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# Long-range-transported Saharan dust in the Caribbean – an electron microscopy perspective of aerosol composition and modification

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From June to July in 2013, the Saharan Aerosol Long-range Transport and Aerosol-Cloud-Interaction Experiment (SALTRACE) was performed in the Caribbean. Airborne aerosol sampling was performed onboard the DLR Falcon aircraft in altitudes between 300 m and 5500 m. Ground-based samples were collected at Ragged Point (Barbados, 13.165 °N, 59.432 °W) and at the Cape Verde Atmospheric Observatory (Sao Vicente, 16.864 °N, 24.868 °W). Different types of impactors and sedimentation samplers were used to collect particles between 0.1 $\mu$m and 4 $\mu$m (airborne) and between 0.1 $\mu$m and 100 $\mu$m (ground-based). Particles were analyzed by scanning electron microscopy with attached energy-dispersive X-ray analysis, yielding information on particle size, particle shape and chemical composition for elements heavier than nitrogen. A particle size correction was applied to the chemical data to yield better quantification. A total of approximately 100,000 particles were analyzed. For particles larger than 0.7 $\mu$m, the aerosol in the Caribbean during the campaign was a mixture of mineral dust, sea-salt at different aging states, and sulfate. Inside the Saharan dust plume – outside the marine boundary layer (MBL) – the aerosol is absolutely dominated by mineral dust. Inside the upper MBL, sea-salt exists as minor component in the aerosol for particles smaller than 2 $\mu$m in diameter, larger ones are practically dust only. When crossing the Soufriere Hills volcano plume with the aircraft, an extremely high abundance of small sulfate particles could be observed. At Ragged Point, in contrast to the airborne measurements, aerosol is frequently dominated by sea-salt particles. Dust relative abundance at Ragged Point has a maximum between 5 $\mu$m and 10 $\mu$m particles diameter; at larger sizes, sea-salt again prevails due to the sea-spray influence. A significant number of dust particles larger than 20 $\mu$m was encountered. The dust component in the Caribbean – airborne as well as ground-based – is composed of mainly silicates and minor amounts of Ca-rich and Fe-/Fe-Ti-rich particles (less than 10 % of dust fraction). The composition of the silicates indicates a major contribution of kaolinite (Al/Si atomic ratio between 0.6 and 1) and a minor contribution of quartz and feldspar particles. The inter-sample variation of the dust composition is generally low, pointing to a very thorough mixing from differently-composed Saharan sources. The temporal evolution of aerosol composition at Ragged Point shows a variation in dust abundance, but strong isolated events could not be identified. An airmass change induced by the passing by of a hurricane, however, is visible in sulfate abundance and their composition. Strong internally mixed particles of dust and sulfate or dust and sea-salt are very rare (up to 1 % of particles in the airborne samples), but a slight increasing tendency with decreasing altitude was found. In the lower MBL at Ragged point, dust/sea-salt mixtures are more frequent (in the same abundance range as pure dust particles). A first conclusion from the data set is that dust aging with respect to internal mixtures does not happen during the long-range transport across the Atlantic Ocean, but rather at the end during the down-mixing of mineral dust into the Caribbean MBL.