Winds of Change

Reducing Transboundary Air Pollutants

The acid rain in Lorraine comes partially from Spain. Similarly, about half the acid rain that falls on Canada originates in the United States, as does a large portion of the ground-level ozone found there. Air pollution never respects international boundaries, but in recent months a spate of meetings and agreements has shown international governments to be more willing than ever to try to limit the amount of their air pollution that drifts into other countries. Recently, nations have begun working harder to identify who exports and who imports the air pollutants that flow across international borders—and who should bear the burden of cleaning the global atmosphere.

In February 2000, the United States and Canada began discussing how to expand their existing bilateral air pollution agreement to include ozone. At a March 20–25 meeting of the United Nations Environment Programme (UNEP) in Bonn, Germany, an agreement on persistent organic pollutants (POPs) was discussed. The goal is to sign a POPs convention in May 2001, which would effectively result in the first-ever global convention on transboundary air pollution. Perhaps even more significant, last December the nations of the United Nations Economic Commission for Europe (UNECE) signed a comprehensive agreement to limit the export of pollutants that cause several environmental problems—acid rain, ground-level ozone, and the eutrophication of waters.

Whatever agreement the United States and Canada reach on ozone will become an integral part of the UNECE's new multipollutant agreement, and the UNEP agreement on POPs will be modeled on an existing UNECE agreement. Out of this web of international conventions, which is entangled with smaller local agreements, has come significant progress toward treating air pollution according to its effects, wherever they occur.

Sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), POPs, particulate matter, and heavy metals are all now being discussed in international forums. Unlike greenhouse gases and ozone-depleting substances—for which global agreements exist—many of these air pollutants were once thought to be problems that could be solved locally, where the effects occur. Behind this policy shift are increasing emissions in some parts of the world, better monitoring, and an improved understanding of air pollution transport. "There is a growing recognition that for these air issues, any national government that attempts to deal with the problem alone will meet with only limited success because they are the kinds of problems that require collective action," says John Buccini, director of the Commercial Chemicals Evaluation Branch of Environment Canada and chairman of the UNEP POPs convention negotiations.

"The problems that we are facing are becoming less of a regional character . . . and more and more of a northern hemispheric or global character," says Henning Wuester, a UNECE official and member of that group's secretariat for its Convention on Long-Range Transboundary Air Pollution. "There is now science showing that pollution travels much further than previously anticipated." Some models have suggested, for example, that POPs released into the air in China will show up in Canada three to five days later.

According to the World Health Organization (WHO), air pollution causes 2.7 million deaths per year. While many of these are caused by indoor air pollution, the WHO estimates that just eliminating ground-level ozone could save 180,000 lives annually (including 5,000 in the United Sates) and reduce suffering for millions of people with asthma and other respiratory ailments. Reductions in emissions of sulfur oxides and particulate matter could save 500,000 lives, according to the WHO. These common air pollutants can also cause defoliation of trees and acidification of soil, as well as other detrimental ecosystem effects. The Ozone Transport Assessment Group of the U.S. Environmental

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Protection Agency (EPA) estimates on their Frequently Asked Questions site at http://www.epa.gov/ttnotag1/otag/faq.html that ground-level ozone causes damage to U.S. crops totaling $2–3 billion each year.

The Gothenburg Protocol

Such problems were the target of the UNECE when it met in December 1999 in Gothenburg, Sweden, to sign its new agreement for controlling emissions of SO_2, NO_x, ammonia, and VOCs. Under the Gothenburg Protocol to Abate Acidification, Eutrophication, and Ground-Level Ozone, 27 nations (including the United States and Canada) agreed that international transport of these pollutants is significant enough to warrant international action. The European parties to this accord went a step further by agreeing that new emissions reductions should be mandated in the agreement based on the levels necessary to protect human health and ecosystems in specific downwind areas. That presents a departure from other international agreements, which have been based on countries' reducing emissions by a percentage that they deem economically or technically feasible.

But the accord is unique in other ways, too. "It's really a very important agreement in the field of international environmental policy making for several reasons," says Wuester. One reason is that the agreement involves many nations and covers a very wide geographic area including—despite the UNECE's name—Canada and the United States. Since Russia is also one of the 55 UNECE member states, agreements formed within this body have the potential to effect the vast majority of the Northern Hemisphere.

The Gothenburg Protocol—which has not been signed by Russia, Ukraine, Poland, or several other important polluters—is the eighth addition to the UNECE's Convention on Long-Range Transboundary Air Pollution, which was originally signed in 1979. Together, these protocols represent the world's largest international set of agreements on transported air pollutants to date. UNECE nations have agreed to limits on SO_2 (1987, 1994, 1999), NO_x (1991, 1999), VOCs (1997, 1999), heavy metals (1998), POPs (1998), and ammonia (1999). The framework convention to these agreements was signed by 44 nations.

The Gothenburg Protocol is unique among these and other agreements also because it includes limits on multiple pollutants that have multiple effects. It recognizes that different environmental problems can be interconnected. "There was a common feature to the issues treated in the modeling work for this protocol," says Wuester. "Either the pollutants were common to a problem or the effects were common to a pollutant."

Addressing ground-level ozone in the protocol meant limiting emissions of NO_x and VOCs, which react to form ozone in sunlight. But NO_x also contributes to eutrophication (uncontrolled growth of plankton or algae), so that problem is included as well. Including eutrophication in the agreement also meant limiting SO_2 emissions, which along with NO_x lead to acidification of soil and water. Ammonia is also included because it too can raise the pH of soil and water.

For each of these problems, critical load maps were drawn for the whole of Europe showing the maximum pollutant concentration that each area could tolerate before detrimental environmental effects would be seen. These were coupled with deposition maps showing how much pollution flows into each area and where it originates. Finally, the costs of abatement were included so that the least expensive solution could be found.

These data were incorporated into a complex computer model known as RAINS (for **R**egional **A**ir Pollution **In**formation and **S**imulation). "This model was developed for the specific purpose of the negotiations of the protocol, and that is fairly exceptional," says Wuester. Also significant is that so many nations were able to agree on the model and the data that went into it, including functions for the cost of abatement in each country.

"The model brought in cost optimization at the outset," says Wayne Draper, associate director of the Transboundary Air Issues Branch of Environment Canada. "They were able to analyze what level of reduction each country should make to meet certain targets and to provide the most economic solution for all of Europe. That is really quite an advancement from the approach that's been used [in the past]."

According to Draper, the methodology that was used was the so-called gap closure methodology. For example, he says, "If you had ambient levels that are here now and you wanted to close the gap between those and the critical loads or levels by 60%, then that was plugged into the model for all the different [measurement sites] around Europe."

For Europe as a whole, the model showed that achieving the desired results would mean cutting SO_2 emissions by 63% from 1990 levels, reducing NO_x by 41%, VOCs by 40%, and ammonia by 17%. Under the agreement, besides mandatory limit values for major emission sources, each country is free to implement whatever national programs it sees fit to meet the individual goals set out for it by the model. If these goals are met, the area where critical loads are exceeded for acidification would decrease from 93 million hectares in 1990 to 15 million hectares in 2010. The area affected by eutrophication would decrease during this same period from 165 million hectares to 108 million hectares, and the number of days when ozone is high enough to adversely affect human health would be reduced by 52%. That would mean 47,400 fewer premature deaths from ozone exposure, according to a UNECE press release.

Noticeably missing from the UNECE's approach is consideration of particulate matter, which can also travel long distances to harm human health and which comes from the same sources as SO_2 and NO_x. "The issue of particulate matter became more and more prominent in the discussions as we progressed with the work for the protocol," says Wuester. "In the early and mid-1990s, there were few who considered particulate matter to be a transboundary issue. But since then, a lot of scientific evidence has emerged that changed that picture. Actually, in the last years, when we calculated benefits from reducing the emissions that we would target by the protocol, we noticed health benefits from reductions of particulates could be the most important set of benefits in the assessment."

Wuester says that particulate matter came into consideration in the final stages of negotiations for the protocol, and that UNECE nations are now considering how to incorporate this pollutant into the accord. "That's where we concentrate scientific work now," he says.

Also not included in the Gothenburg Protocol are limits on POPs and heavy metal pollution, but these are addressed separately in the sixth and seventh protocols to the Convention on Long-Range Transboundary Air Pollution, both of which were adopted in 1998. Those earlier protocols were not, however, based on an analysis of effects. "At the moment, we are working to establish the basis to allow similar modeling for heavy metals," says Wuester, "in particular, using similar concepts like critical loads and levels, which we used for acidification, eutrophication, and tropospheric ozone." UNEP also is currently working toward a new global agreement on POPs.

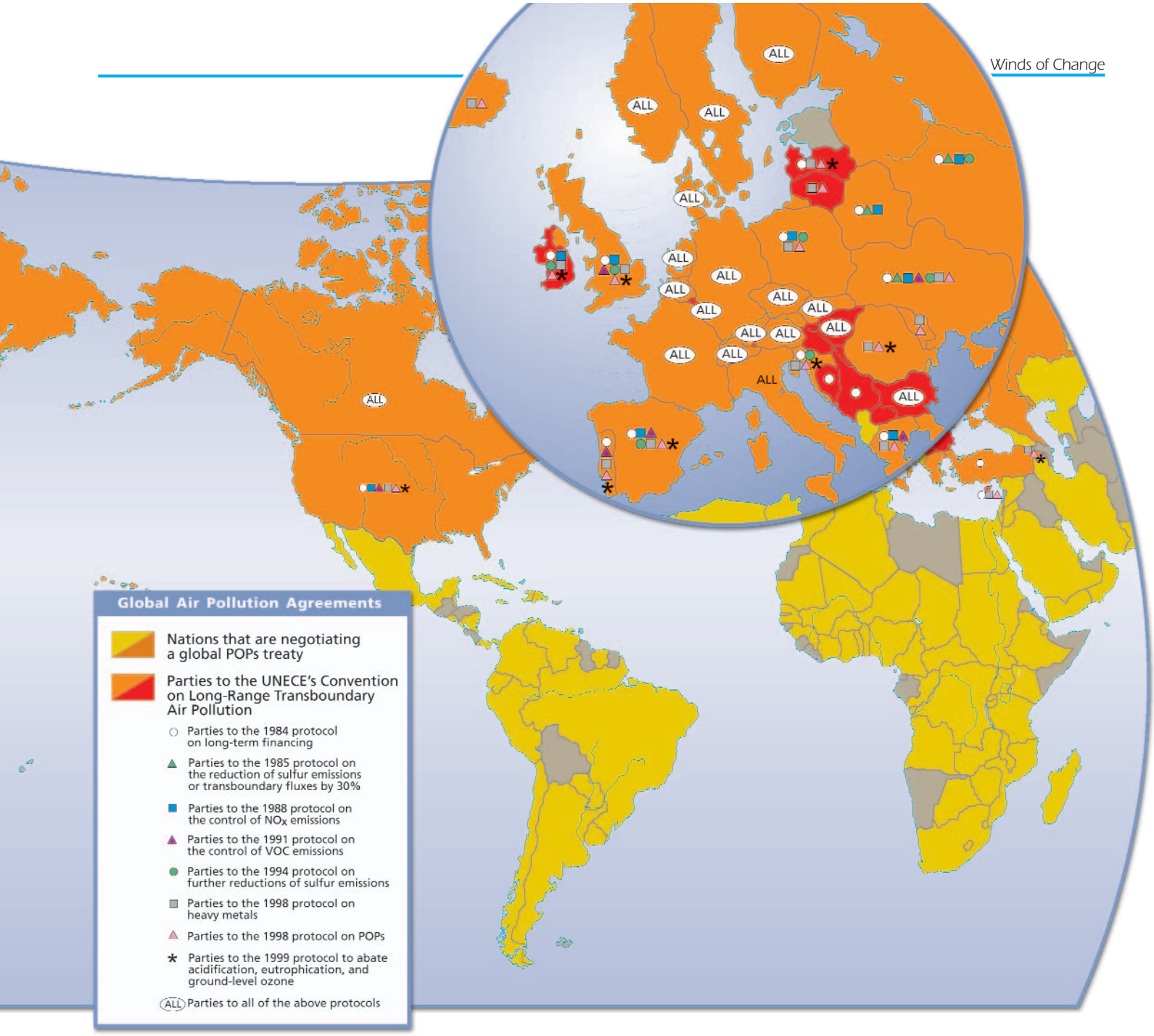
While the modeling work used in the Gothenburg Protocol has been praised for its completeness, it only applies to Europe. For other parties to the protocol, namely the United States and Canada, no single model has emerged for finding the most cost-effective way to protect ecosystems and human health. "There are similar models for North America, though I guess it's fair to say that Canadian and U.S. scientists have not come up with one single model that they agree on," says Wuester.

Source: UNECE (http://www.unece.org/env/lrtap/), UNEP (http://www.unep.org/).

Across the Pond

Since North American emissions reductions were not dictated by the model used for European countries, Canada and the United States have been left to decide for themselves what levels of reduction should be included for them in the Gothenburg Protocol. According to Draper, for Canada and the United States, the commitments in the latest protocol defer to ongoing negotiations between the two nations. These negotiations are called for by the Canada–U.S. Air Quality Agreement, which the two nations signed in 1991. While that agreement was conceived to control acid rain, it created a framework for addressing other air pollution problems as well. In April of 1997, President Bill Clinton and Canadian Prime Minister Jean Chrétien decided the scope of the agreement should be broadened to include tropospheric ozone and particulate matter. First on the agenda is ozone. Negotiations to control this pollutant are ongoing, and any agreement resulting from those talks will also be integrated into the Gothenburg Protocol.

Canada and the United States are not presently considering new agreements to control acidification and eutrophication so, unlike the European countries, these two nations will be included in the Gothenburg Protocol without any new promises to limit ammonia and SO_2 emissions. Currently, there is no agreement between the two countries on ammonia. "I don't think we're going to have any commitments on ammonia, except maybe to get a better handle on its role," says Draper, who is cochairman of the subcommittee charged with reviewing implementation of the Canda–U.S. Air Quality Agreement.



Despite the fact that the United States generates more sulfur than any country in the UNECE—eight times as much as the next biggest emitter—it is not a party to either of the commission's existing protocols on reducing sulfur emissions, which were signed in 1985 and 1994. Under the new protocol, the United States will only be obligated to make the sulfur reductions already required in the amendments to the Clean Air Act—a 50% reduction compared to 1980 levels of sulfur from utilities, establishing a permanent cap by 2010. By 1996, the United States had cut its overall sulfur emissions to 74% of 1980 levels.

Canada, which is among the world's largest SO_2 producers, ratified the two previous UNECE sulfur reduction protocols and had reduced its sulfur emissions by nearly half in the period between 1980 and 1996. However, like the United States, Canada is not required by the Gothenburg Protocol to make additional reductions.

For these two countries, the only new promises that will be included in the Gothenburg agreement will come from the Canada–U.S. Air Quality Agreement to control NO_x and VOCs. Negotiations to control these ozone precursors began in February. However, Draper says that those negotiations will not lead to big changes in ozone policy on either side of the border. Instead, they will codify into an international agreement what the countries hope to achieve as a result of domestic programs. "The commitments of both countries are expected to be based upon what we individually are going to achieve with the current programs that are in place or are being put in place," Draper says.

In the United States, these programs include a recent call by the EPA for 21 eastern states to reduce their emissions of ozone precursors that blow into other areas of the country. However, that action, which was taken in April 1999, was put on hold by a May 1999 decision of the U.S. Court of Appeals that questioned the basis for the agency's formulation of stricter regulations. For Canada, its commitments will be based on what it expects to achieve under federal and provincial smog management plans. One new plan focuses on a smog management area that encompasses about a million square kilometers of Ontario, Québec,

Nova Scotia, New Brunswick, and Prince Edward Island.

In stark contrast to the situation in Europe where Spain, for example, will actually be making emissions reductions to protect other nations such as France, neither the United States nor Canada will make reductions specifically to protect the other. "We are not going to claim that we'll do more in the United States to help Canada than we would be doing anyway to help ourselves," says John Bachmann, the associate director for science/policy and new programs in the EPA's Office of Air Quality Planning and Standards, "but hopefully with this agreement we'll achieve some harmonization in the transboundary region."

So, while the Gothenburg Protocol will be a legally binding treaty with new emissions reductions for the nations of Europe, it will not be for the United States. "For us, this is an executive agreement," Bachmann says. "We can go up to and including things that are already mandated by our law. We can't go beyond that. Otherwise, we'd have to go to Congress to get it approved, and then it's no longer an executive agreement, it's a treaty. We're not doing a treaty here."

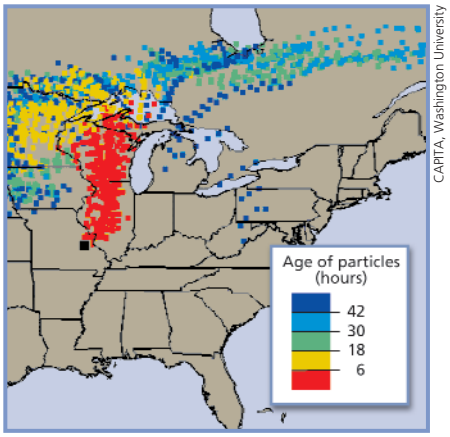
Environmental Reaction

Some environmentalists complain that an agreement that lacks new commitments to pollution reduction is comparable to doing nothing. "It's basically been a bureaucratic shuffle," says Rick Coronado, the interim president and research coordinator of the Citizen's Environment Alliance, a nonprofit education and research organization that has been active in air pollution issues at the U.S.–Canadian border. "[Both sides] are going to the table with weak reduction programs, so basically they have one hand tied behind their backs," he says.

Another criticism of the U.S.–Canadian agreement is that it addresses too few pollutants. "The main comment from the public was 'an agreement is great, but if you don't have limits for transboundary pollution like toxic chemicals and things like that, what use is it? If you don't have particulate matter, then what good is it?' We heard that over and over," says Ed Bailey, an engineering advisor who compiled public comments on the Canada–U.S. Air Quality Agreement for the International Joint Commission, an organization that helps implement environmental agreements between the two nations.

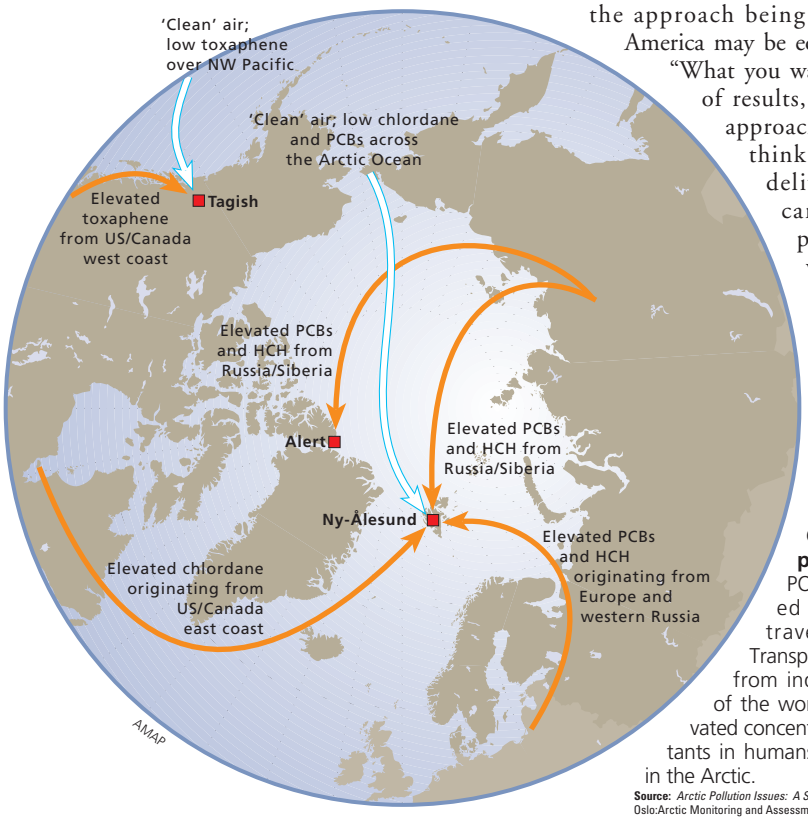
What many critics of the U.S.–Canadian accord would like to see is a treaty like that adopted by the European countries, in which each nation agrees to reduce emissions of several pollutants according to what is necessary to protect human health and the environment downwind. However, Bachmann counters that the approach being taken in North America may be equally as effective. "What you want is equivalence of results, not an identical approach," he says. "We think we are going to deliver that. People can say all we're promising to do is what we're doing anyway. Well, what we're doing anyway is a lot."

But that does not mean that the North American countries have rejected the European loads-based approach outright. Bachmann says that some elements of a critical loads approach are integrated in the U.S. regional haze program as well as some water quality initiatives. "In Canada," says Draper, "we're homing in on the geographic source region that really needs to be controlled to move us most effectively toward looking at critical loads. I think there's a movement in both the United States and Canada to start to look at a much more integrated, comprehensive approach on air quality management, with a multipollutants and multieffects strategy."



CAPITA, Washington University

Ozone from St. Louis. A computer model of conditions on 5 July 1995 shows how ozone released in St. Louis, Missouri, might disperse over a wide swath of the United States and Canada.



Globe-trotting pollutants. Because POPs are not degraded quickly, they can travel long distances. Transport of airborne POPs from industrialized regions of the world may explain elevated concentrations of the pollutants in humans and animals living in the Arctic.

Source: *Arctic Pollution Issues: A State of the Arctic Environment Report.* Oslo:Arctic Monitoring and Assessment Programme, 1997.

The World Versus POPs

New research is showing that some pollutants, including POPs, are carried much farther than previously thought. "There's been a fair amount of work done in North America, for example," says Buccini, "that shows when they're tilling the fields in the cotton-growing region of the southern United States—[in places] where they used toxaphene [a pesticide now classified as a POP] for many years—within three or four days you'll get spikes of toxaphene in rather predictable areas of the northern United States and Canada."

Also, POPs can be deposited in one country and then taken into another by air, water, or animals that ingest them. Wuester says this "grasshopper effect" makes it difficult to integrate POPs transport into the type of model on which the Gothenburg Protocol was based.

In North America, the U.S.–Canadian Great Lakes Water Quality Agreement has addressed POPs on a small regional level for over 25 years, while UNECE nations signed an agreement on them in 1998 that has not

yet gone into force. Other bilateral and regional conventions exist as well. However, many feel an even broader agreement on POPs is needed. At a January–February 1997 meeting in Nairobi, Kenya, the UNEP Governing Council concluded that "a global, legally binding instrument is required to reduce the risks to human health and the environment [posed by POPs]." Four meetings have taken place toward the goal of signing such an instrument in May 2001, the most recent being the March meeting in Bonn.

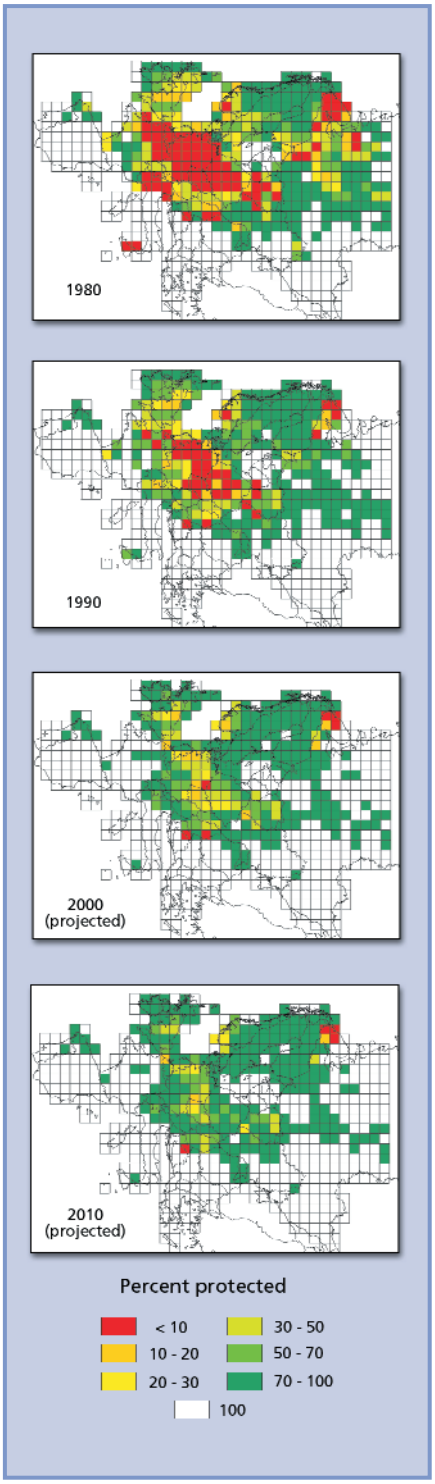
"People are saying the nature of the problem may vary from country to country or region to region, but there is a basis here for taking global action," says Buccini. "There are 36 countries that are part of the [UN]ECE [protocol on POPs], but there's somewhere around 115 or 120 countries that are participating in the [UNEP] negotiations. For a lot of countries there is no existing agreement." Thus, says Buccini, UNEP has an opportunity to drastically reduce worldwide emissions of POPs into the environment. If most of the countries involved in the negotiations ratify the agreement, the UNEP POPs convention could become the first truly global accord to address air pollutants that are deposited across boundaries.

The ultimate goal, says UNEP, is to eliminate all discharges, emissions, and losses of POPs around the world. On its "most wanted" list so far are 10 intentionally manufactured chemicals plus dioxins and furans, which are released chiefly as by-products of waste incineration. The 10 manufactured POPs, for the most part pesticides, include DDT and polychlorinated biphenyls. "With the exception of DDT, I think we are going to see . . . cessation of production," says Buccini. Countries that depend on DDT for controlling disease vectors such as mosquitoes that carry malaria will likely be allowed to continue limited use under the convention, he says.

The 1998 UNECE POPs agreement, which covers 16 substances, will be used as a stepping stone to the UNEP agreement. "Those countries within the UNECE that are parties to the POPs protocol will be trying to reflect their commitments under that protocol in the global instrument," says Buccini.

Emulating Europe

The European lead is being followed elsewhere as well. The World Bank is funding modeling work for air pollution transport in Asia that emulates the RAINS model used for the Gothenburg Protocol. Simultaneously, UNEP is collaborating with the Association of South East Asian Nations to fight the transport of haze from forest fires to nearby nations.



Looking at effects. The UNECE has divided Europe into 150-kilometer grid cells and has begun looking at which cells are being adversely affected by air pollution. Such analyses showed that past agreements limiting sulfur and nitrogen emissions will protect much of Europe from acid rain by 2010. However, further reductions in these air pollutants were included in the 1999 Gothenburg Protocol to reduce the area affected by eutrophication.

There are other efforts under way to protect nations from each other's air pollution. In North America, a trilateral agreement on air pollution is being formed under the auspices of the North American Free Trade Agreement. Regional agreements that protect the Great Lakes and the Georgia Basin ecosystem of southwest British Columbia and northwest Washington State have also been signed. In Europe, there are agreements to protect the Mediterranean and North Seas.

In addition to these are a smattering of local initiatives—agreements formed between towns or regions across the border from one another. For example, residents of Sault Sainte Marie, Michigan, were assisted by the EPA in reducing the emissions from a steel mill across the Canadian border. "We've had some real success with these initiatives at the city and county level," says Stephen Rothblatt, chief of the Air Programs Branch for EPA Region 5.

"In some locations we've got a whole bunch of different programs working at once," says Coronado. "The problem with this system is that you have all these pieces, and the question becomes where do they all fit. It's really hard to know. . . . People don't really know where to look when they are facing these issues." And besides creating unnecessary confusion, redundancy and waste in these programs is likely as well, he says.

"What we're working toward is to be able to look at transboundary air problems in a borderless context," says Draper. Research is constantly suggesting that such an approach is necessary. For example, metals transport from warm to cool climates is suggested as an explanation for why 83% of Inuit men and 73% of Inuit women in the eastern Canadian Arctic were found to have daily intakes of mercury above WHO guidelines, according to research by scientists from McGill University in Québec, Canada, published in the March 1997 issue of *EHP*. The UNECE adopted a protocol on heavy metals at the same time it adopted its POPs protocol, and Buccini sees it as likely that UNEP may follow suit.

Although recent UNECE protocols are being lauded and imitated, Wuester cautions that they are still largely untested. "Only the implementation itself will show us how important the agreements are for the environment," he says.

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