Forecasting for aviation

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MADE TO MEASURE

Gaps between measurements mean that forecasting at airports can be poor. That's about to change

Adverse weather has a big impact on the aviation industry. The US Bureau of Transportation Statistics reports that in the USA alone, weather conditions caused nearly 163,000 flight delays in 2016, accounting for 66% of the total National Aviation System delay time – 9.4 million minutes of delay. According to the US Federal Aviation Administration, up to two-thirds of flight delays could be prevented or significantly reduced with better weather information.[1]

According to one recent estimate, the direct operating cost for a commercial airline is US$65.45 per minute.[2] The financial effect of a single delayed flight isn't significant to an airline. However, weather-induced delays – particularly at busy hubs – tend to affect a large number of flights, and worse, they can have a ripple effect on flight schedules on a national or even international scale. And these direct operating costs don't include passengers' lost productivity, extra workload for customer service agents assisting delayed travelers, or intangibles such as customer frustration or goodwill.

METEOROLOGISTS TO THE RESCUE

Meteorologists are keenly aware of weather's impact on flight operations, and strive to

Figure 1: Mobile SkyCast system at a regional airport: Raptor XBS-T with phased array antenna, MP-3000A MWR, and central processing shelter

Figure 2: MP-3000A operating in adverse coastal weather conditions, China

improve both forecasting and nowcasting accuracy. A major challenge for operational forecasters and modelers alike is a lack of temporally and spatially complete data in the planetary boundary layer (PBL). Changes in the PBL are more rapid in time than those in the free atmosphere and tend to drive the majority of mesoscale weather phenomena.

Radiosondes are typically launched twice daily from a small number of locations; few other *in situ* measurements are available, and satellite observations are weakest in the PBL. For forecasters in many locations, radiosonde data doesn't correspond to times when hazardous weather is most likely. This is particularly important for airport operations, where nowcasting is critical for departure and arrival scheduling.

Data sources such as aircraft meteorological data relay (AMDAR), pilot reports, weather radar, and ASOS/AWOS, are invaluable but limited. Critically, none deliver continuous, real-time wind and thermodynamic profiles.

The Radiometrics SkyCast wind and thermodynamic profiling system (WTPS) addresses this need. SkyCast generates wind, temperature, humidity and liquid profiles, along with display and analysis of atmospheric stability and trends, forecast indices, windshear and fog alerts, and icing conditions. It provides the equivalent of a radiosonde updated every six minutes.

THE SKYCAST WTPS EXPLAINED

SkyCast is an atmospheric profiling instrumentation and display system based on proven technologies now operating at airports in Dubai, Thailand, Bahrain, Colombia, and on over 30 military airbases.

A standard SkyCast airport installation includes a Radiometrics Raptor boundary layer radar wind profiler (RWP), an MP-3000A microwave profiling radiometer (MPR), and an AWP-4000 acoustic wind

Figure 3: Raptor VAD-BL installation at Suvarnabhumi International Airport, Bangkok

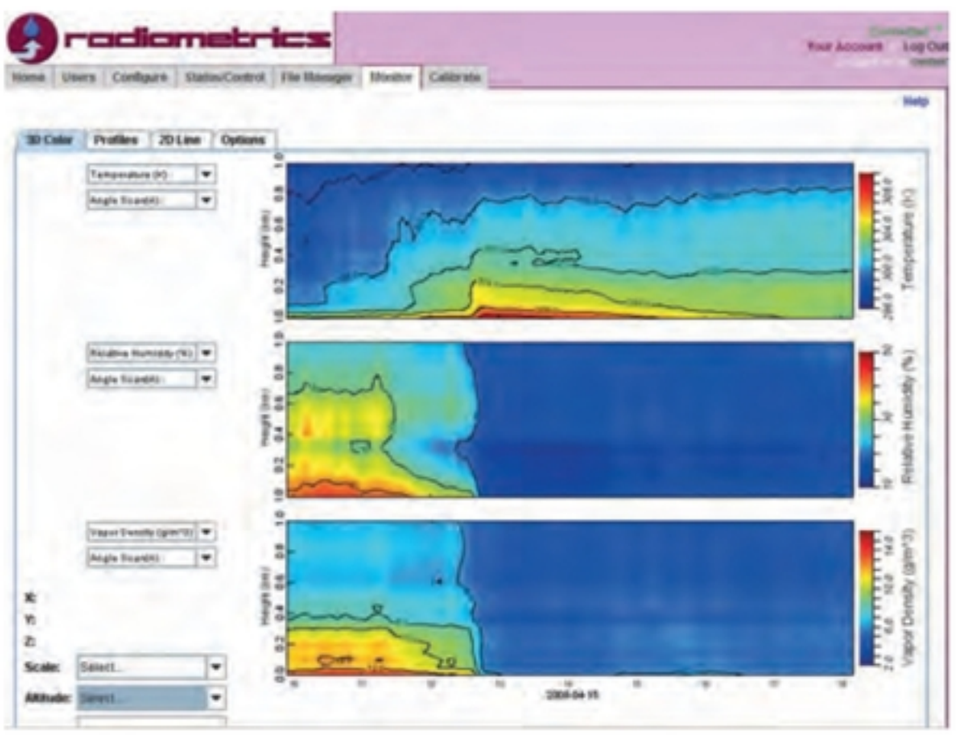

Figure 4: MP-3000A temperature (top), relative humidity (center) and vapor density (bottom) profiles to 1km height AGL at Dubai International Airport over an eight-hour period (time increases left to right). Retreat of the sea breeze can be seen in the rapid heating and drying depicted

profiler (AWP), integrated with WDT Systems' analysis, alerting and display tools. Data from the RWP, MPR, and AWP is transferred to a central processing shelter (CPS). All processing occurs on computer hardware in the CPS, and data products are delivered to forecasters via LAN. One or more universal rawinsonde observation program (RAOB) licenses are included, allowing forecasters to display and interrogate sounding data. Figure 1 shows a trailer-mounted SkyCast system in temporary operation at a regional US airport, with a Raptor XBS-T phased array antenna. Stowed for transit, the antenna is under 2.5m wide.

The Raptor RWP accurately measures wind speed and direction to 3km above ground level (AGL) or higher, depending on Raptor model, site location and atmospheric conditions. All data products are generated in real time, and adaptive quality control software screens out interference. A Raptor VAD-BL is in use at Suvarnabhumi International Airport, Bangkok (Figure 3).

The MP-3000A MPR uses passive microwave sensors to provide all-weather, continuous temperature, moisture and liquid soundings to 10km AGL, with radiosonde equivalent accuracy in the boundary layer. Over 250 MP-3000A instruments are now in operation worldwide. Figure 2 shows how the efficient blower system has kept a radome clear, despite heavy rime ice, at a Provincial Meteorology Bureau facility in China.

Figure 4 shows time-series thermodynamic data from the MP-3000A display at Dubai International Airport. A rapid temperature increase and drying in the PBL can be seen, starting at approximately 12:45 UTC, with the retreat of the sea breeze.

The AWP-4000 provides high-resolution wind observations from the surface to 200m AGL. The measurements fill the gap between the surface station winds and the first RWP measurement gate.

VizAir provides a powerful display and alerting tool for the SkyCast system. Data is processed through nowcasting algorithms to provide continuous, real-time vertical and thermodynamic wind profiles and automated alerts for vertical shear of the horizontal wind, fog, low ceilings and inversions.

Using the SkyCast retrievals, VizAir software identifies areas of vertical windshear using FAA or ICAO thresholds, to give total windshear magnitude and vectors both across and along runways. An example of the VizAir integration and display system can be seen in Figure 5, which shows the three main areas of functionality, including page and instrumentation navigation, plotting, and the automated alerting panel.

OPERATIONAL VALUE

Forecasters supporting airport operations actively monitor the SkyCast displays and alerts, and provide weather updates to both ground operations and Air Traffic Control. Depending on location and time of day, meteorologists closely monitor stability and convective indices to correct forecasts for rapidly changing conditions, significantly reducing delays during peak hours. At other times, trend analysis of temperature and humidity allows meteorologists to better predict freezing conditions and precipitation onset. At Dubai International Airport, meteorologists rely on wind and thermodynamic profiler data to better predict fog formation and dispersion, a major concern to Emirates Airline.[3]

SkyCast data is also useful for regional air routing: meteorologists at the Denver Air Route Traffic Control Center (ZDV) use real-time data from Radiometrics' Boulder, Colorado headquarters to supplement sparse observations leading up to peak air traffic hours at Denver International Airport. ZDV directs over-flights, arrivals, and departures throughout a 285,000 square-mile operations area in the western USA. SkyCast profiles are useful in short-term forecasts of cloud and shower development, the mixing out of inversions in the PBL, and filling in the gap between twice-daily Denver radiosondes.

The Radiometrics SkyCast system provides unique continuous, high-resolution PBL profile data, proven to be invaluable to meteorologists supporting airport operations. SkyCast systems are also used in a diverse range of applications, including air quality monitoring (Mexico City, Mexico; and Clark County, Nevada, USA), severe weather prediction for electric grid safety (San Diego Gas and Electric, California, USA), and atmospheric research (Taiwan Typhoon and Flood Research Institute, Taipei). ▮

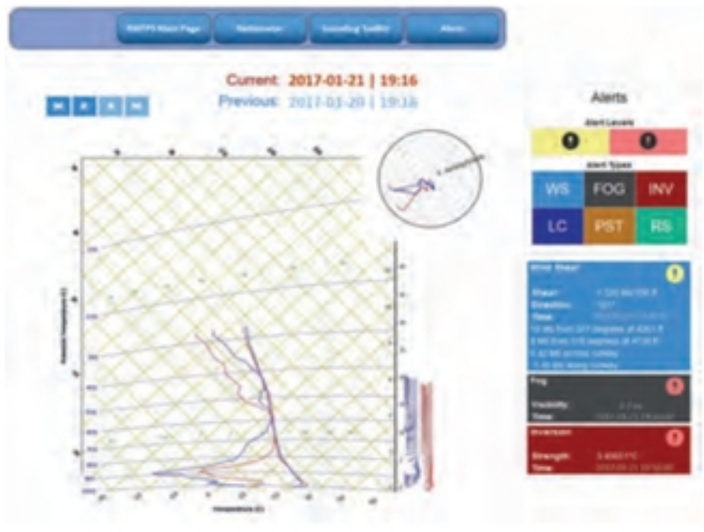

Figure 5: An example of the VizAir output from the SkyCast system

[1] *Research, Engineering and Development Advisory Committee; Report of the Weather-ATM Integration Working Group, October 3, 2007*

[2] *US Passenger Delay Costs, Airlines for America statistics, October 2016*

[3] *Dave Thomas, Spread the Message, Meteorological Technology International, 2010*

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