9.1 THE FAA AVIATION WEATHER RESEARCH PROGRAM'S CONTRIBUTION TO AIR TRANSPORTATION SAFETY AND EFFICIENCY

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1. INTRODUCTION

Anyone who has flown on commercial airlines, or who flies their own plane, knows that weather is an important factor in aircraft accidents and delays. In fact, a recent estimate by the Federal Aviation Administration (FAA) identified weather as being responsible for nearly 70 percent of flight delays. As the amount of air traffic over the U.S. continues to increase, the tendency will be for delays to increase as well. Considering the nation's heavy reliance on commercial air transportation, any efforts to increase the safety and efficiency of air travel will result in numerous direct and indirect benefits.

The FAA's Aviation Weather Research Program (AWRP), through improvements in the knowledge of current weather conditions and reliable forecasts, has been striving to improve aviation safety, and increase system capacity and efficiency. The AWRP provides the capability to generate more accurate and accessible observations, warnings, and forecasts of weather that spawn aviation hazards that can severely impact the nation's transportation system. The weather research areas that impact transportation that will be discussed in this paper include convective weather, in-flight icing, ground deicing, turbulence, ceiling and visibility, oceanic weather, and a weather information dissemination system called the Aviation Digital Data Service (ADDS).

2. CONVECTIVE WEATHER

In September 2001, the National Convective Weather Forecast (NCWF) product was the first AWRP product to be approved for operational use before the joint FAA/National Weather Service (NWS) Aviation Weather Technology Transfer (AWTT) Board. The goal of the NCWF is to decrease flight delays due to convective weather. Thunderstorms account for most of the U.S. air traffic delays, along with many accidents and incidents. 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. 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. Not only is the NCWF beneficial to professional pilots, it is also useful to the general aviation community since many small aircraft do not have access to airborne radar.

A specialized convective weather product for the airport terminal area called the Terminal Convective Weather Forecast (TCWF) achieved a breakthrough in producing a 1-hour forecast which is being tested at the Dallas-Ft. Worth, Memphis, Orlando, and New York airports. This product has evolved over time so that it provides more than an extrapolated position of storms; it also includes the effects of growth and decay. A recent benefits study conducted by MCR Federal Inc. for the TCWF estimated the annual benefit for Dallas Fort Worth and Orlando airports to be $18.4M and $6.0M respectively. Additionally, TCWF benefits for Kennedy, Newark and LaGuardia airports were estimated to be $80M annually. Finally, if a national TCWF system was deployed at Integrated Terminal Weather System installed airports, the estimated benefit would be $524M annually.

3. IN-FLIGHT ICING

Every year, numerous accidents and passenger fatalities occur due to ice that accumulates on aircraft during flight. To address the problem, the AWRP has been funding and managing the development of two weather products designed to warn users of potential areas of in-flight icing. In March 2002 the AWRP's Current Icing Potential (CIP) product, which provides users with information on current in-flight icing conditions became an operational product and transitioned to NWS. At the same time that CIP met the qualifications for operational status before the AWTT Board, the Forecast Icing Potential (FIP) product was approved for experimental use. The CIP and FIP products graphically depict the icing "potential", or the likelihood that icing will occur. By using CIP and FIP, pilots are better able to avoid hazardous icing conditions. The FIP, being a forecast of in-flight icing, is extremely valuable since it allows the user to see icing conditions up to 12 hours ahead. 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

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hazards may be encountered, and allow air traffic controllers to make more informed decisions when re-routing aircraft and assigning holding altitudes. MCR Federal Inc. estimated a potential safety benefit of $30M annually for general aviation, air taxi, and commuter in-flight icing accidents.

4. GROUND DEICING

Even a small amount of ice on the surface of a wing can increase drag and reduce airplane 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, 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 the deicing "decision maker" 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 these conditions out to 6-12 hours ahead of time. In the near future, the WSDDM system will include a virtually maintenance free "hotplate" snowgauge and will feature internet access. In 1999, WSDDM was the recipient of a Government Technology Leadership Award which recognizes information/ communications technology projects that have made exceptional contributions to mission accomplishment, cost effectiveness, and service to the public. A potential annual benefit of $12.7M for Kennedy, LaGuardia and Newark airports combined was derived by MCR Federal Inc.

5. TURBULENCE

Commercial and General Aviation aircraft frequently encounter unexpected turbulence which requires immediate changes in flight or is hazardous to the aircraft and its passengers. Although turbulence is not normally associated with aircraft accidents and fatalities, it is a major contributor to injuries and is very costly to the airlines when aircraft are diverted around potentially hazardous weather areas. For the most part, pilot reports are the only means available for 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 been developed, called the Integrated Turbulence Forecast Algorithm (ITFA), produces easy to interpret web based displays of turbulence with different colors which represent different forecast intensities. The product assesses turbulence potential from numerical weather prediction models and refines those assessments based on comparisons to current pilot reports of turbulence. The model produces turbulence forecasts currently out to 12 hours. The current system produces clear-air turbulence forecasts for flight levels above 20,000 feet, but these forecasts will be expanded to include lower levels in the near future.

6. 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 low clouds and poor visibility due to its location along the coast. During periods of poor weather, aircraft are assigned to holding patterns, or are prevented from taking off en route to San Francisco until the weather clears. The AWRP is working on developing a 1-6 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 would allow additional aircraft to arrive at the terminal as extra capacity becomes available.

Since low ceilings and visibilities impact all airports to some degree, the AWRP began a National Ceiling and Visibility research program in March 2001. This research is extremely important to the General Aviation community since many accidents occur when pilots who are not instrument rated lose control of their aircraft when they fly into areas with low ceilings and visibilities. Weather products are being developed that will display areas with low ceilings and visibilities, and a depiction of "flight conditions" where weather that's hazardous to non-instrument rated pilots can be expected. According to MCR Federal Inc., a marine stratus forecast can potentially provide a benefit of $5.45M annually in arrival and departure delay savings at San Francisco International Airport.

7. 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 weather information is available about rapidly changing weather systems that may be encountered. The Oceanic Weather research area is relatively new and 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 verification data. 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.

8. AVIATION DIGITAL DATA SERVICE (ADDS)

Current and reliable weather information has always been in high demand by a variety of users in the aviation industry. The availability of weather data on the internet has made the acquisition of current weather information from sophisticated numerical models readily available to users. ADDS provides access to graphical, textual and gridded weather data, including winds, temperature, turbulence, convective weather, and icing, as well as reports of hazardous weather to all types of aircraft via the internet. ADDS is operated and maintained by the National Weather Service's Aviation Weather Center and was developed to enable a wide variety of users such as private and commercial pilots, airline dispatchers, military pilots, and weather vendors to easily and inexpensively access the “fruits” of the FAA's weather research program. ADDS was also a winner of a Government Technology Leadership Award in 2000. ADDS weather data can be obtained via the web site at: http://adds.aviationweather.gov.

9. SUMMARY

The FAA’s AWRP has been successful in developing new products and making these products available to users. The AWRP’s policy of “phased implementation” allows users to take advantage of an initial capability now, while researchers continue to work on enhancements which will be added to the product as they become operational. The weather products developed by the AWRP will play a major role in increasing aviation safety, capacity and efficiency. 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 Aviation Weather Research Program will continue to play an important role in ensuring the smooth, safe, and efficient flow of air traffic well into the future. Additional program information is available on the AWRP web site at http://www.faa.gov/aua/awr.