The final authors' comments in response to Anonymous Referee #2

We are thankful to this reviewer for a review and suggestions. Our plan to address the reviewer's comments is as follows.

With regard to four major comments:

1. *It is unclear how the MODIS AOD product is used in the model. How is the vertical resolution obtained? It's only stated on page 835 that "we… provide vertical structures while Chung et al. (2005) assumed uniform vertical aerosol profiles". In addition, it is stated on page 828 that "MODIS onboard the Terra satellite gives near-global coverage ". Looking at a typical daily MODIS coverage, I wouldn't exactly call that "near-global" coverage.*
Answer: The aerosols vertical distributions are determined by the STEM predictions. The mass is adjusted using MODIS/AERONET, but the vertical distributions are retained, so that the vertical profiles before and after assimilation are those predicted by STEM.

The context of the sentence on page 835 is that aerosol data assimilation provides vertical structures. This was reinforced by "STEM-2K1 was used to generate the 3-D aerosol distributions" on page 826. We'll adjust some English to make this point clearer.
On page 828, we meant monthly MODIS AOD. We thank you for finding this mistake. We'll change English to clarify.

2. *In general, the authors use the term "aerosol" in a very casual manner and it is not always clear what they refer to. Is it aerosol mass? Number? Chemical composition? Spatial distribution? Horizontal distribution? E.g page 824, line 8-9 ("…observationally constrained aerosols…", "The simulated aerosols…"), page 826, lines 19-21 ("…aerosol concentration…", "…average annual aerosol distribution…"), page 830, lines 19-20 ("…assimilated aerosol distributions…", …"three-dimensional aerosol concentrations…")*
Answer: We will clarify this by rewording the content.

3. *The description of chemistry/aerosol model is very brief and there is no discussion on how the assumptions made in the model may influence on the results. What aerosol parameters are actually simulated by the model? Only aerosol mass or aerosol mass in different size categories? Is it a model aerosol model or a bin model? Are the aerosols internally or externally mixed? Is there any aerosol chemistry in the model? How are the aerosols treated in terms of wet deposition? And what about other OC emissions than biomass burning? It is also of interest to know which aerosol parameters (e.g. size, mixture) that are used by the radiation model.*

Answer: We have updated the model description section to include more details and pertinent references.
"The model simulates the mass of sulfate, BC, OC, dust (fine and coarse) and sea salt (fine and coarse) aerosols. In this study we have used the STEM-2k1 tracer model. All the aerosols are treated as externally mixed in STEM-2k1 tracer model. The dry deposition of aerosols was

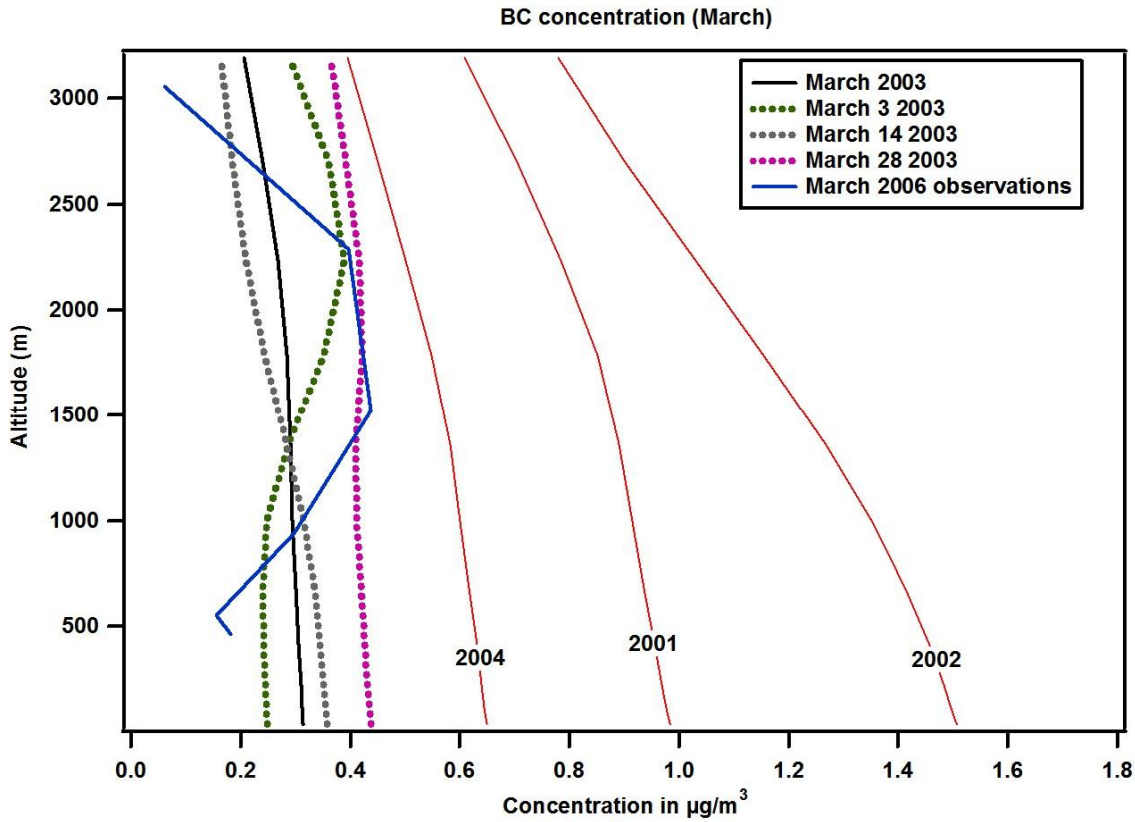
modeled using the 'Resistance in Series Parameterization' (Wesley et al., 2000). Wet deposition of aerosols was calculated as a loss rate based on precipitation rate obtained from MM5 meteorology model. Further details of the wet scavenging and aerosol aging calculations can be found in Adhikary et al., 2007. In addition to the biomass burning, the other OC emissions sources used in are the anthropogenic emissions of OC from the TRACE-P emissions inventory."

Aerosol mass was converted to aerosol extinction coefficient for each aerosol specie using OPAC and Penner's study. We'll include this conversion algorithm in the revised manuscript.

4. *Discussion on vertical BC mass concentration profiles. The authors state that "it is encouraging that the observed BC [mass] concentration magnitude is approximately in the simulation range". This may be true, but the model is generally substantially higher than the observations. What could be the reason for this discrepancy? And what could be the reason for the discrepancy in BL concentrations?*

Answer: The profiles presented in this figure have to be carefully considered. The UAV profiles for several days are presented as a monthly average and compared with a monthly mean profiles derived from the model. The model results for multiple years show that the interannual variability due to meteorology on the amount of BC reaching this location is large. For 2003 March we show more clearly the variability in vertical profiles within the month by plotting profiles for a few specific days in March. We see that during periods the model does produce profiles with vertical structure with BC maximums in layers 2-3 km above the surface.

Revised vertical profile figure below in next page



With regard to minor comments:

We agree to most of minor comments and will revise the manuscript accordingly. However, we would handle the following comments differently.

Page 825, line 12: The authors say that the interannual variability of the simulated East Asian summer monsoon rainfall was improved when using nudged global reanalysis data. How much did the simulation improve? Are there still weaknesses?

The use of nudging in regional climate simulations has been tested by us (PNNL) and others (e.g., von Storch et al. 2000; Castro et al. 2005) and found to significantly improve the simulation of interannual variability. An example of long-term regional climate simulations without nudging is given by Qian and Leung (2007), who showed relatively low anomaly correlation between the monthly mean precipitation anomalies in a simulation over China by the same model (MM5) with observations. With nudging of the large-scale circulation, the simulation used in the present study has a much higher anomaly correlation for monthly mean precipitation. Nudging also improves the variability of the simulated precipitation at daily and sub-daily (diurnal) time scales. However, mesoscale convective systems that form in the Bay of Bengal are not well simulated

by the model, which lead to dry bias in precipitation in the Gangetic Plain as well as diurnal timing of precipitation over the Bay of Bengal.

We have expanded the summary of the regional climate simulation based on the above discussion in the paper.

Page 826, line 3: The authors state that three-hourly meteorological data from the PNNL regional model are used as input to the chemistry model. Does this include cloud and precipitation data? Why is this data then not used for the radiation model?

Cloud and precipitation, in addition to other meteorological forcing data simulated by the regional climate model, are used as input to the chemistry model to provide spatially consistent atmospheric conditions to simulate aerosol and chemical transport processes. To obtain the best estimates of radiative forcing, however, remote sensing products of clouds are used as input to the radiation model. This is consistent with our overall strategy using an offline radiation model at the last step to assimilate as much observations as possible to provide the best observationally constrained estimates of aerosol forcing that also take advantage of the higher spatial and temporal information of aerosols simulated by the climate and chemistry models.

Page 831, lines 6-9: Sea salt is only adjusted towards the coarse mode AOD. How does this work over the ocean where sea salt could contribute substantially to the fine mode AOD?

We choose not to separate out sea salt and dust into fine and coarse modes in the assimilation step because of the large uncertainty associated with resolving the dust and sea salt into size bins based on effective radii. To avoid propagating this uncertainty further in the assimilation method, sea salt and dust were adjusted towards coarse mode AOD. We have also run a test case where fine mode sea salt was adjusted with fine mode AOD and found that it did not have a significant impact on the contribution of fine mode sea salt to the total AOD over ocean.