Spatio-temporal records of snow and ice composition within the coastal East Antarctica: environmental and climatic implications

M. Thamban[1], C.M. Laluraj[1], S.S. Naik[1], W. D'Souza[1], R. Antony[1], R. Ravindra[1] and A. Chaturvedi[2]

[1]National Centre for Antarctic and Ocean Research
Ministry of Earth Sciences, Government of India
Headland Sada, Vasco-da-Gama
Goa – 403004 INDIA.
[2]Geological Survey of India (Antarctica Division)
NH-5P, N.I.T., Faridabad – 121001 INDIA.

Surface snow and shallow ice cores from the Ingrid Christensen Coast (ICC) and the coastal Dronning Maud Land (DML) region respectively, were studied for their major ionic, trace metal, stable isotope and micro-particle composition to assess the spatial and temporal variations in the environmental variability in the coastal region of East Antarctica.

Glacio-chemical profiles of an ice core from a coastal site of the central DML revealed the variability in sea-spray and volcanic aerosol components to the site during past ~500 years. SEM-EDS studies revealed that the micro-particles accreted in the ice during the Agung (1963) and Karkatau (1883) eruptions harboured microbial cells (both coocoid and rods), suggesting that these ash particles may provide a significant micro-niche for microbes and nanobes in the Antarctic ice. The nitrate profile of this core closely follow the South Pole ^{10}Be record at least during the past 200 years, suggesting that small changes in solar activity may indeed influence the environmental changes over Antarctica. Highly resolved proxy records of $\delta^{18}O$ and δD in another high-accumulation core revealed the intrinsic correlation between the summer $\delta^{18}O$ record, annual mean surface air temperatures in the region and the combined ENSO-AAO index. Snow accumulation at the site illustrates a significant decreasing trend for the past two decades and demonstrated a varied relation with summer temperature prior and subsequent to the year 1997 (major ENSO event).

Spatial variations in the major ionic and trace metal composition of surface snow samples collected during the austral summer of 2006/07 along short transects in the Ingrid Christensen Coast suggests that the sea salt constituents reveal a dramatic reduction from the ice edge to the inland sites. The estimated non-sea-salt sulphate ($nssSO_4^{2-}$) reveal large variations with extremely high $nssSO_4^{2-}$ depletion comparable to that in frost flowers especially within the sea/ice edge samples. It is cautioned that the extreme fractionation in the sulphate aerosols occur even during the summer time, leading to serious underestimation in the assessment of summer atmospheric sulphate budget within the coastal Antarctica. Study of sulphur species and bromide in the samples suggests an important biological pathway for the cycling of sulphur species in the coastal Antarctic region. Elevated biogenic bromide in region could react with ozone leading to BrO enhancement with subsequent dimethylsulfide (DMS) oxidation and production of sulfur aerosols. Since BrO based DMS oxidation is much faster than OH^-/NO_3^- pathway, elevated Br^- in the coastal region could contribute more towards formation of cloud condensation nuclei.