Measurements and modeling of cloud condensation nuclei (CCN) in Indian continental and marine air

Atmospheric aerosol particles serving as cloud condensation nuclei (CCN) play an important role in the formation of clouds and precipitation, and influence atmospheric chemistry and physics, the hydrological cycle and climate. One of the crucial challenges is to determine the ability of aerosol particles to act as CCN under relevant atmospheric conditions, an issue that has received increasing attention over the past years. Elevated concentrations of CCN (in a sense of aerosols) tend to increase the concentration and reduce the size of droplets in the cloud. Apart from changing the optical properties and the radiative effects of clouds on climate, this may lead to the suppression of precipitation in the shallow and short lived clouds and to a greater convective overturning and more precipitation in deep convective clouds.

Substantial progress has been made in recent years in understanding the source processes that produce cloud-active aerosols, the properties that enable aerosols to act as CCN, the effects of aerosols on cloud physics and precipitation, and the consequences for the climate system (Andreae and Rosenfeld, 2008). In order to incorporate the effects of CCN in meteorological models at all scales, from large eddy simulation (LES) to global climate models (GCM), knowledge of the spatial and temporal distribution of CCN in the atmosphere is essential. Several studies have reported CCN measurements from various regions around the world, the actual influence and relative importance of aerosol (and hence CCN) size distribution, chemical composition, and mixing state on the variability and predictability of CCN concentrations, however, remained a subject of continued discussion. Incongruous representation of accurate CCN data in climate models, owing to limited measurements, flunks to assess the response of cloud characteristics and precipitation processes to increasing anthropogenic aerosol concentrations and represents one of the largest uncertainties in the current understanding of the climate change. The paucity of such observations over India is highly contradictory to its global relevance as major source of aerosol particles and their role in radiation budget, precipitation, and hydrological cycle. As compared to the global scenario, observations are even more important over India as due to three distinct meteorological seasons aerosol sources and properties are distinctly different; decisively during monsoon season. So forth CCN measurements reported across the globe, barring only couple of them, are integral CCN measurements i.e., measurements of only total CCN number concentration at prescribed water vapor supersaturation. These types of integral measurements, however, are limited in providing detailed scientific information about critical size, chemical composition, and mixing state of the cloud active aerosols.

Hence, it is proposed to carry out CCN measurements for acquiring high-quality field measurement data in Indian continental and marine boundary layer during different levels of anthropogenic pollution at a given location scanning three meteorological season for full one year; and the development and application of formalisms for efficient description and prediction of CCN properties and concentrations.

Objectives

1. Developing robust methods for robust calibration of CCN counter
2. Obtaining high-quality CCN data in either high altitude pristine or urban marine region during distinct seasons for full one year or longer
3. Development, application, and substantiation of different formalism for efficient description and prediction of CCN properties and concentration under different environmental conditions