

R1

The authors thank the reviewer for the careful review and the hints to improve the manuscript.

**L53-54: If there are any previous studies regarding to the remote sensing of aerosols using the FTS, you should mention them.**

Answer:

Turner (2008) and Rathke et. al. (2002) are added to the new version of the manuscript.

**L144-145: Sea salt and dust particles can have larger radius than 1.0  $\mu\text{m}$ . Why is the maximum radius 1.0  $\mu\text{m}$ ?**

Answer:

The main reason for setting the upper limit of the  $R_{\text{eff}}$  to 1  $\mu\text{m}$  is that aerosols in the Arctic region is often below 1  $\mu\text{m}$ , according to the measurements of aerosol size distribution in the Arctic area ((Asmi et al., 2016; Park et al., 2020; Boyer et al., 2022)). In addition, if we do not make such constrain into 1  $\mu\text{m}$ , sometimes, the retrieval of fine particles, such as sulfate and BC, will be mathematically increased for a better fit of the spectrum, which is artificial. Since that, we decided to make such constraint.

When the retrieved  $R_{\text{eff}}$  of sea salt is close to 1  $\mu\text{m}$  and sea salt is dominant during a aerosol event, we will extend the databases to 2.5  $\mu\text{m}$  or even larger size and rerun the retrieval for a better result. While in this paper, the dominant one is sulfate, so the maximum radius is set 1  $\mu\text{m}$ .

**L159: The result of sea salt in Fig. 4a is calculated using the same effective radius as the other particles. When the effective radius of the other particles is 0.70, and 1.25  $\mu\text{m}$ , does the sea salt have comparable radiances with those of the other particles?**

Answer:

Other aerosol types with larger size are presented in Fig. A1. As a result, the radiance from sea salt with the same size as other aerosols is significantly lower; only when sea salt has a large particle size, whereas other particles are smaller, are both radiances comparable.

**The light absorbing capability of the particles could affect the radiances. Does the smallest light absorbing capability of sea salt affect the radiances?**

The smallest light absorbing capability of sea salt affects the radiance. The light absorbing capability is already included in the calculation (both in databases and LBLDIS).

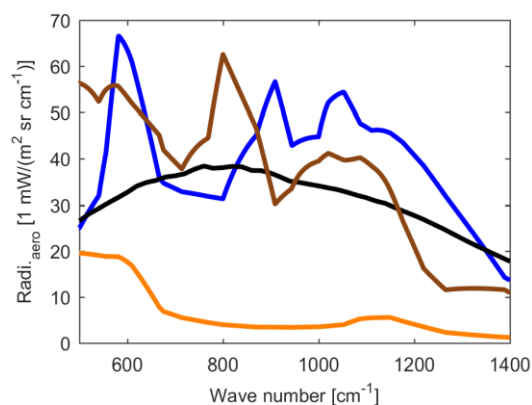


Figure A1. The emission spectra of large aerosol particles (dust in brown, sulfate in blue, sea salt in orange, BC in black) with  $R_{\text{eff}} = 0.70 \mu\text{m}$  and number density =  $2000 \text{ cm}^{-3}$

### L181: Calculation ---> Calibration

Answer:

Corrected.

### L203: Can you show the reliable range of the retrieval AOD from the results in Fig. 5?

Answer:

Aerosol AOD is reliable when it is greater than 0.003. In order to show the reliable range of the retrieval AOD, using similar artificial spectra but for several setting of AOD from 0.001 to 0.1 at 900  $\text{cm}^{-1}$ , the relative uncertainties of AOD in original cases with several preset values are given in Fig. 5b. It shows that the reliability range of the AOD retrieval is reliable for and AOD > 0.003.

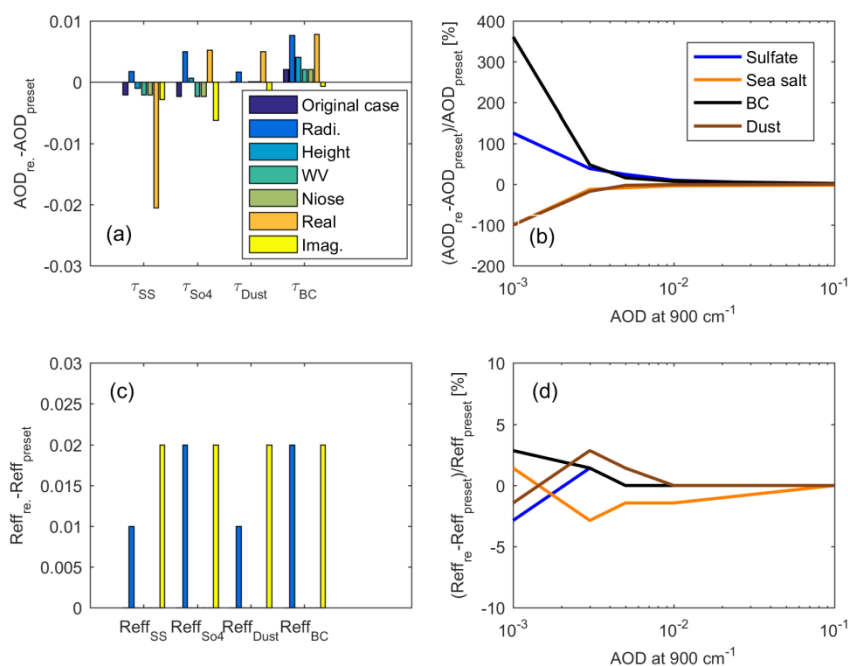


Figure 5. The difference between retrieved AOD in original case and several possible perturbing scenery (compare Table 2.) with preset values (a). The difference between retrieved effective radius in original case and several possible perturbing scenery (compare Table 2.) with preset values (c). The relative uncertainties of AOD in original cases with several preset values (b). The relative uncertainties of effective radius in original cases with several preset values (d).

Note: Fig. 5 (a) and (c) share the same legend in (a); Fig. 5 (b) and (d) share the same legend in (b). The artificial spectra with several preset values in (b) and (d) means the AOD's of aerosols are set from 0.001 to 0.1, compare Line 173. With the same method but for different preset AODs, the reliable range of AOD are given in (b) and (d).

### L215: In general, AOD of BC would be lowest in the four types. The AOD of BC in the MERRA-2 reanalysis is smallest in the four particles. However, the AOD of BC in the retrieval results is larger than AOD of sea salt. The authors show that the AOD of sea salt is underestimated and the AOD of BC is overestimated in Fig. 5. Should we interpret that the AOD of sea salt is underestimated and the AOD of BC is overestimated in Fig. 7?

Answer:

As we mentioned in former answer, the AOD is considered reliable if larger than 0.003. In Fig.7, both BC and sea salt are close to 0.003. Sulfate and dust are much higher than BC and sea salt.

Therefore, the values of BC and sea salt are not valid, and are plotted only for informational purposes.

**L217-219: The authors do not show the uncertainties of the retrieved effective radius. The effective radii of sulfate, dust, and BC are 0.3  $\mu\text{m}$  in Fig. 7.**

Answer:

Fig. 5c shows the similar information as Fig. 5a but for aerosol effective radius. It shows that only the calibration error and the imaginary part of complex refractive index will cause an error of aerosol effective radius, less than 0.02  $\mu\text{m}$ . Fig. 5d shows the relative uncertainties of effective radius in original cases with several preset values same as Fig. 5b. The relative uncertainty of the effective radius retrieval is more stable than that of AOD, less than  $\pm 5\%$  in all artificial spectra cases.

**Does the a priori information affect these results?**

**Yes, errors in measurements are unavoidable and the information content of the measurement itself limited, which means that the a priori information affects the results.** The influence of a priori on the retrieval is encoded in the AVK matrix, telling us the information that how much the measurement is in the results and how much a priori. This is also the reason that we present the AVK in the appendix.

To make such effect more intuitively understood, several retrievals are conducted using the artificial spectrum in the original case in Fig. 5a by changing the apriori of aerosol effective radius from 0.3 to 0.7  $\mu\text{m}$ . The result is shown in Fig. 6. For both AOD and aerosol effective radius retrieval, the more accurate the apriori information of aerosol effective radius is, the closer the retrieved result is to the preset value. Furthermore, sulfate and BC are more sensitive to the apriori information of aerosol effective radius than sea salt and dust, which means good apriori information about the size of sulfate and BC is helpful in the accuracy of retrieval.

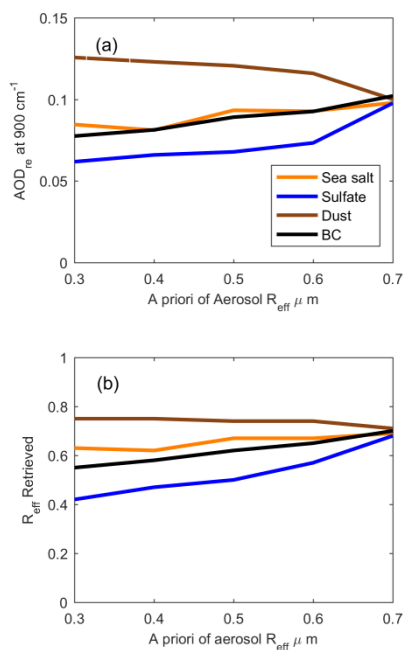


Figure 6. The retrieved AOD and  $R_{\text{eff}}$  using the artificial spectrum (all aerosols' AOD set 0.1 with  $R_{\text{eff}}$  setting 0.7  $\mu\text{m}$ , compare original case in Fig. 5a) with different apriori of  $R_{\text{eff}}$  from 0.3 to 0.7  $\mu\text{m}$ .

**L275: Organic carbon (OC) is one of the major components in the tropospheric aerosols.**

**The authors do not consider OC in the retrieval method, but actually OC would affect the retrieval results. What is the influence of OC?**

Answer:

Organic carbon (OC) is one of the major components in the tropospheric aerosols. It is not considered because there are no data in the complex refractive index at infrared waveband of OC. There are many types of OC, each of them may have a different spectral signature. However if there are spectral features which are not fitted, e.g. due to the presence of aerosol types not accounted for in the scattering database, the error margin on the retrieved aerosol types will be increased.

**L282-319: Matrices are printed in boldface, and vectors in boldface italics. See “submission” of AMT web page.**

Answer:

Corrected.

**L310: Averaging kernels are described in only this section. Were the averaging kernels used in this study?**

Answer:

Averaging kernels are given but not used in this study, since we haven't use AVK to do data comparison. However the averaging kernels belong to the retrieved result, because they include much information about the retrieval results, like the how influence is exerted by the a priori and how independent the retrieved quantities are from each other.

#### **Reference:**

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