Met Office

Briefing note

Severe or extreme weather in a changing climate

We know our climate is changing. Sea levels are rising, air temperatures are going up, ice cover on land and sea is decreasing and rainfall patterns are changing. Scientists are studying all of these, and making projections for the future.

Very often, these projections show us how the average conditions will change, and many national and international initiatives are based around these. For example, the Paris Agreement aims to limit the global temperature rise this century to 1.5 °C. This is 1.5 °C above the pre-industrial average global temperature.

Averages are really useful to help us assess large-scale changes and make policy, but they might not mean much to you and me, especially when we're thinking about what a changing climate might mean for us and our communities. What really affects us is severe or extreme weather, and the impacts this has today, and the impacts it will have in the future.

So scientists around the world are working hard to understand how extremes of weather might change throughout the 21st century and beyond. Although we can't say that any particular extreme weather event is a result of climate change, what we can say is whether climate change has increased the chance of an extreme event happening.

Here's a summary of what the science is currently saying:

Extreme weather around the world

- **Heatwaves** – since 1950, the number of warm days and nights have increased, and some parts of the world have seen more heatwaves. It's very likely that these changes are a result of human activity. For example, the July 2017 heatwave in central-eastern China, which significantly decreased agricultural productivity and electricity and water supplies, is now 20 times more likely to occur in the present day compared to in a world without human greenhouse gas emissions. Looking forward, it is virtually certain that, in most places, there will be more hot temperature extremes as global mean temperatures increase.

- **Heavy rainfall** – assessing rainfall is more complex than temperature, and it is harder to determine how much our activities have contributed to the changes we've seen – particularly as other human activities, such as how we use and manage the land, also influence whether we see flooding. However, we can say that for short-duration rainfall events, a shift to more intense individual storms and fewer weak storms is likely as temperatures increase. Over most of the mid-latitude land-masses and over wet tropical regions, extreme rainfall events will very likely be more intense and more frequent in a warmer world.

- **Drought** – as with heavy rainfall events, detecting changes in drought is really complex, due to a lack of data and the need to distinguish the fingerprint of climate change from the natural variability of our climate. However, we have seen regional changes. For example, the frequency and intensity of drought have likely increased in the Mediterranean and West Africa and likely decreased in central North America and north-west Australia since 1950. As we go through the 21st century, it's likely that some regions will experience drying and possibly more droughts.

- **Cold** – it's very likely that there has been a decrease in the number of cold days and nights from 1950 to today, and that these changes have been driven largely by human activity. It is virtually certain that, in most places, there will be fewer cold temperature extremes as global mean temperatures increase.

- **Tropical storms** – although it's really hard to detect any long-term changes in tropical cyclone activity on a global scale since 1950, it's virtually certain that the frequency and intensity of the strongest tropical cyclones in the North Atlantic has increased since the 1970s. While there is not clear evidence that climate change is increasing or decreasing the frequency of these storms, there is strong evidence that increasing sea temperatures increase the intensity of tropical storms when they develop. Heavier rainfall is also expected as global temperatures rise because a warmer atmosphere holds more moisture. Additionally, rising sea levels increase the risk of coastal flooding as tropical storms make landfall. It is likely that the global frequency of tropical cyclones will either decrease or remain unchanged. At the same time, there is a likely increase in both the maximum wind speeds and rates of rainfall for tropical cyclones globally and that the amount of change will vary by region.

Severe weather in the UK

- **Heatwaves** – we are experiencing higher maximum temperatures and longer warm spells and several studies show strong evidence that human-induced climate change is increasing the risk of heatwaves. For example, the summer of 2018 was the joint warmest on record for the UK as a whole and the hottest ever for England. The Met Office has shown that human-induced climate change made the 2018 record-breaking UK summer temperatures about 30 times more likely than it would have been naturally. Projections for the future have shown that an event like the 2018 is currently rare but that by the middle of the 21st century, they could become normal.

- **Heavy rainfall and floods** - Several indicators show that the UK's climate is becoming wetter, but that the change in rainfall depends on your location – for example, changes are largest for Scotland and not significant for most southern and eastern areas of England. Projections show a trend towards wetter winters and drier summers on average in the UK, with regional differences, and some very high resolution climate modelling suggests that summers may tend to become drier overall but when it does rain it will fall in heavier bursts, which has implications for flash flooding.

- **Drought** - It is very challenging to say whether drought events are becoming more common or more prolonged due to climate change because of the many meteorological, hydrological, and societal drivers that combine to cause them. Projections suggest a trend towards drier summers on average, with generally stronger drying in southern parts of the UK, which could contribute to changes in the occurrence of drought.

- **Cold** – as our climate warms, cold and very cold days, air frost and icing days have all become a bit less common. This doesn't mean, though, that we don't get cold snaps anymore. December 2010 was the coldest December in over 100 years with mean temperatures some 5 °C below the 1971-2000 average, leading to widespread travel disruption and increased hospital admissions. A study showed that the chance of experiencing such a cold December is about half of what it was in the 1960s. Latest projections suggest that the UK will experience warmer, wetter winters and hotter drier summers on average. Colder than average winters and summers will still occur but will become less likely the further we go into the 21st century.

- **Wind storms** – at the moment, we can't discern any trends in storminess in the UK over the last few decades. As our climate changes, projections suggest only small increases in surface wind speeds towards the end of the 21st century, however, the increase in wind speeds is modest compared to natural variability we see in winds from month to month and season to season.

Good sources of information:

Met Office website on weather extremes and climate change **https://www.metoffice.gov.uk/research/climate/understanding-climate/weather-extremes-and-climate-change**

The latest Assessment Report from the Intergovernmental Panel on Climate Change (IPCC AR5 WG1) **https://www.ipcc.ch/report/ar5/wg1/**

The annual Bulletin of the American Meteorological Society (BAMS) reports on attribution **https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/explaining-extreme-events-from-a-climate-perspective/**

UK State of the Climate report **https://www.metoffice.gov.uk/weather/learn-about/past-uk-weather/about/state-of-climate**

UK Climate Projections **https://www.metoffice.gov.uk/research/collaboration/ukcp**

The Met Office provides free education content to support young people aged 7-14 to be prepared for the effects of weather and climate change on them and their communities. Find out more at **www.metoffice.gov.uk/schools**