Global Monitoring Division

Report of the 2013 Review and Response

2013-2017 Review

May 21-24, 2018

Report of the Review of the NOAA

Earth System Research Laboratory

Global Monitoring Division April

3-5, 2013

Review Panel

Dr. Kenneth Jucks, NASA, Chair
Dr. Carl Brennikmeijer, Max-Planck Institute for Chemistry Dr. Oystein Hov, Norwegian Meteorological Institute
Dr. Beverly Law, Oregon State University
Dr. Michael McElroy, Harvard University
Dr. Anne Thompson, Pennsylvania State University

Report of the Review of the NOAA Earth System Research Laboratory Global Monitoring Division April 3-5 2013

Overview

An on-site, expert peer review of the NOAA Global Monitoring Division (GMD) was conducted April 3-5, 2013 in Boulder, CO. The purpose of the review is to ensure that OAR laboratory research is linked to the National Oceanic and Atmospheric Administration (NOAA) Strategic Plan, is relevant to NOAA Research mission and priorities, is of high quality as judged by preeminence criteria, and is consistent with NOAA planning, budgeting, and budget execution.

The review focused on three research areas: Climate Forcing; Ozone and Ozone Depleting Gases; and Baseline Air Quality. The six-member review panel was provided with written materials before the site visit that included guidance to the reviewers, supporting documentation, NOAA's Strategic and Research Plans, and access to the science presentations to be made during the site visit. During the review, the agenda primarily consisted of presentations on the three research areas, as well as some time allotted for informal discussions with GMD staff and stakeholders. This report summarizes individual panel member evaluations and is not a consensus report.

Summary of Laboratory-Wide Findings and Recommendations

The instructions for this review were to concentrate on the relevance, quality, and performance of the activities being performed at the Global Monitoring Division of the Earth System Research Laboratory of NOAA and to rate the research areas on the criteria outlined in the "Charge to Reviewers" document using the following definitions:

- Outstanding--Laboratory goes well beyond the satisfactory level and is outstanding in all areas.
- Satisfactory--In general, Laboratory meets the expectations of the science criteria.
- Needs Improvement--In general, Laboratory does not reach expectations.

The reviewer will identify specific problem areas that need to be improvement.

	Climate Forcing	Ozone and Ozone Depleting Gases	Baseline Air Quality
Jucks	Outstanding	Outstanding	Satisfactory
Brenninkmeijer	Outstanding	Outstanding	Outstanding
Law	Outstanding	Outstanding	Outstanding
Hov	Outstanding	Outstanding	Outstanding
McElroy	Outstanding	Outstanding	Outstanding
Thompson	Outstanding	Outstanding	Outstanding

The bases of these ratings are summed up with the following statements.

Relevance: The activities of GMD support the "Environmental Security" of the nation and are as essential to the NOAA mission as the rest of NOAA.
Quality: GMD has become a NOAA/ESRL star, carrying on the ever more critical climate mission while pushing the frontiers in Climate, Greenhouse Gases, Ozone Depletion, and Air Quality. Their datasets of changing atmospheric composition and standards are those that will be used by the international community for decades to come.
Performance: The investments into GMD have been well optimized in an underfunded environment. Despite the significant set of responsibilities, the work in the different groups focusing on the themes presented to the panel, is of the highest caliber. The scientific community, nation, and beyond are reaping the benefits, and are heavily dependent on GMD. Now is the time to strengthen the capacity of GMD even further to maintain its global lead in these activities.

All of the areas of focus within the GMD are activities that are highly relevant to NOAA's goals of understanding the Earth System as it relates to addressing the information the US Government and citizens need to understand the impacts of decisions on many scales. The Climate, Ozone, and Air Quality research at GMD are all key areas of focus for NOAA and Earth System Science.

The quality of the work, as proven by the broad range of researchers who either use data obtained by GMD or extensively collaborate with GMD researchers is at the highest level. The trusted data sets GMD distributes are key to advancing science and reducing uncertainties in the international assessment process. GMD personnel are committed to this goal and are highly recognized for their work (reference "Preeminence" document).

The GMD has assembled a very skilled team that takes their obligations very seriously, and this shows in how they achieve their mission. They work tirelessly to establish connections to ensure that all of their partners worldwide meet the performance standards of GMD as well. As a result, data, products, and scientific analysis that ensue from GMD activity are quite high, especially with the constraints on resources in which they currently operate.

The long-term observatories and distributed observations of GMD are essential for the monitoring of key atmospheric parameters. There is no redundancy in these data. Reinforcing infrastructure at the current observatories is essential. Equally important is *expanding* capacity to support monitoring in regions where new problems may erupt that affect the US and international partners (e.g., new oil and shale-gas activity, GAW-type locations affected by intercontinental pollution).

The team reports five Findings and associated Recommendations. These are further spelled out our individual findings. These are summarized below. Note that each

Finding touches on one or more of the 3 Review metrics (Relevance, Quality, Performance). Each Finding and Recommendation pair is followed by important evidence and background.

Finding #1

The NOAA GMD Mission is on target, well aligned with the needs of many stakeholders and supporting the activities of other science and regulatory agencies (state, national, and international). The lab is an environmentally strategic asset of the US that has been carefully optimized to conduct highly successful science in the areas of Climate Forcing, Ozone and Ozone-depleting substances and Air Quality.

Recommendation #1: The science GMD carries out to support other science and regulatory agencies (state, national, and international) should be expanded rather than contracted to accomplish NOAA's mission.

Background and Evidence:

GMD activities and researchers address essential "processes" in the "Earth System" that are only understood with long-term, systematic, quality-assured observations. In many cases no other organization has the capability to do this kind of work. GMD has evolved into a distinguished "scientific" national asset.

No single agency or organization doing global Earth System science has the financial or personnel resources to sufficiently achieve the tasks they have defined as priorities. Most localized Earth Science problems are tasked to State agencies (within the US) to monitor/regulate, and they rarely have the appropriate scientific expertise to sufficiently follow through on their mandates. GMD fully recognizes this and works hard to establish both global and local connections and collaborations to help them achieve their goals and those of their partners.

The work with international partners, especially those connected with WMO, ensure that GMD's "climate" and "ozone" related observations are truly global, which is required to answer the science questions related to these fields. Even with these efforts, the spatial and temporal coverage of the resulting data sets is adequate at best. More, not less, effort is required to advance the science in these areas. GMD is the main international coordinator in enhancing and expanding these coordination activities. The strong, central, and internationally leading role for GMD is essential to US interests and must be sustained.

The work with local US partners primarily relates to Air Quality activities, many of which are delegated to the states, and coordinated with the EPA. The recent work by GMD with some western states for understanding the impacts of emissions from gas and oil extraction is a clear example of how NOAA expertise allows regional

policy makers to understand the implications of activities in their individual states that would simply not be possible with their own resources.

Finding #2

The combination of GMD activities and priorities, with a mixture of operations, science and technology is an essential element of its successful approach to carrying out its mission.

Recommendation #2: All three components of GMD work, operations, scientific analysis and technological development, are required for its mission and must be sustained.

Background and Evidence

The term "monitoring" may imply activity that is routine or not important to understanding the basic "mechanisms" of the Earth System. However, it is a synthesis of short term and long term observations that are required to quantify changes and uncertainties in the system as a whole. Both monitoring and process data require interpretation by scientific experts within GMD.

Monitoring implies "operational" in the eyes of many managers within the US government. However, the monitoring activities of GMD require significant scientific and technological expertise that is the foundation of mission success. The types of observations performed by GMD require unique instrumentation, many of which are developed in-house. The operation, upkeep, and improvement of these instruments require a high level of specialization. Having people in-house who are on the forefront of using and interpreting the data scientifically is also critical and makes an internally consistent system. Top- quality scientific data require the full understanding of how random and systematic uncertainties propagate to scientific conclusions and assessments. This requires that GMD scientists who are actively involved in the analysis and interpretation of their data *direct* the operation, upkeep, improvement and deployment of their instrumentation.

Finding #3

GMD "leveraging" of activities done by others is extensive and integral to the scientific mission of GMD and is often an appropriate and required strategy. Although national and international partnerships partially compensate for limited NOAA resources, the continued US leadership role in monitoring and scientific assessments is at risk due to declining budgets!

Recommendation #3: NOAA must put additional resources into all aspects of GMD operations, scientific analysis and innovation.

Background and Evidence

This finding is related to Finding #1 and is illustrated with reference to NOAA's role in the assessment process. NOAA at large makes significant contributions to these mandated assessment activities both within the US Government and in partnership with international organizations where the US Government is a significant contributor. The personnel within GMD play an integral role in many of these assessments and the data sets produced by GMD are at the core of many key findings within these assessments.

- National Climate Assessment
- IPCC assessments
- WMO/UNEP Ozone assessments

Due to the complexity of science and the global scope of GMD research and observations are the backbone of the WMO/GAW, ICOS, and GCOS, especially in the ozone and greenhouse gas areas. Without GMD continuing its leadership role in standards, measurements and reporting, those programs would fall apart and the assessments would be incomplete. The same holds for the collaborative activity within the US agencies where GMD data perform a unique function in integrating climate, ozone and air quality programs. Although NASA and DOI (USGS, USFS) are partners in certain earth observations, no other agency has the expertise, ability, or budget to perform the roles played by GMD within the USGCRP, NACP frameworks nor in connecting air quality to regional composition and climate changes.

The US needs to be prepared for possible future international agreements regarding climate and mitigation. The US Government will need observations from GMD in order to better assess and document how well the US and international partners are meeting their agreed-upon metrics. Only GMD has the multi-decade records and interpretive capability to take on the challenge that such agreements will present.

Finding #4

The scientific capacity of GMD is at risk due to a disproportionately senior workforce, including possible near-term retirements of some of its pre-eminent leadership, and little succession planning for major programs. Most junior and some mid-career scientists with leadership potential in GMD are employed through CIRES, with limited opportunity to advance.

Recommendation #4: Recruitment of new talent and conversion of suitable CIRES staff to NOAA positions are imperative for keeping projects strong.

Background and Evidence

GMD has gathered significant talent within the early and mid-career ranks but most of these individuals are CIRES (the University of Colorado's Cooperative Institute for Research in Environmental Sciences) employees. This limits their ability to advance to leadership positions within GMD. The future of GMD requires that many current CIRES employees be converted to civil servants and assume more active roles in setting direction of GMD activities. Avenues should be put in place now to facilitate development of future GMD leaders.

Finding #5

The GMD observatories are national treasures and strategically located to support their highest priority national and international measurement programs. However, their current number is barely sufficient and NOAA cannot respond to emerging environmental problems with new stations.

Recommendation #5: NOAA should ensure the continued support for the observatory system.

Evidence and Background.

All of the observatories maintained by GMD are in critical locations, and even doubling the number of related observatories would not lead to redundancy. The current set of observatories provides minimal coverage for most of the parameters being observed. There is a need for additional investment in the human resources at the observatories that supporting GMD's measurement program.

Maintaining the current set of GMD observatories is the absolute minimum investment that should be applied to the observatories and should be one of the highest priorities within GMD.

Summary of Findings and Recommendations

1. The GMD mission is strategically aligned with NOAA's mission and stakeholder requirements. Supporting the activities of other science and regulatory agencies (state, national, and international) should be expanded rather than contracted to accomplish NOAA's mission.
2. GMD's programmatic priorities are the "right ones" and are supported by a well-optimized mix of monitoring, science and technology. All of these components of GMD must be sustained.
3. Leveraging national and international partnerships is an integral part of conducting GMD's work, but US leadership in the science and the assessment process is threatened by the current funding environment. Funding for all of GMD's activities must be increased.
4. GMD's pre-eminence in monitoring and science are at risk with a very senior workforce and little succession planning. To remedy this, recruitment of new talent and conversion of suitable CIRES staff to NOAA positions is recommended.

5. The GMD record and scientific output depend heavily on the infrastructure of its observatories. NOAA must ensure continued support for the observatory system.

GMD Final Report to OAR Management re: the 2013 Global Monitoring Division Reviewers' Findings and Recommendations and GMD's Response

[Comments on Actions taken in Blue]

27 July 2015
Revised 10 August 2016

We greatly appreciate the thoughtful comments provided by the Review Panel, and the time they spent in carrying out this review of NOAA's (National Oceanic and Atmospheric Administration) Global Monitoring Division (GMD).

This document responds to issues raised by the reviewers or provides additional information where warranted by the reviewers' comments. In the first section below, we have responded to general comments offered in the written review report. The second section responds to specific points made by the reviewers within the topic areas of the review. Excerpts from the Review Report are shown in italics.

General Comments

We appreciate the positive comments offered by the reviewers concerning the quality, relevance, and performance of atmospheric chemistry, aerosol, and solar radiation research at ESRL. It is good to hear this diverse panel underscore the quality, relevance, essential nature, and value of our data sets and research to assessments and scientists worldwide. We agree that these data and research are essential to the success of international science and are dedicated to maintaining quality and keeping the systems operational under all budget scenarios.

Actions: To sustain the continuity and quality of GMD's data sets, we are aggressively pursuing several options. We actively seek extramural funds from other agencies and we are beginning to charge full cost recovery on services at the observatories. [We have instituted an on-going effort, phasing in charges according to individual agreements at all observatories.] We also have recently engaged the Office of Marine and Aviation Operations (OMAO) for a larger effort by NOAA Corps in providing staff at our observatories, increasing their staffing in GMD and the length of their tours of duty. [This has been completed for a third officer; we continue to seek a fourth.] Though each of these efforts is helpful, none of them is a sufficient amount of funding to provide to adequately upkeep and maintain our sites, nor to cover the plethora of publications our highly productive staff generates from these data. What may be more effective is our effort to secure additional funds through a proposed increase of base funds in the President's budget requests. Although we received a modest increase in base funding beginning in FY2014, fragments of what is needed remain. These were kept in NOAA's request for FY2015 and FY2016 to no avail and we understand these items will again appear in the President's FY2017 request. We will continue to work closely with the

Office of Oceanic and Atmospheric Research (OAR) and NOAA leadership to ensure that GMD has appropriate funding for its critical work.

Specific Comments on the Topic Areas

Finding #1: *The NOAA GMD Mission is on target, well aligned with the needs of many stakeholders and supporting the activities of other science and regulatory agencies (state, national, and international). The lab is an environmentally strategic asset of the US that has been carefully optimized to conduct highly successful science in the areas of Climate Forcing, Ozone and Ozone-depleting substances and Air Quality.*

Recommendation #1: *The science GMD carries out to support other science and regulatory agencies (state, national, and international) should be expanded rather than contracted to accomplish NOAA's mission.*

Response: GMD's mission is essentially unchanged since its inception and that is consistent for an organization designed to provide long-term monitoring to address multi-decadal concerns. GMD's scientific publications, data, and products have become increasingly relevant to other agencies through the US Global Climate Research Program (USGCRP), particularly the Environmental Protection Agency. In addition to their scientific contribution, GMD's ozone observations inform policies on stratospheric ozone and air quality; greenhouse gas observations inform policies on energy development; aerosols and radiation inform policies on energy development and overall air quality.

Actions: GMD will continue to maintain all networks, expand its product base, interact with other agencies to enhance observing systems, inform assessments, build outreach, and publish manuscripts, analyses, and data products in a timely manner. Our Global CO_2 Record and our Annual Greenhouse Gas Index have now been officially adopted as National Climate Indicators. They both also are used routinely in EPA Annual Reports, as are all of our data on ozone depleting gases along with the Ozone Depleting Gas Index. Our studies of oil and gas field emissions of methane are also now used by EPA to evaluate their methane emission inventories and our findings on ozone have influenced recent air quality policy decisions by EPA and we continue our contributions to the ozone assessments that inform the parties to the Montreal Protocol. Internationally, we continue to maintain strong ties with the World Meteorological Organization (WMO) through participation in its Global Atmospheric Watch Programme (GAW) serving on or leading its scientific advisory groups and experts groups, WMO Commission for Atmospheric Sciences (the guiding body for GAW and the World Weather Research Programme), the Baseline Surface Radiation Network, the Federated Aerosol Network, the Global Climate Observing System (GCOS) Atmospheric Observation Panel for Climate, the USGCRP Carbon Cycle Interagency Working Group and Scientific Steering Groups, US Group on Earth Observations (GEO), and the international GEO-Carbon Programme. [GMD continues to leverage its skills and capabilities among these organizations, being key players in the GEO-Carbon Strategy, the emerging WMO Integrated Greenhouse Gas Information System, and the emerging GEO-Carbon Flagship. GMD leads much of the work at the biennial Greenhouse Gas Measurement Techniques meetings where measurement guidelines are evaluated. GMD provides leadership of the Baseline Surface

Radiation Network, two WMO Scientific Advisory Groups, and participation on a third. We continue to update of products, re-establish lost sites with infused funds, participation in WMO, GCOS, GEO events, commissions, panels worldwide, maintain involvement in USGCRP, work to establish Nat'l Climate Indicators, and build capacity through WMO, CEOS, GEO and national partners.]

Overall, we are looking at ways to brand GMD's observing systems for what they are – "Reference Networks for Atmospheric Composition and Radiative Forcing". As reference networks, they have become the core of any global observing system of these variables – other instruments, sites, or systems must yield results that are consistent with GMD's. GMD's observing systems for greenhouse and ozone-depleting gases, ozone, aerosols, and radiation are "reference" networks for several reasons: (1) they are supported internally by world recognized standards, calibration gases, and approaches; (2) their high quality and comprehensive coverage make them particularly useful for comparisons by other observing systems; (3) GMD maintains rigorous, transparent quality control procedures that provide the glue for incorporating outside measurements; (4) products such as GlobalView and CarbonTracker are used universally to initialize and validate climate models; and (5) satellite retrievals similarly use GMD's records for initialization and validation. We are exploring having this "branding" as reference networks for several other of our networks in the near future. A "beta" version for greenhouse gases is currently posted at http://www.esrl.noaa.gov/gmd/ccgg/about.html .

Finding #2: *The combination of GMD activities and priorities, with a mixture of operations, science and technology is an essential element of its successful approach to carrying out its mission.*

Recommendation #2: *All three components of GMD work, operations, scientific analysis and technological development, are required for its mission and must be sustained.*

Response: Our understanding of this finding is that, although much of what we do to ensure the continuity of our observations can be considered operational, it is essential that research and observations be tightly linked under the same roof. This is needed because of the high accuracy and precision of data required, the low concentration levels measured, and the sophistication of the instrumentation. We have maintained this tight linkage since the inception of GMD's predecessor organization (Geophysical Monitoring for Climate Change – GMCC), but especially since 1984, when a review panel for GMCC made it clear to OAR and NOAA leadership that the importance of these observations, the quality needed for them to be of scientific value, and the dependence of the broader community on the observations required an infusion of research scientists within the organization if it is to succeed. The recommendation was acted upon within the following few years and improved the value and impact of what are now GMD's data, products, and research.

Action: GMD will continue to pursue a careful balance between top quality scientists and skilled technicians to ensure the continuity, quality, and relevance of these data. As we work to replace our aging workforce, we will ensure that highly-capable individuals are attracted to oversee and maintain our observing systems. To a great extent such an

attraction already exists because of the relevance and quality of GMD data, the opportunity to work in a pool of innovative scientists, and our engagement with national and international partners. We will enhance this with opportunities for succession and leadership development by fostering even closer coordination among our scientists and technicians, by continuing to give mid-level scientists leadership opportunities, and by encouraging retiring senior federal staff to continue part-time in non-federal positions to provide continuity and mentoring for the new generation of leaders. [We have hired two technicians and Group Chief as federal employees and several scientists and technicians as CIRES Associates with new funds. Several federal employees have retired and we are working on filling positions. We have developed succession plans for all research groups.]

Finding #3: *GMD "leveraging" of activities done by others is extensive and integral to the scientific mission of GMD and is often an appropriate and required strategy. Although national and international partnerships partially compensate for limited NOAA resources, the continued US leadership role in monitoring and scientific assessments is at risk due to declining budgets!*

Recommendation #3: *NOAA must put additional resources into all aspects of GMD operations, scientific analysis and innovation.*

Response: This is a critical issue that GMD has long-recognized. For Fiscal Years 2011-2017, NOAA, with considerable push from GMD, OAR, CPO, and even OSTP, has had requests in the President's Budget for amounts ranging from $5.7M to $12.7M augmentation to GMD, mainly through CPO. The requested funds in the FY 2011-2013 budgets were not appropriated by Congress. In FY2014, $3.5M of the $5.7M request was granted by Congress. This brings us back to 2003 levels in real dollars, which helps, but is still not enough to meet current demand and requirements. Also, with a complete design and cost estimates fully laid out, we have had requests to the NOAA Chief Administrative Officer for funds for a new building at Pt. Barrow for about a decade, getting high in the rankings in many years, but not high enough to compete for the limited, available resources.

A**ction:** For FY2015, GMD has worked closely with OAR Leadership, NOAA Headquarters, and NOAA Office of Program Planning and Integration to request $3M additional funding for NOAA's Atmospheric Baseline Observatories, mainly for operational support. This is now in the FY2015 President's Budget Request. The amount is not sufficient for maintaining our unique reference networks at a level to ensure global leadership, but it will at least prevent our observatories from falling further into disrepair. OMB saw fit to add two additional requests for FY2015 that harbor significant increases for GMD observing networks. One is a request for $4.5M, of which $1.0M is targeted at GMD activities regarding the North American Carbon Program. That is intended to recover most of the remaining FY2014 request. The second request was for $8M for North American carbon research, calling for largely expanded monitoring of CO2 and methane from GMD's aircraft and tall tower networks, supported by enhanced measurement of C-14 in CO2, other isotopes in CO2 and methane, and chemical tracers for attributing emissions. Along with OAR and NOAA HQ, we will meet with key committee staff and members of Congress on several occasions this year as the budget is developed. It is essential not just to GMD, but to NOAA, OAR, and the world scientific

community that these funds become available. In addition, we will work closely with OAR and NOAA and continue to push for funding for a new Barrow facility at the earliest possible chance. [We continue to push for more resources supporting NOAA's long-term observing systems, adding, once again, a request for funds to construct a new building at Barrow, Alaska (BRW).

Finding #4: *The scientific capacity of GMD is at risk due to a disproportionately senior workforce, including possible near-term retirements of some of its pre-eminent leadership, and little succession planning for major programs. Most junior and some mid-career scientists with leadership potential in GMD are employed through CIRES, with limited opportunity to advance.*

Recommendation #4: *Recruitment of new talent and conversion of suitable CIRES staff to NOAA positions are imperative for keeping projects strong.*

Response: GMD has an urgent need to open up NOAA positions if it is to succeed in maintaining leadership within the organization. GMD and OAR agree to continue to push for these positions.

Action: GMD is working with OAR HQ to fill eight NOAA positions this calendar year. These include four scientists, an administrative officer, a budget analyst and two technicians. [GMD has hired two technicians, an Administrative Officer, and two scientists as federal employees. Several CIRES technicians and scientists have also been hired. We are still waiting on two scientists, one technician, and two administrative positions and are preparing a list for further conversions.]
See also discussion of personnel hiring and succession planning in response to recommendation 2.

Finding #5: *The GMD observatories are national treasures and strategically located to support their highest priority national and international measurement programs. However, their current number is barely sufficient and NOAA cannot respond to emerging environmental problems with new stations.*

Recommendation #5: *NOAA should ensure the continued support for the observatory system.*

Response: This is one of several needs for GMD funding, as noted above in our response to Finding and Recommendation #3. These are (1) additional funds for the current atmospheric baseline observatories to accommodate rapidly rising costs and previous budget cuts; (2) support to strengthen and upgrade GMD's reference networks for atmospheric composition and radiative forcing with up-to-date equipment; and (3) facilities support to replace the greatly aged main building at Pt. Barrow, AK.

Action: The additional funding received in FY2014 has taken some pressure off of GMD's observing system infrastructure, but significant gaps remain. As we noted in our response to Finding and Recommendation #3, OAR's request for funding for GMD's Atmospheric Baseline Observatories has appeared in the President's budget for FY2015,

FY2016, and likely FY2017. Other portions of the President's Budget request that support GMD will greatly benefit the overall observing systems that are intricately linked to and support the observatories. These additions will allow NOAA to maintain its leadership position in providing reliable, long term information on global atmospheric composition. [In addition to on-going requests for funds for the ABOs, GMD has solidified its relationship with NOAA Corps, increasing number of NOAA Corps Officers supporting ABOs from 2 to 3. We have also hired additional staff (CIRES) to support and staff observatories.]
