14th Conference on Mountain Meteorology, 30 August – 3 September, 2010 Lake Tahoe, CA

Intense Snowfall Investigation of a Narrow Mountain Gorge

Jeffrey D. Colton*[1], J.D. Ramey Jr.[1], M.C. Schwitzer[1], M.P. Meyers[1], M.P. Chamberlain[1], M. Gober[2]
[1]NOAA/NWS, Grand Junction, CO, [2]CAIC, Silverton, CO.

Introduction

- Record snow fell over the Uncompahgre Gorge in the San Juan Mountains (Figures 1-3).
- Major winter storms frequently produce snowfall amounts in excess of three feet in this region.
  - Areas in the Gorge and below usually experience much lower snow accumulations.
- Under certain conditions, snowfall amounts within the Gorge may be much greater than those experienced over the higher peaks surrounding the Gorge.
- This phenomenon was observed on four separate occasions during the March 2010 season.
  - See Tables 1-2 & Figure 6.
- The focus of this study will be on the 19-20 March 2010 case.

View looking south into the Gorge

Table 1

Top 15 Daily Snowfall Events in Ouray, CO.

Rank	Snowfall (cm)	Date
1	74.2	3/20/2010
2	50.8	3/14/1944
3	44.5	3/11/1977
4	43.2	3/31/1948
5	39.4	3/27/2010
6	37.1	3/4/1981
7	33.3	3/24/2010
8	33.0	3/28/1951
9	31.2	3/31/2005
10	30.5	3/5/1992
11	30.5	3/24/1945
12	30.0	3/12/1975
13	27.9	3/28/1961
14	27.9	3/31/1955
15	27.7	3/11/2010

Table 2

Snowfall Totals 19-20 March 2010.

Location	Snowfall (cm)	Snowfall Amount (inches)
Ouray	75.2	29.6
Monument	43.2	17.0
Red Mountain Pass	39.4	15.5
Grand Mesa (Skyway)	33.0	13.0
Aspen Mountain Ski	33.0	13.0
Ridgeway 5NW	31.2	12.3
Telluride Ski	30.5	12.0
Vail Ski	22.9	9.0
Wolf Creek Ski	17.8	7.0
Crested Butte Ski	12.7	5.0
Silverton	7.6	3.0
Steamboat Springs	6.1	2.4
Coal Bank Pass	2.5	1.0
Durango Mtn Ski	2.5	1.0
Montrose	2.3	0.9

Site Locations and Topography

Located in the San Juan Mountains of southwest Colorado, the three sites chosen include:

- Ouray located at the base of the Gorge at an elevation of 2375 m (Figures 2 & 3).
- Monument located mid-canyon at an elevation of 2905 m (Figures 2 & 3).
- Red Mountain Pass (RMP), the summit of the study, at an elevation of 3358 m (Figures 2 & 3).
- These three sites are separated by ~14.5 km and ~983 vertical meters.
- Gorge is oriented north to south from Ouray to Monument then bends to the southwest to the summit of RMP.

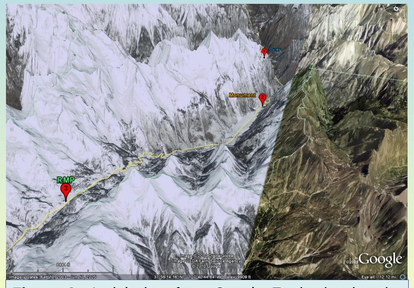


Figure 2: Aerial view from Google Earth showing the location of the study sites. View is to the north.

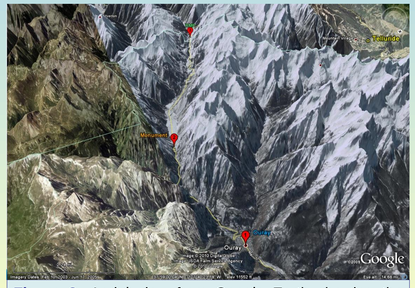


Figure 3: Aerial view from Google Earth showing the location of the study sites. View is to the south.

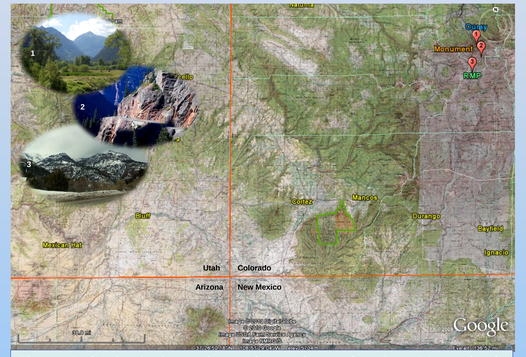


Figure 1: Study plot located over the northwest San Juan Mountains in southwest Colorado. Narrow mountain valley stretches from near Ridgway, CO south to Red Mountain Pass.

Figures 4 and 5: Heavy snow blankets Cooperative Weather Station in the town of Ouray during March 2010 snowstorm. Figure 4 is from 19 March 2010; Figure 5 is from 26 March 2010. Photos courtesy of Karen Risch.

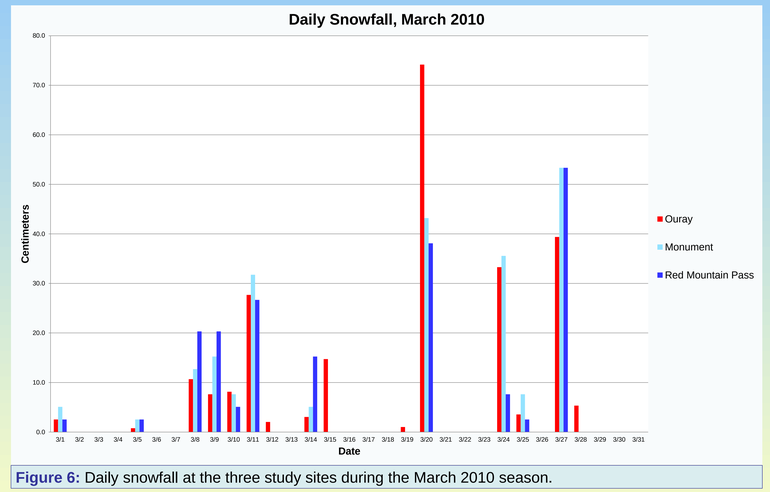


Figure 6: Daily snowfall at the three study sites during the March 2010 season.

Analysis

- Strong, dynamic lift, associated with an approaching low pressure trough, occurred through the afternoon and evening of March 19, as seen by the 500-300 hPa Div Q field (Figure 7), as well as the strong Omega indicated in the time height cross section (Figure 8).
- Dynamic lift, coupled with low level convergence and frontogenetic zone, in late afternoon hours to enhance snowfall production (Figure 7).
- 700 hPa temperatures dropped into the -10°C to -12°C dendritic growth zone region by the overnight hours, which allowed efficient snowfall production to continue after best dynamic lift was observed (Figure 8).
- Weak north to northwest winds, associated with strong cold air advection provided orographic lifting in the Gorge, which aided dynamic lift and enhanced snowfall production (Figure 9).

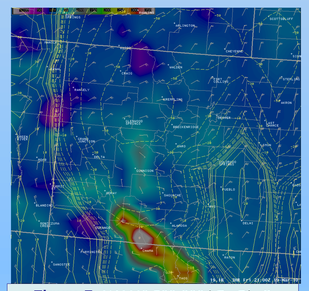


Figure 7: NAM40 500-300 hPa Div Q (yellow dotted line), 850-700 hPa 2D Frontogenesis (image), and 700 hPa winds (yellow barbs) at 2100Z 19 March 2010

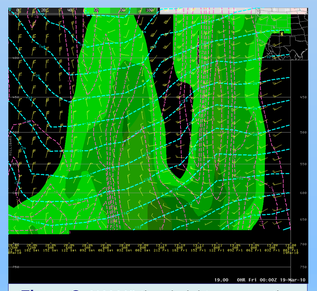


Figure 8: NAM40 time height cross section over Ouray of temperatures (blue dotted lines), relative humidity (image), winds (yellow barbs), and Omega (pink dotted lines)

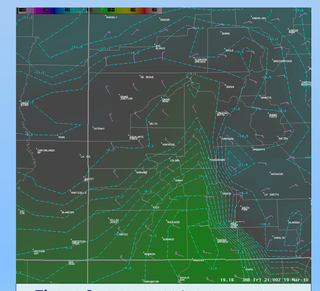
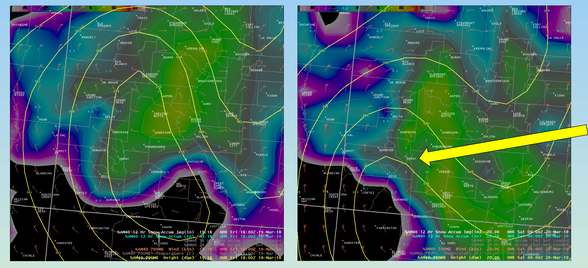


Figure 9: NAM40 700 hPa temperatures (blue dotted line and image) and 700 hPa winds (pink barbs) at 2100Z 19 March 2010



NAM40 forecast snowfall accumulations of 15 to 18 cm (6 to 7 inches) in the Gorge area for the 24 hour period ending at 06Z on March 20

Figure 10: A) NAM40 12 hour snowfall ending at 18Z 19 March
B) NAM40 12 hour snowfall ending at 06Z 20 March

Conclusion

The intense snowfall event in the Uncompahgre Gorge on March 19-20 exhibited strong dynamic lift…low level frontogenetic forcing…strong cold-air advection and weak orographic lifting to generate record snowfall amounts.