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Comment on acp-2020-1317

Anonymous Referee #3

Referee comment on "On the Contribution of Fast and Slow Responses to Precipitation Changes Caused by Aerosol Perturbations" by Shipeng Zhang et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1317-RC3, 2021

Review of Zhang et al. 2020 ACP

General comments

This study evaluated the impact of artificially perturbed aerosol emissions on precipitation in ECHAM-HAM and investigated the underlying mechanisms by looking at individual energetic terms. Following an earlier study, the authors separated the fast and slow responses using atmosphere-only and slab ocean simulations. The major conclusion on global mean precipitation response is similar to previous studies, i.e. both BC and sulphate emission increases reduce the precipitation, but the impacts are through different processes (fast process for BC, but slow process for sulphate). They further compared the decomposed terms of atmosphere radiative cooling and found the largest terms are from aerosol radiative effect for BC and clear-clean sky effect (mainly due to reduced water vapor) for sulphate. Overall I think this study is useful and it provides new information to understand the climate impact of aerosols. Nevertheless, I think the description of slab ocean simulations should be improved and the interpretation of the results needs some clarifications. Below please find my specific comments.

Specific comments

Page 1, abstract, line 24: Non-absorbing aerosols can decrease surface temperature by scattering shortwave radiation, which is a fast process. Do you mean a different mechanism?
Page 3, line 84-85: do you mean the atmosphere-only model?
Page 3, line 102: “which is” -> “which are”
Page 3, line 104: is LW radiative cooling the only term? How about SW changes due to aerosol-cloud interactions?
Page 5, line 153: is the emission perturbation for all or anthropogenic sources only?
Page 5, line 158: please provide more information on how the MLO model was setup in your simulations. For example, how were the QFLUX data derived for MLO?
Page 5, line 160: the time when a slab ocean model reaches equilibrium state is dependent on the model physics and how large the model response (to the perturbation) is. Different models might need different time to reach equilibrium. It’s better to check it in your model (e.g. following the method used in Samset al. 2016).
Page 5, line 170: it would be useful for the readers learn more details on how the energy

transport term is diagnosed, e.g. did you calculate it online or offline?
Page 6, section 3.1, table 1: please check the numbers in the table. It seems to me that L&P is not equal to &ARC - &SH for most cases. Also, it's better to use same unit for the terms shown in the table and in the figure. Right now one (table) in W/m2, and the other (figure) in mm/d.
Page 11, line 401-402: based on the discussion on the fast/slow response, the reduced surface temperature is mainly due to the slow response. The sentence here reads like the dimming effect of aerosols (fast process) leads to reduced surface temperature and the major cooling in NH shown Figure 7a. Is this really what the author meant?