First Direct Evidence of Strong Absorption Associated with Coarse Mode Particles Over CTCZ Region from Aircraft Experiment 2009

A31A-0028

J. Jaidevi, Priya Choudhry, Marykutty Michael, S.N. Tripathi*, Tarun Gupta
Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, India.
*E-mail: snt@iik.ac.in

Introduction

- Continental Tropical Convergence Zone (CTCZ) is characterised by intense convergence associated with the large scale rainfall over Indian region during monsoon season.
- There is a need for prediction of changes in the rainfall intensity and pattern over the CTCZ region. This in turn depends to some extent on vertical and spatial variation of aerosol size, shape and chemical composition that determines their DRF.
- Measurements using an aircraft platform were carried out over the CTCZ region up to 8 km during monsoon (Jun-Jul) 2009 to study the vertical and spatial variation of aerosol optical, microphysical, chemical, hygroscopic and morphological properties. The results for the same are discussed here.

Objectives

- To identify the association of absorption with aerosol size distribution of the CTCZ using aircraft based measurements.
- To compare the commonly available AERONET retrieved size distribution with the *in-situ* measured size distribution

Study area

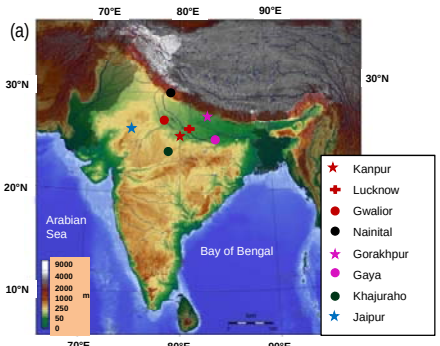

Fig. 1 (a) Map of India showing the regions covered during the study, (b) aircraft with team and (c) Isokinetic inlet probe.

Instrumentation

Table 1: List of instruments onboard the aircraft with their frequency of sampling

Instrument	Parameter	Sampling Frequency
Aethalometer	BC mass concentration at 7 wavelengths (370-950 nm)	2 min
Photo Acoustic Soot Spectrometer	Absorption and scattering coefficient (wavelength -781 nm)	1 s
Aerodynamic Particle Sizer (APS)	Particle size distribution (0.3- 20 µm)	20 s
Scanning Mobility Particle Sizer (SMPS)	Particle size distribution (16.8-569 nm)	1.5 min
PM_1 and $PM_{2.5}$ samplers	PM mass concentration, chemical composition, shape	One each sortie

SSA binned size distribution

- Merged size distribution data obtained from SMPS and APS from the individual flights are grouped into the western (75°-78°E), central (78°-81°E) and eastern (81°-84°E) parts of the IGB.
- Merged size distribution was binned for SSA (<0.7, 0.7-0.8, 0.8-0.9, 0.9-1.0) and altitude (0-2, 2-4 and >4 km) has been plotted to illustrate the absorption patterns with varying height as well as zone.
- Western zone shows that absorbing aerosols in coarse mode with SSA~0.8-0.9 are dominant between 2-4 km. A third mode is present above 4 km similar to eastern zone. But in altitude below 2 km and above 4 km, the aerosols in all size ranges are predominantly scattering type.
- In central zone, coarse mode absorbing aerosols dominate below 2 km, whereas 2-4 km altitude has an overlap of absorbing and scattering type aerosol in coarse mode and above 4 km, aerosol are majorly scattering type.
- In eastern zone, clear dominance of coarse mode absorbing aerosols up to 4 km can be seen. A third mode is also present, which can be explained by high RH in the zone.

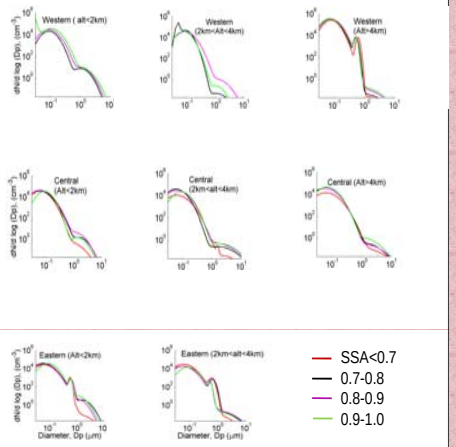

Fig 2 SSA binned size distribution over western (75-78 °E), central (78-81 °E)and eastern (81-84 °E) zone

SEM/EDAX analysis

- Carbon fractals were seen deposited on dust particles in $PM_{2.5}$ ground filter on July 2 over Kanpur in central zone (Figure 3a) which is the possible reason for the increased absorption in the coarse mode particles, as observed in the size distribution plots.
- At higher altitudes, over same place and time, the fractal structure is no longer seen, instead a more compact structure is seen in the $PM_{2.5}$ particles reflecting their ageing.
- The EDX results shown are based on 2 to 8 spots per particle. The EDX of blank PTFE filter gives 7 to 17% C and 83 to 93% F and quartz filter has about 68% O and 32% Si in the background.
- The EDX results show the presence of Fe in the aircraft filter particles indicating presence of mineral dust at higher altitudes.
- Al, which is indicative of soil dust, is present in both ground as well as aircraft filter particles, thus showing lifting of soil dust to higher altitudes.

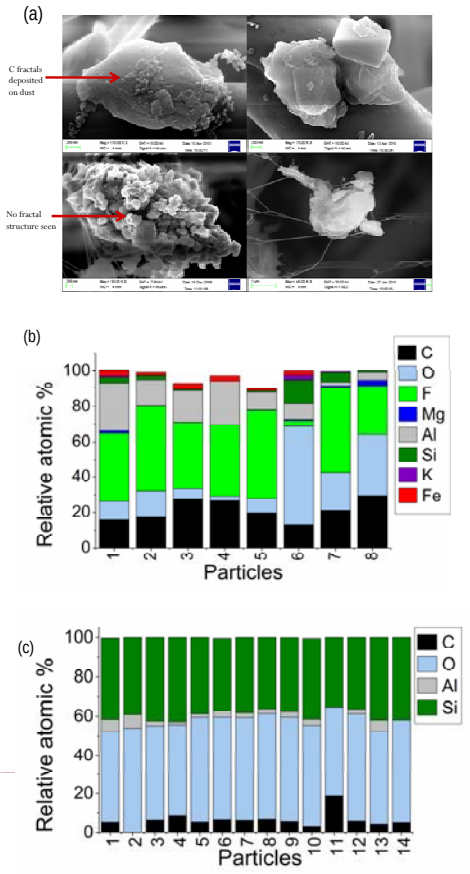

Fig 3.SEM images for $PM_{2.5}$ ground (upper panel) and $PM_{2.5}$ aircraft (lower panel) filter (b) EDX for aircraft filter (PTFE) (c) EDX for ground filter (Quartz) over Kanpur. PTFE filter has 7 to 17% C & 83 to 93% F. Quartz filter has about 68% O & 32% Si.

Comparison with AERONET

- The observed layer-wise number distribution was converted to the columnar volume distribution as obtained from AERONET. This has been done by first converting the number distribution to volume distribution for 1 km thick aerosol layer, and then taking AOD weighted sum of in-situ volume distribution (Osborne et al., 2008). The data was then normalized.
- Comparison of aircraft data with the AERONET size distribution shows a good agreement with respect to peak concentration.
- For both Kanpur as well as Gorakhpur sortie the peak concentration differs in case of fine fraction, but agrees very well for the coarse fraction.
- In both the comparison a shift in modes is seen, where AERONET has a higher mode radii for fine as well as for coarse mode.

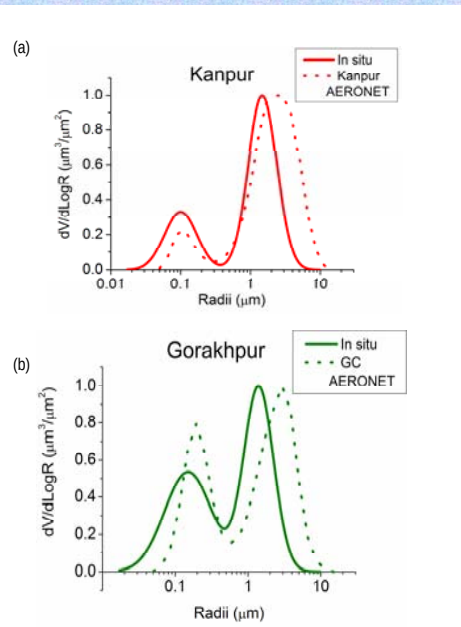

Fig. 4 Comparison of in situ and aircraft data with AERONET data for sites (a) Kanpur and (b) Gandhi College (GC).

Summary

- Strong absorption (SSA as low as 0.7) associated with the coarse mode particles (diameter >1 µm) at higher altitudes were confirmed by the SSA binned size distribution and SEM/EDAX analysis of dust particles collected on backup filter of a $PM_{2.5}$ sampler over western and central zone of CTCZ.
- Comparison of size distribution from ground based remote sensing instrument (AERONET) and *in-situ* observed distribution shows a close match.

Acknowledgement

We are thankful to the DST ICRP and ISRO GBP programme for the financial support. We are grateful to entire NRSC aircraft crew for their cooperation during this experiment.

Reference

Osborne, S. R., B. T. Johnson, J. M. Haywood, A. J. Baran, M. A. J. Harrison, and C. L. McConnell (2008), Physical and optical properties of mineral dust aerosol during the Dust and Biomass-burning Experiment, J. Geophys. Res., 113, D00C03,doi:10.1029/2007JD009551.