Possible Origin of High Concentrations of Methane Sulfonic Acid (MSA) near Coastal Antarctica: Penguin Feces

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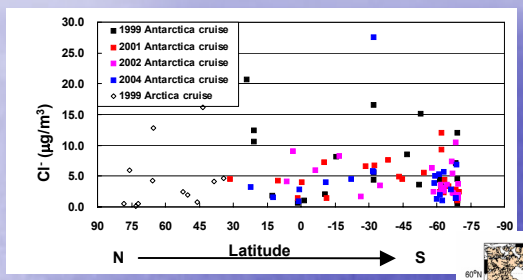
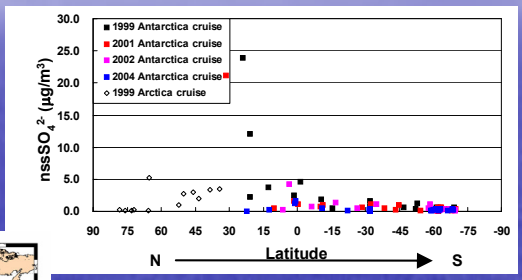
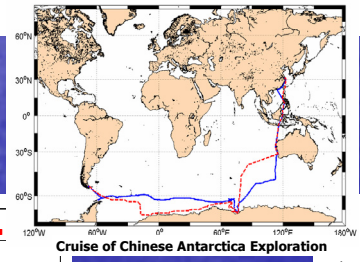
Abstract: Four-year samples of bulk, high-volume aerosol were collected during the cruises of Chinese National Antarctic Research Expedition from Shanghai, China, to the Southern Ocean to Zhongshan Station in the East Antarctica. The results were compared to those from the cruises from China to the Arctic. nss-SO_4^{2-} peaked near cities (e.g. Shanghai), however, the concentrations of MSA peaked near maritime Antarctica. We suggested the possible sources for MSA, besides phytoplankton, were sea animals (penguins or seals) feces.

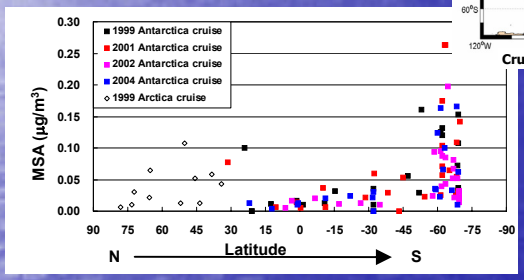


Concentration of Cl^- showed no clear trends along latitude.

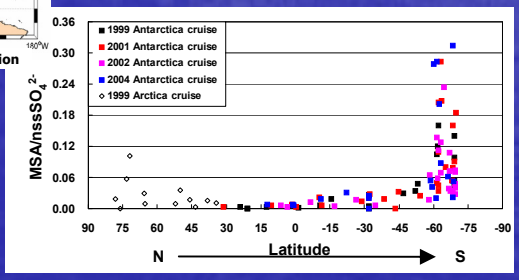


Concentration of nssSO_4^{2-} peaked near cities (e.g. Shanghai).

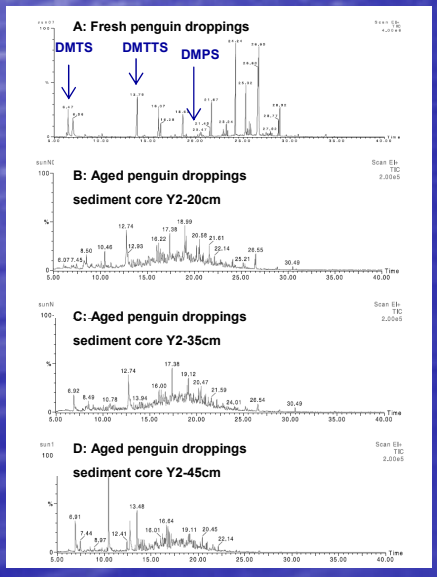




Concentration of MSA slowly increased with latitude and peaked near coastal Antarctica.



MSA/nssSO_4^{2-} slowly increased with latitude and peaked near coastal Antarctica.



Gas chromatograms of gases extracted from penguin excrement samples. (A): Fresh penguin droppings; (B–D): Aged penguin droppings collected in different depth (20cm, 35cm, and 45cm) of lake sediment core Y2 on Ardley Island, Antarctica.

Aerosols of Antarctica had been found to contain relatively high levels of sulfur. The predominant and continuous source of atmospheric sulfur in this region is understood to be biogenic DMS emissions from the surface waters of the Southern Ocean. Less significant source is dusts from distant continents and aerosols from the stratospheric reservoir, which is occasionally enhanced by explosive volcanic eruptions. But this cannot explain that why concentrations of MSA increase near coastal Antarctica but not Arctic.

We have raised one possible explanation for the abnormal high concentrations of MSA: penguin and seal feces. There were two evidences:

We analyzed the volatile compounds in the fresh penguin feces and aged penguin dropping (sediments from penguin colony). Results showed that dimethyl trisulfide (DMTS), dimethyl tetrasulfide (DMTTS), and dimethyl pentasulfide (DMPS) composed more than 12% in the volatile components of fresh penguin feces, but no organosulfur compounds were found in the aged penguin dropping sediments. This indicated that organosulfur compounds had been emitted to the air (Xie et al. 2001).

Near Dumont D'Urville on Ile des Petrels, with 12,000 penguin living there, the concentration of nss-SO_4^{2-} was 3.77 nmol/m^3 for downwind location and 3.11 nmol/m^3 for upwind (Legrand et al., 1998).

There are now 120 million penguins living densely around the Antarctica, and they might contributed a considerable percentage to the atmospheric sulfur.

Reference:

Legrand M, Ducroz F, Wagenbach F et al., 1998., Ammonium in coastal Antarctic aerosol and snow: Role of polar ocean and penguin emissions, J. Geophys. Res., 103, 11,043– 11,056

Xie ZQ, Sun LG, Wang JJ, et al. 2002. A potential source of atmospheric sulfur from penguin colony emissions. J. Geophys. Res., 107: art. no. 4617.

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