

## ***Interactive comment on “A practical method to remove a priori information from lidar optimal estimation method retrievals” by Ali Jalali et al.***

**Anonymous Referee #2**

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The paper is dedicated to removal of a priori information from retrievals of lidar measurements based on optimal estimation technique. This operation uses a coarse grid, in which number of retrieval levels corresponds to the degrees of freedom. Overall, the paper is written in unclear way. The motivation is not described properly. The analyses are based on single retrievals only, which is evidently not sufficient for any conclusion. The detailed comments are below.

### **MAJOR COMMENTS**

My comments will use the Rayleigh temperature retrievals, but they are relevant also to water vapour retrievals.

1. The statement of the problem looks strange: first, you use a priori in retrievals in the

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OEM method (while it is not necessary, the method by Hauchecorne and Chanin (1980) and your retrievals on coarse grid work without a priori), and then “remove” a priori information. While each step is understandable (note, they have different objectives: OEM tries to increase vertical range, while the removal of a priori detects the regions of useful information from measurements solely), their combination looks surprising. It took a while to understand that the OEM retrieval is performed only for determining the optimal coarse grid. The following should be addressed in the paper:

- a. A clear motivation for each step and method with intended applications (climatology, trends, thermo-dynamical processes etc.) should be indicated. Limitations of each method should be indicated and discussed.
  - b. The results should be compared with the traditional method (Hauchecorne and Chanin, 1980), including H-C retrievals on your coarse grid (or/and averaging to a coarse grid). If the results are coinciding with the “removed a priori” retrievals, this should be indicated. Since lidar temperature profiles have been used in several gravity wave studies, please discuss the influence of a coarse grid on this application.
  - c. Please consider changing/revising the title of the paper into e.g. “On optimization of retrieval grid for lidar measurements”, or “Information-based retrievals from lidar measurements” or “Retrievals from lidar measurements using information-centered vertical grid” or similar. From my point of view, this would reflect better the applied method.
2. Using only one profile is far from being sufficient for any conclusion. At least, a representative dataset should be used. Variations in the optimal grid should be illustrated, and implications for applications should be discussed.

### **DETAILED COMMENTS**

- 1) If the major comment 1c will be accepted, the whole paper needs restructuring and rephrasing.
- 2) P.2, lines 14- 32 and illustration: the direct discussion of the figure in another paper

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(Jalali et al., 2018) and its further analysis complicates reading and is not needed in the introduction. It is sufficient simply mention that the influence of climatology at upper altitudes is large and indicate typical values.

3) P.3 L9 : “some of the method's advantages” Which method: yours or von Clar-mann&Grabowski?

4) Section 3, “OEM theoretical background”, should be radically shortened. It is not needed to rewrite many formulae from Rodgers book, please keep only essential ones.

5) X<sub>a</sub> term is missing RHS of Eq.(6)

6) P.5 L 20 “. . . a full RANDOM uncertainty budget”

7) P.6 L. 1 “ if the A is unity at each altitude” (and similar statements below in the paper). Be careful with phrasing: matrix cannot be unity.

8) Figure 2: It would be more clear if cumulative trace of A (y-axis) would be shown as fine grid levels (x-axis), and coarse grid points would be also indicated on this plot.

9) Figure 3 caption: it is sufficient to write only that the measurement response is indicated by red lines, since the definitions and explanations are given in the text.

10) Section 5.1 and 5.2 results: in retrievals, there is usually a trade-off between vertical resolution and random uncertainty. In your retrievals, both vertical resolution and retrieval uncertainty increase. Then an advantage of the method becomes doubtful. Please explain also reasoning behind using a climatology as a priori in RALMO retrievals. Evidently, that climatology cannot be a good a priori. Instead, ECMWF forecast/analysis would provide a more reliable a priori.

11) Illustrations based on one example in Section 5.1, 5.2 and 5.3 are not sufficient for any conclusion. The analysis of a representative dataset should be performed.

12) Summary should be updated after analysis of a representative dataset.

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13) The text like in first two paragraphs of “Conclusions” should be avoided: the papers in AMT are for educated readers. The statements in the 3rd paragraph (p.21, lines 13-16) should be confirmed by the analysis.

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