Communication between NWSFO and FAA Mitigates Effects of Microbursts at Salt Lake City International Airport

November, 2005

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Abstract

One of the duties of the National Weather Service (NWS) aviation meteorologist is to issue Terminal Aerodrome Forecasts (TAF) for utilization by the Federal Aviation Administration (FAA). TAFs are a time and site specific 24 h forecast used by both commercial and general aviators for planning purposes. However, the stringent TAF format frequently hampers the NWS forecaster from clearly conveying a detailed scenario during rapidly changing weather. Consequently, an open line of communication between the Weather Forecast Office (WFO) and the FAA is of utmost importance to effectively reduce the impact of adverse weather on aviation. This is essential at pacing airports – hubs – where a domino effect can have implications on the National Airspace System (NAS). Such a scenario occurred on the evening 09 July 2004 when microburst winds disrupted air traffic at the height of the arrival sequence at the Salt Lake City International Airport (SLC). Based on the confidence of a verbal WFO update, the FAA initiated a strategic plan to mitigate the effects of the microburst winds on air traffic operations. This proactive response was well orchestrated leading to efficient use of airspace and flow management in an otherwise potentially dangerous situation.

Introduction

The National Weather Service aviation meteorologist is responsible for terminal aerodrome forecasts (TAFs) issued every 6 h for a 24 h period for specific small regional general aviation to large international airports within the weather forecast office (WFO) county warning area (CWA). TAFs – a detailed aviationally dictated time-specific forecast – are a decision making planning tool for both general aviators and commercial airlines. Consequently, it must be updated in a timely manner when the weather scenario changes. While this update is important for small general aviation airports its timeliness is much more critical for large airports due to the impact of air traffic flow across the National Airspace System (NAS). Communicating an update verbally to the FAA Air Traffic Control Tower (ATCT) should not only inform them of why or what prompted the update but should also convey a level of confidence that will aid in their flow management strategy.

This case study will examine how a simple phone call to the Salt Lake City (SLC) ATCT by the WFO aviation meteorologist initiated a strategic game plan through a concerted effort by various divisions of the FAA to mitigate the effects of a microburst on the arrival sequence at SLC international airport. In addition, this event will demonstrate how verbal communication can enhance the effectiveness of a TAF and the subsequent actions taken by the FAA.

Synoptic Pattern

Dry low levels and a shallow layer of moisture at mid levels – classic inverted-V signature sounding – were the precursor conditions across northern Utah on 09 July 2004 (Fig. 1). Close examination of this sounding shows that the atmosphere was unstable in the mid levels from about 500 to near 300 mb, eclipsing the weak isothermal layer near 330 mb.

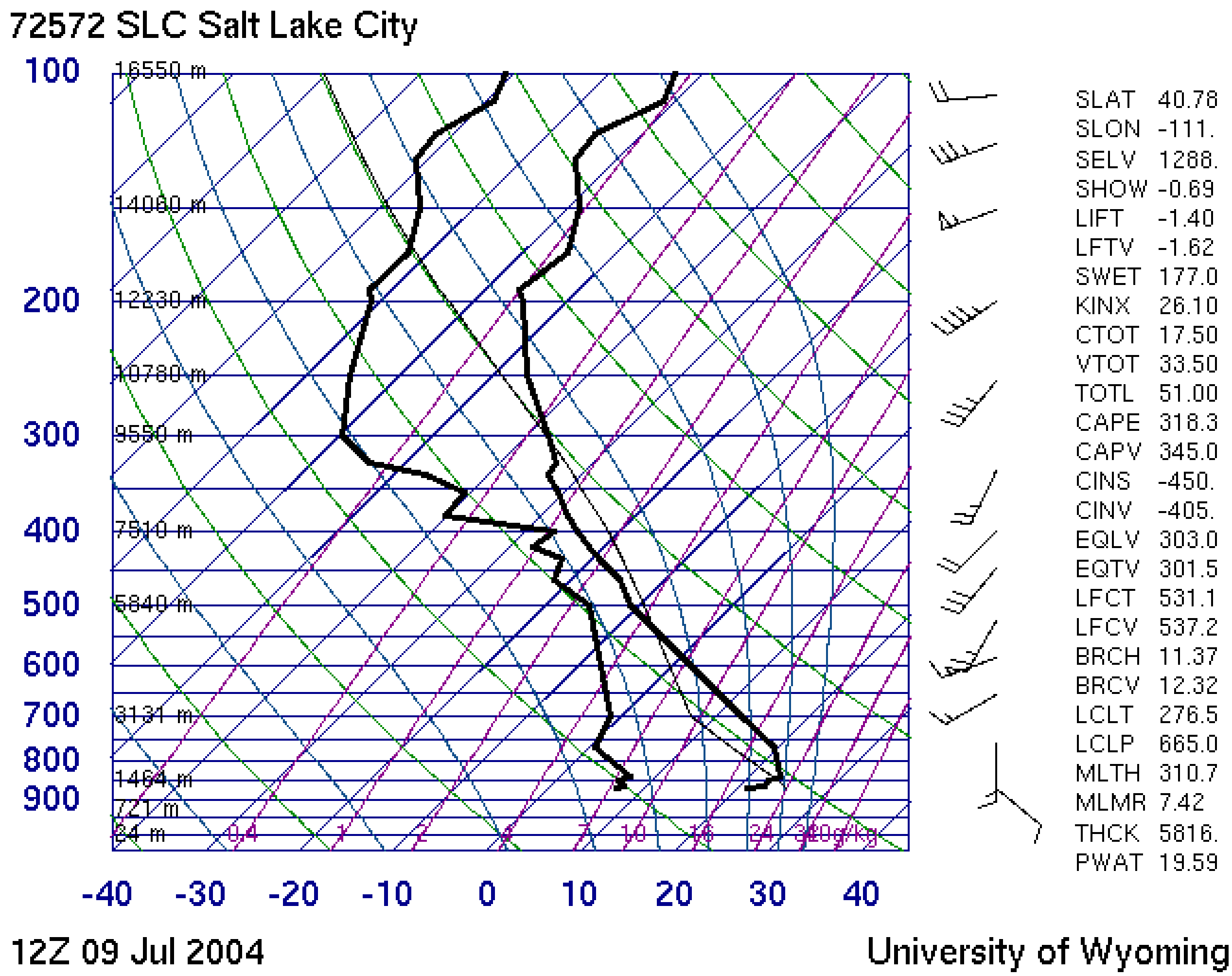

Fig. 1. Skew *T*-log*p* plot of temperature and dewpoint profiles (°C) at SLC valid 12 UTC 09 July 2004. Dry adiabats are indicated by green lines and moist adiabats are blue. Horizontal wind profile is displayed along the right side (pennant, full barb, and half barb denote 10 , and 5 kts, respectively).

Considering this precursor condition, in addition to favorable destabilizing attributes of the afternoon such as solar heating and the forecast proximity to the right rear quadrant of a 50 kt anticyclonic oriented 300 mb jet combining for lift, the atmosphere was ripe for at least shallow elevated convection. Without any identifiable shortwave to initiate the convection at a specific time, the 1800 UTC TAF was kept general with only a CB added to the 2200 UTC FM group.

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FTUS80 KSLC 091818
KSLC 091732Z 091818 16012G18KT P6SM SCT120
     FM2000 17012G20KT P6SM BKN120CB
     FM0200 17010KT P6SM FEW120
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Note - CB tagged onto the cloud group indicates Cumulonimbus cloud.

Although this may appear insufficient, there are no other means of addressng convection within the first nine hours of the TAF without forecasting a greater than 50% probability of occurrence.

Shallow convection was observed over northwest Utah by early afternoon but due to a more stable region above this layer of mid level moisture significant vertical cloud development never materialized (Fig. 2).

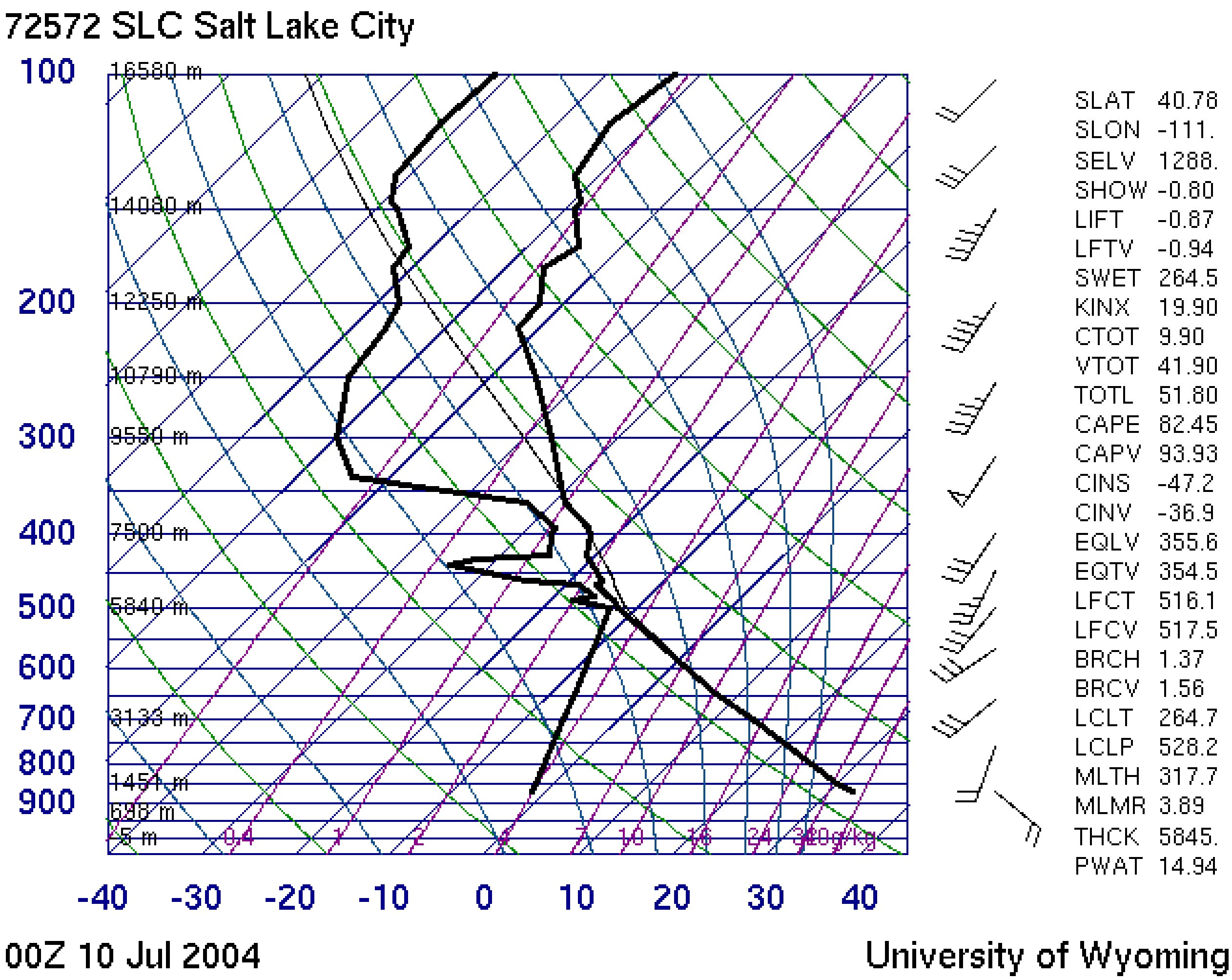

Fig. 2. Same as Figure 1, except valid 00 UTC 10 July 2004. Note a parcel lifted moist adiabatically from the LCL at 528 MB (14,000 ft AGL) would reach a maximum height of about 355 MB (24,000 ft AGL) the equilibrium level EQLV. Therefore, the unstable layer thickness was about 10,000 ft.

The cells that formed were pulse-type storms – non-sustaining intensities – with general movement of about 35-40 kt from the southwest toward the northeast. Strict interpretation of these radar signatures by themselves – without situational awareness of the atmosphere's vertical profile – would not typically alert forecasters from WFO SLC of the strong microburst potential. Consequently, the first storm report of severe wind in excess of 70 mph caused tree and building damage at 2230 UTC 09 July in the Cache Valley (65 miles north of SLC) was not anticipated. However, this occurrence should not have been as much of a surprise considering the inverted-V type vertical profile the North American Model (NAM) forecast that afternoon. Quick inspection of the SLC WSR-88D KMTX radar indicated that this severe wind was the result of a collapsing 35 dBZ echo. In general, the majority of the echoes were in the 20-30 dBZ range with only isolated echoes over 30 dBZ. At 2300 UTC, one such area of slightly enhanced velocities (that correlated well with the greater than 30 dBZ) was observed over eastern

Tooele County from the FAA Terminal Doppler Weather Radar (TDWR) , about 30 miles west southwest of SLC (Fig. 3).

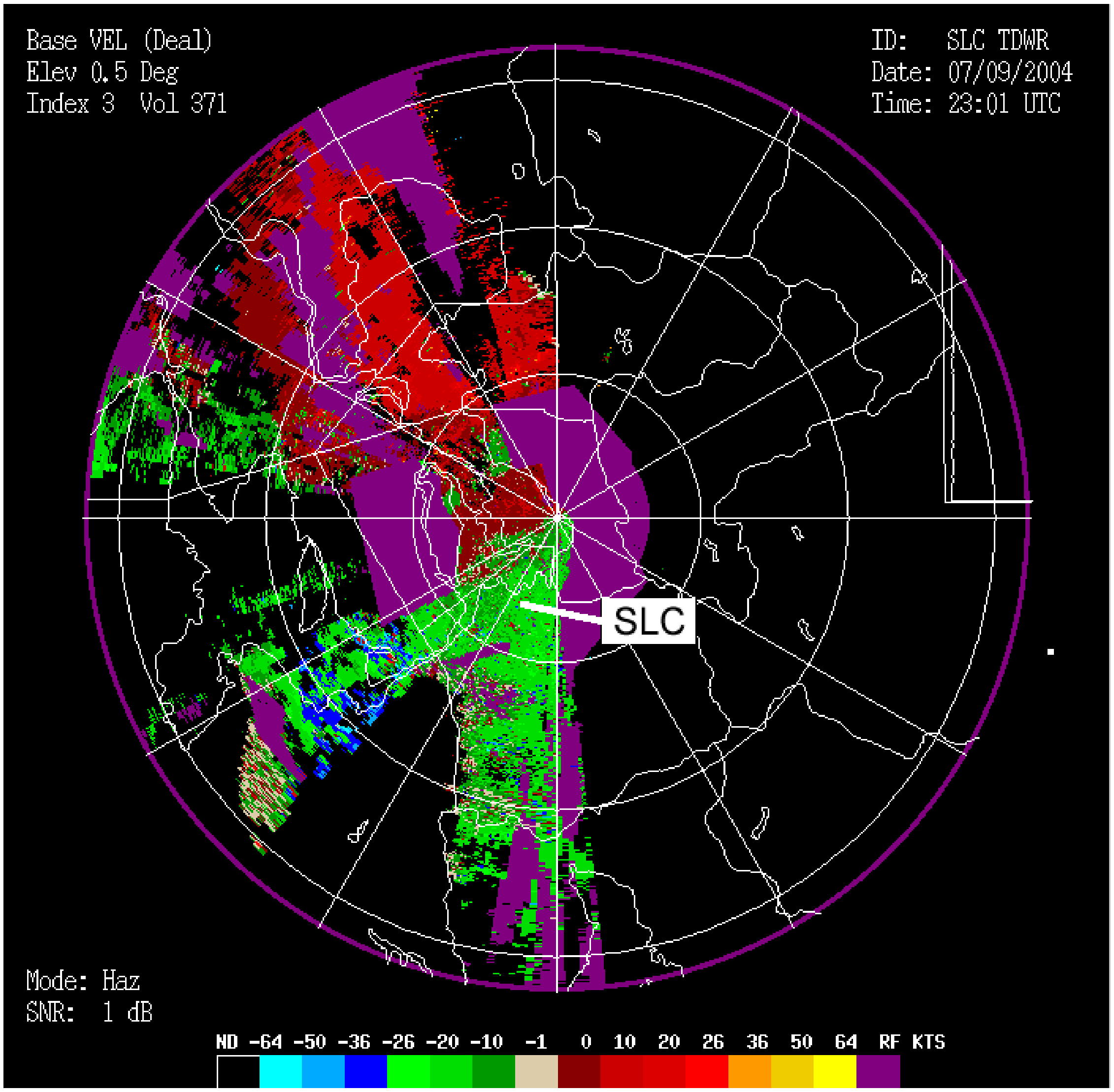

Fig. 3. TDWR image valid at 2301 UTC 09 July 2004 . Inbound velocities are cool colors and outbound are warm. Strongest inbounds (>50 kt) are 25-35 miles west southwest of SLC.

At 2330 UTC, the general public in eastern Tooele County estimated wind gusts over 50 mph. The KMTX radar located at 6574 ft MSL depicted very little velocity returns in this area due to its beam height at 9600 feet above mean sea level (MSL) or about 5400 feet above ground level (AGL). However, the TDWR, located 12 miles north of SLC, whose lowest beam height is only about 870 feet AGL above this portion of the valley renders a much better diagnosis of boundary conditions.

The TDWR registered velocity intensities greater than 50 kt. Consequently, a severe thunderstorm warning for high winds, valid for 45 min, was issued at 2341 UTC for Davis County, just north of SLC (Fig. 4).

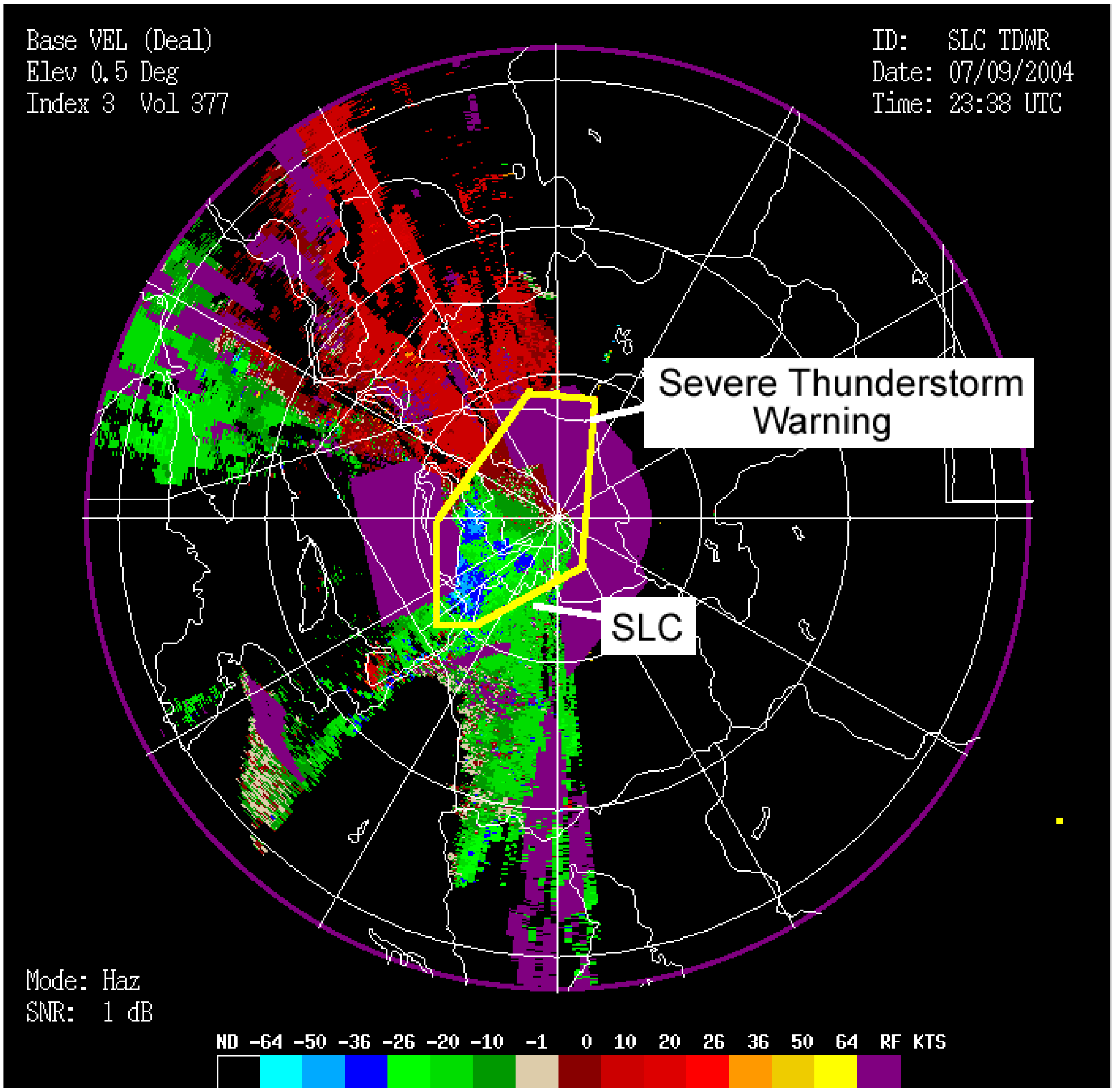

Fig. 4. TDWR image valid at 2338 UTC09 July 2004. Severe Thunderstorm Warning valid through 0030 UTC was issued 3 min after this time for the area surrounded by the yellow border. Note SLC is just outside the warning area.

Winds gusted over 60 mph at both Hill Air Force (HIF) and Ogden (OGD) between 0000 and 0015 UTC 10 July (Fig. 5). Lightning was neither associated with this storm nor any other that day.

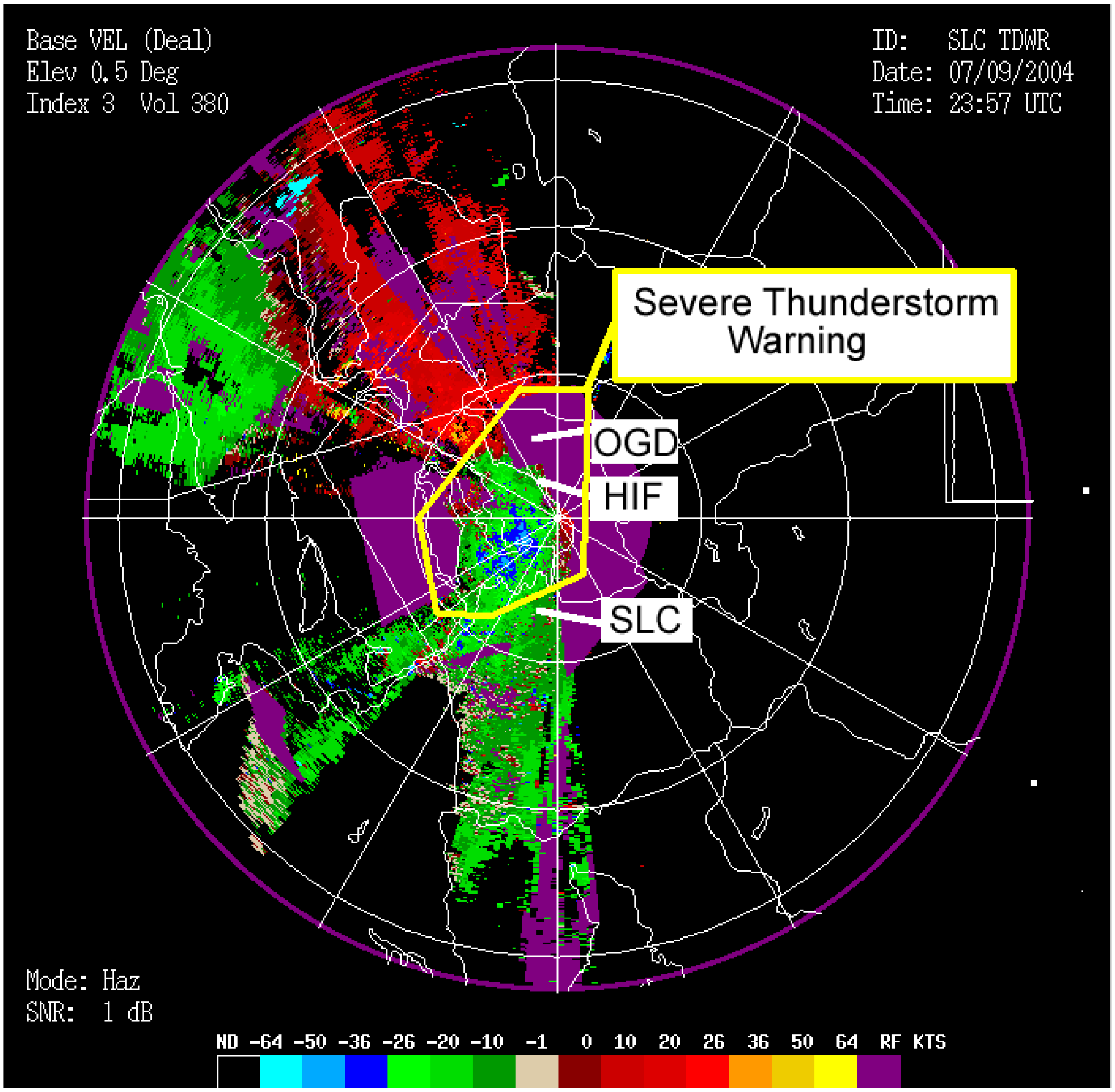

Fig. 5. TDWR image valid 2357 UTC 09 July 2004. The microburst winds associated with the strongest inbound velocities just missed SLC. During the following 15 min wind gusts greater than 60 mph were reported at OGD and HIF.

At 0033 UTC (Fig. 6), TDWR base velocities, which correlated well with 30 dBZ cells (not shown), developed over the Oquirrh Mountains (southwest of SLC) with mid level trajectories that would track them across or near to SLC through 0100 UTC (Figs. 7, 8 and 9).

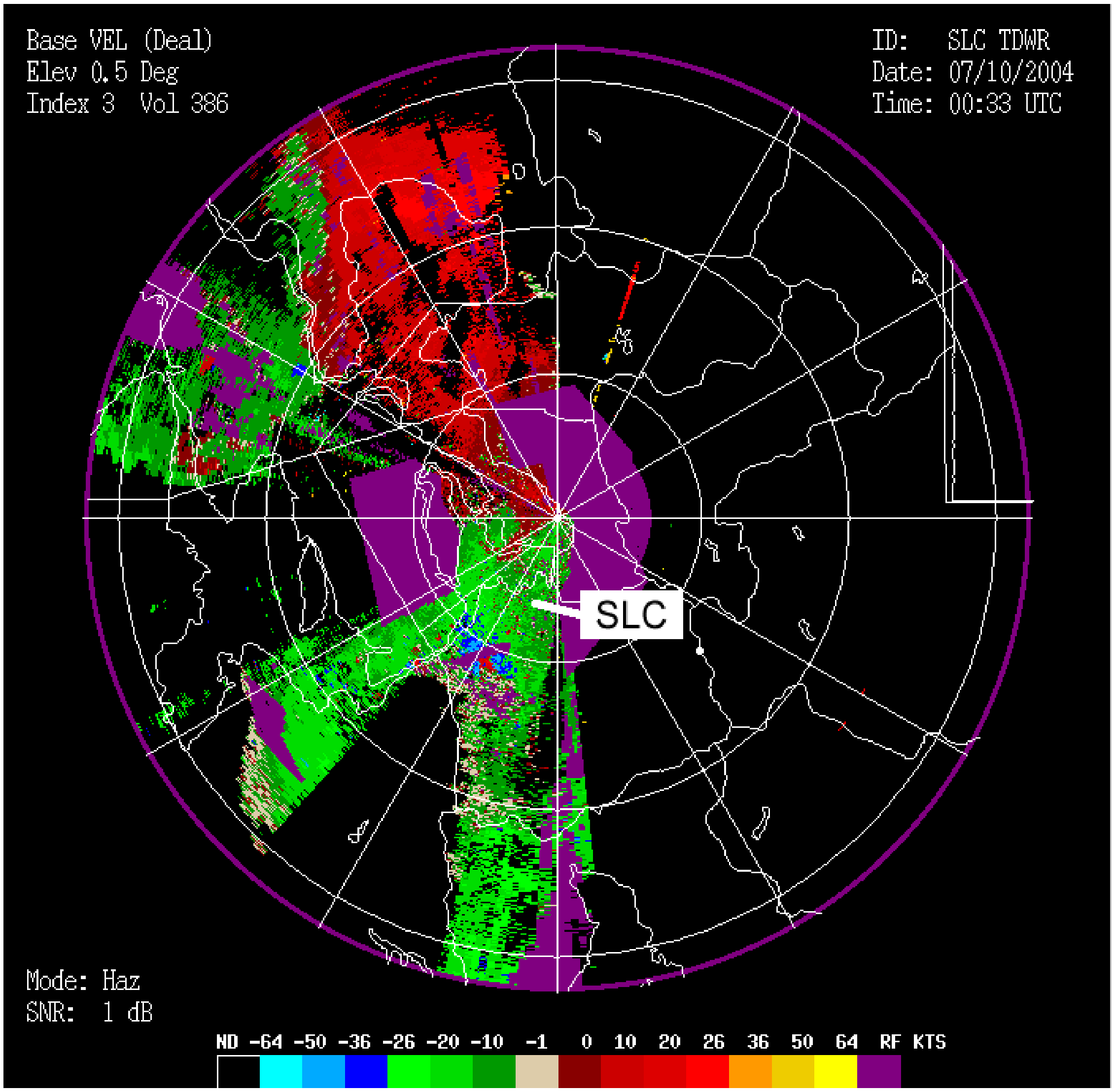

Fig. 6. TDWR image valid 0033 UTC 10 July 2004. Strongest inbound velocities (26-50 kt) are 10-15 miles southwest of SLC.

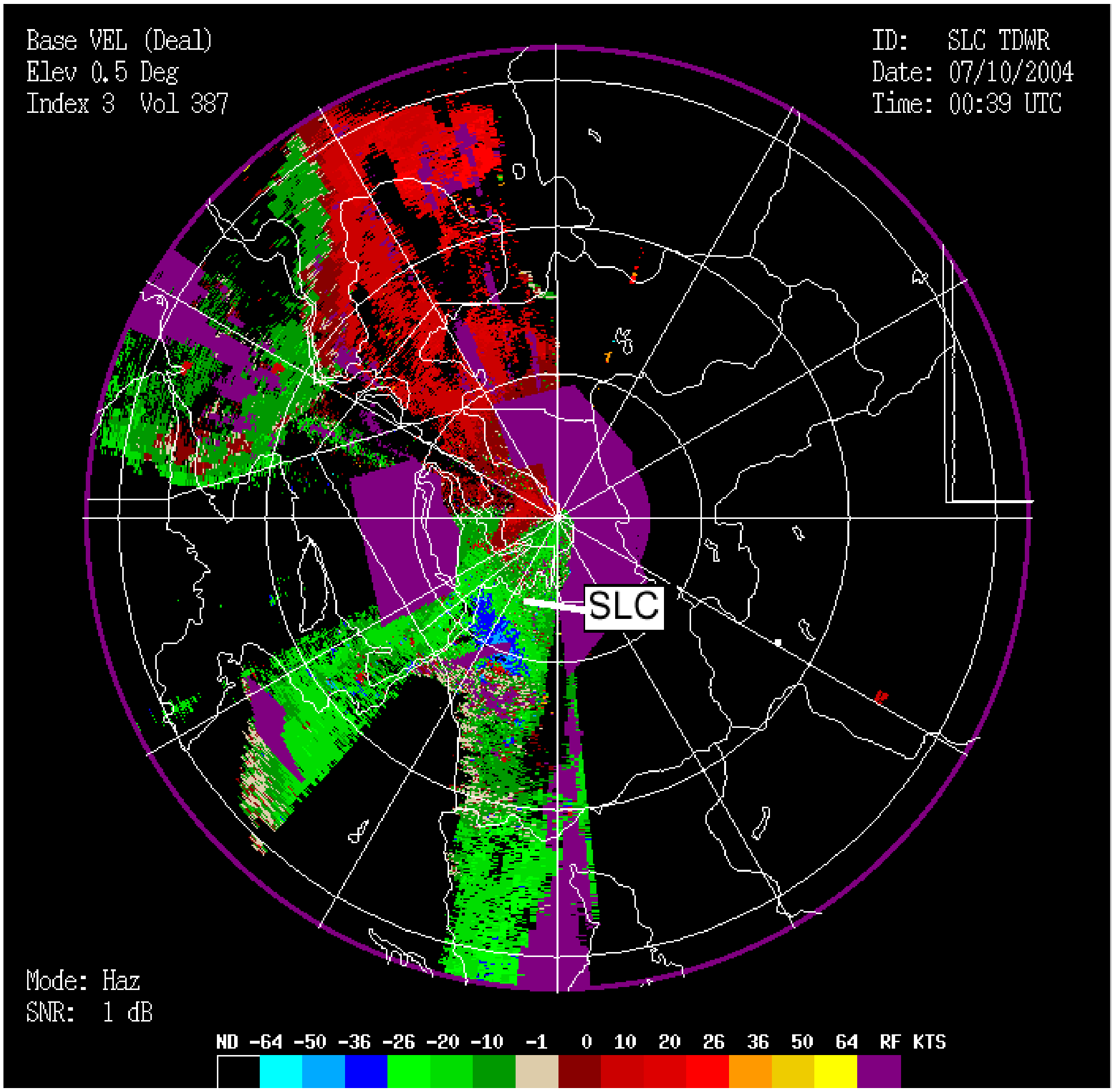

Fig. 7. TDWR image valid 0039 UTC 10 July 2004. Strongest inbound velocities (26-50 kt) are 5-10 miles southwest of SLC.

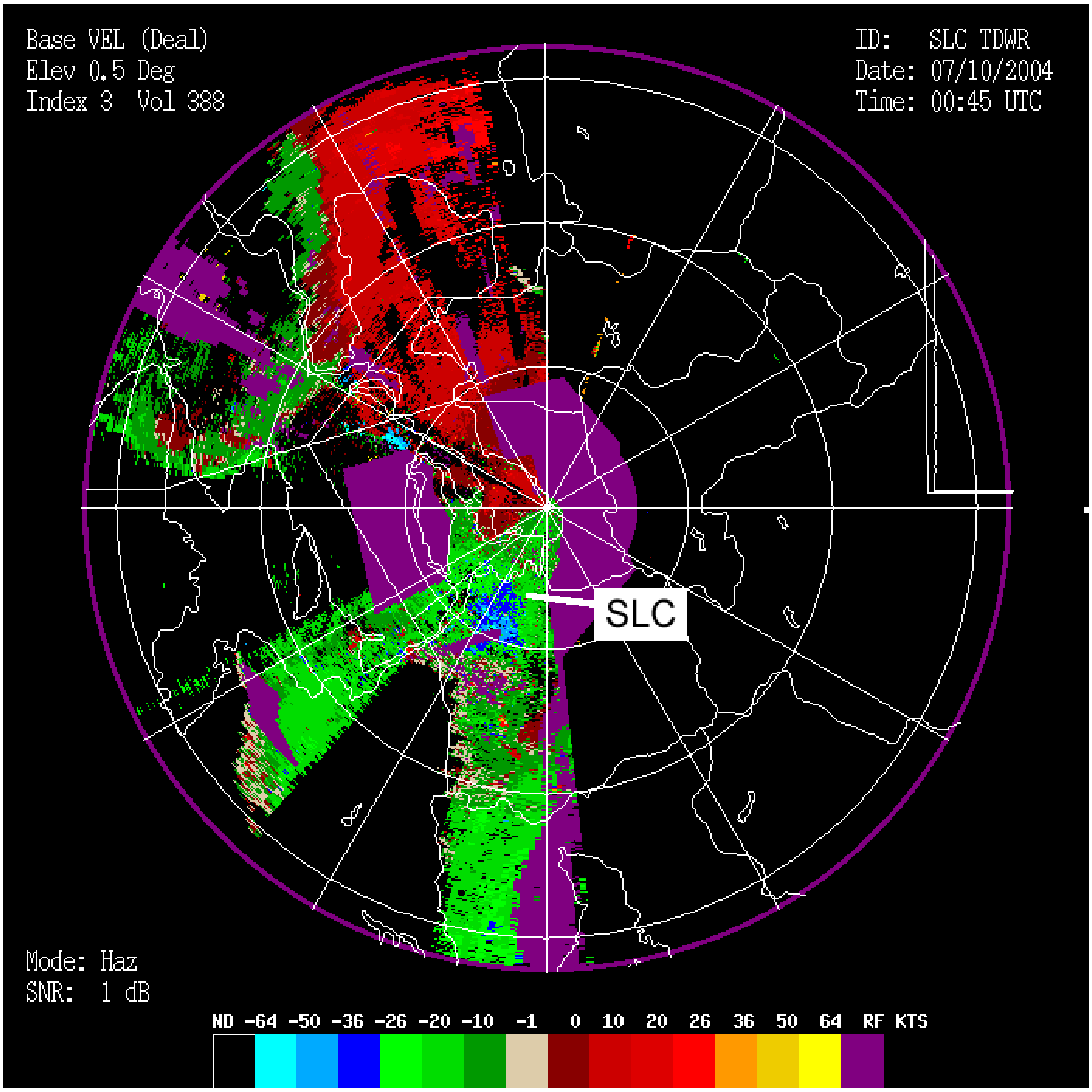

Fig. 8. TDWR image valid 0045 UTC 10 July 2004. Strongest inbound velocities (26-50 kt) are just west and southwest of SLC. Microburst winds of 40-45 kt began affecting SLC a couple of min prior to this time.

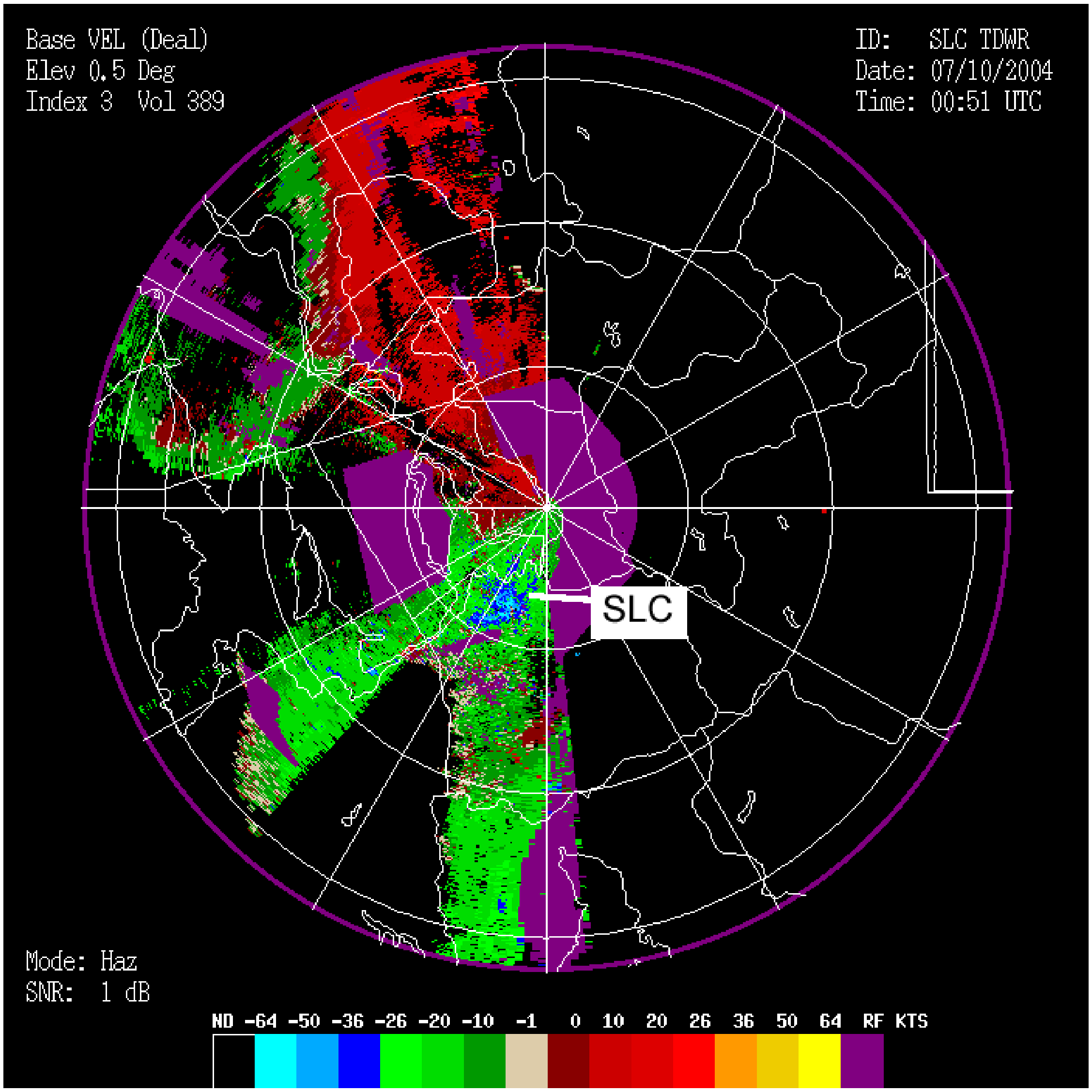

Fig. 9. TDWR image valid 0051 UTC 10 July 2004. Strongest inbound velocities (26-50 kt) are at SLC but are mainly west of SLC. Microburst winds of 40-45 kt continued affecting SLC at this time with visibility reduced to under 2 SM.

These cells produced 40-50 mph winds and widespread blowing dust reducing the visibility under 2 SM for about 5-10 min at SLC.

Communication, Actions and Results

The 1800 UTC 09 July 04 SLC TAF did not include thunderstorms, but did indicate convection with the CB tag. After the first severe weather report was received at 2230 UTC, the aviation meteorologist had to re-evaluate the weather scenario for the remainder of that afternoon and evening. The TDWR indicated that the frequency of both reflectivity returns and velocities, 30-35 dBZ and greater than 40 kt, respectively, increased over northwest Utah during the ensuing hour. This bolstered the forecaster's confidence that SLC airport along with other airports of the Wasatch Front would be affected by microburst winds. Timing and location of the microburst winds and what their potential impacts would be were just a few of the aviation meteorologist's concerns. An update to the TAF was generated and disseminated.

In response to the 2330 UTC severe wind report from Grantsville UT, in eastern Tooele County (where TDWR velocities of 26-50 kts were observed), the public forecaster issued a severe thunderstorm warning at 2341 UTC for an area just north of SLC airport (Fig. 4). The proximity of the airport to the microburst outflow prompted the aviation meteorologist to update the SLC TAF again to include a cross wind with gusts to 40 kt.

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FTUS80 KSLC 092342 AAB
KSLC 092342Z 092418 17015G24KT P6SM BKN120CB
     TEMPO 0001 28025G40KT
    FM0200 17010KT P6SM SCT120
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A westerly component was most likely in the first 30 min then a southerly component after 0015 UTC. However, the stringent TAF format does not allow for an update to include a temporary wind shift (less than 30 min in duration) between 30 min after and the top of the hour. Consequently, the ATCT was notified with an explanation of potential wind directions, strengths and timing and how they were related to the reflectivity and velocity returns depicted by the TDWR.

Due to the surface wind observations closely paralleling the strength indicated by the TDWR, the wind speed forecast was somewhat straight forward. However, the timing of wind direction shifts was difficult to predict due to the rapid movement of the cells and their position in relation to the airport. Unfortunately, it was this variable wind direction that would have the most impact on the arrival approach configuration.

Although, technically, according to the National Weather Service Instruction (Terminal Aerodrome Forecast, dated February 1, 2004), a variable wind direction during convection is permissible, prior ATCT correspondence discouraged variable wind forecasts for SLC, because it serves little purpose for the air traffic flow management decision making process. Base on this established procedure, the ATCT was notified of the TAF update with a TEMPO group containing a westerly component, but with a caveat that depending on where the storm cells were in relation to the airport the winds would come from various directions during the following hour.

This verbal update initialized a concerted effort by various FAA units and centers, namely the Terminal Radar Approach Control (TRACON), the Traffic Management Unit (TMU), the Air Traffic Control Systems Command Center (ATCSCC) located in Herndon, VA, and CWSU support, to mitigate the effects of the microbursts on the arrival sequence at SLC. ATCT and TRACON made a collaborative decision – based on the prevailing TAF conditions and confidence of the verbal update – to request from ATCSCC a reduction in SLC arrival rate. ATCSCC honored the request and decreased the SLC arrival rate from 80 to 48 flights for the following hour. (Note: Without the verbal update including the confidence factor from NWSFO the request to ATCSCC by ATCT may have been denied, according to the ATCT supervisor). TMU then coordinated efforts between ATCT, TRACON and ARTCC to adjust air traffic enroute for these new rates. The reduction in arrivals enabled ATCT and TRACON to manage the airborne aircrafts within the vicinity of SLC with much more efficiency; advancing the landing of some aircraft and delaying others until after the microburst. In preparation for the microburst, ATCT and TRACON made at least three strategic plans on how to account for the air traffic flow at SLC depending on wind direction: cross, north or south winds. When the microburst hit SLC with a southerly component, they were ready with a plan to handle the 12-13 aircraft that were on approach. This number would have been nearly doubled if the arrival rate had not been decreased. The net result was no diversions and safe landings for all involved. During the worst part of the microburst (winds gusted to 40-45 kt and blowing dust restricted visibility to less than 2 miles) the airport was effectively closed down for 13 min with another 30-40 min of reduced aircraft arrivals and departures before normal operations resumed.

Summary

The synoptic and mesoscale pattern on 09 July 2004 consisted of three main components favorable for afternoon convection capable of producing microbursts; mid level moisture, a classic inverted-V sounding and right rear quadrant of a moderately strong anticyclonic 50 kt jet aloft. The more stable atmospheric conditions above 300 mb capped what otherwise would have allowed for deep convection. Consequently, combination of these three favorable ingredients produced shallow elevated convection which KMTX radar depicted with general 25 to 30 dBZ and isolated 35 dBZ reflectivity signatures. Despite these innocuous appearing areas of reflectivity a severe wind gust over 70 mph – generated by the updraft collapse of a 35 dBZ echo – made forecasters aware of the microburst potential. Although the TAF was updated to include strong winds, it was the verbal update to ATCT explaining the developing situation, which initiated the actions taken by the various constituents within the FAA. The result was a reduction of aircraft within the SLC airspace during the hour of the forecasted microburst, which enabled both ATCT and TRACON to effectively accommodate the aircraft traffic.

Conclusion

The meteorologist's understanding of the atmospheric conditions and alert radar monitoring led to timely and accurate forecast updates. The forecast process was considerably enhanced by verbal communication of the adverse weather with affected users. This information directly aided the decision making by various coordinators and air traffic was significantly reduced at the Salt Lake International Airport enabling air traffic personnel to safely manage the airspace more efficiently.

The aviation meteorologist must remain astute during their weather watch and anticipate changes in the weather and determine its impact on the TAF. Forecasters that respond with a proactive TAF update approach, one which includes notifying the ATCT of the forecast change and the reasons behind the change, rather than a spur-of-the-moment reaction to current weather changes, will foster an exemplary working relationship with ATCT. In addition, this proactive approach will provide more lead time to the ATCT, TRACON, TMU, ARTCC and ATCSCC to strategically plan alternative solutions for not only the terminal in question, but for the potential repercussions or ‘domino effects’ on the entire NAS.

This case study is an excellent example of how the NWS aviation meteorologist fulfilled the NWS mission in supporting the Department of Transportation by going the extra step to communicate with the ATCT.