Climate at a Glance: Climate Model Fallibility

Key Takeaways:

- Climate models produce "implausibly hot forecasts of future warming."
- Recent peer-reviewed scientific papers have proven many climate models are biased warmer than reality.
- Comparisons of actual measured atmospheric temperature data to model forecasts show up to a 200% discrepancy between model temperature outputs and observed temperatures.

Short Summary:

Climate models are used to project future climate conditions under varying greenhouse gas emission scenarios. More than one hundred different computer climate models have been created, each producing different results.[1]

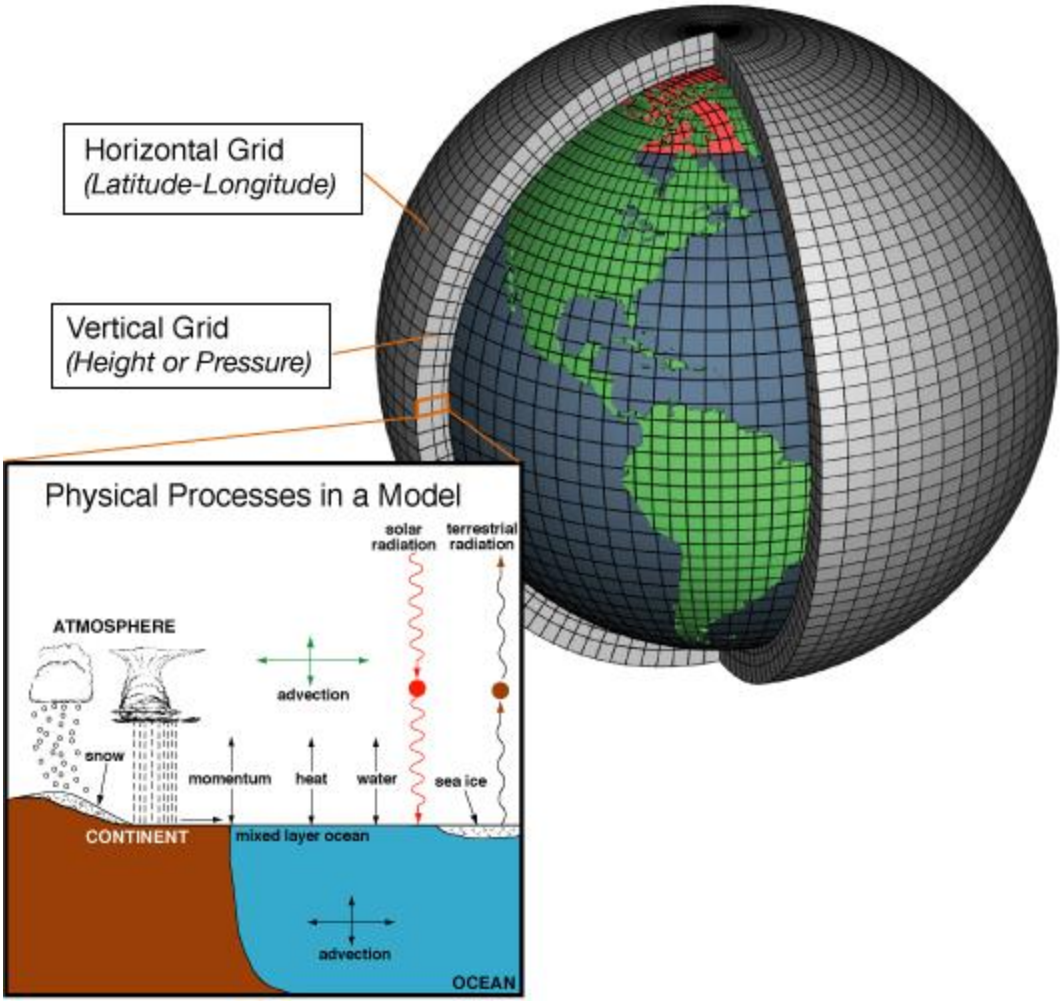

Figure 1. Simplified representation of climate model of the Earth. This image shows the concept used in climate models. Image source: NOAA.

As illustrated in the lower-left graphic insert of Figure 1, different aspects of the land, sea, and atmosphere are considered, including incoming and outgoing solar energy.

The accuracy of climate model projections is limited by the understanding of the myriad complex factors and interactions that drive global temperatures and the ability to model them. Among the numerous factors which drive global temperatures that models do not simulate well two stand out: cloud cover and Equilibrium Climate Sensitivity (ECS).

Climate models struggle to accurately portray clouds because the models cannot resolve the scales within which clouds form. The grid cells used by climate models are around 100 kilometers (62 miles) square for many climate models.[2] Clouds themselves are very seldom that large, and so models miss their "effects." Making models more sensitive with smaller grid cells requires an exponential increase in supercomputing power, which isn't practical or economically feasible.[3,4]

Equilibrium Climate Sensitivity (ECS) – the effect of doubling of carbon dioxide on atmospheric temperature – is not known with any precision and remains hotly debated.[5] ECS estimates range from 0.8°C warming to almost 6.0°C warming by 2100. The uncertainty in ECS values makes projections inherently uncertain. This, combined with missing cloud effects calls into question the accuracy of model-based future temperature projections, even if other factors that drive temperature changes, like large scale oceanic circulation patterns like El Nino/La Nina shifts, the Pacific and Atlantic Multi-Decadal Oscillations, and the Indian Ocean Dipole, were accurately accounted for in models, which they aren't.[6,7,8]

Model errors have become openly acknowledged over the past few years in peer reviewed studies which have concluded climate models are "too hot" and produce "implausibly hot forecasts of future warming."[9,10] This fact is confirmed when actual temperature measurements from surface stations, weather balloons, and global satellites are compared to the warming projected by 102 climate models. The models consistently project too much warming, indeed commonly more than twice as much warming than has been measured (as shown in Figure 2, below).[11]

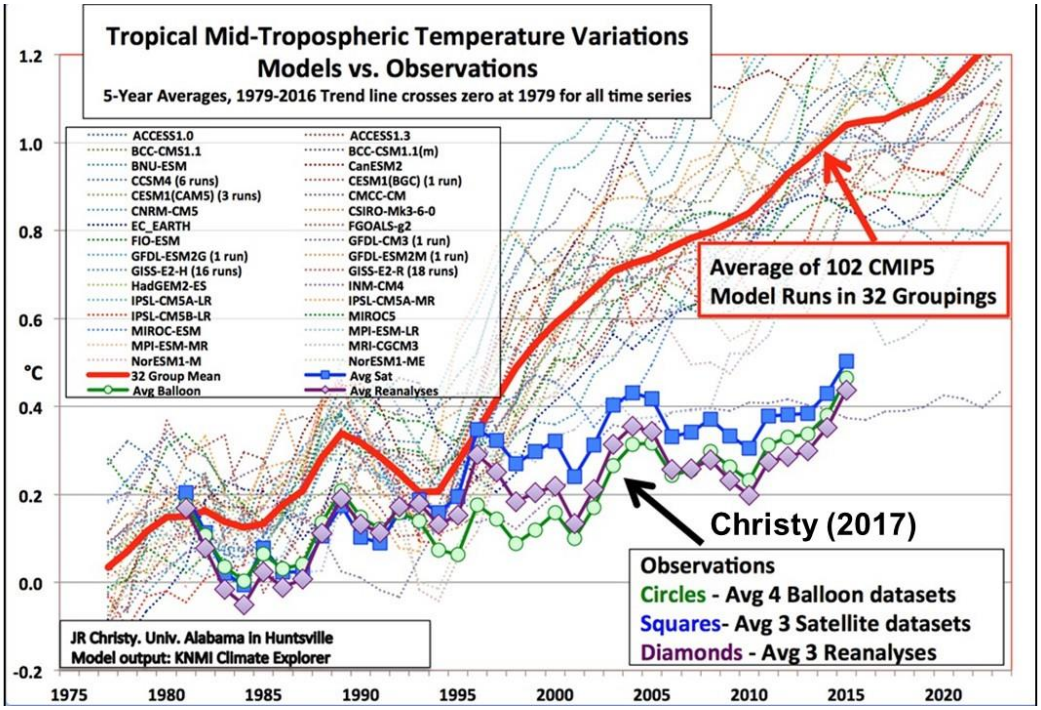

Figure 2. Comparison of climate model output to actual temperature observations from 1979 to 2016 using CMPI5 climate models.

The discrepancy between real world measurements and forecasts shows that climate models are fallible as a result of large uncertainties in the complex climate system that they are unable to account for.

References:

1. IPCC, 2021: *Annex II: Models*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 2087–2138, doi:10.1017/9781009157896.016

2. Dr. Randy M. Russell, UCAR Office of Education and Outreach**,** *Resolution of Climate Models,* accessed June 4, 2023, https://eo.ucar.edu/staff/rrussell/climate/modeling/climate_model_resolution.html
3. UCAR Center for Science Education, *Fast Computers and Complex Climate Models*, accessed June 5, 2023, https://scied.ucar.edu/learning-zone/how-climate-works/fast-computers-complex-climate-models
4. U.S. Department of Energy, DOE Announces $70 Million to Improve Supercomputer Model of Earth's Climate System, August 30, 2022, accessed June 6, 2023, https://www.energy.gov/articles/doe-announces-70-million-improve-supercomputer-model-earths-climate-system
5. The Heartland Institute, *Climate at a Glance: Climate Sensitivity*, accessed, June 6, 2023, https://climateataglance.com/climate-at-a-glance-climate-sensitivity/
6. The Heartland Institute, *Climate at a Glance: El Niño and Global Warming*, accessed, June 7, 2023, https://climateataglance.com/el-nino-and-global-warming/
7. Hayashi, M., Jin, FF. & Stuecker, M.F. Dynamics for El Niño-La Niña asymmetry constrain equatorial-Pacific warming pattern. *Nat Commun* **11**, 4230 (2020). https://doi.org/10.1038/s41467-020-17983-y
8. Bader, David; Covey, Curt; Gutowski, William; Held, Isaac; Kunkel, Kenneth; Miller, Ronald; Tokmakian, Robin; and Zhang, Minghua, "Climate Models: An Assessment of Strengths and Limitations" (2008). US Department of Energy Publications. https://digitalcommons.unl.edu/usdoepub/8
9. Science Magazine, *Use of 'too hot' climate models exaggerates impacts of global warming***,** May 4, 2022, accessed, June 6, 2023, doi: 10.1126/science.abq8448
10. Science Magazine, *U.N. climate panel confronts implausibly hot forecasts of future warming*, July 27, 2021, accessed, June 6, 2023, doi: 10.1126/science.abl6582
11. Christy, J.R., McNider, R.T. *Satellite bulk tropospheric temperatures as a metric for climate sensitivity.* Asia-Pacific J Atmos Sci 53, 511–518 (2017). https://doi.org/10.1007

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