Tellus (1992), *44B*, 250–251

Symposium on the tropospheric chemistry of the Antarctic Region

By BARRY A. BODHAINE, *NOAA, Climate Monitoring and Diagnostics Laboratory, R/E/CG1, 325 Broadway, Boulder, Colorado 80303-3328, USA*, LEONARD A. BARRIE, *AES Environment Canada, 4905 Dufferin Street, Downsview, Ontario, Canada M3H-5T4*, RUSSELL C. SCHNELL, *Mauna Loa Observatory, Box 275, Hilo, Hawaii 96720, USA*, GLENN E. SHAW, *Geophysical Institute, University of Alaska, Fairbanks, Alaska, 99701, USA*, and JULIA K. McKIE, *CIRES, University of Colorado, Boulder, Colorado 80309-0216, USA*

Summary

The Antarctic troposphere is an important part of the global environment; yet, by virtue of its remoteness, it has not been studied as intensively as its counterparts elsewhere. There are many unique features of Antarctica that make it a valuable laboratory for monitoring and understanding the state of our global environment. These include a huge glacial ice sheet containing records of climate and atmospheric composition, a unique one-day/one-night per year light regime, ice surfaces that host heterogeneous chemical reactions, a massive, biologically active ocean, and a stratospheric ozone layer that is a good indicator of anthropogenic influences.

In 1988 at Dookie, Australia, a workshop was held on the *International Global Atmospheric Chemistry Program* (IGAC). It concluded that there was a need for a specialty conference on Antarctic Tropospheric Chemistry. The International Symposium on the Tropospheric Chemistry of the Antarctic Region was held 3–5 June 1991, in Boulder, Colorado, USA. It was followed on 6 June 1991, by a one-day workshop. Workshop sessions addressed the research in Antarctic tropospheric chemistry that is necessary for a better understanding of global change and its impact on the Antarctic region. Sessions covered tropospheric gases, aerosols and clouds, air-snow exchange, glacial records, transport, and troposphere/stratosphere exchange.

The topic of gases covered two sessions of the Symposium, and was represented by more papers and posters than any other single area. The need to understand the occurrence and pathways of gases in the Antarctic troposphere are manifold. They include a better understanding of the role of this remote region in the global budgets of important radiatively active gases such as CO_2 and CH_4 as well as in the budgets of compounds of marine origin such as dimethyl sulfide and organochlorines that may affect climate, the oxidative capacity of the atmosphere, and the stratospheric ozone layer. Gases currently being measured routinely at many locations in Antarctica include O_3 (surface and profiles), CO_2 and isotopes, CH_4 and isotopes, CO, halocarbons, hydrocarbons, N_2O, H_2O, DMS, and MSA. Additional gas and related radiation measurements are needed for H_2O_2, H_2CO, O_2, NO_x, NO_y, spectrally resolved radiative fluxes, isotopes of CO and H_2O, SO_2, COS, D/H of CH_4, HCFCs and HFCs. Vertical profiles of all constituents (including those currently measured) are needed during all seasons for understanding transport and stratospheric-tropospheric exchange processes. Process studies are needed to better understand the oxidative capacity of the Antarctic troposphere, sulfur compounds (DMS, COS, etc.) from the southern oceans, and tropospheric water vapor. In particular, the role of O_3, ultraviolet radiation, organobromides, NO_x, NO_y, and hydrocarbons are of interest; it is important to understand the role of sulfur compounds in cloud albedo feedback, stratospheric sulfate, and climate change as recorded in glaciers.

The recently established World Data Center for Greenhouse Gases (WDCGG) in the Japan Meteorological Agency (JMA) is now ready to manage data from all parts of the world concerning daily and monthly concentrations of greenhouse gases and related gases in the atmosphere. It is valuable to recognize the WDCGG as a mechanism for the coordinated exchange of data on atmospheric gases obtained in Antarctic research.

Workshop discussions on the subject of atmospheric aerosols emphasized their importance in the atmospheric radiation balance. Also, they affect clouds as cloud condensation nuclei (CCN) and ice nuclei (IN). Establishing the role of atmospheric aerosol in contemporary climate and possible feedback processes is essential for an understanding of possible climate change. The objectives of aerosol research are to determine the origins of particles and their precursors, including the contributions from natural and anthropogenic sources, to understand the coupling of the biogeochemical cycles to the atmospheric aerosol, to understand the transport of aerosol species to and within the Antarctic troposphere, to determine the spatial distribution of aerosol species, to understand the chemical transformations taking place between sources and receptor sites, to assess the potential for cross-contamination of sampling sites, and to determine the geochemical budget.

Measurement programs needed for assessing global change are size-fractionated collections, individual particle analysis, transport tracers, aerosol chemical precursors, and aerosol micro- and macroscopic properties. Condensation-nucleus (CN) concentration is a useful indicator for the total aerosol number population; it can reveal strong production, loss, or transport events. Important aerosol macroscopic parameters include aerosol scattering (B_{sp}) and aerosol absorption (B_{ap}) which describe the optical properties of the aerosol. B_{sp} is also a very sensitive indicator of local pollution, and B_{sp} is a good surrogate for the concentration of optically active aerosol particles.

Clouds play a major role in the global radiation balance and the global hydrological cycle. Clouds also represent an important reaction regime for the chemistry of a number of major reactive atmospheric species. High-latitude clouds are a significant factor in the global radiation balance; Antarctic clouds have not been extensively studied and are not well-understood.

Discussions on the roles of Antarctic tropospheric and stratospheric aerosols and gases in the regional climate and as monitors of global changes identified the need to substantially upgrade both the direct measurements of transport events and indirect monitoring, by setting up a circumpolar network of tracer measurement stations. In addition, modeling studies are needed to provide a dynamical framework for an understanding of the variations, and to identify sources of aerosols and gases. Analyses are needed of existing data to describe important transport events, to identify stratospheric intrusions, and to detect climatic trends. Comparative evaluations are needed of atmospheric general circulation models which usually do not simulate the atmospheric behavior at these latitudes with great realism.

Many known processes affect air/snow exchange and therefore the historical records of ice and snow chemistry. Measurements are also affected by variable processes. In accommodating these many processes in our research, we must undertake to better understand the incorporation of many species, including: ^{18}O, ^{2}H, soluble and insoluble particles, reactive gases, organic species, gas precursors of NO_3^-, SO_4^{2-}, MSA, (e.g., NO_x, DMS, SO_2), and atmospheric tracers. Laboratory experiments are needed on gas-ice reactions and aerosol deposition.

Research continues on the topics explored in Boulder, and at the close of the meeting, participants expressed strong support for future meetings on the topic of Antarctic Tropospheric Chemistry. It is our hope that the effort begun with this *Symposium* will continue to stimulate the highest quality of research on the complex and evolving problems of the southern polar troposphere and its role in global change.