

Dear respectful Referee,

Thank you very much for your valuable comments. You raised helpful and precise questions about several parts of the work, especially the important issue of methodology. Our response to each of your comments appeared in a two-row table. The first row includes your comment or question and in the second row we brought our response. We also addressed the changes in the text by the line numbers (L??? - ???) of the current version of the manuscript, at the end of each response. It should be mentioned that some changes are also appeared in the new version of the manuscript based on the comments by the other referee.

We also reviewed once again the whole manuscript for typos and grammatical errors. There are also two small changes in the manuscript that we have to mention them here.

1. The azimuthal angle,  $\varphi$ , direction in Fig. 1 was not correct in the previous version. So, we swapped  $+50^\circ$  and  $-50^\circ$  in Fig. 1 in the current version.
2. The beam expander that we used in this work was a 10x and by a mistake from our previous works it was mentioned as a 5x in the previous version of the manuscript. We made this correction in L 104.

The revised version of the manuscript has now been uploaded. We believe the manuscript is in good shape now, and hope that it would be acceptable for publication in AMT. On behalf of my coauthors and myself, I am very much grateful for your precise review of our manuscript and we are quite open to consider if there will be any further comments or questions.

With kindest regards  
Salar Alizadeh  
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#### Point-by-point response to the comments of Referee #1

Comment #1	<p>Sect. 2.3: Your methodology seems to use a 'mixture' of both, the one-step and the two-step method. The one-step method uses particle depolarization ratios of 0.31 (dust) and 0.05 (spherical, non-dust particles) to characterize the aerosol mixture under investigation, whereas the two-step method uses 0.05 (non dust), 0.15 (fine dust) and 0.35 or 0.39 (for coarse dust) according to Mamouri and Ansmann (2014).</p> <p>Your methodology now uses a dust depol ratio of 0.31 (and not 0.35 or 0.39), a salt dust depol ratio of 0.15. and a wet dust depol ratio of 0.05 in the first step. There is no fine-mode dust contribution (and fine dust depol ratio of 0.15) considered in the first round. Do you think that you removed the ENTIRE dust impact after the first step, when using the dust depol ratio of 0.31 instead of 0.35 or 0.39, so that the remaining backscatter and depolarization information (in the second round) is due to salt dust and wet salt? Please provide a comment on this problem, namely that both, salt dust and fine-mode desert dust produce similar depolarization ratios around 0.15.</p>
Response #1	<p>There are some points that we should point out concerning this question</p> <ol style="list-style-type: none"><li>1- Since in the two-step POLIPHON the atmospheric particles categorized only in three groups, so instead of categorization of particles into coarse dust, fine dust, and non-dust particles as Mamouri and Ansmann (2014), we categorized the atmospheric particles into pure dust, salt-dust, and wet-salt. I have to add we are measuring just above the Urmia Lake surface that is covered with large amounts of salt particle and salt flakes (L 148 – 152). The measurement site also is ~40 km far from the Urmia city (Fig. 1). So, we considered that in September the temperature was ~20 °C during the measurements (L 201), concentration of urban pollution is not so high over the lake.</li></ol>

2- Based on our previous work (Ghomashi and Khalesifard, 2020) and works by other teams (e.g., Nisantzi et al., 2015, Flutsi et al., 2023), linear depolarization of dust particles very rarely goes beyond 0.30. So, in the first step of the POLIPHON we considered all particles having  $\delta_p > 0.31$  are pure dust (not coarse dust). We believe this is a reasonable assumption and stricter on removing the pure dust particle from the calculations compare to putting  $\delta_p > 0.35$ . But it should be mentioned that particles that we called them as salt-dust (L 49) due to mixing with salt and absorbing moisture may have  $0.05 < \delta_p < 0.31$ . Fig. R1 depicts some typical changes on the retrieved  $\beta_i$  and  $MC_i$ , for  $\delta_d = 0.31, 0.35,$  and  $0.39$  (from the recording on Sep. 20, 2022, 07:43 – 08:28 LT). As it shows the corresponding values for sd- and ws-particles don't show considerable changes. To have an overall picture, taking  $\delta_d = 0.39$  instead of  $\delta_d = 0.31$  as the boarder in the first step of the POLIPHON, decreases the total  $MC_d$  for  $\sim 23.8\%$  and increases  $MC_{sd}$  and  $MC_{ws}$ , for  $\sim 3.7\%$  and  $\sim 2.4\%$ , respectively. Where the  $MC_i$  are integrated over the whole detected plume in that recording.

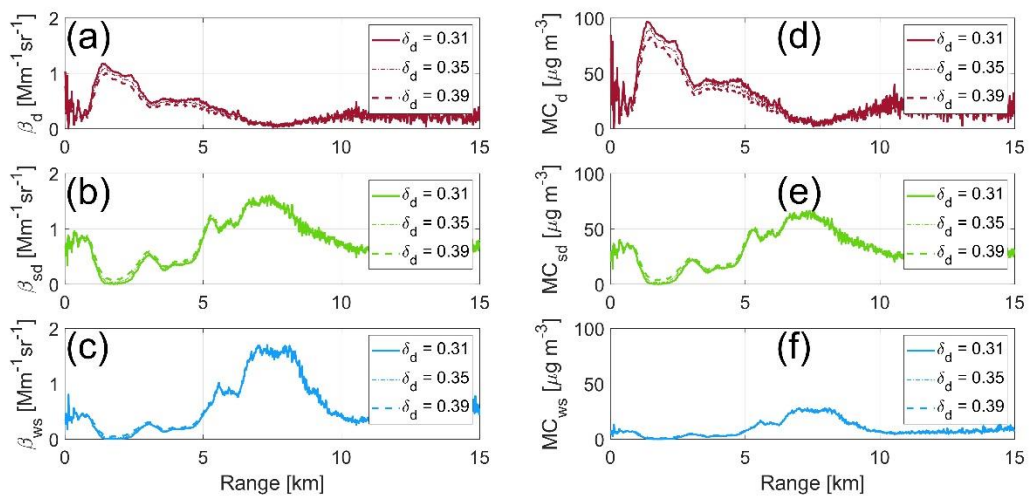


Figure R1. Changes on  $\beta_i$  and  $MC_i$  for  $\delta_d = 0.31, 0.35,$  and  $0.39$ .

3- We have no way to distinguish between fine dust and salt-dust in POLIPHON algorithm but considering the location of the lidar station, azimuthal directions of the lidar scans, and making measurement just over the aerosol plumes that most probably raised from the lake-bed, we considered these three types of the particles.

Comment #2

The discussion of the results is ok. The question is still to what extent the results are influenced by the fact that both, the depol ratios of fine dust and the depol ratio of salt dust are around 0.15 and how this fact influences the presented results.

Response #2	<p>There are some points that should be mentioned here.</p> <ol style="list-style-type: none"> <li>1- The two-step POLIPHON categorize the particles in just three groups, and so instead of “<i>coarse dust, fine dust, and non-dust</i>” we modified it to work on “<i>dust, salt-dust, and wet-salt</i>”.</li> <li>2- The salt-dust depolarization range (i.e., 0.05 – 0.31, see Sect. 2.3) overlaps with that of fine dust and polluted dust. But since; <ol style="list-style-type: none"> <li>a. The lidar scans horizontally just few tens of meters above the dried lake bed,</li> <li>b. The lake bed is covered with salt particles and salt flakes,</li> <li>c. The lidar station is ~40 km far from Urmia the largest city close to the station,</li> <li>d. The campaign was in September when the average surface temperature was ~20 °C,</li> <li>e. Based on reported horizontal visibilities, and HYSPLIT backward trajectories, there was no transregional dust outbreaks for the selected campaign days.</li> </ol> <p>Then we considered that</p> <ol style="list-style-type: none"> <li>a. The detected plumes raised from the lake bed and particles inside them mostly should be mixed with salt except those having <math>\delta_p &gt; 0.31</math>, which are taken as pure dust,</li> <li>b. Due to the distance from Urmia, low elevation of the plumes, and high surface temperature, we don't expect that particles inside the plume got contaminated with urban pollution.</li> </ol> <p>These are the reasons that we considered the mentioned categorization. We added L 210 – 221 to the discussion section, to make this assumption clear. Hope that this would be acceptable.</p> </li> </ol>
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Comment #3	Besides backscatter coefficients one should also provide the related extinction coefficients in Table 2, by using the lidar ratios in Table 1.
Response #3	It is done in the 2 <sup>nd</sup> row of Table 2 and L 273 – 276 is added.

Comment #4	Is it possible to provide even a hypothetical conclusion regarding the unhealthy pollution? In the upcoming years and decades, all the particles of the partly toxic composition of the lake sediment will be pushed into the air with strong winds.
Response #4	To get an idea about the influence of raised particle plumes from the dried bed of the Urmia Lake on its surrounding area, other measurement campaigns should be run on other locations in its catchment area. Especially, in the regions between the lake and the city of Tabriz that is the largest city in Northwest Iran hosting about 1.7 million inhabitants and a considerable number of industries are active in its suburbs. In addition to lidar recordings, aerosol sampling and chemical analysis of the collected samples should be done to have an idea about the toxicity of the aerosols. Such

campaigns should be carried on at the east side of the lake but still our team didn't have proper support to run such a project. Hope that this will happen in future.

We added some sentences to the conclusion on lines:

L 325 – 328.