MOUNTAIN-WAVE INDUCED WINDSTORMS WEST OF WESTCLIFFE, COLORADO.

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Introduction

Windstorms in the lee of mountain barriers have been documented at many locations in the United States and abroad. One highly studied area is in the vicinity of Boulder, Colorado. Other areas with known high winds are Fort Collins, Colorado and Salt Lake City, Utah. Many other places in the western United States can experience high winds, but these places are not well known due to the lack of population as well as absence of resident meteorologists. During the past two years, the National Weather Service (NWS) office in Pueblo has received reports of damaging winds to the west and northwest of Westcliffe, Colorado. During the high wind events, the town of Westcliffe reported strong, but not damaging winds.

A spotter located about 12 km west northwest of Westcliffe Colorado reported wind of 40ms⁻¹ (90 mph) or greater during some of the events using a anemometer mounted on his house. After several reports of these unusually strong winds, a meteorologist from the NWS office in Pueblo visited the site to determine if these reports were realistic. He found that the anemometer was of good quality and mounted properly. While the wind sensor may not be providing the exact speed of the gusts, the observed wind gusts were still of damaging speeds. Other evidence supports

* Corresponding author's address: Paul Wolyn, National Weather Service, 3 Eaton Way, Pueblo, CO 81001; email Paul.Wolyn@noaa.gov the presence of damaging winds in this region. Figure 1 shows the west-facing windows of a nearby house boarded-up permanently after being blown-out by several windstorms.

Figure 2 shows the topography of the region. The area of high winds is generally in a region west to northwest of Westcliffe, Colorado. This location is immediately in the lee of the Northern Sangre de Cristo Mountains. The region of the high winds is at around 2900 m MSL, and about 8 km to the west of the site the Sangre de Cristo Mountains crest at about 4500 m MSL.

Cases

During the winter of 2001-2002, several instances of high winds in this region were reported by the National Weather Service spotters. For two of the cases, operational data on AWIPS (which is the primary operational system of the NWS to view data and compose forecasts) was archived for later display on the Warning Environment Simulation (WES). These are the same data sets that are available to the operational forecaster. The model data includes the full National center for Environmental Prediction (NCEP) suite of operational models. Because of current limitations in bandwidth and CPU power, the data are mapped to grid sizes of 40 km or greater. The model datasets do not show the full resolution of the model and they may miss many of the mesoscale features contained in the full resolution model.

One event occurred on the evening of 5 December 2001, when a spotter reported a wind



Figure 1. Photo of a nearby house showing west facing windows boarded up permanently after being blown-out by several windstorms.



Figure 2. Topographic map of the region around Westcliffe, Colorado. Contour interval is 300 m. Data are smooth to a 1 km grid and the higher peaks are not identified.

gust to 40 ms⁻¹ (90 mph). Figure 3 shows the initial 50 hPa (500 mb) height and wind field for the Rapid Update Cycle (RUC) model from NCEP for 0800 UTC on 6 December 2001. This was around one hour after the high wind report was received. The high winds occurred with, and just after a trough passage in the region. Figure 4 shows a sounding, generated from the RUC at the same time for a location on the west side of the Sangre de Cristo Mountains. The model generated sounding showed a stable layer below 50 hPa. Above 50 hPa, the atmosphere was weakly stable with minimal shear.

At the time of the high winds, the flow appeared to be from the west to northwest, which is not perpendicular to the barrier upstream. Simulations using the RAMS (Regional Atmospheric Modeling System) from Colorado State are currently being run to examine this case in more detail.

Another high wind episode occurred on the evening of 20 January 2002. This high wind event



Figure 3. Wind and height for the 50 hPa surface from the NCEP RUC model for 0800 UTC 6 December 2001. Heights are in dm with a contour interval of 60 dm. Small wind barbs = 2.5 ms⁻¹, large wind barbs = 5 ms⁻¹ and wind flags = 25 ms⁻¹.

occurred with northwest winds aloft after a trough passage. The model generated soundings show a weakly stable layer with little forward shear above 50 hPa. Below 50 hPa the sounding has a nearly isothermal layer with 70 hPa winds around 20ms⁻¹ (40 knots). This vertical thermal and wind structure can be conducive to high winds. However, the winds aloft were from the northwest, which is nearly parallel to the barrier upstream. Further modeling will also be conducted on this case to understand the dynamics associated with this high wind event.

Other cases of high wind events have been observed during the 2001-2002 winter season. During some of the cases the winds were from the southwest to west direction, which is perpendicular to the upwind barrier. While the high winds appear to be more favorable with weak shear or backward shear along with a stable layer near the mountain top, high winds have occurred



Figure 4. Model generated sounding for a location about 30 km west of the high wind region. Sounding is generated from the NCEP RUC model initial fields at 0800 UTC on 6 December 2001. Small wind barb is 2.5 ms⁻¹, full wind barb is 5 ms⁻¹ and wind flag is 25 ms⁻¹.

with strong forward shear and thermal profiles not typically associated with mountain wave induced windstorms.

Summary

A zone of high winds in the lee of the northern Sangre de Cristo Mountains, west and northwest of Westcliffe, Colorado have been observed. Preliminary analysis of a couple cases has shown that the high winds can occur with northwest flow aloft, as well as with west to southwest flow. Numerical modeling of these events may provide more insight into the dynamics of the high wind events. The San Luis Valley, which is a large mountain valley to the west of the Sangre de Cristo Mountains may play a role in establishing a proper upwind profile for high winds. The mountains to the east and southeast of the high wind zone may also play a role in causing the high wind events. In this relatively isolated and data void region, numerical simulations will be the best way to explore the dynamics of the high wind events.