G-P-6

INTER-ANNUAL VARIABILITY OF AEROSOLS IN THE INDIAN REGION DURING 1996-1999 USING GENERAL CIRCULATION MODELING AND POTENTIAL SOURCE CONTRIBUTION FUNCTION

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Several cruise campaigns were conducted over the Indian Ocean to assess the climatic effects of anthropogenic aerosols transported from the land areas to the surrounding oceans during the winter season [*Ramachandran and Jayaraman*, 2002; *Ramachandran*, 2004]. Large inter-annual variability in aerosol loading over the Arabian Sea and Indian Ocean have been observed during 1996-1999 along with a significant latitudinal gradient in fine mode particles [*Ramachandran and Jayaraman*, 2002; *Ramachandran*, 2004]. In this study our aim is to examine the inter-annual variability in the aerosol characteristics by combining these observations with aerosol species surface concentrations obtained from a general circulation model (of the Laboratoire de Meteorologie Dynamique (LMD-ZT)) and analysis of source locations using trajectory modeling (Potential Source Contribution Function (PSCF)).

Modeling Methods

The aerosol species mass concentration is simulated in the LMD-ZT GCM for the cruise periods during 1996-1999. The model estimates sulfate, fly ash, organic matter, black carbon, dust in two size bins; sub-micron and super-micron, and sea salt in 10 size bins between 0.03 and 20 μm radii [e.g., R*eddy et al*., 2004]. The model outputs are sampled along the cruise track to construct daily-mean surface aerosol chemical species concentrations matching the location and time periods of the cruise measurements.

The potential source contribution function (Pij) estimates the conditional probability function which describes the spatial distribution of probable source locations that contributed pollutants measured during a given time period and is given by

$$\mathbf{P_{ij} = m_{ij}/n_{ij}}$$

where $\boldsymbol{m}_{ij}$ is the number of end points in the cell (i,j) that are associated with pollutant concentration exceeding a criterion value (typically its median), $\mathbf{n}_{ij}$ is the total number of trajectory endpoint falls in the cell (i,j). Seven day air mass back-trajectories were computed for different heights (10, 100, 500, 1000, 2500 and 5000 m above ground level) on each cruise day. The total probability of pollutants transfer from multiple heights is calculated from the conditional probabilities associated with each height (*Cheng et al.*, 1993).

Preliminary Results:

Comparison is made of inter-annual variation of model predicted chemical composition with QCM measured aerosol mass concentrations over the Indian Ocean. For evaluating the latitudinal variation of each species, the measured and model simulated mass concentrations are further grouped into three latitude bands namely 10^o S – 0^o, 0^o-10^o N and 10^o N - 20^o N (Figure 1). The model captured the south to north gradient in the fine mode mass concentration in 1996-97. It underestimated the measured fine mode concentrations in 10^oS – 0^o and 0^o-10^o N latitudinal bands during 1998 and 1999.

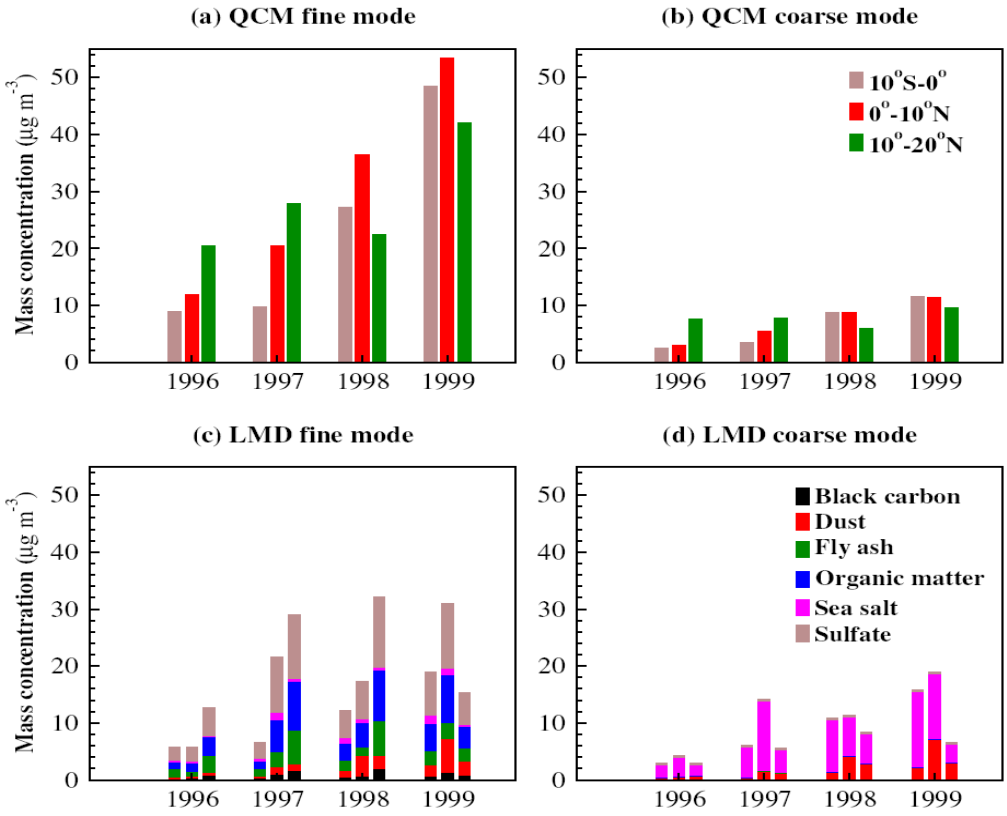

Figure 1: Comparison of model estimated aerosol species mass concentrations with measured values in fine and coarse modes during the INDOEX period of 1996 to 1999 in different latitude bands.

The PSCF surface transport (10-1000 m arrival height) for black carbon in the 0^o-10^o N latitude region indicates the inter-annual variability in aerosol source location during the winter season from 1996 to 1999 (Figure 2). Probable source areas were in the Indo-Gangetic plain (IGP), with transport pathway over the Bay of Bengal in all years except 1998. The paper will contrast variability in natural and anthropogenic aerosols and combine this analysis with emissions inventory information for an explanation of probable sources.

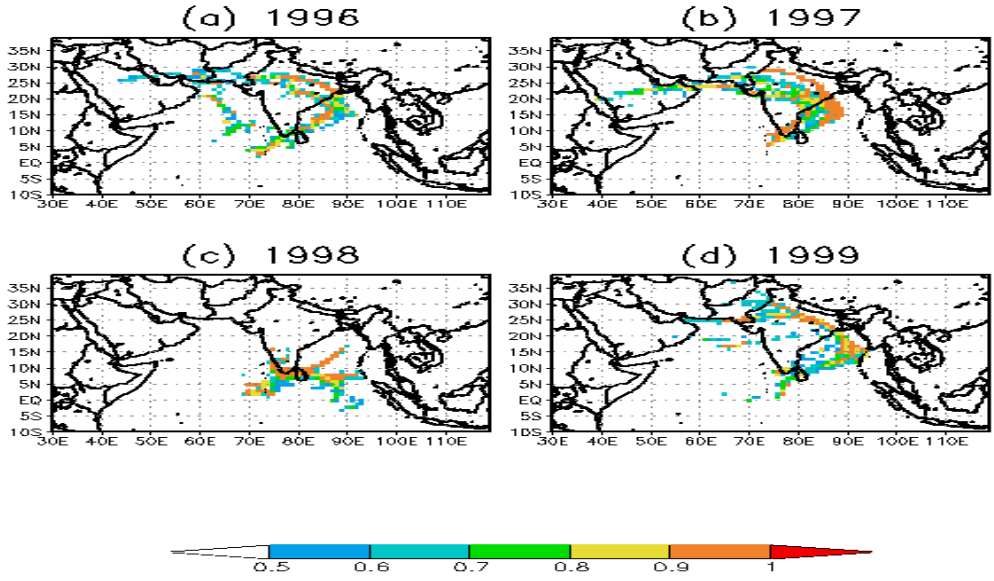

Figure 2. Composite PSCF plots for black carbon surface transport in the 0^{o}-10^{o} N latitude region.

References

1. Cheng, M.D., P.K. Hopke and Y. Zeng (1993), A receptor-oriented methodology for determining source regions of particulate sulfate observed at Dorset, Ontario,
2. *J. Geophys. Res*., **98**, 16839–16849.
3. Ramachandran, S., and A. Jayaraman (2002), Premonsoon aerosol mass loadings
4. and size distributions over the Arabian Sea and the tropical Indian Ocean,
5. *J. Geophys. Res*., **107** (D 24), 4738, doi: 10.1029/2002JD002386.
6. Ramachandran, S. (2004), Spectral aerosol optical characteristics during the northeast monsoon over the Arabian Sea and the tropical Indian Ocean: 1. Aerosol optical depths and their variabilities, *J. Geophys. Res*., **109,** D 19207,
7. doi: 10.1029/2003JD004476.
8. Reddy M. S., O. Boucher (2004), A study of the global cycle of carbonaceous aerosols in the LMDZT general circulation model, *J. Geophys. Res*., **109**, D14202, doi:10.1029/2003JD004048.