

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-401

William Collins (Referee)

Referee comment on "Understanding the surface temperature response and its uncertainty to CO₂, CH₄, black carbon, and sulfate" by Kalle Nordling et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-401-RC2>, 2021

Review of Nordling et al.

This is an excellent paper that brings new understanding to the climate responses to different forcing agents.

Comments:

It would be useful if panel a) of figure 1 could be labelled with all the terms used in section 2.1. Or if this panel is too small, a separate schematic of showing all the terms would be useful.

Line 105: This could clarify at the start that all these fluxes are net, I first interpreted the arrows as meaning upwards and downwards components until I realised they were net.

Line 105: You use the term "cloud radiative fluxes" here, rather than "cloudy-sky radiative fluxes", I presume this is deliberate and part of the APRP decomposition. If so, this should be more explicit at this point.

Line 120: This is defined (eqn 2) as the change in OLR associated with the change in the local effective emissivity of the planet (not atmosphere). It might also be worth clarifying that changes in the effective emissivity of the planet and changes in the atmospheric

emissivity have opposite signs.

Equation 3: It might make more sense for the arrow on C to be leftward rather than rightward since it is inward flux.

Line 144: Some brief explanation of how the CS and CRE decomposition is done would be helpful. Is CRE just the cloudy-sky component?

Equation 11: I found the terminology on the second line of this equation confusing since ΔLW and ΔSW have units of K rather than W/m^2 . Couldn't you use ΔT with different subscripts?

Line 169: I think there should be a minus sign rather than a plus before the $\lambda_{LW_cld} \Delta T$ term? Or at least it should have the opposite sign to all the downward terms.

Line 204: I think it is better to say the semi-indirect effect is "inherent" in all models since it is not something that can be explicitly included or excluded. It would be better to use "meteorological adjustments" rather than semi-direct.

Section 2.4: Why do you not include land-warming corrections? Tang et al. and Richardson et al. show they are important for CO₂.

Line 246: The relationship might be stronger if you remove the land component from the ERF_{sst}.

Line 309: This seems to imply that all the feedback processes are manifesting themselves in the LW and in the clear-sky which is slightly surprising. It might be worth signalling that you will discuss why this differs with Zelinka in the discussion section.

Line 314: The feedbacks however should appear in ΔLW_{clr} . Zelinka suggest the WV+LR feedback is around half the Planck feedback (ΔT in your figure). Does this imply the feedbacks are different for aerosols and not simply a function of surface temperature change?

Line 325: Presumably this the offsetting cloud adjustment found in earlier PDRMIP papers

(Stjern et al.).?

Line 329: For models with an indirect effect I would expect ΔSW_{cld} to be as large (or larger) than the direct effect. Does this imply that there is a negative SW_{cld} feedback that adds (negatively) to the indirect effect?

Figure 5: needs units

Line 387: Can you explain more how the temperature distribution changes in bcx10 and why that means a negative ΔLW_{clr} ? Is it greater LR than WV feedback, or is the initial adjustment?

Line 404: Could you separate the ΔSW_{cld} for the models with and without indirect effects?

Figure 7: Needs unit

Figure S2: This would be easier to interpret if it were divided by ERF.