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ATMOSPHERIC AEROSOL SCAVENGING : A STUDY WITH CONCURRENT MIE LIDAR AND METEOROLOGICAL OBSERVATIONS

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KEYWORDS

Atmospheric aerosols, scavenging, wash-out / dilution processes, lidar, meteorological parameters

INTRODUCTION

The continuing expansion of existing industries, the development of new technology and products, and increasing use of motor vehicles coupled with population growth, especially in large urban areas, are introducing a variety of aerosol pollutants in large quantities into the atmosphere indefinitely. There are a number of scavenging processes such as chemical decay, precipitation mechanism and ground absorption reduce the concentration of pollutants (Changnon, 1980). Of these, precipitation plays an important role in aerosol scavenging and hence in the cleansing of the atmosphere to a greater extent (Twomey, 1977). In the absence of the wet removal processes, dilution of aerosols resulting from winds in the atmospheric boundary-layer reduces the events of pollution hazards caused due to human activities near the earth's surface. As these processes are different for hygroscopic and non-hygroscopic particles, and dependent on size distribution and chemical composition, their study is also essential for understanding of the aerosol-cloud-precipitation cycle (WCRP, 1988). In this paper, we present a decade-long climatology of aerosol scavenging parameters such as wash-out (cm^{-1}) and dilution ($cm^{-1}\ s^{-1}$) coefficients studied from the simultaneous lidar-derived aerosol concentration and metorological parameters during 1987-1996 over an urban station, Pune, India.

EXPERIMENT AND ANALYSIS OF OBSERVATIONS

The computer-controlled, bistatic, Mie (aerosol) lidar at the Indian Institute of Tropical Meteorology (IITM), Pune (18°32′ N, 73°51′ E, 559 m AMSL), India has been operated once in a week and obtained about 570 vertical profiles of aerosol number density (up to ~ 7 km AGL) during October 1986 - September 1996. The lidar essentially consisted of an Argon ion laser as transmitter and a 25-cm diameter Newtonian telescope tailored with detection and real-time data acquisition system as receiver. The complete details of the lidar system and the associated data retrieval techniques have been published elsewhere (Devara and Raj, 1989; Devara et al., 1995). From each vertical profile, aerosol column content or loading in the boundary-layer was computed by integrating the profile throughout the height range up to 1.2 km. Coincident meteorological parameters such as rainfall and pibal wind speed on the days of lidar observations have also been recorded from the India Meteorological Department (IMD), Pune. Using these data, the aerosol wash-out and dilution coefficients were evaluated by coupling the aerosol column content with precipitation intensity and wind speed, respectively.

RESULTS AND DISCUSSION

The wash-out coefficient, expressed as the product of aerosol column content and precipitation intensity during the south-west monsoon (June-September) for the period 1987 through 1996 is

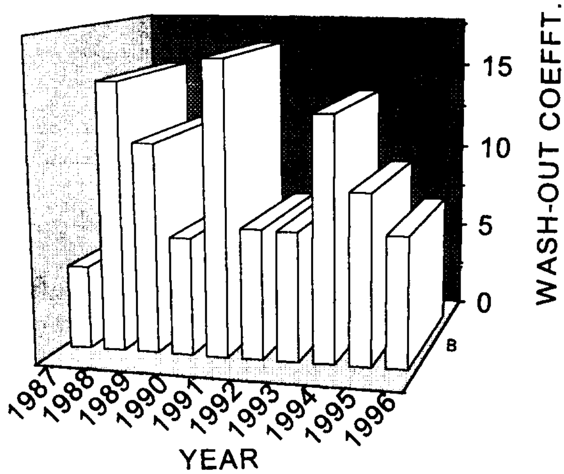

Figure 1 : Inter-annual variability of wash-out coefficient (x10^5 cm^{-1}) over Pune, India

plotted in Fig. 1. It is clear from the figure that the coefficients are higher during 1988, 1991 and 1994. It is interesting to note here that the wash-out phenomenon peaks once in three years which corroborates the higher rainfall received during those years over the experimental station. The relative contribution of aerosol content and precipitation intensity indicates that rainfall plays a dominant role in the wash-out process over Pune. The dilution coefficients which can delineate the dispersion of aerosol particles were computed by making the product of lidar-measured monthly mean aerosol column content and pibal wind speed. The coefficients indicated maximum dilution of aerosol pollutants around the month of May in the years 1988, 1991 and 1995 which is consistent with the greater aerosol content and wind speeds during those periods. The weather at the experimental site during the pre-monsoon (March-May) season is very hot with the daytime maximum temperature reaching around 40°C and surface winds are gusty. During this period, dust content in the atmosphere is at a maximum, and cumulonimbus type clouds development takes place around in the late afternoon. Thus, eventhough the aerosol content is maximum during the pre-monsoon months, most of the aerosol pollutants are diluted / dispersed due to greater wind speed and ventilated by clouds forming over the station during these months.

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