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ABSTRACT

The aerosols based on source defined dust, fume, mist, smoke and fog. The aerosols are of various kinds such as urban aerosols, semiurban aerosols, continental aerosols, desertic aerosols, marine aerosols, volcanic aerosols or stratospheric aerosols. Terrestrial and marine ecosystems are also an important source of aerosol precursors. Some species of phytoplankton produce dimethylsulphide (DMS), a gaseous compound that is oxidized in the atmosphere to form sulphur-containing aerosols. Plants and algae emit volatile organic compounds (VOCs) that are oxidized in the atmosphere and condense and contribute organic material to the atmospheric aerosols. The aerosols play an important role in radiative forcing by warming and dimming of globe.

Keywords: Dimethylsulphide, Volatile Organic Compounds, submicronic sulphate etc.

INTRODUCTION

An aerosol is defined as a colloidal system of solid or liquid particles in a gas. An aerosol includes both the particles and the suspending gas, which is usually air with the size of 5-10 μm . Primary aerosols contain particles introduced directly into the gas whereas secondary aerosols form through gas-to-particle conversion. Based on source the aerosols are classified as dust, fume, mist, smoke and fog. The size of particles has a major influence on their properties, and the aerosol particle radius or diameter (d_p) is a key property used to characterize aerosols. Aerosols vary in their disparity. They are polydisperse colloidal systems, exhibit a range of particle sizes. Liquid droplets are almost always nearly spherical, but scientists use an equivalent diameter to characterize the



properties of various shapes of solid particles, some very irregular. The equivalent diameter is the diameter of a spherical particle with the same value of some physical property as the irregular particle.

Aerosols can also be classified according to their origin. One can distinguish natural from anthropogenic sources. Natural sources consist of emissions from the ocean, soils, vegetation, fires, and volcanoes. Anthropogenic sources are largely dominated by emissions from the combustion of fossil fuels (i.e. coal and oil), biofuels (plant biomass including wood, vegetable oils, animal waste), other fuels (e.g. peat), or vegetation fires caused by humans. Industrial activities, transportation, heating, or even domestic activities related to cooking in developing countries, are important sources of aerosols. Some industrial and agricultural activities can also emit primary aerosols referred to as industrial dust and arable dust, respectively.

Atmospheric Aerosols

Secondary aerosols are synthesized by condensation of atmospheric gas-phase species. They undergo a number of chemical transformations before they condense, are called aerosol precursors. Aerosol properties vary spatially and some of these properties can vary more or less systematically with the type of environment. One can thus speak of urban aerosols, semiurban aerosols, continental aerosols, desertic aerosols, marine aerosols, volcanic aerosols or stratospheric aerosols.

Marine Aerosols

The marine aerosols are formed by wind friction at the ocean surface ejects fine particles of salty marine water into the atmosphere causes evaporation so that the concentration of salt in the particle increases.

This gives rise to sea salt particles that are more or less hydrated according to the ambient humidity. Sea spray aerosols cover sizes 100 nm to 20 μm . The largest particles fall back quickly to the ocean surface and are therefore of lesser climatic importance.

Desert Dust

Desert dust aerosols are also called mineral dust or mineral aerosols. Emissions of desert dust depend very much on environmental and meteorological conditions. They are sporadic in nature. The wind friction on continental surfaces can detach soil particles and suspend them in the atmosphere. This is particularly the case in desertic, arid, and semiarid regions where the wind is not slowed down by the vegetation that is either completely absent or fairly sparse. The emission of soil particles to the atmosphere also requires a reduced soil humidity so that cohesive forces between soil particles are also reduced. As for sea spray aerosols, desert dust particles span sizes that range from typically 100 nm to tens of μm . Larger particles can also be lifted but they fall down quickly.

Volcanic Aerosols

Volcanoes emit volcanic ash during explosive eruptions with the size of few micrometre to millimetres. Volcanoes also emit sulphur-rich gases (in the form of sulphur dioxide, SO_2 , and hydrogen sulphide, H_2S) that get oxidized to form submicronic sulphate aerosols. If these sulphur-containing gases are emitted in the troposphere, the residence time of the subsequent aerosols will be short, a few weeks at most. When the eruption is more the volcanic ashes reside in the stratosphere for few weeks to months.



Biogenic Aerosols

The terrestrial biosphere is a source of primary biogenic aerosol particles (PBAP). They comprise plant and insect debris ($>100\ \mu\text{m}$), pollen ($1\text{--}100\ \mu\text{m}$), spores ($1\text{--}100\ \mu\text{m}$), bacteria ($1\text{--}100\ \mu\text{m}$) and viruses ($<1\ \mu\text{m}$). Seawater also can contain biological material, some of which is transferred to sea spray aerosols during the emission process. This primary organic matter is found preferentially in particles smaller than $200\ \text{nm}$ in diameter (Leck and Bigg 2008) and its amount has been found to depend on the biological activity in ocean waters (Facchini et al. 2008). Terrestrial and marine ecosystems are also an important source of aerosol precursors. Some species of phytoplankton produce dimethylsulphide (DMS), a gaseous compound that is oxidized in the atmosphere to form sulphur-containing aerosols. Plants and algae emit volatile organic compounds (VOCs) that are oxidized in the atmosphere and condense and contribute organic material to the atmospheric aerosol. These aerosols are referred to as secondary biogenic aerosols. Their sizes are typically of the order of a few tenths of a micrometer.

Biomass Burning Aerosols

The burning of biomass generates primary aerosols that stem from the incomplete combustion of the organic matter. Biomass burning aerosols include organic carbon, that is associated with hydrogen and oxygen atoms, and black carbon, where the carbon content is very high. These aerosols are generally submicronic and are clearly visible in smoke plumes. The sources of biomass burning aerosols are both natural and anthropogenic. The combustion of biomass also emits gaseous compounds, such as volatile organic compounds and sulphur dioxide, which are aerosol precursors.

Aerosols from Fossil Fuel Combustion

The combustion of coal and oil derivatives also produces black carbon and organic carbon, as well as sulphur dioxide that converts into sulphate aerosols. These are essentially submicronic particles and formed due to air pollution in developing and industrialized countries. Air pollution due to particles and gas-phase pollutants, such as ozone and nitrogen oxides, is responsible for a wide range of adverse health and environmental effects. Effects on human health include increased respiratory and cardio-vascular diseases and associated mortality. Aerosols and acidic deposition are responsible for damages on historical buildings.

Condensation and evaporation

Aerosol partitioning theory governs condensation on and evaporation from an aerosol surface, respectively. Condensation of mass causes the mode of the particle-size distributions of the aerosol to increase. The evaporation causes the mode to decrease. Nucleation is the process of forming aerosol mass from the condensation of a gaseous precursor, specifically a vapour. Net condensation of the vapour requires super saturation, a partial pressure greater than its vapour pressure. This can happen for three reasons.

- Lowering the temperature of the system lowers the vapour pressure.
- Chemical reactions may increase the partial pressure of a gas or lower its vapour pressure.
- The addition of additional vapour to the system may lower the equilibrium vapour pressure according to Raoult's law

There are two types of nucleation processes. Gases preferentially condense onto surfaces of pre-existing aerosol particles, known as heterogeneous



nucleation. This process causes the diameter at the mode of particle-size distribution to increase with constant number concentration. With sufficiently high super saturation and no suitable surfaces, particles may condense in the absence of a pre-existing surface, known as homogeneous nucleation. This results in the addition of very small, rapidly growing particles to the particle-size distribution.

Stability of generated aerosol particles

Nanoparticles in the air often form agglomerates due to attractive inter-particle forces, such as van der Waals force or electrostatic force if the particles are charged. As a result, aerosol particles are usually observed as agglomerates rather than individual particles. For exposure and risk assessments of airborne nanoparticles, it is important to know about the size distribution of aerosols. When inhaled by humans, particles with different diameters are deposited in varied locations of the central and periphery respiratory system. Particles in nanoscale penetrate the air-blood barrier in lungs and be translocated into secondary organs in the human body, such as the brain, heart and liver. Therefore, the knowledge on stability of nanoparticle agglomerates is important for predicting the size of aerosol particles, which helps assess the potential risk of them to human bodies.

Ding and Riediker (2015) reported it is able to maintain robust aerosolization process and generate aerosols with stable number concentration and mean size from nanopowders. The deagglomeration potential of various airborne nanomaterials can be also studied using critical orifices Stahlmecke et al. (2009). In addition, an impact fragmentation device was developed to investigate bonding energies between particles.

Radiative forcing

The contributions of aerosol particles and gases to the global climate are measured by radiative forcing, which is “the rate of energy change per unit area of the globe as measured at the top of the atmosphere” (Heintzenberg and Charlson, 2009). Radiative forcing is the difference between insolation (sunlight) absorbed by the Earth and energy radiated back to space. Positive radiative forcing means Earth receives more incoming energy from sunlight than it radiates to space. This net gain of energy will cause warming. Conversely, negative radiative forcing means that Earth loses more energy to space than it receives from the sun, which produces cooling. Radiative forcing is quantified at the tropopause in units of watts per square meter (W/m^2) of the Earth's surface. Positive forcing (incoming energy exceeding outgoing energy) warms the system, while negative forcing (outgoing energy exceeding incoming energy) cools it. Causes of radiative forcing include changes in insolation and the concentrations of radiatively active gases commonly known as greenhouse gases and aerosols. The total aerosol direct and indirect effects are -1.2 (-2.7 to -0.4) watts per square meter (Wm^{-2}), which cancels about 70 per cent of the warming effect of CO_2 (Heintzenberg and Charlson, 2009).

Climate Effects of Aerosols

Aerosols influence climate in a number of ways by scattering and absorption of solar radiation. Backscattering of solar radiation towards space results in a reduction of incoming solar radiation at the Earth's surface, a loss of energy and a cooling of the climate system. Absorption of solar radiation is accompanied by a heating within the aerosol layer, but also by a reduction



of incoming solar radiation at the Earth's surface. Such effects occur preferentially, but not uniquely, in clear sky conditions. The absorption of solar radiation by aerosols modifies the vertical temperature profile. This impacts the relative humidity, atmospheric stability, and therefore cloud formation. This effect has traditionally been called the aerosol semi-direct effect, but it can also be seen as a rapid adjustment of the atmospheric state that follows aerosol–radiation interactions.

Aerosols serve as cloud condensation nuclei in liquid water clouds, thus exerting a partial control of cloud microphysical and optical properties. An increase in the concentration of aerosols leads to an increase in the concentration of cloud condensation nuclei, and generally to an increase in the concentration of cloud droplets. For a fixed cloud liquid water content, this is accompanied by a reduction in the cloud droplet size and an increase in the cloud reflectivity. Altogether this leads to less solar energy absorbed and a cooling of the climate system. This effect has been traditionally called the aerosol first indirect effect, but we use here the more general term of aerosol–cloud interactions that includes this and related effects.

The modification of cloud microphysical properties is expected to have an impact on cloud evolution, in particular in terms of the ability of clouds to generate droplets that are large enough to initiate precipitation. Aerosols can impact the properties of mixed-phased and ice clouds, in particular through their role as ice nuclei causes glaciation effect. Absorbing aerosols may deposit onto snow and ice surfaces makes them less reflective which leads to warming of the surface known as the aerosol on snow effect. Finally, aerosols also interact

with vegetation through changes in incoming solar radiation, fraction of diffuse radiation and as a source of nutrients. These are other contributions to aerosol–surface interactions. The multiple effects can be grouped into three main types of interactions: aerosol–radiation interactions (including the direct effect, the semidirect effect and the aerosol on snow effect), aerosol–cloud interactions (including the first and second aerosol effect and the glaciation effect), and aerosol–surface interactions (effects on snow and vegetation).

Conclusion

The aerosol particles counteract the warming effects of greenhouse gases, knowledge of the types and abundances of aerosol particles is critical for understanding changes in the global climatic changes. The environmental chemistry and behavior of the aerosols are tedious to study due to their diverse nature and more surface area. Hence new innovations are needed to focus on the research on aerosols will clearly depict the global climate change.

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