Review 2

We would like to thank reviewer 2 for his/her effort to review this manuscript.

Reviewer 2: General comment:

This article describes the development and deployment of a balloon-borne OPC designed to measure aerosol size distributions in the stratosphere. The instrument was developed in two stages: POPC-06, with 6 size channels, which later advanced to POPC-30, with 30 sizing channels. POPC instruments have been flown extensively, and the results from these flights are presented in this manuscript. There is a brief description of the POPC instrument, followed by a description of the calibration and flight-worthiness test procedures. Comparison flights of POPC to other OPCs are then presented, as well as a comparison of a derived aerosol extinction product to measurements from SAGE III. Finally, a very general overview of the observation history of POPC is given. Overall, the manuscript lacks the detail needed on the instrument development process. The comparison to other instruments is well done and is a strength of the paper. The section overviewing the science is thin and not thorough enough to provide useful insight to the reader. This paper needs significant work before publication.

We have significantly revised the original paper by: i) improving the description of the POPC instrument; ii) adding an error analysis; iii) modifying the figures for consistency; and iv) providing additional information to support the discussion of the results.

Specific

comments:

(1) My main concern with this manuscript is that it does not describe the instrument in sufficient detail for an instrument paper. For example, how was the commercial device made suitable for deployment on high-altitude balloons? How is the thermal environment controlled? What about data management? A better diagram and/or picture of the instrument would help the reader understand what the POPC instrument is. It is mentioned that the counting efficiency of POPC was determined using the SMPS, but the specifics of this are not given. Further, how do the authors know these counting efficiencies remain consistent over the flight domain in the stratosphere, where temperature and pressure change significantly? What is presented is a brief description of the technical specifications of a commercial OPC that was modified in an unspecified way to be flown on a balloon.

In the revised version, we have added information about the thermal insulation of the POPC foam box (Fig. S1). We added a picture of the instrument (Fig.1). Additional information about the calibration is now provided (Fig. 2). We hope that the new version provides the necessary information to response to this comment.

Another example of missing detail is in Section 3.2, on flow analysis. Line 304 states, "We use this information to derive the relative error in flow that we incorporate into an error analysis in the next section." How is the relative flow error derived? (Also, the term Q is never defined.) Generally, I found the description of the flow analysis and Mie calculations confusing. More detail on the steps the authors took to compute aerosol size distributions and extinction coefficients would be beneficial.

We added additional information about the flow error analysis and Mie calculations.

(2) A significant concern with the design of POPC is that the instrument does not appear to have any sort of sheath flow around the sample air as it enters the optical chamber where it is sampled by the laser. How do the authors know there is no divergence of the sample air beam within the optical head across the pressure range in which the instrument operates? POPS, to which POPC is compared in this paper, is known to suffer from similar beam-divergence issues at low pressures. This relates back to the point above about how the counting efficiency is determined: how do the authors know that this characterization of POPC, done at the surface, remains valid in the low-pressure environment of the stratosphere? There is likely a good answer to this question, but the reader is left to guess, as there is insufficient detail about the POPC development process given in the paper.

The Monte Carlo simulation using flow error analysis, counting efficiency derived during the calibration process provides a first order estimate of an uncertainty analysis. However, since the calibration cannot be done at stratospheric conditions, the validation relies on the extensive comparison of the POPC with other in situ instruments (consistency between POPC-06 and POPC-30, POPS, COBALD and SAGE III/ISS).

(3) The introduction could be more specific about what problem is being solved or addressed by the development of POPC. Section 1.3 overviews current OPCs that operate in the stratosphere (though I question the inclusion of LOAC, as it has not been demonstrated that it can measure stratospheric aerosol, a point the authors themselves make), but it does not explain how the addition of POPC will better address any longstanding scientific questions about stratospheric aerosols. For example, both solar radiation management and anthropogenic stratospheric aerosol sources from rockets and satellite reentry are mentioned as new sources of aerosols. These sources are not

discussed anywhere else in the manuscript. Can POPC be used to quantify the impact of these sources on stratospheric aerosol?

We specified in the text the importance of aerosol size distribution measurements to validate numerical simulation, satellite products and gain insights on microphysical processes. The paragraph on LOAC was modified to include recent paper from Renard et al. (2026) describing the LOAC V2. Yes, the POPC can quantify the impact of these sources if the aerosol optical diameter is greater than 0.3 µm. We added a sentence in the manuscript to discuss it.

(4) Perhaps present the percent error when comparing POPC to other OPCs on a linear scale? Using a log scale makes it hard to see errors in the 20–40% range.

Most of the figures of the manuscript have been improved based on reviewer1's comments.

(5) Section 4, Science Results & Interpretations, could benefit from expansion. It is little more than an accounting of when POPC has observed some sort of aerosol plume event in the stratosphere. Is there a way to add more context to these measurements so that the observed features have more significance to the reader? The authors could show size distributions from different plumes to compare particle modes across different layers, or compare volcanic, non-volcanic, and pyroCb-influenced aerosol and discuss how these size distributions influence optical extinction. Time series plots and a map of the balloon launch sites would also be useful for illustrating the influence of the volcanic events on aerosol concentration in the stratosphere as observed by POPC. It is difficult to compare and interpret the profile plots in Figure 13, which show how aerosol concentrations have changed due to aerosol events.

We have improved this section by adding the time evolution of Stratospheric Aerosol Optical Depth (SAOD) derived from satellites to give a broader context of the POPC measurements. In addition, the location of the POPC-06 and POPC-30 measurements are added to Fig. 14. A detailed investigation of the size distribution of volcanic plumes and pyroCbs plumes will be the subject of another study.

Most importantly, what is new in these results that has not already been reported? Is it simply that these are measurements from a new instrument? Related to comment (3), what new scientific insight is being gained from the POPC measurements? Or how do they agree with other aerosol measurements of the same features? Many OPCs have measured aerosol enhancement from the discussed volcanic eruptions — how do those measurements compare to what is observed by POPC? These are just examples of how Section 4 could be made more relevant to readers.

As discussed before, the new scientific insights gained from the POPC measurements will be further assessed in future publications. This paper aims to present the instrument and demonstrate its ability to study stratosphere aerosols. We added additional information about several pyroCb plumes which were intersected with the POPC. Given its modest cost and easy deployment, this is an instrument especially useful for rapid deployment of fresh plumes.

Further, I don't understand why the paragraph starting on line 568 is included. It simply repeats aspects of the development history of POPC that have already been stated and lists encounters POPC has had with aerosol events. What is the value or interest to the reader here?

This part is now reduced in the new manuscript.

(6) The writing and presentation quality are currently insufficient for publication. For example, multi-panel figures are missing labels (see Figure 9). Equation 6 appears to be a screenshot of an equation from a different text. Numerous grammatical and formatting issues occur throughout the text (see lines 170 and 398), file names are used as figure titles, etc. This reads more like a draft than a polished manuscript. Please have the author team do a more thorough editing of the manuscript.

We have modified and improved most of the figures and improved the presentation quality.

Technical corrections:

I won't list specific corrections, as there are many that need to be made, and the text is likely to change significantly if the changes above are addressed.

Specific corrections have been applied based on reviewer 1.

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