

Interactive comment on “Development of on-site self-calibration and retrieval methods for sky-radiometer observations of precipitable water vapor” by M. Momoi et al.

Anonymous Referee #1

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GENERAL COMMENTS

The manuscript by Momoi et al. describes a novel method to self-calibrate the POM sun/sky radiometer for water vapour (WV) retrieval using diffuse sky radiance measurements and to estimate precipitable WV from direct irradiance at 940 nm (using a more "physical" approach than a non-linear empirical parametrisation of the Bouguer-Lambert-Beer law). The method is thoroughly and clearly explained, and the description is supported by sensitivity tests using radiative transfer models. The manuscript is skewed in favour of a theoretical/modelling perspective, with only two ending paragraphs focussed on experimental data, which is however justifiable owing to the main

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purpose of presenting a new method rather than studying the retrieved dataset. I recommend the publication of the manuscript after the authors have addressed some minor remarks, mainly aimed at improving readability by the unexperienced reader.

SPECIFIC COMMENTS

1. The new method seems to provide slightly worse results compared to AERONET, although POM and Cimel instruments are similar. It would be good if the authors could elaborate on this, thus enhancing a bit the experimental part of the paper. What is the most likely reason for this result? Is it due to the more physical (less empirical) approach employed in the study, with fewer empirical constraints? Have the authors explored the sensitivity of the retrievals to the accuracy of the instrumental characterisation (e.g., filter response function, field of view, etc.), to the used spectroscopic data (cross sections) or vertical profiles? If so, they could mention some of their results. More generally, on the basis of what criteria can the results of the WV retrieval be considered satisfactory? What are the maximum expected/permisible deviations, using such kind of instrument?

2. At least one plot of the time evolution of the retrieved w should be presented, also in order to understand when the maximum deviations from reference instruments occur;

3. It should be stressed that the sensitivity tests using synthetic data do not include measurement noise. If the authors also made some tests with noise, it would be interesting to present those results in the paper;

4. The present algorithm splits the instrumental characterisation (F_0 , bandpass, FOV) and the atmospheric parameters (WV profiles), while previous approaches use mixed empirical coefficients (a and b) dependent on both the spectral bandpass and the vertical WV profile. If my understanding is correct, this would permit to use the algorithm in different conditions (place/time) compared to the ones when the instrument was calibrated. Could this be an advantage to be underlined in the conclusions?

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TECHNICAL CORRECTIONS

- l. 19, "whose aerosol channels": too abrupt beginning, especially for the readers not experienced in measurements with POM photometers. I would argue that aerosols are seldom the only influencing factor at a specific wavelength, therefore "aerosol channel" sounds more like a colloquial shortcut than a technical term;
- l. 21-22, "by sky-radiometer remain challenge": some articles (a/the) missing;
- l. 22-23, "generally calibrated by the standard Langley method": only for reference instruments, then calibration is transferred to network instruments (as explained later in the text);
- l. 24, "water vapor channel": please mention the channel wavelength here;
- l. 28, "aerosol channels": specify the wavelengths;
- l. 53, "columns of water vapor content": do you mean column concentrations? Unclear, since radiosonde also measure vertical profiles;
- l. 60, "these previous studies": even the studies by Fowle («1992)?
- l. 64: do you really mean "radiometric calibration" (as in F0) or, e.g., "spectral sensitivity"?
- l. 75, "Sky-radiometer": article (the) missing?
- l. 77, "11 wavelengths": maybe a table of the channel wavelengths, together with the main extinction factors, could be useful. See also my first technical comment about the expressions "aerosol channels ... ozone channels" (e.g., even the "ozone channel" is affected by aerosol);
- l. 79, "observation ... self-calibration": a bit confusing, please reformulate to avoid mixing of observation and calibration procedures;
- l. 80, "works in turbid atmospheric conditions": "only" in turbid conditions or "also" in

turbid conditions?

- l. 81-82, "standard ... modified": please, define what a "standard" method and a "modified" one are;
- l. 93, "two SKYNET sites": explain why these two sites were selected. Do they have any particular characteristics, or was this choice oriented by the co-located instrumentation?
- l. 103, "We explain normalized radiance": article missing?
- l. 107-108, "aerosol ... cloud ... water vapor ... ozone channels": cf. previous comments. These approximate expressions could be used only after a short explanation;
 - Eq. (1): specify earlier in the text that this holds only for a plane-parallel nonrefractive atmosphere (l. 122, now);
 - Eq. (2): if L is defined as sky radiance (l. 106), then it should be already divided by the solid view angle (ω);
- l. 150: the sentence is missing its subject. It is also unclear if this limitation (the real atmosphere not being a single layer) will be addressed in the following text;
- l. 152, "sensitivity of R": ... at a wavelength of 940 nm;
- l. 154: I guess that these AOD values refer to 940 nm, too?
- l. 155-156, "the aerosol optical thickness does not affect this relationship": unclear, since R decreases, but the values do depend on AOD;
- l. 164: I would not define such a change as "drastic". The variation is only visible in the lower subfigures with a linear y-axis (please, put some letters next to the subplots), and mainly for $PWV \leq 2$ cm (as explained later in the text);
- l. 188: is "SKYMAP" an acronym?
- l. 197, "transmittance of the total extinction": isn't just "transmittance" enough?

- Eq. (8): please, explain where the 1.65 factor comes from;
- I. 218, "local minimum": does this local minimum change at every retrieval, then?
- I. 338: specify that the integral of the filter response function was normalised to 1 (not its maximum);
- Eq. (25)-(26): it could be useful to use a subscript (j ?) for the single $F0$'s. Also, please use another letter instead of w (in w_H);
- Eq. (28)-(29): perhaps it would be better to identify the indices with other letters than R (already used for radiances). Also, it should be mentioned that the range of scattering angles for the calculation of index 2 changes during the day;
- I. 390, I. 397 and Table 2, "misjudged"/"incorrect": it is unclear whether the cloud-screening criterium correctly works for the portion of the sky seen by the photometer or not. In the first case, the algorithm does its job, and I think that "misjudged"/"incorrect" are misleading terms, since the conditions of whole sky should not be considered as reference;
- I. 396-397: are <1 and >2 oktas?
- I. 407, "line regression": do you mean linear regression using AOD and wavelength (not logs)?
- Sect. 3: were only "aerosol channels" (I. 107) + "water vapor channel" used in the synthetic retrieval?
- I. 464-465: are the -10% and -3% deviations within the expected uncertainty? If not, can you explain these results? Please, use a proper number of significant digits;
- I. 472: maybe it would be more scientifically correct to plot these values anyway (with another colour/marker) even though they will not be considered;
- I. 478: a more natural choice would be to linearly interpolate the monthly calibrations.

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The authors certainly have good reasons for considering the annual mean value, can they elaborate on this?

- l. 518, "much more": "larger"?
- Figs. 1 and 7: the authors should explain the difference between the straight boxes and the rounded ones, and why the latter were not used in Fig. 7;
- Fig. 2: the label "Principal plane" should be put lower, on the principal place circumference;
- Fig. 3: mention somewhere that the plots refer to the principal plane;
- Fig. 10: colours in the second row are hardly distinguishable. Explain that they overlap (in the caption);
- Table 3, "Retrieved the PWV": "PWV retrieval"?

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