Earth Syst. Dynam. Discuss., 2, C280–C284, 2011
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Earth System Dynamics Discussions

Interactive comment on "The magnitude-timescale relationship of surface temperature feedbacks in climate models" *by* A. Jarvis

Anonymous Referee #2

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This work develops and applies a method for quantifying climate feedbacks as a function of timescale (in contrast to other studies which separate feedbacks into different physical processes). This is applied to long integrations of a GCM, plus an EMIC and an EBM. A picture is obtained of an initial fast negative feedback eroded by a series of positive feedbacks (attributed to equilibration of mixed layer and deep ocean). The deep ocean feedback is somewhat peaked, which is attributed to circulation bringing the deep ocean closer towards well-mixed (single timescale) character.

This is a valuable work, with a clear result (Figure 4). Aside from the method, the key value likes in Figure 4: the clear examination of long-timescale response of a GCM (with backup from EMIC and EBM). In particular the peak in g(tau) for long timescales, and the related physical and systems discussion.

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Interactive Discussion
Discussion Paper

- in the abstract, a call for more long-run GCM experiments could be made.

————————Major comments

My main comment is that the accessibility (and citeability) of the paper could be improved. Fig 4 is a nice clear result, and the discussion should be easier to get hold of.

First, this study could be linked better to existing literature. Starting with the abstract, it currently reads somewhat as if variation of feedback with timescale is ignored more than it actually is.

- The abstract should reflect that the issue of transient negative feedbacks is already published (Baker and Roe), but that discrete phases emerge in the present study due to ocean circulation being included.

- It would be worth bringing Baker and Roe greater prominence in the introduction (perhaps start of second paragraph), as this is a key building block for the current study.

- and in section 5 (results), explicit discussion on the contrast between your Fig 4 and Baker and Roe Fig 6. would be useful (rather than just saying, cf. Fig 4b with their Fig 6).

- Also, could mention that Gregory and Forster 08 kind of include a transient ocean feedback (albeit focussing on a narrow timescale range). Indeed, the current paper mentions later on that Gregory and Forster 08 home in on $\sim$70/e year timescale (i.e. not equilibrium as implied in the introduction).

- another relevant paper: Williams, K.D., W.J. Ingram and J.M. Gregory (2008): Time variation of effective climate sensitivity in GCMs. J. Climate 21(19) 5076-5090 doi:10.1175/2008JCLI2371.1.

Second, accessibility could be improved with more effort to separate technical de-

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tails and language from more physical discussion (e.g. 'feedforward dynamics'). Subheadings could help. Section 7 could be more clearly separated this way. Perhaps in the Results section it would be worth re-iterating briefly in words up front what G and g are. I found use of g and G confusing, as G is often used to mean 'gain'.

Minor issues

————————-Abstract

The use of 'three climate models' is overstated. There is one GCM, and two simpler models. It is encouraging that the simpler models give similar profiles to the GCM, rather than implying that adding the simpler models makes the results much more robust.

Move the sentence 'Rather than split...' up to be the second sentence, as this is the key method point.

In the description of the the results, I would use the phrase 'can be viewed as' or similar, when talking about a negative feedback eroded by spectrum of positive feedbacks. Personally I find Baker and Roe's alternative view of a transient negative feedback more intuitive, but perhaps the progressively-eroded negative view makes sense in the framework of the current analysis.

———————— 2 climate reference and feedback systems

It would help to introduce more clearly what you mean by a reference system (with ref to Roe 2009 right at start). If the reader is familiar with reference systems, the first two sentences are redundant. Also, clarify what exactly you use as a reference system here. Currently it sounds a bit like everything except the deep ocean is in the reference system.

The paragraph starting: 'the physical processes giving rise' can be removed, as this has been stated twice already (abstract and introduction).

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The final paragraph tends to exaggerate the problem:

- 'G only corresponds... as tau->infinity'. Alternatively, if g peaks below the timescale of interest.

- 'highly context specific'. Your results, with the plateaus in G, suggest that it's not _that_ bad.

————————3 The relationship between feedback amplitudes and time constants

Perhaps this could be called, 'quantifying the relationship...', since it is a method section

It would help the reader to identify exactly what your aiming at if you move to the top of the section the part from 'A finite difference approximation...', to 'The objective is to find the values of'. This last sentence is a key one which should be highlighted, in advance of details about annealing and choosing tau.

A question: in specifying tau, did you consider the tau intervals growing with timescale? I.e. I would have thought your method could separate timescales 10 and 20 much better than 1010 and 1020.

About the method's tendency to smooth peaks: is this because you are averaging over 100 anneals? If different anneals tend to centre the peak at different tau, this would smooth the peak. This may be improved I guess. e.g. you could look at the mean magnitude of the peak across the 100 anneals.

———————— 4 Climate models and radiative forcing runs

Some discussion on the nature of the three models would be worthwhile. In particular the ocean treatment, which is central to these results.

———————— 6 Implications for simpler models

The first sentence could be clarified - somewhat obscures the clear point you're trying to make.

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———-references

’BaRker and Roe’..... ’so UNpredicatable’

————–table 1

for GFDL, tau_d and tau_c are reversed I think.

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