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Exploring how temperature has historically changed – as a constant trend or as steps

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Summary

The paper by Jones and Ricketts (2017) entitled “Reconciling the signal and noise of atmospheric warming” is quite interesting. First, the paper introduced an entire area of research to better understand how global temperatures have actually changed over the period of 1880 to 2014 that was quite fascinating. Second, the paper takes a unique statistical perspective for exploring the overall changes in temperature and determining whether the changes have occurred gradually like a trend or whether there have been step-wise changes. Gaining an understanding of the type of change over time allows the authors to draw some important conclusions as to the main factors that are driving overall changes in atmospheric and sea-surface temperatures.

The paper itself is incredibly long because the authors had to present a lot of information to justify their findings. However, the Introduction, Discussion, and Conclusions sections are worth reading for anyone interested in the topic of climate and global temperature change. In particular, the paper suggests that based on their statistical testing, temperatures have changed in a step-wise rather than a continuous gradual trend. The authors indicate that the step-wise temperature change in atmospheric or sea surface temperatures is occurring due to the increase in temperatures being dictated by the oceans (external) and not be factors within the atmosphere (internal). The oceans “soak up” energy until they reach a point where they cannot soak up any more then release the energy all at once causing a step increase in temperature.

The difference does not mean that all of the current climate model predictions are wrong. However, it does indicate that the “processes of radiative transfer and warming take place in two separate domains of the climate system, separated by a delay.” The occurrence of a step-wise process of temperature, therefore, requires a substantial “rethink” of the ways that current models conceptualize methods of detection, attribution, climate forecasting, and characterization of future climate risk.

Methods

The authors used observational data, climate model data, and a very complex and thorough set of statistical models to address the two main hypotheses “that describe how externally driven and internally generated climate may be related over decadal timescales.” These are –

H1: Externally forced climate change and internally generated natural variability change independently of each other.

H2: They interact, for example, where patterns of the response project principally onto modes of climate variability or form a two-way relationship.

To examine these hypotheses and to test the relationship between gradual and step-wise change, the authors performed the following six tests:

Test 1 – What patterns of step changes can be detected in temperature observations? Do particular dates and locations line up with known events or processes?

Test 2 – Do models forced by historical emissions reproduce the patterns of steps changes shown in observations?

Test 3 – What is the relationship between different components of change – steps, internal trends and shifts – to each other and to total warming and equilibrium climate sensitivity (ECS)?

Test 4 – Can step-like change be identified using attribution methods?

Test 5 – Do other climate variables also undergo step changes?

Test 6 – Are temperature time series more step-like or trend-like?

Important Results and Conclusions

The major conclusions can be summarized in three points:

1. “The processes of radiative transfer and warming take place in two separate domains of the climate system, separated by a delay.”
2. “Because methods for detection, attribution, climate forecasting, and characterization of future climate risk are almost totally dependent on being scaled to gradual change in mean variables, a stepwise process will require a substantial rethink as to how these activities can be conceptualized.”
3. Another important point made in the paper is that warming is not coming directly from internal factors in the atmosphere such as greenhouse gases. The processes are separated and the warming is actually coming from the oceans. Greenhouse gases still play a role, trapping energy that gets absorbed by the oceans until they can no longer absorb any more energy, then the energy is released cause a discrete rise in temperature.

Authors

The authors of this paper are from Australia and are both at Victoria University. The lead author is Roger Jones a professorial research fellow in the Victoria Institute of Strategic Economic Studies where he focuses on climate-related risk, ecological and institutional economics and building research in practice.

Citation

Jones, R. N. and J. H. Ricketts (2017). "Reconciling the signal and noise of atmospheric warming on decadal timescales." Earth Syst. Dynam. **8**(1): 177-210.

END OF REPORT