



Met Office

Clearer

Make a difference with the facts
about climate change



Climate change – the big picture

Climate change is a complex subject, with genuine areas of uncertainty and scientific controversy.

There are also a number of misunderstandings which are recycled, often by non-climate scientists, and portrayed as scientific fact.

As one of the world's leading centres on climate change we believe it is important to address all the issues.

Here you will find the known facts about climate change.

Climate change is happening and humans are contributing to it

FACT 1 Climate change is happening and humans are contributing to it

Temperatures provide the clearest evidence that the climate is changing and globally the average temperature has risen by more than 0.7 °C over the last 100 years.

The natural greenhouse gas effect keeps Earth much warmer than it would otherwise be, without it Earth would be extremely cold. Greenhouse gases such as carbon dioxide, methane and water vapour behave like a blanket around the Earth. These gases allow the Sun's rays to reach Earth's surface but impede the heat they create from escaping back into space.

Any increases in the levels of greenhouse gases in the atmosphere mean that more heat is trapped and global temperatures increase – an effect known as 'global warming'.

There is indisputable evidence from observations that the Earth is warming. Concentrations of CO₂, created largely by the burning of fossil fuels, are now much higher, and increasing at a much faster rate, than at any time in the last 600,000 years. Because CO₂ is a greenhouse gas, the increased concentrations have contributed to the recent warming and probably most of the warming over the last 50 years.



FIG 1 Temperature change 1850-2000

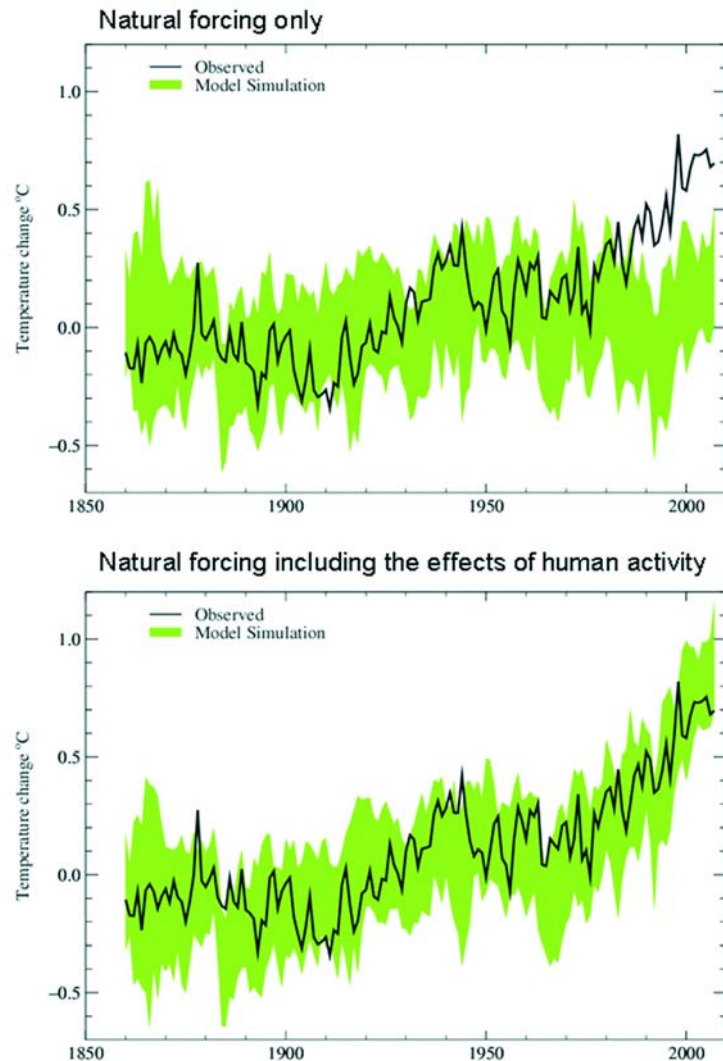


FIG 1 Temperature change 1860-2007, simulations using the latest Met Office Hadley Centre model.

Temperatures are continuing to rise



FACT 2

Temperatures are continuing to rise

The rise in global surface temperature has averaged more than 0.15 °C per decade since the mid-1970s. Warming has been unprecedented in at least the last 50 years, and the 17 warmest years have all occurred in the last 20 years. This does not mean that next year will necessarily be warmer than last year, but the long-term trend is for rising temperatures.

A simple mathematical calculation of the temperature change over the latest decade (1998-2007) alone shows a continued warming of 0.1 °C per decade. The warming trend can be seen in the graph of observed global temperatures. The red bars show the global annual surface temperature, which exhibit year-to-year variability. The blue line clearly shows the upward trend, far greater than the uncertainties, which are shown as thin black bars. The recent slight slowing of the warming is due to a shift towards more frequent La Niña conditions in the Pacific since 1998. These bring cool water up from the depths of the Pacific Ocean, cooling global temperatures.

1998 saw an exceptional El Niño event which contributed strongly to that record-breaking year. Research shows that an exceptional El Niño can warm global temperatures by about 0.2 °C in a single year, affecting both the ocean surface and air temperatures over land. Had any recent years experienced such an El Niño, it is very likely that this record would have been broken. 2005 was also an unusually warm year, the second highest in the global record, but was not associated with El Niño conditions that boosted the warmth of 1998.

Another way of looking at the warming trend is that 1999 was a similar year to 2007 as far as the cooling effects of La Niña are concerned. The 1999 global temperature was 0.26 °C above the 1961-90 average, whereas 2007 was 0.37 °C above this average, 0.11 °C warmer than 1999.

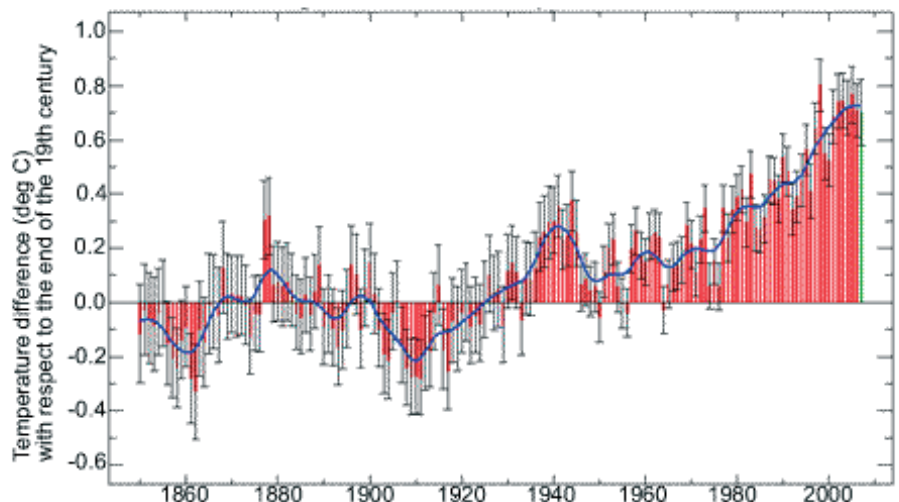


FIG 1 Global temperature 1850-2007

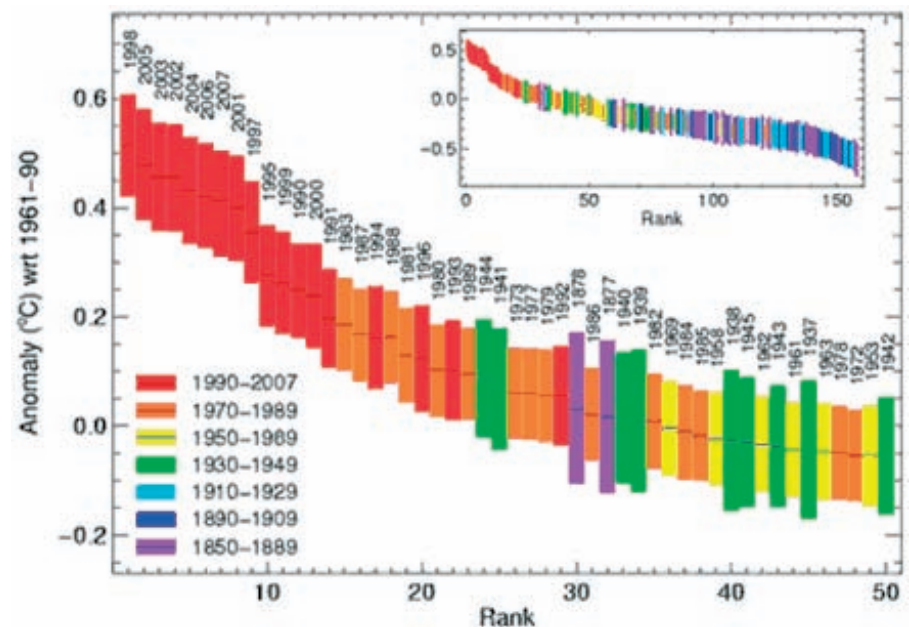


FIG 2 Global temperature anomaly 1850-2007

Current climate change is not just part of a natural cycle

FACT 3 Current climate change is not just part of a natural cycle

Earth's climate is complex and influenced by many things, particularly changes in its orbit, volcanic eruptions, and changes in the energy emitted from the Sun. It is well known that the world has experienced warm or cold periods in the past without any interference from humans. The ice ages are good examples of global changes to the climate, and warm periods have seen grapes grown across much of Britain.

Over the several hundred thousand years covered by the ice core record, Fig 1, the temperature changes were primarily driven by changes in the Earth's orbit around the Sun. Over this period, changes in temperature did drive changes in CO₂. Since the Industrial Revolution (over the last 100 years), CO₂ concentrations have increased by 30% due to human-induced emissions from fossil fuels.

The bottom line is that temperature and CO₂ concentrations are linked. In recent ice ages, natural changes in the climate, such as those due to orbit changes, led to cooling of the climate system. This caused a fall in CO₂ concentrations which weakened the greenhouse effect and amplified the cooling. Now the link between temperature and CO₂ is working in the opposite direction. Human-induced increases in CO₂ are driving the greenhouse effect and amplifying the recent warming.

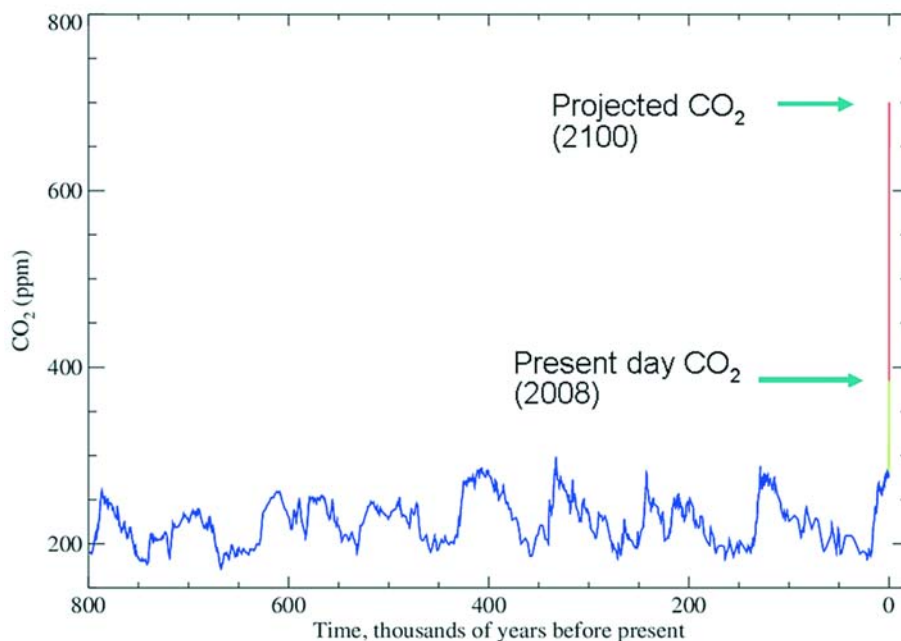


FIG 1 Ice core records and observations

Recent warming cannot be explained by the Sun or natural factors alone

FACT 4 Recent warming cannot be explained by the Sun or natural factors alone

There are many factors which may contribute to climate change. Only when all of these factors are included do we get a satisfactory explanation of the magnitude and patterns of climate change over the last century.

Over the last 1,000 years most of the variability can probably be explained by cooling due to major volcanic eruptions and changes in solar heating.

In the 20th century the situation becomes more complicated. There is some evidence that increases in solar heating may have led to some warming early in the 20th century, but direct

satellite measurements show no appreciable change in solar heating over the last three decades. Three major volcanic eruptions in 1963, 1982 and 1991 led to short periods of cooling. Throughout the century, CO₂ increased steadily and has been shown to be responsible for most of the warming in the second half of the century.

As well as producing CO₂, burning fossil fuels also produces small particles called aerosols which cool the climate by reflecting sunlight back into space. These have increased steadily in concentration over the 20th century, which has probably offset some of the warming we have seen.

Changes in solar activity do affect global temperatures, but research shows that, over the last 50 years, increased greenhouse gas concentrations have a much greater effect than changes in the Sun's energy.

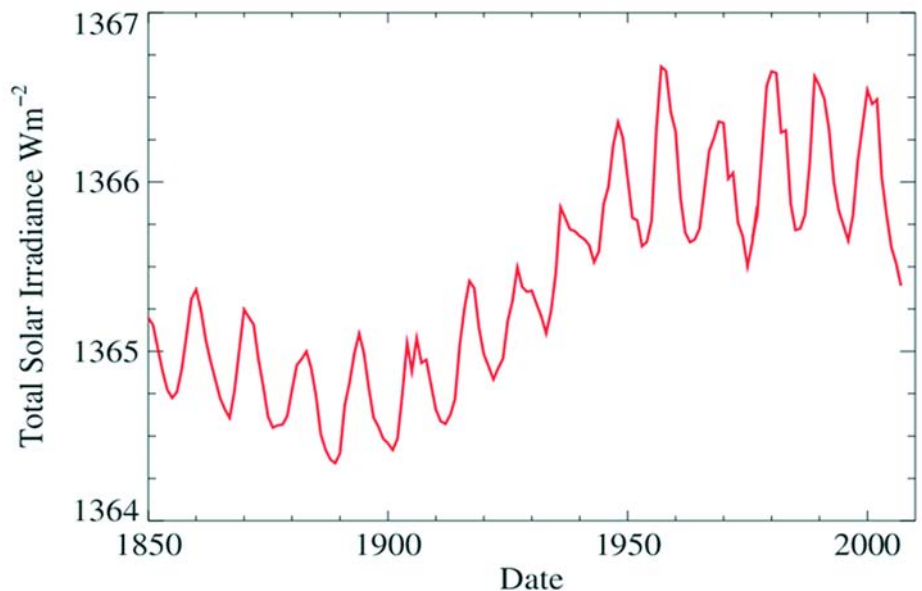
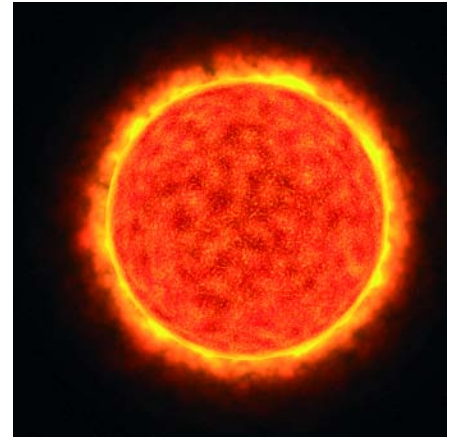


FIG 1 Solar activity 1850-2007

If we continue emitting greenhouse gases this warming will continue and delaying action will make the problem more difficult to fix



FACT 5 If we continue emitting greenhouse gases this warming will continue and delaying action will make the problem more difficult to fix

The global average temperature will increase by 2 to 3 °C this century – according to one of the Intergovernmental Panel on Climate Change’s (IPCC) mid-range estimates (blue line on Fig 1). This rise in temperature means that the Earth will experience a greater climate change than it has for at least 10,000 years and it would be difficult for many people and ecosystems to adapt to this rapid change.

These temperature increases are likely to result in an increased frequency and severity of weather events such as heatwaves, storms and flooding. Rising levels of greenhouse gases in the atmosphere could set in motion large-scale changes in Earth’s natural systems. Some of these could be irreversible – the melting of large ice sheets will result in major consequences for low-lying areas throughout the world.

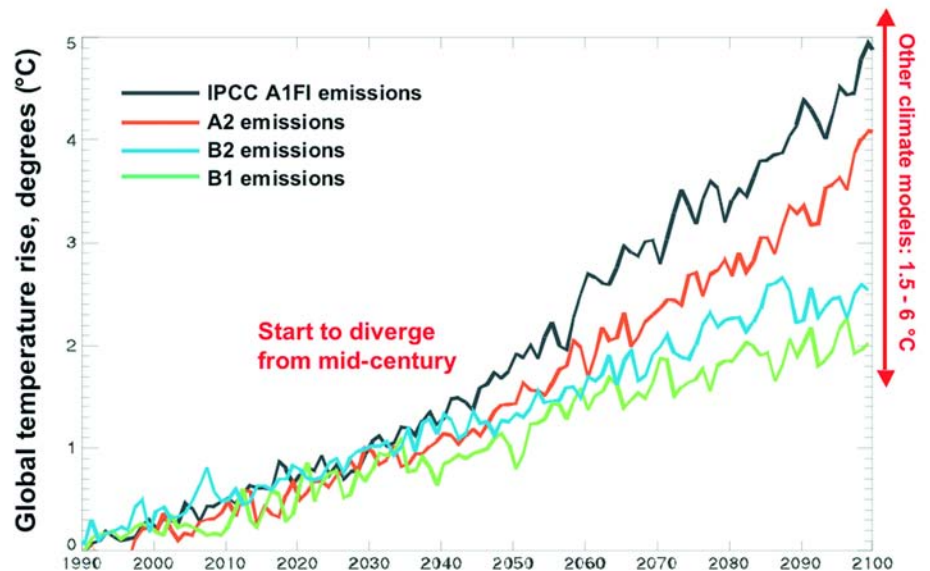


FIG 1 Projected annual mean temperature rise 2000-2100

Climate models predict the main features of future climate

FACT 6 Climate models predict the main features of future climate

There have been major advances in the development and use of models over the last 20 years and the current models give us a reliable guide to the direction of future climate change.

Computer models cannot predict the future exactly, due to the large number of uncertainties involved. The models are based mainly on the laws of physics, but also empirical techniques which use, for example, studies of detailed processes involved in cloud formation. The most sophisticated computer models simulate the entire climate system. As well as linking the atmosphere and ocean, they also capture the interactions between the various elements, such as cryosphere (ice) and geosphere (land).

Climate models successfully reproduce the main features of the current climate (e.g. rainfall in the map below), the temperature changes over the last 100 years, the Holocene (6,000 years ago) and Last Glacial Maximum (21,000 years ago).

Current models enable us to attribute the causes of past climate change, and predict the main features of the future climate, with a high degree of confidence. We now need to develop the models to provide more regional detail of the impacts of climate change, and a more complete analysis of extreme events.

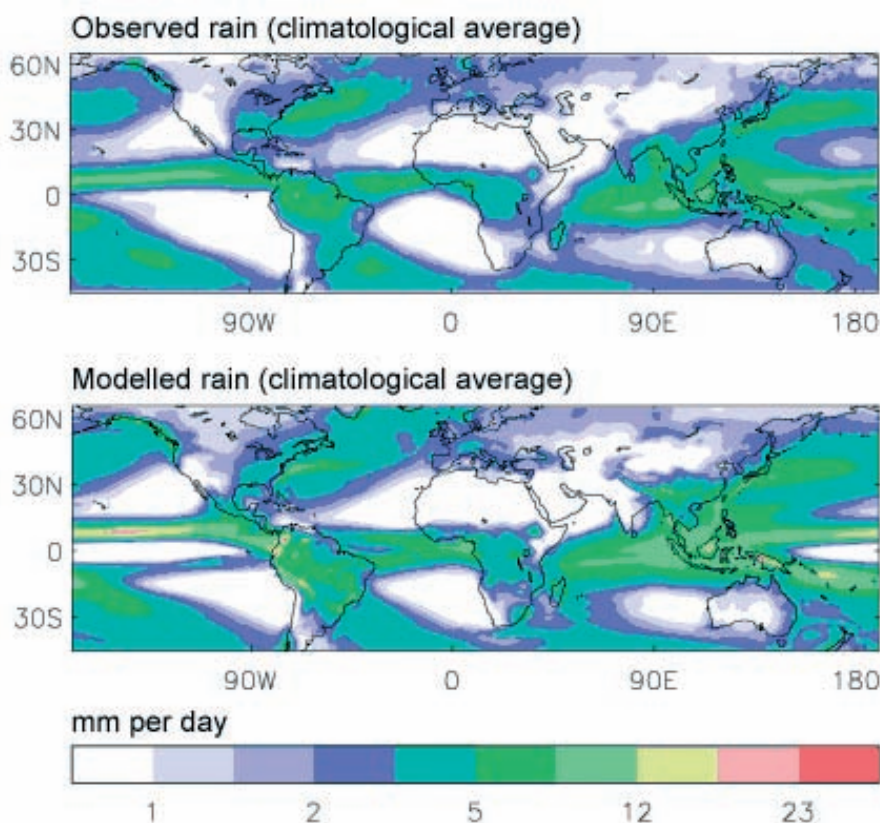


FIG 1 Comparison of observed and modelled rain

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