Reply to Anonymous Referee #2

July 31,2025

Dear Reviewer,

Thank you very much for reviewing our manuscript. We are very grateful for the extremely helpful and constructive comments. In the following, we provide point-by-point replies to the points raised in your report. We have marked the original text of the review in blue colour and our response in black colour.

This is good work addressing a practical problem for holographic cloud probes. The results are important for the atmospheric science community and I would expect that this paper will be published fairly easily after some minor revisions, mainly identified already by the other reviewer.

We thank the reviewer for their positive assessment of our work and for recognizing its relevance to the atmospheric science community.

(C1): The authors use the standard Huygens-Fresnel reconstruction method, which is indeed appropriate here. I do wonder though if they have considered the more accurate angular spectrum method, and if so, why they chose not to use it instead. Probably there is not much difference for such large particles.

(A1): We thank the reviewer for this comment. We would like to clarify that there may have been some misunderstanding due to how the reconstruction method was presented in the manuscript. While the Huygens–Fresnel diffraction was shown in integral (spatial-domain) form for illustrative purposes, we are in fact using a frequency-domain implementation (see line 140 in the original manuscript: “The reconstruction is implemented in Fourier space with a Huygens–Fresnel kernel in filtering form as explained in Fugal et al. (2009)”). To our understanding, this approach is equivalent to what is also referred to as the Angular Spectrum Method. To reduce confusion and respond to the other reviewers feedback about clarity and density, we have since removed the explicit spatial-domain integral form from the revised manuscript (Cemoved lines 134-149 of original manuscript) and clarified in the text that the frequency-domain method described by Fugal (2009) is the one used for wavefield propagation.
It is also worth noting that the focus of this work was not on modifying or optimizing the reconstruction process itself, but rather on the subsequent classification and evaluation. The reconstruction follows the method described in Fugal (2009) (now corrected in the revised manuscript to indicate that no low-pass filtering is applied), with only minor adjustments to background filtering. Our main contributions lie in the downstream processing including classification and evaluation methodology.
We hope this clarification resolves the concern.

(C2): Around line 55, the authors address the promising concepts of skipping reconstruction. Because the particles here are spheres, the problem is actually simplified quite a bit. I wonder if the authors are aware of the very fast, very simple method in Denis et al. to size spherical particles quite accurately without reconstruction? See: Denis, Loïc, Corinne Fournier, Thierry Fournel, Christophe Ducottet, and Dominique Jeulin. "Direct extraction of the mean particle size from a digital hologram." Applied Optics 45, no. 5 (2006): 944-952.

(A2): We thank the reviewer for pointing us to this very relevant and interesting reference. We were not previously aware of the method by Denis et al., and we agree that it offers a promising approach for quickly estimating the mean particle size without reconstruction, particularly in the case of spherical particles. We have added a citation to this work in the discussion of new approaches to skip reconstruction in line 52 of the revised manuscript. The method, however, focuses on extracting only the mean particle size. The main adavantage of in-situ holography in clouds is the resolution of individual droplets and their three-dimensional spatial position and therefore the suggested method can not fully replace the reconstruction procedure. We do see value in potentially implementing this approach as a quick first-look tool for our datasets and greatly appreciate the suggestion.

(C3): Regarding clumping small glass beads around line 275, there is an effective method to deal with this effect. Simply use sonification as shown in Fig. 6 in Giri, Ramesh, and Matthew J. Berg. "The color of aerosol particles." Scientific Reports 13, no. 1 (2023): 1594.

(A3): We thank the reviewer for highlighting this helpful method. We have added a reference to the suggested paper in the revised manuscript (line 271 "The use of ultrasonic dispersion techniques, such as those described in \citet{giri2023color}, may improve the separation of beads and enhance the method's applicability in this regime.") and agree that using ultrasonic sonication can be effective in reducing bead clumping. However, even with improved dispersion, the glass-bead approach remains only suited for comparing size distribution and does not allow for a direct one-to-one comparison between known and measured diameters for individual droplets. As we argue in the paper (highlighted better in revised manuscript line 264), precise validation of individual droplet sizes is critical, which still limits the applicability of calibration beads.

We provide an additional version of the revised manuscript in which all changes are clearly marked, including those made in response to comments from the other reviewers.
Additionally, lines 141–149, 575, and 597–600 were removed, as they referred to a low-pass filter applied during reconstruction that is not used in our process and was incorrectly mentioned. This has now been clarified in line 137 of the revised manuscript, where Fugal (2009) is cited to describe the reconstruction process and explicitly stated that the method is applied without frequency low-pass filtering. The reference Paliwal 2025 in the list of references was corrected.