Weather WX

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Papers

The Weather Track consisted of six papers over two sessions. Despite their common theme, the papers were quite diverse. A person unfamiliar with this research area would gain an appreciation of its vast scope from reviewing these papers. Below is a synopsis of the individual papers.

Paper 8: Weather Forecast Accuracy: Study of the Impact on Airport Capacity and Estimation of Avoidable Costs, presented by Alexander Klein, Air Traffic Analysis Inc. is concerned with estimating the costs of inaccurate terminal area forecasts in terms of avoidable delay and cancellations. The paper does this by comparing actual arrival rates with rates derived from realized weather, forecast weather, and demand. Depending on the relative values of these rates, there are cases when the actual rate would have been larger if the terminal area forecast had been accurate. Using assumption about what this difference would have been, and a model relating rates to delays and cancellations, the paper estimates that 12% and 7% of delay and cancellations, respectively, caused by terminal weather could have been avoided if terminal weather forecasts were completely accurate in the year 2008 at the OEP-35 US airports.

Paper 75: The Impact of Severe Weather on Sector Capacity, presented by by Lixia Song, Mitre CAASD considers how different severe weather metrics affect sector capacity. The metrics are based 2-D sector coverage, 3-D sector coverage, and sector flow pattern. Whereas the first two types of metrics consider only the spatial extent of weather in the sector, the latter takes into account the juxtaposition of weather and air traffic flows. The correlation between the various metrics and the 95th percentile sector flow throughput reveals that in general metrics based on the sector flow pattern work best and those based on 2-D coverage work the least well. The paper also demonstrates that the predictive performance of the sector flow pattern metrics vary according to how 3-D region that must be avoided as a result of the severe weather—the so-called weather avoidance altitude field (WAAF)—is defined.

Paper 99: The Operational Effectiveness of the Route Availability Planning Tool (RAPT) during the 2008 Convective Weather Season, presented by Michael Robinson, MIT LL details the performance of RAPT in reducing departure delays out of the New York airports by providing air traffic managers with timely information about when departure routes can be used when there is convective weather in the vicinity. RAPT reduces the cognitive load required to assess whether a departure released on a given route at a given time will encounter hazardous weather. The evaluation, based on observations at ATC facilities on four convective weather days, assessed the success of the tool in enabling air traffic managers to open or avoid closing departure routes and the resulting delay savings. The latter were estimated to total 2600 hours in 2008. It was also found that there were many missed opportunities, most commonly from the failure to respond to RAPT forecast of unimpeded route conditions in a timely fashion. Obstacles to realizing the potential benefit from RAPT—estimated at six times the benefit that was actually attained—included lack of user awareness, coordination workload required, and differences between managers in different facilities about the acceptability of risk, among others. These findings have been used to refine the tool and its concept of operations for 2009.

Paper 124: Identification of Robust Routes Using Convective Weather Forecasts, presented by Diana Michalek, MIT examines the problem of using a weather forecast in the terminal area to determine which arrival and departure routes are likely to be open in the realized weather. The approach is to take a set of hypothetical terminal routes, determine whether these routes would actually be open (allowing for some wiggle room for maneuvering around the weather), and then look for forecast weather characteristics that are correlated with route blockage. Features that correlate best with route blockage are found to be related to the mean VIL level along the path, and the maximum density of unflyable weather regions along the route. The features are used to train classifiers that predict whether or not a given route will be open, and which can be tuned to ensure a low probability of falsely predicting an open route (since this outcome could have a negative impact on safety). These classifiers do considerably better than the original forecast in keeping such false positive rates low for forecasts with longer time horizons. While developed at the route level, the methodologies can also be extended to give probabilistic forecasts for terminal capacity.

Paper 125: A Model for Determining Ground Delay Program Parameters Using a Probabilistic Forecast of Stratus Clearing by Lara Cook, Mosaic ATM considers how to set optimal ground delay program (GDP) parameters at San Francisco International Airport (SFO) using probabilistic information about the marine stratus burn-off time, when arrival capacity increases from 30 to 60 flights per hour. The probabilistic information is available from the SFO Stratus Forecast System, which uses four component forecasts to determine the expected stratus clearing time as well as the probability of stratus clearing 17, 18, 19, and 20Z. This forecast, combined with historical information about actual fog burn-off, is used to develop a cumulative distribution function (CDF) for burn-off time. The model uses this CDF to determine the expected value of an objective function that depends on the GDP duration and scope, and sets values for these parameters that optimizes the expected value of the objective function. The objective function includes factors that increase with the earliness of GDP end time relative to stratus clearing time—such as the amount of airborne holding required—as well as factors that increase with lateness of GDP end time relative to stratus cleaning time--such as unnecessary delay. It is found that, if the optimal GDP parameters were chosen instead of the actual parameters in 2006-2007, ground delay would have decreased 18%. In contrast, if GDP end times were set with perfect information about stratus clearing, the reduction would be 46%.

Paper 91: Improvement of Thunderstorm Hazard Information for Pilots Through a Ground Based Weather Information and Management System by Arnold Tafferner, DLR describes the Weather Information and Management Systems (WIMS) component of the European Commission sponsored Flysafe project. This four-year, 36 partner, 53 million Euro endeavor aims to develop airborne integrated systems to provide increased protection against flight hazards, including traffic collision, ground collision, and adverse weather. The WIMS uplinks to the cockpit information about atmospheric hazards—including wake vortices, clear air turbulence, in-flight icing, and thunderstorms--tailored to the specific situation, flight state and flight plan. The information exploits the greater capacity of ground-based systems to fuse data from multiple sources and perform numerical prediction. Flight tests conducted during the summer of 2008 confirmed that the WIMS thunderstorm data provided value by providing more clutter free information over a wider spatial area than on-board radar data. Pilots believed that the information provided had operational value by identifying regions outside of which there was definitely no hazard from thunderstorms, but thought that additional information, such as thunderstorm trend information, lightning activity, and more precise severity information, should be provided.

Session Report

Despite their common theme, the papers were quite diverse. A person unfamiliar with this research area would gain an appreciation of its vast scope from reviewing these papers. For example, four of the papers-8, 99, 124, and 125--were concerned with terminal weather and two—75 and 91—with en route weather. “Customers” for these papers include strategic planners wishing the gauge the benefits pool from improved weather products (8), strategic traffic flow planners needing to determine how weather affects capacity of terminal and en route airspace (75, 124), more tactical traffic flow managers seeking decision support for planning GDPs and opening/closing routes (125, 124, 99), and pilots wishing to avoid hazardous weather encounters (91).

These papers, while covering different topics, outline a succession of steps leading to the development of a working decision support tool. 8 motivates the development by quantifying its potential benefits. 75 and 124 begin the development process by studying relationships between weather and weather forecast information to factors of direct relevance to air traffic management. 125 goes further by developing a method for making ATM decisions based on weather forecasts, while 99 and 91 discuss decision support tools that have actually been developed and deployed. The experience discussed in 99 is, however, cautionary, as it shows the obstacles to getting ATM decision-makers to make effective use of even a relatively simple tool. One can imagine that introducing the model from 125 into operational use would face similar challenges, or even more severe ones given the longer time horizon and greater uncertainty involved in planning a GDP.

The different US and European perspectives on weather are evident in these papers. All the papers that pertain to weather in air traffic management are of US origin. This suggests that convective weather is a air traffic management challenge in the US. In addition, it reflects the fact that the European air traffic management system is predicated on IMC weather, while the US system assumes good weather, creating a greater need for tools to manage traffic when the weather turns out not to be good.

General Aspects

5 US papers, 1 European paper. Approximately 45-50 people in attendance. Discussion was lively. Many of the questions were to clarify how the analyses were performed, a reflection that some of the papers were somewhat unclear in this regard.

High Level Recommendations

- The papers show great progress in addressing many of the technical challenges to making more effective use of weather information in air traffic management, and demonstrate that sizable benefits can be attained from doing so.
- Additional efforts should be made to encourage European and other non-US participation in the weather track. Many non-US organizations—including Meteo France, ONERA, and Southeast Asian civil aviation organizations as well as Eurocontrol—are engaged in aviation weather research, but their work was not presented at this conference. Weather researchers from these organizations do interact with their US counterparts. U.S. weather researchers might use these contacts to encourage more non-US participation at this conference.The papers provide relatively little ground truth about how traffic managers, controllers, and pilots currently approach weather-related air traffic management decisions. The experience related in 99 suggests that the importance developing decision support tools that fit real-world circumstances. Many researchers are attracted to weather research in ATM because it provides canonical examples of decision making under uncertainty in a data rich environment. If the research is to yield useful tools, there is a need for other research perspectives, such as human factors and organizational behaviour, to ensure the correct fit between the tools and the decision-making circumstances.