Annual Report of the
UCAR Community Advisory Committee for NCEP

December 19, 2011

Managed by the
University Corporation for Atmospheric Research

UCACN

Frederick Carr, co-chair
James Kinter, co-chair
Lance Bosart
Gilbert Brunet
John Dutton
Maura Hagan
Bill Kuo
Gary Lackmann
Ronald McPherson
Leonard Pietrafesa
Warren Qualley
Steven Smith
Eric Wood

Table of Contents

1. Introduction

1.1 Background and Charge

This report contains the first evaluation of the National Centers for Environmental Prediction (NCEP) by the UCAR (University Corporation for Atmospheric Research) Community Advisory Committee for NCEP (UCACN).

The context for this report was created in November 2008 when UCAR was requested by NCEP to conduct a thorough and thoughtful review of the nine Centers that comprise NCEP, as well as the NCEP Office of the Director (OD). An Executive Committee plus five panels conducted the reviews, which is referred to as the 2009 Review. The reports were completed in early 2010 and are available at http://www.vsp.ucar.edu/UCACN/index.html. One of the major recommendations of the 2009 Review was that NCEP should establish a permanent external advisory committee to provide guidance on improvement of products and services based on the latest advances in science and technology. As a result, UCACN was established by UCAR in March 2011; its primary responsibilities are:

1. *To conduct a comprehensive review of NCEP (the nine Centers and the Office of the Director) every five years, starting in the year 2015.*

2. *In the years between the comprehensive reviews, to:*
   a. *Monitor progress of the Centers in the context of the NCEP strategic plan and the previous review recommendations, and provide informal updates and advice to the UCAR President.*
   b. *Provide input to the strategic planning and long-range goals of the Centers and NCEP as a whole.*

Upon receipt of the 2009 reports, all centers and the OD organized the 263 recommendations from the review into documents that tracked their actions in response to each recommendation. The original review panels were asked in late 2010 and early 2011 to evaluate and provide feedback on these responses. The tracking documents were revised during 2011 as a result of this feedback plus any additional actions that had occurred. These updated tracking documents, a slide presentation on the current activities and plans of the centers, 2020 Roadmap plans for the National Weather Service (NWS) and NCEP, and a Strengths-Weaknesses-Opportunities-Threats/Challenges (SWOT/C) analysis were provided to the UCACN as background materials for its first meeting. The purpose of this meeting was to engage with NCEP on UCACN responsibilities 2(a) and (b) above.

1.2. Procedure

The UCACN met with the NCEP Directors and other leaders of the 9 centers and the OD in Columbia, MD during October 12-14, 2011. Two or more UCACN members were designated as "leads" and "back-up leads" for each center and were responsible for writing the individual

reports. During the first day, the Committee received the NCEP update from Dr. Louis Uccellini, NCEP Director, which included a discussion of short-and long-range plans and major issues that will affect NCEP in the near future. This was followed by presentations on the National Weather Service strategic plan and the subsequent Roadmap planning efforts on "Services" and "Science and Technology". In the afternoon, the individual Center Directors or their designates gave briefings on their responses to date on the 2009 Review, and discussed their specific roadmap plans and SWOT/C analyses. This continued into the second day, and was followed by breakout sessions between the Centers and the UCACN "leads". On the third day, the UCACN leads (or designates) reported out their initial impressions on Center activities and performance. Those briefings were the starting point for the ensuing reports.

This inaugural meeting of the UCACN was intended to provide an overall picture of the state of NCEP and begin the process of formulating advice on strategic planning and long-range goals. In the future, it anticipated that UCACN members will visit the individual NCEP centers to gather more in-depth information about the centers' activities and plans prior to the annual meeting of the committee as a whole.

Please note that a complete list of acronym definitions appears at the end of this report and can be used as a reference for unfamiliar acronyms that are used herein.

Acknowledgment: The UCACN was provided with a tremendous wealth of information and complete cooperation by all members of the NCEP management and staff with whom it interacted, for which the UCACN expressed its satisfaction and gratitude. The UCACN also wishes to thank the UCAR Visiting Scientist Programs office, which provided excellent logistical support.

2. Office of the Director

The UCACN met with the Director of NCEP on 14 October 2011 to discuss overarching issues and upcoming challenges that affect all of NCEP. UCACN members present for the discussion included Fred Carr, Maura Hagan, Jim Kinter, Ron McPherson, and, by telephone, Gilbert Brunet. NCEP Director Louis Uccellini enumerated several "top challenges" that he feels NCEP faces in the coming year or two. He characterized these as very important and central to the ongoing health and productivity of NCEP as a whole. Based on that discussion and subsequent dialogue among UCACN members, a set of findings and recommendations was prepared.

2.1 Introduction

Strong and excellent leadership has resulted in astonishing progress in most of the overarching issues identified in the 2009 UCAR Review of NCEP. The NCEP management team deserves much credit for the corporate response to all of the recommendations that are solely within the authority of NCEP. Other recommendations, largely involving additional resources or organizational changes, are well beyond NCEP's control. In the current constrained budget climate, additional resources have not met with approval by the National Oceanic and Atmospheric Administration (NOAA) or the Department of Commerce (DoC).

UCACN was pleased to hear that the new NOAA Center for Weather and Climate Prediction (NCWCP) in Riverdale Park, Maryland is scheduled to open in late summer 2012. In particular, we note that it has adequate capacity for accommodating visiting scientists and a fully equipped 500-seat auditorium; the latter feature increases by a factor of 10 the current capacity and will be important for team building. This move will be a turning point for NCEP's future. We congratulate the NCEP management team for this great achievement.

2.2 Overarching Issues

The UCACN recognizes that the next decade at least will be very turbulent for all sectors, but especially for public sector entities such as NCEP. Severe fiscal constraints have the potential to lead to serious reductions in the capabilities of science-based service organizations like NCEP. As an example, EMC depends more and more on external funding, which is resulting in mission creep and the performing of critical duties by non-Federal employees. As in the *2009 UCAR Review*, we recommend that NOAA should take steps to correct this situation. In addition, NCEP should work with NOAA to make use of its proposed Innovation Fund to support mission-critical initiatives. In the changing political environment, with potential turnover in high-level leadership positions, maintaining support for NCEP and its mission requires vigilance by both NCEP and external stakeholder community.

The UCACN wants to underscore the necessity that NOAA, the Department of Commerce, the Office of Management and Budget, and Congress protect NCEP and NWS budgets to ensure that the critical services provided by NCEP continue to improve and serve the nation well. The NCEP

Director articulated 12 top challenges (listed below in section 6) that the UCACN agrees require close attention.

The NOAA Science Advisory Board (SAB) recently accepted and is transmitting to NOAA an "Open Weather and Climate Services" (OWCS) concept paper developed by its Environmental Information Services Working Group. The paper, entitled *Towards Open Weather and Climate Services, argues: "… the Nation has yet to realize the full value of NOAA's weather and climate services for two principal reasons. First, various barriers inhibit the ability of NOAA to distribute or otherwise make available all of its weather and climate information, particularly high-resolution datasets such as numerical weather predication model output, satellite and radar data. Second, new technology and services are not developed within NOAA in a sufficiently symbiotic manner with the broader community such that optimized value from that new service or technology to society is quickly realized. An Open Weather and Climate Services ("Open WCS") is proposed in which both NOAA and the community share equal and full access to NOAA information and development…It is recommended that: NOAA leadership should agree that the Open WCS concept as described herein would be beneficial to the nation and that the agency should immediately begin to develop internal programs to implement the paradigm in targeted parts of the organization that will be most effective in delivering the benefits of Open WCS to society...As a general framework, this recommended action plan should:*

- *Recommend that NOAA implement Open WCS incrementally using targeted programs and prototypes rather than developing broad Open WCS policy and implementation concepts.*
- *Quickly identify short-term actions that can target accelerated implementation of the Open WCS in specific areas that have limited risk or cost and can be achieved without a more comprehensive approach.*
- *Consider mechanisms that catalyze better interactions between NOAA's development laboratories and the broader Enterprise such as open access to development datasets and use of open Development Test Centers."*

The SAB commented that NOAA should examine the challenges with implementing the OWCS proposal, particularly with respect to the implications it has for data assimilation, modeling, product generation and data distribution. This could be done through various pilot projects. The mention of the OWCS white paper here is to make NCEP aware of it, to follow its progress, and to actively participate as appropriate in any activities that may be initiated to lead toward implementing the OWCS concepts.

2.3 Comment on the Response to the 2009 UCAR Review

The UCACN is extremely gratified by the seriousness the Office of the Director (OD) demonstrated in leading the organization's response to the recommendations offered by the 2009 UCAR Review.

Many positive developments have been observed since the 2009 UCAR Review:

- The recommended resolution of the dysfunctional relationship between NCEP Central Operations (NCO) and the Environmental Modeling Center (EMC) management has been accomplished through skillful management and installation of appropriate collaborative

measures. These actions appear to have resulted in creating, e.g., a more effective implementation process, and a more collegial atmosphere in general.

- Many significant technological transfers have been announced (e.g., new hurricane forecast system; the Rapid Update Cycle - RUC - replacement with Rapid Refresh; hybrid data assimilation system for 2012 in collaboration with the NOAA office of Oceanic and Atmospheric Research - OAR).
- International collaboration is increasing as recommended, e.g. EUROSIP, collaboration with India on numerical weather and climate prediction, the North American Ensemble Forecast System (NAEFS), and a noticeable and welcome active role in the activities of the World Meteorological Organization (WMO) Working Group on Numerical Experiment (WGNE).

Two important issues mentioned in the 2009 UCAR Review that still need special attention from the OD are described in sections 2.3.1 and 2.3.2.

2.3.1 Unified Modeling System (UMS)

In the context of constrained budgets for high-end computing (HEC) and research and development (R&D) staff, the capacity to develop efficiencies in developing state-of-the-art weather and environmental prediction systems is becoming more critical. The R&D mission is to balance the allocation of scarce resources among important goals such as new numerical algorithms and grids, advanced physics, four-dimensional data assimilation techniques, and utilization of new observational systems. This is a tremendous technical and scientific challenge that requires a tightly coordinated significant mass of scientific and technical personnel. This challenge is getting more and more difficult because of the increasing (i) complexity (e.g., coupled atmosphere, ocean and sea-ice models), (ii) space-time resolution, (iii) volume of new data (especially those that are not direct measures of model variables), and (iv) quality and accuracy requirements of modern numerical prediction systems.

This increasing complication jeopardizes the effectiveness of carrying out technological transfer activities in an affordable and timely manner in a multi-model and multi-disciplinary environment. Hence it is recognized worldwide (by, for example, the United Kingdom Meteorological Office or UKMO, the Chinese Meteorological Agency, Environment Canada, the Australian Bureau of Meteorology or BoM, and Meteo-France) that this scientific and technical bottleneck can be surmounted resourcefully by a teamwork approach based on a unified modeling system (UMS). The UMS approach is also considered by many National Meteorological and Hydrological Services (NMHS) as the lowest cost and shortest pathway to seamless prediction at all space and time scales. The 2009 UCAR Review concluded that EMC uses too many models and has recommended a more streamlined approach for local, regional, and global weather prediction systems. We recommend that OAR and NCEP develop a strategy to engage their workforces in the development and implementation of a UMS. This should be the core activity of the 10-year strategic plan that EMC is developing presently with OAR and other government and academia partners.

2.3.2 Establishment of a Rigorous Technology Transfer Framework between Research, Development and Operations

The complexities of weather and environmental prediction systems have increased tremendously in the last two decades and demand more and more rigorous technology transfer processes and quality management procedures. Many successful NMHS have an ISO9001 certification (e.g., a well-articulated procedural checklist and customer feedback mechanisms) for their chain of innovation (i.e. research-to-operations or R2O). NCEP, with its partners and stakeholders, needs to establish clearly the requirements, roadmaps, and detailed implementation plan (including schedule, critical path, etc.) for its chain of innovation (research, development, operation, and service).

We recommend that the status of major projects (e.g. - Rapid Refresh, testbeds, next generation Climate Forecast System, etc.) should be monitored and documented regularly by a formal technological transfer management and scientific committee. The membership of this committee should include the principal investigators of the projects, senior scientists, and managers from OAR and NCEP. An important term of reference of this committee would be to review and document the performance (e.g., monthly) of the existing and future prediction systems, including comparison with other NMHS, using agreed-upon operational validation and verification methods and metrics as well as the standard WMO recommended practices and metrics used by the majority of the NMHS centers around the globe.

The participation and contribution of scientists to the technological transfer process should be tracked formally by this committee. Not only should the scientists' contributions be valued by their supervisors, and by NCEP, NWS and NOAA, for their input to the scientific literature and advancement of knowledge, but also for their involvement in the technological transfer process at NCEP. This recommendation would, in the long term, help to facilitate a fruitful, efficient and rewarding collaboration between NCEP, OAR and academic partners.

2.4 Comments on Aspects of the NWS 2020 Roadmap

The NWS Roadmaps, now in draft form, are an important aspect of NWS planning. The Roadmaps apparently form a level of planning below the NWS Strategic Planning, and above detailed implementation plans. Although NCEP personnel were involved in the development of the four components of the NWS Roadmaps, the current version provides little or no evidence of NCEP's role in the NWS of 2020. This is particularly evident in the nine proposed pilot projects, in none of which is NCEP's role apparent. This reflects a deficiency in the scientific relevance and completeness of the roadmaps. As an example from the Science and Technology roadmap, the future and important role of data assimilation science in weather and environmental prediction was not mentioned at all.

The UCACN strongly recommends that the developers of the Roadmaps clarify the role of NCEP's management, lead forecasters and testbed personnel in appropriate Centers and consult with them in establishing the final version of the Roadmaps.

2.5 SWOT/C Analysis

Strengths
Dedicated and competent staff
Reputation of NCEP as a critical asset
Excellent leadership

Weaknesses
Very small staff, for a large organizational mandate
No Deputy Director

Opportunities
Open Weather and Climate Services concept
New building

Threats/Challenges
Ugly financial outlook for the next decade
Management turnover
Political instability at NOAA & DoC
Several complex and difficult management challenges (see section 2.6)

2.6 Top Challenges

The NCEP Director provided the UCACN with a list of what he views as the top challenges NCEP faces in the future. The UCACN agrees that these represent major challenges. Attention to all these issues will stretch the resources of the OD and place enormous pressure on the NCEP Centers as well. The UCACN felt that, while all these matters are important and warrant attention, several of them are immediately critical. The list of challenges provided by the NCEP Director is copied below with UCACN suggestions for prioritization (Arial font).

1. Proving adequate computing for operations and R&D, including use of non-NOAA resources
    - This issue was called out in the 2009 UCAR Review as critical. It remains critical and should be the top priority item.

2. Obtaining and managing programmatic support for R2O and operations-to-research (O2R), including internal NOAA and external resources, and considering use of models run at NCEP by other components of NOAA
    - Improving NCEP's image in the research community and among its international peers is a high priority, for which an increasingly successful R2O/O2R program is essential. With the availability of space in the NWCPC, efforts to create an NCEP Visiting Scientist Program (VSP) should be redoubled, with resources garnered from both NOAA and non-NOAA sources.

3. Managing three major transitions in FY12, including the move to NCWCP, the transition to a new Central Computing System (CCS), and the conversion to the second generation of the Advanced Weather Information Processing System (AWIPS2)
    - These are large efforts and will take the bulk of the OD's attention in 2012. As noted elsewhere, the move to NCWCP is viewed as a potential turning point for NCEP. The opening of the new building for NCEP provides a once-in-30-years opportunity for new innovative approaches to take advantage of scientific opportunities and technology transfer through the establishment of the NCEP VSP (see also item 2 above), broadly defined.

4. Planning and implementing a joint NOAA research and operations information technology (IT) test bed
    - A NOAA-wide IT test bed would enable NOAA to stay abreast of developments in the academic and commercial IT communities. It is the province of the NOAA Chief Information Officer (CIO). Within NCEP, this is the likely to be the responsibility of the NCO Director, who may be otherwise engaged during 2012 in item 3 above. Visiting scientists with expertise in IT should be included in the VSP. This should be a high priority for 2013 and beyond.

5. Managing the diverse Test Beds across NCEP centers, using four criteria for success (benefits, efficiencies, IT compatibility, sustainability)
    - This might best be accomplished by an annual workshop of the test bed directors.

6. Co-locating major heavy IT systems (supercomputer, Telecommunications Gateway, Web Operations Center, Network Control Facility) to improve NWS overall performance delivery
    - This important task is the responsibility of the NCO Director, and the OD must monitor its progress, minimize negative impacts on other NCEP centers, and provide the liaison function with other components of NWS that are involved.

7. Monitoring and influencing the development of Open Weather and Climate Services
    - At present, it is unclear how OWCS will evolve, and NCEP is likely to be called upon to participate in pilot projects that involve models, data or services, so a modest level of effort to monitor its progress is needed.

8. Encouraging better transparency in NOAA/NWS budget process and viewing NCEP as a critical operational unit
    - It is difficult for UCACN to comment on this; however we note two things. First, budget transparency would help NOAA units justify requests and would help UCACN understand NOAA choices better. Viewing NCEP as an operational unit (more like a Weather Forecast Office than a headquarters organization) would give it a higher priority in the budget process.

9. Influencing NWS HQ to establish an innovation fund for small innovative projects
    - Connected with the VSP, this could be a powerful mechanism for keeping NCEP on the cutting edge. The OD should work with all NCEP directors to encourage NWS to use this fund to support innovative R2O efforts,

10. Ensuring a stronger NCEP linkage to NWS Roadmaps (see section 2.4 above)
    - A case should be made to NWS management that the Roadmap process should include NCEP at the most basic level of planning.

11. Managing space weather data issues involving NWS and the National Environmental Satellite Data and Information Service (NESDIS), and the Office of the Federal Coordinator of Meteorology (OFCM) initiative to unify the space weather capability across the entire space weather community
    - This will depend on finding a dynamic and forward-looking new Director of the Space Weather Prediction Center.

12. Initiating ecological forecasting, including the establishment of a possible joint test involving NCEP, the National Ocean Service (NOS), and the International Ocean Observing System (IOOS)
    - This long-term challenge involves several organizations outside NCEP and NWS and expertise that does not currently exist within NCEP, so meaningful partnerships are essential. Support for such an initiative should be enlisted at the NWS Director level or higher.

3. Aviation Weather Center

3.1 Introduction

David Bright, Aviation Support Branch Chief, provided the initial briefing, with Robert Maxson, AWC Director, and Warren Qualley, UCACN AWC lead, on the phone. Also present from the AWC for this and the ensuing breakout discussions were Debra Blondin, Domestic Operations Branch Chief, and Matthew Strahan, Supervisory Meteorologist. Fred Carr served as the on-site AWC back-up lead, and facilitated the discussions. It's worth noting that Warren Qualley met informally with Maxson and Bright at the AWC on June 30, 2011, to discuss the newly-created UCACN and possible ways that they could stay connected about AWC matters related to the UCACN. During that discussion, Maxson and Bright provided some updated information related to the AWC's progress on the recommendations from the 2009 Review. This was taken into consideration during the October UCACN discussions.

3.2 Overarching Issues/Recommendations

- The AWC staff has made excellent progress on Recommendations from the 2009 Review and the two annual reports since then.
- "Consistency" of services and products for aviation among the AWC, Weather Forecast Offices (WFOs) and Center Weather Service Units (CWSUs) is one that is not unique to the AWC, but that they need to continue to address through NWS HQ. To ensure that the AWC, and the NWS in general, is successful, there needs to be a focus on consistency of aviation products and services delivered by the NWS and training to the appropriate NWS staff of weather impacts to its aviation customers. These will be addressed as a new Recommendation in Section 5.
- There is a significant opportunity for the AWC/NWS to further strengthen its relationship with the Federal Aviation Administration (FAA). Plans are being made to add NWS full-time equivalent employees (FTEs) at the FAA's Air Traffic Control System Command Center (ATCSCC) in Warrenton, VA, about 40 miles southwest of Washington, DC. The UCACN stands ready to assist in every way possible to make this a success for the AWC, NCEP and the NWS as a whole.
- The AWC faces challenges with establishing new ways of doing business while still required to issue products that are nearly outdated. This is something that needs to be worked directly with AWC's FAA customer and the International Civil Aviation Organization (ICAO), explaining that AWC's resources can't maintain the legacy products or that AWC will work with the other World Area Forecast Centers (WAFC) on automating as many of them as possible.
- The annual Storm Prediction Center (SPC) Hazardous Weather Testbed (HWT) spring experiment provides an excellent opportunity to assess the state-of-the-art science and operations issues related to convective storm forecasting. In 2010, personnel from the SPC, the Hydrometeorological Prediction Center (HPC), and AWC, and their respective communities, other Federal agencies, the National Center for Atmospheric Research (NCAR) and university faculty and their students along with faculty and their students

participated in an experiment on how to apply the output from high-resolution convection-allowing mesoscale models in particular to create new products for use in deterministic and ensemble weather forecasting. The exercise revealed that the AWC was slow to incorporate the knowledge gained from rapid progress in the observational analysis and numerical prediction of convective weather systems into operations. Given the problems that organized convective weather systems cause to the U.S. commercial aviation system, it is critical that existing and new knowledge about convective weather phenomenon be transferred into operations as quickly as possible. This knowledge transfer must include applications of ensemble weather forecasting techniques based on high-resolution convection-allowing models into operations. Success in this endeavor will require a culture change and the retraining of users and forecasters who rely heavily on legacy products that have comparatively little value today and will have even less value tomorrow. Aviation stakeholders and customers will benefit greatly from this change in the long run, especially in the area of understanding how to use the resulting new services and products. The NWS has set a course for the next several years through its Roadmaps. The AWC needs to determine how it will get involved and interact with other Centers, agencies and Industry in this effort. Further details can be found in Section 4.

- The AWIPS2 deployment is presenting training challenges, since the timetable for this deployment at the AWC is fluid.

3.3 Comments on the Response to the 2009 Review

- The Aviation Weather Test Bed is a notable highlight of the Recommendations made by the NCEP Review Team in 2009 and has already proven to be successful.
  - Having personnel who previously worked at the SPC has aided this because 1) it leveraged the success of the HWT, and 2) they served as links for shared experiments.
  - Need to invite operational airline personnel (who deal with the impact of weather) when an experiment involves possible output for use by non-meteorologist users; they can provide valuable feedback during the development of AWC's services.
  - Since "Management of Test Beds" is on the NCEP Director's list of challenges, suggest that NCEP create a list of "best practices" to use for future test bed activities. AWC's linkages with the SPC and its success with the HWTB surely was a part of the success of the stand-up of the AWT.
- Outreach activities have been very good; the UCACN suggests that AWC continue to look for such opportunities. The UCACN also suggests that AWC keep in regular contact with its UCACN liaisons as well, since they interface with many organizations. AWC can also ask its customers for ideas, thus strengthening those relationships.
- There is a positive trend in the AWC's relationship with other Centers and with establishing relationships with new partners.
- Isolation continues to be an issue with regard to R2O and O2R. Since it's not feasible to make a physical move, the UCACN encourages the AWC to consider virtual interactions/experiments when possible. For example, the Next Generation Air Transportation System (NextGen) activities can be conducted with the FAA's William J. Hughes Technical Center in Atlantic City, NJ, obviously coordinated through the NWS NextGen Program Office at NWS HQ.

- We encourage continued interactions with NCAR's Research Applications Laboratory (RAL) and NOAA's Earth System Research Laboratory (ESRL) as well as universities who are strong in meteorology. However, the AWC should assert its rightful role as equal partner in these relationships, reminding the research institutions that while Research to Operations (R2O) is important, it's no more so than Operations to Research (O2R). Without the feedback loop, R2O won't yield nearly the results that it otherwise can.
    - The FAA's Manager of the Aviation Weather Research Team is a former NWS employee who can assist in the issues raised in the above two bullets, and give AWC the added benefit of ground-truthing AWC's research initiatives.
- The UCACN was heartened to hear that the AWC would like to take more ownership of product and service verification, although there might be some internal NWS issues to deal with. AWC should leverage the expertise and relationships of people external to the NWS to assist with this.
- The visitor program has been noteworthy, with at least four professors coming to the AWC this year.
- Staff additions have been excellent. The UCACN has had positive feedback about the leadership team from some of AWC's FAA customers and others outside of the NWS.
- The FAA is the main customer of the AWC.
    - The AWC's role in NextGen with regard to interaction with the FAA and other stakeholders has made noticeable progress, and the AWC should strive to do more in spite of the political, budgetary and in some cases personal challenges. The UCACN suggests that AWC exploit every opportunity to strengthen its relationships with the appropriate people within the FAA.
    - The AWC's active involvement in the Collaborative Decision Making's (CDM) Weather Evaluation Team (WET) is extremely valuable in that it brings AWC into contact with both the FAA (different user groups) and commercial and general aviation users. The UCACN has heard very positive feedback about this involvement.
    - The NWS is on the verge of a huge opportunity with regard to its services to the FAA. At the time of this writing, the NWS plans to place two FTEs into the FAA's Air Traffic Control System Command Center (ATCSCC), the first time NWS personnel will work there since the mid-1990s. The NWS, and in particular the AWC, need to do everything possible to make this a success. The UCACN offers some suggestions in Appendix A at the end of this report, but two of those are worth mentioning here: Learning to speak the language of the customers (e.g. Traffic Flow Management (TFM)- "speak") is critical to the success of this opportunity. It will increase the relevance of AWC's work there, because without it AWC will lose the support of those customers. Consistency among the various aviation products and services issued by different NWS offices is critical in order to gain the trust and respect of their customers.
    - The 2009 UCAR Review Recommendations CWSU1, CWSU3 and CWSU4 are no longer relevant because the NWS no longer has plans to consolidate the CWSUs. Therefore, only Recommendation CWSU2 remains:
        - Regardless of the decision concerning CWSU consolidation, the review panel believes that a stronger operational linkage is essential between the AWC and the CWSUs. The products and services of each group, both now and moving into the NextGen era, must be coordinated, aligned and made fully consistent, a common theme throughout this report.
- The ICAO-mandated legacy products which the FAA requires that the AWC produce make it challenging to move toward a future where the AWC service offerings will very different. First, it's difficult to conceive of new ideas while anchored firmly to old, and in

some cases, outdated product issuance. Second, there is little or no bandwidth for the staff to issue both the legacy and the new products and services. A couple of ideas to address this issue were noted earlier in this document.

- ICAO, and therefore the FAA, have necessarily had to focus on Space Weather since it has significant impact to aviation and since the solar maximum is upon us. The FAA looks to NCEP to provide scientifically sound information about space weather, observations and forecasts, so the AWC must work closely with the Space Weather Prediction Center (SWPC) to ensure that the services and products are user-friendly.
- Physical space limitations need to be addressed in some manner. This will be challenging in the current budget environment, so creativity will be necessary to resolve.
- The 2009 UCAR Review recommended that the AWC write a new Vision and Mission, but the UCACN hasn't yet seen that. While it may seem to be a mere formality, it will be something to point to when motivating all AWC personnel to work toward a positive future for the AWC.
- The AWC isn't alone as it moves into the future. The management team should take advantage of the stronger linkages with the NWSHQ. Specifically, the UCACN suggests working more closely with the Aviation Branch Chief, the director of Office of Climate, Water and Weather Services (OCWWS) and his management team and the NCEP OD to address these challenges. The Regional offices also are a critical component of the delivery of services and products; they must be a pat of this process.

3.4 Comments on Aspects of the 2020 Roadmap

- The NWS has set a course for the next several years through its Roadmap. How will AWC get involved and interact with other Centers, agencies and Industry to move toward the vision contained in the Roadmap? For example:
  - The Science and Technology (S&T) Roadmap presentation seemed to omit what the UCACN considers to be a fundamental piece of NCEP's plans for the future, forecast consistency. This is detailed in section 5, the SWOT/C Analysis, but suffice it here to state that forecast "consistency" is a relevant example of the need for the NWS to ensure that there is an "end-to-end service delivery approach in all pilot projects".
  - How will the AWC populate the **Impacts Catalog** mentioned on slides 5 and 6 of the S&T Roadmap? This is critical and ties directly to the opportunity that the AWC has at the FAA's ATCSCC.
  - Is AWC participating in the Warn On Forecast (WOF) **Pilot Project** program? If not, UCACN suggests that AWC get involved as soon as feasible since WOF has application to products and services, e.g. SIGMETs.
  - Has the NWS cataloged all of the past and current **aviation weather research** done by various groups inside and outside of NOAA? Recognizing that this is a sensitive issue, a catalog is the only way to start a process of prioritizing research. The next critical step is to make a concerted effort to get the current focus on "R" to a more results-oriented focus of R2O and O2R.

3.5 SWOT/C Analysis

Strengths:

- Critical global mission
- FAA-defined requirements
- Reimbursable activities
- Active research community
- Very experienced staff

Weaknesses:

- Knowledge of traffic flow management
- Overdone strengths
- Exposure/recruiting
- Lack of co-located research partners

Opportunities:

- Aviation Weather Testbed
- NextGen
- Many forecast challenges exist
- Ability to shape future requirements

Threats:

- Mission overextension
- International politics
- Relevancy in NextGen

Additional Weaknesses

The UCACN suggests adding another bullet: "Consistency of aviation products/services among AWC, CWSUs, and WFOs."

- Background/Finding: Currently, there is a lack of consistency of products provided by AWC (and ATCSCC), CWSUs and WFOs, and the consistency of products issued within a single office, such as the WFOs. This issue came up recently in the Collaborative Decision Making (CDM) Weather Evaluation Team.
- There was one mention of "consistency" in the AWC presentation to the UCACN, on slide 25.
  - Forecast consistency is a three-fold issue:
    - Consistency of forecast products issued by different NWS groups that produce aviation forecasts (AWC, CWSUs, WFOs);
    - Consistency across offices within one such group (e.g. WFOs in different NWS Regions);
    - Consistency of forecast products within an individual office (e.g. A WFO issuing Terminal Area Forecasts (TAFs) that aren't consistent with its Public forecasts).
    - As examples, in the same order as noted above, are:
      - TAFs (issued by WFOs), Center Weather Advisories (issued by CWSUs) and Convective Significant Meteorological Advisories (SIGMETs;issued by the AWC) aren't always consistent;
      - TAFs issued by one region don't necessarily use the PROB (probability) term in the same way as is done in another region;
      - Thunderstorms mentioned in a public forecast issued by a WFO aren't always mentioned in the TAF from that same office.

With this in mind, the UCACN suggests a new recommendation to address this: "The AWC, in concert with NWS HQ and the Regions (for CWSUs and TAFs), take the lead to formalize and execute a process to ensure consistency of all aviation products and services. As part of this, it's critical that the NWS understands the "impacts" of weather on its aviation customers and establish a process to train those impacts and teach "ATM-speak" to those who interface directly with FAA customers."

3.6 Appendix AWC-A: ATCSCC

With regard to new NWS positions at the FAA's ATCSCC, the UCACN strongly suggests that the AWC (these are intentionally prescriptive, but in no particular order):

a. Develop clear job responsibilities and expectations with ATCSCC management;
b. Ensure that its responsibilities are relevant and highly visible to the ATCSCC's mission;
c. Populate the positions with the best NWS meteorologists available;
d. Train the meteorologists in "ATM-speak", ensure that they are outgoing and fully understand the operational impact of weather on the NAS;
e. The Director of the AWC should establish regular communication with top management at the ATCSCC to review the progress of the positions (suggest bi-weekly at minimum). Have in-person visits by appropriate levels of NWS management on a scheduled basis, at least monthly initially, then bi-monthly. The main purpose is to ensure that the NWS is meeting or exceeding the expectations of ATCSCC management;
f. Use these two people to learn the "hot buttons" of these important customers. This information can be used as input for initiatives in the AWT;
g. Have these meteorologists help address the issue of <u>consistency</u> of the various services and products that the NWS delivers to the FAA;
h. Task the meteorologists to understand the faster response time needed of the NWS by the FAA for operational review of weather events that impacted the FAA. The NWS needs to remember that the FAA's customers, commercial airlines, business aviation and GA require a fast turn-around on such reviews; therefore it's incumbent upon the NWS to do its part to deliver information in a timely manner to its FAA customer so that the FAA can in turn respond timely to its customers. The "Weather Ready Nation" initiative has a tag line, "Making the Extraordinary Ordinary", which when put into practice should result in an appropriately shortened response times in aviation and other service areas of the NWS.

4. Climate Prediction Center

4.1 Introduction

Wayne Higgins, Climate Prediction Center (CPC) Director, provided the initial briefing. Also present for this and the ensuing breakout discussions were Michael Halpert, Jin Huang and Arun Kumar from CPC, Louis Uccellini from NCEP, and John Dutton, Jim Kinter and Eric Wood from UCACN.

4.2 Overarching Issues/Recommendations

The committee is very pleased with CPC's progress and responsiveness since the 2009 UCAR Review report. We note that 29 of 33 recommendations have either been completed or are in-progress. One of the most positive developments since the 2009 review is the progress of the Climate Test Bed (CTB) under the leadership of Dr. Jin Huang, in developing and testing seasonal multi-model ensemble (MME) frameworks based on combining the Climate Forecast System (CFS) and CFS version 2 (CFSv2) with European Seasonal-to-Interannual Prediction system (EUROSIP) forecasts and with national models.

It is noteworthy that CPC has stepped up to the challenges of the nascent NOAA Climate Service (NCS) initiative and is taking a strong role in spite of the organizational complexities of being part of NCEP while NCS is being developed within NOAA's office of Oceanic and Atmospheric Research (OAR), largely through extramural activities coordinated by the Climate Program Office (CPO).

The UCACN encourages CPC to focus on a few key areas over the next year.

a. Further engagement in the development of NCS, including linkages to the private sector, in developing an improved understanding of the customer climate product needs and the forecast/outlook capabilities at NCEP with the view of developing a strategy (probably with the Environmental Modeling Center – EMC – and CPO) for addressing needed model improvements (skill, resolution, regional capacities.)

b. Further analysis of CFSv2 and its forecast skill at all time scales, and improved understanding of the skill from MME systems. CPC should take further advantage of the CTB to develop and refine mechanisms to collaborate with universities and other research groups in these assessments.

c. Continue to develop its verification tools and applications to quantitatively assess the value of current operational and experimental future products. This would help CPC better manage its product portfolio.

d. Continue to develop web-services for its products, including partnering with NCS in the NOAA Climate Services portal and outside groups (e.g. Regional Integrated Sciences and Assessments centers or RISAs and the Regional Climate Centers or RCCs) in assessing needs.

4.3 Comments on the Response to the 2009 Review

CPC has been very responsive to the recommendations of the 2009 UCAR Review and has made substantive progress since the review was completed. In the 2009 review, there were 33 major recommendations across five areas (mission and vision, customers and partners, products and services, information systems, science and technology, people and organizational, and business processes). As of the October UCACN meeting, 16 had been completed, 17 are ongoing and 4 are under discussion. The committee applauds the tremendous progress that CPC has being response to the UCAR Review recommendations. In particular we note the following:

1. CPC has made very good progress in defining its role within an envisioned NOAA climate service framework. The review committee recognizes the challenges facing CPC as the concept of a NOAA Climate Service (NCS) is discussed within the government: challenges of management, science and technology, and product and service development. CPC's approach of broad participation in NCS activities (e.g. the National Climate Prediction and Projection or NCPP project, contributing to the NOAA Climate Service portal, etc.) seems like an appropriate strategy.

2. The Climate Test Bed (CTB) has demonstrated tremendous progress under the leadership of Dr. Jin Huang. The 2009 review included major recommendations that CPC clarify the role of the CTB and that it lead the effort to develop and/or test multi-model ensemble (MME) seasonal forecasts systems – an outstanding recommendation from its own external Science Advisory Board as well as from NRC reports. We are extremely pleased to see that CPC/CTB is evaluating candidate MME systems that include CFS + EUROSIP forecasts as well as a national MME system. The latter achieved its phase-1 goal of assembling and using experimental seasonal predictions from multiple U.S. institutions – the Geophysical Fluid Dynamics Laboratory (GFDL), the Center for Ocean-Land-Atmosphere Studies (COLA), U. Miami, National Center for Atmospheric Research (NCAR), NASA Goddard, and the International Research Institute for Climate and Society (IRI) – beginning in August 2011.

3. The implementation of CFSv2 into operations, and the availability of CFSv2 reanalyses and re-forecasts, represents a significant milestone since the 2009 review. We recognize the challenges of making the complete re-forecast data set available to the community and CPC's efforts in working with the National Climatic Data Center (NCDC) to make the data sets available.

4. We are pleased to see the collaboration between CPC and EMC regarding CFSv2 assessment and in developing plans towards further model improvements that could result in the development of CFSv3. This recognizes the long lead times needed for major model upgrades.

Of the recommendations that have yet to be addressed, the UCACN urges action to help develop a policy for NCEP service center (and more broadly NCS) interactions with the private sector. It is recognized that this is a complex issue that goes beyond CPC, but CPC is expected to be the major climate product provider in NOAA. Given CPC's interests in seasonal model improvements (c.f. CFSv3 white paper), development of verification web tools, regional forecast outlooks, etc.), CPC needs to develop plans to establish a model test facility (operations to research or O2R) as recommended in the 2009 UCAR review (recommendation ST3). One recommendation from the 2009 UCAR review not well addressed in the 2011 UCACN meeting is the recommendation that CPC needs to develop sub-seasonal (weeks 2-4) products in collaboration with HPC. These products are a significant need for CPC customers and we urge CPC to address this need.

4.4 Comments on Aspects of the 2020 Roadmap

CPC reported to the UCACN on its 2020 Roadmap in response to two NOAA Next Generation Strategic Plan (NGSP) Societal Challenges (Climate Impacts on Water Resources and Changes in Extremes of Weather and Climate). To reach the 2020 goals will require new products, whose development and potential skill and usefulness are unknown and will require significant research. Under the Climate Impacts on Water Resources, we support CPC's goal to "issue a new generation of climate outlook products (as a) seamless suite on timescales from weeks to multi-year", yet current models haven't demonstrated the necessary skill in extended seasonal forecasts, let alone decadal forecasts, so that CPC's expected outcome – "water utilities actively use climate outlooks to make decisions" – could be realized. Similarly, significant research is needed for most of the desired products for the changes in extreme weather and climate, particularly in extended forecasts of extreme weather, drought extent and recovery and so forth. CPC should carefully manage expectations with respect to the new products envisioned, and should avoid over-promising by adhering to scientifically defensible goals.

The 2020 roadmap also envisions a variety of new products in response to anticipated needs. An issue from the 2009 UCAR review, which is relevant here, is that CPC must continue to strive to manage its product portfolio by assessing the value of existing products and eliminating products when new replacements are available. This suggest that CPC needs to develop tools to verify existing and new products as well as evaluate the skill and usefulness of all (existing and new) products, with the overall goal to avoid legacy products that are costly to maintain and less skillful solely for the convenience of a limited number of users.

The review committee recognizes that CPC faces a variety of challenges to realize its 2020 service goals. The CPC presentation lists a number of these, some of which are challenges for intraseasonal-seasonal-interannual (ISI) prediction improvements:

- developing regional climate information products, which may require a strategy for high resolution regional climate modeling;
- balancing the dual demands for CPC to provide its services to both NCEP and NCS;
- managing human capital so expertise is available to develop new interdisciplinary climate products (e.g. drought induced hypoxia events; storm-induced near shore water quality impacts); and
- exploiting new product delivery technology (e.g. web services and mobile apps.)

It's beyond the scope of this report to assign priorities to these needs. It is clear though that close, continued engagement with universities must be part of a successful strategy. This also implies that CPC and CPO, which provides research funding, must have a strong working relationship. This is particularly true for improved CFS model development, which is needed to improve ISI skill. Improving the skill of dynamical seasonal forecasts, through a combination of improvements to CFS and MME approaches must be the highest priority of the scientific challenges, going forward.

4.5 SWOT/C Analysis

Overall the identified Strengths, Weaknesses, Opportunities and Threats/Challenges identified in the CPC presentation seem accurate and complete. There are a few areas where further comments may be helpful.

Under weakness, CPC identifies "resource constraints", which has many components. An important constraint is that NCEP (or CPC) has little to no input on CTB funding. Similarly CPC/CTB has no funding commitments from CPO for CFS improvements, regional climate modeling, collaborative research with universities and RISAs, development of new interdisciplinary products to enhance NCS, and so forth, that are central to the needed research to achieve CPC's 2020 goals. These constraints impact realizing the opportunities open to CPC and enhance the threats.

A perceived weakness not listed in the CPC presentation is the lack of a clear vision of various climate service products at different lead times (month 1, seasonal, decadal, multi-decadal), and a pathway to develop these services (probably within a NCS framework). There is the impression that CPC views climate products as evolving from the forecasts/outlook to desired products, rather than an interactive process where it identifies a product (say seasonal climate information for agricultural decisions and crop forecasting), determine the requirements for such a product (skill, regional resolution, etc.) and then the required modeling and partnership needs. CPC may want to determine how to develop a "library" of such services and outlook capabilities. The CPC has the opportunity to be the lead group in developing NOAA climate service products, an opportunity recognized by CPC. But the list of opportunities needs to be prioritized, and a strategy developed to realize these opportunities. Instead of developing all simultaneously, CPC must determine which opportunity (or two) may have the biggest NCS impact and move forward first on that one, given resource constraints.

It's unclear that the lists of threats all have the same level of risk. For example, privatizing NOAA seems a low risk, and probably outside of CPC's control. Another higher risk threat, somewhat outside of CPC's control, is major budgetary impasses in Congress. CPC should be prepared to identify its core activities and how these are maintained. Ensuring that CPC has the workplace skills, as the demands from CPC within NCS and NCEP change, should be a central focus of CPC management. A significant threat to CPC's mission and future plans, which is not listed, is the failure of research to develop improved models at all time scales (seasonal forecast skill, decade predictability, and interpretation of climate projections) useful for decision makers.

5. Environmental Modeling Center

5.1 Introduction

Bill Lapenta, EMC Director (acting), provided the initial briefing. Also present for this and the ensuing breakout discussions were Louis Uccellini from NCEP, and Fred Carr, John Dutton, Jim Kinter, Ron McPherson and Len Pietrafesa from UCACN.

5.2 Overarching Issues/Recommendations

Overall, the committee is pleased with the progress EMC has made since the 2009 Community review. The committee is particularly pleased to note that EMC has significantly improved the coordination and cooperation with NCEP Central Operations (NCO), and has developed a new and more efficient implementation process in collaboration with NCO. The working relationship between EMC and NCO is much improved. EMC has also made significant progress in the development of the next-generation data assimilation system, in collaboration with external developers.

It is noteworthy that EMC is improving the transparency of its decision making process and its outreach to the modeling community.

The review committee encourages EMC to focus on a few key areas over the next 12 months:

a. EMC and NCO must collaborate to prepare a plan to move to a unified model and code base. The current process maintained by EMC and NCO is not sustainable in the future and steps need to be taken now to ensure that NCEP is a world leader in numerical modeling and prediction. [Same recommendation to NCO.]

b. EMC should continue to improve transparency in its decision-making about future modeling systems and its outreach to the modeling community.

c. EMC should establish a Science Advisory Board, possibly as a sub-committee of the UCACN, to provide advice on strategic planning, development, and implementation of modeling systems for the next decade.

5.3 Comments on the Response to the 2009 Review

EMC has completed 8 out of 29 recommendations and has made significant progress on all other recommendations in responding to the 2009 review. The committee is pleased overall with the proactive and positive response to the review recommendations, many of which are not easy to address because they require a change in culture within EMC. The committee applauds EMC management's effort in encouraging the staff to be open and collaborative. Feedback from the community indicates that this transformation is working and has already produced positive results.

The opening up of the CFSv3 development process is considered a refreshing and welcoming change by the research community.

The outstanding items from the last review and the new challenges that have arisen since then that need to be addressed include:

a. Strategic plan for modeling. The committee urges EMC to continue the development of an executable strategic plan for modeling for the next decade, in coordination with NCO and EMC partners in the modeling community. The committee encourages EMC to establish a Science Advisory Board, in close coordination with the UCACN.

b. Recruiting**.** The committee encourages NCEP to develop an expanded Visiting Scientist Program, especially for EMC and NCO, but also for the benefit of other NCEP Centers. The new building near the University of Maryland campus in Riverdale Park, with its 40 spaces set aside for visitors, affords a rare opportunity particularly for EMC. Emphasis should be given to attract graduate students as well as post-doctoral scientists and senior scientists. The committee urges EMC to work with the OD to develop a plan for an expanded and attractive Visiting Scientist Program.

c. Community outreach. The committee recommends that NCEP, and especially EMC and NCO, encourage the use of operational models by research modelers in universities and laboratories. This will require coordination between EMC and NCO, support for visitors, and some cost and investments for community outreach activities (including tutorials, and community user support in partnership with the Development Test Center or DTC). The committee understands that not all ideas arising in the research community will be of equal merit or suitable for incorporation in operations, and is willing to advise on procedures to identify the most meritorious proposals. The committee also encourages NWS to establish a grant program, which would encourage the research community to work on problems that have the potential to lead to improvement of NCEP operational models.

d. **Use of non-NOAA observing assets.** The committee urges NCEP, especially EMC, to take advantage of non-NOAA observing assets, via the MADIS (Meteorological Assimilation Data Ingest System) expanded archives, to expand and enhance assimilation of data into NCEP's suite of operational numerical forecast models.

5.4 Comments on Aspects of the 2020 Roadmap

Significant advance in the numerical guidance provided by EMC is essential for NWS to achieve the transformations identified in the Weather Ready National Service Plan. To meet future service requirements, EMC needs to expand its predictive capability in fine-scale modeling, Earth system modeling, and ensemble prediction. EMC's 2020 Roadmap in these areas is scientifically sound and reasonable. The committee encourages EMC to continue to consolidate and simplify its operational modeling suites, migrating toward a unified modeling approach. Advances in nonhydrostatic, unstructured grid methods for global models offer new

possibilities. The committee also encourages EMC to continue to improve its transparency in decision-making about development and implementation of next generation systems. In particular, it must actively solicit community advice about the development and implementation of future generation modeling and data assimilation systems. EMC should also pay attention to advances in computing technologies, such as graphical processing units (GPU), which may potentially offer significant increases in modeling capability at relatively low cost.

5.5 SWOT/C Analysis

Strengths

- The EMC has a talented staff with significant expertise and knowledge in model development and implementation processes
- EMC leadership is actively committed to in changing the culture of EMC and transforming it into an open and collaborative organization.

Weaknesses

- A reputation within the NCEP community of being insular and obstructive
- Difficulty in attracting new talent from outside the organization
- Lack of transparency in decision making with regards to future generational modeling systems

Opportunities

- Focused collaboration with other US modeling centers in common areas of model development
- Use of community models may provide mechanism for non-NOAA funding to improve operations
- Improved work environment with move to the NCWCP

Threats/Challenges

- Inadequate NOAA operational computing capacity
- Inadequate NOAA support for civil service science positions
- Lack of community inputs on the development of future generation modeling systems in the next decade

6. Hydrometeorological Prediction Center

6.1 Introduction

Jim Hoke, Director of the Hydrometeorological Prediction Center (HPC), provided the initial briefing on 12 October 2011. UCACN back-up HPC lead Lance Bosart was present in person for this briefing along with HPC lead Gary Lackmann, who participated via teleconference. Dave Novak, HPC Science and Operations Officer (SOO), and Ed Danaher, Supervisory Meteorologist in the Development and Training Branch were also present. Additional breakout discussions were held on 13 October, involving Ron McPherson, Lackmann, Fred Carr, Novak, Danaher, and several other NCEP directors and staff.

6.2 Overarching Issues/Recommendations

Responses to the 2009 review have been excellent, especially with respect to engaging the broader research community, growing Hydrometeorological Testbed (HMT) activities, developing a strategic plan, and evolving toward providing new expertise and services over the next 5-10 years. Examples of recent progress include HPC participation in the SPC HWT, modeling a winter experiment after it at HPC, expanding probabilistic product offerings, enhanced collaboration with academia, growth of the visitor program, and development of the HPC HMT. These and other recent activities indicate stronger leveraging of the research community and a greater emphasis on scientific collaboration.

Despite recent progress, much work remains to be done in order for HPC to realize the potential afforded by high-resolution numerical weather prediction (NWP), and ensemble prediction techniques. Recent gains in these areas must be accelerated, and a cultural transformation that rewards those who expand the scientific envelope must be completed. A shortage of development personnel currently reduces the ability to transfer research to operations.

Stronger collaborations and linkages with SPC, NHC, and CPC are needed in order to expand the HPC mission and to minimize or eliminate “seams” evident in forecasts of some high-impact weather events (e.g., inland impacts of tropical cyclones, outbreaks of severe convection, and floods). Decision support services need to be upgraded and expanded to better link HPC with NHC and the SPC in coordination with the Federal Emergency Management Agency (FEMA) and other emergency manager services.

A major recommendation from the 2009 review was for HPC to develop a strategic plan. This has been accomplished, and the plan resonates well with the major elements of the review, while providing a useful template with which to prioritize development and scientific activities at HPC for the coming decade.

The 2020 Roadmap acknowledges changing roles for forecasters. Continuing HPC ability to improve quantitative precipitation forecast (QPF) skill scores over models is impressive but may not last, especially if advanced statistical techniques are able to take full advantage of multi-model

ensembles. Careful planning for the evolution of forecaster roles should begin immediately. The possible expansion of future forecaster roles into decision support and warning coordination may be plausible, but this transition raises questions, including how and when the training will be provided, and by whom. In the short term, the UCACN supports possible realignment of positions using upcoming vacancies to add a Warning Coordination Meteorologist (WCM) and additional development personnel.

Forecast verification metrics must evolve as high-resolution numerical model output increases in availability and accuracy. This also necessitates the development of a national mesoscale analysis of record; HPC may be well positioned to lead efforts in developing and archiving such an analysis. This need is evident throughout the community.

The committee encourages hiring at the master degree (MS) level (or above), and continuation and expansion of visitor efforts and student summer programs. The committee is impressed with professional development efforts, especially since these can in some cases increase work force turnover and decrease diversity (when forecasters advance to positions outside of HPC). Although HPC is using a variety of means to reward scientific leadership, it faces constraints imposed by the current NOAA pass/fail employee evaluation system, which inhibits a more dynamic reward structure for those who advance scientific activities at HPC (and other NCEP centers). At HPC, annual evaluation categories entitled "modernization and evaluation", "professionalism", and "focal point" all contain elements that recognize scientific leadership and professional development. These evaluation categories emphasize leadership and technology, but could be modified to more explicitly recognize scientific collaboration, publication, and innovation.

The committee recommends that the National Operations Center (NOC) be hosted at an existing, experienced NCEP center such as HPC. This expanded role would seem consistent with the proposed new name for HPC, the Weather Prediction Center.

6.3 Comments on Center Responses to 2009 Review

Substantial progress is evident in responding to the 2009 review, and it is clear that a large majority of the recommendations are being actively addressed. As Director Jim Hoke explained, many of the recommendations have not yet been completed due to the long-term nature of the actions required to address them. A few of the recommendations have not been acted upon, such as creating a WCM position, three of the *information systems* recommendations, and the lingering lack of diversity in the workforce at HPC.

Major progress in several key areas is clear since 2009. Several HPC activities demonstrate stronger engagement with the broader research community, including participation in several academic research projects, visits to Norman for the HWT, and an expanded HMT. These activities, and others, all address recommendation "ST2". However, in order to sustain the momentum towards greater scientific integration, recognizing and rewarding scientific innovation is critical. The relevant recommendation is BP2: "Implement mechanisms for rewarding and nurturing efforts to advance the scientific scope of HPC as part of the process of generating forecast products and services." The current pass/fail evaluation system imposes some limits on

the ability to reward creativity and scientific advance. HPC is currently doing what it can in using a variety of means to reward scientific efforts, working within these constraints. Perhaps use could be made of the "Innovation Fund" proposed by NOAA HQ in this capacity.

WCM:
During the breakout discussion for HPC, Director Hoke mentioned that resources for a WCM would not be forthcoming. As further justification, he explained that with changing roles for forecasters in the future, many team members would need to be able to handle WCM-type responsibilities. While this response has merit, it should be noted that the HPC Science Officer mentioned that he would, in fact, like to have a WCM at HPC, an indication that additional discussion of this matter may be helpful. What specific training will be given to forecasters to help them meet this vision of shared WCM responsibility? What is the time frame for this training, and what solutions will be employed in the interim? Given that an increased emphasis on extreme weather events appears in the 2020 roadmap, it would seem that HPC, as much or more than any other of the NCEP centers, would benefit from the services of a WCM.

Decision support services need to be upgraded and expanded to better link HPC with NHC and the SPC, in coordination with FEMA and other emergency manager services.

IT recommendations:
The three recommendations concerning information systems (IS1, 2, and 4) are under discussion, and some of these evidently require collaboration and cooperation from other centers, such as NCO. The committee recommends that HPC remain focused on efforts to address these recommendations, and on coordination with NCO where appropriate.

Diversity and Professional Development:
Finally, the lack of diversity in the workforce at HPC has not improved since the time of the 2009 review. We discussed the lack of gender diversity in more depth than other kinds. The Director attributes this to difficulty in retaining female employees, pointing out that several talented women hired in recent years have moved on to other NOAA positions. The issue of how HPC might improve retention of female employees was not discussed. Another positive activity relating to this recommendation is that several recent summer student interns have been female and/or minority students. It is evident that HPC is making efforts in this regard, but there are evidently several factors working against improved gender diversity, including HPC's own professional development activities (which the UCACN endorses) and the dislike of shift work.

As discussed in the original recommendation, HPC must continue to explore additional means of rewarding those who push the scientific envelope. The HPC Staff regard participation in testbeds as a reward. This is a potential source of leverage to improve the scientific background knowledge of staff members that should be seized. Related, additional means must be identified to increase opportunities for professional advancement in an environment of relatively small staff turnover.

Science infusion:
Despite the advances noted above, such as increased collaboration with the outside research community and participation in the SPC HWT, many scientific opportunities remain. A more comprehensive approach to incorporate ensemble forecasting strategies into operations is needed.

Advances in the research community, at some NWS WFOs (e.g., State College PA with Rich Grumm), and at SPC need to be better leveraged at HPC. While progress is evident, these activities should be accelerated.

HPC needs to extend/improve its linkages with SPC (e.g., when/how a severe weather-producing mesoscale convective system – MCS – will transition into a flood-producing MCS), NHC (e.g., develop a more seamless transition in the rainfall-related threats posed by landfalling tropical cyclones), and the CPC (e.g., ascertain potential week two heavy rainfall threats) in the future to help expand their missions and to eliminate some of the current seams that are apparent in national forecasts when tropical cyclones and severe weather outbreaks are associated with significant rainfall threats.

Another area of opportunity is in forecast verification. Progress is evident in the use of object-oriented techniques, but more sweeping change is needed. A related activity is the need for production and archival of a mesoscale analysis of record for the continental United States (CONUS). HPC is well positioned to take responsibility for mesoscale or quantitative precipitation estimation (QPE) analyses of record.

A major issue at HPC is a shortage of developers. This is listed as a "weakness" at HPC. A new hire to be added to the HMT may help in this regard.

6.4 Comments on Aspects of the 2020 Roadmap

The 2020 roadmap for HPC provides the sense that incremental movement towards a more modern center is envisioned. To what extent does this plan integrate with the evolution of NWS field offices? Given that the future role of forecasters at HPC (and throughout the NWS) is very likely to change in the coming decade, the committee recommends a proactive, rather than reactionary approach to the coming changes. An item at the forefront of the 2020 roadmap relates to the core activities of meteorologists at HPC. Rather than direct involvement in forecasting, the 2020 vision is for "*Meteorologists overseeing a highly automated preparation process, providing forecast decisions in challenging weather situations*, providing impact-based interpretation of the forecasts and levels of forecast confidence to partners and customers, and ensuring a high level of quality in products and services." This is a marked change from how things are currently done. While the committee agrees that a transition of this type is inevitable, such a drastic change must be planned with great care. How will training for these new roles be provided, and when? By whom will it be provided? A related concern is the "limited number of at bats" effect. If forecasters are just overseeing the process on most days, and only actively intervening when high-impact weather is expected, will their basic skills have atrophied to the point where it is not possible to add value to numerically generated forecasts?

It would be prudent to develop a two-pronged strategy that provides training and methods for forecasters to develop skills in nontraditional roles while at the same time encouraging development of high-end meteorological skills related to, for instance, high-resolution models and ensemble techniques. A related opportunity coincides with the availability of the new NCEP

building in 2012. With this facility, a winter weather experiment modeled after the SPC HWT would be feasible, if additional resources can be identified.

High-resolution (e.g., 2-4 km grid length) numerical prediction is likely to provide limited deterministic skill for the near-term future. However, more complete utilization of high-resolution ensembles, and preparation for how to use quantitative information from very high resolution models when eventual skill increases do occur, can begin immediately.

The idea of a "National Operations Center" (NOC) housed at NCEP is a featured element of the 2020 roadmap. For a 24x7 operation, it would make sense for this center to be housed at HPC. HPC has been working in the realm of high-impact weather for many years, and would be well positioned as the site of the NOC. The committee recommends that the NOC be located at HPC.

It is good to see that the 2020 roadmap includes specific mention of forecasting at fine temporal and spatial scales. Continued effort at utilizing emerging strategies for verification of such forecasts will be required to gauge the success of these efforts.

6.5 SWOT/C Analysis

The SWOT/C overview provided by Jim Hoke seems accurate and complete, with a few suggestions, additions, and comments. For example, an additional opportunity for HPC is perhaps an increased emphasis on ensemble forecast interpretation. New products and services could be provided to NWS field offices and other stakeholders via discussing forecast confidence gleaned from the suite of ensemble guidance. This also suggests additional opportunities and active involvement in targeted observations strategies.

The threat of HPC becoming irrelevant is very real, and may apply more to HPC than to most other NCEP centers given the strong current emphasis on the human element in the forecast process. A recent article drafted by HPC SOO Dave Novak demonstrates the continued value added by HPC forecasters to model guidance; this accomplishment is remarkable and which should be advertised freely outside of HPC. How long can this continue? Until there is some indication that human forecasters can no longer add skill, it is perhaps too soon to begin a transition away from subjective human forecasting. At the same time, the best way to ensure future relevance is to broaden the scope of scientific input to HPC, and to develop products and services that leverage the latest scientific and technological advances in our field.

A fundamental NOAA-wide limitation that may limit efforts to expand scientific advance is that the employees are evaluated on a pass/fail basis. A more flexible evaluation system would allow more meaningful recognition of those who show leadership in scientific advance.

6.6 Appendix HPC-A: The HPC Strategic Plan

HPC provided a nearly completed version of its Strategic Plan for UCACN to examine. The plan resonates strongly with the 2009 recommendations. Emphasis on partnerships and collaboration, technical and scientific advance, and improved information delivery are excellent.

Under the category of Federal Partners, NOAA partners, specific mention of seamless collaboration with NHC and SPC could be mentioned, as discussed in section 3 above. Seamless prediction during a landfalling tropical cyclone, such as for Hurricane Irene in 2011, will require significant collaboration beyond what is current practice.

7. National Hurricane Center

7.1 Introduction

William Read, Director of the National Hurricane Center (NHC), provided the initial briefing on Oct. 12. UCACN lead Lance Bosart was present for this briefing along with other members of UCACN, and NCEP and NWSHQ personnel. During the breakout session with Read on Oct. 13, Fred Carr led the discussion, Bosart was present on the phone, and UCACN member Ron McPherson was also present.

7.2 Overarching Issues/Recommendations

The NHC is perhaps the most publicly visible of the NCEP centers and it continues to make progress toward implementing some of the major recommendations from the 2009 NCEP review where possible. Responses to the 2009 review have been very good and they reflect well on NCEP and the commitment of the NWS to the nation. A measure of this progress is that the NHC is making very good use of the Joint Hurricane Testbed (JHT) and Hurricane Forecast Improvement Project (HFIP) projects (ironically, however, the success of these two projects raises a concern about their future viability when support from the NWS peaks, decreases, or ends). The biggest imminent challenge facing the NHC is the ability to continue to make innovative advances in hurricane forecasting skills and improved communication of hurricane forecasts to the general public in the face of static or decreased budgets.

The NHC has an IT bottleneck that seems to be more severe than at many of the NCEP centers. The bottleneck appears to be most concentrated on getting IT support to implement many good ideas from forecasters into operations. The NHC appears to be critically short on development staff, given that the majority of IT resources are currently devoted to addressing IT security problems.

Because NHC is somewhat unique among the NCEP centers in the importance of its linkages to non-NCEP units to daily operations, it is especially vulnerable to budget cutbacks beyond its direct control. For example, NHC makes heavy use of two NOAA P3s (N42 and N43) that are used for hurricane reconnaissance and hurricane research by the Hurricane Research Division (HRD) of NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) in support of NHC operations. NOAA Aviation Operations Center (AOC) is under increasing budgetary pressure to cutback support for these P3 aircraft, especially since major and expensive maintenance will be needed on these aircraft in the years ahead (e.g., replacement wings). Likewise, cutbacks to the U.S. Air Force (USAF) 53rd Reconnaissance Wing raises the possibility that fewer USAF planes will be available for hurricane reconnaissance in future years. Similarly, an ocean buoy replacement rate that is smaller than the annual loss of these buoys is decreasing the ability of the NHC to obtain real-time oceanic and atmospheric measurements in tropical cyclones (TCs). Ongoing budget cuts at HRD raise the risk that the transfer of scientific research done at HRD into NHC operations might be curtailed.

One area of potential concern involves needed coordination between NHC, HPC and the NWS RFCs on TC-related QPFs. NHC is working on adding NCEP HPC QPF products to its web page to create a "one-stop shopping" opportunity for likely users interested in obtaining comprehensive information on rainfall-related threat hazards associated with TCs. We strongly support this cooperative effort. So far, however, working with RFC is proving to be a more difficult challenge for NHC than working with NCEP HPC.

Another area of concern pertains to the challenges to the 2009 recommendations, particularly with regard to realigning Tropical Analysis and Forecast Branch (TAFB) duties with NCEP Ocean Prediction Center (OPC) during hurricane season (NHC reports that it is addressing this issue through better staffing at TAFB), reducing staff at the Central Pacific Hurricane Center (CPHC) and reallocating the resources elsewhere to NHC (action was blocked by politics), establishing a national level exercise and training unit (resistance here, but it is not clear why), critical increased IT support (not going anywhere because of budgetary constraints but may be partially alleviated through better cooperation and coordination with NCEP NCO), supporting higher risk R2O for the JHT (not being done because of budgetary problems), and lead shelter effort and increased emergency management (EM) training for FEMA and DHS (Department of Homeland Security; insufficient resources and an argument that shelter jurisdiction is a state and local, not a federal, level issue).

7.3 Comments on the Response to the 2009 Review

A major mission and vision (MV) recommendation (MV1) that NHC should continue to leverage its high public visibility and positive image to advocate for improved public preparation and education to help mitigate the negative effects of hurricane-related disasters (loss of lives and property damage) is continuing. NHC is continuing its extensive outreach program in this area. A related recommendation that the NHC and OPC Directors coordinate on revising their MV statements to reduce the appearance of overlap between their respective missions has not been implemented but is being studied. Likewise, a recommendation that the NWS re-examine whether a fully staffed CPHC is necessary when on average only one land-threatening storm per year occurs in the central Pacific has been put on hold by NWS HQ because of political resistance.

In the customers and partners (CP) category, recommendations related to broadening and deepening NHC interactions with the oceanic community within NCEP (e.g., OPC), NOAA, and the Navy to coordinate tasking for national oceanographic support are being discussed and considered. The position of NHC is that it will respond appropriately when it senses an increase in the call for oceanographic-related products. Currently, NHC through TAFB and the Hurricane Specialist Unit (HSU) is providing operational oceanic support (e.g., new gridded products) that is coordinated among NOAA line offices. For example, TAFB now provides gridded marine forecasts and marine parameters that can be used as input to ecological dispersion models used by NOS and other Defense Security Service (DSS) agencies.

One area of potential concern is in hurricane-related storm surge and inundation (SS&I) and flooding, given its importance to hurricane forecasting and the protection of lives and property. A CP recommendation that the NHC should continue to partner with FEMA to support needed SS&I

and flooding modeling through the NOAA Storm Surge Roadmap is starting to be addressed subject to the limitation that none of the advanced community models for storm surge are ready to be implemented operationally as yet. Although progress is occurring, none of these new models in development are able to fulfill functions currently done with the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model. Application of ensemble forecasting techniques to operational storm surge models will likely require additional computer infrastructure and IT support. In order to make progress toward the development of more advanced models and ensemble forecasting we recommend that NCEP assume the primary responsibility for storm surge modeling. Although resource limitations constrain this recommended modeling effort right now, improvements in modeling efficiencies and faster computers may permit the implementation of this recommendation within a couple of years. Preparations for this change (training, etc.) should be considered now.

A CP recommendation that NHC and NCEP OD support a National Level Exercise and Training Unit for FEMA and DHS has been discussed but not implemented owing to a lack of adequate staff resources and a belief that this is a state and local level issue where the federal government does not have jurisdiction. Finally, a CP recommendation that the 48/36 hour watch/warning time extension be implemented, given that forecast track skill continues to increase, is being assessed. The NHC indicated that extensive discussions with Federal, state, and local evacuation decision makers indicate a preference to reduce, not extend, evacuation decision timelines rendering this topic moot for the time being. As a matter of good science, however, as hurricane-forecasting skill continues to increase NHC should assess the merits of further extensions of watches and warnings.

In the area of Products and Services (PSs), the NHC has indicated that the recommendation to improve communications with the non-English-speaking population runs up against budget realities and civil service regulations that candidates for job positions cannot be required to be fluent in languages other than English. It is to NHC's credit that several staff members who are fluent in Spanish actively and regularly communicate hurricane outlooks and watch and warning information widely to the Spanish-speaking media across the Caribbean and within the U.S.

Other PS recommendations relate to improving the electronic dissemination of digital and graphical information (e.g., hurricane location) to local, regional, and international governments and other customers through web-based products. NHC is making progress on these recommendations and will revisit the issue in advance of the 2012 Regional Association IV (RA-IV – Caribbean) Hurricane Committee meeting. All graphical products on the web will be in Geographic Information System (GIS) compatible format. NHC is committed to initiating new actions in this area as resources become available.

A PS recommendation that the pros and cons of a further extension of the 48/36 watches and warnings be debated by examining the needs of FEMA, the media outlets, and social science and communications experts, and a variety of other users of NHC products within the framework of the status of the science is being examined in concert with the CP recommendation discussed above on the same subject. Part of this recommendation also includes the need to develop new products (e.g., experimental storm surge forecasts) that can be disseminated along with the traditional hurricane watches and warnings. The NHC noted that budget realities preclude additional outreach activities through FY-12 and that it is working with NWS HQ and WFOs to develop

experimental storm surge warning products. We recommend that when the science justifies an extension of forecast warnings from 36 h to 48 h based upon demonstrable advances in forecast skill that the extension be implemented.

Related to this recommendation, is another recommendation, so far not implemented, that NHC engage in continuous forecast verification through the hurricane season instead of waiting until the end of the season and be prepared to implement any significant forecast improvements into operations once their value has been demonstrated. NHC argues that "mid-year modifications to operational models is not advisable for both technical and user-familiarity reasons, except for emergency corrections" but notes that it is committed to the development and introduction of additional forms of "guidance on guidance" products into forecast operations through the JHT.

A critical PS recommendation is that "storm-surge forecasts and products need more attention, visibility, and support to enhance NHC's ability to effectively communicate actionable information on SS&I to a wide variety of customers to improve preparedness and decrease loss of life and property." NHC concurs and notes that it is a major player in the NOAA Storm Surge Roadmap and that "storm surge" has been listed as an NHC priority in JHT "announcements of opportunity." NHC will again indicate that storm surge is a high priority in the upcoming JHT 6th round announcement. NHC and its WFO partners are exploring social science and media partnerships to improve public communications through the NWS storm surge team and is involved in multiple NCAR social science projects related to this topic. With regard to ensemble storm surge forecasting, NHC introduced two kinds of probabilistic storm surge products since 2009 and will continue to develop products in this area. NHC also notes that the Roadmap will address the need to establish a formal plan to clarify relationships and roles with partners including agencies with related requirements, the academic and private sectors.

In the area of Information Systems (IS) and Science and Technology (ST) the NHC noted that discussions with NCEP NCO are underway to come to agreements on NCO's role in supporting NHC in the areas of IT security, system maintenance and upgrades, ÅWIPS2 support, and other NCEP center-common tasks. This effort is of critical importance to NHC because success in this endeavor will enable NHC IT support staff to devote more of their resources toward implementing forecaster-driven new products and services. A related recommendation that NHC and NCEP OD should promote the creation of a multiple NCEP center and federal agency team that includes national and international stakeholders and academic institutions to develop a strategic plan for an advanced, collaborative approach to coastal, surge and ocean forecasting is being addressed through NHC working toward the goal through collaborations formed within the NOAA storm surge roadman, the JHT and HFIP.

An ST recommendation that there "should be a better balance between higher risk but potentially higher reward research projects in JHT that attempt, for instance, to incorporate recent theoretical findings on hurricane dynamics into intensity forecasting" is proving somewhat controversial. NHC disagrees with this recommendation and argues that "the JHT was established specifically to facilitate and expedite the transfer of promising research into operations within a ~ 2 year time frame." The NHC further argues that this focus has not changed and that the proposal review criteria do include risk vs. benefit analysis, and that more risky and longer-term research should remain the purview of HFIP and/or applied or basic research institutions. Our original

recommendation remains unchanged on fundamental science grounds. Finally, an ST recommendation that NHC operational forecasters and Technical Services Branch (TSB) personnel should be involved in close collaboration with NCEP EMC and HRD and perhaps other groups in studying model "skill-dropout" and successful model forecasts was addressed through the hiring of a contractor to work at NHC through HFIP.

In the People and Organizational Culture (POC) arena, NHC initiated a social science team within HFIP in 2011 to address how best to improve product design, web design and public communications, and forecast effectiveness and public understanding. Improvements in this area are ongoing. It was also recommended that NHC needs to address employee concerns and ideas relevant to improving the working environment with the benefit of outside experts. NHC addressed this recommendation for outside experts and staff as formalized in its Annual Operating Plan (AOP) formed of staff input.

In the realm of Business Practices (BP), NHC is continuing to test its ability to operate and provide safety and security to employees during unexpected and/or unusual situations through annual backup tests in response to the first BP recommendation. Conducting full-scale back-up tests where staff is relocated to Washington, D.C, would be cost prohibitive. Another BP recommendation that NHC pursue all avenues to educate its stakeholders on hurricane preparedness, and response is being addressed through the annual NOAA hurricane conference, awareness tours, operational conference calls, presentations at various workshops in coastal areas, and at professional AMS meetings in 2010 and 2011.

7.4 Comments on Aspects of the 2020 Roadmap

The NHC's proposed 2020 Roadmap plan addresses critical issues related to the shift to digital forecasting, the need to transition forecasts into a probabilistic format, a desire to extend forecasts of hurricanes to seven days, have a fully functional storm surge prediction system, and have a working plan in place to fully implement HFIP research findings to improve hurricane intensity forecasting. Success with the Roadmap will require significant new model development, a major improvement in computer resources and capabilities to support a future AWIPS, and close adherence to the storm surge Roadmap to develop inundation data, and surge forecasts and warning. A strength of the 2020 Roadmap is the working partnerships with FEMA and the social science communities. A potential weakness of the Roadmap is the absence of a comprehensive plan as to how new science, particularly as related to hurricane intensity change and theoretical understanding, will drive operational practices

7.5 SWOT/C Analysis

The SWOT/C overview analysis provided buy NHC Director Bill Read seems, accurate, timely, and complete. The enumerated strengths, weaknesses, and opportunities are well stated and are properly linked to take advantage of ongoing and planned initiatives to address the core recommendations in the 2009 review. One possible omission under opportunities is a ringing statement that NHC is the most publicly visible and nationally credible NCEP center. The

importance of this strength should neither be overlooked nor underestimated. Likewise, more weather-related opportunities should be listed (e.g., improved landfall wind, rain, and storm surge forecasts; improved forecasts for inland flooding through improved coordination with NCEP HPC), mindful that Congress relates better to short-term weather opportunities as opposed to long-term climate issues. Several of the weaknesses should be clarified by being more specific (e.g., IT issues are preventing results from new science ideas and scientific understanding from being transferred into operations expeditiously).

In the threats section the focus is entirely on budgetary issues. While these budgetary issues are critical to NHC's ability to function operationally, particularly with regard to infrastructure, AOC hurricane reconnaissance aircraft, and the deployment and maintenance of operational buoys, the organization needs to recognize the threat that could arise if the organization is slow to adopt ongoing and future scientific advances in ensemble forecasting and hurricane intensity change into operations. Addressing these non-budgetary threats properly will require that the NHC develop improved working relationships and closer collaborative efforts with other NCEP centers as well as the academic and private sectors.

8. NCEP Central Operations

8.1 Introduction

Ben Kyger, NCO Director, provided the initial briefing. Also present for this and the ensuing breakout discussions were Louis Uccellini from NCEP, and John Dutton, Maura Hagan, Jim Kinter and Steve Smith (by telephone) from UCACN.

8.2 Overarching Issues/Recommendations

Overall, the committee is pleased with the excellent progress on responding to the recommendations from the 2009 review. Most importantly, the communication, transparency, cultural change, and focus on collaboration that were deemed necessary for NCO to be an effective branch of NCEP are now clearly evident. This, combined with a new spirit of cooperation between NCO and EMC, has positioned the two organizations to develop a timely, action-based environment in responding to NCEP's needs both now and in the future. There are three key themes that should be focused on by NCO as an organization over the next 12 months.

1. NCO and EMC must collaborate to prepare a plan to move to a unified model and code base. The current process maintained by NCO is not sustainable in the future and steps need to be taken now to ensure that NCEP is a world leader in numerical modeling and prediction.

2. NCO should focus on revising its vision and mission statement and consider a name change that reflects its standing in excellence at operational IT support and as a supercomputing resource.

3. NCO must continue to focus on outreach, both internally to other NCEP centers and to end users of NCEP products in academia and the commercial enterprise.

8.3 Comments on the Response to the 2009 Review

Significant progress has been made in responding to the 2009 review, including the completion of 14 out of the 19 recommendations. Nevertheless, a few issues still remain that need to be worked on with the same fervor as the completed recommendations. Moreover, NCO must be prepared to recognize and prioritize new challenges that will arise in the dynamic world of IT as they combine with an evolving NCEP's mission.

The outstanding items from the last review and the new challenges that have arisen since that now need to addressed include:

1. NCO leadership firmly stated that the current code base and process for implementing model upgrades is 'very difficult to maintain' and is not sustainable in the future. To further this goal, advancing the use of operational NCEP codes in research (O2R) is essential and requires an emphasis and insistence in both EMC and NCO on formal standards and documentation. NCO and EMC must jointly create an effective process to develop a plan and begin execution toward a unified model approach (Outstanding recommendation IS2, see Appendix A for all recommendations from the 2009 review).

2. The 2009 Review strongly recommended that NCO revise its rather pedestrian vision and mission statement (Recommendation MV1), but little progress has been made. The Advisory Committee suggests that NCO create a working team of promising future leaders to propose a revised vision statement and a new name for the organization that would represent its excellence as a super computer center and operational support center for NCEP.

3. With supercomputer operations becoming a critical to NCEP operations, NCO should put strong emphasis on attracting visitors from other supercomputer centers, both as lecturers and consultants. The creation of a visiting staff / scientist exchange program with some of these centers might also prove advantageous. (This is a logical extension of Recommendation CP3.)

4. NCO must continue its initiatives to have staff members engaging with the rest of supercomputer world by attending meetings and participating in governance of various professional organizations. The initiatives with the new supercomputer center at University of Maryland, Baltimore County are significant and will help to understand the advantages and challenges of heterogeneous architectures (including Graphics Processing Units).

5. NCO should consider offering regular workshops aimed at end users and at peers with the government and commercial sectors.

8.4 Comments on Aspects of the 2020 Roadmap

Technology changes and advances will continue to be a major theme in shaping the NCEP workflow and process of the future. As such, NCO will be looked upon to play a major role in this transition. In order to meet these demands, NCO must be prepared to research, embrace and operationalize new technologies throughout the enterprise. This will include developing a strategy to centralize core IT activities, such as high-volume data centers to maximum speed and agility, while consolidating costs to meet an expected demanding budget environment. NCO must also find a way to champion these new technologies by finding partners within the various centers for collaborate efforts to ensure successful implementations and adoptions.

8.5 SWOT/C Analysis

Strengths

- A proven ability to implement procedures needed to manage time critical processes
- The IT savvy and expertise needed to continue to promote the NCEP mission now and into the future
- A strong and unremitting focus toward high on-time performance metrics

Weaknesses

- A reputation within the NCEP community of being internally focused and inflexible
- Difficulty in finding the right balance of flexibility between having an strong, strict testing and implementation process versus a timely upgrade

Opportunities

- Taking a leading role in the coordination with co-locating computing power with various NCEP centers and partners is critical for future performance
- Self-promotion of NCO activities and services throughout the enterprise will enhance its ability to effect and direct change in the future
- More visible and focused collaboration with the entire atmospheric sciences enterprise could make NCO a major player and contributor to new ways of serving the nation

Threats

- The federal government budget will always be a threat to limiting NCO's effectiveness for HEC (High-End Computing) needs and allowing the team to grow as needed
- Keeping up with the changing technologies and strategies around managing an HEC environment

9. Ocean Prediction Center

9.1 Introduction

Ming Ji, OPC Director, provided the initial briefing. Also present from the OPC for this and the ensuing breakout discussions were Len Pietrafesa, Jim Kinter and Ron McPherson from UCACN.

9.2 Overarching Issues/Recommendations

The OPC, like all the other NCEP Centers, has been very responsive to the recommendations of the 2009 UCAR Review of NCEP. Significant progress has been made since the review was completed, and the OPC is on track to address some of the identified ongoing concerns.

The rising population in coastal communities, rising general interest in all things coastal, and sea level rise associated with global climate change all present challenges as well as opportunities to the OPC. There is a large opportunity for OPC to collaborate with NOS on matters near the coast and in blue water – the UCACN strongly encourages NOS to fulfill long-standing commitments and work with OPC to explore seriously these possibilities. In particular, the possibility of expanding the enterprise to include ecosystem prediction should be explored in collaboration and consultation with NOS, but also see discussion below about engagement with the private sector.

The advances made in expanding and enhancing international responsibilities in the area of marine transportation safety are laudable and will help to establish OPC as the key provider of oceanic and coastal products and services that will aid and abet the safety of surface transportation.

Despite these positive developments and trends, there are some perceived present weaknesses, shortcomings and dependencies that could compromise future successes by OPC. The OPC continues to operate according to a strategic plan that is largely unchanged from that articulated at the time of the 2009 UCAR review, except for a greater emphasis on ecosystem prediction. Many of the weaknesses described below can and should be addressed in an updated strategic plan.

There is a perceived lack of private sector engagement in the ecological arena. Ecological forecasting (EF) is a new and high value area that deserves appropriate organizational attention and resources; i.e. a strategy to get up and running. While federal and state agencies are confronted by marine issues that affect public waters, deleterious environmental conditions and the health of marine life, they generally have their own marginal staffs that tend to address these issues as they arise. In contrast, private industry has differing issues that could benefit greatly from an OPC ecological forecasting capability. The private sector should be engaged to assess its collective needs and issues of high priority that could lead to short-term successes for OPC. There are potential issues of fresh water versus salinity for oyster and clam growers in the Chesapeake Bay and Delmarva Peninsula area that would benefit greatly from seasonal forecasts of precipitation; requiring interactions of OPC with HPC and CPC. The sea nettle prediction pilot project is a good example of a response to user needs and issues. There are also opportunities for reliable forecasts of hypoxia and Red Tide outbreak conditions from Maine to Florida that sometimes lead to fish

kills, shellfish impacts and deleterious recreational conditions. Such forecasts would help marine environment-related industries plan. It is of note that EF will require an ecological model with multiple variables and a hydrodynamics model that will serve as the "backbone" of the ecological model. The NOS and several regional universities, including University of Maryland and the Virginia Institute of Marine Science (VIMS), have in-house expertise that could be exploited; particularly via the co-sponsorship of graduate students by industry and university partners.

Because OPC lacks an in-house SOO, progress on the uptake and ingest of scientific advances is limited. Furthermore, OPC's broad scope would require its SOO to have to have a wide-ranging portfolio of cross-cutting marine, oceanic, atmospheric, and ecological knowledge. If a SOO cannot be newly hired any time soon, the UCACN suggests that the Director of OPC solicit and entertain the input of all interested staff in monthly meetings to consider what issues could be addressed with new scientific or technological advances, that could be transitioned to operations or that would improve operations.

The OPC product suite must be packaged in displays that can be received at sea by maritime customers; however, progress toward this has not been as rapid as desired. This is basically a technological issue that must rely on advances in the near-real-time transmission and delivery of information that can be readily interpreted and understood. OPC should explore new communication pathways (mobile devices) that will enable more effective dissemination of products to its customers.

The OPC has recognized the requirement to deliver probabilistic forecasts, but the staff does not have all the necessary expertise to take on this work, from understanding the methodology of statistical prediction to developing the scripts to generate probabilistic products. It is recommended that OPC arrange for its staff members to receive a series of content-rich tutorials on the methodologies and value of statistical forecasting. Some of the necessary expertise resides in NCEP's Hydrometeorological Prediction Center (HPC), so arrangements could be made through HPC.

Given the likely downward pressure on the budget and its likely deleterious effect on the OPC, which is not viewed as having extra or under-utilized staff, it is recommended that OPC continue to engage marine industry stakeholders.

The committee encourages OPC specifically to work closely with the OD to further develop a Visiting Scientist Program, to expand its core knowledge assets and to build enabling capacity, particularly in the area of ocean modeling. The new building near the University of Maryland campus in Riverdale Park, with its 40 spaces set aside for visitors, affords a rare opportunity particularly for OPC. Emphasis should be given to attract graduate students as well as post-doctoral scientists and senior scientists. In addition to a Visiting Scientist Program, OPC should continue and expand on the success it has had in attracting summer students from the Coast Guard Academy and Howard University.

9.3 Comments on the Response to the 2009 Review

The UCACN notes the documented and perceived strengths, accomplishments and progress that OPC has made in important areas since the 2009 UCAR Review.

Advances have been made in establishing solid professional, collegial and demonstrated interactions and collaborations with companion NCEP centers; specifically, HPC, NHC, EMC, NCO, SPC, SWPC, and CPC (the latter still in progress). While OPC stands alone as a center, it's mission as the NCEP "ocean" prognostic center requires that it share responsibilities, in a not so easily shared environment, with other centers, and also that it rely on other centers for numerical modeling, information technology and web support. The OPC has done this admirably in a collegial, professional, cooperative manner and is highly commended for this approach.

The establishment of a proven, demonstrated ability to integrate satellite data into operational products that are of critical use to the marine transportation sector, federal and state agencies, the academic community and other stakeholders is laudable. This sets the stage for more and better visual products and services that are spatially extensive.

In its specific responses to the 2009 review, as of FY11, OPC has completed 18 out of 27 recommendations and has made significant progress on 8 other recommendations, 7 which are in progress and targeted for completion during FY12, 13 or 14. There are 2 recommendations that are longer in scope, requiring action out to FY16,. In addition, OPC has an ambitious list of short term, mid-term and long-term goals in the context of the 2009 review that are listed in the Appendix. The UCACN is pleased overall with the highly proactive and genuinely positive response to the review recommendations, many of which have not been easy to address because they may have required an expansion of in-house expertise, within OPC, i.e., via expansion in personnel, replacements or advanced training. The UCACN applauds OPC management's effort to encourage the staff to be ambitious and collaborative. Feedback from stakeholders indicates that this transformation is working and has already produced positive results.

9.4 Comments on Aspects of the 2020 Roadmap

OPC's 2020 Roadmap is in keeping with the NWS/NCEP strategic plan and is deemed scientifically sound, reasonable and doable; with some reservations. The UCACN encourages OPC to move forward on its plans to:

- provide marine, ocean and coastal services based on gridded infrastructure
- provide probabilistic marine weather forecasts
- provide extratropical storm surge guidance and link the guidance to inundation to street level
- achieve probabilistic extratropical storm surge guidance including inundation information
- assist the development of Space weather warning for navigational safety, including Global Positioning Satellite (GPS), satellite communications, and high-frequency (HF) communications
- develop and provide a well coordinated marine emergency response capability to track hazard materials leaking into the ocean

- achieve OPC operational service delivery infrastructure (24x7, clock driven) and ensure that this delivery is leveraged to deliver ecological forecast services.
  The UCACN encourages OPC to take a leadership role with EMC and NCO to develop a numerical modeling architecture that will utilize community hydrodynamic models that are fully physics based (e.g., the Environmental Fluid Dynamics Code or EFDC, the Regional Ocean Modeling System or ROMS, or the Finite Volume Coastal Ocean Model or FVCOM) and that can be interactively coupled to the operational atmospheric model and can be used as the backbone for the ecological model (e.g. the EFDC System, the ROMS System) for both extratropical storm surge and inundation modeling and ecological forecast modeling.

9.5 SWOT/C Analysis

Strengths:

- Collegial, dedicated, highly motivated and professional staff
- Excellent leadership
- Solid professional, collegial, demonstrated and planned interactions with companion NCEP centers; specifically, HPC, NHC, EMC, NCO, SPC, SWPC, and CPC (in the queue)
- Established and growing international responsibilities in the area of marine transportation safety
- Demonstrated ability to integrate satellite data into operational products

Weaknesses:

- Lack of private sector engagement in the ecological arena
- Lacking an in-house SOO; so progress on the uptake and ingest of scientific advancement is limited
- Product suite not yet packaged in displays to be received at Sea by maritime customers
- Dependent on AWIPS-2 capabilities
- Essentially at the beginning stages of delivering probabilistic forecasts

Opportunities, both near-term and in the future:

- Improve presentation of offshore warnings into gridded products, i.e. hazard grids
- Present new products of the forecasts of Extra-Tropical Cyclone induced coastal inundation and potential coastal erosion
- Improve the spatial resolution of products detailing the forecasts of coastal and offshore convection, including lightning
- Improve the visual depiction and communication of the forecasts of coastal and offshore cyclogenesis, particularly explosive cyclogenesis
- Improve the visual depiction and communication of the forecasts of coastal and offshore fog and reduced visibility
- Provide more oceanographic feature data based on stakeholder needs
- Take advantage of the potential for an OPC Ocean Test Bed at NCWCP

- Take advantage of "Training Space" in NCWCP to work with the OD to begin a Visitors Program by engaging faculty and their graduate students. The graduate students would work on R2O projects of interest to and at the direction of OPC staff and their advisors, who would also visit. The unit of currency for a graduate student is ~ $50K/year. The Director of NCEP has taken a leadership role and approached NSF about re-creating the former NSF sponsored NCEP program and OPC should take advantage of this pro-active work at the top of NCEP. This could offer advancements in OPC products and introduce the next generation of scientists to the OPC culture.
- Define the needs of OPC to EMC/NCO and NOS so that these partners will create vastly improved numerical physics-based probabilistic model output that can be turned into user community and stakeholder products, be inter-actively coupled to the NCEP operational atmospheric forecast model and also serve as the backbone of the ecological model
- Find a pathway to team with outstanding ocean and coastal numerical modelers at the University of Maryland Eastern Shore (UMES) and now NOS
- Work with NOS to follow through on the several decade old commitment to provide personnel slots (17 at the time) to build R2O and O2R enabling capacity to the OPC and NOS and thus interactively couples NWS to NOS
- Emphasize "coasts" in future product development (that is where people actually live, work and play)
- Design improved product suite so that the products can be provided on grids via iPhones and iPads

Threats/Challenges:

- US Congressional budgetary actions which could result in a cut in OPC FTEs
- AWIPS-2 ability to support multiple large domains
- Be subjected to Congressional earmarks that would use OPC to justify its appropriations; thus possible moving or reallocating resources from other core NCEP programs

9.6 Appendix OPC-A: Outstanding Items from 2009 UCAR Review

The outstanding items from the last review and the new challenges that have arisen since then that need to be addressed in the context of the 2009 review include:

a. Complete and Ongoing (issues addressed, efforts are ongoing)
   - Enhance Ocean Applications Branch capacity
   - Enhance Web development
   - Enhance the use of ensembles in marine weather forecasts
   - Enhance R2O, O2R efforts with partners (e.g., Navy, NOS)
   - Enhance OPC's role in ocean observations

b. Short Term
   - Expand into (enabling) ecological forecasting
   - Accelerate toward digital marine services (Graphical Forecast Editor or GFE; National Digital Forecast Database or NDFD) by shifting focus toward GFE

infrastructure development coordination and eventually implementing GFE for operations
  - Engage in joint OPC-NOS activities at NCWCP
  - Enhance OPC-TAFB synergy
  - Port to AWIPS-2 in FY12
  - Establish NWS-wide "marine grids" effort involving OPC, TAFB, Alaska Region (AR), and Pacific Region (PR)
  - NDFD expansion: with AWIPS-2 + GFE/FOC (Full Operational Capacity)
  - Continue the ongoing R2O efforts with Navy, NESDIS, and the National Ocean Partnership Program (NOPP) partners.
  - Employ Global Hybrid Coordinate Ocean Model (HYCOM) for OPC applications
  - Use Multi-Instrument Sea-Surface Temperature (MISST-2) with EMC (funded)
  - Work through IOOS toward an ocean/coastal testbed in OPC (FY12)
  - Develop a capability to use altimeter significant wave height (SWH) data for open ocean wave height forecast verification

c. Mid-Term
  - Improve marine weather forecast verifications

d. Long-Term
  - Expand products and staff skill sets (e.g., oceanography, marine biology)

e. For Mid- and Long-Term, need to:
  - Enhance use of ensembles in marine weather forecasts to include uncertainty information and develop probabilistic wind warning products
  - Web enhancements: probabilistic guidance; ecological forecasting; arrangement with WOC (by NCO) for sustainability, reliability; advanced graphic and gridded (data) services
  - Expand and broaden OPC staff abilities to include statistical and empirical tools
  - Establish a collaborative team with NOS to establish a Chesapeake Bay Sea Nettle forecasting demonstration project, to be eventually made operational; hypoxia forecasting to follow
  - Enhance OPCs' role in influencing future ocean and coastal observations by engaging the WMO Rolling Review of Requirements through the Joint Technical Commission on Oceanography and Marine Meteorology

10. Storm Prediction Center

10.1 Introduction

Russell Schneider, Director of the Storm Prediction Center (SPC), provided the initial briefing on Oct. 12. UCACN SPC lead Lance Bosart was present for this briefing along with other members of UCACN, and NCEP and NWSHQ personnel. During the breakout session with Schneider on Oct. 13, Bosart was not able to attend, and Fred Carr led the discussion. Dave Caldwell, Director of OCWWS, and Wayne Higgins, CPC Director, were also present.

10.2 Overarching Issues/Recommendations

The SPC continues to make excellent progress toward implementing the major recommendations from the 2009 NCEP review. A measure of this progress is the continuing enhancements to the HWT spring program in the area of new science and transfer of scientific knowledge to operations. An important highlight of the SPC HWT spring program is SPC's involvement with (or emulation by) other NCEP centers. SPC continues to advance and expand its pioneering and state-of-the-art programs focused on collaborative research through the HWT, probabilistic forecasting, and innovative real-time forecast verification strategies in the products and services (PS) arena.

The SPC has made a major commitment to increase support for fire weather services through the creation of new products. Specifically, a suite of product and service (PS) recommendations has been implemented (e.g., day 1 & 2 fire weather outlooks and updates and day 3-8 fire weather outlooks; redesign of the mesoscale analysis web-based product through integration with GIS technology; working with new University of Oklahoma (OU)-NOAA partnership for social science research) with help from two additional FTE positions. Other major PS recommendations pertaining to assuring the long-term viability of the SPC fire weather program (e.g., implementation of probabilistic experimental day 3-8 fire weather outlooks) will require additional resources and will take longer to implement.

The SPC has also initiated event-driven, severe weather coordination calls with FEMA that emphasize the exchange of relevant graphical products for forecast major severe weather events and extreme fire weather situations (these coordination calls occurred on more than 40 days). Response to this initiative from FEMA has been excellent as evidenced by the participation of the FEMA Administrator in several conference calls and positive feedback to the SPC effort by FEMA emergency managers around the country. From FEMA's perspective, it has an "excellent partnership" with the SPC. We strongly support ongoing efforts by the SPC to increase its interactions with FEMA, the linking of these efforts to the private sector, and the integration of social scientists into this process to effectively improve communication with users and user understanding of "actionable information" in severe weather and extreme fire weather situations. In terms of Weather Ready nation, the SPC provided exceptional forecast services to the nation throughout the historic 2011 tornado and fire weather seasons. In particular, the SPC supported successful national and local IDSS.

10.3 Comments on the Response to the 2009 Review:

The major recommendation that SPC's mission and vision (MV) statement (MV1) be updated and clarified is being implemented in coordination with the local NWS Employee Organization NWSEO) Vision Team with completion expected in FY12.

In the customers and partners (CP) category recommendations related to broadening and deepening SPC interactions with the social sciences community in product development and communication with users have been completed (e.g., proposal to NWSHQ to fund a collaborative effort with Social Science Woven into Meteorology or SSWIM) or are in progress (e.g., increase social scientist participation in the National Severe Weather Workshops – NSWW – and execute more effective interactions with the AWC through the HWT). We applaud the effort initiated by the SPC to implement the 2009 recommendation to pursue broader and deeper interactions with the social sciences community. In order to sustain this worthy effort going forward additional resources will be needed.

The SPC has fully embraced ensemble forecasting. This effort is state-of-the-art and is earning the SPC national and international recognition. Many new excellent probabilistic forecast products have been implemented into operations (e.g., Day 3-8 probabilistic dry thunderstorm outlooks) and other new probabilistic forecast products are in development (e.g. began transition to year-round enhanced thunderstorm outlooks). This effort is being leveraged into better capturing and communicating user needs at multiple levels to facilitate the preparation of product road maps for the user community. Since these road maps will be used by the SPC to improve its interactions with the user community it is critical that the information contained on these maps have a clear meaning in the user community.

In the area of Information Systems (IS) and Science and Technology (ST) the SPC has implemented GIS-enabled forecast graphics and has added multi-media briefings for forecast major severe weather outbreaks and extreme fire weather days. The SPC web-based mesoscale analysis and forecast pages are state-of-the-art and a standard of excellence for the other centers. This leading-center effort that demonstrates that the SPC is using IS and ST in highly innovative ways to integrate science into operations that are a model for other NCEP centers. This effort needs to be monitored carefully to ensure that adequate IT and ST resources are available to sustain innovation and the associated growth in PS. A road map as to how these IT and ST resources are to be used for this purpose should be included in the ongoing review process from which a new HWT strategic plan will emerge.

The SPC has supported improved Impact-based Decision Support Services (IDSS) for national emergency management preparedness (initiated with no additional resources at FEMA's request) that is being led by FEMA's Response Watch Center that includes NWS Regional Operations Centers (ROCs). A review and planning for ongoing collaboration in 2012 is being conducted this fall.

In the area of People and Organizational Change (POC), we note that the SPC is the second smallest NCEP center overall and is the smallest NCEP remote center. The SPC uses its FTE resources very efficiently to do excellent science and to create highly innovative new products based on ongoing scientific projects that provide "actionable information" in its numerous PS. As the NWS takes steps to implement the "2020 roadmap" an opportunity exists to consider targeting and augmenting SPC resources so that the outstanding culture of innovative new PS developments can be fully exploited to the benefit of NOAA, NWS, the Weather Enterprise, and Weather Ready Nation.

In the area of Business Processes (BP), SPC has implemented a collaboration with the local NWSEO to address perceived lack of communication issues between management and staff (e.g., a communication question was added to the annual "360 feedback" to generate additional ideas for improving communication). SPC is also participating in ongoing NCEP wide efforts to review IT security mandates and administrative processes within the organization. We also note that SPC has yet to implement a recommendation "to provide SPC staff with opportunities to become familiar with, and have greater interaction with, appropriate sister NCEP units." It is in the best long-term interest of SPC, NCEP, NWS, and NOAA that this recommendation be implemented, given ongoing and future budget realities.

10.4 Comments on Aspects of the 2020 Roadmap

The SPC's proposed 2020 Roadmap plan seems well thought out and will very likely be a recipe for success if the proposed implementations are carried forward and adequate resources are available to ensure that these implementations are successful. A strength of the plan as envisioned is that it actively engages the research and operational communities in a variety of new innovative partnerships to develop effective storm-scale ensemble forecasting and post-processing of these model forecasts to allow the generation of storm-scale probabilistic forecasts. An additional strength of the 2020 Roadmap is the working partnerships with FEMA and the social science communities. The more than 500 severe weather-related deaths in 2011 clearly speaks to the need and importance of maintaining SPC interactions with the social scientist community.

10.5 SWOT/C Analysis

The SWOT/C overview analysis provided buy SPC Director Russ Schneider seems, accurate, timely, and complete. The enumerated strengths ,weaknesses, opportunities, and threats are well stated and are properly linked to take advantage of ongoing and planned initiatives to address the core recommendations in the 2009 review. The SPC recognizes the need to work more closely with the FO's and RD's in the watch management area, especially with regard to moving the back edge of any watch box on a continuously evolving basis. In the threats section it is clear that the SPC recognizes the critical need to engage more proactively with other NCEP centers. A clear strength of the SPC that could perhaps be better articulated in the SWOT/C analysis is its "proximity to and good working relationships with the National Severe Storms Laboratory (NSSL), the Center for Analysis and Prediction of Storms (CAPS), the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS), and the OU School of Meteorology."

In terms of opportunities, we are pleased with the commitment that SPC has made to ensemble forecasting and its recognition of the value to its mission of continuing to exploit/mine the information contained in ensemble weather forecasts in support of its operational mission. We also see an opportunity for the SPC to support a robust national IDSS and an equally robust HWT collaborative (SOO focus) research effort. Success in the first endeavor will require assigning an additional (6^{th} lead forecaster) FTE on the forecast desk to help with forecaster training and staff transitions on critical severe weather days. Success in the second endeavor is linked to a history of producing refereed journal articles from ongoing HWT research activities that are the basis for innovative new PS. Success in the second endeavor will also be linked directly to the allocation of more resources to support the research needed to have strong science-based improvements in storm-scale understanding and convection-allowing numerical weather prediction models (HFIP-like effort? Make use of NOAA's innovation fund?).

The SPC might want to consider future interactions with NCEP/CPC to construct: 1) favorable severe weather regimes in space and time as a function of the phase and amplitude of El Niño and the Southern Oscillation (ENSO) and the Madden-Julian Oscillation (MJO), and 2) environmental scenarios that could be favorable for the occurrence of severe weather in likely future climate regimes. For example, given that more than 500 severe weather-related deaths occurred in 2011 in a La Nina regime, and given that La Niña is expected to continue through spring 2012, the SPC might want to consider the pros and cons of coordinating with the CPC (and other NCEP units as well as FEMA) on identifying possible environmental flow regimes associated with La Niña that could lead to earlier recognition of those environmental flow regimes that could be associated with higher probabilities of severe weather outbreaks.

A related opportunity that is likely to pay big dividends to NCEP, NWS, and NOAA is for SPC to play a lead role in enabling a WFO and Weather Enterprise IDSS and an associated national communication Integrated Warning Team (IWT; public, private, media) that would have the following components: 1) support WFO IDSS for tornadoes and severe weather through high temporal resolution probabilistic outlooks for the 0-9 hour period to encourage innovative risk-based decision making, 2) support data mining and innovative forecast tool development for storm-scale numerical weather prediction (NWP) and ensemble forecasting, 3) support development of new PS for lightning forecasts and hazards, and associated risk-based decision making, and 4) exploit CFSv2/v3 and reforecast capabilities to extend severe weather prediction to week two, monthly, and seasonal time scales. For example, item 4) could be accomplished in cooperation with the CPC as noted above.

11. Space Weather Prediction Center

11.1 Introduction

Brent Gordon, SWPC Deputy Director, provided the initial briefing. Also present for this and the ensuing breakout discussions were Maura Hagan, Jim Kinter and Len Pietrafesa from UCACN.

11.2 Overarching Issues/Recommendations

The recent development of an Integrated Action Plan (IAP) documents the actions the National Space Weather Program (NSWP) agencies intend to undertake for the development of a Unified National Space Weather Operational Capability (UNSWOC). SWPC plays a key role in realizing the laudable commitments to streamline efforts, to unify and share information across the entire enterprise and to raise awareness for new users, decision makers, and policymakers detailed in the IAP (Appendix A) and in the status of ongoing UNSWOC activities (Appendix B).

SWPC is unique in its long-standing service to the space weather community, including the provision of products and services, its healthy and venerable relationship with the users of these products and services, and its exemplary standing in the national and international communities. The recent inclusion of the so-called Enlil physics-based forecast model in the SWPC suite of products and services represented a landmark achievement. Further, this achievement set a successful precedent for future transitions of research models into operations at SWPC**.**

One of the outstanding issues originally raised in the 2009 Review Report is SWPC's ongoing obligation to acquire, process, validate and verify satellite measurements. These activities are clearly beyond the purview of the SWPC mission and should be the responsibility of others in a UNSWOC. The UCACN also notes the recent creep into the service mission by elements of the space weather enterprise beyond SWPC. This too is inconsistent with the philosophy of a UNSWOC and should be mitigated as the IAP is further developed and implemented.

The UCACN strongly endorses the preservation of SWPC's unique role in the provision of space weather products and services as the UNSWOC is further developed and implemented. SWPC's role in the NSWP should remain true to its mission "To deliver space weather products and services that meet the evolving needs of the nation."

11.3 Comments on the Response to the 2009 Review

The UCACN is pleased and impressed by the progress that SWPC has made in addressing the recommendations that emerged from the 2009 Review, especially the in the areas of Information Systems and People and Organizational Change. Our assessment of the status of the specific recommendations is overviewed in Appendix C. Below we call out some important and outstanding 2009 Review issues with UCACN reactions to their status.

As highlighted above in Section 2 the 2009 SWPC review panel recommended that "*Activities related to satellite data acquisition, processing, validation, and verification are not aligned with the NWS mission, but are better aligned with the National Environmental Satellite, Data, and*

Information Service (NESDIS) mission. The NESDIS already carries out these functions for terrestrial weather activities across the NWS. The panel supports the transfer of the satellite data activities from SWPC to NESDIS, which allows SWPC to focus on space weather prediction."

SWPC attempts to port the Geostationary Operational Environmental Satellites-N through P (GOES-NOP) project to NESDIS are stalled. There were insufficient resources to support the transfer in FY11. Plans to reinvigorate the GOES-NOP project depend upon available resources in FY12. Notably, there is no clear funding path for NESDIS to create the GOES-R NWS space weather products. It appears that NESDIS will not undertake an unfunded mandate and NWS will not fund the effort. In addition, the GOES-R Program cut deeply into the ground system budget and eliminated two contract options that would have allowed for an extended product set and higher cadence. Even if the options for Space Weather Level-2 product generation were funded, SWPC requirements are still above and beyond what was planned in the cancelled options.

The UCACN notes that space data acquisition, processing, validation and verification remain beyond the purview of the NWS and should be undertaken by NESDIS. The responsibility to resolve the current stalemate rests squarely with NOAA.

SWPC recognizes that Advanced Composition Explorer (ACE) satellite measurements of the solar wind at L1 are critical to its mission. These needs are also embodied in the 2009 review panel recommendation that *"NOAA should continue leading efforts within Office of the Federal Coordinator for Meteorology (OFCM) and the Office of Science and Technology Policy (OSTP) in coordinating an inter-agency partnership for continuity of solar wind measurements from L1."*

The UCACN applauds the strong partnership between the NCEP and SWPC Directors in their advocacy for the Deep Space Climate Observatory (DSCOVR) mission and strongly endorses DSCOVR as a critical warning system priority for NOAA.

The 2009 Review Panel also recommended that. *"Upon completion of a thorough review of staff roles and responsibilities, the SWPC management team should review the current personnel qualifications and assignments to assess any possible gaps. This process may reveal individual shortfalls that may be filled by providing additional training, direction or detailed guidance to employees tasked with new or different."*

The UCACN acknowledges a recent infiltration of new leadership and talent, which has invigorated both forecast and IT capabilities at SWPC. **The UCACN encourages SWPC to pursue an analogous rejuvenation of research and research to operations capabilities. Toward this end SWPC research staff should proactively align themselves with cutting-edge research efforts that hold the promise of meeting operational needs. The SWPC should also more proactively engage in R2O activities.**

The 2009 Review Panel made three science and technology related recommendations regarding SWPC interactions and alliances with the research community as follows, *"Given the need for partnerships between SWPC and the research community, SWPC should establish a scientific partnership with CIRES that is consistent with SWPC's mission, and stronger and formal partnerships with the broader space weather research community for the successful implementation of its plan."* Secondly, *"**NOAA should develop a space weather research program internally that is aligned with the SWPC mission.** This could be implemented through a partnership between the OAR and SWPC, with a well-defined role for CIRES and a more vigorous effort to entrain university research more broadly. Additionally, a well-trained development staff*

to ensure successful R2O transition is required. The SWPC should undertake the first steps toward establishing a viable research and development program as follows:

- *organize a workshop to develop a long-range plan for numerical space weather prediction, and*
- ***establish an advisory committee to oversee development and implementation of the long-range plan***.

Finally, the Review panel encouraged SWPC to *"Develop comprehensive, robust business models for the SWPT and the R2O function. There are a number of successful organizational arrangements (e.g., the Applied Meteorology Unit at Cape Kennedy, FL) and processes that can be adapted or emulated during development of the business models. A well-trained development staff is required to ensure a successful R2O."*

The UCACN acknowledges SWPC's progress toward these recommendations along with significant deficits, including its unsuccessful attempt to create a Space Weather Research capability at OAR. SWPC's establishment of the Space Weather Prediction Testbed (SWPT) with the mission to provide scientific, research and R2O expertise for space weather operations is commendable. In addition to its applied research activities, SWPT is charged with undertaking the initial testing, documentation, and validation of new models, data, and products as it begins its transition from research to operations. The resources for the SWPT currently come from two sources; SWPC base funds provide funding for federal staff salaries and a few CIRES staff, research grants and contracts from other agencies (NASA, NSF, DoD) fund the remaining CIRES salaries.

The UCACN is concerned about the ongoing SWPT budget challenges. There are inadequate resources and personnel needed to test and transition the suite of major physics-based models for SWPC forecast operations (i.e., models in addition to Enlil.) We encourage NCEP to address these deficits.

Further, the UCACN is concerned that the so-called SWPT-Interest Group may not be meeting the expectations of the panel regarding the role of the recommended external advisory committee. The UCACN underscores the importance of regular external counsel for the research and R2O components of SWPC activities.

11.4 Comments on Aspects of the 2020 Roadmap

The integrated service approach for a weather-ready nation as outlined in the 2020 Roadmap is a set of transformational concepts that are poised to serve the nation well. The inclusive nature of the Impact-based Decision Support System (IDSS) is particularly innovative and heartening. The UCACN applauds the inclusion of space in the so-called "Emerging and Collaborative Service Sectors." However, the pilot programs designed to support the key concepts in the 2020 Roadmap are unrelated to SWPC, so further comment is beyond the purview of this report.

11.5 SWOT/C Analysis

The success of the SWPC mission depends on both internal and external forces. The results of the recent SWPC SWOT analysis identify the forces at play and are highlighted in this section.

Strengths:

- SWPC is indisputably *the* source for space weather information worldwide.
- The SWPC Director proactively engages stakeholders; his aggressive outreach efforts have successfully captured the attention of the White House and FEMA.
- SWPC engages internationally, including the recent
  - MOA with United Kingdom Meteorological Office (UKMO),
  - MOA with Korea Meteorological Administration (KMA), and
  - activities within the World Meteorological Organization.
- The SWPC portfolio of activities in support of its mission to provide products and services is extensive, including research, development, education and outreach components.
- Within NCEP, SWPC is strongly linked to the Aviation Weather Center, and successfully serving the space weather needs of the aviation community.
- With the recent addition of Genene Fisher, SWPC now has a new formal and valuable presence within the NWS Office of Climate, Weather and Water Services (OCWWS)

Weaknesses:

- In the areas of data acquisition, processing, validation and verification SWPC continues to carry out activities that should be undertaken by NESDIS.
- Some of the ongoing research and development efforts within SWPC are not well aligned with the organizational mission.
- There is a need to transition additional research models to operations and an apparent bottleneck in these efforts.
- Previous education and outreach efforts have been modest and limited in scope. Notably, plans for FY12 suggest imminent invigoration of this effort.
- SWPC products and services remain overwhelmingly data driven. There is a need for increased model guidance.
- Media attention can be fleeting. The promise of space weather events with the rise of the solar cycle captivates media attention. Interest will wane if either the promise doesn't materialize or the impacts of solar activity are not geo-effective.

Opportunities:

- NWS and NCEP continue to support the space weather enterprise.
- NASA is a potential source of space weather funding, as well as observations and models all of which bolster the SWPC mission.
- The integration of the Whole Atmospheric Model (WAM) within the NCEP Global Forecast System (GFS) is a realistic since WAM is an upward extension of the GFS model that includes the physics of the upper atmosphere.
- The mitigation of all Certification & Accreditation (C&A) findings and the establishment of an alternate processing site are anticipated in FY2012.
- SWPC's new international partners (e.g., WMO, Korea, UKMO) bring expectations of deeper collaboration and a stronger profile worldwide.
- SWPC's location provides ready opportunities to partner with other Boulder Colorado institutions engaged in the space weather enterprise, including both the Laboratory for Atmospheric and Space Physics (LASP) and the Cooperative Institute for Research in the Environmental Sciences (CIRES) at the University of Colorado (CU), as well as the

High Altitude Observatory (HAO) at the National Center for Atmospheric Research. The anticipated move of the National Solar Observatory (NSO) to CU in 2016 further extends these opportunities.

Threats and Challenges:

- There is an urgent need to replace the 15-year-old solar wind monitor onboard the ACE satellite at L1. The prospects for the DSCOVR mission remain uncertain.
- The NASA Community Coordinated Modeling Center (CCMC) has recently encroached on the SWPC mission by disseminating space weather forecasts.
- Budget pressures preclude progress in several areas of the SWPC plan.
- A weak solar maximum with few high impact storms may lead to disinterest in space weather.
- Improvements to the lead-time of space weather forecasts rely, at least in part, on unrealized measurements at L5.
- The continuity of coronagraph measurements to monitor coronal mass ejections is not assured.
- There is a perceived lack of interest in the SWPC mission within DoD.

11.6 Appendices

Appendix SWPC-A - UNIFIED NATIONAL SPACE WEATHER CAPABILITY

Integrated Action Plan (draft 9/23/11)

Purpose: This Integrated Action Plan documents the actions the NSWP agencies intend to take in order to develop a Unified National Space Weather Capability that achieves the Vision of the NSWP:

> *A nation that capitalizes on advances in science and forecasting to better cope with the adverse impacts of space weather on human activity and on advanced technologies that underlie our global economy and national security.*

Background: National Space Weather Program Council (NSWPC) directed the Committee on Space Weather (CSW) to develop, track, and update an integrated action plan for the Unified National Space Weather Capability. In 2010, the executive Office of the President approved the NSWP Strategic Plan and Subcommittee for Disaster Reduction (SDR) Space Weather Implementation Plan (I-Plan). The NSWP goals provide the guiding principles for this IAP. Each NSWP Goal is support by several objectives. Additionally, the SDR I-Plan also provides a time-phased list of interagency actions to improve our national space weather capability. This IAP documents NSWP priorities and time-phasing for addressing these actions.

NSWP Goals

The NSWP partner agencies will develop the Unified National Space Weather Capability and fulfill the goals of the NSWP through collaborative and individual efforts. Complete descriptions of the NSWP Goals are contained within the Strategic Plan.

1. **Discover and understand the physical conditions and processes that produce space weather and its effects.**
2. **Develop and sustain necessary observational capabilities.**
3. **Provide tailored and accurate space weather information where and when it's needed.**
4. **Raise national awareness of the impacts of space weather.**
5. **Foster communications among government, commercial, and academic organizations.**

Interagency Actions

Based in NSWP Goals and Objective statements and the recommendation from the SDR Space Weather I-Plan, the NSWP partners' agencies plan to take the following actions.

Near-term actions (within next year)

N-1: Examine current processes and agreements between space weather service providers and science and research agencies to transition research to operations. (NSWP Goal 1)

N-2: Survey ongoing research to support solar and space environmental science (NSWP Goal 1)

N-3: Identify near-term opportunities to share existing space weather data between agencies e.g. Make DMSP SSUSI data available to research partners. (NSWP Goal 2)

N-4: Complete the NSWP Space Environmental Gap Analysis (SEGA) for observing systems and support the council's recommendations. (NSWP Goal 2)

N-5: Review existing operational product catalogs among the provider agencies and develop initial list of space weather products to be made available through the National Space Weather Capability. (NSWP Goal 3)

N-6: Establish a national space weather web-site portal and net-centric capability to deliver the unified capability and which makes space weather products available worldwide. (NSWP Goal 3)

N-7: Survey national space weather education and training opportunities. (NSWP Goal 4)

N-8: Regularly engage with industry and commercial space weather providers through the American Commercial Space Weather Association (ACSWA) and other public forums. (NSWP Goal 5)

N-9 Examine and improve internal NSWP communication, coordination, and partnership. (NSWP Goal 5)

N-10 Complete the Memorandum of Understanding for the National Space Weather Capability. (NSWP Goal 5)

Intermediate actions (1-3 years)

I-1: Document standards for the transition of research to operations. (NSWP Goal 1)

I-2: Document unmet operational and research needs and match in order to assist agencies in the prioritization of ongoing research efforts and address unmet observational needs and requirements. (NSWP Goal 1)

I-3: Develop recommendations on Space Weather Prediction Testbeds and Rapid Prototype Centers to support research to operations transition at the operational centers (NSWP Goal 1)

I-4: Identify additional opportunities and needs to share existing space weather data and initiate actions to secure the data sources. (NSWP Goal 2)

I-5: Identify and prioritize additional space weather products and services needed by Unified National Space Weather Capability. (NSWP Goal 3)

I-6: Organize and initiate a review of customer needs; current capabilities to meet these needs; the R&D activities needed to fill the gap between customer driven requirements and current capability. This activity should proceed from the results of the Decadal Survey and NSWP SEGA Final Report. (NSWP Goal 3)

I-7: Continue Public Education and Outreach activities e.g. NOAA Space Weather Workshop, NSWP Space Weather Enterprise Forum . (NSWP Goal 4)

I-8: Increase efforts on international cooperation. The NSWP should play a more active role in the international space weather community. Provide leadership within the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) Working Group on Long-Term Sustainability of Space Activities (LTSSA) to build an international consensus on cooperation to improve space weather services via the set of voluntary guidelines to be drafted in this effort. (NSWP Goal 5)

Long-term actions (Beyond 3 years)

The NSWP Goals and Objectives and the Interagency Actions listed in the SDR I-plan comprise the long term actions of this Integrated Action plan.

Annual Review: The CSW will report progress on this plan to the NSWPC and update it on an annual basis.

Appendix SWPC-B - Status of National Space Weather Capability Activities as of July 8, 2011 (N.B., The National Space Weather Capability was renamed and is now called the Unified National Space Weather Operational Capability (UNSWOC).)

- MOU between NOAA, NASA, NSF, USAF/AFW and DoI/USGS under development.
  - Will specify short-term roles and responsibilities for coordinated inter-agency efforts
  - No exchange of funds between organizations
  - Emphasis on near-term tangible deliverables that leverage existing capabilities
  - Oversight of process via OFCM, August meeting there with principals to converge on agreeable steps forward
- Development of Space Weather Training Modules
  - UCAR COMET program and NWS Training Center (KC) will work with SWPC to develop a series of on-line education, outreach and training modules
  - One set directed at MIC's, SOO's and WCM's at 122 NWS WFO's to permit them to handle routine customer inquiries about space weather and to utilize, explain and point to SWPC products and services (NWS TC lead)
  - Another aimed at new international users of space weather products and services via the WMO (see below)---particularly in Africa and developing world---specifically targeted at facilitating their use of existing SWPC products relevant to their commerce and security
  - A third set aimed at particular user segments who need to know about space weather and its effects on their activities
    - Aviation Industry
    - Precision GPS users
    - Emergency managers and responders
    - Power grid operators
    - Satellite operators
- Creation of a Space Weather Web Portal
  - A one-stop shopping site for space weather resources from policy to research to operations
  - Supported by, and containing inputs from and connections to, the National Space Weather Program constituent agencies (NASA, NSF, NOAA, USGS, FAA, DoE, DoS, DHS) and the commercial service sector
  - Content managed by the OFCM, but administered via NOAA through http:///www.spaceweather.gov, to which NOAA owns the rights
- WMO Linkage
  - Designate Terry Onsager to support efforts of the WMO's Space Programme
  - Goals are to
    - make current NOAA space weather products available to and used by developing nations
    - develop procedures to bring ground-based space weather data into the WMO and disseminated to US, UK and EU space weather modeling efforts from developing nations
    - create regional (local language specific) space weather warning and coordination centers based on the existing International Space Environment Service conops

- Strengthen operational partnerships with UK Met Office, Korea's Radio Research Agency and Meteorological Agency, Australia's Bureau of Meteorology and possibly Chinese space weather agencies
    - 24x7 civilian backup of selected SWPC products by close of CY2011
    - Targeted whole-atmosphere forecast model development
    - Coordinated real-time data delivery and dissemination
    - World-wide ground sites for real-time data acquisition from existing (ACE, STEREO) and future (COSMIC, DSCOVR) satellite missions
- Media education and outreach activities
    - Develop space weather pieces for *The Economist* and *Nature* to draw attention to space weather impacts on advanced technology systems and economic and societal well being
    - Augment *American Scientist* weather impacts piece to include a small space weather segment
    - Special space weather sessions are scheduled for the Fall American Geophysical Union meeting in San Francisco (December, 2011) and the American Association for the Advancement of Science meeting in Vancouver (February, 2012)

Appendix SWPC-C – Status of Responses to 2009 UCAR Review

Mission and Vision (MV) Status

Recommendation MV1: *Activities related to satellite data acquisition, processing, validation, and verification are not aligned with the NWS mission, but are better aligned with the National Environmental Satellite, Data, and Information Service (NESDIS) mission. The NESDIS already carries out these functions for terrestrial weather activities across the NWS. The panel supports the transfer of the satellite data activities from SWPC to NESDIS, which allows SWPC to focus on space weather prediction.*

MV1.1 Stalled GOES-NOP port project: There were insufficient resources to support transfer to NESDIS operations in FY11. Plans to reinvigorate this project depend upon available resources in FY12. There is no clear funding path for NESDIS to create the GOES-R NWS space weather products. The GOES-R Program cut deeply into the ground system budget and eliminated two contract options that would have allowed for an extended product set and higher cadence. Even if the options for Space Weather Level-2 product generation were funded, SWPC requirements were still above and beyond what was planned in the cancelled options.

MV1.2 Completed ACE project: ACE code was updated by NESDIS to run on modern architecture and the code is now in operation at SWPC.

MV1.3 Ongoing Transitions: NOAA satellite science, engineering, and algorithm support and data stewardship was transitioned to NESDIS/NGDC beginning in late FY11. This transfer of knowledge and personnel will continue into FY12.

Customers and Partners (CP) Status

Recommendation CP1: *NOAA should continue leading efforts within Office of the Federal Coordinator for Meteorology (OFCM) and the Office of Science and Technology Policy (OSTP) in coordinating an inter-agency partnership for continuity of solar wind measurements from L1.*

CP1.1 Ongoing: The SWPC director continues to push this issue with senior NOAA, DOD, DHS/FEMA, and Office of Management and Budget (OMB) leadership in addition to pursuing Space Weather Enterprise Forum (SWEF) advocacy.

Recommendation CP2: *A formal plan is needed to identify current and new potential customers, and a process should be developed for customer requirements collection, validation, and feedback to ensure the value, usability, and relevance of SWPC products and services.*

CP2.1 Ongoing: The plan for customer identification, requirements solicitation, requirements validation, and periodic evaluation of the efficacy of SWPC's products is occurring on a very small scale.

CP2.2 Ongoing: The periodic top to bottom inventory of customer requirements and assessment of how well customer needs are being met is planned for FY14.

CP2.3 Ongoing: Customer feedback and internal feedback continue to prompt SWPC to make changes to its products and services.

Recommendation CP3*: A formal education and outreach plan for stakeholders and customers is needed to increase understanding of the value and importance of space weather based on SWPC products and services. However, in the current budget climate, the public component of the SWPC education and outreach portfolio should remain dormant.*

CP3.1 Complete: SWPC began an aggressive education and outreach plan at the end of FY2011. Initial efforts are focused on updating external web pages and education modules for NWS, WMO, Aviation, and the general public.

Products and Services (PS) Status

Recommendation PS1: *The SWPC should continue with its efforts to address transitioning empirical techniques/models/tools into operational services.*

PS1.1Complete: New processes were developed to facilitate the transition of empirical techniques/models/tools into operations. The US-Total Electron Content (USTEC) model and D-Region Absorption Predictions (D-RAP) are examples of completed transitions.

PS2.1 Complete: FY10 base plus-up allows for staffing increase.

Recommendation PS2: *The SWPC should develop a formal project management plan to transition the Enlil model into operations. The Enlil transition will be the inaugural activity of the new SWPT. It is imperative that the R2O transition is implemented effectively, since it will set a precedent for future transitions.*

2.1 Complete: Annette Parsons (Air Force liaison office to SWPC) is the project manager for the Enlil transition to operations.

2.2 Complete: NCO style project management plan for the Enlil transition was initiated by the SWPC director in January 2010.

2.3 Ongoing: The Enlil transition is evaluated intermittently.

Information Systems (IS) Status

Recommendation IS1: *NCEP should ensure the continuation of sufficient funding and SWPC should implement its plan: (1) to complete the migration from legacy hardware/software information systems to modern equipment; and (2) to maintain and upgrade the equipment, as necessary, after the migration is completed.*

IS1.1 Complete: Three SWPC antiquated computer systems were decommissioned, including the HP-UX, DEC-Ultrix and QNX/386 in FY09, FY10 and FY11, respectively. (N.B., The QNX retirement required that the ACE code be updated/rewritten; see MV1.2.) The SWPC computer room was remodeled in FY11 to facilitate AWPS-II. The Table Mountain Observatory was decommissioned and the property was transferred to DOC/ National Telecommunications and Information Administration (NTIA) on October 1, 2011.

IS1.2 Ongoing: SWPC is continuing to upgrade its IT systems as budgets allow.

Recommendation IS2: *A catastrophe mitigation and Continuity of Operations (COOP) plan for SWPC should be developed. For example, NCEP could investigate the possibility of using the AFWA as a backup to ensure that products are available to customers.*

IS2.1 Ongoing: In late FY11 SWPC procured hardware and services for a true Alternate Processing Site, which will be located at the new NCEP building in College Park.

IS2.2 Ongoing: SWPC is finalizing an MOU with Air Force Weather Agency (AFWA) which details backup capabilities for both parties. SWPC established an agreement with UCAR for local backup and is also exploring options with USGS in Golden, FAA in Longmont, and NWS in Cheyenne for longer range options.

Recommendation IS3: *As part of the modernization of the SWFO, NWS should investigate incorporating space weather information into AWIPS-II*

IS3.1 Complete: SWPC delivered space weather requirements for AWIPS-II to NCO in FY11.

IS3.2 Ongoing: SWPC is working with NCO in the context of the new NCEP Strategic Evaluation and Execution (SEE) budget process to secure resources for the inclusion of space weather in AWIPS-II.

IS3.2 Ongoing: SWPC hired a new developer to work locally on requirements with NCO, and also funded ½ FTE in NCO to jump-start its development effort in FY12. Hardware installation is on track for early FY12. The Forecast Operations Center (FOC) will require additional attention from NCO in FY13.

IS3.3 Ongoing: In FY11 SWPC developed the capability to produce space weather products in GRIB2 format for AWIPS-II. SWPC plans to continue this product transition into GRIB2 during FY12.

Recommendation IS4: *SWPC management, working with NCEP Central Operations, should develop an IT Security Plan that will accommodate the requirements of all components of the Center.*

IS4.1 Complete: Users now able to access space weather data without entering SWPC operational network space.

IS4.2 Complete: SWPC developed a space weather archive agreement with NGDC.

IS4.3 Ongoing: SWPC developed a process to make research quality data available on the non-operational side of its network. Plans to establish an automatic near-real-time data store (real-time replication of the Space Weather Data Store (SWDS): R-SWDS Project) for research is constrained by budget and competing priorities.

IS4.4 Complete: SWPC developed an action plan for its IT security system and will monitor security on a continuing basis in anticipation of Certification & Authentication (C&A) security requirements.

Science and Technology (ST) Status

Recommendation ST1: *Given the need for partnerships between SWPC and the research community, SWPC should establish a scientific partnership with CIRES that is consistent with SWPC's mission, and stronger and formal partnerships with the broader space weather research community for the successful implementation of its plan.*

ST1.1 Ongoing: SWPC made attempts to establish a Space Weather Research capability at OAR, but OAR was not receptive. SWPC instead established the Space Weather Prediction Testbed (SWPT) with the mission to provide scientific and research needs for space weather operations. In addition to applied research activities, SWPT is charged with undertaking the initial testing, documentation, and validation of new models, data, and products as it begins its transition from research to operations. The resources for the SWPT currently come from two sources; SWPC base funds provide funding for federal staff salaries and a few CIRES staff, research grants and contracts from other agencies (NASA, NSF, DOD) fund the remaining CIRES salaries. Current SWPT resources do not provide adequate resources and the personnel needed to test and develop another major physics-based model (i.e., in addition to Enlil). Additional funding will be needed.

Recommendation ST2: *NOAA should develop a space weather research program internally that is aligned with the SWPC mission. This could be implemented through a partnership between the OAR and SWPC, with a well-defined role for CIRES and a more vigorous effort to entrain university research more broadly. Additionally, a well-trained development staff to ensure successful R2O transition is required. The SWPC should undertake the first steps toward establishing a viable research and development program as follows:*

- *organize a workshop to develop a long-range plan for numerical space weather prediction, and*
- *establish an advisory committee to oversee development and implementation of the long-range*

plan.

ST2.1 Complete: SWPC completed a plan to establish a Space Weather Research capability within OAR, but it was overcome by events. (See above ST1.1 status.)

ST2.2 Ongoing: SWPC selected the Enlil numerical model for implementation into operations. The next numerical prediction model slated for implementation will be decided in FY12.

ST2.3 Ongoing: Rather than hosting a workshop, SWPC reaches out to the research community via numerous forums. It established a Space Weather Prediction Testbed (SWPT) Interest Group and continues to seek community engagement at various workshops both nationally and internationally. SWPC (CU CIRES) research staff write proposals to other agencies to garner support for its numerical space weather modeling needs.

ST2.4 Stalled: SWPC has no apparent plan to establish an external advisory committee for the research component of its activities. It is unclear that the expertise and membership of the so-called SWPC-Interest Group addresses the intent of the panel recommendations.

People and Organizational Culture (POC) Status

Recommendation POC1: *Clearly define the roles and responsibilities in the current SWPC organization. This should be done by reviewing employee job descriptions currently being utilized at the Center, assessing their clarity, and evaluating specifics of the objectives, definitions, duties, responsibilities contained in the descriptions. This will be critical for updating the current organization and R2O. As a follow-on, incorporate these updated descriptions into a user-friendly business manual that reflects the current directives and reporting structure of the organization. The manual should also include appropriate skill sets for all positions within the organization, and be aligned with objectives, directives and the overall mission.*

1.1 Ongoing: SWPC completed a minor reorganization in FY10, aligning personnel and functions with sections and branches. A larger reorganization to better balance branches and supervisory workload remains under consideration.

1.2 Completed and Ongoing: Existing position descriptions (PDs) and performance plans now align with the new SWPC structure and will be reassessed annually, and employees will receive copies of their PDs as part of the annual performance appraisal process.

Recommendation POC2: *Evaluate the accessibility and continuity of current formal and informal internal communication modes and methods. Communications should reach all employees in a timely fashion with a well-understood prioritization. A standard procedure for employees to routinely 'check into' communications should be established in order to ensure relevant notifications, directives and information are received and understood by staff.*

2.1 Ongoing: SWPC established all-hands and monthly Branch meetings. In addition, SWPC is using monthly, internal publication (Sol Source) to disseminate information on key happenings and events. Branch Chiefs present progress towards completion of the SWPC Annual Operating Plan at their monthly meetings.

2.2 Complete: SWPC implemented an employee feedback system into its OnTime® system and rolled it out during an FY10 All Hands meeting.

2.3 Complete: New branch chiefs for the Space Weather Services Branch and Administration and Technical Support Branch are positively impacting on the communication of news, directives, and ideas from the SWPC management.

Recommendation POC3: *Upon completion of a thorough review of staff roles and responsibilities, the SWPC management team should review the current personnel qualifications and assignments to assess any possible gaps. This process may reveal individual shortfalls that may be filled by providing additional training, direction or detailed guidance to employees tasked with new or different.*

See POC1 Status.

3.1 Ongoing: In FY11 training was a high priority for SWPC management. In spite of uncertainty in the SWPC budget, employees were encouraged and/or directed to engage in training activities.

3.2 Complete and Ongoing: New hires in the SWPC Forecast Office, Technology Support Branch, and the Development and Transition Section invigorated the center with highly capable and motivated staff.

Recommendation POC4: *As we near Solar Maximum, the number of forecasters may not be sufficient to provide consistently accurate products and services to the user community. Evaluate the manpower needs for forecaster capability as it relates to increasing future demand for services as Solar Maximum approaches.*

4.1 Ongoing: SWPC reallocated positions within the forecast office and are in the process of finalizing two additional hires. The outcome means that there will be two forecasters on duty 24x7.

Recommendation POC5: *Create a small team to evaluate and formulate a structured plan to mitigate the current NOAA HR hiring process, which is impeding SWPC's ability to achieve its mission objectives. It is possible that this team could work closely with other NCEP or NWS teams that are addressing the same issues.*

5.1 Ongoing: SWPC is working with both NCEP and HR to get qualified candidates into vacant positions as quickly as possible.

Recommendation POC6*: SWPC should reconsider the organizational chart to create more efficient communication and best utilize the staff's capabilities.*

See POC1 Status.

Business Processes (BP) Status

Recommendation BP1: *Establish a permanent space weather liaison in the Washington, D.C. area. SWPC and NCEP leadership should determine the appropriate location and level for the position to reside.*

1.1 Complete: Genene Fisher was hired as the SWPC liaison within the Office of Climate, Weather and Water Services (OCWWS).

Recommendation BP2: *Develop comprehensive, robust business models for the SWPT and the R2O function. There are a number of successful organizational arrangements (e.g., the Applied Meteorology Unit at Cape Kennedy, FL) and processes that can be adapted or emulated during development of the business models. A well-trained development staff is required to ensure a successful R2O.*

2.1 Complete: The Space Weather Prediction Test Bed Concept of Operations (CONOPS) was developed in FY11.

2.2 Complete: An external SWPT Interest Group was created in FY10.
2.3 Ongoing: SWPC continues to enhance staff by bringing in national and international research partners to help with our ionospheric, geospace, and solar research needs. In addition, positions were realigned within SWPC to support the hire of 3-GS13 development staff.
2.4 Ongoing: SWPC is working within the NWS SEE budget process to identify critical support for SWPT in the FY14 budget. In the meantime, SWPC will begin to explore the possibility of utilizing grants to support federal staff on the SWPT team to fill critical R&D positions.

Recommendation BP3: *The SWPC should define its expectations and requirements for the function currently being performed by CIRES researchers in preparation for the upcoming contractual competition. Possible options include a Memorandum of Understanding/Agreement that spells out the working relationship between the two staffs, which can be developed either as part of the request for proposals or negotiated upon contract award. This would be most helpful to both sides.*

3.1 Complete: SWPC is holding monthly meetings with the CIRES project leads to discuss work efforts and expenditures.
3.2 Complete: SWPC aligned CIRES efforts into two groups, research and IT. NOAA satellite support and data stewardship were transitioned to NGDC.
3.3 Ongoing: SWPC will participate in the CIRES contract re-competition with NOAA/OAR.

12. Appendix: Acronyms

ACE	Advanced Composition Explorer
ACSWA	American Commercial Space Weather Association
AMS	American Meteorological Society
AOP	Annual Operating Plan
AOC	Aviation Operations Center (NOAA)
AOML	Atlantic Oceanographic and Meteorological Laboratory
AR	Alaska Region
ATCSCC	Air Traffic Control System Command Center
AWC	Aviation Weather Center
AWIPS	Advanced Weather Information Processing System
AWIPS-2 (or II)	Advanced Weather Information Processing System (generation 2)
AWT	Aviation Weather Testbed
BoM	Bureau of Meteorology (Australia)
BP	Business Processes
CAPS	Center for Analysis and Prediction of Storms (OU)
CCMC	Community Coordinated Modeling Center (NASA)
CDM	Collaborative Decision Making
CFS	Climate Forecast System
CIMMS	Cooperative Institute for Mesoscale Meteorological Studies (OU)
CIO	Chief Information Officer
CIRES	Cooperative Institute for Research on Environmental Systems
COLA	Center for Ocean-Land-Atmosphere Studies
CONUS	Continental United States
CP	Customers and Partners
CPC	Climate Prediction Center
CPHC	Central Pacific Hurricane Center
CPO	Climate Program Office
CTB	Climate Test Bed
CWSU	Center Weather Service Unit
DHS	Department of Homeland Security
DMSP	Defense Meteorological Satellite Program
DoC	Department of Commerce
DoD	Department of Defense
DoI	Department of the Interior
DSCOVR	Deep Space Climate Observatory
DSS	Defense Security Service
DTC	Development Test Center
EF	Ecological Forecasting
EFDC	Environmental Fluid Dynamics Code
EMC	Environmental Modeling Center
ENSO	El Niño and the Southern Oscillation
ESRL	Earth System Research Laboratory
EuroSIP	European Seasonal to Interannual Prediction system
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FOC	Full Operational Capacity

FTE	Full-Time Equivalent
FVCOM	(Unstructured Grid) Finite Volume Coastal Ocean Model
GFDL	Geophysical Fluid Dynamics Laboratory
GFE	Graphical Forecast Editor
GIS	Geographic Information Systems
GOES	Geostationary Operational Environmental Satellites
GPS	Global Positioning System
GPU	Graphical Processing Unit
HAO	High Altitude Observatory
HDQ (or HQ)	Headquarters
HEC	High-End Computing
HF	High-Frequency
HFIP	Hurricane Forecast Improvement Project
HFO	Honolulu Forecast Office
HMT	Hydrometeorological Testbed
HPC	Hydrometeorological Prediction Center
HRD	Hurricane Research Division
HSU	Hurricane Specialist Unit
HWT	Hazardous Weather Testbed
HYCOM	Hybrid Coordinate Ocean Model
IAP	Integrated Action Plan
ICAO	International Civil Aviation Organization
IDSS	Impact-based Decision Support Services (or System)
IOOS	International Ocean Observing System
IRI	International Research Institute for Climate and Society
IS	Information Systems
ISI	Intraseasonal, Seasonal and Interannual
ISO9001	International Organization for Standardization (quality management standards)
IT	Information Technology
IWT	Integrated Warning Team
JHT	Joint Hurricane Testbed
KMA	Korea Meteorological Administration
LASP	Laboratory for Atmospheric and Space Physics
LTSSA	Long-Term Sustainability of Space Activities
MADIS	Meteorological Assimilation Data Ingest System
MCS	Mesoscale Convective System
MIC	Meteorologist in Charge
MISST-2	Multi-Instrument Sea-Surface Temperature (2^{nd} field program)
MJO	Madden-Julian Oscillation
MME	Multi-Model Ensemble
MS	Master of Science
MV	Mission and Vision
NAEFS	North American Ensemble Forecast System
NAS	National Airspace System
NAWIPS	NCEP AWIPS
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NCO	NCEP Central Operations
NCPP	National Climate Prediction Project
NCS	NOAA Climate Service

NCWCP	NOAA Center for Weather and Climate Prediction
NDFD	National Digital Forecast Database
NESDIS	National Environmental Satellite Data and Information Service
NextGen	Next Generation (Air Transportation System)
NGSP	Next Generation Strategic Plan
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
NOC	National Operations Center
NOPP	National Ocean Partnership Program
NOS	National Ocean Service (NOAA)
NSSL	National Severe Storms Laboratory
NSO	National Solar Observatory
NSWP	National Space Weather Program
NSWPC	National Space Weather Program Council
NSWW	National Severe Weather Workshop
NWP	Numerical Weather Prediction
NWS	National Weather Service
NWSEO	NWS Employees Organization
NWSHQ	NWS Headquarters
O2R	Operations to Research
OAB	Ocean Analysis Branch
OAR	Oceanic and Atmospheric Research
OCWWS	Office of Climate, Water and Weather Services
OD	(NCEP) Office of the Director
OFCM	Office of Federal Coordinator of Meteorology
OPC	Ocean Prediction Center
OS-21	Marine Branch (OCWWS)
OSTP	Office of Science and Technology Policy
OU	University of Oklahoma
OWCS	Open Weather and Climate Services
POC	People and Organizational Culture
PR	Pacific Region
PS	Products and Services
QPE	Quantitative Precipitation Estimation
QPF	Quantitative Precipitation Forecasts
R2O	Research to Operations
RA4 (or RA-IV)	Regional Association IV (Caribbean)
R&D	Research and Development
RAL	Research Applications Laboratory
RCC	Regional Climate Center
RFC	River Forecast Center
RISA	Regional Integrated Sciences and Assessments
ROC	Regional Operations Centers (or Radar Operations Center) (or Relative Operating Characteristic)
ROMS	Regional Ocean Modeling System
RUC	Rapid Update Cycle (model)
SAB	Science Advisory Board (NOAA)
SDR	Subcommittee for Disaster Reduction
SEGA	Space Environmental Gap Analysis
SIGMET	Significant Meteorological Advisory

SLOSH	Sea, Lake and Overland Surges from Hurricanes
SOO	Science and Operations Officer
SPC	Storm Prediction Center
SS&I	Storm Surge and Inundation
SSUSI	Special Sensor Ultraviolet Spectrographic Imager
SSWIM	Social Science Woven into Meteorology
ST (also S&T)	Science and Technology
SWH	Significant Wave Height
SWOT/C	Strengths, Weaknesses, Opportunities and Threats/Challenges
SWPC	Space Weather Prediction Center
SWPT	Space Weather Prediction Testbed
TAF	Terminal Area Forecast
TAFB	Tropical Analysis and Forecast Branch
TC	Tropical Cyclone
TFM	Traffic Flow Management
TSB	Technical Services Branch (NHC)
UCACN	UCAR Community Advisory Committee for NCEP
UCAR	University Corporation for Atmospheric Research
UKMO	United Kingdom Meteorological Office
UMES	University of Maryland Eastern Shore
UMS	Unified Modeling System
UNCPUOS	United Nations Committee on the Peaceful Uses of Outer Space
UNSWOC	Unified National Space Weather Operational Capability
USAF	United States Air Force
USGS	United States Geological Survey
VIMS	Virginia Institute of Marine Science
VSP	Visiting Scientist Program
WAFC	World Area Forecast Center
WAM	Whole Atmospheric Model
WCM	Warning Coordination Meteorologist
WET	Weather Evaluation Team
WFO	Weather Forecast Office
WGNE	Working Group on Numerical Experimentation
WOF	Warn on Forecast
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting (model)
WWB	World Weather Building