April 20, 2013

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Review of:

The sensitivity of the energy budget and hydrological cycle to CO2 and solar forcing N. Schaller, J. Cermak, M. Wild, and R. Knutti

The authors consider "transient responses" of the energy budget and the hydrological cycle to CO_2 and solar forcings "of the same magnitude" in a global climate model and analyse the processes that determine such responses in the adopted model. They find that less energy is available at the surface for global annual mean latent heat flux and, as a consequence, for global annual mean precipitation in simulations of transient CO_2 concentration increase compared to what happens in simulations with an equivalent transient increase in the solar constant, while lower tropospheric water vapor increases more in simulations with CO_2 compared to what happens with a solar forcing increase "of the same magnitude" and, as a consequence, the response in precipitation is more relevant than the response in water vapor in CO_2 forcing simulations, leading **to a larger increase in residence time of water vapor in the atmosphere compared to what happens in solar forcing simulations**. Moreover, energy budget calculations show that **poleward atmospheric energy transport increases more in solar forcing compared to equivalent CO_2 forcing simulations**.

The authors also test, with particular attention, the assumption that the responses to forcings are "linearly additive, i.e. whether the response to individual forcings can be added to estimate the response to the combined forcing" and find that **the forcings do not add linearly**. The authors point out in the Conclusions that "Depending on the application, the errors introduced by assuming linear additivity when it does not apply might be considered negligible or not. In any case, **these results cannot be captured properly by models of lower complexity, which are often used to inform policy makers or for impact studies**, and are implicit when characterizing the overall magnitude of climate change or a target for stabilization in terms of global mean temperature or total radiative forcing. The linear additivity assumption is also tested for surface temperature, large-scale and convective precipitation in the tropics, midlatitudes and high latitudes and appears to be not valid in general, regardless of the sub-region considered."

General comments

In my opinion the problems proposed in this paper are interesting, the analysis is conducted with care and the proposed results are relevant and adequately documented. As a consequence, I think the paper can be published in essentially the present form.

I suggest some minor text integrations: essentially clarifications addressed to helping readers to follow the reasoning and understand the proposed results without too much effort. Some specific requests in this sense are listed below.

Specific comments

Pag. 394 line 2
"The transient responses of the energy budget and the hydrological cycle to CO_2 and solar forcings of the same magnitude in a global climate model are quantified in this study."
I would suggest something like "normalised forcing procedures" rather then "forcings of the same magnitude".

Pag. 396 line 9
"Many studies have quantified the climate responses in simulations where the forcing is increased

instantaneously (e.g. Bala et al., 2010). While much can be learned from those, there is also currently a need to understand transient climate change as this is what is occurring in the real world. The aim of this study is therefore to quantify the transient response of the energy budget and the hydrological cycle to different forcing agents, globally and zonally."
In what sense transient responses cannot be considered in a simulation in which the forcing is "increased instantaneously"?

Pag. 397 line 20
"A set of idealized transient simulations is performed with the NCAR Community Climate System Model version 3.5 (CCSM3.5) (Collins et al., 2006; Gent et al., 2010). The finite volume dynamical core of this fully coupled ocean and atmosphere model has a spatial resolution of 1.9_ in latitude and 2.5_ in longitude, with 26 levels in the vertical." This is the proposed description of the model.
Considered that only one model is used in the proposed numerical experimentation and many conclusions concerning the internal conversion mechanisms are drawn, it would help the reader to dispose of a minimal description of how some basic processes (precipitation, in particular) are numerically dealt with in the adopted model.

Pag 398 line 1
"….consists of five initial condition ensemble members to robustly quantify the model internal variability."
I would hesitate to use the adjective *robust* in connection with statistics of five elements……

Pag.399 Section 3.1 Linear additivity of the responses
The authors seem to be referring to *linearity* in two different ways:

- "linear additivity" of a specific variable with respect to the superposition of different climate forcing-modulation agents;
- linear *response* of a specific variable to a single forcing-modulation agent.

Do I understand correctly?