Emission Control Will Control Acid Rain

An expert panel finds that emission reductions will produce proportionate reductions in acid deposition, but it says there is a catch

A panel of the National Research Council (NRC) has concluded that, contrary to industry claims, a 50 percent reduction in the emissions of sulfur and nitrogen gases will produce about a 50 percent reduction in the acids falling on the land and water downwind of the emission source. That clears a major roadblock to the formulation of a control policy—every dollar invested in emission control should generate the maximum return in the reduction of acid deposition and the damage it causes.

The catch, says the panel, is that scientists cannot be specific about exactly where the reduction in deposition will occur. The computer models that simulate the atmospheric transport and deposition of acid are too inaccurate to say where in eastern North America emissions will end up, the panel found. The modelers doing the research, who were not represented on the eight-man panel,* tend to disagree.

The panel based its conclusion—that there is a nearly proportionate or linear relation between emission and deposition—on both historical and laboratory data. The panel cast doubt on any computer simulations of the transformation of sulfur dioxide gas into sulfuric acid that do not regenerate intermediate chemical species essential to the continued oxidation of the sulfur dioxide. Some combinations of chemical reactions seemed to oxidize sulfur dioxide while consuming reactive hydroxyl radicals in the atmosphere, which would allow additional sulfur dioxide to accumulate. Reductions in emission would thus tend to reduce the accumulation of sulfur dioxide but not the production of acid. A similar nonlinear relationship complicates the control of ozone production in urban smog. But the panel suggested that the reasonable replacement of one of the 19 chemical reactions with one that allows the regeneration of reactive intermediates would make the transformation linear. Recent laboratory experiments support the existence of such linear reactions in the atmosphere, the panel said.

Historical records of acid deposition at the Hubbard Brook Experimental Forest in New Hampshire, the only North American site offering a reliable, long-term record, also suggest that acid deposition responds in full measure to changes in emission. More extensive records in Europe have indicated that increasing emissions there have not led to proportionate increases in deposition. But the panel noted that the deposition of sulfate at Hubbard Brook has decreased about 33 percent since 1965 while sulfur emissions in the eastern United States decreased 8 percent and emissions in the Northeast decreased about 40 percent. "The nitrate deposition data also appear to reflect emission trends in the Northeast," noted the panel report. The panel also cited the relative uniformity of the proportions of sulfate and nitrate deposited across the eastern United States as evidence of the linearity of the chemical reactions involved. The oxidation reactions of some proposed nonlinear schemes predict a preference for the production of nitric acid over sulfuric acid near the source and a shift toward more efficient production of sulfuric acid with increasing distance downwind.

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Nonlinear transformation into acids probably exists, the panel concluded, but it does not appear to be of significance over broad areas of eastern North America. Europe's differing meteorology, distribution of sources, or location of receptor areas may bring nonlinear reactions into play there. They may also be significant near American sources, notes Perry Sampson of the University of Michigan, but over large distances between a major source area, such as the Ohio Valley, and an environmentally sensitive area, such as the Adirondacks, nonlinear chemical reactions would appear to be insignificant.

Emission reduction will help, but the panel could not say where it would be most effective. At a press conference, Jack Calvert, a chemist at the National Center for Atmospheric Research and chairman of the committee, explained why the panel could not be more specific. "Based on our analyses of both the available data and currently available computer models of long-range transport, we conclude that the relative importance of long-range and nearby sources to the acidification of sensitive areas cannot be determined with reasonable certainty at this time." The current models are "very approximate" and "are not formulated from first principles of physics and chemistry." In addition, field observations are too limited to validate models sufficiently.

Modelers of long-range transport tend to think that their present, admittedly simple, models are not all that bad. The differing perceptions seem to go back to a comparison of the performance of nine models during the technical work for the memorandum of understanding (MOI) between Canada and the United States. Both the NRC committee and the White House–appointed MOI review panel (see story on p. 241), which also holds modeling in low esteem, appear to have leaned heavily on the MOI analysis. Neither group includes any modelers, but those modelers contacted by *Science* believe that the MOI analysis had severe limitations. They include the limited 1978 data used for validation, the unusual meteorological conditions during parts of 1978, and the comparison of models of varying sophistication and differing intended uses.

Despite these problems, notes Sampson, the relative importance of various source regions was similar from model to model. James Young, the Canadian technical coordinator for the MOI model comparison, says that model validation with the more extensive and reliable data from 1980 has been considerably more successful than that included in the earlier MOI work. All in all, many modelers believe that if the proper model is run enough times, they can now determine with some confidence the relative importance of a major source region in the transport of acid into a distant region. How much confidence will be enough in the political process of policy-making remains to be seen.—**RICHARD A. KERR**

*Members of the committee are Jack Calvert, National Center for Atmospheric Research, chairman; Jeremy Hales, Battelle Pacific Northwest Laboratories; George Hidy, Environmental Research & Technology, Inc.; Jay Jacobson, Boyce Thompson Institute; Allan Lazrus, NCAR; John Miller, National Oceanic and Atmospheric Administration; and Volker Mohnen, State University of New York, Albany. Copies of the committee's report, *Acid Deposition: Atmospheric Processes in Eastern North America*, are available for $16.50 (prepaid) from the National Academy Press, 2101 Constitution Avenue, NW, Washington, D.C. 20418.