

## ***Interactive comment on “Nocturnal aerosol optical depth measurements with modified skyradiometer POM-02 using the moon as a light source” by Akihiro Uchiyama et al.***

### **Anonymous Referee #2**

Received and published: 23 July 2019

#### **General comments:**

Overall, this is a well-written paper describing the modification of the current PREDE-POM radiometers to extend the aerosol monitoring at night-time using the moon as the light source. Considering this to be the reference instrument of one of the most important ground-based networks such as Skynet, the adoption of this new system will provide valuable information for atmospheric research and will certainly be widely used. I consider that this manuscript fits perfectly into the scope of AMT. I recommend publishing the manuscript, but there are some important discussion points and details that I would like the authors to address before its final publication:

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- This referee is concerned about the lack of continuous lunar measurements shown in this paper. The authors measured 2 moon cycles in MLO but they do not show any results in terms of AOD. Furthermore, they have 6 moon cycles in Tsukuba, but only a few days are shown in figure 7. They claim they can perform measurements at higher phase angles, but there is no evidence of this in the text. Figure 7 offers no information as to what phase angle corresponds with these measurements, and they do not constitute proof of continuous lunar measurements in themselves (see also specific comments).
- Moreover, the choice of the NIES/HSRL as the only validation analysis of this paper seems to be an important weak point (it needs interpolation or the assumption of a constant extinction coefficient at altitudes of less than 500m). There is a Cimel CE318-T taking measurements at MLO during the period the Prede was calibrating there. I suggest the authors include this interesting comparison in their study. Furthermore, the statistics involved in the day/night/day continuity of AOD will give important information about the instrument's performance.
- In the manuscript there is sometimes a lack of required scientific and analytical rigor and therefore, I suggest that potential subjective sentences be avoided. I would like to highlight the following examples:
  - The ability of POM-02 to perform measurements beyond the quarters. In the conclusions the authors stated that this instrument is able to measure up to 120 degrees in phase angle. This value is quite surprising because it is the first time I have read it in the text. Notwithstanding, considering this to be the limit of your instrument's measuring capabilities, the authors must provide proof of that. Sections 2 and 3 describe a sensor able to perform measurements between  $\pm 90$  degrees and the authors claim that it is possible to extend this range if the instrument is accurately installed. Firstly, this assumption is vague and imprecise, and secondly there is no

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evidence in the manuscript showing this instrument is capable of providing measurements in this claimed phase angle range.

- The authors use only the ROLO model in terms of reflectance, assuming the relative change in the model's reflectance is correct. But as Kieffer and Stone (2005) stated, direct dependence on solar model will cancel itself out as long as the same model is used in going from irradiance to reflectance and back again. That means, the authors are introducing an "uncounted" error in this step, and they are not correcting their model implementation by using the Apollo spectra either. The authors should give some discussion about this effect, taking into account that they attribute the residuals of the C coefficient solely to errors of the ROLO model itself or to lunar librations. There are also other sources of error such as interpolation/extrapolation of the ROLO coefficients, temperature correction, Langley fitting, possible non-linearity of PREDE-POM sensor, noise, among others.
- Similar precision and accuracy of night-time measurements in comparison to daytime: I suggest the authors present some evidence which justifies this statement or avoid giving vague assumptions. I understand that an uncertainty analysis could be out of the scope of this paper (although it would be very illuminating). However, without this study, the authors should not state that the uncertainty at daytime is similar to the one at night-time.

#### **Specific comments:**

This is not the first time that an attempt for ROLO correction has been published. Therefore, I recommend including some discussion about similar corrections already presented in previous publications.

Amplification in the new PREDE-POM: I am not sure by reading the text if the new instrument includes amplification or not. I read on page 3, lines 170-172, that it can use amplifiers in the visible and NIR spectral range (1 to 7). However, in Eq. 2, there is

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no amplification used between sun and lunar measurements. Could you please clarify this?

This is a technical paper aiming to extend AOD capabilities to night-time. Nonetheless, the authors presented a correction of the lunar irradiance model without showing its impact in terms of AOD. Furthermore, this goal seems very ambitious, taking into account that the continuous operation of this instrument has not been appropriately verified.

Page 13, lines 404-417: How many points do you use (C coefficients) to perform your ROLO correction? What about the residuals? Do you use the residuals to estimate the precision of this correction by 1%? Please clarify.

Page 15, lines 469-472: there are references to "similar time variations" or "systematic differences" without quantifying them. The authors also claimed that this figure constitutes a continuous series, but it contains only 11 different nights from 3 different moon cycles (with 4, 4 and 3 nights, respectively). You do not provide any more data for an entire moon cycle, and is this because of clouds, technical problems. . . Please clarify.

I feel lost with units in Section 2.1. You write Amps almost everywhere, but sometimes I think you are talking about physical units (irradiance or radiance units). Figure 1 presents solar direct and scattered irradiance in Amps. Why do you convert everything into current intensity?

#### **Technical comments:**

Page 1, line 33: Please define MLO.

Page 1, line 33: I read in the text (page 8 line 258) that the calibration period is September-November. Please verify.

Page 2, line 44: Please define MRI/JMA.

Page 2, line 44: Please define NIES.

Page 2, line 50: As written in general comments, the authors should avoid making

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vague assumptions.

Page 2, line 65: there is a typo in AERONET.

Page 3, lines 79-84: Please homogenize if you write acronyms or not.

Page 3, line 98: “in many cases” Please be more specific. Are the authors talking about elastic lidars?

Page 5, section 2.2: I feel the FOV of the instrument is missing here. I assume it is the same as the non-modified Prede, but I consider it will be useful for the reader to include this information.

Page 8, line 257: How many measurements?

Page 9, section 5.1: I recommend the authors to separate this section into two, one for daytime calculations and another one for the methodology applied to night-time. I consider it will certainly improve the readability of this section.

Page 9, line 370: Is the  $R_m$  distance also expressed in AU? ROLO refers the reference to the mean Earth-Moon distance in km (384400km).

Page 10, line 325: Why the authors say “it is often used”? Because they use it sometimes and sometimes not? Please clarify.

Page 10, line 351: Please be clearer about “several atmospheric models”.

Page 13, line 407: “. . .the moon and the sun”.

Page 19, line 639: This is the first time I have read 120 degrees in the text.

Figure 2: Please label each figure and include some information about each sub-plot. According to page 12, line 392 and Eq. 10, the y-axis of this plot must be  $\ln(\pi \cdot V \cdot R_s^2 \cdot R_m^2 / A \cdot \Omega)$ ?

Figures 6 and 7: Please include information about wavelength.

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-230, 2019.

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