

Global Monitoring Division

Charge to Reviewers

2013-2017 Review

May 21-24, 2018



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Global Monitoring Division Science Review

May 21-24, 2018

Charge to Reviewers

Purpose of the Review

The National Oceanic and Atmospheric Administration (NOAA) Office of Oceanic and Atmospheric Research (OAR) conducts laboratory science reviews every five years to evaluate the quality, relevance, and performance of research conducted in its laboratories. This review is useful both for internal OAR/NOAA planning, programming, and budgeting, and for the laboratory's strategic planning of its future science. These reviews should also ensure that OAR research is linked to the NOAA Strategic Plan, relevant to NOAA's research mission and OAR corporate priorities, of high quality as judged by preeminence criteria, and 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 Earth System Research Laboratory, Global Monitoring Division (GMD) over the last five years. The research areas and related topics for the review are: 1) Tracking Greenhouse Gases and Understanding Carbon Cycle Feedbacks; 2) Monitoring and Understanding Changes in Surface Radiation, Clouds, and Aerosol Distributions; and 3) Guiding Recovery of Stratospheric Ozone. There are also two supporting infrastructure areas for review: 1) Calibrations and Standards and 2) Atmospheric Baseline Observatories.

Description of GMD Research Areas

Research Area #1: Tracking Greenhouse Gases and Understanding Carbon Cycle Feedbacks

Today's anthropogenic climate change is largely driven by increasing greenhouse gases (GHGs) in the atmosphere, modified to some extent by the distribution of aerosols and aerosol properties. To understand the influence of changing atmospheric composition on climate change and minimize its eventual magnitude, society needs the best possible information on the trends, distributions, emissions and removals of greenhouse gases. It is necessary to develop a solid scientific understanding of their natural cycles, and how human management and the changing climate influence those cycles. Our atmospheric measurements can also provide fully transparent and objective quantification of emissions, supporting national and regional emissions reduction policies and generating trust in international agreements.

The NOAA Global Monitoring Division (GMD) is a world leader in producing the regional to global-scale, long-term measurement records that allow quantification of the most important drivers of climate change today. Global monitoring of atmospheric greenhouse gases, in particular carbon dioxide (CO₂), has been part of NOAA's mission for over 50 years. GMD provides and interprets high-accuracy measurements of the history of the global abundance and spatial distribution of a suite of long-lived greenhouse gases. The spatial distributions, together

with models of the winds and mixing (derived from weather forecasts) allow us to infer time-dependent patterns of emissions/removals that are consistent with our observations. Because the measurements are calibrated they stand on their own, and can be used far into the future with better models, and also to compare with satellite retrievals of column-averaged GHGs that cannot be calibrated, but still need to be used together with calibrated data.

NOAA measurements of climatically important gases began in the late-1960s and expanded in the mid-to-late 1970s for CO₂, nitrous oxide (N₂O), and chlorofluorocarbons (CFCs). Over the years other gases and isotopic ratios have been added, including methane (CH₄), carbon monoxide (CO), hydrogen (H₂), numerous hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), methyl halides, and sulfur hexafluoride (SF₆). GMD produces and maintains global standards for most of the climate-relevant gases. The use of common standards enables measurements by different methods, and by different countries and organizations to be used together, greatly increasing the value of the international cooperative measurement system.

Research Area #2: Monitoring and Understanding Changes in Surface Radiation, Clouds, and Aerosol Distributions

Changes in the radiative energy balance at Earth's surface and at the top of the atmosphere result from forcing by greenhouse gases, aerosols, and related changes in the global atmospheric circulation. The distribution of clouds is the primary influence on the surface radiation budget and is sensitive to changes in the circulation, but the nature of the response of different cloud types in different climatic regions is uncertain. Cloud radiative properties are also sensitive to aerosols which are highly variable in space, time, and composition. Their role in radiative forcing is complex and can be either positive or negative and, in addition to their impacts on clouds, can influence the climate directly via long term changes in light absorption and scattering. The uncertainty in cloud responses to climate forcing constituents, either through direct interaction with aerosols or through circulation changes, is the primary factor limiting our ability to narrow estimates of the climate sensitivity, or the warming resulting from a change in a climate forcing agent.

GMD observatories host long-term measurements of globally representative, climate-critical radiation variables such as the continuous measurement of the solar energy reaching Mauna Loa Observatory that began in 1958, the longest such record on Earth. Broadband measurements of incoming and outgoing solar and terrestrial radiation are made in the U.S. and at global baseline observatories to quantify the surface radiation balance and to track changes in cloud radiative properties. GMD has focused on the direct radiative effects of aerosols with measurements of aerosol optical properties that began in the 1970s. In response to the finding that anthropogenic aerosols create a significant perturbation in the earth's radiative balance on regional scales, GMD expanded its aerosols research program to include stations for monitoring aerosol properties in regions where significant aerosol forcing was anticipated.

To support these measurements, GMD maintains calibration facilities tied to the world standards and also shares calibration services with collaborators worldwide. GMD and its national and international partners have made substantial improvements in the accuracy of both solar and

infrared measurements over the past 25 years, allowing detection of small changes in the radiation balance that have dramatic consequences for weather and climate. GMD also provides leadership to the international aerosol and surface radiation monitoring communities by providing technical expertise, calibrations, consistent sampling and measurement protocols, and open source data acquisition, processing, visualization and editing software.

Research Area #3: Guiding Recovery of Stratospheric Ozone

Depletion of stratospheric ozone can result in enhanced UV radiation levels that increase skin cancer rates and adversely affect organisms and ecosystems. Concern over these effects provided impetus for ratifying the 1987 Montreal Protocol, enacting the U.S. Clean Air Act of 1990, and initiating GMD's global-scale monitoring of stratospheric ozone and the gases responsible for its destruction.

GMD has implemented a carefully designed network to monitor variations in ozone, ozone-depleting substances, stratospheric aerosols, and UV radiation. GMD research has been critical in determining long-term changes in concentrations of stratospheric ozone and chemicals causing ozone depletion. Our unique long-term observational records have led to an improved understanding of the production and fate of stratospheric ozone and the compounds and processes that influence ozone's abundance. These advances have furthered our understanding of the fundamental atmospheric processes affecting stratospheric ozone and provide usable information to policy-makers for guiding the recovery of the ozone layer.

GMD conducts year round balloon-borne vertical structure and total column optical measurements of ozone over the South Pole. During the winter preceding the early springtime Antarctic "ozone hole", satellites are unable to measure polar ozone without sunlight. GMD monitors stratospheric ozone at lower latitudes and in the Arctic, measures the gases responsible for depletion of stratospheric ozone, and monitors changes in ultraviolet radiation that is controlled by the amount of ozone in the stratosphere. As such, understanding the production and fate of ozone and the ozone-depleting compounds is a focal point of GMD research.

Ground based measurements of total-column ozone have been made for over 50 years with the Dobson spectrophotometer; the 14-station GMD Cooperative Dobson Network is a significant portion of the global Dobson network as are the six GMD balloon-borne ozonesonde stations. These stratospheric ozone measurements, along with the GMD greenhouse gas, surface ozone, aerosols, radiation and halocarbons measurement networks are linked to the world calibration standards maintained by GMD as are a preponderance of the stations in other international global networks.

Three gases that make a significant contribution to stratospheric ozone depletion, CFC-11, CFC-12 and N₂O, have been monitored by GMD since the mid-1970s. Since then, numerous additional CFCs, HCFCs, and other halogenated gases have been incorporated into the measurement program as the number of monitoring sites increased. Most of the gases that are responsible for depleting stratospheric ozone are anthropogenic, but some, such as methyl bromide and methyl chloride have natural contributions as well.

Supporting Infrastructure #1: Calibrations and Standards

Accurate and reliable calibrations are an essential component of all high-quality measurement programs. This is particularly true of measurements made to carry out research within GMD. Bias or drift in reference materials can have a significant impact on our ability to interpret measured spatial gradients and trends. Further, for data from multiple instruments or measurement networks to be interpreted together, they must be linked to common calibration scales.

GMD calibration activities support measurements of greenhouse gases, ozone-depleting gases, column ozone, and solar radiation. GMD serves as the World Meteorological Organization, Global Atmosphere Watch (WMO/GAW) Central Calibration Laboratory for five gases (CO₂, CH₄, N₂O, SF₆, CO), and serves as the World Calibration Center for Dobson ozone (total column ozone). The goal is to minimize bias among measurements made within the WMO/GAW network, of which NOAA GMD is a major contributor. GMD performs research on the preparation of primary standards, scale development, scale propagation, and comparison. In practice, GMD offers trace gas reference materials and calibration services to WMO/GAW and other partners, calibrates WMO Dobson standard instruments by the Langley method, and WMO regional standard instruments and other Dobson instruments in North America by direct comparison, and calibrates standard ultra-violet lamps to promote compatibility in solar radiation measurements. Much of this work is done on a cost-reimbursable or cost-sharing basis.

GMD collaborates with other institutions to compare and improve traceability, including National Metrology Institutes (such as NIST), the Bureau of International Weights and Measures (BIPM), WMO/GAW central facilities, and others that maintain long-term measurement programs. The Central UV Calibration Facility is a joint NOAA/NIST project.

Supporting Infrastructure #2: Atmospheric Baseline Observatories

At the core of the Global Monitoring Division's global observation networks are the Atmospheric Baseline Observatories (ABOs). GMD's four ABOs are strategically located far from human influence and local pollutants, to prevent contamination and sample the cleanest air possible. The long-term measurements from the ABOs are considered among the best in the world for understanding background atmospheric composition.

The ABOs are the only sites where measurements from GMD's three research themes converge; NOAA instruments supporting greenhouse gas and carbon cycle feedback, surface radiative energy budget, and stratospheric ozone research are co-located in these remote locations. Four decades of data are critical to GMD's understanding of atmospheric changes over time. Data from the ABOs are downloaded by thousands of researchers, resource managers, and policy makers and viewed by tens of thousands of people every year.

Not only are the ABOs critical for GMD research, they are also the backbone measurement sites for the WMO/GAW network and support numerous cooperative research projects. Being staffed by full-time NOAA and university employees, the ABOs provide world-class scientific support to U.S. state and federal agencies, universities, and foreign researchers. Collaboration at the

ABOs encourages data collection beyond GMD's research scope enhancing NOAA's understanding of the atmosphere.

Barrow: The Barrow Observatory (BRW), established in 1973, is located on the northern most point of the United States. It is about 8km northeast of the village of Utqiagvik (formerly Barrow) and has a prevailing east-northeast wind off the Beaufort Sea.

Mauna Loa: The Mauna Loa Observatory (MLO), originally established in 1956, is located on the north flank of the Mauna Loa Volcano at 3,397 masl on the Big Island, Hawaii. GMD is currently the steward of 8 acres of land where buildings for MLO are located.

American Samoa: The American Samoa Observatory (SMO), established in 1974, is located on Cape Matutula, the northeastern tip of American Samoa. The observatory is situated on a 26.7-acre site that receives prevailing winds off the ocean.

South Pole: The South Pole Observatory (SPO), originally established in 1957, is located on Antarctica's polar plateau at 2,840 masl. SPO is the primary tenant of the NSF's Atmospheric Research Observatory, a building upwind of the main station on the border of the internationally recognized and managed Clean Air Sector. The NSF provides housing and logistical support for GMD's research at South Pole.

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*: Laboratory meets expectations and the criteria for a Satisfactory rating.
- *Needs Improvement*: 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, and to provide one of the overall ratings above for each research area reviewed. We also ask that, in addition to the overall ratings for each research area, if possible, also assign one of these ratings for the subcategories of Quality, Relevance, and Performance within the research area reviewed. Ratings are relative to the Satisfactory definitions shown below.

1. **Quality**: Evaluate the quality of the Laboratory's research and development. Quality is a measurement of merit within the scientific community based on the novelty, soundness, accuracy, and reproducibility of a specific body of research, as represented by outputs delivered by the Laboratory. Assess whether appropriate policies 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 Preeminence.” Preeminence is tied to the frequency and level of peer review publication undertaken or supported by the Laboratory along with corresponding bibliometric data, as this information serves as a benchmark with which to compare the Laboratory to other organizations of similar size and scope.

➤ **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.

➤ **Evaluation Questions to consider:**

- Does the Laboratory conduct or support/fund preeminent research? Are the scientific products and/or technological advancements meritorious and do they significantly contribute 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)?
- Is the Laboratory supporting the right people doing the best science?

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

- The 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 the Laboratory’s scientific staff by individual or some aggregate.
- A measure (often in the form of an index) that represents the value of either an individual scientist or the Laboratory’s integrated contribution of refereed publications to the advancement of knowledge (e.g., Hirsch Index). NOAA librarians recommend percentile analysis as the preferred bibliometric approach.
- 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, steering groups, and committees of international research-coordination organizations. Evidence of collaboration with other national and international

research groups, both inside and outside of NOAA as well as within the Laboratory itself, 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 Laboratory's research and development is relevant to NOAA's and OAR's missions and of value to the Nation. It is a direct expression of the OAR Vision and corporate priorities— to deliver NOAA's Future needs. Relevance refers to the value of the Laboratory's activities to users beyond the scientific community, both in terms of hypothetical value and actual impact. It is measured by how well the specific research or activity supports OAR's and NOAA's missions and broader societal needs. This can come in the form of applying scientific knowledge to policy decisions, improving operational capabilities at NOAA's service lines, or patenting and licensing new products for commercial use. Assess whether the Laboratory identifies the overarching problem(s) it seeks to address and whether its activities address its goals, the goals of relevant inter-agency working groups, relevant legislative requirements, and impacts to society at large.

➤ **Relevance Rating Criteria:**

- *Satisfactory* rating -- The R&D enterprise of the Laboratory shows linkages to NOAA's and OAR's missions, Strategic Plan, OAR corporate priorities 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. Transition plans for delivery of research products to customers or operators are being developed constantly but do not yet cover all applicable activities.

➤ **Evaluation Questions to consider:**

- Does the research address existing (or future) societally relevant needs (national and international)?
- How well does the research address issues identified in the NOAA strategic plan and research plans or other policy or guiding documents, including inter-agency working group goals and relevant legislative requirements?
- 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? Does the Lab have an identified Transition pathway (R2X) so their products are moved to the relevant customers?
- Does the science and outreach conducted or funded by the Laboratory fulfill stakeholder needs, including the needs of other Line Offices?
- 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 should not be limited to the following (note: not all may be relevant to each Laboratory)
 - 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.
 - Evidence of linkages to objectives in the NOAA strategic plan (e.g., milestones completed in the Annual Operating Plan).
 - Successfully implemented transition plans with documentation of effective transitions to customers.
 - Economic value of Laboratory products, as demonstrated by cost-effectiveness and impacts analyses conducted by NOAA's Office of the Chief Economist.
 - Access to Laboratory products, as demonstrated by counts of hits/usage of and downloads from Laboratory web sites.
 - Evidence of public outreach, such as visitors to Laboratory, product demonstrations or local education efforts conducted by Laboratory personnel.

3. Performance: Evaluate the overall effectiveness with which the Laboratory executes its mission and meets NOAA Strategic Plan objectives and the needs of the nation, given its resources. Performance is a measurement of effectiveness (ability to achieve useful results) and efficiency (ability to achieve quality, relevance, and effectiveness in a timely fashion with minimal waste). It refers not only to how well tasks are executed, but also to the adequacy of the leadership, workforce, and infrastructure in place to meet the Laboratory's goals. One of the key criteria of performance is the quality of management: how well Laboratory leadership interacts with stakeholders, articulates its strategic direction, and manages its R&D portfolio. Performance therefore is also a measure of accountability: how well the Laboratory oversees and directs its own operations and how well those operations adhere to and further the goals of NOAA's and the Laboratory's strategic plans. Laboratories are judged on how well they plan and conduct their research and development. 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.
 - Laboratory management generally functions as a team and works to improve operations.
 - 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.

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? If so, how well does it adhere to that process?
- How does the laboratory manage its transition process? What does the lab do throughout its research and development activities to enhance the likelihood of successful transitions?
- Does the Laboratory identify the overarching problem(s) it seeks to address through research and development or science and outreach? Are scientists required to develop a good plan, execute that plan, and report on it?
- 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).

- Research Plan
- Program/Project Implementation Plans
- Transition Plans
- Annual Operation Plan performance measures and milestones
- Active involvement in NOAA planning and budgeting process
- Early engagement with end users for technology
- Final report of implementation of recommendations from previous reviews

B. Efficiency and Effectiveness: Assess the efficiency and effectiveness of the Laboratory's research and development, given its goals, resources, and constraints and how effective it 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 its goals, resources, and constraints?
- Is the Laboratory organized and managed to optimize the planning and execution 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 Laboratory's 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 it 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?
 - How effective is oversight of the Laboratory? 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 should not be limited to, the following (Note: Not all may be relevant to each Laboratory).
- List of active collaborations
 - Number, types, and longevity of partnerships (indicates how well the Laboratory leverages relationships with collaborators to maximize research outputs)
 - Funding breakout by source (indicates involvement and commitment of NOAA vs. external stakeholders)
 - Laboratory demographics (e.g. diversity)
 - Ability to meet required deadlines (e.g. reports to Congress)
 - Performance metrics of products and services.
 - Employee satisfaction (e.g. from internal surveys)

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

➤ **Evaluation Questions to consider:**

- How well is the transition of research to applications, commercialization, 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 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.
 - Significance and impact of transition to industry, including patents, license agreements and other related activities.

- Discussions or documentation from stakeholders.

Proposed Schedule and Time Commitment for Reviewers:

The review will be conducted May 21-24, 2018, in Boulder, Colorado, to coincide with GMD's annual science conference. Two teleconferences before the review are planned with the OAR Deputy Assistant Administrator for Programs and Administration, Ko Barrett, who will be the Executive liaison with the review team and for the completion of the report. All relevant information requested by the review team will be provided on the review website at least two weeks before the review.

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 Philip Hoffman in OAR headquarters. The Chair, Dr. Anne Thompson, 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 Ko Barrett. 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 OAR Assistant Administrator, Craig McLean.

Review Team Resources:

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

1. Review Team Support: Information to address each of the laboratory's research themes to be reviewed will be prepared and posted on a public review website. 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 by GMD and paid for by OAR.
3. On-site review team support to acquire and deliver to the team any additional relevant documents requested during the review which will aid in assessing the Laboratory.

Evaluation Worksheets
(Note in WORD the boxes below will expand to fit the text)

Evaluation Worksheet 1

Research Theme 1: Tracking Greenhouse Gases and Understanding Carbon Cycle Feedbacks

Reviewer:

Overall Evaluation:

- 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*--Laboratory meets expectations and the criteria for a Satisfactory rating.
- Needs Improvement*--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.

QUALITY Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

RELEVANCE Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

PERFORMANCE Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

Recommendations for Tracking Greenhouse Gases and Understanding Carbon Cycle Feedbacks
Please provide specific, actionable recommendations based on your observations/findings

Evaluation Worksheet 2

Research Theme 2: Monitoring and Understanding Changes in Surface Radiation, Clouds, and Aerosol Distributions

Reviewer:

Overall Evaluation:

- 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*--Laboratory meets expectations and the criteria for a Satisfactory rating.
- Needs Improvement*--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.

QUALITY Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

RELEVANCE Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

PERFORMANCE Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

Recommendations for Monitoring and Understanding Changes in Surface Radiation, Clouds, and Aerosol Distributions

Please provide specific, actionable recommendations based on your observations/findings

Evaluation Worksheet 3

Research Theme 3: Guiding Recovery of Stratospheric Ozone

Reviewer:

Overall Evaluation:

- 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*--Laboratory meets expectations and the criteria for a Satisfactory rating.
- Needs Improvement*--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.

QUALITY Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

RELEVANCE Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

PERFORMANCE Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

Recommendations for Guiding Recovery of Stratospheric Ozone

Please provide specific, actionable recommendations based on your observations/findings

Evaluation Worksheet 4

Supporting Infrastructure #1: Calibrations and Standards	
<p>Reviewer:</p> <p>Overall Evaluation:</p> <p><input type="checkbox"/> <i>Highest Performance</i>--Laboratory greatly exceeds the Satisfactory level and is outstanding in almost all areas.</p> <p><input type="checkbox"/> <i>Exceeds Expectations</i>--Laboratory goes well beyond the Satisfactory level and is outstanding in many areas.</p> <p><input type="checkbox"/> <i>Satisfactory</i>--Laboratory meets expectations and the criteria for a Satisfactory rating.</p> <p><input type="checkbox"/> <i>Needs Improvement</i>--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.</p>	
QUALITY	<input type="checkbox"/> Highest Performance <input type="checkbox"/> Exceeds Expectations <input type="checkbox"/> Satisfactory <input type="checkbox"/> Needs Improvement
<p>Comments and observations/findings:</p>	
RELEVANCE	<input type="checkbox"/> Highest Performance <input type="checkbox"/> Exceeds Expectations <input type="checkbox"/> Satisfactory <input type="checkbox"/> Needs Improvement
<p>Comments and observations/findings:</p>	
PERFORMANCE	<input type="checkbox"/> Highest Performance <input type="checkbox"/> Exceeds Expectations <input type="checkbox"/> Satisfactory <input type="checkbox"/> Needs Improvement
<p>Comments and observations/findings:</p>	

Recommendations for Calibrations and Standards

Please provide specific, actionable recommendations based on your observations/findings

Evaluation Worksheet 5

Supporting Infrastructure #2: Atmospheric Baseline Observatories

Reviewer:

Overall Evaluation:

- 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*--Laboratory meets expectations and the criteria for a Satisfactory rating.
- Needs Improvement*--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.

QUALITY Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

RELEVANCE Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Comments and observations/findings:

PERFORMANCE Highest Performance Exceeds Expectations
 Satisfactory Needs Improvement

Recommendations for Atmospheric Baseline Observatories

Please provide specific, actionable recommendations based on your observations/findings

**Reviewer Feedback Worksheet –Comments and Feedback on the Review Process.
Reviewer:**

Additional comments for OAR and laboratory management:

**Additional comments and suggestions on conduct of the review for use in future
laboratory reviews**

Please help OAR improve our science review process by telling us what worked well and did not work well throughout the process. In order to reduce the burden on you and the Laboratory staff, we would like to provide only the useful background information. What information provided was especially useful or not useful in your evaluations?
What additional information would have helped you in your evaluation? What information could have been omitted without impacting the quality of your review?

