Response to Referee 2

We would like to thank the Referee for reading the manuscript and for kind words about our work.

The work is devoted to the problem of recognizing and identifying the type of aerosol in lidar measurements. It is known that aerosols in the atmosphere arise from numerous sources and undergo intense mixing during atmospheric transport. Typically, the aerosol environment at a particular geographic location is a mixture of different types of particles. In this regard, the task of recognizing aerosol particles by their origin is extremely important. The article under discussion presents an original approach to recognizing the components of aerosol mixtures based on the analysis of polarization and spectroscopic properties of backscattering coefficients. The proposed method uses data obtained with the Mi-Raman fluorescent lidar at the University of Lille, France. This lidar is well known from the authors' past publications and, with its advanced measurement capabilities, provides rich information on aerosols.

The authors propose to take the aerosol backscattering coefficient, the particle depolarization coefficient, and the fluorescent ability as the main input parameters to identify the type of aerosol. Fluorescence ability is defined as the ratio of the fluorescence backscatter coefficient to the backscatter coefficient of particles at the un shifted scattering line. In this case, it is possible to write a system of three lidar equations, the solution of which allows one to determine the composition of the three-component aerosol mixture. The work shows that the method allows one to reliably separate the contributions of such types of aerosols as forest fire smoke, urban aerosol, and dust into the total backscattering coefficient at a wavelength of 532 nm. To achieve this, much work has been done on statistical analysis of the scattering properties of each of these types of aerosols. Obviously, due to the variability of the scattering properties of aerosols, only some statistical relationship is possible between the type of aerosol and the combination of its scattering properties. Understanding this well, the authors use the Monte Carlo method, provided that the scattering properties of aerosols are uniformly distributed within predetermined intervals. This approach provides a statistical sample of possible solutions, allowing the average and dispersion to be calculated over the entire set of solutions. In this case, the dispersion serves as an indicator of the uncertainty of the method. This approach was tested using 28 observations carried out at the ATOLL Observatory, Laboratoire d'Optique Atmosphérique, University of Lille, France.

The presented publication is undoubtedly an important step towards improving lidar methods for their more complete use for studying the dynamics of aerosol layers, atmospheric circulation processes, global transport phenomena, etc. The proposed approach can significantly expand the capabilities of lidar systems and increase the efficiency of lidar networks.
It should be noted that the proposed method has some limitations. There is no doubt that the method works well for dry aerosol and it is quite obvious that it will stop working in case of wetting of aerosol particles. Fortunately, the authors, being experienced experimenters, understand this and discard measurements made in conditions of relative humidity greater than 60%.

However, it is not very clear from the publication how they control the relative humidity along the sounding path. This suggests some recommendation to the authors to supplement their lidar, for example, with Raman channels for measuring temperature and humidity. This modernization is quite possible. In this case, all questions about the applicability of the method would be automatically resolved.

To derive the RH profile we use water vapor measurements of our lidar and the temperature profile from radiosonde in Belgium. The measurements are not collocated, but this is the best from available at the moment. The Reviewer is right; temperature measurements would be very useful to increase capability of our instrument. Incorporation of temperature channel is in our plans.

According to formal characteristics, the article fully complies with the requirements of the AMT, since it discusses scientific issues relevant to the topic of AMT. The publication presents new concepts, ideas, tools, and data. Substantial conclusions are drawn and the scientific methods and assumptions are reasonable and clearly stated. The findings are sufficient to support interpretations and conclusions. Descriptions of experiments and calculations are presented quite fully and accurately, and can be reproduced by fellow scientists. The authors pay due attention to the achievements of colleagues in the field under discussion and clearly indicate their original contributions. The title of the article reflects the content. The abstract contains a brief and complete summary of the content of the article. The overall composition of the article is well structured and understandable. The language of presentation is quite free and precise. Mathematical formulas, symbols, abbreviations, and units of measurement are defined correctly and used as intended. There is no need to shorten, combine or exclude any parts of the article (text, formulas, figures, tables). The number and quality of links correspond to the content of the text. The quantity and quality of additional material meets the requirements. To summarize, it should be noted that the publication under discussion makes the most pleasant impression, is a significant contribution to the development of remote methods for monitoring atmospheric parameters, and can be published without modifications.

Thanks again for high assessment of our work.