# Charge to Reviewers
## NOAA Air Resources Laboratory
## 5-Year Laboratory Science Review
## March 22-24, 2022

**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 OAR/NOAA use for planning, programming, and budgeting, and external interests. It helps the Laboratory in its strategic planning of future research directions. These reviews are also intended to ensure that OAR laboratory research is linked to 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 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 Air Resources Laboratory (ARL) from 2016 to the present. The research themes and related topics for the review are all developed in the context of boundary layer research, the lowest 1 to 2 km of the atmospheric layer, the layer closest to Earth's surface. The structure of the boundary layer (BL) influences a range of atmospheric and environmental issues falling within NOAA's mission, such as: atmospheric circulations, dispersion of airborne hazardous materials, low-level winds and turbulence, initiation of convection, air quality, regional climate change, and the fate of chemical compounds released into the environment. Understanding the BL is of vital importance for a number of NOAA core activities: forecasting weather and predicting climate, as well as for identifying the specific processes that transfer energy, momentum, water, trace gases, and aerosols between Earth's surface and the atmosphere. ARL's unique boundary layer expertise can be evaluated with respect to three research themes:

- Surface-Atmosphere Exchange
- Atmospheric Transport & Dispersion
- Boundary Layer Characterization

**Description of ARL Research Themes:** ***Surface-Atmosphere Exchange; Atmospheric Transport & Dispersion; Boundary Layer Characterization***

ARL research will be evaluated under three topics: Surface-Atmosphere Exchange; Atmospheric Transport-Dispersion; Boundary Layer Characterization. ARL performs both observational research as well as high fidelity modeling of the boundary layer to support these research themes. Models and observations are essential to advance understanding of the chemical, physical, dynamical, and radiative processes in the lower atmosphere. Observations are obtained in the atmosphere during field studies, from remote sensing instruments, and from small unmanned aerial systems. A variety of numerical models of the atmosphere with a range of complexity are used, often in collaboration and cooperation with other scientific groups.

**Surface-Atmosphere Exchange**
*GOAL: Improved understanding of the Surface-Atmosphere interface where the exchanges of energy, momentum, moisture, gases, and aerosols take place and where weather and climate begin.*

Surface-atmosphere exchanges of momentum, energy, moisture, trace gases, and aerosols drive much of the dynamic behavior and composition of the atmosphere and thereby play a critical role in affecting weather, climate, and air quality. ARL's research in surface-atmosphere exchange aims to improve the representation and accuracy of these critical processes in NOAA's weather and climate models, including GEFS as well as UFS. Atmospheric aerosols affect weather and climate through impacts on radiative transfer and cloud microphysics. The inclusion of prognostic aerosol distributions in weather and climate models is an active area of current research and should lead to more realistic atmospheric simulations, especially for sub-seasonal to seasonal (S2S) forecasts and short-term impacts of heavy aerosol loadings (e.g., wildfires or dust). ARL produces emissions algorithms and datasets that are being used in regional and global models, and performs research to improve the accuracy and timeliness of these products.

ARL also performs aircraft and field measurements to better characterize the exchange of chemical species between the Earth's surface and the atmosphere. One example is the surface-atmosphere exchange of reactive nitrogen (nitrogen oxides and ammonia), which is highly uncertain and difficult to model, even though these species serve important roles in the formation of tropospheric ozone and aerosols, and their deposition to ecosystems can have harmful environmental consequences (e.g., eutrophication in coastal and inland waters and wetlands and reduced biodiversity in forests). ARL's research in this area improves scientific understanding of the processes that influence the exchange rates, which are then used to improve emissions and deposition modeling of these compounds on local and regional scales.

Other research activities in surface-atmosphere exchange include the Surface Energy Budget Network (SEBN), which provides valuable data and understanding on the factors that drive the exchange of energy and mass between the land and atmosphere, leading to an enhanced predictive understanding of interactions and feedbacks. Observations in the SEBN are continuous and long-term, and thereby contribute not only to current weather and climate diagnostics and model development, but also provide knowledge of land-atmosphere feedbacks and responses to infrequent but significant events such as a major drought, extreme heat, or cold waves.

**Atmospheric Transport & Dispersion**
*GOAL: Understand the main processes that drive the transport and dispersion of harmful substances in the atmosphere not only to improve the quality of our modeling tools, but also to assess the uncertainties and applicability of those tools.*

ARL researches the processes that drive the transport and dispersion of harmful substances in the atmosphere in order to improve the quality of our modeling tools, and to assess the uncertainties and applicability of those tools. Investigation of the transport and dispersion of chemicals in the atmospheric BL serve to provide quantitative flow-visualization information that can lead to new insights and improvements in weather modeling.

HYSPLIT is the core engine of ARL's transport-dispersion modeling activities and it is one of the

most widely used models for atmospheric trajectory and dispersion calculations. Applications range from tracking and forecasting the release of radioactive material, wildfire smoke, windblown dust, or pollutants from various stationary and mobile emission sources, to forecasting allergens and volcanic ash. A HYSPLIT inverse system based on variational data assimilation and a Lagrangian dispersion transfer coefficient matrix has been developed and successfully applied to estimate plumes of volcanic ash, wildfire emissions, and Cesium-137 releases during the Fukushima nuclear accident. ARL is expanding the applications for the inverse modeling approach to estimate greenhouse gas emissions for climate mitigation purposes.

Model evaluation is crucial for developing improvements and in gaining confidence in models; atmospheric tracers are a primary way to evaluate the skill of dispersion models. ARL's intentional tracer studies provide a repository of data that includes meteorological model, tracer data, and statistical and graphical tools to evaluate model changes and determine the accuracy of the dispersion prediction. ARL is researching and developing new tracer compounds from a variety of ground-based, mobile and aerial platforms, and is working to replace SF6. Tracers of opportunity, chemical species emitted as a result of normal human activities, are used to expand the data against which HYSPLIT can be evaluated; sulfur dioxide (SO2) and carbon dioxide (CO2) emitted from power plants are examples of such tracers of opportunity.

NOAA supports, as a requirement of the Paris Climate agreement, a Global Stocktake which will assess the international progress in reducing greenhouse gas (GHG) emissions and mitigating the climate impacts. ARL's characterization and modeling capabilities can be used to create an independent, transparent evaluation of GHG emissions and changes in emissions at various scales.

**Boundary Layer Characterization**
*GOAL: Improve Boundary Layer parameterizations, both short and long term, for weather and climate predictions to provide accurate meteorological state variable observations such as temperature, wind direction and speed, humidity, soil moisture.*

Accurate meteorological observations of air temperature, precipitation, relative humidity, and soil moisture and temperature, constitute the backbone of ARL's endeavor to develop and improve BL parameterizations for weather and climate predictions. Short and long-term measurements are part of carefully designed networks and planned observation campaigns. In addition, new technological advances are pursued in order to decrease uncertainties and improve spatial and temporal coverage. ARL maintains the U.S. Climate Reference Network (USCRN) for continuous, high-quality, long-term scientific observations of the global environment which consists of 139 stations across the conterminous US (114 stations), Alaska (23 stations), and Hawaii (2 stations). The USCRN is critical for defining the current state of the Earth's integrated environmental system, and in particular, the constantly changing conditions of the atmosphere, hydrosphere, and biosphere through long-term climate observations that are necessary to document climate change trends for the United States. Additionally, the USCRN provides high-quality surface data for use by National Weather Service Weather Forecast Offices in support of their forecasting and warning operations.

ARL is leading research to understand how data acquired by small unmanned aircraft systems (sUAS) can be validated and used to better understand BL evolution during the formation of severe storms, and how sUAS platforms can be used to measure mesoscale patterns and trends in the atmosphere. ARL mesonets in the western US – a long-term partnership with the U.S. Department

of Energy (DOE) – collect BL data and are used to develop industry specific daily weather forecasts, provide weather surveillance for weather-related safety advisories, and conduct wind flow studies over complex terrain.

ARL, in collaboration with several OAR labs, is developing a series of heavily instrumented supersites to focus on boundary layer measurements from both the physical and chemical points of view. These sites will include boundary layer height, turbulence, meteorology, components of the surface energy budget to provide input of heat and moisture to the atmosphere, and chemistry measurements that will characterize specific locations and seasons for better understanding of the BL behavior over a variety of environmental conditions.

**Evaluation Guidelines:**

For each research area reviewed, each reviewer will provide one of the following overall ratings:

- Highest Performance -- Laboratory greatly exceeds the Satisfactory level and is outstanding in almost all areas.
- Exceeds Expectations -- Laboratory goes well beyond the Satisfactory level and is outstanding in many areas.
- Satisfactory -- In general, Laboratory meets expectations and the criteria for a Satisfactory rating.
- Needs Improvement -- In general, Laboratory does not reach expectations and does not meet the criteria for a Satisfactory rating. The reviewer will identify specific problem areas that need to be addressed.

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. The narrative below provides descriptions of the criteria, evaluation questions to consider, and indicators. The scoring matrix in the appendix to this document summarizes this information.

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 similarly sized 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 scientists 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.
- *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)? Is the research driven and engaged by stakeholders? Are customers/users engaged to ensure relevance/usability of the research? Is project success determined by the Lab's contributions?
- How well does it address issues identified in NOAA strategic documents and research plans or other policy or guiding documents?
- 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 have commitment to OAR values, namely scientific integrity and diversity, equity, and inclusion?
- 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).

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 on March 21-25, 2022. 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 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 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 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. 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.

## Appendix: Scoring Matrix

**Quality** is a measure of the novelty, soundness, accuracy, and reproducibility of a specific body of research.

| QUALITY Element | Needs Improvement | Satisfactory | Exceeds Expectations | Highest Performance |
|---|---|---|---|---|
| **Novelty** | Scientific products are duplicative | Scientific products add to the field | Scientific products contribute significantly to the field | Scientific products are breakthrough advancements |
| **Soundness, accuracy, and reproducibility** | Science produced is not sound, accurate, or reproducible | Science produced is sound, accurate, and reproducible | Science produced exceeds expectations in soundness, accuracy, and reproducibility | Science is top ranked among research intuitions |
| **Publications*** | Few publications | A modest number of publications in respected journals relative to staff size | Large number of publications relative to staff size in top journals. Large number of citations | Multiple bibliometric indicators show very high value of research to advancement of knowledge |
| **Technology Development*** | Few or no technologies (e.g., observing systems, information technology, numerical modeling algorithms) transferred to operations/application | Multiple technologies transferred to operations/application and assessment shows positive impacts. | Multiple technologies transferred to operations/application and assessment shows significant positive impacts. | Numerous technologies transferred to operations/application and assessment shows transformational impacts. |
| **Data Contributions*** | Little contribution to data systems or poor quality, inaccurate, or inaccessible data | Contributions of data streams and involvement in developing databases that are quality controlled to ensure accuracy, precision, interoperability, and accessibility | Prior column plus contributions are numerous and significant | Shows leadership in developing or contributing to data streams with high impact to society |
| **Outreach and Communications*** | Little outreach is conducted, communications are unclear | Outreach program and products, communications, and education programs fulfill basic needs | Outreach exceeds expectations | Outreach and education results in transforming public behavior |
| **Scientists are Leaders in their Fields** | Researchers are not represented in any national or international leadership positions | Researchers participate actively in national and international organizations but do not have formal leadership positions | Researchers in national and international leadership positions | Numerous researchers in national and international leadership positions |
| **Awards and Recognitions** | Scientific work and researchers have not received awards or other forms of recognition . | Scientific work and researchers have received awards / recognition | Scientific work and researchers have received multiple, prestigious awards / recognitions. | Scientific work and researchers have received numerous, prestigious awards / recognitions. |

***WORK PRODUCT AREAS** (Publications, Technology Development, Data Contributions, Outreach and Communications) - Not all of the work product areas are applicable to all labs/programs. For example, some labs may have lower publication rates but high transition rates. Reviewers should indicate the 2 to 4 work product areas on which they believe the lab/program should be scored for quality.

**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.

| **RELEVANCE Element** | **Needs Improvement** | **Satisfactory** | **Exceeds Expectations** | **Highest Performance** |
|---|---|---|---|---|
| **Mission Linkage** | Research only weakly linked to NOAA mission | Research linked to NOAA mission | Research strongly linked to NOAA mission | Research achieves key aspects of NOAA mission |
| **Strategic Plan Linkage** | Research only weakly linked to OAR and lab/program strategic plans | Research linked to OAR and lab/program strategic plans | Research strongly linked to OAR and lab/program strategic plans | Research achieves key aspects of OAR and lab/program strategic plans |
| **Value to Society** | Research does not address existing or future societally relevant needs | Research addresses societal needs | Research is applied to policy decisions, improves operational capabilities of NOAA's service lines, and/or results in inventions for commercial use | Research improves important policy decisions, revolutionizes operational capabilities, and/or results in transformational inventions for commercial use |
| **Responsiveness to Stakeholder Needs** | Lab/program develops products intended to meet stakeholder needs but products do not meet needs | Some efforts to work with stakeholder needs but these are not consistent throughout the activity area | Lab/program builds trusted relationships with stakeholders and develops products that meet their needs and exceed expectations | Lab/program continuously engages with stakeholders to deliver solutions with high impact to stakeholders and society |

**Performance** is a measure of both effectiveness (the ability to achieve useful results) and efficiency (the ability to achieve results in timely fashion and with little waste). It considers how research activities are progressing relative to targets and milestones as well as how research is conducted (leadership, planning, etc).

| PERFORMANCE Element | Needs Improvement | Satisfactory | Exceeds Expectations | Highest Performance |
|---|---|---|---|---|
| **Leadership** | Management does not function as a team, work to improve operations, or foster culture conducive to achieving mission | Management functions as a team and works to improve operations. Management fosters diversity, equity, and inclusion. | Prior column plus leadership nurtures organizational culture that supports creativity and maximizes staff morale and productivity. Lab/program implements effective succession planning | Prior column plus leadership demonstrates visionary thinking and flexibility in responding to emerging needs, capabilities and unanticipated events. Leadership serves as a model for other organizations. |
| **Strategic Planning** | Lack of lab/program strategic plan, lack of effective process for planning research | Objectives documented in lab/program strategic plans. Lab/program has a process for evaluating and prioritizing activities. | Prior column plus lab/program planning process results in selecting/continuing those projects with consistently high marks for merit, application, relevance, and priority fit. | Prior column plus lab/program maximizes strategic planning to drive results. Serves as a model for other organizations. |
| **Effectiveness** | Key performance targets and milestones in Annual Operating Plan (AOP) missed without explanation, or AOP non-existent. | Meaningful, timely progress towards performance targets and milestones in AOP. Key products delivered. Effective project management. | Prior column plus targets and milestones in AOP are challenging and are met or exceeded in most cases. | Prior column plus lab/program performance substantially advances NOAA goals well beyond expectations. |
| **Efficiency** | Financial, staff, and/or time resources not used wisely. | Lab/program operates with efficiency (efficient use of financial resources, workforce, time) | Prior column plus leadership deftly navigates planning and budgeting processes at the lab/program, OAR, and NOAA levels as well as with external partners to maximize mission achievement | Prior column plus lab/program uses novel efficiencies and/or partnerships to achieve mission with fewer resources than expected |
| **Recommendations from Previous Review Implemented*** | Lab/program has not responded to recommendations from previous science reviews. | Lab/program has responded to and/or implemented most recommendations from previous science reviews. | Lab/program has responded to and/or implemented all recommendations from previous science reviews in a way that exceeds expectations. | Prior column plus lab/program leveraged prior review to spur significant growth and progress. |
| **Managing Transition of Research to Applications** | Lab/program fails to transition any research into application | Lab/program transitions research into applications effectively | Prior column plus transitioned products exceed expectations of users | Prior column plus transition management is model for others |

*Not relevant for programs undergoing their first review.