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Laboratory estimate of the regional shortwave refractive index and single scattering albedo of mineral dust from major sources worldwide

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Mineral dust is one of the most abundant aerosol species in the atmosphere and strongly contributes to the global and regional direct radiative effect. Still large uncertainties persist on the magnitude and overall sign of the dust direct effect, where indeed one of the main unknowns is how much mineral dust absorbs light in the shortwave (SW) spectral range. Aerosol absorption is represented both by the imaginary part (k) of the complex refractive index or the single scattering albedo (SSA, i.e. the ratio of the scattering to extinction coefficient).
In this study we present a new dataset of SW complex refractive indices and SSA for mineral dust aerosols obtained from in situ measurements in the 4.2 m3 CESAM simulation chamber at LISA (Laboratoire Interuniversitaire des Systemes Atmospheriques) in Créteil, France. Investigated dust aerosol samples were issued from major desert sources worldwide, including the African Sahara and Sahel, Eastern Asia, the Middle East, Southern Africa, Australia, and the Americas, with differing iron oxides content. Results from the present study provide a regional mapping of the SW absorption by dust and show that the imaginary part of the refractive index largely varies (by up to a factor 6, ∼0.003-0.02 at 370 nm and 0.001-0.003 at 950 nm) for the different source areas due to the change in the particle iron content. The SSA for dust varies between ∼0.75-0.90 at 370 nm and 0.95-0.99 at 950 nm, with the largest absorption observed for Sahelian and Australian dust aerosols. Our range of variability for k and SSA is well bracketed by already published literature estimates, but suggests that regional–dependent values should be used in models. The possible relationship between k and the dust iron oxides and elemental iron content is investigated with the aim of providing a parameterization of the regional–dependent dust absorption to include in climate models.