Responses to comments from Review # 1

■ General Comment

Juseon Bak et al. provide the first comprehensive characterization of the GEMS operational ozone profile retrieval, including detailed descriptions of the spectral and radiometric calibration enhancements introduced in the version 3.0 algorithm. These improvements are fundamental for the exploitation of the full potential of the geostationary ozone profile data, not only for application in air-quality monitoring but also for investigating local transport processes. Furthermore, the calibration methodologies described and the retrieval show cases are a valuable reference for the ozone profile retrieval community. Therefore, I believe this work aligns closely with the AMT journal's scope and I recommend the publication after addressing the comments below.

Reply to general comments: We sincerely thank Dr. Serena Di Pede for the positive and encouraging comments. We are pleased to hear that the reviewer finds our work relevant to the AMT journal's scope and a valuable contribution to the ozone profile retrieval community. We have carefully addressed all the comments provided below.

■ Specific Comments

Comment #1 Is a reference available demonstrating the capabilities of the OMI ozone profile product (cited at lines 62-64)?

➔ **Reply** Thank you for pointing this out. As detailed in Bak et al. (2024), "The OMPROFOZ product has contributed to a better understanding of chemical and dynamical ozone variability associated with anthropogenic pollution over central and eastern China (Hayashida et al., 2015; Wei et al., 2022), transport of anthropogenic pollution in free troposphere (Walker et al., 2010) and stratospheric ozone intrusion (Kuang et al., 2017) as well as ozone concentration changes in the Asian summer monsoon (Lu et al., 2018; Luo et al., 2018). Moreover, this product has been used to quantify the global tropospheric budget of ozone and to evaluate how well current chemistry-climate models reproduce the observations (Hu et al., 2017; Zhang et al., 2010)." To address the reviewer's comment, we have revised the manuscript to cite Bak et al. (2024) and the references therein.

Comment #2. It is not very clear to me the citation at line 67 of (Keppens et al., 2024), which does not explicitly refer to GEMS L2 assessment in the context of the PEGASOS project. Is there an explicit reference available for the PEGASOS project?

➔ **Reply** Thank you for pointing this out. The citation of Keppens et al. (2024) was incorrect in this context. The PEGASOS validation report is an internally shared document and is not publicly available as a formal publication. Therefore, we have replaced the citation with the official project webpage: https://www.dlr.de/en/eoc/research-transfer/projects-missions/pegasos.

Comment #3 Please look into line 642, which seems to contain an incorrect doi of 2015

➔ **Reply** The reference has been corrected.

Section 2.4 When I first read the manuscript it was not clear to me that the algorithm updates would be described in this section. Could it be an idea to add "Implementation details and algorithms updates"? It seems to me that this section is mostly about the algorithm updates introduced in v3.0.

➔ **Reply** Thank you for your insightful suggestion. To improve clarity and guide the reader more effectively, we have revised the section title to "Implementation Details and Algorithm Updates."

Figure 7 I find the choice of these retrievals show cases very helpful to understand the retrieval capabilities. I find the higher DFS (orange) region in Fig.7b and lower DFS (darker green, around Vietnam-Laos) in Fig.7c quite interesting, but they don't seem to be correlated to their corresponding ozone distribution in Suppl. Fig. 2. However, it seems that the higher DFS region in Fig. 7b has some correlation to Fig. S2 (d), which I was curious to know if you were expecting it.

➔ **Reply** Thank you for your thoughtful comment and for giving us the opportunity to enhance the analysis. In the stratosphere, the DFSs enhance with longer light path length. The darker green (Fig 7c), as noted by the review, corresponds to areas with small solar zenith angles (SZA < 10°), which is also evident in Fig. 7d. In the troposphere, while DFS is also influenced by the light path length, the relationship becomes more complex due to additional factors such as tropospheric ozone amount, surface reflectance, cloud optical properties, aerosol scattering, and other scene-dependent characteristics. As shown, tropospheric DFSs show a significant correlation with tropospheric ozone amounts in regions where SZA is not extreme. On December 16, 2021, the high DFS values (~0.8) appear to be associated with elevated surface albedo. This high albedo was retrieved because the cloud input was missing in the ozone profile retrieval. As shown in the following figures, the GEMS cloud l2 product did not provide valid output over the central region of the large-scale cloud system identified from RGB image. In the absence of cloud information, the retrieval algorithm estimated a higher surface albedo to fit the observed radiance. We have added the relevant figures to the Supplement (Figure S3) and revised the manuscript to include this explanation.

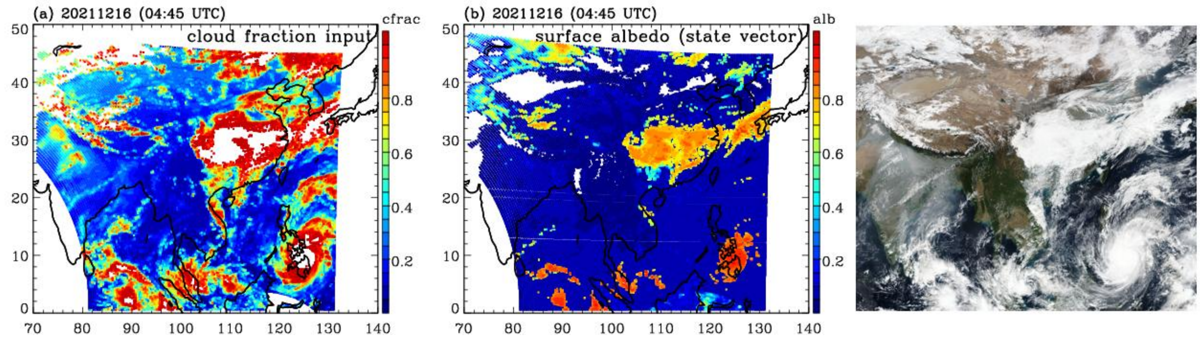

Figure 1. (left) effective cloud fraction taken from GEMS L2 cloud product on 16 December 2021; (center) surface albedo fitted from GEMS L2 ozone profile product; (right) RGB image from the VIRR instrument.

Figure 8 I was not expecting this behavior for the retrieval offset, looking at the quite well-behaved shape of the averaging kernel, shown in Figure 6. If I compare this figure with the one of the TROPOMI ozone profile (Fig. 11a, Keppens et al., 2024), the offset trend is driven by the higher information content, but this doesn't seem the case for Figure 8. So I am wondering if this could be related to the different algorithm settings or if it is more instrument related.

➔ **Reply.** The retrieval offset represents a mismatch between the peak altitude of averaging kernel and the altitude the retrieval is intended to capture. Ideally, the peak of each averaging kernel should align with the corresponding retrieval grid, assuming sufficient vertical sensitivity. However, GEMS uses a more limited spectral range (310–330 nm) compared to TROPOMI (270–330 nm). As shown in Fig. 11a of Keppens et al. (2024), TROPOMI retrievals exhibit nearly zero offset between 20 km and 50 km, benefiting from the Hartley ozone band (270–310 nm), which provides strong height-resolved information through Rayleigh scattering. In contrast, the GEMS averaging kernels generally peak between 15 and 25 km, and above this range, the retrieval offset increases negatively due to the lack of sufficient information at higher altitudes. In the troposphere, both GEMS and TROPOMI exhibit similar offset behavior, with increasing values toward the surface.

Conclusions It might be helpful to add some information regarding the time of the implementation of the updates of version 3 in the operational stream, or if they are already publicly available.

➔ We completely agree — this is an important point that should have been mentioned. The reprocessing has been completed for the entire mission period, and the GEMS v3.0 ozone profile product is now publicly available from November 2020 onward. "*The reprocessing of the GEMS ozone profile dataset has been completed and the version 3 product is publicly available through the Environmental Satellite Center website (https://nesc.nier.go.kr/en/html/datasvc/index.do; NIER, 2025).*" has been added in the conclusion section of this paper.

■ Minor comments

1.Line 76 I think the "and" can be omitted in point (3)

➔Accepted.

2.Line 297, repetition of Fig. 7c and the first one should refer to Fig.b as the text refers to the troposphere

➔ Thank you for your careful review. The issue has been corrected — the first reference now correctly points to Fig. 7b, as it pertains to the troposphere.

3.Reference Bak et al (2019) in line 347 is missing

➔*Bak, J., Baek, K.-H., Kim, J.-H., Liu, X., Kim, J., and Chance, K.: Cross-evaluation of GEMS tropospheric ozone retrieval performance using OMI data and the use of an ozonesonde dataset over East Asia for validation, Atmos. Meas. Tech., 12, 5201–5215, https://doi.org/10.5194/amt-12-5201-2019, 2019.* Is added in the reference list.