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WCRP Grand Challenge on Extremes data workshop.

UNSW, Sydney, Australia, 25th-27th Feb 2015

INTENSE: addressing the grand challenges on weather and climate extremes

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Introduction

INTElligent use of climate models for adaptatioN to non-Stationary hydrological Extremes

- Some results indicate that sub-daily precipitation extremes will intensify more than is anticipated based upon theoretical considerations (CC scaling).

- Short time-scale precipitation (down to 5 minute) extremes are used in the engineering design of infrastructure.

- Very high resolution RCMs (<4km) now more commonplace and can provide improvements to convective rainfall etc.

- Appropriate datasets and methods not necessarily available to evaluate model outputs.

INTENSE Key Research Questions

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

1. Changes in sub-daily maximum precipitation over the last century?

2. How does precipitation at different time-scales vary with atmospheric temperature and atmospheric moisture as the atmosphere warms?

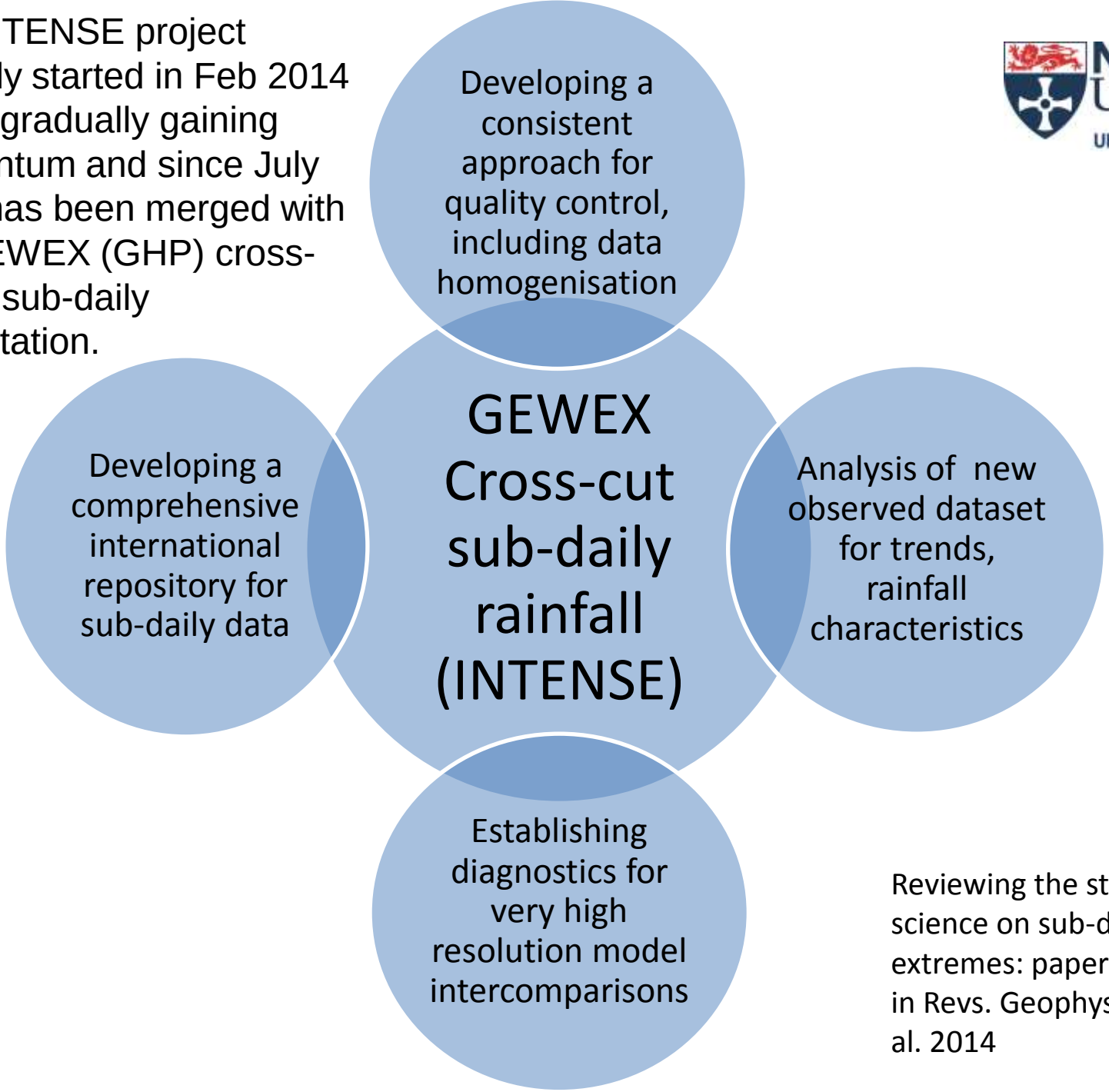
3. Role of large-scale atmospheric and oceanic features to influence observed changes in extremes, clustering and the variability between 'drought' and 'flood' periods?

4. Influence of climate model resolution and structure?

5. Response to warming of precipitation and precipitation extremes at different time- scales?

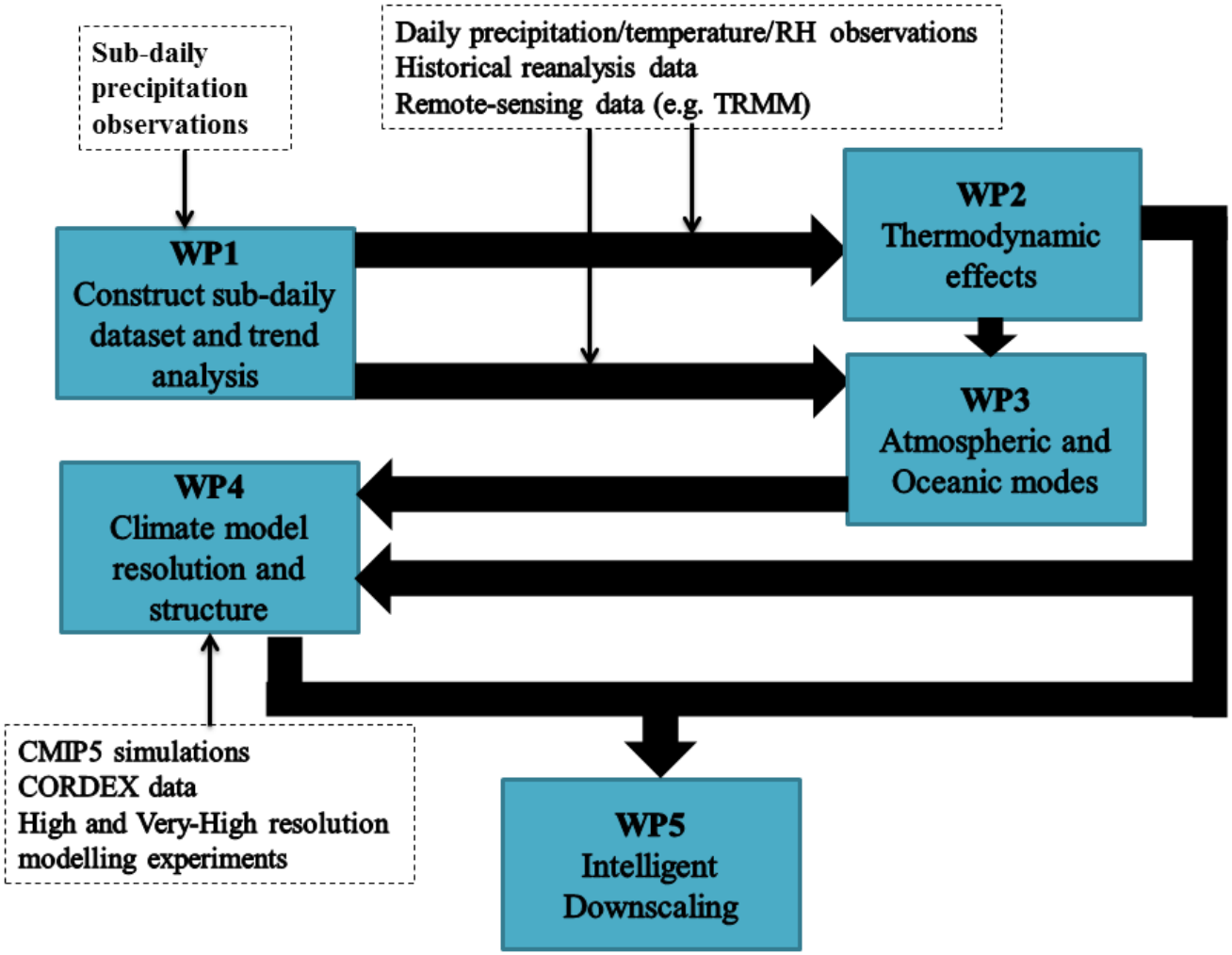
6. How to use information from both high- and coarse-resolution climate models in a more intelligent way to inform decision making?

The INTENSE project officially started in Feb 2014 and is gradually gaining momentum and since July 2014 has been merged with the GEWEX (GHP) cross-cut on sub-daily precipitation.



Reviewing the state of the science on sub-daily extremes: paper published in Revs. Geophys. Westra et al. 2014

INTENSE Objectives

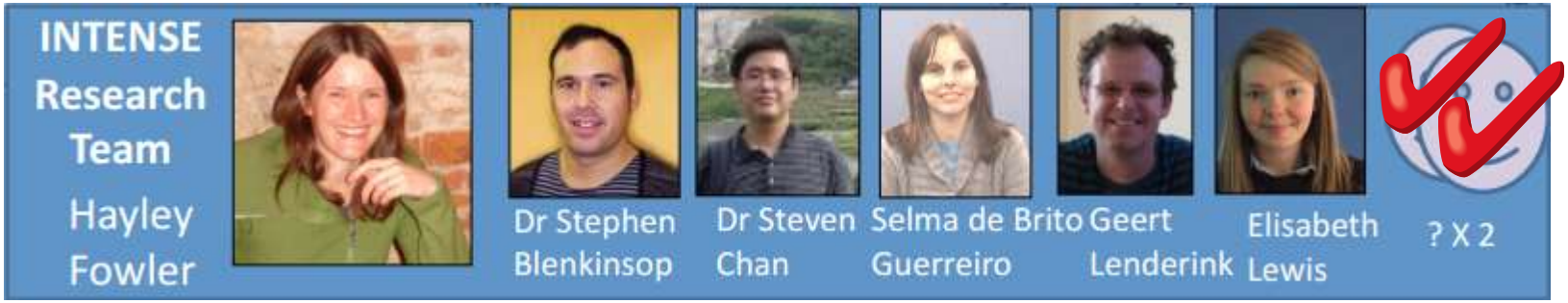


INTENSE Status

- INTENSE has acquired sub-daily (mainly hourly) precipitation data from 8 countries around the world. Numerous contacts have been made and more deliveries of precipitation data are pending, especially for Australia and the European region. At the moment this is held ad-hoc at Newcastle University.

- Progress in developing checks on the quality of sub-daily (hourly) rainfall data using UK data. It would be useful to find out more on how sub-daily data is quality controlled in different parts of the world by the Met Agencies.

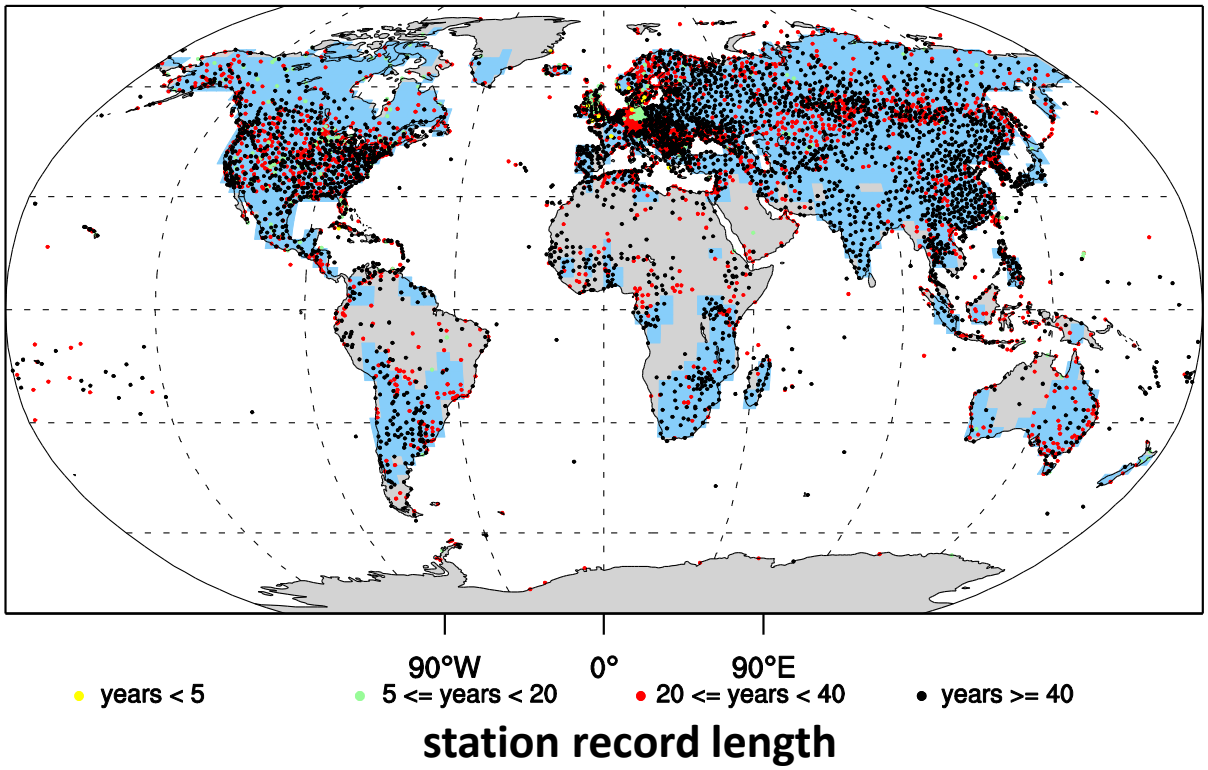
- Employed 2 PDRAs since July 2014 (4 year contracts), one since Feb 2015 and will have three more starting in May 2015 which should provide additional momentum.



INTENSE activities 2014

- Review paper published in Revs. Geophys. Westra et al. 2014.
- Article published in GEWEX news in Aug 2014 about comparison of very-high resolution RCMs – set up a working group and a website to share model outputs and compare using standard diagnostics.
- Developing a comprehensive international repository for sub-daily data.

GEWEX and INTENSE – augmenting and quality controlling the HadISD dataset



Locations of freely available sub-daily precipitation data from the HadISD dataset (Dunn et al. 2012 – updated from Robert Dunn 13th Feb 2014).

The blue shading represents regions where daily rainfall intensity measures are available from the HadEX2 dataset (Donat et al. 2013b) over the period 1951-2010 (Westra et al., submitted).

GEWEX and INTENSE – augmenting and quality controlling the HadISD dataset: Progress so far

- Sub-daily precipitation data collected for:

USA (1029 stations with <10% missing data for 1950–2009), Netherlands (20-30 stations with >30 years of data; De Bilt from 1906), Malaysia (>1[illegible]s), Japan (17 hourly stations, 1980-, some 10min data), UK (13[illegible]00 with >20y record, all have been QCd), Italy (>30 stati[illegible] stations), Canada (few stations – more coming)

- Sub-daily datasets identifi[illegible]n in:

Sweden (~120 stations, 15-min da[illegible]), Denmark (~100 stations, 15-min data), Germany (~[illegible]data from 1997, some 30 year records); Belgium (1[illegible]erland (4 stations, 30y), Portugal, (2001-); Easte[illegible]s, 1966-2005); India (72 stations, 1969-2006); H[illegible], 1885-); Indonesia (1 station, 100y); Singapore (28 stat[illegible]n data (137 stations with >10y data)

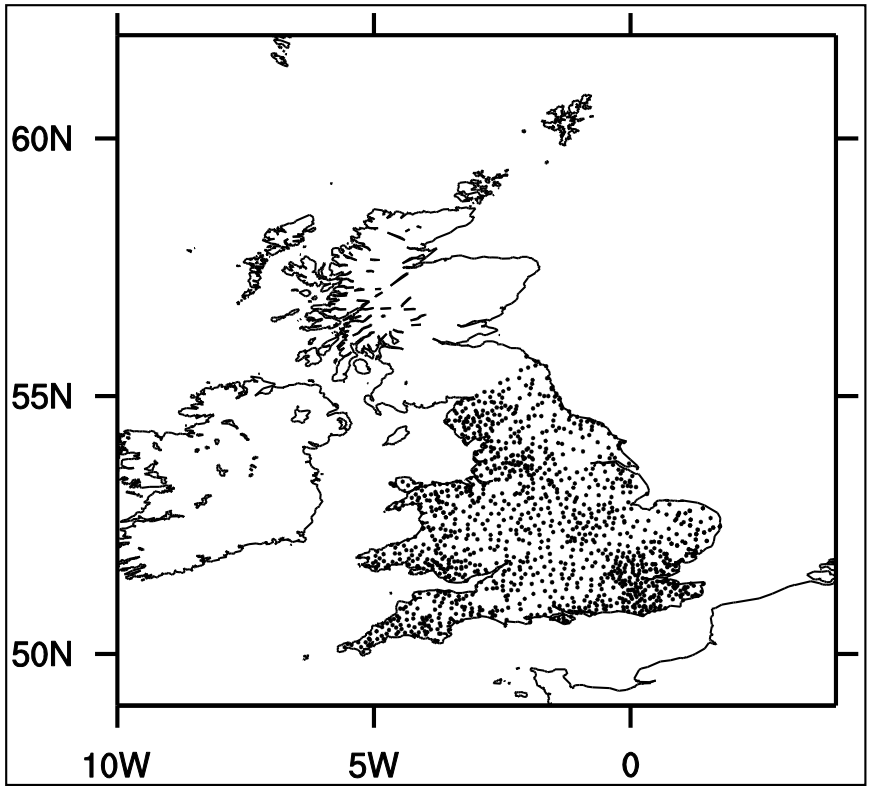
Major contribution to GC white paper Q1 on collation, dissemination & quality of observations.

- Need standard request letter and route through to correct data provider – GHP and GPCC to help with this

Sub-daily gauge data from UK – QC issues

We have used:

- Met Office Integrated Data Archive System (MIDAS),
- Scottish Environment Protection Agency (SEPA)
- Environment Agency (EA), ~1300 tipping bucket gauges across England & Wales (15min & 0.2mm)

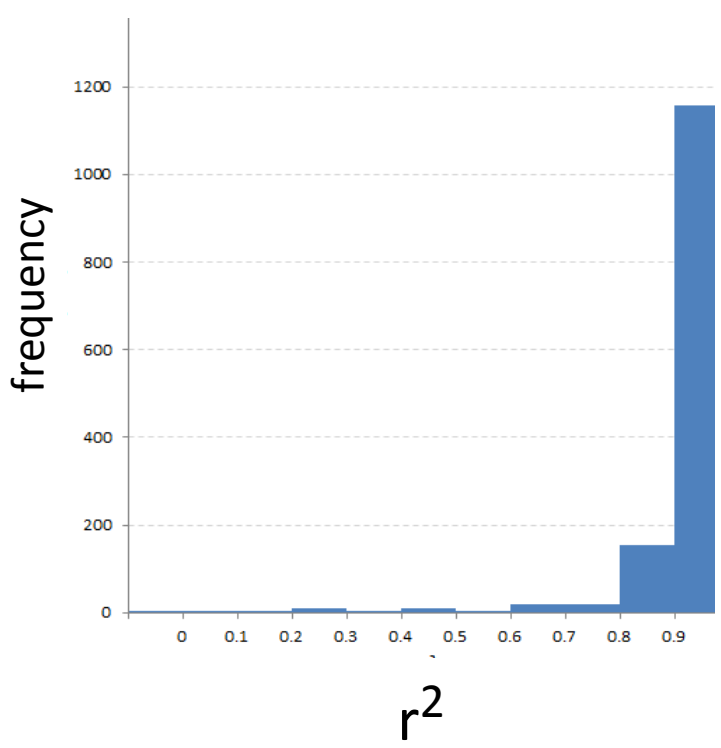


Location of EA tipping bucket rain gauges before quality control procedures

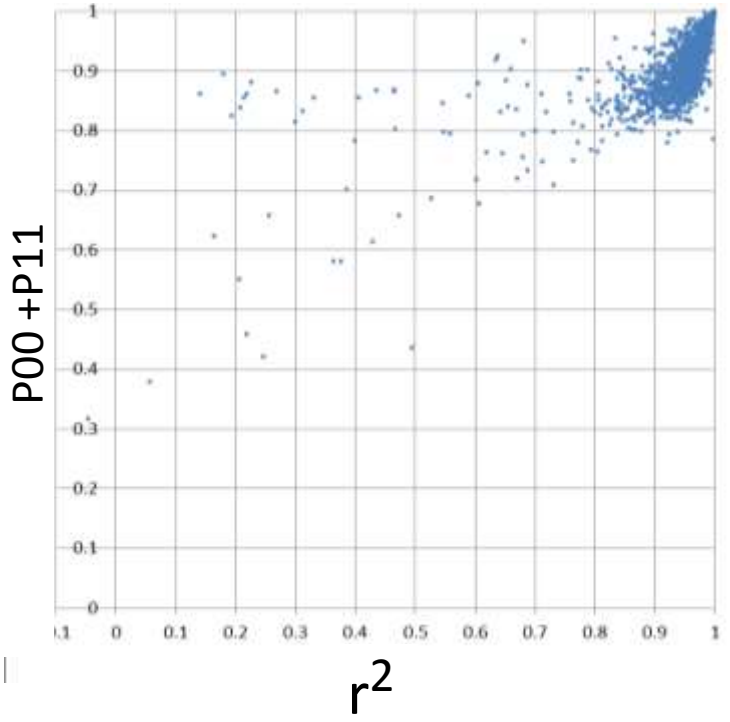
Assessing data quality?

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):



Quality control of UK sub-daily rainfall d

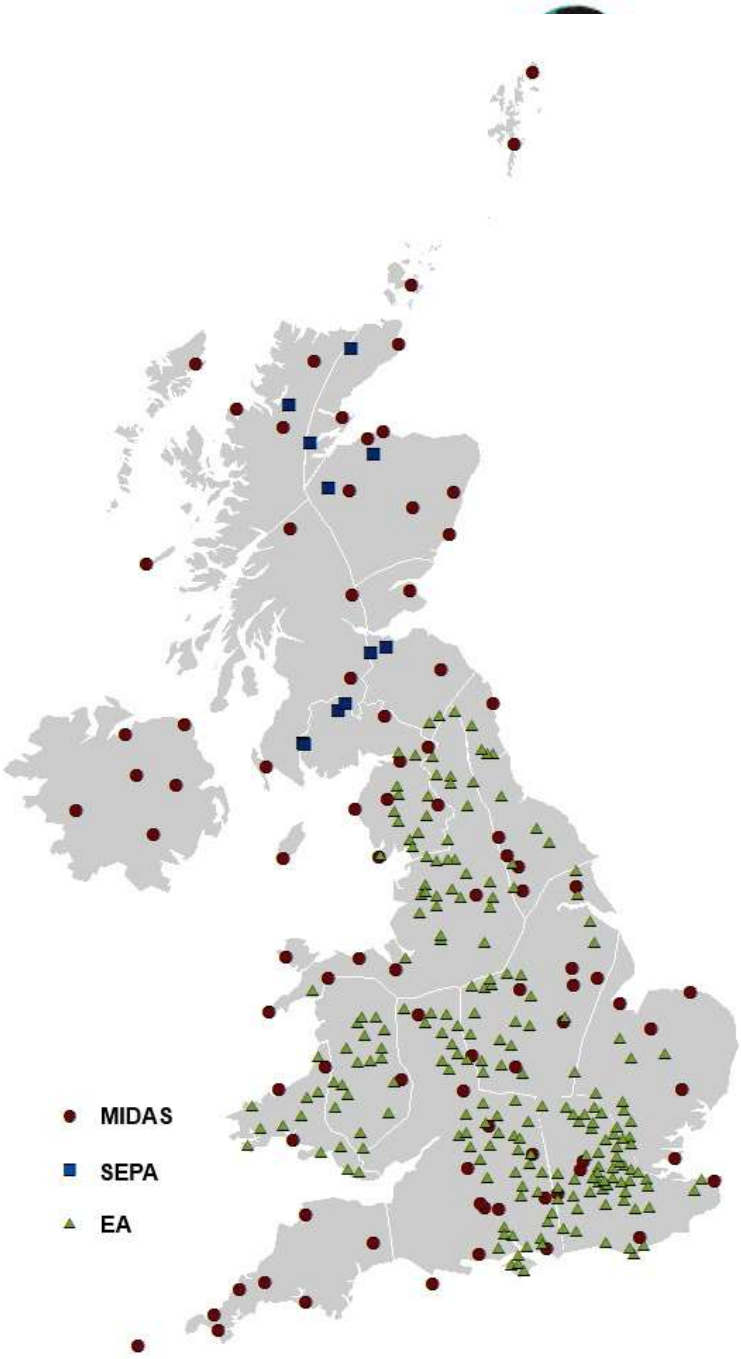
Limited existing quality control/testir

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

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

Comparison with other precipitation products – daily 5km gridded dataset

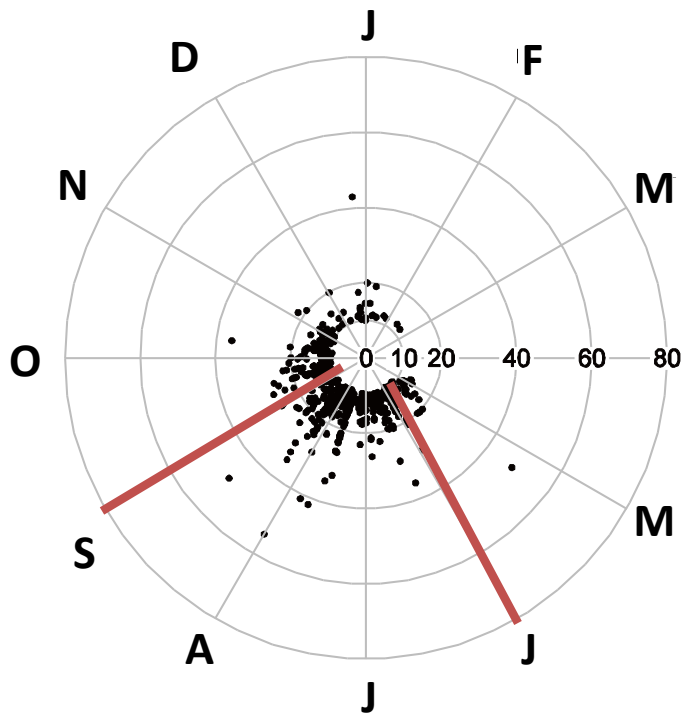
Long dry periods representing gaug malfunction are identified and excluded.



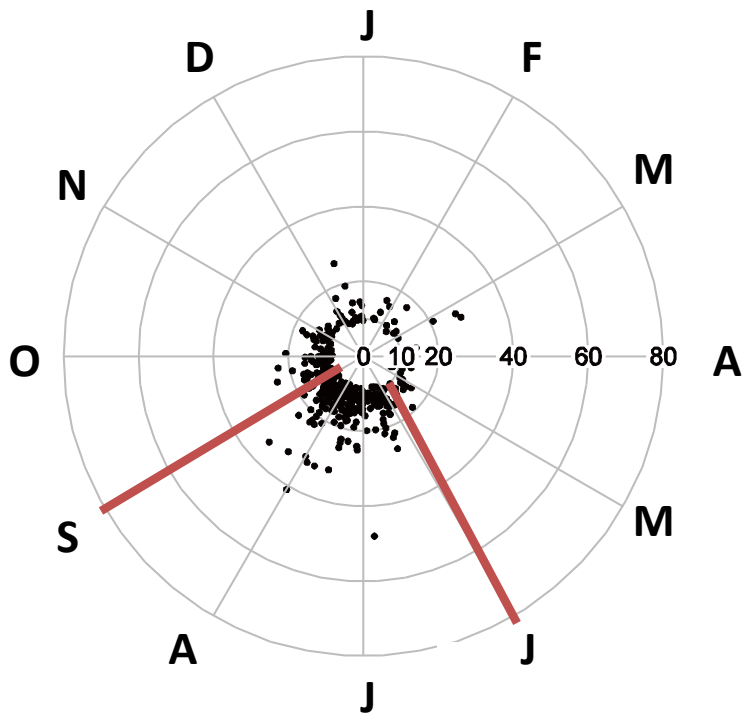
When do the most intense events occur?

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



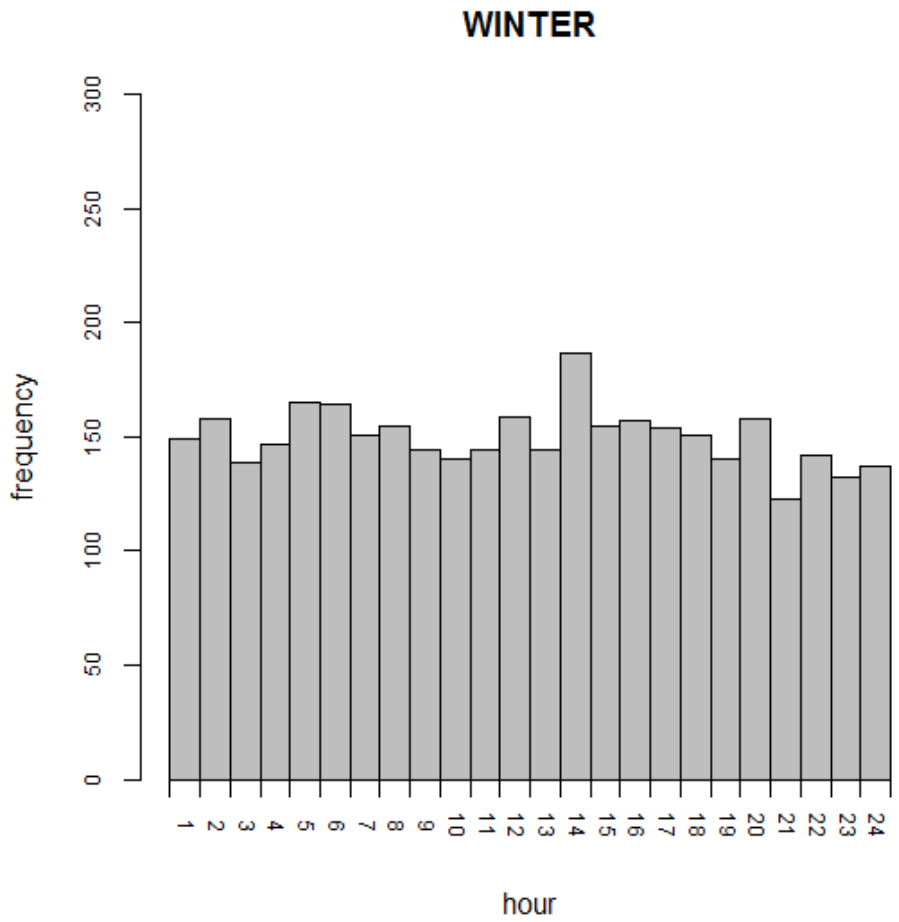
North west England

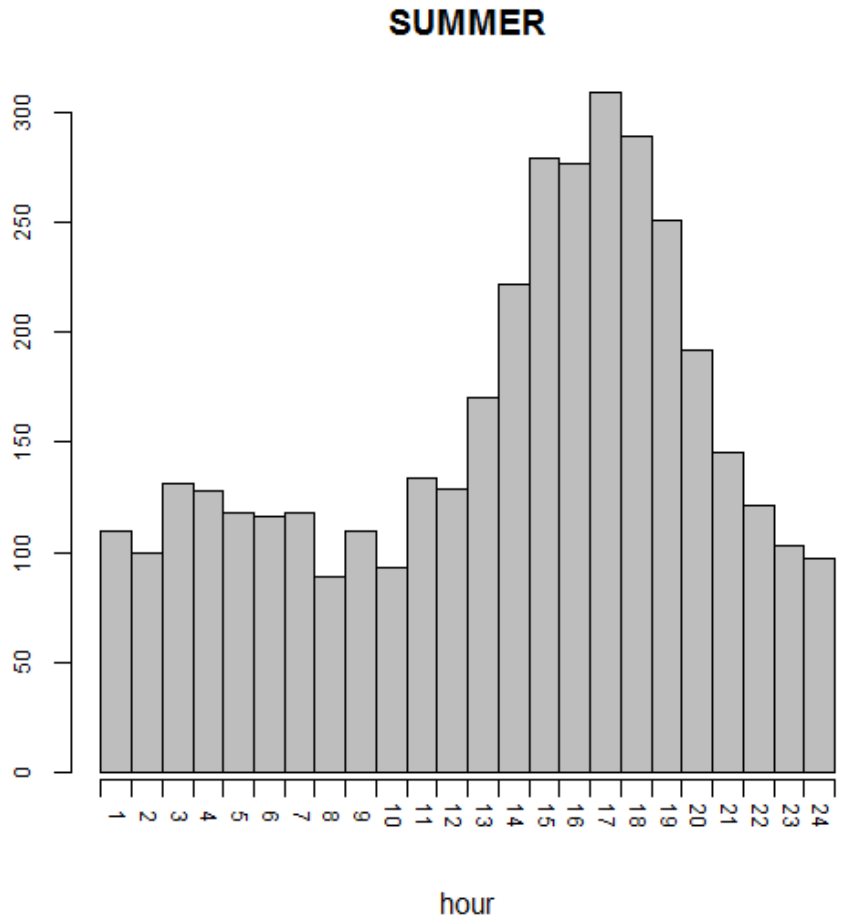


Summer is the most important time of the year AND tends to see the most intense events.

When do the most intense events occur?

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





INTENSE future activities

- Continued data acquisition strategy and initiatives on a regional basis to update and expand the existing database. Thought given to where to host data and development of new indices for sub-daily precipitation to support research community.

Precipitation indices:

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Index**	**Description**	**Formula**	**ClimDex**	**Frich**	**ECA**	**KT&K**	**Kiktev**	**STARDEX**	**Osborn**	**Bonsal**	**KleinT**		**Interpretation**
2	R10mm	Heavy precipitation days	No. days RR ≥ 10mm	●	●	●	●	●						Day count; fixed threshold
3	R20mm	Very heavy precipitation days	No. days RR ≥ 20mm			●	●							Day count; fixed threshold
4	RX1day	Highest 1 day precipitation amount	Greatest RR sum for 1 day interval			●	●							Precip amount
5	R5D or RX5day	Highest 5 day precipitation amount	Greatest RR sum for 5 day interval	●	●	●	●	●	●					Precip amount
6	CDD	Consecutive dry days	Greatest no. consec. days RR < 1mm	●	●	●		●	●					Maximum span of days
7	CWD	Consecutive wet days	Greatest no. consec. days RR ≥ 1mm			●								Maximum span of days
8	R75p, R95p	Moderate / very wet days	No. days RR > 75ptile calculated for wet days (on basis of 1961-90)			●	●							Day count; percentile threshold of amounts on wet days only
9	R99p	Extremely wet days	See R75p			●								See R75p
10	R90N	No. of events > long-term 90th percentile of raindays	See R75p						●					See R75p
11	R75pTOT, R99pTOT	Precipitation fraction due to R75p / R99p	Quotient of amount on R75p days and total amount			●								Fraction of total amount due to am. on R75p days
12	R95T or R95pTOT	Precipitation fraction due to R95p	See R75pTOT	●	●	●	●							See R75pTOT
13	R90T	% of total rainfall from events > long-term P90	See R75pTOT						●					See R75pTOT
14	SDII	Simple daily intensity index	Quotient of amount on days RR ≥ 1mm and no. days RR ≥ 1mm	●	●	●		●	●			●		Mean precip amount per wet day
15	Prec90p	90th percentile of rainday amounts (mm/day)	90ptile calculated for wet days						●					90ptile in distribution at wet days

INTENSE future activities

- Continue to support the development of quality control measures for sub-daily precipitation data and produce a report on this.
- Actively support international programmes and initiatives for improved exchange and sharing of hydro-meteorological data.
- Further develop the working group on very high resolution models and common analyses of model outputs.
- Publish and maintain INTENSE website.

Summary

- Efforts should focus on collection of sub-daily data into an international archive and proper quality control.
- Blended gauge and radar products may also be beneficial.
- Analysis of these products for trends/variability and drivers (local, regional) will provide better understanding of changes in sub-daily precipitation extremes.
- Km scale RCMs are now more commonly available and better observations and novel techniques are needed to evaluate these models, particularly for precipitation – we need to determine the best methods by which to produce these.

Recommendations

A focussed international research effort is required to better understand changes to sub-daily extreme rainfall:

1. Improving both gauge-based and remotely-sensed observing networks.

2. Developing and applying extreme value techniques appropriate to sub-daily data.

3. Applying km scale models in climate studies and improved assessment of the performance of these models in simulating short-duration rainfall.

4. Strengthening the link between climate science and impacts science, focussing on how extreme rainfall leads to flood risk.

From Westra *et al., Revs. Geophys.*