Author Responses to Manuscript ID: egusphere-2024-604

Improved Mean Field Estimates of GEMS AOD L3 Product: Using Spatio-temporal Variability

We are grateful to the reviewers for their insightful comments and thought-providing questions. In response to their feedback, we have prepared a comprehensive point-by-point explanation. Furthermore, we have made significant revision efforts to our manuscript, incorporating their suggestion to improve the overall quality and clarity of our revised manuscript. We trust that the editors and reviewers will find the revised manuscript to be significantly enhanced and more effectively conveys the significance of our research.

1 Responses to Referee's Comments : RC1

1. In Section 3.1, the radius is set to be 0.1°, but the actual area covered by a circle with a 0.1° radius varies significantly depending on the latitude bands. Since the GEMS AOD data analyzed here cover a large spatial domain, this can introduce some unexpected artifacts. I am wondering if the authors have considered such issues.

   Response: We appreciate the reviewer's attention to these details. In our preliminary study, we found that the output is not sensitive to the choice of radius, as our analysis primarily focuses on East Asia region. Figure 1 compares between the outputs obtained from 0.1° radius and a 10km radius. The spatial patterns exhibited by both outputs are highly similar, indicating that the choice of radius does not significantly impact the overall results within the scope of our study.

2. In Section 3.2.2, I do not quite follow the motivation and the description of the regression-based method. If I understand correctly, the method is regressing the computed average variability σ_{IDW} on different radius values. If so, why is it stated that "the spatio-temporal variability in Equation (4) becomes small as the spatial or temporal distance between grids becomes larger"? Perhaps what is more relevant is the fact that average variability is highly correlated with the number of points used to compute the variability. Also, why is the second-order design matrix used rather than other possibilities?

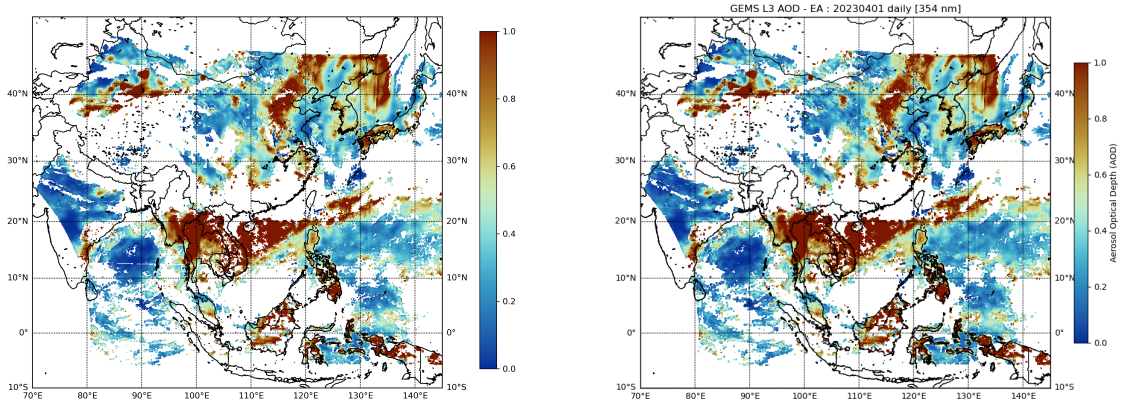

Figure 1: Daily mean-field estimates of GEMS AOD L3 product on April 1, 2023 with 0.1° radius (left) and 10km radius (right).

Response: Thank you for pointing this out. It was our mistake. Spatio-temporal variability increases as the distance between grids increases. We have now fixed the typo. The previous

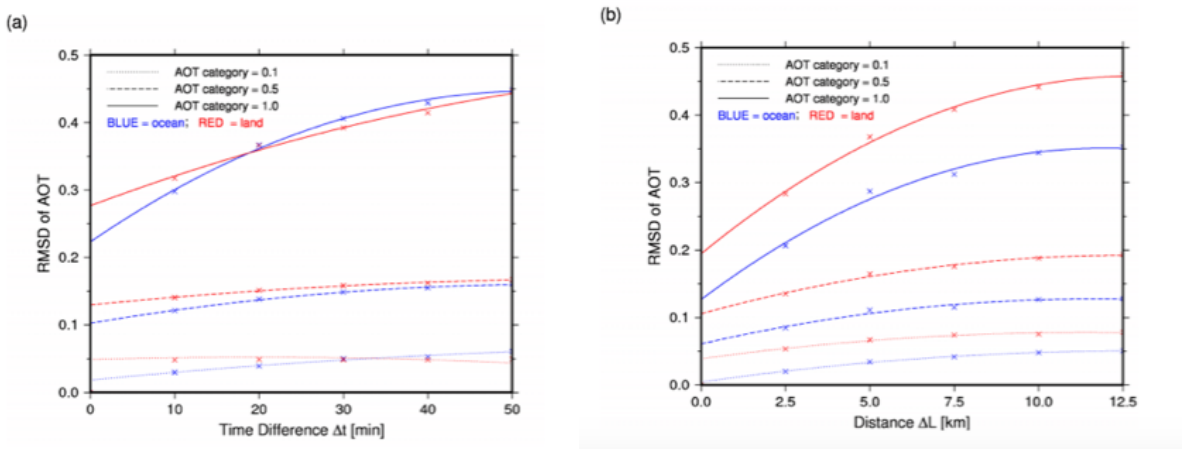

Figure 2: Figure 3 in Kikuchi et al. (2018)

work in Kikuchi et al. (2018) showed that there is a quadratic relationship between the RMSD of AOD estimates and the spatio-temporal distances (Figure 2). In our study, we also follow this convention.

(Section 3.2.2, instead of "small") Spatio-temporal variability increases as the distance between grids increases.

3. Figure 4 shows that the IDW method clearly leads to oversmoothing. I think the authors need to discuss this issue.

Response: In our initial analysis, we set the radius size as 9, which can lead to oversmoothing when applied to the simulated datasets. To address this issue and maintain consistency with the real data application, we have now adjusted the radius size to 3 in the main manuscript. This modification has proven effective in mitigating the oversmoothing problem, ensuring that the simulated results more accurately represent the underlying patterns. To maintain transparency and provide a comprehensive overview, we have relocated the IDW results obtained using a radius size of 9 to the Appendix.

(Section 4.3) After careful consideration and analysis, we have chosen to set the neighboring order to 3 for our study because varying the order of neighbor did not yield any significant differences in the mean squared error (MSE). However, to provide a comprehensive understanding of the impact of order on the interpolation process, we have included additional IDW results with increasing order sizes in Appendix A. These supplementary results demonstrate that larger order sizes can potentially lead to oversmoothing.

References

Kikuchi, M., H. Murakami, K. Suzuki, T. M. Nagao, and A. Higurashi (2018). Improved hourly estimates of aerosol optical thickness using spatiotemporal variability derived from himawari-8 geostationary satellite. *IEEE Transactions on Geoscience and Remote Sensing 56*(6), 3442–3455.