Referee #4

This is a very interesting paper presenting a new instrument for measuring aerosol optical properties.

Response: Thanks.

I have read the previous reviewer comments and the new manuscript and I could say that most of them has been taken into account.

Response: Thank you.

One aspect is that the instrument does a similar "job" with the AERONET/CIMEL instrument. The authors way to prove that the instrument provides good results is the agreement with the CIMEL instrument. So, I think discussion on comparing which one is "better" cannot be included.

Response: Thank you for your constructive comment. As we have mentioned in the response to Community Comment #1, the main target is to evaluate the performance of aerosol microphysical, optical and radiative properties measured from a multiwavelength photometer, rather than a commercial statements or competition for a monitoring instrument. We all agree that as an evaluation work, the discussion on comparing which one is "better" should not be included. So, we have check through this paper and substantially revised relevant statements. Revised portion are marked in **red** in the revised paper (tracked changes).

By the way, comparing with the CIMEL and having a good agreement does not mean also an accurate representation of reality. Moreover, as both instruments use the same calibration and same post processing algorithms and assumptions especially in the inversion products.

Response: The reviewer's suggestion is really appreciated. We all agree that the good agreement with CIMELs does not mean an absolutely accurate reality, since the they exactly have inherent algorithm and assumptions uncertainties in AOD and other inversions. With that in mind, as well as the practicality of this evaluation work, we used "Beijing-CAMS" 's results from AERONET' as the reference. Because all the devices in this campaign are running at the observation platform of CAMS, the departure originated from spatial difference could be regarded as inexistent, to minimize the errors with real results. In our plan for next steps, we will conduct the long-term validation of CW193 not only in different regions but also with different reference results, such as POM-02 and PFR, to further assess the performance of CW193. We have added this in our revised paper as below.

Line 601 in revised paper (Line 601 in clean version)

"the instruments still need to be further tested under different environment conditions, including long-term observations in mountainous, coastal, and desert regions with the reference of CE318, POM-02 and PFR."

One aspect that I am missing is a discussion on the temperature dependence of the instrument. AERONET/CIMELs lately have been presenting these corrections and it would be important to understand: how the temperature dependence have been identified and characterized, if it is

considered the same for all instruments and what are the ways of post corrections.

Response: Thanks a lot for your constructive suggestion. The temperature response of instrument and its configuration, correction is an essential part for the data evaluation, as it could have certain influence on the calculation for infrared channel measurements. In fact, we also found in this campaign that greater departures in near-infrared bands, which could be influenced by ambient temperature, as show in Line 360 (Line 359 in clean version) in. However, the sensitive experiment of temperature was not presented in this work due to the limited by observation period and temperature chamber. In future, we plan to conduct the sensitive experiment of temperature to determine the temperature coefficients via a larger range of temperature chamber.

A minor comment is in the new text line 105 needs re writing

Response: The comment is really appreciated. We have revised corresponding statements according to review's suggestion as below.

Line 95 in revised paper (Line 94 in clean version)

"So far, except for CE318, POM-02 (Nakajima et al., 2020) and PFR (Kazadzis et al., 2018), there are many photometers have realized the function of AOD measurement in China…"

Reference

Kazadzis, S., Kouremeti, N., Nyeki, S., Gröbner, J. and Wehrli, C.: The World Optical Depth Research and Calibration Center (WORCC) quality assurance and quality control of GAW-PFR AOD measurements, Geosci. Instrumentation, Methods Data Syst., 7(1), 39–53, doi:10.5194/GI-7-39-2018, 2018.

In general, I think it is an interesting work that it is adequate to the AMT journal standards.

Response: Thanks! We all greatly appreciate the reviewer's insightful comments and constructive suggestions for improving the quality of our paper.

Referee #5

This paper presented an evaluation of aerosol microphysical, optical and radiative properties measured from a multiwavelength photometer, named CW193. As introduced by the authors, the instrument has a highly integrated design, smart control performance, and is composed of three parts (optical head, robotic drive platform, and stents system). Then the CW193 product was inter-compared and validated using reference data from the AERONET based on the synchronous measurements. The results of this preliminary evaluation indicated that the CW193 is appropriate for monitoring aerosol microphysical, optical, and radiative properties, characterized by the good agreement of raw digital counts, accurate AOD results and comparable retrievals with AERONET. In summary, this paper is a good work and has lots of general interest for Atmospheric Measurement Techniques and related communities. Therefore, I have no more major comments and have recommended for acceptance after a minor revision. I suggested the following few comments may improve and strengthen the quality of the manuscript.

Response: Thank you for giving us the opportunity to improve the quality of this manuscript. We have substantially revised this manuscript by following your insightful comments and constructive suggestions. Please find out our point-by-point responses below. We have studied comments carefully and have made correction which we hope meet with approval. Revised portion are marked in **red** in the revised paper (tracked changes).

Specific Comments:

1. Line no. 61-64: Authors can be mentioned about the limitation of the polar orbiting or lower earth orbiting satellites with relevant references. For example, due to poor spatial and temporal resolution of such satellites, there are about 50% data lost over high-altitude sites mountainous sites in particular at 0.05 x 0.05 degree spatial resolution of MODIS (Terra) data (e.g. Ningombam et al., 2021).

Response: Thanks for your constructive suggestion. Yes, the orbiting satellites monitoring has many merits, such as the wide spatial coverage. But the low spatial and temporal resolution could not meet the advanced requirements for aerosol information over specific regions. We all agree that the data missing is a big challenge for satellites as the reviewer have mentioned. So we conduct this evaluation work to examine the performance of a multiwavelength photometer, which could be a contributor in ground-based observation in future. According to reviewer's suggestion, the relevant statements have been revised as below.

Line 63 in revised paper (Line 63 in clean version)

"In addition, owing to the limitation of the temporal resolution of satellite-borne platforms over a specific region, such as high-altitude areas and huge-emission areas, satellite AOD retrieval products cannot meet the advanced requirements for ecological environment assessment, heath effect study and real time monitoring."

Reference

Ningombam, S. S., Song, H. J., Mugil, S. K., Dumka, U. C., Larson, E. J. L., Kumar, B. and Sagar, R.: Evaluation of fractional clear sky over potential astronomical sites, Mon. Not. R. Astron.

Soc., 507(3), 3745–3760, doi:10.1093/MNRAS/STAB1971, 2021.

2. Line no. 79-80: It is also very important to expand such robotic measurement made at high-altitude and mountainous region where there are limited ground-based data available due to harsh climatic condition and lack of manpower support for operating the instruments.

Response: The reviewer's suggestion is really appreciated. We have revised corresponding statements as below.

Line 78 in revised paper (Line 77 in clean version)

"These networks have an important role in determining the climatic and environmental effects of aerosols, especially in polar and plateau regions, where the robotic measurements could be a better choice due to the harsh climatic condition and lack of manpower support, and the measurement results have been strictly verified under a wide range of conditions (Dubovik et al., 2000; Eck et al., 1999; Xing et al., 2021a; Zhuang et al., 2017)."

3. Line no. 134: Please put the unit of water vapor (mm or cm?) after +/- 0.10. Also, I found several places in the manuscript where the authors did not put the unit.

Response: Thanks a lot for pointing out. We check through this paper and added the missing unit in corresponding sentences as below.

Line 146 in revised paper (Line 145 in clean version)

"...at 936 nm for water vapor (WV), with uncertainties within ±0.02 and ±0.10 cm, respectively."

Line 555 in revised paper (Line 555 in clean version)

"Figure 12. The same as Figure 7 and Figure 8 but for water vapor (unit: cm)."

Line 592 in revised paper (Line 591 in clean version)

"The biases mostly varied within ±0.04 cm, whereas its mean values were concentrated within ±0.02 cm."

4. Line no. 249: Please mention which version of AERONET data is used as a reference in the present work.

Response: Thanks. We used AERONET's results in Version 3.0 as reference in this campaign. We have added this in our revised paper as below.

Line 274 in revised paper (Line 273 in clean version)

"...the cloud-screening results of AERONET as a reference (Version 3.0) ..."

5. Line no. 306-308: Authors may be added few more relevant references about the importance of quality-controlled data over high-altitude and clean environments where the estimated aerosol

parameters are of the order of measurement uncertainties.

Response: The reviewer's comment is really appreciated. We have added some new references here to highlight the importance of data evaluation as below.

Line 326 in revised paper (Line 325 in clean version)

"In terms of AOD evaluation, the key point is that the performance under quite low aerosol loading is largely affected by the instrument accuracy and stability (Campanelli et al., 2007; Che et al., 2009; Kazadzis et al., 2018; Ningombam et al., 2019; Tao et al., 2014)."

References

Kazadzis, S., Kouremeti, N., Nyeki, S., Gröbner, J. and Wehrli, C.: The World Optical Depth Research and Calibration Center (WORCC) quality assurance and quality control of GAW-PFR AOD measurements, Geosci. Instrumentation, Methods Data Syst., 7(1), 39–53, doi:10.5194/GI-7-39-2018, 2018.

Ningombam, S. S., Larson, E. J. L., Dumka, U. C., Estellés, V., Campanelli, M. and Steve, C.: Long-term (1995–2018) aerosol optical depth derived using ground based AERONET and SKYNET measurements from aerosol aged-background sites, Atmos. Pollut. Res., 10(2), 608–620, doi:10.1016/J.APR.2018.10.008, 2019.

6. Line no. 315: Table 4: PM10 for Level I on 7 November is found to be high. Please check if there are any issues in the data. Moreover, aerosol measurement on the same day for Figure 6 might have disrupted due to frequently passing cloudy which may be attributed the high AOD.

Response: The reviewer's suggestion is really appreciated. We checked the data and found they are okay. In fact, we did find there are some days when the $PM_{2.5}$ are low while the high values for PM_{10}. However, considering the significant health effects of fine particles, we just used daily $PM_{2.5}$ to defined the air quality in this study. Also, we revised some statements to avoid misleading as below.

Line 308 in revised paper (Line 307 in clean version)

"the daily average $PM_{2.5}$ and PM_{10} concentrations were calculated for the air quality classification with the reference of the ambient air quality standards of China…"

Line 311 in revised paper (Line 310 in clean version)

"In this study, Level I air quality is defined as…"

7. Line no. 346: Please correct the wavelength range '70 nm', I think it must be 870 nm.

Response: Thanks a lot for pointing out. We have revised this error as below.

Line 364 in revised paper (Line 365 in clean version)

"…at the longer wavelengths of 870, 1020 and 1640 nm."

8. Figure 12: Please put the unit of water vapor (mm or cm ?) in the Figure. Also, I found several places where the authors did not put the unit.

Response: The reviewer's suggestion is really appreciated. We have added the unit for this figure as below.

Line 146 in revised paper (Line 145 in clean version)
"…at 936 nm for water vapor (WV), with uncertainties within ±0.02 and ±0.10 cm, respectively."

Line 555 in revised paper (Line 555 in clean version)
"Figure 12. The same as Figure 7 and Figure 8 but for water vapor (unit: cm)."

Line 592 in revised paper (Line 591 in clean version)
"The biases mostly varied within ±0.04 cm, whereas its mean values were concentrated within ±0.02 cm."

References:

Shantikumar S Ningombam, H-J Song, S K Mugil, Umesh Chandra Dumka, E J L Larson, Brijesh Kumar, Ram Sagar, Evaluation of fractional clear sky over potential astronomical sites, Monthly Notices of the Royal Astronomical Society, 2021, Volume 507(3),pp.3745–3760, https://doi.org/10.1093/mnras/stab1971.

Response: The reviewer's suggestion is really appreciated. We have studied this paper and agree that the spatial and temporal resolution is a challenge for satellite monitoring, which the degree of influence is varied from regions to regions. This reference is very useful to highlight the importance of ground-based observation, so we cited this in our revised paper as below.