USES AND LIMITATIONS OF MODELING IN ANALYZING AND DESIGNING O₃ STRATEGIES

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Abstract. A sufficient historical record in grid-based O₃ modeling now exists to permit assessment of its role and limitations in policy analysis. In this presentation, several topics are examined: past experience in model evaluation and use, the present status of modeling, the value of modeling in policy analysis, and key issues and future needs. First, the role of grid-based O₃ modeling in policy analysis was assessed through a case study of nearly 10 years of model applications in the South Coast (Los Angeles) Air Basin. Changes in quality of performance and in degree of acceptance of grid-based models (in policy analysis) with time were analyzed and compared. Degree of acceptance appears to depend on a variety of factors, including level of understanding and familiarity, perception of need, and relative degree of acceptability, as compared with other available models. Improvements in quality of performance with time were limited (and, in any event, knowledge of such changes were not available), and thus this factor seems to have had little or no role in influencing model acceptance. Second, the current state of modeling, in terms of both science and art, is appraised, considering the state of knowledge, availability of data bases, adequacy of performance evaluation procedures, and quality of predictive performance. Significant deficiencies have existed in knowledge and treatment of key governing processes in models. Until recently, data bases suitable for use in evaluating model performance were unavailable. Quality of performance has not been sufficiently good to confer confidence in models' use in a regulatory environment. Evaluative testing did not provide sufficiently for ‘stressing’ models. For many, but not all of these issues, attention is now being, or soon will be, given to alleviating concerns. Third, the role and value of modeling in policy analysis is discussed. Attention is given to the role of the modeling expert in the policy forum, as compared with the model itself, and with the consideration of modeling as a longer term process rather than as a direct or short term means of generating ‘answers’. Finally, key concerns and future needs are delineated, and some unsolved problems are discussed.

1. Scope of Paper

Grid-based photochemical air quality simulation models (PAQSMs) were first developed in the early 1970s. They have undergone continuing evaluation, improvement, and refinement to the present day. However, until the mid-1980s they saw only limited application. The regulatory community viewed them as having overwhelming data requirements, long applications times, and substantial computing expense. In short, they were considered ‘research’ models; the appeal of the much simpler EKMA formulation was greater.

Since 1985, application of PAQSMs has expanded greatly – in number of applications, diversity of geographical locations, and sponsors' commitment to acquiring data bases to support such modeling. The current commitment to their use probably derives, in part, from the belief that these models are the ‘best available’. Concerns about costs have, in some cases, diminished. Computing costs, themselves, are now only a small fraction of the total cost of application. Decision makers
seem more willing today to bear the cost of data acquisition (i.e., field studies) to support modeling. In addition, automation of model inputs and experience gained in model applications have led to a substantial reduction in the time required for carrying out the computational portions of a study.

The 1990 Clean Air Act (CAA) prescribes the use of grid-based photochemical models in developing emissions control plans for ozone nonattainment areas. As the control of VOC emissions has long been the primary strategy of EPA in attempting to achieve attainment, key issues that arise in such planning are:

- the appropriateness of reducing NO\textsubscript{x} emissions as well,
- the amount of emissions reductions needed to achieve attainment, and
- the reliability of the estimates.

Other topics that are now receiving increased attention and, due to that attention, are influencing the nature of the modeling that is being undertaken include:

- the impact of emissions reduction strategies on transport of O\textsubscript{3} and precursors to downwind areas and the influence of these pollutants on local control strategies,
- the introduction of alternative fuels and the influence of changes in reactivity on control strategy development, and
- the explicit consideration of uncertainty in developing emissions reduction requirements.

The CAA requirements will greatly extend the use of PAQSMs. One might ask:

- 'Is this a good thing?'
- 'Are the models suitable for regulatory application?'
- 'Will inadequacies in supporting data bases severely limit the usefulness of such applications?'

The tangential role assigned to PAQSMs in the 1970s and, particularly, in the early 1980s was a source of concern to some in the scientific community. It was felt that an important resource was not being adequately utilized. Now, discomfort is developing with the potential for 'wholesale use' of these models. Questions arise concerning:

- adequacy of supporting data bases for the many cities experiencing exceedances of the O\textsubscript{3} standards,
- availability of qualified, experienced modelers to satisfy the potential demand,
- adequacy of the procedures used for evaluating model performance,
- the degree of commitment to assuring that adequate performance is achieved before a model is accepted for use, and
- the potential for model acceptance based on only limited evaluation (and, perhaps, questionable performance) because of a desire to satisfy an immediate need and/or because of the model's status as the 'best available'.

Concerns about the use of PAQSMs form the basis for this paper. They stem, overall, from a perception that expectations of these models in regulatory application may be exaggerated or even inappropriate. The objective of this paper is to provide perspective on the use and limitations of PAQSMs in regulatory application and policy analysis. Specifically, we will:

- examine experience acquired in modeling in California,