Atlantic Oceanographic & Meteorological Laboratory Response and Implementation Plan Final Report

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Review Panel Report: February 2, 2009
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This report lists the recommendations outlined in the AOML Review Panel Report and the Implementation plan and provides AOML's responses to the recommendations.

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Submitted by Robert Atlas, Director, Atlantic Oceanographic and Meteorological Laboratory (AOML) with contributions from AOML division directors and research staff, April 2, 2009, with amendments included August 28, 2009, January 11, 2010, and May 9, 2011.

The following document addresses recommendations made by the research review panel, as well as additional comments highlighted in the reviewers' synthesis report by the office of Oceanic and Atmospheric Research (OAR) Headquarters. The latter were comments and recommendations that were not part of the reviewers' recommendations but that OAR felt were important to consider in AOML's response. Subsequent comments from OAR's Labs and Cooperative Institutes (LCI) office and Policy Planning and Evaluation (PPE) office have also been addressed. The responses are presented by research theme, the same format used in the Reviewer Response. This document also includes two appendices entitled "Filling Up the Gaps" and "AOML-GFDL Collaboration," referenced herein. The table below lists the reviewer recommendations and their action completion dates. This report closes out AOML's required actions for this review cycle.

Theme	Description of Suggested Action	Completion date
Hurricane		
1	NOAA modeling centers must share model code to engage research community.	06/2008
2	AOML hurricane Observing System Simulation Experiments (OSSEs) initiative should be encouraged in coordination with JCSDA.	04/2009
3	Balance HRDs unique hurricane observational expertise with the new modeling expertise.	09/2009
4	HRD and EMC should share model code on a continuing basis.	06/2008
5	Add flight hours for focused hurricane research programs	06/2008
6	Improve HRDs publication record and recruit new scientific leaders in hurricane research	09/2009
7	Reconnect with the external community to conduct hurricane aircraft experiments	06/2008
Oceans and Climate		
1	Facilitate and enable climate modelers to be more engaged with the scientists responsible for observations	01/2009
2	Complement ocean observations with analysis and modeling efforts	04/2009
3	Emphasize the contributions of key long-term climate observing projects and the new modeling program in a new AOML strategic plan	5/2011
4	Expand the visiting scientist program	09/2010

5	Recruit replacements for the OCD and PhOD director and AOML deputy Director, and other senior PI's	01/2010
6	Partner with other entities to evaluate impacts of ocean climate on natural resources	04/2008
7	Better articulate the relevance of PhOD's programs to the public	05/2011
8	NOAA should allocate resources to analyze ocean observations data	NOAA Climate Service may determine this outcome
Ecosystems		
1	Top to bottom review of priorities in OCD	05/2011
2	Manage ecosystem portfolio to reduce external service functions	05/2011
3	Revisit the ecosystem research portfolio needs as staff retire	05/2011
4	Assess whether the presence of reimbursable research activities are consistent with its long-term plans and priorities	05/2011
5	AOML and the NMFS facility should develop a strategic outlook and plan for cooperative ecosystem studies.	06/2009
6	AOML needs to be a national and global leader in ocean acidification and geoengineering solutions to the CO2 issues	04/2010
Ship Support for Ocean Missions		
1	The research fleet of NOAA must be better maintained and regain reliability	This is being discussed at the NOAA level
Lab Wide		
1	Improve visibility by updating and improving the website	01/2011

Hurricane (Tropical Cyclone Intensity Change, Tropical Cyclone Structure and Precipitation, Tropical Cyclone Tracks, and Tropical Cyclone Frequency and Intensity):

Recommendations:

1. **NOAA modeling centers must share model code in order to engage the research community in the development of better hurricane forecasts.**
   (Completed 06/2008)

Since the review in the spring of 2008, the Atlantic Oceanographic and Meteorological Laboratory (AOML) has actively participated in a number of NOAA planning activities that have resulted in much closer cooperation between NOAA's Environmental Modeling Center (EMC) and the NOAA hurricane research community. These planning activities have resulted in AOML's Hurricane Research Division (HRD) and the Earth System Research Laboratory's (ESRL) Global Systems Division (GSD) having access to the operational model code. Under the umbrella of NOAA's Hurricane Forecast Improvement Project (HFIP, approved by NOAA management in June 2008), regional hurricane and global model improvements were made a high priority. In order to facilitate these developments, the operational model code (Hurricane Weather Research and Forecasting (HWRF) and Global Forecast System (GFS)) were ported to the Developmental Testbed Center (DTC) in Boulder, Colorado to make them part of the model repository for the general research community. HRD, working with DTC and EMC, has upgraded the HWRF atmospheric model to the latest Weather Research and Forecasting (WRF) model version (3.01) and has worked to improve the operational atmospheric model components. HFIP also held a workshop in April 2008 that organized a test of resolution impacts on the model forecasts. As part of this effort seven teams, including a NOAA research team using the upgraded atmospheric version of HWRF, agreed to run their model configurations on 69 cases selected by NOAA's National Hurricane Center (NHC) at three horizontal resolutions (9-10 km, 3-5 km, and 1-2 km) and to evaluate them using the operational evaluation packages within one year. The test was to be evaluated by the DTC. As HFIP progressed, it received support under a Presidential Supplemental in the fall of 2008 that accelerated the HFIP effort by one year. Eleven teams were organized to create an implementation plan, milestones, and budgets. As part of this effort, two regional model developments were approved based on HWRF: the operational version coordinated and executed by EMC and an experimental research developed version, the Experimental Hurricane Weather Research Forecasting Model (HWRFX, the successor to the HRD and ESRL/GSD developed version), that would be available to the research community and supported through the repository at DTC. HFIP model development teams composed of NOAA research and operational staff laid out the first two years of HWRFX model development efforts that were of particular interest to the operational community, including the completion of the HFIP high-resolution test plan, addition of a third moving nest (developed at HRD), development of a code management system for research and operations, examination and evaluation of improved physics packages, and the establishment of a restart capability for HWRF to implement more experimental data assimilation approaches (e.g., Ensemble Kalman Filter (EnKF), Four Dimensional Variational Data Assimilation (4DVAR)). Much of the HWRFX development will be conducted at the new HFIP-funded hurricane research high-performance computing center.

As HWRF and HWRFX are advanced, the HFIP plan is to maintain and share all versions of the model code through the DTC central repository and to utilize DTC to provide documentation and training for the research community who wish to access the HWRF and HWRFX component software packages for the basic model and physics packages that DTC approves for addition to the repository. Currently, the final approved version of the HWRF code is being completed and documented for inclusion to the repository with support from HFIP (based on the operational version available in 2009 with an updated version of the

Weather Research and Forecasting Non-hydrostatic Mesoscale Model (WRF-NMM) core to v3.1), and the first HWRF tutorial occurred in February 2010. As these HWRF components are finalized, the plan is to submit all additional components available through HWRFX (e.g., third moving nest, alternative physics packages) for approval, broadening the model components available for testing and evaluation by the research community.

2. **AOML hurricane Observing System Simulation Experiments (OSSEs) initiative should be encouraged and it should be required that this plan be coordinated and synergized with the ongoing OSSE activities of the Joint Center for Satellite Data Assimilation (JCSDA).**
(Completed 04/2009)

(Associated comment highlighted by OAR Headquarters from the reviewers' synthesis report)

We need to do a better job of setting requirements for the hurricane problem in particular, thereby avoiding problems like that dogging QuikSCAT. Hurricane OSSEs may help us see the benefits of an observing system before it is designed, built, and launched.

This is underway, and substantial progress has been made. Limited hurricane OSSEs are currently running at HRD, and plans for more detailed OSSEs are being prepared. For the more advanced OSSEs, an accurate model and data assimilation for the hurricane inner core are needed. This is part of the HFIP model development effort. As mentioned in the previous response, improved data assimilation and models are a major priority for the HFIP effort. A second high priority for HFIP was the development of a hurricane observing system analysis capability which is to be based on the improved models and data assimilation efforts. HFIP did not want to tie the forecast improvements to any one observing system approach; instead, the goal is to test the existing (dropsondes, Doppler radar, QuikSCAT, etc.) and new NOAA observing capabilities to determine how they improve the hurricane forecasts in particular (Geostationary Operational Environmental Satellite R-Series (GOES-R), Unmanned Aerial Systems (UAS), Extended Ocean Vector Wind Mission (XOVWM), etc.). HFIP is supporting the evaluation of a number of these systems using OSSE approaches starting in FY09. The AOML Director is currently coordinating our OSSE planning with the Joint Center for Satellite Data Assimilation (JCSDA) and external partners.* He also prepared a plan for an OSSE testbed for the U.S. Weather Research Program (USWRP) that was due by September 30, 2009. This was endorsed at the April 30, 2009 meeting of NOAA's USWRP Executive Committee.

* Partners include: ESRL, EMC, the National Environmental Satellite Data and information Service – Center for Satellite Applications Research (NESDIS-STAR), NASA (Goddard Space Flight Center (GSFC), Jet Propulsion Laboratory (JPL), Marshall Space Flight Center (MSFC), Langley), Simpson Weather Associates, Atmospheric Environmental Research, Rosenstiel School for Marine and Atmospheric Science (RSMAS), Florida State University (FSU), University of Central Florida (UCF), University of Utah, and Naval Research Laboratory (NRL). We are open to more partners, but these are the current partners to date.

3. **AOML needs to carefully consider where in the spectrum of hurricane research its mission should fall. A number of other institutions provide state-of-the art modeling**

expertise, but the historical strength of AOML hurricane research has been in observations, which it is uniquely qualified to provide.
(Completed 09/2009)

(Associated comment highlighted by OAR Headquarters from the reviewers' synthesis report)

The observational leadership capability of HRD needs to be reinvigorated by hiring staff with observational skills and scientific capability and by redirecting the NOAA P3 aircraft back to the research role that they are intended to play. If AOML rebuilds HRD with too strong a priority on modeling and relegates observational work to secondary status there is a danger of killing the goose that laid the golden egg. Deemphasizing observations will reduce HRD's usefulness to the observational research community, particularly that part of the community outside of NOAA.

It is precisely HRD's leadership in observations of hurricanes that makes it imperative to have a modeling capability at HRD, especially at this critical juncture in time as the current research and operational models are starting to resolve and simulate features of the hurricane vortex. HRD scientists are ideally situated to take advantage of in-house modeling expertise to advance research and operational model capabilities through the use of observations in model evaluation and improved initialization. HRD's observations and experiment design experience is critical to improving the representation of physical processes within the research and operational model systems, in particular those processes related to air-sea interaction, atmospheric and oceanic boundary layers, vortex evolution, and convective structure. The data sets collected by the NOAA P-3 hurricane hunter (WP-3D) and Gulfstream-IV (G-IV) aircraft in the storm core are also essential to improve the initial conditions for these model systems as we try to improve the analysis of the vortex structure. These data sets also improve our ability to sample the storm structure. HRD is continuing its leadership in pioneering new hurricane observing systems with Doppler Wind Lidar, a Hurricane Imaging Radiometer (HIRAD), and UAS. Having an in-house modeling and data assimilation capability affords a direct connection between the researchers who understand hurricanes through observations with those trying to simulate them. This capability was a mainstay of HRD and its predecessors (with scientists like Rosenthal, Ooyama, Jones, Lord, and Shapiro working closely with observationalists), which has been lost over the last 10-15 years through attrition.

Over the last two years, HRD has actively pursued modeling, data assimilation, and observational experience in a balanced manner. To date, HRD has hired Full Time Equivalent (FTE) employees to conduct hurricane model development (Gopalakrishnan), and we just filled two more positions, one to work on inner core data assimilation (Vukicevic) and one to assist with the analysis and use of the airborne Doppler radar (Reasor). We also hired two Cooperative Institute for Marine and Atmospheric Studies (CIMAS) model developers (Yeh and Zhang) and two CIMAS observationalists to oversee our dropsonde (Sellwood) and Stepped Frequency Microwave Radiometer (SFMR) (Klotz) observations. We also recently had four post docs, one modeler (Fierro, National Research Council (NRC)), one data assimilation specialist (Aksoy, CIMAS), and two working in hurricane boundary layer research (Zhang, NRC, and Lorsolo, CIMAS). Three of the four (Fierro,

Aksoy, and Lorsolo) finished their post-docs in the last few months and two (Aksoy and Lorsolo) were retained as CIMAS assistant scientists.

In some ways, bringing modeling back into HRD at this critical juncture restores the balance in the capability for NOAA to tap the expertise in observing these storms. This approach fits the new HFIP paradigm perfectly (which focuses on improving the models, observing strategies, and products for the forecasters), providing a corps of talent that NOAA can capitalize upon to accelerate improvements in our hurricane forecasts. The HFIP approach recognizes that only through the combined expertise of all of NOAA's hurricane research efforts in all three areas can we begin to accelerate improvement. HRD is the only place in NOAA where all these issues can be addressed in one place. HFIP has made a major commitment to address these issues and has provided the funding to support such an effort.

4. **OAR and AOML laboratory management should work with the Environmental Modeling Center (EMC) management to make it possible for the Hurricane Research Division (HRD) and EMC to share the model code on a continuing basis to accelerate the model development efforts.**
(Completed 06/2008)

   This is already happening very successfully through the DTC and HFIP teams. Initial discussions began between the Director of AOML and the Director of NOAA's National Centers for Environmental Prediction (NCEP) and have continued between the leadership of HRD and EMC. HFIP has unified all NOAA efforts in hurricane research and development around a single effort, and NOAA management has provided oversight (see prior response (1) for details).

5. **HRD should be provided with additional flight hours annually solely for the purpose of carrying out focused research programs.**
(Completed 06/2008)

   Through HFIP, NOAA has made a major commitment to provide the resources for flight hours and expendables for hurricane missions under the Intensity Forecast Experiment (IFEX) umbrella (e.g., 900 flight hours in FY09 for all hurricane flights, plus $1.5M for expendables - primarily dropsondes and Airborne Expendable Bathythermographs (AXBTs)). Through IFEX all of NOAA's requirements for missions into hurricane environments are met, and the resources are shared to insure that every mission provides the necessary data sets for NOAA's partners' needs, from a figure-4 pattern for the Doppler radar data for use by EMC and NHC, to repeated profiles in heavy rain and strong wind for NESDIS scatterometer work, to pre- and post-storm ocean surveys for EMC's ocean model initialization. Within this framework, there are substantial opportunities for research to implement short modules that can be executed between Doppler legs or during the NESDIS profiles. There are also enough flight hours for HRD to be aggressive in tasking the aircraft to look at weaker systems for genesis research and also near landfall when the operational interests are less. Beyond FY09, the HFIP plan calls for comparable commitments (on the order $1.5M-$2.0M) to augment the National Weather Service (NWS), NESDIS, and OAR resources needed to support IFEX.

6. **HRD needs to continue to improve its publication record and recruit staff who will be intellectual leaders that contribute usefully to the literature on tropical cyclones.** (Completed 09/2009)

The proliferation of significant HRD publications was described as diminished in the past two decades. The main reason given was attributed to HRD's resources being level for 20-25 years. According to the reviewer, this led to a loss of intellectual leadership in hurricane research and lower numbers and reduced impact of HRD's publications. We share the concern of the loss of some intellectual leadership at HRD in the past 10-15 years. It is true that some of this loss is attributable to the lack of budget increases over the last 25 years. However, in the last five years HRD has been very active in rebuilding its intellectual leadership in hurricane research through the addition of four young researchers who are demonstrating potential to grow into intellectual leaders in hurricane research. In FY09, we also added three FTEs, four CIMAS scientists, plus two post-docs with great potential to grow into intellectual leaders. HRD has not seen such expansion since the influx of talent in the late 1970s. The impact of such growth is a strong upside for HRD, as there is clear evidence that over the last five years HRD's publication output has increased at a steady rate. HRD has produced roughly 15 papers per year. In the last three years, however, HRD has averaged 26 papers per year (a 75% increase). This includes a number of major papers in the American Meteorological Society's (AMS) *Bulletin of the American Meteorological Society* (BAMS), *Monthly Weather Review* (MWR), and *Journal of the Atmospheric Sciences* (JAS).

It is important to note that HRD is part of a federal laboratory that has a core focus in one portion of the atmospheric and oceanic sciences. Our strength is the focused effort we can bring to bear on that single problem. We need a broad range of talents from data processing and analysis, data archival, and database management along with our research talent. Without the team members dedicated to managing our observational and model data sets, HRD would be unable to meet its obligations to NOAA and the general research community as stewards of NOAA's unique hurricane data sets. We would not term any of these team members as unproductive just because they do not publish on a regular basis. Most university departments could not afford to maintain such an effort and, in fact, HRD has many university partners who are able to write proposals and publish papers using our data sets thanks to the hard work of these individuals. HRD does have some researchers that are not publishing at a steady rate, and we are addressing this issue through a number of initiatives (e.g., building teams that work on papers, conducting regular monthly science meetings to discuss active research, requiring papers to be published on any conference presentation, restricting conference participation to those who publish, and redirecting staff who do not publish regularly to focus on providing vital data sets). Many of these team members are now responsible for major HRD data sets such as data from flight level, dropsondes, radar, SFMR, AXBTs, and H*Wind surface wind products and, therefore, provide significant value to HRD, NOAA, and the general research community.

7. **HRD should rebuild its connection with the external community to carry out the aircraft experiments needed to advance hurricane knowledge.**
(Completed 9/15/2010)

HRD has a long, very successful track record of collaborating with the external community through its observing and research programs. Recent collaborations in the past ten years that come to mind include the National Aeronautics and Space Administration (NASA) Convection and Moisture Experiments (CAMEX-3 & 4), Tropical Cloud Systems Processes (TCSP), and NASA African Monsoon Multidisciplinary Analysis (NAMMA) field efforts, the National Science Foundation (NSF) Rainband Experiment (RAINEX) and upper ocean impacts field efforts, and the Office of Naval Research (ONR) Coupled Boundary Layer Air-Sea Transfer (CBLAST) effort. In each of these programs, HRD field program directors worked very closely with program managers from the partner agencies to coordinate co-incident aircraft flight patterns, share data collected during the experiments, and collaborate on publications that result from the research. In recent years, HRD has made extensive and regular use of GoToMeeting to virtually connect partners based in other locations to participate in daily weather discussions and to discuss specific flight opportunities.

Because of this extensive field experience, HRD scientists are recognized internationally for their knowledge of tropical cyclones, as well as their expertise in technological areas such as airborne Doppler radar, dropsondes, cloud microphysics, and air-sea interaction, to name a few. These assets make HRD unique worldwide and provide NOAA a unique capability. HRD has close ties with a number of NASA (e.g., Braun, G. Heymsfield, Miller, Hristova), NRL (P. Black, Harasti, Hawkins), and the National Center for Atmospheric Research (NCAR) (e.g., A. Heymsfield, Lee, Bell) researchers working on hurricanes. We also collaborate very closely with a number of university Primary Investigators (PIs) in their research, e.g., Shay, Drennan, Majumdar, and Nolan (RSMAS); Barnes (University of Hawaii); Montgomery and Harr (Naval Post Graduate School (NPS)); F. Zhang, Evan, and Bosart (Pennsylvania State University (PSU)); Molinari (State University of New York, Albany (SUNYA)); Eastin and Etherton (University of North Carolina (UNCC)); Zipser (University of Utah); Emanuel (Massachusetts Institute of Technology (MIT)); Bluestein (University of Oklahoma (OU)); Houze (University of Washington (UW)); Wu (National Taiwan University (NTU)); Schroeder (Texas Tech University (TTU)); Masters (University of Florida (UF)); Willoughby (Florida International University (FIU)); and many others. HRD is known in the research community as the place to come for any hurricane observational data sets. We have expanded the number of these data sets that are available to the external research community, and we continue to improve our interactions with our data users, implementing a clear data policy available on our website that adheres to NOAA's data policy. We intend to keep pushing data availability to enable researchers to access near real-time data sets as part of the HFIP effort. HFIP also clearly recognizes that NOAA cannot make the improvements called for by ourselves, and we have begun to make funds available to the external community through vehicles such as the joint ONR-NOAA National Ocean Partnership Program (NOPP) effort for improving tropical cyclone research. HRD is also very active in the Office of the Federal Coordinator for Meteorology (OFCM) Working Group on Tropical Cyclone Research which is developing an implementation plan for all federally-funded hurricane research. These interactions demonstrate that a strong connection

to the external community already exists. Nevertheless, we are actively expanding our collaborations through the HFIP and our visiting scientist program.

Within NOAA, HRD has collaborations with NHC (Franklin, Landsea), EMC (Talapragada, Kwan, Tuleya, Surgi, Zhang, Tolman), the Geophysical Fluid Dynamics Laboratory (GFDL) (Marchok, Bender), ESRL (Fairall, Bao), and the UAS office (Hood).

Oceans and Climate (Climate Observing Systems, Atlantic Circulation and Fluxes, Atlantic Meridonal Overturning Circulation, Western Hemisphere Warm Pool and CO_2):

Recommendations:

1. **AOML should facilitate and enable climate modelers to be more engaged with the scientists responsible for observations so that two-way feedback can be enhanced to ensure that modelers fully utilize observations to validate and improve their models and that field scientists are providing the optimal set of observations for the model efforts.** (Completed 01/2009)

   (Associated comments highlighted by OAR Headquarters from the reviewers' synthesis report)

   AOML's Physical Oceanography Division (PhOD) should expand their involvement in validating models. This can be accomplished two ways: generate an in-house modeling capability, or increase collaboration with external modelers, either at NOAA labs (e.g., GFDL) or elsewhere (e.g., Los Alamos National Laboratory). The latter approach is favored. PhOD should move toward developing a large Ocean General Circulation Model (OGCM) or climate modeling capability.

   PhOD scientists are expanding their involvement in validating models. This is a significant effort currently underway. PhOD recently hired a senior modeler for OSSEs as a Federal employee and a junior modeler as a CIMAS contractor. AOML feels that in order to successfully collaborate with external modelers the laboratory must first have an experienced modeler who conducts model studies in-house and can effectively collaborate with the broader modeling community. Our recent hires provide that crucial translations expertise.

   PhOD made a proposal to GFDL for Collaborative Research on January 6, 2009 to improve climate/ocean models, predictions of climate variability for societal benefit, and our understanding of seasonal-to-multidecadal climate variability. GFDL requested that the collaborative project commence after their laboratory review and the upcoming Fifth Intergovernmental Panel on Climate Change (IPCC 5). AOML will be providing data and analysis from relevant projects in the interim. AOML and GFDL scientists have also begun limited collaborations on climate issues, including recent joint publications and funding proposals. A new joint AOML/GFDL proposal will be submitted to NOAA's Climate Program Office (CPO) this year to improve characterization of variations in climate prediction models in the Atlantic. There is also a joint seminar series planned to enhance communication.

AOML submitted a proposal to NOAA/CPO entitled "Assessing the Sensitivity of Northward Heat Transport/Atlantic Meridional Overturning Circulation to Forcing in Existing Numerical Model Simulations" by S. Dong, M. Baringer, G. Goni, and G. Halliwell, in which it is proposed to investigate and assess differences in the Atlantic Meridional Overturning Circulation (MOC) index between observations and GFDL model output. The contact scientist at GFDL is Dr. Rong Zhange.

2. **AOML should continue to emphasize strengths that have traditionally been in observational work but add complementary analysis and modeling efforts to better connect its work with the larger research community.**
(Completed 04/2009)

(Associated comment highlighted by OAR Headquarters from the reviewers' synthesis report)

The perception of the present situation at AOML is that there are not sufficient funds made available by NOAA for the specific task of analyzing data, as opposed to collecting it. It is recommended that NOAA make more funds available specifically for data analysis.

AOML's efforts in maintaining its leadership in ocean observations for climate can be corroborated by its participation at the recent OceanObs'09 international meeting. AOML scientists were lead authors of two white paper proposals and coauthors of 10 white papers. However, support to collect the observations has been kept at level funding, resulting in a net loss of about 10% per year due to inflation. The result is that fewer observations are collected and sustainability of the observing system components managed by AOML is becoming more difficult. Even more important is the lack of funding for analyzing these data. Drs. Gustavo Goni and Silvia Garzoli have submitted five alternative proposals to the Climate Observations and Monitoring Alternatives program to explore possibilities for increased funding in PhOD.

In order for modeling collaboration across NOAA to occur and for AOML observational expertise to be effectively used by NOAA modeling organizations, a limited number of modelers must exist at AOML. This will increase communication and collaboration. Modelers at AOML research different aspects of modeling challenges than those addressed by modeling centers and other NOAA offices. These include:

- Observing system experiments (OSEs) which allow modelers to help identify how and where the ocean should be best sampled.
- Modelers working very closely with observational researchers to identify and study important climate processes.
- Observations and models constantly being compared since neither can completely and perfectly resolve all ocean processes.
- New models that will be researched and designed in direct relation to observational needs.
- Ocean modelers working with hurricane researchers to incorporate the HYCOM ocean model into the experimental HWRF model to improve characterization of ocean heat transfer.

Since the modeling effort was initiated at AOML, there has been an increase in the interaction with modeling centers and, in particular, GFDL. Projects initiated at AOML such as Observing System Simulation Experiments (OSSE) will continue increasing the interest of AOML PIs on modeling efforts and their interaction with GFDL scientists.

3. **AOML should articulate in a new AOML strategic plan the scope of key projects, particularly related to long-term climate system observing including the most important cost-effective projects to the mission and the new emphasis on modeling to maximize future contributions of AOML to the ocean and climate community**
(Completed 05/2011)

(Associated comments highlighted by OAR Headquarters from the reviewers' synthesis report)

It is very important to articulate the rationale for the relevance, cost-effectiveness, etc., of PhOD's programs (and the other AOML division programs) to NOAA's mission goals be readily available to the public. (Following text recommending an AOML Strategic Plan be developed)

In order to maximize future contributions of AOML to the ocean and climate community, it would be helpful if the scope of key projects, particularly related to long-term climate system observing and the new emphasis on modeling, were articulated more specifically in a new AOML Strategic Plan.

Strategic Plans are essential for AOML's visibility and funding health. Especially, this would be the document where one would expect to see discussions of the rationale and linkage of AOML's specific programs to NOAA's Mission Goals.

The AOML Director, Deputy Director, and Science Division Directors held a retreat on April 15, 2009 to begin the process of creating a new AOML Strategic Plan. The first draft of the new AOML strategic plan was completed October 1, 2009. The final version was completed on May 6, 2011 and is now available on the AOML website. The plan contains a short summary document, as well as a longer version with more detail. It articulates the rationale, scope, linkage to NOAA goals and the Five-Year Research Plan, and cost effectiveness of all of the major programs of each of the divisions and for the laboratory as a whole. This includes: development and maintenance of observing systems for hurricanes, oceans, and climate; OSSEs; modeling and environmental assessments; oceanic microbiology related to human health; and process studies necessary for improving understanding and increasing predictive skill.

4. **AOML should expand the visiting scientist program as a way to improve modeling activities at AOML. A good way to start would be to make sure all of the potentially important connections exist with the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS) scientists across the street.**
(Completed 09/2010)

AOML and PhOD already conduct numerous joint activities with RSMAS, including running the Hybrid Coordinate Ocean Model (HYCOM) model, conducting Rapid Climate Change

Meridional Overturning Circulation and Heat Flux Array (RAPID-MOCHA) experiments and analysis, sharing technicians, writing proposals, and publishing journal articles. Both AOML and RSMAS oceanographers receive announcements of each other's seminars and actively attend and participate in discussions. AOML is also working on adopting the Fellows program created at NOAA's National Severe Storms Laboratory (NSSL) and approved by OAR to provide a formal process for inviting distinguished faculty from RSMAS and other institutions to visit and interact with AOML on an annual basis to foster increased collaboration. The program will provide an opportunity for national and international scientists from academia, government, and private industry to partner with AOML scientists. This is an ongoing effort. Additionally, PhOD will start inviting modelers to visit the lab and work on manuscripts. A visit by Dr. Ricardo Matano of Oregon State University occurred in November 2009.

5. **AOML should begin planning for succession. A few senior level hires are needed to ensure that new division leaders are in place and overlap with present directors of the Ocean Chemistry and Physical Oceanography groups before they step down.**
(Completed 08/15/2010)

   (Associated comment highlighted by OAR Headquarters from the reviewers' synthesis report)

   A few senior level hires are needed to ensure that new division leaders are in place and overlap with present directors of the Ocean Chemistry and Physical Oceanography groups before they step down. A plan should be developed for retirement-eligible scientists to provide retirement incentives.

   A succession plan is in place at PhOD. Three scientists were promoted from band IV to band V in 2008. An announcement for band IV/V FTE positions was made last year. A new band IV scientist was hired. Other offers were issued but not accepted. The main problem is that salaries for AOML band V positions are considerably lower than those offered at universities at this level. We were not able to successfully hire anyone at the band V level. PhOD was successful in selecting an internal candidate, Dr. Gustavo Goni, to serve as the new division director as of May 12, 2009. OCD's Division Director departed in 2008 without the recruitment of a potential replacement. A recruitment action was initiated immediately, and AOML's Deputy Director, Judy Gray, assumed the duties of Acting OCD Director in addition to her Deputy duties. The job announcement closed on March 13, 2009, and AOML selected Dr. Michelle Wood of the University of Oregon. Dr. Wood began at AOML on January 18, 2010. Within OCD, PIs have traditionally ensured that they have an heir apparent and continue to do so. This is true in the microbiology lab, the South Florida Program, and the Coral Reef Early Warning System – Integrated Coral Observing Network (CREWS/ICON) program where PIs are nearing retirement eligibility. This proactive planning will be considered in the future for other projects that currently have young PIs. We are also training an internal replacement for the OCD Deputy Director.

6. **AOML leadership should consider partnering with operational NOAA elements and other agencies to evaluate impacts on ocean climate on natural resources, coastal communities, and other issues of relevance to people.**
(Completed 04/2008)

AOML agrees and will continue its efforts to work with other NOAA offices. Some examples of our collaborations include the following:

1) AOML's South Florida Program (SFP) and the developing South Florida Regional Observing System (SF-ROS) have been partnering with several operational NOAA elements (National Ocean Service (NOS)/ Florida Keys National Marine Sanctuary and National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC)) and other agencies (United States Geological Survey (USGS), South Florida Water Management District (SFWMD)) since 1995. The goal of the evolving program is to observe, analyze, and understand the complex coastal and estuarine marine ecosystems of south Florida. Towards this end, we work with several universities (UM, FIU, and USF) to combine our oceanographic observations with meteorological observations, remote sensing products, and numerical model outputs. Part of the program aims to monitor and understand the changes to these ecosystems that are expected as a result of the massive Everglades restoration effort. The temporal and spatial scales involved include climate change issues such as sea level rise, global warming, ocean acidification, and hurricane severity and frequency. These issues are uniquely important to south Florida, which possesses the Everglades ecosystem, the largest (contiguous states) U.S. coral reef system, low coastal land elevations, economically significant tourism and fisheries industries, and a large and rapidly growing coastal population. AOML has also formed a partnership with the Florida Sea Grant program and has cost-shared a Sea Grant Outreach and Education Coordinator for the NOAA South Florida Program, hosted at AOML, since 2006.

2) AOML researchers have been partnering since 2002 with researchers from the NMFS/SEFSC. Collaborative research includes larval reef fish population distribution, abundance, and diversity with the physical connectivity of the coastal and offshore currents of south Florida, the Gulf of Mexico, the Mexican/Belizean Yucatan and, more recently, the northeastern Caribbean including the U.S. Virgin Islands and Puerto Rico. We collaborate with NOAA and non-NOAA entities to utilize remote sensing and numerical model products to aid in understanding the complex regional circulation of the Caribbean and Gulf of Mexico and its importance to the economically important coral reef ecosystems. The same climate change issues listed above for south Florida natural resources, coastal communities, and other issues are also critically important to the coastal areas of the wider Caribbean/Gulf region and their diverse ecosystems. AOML and SEFSC have recently written a proposal to down scale a climate model to the Gulf of Mexico region and use this in collaboration with fisheries biologists to model climate impacts. Efforts like these will open doors to the future of true ecosystem modeling.

3) The coral work at AOML is integrated with coral activities from across NOAA, including NOS International Affairs, and the NESDIS Coral Watch Program. The CREWS data and alerts are broadcast worldwide, and researchers from other NOAA and national and international programs use or co-deploy instruments in conjunction with the CREWS/ICON stations.

4) With respect to climate impacts, the new Ocean Acidification (OA) aspect of the CO_2 program will be partnering with agencies concerned with impacts through an OA researcher who has been working with partners from NMFS/SEFSC and NOS' Center for Coastal Fisheries and Habitat Research, Center for Sponsored Coastal Ocean Research, and Office of National Marine Sanctuaries to develop a Southeast Atlantic and Gulf of Mexico Ocean Acidification Research Plan for NOAA.

7. **The articulation and relevance of PhOD's programs to NOAA's mission should be made available to the public.**
(Completed 05/2011)

   The relevance of each of AOML's research programs as they pertain to the NOAA mission are articulated clearly in the new AOML strategic plan and available to the public through our newly revised website. In addition, the relevance of PhOD's programs to NOAA's mission has been made available to NOAA's Climate Office through their quarterly publication "Climate Goal Quarterly Newsletter." This newsletter is posted on the CPO website and is made available to the public. However, due to the availability of space, the newsletter does not always report all of our achievements. The new AOML website will help solve this problem by publishing all of our accomplishments and their relevance to the NOAA mission.

8. **NOAA should allocate sufficient resources to analyzing data as opposed to simply collecting it.**

   AOML fully agrees with this suggestion and has submitted a total of five alternative proposals to support this deficiency. Please see the response to suggestion 2 above regarding modeling activities.

Ecosystem (Florida Coastal Ecosystems, Corals):

Recommendations:

1. **Laboratory management should set some bounds on the degree to which specific applications are pursued versus research and development activities. It should be a high priority of the Division to do a top-to-bottom review of its internal priorities and long-term focus consistent with NOAA's and AOML's priorities as identified in the strategic plans and research plans.**
(Completed 05/2011)

   AOML and OCD agree. A top-to-bottom review of OCD has been completed by the OCD Director and is reflected in the AOML Strategic Plan, available on the laboratory website: http://www.aoml.noaa.gov/about_us/.

2. **The lab needs to carefully manage its ecosystem portfolio so as not to be subsumed by service functions to these other organizations, resulting in a predominant service portfolio.**

(Completed 05/2011)

OCD is carefully examining the activities being proposed with partners in Florida. OCD is committed to providing the scientific underpinning to describe the biogeochemical environment upon which the development of regulations or permits may be based. We recognize that this can be a delicate balance and with all new research we will continue to evaluate its relevance to the NOAA mission and its ability to advance the science. Peer-review publications will remain the hallmark of scientific productivity in the division.

3. **As staff retire, AOML should revisit the research portfolio rather than simply replace outgoing expertise one-for-one.**
(Completed 05/2011)

AOML agrees with this statement and performs regular reviews of the research portfolio and hires according to NOAA mission needs as articulated in the Next Generation Strategic Plan and Five-Year Research Plan. With the recent completion of our Strategic Plan for 2010-2015, we again carefully reviewed our research portfolio and reference it when making any recruitment decisions.

4. **AOML needs to assess whether the presence of reimbursable research activities are consistent with its long-term plans and priorities, especially if they require new hires to sustain in the future.**
(Completed 05/2011)

(Associated comment highlighted by OAR Headquarters from the reviewers' synthesis report)

The proportion of AOML's funding, especially in PhOD and OCD, has been drifting from base-generated to proposal-generated. Unless the in-house NOAA proposal success rate is very high, the reliance on proposal-driven funding is a dangerous trend toward an inefficient funding model. If the competition stiffens, and the funding success drops, productivity will decline.

AOML is similarly concerned with the increased need for proposal-based support for FTE salaries. One of the primary reasons for the increased reliance on proposal-based funding to support FTEs is the relatively static nature of AOML's base budget for the past decade (and beyond). Unfortunately, AOML has not seen the same level of base increases other NOAA Labs and Programs have seen over the past decade. As a result, AOML, like other organizations, steady increases in labor and operating costs without the attendant increases in our base funding continues to erode our ability to satisfy our FTE salary requirements without augmenting from external (to AOML) sources.

At the same time, many of AOML's internal NOAA partners and Programs have grown to rely upon AOML to meet their Program Missions. As such, much of AOML's reimbursable research, including PhOD and OCD observing system resources and OCD funds for coral reef conservation, have become "quasi-base" resources. That is to say, the funds are renewed annually upon the submission of a report of the work completed. One challenge with this situation is the fact that NOAA does not allow inclusion of NOAA FTE salaries in the

proposals but does allow for inclusion of non-NOAA salaries (e.g. cooperative institute employees). This challenge also holds for NASA and NSF proposals, which also can not be used to support Federal salaries.

Finally, it should be noted that NOAA's reimbursable research policy allows for a portion of Laboratory FTE salaries to be funded from non-base resources. AOML is fully compliant with this policy and strives to limit our reliance on non-base resources through continued active participation in the NOAA budget process and proactive engagement with OAR and NOAA Leadership. AOML will also continue to invite and host NOAA budget office staff to visit AOML for briefings on our science and issues that are of importance to the lab.

5. **AOML and the NMFS facility should develop a strategic outlook and plan for cooperative ecosystem studies.**
(Completed 06/2009)

(Associated comment highlighted by OAR Headquarters from the reviewers' synthesis report)

It would be in the best interest of both AOML and SEFSC to develop a strategic outlook and plan for cooperative ecosystem studies. The "One NOAA" concept should be pursued with increased vigor in the ecosystem realm among NOS, NMFS, and OAR in the southeast.

AOML enthusiastically agrees. The SEFSC and AOML Directors have begun monthly lunches, as have their Deputies (the IT staff continue to meet weekly with RSMAS as well). There are several ideas on the table including cooperative model development using AOML for physical measurements that complement those of fisheries (expanding the work of Johns/AOML and Lamkin/SEFSC to other scientists and programs). There have also been discussions in regard to rejuvenating the marine mammals and acoustics program. Ocean acidification is a new AOML program that is already being researched jointly with SEFSC. AOML scientist Kelly Goodwin is currently located at the Southwest Fisheries Science Center (SWFSC) in La Jolla, California to increase NMFS/OAR interaction. During a June 2009 meeting to discuss possible collaborations between SEFSC and AOML, a jointly-funded NRC post-doc was discussed to facilitate more formal exchange.

6. **AOML needs to be a national and global leader in ocean acidification and geoengineering solutions to the CO_2 issues, taking advantage of its staff expertise and strategic relationships (e.g., among global, national, and the network of OAR researchers). Given its proximity to other line offices with complementary expertise (NOS, NMFS), such research should be conducted to evaluate not only ocean chemistry issues but ecological impacts as well.**
(Completed 04/2010)

AOML recognizes the importance of multi-disciplinary studies on ocean acidification and has recently hired a well-established, mid-level scientist with expertise in this area. AOML is currently leading the Southeast Regional planning efforts on ocean acidification that encompasses the southeast coast (south of Virginia), Gulf of Mexico, and Caribbean. The possible impacts of ocean acidification have only recently been recognized. There are huge scientific misconceptions of the phenomena that can best be resolved by entraining young

and mid-level scientists who have the time and energy to become leaders in this rapidly-evolving field. AOML has the senior personnel who are leaders in ocean carbon research and coral reef monitoring. They will provide the guidance to the personnel to become the leaders in NOAA's ocean acidification programs. Indeed, the scientists in question (Drs. Manzello and Gledhill) are already internationally recognized for their scientific contributions to OA research. AOML believes that this strategy of developing younger leaders in the field is a sound approach. Ocean acidification is a multi-faceted subtopic of the overarching goals of global carbon cycle research and coral reef health monitoring. Established leadership at AOML in these overarching goals should not be diverted; rather, we must entrain new leaders.

AOML has the only scientists in NOAA (Drs. Peng, Wanninkhof, and Zhang) who were involved in the original open ocean iron enrichment (cf. "ocean fertilization") studies and modeling. This work was either performed before the investigators joined NOAA or through funding from other federal agencies. Studies to date have shown that sequestration efficiency from deliberate iron additions is poor, and that quantification and verification of commercial sequestration endeavors would be costly (or perhaps even impossible). AOML scientists have been actively involved in the scientific debate within NOAA and development of a NOAA State of Science fact sheet on ocean fertilization and the position statement of the U.S. government on regulating ocean fertilization through appending the London Protocol on ocean dumping.

The NOAA Research Council has not yet approved a consensus document on iron fertilization, although AOML has provided input. At this point, AOML is not planning to become engaged in geoengineering solutions to the CO_2 issues due to the highly politicized nature of the topic and lack of engineering expertise necessary to fruitfully contribute.

Ship Support for Ocean Missions:

Recommendations:

1. **The research fleet of NOAA must be better maintained and regain reliability if AOML is going to be able to achieve its research mission. One reviewer thought this is the most important issue that emerged in the AOML review. If the lab is going to support an ocean observations program at the Atlantic basin to local scales, reliable access to ship time, either aboard NOAA ships with time allocated directly to AOML, allocated to its sister agencies (e.g., NOS, NMFS), charters aboard University-National Oceanographic Laboratory System (UNOLS) and other ships, or in conjunction with other entities (e.g., NSF) is critical.**
   (This is currently a very active topic at Senior NOAA levels. AOML employee Judy Gray is one of the primary NOAA POCs for this activity.)

   Many, but not all, of the problems referred to by the reviewers relate to the use of the NOAA Ship RONALD H. BROWN. AOML is leading a team of representatives from OAR, the Climate Program Office, and the academic community who use the BROWN to work with NOAA's Office of Marine and Aviation Operations (OMAO) to find solutions to ongoing

challenges with the management and operation of the vessel. In June 2009, a team meeting was held in Charleston, South Carolina to discuss progress to date and to continue searching for positive solutions to these challenges. The team is working closely with senior leaders from OMAO and will ultimately make formal recommendations to the director of OMAO for remedies. It is expected that the solutions developed for the BROWN will inform and aid operations on all OMAO vessels.

Other Recommendations:

1. **One of the best ways to improve the visibility of AOML is by improving its website. The Team strongly recommends that a professional web designer be brought in for this, and that this web designer does a considerable amount of beta testing with the external user community.**

   AOML has made tremendous progress in improving its visibility through increased publications, collaborations, and enhanced participation at national and international conferences, as well as on panels and committees. Nevertheless, we agree that internet-based communications are vital and have implemented a new website to better communicate through this medium.

   Drawing on in-house capabilities, AOML was able to create its own Content Management System to populate and maintain a newly designed AOML website. AOML has created an internal web group to coordinate management between all of the science divisions and the office of the director. Through this group AOML will consider and develop new ways to improve upon the site and add new features to further enhance its effectiveness as a communication tool.

Additional Comments Highlighted by OAR Headquarters from the Reviewers' Synthesis Report)

- *OSSEs work best when the question being asked is focused on a characteristic of a specific phenomenon. For most oceanic/climate questions, such as how best to observe the AMOC (which no model known to me has accurately reproduced, either in magnitude or structure) or, even more broadly, how best to observe climate variability, the oceanic and climate models have much too little physical realism to trust their pronouncements of where and what to observe. Model validation should proceed before OSSEs.*

  This was a major topic of discussion at the Ocean OSSE Workshop that we held at AOML in April 2008. We agree that model validation should be performed, and AOML/PhOD has been leading this activity. However, we do not believe that meaningful OSSEs cannot be performed with the current state of ocean modeling. As the AOML Director explained at the workshop, OSSEs for the atmosphere were performed long before atmospheric models reached a satisfactory state. Those OSSEs contributed to advancing the models, observing system, and data assimilation in an iterative process.

OSSEs for the ocean can contribute in a similar manner, as long as the limitations of each experiment are properly taken into account. AOML is continuing to expand its model validation activities and, at the same time, is developing OSSE systems for the ocean in collaboration with both internal and external partners.

Please see the response to suggestion #2 under Hurricanes to reference model validation activities.

- *If there is insufficient science and technical support, the top-level researchers will be burdened with maintenance tasks that inhibit the accomplishment of knowledge producing research from the data. An important consequence of maintenance demands is that great care must be taken that with each new commitment, that is, each observing program initiated, a realistic assessment of technical personnel requirements for maintenance is made and funded.*

  AOML fully agrees. The Ocean Chemistry Division has implemented in its monthly PI meetings a budget presentation that is being negotiated with the PIs to show exactly where each project stands in terms of income-to-date, expected income, expenditures to date, expenditures planned, and needs to be met. The budget presentation is becoming a tool for both discussion and decision making. This new business model will be used to assist the new OCD Director in understanding the current state, future plans, and needs of this complex science division. The new OCD Director is responsible for assuring that new projects being proposed have available resources (money as well as people with the correct skills) or a plan for assessing what is required and when programs or technology are deemed ready to be transferred to operations. An internal OCD review, to be conducted by the new Director, will also decide where needs are not being met.

- *There is a significant need for a seasoned, multidisciplinary researcher who comprehends the connections between the disciplines in the Ocean Chemistry Division and who can guide and shape ongoing priorities. It should be a high priority of the laboratory to replace the Ortner position with a similarly qualified individual with this capability.*

  The recruitment of the OCD Director is complete. AOML agreed that the optimal candidate would be an interdisciplinary researcher with a solid reputation and a deep understanding of the research conducted in this complex and diverse division. AOML has selected such a candidate in Dr. Michelle Wood from the University of Oregon.

- *The intensive work at the regional (South Florida) and local (water district) levels may drain focus from regional (Caribbean, South Atlantic, Gulf of Mexico), Atlantic basin, and international activities in keeping with NOAA's broader focus. In particular, it is evident that little of the Division and in fact the Laboratory's resources are devoted to the Gulf of Mexico issues, given the proximity to that sub-region and the focus for so many of NOAA's issues there.*

AOML is no longer receiving support from NOAA's Integrated Ocean Observing System (IOOS), and this funding is required for increased regional observations. It also appears that ecosystems, like politics, are often viewed as local programs for primarily local funding. AOML is coordinating its research with those conducting research in the Gulf of Mexico. The Gulf has a rich research constituency. Historically, AOML has had large programs in the Gulf, e.g., the Nutrient Enhanced Coastal Ocean Productivity program (NECOP). When that program ended, efforts were focused on issues in the state of Florida that have far-reaching consequences, e.g., closing ocean outfalls by 2025. Several AOML PIs are involved with the Northern Gulf of Mexico Cooperative Institute and the Gulf of Mexico Alliance (GOMA). For example, PIs with AOML's microbiology lab are currently working on microbial source tracking and pathogen detection methodology in the Gulf, as well as participating on workshop committees to draft action items for GOMA. Two OCD PIs are working in Mobile Bay, Alabama in cooperation with the University of Southern Alabama. The microbiology lab is continuing its research on the long-term impacts of Hurricanes Katrina and Rita in regard to the local ecology and how the microbial landscape might be impacted in the Gulf. There are pending proposals for work in the Gulf of Mexico for the microbiology lab. There are also Gulf of Mexico proposals in development for ocean acidification research. OCD has a representative on NOAA's Gulf of Mexico Regional Team. Researchers with the CREWS/ICON program are working regionally throughout the Caribbean, as well as in the Pacific.

- *Very little and insignificant amount of work is being devoted to study the impact of satellite observations (in HRD), the assimilation of existing satellite measurements, or recommending new observation systems.*

  AOML and HRD do not have a long history of studying the impact of satellite observations, but this has been gradually changing over the last several years and will increase dramatically when their hurricane modeling and data assimilation capability reach maturity. At the present time, AOML and HRD in particular are interacting with several NASA science teams (Ocean Vector Winds, Altimetry Science and Precipitation, and Atmospheric Infrared Sounder (AIRS)) and are conducting satellite data impact studies for QuikSCAT, Advanced Scatterometer (ASCAT), HIRAD and NASA's Global Wind Observing System (GWOS). In addition, HRD participated in the OAR/NESDIS retreat which identified two research thrusts that are designed to improve the use of satellite observations for evaluating model simulations and forecasts, and to improve the use of satellite data in initializing these models through OSE/OSSE experiments. For more details, see the response to the OSSE/OSE strategy issue.

- *The HRD staff has participated in the development of all instruments on-board the NOAA aircraft and has played a strong role in the respective observation strategies. Some of these instruments are no longer state-of-the-art and there is no mechanism that appears to be in place to update the instrument suite.*

  HRD works with NOAA's Marine and Aviation Office (NMAO) on their roadmap planning. NOAA is actively updating the P-3 aircraft instrumentation, and HRD is

participating in defining the requirements and providing evaluation for these observing system upgrades including the cloud microphysics system, ocean expendables, radar systems, dropsonde system, main data systems, turbulence sampling, and new remote sensors such as Imaging Wind and Rain Airborne Profiler (IWRAP), Wind Swath Radar Altimeter (WSRA), W-band radar, and a Doppler wind lidar. HRD is also providing a similar advisory role in the upgrades and instrumentation on the G-IV, as well as actively participating in the testing and evaluation of the SFMR and Doppler radar system.

- *Anecdotal evidence suggests the low salaries of the CIMAS science and technical support staff and the declining technical support within AOML. AOML's observation programs are too important to let falter for lack of technical support.*

  There is an annual effort to maintain equity between the UM and NOAA pay scales. Federal personnel benefit from an annual pay-for-performance increase (ZP average 1.86%) compounded by an annual cost-of-living/locality pay adjustment (recently over 3% per year). CIMAS personnel have averaged an annual pay increase of 3-3.5%, therefore lower than their Federal peers. However, CIMAS has several layers of potential promotion with a typical pay increase of 10%. Feds often have no promotions or, at most, two over their careers due to the low number of bands in the Commerce Alternative Personnel System (CAPS). This allows large jumps that, we hope, make up the difference in pay over time. CIMAS has other benefits that are not open to their Federal partners at AOML including tuition waivers for their children and other attractive university benefits. Annually, AOML works with UM and CIMAS leadership to ensure that similar work is rewarded similarly. In addition, after years of requests, it appears that CIMAS will be allowed to offer parallel recognition awards for CIMAS employees who are partners on teams that win federal awards. If this succeeds, it will be a huge step forward. Our goal has been and will continue to be equity in pay for similar work.

Acronyms

4DVAR:	Four-Dimensional Variational Data Assimilation
AIRS:	Atmospheric InfraRed Sounder
AMOC:	Atlantic Meridional Overturning Circulation
AMS:	American Meteorological Society
AOML:	NOAA Atlantic Oceanographic and Meteorology Laboratory
ASCAT:	Advanced Scatterometer
ATB:	Adjustment to Base
AXBT:	Airborne Expendable Bathythermograph
BAMS:	Bulletin of the American Meteorological Society
CAMEX:	Convection and Moisture Experiments
CBLAST:	ONR Coupled Boundary Layer Air-Sea Transfer Experiment
CIMAS:	UM and NOAA Cooperative Institute for Marine and Atmospheric Studies
COD:	NOAA Climate Program Office Climate Observation Division
CPO:	NOAA Climate Program Office
CRCP:	Coral Reef Conservation Program
CREWS:	Coral Reef Early Warning System

DTC: NOAA Developmental Testbed Center
EMC: NWS Environmental Modeling Center
EnKF: Ensemble Kalman Filter Data Assimilation
ESRL: NOAA Earth System Research Laboratory
FIU: Florida International University
FSU: Florida State University
FTE: Full Time Equivalent
FY: Fiscal Year
GSFC: NASA Goddard Space Flight Center
GFDL: NOAA Geophysical Fluid Dynamics Laboratory
GFS: Global Forecast System
G-IV: Gulfstream-Four Aircraft
GOES-R: Geostationary Operational Environmental Satellite-R Series
GOMA: Gulf of Mexico Alliance
GSD: ESRL Global Systems Division
GSFC: NASA Goddard Space Flight Center
GWOS: NASA Global Wind Observing System
HFIP: Hurricane Forecast Improvement Project
HIRAD: Hurricane Imaging Radiometer
HRD: AOML Hurricane Research Division
HWRF: Hurricane Weather Research and Forecasting Model
HWRFX: Experimental Hurricane Weather Research and Forecasting Model
HYCOM: Hybrid Coordinate Ocean Model
ICON: Integrated Coral Observing Network
IFEX: NOAA Intensity Forecast Experiment
IOOS: NOAA Integrated Ocean Observing System
IPCC: Intergovernmental Panel on Climate Change
IWRAP: Imaging Wind and Rain Airborne Profiler
JAS: AMS Journal of the Atmospheric Sciences
JCSDA: Joint Center for Satellite Data Assimilation
JPL: NASA Jet Propulsion Laboratory
LCI: NOAA Labs and Cooperative Institutes
MIT: Massachusetts Institute of Technology
MOC: Meridional Overturning Circulation
MOCHA: Meridional Overturning Circulation & Heat Flux Array
MSFC: NASA Marshall Space Flight Center
MWR: AMS Monthly Weather Review
NAMMA: NASA African Monsoon Multidisciplinary Analysis Experiment
NASA: National Aeronautics and Space Administration
NCAR: National Center for Atmospheric Research
NCEP: NOAA National Center for Environmental Prediction
NECOP: Nutrient Enhanced Coastal Ocean Productivity Program
NESDIS: NOAA National Environmental Satellite Data and Information Service
NHC: NWS National Hurricane Center
NMAO: NOAA Marine and Aviation Office
NMFS: NOAA National Marine Fisheries Service

MSFC: NASA Marshall Space Flight Center
NOAA: National Oceanic and Atmospheric Administration
NOPP: Naval Ocean Partnership Program
NOS: NOAA National Ocean Service
NPS: Naval Postgraduate School
NRC: National Research Council
NRL: Naval Research Laboratory
NSF: National Science Foundation
NSSL: National Severe Storms Laboratory
NTU: National Taiwan University
NWS: NOAA National Weather Service
OA: Ocean Acidification
OAR: NOAA Office of Oceanic and Atmospheric Research
OCD: AOML Ocean Chemistry Division
OFCM: NOAA Office of the Federal Coordinator for Meteorology
OGCM: Ocean General Circulation Model
OMAO: NOAA Office of Marine and Aviation Operations
ONR: Office of Naval Research
OSE: Observing System Experiment
OSSE: Observing System Sensitivity Experiment
OU: University of Oklahoma
PhOD: AOML Physical Oceanography Division
PI: Primary Investigator
PSU: Pennsylvania State University
QuikSCAT: NASA satellite scatterometer
RAINEX: NSF Rainband Experiment
RAPID: Rapid Climate Change
RSMAS: UM Rosenstiel School for Marine and Atmospheric Studies
SEFSC: NOAA Southeast Fisheries Science Center
SFMR: Stepped-Frequency Microwave Radiometer
SFWMD: South Florida Water Management District
SFP: AOML's South Florida Program
SF-ROS: South Florida Regional Observing System
STAR: NESDIS Center for Satellite Applications and Research
SUNYA: State University of New York at Albany
SWFSC: Southwest Fisheries Science Center
TCSP: NASA Tropical Cloud Systems and Processes Mission
TTU: Texas Tech University
UAS: Unmanned Aerial System
UCF: University of Central Florida
UF: University of Florida
UM: University of Miami
UNOLS: University-National Oceanographic Laboratory System
USF: University of South Florida
USGS: United States Geological Survey
USWRP: U.S. Weather Research Program

UW: University of Washington
WP-3D: NOAA P-3 aircraft
WRF: Weather Research and Forecasting Model
WSRA: Wide Swath Radar Altimeter
XOVWM: Extended Ocean Vector Wind Mission