National Remote Sensing Centre

Indian Space Research Organisation, Government of India, Hyderabad.

Science Story

Atmospheric aerosol optical properties and trends over Antarctica using in-situ measurements and MERRA-2 aerosol products

Aerosols are very important to the climate and are a more influential player in climate extremes than greenhouse gases. The impact of aerosols on the Earth's radiation budget depends on their properties and distribution in the atmosphere and the nature of the underlying surface. Radiative effects of aerosols, especially of absorbing type aerosols such as black carbon (BC), are more intense when they reside over high albedo surfaces, as they get more radiation to interact with. Being a potential climate-forcing agent, atmospheric aerosols have been the focus of the global scientific community. The dramatic increase in human activities in recent years necessitates continuous monitoring of aerosol abundance over different regions of the globe. Being isolated from middle latitudes and tropical continental regions, Antarctica provides a near-pristine environment for background measurements of atmospheric constituents, including aerosols. Hence, continuous monitoring of aerosol characteristics over Antarctica provides a unique opportunity to understand the anthropogenic impact on the Earth's climate. As part of the 36th ISEA, columnar and surface level aerosol properties were measured from the Indian Antarctic stations, Bharati and Maitri. While columnar AOD measurements were carried out at both stations, surface-level atmospheric BC measurements were done at the former station.

Columnar aerosol loading is found to be higher at Bharati (0.101±0.01) compared to that at Maitri (0.047±0.003). Surface level atmospheric BC concentration is observed to be 24±16.5 ngm^{-3} at Bharati. Comparison of this AOD and BC with previously reported values over the same region indicates an increasing trend in BC concentration over Antarctic environments. Long-term (1997-2017) trends in MERRA-2 AOD and Surface BC show an increasing trend with 0.005 (0.007) per year and 0.3 (0.27) ngm^{-3} per year over Bharati (Maitri), respectively. This can have a significant impact on the regional and global climate. The absorption angstrom exponent is close to unity, indicating that fossil fuel emission is the primary source of BC aerosols over this region. Air mass back trajectory analysis during the study period indicates that the air masses originate from

the Antarctic continent, coastal and southern ocean region with no long-range transport from other continents located in the southern hemisphere.

Links for accessing article

https://authors.elsevier.com/a/1i2sy6g5o7S3nW (free access until 27th December 2023)

https://www.sciencedirect.com/science/article/pii/S1873965223001184

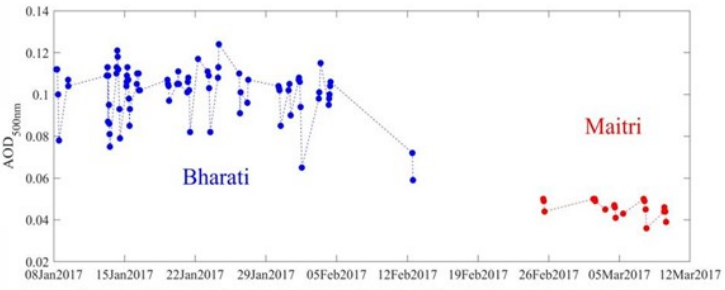

Fig.1. Time series of columnar aerosol optical depth (AOD) at 500nm at the Indian Antarctic stations Bharati and Maitri.

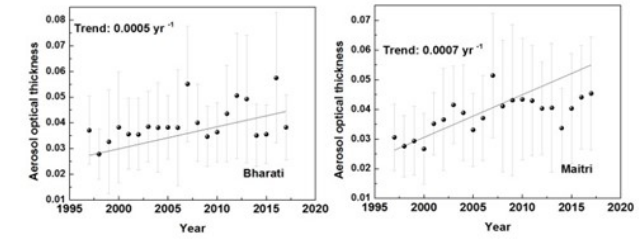

Fig.2. Long-term trend (1997-2017) in Mean AOD (550 nm) during the January month using MERRA-2 data.

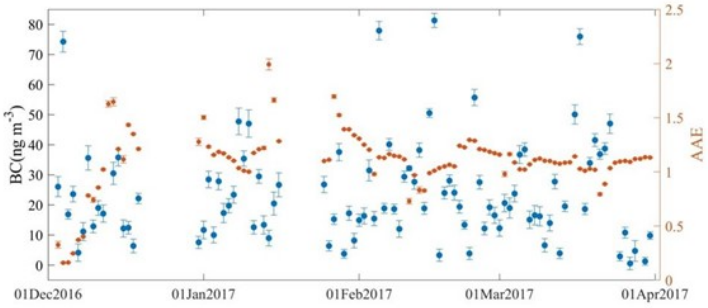

Fig.3. Time series of daily mean surface level atmospheric BC concentration (blue) and absorption angstrom exponent (AAE) (red) at Bharati

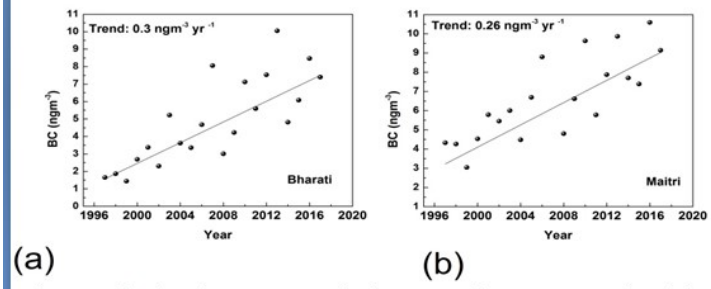

Fig.4. Surface level BC concentration in January from MERRA2 simulations over (a) Bharati and (b) Maitri.

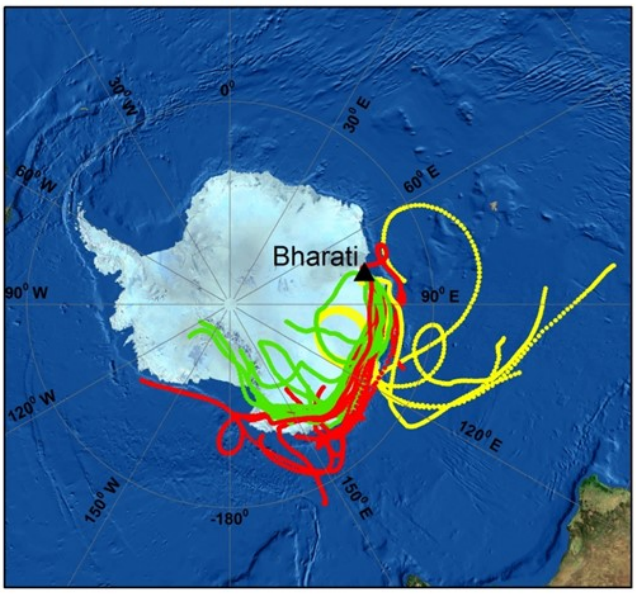

Fig.5. The air mass back trajectories arriving at Bharati at 500 m a.m.sl during January 2017.