ACTRIS TNA Activity Report

Quality Assurance Training for Lidar operation at University of Warsaw (QAT4LUW)

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- Introduction and motivation

The Radiative Transfer Laboratory (RT-Lab) developed recently remote sensing capacities which vitally extended activity range of the Atmospheric Physics Department at the Faculty of Physics of the University of Warsaw. However, although we deployed a multi-wavelength lidar at the RT-Lab at the end of June 2013, due to insufficient man-power and a few technical problems with the instrument we were not able to perform regular and quality assured measurements.

During this time our 8-wavelength aerosol-depolarization-Raman lidar was operational at the RT-Lab site in Warsaw during 125 measurement days, upon total of 553 possible days in 2013 and 2014. Most of the missing days are due to the bad weather conditions (mainly rain/snowfall or fog). For additional 55 days the missing data are due to the laser issue and its repair time, 10 days due to HDD failure, 17 days due to the data storage space problem, and another 28 days due to lack of permission to perform measurements (eye-safety issue).

Within the available 125 successful measurement days, due to the man-power issue most of the data are not yet evaluated in quality assured way, although quick looks for each day are available on-line and in real-time via PolandAOD IGFUW website at www.polandaod.pl and PollyNET TROPOS website at www.polly.rsd.tropos.de (Althausen et al. 2013).

With the aim of improving this situation, we took an opportunity to use the host-infrastructure of the Romanian Atmospheric research 3D Observatory (RADO) in Magurele, Romania for professional training benefits within the ACTRIS integration activity: Clouds and aerosol quality-controlled observations.

This initiative is strongly related with our intention to become a member of the The European Aerosol Research LIdar NETwork (EARLINET), and to contribute to the goal of providing a comprehensive, quantitative, and statistically significant data base for the aerosol distribution over Europe by performing harmonized multi-wavelength lidar observations with rigorous quality control and fast-delivery of standard data products.

So far, the EARLINET includes 8 advanced multi-wavelength Raman lidar stations, that enable to retrieve aerosol optical and microphysical properties (Pappalardo et al. 2014). At the moment we are on the way of becoming a part of this infrastructure, contributing to the EARLINET with our 8-wavelength Raman lidar observations, just as we do contribute to the AERONET observations with our depolarization-photometer.

The second, purely scientific objective of this TNA visit was initially focused on assessment of the role of the Carpathian Mountains and strong precipitation events in aerosol modifications during May 2014. Both RADO and RT-Lab observatories conducted lidar measurements during this period, however, unfavorable weather conditions (passing clouds over both measurement sites) prevented direct comparison of the mentioned above effects at both sites. Thus, the data base at RADO and the data base of Poland_AOD from July 2013 until December 2014 were searched for an appropriate case to perform this study, i.e. 19-21/07/2014.

- Scientific objectives

In the frame of this short and intensive 10 days training activity we acquainted ourselves with the rigorous EARLINET quality assurance (QA) program, which need to be applied at both instrument and algorithm level in order to perform approved systematic unbiased high-quality measurements on a regular basis. We learned how to apply the specific technical procedures (e.g. telecover tests, dark measurement, zero-bin measurement, Rayleigh-fit, and depolarization calibration); how to prepare the lidar data files to be implemented into the single-calculus chain algorithm; how and in what formats to provide the categorized optical profiles (e.g. aerosol extinction, backscatter and lidar ratio) to the EARLINET data base.

On scientific point of view, we focused on evaluating data of multi-wavelength lidar (at both RT-Lab and RADO sites) for the observations taken on 19-21/07/2014 to search for similarities and differences in terms of obtained vertical profiles of physical quantities describing atmosphere, in order to find an evolution of the air flow properties thorough Poland (Warsaw and Strzyżów stations) and Romania (Cluj and Magurele station).

- Reason for choosing station

As for fulfilling the technical training part of this project, one could think that an access to any of TNA ACTRIS stations equipped with the multi-wavelength lidar could serve the objectives. We chose RADO as it is directly involved in the development of the QA program of the EARLINET and in guidance of the new stations. RADO also specifically targets the users from Eastern Europe. Although there was already established collaboration between IGF UW and INOE (which resulted in a joint paper on modification of the volcanic ash; Nemuc, et al. 2014) this TNA gave us a great opportunity to work together at the RADO site.

On the scientific site of our goal, the RADO is the only one of the TNA access stations within the ACTRIS project that is equipped with several lidars and located South-East of Poland. Such configuration allows us to study the aerosol modification across the Carpathian Mountains by analyzing the data from along-line located stations in Warsaw and Strzyżów (Poland), and then Cluj and Magurele (Romania).

- Method and experimental set-up

The lidar data base of RADO and TR-Lab was searched, within available duration between July 2013 and December 2014, for an appropriate case well representing both sites, which resulted in choosing the period of 19-21/07/2014 for further analysis.

We interpreted preliminarily these results on basis of long-range aerosol transport analysis, the local and regional meteorological situation development, as well as information obtained from satellite imagery (e.g. MODIS, GOES).

The specific tasks carried out by the participants from IGFUW and the experts at RADO are listed in the Implementation Plan communicated to ACTRIS.

In order to find the evolution and modification of the air flow properties over the two countries between July 19th and 21th the particle backscattering coefficient profiles at 355, 532 and 1064nm and the particle extinction profiles at 355 and 532nm, were obtained at both sites (Ansmann et al., 1990). Also the calibrated depolarization profiles at 532nm at RADO and 532 and 355nm at RT-Lab were calculated (Freudenthaler et al., 2009). If feasibly, the retrieval of micro-physical properties of aerosols for characteristic layers will be performed (Veselovskii et al., 2002). As an example of preliminary results the particle backscatter profiles at 355 and 532 nm from 18:00 to 20:00(UTC) on 19/07/14 over Warsaw and from 17:49 to 20:01 on 21/07/14 over Magurele are given in Fig.1.

The analysis is completed with data from Cluj station in Romania and AERONET sites in Strzyżów and Belsk in Poland. The ceilometer measurements at Strzyżów site are evaluated using routines by Stachlewska at al. 2012, Sokół et al. 2014, Costa-Surós et al. (2014) for both aerosol content and PBL/cloud layering retrieval.

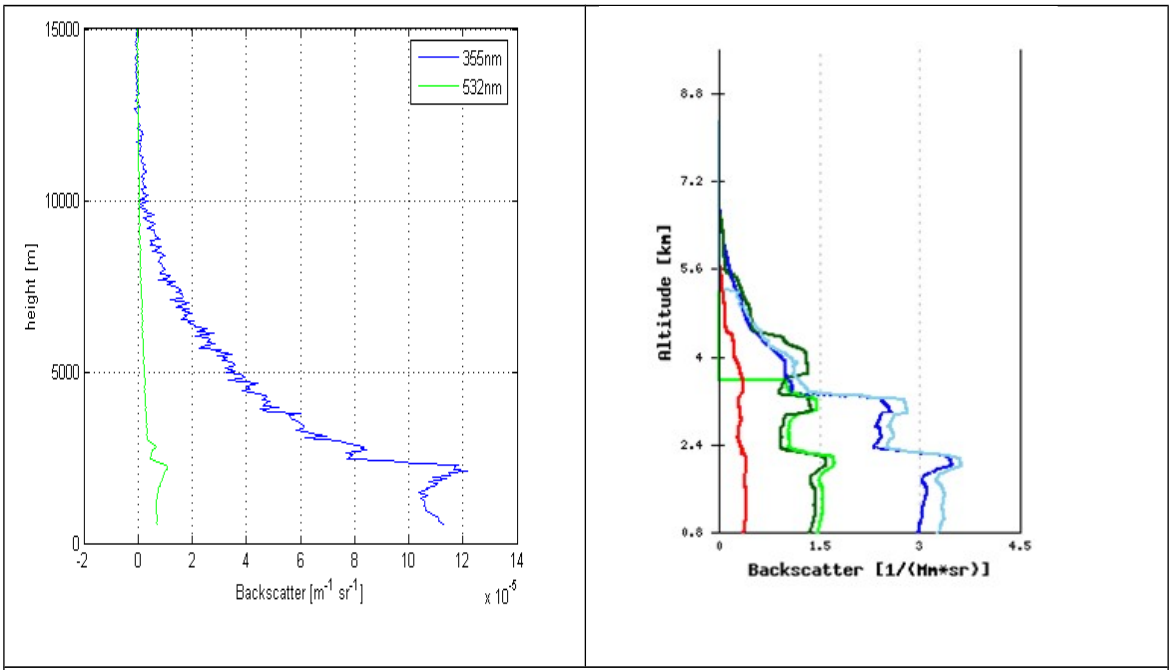

Fig. 1. Backscatter profiles from 19:00 to 20:00 at Warsaw (left) and from 17:49 to 20:01 UTC on 21/07/14 over Magurele (right). Red line is backscatter profile at 1064nm, green at 532nm and blue at 355nm. For Magurele profiles: dark green and dark blue lines are Klett approximation and light green and light blue lines are Raman calculations.

- Preliminary results and conclusions

Accordingly to NOAA Hysplit 4-days backward trajectories ending up at Magurele at 0.5, 1.5 and 3km, during the identified period of 19-21/07/2014 an air-mass transported from western Europe, that entered Poland from the north-west on 19/07/2014, descended on the following day over the Poland AOD station in Strzyżów, and end up at Magurele on 21/07/2014 (Fig.2).

Both lidars reveal multi-layered aerosol structures during this period. The lidar data at RADO on 21/07/2014 reveal layered structure with peaks at 1,5km, 2.9km and 4 km (Fig.1).

Backward trajectories show that an air-mass located at 4.5km over Warsaw on 19/07/14 two days later descended into the boundary layer at a level of about 1.5km over Magurele on 21/07/14 (Fig.2). Based on both lidar data it seems that it kept similar properties.

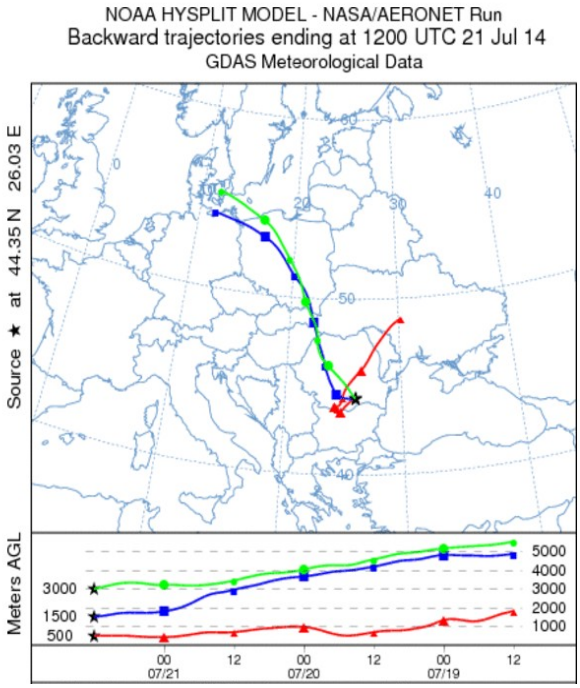

Fig. 2. Backward trajectories from NOAA Hysplit Model ending at 12 UTC on July 21th 2014, for 0.5, 1.5 and 3 km. The figure show how the fluxes of all three levels cross Poland and reach Romania on July 21th.

Within the multi-layered structures between 2 and 4.5km over Magurele, some give depolarization signature at 532 nm, mostly at about 4km. The backward trajectories show that the air located at 4km over Magurele on 21/07/2014 was at about 6km over Warsaw 2 days earlier, and thus it was most probably modified by Carpathian Mountains.

Warsaw lidar signals showed haze on 20/07/14 for almost all day and a typical clear sky on 21/07/14.

CHM15k ceilometer retrievals at 1064nm over Strzyżów show some structures of enhanced aerosol loads at 1km between 19 UTC on 19/07/14 and 5 UTC on 20/07/14.

- Outcome and future studies

As a result of this short but intensive ACTRIS TNA activity and know-how gained within EARLINET a poster entitled: “Analysis of air-mass modification over Poland and Romania by the means of multiwavelength Raman lidars – a case study 19-21/07/2014”, atuhors: M.Costa-Surós, I.S. Stachlewska, D. Nicolae, A. Nemuc, L. Janicka, K.M. Markowicz, L. Belegante, C. Talianu, B. Hesse, and R. Engelmann, was accepted for the EARLINET session (AS3.17/GI2.2 - Lidar and Applications) at the EGU-2015.

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