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Atmospheric Measurement Techniques Discussions

Interactive comment on "The instrument constant of sky radiometer (POM-02), Part I: Calibration constant" *by* Akihiro Uchiyama et al.

Anonymous Referee #2

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The paper describes in-field and laboratory calibrations of POM-02 sky radiometers used by SKYNET aerosol Network. The first method includes Langley-plot "zero air-mass" intercept determination at high altitude Mauna Loa observatory for the POM-02 (Calibration reference) instrument with following calibration transfer to other instruments on-site (e.g., at Tsukuba site). The second on-site calibration method includes Improved Langley calibration (IML), without using reference instrument. Temperature effect on the calibration constant is shown to be important in the UV (340nm and 380nm) and shortwave infrared (2200nm) spectral channels. The temperature sensitivity varies for different instruments. The temperature effect on visible and NIR channels is generally small (< 0.5% for a typical temperature range).

The paper is of general interest for ground-based aerosol measurement community

and could be published after major revision.

General comments: The main manuscript should be clarified focusing on main conclusions, while supporting material (technical details, tables and plots) could be moved to the supplement. Clarify calibration adjustment to account for changing sun-Earth distance. English should be improved. References need to be updated. Figure quality needs improvements

Specific comments: Describe how spectral response functions were measured. Replace "near-infrared" with "shortwave infrared": for > 1-micron channels Suggest replacing "SVA" with commonly used Field of View (FOV)

Improved Langley method (IML) should be clearly explained – see comments L359-379

L21: indicate temperature climatology in Tsukuba L23: Is this accuracy at Tsukuba or Mauna Loa? L25: quantify V0 uncertainty in UV-VIS-NIR and degradation (V0 time drift?) L26: Clarify that this is accuracy of calibration transfer only during best stable atmospheric conditions. Indicate time intervals for calibration transfer L33: change to short infrared L35: this sentence does not belong to the abstract L37: Quantify accuracy for each channel.

L59: Column average effective aerosol characteristics . . . L68: add references L71: SVA is usually called Field of View (FOV) L74: Provide instrumental reference. L135: which temperature sensor is used to start the heater? L136: ". . . the instrument is heated. . ." – to what temperature? When does the heater stop ?

L139: use "shortwave infrared" L142: inside temperature[s]? L146, Fig 1: Explain why if the temperature control setting was 20C , the inside temperature was 30C when the ambient temperature was 20C?

L153: . . . wavelengths shorter than 1020nm . . .

L 157 "near-infrared region" – common name is "shortwave -infrared region"

L161: “change in the temperature less than 1.5%” -> “change in the instrument response less than 1.5%”?

L188, Fig.4: Specify units in Y axis , e.g. counts per second? – this is usually a large number: explain scaling.

L197-248, Table 1: Explain units for calibration constant (V0) ? Table 1: Explain if correction for changing Sun-Earth distance was applied to daily V0s?.

L204 The [standard] error L210 “is large . . .” – quantify L222” without consideration of the temperature . . .” –for MLO conditions only L233”was replaced” -> were replaced L240: What are reasons for such large V0 changes ? L244: It would be useful to show monthly V0 values (corrected for sun-Earth distance) in fig.5.

L250: “Accuracy of [V0 calibration] transfer by direct solar measurement”

267 5. Improved Langley method - Add paragraph describing IML here

L289 IML value[s] L295: delete “by” L330 layer -> atmospheric column optical thickness

322 5.2 Review of Improved Langley method – move this section up after L267

325 The solar direct irradiance at the surface [normal to the solar beam] 330 zenith angle, and [tau] is the layer optical thickness. – total atmospheric optical thickness (Rayleigh plus aerosol plus gases) 331 The single scattering by aerosol in the almucantar - replace “by aerosol plus molecular (Rayleigh) scattering in the almucantar “

L340 direct solar [voltage] measurement L341: Equation (3) neglects forward scattered radiation into the FOV L341-345: Equations (3) and (4) should include Earth-sun distance (see eq. (19))

L353: Explain how tau or tau_scat can be obtained independently from the V0 ? L359: Explain how tau is obtained ? L360: Explain how tau_scat is obtained? L367: SVA -> FOV (common name) L368: “.. is the [radiometer output (voltage) due to] direct solar irradiance [at the surface]

L375: “Once the single scattering component is retrieved, m*tau and m*tau_scat are estimated” - Solving radiation transfer equation is only possible if tau, Phase function and tau_scat are known. Explain how tau, P(scat) and tau_scat are obtained?

What are introduced uncertainties due to assumptions about unknown aerosol refractive index, size distribution, modeling of aureole forward scattered radiation?

379 “Once m*tau is obtained,” – explain how tau is obtained before knowing calibration constant V0? Is another co-located radiometer used to derive tau?

L380-381 do not use capital for single scattering albedo: W0 L384 “W0 is frequently greater than 1.” – are these unphysical retrievals used for calibration? L387 Figs. -> Fig.9 L389 “V0 values with errors less than 0.01” – Is this error in ln(V0) ? L393, Fig9(c): In this plot was V0 corrected for the changing sun-Earth distance? L398 “ . . . are systematically overestimated”. – please, clarify this statement

ÂňÂň L414 “ [and spectral response function of the] radiometer are necessary”

L438: Table 4: Provide units for Vsun and V0

L444-455: Fig 10: Compare with more recent sources of high spectral resolution extra-terrestrial solar irradiance, e.g. https://www.cfa.harvard.edu/atmosphere/publications/Chance-Kurucz-solar2010-JQSRT.pdf

L466: which takes [into] account . . . L488-490: Use tau_aer in Eq (19) and 490 L492. “.. is interpolated from the optical thicknesses at 870 and 1020 nm” – explain interpolation method, e.g. linear, power law?

L496: explain how R is calculated? L497-499: explain how coefficients a and b were calculated? L504-505: explain units for calibration coefficients? L548: use tau_aer L640: “seasonal variation of 1 to 3%.” – Correcting for sun-Earth distance ?

Technical comments:

L559-560: Equations (24) and (25) can be combined. L585: "... is an alternative to the Langley method." – extension of Langley method? L629: " The annual variation of the calibration constants..." – The long-term changes

Fig 1 caption: "inside temperature[s]" Fig.4. Check the Y units: be counts per second? What is the scaling factor? Fig.5. Show monthly V0 values to check V0 seasonal dependence Fig. 8 Too small axis labels. Suggest scaling Y axis for clarity

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