Charge to Reviewers
National Severe Storms Laboratory (NSSL)
5-Year Laboratory Science Review
15- 19 November 2021

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 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 at least one activity 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 NSSL over the last five years. The three activity areas for the review are: 1) Observations and Understanding; 2) Numerical Modeling and Forecast/ Warning Applications; and 3) User Informed Evaluation and Further Development.

Activity Area 1: Observations and Understanding

Improved understanding and prediction of severe-weather phenomena (e.g., tornadoes, large hail, heavy rainfall, and thunderstorm-induced high winds) are critically dependent on observations of the phenomena themselves, antecedent atmospheric processes, and enabling environmental conditions. At NSSL, we develop advanced observation technologies and instruments ranging from mobile mesonets to weather radar. We innovate, calibrate, and field-test instruments that are custom-designed to measure atmospheric properties and/or observe phenomena that are not measurable or observable with routinely available observations. We design and plan collaborative, internally and externally funded field programs to execute targeted deployments of these instruments and collect uniquely valuable datasets, then we use these data to make foundational advances in our knowledge and understanding of severe weather. Selected innovations in technology and instrumentation are further developed by NSSL for implementation in National Weather Service (NWS) operations. For example, NSSL has been a national leader in developing the scientific basis, engineering foundations, and sampling strategies for weather radars since the lab's inception, leading directly to the nationwide NEXRAD radar

network in 1988, its dual-polarization upgrade in 2010, and the next-generation weather radars that are currently under development.

Activity Area 2: Numerical Modeling and Forecast/Warning Applications
Development of increasingly advanced prediction models, applications, and tools is essential for improving the quality of forecasts and warnings issued by the NWS. NSSL scientists are world leaders in the development of numerical weather prediction models and data assimilation techniques for storm-scale prediction and they are key contributors to the national community-based Unified Forecast System (UFS). Furthermore, they are world leaders in development of tools for nowcasting severe convective storms using algorithms derived from observations, analogs based on reanalysis of historical radar data, statistical approaches, as well as artificial intelligence and machine learning. These developments all provide increasingly skillful guidance for forecasters in the NWS and elsewhere to enable more timely and accurate severe-weather forecasts and warnings across a broad spectrum of time and space scales.

Activity Area 3: User Informed Evaluation and Further Development
NSSL ensures that internal prioritization of its research activities is informed by the specific needs of the public as well as other users and stakeholders, and that the outcomes of the research and development conducted by its scientists and engineers directly address those needs. Together with NWS partners, NSSL developed and continues to operate the NOAA Hazardous Weather Testbed (HWT) as a facility where research scientists and developers work side-by-side with forecasters to evaluate the efficacy of new forecasting tools in simulated operational forecasting/warning operations. The HWT also provides a venue for our scientists to work with other stakeholders and users to ensure that hazardous-weather information is communicated all along the line from basic researchers to developers to forecasters to emergency managers, the media, and ultimately the public in such a way as to elicit a response that is optimized for preserving life and property.

A critically important component of this engagement is accomplished by a cadre of social, behavioral, and economic (SBE) scientists who help us in numerous fundamental ways. For example, SBE scientists identify and provide insights about weak links in the string of communications that ends in the public receiving a forecast or warning, including basic transfer of physical-process knowledge from researchers to practitioners, interpretation of automated forecast/warning guidance that forecasters receive from prediction models and algorithms, to human-generated forecast graphics and worded statements that are disseminated directly to the public. SBE scientists reveal nuanced relationships between demographics and different characteristic responses to environmental threats, helping to identify and better serve the most vulnerable segments of society. Furthermore, they provide valuable insights about who should take action when severe weather threatens, what the course of action should be, and what the cost of inaction could be for different types and levels of threat.

Perhaps most importantly, NSSL maintains alignment with the needs of forecasting operations through foundational relationships with core NWS partners with whom we share our facilities. NSSL's Warning Research and Development Division (WRDD) is rooted

in collaborations with the Oklahoma City NWS forecast office, dating back to the inception of NSSL in the 1960s. This relationship was strengthened in 1987 when the NWS OKC forecast office moved to Norman, just across the street from NSSL, inspiring the formation of a jointly run experimental forecast facility and laying the foundation for future collaborative efforts on forecast/warning challenges. Also around this time, development of Doppler weather radars was nearing fruition. The NWS created the Radar Operations Center (ROC) in Norman to shepherd NSSL's radar innovations into NWS operations and NSSL created a Radar Research and Development Division (RRDD) to work directly with the ROC. RRDD and the ROC continue to work hand in hand in an efficient Research to Operations - Operation to Research (R2O-O2R) process that enables rapid and efficient transition of the latest weather-radar technologies from research and development at NSSL to NWS operations via the ROC. The final piece of the puzzle fell into place in 1995, when the NWS Storm Prediction Center (SPC) moved to Norman from Kansas City. This was particularly significant because it brought together the designated national centers for severe-weather prediction (SPC) and research (NSSL). This move catalyzed an exceptionally productive collaboration and inspired the formation of the HWT. In 2006, NSSL and these three longstanding NWS partners moved together to the National Weather Center building on the University of Oklahoma campus. Collaborations with the Norman WFO, the ROC, and the SPC are stronger and more productive than ever, forming the linchpin of NSSL's stakeholder engagements.

Evaluation Guidelines

NOAA guidance asks reviewers to consider the quality, relevance, and performance of NSSL and to provide an overall rating for each activity area reviewed. For each activity area, each reviewer will provide one of the following overall ratings:

- *Highest Performance:* In general, the laboratory greatly exceeds the satisfactory level and is outstanding in almost all areas.

- *Exceeds Expectations:* In general, the laboratory goes well beyond the satisfactory level and is outstanding in many areas.

- *Satisfactory*: In general, the laboratory meets expectations and the criteria for a satisfactory rating.

- *Needs Improvement:* In general, the 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 activity area, if possible, reviewers should also assign one of these ratings for the subcategories of Quality, Relevance, and Performance within the activity area reviewed. Please note that ratings for each activity area are relative to the satisfactory definitions shown below.

1. **Quality:** Evaluate the quality of the Laboratory's research and development. "Quality" is "a measure of the novelty, soundness, accuracy, and reproducibility of a specific body

of research" (NOAA Administrative Order (NAO) 216-115). This refers to the merit of R&D within the scientific community. Assessing the quality of scientific and technical work relies heavily on the time honored tradition of peer review. Bibliometric data on peer-reviewed publications and citations, patents, awards, and other professional recognitions are some of the factors to consider. 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 laboratory'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 an 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" is "a measure of how well a specific body of research supports NOAA's mission and the needs of users and the broader society" (NAO 216-115). This primarily refers to the value of R&D to users beyond the scientific community. Relevance includes not only hypothetical value, but actual impact. It considers the question, "What would not have happened if you did not exist, and how much would society have missed?" Examples of ways the impact of R&D can be realized include the application of scientific knowledge to policy decisions, the improvement of operational capabilities at NOAA's service lines and other collaborating institutions, or licensing of inventions for commercial use.

   Relevance Rating Criteria:
   - *Satisfactory* rating - The R&D enterprise of the Laboratory shows linkages to NOAA's mission, Research Plan, and other relevant strategic plans, and is of value to the Nation. There are some efforts to work with customer needs but these are not consistent throughout the activity 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 NOAA's 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 are not? Are there R&D topics in NOAA and OAR plans that the laboratory should be pursuing but are 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 surveys 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**: "Performance" is "a measure of both effectiveness (the ability to achieve useful results) and efficiency (the ability to achieve quality, relevance, and effectiveness in timely fashion and with little waste)" (NAO-216-115). It refers to the effectiveness and efficiency with which R&D activities are organized, directed, funded, and executed. Assessing performance may include considerations of technical execution, finances, workforce, infrastructure, and leadership necessary to achieve the organization's goals, though the laboratory or program's own capacity and that of its partners. This necessarily involves understanding the quality of management, including interaction with stakeholders, clear articulation of strategic direction, as well as the balance of the R&D portfolio across time frames and intended applications.

   Evaluate the overall effectiveness with which the Laboratory plans and conducts its research and development, given the resources provided, to meet NOAA's 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 meets at least half of its performance measures and milestones included in the Annual Operating Plan.
   - 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).
  - Laboratory Strategic Plan
  - Program/Project Implementation Plans.
  - Active involvement in NOAA planning and budgeting process.
  - 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).

- List of active collaborations
- Funding breakout by source
- 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 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 involvement with patents, Cooperative Research and Development Agreements (CRADAs) and other activities with industry, other sectors, etc.
- Discussions or documentation from laboratory stakeholders

Proposed Schedule and Time Commitment for Reviewers:
The virtual review will be conducted 15-19 November, 2021. Two teleconferences will be planned prior to the review, the first will be with OAR's 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 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 teleconference we will discuss the draft review agenda and the reporting form for reviewers to use for their evaluations. During both teleconferences, 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. As this is a virtual review, pre-recorded presentations of the work being conducted by the NSSL will be shared with the review panel members prior to 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. 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 OAR Deputy Assistant Administrator for Science with a copy to the OAR Strategic Management Team (oar.hq.smt@noaa.gov). Once the report is received, OAR staff will review the report to identify any factual errors and will send corrections to the review team. Once corrections are accepted by reviewers, we ask that the final summary report be submitted to the OAR Assistant Administrator, OAR Deputy Assistant Administrator for Science, and NSSL 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 as soon as they are made available.