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The influence of large mineral dust particles on the atmospheric radiative effects of an in-situ measured Saharan dust plume

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During the ACE-2 experiment 1997 over the Canary Islands aerosol size distributions were measured between 0.9 and 12 km altitude in a Saharan dust plume. The distributions show significant fractions of large particles having diameters from 4 to 30 μm. Taking the microphysical particle measurements as input for Mie scattering computations, comprehensive radiative flux density calculations have been carried out to obtain shortwave, longwave and total atmospheric radiative effects (AREs) of the measured dust plume over ocean and desert. In the simulations parameters like solar zenith angle, total dust optical depth, tropospheric standard aerosol profiles and particle complex refractive index have been varied. The results demonstrate that the large particle fraction has a significant influence on the dust optical properties, which vary strongly with altitude. The asymmetry parameter and the single scattering albedo were simulated between g(0.55 μm) = 0.65-0.81 as well as ω_o(0.55) = 0.75-0.96 in the entire dust column using a mean complex refractive index of mineral dust, which was calculated by a moving average over a big number of literature data. Within the main dust layer at 4 km altitude the values g(0.55) = 0.81 and ω_o(0.55) = 0.76 indicate strong forward scattering and predominant absorption by the large particles affecting the radiative transfer.

The measured dust locally cools the atmosphere over the ocean (ARE = -53 W m^{-2}) and warms it over the desert (+107 W m^{-2}). This opposite behaviour is due to the larger spectral surface albedo and surface temperature of the desert. Since the large particles absorb strongly, they contribute at least 20 % to the ARE in the dusty atmo-

sphere. Thereby, their absorption properties and, thus, local heating effects are significantly affected by the spectral complex refractive index of the particles and its uncertainty.

To emphasize the role of the large particle fraction from the measured size distributions the parameters of a bimodal lognormal column volume size distribution are deduced, resulting in a coarse volume median diameter of $\sim 9\ \mu$m and a column single scattering albedo of 0.78 at 550 nm. For exploring the decisive role of the large particles, a sensitivity study will be presented with respect to uncertainties in the size distribution parameters on the dust ARE.

It should be stressed that the variability and uncertainty of the spectral complex refractive index of the dust particles have a significant influence on the dust ARE. Therefore, detailed information about the refractive index of mineral dust samples as function of wavelength and particle composition in the particle size ranges are required to perform more exact radiative transfer computations compared to in-situ measurements of the optical properties and the shortwave as well as longwave radiation during dust outbreaks. This must be the aim of future closure studies. Moreover, mineral dust particles possess non-spherical shapes, and their composition depends on particle size, too. These properties are expected to play an important role for radiative budget and remote sensing purposes. Recently, in-situ observations have been carried out during the SAMUM experiment (http://samum.tropos.de/) in summer 2006 in Morocco, which have the potential to provide such information.