Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-1212-RC2, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effective radiative forcing and adjustments in CMIP6 models" *by* Christopher J. Smith et al.

Anonymous Referee #2

Received and published: 19 March 2020

This paper investigates the effective radiative forcing (ERF) from 13 CMIP6 models, and contributes to the RFMIP project. It presents contributions of particular climate forcers to anthropogenic forcing, including greenhouse gases, aerosols, and land-use. Results show a smaller anthropogenic ERF compared to AR5, and it is contributed by a stronger aerosol ERF. Additionally, the range of aerosol ERF from CMIP6 is narrower than CMIP5. This work introduces a range of methods to calculate ERF and adjustments as well. It is certainly a very comprehensive work and would make a valuable contribution to IPCC next assessment report. However, I feel there still could be some more interpretations of the work presented here. For these reasons, I am recommending this paper to be accepted for publications with minor revisions.

General comments:

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Discussion paper

1. It is interesting to see the range of aerosol ERF is narrower in CMIP6. However, it could be better if the authors can demonstrate which part (e.g., ERFari or ERFaci) contributes to the improvement most, and why is it.

2. The Introduction part could add some a short paragraph to talk about the contribution of aerosols, GHGs, and land-use to anthropogenic ERF, in terms of sign and magnitude. For example, how aerosols ERF counteracts a large part of the warming effect from GHGs meanwhile has the largest uncertainty.

3. Fig 8: Not fully understand why do the correlation between aerosol ERF and ECS/TCR. According to the definition, ECS and TCR are directly related to CO2, so it won't be a surprise to me that the correlation is bad. Can you give more explanations here?

4. This paper provides a number of methods to examine ERF from different climate forcers by using several climate models. It is certainly a very comprehensive work. However, it is easy to get lost when I am trying to understand the results. It would be of interest if some further work can be done to help the audience to better understand the results (not necessarily in this paper). For example, the adjustment from clouds contributes to most of the uncertainties. Are these uncertainties caused by different methods or different models? If it is caused by model variability, then what are the essential parameterization of clouds been used in these models? The geographical patterns shown in Fig 5, 6, 7, 11, and 12 are interesting, and it would be nice if the authors can explore more on them.

Specific comments:

1. Figure 2: maybe put this figure in the supplementary file? It is an interesting figure in terms of methodology, but not very necessarily related to the story and may distract readers.

2. Figure 3: GISS-E2-1-G is acting very differently to other models, especially on

adjustments from aerosols. Why is that?

3. Fig 4, x axis: It is hard to read the rightmost labels as they are overlaid.

4. Line 276 and the following paragraph: “This effect is traced to a slight cooling in the mid-troposphere in this model whereas other models show a distinct warming.” It is interesting, but why GISS-E2-1-G shows a cooling which is apparently different from other models.

5. Line 331: “Atmospheric adjustments are small in magnitude in the aerosol forcing experiment, but large enough such that there is a noticeable difference between ERF and RF.” I assume this conclusion is derived from table 5?

6. Line 338 and the following paragraph: I agree with the explanations. However, it is possible that absorbing aerosols play a minor role compared to non-absorbing aerosols just due to the smaller BC emissions than sulphate?

7. Line 410: Why LW ERFari+aci from the double call method doesn’t always equal the total ERF? According to equation 8 and 9, it should be closed. And. Additionally, is this only for LW or both SW and LW?

8. Fig 11: I am a bit confused about land-use ERF results here. I can understand that it is small on global averages. However, I am surprised that it is still insignificant in some regions (e.g., North America, China), even though the regional ERF there is large ($\sim$ -6 W m-2) (Fig 11). How’s the significance been calculated?

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