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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Spatial distributions and seasonal cycles of aerosol climate effects in India seen in global climate-aerosol model" *by* S. V. Henriksson et al.

Anonymous Referee #2

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The impact of anthropogenic aerosols on the South Asian summer (southeastern) monsoon has recently attracted attention from the climate community and become an active research topic. This paper reports yet another effort to use climate models including aerosol representation to study such an impact. In the study, the authors used the ECHAM5-HAM model. A series of simulations were designed and conducted in an attempt to derive different monsoonal responses to various aerosol forcings among other factors such as SST gradient reduction. Unfortunately, the methodology adopted in this study, i.e., to use a climate-aerosol model with fixed SST is inadequate to address several emphasized issues including circulation and precipitation change forced by aerosol

effects. The authors must have already realized this weakness and, as a matter of fact, they clearly indicated it in Section 2. The reason for adopting such a method offered in the paper, i.e., lack of computational resource needed for conducting coupled model runs, however, is not appropriate. Therefore, as it stands now, the paper contains conclusions drawn with inadequate methodology and thus is not proper for publication in ACP. If conducting long integrations with coupled ocean model is indeed not feasible, the authors could use the current configuration to address adequate issues such as the aerosol distribution and radiative forcing without considering responses. Thus, I would encourage the authors to make a major revision to the paper, at least to shift the emphasis of analyses (e.g., on Figure 13 and related results).

To comment further on the methodology, when a fixed SST configuration is adopted, the ocean surface becomes stiff to atmospheric perturbation, so does the surface latent heat flux (evaporation). Aerosol forcing is often local. However, the monsoon circulation is powered by large-scale forcing where ocean-land temperature and energy contrast play a major role (i.e., large-scale stability) and the response and feedback to aerosol forcing from ocean in various scales are critical to understand the impacts of aerosols on monsoonal circulation and precipitation. This has been widely discussed in literature. Using a fixed SST configuration and also integrate the model for only 10 years leave a lot of rooms for uncertainty regarding the results. There are a few other issues in the analyses, such as using a single rainfall aggregate rather than precipitation pattern in discussion. Comparing to the basic methodology problem, these are rather secondary.

In addition, reanalysis data and prescribed SST should already reflect system responses to anthropogenic forcing including that of aerosols. The aerosol forcing applied in the model, therefore, is an additional forcing to the system and the responses would only be useful to evaluate the sensitivity of the system to the forcing, not adequate for addressing the real response of the system in particular comparing to observations. Actually, the simulations with assumed cooling over northern Indian ocean

would be more close to the actual situation under aerosol forcing (note that the total aerosol forcing would lead to surface cooling regardless whether absorbing aerosols exist or not). The comparison between SSTMODIF and ZERO would be more close to actual response to aerosols, although the model would still need to be integrated long enough to allow the system to reach equilibrium.

The paper is also suffering from lack of focus in discussion. The authors barely discussed the purpose along with physical/dynamical background and processes surrounding these simulations, and most importantly, in the discussions of results. The discussion lacks depth and thus leaves many questions unanswered. For example, why the total radiative flux anomaly appears positive in the summer due to anthropogenic aerosols? Why the modeled seasonal cycle of BC surface concentration appear to be different than observations? Why the indirect effect causes positive TOA anomaly in wintertime shortwave radiation?

Certain modeling issues are also worth explanation. The authors mentioned that the no-absorbing-aerosol run was simply configured by setting the single scattering albedo to 1. Did this apply to the bulk of aerosols or just BC? Due to the difference in extinction coefficient, this simple configuration could cause different total forcing. Also, what was the assumption regarding cloud radiative properties in the runs excluding indirect effect? When the indirect effect was included in the model, was the scavenging of aerosols during activation included? These are needed details for the reader to understand the results regardless the emphasis of the analysis is about climate response or aerosol forcing.

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