# GMD Response to the 2018 Global Monitoring Division Reviewers’ Findings and Recommendations

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## OVERVIEW

We greatly appreciate the Review Panel’s time spent and attention in evaluating the Division during the 21-24 May 2018 formal GMD 5-year Review. Panel members included Dr. Anne Thompson, NASA-Goddard (Chair); Dr. David Crisp, NASA Jet Propulsion Laboratory, Caltech; Prof. Kenneth Davis, Penn State University; Prof. Eric Saltzman, University of California, Irvine; Dr. Paul Stackhouse, NASA-Langley; Prof. Ray Weiss, University of California, San Diego/Scripps Inst.

Oceanography; and Prof. Steven Wofsy, Harvard University.

This document describes GMD’s concurrence with the Review Panel’s recommendations and our response to issues raised, the resources we will use to respond, and challenges we anticipate in executing these activities. Additional information and remarks in response to the reviewers’ comments are provided, where necessary. In some cases, topics highlighted by the review panel are combined when a particular GMD response is relevant to more than one topic.

Material extracted directly from the Panel Report is shown in *italics*.

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| **Table 1.** Definitions used by the Global Monitoring Division for the five operational groups within the division, the three GMD research theme, and the acronyms the themed groups are addressed within the Panel Report. |
| **Global Monitoring Division: Research Group Definition** | **Global Monitoring Division: Theme Designation** | **Panel: Group and Theme Designation** |
| CCGG (Carbon Cycle andGreenhouse Gases | GHG/CC (Greenhouse Gasesand Carbon Cycle Feedbacks) | GHG/CC |
|  |
| HATS (Halocarbons and other Atmospheric Trace Species) | Ozone Recovery (Ozone Depleting Substances and Ozone) | ODS/03 |
| OZWV (Ozone and WaterVapor) |
|  |
| G-RAD (Global RadiationGroup | Radiation, Clouds and Aerosols | RAD-CA |
| AERO (Aerosols) |
|  |
| 1Five research groups:* Carbon Cycle and Greenhouse Gases (CCGG) – manages the Global Greenhouse Gas Reference Network at more than 70 globally distributed sites.
* Halocarbons and other Atmospheric Trace Species (HATS) – manages a long-term, global network for monitoring ozone-depleting gases and halogen-containing GHGs.
* Ozone and Water Vapor (OZWV) – makes ozone and water vapor measurements at 25 locations worldwide.
* Aerosols (AERO) – makes identical, continuous measurements of in situ aerosol optical properties at 32 sites globally through the NOAA Federated Aerosol Network (NFAN).
* Global Radiation (G-RAD) – makes downwelling solar global, direct, diffuse, and infrared radiation measurements across the U.S. and at global observatory sites.
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1. **General Summary of Laboratory-wide Findings, Recommendations, and Actions**

This diverse panel was highly supportive of addressing research questions under the three new scientific themes1 “Tracking Greenhouse Gases and Understanding Carbon Cycle Feedbacks” (GHG/CC), “Monitoring and Understanding Changes in Surface Radiation, Clouds, and Aerosol Distributions” (Rad-CA), and “Guiding Recovery of Stratospheric Ozone” (ODS/O3). They underscored the quality, relevance, essential nature, and value of our data sets and research to assessments and scientists worldwide, and emphasized that GMD’s datasets are increasing in demand and importance, and are as vital to the Nation’s “climate readiness” as NOAA’s satellites and radar are to “weather readiness”, being delivered by some of the finest scientists in the world. We agree that GMD’s data and research are irreplaceable, essential to the success of science around the world,

and of utmost importance for many applications including informing decisions on climate change, weather variability, carbon cycle feedbacks, ozone-depleting gases and stratospheric ozone depletion.

The panel noted that, while GMD is dedicated to maintaining the highest possible quality research, sustaining all of its observing systems and networks, and maintaining key partnerships to enable sustained global networks, there are strong concerns when inflation is reducing our spending power every year. Without additional funding, the only possible solution is cutting people and, without staff, infrastructure cannot be maintained. Based upon low scientific return for the funds expended, GMD reduced operations at the Summit, Greenland and Trinidad Head, CA observatories in the past three years and is considering closing marine global radiation sites at Kwajalein and Bermuda.

Terminating these long-term records in remote areas or where no other observations exist would be a tremendous loss to the scientific community.

Loss of the long-term observations from the Baseline Observatories and the other networks such as the greenhouse gas, halocarbon, solar radiation, aerosols, stratospheric water vapor, and ozone observing networks are unique on Earth. Their loss or reduction in measurements would have impacts on the satellite and modeling communities at a time when it is highly important to understanding the connection to climate, weather, ecosystems, agricultural, human health, and our economy.

The scientific community cannot respond to the nation’s needs without these sustained, high quality measurements. Our capacity to serve as leaders of the global scientific community is compromised without additional support for our atmospheric composition and radiation measurements, and global monitoring networks. This is why we are pursuing every possible avenue to increase funding to GMD and advance opportunities that could transform over the long term the delivery of high density, high quality observations to support global climate, weather, and ecosystem research.

**GMD Actions:** We are taking several approaches to sustain the continuity and quality of GMD’s data sets.

* + We continue to seek extramural funds from other agencies for activities related to GMD’s mission. GMD only engages in reimbursable activities directly related to GMD themes and priorities. We have also instituted an on-going full cost recovery on services at the GMD Atmospheric Baseline Observatories (ABOs), phasing in charges according to individual agreements. Though each of these efforts is helpful, none is sufficient to adequately upkeep and maintain our sites, nor to cover the plethora of publications our highly productive staff generates from these data.
	+ We are currently writing white papers to describe a number of transformative opportunities we plan to pursue in the next 3-5 years, building on innovative activities listed in the GMD 5- year Research Plan (pp 62-63) and others. These transformative opportunities include:
		- Commercial Aircraft Observations to Improve Model Verification
		- Expanded U.S. National Network for Clouds, Aerosols, and Surface Radiation for Boundary Layer Applications
		- U.S. Tall Towers Network for Boundary Layer Physics and Composition Studies
		- Revolutionary, Inexpensive and Reliable Gas and Aerosol Profiling from the high Stratosphere to the Surface with Recoverable Balloon Packages
		- Carbon-14 Measurements to Separate Human from Natural Emissions of CO2
		- Upper Atmospheric Research to Better Understand Stratospheric Processes for Climate
		- Studying the dramatic radiation and stratospheric ozone reductions from volcanic eruptions observed in half-century long Global Monitoring Division records as analogs to anthropogenic “Geoengineering” by adding aerosols to the stratosphere.
	+ We are focusing on succession planning to ensure continued strong leadership within the Director’s Office and in each research group within GMD. A new Administrative Officer is now on board, a Deputy Director successor is taking on increasing responsibilities within the Division, a new lead selected for the Carbon Cycle Greenhouse Gases group is making positive changes, two Group Chief positions are moving forward in the federal hiring system, and GMD leadership training is in progress to identify and prepare GMD’s future leaders for positions and activities to strengthen the Division.
	+ An important success that we have been working on with OAR for decades involves support for new infrastructure at our Barrow Atmospheric Baseline Observatory (BRW). In FY18, OAR obtained funds for a new BRW Observatory building. GMD staff and members of an OAR team managed to expedite the design/build procurement of the new building in record time from May 11 – September 29, 2018. That required extensive collaboration across multiple line offices. The Barrow Observatory directly supports OAR and NESDIS mission requirements and multiple other collaborative Federal partners including DOE, USGS, USAF and NSF. The new energy-efficient facility will enable sustained long-term observations and support science from national and international partners. Our ability to understand the causes and consequences of climate change in Arctic systems will be considerably enhanced as will our understanding of the Arctic’s impacts in lower latitude weather, climate, and ocean ecosystems. This is proof that OAR is working to support the long-term observations that GMD conducts.

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## SPECIFIC RESPONSES TO THE 2018 REVIEWERS’ FINDINGS AND RECOMMENDATIONS

1. **Specific Comments on the Topic Areas**

### Panel Recommendations and Topic #1: GMD’s Portfolio & Position in NOAA’s Mission

* 1. **Panel Findings - Excerpts from Sections 1.2 and 2.1**:

*The quality of NOAA GMD work in every area of activity is outstanding. GMD is … one of the most distinguished and best-known scientific organizations in the Nation. There is no other laboratory or organization in NOAA or the Nation charged with the monitoring activities that GMD conducts . . . . The relevance of GMD could not be higher. The observatories, standards and technology as well as its highly trained scientists and the products they release, cannot be duplicated or replaced….*

*A post-2013 Review bump-up in budget allowed some critical observatory repairs to be made and GMD was able to maintain most of its staff and observing systems over the past 5 years. However, year-by-year inflation associated with normal salary increases . . . has left GMD at virtually where it was in 2012, minus two ABOs. In summary, a statement that GMD finds*

*itself in crisis in 2018 despite growing scientific prominence, impact and national need is not an exaggeration. This situation must be remedied by NOAA as soon as possible.*

*The three themes of NOAA GMD, (1) greenhouse gases and carbon dioxide (GHG/CC); (2) ozone recovery (ODS/O3); (3) radiation, clouds and aerosols (Rad-CA) are the most appropriate priorities for its mission. GMD’s work is to make the US “climate-ready” by*

*collecting the best data for modelers and policymakers tasked with preparing for the century ahead GMD is as important to the Nation as the National Weather Service.*

* 1. **Panel Recommendations**: *Grow, do not shrink, GMD. This requires funding increases in every area, not necessarily huge, but solid and sustained. Immediate hiring of 10-12 Federal staff and funding increases in GMD’s three scientific sectors and supporting infrastructure is needed. The science conducted by GMD needs to expand to keep up with demands for climate-related data in all these areas and to enable partnerships that transfer knowledge for even greater benefit to the Nation and beyond. A fundamental change in OAR’s priorities must take place if GMD is not to be destroyed one species, one unit or one facility at a time.*
	2. **GMD Response**: We concur with the panel’s recognition of the fundamental importance of these themes and their relevance to weather and climate. Regarding the call for more federal staff, we are seeking to fill 11 positions in the following areas to support the research and accompanying administrative needs within the Division, the three research themes and GMD’s supporting infrastructure. However, the Office of Human Capital Services (OHCS) manages the hiring process with input from GMD. OHCS makes final decisions and is responsible for final actions to hire NOAA personnel. GMD is responsible for initiating hiring actions and participating in the hiring process. GMD will provide the best possible submissions to facilitate the selection and filling of future positions.
		1. Our highest priority federal positions that have been approved by OAR include the following:
			1. Budget Analyst
			2. Senior Scientist
			3. Group Chief, Radiation and Aerosols
			4. Group Chief, Ozone and Water Vapor
			5. CCGG Physical Scientist
			6. Program Support Specialist
		2. The next group of federal positions that are in the process of being approved by OAR include the following future staffing requests and hiring for the following federal positions:
			1. Physical Scientist (GRAD)
			2. Computer Scientific Programmer (GRAD/AERO)
			3. Computer Scientist (accretion of duties to the IV from the III)
			4. Program Support Specialist
			5. Physical Scientist (HATS)
		3. A full-time, on site Administrative Officer was hired in spring 2019 and positions have been filled for observatory positions in the Antarctic and at the Barrow Observatory. Two Budget Analysts will soon be hired through the Direct Hire process to support the Division.

Funding decisions are dependent upon appropriations from Congress (as approved by the President). Requests for appropriations are made by the President based upon his priorities. OAR develops requests for each year's funding based on guidance provided by OMB through DOC to NOAA to OAR. The requests are then considered by NOAA and DOC in the budget formulation process. Ultimately, the President decides the funding requests that are submitted to Congress. Over the past three fiscal years, the President has requested substantial reductions to OAR budgets, many of which have not been accepted by Congress. OAR will continue to work within the processes provided to formulate budget requests that recognize the priorities established by and for the organization by the Executive Branch.

We are identifying transformative opportunities that would advance the GHG and surface radiation networks, and allow us to maintain stratospheric ozone observations. These initiatives are listed in the GMD 5-year Research Plan. The Director intends to meet regularly with the OAR DAA to discuss the plan going forward. However, because of the importance of sustaining the observations we currently have, we are also seeking to have the NOAA Science Advisory Board Climate Working Group evaluate NOAA’s ability to sustain long-term observations in the future.

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### Topic #2: GMD Support and Resources and Topic #4 GMD Leadership & Management

* 1. **Panel Findings**: *Budget and hiring plans must support their work and both must expand to allow GMD to better fulfill its mission. Funding from NOAA must be increased in every area*

*. . . Succession planning to attract experienced leaders and to put promising junior scientists on a career track must occur without delay. Refresh GHG/CC leadership at all levels. The overall perception among GMD staff is a lack of transparency on important decisions.*

* 1. **Panel Recommendations related to Topics #2 and #4**: *The ABOs must be maintained; there is no redundancy. The decline in numbers of Federal personnel need to be reversed. Succession planning to attract experienced leaders and to put promising junior scientists on a career track must occur as soon as possible.*

*Senior management should follow best practices in working with group leaders as a team. The current five groups should be merged into three units that match the themes. This would make two units (Rad-CA, ODS/O3) roughly comparable in core support. Consolidation should save management costs and allow personnel more time to strengthen analysis output and visibility for those two groups. GMD management should consider consolidation of some groups as it carries out succession planning.*

*The most important actions for NOAA to undertake in the ODS/O3 area are in leadership and succession planning. There is not a cohort of more junior scientists being trained for leadership in either group. There has been no Federal Head of the OZWV group for 5-plus years, presumably due to lack of budget. Succession planning for the HATS group is unclear. It is recommended that the HATS group be combined with OZWV at the appropriate time.*

*Leadership needs to be re-invigorated.*

* 1. **GMD Response**: Maintaining Atmospheric Baseline Observatories (ABOs) and observing systems at their current state will require significant investments to keep instrumentation and infrastructure up-to-date and running properly to ensure high quality observations. GMD is constantly adjusting its activities to achieve its ABO objectives within available resources.

We concur with the panel’s comments on organization and leadership within GMD. Since the 2013 GMD Review, GMD filled positions with mid-career scientists as part of an initial succession plan. Positions included:

* + 1. Hiring Dr. Allison McComiskey in 2017 as G-RAD Group Chief after the retirement of Dr. Joe Michalsky (Allison has since left to become Department Chair of Environmental and Climate Sciences at Brookhaven National Laboratory).
		2. Hiring Dr. Diane Stanitski in 2016 to overlap with and be mentored by Dr. Russell Schnell as part of a Deputy Director succession plan.
		3. Post-doc hires by CCGG, OZWV and AERO to bring in early career scientists to potentially climb the ladder in each group.
		4. Hiring two early career radiation scientists (Dr. Laura Riihimaki and Dr. Joseph Sedlar) in G-RAD in 2019 to focus on analysis of long-term data sets and renewable energy applications.

As of the May 2018 Review, GMD was organized under five research groups. In response to the Panel’s concerns, GMD consolidated its research groups from the five separate units to four and is currently evaluating the plusses and minuses of consolidating to three.

Other Tasks Completed:

* Since the May 2018 Review, GMD merged the G-RAD and AERO groups to form a more cohesive scientific unit to respond to the theme *Monitoring and Understanding Changes in Surface Radiation, Clouds, and Aerosol Distributions*. Combining the two groups also achieves closer to critical mass, especially for the aerosol group, which had only three staff members.
* Dr. Arlyn Andrews now serves as the CCGG Group Chief. As Dr. Andrews’ plans are implemented, additional leadership opportunities will evolve within the group.
* As the G-RAD Group Chief (Dr. Allison McComiskey) accepted a new position in August 2018, an Acting Chief has been named and is leading the transition and evolution of the group. The new joint group meets regularly and is planning additional collaborative efforts.
* GMD is conducting joint theme meetings between the OZWV and HATS groups to establish better rapport and identify areas of overlap in research and science going forward. These meetings address the research theme *Guiding Recovery of Stratospheric Ozone* and collaboration is encouraged in areas relevant to GMD’s mission.
* Twenty-one GMD mid-career scientists undertook a leadership training course in May 2019. GMD’s management meetings now include mid-career staff who engage in discussions relevant to NOAA, OAR, GMD, and the international observing community’s needs.

Tasks Planned:

* The GMD Director’s Office will implement additional leadership changes (succession planning and execution) in the coming year. These changes are being discussed regularly with current group leads and with mid-career scientists who are preparing for future opportunities to assume new leadership responsibilities, including Group Chiefs and Director.

### GMD Challenges

* Though merging improves our understanding of the theme *Monitoring and Understanding Changes in Surface Radiation, Clouds, and Aerosol Distributions*, we must ensure the viability of the former Aerosol group under personnel reductions and support the aerosol effort within the larger, newly merged group.
* Current staff are shouldering more work as positions have not been replaced.

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### Topic #3: GMD Visibility

* 1. **Panel Findings**: *The overall lack of visibility for GMD within NOAA is harmful and hard to understand. The lack of visibility undermines GMD’s outstanding accomplishments and is detrimental to the morale of its exceptional staff.*
	2. **Panel Recommendations related to Topic #3**: *NOAA and GMD both need to make GMD’s work and its scientists more visible. Actions could include: (1) more publications postings, press releases and updated personnel websites; (2) NOAA awards and promoting recognition by professional societies. The Director needs to work with senior staff to plan the future more strategically and to reward and promote staff, including for external recognition.*
	3. **GMD Response**: GMD recognizes the panel’s findings and has taken on several efforts to make GMD more visible within OAR, NOAA, and beyond. GMD is highly recognized within the interagency community where we are engaged with scientists from 14 federal agencies (i.e., U.S. Global Change Research Program – USGCRP). Our work is also greatly regarded across the globe as we work internationally with 67 countries. It is in large part GMD’s responsibility to advance efforts to enhance our visibility within NOAA and OAR. We are developing a strategy to engage more often with OAR labs, programs, and OAR HQ through frequent visits and inviting OAR, NOAA, and Congressional staff to visit GMD facilities around the nation and the globe.

Completed and ongoing:

* A GMD Awards Committee was established in August 2018 to identify awards and opportunities for recognition of all GMD staff members. The committee is establishing an inventory of all internal and external awards and overseeing the development of award materials and packages. Two new internal peer awards were established to recognize GMD staff and their accomplishments.
* There has been a pronounced increase in awards granted to GMD staff in this past year.
* GMD is increasing its contributions to OAR Weekly Reports, incorporating key messages from our Observatory Reports, and working more closely with OAR on their stories and communications, including press releases.
* Our staff are ensuring that GMD’s accomplishments are highlighted in several OAR and NOAA fora, including presentations to OAR leadership and staff and through contributions to OAR and NOAA information outlets.
* GMD presentations to Headquarters staff have increased considerably through Spotlight presentations and lightning talks (e.g., Montzka, Hu, Bruhwiler, Sweeney).
* Dr. Colm Sweeney will serve as Acting Deputy Director for the OAR Ocean Observing and Monitoring Division (OOMD) under David Legler during fall 2019. This will give GMD the opportunity to connect with more programs across OAR.

Planned:

* A survey of other governmental agency models and other NOAA promotion strategies will be conducted to assess GMD’s approach to staff promotions.
* We are working to develop better practices for performance management and evaluation, with major revisions and enforcement for GMD Federal employees being put into place, and intend to ensure that the playing field is fair and representative for all GMD staff. GMD will dedicate time to identify clear career paths to enhance recruitment of leaders and retain the best junior talent.
* By October 2019, all GMD staff will have up-to-date staff web pages.

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1. **Topic #5: GMD Leveraging & Partnerships and Topic #6. Integration of Efforts Within and Beyond GMD**
	1. **Panel Findings**: *GMD’s activities in the Nation’s interest include leveraging work by stakeholders from many sectors and international partners as well. NOAA’s mandate to play a leading role in national and international assessments rests on commitments from GMD scientists. GMD could be even more effective with stronger integration of efforts within and across groups, across NOAA and beyond . . . Collaborative efforts are a necessary strategy for bringing in more external funding, strengthening GMD science and for better serving the US Earth-system sciences community. Innovation is needed!*
	2. **Panel Recommendations related to Topics #5 and #6**: *NOAA budgets and personnel must continue to support a range of activities that follow from national and international commitments to data collection, calibration, scientific reviews and the assessment process. In all three scientific areas (GHG/CC, Rad-CA, ODS/O3) GMD should leverage its expertise, networks, innovative and established capabilities to expand and sustain growth with stakeholder partners, other Agencies and evolving national programs. Collaborative*

*opportunities for all of GMD’s groups should be better exploited within GMD, across NOAA and with outside organizations.*

* 1. **GMD Response**: By sharing expertise, GMD scientists have helped institutions throughout the world develop and improve their observing systems. GMD’s global networks have expanded via collaboration with scientists at various domestic and international agencies, institutions, and universities to increase global coverage and collection of high-quality data. GMD’s efforts in this respect are strongly endorsed by WMO in its efforts to build and sustain global observing and research capacity.

Tasks Completed:

* GMD has engaged in discussions with CIRES leadership and the CU Boulder Policy Program to identify CU Boulder staff and students who can support economic valuation activities and develop value stories about GMD’s contributions to society and the economy through our research.
* GMD hosted scientists and staff from the National Ecological Observatory Network (NEON) at the NOAA Boulder Laboratory in Fall 2018 and a methane working group will meet during 2019. GMD provided a letter of support for NEON to incorporate methane into their measurement network.
* The Climate Portfolio Steward established a Climate Program Office (CPO)-GMD Partnership team in July 2018, focusing on developing stronger partnerships with CPO and other labs and programs across OAR and NOAA. Initial discussions focused on GMD’s contributions to topics including the Surface Energy Budget Network, Observations and Modeling, Heat-Health, Arctic, and S2S.
* We have developed joint milestones with partnering Line Offices (NESDIS and NWS) for the FY19 Annual Operating Plan around GMD measurements for satellite validation.
* GMD participated in a CPO Earth System Science and Modeling (ESSM) workshop (6-7 November 2018), bringing together CPO internal and external partners and stakeholders to discuss climate and Earth system research priorities and partnership strategies for the next 1-5 years.

Tasks Ongoing and Planned

* GMD will continue to provide support to existing global observing partners and will seek additional national and international partnering opportunities where resources permit.
* We will work with the NOAA Library to identify users of GMD data by conducting intensive searches across the literature.
* We will continue to seek ways to identify users as they request data from GMD, NCEI and global data centers.
* We will continue working with Colorado’s CO-LABS to identify local partners and users. GMD hosted a CO-LABS open house in May 2019, inviting potential collaborators to our Division.
* GMD staff are engaged in several Interagency Working Groups (IWGs) (e.g., U.S. Global Change Research Program). We plan to increase our visibility by ensuring early- and mid-career scientists have more opportunities to get involved and lead.
* We will work with the OAR Climate and Weather Portfolio Stewards to discuss ways to highlight GMD science and resources for application in other NOAA Line Offices. We will strengthen collaborations with current and potential users of GMD data so metrics are aligned and resources are applied to the most compelling issues.
* GMD will work closely with CIRES and university departments where students (undergraduate and graduate) can offer time, energy, and skills to GMD needs and value story development.
* We continue to pursue collaborative opportunities with national programs like the National Ecological Observatory Network (NEON) to determine how we can leverage resources and identify joint opportunities.
* We will engage more with other OAR labs and programs as well as NWS and NESDIS to identify additional ways to collaborate.
* We will continue to host our annual Global Monitoring Annual Conference (GMAC) with 20 countries and ~200 participants, collaborators and users of GMD data and expertise.
* GMD will participate in the new Atmospheric Composition and Chemistry group developed out of the first OAR Forum to further develop internal partnerships across NOAA.
* A joint GMD-NESDIS workshop will take place during fall 2019 to discuss the value of GMD’s in situ data to validate satellite retrievals, improve algorithms, and develop satellite products, with planning in support of anticipated product development.
* GMD will meet with GFDL during a cross-OAR modeling workshop in FY20 and will also hold a separate GMD-GFDL meeting to discuss areas of modeling needs where GMD can support and respond to GFDL observational requirements.

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## Specific Comments on the GMD Themes

### Theme: Tracking Greenhouse Gases and Understanding the Carbon Cycle

* 1. **Panel Findings**: *The GHG/CC theme constitutes the largest in terms of people and funding at GMD. It draws from the Carbon Cycle group as well as from many of the trace gas measurements in the HATS group. Quite simply, the measurements of this group*

*constitute the foundation of the Nation’s (and the world’s) understanding of the changing GHG composition of the atmosphere. Without their data we could not analyze past climate nor predict the future with any certainty.*

*The impact of the GHG/CC theme continues to grow Specific strengths of GHG/CC*

*include:*

* *An optimized global CO2 observing system, that augments the historical record from the ABOs with tall tower measurements, AirCore, airborne monitoring and participation in airborne experiments (mostly NASA-sponsored);*
* *The buildup and sharing of unique analytical tools for understanding these trace gas sources and transport: CarbonTracker, CarbonTracker-CH4, CarbonTracker- Lagrange;*
* *A critical mass of top-notch scientists whose measurement capabilities, datasets and interpretive capabilities are matchless;*
* *The US system for validating new space-based CO2 measurements.*

*However, the current mixture of junior, mid-career and senior scientists appears to be poorly organized and without a clear strategy for the future. GHG/CC scientists are exceptionally dedicated to “mission,” staff expressed frustration about a lack of overall direction. They feel that are not having the impact they merit.*

### Panel Recommendations for the GHG/CC theme:

* + - *With GMD senior leadership, GHG/CC needs to develop a strategic plan that defines goals for the next 5 and 10 years along with appropriate implementation. Better integration of measurements and models within the Theme and with NOAA’s climate model Lab and beyond, should be a key part of such a plan.*
		- *Refresh GHG/CC leadership at all levels. There should be clear career paths and timetables for promotion of Federal staff and hiring promising CIRES scientists to Federal appointments. The group should be writing fewer external proposals.*

### GMD Response:

* + - We agree with the panel that this theme consumes the largest amount of GMD’s resources. We also recognize the need for a well-developed strategy for carbon cycle research in GMD. In her new role, Dr. Andrews will be pursuing this task.
		- Our current research plan (2018-2022) clearly establishes the goals and aspirations of this theme for the next five years. The new chief of the carbon cycle and greenhouse gases group, however, is re-evaluating the structure and financing of the group and its activities to achieve more ordered operations.
		- The second recommendation is being addressed. GMD is working toward a plan to transition mid-career staff members into leadership positions within the Division.

### GMD Actions:

* + - Dr. Arlyn Andrews began her role as CCGG Group Chief in March 2019 after several discussions were held with GMD’s mid-career scientists to discern their interest in a leadership position.
		- Efforts are being made to strengthen collaborations with GFDL, ARL, GSD, and other OAR labs. CarbonTracker has been a strong area of interaction with modeling groups and GMD is recognized for its contributions to modeling initiatives.
		- The request for "Fewer external proposals" is difficult to address. There would be no CarbonTracker, and evaluation of satellite retrievals with calibrated data would be severely hampered; 85% of our CarbonTracker efforts and the production of ObsPack is supported by grants outside of NOAA. Competing for grants has been an indispensable component of retaining our critical mass of top-notch scientists. GMD is developing initiatives to pursue funds to expand and add to current capabilities. In the meantime, CCGG will keep its current overall capabilities but reduce capacity.

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### Theme: Monitoring & Understanding Changes in Surface Radiation, Clouds and Aerosol Distributions

* 1. **Panel Findings**: *This theme is a welcome new emphasis since the 2013 Review, having replaced the Air Quality element that was more peripheral to GMD’s mission. The radiative properties of clouds and aerosols and their feedbacks with surface radiation remain the largest uncertainty in understanding and predicting climate forcing. UV changes are linked to ozone changes so this theme is closely connected to monitoring ODS/O3. Thus, the Rad- CA theme is central to NOAA and GMD’s mission to build a strong climate data record.*

*The Rad-CA theme is a bright spot in GMD with exceptional potential for high-impact and wider visibility. Scientists in the Rad-CA theme have a strong record of accomplishments. With fresh leadership they are well positioned to integrate their measurement capabilities into major NOAA programs and beyond. However, as with other GMD groups, thin resources preclude expansion and even basic operations are threatened.*

### Panel Recommendations for the Rad-CA theme:

* + - *Commit resources to fill out instrumentation at existing networks, e.g. add SURFRAD type instruments to existing UV, aerosol and latent/sensible heat flux sites and vice versa, to provide denser sampling of US climate zones.*
		- *Expand measurements at existing sites, e.g., install ceilometers and cloud optical depth spectrometers.*
		- *More closely integrate the aerosol group science with G-Rad. Better yet, combine the two groups to achieve closer to critical mass.*
		- *Expand products useful for the renewable market.*
	1. **GMD Response**: We acknowledge and appreciate that the panel agrees with our forming a merged theme and that clouds and aerosols are important. GMD strongly supports the Rad- CA science and will seek every way possible to provide a viable strategy going forward. Promoting SURFRAD and Surface Energy Budget Network (SEBN) is a high priority within G-RAD and beyond.

### GMD Actions:

* + - Two new CIRES radiation scientists started in March 2019, replacing a retired senior scientist and supporting renewable energy efforts. These are extremely important hires of early- to mid-career staff who provide new energy and ideas to the team.
		- Funds for new ceilometers at the SURFRAD sites were received and the instruments are being installed during FY18/19. Other instruments will be added to these SURFRAD and SOLRAD sites as funds allow.
		- GMD has been engaging with the Climate Portfolio Steward and OAR’s Climate Portfolio Team to discuss the need for a SEBN, along with other labs (e.g., ARL) and programs across OAR and NOAA. An ARL senior scientist has joined GMD/G-RAD to promote boundary layer research more broadly, co-presenting a lightning science talk on SEBN to the Climate Portfolio group (a FY19 priority) and a SEBN talk at AGU 2018. We will continue seeking funds for boundary layer research that will enhance instrumentation at sites across the US.
		- Since the May 2018 Review, GMD merged the G-RAD and AERO groups. Combining the two groups achieves closer to critical mass, especially for the aerosol group, which had only three staff members. Funded by OWAQ, the group is adding aerosol instrumentation at Table Mountain, CO as a first test of collocated measurements for enhanced analysis opportunities.
		- The G-RAD group built three RadSys stations during summer 2018 and deployed them around Table Mountain, CO. These will be used for evaluating sub grid scale clouds in NWP models such as the HRRR and RAP, and also in an upcoming OWAQ-funded field campaign in Wisconsin. In the future, the RadSys stations can be used for development of a short-term forecasts needed by the utility industry.
		- Two Aerodyne TWST instruments that measure Cloud Optical Depth are being transitioned from the Air Force to GMD and will be deployed for a Wisconsin field campaign and stationed permanently at the Table Mountain field site north of Boulder.
		- The G-RAD Group Chief accepted a position at Brookhaven National Laboratory in August 2018. A stronger partnership with DOE is anticipated through ongoing collaboration. An Acting Chief is overseeing and leading the merged Radiation and Aerosols Group. A new Group Chief position has been approved by OAR and is in the queue at the OHCS.
		- To address scientific gaps in our understanding of the boundary layer, we are seeking ways to expand GMD’s system of surface radiation measurements across the conterminous U.S. (SURFRAD), in both capability and spatial density, building the system into a full Surface Energy Budget network (SEBN). We are pursuing funding in the outyears by highlighting these essential observations that are one of the most fundamental needs for understanding weather and climate. Recent work with foundational surface energy budget models developed by NOAA have shown that existing surface radiation data can be used to detect, diagnose, and improve model biases.
		- A recent success was the receipt of FY19 funding from the Office of Weather and Air Quality (OWAQ) to expand our aerosol measurements at nearby Table Mountain, CO, collocating aerosol instrument with surface radiation measurements for enhanced understanding of the role of aerosols in weather and climate models. The alignment of GMD efforts with OAR and NOAA mission priorities ensures that GMD remains visible and highly relevant to our current national needs. This is the start of similar efforts collocating instrumentation at surface radiation stations.

### GMD Challenges:

* + - It can be a year or more before a new Group Chief is hired due to the lengthy time for Federal hires.
		- Scientific staffing in both aerosols and radiation who have the time to work on product development is waning. A leading scientist who advanced the group retired at the end of December 2018 and another is retired in 2019.
		- GMD is working to find resources and creative ways to enhance the visibility and resources to support the aerosol capability.
		- While we are working on an initiative to generate funds for an SEBN, we are down to a critical mass of people and projects in several groups; major concerns and stress exist across the Division.
		- It is possible that the UV network in Antarctica will be scaled back in order to retain the EPA-required UV radiation measurements in North America. Long-term UV Index measurements are at stake since Antarctic and other UV measurements may be lost.

This benchmark SEBN network will integrate radiation and energy budget measurements, including spectral direct and diffuse irradiance measurements for aerosol and cloud properties. Expanding the number of sampling locations will provide the geographical representativeness that model developers require, and modest upgrades to instrumentation and long-term network management will benefit the forecasting and predictability community into the future. Without an expanded network, models will continually be tied to just a few disjointed validation points with forecast errors propagating away from these points. A national SEBN will provide the foundation to improve reanalyses, NOAA satellite products, NOAA climate models, weather forecasts, and climate assessments, significantly aiding NESDIS and NWS, and the general atmospheric science research community.

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### Theme: Guiding the Recovery of Stratospheric Ozone

* 1. **Panel Findings**: *The preeminence of GMD’s ODS/O3 research is at risk. Staying at the forefront of ODS measurements requires keeping current with equipment and the specialists who operate them. Demand for data is growing but support has decreased so that both staff and data-taking have been reduced. GMD has stopped launching sondes at 3 stations and scaled back frequency at partner sites in the tropics where more, not less, data are required. The harmful effects of other cutbacks are more subtle. For example, fewer staff means less documentation of methods and fewer publications that give GMD credit.*

*One of the greatest needs in the ODS/O3 area is for re-invigorated leadership. Of the two groups making up this theme, there does not seem to be a cohort of more junior scientists being trained for leadership. There has been no Federal Head of the O3/WV for 5-plus years. Succession planning for the HATS group is unclear.*

### Panel Recommendations for the ODS/O3 theme:

* + - *Implement a succession plan for group leadership and consider combining the HATS and O3/WV groups.*
		- *Restore sonde measurements as much as possible, keeping in mind the need for weekly statistics for assessments.*
		- *Provide sufficient resources to keep ODS data-collection techniques current.*

### GMD Response:

* + - We recognize the need for group leadership, restoring sondes and a succession plan.
		- Along with OAR and NOAA HQ, we will continue to meet with key committee staff and members of Congress each year as the budget is developed, describing the value of our ODS/O3 measurements for global communities.
		- GMD will continue to seek resources to strengthen its sonde measurements and other network needs.

### GMD Actions:

* + - The HATS group has a succession plan with two possible Federal successors now involved in budget planning and interacting closely with the GMD group chief.
		- GMD is considering various models for theme leadership:
			* A lead and deputy for each group – one senior, one earlier career
			* Theme leads - two groups with group Chiefs and a designated theme lead for coordinating and ensuring relevance of the theme
		- The GMD HATS research team has made significant research advances leading to identification of international breaches of the Montreal Protocol. This outstanding research has led to international policy change and worldwide recognition of NOAA’s and GMD’s outstanding science. This kind of research must continue.
	1. **GMD Challenges**:
		+ In the HATS group, the *in situ* and flask GC instruments are over 20-25 years old. Level budgets have not allowed an infusion of new funds to replace or update instruments.
		+ More people need to be hired into federal positions to assure that networks will be sustainable in the future. OZWV and HATS groups have very different sampling and analytical capabilities, which suggests they would function best as separate groups operating within the same theme.
		+ Ozone and ozone-depleting substances (ODS) monitoring is the only activity within GMD required by Congress, i.e., the Clean Air Act of 1990, yet continuing these networks is challenging.
		+ We need to identify ways to make monitoring more appealing to NOAA, OAR, and other audiences. Exploration opportunities do exist, such as
			- Use of Unmanned Aircraft Systems (UAS) to bring balloon-born instruments back to a selected location. Increased collaborations across Divisions and Line Offices, most notably with CSD for validation of models, NCEP for validation of their forecast models (GFS and beyond), ARL for validation of forward and back trajectory forecasts with timed balloon launches, and NWS for validation of subseasonal and seasonal forecasts with balloon-borne instruments.
			- Enhanced collaboration with national and international partners.
			- Example: ECMWF or Copernicus is interested in near real time data to improve their air quality forecasts.
		+ One opportunity is to seek additional funding from NOAA satellite validation activities.
1. **Panel Recommendations to OAR and NOAA**
	1. **Panel Recommendations**:
		* *NOAA OAR must recognize the unique role of GMD in its research portfolio and commit to an appropriate growth trajectory.*
		* *NOAA must also raise the visibility of GMD’s remarkable track record of observations, science and technology.*
		* *The science conducted by GMD must expand to keep up with demands for climate-related data in all these areas and to enable partnerships that transfer knowledge for even greater benefit to the Nation and beyond. A fundamental change in OAR’s priorities must take place if GMD is not to be destroyed one species, one unit or one facility at a time.*
		* *NOAA budgets and personnel must continue to support a range of activities that follow from national and international commitments to data collection, calibration, scientific reviews and the assessment process.*

### GMD Response:

* + - GMD will work closely with OAR to inform and educate NOAA HQ staff as to the unique and crucial role GMD plays in the global community. We will provide justification for new staffing requests and, as possible, develop products (e.g., economic valuation results, publications, tools for the public) showing the value of GMD data.
		- GMD will work to improve NOAA’s recognition and appreciation for what it takes to maintain long-term observations in GMD, the Ocean Observing and Monitoring Division (OOMD), ARL, AOML, GLERL, OAP, PMEL and other laboratories. We are seeking ways to elevate the discussion of sustaining long-term observations within NOAA through the Climate Working Group, a subset of the NOAA Science Advisory Board. We are working closely with the Climate Portfolio in this endeavor. Sustainable funding for long-term observations is essential to sustain the monitoring of our changing atmosphere forcing changes around the planet.
			* GMD plans to engage with other OAR relevant organizations to develop a plan to present to OAR leadership regarding how best to move forward with long-term observations. We are considering coordinating an OAR-wide workshop to discuss long-term observations.
			* Part of that plan would involve developing milestones and metrics for long-term observing.
		- GMD will focus on developing metrics that clearly reveal the value of the observations, science and technology emerging from our work.
		- Observing systems at risk of collapse within the next five years:
			* Antarctic and North American UV Programs
			* Federated Aerosol Network
			* North American Aircraft Program
			* Tall tower Network
			* Tropospheric ozone measurements
			* Global (outside US) radiation observations
			* In situ measurements of ozone-depleting gases
			* American Samoa Observatory and other remote sites