Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-1335-RC2, 2019

Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Role of climate model dynamics in estimated climate responses to anthropogenic aerosols" *by* Kalle Nordling et al.

Peter Haynes (Referee)

phh@damtp.cam.ac.uk

Received and published: 27 April 2019

This paper considers the response of two different climate models to the addition of anthropogenic aerosols. The aerosols are specified in exactly the same form in the two models. The paper argues that whilst the global average temperature and precipitation responses are quite consistent between the two models, there are major differences between the regional responses. The conclusion is that it is the intrinsic differences in the dynamics of the circulation between the two models that determines the differences in the regional responses. This conclusion is supported by additional evidence. The first evidence is from the results of adding the aerosol radiative forcing evaluated in one model into the second – which gives a response more similar to that to the aerosol added to the second model than to that to the aerosol added to the first. The second

evidence is from the response to aerosol in previously reported model experiments which show good spatial correlation, at least in temperature, to the responses in the new experiments reported here.

I see this as an interesting study, which usefully adds to the body of recent work emphasising the importance of the circulation response in determining regional climate change (and also in determining the geographical variation of internal variability that may dominate any clear climate change signal in the short term).

The first referee has already made some comments, which seem reasonable to me, about the general conclusions of this paper – e.g. whether a message of 'the usefulness of research on aerosol representation in models is fundamentally limited until we are more certain about circulation response' is a bit too sweeping.

My own comments are as follows:

General comment: Can you provide any information on the typical geographical distribution of differences in response between the two models you consider for other forcings? Perhaps other results from other experiments with these two models are available (either published or unpublished). Also recent papers on circulation response such as Shepherd (2014, Figure 4) have tended to show differences in winds rather than temperatures. To put your results in context it would therefore be interesting to see differences in, say, 850hPa winds. Also there tends to have been an emphasis on differences in the North Atlantic region. You are showing significant temperature differences in the North Pacific – are you aware of other work that has showed up differences in circulation response between models in that region?

p1 l19: 'unless the dynamical core of the climate models are improved as well'. 'Dynamical core' is often used to mean the part dealing with the dry thermodynamics and dynamics. If that is what you intend then I think that this may be too narrow a view – I don't see why the moist processes, including coupling between circulation and clouds, shouldn't play a role as well.

p3 l16: 'The original ...'

p3 l21: 'were run'

p3 l22: 'intrinsic slab ocean configurations of the models' – again in principle this might be something that controls the different responses of the model and doesn't fit naturally under the heading of 'dynamical core'.

p4 l2: 'properties of are' > 'properties are'?

p4 l10: 'constructed from two identical runs' – do you mean that for each model the control run was constructed from two runs, or do you mean 'two identical runs, one for each model'?

p4 l14: 'experiments' seems an odd word to use about taking differences between simulations.

p5 l3: 'from the MACv2-SP'

p5 l7: The panels in Fig A1 are very small.

p5 l18: 'nearly all the variance' – do you mean 'variance' or 'difference'?

p5 l22: 'Previous research shows that the aerosol radiative forcing can also depend on the meteorology (surface winds and precipitation) produced by the models, partly driven by the natural variability of the climate system (Baker et al., 2015; Bony et al., 2015; Shepherd, 2014).' – my reading of these papers was that they were saying that it was the response to e.g. aerosol radiative forcing, that depends on the meteorology and that the relevant aspects of the meteorology were those that were also responsible for natural variability.

p7 l2: 'disagree the most in high latitude regions' – part of this disagreement is well to the south of 60N.

p7 l3: Are you implying that the changes in surface albedo feedback cause the differ-

ences in temperatures? What reasoning are you using for that?

p7 l6: The disagreement would be 'curious' if the zonal-mean temperature response at high latitudes was locally forced. Are you confident that it is?

p8 Figure 3 etc: You are choosing to quantify the change in precipitation by the percentage change. This means, for example, that in Figure 4 there is a conspicuous difference in precipitation response over much of Australia (where the actual precipitation is very small). I see that in the Samset et al (2017) paper they choose to show change in precipitation normalised by change in temperature. Have you considered carefully whether your choice is the most effective way to show change in precipitation.

p8 l13: 'Africa'

p10 l6: I'm not convinced that the change in vertical velocity can be regarded as a cause of the change in precipitation – don't the two go together as part of an overall coupled change in circulation and precipitation.

p10 l19: For your comparison between NorESM1-MACSP and NorESM1-EF you shown only the zonal-mean and give spatial correlation information. To me the argument that you are trying to make, that the these two simulations closely resemble each other, would be more convincing if you also showed a limit amount of latitude-longitude information – e.g. adding to the information in Figs 2 and 4.

p10 l24: 'dynamical responses' – again I wonder if something like 'circulation responses' might be better (implying something more complex than simply dry dynamics).

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-1335, 2019.