2.2 EARLINET-ASOS: EUROPEAN AEROSOL RESEARCH LIDAR NETWORK-ADVANCED SUSTAINABLE OBSERVATION SYSTEM

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1. INTRODUCTION

The present knowledge of the aerosol distribution is far from sufficient to properly estimate the role of aerosols in changes of the global and regional environmental conditions and climate. Improving the observation system for aerosols will contribute to almost all areas of societal benefits listed in the GEOSS (Global Earth Observation System of Systems) Implementation Plan.

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Since it is in particular the information on the vertical distribution that is lacking, advanced laser remote sensing is the most appropriate tool to close the observational gap.

EARLINET, the European Aerosol Research Lidar Network, is the first aerosol lidar network, established in 2000, with the main goal to provide a comprehensive, quantitative, and statistically significant data base for the aerosol distribution on a continental scale.

The EARLINET-ASOS (Advanced Sustainable Observation System) EC Project, starting on the EARLINET infrastructure, will contribute to the improvement of continuing observations and methodological developments that are urgently needed to provide the multi-year continental scale data set necessary to assess the impact of

aerosols on the European and global environment and to support future satellite missions.
The main objective is to improve the EARLINET infrastructure resulting in a better spatial and temporal coverage of the observations, continuous quality control for the complete observation system, and fast availability of standardised data products.

2. EARLINET

EARLINET is a coordinated network of stations using advanced lidar methods for the vertical profiling of aerosols (Bösenberg et al., 2003). At present, more than 20 stations distributed over Europe (see Figure 1) are part of the network.
The network activity is based on scheduled measurements, a rigorous quality assurance program addressing both instruments and evaluation algorithms, and a standardised data exchange format.
In order to collect unbiased data, all the network stations perform measurements simultaneously at three fixed dates a week. Lidar observations are performed on a regular schedule of one daytime measurement per week around noon, when the boundary layer is usually well developed, and two night time measurements per week, with low background light, in order to perform Raman extinction measurements. In addition to the routine measurements, further observations are devoted to monitor special events such as Saharan dust outbreaks, forest fires, photochemical smog and volcano eruptions.
Moreover, EARLINET started correlative measurements for CALIPSO since 14 June 2006 (Pappalardo et al., 2006). These EARLINET correlative measurements are performed at each station in coincidence with CALIPSO overpasses. Each observation lasts for a minimum of 1 hour centered around the overpass time, longer record of measurements are performed for special case studies (Saharan dust layers, forest fires, long range transport, etc.).
Special care has been taken to assure data of highest possible quality. Therefore all network stations participated in intercomparisons both at instrument and algorithm levels with standardised procedures (Matthias et al., 2004a; Böckmann et al., 2004; Pappalardo et al., 2004b).
EARLINET measurements started in May 2000 and are still continuing; up to now the EARLINET database represents the largest database for the aerosol distribution on a continental scale. At present, it contains more than 20000 aerosol profiles in terms of extinction, backscatter and lidar ratio, whereas lidar ratio data have been retrieved from simultaneous and independent lidar measurements of aerosol extinction and backscatter.

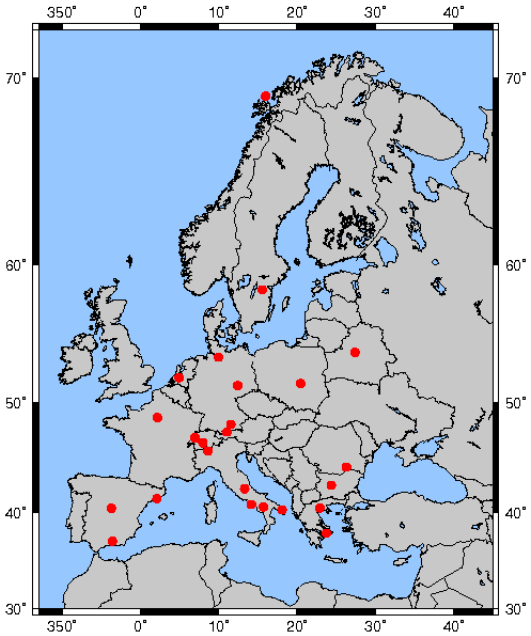

Figure 1. Map of Europe with the distribution of all the EARLINET lidar stations.

All the files are divided in different categories related to regular and special observations:

- Climatology (regular measurements)
- Cirrus
- Diurnal cycles (diurnal and seasonal cycle of aerosols in the boundary layer)
- Volcanic eruptions (observations of the Etna eruption events in 2001 and 2002)
- Forest Fires (observations of large forest fires)
- Photosmog (observations of photochemical smog episodes in large cities)

- Rural/urban (nearly simultaneous measurements at pairs of stations that are sufficiently close to minimize the effect of large scale patterns, but sufficiently apart to reflect the differences in the surrounding: urban versus rural or pre-rural)
- Saharan dust (special observations of Saharan dust outbreaks following the alert system based on dust forecast)
- Stratosphere (stratospheric aerosol observations and detection of smaller scale features of stratospheric aerosol distribution and its interdependence with dynamics and heterogeneous chemistry)
- CALIPSO (correlative measurements in coincidence of the CALIPSO overpasses).

EARLINET data have already conducted to a first statistical analysis of the aerosol optical properties over Europe (Matthias et al., 2004b), climatological studies (Matthias and Bösenberg, 2002; Mattis et al., 2004; Amiridis et al., 2005), studies on Saharan dust events (Ansmann et al., 2003; Balis et al., 2004), volcanic eruptions (Pappalardo et al., 2004a), bio-mass burning (Balis et al., 2003), long range transport (Wandinger et al., 2004) and solar aerosol radiative forcing (Wendisch et al., 2006). Moreover, retrieval algorithms for aerosol microphysiscal properties (Böckmann et al., 2005; Müller et al., 2004) were developed and tested extensively with synthetic data and with real multiwavelength lidar data.
EARLINET is continuing its activity and further lidar stations are going to join the network. In particular, within the network a large effort is devoted to implement Raman channel or high-spectral-resolution capability for aerosol extinction measurements. At the moment, EARLINET consists of 24 lidar stations: 9 single backscatter lidar stations, 8 Raman lidar stations with the Raman channel in the UV for independent measurements of aerosol extinction and backscatter, and 7 multi-wavelength Raman lidar stations (elastic channel at 1064 nm, 532 nm, 355 nm, Raman channels at 532 nm and 355 nm, plus depolarization channel at 532 nm) for the retrieval of aerosol microphysical properties.

3. EARLINET-ASOS

EARLINET-ASOS is a 5-year EC project, which started on 1 March 2006.

The main objectives of the EARLINET-ASOS project are:

- to extend the development of the European Aerosol Research Lidar Network as a world-leading instrument for the observation of the 4-dimensional spatio-temporal distribution of aerosols on a continental scale, resulting in accurate, well-defined, and easily accessible data products for use in science and environmental services.
- to enhance the operation of the network to foster aerosol-related process studies, validation of satellite sensors, model development and validation, assimilation of aerosol data into operational models, and to build a comprehensive climatology of the aerosol distribution.

This will be reached through several activities:
Quality assurance
The quality assurance program will be implemented by defining standardised tools for internal quality checks at both instrument and inversion algorithm levels, by providing assistance to the participating stations to apply these tools to their instruments and procedures, and by compiling the different system and subsystems setups at individual stations. This activity will ensure that the data products provided by the individual stations are permanently of highest possible quality according to common standards and are thus usable by the research community in a homogenous manner.
Optimization of instruments
Starting from individual solutions found at the different partner stations, an optimal approach to the instrumentation both at the system and at the subsystem level will be defined. Emphasis will be made on automation, for extended temporal coverage, and standardization, for improved interoperability in future networks.
Optimization of data processing
The main objective of this activity is to provide a common single processing chain for the evaluation of lidar data, from raw signals to final products. Raw signals may come from different types of system, final products are profiles of optical properties like backscatter and extinction and, as far as instrument properties permit, microphysical properties. This activity will have a strong impact on the scientific community because data with homogeneous well characterized quality will be made available in near real time, permitting studies of important

events in a timely way and permitting comparative studies between different regions.

Database construction and operation

The aim is building a common database that is automatically and continuously updated through a software system which collects the data products provided by the individual stations and makes them available to the community; in addition to the continuously updated quality-controlled lidar data, the database will include auxiliary data allowing to search for data meeting specified criteria. It will be accessible through a web-based interface to provide easy access to data products for internal and external users.

The expected outcome of EARLINET-ASOS is the most comprehensive data source for the 4-D spatio-temporal distribution of aerosols on a continental scale.

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