Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-1029-RC1, 2021

Atmospheric Chemistry and Physics Discussions

Interactive comment on "How Asian aerosols impact regional surface temperatures across the globe" *by* Joonas Merikanto et al.

Anonymous Referee #1

Received and published: 9 January 2021

General comments:

The authors analyse slab-ocean simulations with two different climate models (NorESM1 and ECHAM6.1) to understand the global surface temperature responses to a 100% reduction in Asian anthropogenic aerosol emissions. The manuscript adds to a growing body of literature investigating climate responses to regional aerosol emissions, increasingly recognised as important because of the heterogeneous nature of the forcing, and the additional warming which is anticipated as Asian aerosol emissions in particular are projected to decline steeply over coming decades.

Although other multi-model studies have previously investigated removing Asian aerosol emissions, the present study goes further by describing a method to decompose the global pattern and seasonal cycle of surface temperature changes into con-

tributions from different energy fluxes. The novel application of this methodology to understand the global response to a regionally-localised radiative forcing in a complex climate model, provides considerable insight into the contributions of different atmospheric processes in redistributing heat to create a hemisphere-wide surface temperature response.

The manuscript is timely, well written and presented, and certainly of interest to the audience of this journal. I really only have a small number of very minor comments and technical corrections listed below that I would like to see the authors address, and subject to these I would recommend it be accepted for publication in Atmospheric Chemistry and Physics.

Specific comments:

Introduction: The authors could consider to also reference the study by Liu et al. (J. Clim 2018, https://doi.org/10.1175/JCLI-D-17-0439.1) which looked at patterns of climate response to a regional Asian aerosol perturbation in multiple models, including by performing a breakdown of the response into different energy budget terms (though far less comprehensively than in this study) - predominantly with regard to understanding the precipitation change although the temperature responses are also discussed

L91: By "background aerosol" I assume this refers to natural aerosol sources (e.g. dust, sea salt)? It might be useful just to explicitly say this here (e.g. "The background *natural* aerosols..." or something similar), so it's clear that only natural aerosols are represented differently between the two models.

L133-134: consider mentioning that that SH and LH are the *net downwards* sensible and latent heat fluxes (at least this is what they seem to be, from the sign of the terms in the equation), since this is opposite to the conventional sign of these terms which are more commonly defined as net upwards

L167-168: "We mark ... collectively as CONV" - consider adding something like "as

together they represent the convergence of energy" or something similar, so that it is clear where the abbreviation CONV comes from

L390-391: "changes in the clear-sky longwave responses spread the surface temperature warming over both hemispheres" - maybe I haven't understood the plots properly, but based on Fig 2 this statement doesn't seem right. Looking at Fig 2G, it appears to me that the LW_clr term is highly restricted to the northern hemisphere, and is mostly zero or slightly negative in the southern hemisphere. In fact it appears to be one of the few terms which *doesn't* contribute much to the southern hemisphere response. But maybe I've misunderstood the figure here, so please correct me if so! On a related note, if LW_clr is indeed the main term responsible for spreading the response to both hemispheres, there would seem to be a chicken-and-egg question of causality: Earlier in the manuscript I think the authors attribute the LW_clr response to water vapour and lapse-rate feedbacks, but presumably this requires there to first be some initial warming due to another process. I realise these are equilibrium responses so it is hard to diagnose, but again it seems counter-intuitive that LW_clr could be the main redistributor into the southern hemisphere unless it's the feedback to another term which is already moving heat into the southern hemisphere. Do the authors have any hypothesis what that initial process might be? (Again I understand this might be hard to determine from these simulations, mainly I'm curious just to satisfy myself that there's a plausible hypothesis)

L400: From Fig 4, it looks to me like the LW_clr term actually contributes more than the albedo term to both the seasonality and the total Arctic amplification (which incidentally is the same as Pithan and Mauritsen find). However the current wording makes it sound like the LW_clr term is secondary to the ice-albedo feedback. Maybe say something like "However, the longwave clear-sky response contributes *even more* to the seasonality and the overall Arctic warming" or something similar? Again, unless I have misinterpreted Fig 4 in which case please correct me!

Other technical corrections:

L38 and L54: Reference misspelt, should be 'Westervelt'

L43: Reference should be Lamarque et al., not just Lamarque

L98: There appears to be a missing word - I assume it should say "aerosol radiative forcings" or "aerosol radiaitve effects" or something similar

L102: Typo - "NoreSM1" should say "NorESM1"

L334: KK -> K

L597 & L643: Kelvins -> kelvin or kelvins (lower case k, pluralisation optional)

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1029, 2020.