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Atmospheric Measurement Techniques
Discussions

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Interactive comment

Interactive comment on "An overview and issues of the sky radiometer technology and SKYNET" *by* Teruyuki Nakajima et al.

Anonymous Referee #2

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Review for Atmospheric Measurement Techniques

Title: An overview and issues of the sky radiometer technology and SKYNET

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General Comments: A paper focused on the issues and algorithms of the SKYNET network is needed and could prove quite useful to the scientific community. The title

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Discussion paper

and Introduction section of this paper holds significant promise, however upon reading there was a strong emphasis on calibration methods within SKYNET (which is good), but then a lack of detail or even complete omission of some other important issues. On page 2 (lines 24-26) of the introduction you say: “Compared to the AERONET technology, SKYNET has several differences in measurement and analysis methods, which are useful to overview and assess for the world community to understand the system, which is the purpose of this paper.” This sentence outlines the basis for an interesting and useful manuscript, however the differences (between SKYNET and AERONET) in measurement sequences, cloud screening, data quality checking, and some algorithms were not adequately addressed in the current paper. However, revisions with additional in-depth discussion of these issues could make this paper a very valuable and important reference for SKYNET network data users and aerosol researchers worldwide.

Specific Comments:

Abstract: This is likely the shortest abstract I have ever seen, and hardly informative. I recommend that a few specifics be mentioned as there is really nothing of substance in this abstract.

Page 3, lines 4-5: Here you discuss the nations that contribute to SKYNET and that a committee was formed for collaboration. Please add information on the availability of data to the scientific community from these regions/sub-networks and include specific data access websites and data policies.

Page 3, lines 4-5: It is necessary (here or elsewhere in the text) to include information on the temporal frequency of the direct sun and sky radiance measurements for SKYNET sun-sky radiometers. Also important are the types of sky scans made by SKYNET instruments. Are they all almucantar and/or some additional solar principal plane scans? How often are the sky scans made, and over what solar zenith angle (SZA) range? This should be contrasted with the AERONET measurement protocols, almucantar and hybrid scans. Also over what SZA range are SKYNET almucantars identified as high quality retrievals. For AERONET the minimum SZA for Level 2 (high quality) almucantar retrievals is 50 degrees, corresponding to 100 degrees scattering angle range.

Page 3, lines 4-5: It is surprising that the interference filters for the UV wavelengths would have such a wide band-pass of 10 nm. AERONET filters in the UV have 2 nm band-pass due to solar zenith angle dependent Rayleigh OD issues in measurement of AOD in the UV region.

Page 4, lines 17-18: A short summary of the SKYNET cloud screening is warranted here in the text. It would be very useful to compare what aspects of the cloud screening are similar and which ones differ from the AERONET cloud screening (please refer to V3 cloud screening, discussed in Giles et al (2019)). For example, AERONET uses the angular steepness of the solar aureole as a cirrus filter, while I think that SKYNET does not.

Page 5, line 16: Regarding the improved Langley (IL) method, please provide some estimated ranges of accuracy for different optical depth magnitudes. Also provide accuracy estimates of Fo determination for temporal variation in AOD over the Langley measurement sequence, as it would be expected that this would also be a factor.

Page 6, line 13: Should be ’wasting’ instead of ’waisting’ here.

Page 6, line 20: Since the AOD is much larger (and more variable) at 400 nm than 870 nm it seems that the error would be larger for the shorter wavelengths. Please explain why this would not be a factor or else include a statement that errors would be larger at shorter wavelengths unless the aerosol is coarse mode dominated (Angstrom Exponent of $\sim$zero).

Page 7-8 (last 2 sentences of P7 and first 2 sentences of P8): This data in Figure 4b should be discussed in more detail in the next section of Sky radiance calibration

(Section 4).

Section 4, starting on Page 9: Please provide some explanation of the causes of the temporal variance of the SVA as shown in the time series in Figure 4b. This data is from high altitude sites with stable very low AOD and therefore would be expected to be a best case scenario. Also discuss what the variability in SVA from sky scans would look like at a sea level site with moderate and variable turbidity, say AOD=0.5 +-0.3 at 500 nm with alpha=1.5.

Page 10, lines 13-15: It would be useful to provide the reader with an estimate of the magnitude of the error in sky radiance calibration as a result of this uncertainty in SVA from the disk scan. Or else state that the entire data base of SKYNET has been reprocessed with the correction method that was outlined by Uchiyama et al. (2018b).

Page 10, lines 20-24: Why are the retrievals within SKYNET made with two different versions of the Skyrad.pak code (Version 4.2 or version 5)? What are the effects of these different codes on the inverted parameters? Why is there no standardized inversion code for the entire network? Or if I have mis-interpreted this then please clarify in the text what the consistent data processing is for the data from all sites in the SKYNET network.

Page 11, line 1: Please state here whether this Cimel instrument in Beijing is part of the AERONET network with their data processing algorithms or a part of CARSNET network with somewhat different algorithms (especially when compared to V3 of AERONET).

Page 11, lines 2-3: Please explain here why the error in AOD is smaller in the shorter wavelengths even though the AOD and its absolute temporal variance is larger at the shorter wavelengths. This seems to be counter-intuitive, and I would need some significant evidence presented in the paper in order to be convincing.

Page 11, lines 10: This is a relatively large difference in Angstrom Exponent (0.5), but not if AOD is very low. Please state the AOD levels for these AE comparisons.

Page 11, lines 13: It would be useful to also show or discuss comparison statistics of AOT for 380 nm (in addition to 870 nm in Figure 8) since all instrument types have larger uncertainties at this wavelength.

Page 11, lines 17-18: When discussing differences in AOD it is much more useful to provide the differences in AOD rather than percentages.

Page 11, lines 19: Provide some quantification here of the SSA overestimate found by Che et al. (2008).

Page 11, lines 23: There needs to be more discussion of the SKYNET cloud screening algorithms and comparison to co-located AERONET site data in order for users to understand the cloud contamination issue better.

Page 11, lines 23-25: It is puzzling as to why all the data are not processed with Version 5. This suggests that data at some sites that process the data with V4.2 will have more cloud contamination than other sites that use V5. Please provide some clarification on which versions of SKYRAD.pak software/algorithms are used to process the data for what sites.

Page 11, line 28: More details on the stricter cloud screening in V5 are needed here in the text, not just providing literature references.

Page 12, lines 1-3: Your discussion of SSA differences (Fig 9) is misleading since the agreement was much poorer with standard SKYNET retrievals of SSA. The study of Mok et al. (2018) replaced the crude surface reflectance assumptions utilized by SKYNET with values derived from MODIS measurements (these were AERONET values). More discussion of the spectral surface reflectance used as input to the SKYNET retrievals is needed here.

Page 12-13, last 2 lines of P12 & first 4 line of P13: Please note whether this is a SKYNET retrieval product for W (column water vapor) or just a possibility for future implementation. Also does SKYNET provide W retrieved from both methods shown in Fig 11 in the database for all sites?

Page 13, line 11: It is very surprising that you use a 10 nm wide filter at 315 nm as stated on page 4 in this paper. This should cause significant SZA dependence in the signal and result in SZA dependence of the retrieved columnar ozone.

Page 13, lines 26-28: With only 1% of the variance explained in this scatterplot (Fig 13b), it seems that there are likely other issues involved in the retrieval of CER from both the sky radiometers and also the satellite measurements. The result could not be any worse than this and therefore it seems like this could just be mentioned in the text without the need of a plot.

Page 14, line 2: This statement is confusing. The accuracy shown in the paper is better than 10% if the AOT is high. For example, if the AOD at a site averages 0.5 for a month then the accuracy of the IL calibration does not result in 0.05 uncertainty.

Page 14, lines 2-3: This 'conclusion' is also misleading since the 'accuracy' of SSA is very hard to define as there is no gold standard for SSA measurement to use as a benchmark. Additionally. as discussed before this value of 0.015 (difference with AERONET and Pandora) is not based on standard SKYNET retrievals but on retrievals made with much more accurate inputs of surface reflectance (AERONET values were used). Also, Mok et al. (2018) applied additional improved quality checks to SKYNET retrievals, not the standard SKYNET product. The way it is currently written would give most readers a false sense of the consistency of the SKYNET retrievals of SSA versus AERONET.

Page 14, line 8: This is the first time the size of the financial budget for SKYNET has been mentioned in the entire paper. It is therefore a bit strange and confusing to include budget considerations in the Conclusions section.

Page 14, lines 10-13: It is odd to put these alternate calibration methods in bullet form in the Conclusions section. Please format into a typical sentence structure.

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