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7-year Climatology of Long-range Transport from Raman Lidar Observations at Leipzig, Germany, in the Framework of EARLINET

I. Mattis, D. Müller, A. Ansmann, U. Wandinger
Leibniz-Institute for Tropospheric Research, Leipzig, Germany (contact ina@tropos.de))

1 Introduction

The Raman lidar of the Institute for Tropospheric Research (IfT) Leipzig, Germany, is part of the European Aerosol Research LIdar NETwork (EARLINET) [1]and monitors the aerosol profiles throughout the troposphere on a routine basis since September 1997. The aim of EARLINET is the establishement of a quantitative, vertically resolved aerosol climatology over Europe. About 20 lidar stations across Europe perform 2-3 regular measurements per week at predefined dates. Additional measurements are carried out during long-range transport events. In about 45% of the regular EARLINET measurements we detect aerosol layers in the free troposphere over Leipzig. Such layers are mainly caused by long-range transport of aerosol particles.

In July and August 2004 the ICARTT campaign was conducted in the North Atlantic region to study the outflow and long-range transport of aerosols from the North American continent by means of airplane measurements and satellite observations. Some EARLINET lidars also took part in this experiment and measured the vertical structure, optical and microphysical properties of the North-American aerosol layers over Germany, Italy, Greece, and Belarus. Especially the vertical structure is an important parameter for the validation of long-range transport modelling but cannot be derived from satellite column observations. 7 years of regular monitoring of free tropospheric layers over Leipzig allow an estimation of the climatological significance of the short-term ICARTT measurements.

2 Tools

The IfT Raman lidar provides height profiles of the particle backscatter coefficient at 355, 532, and 1064 nm, the volume extinction coefficient of the particles at 355 and 532 nm, the Ångström exponent, the particle lidar ratio at 355 and 532 nm, and the depolarization ratio at 532 nm as well as profiles of the water-vapor-to-dry-air mixing ratio and temperature. The IfT Raman lidar and data analysis are described in [2]and [3].Effective radius, volume and surface-area concentration, complex refractive index, and single-scattering albedo are derived from the optical data with an inversion scheme [4].

To obtain the origin of the observed aerosols we use trajectories calculated by the German Weather Service as well as HYSPLIT4-trajectories [http://www.arl.noaa.gov/ready/open/hysplit4.html] and transport simulations with the FLEXTRA / FLEXPART model [5].

3 Results

About 20% of the free tropospheric aerosol layers result from Saharan dust outbreaks [2]and about 35% are due to long-range transport of forest fire smoke or anthropogenic particles from North America [6].We also observed arctic haze layers [7]and forest fire smoke layers from Siberia [8].In this contribution we will present the results of a statistical analysis of the free tropospheric layers in terms of frequency, mean geometrical properties (height and depth), mean optical properties, and microphysical properties for the most important source regions. The configuration of the IfT Raman lidar allows a clear identification of different aerosol types like aged smoke, Sahara dust, or anthropogenic aerosols.

In addition to the statistical analysis we also present individual case studies for the different source regions. The ICARTT measurement taken on July 22, 2004, showed a lofted aerosol layer between 3 and 8-km height. The optical depth of this layer was 0.2 at 532 nm, the mean lidar ratios were 57 sr at 532 nm and 35 sr at 355 nm. This spectral behavior is typical for aged forest-fire smoke. The mean Ångström exponent was 0.9, and the mean effective radius was 0.23 μm. The single-scattering albedo was about 0.9. The relative humidity was below 20%.

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