

We would like to thank the reviewer for the comments on our manuscript. Below we give our responses. The original reviewer comments are shown in blue color, while our responses are in black color.

Reviewer: The authors address this problem by constructing a different set of variables (labeled as the vector **b** as opposed to the traditional vector **c**) that allows “for a proper analytic treatment of their error covariance matrix”. They also make generalization to the case of the covariance error matrices with nonzero nondiagonal elements. It is shown that the theoretical expressions for the error covariance matrix with respect to the vector **b** are in better agreement with their estimations from the real radar data than the ones with respect to the vector **c** as demonstrated by the comparison of Figs. 8 and 9 in the manuscript.

Response: We would like to emphasize that the vector **b** is not something we invent. The elements of the vector **b** are an intermediate step between raw radar measurements (I/Q data) and the widely known elements of the vector **c** (reflected power, ZDR, Rho_hv, Phi_dp). In other words, in order to calculate elements of the vector **c**, one calculates elements of the vector **b** first. One of our main messages is that it is much easier to properly describe the covariance matrix of the vector **b** than the one of the vector **c**.

Reviewer: I do believe that this study raises an important issue and is a step in the right direction although I personally do not foresee wide utilization of the variational retrieval methods for practical applications in the near future due to their complexity.

Response: We agree with the reviewer that variational retrievals are not yet widely used in meteorological radars. There are however a number of studies we cite in the introduction section, which show first successful attempts. We expect that with increasing computation power these methods are becoming more and more widely used. Also note, that methods which require measurement error covariance matrix are not limited by variational retrievals. Sensitivity analysis and data assimilation are performed by many national weather services, academic institutions and private companies and often lack a proper treatment of the measurements uncertainties. Here as well there are first attempts made to assimilate polarimetric weather radar data. We already declared the range of possible applications of the study at Lines 11, 56, 231, 261, 379.

I do not have any specific comments and suggestions mainly because the manuscript contains plenty of mathematical derivations that are quite difficult to follow and check, and a reader has to trust the authors regarding their validity.

Response: This manuscript is a result of few years of work. We agree that it has a very specific content loaded with mathematical expressions. We, however, see this as a necessity to ease the following of the mathematical derivation of all the analytic formulas. All the steps required to understand how results were derived and explicitly written. Only the most lengthy derivations are pushed to the appendix section. An interested reader familiar with linear

algebra and statistics should be able to follow the explanations. For every step we give references and detailed explanation. In addition, we share the raw radar data and the code, which can be downloaded and checked against the sample data used in the paper or even the original data. Therefore, although we value the reader's trust we think that we made every possible step to overcome any possible doubt towards this work. We think that the statement "a reader has to trust the authors" is unjustified, because everything can be checked. We made the manuscript and supplementary material as open as possible.

I am not even sure that the paper is a good fit for the AMT journal. It may be more suitable for Journal of the Atmospheric Sciences but this is, of course, for the editor to decide.

Response: We believe that our manuscript perfectly fits the declared scope of the journal, which we quote: "The main subject areas comprise the development, intercomparison, and validation of measurement instruments and techniques of data processing and information retrieval for gases, aerosols, and clouds. **Papers submitted to AMT must contain atmospheric measurements, laboratory measurements relevant for atmospheric science, and/or theoretical calculations of measurements simulations with detailed error analysis** including instrument simulations." This is further reinforced by the aims of the AMT special issue "Fusion of radar polarimetry and numerical atmospheric modelling towards an improved understanding of cloud and precipitation processes" which clearly focuses on the practical applications of polarimetric radar measurements. On the other hand, the suggested alternative, Journal of the Atmospheric Sciences (JAS): "publishes basic research related to the physics, dynamics, and chemistry of the atmosphere". Our manuscript is focused on measurement uncertainties and does not contain any results about physics, dynamics, or chemistry of the atmosphere.