Tracing Sources of Acid Rain Causes Big Stir

New data suggest that the Midwest may not be responsible for all of the Northeast's acid rain

A three-page document prepared by a prominent atmospheric chemist is causing an uproar in environmental circles in Washington, D.C. The statement claims that the oft-quoted attribution of the Northeast's acid rain to the long-range transport of pollution from the Midwest may be an oversimplification. New evidence summarized in the statement has already been construed both as questioning the existence of long-range transport from the Midwest and as having nothing to do with the effect of distant pollution sources on the Northeast. Fueling the controversy are the upcoming revision of the Clean Air Act and proposed new controls on industry.

All the hubbub has arisen over an informal statement by Kenneth Rahn of the University of Rhode Island. In it Rahn claims that "instead of a monolithic Midwestern source, the Northeast is now seen to have a rich variety of sources and transport. . . ." He does caution that "we do not propose that it [the new evidence] challenges the basic picture of long-range transport in the Northeast—such an allegation would be premature. . . ."

Outside of Washington, Rahn's conclusions elicit only general agreement, although most scientists are reserving judgment of his evidence until it is formally published. Gene Likens of Cornell University, the man who first gave prominence to the U.S. acid precipitation problem, agrees that there is more to the long-range transport of acid rain into the Northeast than a simple link to the Midwest. "It's a mix of a variety of sources," he says. Likens and most other specialists point out that the simplest explanation of pervasive acid precipitation in the Northeast is still transport from the Midwest. But doubt remains about what proportion of the acid deposited at a particular site actually came from the Midwest.

Rahn is recognized as an expert in identifying the ultimate source of polluted air by analysis of its trace element content. He was the first to claim, amid some controversy, that industrial pollution fouls the once-pristine air of the Arctic (*Science*, 20 July 1979, p. 290). To prove that, he relied on the detection of the element vanadium in fine particles in the winter Arctic air. The amounts of vanadium detected (in the range of nanograms per cubic meter of air) could not be completely accounted for in terms of soil dust or local pollution sources. The logical source seemed to be the burning of fuel oil, which is rich in vanadium, in the middle latitudes. Additional sampling confirmed Rahn's supposition (*Science*, 29 May 1981, p. 1013). Rahn also combined the vanadium data with data on airborne manganese, which metal processing and some coal burning produce in copious amounts, to pinpoint the central Soviet Union and western Europe as the primary sources of the polluted Arctic haze.* No other areas had both the opportunity to pollute air on its way to the Arctic and the proper trace metal "signature" or ratio of coal- and ore-derived manganese to oil-derived vanadium.

Last fall, Rahn used the manganese-vanadium ratio to look in the Northeast for long-range transport from the Midwest. Earlier investigators had started at the biggest source, industrial emissions in the Ohio River Basin, and attempted to follow the pollution to its destination. Rahn instead analyzed particles from the air at the receiving end—at High Point, in far northwestern New Jersey, and at his laboratory in Narragansett, Rhode Island. According to his hypothesis, episodes of high pollution should have a Midwest signature of high manganese-vanadium ratios. The ratio is high (1 to 10) in the Midwest as compared with the East (0.1 to 0.2), where less coal and more oil is burned, Rahn says.

At High Point the observations fulfilled Rahn's expectations. Air moving from the interior had manganese-vanadium ratios eight times higher than air from the direction of the coast. But in Rhode Island Rahn found ratios that were consistently "eastern," about 0.1 to 0.2, even during episodes of high sulfate pollution. Data collected by others outside Boston, in Watertown, also fail to show a Midwest influence on the ratio, Rahn says.

This preliminary evidence suggested to Rahn that the Midwest may be responsible for different proportions of the pollution at different sites in the Northeast. Sources in the Midwest may dominate the air over western New York and the Adirondacks, where acid precipitation and its effects on lakes has received much attention. Closer to the coast, sources more to the south may make the largest contribution, he says.

Rahn cautioned in his statement that these are early results and that there are potential problems associated with using manganese and vanadium as tracers in the Northeast. For one, the transport routes across the United States are more complicated than those entering the Arctic. Pollutants from mid-latitude sources move into the otherwise clean Arctic without passing over other sources. Air from the Midwest having a high manganese-vanadium ratio, on the other hand, could pass over and be mixed with an eastern source before being sampled, which would drastically lower the ratio by the addition of vanadium.

Another potential problem is that manganese and vanadium may not behave enough like the sulfur that produces acid precipitation to be sensitive tracers. They leave a smokestack in particles that immediately begin to fall out of the air. Sulfur gets a free ride for a time as sulfur dioxide gas before forming acidic particles. Thus, the Midwest signature could fade beyond detection before the acid reached the East Coast. Adding to the uncertainty is the mystery of the cause of the high manganese-vanadium ratio in the air over the Midwest. Some excess manganese probably comes from metal processing, but coal burning in the Midwest apparently does not produce enough manganese to affect Rahn's ratio.

The evidence may be tentative, qualified by several caveats, limited to a small part of the Northeast, and supportive of a generally accepted idea, but that has not prevented it from becoming a hot topic in Washington. Because this is the first use in the United States of trace element analysis to identify distant pollution sources, improvements can be expected. Arsenic and selenium are already being suggested as more useful tracers.—RICHARD A. KERR

*K. Rahn, *Atmos. Environ.* **15**, 1457 (1981).

0036-8075/82/0212-0881$01.00/0