2009 Community Review of the

NCEP Aviation Weather Center

Carried out by the

University Corporation for Atmospheric Research

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Executive Summary

The University Corporation for Atmospheric Research (UCAR) was requested in November 2008 by the National Centers for Environmental Prediction (NCEP) to facilitate a thorough and thoughtful community review of the nine centers that comprise NCEP, as well as the NCEP Office of the Director. This report summarizes the review of the Aviation Weather Center (AWC) and was conducted by the panel that also reviewed the Storm Prediction Center (SPC).

Among all NCEP service centers, AWC is unique in that its mission is driven principally by the requirements of a Federal agency different from the one by which it is administered, and also because AWC does not have an operationally "quiet season." In the midst of a notably challenging environment, AWC provides quality services and has achieved important product innovations. However, AWC is entering a time of great change and its response to and engagement in that change must be carefully planned. To be successful going forward, AWC must:

- Become more directly involved with planning for the Federal Aviation Administration's (FAA's) Next Generation Air Transportation System (NextGen) initiative, which will fundamentally change the way aviation stakeholders interact with the air traffic infrastructure as well as how decisions are made with aviation weather products and services. It is critical that AWC establish itself as a major player on the NWS team supporting NextGen, because AWC's role, products and operational strategy likely will be profoundly different in the NextGen era.

- Establish the Aviation Weather Test Bed as a vibrant environment for intellectual activities and the development of partnerships throughout the aviation weather community. Although one goal will be for the Test Bed to serve as a mechanism for transferring research to operations, the pathway for doing so is via partnerships, including those with organizations for which little or no direct interaction might now exist. Properly done, the Test Bed will become a forum for exploring important practical problems, developing trust and relationships, and building pathways toward future products and services such as those integral to NextGen.

- Explore additional mechanisms for automating the creation and delivery of products and services. The current product generation strategy is a mixture of manual and automated methodologies and thus is an important limiting factor in the ability of AWC to provide new products. With programs like NextGen on the horizon, many AWC forecast products will become obsolete unless they are re-tailored into tools for the NextGen decision support framework. Additionally, legacy products – which are difficult to retire for a variety of reasons – need to be carefully examined in collaboration with FAA and users with a view toward eliminating those that are of marginal value or have relatively few users.

1. Introduction

1.1. Purpose: Context and Summary of Charge

The University Corporation for Atmospheric Research (UCAR) was requested in November 2008 by the National Centers for Environmental Prediction (NCEP) to facilitate a thorough and thoughtful community review of the nine centers that comprise NCEP, as well as the NCEP Office of the Director. NCEP is organized under the National Weather Service (NWS) of the National Oceanic and Atmospheric Administration (NOAA). The nine centers include:

- Aviation Weather Center (AWC; Kansas City, MO)
- Climate Prediction Center (CPC; Camp Springs, MD)
- Environmental Modeling Center (EMC; Camp Springs, MD)
- Hydrometeorological Prediction Center (HPC; Camp Springs, MD)
- NCEP Central Operations (NCO; Camp Springs, MD)
- Ocean Prediction Center (OPC; Camp Springs, MD)
- Space Weather Prediction Center (SWPC; Boulder, CO)
- Storm Prediction Center (SPC; Norman, OK)
- Tropical Prediction Center (TPC; Miami, FL)

This report concerns the Aviation Weather Center (AWC) and was conducted by the panel that also reviewed the Storm Prediction Center (SPC). The last AWC review facilitated by UCAR occurred in 1998.

The 2009 review of NCEP was undertaken because the centers of NCEP are viewed collectively as a critical national resource that delivers national and global weather, water, climate and space weather guidance, forecasts, warnings and analyses to its partners and external user communities. These products and services respond to user needs to protect life and property, enhance the Nation's economy and support the Nation's growing need for environmental information. As the centerpiece of the National Weather Service's science-based forecast enterprise, NCEP serves as the focal point for weather, climate and space weather modeling, analysis and dissemination of forecast products and services. As such, it is essential that NCEP be held to a set of high standards that define the quality, quantity, timeliness, impact and improvement over time of its products and services. An independent, external evaluation of the effectiveness with which NCEP is accomplishing its mission and realizing its vision was deemed necessary.

It has been over a decade since most centers have been assessed, as external reviews of each center occurred independently most recently during the period 1996 – 2001. In particular, the complementary roles and interactions among the centers were not comprehensively reviewed. The goal of the current review is to evaluate the entire range of NCEP activities, with particular emphasis on the way in which the various centers interact with each other, and in some cases rely upon each other, and with other NOAA, federal, academic and non-governmental entities.

This is a particularly appropriate time to conduct such a review insofar as many national and international challenges have arisen that require NCEP to operate at the highest possible level of

scientific and technological excellence. Examples of challenges facing the Nation for which NCEP's products and services are essential include the following:

- The growing threat of hazardous weather reached a new and staggeringly high level of severity in the 2005 hurricane season during which 28 named storms threatened the U.S. Atlantic and Gulf of Mexico coastlines, including Hurricane Katrina that caused massive damage and loss of life in New Orleans and along the Gulf coast.

- The 2007 International Panel on Climate Change released its fourth assessment report, stating unequivocally that the Earth's climate is changing at an unprecedented rate as a result, in part, of human activities. This recognition, along with the growing predictive understanding of the influence of El Niño and the Southern Oscillation, and a host of other climate factors and conditions, on climate-sensitive sectors of the U.S. population and economy, has led NOAA to begin planning for a suite of National Climate Services.

- Adverse weather continues to strongly affect the aviation industry, and the NWS' pledge of support to satisfy the weather requirements of the Federal Aviation Administration's (FAA's) NextGen initiative will place increased demands on NCEP services.

- Solar activity, in the form of flares and coronal mass ejections, has a profound influence on the Earth's atmosphere (causing beautiful auroral displays) and can project fluxes of high energy particles that can disrupt communications, navigation, satellites, electric power grids, and human space flight. Solar activity has an approximately 11-year cycle and has been at a minimum for the past few years, and is expected to rise to its next maximum in 2013. Given the increasing dependence of the U.S. and world economies on aviation, telecommunications, and the Global Positioning System (GPS), the coming Solar Maximum has the potential to be highly disruptive.

Because the threat to life and property from weather, climate and space weather anomalies has never been higher and continues to rise, the products and services of NCEP must be of the highest quality, timeliness and impact.

In order to provide a review that could be most useful to NCEP, the UCAR review was organized into five panels, each of which was asked to review two NCEP centers both individually and as a complementary pair. The five panels were asked to review:

- AWC and SPC
- CPC and HPC
- EMC and NCO
- OPC and TPC
- SWPC

In each case, the pair of centers was chosen specifically because the two centers in each pair are expected to work more closely together, having affinities of mission and/or stakeholder communities.

Each panel was asked to review the centers' vision and mission to determine its relevance, appropriateness and alignment with NCEP's strategic plan. The review also assessed the productivity and quality of the scientific activities, and the quality, relevance and impact of operational products and services. Special emphasis was placed on the ability to gauge and meet customer demand and emerging requirements, the effectiveness of activities intended to support technology transfer based on research conducted either within or outside NOAA, and the effectiveness of collaboration with the academic research community or the private sector. The review evaluated the balance between operations and research and development and assessed the plans for evolving the suite of products and services. Finally, as indicated above, the interactions of each center with its "sister" center (except SWPC) and the outside community were evaluated. The full charge to the review panels is provided in Appendix A

1.2 Procedure

The review panel conducted its site visit to AWC on 23-24 June 2009. To prepare for the visit, a set of questions was provided to AWC leadership. In return, a comprehensive binder of material was provided to the review panel. This included responses to the panel's questions; AWC overview documents; and information on customers, products, and services, transition of research to operations, performance measures, budgets, and strategic planning. A web-based survey also was distributed to a variety of stakeholders.

At the visit, AWC Director Bob Maxson presented highlights of the center including successes and challenges. Other presentations were given on topics including customers and partners, products and services, quality assurance, the NWS Employees Organization (NWSEO), NextGen, the Aviation Weather Test Bed (AWT), and information systems and technology resources. Time also was spent conducting interviews with staff in the Support Branch, Domestic Branch, International Branch, and with the Collaborative Convective Forecast Product (CCFP) and convective Significant Meteorological Advisory (SIGMET) forecasters. A tour was provided of operations, and the visit concluded with a briefing of initial findings and recommendations to AWC leadership and the NCEP Director, Dr. Louis Uccellini.

2. Overview of the Aviation Weather Center

2.1 Mission and Vision

The AWC is part of the NWS and one of seven service centers in NCEP. According to the AWC Five-Year Strategic Plan (2009-2013) dated 2 September 2008, the mission of AWC is as follows:

> *The AWC delivers consistent, timely and accurate weather information for the world airspace system. We are a team of highly skilled people dedicated to working with customers and partners to enhance safe and efficient flight.*

Likewise from the same document, the vision of the AWC is as follows:

> *The trusted authority and leading innovator for aviation weather information.*

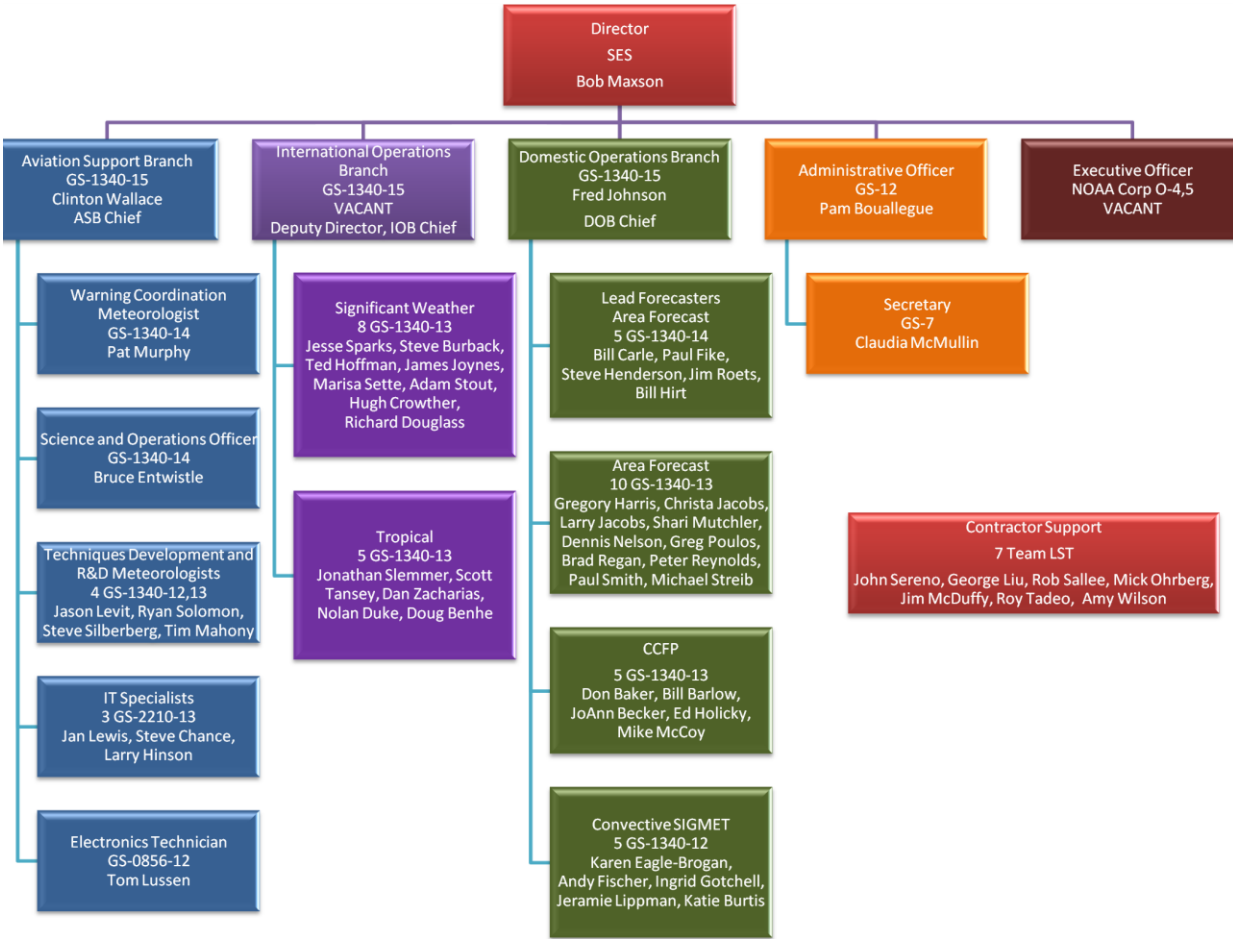
AWC provides a broad suite of products and services to aviation interests to help ensure safe, efficient operations within the US National Airspace System (NAS) as well as globally. AWC prepares all NWS domestic and international aviation products with the exception of gridded forecasts for flight planning, terminal forecasts, transcribed weather broadcasts, and certain products issued by Center Weather Service Units (CWSU) and the Alaska and Pacific Regions. AWC customers include but are not limited to commercial airlines, business and cargo operators, general aviation, academia, and other users having interests in aviation weather.

2.2 Brief History

Formerly known as the National Aviation Weather Advisory Unit (NAWAU), AWC was established in 1995 as part of a comprehensive NWS modernization. Its establishment was concurrent with conversion of the Severe Local Storms (SELS) Unit of the National Severe Storms Forecast Center into SPC. In 1999, AWC moved to a new building in northern Kansas City, MO to be co-located with the NWS Training Facility and Central Region Headquarters.

2.3 Organizational Structure

AWC is organized into an Aviation Support Branch, International Operations Branch, and Domestic Operations Branch, with leadership consisting of a Director, three Branch Chiefs (one of whom also serves as Deputy Director), and an Administrative Officer and Executive Officer (see figure below). At the time of the review, AWC staff comprised 38 operational forecasters, nine support staff, seven management staff, one NOAA Corps staff and seven contract employees.



3. Progress Since the Previous Review

AWC has made considerable progress since its last review in 1999. Some actions stem from explicit recommendations made by the review panel while others arose from external stimuli and internal initiatives.

Owing to the AWC's new facilities with improved office and forecaster floor space as well as upgraded communications, previous issues regarding antiquated computing equipment are no longer valid, and AWC has a good equipment replacement plan. Two World Area Forecast Centers (WAFCs) have been instituted, one in Washington, DC and the other in London, to provide complementary global coverage of aviation weather. AWC serves the Washington Center WAFC by issuing Significant Weather Forecasts (SIGWX). WAFC Washington also is the backup for WAFC London (and vice-versa).

The Collaborative Convective Forecast Product (CCFP) is now in its ninth season and is designed to aid the FAA Command Center in maintaining a smooth flow of air traffic even in the presence of convective storms. AWC is the centerpiece of this activity to which five GS-13

personnel have been assigned. CCFP products are issued every 2 hours and include 2, 4, and 6-h forecasts. Collaborators include FAA, CWSU meteorologists, and airline personnel.

The Tropical Area Forecast Desk was transferred from TPC/NHC to AWC and provides text-based area forecasts (FA) for general aviation pilots including information regarding clouds, visibility, thunderstorms, rain/snow/fog, and wind. AWC has responded to suggestions that it make the information in its products more easily interpretable. For example, G-AIRMETs (Graphical AIRMETs), which convey AIRMET information in a more accessible graphical form, are under development. These have been produced operationally since 2008 and are assigned an "experimental" status by FAA until completion of their safety analysis process (scheduled for late 2009), at which point G-AIRMET will be considered a primary product.

AWC also has implemented a suite of operational automated products, the development for most of which was supported by the FAA's Aviation Weather Research Program (AWRP), with the associated research conducted by principally the National Center for Atmospheric Research (NCAR), NOAA Earth Systems Research Laboratory (ESRL) Global Systems Division (GSD), Massachusetts Institute of Technology (MIT) Lincoln Laboratory, and several universities. These products include the Current and Forecast Icing Products (CIP and FIP), the Graphical Turbulence Guidance (GTG), and the National Convective Weather Forecast (NCWF). Additional automated products, such as a ceiling and visibility analysis, are in experimental stages and will be transferred to AWC when they are approved by FAA and NWS. The implementation of research from sources external to AWC is in line with recommendations from the previous review panel.

AWC operates its own web site, http://aviationweather.gov, which includes a suite of products in text and graphical format as well as the International Flight Folder Documentation Program (IFFDP). Significant development of this site has occurred since the last review, in line with panel recommendations.

AWC also is home to ADDS, the Aviation Digital Data Service, which is found at http://adds.aviationweather.gov. This is a one-stop-shopping location for a variety of aviation weather hazard products, including the aforementioned automated products as well as aviation-relevant observations and model-generated fields. Since its inception in January 2003 the number of monthly web hits has risen from ~1 million to over 10 million.

4. Summary of Stakeholder Survey

To gain a better understanding of stakeholder perspectives, the review panel developed a survey that was distributed to several thousand AWC customers including airlines, corporate and general aviation associations, commercial service providers, government (including Federally Funded Research and Development Centers), the military and foreign interests. An analysis of survey responses is located at the web link http://www.vsp.ucar.edu/events/NCEP/.

Sixty customers provided responses, with over half of them indicating their profession as "Other" or "Not answered". Text input for "Other" indicates that at least six were from NWS, four others listed themselves as "Meteorologist", four as "Education", "Professor" or "Teaching", two as "Flight Dispatchers", and one as a "Sales Representative" and one as a "Manager".

- The majority of responses indicated a clear preference ("Strongly Agree") to obtain aviation weather information from NOAA. The same was true when asked if "Products are accessible in a timely fashion" and if "AWC's mission is known by my organization".

Nearly all of the remaining questions received less than a 50% response rate.

- The majority of responses were "Agree Somewhat" to questions about the degree to which AWC understands its organization's needs, that "AWC has an effective mechanism for requesting input from stakeholders", that "AWC responds to questions and problems," and that "AWC is responsive to suggestions for improving products or developing new ones". Further, the majority of responses were "Agree Somewhat" to questions regarding "product consistency", whether "existing products are improved at an appropriate pace," and whether "AWC products are state of the art.".

- In the category "Importance of Product" and "Usefulness of Product," the same five products were listed in nearly the same order of decreasing importance: SIGMET, Convective SIGMET, CCFP, AIRMET and World Area Forecast Systems (WAFS) charts.

Open comments covered a wide range of topics and those having a common thread are listed below:

- Benefits to stakeholders: the website is great for use in the classroom; ADDS, CCFP, 24x7 support also provide notable benefits.

- SIGMETs: too broad for commercial airline use; zero lead time and need to wait for urgent pilot reports before issuing.

- CCFP: Need to collaborate with SPC; get more involved in the Collaborative Decision Making Weather Evaluation Sub-team process; make CCFP more probabilistic.

- Process: Slow to change; lack of consistency from forecaster to forecaster; too little collaboration with researchers; should have more of a role in the Aviation Weather Research Program; how is AWC fitting into NextGen?; staff needs to be energized; AWC, NCEP, NWS headquarters need to work together, not independently.

5. General Observations and Overarching Issues

Among all NCEP service centers, AWC is unique in that its mission is driven principally by the requirements of a Federal agency different from the one by which it is administered, and also because AWC does not have an operationally "quiet season." The NAS operates at near peak levels year round, and consequently AWC must provide products and services on a continuous basis. AWC supports a stakeholder community that spans a wide range of public and private sector organizations, ranging from FAA to commercial air carriers to corporate flight departments and general aviation pilots. Also unlike other NCEP centers, AWC's domain of responsibility is international. Its products are a mix of automation and collaboration, a mix of the very old and the cutting edge, and a mix of core responsibilities and unfunded mandates. In the midst of a notably challenging environment, AWC provides quality services and has achieved important product innovations. However, AWC is entering a time of great change and its response to and engagement in that change must be carefully planned.

The greatest change on the horizon, led by FAA, is NextGen, which will fundamentally change the way aviation stakeholders interact with the air traffic infrastructure as well as how decisions are made with aviation weather products and services. This initiative extends beyond the US and no doubt will serve as a model for other nations. It is critical that AWC establish itself as a major player on the NWS team supporting NextGen. If NWS is the major contributor to the "Single Authoritative Source for Weather", as stated in NextGen planning documents, then AWC must be a key contributor to the value proposition in the weather content. Today's AWC products and services will not support that mission. Persistence does not win in this case – it takes creative, motivated, intellectually stimulated individuals in a supportive and enabling environment to ensure success of the weather components of NextGen.

An initiative also exists to re-organize CWSUs from their traditional on-site support role at the Air Route Traffic Control Centers (ARTCCs) to a more central operating role under the AWC umbrella. This first step in addressing a longstanding problem in aviation weather support is critical to the future success of AWC. AWC must repair relationships torn apart from years of miscommunication and perceptions of disinterest. It must reconstitute processes that will not only support but also outlive the current NAS structure. And it must revitalize a workforce that has been poorly managed in the past. These challenges will require time, commitment and innovation on the part of AWC management and, in particular, strong support from NCEP leadership.

Several areas of opportunity exist for AWC, including (1) people and facilities; (2) management style and environment; and (3) leadership support and communication. If AWC continues to operate as it does today, it will become obsolete by the end of the decade. It was apparent when speaking with all groups at AWC that a chronic problem exists with regard to staffing. If left unaddressed, the opportunities and challenges listed above will hobble AWC's efforts to move forward. With adequate attention given to these areas, reflecting specific recommendations made herein, a very good chance exists that AWC will become a major contributor and integral part of NextGen – a goal which AWC should embrace.

One of the most important recent changes at AWC concerns leadership. The team now in place is extremely capable and collegial, and the new director has created an environment of openness.

However, notable challenges remain, such as customer engagement, prioritizing plans, and working with bureaucracy to get the job done. The lines of communication among NWS headquarters, NCEP leadership and AWC management need to be more clearly executed to provide a common message. Providing a united front to FAA is advantageous for yielding the products and services critical to the FAA's success. NextGen is as much a cornerstone of the future for NWS as it is for FAA, and AWC should be the star player on the NCEP team. Making that happen is a critical issue for NCEP leadership going forward.

6. Findings and Recommendations

6.1 Mission and Vision

The first part of AWC's mission statement could be made more inspiring, and better set AWC apart from other aviation weather forecast facilities in the world. The current vision is a pronouncement instead of an aspiration. For example, the vision statement of General Motors (GM) is "to be the world leader in transportation products and related services. We will earn our customers' enthusiasm through continuous improvement driven by the integrity, teamwork, and innovation of GM people." We suggest NCEP leadership revisit both the mission and vision statements of AWC to more effectively distinguish this important organization, especially in light of emerging opportunities associated with NextGen.

6.2 Customers and Partners

The role of AWC is to provide aviation warnings and forecasts of hazardous flight conditions at all levels within domestic and international air space (NCEP Strategic Plan 2009-2013). AWC products are critical for safe and efficient flight, and AWC is dedicated to delivering these services to the aviation community to ensure value, usability and relevance through improved linkages with customers and partners.

The aviation market is highly segmented. AWC customers range from pilots (general aviation to commercial air carriers) to flight dispatchers and aviation meteorologists, Federal Aviation Administration (FAA) Flight Service Station (FSS) briefers, and ARTCC traffic managers. AWC's reach also extends to the international counterparts of its domestic customer base through the International Civil Aviation Organization's (ICAO) WAFS (NOAA and FAA compose one of the two WAFCs, the other being the UK Met Office in Exeter, UK). It is important to note that products delivered to these users are needed globally on a 7x24x365 basis for all aviation-related weather conditions. AWC customers depend upon the most timely and technologically advanced forecasts to plan their use of the global airspace in the safest, most efficient way possible.

However, AWC requires partners for completing its mission. The breadth and depth of aviation weather information users requires very close linkages among AWC and its partners. AWC

works with NWS Weather Forecast Offices (WFOs), CWSU meteorologists, the Alaskan Aviation Weather Unit and regional aviation managers, in addition to other NCEP centers including SPC, TPC, EMC and NCO to produce and disseminate forecasts on a daily basis. AWC coordinates these efforts with the US Air Force Weather Agency (AFWA) and its Operational Weather Service (OWS) centers, airline private meteorological service providers, the UK Met Office, and the Meteorological Service of Canada (MSC) to provide sufficient back-up support for reliable and continuous service on a daily basis.

AWC also depends upon partners in the research community to improve current products and identify and develop new products to meet emerging requirements. These partners include scientists from Federal research laboratories, universities, and private industry (e.g., contributing to the FAA's Aviation Weather Research Program including ESRL in NOAA, NCAR's Research Applications Laboratory, and MIT Lincoln Laboratory). In addition, the landscape in which aviation weather users operate is undergoing significant change as FAA designs and establishes NextGen (see Section 6.8). Although AWC has noted in its strategic plan the importance of working collaboratively with partners to maintain product relevance, effective execution of the plan will determine the relevance of AWC going forward.

6.2.1 Findings

Finding CP1: The review panel endorses the decision by AWC management to re-define the Warning Coordination Meteorologist (WCM) role for greater alignment with counterparts in WFOs. The review panel recognizes the decision to institute a WCM position in 2008 has yielded positive impacts on AWC outreach activities. These activities appear to be of the proper scope, have adequate stakeholder participation, and are focused on appropriate subject matter. The review panel found the AWC WCM to have tireless enthusiasm and a passion for customer satisfaction, which is an important attribute for the center.

Finding CP2: AWC customer and partner engagement (industry, FAA, research laboratories, academia) have not improved to the extent one might have expected since the last review. The review panel recognizes that AWC management has attempted to improve its connectivity to the aviation weather community by building additional strategic partnerships, and that AWC staff members have responded to a number of customer needs during the past five years. However, the execution of these actions has been somewhat delayed. Specifically, the last review in 1998 recommended better engagement with stakeholders; however, such engagement has only begun to take shape over the past 12-18 months. A series of events involving changes in AWC management, including retiring and rehiring of staff and other factors beyond the control of current management, appear to be the primary contributing factors. However, the review panel highlights the need to continue efforts to re-engage with stakeholders in the aviation community.

6.2.2 Recommendations

Recommendation CP1: The AWC WCM is to be commended for the breadth of his approach in reaching out to stakeholders. We encourage continuation of this activity, though with emphasis on strategic planning to maximize effectiveness. AWC has a long list of domestic and international stakeholders but has limited resources for interacting with them in appropriate ways. Leveraging nationally sponsored NWS outreach efforts at aviation-related venues, and

attendance at key conferences (e.g., those sponsored by ATCA, IATA, EAA, NBAA, ALPA – see Appendix C for acronyms), are but two examples of available mechanisms for increasing linkages between AWC and the broader aviation community.

Recommendation CP2: AWC should place greater emphasis on reaching out to a key customer, FAA. AWC management is tasked with a difficult mission, the requirements for which are set by an agency different than the one to which it reports. Additionally, the AWC customer base is highly diverse and international in scope. This unique framework requires an unusual level of understanding and leadership and, most notably, outstanding relations with FAA. The review panel recommends that AWC management redouble its efforts to engage directly with FAA management on topics relevant to its mission and, most importantly, to ensure successful pathways to NextGen. A "discussion topic list" for the NWS Director and his counterpart at the FAA (no single one of which now exists) could be used to clarify roles and expectations of both organizations.

Recommendation CP3: AWC should develop a clear and compelling strategic plan for AWT. AWT represents an ideal mechanism for developing partnerships throughout the aviation weather community. Although one AWT goal will be to serve as a mechanism for transferring research to operations (R2O), the pathway for doing so is via partnerships, including those with organizations for which little or no direct interaction might now exist. The review panel encourages AWC management to visit other successful test beds (for example, Hazardous Weather Testbed (HWT) at SPC) and identify best practices as well as mechanisms for mutual interaction.[1] Properly done, AWT will become a forum for exploring important problems, developing trust and relationships, and building pathways toward future products and services (such as those integral to NextGen) – all of which have direct relevance to R2O. However, to be effective, NCEP and NWS leadership must support AWT and provide resources necessary to ensure its success.

6.3 Products and Services

AWC products and services are critical for safe and efficient flight, and AWC is committed to delivering these products to a wide spectrum of customers and partners in the global aviation community. AWC's goal is to maintain and improve aviation decision support capability to meet stakeholder needs by defining and enhancing a seamless product and service suite, responding to existing high-demand needs in programmatic areas, and anticipating emerging needs.

The AWC product suite consists of three major groups: (1) US forecasts and warnings (SIGMETs, Convective SIGMETs, AIRMETs/G-AIRMETs, Area Forecasts, Low-Level Significant Weather and the CCFP); (2) automated products (GTG, Current Icing, FIP and NCWF); and (3) international forecasts and warnings (Global Weather Forecast maps for

[1] The review panel notes with great satisfaction that such linkages are now being developed, in part as the result of this evaluation and preliminary recommendations conveyed to Center leadership during the site visit out-brief.

Medium and High Level Significant Weather, Enroute Forecasts and Warnings for Oceanic SIGMETs, and Caribbean and Gulf of Mexico Area Forecasts). In addition to NWS dissemination processes provided by the NWS Telecommunications Gateway and Wide Area Forecast Center (WAFC) satellite broadcasts, AWC also provides products directly to aviation customers through two web-based services, ADDS, and AviationWeather.gov. It also makes products available via the International Flight Folder Documentation Program.

One of AWC's forecast products, the CCFP, is somewhat unique because it is one of the few operational multi-agency, multi-sector collaborative products in the weather industry. The CCFP supports FAA strategic traffic flow management. On a daily basis, CCFP begins with the AWC convective forecast and evolves into an operational product based on a collaborative discussion of forecast conditions among individuals from FAA, CWSUs, airlines, AWC, and MSC. Although AWC does not set requirements for CCFP nor does it have editorial rights over the daily released version, ownership for the product falls within the purview of AWC and NOAA. As a result, the aviation community identifies AWC as the sole producer and responsible party for a product to which it contributes substantially but does not control.

6.3.1 Findings

Finding PS1: AWC's effort to enhance current products, and add new products, is commendable. Although time spent on enhancements to current products, and that committed to new product development, is somewhat limited due to operational staffing priorities, AWC has managed to expand its products and services since the last review in 1998. It is important to note that aviation weather is not 'seasonal' in the same way as hurricanes and tornadoes. When AWC is not issuing Convective SIGMETs, it may be providing guidance about icing or turbulence hazards. Although AWC provides neither point forecasts nor terminal aerodrome forecasts (TAFs), it supports WFO meteorologists who do. The impact of this rigorous operational activity exacts a toll on the time staff can dedicate to product enhancement and development.

Finding PS2: ADDS is a significant achievement that has been widely adopted by the aviation community. AWC made significant progress in implementing the web-based ADDS, as recommended in the 1998 review. As evidenced by over 10 million hits per day, the aviation community is resonating with the more streamlined, web-based availability of AWC products. Interestingly, 80% of the pilots polled during the 2007 NWS Customer Survey noted that the Internet was their preferred method of obtaining weather information. Finally, AWC also is to be commended for collaborating with partners, such as NCAR and NOAA GSD, in developing operational service and planning strategies for future integration with NextGen.

Finding PS3: R2O efforts have produced products and services useful to AWC forecasters (e.g., Rapid Update Cycle model, version 2, or RUC2, and the High Resolution Rapid Refresh model, or HRRR). AWC has benefited from a number of NOAA R2O initiatives that, in some cases, have provided quantitative improvements to current aviation models (e.g., RUC2, HRRR) and in other cases have provided global grids of new parameters (e.g., WAFS global grids of cumulonimbus clouds, icing, turbulence). AWC is to be commended for integrating the outcomes of these initiatives into their tools and processes for use in operational products.

Finding PS4: AWC forecasters continue to excel in providing products and services mandated by FAA. AWC forecasters have been relentless in their support of products and services mandated by FAA, even though some represent legacy capabilities which are difficult to produce and do not reflect the best scientific capabilities available. The review panel sensed management's frustration in continuing to provide legacy products when resources are scarce and more useful and effective products could be made available.

Finding PS5: Forecast verification remains a challenge, as does understanding the use and impact of products and the translation of this understanding into product improvement. The review panel found AWC's forecast verification process lacking in many ways. Specifically, a suitable process does not exist to ascertain the true value (different than but necessarily in addition to statistical skill) of forecasts, and some products, such as the CCFP, are not verified by AWC even though one of the principal customers (FAA) seems to attach a level of confidence to it. Also lacking is communication of product skill to AWC forecasters, who take pride in their work but do not have sufficient information, or immediate feedback from their customers, to understand the impact of their products or to use it for improving them.

Finding PS6: AWC has made considerable progress in automation. AWC is to be commended for employing automation in generating certain products and services. Minimizing forecaster time spent manipulating model grids, for example, affords a significant advantage.

6.3.2 Recommendations

Recommendation PS1: More frequent interaction is needed between those performing forecast verification and those developing verification techniques**.** The review panel strongly recommends that AWC make forecast verification a high priority and foster improved communication between operational AWC forecasters and other users, and researchers who develop forecast verification techniques. AWT could play a critical role in this enhanced interaction, and a goal is not only to help forecasters and other users understand the value and limitations of AWC products, but to provide useful guidance to those developing new approaches and enhancing existing ones. A great opportunity exists to engage customers in the verification process and it should be vigorously pursued.

Recommendation PS2: AWC should expand its use of automation in the product generation process. The review panel strongly recommends that AWC explore additional mechanisms for automating the creation and delivery of products and services. The current product generation strategy, for example, which is a mixture of manual and automated methodologies, is an important limiting factor in the ability of AWC to provide new products. With programs like NextGen on the horizon, AWC forecast products will become obsolete unless they are re-tailored into tools for the NextGen decision support framework. AWC should embrace the opportunity to make available its expertise to guide the development of the next Advanced Weather Information Processing System (AWIPS-II) with regard to requirements of four-dimensional (plus probabilistic) NextGen weather products and services (as noted in the NextGen Concept of Operations (CONOPS) and related NextGen documents).

6.4 Information Systems

AWC information systems (hereafter IS) staff are part of the Aviation Support Branch and include four NCEP employees and four contractors. These individuals are critical to the smooth operation of AWC. IS staff members maintain hardware and software and enable R2O via installation, testing, and maintenance of programs and algorithms. These staff also will be at the center of the AWIPS-II transition, and for Common Aviation Weather Subsystem (CAWS) and AWT development. IS personnel implement security procedures and protocols, streamline password authentication, enhance AWT infrastructure by focusing on NextGen capabilities, and will be responsible for facilitating the evaluation of the Interactive Correction in 4 Dimensions (IC4D) workstation. They also maintain a strong web presence through Qualified Information Communication Provider, or QICP, CAWS, and ADDS.

IS staff have drafted a multi-year lifecycle replacement plan, improved AWC security audit processes, and have applied (mid-July 2009, following the site visit) for QICP certification – the FAA Internet services standard for reliability, accessibility and security to formally authorize usage of their products by commercial operators.

6.4.1 Findings

Finding IS1: The AWC IS environment is quite robust and includes solutions to problems previously identified. The 1998 review found that AWC was hampered in its ability to incorporate into operations new research results and technology. In response, AWT was conceived and NCEP came forward to support an improved and accelerated R2O process. Also, a recommendation was made to incorporate graphics products into forecasts, and a result, the highly successful ADDS became operational and the Graphical AIRMET has been developed and is pending FAA approval.

Finding IS2: AWC has a good continuity of operations plan with AFWA and the 15th Operational Weather Squadron at Scott AFB providing back up services for domestic products. The UK Met Office, NHC and Honolulu WFO provide back up for AWC international products. Additionally, AWC shares global infrastructure load balancing with three locations (NWS Central Region Headquarters in Kansas City, MO, NWS Headquarters in Silver Spring, MD, and the NWS Southern Region Headquarters in Fort Worth, TX), all of which improves redundancy, requires less equipment, and lowers operating costs.

6.4.2 Recommendations

Recommendation IS1: IS staff and AWC management should seek common security and AWIPS-II solutions with other NCEP centers. IS staff are concerned that security issues are taking significant staff time – currently estimated at ~1/2 full time equivalent (FTE), with this level of engagement likely to increase in the near future. Other service centers have similar concerns, and this type of load imbalance could have serious negative consequences for the vitally important AWIPS-II transition. The review panel recommends that NCEP leadership address this issue via effective coordination among all service centers as well as NCO.

Recommendation IS2: IS staff should draft a plan for the AWIPS-II transition, with a timeline that includes installation, training, and migrating AWC-specific applications to the new workstation framework. The transition to AWIPS-II will be quite demanding (e.g., a new software environment, installation, training at different levels, and maintenance of the legacy system during transition), but perhaps could provide an opportunity for building in new efficiencies and those capabilities needed for NextGen if AWC staff can give direct input to AWIPS-II developers. CAWS and AWT also represent notable challenges but are not as daunting. Consequently, a detailed transition plan is essential for managing the complexity of the transition and should be developed as soon as possible.

Recommendation IS3: AWC management should ensure full engagement of IS staff in AWT planning. Part of the AWT challenge concerns providing sufficient resources to develop IS systems which will be effective for ensuring an efficient R2O process. To be successful, IS staff must be fully engaged in all aspects of AWT planning, including the creation of its strategic plan (see Recommendation CP3).

6.5 Science and Technology

One important mission of NCEP centers is to accelerate science and technology infusion to enhance the value of NCEP analyses, forecasts, and warnings over all spatial and temporal scales. This includes development and implementation of the next generation unified numerical forecast system, as well as infusion of science and research into operational systems through partnerships and knowledge transfer with the scientific community both within and outside NOAA. The test bed concept is an important part of this R2O and Operations-to-Research (O2R) exchange.

AWC has the opportunity to be the premiere location for transferring aviation research to operations and using corresponding input from operations to enhance activities in the research community. This is not an easy task, nor is it one that can be accomplished without buy-in from AWC management to individual forecasters, and up through NCEP and NWS leadership. Although AWC has made laudable progress incorporating research results into operations, it has yet to reach its full potential. This is due in part to an operational workload that leaves little time for creative thinking and research, and in part to a lack of full engagement at all staff levels.

6.5.1 Findings

Finding ST1: R2O efforts have produced products and services [e.g., the GTG, FIP, National Convective Weather Diagnostic, or NCWD, CIP, Convective SIGMET, or C-SIG, G-AIRMET] useful to AWC forecasters. AWC does little research in-house, and this is appropriate given the substantial operational staff workload and the lack of an "off" season. Thus, AWC has placed more emphasis on bringing outside research developments to the operations floor. In particular, output from current high-resolution, rapid-update models (e.g., RUC2 and HRRR) has been made available to forecasters to aid in producing convective forecasts. AWC staff members also seem to have an ongoing dialogue with NOAA/ESRL and NCAR to provide feedback on their

products, and SPC led a Cooperative Meteorological Education and Training (COMET) project with the University of Georgia to improve turbulence guidance. These efforts are commendable.

Finding ST2: AWT presents a profoundly important opportunity but needs considerable additional planning and vision. That AWC leadership is planning to devote significant space to AWT indicates realization of its importance. However, the strategic plan for the test bed gives a somewhat vague list of activities rather than an overall vision of its personality and its interactions with the outside community.

Finding ST3: AWC staff members have insufficient time to pursue R2O activities, instead performing them during "spare time." A pervasive feeling exists that current staff levels are barely sufficient to maintain operations at the level required by FAA. Until this situation can be resolved, either through automation of some products, retirement of legacy products, or increases in staffing levels, it is difficult to envision a thriving, fully-engaged relationship between AWC and the research community. However, without this relationship, it is equally hard to envision AWC products and services remaining current and relevant as the aviation world changes in the coming years, particularly in light of NextGen.

Finding ST4: Verification of AWC products remains a challenge, as does understanding the use and impact of products and the translation of this understanding into product improvement. Consonant with Finding PS5 and Recommendation PS2, AWC products, such as turbulence and icing, among others, are inherently difficult to verify. AWC relies on pilot reports (PIREPs) for a great deal of its verification, but such reports are inconsistent and may even lead to biases as they tend to be submitted more often when forecasts and/or weather are poor. Further, they are not truly representative of or show value to the needs of AWC customers. Some external development efforts, such as the Real Time Verification System (RTVS) and the upcoming Net-Enabled Verification Service (NEVS), will aid somewhat the meteorological verification efforts. For those products that can be validated, AWC uses traditional verification statistics such as probability of detection (POD) and the false alarm rate or ratio (FAR). More sophisticated means of validation, which have been developed within the research community during the past several years, have not yet been employed.

Finding ST5: Although a few members of AWC staff are actively engaged in R2O and O2R activities, these efforts are not naturally interwoven in the AWC cultural fabric. AWC rightfully takes pride in the number and timeliness of products it produces. However, the emphasis on quantity of products seems to have led to a "forecast factory" mentality among a good portion of the staff such that they lack a vigorous level of curiosity regarding methods for improvement. For example, substantial ownership of R2O and O2R activities is lacking at the forecaster level, and this is likely compounded by the lack of available time to pursue them.

6.5.2 Recommendations

Recommendation ST1: AWT should be used as a mechanism for addressing number of issues, including providing AWC with a stronger identity through stakeholder engagement and connectivity, verification and product understanding and improvement, automation, and intellectual stimulation via research collaboration. AWT should serve as the "intellectual playground" at the intersection of aviation research and operations. It should be a stimulating

physical location with frequent visitors (either in person or via teleconference), vigorous and rigorous discussion, and the evaluation of cutting edge techniques and technologies. If done correctly, AWT should be a place that airline operators, and researchers and forecasters, want to visit, and where AWC staff are able to satisfy their intellectual curiosity in a manner that is difficult to achieve within the confines of shift work. To accomplish these goals, which the review panel believes are essential for the very future of AWC, NCEP and AWC management will have to be more creative and assertive in its interactions with the external research community. Although some level of interaction currently exists with other NOAA and NCAR groups, the review panel encourages AWC to deepen these linkages while also expanding their network to include more universities and, in particular, commercial airlines.

Recommendation ST2: Some staff time must be recovered via automation, a re-prioritization of activities, additional staffing, or utilization of NOAA rotational assignment programs, to foster greater forecaster involvement in AWT activities. In order to tap into the extraordinary opportunity of leading the Nation in the transfer of aviation research to operations, several fundamental changes must occur within AWC and be vigorously supported by NCEP and NWS leadership. Among these is a change in overall workload, either through the addition of new staff, or via greater automation of products or a reduction in the number or type of products while continuing to provide those that are mandated by FAA. Historically, efforts along these lines have been unsuccessful; however, that fact cannot be used to avoid the use of creative strategies for implementing this recommendation. Indeed, a complete portfolio review may be helpful for establishing absolutely essential products while working toward the elimination of legacy products currently mandated but of lesser use to the community. AWC management discussed using the NOAA Rotational Assignment Program (NRAP) to rotate forecasters through AWT, and this could potentially be a very good mechanism for transferring the wealth of forecast experience at AWC to the research community.

Recommendation ST3: In addition to traditional measures of statistical skill, verification needs to emphasize user-based impact and value. Recognizing the difficulty in validating many AWC products, the review panel encourages greater collaboration with research groups performing cutting-edge research in forecast verification. We reiterate that AWT can be the venue for bringing people together and evaluating new approaches to validation. Additionally, operational verification is critical and should be embraced by AWC. The value of such verification cannot be overstated because it can lead to 1) product improvement and directions for change, 2) a greater appreciation by users of AWC's value as an organization, 3) internal and external recognition of the value of AWC products/services, 4) a stronger relationship with FAA, including NextGen activities, and 5) a method to communicate directly with AWC customers and draw them into AWT.

6.6 People and Organizational Culture

Among NCEP service centers, AWC is unique in that its products and service requirements are set principally by FAA, though in collaboration with NOAA, NWS and NCEP leadership. This presents a set of unique challenges as well as opportunities, both of which are recognized but neither of which has been adequately addressed since AWC was established anew in 1995. The

urgency attached to redressing this inaction cannot be overemphasized in light of NextGen which, by every measure, will profoundly transform the NAS and in so doing, fundamentally change the role, and possibly the operational structure, of AWC.

AWC staff and leadership exhibit the highest degree of capability and professionalism, and solid relations clearly exist between NWSEO and the directorate. Additionally, relationships among the new director, staff and management are quite good. Flexibility in work structure, collaboration among programmatic areas, and communication appear to be notable attributes of the center.

It is without exaggeration to state that, with NextGen on the horizon, AWC is at a crossroads. Although it does not entirely or even mostly control its programmatic destiny, it can take a much more active role in converting challenges to opportunities. The nascent AWT represents such an example, and with it AWC has an opportunity to build from good examples at other NCEP centers (especially HWT, which shares a great degree of commonality in the important area of convection) and chart a truly exciting course forward. Perhaps unlike any other NCEP service center, AWC can engage a broad array of private sector users in AWT, including but certainly not limited to commercial and cargo carriers as well as business and general aviation interests. Additionally, AWT provides an opportunity to engage academic institutions and infuse AWC with a new sense of intellectual excitement, particularly via graduate and undergraduate student researchers. In this endeavor, NOAA and NCEP leadership are compelled to stand firmly behind AWC in achieving a bold vision. Failure to do so could literally mean passage of AWC into irrelevance.

6.6.1 Findings

Finding POC1: AWC has adequate facilities and has taken measures to maximize their effectiveness. The relocation of AWC to a new facility several years ago provided an opportunity to reorganize forecast and support operations to maximize their effectiveness. More recently, the forecast floor was restructured and additional space set aside for the AWT. Staff members were very positive regarding both changes.

Finding POC2: AWC recognizes the importance of its role as one of two WAFCs. The importance of AWC internally is clearly expressed by its service as one of two WAFCs. AWC leadership is fully engaged in WAFC activities.

Finding POC3: AWC leadership has been open to alternative work arrangements and professional development. Interviews with forecast and support staff revealed a high degree of respect for center leadership and appreciation for flexible work arrangements they provide, e.g., telecommuting. Additionally, staff commented upon opportunities for professional development which, though never sufficient in light of the center's mission, are vitally important for maintaining professional competence and creating an environment that is desirable for attracting new talent.

Finding POC4: Good relations exist between NWSEO and management and among management. The review panel was particularly impressed with the degree of communication between union representatives and AWC leadership. Such relations are vitally important to any

organization having union membership, and AWC is to be commended for paying attention to this important need. Additionally, the AWC management team is cohesive, mutually respectful, and clearly enjoys working as a functional unit to achieve the center mission.

Finding POC5: The level of enthusiasm and energy at AWC is not commensurate with opportunities that lie ahead. The review panel detected a notable lack of enthusiasm and energy among staff and leadership. This may arise from the fact that AWC is driven principally by the needs and requirements of another Federal agency, which may contribute to an environment in which needs are met, but lacking intellectual excitement and vision for the future. These characteristics perhaps are exacerbated by the absence of nearby organizations with which AWC can collaborate, notably NOAA research and operational facilities as well as academic institutions.

Finding POC6: Although management and staff are spread thin, some time could be recovered via automation and reprioritization. AWC produces an enormous number of products for an exceptionally diverse user community. As a result, the retirement of legacy products – including, remarkably, those in purely alphanumeric form as well as those transmitted by facsimile – is exceedingly difficult. The introduction of new products, mandated by the FAA, thus places an increasing and unsustainable burden on staff when personnel levels are capped. Note, however, that any time freed by automation – and intended for use in activities like HWT – should be carefully protected and not redirected toward routine needs.

Finding POC7: As is the case with most organizations in industry, government and academia, AWC is facing the loss of considerable talent owing to impending retirements.

6.6.2 Recommendations

Recommendation POC1: NOAA, NWS and NCEP leadership must realize the challenges faced by AWC at this point in its history and provide assistance in working with FAA, particularly in planning for NextGen. In many respects AWC is a dog wagged by the FAA tail. The very future of AWC depends upon proactive engagement in NextGen (see Section 6.8), and NOAA, NWS and NCEP leadership must play an active role in seeing it through. Additionally, leaders of these organizations must work with FAA to manage the injection of new mandates and strongly support the retirement of legacy products. NextGen is an evolutionary process already underway, and thus it is imperative that AWC staff and leadership act now to affect a role in NextGen development as well as a meaningful transition to it.

Recommendation POC2: AWC leadership should identify additional opportunities to engage with outside organizations, particularly through AWT, to reinvigorate the center with intellectual vitality. As noted previously, the review panel was struck during the site visit by the relative isolation and lack of excitement within AWC as an organization. It is important to recognize that this finding has no intrinsic relationship to AWC personnel including leadership, but rather reflects the nature of the center's mission, physical location, and the intrinsic lack of reward for a job well done in aviation operations in comparison to media attention given to other NCEP centers (e.g., NHC). Although AWC does indeed collaborate with other organizations, the level and nature of those collaborations are not sufficient for the future. Consequently, NOAA, NCEP and NWS leadership must work with AWC management to find ways of reenergizing staff and

provide the resources needed to provide, for example, small travel grants and short-term release from shift duty. Linkages with SPC in establishing AWT are but one mechanism, as are two-way visiting programs with universities (see Recommendation ST1) and greater involvement in R2O through forecaster representation as a point-of-contact in AWT research projects.

Recommendation POC3: AWC should, in collaboration with appropriate organizations and stakeholders, conduct a portfolio review of its products and services with a specific view toward maximizing automation and minimizing attention given to low priority items. In light of budget realities, the need to emplace new products and services, and the lack of will by FAA and users to retire legacy capabilities, AWC must look at other mechanisms for recovering staff time. The only solution is to maximize the degree of product automation and re-prioritize other activities.

6.7 Business Processes

This section addresses operating practices that are implemented to ensure the quality and effectiveness of AWC products and services. These practices include defining processes to monitor and measure the effectiveness of AWC output; exercising these regularly and documenting the results; regularly reviewing quality assurance processes and revising them as appropriate; and facilitating continuous evolution of products and services as customer requirements evolve.

Maintaining effective business processes requires coordination and alignment with product requirements and capabilities imposed by external organizations such as FAA, other NCEP centers, and research organizations. It also requires that internal processes maximize the effectiveness of AWC personnel at all levels in realizing tactical and strategic objectives. Responsibility for implementing effective business processes lies primarily with AWC management. To be effective however, management must achieve buy-in at all levels throughout the center.

6.7.1 Findings

Finding BP1: AWC management recognizes the need for a formal quality management system (QMS) and has implemented processes to incorporate QMS into the center's day-to-day operations. The review panel was briefed on AWC efforts in this area based on International Standards Organization (ISO) 9001:2008 standards. It was noted that many AWC processes already utilize this standard, e.g., strategic planning and NCEP Technical Operating Plans (NTOP), tracking of product timeliness, verification of product accuracy, and management of labor relations.

Finding BP2: In addition to traditional measures of statistical skill, verification needs to emphasize user-based impact and value. The multi-agency NextGen program is based on a set of strategic goals including increased capacity, efficient operations and mitigation of environmental impacts. Reducing the impacts of adverse weather is a key element of NextGen and the effectiveness of associated products and services must be assessed relative to these goals. AWC does not have a process in place to evaluate the quality of its output in these terms. As an example, improvements in CCFP skill were cited based on meteorological verification

techniques rather than measures of operational value – which can be quite different from skill. In fact, this product has been (and continues to be) problematic for operational use by FAA and the airline traffic flow management community. It is not clear that advertised improvements in forecast skill have addressed core issues involved in the operational use of CCFP.

Finding BP3: QMS does not adequately track the evolving requirements of two key customers: the commercial aviation sector and the NextGen Air Traffic Control (ATC) system being implemented to support it. AWC QMS needs to anticipate future NextGen meteorological service needs that undoubtedly will require a greater deal of automation to meet timeliness, resolution and update requirements. AWC needs to at least begin assessing their operating practices relative to a future that is likely to involve a very different role for its forecasters.

6.7.2 Recommendations

Recommendation BP1: AWC should define product verification methodologies that address end-user metrics such as commercial aviation delay, ATC efficiency and environmental impacts (airport noise and emissions). Implementing this recommendation will require use of new analysis tools, FAA performance tracking databases, operational data and perhaps periodic facility observation programs. It also must be done in collaboration with other agencies, especially FAA, as well as end users. In that regard, AWC leadership should form partnerships with researchers and operational personnel who are dealing with the very challenging problem of assessing the operational value of meteorological forecast products in the aviation system. Implementing a more end-user based QMS process would increase ATC domain-knowledge on the part of AWC personnel and would provide important insight into how AWC products are or could be used to improve strategic and tactical air traffic management decisions. These outcomes would in turn have a positive impact on the ability of AWC to evolve its products to be more effective for the customer.

Recommendation BP2: AWC leadership must lay out a strategic plan that defines QMS needs for the NextGen "mid-term" (circa 2018) and "end-state" (circa 2025). Meteorological services required to support higher density, trajectory-based operations in these time frames will require a substantially larger degree of automation as well as more stringent product availability, reliability and accuracy. It is not clear that current AWC QMS practices will be relevant, even for mid-term NextGen needs. Specifically, the review panel believes that a much greater degree of automation must be introduced into the QMS process if it is to keep pace with the demands of the NextGen meteorological product generation system.

6.8 NextGen

NextGen, which began in 2003 and is slated to achieve full operational capability in 2025, is a multi-agency government/industry/academia program that seeks to overhaul the NAS. Weather will play a critical role in NextGen because weather impacts are pervasive. Because NOAA is formally charged with providing weather information for NextGen, NextGen will have profound impacts on AWC. These will be manifested in the form, development and delivery of products

and services, and the future role and function of AWC meteorologists. In short, NextGen will fundamentally change the way the AWC does business.

Historically, aviation weather users have been presented with raw observation and forecast information in the form of text and graphics and left to interpret the impact of this information on their particular area of concern regardless of meteorological background and experience. This subjectivity often leads to different interpretations by different users, frequently resulting in the impression that weather information, and by extension its producers, are inaccurate and unhelpful. A major NextGen goal is integration of all data, including weather, into decision support systems with output that provides a range of options to which business rules will be applied. This output will require relatively little interpretation, and decisions will be made objectively, purportedly resulting in consistent application among all users.

A critical issue for NextGen is the role of human forecasters in the generation of operational weather information. Owing to requirements for higher resolution and more frequently updated weather information for decision support tools, a greater degree of automation will be required in NextGen. The role of AWC staff will evolve away from that of "product creator" (for example a SIGMET or CCFP) and instead to functions such as the following:

- Quality control for automated diagnostic and forecast products;
- Real-time support for end-users (e.g. FAA Traffic Management (TM) and airline dispatch personnel), especially for high-impact weather events. For example, TM and/or dispatch personnel may have questions, concerns, or proposed alternatives to strategies put forth by NextGen systems and personnel. They may wish to evaluate these in concert with AWC personnel who might have greater insight into the underlying weather scenario;
- Analysis, evaluation and product improvement for NextGen operational weather services, which will be end-to-end in the sense of requiring high quality observations, robust modeling and forecasting, and effective decision support exploitation of weather information including its inherent uncertainties.

In short, AWC staff in the NextGen era will play a significantly broader role than now is the case, helping translate weather information into operationally effective decision-making guidance.

6.8.1 Findings

Finding NG1: AWC leadership is familiar with NextGen but appears to be taking a passive approach to it. That is, AWC management leaves to executive NWS leadership the task of bringing AWC into the NextGen loop as necessary. Until relatively recent outreach by the NWS Office of Science and Technology, AWC has had little involvement at NWS Headquarters in activities related to NextGen. AWC is involved in a number of NextGen project and demonstration teams but sees a failure on the part of FAA to reach out and invite involvement in a more comprehensive, meaningful sense. AWC management also has not fully engaged its staff regarding NextGen.

Finding NG2: Little awareness was evident by AWC staff of NextGen and its potentially large upcoming impact on their work. Discussions between the review panel and AWC staff exhibited an underpinning of fear by staff of displacement owing to automation, i.e., Human In The Loop (HITL) vs. Human Over The Loop (HOTL). Most AWC products are driven by FAA requirements, some of which are from ICAO Annex 3 Standards and Recommended Practices (SARPS).

Finding NG3: No evidence appears to exist of a strategic plan for bringing AWC staff skill sets forward to meet the broader operational role of AWC in the NextGen era.

Finding NG4: A rather limited vision exists for increasing the automation of AWC products which, if successful, could alleviate some staff workload issues.

Finding NG5: AWC continues to be the producer of the highly-visible CCFP**.** CCFP is one of the key AWC products planned for NextGen Initial Operating Capability (IOC) in 2013.

Finding NG6: Although planning is underway to enhance AWT, it appears to be languishing due to limited staffing and the lack of a firm vision.

6.8.2 Recommendations

Recommendation NG1: AWC should make a determined effort to actively participate in all aspects of NextGen. NWS leadership should not only support this effort but also formally engage highly experienced AWC representatives in all discussions and activities at NOAA involving NextGen.

Recommendation NG2: AWC, with the support of NWS, should work closely with FAA on developing decision aids prior to the current Strategic Plan date of FY11. Active AWC participating in NextGen Joint Planning and Development Office (JPDO) activities will provide a better understanding of potential strategies regarding future services. This participation will prove challenging because the type and/or data formats for many required FAA and ICAO products will lag by several years those designed for NextGen, likely leading to the necessity of supporting legacy and NextGen products simultaneously. This issue needs to be addressed not only in the context of staffing, but for NextGen in a broader sense, which will place on staff new requirements and workloads.

Recommendation NG3: AWC leadership should immediately and fully engage its staff in NextGen activities, address cultural and human factors changes associated with transformation to NextGen, and mine the expertise of staff to obtain ideas about operational concepts in the NextGen era. Doing so will hopefully create a sense of excitement about the future of AWC and make it an organization of preference for other NWS forecasters as well as new employees.

Recommendation NG4: AWC leadership must strengthen its relationships with FAA personnel working on NextGen weather capability development. This includes not only the "Operations Planning" group, but also the "System Operations" and Terminal Weather groups. AWC leadership also must develop and execute a staff "recapitalization" plan to evolve core skills to the broader missions required in the NextGen era. A core goal will be to build real domain expertise in the impacts of adverse weather on NAS operations, the manner in which weather

information is used by NextGen decision support tools and operational personnel, and the manner in which human guidance (quality control and/or operational interpretation) can add value to products generated automatically. Staff with a keen interest in weather impacts related to air traffic management must be brought on board to complement current meteorological forecaster and information technology groups within AWC, and training in ATM must be provided to existing staff as well.

Recommendation NG5: AWC should use NextGen-related demonstrations as an early component of AWT. AWT provides a logical mechanism for addressing research opportunities, conducting demonstrations, and providing staff training for NextGen requirements. AWT could facilitate AWC and JPDO NextGen interactions including those involving non-government customers, particularly commercial airlines. Automation of selected current products would ease workload issues, and AWT represents an ideal framework with which to address automation.

6.9 Center Weather Service Unit (CWSU) Impact on AWC

At the time of the site visit and preparation of this report, NWS was negotiating with FAA regarding the status of CWSU service. FAA requested that NWS submit a proposal to consolidate, from 20 to two, the CWSUs, which are located at the 20 Continental US ARTCCs. NWS responded with a plan to conduct a demonstration and validation (DemVal) effort that, if successful, would result in one CWSU facility at the new NCEP building in College Park, MD and the other at AWC. The proposal also calls for the AWC Director to oversee the CWSU program. FAA replied to this proposal with questions and NWS currently is in the process of responding.

6.9.1 Findings

Finding CWSU1: AWC will be impacted by the current proposed consolidation of the CWSUs. The AWC Director and management team are actively engaged in discussions about the CWSU consolidation process and have held a town hall meeting with AWC staff. The NWS Director also is regularly informing all staff who might be impacted by the proposed change. NWSEO personnel have been informed about consolidation plans, but because the NWSEO currently opposes the proposed consolidation, its membership is not actively involved with AWC management on this initiative.

Finding CWSU2: Plans exist to utilize AWT for the CWSU DemVal should FAA agree to the consolidation proposed by NWS. Regardless of the DemVal, AWC recognizes the importance of AWT in moving forward with R2O and O2R, especially NextGen-related activities, and leveraging strengths of the SPC HWT in doing so.

Finding CWSU3: The AWC Director believes proposed AWC forecaster staffing levels are adequate to support a two-center CWSU model. However, the Director does not believe CWSU consolidation addresses the *administrative* staffing necessary to support the additional 55 personnel under the consolidation plan, nor does it address existing staffing limitations.

6.9.2 Recommendations

Recommendation CWSU1: The AWC management team and NCEP and NWS leadership must continue to ensure transparency in the proposed CWSU consolidation, and communicate with AWC staff and NWSEO on a frequent and regular basis.

Recommendation CWSU2: Regardless of the decision concerning CWSU consolidation, the review panel believes that a stronger operational linkage is essential between AWC and CWSUs. The products and services of each group, both now and moving into the NextGen era, must be coordinated, aligned and made fully consistent.

Recommendation CWSU3: AWT is the ideal place to conduct the CWSU consolidation DemVal, leveraging the experience of HWT and involving AWC customers and stakeholders. This is still imperative even if the consolidation does not occur.

Recommendation CWSU4: If the proposed CWSU consolidation is approved, NCEP and NWS leadership must provide adequate resources (equipment, personnel and technology) to AWC in order to ensure success of the consolidation.

Appendix A

National Centers for Environmental Prediction Review
Charge to the Review Panels

Charge

The University Corporation for Atmospheric Research (UCAR) will carry out a review of the National Centers for Environmental Prediction (NCEP) in 2009 through a series of panels that will assess the individual Centers, their interaction with each other and with other NOAA, federal, academic and non-governmental entities to determine how effectively NCEP is accomplishing its mission and realizing its vision. In particular, for each center and NCEP as a whole, the Review will assess:

- Statements of mission, vision and five-year plans.

- Productivity and quality of scientific activities and/or operational products and services with an emphasis on the progress since the most recent review.

- Relevance and impact of the research and/or products. Ability to meet customer demand and emerging requirements.

- Effectiveness of activities or specific plans for transition of research to operations (R2O), including research conducted outside NCEP within NOAA, within the federal research enterprise, and in academia or the private sector.

- Effectiveness of activities or specific plans for support of research by and/or joint efforts with program elements within NOAA that provide support for or conduct research as their primary mission and also with outside entities (academia; research laboratories) via the provision of operational products, services and in-house support (operations to research - O2R).

- Balance between operational responsibilities and research and development initiatives.

- Programmatic plans for new scientific activities and operational products and services, including plans for continuations and terminations.

In addition, the Review will address any specific other issues or questions raised in the course of the review.

Procedure

1. The Review will be organized under the leadership of an Executive Committee composed of two co-chairpersons, representatives of the operational environmental prediction and NCEP user communities, and each of the chairpersons of the individual Center Review Panels. Each Center Review Panel will have 5-6 members with diverse representation from academia, federal labs and users. The Executive Committee will develop a slate of panel members in consultation with the Director of NCEP. The Executive Committee will recommend a panel review slate to the President of UCAR, who will appoint the Review Panels.

2. The following documentation will be requested from each center and NCEP:
   - Vision and mission statement (strategic plan, if extant)
   - Organization chart and list of present staff and visitors (staff turnover since last review)
   - Summary narrative of recent highlights and accomplishments
   - Summary narrative of R2O and O2R activities
   - Summary narrative of collaborative work
   - List of publications and/or reports since last review (with sample of reprints)
   - List of products and services, along with selected samples
   - Summary of budget, sources of support and expenditures
   - The NCEP and/or individual center responses to the reviews conducted between 1996 and 2001.

3. Each center will be asked to submit documentation, at least one month before the on-site visit, to UCAR for distribution to Review Panel members before the on-site visit.

4. An on-site review (typically 1.5-2 days) will be conducted at each center. The date for each review will be fixed in consultation with the Center Director and the Director of NCEP.

5. Each Review Panel will provide a preliminary briefing to the Director of NCEP at the conclusion of each on-site review.

6. Each Review Panel will write a report of its findings. A draft of the review report for each center will be shared with the Center Director to correct any factual errors.

7. The Executive Committee will write a final report, directed to the President of UCAR, that summarizes the findings of the reviews of the individual centers as well as NCEP as a whole, and will make recommendations for improvements.

UCAR will provide administrative help for the preparation of the individual Center Review Panel reports and the final report of the NCEP Review.

Appendix B

AWC Review Panel Membership

Kelvin K. Droegemeier (Chair)
University of Oklahoma

Greg Forbes
The Weather Channel

Maria Pirone
Atmospheric and Environmental Research Inc.
(subsequently joined Harris Corporation during the review)

Marcia Politovich
National Center for Atmospheric Research

Warren Qualley
Harris Corporation

Yvette P. Richardson
The Pennsylvania State University

Mark Weber
MIT Lincoln Laboratory

NCEP Review Executive Committee Members

Frederick Carr (Co-chair)
University of Oklahoma

James Kinter (Co-chair)
Center for Ocean-Land-Atmosphere Studies

Gilbert Brunet
Environment Canada

Kelvin K. Droegemeier
University of Oklahoma

Genene Fisher, Panel Chair
American Meteorological Society

Ronald McPherson
American Meteorological Society (Emeritus)

Leonard Pietrafesa
North Carolina State University

Eric Wood
Princeton University

Appendix C

List of Acronyms and Terms

ADDS	Aviation Digital Data Service
AFWA	US Air Force Weather Agency
AIRMET	Airmen's Meteorological Information
ALPA	Air Line Pilots Association
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
ATCA	Air Traffic Controllers Association
AWIPS	Advanced Weather Interactive Processing System
AWIPS-II	Second Generation Advanced Weather Interactive Processing System
AWC	Aviation Weather Center
AWRP	Aviation Weather Research Program
AWT	Aviation Weather Test Bed (at the Aviation Weather Center)
BP	Business Processes
C-SIG	Convective Significant Meteorological Advisory
CAWS	Common Aviation Weather Subsystem
CCFP	Collaborative Convective Forecast Product
CIP	Current Icing Potential
COMET	Cooperative Program for Operational Meteorological Education and Training
CONOPS	Concept of Operations
CP	Customers and Partners
CPC	Climate Prediction Center
CWSU	Center Weather Service Unit
DemVal	Demonstration and Evaluation
EAA	Experimental Aircraft Association
EMC	Environmental Modeling Center
ESRL	Earth System Research Laboratory
FA	Area Forecasts
FAA	Federal Aviation Administration
FAR	False Alarm Rate or Ratio
FIP	Forecast Icing Potential
FTE	Full Time Employees
FSS	Flight Service Station
G-AIRMET	Graphical AIRMET Products
GM	General Motors
GPS	Global Positioning System
GSD	Global Systems Division
GTG	Graphical Turbulence Guidance
HITL	Human in the Loop
HOTL	Human Over the Loop

HPC	Hydrometeorological Prediction Center
HRRR	High Resolution Rapid Refresh (Model)
HWT	Hazardous Weather Test Bed (at the Storm Prediction Center)
IATA	International Air Transport Association
IC4D	Interactive Correction in 4-Dimensions
ICAO	International Civil Aviation Organization
IFFDP	International Flight Folder Documentation Program
IOC	Initial Operating Capability
IS	Information Systems
ISO	International Standards Organization
JPDO	Joint Planning and Development Office
MSC	Meteorological Service of Canada
MIT	Massachusetts Institute of Technology
MV	Mission and Vision
NAS	(US) National Airspace System
NAWAU	National Aviation Weather Advisory Unit
NBAA	National Business Aircraft Association
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NCO	NCEP Central Operations
NCWD	National Convective Weather Diagnostic
NCWF	National Convective Weather Forecast
NEVS	Net-Enabled Verification Service
NextGen	Next Generation Air Transportation System
NOAA	National Oceanic and Atmospheric Administration
NRAP	NOAA Rotational Assignment Program
NTOP	NCEP Technical Operating Plan
NWS	National Weather Service
NWSEO	NWS Employees Organization
O2R	Operations-to-Research
OPC	Ocean Prediction Center
OWS	Operational Weather Service
PIREP	Pilot Report
POC	People and Organizational Culture
POD	Probability of Detection
PS	Products and Services
QICP	Qualified Internet Communications Provider
QMS	Quality Management System
R2O	Research-to-Operations
RTVS	Real Time Verification System
RUC2	Rapid Update Cycle (Model) Second Generation
SARPS	ICAO Annex 3 Standards and Recommended Practices
SELS	Severe Local Storms Unit
SIGMET	Significant Meteorological Advisory
SIGWX	Significant Weather Forecasts

SPC	Storm Prediction Center
ST	Science and Technology
SWPC	Space Weather Prediction Center
TAF	Terminal Aerodrome Forecast
TM	Traffic Management
TPC	Tropical Prediction Center
UCAR	University Corporation for Atmospheric Research
WAFC	World Area Forecast Center
WAFS	World Area Forecast System
WCM	Warning Coordination Meteorologist
WFO	(US National Weather Service) Weather Forecast Office