G-P-7

GENERATION, TRANSPORT AND DISTRIBUTION FEATURES OF AEROSOLS OVER BAY OF BENGAL DURING ICARB

Marina Aloysius, Mannil Mohan*, K. Parameswaran and K. Krishnamoorthy

SPL, VSSC
(* *Corresponding author*, email: mannil_mohan@vssc.gov.in)

1. Introduction

Spatial and temporal variations of aerosols are strongly influenced by locations and strengths of aerosol production sources as well as the circulation features of the atmosphere. The limited coverage of surface observations over land and oceans in particular, is inadequate for a proper investigation into the synoptic scale dynamics of aerosols. Lack of regularly updated global information on aerosol distribution and their radiative properties is one of the major causes of uncertainties in numerical climate prediction models (Hansen and Lacis, 1990; IPCC, 2001). Space-borne remote sensing of recent times, with the capability of global coverage every few days, has started a new era in aerosol studies. The currently orbiting sensor MODIS (Moderate Resolution Imaging spectroradiometer) onboard the twin satellite platforms Aqua and Terra has the ability to monitor aerosol distribution over both land and ocean on a daily basis.

Surrounded by landmasses on three sides, the properties of aerosols over the Bay of Bengal (BoB) are controlled by the anthropogenic as well as natural influences from land and oceans with strong seasonal variations (Satheesh, et. al, 2006). ICARB (Integrated Campaign for Aerosols, gases and Radiation Budget) was a campaign conducted during March 18 to May 11, 2006 to characterise the spatial and temporal distribution of aerosols and trace gases over the Indian subcontinent and adjoining oceanic regions using observations carried out from the main land, islands, moving ships and aircrafts.

In this work, MODIS derived data on aerosol parameters, NCEP (National Centre for Environmental Prediction) reanalysis wind fields and QuikSCAT ocean surface winds were made use of to investigate the generation and distribution of aerosols over the BoB (Study domain: 10°N-21°N, 80°E-95°E) in response to the prevailing meteorological conditions during the first leg of ICARB (March18-to April 12, 2006) when the ship observations were mainly concentrated in this region.

2. Methodology

A detailed examination of MODIS Level-3 aerosol optical depth (AOD) data over the study domain at 1°x1° resolution showed that the day to day variations in AOD were affected by ocean surface winds (provided by QuikSCAT) and the strength of circulation variables (computed from NCEP reanalysis winds) at different altitudes. So a quantitative analysis was first carried out to look for relationships between AOD and ocean surface wind speed, wind convergence and vorticity at different atmospheric levels.

In order to identify sources of aerosol generation, AOD data from MODIS and winds from NCEP were incorporated into an aerosol flux continuity equation

$$\frac{\partial \tau}{\partial t} + \frac{\partial}{\partial x}(\tau u) + \frac{\partial}{\partial y}(\tau v) = s(x, y, t) \qquad (1)$$

where τ is AOD, u and v are the zonal and meridional winds and s is the net source which includes production through natural and anthropogenic processes and loss through dry deposition, impaction, wet removal, coagulation, turbulent diffusion, etc.

Results

Comparison between spectral AOD and ocean surface wind speeds revealed an exponential relationship of the form (Fig.1)

$$\tau_\lambda = \tau_{\lambda 0}\, exp(b_\lambda U) \qquad (2)$$

where τ_λ is AOD at wave length λ, U is wind speed, $\tau_{\lambda 0}$ is the AOD at zero wind speed and b_λ is the 'wind index'. The value of b_λ increased from 0.09 to 0.15 with the increase of λ from 470 nm to 1600 nm.

Daily AOD distribution over the study domain particularly, in the northwestern parts, was found strongly modulated by advection from the central and northern parts of Indian landmass towards BoB and also by the atmospheric subsidence associated with the wind vorticity.

An isolated patch (size ~ 3°x3°) of high AOD values (>0.45) observed in MODIS observations over the north western BoB [circled region in Fig.2 (a)] during March 19-24, agreed closely with the detached high in AOD captured by the ship measurements. The position of this detached high also nearly coincided with the maximum of wind vorticity over this region [circled region in Fig. 2 (b)], indicating the possibility of strong confinement of aerosols by the vertical downdraft.

Analysis with the aerosol flux equation showed that the aerosol generation over the study domain was mainly governed by ocean surface wind field with the sources located near the regions of high wind speed.

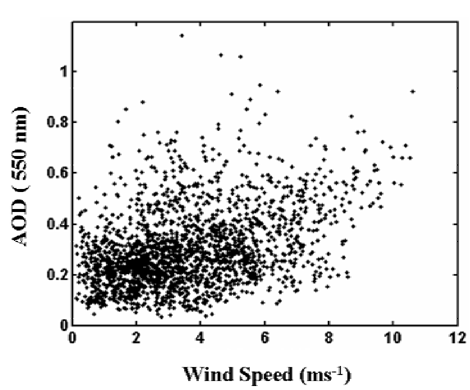

Fig.1. Relation between AOD (550 nm) and QuikSCAT wind speed (10 m level)

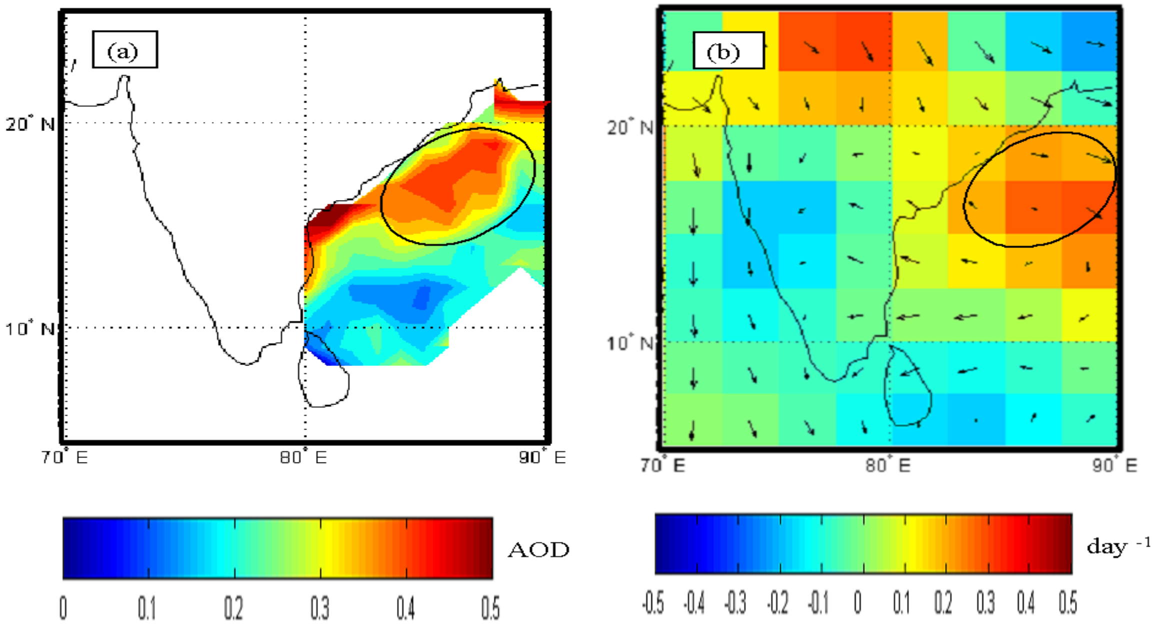

Fig.2 Spatial distribution of MODIS measured AOD over Bay of Bengal (a), and negative NCEP wind vorticity at 925 mb (b) for the period March 19-24, 2006

References

1. Hansen, J.E., and Lacis, A.A., Sun and dust versus greenhouse gases: An assessment of their roles in global climate, Nature, 346, 713 – 719, 1990.
2. Intergovermental Panel on Climate Change (IPCC): Climate Change 2001 – The Scientific Basis, Cambrigde Univ. Press, Cambridge, 2001.
3. Satheesh, S.K., Srinivasan, J., and K.K.Moorthy., Spatial and temporal heterogeneity in aerosol properties and radiative forcing over Bay of Bengal and role of aerosol transport, J. Geophys. Res, 111, D08202, 2006.