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Climate of the Past Discussions

Reply to Comment on "Using multiple observationally-based constraints to estimate climate sensitivity by Annan and Hargreaves (2006)" by Henriksson et al. (2010)

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Abstract

Henriksson et al. (2010), hereafter HALTL10, criticise Annan and Hargreaves (2006a) (AH06) primarily on the grounds that we assumed that different sources of data were conditionally independent given the climate sensitivity. While we consider this approximation to have been a reasonable one in the circumstances (and provided arguments to justify this approach), we also acknowledged its importance in our original paper and performed several sensitivity analyses. The alternative calculations presented by HALTL10 appear to strengthen rather than contradict our conclusion.

HALTL10 additionally criticise Annan and Hargreaves (2009) (AH09) for proposing a Cauchy-type prior (as an alternative to the use of a uniform prior which was widespread up to that time) "without sufficient support", and further claim that our choice was irrationally based on an economic assessment. We are surprised by these baseless claims, especially considering that the proposed prior was justified at some length both on the basis of both the "Charney report" (National Research Council, 1979) and basic physical arguments, and also in light of our elementary demonstration of the pathological failings of the most commonly-used alternative. Thus, these claims are factually incorrect.

1 Overview

We are pleased to see that HALTL10 explicitly acknowledge that by combining information from various sources, a more precise estimate of the climate sensitivity should be obtained. This is merely a special case of a well-known theorem of probability (e.g. Lindley, 1956). Therefore, it is virtually assured that those analyses which ignore relevant information by focussing only on one or two summary indicator variables and periods when attempting to form probabilistic estimates of climate sensitivity will have unrealistically high uncertainty (long tails), when compared to a more comprehensive calculation. This was of course the main point of AH06. It is therefore unclear to us

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how HALTL10 can justify their endorsement of previous research that suffers from this limitation, and indeed they do not explain this apparent contradiction. We now address their specific criticisms in detail.

2 Independence

HALTL10 criticize the way that multiple lines of evidence were combined in AH06 under the assumption that they could be considered conditionally independent given the climate sensitivity. We note that the assumption of independence in combining different constraints was not in itself a particular novelty of AH06. In fact such an approximation has been often used in other work, sometimes implicitly, without attracting particular criticism (e.g., Hasselmann, 1998; Knutti et al., 2002; Hegerl et al., 2006). Crucially, ignoring relevant data is always expected to result in exaggerated uncertainty, whereas an assumption of independence may cause either an overestimate or underestimate of uncertainty, compared to a more precise calculation which accounts for (estimated) covariances. Of course each case needs to be considered on its merits, but it does not seem unreasonable to adopt this as a plausible approximation in the absence of a more accurate assessment, and our approach here appears to be in line with prior literature. We also performed sensitivity analyses (summarised in paragraph 13 of AH06) to check the robustness of our original result, and concluded that "We cannot assign a significant probability to climate sensitivity exceeding 6C without making what appear to be wholly unreasonable assumptions to discard data and/or hugely inflate the uncertainties attached to a range of observational evidence". HALTL10 also present two alternative interpretation of the observational evidence, and obtain upper 95% bounds for the climate sensitivity of 5.6 °C and 6 °C. It is therefore difficult to see what grounds they have for disagreeing with our conclusion. Indeed it is worth remarking that the estimates of HALTL10 also represent an improvement of the upper bound compared to the best estimate of the time, which appears to be that of Hegerl et al. (2006).

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3 Priors

HALTL10 also criticise AH09 by claiming that the Cauchy-type prior presented in that paper was inadequately justified. More seriously, they also imply that we had irrationally used future economic damages as a means of selecting the prior. The first claim is refuted with reference to Sect. 3.2 of AH09, which presents in some detail several lines of argument to support the choice of prior: the assessment of National Research Council (1979) and synthesis of a survey of climate scientists by Webster and Sokolov (2000), and also the consensus of scientific understanding regarding the basic physical processes of radiative balance. While such arguments can never be definitive given the inherently subjective nature of Bayesian probability, it is hardly tenable to claim that these arguments are less substantive than the inadequate and misleading manner in which uniform priors have historically been proposed (for example, as representing "ignorance") in the earlier papers which HALTL10 favour. Indeed this argument seems to have been widely accepted now in the relevant community (Jewson et al., 2009; Sokolov et al., 2009; Urban and Keller, 2010), even by many of those who were previously the strongest advocates of a uniform prior.

In respect of the second claim that the choice of prior was motivated by anticipated economic damage, this is again easily refuted both by the arguments mentioned above, and also by the observation that the Cauchy-type prior had been proposed on the basis of those arguments several years earlier (Annan and Hargreaves, 2006b, 2007), with the economic analysis only having been added at a later stage to demonstrate the practical impact and significance of this seemingly arcane debate. Thus, their claims regarding AH09 are factually incorrect.

HALTL10 are of course entitled to advocate for their preferred choice of prior, but they have failed to do so, other than implicitly. Neither have they presented any argument to refute those of AH09.

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4 Conclusions

HALTL10 agree that a comprehensive analysis of the evidence will result in climate sensitivity estimates having a lower uncertainty range than the limited analyses that they endorse. Further, their alternative calculations appear to support, rather than refute, the sensitivity analysis of AH06. Their criticism of AH09 is wholly unsupported, as they do not discuss the content of that paper in any meaningful manner. HALTL10 endorse the use of the $U[0\,^{\circ}\mathrm{C},10\,^{\circ}\mathrm{C}]$ prior through their endorsement of Hegerl et al. (2007) but nowhere present any argument for this choice, which has been increasingly abandoned even by those who were previously its strongest advocates. We encourage all those who would prefer to discard the particular results of AH06 (and perhaps AH09) to calculate their own alternative estimates, taking account of the valid points made in these papers. Based on the sensitivity analyses which we have already performed, we are confident that credible and reasonable attempts to do so will support our results.

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