Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Cloudy sky contributions to the direct aerosol effect" by Gunnar Myhre et al.

Anonymous Referee #2

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In this work, the authors investigate the contribution of aerosol in cloudy skies to the magnitude of the aerosol direct effect (RFari). They results from a collection of global models to show that the contribution to the RFari from cloud skies is small. They also investigate the parameters that affect this between different models, showing that the shortwave cloud radiative effect is the biggest contributor to inter-model differences.

This work is within scope for ACP and would be relevant for the readers. I have some comments, particularly regarding the notation and some of the explanation, after which I believe it would be suitable for publication.

Major points

Has the choice for the meaning of RFari$_{clear}$ and RFari$_{cloudy}$ been made in a previous paper? If not, a change in the notation might improve readability. My understanding is that radiative forcings usually sum, such that Eq. 1 could be written as

$$RFari_{allsky} = RFari_{clear} + RFari_{cloudy}$$

rather than a cloud-fraction weighted sum. This would improve readability throughout the paper, as "contribution of cloud sky to RFari" is written much more often than RFari$_{cloudy}$ at the moment (perhaps $RFari_{cloudy} = AC \times RFaci|_{cloudy}$). Having a linear sum of terms would also match better with the approximate linear sum $ERFaer = ERFari + ERFaci$. This is somewhat a matter of taste, so I understand if the authors prefer to stick with the current notation.

Second, while I like the idea of the PCA decomposition, I found it hard to interpret and ended up mostly looking at the correlogram (Fig. 4b). Some more explanation and guidance to interpretation would be useful here. Does it use only the values in Tab. 1 (the global mean values)? What does it mean that SW_CRF has no contribution to PC1, yet has the strongest correlation to the cloudy sky contribution to the RFari in 4b? "Cloudy, FIX2 and FIX3 are plotted but don't affect the projection of the other variables." - I am not quite sure what this means for the interpretation of their position, is this just their correlation with PC1 and PC2? What does this shown. Also, Fig 4c does not appear to be referenced in the text at all. Is this intentional?

Third, how do these value fit in with the "error in the cloud radiative forcing" calculated using the method in Ghan (ACP, 2013)? That method would suggest a contribution to the RFari from aerosol above cloud of +0.40 Wm^{-2}. Higher values (although not as large as this) are also found in Gryspeerdt et al. (ACP 2020), which uses essentially the same method.

Finally, a few more commas would be nice to improve readability and there are a few typos which could be caught in the next round (I have identified some of them below)

Minor points

L28 - Why are SSA and SW_CRF called out here, when they control PC2?

L68 - substantially

L99 - constraint

L102 - FIX2scat, FIX3abs? These acronyms are used in Tab. 1, but not elsewhere. Having the "scat" and "abs" suffixes is helpful for those less familiar with the experiments.

L121 - Not quite clear what is going on here. Why is the variable for which you are trying to explain the variance added to the list of variables in the PCA?

L151 - "All sky RFari" or $RFari_{allsky}$? I know these are the same, but it might help keep things clear.

L161 - "present-day" instead of "current" would make this clearer that it is not referring to a current estimate.

L184 - SW_CRE vs SW_CRF - Cloud radiative effect is referred to, but the acronym suggests radiative forcing.

L188 - Supplementary information seems to be missing

L189 - FIX2 and FIX3 are hardly used. Is there more that could be said here?

L194 - "PCA finds a weak dependence"

L207 - "However, when analyzing multi-model simulations, additional factors become important."

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2019-1051, 2019.

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