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AEROSOL PROPERTIES AND BC MASS MIXING RATIOS OVER THE ARABIAN SEA DURING ARMEX 2004

Vijayakumar S Nair, S Suresh Babu and K Krishnamoorthy
Space Physics Laboratory, Vikram Sarabhai Space Centre, Trivandrum – 695022 , India

Introduction

The Arabian Sea, ie the oceanic region bound between 50°E to 77°E and 5°N to 22°N, plays a significant role in the weather and climate system of South Asia and Africa through seasonally changing wind fields and associated changes in the precipitation. The contrasting airmass types associated with the Asian monsoons is capable of producing significant changes in the aerosol environments leading to heterogeneity (both spatial and temporal) in their characteristics and the radiative properties [*Moorthy et al.*, 2005]. Long-range transport of aerosols from the adjoining landmasses also contributes to this. During the second phase of the ARMEX, collocated measurements of aerosol properties were made onboard the ORV Sagar Kanya during its cruise SK219 during April-May period. These measurements were made during the transition period of airmass from continental to marine and the effect of wind speed are significant to modify the aerosol physical properties, composition and its radiative impacts. In this paper we present the results of effect of changes wind speed on the aerosol properties.

Campaign details and measurements

As a part of Arabian Sea Monsoon Experiment (ARMEX) aerosol measurements were carried out onboard the *Oceanic Research Vessel (ORV) Sagar Kanya* during 17 April to 7 May 2004. The study region was the Arabian Sea warm pool area, centered at 8.2°N and 72.65°E and the cruise track with reference to the west coast of India is shown in Fig. 1. Because of the very small spatial extent covered, the observations can be considered as a time series observation. Collocated measurements of aerosol parameters, made onboard the ORV, comprised of columnar spectral aerosol optical depth (AOD), columnar water vapor (W), mass concentrations - (M_T) of composite aerosols, and M_B of black carbon (BC) aerosols, and number concentration (Ni) of ambient composite aerosols in the size range 0.3 to 20μm in 15 size bins.

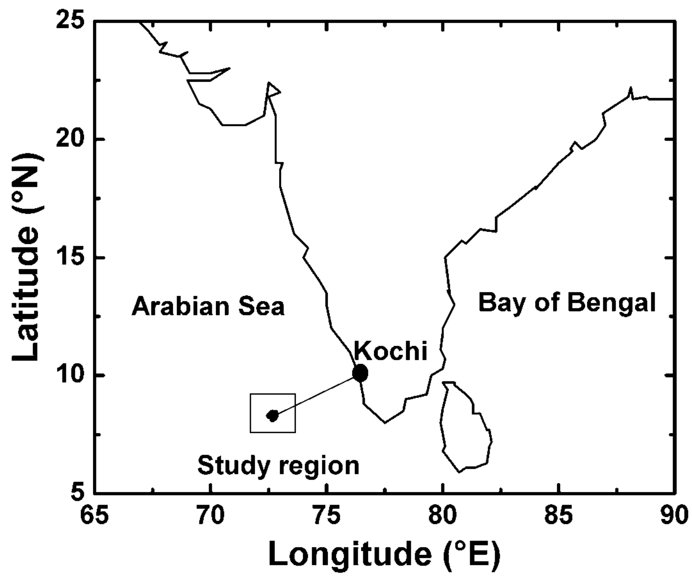

Fig. 1: Cruise track for ARMEX second phase (SK219). Starting point and study region are also shown.

Results and Discussion

Aerosol Optical Depth

Temporal variations of the daily mean AODs, at the 6 wavelengths (340, 380, 500, 675, 870 and 1020nm), obtained using the Microtops sunphotometer onboard during the campaign period are shown in the top panel of Fig 2. The Average AODs (at 500nm) were 0.48 ± 0.04 near to the coast and 0.29 ± 0.01 for the study region during April 21- May 6. Spectral variation of AOD contains the information regarding the columnar size distribution of the particle and is expressed using Angstrom equation $\tau_P(\lambda) = \beta\lambda^{-\alpha}$ where α is a measure of the ratio of abundance of accumulation mode (sub micron) to the coarse mode aerosols and β is the turbidity coefficient indicative of the total aerosol loading. α and β are estimated from the regression slopes and intercept of the graph connecting $\tau_P(\lambda)$ (AOD) and λ in log-log scale. Temporal variations of α are shown in Fig. 2. Over the study region, large temporal variation of aerosol optical depth and the Angstrom exponent (α) were observed. α varied from 1.6 to 0.5 during a period of 17 days over a far oceanic region, implying large changes in the aerosol size spectrum.

Total and black Carbon mass concentration

Varaitions of the daily mean mass concentrations of total (M_T), black carbon (M_B) aerosols and the mass mixing ratios of BC ($F_{BC} = M_B / M_T$) are shown in bottom panel of Fig. 2. M_T values were very high (~40 µg m^{-3}) in the mainland (Kochi Port) and close to it, and fall off steeply towards Open Ocean to very low values (~ 13 µg m^{-3}) by April 24. Thereafter there is an increase to a very high value (~43 µg m^{-3}). The percentage of share (F_{BC}) of BC to total aerosol mass concentration showed lowest value (~1.5%) during the end of April (Fig.2). It is also important to note that F_{BC} was quite high (4.5%) on April 24 when AOD and M_T were the lowest and α the highest. This large variation (by a factor of ~3) of F_{BC} over the small study area with in a short period implies significant changes in the forcing efficiency of aerosols.

Number size distribution

Number concentration measurements were made at every 5 minute over the study region using an aerosol optical particle counter (OPC). Number densities in all sizes decrease quite rapidly as the ship moved off the coast. Parameterization of the number size distribution, its temporal variations, and the association with various aerosol properties will be presented.

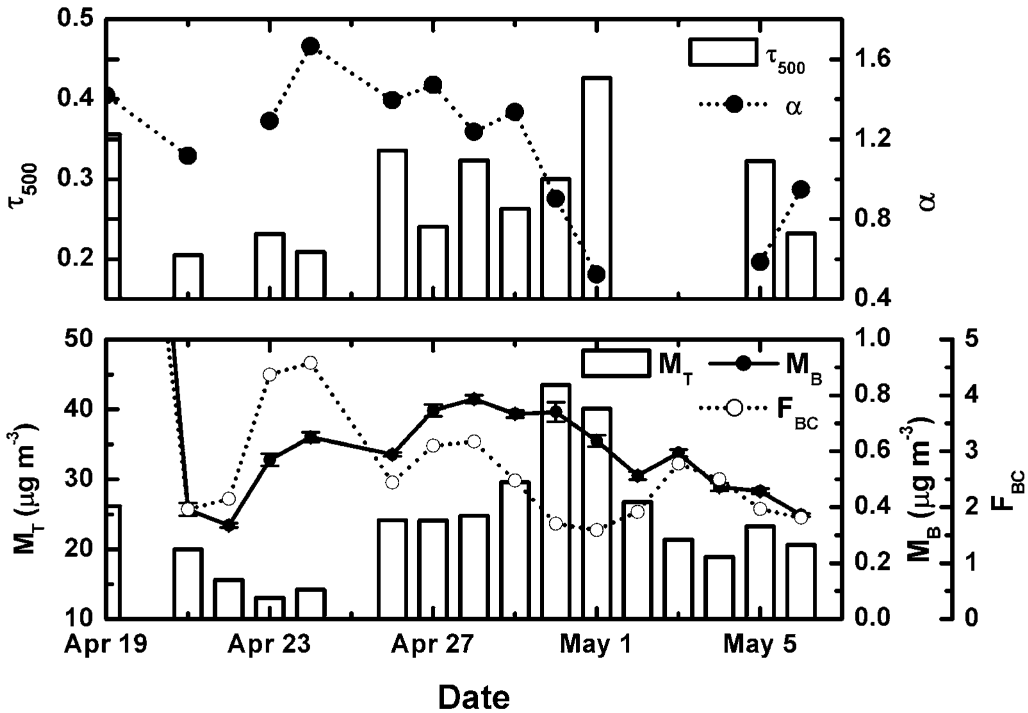

Fig. 2: Temporal variation of aerosol optical depth at 500 nm (τ_{500}) and the corresponding Angstrom exponent (top panel) and total & BC mass concentrations and BC mass mixing ratio (F_{BC}) (bottom panel) over the Arabian Sea.

Reference

1. Moorthy K. K., S. S. Babu and S. K. Satheesh, 2003, Aerosol characteristics and radiative impacts over the Arabian Sea during the intermonsoon season: Results from ARMEX field campaign, J. Atmos. Sci., 62, 192-206.