

## REPLY COMMENT

**Modeling climatic effects of anthropogenic carbon dioxide emissions: unknowns and uncertainties. Reply to Karoly et al. (2003)**Willie Soon<sup>1,2,\*</sup>, Sallie Baliunas<sup>1,2</sup>, Sherwood B. Idso<sup>3</sup>, Kirill Ya. Kondratyev<sup>4</sup>, Eric S. Posmentier<sup>5</sup><sup>1</sup>Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts 02138, USA<sup>2</sup>Mount Wilson Observatory, Mount Wilson, California 91023, USA<sup>3</sup>US Water Conservation Laboratory, Phoenix, Arizona 85040, USA<sup>4</sup>Research Centre for Ecological Safety, Russian Academy of Sciences, St. Petersburg 197110, Russia<sup>5</sup>Long Island University, Brooklyn, New York 11201, USA

We encourage the readers of this Comment/Reply exchange to read our original paper (Soon et al. 2001) in its entirety because of the way Karoly et al. have portrayed the content and the context of our research paper. For example, when we referred to our reviews concerning the weaknesses of GCMs as being 'biased', we said that 'we are biased in favor of results deduced from observations.' Karoly et al.'s reference to this is a quote out of context that, if read alone, mischaracterizes our meaning.

In passing, we are surprised by Karoly et al.'s apparent reference to the popular meaning of the word 'biased'. It appears that they are treating our reference to bias as though greater confidence would be warranted in work where systematic biases are not acknowledged, as in the IPCC Third Assessment Report they recommend (IPCC 2001). They do not follow up with any rejection of the analyses, or of the discussion of observational and modelling difficulties in our original article.

Three points form the substance of the Comment. The first is a discussion of our statement that unique attribution of climate change to increasing atmospheric CO<sub>2</sub> is not possible. Despite the promise of controversy in pre-emptive staking of theirs and IPCC's authority on climate science, in substance their discussion concludes that we are correct.

Second is a discussion of our statement that modelling studies have not substantiated the attribution of climate change to rises in CO<sub>2</sub>. Karoly et al. respond that 'modelling studies have helped to substantiate that CO<sub>2</sub> added to the air is likely to have caused significant global warming'. This is cautious wording. Modelling studies may have helped—especially as the

notion of 'help' is subjective; nevertheless, the attribution of climate change to CO<sub>2</sub> is not substantiated, and Karoly et al. have not affirmed that it is substantiated. They are right to be careful.

The Comment offers a discussion of precisely how modelling studies are or can be used, or be 'helpful', even if falling short of substantiation. Karoly et al. are overly optimistic, in our view, in not acknowledging the importance of what is unknown and unquantifiable in our current limited knowledge of the climate system, and in turn the major uncertainty in use of these models to interpret observational variables. The burden of our paper was to demonstrate these gaps, leading to the conclusion we summarized in our abstract, '[U]ncritical application of climate models has led to the commonly held but erroneous impression that modeling has proven or substantiated the hypothesis that CO<sub>2</sub> added to the air has caused or will cause significant global warming.'

Karoly et al. sketch the application of a formal method for detection/attribution of greenhouse gas forcing and climate change response. However, to outline the existence of a formal method is not to demonstrate the meaningfulness of its application. Quantification of the effects of anthropogenic greenhouse gases is confounded by numerous unresolved climate issues—both anthropogenic issues, such as the direct and indirect role of multi-component aerosols, deforestation and land-use changes, and also natural issues, such as volcanic forcing and the influence of solar forcing. Yet one readily finds such assumptions in current detection/attribution literature as: '[E]stimates of natural internal variability and the forced climate change signal required to apply standard detection tech-

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nique... are computed from control and transient climate change simulations produced' by GCMs (Zwiers & Zhang 2003). The problems and issues with the current generation of GCMs make us skeptical of the practical utility of that detection/attribution method.

Systematic errors in observational data also hinder meaningful linkage of observations to causes. Referring to sources of error such as urbanization of studied areas, changes in measurement practices, and so on, Hegerl et al. (2001), for example, have recently concluded that the effect of systematic instrumental error cannot be assessed at present.

Finally, the Comment takes up our statement that 'our review does not disprove a significant anthropogenic influence on climate.' They agree with this as well. Yet we cannot let pass without comment their suggestion that there is a logical contradiction between our remark that the attribution of climate change to CO<sub>2</sub> is unsubstantiated and our remark that anthropogenic influence is not disproved. We are pointing to a grey area. While it may be true that, in the public mind, to set aside a proof is to disprove, that state of affairs is deplorable and in no way improved by

IPCC authors' lack of clarity about the difference between what may be true and what is known.

A similar concern about hedged statements versus true uncertainty or unknowns (including knowledge gaps emphasized in our paper) has also been voiced in a recent editorial by Trevors (2003).

#### LITERATURE CITED

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