Improving long-term climate calculations

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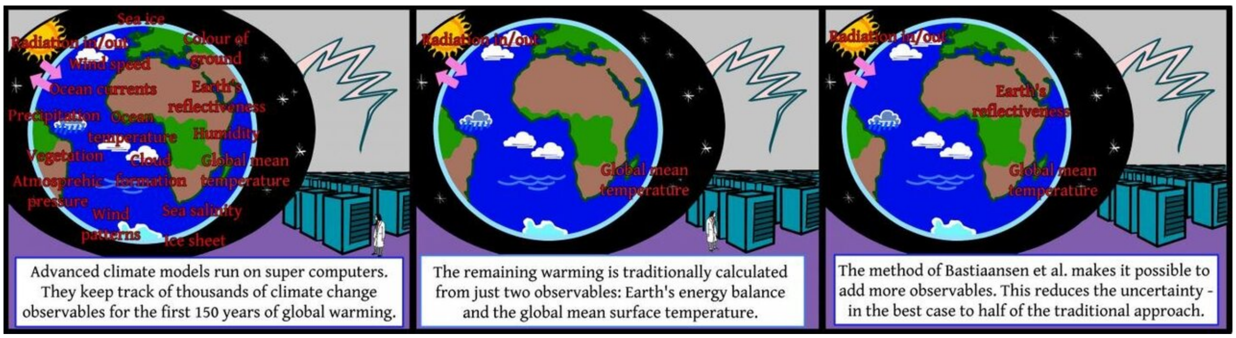


The approach of Bastiansen et al. results in more accurate estimations of long-term warming. Credit: TiPES/HP

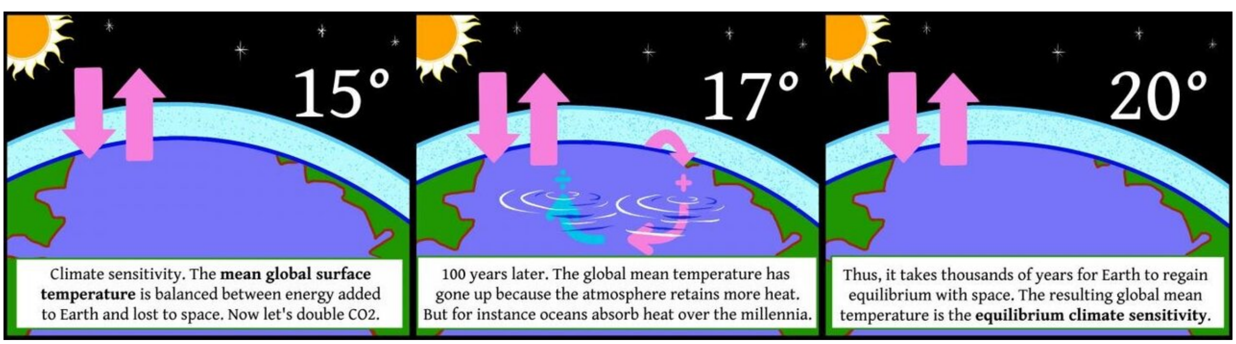
Climate researchers have found a simple but efficient way to improve estimations of ultimate global warming from complex climate models. The finding is relevant for the evaluation and comparison of climate models and thus for accurate projections of future climate change—especially beyond the year 2100. The study is published in *Geophysical Research Letters* by Dr. Robbin Bastiaansen and colleagues at the Institute for Marine and Atmospheric Research Utrecht, Utrecht University, The Netherlands. The work is part of the European TiPES project coordinated by the University of Copenhagen, Denmark.

Complex climate models are rarely used to simulate the effect of global warming for a given amount of CO_2 beyond a couple of centuries into the future. The reason for this is twofold. First, even on a supercomputer, such a model must already run for months to obtain a 150-year projection; reaching the end of a long simulation is therefore not practical. Second, policymakers are mainly concerned about how much climate change a given amount of CO_2 will cause within the coming decades.

Earth warms for more than 1000 years

In the real world, however, temperatures continue to go up for more than a thousand years after CO_2 is added to the Earth system. A typical climate model simulation therefore estimates less than half of the summed global warming. That is a challenge because, in order to improve models, it is necessary to compare and evaluate models. The final global mean temperature from a given amount of CO_2 is an important parameter in the evaluation of a model.

The traditional way of solving this problem is to take the two most predominant results (called observables) from the simulation of the first 150 years and use these to estimate at which global mean surface temperature a full simulation would have ended. The two observables most often used are the global mean surface temperature and the radiation imbalance at the top of the atmosphere. This leads to a rather good estimation but the approach introduces considerable uncertainty—mainly underestimating total global warming.



Earth takes thousands of years to reach the final global mean temperature. Credit: TiPES/HP

More accurate estimates

However, an advanced climate model produces a multitude of other data on, for example future ocean currents, weather patterns, sea ice extend, ground color, climate belts, precipitation, and many more.

"And what we did, was add another observable on top of the two traditional ones. That is the idea. If you use additional observables, you will improve estimates over longer time scales. And our work is proof that this is possible," explains Dr. Robbin Bastiaansen.

In the best-case scenario, the new method halved the uncertainty compared to traditional methods.

The work is expected to be useful in assessing tipping points in the Earth system, as studied in the TiPES project, funded by the EU Horizon 2020.

More information: Robbin Bastiaansen et al, Multivariate Estimations of Equilibrium Climate Sensitivity From Short Transient Warming Simulations, *Geophysical Research Letters* (2020). DOI: 10.1029/2020GL091090

Provided by University of Copenhagen