Name of research institute or organization:

Department of Geosciences, University of Fribourg

Title of project:

Single particle analysis of aerosols from Saharan dust events

Project leader and team:

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Project description:

Mineral Dust from the Sahara has a pronounced influence on the optical parameters of the aerosol. During a Saharan Dust Event (SDE) the wavelength dependence of the Single Scattering Albedo (SSA) shows an inversion (Collaud Coen et al., 2004). Such a behavior is predicted from modelling by Sokolik and Toon (1999) assuming that during a SDE the particle size distribution changes and that more hematite particles are present. Whereas changes in particle size distributions during SDE have already been demonstrated, there is only scarce information on the quantitative mineralogy of SDE's available. The aim of this study is, therefore, to characterize the particle size distribution, the morphology, and the chemical/mineralogical composition of aerosol particles from SDE's.

For that purpose a sampling campaign took place at the high alpine research station Jungfraujoch between 14th and 30th of May 2008 (during CLACE 2008). Within this time a remarkable SDE occurred (26th – 30th of May). The sampling devices used were a PM-10 filter sampler (flow rate: 4l/min; filter: Nuclepore polycarbonate filter) and an electrostatic sampler (described in Fierz et al., 2007), which allows to collect particles directly on a transmission electron microscopy grid (TEM-Grid). The analysis of the particles was done by Scanning Electron Microscopy (SEM) combined with Energy Dispersive X-ray Spectroscopy (EDX). An automatized particle analysis routine of the EDAX GENESIS software package allows to obtain chemical and morphological data of >1000 particles in a few hours. The TEM-grids were analysed "manually" by Transmission Electron Microscopy (FEI CM200, CSEM Neuchâtel) using bright field imaging, EDS and electron diffraction.

During the SDE the particle number and mass concentrations of "coarse" particles (0.4-10 µm) were with 30 particles per litre respectively 10'000 ngm^{-3} about 10-100 times higher than background concentrations. The particle size distribution, determined by computer controlled SEM (CCSEM), changed clearly during the SDE. Particle number concentrations of particles in the size fraction 0.4-1.0 µm increased more strongly than the one of bigger particles.

For the chemical and mineralogical composition no differences could be detected by CCSEM. The most abundant particles are agglomerates of clays. Minor components are other silicates (quartz and feldspars), carbonates, sulphates and metal oxides/hydroxides. The few iron and iron oxides could be, based on morphology, reminiscent of rail way traffic derived particles. The TEM analysis, however, allowed to discover nanoparticles of iron oxide included or attached to clay agglomerates. These inclusions are not detectable by SEM techniques nor bulk technical techniques,

because the clay minerals themselves contain iron. Additionally also titanium oxide nanoinclusion could be detected as components of the agglomerates. All this inclusions are in a size range of 10-100 nm.

The assumptions of Sokolik and Toon could be confirmed. The optical properties of iron oxide particles may, however, have to be reconsidered based on their size. Reflectivity and absorption of nanometric hematite differs considerably from macro hematite. (f.ex. Morris et al., 1985; Lane et al., 2000)

Sampling and analysis of more SDE's for a better aerosol characterization of Saharan Dust is necessary. For that purpose an automated PM-10 sampling device was tested for first time in October 2009 on the Jungfraujoch. This device is connected to the Global Atmosphere Watch (GAW) computer (maintained by Paul Scherrer Institute) and uses the inversion of the wavelength dependence of the SSA as a start signal for the air pump of the PM10 sampler. Several time controlled air channels allows to obtain up to 7 samples. This method will make it possible to take samples from different Saharan Dust Events in 2010. Additionally the passive sampler (SIGMA 2) was tested also in October 2009 but the harsh climatic conditions at Jungfraujoch make an operation of this device impossible during winter time.

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Key words:

Saharan dust, Mineral dust, Aerosol composition, Aerosol morphology, SEM, TEM

Collaborating partners/networks:

Martin Collaud Coen (MeteoSwiss)
Paul Scherrer Institute (PSI)
Volker Dietze (Deutscher Wetterdienst)
Trinational Network: Airborne particles and their health effects

Scientific publications and public outreach 2009:

Conference papers

Meier, M.F., B. Grobéty, and M. Collaud Coen, Aerosol properties of Saharan dust collected at the Jungfraujoch: determined by single particle analysis, 7th Swiss Geoscience Meeting, Neuchâtel, Switzerland, 20th – 21st November, 2009, Abstract Volume: 5. Meteorology and climatology, 2009.

Meier, M.F., B. Grobéty, M. Collaud Coen and G. Wehrle, Single particle analysis of a Saharan dust event on Jungfraujoche, 19th Annual VM Goldschmidt Conference, Davos, Switzerland, June 21- 26, 2009, Geochimica et Cosmochimica Acta, 73 Supplement, A 866, 2009.

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