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Does the long-range transport of African mineral dust across the Atlantic enhance their hygroscopicity?

Cyrielle Denjean (1,2), Sandrine Caquineau (3), Karine Desboeufs (1), Benoit Laurent (1), Mariana Quiñones Rosado (4), Pamela Vallejo (4), Olga Mayol-Bracero (4), and Paola Formenti (1)

(1) CNRS/UPEC/UPD/IPSL, LISA, Créteil, France (paola.formenti@lisa.u-pec.fr), (4) Institute for Tropical Ecosystem Studies (ITES), University of Puerto Rico, San Juan, USA, (3) Institut de Recherche pour le Développement (IRD), Bondy, France, (2) Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, Germany

Influence of mineral dust on radiation balance is largely dependent on their ability to interact with water. While fresh mineral dusts are highly hydrophobic, various transformation processes (coagulation, heterogeneous chemical reaction) can modify the dust physical and chemical properties during long-range transport, which, in turn, can change the dust hygroscopic properties. The model predictions of the radiative effect by mineral dust still suffer of the lack of certainty of dust hygroscopic properties, and their temporal evolution during long-range transport.

We present the first direct surface measurements of the hygroscopicity of Saharan dust after long-range transport over the Atlantic Ocean, their relationship with chemical composition, their influence on particle size and shape and implications for optical properties. Particles were collected during the DUST Aging and TransporT from Africa to the Caribbean (Dust-AttaCk) campaign at the Cape San Juan Puerto Rico station in June-July 2012. Environmental scanning electron microscopy (ESEM) was used to analyze the size, shape, chemical composition and hygroscopic properties of individual particles.
At different levels of concentrations in summertime, the coarse mode of atmospheric aerosols in Puerto Rico is dominated by Saharan mineral dust. Most of aged dust particles survived atmospheric transport intact with no observed internal mixture with other species and did not show hygroscopic growth up to 94% relative humidity. This is certainly due to the fact that in summertime dust is mostly transported above the marine boundary layer. A minor portion of mineral dust (approximately 19-28% by number) were involved in atmospheric heterogeneous reactions with acidic gases (likely SO_2 and HCl) and sea salt aggregation. While sulfate- and chloride-coated dust remained extremely hydrophobic, dust particles in internal mixing with NaCl underwent profound changes in their hygroscopicity, therefore in size and shape. We show that this change in particles size has important implications for their ability to scatter and absorb light. This behavior is also important for cloud properties since the increase of particles size reduces the supersaturating required for cloud droplet activation.