Climate Change Predictions for the Cheviot Hills

Summary of climate change projections using data from the UK Climate Impacts Programme (UKCIP) and UK Climate Projections (UKCP09)

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cheviotfutures
united in a changing landscape

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Climate Change Projections for the Cheviot Futures Project Area

Background

Cheviot Futures is a cross-border initiative aiming to assist farmers and land managers adapt to the challenges of a changing climate.

The project area encompasses the landscape of the Cheviot Hills within north Northumberland and the Scottish Borders, including the valleys of the Coquet, Breamish, College, Bowmont-Glen, and further afield within the wider Tweed Catchment.

The project provides advice and guidance relating to simple, practical adaptations and resilience efforts that can be made at the farm and landscape scale to increase the resilience of land management to the effects of a changing climate – managing potential negative impacts and taking advantage of potential opportunities that may arise.

Key work areas of the project include the innovative and unique Farm Resilience Planning (FRP) approach – looking at the impacts that predicted climate change effects will have for the individual farm holding, and how to adapt to become more resilient; and also the development of demonstration projects, showcasing practical capital works implemented throughout the project area, demonstrating adaptation to a wide range of climatic impacts.

The UK Climate Impacts Programme (UKCIP) supports adaptation to the unavoidable impacts of a changing climate. The publicly funded initiative works at the boundary of scientific research, policy making and practical adaptation practice.

UKCIP coordinates and influences research into adapting to climate change, sharing outputs in ways useful to stakeholders, including organisations and those responsible for addressing the challenges that climate change will bring, as well as those seeking to make adaptations to their business to ensure resilience to the altered climate.

UKCIP was established in 1997 by the UK government, and is based at the Environmental Change Institute at the University of Oxford.

The UK Climate Projections (UKCP09) offers background and key findings for the latest future climate change information, and gives climate information for the UK to the end of this century. Projections of future changes to our climate are provided, based on simulations from climate models.

The purpose of providing information on the possible future climate is to help those needing to plan how they will adapt to help society and the natural environment to cope with a changing climate.

The UK Climate Projections provide climate information designed to help inform adaptation strategies to increase resilience e to the impacts and effects of climate change across the UK.

Projections are presented for the three different future scenarios representing High, Medium and Low Greenhouse Gas Emissions levels.

Scope and Source of Information Presented

This summary intends to draw together the main probable predicted changes in the climate for the Cheviot Hills area of north Northumberland and the Scottish Borders.

The information gathered here is taken from the UKCP09 data relating to the North East England and East Scotland administrative regions.

We have reproduced the information relating to the Medium emissions scenarios, and the 90% probability level, on the basis that this gives a reasonable average indication of the changes in climate likely to affect this area of the UK.

As such this report is largely based on the research and presentation of findings by others, rather than original content developed and produced by Cheviot Futures directly. The predominant information source is at http://www.ukcip.org.uk/. Data from this website is provided by public funds and as such is freely available to all. Data from the website cannot be reproduced for commercial purposes, but content including images may be reproduced with appropriate acknowledgement of UKCIP as the source.

Section 1 – Overview

1.1 Climate Change

Climate refers to the average weather experienced over a long period – usually around 30 years. Natural causes have resulted in the climate of the Earth changing many times throughout history – the term 'climate change' is usually used in reference to changes that have occurred since the early 1900s.

Global climate is affected by both human and natural influencing factors. Natural causes include interactions between the ocean and the atmosphere, changes in the Earth's orbit and volcanic activity.

Humans influence global climate through the release of greenhouse gases – carbon dioxide, methane, and others – into the atmosphere. These gases absorb energy that is radiated from the surface of the Earth, warming the atmosphere and increasing the global temperature.

Much of the observed increase in global average temperatures since the mid-20th Century has been attributed to being likely due to the observed increase in anthropogenic (man0made) concentrations of greenhouse gases (Intergovernmental Panel on Climate Change (IPCC), 2007).

1.2 Adaptation and Mitigation

Adaptation is the term used to describe changes and actions put in place to adapt to the challenges or opportunities presented by climate change effects. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as:

> "adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit potential beneficial opportunities".

Adaptation can be classified by the nature of the driver:

- **Anticipatory adaptation** – takes place before impacts of climate change are observed. Also known as proactive adaptation.
- **Autonomous adaptation** – is triggered by changes in natural systems, and by market or welfare changes in human systems. Also known as spontaneous adaptation.
- **Planned adaptation** – a deliberate policy decision, based on an awareness of changing conditions and understanding that action is required.

It can also be categorised as measures and strategies that contribute either to:

- **Building adaptive capacity** – creating the information (research, data collecting and monitoring, awareness raising), supportive social structures (organisational development, working in partnership, institutions), and supportive governance (regulations, legislations, and guidance) that are needed as a foundation for delivering adaptation actions; or

- **Delivering adaptation actions** – actions that help to reduce vulnerability to climate risks, or to exploit opportunities.

Mitigation is the term used to refer to efforts to limit the man-made causes of climate change. There will be some degree of unavoidable contribution despite any mitigation efforts due to historic greenhouse gas emissions and the persistence of these gases in the atmosphere, as well as the slow warming of the oceans. The delayed response of the oceans will result in temperatures and sea-level continuing to increase for several decades regardless of any present-day emissions reductions.

Mitigation is therefore concerned with reducing the emissions of greenhouse gases such as carbon dioxide. It is only by reducing these emissions that we can minimise the human-induced (anthropogenic) element of climate change. Many measures that help reduce emissions – such as energy efficiency efforts and alternative energy and transport provision – can also have other benefits such as saving money and encouraging a generally more sustainable society.

Mitigation and adaptation are closely linked and should ideally be considered side by side when looking at options for action. This is not always possible but any adaptation actions should take account of mitigation (e.g. offsetting emissions or alternative options), and mitigation efforts should take account of the need for adaptation.

1.3 Climate Impacts and Trends

Our global and national climate is already changing – that much is certain. Rainfall patterns are changing, sea levels are rising, glaciers are retreating, arctic sea ice is thinning and the incidence of extreme weather is increasing in some parts of the world.

Average global temperature and sea level have risen since the late 19th century, and at an increased rate over the past few decades.

- Warming of the global climate system is unequivocal, with global average temperatures having risen by nearly 0.8 ºC since the late 19th century, and rising at about 0.2 ºC/decade over the past 25 years.
- It is very likely that man-made greenhouse gas emissions caused most of the observed temperature rise since the mid 20th century (IPCC Fourth Assessment Report, 2007).
- Global sea-level rise has accelerated between mid-19th century and mid-20th century, and is now about 3 mm per year. Human activities have likely contributed between a quarter and a half of the rise in the last half of the 20th century (IPCC Fourth Assessment Report, 2007).

Observed trends for the UK:

Average UK temperature has risen since the mid 20th century, as have average sea level and sea surface temperature around the UK coast. Over the same time period, trends in precipitation are harder to identify.

- Central England Temperature has risen by about a degree Celsius since the 1970s, with 2006 being the warmest on record. All regions of the UK have experienced an increase in average temperatures between 1961 and 2006 annually, and for all seasons. Increases in annual average temperature are typically between 1.0 and 1.7 °C, tending to be largest in the south and east of England and smallest in Scotland.
- All regions of the UK have experienced an increase over the past 45 years in the contribution to winter rainfall from heavy precipitation events; in summer all regions except north east England and north Scotland show decreases.
- Severe windstorms around the UK have become more frequent in the past few decades, though not above that seen in the 1920s.
- There has been considerable variability in the North Atlantic Oscillation, but with no significant trend over the past few decades.
- Sea-surface temperatures around the UK coast have risen over the past three decades by about 0.7 ºC.
- Sea level around the UK rose by about 1 mm/yr in the 20th century, corrected for land movement. The rate for the 1990s and 2000s has been higher than this.
- The annual number of days with air frost has reduced in all regions of the UK between 1961 and 2006. There are now typically between 20 and 30 fewer days of air frost per year, compared to the 1960s, with the largest reductions in northern England and Scotland.
- There has been a decrease in the average number of Heating Degree Days (HDD), and an increase in the average number of Cooling Degree Days (CDD) in all administrative regions of the UK as a whole, between 1961 and 2006.
- There has been a slight increase in average annual precipitation in all regions of the UK between 1961 and 2006, however this trend is only statistically significant above background natural variation in Scotland where an increase of around 20% has been observed. Likewise for an increase in average winter is only statistically significant in northern England and Scotland where increases of 30– 65% have been experienced.
- Average annual and seasonal relative humidity has decreased in all regions of the UK, except Northern Ireland, between 1961 and 2006, by up to 5%.

Section 2 – Maps and Key Projections

2.1 Interpretation Overview

The UKCP09 data provides probabilistic climate change projections – a projection of future change in climate (relative to the baseline period of 1961-1990) that assigns probability levels to different climate change outcomes.

This means that different future climate outcomes are described in probabilistic terms, based on the strength of evidence associated with them. As such, probability levels associated with a given change should be interpreted as indicating the relative likelihood of the projected change being at or less than the given change.

For example, if a projected temperature change of +4.5°C is associated with the 90% at a particular location in the 2080s for the UKCP09 medium emission scenario, this should be interpreted as it is projected that there is a 90% likelihood that temperatures at that location will be equal to or less than 4.5°C warmer than temperatures in the 1961–1990 baseline period. Conversely, there is a 10% likelihood that those temperatures will be greater than 4.5°C warmer than the baseline period.

The information reproduced here is taken from the UK maps and key findings section of the UKCIP website. The website includes full sets of maps that show a range of possible outcomes, based on the 10, 50 and 90% probability levels for high, medium and low emissions scenarios for the three time periods of 2020s, 2050s, and 2080s, for a range of climatic variables.
UKCP09 uses 30-year time periods for both the baseline climate and for all future climate projections. The projections are reported for seven overlapping 30-year time periods. Each future time period is referenced against the decade upon which it is centred – i.e.:

- 1961 to 1990 – the baseline period
- 2010 to 2039 – the 2020s;
- 2020 to 2049 – the 2030s;
- 2030 to 2059 – the 2040s;
- 2040 to 2069 – the 2050s;
- 2050 to 2079 – the 2060s;
- 2060 to 2089 – the 2070s;
- 2070 to 2099 – the 2080s

We have reproduced here as indicative for the Cheviot Futures project area, the maps relating to the 10% and 90% probability level projections under medium emissions, for the 2050s and 2050s for both the North East England region and the East Scotland region. The full range of maps can be viewed at http://ukclimateprojections.defra.gov.uk/21708. The 10% probability level data shows the 'not less than' scenario, whilst the 90% probability level data shows the 'not greater than' scenario.

2.2 UKCP09 Region North East England

Key findings: medium emissions/2020s time period

The wider range is from the lowest to highest value for all emissions scenarios and three (10, 50, and 90%) probability levels for each 30-year time period.

- Under medium emissions, the central estimate of increase in **winter mean temperature** is 1,2ºC; it is very unlikely to be less than 0.5ºC and is very unlikely to be more than 2ºC. A wider range of uncertainty is from 0.3ºC to 2.1ºC.

- Under medium emissions, the central estimate of increase in **summer mean temperature** is 1.5ºC; it is very unlikely to be less than 0.6ºC and is very unlikely to be more than 2.5ºC. A wider range of uncertainty is from 0.6ºC to 2.5ºC.

- Under medium emissions, the central estimate of increase in **summer mean daily maximum temperature** is 1.9ºC; it is very unlikely to be less than 0.3ºC and is very unlikely to be more than 3.5ºC. A wider range of uncertainty is from 0.3ºC to 3.5ºC.

- Under medium emissions, the central estimate of increase in **summer mean daily minimum temperature** is 1.4ºC; it is very unlikely to be less than 0.5ºC and is very unlikely to be more than 2.6ºC. A wider range of uncertainty is from 0.5ºC to 2.6ºC.

- Under medium emissions, the central estimate of change in **annual mean precipitation** is 0%; it is very unlikely to be less than –4% and is very unlikely to be more than 5%. A wider range of uncertainty is from –4% to 5%.

- Under medium emissions, the central estimate of change in **winter mean precipitation** is 4%; it is very unlikely to be less than –4% and is very unlikely to be more than 14%. A wider range of uncertainty is from –4% to 14%.

- Under medium emissions, the central estimate of change in **summer mean precipitation** is –6%; it is very unlikely to be less than –19% and is very unlikely to be more than 8%. A wider range of uncertainty is from –19% to 9%.

Key findings: medium emissions/2050s time period

The wider range is from the lowest to highest value for all emissions scenarios and three (10, 50, and 90%) probability levels for each 30-year time period.

- Under medium emissions, the central estimate of increase in **winter mean temperature** is 2ºC; it is very unlikely to be less than 1.1ºC and is very unlikely to be more than 3.1ºC. A wider range of uncertainty is from 0.8ºC to 3.4ºC.

- Under medium emissions, the central estimate of increase in **summer mean temperature** is 2.5ºC; it is very unlikely to be less than 1.2ºC and is very unlikely to be more than 4.1ºC. A wider range of uncertainty is from 1.1ºC to 4.7ºC.

- Under medium emissions, the central estimate of increase in **summer mean daily maximum temperature** is 3.2ºC; it is very unlikely to be less than 1ºC and is very unlikely to be more than 5.7ºC. A wider range of uncertainty is from 0.9ºC to 6.4ºC.

- Under medium emissions, the central estimate of increase in **summer mean daily minimum temperature** is 2.5ºC; it is very unlikely to be less than 1ºC and is very unlikely to be more than 4.4ºC. A wider range of uncertainty is from 0.9ºC to 4.9ºC.

- Under medium emissions, the central estimate of change in **annual mean precipitation** is 0%; it is very unlikely to be less than –5% and is very unlikely to be more than 5%. A wider range of uncertainty is from –6% to 5%.

- Under medium emissions, the central estimate of change in **winter mean precipitation** is 11%; it is very unlikely to be less than 1% and is very unlikely to be more than 24%. A wider range of uncertainty is from –1% to 26%.

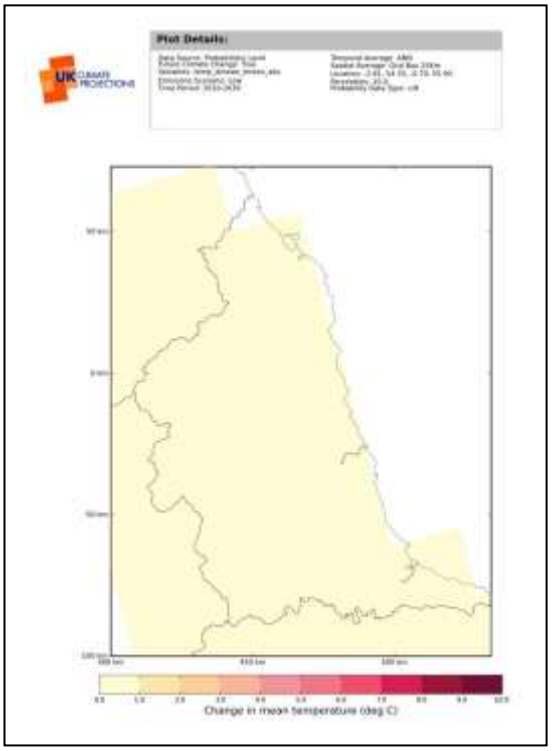
- Under medium emissions, the central estimate of change in **summer mean precipitation** is –15%; it is very unlikely to be less than –30% and is very unlikely to be more than 1%. A wider range of uncertainty is from –31% to 7%.

Maps

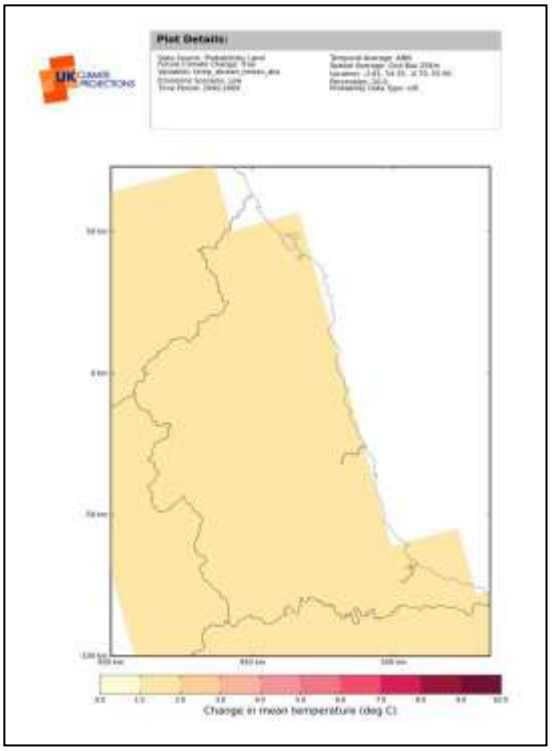
All maps reproduced below are © UK Climate Projections, 2009

Average Annual Temperature – 10% probability level data (i.e. not less than)

2020s/medium emissions

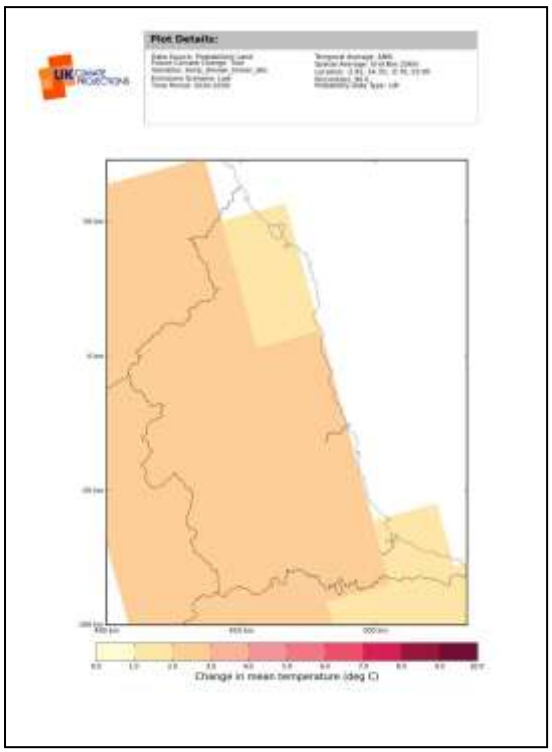


2050s/medium emissions

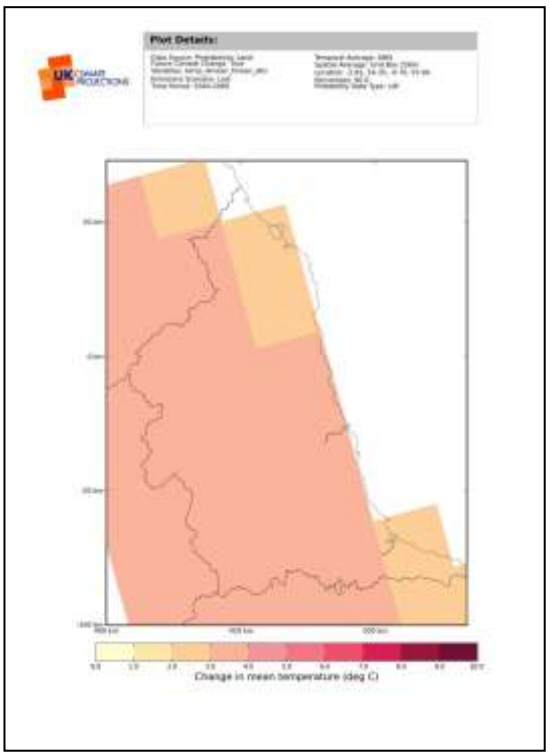


Average Annual Temperature – 90% probability level data (i.e. not greater than)

2020s/medium emissions

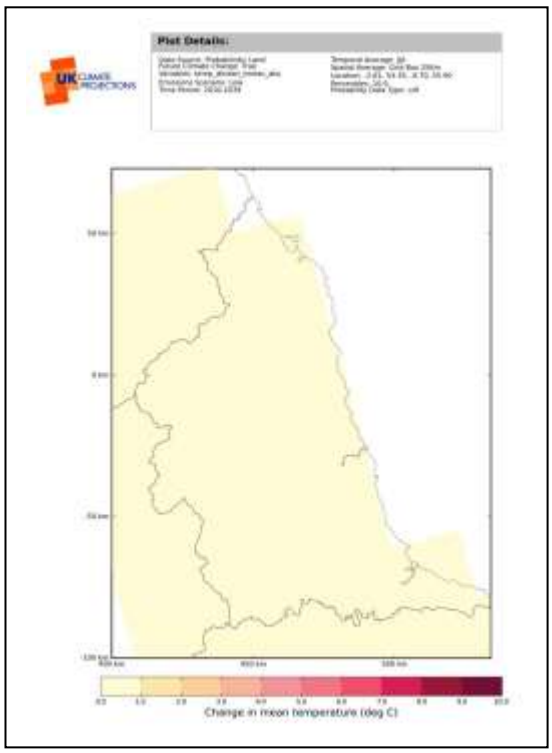


2050s/medium emissions

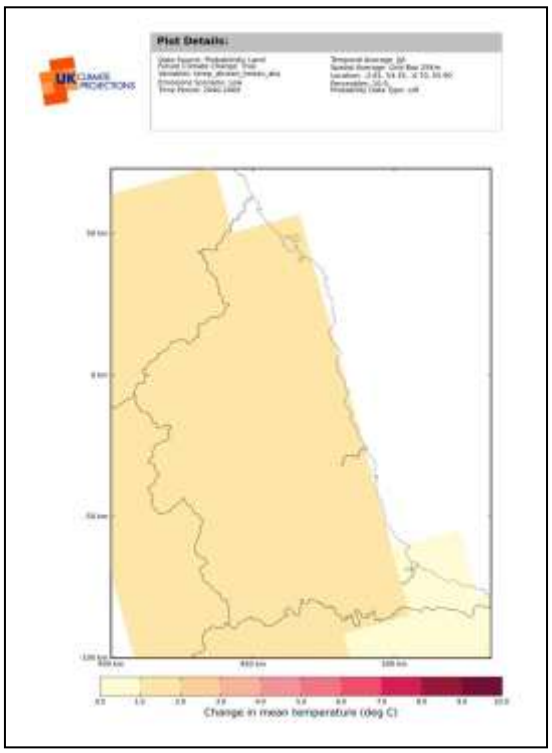


Summer Average Daily Temperature – 10% probability level data (i.e. not less than)

2020s/medium emissions

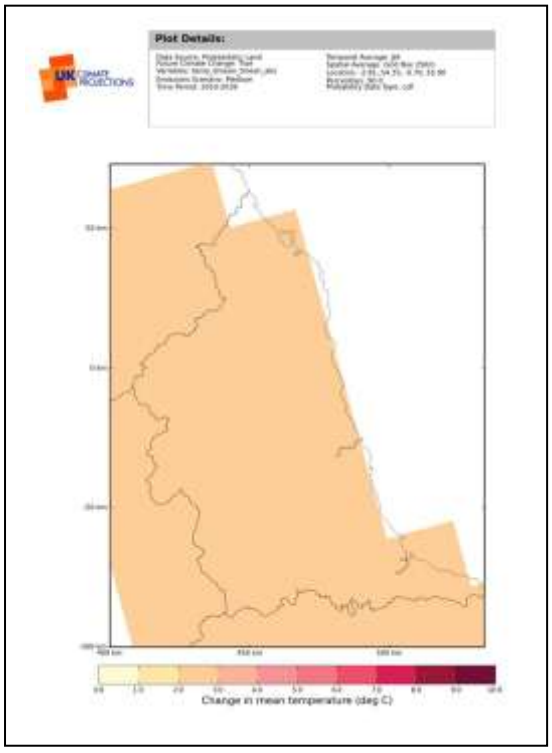


2050s/medium emissions

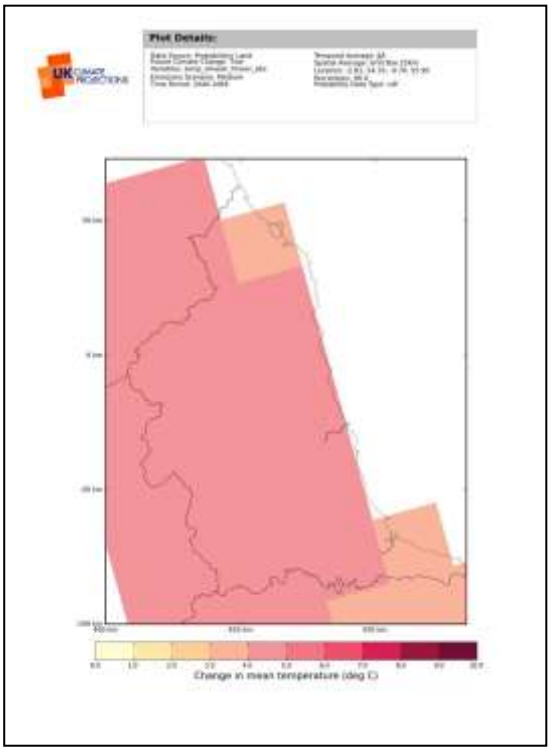


Summer Average Daily Temperature – 90% probability level data (i.e. not greater than)

2020s/medium emissions

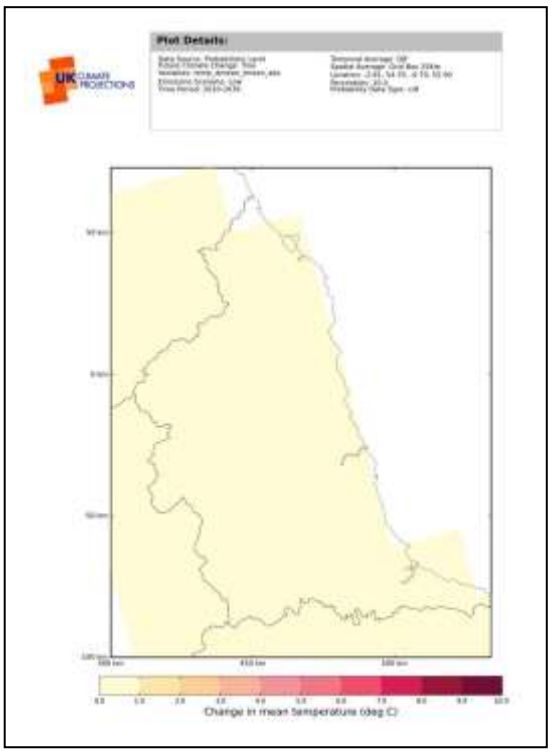


2050s/medium emissions

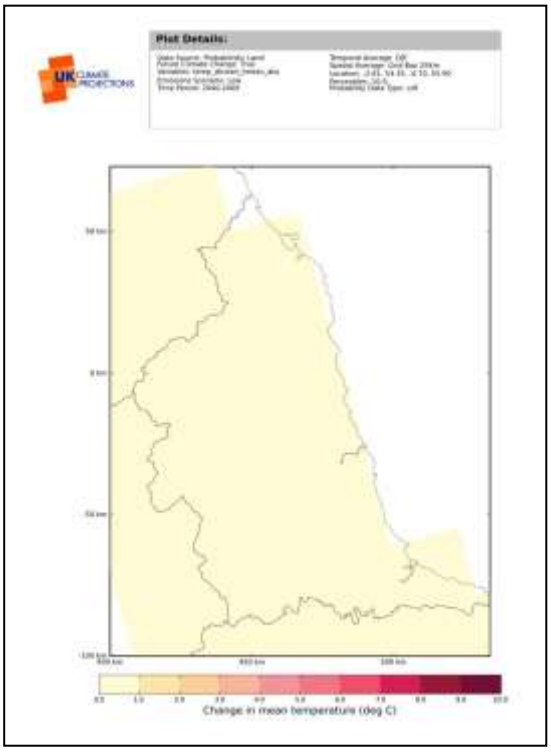


Winter Average Daily Temperature – 10% probability level data (i.e. not less than)

2020s/medium emissions

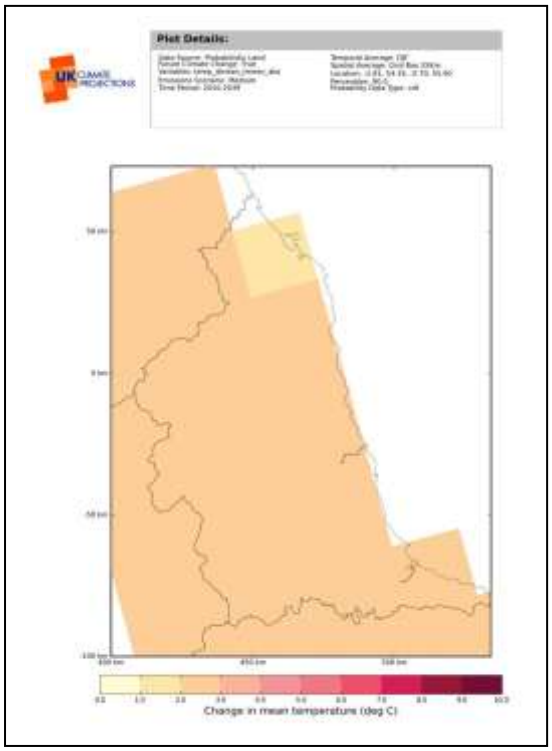


2050s/medium emissions

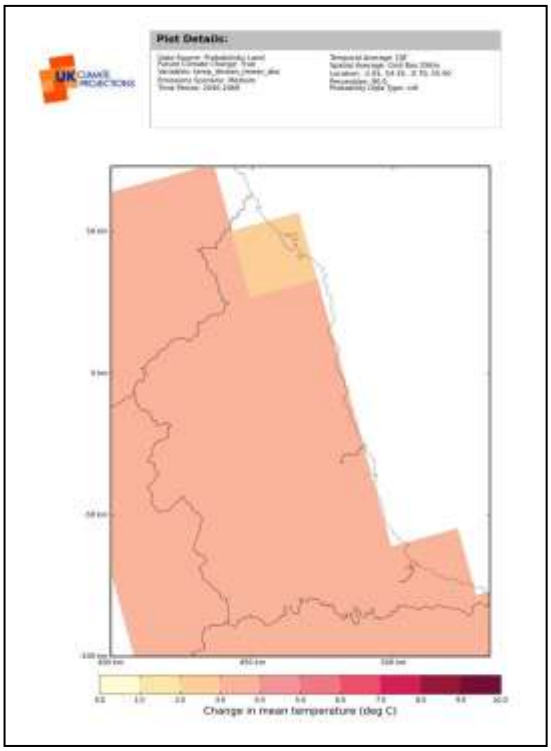


Winter Average Daily Temperature – 90% probability level data (i.e. not greater than)

2020s/medium emissions

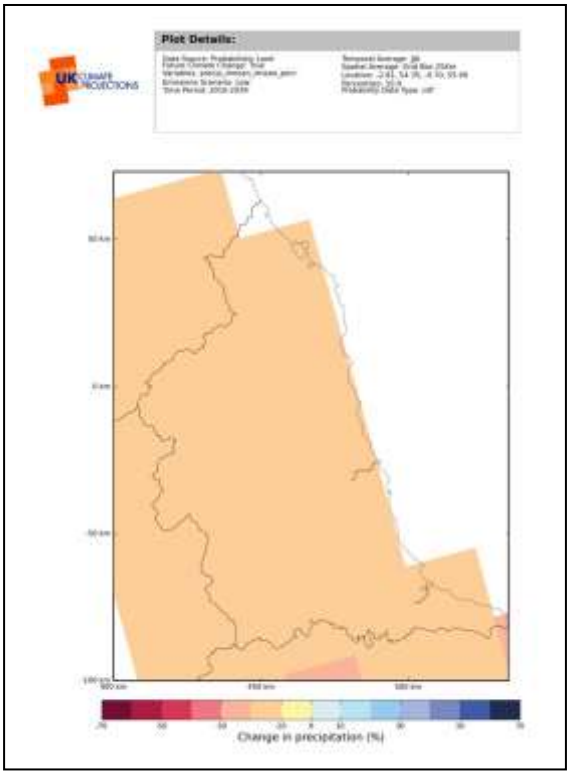


2050s/medium emissions

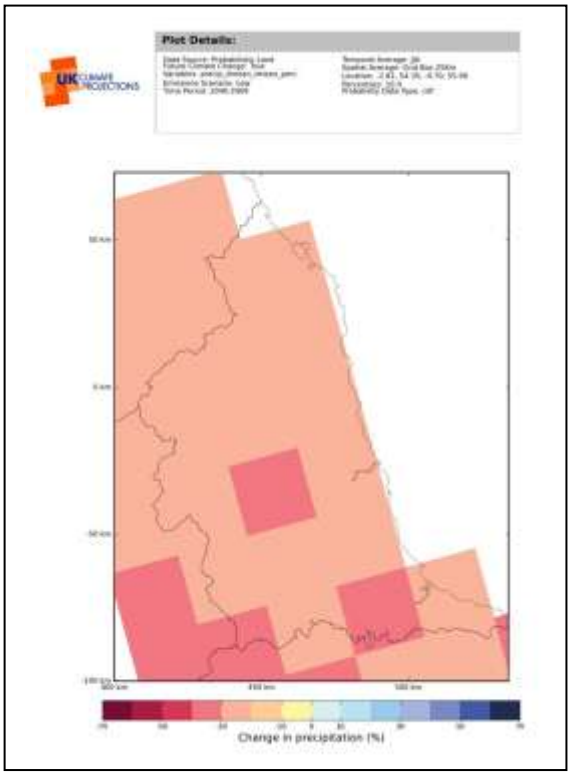


Summer precipitation – 10% probability level data (i.e. not less than)

2020s/medium emissions

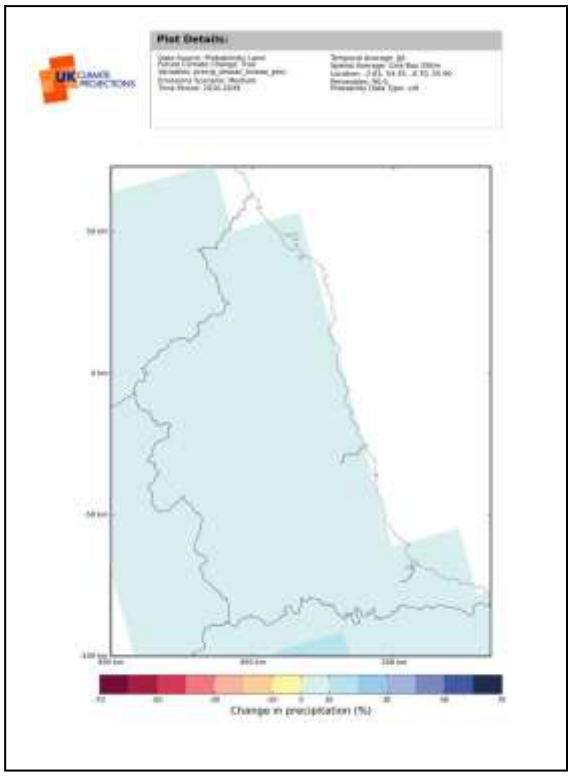


2050s/medium emissions

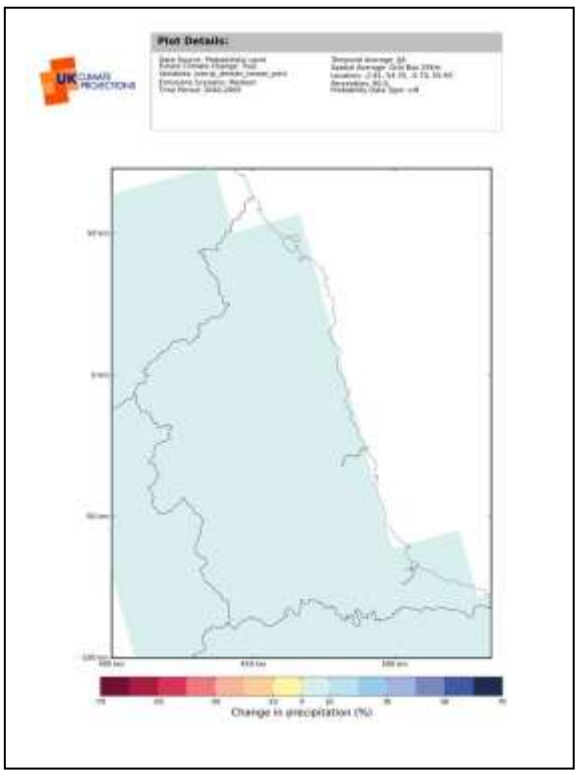


Summer Precipitation – 90% probability level data (i.e. not greater than)

2020s/medium emissions

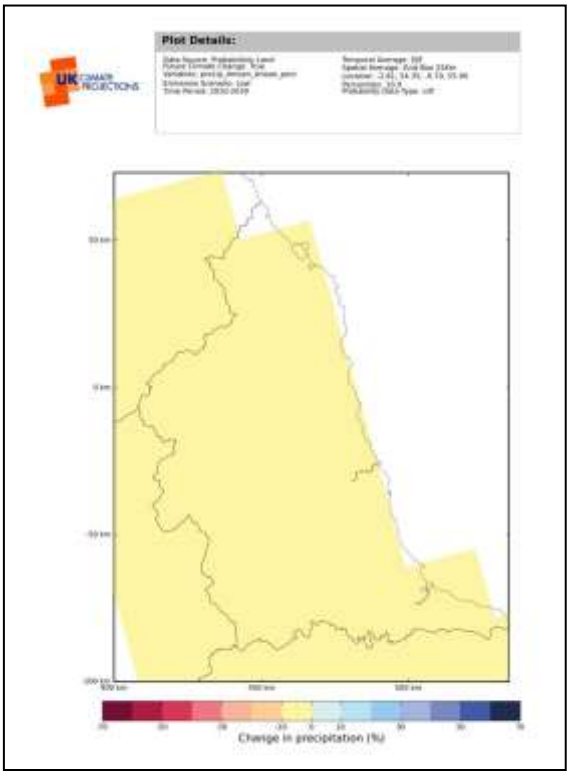


2050s/medium emissions

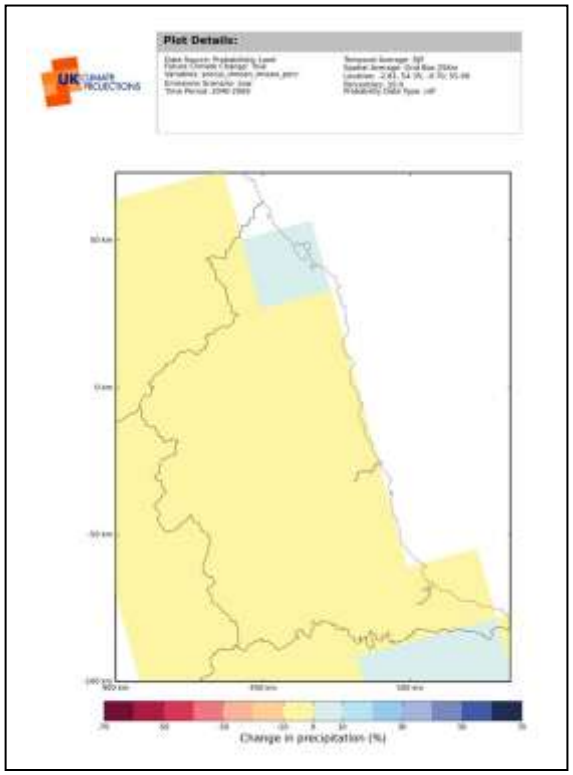


Winter precipitation – 10% probability level data (i.e. not less than)

2020s/medium emissions

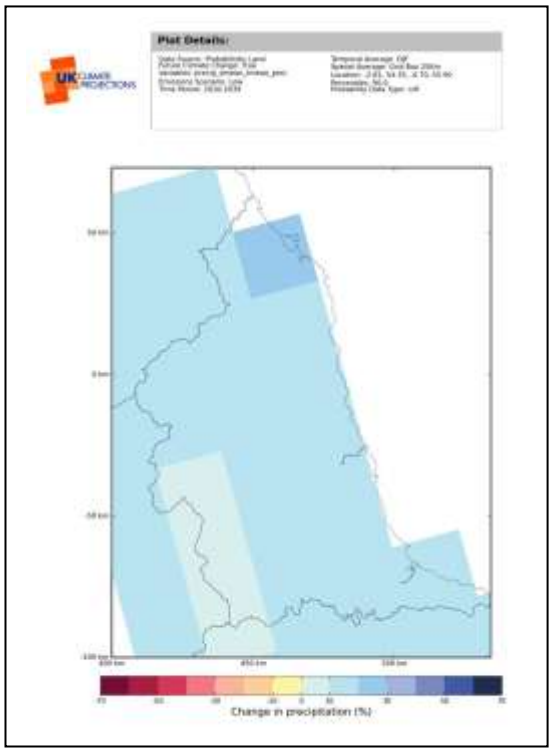


2050s/medium emissions

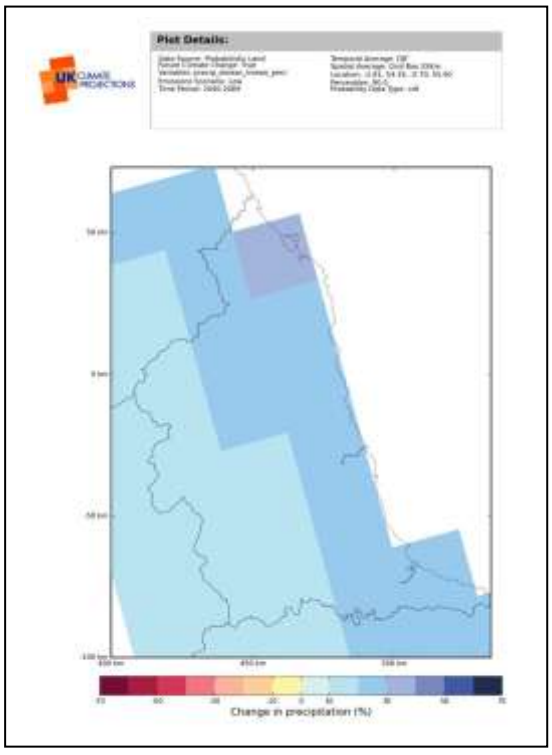


Winter precipitation – 90% probability level data (i.e. not greater than)

2020s/medium emissions



2050s/medium emissions



2.3 UKCP09 Region East Scotland

Key findings: medium emissions/2020s time period

The wider range is from the lowest to highest value for all emissions scenarios and three (10, 50, and 90%) probability levels for each 30-year time period.

- **Under medium emissions**, the central estimate of increase in winter mean temperature is 1.1ºC; it is very unlikely to be less than 0.2ºC and is very unlikely to be more than 2ºC. A wider range of uncertainty is from 0.1ºC to 2.1ºC.

- Under medium emissions, the central estimate of increase in **summer mean temperature** is 1.4ºC; it is very unlikely to be less than 0.6ºC and is very unlikely to be more than 2.4ºC. A wider range of uncertainty is from 0.6ºC to 2.4ºC.

- Under medium emissions, the central estimate of increase in **summer mean daily maximum temperature** is 1.8ºC; it is very unlikely to be less than 0.4ºC and is very unlikely to be more than 3.4ºC. A wider range of uncertainty is from 0.4ºC to 3.4ºC.

- Under medium emissions, the central estimate of increase in **summer mean daily minimum temperature** is 1.5ºC; it is very unlikely to be less than 0.6ºC and is very unlikely to be more than 2.6ºC. A wider range of uncertainty is from 0.6ºC to 2.6ºC.

- Under medium emissions, the central estimate of change in **annual mean precipitation** is 0%; it is very unlikely to be less than –4% and is very unlikely to be more than 5%. A wider range of uncertainty is from –5% to 6%.

- Under medium emissions, the central estimate of change in **winter mean precipitation** is 4%; it is very unlikely to be less than –2% and is very unlikely to be more than 12%. A wider range of uncertainty is from –4% to 12%.

- Under medium emissions, the central estimate of change in **summer mean precipitation** is –6%; it is very unlikely to be less than –17% and is very unlikely to be more than 7%. A wider range of uncertainty is from –17% to 8%.

Key findings: medium emissions/2050s time period

The wider range is from the lowest to highest value for all emissions scenarios and three (10, 50, and 90%) probability levels for each 30-year time period.

- Under medium emissions, the central estimate of increase in **winter mean temperature** is 1.7ºC; it is very unlikely to be less than 0.7ºC and is very unlikely to be more than 2.9ºC. A wider range of uncertainty is from 0.6ºC to 3.1ºC.

- Under medium emissions, the central estimate of increase in **summer mean temperature** is 2.3ºC; it is very unlikely to be less than 1.1ºC and is very unlikely to be more than 3.9ºC. A wider range of uncertainty is from 1ºC to 4.5ºC.

- Under medium emissions, the central estimate of increase in **summer mean daily maximum temperature** is 3ºC; it is very unlikely to be less than 1ºC and is very unlikely to be more than 5.4ºC. A wider range of uncertainty is from 1ºC to 6.4ºC.

- Under medium emissions, the central estimate of increase in **summer mean daily minimum temperature** is 2.5ºC; it is very unlikely to be less than 1.1ºC and is very unlikely to be more than 4.3ºC. A wider range of uncertainty is from 1ºC to 4.9ºC.

- Under medium emissions, the central estimate of change in **annual mean precipitation** is 0%; it is very unlikely to be less than –5% and is very unlikely to be more than 5%. A wider range of uncertainty is from –6% to 6%.

- Under medium emissions, the central estimate of change in **winter mean precipitation** is 10%; it is very unlikely to be less than 1% and is very unlikely to be more than 20%. A wider range of uncertainty is from –2% to 20%.

- Under medium emissions, the central estimate of change in **summer mean precipitation** is –13%; it is very unlikely to be less than –27% and is very unlikely to be more than 1%. A wider range of uncertainty is from –28% to 6%.

Maps

All maps reproduced below are © UK Climate Projections, 2009

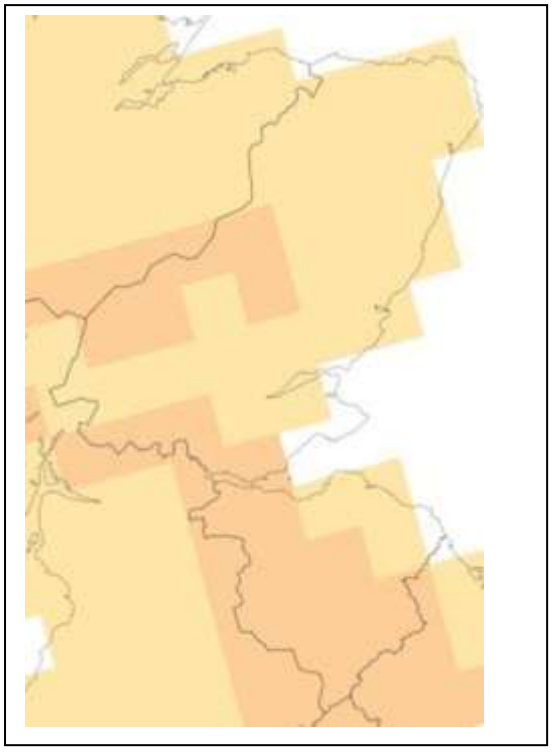
Average Annual Temperature – 10% probability level data (i.e. not less than)

2020s/medium emissions

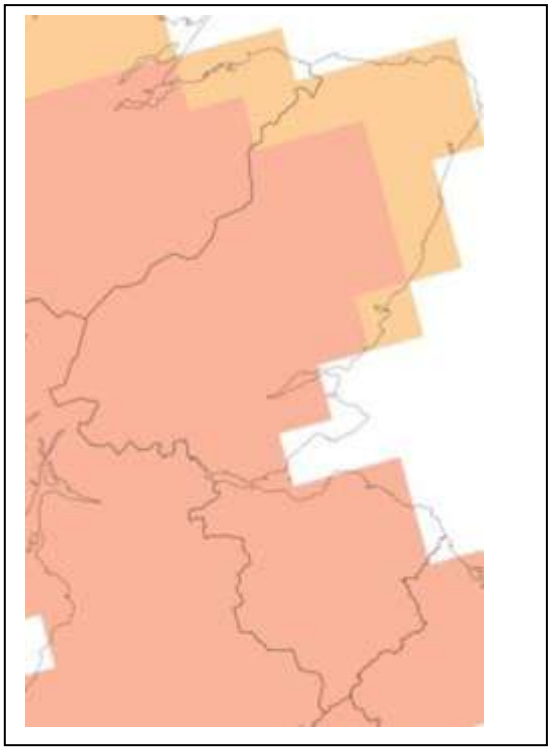
2050s/medium emissions

Average Annual Temperature – 90% probability level data (i.e. not greater than)

2020s/medium emissions



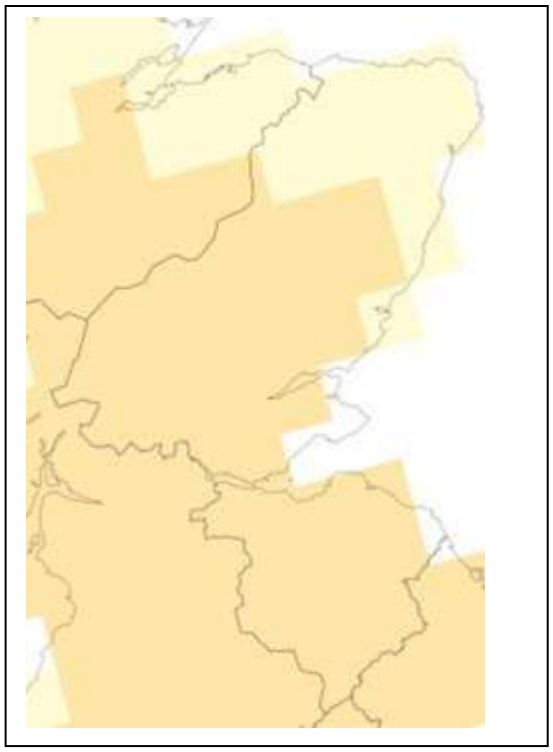
2050s/medium emissions



Summer average daily temperature – 10% probability level data (i.e. not less than)

2020s/medium emissions

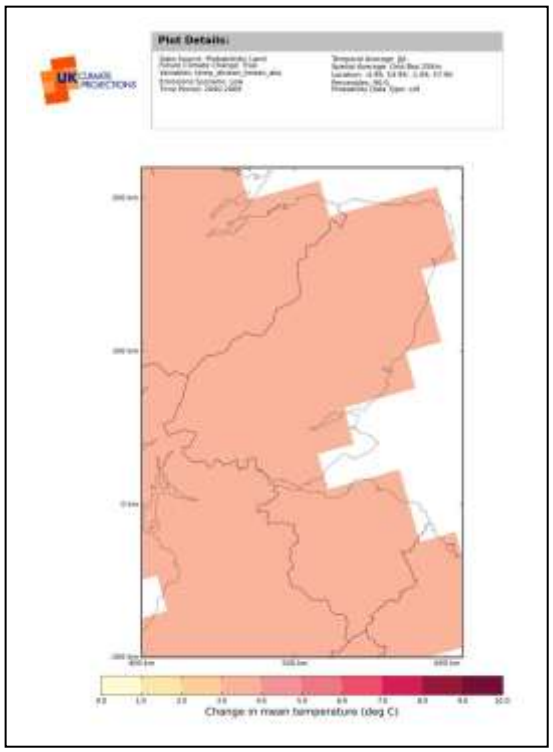
2050s/medium emissions



Summer average daily temperature – 90% probability level data (i.e. not greater than)

2020s/medium emissions

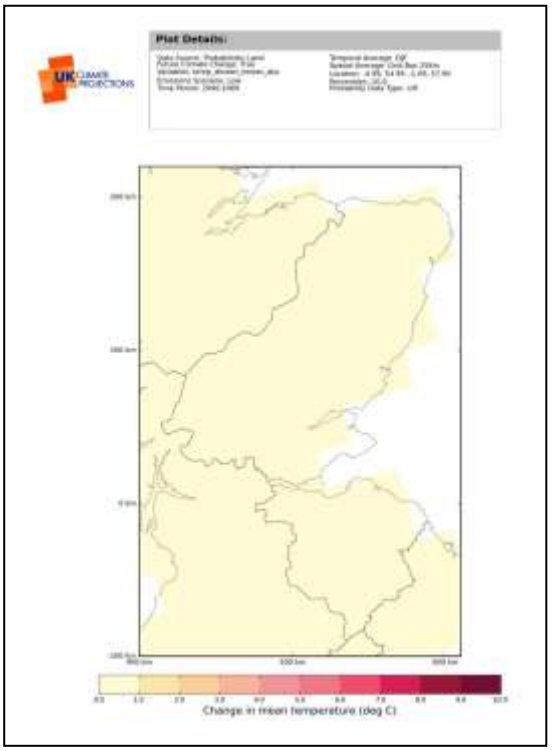
2050s/medium emissions



Winter average daily temperature – 10% probability level data (i.e. not less than)

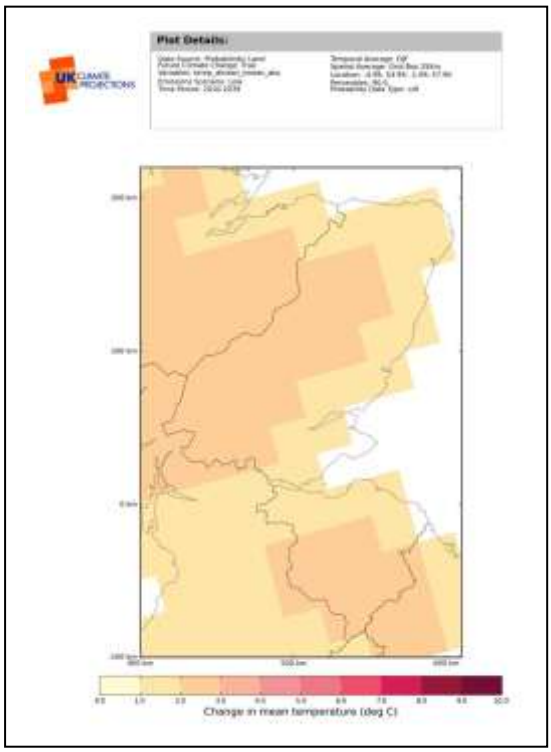
2020s/medium emissions

2050s/medium emissions

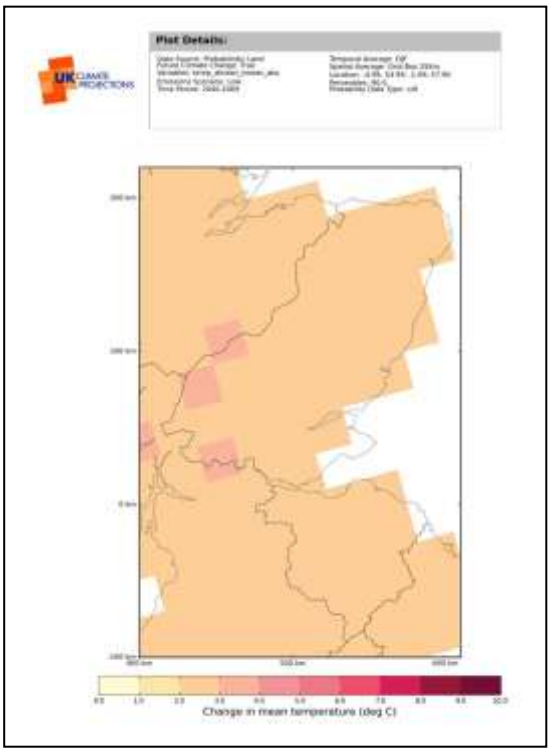


Winter average daily temperature – 90% probability level data (i.e. not greater than)

2020s/medium emissions

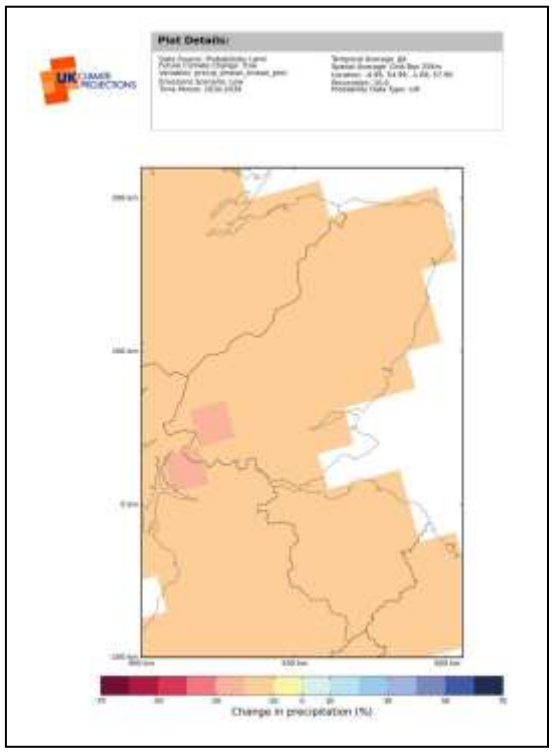


2050s/medium emissions

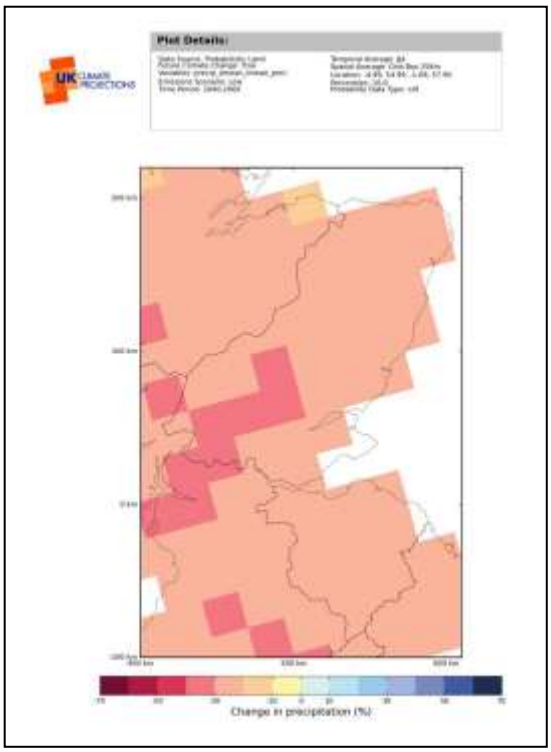


Summer precipitation – 10% probability level data (i.e. not less than)

2020s/medium emissions



2050s/medium emissions



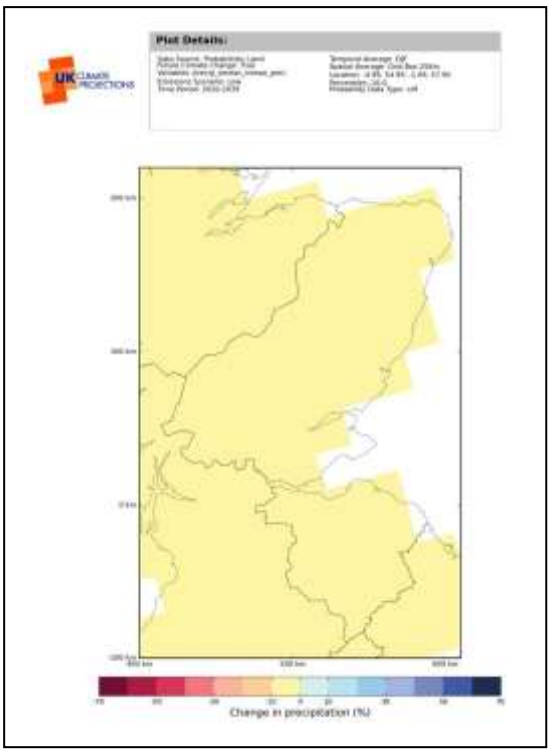
Summer precipitation – 90% probability level data (i.e. not greater than)

2020s/medium emissions

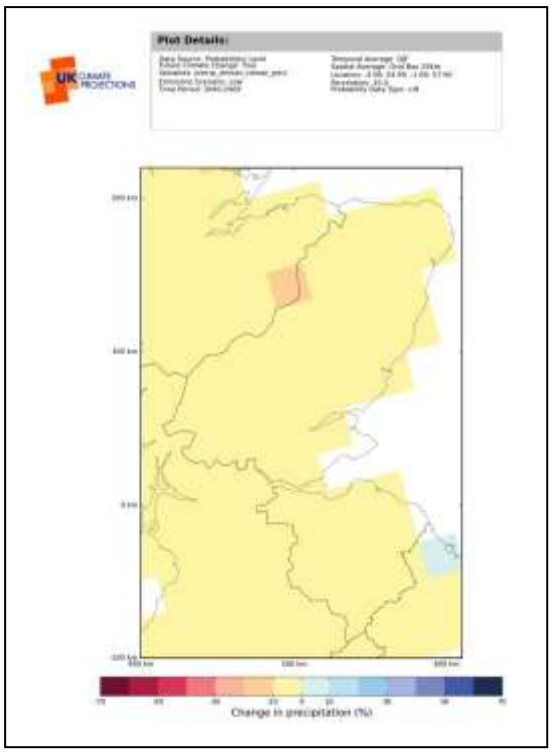
2050s/medium emissions

Winter precipitation – 10% probability level data (i.e. not less than)

2020s/medium emissions

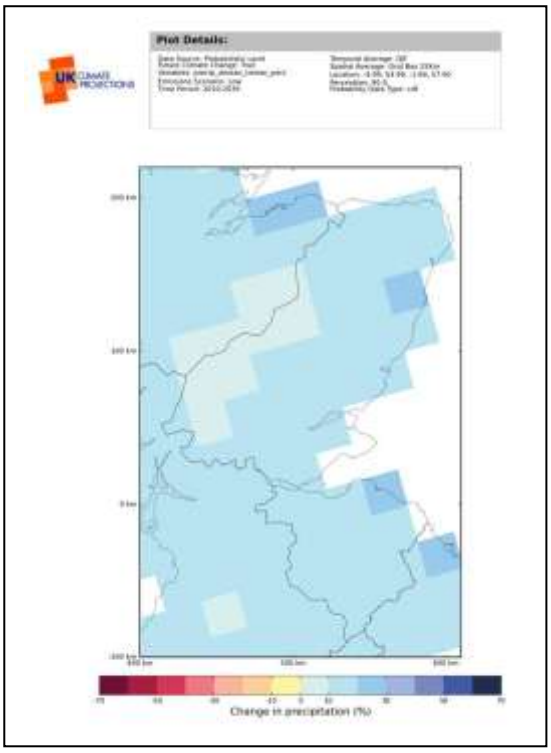


2050s/medium emissions



Winter precipitation – 90% probability level data (i.e. not greater than)

2020s/medium emissions



2050s/medium emissions