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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.

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 #1 Received and published: 19 November 2007

General Comments

Q: The paper addresses the important question in how far the SKYNET and AERONET ground-based measurements of aerosol optical properties agree with each other. New SKYNET data are presented, and are compared with AERONET measurements performed at the same site. Generally, there seems to be a good agreement, although discrepancies exist for the single scattering albedo and imaginary refractive index, es-

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pecially at wavelengths larger than 670 nm. These differences are acknowledged, but not expanded upon by the authors. The second part of the paper attempts to classify three different aerosol scenarios in Beijing, China in 2004. The scenario type is estimated from MODIS satellite data, and pyranometer and PM10 measurements were taken into account in the analysis, in addition to SKYNET and AERONET measurements. The aerosol scenarios could be convincingly classified as dust, pollution, and background, and this conclusion was supported by backtrajectory analyses of each studied scenario.

A: The authors would highly appreciate the reviewer's important comment. Some explanation about the differences between the results (SSA, refractive index) of SKYNET and AERONET has been added in the revised paper according to the reviewer's suggestion.

Specific Comments

1.Q: p. 16025 - l.2/3: Comment: Ground-based measurement networks are very useful for studying aerosol (optical) properties, but they cannot obtain global coverage. This can only be achieved by satellite measurements (and eventually by aerosol models).

A: The authors agree with the reviewer's comment. The sentence has been corrected as "Although ground-based measurement networks cannot obtain global coverage of aerosol optical characteristics like satellite measurements or aerosol models, they are very useful and accurate way to research aerosol optical properties".

2.Q: - l.15/16: Why are the quoted studies not sufficient to compare the AERONET and SKYNET? What were their conclusions?

A: Sano et al. (2003) compared the AOD between AERONET and SKYNET measurements. They found the difference of AOD at 670 nm 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. They also pointed simulta-

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neous observations for two instruments should be continued at least during one year for verifying the combined use of the two networks. Campanelli et al. (2004) also compared the aerosol optical properties between AERONET and SKYNET measurements based on about two weeks observations. 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. 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. They pointed the SKYRAD code should improved the comparison using Version 4.2.

Based on their studies, the comparison of aerosol optical properties including AOD, Angstrom exponent, SSA, volume size distribution, refractive index were done in this study using about one year continuous observations. The latest SKYRAD version 4.2 is used to retrieve these parameters. The algorithm seems more stable than the former versions. It was found that the difference of aerosol optical properties between the two instruments are smaller comparing to the studies of Sano et al. (2003) and Campanelli et al. (2004).

3.Q: p.16029 - l.11/12: Mightn t a comparison of an interpolated SKYNET value of Angstrom exponent at 440 nm with AERONET Angstrom exponent at 440 nm be more informative than a comparison of alpha(400 nm) and alpha (500 nm) of SKYNET with alpha (440nm) of AERONET?

A: The authors are a little bit confused by the reviewer's suggestion. Does the reviewer suggest doing a comparison of an interpolated SKYNET value of SSA at 440 nm with AERONET SSA at 440 nm shown in Figure 4? Usually, the alpha is calculated with AOD values between two wavelengths. There are only three common wavelengths of 670, 870, and 1020nm for both instruments. The skyradiometer of SKYNET has 400 and 500 nm wavelengths. The sunphotometer of AERONET has 440 nm wavelength.

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To compare the alpha values between different wavelengths of two instruments, we first use 400nm and 500nm AOD of SKYNET to calculated the alpha, then we use the alpha to interpolate the AOD at 440 nm for the skyradiometer of SKYNET. Finally, we get the alpha values between 440-670nm, 440-870nm of SKYNET. Similarly, we get the alpha values between 500-870nm of AERONET. Then we compared the 3 parameters of alpha between 440-670nm, alpha between 440-870nm, alpha between 500-870nm for SKYNET and AERONET.

4.Q: - l.15: The third percentage on this line (0.06%) seems extremely small for values that correlate so badly (as seen in figure 2), especially since the percentages calculated for larger wavelengths are larger despite the (much) better correlation p.

A: The authors agreed to the reviewer's comment. This comment has been included in the revised paper.

5.Q: 16030 - l.2/3 and l.15/16: why are the number of measuring days and the number of measurements not consistent?

A: This is meanly due to the protocol difference between two instruments and to the algorithm of AERONET. For Cimel sunphotometer the sun measurement scenarios are more frequently than almucantar measurement ones during a day. For Prede skyradiometer, it measures the sun measurements and almucantar measurements at every scenario. That's why we get fewer simultaneous measurements of SSA, volume size distribution, refractive index and so on than those AOD.

For different number of measuring days about SSA and volume size distribution as the reviewer pointed, it is mainly due to the AERONET algorithm. There are volume size distribution data but without SSA data in AERONET retrievals concentrating on AOD < 0.4. This is reasonable. As the reviewer suggested below, the SSA, as well as other optical parameters, cannot be accurately determined at very low ($<<0.4$) AOD. Thus the number of measuring days and the number of measurements between SSA and volume size distribution are not consistent.

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6.Q: p. 16031 - l.24 and further, figure 7: There are MODIS instruments on NASA s TERRA and AQUA satellites; please include the satellite (AQUA for 7 September and 28 March 2004, TERRA for 13 December 2004) and the overpass time. There are MODIS pictures at better resolution available from the AERONET website (although not for 13 December 2004); personally I don t think one can make very conclusive remarks from the figures shown in the paper due to the small scale.

A: The authors thank for the reviewer's comments. The AQUA for 7 September and 28 March 2004, TERRA for 13 December 2004 and the overpass time are added in the figure caption. And the pictures are also replaced by better resolution ones in the revised paper. The figures shown in this paper are mainly to let the readers have an intuitionistic view of no-cloud, pollution, and dust covered over Beijing. Further, we use the pyronometer, and PM10 measurements to validate three weather conditions. Then we could exclude the effect of cloud maximally. Finally, we could compare the aerosol optical properties under different weather conditions.

7.Q: p. 16032 - l.18: Please mention that the AOD were obtained from SKYNET measurements. Why are they not compared with AERONET data? This is available at the website for all days mentioned. The comparison will show 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, presumably because the assumption of spherical particles (in case of SKYNET) is wrong in this case.

A: The authors agree with the reviewer very much. In the revised paper, the AERONET data about AOD are included under dust and haze weather conditions. The AOD values on haze day of SKYNET agree very well with the AERONET ones. But on the dusty day the AOD retrieved by SKYNET is lower than by AERONET. As the reviewer's suggested, for dusty day the AOD retrieved by AERONET is much higher than by SKYNET, presumably because the assumption of spherical particles for SKYNET algorithm is wrong in this case. The reviewer's constructive suggestion is considered in the revised manuscript sufficiently.

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8.Q: p. 16033 - l.10 and further: The single scattering albedo, as well as other optical parameters, cannot be accurately determined at very low ($<<$0.4) AOD. This is most probably the reason for the strong fluctuations seen in figure 12. Might this also be the reason that the correlation of the aerosol parameters studied in the first part of the paper decreases with increasing wavelength (and, therefore, generally decreasing optical depth)? What happens to the correlations of the aerosol parameters if they are separated according to AOD (e.g. in a scatter plot with only values for AOD$>$0.4 or AOD$<$0.4)?

A: The reviewer's comments are very important. The authors agree that the strong fluctuations seen in figure 12 a (clean day) is because of the very low AOD. This comment has been added in the revised paper. The authors checked the data in Figure 4 (SSA) and Figure 6 (imaginary part of refractive index) again according to the reviewer's suggestion. There are no SSA and refractive index in Level 2.0 Almucantar Retrievals (Version 2) of AERONET when AOD at 440 nm less than 0.4. That is to say, the scatter plots of Figure 4 and 6 only show the cases of AOD at 440 nm larger than 0.4. Thus the authors could not compare the separated correlations of the SSA and the imaginary part of refractive index according to AOD.

So far, the authors could not explain the reason for the correlation of the aerosol parameters (eg. SSA and refractive index) studied in the first part of the paper decreasing with increasing wavelength.

Technical Corrections

1. Q: p.16024 - l.16: probablely -$>$ probably

A: The word "probablely"; has been corrected as "probably"

2. Q: - l.19/20: a part of the sentence before CAN on l.20 is missing.

A: The word "which" has been added.

3. Q: p.16025 - l.17: nearby -$>$ nearly

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A: The word "nearby" has been corrected as "nearly".

4. Q: - l.17: include OF between YEAR and SIMULTANEOUS

A: The word "of" has been added.

5. Q: - l.21: lights -> light A: The word "lights" has been corrected as "light".

6. Q: p.16028 - l.17 and further: intercompare -> compare

A: The word "intercompare" has been corrected as "compare" in p.16028 - l.17 and further.

7. Q: p. 16029 - l.9: remove one THE

A: The repeated word "the" has been deleted.

8. Q: p.16030 - l.7: skyradiometr -> skyradiometer

A: The word "skyradiometr" has been corrected as "skyradiometer".

9. Q: p.16031 - l.4/5: systemically -> systematically

A: The word "systemically" has been corrected as "systematically".

10. Q: - l.19: skyradiometr -> skyradiometer

A: The word "skyradiometr" has been corrected as "skyradiometer".

11. Q: p.16032 - l.1: effect -> was present

A: The word "effect" has been changed as "was present".

12. Q: - l.2: three -> two (pyranometer measurements shown for only two days)

A: The word "three" has been changed as "two",because only two days' pyranometer data were shown.

13. Q: - l.28: add ON THE DUSTY DAY between AND and ARE

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A: The phase of "on the dusty day" has been added between AND and ARE

14. Q: p.16033 - l.23 and further: bi-mode -> bi-modal

A: The word "bi-mode" has been corrected as "bi-modal" in p.16033 - l.23 and further.

15. Q: - l.28: difference -> differences

A: The word "difference" has been corrected as "differences".

16. Q: p.16034 - l.2: very lower -> much smaller

A: The phrase "very lower" has been corrected as "much smaller".

17. Q: - l.5/6: insert RELATIVE between THE and FINE MODE, substitute POSSESSES LARGE SCALE with IS LARGER WITH RESPECT TO

A: Both have been corrected according the reviewer's suggestion. The sentence has been changed as "While on the haze day, the relative fine mode volume of aerosol particles is larger with respect to the total volume size distribution comparing to clean or dust days which means the fine particles contributed larger under haze day than dust day to the aerosol optical properties."

18. Q: - l.15: past -> passed

A: The word "past" has been corrected as "passed".

19. Q: - l.15: acrossed -> crossed

A: The word "acrossed" has been corrected as "crossed".

20. Q: - l.16: northeastwardly -> southwestwardly

A: The word "northeastwardly" has been corrected as "southwestwardly".

21. Q: - l.22: original -> originally

A: The word "original" has been corrected as "originally".

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22. Q: p.16035 - l.21: systemically -> systematically

A: The word "systemically" has been corrected as "systematically".

23. Q: p.16036 - l.4: manufactory -> manufacturer

A: The word "manufactory" has been corrected as "manufacturer".

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