United States
Environmental Protection
Agency

Atmospheric Research and Exposure
Assessment Laboratory
Research Triangle Park NC 27711

Research and Development

EPA/600/S3-90/029 June 1990

EPA

Project Summary

The Role of Biogenic Organics in the Southeast Ozone Problem: Preliminary Assessments and Implications

Basil Dimitriades

Literature review and modeling studies were performed to assess the role of biogenic VOC emissions in the photochemical ozone problem of urban areas. The assessment effort focused specifically on recent research results reported by Georgia Institute of Technology (GIT) scientists indicating that biogenic VOCs in Atlanta reduce substantially the effectiveness of VOC controls in reducing ambient ozone. The GIT findings were checked for accuracy and for consistency with previous studies and also for applicability in other urban areas. EPA and SAI modelers replicated the GIT modeling study and verified its results and conclusions. A conflict between the GIT study and an earlier modeling study by others was resolved, further establishing the validity of the GIT results. Sensitivity studies by EPA modelers showed, however, that the GIT findings, while unquestionably valid for Atlanta, were not necessarily applicable to all urban non-attainment areas. Factors affecting the strength of the biogenic VOC role in the urban ozone problem were found to be the abundance and reactivity of biogenic emissions, the prevailing wind speeds during ozone episodes, the maximum afternoon mixing height, the size of the urbanized area, and perhaps other factors also.

This Project Summary was developed by EPA's Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Photochemical ozone pollution, recognized over three decades ago, has turned out to be one of the most persistent and intractable air pollution problems in the US and other parts of the world. Despite multi-year efforts to reduce emissions of volatile organic compounds (VOCs), the ozone air quality standard continues to be violated in over 100 urban areas in the US, many of which are in the Southeast part of the country.

Several reasons have been hypothesized in the past, explaining slow progress in alleviating the ozone non-attainment problem. One possible reason for the problem was suggested recently when new modeling studies by Georgia Institute of Technology (GIT) scientists for the Atlanta urban area indicated that, contrary to previous general understanding, VOC emissions from vegetation might reduce the effectiveness of VOC control substantially, at least in the Southeast. EPA is concerned about the Southeast ozone problems and about the role attributed to biogenic VOCs. If biogenic VOC emissions have indeed contributed to an underestimation of the level or type of controls needed in

Atlanta, similar effects may have occurred in some other urban areas as well. Before significant resource commitments are made, however, to explore this possibility, the Agency needs assurances that the evidence pointing to the need for further studies is credible and conclusive. The research work described and discussed here is an attempt to evaluate the GIT evidence for the purpose of providing the requisite assurances. The intent was to identify and justify future research needs—clearly, not to suggest changes in regulatory policy or strategies. Time and resource constraints dictated that this effort be limited to reviewing published information, and doing quick modeling computations using EKMA and other comparably simple modeling techniques.

Discussion of Results and Conclusions

There are three questions regarding the role of biogenic VOC that need to be addressed. First is the question of whether or not all studies agree that the role of biogenic VOC in the urban ozone problem is significant. The second question deals with the magnitude of the biogenic VOC effect and, specifically, with the degree to which biogenic VOCs increase the VOC emission control requirement for ozone attainment. Finally, there is the question of whether or not the GIT results for Atlanta reflect an Atlanta "uniqueness," or, more generally, the question of the degree to which the biogenic VOC effect varies from city to city for the various US non-attainment cities.

Studies of the biogenic VOC involvement in the ozone problem include smog chamber studies and atmospheric chemistry and modeling studies. The unanimous current assessment is that existing smog chamber data are consistent with an important role of biogenic VOCs in the urban ozone problem comparable to the role of the anthropogenic VOCs. Smog chamber experimentation and evidence, however, while strongly suggestive, are somewhat unrealistic and for that reason their validity is questionable. Field measurements and evidence are inherently more valid but the biogenic VOC issue is far too complex to be resolved through field studies alone. Ozone models, when properly validated against theory and smog chamber and field data, are thought to be both credible and useful tools for investigating issues such as the one in hand. One such modeling study was done in 1983-84. The investigators modeled the Tampa-St. Petersburg urban plume using the ELSTAR photochemical trajectory model, and interpreted their results to mean that the biogenic VOC contribution to the urban ozone problem was not significant. Because of apparent conflicts between that study and other newer modeling studies, the Tampa-St. Petersburg study was repeated in the light of the latest understanding regarding the chemistry and precursor roles in the ozone-forming process. The results from the new study indicated that inclusion of the biogenic VOCs resulted in a small increment in peak ozone concentration but the anthropogenic VOC control requirements were substantially increased when biogenic VOCs were included, in agreement with the GIT results.

There are several factors that can cast doubts on the modeling estimates of the magnitude of the biogenic VOC effect. First, there is the "model uncertainty" factor which, judging from the differences among the different models' predictions reported here and from current judgment, in general, concerning the validity and accuracy of current ozone models, will have to be considered as an important one. Then there is, also, the biogenic VOC emissions level, composition and atmospheric chemistry accuracy factors, the effects of which were studied to some extent by the GIT and EPA modelers and found to be important. Finally, there are several other factors the importance of which was established through a sensitivity analysis done by the EPA modelers. These latter factors include atmospheric dilution (i.e., maximum afternoon mixing height) and size of the urbanized section of the urban area. The conclusion from the studies and theoretical analyses reported here was that the magnitude of the biogenic VOC effect, while unquestionably significant, cannot be quantified with confidence at this time.

Finally, while there can be little doubt at this point that biogenic VOCs reduce significantly the effectiveness of anthropogenic VOC controls in Atlanta, this may or may not be the case for each and every non-attainment urban area. To explore this possibility, EPA modelers performed a sensitivity analysis to determine the degree to which factors that vary from city to city affect EKMA computations of the biogenic VOC role. The conclusion from that study was that the biogenic VOC factor for some urban areas may be as strong or stronger than in Atlanta but for other cities it may be considerably less important. Each urban area should be judged separately, based on its own biogenic VOC emissions loading factor, the biogenic VOC composition, the size of its "urbanized section," the prevailing wind speeds during ozone episodes, the maximum afternoon mixing height, and perhaps other factors also.

In summary, the results from this assessment effort were:

- Biogenic VOCs in Atlanta are more important than previously believed.
- "Importance" in other cities varies, possibly widely.
- Much uncertainty exists in quantitative estimates of the biogenic VOC role because of limited data on levels composition and atmospheric chemistry of biogenic VOC emissions.
- VOC control requirements in the past were probably underestimated because of lack of data on or underestimated biogenic VOC role.
- NO_x emissions may be more important than previously believed in areas high in biogenic VOC emissions.

The EPA author, ***Basil Dimitriades*** *(also the EPA Project Officer, see below), is with Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.*

The complete report, entitled "The Role of Biogenic Organics in the Southeast Ozone Problem: Preliminary Assessments and Implications," (Order No. PB90-188 855/AS; Cost: $39.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Atmospheric Research and Exposure Assessment Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

Official Business
Penalty for Private Use $300

EPA/600/S3-90/029