Annual Report of the
UCAR Community Advisory Committee for NCEP

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UCACN

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1. Introduction

1.1 Background and Charge

This report contains the annual evaluation of the National Centers for Environmental Prediction (NCEP) by the UCAR (University Corporation for Atmospheric Research) Community Advisory Committee for NCEP (UCACN, pronounced, "you-can").

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.*

In preparation for its 2012 annual meeting, the UCACN was provided with updated reports on activities and plans from each of the nine NCEP centers, including summaries of each center's annual operating plan for FY2013.

1.2. Procedure

The UCACN met with the NCEP Directors and other leaders of the 9 centers and the Office of the Director (OD) October 25-26, 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD. 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 UCACN heard introductory remarks by NCEP Director Louis Uccellini, who provided an update on the move into NCWCP, NOAA and National Weather Service priorities and issues, a summary of recent NCEP progress and challenges for the future. There were also presentations by Ed Johnson (given by John Sokich) summarizing the recent NRC report "Weather Services for the Nation: Becoming Second to None", Bill Lapenta (Environmental Modeling Center director) on "Steps toward a more unified modeling strategy", Ben Kyger (NCEP Central Operations director) on "The high performance computing strategy", and John Cortinas (OAR) on "NOAA's Next Generation Strategic Plan: Integrated Environmental Modeling".

The UCACN meeting included separate breakout sessions for all of the NCEP centers, followed by a plenary session in which preliminary findings were discussed. The OD and the nine Center reports that follow are based on these discussions as well as material sent to UCACN in advance, summaries of the 2013 Annual Operating Plan (AOP) meeting, and, in most cases, site visits over the previous 6 months.

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 once again 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 expresses 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

1. Preface/Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP), which is abbreviated UCACN, held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD. Material for this Office of the Director (OD) report comes not only from the pre-meeting slides and summaries of the September 5-7 AOP meeting, but also from discussions with the NCEP Director and from the set of overarching issues and recommendations from the nine Center reports. The reader should also note that while most of the recommendations are directed to NCEP leadership, many are also intended for NCEP's parent organizations, the National Weather Service and NOAA, since many issues can only be addressed at higher administrative levels.

2. Overarching issues/recommendations

The UCACN finds that NCEP leadership provided by the Director and his staff continues to be excellent. The response to the 2009 UCAR Review of NCEP and the recommendations made by UCACN at its 2011 meeting have been forthright and proactive, and this has led to improvements up and down the line. There are a great many opportunities for NCEP to improve and move toward the vision of being part of a National Weather Service that is "second to none" (as envisioned in the recent NRC report[1]), and the Office of the Director is well-positioned to take advantage of many of those opportunities. Nevertheless, there are also substantial challenges facing NCEP, some of which can be managed internally but most of which are externally-driven and related to the insufficiency and uncertainty of the budget.

It is essential that NOAA, the Department of Commerce, the Office of Management and Budget, and Congress enhance NCEP and NWS budgets to ensure that the critical services provided by NCEP continue to improve and serve the Nation well.

The UCACN believes that NCEP, through the Office of the Director (OD), can:

- **Take advantage of opportunities associated with the move to NCWCP** to enhance staff morale and engage with the external community
- **Build an effective Visiting Scientist Program** with substantial support from NOAA and other Federal agencies
- **Develop a strategic plan for a unified atmospheric, oceanic and coupled modeling system** in concert with other parts of NOAA and the weather & climate enterprise; **the plan must include increased resolution for both deterministic and ensemble prediction systems**
- **Strengthen partnerships to develop the next data assimilation and ensemble systems** - e.g., hybrid 4DVar; NMME
- **Strengthen test beds** to accelerate R20 and O2R
- Work with its Centers and NWS Forecast Offices on Impact-based Decision Support Services (IDSS)), taking care not to violate current policies on the relative roles of the private sector

[1] http://www.nap.edu/catalog.php?record_id=13429

and government in providing forecasting services.
- Initiate Open Environmental Information Services (Open EIS) activities

To reduce the external pressures that impede NCEP from fully accomplishing its mission, NOAA should:

- NOAA/NWS should develop ways to better communicate to Congress how the mission directly impacts their constituents.
- Enhance NCEP's budget to ensure that the critical services it provides continue to improve and serve the nation
- Ensure NCEP has adequate computational/IT resources for both operations and R&D
- Ensure NCEP's near-term budget includes funds to replace aging research spacecraft (NASA) with operational (NOAA) spacecraft to maintain the expected level of forecasting services to the nation. For example, SWPC uses NASA's research satellite (SOHO) for its coronograph to issue space weather forecasts. NOAA should not rely on research satellites for its mission and needs to replace the SOHO with one of its own in the near term (2017-2018).
- Provide mechanisms to attract and retain talented scientists to NCEP to ensure its future
- Ensure that NCEP will welcome and attract the support of the Earth system modeling community in designing and implementing the next generation models.

In the following sections, we provide an update on NCEP's response to the 2009 UCAR Review of NCEP (Section 3), comments on NCEP's challenges and strategic planning (Section 4), and, to conclude, specific recommendations to the OD on management, partnerships, computing and information technology, and modeling (Section 5).

3. Comments on NCEP's continuing response to 2009 Review

The 2009 UCAR Review of NCEP formulated 263 recommendations to the OD and the nine Centers. The review reports are publicly available at:
http://www.vsp.ucar.edu/UCACN/index.html.
The NCEP OD is tracking the responses to all 263 recommendations, with action plans for each Center made part of its Annual Operating Plan and coordinated with NWS HQ and the NOAA Budget and Planning process. Here we highlight and update some of the recommendations from the 2009 Review and the 2011 and 2012 UCACN meetings that are specific to the OD.

We begin with a number of significant POSITIVE FINDINGS:

- NCEP is **performing well in its primary mission** of providing products and services in support of protecting life and property in a timely manner.
- NCEP's **service centers are recognized as world leaders** in their particular missions for hurricane, severe weather, aviation, space weather, QPF, and ocean and climate forecasting.
- NCEP is the world leader in **making real-time weather and climate data, codes, and other products freely available**.
- **Interactions among NCEP centers are strong and continuing to increase, indicating that NCEP as a whole is greater than the sum of its parts - but is also a work in progress.**
- **NCEP is regarded as a national resource - opportunities exist to leverage this respect.**
- The **transition to the new NOAA Center for Weather and Climate Prediction (NCWCP) has gone very well.**
  - Transition of operational infrastructure and services transparent to users

  - Big boost for staff morale and image of NCEP in external community
- The **procurement of the next operational computing facility** is proceeding well. It is recognized that operating a turnkey operational facility, inclusive of the infrastructure for space, power, and cooling at multiple redundant locations with extremely high reliability and near-instantaneous failover, is complex and more expensive than simply purchasing computational capacity.
- The **GSI Hybrid EnKF-3DVAR implementation** in May is a good example of the benefits of NCEP partnership with OAR, NASA and Universities.
- Operational highlights from 2012 include the excellent long-range outlooks and watches for the April 14 Tornado Outbreak over the Great Plains, the accurate forecasts for Hurricane Isaac (and for the 2012 hurricane season in general), the improving GFS skill scores, and many new or upgraded model implementations. The difficult NHC-NWS handoff issue (made apparent by Hurricane Sandy) was recognized and vigorously addressed.
- Much of this progress is due to the **strong leadership of the NCEP Director and the leadership at the individual NCEP centers**, which UCACN recognizes and commends.

In order to continue to make progress going forward, the following bullets highlight the issues that WARRANT CONTINUING OR MORE FOCUSED ATTENTION:

- **NCEP does not have adequate resources to accomplish its mission**.
  - All centers provide increasingly more services and products with roughly unchanging size of its workforce
  - NOAA base funding of NCEP is too small and too large a fraction of NCEP expenses are met with soft external funds.
- **NCEP computing resources, including planned next generation facilities, are not commensurate with the demands of the mission**. The CPU, disk storage, long-term archival systems and data communication bandwidth are each at least an order of magnitude under-powered relative to the requirement. The limitation of operational computing hinders research and development of experimental new data assimilation and forecast systems. There is an impression in the community that NCEP (NWS/NOAA/DOC) could have gotten more computing capacity for the money.
- **EMC is not equipped to fulfill its vision to provide world-leading models with its current structure and broad portfolio**. EMC finds working closely with external partners challenging, because such collaboration represents additional unfunded burden that exacerbates the mismatch between resources and mission scope.
- Several NCEP service centers have an **unmet need for** deterministic and ensemble **storm-scale modeling** capability.
- The recent Open EIS initiative will **require NCEP to exchange additional information with its customers**.
- While Superstorm Sandy was viewed as a significant success story, there were clearly issues that remain in the **arena of NOAA-wide communication with public officials that need attention, especially as relates to inundation and flooding.**
- **There are significant shortcomings in NOAA's ability to properly and correctly forecast the spatial and temporal dynamics of inundation and flooding**, as different line offices have different responsibilities and the individual parts presently exceed their collective sum in terms of accuracy.

4. Comments on Strategic Planning

In order to help the US become a Weather-Ready Nation, NOAA and the NWS are leading or involved in many complex programs and initiatives required to attain this vision. Since most of these will require involvement by and/or directly impact NCEP, UCACN suggests that NOAA and NWS involve NCEP leadership from the beginning on the following crucial issues that confront the Weather and Climate Enterprise:

- The provision of climate services
- NWS role in FAA NextGen
- NWS Roadmap Planning and Pilot Projects
- Process improvement for the hiring of personnel
- Warn on Forecast; IDSS
- Hurricane Forecast Improvement Project
- Forecasting ecosystems, air/water quality, space weather, decadal climate ...
- High-performance computing, IT security, storage and bandwidth
- Multi-model ensembles and probabilistic forecasting on all scales
- Sustaining COSMIC-2, DSCOVR, SOHO, GOES, & NPSS programs - new instruments/channels/data volume/data processing
- Improved data assimilation and linkages to observing systems
- New GFS and CFS models (unified systems); associated reanalysis/reforecast efforts
- AWIPS2 and NEMS/ESMF software development
- The Open EIS initiative
- Creating and implementing a vision and model for cooperating with the private sector in developing and delivering weather and climate capabilities and services

It is important to recognize that as these projects and programs come to fruition, NCEP's mission and responsibilities will inevitably increase. The UCACN urges that NCEP/NWS/NOAA be proactive in their strategic planning on anticipating these increased requirements and in obtaining the resources to support them.

In addition to the multi-year, multi-agency projects above, NCEP faces a large number of specific challenges in the near-term that will require significant attention. Again, NCEP (with NOAA/NWS in some cases) must develop a strategic plan and appropriate tactics to address these issues. Some of these challenges include, roughly in priority order:

- Budget uncertainty; budget process changes
- Leadership changes in NOAA
- Development and transition to operations of a Unified Modeling System
- Transition to new computing systems in FY13 and (longer term) improving NCEP's High-End Computing capacity with significant upgrades
- Establishment of an effective Visiting Scientist Program with support from NOAA and other relevant Federal agencies
- Obtaining and managing programmatic support for R2O/O2R and enhancing internal (NWS/OAR) and external (other agencies, private and academic sectors) partnerships
- Planning/implementing joint NOAA research and operations IT test bed
- Administrative overload; establishing an NCEP Deputy Director position
- Managing and funding diverse Test Beds across NCEP centers using the following criteria for success: best practices from established center Test Beds, benefits, efficiencies, IT compatibility, sustainability
- Managing space weather data issues involving NWS and NESDIS

- Unify the space weather capability across the entire space weather community
- Improvement of QPF forecasts and promoting the value of the water cycle in weather and climate linkages
- Addressing NRC "Second to None" report recommendations and (longer term) development of next NCEP Strategic Plan
- Role in international programs and initiatives

5. Specific Recommendations to the Office of the Director

While we find that NCEP leadership is performing at a very high level of effectiveness and efficiency, the UCACN has a number of recommendations to address issues facing NCEP that require serious attention in the year ahead in the areas of management, partnerships, information technology, and modeling. These are enumerated below.

MANAGEMENT

- **EMC and SWPC require dynamic, forward-looking Directors.** These personnel decisions should be brought to a conclusion soon to eliminate uncertainty and enable progress.
- **NCEP requires a Deputy Director.** Despite the success of the Director so far, a single person can no longer effectively manage the growing responsibilities and complexities of the NCEP mission and operations while concentrating on the high-level issues identified here. Some of the responsibility must be shared. Having a deputy with a thorough knowledge of NCEP would be critical to maintain momentum and continuity should the present Director leave the post.
- NCEP should work with NOAA/NWS to **reduce its reliance on extramural funding** and avoid mission creep.
- NCEP should continue to broaden and deepen its engagement with external stakeholders to communicate its value and its status as a national resource, thereby **ensuring continued support.**
- The OD should continue to look for and take advantage of {synergies} in **assets or talents in individual Centers that can be applied more broadly across NCEP** (e.g. certification and accreditation support from SWPC), especially IT-related services that can be provided by NCO.
- **Possible opportunity provided by *Sandy* to enhance US weather services.** Excellent forecasts of this very high-impact event, issued with substantial lead-time, led to significant savings of life and reductions in the time it took to restore services. The fact that the ECMWF model was perceived to provide superior forecast guidance at longer lead times could be a motivation for obtaining greater HEC capacity.

PARTNERSHIPS

- With the availability of space in the NCWCP, redouble efforts to **create an NCEP Visiting Scientist Program (VSP)**, with resources from both NOAA and non-NOAA sources. If established, NCEP should ensure that the first participants have a favorable experience so that external funding will continue.
- Work with NWS HQ to develop multi-faceted plan to **enhance engagement with the Weather Enterprise & its stakeholders for improving products & services (Open EIS goal)**.
- NCEP should work with NOAA to **create more effective mechanisms for support of NCEP operations by OAR organizations**
- NCEP should initiate a discussion within NOAA to develop a **more coordinated inter-agency approach to issues associated with storm surge and inundation forecasts**

- The National (North American) Multi-Model Ensemble (NMME) for seasonal climate prediction should be maintained through the experimental phase **– a strategic plan is needed for sustaining the NMME**
- **Create a grants program for weather and NWP in OAR** (consistent with recent draft SAB report on NOAA R&D portfolio)
- The Open EIS initiative requires increasing temporal frequency of forecast output, providing data at the native model resolution (but not necessarily on the native model grids), more ensemble fields, etc. The Open EIS initiative also seeks to enable external users to provide feedback on experimental models early in the development process – while this is more challenging to implement, a pilot project to test its viability is warranted.
- NCEP can foster a vibrant research environment by **increasing interactions with the international research community**. Several initiatives in the World Weather Research Program (WWRP) and World Climate Research Program (WCRP) are ideal for NCEP involvement, e.g., the THORPEX legacy projects on Subseasonal to Seasonal Prediction and the Polar Prediction Project.
- NCEP should ensure that each center has a process to work with their customers to **understand what multi-model ensemble and probabilistic forecast output mean** in the context of that center's products and services.
- NCEP should continue to encourage its centers, as appropriate, to **establish strong relationships with their customers**, for example inviting them to take part in their Test Bed activities, meeting with them at conferences and symposia as budgets allow, getting involved in industry activities, via web sharing and teleconference if necessary, etc.

COMPUTING AND IT

- NCEP requires a **significant increase in its computing capability**, with at least an order of magnitude increase in capability over the next five years.
  - This is crucial for higher resolution models, modern data assimilation system, more sophisticated physics, increased size and resolution of ensembles (for probabilistic forecasting), and other new requested capabilities
- UCACN encourages NCEP to continue to justify and **push for even greater HPC capacity**, and work with external stakeholders who can advocate on their own behalf. NCEP should broaden its view of potential solutions to include partnerships and alternative models such as "cloud computing".
- An **NCO IT testbed** should be created to enable NCO to enhance professional development and stay abreast of trends and practices in federal, academic and commercial IT communities, such as cloud computing.
- EMC and NCO (along with other centers), building on recent improvements in model implementations, should continue to refine a more **thorough, standardized and competent evaluation and implementation process**, perhaps involving an independent evaluation entity.

MODELING

- The **full suite of models, including global atmosphere, coupled and limited area models, should be strategically re-examined** in light of user requirements, accuracy, suitability for current and future computing platforms, the trend toward unified modeling for weather and climate, and compatibility with models developed/used by NCEP collaborators and strategic partners (e.g. under NUOPC)
- Many NWP centers (e.g. the UK Met Office, Meteo-France, ECMWF) are developing strategies for unified modeling systems to be implemented by 2020 with scalable code out to at least one million processors, in close collaboration with academic research partners.

These strategies will depend strongly on the next generation of processors and HEC architectures. There are still uncertainties about the nature of these future HEC platforms and hence also about the proper numerical approaches to be utilized, e.g., whether the dynamical core of the global atmospheric model should continue to employ a spectral method or switch to an unstructured grid. It is too soon to make a definitive decision on the numerical approaches most suitable for the next generation of HEC platforms. In light of this important challenge, NCEP should view the current uncertainty as an opportunity to develop its next generation NWP dynamical core long-term plan in a genuine partnership with OAR and NCAR.

- NCEP, with external experts, should **develop a strategic plan for atmospheric and oceanic data assimilation**
  - involves greater collaboration with the weather, ocean and climate enterprise, including, NOS, OAR, university communities and the private sector
- NCEP should **develop a strategic plan for an advanced, collaborative approach to coastal, surge/inundation and ocean forecasting**.
- **Establish meaningful partnerships to initiate ecological forecasting capability**, supported by the NWS Director or NOAA Administrator**.**
- NCEP/EMC should consider calling on **UCACN to form a modeling sub-committee**, including external additional members, to provide advice and guidance on future directions in all these critical modeling areas.
- In the context of the NOAA Integrated Environmental Modeling initiative, NCEP, the relevant OAR laboratories and NCAR, should **organize a modeling summit meeting** to translate the IEM vision into real action.

3. **Aviation Weather Center**

1. Preface/Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

Dr. David Bright, Aviation Support Branch Chief, provided the AWC briefing. A break-out session on Thursday, October 25, was conducted with Dr. Bright and UCACN members Warren Qualley (AWC Lead) and Karen Shelton-Mur (AWC back-up lead). It's worth noting that Warren Qualley conducted a site visit to the AWC and met with Director Bob Maxson and his management staff at the AWC on June 12, 2012. The staff had prepared information which addressed the status of recommendations from both the 2009 Review and 2011 Report. These were taken into consideration during the October UCACN discussions.

2. Overarching Issues

A. The AWC staff continues to make excellent progress on Recommendations from the 2009 Review and the 2011 follow-up.
B. The placement of two National Aviation Meteorologists (NAMs) at the FAA's Air Traffic Control System Command Center (ATCSCC) in Warrenton, VA, in June, 2012, was a major accomplishment and notable milestone. However, the plan to have a total of six meteorologists (5 operational and one MIC) in order to cover all shifts and services may be in jeopardy due to resource limitations. An onsite MIC would take over supervisory responsibilities as well as oversee the Impact-based Decision Support Services (IDSS) program, coordination with the FAA, participation on various teams, etc. Another concern is the bandwidth of the communication line between the AWC and ATCSCC. While the current bandwidth is adequate, it is not sufficient for the unit to reach its full decision-support potential (e.g. timely download of model data, AWIPS II coming online; see related comment in E. iv. below). [It should be noted that the current communication line was a critical piece of standing up the NAM unit and was installed in a short time. Although it has met or exceeded year one expectations, it was not intended to be a long term solution.] Both the need for additional staff and the communication link should be addressed in a timely manner. *(Related to 11a, b, c and d in section 3 below)*
C. The NWS is working closely with the FAA to review all aviation products and services provided to the FAA. This process, facilitated through the Aviation Requirements Working Group (ARWG), addresses the "consistency" issue which had been raised in the 2011 Review. As was mentioned at the 2012 UCACN annual meeting, the National Academy of Public Administration (NAPA) has been commissioned to perform a study on the future office structure of the NWS. This will provide an opportunity for the NOAA/NWS/NCEP to address the rather disjointed structure of NWS aviation services (e.g. products/services consistency). *(Related to11d in section 3 below)*
D. The AWC has embraced and has taken the lead in the development of aviation IDSS, a high priority in their AOP and their Strategic Planning. Further, the IDSS development is very much in alignment with the FAA's NextGen weather initiatives (it can be stated that they are moving their services from "NowGen" to NextGen). More detail about IDSS can be found in

sections 3, 4 and 5 below.

E. The AWIPS II deployment continues to present challenges (new information in green):
   i) Scheduling training for the staff, since the timetable for this deployment at the AWC is fluid;
   ii) Back-up and COOP responsibilities by Scott AFB and Offutt AFB is jeopardized since there isn't a plan to provide AWIPS II at those facilities. (The SPC in Norman, OK uses Scott and Offutt AFBs for their backup and COOP, respectively. Thus, the SPC is in an identical situation concerning AWIPS II backup responsibilities.)
      (1) There is still no solid plan in place. The targeted platform is the AWIPS II thin client, which to date is a Weather Forecast Office (WFO) perspective, not a National Center's perspective (NCP). The NCP is currently under development for the AWIPS II thin client, but not yet tested or demonstrated.
   iii) There is no plan for the AWT, which is on the research network, to move to AWIPS II, which is what the Operations network will have in place. This is a risk for the AWT, with the same being true at the HWT at SPC and the HMT at HPC.
   iv) The performance of the AWIPS II thin client in place for the NAMs at the ATCSCC is unacceptable, so the NAMs don't use it. Rather, they use NAWIPS and due to their national scope, are likely to favor the NCP of AWIPS-II. Work is ongoing to upgrade to the latest version of the AWIPS-II thin client which will likely improve performance (to an unknown degree) of the AWIPS-II thin client.

3. Comments on the AWC's Continuing Response to the Recommendations in the 2009 Review and in the 2011 Report

(Note: Numbered bullets are unique to this report and do not necessarily correlate to those from past reports. Correlation is as follows: Issues and Recommendations from the 2011 UCACN Review are underscored, Recommendations which are *italicized* are from the 2009 NCEP Review. UCACN comments in green are those that are new to this report.)

1) "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. [The Recommendation is: "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".]

2) The Aviation Weather Testbed is a notable highlight of the Recommendations made by the NCEP Review Team in 2009 (*Recommendation CP3*) and has already proven to be successful.
   a. 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.
   b. 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.

UCACN comment:

The 2012 Summer Experiment was a successful 2-week test of the Collaborative Decision Making (CDM) Weather Evaluation Team's (WET) Operational Bridging (OB) initiative. Airline personnel, MET and non-MET attended. It led to the successful start-up of the OB Demonstration/Evaluation at the FAA's ATCSCC, using the new NWS National Aviation Meteorologists there as the leads. More detail about OB can be found in section 4 below.

It is worth noting that the AWC's involvement with CDM, which focuses on near-term fixes to problems faced by every user of the NAS, has ensured that their tasks are aligned with NextGen initiatives. The AWC recognized and has taken advantage of this as a logical pathway to move their current service offerings toward those in the NextGen Implementation Plan.

c. 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 HWT surely was a part of the success of the stand-up of the AWT.

UCACN comment:

The AWC is becoming more involved with the NOAA-level oversight of testbeds (see www.testbeds.noaa.gov).

3) 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.

UCACN comments:

- The AWC has demonstrated and continue to do this very well. They had representation at two IATA meetings, the annual EAA AirVenture, Women In Aviation International, Friends and Partners of Aviation Weather, NBAA.
- However, the reduction in the travel budget, especially for international travel, will negatively impact the AWC's efforts to have representation at some of these activities, particularly at mission critical ICAO functions.
- Also see number 8. below.

4) There is a positive trend in the AWC's relationship with other Centers and with establishing relationships with new partners.
5) 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.

UCACN comments:

- The AWC has worked with the CDM and with the FAA to develop new and enhance current products. An example of a new, IDSS, product is the Aviation Winter

Weather Dashboard (AWWD, while an example of the enhancement of a current product is the Extended Convective Forecast Product (ECFP)..

- The "Towards Open Weather and Climate Services" (now known as Open Environmental Information Services- Open EIS) white paper also has the potential to help address this.

6) 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.
   a. The FAA's Manager of the Aviation Weather Research Program (AWRP) 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.

UCACN comments:

1. The AWC established a cooperative agreement with CIRA, an important step to improving O2R.
2. The AWC has demonstrated this, working with ESRL and with the appropriate Centers in NCEP.
3. The manager of the FAA's AWRP is working with the AWC to ensure that their research focus is customer-driven.

The following comments apply to all bullets above.

A. The AWC needs to be more proactive and robust in communicating their requirements to the EMC for high-resolution (e.g. storm-scale) model output.
B. Huge computational constraints at NCEP hurt the AWC.
C. The AWC management needs to continue to focus on the infusion of Science and Meteorology into operations, along with appropriate training, to ensure that the AWC's products and services remain relevant. Their work on IDSS underscores their understanding of the importance of this issue.

7) 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.

UCACN comments:

1. The AWC works closely with ESRL on the verification of their products and services. This is underscored by the recent hiring of two verification experts (both of whom came from ESRL). They will help build the AWC's relationship with ESRL and as well as develop impact-based and operationally relevant verification.
2. Ensure that the verification is based on customer impact, not just on meteorological accuracy.

8) The visitor program has been noteworthy, with at least four professors coming to the AWC this year.

UCACN comment:

The AWC hosted 25 meteorologists from the Civil Aviation Authority of China (CAAC) for one week last year, training them in the AWC's forecast process. The China Meteorological Administration (CMA) has expressed interest in funding a training desk at the AWC. While there is great interest in making this a reality, the AWC is appropriately working this opportunity through the International group at NWSHQ and the FAA. If the plan moves forward, the AWC would prefer to expand the focus to include all of Asia.

9) 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.

UCACN comments:

1. The management of the AWC will need to be vigilant to ensure that they leverage the skills of the current staff with the requirements for each position.
2. They'll also need to use management and operational staff turnover to 1) hire the people whose skills and interests best fit the job for which they are hired, and 2) use these as opportunities to align their procedures toward theirs and NCEP's Strategic Plan.
3. AWC managers have the capability and do work operational shifts, sometimes out of necessity, but this is essential for multiple reasons (e.g. forecaster buy-in, operational experience, ideas, understanding the foundation of existing processes) to modernizing the forecast process toward Meteorologist-Over-The-Loop (MOTL) and Impact Decision Support Services (IDSS). More detail on IDSS can be found in section 4 below. The UCACN applauds and encourages this practice of management working shifts.
4. The AWC hired a GOES-R scientist (Amanda Terborg) for their AWT who has proven to be invaluable addition to the staff. All of the NCEP Centers with a Testbed have a GOES-R scientist. Funding is provided through NESDIS and the GOES-R proving ground.

10) 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.

UCACN comments:

1. To meet an FAA requirement the AWC needed to establish a Quality Management System (QMS). Looking at this from a global perspective, they chose to get awarded the ISO 9001:2008 certification. This satisfied not only the FAA requirement, but an ICAO recommendation.
2. The AWC achieved harmonized WAFS global grid operational availability with the London WAFC.
3. Some key decision makers at the ATCSCC who were also "champions" for the NAM position retired at the end of 2012 (Ellen King, Mark Libby and Ed Masterson). This presents AWC management with a challenge and an opportunity. The challenge will be to quickly establish a relationship with these people's replacements. The

opportunity, which will help with the challenge, is to establish a procedure through which a regular dialog takes place between AWC management and ATCSCC management about the services provided by the NAM position. The UCACN strongly suggests that the AWC set up a periodic (e.g. monthly, quarterly) teleconference to discuss anything related to the provision of the NAM service. Further, the UCACN suggests that an additional procedure be established, an ad hoc communication between the two management groups. It would be to the AWC's benefit to initiate these ad hoc communications in the immediate wake of weather events which are obviously disruptive to the NAS.

- 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.

UCACN comments:

1. All of the above have been accomplished, in process or ongoing, and the results have been very successful.
    a) Example: An AWC manager and each of the NAMs attended the annual fall CDM General Meeting held in the DC area. This is an excellent example of how the AWC is working with their main customer, the FAA, through the CDM process.
    a) Customer feedback about the OB included a comment that the Aviation Weather Statement (AWS- the message part of the OB process) contained too much weather-centric language. More detail about OB and the AWS can be found in section 4 below.
2. There are two threats to this critical function: full staffing and the communication bandwidth.
    - The NWS and FAA are working together to address the staffing concerns.
    - Further study of an improved IT solution at the ATCSCC needs to be conducted by NWS (NCEP NCO) and the FAA ATCSCC Support Staff.

- 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.

UCACN comments:

1. This is being addressed through the newly-created Aviation Requirements Working Group (ARWG), a joint FAA-NWS team of people who are looking at current and future products and services and consistency of aviation weather products among the various groups at the NWS (e.g. CWSU, WFO, AWC).
2. The work on IDSS is an example of how the AWC is working with the FAA (and airlines) on NextGen.

11) 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 be 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.

UCACN comments:

1. This continues to be a challenge, but the AWC stands ready to work in this direction if/when their FAA customer changes their requirements and when resources and/or skill sets of the staff provide the opportunity for changes.
2. This is tied to comment 8 above, noting that several things need to occur for the AWC to evolve their service offerings: gaining efficiencies in operations, hiring the right people for the right positions, managers getting a first-hand understanding of the forecast products/services and processes.

12) 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.

UCACN comments:

1. The AWC conducted seminars on new methods to forecast icing and turbulence to get the meteorologists to rely much less on legacy forecast processes.
2. The AWC is committed to the process of training and development, with ongoing turbulence training via lab-like training sessions this fall and training on NWP/ensembles later in the winter. They also have a winter weather experiment planned for mid-February that will consist of a one-week shared briefing with the HPC's HMT Winter Experiment.

13) ICAO, and therefore the FAA, has necessarily had to focus on Space Weather since it has significant impact to aviation and since the solar maximum is soon to be 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.

UCACN comments:

1. The AWC works closely with the SWPC, for example by actively participating in this past spring's Space Weather Workshop.
2. The NAMs should ensure that their customer at the ATCSCC is aware of the importance to the airlines of the adverse impact that Space Weather has on them and therefore on the National Airspace System (NAS). They should regularly monitor the Space Weather website via the link on ADDS.

14) 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.

UCACN comment:

The AWC completed construction of new cubicle office space to support AWT staff. And installed two new Lieberts for the IT Room, installed redundant commercial power and decoupled the air handlers in the forecast operations and computer room.

15) The 2009 UCAR Review recommended that the AWC write a new Vision and Mission Statement (found in Section 6.1 of that report), 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.

UCACN comment:

According to the AWC, this is in process for FY13.

16) The AWC isn't alone as it moves into the future. The management team should take advantage of the stronger linkages with the NWS Headquarters (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 part of this process.

UCACN comment:

The NWS Office of Science and Technology (OST) has established an AWT Research Association position through the Cooperative Institute for Research in the Atmosphere (CIRA) and has filled that position. The individual chosen (Ben Schwedler) came on board in January 2012 and has done a great job with NextGen and the AWT.

17) The AWC, in concert with NWSH 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.

UCACN comments:

1. The AWC responded to this recommendation during the site visit in June 2012, stating in summary that it may be best to be driven by NWSH and that it will be resource-intensive.
2. Further discussion during the UCACN 2012 Annual Meeting highlighted progress on this recommendation through the development of the ARWG, the OB initiative which necessarily involves the CWSUs, the WFOs, NWSH, as well as the QMS thrust area for FY13.

3.4 Comments on FY13 Annual Operating Plan (AOP)

The AWC's four major thrust areas for FY13 are aligned with NCEP's strategic plan and include topics which address the Recommendations in this report. As an example, the NAMs are the focal point of the OB service, which requires 1) collaboration among internal NWS aviation entities (CWSU, WFO and AWC) and groups external to the NWS (FAA, airlines, General Aviation (GA)), 2) the use of the Aviation Weather Testbed, 3) training and use of AWIPS II, 4) is an example of an Impact Decision Support Services, and 5) a Quality Management System (QMS). All of these are key components of the NextGen initiative that the FAA leads and of which the NWS is a supporting agency.

The AWC is addressing the IDSS concept, which involves moving away from generic dissemination to focus on specific impacts, which lead to providing weather information where and when it is important to their customers. AWC has engaged their customers (e.g. CDM WET, which is composed of operational airline personnel, Air Traffic Controllers, Air Traffic Managers, as well as ATCSCC personnel, and others) to determine the look and feel of their IDSS. Examples of current experimental IDSS are:

- Aviation Winter Weather Dashboard (AWWD), a product intended for local and national air traffic managers, operational commercial airline personnel and operational meteorologists. Information about the AWWD can be found here: http://testbed.aviationweather.gov/docs/winterdashboard/WinterWeatherDashboard_PDD.pdf
- The Operational Bridging demonstration began in July 2012 and is still in place. It combines the decision support currently provided for by the CWSU meteorologists for their individual ARTCC support with event-driven (vice time-based issuance)

weather collaboration. The OB scales this TFM support to the national level by reconciling differences between multiple forecast solutions issued by multiple sources and facilitating the transition of forecasts from long-range (probabilistic) to near-term (deterministic) solutions. A new experimental product was introduced for this, the Aviation Weather Statement (AWS). It's a graphic with a brief text description of forecast impact location (in ATM terms such as NAS routes) timing, permeability, and severity. Information about the OB and AWS can be found here: http://testbed.aviationweather.gov/docs/ob2012/opbridgingdemo4nws.pdf

Two mid-term IDSS are under development at the AWC:

- Aircraft Situation Display for Industry (ASDI) and weather data displays. Users will be able "see" weather information integrated with air traffic and other data, while meteorologists will be able to "see" the effects/impacts of weather on NAS users and can focus their messages about impact on the area(s) of concern to the users.
- Convective Impact Maps combine SREF ensemble forecasts with a history of air traffic and compare it to the current day in order to identify areas with potential high impact from weather.

Resource constraints, specifically budget constraints, will require creativity to overcome. This makes it critical that the AWC collaborate with the Centers in NCEP, with other parts of the NWS/NOAA, other government agencies, as well as with the commercial and academic sectors. As noted in the comments in sections 2 and 3, the AWC has demonstrated their willingness and ability to do that and they have taken action as shown by the experiments in their AWT and being a lead in the development of the AWWD and the OB initiative at the ATCSCC.

3.5 Comments on Strategic Planning

The AWC shares many of their challenges with the other Centers which make up NCEP. Limited resources, both FTEs and HW/SW, will make it difficult to maintain the status quo, much less move forward. However, the AWC will necessarily have to use opportunities such as guidance from working directly with customers such as those at the ATCSCC and from upcoming staff turnover to adjust processes, products and services.

The VSP may offer an opportunity for the AWC, but it will likely be shared with NWSH. An example of that occurred in 2012 when a scientist from the Japan Meteorological Agency was hosted by NWSH, spending several months at various NWS locations, including the AWC, and at industry events. As with all Centers, High-Performance Computing is crucial for the AWC to meet its goals.

The AWC's continued involvement with the CDM community should provide them opportunities to develop IDSS based on customer input, a key tenet of the FAA's NextGen initiative.

4. Climate Prediction Center (CPC)

1. Preface/Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

The UCACN meeting included separate breakout sessions for each of the NCEP centers, including the Climate Prediction Center. A summary of the discussion, findings and recommendations from that session is given below.

2. Overarching Issues/Recommendations

CPC is taking an increasingly active role in advancing NOAA climate services, both by improving its products and services and by assisting NOAA to integrate its attempts to meet the increasing demands for climate information and to meet the consequent scientific and service challenges. But CPC is struggling because its mission and responsibilities are expanding while its resources contract.

Like other parts of NCEP, CPC is increasingly dependent on numerical prediction models and computer-based analyses and reanalyses of atmospheric and oceanic observations. There has been some initiative toward addressing the UCACN 2009 recommendations about a more integrated and rational approach to computer modeling across a range of temporal and spatial scales, including those assigned to CPC. But a compelling and achievable vision for dramatically improved atmospheric computer modeling has not yet emerged in NCEP or NOAA. Reward entails some risk.

The Climate Test Bed (CTB), whose mission is to accelerate the transition of scientific advances from the climate research community into NOAA operations in order to improve NOAA climate forecast products and services, is under pressure to define its viability. Through a complex arrangement with external funding in the form of grants fro the NOAA Climate Program Office, NCEP human resources from both CPC and EMC, and uncertain allocations of computing resources, the CTB faces serious and continuing challenges that must be addressed to enable effective transfer of climate research results into operations.

CPC has a suite of products and activities that serve broad and critical national responsibilities. Its resources are not commensurate with those responsibilities or with the growing demands for climate services.

Findings

- CPC is an increasingly important component of NOAA and is moving as rapidly and effectively as possible to contribute to the goals of the NOAA Strategic Plan. It provides contemporary capabilities in climate prediction, monitoring, and diagnostics that will be a foundation for the development of regional climate services in all of the NOAA societal challenge areas.

- CPC cannot continue to sustain operational products and services by using contractor support from competitive grants. CPC cannot implement new operational products without new resources. CPC has increasing needs for high-performance computing that presumably can be met with the new NOAA climate computer at ORNL.
- Partnerships, collaboration, and visiting scientists are all expected to be highly beneficial to CPC and NOAA, but all bring costs and complexity, often of unexpected magnitude.
- The CTB has made significant progress in the past year advancing both the efforts to plan for the next generation of Climate Forecast System (CFS) and the major collaborative enterprise to build a National Multi-Model Ensemble (NMME). Serious challenges to the success of both initiatives are associated with factors beyond CPC's control, including the model development strategy being developed by EMC and the data archival and distribution function that is currently being addressed by a mixture of NOAA (National Climatic Data Center) and non-NOAA (International Research Institute for Climate and Society, National Center for Atmospheric Research) entities.
- One of the principal tools used for operational climate prediction, the CFS, is in use by a small group of external researchers. Increasing the use of CFS in the climate research community is hindered by the lack of documentation and barriers to easy application of CFS to research problems.
- CPC progress in the years to come will not match its recent performance without additional resources and additional support from other components of NCEP and NOAA.
- The current structure in which much of the CPC development resources flow through CPO or come from other agencies rather than being a part of the CPC base budget is an impediment to scientific progress and organizational effectiveness. It difficult to understand why this arrangement is considered advantageous.

Recommendations

- NOAA should direct more resources to CPC and should provide support in the CPC base budget for development of new and enhanced capabilities and services, for broadening its collaboration within NOAA, and for strengthening its contributions to meeting the goals of the NOAA Strategic Plan.
- NOAA and NCEP should act more creatively and decisively to create an agency-wide vision and commitment for improved numerical modeling to take advantage of innovations in model frameworks and new high-performance computer capabilities. It may be especially rewarding to focus part of the effort on high risk-high reward experiments.
- NOAA and NCEP should support the transition of climate prediction research to operational forecasts by providing CTB with adequate resources and an organizational structure that will allow it to gain more control of the activities required to execute its strategic plan.
- The CTB should prepare a formal, three-to-five year strategic and operational plan based on scientific and computational capabilities and expectations but independent of funding and personnel realities. This will provide a valuable prospectus for what could be accomplished by CTB and serve as a benchmark for measuring NOAA commitment and support of CTB over the next few years.

- CPC, EMC, and NCEP must continue to explore and advance the collaborative pathways that have been established in the past few years, in part as a result of the 2009 findings and recommendations.
- NOAA, NCEP, and CPC must develop a vision and specific plans for enhanced and meaningful collaboration with the private sector as a partner in providing climate services to a broad range of users.

3. Comments on the CPC's Continuing Response to the Recommendations in the 2009 Review and in the 2011 Report

CPC has completed its response to 18 of the 2009 recommendations and is working on the remaining 15. It has made good progress on the major recommendations:

- Provide support to enhance NOAA climate services
- Embrace the weather-climate linkage as the basis for interacting with other NCEP centers
- Sustain R&D and the transition R2O through CPO and CTB
- Enhance timely access, delivery, and display of CPC products.

CPC clearly recognizes its unique opportunity to enhance NOAA climate services and is working actively in the organizational structures being created to achieve the goals of the NOAA new strategic plan. It has accepted and is implementing the recommendation to manage expectations about new products and services by adhering to scientifically defensible goals and carefully identifying sources of predictability.

The recommendations on which CPC has not completed action include developing policies for private sector interactions, reducing reliance on contractor personnel for product generation, and establishing a model test facility as a joint effort of NCEP and CPO.

UCACN Site Visit to CPC

The most immediate issues for CPC involve the demographics and funding for scientific staff and continual tuning of the suite of operational products. Research productivity remains high.

Demographics of CPC staff

The overriding challenge for CPC is that a substantial fraction of its professional staff are contract employees funded by external grants. This situation is becoming increasingly unstable and must be addressed by NCEP, NWS, and NOAA.

- The CPC staff is about two-thirds civil servants and one-third employees of Wyle Information Services, which contracts with GSA to provide the staff:

Federal staff (FY12)	Contractor staff (FY12)
49 persons $6.3M/year	24 persons $3.1 M/year

- Benefits, working conditions, and enthusiasm for the CPC activities are comparable and CPC leadership says the two groups work together seamlessly.
- Promotion opportunities are essentially non-existent for both groups.

- The non-labor budget has been reduced and there are insufficient funds for professional travel, collaboration, and training. Travel, which is an essential aspect of much of CPC's scientific, outreach and collaborative activities, is especially threatened by recent developments at the NWS, NOAA and government-wide levels.
- The contract staff is largely engaged in the development of new capabilities and analyzing the quality of products and is supported by competitive grants from other agencies. This creates unrelenting pressure to bring in a continuing flow of money and produces attractive new capabilities for which there are scant or no implementation resources.

CPC Products and Plans for Improvement

CPC produces a broad suite of operational and research products, made available to users on CPC websites or NOAA servers. As discussed below, CPC must develop and implement a plan for interacting effectively with the private sector value-added providers in order to take advantage of their potential for fulfilling user needs.

- Climate outlooks are the most important products, including extended-range temperature and precipitation outlooks for the U.S., hurricane and typhoon seasonal outlooks, ENSO outlooks, and U.S. and global outlooks for hazards.
- Other important products include climate monitoring, diagnostics, and attribution; interagency and international commitments, the climate test bed, and data base management.
- CPC has a ten-year prospectus for determining user needs, putting more emphasis on comparison of user costs and benefits, for developing new probabilistic products, and for creating an interactive model output engine that would allow users to enter forecast specifications and calculate risk and reward estimates. This plan does not yet address collaboration with the private sector (see *Taking Advantage of Private Sector Capabilities* below.)
- CPC has no resources to pursue this plan.

CPC Research Productivity

In addition to the operational products, CPC scientists have a record of substantial research contributions, some devoted to understanding climate variability, some to providing strategies and methods for improving or developing operational products.

- CPC has a strong role in research in comparison to other NWS organizations. In FY 11 CPC authors published 55 articles, 50 in FY 12. This is an admirable record, given the operational imperatives that CPC faces. Further evaluation of the impact of these publications might be even more impressive.
- Some three-quarters of the papers had joint authors from government (outside NCEP), academe, or the international science community.

4. Comments on Strategic Planning

Climate variability on all temporal and spatial scales poses increasingly evident and substantial risk and opportunity in a wide variety of public and private activities thereby creating an increasing demand for climate services. CPC will certainly have an increasingly important role as NOAA tries to provide climate services that meet these demands. The UCACN assessment of CPC strategic planning focused on a few important topics.

Plans for the Next Climate Forecast System

The evolution of the computer probability forecast models available to CPC to generate climate services products is being examined as part of the consideration of a unified modeling strategy for NCEP, NOAA, and perhaps the national modeling community. A recent CPC-sponsored community planning workshop urged NCEP to be bold rather than incremental in planning for the Climate Forecast System (version 3) — the next generation seasonal prediction model.

- Bold plans for model improvement cannot be undertaken by CPC alone –they must involve EMC and the external community. CPC believes that model improvement will be incremental but that bold new organizational approaches are merited within NCEP. An NCEP Climate Modeling Team has been established. NCEP and CPO have signed a rather ambitious MOU intended "to position NCEP as the world leader in ISI modeling and prediction based services".
- These organizational initiatives have not yet extended to NOAA-wide discussion to take account of numerical modeling developments in ESRL or GFDL. They have not included consideration of a formal involvement of the broader scientific community, as foreseen by UCACN.
- A new weather-climate model framework that could offer optional dynamic cores (isentropic rather than pressure coordinates, for example) or model component coupling strategies has been discussed by the community but seems not to be considered attractive at NCEP. Such experiments are underway at ESRL, however.
- The issue of whether a new reanalysis should be included in the plans for CFSv3 is being considered, but perhaps not with sufficient enthusiasm. It would be expensive—demanding of personnel and computer time—but success could be an important catalyst to progress in both climate monitoring and prediction.

CPC Collaboration

Considerable pressure is exerted on NCEP and CPC by NOAA, NWS, SAB, and UCACN to engage a variety of partners in the external community. But collaboration has costs as well as advantages leading UCACN to discuss with CPC whether broad collaboration by CPC with external partners would actually advance the national climate prediction enterprise.

- CPC recognizes that it must engage external users to understand needs and must form partnerships with other parts of NOAA and other agencies and academic groups to meet those needs.
- CPC has important roles in the NOAA initiatives in Water Resources, Coastal Inundation, Marine Ecosystems, and Weather and Climate Extremes and will seek to form partnerships and identify regional stakeholders.
- Partnerships bring increased costs along with benefits and thus must be carefully considered and structured to ensure maximum advantage to all concerned.
- Partnerships with private or not-for-profit entities have not been considered, in part because of the lack of a guiding policy (see the discussion below).

CPC Visiting Scientist Program

The NCEP Visiting Scientist Program (VSP) could be an important facet of the CPC collaboration with the community and could be quite stimulating if CPC could form strong relationships with leading climate scientists and modelers.

- The opportunities are considerable, but as yet there are no funds to sponsor distinguished scientists, graduate students, or post-docs.
- CPC currently has many visitors—from other countries.
- UCACN leadership has discussed funding for the program with NSF and prospects are favorable. A visible investment by NWS, or more broadly NOAA, to supporting the VSP with explicit infrastructure and staff support commitments, would contribute significantly to the potential success of the program.

Taking Advantage of Private Sector Capabilities

Relationships and partnerships between CPC and users and value-added providers in the public sector are an increasingly important as demand for climate services accelerates. This should now be a more significant component of strategic planning in NOAA, NCEP, CPC and the relevant components of the private sector.

- CPC recognizes that it must remain focused on key science issues and that its role in directly engaging or serving users must be limited.
- NOAA did not ask CPC to comment on the SAB report *A Vision and a Model for NOAA and Private Sector Collaboration in a National Climate Services Enterprise*. (The report and the NOAA response are available at http://www.sab.noaa.gov/Meetings/2012/november/november_14-15_2012.html)
- The need for a policy and plans to shape NCEP service center interactions with the private sector is increasingly urgent.

5. Environmental Modeling Center

1. Preface / Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

The UCACN meeting included separate breakout sessions for each of the NCEP centers, including the Environmental Modeling Center. A summary of the discussion, findings and recommendations from that session is given below.

2. Overarching issues/recommendations

EMC has faced significant budget cuts in recent years. In 2012, EMC lost 15 contractors/visiting scientists, which accounted for approximately 10% of its work force. With the challenging fiscal environment, it is important for EMC to find ways to streamline its operation, and to consolidate components of its production suite (some of which are developed by its partners). We are pleased to see that EMC has phased out the ETA, RSM models over the past few years, and is planning to phase out the NMM-E. This plan will have implications for the HWRF (which is based on NMM-E) as well as the SREF (Short-Range Ensemble Forecast) system. We recommend EMC accelerate the migration of HWRF to another model framework (e.g., NMM-B/NEMS, or other alternatives) to reduce the time table for consolidating modeling systems and to minimize the impact on operational hurricane prediction. It is important to take into consideration the role of regional models in future hurricane prediction in this transition, given the increasing resolution of NCEP global forecast system (GFS) and its superior performance in hurricane track forecasting.

It is recognized that the requirements for high-resolution numerical products by NCEP forecast centers (e.g., SPC, HPC, AWC and NHC) continue to grow with time. EMC has been doing its best to meet these requirements, given its computational and budget constraints. Forecast centers indicated that the communication between EMC and forecast centers with regards to forecast products requirements and development has been very good in general. On occasion, EMC has done post-processing in some very specific areas without involving the relevant centers. Such communication breakdowns are being addressed, and improving. The key challenge for EMC is the development and operation of ensemble prediction system at cloud-resolving resolution, which would require a significant increase of computing resources beyond what is currently planned. The planned migration to a North American Rapid Refresh Ensemble (NARRE) system, using both the NMM-B and ARW dynamic cores, is a move in the right direction. However, this transition will not be possible before 2016 due to high-performance computing limitation. We recommend EMC explore ways to accelerate the development and transition to NARRE, and to identify alternative computing resources to achieve this goal.

Inspired by monitoring activities at ECMWF, Met Office and GMAO, EMC has established a Model Evaluation Group (MEG) project, which is designed to focus on product quality on a daily basis with feedback into the model development cycle. The MEG project has been very successful, and has brought significant benefits to the center, including enhancing communications and situation awareness among different modeling teams, providing critical feedback to modelers and managers,

and providing streamlined feedback to outside users with model concerns. The MEG project can potentially serve as a point-of-contact for all model concerns outside of EMC. We complement EMC's effort on this project, and strongly encourage EMC to continue this project. Building on this success, we recommend EMC seek community's participation and support for the evaluation of EMC modeling systems. We recommend EMC present results from MEG projects at major NWP workshops (including the WRF workshop) or meetings, and to solicit community participation in the diagnosis of model problems and testing of alternative approaches. EMC should take advantage of its partnership with the Developmental Testbed Center (DTC) to pursue community participation in MEG project. DTC has close collaboration with EMC on several modeling systems, including WRF, NMM-B, HWRF, and GSI. With its strong linkage to the broader community, DTC can serve as a conduit for the EMC.

The recent development and operational implementation of GSI-EnKF Hybrid (through a collaboration between EMC and ESRL) is a resounding success. The improved global analysis from GSI-Hybrid led to improved global forecasts that benefitted all downstream models. This work is a great example of effective collaboration between a research laboratory and an operational center. We strongly encourage EMC to continue close collaboration with NOAA laboratories and the broader research community on the development of next-generation operational modeling and data assimilation systems.

3. Comments on Center's continuing response to 2009 Review

Significant progress has been made over the past two years on all issues identified in the 2009 Review. We are particularly pleased to see that the EMC-NCO relationship is amicable and conducive to effective collaboration. We also take note that the implementation process has greatly improved since 2009. EMC and NCO are encouraged to continue the collaboration on instituting an implementation process that is efficient and effective. We also note that significant progress has been made in unifying modeling codes and libraries for EMC and NCO.

One recommendation from the 2009 Review that EMC continues to work on is CP2. In particular, EMC must lead the development of a 10-year strategic plan for NOAA operational modeling. We realize that such effort would require commitment across NOAA and engagement of the national and international modeling center, and is challenging, as EMC must still deliver improved systems in the near term. We recommend EMC to take steps in formulating its vision for a 10-year strategic plan. The first step can be an EMC internal retreat to develop a draft 10-year modeling plan, with sufficient details on the goals, requirements, and approaches for future modeling systems. Once such a draft plan is developed, EMC should seek broader engagement from NOAA laboratories (e.g., GFDL, ESRL). This will allow the EMC's planning effort to be aligned with the broader NOAA Environmental Modeling Planning effort. Once the strategic plan is sufficiently mature, EMC should engage the broader science community for comments and participation.

4. Comments on FY13 Annual Operating Plan

EMC has developed a solid Annual Operating Plan (AOP) for 2013. The key activities include: (1) joint EMC-NCEP center projects, (2) hosting WGNE-GODAE workshop, (3) NCEP climate modeling team (NCMT), (4) Earth System Prediction Capability (ESPC) Demo Projects, (5) Model Evaluation Group (MEG), and (6) Development Cycle for various modeling systems: (a) Real-time Ocean Forecast System, (b) Wave Systems, (c) GDAS/GFS, (d) GEFS, (e) NAEFS, (f) NAM, and (g) HWRF. These activities are important and appropriate for EMC. The proposed efforts are feasible and

scientifically worthwhile. As mentioned earlier, we recommend EMC to seek community participation in the MEG project. Engaging the community in the evaluation, diagnosis and testing of operational models will strengthen R2O and bring significant benefits to EMC.

As part of AOP 2013, EMC has proposed to establish a Scientific Steering Committee (SSC), with the purpose of providing an independent assessment of the quality and relevance of EMC scientific development and associated strategy. The proposed SSC can also help foster productive links with the global meteorological and climate community. We support the proposed concept of a SSC and its charge. However, we recommend that the SSC be formed after EMC has developed its draft 10-year strategic modeling plan (as suggested in section 2). SSC can be called upon to provide an assessment of the strategic plan and provide recommendations to EMC and NCEP management. Also, we would like to recommend that the SSC be incorporated as a sub-committee of the UCACN (instead of an independent body) to ensure close coordination between UCACN and SSC.

5. Comments on Strategic Planning

(a) Unified Modeling:

The possible transition to a unified modeling strategy will have a significant positive impact on EMC. NOAA is facing significant budget challenges. In order to continue to provide quality service in a challenging fiscal environment, EMC needs to consolidate components of its production suite, yet continue to provide an operational numerical guidance system that meets NOAA operational requirements. The migration toward a unified modeling system will enhance collaboration and synergies among different modeling teams within EMC, and may result in significant saving in resources.

(b) Visiting Scientist Program:

The Visiting Scientist Program (VPS) will have a significant positive impact on EMC. To accelerate the development and improvement of NCEP operational models, it is highly desirable for EMC to engage the broad science community in the testing and evaluation of its modeling systems. We strongly endorse the VSP program. We are pleased that NSF is interested in conducting a pilot program to support university PIs' to collaborate with NCEP as part of their funded proposals.

EMC is interested in establishing an "ECMWF-like" model testing facility (inspired by EMCWF's practice), where a researcher can visit EMC and perform experiments using EMC's modeling systems. This is an interesting concept, and deserves serious consideration. The development and operation of such a facility would require considerable resources and support from EMC and NCEP. We recommend EMC seek partnership with the DTC to explore the feasibility of establishing such a facility.

(c) High-Performance Computing:

We are pleased to see that EMC is working closely with NCO to make full use of its high-performance computing resources, this progress was indicated by the raising of the 'high-water mark" in its computer usage. As noted earlier, the current plan for high-performance computing does not provide adequate computing for EMC. As a result, EMC cannot implement NARRE ensemble prediction at cloud-resolving resolution until 2016, which is necessary for EMC to support product developments required by NCEP forecast centers. The lack of computing resources also limits EMC's ability to perform global data assimilation, global forecast, and global ensemble

prediction at resolutions competitive with ECMWF. NOAA management needs to continue to find ways to enhance high-performance computing resources for EMC. EMC should also explore other computing technology for its modeling systems.

6. Hydrometeorological Prediction Center

1. Preface / Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

The UCACN meeting included separate breakout sessions for each of the NCEP centers, including the Ocean Prediction Center. A summary of the discussion, findings and recommendations from that session is given below.

The UCACN visit on 25-26 October 2012 coincided with the developing threat associated with Hurricane Sandy. The timing was fortuitous, because it provided the committee with an opportunity to observe coordination activity between several centers (NHC, OPC, HPC, and EMC) during a high profile event.

2. Overarching issues/recommendations

An NCEP-wide issue ***is how to meet the increasing demand for high-resolution ensemble numerical model output***. Several experiments have demonstrated the feasibility and utility of high-resolution (convection allowing) deterministic and ensemble modeling systems in operational settings. While the expenses associated with the implementation of such a system are formidable, the capability exists and must be utilized. HPC forecaster involvement with the SPC/NSSL Hazardous Weather Testbed has accelerated the demand for high-resolution products, and this was also a key recommendation for the 2009 review. Significant progress has been achieved in this area, however, initial experiences have served to increase HPC forecaster appetite for storm-scale information.

A related issue that is critical, and perhaps underemphasized, ***is the need to improve utilization of high-resolution NWP products***; this is a NWS-wide issue. Severe bandwidth limitations prevent the dissemination of high-resolution information to NWS field offices, and software development is sorely needed to place forecasters in a better position to utilize ensemble information. Visualization and analysis software must be ready to handle the very large NWP datasets, and it is not clear that AWIPS-II will be suitable for the task.

A third overarching issue relates to the ***NWS Operations Center (NOC).*** In 2011, the UCACN ***recommended that the NOC be housed at NCEP, ideally within HPC***. The current structure, which features a separate NOC, seems inefficient, and creates difficulty in sending a consistent, coordinated NWS message. Were the NOC to be housed within HPC, it would increase efficiency, and aid HPC in its desired transition towards DSS, and event-based impact assessments. The occurrence of Hurricane Sandy during the fall 2012 was insightful, and this event underscored the need for a streamlined and consistent NOC within NCEP.

While strictly-speaking not an "overarching issue***", the UCACN supports the proposed name change of the HPC to Weather Prediction Center (WPC).*** There are numerous reasons for the change, not the least of which is continued confusion of HPC with "high-performance computing"; this confusion was evident on several occasions even during presentations by NCEP personnel during the UCACN meeting.

3. Comments on the HPC's Continuing Response to the Recommendations in the 2009 Review and in the 2011 Report

The HPC has done an outstanding job of responding to the 2009 review, having made substantial progress on over 90% of the initial recommendations. The remaining items are either ongoing, or have been stymied by the currently unfavorable budget environment. Some highlights will be explicitly mentioned below.

In 2009, the review committee found strategic planning at HPC to be limited, and reactive in nature. Since then, HPC has developed a solid strategic plan that demonstrates a more forward-thinking and proactive planning process. This includes an active discussion of and planning for the evolving future role of its forecasters, and increased decision-support activity. A related recommendation, that HPC employ a Warning Coordination Meteorologist (WCM), has yet to be fulfilled due to budgetary considerations.

As mentioned in section 2, a key 2009 recommendation was for HPC to increase use of high-resolution and ensemble-based numerical model guidance, and to develop additional probabilistic forecast products. HPC has made great strides in this area, and now routinely issues several probabilistic products, including experimental winter weather products. Participation of HPC forecasters in the SPC/NSSL HWT has accelerated HPC towards this goal, both in terms of training and increased understanding of potential capabilities. The HPC Winter Weather Experiment draws on several of the elements from the HWT. It is notable that the Hurricane Sandy briefing provided by the HPC during the UCACN meeting featured several ensemble products.

Another important recommendation related to culture, and the need to recognize and reward those who contribute scientific innovation. Along these lines, substantive changes to forecaster evaluation procedures have taken place, and the staff has responded with increased scientific engagement. Participation in the atmospheric rivers reforecast experiment and winter weather experiment are evidence of this cultural change.

4. Comments on FY13 Annual Operating Plan

Clear progress and strategies are outlined for all 14 of the recommendations in the 2012-2013 HPC action plan dated 23 October 2012. The UCACN endorses these actions, and applauds the impressive response by HPC management and staff to meet these recommendations.

Several ambitious projects are planned for FY13, including the establishment of a Meteorological Watch Desk. This initiative is consistent with a longer-term vision for HPC playing a larger role in IDSS and event-driven activities. The MWD products can be viewed as analogous to the Mesoscale Discussions issued by the SPC, except aimed towards heavy precipitation and threatening winter weather events. In order to staff this desk, streamlining of the current suite of products is needed, and the retirement of some experimental products will be required.

Gridded QPF for Puerto Rico, the Air Quality forecast discussion, and a more streamlined model diagnostic discussion are examples of places where HPC might better streamline its product suite.

In order to better serve the needs of NWS field offices, HPC plans to change the time of issuance of medium-range forecast information. Ideally, this would serve to allow field offices to better utilize HPC information. No additional resources are needed for this change, although additional nighttime staffing may be required.

5. Comments on Strategic Planning

The HPC longer-term strategic plan, consistent with UCACN 2009 recommendations, includes attention to the evolving future roles of forecasters. Two leading issues featured in the short-term plan are: Expanding medium-range forecast coverage to twice per day, and (ii) developing a Meteorological Watch Desk. These activities are expected to strengthen HPCs position as a strong provider of forecast information to NWS field offices and other customers.

7. NCEP Central Operations

1. Preface/Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

The UCACN meeting included separate breakout sessions for each of the NCEP centers, including NCEP Central Operations. A summary of the discussion, findings and recommendations from that session is given below.

2. Overarching issues/recommendations

Overall, NCO continues to make excellent progress on responding to the recommendations from the 2009 review and subsequent 2011 follow-up recommendations. Most importantly, it should be noted the relationship between NCO and EMC has become collaborative, supportive, and productive and has positioned both organizations to grow and meet NCEP's current and future needs. The good partnership has allowed the two organizations to work together to solve the most challenging research to operation transition challenges. Further, NCO should be commended for its successful acquisition and subsequent implementation process and timeline with the new HPC machine in the face of mounting external budget constraints and the tremendous logistics challenges during the move from World Weather Building to the new NOAA Center for Weather and Climate Prediction building. The new supercomputing architecture is especially strategically important since it is wildly used throughout the weather and climate modeling enterprise. The move to this new architecture enables NCO to reuse many of the research and development results from other centers including NCAR and NASA/GSFC.

There are three key themes that should be focused on by NCO as an organization over the next 12 months.

(1) Observation: There is a significant desire to reduce the major transition schedule to two releases a year. Because of many modeling systems are interconnected (e.g. global models feed the results to regional models), the integration testing may become duplicative when the releases are done piece by piece. EMC and NCO have been working together on the process to cut down the work load in the R2O transition. One success example is the Global Wave Model 2 release. EMC and NCO worked together to streamline the package regression and integration testing and cut down the transition time by half. It is desirable to apply the same level of planning and coordination to all the releases.

Recommendation: NCO and EMC need to jointly work together to develop and implement a plan that would create a transparent, predictable and scheduled numerical model update process known to both organizations and the meteorological community. In particular, NCO and EMC need to jointly develop and implement a plan to do a set model update and implementation schedule in FY13 and beyond. Such a plan could include limiting model updates to twice per year. In addition, NCO and EMC should take the lead in creating a joint

working group amongst the other centers who would be affected downstream of these changes in an effort to streamline communication and identify any impacts.

(2) Observation: The capacity of operational supercomputer is still limited. NCO had to run parallel testing on the backup system. With the new acquisition of the IBM iDataPlex system, there is a possibility that the capacity of the operational supercomputer may catch up with the main competitor (e.g. ECMWF). However, NCEP has a much more complex mission compare to its competitor, the capacity of supercomputing may still not be sufficient. Meanwhile, new computing technologies (e.g. many integrated cores and graphic processing unites) have been surfacing that may increase the supercomputing capacity considerably. By focusing on the current generation operational ready computing architecture, NCO may not be able to take advantage of the new computing architecture just a year or two later.

Recommendation: NCO should continue to push to take a leadership position in the HPC community by continuing to leverage external HPC resources through site visits to R&D supercomputing centers and attending external conferences. In addition, NCO should work with external communities including the NCEP product user community, supercomputing vendors, and the entire weather enterprise to define the value and benefits of increased HPC capacity in order to continue to serve public and private users throughout the nation.

(3) Observation: NCO had not been actively working on the external communications and collaborations including software engineering and supercomputing best practices in the past. Lately, NCO started to participate in collaborations with UKMO and ECMWF. For example, the ecFlow workflow tool from ECMWF has been adopted at NCEP. This is a very positive development. With NCEP becoming more open to the external R&D community, there is a significant need to develop an open collaborative software engineering and environmental prediction infrastructure.

Recommendation: NCO working with EMC must continue to improve, streamline and outline best practices for the software engineering process for each organization. This should include procedures for source code / version control and specific testing and regression plans with an agreed upon, specific goal to reduce the transition time to operations between both organizations. Through site visits to other forecasting centers and through the collaborative development of similar software engineering, workflow, and tools, NCO may take the leadership in the development of a streamlined environmental prediction environment.

3. Comments on the NCO's Continuing Response to the Recommendations in the 2009 Review and in the 2011 Report

Significant progress and advancement was made in responding to the 2009 review and the multiple follow-up site visits. As previously stated in prior reviews, NCO must continue to be prepared to recognize and prioritize new challenges that will arise in the dynamic world of IT as they combine with an evolving NCEP mission. As a result, the following focus items should always remain as key fundamental drivers to any NCO operating plan:

(1) Streamlined software engineering practices will be an increasingly critical part of NCO efforts to effectively and efficiently implement the required numerical model needs in the years to come. To achieve this, a focused effort and collaboration with EMC will be needed

to ensure that both organizations understand the new procedures and to ensure each organization has a fully vetted testing and operations plan. Software engineering practice is improving but is not ubiquitous yet. The most successful implementation is the data assimilation system. All the data assimilation system codes are under revision control. A sound software engineering practice does not stop at a good software source code control. It should include a better SW requirement analysis, architecture, design, implementation, testing, and operation and maintenance. NCO must continue to take a leadership role within NCEP to promote sound and efficient software engineering process. Good, efficient IT process will always pay dividends to speed up the transition from research to operation. NCO and EMC should jointly develop a implementation plan for software engineering practice to codify the role of software engineering in a transparent and predictable R2O transition process.

(2) NCO will need to continue to be active in the HPC community in order to keep its current staff up to date and also to recognize the latest trends and advances within the field. NCO will be relied upon to budget and advocate for staying ahead of future capacity needs. As NCEP, NOAA and the nation continue to face mounting pressure to reduce operating budgets, NCO must continue to aggressively champion and protect the need for increased HPC both now and in the future. In order to accomplish this mission, NCO with the support of NCEP need to examine and articulate the potential benefits of continually increasing HPC and justify adequate resources to take advantage of evolving model and computer capabilities to serve public and private users throughout the nation. NCO should leverage the opportunities such as the recent article in Science after super-storm Sandy caused significant damage in Mid-Atlanta Region ("Weather Forecasts Slowly Clearing Up" Science, Vol. 338, No. 6108, P. 734-737.) to argue for additional HPC resources.

4. Comments on FY13 Annual Operating Plan

The FY13 operating plan includes the five main thrusts: (1) WCOSS transition and go-live, (2) Begin FOTE for AWIPS II NCP, (3) Deploy alternate processing capability at Reston, (4) Upgrade remote center WAN circuits, and (5) Absorb full MADIS system within NCO. These are significant amount of work in FY13 that is required to stabilize the NCEP IT infrastructure. We note the following observations:

1. NCO appears to be ahead of schedule implementing the first phase of the new HPC contract secured in FY12. Efforts should continue to ensure this phase is delivered on the accelerated schedule being reported and worked by NCO staff. The increased capacity gained here will be critical for the appropriate planning of a unified model update and release schedule (see the first recommendation of this chapter.)
2. The transition to AWIPS-II NCP is strategically important. This will allow a unified AWIPS-II based infrastructure and significantly reduce the additional operational and maintenance work required at NCO to maintain a separate "national center" version of the AWIPS. This may free up resource for NCO to tackle other near term challenges.
3. The infrastructure enhancement projects such as remote center WAN upgrade, alternate processing capacity, and the absorption of MADIS into NCO are also important activities in the near term.
4. The NCO FY13 operation plan does not seem to include specifics of the new model releases in this year. Most likely this is simply something overlooked. However, it is important to note that a transparent transition process is highly desired by organizations within NCEP and the general meteorological community. (Once again, see the first recommendation of this chapter.) Not only NCO should document the transition plan and schedule, NCO should

widely disseminate this plan and schedule in many community meetings starting at the AMS.

5. Comments on Strategic Planning

HPC capacity has been and will continue to be a major theme for years to come for both EMC and NCO. Mounting budget pressures will force NCO in conjunction with NCEP to justify the annual expenditures necessary to accomplish the organization's mission and also remain competitive as a global numerical modeling organization. While the current HPC plan *appears* adequate in the near term any reduction in budget or slippage in implementation and procurement cycles will directly lead to a significant disadvantage for NCEP to continue to evolve and innovate.

Further, NCO must continue to devote resources to carefully monitor changing technology trends (such as the use of GPUs and MIC processors) and develop an initiative to start some modest experiments of its own. Understanding these developments may be critical with the next major HPC procurement process or even with the incremental upgrades available later in the present acquisition cycle. It is commanded that the WCOSS status presentation (to UCACN) material includes significant discussion how NCO is planning to monitor the new technology development and the technology selection/adoption criterion used by NCO. It is recommended that NCO follows this presented strategy closely to develop external collaborations and to test the technologies.

Finally, although not stated explicitly, NCEP has made tremendous progress toward more open and collaborative architecture. This will allow must easier community input and contribution to advance the missions at NCEP. To continue the progress, NCO and EMC should jointly identify the road blocks and aggressively remove them accordingly. For example, the current GFS model code may be inheriting decades of modeling research and develop lineage, it has been recognized by the community that the code requires modernization to facilitate collaboration. This is the kind of necessary infrastructure project strategically important but not tremendously exciting. EMC and NCO should document the common vision and mission with the supporting infrastructure carefully articulated so that this kind of infrastructure projects may become a priority and be funded appropriately.

It's been noted that EMC is establishing a visiting scholar program. NCO may want to use this program as a driver to modernize a model development and software engineering architecture with that aim to allow visiting scholars from any external organizations to be able to start working within days upon arriving the UCWCP building.

8. National Hurricane Center

1. Preface/Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

The UCACN meeting included separate breakout sessions for each of the NCEP centers, including the National Hurricane Center. A summary of the discussion, findings and recommendations from that session is given below.

2. Overarching Issues/Recommendations

The NHC has a clear mission statement and is perhaps the best-known NCEP Center, given the disruptive impacts that landfalling tropical cyclones have on a modern society. The Center is viewed very positively by the general public and the media in large part because NHC top management is very media savvy. The NHC is also fortunate to be blessed with an outstanding group of dedicated hurricane forecasters (Hurricane Specialists) who instill high public confidence in NHC's operational products. The Hurricane Specialists are strongly motivated individuals who are very interested in their jobs and doing the best job possible. The NHC continues to make excellent new hires who have very good science backgrounds and who are very interested in hurricanes. At the same time, forecasters in TAFB are leading the effort to transition TAFB into the gridded products world.

A new advanced community storm surge and inundation model from Jamie Rhome's group in the TSB looks to be outstanding and hopefully it can be made ready for operational implementation with a year or two (success in this endeavor will require a larger computer allocation since the new model will take longer to run and a large number of ensemble runs are required to cover all landfall scenarios and permit probabilistic forecast assessments). In a parallel effort, NHC has initiated another major storm surge communication and messaging initiative targeted at developing a new public "storm surge warning." The NHC also earns high praise for its pioneering efforts with FEMA, social science communication experts, and the broadcast media on forecast product construction and dissemination, and training in how to interpret and use these forecast products. Noteworthy are ongoing discussions between the NHC and these groups that are focused on coordination plans on the preparation of day 2, and possibly day 3, watches and warnings. NHC also continues to actively engage the emergency management community through FEMA through such exercises as hosting hurricane preparedness courses and developing FEMA national level hurricane exercises.

The NHC also has an outstanding rigorous and open forecast verification process that is the gold standard for the NWS and the Federal government. Indeed, Nate Silver's recent article in the New York Times Sunday Magazine section on the value of modern weather forecasts was effusive in its

praise of the NWS and the NHC for employing a rigorous and open quantitatively based forecast verification process that contributes significantly to confidence in the reliability of forecasts issued to the general public.

The NHC needs to continue to press forward on bringing the new storm surge and inundation model into the GIS architecture to expedite operational implementation, a task already underway but one that would benefit from broader agency-wide support. However, because of staff shortages, new product development from visualization and concept to application is fraught with bottlenecks. An absence of critical information technology (IT) support prevents NHC Hurricane Specialists and IT specialists from working together effectively to produce new operational products. In a related issue, AWIPS-2 delays and problems are adversely impacting new operational product development because of the associated development freeze. A creative and innovative solution to the IT bottleneck problem is needed because all of the required IT work needed to facilitate the operational implementation of new products can't be done remotely. Consideration should be given to whether IT specialists working with NCO can be available to help NHC expedite the operational implementation of new products. Although the NHC has been a leader in GIS product development and implementation within the NWS for some time, NHC would benefit even more if the use of GIS for the integration of new products critical for decision support services into operations could be embraced more widely.

It is also recommended that NHC:

1. Place more emphasis on the adoption of modern ensemble forecasting techniques and the development of new ensemble-based forecast products into operations
2. Continue to improve the coordination between TAFB and HSU and encourage HSU specialists with a strong interest in science to work on operationally relevant research during the off season,
3. Create incentives for NHC and HRD to work together more effectively on new research projects and the transfer of research results into operational products (this issue is currently being addressed through the CHART effort)
4. Consider modifications to the current shift schedules for the Hurricane Specialists to reduce the staff fatigue that seems to be an occupational hazard by the end of the season. Because there is a perception of an overlap in many quarters between the mission statements and responsibilities of NHC, OPC and HPC, consideration should also be given as to how best reduce any overlap and improve the coordination of services between these Centers. While we appreciate that each of these Centers will likely resist this suggestion and argue that only they have the expertise to do what they do, from the perspective of the UCACN review panel taking a more holistic view that removes artificial latitudinal boundaries between the individual Center area of responsibilities is likely to pay dividends in the long run.

The continuing decline in basic observations (e.g., buoys, Caribbean radiosondes) and possible future decreases in reconnaissance/research aircraft support needs to be reversed. There is still a great science need for research aircraft and for the transfer of aircraft-derived research findings, and their associated aircraft/satellite technologies, into operations. A generic problem across the Centers is that in order to maximize the output of existing staff the process of filling vacancies needs to be made much more efficient. In the case of NHC, the current NCEP-wide travel

restrictions are counterproductive because they adversely impact off-season outreach activities that are required as a part of NHC's mission.

3. Comments on Center's Continuing Response to 2009 Review:

In addition to what was discussed in section 2, the NHC has responded very well to the recommendations and findings in the 2009 NCEP review. Although significant resource constraints have precluded the implementation of all of the earlier recommendations as noted above, the NHC has been aggressive in implementing as many of these recommendations as possible and now/still appropriate, and they have seized new opportunities where these opportunities related to their mission statement (e.g., broadening hurricane-related outreach activities with emergency managers and the social sciences community).

Among the issues identified in the 2009 report, the NHC continues to make slow progress in reducing the IT bottleneck through the addition of new hires. Further progress in this area in FY13 appears unlikely at this time, given severe budgetary constraints, staff limitations and commitments to ongoing projects. Likewise, no decisions have been made about the future of the NOAA P3s and the USAF reconnaissance support. NHC would like to see a least one of the P3s re-winged which would extend the life of the airframe ~20 years but the estimated cost (~$30M) may be prohibitive. The critical ocean buoy network continues to be underfunded and inoperative buoys may be out of service for months until funds can be found to repair and reposition them.

4. Comments on FY13 Annual Operating Plan:

The strong likelihood of no new resources in FY13 will significantly impact the FY13 annual operating plan of every NCEP Center. The highest FY13 priority should be to develop and sustain new operational model capability. The heavy lifting (model development and improved model guidance) will have to be done at EMC/NCEP in collaboration with NHC. Since recent TC track and intensity forecast verification studies indicate that the global models (GFS and ECMWF) remain superior to high-resolution regional models in forecasting TC track, strong consideration should be given to the development of a higher resolution GFS along with higher resolution ensemble forecasts with more ensemble members. Success in this endeavor will have a favorable impact on all of the NCEP Centers and will likely lead to the dynamical models overtaking the operational statistical models in forecast skill. A just-completed review of NHC's FY13 Annual Operating Plan suggests that "no new development work will be possible, since all staff time is likely required for ongoing operations and maintenance and mandatory IT projects unique to this coming year, such as conversion to the WCOSS supercomputer and our migration to AWIPS-II." While staff limitations are indeed an obstacle to developing new products, there are several things that can probably be done with existing resources that would improve NHC operations (e.g, addressing actions and recommendations from the TC Irene Service Assessment, expanding storm surge discussion opportunities with EMC, and collaborating and coordinating with social scientists and other NCEP centers on implementing some of the vital communication lessons learned in the aftermath of TC Sandy

5. Comments on Strategic Planning:

The ongoing development of a unified modeling strategy for NCEP has a direct impact on the NHC. NHC has a strong role in HFIP, in its strategic planning management, development work and the use

of real-time output in operations (e.g., NHC created HFIP "Stream 1.5" concept whereby NHC Hurricane Specialists receive real-time HFIP model guidance). Likewise, NHC's Joint Hurricane Testbed has been very successful in supporting R2O projects that lead to operational products; these results are summarized in a review paper by Rapport et al. (2012) in the Bulletin of the American Meteorological Society. NHC has also been involved in ongoing discussions with the HFIP community on the need to incorporate ensemble forecasting techniques into operations, but to date very few ensemble forecasting applications have emerged from this effort. What ensemble forecasting techniques that have emerged have demonstrated only a limited ability (at best) to improve on conventional climatological and statistical analyses for representing forecast uncertainty. Although single model ensemble mean forecasts have not been able to do better than their parent higher resolution deterministic forecasts in predicting hurricane tracks and hurricane track uncertainty to date, we note that the FSU Superensemble (FSSE) had the best track forecasts during the 2012 season. The success of the FSSE suggests that the NHC should consider applying more sophisticated statistical data mining procedures to better extract the probabilistic information contained in multi-model TC forecast solutions. Note also that TAFB forecasters have been using the GFS/ECMWF ensemble forecast products in producing the Day 3-5 marine forecasts. The forecast future is probabilistic and the NHC is moving in the right direction in this area.

Although the proposed NCEP Visiting Scientist Program would primarily serve the NCEP Centers collocated at the NCWCP, the NHC already has a track record in this area because they have included on-air broadcast meteorologists as a part of the NHC Visiting Scientist program that was launched in 2010. As plans for the NCEP Visiting Scientist Program move forward toward implementation, subject to ongoing and future budgetary constraints, the NHC should be prepared to take fuller advantage of this program to enable scientists and interested graduate students to participate in a variety of hurricane-related research projects.

9. **Ocean Prediction Center**

1. Preface / Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

The UCACN meeting included separate breakout sessions for each of the NCEP centers, including the Ocean Prediction Center. A summary of the discussion, findings and recommendations from that session is given below.

The UCACN meeting coincided with the developing threat associated with Hurricane Sandy. The timing was fortuitous, because it provided the committee with an opportunity to observe coordination activity between several centers (NHC, OPC, HPC, and EMC) during a high profile event.

2. Overarching Issues/Recommendations

A larger issue which emerged during the OPC breakout session and other presentations at the October meeting is the need for a more strongly coordinated NOAA-wide ocean modeling strategy. Specifically, a stronger connection with the Coastal Survey Development Lab (CSDL) in NOS is needed, given that EMC lacks the requisite expertise for ocean model development. The UCACN recommends stronger and more direct collaboration between CSDL, EMC, and OPC in hydrodynamic model development. External to NOAA, these efforts would benefit greatly from leverage with ongoing work by the US Navy.

It is of note that these very same recommendations were made in 2004 in the Ocean Modeling External Review Report submitted to the NOAA SAB. The request for the external review was made by NCEP to the SAB. To be more specific, the NOS CSDL has on staff several bona-fide ocean and estuary and surge and inundation modelers. At least one of the staff members has extensive experience with at least multiple model systems, such as POM, ROMS, MOM, EFDC, FVCOM, SLOSH, ADCIRC, etc. Moreover this staff member has extensive experience with working with NWS WFO forecasters during severe storm conditions and providing probabilistic surge and inundation and retreat model output including currents, tides and waves for every 6 hours update on storm track, intensity, size, etc. CSDL does have ensemble-based probabilistic forecast capabilities. The US Navy does not have the in-house expertise that CSDL has presently.

The expansion of OPC into ecological prediction was discussed extensively. It is not clear that OPC has the expertise in house to sustain this effort, given that they have no apparent plans to hire an ecological modeler. Here, UMD Eastern Shores and VIMS are nearby universities that have in-house expertise that could be engaged to get the ecological forecasting initiative up and running. For example, at UMD Eastern Shores, an HBCU campus, there is a young academic who can run an ecological model that uses several of the more advanced 3-D,t models listed above, e.g., EFDC, as the hydrodynamic backbone, and can predict upwards of 21-22 ecological variables. Such an undertaking is very doable and would just require a partnership between NCEP/OPC and UMD

Eastern Shores. The model codes are public domain but require a scientist skilled at running 3D,t hydrodynamic and ecological models; such as exists at UMD-ES.

3. Comments on the OPC's Continuing Response to the Recommendations in the 2009 Review and in the 2011 Report

Considerable progress is evident for the majority of 2009 recommendations by the UCACN. The move to gridded forecasts and improved coordination with TPC are two notable areas of recent and continuing progress.

Other recommendations have been hampered by a lack of resources; for example, the need for a Science and Operations Officer (SOO) remains as strong as ever, but resource limitations make it unlikely that this position, which was recommended by the UCACN, will be filled. The addition of a SOO would put OPC in a stronger position to develop more ensemble-based probabilistic products in the marine realm.

Verification strategies using buoy and other observational data would also benefit from the addition of a SOO at OPC.

Other impressive accomplishments include the successful launch of a mobile web site, and strong engagement with external sectors in the realm of ecological forecasting. Regarding the latter, forecasts of sea nettles in Chesapeake Bay have been very popular, producing large numbers of hits on the Chesapeake Bay web site. Developing, and handing off a project of this type would demonstrate an effective public-private partnership.

4. Comments on FY13 Annual Operating Plan

A major effort is underway to transition to a gridded forecasting environment. Major challenges in this task include the mechanism for collaboration with a large number of coastal NWS field offices, and with NHC/TAFB. Nevertheless, OPC is targeting 1 April 2013 as the operational date for the debut of gridded forecast products.

Coastal NWS offices may exhibit a tendency to be more conservative in warning issuance for coastal waters than OPC, which could result in a mismatch in gridded guidance.

One of the UCACN recommendations from 2009 was stronger coordination with TAFB, and as a result, the Marine Synergy Team was formed. This initiative also includes coordination with the NWS WFO in Honolulu. The addition of forecaster Chris Juckins has been helpful, because he came to OPC from TAFB, and is very strong in GFE development.

5. Comments on Strategic Planning

The OPC should be involved in larger NCEP, NWS and NOAA ocean modeling strategic planning efforts. As the demand for ecological forecasting increases, there will be an increasing demand for products and services from OPC, but, as noted above, there is a shortage of relevant expertise within OPC to address this increasing demand. Therefore, steps to identify and hire such individuals as could enhance OPC's in-house expertise in this area are encouraged.

10. **Storm Prediction Center**

1. Preface/Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

The UCACN meeting included separate breakout sessions for each of the NCEP centers, including the Storm Prediction Center. A summary of the discussion, findings and recommendations from that session is given below.

2. Overarching Issues/Recommendations

The SPC is a very well managed organization with a clear mission statement and goals. This organization has a very dedicated and professional work force that sets a gold standard for the NWS on how to use limited resources effectively and efficiently. SPC forecasters and managers are also to be commended for a strong commitment to science and the publication of new scientific findings. Examples of this commitment include the SPC's pioneering leadership effort in the development of new science-based ensemble forecast products, the annual Spring Experiment which is second to none in enabling researchers and forecasters interested in the science and forecasting of severe weather to test-drive potential new operational products based on advances in convection-allowing numerical models and new observational datasets, and the long history of forecaster involvement in the science of severe weather forecasting as evidenced by their numerous refereed publications. We also note that the SPC has been very effective in working with FEMA, social scientists, and the media on communications, education, and forecast product dissemination. FEMA personnel are very pleased with the SPC Coordination efforts.

Although the SPC makes very effective "cross-utilization" use of staff in running "lean and mean," this praiseworthy effort hides but does not eliminate a staff shortage problem due to the prolonged illness of a lead forecaster. Because of this staff shortage new product development from visualization and concept to application is fraught with bottlenecks. An absence of critical information technology (IT) support prevents forecasters and IT specialists from working together effectively to produce new operational products. Although AWIPS-2 delays and problems are adversely impacting new operational product development, the review committee is pleased that limited development to allow critical service improvements has been embraced as part of the NCEP transition.

3. Comments on the SPC's Continuing Response to the Recommendations in the 2009 Review and in the 2011 Report

The SPC has responded very well to the recommendations and findings in the 2009 NCEP review. Although significant resource constraints have precluded the implementation of all of the earlier recommendations as noted above, the SPC has been aggressive in implementing as many of these recommendations and they have seized new opportunities where these opportunities related to their mission statement.

Four issues pertaining to the 2009 NCEP review and subsequent updates that related directly to the SPC's mission statement remain unresolved because of resource limitations and staffing issues. First, the SPC needs a 6th lead forecaster/decision support lead, a deputy director, and an IT/science project team lead. To assure that forecaster experience and acumen is preserved, lead forecaster numbers need to be maintained. Forecaster experience and the associated deep knowledge are invaluable in severe storm forecasting and facilitating effective interactions with partners (e.g., FEMA) and communicating with the media (e.g., chat rooms, The Weather Channel, private companies). The availability of an IT/Science Project team lead would help leverage the development of forecaster-initiated products and their transfer to operations. Second, the creation of an effective R2O process for storm-scale numerical weather prediction would be facilitated by the establishment of formal priorities for severe weather service improvements (with service providers including SPC strongly represented) and linking these priorities to an effective research and R2O funding mechanism similar to HFIP. Third, a possible casualty of the long-delayed and resource-constrained AWIPS-2 implementation is that creative and innovative "bottom-up" forecaster-initiated product development may be unintentionally hindered. In this regard, a framework for innovative "bottom-up" development could rest on "little things" such as preserving the operational utility of GEMPAK, given its simplicity, elegance, and flexibility. The current "milestone-driven" culture results in too many new "top-down" mandates that can lead to "mission creep" and further squeeze forecaster time to develop new "bottom-up" products. Fourth, specialized service centers, including the SPC, should lead NWS development of mission-focused post-processed guidance enabled by an NWS data-flow strategy that allows it to be shared with internal and external partners in all sectors of "The Weather Enterprise." Focusing development of this specialized guidance at service centers like the SPC will enable creation of innovative products through effective exchanges between specialized developers and important user communities.

4. Comments on FY13 Annual Operating Plan:

The strong likelihood of no new resources in FY13 will significantly impact the FY13 annual operating plan of every NCEP Center. The highest FY13 priority should be to develop and sustain new operational model capability. Success in this endeavor will have a favorable impact on all of the NCEP Centers. We recommend that the SPC have a "conversation" with EMC/OD about establishing a future suite of limited-area high-resolution convection-allowing model runs.

5. Comments on Strategic Planning:

The ongoing development of a unified modeling strategy for NCEP has a direct impact on the SPC. Currently, the NSSL WRF is the most important storm-scale model operational model available to the SPC. The SPC needs a dedicated storm-scale numerical model for operations. The establishment of a formal severe storm program within the NWS to be based at the SPC would enable the SPC to take full advantage of a unified modeling strategy at NCEP.

Although the proposed NCEP Visiting Scientist Program would primarily serve the NCEP Centers collocated at the NCWCP, a compelling argument can also be made for allowing the SPC to also host visiting scientists. The colocation of NSSL and the SPC at the National Weather Center in Norman, OK, would enable the SPC and NSSL to take maximum advantage of the implementation of a unified modeling strategy at NCEP, especially if a formal severe storm R2O process is established within the NWS.

We strongly endorse the SPC recommendation that transition from RAP to RAPv2 be accelerated as soon as possible to support SPC and NWS operational severe weather forecasting. The SPC has found that the RAP analysis has performed poorly at times compared to the previous RUC and the newer RAPv2, especially with regard to representing PBL structures properly (e.g., capping inversions and vertical moisture profiles). Success will require a coordinated effort by SPC, GSD, EMC, and NCO.

11. Space Weather Prediction Center

1. Introduction

The University Corporation for Atmospheric Research (UCAR) Community Advisory Committee for the National Centers for Environmental Prediction (NCEP) held its annual meeting on 25-26 October 2012 at the National Center for Weather and Climate Prediction (NCWCP), a beautiful new facility operated by the National Oceanic and Atmospheric Administration (NOAA) in Riverdale Park, MD.

Brent Gordon, SWPC Operations Officer, was present for the UCACN meeting. A breakout session on Thursday, Oct 25th was held with Brent Gordon and UCACN members, Karen Shelton-Mur (SWPC lead), and Warren Qualley (SWPC back-up lead). A summary of the discussion, findings and recommendations from that session is given below.

2. Overarching Issues/Recommendations

The SWPC continues to take seriously the recommendations from the 2009 NCEP review and has made good progress; currently, they have completed more than half (38/58) of the action items and the UCACN appreciates their due diligence. We also want to point out that due to the severe budget environment that the Federal Government has been under; several of the actions were cancelled, delayed, or re-scoped due to budget constraints and/or unrealizable funds. The following items are overarching recurring, or new issues that were brought out in the recent UCACN meeting.

The lengthy hiring process within NOAA is a recurring theme that impacts many of the other centers. Two examples from the SWPC are as follows:

1. SWPC has been without a director since Feb 2012; and as of the date of this report, there is still no new director.
2. Attempts to fill an IT position have been ongoing for 16 months.

Fortunately, the competent leadership of the NCEP director and within SWPC has helped keep the center functioning on schedule. **The UCACN recommends that SWPC reopen this action item so that NCEP continue to work with NOAA leadership on process improvement for the hiring of all center personnel.**

Other challenges that remain from the 2009 review have to do with satellite data acquisition, processing, and validation. The UCACN recognizes that these actions can be challenging to enact because they depend on other divisions accepting responsibility for, and adding new line items to their budget and congress appropriating the funds. However, they are extremely important to the growth and well-being of the SWPC which is why the UCACN continues to bring this up as a concern and strongly urges SWPC to continue these efforts. Specific recommendations are given in the section that follows.

UCACN has become increasingly concerned about a risk to SWPC's successful mission operation regarding the possible loss of a coronagraph currently located on NASA's SOHO research satellite. SOHO, designed for a two-year mission, was launched in 1995 and is currently 15 years past its mission design. SWPC also utilizes data from NASA's STEREO satellites; another research mission The UCACN is concerned that SWPC is utilizing data from research missions as a critical tool to support its operations. The **UCACN recommends that SWPC work within NOAA to fund an operational coronagraph replacement and ensure that NESDIS add a satellite/coronagraph to its near term budget (2017-2018). The UCACN also recommends that SWPC identify a**

contingency plan for space weather forecasting in the event that the SOHO spacecraft were to fail before a replacement is in place.

Another new challenge for SWPC's future data needs is ensuring that the necessary ground data acquisition network as well as a processing center is available for the COSMIC-2 mission. **The UCACN recommends that SWPC continue to work with NESDIS and UCAR to ensure that this necessary segment of the COSMIC-2 mission is adequately funded.**

While some progress has been made in regard to the identified "Mission Creep" threat that emerged between NASA's Community Coordinated Modeling Center and the SWPC; this event escalated this past summer due to a Washington Post article highlighting inconsistent space weather forecasts issued by the two Federal Agencies for the same solar storm. While leadership within both agencies have been working to clarify and identify clear-cut roles and responsibilities via a governance document that is planned to be signed in November, 2012 by Dr John Grunsfeld (NASA - Associate Administrator for Science Mission Directorate) and Ms. Laura Furgione (NOAA – Acting Assistant Administrator for Weather Services), there continue to be noticeably strained relationships within the lower-level research community. See the UCACN recommendation in the next section for mitigation of this threat.

The last major overarching issue involves high performance computing concerns in the near future to support the Whole Atmosphere Model (WAM) and emerging geospace models that will require significant computing capacity. **The UCACN recommends that SWPC ensure that operational capacity will be available in the near future (2015-2017) by working with NCO and EMC to identify the required computing capacity now and adding any deltas to future budget requests.**

3. Comments on the SWPC's Continuing Response to the Recommendations in the 2009 Review and in the 2011 Report

Below we call out the UCACN recommendations that were identified in the 2009 review and are being actively worked by the SWPC.

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*."

Status:

- 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 FY10, 11 & 12.
- With DSCOVR replacing ACE in FY14 and the GOES-R ground system coming online in FY15, it was determined that the funding SWPC did receive would be better spent on Test Bed transition activities.
- New action item has been identified to ensure that GOES-R and DSCOVR are adequately funded and supported by NESDIS

The UCACN concurs with the decision to maintain the current status quo and to shift focus to ensure the GOES-R and DSCOVR missions will be serviced or funded under NESDIS.

Recommendation MV2: "*Recent creep into SWPC service mission by elements of the space weather enterprise beyond SWPC needs to be addressed*"

Status:

- UNSWOC MOA is now in final form and being reviewed by each agencies' general counsel.
- NWS, NCEP, and SWPC continue to foster a constructive relationship with Barbara Giles, the new NASA Heliophysics Director
- Governance document ready to be signed

The UCACN commends the SWPC for its due diligence to eliminate this threat with the governance document. The UCACN further recommends that in addition to the completion of the MOA and governance documents, SWPC take further action to minimize any lingering negative impacts among the working-level employees. SWPC should ensure that both SWPC and CCMC employees (that have not been directly involved. i.e. researchers, etc.) are clear on their roles/responsibilities for their given agency. The UCACN further recommends that information sharing and collaboration between both agencies is transparent and is returned to the same level of cooperation prior to this event.

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."*

Status

- Work is ongoing, but on a much smaller scale than originally envisioned.
- Targeting priority customers with immediate needs through Solar Max.
- Readdressed on a larger scale after Solar Max

The UCACN believes that requirements identification and relevance of SWPC products and services, using input from their varied customer base, is even more critical during Solar Max. An increased effort should be made in FY2013 to work through this action.

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"*

Status

- Delayed FY14-15. Attempts to establish this through OAR failed
- Current NOAA budget priorities make this option non-viable
- Established the Space Weather Prediction Testbed (SWPT) to provide research needs

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 R20 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,*
- *Establish an advisory committee to oversee development and implementation of the long-range plan.*

Status

- Delayed – FY14.

- Will Establish SWPT Executive Committee (Oversight Board) in FY12 as a stop-gap

Recommendation BP2: "*Develop comprehensive robust business models for the SWPT and the R20 function. There are a number of successful organizational arrangements 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 R20 transition:*

Status

- Internal SWPT interest group formed in 2010
- Will establish a steering committee in FY12 with NOAA, DoD, NASA, NSF
- Realigned positions within SWPC to hire 3 GS13 staff members
- Working to identify SWPT funding as critical gap for Fy14 budget.
- Assessing in place federal staff members to utilize grants to fill critical R&D positions.

The UCACN recognizes that government agencies are facing severe budgetary pressures and applauds SWPC's efforts to continue to find solutions regarding recommendations ST1, ST2, and BP2. UCACN also acknowledges the NCEP Director's message on Oct 25, 2012, regarding sub-optimal research due to limited funds and it is best to leave the research to the agencies that have a research mission (such as NASA, NSF, etc.). The UCACN recommends that SWPC, with the help of the UCACN, establish the SWPT advisory committee. This advisory committee should then help focus the efforts of the appropriate research agencies onto topics that can be best applied to SWPC's operational mission. The UCACN also recommends that SWPC continue to improve the working relationship with CIRES by communicating ongoing R&D initiatives/planning and invite them to participate on R&D advisory committees (numerical space weather prediction advisory committee, etc.).

4. Comments on the FY13 Annual Operating Plan

SWPCs identified activities, and focus for FY 13 appear reasonable and continue to address its challenges and work towards improvement of its science and technology, personnel and organization, processes, customers and partners, products and services, and information systems. The UCACN suggests that the new recommendations presented in this document be added to its FY 13 operating plan budget. For example, plans to establish the DSCOVR, GOES-R COSMIC, and coronagraph data processing and funding capabilities within NESDIS should be added in addition to planning and collaboration with other centers for future WAM/geospace model computing capacity, and a backup plan for potential loss of a coronagraph.

5. Comments on Strategic Planning

SWPC's FY13 Strategic plans are progressive and incorporate relevant space weather research, products and services, and focus on establishing a healthy working environment, good relations and collaboration among its customers and partners and are focused on transitioning research to operations. The UCACN is pleased that SWPC is developing and assessing new products to better serve its current customer base such as aviation, satellite operators, and the commercial space weather providers. The UCACN would like to see SWPC incorporate planning for future space weather products and services that would serve the needs of the commercial space transportation industry and FAA NextGen transportation system. SWPC should also ensure that it addresses and incorporates any new R&D activities listed in the National Research Council's recently released Decadal Survey for Space Weather 2012.

SWPC has a process similar to the proposed NCWCP Visiting Scientist Program (VSP) and is considering the idea of bringing on board a scientist through the NSF to work in the new NCWCP

building. The UCACN suggests that they consider using the proposed NCWCP VSP instead of their program; the visiting scientist could conduct applied research on the WAM/geospace WSA-Enlil ensemble, and radiation models for aviation.

12. Appendix: Acronyms

ACE	Advanced Composition Explorer
ACSWA	American Commercial Space Weather Association
ADCIRC	ADvanced CIRCulation model
AFB	Air Force Base
AMS	American Meteorological Society
AOC	Airline Operations Center (NOAA)
AOML	Atlantic Oceanographic and Meteorological Laboratory
AOP	Annual Operating Plan
AR	Alaska Region
ARWG	Aviation Requirements Working Group
ASDI	Aircraft Situation Display for Industry
ATCSCC	Air Traffic Control System Command Center
ATM	Air Traffic Management
AWC	Aviation Weather Center
AWIPS	Advanced Weather Information Processing System
AWIPS-2 (or II)	Advanced Weather Information Processing System (generation 2)
AWRP	Aviation Weather Research Program
AWT	Aviation Weather Testbed
AWWD	Aviation Winter Weather Dashboard
BoM	Bureau of Meteorology (Australia)
BP	Business Processes
CAAC	Civil Aviation Authority of China
CAPS	Center for Analysis and Prediction of Storms (OU)
CCMC	Community Coordinated Modeling Center (NASA)
CDM	Collaborative Decision Making (FAA)
CFS	Climate Forecast System
CIMMS	Cooperative Institute for Mesoscale Meteorological Studies (OU)
CIO	Chief Information Officer
CIRA	Cooperative Institute for Research in the Atmosphere
CIRES	Cooperative Institute for Research on Environmental Systems
CMA	China Meteorological Administration
COLA	Center for Ocean-Land-Atmosphere Studies
CONUS	Continental United States
COOP	Continuity Of Operations Plan
COSMIC-2	Constellation Observing System for Meteorology Ionosphere and Climate
CP	Customers and Partners
CPC	Climate Prediction Center
CPHC	Central Pacific Hurricane Center
CPO	Climate Program Office
CSDL	Coastal Survey Development Lab
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
DoE	Department of Energy
DoI	Department of the Interior
DSCOVR	Deep Space Climate Observatory
DSS	Defense Security Service
DTC	Development Test Center
ECFP	Extended Convective Forecast Product
ECWMF	European Center for Medium-range Weather Forecasting
EF	Ecological Forecasting
EFDC	Environmental Fluid Dynamics Code
EIS	Environmental Information Services (as in "Open EIS")
EMC	Environmental Modeling Center
ENSO	El Niño and the Southern Oscillation
ESMF	Earth System Modeling Framework
ESRL	Earth System Research Laboratory
EuroSIP	European Seasonal to Interannual Prediction system
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FOC	Full Operational Capability
FSSE	Florida State Superensemble
FTE	Full-Time Equivalent
FVCOM	(Unstructured Grid) Finite Volume Coastal Ocean Model
GFDL	Geophysical Fluid Dynamics Laboratory
GFE	Graphical Forecast Editor
GFS	Global Forecast System
GIS	Geographic Information Systems
GOES	Geostationary Operational Environmental Satellites
GPS	Global Positioning System
GPU	Graphical Processing Unit
GSD	Global Systems Division
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 (or High Performance Computing)
HRD	Hurricane Research Division
HSU	Hurricane Specialist Unit
HWT	Hazardous Weather Testbed
HYCOM	Hybrid Coordinate Ocean Model
IAP	Integrated Action Plan
IATA	International Air Transport Association
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 (2nd field program)
MJO	Madden-Julian Oscillation
MME	Multi-Model Ensemble
MOTL	Meteorologist-Over-The-Loop
MS	Master of Science
MV	Mission and Vision
MWD	Meteorological Watch Desk
NAEFS	North American Ensemble Forecast System
NAM	National Aviation Meteorologist
NAPA	National Academy of Public Administration
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
NEMS	NOAA Environmental Modeling System
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
NMME	National (North American) Multi-Model Ensemble
NOAA	National Oceanic and Atmospheric Administration
NOC	National Operations Center
NOPP	National Ocean Partnership Program
NOS	National Ocean Service (NOAA)
NPSS	NOAA Polar Satellite System
NRC	National Research Council
NSO	National Solar Observatory
NSSL	National Severe Storms Laboratory
NSWP	National Space Weather Program
NSWPC	National Space Weather Program Council
NSWW	National Severe Weather Workshop
NUOPC	National Unified Operational Prediction Capability

NWP	Numerical Weather Prediction
NWS	National Weather Service
NWSEO	NWS Employees Organization
NWSHQ	NWS Headquarters
O2R	Operations to Research
OAB	Ocean Analysis Branch
OB	Operational Bridging
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)
OST	Office of Science and Technology
OSTP	Office of Science and Technology Policy
OU	University of Oklahoma
Open EIS	Open Environmental Information Services
PBL	Planetary Boundary Layer
POC	People and Organizational Culture
POM	Pacific Ocean Model
PR	Pacific Region
PS	Products and Services
QMS	Quality Management System
QPE	Quantitative Precipitation Estimates
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
RAP	Regional Area Prediction
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
SOHO	
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 Aerodrome Forecast
TAFB	Tropical Analysis and Forecast Branch
TC	Tropical Cyclone
TFM	Traffic Flow Management
THORPEX	The Observing System Research and Predictability Experiment
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
WCOSS	Weather and Climate Operational Supercomputing System
WCRP	World Climate Research Program
WET	Weather Evaluation Team
WFO	Weather Forecast Office
WGNE	Working Group on Numerical Experimentation
WMO	World Meteorological Organization
WOF	Warn on Forecast
WRF	Weather Research and Forecasting (model)
WWB	World Weather Building
WWRP	World Weather Research Program