

UKCP: New Local (2.2km) results

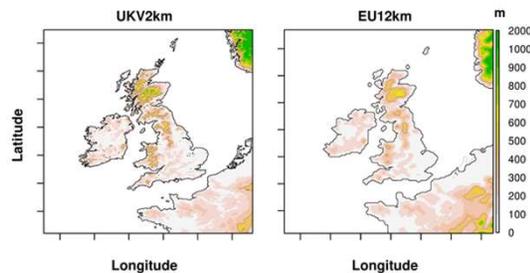
Dr. Elizabeth Kendon

Giorgia Fosser, James Murphy, Steven Chan, Robin Clark, Glen Harris, Adrian Lock, Jason Lowe, Gill Martin, Jenny Pirret, Nigel Roberts, Mike Sanderson, Simon Tucker.

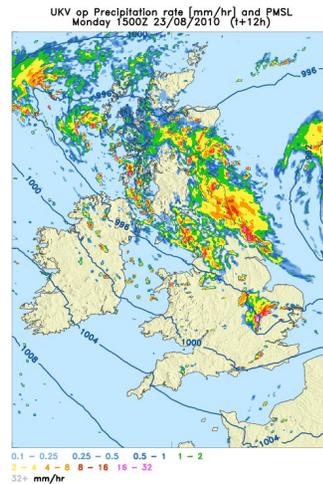


Working together on
UK Climate Projections

What are the 2.2km projections?



New set of 12 climate projections using a model as detailed as that typically used for weather forecasts



Enabling us to explore

New estimates of changes in daily and hourly extremes

- Storms
- Summer downpours
- Severe wind gusts



Supports UK risk assessments

Hydrological impacts modelling e.g. flash floods



Climate change for cities e.g. urban extremes

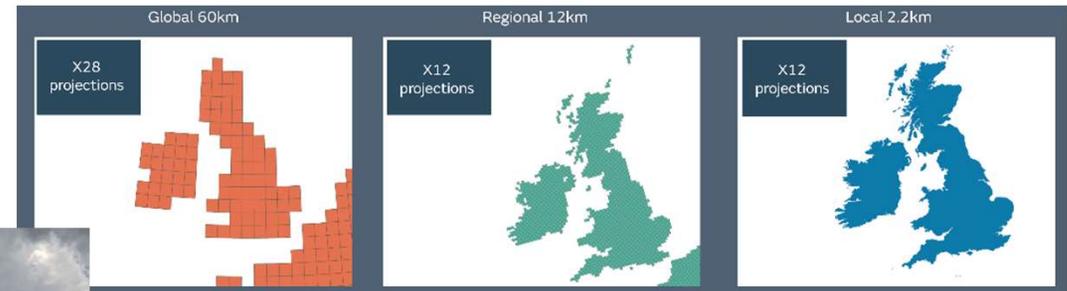


First ensemble of climate projections at convection-permitting scale

**The Local (2.2km)
model better
represents small scale
behavior in the real
atmosphere, such as
convection.**



Local (2.2km) better captures the influence of mountains, coastlines and urban areas, due to the high resolution.



Specification of urban areas is much more precise



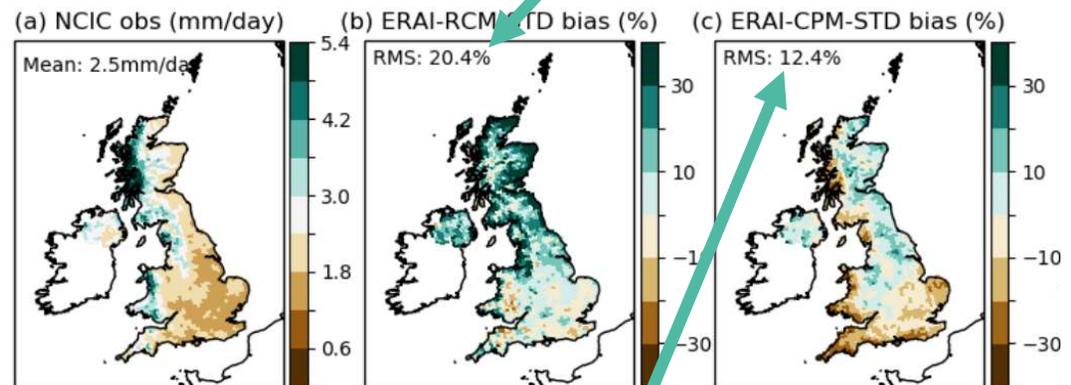
Local (2.2km) describes the types and extremes of weather for your local area over coming decades.

The Local (2.2km) model better simulates several aspects of present-day climate, which is verified by comparing the model results with observations of the real world.

Summer mean rainfall

Observations

Regional model bias

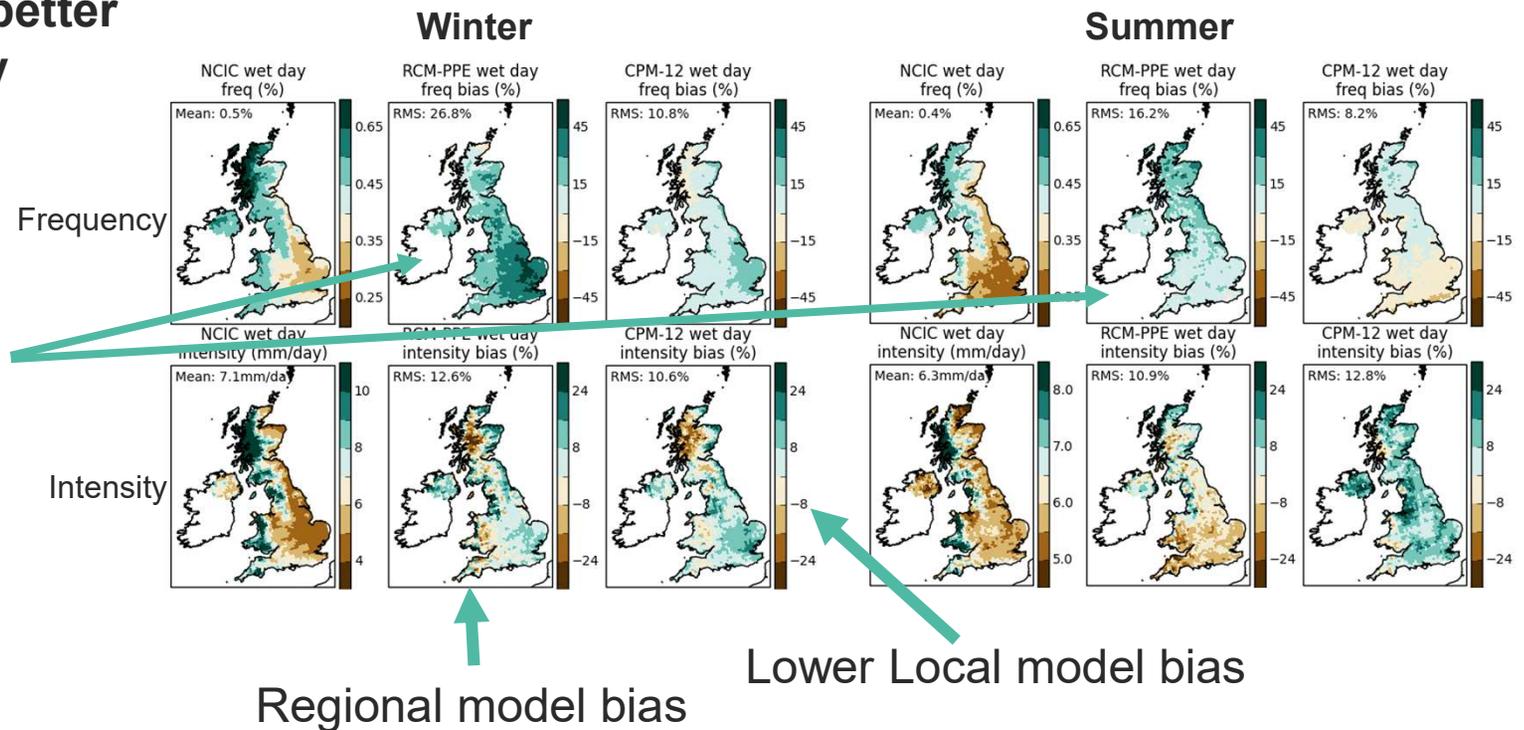


Lower Local model bias

Local (2.2km) gives reduced biases in both summer and winter mean rainfall.

Local (2.2km) better simulates daily precipitation variability

- Regional (12km) has too many wet days, which is improved in Local (2.2km)
- Local (2.2km) overestimates rainfall intensity away from orography

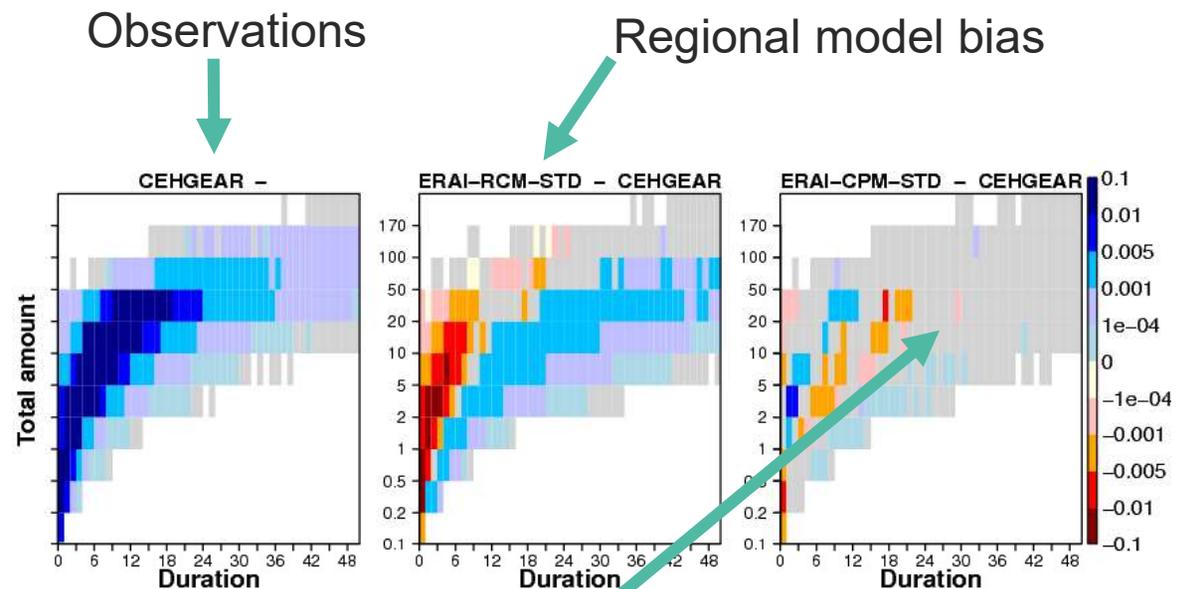


Local (2.2km) gives some improvements in how rainfall varies day-to-day and hour-to-hour.

Winter rainfall events

Local (2.2km) better simulates hourly rainfall, including intensity and duration.

For the first time, it provides credible information for changes on hourly scales.

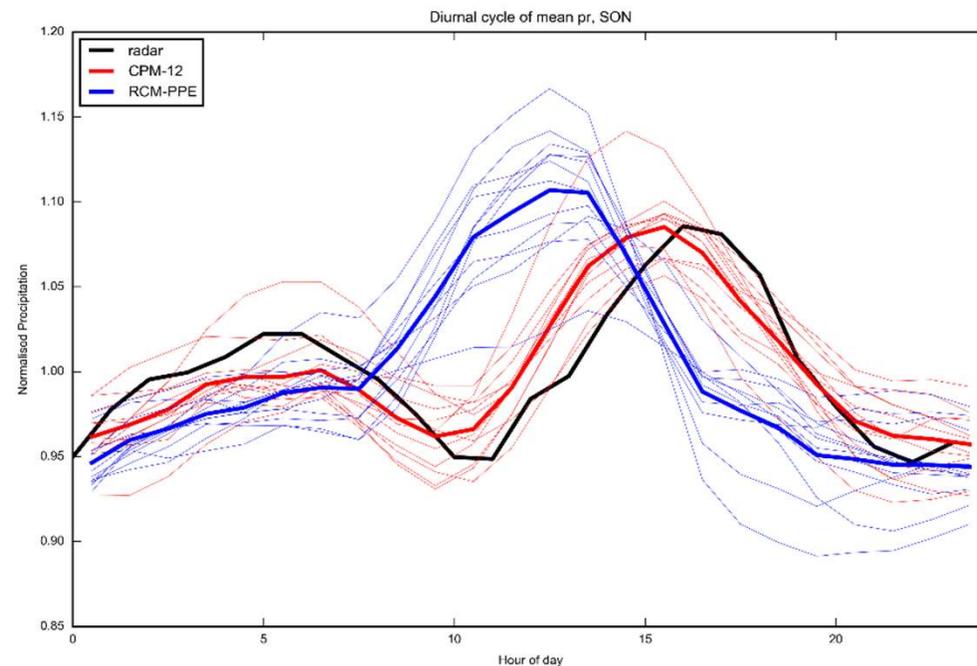


Lower Local (2.2km) model bias

Local (2.2km) gives some improvements in how rainfall varies day-to-day and hour-to-hour.

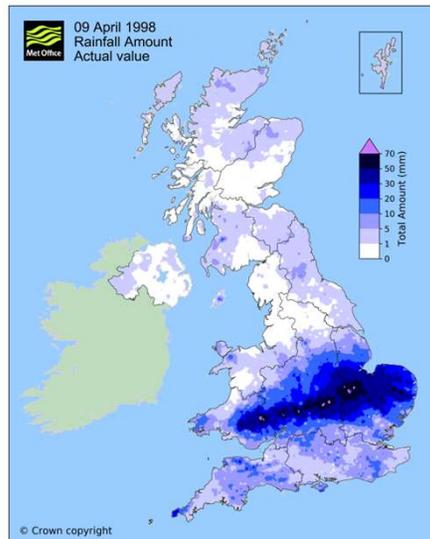
Local (2.2km) better represents the daily cycle of rainfall in some parts of the year.

Big improvement in autumn, still some issues with model timing in summer

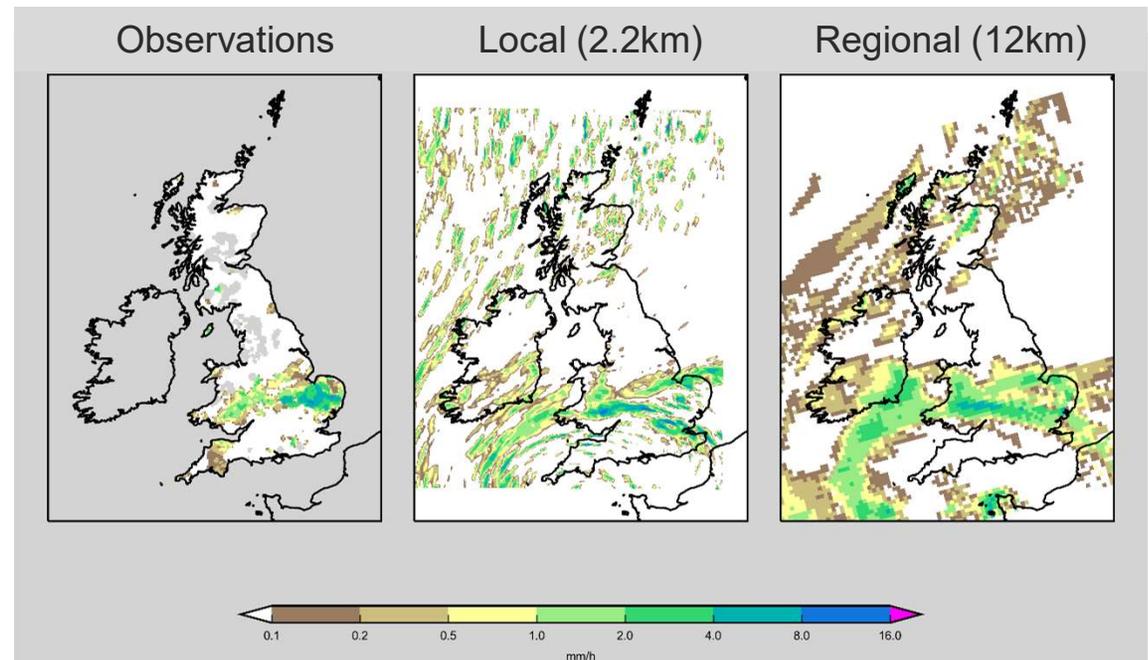


Local (2.2km) gives some improvements in how rainfall varies day-to-day and hour-to-hour.

Easter floods 1998



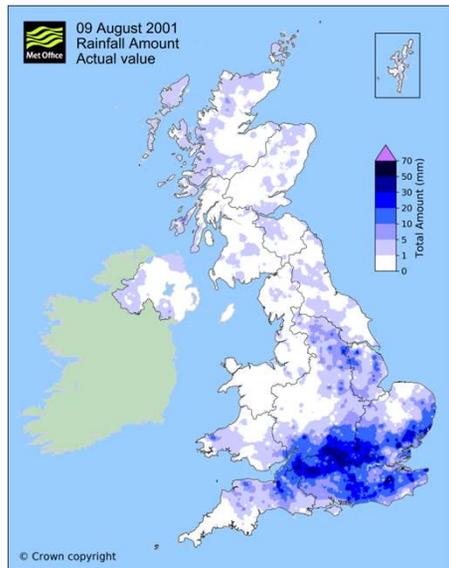
Observed rainfall for 24 hours from 09Z 9th April 1998. 61.6mm fell in 12 hours near Worcester, with peak rainfall rate of 10mm/h at 11am.



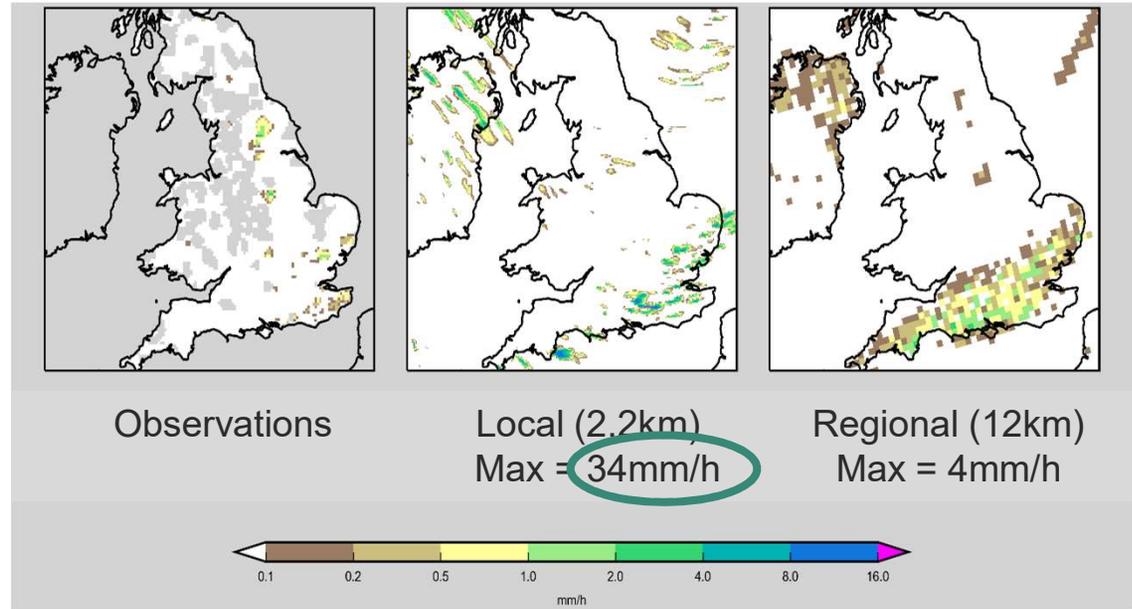
Hourly rainfall snapshot at 11am on 9th April 1998 in 5km observations, 2.2km and 12km models on native model grid

Local (2.2km) provides more realistic representation of showers and embedded convection.

August 2001 Heavy rainfall/storm



Observed rainfall for 24 hours from 09Z 9th August 2001. At Northolt the 12h accumulation was 57mm, with a peak hourly rate of 34mm/h.



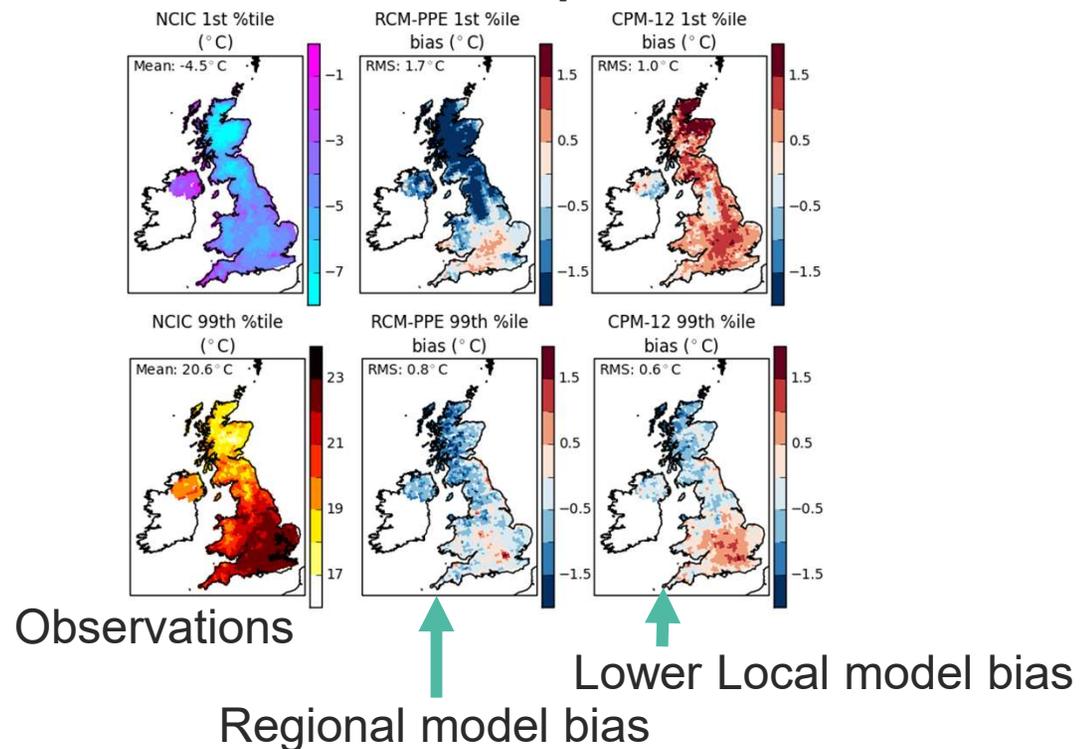
Hourly rainfall snapshot at 1pm on 9th August 2001 in 5km observations, and 2.2km and 12km models on native grid.

Local (2.2km) captures heavy nature of showers, showing intensities of up to 34 mm/h.

Local (2.2km) better represents cold winter days and the number of intense cold spells in the north UK in the present-day.

In summer, local (2.2km) is warmer than the regional model, giving better agreement with observations in the north but not in the south

Winter and summer temperature extremes



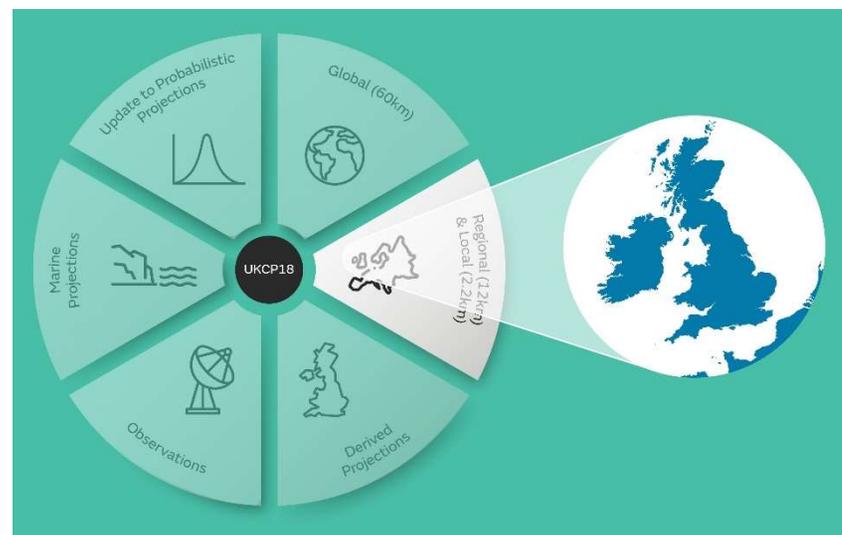
Model differences likely due representation of snow, cloud, and drier soils in Local 2.2km

Projecting the future using the Local (2.2km)

UKCP18 2.2km ensemble

- 2.2km resolution for UK
- 12 members driven by 12km Regional
- 1981-2000, 2021-40, 2061-80
- High emissions scenario RCP8.5

The local (2.2km) results do not change the UKCP18 headline message of a “**greater chance of warmer wetter winters and hotter drier summers**” across the UK in future



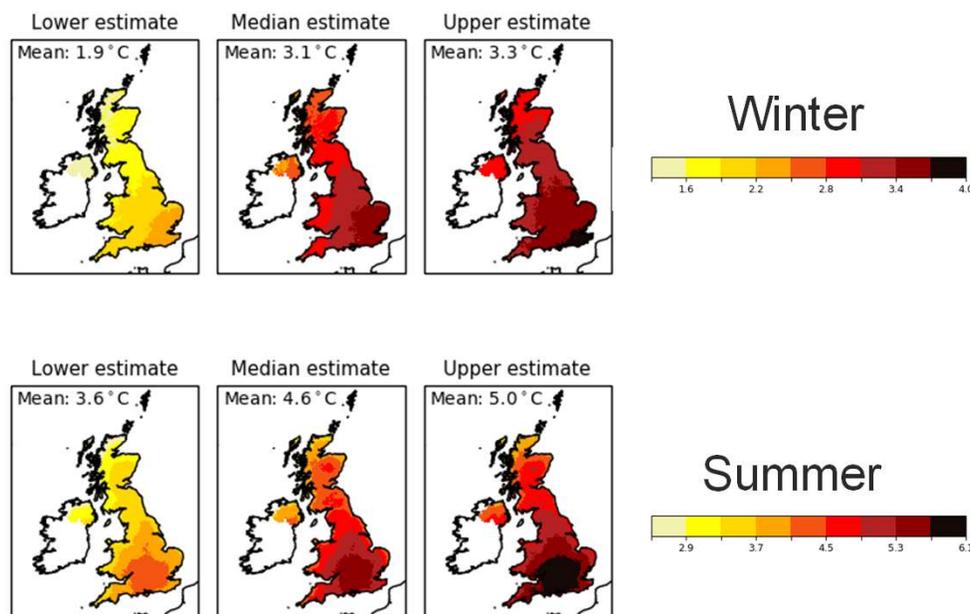
Local 2.2km adds further capability to the UKCP18 suite of climate projections.

Projecting future seasons using the Local (2.2km)

The Local (2.2km) ensemble suggests:

Winters will be warmer by 1.9-3.3°C and summers will be hotter by 3.6-5.0°C

*Projected changes to 2061-2080
for RCP8.5 in °C*



In general the Local (2.2km) model reinforces the results from the Regional (12km) model

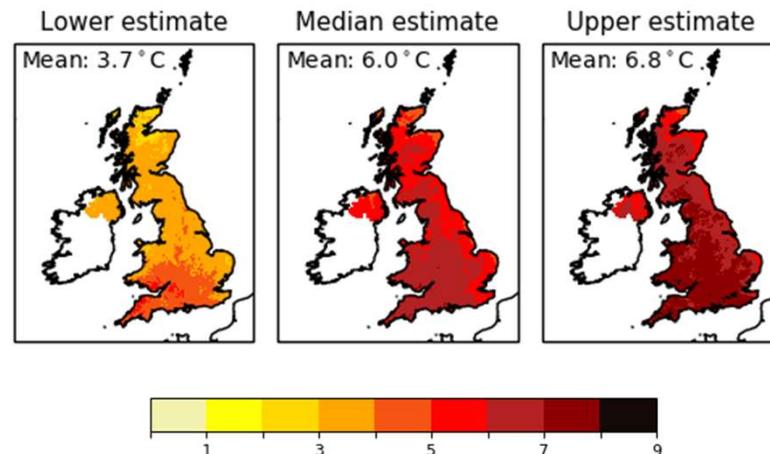
How much might hot summer days warm?

The Local (2.2km) ensemble suggests:

Hot summer days will warm more than the summer average

Range is 3.7 to 6.8°C

Hot summer days warm more than cold winter days

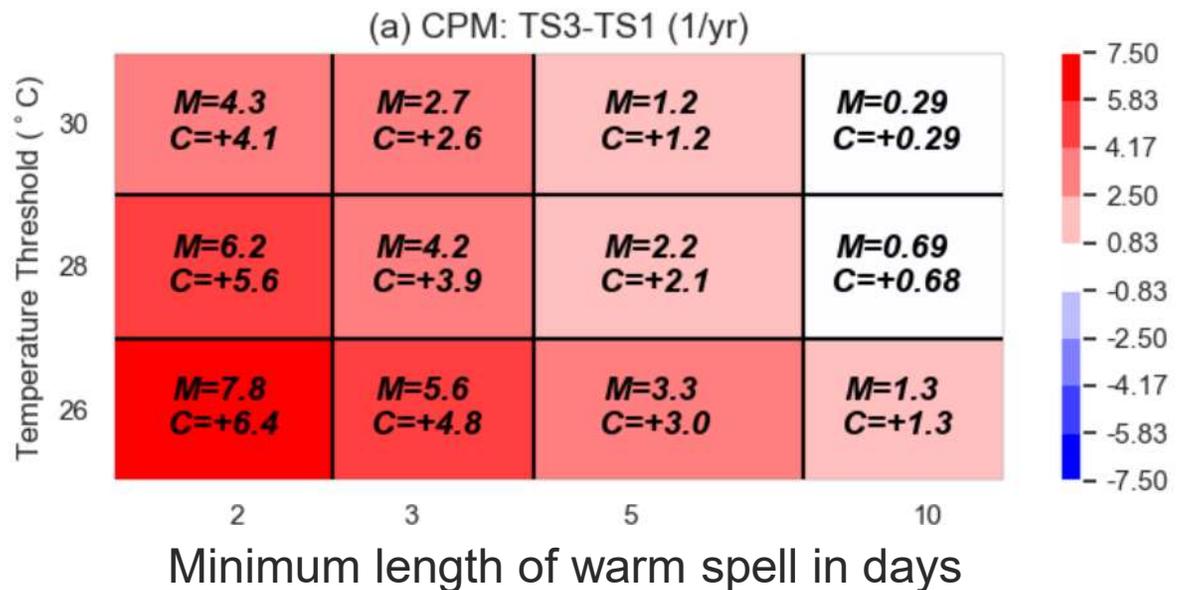


*Projected changes to 2061-2080 for RCP8.5
(°C)*

In general the Local (2.2km) model reinforces the results from the Regional (12km) model

Hot spells become more frequent.

Exceeding 30°C for >2 days rises from typically once every 4 years now, to about four times every year by 2070s.



Projected changes to 2061-2080 for RCP8.5

M=model future value and C=change from present

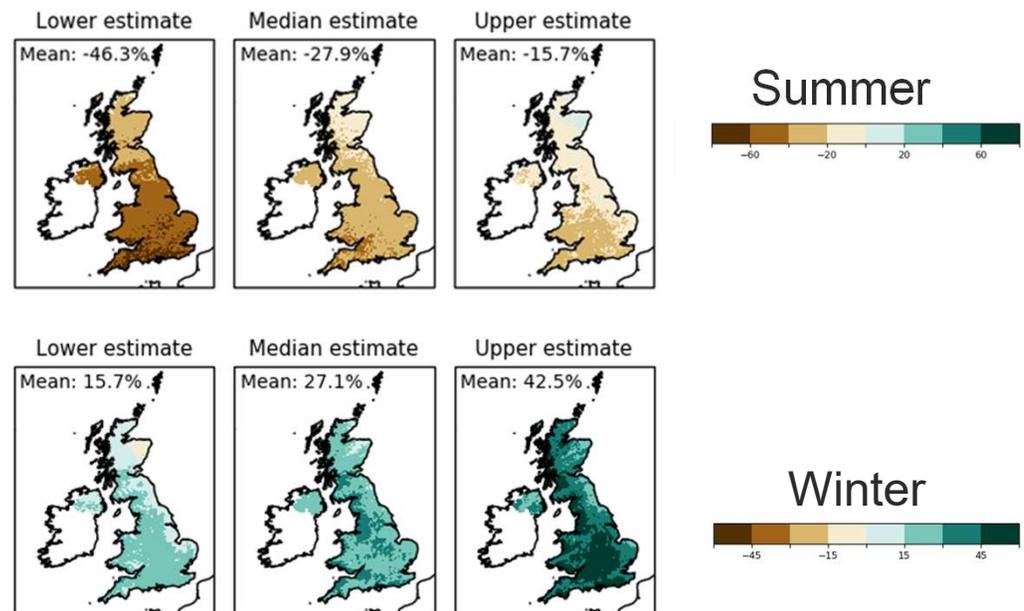
In general the Local (2.2km) model reinforces the results from the Regional (12km) model

Projecting future seasons using the Local (2.2km)

The Local (2.2km) ensemble suggests:

Summers will drier by 16-46% and winters will be wetter by 16-42%.

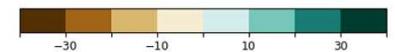
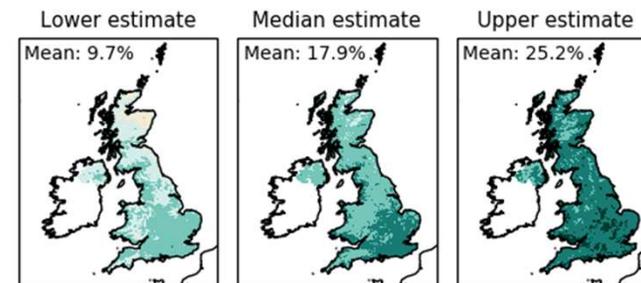
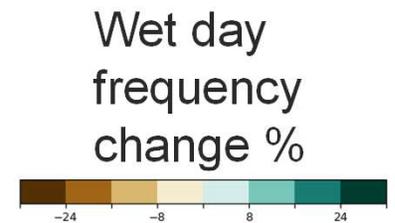
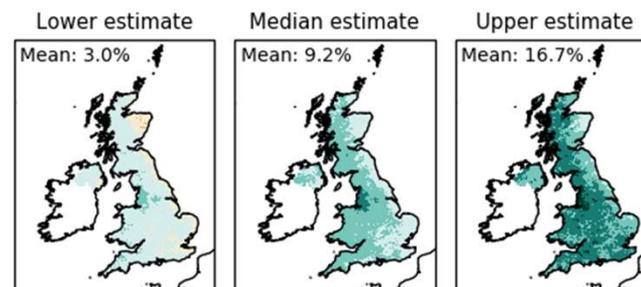
Projected changes to 2061-2080 for RCP8.5 as %



Winter precipitation increases are substantially larger in Local (2.2km) than Regional (12km)

Winter precipitation increases in both frequency of wet days and intensity on wet days

Projected changes to 2061-2080 for RCP8.5 as %

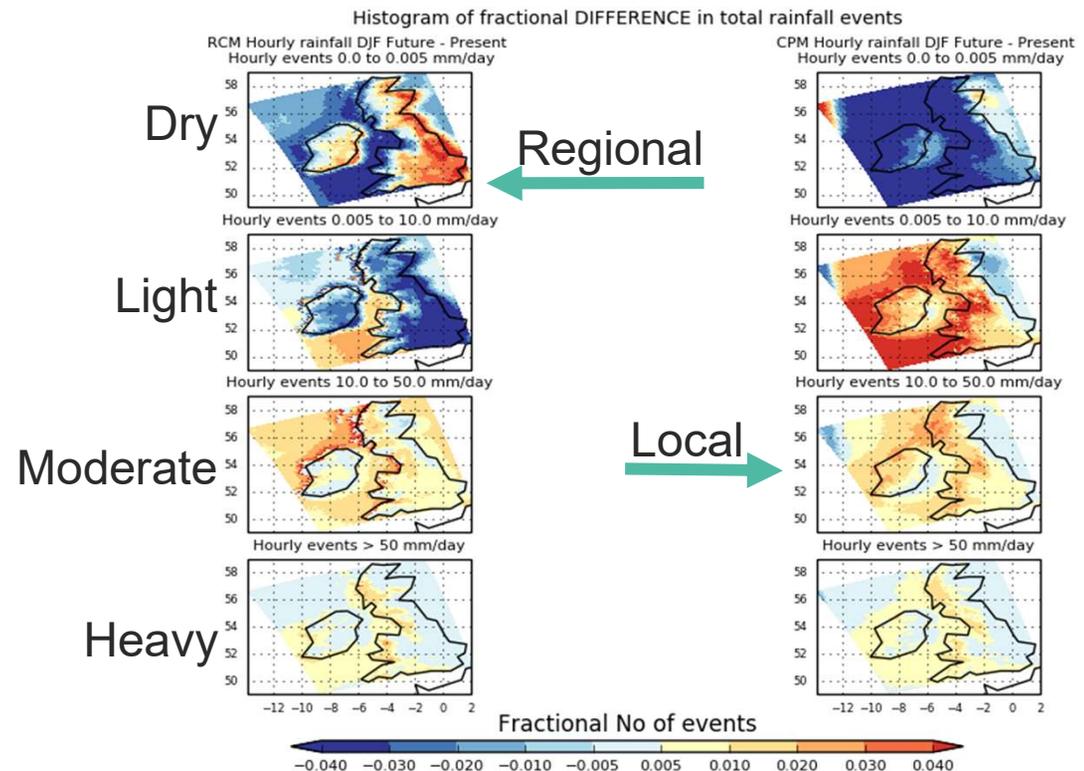


Wet day intensity change %

Local (2.2km) shows larger increases in wet day frequency than Regional (12km)

Hourly precipitation changes are different in Local (2.2km) compared to Regional (12km)

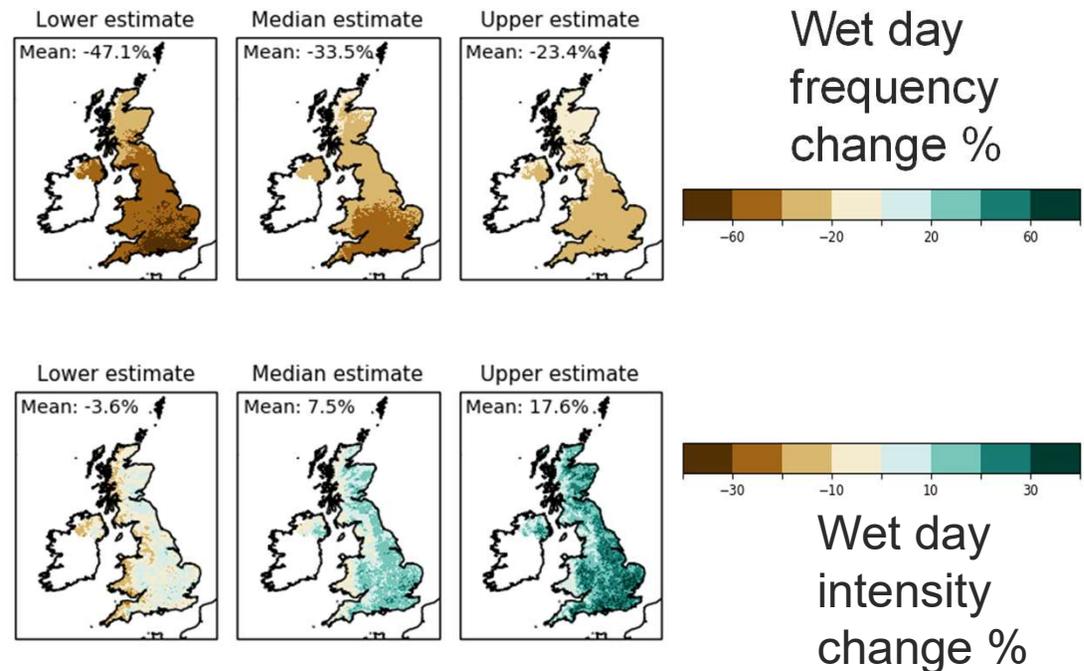
Projected winter changes to 2061-2080 for RCP8.5 – fractional difference in winter events of different intensity



Possible explanation: improved representation of convective showers in Local (2.2km)

Despite overall summer drying, Local (2.2km) suggests future increases in the intensity of summer rainfall.

Projected changes to 2061-2080 for RCP8.5 as %

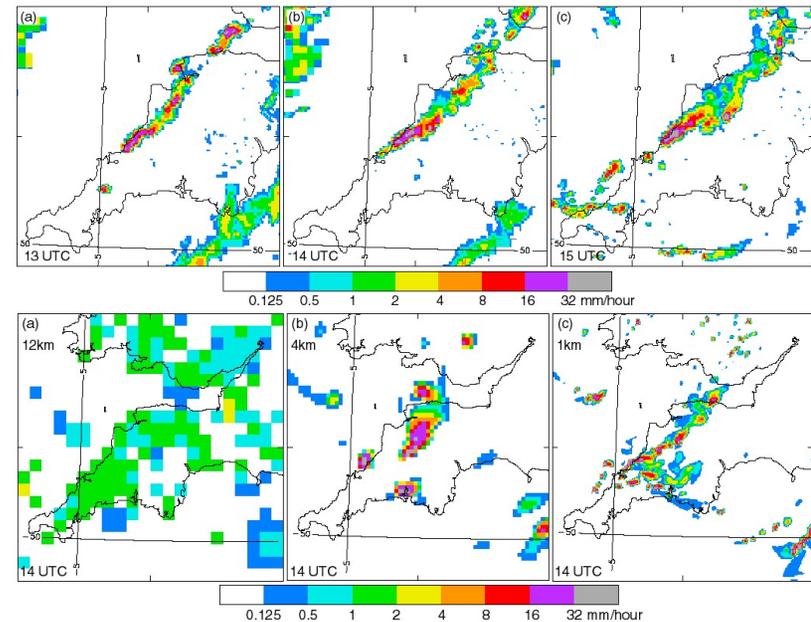


Local (2.2km) shows greater increases in summer rainfall intensity than Regional (12km).

Local (2.2km) suggests significant increases in hourly precipitation extremes.

The rainfall associated with an event that occurs typically once every 2 years increases by 25%, by 2070s.

The frequency of days with hourly rainfall >30mm/h almost doubles, by 2070s – increasing from UK-average of once every 10 years now to almost once every 5 years

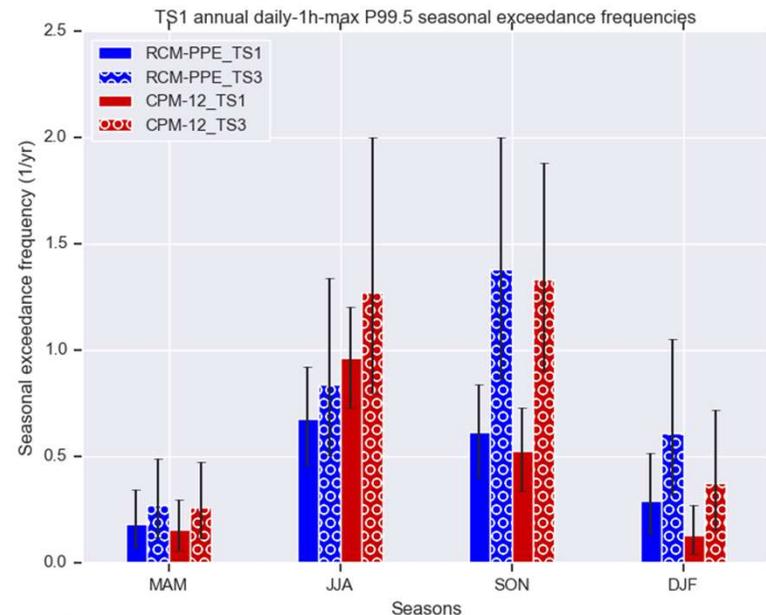


Boscastle flash flood, 16th August 2004. 75mm rain in 2h (~ typical total rainfall for whole of August). Hourly rates from radar, and model forecasts at 12km, 4km, and 1km.

Local (2.2km) provides credible projections of future changes in hourly rainfall extremes

Future climate change is projected to bring about a change in the seasonality of extremes.

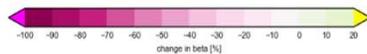
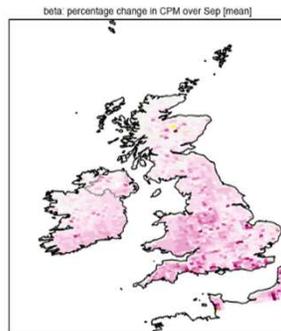
Local (2.2km) projects an extension of the convective season into autumn, with significant increases in hourly rainfall extremes in autumn.



Seasonal occurrence of extreme threshold exceedances. Threshold is 99.5th percentile of daily maximum hourly precipitation at each grid box.

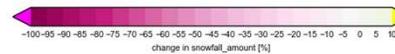
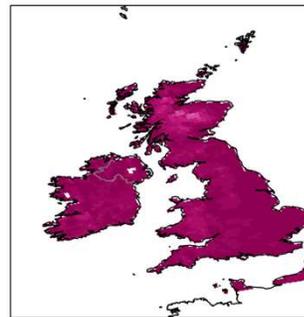
Local (2.2km) shows change in seasonality of hourly precipitation extremes

Soil Moisture



SE already water stressed. Projection of large further reductions

Snow



Projection of large reductions. Less of a change on Scottish mountains

Lightning



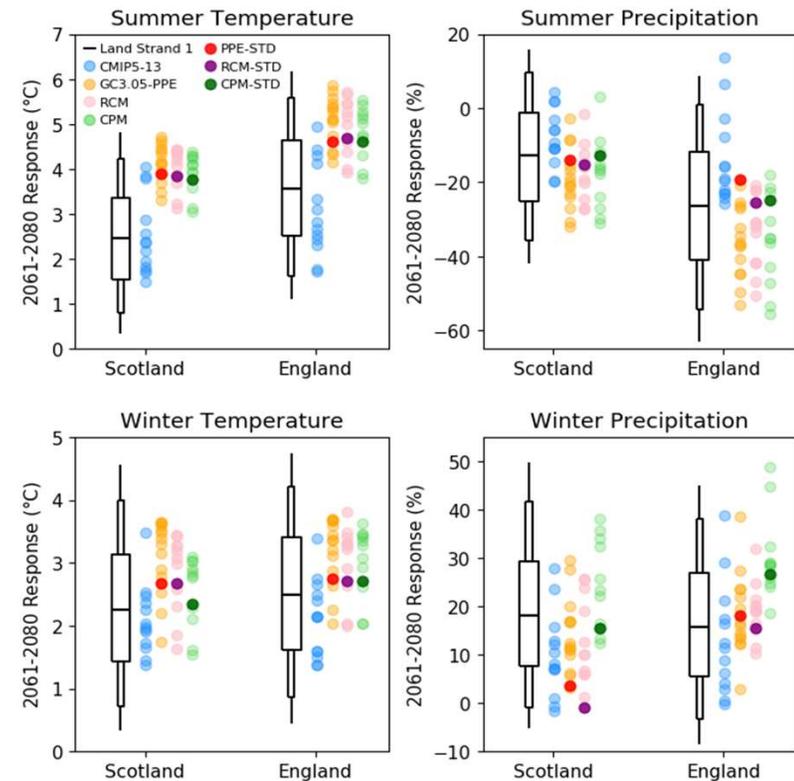
Some evidence of a summer decrease but more work needed to understand this

UKCP18 includes information on future changes for a greater range of metrics.

Local (2.2km) and Regional (12km) are driven by a subset of the Global (60km) projections, in particular those that simulate relatively high levels of global warming.

Strands 1 and 2 reveal wider range of potential outcomes for changes in summer, sampling smaller increases in temperature and smaller reductions in rainfall.

Projected changes to 2061-2080 for RCP8.5

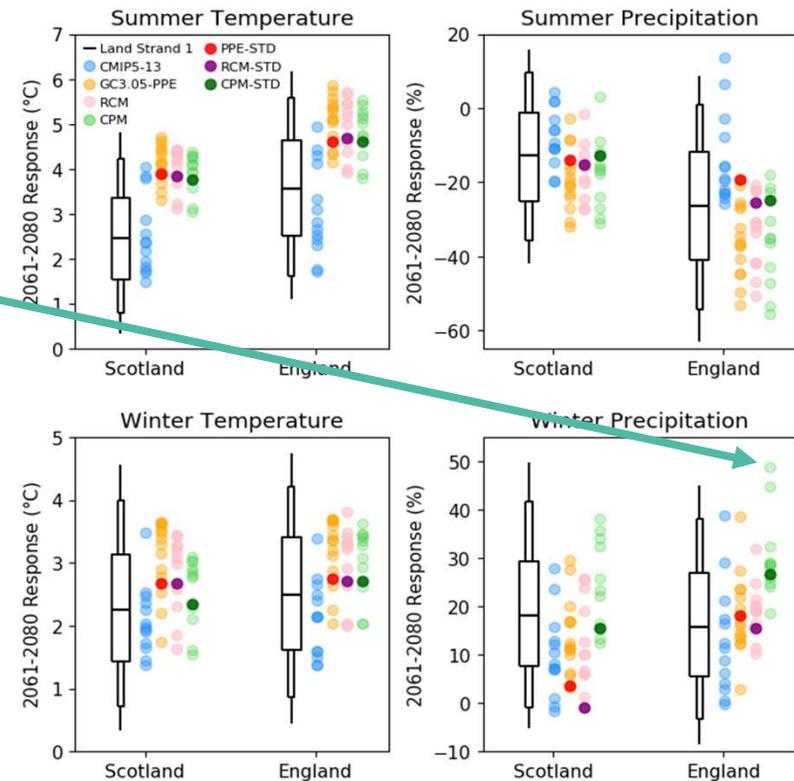


Local (2.2km) and Regional (12km) projections span narrower uncertainty range than Global (60km).

Local (2.2km) shows greater increase in winter precipitation compared to Regional (12km). For one member, increase is outside 5-95% range from probabilistic projections.

Very large winter precipitation increases may be more likely than the probabilistic projections suggest.

Projected changes to 2061-2080 for RCP8.5



We recommend that the various UKCP18 land projection tools are used together

		Global	Regional	Local
General usage considerations		Use where exploration of a wider range of future outcomes is more important than spatial detail (some exceptions, e.g. winter mean precipitation)	Use where improved representation of extremes or spatial detail is more important than exploring a wider range of future outcomes	<ul style="list-style-type: none"> Enhanced local resolution balanced against larger data processing overheads Hourly and 3-hourly data Generally better agreement with observations
Temperature Metrics	Summer mean temperature	✓	✓ But only samples warm outcomes	✓ But only samples warm outcomes
	Hot spells	✓ But better representation of daily extremes in Regional/Local	✓ But only samples warm outcomes	✓ But only samples warm outcomes
	Cold winter days	✓ But better representation of daily extremes in Regional/Local	✓	✓ Smaller increase in temperature over Scotland than in Regional
Precipitation Metrics	Winter mean precipitation	✓ But may underestimate "upper-end" response	✓ But may underestimate "upper-end" response	✓ Greater increase in precipitation than Regional. Samples "upper-end" responses outside range of Global and Regional outcomes
	Summer mean precipitation	✓	✓ But only samples dry outcomes	✓ But only samples dry outcomes
	Heavy daily events in summer			✓
	Hourly precipitation extremes (all seasons)			✓

Use of Local (2.2km) in context of UKCP18 suite of tools

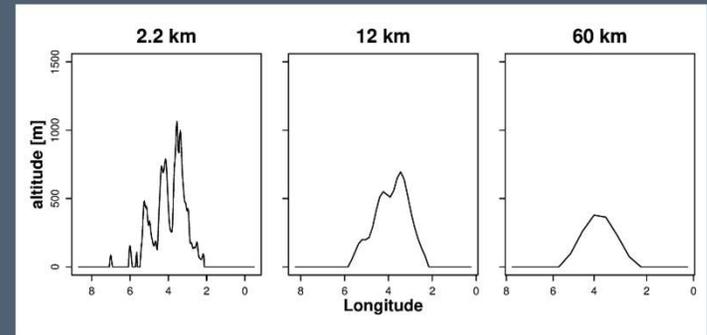
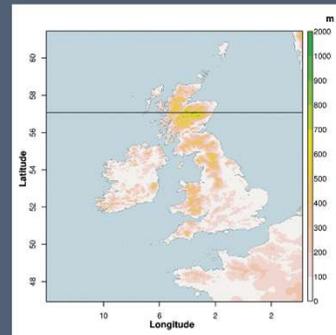
Local (2.2km) provides data at kilometre and hourly scales that can be directly fed into impact models.

For example:

- ❖ Hourly rainfall data for flood risk assessment
- ❖ Data on future extreme heat for local decision-making tools around key infrastructure.
- ❖ Enhanced spatial detail to explore urban climate change or changes over mountainous terrain



Surface height cross-section across Scotland at about 57° N, in Global (60km), Regional (12km) and Local (2.2km) models.



The height of the North-West Highlands and Cairngorms is better resolved in Local (2.2km)

Mountainous terrain is significantly smoothed at coarse resolution.

Local (2.2km) provides data to better inform local decision-making

Accessing Local (2.2km) Data



UK Climate Projections

The UK Climate Projections provides the most up-to-date assessment of how the climate of the UK may change over the 21st century. Find information to help with your climate change risk assessments and adaptation plans.

The UK Climate Projections is a climate analysis tool that forms part of the Met Office Hadley Centre Climate Programme which is supported by the Department of Business, Energy and Industrial Strategy (BEIS) and the Department for Environment, Food and Rural Affairs (Defra).

You can find the headline findings here and infographics for the projections over land and marine. These are summarized in a set of slides and slide notes. You may also find the executive summary from the Science Overview report useful.

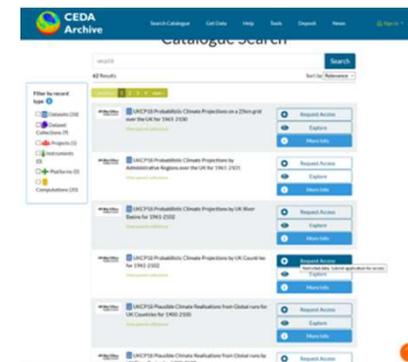
Variable at the surface (short name in data file)	Units	Probabilistic	Global	Regional	CPM	Derived
Cloud cover (cIt)	%	✓	✓	✓	✓	
Precipitation (pr)	mm/day, mm/hour	✓	✓		✓ hourly	✓
Radiation, total downward short wave flux (rtds)	W/m ²	✓				
Radiation, net long wave (rls)	W/m ²	✓	✓	✓	✓	
Radiation, net short wave (rsx)	W/m ²	✓	✓	✓	✓	
Relative humidity (hurs)	%					✓
Snow: snowfall amount	mm/day			✓	✓	
Snow: lying snow amount	mm/day			✓	✓	
Specific humidity (huss)		✓	✓	✓	✓	
Temperature, maximum (tasmax)	°C	✓	✓	✓	✓	
Temperature, mean (tas)	°C	✓	✓	✓	✓ hourly	✓
Temperature, minimum (tasmin)	°C	✓	✓	✓	✓	
Wind gust	m/s				✓ 3-hourly	
Wind speed (sfcWind)	m/s				✓ 3-hourly	✓
Wind speed eastwards (uas)	m/s			✓	✓	
Wind speed northwards (vas)	m/s			✓	✓	
Time steps *	Monthly, Seasonal, Annual, 20/30-year means	Daily, Monthly, Seasonal, Annual, 20/30-year means	Daily, Monthly, Seasonal, Annual, 20/30-year means			

Table 4 of UKCP Factsheet: Local (2.2km) Projections

<https://ukclimateprojections.metoffice.gov.uk>



<https://ukclimateprojections-ui.metoffice.gov.uk>



<https://catalogue.ceda.ac.uk>

Regridded data on Ordnance Survey's British National Grid (5km)

Original climate model data on rotated pole (2.2km)

For more information:

See Science report and Guidance documents at
ukclimateprojections.metoffice.gov.uk