

Interactive comment on “Estimating ground-level PM_{2.5} in Eastern China using aerosol optical depth determined from the GOCI Satellite Instrument” by J. Xu et al.

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General comments: In this study remote satellite derived PM_{2.5} fields are presented. These fields have been obtained based on GOCI observations of AOD and in-situ ground-based PM_{2.5} measurements that in turn has been linked to each other according to relationships between these two parameters that have been established from model simulations, where emissions inventory for China and surrounding East Asia regions have been used. I think this is a very good approach in an attempt to monitor PM_{2.5} from space over the present very interesting regions. However, there are two important questions or major comments that are in dispute and must be settled before

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this study can be accepted for publication in ACP.

RESPONSE: We are grateful to the referee for recognizing the value of this work. Thank you for the comments and suggestions below. We have taken them into full consideration when producing the revised version of manuscript. Responses to these comments are provided below.

Major comments: 1. Second paragraph of Section 3.2 and corresponding Figure 4. It is clear that a seasonal variation in ground level PM_{2.5} appears for the eastern China region, and then I do not understand why annual averages of PM_{2.5} are presented in Figure 4. I suggest to subdivide the comparison between GOCI-derived and ground measured PM_{2.5} with respect to season. I suggest also to present statistic results of for example relative RMSE when comparing satellite and ground-based PM_{2.5}.

RESPONSE: Thanks for the suggestion. The annual averages of PM_{2.5} presented in Fig. 4 are useful for the assessment of PM_{2.5} exposure (i.e., estimation of disease burden from PM_{2.5} by the World Health Organization). We have added the seasonal comparison between GOCI-derived and ground measured PM_{2.5} next to the annual comparison in Fig. 4. We have also revised the related text from page 13 line 18 to page 14 line 3. Relative RMSE is now presented in Fig. 2, Fig. 5 and Fig. 6.

2. The language is on the whole confusing and need to be improved, language is clearer in some few chapters and less clear in most others. Some suggestions are presented in "Specific comments" below, however, the full text needs an English proof-check.

RESPONSE: Thanks for the suggestion and helpful comments in "Specific comments". We have carefully revised the language and have modified the text according the "Specific comments" below.

Minor comments 1. Page 5, Lines 10-13. Clarify if you mean comparison to polar satellites? The temporal resolution is indeed higher for the present platform, but then

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with respect to the time period 9:00 – 16:00, which should be pointed out in the text. How is the factor 8 estimated?

RESPONSE: The factor 8 was estimated by considering the fact that traditional low-Earth polar-orbiting satellite instruments usually provide 1 retrieval/day over a location, whereas GOCI provides 8 hourly retrievals/day. On Page 4 line 9-12, we have changed to “GOCI has a high observation density of 8 retrievals/day (hourly retrievals from 09:00 to 16:00 Korean Standard Time) over a location, which exceeds the retrieval density of traditional low-Earth polar-orbiting satellite instruments”.

2. Section 2.2. AERONET level 2 is to prefer, are these data not available for 2013?

RESPONSE: AERONET level 2 data for 2013 are not available for some stations discussed in this paper. Thus, we use level 1.5 data for consistency. We have also compared level 2 and level 1.5 data for 2013 for stations that do have level 2 available, and found level 1.5 AOD is highly consistent with level 2 AOD with RMSE of 0.01-0.02 (relative RMSE of 2%-7%).

3. Considering the statistical equations (1 – 3) on page 10. I do not see any reason to use eq. 1 without presenting relative RMSE, and neither eq. 2 if the skewness of the deviation is not discussed in the manuscript. For example instead of presenting RMSE of 0.079 (however, keep this value in the figure) at line 7 on page 11 focus on presenting the relative RMSE when you discuss the results. What is meant by a “forecast value” at line 9 on page 10? I suppose you do not deal with predictions in this work.

RESPONSE: We have added the definition of relative RMSE in Section 2.5 and have focused on relative RMSE in result discussions. We have included discussions about the skewness of the deviation when MFE or MFB is discussed. We have also changed the “forecast value” to “satellite-derived value” and substituted the “Fi” in equation to “Si”.

4. Page 11, Lines 2 -3: Clarify if the 10.3% is obtained for this special case or for all data of 2013 investigated in the study?

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RESPONSE: We have changed to “Our filters reject 10.3% of all the operational GOCI AOD data investigated in this study”.

5. Page 11, Lines 14-16: Then it seems that you do not have any advantages with the higher temporal resolution (minor comment 1 above) when you use the GOCI retrievals in the present investigation area, or thus the results have some other implications?

RESPONSE: The results have other implications as suggested. The strength of higher temporal resolution lies in data density. Thus, on page 14 line 4-7, we clarified this implication by adding “we also estimated PM_{2.5} from MODIS Collection 6 AOD for 2013, and found GOCI-derived PM_{2.5} achieves greater consistency than MODIS-derived PM_{2.5} when compared with ground-based measurements (slope=1.1, r²=0.61).”

6. Pages 12-13 and paragraph beginning with “Figure 4 compares...” Based on the results in Figure 2 left bottom I suppose several relationships between AOT and PM_{2.5} have been obtained with respect to seasons with GEOS-chem model? If this is not mentioned clearly in the manuscript you have to do that. As it is written here and presented in the figure, I suppose the correlation coefficient of 0.81 is obtained based on the fitted linear curve with slope 1.01. You should then instead present the squared correlation coefficient (coefficient of determination), since R² describe how well the fitted curve explain variance divided by the total variance. Similar for MODIS derived PM_{2.5}.

RESPONSE: We have changed the text on page 8 line 18 to “We apply GEOS-Chem to simulate daily relationships between ground level PM_{2.5} and column AOD, specifically PM_{2.5}/AOD” to make clear that the simulated relationship is on a daily basis. We have also replaced the correlation coefficient with the squared correlation coefficient in Fig. 4 and related text.

7. Page 14, sentence beginning on line 16: I guess, based on the results in Figure 2 (left top and left bottom figures), that the seasonal variation in mixing height is the main factor explaining the variations in PM_{2.5} shown in Figure 6?

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RESPONSE: Mixing height, emissions and nitrate formation all play a role. The topic sentence of Fig. 6 has been rephrased to emphasize that point. Fig. 2 also reflects those three processes. We also offer the mixing height change over northeastern China to more easily relate with Fig. 2.

Specific comments Page 2, line 6: You have to write out AERONET here, since the abstract is separated from the main text in the manuscript. In the same way you do not need define PM2.5 and AOD once again in Section 4, since this section is not separated from the previous sections where you already have written out the names of these two parameters.

RESPONSE: Thanks for your advice. We have written out AERONET in the abstract and removed the definitions of PM2.5 and AOD in Section 4.

Page 3, line 7: Write put units after 500.

RESPONSE: We have removed the sentence containing 500 in the revised manuscript before uploading to ACPD, because the unit is confusing and this statement is not important. The initial 500 was AQI (air quality index) of PM2.5 which is unitless.

Line 8: "Thus, it is."

RESPONSE: We have corrected it in the revised manuscript before uploading to ACPD.

Line 9: Suggestion "remote sensing has a high potential to monitor PM2.5."

RESPONSE: Revised.

Line 12: Suggestion "have long been recognized to relate to ground level PM2.5...."

RESPONSE: We have changed it in the revised manuscript before uploading to ACPD.

Lines 14-15: Suggestion "...surface PM2.5 to estimate surface."

RESPONSE: We have changed to "Many studies have developed advanced statistical relationships to estimate with high accuracy surface PM2.5 from satellite AOD."

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Lines 17-18: The word "significant" does not suit here. "...and found relatively good correlation ($R^2=0.64$)"

RESPONSE: Revised.

Line 22: "...demonstrated using data from the Multiangle...."

RESPONSE: We have changed it in the revised manuscript before uploading to ACPD.

Page 4, lines 6-7: "...to produce a 15-year (1998-2012) global trend in ground-level PM2.5."

RESPONSE: We have changed it in the revised manuscript before uploading to ACPD.

Line 18: "speciation" ?

RESPONSE: We have replaced "speciation" with "composition" for the entire manuscript.

Line 19: "of the current"

RESPONSE: Revised.

Page 5, line 8: Change to "6 km²"

RESPONSE: We have changed to "6km by 6km" for the entire manuscript.

Lines 14-18: Suggestion "A challenge using GOCl to detect aerosols in the atmosphere is the absence of mid-infrared.to detect clouds, which means that significant errors are probably induced in the estimates of AOD. The operational product screen clouds based on spatial.at each pixel in combination with a.at 4km² resolution aboard. "

RESPONSE: We have changed it in the revised manuscript before uploading to ACPD.

Line 19: "However, as will be shown here cloud."

RESPONSE: We have changed it in the revised manuscript before uploading to ACPD.

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Lines 21-22: The filter methods include 1) setting a minimum number of 15 valid AOT values per grid cell of 30 km², 2) using a local variance check to eliminate grid cells where the coefficient..... of AOD is larger than 0.5 within a grid cell, and 3).”

RESPONSE: We have changed it in the revised manuscript before uploading to ACPD.

Page 6, Line 5: “ground-based”

RESPONSE: We have replaced all the “ground measurements” to “ground-based measurements” in the revised manuscript before uploading to ACPD.

Lines 8-9, “Here we use AERONET level 1.5 cloud screened data (Smirnov et al., 2000) from 4 stations within the GOCI domain: Beijing.and EPA-NCU.”

RESPONSE: Revised.

Lines 11-12: “Criteria for selecting an AERONET station is 1) a PM_{2.5} ground-based station has to be located within 10 km and 2) a complete time series of PM_{2.5} data for the period of study has to be available.

RESPONSE: We have changed it in the revised manuscript before uploading to ACPD.

Line 14: “However, due to interrupted time series of PM_{2.5} at both these stations we combine the AERONET AOD from the Beijing and Beijing-CAMS stations and PM_{2.5} from the corresponding two in-situ ground-based sites.” RESPONSE: Revised.

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