Air Resources Laboratory
May 3-5, 2011 Laboratory Research Review
Response to Review Recommendations and Implementation Plan
November 29, 2012

Introduction

The Air Resources Laboratory (ARL) would like to acknowledge the time and effort of the Review Team to thoroughly review our research programs. We appreciate its key findings of our programs:

Concerning quality: "The group as a whole does solid quality science and has a strong commitment to supporting other agencies and organizations with good service, application of the best methods and developing effective partnerships. The employees clearly pride themselves on doing high quality work and collecting the best data possible. The stakeholders who support NOAA research and data collection were overwhelmingly impressed with the work done for them by ARL, the professionalism of the employees, and the quality of the products."

Concerning relevance: "Overall the NOAA ARL consists of a highly competent group of researchers and support staff that perform an important role within the NOAA mission, including collecting observational data, developing data collection methods and modeling systems, and doing research on issues that are relevant to the atmosphere, ecosystems, and oceans. Their work is focused on highly relevant atmosphere-ocean issues that are important for the nation and internationally."

Concerning preeminence: "The indicators of preeminence are many including good publication track records in high quality journals (in spite of the many other obligations and deliverables) and development of widely used modeling programs and measurement methods, as well as awards, active memberships in prestigious organizations, service, and excellent collaboration with other agencies."

ARL also appreciates the recommendations provided by the Review Team concerning ways that we can improve our contribution to NOAA and our other customers. The remainder of this document addresses their specific recommendations. The numbering scheme corresponds to the section and recommendation numbers of the review panel report.

Context for Response

Several overarching factors set the context for ARL's response to the recommendations:

- Given that the reviewers found significant value in ARL's work (e.g., ARL's "work is focused on highly relevant atmosphere-ocean issues that are important for the nation and internationally"), ARL will strive to continue work in its existing scientific areas, evolving as appropriate.
- ARL base funding has not kept pace with inflation for more than two decades. With inflation-adjusted base funding in a long-term decline, less important activities have been eliminated over this period of time to continue support for core activities and staff.

- The Federal budget climate is bleak with a greater likelihood of funding cuts than increases. At the time this response was being prepared, there was a possibility that FY 2013 funding will be reduced by more than 8%.
- Most of ARL's funding is provided by sponsors with the expectation of specific deliverables. This funding can only be redirected to new purposes with concurrence of the sponsor, which can only be obtained for activities that are a high priority to the sponsor.
- Funding for some key ARL projects, including climate reference networks and air quality forecasting has decreased significantly in recent years.
- When there is an opportunity to redirect existing funding, that redirection will typically be at the expense of existing contractors, post-docs, etc. and/or ongoing monitoring activities.
- The Fiscal Year 2013 President's Budget proposes terminating NOAA's operational air quality predictions based on the Community Multiscale Air Quality model (CMAQ). This has already led to reductions in development activities supported by the National Weather Service. If those predictions are terminated, opportunities for CMAQ-based work will likely diminish.
- The Administration has directed that travel expenses be decreased relative to fiscal year (FY) 2010 levels, by 20% in FY 2012 and 30% in FY 2013.

While these challenges constrain the lab's options, ARL continues to evolve and look for opportunities to continue and expand its activities in response to societal needs and scientific and technical developments. The input from the Review Team will help shape this ongoing evolution.

General Responses to Recommendations

The common themes of increasing integration and interaction were evident in multiple recommendations. To address those themes, ARL has developed some "General Responses," which are described below. These General Responses will be referred to below when discussing actions for individual recommendations.

General Response "Integration": Several recommendations discuss greater ARL-wide integration of activities. ARL already takes multiple steps to support scientific integration within the lab. For instance, through ARL seminars and internal manuscript review processes, expertise from staff involved in these different research elements is shared. Also, ARL has a number of external collaborators. Such external collaborations are sometimes more beneficial than internal collaborations due to greater alignment of skills and needs.

However, ARL agrees exploring whether there are additional opportunities to integrate currently separate activities to improve outcomes would be worthwhile. Identifying the most appropriate and promising opportunities will require careful consideration, balancing the priorities of ARL and its parent organizations, practicality, resources, and commitments to customers. ARL will explore these opportunities through the development of an ARL strategic plan. This plan will incorporate the 2011 ARL dispersion strategic plan, build upon the lab's 2008 climate strategic plan, and address air quality and boundary layer directions. A draft strategic plan will be prepared within 6 months of approval of this response plan.

ARL will also hold periodic meetings to share developments and directions in its science themes across divisions. Related to those meetings, ARL will also hold one or more meetings specifically intended to

look for and pursue new opportunities to integrate activities. These activities will start within 3 months of the approval of this plan.

General Response "Interaction": Multiple recommendations call for greater in-person interaction among lab staff. ARL agrees that this would be desirable, but strict requirements for significantly reducing travel expenses will prevent ARL from accomplishing this to the desired degree. As an alternative--budget permitting--within 3 months of receiving an FY 2013 appropriation ARL will start the process of obtaining video teleconferencing (VTC) equipment for its locations.

Timing of Actions

The proposed actions would occur across multiple timescales. These include the following:

- Already started or addressed
- Planned, with a fixed deadline
- Execution is dependent on an external condition outside of ARL's control (such as the FY 2013 appropriation)
- Ongoing activities, such as continuing current activities or looking for future opportunities

The language of each action will make this clear.

1. Overarching Recommendations:

1 ARL could use additional technician support for the scientists

Response:

ARL agrees but its options are very limited with existing funding.

Action:

ARL will keep this issue in mind as it develops short- and long-term funding requests.

2 Having more regular meetings within and between ARL divisions would facilitate collaboration and allow NOAA to better capitalize on the skills within ARL

Action:

As described in General Response "Integration," ARL will establish meetings as required to implement its strategic plan and will also schedule periodic meetings for the research themes.

3 Inter-group interaction at all levels should be encouraged and rewarded

Action:

ARL will continue its ongoing efforts to encourage and reward group interactions. For example, ARL will continue to include inter-group interactions in performance plans at all levels as appropriate. In addition, it will pursue the steps described in General Response "Integration."

4 **Interaction should increase across themes and projects within ARL that are engaged in various national and regional monitoring efforts**

Action:

This will be considered during the activities described in General Response "Integration," including development of a strategic plan and establishment of integration discussions.

5 **More should be done to involve those personnel located in offices away from Silver Spring, MD in collaborative decision making and other ARL team processes**

Action:

The activities in General Responses "Integration" and "Interaction" address this recommendation.

6 **ARL's leadership and vital staff could be lost if appropriate levels of human resources with succession plans and alternatives to traditional hiring practices are not devised. This is perhaps the most serious issue that ARL needs to address and should be done as soon as possible.**

Action:

ARL recognizes that there are scientists in the laboratory who have knowledge and expertise essential to the continuation of core, ongoing ARL capabilities. ARL has worked to spread this knowledge and expertise among multiple staff members to support continuity of activities. For instance, this has included hiring more junior staff to work with lead scientists. ARL will continue identifying and addressing risks in this area.

7 **Create an ARL Fellows program by selecting a small cohort of scientists and providing resources for the cohort to develop and lead ARL integrated research development.**

Response:

Resources are a serious constraint for implementing this recommendation. Many current staff members are working on project-specific funds (e.g., NOAA climate reference networks, Department of Energy activities). While ARL does integrate activities to the extent feasible across all of the lab's projects, we must be cautious about who is leading which people so there is no actual or perceived concern about project-specific resources being applied inappropriately. Further, without discontinuing an existing activity, ARL does not have sufficient resources to supply to Fellows to support such a recommendation.

Another challenge with this recommendation is the tight connection specified between the designation as an ARL Fellow with leadership of an integrated R&D activity. Designation as a "Fellow" implies that one is a leading scientist in ARL. But some leading scientists may not have scientific or professional interests that are consistent with leading an integrated R&D project. Or a person who may be ideal for leading an integrated project may not have the stature yet to be considered a Fellow.

While it may not have been obvious during the review, since its 2005 review ARL has established integrated activities across both scientific and organizational boundaries. These include close

coordination of mercury modeling and measurements including scientists from two divisions, cross-divisions projects in areas such as the development of web-based decision support tools and quality assurance of climate data, coordination on wind energy research, and cross-pollination between Eulerian and Lagrangian modeling activities.

Action:

ARL will continue to leverage its multiple scientific disciplines, locations, and projects to deliver more than would be possible if these activities were conducted separately. ARL will also pursue the steps discussed in General Response "Integration" to further enhance integration across the lab.

In addition, ARL will focus its future National Research Council (NRC) post-docs or senior scientists on projects that span ARL divisions and/or connect traditionally separate scientific disciplines within the laboratory.

8 **Design use of the mesonets as an integrated ARL testbed for boundary layer and model development and evaluation (incorporate modeling teams—WRF, HYSPLIT, and CMAQ—in the design and use of these testbeds).**

Response:

ARL appreciates the suggestion to better integrate its modeling and mesonet activities.

For CMAQ, ARL does not have a need or funding to monitor air quality parameters at its mesonet sites. Also, the larger of the mesonets are in locations, DOE reserves, where high spatial resolution of ozone and particulate matter may not provide much value for model evaluation. Instead, ARL depends on multiple types of air quality measurements from existing networks to evaluate CMAQ.

The intersection between HYSPLIT and the mesonets are the meteorological fields, such as those produced by the Weather Research and Forecasting model (WRF). ARL is already using its mesonets to evaluate its and other organizations' WRF simulations.

Action:

ARL will continue to employ its mesonets to evaluate WRF and other meteorological models. ARL will also consider this issue when it develops its strategic plan (General Response "Integration").

9 **Integrate PBL climatology work with surface energy network analyses, WRF-CMAQ and HYSPLIT developments, and regional climate modeling (WRF) to create value-added analysis results.**

Response:

There are some limitations to the combinations suggested. For instance, the PBL climatology work depends on long-term profile measurements collected by other organizations while the surface energy network analyses are not co-located with profile measurements and there is not currently funding for routine, long-term profile measurements as the surface energy network sites.

Action:

ARL will consider opportunities for integration in these areas during the development of its strategic plan (General Response "Integration").

10 Design ways to rotate scientists for short or long periods among divisions.

Response:

ARL has limited ability to implement this recommendation. Issues include cost, restrictions on travel expenditures, and--in some cases--reluctance of people to work for extended periods away from home.

However, there have been at least seven occasions over the past decade where it has become evident that a scientist may fit better in a different division, and ARL has made the most of those opportunities for permanent change. In addition, we have recruited new ARL employees from other line offices in NOAA.

Action:

As opportunities arise for long- and short-term rotations among scientists, ARL will continue to explore them. ARL will also continue taking advantage of opportunities to have staff from different divisions work together during field experiments and other projects.

11 Continue to develop ARL wide communications and interaction, including regular science meetings among divisions.

Action:

ARL will continue ARL-wide science seminars and weekly updates, expand inter-divisional meetings, and establish VTC capabilities at all of the divisions. See General Responses "Integration" and "Interaction."

12 Employ the WRF (both forecast and regional climate modeling), HYSPLIT, and CMAQ developments as a focal point for integration of surface energy budget network, N, Hg, precipitation chemistry and other measurement capabilities to develop enhanced and much more integrated research programs.

Response:

ARL already uses information from some of its measurement activities to evaluate and/or improve the models--including in the areas of mercury and weather.

Action:

During the development of its strategic plan ARL will consider opportunities to better integrate measurement and modeling activities.

13 Continue to encourage scientists to publish their results in high quality journals.

Action:

ARL will continue to encourage publication in high quality journals. To support this, within two months of the acceptance of this plan ARL will modify its internal paper review process to further encourage publication in such journals.

14 **Grow the scientific workforce with careful selection and nurturing of new, young scientists—explore ways to use post-docs as the entry point for new scientists.**

Response:

ARL has been doing this. For instance, a recently hired Federal scientist and cooperative institute employee each started as post-docs.

Action:

ARL will continue to use post-docs as an entry point for new employees as appropriate. ARL headquarters may also have future opportunities to participate in a building-wide visiting scientist program at its new location.

15 **Link the WRF improvements via the regional climate modeling program with ongoing wind energy and PBL research to yield simulation and forecast tools.**

Response:

ARL does not currently have support for such work.

Action:

ARL will consider this during the development of its strategic plan.

2. Air Quality Recommendations:

1 **Closer relationship between HYSPLIT and the Eulerian AQ forecasting system should be considered. There may be value in developing a more systematic strategy of linking the two models.**

Response:

The level of effort invested in the Eulerian forecast system and integration with the Lagrangian system will significantly depend on the results of the FY13 appropriation and the future of CMAQ-based operational air quality predictions.

Action:

ARL will consider this issue in the development of its strategic plan. As appropriate, ARL will identify and pursue opportunities to more closely integrate the two activities. Examples might include the adaptation of dust algorithms developed for CMAQ to HYSPLIT and the use of HYSPLIT to provide dynamic smoke boundary conditions for CMAQ.

2 **To link with the climate focus of NOAA, initiation of research on black carbon wet deposition is recommended**

Response:

While ARL agrees that black carbon measurements in precipitation should be handled on a network basis, significant investment would be required for development of collectors and measurement protocols to do this correctly. Current infrastructure for precipitation chemistry is not up to the task. More than $1M a year might be required for method development, installation, operation, and analysis. While ARL has the capability to develop such a program, this work cannot be supported within ARL's current funding.

Action:

As opportunities arise, ARL will work to include consideration of such a program in NOAA's planning process.

3 **Continued efforts to strategically link AQ forecasting to weather forecasting for the benefit of both are encouraged**

Response:

Since the time of the review, the FY2013 President's Budget proposed discontinuing NOAA's operational Eulerian air quality modeling. This would significantly constrain opportunities and resources for pursuing such linkages.

Action:

ARL will consider this issue as appropriate after the future of operational Eulerian air quality predictions has been determined.

4 **Better coordination, integration and communication between researchers within this area focused on different AQ parameters (O3, PM, Hg, N) could provide a more efficient means of addressing specific research questions.**

Action:

ARL will include consideration of this issue in the activities discussed under General Response "Integration."

5 **ARL should ensure that all projects within the ARL AQ area have the opportunity to publish the results of their work, even if this means supplementing cooperator funding with NOAA funding for publication.**

Action:

ARL has shifted most of its non-Federal air quality scientists from a contractor to the Cooperative Institute for Climate and Satellites at the University of Maryland. ARL expects that this environment will be more conducive to publishing results.

6 **NOAA ARL should consider taking a leadership or co-leadership role in the analysis and summarization of monitoring data from automated instrumentation to measure speciated mercury in air concentrations, which is now available (NADP-AmNet), at the national or regional level.**

Action:

ARL participated in two national-scale mercury publications in 2012 that use national AmNet data:

> Nested-grid simulation of mercury over North America, by Y. Zhang, L. Jaeglé, A. van Donkelaar, R. V. Martin, C. D. Holmes, H. M. Amos, Q. Wang, R. Talbot, R. Artz, S. Brooks, W. Luke, T. M. Holsen, D. Felton, E. K. Miller, K. D. Perry, D. Schmeltz, A. Steffen, R. Tordon, P. Weiss-Penzias, and R. Zsolway, *Atmos. Chem. Phys.*, **12**, 6095-6111, 2012.
>
> Seasonal and diurnal variations of atmospheric mercury across the US determined from AMNet monitoring data, X. Lan, R. Talbot, M. Castro, K. Perry, and W. Luke. *Atmos. Chem. Phys. Discuss.*, **12**, 10845-10878, 2012.

As resources permit, ARL will continue to perform similar studies in the future.

7 The AQ group should dedicate at least some resources to identifying and producing high-value and high profile products from the large amount of available data from regional and national air and deposition monitoring networks

Response:

Working through the World Meteorological Organization Global Atmosphere Watch Precipitation Chemistry program, ARL is co-leading the development of a Global Precipitation Chemistry Assessment. NADP National Trends Network and AIRMoN data provide an important contribution to that publication. Journal submission is anticipated in early calendar year 2013.

Action:

ARL will co-lead the submission of a journal article describing the findings from the Global Precipitation Chemistry Assessment.

Resources permitting, ARL will initiate the process of hiring a graduate student to analyze trends in Multistate Atmospheric Power Production Pollution Study (MAP3S) and AIRMoN-wet data collected beginning in 1976.

8 It would be useful if this group could focus on getting descriptions of research method development and testing, and other efforts out into the peer reviewed literature. However this is currently limited by their lack of technical support and their need to wear many hats in their job.

Response:

ARL has published peer reviewed methods in collaboration with national and international partners:

> Through the National Atmospheric Deposition Program, AIRMoN protocols can be found at: http://www.isws.uiuc.edu/pubdoc/MP/ISWSMP-184.pdf

Through the World Meteorological Organization Quality Assurance/Science Activity Center-Americas web site, NADP AIRMoN and National Trends Network information has been incorporated into a World Meteorological Organization (WMO) Guidance Document for the collection of precipitation chemistry: http://qasac-americas.org/sites/default/files/GAW-Precip%20Chem%20Manual%20No.160.pdf

For mercury, as a part of the NADP Atmospheric Mercury Network program, ARL has contributed to field and laboratory sampling protocols. For example, see http://nadp.sws.uiuc.edu/amn/docs/AMNet_Operations_Manual.pdf

3. Atmospheric Dispersion and Boundary Layer Recommendations:

1 Encourage development of a more cohesive dispersion measurement and modeling research program by hiring a mid-career dispersion modeling lead for the FRD group.

Response:

A senior FRD staff member retired in June 2012. Depending on the funding outlook, this may provide an opportunity to hire a dispersion modeler to fill the vacated position. Due to budget limitations, it is likely that any new hire would be an early career scientist rather than mid-career, perhaps a post-doc.

The implementation of this recommendation would help support the succession recommendations given in 1.6, 3.2 below, and in several other sections. For example, some of the HYSPLIT development and support effort could be assigned to this dispersion modeler. A new modeler at FRD would also provide a better balance of field and modeling expertise at the division. Historically, FRD's staff has been heavily weighted towards expertise in tracer measurements. Such a level of specialization may have been optimal when funding for tracer studies was relatively plentiful, but a more balanced combination of modeling and tracer expertise may be more effective in the current budget environment.

Action:

As the funding outlook becomes clearer, ARL will consider hiring a dispersion modeler at FRD.

2 Provide for continuation and development of HYSPLIT by creating a larger and more distributed HYSPLIT team with less reliance on single PI expertise.

Action:

Since the review ARL HQ has received multi-year reimbursable funding that has allowed ARL to add another modeler to the HYSPLIT team. Also, as discussed in the previous recommendation, ARL will consider hiring a HYSPLIT modeler at FRD.

3 The use of HYSPLIT by external organizations with varying degrees of expertise, especially during high-profile atmospheric release events, raises the question whether ARL should explore planning and executing model runs and providing model output products in addition to providing the model.

Response:

The use of HYSPLIT by external organizations with varying degrees of expertise is a risk intrinsic in distributing a flexible modeling system. ARL offers training materials and programs to help users understand how to effectively apply the modeling system.

As an R&D laboratory, neither ARL's mandate nor funding include providing routine dispersion prediction services. For routine situations and/or standard scenarios, other parts of NOAA or other agencies have the responsibility to provide predictions. Within NOAA, the National Weather Service and the National Ocean Service each have operational atmospheric dispersion responsibilities. ARL works closely with both line offices to improve the services they provide and to provide consultation and specialized simulations as required. As was mentioned during the review, ARL has worked with other line offices to propose further expansion and better integration of NOAA plume prediction activities, but resources have not been available to implement that vision.

ARL does execute model runs and appropriately share products for non-standard situations and requests and for locations where ARL offers localized support. These runs are typically conducted at the request of other NOAA line offices or other agencies and the results are provided back to those organizations for appropriate use or distribution.

Given ARL's mandate and its limited resources, it feels that its current role--taking into account the partnerships with NOAA's operational line offices--is appropriate.

4 **ARL should consider a small project, possibly by supporting a library sciences graduate student, to develop a system to better identify and archive publications by external organizations utilizing HYSPLIT.**

Response:

ARL appreciates the suggestion to better highlight use of HYSPLIT. While not perfect, Google Scholar provides a fast and existing mechanism to identify articles that mention HYSPLIT. A search for the past 10 years produces more than 5000 citations, with more than 1000 in 2011 and 2012.

A greater challenge is to decide what to do with this information. Listing 5000 publications on the ARL web site would not be very useful for visitors, nor is it feasible to obtain even a substantial fraction of these publications to be archived at ARL. Further, any type of searching capabilities that ARL could provide would likely only duplicate a subset of the capabilities already provided by Google Scholar.

Action:

ARL will continue to update the HYSPLIT web site with citations provided by their authors. ARL will also complement that information with a reference to Google Scholar and/or a count of citations reported by Google Scholar.

5 **Develop and maintain a 5-year laboratory-wide plan that provides for integration of modeling and measurement capabilities.**

Action:

During the development of its strategic plan (General Response "Integration") ARL will include as appropriate integration of modeling and measurement capabilities.

4. Climate Recommendations:

1 **Inter group collaboration between the analysis, modeling and climate network instrument scientists should be expanded and used to create new opportunities, increased publication and visibility of all members.**

Action:

As described in General Response "Integration," ARL will encourage discussion among the relevant scientists and identification of appropriate collaborative opportunities.

2 **The national and international leadership shown in the upper air analysis work should be extended to all data within ARL/NCDC (e.g. analysis of data from the CRN, NADP, AIRMon-wet, etc).**

Response:

ARL appreciates the recognition of the outstanding work conducted by its upper air analysis group.

There are some issues that make it impractical for ARL to fully implement this recommendation. NCDC is the steward for a tremendous volume and diversity of data. ARL does not have the capacity to analyze all of that data. Also, NCDC has its own analysis capability, with which ARL collaborates. In addition, the CRN data record is yet too short to allow meaningful climatological analysis.

Action:

Analysis of air quality data sets is discussed above.

ARL has several recent activities underway to evaluate and/or improve the quality of climate observations and to use these observations to improve predictions. These activities include the following:

- ARL is a key participant and is playing a leading role in the WMO Solid Precipitation Intercomparison Experiment (SPICE). The primary goals of SPICE are to:
    - To Improve the understanding of the performance of various solid precipitation gauge/ shield combinations;
    - Develop transfer functions between the various solid precipitation gauge configurations to improve estimates of liquid water equivalent snowfall in support of real-time applications, hydrological models and data continuity in the climate record; and
    - Define a field standard for automated solid precipitation gauges.
- ARL is analyzing biases associated with air temperature measurements near roadways and buildings to provide some physical basis for the ongoing controversy focused on the U.S. surface temperature record and the errors associated with the site classification criteria.

Measurements are being recorded with a co-located NOAA US Climate Reference Network temperature measurement system and the National Weather Service Maximum Minimum Temperature Sensor system.

- ARL is evaluating above ground climate data from CRN as inputs for evapotranspiration models and the below-ground soil moisture and soil temperature data as inputs for predicting water transport within the soil. The combination of evapotranspiration, precipitation, and changes in soil water storage will be used to develop a robust tool to quantify site-specific soil water budgets important to agriculture, hydrology, climate and weather across the U.S.

3 **A much more robust use of the regional climate modeling (CWRF) as an assessment tool of regional climate impacts and the role of this in AQ studies should be encouraged.**

Action:

Since the review, ARL has hired an NRC post-doc to investigate bidirectional climate-particulate matter interactions. ARL will continue to look for other opportunities to apply CWRF in these areas.

4 **Concrete goals should be enumerated on how ARL-Climate fits in the "lab in transition" processes. This can start with a clear definition of how the "PBL theme" as a cross-cutting theme will fit into the Climate strategy goals and plans.**

Action:

During the preparation of its strategic plan (General Response "Integration"), ARL will consider R&D related to the climate of the boundary layer.

5 **The group is encouraged to take a pro-active stance in the overall NOAA climate services discussion and define its role with the planned reorganization.**

Response:

Since the review, Congress has declined to approve the proposed Climate Service reorganization. Instead, NOAA will coordinate its climate activities through the NOAA Climate Goal.

Action:

Since the review, ARL has joined NOAA's climate goal planning team and will continue its engagement with that team.

6 **Expand or at least continue work related to changes in the climate of the planetary boundary layer**

Response:

Analysis of the climate of the PBL is continuing. While our early work focused on understanding definitions of the PBL and their application in climate studies and on understanding the stable PBL in the

polar regions, current work is focused on PBL mixing heights in mid-latitude continental regions (the US and Europe). Our intention is to develop collaborative relationships to ensure these analyses are of value to other parts of the atmospheric science community.

Action:

As resources and opportunities permit, ARL will seek to undertake the following tasks:

- Collaborate with partners in the carbon cycle modeling community to understand the role of the PBL in the global carbon cycle.
- Explore other opportunities for collaboration and partnership with other NOAA labs, universities, and international organizations.

7 **A stronger across-the-board publishing performance would enhance the scientific contributions of the climate group. This is also needed to establish a broader presence in national and international assessments and participation in prestigious groups. There are strong performers in this group but there are also some weak performers who may not be taking full advantage of publishing opportunities.**

Action:

ARL will set higher expectations for weak performers during its performance management process.

8 **The current prominent position of the group in upper air research should be maintained as this will likely continue to be a critical issue for climate change detection and attribution.**

Action:

ARL will continue to support upper air research.

Since the review ARL, with NOAA and Department of Commerce approval, has promoted its leader of this effort to a Senior Scientist, becoming one of fewer than 20 Senior Scientists in NOAA and a member of the Council of NOAA Fellows.