

REPLY TO COMMENTS AND REVIEWS OF "A COLORFUL LOOK AT CLIMATE SENSITIVITY"

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GENERAL REMARKS

The reviewer is thanked for his careful reading. As was the case previously the suggestions were thoughtful and constructive and motivated us to considerably revise the presentation of the section on cloud effects, and add more terminological precision throughout.

Specifically, and as mentioned in the itemized reply to the reviewers, we have made the following changes:

- (1) We added tables of symbols.
- (2) We reorganized §5 to better structure the presentation of the cloud effects and the derivation of the all-sky sensitivity.
- (3) We simplified the notation throughout.

We include the difference file (as requested) to more specifically document the nature and extent of the changes.

RC1

RC1 Major comments.

- (1) Spectral masking: The rationale for recapitulating the work of Koll, Jeevanjee While the work on all aspects of radiation in the LW is very detailed, the statements concerning changes in the cloud fraction on the one hand, and what is happening in the SW domain on the other, are treated superficially. The small change in cloud fraction (Myers et al., 2021; Vogel et al., 2022) only concerns tropical clouds. While the change in the liquid water content of clouds has little influence in the LW (and is therefore not discussed in this manuscript), it can have a much greater influence in the SW. For example, in mid-high latitudes, the SW effect of clouds is very different depending on how the water-ice transition is treated. In addition, section 5.4 is a bit of a "kitchen sink" in its current state. I think that part of this section should be elsewhere, in one (or more) section where the contribution of clouds to the 3 quantities, forcing, response, sensitivity would be formalised (see also my comment below on section 5.1). I understand the authors' desire to highlight the paradoxical nature of the role of clouds, but in this case they should consider a wider range of possible values and to be more explicit about what they have firmly established, what they 'roughly' estimate.

This comment motivated the substantial restructuring of §5, where more specifically we followed the reviewer's suggestion (also below) to better organize and formalize the various discussions of forcing, response and sensitivity. We also took care to ensure we

emphasized when and where we were assuming clear-sky quantities, often by adding this to section headings to increase its prominence (e.g., §5.21 and to differentiate between things we demonstrate and things we ‘crudely approximate’ (phrase taken from our revised text.

- (2) I feel some text is missing to explain how to read section 5.1 (clouds). Currently this section discusses the role of clouds on (1) forcing, (2) response (3) sensitivity, but this clarification is not done and only the “response” part is well structured. The effect of clouds on forcing is first presented very crudely (336-342), and then better formalised in the “polar” section, although this formalisation remains incomplete. For example, the term fCO_2 is much discussed, but it is not precisely defined, and we do not know exactly where and how it comes into play. Why not having a section on “forcing” where all this would be clearly presented? The same for the sensitivity part, quickly and with little justification mentioned lines 343-344, then developed section 5.1.4 but without saying it explicitly.

We have more precisely defined the various cloud quantities, and addressed the suggestion of restructuring as noted above.

- (3) In addition I’m still confused by the section on polar amplification. Based on results already presented in the manuscript, this section starts by explaining that the purely radiative sensitivity should be very high at the poles. Finally, using the equations themselves, in clear sky conditions, the authors find that the purely radiative sensitivity at the poles is low after all (Figure 9). So, what?

The last sentence of this section was confusing as it seemed to unravel the main point which was carried in the previous sentence. We have revised the ending to emphasize the ability of clouds to greatly amplify the sensitivity of the polar regions.

- (4) Specific Comments in Text Order and some details

All of the reviewer’s comments were helpful, clarified the manuscript and were addressed as suggested.