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AIRCRAFT MEASUREMENTS OF AEROSOL BLACK CARBON FROM A COASTAL LOCATION IN THE NORTH-EAST PART OF PENINSULAR INDIA DURING ICARB

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Introduction

Aerosol black carbon (BC) or soot, the byproduct of all incomplete combustion process, is mostly of anthropogenic origin. Being combustion by product, soot particles are generally in the fine, sub micron size range and are hydrophobic and as such, they have long atmospheric life times enabling easy vertical transport to higher regions of the atmosphere. Because of its strong absorption over a wide range of wavelengths, BC contributes significantly to atmospheric warming (Jacobson, 2001) and its forcing potential strongly depends on the vertical profile. In addition, presence of an elevated BC layer above the cloud results in an increased absorption due to enhanced interaction of sunlight with BC reflected back by the cloud (Satheesh. 2002). Thus the study of vertical distribution of aerosol black carbon is very important. Despite, limited information is available worldwide and especially over India except few recent efforts (Moorthy et al., 2004; Tripathi et al., 2005).

During the Integrated Campaign for Aerosol gases Radiation Budget over India (ICARB, Moorthy et al., 2006) extensive observations of several aerosol parameters such as mass concentrations of total aerosols (M_T) and BC particles (M_B), scattering coefficient and number size distributions were made onboard a propeller aircraft (beach craft 20) of the National Remote Sensing Agency (NRSA). In all 26 sorties were made from 5 bases during the campaign; two each along the east (Bhubaneswar and Chennai) and west coasts (Thiruvananthapuram and Goa) and one from the inland station Hyderabad. In this paper, we present the results obtained from the measurement of the altitude variation of BC from Bhubaneswar (BBR), in the east coast of India.

Experimental Setup

The black carbon mass concentration (M_B) measurements were made using a portable, single channel, aethalometer (model AE 42 of Magee Scientific). The instrument was mounted inside the cabin of the aircraft, which was kept unpressurised. The ambient air was aspirated through a stainless steel pipe, fitted to the body of the aircraft under its nose, such that the inlet opens into the incoming air as the aircraft flies. The inlets of the instruments were connected to the pipe using Teflon tubes, ~1.5 m long. Aethalometer estimated M_B by measuring the change in the transmittance of its quartz filter tape on to which the particles impinge. The flow rate determined by its internal pump operated under standard mass flow condition and the time base is programmable. The measured concentrations were corrected for the change in pumping speed caused by the change in the ambient pressure as the aircraft climbs to different height levels following the principle outlined in Moorthy et al (2004). The instantaneous position of the aircraft at every second was recorded using a global positioning system (GPS). The flight tracks of the sorties performed from Bhubaneswar are shown in Fig.1.

Results

The vertical profile of M_B (after the correction mentioned earlier) from the aircraft measurement made on 28th March 2006 is shown in Fig.2. This profiling was done over the ocean (Bay of Bengal), ~50 km off shore BBR. Measurements were made at eight different levels namely 500 m, 800 m, 1100 m, 1400 m, 1700 m, 2000 m, 2500 m and 3000 m above msl (mean sea level). During the same period, measurements of M_B were also made onboard the ship ORV Sagar Kanya, along the coastal water off BBR as part of the ocean segment of ICARB (Moorthy et al., 2006). The '0' level (surface) value is obtained as average of the shipboard measurements conducted in the same region. The altitude distribution of M_B showed two peaks (though small) at 800 m and 2000 m. Except for these, M_B showed a more or less a steady vertical distribution with a mean value almost same as that observed at the surface. It is important to note that even though these M_B values are not unusually high, their constancy throughout the vertical column up to 3 km will have important implications to radiative forcing. The most striking difference of the profile at BBR from those obtained earlier at Kanpur (Tripathi et al., 2005) and Hyderabad (Moorthy et al., 2004) is the steady nature, showing a thorough mixing (vertical) probably by convection. It is also to be noted that during the period of the experiment, the region around BBR was extremely warm with ambient air temperature in the range 40 to 42 °C, a condition favoring vigorous thermal convection.

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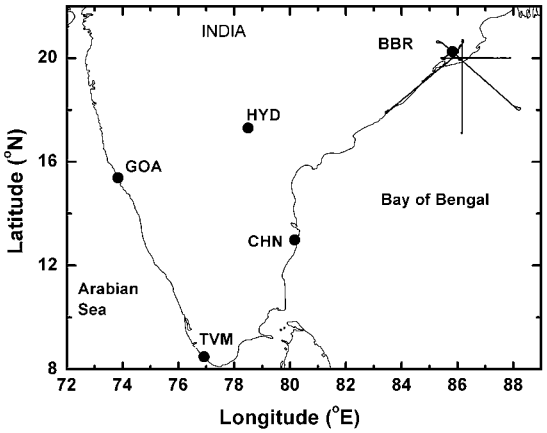

Fig.1 The flights paths of the aircraft from Bhubaneswar during 25 to 30 March 2006.

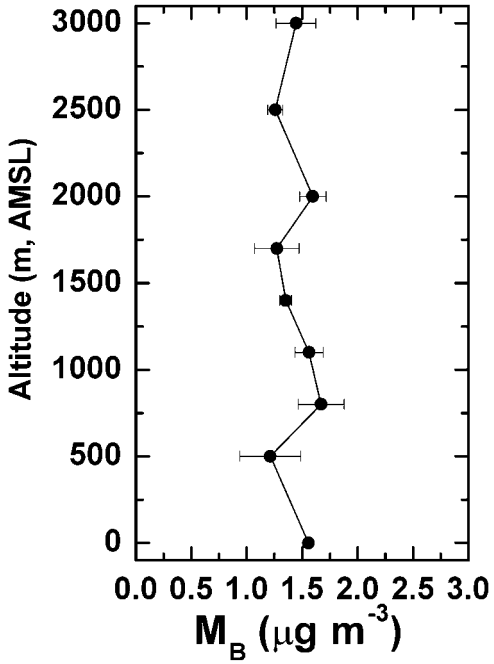

Fig.2. Altitude profile of M_B off BBR on 28th March 2006.