**Atmospheric
Chemistry
and Physics
Discussions**

# *Interactive comment on* "AERONET and ESR sun direct products comparison performed on Cimel CE318 and Prede POM01 solar radiometers" *by* V. Estellés et al.

**V. Estellés et al.**

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REVIEWER COMMENT: The authors compare the aerosol optical thickness, Angstrom exponent, and water vapor content obtained from data observed PREDE sky radiometer and CIMEL sun-photometer. In this study the authors applied a sunrad code, which is built by borrowing subroutines of two different algorithms for PREDE sky radiometer and CIMEL sun- photometer. The paper can be accepted for the publication if authors thoroughly revise the manuscript.

AUTHOR RESPONSE: We thank the anonymous reviewer for the comments that helped us improving the manuscript.

As a response to this general comment, it is important to stress that we only borrowed the subroutines for mode 1. The subroutines for mode 2 were implemented from ground (based in published methods) or adapting the correspondent subroutines provided by different authors.

REVIEWER COMMENT: (i). The English should be thoroughly checked. AUTHOR RESPONSE: We will make the English be reviewed before the final version of the manuscript

REVIEWER COMMENT:(ii). The sunrad code is simply a merge of some routines of algorithms for PREDE sky radiometer and CIMEL sun-photometer. The authors should explain their original contributions in this code. AUTHOR RESPONSE: As stated before, we have taken the subroutines from SKYRAD to ensure homogeneity with SKYNET. However, no AERONET code was available to take the subroutines from. Therefore, we implemented equivalent subroutines based on other authors (for example Blanco-Muriel (2000), Bruegge et al. (1992), Halthore et al. (1997), Gueymard (2001)...). In other cases, the subroutines were not based in any specific paper (for example, the routines for filter convolution, Angström exponent, temperature correction...).

In general, we would say that the subroutines for mode 1 were taken from previous existent codes, and the subroutines from mode 2 were implemented by us based on already published material.

Finally, in the subroutines headers, the user can find adequate acknowledgement for the origin of the code. For example, if a subroutine was directly taken from Skyrad version 4.2 source code, it is clearly stated. If a subroutine was based on Smirnov (2001) paper, the paper is cited in the source code of the program.

In any case, we have slightly changed the paragraph in the manuscript.

REVIEWER COMMENT: (iii). The given discussions are not enough and clear. The

authors may include scatter plot diagram to show how well results from two different instruments match. As I indicated in specific comments, the discussion section is not satisfactory and lacks scientific merit. For example, the authors transferred calibration coefficients of CIMEL sun-photometer to PREDE sky radiometer by assuming that optical thickness produced by both instruments should be same. After that, the authors used such calibration coefficients to calculate AOTs and compared the results. What is the use of such comparison since calibration coefficients for PREDE instrument were already tunned to produce optical thicknesses equal to those given by CIMEL sun-photometer? AUTHOR RESPONSE: The reason to use the same calibration or a calibration transfer here is not to artificially make AOD match, but to isolate the effect of the algorithms in the retrieval of AOD (in the case of Cimel) and to show that the code can be indistinctly applied on both instruments (in the case of Prede comparison). It is important to show that the code to be used in ESR is able to retrieve equivalent aerosol parameters from both Cimel and Prede instruments by using the same package. If we used an alternative source of calibration, differences in AOD would be the sum of differences due to the algorithms and differences due to the calibration; but our objective was to see that the same code can be applied in both instruments to see that, (under equivalent calibration) they can retrieve the same parameters.

We think that the methodology used in our study reports a very detailed information on the relative performances, but we will follow the reviewer suggestion and build scatter plot diagrams in the revised manuscript.

SPECIFIC COMMENTS:

Title

1. The title is ambiguous. Please revise the title that reflects the main content of the paper at a glance. AUTHOR RESPONSE: The title has been changed.

2. In title, sun direct product-→direct sun product? AUTHOR RESPONSE: corrected.

Abstract

3. Line 4: SKYNET (SKYrad network)–> The meaning of SKYrad is not clear. Actually, what does SKYrad mean? Does it mean only sky radiometer or other instruments too? AUTHOR RESPONSE: The text has been changed.

4. Line 8:The retrieval of direct sun products. . ..âĂŤ->What type of products, please write in the parenthesis AUTHOR RESPONSE: Written

5. Line 9:. . .to derive aerosol optical properties. . . âĂŤ>what type of products, please write in the parenthesis. AUTHOR RESPONSE: Written

6. What are the new features of ESR algorithm in comparison to the present algorithms for CIMEL sun-photometer and PREDE sky radiometer to retrieve aerosol optical thickness and water vapor content? Please describe very concisely in the abstract. This helps the user to figure out the most interesting part of this paper from the abstract. AUTHOR RESPONSE: Written

7. The aerosol optical thickness difference described in the abstract is for which wavelength or wavelength range? AUTHOR RESPONSE: Written (340 to 1020 nm)

8. What about the difference for other products (angstrom exponent, water vapor content), more importantly water vapor content? AUTHOR RESPONSE: Written

Introduction

9. Line 1 of the 2nd paragraph: . . ..the optical and radiative properties of the aerosols. . .. âĂŤ>Instead of "property", the word "parameter" is suitable. Correct such mistake for the whole manuscript. Basically, the words "optical" and "radiative" are used with the same meaning in the literature. What are the optical parameters and what are the radiative parameters? Please carefully revise the manuscript to eliminate confusion to the readers. AUTHOR RESPONSE: several sentences have been corrected in the text

10. Line 1 of the 4th paragraph: The paper of Dubovik and King, 2000 is not in the

correct alphabetical order in the references section. AUTHOR RESPONSE: corrected

11. Line 1 of the 5th paragraph: No title of the paper in the references section for Takamura and Nakajima, 2004: AUTHOR RESPONSE: corrected

12. Line 3 of the 5th paragraph: . . .Currently it holds 37 sites. . .–> Are 37 sites in only Asia or whole over the world? AUTHOR RESPONSE: the number referred to the whole world, after adding the ESR PREDE locations to the 25 locations shown in the SKYNET website.

13. Line 3 of the 5th paragraph: . . .the Prede POM radiometer . . .. âĂŤ>Please write in a very easy to understand way. As Prede is the name of the company, POM is the model of the instrument, please write them clearly. You may write as .. sky radiometer, manufactured by PREDE Co. Ltd., Japan. It has two models: POM-01 and POM-02 . . .. . ... For the sentences after it, you may write PREDE sky radiometer (not Prede radiometer) AUTHOR RESPONSE: corrected throughout the text.

14. Line 1 of the 6th paragraph: ESR website, 2011âĂŤ>Not applicable for scientific particle. Write the link of the webpage. AUTHOR RESPONSE: previously, the website was included in the reference list. Now it is inserted in the text as suggested by the reviewer.

15. Line 2 of the 7th paragraph : âĂŤthan can be applied. . .âĂŤ> . . ..that can be applied. . . AUTHOR RESPONSE: corrected

16. Line 1 of the 8th paragraph: write the types of direct sun product AUTHOR RESPONSE: Done

17. Line 5 of the 8th paragraph: AERONET web site, 2011–>Not applicable for scientific article. Write the link of the webpage. AUTHOR RESPONSE: Done

Instrumentation, calibration, and methodology

Instrumentation

18. Line 4 of the 1st paragraph: Write shortly about direct sun triplets. AUTHOR RESPONSE: Done

19. Line 4 of the 1st paragraph: RIMA website, 2011–> Not applicable for scientific article. Write the link of the webpage. AUTHOR RESPONSE: Done

20. Line 9 of the 2nd paragraph: #424 and #425âĂŤ>Those numbers suddenly appear here without any description in the previous lines. From where they were brought. Write more clearly. If they are from other RIMA-AERONET, state it in previous lines. AUTHOR RESPONSE: these numbers corresponded to alternative units that were deployed in the site. Few words have been included for clarification.

Calibrations

21. Lines 1 and 2 of the 1st paragraph: Describe very shortly about the pre and post calibrations. AUTHOR RESPONSE: We have included few words about what pre and post-calibration are.

22. Line 1 of the 2nd paragraph: . . .sun direct reading . . .âĂŤ>direct sun reading ? AUTHOR RESPONSE: Corrected

23. Lines 6 and 7 of the 2nd paragraph: These calibration transfers were periodically performed . . ...âĂŤ->periodically means at what time interval? AUTHOR RESPONSE: The periodicity depended on weather conditions and time availability, usually from 1 to 3 months.

24. Calibration procedure of the 3rd paragraph: The sentences are very ambiguous. Please reformat your sentences to make them clear and easy to understand. AUTHOR RESPONSE: The paragraph has been simplified

25. Line 4 and Line 6 of the 6th paragraph: post-calibration and pre-calibration âĂŤ>Why talic here? AUTHOR RESPONSE: The sentence was removed

Implementation of the sunrad module

26. The last line of the 1st paragraph: . . ...will be made public through ESR website (2011) âĂŤ-> Why only year within the parenthesis? Do you want to write the reference within the parenthesis? AUTHOR RESPONSE: We intended to follow the journal guidelines, but we have now included the full website address instead.

27. Lines 2-3 of the 2nd paragraph: . . .a formatting program (dsform) reads the Cimel and Prede data ïnAles and converts them to a common data format ïnAleâĂŤ>In order to use this program, does the user need to have simultaneous observation of both CIMEL and PREDE sky radiometers? If the user has data of only a single type of the instrument, is this program applicable? Please write few sentences about it. AUTHOR RESPONSE: No, we intended to say that the user can feed the program with any CIMEL or PREDE data, indistinctly; the user does not need to have simultaneous observations of CIMEL and PREDE sky radiometers. We have changed the sentence and we hope it is clear now.

28. Line 7 of the 3rd paragraph: (AERONET website, 2011) âĂŤ> not applicable for scientific article. AUTHOR RESPONSE: done

29. Lines 6-8 of the 7th paragraph: Equivalent triplets can be built during the data formatting stage, so equivalent triplet criteria are imposed.âĂŤ>How is it possible to generate the equivalent triplets? Please explain the methodology briefly. AUTHOR RESPONSE: the methodology will be explained briefly in the manuscript. The CIMEL triplets are sets of three sun measurements performed in approximately 1.5 minutes. Therefore, for the construction of PREDE triplets we select three consecutive measurements and interpolate two of them to obtain three measurements separated by 30 seconds. The two interpolated readings are used for the cloud screening, not for the AOD retrieval.

30. I was expecting something new in this section. In sunrad code, the calculation technique or subroutines of mode 1 are borrowed from Skyrad.pack software and the calculation technique or subroutines of mode 2 are borrowed from AERONET sun di-

rect algorithm. Where are the original contributions of the authors in sunrad code? AUTHOR RESPONSE: as we stated in the manuscript, we borrowed mode 1 subroutines from Skyrad. However, we do not borrow any subroutine from AERONET code, as we did not have access to this code. To develop a code that could be similar to AERONET, we consulted the information available in the AERONET website and implemented equivalent subroutines based on the original papers (for example, Michalsky (1988), Bodhaine et al. (1999)...). If we did not get access to a given paper or we considered an alternative paper to be equivalent, we adopted the second one. In case any of these papers included the source code, we directly adopted it or translated into FORTRAN (if the programming language was different). And final consideration, homogenization of subroutines for its application to both types of data (CIMEL and PREDE) took a significant amount of developement time, mainly if we take into account that was our objective to implement a software that could be well understood by non-skilled FORTRAN programmers, so we tried to comment all the subroutines and program blocks.

Comparison methodology

31. Line 2 of the 2nd paragraph: (OMI website, 2011)âĂŤ>The same mistake as above. Not applicable for scientific article. AUTHOR RESPONSE: done

32. Line 4 of the 6th paragraph: What is U95? AUTHOR RESPONSE: U95 referred to percentile 95. It has been changed now to P95 and introduced in the text.

33. Line 5 of the 6th paragraph: Since the authors are comparing results obtained from two different codes, I do not understand the necessity to remove outliers here. Why is it necessary? AUTHOR RESPONSE: Although we are comparing the codes, any of the simultaneous measurements performed by the CIMEL and PREDE sky radiometers can be affected by spurious causes (bad pointing, shadows casted by close obstacles, insects in the optical head tube, etc) that would introduce a higher deviation than the mean. Therefore, in this case it is needed to introduce an outlier filtering. However,

in the text we described the methodology used in the comparison without making a difference between the case we use different instruments or the same instrument. This has been corrected in the text.

Results

Comparison of ESR and AERONET for Cimel photometer

34. The title of subsection 3.1 does not make any sense to me. AUTHOR RESPONSE: the title has been changed.

35. As stated in the second paragraph of this section, the seasonal variability of differences in Figure 3 are due to inaccuracies of solar position and optical airmass routines of mode 1. Before discussing the results of Figure 3, the authors are suggested to briefly discuss the errors in airmass and solar position calculations caused by routines of mode 1. AUTHOR RESPONSE: mode 1 air mass expression is only valid when the earth's curvature is ignored and if we assume that the atmosphere is non-refractive and homogeneous. Otherwise, the error is estimated 0.25% at a solar zenital angle of 60° (Iqbal, 1983). Moreover, the Michalsky correction for refraction is less than 0.1% for a zenith angle of 70° (not used in mode 1). In turn, mode 2 expression is the same used by AERONET (Kasten, 1989) and corrected for refraction. Therefore the relative difference is negligible when using mode 2, but higher when we use mode 1.

For the solar coordinates, mode 1 uses the algorithm borrowed from SKYRAD codes. But unfortunately, we do not have information about the errors introduced by this algorithm. In turn, mode 2 uses the PSA algorithm from Blanco-Muriel et al. (2011). In their article they state that the PSA algorithm is better than Michalsky (1988) algorithm with a standard deviation of the estimated error of 22% and 14% lower for the zenith distance and azimuth angle, respectively, during the period 1990 – 2015, and in comparison to the Multiyear Interactive Computer Almanac. Specifically, the PSA algorithm error was estimated to be 0,091 and 0,138 minutes of arc. This is an small improvement over Michalsky method and therefore, we again expect a minor differ-

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ence between AERONET and ESR codes in mode 2, but a sensible improvement over differences obtained with mode 1. These comments have been included in the text.

Comparison of ESR for cimel and prede radiometers

36. The title of subsection 3.2 does not make any sense to me. AUTHOR RESPONSE: the title has been changed.

37. As stated in previous section, the calibration coefficients for PREDE sky radiometers had been transferred from CIMEL sun-photometer. In other words, authors had determined calibration constants for PREDE instrument in such a way that total optical thicknesses produced by both instruments should be exactly same. In this section, the authors have used such calibration constants to determine aerosol optical thickness (AOT) for PREDE instrument. There is no meaning of discussing comparison results of AOT when such calibration constants transferred from CIMEL instrument are used for PREDE instrument. It would be more informative if authors had compared AOTs those were derived independently. AUTHOR RESPONSE: the corrected title and the added paragraph better explains this section objective: to show that this new software can be used indistinctly in both instruments. As one of the ESR network objectives is to include non-AERONET CIMEL's, we need to show that the results obtained with both instruments and the new software are equivalent, for homogeneity purposes within the network. Of course, we agree with the reviewer that it would be interesting to see what is the total effect of using independent calibrations. However, this is a subject we are currently working on and surpassed the objective of the current manuscript. The in situ improved calibration method described by Campanelli (2004) was applied in a PREDE sky radiometer; in Campanelli et al. (2007) we tested the method in a independent CIMEL. Our current study is focused on validating the in situ improved method for co-located CIMEL and PREDE instruments, against standard high altitude Langley plots, for a 2-3 year period.

Comparison of ESR –prede and AEONET cimel

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38. The title as well as content of subsection 3.3 do not make any sense to me. AUTHOR RESPONSE: the title has been changed.

References

39. The references are not in alphabetical order.

40. Authors' name, article title, published year etc. are randomly written. AUTHOR RESPONSE: in the reference list we have tried to keep the journal style, although we have detected some errors in the order. We have also removed the websites from the references list as they have moved to the text by previous reviewer recommendations. These errors have been removed. The references follow the general format: "Authors: Title, Journal, volume, issue, pages-pages, year".

Table and Figure captions

Please write the captions for Tables and Figures in such a way that they could be understood even without reading the main text. AUTHOR RESPONSE: we have tried to make the captions clearer for the reader.

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Interactive comment on Atmos. Chem. Phys. Discuss., 12, 4341, 2012.

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