ATMOSPHERIC PROCESSES AND MODELS

Sulfur and nitrogen have important natural cycles in the environment in which they go through various oxidation and reduction reactions and translocations among the atmosphere, biosphere, hydrosphere, pedosphere, and lithosphere. Human activity (especially fossil-fuel combustion) has added a major perturbation to these natural cycles, and perhaps modified the natural translocation rates and sizes of the reservoirs. The fluxes of sulfur translocation between reservoirs have been estimated for the paths shown in Fig. 1 and are presented in Table I. The agreement among the reported values is not good, especially so for the estimates of annual anthropogenic sulfur fluxes to the atmosphere which range from 11 to 45% of the total sulfur involved in the atmospheric balance.

The fluxes of nitrogen translocation between reservoirs have been estimated for the pathways shown in Fig. 2 and are presented in Table II. The nitrogen fluxes are more poorly established than those for sulfur. Only the industrial fixation flux is known with confidence. Also, it is likely that the global cycles of sulfur, nitrogen and carbon are interactive in complex ways that may distort our understanding based on the simpler elemental cycles.

The global sulfur and nitrogen cycles and the annual fluxes between compartments provide a broad view of the processes that may lead to adverse impacts upon mankind and ecological systems. However, the global scale and annual fluxes are clearly beyond the interest in transboundary flow of pollutants between the U.S. and Canada. S- and N-oxides emissions are not uniformly distributed over the land mass of the U.S. and Canada, and the effects often have characteristic response-times that are much less than 1 year.

For areas of regional or smaller scale and times of hours to days, a reasonable way to relate source-emission areas to impact areas is to trace the pollutants' chemical transformation--atmospheric translocation pathways on a finer scale than indicated in Figs. 1 and 2.

A direct approach is through mass-conservation mathematical formulations (models) that simulate the important physico-chemical processes