tant is not conservative, either in its physical properties or due to loss by deposition on the ground, vegetation, water, and so forth; these modifying effects must be included in any attempt to predict the location and concentration of such airborne materials.

Data from intensive studies of the transport and diffusion of gaseous materials in the lower atmosphere and for travel distances up to 20 to 30 miles are now available. Much less complete information is available for travel distances of the order of hundreds of miles, but some studies and data show very clearly that the reduction in concentration of a pollutant from a single source is, on the average, well approximated by mathematical equations. The equations provide the basic mathematical model for predicting the contribution of a single source to the concentration of a pollutant at any travel distance. Finally, it is important to determine the total concentration of a pollutant as a function of place and time. This concentration will generally represent the sum of contributions from a number of sources. Such a summation is straightforward once we have solved the diffusion and trajectory equations for each source. The position and source strength for each of the sources will be required for this summation. As soon as a model has been developed which predicts with reasonable accuracy present air quality levels, projections can be made of air pollution emissions for 5, 10, and 20 years in the future, based on various assumed degrees of industrial air pollution control, expected population increases, changes in transportation—for example, rail transit systems in cities and more car travel in the country—changes in fuel for home heating, conversion of power generation from fossil to nuclear fuel, and so forth. These projections may be plugged into the model to permit prediction of future air quality based on various selected assumptions consistent with long-term growth estimates over an area.

In sum, I would urge that the development and perfection of simulation models be an essential ingredient of the national research strategy. I believe it is unnecessary to belabor the point that the ogre of computers making decisions need not be feared. The simulation models on computers are tools in the hands of human decision-makers and are not to be confused with the decision-makers themselves.

My fourth point is related to the question raised with respect to the consequences of increasing the carbon dioxide content of the atmosphere and is relevant to the issue concerned with the establishment of meaningful cause-and-effect relationships in the environment when long time lapses occur—for example, 20 to 30 years. The increased carbon dioxide, in effect, keeps the long wave radiation from going out into space while allowing the short wave radiation to come in. Increasing carbon dioxide in the atmosphere, again in effect, is similar to providing an "extra blanket" around the earth. The outlines of a technical method for analysis of this problem and some preliminary results have been provided as a result of the elegant work of Dr. S. Manabe and his collaborators in the Environmental Science Services Administration. They have examined the dependence of the temperature in the atmosphere as a consequence of increased carbon dioxide. The technique is to employ a sophisticated mathematical model on a large-scale high-speed computer taking into account the complex interaction of the physical processes governing atmospheric motion. The preliminary