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Shake-up for climate models

Models simulating global climate don't capture fine-scale ups and downs of temperature.

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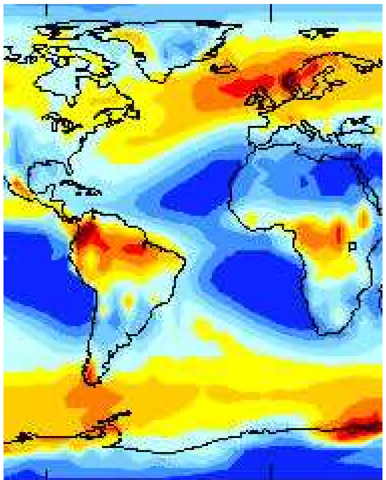

Model figures don't wobble right.
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Models that simulate and forecast global climate don't produce the right wobbles, a new study concludes. Despite immense complexity and sophistication, these computer models fail to capture the fluctuations of atmospheric temperatures over months and years.

The models mimic fluctuations better when they include the effects of dust and other small atmospheric particles or 'aerosols' on the sunlight that the atmosphere reflects and absorbs. Over the past decade, aerosols have been recognized as a crucial aspect of the climate system. The study supports the contention that models that take these particles into account are more accurate.

Armin Bunde of the University of Giessen and colleagues in Israel and Germany compared the results of seven different climate models (general circulation models, or GCMs) against measurements of real atmospheric temperatures. The latter consisted of monthly averages of the daily maximum temperatures recorded over several years at two monitoring stations in Russia and Texas[1].

Previously, the same team had found that a universal mathematical relationship known as a power law describes the correlations between temperature fluctuations over different timescales. This 'scaling law' holds fast for timescales from a few months to ten years or more.

Now the researchers have found that existing GCMs do not generate this observed scaling law. Some GCMs produce something that looks a little like it on short timescales, but they mostly generate temperature fluctuations that are essentially random over timescales of more than two years.

Even when the GCMs do produce something that looks like the proper scaling law, the precise numerical nature of the law is different from that found in real life, and varies for simulated climates of different geographical regions.

One reason for the deficiency, says Bunde's team, might be that models fail to include some potentially crucial factors, such as volcanic eruptions and changes in the Sun's output, that can influence climate over several years. It is also possible that the models do not properly capture the fundamental workings of the climate system.

> **Studying fluctuations may provide a valuable way of testing different models**
>
> **Peter Cox**
> **UK Meteorological Office**

"It doesn't surprise me that climate models don't capture this behaviour," says Peter Cox of the UK Meteorological Office's Hadley Centre for Climate Prediction and Research. Cox is nonetheless heartened that the models reproduce the right behaviour under some conditions.

Their ability to predict long-term temperature changes, for example, is not called into question, he points out. Cox suspects that the differences between simulations and the real world probably stem from well-known limitations in resolution - how finely the simulations can divide up time and space.

And studying fluctuations, rather than trends - in effect, 'noise' rather than 'signal' - may provide a valuable way of testing different models, he notes. "Looking at scaling behaviour is an intriguing new way to study how a system behaves," says Cox.

References

1. Govindan, R. B. et al. Global climate models violate scaling of the observed atmospheric variability. **Physical Review Letters**, **89,** 28501, (2002).