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CCN formation by mixing processes between Saharan dust and European pollution aerosols

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The evolution of dust properties is illustrated in this study through a case of long-range transport of Saharan dust over northwestern Europe during May 2008. This spread of dust over northwestern Europe is investigated by combining satellite, airborne, ground-based observations and the non-hydrostatic meso-scale model Meso-NH. The total dust amount emitted during the study period is estimated to 185 Tg. The analysis of the removal processes reveals that only 12.5 Tg is lost by dry deposition, and that wet deposition is the main process of dust removal (73 Tg).The observed aerosol optical thickness ranged from 0.1 to 0.5 at the wavelength of 440 nm, with a maximum value close to unity found over the Netherlands (51.97°N, 4.93°E). Over that site, the main dust layer is located between 1.8 and 5.2 km above sea level (asl), moreover dust was also present at 0.9 km asl. The nephelometer measurements on board the ATR-42 aircraft revealed a strong wavelength dependence of the scattering coefficient over the Netherlands. The Angström exponent is greater than 0.5, whereas usually it approaches zero in presence of Saharan dust. This specific behavior is attributed to high precipitation scavenging efficiency for the coarse mode. Over the Netherlands, the observed CCN concentration significantly increased between the 29th and 31th May, with a maximum value close to 16000 particles per cm3 at 0.45% supersaturation. The numerical simulations revealed the dust plume reached the Netherlands on the 30th May passing by Italy on the 28th May. Furthermore, the presence of mixing layers between dust plume and pollution aerosols are simulated over Italy and the Netherlands. The mixing layer is simulated between 1 and 4 km over Italy, whereas it is simulated between the surface and 3 km over the Netherlands. Our results suggest that this significant increase of the CCN concentration is due to an enhancement of the dust hygroscopic properties, by coating soluble materials during their transport to the Netherlands. Thus, this study reveals the two primary mechanisms of evolution of the Saharan dust properties are wet deposition and mixing processes with the European pollution aerosols.