EARLINET DATABASE:

NEW DESIGN AND NEW PRODUCTS FOR A WIDER USE OF AEROSOL LIDAR DATA

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ABSTRACT

The EARLINET database is facing a complete reshaping to meet the wide request for more intuitive products and to face the even wider request related to the new initiatives such as Copernicus, the European Earth observation programme. The new design has been carried out in continuity with the past, to take advantage from long-term database. In particular, the new structure will provide information suitable for synergy with other instruments, near real time (NRT) applications, validation and process studies and climate applications.

1 INTRODUCTION

EARLINET (European Aerosol Research Lidar Network) is the aerosol vertical profile component of ACTRIS (Aerosol, Cloud and Trace gases Research infraStructure). EARLINET aerosol profile data are collected at each station applying measurement procedures compliant with the recommendations provided by the ACTRIS aerosol profile community. Data in the EARLINET DB are reported in netCDF format in accordance with the reporting procedures (available at http://www.earlinet.org/).

The EARLINET database contains at the moment quality assured aerosol extinction and backscatter profiles, reported in separated files (called e- and b-files). The main concept behind the current EARLINET database is to provide basic aerosol lidar products at the best available resolution.

A strong link with EARLINET data users has been established since the beginning of EARLINET, in which network members acted as mentors and guides for users to assure a correct use and interpretation of the lidar data. This big effort for the EARLINET community has been an excellent opportunity to improve the knowledge about the user needs.

The main result of this learning process was to realize that the EARLINET database is under-exploited, because although it contains a lot of information needed for several applications, the way these data are provided are not easily understandable to many external (non-lidar) users.

This awareness was the seed for the development of new products for making EARLINET data more visible, effective and easier to handle to potential users of different communities.

2 NEW EARLINET DATABASE

The new EARLINET database follows a general concept used for most databases in the atmospheric field: a level structure going from low level and fast delivered data towards more advanced and correspondingly later released data.

The new structure of the EARLINET database is schematically reported in Figure 1. Level 1 contains pre-processed lidar data, i.e. a step in between the raw signal (Level 0 data stored at each station) and the optical properties, where all instrumental corrections have been already implemented. The Level 1 data are the base for the retrieval of the optical properties contained in the Level 1.5 products. The Level 1.5 datasets are not quality checked, except for format aspects, and therefore released as soon as data originators submit them to the database. Afterwards, all the Level 1.5 data pass through the quality check procedures described in section 2.1. The optical data that passed such quality checks are promoted

to Level 2 product. Finally, the Level 3 data contain climatological datasets retrieved from the Level2optical products.

The increase of quality checks (QC) from the Level 1 to Level 3 implies a corresponding increase in the delivery time of the data which ranges from potential NRT for Level 1 and 1.5 to annual and bi-annual release of Level2 and Level 3 data.

The new structure of the EARLINET database will take advantage from the centralized data processing through the common standardized automatic analysis software developed within EARLINET, the Single Calculus Chain (SCC) [1] , even if it will be still allowed the submission to the database of data analyzed by using specific QA and documented software. The usage of the SCC assures the usage of QA retrieval algorithms and the full traceability of all EARLINET products.

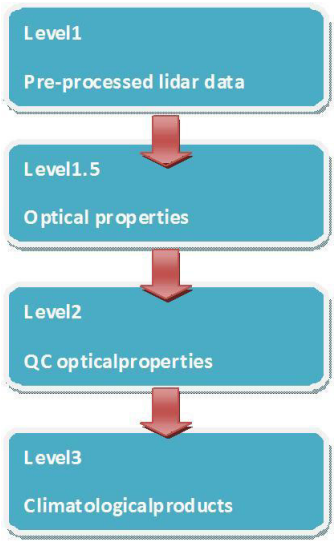

Figure 1Layout of the new structure of the EARLINET database.

2.1 Level 1 products

The Level 1 data contain the pre-processed lidar data, i.e. range-corrected signals derived from the raw lidar data measured by each station for each detection channel of the lidar system corrected for several instrumental effects like dead-time, partial overlap between laser beam and receiving system etc. The input parameters needed to correct for these effects are measured applying the QA procedures through the Lidar Calibration centre (http://lical.inoe.ro). Level 1 products are used internally to deliver aerosol optical products (Level 1.5). At same time, they could be used by external processing modules to calculate combined/advanced products, for example in combination with Cloudnet data. In addition, the ICARE thematic center (http://www.icare.univ-lille1.fr/) will automatically process the L1 products combining them with coincident AERONET data through the GARRLiC (Generalized Aerosol Retrieval from Radiometer and Lidar Combined data) algorithm.

The standardized and quality-assured pre-processed lidar data have been also used to develop a homogeneous network-wide, open and freely accessible quick-look database (high-resolution images of time-height cross sections). The quick-look database is now in the testing phase and will be externally accessible starting from June 2017.

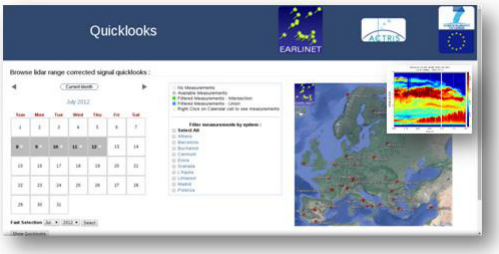

Figure 2 Web interface of the new EARLINET quicklook database.

Furthermore, the results of cloud/aerosol masking will be graphically reported in these quick-looks.

2.2 Level 1.5 products

In order to foster the fast use of the EARLINET data which is essential for assimilation purposes and hazards, and to clarify the difference between quality-checked and not quality-checked, an intermediate step between the pre-processed and quality-checked data has been added: Level 1.5. The data products contained in there are the same aerosol optical products planned for the Level 2 (see next section) with the difference that for Level 2. The only difference is no quality check procedures were applied except of some basic format checks. These technical checks are applied to the data to assure the consistency between the file contents and the file structure as defined in the EARLINET database.

The Level 1.5 products allow for a NRT use of lidar data. EARLINET already proved its capability of providing data in NRT using the SCC during a 72-h experiment carried out in the summer 2012 ACTRIS campaign [2].

2.3 Level 2 products

Level 1.5 data submitted to the EARLINET database are subject to centralized quality check procedures. In addition to some technical quality checks, scientific QCs are applied to assure the validity of the measured parameters from physical point of view. The data submitter receives feedback about the outcome of the QC. Data compliant to all the QC requirements are made public available as Level2 data. Level 2 data will be regularly published with primary Digital Object Identifiers (DOIs) in continuity with previous volume publications on the CERA database [3].

Three different data products are present in Level 2 (and Level 1.5): single-wavelength profiles, multi-wavelength profiles and layer products.

Single-wavelength profiles

In continuity with the past, the new EARLINET database will report the extinction and backscatter profiles at their best vertical resolution in separated products. This allows for a consistent extension of the previous database version already published with DOI on the CERA database [3].

Multi-wavelength profiles

In addition to the standard (single-wavelength) optical property profiles, a new product is envisaged in order to take the most from the multi-wavelength capabilities widely available within the network. The multi-wavelength profile product contains the vertical profiles of all the optical properties measured in the same temporal window and with the same vertical resolution. This allows investigation of the aerosol type and, if applicable, mixing [e.g., 4] as well as the determination of aerosol microphysical properties [e.g., 5].

Layer products

Building on the previous experiences in providing tailored datasets to different communities [6, 7, 8], specific products focused on aerosol layer properties have been introduced. For each Level 2 product, a corresponding Level 2 Layer Product is generated reporting the relevant layer information such as the base height, top height and thickness of each identified layer as well as mean, median, standard deviation and mean statistical error for each measured optical property. Integrated quantities within each layer and the corresponding columnar ones are reported as well for extensive optical properties. Finally, preliminary information about the aerosol typing is provided whenever available [9, 10].

2.4 Level 3 products

The Level 3 standard product contains climatological datasets obtained as aggregated products from the Level 2 aerosol optical products. Data will be aggregated into monthly, seasonal and annual datasets for both profiles and vertically integrated quantities. Information about the number of collected samples, mean, median and standard deviation of the properties, as well as mean statistical error for each property are reported. Metrics of the comparison against reference datasets (e.g. AERONET for AOD) are included whenever available, in order to provide information about data representativeness. At the moment, a bi-annual release of the Level 3 standard dataset is envisaged. The Level 3 standard product is the result of the cooperation between EARLINET and AEROCOM (Aerosol Comparisons between Observations and Models project) carried out during the previous ACTRIS project, responding to need of the global aerosol modeling community for aggregated data together with information about their representativeness.

2.5 Advanced secondary data sets

Additional advanced products will be designed step by step following the specific needs of specific studies.

At the moment, two secondary datasets are available at www.earlinet.org and linked to the ACTRIS data portal: the Eyjafjallajökull 2010 – EARLINET database, and the EARLINET 72h operational exercise dataset. The first reports the four-dimensional (4-D) distribution of the Eyjafjallajökull volcanic cloud in the troposphere over Europe as observed by EARLINET [8]. The second instead collects the SCC products obtained

during the 72h EARLINET exercise for near-real time data provision [2].

A new dataset will be provided as results of the collaboration with ICARE for the lidar+photometer data processing through GARRLiC. This dataset will provide vertical profiles of aerosol microphysical properties.

Further advanced products can be the results of the specific case studies and measurement campaigns, and will be provided as additional datasets where aerosol profile data are combined to different platform data and analysis.

3 CONCLUSIONS

The EARLINET database is facing a complete redesign with the implementation of a new workflow and delivering new products as response to the growing demand of aerosol vertical profiling information. The complete switch to the new version is foreseen by the end of ACTRIS-2 project in May 2018, but many new products and procedures are already in place. Advances will be presented at the conference. In particular, the climatological products and their potential applications will be presented as result of the implemented QC and averaging schemes, underlying their scientific content in terms of aerosol climatological analysis over Europe in the last 15 years.

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