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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Intercomparison between aerosol optical properties by a PREDE skyradiometer and CIMEL sunphotometer over Beijing, China" *by* H. Che et al.

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Interactive comment on;Intercomparison between aerosol optical properties by a PREDE skyradiometer and CIMEL sunphotometer over Beijing, China; by H. Che et al. Anonymous Referee #3 Received and published: 4 December 2007

General Comments

Q: The authors compared the PREDE skyradiometer and CIMEL sunphotometer aerosol optical properties over Beijing, China and analyzed three different aerosol events over Beijing. The optical thicknesses have very good correlation between skyradiometer and sunphotometer measurements. The results are relevant for the algorithm comparison. The paper shows the consistency of the AOD and discrepancy of other

aerosol optical properties. I feel it is a pity that the authors did not explain more details about the algorithms and what kind of differences we could expect in the aerosol optical properties due to the differences in algorithms. Do the differences found by the authors agree with the previous comparisons?

A: The authors would thank for the reviewer's important comments. Some details about the algorithms will be added in the revised paper. The submitted paper shows the consistency of the AOD and discrepancy of other aerosol optical properties. One of the important reasons is due to the original assumption about the size distribution. It could be seen clearly in Figure 5, the volume of coarse mode of SKYNET is larger than that of AERONET on average. The coarse mode particles have larger scattering ability than the fine mode particles. The SSA is defined by Sigma(scattering) /(Sigma(absorption)+ Sigma(scattering)), which means the more coarse mode particles will cause more scattering, then the SSA retrieved from SKYNET would be larger than those of AERONET. This is also explained that the SSA of SKYNET are larger than AERONET ones systematically.

As Referee #1 suggested, the comparison of AOD between AEROENT and SKYNET on the clear and hazy days agree very well, whereas on the dusty day the AOD retrieved by AERONET is much higher than by SKYNET. This is presumably because of the wrong assumption of spherical particles of SKYNET under dust weather conditions. The aerosol particles are mainly composed by mineral dust on the dusty days. These mineral dust particles are more non-spherical than the particles on clear and haze days.

Sano et al. (2003) compared the AOD between AERONET and SKYNET measurements. They found the difference of AOD between the instruments is less than 4% based on one day observation. Because they used SKYRAD version 3, they found there is large discrepancy between two instruments. In this study, it was found the difference of AOD between two instruments at 670nm is about 1% based on about one year continuous observation. And for the size distribution, the SKYRAD version 4.2 is

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used to process the skyradiometer measurements in this study. The patterns between the two instruments are similar, but there are still some differences. The volume size distribution of coarse mode of SKYNET is larger than that of AERONET.

Campanelli et al. (2004) also compared the aerosol optical properties between AERONET and SKYNET measurements based on about two weeks observation. They found the AOD of two instruments are comparable between 10-12%, for optical depth reference values of ˜ 0.12 at 500 nm. The Angstrom exponent is also comparable to within 10-12%. The SSA retrieved by SKYRAD version 4.0 is found to be within 10-12%, comparing to Dubovic spherical retrievals. In this study, it was found the AOD differences between two instruments were less than 1.5%. The Angstrom exponent differs within 10-12%. The SSA differs within 3%-8%. Campanelli et al. (2004) found the retrieved refractive index results did not agree very well because of the few number of common measurements and the unstable SKYRAD version 4.0 algorithm. In this study, it was found the imaginary part(m_i) from the SKYNET at all wavelengths are systematically lower than those from AERONET. And the SKYRAD version 4.2 algorithm seems more stable than the former versions.

Specific comments 1. Q: In Fig. 1, some aerosol optical thicknesses are too high. Is it possible there are some cloud contaminations?

A: The AOD data of AERONET in this study are Level 2.0 data. For the CE318 sunphotometer of AERONET, it has three measurements during one scenario. The AOD (Level 1.0 results) values retrieved from these three measurements are cloud screened by using a cloud-screening scheme (Smirnov et al. 2000). Then the Level 1.5 data are obtained. Finally the Level 2.0 results are obtained after some bad results are deleted manually. Thus these Level 2.0 AOD data are regarded as high-quality data. That’s to say, the cloud contaminations are avoided in the largest degree. Because of the different protocol, there is only one automatic measurement for the skyradiometer during one scenario. Cloud contaminations can not be differentiated in some weather conditions. But in this study, only the results from both instruments within 3

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minutes are used, thus the AOD data from skyradiometer could also be considered as the cloud-screened data.

2. Q: In Fig. 10 the maximum optical thickness at 440 nm on the dust day is about 1.5. Comparing to the optical thickness in Fig. 1, 1.5 is about the middle of the values. Can we expect there are so many dust days in Beijing?

A: During 2004, there were only several dust events in Beijing during the whole year. The high AOD are probably due to the pollution events. Although the air quality in Beijing looks better in recent years, the heavy pollution events are still serious especially under the stable weather conditions. The haze day in Figure 10 is just one common polluting day. There are more serious days than shown in this study. The effect of the water vapor on aerosol particles especially in summer time seems to be another reason for the high AOD in Beijing.

3. Q: The authors explained that the difference between two patterns of the volume size distributions probably due to the difference algorithm, using combines spherical and spheroid particle or only spherical particles. Are there any comparison of the algorithm using the simulated aerosol measurements?

A: The authors did not do the comparison of the algorithm using the simulated aerosol measurements in the submitted paper. According to the suggestions of Referee #1, the comparison was done in the revised paper. It shows that on the clear and hazy days the AOD for both measurement types agree very well, whereas on the dusty day the AOD retrieved by AERONET is much higher than by SKYNET, which is presumably because the assumption of spherical particles for the SKYNET algorithm is wrong in this case.

Another reason for the difference between two patterns of the volume size distributions probably is mainly due to the assumptions of the size distribution. The AERONET algorithm uses 22 stage radii (0.05, 0.07, 0.09, 0.11, 0.15, 0.19, 0.26, 0.33, 0.44, 0.58, 0.76, 0.99, 1.30, 1.71, 2.24, 2.94, 3.86, 5.06, 6.64, 8.71, 11.43, and 15.00 um)

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to retrieve the volume size distribution, while SKYNET algorithm uses 20 stage radii (0.01, 0.02, 0.03, 0.04, 0.06, 0.08, 0.12, 0.17, 0.25, 0.37, 0.54, 0.79, 1.16, 1.69, 2.47, 3.62, 5.29, 7.73, 11.31, and 16.54 um). In AERONET retrieve algorithm, the volume size spectra (dv/dlnr) is nearly 0 um3/um2 for the radii less than 0.05um and larger than 15.00 um for most cases. However, in SKYNET retrieve algorithm, the volume size spectra (dV/dlnr) is NOT 0 for the radii less than 0.05 um and larger than 15.00 um for most cases.

All above responses have been considered in the revised paper.

4. Q: Are values of the differences as expected from the algorithm? In Fig. 6 the m_i from the skyradiometer at all wavelengths are systematically lower than those by sunphotometer. How to explain it from the algorithm?

A: Yes. The reviewer's question is very important! As mention in the response to General comments above, the size distribution is an important reason which causes the difference in Fig.6. The m_i from the skyradiometer at all wavelengths are systematically lower than those by sunphotometer. This could be explained referring to Figure 5. One can see the fine mode particles' proportion against the whole mode (from 0.01 um to 15 um) of AERONET is larger than that of SKYNET. The refractive exponent consists of the real part and the imaginary part. The imaginary part reflects the absorption ability of aerosol particles. The volume of fine mode particles retrieved from AERONET is larger than that from SKYNET in most cases, which means the AERONET retrieved particles would have more absorption comparing to the SKYNET ones. This would probably cause larger m_i for AERONET than SKYNET in Figure 6. On the contrary, SSA of AERONET is less than that of SKYNET in Figure 4.

5. Q: In Fig. 10 the single scatter albedo have a large variation in the clean day but relative stable in the dust and haze day. The angstrom exponent and AOD on clear day do not show much variations comparing to the dust and haze day. Is the variation of single scattering albedo real or because of the retrieval algorithm?

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A: The reviewer's suggestion is very good. As shown in Fig 12, the SSA has a large variation in the clean day but relative stable in the dust and haze day. According to the comments of reviewer #1, the single scattering albedo, as well as other optical parameters, cannot be accurately determined at very low AOD. This is most probably the reason for the strong fluctuations seen in Figure 12 and Figure 10. That's to say, the variation of single scattering albedo is probably because of the retrieval algorithm.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 16023, 2007.