

Interactive comment on “The impact of model variation in CO₂ and temperature impulse response functions on emission metrics” by D. J. L. Olivié and G. P. Peters

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Summary

This is a useful piece of work but needs improvement in the presentation. I would largely endorse the on-line review comments by K Tanaka. Possibly, if the role of the paper was better defined relative to Joos et al (2012) then the focus on IRFs might be easier to justify.

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- I would argue that metrics (as single numbers) are convenient rather than necessary – see opening sentence of abstract and section 1.
- The sentence ‘Analytic .. (IRFS).’ seems out of place – but maybe just the word ‘Analytic’ is unnecessary. (p937)
- p937 L19–23: The IRFs .. temperature IRF’. It is not clear whether this is meant to be a generic description or a summary of what is done in this paper.
- p939 L17: ‘non-linearities in the ocean’ → ‘non-linearities in the behaviour of the ocean’
- p940 L23–25: IRFs are a condensed way to describe any linear system.
- the term ‘climate sensitivity’ has been long-established (especially in IPCC) reports as meaning the amount of equilibrium warming from doubling CO₂. However unfortunate one might consider this, a paper such as this one must either acknowledge this prior usage OR use an alternative term for λ (e.g. ‘climate sensitivity parameter’ as used by Olivié and Stuber) — or, of course, do both. (p943 L6 and p948 L8)
- p945 L1–2: This sentence is trying to combine too many cases. the ‘and eventually CO₂’ only applies to two of the four metrics for non-CO₂ species.
- p950, L11: suggest: ‘response’ → ‘available output’
- p952, L20: ‘The IRF.’ which one? Four IRFs (2 from C4MIP plus J07 and LTMIP) are mentioned in the previous sentence.
- p957 L12 ‘short’ → ‘briefly’

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- p957: overall, I think that this part of the discussion could be shortened
- p961 L2; ‘The impact from .. has a similar impact ..’. This sentence needs to be reworded.

Comments/queries on the science

- General: Metrics for comparing greenhouse gases are usually intended for potential substitutions of emissions and so are generally intended for relatively small changes.
- p938, L6–7. It is not the negative feedback that creates the non-linearity, it is the saturation of this process at higher CO₂.
- p938 L8: main non-linearity associated with ocean circulation is feedback from warming;
- p938 L9: ‘reduces the CO₂ uptake’ → ‘reduces the net CO₂ uptake’ — since arguably higher temperatures often increase both photosynthesis and respiration, but increase the latter more.
- p939 L6: this equivalence does of course, assume linearity;
- p939 L15: possibly worth noting that Hansen has talked about additional longer timescale associated with cryosphere processes.
- p940 L2: IPCC used Bern CC response to define a GWP of 1.
- Knutti (2010) gives a discussion of why intercomparisons are not set up to lead to probability distributions — the authors need to engage with those comments.

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- p959 L1–2: saying that the ‘combination of potentially inconsistent responses is done routinely’, is disappointing. The Monte Carlo techniques used here have the capability of dealing with such lack of independence in a way that other approaches might struggle to follow — a missed opportunity.

Abbreviations

The large number of abbreviations and acronyms makes for disjointed reading. Some suggestions for mitigating this problem (without undue expansion of the length) are:

- ‘SCM’ is not used often (p940, L13; p949, L11) — it could be written out in full;
- not clear whether ‘models’ could replace AOGCM – the context CMIP3 etc usually carries the implications of what sort of model;
- Note also that ‘BC’ is not defined in the abstract (which should be self-contained). It may be worth spelling out ‘black carbon’ in all contexts except column headings in tables. (p938 L20, p955 L2)
- p946, L1, L5: ‘CC’ seems to be undefined except as part of C⁴MIP.- it seems a bit strange to only expand part of the C⁴.
- p 960 L5: MLO-AGCM apparently undefined. Presumably mixed layer ocean (but for the carbon cycle community, MLO means Mauna Loa Observatory (and the NOAA code for CO₂ data from there).

Queries

- p942, L1: in what sense is the fit ‘best’?

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- p952, L1: it is not obvious why this ‘square root’ factorisation is necessary (or even useful) – I would have thought that an eigenvector decomposition (to independent normally-distributed components) would have been more useful – please clarify.

Referencing

There are several points where the referencing is inadequate:

- p949, L11: Tarantola (2005) is substantial book. A page or section number should be specified (and a name for the method if possible).
- IPCC (2007) is not an appropriate reference. If (as seems not to be the case here) a reference to the whole volume is required it should be by editors (Solomon et al). However in this paper, most of the IPCC references should be to individual chapters, referenced by chapter authors (both to give credit to those who wrote them and more importantly to help the reader) with the reference in the text supplemented by page number or (better) section number (or table number as appropriate) – again to help the reader.
- Same remarks apply to citing Houghton (1990) – p937,L13
- Same remarks apply to citing IPCC(2001), p938 L27

The authors and/or editors should also check to ensure that the journal abbreviations comply with *ESD* standards.

Suggestions for clarification

- For consistency, $B(t)$ and $E(t)$ should be written as $B_X(t)$ and $E_X(t)$ — eqn (3) and p941, L5.

- equations 17, 18 and p951, L5: maybe use m for number of models since n is used for number of exponentials in IRF.
- I think that in Figs 3,4 5 the graphical presentation (in the right hand columns) of percentage spreads does not convey much. Perhaps it would convey more if such information from figures 3 and 4 was combined into a restructured figure 5 so that the spread was shown as ‘total’ (as now) alongside the contributions from uncertainties in CO₂ IRFs (from fig 3) and temperature IRFs (from fig 4).

Issues with English

- ‘singe’ → ‘single’ – p936 L3
- ‘life time’ → ‘lifetime’ – p936 L25, p938 L19 (twice), p941 L8, p957 L14
- p941 L16: ‘fast’ → ‘rapidly’
- ‘undimensional’ → ‘dimensionless’ – p945, L21 – p 944, L9,12
- ‘extend’ → ‘extent’ – p957, L29
- ‘manor’ → ‘manner’ – p958, L28

Minor typographical errors

- ‘o f’ → ‘of’ p942 L18
- ‘acoupled’ → ‘ a coupled’ in Cox reference

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References

R. Knutti. The end of model democracy (an editorial comment). *Climatic Change (on line)*, (on line):doi: 10.1007/s10584-010-9800-2, 2010.

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