Earth System Research Laboratory
Global Systems Division Review
November 3-5, 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 Earth System Research Laboratory's (ESRL) Global Systems Division (GSD) over the last five years. The research areas and related topics for the review are: 1) Numerical Weather Prediction; 2) Decision Support; and 3) Advanced Technology.

Description of ESRL GSD Research Areas

Research Area I: Numerical Weather Prediction

The Global Systems Division is a world leader in developing storm-scale to global weather prediction models and is well aligned with NOAA's objectives to build a holistic understanding of the Earth system and an integrated environmental modeling system. Through the research and development of the hourly-updating Rapid Refresh (RAP) and the High Resolution Rapid Refresh (HRRR) models, GSD transformed storm-scale modeling technologies to greatly improve localized severe weather forecasts by operational weather services. GSD will continue to evolve these models to better support timely decision-making, particularly for disaster preparedness, air traffic management and energy development. Working with colleagues from other organizations, GSD researchers are performing in-depth Observing System Simulation Experiments (OSSEs) and Observing System Experiments (OSEs) to quantitatively evaluate the benefits of current and future observing systems for improving weather forecasts from numerical models. GSD scientists are also working to develop the next-generation global hydrostatic and non-hydrostatic

atmospheric models to help the National Weather Service build a Weather-Ready Nation. Using its own internal supercomputing facility plus external high performance computing resources, GSD is also testing the current generation of global models, running them at unprecedented resolutions in real-time, to evaluate the model output and compare the different data assimilation techniques. These results will inform model developers how to improve the next generation of global models. GSD will be at the forefront of coupling atmospheric, land surface, ocean and air chemistry models, an effort towards an earth system model which will enhance the scope and accuracy of weather predictions.

Research Area II: Decision Support

Supporting NOAA's goal to improve preparedness, response, and recovery from weather and water events by building a Weather-Ready Nation, GSD continues to develop innovative, leading-edge forecast tools. The tools, usable by human and automated decision-making processes, will improve public safety, transportation safety and efficiency, effective usage of wind and solar energy, and improvements to other economic activities strengthening the resiliency of the Nation's communities. Since the early 1980s beginning with the Advanced Weather Interactive Processing System (AWIPS), GSD has developed and transitioned decision-support tools to the National Weather Service (NWS). Over the next 5-10 years, GSD will build and deploy advanced technologies that revolutionize and streamline operations for NWS and other partners by developing tools for: 1) issuing timely and accurate weather hazard information, 2) monitoring forecasts and providing short-term updates as weather changes, 3) two-way communication for collaboration between forecasters and decision-makers, and 4) the effective use of ensemble forecast information to better convey weather uncertainty to decision-makers and the public. GSD will continue to work with its Federal Aviation Administration partner to develop and transition state-of-the-art technologies used by air traffic planners to identify and mitigate the effects of potential weather impacts resulting from convective storms, low ceiling or visibility, icing, strong winds, or turbulence within the National Airspace System (NAS), thus improving traffic flow efficiency and reducing flight delays.

Research Area III: Advanced Technologies

GSD is a world leader in advancing technologies that make it possible for: 1) numerical weather and climate prediction to occur on the fastest computer technologies available, 2) the creation of next generation weather and environmental forecast and analysis systems to ingest, manage, analyze, understand and forecast, and 3) bringing this complex information in a form viewable, understandable and seen by millions worldwide. GSD efforts are central to both Scientific and Enterprise Goals established by NOAA in its Next Generation Strategic Plan and are foundational for the creation and use of an Earth Modeling System. The advanced computing efforts in GSD have forged the basis of virtually all High Performance Computing methods used in NOAA operations and research. Through their design and management efforts, GSD researchers are leading the world in reinventing this framework for Massively Parallel Fine Grain (MPFG) systems by providing some key

benchmarks in MPFG computing that are being used by industry to create the next generation hardware. GSD is reimagining how users will use and interact with global environmental information with its NOAA Earth Information System (NEIS). NEIS has leveraged the latest in server technology and new gaming paradigms developed in-house to selectively transport vast amounts of information across the Internet to scientific users who will use a visually compelling interface. GSD has been a leader closing data gaps for NOAA Operations and the meteorological community and with GSD's recent transition of MADIS to Operations a path has been forged for rapid expansion of observation density and quality. Tools have emerged from MADIS related efforts that have led to a better understanding of real-time environmental conditions and are a clear value-added within the NWS and with other decision-making partners. NOAA calls for an educated public with an improved capacity to make scientifically informed environmental decisions. GSD is a clear NOAA leader in pursuit of this goal with its growing worldwide Science On a Sphere® (SOS) program which is actively pursuing the SOS Explorer concept to bring this information to educators and the public via the Internet.

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.

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 Preeminence."
   - **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 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.
   - **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.

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 November 3-5, 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 late September/early October 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, to be scheduled for late October 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 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.