

## ***Interactive comment on “Earth’s energy imbalance and implications” by J. Hansen et al.***

### **Anonymous Referee #1**

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Referee comments on "Earth's Energy Imbalance and Implications" submitted by Hansen et al. for consideration for publication in the Atmospheric Chemistry and Physics. Comments are indexed by page ( P ) and line ( L ) numbers as appropriate.

General comments:

This manuscript proposes that a recent minimum in solar irradiance and time-dependent effects of Mt. Pinatubo volcanic eruption aerosols on climate can explain recent global heat uptake patterns. It uses climate forcings, the observed global surface temperature record, and a simple Green's function model to argue that ocean mixing is too effective at taking up heat in climate models, resulting in model aerosol indirect forcing being tuned to be overly positive. Interestingly, no mention is made on the connection of aerosol forcing to changes in the hydrological cycle, which may provide another way to diagnose this bias.

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The manuscript is certainly a potentially interesting contribution to the scientific literature. It tends toward excess verbosity and may be a bit too tutorial for a research article. However, it should be published after minor revision

Unfortunately, throughout the entire manuscript the explication is gummed up by insertion of figure captions into the manuscript. For instance, the paragraph starting on P4, L17 begins with "Figure 1 shows climate forcings . . .". This sentence is completely unnecessary, it detracts from the flow of the manuscript, and it makes it longer. The second sentence could be rewritten along the lines of "We employ climate forcings (Figure 1) for simplified calculations . . .". The focus of this manuscript would be much improved (and it would be shortened considerably) if figures were referred to parenthetically wherever possible, and all figure caption material were moved out of the text into the figure captions, where it belongs. Again, this problem is endemic in the manuscript.

#### Specific comments

P2, L18-23. This section of the abstract could be omitted as it strays into policy and is not central to the investigation.

P2, L24 - P3, L2. Again, this section of the abstract is rather basic, and perhaps detracts from the focus of the manuscript. It could be omitted.

P2, L3-20. While this material is useful, it may be a bit tutorial for the abstract. It could be shortened and moved to the introduction.

P5, L6-9. The use of Grandchildren's names in a manuscript is an eccentricity not afforded most authors.

P6, L20. Presumably the long feedback albedo is mostly continental ice. If so, this might be mentioned here.

P8, L11-13. A one sentence summary of the Russell Ocean model would be helpful here.

P11, L2-11 & P12, L21 - P12 L14. A good deal of ocean model-observation tracer comparison work was done during OCMIP (<http://www.ipsl.jussieu.fr/OCMIP/>). Those studies support the hypothesis presented here, regarding too-vigorous ocean mixing and may be worth citing instead of a personal communication. Also see Gent et al., (2006, J. Climate).

Section 9. Church et al. (2011, Geophys. Res. Lett.) have just published an energy imbalance study that should be worked into this discussion.

P21, L 6-12. Gouretski and Koltermann (2007, Geophys. Res. Lett.) and Levitus et al. (2009, Geophys. Res. Lett.) also proposed instrument biase corrections.

P22, L5-10. Barker et al. (2011, J. Atmos. Oceanic Technol.) discusses and existng bias in Argo (pressure sensor drifts) and its effect on global ocean temperature anomaly estimates. This work should be reflected in the error discussion.

P24, L 4-13. It is too bad there is no recent heat content change estimate for the deep North Atlantic. Purkey and Johnson (2010) focuses mostly on the Southern Ocean and Antarctic Bottom Water, and their method of considering exact repeat sections only does not bring all the data available in the North Atlantic to bear on the problem. Levitus et al. (2005, Geophys. Res. Lett.) showed earlier warming in the deep N. Atlantic, but the North Atlantic Oscillation Index (and Labrador Sea Water temperatures) have changed since that study, so more recent contributions of N. Atlantic Temperature changes be different than those previously published.

P26, L25 - P27, L6. Again, there is already considerable work on ocean model mixing being too vigorous in the published literature. Please cite some of it.

P27, L12-17. Is the recently slowed rate of sea level rise associated with La Nina owing to temporary increases in precipitation over land and land water storage (as this reviewer has heard) or some other effect.

P38, L22-28 sand L44, L22-28. Again, Barker et al.'s (2011) work on Argo biases might

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be mentioned or taken into account here.

P39 L23 - P40, L 1. Again, there are published studies looking at transient tracer evolution in models vs. observations that support the point being made here. They could be cited.

The topic sentences of the first and second paragraphs of section 13.5 appear to be in conflict. Make the former more precise by adding an "average" somewhere.

P41, L13-19. Again, is this La Nina associated slow down in sea level rise thought to be owing to changes in ocean heating, or to changes in temporary land water storage, or both?

Figures 8-11, & 14. Is it possible to include error bars on any of these estimates? If so, they should be included.

Technical corrections:

P10, L12. "minimized" could be changed to "reduced".

P15, L15-16. Should "has a minimal rate of" be changed to "is a lower bound on"?

P15, L23. The entire sentence "Green's function calculations . . . constant" could be deleted.

P32, L20-21. "we bear in mind that there remains a possibility that" is an excellent example of unnecessary verbosity. Strike it and replace "exists" with "is possible".

P33, L17. Should "balance" be "imbalance" here?

Like many other portions of the manuscript, Much of the text in Section 12.4 is a figure caption! Use of good topic sentences and referring to figures parenthetically would greatly improve the manuscript by making it more concise and focused.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 27031, 2011.