

Interactive comment on “A depolarisation lidar based method for the determination of liquid-cloud microphysical properties” by D. P. Donovan et al.

Anonymous Referee #1

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This is a nice paper that explores the potential of using depolarization lidar to retrieve cloud base properties, in particular particle size, which is very difficult to obtain remotely by other means. The method appears robust and the results are convincing. I therefore recommend publication subject to minor corrections. My specific comments are below.

1. It would be useful to comment somewhere about the applicability of something like this approach to spaceborne lidar. Obviously the receiver footprint on the cloud would be much larger and the cloud is viewed from above, but the global information obtained if it would work from space could be very valuable.

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2. Line 4 of the abstract: I would regard "macrophysical" properties to be things like the overall cloud width, height and overlap; LWC is a microphysical property.

3. Section 2.1, equations 4, 12 and others: please provide all equations in SI units, rather than containing arbitrary powers of 10 to convert between SI units. In Eq. 4, the units of R_{eff} are not stated - are they microns? Best to have their units and those of "z" as metres, and to add the reference height $z_{\text{ref}} = 100$ m into the equation.

4. Last line of page 9932 and elsewhere: Specify that this is the error covariance matrix of the observations.

5. Equation 27: Rather than using $\ln(R_{\text{eff},100})$ and α_{100} as state variables, which are likely to be strongly correlated, it seems more natural to choose, say, total number concentration N_T and the liquid water content gradient $d\text{LWC}/dz$. Then one could add a sensible a-priori estimate on both, and even add physical constraints such as that the gradient of LWC should not be steeper than adiabatic.

6. Last paragraph of page 9938: Gradient-free minimizations are used, but then the curvature is used to compute the error covariance of the solution. If the curvature of the cost function in the form of the Hessian matrix is available, can't this be used in a more efficient minimization method such as Gauss-Newton or Levenberg-Marquardt?

7. Figure 5: It would help if the caption could say *what* is plotted so the reader doesn't need to turn his/her head to read what's written up the side of the colorbar. This applies to some of the other figures too.

8. Figure 12: State if this is observations or simulation.

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