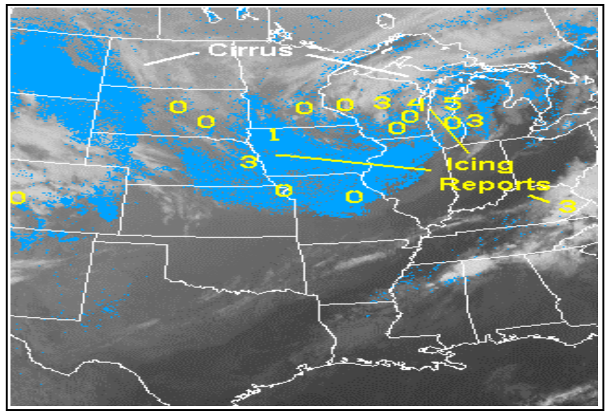
Panel 1 -- Product Development



Moderator: Mr. John E. Jones, Jr., *Deputy Director, National Weather Service*

Rapporteurs: Ms. Dorothy Haldeman, *Aviation Program, Office of Meteorology, National Weather Service*

Mr. Thomas S. Fraim, *Senior Staff Meteorologist, Office of the Federal Coordinator for Meteorology*

Synopsis

There were several themes which cross-cut the presentations and discussions resulting in the following items:

- Products need to be requirements driven but resources are often the limiting factor to product development.
- As communication and display technology advance, graphical products are preferred over alpha-numeric.
- The time from development to operations needs to be minimized through rapid-prototyping together with a process of pre-planned product improvement.
- Training needs to be an integral part of product development.
- To increase the likelihood for success, the user needs to be involved in the product development process.
- In the product development process, there is a need for coordination, collaboration, cooperation and standardization among the agencies and universities to the maximum extent possible.
- Ensure usability of products -- they should be adaptable to varied users.
- A process of product validation should be established which ensures a quality product.
- As called for in the "National Aviation Weather Initiatives" document, there is a need to continue development of a capability, via applied research, to generate

weather observations, warnings, and forecasts with higher resolution and accuracy. This will require a concerted philosophy on the part of the aviation weather community toward the development and use of a wider array of sensors for mesoscale to microscale observations and products produced from finer scale models.

- The roles and responsibilities between the public and private sectors in product development, research and development should be reviewed.
- There is a need for consistency between products to facilitate meteorological discussion, determine impacts on operations, and facilitate the decision making process.

Presentations for the product development panel were given by representatives from the Department of Commerce (DOC), Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), Department of Defense (DOD), and the aviation industry. In keeping with the overarching objectives of the forum, the presentations highlighted products that have been recently implemented or are close to implementation and products that show promise but need further resources to reach fruition. In some cases, the presentations highlighted areas where little or no work is planned and areas where work is ongoing within multiple activities. It also should be noted that the definition of a product isn't limited to the traditional "weather products" but includes systems such as the FAA's Integrated Terminal Weather System (ITWS) or NASA's Aviation Weather Information (AWIN) project.

Presentations from DOC highlighted aviation products from the National Oceanic and Atmospheric Administration (NOAA) which range from experimental products derived from satellite data developed by the National Environmental Satellite, Data, and Information Service (NESDIS) to operational products provided by the National Weather Service's Aviation Weather Center. Also included is the Volcanic Ash Hazards Program which is a collaborative effort among the National Centers for Environmental Prediction (NCEP), the Air Resources Laboratory (ARL), Alaskan Aviation Weather Unit (AAWU), and NESDIS's Satellite Analysis Branch (SAB). The experimental products include those for the detection of fog and low ceilings, in-flight icing, volcanic ash, and the potential for strong convective wind gusts (microburts). Validation efforts using pilot reports and observations have shown that these products have good promise; however limited resources and limited involvement by other agencies are delaying the improvements needed to move these products from an experimental status into operations.

Within the Volcanic Ash Hazards Program, NCEP, ARL, and NESDIS are cooperating to develop the experimental Volcanic Ash Graphic (VAG) which will be a man-machine mix product combining the output from the Volcanic Ash Forecast Transport and Dispersion Model (VAFTAD), meteorological models, satellite sensors and skilled meteorologists. The goal is to graphically present an initial analysis along with an 18 hour outlook divided into three six hourly periods. A text product will also be produced from the graphic and both products will be used by Meteorological Watch Offices (WMO's) to produce warnings (SIGMETs) for aviation. The ultimate goal is to have all products based on the same information in order to ensure common situational awareness.

Keeping with the theme of systematically moving new products from experimental status to operations, the Aviation Weather Center discussed the TEGO process which stands for Test, Experimental, Guidance, and Operational. TEGO is a disciplined step-wise process for technology transfer. In addition to the TEGO process, the transfer of technology to operations has been guided by several concepts, including a quantitative evaluation using the Real-Time Verification System (RTVS), an Aviation Testbed, delivery via the Internet, interagency commitments and collaboration, and rapid prototyping. Several new products have become operational or are moving through the TEGO process and are expected to become guidance/operational in the near future. These products include the Integrated Icing Detection Algorithm (IIDA), the Integrated Turbulence Forecast Algorithm (ITFA), the Mountain Wave Turbulence Product (MWAVE), the Integrated Icing Forecast Algorithm (IIFA), the Aviation Digital Data Service (ADDS), the Collaborative Convective Forecast Product (CCFP), which was cited as a great example of rapid prototyping, and the National Convective Weather Forecast (NCWF). Two other programs show promise; these are the Dallas-Ft. Worth Collaborative Aviation Forecast Study (DCAFS) and the Airport Specific TAF Amendment Criteria (ASTAC).

The FAA highlighted a number of products which are nearly operational. These products are being developed through the Weather Processors Program and the Aviation Weather Research Program (AWRP). Within the Weather Processors Program, the Integrated Terminal Weather Processor (ITWS) and the Weather and Radar Processor (WARP) are two systems being deployed to provide weather information for the terminal and en route environments respectively. The products generated are highly intuitive and require no meteorological interpretation. There are currently four ITWS prototypes operating and the system will eventually be deployed to forty-seven airports which also have the Terminal Doppler Weather Radar (TDWR). The ITWS production decision will be made in FY 2001 and full scale production and installation is planned for the 2002-2003 timeframe. The WARP will support the en-route environment with deployment in the Air Route Traffic Control Centers (ARTCC) and the ATC System Command Center (ATCSCC). The WARP will serve as the prime source of weather information for controllers, pilots, and meteorologists for tactical and strategic decision making. WARP Stage 0 has been deployed since 1997. WARP Stage 1 full-scale development is complete and operational testing is currently being conducted at the Fort Worth ARTCC. Full scale production and installation is planned for the 2001-2002 timeframe.

Within the FAA's AWRP, there are nine focused Product Development Teams (PDT) working on products ranging from in-flight icing, turbulence, and convective hazards to modeling and gridded forecast systems. The emphasis is on graphical products and also on shortening the period for transitioning products from development to operations through rapid prototyping, multiple pathways and preplanned product improvement. A number of products were highlighted including the ADDS which is operational at the Aviation Weather Center; the IIDA which will be operational by the end of 2000, the IIFA which is currently in the test phase and is expected to be released in 2001; the

NCWF which is scheduled for release by the end of 2000; the Terminal Convective Weather Forecast (TCWF) to be released in 2001; the ITFA to be released in 2001; and the Weather Support to Ground De-Icing Decision Making (WSDDM) which is operational at three New York Airports.

NASA's Weather Accident Prevention Project is focused on developing enabling technologies to reduce accidents where weather is an attributing cause or one of the precursors to an accident. The Project's goals are to provide all users with high fidelity, timely graphical information and to detect and mitigate weather hazards. The Project's products are: (1) Aviation Weather Information (AWIN) technologies and system design guidelines, (2) aviation weather hazard characterization and graphical product development, (3) electronic pilot reporting, (4) forward-looking turbulence sensor technologies, and (5) control system design technologies for turbulence mitigation. Project milestones include initial AWIN and forward-looking turbulence detection flight evaluation by the end of FY 00; a national AWIN capability by the end of FY 02; and an international AWIN capability demonstration by the end of FY 04.
Implementation strategy includes industry cost sharing (whereby partners foot up to 50% of the cost), marketing assessment studies, participation in working groups and steering groups, and other collaborative efforts. Product development requires close collaboration between NASA and the NWS/FAA but is also needed with other interagency providers and users.

The DOD (USAF) briefed several capabilities and products which have been developed to support Air Force Weather's (AFW) reengineering initiative. The AFW organizational structure was re-organized into a strategic center, operational weather squadrons, and combat weather teams structure. The emphasis is on providing a weather product reach-back capability to forward deployed weather units who then tailor the products for their customer's specific mission needs. A wide variety of mission-scale products are produced in fine-scale resolution; in some cases down to 4km. Model areas of coverage (windows) are relocatable based on military mission requirements (exercises, contingencies) or weather challenges of the day (i.e. potential severe convective weather areas, hurricanes), and a suite of products can be made available within 12 hours. Additionally, the Global Theater Weather Analysis and Prediction System (GTWAPS) is scheduled to become fully operational in September 2000 and the Cloud Depiction and Forecast System (CDFS) II which constructs three-dimensional depictions of cloud amount and type from space and surface-based systems is scheduled to become operational in 2001. At the tactical level, the New Tactical Forecast System (N-TFS), a scaleable system to support fixed/deployed operations, ingests/displays weather data, provides a distributed computing environment of various applications, and provides collaboration for the Operational Weather Squadron and Air Force/Army customers.

For the aviation industry, presentations were made by Northwest Airlines and American Airlines. Both presentations highlighted the fact that severe weather has significant adverse impacts on airline operations and, in cases where the cost-benefit is favorable, airlines will do what it takes to develop a capability to mitigate the effects of weather on their operations. The Collaborative Convective Forecast Product (CCFP) is an example of a collaborative effort between the airline industry and government to rapidly develop a product to aid traffic management decision-making and increase system efficiency. One of the keys to success for this product was the involvement of the user in its development. Another example of collaborative product development resulting from a costly weather event is the Hub-CAPS Project, an effort between American Airlines and the Center for the Analysis and Prediction of Storms (CAPS). The airline had a requirement for a storm-scale product so the business decision was made to enter into partnership with CAPS. This is also an example of rapid prototyping (where the product is fast-tracked to operations). The industry presentations also pointed out that the recipe for success in product development is to involve the user in defining and validating product requirements, establishing a process that ensures quality control, and building in training as part of the product development. The airlines are trying to transition to a predictive decision rather than reactive decision philosophy with regard to weather impacts on flight operations.

Panel Discussions:
Several issues surfaced during panel discussions with the audience. A question was raised concerning the standardization of data sets and product formats. Panel members concurred that this was an issue that needs to be addressed. Another issue was raised regarding the roles and responsibilities between the public and private sectors with regard to aviation weather. This generated much discussion and comment and there was a consensus that the aviation community should stay abreast of this issue.

Aviation Products Derived from GOES Satellite Data

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ABSTRACT

Derived products for the improved detection and short range prediction of several aviation hazards are under development using data from the Geostationary Operational Environmental Satellite (GOES). GOES data provides an ideal combination of image resolution (1 - 4 km) and temporal frequency (15 - 30 min) data for support of aviation forecasting. The experimental products were developed to show possible areas of: (1) fog and low ceilings, (2) in-flight icing, (3) volcanic ash, and (4) potential for strong convective wind gusts (microbursts). The latter consist of indices to estimate the maximum possible surface wind gusts, and the potential for both wet and dry microbursts, all derived from GOES Sounder data. In-house validation using PIREPs, and surface and upper air observations shows generally good quality for these products. A number of improvements are suggested, such as the inclusion of cloud top height information on the icing product. The products are generated hourly, and may be accessed on the Web at: **http://orbit-net.nesdis.noaa.gov/arad/fpdt** Users include forecasters from the National Weather Service, military, airlines, and university researchers.

The NOAA Volcanic Ash Program

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ABSTRACT

The NOAA volcanic ash program consists of efforts by the Air Resources Laboratory (ARL), the National Weather Service (NWS) and the National Environmental Satellite, Data, and Information Service (NESDIS). The Air Resources Laboratories is responsible for air transport and dispersion model development and technical support for its Volcanic Ash Forecast Transport and Dispersion Model (VAFTAD). The National Weather Service is responsible for issuing official aviation warnings for volcanic ash, referred to as SIGMETS, through its Meteorological Watch Offices (MWOs) in Kansas City, Honolulu, Guam and Anchorage, Alaska. The National Environmental Satellite, Data, and Information Service provides satellites and develops technology for volcanic ash detection. In 1997 ICAO established a global system of Volcanic Ash Advisory Centers (VAACs). NOAA provides two VAACs; one in Washington, D.C. which covers most of the U.S. Flight Information Regions (FIRs), Mexico, the Caribbean, Central America, and extreme northern South America; the other in Anchorage, Alaska covering the Alaskan FIR and its unique number of volcanos. The Washington VAAC is also unique in that merges the science, technology and products and services of both the NWS' National Centers for Environmental Prediction (NCEP) for modeling and forecasting with those of NESDIS for detection and analysis. The combined effort has resulted in several operational products supporting Met Watch Office operations, both domestic and foreign, and aviation industry operations in the vicinity of volcanic ash (the Volcanic Ash Advisory Graphic, the Volcanic Ash Advisory text message, and the maintenance and execution of the VAFTAD model forecast in a fully supported operational environment. Ongoing is the experimental development of a new product, the Volcanic Ash Graphic, which will combine the best of the technology of all three NOAA agencies into a volcanic ash analysis, forecast and outlook in a single product

National Weather Service Development Activities

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ABSTRACT

Within the context of current operational warnings and forecasts that are delivered to meet existing national and international aviation responsibilities, several new products have passed from research and testing into operational use. This year the CCFP (Collaborative Convective Forecast Product) has become an operational product (7x16) after 3 years of prototyping with the collaboration of the airlines, several offices of the FAA, and the NWS. In addition, the NCWF (National Convective Weather Forecast) that was developed at NCAR, has been evaluated and documented as a guidance-level product and is now delivered from an operational environment at the AWC. Several other products will be evaluated for operational use this year. All operational products, as well as Experimental and Guidance level products are available to users on the AWC Homepage <**www.awc-kc.noaa.gov>.** The experience of the prototyping and transferring research technology have been guided by several concepts: a disciplined step-wise process for technological transfer (TEGO); a quantitative evaluation (RTVS); a focus at the Aviation Testbed; delivery on Internet (Aviation Digital Data Service, ADDS); and institutional commitments and collaboration. Some important lessons have been learned regarding the resources and collaboration that are needed, and continued success depends upon partnership with federal clients and national users. Other programs within the National Weather Service show promise for improvement of terminal and en-route aviation weather warnings and forecast in the tactical and strategic time frames.

Weather System Acquisition

Kevin Young
Product Lead for Weather Processors
Federal Aviation Administration (FAA)

ABSTRACT

The presentation by Mr. Kevin Young illustrates the use of weather processors by the FAA. Two processors are in development by the FAA. Integrated Terminal Weather System (ITWS) which takes all the weather data around a specific terminal area; combines the data and warns FAA personal of potential hazards. This processor is primarily for non-meteorologist and designed to provide short term warnings over a relatively small area.

The Weather and Radar Processor (WARP) provides meteorological data to the meteorologist in the Air Route Traffic Control Center and personnel in the Air Traffic Control System Control Center. WARP further disseminates weather information to controllers and supervisors. WARP will shortly mosaic all WSR-88D data and provide this to the enroute controller for integration with aircraft data to provide decision assistance to the pilot on the safest route of flight during convective weather.

Product Development:
FAA Aviation Weather Research Program (AWRP)

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Federal Aviation Administration (FAA)

ABSTRACT

The FAA Aviation Weather Research Program (AWRP) seeks to reduce weather-related aviation accidents and the impact of weather on air travel delays. It does this by developing new technologies for generating weather products and improving the accessibility of weather information to aviation users. AWRP focuses its research through nine product development teams engaged in such projects as in-flight icing, turbulence, and convective weather. The teams consist of scientists at national laboratories and universities.

Technologies developed by AWRP are intended to be implemented and be available to users by a varied of paths, including FAA systems, National Weather Service systems, and over the internet. The most accessible of these is the highly-successful Aviation Digital Data Service (ADDS) which AWRP developed for operation at the NWS Aviation Weather Service. ADDS provides a mixture of experimental, guidance, and operational graphical products. Included are product depicting in-flight icing, turbulence, and convective weather. Another AWRP product, the Weather Support to De-Icing Decision Making (WSDDM) is in operation at all three New York airports. WSDDM has been turned over to private industry for implementation.

For more information, see the AWRP web page at http://www.faa.gov/aua/awr. To obtain weather information from ADDS see http://adds.awc-kc.noaa.gov/.

Product Development:
NASA Weather Accident Prevention Project

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ABSTRACT

In 1997 a national goal was announced to reduce the fatal accident rate for aviation by 80% within ten years. NASA immediately responded with a major program planning effort to define appropriate research areas to be conducted in partnership with the Federal Aviation Administration (FAA), Department of Defense (DOD), other government agencies, Industry, and academia. One such research area focused on developing enabling technologies that could reduce accidents where weather was the attributing cause of or one of the precursors to an accident. The Weather Accident Prevention effort under the NASA Aviation Safety Program (AvSP) is performing research in the following areas:

1. Aviation Weather Information, AWIN
2. Weather Information Communication, WINCOMM
3. Turbulence Detection and Mitigation, TDAM

The Aviation Weather Information (AWIN) project will develop enabling technologies that will provide accurate, timely and intuitive information to pilots, dispatchers, and air traffic controllers to enable the detection and avoidance of atmospheric hazards. New and derivative weather products will be developed, complementing existing weather sources with in situ and remote sensing capability where necessary, to provide necessary information at appropriate temporal and spatial resolution for both tactical and strategic decision making for aviation users. Enhanced weather presentations will be developed to minimize interpretation and training required, enhance situation awareness and engagement, and reduce workload. It will also develop aids to improve decision-making, including collaborative processes, and will identify training needs and guidelines to support use of weather information technologies.

The Weather Information Communication (WINCOMM) project will develop enabling communication technologies and system concepts that will provide accurate, timely and intuitive weather information to pilots. WINCOMM will define the communications requirements associated with delivering weather information to the appropriate aviation users and assess the current aviation communications infrastructure and its ability to support current and future weather product. WINCOMM will develop in collaboration with the FAA advanced communications systems, along with supporting standards and protocols definition, to ensure the efficient implementation of advanced weather products. An investigation of current communications technologies and their ability to address identified technology gaps via appropriate enhancement will be performed. Appropriate ground and, where necessary, airborne experiments will be performed to demonstrate new data links and validate new and modified communications technologies and weather products for accelerated implementation.

The Turbulence Detection and Mitigation (TDAM) project will develop enabling technologies that will provide accurate and timely atmospheric turbulence hazards products to pilots, dispatchers, and air traffic controllers. New and derivative turbulence models will be developed, complementing existing weather sources with in situ and remote sensing capability where necessary, to provide necessary information at appropriate temporal and spatial resolution. AWIN will develop the turbulence product to be used for both tactical and strategic decision making for aviation users. On-board forward looking turbulence detection sensors will be developed to warn pilots of upcoming turbulence for proper tactical re-route maneuvers and/or cabin warning. In situations where the aircraft penetrates turbulent regions, on-board in-situ detection along with Flight Management System control schemes will be developed to damp out encountered turbulence. All of these program elements are needed to address the full potential for turbulence accident reduction for commercial transport aircraft.

Product Development: Mission Tailored Support

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ABSTRACT

The mission of Air Force Weather (AFW) is to "Deliver the highest quality mission-tailored weather and space environment information, products, and services to our Nation's combat forces…anytime, anyplace…mud to the sun." AFW is organized in three tiers, strategic, operational, and tactical. On the global or strategic level, the Air Force Weather Agency (AFWA) leverages other DoD and civilian resources, and runs theater-scale weather models and applications to produce a worldwide analysis and forecast database. The operational level has nine hubs or operational weather squadrons, which produce weather products and briefings focused on their region or area of responsibility. Finally, at the tactically level approximately 130 weather flights provide tailored weather impacts to their specific customers.

AFWA continuously refines their product suite in response to changing requirements and new technology. However, the bulk of new product development is being done on the regional and tactical levels. The operational weather squadrons were created over the past three years to efficiently provide weather products and services with a strong regional focus. They are integrating new tools and working with both their war-fighter customers and supported weather flights to meet current and future weather support requirements.

Product Development: A Northwest Airlines Perspective

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ABSTRACT

Product Development approaches which can be either recipes for success or failure will be discussed. Two examples of weather product development in which NWA has been involved will be given. One example could be considered Safety related- Weather Hazard Alerts and specifically Convective Wind Shear Alerts. These alerts are one of eight hazards included in the NWA Turbulence Plot System (TPS). The primary source of this automated wind shear alert information is the FAA¡s Terminal Weather Information for Pilots (TWIP) program.

The second example could be considered Efficiency related Strategic Planning Team weather forecast tools and specifically the Collaborative Convective Forecast Product (CCFP). The successful aspects as well as the components of the two examples, which still need additional work, will be identified. General lessons learned about weather product development will also be highlighted and shared.

Product Development:
American Airlines Weather Services

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ABSTRACT

Through its 65-year history, the Weather Services department of American Airlines has developed numerous procedures and programs to enhance the safety and efficiency of our flight operations. Many of these have involved the relay of information to flight crews, flight dispatchers and operations personnel. Others address specific forecasting practices within the Weather Services group.

Historically, the aviation meteorological community has relied upon various research groups to provide the latest in forecasting tools. Great strides have been made in weather forecasting using this process, especially during the past 30 years. Most of the advances, however, occurred in general weather forecasting, leaving the aviation meteorology community to adapt the new tools to their type of forecasting.

In more recent times, the research community has brought the users into the R&D loop earlier in the process. Further, a few research groups have focused specifically on aviation weather. The process from initial research to deployment, though, still took a fair amount of time. One of the major reasons for this was funding. Commercial aviation felt that the financial responsibility should be shouldered by the government, specifically the National Weather Service and/or the Federal Aviation Administration. Indeed, this was logical because most advances were expected to benefit the airlines equally.

However, each airline has slightly different operating philosophies. American Airlines operates very proactively when it comes to mitigating the effects of weather on their flight-operating schedule. A costly hailstorm at DFW airport on April 29, 1995, propelled weather research into the forefront at American. The hope was to avoid in the future the damage caused by that event. AA Weather Services and the Center for the Analysis and Prediction of Storms (CAPS) at the University of Oklahoma had been working together informally prior to 1995. After the hail event, CAPS presented to AA the latest developments of their storm-scale numerical weather prediction (NWP). A CAPS proposal was well-received by AA's upper management and a 3-year R&D partnership, Project Hub-CAPS, was formed in mid-1996.

The project officially ended in mid-1999, with very favorable results. The analysis and forecasting tools are in regular use by American's meteorologists, and are also available on the Internet to other users. CAPS research continues, and AA will likely see further benefits as storm-scale NWP progresses.

The Hub-CAPS project was a great example of research and operations working together for toward a common goal. Knowledge of each group's "world" was shared throughout the process, plus ancillary benefits were gained by both.