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Estimating aerosol light-scattering enhancement from dry aerosol optical properties at different sites

Gloria Titos (1,2), Anne Jefferson (3,4), Patrick Sheridan (3), Elisabeth Andrews (3,4), Hassan Lyamani (1,2), John Ogren (3), Lucas Alados-Arboledas (1,2)

(1) Instituto Interuniversitario de Investigación del Sistema Tierra en Andalucía, Universidad de Granada, Junta de Andalucía, Granada, 18006, Spain (gtitos@ugr.es), (2) Department of Applied Physic, University of Granada, Granada, 18071, Spain, (3) Earth System Research Laboratory, National Oceanic and Atmospheric Administration, Boulder, CO, 80305, United States, (4) Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO, 80305, United States

Microphysical and optical properties of aerosol particles are strongly dependent on the relative humidity (RH). Knowledge of the effect of RH on aerosol optical properties is of great importance for climate forcing calculations and for comparison of in-situ measurements with satellite and remote sensing retrievals. The scattering enhancement factor, f(RH), is defined as the ratio of the scattering coefficient at a high and reference RH. Predictive capability of f(RH) for use in climate models would be enhanced if other aerosol parameters could be used as proxies to estimate hygroscopic growth. Toward this goal, we explore the relationship between aerosol light-scattering enhancement and dry aerosol optical properties such as the single scattering albedo (SSA) and the scattering Ångström exponent (SAE) at multiple sites around the world. The measurements used in this study were conducted by the US Department of Energy at sites where different aerosol types predominate (pristine marine, polluted marine, dust dominated, agricultural and forest environments, among others). In all cases, the scattering enhancement decreases as the SSA decreases, that is, as the contribution of absorbing particles increases. On the other hand, for marine influenced environments the scattering enhancement clearly increases as the contribution of coarse particles increases (SAE decreases), evidence of the influence of hygroscopic coarse sea salt particles. For other aerosol types the relationship between f(RH) and SAE is not so straightforward. Combining all datasets, f(RH) was found to exponentially increase with SSA with a high correlation coefficient.