Earth System Research Laboratory/Chemical Sciences Division

Science Review

March 30-April 1, 2015

Charge to Reviewers

Purpose of the Review: Laboratory science reviews are conducted every five years to evaluate the quality, relevance, and performance of research conducted in the National Oceanic and Atmospheric Administration (NOAA) Office of Oceanic and Atmospheric Research (OAR) laboratories. This review is for both internal OAR/NOAA use for planning, programming, and budgeting, and external interests. It helps the Laboratory in its strategic planning of its future science. These reviews are also intended to ensure that OAR laboratory research is linked to the NOAA Strategic Plan, is relevant to NOAA Research mission and priorities, is of high quality as judged by preeminence criteria, and is carried out with a high level of performance. Each reviewer will independently prepare his or her written evaluations of at least one research area. The Chair, a Federal employee, will create a report summarizing the individual evaluations. The Chair will not analyze individual comments or seek a consensus of the reviewers.

Scope of the Review: This review will cover the research of the Chemical Sciences Division (CSD) from 2008 to the present. The research themes and related topics for the review are: 1) Climate (including Stratospheric Research), 2) Air Quality, and 3) Connections: Climate, Air Quality and the Stratosphere.

Description of CSD Research Themes

1. Climate Research (Including Stratospheric Research)

Objective: Improved predictive capability through a better understanding of the connections between emissions, atmospheric composition, and Earth's climate system.

CSD Climate Research is focused on (1) short-lived climate pollutants (SLCPs); and (2) addressing water vapor and aerosols (airborne fine particles) — two of the greatest uncertainties in current climate models. This is done through understanding and quantifying various chemical and dynamical processes that influence climate.

Short-lived climate pollutants (SLCPs) include methane, tropospheric ozone, aerosols (including black carbon), and substitutes for ozone-depleting substances (including hydrofluorocarbons, HFCs). They contribute directly to climate forcing, are key to many climate feedbacks, link climate change and air quality, and are areas of current focus for policy formulation. The IPCC has identified the role of atmospheric aerosols in climate change as the single greatest uncertainty in our ability to predict changes to the climate system. This includes physical and chemical processes by which aerosols influence clouds, as well as various cloud properties.

Research at CSD is addressing key uncertainties related to: (1) tropospheric ozone, (2) aerosols (both absorbing, e.g., black carbon, that warm the Earth's atmosphere and scattering, e.g., sulfate

aerosols, that cool the surface), (3) emissions of chemically active greenhouse gases such as methane and nitrous oxide, and (4) quantifying the influence of aerosols on cloud formation, extent, and optical properties (Earth's radiation balance) as well as on precipitation. This research integrates laboratory, field, and modeling work to understand processes related to chemistry and transport. Central to this work is the development of instruments that are sensitive and selective for "difficult-to-measure," but important, atmospheric gases and particles. A particular focus is on quantification of emissions of precursors for ozone and aerosols, as well as of key chemically active greenhouse gases, such as nitrous oxide and methane.

The water vapor abundance in the upper troposphere and lower stratosphere (UT/LS) is a critical factor in determining the amount of radiation lost to space and thus determining the energy budget of Earth's surface. Water vapor in this region, though, is particularly difficult to quantify. A better quantification of water vapor and its distribution in this part of the atmosphere is needed to properly account for past changes in the Earth's climate and reliably predict/project future changes. Work is underway in CSD to improve the measurement of water vapor in the UT/LS and enhance the understanding of its atmospheric distribution.

CSD makes ongoing contributions to (1) advancing scientific knowledge regarding the processes involved in ozone-layer depletion by chlorofluorocarbons and other compounds, (2) assessments of the state of knowledge regarding stratospheric ozone, and (3) communication of that information to policymakers in formats that are useful to their decision-making process. CSD is a lead participant in scientific state-of-understanding assessment reports for decision-makers, and has been since the inception of the United Nations Montreal Protocol, the 1987 international agreement that protects the ozone layer. U.S. policy makers, the U.S. chemical industry, EPA, and other national and international agencies rely on these scientific assessments as a basis for their development of scientifically sound, well-informed policies.

2. Air Quality Research

Objective: Provide sound science to support informed air-quality decision-making at national, state, and local levels.

Air quality research on (i) improving understanding of the processes responsible for poor air quality, i.e., surface ozone and particulate matter suspended in air (PM, also referred to as aerosols), and (ii) enhancing predictive capability is essential for air quality management and forecast applications. There is also a strong demand for working with stakeholders to identify their needs up front, and then communicating research results to air quality decision-makers in a timely, user-friendly manner.

Many atmospheric constituents, both natural and manmade, interact to affect surface ozone and PM levels. In addition, the factors that influence air quality differ at the regional scale across the U.S. CSD research is focused on key regions of the U.S. that are impacted by poor air quality. The aim of the research is to understand the sources of these constituents and the nature of their

interactions, in order to provide a basis for determining how to mitigate the problem of surface ozone and PM pollution. CSD scientists also focus on understanding the precursors, chemical processes, and boundary layer meteorology that influence the formation of atmospheric aerosols. As air quality regulatory standards tighten, regional to intercontinental transport of pollution, as well as stratospheric intrusions of ozone, become critical issues for attainment of those standards. Moreover, national policy, such as the quest for energy independence via oil and natural gas development, can have a significant impact on regional and local air quality issues. CSD research is addressing these emerging air quality issues through laboratory studies, instrument development activities, biennial intensive field studies coupled with model analysis, and providing the information to users.

3. Connections: Climate, Air Quality, and the Stratosphere

Objective: Linking emissions to impacts – climate and air quality.

The three major environmental issues of climate change, air quality, and stratospheric changes are interlinked in science and in policy. Research is needed to advance scientific understanding at the intersections of these issues.

The interplay between air quality and climate change with regard to the short-lived climate pollutants (SLCPs) is a major research theme. Emissions of SLCPs and their precursors are one of the most uncertain components in understanding, attributing, and predicting climate change and its interactions with other impacts, in particular air quality. A key example is tropospheric ozone. Emissions from anthropogenic activities have made ozone a regional air quality problem, but increases in tropospheric ozone have also exacerbated climate forcing. Many air quality regulatory actions are already codified and their implementation will have impacts on climate—some negative, some positive, and some neutral. One of the main issues in climate change mitigation efforts is to manage emissions (one of the few knobs a society can turn!) for the benefit of multiple issues, but also to avoid unintended consequences. For example, current agricultural practices require intensive application of nitrogen-based fertilizers to increase crop yields. This has the potential to affect (1) air quality through soil emissions of nitrogen oxides (NO_x), (2) climate change via soil emission of the potent greenhouse gas nitrous oxide (N_2O), and (3) stratospheric ozone, again via soil emission of N_2O.

There is evidence that stratospheric changes affect climate or might be affected by climate. The connection between the recovery of the stratospheric ozone layer and climate is a prime example. Other examples include connections between stratospheric water vapor and surface temperature changes, and changes in stratospheric circulation that influence, and are influenced by, climate change.

CSD is working to provide scientific information that helps identify options for air quality management that will also benefit climate change mitigation and for climate policy issues that influence air quality. Similarly, CSD also addresses issues such as the role of stratospheric

intrusions on surface ozone, the role of transport from other continents on surface ozone, etc. A major example of how CSD implements this research is our field missions, augmented by laboratory studies and modeling analyses, which are designed to address both air quality and climate objectives. The thrust is to provide science-based information to decision-makers. CSD achieves these objectives through research and communicating the information in a usable form to decision-makers.

Evaluation Guidelines

For each research area reviewed, each reviewer will provide one of the following overall ratings:
• Highest Performance--Laboratory greatly exceeds the Satisfactory level and is outstanding in almost all areas.
• Exceeds Expectations--Laboratory goes well beyond the Satisfactory level and is outstanding in many areas.
• Satisfactory--In general, Laboratory meets expectations and the criteria for a Satisfactory rating.
• Needs Improvement--In general, Laboratory does not reach expectations and does not meet the criteria for a Satisfactory rating. The reviewer will identify specific problem areas that need to be addressed.

Reviewers are to consider the quality, relevance, and performance of the laboratory.

1. **Quality:** Evaluate the quality of the Laboratory's research and development. Assess whether appropriate approaches are in place to ensure that high quality work will be performed in the future. Assess progress toward meeting OAR's goal to conduct preeminent research as listed in the "Indicators of Quality."
    - **Quality Rating Criteria:**
        - *Satisfactory* rating -- Laboratory scientists and leadership are often recognized for excellence through collaborations, research accomplishments, and national and international leadership positions. While good work is done, Laboratory scientists are not usually recognized for leadership in their fields.
        - *Needs Improvement* rating -- In general, Laboratory does not reach expectations and does not meet the criteria for a *Satisfactory* rating. The reviewer will identify specific problem areas that need to be addressed.
    - **Evaluation Questions to consider:**
        - Does the Laboratory conduct preeminent research? Are the scientific products and/or technological advancements meritorious and significant contributions to the scientific community?
        - How does the quality of the Laboratory's research and development rank among Research and Development (R&D) programs in other U.S. federal agencies? Other science agencies/institutions?
        - Are appropriate approaches in place to ensure that high quality work will be done in the future?
        - Do Laboratory researchers demonstrate scientific leadership and excellence in their respective fields (e.g., through collaborations, research accomplishments, externally funded grants, awards, membership and fellowship in societies)?
    - **Indicators of Quality:** Indicators can include, but not be limited to the following (note: not all may be relevant to each Laboratory)

- A Laboratory's total number of refereed publications per unit time and/or per scientific Full Time Equivalent scientific staff (FTE).
- A list of technologies (e.g. observing systems, information technology, numerical modeling algorithms) transferred to operations/application and an assessment of their significance/impact on operations.
- The number of citations for a lab's scientific staff by individual or some aggregate.
- A list of awards won by groups and individuals for research, development, and/or application.
- Elected positions on boards or executive level offices in prestigious organizations (e.g., the National Academy of Sciences, National Academy of Engineering, or fellowship in the American Meteorological Society, American Geophysical Union or the American Association for the Advancement of Science etc.).
- Service of individuals in technical and scientific societies such as journal editorships, service on U.S. interagency groups, service of individuals on boards and committees of international research-coordination organizations.
- A measure (often in the form of an index) that represents the value of either individual scientist or the Laboratory's integrated contribution of refereed publications to the advancement of knowledge (e.g., Hirsch Index).
- Evidence of collaboration with other national and international research groups, both inside and outside of NOAA including Cooperative Institutes and universities, as well as reimbursable support from non-NOAA sponsors.
- Significance and impact of involvement with patents, invention disclosures, Cooperative Research and Development Agreements and other activities with industry.
- Other forms of recognition from NOAA information customers such as decision-makers in government, private industry, the media, education communities, and the public.
- Contributions of data to national and international research, databases, and programs, and involvement in international quality-control activities to ensure accuracy, precision, inter-comparability, and accessibility of global data sets.

2. **Relevance**: Evaluate the degree to which the research and development is relevant to NOAA's mission and of value to the Nation.
   - **Relevance Rating Criteria:**
     - *Satisfactory* rating -- The R&D enterprise of the Laboratory shows linkages to NOAA's mission, Strategic Plan, and Research Plan, and is of value to the Nation. There are some efforts to work with customer needs but these are not consistent throughout the research area.
     - *Needs Improvement* rating -- In general, Laboratory does not reach expectations and does not meet the criteria for a *Satisfactory* rating. The reviewer will identify specific problem areas that need to be addressed.
   - **Evaluation Questions to consider:**
     - Does the research address existing (or future) societally relevant needs (national and international)?

- How well does it address issues identified in the NOAA strategic plan and research plans or other policy or guiding documents?
- Are customers engaged to ensure relevance of the research? How does the Laboratory foster an environmentally literate society and the future environmental workforce? What is the quality of outreach and education programming and products?
- Are there R&D topics relevant to national needs that the Laboratory should be pursuing but is not? Are there R&D topics in NOAA and OAR plans that the Laboratory should be pursuing but is not?

➢ **Indicators of Relevance:** Indicators can include, but not be limited to the following (note: not all may be relevant to each Laboratory)

- Results of written customer survey and interviews
- A list of research products, information and services, models and model simulations, and an assessment of their impact by end users, including participation or leadership in national and international state-of-science assessments.

3. Performance: Evaluate the overall effectiveness with which the Laboratory plans and conducts its research and development, given the resources provided, to meet NOAA Strategic Plan objectives and the needs of the Nation. The evaluation will be conducted within the context of three sub-categories: **a) Research Leadership and Planning, b) Efficiency and Effectiveness, c) Transition of Research to Applications (when applicable and/or appropriate)**.

➢ **Performance Rating Criteria:**

- *Satisfactory* rating --
    - The Laboratory generally has documented scientific objectives and strategies through strategic and implementation plans (e.g., Annual Operating Plan) and a process for evaluating and prioritizing activities.
    - The Laboratory management generally functions as a team and works to improve the operation of the Laboratory.
    - The Laboratory usually demonstrates effectiveness in completing its established objectives, milestones, and products.
    - The Laboratory often works to increase efficiency (e.g., through leveraging partnerships).
    - The Laboratory is generally effective and efficient in delivering most of its products/outputs to applications, operations or users.
- *Needs Improvement* rating -- In general, Laboratory does not reach expectations and does not meet the criteria for a *Satisfactory* rating. The reviewer will identify specific problem areas that need to be addressed.

A. Research Leadership and Planning: Assess whether the Laboratory has clearly defined objectives, scope, and methodologies for its key projects.

➢ **Evaluation Questions to consider:**

- Does the Laboratory have clearly defined and documented scientific objectives, rationale and methodologies for key projects?

- Does the Laboratory have an evaluation process for projects: selecting/continuing those projects with consistently high marks for merit, application, and priority fit; ending projects; or transitioning projects?
- Does the laboratory have the leadership and flexibility (i.e., time and resources) to respond to unanticipated events or opportunities that require new research and development activities?
- Does the Laboratory provide effective scientific leadership to and interaction with NOAA and the external community on issues within its purview?
- Does Laboratory management function as a team and strive to improve operations? Are there institutional, managerial, resource, or other barriers to the team working effectively?
- Has the Laboratory effectively responded to and/or implemented recommendations from previous science reviews?

➢ **Indicators of Leadership and Planning:** Indicators can include, but not be limited to, the following (Note: Not all may be relevant to each Laboratory).

a. Laboratory Strategic Plan
b. Program/Project Implementation Plans.
c. Active involvement in NOAA planning and budgeting process.
d. Final report of implementation of recommendations from previous Laboratory review.

B. Efficiency and Effectiveness: Assess the efficiency and effectiveness of the Laboratory's research and development, given the Laboratory's goals, resources, and constraints and how effective the Laboratory is in obtaining needed resources through NOAA and other sources.

➢ **Evaluation Questions to consider:**

- Does the Laboratory execute its research in an efficient and effective manner given the Laboratory goals, resources, and constraints?
- Is the Laboratory organized and managed to optimize the conduct and planning of research, including the support of creativity? How well integrated is the work with NOAA's and OAR's planning and execution activities? Are there adequate inputs to NOAA's and OAR's planning and budgeting processes?
- Is the proportion of the external funding appropriate relative to its NOAA base funding?
- Is the Laboratory leveraging relationships with internal and external collaborators and stakeholders to maximize research outputs?
- Are human resources adequate to meet current and future needs? Is the Laboratory organized and managed to ensure diversity in its workforce? Does the Laboratory provide professional development opportunities for staff?
- Are appropriate resources and support services available? Are investments being made in the right places?
- Is infrastructure sufficient to support high quality research and development?

- Are projects on track and meeting appropriate milestones and targets? What processes does management employ to monitor the execution of projects?

➢ **Indicators of Efficiency and Effectiveness:** Indicators can include, but not be limited to, the following (Note: Not all may be relevant to each Laboratory).

a. List of active collaborations
b. Funding breakout by source
c. Lab demographics

C. Transition of Research to Applications: How well has the Laboratory delivered products and communicated the results of their research? Evaluate the Laboratory's effectiveness in transitioning and/or disseminating its research and development into applications (operations and/or information services).

➢ **Evaluation Questions to consider:**

- How well is the transition of research to applications and/or dissemination of knowledge planned and executed?
- Are end users of the research and development involved in the planning and delivery of applications and/or information services? Are they satisfied?
- Are the research results communicated to stakeholders and the public?

➢ **Indicators of Transition:** Indicators can include, but not be limited to, the following (Note: Not all may be relevant to each Laboratory).

a. A list of technologies (e.g. observing systems, information technology, numerical modeling algorithms) transferred to operations/application and an assessment of their significance/impact on operations/applications.
b. Significance and impact of involvement with patents, Cooperative Research and Development Agreements (CRADAs) and other activities with industry, other sectors, etc.
c. Discussions or documentation from Laboratory stakeholders

Proposed Schedule and Time Commitment for Reviewers:

The on-site review will be conducted on March 30-April 1, 2015, in Boulder, Colorado. Two teleconferences are planned with the Deputy Assistant Administrator for OAR, who will be the liaison with the review team and for the completion of the report. The goal of the first teleconference, in January 2015, will be to discuss the charge to you, the reviewer, as well as the scope of the review, focus areas for the review questions to be addressed, and initial information provided to reviewers that addresses the questions. In the second phone call, scheduled for March 2015, the Deputy Assistant Administrator will discuss the draft review agenda and the reporting form for reviewers to use for their evaluations. During this call, we ask that you as a reviewer identify any additional information needs. All relevant information requested by the review team will be provided on the review website at least two weeks before the review and prior to the second pre-review teleconference with the review team.

Each reviewer is asked to independently prepare their written evaluations on each research theme, including an overall rating for the theme and provide these to the Chair with a copy to Michael Uhart in OAR headquarters. The Chair, a Federal employee, will create a report summarizing the individual evaluations. The Chair will not analyze individual comments or seek

a consensus of the reviewers. We request that within 45 days of the review, the review team provide the draft summary report to the Deputy Assistant Administrator, OAR. Once the report is received, OAR staff will review the report to identify any factual errors and will send corrections to the review team. The final individual evaluations and the summary report are to be submitted to the Assistant Administrator, OAR.

Review Team Resources:

OAR will provide resources necessary for the review team to complete its work.

1. Review Team Support: Information to address the each of the Laboratory's research themes to be reviewed will be prepared and posted on a public review website. Preliminary information will be compiled and posted before the first teleconference meeting and the second major update, which includes final review presentations and materials, will be provided prior to the second teleconference. A copy of all the information on the website will also be provided to reviewers at the review.
2. Travel arrangements for the onsite review will be made and paid for by OAR.