Northeast

Richard Poirot – Conference of New England Governors and Eastern Canadian Premiers

I first became interested in and concerned about acid rain about 25 years ago, as a brand new employee for the Vermont air pollution control program. My first assignment was to write a state implementation plan revision to assure attainment of air quality standards for particulate matter in Vermont.

In those days we were regulating a pollutant called total suspended particulate or TSP which, as Dr. Lippmann explained yesterday, was a fairly primitive concept of particulate matter. Nonetheless, it was the state of the knowledge at the time, at least from a regulatory perspective. We had a bit of non-attainment in Vermont in those days (actually, it was the last non-attainment that we had), and it was measured at an urban monitor next to a heavily traveled city street.

Every spring, as the snow banks would melt away from the sides of the road, the sand that we had put down all winter long would blow into the monitor and we would get high TSP concentrations. We could examine the high concentration filters under an ordinary light microscope and actually see the huge grains of sand on filters, and we could analyze the filters chemically and find lots of silicon and aluminum and iron and calcium (we even had calcium in those days). We fixed that problem in the usual way – by moving the monitor a little bit further back from the roadway – and our air quality improved substantially.

But as we also got into this business of analyzing some of our filters, we realized that we had another period of high concentrations in the summer. When we analyzed those filters, there wasn't much sand on them, but instead we found an exotic new pollutant called "sulfate". When the concentrations were high in our largest urban areas, we found that they were high everywhere across the state, and were sometimes even higher at our most remote background sites.

This led us to start to look into the historical literature and as it turns out, we actually knew quite a bit about sulfate aerosols, acid deposition and so forth decades ago. We just keep forgetting and re-discovering this information.

These figures (Figure 1) showing health and visibility effects of sulfate aerosols, were taken from a federal criteria document on sulfur oxides

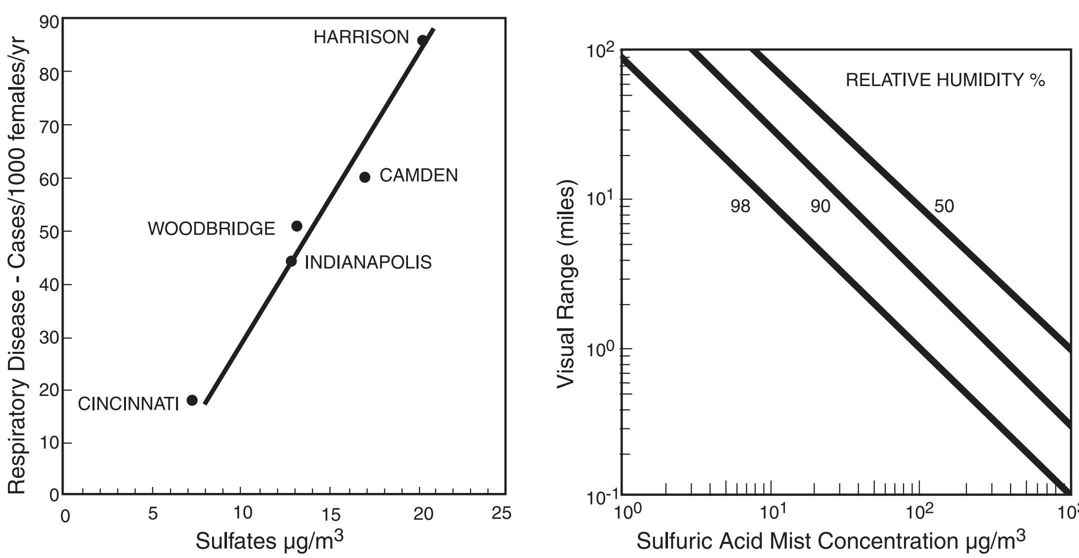

Figure 1. Detailed discussion of effects of sub-micron sulfate aerosols on human health and visibility (From: Air Quality Criteria for Sulfur Oxides, National Air Pollution Control Admin., US Dept of H.E.W, January, 1969).

published by the US Dept. of Health, Education and Welfare in 1969 – a year before the US Environmental Protection Agency was established. This 1969 document also included extensive discussions of the effects of sulfuric acid mist on metals, stonework and masonry (not as detailed as Mary Striegel described yesterday, but nevertheless indicating a thoroughly evolved scientific understanding of materials damage functions), as well as detailed discussion of the effects of sulfuric acid on vegetation.

The estimated health effects vs. sulfate relationship in 1969 was not exactly the same as the ones that Dr. Lippmann was showing you yesterday, but actually it is not all that dissimilar. The plot of sulfate vs. visual range, including effects of a hygroscopic aerosol growth function with increasing relative humidity, is conceptually very similar to the "modern" equations used to calculate "reconstructed light extinction" (from sulfate and relative humidity) which have been recently included in new EPA regulations to reduce regional haze in National Parks and Wilderness areas. Congress called for these visibility regulations in the 1970s; the scientific understanding of sulfate/visibility effects was reasonably clear in the 1950s; and now in 2001, we finally have a regulatory program in place – although these regulations will not be fully implemented for another 60 years.

As I began to discover a large body of historical scientific literature indicating that the aerosol conversion products of sulfur dioxide emissions had a wide variety of health, environmental and welfare effects, I was encouraged to learn that EPA, in 1973 Congressional hearings, indicated that they were working on an ambient aerosol sulfate standard, and that this would take some three to five years to develop. So when I started work for the State of Vermont in the late 1970s, I figured that any day now we were going to see a strong federal regulatory program to control these sulfur emissions. Just a matter of time.

The next implementation plan revisions that we had to develop in Vermont were in response to the visibility protection requirements of the 1977 Clean Air Act. In 1985 we tried to sneak in an acid rain control program as our State Implementation Plan to protect visibility in the Lye Brook Wilderness area. This cover of this 1985 document (Figure 2) illustrates a sulfate episode that occurred on July 17, 1982, with sulfate concentrations increasing from 1 to 7 to 14 to 35 micrograms per cubic meter over a 4-day period, and visibility declining to less than two miles. We had modeled this sulfate haze event using seven different

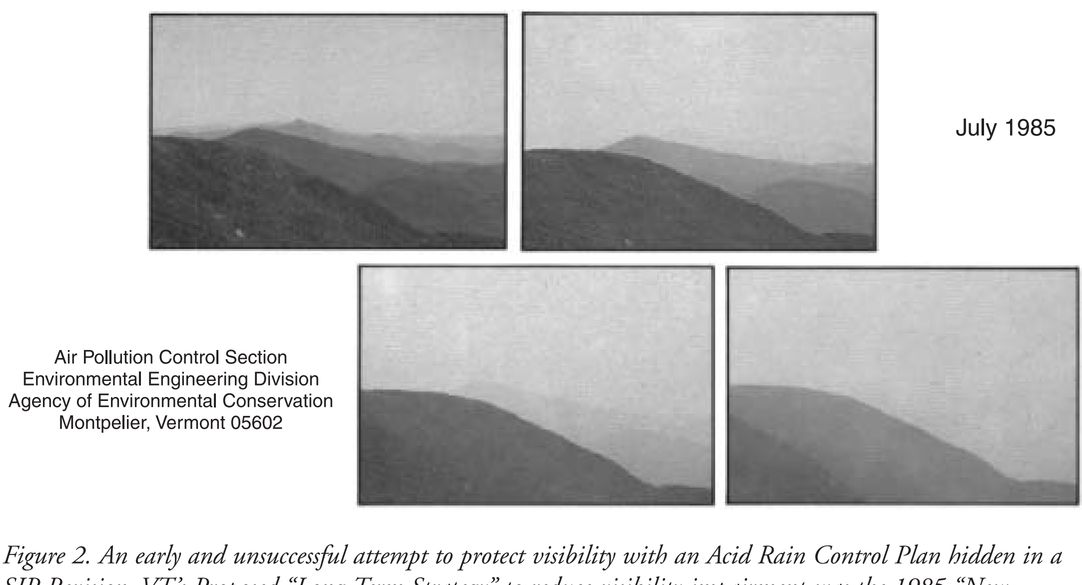

Figure 2. An early and unsuccessful attempt to protect visibility with an Acid Rain Control Plan hidden in a SIP Revision. VT's Proposed "Long-Term Strategy" to reduce visibility impairment was the 1985 "New England Eastern Canada Sulfur Dioxide Emissions Reduction Plan."

techniques that clearly indicated it was a midwestern sulfate transport episode. We proposed in this visibility plan, a VT annual average state sulfate standard of two micrograms per cubic meter, to be attained over a 10 year period, which would have achieved a roughly 50% improvement over early-1980's levels. We argued that this would represent "reasonable progress" toward protecting visibility as required under the Clean Air Act, and would have the "ancillary benefits" of reducing regional haze, fine particle concentrations and acid deposition throughout the eastern US and Canada. That is, given the large regional scale of the problem, improvements could not be seen in Vermont without improvements throughout most of eastern North America.

We also included as our long-term visibility strategy an international acid deposition control plan that had been developed by the New England Governors and Eastern Canadian Premiers in 1985. A key element of that 1985 international agreement called for national SO_2 reductions in the range of 50 percent from 1980 levels, by 1994, in both the United States and Canada.

Another key element of this international agreement was that it merged the "effects-based" approach that the Canadians have used, with emphasis on controlling specific sources to maximizing the benefits on acid sensitive regions, with the U.S. "emissions-based" approach, which is more of a broad based roll-back of utility sulfur emissions in the most cost efficient way (allowing a maximum SO_2 emissions rate of 1.2 pounds per million BTUs of heat input). A very significant aspect, in my view, of this early governors/premiers plan was not only proposals for upwind reduction but also commitments to reduce our own emissions, clean up our own house, put our money where our mouth was – regardless of what happened in upwind jurisdictions. Five years later, under the United States – Canada Air Quality Agreement, both countries did commit to significant national SO_2 control programs, which were not directly based upon, but were actually very similar to those proposed by the New England Governors and Eastern Canadian Premiers in 1985.

These national programs have, to a very large extent, run their course, causing the New England Governors and Eastern Premiers to pick up the issue again and take stock of how far have we gone, how far do we need to go. This led to a recognition that, while we made some progress, we were not seeing the kind of ecological recovery that we were interested in, and a number of additional issues had emerged.

In 1998, the Governors and Premiers signed another acid rain action plan calling for yet another round of reductions of at least 50 percent sulfur dioxide and annual NO_X reductions of 20 to 30 percent in both countries (Figure 3). As with their 1984 plan, this new agreement also included

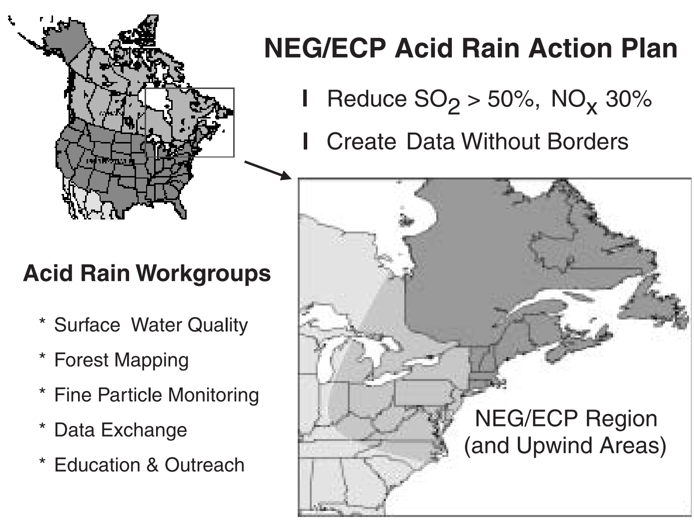

Figure 3. NEG/ECP Acid Rain Action Plan.

commitments to reduce our own emissions within this 11-jurisdiction transboundary region, regardless of what happens upwind. In addition, a number of technical work groups were established that are developing, and in some cases repairing or rediscovering, some of the historical data sets, and monitoring and research activities, that were much more prominent (and more adequately funded) during the "acid rain decade" of the 1980s.

One area of emphasis in this 1998 plan, and I think we have heard it emphasized by almost all the speakers so far, is the need to really look at the big picture and understand the multiple effects that are associated with these pollutants. You can jump into the issue any which way – call it acid rain if you like – but really, it is not very different from the visibility issue, the fine particle health issue, the effects on ozone and eutrophication of coastal estuaries and so on and so forth. So the plan specifically defines its focus as on "the multiple effects associated with emissions of sulfur and nitrogen oxides" or conversely, "the multiple benefits that would accrue with further reductions of sulfur and nitrogen oxide emissions" (Figure 4).

Sulfur and nitrogen oxides are certainly not the only atmospheric pollutants of concern, but from a northeastern perspective, they are sufficiently important, their effects are sufficiently adverse, continuing, cumulative and spatially widespread, and their control costs are sufficiently modest, that additional future emissions should be initiated without further delay. Within the New England/ Eastern Canada Region a number of substantial intra-jurisdictional emissions reductions commitments have recently been achieved (Table 1). Generally, most of these include commitments of additional sulfur reductions of 50 percent or more. Some of these programs include commitments for NO_X reductions, some include mercury and some include sulfur, nitrogen, mercury and CO_2 as well. There are also similar emission control commitments that are currently in the works or in legislation in areas directly upwind of us in New York and Ontario.

In addition to the need to extend these regional control programs to an international scale in the US and Canada, other areas where coordinated bi-national initiatives would be especially helpful include the development of emission inventories that are consistent across the United States and Canada, and that are consistent over time. I think this is kind of an international embarrassment that we really do not have consis-

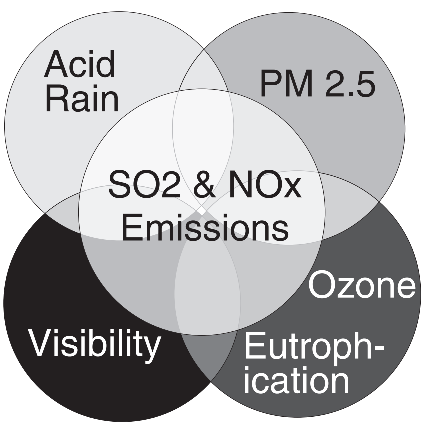

Figure 4. "Ecosystem sensitivity" refers to all the environmental effects associated with the emissions of sulfur and nitrogen oxides which cause acid rain... Or conversely, a consideration of all of the environmental benefits that would result from further reductions in sulfur and nitrogen oxide emissions.

Table 1.

NEG/ECP Unilateral SO_2 Emissions Reductions Commitments:

- Connecticut: 40% SO_2 by 2002 (0.5 lbs/ MMBtu), > 50% by 2003 (0.3 lbs MMBtu = 0.3% S in fuel)
- Quebec: 40% by 2002, 50% by 2010
- Massachusetts: 53% – 74% by 2008 (6 lbs/ MWH by 2004 or 2006; 3 lbs/MWH by 2006 or 2008, later dates for re-powering)
- New Brunswick: 30% by 2005; 50% by 2010
- New Hampshire: (multi-pollutant Bill currently in Legislature)
- Nova Scotia: (currently in Negotiation, proposed 50% SO_2)
- Similar commitments in progress from NY & Ontario

All of above also include NO_x reductions, some include Hg, CO_2 and a few include emissions/allowance trading.

tent emission inventories that are more modern than 1985 NAPAP. We also need to have some much better agreement and coordination on what do we consider to be reasonable US and Canadian emissions reduction scenarios for the future. How do we allocate future emissions reductions so that we can evaluate them in our modeling assessments? Depending on which country is doing the modeling, one country tends to make really silly assumptions about what might be happening in the other country for future emissions. We also need these models to be comprehensive in nature to evaluate the multiple effects and multiple benefits in not only deposition but aerosol concentration, fine particles and so forth. These models can't continue to focus on just a few short-term events (although we need those kinds of sophisticated models), we also need to look at more long-term concentrations of multiple pollutants and deposition over at least continental-scale domains. We would also want to consider alternative controls to maximize reductions of mercury and carbon dioxide, but these emerging issues should not be used as an excuse to further delay emission reductions of sulfur and nitrogen.

To illustrate a few of these points with bits of regional data, here is some good news in the historical precipitation record of sulfate deposition from the Bennington, VT NADP site (Figure 5). In the most recent year, we have received the lowest deposition rate and lowest concentration in this long-term record! We are concerned, however, that proposed budget cuts at USGS may jeopardize some of the water monitoring and research activities there, possibly reducing future support for this kind of monitoring effort. The critical importance of monitoring programs is a hard thing to sell politically, but it is absolutely critical if we are going to move forward.

In parallel to the modest regional improvements in sulfate deposition, we have seen similar reductions in aerosol sulfate concentrations, as evident in this long-term data from Acadia National Park in Maine from the national IMPROVE network (Figure 6). The blue line is a long-term average, about a one-year running average and the red dots are the actual daily concentrations. The trend line indicates a fairly steady long-term improvement. From the right hand scale (in nanograms per cubic meter), you may note that we are actually getting down close to the annual average of 2 micrograms per cubic meter, that we proposed 20 years ago as a visibility standard in Vermont. We have made some progress.

On the other hand, take a look at the actual daily concentrations. The episodes are as high as they've ever been, and July 17, 1999 was the highest sulfate level ever recorded at Acadia. In Vermont we had even higher sulfate concentrations that were up in the range of 35 micrograms per cubic meter, tying the all-time record for aerosol sulfate that was last measured exactly 17 years ago to the day earlier on July 17, 1982 (the day on the cover of our old visibility plan).

This was a whopping big sulfate episode, and resulted in exceptionally high fine particle concentrations extending from the Ohio River Valley well

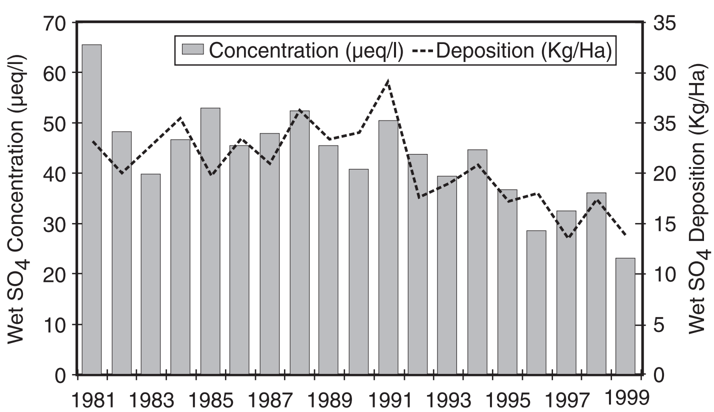

Figure 5. Wet sulfate deposition in Bennington, VT (NADP).

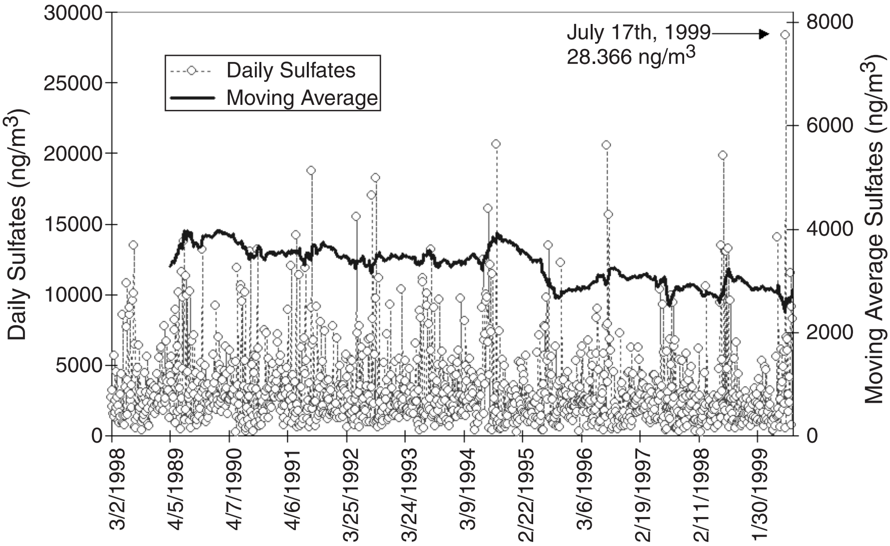

Figure 6. Daily and "annual average" sulfate at Acadia National Park, 1988-1999 (sulfate expressed at $[NH_4]_2\ SO_4$; 100 sample mixing average).

up into northern New England, and of course into eastern Canada as well, although we always tend to cut off our data at the borders. These concentrations, by the way, were well below – you might say "safely" below – the U.S. fine particle short term standard. On the other hand, they were well above the Canadian short term standard (Figure 7).

Healthy or not (and we suspect not), one thing that's clear is that you can't see through air which contains this kind of acidic sulfate pollution. The chart on the lower left (Figure 8) shows that hourly fine particle concentrations in Roxbury, MA were approaching 100 micrograms per cubic meter. In the upper left panel we see that these fine particle concentrations coincided with light extinction measurements (the inverse of visual range) that approached 1000 inverse megameters at sites in Vermont and New Hampshire. The panels on the right show the view of Boston on a clear day (top) and on July 16, 1999 (bottom) in the midst of this regional episode. Four hours after that picture was taken, John F. Kennedy's plane went down over extremely hazy skies over Martha's Vineyard. In a National Transportation Safety Board report on that accident, the word haze is mentioned 23 times and the word pollution is not mentioned once.

So, even though we have made progress, I think that we still have a long ways to go. Thank you.

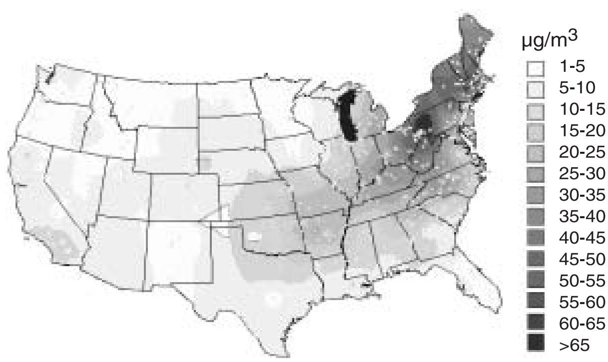

Figure 7. $PM_{2.5}$ concentrations on 7/17/99. "Safely" below US short-term $PM_{2.5}$ standards in New England but well above Canadian standards throughout Northeast and Eastern Canada.

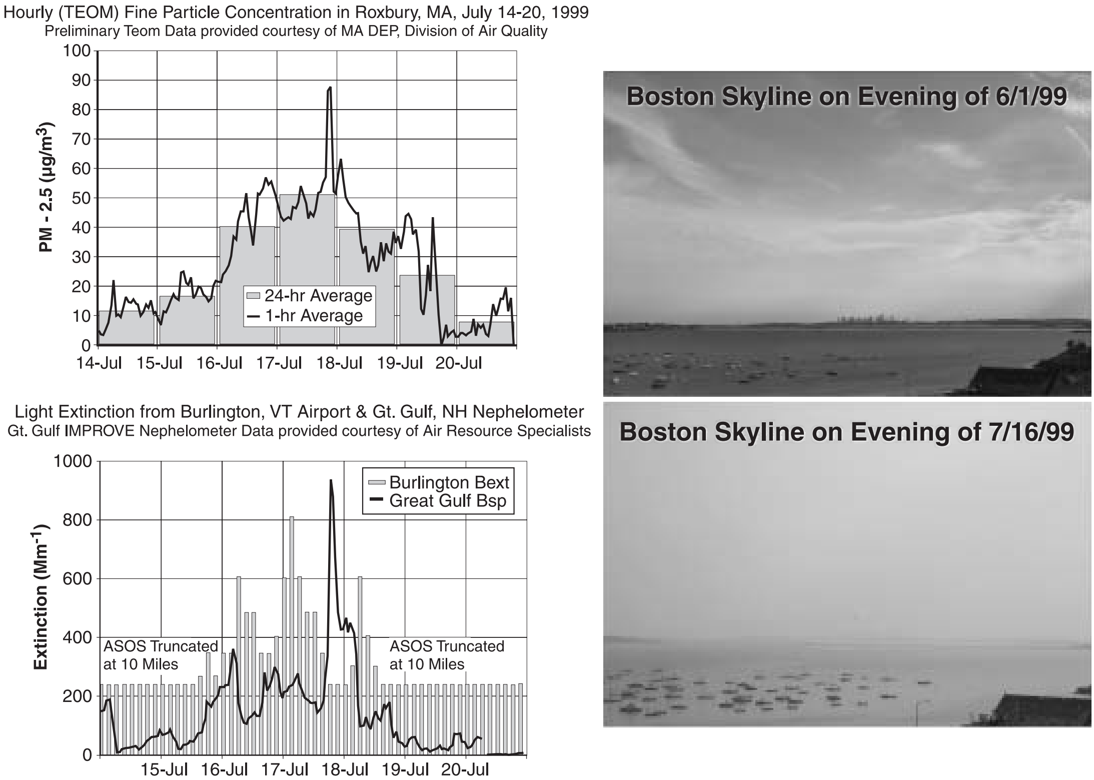

Figure 8.

QUESTIONS

MR. FRANKEL: Frankel, GAO. With regard to the loss of data if monitoring money is reduced, there is a tradition of getting rid of the messenger.

I wonder in a similar vein if all the dealings of the New England Governors and Canadian Premiers have ever been subject to scrutiny under the trading with the enemy act.

MR. POIROT: I don't know that act. I guess we would invoke the free trade agreement.

MR. LEWIS: Preston Lewis, New York State Department of Environmental Conservation. I guess my favorite topic is modeling and you mentioned it. I am curious to know who is going to do this comprehensive modeling. Who would you suggest?

MR. POIROT: I think there is a tendency for the modelers to keep thinking of new sophisticated tweaks to add to their models that almost exactly eats up all the advances in computer speed, such that we can never afford to model more than a few short episodes with these state-of-the-art models. While these continuing advances in model complexity are necessary as our knowledge increases, I think its also essential to keep working on developing the best multi-pollutant models we can afford that can be run to cover multi-year periods and large, continental-scale spatial domains. In both cases, I think the federal governments (perhaps in a collaborative effort between the US and Canada) are logical places for the development and deployment of these large regional models, and also for the detailed (and expensive) emissions inventory and meteorological information needed to run the models

As these regional models are developed and evaluated at the federal level, I think its also important that they become "transferable" to States, Provinces and other users. We each have specific pollutant mixes, time periods, and sensitive resources of local interest, and we also likely have slightly different ideas of what would be "reasonable" future control (or growth) strategies to consider.