Anonymous Referee # 3

: We would like to thank the Reviewer for providing thoughtful comments on the manuscript. Please find below our detailed replies. 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.

This paper presents comparisons of AOD by aerosol components obtained from the MISR sensor and the chemistry transport model (CTM) SPRINTARS for different regions (East Asia, West Africa and Sahara Desert). The approach is interesting, but the method is not robust enough at this stage and it is not easy to judge the contribution of this method for improving the model used. The methodology proposed in this work is realized in a too simple and incomplete ways and based on comparisons of MISR AOD derived by particle types with those simulated by the CTM SPRINTARS model using single aerosol species.

: SPRINTARS CTM does not assume a single aerosol species. The aerosols in SPRINTARS always exist as a mixture of sulfate, sea salt, dust, and carbonaceous aerosols. Our study used a single simulation result where optical depths are calculated for four different types of aerosols in the mixture.

The SPRINTARS simulated AOD using carbonaceous aerosols only are combined with MISR AOD for weakly plus strongly absorbing aerosols. This comparison excludes the possible mixing of carbonaceous aerosols with secondary aerosols that could strongly affect the absorbing properties of aerosols. In addition, and depending on the mineralogy and size distribution, desert dust aerosols are able to absorb solar radiations and are not taken into account for the comparisons. For non-absorbing particles, comparisons are based on sulfate particles only, while secondary organics and inorganic aerosols as well as fine sea-salt could also significantly contribute to AOD over polluted coastal regions as studied here over East Asia. These aerosol species are not taken into account and this approach can create important bias in the AOD comparisons.
In that sense, the presented simulations are not sufficiently complete to make realistic comparisons. As most of CTM models contain a detailed description of atmospheric aerosols, including secondary organic and inorganic particles, I recommend to carry out new more complete simulations to make further comparisons. A more adequate particle pairs must be defined from SPRINTAS (Table 1) to realize the comparisons.

: We agree that the aerosols in both GOCART and SPRINTARS are somewhat simplified. 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. So there are dominant aerosol types in each region, and the simplified aerosol mixtures in models may represent the characteristics of aerosols over the regions.
Even with output from a chemistry model simulating more realistic mixtures of aerosols, we cannot fully use the detailed aerosol information to compare with satellite aerosol retrievals. As mentioned in the Introduction (Unfortunately, the retrieval of AOD by type from satellite observations and using the retrieved AOD for chemistry model evaluation have been, and remain, a significant

challenge. … In their study, total column AOD and surface reflectivity were derived from AATSR observations and these variables were used to simulate spectra for pre-defined aerosol mixtures, which were selected by comparison with the observed SCIAMACHY spectra.), the particle composition information from satellites is limited. Nevertheless, even the limited information on aerosol composition information from MISR can be extremely useful for evaluating chemistry models and studying climate change.

Furthermore, it raises the question of why the simulations are carried out over a short period of time and directly compared with climatological mean MISR AOD. It would be more rigorous to perform simulations for a specific month or seasons directly comparable with MISR AOD for similar periods.

: We agree with this point. In the revised manuscript, we compare AOD from the GOCART model for 8 years between 2000 and 2007 with the MISR climatology for the same period, along with the 8-days average from SPRINTARS. Figures 2, 3, 4 and 6 have been redrawn with climatological maps and histograms of GOCART AOD.

Based on these new findings, the authors must further discuss the contribution of this method on the improvement of the model used.

: We thank for the reviewer's comment. We have revised the Conclusions.
(We believe that the comparison of AOD distributions by components between MISR and chemistry models will provide useful guidance to improve model emissions, transport processes, and will ultimately improve computations of aerosol-related radiative forcing in the models. The first step should be matching simulated AOD by component with those from MISR by adjusting emissions and lifetime of aerosols in models.)

Important points:
A detailed presentation of the model CTM SPRINTAS used in this work is totally absent, although it is an important tool for the study. Authors should provide more detailed information about the simulations, as the inventory emission, the processes used for primary dust and sea-salt emissions.
What processes are included in the CTM SPRINTAS for secondary (organic and inorganic) aerosols? Particles are represented by bins or log-normal ? Are they represented in external or internal mixing ways ? The deposition processes (dry and wet) should be also provided.
As most of the comparisons are based on AOD, the estimation of this optical parameter is necessary and the authors should indicate the optical properties used for each aerosol and the treatment of hygroscopicity.

: In the Introduction, we list some references giving detailed information on GOCART and SPRINTARS. We would like to highlight the added value of MISR JOINT_AS data: providing fractional optical depths for spherical non-absorbing, spherical absorbing and non-spherical particles whose optical properties are similar to simplified aerosol species simulated in chemistry models. We cannot investigate the detailed chemistry of aerosols in GOCART and SPRINTARS using MISR observations. The valuable, but limited information from MISR AOD at mid-visible wavelength by components cannot directly constrain aerosol size distributions, the formation of secondary aerosols, mixing process, deposition, and hygroscopicity of the aerosols in chemistry models.

As mentioned below, the period of simulations for each case studied (East Asia, Sahara Desert, South Africa) is not consistent with the period of MISR observations. I recommend to perform new simulations and comparisons for similar periods. It would be very interesting to include AOD simulated and observed over land for the Sahara Desert region.

: In the revised manuscript, we provide simulation results from GOCART for 8 years. The dust AOD over the Sahara Desert is shown in the revised Figure 4.

Minor comments :

P33902, L5 : the « high-resolution » term is not adapted here for 7km of horizontal resolution. I would change by « ...and simulations with an horizontal resolution of 7 km from...»

: Text has been revised.

(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. One is from the Goddard Chemistry Aerosol Radiation and Transport (GOCART) model (Chin et al., 2002, 2014), and the other is from the SPectral RadIatioN-TrAnSport (SPRINTARS) model for Aerosol Species (Takemura et al., 2002, 2005) interactively coupled to the Nonhydrostatic Icosahedral Atmospheric Model (NICAM) (Satoh et al., 2008, 2014; Suzuki et al., 2008).)

P 33904, L8 : ... « only for AOD values less than about 0.02,... ». In figure 1, number of observations indicate absorbing AOD higher than 0.02 ?

: There are only three cases where absorbing AOD is higher than 0.02. In those three cases, AOD is between 0.02 and 0.021.

P 33906, L24 : « ...because of the broad impact of Asian aerosols on the North... ». Please indicate the impact here : on air quality ? climate ?

: We appreciate this comment. Yu et al. (2008) showed the impact of Asian originated aerosols on aerosol loading over North America, but did not specifically assessed the impact on climate or air quality. Text has been revised.

(Rapid increases in emissions of aerosols and their precursors in East Asia have caused growing concern because of the broad impact they have on aerosol loading over the North Pacific and mainland North America, especially the United States (Yu et al., 2008).)

P33907, L6 : « ...due to transport and deposition processes. ». This specific point should be detailed here. The deposition is due to dry deposition? If scavenging occurs, authors should provide analyses of precipitation for this event.

: The deposition includes both dry deposition and wet scavenging. In our study, we focus on comparing climatological AOD distributions in a statistical sense, with overall results that are affected by both the emissions and removal processes used in chemistry models. We think that analyzing individual precipitation events during the analysis period and assessing each model's wet scavenging parameterization is beyond the scope of this study.

P 3.3 : I would replace « West Africa » by « South-Africa »
: Thank you for suggestion. The major emission source is located in Central Africa. The subsection's title has been revised.

Figure 1. Please indicate the wavelenghts used for the MISR derived absorbing and non-absorbing AOD and simulated SPRINTAS AOD.
Figure 2. Please indicate the wavelenghts.
: The wavelength information can be found in the data section. Figure1's caption has been revised with the wavelength information.
(The representative vectors have eight elements, which are the mid-visible (558 nm) AODs assigned to the eight components in the MISR's algorithm climatology.)
(The GOCART CTM provides daily optical depths of total aerosols, black carbon, dust, organic aerosols, sulfate and sea salt at 550 nm wavelength.)
(SPRINTARS simulation is coupled to high-resolution NICAM model, which reports AOD at 550 nm wavelength every three hours for four different types of aerosols (carbonaceous, dust, sea salt, and sulfate) with a horizontal resolution of 7 km globally.)
Thank you again for all of the comments.