Sci. Bull. (2015) 60(1):122–135
DOI 10.1007/s11434-014-0699-2

www.scibull.com
www.springer.com/scp

Article

Earth Science

Why models run hot: results from an irreducibly simple climate model

Christopher Monckton · Willie W.-H. Soon · David R. Legates · William M. Briggs

Received: 27 August 2014 / Accepted: 12 November 2014 / Published online: 8 January 2015

Abstract An irreducibly simple climate-sensitivity model is designed to empower even non-specialists to research the question how much global warming we may cause. In 1990, the *First Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC) expressed "substantial confidence" that near-term global warming would occur twice as fast as subsequent observation. Given rising CO_2 concentration, few models predicted no warming since 2001. Between the pre-final and published drafts of the *Fifth Assessment Report*, IPCC cut its near-term warming projection substantially, substituting "expert assessment" for models' near-term predictions. Yet its long-range predictions remain unaltered. The model indicates that IPCC's reduction of the feedback sum from 1.9 to 1.5 W m^{-2} K^{-1} mandates a reduction from 3.2 to 2.2 K in its central climate-sensitivity estimate; that, since feedbacks are likely to be net-negative, a better estimate is 1.0 K; that there is no unrealized global warming in the pipeline; that global warming this century will be <1 K; and that combustion of all recoverable fossil fuels will cause <2.2 K global warming to equilibrium. Resolving the discrepancies between the methodology adopted by IPCC in its *Fourth* and *Fifth Assessment Reports* that are highlighted in the present paper is vital. Once those discrepancies are taken into account, the impact of anthropogenic global warming over the next century, and even as far as equilibrium many millennia hence, may be no more than one-third to one-half of IPCC's current projections.

Keywords Climate change · Climate sensitivity · Climate models · Global warming · Temperature feedbacks · Dynamical systems

1 Introduction

Are global-warming predictions reliable? In the 25 years of IPCC's *First* to *Fifth* Assessment Reports [1–5], the atmosphere has warmed at half the rate predicted in FAR (Fig. 1); yet, Professor Ross Garnaut [6] has written, "The outsider to climate science has no rational choice but to accept that, on a balance of probabilities, the mainstream science is right in pointing to high risks from unmitigated climate change." However, as Sir Fred Hoyle put it, "Understanding the Earth's greenhouse effect does not require complex computer models in order to calculate useful numbers for debating the issue. ···To raise a delicate point, it really is not very sensible to make approximations ···and then to perform a highly complicated computer calculation, while claiming the arithmetical accuracy of the computer as the standard for the whole investigation" [7].

The present paper describes an irreducibly simple but robustly calibrated climate-sensitivity model that fairly represents the key determinants of climate sensitivity,

Electronic supplementary material The online version of this article (doi:10.1007/s11434-014-0699-2) contains supplementary material, which is available to authorized users.

C. Monckton (✉)
Science and Public Policy Institute, Haymarket, VA 20169, USA
e-mail: monckton@mail.com

W. W.-H. Soon
Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA

D. R. Legates
Department of Geography, University of Delaware, Newark, DE 19716, USA

W. M. Briggs
New York, NY 10021, USA

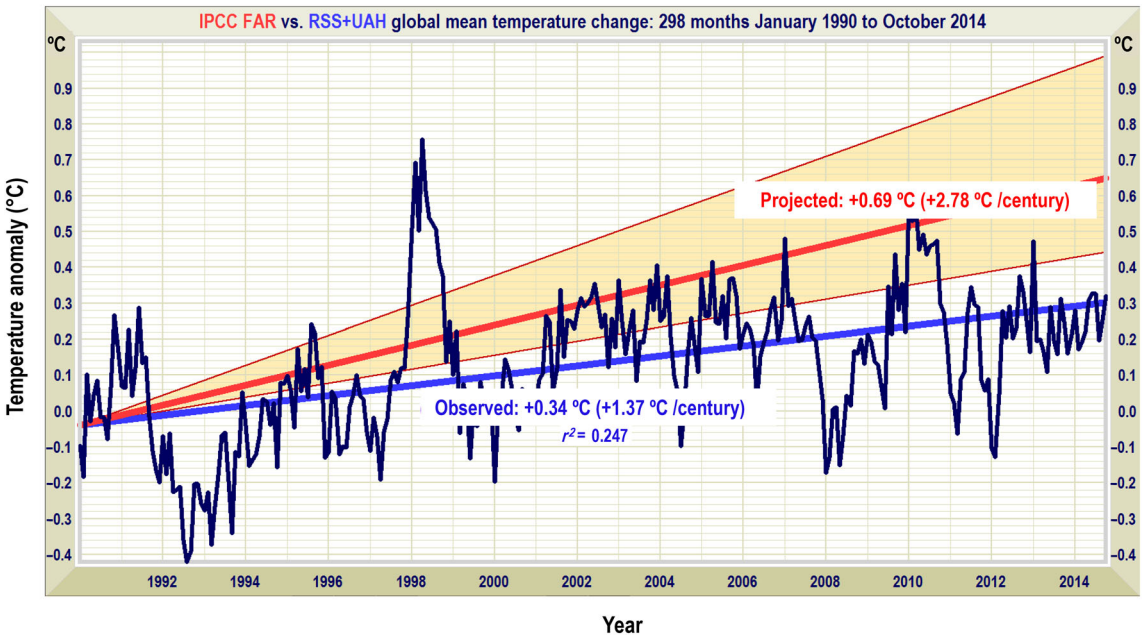

Fig. 1 Medium-term global temperature trend projections from FAR, extrapolated from January 1990 to October 2014 (*shaded region*), vs. observed anomalies (*dark blue*) and trend (*bright blue*), as the mean of the RSS, UAH, NCDC, HadCRUT4 and GISS monthly global anomalies [9–13]

flexibly encompasses all reasonably foreseeable outcomes, and reliably determines how much global warming we may cause both in the short term and in the long term. The model investigates and identifies possible reasons for the widening discrepancy between prediction and observation.

Simplification need not lead to error. It can expose anomalies in more complex models that have caused them to run hot. The simple climate model outlined here is not intended as a substitute for the general-circulation models. Its purpose is to investigate discrepancies between IPCC's *Fourth* (AR4) and *Fifth* (AR5) Assessment Reports and to reach a clearer understanding of how the general-circulation models arrive at their predictions, and, in particular, of how the balance between forcings and feedbacks affects climate-sensitivity estimates. Is the mainstream science settled? Or is there more debate [8] than Professor Garnaut suggests? The simple model provides a benchmark against which to measure the soundness of the more complex models' predictions.

2 Empirical evidence of models running hot

How reliable are the general-circulation models the authority of whose output Professor Garnaut invites us to accept without question? In 1990, FAR predicted with "substantial confidence" that, in the 35 years 1991–2025, global temperature would rise by 1.0 [0.7, 1.5] K, equivalent to 2.8 [1.9, 4.2] K century^{-1}. Yet 25 years after that prediction the outturn, expressed as the trend on the mean of the two satellite monthly global mean surface temperature anomaly datasets [9, 10], is 0.34 °C, equivalent to 1.4 °C century^{-1}—half the central estimate in FAR and beneath the lower bound of the then-projected warming interval (Fig. 1). Global temperature would have to rise over the coming decade at a rate almost twice as high as the greatest supra-decadal rate observed since the global instrumental record began in 1850 to attain even the lower bound of the predictions in FAR, and would have to rise at more than thrice the previous record rate—i.e., at 0.67 K over the decade—to correspond with the central prediction.

Since 1990, IPCC has all but halved its estimates both of anthropogenic forcing since 1750 and of near-term warming. Though the pre-final draft of AR5 had followed models in projecting warming at 0.5 [0.3, 0.7] K over 30 years, equivalent to 2.3 [1.3, 3.3] °C century^{-1}, approximating the projections on the four RCP scenarios, the final draft cut the near-term projection to 1.7 [1.0, 2.3] °C century^{-1}, little more than half the 1990 interval and only marginally overlapping it (Fig. 2).

Empirically based reports of validation failure in complex general-circulation models abound in the journals [14–29]. Most recently, Zhang et al. [30] reported that some 93.4 % of altocumulus clouds observed by collocated CALIPSO and CloudSat satellites cannot be resolved by climate models with a grid resolution >1° (110 km). Studies of paleo-vegetation and pollens in China during the mid-Holocene climate optimum 6,000 years ago find January (i.e., winter minimum) temperatures to have been 6–8 K warmer than present. Yet, Jiang et al. [31] showed that all 36 models in the Paleoclimate Modeling Intercomparison Project backcast