Referee #3

General comments:

Atmospheric aerosols have significant influence on regional air quality, regional climate change, as well as human health. Their loadings have been increased substantially compared with those in Pre-industrial times. A detailed description on the aerosol optical and physical properties is the prerequisites for better evaluating the effects of the aerosols. Unfortunately, uncertainties of the aerosol radiative forcing and climate effects still exist due to a lack of knowledge about the aerosol properties. Therefore, a new highly integrated observation instrument is necessary to be developed to fill the gap of current observation system. This study proposes a new multispectral photometer (CW193) with a highly integrated designing and smart control performance for monitoring aerosol microphysical, optical, and radiative properties. The results indicate that CW193 can well observe and capture the aerosol characteristics by comparing with AERONET products, implying that the instrument may have a wide application prospect in the further. The topic of this study is interesting and novel. Therefore, the paper has a potential for publication in the journal.

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.

Specific comments:

1. Why the new instrument is named as CW193? The authors can make a detailed introduction.

Response: Thanks for your constructive suggestion. Yes, the name of CW193 contains lots of meanings. Firstly, the CW means the **C**hinese device for **W**orld. We hope that this instrument could meet the international standard for aerosol monitoring. Also, the it represented the inter-comparison in this paper was conduct and affiliated in the **C**AMS atmospheric composition **W**atching program. Last but not least, we hope the CW193 to show respect to CE-318, as the latter is the wildly used device in the world with high accuracy and stability—that is "**C**E-318's quality is **W**anted". However, in order to make our paper more concise, we decided only to show the first meaning of "**C**hinese device for **W**orld" after the discussion with all author, and we think this point could express our quality requirement, confidence and best wishes to CW193.

2. What is the main difference (or progressiveness) of the CW193 against to the CE-318?

Response: Thanks for your comment. We suggested that the main difference of CW193 against CE-318 is CW193's portability (highly integrated design). As the left part in Figure 2 shows, the whole device is consisted of optical head, robotic drive platform and stents system. These three parts can be easily connected together only by a few screws. Except for its highly integrated design, the cross weight is about 12 kg, and this make it easier to transport. We have rewritten corresponding sentences in our paper as follow to highlight this difference.

Lines 143-147 in the revised paper:
"The instrument is mainly composed of three parts: optical head, robotic drive platform, and stents system (as shown in the left part of Figure 2). These three parts can be easily connected together only by a few screws. Except for its highly integrated design, the cross weight of CW193 is about 12 kg, and this make it easier to transport. Specifically, we presented the comparison of technical specifications between CE318-N and CW193 in table 1."

3. How many observation intervals can be set for CW193?
Response: Thanks for your kind suggestion. In Table 2, we present the observation frequency for Sun measurement of CW193, and measurement is conduct in every 3 minutes, which can be set up to 2 minutes. As for the routine of sky radiance observation (ALM, PPL), the CW193 can conduct continuous observation once the corresponding observation schedule is set. We have added these supplementary notes in the Table 2 as follow.

Line 202 in revised paper:
"

Observation frequency for sky radiance	*...*	*...*
*Observation schedule***	*SUN, ALM, PPL*	*- SUN, ALM, PPL (in default)* *- only SUN (Optional)* *- only ALM (Optional, **consecutive**)* *- only PPL (Optional, **consecutive**)*
Monitoring Software	*...*	*...*

"

4. The authors state that CW193 has a low maintenance requirement. How long and in what conditions does it need to be taken to maintain? I think all the ground-based instruments are needed to have a routine maintenance.
Response: Thanks for your constructive suggestion. We all agree that the routine maintenance is an important and necessary process in the observation campaign. At line 19 in the Abstract, this misleading sentence have been corrected. We intended to state that the CW193 is appropriate for the deployment in remote and unpopulated regions due to its portability, including highly integrated design and smart control performance. So we used "these characteristics" to represent the difference against CE318 in our revised paper as follow.

Lines 19-20 in revised paper:
"Because of these characteristics, this instrument is appropriate for the deployment in remote and unpopulated regions."

5. To make the instrument more reliable, more observation and validation works should be carried out in the further. For example, the authors can perform a series observation activity with different pollution levels, in different time scales, in different regions as well as in different seasons.

Response: Thanks for your constructive comment. We could not agree more that the new device should be tested in detail under different pollution levels, in different time scales, in different regions as well as in different seasons (as shown in lines 596 to 599). As for the verification under the different pollution levels, we have preliminarily tested its performance in this paper with the $PM_{2.5}$ varying from 6 to 104 μg m^{-3}. However, its accuracy and stability under heavy pollution is still need to be further assessed when $PM_{2.5}$ exceed 150 μg m^{-3}. As for the observation in different seasons and regions, we plan to conduct long-term field campaign in next year considering the various restriction by COVID-19 in this year. It should be note that we found that the WV bias (within ±0.04 in this paper) showed increasing trend with the values in this campaign, which means the performance of CW193 is still need to be further tested in humid summer days (as shown in lines 554-555).

6. Conclusion should be more refined instead of repeating the results. An additional discussion on the potential application of the instrument in the future can be involved in this section.

Response: Thanks for your suggestion. We suggested that the CW193's portability (highly integrated design) makes it more appropriate for the deployment in remote and unpopulated regions, to complement the observation gaps of CARSNET. In addition, the optional observation schedule (such as only ALM) could meet the different requirement of the aerosol microphysical, optical, and radiative properties. Especially when the VSD and SSA is in great demand for the modification of numerical model and the verification of satellite inversion products, in only ALM mode, these inversions could be obtained about 2 to 3 times in an hour, while for once in default observation schedule. We have added this discussion and application in our revised paper as follow.

Lines 606-609 in revised paper:

"Due to its smart control performance and optional observation schedule, such as ALM mode, the CW193 could meet the different requirement of the aerosol microphysical, optical, and radiative properties. When the VSD and SSA is in great demand for the modification of numerical model and the verification of satellite inversion products, these inversions could be obtained about 2 to 3 times in an hour, while for once in default observation schedule."

7. English should be corrected throughout the whole manuscript.

Response: Thanks for your kind suggestion. The major change is that we re-organized the section 2.2.3 to present the calibration and data processing in this campaign. Except for this, we have check through this paper and revised some spelling error and grammar mistakes. Also, we revised some phrases and supplementary notes to make our manuscript more logical and concise. Here we presented some minor corrections as follows.

Line 19-20 in revised paper:

*"...is composed of three parts (**optical head**, **robotic drive platform**, and **stents system**)."*

Line 143 in revised paper:

*"AOD and other retrievals (**such as** microphysical, optical, and radiative properties of aerosols)*

from Sun radiation…"

Line 210-211 in revised paper:
"…using the method of coefficient transfer ***(inter-comparison)*** *with the reference master instruments of AERONET…"*

Line 577-578 in revised paper:
*"****As a result****, the CW193 retrievals in this study showed high precision for SSA and ADRF…"*