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Aerosol lidar ratio measurements in the framework of EARLINET

G. Pappalardo (1) and THE EARLINET LIDAR RATIO TEAM

(1) Istituto di Metodologie per l'Analisi Ambientale IMAA-CNR, Potenza, Italy, (2) Max-Planck-Institut für Meteorologie, Hamburg, Germany, (3) Aristoteleio Panepistimio, Thessalonikis, Greece, (4) Leibniz-Institut für Atmosphärenphysik, Kühlungsborn, Germany, (5) Università degli Studi – L'Aquila, Italy, (6) Physics Department, University of Wales, Aberystwyth, United Kingdom, (7) Max-Planck-Institut für Meteorologie, Hamburg, Germany; Current affiliation: Institute for Coastal Research, GKSS Research Center, Geesthacht, Germany, (8) Institut für Troposphärenforschung, Leipzig, Germany, (9) Ethnikon Metsovion Polytechnion Athinon, Athens, Greece, (10) University of Lecce, Physics Department, Lecce, Italy, (11) Istituto Nazionale per la Fisica della Materia, Napoli, Italy, (pappalardo@imaa.cnr.it / Fax: +39 0971427271 / Phone.+39 0971427265)

Introduction

The EARLINET database contains up to now more than 15000 aerosol profiles and it represents the largest database for the aerosol distribution on a continental scale.

In particular, the EARLINET database contains a large data-set concerning the ratio of aerosol extinction to backscatter (lidar ratio) retrieved from simultaneous and independent lidar measurements of aerosol extinction and backscatter by using the Raman lidar technique. Within EARLINET, 10 lidar stations have the capability of measuring Nitrogen Raman scattering in the UV simultaneously to the elastic backscatter; among these lidar stations, two have the capability to measure Nitrogen Raman scattering also in the visible domain (Kühlungsborn and Leipzig).

This data set will be very useful for investigating the climate impact of aerosols, as input data for implementation of atmospheric models and for calibration and validation of atmospheric satellite data, in particular for the CALIPSO mission.

Lidar ratio data analysis

Lidar ratio is defined as the ratio of aerosol extinction to backscatter ratio and it is re-

trieved from simultaneous and independent lidar measurements of aerosol extinction and backscatter. The high quality of lidar EARLINET data is assured by the intercomparison of the lidar systems (Matthias et al., 2004a) and of the algorithms used by each group for the retrieval of extinction and backscatter profiles(Böckmann et al., 2004; Pappalardo et al., 2004a). Lidar ratio measurements, in conjunction with information on the air masses characteristics, can provide information on microphysical properties of the aerosol on a wide range of meteorological conditions on a continental scale.

A statistical analysis on the lidar ratio data in the UV spectral region for the period May 2000 – December 2002, corresponding to the formal measurements period of the project, has been performed.

All the collected lidar ratio data have been divided between regular measurements, establishing the climatology, and special measurements (Saharan dust outbreaks, forest/industrial fires, photochemical smog episodes, volcanic eruptions etc.).

Mean values of the lidar ratio data in the Planetary Boundary Layer (PBL) have been calculated for each station and for winter (October-March) and summer (April-September) periods starting from the regular measurements. The seasonal variation and the frequency distribution have been studied. The statistical distribution of the lidar ratio is broad for all stations. Mean values range from 32 sr to 76 sr and no significant seasonal dependence is observed respect to the strong seasonal dependence observed for the aerosol optical depth (Matthias et al., 2004b). However, a strong variability (about 40% in average) has been observed along the vertical profiles in the PBL for all the stations and for the whole dataset.

A correlation analysis of the mean lidar ratio values in the PBL with air mass origin has been performed by using the 96 hours analytical back-trajectories provided by the German Weather Service. Higher lidar ratio values measured in Southern stations are correlated with air masses coming from Saharan regions (De Tomasi et al., 2003). High lidar ratio values measured in central Europe seem to be correlated with air masses coming from east direction related to more continental and polluted aerosols, while lower values have been observed for air masses coming from the ocean, representing more maritime aerosols (Matthias and Bösenberg, 2002; Mattis et al., 2004).

Lidar ratio measurements in the free troposphere have been studied also in case of special events as Saharan dust outbreaks (Ansmann et al., 2003) and volcano eruptions (Pappalardo et al., 2004b).

Conclusions

EARLINET is the first lidar network that has produced the largest database for the aerosol distribution on continental scale.

In particular this database contains the largest data set of lidar ratio data on continental scale covering more than 3 years of systematic observations that is very important for the characterization of the aerosol and it is greatly important for the estimation of aerosol extinction from pure backscatter lidar measurements as for the validation of future spaceborne lidar missions.

First results of the statistical analysis performed on this data set provide already useful input for climate models and the observed large variability of the lidar ratio demonstrates how it is important to continue these systematic observations on continental scale.

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