

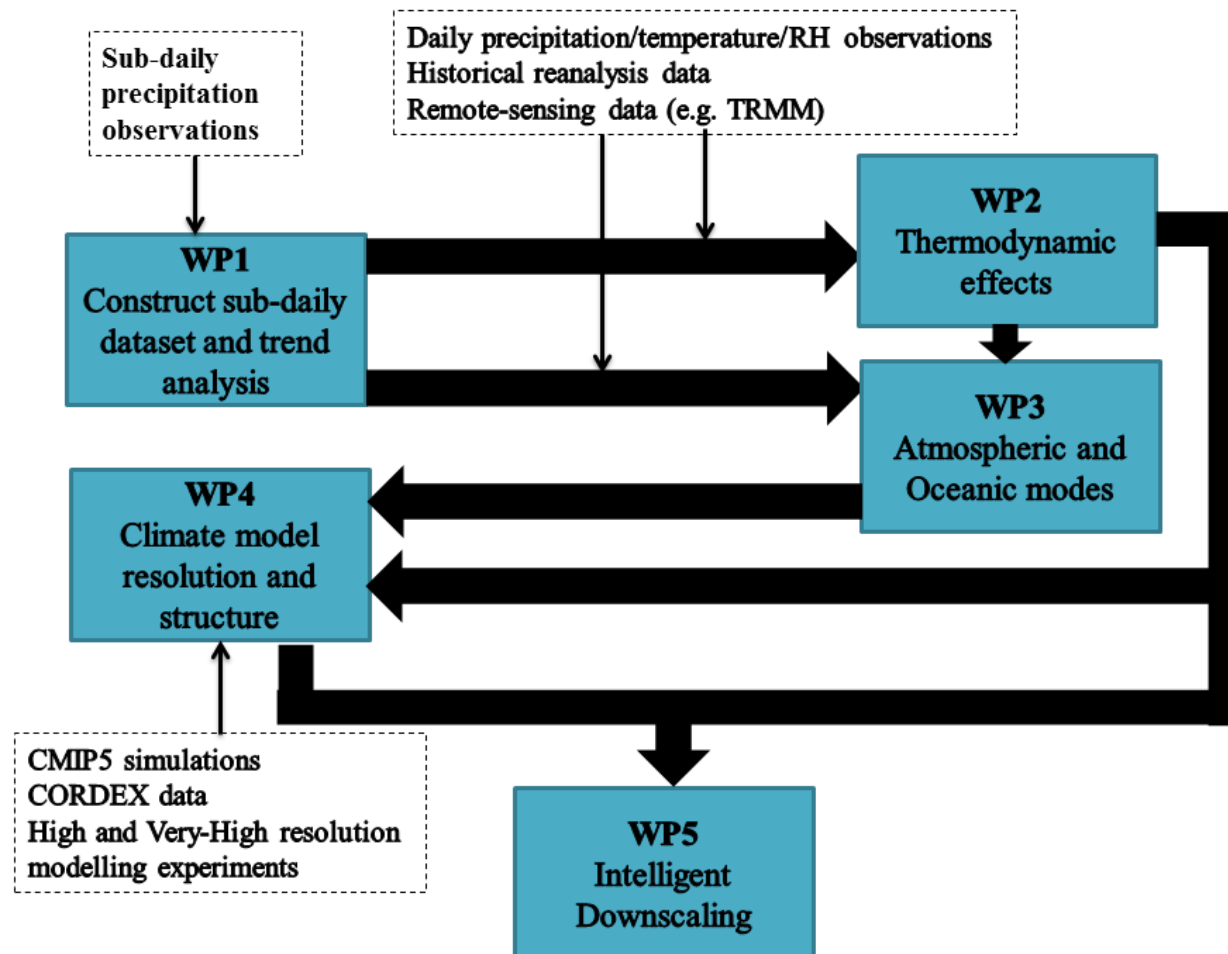
INTENSE: GHP/GEWEX cross-cut on sub-daily precipitation Report: November 2015

Dr. Renaud Barbero on behalf of Prof. Hayley Fowler
Newcastle University, UK



INTENSE: “INTElligent use of climate models for adaptation to non-Stationary hydrological Extremes”

2M ERC Consolidators Grant: provides funded core of a community effort into the collection and analysis of sub-daily precipitation data and model outputs



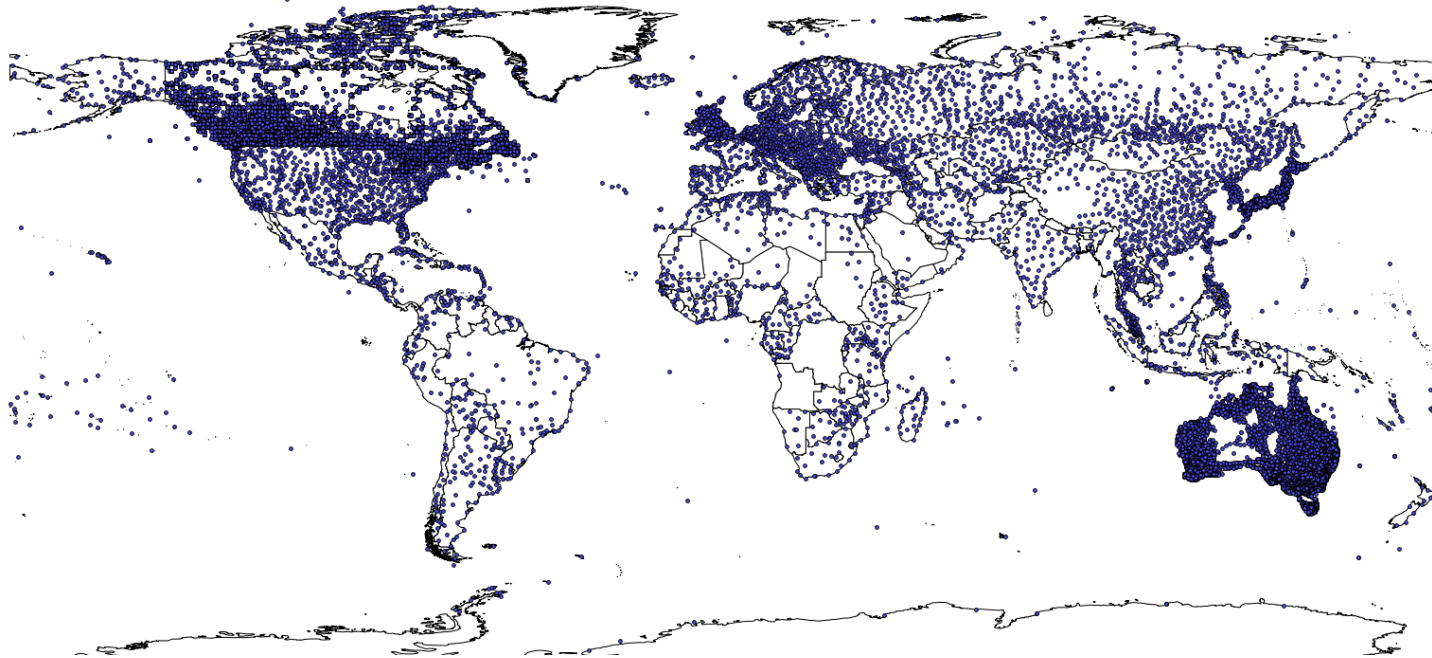
INTENSE Key Research Questions

1. How has sub-daily maximum precipitation changed over the last century, across continents, climate regimes and seasons?
2. How does precipitation at different time-scales vary with atmospheric temperature and atmospheric moisture as the atmosphere warms?
3. How do large-scale atmospheric and oceanic features influence or modulate the observed changes in precipitation extremes, the clustering of extremes and the variability between 'drought' and 'flood' periods, in different climate regimes and seasons?
4. What is the influence of climate model resolution and structure on the simulation of precipitation extremes for different climate regimes and seasons?
5. What is likely the response to warming of precipitation and precipitation extremes at different time- scales across different climate regimes?
6. How can we use information from both high-resolution and coarse-resolution climate models in a more intelligent way to inform climate change adaptation decision making to better manage extreme hydrological events?

INTENSE Status

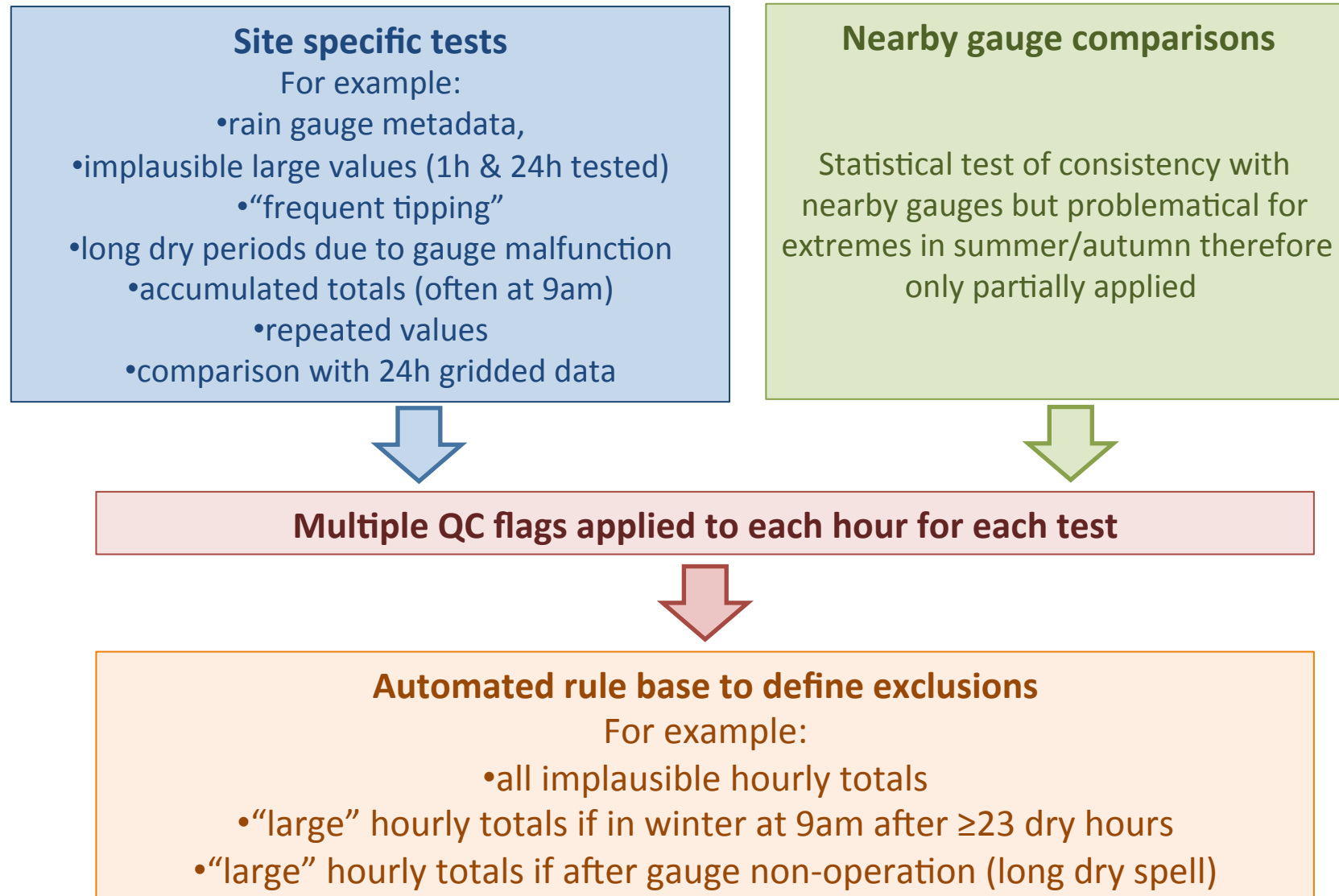
- Recruitment of 4 new research staff
- Visits by four INTENSE project partners: Dr Seth Westra, University of Adelaide, Dr Lisa Alexander, UNSW, Dr Mari Tye, NCAR, Dr Robert Dunn, UK Met Office.
- Attendance at WCRP Grand Challenge on Extremes Data Workshop at UNSW, Sydney, Australia.
- Workshop hosted at The Royal Society in London in January
- Consultancy work for 'UK Water Industry Research' (UKWIR) on the potential effect of changes in intense rainfall on urban drainage

Main achievements: database



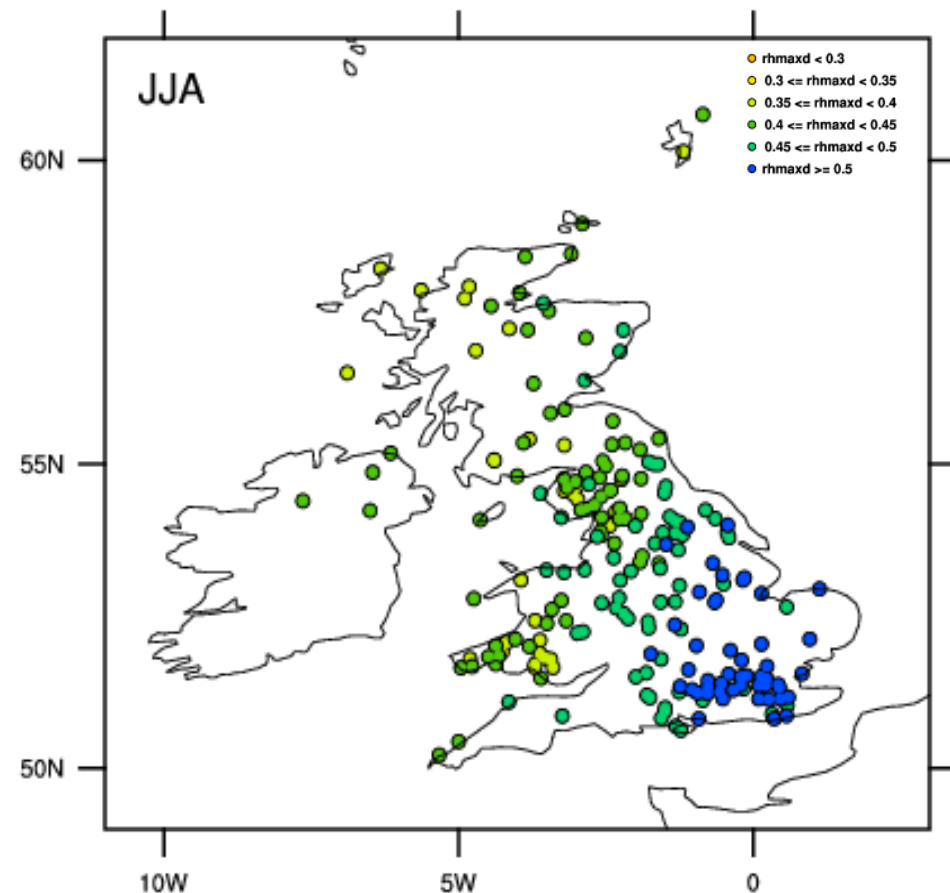
- Developed standard request letter and identified routes through to correct data provider for many locations with Lisa Alexander.
- Sub-daily precipitation data has been collected for: USA, Australia, Canada, Japan, Malaysia, UK, Netherlands, Singapore, HadISD (UK Met Office sub-daily dataset comprising precipitation and other variables).
- We are in the process of receiving data from Norway, Portugal, The Philippines and New Zealand. Contacts have been obtained for further countries and are being pursued.

Main achievements: quality control 1



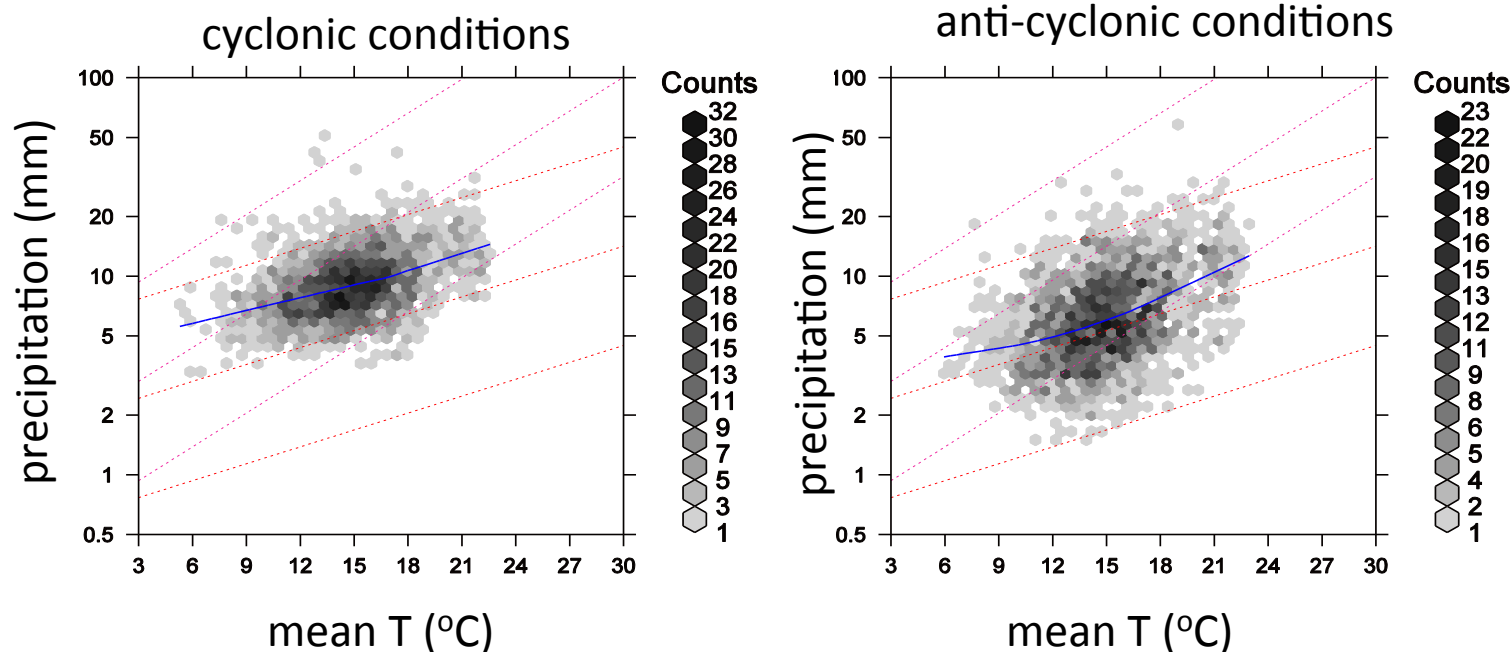
Main achievements: understanding of intense hourly rainfall

- Initial analysis of climatology of UK hourly extremes on quality controlled gauge data. Some examples:
- Intense rainfall events generally occur in summer – mid autumn across most of the UK, this seasonality tending to be strongest in eastern regions
- Ratio between the maximum 1h and total 24h accumulations (right) shows that for summer in south and east England > half of daily total typically occurs in a one-hour burst



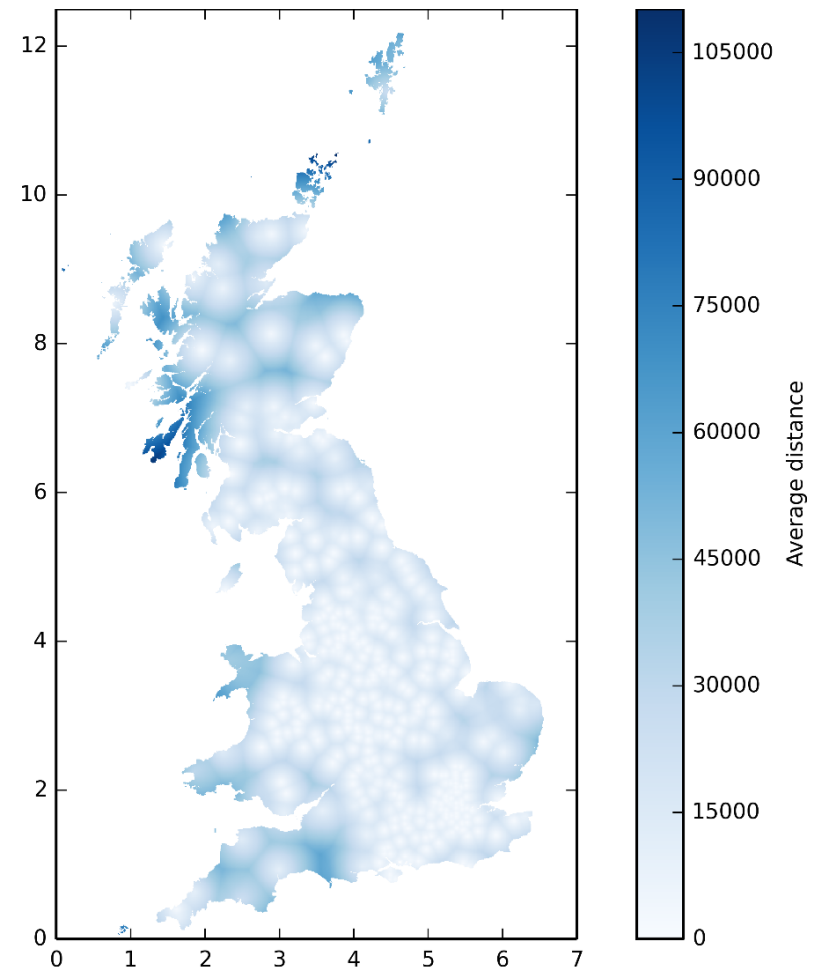
Main achievements: dynamical and thermodynamic drivers

- Analysis of extreme hourly precipitation scaling with temperature using the new UK dataset has shown:
 - an increase in summer precipitation intensities (q_{99}) with temperature at \sim Clausius-Clapeyron rate ($6.9\% \text{ } ^\circ\text{C}^{-1}$).
 - examination of indicators of large-scale circulation conditions has shown a dependency on the circulation regime (published in Environmental Research Letters).

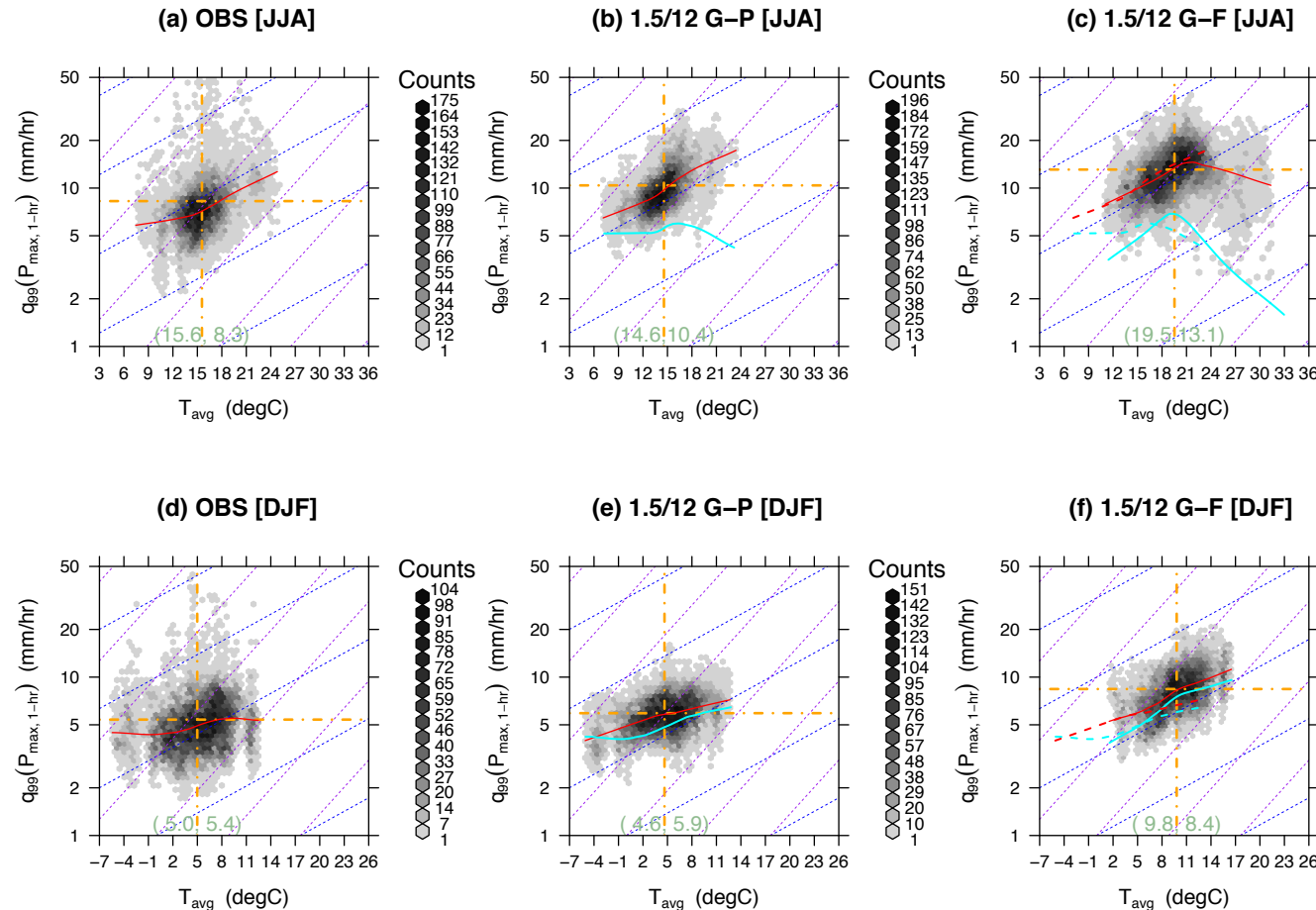


Main achievements: a gridded hourly rainfall product

- Quality controlled UK data has been used to create a gridded hourly rainfall product for the UK for 1991-2013. This is to be hosted online at Centre for Ecology & Hydrology (CEH) together with the CEH-GEAR daily gridded product.



Simulated relationship between high hourly P intensities and temperature



Chan et al. (2015)
Nature Geosciences

Relationship between wet-day surface air temperature and extreme precipitation intensity. Left, centre, right: Radar, control-climate simulation, future-climate simulation; top, bottom: JJA, DJF; red, cyan: 1.5-km model or observations, 12-km model.

Main achievements: climate models

$P_{10\text{-min}}$ intensity profile for events with $P_{10\text{-min}} \geq Q_{0.99}$ with a minimum threshold of 0.05mm/10min

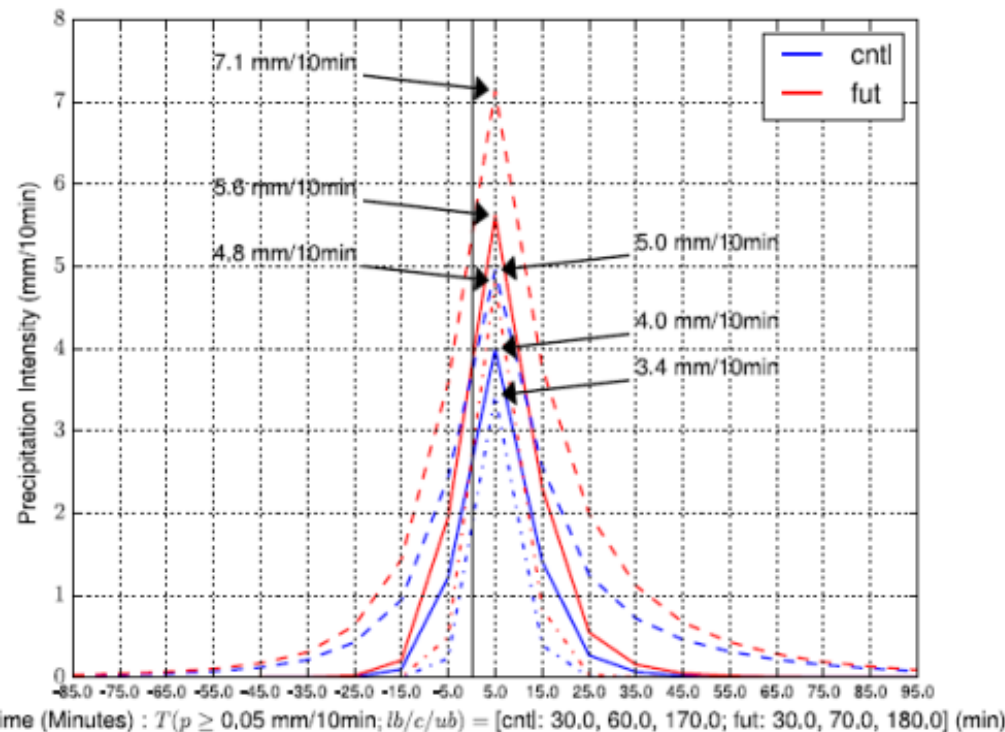
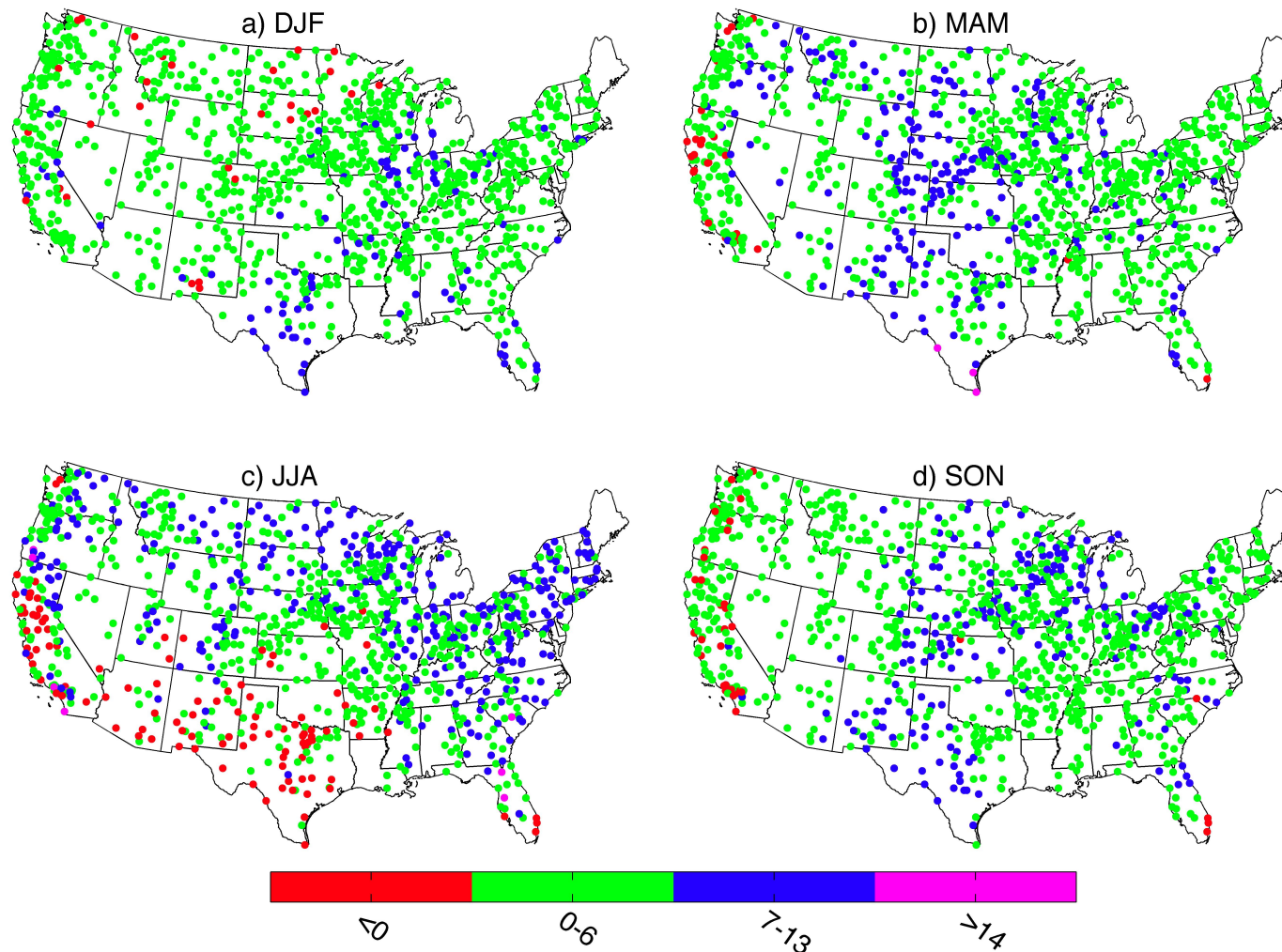


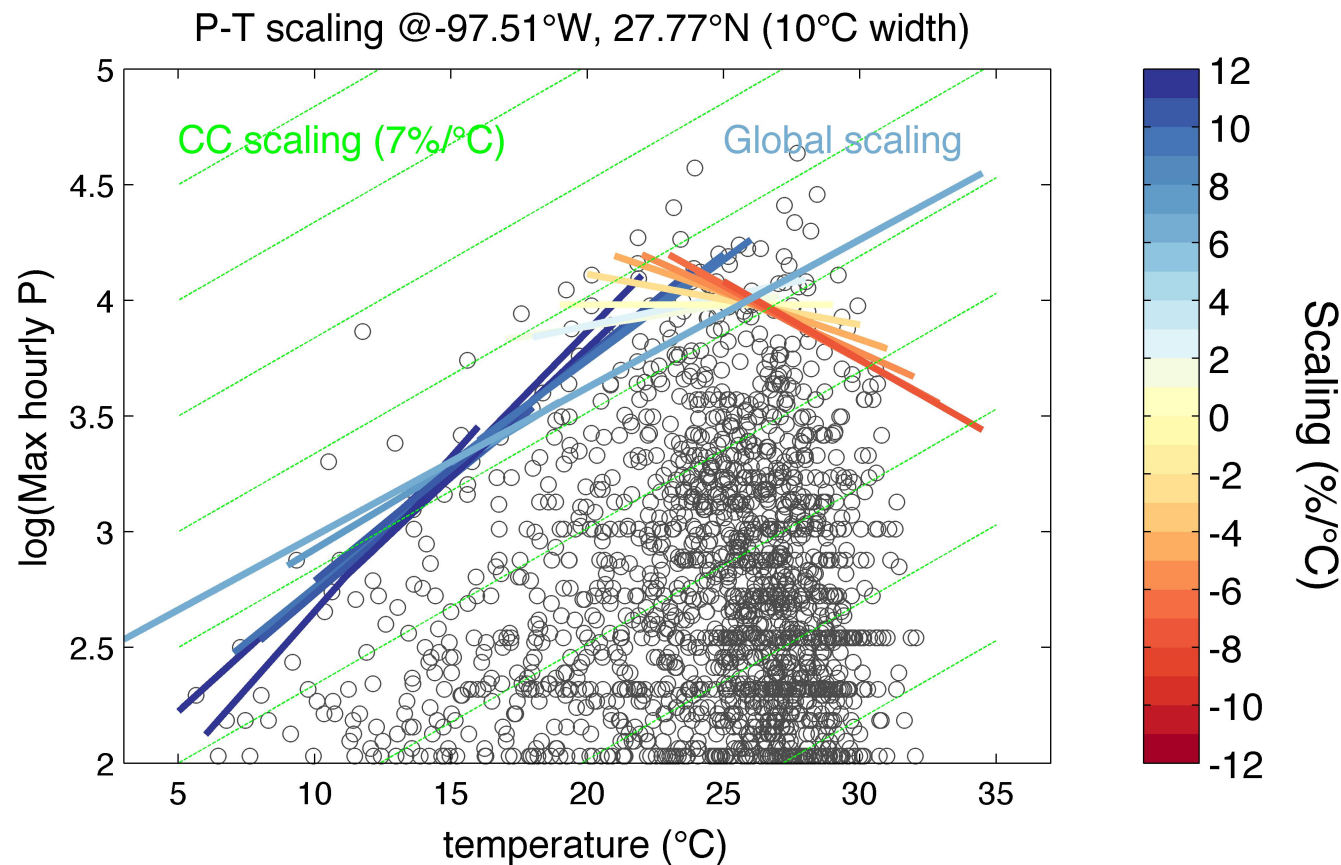
Figure 2: Intensity profiles are diagnosed at each southern UK land grid point and then we take the spatial median. Estimated duration given in figure footer; change signal: 75%:7.1/5.0 = 1.42; 50%:5.6/4.0 = 1.4; 25%:4.8/3.4 \approx 1.41

Dynamical and thermodynamic drivers: work in progress



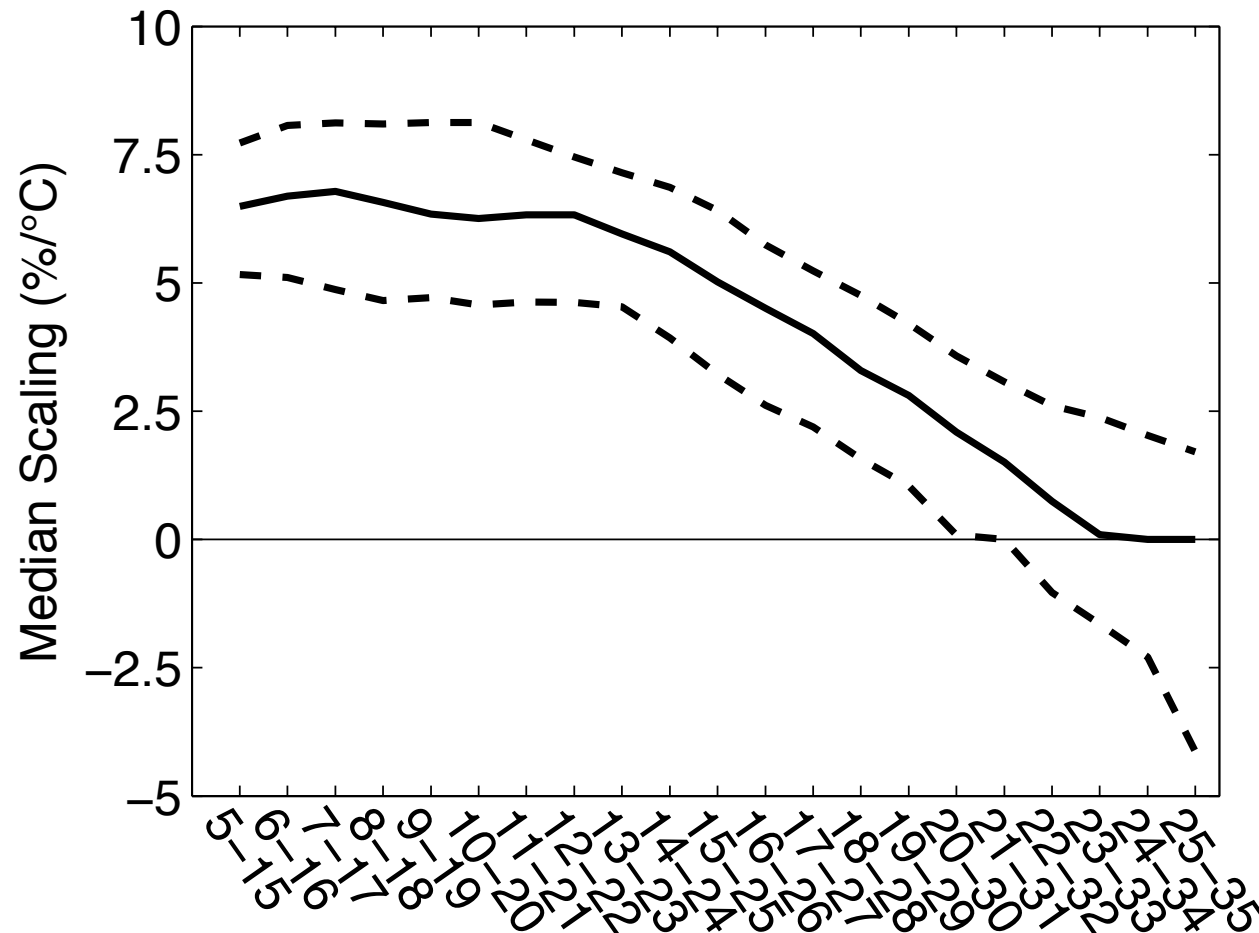
- Initial investigation of US extreme hourly rainfall has been undertaken, examining scaling with temperature
- Precipitation-temperature scaling ($\%/^{\circ}\text{C}$) computed on the 1950-2011 period

Dynamical and thermodynamic drivers: work in progress



- P-T scaling is estimated using 1) the entire range of temperature (global scaling) and 2) running windows of 10°C width
- As expected, the P-T scaling is highly dependent on the temperature range

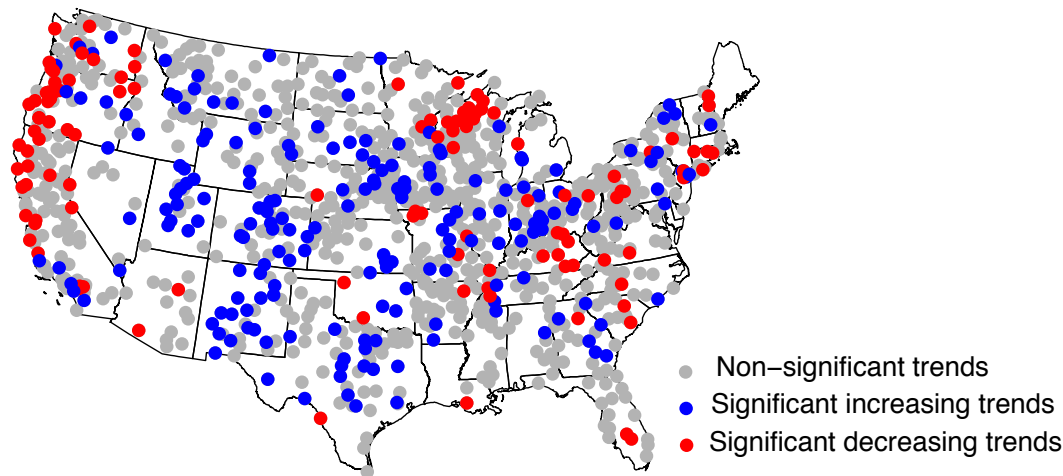
Dynamical and thermodynamic drivers: work in progress



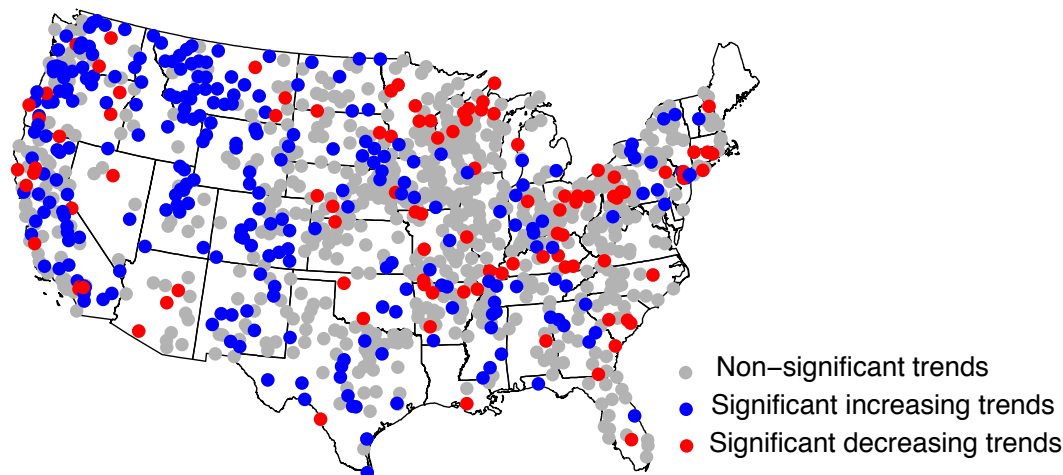
- Median (solid line) and inter-quartile range (dashed lines) of the P-T scaling at the US scale

Trends in extreme P: work in progress

a) Trends in annual heavy rainfall events (daily scale)



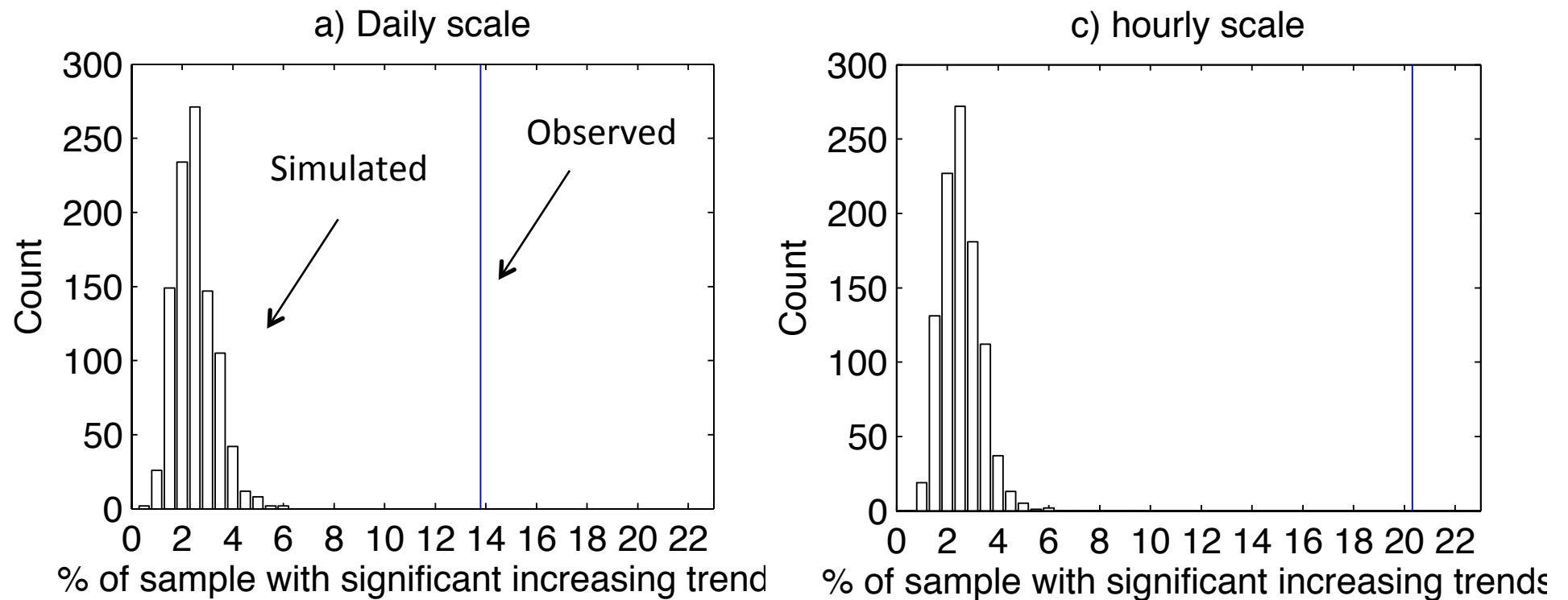
b) Trends in annual heavy rainfall events (hourly scale)



- Heavy rainfall events defined as events >95th percentile (the distribution includes only wet days or wet hours)

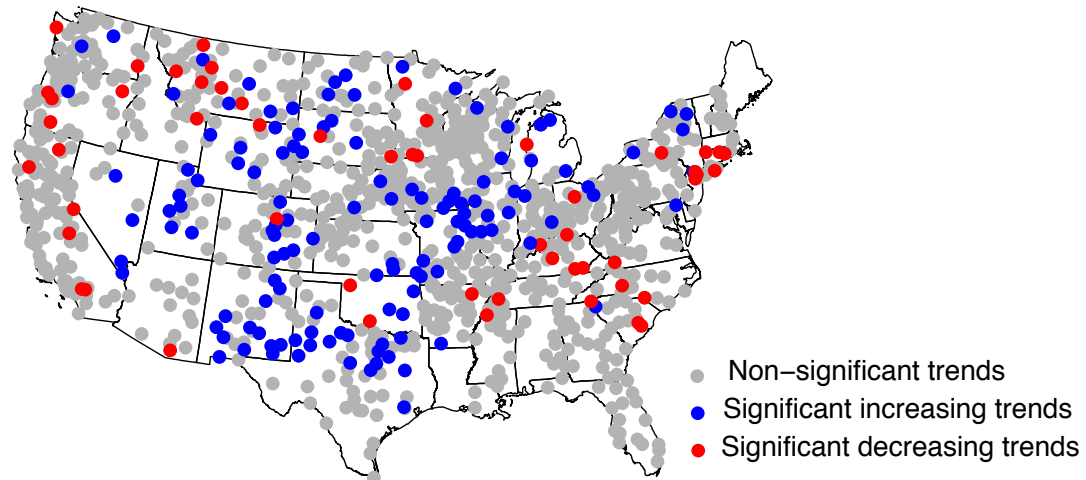
- Trends are evaluated in terms of frequency from a Mann-Kendall test following Westra et al. (2013)

Trends in extreme P: work in progress

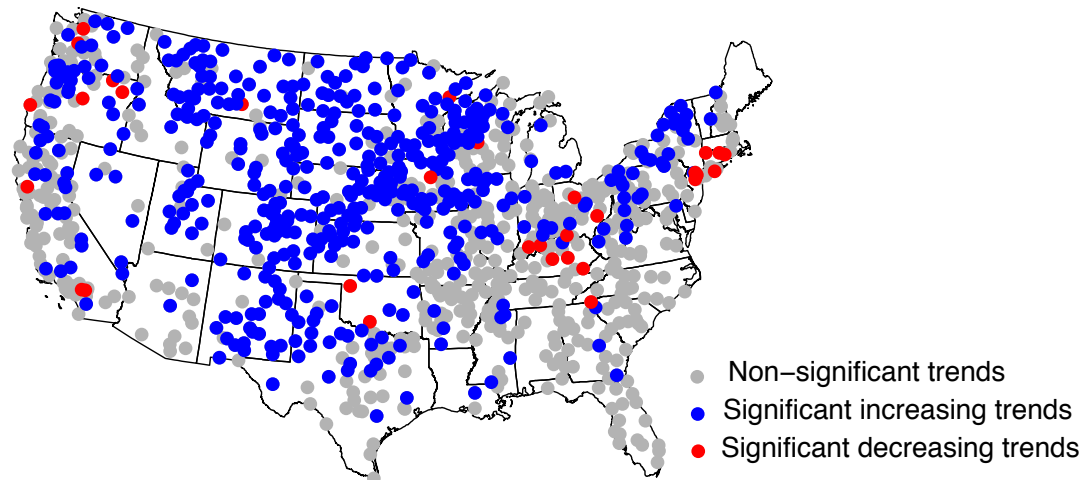


Trends in extreme P: work in progress

a) Trends in DJF heavy rainfall events (daily scale)

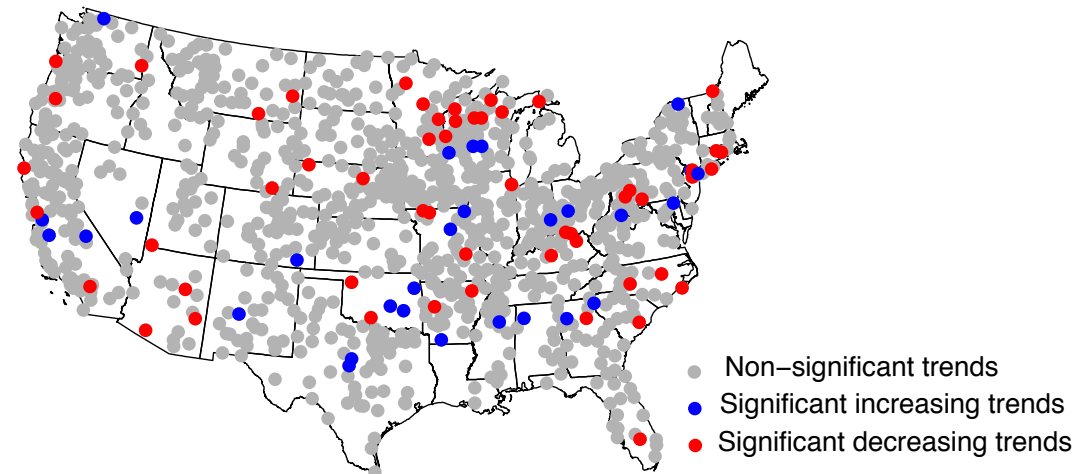


b) Trends in DJF heavy rainfall events (hourly scale)

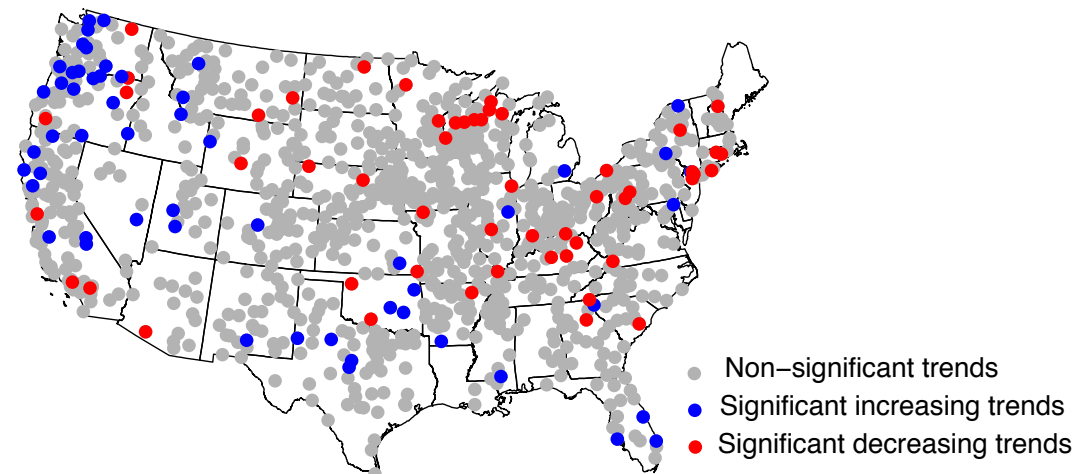


Trends in extreme P: work in progress

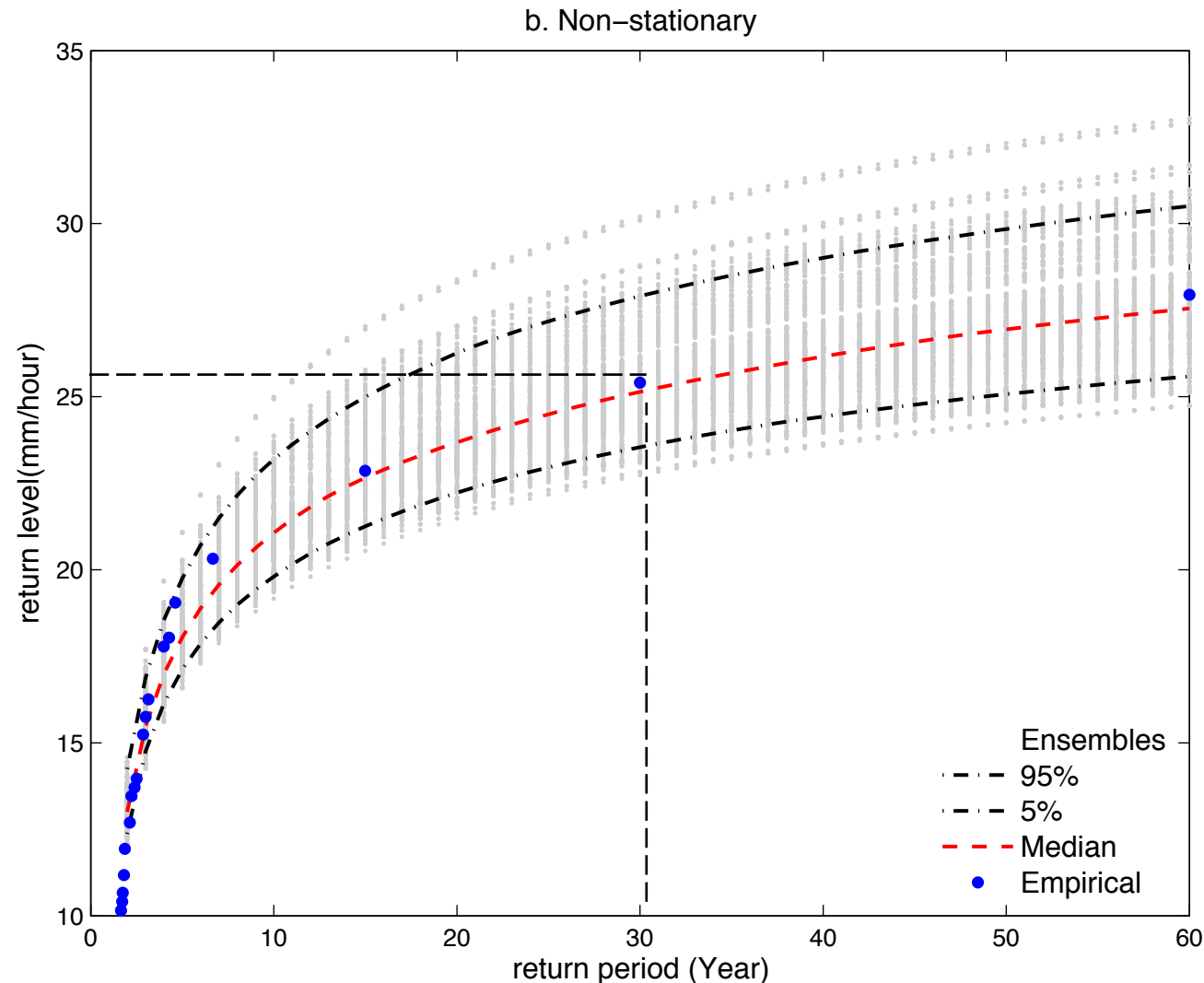
a) Trends in JJA heavy rainfall events (daily scale)



b) Trends in JJA heavy rainfall events (hourly scale)

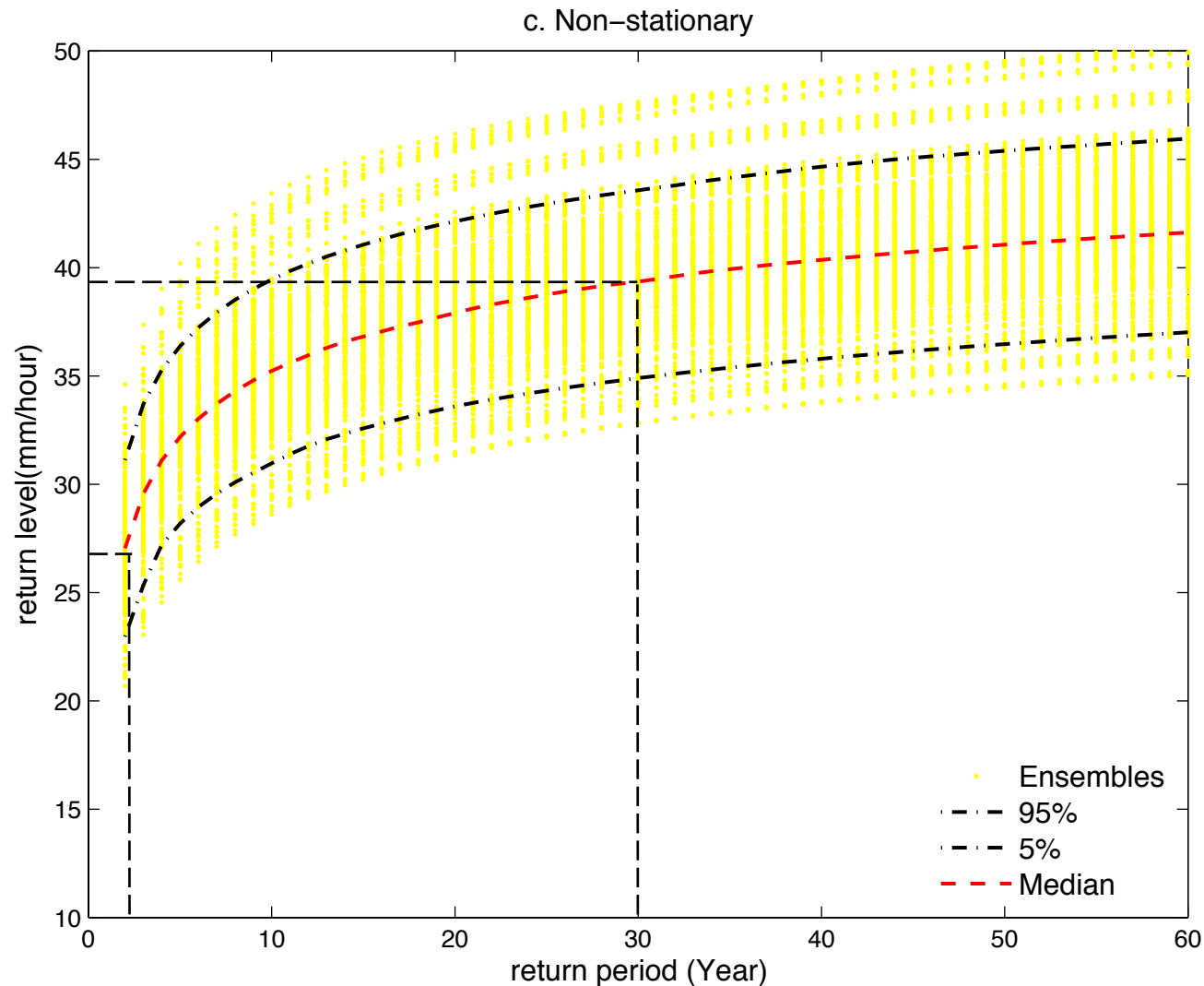


Trends in extreme P: work in progress



- Return level vs return period over the historical period (1950-2009) in Southern Idaho

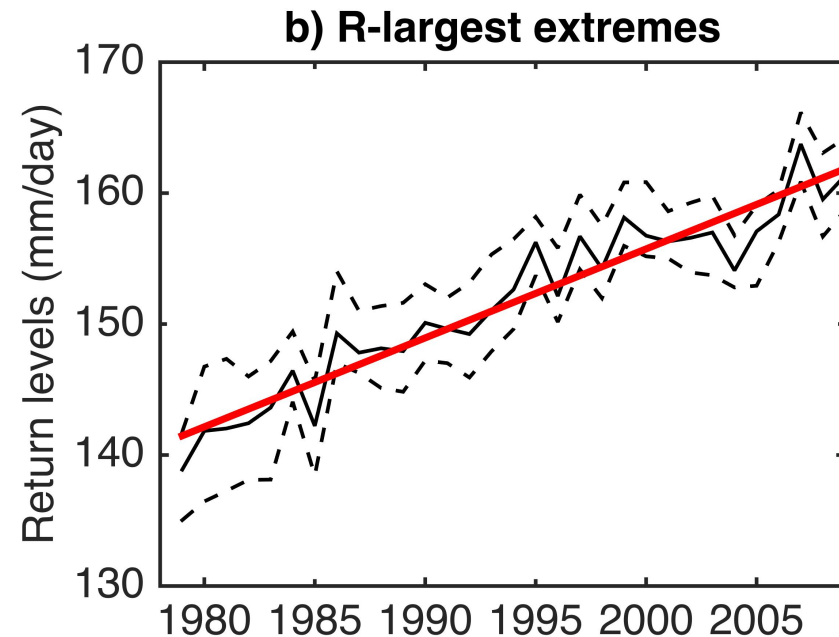
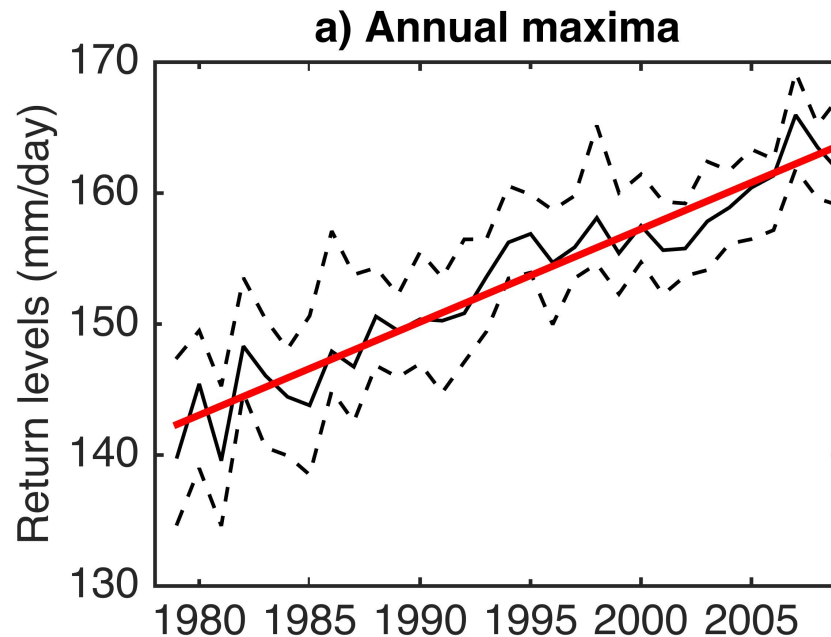
Trends in extreme P: work in progress



- Return level vs return period over the next 100 yrs (2010-2109) in Southern Idaho

Trends in extreme P: work in progress

- Return levels associated with a 20-year return period at one station in Washington state
- Solid line=median across 1,000 estimates
- Dashed lines= 40th and 60th percentile across 1,000 estimates



INTENSE planned activities (2016)

Database

- Continued data acquisition strategy and initiatives on a regional basis to update and expand the existing database.
- Continue to support the development of quality control measures for sub-daily precipitation data.
- Construction and analysis of a comprehensive UK sub-hourly (10-15 minute) dataset is planned using UK rain gauge data.

Research

- A global scale analysis of the extreme precipitation-temperature relationship will be undertaken using subdaily datasets gathered by INTENSE.
- Further develop the working group on very high resolution models and common analyses of model outputs.
- First analyses of data observations from around the world and first global results.

INTENSE planned activities (2016)

Publications

- Two publications are planned on the quality control of sub-daily precipitation. (i) development of tests of spatial consistency with neighbouring gauges and their application to produce a gridded 1km hourly precipitation product for the UK. (ii) Development of generic methodology.

Workshops and meetings

- Planned international workshop in 2016 to include INTENSE partners (funded) and other interested parties (unfunded). This will take forward some of the questions/activities identified at the WCRP workshop in Sydney in Feb 2015, in particular, identification of indices for sub-daily precipitation.
- Attendance at the UK Royal Meteorological Society annual conference and European Geophysical Union (EGU) General Assembly in 2016 where a session has been approved on high-resolution climate models.

INTENSE planned activities (2016)

Preparation of INTENSE project web-site :

- allow people to get more information about the project,
- provide a central repository for INTENSE publications,
- see the current status of the project / keep working group members informed of project activities
- let INTENSE know about data they would like to contribute
- get access to data when it is ready
- be able to add their own papers when they are relevant