

# **INTENSE: GHP/GEWEX cross-cut on sub-daily precipitation**

**Overview of the development of sub-daily precipitation data sets for the evaluation of precipitation extremes**

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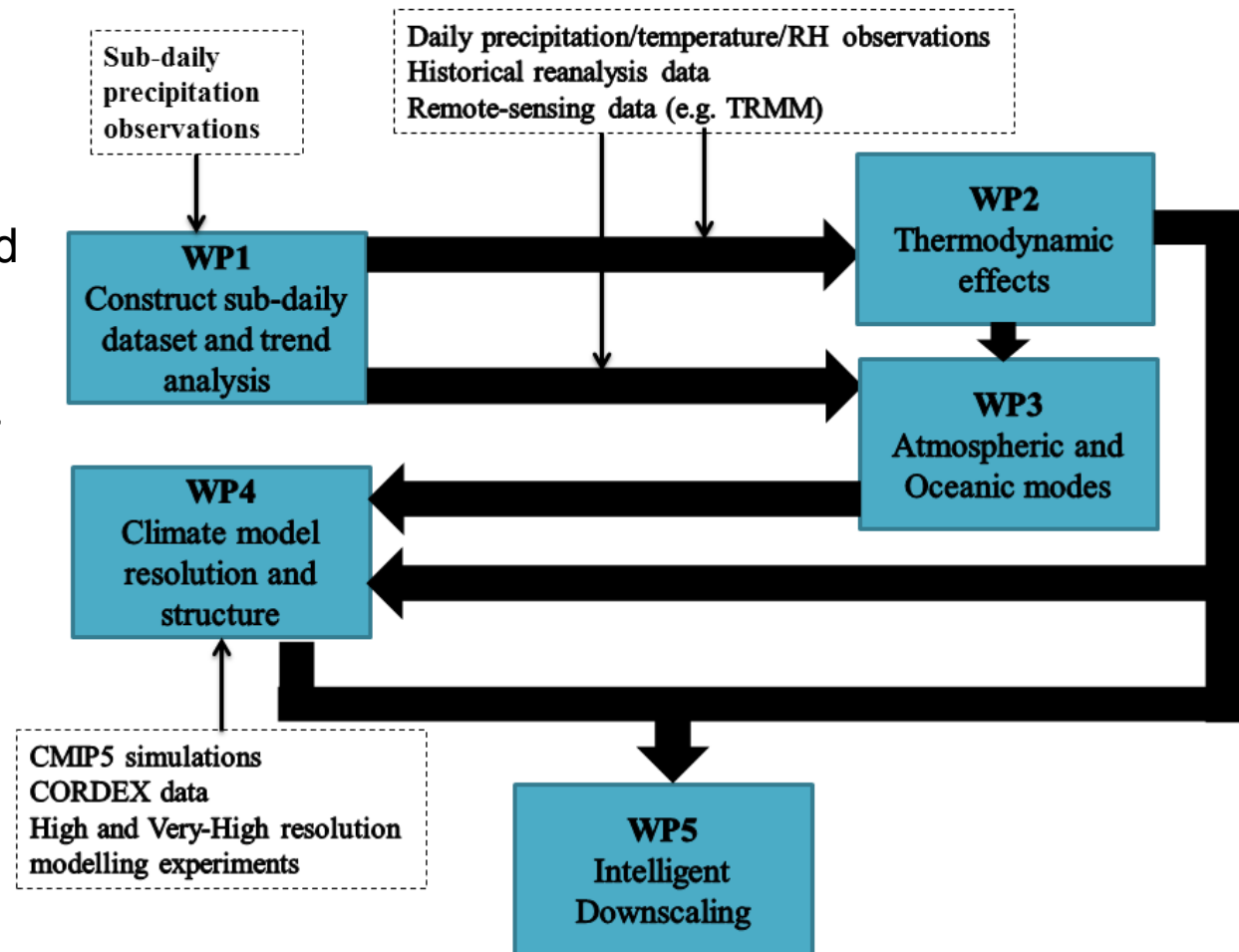
# Introduction

- Very high resolution RCMs (<4km) now more commonplace
- Number of simulations now run as full decadal length integrations
- Can provide improvements to convective rainfall, diurnal cycle, orographic rainfall and urban and land surface feedbacks
- Appropriate datasets and methods not necessarily available to evaluate model outputs



**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**

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



# 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?

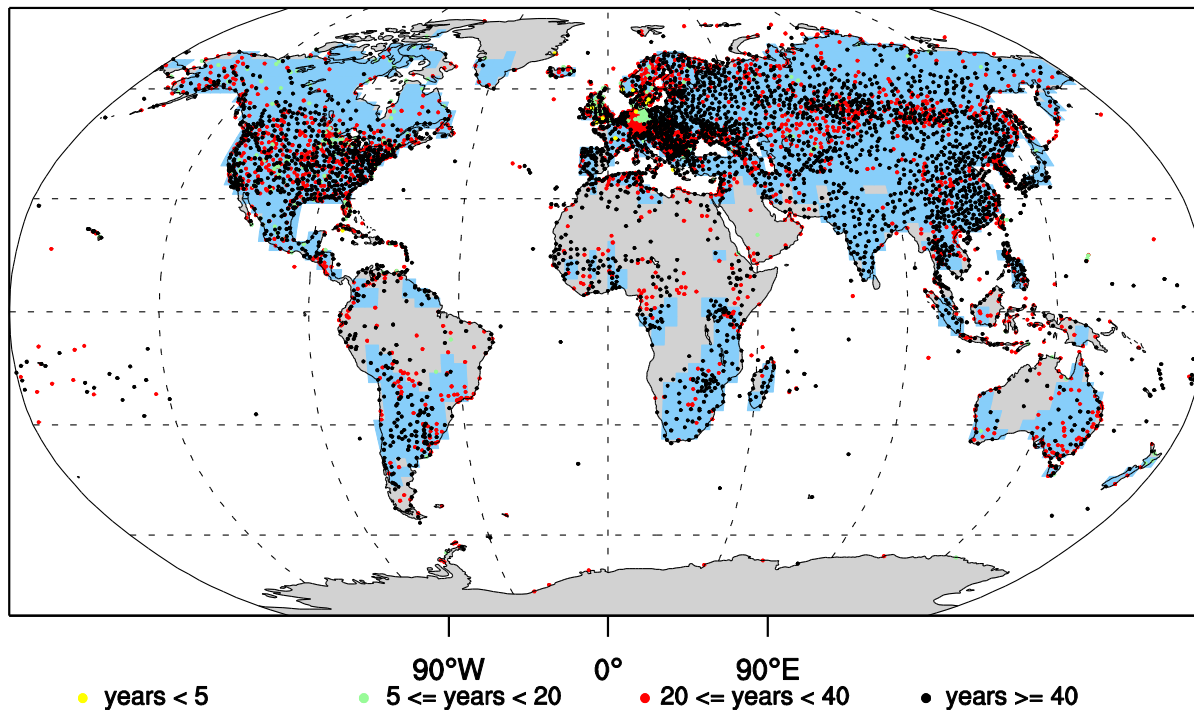
# INTENSE Objectives

- To implement a unique and very large-scale data collection effort for sub-daily precipitation data across four, or more, continents, over a globally synchronous period of more than 30 years, coordinating the collection over national Met services.
- To set/develop a consistent approach for quality control, including data homogenization and expand the ETCCDI indices to include the sub-daily data.
- To examine changes in precipitation extremes at daily and sub-daily levels over a global domain and how these are related to changes in thermodynamical and dynamical forcings.
- To analyse new and existing precipitation and temperature datasets to quantify the scaling relationship between extreme precipitation and temperature for different climate regimes and seasons, then extending this to examine the effects of atmospheric humidity on precipitation extremes.
- To explore how the frequency and magnitude of drought and heavy rainfall are linked through circulation variability.
- To extend work developed in the CONVEX project to explore the influence of climate model resolution and structure on the simulation of precipitation extremes, providing a quantification of how these might influence the simulation of precipitation and may change in a warming world. This will include inter-model comparisons of very high resolution models.

# INTENSE Status

- During the reporting period INTENSE has managed to acquire sub-daily (mainly hourly) precipitation data from 7 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 but it would be useful to think about where the best place would be to store the data (not all of which can be made publicly available).
- INTENSE has made progress in developing a methodology for the quality-control of sub-daily (hourly) rainfall data and this has been tested on 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.
- INTENSE has employed 2 PDRAs since July 2014 (4 year contracts) and is currently in the recruitment process for four more PDRAs to start work on the project (3 year contracts) in early 2015 which should provide momentum. Interviews will be held in early Jan 2015.

# 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). Dot colours represent station record length. Stations may be open or closed and periods of record are not necessarily coincident, nor do they necessarily reflect the amount of non-missing data in the record. 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

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- 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 (>10 station), Japan (17 hourly stations, 1980-, some 10min data), UK (1300 stations, ~300 with >20y record, all have been QCd), Italy (>30 stations), Singapore (>10 stations)
- Sub-daily datasets identified for collection in:  
Sweden (~120 stations, 15-min data, most start 1997/8), Denmark (~100 stations, 15-min data), Germany (~100 stations, 5-min data from 1997, some 30 year records); Belgium (1 station, 50y), Switzerland (4 stations, 30y), Portugal, (2001-); Eastern China (>30 stations, 1966-2005); India (72 stations, 1969-2006); Hong Kong (1 station, 1885-); Indonesia (1 station, 100y); Singapore (28 stations, 30y); Australian data (137 stations with >10y data)
- Need standard request letter and route through to correct data provider – can daily data collection experiences in GEWEX help with this?



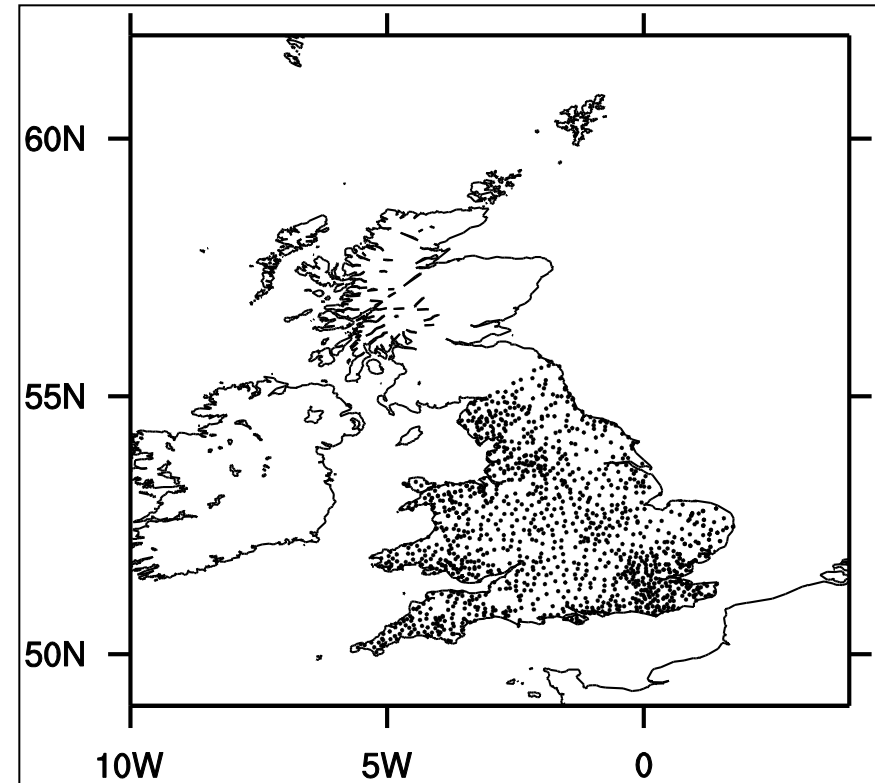


# Sub-daily gauge data from UK – QC issues



## 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)



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

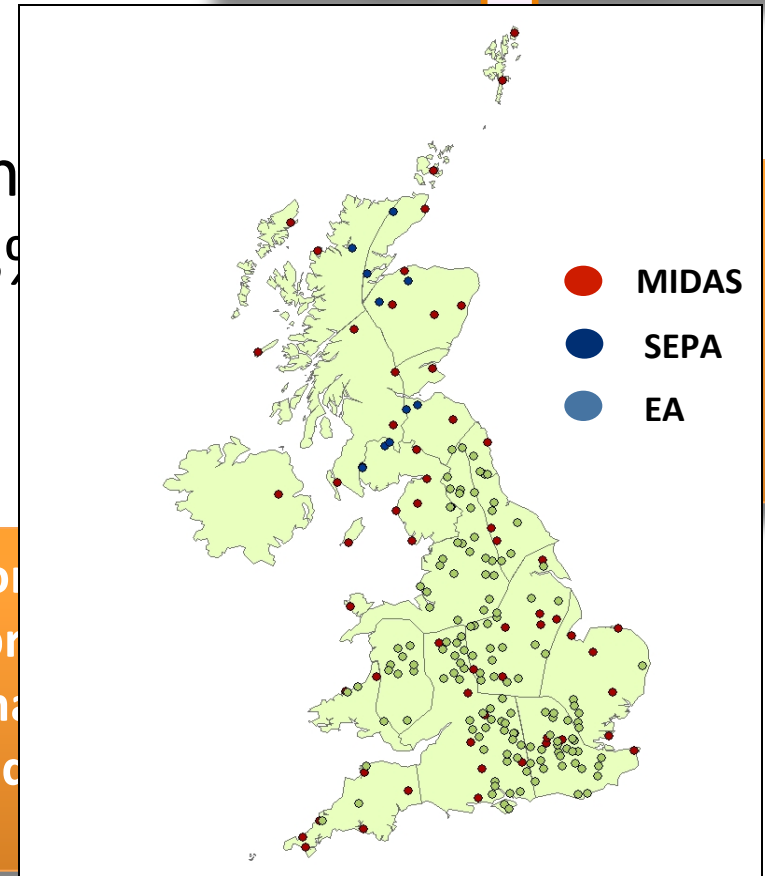


# Quality control of UK sub-daily rainfall data

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  $\pm 2\text{mm}$  ( $\pm 8\%$ ) of the check gauge then data are classified as “good”.

Data identified as ‘suspect’ in EA metadata are excluded.



Comparison with other precipitation products – radar, daily 5km gridded dataset

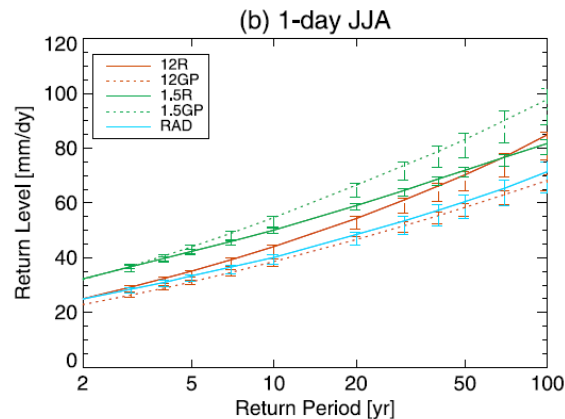
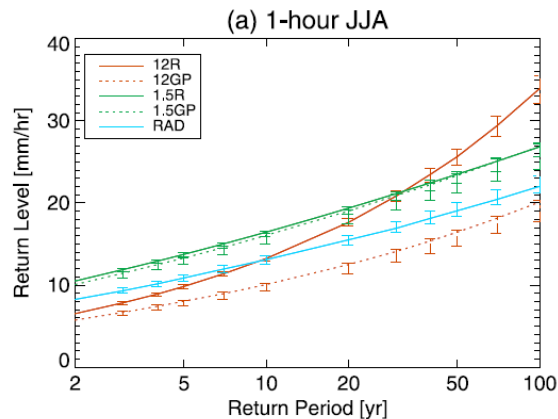
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# INTENSE activities 2014

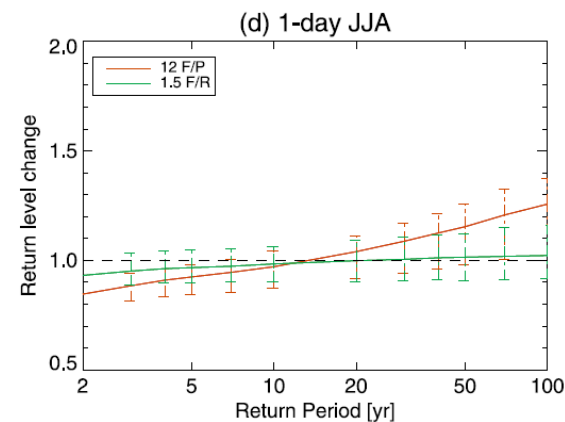
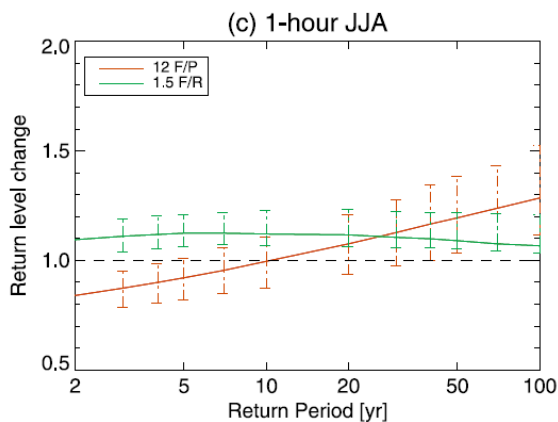
- Review paper published in Revs. Geophys. Westra et al. 2014
- Article published in GEWEX news in Aug 2014 about comparison of very-high resolution RCMs – set up a working group and a website to share model outputs and compare using standard diagnostics.
- Developing a comprehensive international repository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

# INTENSE first results published

- Chan, S.C., Kendon, E.J., Fowler, H.J., Blenkinsop, S., Roberts, N.M. 2014: Projected increases in summer and winter UK sub-daily precipitation extremes from high-resolution regional climate models. Environmental Research Letters, 9(8), 084019.



Spatial median return level (for all grid cells over domain) for 12km model (red) and 1.5km model (green) vs radar (blue) for reanalysis (R) and control (GP) for 1h and 1d in summer.

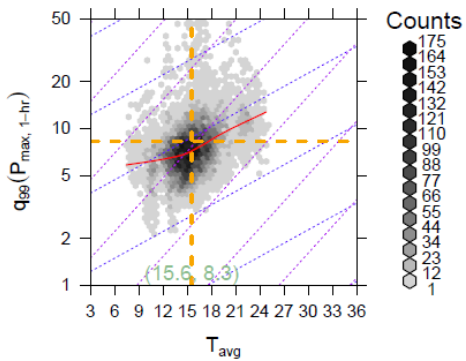


Spatial median change in return level (for all grid cells over domain) for 12km model (red) and 1.5km model (green) for future (2100; RHP8.5) for 1h and 1d in summer.

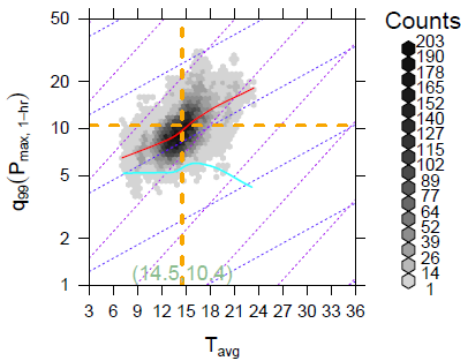
# INTENSE submitted paper

- Chan, S.C., Kendon, E.J., Roberts, N.M., Fowler, H.J., Roberts, M.J. Blenkinsop, S. Temperature and humidity constraints on UK future sub-daily precipitation intensities. Submitted to Nature Geoscience.

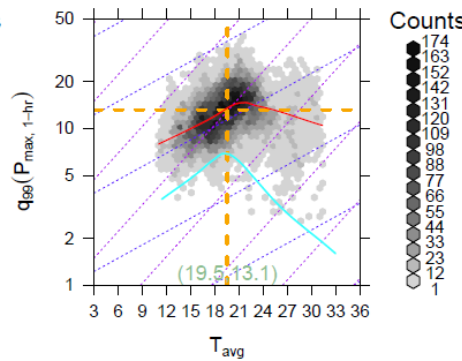
(a) OBS [JJA]



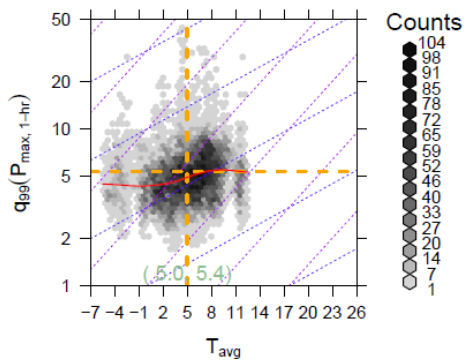
(b) 1.5/12 G-P [JJA]



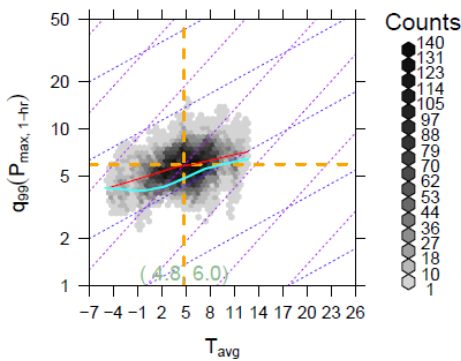
(c) 1.5/12 G-F [JJA]



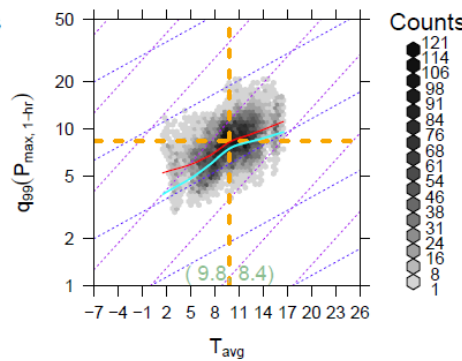
(d) OBS [DJF]



(e) 1.5/12 G-P [DJF]



(f) 1.5/12 G-F [DJF]



Observed (left, red), model control (centre) and future (right) JJA and DJF relationships between mean surface air temperature ( $T_{avg}$ ) and 99th quantile of daily maximum 1-hr precipitation ( $P_{max,1-hr}$ ). For panels (b) and (c) red lines indicate 1.5-km RCM, cyan lines indicate the 12-km RCM. The blue and purple dashes indicate 1x and 2x C-C scaling respectively.

# INTENSE future activities

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- 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.
- Preparation of INTENSE project web-site which will:
  - Provide a central repository for INTENSE publications,
  - allow people to get more information about the project,
  - 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
- Continue to support the development of quality control measures for sub-daily precipitation data and write up a report on this.
- Support actively international programmes and initiatives for improved exchange and sharing of hydro-meteorological data.
- Support the research community with relevant sub-daily precipitation datasets or their derivatives.
- Further develop the working group on very high resolution models and common analyses of model outputs.



# Summary

- Efforts should focus on collection of sub-daily data into an international archive and proper quality control
- Blended gauge and radar products would also be beneficial
- Analysis of these products for trends and drivers (local, regional) will provide better understanding of changes in sub-daily precipitation extremes
- Kilometre 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
- Techniques are available which can evaluate models based on frequency distributions rather than absolute values which overcomes the known bias in observational products



# 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 that can handle artefacts typically found in sub-daily data.
3. Applying kilometre 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



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# EXTRA SLIDES

# GEWEX Cross-cutting activity: sub-daily rainfall: research questions

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- What is the spatial distribution of observed precipitation extremes, and their trends, globally at daily time-scales?
- What is the spatial distribution of observed precipitation extremes, and their trends, globally at sub-daily time-scales?
- What is the relationship between daily and sub-daily extremes, their trends and global warming and natural variability?
- Are global and/or regional climate models able to simulate precipitation extremes at daily and sub-daily times-scales?
- What are the projected future changes in daily and sub-daily precipitation extremes due to global warming?