OCCURRENCE AND TRENDS OF POLLUTION IN THE ARCTIC TROPOSPHERE

Leonard A. Barrie
Atmospheric Environment Service
4905 Dufferin Street
North York
Ontario M3H 5T4
Canada

Introduction

The chemical composition of the troposphere (0 to -8 km above msl) in the Arctic is distinctly different than it is in the Antarctic. As pointed out in previous reviews (Barrie, 1986; Barrie et al, 1992; Barrie, 1993; Barrie, 1995), the Arctic is surrounded by populated continents from which pollution is released to the atmosphere and is transported readily to the north. In contrast, the Antarctic region is entirely surrounded by the southern Pacific ocean and is remote from human activities. Thus, it comes as no surprise that the tropospheric concentration of many anthropogenic aerosols and gases is much higher in the Arctic than in the Antarctic. What may be less obvious is that atmospheric trace constituents of natural origin are found to have a different chemical climatology in the Arctic than in the Antarctic. Substances derived from sea spray, wind blown dust, marine biogenic activity and volcanoes generally have different seasonal variations and concentrations in the Arctic compared to the Antarctic.

This is attributable to the uniquely different topography and geographical configuration of oceans and continents relative to the locations of measurement locations in the two regions (Figure 1). Topographically, the Arctic is very flat compared to the Antarctic (major exceptions- Greenland reaching 2 to 3 km above msl and the Rocky Mountains of eastern North America reaching ~ 6km). The northern troposphere is underlain by the Arctic ocean while the southern troposphere is bounded below by the massive Antarctic ice sheet that covers most of the continent from about 65 °S to the pole and reaches elevations of 3 to 4 km above msl.

Anthropogenic trace constituents enter the Arctic atmosphere via transport after being released near the Earth's surface. They tend to be most concentrated in the first 2 km of the atmosphere declining to much lower "background values" in the upper
Figure 1  A schematic contrasting the topographical and geographical differences of the two polar regions that play a major role in the composition of the atmosphere. Also shown are selected atmospheric and glacial ice chemistry measurement sites.

troposphere. Natural constituents can enter the Arctic troposphere from sources within the Arctic such as volcanoes in the Aleutians or Iceland, dust erosion from exposed land surfaces around Greenland and in the Canadian Archipelago, sea spray production from whitecaps in open Arctic Ocean areas or from biogenic marine sources