Response to the comments of the reviewer #1

We truly appreciate all the constructive comments and suggestions from both reviewers. We have adopted all the suggestions in our revised manuscript. The following are our point-to-point responses to the reviewers' comments (the comments are shown with Italic and bold font).

General comments

There are few problems with the presentation of the results and the paper misses a serious discussion on the model's limitations. Moreover, the model results are presented without any validation from satellite data or any other source.

We have rewritten many parts of the Results section in the revised manuscript in responding to the reviewer's comments. Also, the model configuration along with its limitation has been indicated more clearly in the paper. Please refer to the response to specific comments as well.

The aerosol-climate model used in our research is developed based on the community climate model of NCAR. Regarding the performance of the model itself in simulating atmospheric circulation, clouds, and precipitation with comparison to available observations, there are many articles published along with online materials on the website of NCAR. The results of modeled aerosols were compared with satellite, aircraft, and ground-based measurements as well as the other modeling studies and described in detail in previous articles including Kim et al. (2008) and Wang et al. (2009). To adopt the reviewer's suggestion, we have specifically added citations to related papers in the revised manuscript, including:

Kim, D., Wang, C., Ekman, A. M. L., Barth, M. C., and Rasch, P.: Distribution and direct radiative forcing of carbonaceous and sulfate aerosols in an interactive size-resolving aerosol-climate model, J. Geophys. Res., 113, D16309, doi:10.1029/2007JD009756, 2008.

C. Wang, G. R. Jeong, and N. Mahowald, Particulate absorption of solar radiation: anthropogenic aerosols vs. dust, Atmos. Chem. Phys., 9, 3935-3945, 2009

Collins, William D., and Coauthors, 2006: The Community Climate System Model Version 3 (CCSM3). Journal of Climate, 19, 2122-2143

Boville, Byron A., Philip J. Rasch, James J. Hack, James R. McCaa, 2006: Representation of Clouds and Precipitation Processes in the Community Atmosphere Model Version 3 (CAM3). Journal of Climate, 19, 2184-2198

Hurrell, James W., James J. Hack, Adam S. Phillips, Julie Caron, Jeffrey Yin, 2006: The Dynamical Simulation of the Community Atmosphere Model Version 3 (CAM3). Journal of Climate, 19, 2162-2183

Hack, James J., Julie M. Caron, Stephen G. Yeager, Keith W. Oleson, Marika M. Holland, John E. Truesdale, Philip J. Rasch, 2006: Simulation of the Global Hydrological Cycle in the CCSM Community Atmosphere Model Version 3 (CAM3): Mean Features. Journal of Climate, 19, 2199-2221

Specific comments

Great parts of the model results are attributed to clouds. It is not always clear which effect on clouds is the reason for the presented results. Is it changes in cloud properties due to aerosol absorption? Or is it due to indirect effects (on cloud microphysics). In any case, since clouds are the main player in this study, it is important to understand the model potential (and limitations) to describe realistic clouds and realistic aerosol effects on clouds. This is a key issue here especially because it is a challenging task and it is not clear which models are capable in doing so. A non-modeler reader (or even one who uses other models) does not have the tools to judge or evaluate the quality and the correctness of the presented model output. Can the authors provide a validation and references for the model capabilities?

To incorporate the reviewers' comment here, we have indicated more clearly in the revised manuscript (in both model description and results section) that our modeling does not consider the indirect effects of aerosols (the change of cloud properties by alteration in activated aerosol number concentration – the microphysical path). Therefore, all the cloud changes presented in the paper are caused by the direct radiative effects of aerosols and possibly by the circulation change.

On the model performance in simulating clouds, again, we have added citations of publications of CAM3 related model comparison and validation efforts (see above response).

The results part is too dense and is hard to follow. The authors show many results of numerous attributes using acronyms. It would be nice if they consider expending the results part and showing them one by one with more details and less acronyms.

The reviewer's comment is well taken. We have significantly revised the results section.

Firstly, we have done our best to eliminate the usage of model variable related acronyms, at least in text. In cases where we have to use them for the convenience in description, we have provided explanation the first time we used.

In the Results section, we have done the following major revisions:
1) Addition of new figures and figure panels to show specifically the seasonal variation of differences in convective cloud cover along with convective precipitation caused by the seasonality of BBCA emissions. Corresponding discussions are also added.
2) We have discussed more in detail that the BBCA seasonality caused difference in large-scale circulation in responding to the direct forcing of aerosols. In particular, we did not clearly indicate that the overall effects of BBCA aerosols were scattering rather than absorbing and this has been indicated in the revised paper.
3) We have made it more clearly in the discussion that the tropical ITCZ difference is to respond to the heating or cooling effect caused by aerosols, which is not necessarily reflected in actual surface air temperature change in many cases. The changes in the latter parameter are much more complicated and easy to misunderstand.

The Hovmöller diagrams are very informative but could be presented better. First, it would be nice if they will rotate the figure in order to have the latitude information in the vertical axis. Then they should consider showing Hovmöller averaged over a limited range of longitudes, showing the selected attribute evolution in time for more specific places. This can be shown together with the current (360 degrees averaged) Hovmöller figures.

We appreciate the suggestion of the reviewer. We have re-plotted the Hovmöller diagrams by switching the latitude to vertical axis and by limiting displayed latitudinal range in several figures.