We thank both reviewers for their careful readings and helpful suggestions. Below, the reviewers' comments are shown in color with our responses in black.

Comments of Reviewer 2

R2.1: The manuscript of S. Burton et al. presents an interesting study about the information content of 3+2 lidar measurements in respect to aerosol microscopical properties. The topic is interesting and relevant to the lidar community. Apart from the comments of the first reviewer, my main concern is that the authors ignore an important previously published work with similar topic (and title):

Veselovskii, I., Kolgotin, A., Müller, D. and Whiteman, D. N.: Information content of multiwavelength lidar data with respect to microphysical particle properties derived from eigenvalue analysis, Appl. Opt., 44(25), 5292–5303, doi:10.1364/AO.44.005292, 2005. The authors should discuss their methodology and results taking into acount this work (what are the benefits of Optimal Estimator method in respect to eigenvalue analysis? Are the results of the two methods similar and how do they explain possible differences?)

Thank you for pointing out this important study which we previously overlooked. Indeed the eigenvalue analysis of Veselovskii et al. (2005) based on Twomey (1977) has much in common with the Optimal Estimation tools used in the current study. The DOF metric in Optimal Estimation is calculated by taking the trace of the error-weighted Jacobian matrix, which is operationally very similar to doing an eigenvalue analysis on the Jacobian matrix and comparing to the measurement error bars, as done by Veselovskii et al. (2005). There are a lot of interesting and useful items in the study by Veselovskii et al. (2005) including an explanation of the information content of the backscatter and extinction measurements separately. We especially like that both that study and ours allow for assessment of the measurement system in a way that is mostly independent of retrieval methodology. However, there are some differences between the studies. One difference is that the error analysis by Veselovskii et al. 2005 doesn't include all five state variables; since the current manuscript includes discussions of the retrieval error of the number concentration and of the geometric standard deviation (called dispersion by Veselovskii et al. 2005), this manuscript can at the very least be seen as furthering the earlier work in that way. There are also operational differences that we believe make the OE methodology much easier to use. For just one example, the retrieval uncertainties are a direct output of the methodology described in this manuscript. There is no need to repeat the analysis with a variety of different increments to determine the sensitivity to each state variable. Yet, the most important difference between the eigenvalue analysis method and the OE method is the role of prior constraints or external information. Veselovskii et al. (2005) use the eigenvalue analysis primarily to assess the retrieval errors (which we also do in our analysis) but do not specifically address the fact that the retrieval system is underdetermined. In an underdetermined system, prior constraints or external information of some kind becomes critical. The OE system is designed to include a priori information in an integrated and transparent way. This allows us in our study first to consciously minimize the prior information, but then also to lay the framework for how external information or additional measurements are included in the retrieval system. We think it is very important for any implementation of a retrieval of the $3\beta + 2\alpha$ lidar system or a related system to explicitly address how constraints and a priori information are incorporated, and we think the OE system is one of the best ways of making this clear and transparent.

We made the following revisions to the manuscript. We added the following "Veselovskii et al. (2005) also discuss an assessment of the information content and retrieval uncertainties of the 3β + 2α lidar measurements using an eigenvalue analysis based on work by Twomey (1977), which, like the OE framework, allows for an assessment of the information content in a way that is mostly independent of any retrieval methodology." Later, we add "Finally, the OE method provides a formalized means of representing the retrieval constraints, a critical part of an underdetermined retrieval like this, but one which is not well represented using a perturbation sensitivity study or the eigenvalue approach of Veselovskii et al. (2005) and Twomey (1977)"

Technical comments:

R2.2: Page2, line 32: "between 30nm and 8um". Specify that these are only typical values.

E.g. other authors have uses different bound for their search space (0.05 – 25um):

Veselovskii, I., Dubovik, O., Kolgotin, A., Lapyonok, T., Di Girolamo, P., Summa, D.,Whiteman, D. N., Mishchenko, M. and Tanré, D.: Application of randomly oriented spheroids for retrieval of dust particle parameters from multiwavelength lidar measurements, J. Geophys. Res., 115(D21), D21203, doi:10.1029/2010JD014139, 2010.

OK, we did that. We added "for example" and then clarified "the limits of the search-space vary somewhat for different authors".

R2.3: Page 3, line 23: Give references that describe these approached.

All of the approaches are described by Rodgers 2000, chapter 10, so we added that citation at that point in the manuscript.