EARLINET/ACTRIS Quality Assurance Tests on UV Depolarization Raman Raymetrics Lidar

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- Introduction and motivation

  EARLINET (European Aerosol Research Lidar Network) was established in 2000, with the main goal to provide a comprehensive, quantitative and statistically significant database of aerosol distribution on a continental scale.
  Within EARLINET a rigid quality assurance program has been developed. The EARLINET quality assurance program involves both the lidar hardware and the data analysis software. All EARLINET systems must be compliant with this quality assurance program. The main goal of this proposal is to apply all quality assurance tests defined within EARLINET on a Raymetrics UV Raman Depolarization lidar system.
  To meet all the EARLINET requirements, the following activities have been planned:

  - Intercomparison of the Raymetrics system with the EARLINET reference system MUSA (MUltiwavelength System for Aerosol) operating at IMAA – CNR

  - Intercomparison of optical products and usage of the SCC (Single Calculus Chain) on the raw data measured using the Raymetrics system

- Scientific objectives

  The main objective covered by this proposal is to asses the performances of a Raymetrics UV Raman Depolarization lidar against the EARLINET reference lidar MUSA operating at CNR-IMAA.
  MUSA can measure the elastic backscattered signal at 355nm, 532nm and 1064nm, the Raman signal at 387nm and 607nm and finally the particle linear depolarization ratio at 532nm. By making co-located and coordinate measurements with a Raymetrics UV Raman Depolarization lidar system, a direct comparison of the range corrected Raman signals at 387nm (measured by both systems) and an indirect comparison of the range corrected elastic signal at 355nm (measured directly by MUSA and by a combination of cross and parallel polarization components by Raymetrics lidar) have been made. This last comparison also allowed for testing of the quality of the depolarization calibration provided by the Raymetrics lidar.

  Single Calculus Chain (SCC - the common EARLINET automatic tool for the analysis of lidar data) has been also used on the Raymetrics system to provide optical products in fully automatic way.

- Reason for choosing station

  The CNR-IMAA Atmospheric Observatory (CIAO) has a long experience in lidar technique: instrumentation design and development, quality check, retrieval algorithms and data analysis. In addition, this group is one of the three main groups involved in the SCC development. Moreover the EARLINET reference system MUSA operates at CIAO.

- Method and experimental set-up

Concerning the experimental point of view, the following EARLINET quality assurance tests have been implemented on the Raymetrics lidar:

- Telecover test
- Rayleigh fit
- Measurement of dead time for all photon counting lidar channels
- Measurement of the trigger delay for all lidar channels
- Depolarization Calibration Test

Beside to these tests combined measurements with the co-located MUSA system have been made in different atmospheric conditions. This has been made to assess the performance of the Raymetrics system in case of different atmospheric aerosol load.

Moreover the Raymetrics system has been registered in the SCC database. This means to report in SCC database all the experimental parameters needed to perform the automatic analysis of lidar data. In particular two different configurations were registered: one corresponding to nighttime conditions in which the SCC is configured to deliver the aerosol extinction and Raman backscatter coefficient profile at 355nm and a second one to use in daytime conditions when the Raman channels are not available and only the aerosol elastic backscatter can be delivered.

- Preliminary results and conclusions

Concerning the Telecover test a specific tool has been developed to allow the measurements of the radiation from the specific sections of telescope primary mirror surface prescribed by such tests. An example of telecover measurements is shown in figure 1.

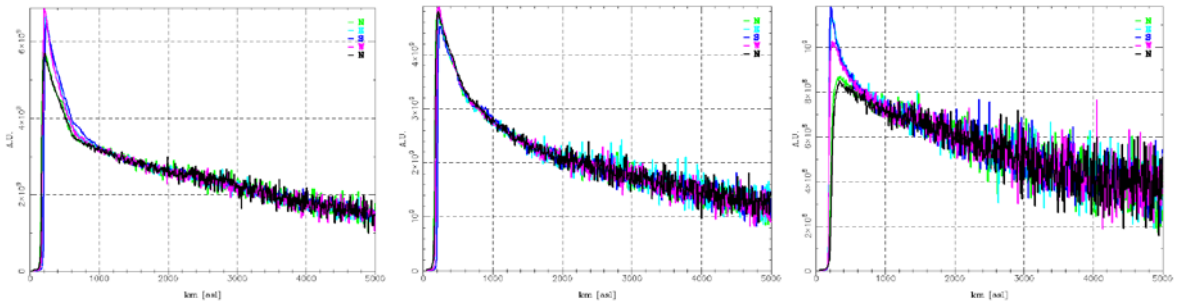

Figure 1: Example of telecover measurement made on all the three channels of Raymetrics UV depolarization Raman lidar at 355nm.

Rayleigh fit has been made to check no important distortions are present in the lidar signal in correspondence of the atmospheric signal backscattered by the far range.

The dead time for the 3 photon counting channels at 355s 355p and 387nm has been measured taking into account the deviations (at the first order of t/τ where t is the sampling time and τ the dead time) of the measured probability distribution from a pure Poisson one. The dead time is an important parameters to use in the lidar data analysis to extend the linearity of photon counting signal at high count rates. The measured value was registered to the SCC database in a way the SCC can correct for this effect automatically.

The trigger delay for all channels (analog and photon counting) has been measured following the recommendation provided by EARLINET quality assurance program. Also this parameter has been registered to the SCC database to assure correct link between lidar signal and the actual atmospheric altitude.

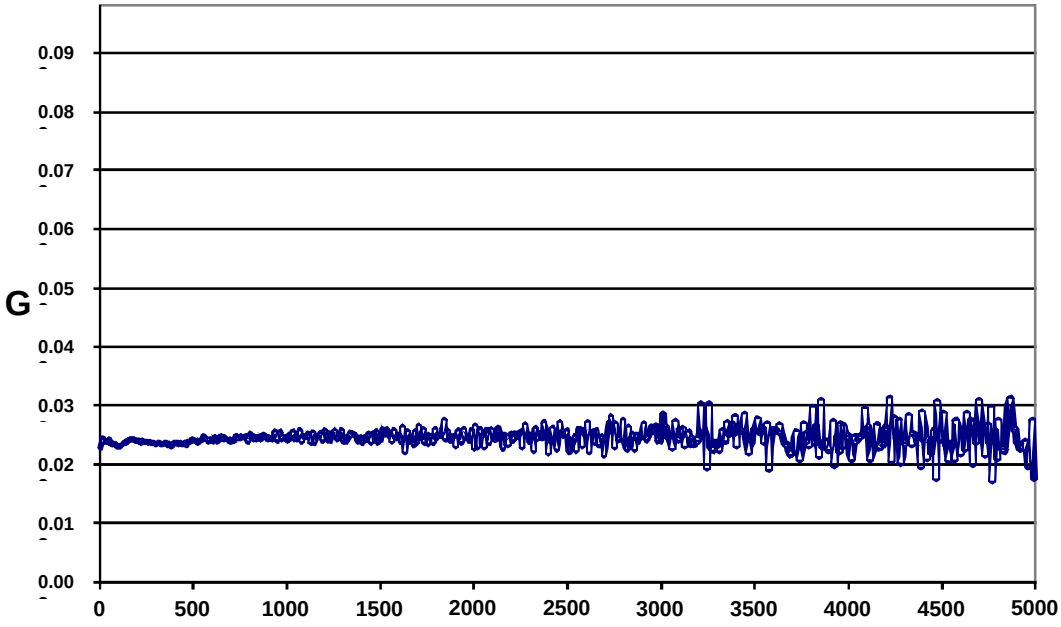

Figure 2: Measurement of depolarization calibration factor for the Raymetrics lidar

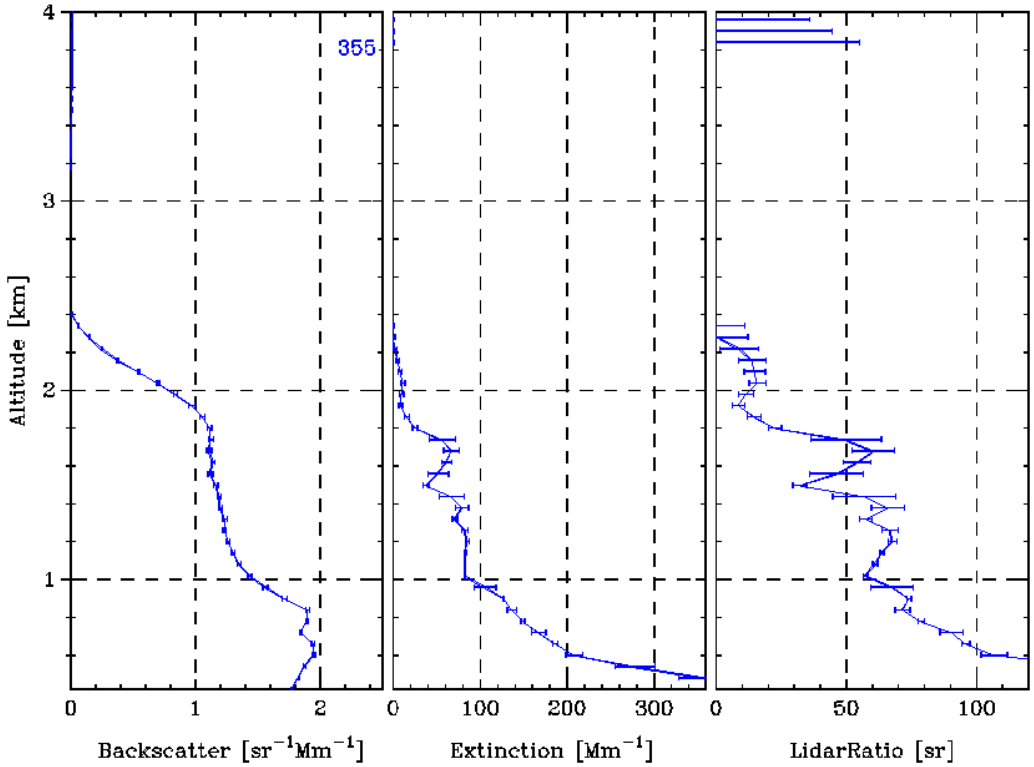

Figure 3: Example of optical products automatically retrieved by the SCC using raw data of Raymetrics system. On the left panel it is plotted the Raman aerosol backscatter profile (with corresponding error bars). In the central panel it is shown the aerosol extinction profile and finally on the right panel it is shown the lidar ratio (ratio between the aerosol extinction and backscatter profiles).

The stability and the reliability of the calibration of depolarization channels has been assessed. In particular the ±90 method has been taken into account. This method is the one suggested by EARLINET for the calibration of depolarization lidar channel as it minimizes the systematic errors involved in the calibration procedure. The figure 2 shows an example of the measurement of calibration constant: the constant value over a quite large altitude range indicates a good reliability of the lidar system.
Finally the figure 3 shows an example of the optical products calculated automatically by the SCC starting from the raw data of Raymetrics lidar.

- Outcome and future studies

It is planned to implement all the procedures and the tools developed in the framework of the present proposal as standard option for all the Raymetrics systems.