UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

October 25, 2005

EPA-CASAC-CON-06-002

Honorable Stephen L. Johnson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Subject: Clean Air Scientific Advisory Committee (CASAC) Ozone Review Panel's Consultation on EPA's Draft *Ozone Environmental Assessment Plan: Scope and Methods for Exposure, Risk and Benefits Assessment* (August 2005)

Dear Administrator Johnson:

EPA's Clean Air Scientific Advisory Committee (CASAC), supplemented by subject-matter-expert Panelists — collectively referred to as the CASAC Ozone Review Panel ("Panel") — met via a public teleconference on October 3, 2005, to conduct a consultation with staff from EPA's Office of Air Quality Planning and Standards (OAQPS), within the Office of Air and Radiation (OAR), on the Agency's draft *Ozone Environmental Assessment Plan: Scope and Methods for Exposure, Risk and Benefits Assessment* (August 2005). The current CASAC roster is attached as Appendix A of this letter, and the CASAC Ozone Review Panel roster is found in Appendix B. EPA's charge to the Panel is contained in Appendix C to this letter, and Panelists' individual written comments are provided in Appendix D.

The SAB Staff Office has developed the consultation as a mechanism to advise EPA on technical issues that should be considered in the development of regulations, guidelines, or technical guidance before the Agency has taken a position. A consultation is conducted under the normal requirements of the Federal Advisory Committee Act (FACA), as amended (5 U.S.C., App.), which include advance notice of the public meeting in the *Federal Register*.

As is our customary practice, there will be no formal report from the CASAC or the SAB as a result of this consultation, nor does the Committee expect any formal response from the Agency.

Sincerely,

/signed/

Dr. Rogene Henderson, Chair
Clean Air Scientific Advisory Committee

Appendix A – Roster of the Clean Air Scientific Advisory Committee

Appendix B – Roster of the CASAC Ozone Matter Review Panel

Appendix C – Charge to the CASAC Ozone Review Panel

Appendix D – Comments from Individual CASAC Ozone Review Panelists

Appendix A – Roster of the Clean Air Scientific Advisory Committee

U.S. Environmental Protection Agency
Science Advisory Board (SAB) Staff Office
Clean Air Scientific Advisory Committee (CASAC)

CHAIR

Dr. Rogene Henderson, Scientist Emeritus, Lovelace Respiratory Research Institute, Albuquerque, NM

MEMBERS

Dr. Ellis Cowling, University Distinguished Professor-at-Large, North Carolina State University, Colleges of Natural Resources and Agriculture and Life Sciences, North Carolina State University, Raleigh, NC

Dr. James D. Crapo, Professor, Department of Medicine, National Jewish Medical and Research Center, Denver, CO

Dr. Philip Hopke, Bayard D. Clarkson Distinguished Professor, Department of Chemical Engineering, Clarkson University, Potsdam, NY

Dr. Frederick J. Miller, Consultant, Cary, NC

Mr. Richard L. Poirot, Environmental Analyst, Air Pollution Control Division, Department of Environmental Conservation, Vermont Agency of Natural Resources, Waterbury, VT

Dr. Frank Speizer, Edward Kass Professor of Medicine, Channing Laboratory, Harvard Medical School, Boston, MA

Dr. Barbara Zielinska, Research Professor, Division of Atmospheric Science, Desert Research Institute, Reno, NV

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Mr. Fred Butterfield, CASAC Designated Federal Officer, 1200 Pennsylvania Avenue, N.W., Washington, DC, 20460, Phone: 202-343-9994, Fax: 202-233-0643 (butterfield.fred@epa.gov) (Physical/Courier/FedEx Address: Fred A. Butterfield, III, EPA Science Advisory Board Staff Office (Mail Code 1400F), Woodies Building, 1025 F Street, N.W., Room 3604, Washington, DC 20004, Telephone: 202-343-9994)

Appendix B – Roster of the CASAC Ozone Review Panel

U.S. Environmental Protection Agency
Science Advisory Board (SAB) Staff Office
Clean Air Scientific Advisory Committee (CASAC)
CASAC Ozone Review Panel

CHAIR

Dr. Rogene Henderson*, Scientist Emeritus, Lovelace Respiratory Research Institute, Albuquerque, NM

MEMBERS

Dr. John Balmes, Professor, Department of Medicine, University of California San Francisco, University of California – San Francisco, San Francisco, California

Dr. Ellis Cowling*, University Distinguished Professor-at-Large, North Carolina State University, Colleges of Natural Resources and Agriculture and Life Sciences, North Carolina State University, Raleigh, NC

Dr. James D. Crapo*, Professor, Department of Medicine, Biomedical Research and Patient Care, National Jewish Medical and Research Center, Denver, CO

Dr. William (Jim) Gauderman, Associate Professor, Preventive Medicine, Medicine, University of Southern California, Los Angeles, CA

Dr. Henry Gong, Professor of Medicine and Preventive Medicine, Medicine and Preventive Medicine, Keck School of Medicine, University of Southern California, Downey, CA

Dr. Paul J. Hanson, Senior Research and Development Scientist, Environmental Sciences Division, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN

Dr. Jack Harkema, Professor, Department of Pathobiology, College of Veterinary Medicine, Michigan State University, East Lansing, MI

Dr. Philip Hopke, Bayard D. Clarkson Distinguished Professor, Department of Chemical Engineering, Clarkson University, Potsdam, NY

Dr. Michael T. Kleinman, Professor, Department of Community & Environmental Medicine, University of California – Irvine, Irvine, CA

Dr. Allan Legge, President, Biosphere Solutions, Calgary, Alberta, Canada

Dr. Morton Lippmann, Professor, Nelson Institute of Environmental Medicine, New York University School of Medicine, Tuxedo, NY

Dr. Frederick J. Miller*, Consultant, Cary, NC

Dr. Maria Morandi, Assistant Professor of Environmental Science & Occupational Health, Department of Environmental Sciences, School of Public Health, University of Texas – Houston Health Science Center, Houston, TX

Dr. Charles Plopper, Professor, Department of Anatomy, Physiology and Cell Biology, School of Veterinary Medicine, University of California – Davis, Davis, California

Mr. Richard L. Poirot*, Environmental Analyst, Air Pollution Control Division, Department of Environmental Conservation, Vermont Agency of Natural Resources, Waterbury, VT

Dr. Armistead (Ted) Russell, Georgia Power Distinguished Professor of Environmental Engineering, Environmental Engineering Group, School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, GA

Dr. Elizabeth A. (Lianne) Sheppard, Research Associate Professor, Biostatistics and Environmental & Occupational Health Sciences, Public Health and Community Medicine, University of Washington, Seattle, WA

Dr. Frank Speizer*, Edward Kass Professor of Medicine, Channing Laboratory, Harvard Medical School, Boston, MA

Dr. James Ultman, Professor, Chemical Engineering, Bioengineering Program, Pennsylvania State University, University Park, PA

Dr. Sverre Vedal, Professor of Medicine, Department of Environmental and Occupational Health Sciences, School of Public Health and Community Medicine, University of Washington, Seattle, WA

Dr. James (Jim) Zidek, Professor, Statistics, Science, University of British Columbia, Vancouver, BC, Canada

Dr. Barbara Zielinska*, Research Professor, Division of Atmospheric Science, Desert Research Institute, Reno, NV

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Mr. Fred Butterfield, CASAC Designated Federal Officer

* Members of the statutory Clean Air Scientific Advisory Committee (CASAC) appointed by the EPA Administrator

Appendix C – Charge to the CASAC Ozone Review Panel

Within the main sections of the draft Environmental Assessment Plan, questions that we ask the Panel members to focus on in their review include the following:

Overview of Planned Assessment

1. Do Panel members have any comments on the major components of the planned environmental assessment as depicted in Figure 1?

National Air Quality Analysis

1. The importance of characterizing O_3 exposure of vegetation in non-monitored areas is described in section 3 of the draft plan. What are the Panel members' views on staff's primary approach to create a National Ozone Exposure Surface (NOES) using interpolated monitored data with spatial scaling from Community Multiscale Air Quality (CMAQ) model outputs?

2. Staff plans to characterize air quality in terms of the 12-hr SUM06 and current 8-hr average indices. Do Panel members have suggestions of other indices that the staff should consider?

Crop Exposure, Risk and Economic Benefits Analyses

1. Staff plans to use concentration-response (C-R) functions from the National Crop Loss Assessment Network (NCLAN) to estimate crop yield losses related to O_3 exposures in the U.S. What are the Panel members' views on staff's continued reliance on these C-R functions?

2. Do Panel members have any comments on the overall approach for updating the benefits analysis for crops, including using the Agricultural Simulation Model (AGSIM©)?

3. Staff believes it is important to compare study results obtained using the open top chamber (OTC) exposure methodology with those obtained using the alternative "free air" exposure methodology. Do Panel members have any comments on staff's planned approach for comparing these two exposure methods using soybean yield loss data, as available (as described in section 4.5)?

Tree Exposure, Risk and Economic Benefits Analysis

1. What are the Panel members' views on staff's continued use of National Health and Environmental Effects Research Laboratory-Western Ecology Division (NHEERL-WED) OTC C-R functions to characterize the risk of tree seedling biomass loss from O_3-related exposures in the U.S.?

2. Staff is interested in assessing O_3 exposure-related effects on trees beyond the seedling stage. To accomplish this, staff is considering using the linked tree growth (TREGRO) and stand growth (ZELIG) model system to evaluate how tree or forest growth will respond to O_3 air quality under "as is" and just meeting alternative standard scenarios (Section 5.4). Staff plans to apply this method to ponderosa pine in the San Bernardino Mountains.

    a. What are the Panel members' views on the appropriateness of using the linked TREGRO and ZELIG modeling system to assess the impacts of O_3 air quality on forest growth under current and alternative standards?

    b. What are the Panel members' views on using the USDA Forest Service's Timber Assessment Market Model (TAMM) to quantify the economic impact of growth rate changes, modeled by TREGRO/ZELIG, for the different air quality scenarios?

    c. What are the Panel members' views on the utility of applying this model system, given staff's plans to focus on a single species?

    d. Can the Panel members suggest other approaches for quantifying the long-term impact of O_3 exposure on mature tree and/or forest growth?

3. What are the Panel members' views on the staff's approach using NHEERL-WED C-R functions to predict aspen seedling biomass loss in the Aspen FACE study (described in section 5.5)?

4. Staff is also interested in assessing O_3 effects on vegetation in natural settings. One approach is to make use of the visible foliar injury data within the large bio-monitoring database maintained by the USDA Forest Service Forest Inventory and Analysis (FIA).

    a. What are the Panel members' views on using this database to evaluate the degree of co-occurrence of visible foliar injury and areas of high estimated O_3 exposure as indicated by the NOES (outlined in section 5.6)?

    b. Do Panel members have other suggestions on how to analyze this bio-monitoring database or more broadly, to assess O_3 impacts to vegetation in natural settings?

Appendix D – Comments from Individual CASAC Ozone Review Panelists

This appendix contains the preliminary and/or final written comments of the individual members of the Clean Air Scientific Advisory Committee (CASAC) Ozone Review Panel who submitted such comments electronically. The comments are included here to provide both a full perspective and a range of individual views expressed by Panel members during the consultation process. These comments do not represent the views of the CASAC Ozone Review Panel, the CASAC, the EPA Science Advisory Board, or the EPA itself. Panelists providing written comments are listed on the next page, and their individual comments follow.

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Dr. Ellis Cowling

Dr. Ellis Cowling
North Carolina State University
October 20, 2005

Review of the Ozone Environmental Assessment Plan: Scope and Methods for Exposure, Risk, and Benefit Assessment

General Comments on the Assessment Plan

One of the most interesting parts of the August 17, 2005 "Ozone Environmental Assessment Plan" is the following statement [see indent paragraphs below] which outlines more thoroughly than I have ever seen before, the details of how the Administrator of EPA **did in fact propose in 1997** to "replace the existing 1-hr O_3 secondary [welfare based] NAAQS with … a new seasonal standard expressed as a sum of hourly concentrations greater than or equal to 0.06 ppm, cumulated over 12 hours per day during the maximum 3-month period during the O_3 monitoring season (SUM06), set at a level of 25 ppm-hr … or alternatively … a [secondary] standard identical to the proposed 0.08 ppm, 8-hr primary [public health based] standard."

"In her final decision, the Administrator … decided that it was not appropriate **at that time** [emphasis by me] to establish a new separate seasonal secondary standard … [but that] setting the secondary standard equal to the primary standard would allow EPA the opportunity to evaluate more specifically the improvement in rural air quality and in O_3–related vegetation effects resulting from measures designed to attain the new primary standard. This information would allow for better evaluation of the incremental need for a distinct seasonal secondary standard in the next review of the O_3 criteria and standards (62 FR 38877-78, July 18, 1997)."

Based on the scientific evidence contained in the 2005 Criteria Document for Ozone, and the approaches outlined in the present Ozone Environmental Assessment Plan, I am even more convinced that **EPA Staff should to do all within their powers of persuasion (after further analysis of more currently available scientific evidence as proposed in this Plan!) to convince the Administrator of EPA that a secondary (public welfare-based) standard for ozone that is different in form from the primary standard should be promulgated and implemented by the Agency in 2007**.

Based on a thorough review of the latest scientific information available in 1996, as described in the 1996 O_3 AQCD, on vegetation effects associated with exposure to ambient levels of O_3, as well as (1) staff assessments of the policy-relevant information in the 1996 O_3 AQCD and staff analyses of air quality, vegetation exposure and risk, and economic values presented in the 1996 O_3 Staff Paper; (2) consideration of the degree of protection to vegetation potentially afforded by the proposed 0.08 ppm, 8-hr primary standard; (3) CASAC advice and recommendations; and (4) public comments, the Administrator proposed to replace the existing 1-hr O_3 secondary NAAQS with one of two alternative new standards: a standard identical to the proposed 0.08 ppm, 8-hr primary standard, or alternatively, a new seasonal standard expressed as a sum of hourly concentrations greater than or equal to 0.06 ppm, cumulated over 12 hours per

day during the maximum 3-month period during the O_3 monitoring season (SUM06), set at a level of 25 ppm-hr (61 FR 65716, December 13, 1996).

In her final decision, the Administrator determined that replacing the then current secondary standard with an 8-hr standard, set at a level of 0.08 ppm, identical in all respects to the new primary standard, would provide adequate protection to vegetation. The Administrator judged that this standard would provide substantially improved protection for vegetation from O_3-related adverse effects as compared to that provided by the then current secondary standard, while allowing time for additional research and the development of a more complete rural monitoring network and air quality database from which to evaluate the elements of an appropriate seasonal secondary standard. The decision not to set a cumulative seasonal secondary standard at that time was based in large part on the Administrator's recognition that the exposure, risk, and monetized valuation analyses presented in the proposal contain substantial uncertainties, resulting in only rough estimates of the increased public welfare protection likely to be afforded by each of the proposed alternative standards. In light of these uncertainties, the Administrator decided that it was not appropriate at that time to establish a new separate seasonal secondary standard given the potentially small incremental degree of public welfare protection that such a standard might afford.

The Administrator further concluded that continued research on the effects of O_3 on vegetation under field conditions and on better characterizing the relationship between O_3 exposure dynamics and plant response would be important in the next review because:

• The available biological database highlighted the importance of cumulative, seasonal exposures as a primary determinant of plant responses.

• The association between daily maximum 8-hr O_3 concentrations and plant responses had not been specifically examined in field tests.

• The impacts of attaining an 8-hr, 0.08 ppm primary standard in upwind urban areas on rural air quality distributions could not be characterized with confidence due to limited monitoring data and air quality modeling in rural and remote areas.

It was determined that setting the secondary standard equal to the primary standard would allow EPA the opportunity to evaluate more specifically the improvement in rural air quality and in O_3–related vegetation effects resulting from measures designed to attain the new primary standard. This information would allow for better evaluation of the incremental need for a distinct seasonal secondary standard in the next review of the O_3 criteria and standards (62 FR 38877-78, July 18, 1997).

Specific Comments in Response to the Charge Questions:

The following comments are focused on the specific CASAC "Charge Questions" raised in Karen Martin's letter to Fred Butterfield dated August 17, 2005. Please note in the paragraphs below, that my suggested responses to Karen Martin's questions are written in indented paragraphs, whereas the background statements by Karen Martin and her specific Charge Questions are written in non-indented paragraphs.

<u>Overview of Planned Assessment</u>

1. Do Panel members have any comments on the major components of the planned environmental assessment as depicted in Figure 1?

My major reservation about the categories of risks and benefits depicted in Figure 1, is the apparent restriction of the "categories of risks and benefits" now being planned for assessment to yield of saleable commodities (such as Crop yield, Seedling growth, Foliar injury, Crop loss, and Timber Loss) rather than also including the much more appropriate and broad array of non-commodity-based "ecosystem services" provided by both natural and managed ecosystems (such as clean water, clean air, carbon sequestration, aesthetic values of scenic vistas -- not only in wilderness areas but also in urban and suburban areas, etc., etc.). Assessment of ozone-induced changes in "ecosystem services" would be much more appropriate and beneficial addition to an up-to-date assessment of the need for a secondary standard for ozone that is different in form from the present 8-hour primary standard.

National Air Quality Analysis

1. The importance of characterizing O3 exposure of vegetation in non-monitored areas is described in section 3 of the draft plan. What are the Panel members' views on staff's primary approach to create a National Ozone Exposure Surface (NOES) using interpolated monitored data with spatial scaling from Community Multiscale Air Quality (CMAQ) model outputs?

In the absence of substantial and well-distributed sets of ozone monitors in near-urban, rural, and remote wilderness areas in various parts of the US where most agricultural crops, natural grasslands, and forest lands are concentrated, there appears to be no choice but to try to infer what these exposures are likely to be by using the best available air quality models. I agree that CMAQ is presently regarded as the best model to use in creating a National Ozone Exposure Surface.

2. Staff plans to characterize air quality in terms of the 12-hr SUM06 and current 8-hr average indices. Do Panel members have suggestions of other indices that the staff should consider?

Some crop and forest air pollution scientists believe that the W126 index is also worth considering. But I believe that most ecologically focused air quality scientist believe that a 12-hour SUM06 index would be: 1) more generally applicable to crops, forests, and natural ecosystems, 2) much easier for air quality managers to implement, and 3) useful in educating the general public about why this index is necessary and appropriate.

Crop Exposure, Risk and Economic Benefits Analyses

1. Staff plans to use concentration-response (C-R) functions from the National Crop Loss Assessment Network (NCLAN) to estimate crop yield losses related to O3 exposures in the U.S. What are the Panel members' views on staff's continued reliance on these C-R functions?

NCLAN is still the most comprehensive and thoroughly researched yield-loss assessment data base available anywhere in the world. The re-analysis approach called for in Section 4.2 of the Assessment Plan seems very reasonable to me.

2. Do Panel members have any comments on the overall approach for updating the benefits analysis for crops, including using the Agricultural Simulation Model (AGSIM©)?

> The general approach described in Section 4.3 for estimation of benefits from decreasing ozone exposures for crops and forests appears appropriate. I have no experience with the AGSIM model and thus can not offer a specific comment on its usefulness as a tool of analysis.

3. Staff believes it is important to compare study results obtained using the open top chamber (OTC) exposure methodology with those obtained using the alternative "free air" exposure methodology. Do Panel members have any comments on staff's planned approach for comparing these two exposure methods using soybean yield loss data, as available (as described in section 4.5)?

> My impression from the evidence presented in the Ozone Criteria Document is that most of the largely theoretical limitations of open top chamber methods for analysis of the impact of ozone on plants have proven to be of little importance in drawing inferences from comparisons based on "free air" exposure methods and open top chamber studies. Thus, I can't help but wonder if this suggested comparison of these two types of methods is of very high priority?

<u>Tree Exposure, Risk and Economic Benefits Analysis</u>

1. What are the Panel members' views on staff's continued use of the National Health and Environmental Effects Research Laboratory-Western Ecology Division (NHEERL-WED) OTC C-R functions to characterize the risk of tree seedling biomass loss from O3-related exposures in the U.S.?

> I have had no personal experience with NHEERL-WED OTC C-R functions and thus have no basis for providing useful comments with regard to this question.

2. Staff is interested in assessing O3 exposure-related effects on trees beyond the seedling stage. To accomplish this, staff is considering using the linked tree growth (TREGRO) and stand growth (ZELIG) model system to evaluate how tree or forest growth will respond to O3 air quality under 'as is' and just meeting alternative standard scenarios (Section 5.4). Staff plans to apply this method to ponderosa pine in the San Bernardino Mountains.

a. What are the Panel members' views on the appropriateness of using the linked TREGRO and ZELIG modeling system to assess the impacts of O3 air quality on forest growth under current and alternative standards?

> In this case also, I have had no personal experience with the TREGRO and ZELIG modeling systems and thus have no basis for providing useful comments with regard to this question.

b. What are the Panel members' views on using the USDA Forest Service's Timber Assessment Market Model (TAMM) to quantify the economic impact of growth rate changes, modeled by TREGRO/ZELIG, for the different air quality scenarios?

c. What are the Panel members' views on the utility of applying this model system, given staff's plans to focus on a single species?

Extrapolations of findings from analyses of any set of single tree species analyses are always subject to question. Are funds not adequate to maybe do a less-detailed analysis but do it on more than just one tree species?

d. Can the Panel members suggest other approaches for quantifying the long-term impact of O3 exposure on mature tree and/or forest growth?

My only suggestion would be to see if there is a correlation between the National Ozone Exposure Surface (NOES) and the US Forest Service's Forest Inventory and Analysis (FIA) data on: 1) age-class distribution in forest stands, 2) their disease and insect incidence data, and 3) general rate of growth data for various species of trees in different parts of the US.

3. What are the Panel members' views on the staff's approach using NHEERL-WED C-R functions to predict aspen seedling biomass loss in the Aspen FACE study (described in section 5.5)?

Once again, I must confess having had no experience with the NHEERL-WED C-R functions. Thus, I have no basis for providing useful comments with regard to this question.

4. Staff is also interested in assessing O3 effects on vegetation in natural settings. One approach is to make use of the visible foliar injury data within the large bio-monitoring database maintained by the USDA Forest Service Forest Inventory and Analysis (FIA).

Please note the comment in response to Question d (above).

a. What are the Panel members' views on using this database to evaluate the degree of co-occurrence of visible foliar injury and areas of high estimated O3 exposure as indicated by the NOES (outlined in section 5.6)?

I think these are promising possibilities and encourage further exploration of these ideas with US Forest Service FIA personnel.

b. Do Panel members have other suggestions on how to analyze this bio-monitoring database or more broadly, to assess O3 impacts to vegetation in natural settings?

My only suggestion is to see if there are natural grasslands inventory data that could be used in a manner similar to the possibilities suggested earlier for collaborative analysis like those discussed earlier with the US Forest Service FIA units across the country.

Dr. James D. Crapo

Consultation on Draft Ozone Environmental Assessment Plan
(Teleconference October 3, 2005)
Comments of Dr. James D. Crapo
October 5, 2005

I agree with the general approach being proposed by OAQPS under their draft Ozone Environmental Assessment Plan. The proposal to develop a national ozone exposure surface map for the United States should provide a useful mechanism to look at existing air quality conditions. The limitations of this model will need to be clearly identified in terms of extrapolations to areas where little or no monitoring data exists. Rigorous testing of the model against existing monitoring data will be essential, particularly to understand regions where the model does not fit observed monitoring data.

Plans to characterize air quality in terms of the 12 hour SUM06 and current 8 hour average indices are appropriate. It will be necessary to validate the 12 hour SUM06 model and defend why this model is better than other possibilities such as AOT06 and W126. A clear discussion of the validation of each of the models to be selected for the analysis needs to be done. This should validation of the data from NCLAN and NHEEL-WED programs. The limitations and assumptions inherent in these data sets need to be carefully identified.

There is a need to consider interactions of ozone with other environmental factors, or the independent impact of other factors, when estimating the impact of ozone on vegetation. Actual effects are almost always overestimated when only one factor is considered. For example, is the net impact of variations in ozone levels altered in the presence of draught conditions, etc. Again, the assumptions inherent in and limitations of models involving crop loss, vegetation loss, and economic benefits analysis will be an important part of the final report.

Dr. Henry Gong

Consultation on Draft Ozone Environmental Assessment Plan
(Teleconference October 3, 2005)
Comments of Dr. Henry Gong, Jr.
October 10, 2005

My initial reading of the OAQPS Assessment Plan (version 8/05) left me concerned about the many assumptions implicit in the foundation of the plan (e.g., in Figure 1) and references that were either not yet peer-reviewed or part of previous EPA monographs (which I am admittedly not an authority). I surmised that there were still significant knowledge gaps that are, in part, related to the lack of specific research (or published research) and inadequate monitoring network, and that we might be attempting to essentially fill the "round" gaps with "square" solutions.

I can now better appreciate why I was unclear about some aspects of the document and assessment plan. The discussion during the teleconference was enlightening for me. I not only agree with the insightful comments by my CASAC colleagues but they also seem to confirm my initial uncertainties. This is not to say that we cannot attempt to develop plans and models, but we must definitely define their boundaries and acknowledge any substantial limitations of the assumptions. If this is done, we may end up deleting certain initial models and parts of the plan (Figure 1), as was frequently pointed out during the teleconference. We should also be able to honestly admit that we do not currently have sufficient tools or results to go further. The final product may be smaller in depth and breadth but it will at least be as accurate and complete as possible.

Dr. Paul J. Hanson

Draft Ozone Environmental Assessment Plan: Scope and Methods for Exposure, Risk and Benefits Assessment
October 3, 2005

Written Comments from Paul J. Hanson

1. <u>Do Panel members have any comments on the major components of the planned environmental assessment as depicted in Figure 1?</u>

The diagram in Figure 1 appears to give equal weight to crop yield, tree seeding exposure and foliar injury data. I don't believe this is appropriate. While visible injury data are related to ozone exposure, the connection between ozone foliar injury data and productivity measures is not strong. How will OAQPS weigh foliar injury data against experimentally derived growth observations?

The diagram and text suggests that Soy and Aspen FACE data will be evaluated for their comparability to chamber-based exposure response data. This is a reasonable idea, however, such data are not yet peer-reviewed. Are there adequate quality assured ozone concentrations within the FACE exposure rings to support the proposed assessment?

Figure 1 provides a misleading impression that tree seedling exposure response data are used to inform the TREGRO/ZELIG model simulations. It is my understanding that TREGRO plant responses to ozone would be driven by the response of photosynthesis to hourly ozone uptake rather than the empirical seedling exposure/response relationships. The TREGRO/ZELIG simulations should be shown as parallel (not interconnected) operational pathways.

<u>National Air Quality Analysis</u>

1. The importance of characterizing O3 exposure of vegetation in non-monitored areas is described in section 3 of the draft plan. What are the Panel members' views on staff's primary approach to create a National Ozone Exposure Surface (NOES) using interpolated monitored data with spatial scaling from Community Multiscale Air Quality (CMAQ) model outputs?

I agree with the plan to develop an interpolated national ozone surface, but feel that it should be done for hourly data. The national ozone surface database for 2100 should have the flexibility to address multiple ozone exposure indices.

2. Staff plans to characterize air quality in terms of the 12-hr SUM06 and current 8-hr average indices. Do Panel members have suggestions of other indices that the staff should consider?

These indices are acceptable, but others might be calculated to allow alternate and independent assessments. In any case, the exposure response indices previously used within published crop and tree seedling concentration response studies must be reproduced from the national ozone concentration surface to facilitate appropriate extrapolations.

Crop Exposure, Risk and Economic Benefits Analyses

1. Staff plans to use concentration-response (C-R) functions from the National Crop Loss Assessment Network (NCLAN) to estimate crop yield losses related to O3 exposures in the U.S. What are the Panel members' views on staff's continued reliance on these C-R functions?

Do the crop varieties used in the NCLAN exposure-response studies of the 1970s still represent those widely planted in the US today? As the only viable alternative data source, the current assessment will need to use NCLAN results for their risk analysis activities. If, however, the current varieties of plants used throughout the US differ from those studied during the NCLAN program, the final report must clearly state that the assessment analyses could be biased. As discussed during the consultation, continued development of crop varieties over the past 20 to 30 years since the completion of the NCLAN work may have produced less sensitive crop varieties.

Few research studies on plant response to ozone exposure have been conducted since the 1996 OAQPS staff paper review of the NAAQS for ozone. The paucity of new information results from a lack of research support for empirical and mechanistic studies. Funding agencies must realize that changing ambient exposures and agricultural practices over time can lead to the use of new crop varieties. New varieties may exhibit different ozone response characteristics, and a research program to periodically re-evaluate plant ozone responses is needed to capture the true nature of crop ozone responses as new varieties come into general use.

2. Do Panel members have any comments on the overall approach for updating the benefits analysis for crops, including using the Agricultural Simulation Model (AGSIM©)?

No comment.

3. Staff believes it is important to compare study results obtained using the open top chamber (OTC) exposure methodology with those obtained using the alternative "free air" exposure methodology. Do Panel members have any comments on staff's planned approach for comparing these two exposure methods using soybean yield loss data, as available (as described in section 4.5)?

This is an excellent research goal and could be included in the current assessment activity if it is supported by adequate peer-reviewed data. Are adequate archived data on the ozone concentrations throughout experimental FACE rings available? FACE exposure technology depends on feedback controls referenced to target concentrations at the center of the exposure ring. Gradients of gas concentrations exist across the FACE rings from the source to the measurement location at the center of the ring. Plants located closer to the ozone source pipes (around the ring edges) receive higher ozone exposures than plants further from the vent pipes.

Such variation across the ring must be considered when exposure vs. growth data from FACE studies are compared to data from the open top chamber studies with relatively well-mixed ozone exposures.

Tree Exposure, Risk and Economic Benefits Analysis

1. What are the Panel members' views on staff's continued use of National Health and Environmental Effects Research Laboratory-Western Ecology Division (NHEERL-WED) OTC C-R functions to characterize the risk of tree seedling biomass loss from O3-related exposures in the U.S.?

This is acceptable but insufficient to capture the range of responses of important species of the United States. Other ozone response data are available (see especially Table 9-18 and 9-19 of the first review draft of the ozone criteria document). These new research results should not be ignored.

2. Staff is interested in assessing O3 exposure-related effects on trees beyond the seedling stage. To accomplish this, staff is considering using the linked tree growth (TREGRO) and stand growth (ZELIG) model system to evaluate how tree or forest growth will respond to O3 air quality under 'as is' and just meeting alternative standard scenarios (Section 5.4). Staff plans to apply this method to ponderosa pine in the San Bernardino Mountains.

a. What are the Panel members' views on the appropriateness of using the linked TREGRO and ZELIG modeling system to assess the impacts of O3 air quality on forest growth under current and alternative standards?

The TREGRO/ZELIG model structure is appropriate, but other methods are available. The OAQPS staff should include alternate modeling methods or include a discussion within the staff document suggesting why other methods were considered but rejected.

b. What are the Panel members' views on using the USDA Forest Service's Timber Assessment Market Model (TAMM) to quantify the economic impact of growth rate changes, modeled by TREGRO/ZELIG, for the different air quality scenarios?

No comment.

c. What are the Panel members views on the utility of applying this model system, given staff's plans to focus on a single species?

The single focus on ponderosa pine is too limiting. TREGRO has been successfully applied to many other species (see list on page 16 of the assessment document), and the staffs' analyses should reflect the anticipated responses for both sensitive and insensitive species for various regions of the United States. Ponderosa pine simulations conducted for southern California air environments are not representative of the potential responses for other areas of the country. In particular, the staff paper should include data that reflect the mean sensitivity of trees of the

eastern United States (see also Chappelk and Samuelson 1998 New Phytologist 139:91-108).

d. Can the Panel members suggest other approaches for quantifying the long-term impact of O3 exposure on mature tree and/or forest growth?

The following papers include alternate modeling forms (PnET and TEM, respectively) with the capacity to handle plant ozone responses:

- Felzer B, et al. (2004) Effects of ozone on net primary production and carbon sequestration in the conterminous United States using a biogeochemistry model. Tellus 56B:230-248.

- Ollinger SV, et al. (2002) Interactive effects of nitrogen deposition, tropospheric ozone, elevated CO2 and land use history on the carbon dynamics of northern hardwood forests. Global Change Biology 8:545-562.

These models represent other possible means of assessing plant or ecosystem responses to ozone at regional scales. I recognize that these models are not set up to allow extrapolation of productivity data directly to products of commercial value, but their strength would be their application to regional analyses.

3. What are the Panel members' views on the staff's approach using NHEERL-WED C-R functions to predict aspen seedling biomass loss in the Aspen FACE study (described in section 5.5)?

Were NHEERL-WED C-R functions developed for the same clones being used in the Aspen FACE study? If the same clones were not used inter-comparisons may not be appropriate. Appropriate data for a FACE OTC comparison may be available from the following papers:

Karnosky, D. F.; Gagnon, Z. E.; Dickson, R. E.; Coleman, M. D.; Lee, E. H.; Isebrands, J. G. (1996) Changes in growth, leaf abscission, biomass associated with seasonal tropospheric ozone exposures of Populus tremuloides clones and seedlings. Can. J. For. Res. 26: 23-37.

Karnosky DF et al. (2005) Scaling ozone responses of forest trees to the ecosystem level in a changing climate. Plant, Cell and Environment 28:965-981.

Aspen ozone sensitivity is specific to individual clones. OTC vs. FACE comparisons must include the evaluation of the same Aspen clones.

4. Staff is also interested in assessing O3 effects on vegetation in natural settings. One approach is to make use of the visible foliar injury data within the large bio-monitoring database maintained by the USDA Forest Service Forest Inventory and Analysis (FIA).

a. What are the Panel members' views on using this database to evaluate the degree of co-occurrence of visible foliar injury and areas of high estimated O3 exposure as indicated by the NOES (outlined in section 5.6)?

Foliar injury data might be used to evaluate the sensitivity of natural ecosystems to ambient ozone exposure, but the ability to extrapolate such data to meaningful economic loss needs further justification. Foliar injury is not necessarily an indication of lost productivity.

b. Do Panel members have other suggestions on how to analyze this bio-monitoring database or more broadly, to assess O3 impacts to vegetation in natural settings?

Can long-term data on visible ozone foliar injury collected by the USFS FIA program be used to evaluate the efficacy of CMAQ-based predictions of a national ozone surface?

Dr. Philip K. Hopke

I will raise the issue of the lack of valuation of ecosystems as part of the plan. Right now they think of trees only in terms of lumber and not valuating the ecosystem function and services. I think this is a serious deficiency. There is an SAB committee working on methods for valuing ecosystems and they are fairly far along. They will be holding a workshop a week after we review the revised CD in December. I would like to press OAQPS to be much more creative in their assessment of the benefits of controlling ozone in terms of protecting ecosystem function and services. I urge OAQPS to contact Angela Nugent at the SAB office to start a liaison with the ecosystem valuation committee and see if we cannot greatly improve our ENVIRONMENTAL PROTECTION functions in the Environmental Protection Agency.

Dr. Michael T. Kleinman

Comments on "Draft Environmental Assessment Plan: Scope and Methods for Exposure, Risk and Benefits Assessment."

Michael Kleinman
Department of Community and Environmental Medicine
University of California, Irvine

Overall this plan addresses many of the key points raised by the last assessment. Below I address some comments in response to the charge questions provided.

1. Comments on major components of plan (Fig. 1.) – Could the plan more clearly articulate an assessment of uncertainties, at least in general terms? A more specific plan could be helpful in any decision-making later.
2. Use of interpolated monitored data to create NOES – This seems like a valid approach. Are there any data sets that would be amenable to use as test data to examine the efficacy of the approach in at least a limited setting? Would the data collected in Alpine CA be useable as test site data? The report should stress improvements of this approach to the potential exposure surface (PES) approach used in the previous analysis.
3. Comparison of OTC to FACE - What is the scheduled availability of the SOYFACE data? If it is not available it would be useful to include a backup set of non-US data that could be used, along with a discussion of pros- and cons of using the non-US data.
4. The use of FIA data - Assessing O_3 effects on vegetation in natural settings using the FIA database might be compared to an epidemiological study. The approach could be subject to various confounding effects from various factors (e.g. meteorology) and co-factors (e.g. plant diseases and insect infestations). There might be recursive influences that should be examined in this respect. If this analysis is to be conducted, a comprehensive, *a priori*, approach to identifying potential confounders and controlling for them would be very helpful.

Dr. Allan Legge

REVIEW COMMENTS: Allan H. Legge

Ozone Environmental Assessment Plan: Scope and Methods for Exposure, Risk and Benefits Assessment (Draft, August, 2005)
Prepared by:
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina

Overall Comments:
The Staff at OAQPS are to be commended for trying to put together an ozone environmental assessment plan. Unfortunately, the 'draft' document makes it clear that there has been little change in scientific knowledge and understanding of the effects of ozone on plants since the last review of the ozone air quality standard. As a result, it is proposed by OAQPS that the current 'Ozone Environmental Assessment Plan' again use agricultural crop growth and yield data obtained from the NCLAN Program (National Crop Loss Assessment Network Program) and tree seedling biomass data obtained from the research conducted by the National Health and Environmental Effects Research Laboratory-Western Ecology Division (NHEERL-WED) using the open-top chamber (OTC) ozone exposure methodology. The fundamental problem with this approach is that essentially the same scientific uncertainties which were evident in the biological data during the last review are still evident today.

This does not mean to suggest that the experimental data produced using OTCs by the NCLAN Program and NHEERL-WED were not good science but rather that the extrapolation of these data and the resulting concentration-response (C-R) functions to plant response in the ambient environment is still highly uncertain. It is also highly questionable to suggest that ozone exposure in the ambient environment can be used as a surrogate for plant uptake. This assumption, however, is fundamental to the proposed growing season exposure indices to be used in the 'draft plan' such as SUM06 or AOT06. At the very least, one would need to convert the hourly ozone concentrations at air quality monitoring trailer measurement height to plant height (refer to Grünhage et al. [1999] "The European critical levels for ozone: improving their usage", Environmental Pollution 105: 163-173). That being done, one is still left with the uncertainty of assuming that this modified ozone exposure concentration can be used as a surrogate for ozone plant uptake over the growing season.

NOTE: AOT is defined in the 'draft plan' in the footnote on the bottom of page 3 as "the areas over the threshold". This should read "the accumulated exposure over a threshold".

OAQPS Staff does not seem to appreciate the uncertainties associated with data obtained from OTCs. The 'draft plan' understates this uncertainty in paragraph 1 on page 3 where it is stated that "An evaluation of whether the OTC itself might influence the O_3 exposure-plant response relationship found no results to suggest a difference in plant response to O_3 when grown in

chambered and non-chambered plots (Heagle et al., 1988).” The same Heagle et al. (1988) reference, however, states the following on page 174 in paragraph 2 in Section 7.5 Research Needs: “ Open-top chambers cause major changes in wind velocity, light profile, air velocity profiles, and O_3 concentration-fluctuation compared to ambient. Chambers can affect plant growth and yield. Thus there is a lingering question as to whether plant response to O_3 in open-top chambers is similar to that in commercial fields.”

It is noted in the ‘draft plan’ that during the NCLAN Program that a total of 15 agricultural crop species were evaluated for their growth and yield responses to experimental ozone exposures in OTCs and that these 15 crop plant “species accounted for greater than 85% of the U.S. agricultural acreage planted at that time.” While it is recognized that every effort was made during the NCLAN Program from 1980 - 1986 to test the most economically important and most widely grown cultivars within a given region such as the use of nine cultivars of soybean, it is important for OAQPS Staff to be aware that for the majority of the NCLAN crop species tested that only one cultivar was evaluated. Further, since almost 20 years have elapsed since the completion of the NCLAN Program research, one must question the advisability of applying C-R functions based upon the responses of cultivars developed more than 20 years ago. It is highly unlikely that these same crop species cultivars are in use today. Plant breeders have been working on improving growth and yield as well as disease resistance during the intervening years. It is also highly likely that the sensitivity of the modified cultivars to ozone uptake will have changed over time. The use of the term ‘NCLAN To carry out an assessment today, one would need to have a more current measure of the ozone uptake responses of the most economically important crop species and most widely grown cultivars. The problem facing OAQPS, however, is that these data are not available. The reason these as well as other plant response data are not available today is that the research funding which was required to obtain these data was not made available by the EPA after the 1996 scientific review of the ozone standard as recommended. The research funding that was available during this time period was directed at issues related to ‘particulate matter’. This was most unfortunate.

Specific Comments Selected ‘Charge Questions’:

Consideration should be give to the use of the available passive ozone monitoring data and the foliar injury surveys which have been carried out by the park service.

The idea of creating a National Ozone Exposure Surface (NOES) using interpolated data has merit. One of the important uncertainties will be the adequacy in the number of the rural/remote air quality monitoring stations. This was a major problem during the last review of the ozone standard. The extent to which the air quality models better address this problem must be clearly evaluated.

There is merit in comparing the output from the OTC exposure methodology with the ‘free air’ exposure methodology such as ASPEN FACE and SOY FACE. Each of these exposure methodologies have their advantages and disadvantages and resulting uncertainties. It is vital that these be clearly understood before any conclusions are drawn.

The use and continued reliance by OAQPS Staff on the OTC C-R functions derived from the

NCLAN Program is not recommended. One important reason is that the cultivars on which the C-R functions are based are no longer in use.

The use and continued reliance by OAQPS Staff on the OTC C-R functions derived from NHEERL-WED research is not recommended. This work was done with tree seedlings in pots. Further, there is still much debate in the scientific community about the responses a seedlings and mature tree being different.

Dr. Frederick J. Miller

Consultation on Draft Ozone Environmental Assessment Plan
(Teleconference October 3, 2005)
Comments of Dr. Fred J. Miller
October 4, 2005

Overall, the draft environmental assessment plan developed by OAQPS staff contains all of the key elements. This is a situation, however, where 'the devil is in the details". In that regard, other CASAC panel members are in a better position to provide feedback. There are, however, some general comments that pertain to the document. These are:

- There are a number of models that will be used by OAQPS in the vegetation and tree biomass analyses. Examining the reference list, one is left with the impression that many of these models have not been published in the peer reviewed literature. To the extent that they have been so published, the assessment plan should note this. Results from peer reviewed models carry a far greater weight than those that arise from non peer reviewed models because the assumptions, governing equations, etc. are usually spelled out and defended in peer reviewed modeling publications. Book chapters are not considered as peer reviewed publications. Thus, reference to the Taylor et al chapter as representing a peer reviewed model is incorrect.
- Given staff conclude that there is little new information since the 1996 Ozone Criteria Document review, careful attention should be placed on evaluating the desirability and usefulness of completing all of the analyses referred to in the draft assessment plan. Resources are limited and the analyses to be conducted should be prioritized.
- Many of the proposed analyses will utilize results from fixed site monitors that measure ozone concentrations at a height different than the height at which a particular crop plant is exposed. Independent of the indicator variable (SUM06, W126, AOT06, etc.), a defensible method must be established by which the monitored values can be adjusted or extrapolated to estimates of the ozone concentration the plants are most likely to have seen. Without this correction, there will almost certainly always be an overestimation of the economic benefits from further reductions in ozone levels.

Dr. Maria Morandi

Consultation on Draft Ozone Environmental Assessment Plan
(Teleconference October 3, 2005)
Comments of Dr. Maria T. Morandi
October 10, 2005

My impression after reading the Draft Plan –confirmed during the teleconference discussions of October 3 – is that there have not been sufficient additional and significant research findings to provide appreciable reductions in uncertainties since the 1996 assessment. Consequently, and as other members of the panel indicated, the Agency needs to consider carefully if the time and human resources needed to undertake the work proposed in the Draft Plan are warranted by the likelihood of very modest, if any, improvements over the last assessment.

Data appear to be insufficient across the concentration-effect continuum. Statistics can compensate for some lack of data and less than complete understanding, only up to a point. The overwhelming majority of available ozone concentration data centers in urban environments, with sparse monitoring data in rural areas. It is not apparent that uncertainties in CMAQ estimates of ozone concentrations in remote rural areas are known or can be evaluated (since there are few monitors in such areas). The concentration indices proposed for evaluation of plant effects have been driven by human health concerns and these metrics may or may not be appropriate for vegetation effects. Research for relating concentration at various heights to exposure at the point of contact with vegetation appears to be scarce and too limited for the breath of potentially affected cultivars. The relationship between exposure (i.e., concentration at the point of contact as defined for human exposure) and biologically-relevant uptake for the variety of vegetation likely to be affected under the breath of environmental conditions that can alter the uptake and/or the effect is not sufficiently known. Information on the effects themselves at various concentrations is also less than the minimally necessary. In addition, experimental approaches used to collect some of these data may have introduced biases so that findings cannot be applied directly to the natural environment. In my opinion, these limitations are hard to overcome without additional information. The outcomes from the new assessment will nor be robust from a scientific standpoint and thus will not afford a reliable instrument for policy makers.

At this time, engaging in this assessment appears not to be a fruitful endeavor. Instead, time and personnel resources could be redirected to formulate a prioritized list of critical uncertainties and data gaps, and a plan to meet those critical needs so that the next ecological assessment clearly represents an improvement over the prior one.

Dr. James Ultman

Consultation on Draft Ozone Environmental Assessment Plan
(Teleconference October 3, 2005)
Comments of James Ultman
October 11, 2005

The Draft Ozone Environmental Assessment Plan lays the groundwork and provides many of the details for providing a sound, scientifically-based risk assessment. As I understand it, the conceptual approach and indeed many of the specifics of the proposed assessment follow closely from the assessment that was described in the previous staff paper in 1996. The newest aspect of the plan appears to be the National Air Quality portion of the plan, where the CMAQ model will be used in conjunction with spatial interpolation with the BenMAP model in order to obtain a surface map of ozone concentrations. I commend staff on the construction of the workable framework presented in figure 1. However, given the fact that key information, including data as well as model validations, has not been peer-reviewed or may not be available at all, I question the wisdom of using this framework at the present time to update the risk assessment presented in the 1996 review.

As other panelists have also mentioned, I urge staff to use the current assessment process to provide information on two important points that will improve future assessments of crop and vegetation damage: 1) the uncertainties and limitations in each stage of the assessment and their effects on the overall predictions of the process should be described and, as much as possible, quantified; and 2) critical gaps in research should be identified.

There are two items that I find are particularly problematic about the current plan. The first is the "quadratic rollback" method used to extrapolate "as is" to "what if" air quality. This approach is neither explained nor justified in the assessment plan. Second, the use of ozone concentration monitored at or extrapolated to values that actually occur well above the level of the vegetation itself. Some attempt should be made at correcting for this effect.

Dr. James Zidek

Comments on "Draft Ozone Environmental Assessment Plan"
Prepared by Jim Zidek
September 29, 2005

National Air Quality Analysis

Q1.

- **Data Quality.** It is not clear to what extent existing ozone monitoring networks provide an unbiased picture of the ozone field given their primary role of detecting non-compliance with standards. Thus data from some network sites may well overestimate overall ozone concentrations.

- **CMAQ vs. the Ozone Field.** CMAQ outputs predictions on a mesoscale while monitors output measurements of ozone fields on a microscale. Thus there is a fundamental difference between these two outputs and comparing them directly may not be meaningful. As noted by Fuentes and Raftery (2004),

  > "Statistical assessment is tricky in this case, because the model predictions and the observations do not refer to the same spatial locations, and indeed are on different spatial scales. The fact that they are on different spatial scales is called the 'change of support' problem."

- Comparison of the outputs have in fact been made according to the EPA's web page for CMAQ that states:

  > "Initial results from the test simulations indicated that the new version of the CMAQ model reproduced patterns of major pollutants during this time period reasonably well."

  This assessment seems more optimistic than that of Fuentes and Raftery (2004) who find CMAQ outputs for SO_2 at least to be both additively and multiplicatively biased relative to CASTNET monitoring data. In fact they find the additive bias to be a polynomial function of location co-ordinates while the constant multiplicative bias is 0.5 plus or minus 0.5. Roughly speaking the latter means the CMAQ outputs underestimate the true point SO_2 values. For hourly O_3 concentrations I, in unpublished work with a PhD student, found similar biases in MAQSIP model outputs relative to AIRS data, with MAQSIP tending to overestimate point concentration values during the day and underestimating them during the night. The use of block kriging, one of the options in BenMAP, would help to align the supports but that leads to other technical challenges described below.

- The Plan rightly recognizes that in standards setting the spatial fields for various indices like 4^{th} highest average, not the ozone field itself that are relevant. Moreover, it proposes (p 12) to "characterize" monitoring and CMAQ outputs in terms of these indices. However the Plan gives no indication of how this is to be done. In fact, some very challenging issues will arise.

For one thing, intersite correlations between site pairs will likely decline, in some cases a great deal in passing from the hourly ozone field to the index field. That could mean far greater reliance on CMAQ outputs than would be anticipated by looking at the hourly ozone concentration field itself.

- For another the probability distribution of these indices will be much further from Gaussian or even the multivariate t than the hourly ozone concentration field itself (which needs to be square root transformed to get a symmetric distribution). Yet such a distributional assumption must be met to justify the proposed use of kriging as a linear prediction methodology. A logarithmic transformation might well make that assumption hold at least approximately. However new challenges then arise in block kriging since the logarithm, a nonlinear transformation cannot be passed through the surface integral used to construct the "block" that would make the support of the process line up with the CMAQ output.

- A further difficulty with kriging arises from its assumption of an isotropic covariance field. This difficulty might be partially addressed by partitioning the USA into homogeneous sub-regions and interpolating the processes separately within each region. However, some difficulties will likely remain since things like topography can sometimes make the intersite correlation between two distant sites larger than that between two nearby sites in the same regions. The failure of the assumed covariance model will not likely affect point estimates so much as it will their predictive intervals: 95% predictive intervals may well cover far less than 95% of the predicted values. [This and other issues have been addressed in research over the last few years but the Plan makes no reference to such work.] In any case, spatial predictors under consideration should be "road tested" say by cross validation before they are implemented.

- Kriging assumes the covariance to be known when the optimal spatial predictor is found. Subsequently, that covariance is estimated to get round that assumption but the additional uncertainty thereby introduced is ignored. That can lead to serious undercoverage of the 95% and the other predictive intervals, thereby giving a misleadingly favorable impression of the predictor's accuracy. Methods have been proposed for correcting that deficiency and these may be seen in Cressie (1993).

Crop Exposure, Risk and Economic Benefits Analysis

Q1. This answer to this question depends on how representative of the current population of crops, the sampled responses collected a decade ago might be. That sample was used then to estimate the various sub-population C-R functions. The quality of those estimates would have depended on the representativeness of the sample. That in turn would have depended on such things as the variability within regions and between regions. I would have thought that the population would have evolved since then and wonder how good the C-R estimate would be for today's population, concern about its previous quality notwithstanding. A similar comment could be made about the relevance of the original survey of trees.

Q3. How were/are comparisons of the sampling methods made? Certainly these different experiment approaches (FACE etc) would yield responses with different characteristics. A

sufficiently large sample would lead to the rejection of the hypothesis of no difference, an unduly small one to non-rejection. The issue that needs addressing concerns the degree of the differences in the populations of responses that would matter for regulatory/scientific purposes. If there are significant differences among the possible response populations, which one would most closely resemble what would actually occur under non-experimental conditions? (This issue also relates to Sections 4.5 and 5.5.)

References:

Cressie N (1993). *Statistics for spatial data.* New York: Wiley.

Fuentes, M and Raftery, AE (2005). Model evaluation and spatial interpolation by Bayesian combination of observations with outputs from numerical models. *Biometrics*, 61, 36-45.

NOTICE

This letter has been written as part of the activities of the U.S. Environmental Protection Agency's (EPA) Clean Air Scientific Advisory Committee (CASAC), a Federal advisory committee administratively located under the EPA Science Advisory Board (SAB) Staff Office that is chartered to provide extramural scientific information and advice to the Administrator and other officials of the EPA. The CASAC is structured to provide balanced, expert assessment of scientific matters related to issue and problems facing the Agency. This letter has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the EPA, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use. CASAC letter and reports are posted on the SAB Web site at: http://www.epa.gov/sab.