Anonymous Referee #1

The authors inter-compared aerosol speciation from the MISR JOINT_AS product and the SPRINTARS model. The authors show that the MISR JOINT_AS product can be used to assist model validation, which shall be interesting to modelers. However, there are some major issues I would hope the authors can address.

: We would like thank the reviewer for providing valuable comments on the manuscript. Please find below our replies following the comments. Comments are listed first, followed by replies. Please note that the brown text inside parentheses is from the revised version and the red text shows changes from the previous version.

1. Comparing an 8-day model run (July 1-8, 2006) with a 15 year (July only) climatology bothers me. To justify their study, the authors assume that AOD distributions don't change from year to year. As shown from Figure 5, however, AOD distribution does have a yearly variation (also mentioned by the authors). Therefore, the comparison between the 8-day model data and 15 year MISR climatology is less meaningful as I/readers do not know if the similarity and/or the differences are introduced by the real difference between the model and observations or simply caused by the temporal variability in the MISR JOINT_AS data. I would suggest the authors also show the MISR JOINT_AS data from July 2006, which should not be a difficult thing to do.

: We agree with this point. As the reviewer pointed out, the interannual variability of AOD is considerably large. In the revised manuscript, we compare AOD from the GOCART model with those from MISR and SPRINTARS. In both MISR and GOCART, the AOD climatology in July is an average over eight years between 2000 and 2007.
One of the key messages in our paper is the importance of using probability density functions when comparing observed and simulated AODs. Unfortunately, the repeat cycle of Terra satellite is 16 days. So MISR's data from July 2006 may not be enough to build a probability density function of AOD for each aerosol component.

2. As shown in Figure 3, both non-absorbing and absorbing aerosols are significant over East Asia. However, for the model and MISR data comparison, only nonabsorbing aerosols are shown. What about adding sulfate, dust and carbonaceous aerosols from the SPRINTARS model to Figure 3 as well?

: We have added AOD from GOCART and SPRINTARS to the revised Figure 3.

3. The authors need to justify the reason why only East Asia, Eastern Atlantic and Western Africa regions are selected. Aerosol events are also significant over regions such as India, the Middle East and South America during the study period.

: Our three target regions, China, Northwestern Africa and Central Africa, are the largest emission sources of sulfate (Ohara et al., 2007), dust (Engelstaedter et al., 2006), and carbon (van der Werf et al., 2010), respectively. MISR's aerosol-type information becomes more reliable in the regions

where AOD exceeds about 0.15 and 0.2. So we selected the three regions for better accuracy of MISR AOD by components. The following paragraph was revised to explain why we chose the three regions.
(MISR's aerosol-type information becomes more reliable in the regions where AOD exceeds about 0.15 and 0.2 (Kahn et al., 2010; Kahn and Gaitley, 2015). Therefore, here we focus, in particular, on characterizing AOD distributions in the regions near major aerosol emission sources: East Asia, the Sahara Desert, and West Africa with comparisons between MISR climatological observations and two model simulations.)

4. To my understanding, the comparison between the 8-day model data and the 15 year MISR climatology seems to serve two purposes: (1) raise the awareness of the MISR JOINT_AS product; and (2) demonstrate the usage of the MISR JOINT_AS product through inter-comparing with the SPRINTARS model. To really make this study publication-worthy, it might be useful to show comparisons between the MISR JOINT_AS data and other observations. For example, using space-borne or surfacebased lidar data, which also includes aerosol speciation. Or is it possible that the authors can compare MISR JOINT_AS data with AERONET-based climatology (e.g., fine mode fraction)?
: Many thanks for this suggestion. In the revised manuscript, the total AOD from AERONET is also compared with the other datasets. However, comparing fine mode fraction of AOD and Ångström exponent was done for the MISR Level 2 Aerosol Product by Kahn and Gaitley (2015), so it is not the main focus of this study. Here, we highlight the added value of MISR JOINT_AS data: providing fractional optical depths for non-absorbing, absorbing and non-spherical particles whose optical properties are similar to aerosol species simulated in chemistry models.
As mentioned in the Introduction, there are other satellite datasets providing AOD by components. Our manuscript provides a summary of the previous studies that have analyzed other datasets. However, adding another satellite dataset to the current comparison between MISR and two models is beyond the scope of this paper. For example, comparing MISR with POLDER requires careful interpolation of POLDER's AOD at 865 nm to MISR's AOD at 555 nm, and as they are in different orbits, there are few good coincidences. Our point of view on inter-comparison of speciated AODs from different satellite instruments is now stated in the Introduction.
(Even these state-of-art satellite observations providing information on AOD by components cannot be readily compared with simulated AOD for different aerosol types. The aerosol type in satellite retrievals is defined by optical properties, whereas the simulated aerosol type is specified by chemical composition.)

References

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van der Werf, G. R., and Coauthors, 2010: Global fire emissions and the contribution of deforestation, savanna, forest, agricultural, and peat fires (1997-2009). Atmos Chem Phys, 10, 11707-11735.