Multi-Year Repeated Sounding of Aerosols over a Tropical Site for Climate and Air Quality Studies

P.C.S. DEVARA
Indian Institute of Tropical Meteorology, Dr. Homi Bhabha Road, Pashan, Pune-8, India
(E-mail: devara@tropmet.res.in; Tel.: +91-020-25904251; Fax: +91-020-25893825)

Aerosols perturb weather and climate mainly via three different pathways, namely, Earth-atmosphere radiation balance, environmental pollution and hydrological cycle[1]. Aerosols effect atmospheric radiation field directly and indirectly, and interact strongly with the processes of formation of clouds and precipitation. Much of aerosol-cloud-climate interaction processes, particularly the second indirect effect and its association with environment, are still not well understood. While scattering aerosols cool the atmosphere, absorbing aerosols enhance lower-level heating and intensify the Indian monsoon precipitation[2]. The suppression of coalescence and precipitation processes by aerosols remains inconclusive till today. Air pollution also either suppresses or delays the precipitation[3]. Among the absorbing aerosols such as carbonaceous particles, containing both elemental and organic fractions, and dust particles coated with organic/inorganic materials (internal and external mixing) exert complex forcing on Earth-atmosphere radiation balance and hydrological cycle. These complex processes, particularly the aerosol indirect effects, are poorly represented in weather and climate models; and have been recognized as major sources of uncertainty in any attempt on future climate projections and seamless predictions.

Aerosols are highly heterogeneous in both space and time on shorter time scale, so long-term continuous monitoring with shorter time period is highly essential. Moreover, efficient methods for real-time monitoring of aerosols are of great interest in the programs connected with impact assessment, control and forecast of anthropogenic activities on climate system. Compared to direct measuring techniques, which provide reasonably reliable information with good time resolution at a specific location, more representative information can be obtained with remote sensing techniques[4]. In this context, LIDAR (active remote sensor) and solar radiometry (passive remote sensor) have been recognized to be powerful and versatile tools for atmospheric diagnostics[5]. Although satellite data are available for this purpose, because they are coarse in both in space and time, vertical profile measurements which delineate accumulation of energy (elevated layers) in narrow height regions that are often needed for accurate estimation of radiative forcing due to aerosols are essential. A variety of LIDAR and radiometric techniques developed for the past several years at the Indian Institute of Tropical Meteorology (IITM), Pune, India and the multi-year, multi-institutional, multi-platform, vertical profile / columnar distributions of aerosols, gases, clouds and state variables including air quality, archived with these facilities and salient results are reviewed[6,7]. With the advent of recent technological developments, the state-of-the-art sun-sky radiometers and autonomous Dual Polarization Micro Pulse Lidar (DPMPL), installed at the Institute in the recent past for understanding the direct and indirect aerosol effects, particularly of anthropogenic origin, will be highlighted. Some novel results, bringing insight into the complex interactions and feedback processes underlying aerosols, boundary-layer clouds and monsoon precipitation using these advanced techniques, documenting the impact of aerosols on weather and climate are presented[7-10]. The results suggest better data assimilation and sensitivity techniques which may allow compatibility between the available models and existing data sets. Added, development of cloud and thermo-dynamical parameterization schemes with available and planned observations will further help improving the weather and climate prediction techniques. An overview of the above findings and future scope will be presented.

References

[1] V. Ramanathan, *J. Geophys. Res.*, **106,** 28371 (2001).
[2] K.M. Lau and K.M. Kim, *Geophys. Res. Lett*., **33,** 121810 (2006).
[3] D. Rosenfeld, *Science*, **287**, 1793 (2000).
[4] P.C.S. Devara, *Int. J. Remote Sens.,* **19**, 3271 (1988).
[5] P.C.S. Devara and Co-authors, *SPIE Newsroom*, 1 (2007).
[6] P.C.S. Devara and Co-authors, *Int. J. Climatol.*, **22**, 435 (2002).
[7] P.C.S. Devara and Co-authors, *Mausam*, ***Daimond Jubilee Spl. Vol.***, 155 (2009).
[8] R.L. Bhawar and P.C.S. Devara, *Atmos. Chem. Phys.*, **10**, 29 (2010).
[9] P.R.C. Rahul and Co-authors, *Geophys. Res. Lett.*, **35** (2008).
[10] P.R.C. Rahul and Co-authors, *IEEE Geosci. Remote Sens. Lett.*, 1 (2009).