

EUROPEAN AEROSOL RESEARCH LIDAR NETWORK – ADVANCED SUSTAINABLE OBSERVATION SYSTEM (EARLINET-ASOS) PLANS FOR QUALITY ASSURANCE

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ABSTRACT

The European Aerosol Research Lidar Network (EARLINET) is dedicated to enlarge the common data base for the 4-D spatio-temporal distribution of aerosols on a continental scale. The improvement and assurance of the data quality will be a main concern within the EARLINET-ASOS project during the next five years. The EARLINET approved quality assurance practices will be supplemented with lidar subassembly check tools and standardisations of the procedures. In this paper we will give an overview over the plans.

1. INTRODUCTION

During EARLINET [1] the quality assurance of the aerosol backscatter and extinction coefficient profiles in the common data base has been established by means of two tools: first testing and improving the accuracy of the different lidar inversion algorithms of all project partners with the same synthetic lidar signals [2,3], and second with a series of lidar system intercomparisons [4]. Large profit was made by the exchange of expertise during these concerted activities. New stations joined EARLINET with presently 23 lidar stations ranging from Spain to Belarus and from Greece to Norway, and other stations upgraded their lidar systems, which is an ongoing process.

2. EARLINET-ASOS

In the frame of the EC funded EARLINET-ASOS project we will retain the approved inversion algorithm tests and also the lidar system intercomparisons, but because the lidar intercomparisons are cost- and labour-intensive and cannot be performed as frequently as necessary, additional quality assurance procedures must be collected and standardised in such a way, that they are reproducible and that their results are an objective

measure of the performance of an individual lidar system in comparison with all the other lidar systems in the net.

3. ALGORITHM CHECKUP PROCEDURES

In a first part of the inter-comparison the software of each individual group for the data evaluation from raw lidar signal, i.e. elastic and inelastic ones, to receive backscatter-, extinction- and lidar-ratio profiles, will be tested. This will be done, firstly, by means of centrally managed algorithm inter-comparisons and, secondly, by means of controlled regular internal quality checks. The main objective is the establishment of a common European standard for routine quality assurance of the retrieval algorithms for permanent control and usable by the research community in a homogeneous manner.

In May 2006 an inter-comparison of aerosol backscatter lidar algorithms (also known as Klett-Fernald algorithm [5], [6]) and of Raman lidar algorithms [7] as well started in the frame of EARLINET-ASOS.

The objective of this procedure is to test the correctness of the two algorithms and the influences of the needed reference values, the temperature and pressure profiles as well as the lidar-ratio profile used by the various lidar teams involved for the calculation of the backscatter-coefficient profiles at 355, 532 and 1064 nm concerning the backscatter algorithm as well as the extinction-coefficient and the lidar-ratio profiles at 355 and 532 nm concerning the Raman algorithm from the elastic and inelastic lidar signals, respectively. The exercise consists of processing synthetic elastic and inelastic lidar signals of the same example, i.e. of the same synthetic atmosphere situation.

The procedure consists of four stages with increasing knowledge on the input parameters. In the first stage only the elastic lidar signals are distributed with the only knowledge of the ground values of temperature and pressure. In the second stage the inelastic Raman signals

are distributed without any further information, and in the third stage additionally the input pressure and temperature profiles, the reference value and height of the backscatter coefficients, and the exponent k for the wavelength dependence of the aerosol extinction coefficient are distributed. Finally, the height dependent lidar ratios are distributed to all groups. After each stage all groups deliver their results concerning the backscatter and/or Raman algorithm, respectively, for inspection by an impartial referee.

Furthermore, after succeeding the inter-comparison in the frame of EARLINET-ASOS a standard procedure for the quality assurance of common algorithms should be developed and applied to EARLINET-ASOS products.

4. LIDAR SYSTEM CHECKUP TOOLS

At present two strategies are under investigation to overcome the lidar calibration problem at the hardware level: first using calibration signals for lidar system electronic and opto-electronic subassemblies, and second comparing lidar signals from different parts of the optical aperture.

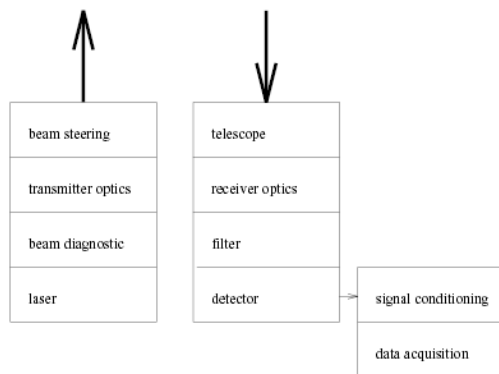


Fig. 1: Subsystems of a lidar system (adapted from [8]).

Fig.1 shows a block diagram of a lidar system. Main error sources of a lidar system are misalignments and degradation of the transmitter and receiver optics, and systematic errors of the electronic parts.

The electronic subsystem (signal conditioning and data acquisition) can be tested e.g. with calibrated electrical test signals, and the detector plus electronics can be tested with a calibrated optical test pulse. The challenge in EARLINET-ASOS is to provide all network partners with the same calibrated test pulse generators, to define common quality criteria and measurement procedures, and to centrally document the results of the regular test measurements.

A test of the optical subassembly from the laser to the optical surface of the detectors can be done e.g. by means of comparing lidar signals with different optical apertures (see fig.2) subsequently measured under stable atmospheric conditions. As can be seen in fig.2, the ray-bundles from different telescope apertures have different optical paths through the system, and they also can have different incident angles on optical surfaces like interference filters. Thus the different ray-bundles are possibly subject to different vignetting and different transmittance, resulting in range dependent discrepancies between their lidar signals.

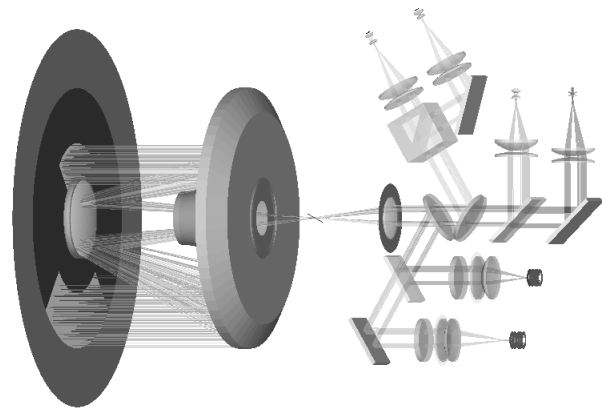


Fig.2: Ray trace simulation of the optical setup of a 6-channel lidar, with two different telescope apertures.

The optically undistorted measurement range of a lidar is that range, where all the different ray-bundles yield the same range dependent lidar signal except for a constant factor. This important result can be found without any further investigations. The overlap function can be determined quite easily with this method as well as laser pointing misalignments. Comparing such sets of measurements before and after a change or realignment of optical components can verify that the system has the same performance as before. Regular checkups with this tool can thus certify the stability and reliability of a lidar system and the constant quality of the data submitted to the EARLINET database. Again, common quality criteria and measurement procedures must be defined and the results of the checkups must be centrally documented.

The optical check-up tool can be elaborated in order to find possible reasons for discrepancies of the signals from different ray-bundles by comparing the measurements with ray tracing simulations of the optical system, which must include all critical components like beamsplitter coatings, interference filters and apertures.

The lidar system check-up tools are not only tools for certifying the constant quality of the systems, but can also serve as training tools for the lidar groups, and they can help to find critical parts of the lidar system in order to improve or replace them.

Finally, direct lidar system inter-comparisons will supplement the internal checkups in order to verify their applicability and reliability.

5. CONCLUSION

In addition to the approved quality assurance practices in EARLINET, i.e. inversion algorithm tests and lidar intercomparisons, we will implement several internal quality check-up tools for subassemblies of the lidar system in order to improve the individual systems, train the lidar groups, and monitor the constant quality of the lidar systems. Common quality criteria and measurement procedures for the algorithms and all sub-system tests will be defined. The results of the regular lidar check-ups of all EARLINET-ASOS partners will be centrally documented and will thus verify the quality of the data in the common data base.

ACKNOWLEDGMENTS

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