Key challenges and future developments

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Introduction

- Very high resolution RCMs (<4km) now more commonplace

- Can provide improvements to convective rainfall, diurnal cycle, orographic rainfall and urban and land surface feedbacks

- Such models are still not able to fully resolve convection leading to inherent deficiencies

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

- Yet we need projections of how extreme rainfall might change in the future!

The need to understand changes to extreme rainfall
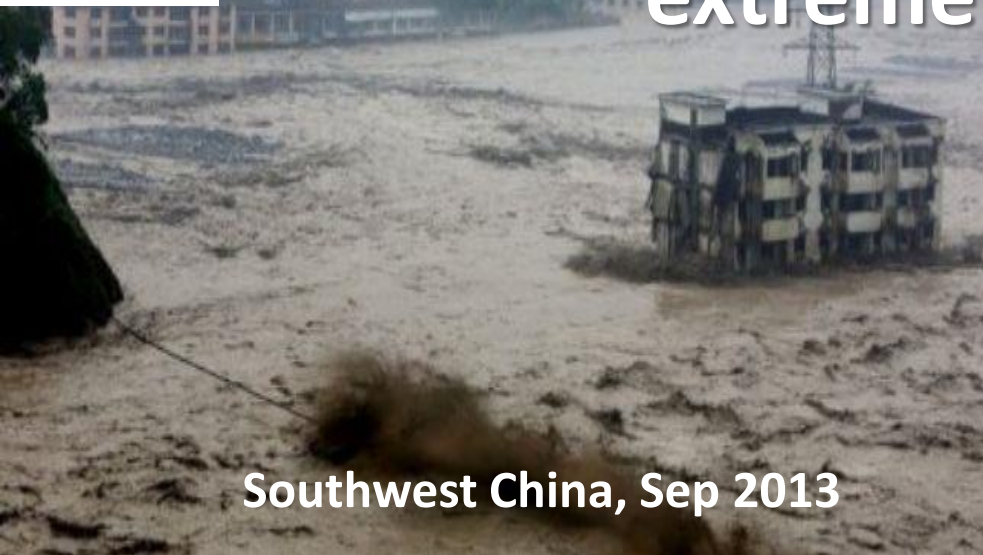
Southwest China, Sep 2013

Mexico, Sep 2013

Singapore, Sep 2013

Colorado, Sep 2013

Summary of Key Challenges: Models

- Applying additional km-scale models in climate studies and further development of methods for model evaluation

- Producing km-scale model inter-comparisons to better understand uncertainties and robustness of results

- Examining the potential benefits of km-scale models for the simulation of different variables such as temperature, wind, lightning etc.

**many from Westra *et al., Revs. Geophys., 2014***

Summary of Key Challenges: Observations

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

- Determining the best way to develop blended gauge and radar products which would also be beneficial for model evaluation

- Collection of sub-daily data into an international archive with proper quality control

- Understanding changes in hourly rainfall extremes in different regions – trends and drivers
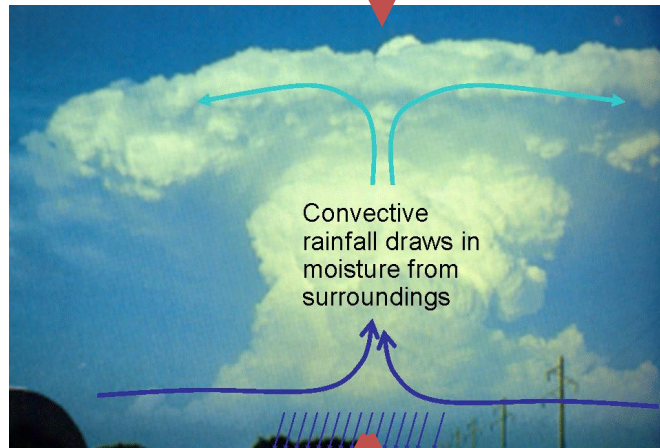
many from Westra *et al., Revs. Geophys., 2014*

INTENSE: INTElligent use of climate models for adaptatioN to non-Stationary hydrological Extremes
## (2M€ ERC Consolidators Grant)

Mechanisms

SSM/I Satellite data, Dec 2006
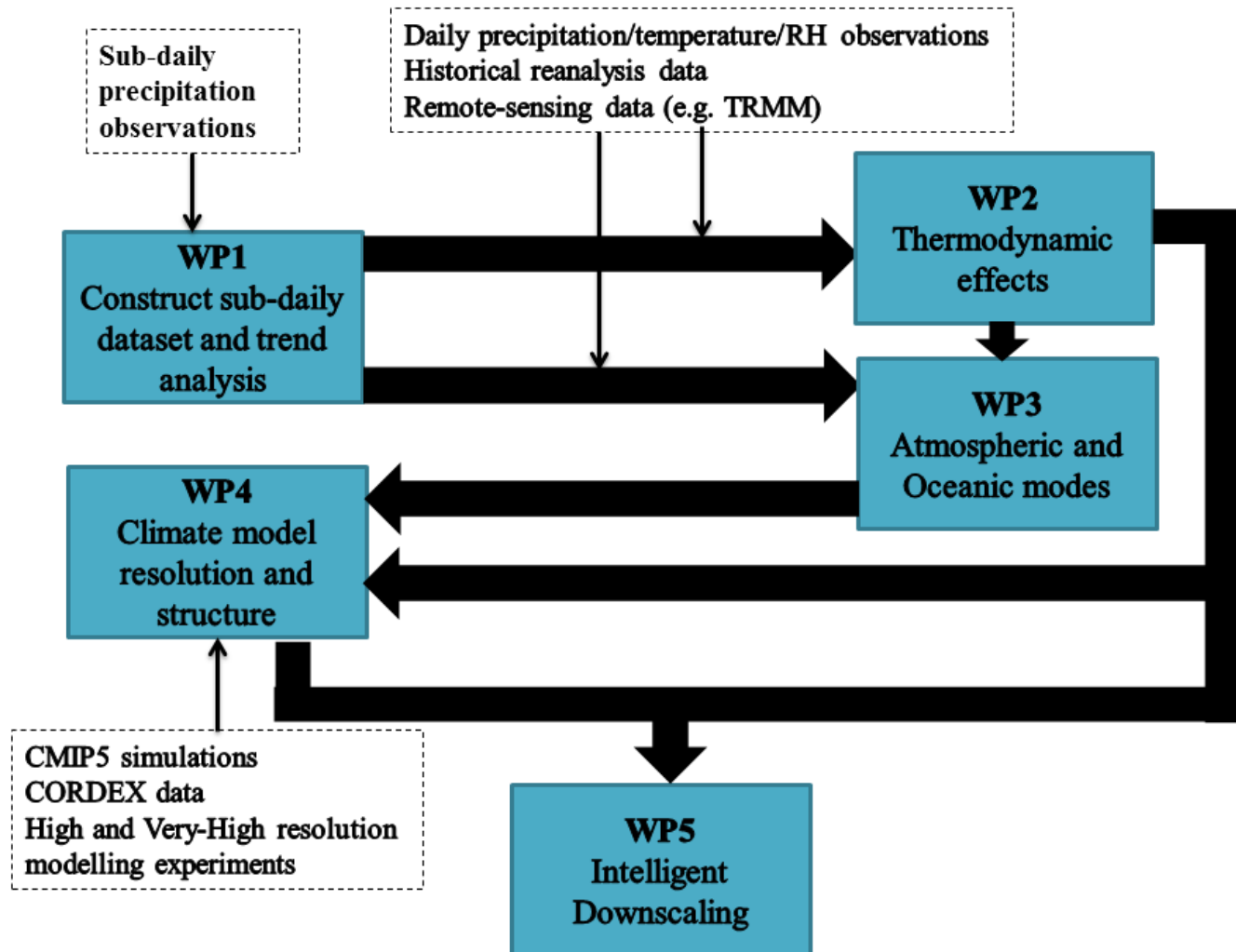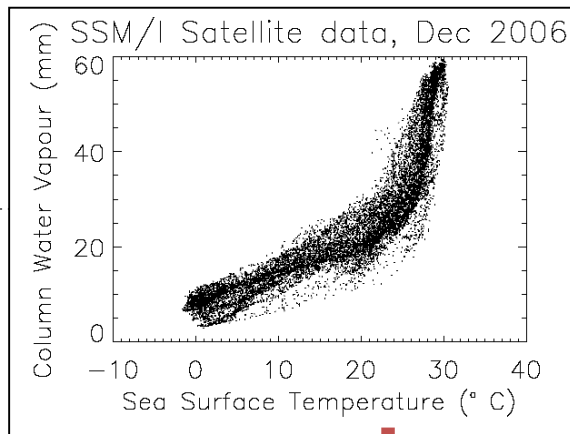
Low-level water vapour increases at around 6-10%/K

References: e.g.,
Berg et al. (2013) Nature Geosciences

O'Gorman & Schneider (2009) Nature Geosci

Trapp et al. (2009) GRL

Harvey et al. (2012) GRL

Convective rainfall draws in moisture from surroundings

Increased moisture convergence in storms → increased precipitation

Atlantic Ocean
Jetstream August 2003
Jetstream July 2004

Latent heat release stabilises atmosphere on larger space/time-scales

Latent heat release invigorates storms on smaller space/time-scales
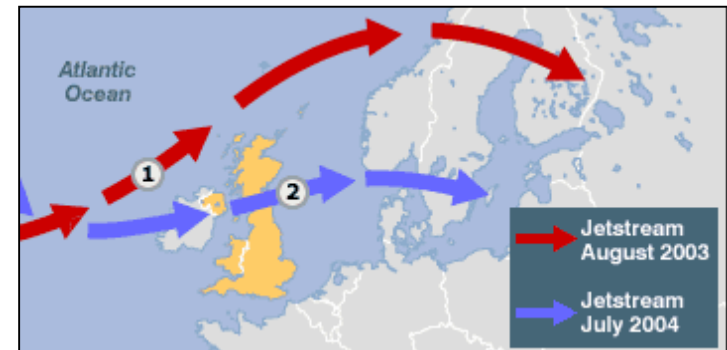
Changing position/orientation/ clustering of storm systems

← THERMODYNAMICS

Character of rainfall events

DYNAMICS →

Courtesy: Richard Allan, Reading University

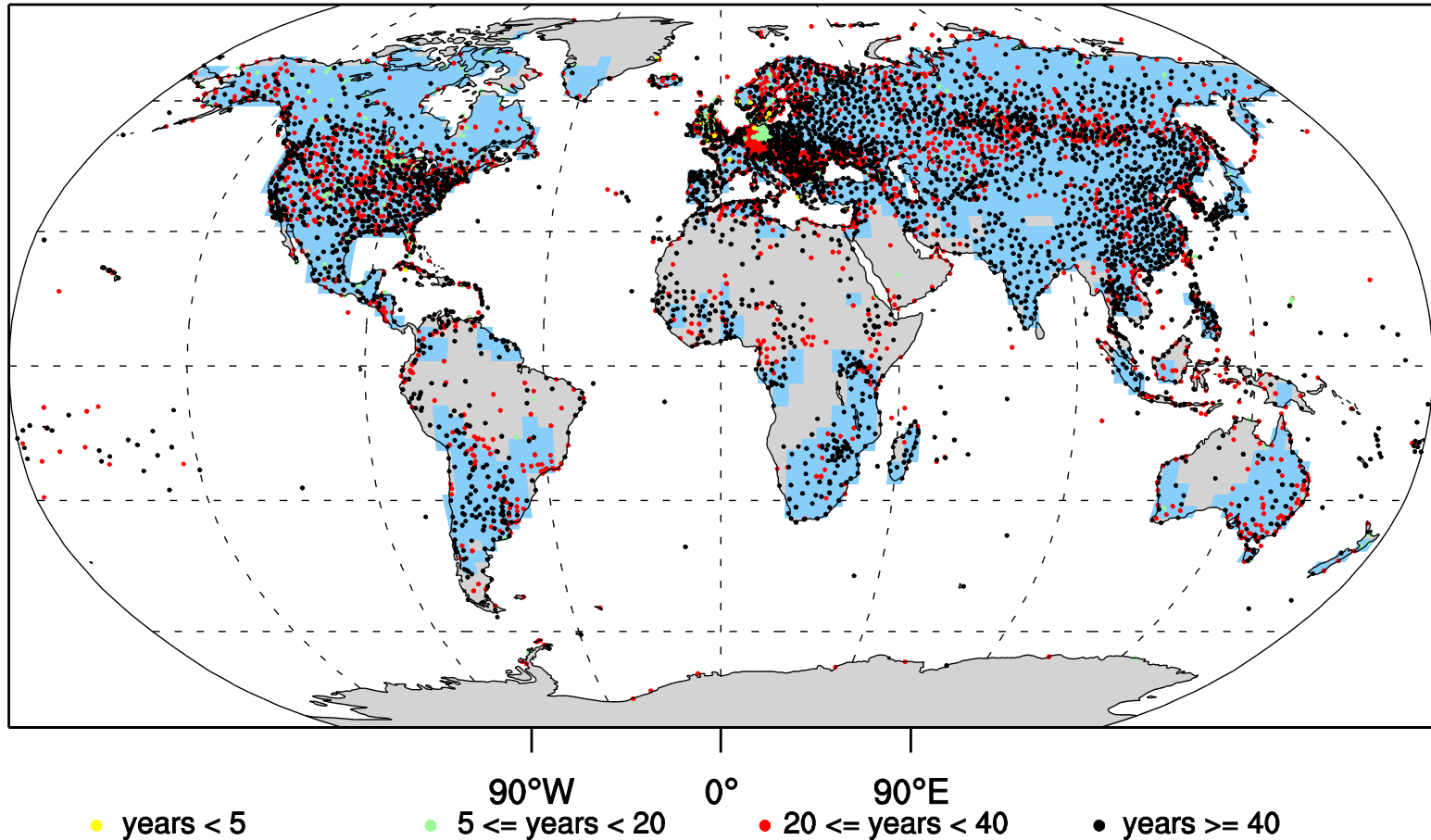# Understanding climate model deficiencies

1. Examine the influence of climate model resolution and structure

2. Understand likely response to global warming

3. Define the key features needed in the next generation of climate models

4. Develop innovative approaches for new extreme rainfall projections, particularly for short-duration events

GEWEX

Developing a consistent approach for quality control, including data homogenisation

Developing a comprehensive international repository for sub-daily data

GEWEX Cross-cut sub-daily rainfall (INTENSE)

Analysis of new observed dataset for trends, rainfall characteristics

Establishing diagnostics for very high resolution model intercomparisons

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

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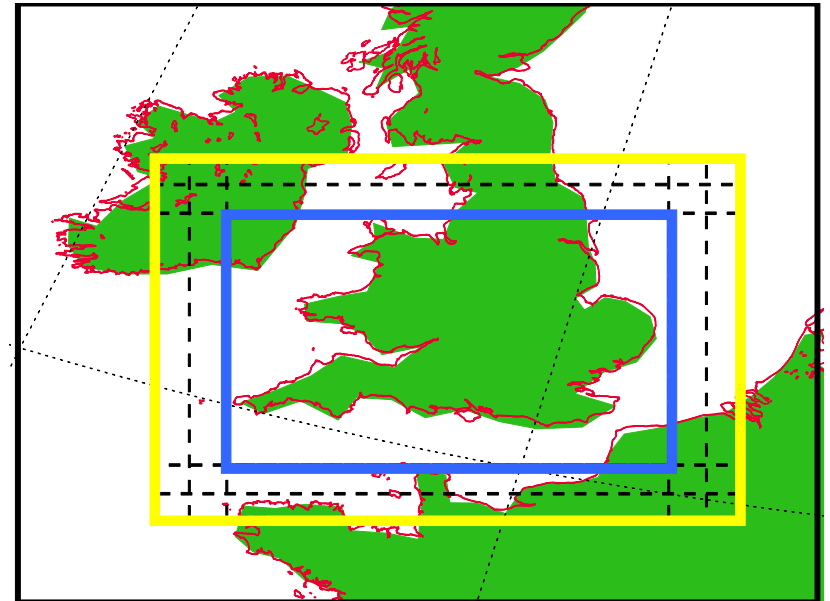# GEWEX/INTENSE – augmenting and quality controlling the HadISD dataset

years < 5   •   5 <= years < 20   •   20 <= years < 40   •   years >= 40

from Westra et al. (2014)

Met Office Hadley Centre planned km-scale climate model runs

- 2.2km Europe

- 1.5km Singapore

- 1.5km UK-wide

- Other possibilities...

Summary of Key Challenges: Impacts

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

- Exploiting new understanding from km-scale models in impacts modelling

- Translating these scientific results through into policy and practice, such as informing new design guidelines, and providing evidence to inform decisions

many from Westra *et al., Revs. Geophys., 2014*

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Engineering for Climate Extremes Partnership

Vision: An interdisciplinary partnership bringing together engineering, scientific, cultural, business and government expertise to develop robust, well-communicated predictions and advice on the impacts of weather and climate extremes in support of society

Aims to reduce impacts and costs of extreme weather through multidisciplinary research and tool development aimed at:

- Direct prediction of impacts using weather/climate models and advanced statistics
- Improving resiliency and reducing vulnerability
- Facilitating adaptation design
- Improved approaches to communicating risk
- Global Resiliency Improvement Program

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CONVEX: Avenues for outreach

- Possible improvements to FEH

- UKCP09 updates and UKCPnext

- Guidance updates such as Urban Drainage work for UKWIR

- Gridded km-scale observed hourly dataset will be available subject to license

Summary

- CONVEX is a pioneering study which has shown the benefits of km-scale modelling for climate change projections

- Challenges remain – many of which will be addressed by research projects like INTENSE and on-going work on km-scale simulations at the UK Met Office Hadley Centre

- Ultimately, we need information like this to inform guidance and decision making about climate change adaptation

- We welcome suggestions on how the new results from CONVEX can be better used by those outside the research community

Thank you

The CONVEX project website:
http://research.ncl.ac.uk/convex/

Follow us on twitter: #CONVEX_PROJECT

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