

AEROSOLS - THE COLLOIDS OF THE ATMOSPHERE

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ABSTRACT

Aerosols, which are colloidal suspensions of solid or liquid particles in a gas, are important constituents of the atmosphere. They have major effects on human health, visibility and the environment, and on Earth's radiative balance and thus on climate and climate change. The major groups are sulfates and nitrates of various types, organic molecules, elemental (or black) carbon, sea salt, and mineral dust. Smoke, dust, haze, and smog are terms loosely reflective of aerosol origins and compositions. Clouds are a special class of aerosols in which the particles consist mainly of liquid or solid water, almost all of which contain suspended and dissolved (but originally solid) matter upon which the droplets nucleated. The abundance and especially the types of solids in the atmosphere, notably including anthropogenically-produced particles, greatly influence cloud formation.

The principal mechanisms through which aerosols influence the Earth radiation budget is by the scattering and absorption of solar radiation (the so-called "direct effect"), and through their influence on clouds and precipitation, which affects both radiation and hydrology (the so-called "indirect effect"). Although mineral particles are by far the most abundant atmospheric aerosol by mass, man-made particles can have major effects on climate and climate change and are an increasing focus of research attention because major uncertainties exist in evaluating aerosol-particle effects; the cooling they produce through scattering solar radiation can offset much of the net warming influenced by the far better understood greenhouse gases.

Desired particle properties for characterization include size, composition, crystallographic structure, aspect ratio, and mixing state (internal or external). Transmission electron microscopy (TEM) is the only way to determine all the above properties (at least of the particles in the collected, dried state), and it covers sizes from <1 nanometer to 10 or more micrometers. Compositions are obtained using energy-dispersive spectrometry of emitted x-rays and electron energy-loss spectroscopy. In combination with structural studies using electron diffraction, these techniques allow the identification of different aerosol particle types as well as the determination of atmospheric reactions. Experience as mineralogists and geochemists allows us to provide details regarding airborne minerals and their coatings, extent of aggregation, and speciation for all major particle types. Examples will be shown of aerosols from a variety of environments.

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