Climate change
Climate is changing


Carbon dioxide concentration (parts per million)
- Meuna Loa CO2
- NOAA CO2
- WDCGG CO2

Global mean temperature difference from 1850-1900 (°C)

Global sea level difference from 1993-2010 (mm)
Role of greenhouse gases


Average model output output

Natural forcing

Temperature anomaly (°C)

- CMIP3
- CMIP5
- observations

Year

1860 1880 1900 1920 1940 1960 1980 2000

Natural and Human forcing

Temperature anomaly (°C)

- CMIP3
- CMIP5
- observations

Year

1860 1880 1900 1920 1940 1960 1980 2000
A tipping point

Arctic Sea Ice Loss

The September minimum Arctic sea ice extent in 2019 was the 2nd lowest on record.

Over the last four decades, September Arctic sea ice extent has declined by over 87,000 km² per year equating to an average of 12% per decade.*

**Annual loss**

87,055 km²
An area greater than Scotland.

Surface area of Scotland = 80,256 km² (World Bank)

**Decadal loss**

870,550 km²
An area greater than the UK, Ireland and France combined.

Surface area of UK, Ireland and France = 83,715 km² (World Bank)

**40 year loss**

3.48 million km²
An area greater than India, Bangladesh and Bhutan combined.

Surface area of India, Bangladesh & Bhutan = 3,287,269 km² (World Bank)

*Source: HadISST1 2.0.0 dataset. Produced by the Met Office. Met Office and the Met Office logo are registered trademarks. © Crown Copyright 2019, Met Office 01101
More extremes in a warming world

**HadEX3 – changes in temperature extremes 1950-2018**

**Annual trend in number of days daily max temperature > 90th percentile**

- Trend (days/10 year)

**HadEX3 – changes in rainfall extremes 1950-2018**

**Annual trend in rainfall on wettest day of year**

- Trend (mm/10 year)
Heatwaves and health

Wildfires

<table>
<thead>
<tr>
<th>Category</th>
<th>Forest Fire Danger Index</th>
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<tbody>
<tr>
<td>Catastrophic*</td>
<td>100+</td>
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<tr>
<td>Extreme</td>
<td>75 - 99</td>
</tr>
<tr>
<td>Severe</td>
<td>50 - 74</td>
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<tr>
<td>Very high</td>
<td>25 - 49</td>
</tr>
<tr>
<td>High</td>
<td>12 - 24</td>
</tr>
<tr>
<td>Low - Moderate</td>
<td>0 - 11</td>
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</tbody>
</table>

Table 1: McArthur FFDI scale of fire danger

* Catastrophic refers to fires that spread so quickly that they present a threat to life and safety.
Controlling future warming: carbon budgets

(A) Risks from climate change... (B) ...depend on cumulative CO₂ emissions...
Projections of future climate

CMIP6 (SSPs) vs CMIP5 (RCPs)

Global surface temperature change (°C)

Year

Figure courtesy Erich Fischer
Decadal prediction

Global mean temperature change from new experimental decadal prediction system. Black: Observations; Blue: forecast; Red: previous predictions at 5-year intervals
Limiting climate change

**2100 WARMING PROJECTIONS**
Emissions and expected warming based on pledges and current policies

- **Warming projected by 2100**
  - Baseline: 4.1 – 4.8°C
  - Current policies: 2.8 – 3.2°C
  - Optimistic policies: 2.8°C
  - Pledges & Targets: 2.5 – 2.8°C
  - 2°C consistent: 1.6 – 1.7°C
  - 1.5°C consistent: 1.3°C

Dec 2019 update
## Tipping points:

<table>
<thead>
<tr>
<th>Tipping point category</th>
<th>Consequences of passing tipping point</th>
<th>Implications for UK projections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbon cycle / other biogeochemical cycles</strong></td>
<td>Acceleration / lock-in of CO₂ rise and global warming</td>
<td>Projected UK impacts reached sooner</td>
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<tr>
<td>- Amazon forest dieback</td>
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<tr>
<td>- boreal forest dieback</td>
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<tr>
<td>- Permafrost thawing</td>
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<tr>
<td><strong>Cryosphere and sea level</strong></td>
<td>Acceleration / lock in of sea level rise</td>
<td>Projected UK coastal flooding reached sooner</td>
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<td>- Greenland ice sheet</td>
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<tr>
<td>- West Antarctic Ice Sheet</td>
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<tr>
<td><strong>Ocean / atmosphere circulation</strong></td>
<td>Shifts in regional climate patterns</td>
<td>UK climate change potentially very different to standard projections</td>
</tr>
<tr>
<td>- Atlantic Meridional Overturning Circulation (AMOC)</td>
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<tr>
<td>- Jet stream</td>
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