East Wind Events at Double Eagle II Airport

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May 2008

1. Introduction

East canyon wind events are notorious for their strength and sudden onset in New Mexico's Rio Grande Valley. Locations below canyons opening into the valley from the east commonly experience surface winds at speeds from 15 to 25 mph with gusts around 35 mph during east canyon wind events, and these gap winds can be much stronger depending on the strength of the surface pressure gradient and other factors. Along with their gusty nature, east canyon winds can significantly impact aviation operations in the Albuquerque area because of the turbulence and wind shear they produce within the lowest few thousand feet of the atmosphere. Their quick development also forces changes in runway usage at both the Albuquerque International Sunport (Sunport) and Albuquerque's Double Eagle II Airport (Double Eagle). Furthermore, east canyon winds can produce significant crosswinds on takeoff and landing at Double Eagle. Forecasters at the Albuquerque National Weather Service Forecast Office are knowledgeable about both the development and impact of east winds on the Sunport, but less is known about east winds at Double Eagle. Therefore, this study focused on understanding the development and impact of east canyon wind events on Double Eagle II Airport. To help weather forecasters, Double Eagle management, and pilots better anticipate east wind events and their impacts, this web feature quantifies and describes the effects of 14 east wind events on Double Eagle II Airport. The feature begins by briefly describing the method used to obtain the data. Then, results are explained and findings summarized. View Full Length Report

2. Methodology

This study examined hourly wind reports from 14 east canyon wind events in the Rio Grande Valley to better understand the development and impact of east canyon winds at Double Eagle II Airport. Because weather observations at the Sunport respond quickly to the development and demise of east canyon winds in the Rio Grande Valley, Sunport weather observations were reviewed from 2002 to 2005 to identify numerous east wind events for potential study. Sunport observations of generally east winds (50^o – 130^o) with speeds greater than or equal to 15 m/s (29.2 kt) for at least one hour were identified. Consecutive observations were included until they trended below 9 m/s (17.5 kt) and/or their directions trended away from the generally easterly direction (i.e., out of the 50^o – 130^o range). The events for which Double Eagle also had data were included in the study. The number of events was increased by searching the Sunport data set for the top 34 east wind gusts within the range 50^o – 130^o, and identifying other time periods with matching data at Double Eagle II Airport. Two east wind events that occurred during June 2007 were later added to the list of events for study, even though the strength of the June 2007 events did not rank them among the top east wind events at the Sunport.

3. Results

Using observations from all 14 cases simultaneously, the wind roses and wind gust roses in Fig. 1 (below) illustrate wind direction and wind speed tendencies at both airports during east wind events. The wind roses depict the percentage of time that the sustained wind blew from various directions and at certain ranges of speed. The wind gust roses depict the same information for wind gusts.

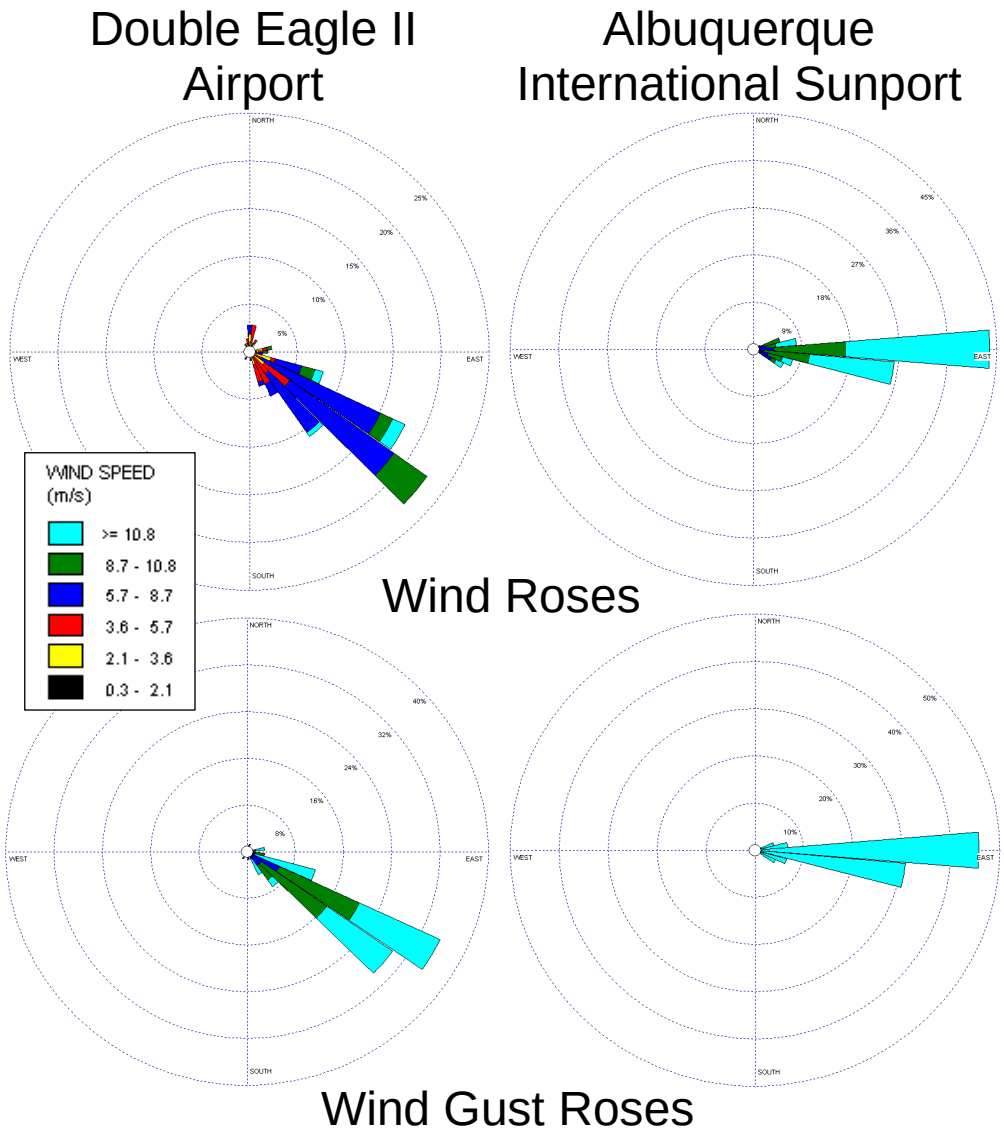


Figure 1. Wind roses (top) and wind gust roses (bottom) from Albuquerque's Double Eagle II Airport (left) and International Sunport (right) for the 14 east wind events studied. Plotted using Lakes Environmental's WRPlot View (Version 5.3).

a. Wind Direction Characteristics – As illustrated in Fig. 1, the wind direction data from these 14 east wind events indicates: (1) Winds blow primarily from the southeast at Double Eagle during east wind events, rather than the easterly direction common at the Sunport. (2) Double Eagle wind direction also tends to be more variable than winds at the Albuquerque Sunport during east wind events.

These wind direction and directional-variability differences between the two airports can be explained by differences in their distance and direction from Tijeras Canyon, and possibly also by the proximity of Double Eagle II Airport to the volcanoes and escarpment of the Petroglyph National Monument. Fig. 2 (below) depicts the location of both airports with respect to the Petroglyph National Monument and Tijeras Canyon. Since Tijeras canyon is only 12 miles due east of the Sunport, and there are no topographic obstructions between the canyon and the Sunport, the Sunport experiences persistent east winds as they exit the canyon. In contrast Double Eagle is approximately twice as far from Tijeras Canyon, is located northwest of the canyon's opening into the Rio Grande Valley, and east winds must cross over the Petroglyph National Monument in order to reach Double Eagle. As a result, Double Eagle experiences southeast winds after they exit the canyon. The volcanoes and southeast-to-northwest-oriented protrusions in the escarpment of the Petroglyph National Monument may also help to funnel east winds toward Double Eagle from the southeast after they exit Tijeras Canyon (see Photo 1 below). Upon exiting the canyon, as the east canyon wind spreads toward the northwest to reach Double Eagle, it tends to weaken and the direction becomes more variable due to frictional effects within the lowest levels of the atmosphere. Wind reports received by the National Weather Service during east canyon wind events consistently reflect this effect in weaker readings for portions of Albuquerque located northwest of Tijeras Canyon. Additionally, friction influences the east wind more significantly as terrain rises west of the Rio Grande River, and especially over the Petroglyph National Monument in route to Double Eagle.

Upon closer inspection, the Double Eagle wind rose indicates that there was a small percentage of time that the Double Eagle Automated Weather Observing System (AWOS) reported winds from the north and other directions besides the southeast during the 14 east wind events. This variability may have occurred at times when east canyon winds weakened enough to allow other influences to override them, like early morning drainage winds flowing southward across the airport from higher terrain further north, precipitation outflow boundaries and smaller scale pressure gradients. At times, east winds may also have washed around the northern end of the Sandia Mountains and into the Rio Grande Valley in a broad eddy with a northerly component to the wind flow in the vicinity of Double Eagle. When they occurred, winds from directions other than the southeast were generally much weaker than the southeasterly winds that commonly developed at Double Eagle during the east wind events. We will discuss the strength of east canyon winds at Double Eagle next.

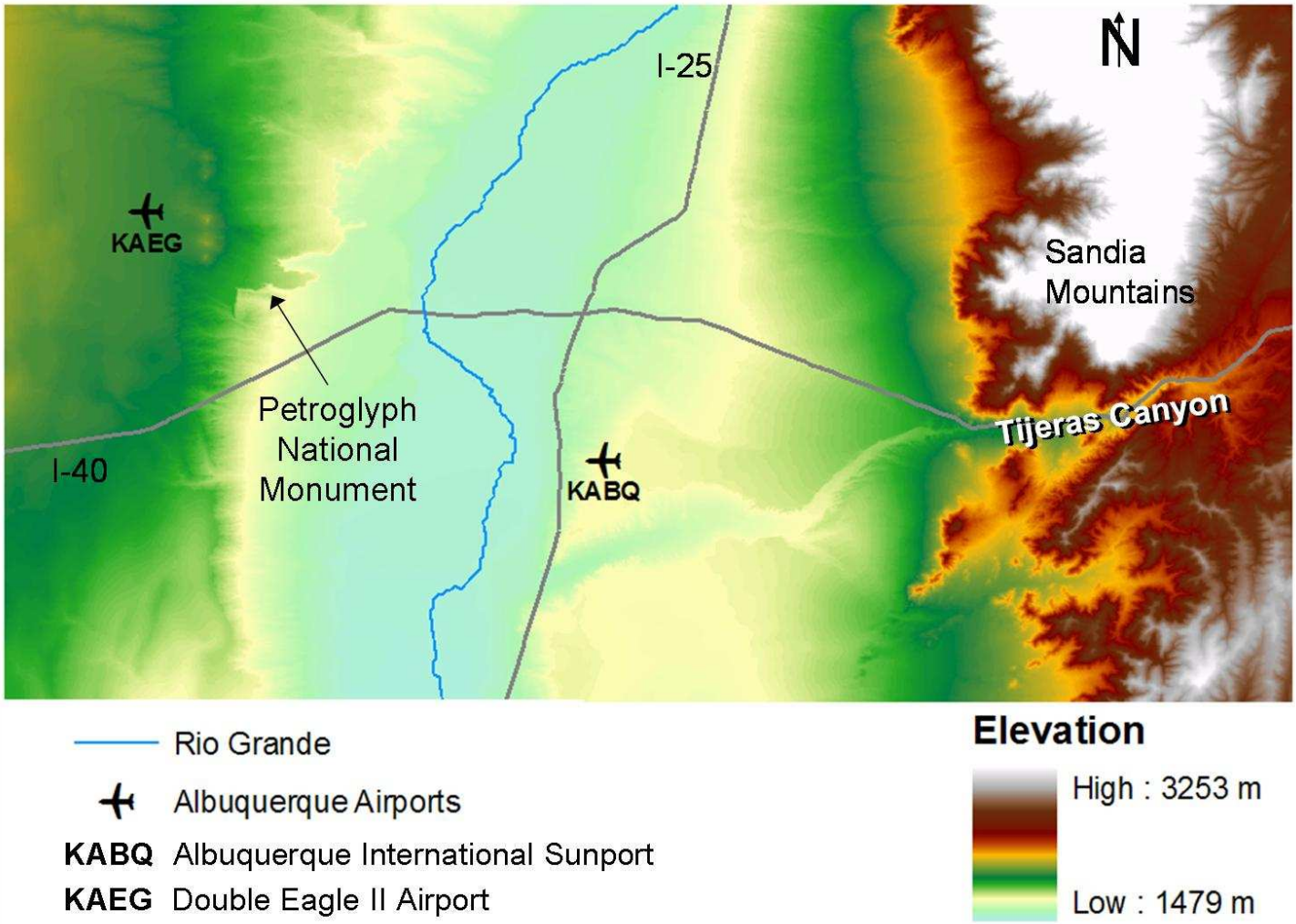


Figure 2. Topographic map of Tijeras Canyon, the Rio Grande Valley and Albuquerque's Airports.

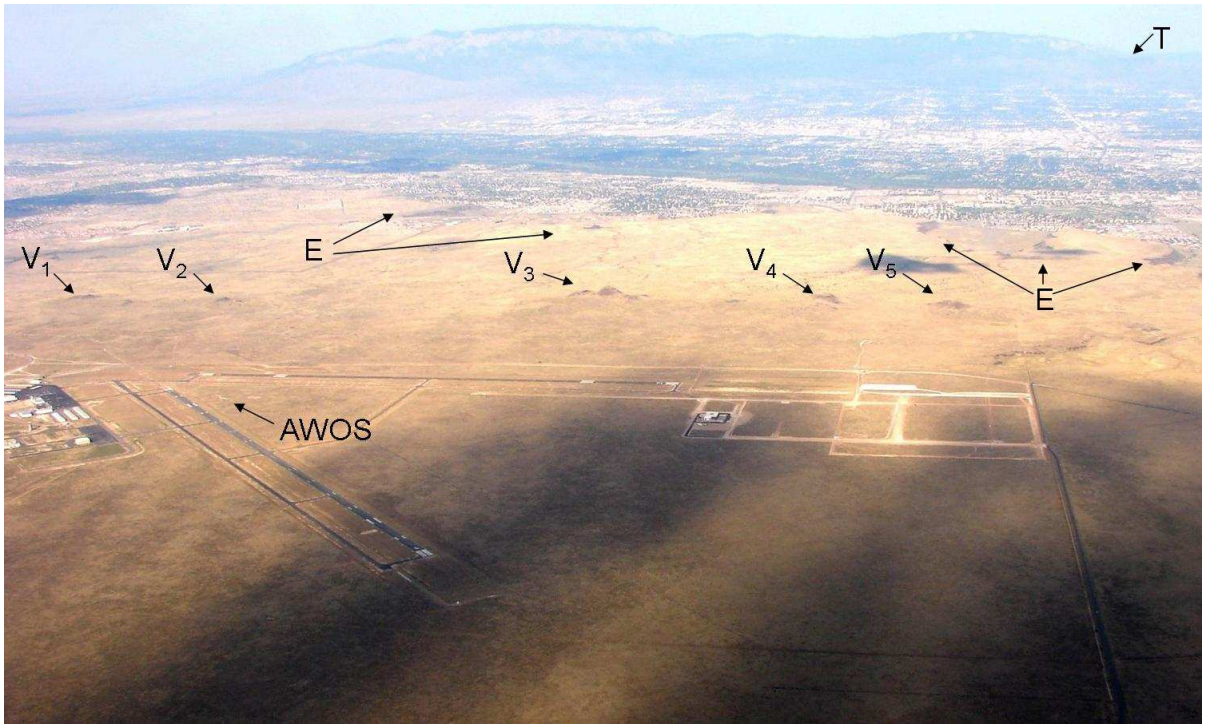


Photo 1. View of Double Eagle II Airport looking toward the east and northeast with the Rio Grande, Albuquerque and Sandia Mountains in the background. Note the location of the AWOS with respect to the volcanoes (V1 – V5) and the escarpment (E) of the Petroglyph National Monument. T points to Tijeras Canyon. Not shown are the Manzano Mountains south of Tijeras Canyon, and the Albuquerque International Sunport on the southeast end of Albuquerque. Photo taken in August 2007, courtesy of Gary Hoe.

b. Wind Speed Characteristics – Wind speed data from these 14 east canyon wind events indicates that east winds tend to be weaker, less gusty, and less persistent at Double Eagle than they are at the Sunport. The wind class frequency distributions in Fig. 3 (below) illustrate this most clearly, with 80.6% of the Sunport's hourly wind reports in the two highest wind classes (greater than 17 kt) compared to only 11.3% at Double Eagle. At 42.9%, the third highest wind class was by far the most common wind class observed at Double Eagle. Meanwhile, Double Eagle wind gusts reached the highest wind class (greater than 21 kt) in 45.6% of observations with gusts, compared to 94% at the Sunport. During the east wind events studied, 32% of the hourly wind readings from Double Eagle reported gusts, compared to 70% at the Sunport. Also noticeable in Figure 3, is the difference in the percentage of hourly wind reports with calm winds at Double Eagle (7.5%) compared to the Sunport (0%). Thus, Double Eagle's winds tend to be more sporadic than the Sunport's during east wind events, sometimes changing directions (as mentioned previously) or briefly calming.

As described earlier, wind direction and directional-variability differences between the two airports can be explained by differences in their distance and direction from Tijeras Canyon, and possibly also by the proximity of Double Eagle II Airport to the volcanoes and escarpment of the Petroglyph National Monument. Double Eagle is located northwest of

Tijeras Canyon, which accounts for the southeast winds common at Double Eagle during east wind events, and it is almost twice as far from the mouth of the canyon, which results in friction having a greater influence on Double Eagle's wind speeds. Winds also encounter greater friction as they rise up the west bank of the Rio Grande and over the escarpment and volcanoes of the Petroglyph National Monument in order to reach Double Eagle. Pilots have reported that east and southeast winds interact with the terrain of the Petroglyph National Monument to produce updrafts with significant turbulence and wind shear along the volcanoes and the escarpment, especially on the approach end of Double Eagle's Runway 17/35. If these obstructions to the low level winds can impact airflow aloft, they should be able to influence the strength and direction of the surface winds at the AWOS location, which is only a little over a mile northwest of the widest and tallest volcano (V_3 in Photo 1). It is also worth noting that aircraft approaching Runway 17/35 from the south cross the main stream of the east wind in the vicinity of Interstate 40 (I-40), which is due west of Tijeras Canyon at that range. Since this runway approach encounters stronger winds near I-40, it is reasonable to expect greater turbulence and wind shear as the stronger winds rise over the higher terrain on the western edge of the Rio Grande Valley. The tendency for southeast winds to strengthen during east wind events not only impacts Double Eagle through greater wind shear and turbulence, but also through greater crosswinds.

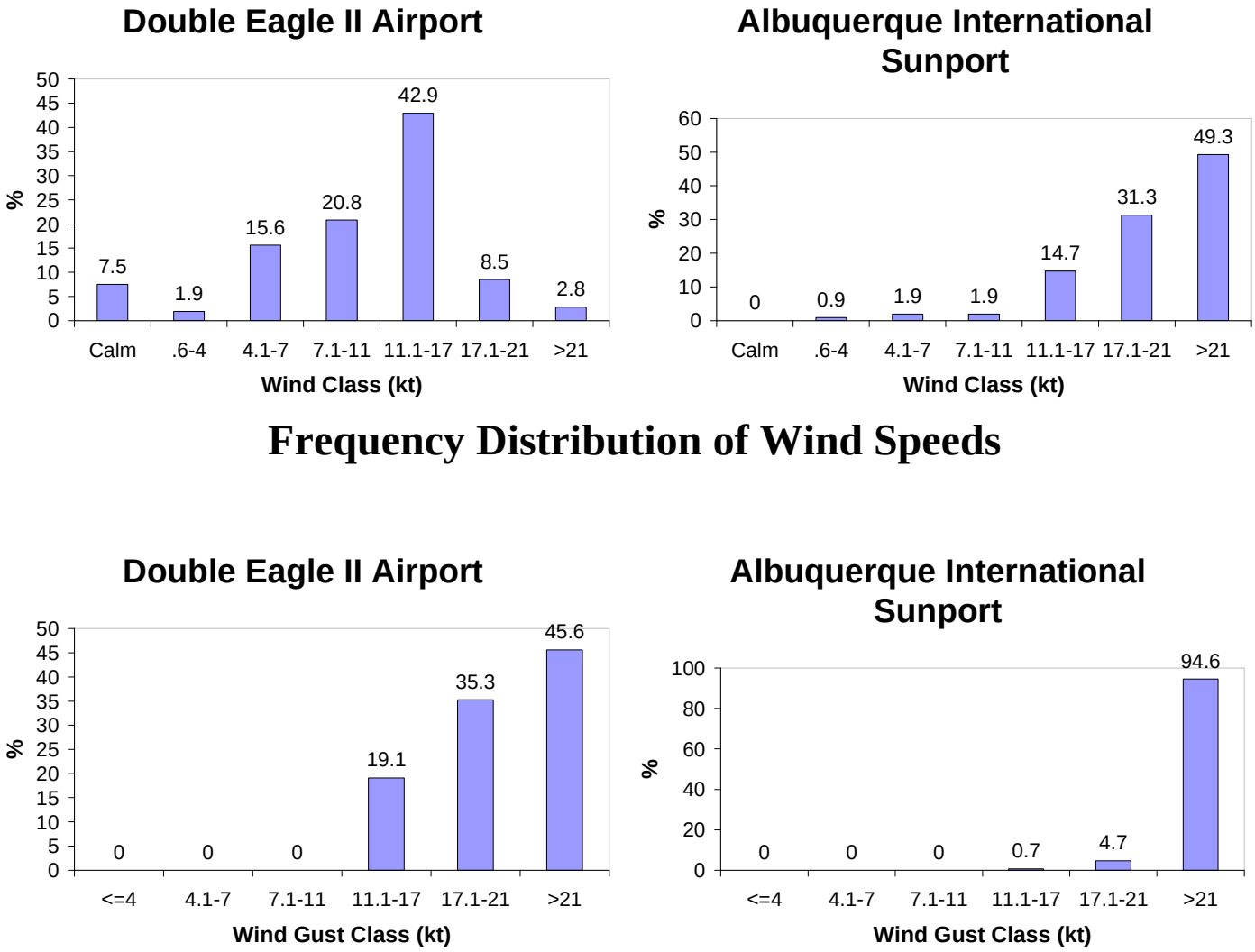
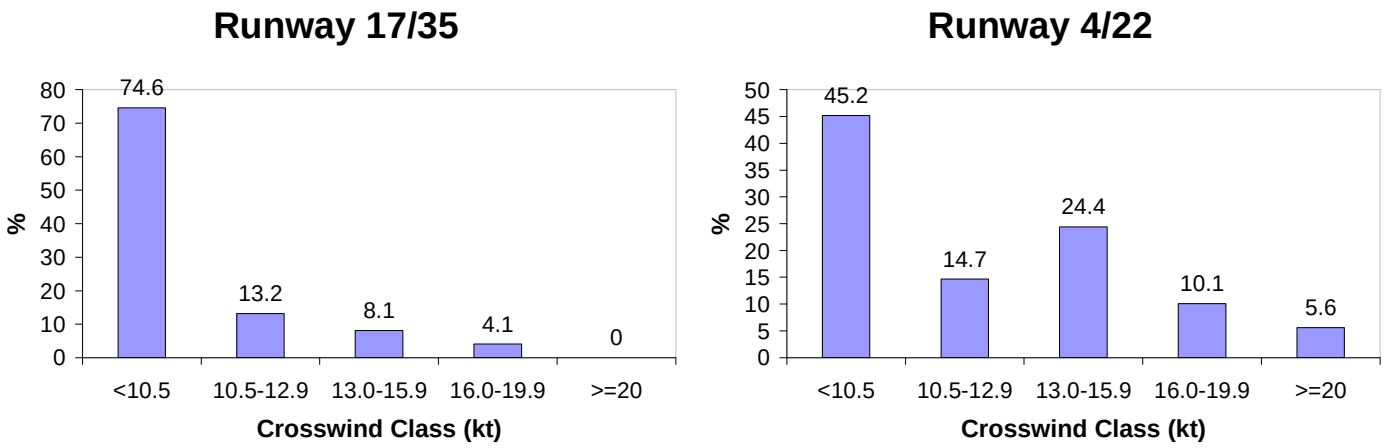


Figure 2. Frequency Distribution of wind speeds and wind gusts at Double Eagle II Airport and the Albuquerque International Sunport for the 14 Rio Grande Valley east wind events studied.

c. Crosswinds – According to the National Transportation Safety Board's accident database, 60.7% of the weather-related aircraft accidents that occurred in New Mexico between 1996 and 2006 were primarily attributed to strong and gusty winds or crosswinds. This is much more than any other weather hazard. Because crosswinds pose such a significant threat to aviation safety, this study also examined the occurrence of crosswinds at Double Eagle II Airport during the Rio Grande Valley east wind events. The Albuquerque International Sunport uses an east/west runway during east wind events, which mitigates the impact of crosswinds. However, this study found that Double Eagle's runway configuration can leave the airport susceptible to significant crosswinds during east wind events.

Fig. 4 (below) plots the frequency distribution of crosswind components for the sustained wind and wind gusts on Double Eagle's two runways: 17/35 and 4/22. Crosswinds generally have a greater impact on small aircraft, like those used at Double Eagle, than on large aircraft. Nearly all small general aviation aircraft can operate safely with crosswinds under 10.5 knots. With 74.6% of crosswinds under 10.5 knots, the data indicates that Runway 17/35 had the fewest crosswind problems during the east wind events, compared to only 45.2% on Runway 4/22. Crosswind components over 10.5 knots can become problematic for small aircraft, and crosswinds over 20 knots are especially dangerous. Fortunately, during the 14 east wind events studied, crosswind components of the sustained wind did not exceed 20 knots on Runway 17/35. However, 16.4% of wind gusts had crosswind components greater than or equal to 20 knots on 17/35. Because of its perpendicular orientation to the southeast wind that develops at Double Eagle during Rio Grande Valley east wind events, Runway 4/22 faired significantly worse, with 5.6% of sustained winds bearing crosswind components greater than or equal to 20 knots and over 55% of wind gusts exceeding that threshold. For this reason, aviators have indicated they prefer to use Runway 17/35 during east wind events. However, as mentioned previously, using Runway 17/35 during east wind events exposes aircraft more directly to wind shear and turbulence as east winds rise over the escarpment and volcanoes of the Petroglyph National Monument.



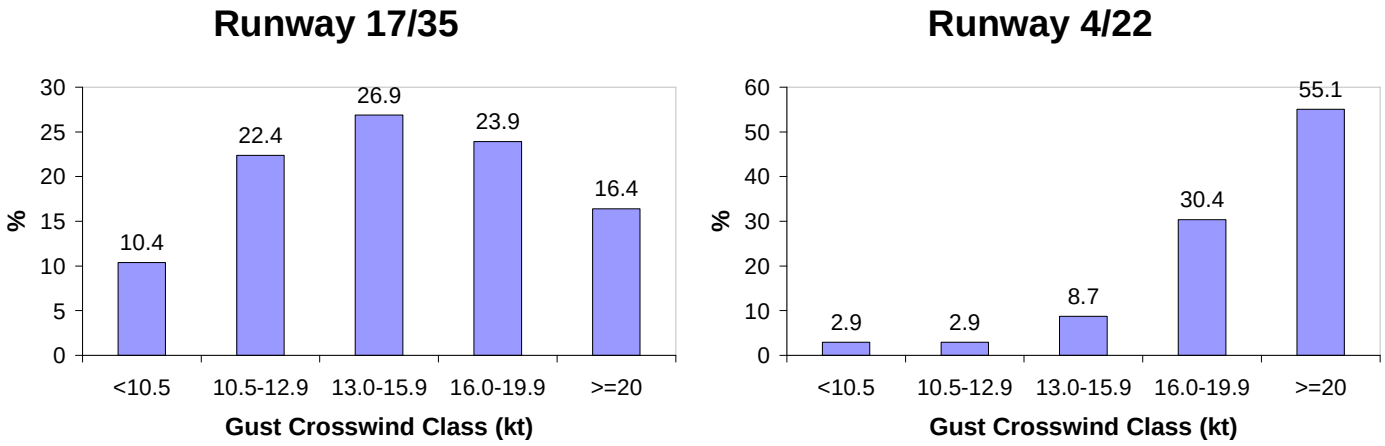


Figure 3. Frequency distribution of crosswind components plotted by class (top) for the two runways at Double Eagle II Airport, from the 14 Rio Grande Valley east wind events studied. The frequency distribution of wind gust crosswind components is also plotted (bottom).

4. Summary

In this study, wind reports from 14 east canyon wind events in the Rio Grande Valley were analyzed to better understand the development and impact of east canyon winds at Double Eagle II Airport. The data revealed that east canyon winds blow from a southeasterly direction at Double Eagle (120^{o}-140^{o}), rather than an easterly direction like the Albuquerque International Sunport (90^{o}-100^{o}). Double Eagle winds also tend to be weaker, less gusty, and more variable than winds at the Sunport during east wind events, sometimes changing to another direction or becoming calm. The data also showed that significant crosswinds can develop during Rio

Grande Valley east wind events at Double Eagle II Airport. Because of their tendency to gust out of the southeast at this airport, Rio Grande Valley east wind events have a greater impact on Runway 4/22 than on Runway 17/35. Using Runway 17/35 will help pilots minimize the impact of crosswinds during east wind events; however, users of this runway must also deal with greater wind shear and turbulence on approach and landing because it is located very closely along the escarpment and volcanoes of the Petroglyph National Monument (see Photo 1).

There are many reasons why east canyon wind events impact Double Eagle II Airport differently than the Albuquerque International Suport. Some of the more important reasons discussed in this report include: (1) Double Eagle is almost twice as far from Tijeras Canyon as the Sunport, enabling frictional effects to more strongly influence Double Eagle's winds. (2) Unlike the Sunport, Double Eagle is not located directly in the main flow of the low level east wind exiting Tijeras Canyon, and instead is impacted by an east canyon wind that spreads in a northwesterly direction prior to reaching the airport. (3) The volcanoes and escarpment of the Petroglyph National Monument lie between Double Eagle and Tijeras Canyon, and probably block and channel the east canyon wind to some extent before reaching the Double Eagle AWOS.

5. References

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