We appreciate the reviewer's insights and helpful comments, which improved the scientific quality of our manuscript. We carefully revised our manuscript basically reflecting reviewers' comments as much as we can. Our responses to the reviewer's comments are continued below with blue highlight. Please find our responses attached below.

Authors' response to RC1

Using observations from GEMS, the authors presented methods for retrieving aerosol optical properties, including AOD, SSA, ALH, UVAI and VisAI. Retrieved AOD, SSA and ALH data were evaluated against AERONET and CALIOP data. The concepts included in the study, including aerosol retrievals from UV and VIS observations, as well as using a machine learning method for noisy data removal, are not new. Still, this paper has some merits by applying the above mentioned methods to GEMS data. Still, there are major issues in this study that need to be addressed.

1. The post-processing step involves refining/correcting retrieved AOD and SSA values using AERONET data (1-30 days data before a given date) and through a machine leaning method (RF). This creates a potential issue, as non-trivial autocorrelations may exist in AERONET AOD and SSA data for a given AERONET station. Thus, by use the same AERONET site for training and testing, the results of the study may be biased toward AERONET sites. It is unknown the performance of the retrieved data over regions without AERONET data. I would suggest the authors pick some AERONET sites as the testing sites, and AERONET data from these test sites shall not be used for training purposes for the machine learning method.

We appreciate the reviewer's comment. We evaluated the post-processing results by separating the training and prediction periods temporally in the AERONET data. However, there could be spatial autocorrelation for AOD and SSA at the given AERONET station. To investigate the performance in areas without AERONET data, we conducted Leave-One-Site-Out Cross-Validation. The principle involves excluding the data from one site and training the model using the data from all other sites. The performance of the model is then evaluated using the data from the excluded site. The station chosen for evaluation is excluded from the model fitting process. For the period ranging from 30 days prior to the current day up to 1 hour before the target day, modeling is conducted, excluding data from site '*x*'. The model's predictive accuracy is then evaluated specifically for site '*x*' at the target day. Figure S2 shows the statistic maps illustrating the results of Leave-One-Site-Out Cross-Validation for post-process corrected GEMS AOD for the 1-year period of November 1, 2021, to October 31, 2022. In Northeast Asia, there is a notably high R, indicating a strong relationship in the AERONET data. However, sites closer to the equator tend to exhibit lower R values, around 0.5. The RMSE follows a similar pattern, with lower values in densely populated Northeast Asia, reflecting a better fit between predicted and AERONET values in this region. The MBE in Northeast Asia tends to be close to zero, suggesting minimal bias in the predictions. In contrast, the Indian region shows negative MBE values, indicating underestimation, while Southeast Asia has positive values, signifying overestimation. Therefore, our post-processing method may have the potential to have decreased accuracy in areas without (or with few) AERONET sites.

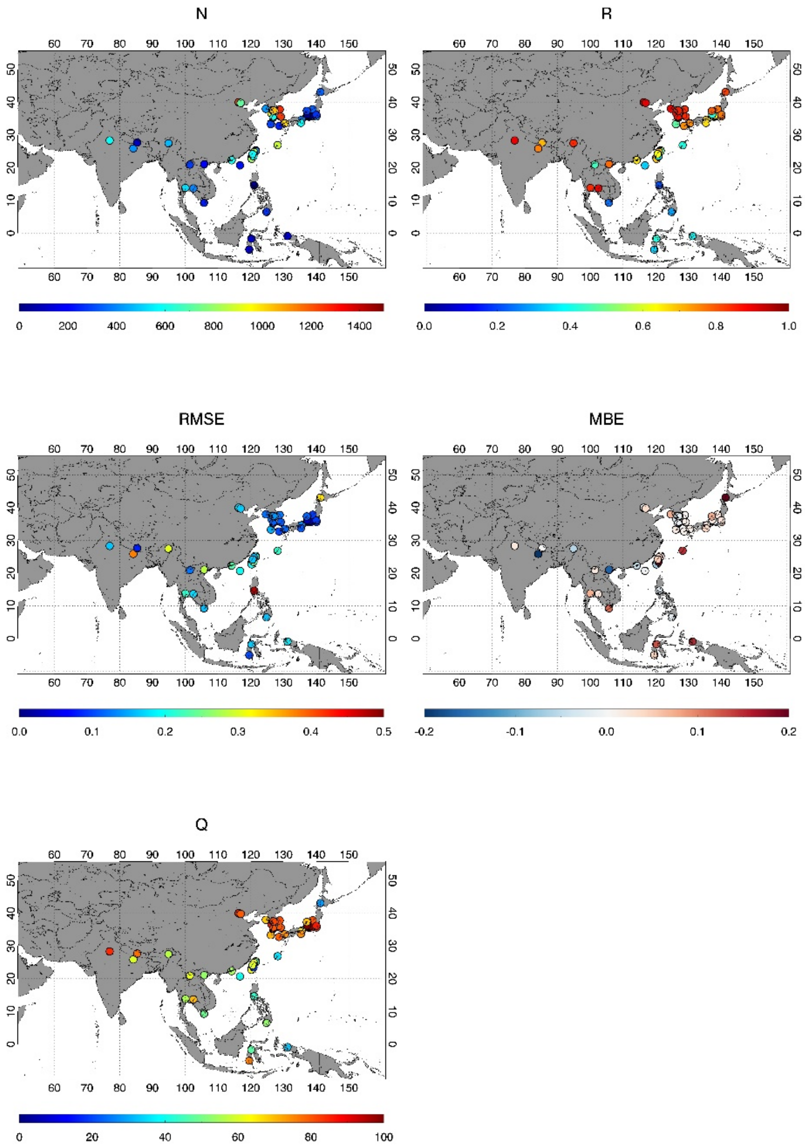

Figure S2: The statistic maps illustrating the results of site-based cross-validation for post-process corrected GEMS AOD for the 1-year period of November 1, 2021, to October 31, 2022.

2. Also, cloud contamination exists prior to the post-processing step (Figure 7) yet is suppressed by the post processing step (Figure 8). Any reason for that? Could this be potentially causing an issue? Those cloud contaminated pixels should be excluded in the study.

Thanks for careful comments. As the reviewer pointed out, we checked that pixels contaminated by clouds were included during the post-processing step. Including cloud-contaminated pixels in the modelling of the post-processing step could lead to improper training and should therefore be excluded. We have revised our spatiotemporal collocation criteria to exclude such cloud-contaminated pixels during the modelling process, considering better cloud masking of AERONET. When an AERONET site is located within a GEMS pixel, AERONET data are temporally matched within a ±10-minute window of the GEMS observation time. Data from three AERONET sites (Sorong, Jambi and BMKG_GAW_PALU) with severe sub-pixel cloud contamination were excluded from the training. By strictly applying criteria to the data used for removing cloud-contaminated pixels from the modelling process, we achieved an enhancement in prediction performance. The R value increases from 0.899 to 0.920, and the Q value also raised from 79.13% to 82.17%.

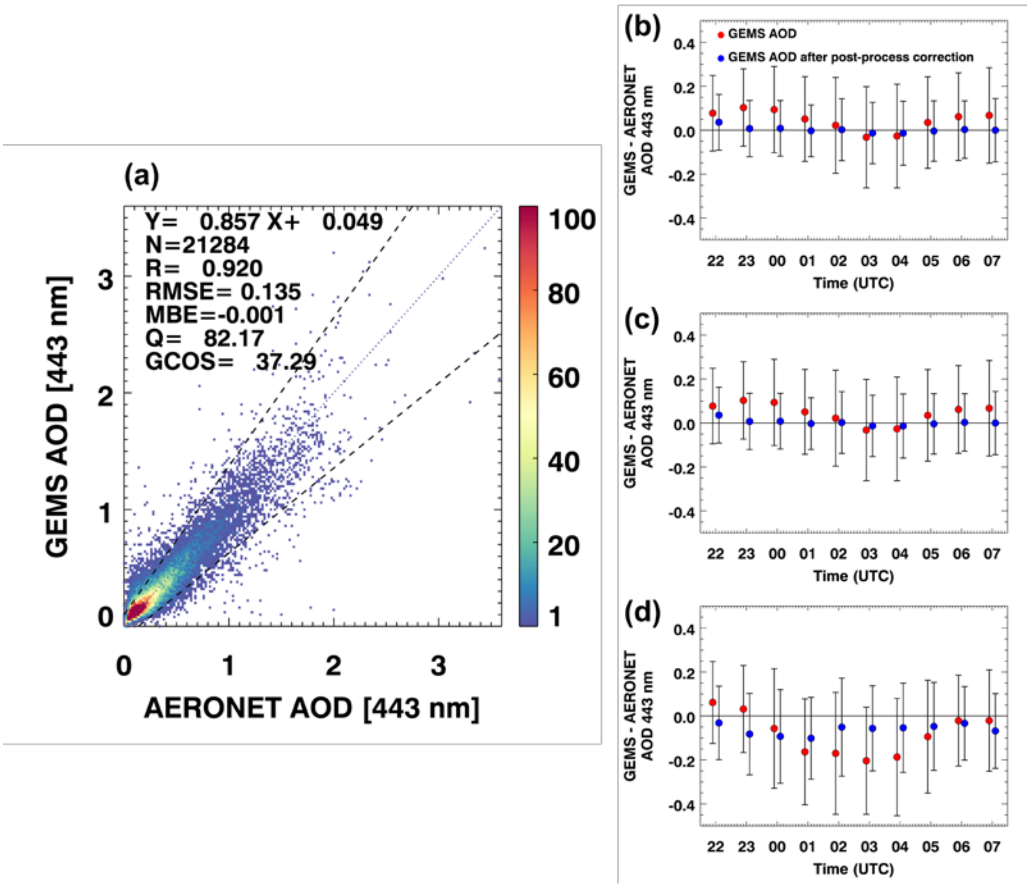

Figure 8: (a) Comparison of GEMS AOD after post-process correction by machine learning and AERONET AOD. The dashed lines indicate an uncertainty envelope of a larger 0.1 or ±30% in AOD. The dotted lines represent the 1:1 line. The difference between GEMS AOD and AERONET AOD in terms of time. (b) All pixels, (c) pixels when AERONET AOD < 0.4, and (d) pixels when AERONET AOD > 0.4. The red circles represent the GEMS AOD, and the blue circles represent the GEMS AOD after post-process correction. The error bars correspond to the standard deviation. Data from November 1, 2021 to October 31, 2022 are used for comparison.

3. Version 3, level 1.5 AERONET data were used in this study. I would recommend the authors use version 3, level 2 AERONET data as it is quality assured. There is a reason why the AERONET team spent efforts creating level 2 data from level 1.5 data. The additional data included in the level 1.5 AERONET data may likely be problematic retrievals.

We appreciate the reviewer's helpful comments. We agree that AERONET Level 2.0 data ensures higher quality compared to Level 1.5. With your suggestion, we have updated the validation results using Level 2.0 data (Figure7, Figure 9, Table 2, Table 3 and Table 4). However, using AERONET Level 2.0 data in the post-processing step presents two major challenges: 1) There is a significant reduction in the volume of data available for the modelling process, with a particularly noticeable impact on SSA. The amount of data has decreased to such an extent that it affects the modelling and prediction processes (a reduction to ~1/4th of the original volume). 2) Near-real-time modelling has become impossible. Given the focus on post-processing process in near-real-time, the second issue in particular poses risks. Due to these concerns, we decided to continue using AERONET level 1.5 data for post-processing step (Figure 8 and Figure 10). Additionally, the data previously used for comparison from December 1, 2021, to October 31, 2022 (11 months). To extend the validation period to one year, we have updated the comparison to include data from November 1, 2021, to October 31, 2022.

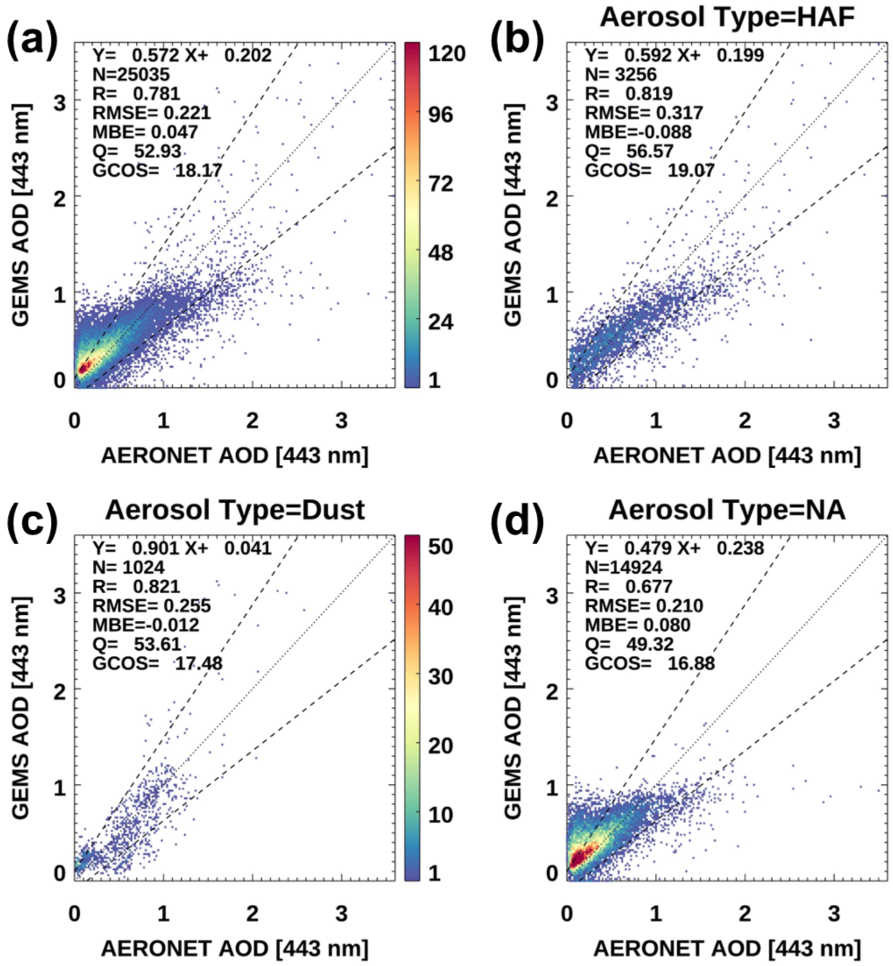

Figure 7: Comparison of GEMS and AERONET AOD for (a) total and individual aerosol types: (b) HAF, (c) dust, and (d) NA. The dashed lines indicate an uncertainty envelope of maximum (0.1 or 30%) in AOD. The dotted lines represent the 1:1 line. Data from November 1, 2021 to October 31, 2022 are used for comparison.

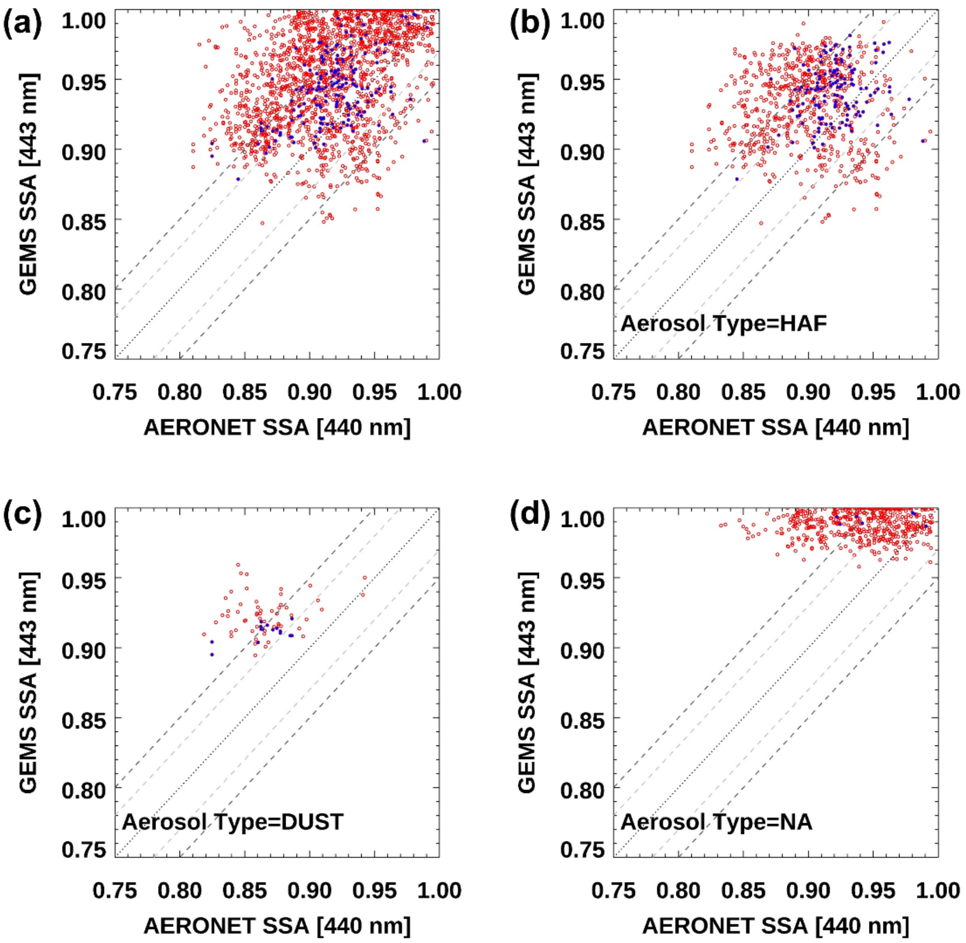

Figure 9: Comparison of GEMS and AERONET SSA for (a) total and individual aerosol types: (b) HAF, (c) dust, and (d) NA. The red circles represent the pixels when AOD > 0.4, and the blue circles represent the pixels when AOD > 1.0. The gray dashed lines indicate an uncertainty envelope of ±0.03 in SSA, the black dashed lines indicate an uncertainty envelope of ±0.05 in SSA, and the dotted lines represent the 1:1 line. Data from November 1, 2021 to October 31, 2022 are used for comparison.

Table 2: Statistic of hourly comparison of GEMS and AERONET AOD in Figure S5.

Time	N	Slope	y-intercept	R	RMSE	MBE	Q (%)	GCOS (%)
22:45	801	0.725	0.177	0.738	0.181	0.094	60.42	24.97
23:45	1413	0.728	0.193	0.752	0.187	0.115	53.93	19.89
00:45	2879	0.600	0.221	0.698	0.218	0.112	48.32	15.56
01:45	3345	0.490	0.211	0.715	0.209	0.063	52.68	16.95
02:45	3718	0.533	0.193	0.780	0.214	0.039	52.66	17.86
03:45	3504	0.577	0.171	0.830	0.238	-0.011	53.48	16.67
04:45	3556	0.592	0.176	0.824	0.238	-0.001	53.12	17.97
05:45	3186	0.518	0.233	0.725	0.043	0.043	50.00	18.33
06:45	2117	0.606	0.241	0.766	0.239	0.069	52.01	19.79
07:45	1299	0.632	0.227	0.754	0.245	0.063	54.89	19.86

Table 3: Comparison of GEMS and AERONET SSA for different aerosol types in Figure 9. N represents the number of data, and EE% denotes the percentage within the expected error range of ±0.03 (±0.05).

	GEMS AOD > 0.4		GEMS AOD > 1.0	
Aerosol Type	N	EE% ±0.03 (±0.05)	N	EE% ±0.03 (±0.05)
All	1841	34.22(61.38)	174	48.85(84.48)
HAF	764	31.68(62.43)	136	54.41(89.71)
Dust	71	12.68(45.07)	15	13.33(66.67)
NA	536	32.46(56.72)	7	42.86(57.14)

Table 4: Statistic of comparison of GEMS and AERONET SSA in Figure S6.

	GEMS AOD > 0.4		GEMS AOD > 1.0	
Time	N	EE% ±0.03 (±0.05)	N	EE% ±0.03 (±0.05)
22:45	49	67.35(89.80)	13	61.54(92.31)
23:45	76	64.47(82.89)	18	77.78(94.44)
00:45	100	62.00(87.00)	21	90.48(100.00)
01:45	138	57.25(81.16)	29	72.41(96.55)
02:45	190	31.58(56.84)	72	31.94(56.94)
03:45	391	18.67(44.76)	206	15.05(46.60)
04:45	406	22.41(52.46	209	23.44(58.85)
05:45	223	30.49(61.88)	94	28.72(65.96)
06:45	175	37.14(69.71)	83	40.96(75.90)
07:45	93	53.76(73.12)	46	54.35(76.09)

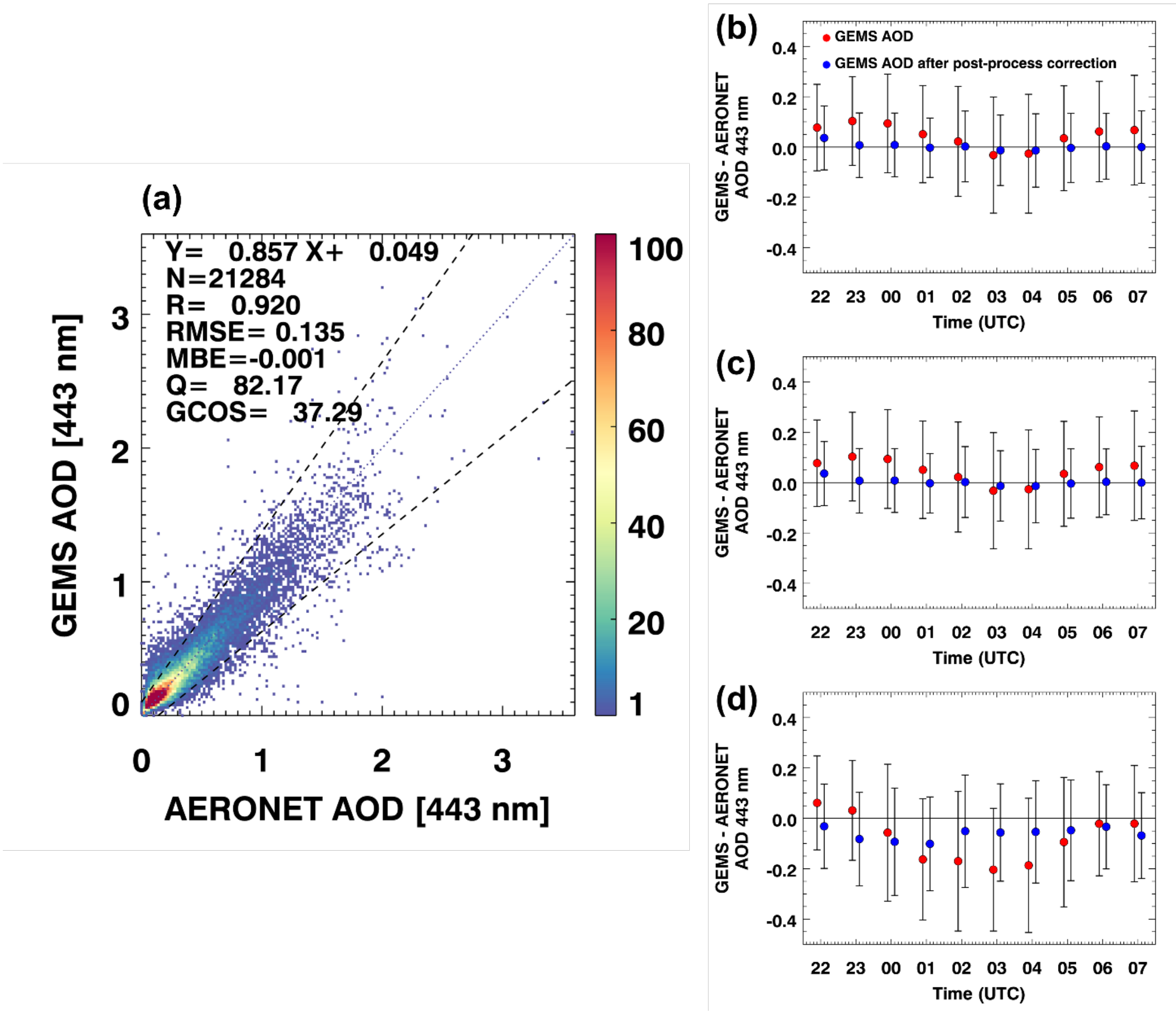

Figure 8: (a) Comparison of GEMS AOD after post-process correction by machine learning and AERONET AOD. The dashed lines indicate an uncertainty envelope of a larger 0.1 or ±30% in AOD. The dotted lines represent the 1:1 line. The difference between GEMS AOD and AERONET AOD in terms of time. (b) All pixels, (c) pixels when AERONET AOD < 0.4, and (d) pixels when AERONET AOD > 0.4. The red circles represent the GEMS AOD, and the blue circles represent the GEMS AOD after post-process correction. The error bars correspond to the standard deviation. Data from November 1, 2021 to October 31, 2022 are used for comparison.

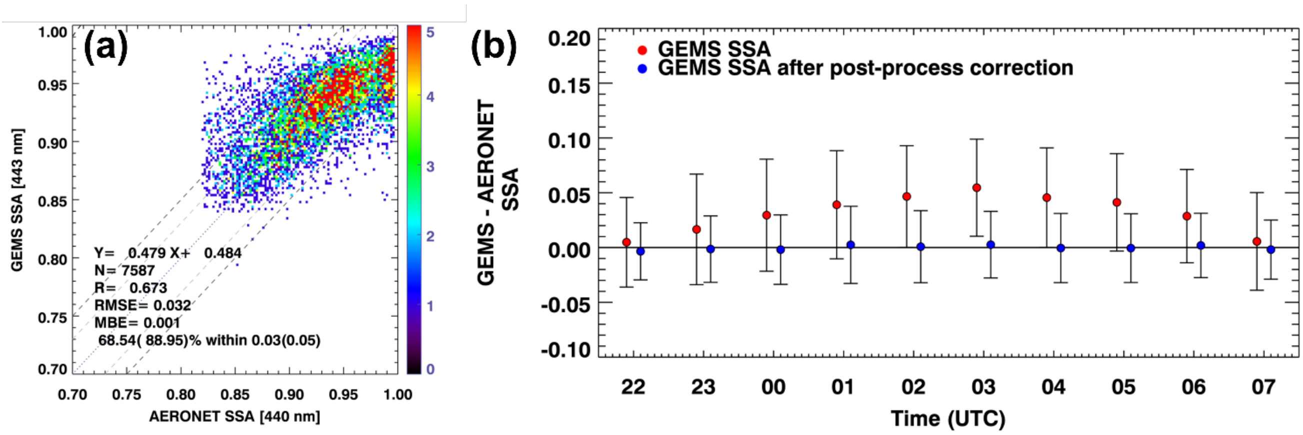

Figure 10: (a) Comparison of GEMS SSA after post-process correction and AERONET SSA. The gray dashed lines indicate an uncertainty envelope of ±0.03 in SSA, the black dashed lines indicate an uncertainty envelope of ±0.05 in SSA, and the dotted lines represent the 1:1 line. (b) The difference between GEMS and AERONET SSA in terms of time. Data from November 1, 2021 to October 31, 2022 are used for comparison.

4. The paper needs to be carefully proof-read. There are quite a few places that I tried to guess what the authors were trying to say.

Done. Thank you.

5. It would be interesting to show seasonal and regional variations of AOD, SSA and ALH as a function of local time (diurnal patterns). It shall not be a difficult task as the authors have the data handy for the task.

Thanks for careful comments. Figure S7 shows seasonal and regional variation as a function of UTC for each of the following four regions: Korea (33° N–39° N and 124° E–132° E), North China (33° N–34° N and 110° E–124° E), South China (21° N–33° N and 110° E–122° E), Indochina peninsula (8° N–22° N and 92° E–110° E). The Indian region was excluded from the regional analysis because the observable area within the total region of India varies significantly depending on the GEMS scan profiles. After gridding the GEMS AOPs into a 0.1° × 0.1° grid box, monthly averages were calculated. After the monthly averaging, seasonal averages were calculated for each pixel, but only where all three months within a season had data available for the given pixel. Regional averages were conducted only when more than 50% of the available values within the domain. For AOD, a U-shaped or flat diurnal variation was observed in all four regions. In the case of SSA, higher values were observed during JJA (June, July, August) in Korea, North China, and South China, which is considered to be influenced by aerosol hygroscopic growth due to relatively high atmospheric humidity. However, the Indochina Peninsula showed the highest SSA values in SON (September, October, November) and the lowest in DJF (December, January, February), which is consistent with the relatively low SSA values observed at the Chiang Mai AERONET site from 2011 to 2016 during DJF (Liang et al., 2019). However, there are limitations in investigation of diurnal variation for ALH. The diurnal variations of ALH were not consistent with those of mixing layer height. One reason for the uncertainty in ALH is that it is retrieved from OE, depending on the uncertainty of *a priori* AOD, SSA and ALH. Before post-processing, GEMS AOD and SSA exhibited diurnal biases pattern compared to AERONET data (details in Sections 5.1 and 5.2). Those uncertainties cloud affect the uncertainty in the diurnal variation of ALH. Since GEMS ALH cannot be post-corrected using CALIOP data (details in Section 3), we are considering post-process corrected ALH using ground-based lidar observation networks (i.e., Korea Aerosol Lidar Observation Network; the Asian dust and aerosol lidar observation network) in the future study. Therefore, one of the limitations of the paper is that GEMS ALH has limitations in the detailed investigation diurnal variations of ALH due to its much weaker signals.

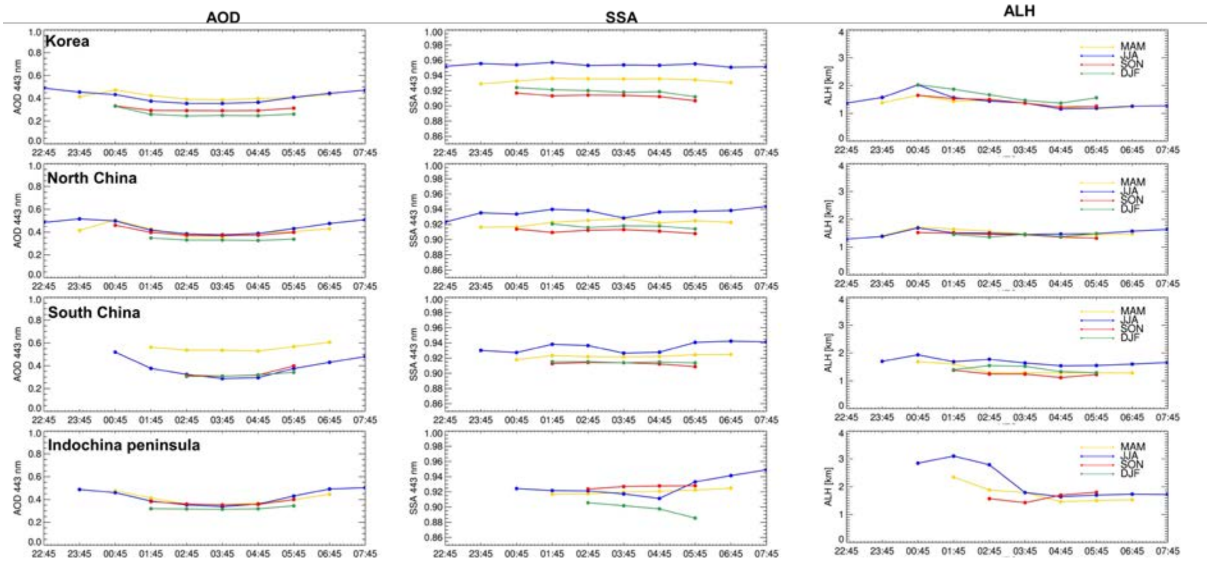

Figure S7: Seasonal and regional AOD, SSA, and ALH variation as a function of UTC for each of the following four regions: Korea (33° N–39° N and 124° E–132° E), North China (33° N–34° N and 110° E–124° E), South China (21° N–33° N and 110° E–122° E), Indochina peninsula (8° N–22° N and 92° E–110° E) during the period of November 1, 2021, to October 31, 2022. The yellow lines represent spring MAM: March, April, and May), and the blue lines represent summer (JJA: June, July, and August), and the red lines represent autumn (SON: September, October, and November), and the green lines represent and winter (DJF: December, January, and February).

Minor comments are corrected.

Page 1, lines 30 and 34. "GEMS AOD". Wavelength for the mentioned AOD?

Done. Thank you.

Page 2, line 46, "While significant diurnal variations in AOPs have been observed". Provide references.

Done. Thank you.

Page 3, line 82,"Considering the solar zenith angle". What do the authors mean? Considering the sun position changes??

I have clarified the sentence for better understanding. Thank you.

Page 3, lines 96-97, I am not sure what the authors try to express. Please try to rewrite.

I have clarified the sentence for better understanding. Thank you.

Page 3, line 115, "In this paper, we report the first aerosol monitoring results"?? Aerosol retrievals?? Please rewrite.

I have clarified the sentence for better understanding. Thank you.

Page 4, lines 125-126 make no sense to me. Please try to rewrite.

I have clarified the sentence for better understanding. Thank you.

Page 4, equation 1. Where is SZA? Downward solar radiation shall be a function of SZA.

The term "normalized radiance" mentioned in this paper refers to the "sun-normalized radiance" as defined in the OMI Algorithm Team's Terms and Symbols (https://eospso.nasa.gov/sites/default/files/atbd/ATBD-OMI-Terms-Symbols.pdf). Therefore, the Solar Zenith Angle (SZA) is not required.

Page 5, line 166, "The preliminary GEMS AERAOD".. Shall be "An early version of GEMS AERAOD"??

Done. Thank you.

Page 5, line 190. Define "the Levenberg-Marquardt equation". Or provide a reference.

Done. Thank you.

Page 6, line 208, "the calculations were performed using the Mie theory" Be specific. I assume the authors computed optical properties using the Mie code and applied the computed optical properties in RTM calculations. What about needed parameters for Mie and RTM simulations? But please be precise with your discussions.

Done. Thank you.

Page 6, line 211, provide references for the GEMS spectral response function. Also, GEMS has a spectral resolution of 0.6 nm. Why do the authors resample the spectral data (from RTM) to a spectral resolution of 0.2 nm?

GEMS measures radiance/irradiance in ultraviolet and visible wavelengths with 0.2 nm spectral sampling and about 0.6 nm FWHM resolution. Therefore, we resampled according to 0.2 nm spectral sampling.

Page 6, line 226, "minimum reflectance method" Need a reference here.

Done. Thank you.

Page 7, line 242, this equation doesn't make sense. Please check.

Done. Thank you.

Page 7, Section 2.1.4, may need plots to demonstrate cloud detection steps.

I have clarified the sentence for better understanding. Thank you.

Page 10, line 379. Define Q value. Be specific about GCOS requirement.

Done. Thank you. (Page8 Line 283-286.)