Internally mixed aerosols observed by individual particle analysis and effect on optical properties

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Often, atmospheric aerosol representation in climate models relies on the assumption of homogeneous particles or their external mixture. However, atmospheric aerosol can be a heterogeneous mixture of various species that present a complex morphology, such as internally mixed particles. The aerosol optical properties may strongly depend on their chemical composition, morphology and mixing state. Therefore, in this work we perform observations of collected airborne particles by microscopy techniques and based on these observations conduct numerical simulations of aerosol optical properties.

For this purpose, size-segregated atmospheric particles were collected by cascade impaction, in regions affected by different pollutants: 1) a remote desert site in the Negev Desert - Sede Boker, Israel; 2) a coastal desert site in western Africa - Mbour, Senegal; 3) a coastal urban/industrial site in northern France - Dunkerque; and 4) an urban site in northern France - Lille.

Laboratory experiments, using individual particle analysis with scanning and transmission electron microscopy coupled to energy-dispersive X-ray spectroscopy, have shown that internally mixed particles often outnumbered externally mixed homogeneous particles. Internally mixed particles were also reported for some sites of interest previously Deboudt *et al* (2010). Moreover, particles present complex morphology such as core-shell structure (Figure 1 and 2). Here, the formation of secondary products on the surface of dust (Figure 1) and soot (Figure 2) particles may enhance their ability of absorbing water vapour resulting in the conversion of particles into aqueous droplets under high relative humidity atmospheric conditions.

Furthermore, we perform simulation of optical properties in single scattering approximation for polydisperse particle ensemble and in particular for the case of coating. We use numerical codes (Dubovik *et al,* 2006; Wiscombe, 1980) to illustrate how, for realistic atmospheric aerosol size distributions, coating by different materials (non-absorbing or absorbing) can modify the light scattering and absorbing properties of particles.

The single scattering albedo (SSA) has a significant role in estimation of direct aerosol radiative forcing of Earth's climate. Our numerical simulations show how the SSA of absorbing carbonaceous and dust particles vary as a function of coating dimensions and type of material. The results show an increase of SSA for particles, both dust and carbonaceous, coated by non-absorbing material. The SSA continues to increase as the non-absorbing coating become thicker.

Particles coated by different chemical species have been observed in every region studied in this work. The coating was also shown to modify significantly the scattering and absorption properties of particles. Therefore, implications for assessment of aerosol radiative forcing of climate are important.

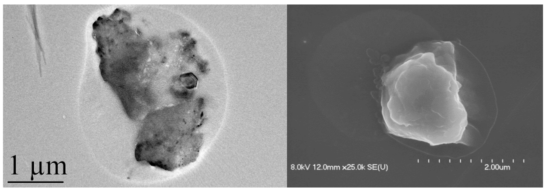

Figure 1. TEM image of a desert dust particle with halo, collected in Mbour, Senegal, western Africa (left); SEM image of an internally-mixed sea-salt/dust particle with halo, collected in Negev desert, Israel (right).

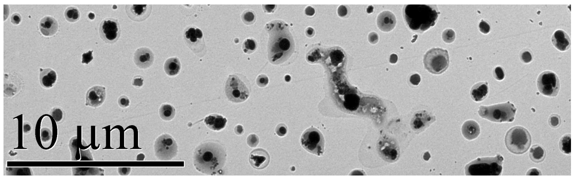

Figure 2. TEM image of urban pollution particles composed of soot cores surrounded by halo, collected in northern France

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