3.1 IMPROVING AVIATION WEATHER FORECASTS: THE FEDERAL AVIATION ADMINISTRATION'S EFFORTS TO ENHANCE AIR TRAFFIC SAFETY AND EFFICIENCY

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1. INTRODUCTION

Weather is a major cause of aircraft accidents and incidents and the single largest contributor to air traffic system delays. The Federal Aviation Administration's (FAA) Aviation Weather Research Program (AWRP), through increased knowledge of current weather conditions and reliable forecasts, is working towards the improvement of aviation safety and efficiency. The FAA's AWRP conducts applied research on weather hazards that specifically impact aviation. The weather research areas that have the greatest positive impact on air traffic safety and efficiency include: in-flight icing, ground deicing, turbulence, convective weather, oceanic weather, and ceiling and visibility. Within the past year, forecast products for in-flight icing and turbulence have been approved for operational use, and an in-flight icing diagnostic product for Alaska was approved for experimental use. This paper describes how the products developed by the AWRP's weather research areas contribute to improved weather forecasts, and in turn benefit the aviation industry.

2. IN-FLIGHT ICING

Every year, numerous accidents and passenger fatalities occur due to ice that accumulates on aircraft surfaces during flight. To address the problem, the AWRP has been funding and managing the development of weather products designed to warn users of potential areas of in-flight icing. The first of these, the Current Icing Potential (CIP) product provides users with information on current in-flight icing conditions (Figure 1). CIP's companion product, called the Forecast Icing Potential (FIP), which was approved by the FAA and NWS in FY03 for operational use, is extremely valuable since it allows users to see icing conditions out to 12 hours. CIP and FIP graphically depict the icing "potential" or the likelihood that icing will occur. By using CIP and FIP, pilots and controllers are better able to help aircraft avoid hazardous icing conditions. The technology used to create these products includes a combination of radar and satellite data, surface weather observations, numerical weather models, and pilot reports. These products enable users to better anticipate where icing hazards are going to occur, and allow air traffic controllers to make more informed decisions when re-routing aircraft and assigning holding altitudes. The FAA is also making a special commitment in Alaska where heavy reliance on air transportation meets with a difficult operating environment. To address this problem, the AWRP has developed an in-flight icing product for Alaska, called the Current Icing Potential – Alaska (CIP-AK). This product has recently been approved for experimental use.

3. GROUND DEICING

Even a small amount of ice on the surface of a wing can increase drag and reduce aircraft lift by as much as 25 percent. This type of ice accumulation has been a cause or a factor in 10 commercial aircraft takeoff accidents which involved fatalities between 1978 and 1997. The AWRP's research into the cause of these accidents resulted in development of an integrated display system that depicts accurate, real time determinations of snowfall rate, temperature, humidity, and wind speed and direction, called the "Weather Support to Deicing Decision Making" (WSDDM) system. The sources of weather data used by WSDDM include Doppler radars, surface weather stations, and snow gauges located near the airport, which accurately measure the amount of water in the snow. This system has been used operationally at all three major New York airports and was recently installed at Denver International Airport. During the winter season, aircraft deicing and anti-icing operations on the airport ramp frequently lead to takeoff, and downstream delays for commercial airlines. The WSDDM system allows deicing "decision makers" to anticipate deicing conditions for up to an hour in the future which facilitates the deicing/anti-icing process and shortens the time required for aircraft from deicing to departure. The long-term goal is to be able to predict ground icing conditions out to 12 hours. The system is also a valuable tool for airport operations personnel who are responsible for clearing airport runways, taxiways and access roads. In this case, WSDDM provides an indication of how much snow to expect and how heavy the snow will be. Enhancements to WSDDM include a new, virtually maintenance free snow gauge called a "hotplate" and access to the system via the Internet which decreases the cost of the system.

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4. TURBULENCE

Although turbulence is not normally associated with aircraft accidents and fatalities, it is a major contributor to passenger and crew injuries and is very costly to the airlines when aircraft are diverted around potentially hazardous weather areas. For the most part, air traffic controllers, pilots and meteorologists are currently dependent upon pilot reports for positively identifying areas of turbulence. Therefore, data is only available over routes, and at altitudes, where aircraft are flying. The goal of the AWRP is to produce timelier and more accurate analyses and forecasts of turbulence, and develop user-friendly turbulence products. A product that has recently achieved operational status via approval by a joint FAA/National Weather Service (NWS) board, called the Graphical Turbulence Guidance (GTG) product, produces easy to interpret web based displays of turbulence intensities at selectable altitudes. The product determines turbulence potential from numerical weather prediction models, pilot reports and lightning data. The current system produces clear-air turbulence forecasts for flight levels above FL200, but these forecasts will be expanded to include flight levels above FL100 within the next two years. In the future, the product will be expanded to include levels down to the surface.

5. CONVECTIVE WEATHER

The goal of the AWRP's National Convective Weather Forecast (NCWF) and Terminal Convective Weather Forecast (TCWF) products is to decrease flight delays due to convective weather. Thunderstorms account for most of the U.S. air traffic delays. The NCWF combines national radar information and cloud to ground lightning data into a six-color hazardous weather depiction which is also designed to filter out brief, small-scale storms that are not a hazard to aviation or are not likely to persist for an hour (Figure 2). It's designed specifically to minimize delays caused by convection as it provides locations of significant convection, one hour in the future, with updates every 5 minutes. A goal is to eventually develop forecasts of convective weather out to six hours. The TCWF provides a forecast of growth and decay out to one hour for a specific terminal. It is part of the Integrated Terminal Weather System (ITWS) which is being demonstrated at four airports in the U.S. Not only are these products beneficial to professional pilots and controllers, they are also useful to the general aviation community since many small aircraft do not have access to airborne radar.

6. OCEANIC WEATHER

At present, aircrews for long-range oceanic flights receive a general weather briefing before departure, including a summary of flight level winds and expected en route weather conditions. Over the ocean, little or no information is available about rapidly changing weather systems that may be encountered. The Oceanic Weather research team is working to better forecast convective weather, en route winds, volcanic ash, in-flight icing and turbulence over the ocean. The forecasting of weather over oceanic areas is more difficult than over CONUS due to the lack of observations and pilot reports. The transmission and receipt of weather data over the ocean is another challenge that is being worked by the AWRP. The first product to be developed by the oceanic research team is called the Cloud Top Height product. This product provides a graphical or textual depiction of cloud tops up to 40,000 feet which frequently provide indications of hazardous convective weather. The next oceanic product to be available, called the oceanic turbulence product, has recently been approved to begin the "test" phase. This product will provide a global forecast of clear air turbulence.

7. CEILING AND VISIBILITY

Airports often experience takeoff and landing delays due to their geographic location. One example is San Francisco International Airport which is adversely affected by marine stratus due to its location along the coast. During periods of marine stratus, the aircraft arrival rate is decreased by up to 50 percent as parallel approach procedures cannot be utilized. The AWRP has developed a 0-6 hour forecast for the time when simultaneous parallel approaches can be resumed so that the aircraft arrival rate at San Francisco matches the acceptance rate. This system is being technology transferred to the National Weather Service for operations in FY04. Since low ceilings and visibilities impact en route airspace, the AWRP began a National Ceiling and Visibility research program which is extremely important to the General Aviation community. Many accidents occur when pilots lose control of their aircraft after unexpectantly flying into areas with low ceilings and visibilities. Products are currently under development that will display forecasts of areas with low ceilings and visibilities, and a depiction of "flight categories".

8. AVIATION DIGITAL DATA SERVICE (ADDS)

ADDS is an internet-based weather dissemination system developed by the AWRP which is extremely popular among many different classes of users including general aviation, military, and commercial pilots, dispatchers, and meteorologists. ADDS allows users to view graphical displays of AWRP weather products and to designate a route of flight and examine a vertical cross section which helps to avoid altitudes where hazardous weather may be present. ADDS is available at http://adds.aviationweather.gov.

9. SUMMARY

The FAA's Aviation Weather Research Program has been successful in developing new products and making these products available to users. The goal is

for many of the products to be available on FAA platforms. The AWRP's policy of "phased implementation" allows users to take advantage of an initial capability now, while researchers continue to work on product enhancements. The AWRP products described play a major role in increasing aviation safety, as well as capacity. As the amount of air traffic over the U.S. continues to increase, the tendency will be for delays to increase as well. With weather being the largest cause of delays, and a primary contributor to accidents, the FAA's AWRP will strive to develop more accurate and longer range forecasts. Additional program information is available on the AWRP web site at http://www.faa.gov/aua/awr.

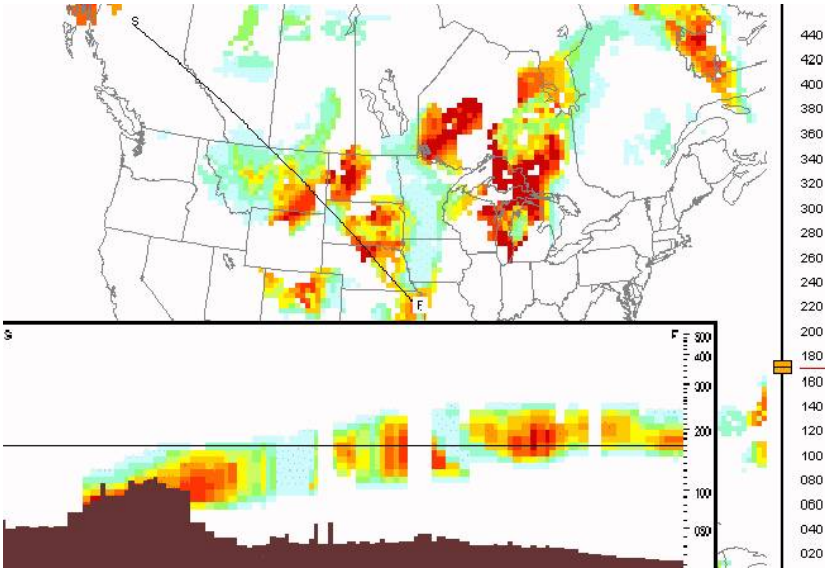

Figure 1. In this example, the Current Icing Potential horizontal view shows the locations of icing at 17,000 feet. The vertical cross section insert shows icing and terrain at all altitudes along the flight path from Smithers, BC to Kansas City, MO.

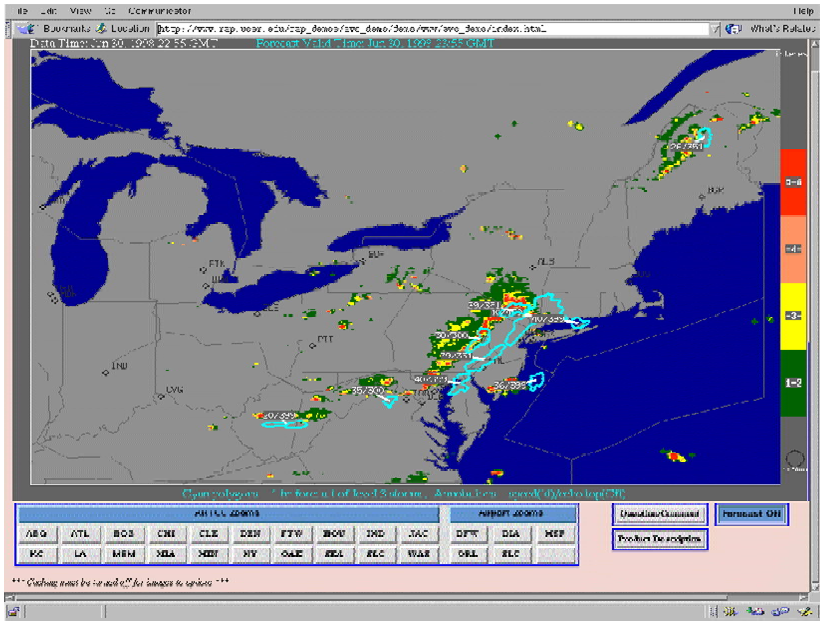

Figure 2. The National Convective Weather Forecast (NCWF) displays areas of hazardous convective weather, including forecast positions.