

**NOAA Office of Oceanic and Atmospheric Research
Global Systems Laboratory
Science Review**

May 10-14, 2021

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 internal NOAA/OAR use for planning, programming, and budgeting, and external interests, and it helps the Laboratory in its strategic planning of future research directions. These reviews are also intended to ensure that OAR laboratory research is aligned with NOAA's Research mission and priorities and other relevant strategic plans, 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 one or more research areas. The Chair, a Federal employee, will create a report summarizing the individual evaluations. The Chair will not analyze individual comments nor seek a consensus of the reviewers.

Scope of the Review

This review will cover the research of the Global Systems Laboratory (GSL) from 2015 to the present. The research themes and related topics for the review are: Organizational Excellence, Advanced Technologies, Earth System Prediction, and Decision Support.

Introduction

As one of NOAA's premier research laboratories, the Global Systems Laboratory (GSL) has a history of successfully transitioning atmospheric research into advanced products and services for weather operations. GSL is one of four laboratories within the Earth System Research Laboratories (ESRL) and is part of the National Oceanic and Atmospheric Administration's (NOAA) Office of Oceanic and Atmospheric Research (OAR) within the U.S. Department of Commerce. GSL has five divisions that focus on advanced technologies, decision support services, model development, innovative data assimilation and verification techniques, and high-performance computing and architectures.

NOAA's long-term goal of a "Weather-Ready Nation" drives GSL's preeminent weather research and development portfolio. Our tagline is "research today for better forecasts tomorrow." GSL delivers innovative research to provide the NOAA National Weather Service (NWS), Federal Aviation Administration (FAA), and other stakeholders with increasingly-accurate, rapidly-updating environmental models to save lives and property and support a vibrant economy. GSL's

work to develop state-of-the-art decision support and data-delivery tools help inform the public, so they are more resilient to high-impact weather. Finally, GSL's cutting-edge visualization systems and high-performance computing technologies lead the environmental science community.

GSL's core competencies, expertise, and mission align with DOC, NOAA, and OAR objectives and support Congress's Weather Research and Forecasting Innovation Act of 2017 and the National Integrated Drought Information System Reauthorization Act of 2018. GSL prizes its strong relationships with forecasters, the aviation community, university research partners, other NOAA organizations, the private sector, and its Cooperative Institute partners (CIRES and CIRA) in accomplishing its mission.

GSL's talented workforce has a legacy of delivering ground-breaking research that has revolutionized weather operations. GSL aspires to develop and empower our future leaders by committing to diversity, inclusiveness, excellence, and integrity to transform NOAA's future in world-class science. This next generation of scientists will be critical in developing new ideas and technologies and performing mission-relevant research to serve local, national, and global communities.

Global Systems Laboratory Themes

GSL's four themes-- Organizational Excellence, Advanced Technologies, Earth System Prediction, and Decision Support-- are described in more detail below. These four themes are the foundation to achieving the GSL Grand Challenge:

Deliver actionable global storm-scale prediction and environmental information through advanced technologies to serve society.

Organizational Excellence

GSL strives to advance its workforce scientifically, technically, and professionally. GSL is committed to increased diversity and inclusion as well as a strong foundation for succession planning and career growth. GSL hosts team-building and training, conducts annual retreats and employee satisfaction surveys, and provides leadership opportunities to early- and mid-career staff to contribute to GSL and develop professionally. GSL also values long-term collaborative research continuity and invests base funding toward activities that support the GSL mission and collaboration across themes towards our Grand Challenge. While GSL's Grand Challenge is a scientific and technical goal, a healthy organization invested in GSL's mission will enable the collaboration and innovation needed to achieve this goal.

Future plans: Continue to increase staff diversity and inclusivity; make strategic federal hires to fill vacancies and early-to-mid-career scientific positions; integrate GSL's science strategy across research themes.

Advanced technologies

GSL is invested in researching new technologies and maintaining an advanced IT infrastructure needed to support innovative research, development, and implementation across NOAA. GSL is a world leader in advancing new technologies and methods in computing, modeling, visualization, data access, and information delivery to support NOAA's Earth system prediction and decision support capabilities. The advanced computing efforts in GSL are the foundation of virtually all High Performance Computing methods used in NOAA operations and research. GSL research includes using innovative numerical methods and software design that improve the performance, portability, and scientific accuracy of models running on next-generation exascale computers. GSL also researches and implements cloud computing capabilities to address the challenges of the end-to-end Unified Forecast System used by NOAA and the research community. Researchers are developing machine learning algorithms to increase the use of observations in data assimilation, improve model prediction capabilities, and gain a better understanding of complex data. GSL has been a leader in closing data gaps for NOAA Operations with the Meteorological Assimilation Data Ingest System (MADIS), a database of weather observations from a variety of sources that is used worldwide. GSL researchers leverage the latest server and gaming technologies in SOS Explorer™ Mobile, a free app for smart phones to bring environmental information and education to your hands.

Future plans: Develop advanced technologies to enable the delivery of information and improved Earth-system prediction models.

Earth System Prediction

GSL is renowned internationally for the development of storm-scale to global-scale weather prediction models and innovative data assimilation techniques. This aligns GSL research with NOAA's objectives to build a holistic understanding of the Earth system and a coupled environmental modeling system while contributing to the Unified Forecast System (UFS). Recent successes are NOAA's hourly-updating Rapid Refresh (RAP) and the High-Resolution Rapid Refresh (HRRR) high-impact weather prediction models. The RAP and HRRR predict atmospheric variables relevant to severe weather, aviation weather, the wind energy industry, and fire weather. Another recent success was the GSL-led GEFS-Aerosols model-- an atmospheric composition model that integrates weather and air quality-- that recently went into operations. Through the Developmental Testbed Center (DTC), GSL supports the modeling community by developing infrastructure, providing support to users and developers of the UFS and Hurricane WRF models, assessing contributed innovations, and organizing events to bring together the research and operational communities.

Future plans: With expertise in physics, model coupling, data assimilation, modeling, and verification, GSL will advance Earth-system capabilities toward a continuous global-to-local storm-scale system.

Decision support

GSL's history was forged in developing tools that support the weather decision-making process. This work began in the early 1980s with the development of the Advanced Weather Interactive Processing System (AWIPS), and is continuing now with incremental deployments of GSL's Hazard Services system to NWS offices. Hazard Services streamlines NWS watch, warning, and advisory-related services into one interface and can be customized for each office, region, or type of weather. GSL is also advancing the Weather Archive and Visualization Environment (WAVE) project, a web-based multi-purpose system where NWS forecasters create impact-based graphics about weather hazards to deliver via their websites and social media. GSL also works to understand how weather information is used through impact-based forecast assessments and targeted real-time information delivery to benefit decision-making in response to high impact weather events.

Future plans: GSL will build tools and systems that will provide actionable information and enable understanding of impacts of weather.

Evaluation Guidelines

For each research theme 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.

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 theme reviewed. Please note that ratings for each theme are relative to the Satisfactory definitions shown below.

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 Research mission and 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 theme.
- *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 NOAA strategic documents 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's Research mission and priorities 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 review will be conducted virtually on May 10-14, 2021. Prior to the review two teleconferences are planned, the first with the OAR Deputy Assistant Administrator for Science, who will be the liaison with the review team and for the completion of the report. The goal of the first teleconference, tentatively scheduled for March 2021, 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, tentatively April 2021, we will discuss the draft review agenda and the reporting form for reviewers to use for their evaluations. During both calls, we ask that you as a reviewer identify any additional information needs. All relevant information requested by the review team will be provided to the review team as soon as the information is available and will also be posted 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 the OAR Strategic Management Team (oar.hq.smt@noaa.gov). 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 panel provide the draft summary report to the OAR Deputy Assistant Administrator for Science with a copy to the OAR Strategic Management Team (oar.hq.smt@noaa.gov). After receiving the draft report, the Strategic Management Team will ensure that the report meets the requirements before sending it to the GSL review team. GSL will complete a factual (technical) review and provide any proposed changes in “Track Changes” format with a corresponding explanation for each proposed change. GSL will submit these revisions to the Strategic Management Team for transmission to the review panel chair. Within 30 days of receiving the corrections, we ask that the reviewers make any needed edits and submit the final summary

report to the OAR Assistant Administrator, OAR Deputy Assistant Administrator for Science, and GSL Director, with a copy to the OAR Strategic Management Team.

Review Team Resources

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