FORUM

Environment Canada Cuts Threaten the Future of Science and International Agreements

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In August 2011, 300 Environment Canada scientists and staff working on environmental monitoring and protection learned that their jobs would be terminated, and an additional 400-plus Environment Canada employees received notice that their positions were targeted for elimination. These notices received widespread coverage in the Canadian media and international attention in *Nature News*. Environment Canada is a government agency responsible for meteorological services as well as environmental research.

We are concerned that research and observations related to ozone depletion, tropospheric pollution, and atmospheric transport of toxic chemicals in the northern latitudes may be seriously imperiled by the budget cuts that led to these job terminations. Further, we raise the questions being asked by the international community, scientists, and policy makers alike: First, will Canada be able to meet its obligations to the monitoring and assessment studies that support the various international agreements in Table 1? Second, will Canada continue to be a leader in Arctic research?

Ozone Depletion

Environment Canada's measurement stations and analysis for ozone trends are a gold standard in the northern high latitudes, which are most vulnerable to stratospheric ozone depletion. Ozone profiles provided by balloon-borne sondes launched by Environment Canada are part of a coordinated international capability that enable tracking of chemical ozone loss as air masses traverse the Arctic [*World Meteorological Organization* (*WMO*), 2011]. Soundings at Resolute (75°N) started in 1966, and three stations spanning much of Canada started in the early 1970s. Two more Arctic stations were added in 1987 and 1992, and four stations were added in southern Canada in 2003.

Measurements made by the Canadian component of the global Brewer-Dobson network provide essential ground truth for validating satellite observations of the total ozone column, particularly in the Arctic. Although satellites measure total ozone over the sensitive Arctic, most instruments do not make measurements during polar night. Sonde profiles provide the only measurements of ozone until the Sun returns. The need for ozone measurements, both total and vertical profile, along with monitoring of surface ultraviolet (UV) radiation, are spelled out in the Vienna Convention to Protect the Ozone Layer (http://ozone.unep.org/new_site/en/Treaties/treaty_text.php?treatyID=1), which was ratified by the Canadian Parliament in 1986.

Likewise, the combination of Canadian soundings, ground-based measuring devices, and satellite instruments such as the Atmospheric Chemistry Experiment (ACE) and Optical Spectrograph and Infrared Imager System (OSIRIS), along with computer models and trend analyses, provides required inputs to the quadrennial Scientific Assessment of Ozone Depletion reports issued by the World Meteorological Organization/United Nations Environment Programme (WMO/UNEP), pursuant to Article 6 of the Montreal Protocol [*WMO*, 2011]. The Montreal Protocol, finalized on 16 September 1987, led to a worldwide ban on the industrial production of ozone-depleting substances (ODSs) and is considered a model of government, academia, and the private sector working together to solve a global environmental problem.

It is ironic that the threatened cuts to the Canadian ozone program should arise now, because Canadian observations were essential to the quantification of last year's Arctic ozone hole. Stratospheric temperatures in the Arctic reached record lows in spring 2011, giving rise to polar stratospheric clouds that facilitate rapid chemical loss of ozone. Even though levels of ODSs have declined slightly in the past decade due to the success of the Montreal Protocol, March 2011 marked the first time that Arctic ozone depletion was comparable to amounts commonly observed over Antarctica [*Manney et al.*, 2011].

Ozonesonde profiles obtained over Eureka, Canada, before and during the 2011 Arctic ozone hole, can be found in the online supplement to this Forum (http://www.agu.org/journals/eo/v093/i007/2012EO070009/2012EO070009_suppl.pdf). These data, available to the public at the Canadian World Ozone and Ultraviolet Radiation Data Centre Web site, demonstrate the importance of having accurate ozone profile measurements to quantify Arctic ozone depletion.

Tropospheric Pollution

Environment Canada is the lead agency for measuring and modeling Canadian air quality and climate change. The ozone

Table 1. International Agreements Potentially Affected by Environment Canada Budget Cuts

Agreement/Commitment (Date in Force)	Parameters/Archive	Environment Canada Activity/Archive
Article 3, Annex 1, of Vienna Convention to Protect Ozone Layer (1985), Montreal Protocol (1987), Ottawa Declaration (1996)	column, profile ozone, surface measurements, and surface UV measurements; archive of column and UV data	sondes, Brewer-Dobson, surface UV networks, calibration facilities; trend analysis for quadriennal WMO/UNEP Scientific Assessment of Ozone Depletion reports; World Ozone and Ultraviolet Radiation Data Centre in Toronto
Great Lakes Water Quality Agreement Annex 1 and Annex 15 (1988)	Integrated Atmospheric Deposition Network	measure wet and dry deposition of persistent organic pollutants; follow trends in atmospheric deposition
U.S.-Canada Air Quality Agreement (1991)	Canadian Acid Precipitation Monitoring Network	measure wet and dry deposition of acid rain chemicals and precursors; lidar measurements in CORALNet; air quality modeling
Articles 4(1)g and 5, U.N. Framework Convention on Climate Change (1992)	trace gas and aerosol monitoring; lidar aerosols for World Meteorological Organization/Global Atmospheric Watch; model predictions of temperature and precipitation changes	greenhouse gas monitoring at core sites including the Arctic; climate mitigation and adaptation studies; CORALNet lidar measurements; climate and air quality modeling

sounding network has shown the incursion of pollution from growing Asian sources and documents filaments of pollution crossing back and forth between Canada and the United States. A related activity, the Canadian Operational Aerosol Lidar Network (CORALNet), monitors atmospheric aerosols, measuring both natural and anthropogenic particles. The impact of soot and other particulate pollution from Europe and Asia on Canada has been investigated for more than 30 years, showing the effects of the growth of emissions from fossil fuel use in Asia and from boreal forest fires. Part of the WMO's Global Atmosphere Watch Aerosol Lidar Observation Network, CORALNet consists of five lidar (light detection and ranging) instruments as an early warning system for the buildup of particles that come from long-range transport to Canada.

In mid-October 2011, because of the Environment Canada budget cuts, the CORALNet Web site (http://www.coralnet.ca/) read "site discontinued;" now it is gone, and the lidar data are no longer being taken.

Atmospheric Transport of Toxic Chemicals

Table 1 refers to sections of the Great Lakes Water Quality Agreement (GLWQA) between the United States and Canada that have been in force since 1988, designed to monitor persistent toxic chemicals in the water column. Annex I of the GLWQA includes atmospherically transported chemicals. In response to Annex 15 of the agreement, Canada and the United States formed the International Atmospheric Deposition Network (IADN). IADN has monitored trends in persistent chemicals over the Great Lakes since that time. Over several multiyear reviews, IADN has increased the suite of chemicals monitored to include dioxins and pesticides that reach the lake by atmospheric deposition.

An EPA Web site (http://www.epa.gov/glindicators/air/airb.html) shows the trends in gas phase polychlorinated biphenyls (PCBs), pesticides, and polycyclic hydrocarbons in air and precipitation at the five international master stations of IADN since 1992. More current results by *Hites et al.* [2008] extend this data series. In each case, the concentrations are decreasing, which is positive news for the health of the lakes. Other currently used chemicals (e.g., atrazine, polybrominated diphenyl ethers, and pentachloronitrobenzene) need continued scrutiny to determine trends in deposition.

Tracking multiyear trends in toxic inputs to the Great Lakes must remain an obligation for Canada and the United States. At this point, because of the Environment Canada budget cuts, it is not clear whether the Canadian contribution to IADN will continue and if these parts of the GLWQA will remain in force.

Cuts Could Endanger International Commitments

Canada has long been a leader in Arctic research. The Arctic Council, which Canada first chaired, was established by the Ottawa Declaration in 1996 to promote international cooperation in Arctic research. We are concerned, in light of the Environment Canada budget cuts, that the international community may no longer be able to rely on the exceptional efforts and past leadership role provided by Canada for Arctic research. With the loss of so many scientists who conduct environmental research in this unique part of the world, it is not clear whether Canada will be able to keep its commitment to such international agreements as those listed in Table 1.

References

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