The Faraday/Vernadsky research station.

Climate of change?

Earth is getting warmer, and the Antarctic Peninsula is one of the most rapidly warming places on the planet. But how do we know if rising temperatures in one place are due to global warming or natural fluctuations? Christian Franzke is trying to figure it out.

I am interested in the mechanisms behind the weather we see every day. Why is one winter different from the next? Can we predict what next summer will be like? Can we predict what winter will be like in ten years' time? And I'm particularly interested in how we can distinguish between natural and man-made climate changes.

Most people would probably like to know if changes in weather where they live are due to global warming or are simply random, natural, fluctuations – but how can we be sure?

The fact is, it can take a long time to recognise the influence of climate change with any certainty. One of the difficulties we face is that natural climate fluctuations affect weather over long periods of time and can obscure the effects of global warming due to greenhouse-gas emissions. For instance, the natural oceanic El Niño phenomenon in the Pacific affects the weather and surface temperature over the whole planet over the course of a winter.

So even though the Earth is getting warmer on average, the temperature where you are can temporarily drop – as we've experienced during the last few cold winters here in the UK for example. This is because a global average is just that – the average of local measurements: the global picture of a warming world can and does include local, short-term cooling.

One of the fastest-warming places in the world is Marina Point, on Galindez Island just off the coast of the Antarctic Peninsula, where the research station Faraday/Vernadsky is located. Temperature measurements began here in February 1947 and continue today, so we have a very long temperature record in one of the most remote and hostile environments on the planet. The temperature there has increased by almost 4°C over the last six decades. But is this because of global warming?

To find out, the first step is to work out if the warming is statistically significant – and therefore likely to be due to global warming – or whether it's more likely that the same conditions could have occurred just by chance. We do this by comparing actual observations of temperature change with models of natural climate variations produced using 'time-series generators'. These use information about what's happened in the past to generate random trends which could happen by chance in the future.

We then compare our real data with the generated trends. If fewer than 5 out of 100 of the generated trends are larger than the observed trends then we meteorologists say that our observed trends are significant – they are very unlikely to have happened by chance.

Essentially there are two types of time-series generators: short- and long-range dependent. Short-range dependent systems predict tomorrow's weather based only on information about today's weather. In contrast, long-range dependent systems use information about the climate system a long way into the past, so these past events influence the generator's results a long way into the future.

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Until now, short-range dependent time-series generators have been most commonly used in climate studies, but there is increasing evidence that long-range systems are better at indicating whether observed climate fluctuations are random or are part of a real trend. This is because long-range dependent systems are better at capturing the persistence of the climate system – the fact that warm days are likely to be followed by many warm days rather than just a few. Short-range dependent generators underestimate this persistence, so when we use them to test our observed data they are more likely to mistake natural fluctuations for a real, statistically significant, trend. In practice, short-range dependent generators are good at capturing temperature fluctuations on a daily or monthly basis, while long-range dependent generators capture fluctuations best on annual and decadal time scales. Remember that these latter time scales are very important for trend estimation.

This might all sound very academic but it can have a big impact in practice, as I discovered when I analysed temperature readings from three stations in Antarctica, including Faraday/Vernadsky. I could see that temperatures at all three stations had risen over the last few decades. I produced as many random temperature predictions as possible, with both short- and long-range dependent generators, then tested the observed warming trends against these to see if they were statistically significant.

Remember that if less than 5 out of 100 generated trends are larger than the observed trends (so in this case larger than 4°C at Faraday/Vernadsky), then we consider that the observed trends are significant and are very unlikely to have happened by chance. When I used the short-range dependent generator I found this seemed to be the case: for all three stations, less than 5 out of 100 of the generated trends were larger than the observed trend, suggesting that the warming in this part of Antarctica is related to global warming. But when I used the long-term generator, only the readings from Faraday/Vernadsky had a significant warming trend.

Does this disprove global warming? No. It simply means we can't yet be sure whether, or how, global warming is affecting temperature changes at some sites.

I am currently examining many other weather-station data worldwide and find many stations which show a significant temperature trend – central England for example – just like at Faraday/Vernadsky.

So we know we are already feeling the effects of global warming in some areas. But in many places local variability is still, for now, obscuring global warming trends. We will have to wait a bit longer before we know what's behind all the local weather changes people are experiencing around the world. ■

MORE INFORMATION

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