G-P-8

SOME RESULTS OF SUMMER AEROSOL CHARACTERIZATION EXPERIMENTS OVER MAITRI AND LARSEMANN HILL IN ANTARCTICA

S.M. Sonbawne, P.C.S. Devara and S.K. Saha

Indian Institute of Tropical Meteorology, Pune 411 008, India
e-mail: devara@tropmet.res.in

1. Introduction

Antarctic is the remote polar region characterized by the highest surface albedo and one of the less illuminated by solar radiation for a major time period during the year. In this region, while the total mass of the aerosol particles suspended in the vertical atmospheric column of unit cross section yields smaller values, the lower aerosol optical depth at all the visible and near-infrared wavelengths is of great concern for Earth's radiation budget studies. The attenuation of solar irradiance and the processes of scattering and absorption by the aerosol particles may cause appreciable effects on the radiative exchange mechanisms occurring in the Antarctic atmosphere. Hence the aerosol properties and their effects on weather and climate of this region are certainly different from other continental areas.

Numerous studies that have been performed during the Indian Ocean Experiment (INDOEX, India) and also nationwide, multi-Institutional experiments, namely, BoBMEX, ARMEX (Phases I & II) and Land Campaign using Road Network have provided valuable information on land/continental and maritime/ocean aerosols and their interface through long range transport and mixing processes. In order to study the climatic and health effects of aerosols, limited field campaign programs have been conducted over the Antarctic region (Ramachandran et al., 1995; Jain et al., 2004; Gadhavi and Jayaraman, 2003). Studies have also been carried out to understand the effect of aerosols and cloud scattering phenomenon on UV-B radiation and thereby ozone concentration (Hanjura and Singh, 1995) and wave dynamics of Antarctica ozone content variations (Pasricha, 1994). Studies have been carried out also during the 24th Indian Antarctica Expedition (IAE) and some interesting results with regard to the estimation of aerosol radiative properties over Maitri have been reported (Devara and Sonbawne, 2006). Therefore, field measurements of aerosols and pre-cursor gases over this important region under different meteorological situations are highly essential for determining the local radiation budget and hence to define with good accuracy the role played by Antarctica and neighboring regions in the energy balance of our Planet. With this view, observations have been carried out of aerosols, pre-cursor gases and SW radiation flux using Microtops II and short-wave pyranometer at Maitri and Larsemann Hill during the period of 26th IAE. Some interesting results obtained during the period of this expedition are presented and discussed in this paper.

2. About Experimental Station

The Indian Antarctica Station, "Maitri", is located in the Schrimacher Oasis in the Dronning Maud Land, East Antarctica (117 m MSL). The nearest steep cliff of the east-west trending glacier on the southern side of the station is more than 700 m away from the station and is 300 m in height. The snow covered surface during summer season was more than 0.5 km away

from the station. The instruments were installed on barren land near the station. The surface of the station area is mainly covered by sandy and loamy sand types of soil. Antarctica has a desert like climate with clear skies, very low atmospheric aerosol content. In summer, the prevailing winds are light, following nearly constant direction, and are relatively free from turbulent and convective motions. The cloud cover over the station occurs mainly under the influence of sub-polar low-pressure systems and shows an alternating sequence of clear-sky changing over to the overcast and the again clearing as the system moves away.

3. Methodology

The instruments that have been deployed for the present study include hand-held solar radiometer and a broad-band pyranometer. The radiometer (Microtops II) provides integrated AOD (extinction) at six wavelength covering form UV to NIR and Ozonometer determine total column ozone (at UV wavelengths) and perceptible water content (at NIR band) simultaneously. The pyranometer yields down-welling radiative flux, which has been used to estimate aerosol direct radiative forcing employing SBDART model. Figure 1 depicts photograph of the above

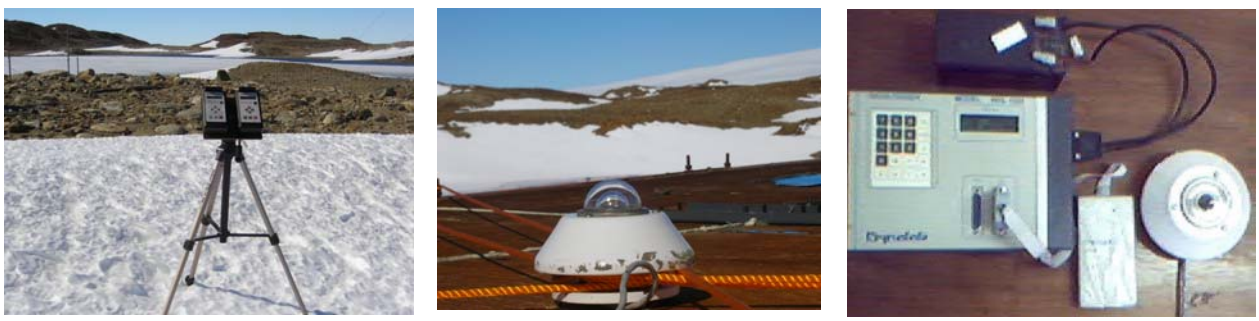

Figure 1: Sun photometer, ozonometer and global short-wave pyranometer with data acquisition systems in operation at Maitri and Larsemann Hill in Antarctica during 26th IAE

instruments during their operation at Antarctica. The details on data acquisition and analysis procedures can be found in the literature (Devara et al., 2001; Pandithurai et al., 2004).

3. Results and Discussion

(a) Day-to-day variations in spectral distribution of AOD

The day-to-day variations in AOD at different wavelengths are shown plotted in Figure 2. The optical depths are very low as expected and they are almost consistent with the earlier observations (Gadhavi and Jayaraman, 2003), and the corresponding aerosol direct radiative forcing values are also noticed to be small. The most interesting feature that was observed during the 26th IAE is that the AOD at 870 nm, as compared to other wavelengths, showed highest values from December 2006 till mid-January 2007 with a broad peak during December -January transition period. This could be due to the dimethylsulphide (DMS), which is a trace sulphur gas found in most atmospheric, surface water samples and terrestrial plant species. It is derived from dimethylsulphonioproprionate (DMSP). It is known that small fraction of DMS that is emitted to the atmosphere causes potential impact on climate through

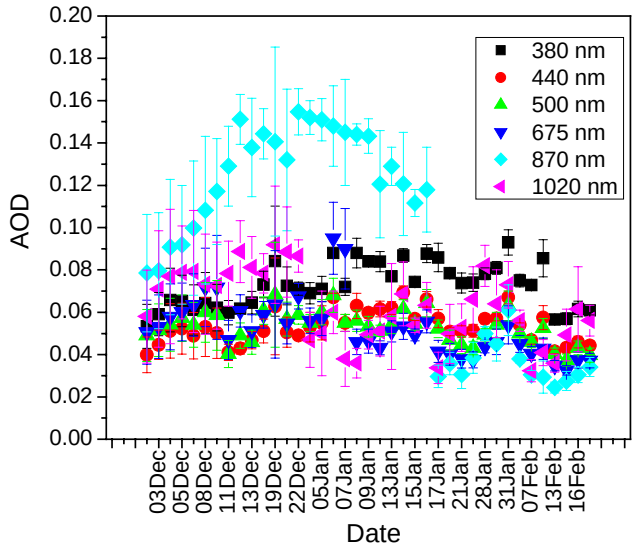

Figure 2: Day-to-day variations in AOD in the Antarctic region during 26th IAE

indirect aerosol effect. Moreover, these DMS emissions are thought to be major precursors of cloud condensation nuclei (Buckley and Mudge, 2004). From January 17 onwards, AOD at this wavelength behaved normal as per the light scattering theory. However, these aspects need further study.

(b) Daily variation in total column ozone and water vapor

Figure 3 (a and b) illustrates day-to-day variations in column-integrated ozone and precipitable water content observed in the Antarctic region during the study period. One

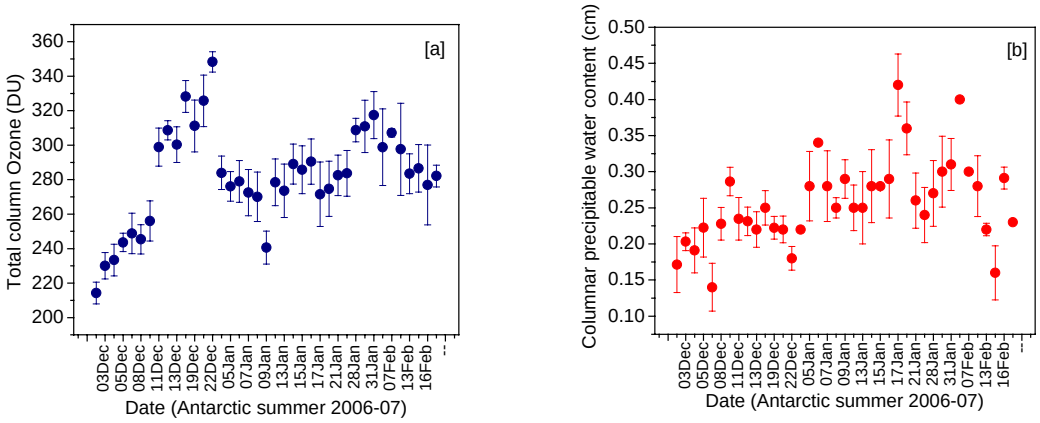

Figure 3: Day-to-day variations in total column ozone (a) and water vapor (b) observed in the Antarctica region during the 26th IAE. The vertical bars at each data point denote standard deviation in the measurement.

common feature in these variations is that ozone showed well defined peaks, one around 22 December and the other around 31 January. The variations in water vapor also appear to exhibit

two peaks around the same period as that of ozone, but they are not that clear as they are seen in ozone variations. In both parameters, the first maximum is seen in the December-January transition and the other one in the January-February transition period.

4. Conclusions

The preliminary results of the aerosol optical, microphysical and radiation observations carried out at Maitri and Larsemann Hill have shown smaller aerosol optical depths, with an interesting variation in AOD at 870 nm wavelength which is considered to be due to abundance of DMS emissions. The daily mean total column ozone and precipitable water content exhibits almost similar variations with distinct behavior during the transition period. Further analysis of observations in conjunction with concurrent satellite and meteorological data is in progress. In addition, back-trajectory wind field analysis is being carried for the days of observations to locate the sources and study the long-range transport of air mass.

References

1. Buckley, F.S.E., and S.M. Mudge, 2004: Dimethyl sulphide and ocean-atmosphere interactions. *Chemistry and Ecology*, **20**, 73-95.
2. Devara, P.C.S., R.S. Maheskumar, P.E. Raj, K.K. Dani and S.M. Sonbawne, 2001: Some features of aerosol optical depth, ozone and precipitable water content observed over land during the INDOEX-IFP99, *Meteorologische Zeirschrift*, **10**, 901-908.
3. Devara, P.C.S., and S.M. Sonbawne, 2006: Characterization of aerosols and gases over Maitri during 24th Indian Antarctica Expedition. *Proc. SCAR Open Science Conference*, Hobert, Australia, 12-14, July 2006.
4. Gadhavi. H. and Jayaraman, A., 2003: Aerosol characteristics and aerosol radiative forcing over Maitri-Antactica, *Current Science*. **80**, 296-304.
5. Hanjura, A.K. and Singh, R., 1995: UV-B radiation intensity measurements at Antarctica, **26A**, Issue 1, 17-34 pp.
6. Jain, S.L., B.C. Arya, S. Ghude, A. Kumar and P.C. Pandey, 2004: Measurement of greenhouse gases and ozone at Maitri, Antarctica, *Proc. XXVIII SCAR Open Science Conference*, Brochure 2004.
7. Maheskumar, R.S., P.C.S. Devara, P.E. Raj, Y. Jaya Rao, G. Pandithurai, K.K. Dani, S.K. Saha, S.M. Sonbawne and Y.K. Tiwari, 2001: Aerosol measurements using lidar and radiometers during INDOEX field phases, *IITM Research Report*, No. **RR-90**, pp. 1-35.
8. Pandithurai, G., R.T. Pinker, T. Takamura and P.C.S. Devara, 2004: Aerosol radiative forcing over a tropical urban station in India. *Geophys. Res. Lett*., **32**, L12107, doi:10.1029/2004GL019702.
9. Pasricha, P.K., 1994: Comparative study of the variability in the observed ozone and that obtained from a statistical model of catalytic destruction over Antarctica, *Scientific Report*, 9th Indian Expedition to Antarctica, Tech. Publication **No. 6**, New Delhi, DOD, pp.57-64.
10. Ramachandran, T.V. and M.C. Balani, 1995: Report on the participation by the Bhabha Atomic Research Centre in the Tenth Indian Expedition to Antarctica, *Technical Publication*, **No.8**, pp. 159-180.