Thick absorbing aerosol layer observed in the monsoon season over India

S. N. Tripathi1, Sagnik Dey1, J. Jaidevi1, B. N. Singh1, Marykutty Michael1 and Tarun Gupta1

1Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, 208016, India
2Centre for Atmospheric Sciences, Indian Institute of Technology Delhi, New Delhi, 110016, India
Email*: snt@iitk.ac.in

Abstract

The link between absorbing aerosols and South Asian monsoon climate remains debated and unexplained partly due to the paucity of observations during monsoon season. Here we present the first detailed aerosol measurement of 3-D distributions of aerosol properties during the early monsoon season of the year 2009 across the Indo-Gangetic Basin (IGB), where the monsoon rainfall depth is largest within South Asia. Highly polluted (teal variability) aerosol layers over the Indo-Gangetic Basin (IGB) were observed from a gradient wind rose (E-W) to south (SSW), while the size distribution shows a complex 3-D pattern.

Introduction

Understanding the link of aerosols on hydroclimates is a key factor in quantifying the atmospheric response of the climate system (Hansen et al., 2003). In recent decades, aerosols in the Indian region have experienced monsoon season (2000-2009) mean AOD

distributions of aerosol properties during the early monsoon season of the year 2009 across the Indo-Gangetic Basin (IGB) were observed from a gradient wind rose (E-W) to south (SSW), while the size distribution shows a complex 3-D pattern.

Vertical Distribution of Aerosol Properties

Vertical Distribution of Aerosol Properties

- Fig. 1: Spatial distributions of single scattering albedo (SSA) (%) and change in the monsoon season of the year 2009 compared to 10 years. The measurements of 3-D distribution of aerosol properties reduced the uncertainty in estimates of climate models incorporating this 3-D distribution of aerosol heating.

Aircraft Experiment

The west (high) to east (low) gradient shows a very close agreement between modeled and measured SSA and extinction coefficient regarding their values in the western part of the IGB. However, the relative role of semi-direct effect due to high aerosol absorption and direct radiative effect in providing first direct evidence of coarse mode absorption.

Model vs Measurement

The modeled extinction coefficient and SSA from SINDOE were compared with the measured ones. The aerosol forcing over the western, central and eastern IGB are comparable (-6.8 ± 0.9 W m-2) IGB, and are comparable to the aerosol forcing over the western IGB, thus indicating the persistence of high aerosol heating in the monsoon season when aerosols are expected to be washed out.

Fig. 2: Aircraft Experiment Results: (a) AOD and SSA from SINDOE vs. observations during the early monsoon season of the year 2009. The vertical and horizontal bars through each point are ±1 standard deviation.

Results

- The west (high) to east (low) gradient diminishes with increasing altitude, while the SSA gradient enhances.

Conclusion

- The measurements of 3-D distribution of aerosol properties reduced the uncertainty in estimates of climate models incorporating this 3-D distribution of aerosol heating.

Acknowledgements

We thank IARC, IITK, DST, ICRP, IFCPAR, and ISRO for providing the MISR data. Multiangle Imaging Spectroradiometer (MISR) was used for measuring the aerosol size distribution in the range 0.03-0.3 μm.

References