Review of Lennartson et al. (submitted to ACP)

Overall comments:

I recommend this paper for publication after some suggested revisions. This is an interesting study that explores different dimensions (spatial variations, diurnal variations, etc.).

Reply. Thank you for your time in doing a constructive, thorough review that is now considered in our revision to improve the manuscript.

The paper clearly needs to be improved in terms of use of English. Some corrections that I suggested at quick-review stage were not included in the current manuscript. The corrections or additions that were already made to the manuscript will be helpful for the readers.

Reply. Thanks. We have done more proof-reading for the revised manuscript.

GOCI does not have a channel longer than 865 nm. This seems like a weakness since it must be difficult to retrieve an unbiased estimate of the surface reflectance when the AOD is high. Since accurately estimating the surface reflectance is the biggest challenge to overcome when retrieving AOD over land from radiance measurements, I feel that there should be a sentence describing how GOCI handles the estimation of surface reflectance over land. Although probably too much to ask, I would have been more interested in (the diurnal variation of) AOD from the Advanced Himawari Imager, which seems more suited to measuring AOD over land with its shortwave IR channel. I suggest that the authors assess whether 68% of GOCI-AERONET AOD differences fall within the 0.15□ ± 0.05 accuracy envelope mentioned on P8L11 by lumping together the AERONET-GOCI pairs from all sites during KORUS-AQ (especially if the authors feel this does not repeat previous work).

Reply. While GOCI doesn't have NIR band, it also used a different approach to tread surface reflectance. In the revision we have added that: "The V2 algorithm (Choi et al., 2018) uses the climatology of land surface reflectance that is obtained from the minimum reflectivity technique; in this technique, the minimum value of multi-year top-of-the-atmosphere reflectance measured by GOCI (for each pixel, each month and each hour) after Rayleigh correction is considered as the surface reflectance (for that pixel, that month, and that hour)". The 0.15tau ± 0.05 accuracy is based on the 5-year validation of GOCI retrieval (Choi et al., 2018). We added that "When validating with AERONET AOD from 2011 to 2016, the V2 reduced median bias compared to V1, and 62% and 71% of GOCI-AERONET AOD difference is within the expected error (EE) of AOD retrieved from MODIS dark target(DT) algorithm over land and ocean, respectively.". The AERONET-GOCI plot during KORUS-AQ is shown in Figure 5. We added that "during the KORUS-AQ time period, only ~40% of GOCI-AERONET AOD difference is within EE of MODIS DT over land because of its systematic low bias by 0.04. By adding COGI AOD by 0.04, 40% is increased to 56% (Figure 5c)."

The authors found that WRF-Chem AOD does not correlate well with AERONET AOD, which is interesting, albeit disappointing. WRF-Chem's AOD bias is smaller than that of GOCI AOD however.

Reply. Yes, indeed. We revised the text with more description. "WRF-Chem can both over- and under-predict the AERONET AOD values, thereby yielding no bias overall, while the GOCI satellite typically underpredicted them during the KORUS-AQ timeframe (with an overall low bias of 0.04). In reference to

the AERONET AOD values, GOCI AOD has smaller RMSE (0.16) than that (0.28) of WRF-Chem predictions".

Specific comments:

P1L24 (see also P17L10): "the deficiency to describe" -> "a deficiency in describing"

Done.

P1L24: relatively -> relative

Done.

P1L27: patter -> pattern

Done.

P1L27: relative -> relatively

Done.

P1L29: "for constrain" -> "to constrain"

Done.

P2L1: "Their presence leads to" -> "They are involved in"

Done.

P2L5: track -> tract

Done.

P2L9: averages -> average

Done.

P2L10: with -> and

Done.

P2L17: "24" -> "24 times"

Done.

P2L17: This sentence implies that clouds do not exist at the surface. However fog is essentially cloud at the surface. Please verify that fog does not affect the performance of surface aerosol monitors.

Reply. We revise the text as follows. "These monitors provide invaluable information regarding $PM_{2.5}$ levels 24 times per day and are not affected by weather conditions particle-bound water included in the sampled air is removed by heating at a constant temperature (usually at 50°C) inside the monitoring instrument (Wang et al., 2006).".

P2L21: Delete "in emerging need of surface monitors"

Done.

P3L5: “one of its first kind” -> “the first of its kind”

Done.

P3L5: “that, through” -> “involving”

Done.

P3L11: Delete “needed”

Done.

P3L12: that -> what

Done.

P3L32: Add “over water” after hourly data.

Done.

P4L5: “ “season invariant” ” -> “seasonally invariant”

Done.

P4L14: Delete “studying”.

Done.

P4L14: Add “studies” after variation.

Done.

P4L24: Re “since these concentrations”, please clarify whether the concentrations were higher at midnight in fall/winter relative to spring/spring or in general (i.e., averaged over day).

Reply. Done. Text was added to clarify that the concentrations were higher from late afternoon to midnight in fall/winter relative to spring/summer.

P5L2: add space before m-3

Done.

P5L3: peaks -> enhancements

Done.

P5L8: emergently -> urgently

Done.

P5L16: category -> categories (?)

Done.

P5L16: What does “with an accuracy of 90%” mean? If this means “typical errors of ±10%”, please use this expression instead.

Done.

P6L5: advances-> improvements

Done.

P6L28: Delete “Joint”

Done.

P6L28: “between the” -> “developed at”

Done.

P6L29: Delete “data”

Done.

P7L14: Cite reference for CREATE if possible.

Added the citation as follows:

Reply. Goldberg, D. L., Saide, P. E., Lamsal, L. N., de Foy, B., Lu, Z., Woo, J.-H., Kim, Y., Kim, J., Gao, M., Carmichael, G., and Streets, D. G.: A top-down assessment using OMI NO2 suggests an underestimate in the NOx emissions inventory in Seoul, South Korea during KORUS-AQ, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-678, in review, 2018.

P8L9: Imagine -> Imaging

Done.

P8L11: Move “compared to V1” immediately after “bias” in this line.

Done.

P8L18: Define HUFS here.

Done.

P8L28: Delete “(or baseline)”. I suggest “climatological” over “baseline” throughout the manuscript.

Done.

P8L29: form -> from

Done.

P9L18: Do the authors mean: “has fewer intra-class similarities as compared to the coastal rural class.”?

Yes. Thank you for the suggested clarification. The change has been made.

P9L29: “evening-build” -> “late afternoon buildup” (see also P10L8)

Done. The change has been made at P9L29 and P10L8.

P10L14: “maxima AOD” -> “AOD maxima” (see also P10L15).

Done. The change has been made at P10L14 and P10L15.

P10L19 (and elsewhere): Exponent -> exponent

Done. Changes have been made to read “Angstrom exponent” versus “Angstrom Exponent” throughout.

P10L20: This sentence is debatable. It implies that naturally occurring smoke from biomass burning is a minor contributor to the aerosol load. If that is true, the statement is OK.

Reply. We added one sentence in the end of this paragraph. “this is especially true for the KORUS-AQ because biomass burning sources in east Asia in growing season (e.g., the study period here) is minimal (Polivka et al., 2015).”.

P10L27: build -> increase

Done.

P10L32: build -> rise

Done.

P11L11: statically -> statistically

Done.

P11L16: later -> late

Done.

P11L17: started -> start

Done.

P11L17: diminishes -> diminish

Done.

P12L13: c -> cohesive (?)

Yes. The change has been made.

P12L28: “findings surprising” -> “surprising finding”

Done.

P12L28: “longer observation than the” -> “as long a record as”

Done.

P13L3 (and elsewhere): AEROENT -> AERONET (e.g., see P15L2)

Done. “AEROENT” has been changed to “AERONET” throughout.

P13L4: time -> times

Done.

P13L8: is -> are

Done.

P13L12: under-predicted -> under-predict

Done.

P13L13: of -> to

Done.

P13L26: “over predicted” -> “overpredicted” (“overestimated” is actually better since these are not predictions, they are measurements)

Done. Over predicted was changed to overestimated.

P13L28: amply -> amplify

Done.

P13L28: Can’t the larger standard deviation for GOCI AOD be due to larger random errors than AERONET AOD?

Yes. Thank you for suggesting this possibility. Text was added.

P13L32: “minutely” -> “every minute”

Done.

P14L13-14: I am not convinced that the minima and maxima are real. The authors should add the standard error as a vertical error bar to each hour of the Jeju curve in Fig. 7c and use these (or a t-test) to judge whether these maxima and minima are statistically significant.

Reply. The maxima and minima here are indeed not distinct. We added that “the difference between maxima and minima within 4 μg m^{-3} (or ~10-12% from the mean), suggesting insignificant diurnal variation pattern”.

P14L21: Re: “process”, is there only one process? If not, change to “processes”.

Done. Changed to “processes.”

P14L29: The systematic bias is more like 0.04-0.09 between 9 and 15 KST. This needs to be corrected.

From 9-15 KST, GOCI AOD ranges from 0.25 to 0.3. Perhaps this 0.04-0.09 range would be from 9-16 KST?

Changed. Yes, 0.04 overall low bias is consistent with results in Figure 5, but biases increases in the late afternoon.

P14L32: Delete “also”.

Done.

P14L32: shows -> show

Done.

P14L32 (and elsewhere): later -> late

Done. Later was changed to “late” throughout.

P15L3: “that from” -> “with”

Done.

P15L4: relatively -> relative

Done.

P15L6: “too much skewness” -> “an overly strong tendency” (a suggestion)

Thank you for the suggestion. This text was added.

P15L11: “Similar as its AOD variables” -> “Similar to AOD”

Done.

P15L12: “PM2.5” -> “PM2.5 data”

Done.

P15L24: outliner -> outlier

Done.

P16L4: AEROENET is not the correct spelling.

Done.

P17L1: larger -> large

Done.

P17L6: prolife -> profile

Done.

P28: Is what follows the ‘±’ for y and x the standard deviation of the mean? Please add this info to Fig. 5 caption. Assuming it is one standard deviation, it shows that GOCI AOD has a significant overall low bias.

Clarifying text was added.

P29: The caption should be "…AERONET AOD vs WRF-Chem AOD…", etc.

Done.

P30: (Fig. 7 caption): m-3 -> m^{-3} (occurs twice)

Done.

P30: (Fig. 7 caption, and elsewhere): PM2.5 -> PM2.5

Done.

P30: (Fig. 8 caption): R2 -> R2

Done.

P31: I suggest plotting AERONET and GOCI separately in Fig. 9b.

Done.