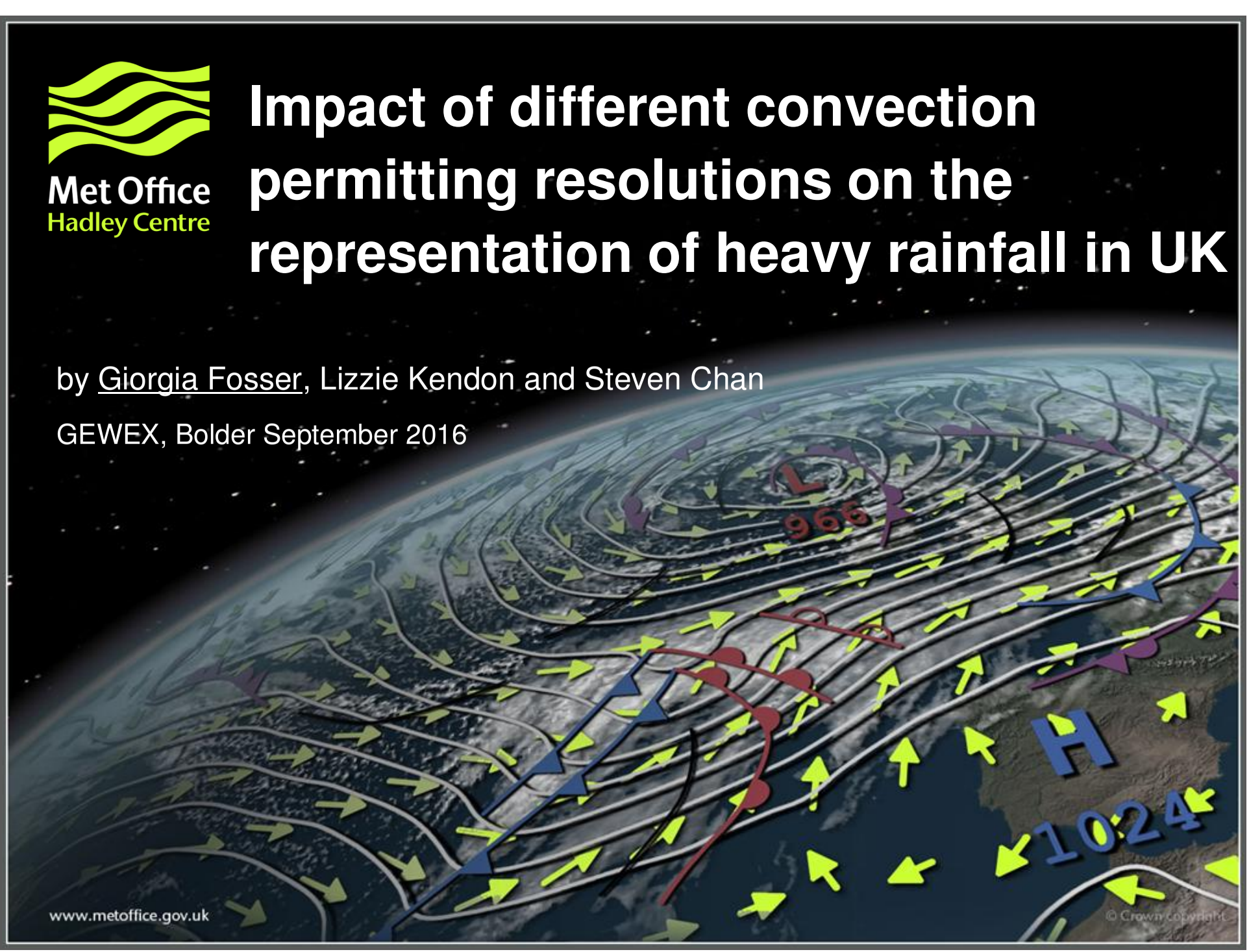
Impact of different convection permitting resolutions on the representation of heavy rainfall in UK

by Giorgia Fosser, Lizzie Kendon and Steven Chan

GEWEX, Bolder September 2016

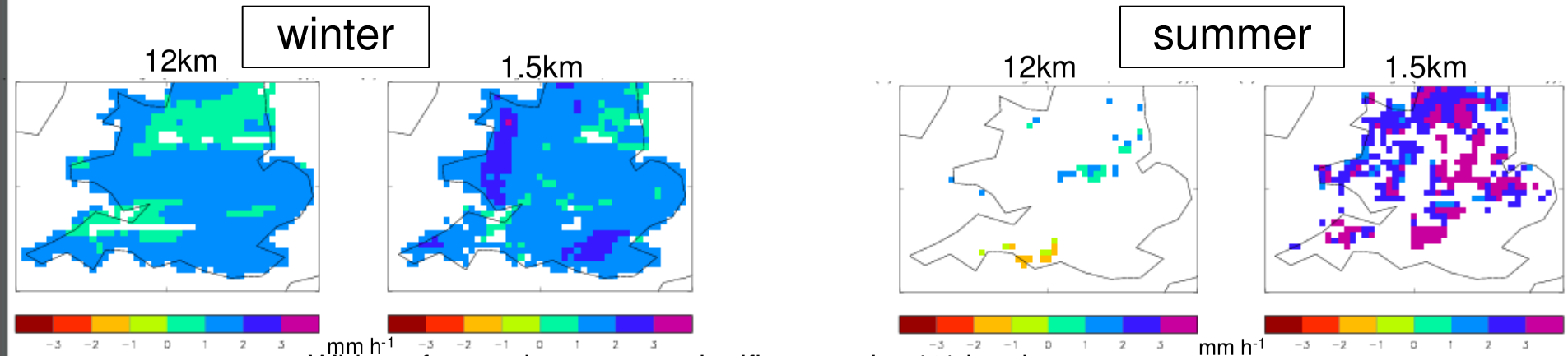


Convection permitting models (CPMs) in the climate change context

- CPMs simulate realistic hourly rainfall characteristics, unlike coarser RCMs, giving us confidence in their ability to project future changes

Future change in heavy hourly precipitation

Kendon et al, 2014, Nature Clim. Change



White = future changes not significant at the 1% level

- Accurate representation of the local storm dynamics is essential for capturing changes in the duration and intensity of summertime rain

Emerging strengths and weaknesses of CPMs

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Emerging strengths and weaknesses of CPMs

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- Accurate representation of the local storm dynamics is essential for capturing changes in the duration and intensity of summertime rain

- Results are for single model run over small domain (very computationally expensive)
- Tendency for heavy rain to be too intense
- Reliant on large-scale conditions from driving GCM

UKCP18: a new step forward

- First ensemble of projections at convection permitting scale
- driven by the ensemble of global climate simulations (HadGEM3-GC3 model, at ~60km) sampling both modelling uncertainty and variability
- run over UK with ~20 ensemble members
- allow estimate of uncertainty at km-scale
- support UK risk assessment studies

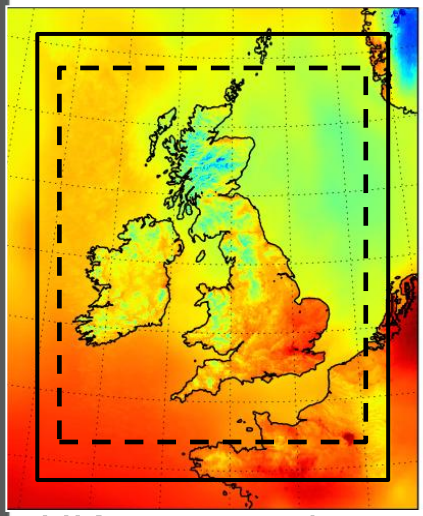
PHASE 1 → Identify the suitable UK domain, resolution and experimental design for convective-scale projections ensemble using ERA Interim driven CPMs simulations

PHASE 2 → Run and evaluate an CPM ensemble over the UK domain selected in phase 1

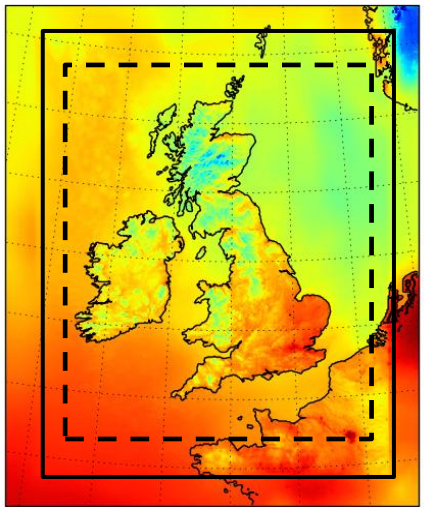
PHASE 1: Selection of CPMs resolutions and domains

- ERA Interim reanalysis-driven simulations
- Run from March1996 – 2005

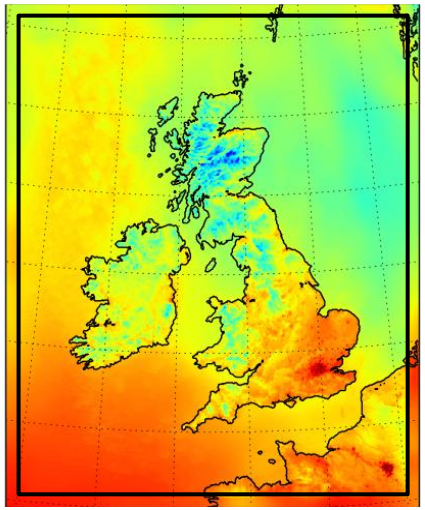
UKV_1p5km



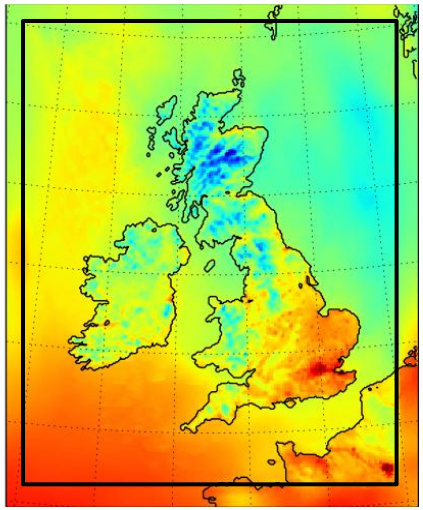
UKV_2p2km



UK_2p2km



UK_4km



UK = 2.2 or 4km outer rim (boundary relaxation zone) and inner domain

UKV = 4km outer rim, variable resolution inner rim, 1.5 or 2.2km domain

ADDITIONAL TEST:

- Alternative nesting strategy for 4km option:

ERA Interim -> 12 km over Europe -> 4km UK, cf ERA Interim -> 4km UK directly

Phase I: Validation methodology

Focus on:

- Precipitation (and temperature, snow, heat waves, ….)
- Summer (but other seasons also investigate)

Comparison with observational datasets

- Radar 2003 - to present, 5 km grid, hourly
- Rain gauges 1958-2015, 5 km grid, daily

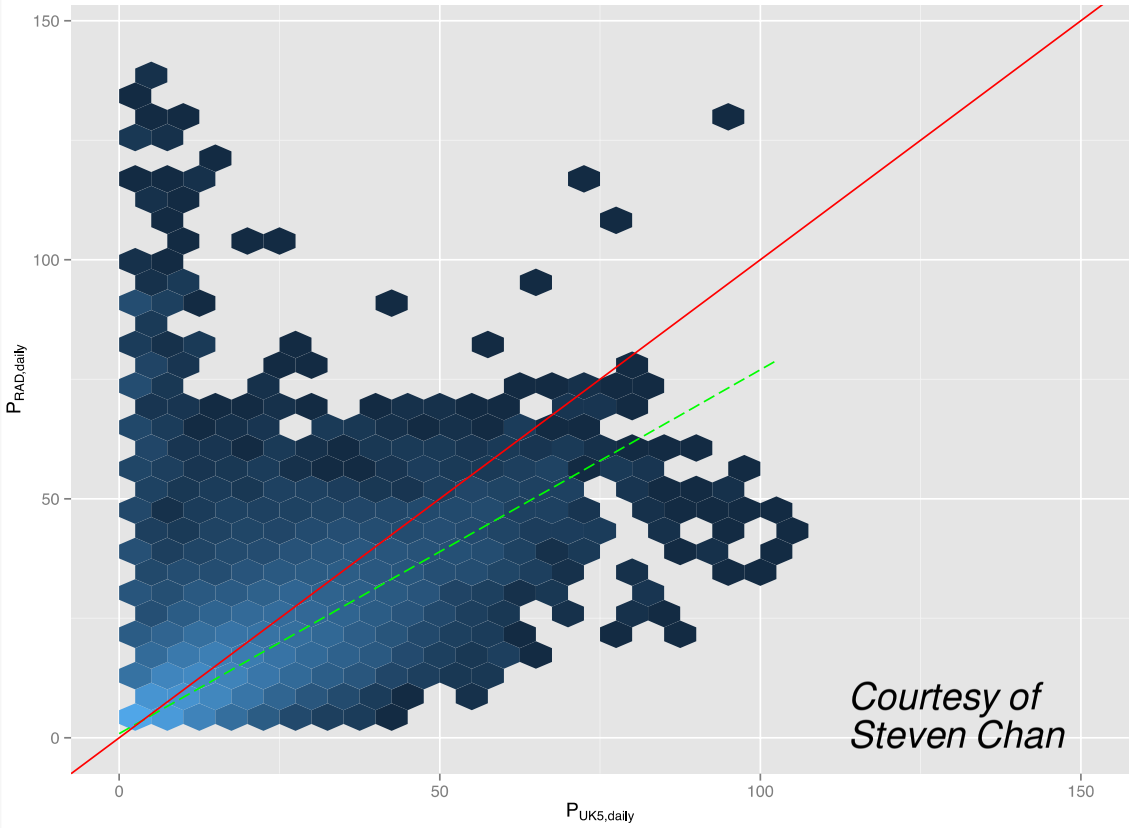
- Simulations conservatively remapped to the radar grid (~5 km)
- Comparison simulations and rain gauges JJA 1996-2005 versus radar JJA 2003-2011

Observational datasets

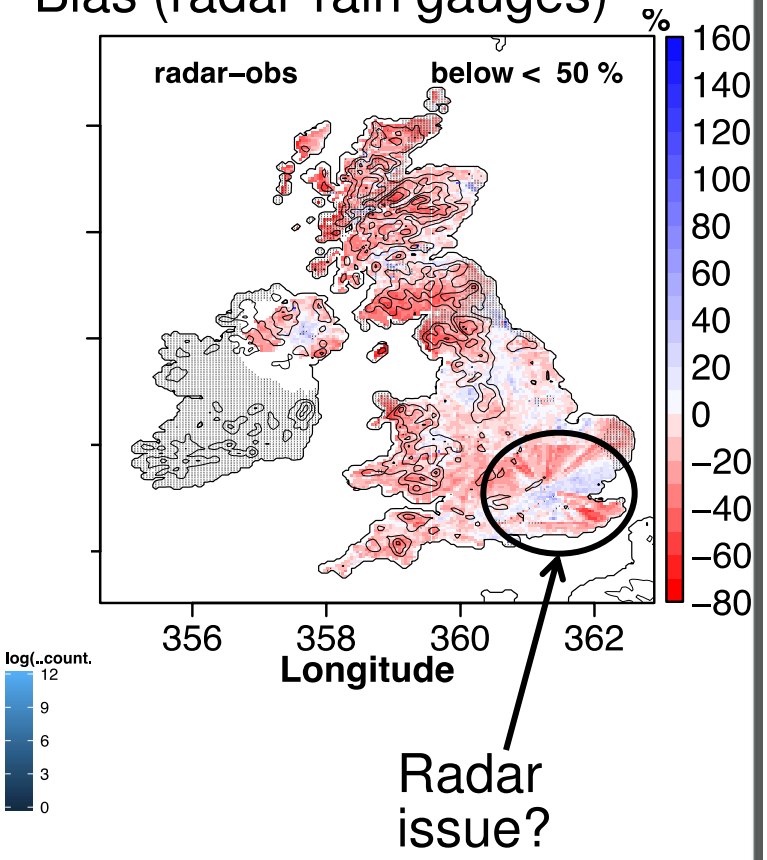
…where is the truth?

JJA 2003-2012

Daily pdf, Southern UK

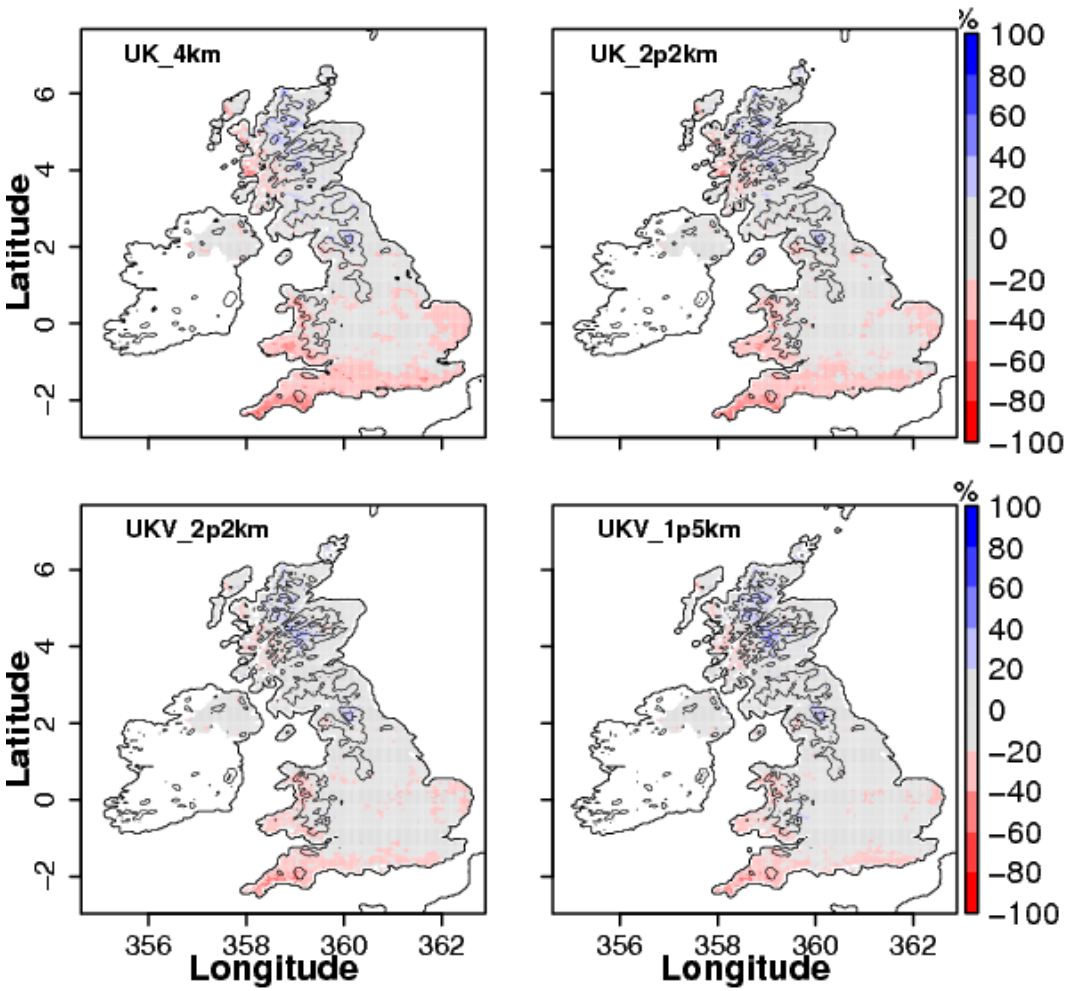


Bias (radar-rain gauges)



Phase I: Early results

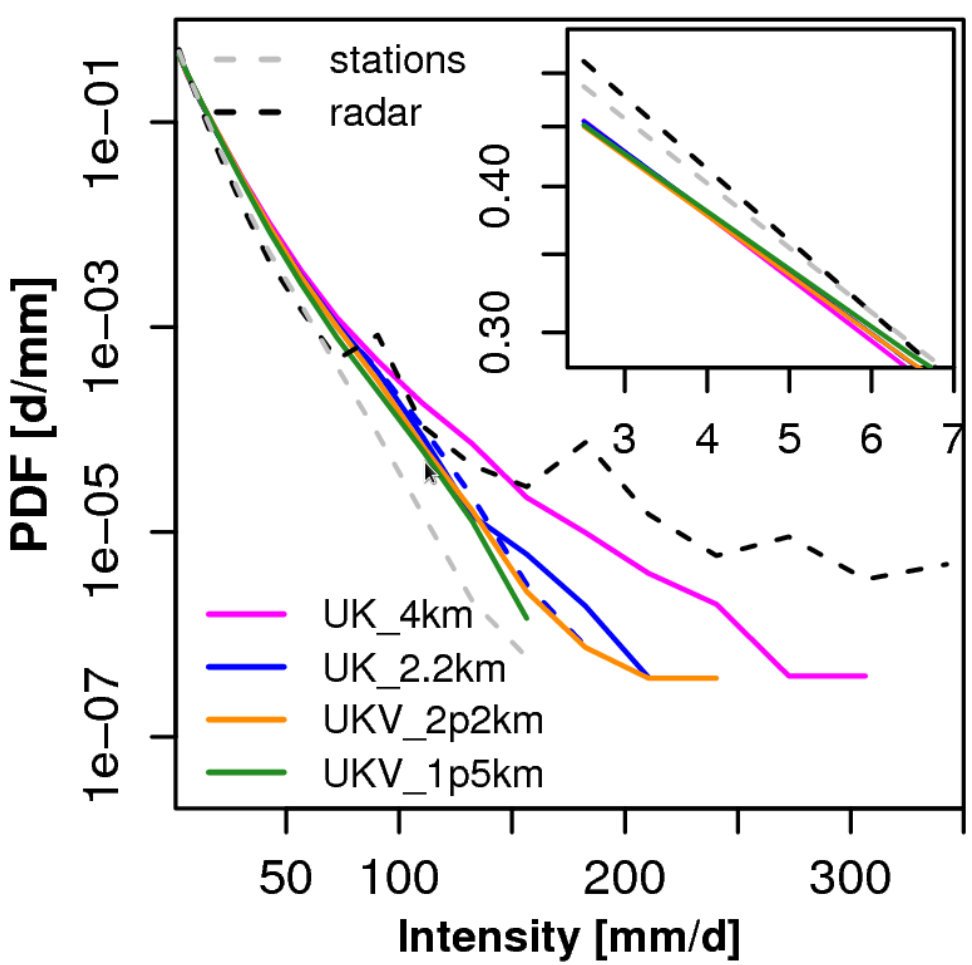
Daily mean precipitation bias versus rain gauges data

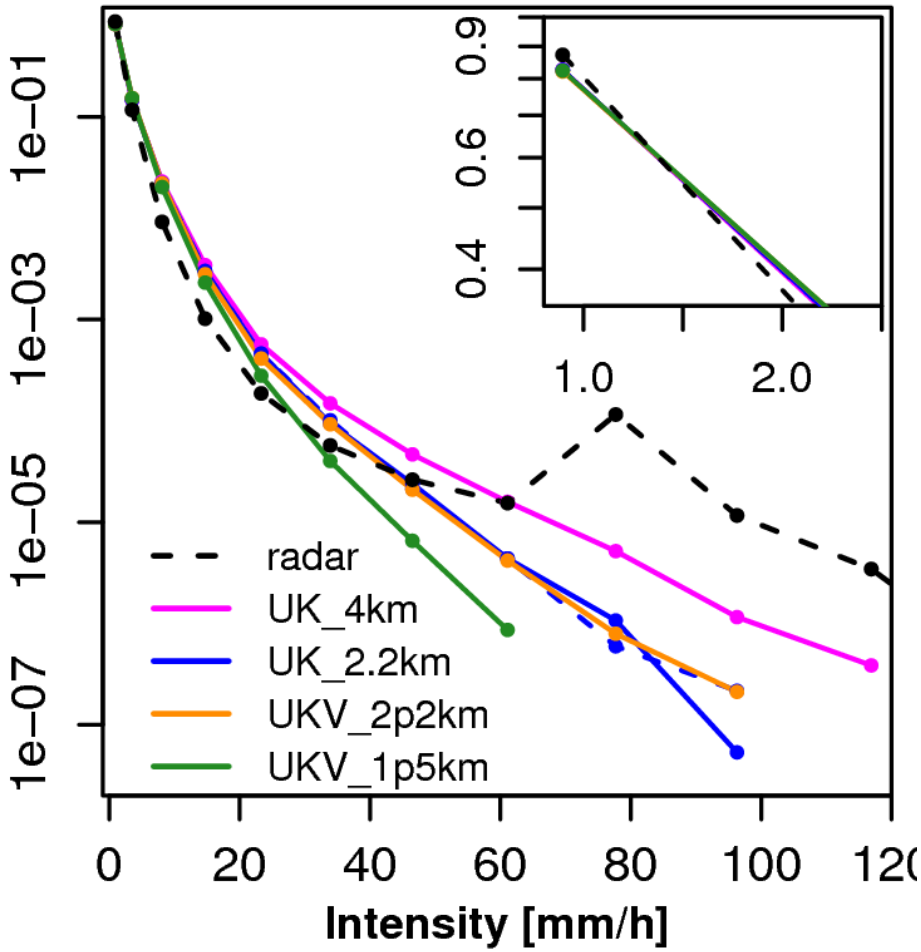


	Dry days (P<1mm/)	Dry hours (P<0.1 mm/h)
Radar	61.3 %	86.7%
UK_4km	70.4%	91.2%
UK_2.2km	69.2 %	90.9%
UKV_2.2km	68.8 %	90.8%
UKV_1.5km	67.5 %	90.5%

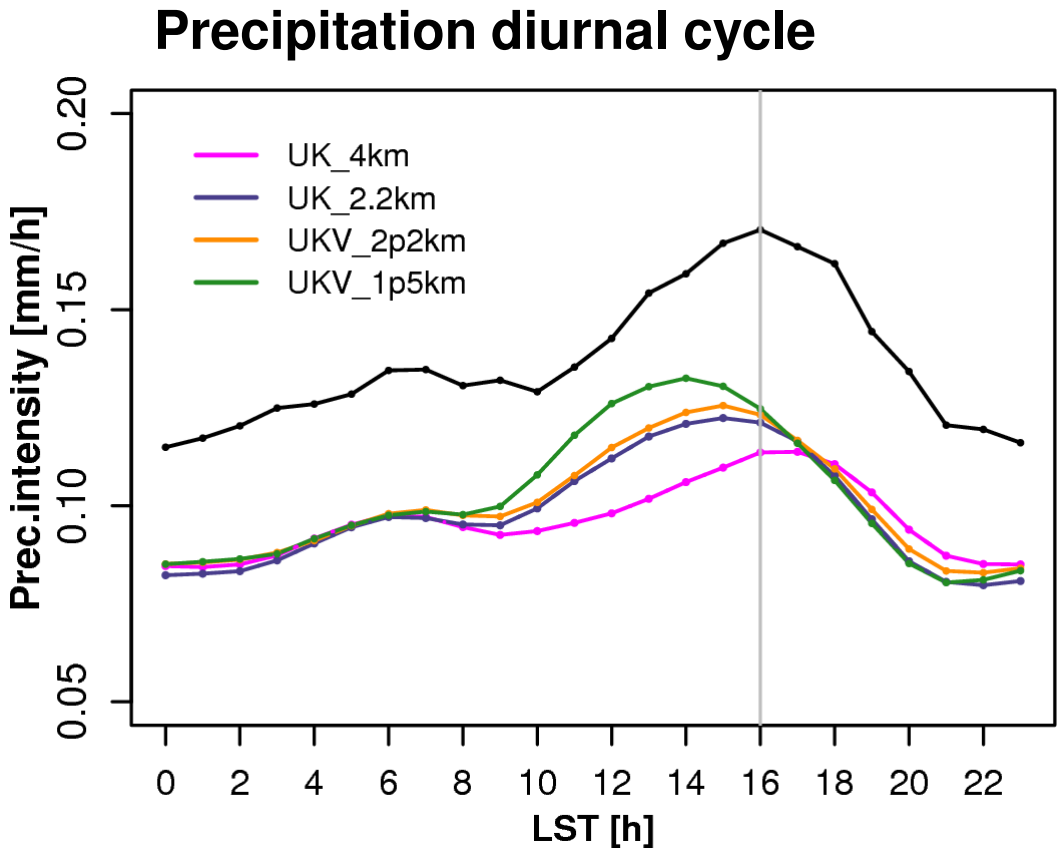
Phase I: Early results

Precipitation daily and hourly pdf



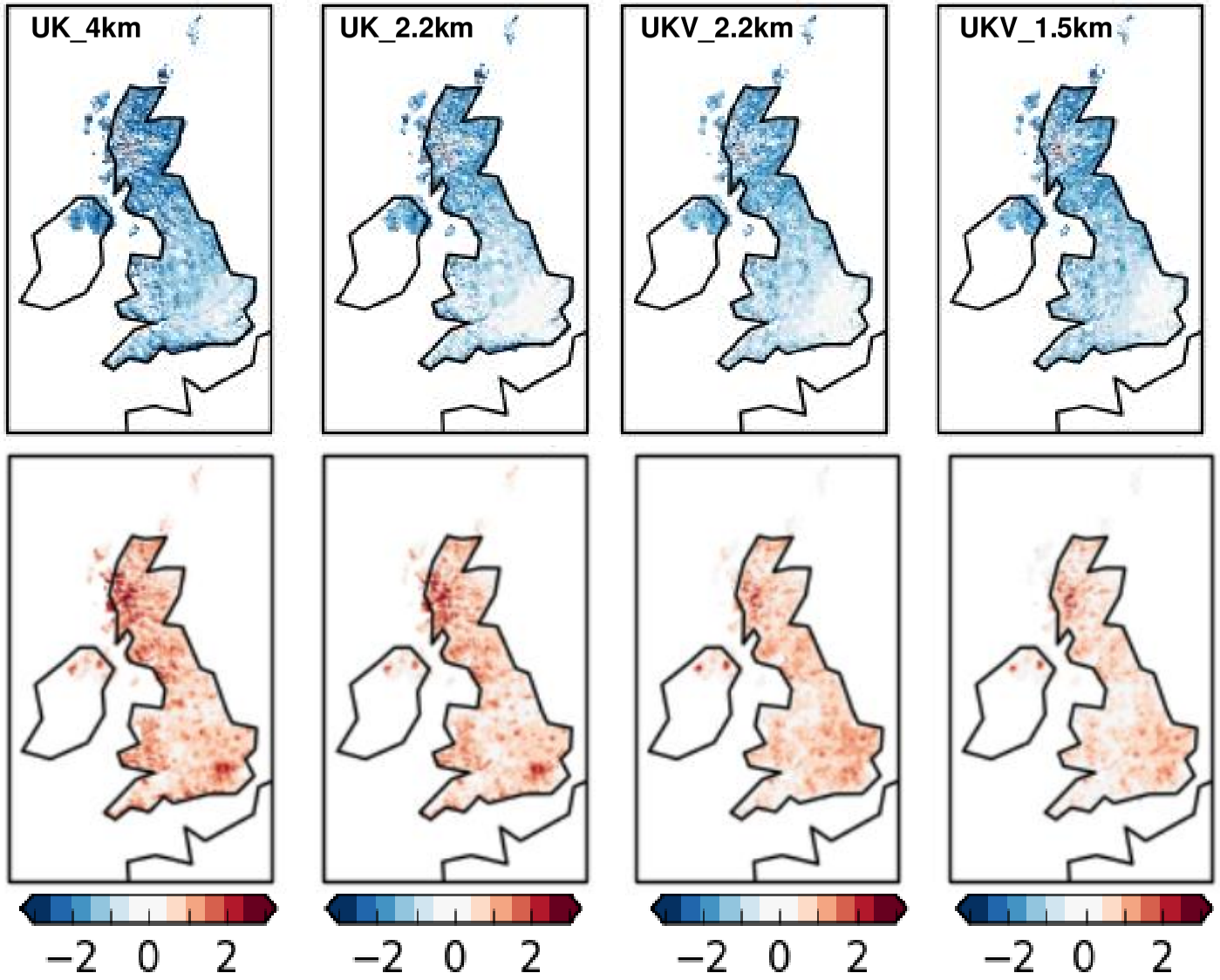


Phase I: Early results



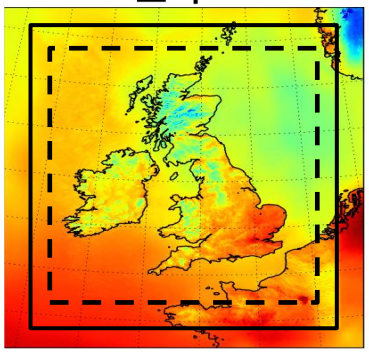
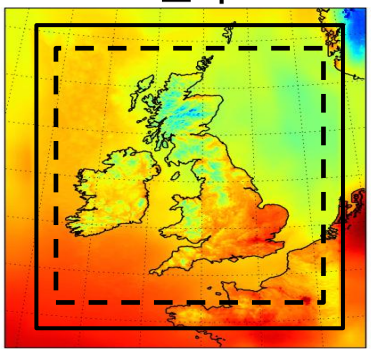
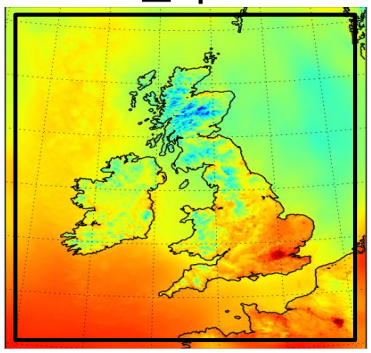
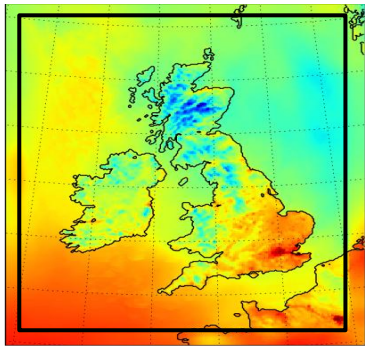
Phase I: Early results

Bias in daily max (top) and min (bottom) temperature



Courtesy of Robin Clark

PHASE 1: Selection of CPMs resolutions and domains

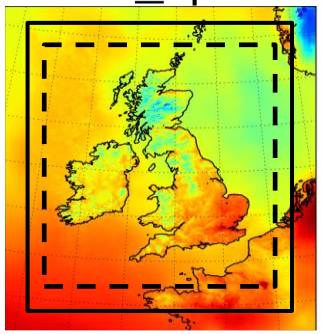
	UKV_1p5km	UKV_2p2km	UK_2p2km	UK_4km
				
Time required to run 1 year simulation	13 days	9.5 days	5.5 days	2.5 days
Options within UKCP18 project	40 seasonal snapshots	2*20 years time slices in parallel	2*20 years time slices	100 years
Number of possible ensemble members within UKCP18	20	10	12	20…

Conclusions and step forwards

Given the computational and time constrains, the key question is:

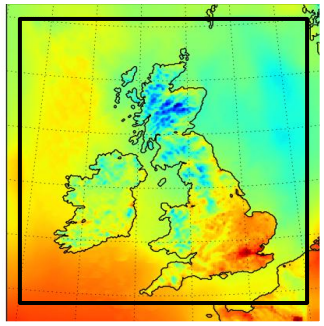
How well does the 4km CPM replicate improvements in the representation of rainfall achieved at 1.5km ?

UKV_1p5km



40 seasonal snapshots

UK_4km



100 years

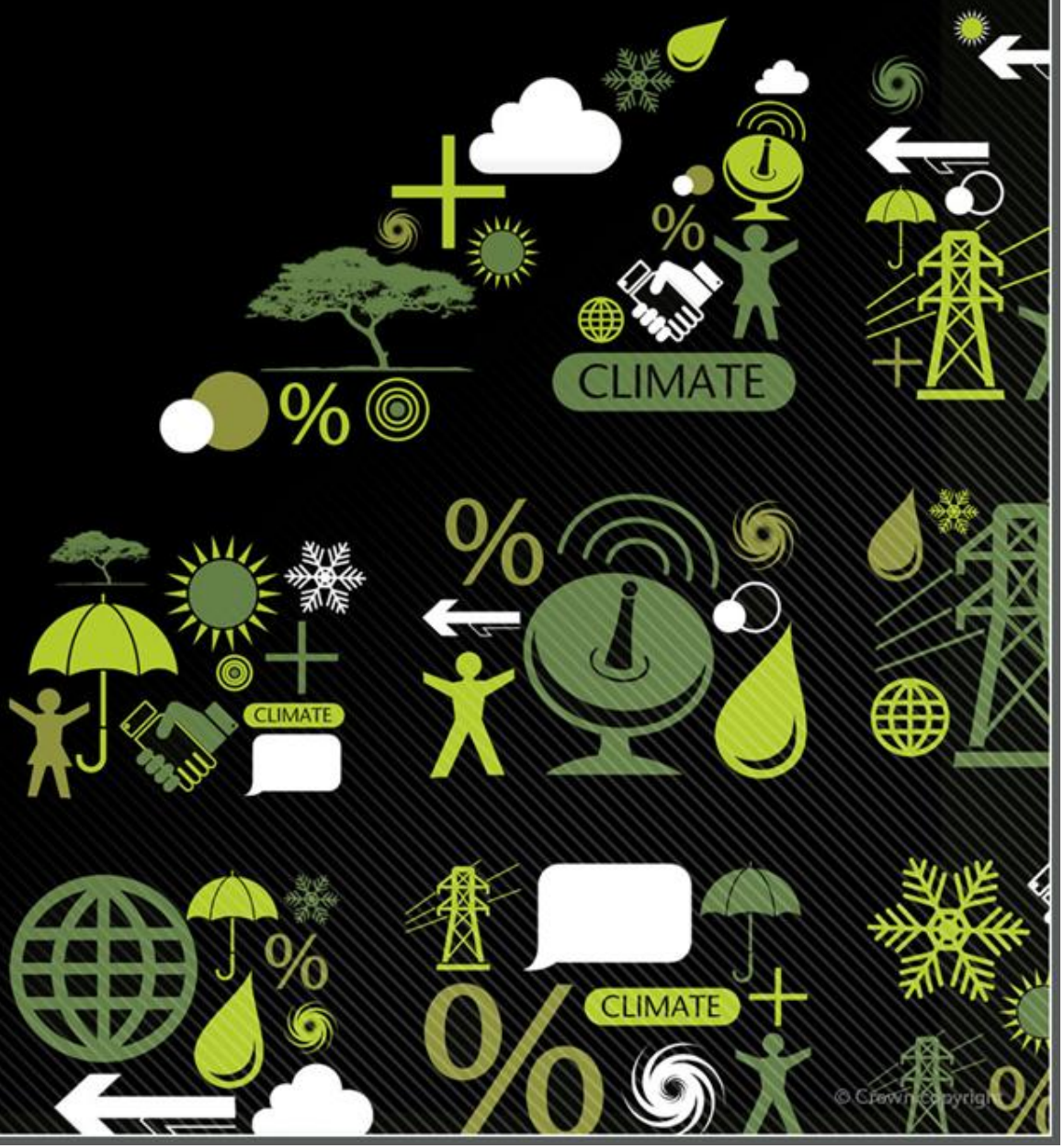
Main differences among resolutions are found :

- higher precipitation intensities
- timing of the peak in the diurnal cycle of precipitation

- If the differences between the 4km and the 1.5km are within the observation uncertainties
- Understanding of what is physically plausible

Met Office
Hadley Centre

Questions ?



www.metoffice.gov.uk