Review of “A Colorful look at Climate Sensitivity” by Bjorn Stevens and Lukas Kluft

The authors have considerably revised and improved their manuscript, and I would like to thank them for that. This manuscript now has all the qualities needed to make an exceptional article, which will have a major impact on our community because of the advances it makes on the physical phenomena that control the value of climate sensitivity. I think that developing an approach to understanding, describing qualitatively but also quantifying climate sensitivity (i.e. forcing + response) was a goal for many of us, and it has now been achieved, at least for the LW. Although it is of course based on numerous previous studies, but bringing them together and making them consistent in order to quantify climate sensitivity, both under clear skies and with clouds, is an indisputable contribution. It seems to me that one of the challenges is to make this article readable by a wide audience, and therefore to make as little reference as possible to jargon, to make some additional comment when presenting results that are 'well known', but only to a small community. In the detail of the writing, it may be helpful to regularly remind people of the meaning of the different symbols used (forcing F, sensitivity S, etc..)

Major comments:
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1) 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 their should consider a wider range of possible values and to be more explicit about what they have firmly established, what they 'roughly' estimate.

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 fCO2 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.

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?

More specific comments (in text order):
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Figure 1 is very welcome and very useful. However Figure 1, Eq. (3) and the text are not consistent. T1 and T2 are inverted between figure and text. I’m not sure T1 and T2 are necessary, Te,x and Te,y are probably sufficient. Equation of F in the figure and in the text are not consistent (I take Eq. 3 as the correct one). I’m not convince that the large arrows on the left (tau_nu,x >1) and on the right (tau_nu,y =1) are useful.

l. 158. Until now W was the amount of water vapour between the surface and the top of the atmosphere (line 75). From here you consider W as the amount of water vapour between TOA and where temperature is T. I think the distinction between the two is crucial to understand the manuscript.

l. 201: “... then the emission must also be independent of T. … explains why it cools when CO 2 levels rise.” To write that the effect of CO2 in the stratosphere is independent of temperature and in the following sentence to say that this explains the radiative cooling when CO2 is increased will lose more than one reader, even if it is perfectly accurate. I suggest either deleting the sentence on cooling (which adds nothing here), or going into more detail.

l. 200-204: It seems to me that a major simplification of the reasoning is to neglect the radiative effect of ozone, when it is not, particularly in the LW. If I'm not mistaken, the entire stratosphere is in quasi-radiative equilibrium, so the adjustment doesn't just concern the spectral range where CO2 absorbs, but also the ozone band at 9um. I have no problem with this simplification, but it deserves to be mentioned.

l. 221: “Fig. 6 shows χ…” => Fig. 6 shows the spectral transmissivity

l. 243: “… as predicted by Eq. (3)” and using the “First-to-one” approximation

l. 255: “We focus on the temperature sensitivity of Λ because it plays a role in interpreting the cloud effects…” but also to interpret climate sensitivity even without clouds!

Figure 7: please add the value corresponding to the lowest tick, it will help when reading line 262

l. 290: “where W_R(T*) = κ ν,ν ,” => where W_R(T*) * κ ν,ν = 1

l/. 290 .. as tbe => as the

l. 305 which we deonte => note(?)

l. 306: T_W = 282.13 K; How this value has been obtained?

l. 307: αe||ν−νc||/l : a minus is missing in the exponential

l. 309: “the amount 2l ln(2)”; the two “2” numbers have very different meaning and origin! I will suggest to consider a burden NC, therefore the amount will be 2l ln(N), to avoid confusion and error. Same modification in Eq. 15

l. 327: Inferences for Earth’s atmosphere and estimates of S => of sensitivity S

l. 337: “The degree of masking will mostly depend on the cloud-top pressure, although a more minor effect might arise if clouds set a colder baseline than water vapor, …” This sentence is hard to understand. I suggest to be more explicit, something like: If the cloud top pressure is lower than CO2 emission pressure, then masking, otherwise not masking but setting TW in Eq. 14

l. 344: “from 2.2 W m −2 K” why not 1.9 (results obtained with Eq. 11)?

l. 346: “...contribute to the masking of emissions from the surface” => from where radiation has been emitted, from where W is defined

l 347: please emphasise that Sα is all sky sensitivity. Because Sα is quite confusing, Sas (all sky) could be more explicit.

l. 360: “magnitude”; add: (second term of Eq 18)

l. 360 thermostat => rather a radiator ?

328-330. beginning section 5 (and also in some discussions), I think it's important to specify that the cloud fraction is assumed to be unchanged

l. 397: … we compare estimates of the Sα ; …. the all sky sensitivity, Sα. But why to compare Sα with lambda, which is a sensitivity?

l. 402-404: I understand (I hope correctly) from Figure 9 (note from the text) that fCO2 is the “corrected cloud fraction” that masks the CO2 forcing. This should be made clearer. It should also be made clear how this affects the expression of forcing. There is probably a link with ωF used later on. Why this parameter is introduce only here and not when discussing how to clouds affect the CO2 forcing (lines 336-341)? How the could temperature is computed is not specified (I think), and should be specified.

l. 419: Section 5.1.5: don't forget to specify that only the LW response of clouds have been considered here.

l. 420: … and temperatures do not change. What do you mean, as you analyse the response to a warming?

l. 442: … enough such that with $\omega F < \omega\lambda$. Please put some words to explain/remember what ωF and ωλ are.

Some details:
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l. 73: “path integrated mass burden of x...” => “path integrated mass burden of x, Bx, ...”. To avoid confusion with Planck, Mx could be better than Bx

l. 103: (?); ??

l. 146: ...the radiative response.=> the surface radiative emission response (to warming?).

Figure 4: “for two different surface temperatures (indicated)” Not indicated

l. 177: The lapse-rate constraint… please be more precise: constant lapse rate?

l. 186:-187. As a non native English reader, I find this sentence hard to understand. Suggestion:… R than it would if R were held fixed/would remain fixed

l. 192 the the

l. 200 is is

l. 212: hte => the

l. 260. Fig.3 => Fig.3 and 6

l. 299 Kluft et al. (2019, 2021) => (Kluft et al.(2019, 2021)

l. 299: not only quantitative, but also quantitative => not only qualitative, but…

l. 302: The first is to replace the source function… “=> Planck source function

l. 381: “In the cold regime” ; add “(η <1)”

l. 393: “of the fixed albedo Scs” => of the fixed albedo climate sensitivity Scs

l. 402: “calculate F” => calculate the forcing F

l. 420: “the forcing masking fraction fCO2” add somewhere “by clouds”

l. 459: all=>call

l. 464-465: problems with ,