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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Improving the Sectional MOSAIC Aerosol models of WRF-Chem with the revised Gridpoint Statistical Interpolation System and multi-wavelength aerosol optical measurements: DAO-K experiment 2019 at Kashi, near the Taklamakan Desert, northwestern China" *by* Wenyuan Chang et al.

Anonymous Referee #2

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The study of Chang et al. developed the GSI 3Dvar capability to assimilate AOD, scattering/absorbing coefficients for MOSAIC scheme. A few DA tests (both simultaneously and separately experiments) were conducted for northwestern China and compared with surface observations at Kashi. The authors should have spent great efforts on the system development and presented very comprehensive results.

Based on my current understanding, some more work need to be done to facilitate the readers to understand, including some essential considerations of the DA core details and the clarifications of the texts. In this way, the system would be better understand/promoted and readers would be more convinced.

My general comments are as below:

1. Actually GOCART is understood for the better performance of dust simulation and the relevant optical properties had been well verified; while the MOSAIC scheme is thought to be more suitable for anthropogenic emission related simulation, but the optical simulation is rather complex.

In this study, the system is developed for MOSAIC but the verification is conducted for a site in desert. This required intensive investigation of the DUST related properties representation in the MOSAIC scheme, for example,

(a) the refractive index of OIN since it is mostly treated as DUST (while there should be distinctive differences between the two);

(b) the species partitioning (NO3 is not changed in option 2 which might not be reasonable and lead to unbalanced chemistry partitioning), (c) the size distribution (d) the number concentration, since the three factors determining the absorbing and scattering efficiency;

(e) aerosol water content which are not considered but actually may change the optical properties. With very limited observational data to verify the above-mentioned information, the results in this study is really hard to interpret.

2. Some descriptions about DA core and observational data should be provided. For example, it seemed not only AOD, but also wavelength depended absorbing and scattering efficient were all assimilated, the corresponding observational operators and the errors should be given in more detail.

Comments by lines:

1. Line 65 and other places. Adjoint operator, is it referred as TL-AD? Please clarify

2. Line 86 GIS ?

3. Line 100 Zang et al 2016, acutally a different DA system was used other than GSI in this study. Please check.

4. Line 181 regarding of the low anthropogenic and biogenic emissions in the desert, why not use GOCART instead?

5. Line 184-190. Actually the optical properties of NH4SO4, OC, dust, NaCl, H2O are treated as wave-length depended in the model, this information should be investigated and provided. As it seemed that multi-wavelength aerosol scattering and absorption coefficients are assimilated. The uncertainties of the assumption in the model and observational data should be provided.

6. Line 228. Why NO3 is not considered? In this case, it may lead to unbalanced chemistry partitioning.

7. Section 2.2.3 It seemed that scattering and absorbing coefficients are also observational assimilated. Please provide details.

8. Line 101: are the Mi,z,k in the two terms the same, maybe possibly dry and wet mass concentration respectively? If not, please clarify.

9. Line 315: is rwet related with aerosol water content, considering the hygroscopicity? Any uncertainty by not considering aerosol water content. Please clarify.

10. Line 352, please clarify mizk as dry or wet mass?

11. Line 367. Any uncertainty by considering constant radius?

12. Line 703-706. Please dig more on this issue.

13. Line 765. Please investigate the uncertainties of the modeled and observed absorption coefficients.

14. Figure2. Why the domain averaged standard deviation (c) is significantly larger than that of column averages (d, e)?

15. Figure 3. Why background error standard deviation of the OIN is two magnitudes larger than the other species? Indicating dominating contribution of dust? In this case, is it meaningful to investigate other species changes?

16. Table 1. Please explain how the errors are determined?

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