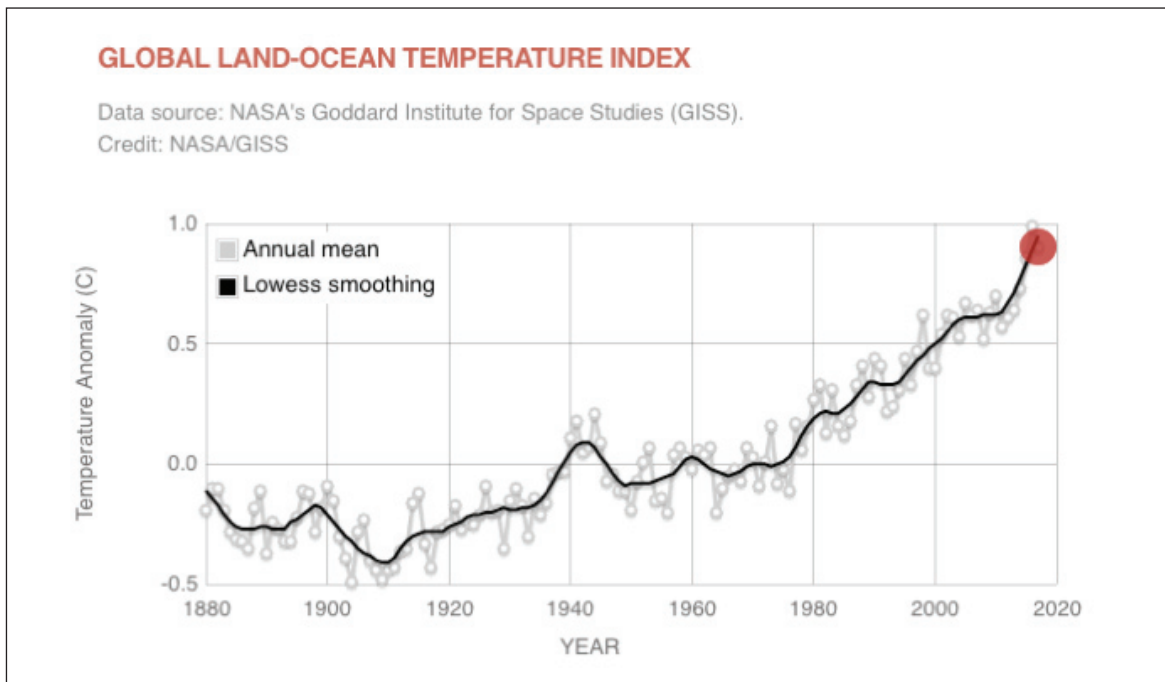


"But it's just a natural cycle ..."

Jane Young



After living for decades in the Catlins it came as a bit of a shock this summer to find myself moaning about high temperatures and lack of rainfall. Even the locals – and you’ve got to live here for much longer than 30 years to be considered a local – acknowledged that this was one of the warmest summers they could remember. Then on 02 Feb, amidst storms, floods and fires, NIWA announced that January had been the hottest New Zealand month during the 108 years for which we have reliable records. Of course one record-breaking summer doesn’t ‘prove’ climate change; it’s the trend that matters. And when we look at the trend, it’s just getting hotter and hotter.

Even when people concede that the climate is in fact changing, they are often still reluctant to accept that human activities are the cause. Conversations tend to be along the lines of: ‘I remember summers that were this hot when I was a boy. It’s just a natural cycle.’

It’s hard not to respond by throwing facts at people in the hopes that this will make them instantly see the light and decide to bike to work, eat less meat, plant lots of trees, etc. And, most importantly, push for change at corporate and government levels.

Social scientists debate whether climate change facts can change people’s minds or just make them hang on more tenaciously to their existing viewpoint. I’ve been reading a fascinating book by George Marshall: *Don’t even think about it: why our brains are wired to ignore climate change*, which delves into all the reasons why it’s so hard for us to accept the reality of what’s happening. Nevertheless, because some of the arguments used to justify lack of action appear at first glance to sound quite reasonable, we need to be clear about the facts.

Claim 1: It’s all caused by the sun.

It’s certainly true that changes in solar activity can affect earth’s climate. The cooler period in the Northern Hemisphere known as the ‘Little Ice Age’, which lasted from the 16th to the mid 19th centuries, was caused by a number of factors, but the main one was the occurrence of two periods in which solar activity was lower than any other period in at least the previous thousand years. In the mid 1800s a period of increased solar activity brought the Little Ice Age to an end. Human industrial and agricultural activities were already increasing the amount of greenhouse gases in the atmosphere, but it wasn’t until about the 1970s that anthropogenic (human-caused) activity outweighed the natural ‘forcings’. For the last three decades the sun’s output has been slowly decreasing (*not* increasing) but again, any cooling effect is being more than counteracted by human activities as we continue to destroy forests and burn fossil fuels.

Claim 2: Volcanoes are responsible – they put out far more CO₂ than humans do.

Volcanoes tend to have a short-term *cooling* affect on the climate. During the Little Ice Age there was a stretch of increased volcanic activity which brought about an increase of dust and sulfate aerosols in the atmosphere. Just like the aerosols caused by industrial pollution, they have a cooling effect because they scatter sunlight. Similarly, after the 1991 Pinatubo eruption there was an overall cooling in the lower atmosphere. (One especially hair-brained idea for ‘fixing’ global warming is to deliberately pump aerosols into the atmosphere to try and cool things down. Acid rain, anyone?)

According to the US Geological Survey, the world’s

volcanoes generate about 200 million tonnes of CO₂ a year. That sounds a lot, but is less than one per cent of the 24 billion tonnes put out by cars and industry. In 2016, the manufacture of cement alone added 1,450 million tonnes of CO₂ to the atmosphere.

Claim 3: It's getting hotter because of changes in the earth's orbit.

For the last 2.6 million years the earth has been in a long-term ice age. During this time there's been a pattern of glacial periods lasting for 100,000 years or so, punctuated by inter-glacials, lasting on average for about 11,500 years. Human agriculture and civilisation developed in the 'Goldilocks' period of the current interglacial, which began about 11,000 years ago.

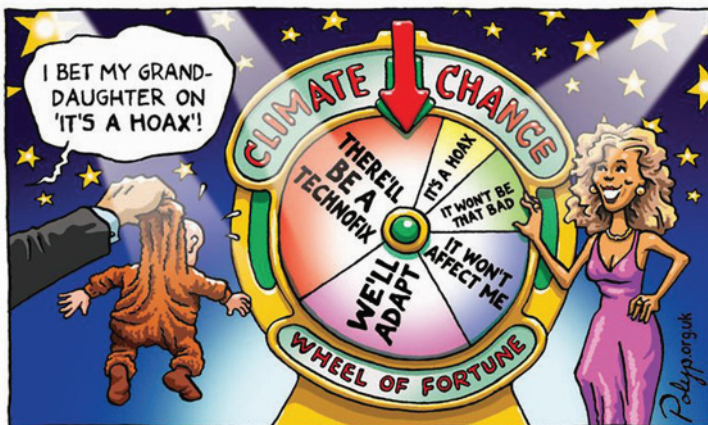
This glacial–interglacial pattern is driven largely by the effect of the Milankovitch cycles on the amount of sunlight hitting the northern hemisphere (it has more land mass than the southern hemisphere so its temperature changes more quickly). These cycles result from the earth's orbit becoming more or less elliptical, the earth's tilt changing, and the earth wobbling on its axis of rotation. They aren't as regular as a pendulum swinging back and forth – for example, some geologists believe it's likely that the current interglacial will last longer than average.

At present we're at the stage when we'd expect the earth to be in a weak *cooling* phase, but this natural trend is being far outweighed by the warming effect of the greenhouse gases we're pumping out into the atmosphere. Consequently, most of the world's ice cover is actually retreating, and at an ever-increasing rate.

Claim 4: There's no link between CO₂ and changes in global temperature.

When we look at ice-core data there is often a pattern in which CO₂ changes lag hundreds of years *behind* the temperature starting to warm. Surely it should be the other way round?

At the point in the natural ice age cycle when polar ice warms up and melts, the influx of freshwater into the oceans disrupts water circulation patterns. Because gases are less soluble in warm water than in cold, as the massive Southern Ocean warms up it expels some of its dissolved carbon dioxide into the atmosphere where the gas traps more heat energy and sets up a positive feedback loop. So in this case carbon dioxide doesn't cause the initial warming – that's due to changes in the earth's orbit – but it reinforces the trend and is eventually responsible for most of the total warming.



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Climate forcings are the different factors that affect the Earth's climate. They drive or 'force' the climate system to change. Forcings can be positive (causing the earth to warm up) or negative. Forcings are natural and/or anthropogenic (caused by human activity). They include changes in:

- Energy output of the sun
- Earth's orbital state
- Volcanic activity and plate tectonics (movement of the earth's crust)
- Land use, eg amount of forest
- Greenhouse gases in the atmosphere
- Aerosols and dust
- Surface reflectivity (albedo)

At any one time the overall forcing (aka radiative forcing) will be the sum of all the individual forcings.

NB A forcing effect isn't the same as feed-back. For example if the earth cools because it's getting less energy from the sun, that's a negative forcing. As more ice is formed and reflects more heat back into space, the earth will cool further. That's a positive feedback loop. Sort of, the more you get (in this case, cooling) the more you get.

Claim 5: There's no point in trying to reduce CO₂ emissions – water vapour is a much stronger greenhouse gas than CO₂.

When I drove into town this morning, the main greenhouse gases my car was adding to the atmosphere were carbon dioxide and water vapour. The CO₂ is likely to stay there, trapping heat, for years or even centuries until it becomes part of a biological cycle; or dissolves in water, causing the water to become more acid; or is removed by slow geological processes.

For the water vapour it's a different story. At any given temperature the atmosphere can only hold a certain amount of water vapour. As soon as the temperature falls, any excess vapour will condense and turn back into a liquid. When the temperature rises, more water will evaporate until the air becomes saturated again. This means that long term, the global warming caused by humans flooding the atmosphere with CO₂, will result in a steady increase in the amount of water vapour that the the air can hold. The more heat trapped in the atmosphere, the more water vapour; the more water vapour, the more heat.

In other words, water vapour acts as a feedback not as a forcing – it amplifies the heating effect of other greenhouse gases, but is a follower, not a trend-setter. ■

For more responses to sceptical statements about climate change, see *How to change minds about our changing climate* by Seth B Darling and Douglas L Sisterson or <https://skepticalscience.com/>.

There's a good video on Bernie Sanders facebook page in which actual climate scientists answer questions posed by the woefully ignorant Kathleen Hartnett, Trump's choice to lead the White House on environmental policy: <https://www.facebook.com/senatorsanders/videos/10156723085332908/>