# *Very* Basic Climate Science

PLEASE DON'T read this unless you want an extremely simple introduction to a few of the most straightforward facts about the science of climate change (this description is better than calling it "global warming", because as the climate alters it will probably mean that some parts of the world grow colder and wetter, not warmer and drier). The science is already complex, and it is advancing all the time. But journalists don't need to know all the details: what we have to have at our fingertips is just enough to make sense of the subject so that we can help our audiences. For a good and more detailed summary, see *The Science of Climate Change: Questions and Answers*, from the Australian Academy of Science – http://www.science.org.au/reports/climatechange2010.pdf

The climate is changing in several ways: floods and droughts are becoming more common in many parts of the world, the sea level is rising, there are more frequent storms – and the global average temperature is slowly but steadily rising. The climate has always changed, because of natural influences, but it has been fairly stable for about the last 8,000 years. In the last century, though, the global average temperature has risen by more than 0.7 degrees Celsius. The rate of warming over the past 50 years was nearly twice as fast as for the whole century, and the last decade has been the warmest on record.

There is a simple reason for this: the amount of **carbon dioxide (CO2)** in the atmosphere is rising. CO2 is a gas which comes mainly from the burning of **fossil fuels** (coal, oil and gas) in industry, and from agriculture and deforestation.

Since the start of the Industrial Revolution around the year 1750 human activities have been emitting more and more CO2 into the atmosphere, where it stays for hundreds or thousands of years. It has increased from about **270** parts per million (**ppm**) in pre-industrial times to nearly **390 ppm** today – a rise of almost a third in just 200 years. The present level is higher than at any time during the last 800,000 years.

Carbon dioxide matters for one particular reason – it traps some of the Sun's heat (known as solar radiation) in the atmosphere. With several other gases (the main one is **methane, called CH4**) it acts like a blanket of insulation. That is why they are called **greenhouse gases (GHGs),** because they act like the glass in a greenhouse. The Earth needs some of the Sun's heat to stay near the surface, or else it would be a cold, lifeless lump of rock. For millions of years the amount of heat trapped by greenhouse gases has been roughly enough for life to develop and thrive. But now the rising quantity of the gases is trapping more solar heat (which would normally escape back into space), and so the Earth is warming – both the land and the seas. There are several other greenhouse gases regulated by the Kyoto Protocol, the international treaty on tackling climate change: they are nitrous oxide, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons.

The level of CO2 is rising by about 1.9 ppm a year. Even at that rate (which is likely to increase), by 2040 there will probably be 450 ppm of CO2 in the atmosphere. And many people think that is a level we should not exceed. If we stay below 450 ppm, scientists say, there is a 50% chance the global average temperature will not rise by more than **2C** above its pre-industrial level. And any rise beyond 2C is thought likely to trigger uncontrollable climate change, taking us into a world we have not experienced before where there will be no hope of slowing down the effects. That would be what scientists call **a tipping point** – the point at which something becomes inevitable, even if it is unlikely to happen for a long time.

To stay below 2C, global greenhouse gas emissions will need to peak by 2015 and then decline rapidly, to virtually zero by the middle of this century. Yet all the signs are pointing the other way. The International Energy Agency estimates that by 2030 there will be a 40% increase in energy demand, with three-quarters of the supply coming from fossil fuels. By 2050, this would mean a GHG concentration in the atmosphere of around **1,000 ppm**, more than twice the supposed maximum safe level policymakers are aiming for.

Some people say even 2C of warming would be too much, and argue that we should aim to limit it at 1.5C. They say that would mean pegging CO2 emissions at 350 ppm – about 40 ppm *lower* than they are today. Support for this lower level comes from groups like the Alliance of Small Island States (AOSIS) – http://www.sidsnet.org/aosis/ - and others. The Intergovernmental Panel on Climate Change (the IPCC, http://www.ipcc.ch/) thinks the world will warm, on present trends, by anywhere between 1.1 and 6.4C by 2100.

> **You will hear discussion at the COP about 450 and 350 ppm, about 2C and 1.5C, about reducing emissions by 25-40% by 2015 and by 90% by the middle of the century. It helps to understand what the figures mean without having to check them each time you are writing a story.**

The IPCC represents the mainstream scientific understanding of climate change. It does no research itself, but reviews and reports on the work of other scientists. Its latest report was its Fourth Assessment Report (FAR) in 2007, and the fifth in the series is due out in 2014. The science works partly by examining evidence from the past (for example from tree rings and from ice cores drilled from the Greenland and Antarctic ice caps), and it looks into the future through computer modelling. The scientists test how reliable their models are by a process called "backcasting" – trying to see what past climates should have been like. The results have been good enough to persuade them that they can trust their forecasts as well.

There are other factors causing climate change as well as human activities – volcanic eruptions, for example, natural variations and solar activity. But they contribute far less warming than we do. The only way scientists can explain what is happening now is by including what we are doing to the climate.

Climate change, as we saw, is more than just global warming. One of its most serious consequences will be to **worsen other problems**: where water is already short, climate change may make the shortage worse; where people go hungry, it may make it harder to grow food. One particular area of concern is **sea level rise**. The IPCC said in 2007 it expected the level

would rise this century by between 18 and 59 cm, relative to where it was between 1980 and 1999. But this could well be an underestimate, especially if the Greenland and Antarctic ice caps do melt significantly (and there are signs that they could. Greenland could raise global sea levels by about six metres if it ever melted completely, and the Antarctic by a scarcely-believable 60 m. It would take centuries for a complete melt to happen, if it ever did – but the melting could possibly be triggered some time not far ahead. That would be a significant **tipping point**). Some scientists believe the possible sea level rise this century could be a metre or more, which would spell disaster for many small island states, and for millions of people living in coastal zones and cities like Dhaka, Cape Town, Shanghai, London – and Cancun.

Whatever we think we know about climate change, we will almost certainly be surprised at some point by what really happens, because of what are called **feedbacks**. These are processes where climate change, in effect, feeds on itself. One example is in the Arctic: when the white ice and snow melt, as they are doing, they are replaced with darker water and rock. White and light colours reflect sunlight back into space: dark colours absorb it. So the melting means light colours are replaced by dark ones, more heat is absorbed instead of being reflected harmlessly away, and the warming becomes more pronounced. Another surprise may come from the fact that the effects of climate change will not be evenly spread across the planet. Already the science shows that the Arctic and Antarctic are more affected than areas closer to the Equator. And temperatures may rise sharply in inland areas. Some predictions suggest that parts of Central Asia could be 4C warmer by the end of this century – it's more than 25 million years since the Earth was as hot as that. (One recent study said it was possible global temperatures could reach 4C by 2060 – half a century from now, and well within the expected lifetimes of many people at this COP.) The IPCC said in its 2007 report we might see "abrupt and irreversible" changes. Irreversible? A statement by the Geological Society of London in November 2010 said that "continued emissions of carbon from burning oil, gas and coal at close to or higher than today's levels… " were "likely to raise average global temperatures by at least 5-6C, and possibly more… recovery of the Earth's climate… could take 100,000 years or more."

Climate change may have the potential to devastate life on Earth (and it will affect all life, not just humans, who have some ability to adapt to changed conditions). It may possibly turn out to be much less damaging than the science suggests, and for all our sakes we must hope that it does. Either way, it helps to remember some basic principles about it:

- **many GHGs are very long-lived** (and the oceans are very slow to react. They will go on warming for centuries even if we ended GHG emissions today)
- **climate change is happening now**, and happening **faster** than most climate scientists expected just a few years ago
- **it can drive itself** through feedbacks
- **the decisions we take – or don't take – today may have impacts centuries ahead**
- **we are responsible** for most of the climate change now occurring

- it's urgent – **GHG emissions should peak in four years from now** and then drop fast.

And do remember one simple point which many people often forget – **weather and climate are not the same!** Weather is what happens over the next few days. Climate operates over decades, centuries or sometimes even millennia. Cold weather one winter in part of the northern hemisphere (which arrived in 2009/10) does not mean that climate change is not happening. It just means that its effects are uneven and unpredictable. In the long run, though, most scientists are convinced that climate change is a real threat to human and other life.

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