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Using aircraft measurements to determine the refractive index of Saharan dust during the DODO Experiments

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Much uncertainty in the value of the imaginary part of the refractive index of mineral dust contributes to uncertainty in the radiative effect of mineral dust in the atmosphere. A synthesis of optical, chemical and physical in-situ aircraft measurements from the DODO (Dust Outflow and Deposition to the Ocean) experiments during February and August 2006 are used to calculate the refractive index mineral dust encountered over West Africa.

Radiative transfer modeling and measurements of broadband shortwave irradiance at a range of altitudes are used to test and validate these calculations for a specific dust event on 23 August 2006 over Mauritania. Two techniques are used to determine the refractive index: firstly a method combining measurements of scattering, absorption, size distributions and Mie code simulations, and secondly a method using composition measured on filter samples to apportion the content of externally mixed quartz, calcite and iron oxide-clay aggregates, where the iron oxide is represented by either hematite or goethite and clay by either illite or kaolinite.

The imaginary part of the refractive index at 550nm (n_i^{550}) is found to range between 0.0001i to 0.0046i, and where filter samples are available, agreement between methods is found depending on mineral combination assumed. The refractive indices are also found to agree well with AERONET data where comparisons are possible. n_i^{550} is found to vary with dust source, which is investigated with the NAME model for each case. The relationship between both size distribution and n_i^{550}on the accumulation mode single scattering albedo at 550nm (ω_0^{550}) are examined and size distribution is found to have no correlation to ω_0^{550}, while n_i^{550} shows a strong linear relationship with ω_0^{550}.

Radiative transfer modeling indicates that Mie-derived values of $n_i^{550}$and the goethite-kaolinite combination resulted in the best agreement with irradiance measurements, for the particular dust event examined. The radiative effect of the dust is found to be very sensitive to the mineral combination (and hence refractive index) assumed.