Geophysical Research Abstracts
Vol. 16, EGU2014-16876-1, 2014
EGU General Assembly 2014

Modification of Saharan Mineral Dust during Transport across the Atlantic Ocean - Overview and Results from the SALTRACE Field Experiment

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At present one of the largest uncertainties in our understanding of global climate concerns the interaction of aerosols with clouds and atmospheric dynamics. In the climate system, mineral dust aerosol is of key importance, because mineral dust contributes to about half of the global annual particle emissions by mass. Although our understanding of the effects of mineral dust on the atmosphere and the climate improved during the past decade, many questions such as the change of the dust size distribution during transport across the Atlantic Ocean and the associated impact on the radiation budget, the role of wet and dry dust removal mechanisms during transport, and the complex interaction between mineral dust and clouds remain open.

The Saharan Aerosol Long-range Transport and Aerosol-Cloud-Interaction Experiment (SALTRACE: http://www.pa.op.dlr.de/saltrace) was conducted in June/July 2013 to investigate the transport and transformation of Saharan mineral dust during long-range transport from the Sahara across the Atlantic Ocean into the Caribbean. SALTRACE is a German initiative combining ground-based and airborne in-situ and lidar measurements with meteorological data, long-term measurements, satellite remote sensing and modeling which involved many national and international partners.

During SALTRACE, the DLR Falcon research aircraft was based at Sal, Cape Verde, between 11 and 17 June 2013, and at Barbados between 18 June and 11 July 2013. The Falcon was equipped with a suite of in-situ instruments for the measurement of microphysical and optical aerosol properties, with sampling devices for offline particle analysis, with a nadir-looking 2-μm wind lidar, with dropsondes and instruments for standard meteorological parameters. Ground-based lidar and in-situ instruments were deployed in Cape Verde, Barbados and Puerto Rico.

During SALTRACE, mineral dust from five dust outbreaks was studied by the Falcon research aircraft between Senegal, the Caribbean and Florida under different atmospheric conditions. On the eastern side of the Atlantic, dust plumes were quite homogenous and extended up to 6-7 km altitude. In contrast, the dust layers in the Caribbean showed three layers with different dust characteristics and were mainly below 4.5 km altitude. In the upper part of the dust layers in the Caribbean, the aerosol properties were similar to the observations near Africa. In contrast, much more variability in the dust microphysical and optical properties was observed between 0.7 and 2.5 km altitude. The aerosol optical thickness of the dust outbreaks studied in the Barabados area ranged from 0.2 to 0.6 at 500 nm. Highlights during SALTRACE included the Lagrangian sampling of a dust plume in the Cape Verde area on 17 June which was again measured with the same instrumentation on 21 and 22 June 2013 near Barbados. The event was also captured by the ground-based lidar and in-situ instrumentation. Another highlight was the formation of tropical storm Chantal in the dusty environment.

In our presentation, we give an overview of the SALTRACE study and investigate the impact of dust aging processes between the Cape Verde region and the Caribbean on dust microphysical and optical properties. We show vertical profiles of dust size distributions, CCN and dust optical properties and compare our results with the ground-based in-situ, sun photometer and lidar measurements. In particular, we show the results from the

trans-Atlantic Lagrangian dust study and discuss similarities and differences of the dust plumes observed over Cape Verde and in the Caribbean.