UKCP: New Local (2.2km) results

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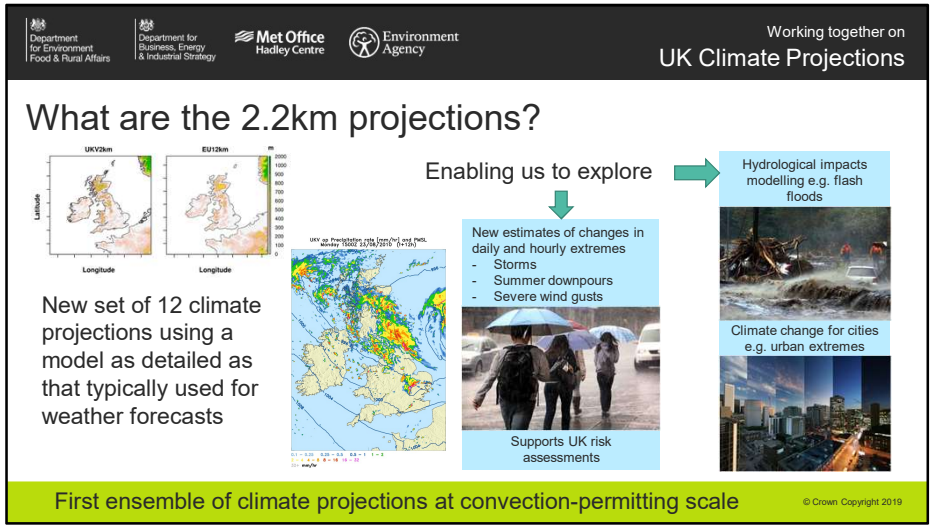
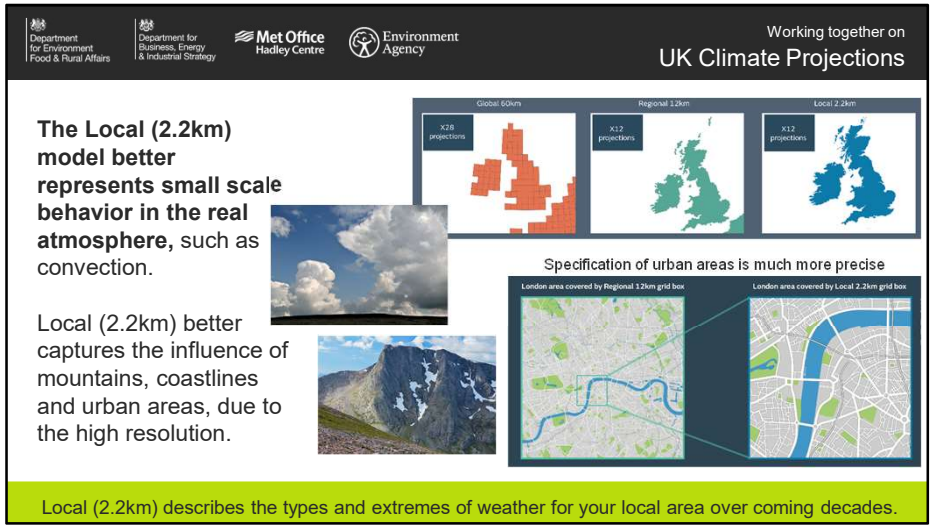


Here we are providing a new set of 12 projections at 2.2km resolution.
This is the first time anywhere, that national climate scenarios are being provided at a resolution on par with current operational weather forecast models.
And is a major step forward in national climate capability, allowing us to look at future changes in hourly rainfall and also on small spatial scales such as cities.
For example, this information will allow us to look at future changes in flash floods, like the Boscastle type of event, and …
at temperature extremes in cities, for example a temperature record was recently broken with 38.7 recorded in Cambridge in July.



The 2.2km projections provide detailed information on climate change, going all the way from global to local.
For example, here you can see how the UK is represented with much greater definition going from a 60km to a 2.2km model grid box.
This higher level of detail means that we are able to better represent small scale behaviour in the real atmosphere, such as convection – by which we mean, for example, thunderstorms and heavy showers.
It also allows us to better represent the influence of mountains, coastlines and urban areas – here we can see how the specification of London becomes much more precise …
We are also talking about better representation of snow over mountains, sea breezes …

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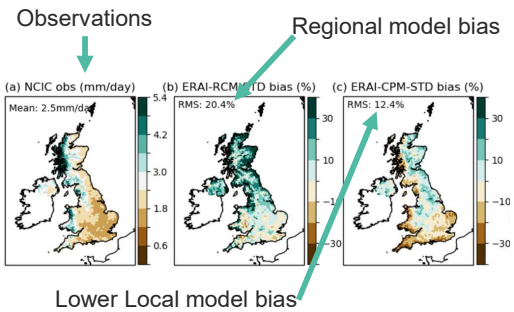
The Local (2.2km) model better simulates several aspects of present-day climate, which is verified by comparing the model results with observations of the real world.

Summer mean rainfall

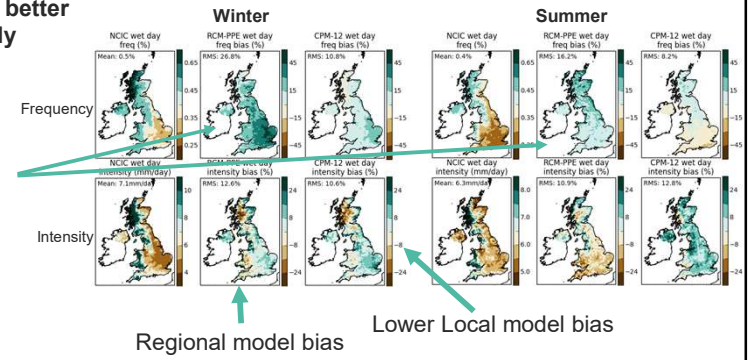


Local (2.2km) gives reduced biases in both summer and winter mean rainfall.

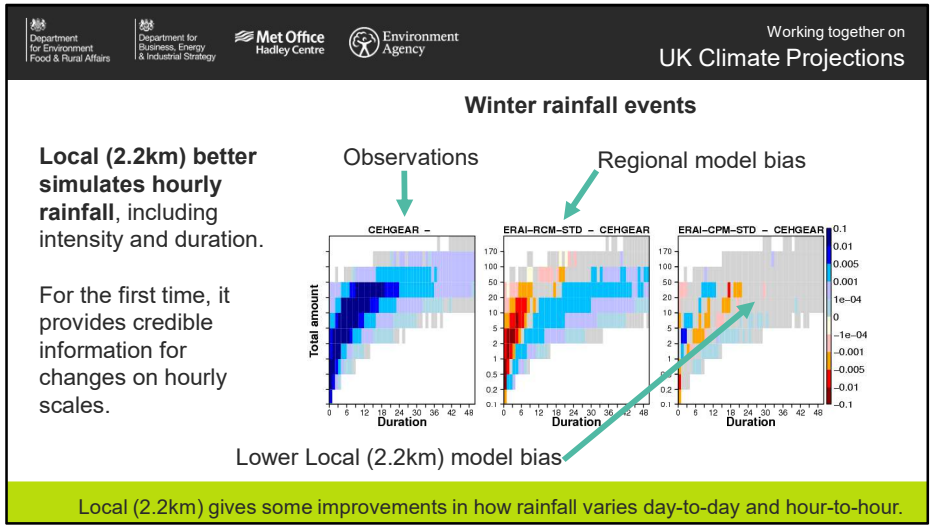
In winter, bias reduced from 24.0% to 12.3%.

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.



There are still biases in the Local (2.2km) model – in particular there is a tendency for heavy rainfall to be too intense. However, overall the Local model represents a major improvement in the realism of rainfall so that for the first time, it provides credible information on hourly scales.

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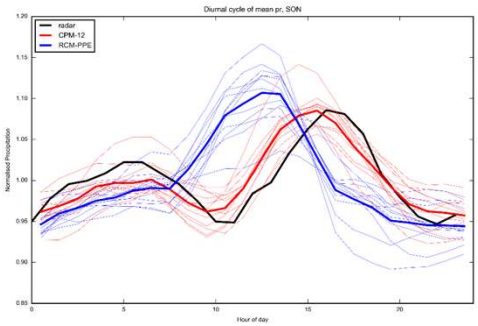
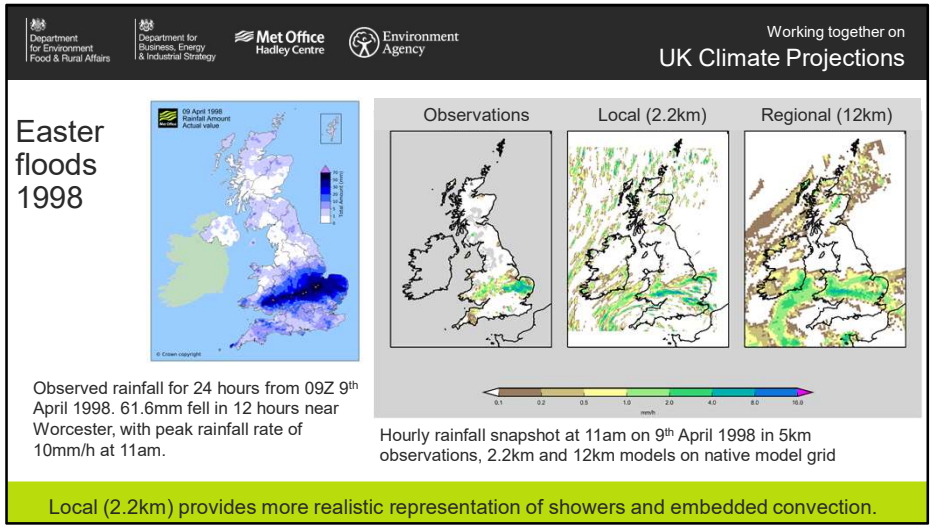
Local (2.2km) better represents the daily cycle of rainfall in some parts of the year.

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.

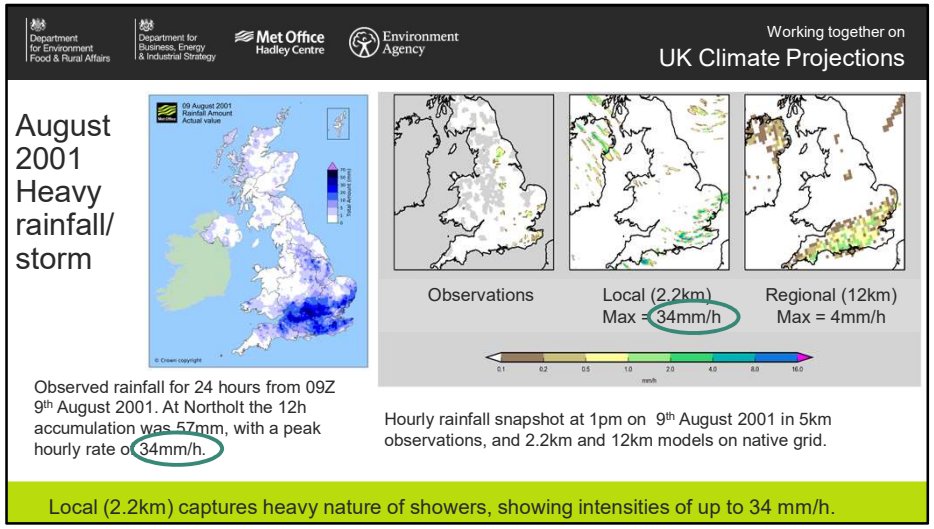
Here we are looking at the timing of rainfall during the day.
In the 12km model in blue we see a pronounced midday peak, whereas in reality the peak in rainfall is later in the day with showers building during the afternoon.
The 2.2km model is able to capture this much better.
In summer the peak in rainfall is a bit too early in the 2.2km model, but still improved compared to the 12km model.



Here we are looking at the example of an actual event, that nicely demonstrates the improved realism of rainfall in the Local (2.2km) model …

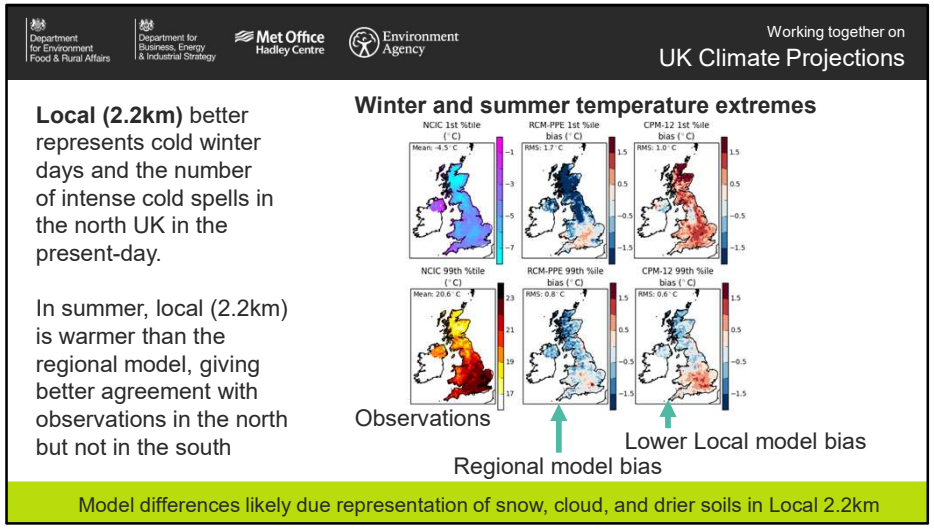
Can see that the 12km and 2.2km models agree well on the position of the front, but the 2.2km model provides more detail including embedded convective elements.

It also gives a much more realistic representation of showery activity over the north of the UK.



This is another example of an actual event – which illustrates how the Local model is able to capture the heavy nature of showers.

The Regional 12km model tends to underestimate the intensity of showers, giving more widespread light rainfall.



Cold winter days are too cold in the RCM especially in the north, with biases improved in CPM. Differences related to snow scheme, with more lying snow in RCM.
Hot summer days are too cold in RCM in north, and too hot in CPM in south. Drier soils in CPM may be contributing factor.

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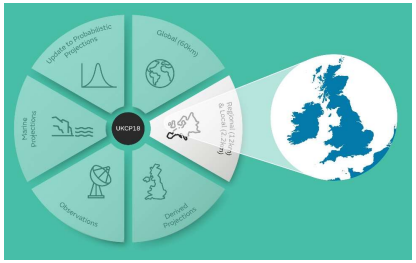
Projecting the future using the Local (2.2km)

UKCP18 2.2km ensemble

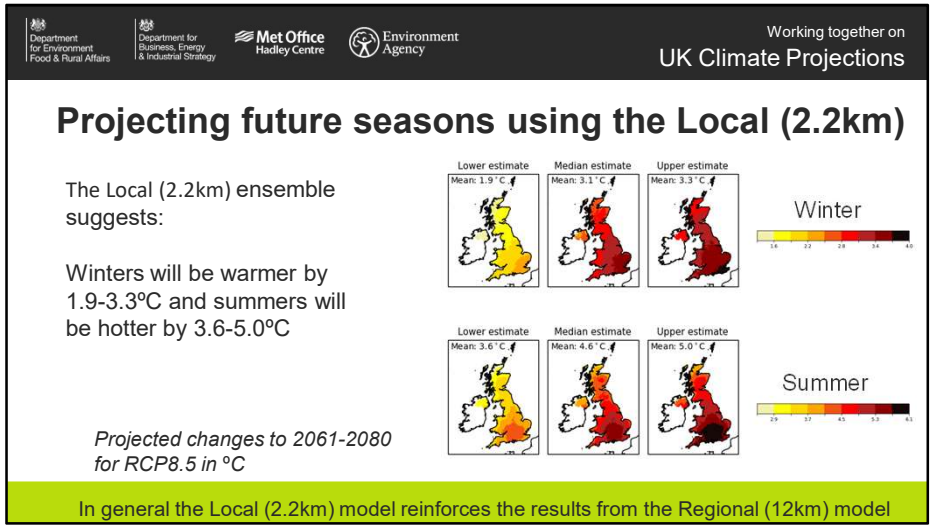
- 2.2km resolution for UK
- 12 members driven by 12km Regional
- 1981-2000, 2021-40, 2061-80
- High emissions scenario RCP8.5

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.

The Local 2.2km projections are the newest addition to the UKCP18 suite of climate models, adding further capability. You can see the other UKCP18 products as providing the basic climate change patterns, whilst the 2.2km projections provide further detail and improved information on extremes.
However, they sample a narrower range of uncertainty than the global and probabilistic projections.
Local 2.2km projections are provided for a high emissions scenario only. This is important for ensuring UK resilience to climate change, but also the results can be scaled back to give information at lower levels of warming if we reduce our emissions of greenhouse gases.



In general in terms of seasonal temperature changes the Local projections reinforce the results from the Regional model.

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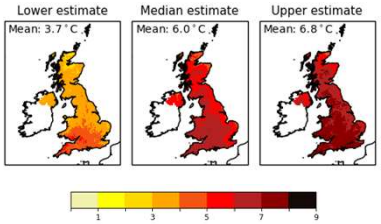
How much might hot summer days warm?

The Local (2.2km) ensemble suggests:

Hot summer days will warm more than the summer average

Range is 3.7 to 6.8ºC

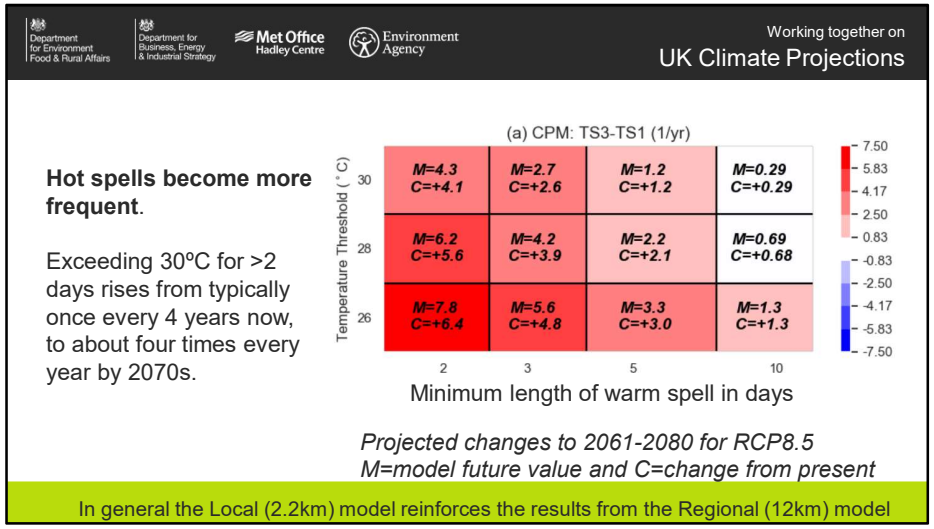
Hot summer days warm more than cold winter days



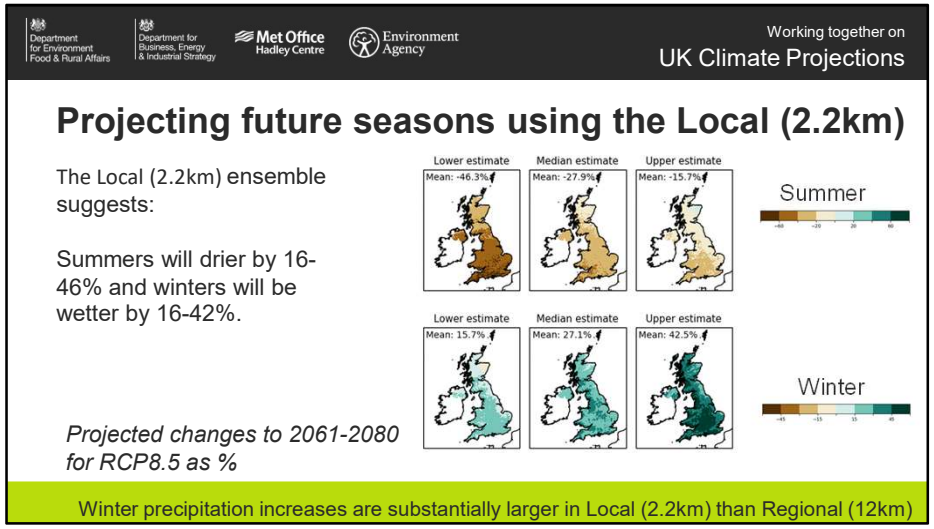
Projected changes to 2061-2080 for RCP8.5 (ºC)

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

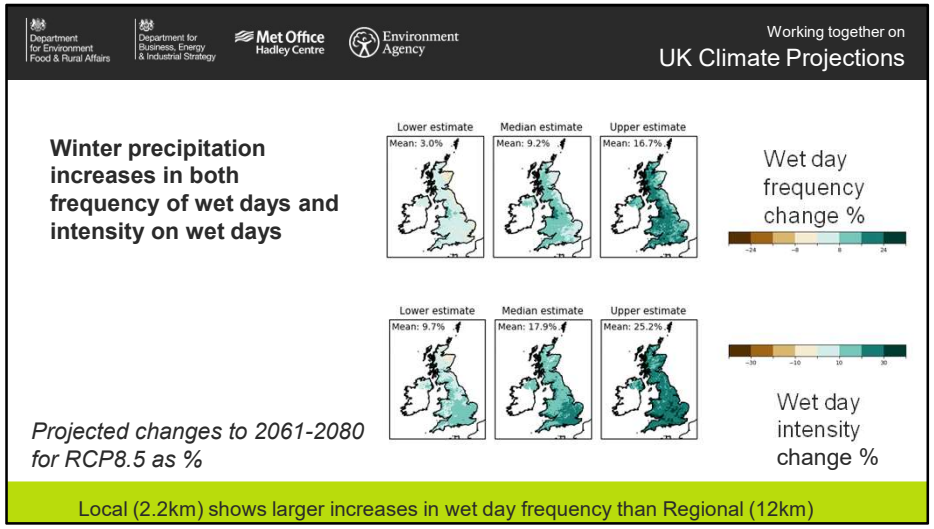
Hot summer days are the 99th percentile of daily mean temperature.
For cold winter days range is 2.7 to 4.7 degC increase



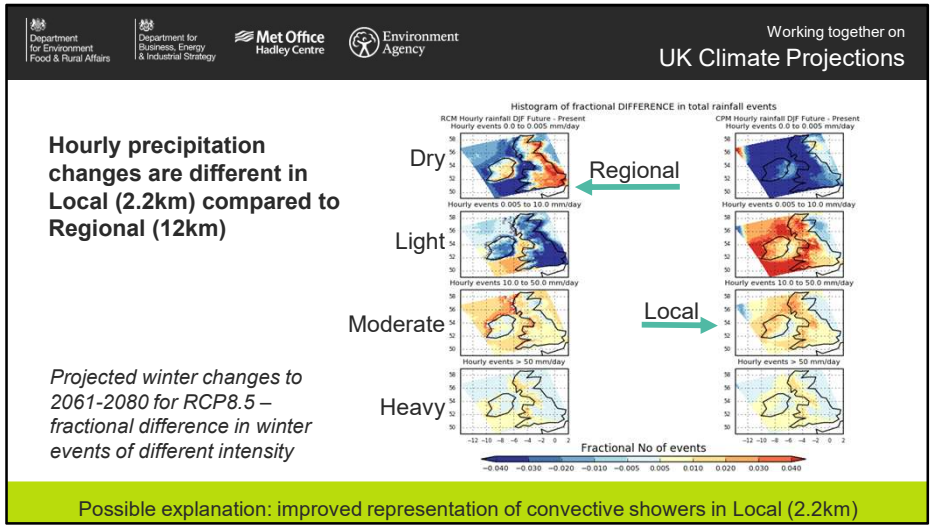
Hot spells here are defined as daily max exceeding 30C for 2 or more consecutive days, and this is the threshold used to trigger public health warnings.
Here we a seeing a 16-fold increase!



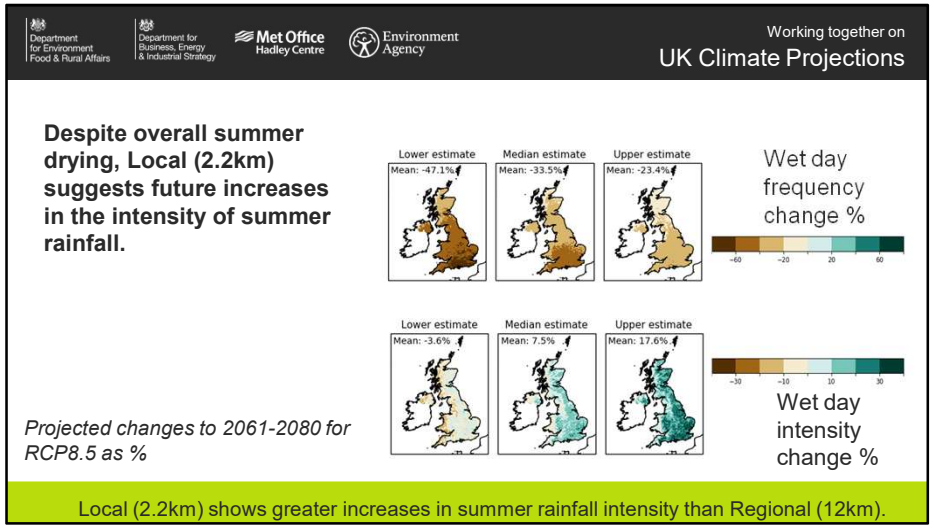
Winter precipitation increase 27.1% in 2.2km compared to 16.1% in 12km.
This was one of the surprises from the Local projections.
In this case we are getting much greater increases in the occurrence of rainfall in future in the Local than Regional model over the UK ...
And is likely due to the different representation of rainfall, including the improved representation of winter time convective showers in the Local model.



Wet day frequency increase 9.2% in 2.2km versus 0.6% in 12km – i.e. Much larger in 2.2km
Wet day intensity increase 17.9% in 2.2km versus 16.9% in 12km



Here we are looking at future changes in the numbers of hourly events of differing intensities, and we can see there are quite considerable differences in the patterns of change in hourly rainfall in winter.
So in the regional model there are fewer light rainfall events over the UK, whereas there is an increase in these in the Local projections.
So what we think is happening here is that in the future more convective showers are being triggered over the sea, which are then advected inland in Local model.
Whereas this is not seen in the regional model – where we are seeing a strong land-sea contrast.
This is one of the possible explanations for the greater increase in winter precipitation over the UK in the Local model.



For wet day intensity changes, central estimate is 7.5% increase in Local but 2.7 decrease in Regional

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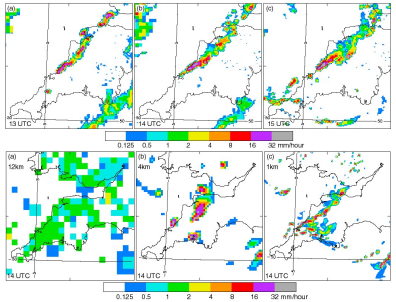
Local (2.2km) suggests significant increases in hourly precipitation extremes.

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

Boscastle is an example of the type of event we are now able to provide information about – in this case a whole month's rainfall fell in just 2h.
30 mm/h is official threshold used to issue a warning regarding flash flooding – for Greater London (400 grid boxes) similarly see approx. doubling of frequency by 2070s, whereas for City of London (just 10 boxes) the increase in frequency is x1.5 by 2070s but with more uncertainty.

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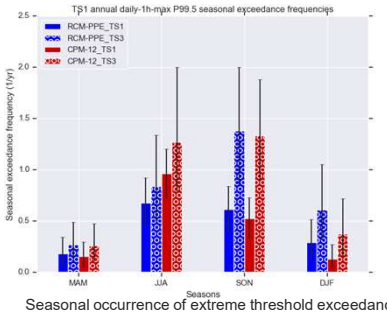
Future climate change is projected to bring about a change in the seasonality of extremes.

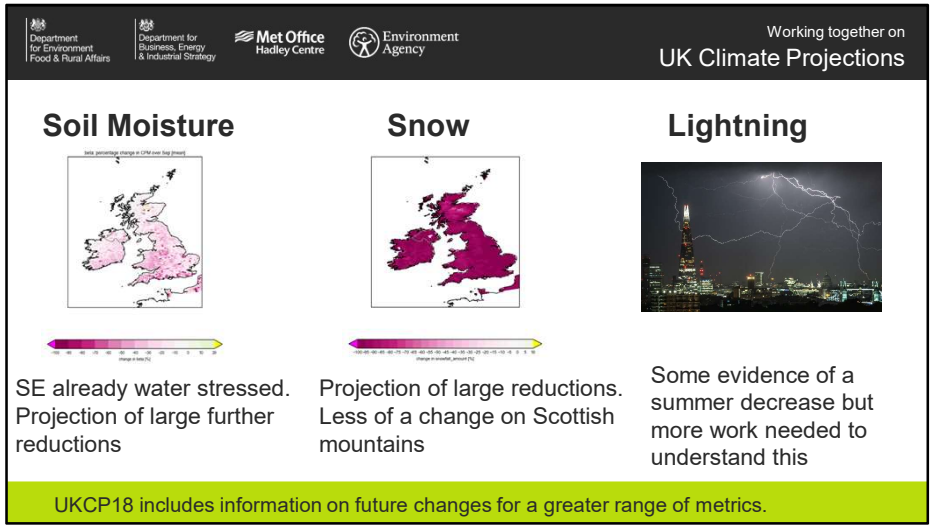
Local (2.2km) projects an extension of the convective season into autumn, with significant increases in hourly rainfall extremes in autumn.



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

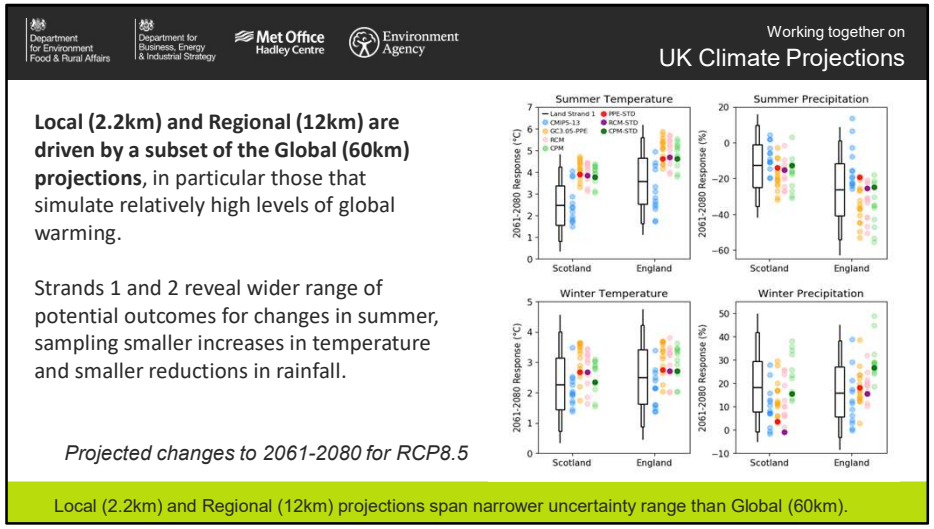
Local (2.2km) shows change in seasonality of hourly precipitation extremes

Plotted is central estimate, with black lines giving 2nd lowest to 2nd highest estimate.



Global 60km, Regional 12km and Local 2.2km all project a decrease in soil moisture in summer in the future, consistent with the reduction in summer rainfall.

By the end of 21st century, lying snow decreases by almost 100%, although with smaller decreases over mountainous regions in north and west.



It is important for users to be aware that the Local and Regional projections are driven by a subset of the Global projections …
This is shown here where the blue are the CMIP5 models and the yellow the Hadley Centre models used in Strand 2.
The Regional (pink) and Local (green) are only driven by the Hadley Centre models (yellow).
Black box and whiskers denote the 5, 10, 25, 50, 75, 90 and 95% probability levels of the Strand 1 probabilistic projections.

So in summer the Strand 1 and global (strand 2) projections show a wider range of outcomes,
… whilst the regional and local projections sample greater levels of warming and drying.

This shows that it is important to consider the Local projections in the context of the wider sampling of uncertainty from the Global and probabilistic projections.

In old 1.5km SUK model got the following results:
Mean winter precipitation increase of about 25% across southern England, both in CPM (23%) and driving 12km (28%)

model.
Mean summer precipitation decrease of about 40% across southern England, both in CPM (44%) and driving 12km model.

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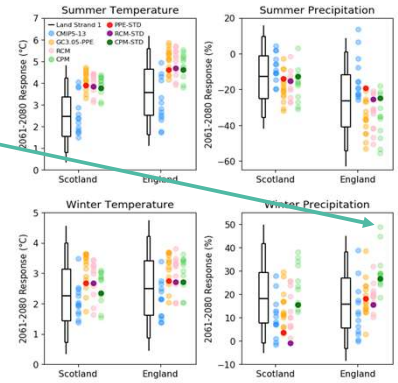
Local (2.2km) shows greater increase in winter precipitation compared to Regional (12km). For one member, increase is outside 5-95% range from probabilistic projections.

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

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		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	• 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
Temperature Metrics	Hot spells	✓ But better representation of daily extremes in Regional/Local	✓ But only samples warm outcomes	✓ But only samples warm outcomes
Temperature Metrics	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
Precipitation Metrics	Summer mean precipitation	✓	✓ But only samples dry outcomes	✓ But only samples dry outcomes
Precipitation Metrics	Heavy daily events in summer			✓
Precipitation Metrics	Hourly precipitation extremes (all seasons)			✓

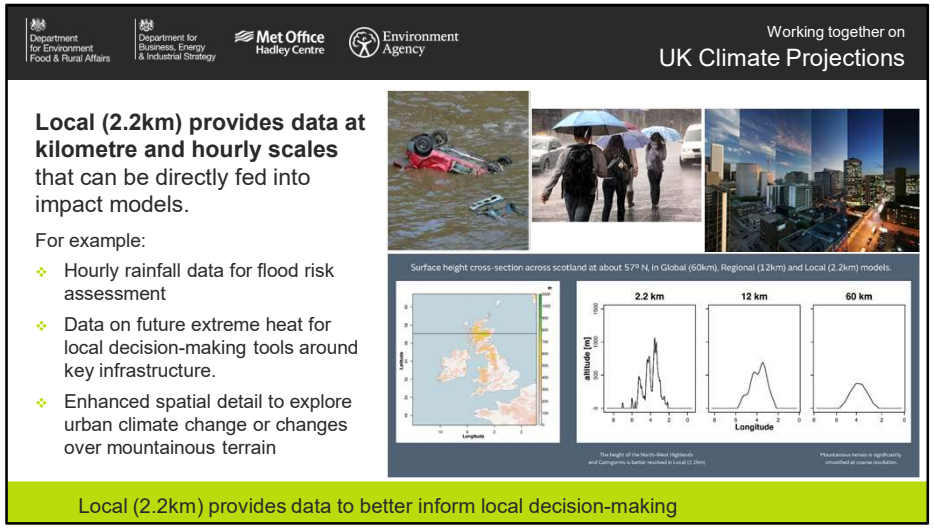
Use of Local (2.2km) in context of UKCP18 suite of tools

Guidance documents are provided (and available from the website) to guide the use of the Local projections in the context of the wider UKCP18 suite of tools.

In general we recommend using the global projections where exploring a wider uncertainty range is more important than spatial detail. However there are some exceptions …

For applications where spatial detail is important we expect the Regional and Local projections to be the primary source of information, but they provide a narrower sampling of uncertainty …

For heavy daily events in summer and hourly precipitation extremes, we would recommend use of the Local projections only.



Local 2.2km provides data to better inform local decision-making.
For example this is important for urban sewer design – where information on hourly rainfall change is needed.
It is also important for designing key infrastructure such as bridges, train-lines, buildings – where information on local temperature extremes is needed e.g. potential to look at local temperature extremes, such as exceeding 40C.
It better captures changes in cities, where the urban environment exacerbates heat exposure.

These new results are building on national climate capability – not only can we provide large-scale changes in mean variables, but now information on hourly extremes and on local scales that can be directly fed into impacts models.
This is a cutting-edge tool – and of course there are uncertainties – but we see this a key step forward in providing locally-relevant climate change information for decision-making and adaptation-planning.

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Accessing Local (2.2km) Data

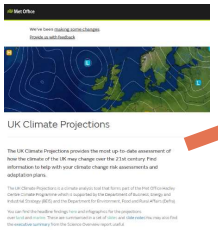

Table 4 of UKCP Factsheet: Local (2.2km) Projections

https://ukclimateprojections.metoffice.gov.uk

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

https://ukclimateprojections-ui.metofffice.gov.uk

Original climate model data on rotated pole (2.2km)

https://catalogue.ceda.ac.uk

For more information:

See Science report and Guidance documents at
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