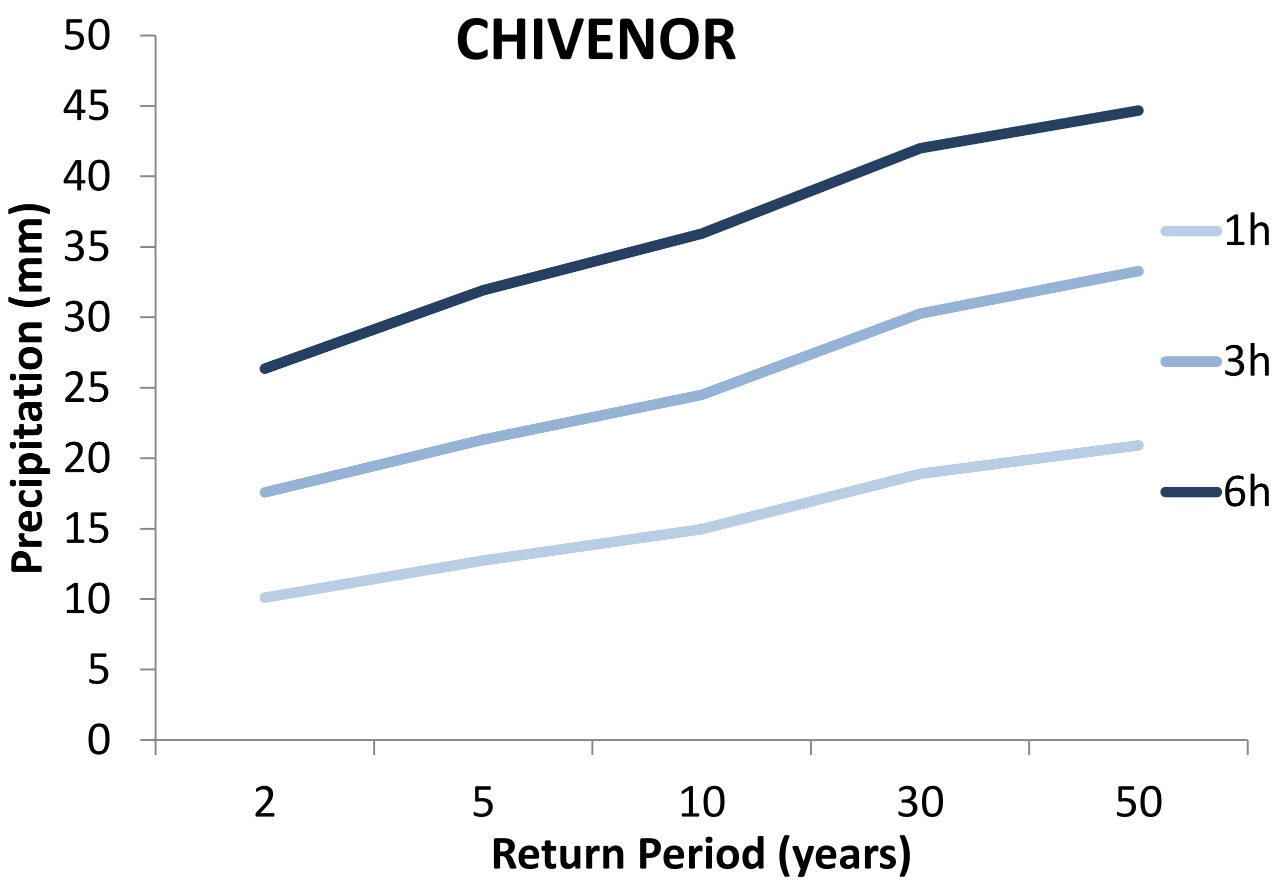
A sub-daily climatology of extremes

Based on quality-controlled data using different indices of extremes: annual maxima, peaks-over-threshold, extreme rainfall alerts (ERA) – different patterns to daily climatology.

R_{med} – the median of the annual maxima



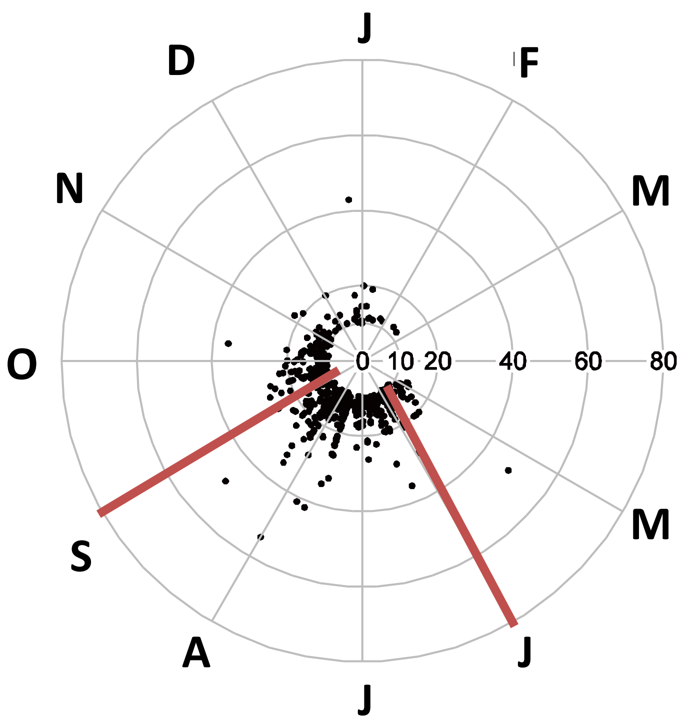
Extreme value analysis used to examine multi-hour extremes and construct depth-duration-frequency curves. See application by Murray Dale.



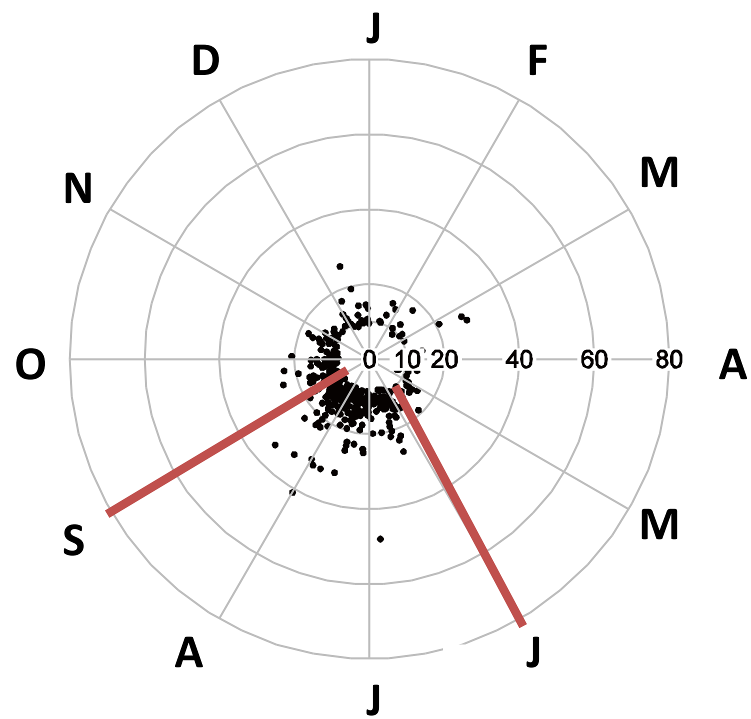
When do the most intense events occur?

Peaks-over-threshold (POT1) was used to identify events, - represents the largest 1 x *n* events, where *n* is the number of years in the record.

South coast England



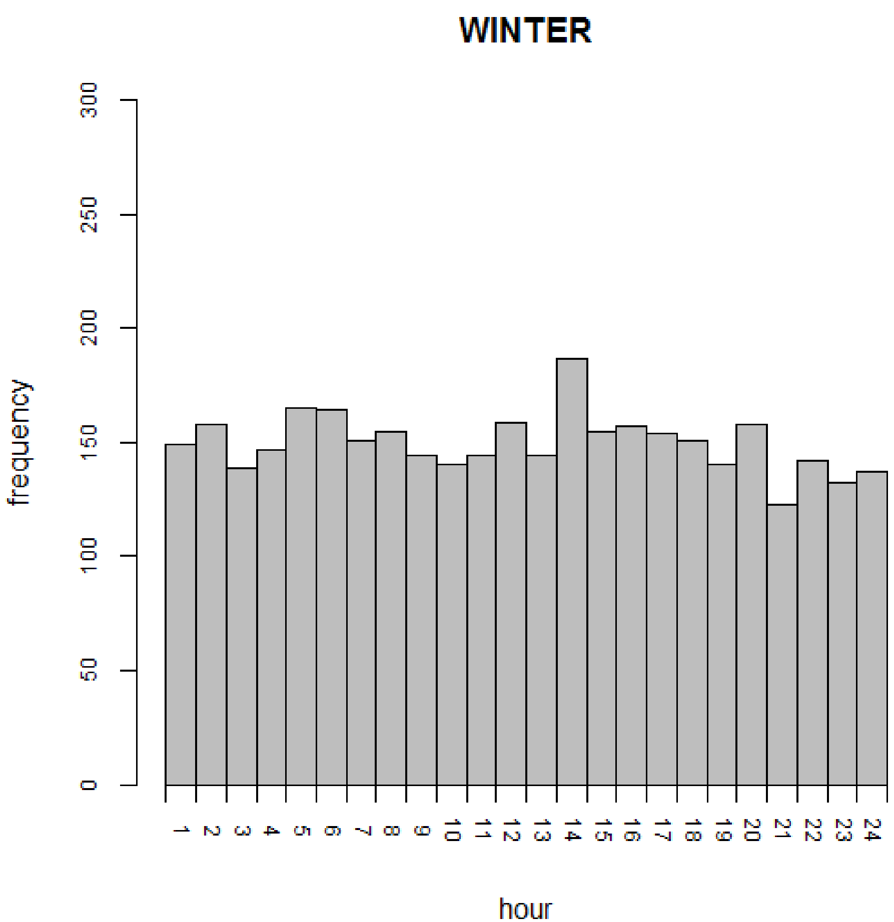
North west England

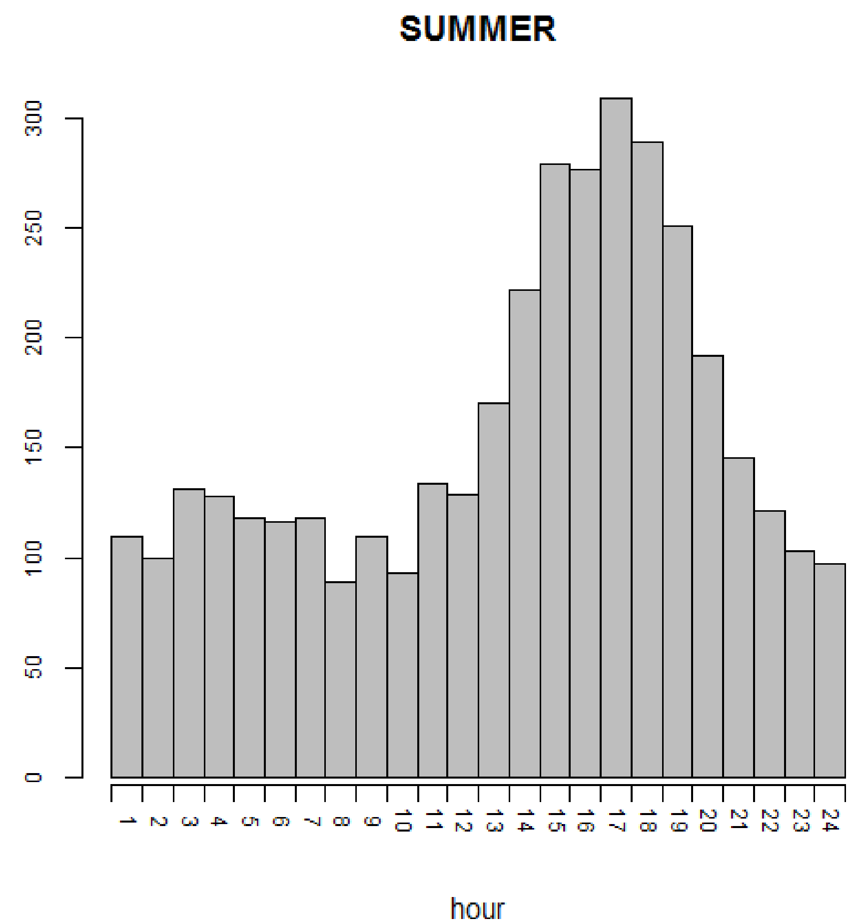


Summer is the most important time of the year AND tends to see the most intense events.

When do the most intense events occur?

No diurnal cycle identifiable in average rainfall but for the most intense events:

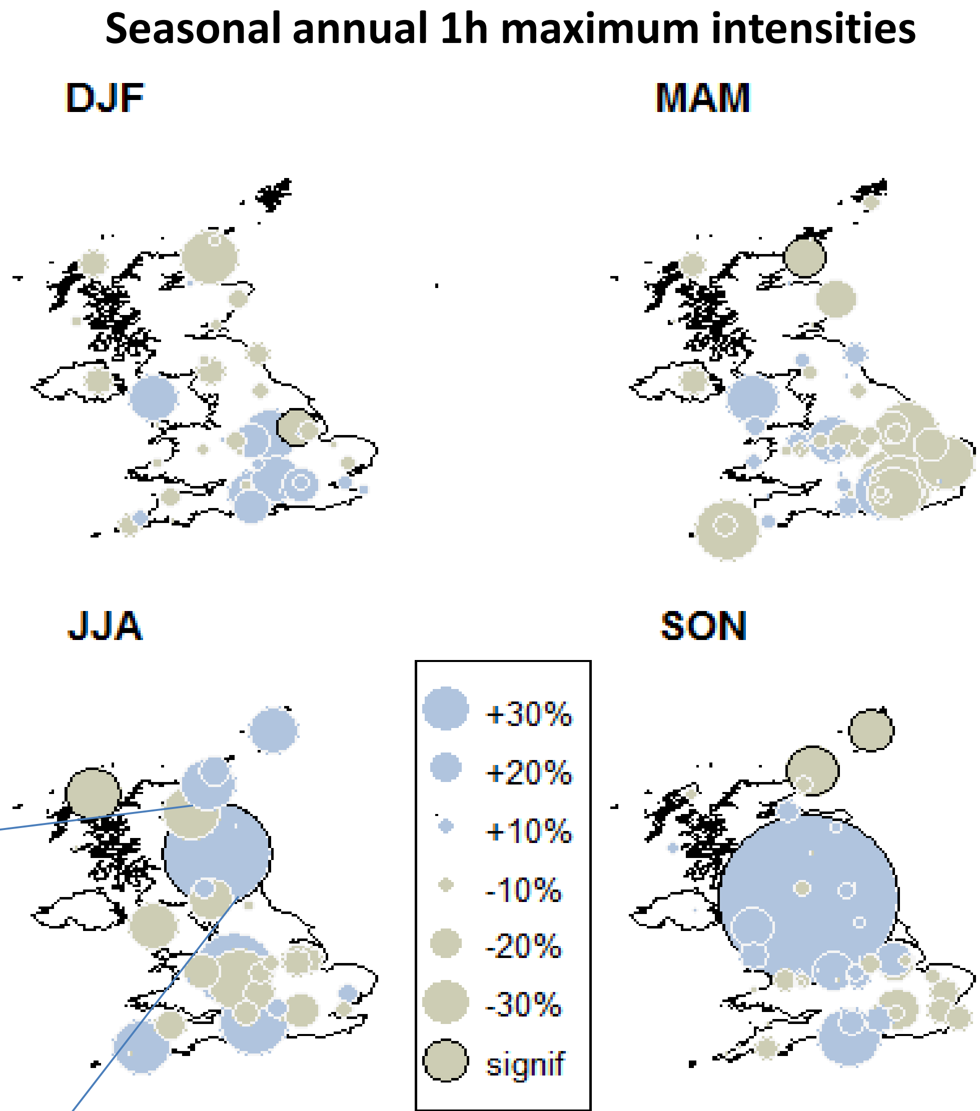


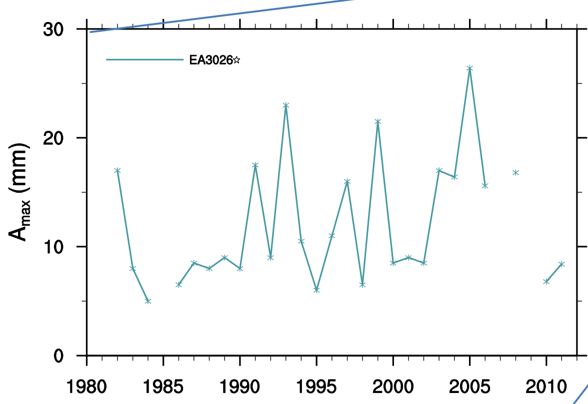


Are we seeing evidence for projected changes in observations?

Limited data availability hampers analysis but no clear evidence of significant increases in summer extremes.

Linear methods not necessarily the best approach – variability may point to important mechanisms.

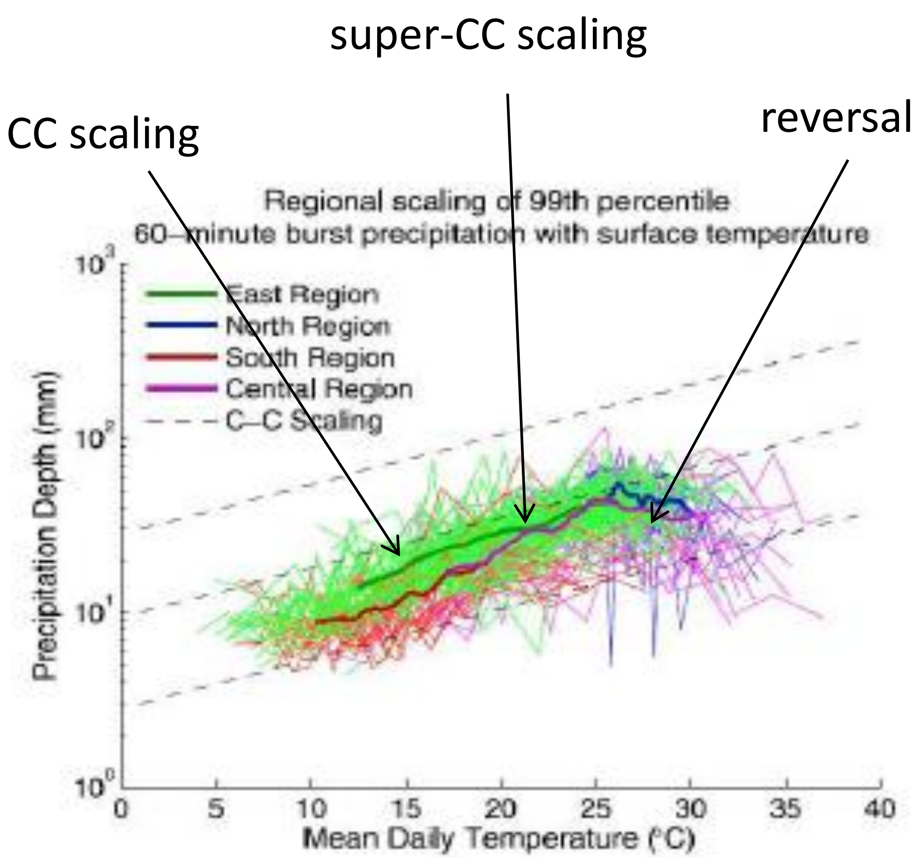




Based on period 1982-2011.

An example application: Temperature-precipitation scaling

Precipitation intensity should increase with temperature at approx Clausius-Clapeyron (~7% °C^{-1}) (Trenberth *et al.* 2003).

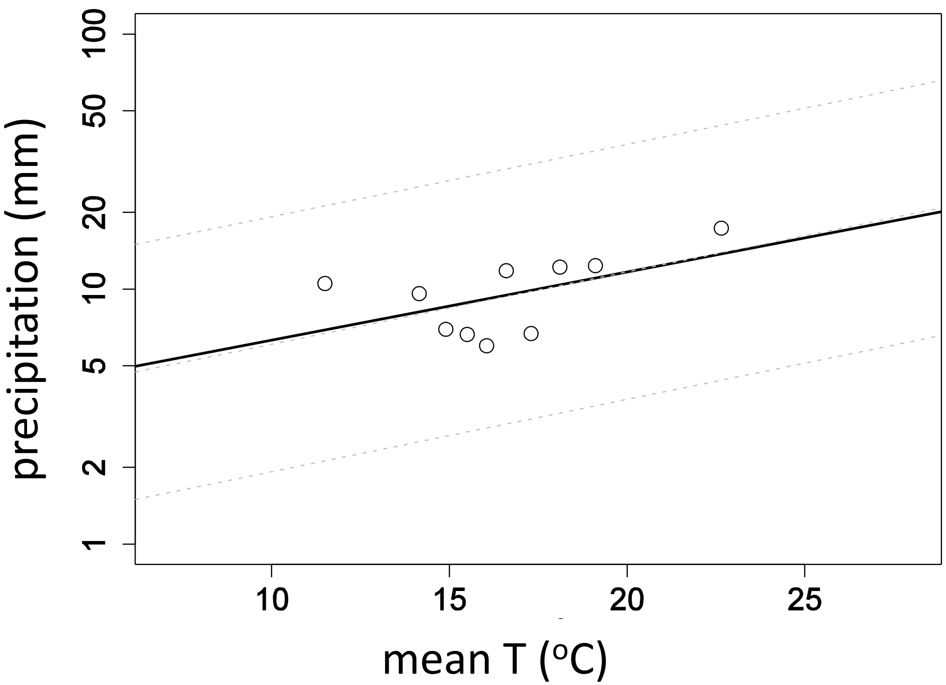


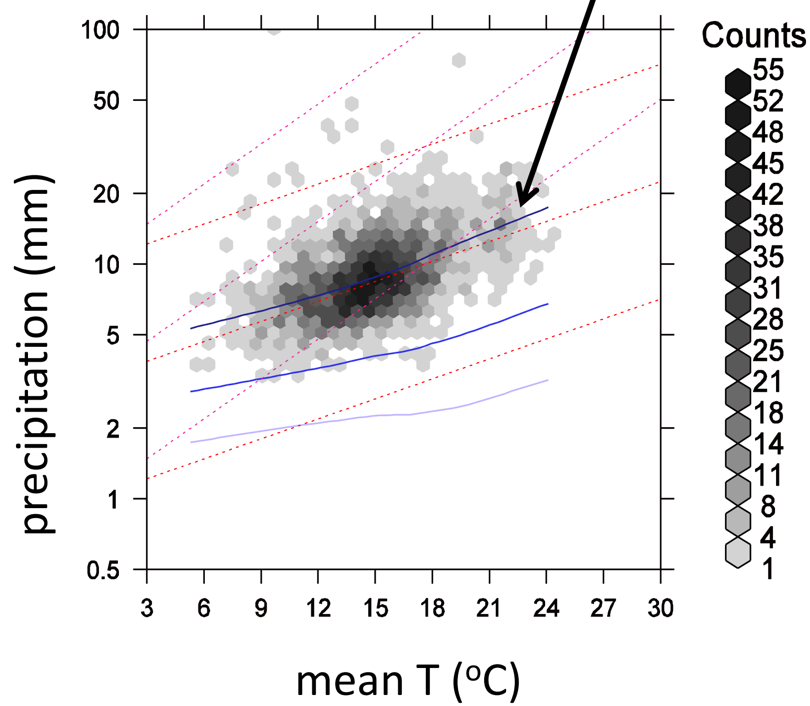
Regional scaling behaviour of 99th percentile daily precipitation and maximum 60-minute precipitation on wet days.

Thick lines are smoothed regional averages for Australian regions (from Hardwick-Jones *et al.* (2010)).

Relationship between rainfall intensity and temperature: 1

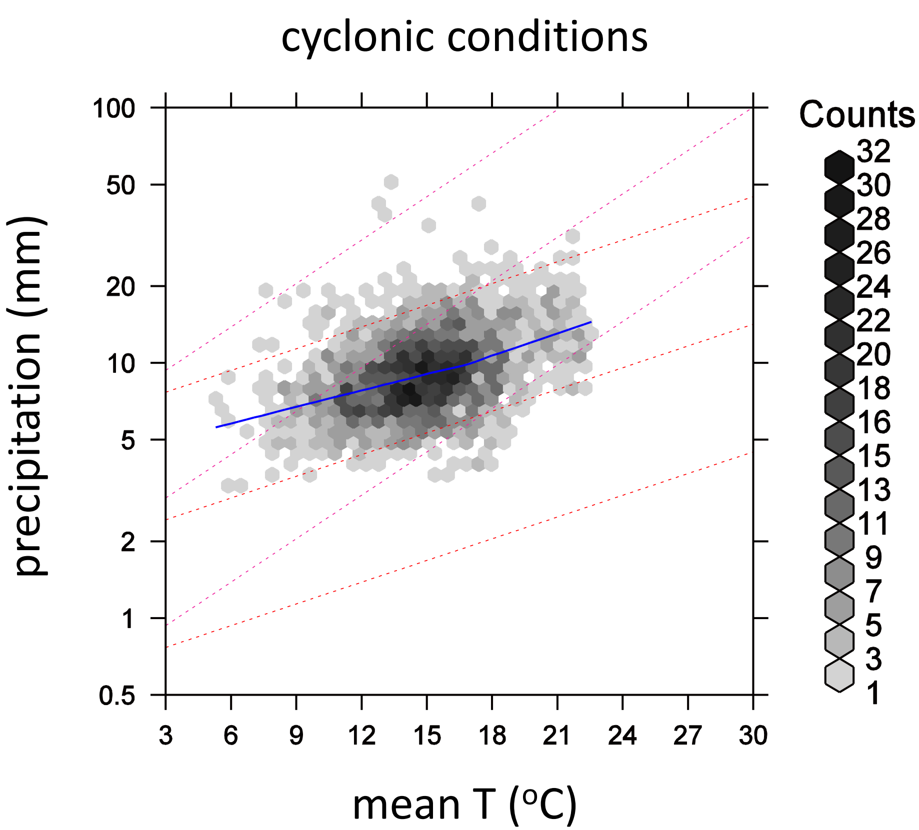
Summer (JJA) scaling between mean daily temperature (T) and the 99th percentile precipitation for each temperature bin

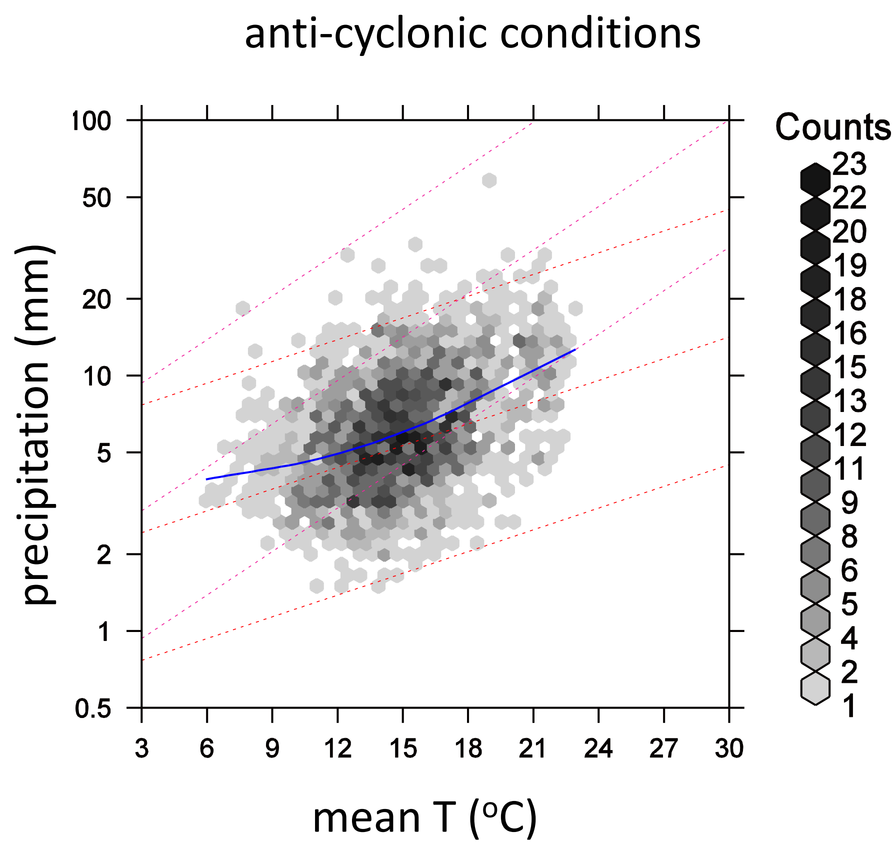




Although other regions demonstrate scaling of up to 2x CC, for the UK scaling of intense rainfall with temperature is at a rate approximating CC.

Relationship between rainfall intensity and temperature: 2





Results suggest future changes in intense rainfall are not just dependent on temperature change but also on changes in the frequency of different circulation regimes

How else might the data be used?

Additional NERC funding has been agreed to produce a gridded hourly rainfall dataset.

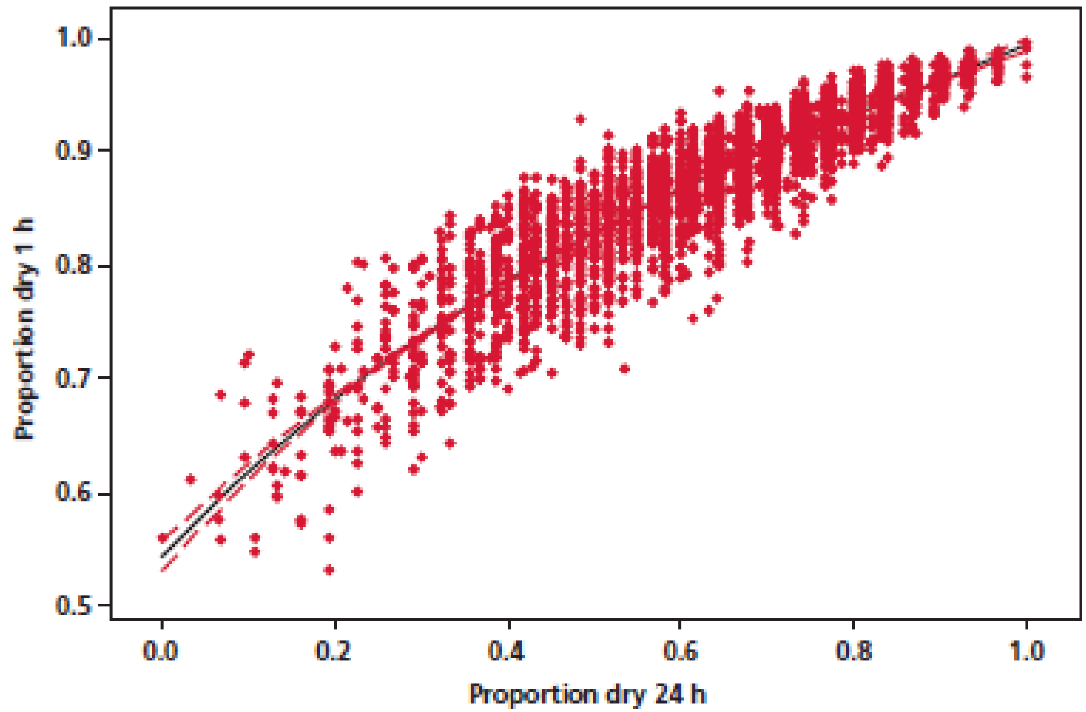
Applications include hydrological modelling applications and climate model validation.

Opportunity to exploit sub-hourly data for some of the TBRs.

How else might the data be used?

Information on trends and variability in (multi-) hourly rainfall could be used to supplement the UKCP09 "Observed trends report".

New observational data & results would allow us to improve the parameterization (based on 17 sites) of the **UKCP09 Weather Generator** for hourly rainfall extremes.



Relationship used to predict 1h proportion dry from 24h (from UKCP09 Weather Generator Report (Jones et al., 2010.)

Conclusions

- CONVEX has developed the most comprehensive, quality checked sub-daily precipitation dataset for the UK.
- There are considerable problems associated with observations, what is the truth? - difficult to determine at the 1h timescale.
- There is a lack of an established, consistent methodology for assessing the quality of sub-daily data.
- No evidence has been found for trends in intense rainfall for the UK.

Conclusions

- Observed relationships between rainfall and temperature provide physical basis for potential increases in extremes with warming.

- Future changes in intense rainfall are not just dependent on temperature change but also on changes in the frequency of different circulation regimes (and other variables).

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