Boundary layer aerosol size distributions during SAMUM I-II Morocco 2006 and Cape Verde 2008

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Introduction

The Saharan Mineral Dust Experiment (SAMUM) is dedicated to the understanding of the radiative effects of mineral dust. Two major field experiments were performed: A first joint field campaign took place at Ouarzazate and near Zagora, southern Morocco, during May-June, 2006. Aircraft and ground-based measurements of aerosol physical and chemical properties were performed to collect a data set of surface and atmospheric columnar information within a major dust source. This data set, combined with satellite data, provides the base of the first thorough columnar radiative closure tests in Saharan dust. A second field experiment was conducted during January-February, 2008, in the Cape Verde Islands region, where about 250 Tg of mineral dust are transported annually across the Subtropical North Atlantic towards the Caribbean Sea and the Amazon basin. Along its transport path, the mineral dust is expected to influence significantly the radiation budget – by direct and indirect effects – of the Subtropical North Atlantic. One focus of the investigation within the trade wind region is the spatial distribution of mixed dust/biomass/sea salt aerosol and their physical and chemical properties, especially with regard to radiative effects.

Methods

Measurements of size distributions were conducted at the Zagora (Morocco) and Praia (Cape Verde Islands) ground stations. The aerosol size distribution from 20 nm to 500 µm was measured. The size range of 20 nm < d < 10 µm was investigated by a DMPS/APS combination, whereas particles with 3 µm < d < 500 µm were measured by (single stage and free-wing) impactor collection on coated glass substrates followed automated microscopic image analysis of the individual particles. The DMPS/APS combination was measuring quasi-continuously; the large and giant particle range was investigated once a day in Morocco and twice a day at Cape Verde.

Morocco

The measurements in Morocco (Fig.1) showed that large variations due to local and regional mineral dust emissions could be observed. Mainly local production of dust contributed to the giant particles and significant portions originating from advection contributed to the concentration of the smaller ones. The size distributions show signatures of anthropogenic influence in the submicron range for particles less than 500 nm. Under high dust concentrations, giant particles with d > 10 µm account for more than 90 % of the total airborne aerosol mass. The largest variations were found in the giant particles range above 100 µm during dust storm conditions. For particles with dp < 30 µm, the size distributions measured on board of the Falcon aircraft in altitudes of about 500 m above Tinfou follow a pattern similar to the ground-based measurements. This indicates that the boundary layer is rather well mixed up to an altitude of 3 to 5 km depending on meteorological situation.

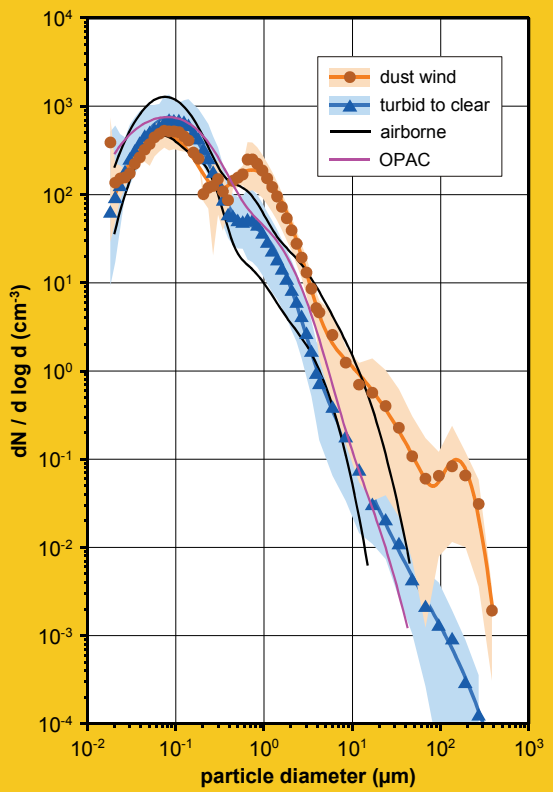

Fig.1: Boundary layer aerosol size distributions at Tinfou, Morocco. Range of airborne measurements by the DLR-Falcon aircraft, and the OPAC aerosol model approximation “desert” plus ”500 cm-3 of water-soluble particles” (Hess et al., 1998). Lines are parameterization curves, the shaded areas show the variability between maximum and minimum values

Cape Verde Islands

The size distributions (Fig. 2) measured on the Cape Verde Islands show moderately enhanced concentration levels during Saharan dust outbreaks. Ultra giant particles are reduced due to the long-range transport of more than thousand kilometers compared to the source-near distributions in Morocco. Average size distributions measured in the same region during past campaigns (Meteor cruises in 1969 and 1973 and the Cape Verde 73 dataset of Sal Island) were added for comparison, since there are no other data available for the boundary layer. Obviously, for particles less than 500 nm little variability of the concentrations can be observed. This size range is composed of the well mixed marine background aerosol merely unaffected by Saharan dust intrusions. However, for particles larger than 500 nm a considerable variability of up to more than one order of magnitude exists during advection of Saharan dust.

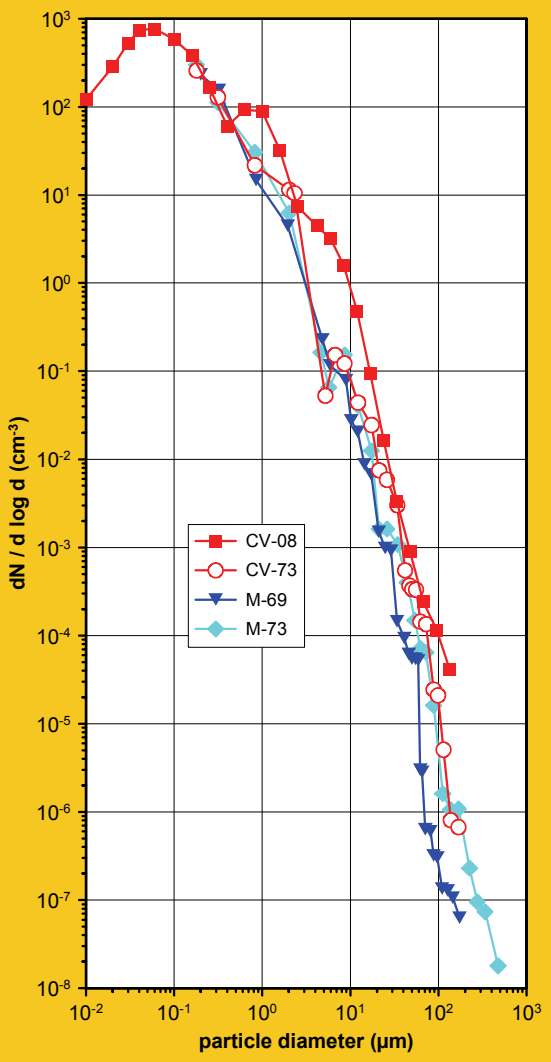

Fig. 2: Boundary layer aerosol size distributions measured at Praia, C.V. 2008 and measurements of previous campaigns on board of the R.V. Meteor in 1969 and 1973 in the vicinity of the Cape Verde Archipelago and on Sal

Acknowledegments

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