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COLUMNAR AND NEAR-SURFACE AEROSOL SIZE DISTRIBUTIONS OVER CENTRAL HIMALAYAS

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1. INTRODUCTION

The spectral aerosol optical depth (AODs) estimates contain an imprint of the columnar size distribution of aerosols. Measurements of AOD by means of ground based, ten-channel, multi-wavelength radiometer (MWR) at the Manora Peak (29.4°N; 79.5°E; ~1950 m AMSL) during January 2002 to December 2005 are used for inferring on the columnar size distributions of atmospheric aerosols. Collocated measurements of the number-size distributions of boundary layer aerosols were obtained using an optical particle counter (OPC). In this paper, we present the results of CSDs and near surface aerosol size distribution over Central Himalayas and their association.

2. EXPERIMENTAL DETAILS AND DATA BASE

The experimental data consisted of AOD, estimated at ten wavelengths (centered at 380, 400, 450, 500, 600, 650, 750, 850, 935 and 1025 nm, with FWHM 5 nm each), using a 10-channel MWR [*Sagar et al.,* 2004]. Estimates of AODs were made regularly on all clear sky days during the four-year periods (2002 to 2005). These are averaged to get the monthly mean AOD spectra. A total of 39 AOD spectra, thus generated during the above period, formed the basic data set in the present study. In addition, the size distributions of boundary layer aerosols were estimated by using an optical particle counter (OPC, Model No. 1.108 of Grimm Aerosol Technique, GmbH, Germany; *Pant et al.,* 2006) in the size range between >0.3 to > 20 μm during the period 2005-06.

3. RESULTS AND DISCUSSION

3.1 COLUMNAR AEROSOL SIZE DISTRIBUTIONS

The CSDs were retrieved from the spectral AOD following the constrained linear inversion technique [*King et al*., 1978]. More details of the inversion technique as applied to the MWR data to retrieve the CSD are given in *Saha and Moorthy*, [2004]. In general, a size range of 0.05 to 3 μm was used as the lower and upper radii limits for the inversion. A typical columnar size distribution deduced from the monthly mean AOD spectrum for December 2004 is shown in Figure 1(panel b), with solid curve. In Figure 1(top-panel), the measured AODs (by points with error bars) and the AODs re-estimated from the CSDs (by continuous line) are plotted as a function of λ. The retrieved CSD obtained from AODs, in general shows bimodal size distribution with a prominent secondary peak (coarse mode) occurring at large value of radius (~1 μm), while the primary (fine mode) does not appear explicitly. From the CSDs, the other characteristic physical parameters of aerosols such as power law index (ν) mode radii (r_{mi}), width of the size distribution (σ_{mi}), columnar mass loading (M_L), effective radii (R_{eff}), total columnar content (N_t), and number concentration of the accumulation and coarse mode (N_a & N_c) are evaluated. It was observed that the N_t,

N_a, N_c and the dimensionless ration N_c/N_a are increases from winter to summer. The increase in N_c/N_a during the summer seasons indicates the dominance of the large mode aerosols in the size spectrum during the summer seasons. The columnar aerosol mass loading increases from a low value during winter to a very high value in summer.

3.2 *BOUNDARY LAYER AEROSOL SIZE DISTRIBUTIONS*

The number size distributions of boundary layer aerosols are estimated from the individual measurements of OPC data. Typical boundary layer aerosol size distribution, for the month of December 2004 is shown in Figure 1 (bottom) with dotted curve. The near-surface number size distribution is also bimodal in nature, with a secondary mode at ~1.0 μm, while the primary mode does not appear because of the high lower cut-off of the OPC. Using this number size distribution, and assuming the same values of refractive indices as used in the inversion of AOD, spectral extinction coefficients are estimated using the Mie theory [*Wiscombe* 1980]. The wavelength dependence this extinction coefficient is shown in the top panel of the figure as the dotted line joining the triangles. The spectral variation of surface extinction coefficients was approximated to the Angstrom relation and the Angstrom parameters β and α are estimated. These α and β are comparable to the values obtained from the columnar AOD as described by *Sagar et al.,* [2004].

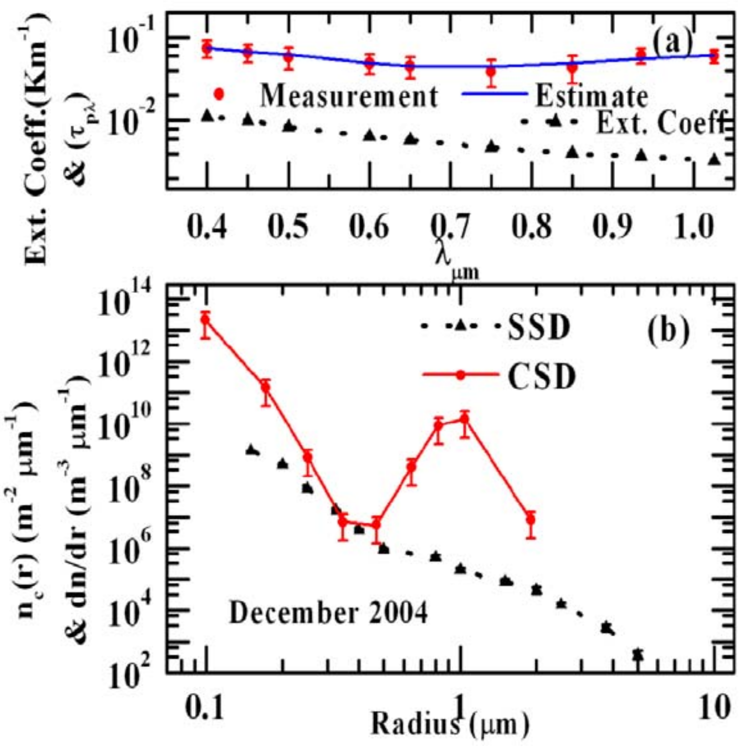

FIGURE 1: - Bottom panel (b) shows CSD obtained from the inversion of spectral AOD (continuous line joining the points) along with the mean number size distributions at the surface (SSD) estimated from the obtained from the OPC data (dashed line joining the filled triangles) and top-panel shows the AOD values obtained from MWR (points with error bars) and those re-estimated from the CSD shown below (by continuous line) and the extinction coefficients computed from the boundary layer size distributions (filled triangles with dotted line).

The comparison of the CSDs along with the boundary layer aerosol size distributions is found to be a good agreement, especially in its nature of variation with size. Further we found that the share of sub-micron and super micron aerosol to the total aerosol concentration (for both in column and surface) indicates the dominant role of sub-micron aerosols and it is account around >90% of total, and also the share of surface extinction coefficients to the columnar optical depths is ~10% during the study period.

4. CONCLUSIONS

The main conclusions of our study are as follows:

1. The aerosols CSDs retrieved from the inversion of spectral AODs in general, show bimodal type distributions, with a prominent secondary peak of coarse mode aerosols occurring at a fairly large value of radius (~1 μm), while the primary peak of fine mode aerosols does not appear explicitly or perhaps occurring at or below radius ≅ 0.1 μm.
2. The number size distribution of near surface aerosols derived from the OPC is also reveled the bimodal distributions in nature, with a coarse mode ~ 1 μm.
3. The aerosol physical parameters estimated from the shows minimum values during the winter seasons and maximum during summer months.
4. The share of surface extinction coefficients to the columnar optical depths is ~10% during the study period

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