

Interactive comment on “Improvements in AOD retrieval from geostationary measurements over Asia with aerosol optical properties derived from the DRAGON-Asia campaign” by M. Kim et al.

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Comments from the Reviewers: The reviewer's comments and suggestions were precise and helpful to improve the scientific contents of the manuscript. We appreciate the efforts by the reviewer and editor. Basically we reflected all the comments and suggestions by the reviewers.

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Reviewer #1:

General comments

C7181

1. Some sections in the manuscript just report the results found but not explain what causes them. Therefore, the authors need to analyze more in detail the results with relevant references.

- Per reviewer's suggestion, detail and relevant references of results were added throughout the revised manuscript.

2. The most important scientific issue in this study is the updated aerosol optical properties from the DRAGON-Asia campaign that can improve the AOD retrieval in single visible channel algorithm. However, since in the case of SSA, it is only available under the specific condition (i.e. AOD at 440 nm is larger than 0.4), the LUT based on AERONET INV data could not work well in the single visible channel algorithm when the AOD is small. Therefore, further evaluations with AERONET sun-photometer observations are needed for the cases divided into small and large AOD (i.e. $\text{AOD}_{440\text{nm}} < 0.4$ and $\text{AOD}_{440\text{nm}} \geq 0.4$).

- As reviewer's comment, AERONET science team recommend to use the inversion data where the AOD at 440 nm is higher than 0.4. Thus the number of data point for low AOD bin (< 0.3 at 550 nm) was clearly lower than that for higher AOD bins as shown in table 2 in the revised manuscript. The insufficient data might raise the uncertainty in the assumed aerosol model for low AOD. Thus, per reviewer's suggestion, the uncertainty related with the number of inversion data was described in lines 601-604. Additionally, the MI AOD was evaluated with AERONET value by dividing into small and large AOD case, and the comparison result was shown in lines 604-608 in the revised manuscript.

3. Occasionally, it is difficult to follow the logical flow of the text because of weak connection between sentence and sentence or between paragraph and paragraph. The authors need to clarify and rephrase difficult sentences for delivering more clearly what they want to show in this paper.

- Per reviewer's suggestions, many sentences and paragraphs were rephrased throughout the revised manuscript.

C7182

Specific comments , Pages 10774, lines 5 in Abstract: Please provide the exact period of DRAGON campaign.

- The exact period (March to May, 2012) was added on line 30 in the revised manuscript.

Pages 10774, lines 9~11 in Abstract: Please clarify the sentence, i.e. explain, clearly how much “4% difference in SSA” is and why the overestimation of SSA leads to an underestimation of AOD.

- Per the reviewer’s suggestion, the sentence in lines 35 - 40 was revised. Details can be found in the main texts.

Pages 10774, lines 13~14 in Abstract: Since the authors mentioned that even a small difference in SSA can lead to a large difference in AOD, they need to provide the seasonal standard deviation for each seasonal SSA mean so that the readers can estimate how much the SSA varies at each season.

- The standard deviation was shown on lines 42 and 44 in the revised manuscript.

Pages 10774, lines 23 in Abstract: Please clarify what “original aerosol model” is.

- Per the reviewer’s suggestion, the meaning of the “original aerosol model” was explained in lines 45-48 in the revised manuscript.

Pages 10774, lines 24-25 in Abstract: I don’t understand “while the change of the y-offset of -0.08 is significant”. What does “significant” mean?

- The sentence was corrected and rephrased in lines 55-57 in the revised manuscript.

Pages 10774, lines 22-27 in Abstract: The last concluding sentence is derived from the previous sentences related with the regression slope, y-offset, and correlation coefficient. However, it is difficult to distinguish which values are representative for the “original” or the “new”, and therefore hard to understand how the authors conclude “significant improved”. Please rephrase the sentences.

C7183

- To clarify the meaning of sentences, the paragraph in lines 53-59 was revised in the manuscript.

Pages 10775, lines 7-8 in Introduction: The authors might want to change “The global aerosol distribution shows high spatial and temporal variability, and many studies . . .” into “Since the global aerosol distribution shows high spatial and temporal variability, many studies. . .”.

- The sentence was corrected in lines 71-72 in the revised manuscript.

Pages 10775, lines 9-15 in Introduction: Please select some of the most important or representative papers as reference and replace von Hoyningen- Huene et al. (2003) with von Hoyningen-Huene et al. (2011).

- The list of papers in lines 74-76 was updated as per the reviewer’s suggestion.

Pages 10775-10776, lines 26-2 in Introduction: Please provide the exact values (i.e. Pearson coefficient, regression slope, and the percentage of data within an expected error bound.) for supporting the sentence.

- The statistic values were added in lines 98-99 in the revised manuscript.

Pages 10777, lines 14 in Introduction: Please explain briefly “critical reflectance method”.

- Detail of the “critical reflectance method” was described in lines 435-442 rather than in introduction.

Pages 10777, lines 20-22 in Introduction: Please clarify the difficult sentence.

- The paragraph in lines 133-146 was revised, and the sentence was changed as lines 143-146 in the revised manuscript.

Pages 10777, lines 22-23 in Introduction: Please explain why the BAOD correction is used in this study, but the critical reflectance method is not.

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- As mentioned in lines 145-146, the critical reflectance method was not adopted here to evaluate the effects of aerosol model assumption in the AOD retrieval. Additionally, the critical reflectance method can be assured when the aerosol distribution is optically homogeneous over heterogeneous surface. Thus it can be limited where diverse source of emission lead large spatial variation of aerosol condition.

Pages 10778, lines 2 in 2.1 AERONET: Please present the kind, version, and level of AERONET data used in this study at the subsection title.

- The subsection title was changed into "DRAGON-NE Asia Campaign" on line 160 in the revised manuscript.

Pages 10778, lines 15 in 2.1 AERONET: Generally, the "trend" has the meaning of "temporal change or variation towards something new or different". It might be good to be changed into "behavior".

- The "trend" on line 181 was changed to "behavior" in the revised manuscript.

Pages 10778, lines 26-27 in 2.1 AERONET: Please enhance the sentence with relevant references and further discussions about the spatial AOD and AE over East Asia.

- The sentence was enhanced with a reference of [Park et al., 2014] on line 192 in the revised manuscript.

Pages 10779, lines 1 in 2.1 AERONET: Is there any special reason why the "daily" data are used. If yes, please mention it.

- The reason was mentioned in lines 196-199 in the revised manuscript.

Pages 10779, lines 3 in 2.2 Meteorological imager: The authors might want to change the subsection title into "2.2 COMS meteorological imager".

- The subsection title was changed into the "2.2. COMS Meteorological Imager" on line 210 in the revised manuscript.

C7185

Pages 10779, in 2.2 Meteorological imager: Since many readers might not know well about COMS, please provide more information about COMS calibration status, available, products, and web address with relevant references.

- The paragraph in section 2.2 was revised in lines 221-226 as per the reviewer's suggestion.

Pages 10780 in 2.3 MODIS AOD: Please explain why the authors choose MODIS-AQUA AOD products to estimate BAOD over East Asia. Furthermore, the expected error of BAOD can be over $\pm 100\%$ when BAOD is smaller than 0.05. Since generally BAOD is very small value, the authors need to mention or discuss the possible error range in the BAOD correction.

- The reason of using the MODIS products was explained in lines 234-237 in the revised manuscript, and the demerits of using the MODIS products were shortly mentioned in lines 239-242. And the uncertainty related with the BAOD assumption was described in lines 477-494 in section 3.5.

Pages 10781, lines 5 in 3 Single channel algorithm: The authors might want to put a new subsection title, "3.1 Cloud masking", before the opening paragraph of threshold method for distinguishing cloud and aerosol pixel.

- The subsection title was put on line 270 in the revised manuscript.

Pages 10781, lines 13-19 in 3 Single channel algorithm: Please briefly explain what each threshold value is targeting at.

- The target of each threshold was shown in lines 279-282.

Pages 10781, lines 20 in 3.1 Surface reflectance and BAOD: The authors might want to change the subsection number, "3.1" into "3.2".

- The subsection number was changed into "3.2" in the revised manuscript.

Pages 10781, lines 24 in 3.1 Surface reflectance and BAOD: I cannot find Kim et al.

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(2015) in the reference list of the manuscript.

- The paper is in preparation. There was a mistake during type setting process.

Pages 10781, lines 24-25 in 3.1 Surface reflectance and BAOD: “An underestimation of BAOD results in an overestimation of retrieved AOD” is wrong and contradictory to the explanation at Pages 10777, lines 17-20. Please correct it.

- The “overestimation” was corrected by “underestimation” on line 297 in the revised manuscript.

Pages 10782, lines 6-8 in 3.1 Surface reflectance and BAOD: I don't understand why authors mention the BAOD median values over land and ocean. Please explain what you want to show with the median values.

- The sentences were revised in lines 304-308.

Pages 10782, lines 17 in 3.2 Aerosol model: The authors might want to change the subsection number, “3.2” into “3.3”.

- The subsection number was changed into “3.3” in the revised manuscript.

Pages 10783, lines 11-12 in 3.2 Aerosol model: AERONET INV data provide four spectral SSAs at 440, 675, 870, and 1020 nm. I guess that authors choose the SSA at “675 nm” because it is the closest wavelength to the COMS MI central wavelength. Please explain why.

- The explanation was shown in lines 349-351 in the revised manuscript. , Pages 10783, lines 12-15 in 3.2 Aerosol model: Please provide the seasonal standard deviation ($\pm 1\sigma$) with each seasonal SSA mean.

- In the revised manuscript, the sentence which describes the seasonal variation of the SSA was removed, but the standard deviation of the SSA for MAM was shown on line 355 and 366.

C7187

Pages, 10783, lines, 20-21 in 3.2 aerosol model: since SSA is only available under the specific condition (i.e. AOD at 440 nm is larger than 0.4), it is difficult to understand how to calculate the SSA mean for an AOD bin of 0.15. The authors need to explain more about how to derive the mean value for each bin, and also to add the bin size, range, and number of data fall into each bin.

- Since this study used daily inversion data, which provides diurnal average value of each product, there are data points with AOD lower than the threshold. In the compiled inversion dataset, the minimum AOD obtained with SSA was 0.157 at 550 nm. - As reviewer's suggestion, the bin sizes were described in lines 347-349. The data number was also shown in Table 2 in the revised manuscript.

Pages 10784, lines 13-22 in 3.2 Aerosol model: Please enhance the sentences by citing relevant references.

- The paragraph was revised with relevant reference in lines 372-380 in the revised manuscript.

Pages 10785, lines 7 in 3.3, sensitivity to assumed aerosol optical properties: the authors might want to change the subsection number, “3.3” into “3.4”.

- The subsection number was changed into “3.4” in the revised manuscript.

Pages 10785, lines 10-15 in, 3.3, sensitivity to assumed aerosol optical properties: Please explain why the authors perform the sensitivity test with “assumed conditions”, i.e. a $\pm 4\%$ variation in SSA relative to the reference condition, the surface reflectance of 0.05 and 0.10, and the scattering angle from 135.7° to 173.2° .

- The explanation was shown in lines 402-403 in the revised manuscript.

Pages 10786, lines 6-9 in 3.3 Sensitivity to assumed aerosol optical properties: Please, put “+” in front of a positive error in the manuscript.

- We put “+” symbols in front of a positive error in lines 427-430 and 435 in the revised

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manuscript.

Pages 10787, lines 5-7 in 4.1 Comparison with MODIS AOD: The authors might want to cite Yoon et al (2014) with mentioning another advantage that the AOD derived from geostationary satellites can minimize the uncertainty caused by the different/limited sampling of polar-orbiting-satellite in the trend estimate.

- We cited Yoon et al. (2014) and add a sentence in lines 518-520 in the revised manuscript.

Pages 10787, lines 17-19 in 4.1 comparison with MODIS AOD: I don't understand the meaning of "...03:00 UTC 55" and "... 05:00 UTC 15".

- The time was revised by "03:16 ... UTC" on line 523 in the revised manuscript.

Pages 10789, lines 1-4 in 4.2 Comparison with AERONET: DRAGON-Asia: Please clarify and rephrase difficult sentences, and explain more in detail why the comparison results (i.e. slope, correlation coefficient, and percentage of the comparison dataset distributed within $\pm 30\%$ on the basis of the one-to-one correspondence) in Fig.8(d) are worse than the results in fig.8(c).

- The sentence was revised with detail of the comparison results in lines 587-596 in the revised manuscript.

Pages 10790, lines 7-14 in 4.2 Comparison with AERONET: This part just reports the results found in the manuscript but not explain what causes them. Please analyze more in detail the results with relevant references. Pages 10790, lines 15-27 in 4.2 Comparison with AERONET: The authors need to categorize the AERONET sites as e.g. improved and worsened results compared to the original, and explain more in detail the leading causes of the results with relevant references.

- Per the reviewer's suggestion, the paragraphs in lines 634-682 were revised to show detail of the comparison for each site.

C7189

Pages 10792, lines 29 in 5 Summary: I cannot find Choi et al. (2015) in the reference list of the manuscript.

- The paper was accepted in AMTD, and was updated in the reference list.

Pages 10793, lines 1-2 in 5 Summary: The authors need to explain briefly why.

- The sentences were revised in lines 746-748 in the revised manuscript.

Pages 10799, in Table, 1: It is difficult to distinguish the italic font. Please mention again the period for dDRAGON2012.

- The period was shown in bottom of Table 1.

Pages 10800, in Table 2: It is difficult to distinguish the italic font. Please add the bin size, range, and number of data fall into each bin, and provide the seasonal mean with 1 standard deviation. Pages 10801 in Table 3: Please add the bin size, range, and number of data fall into each bin, and provide the seasonal mean with 1 standard deviation.

- Table 2 and Table 3 was combined and revised as Table 2 in the revised manuscript.

Pages 10802, in Table 4: please add a new column of "relative difference between DRAGON AOD and, MI AOD". Pages 10803, in Table, 5: Please add a new column of "relative difference between DRAGON AOD, and, MI AOD".

- The difference between DRAGON AOD and MI AOD was added in Table 3 and Table 4 in the revised manuscript.

Pages 10808, in Figure 5: It is difficult to distinguish the colors for different AODs. Please change it.

- The Figure 5 was revised to show the compiled size distribution from the original model and the new model. The color bar was changed also.

Pages 10812, in Figure 9: Please put the labels (a) and (b) on the figures.

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- We put the label (a) and (b) in the Figure 10.

Additional references used in this review

- Those references were cited in the revised manuscript.

von Hoyningen-Huene, W. Yoon, J. Vountas, M. Istomina, L. G. Rohen, G. Dinter, T. Kokhanovsky, A. A. and Burrows, J. P.: Retrieval of spectral aerosol optical thickness over land using ocean color sensors MERIS and seaWiFS, *Atmos. Meas. Tech.* 4, 151-171, doi:10.5194/amt-4-151-2011, 2011. Yoon, J. Burrows, J. P. Vountas, M. von Hoyningen-Huene, W. Chang, D. Y., Richter, A. and Hilboll, A.: Changes in atmospheric aerosol loading retrieved from, space-based, measurements during the past decade, *Atmos. Chem. Phys.*, 14, 6881-6902, doi:10.5194/acp-14-6881-2014, 2014.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/15/C7181/2015/acpd-15-C7181-2015-supplement.pdf>

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 15, 10773, 2015.