

# Evaluating the Small-scale Space Time Structure of Rainfall in the Convection Permitting Model of UKCP18

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# Introduction

## Background

Sub-daily rainfall at Km-scale resolution is critical in a wide range of hydrological applications.

## Question?

How credible is the UKCP18 local projection for hydrological use?

## Our study

Evaluation is needed, particularly on it's small-scale feature.

# Data and Methods

## UKCP18 Local(2.2Km) Projection(1)

- Resolution: 1hour, 2.2km, over the UK
- Length: 12 ensemble members, 1980-2000

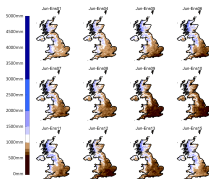


Figure 1: Mean rainfall (mm/yr) in July from 12 ensemble members

## Observations

Three observation dataset, (including CEH-GEAR (2), HadUK-Grid(3) and UKMO C-band radar composite(4)), were used for comparison.

- ✓ Quality controlled
- ✓ Conservatively remapped to 2.2 Km resolution.

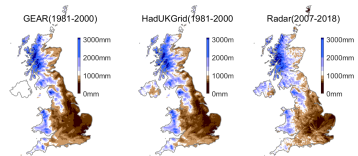


Figure 2: Mean precipitation intensities from a) CEH-GEAR. b) Haduk-Grid. c) C-band Radar Composite

## Statistical Analysis

We analysed:

### Mean bias:

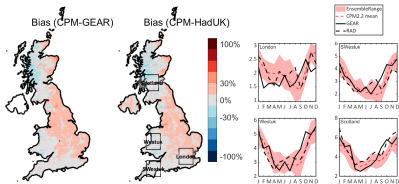
Mean precipitation, Correlation in space, Temporal Statistics;

### Spatial structure of heavy rainfall:

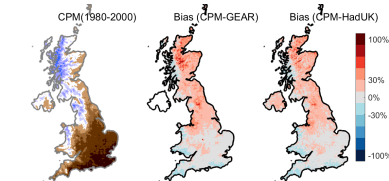
Characteristics of rainfall cells, Clustering feature, Areal reduction factors

# Mean bias

## Mean precipitation

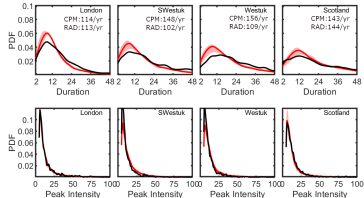


**Figure 3: Relative bias of annual mean precipitation between CPM2.2 and observation a) relative bias between CPM2.2 and CEH-GEAR. b) relative bias between CPM2.2 and HadUK-Grid. Non-significant difference at 5% level is shown as grey color. c) Averaged monthly rainfall pattern for areas marked in b).**



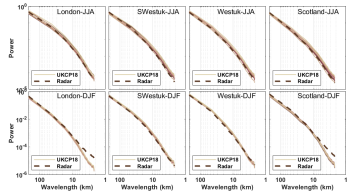
**Figure 4: Precipitation in JJA a) CPM, b) and c) same as Figure3, but for JJA.**

## Temporal Feature Rainfall events were extracted (in space-time domain).



**Figure 5: PDFs of event duration and peak intensity.**

## Spatial Correlation

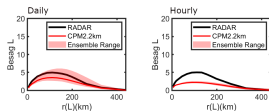


**Figure 6: Radially averaged power spectrum (RAPS) at four locations (110Km × 110Km per each).Upper: JJA. Lower: DJF**

# Spatial Structure of Heavy Rainfall

## Clustering feature (5)

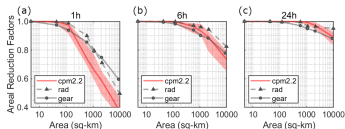
Clustering feature at a daily scale: observation is within ensemble range. At an hourly scale: tends to be more dispersed.



**Figure 7: Clustering features for extreme rainfall during summer (heaviest 48 hours/season/yr), using Besag-L function. a) at daily resolution. b) at hourly resolution**

## Areal Reduction Factors

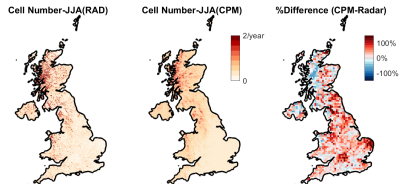
Based on fixed-area method (6)



**Figure 8: Areal Reduction Factors (ARFs) for precipitation in southern UK. a) 1h duration. b) 6h duration. c) 24h duration.**

## Heavy Rainfall Cells

We examined occurrence of rainfall cells (centroid) during JJA.



**Figure 9: Spatial distribution of numbers of heavy rainfall cell "hotspot" (> 3mm/h) during summer. a) Radar observation. b) model simulation. c) Relative difference**

## Summary

In our study, the 2.2Km CPM overall shows a satisfying performance and it captures rainfall organisation both on space and time. In term of heavy rainfall: clustering feature at a daily scale is well reproduced, but a bit worse at an hourly scale. Correspondingly, the simulation produces too many heavy-rain cells. It gives slightly overestimated spatial reduction (lower 1-hour ARFs) for large catchments (1000-10000Km<sup>2</sup>).

# References

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- [3] Dan Hollis, Mark McCarthy, Michael Kendon, Tim Legg, and Ian Simpson. Haduk-grid—a new uk dataset of gridded climate observations. *Geoscience Data Journal*, 6(2):151–159, 2019.
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