The Global Climate

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1. What is climate change?

An analogy: It is as though we had been comfortably walking in the sunshine but then felt we *had to go faster*. As we picked up speed we got hotter but then realised we couldn't sweat the heat off. With our temperature going on up we saw we would over-heat.

In a nutshell: It is a long-term change in the world's weather patterns resulting from a lift in the average temperature i. e. global warming. We have been protected from the heat of the sun by the Earth's atmosphere but human activities have changed its composition. We have been burning fossil fuels like coal, oil and gas far more than before and these release gases which, like a blanket keep more heat near the surface.

Explanation: The average temperature at the surface of the globe has been rising for over 100 years but has been rising more quickly in the last decade. The past five years, 2015–2019, were the warmest on record. As the surface temperature rises more water evaporates into the atmosphere and weather patterns become more extreme so that all regions will have more and worse droughts, storms, high winds etc. than we are used to.

Greenhouse Gases The main heat-trapping gas given off by burning fossil fuels is carbon dioxide (Co2) but we have also increased emissions of other gases such as methane, nitrous oxide and hydrocarbons which trap even more heat. We refer to all these gases 'Greenhouse Gases' (GHG).

Co2 occurs naturally in the atmosphere but the Earth has always maintained stability by both producing and absorbing Co2. Fires and volcanoes are amongst the producers of atmospheric Co2 whilst the absorbers include the oceans (up to half) and land-based organisms like trees and plants.

Co2 levels are 30% higher than before 1750 (higher than it has been for at least 800,000 years). Other greenhouse gases such as methane, nitrous oxide and fluorocarbons are much less abundant but are much worse (up to 10000 x) than carbon dioxide. We describe and measure the heat-trapping effect of all these gases as 'equivalent to Co2' or Co2e.

The main concern

Scientists used to warn that a rise of 2C would be the gateway to dangerous warming but most now agree that limiting temperature rises to 1.5C is safer. https://www.ipcc.ch/sr15/ and BBC commentary https://www.bbc.co.uk/news/science-environment-45784892

The risk is that above a debated level, some say 2.3C, the additional warmth will reach a 'tipping point' when changes become irreversible e. g. as ice-caps which normally reflect the sun's rays melt more of the sea is exposed to the sun which increases the warming effect; another is when permafrost - frozen soil found mainly at high latitudes – melts methane is released (trapping 28x more heat than Co2 over 100 years).

Exeter University is a prominent player in the understanding of Climate Change. They explain further about its effects

'Climate change is more than just global warming. About one-third of our carbon dioxide emissions are absorbed by the oceans, where they react with seawater to form a weak acid. This results in **ocean acidification**, a lowering of the ocean's pH. Furthermore, the oceans are becoming warmer as they absorb much of the extra heat energy being trapped by the atmosphere. This extra heat initially goes into the surface ocean, where for example it can supply more energy to hurricanes, making these storms more ferocious. The acidity and extra heat is also slowly being mixed down into the deep ocean, with worrying implications for ecosystems and habitats that we know very little about, such as deep sea coral reefs.

Back on land, climate change is starting to change precipitation (rain or snowfall) patterns. A warmer atmosphere holds more moisture, and extreme precipitation events are getting more frequent in some regions. Also, the melting of sea-ice surrounding Greenland means more moisture can be picked up and transported to the centre of the Greenland ice sheet and deposited as snowfall there. However, other land regions are getting drier thanks to warming and changes in atmospheric circulation. For example, severe droughts have hit the Amazon rainforest - in 2005, 2010 and again in 2015/6. The Mediterranean is also suffering worsening droughts.

We can look back at the Earth's history to know that what we're seeing today is unprecedented. The rock record allows us to reconstruct the Earth's climate history - nearly all 4.5 billion years of it. For the last 800,000 years, ice cores record changes in the climate and the composition of the atmosphere. Tree rings and pollen records help identify natural variability in recent millennia. By comparing what we know about normal variability in the climate system to what we've observed over the last century we can establish that the climate change we're seeing today is a) occurring at an unprecedented rate and b) caused by human activity.

All parts of the world will be affected in some way by climate change. The Arctic is one of the fastest warming places and sea-ice cover is declining year on year. Glaciers of the Greenland ice sheet and Antarctic peninsula are accelerating and retreating at rates never before seen. Desert expansion is affecting agricultural land in Africa. By the end of this century, sea-level rise will threaten hundreds of millions of people in low-lying cities and countries, including Bangladesh, Bangkok and New York. If you think it won't happen any time soon, remember the events of Hurricane Sandy, when much of Manhattan was flooded by this extreme event.' C. University of Exeter

The Global Climate Facts
The 2010-2019 decade was the warmest on record globally.
The Global mean surface temperature has been increasing since 1970 by 0.18 °C each decade.
Detail on the *Global mean surface temperature change since 1880. Baseline temperature[1] is about 14 °C. Source: NASA's Goddard Institute for Space Studies NASA GISS.*
The *Global mean sea level* has risen about 8–9 inches (21–24 cm) since 1880, with about a third of that coming in just the last two and a half decades. https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level
CO2 in the atmosphere. The first measurements were made at Mauna Loa in Hawaii in 1958 when it was 315ppm(parts per million). In 1986 it was 350ppm, 27 years later it was 400ppm in 2013, 8 years later its now 415ppm----------

Global progress towards tackling climate change
Global greenhouse gas emissions. Over the 2009-18 period the global population grew by 11% and the global economy by over 42%. Over the same period, global greenhouse gas (GHG) emissions increased by 15%, with this growth almost entirely arising from developing regions. The growth of global emissions in this decade was slower than in the 1999-2008 decade preceding it

There are several authoritative explanations of climate change to choose from. Here are two:
A short summary in journalistic style (with links to further pages) is from the BBC What is climate change? https://www.bbc.co.uk/news/science-environment-24021772
A detailed wider description comes in FAQ form from the Grantham Institute at Imperial College which is really helpful for getting detailed answers to specific questions
http://www.imperial.ac.uk/grantham/publications/climate-change-faqs/

2. Some Prominent Views
'Climate change is our greatest threat' David Attenborough
https://www.bbc.co.uk/news/science-environment-46398057
'Its an existential threat to humanity' – UN General Secretary
'Humanity has never tackled an issue this big and this urgent' – Bill Gates.
'The world adds 51bn tonnes of GHG to the atmosphere every year. Setting a goal to reduce our emissions won't do it. The only sensible goal is zero'. He likened it to a bath being filled, you have to turn the tap off or it will overflow.

The World Meteorological Organisation says that if the current warming trend continues, temperatures could rise 3-5C within 80 years.

Notes

The importance of marine ecosystems from UNESCO's Blue carbon report

Blue carbon ecosystems globally cover only about 1% of the planet, they are responsible for about half the CO2 absorbed by oceans. Mangroves, tidal marshes and seagrass meadows around the world are known to have vast stores of carbon (c.33bn tonnes) that have been accumulating for thousands of years. If left undisturbed, the carbon stays locked away in sediments. Seagrass sequesters 30x faster than rainforests!
About 5bn tonnes of CO2e is stored in World Heritage sites which are threatened by marine heatwaves, rising sea levels, clearing for fuel, developments and aquaculture.
Even though. https://whc.unesco.org/en/blue-carbon-report
Also described in a news item
https://www.theguardian.com/environment/2021/mar/03/blue-carbon-how-three-australian-marine-sites-lock-away-2bn-tonnes-of-co2?utm_term=8ecb83626156232fd176631723407c24&utm_campaign=GuardianTodayAUS&utm_source=esp&utm_medium=Email&CMP=GTAU_email

BBC Articles
The IPCC's 2018 report on keeping to 1.5C gave a serious warning The BBC said
'Their dramatic report on keeping that rise under 1.5 degrees C says the world is now completely off track, heading instead towards 3C.'
https://www.bbc.co.uk/news/science-environment-45775309 Sept 2018

Jan 2020 BBC summary article 'Where we are now and what can we do?'
https://www.bbc.co.uk/news/science-environment-46384067