Winter Storms in the Uinta Range of Utah

The Uinta Range of northeastern Utah is an east-west oriented range, with a crest level of about 10,000 to 12,000 feet. An analysis of ~70 significant storm events producing ~0.5 inch or more of precipitation on the south side of the crest from 1991-2001, during the November – April season, shows that cross-barrier flow is most favorable for enhancing precipitation due to topography. On average, there were approximately 7 storms per winter season producing ~0.5" or greater precipitation over the area examined. Approximately 2-3 per season produced ~0.75" or more, and about 1 storm per season produced over an inch of water equivalent at the majority of the examined SNOTEL sites. For the three sites examined, the average November-April precipitation is 15.1" at Chepeta (10,300 ft), 15.3" at Five Point Lake (11,000 ft), and 12.4" at Trout Creek (9400 ft).

Many of the examined storm events appear to be fairly typical mid-latitude frontal systems, with a distinct shift from SW to NW flow near and below crest level during the event, associated with a cold frontal passage. Significant precipitation, enhanced by cross-barrier flow, seems to occur in both the pre-frontal (SW) and post-frontal (NW) wind flow environments. Some of the heaviest precipitation amounts were observed during periods of strong southerly flow, nearly perpendicular to the Uinta Range. Only a very few significant storm events, mostly during the spring, seemed to be accompanied by wind flow with an easterly component.

Upper-air soundings from Salt Lake City showed the atmosphere to be well-mixed with most of these storm events, with neutral stability or slightly stable conditions the most common. 700-mb temperatures averaged -7 to -8 C with these storm events, with a range of 0C to -20C. Pre-frontal (S-SW) flow regimes typically were between -3 to -8 C at 700 mb, with post-frontal (N-NW) temperatures usually between -5 and -15 C at 700 mb.

One of the most common types of weather systems to result in these significant precipitation events was a fairly deep (often marginally closed) trough over the Great Basin, often extending southward across southern California with a strong southerly flow across UT. The combination of significant mid- and upper-level moisture with strong flow perpendicular to the Uinta Range resulted in significant precipitation in many of these cases. Eventually, these systems would typically move eastward across Utah and Arizona.

Another common scenario involved a deep trough over the Pacific Northwest, with a strong onshore, southwesterly flow across California and the Great Basin. Shortwave troughs were usually embedded in this moist, onshore flow and brought significant precipitation to favored mountain locations, including the Uintas.

Some other systems were simply classic mid-latitude frontal systems and brought significant moisture to the Uintas in the pre-frontal southwesterly flow and/or post-frontal northwesterly flow.

Some less common scenarios involved light northerly flow around the back of a trough located over the Rockies, and a few cases of significant precipitation resulted from a strong northwesterly jet, with a moist onshore flow in the Pacific Northwest extending down into northern Utah. A few of the examined cases had very little wind in the lower levels or aloft, and were likely due to springtime convective snow showers developing in a cold, unstable air mass associated with a large and nearly stationary trough over the western U.S. There were only a few cases with an easterly component to the flow, associated with deep springtime storms over the southwestern U.S.

Overall, about 10 of these storm events occurred during November, 8 in December, 11 in January, 14 in February, 12 in March, and 16 in April. The following table shows the distribution of wind directions and 700-mb temperatures for each month:

Table 1. General summary of examined storm events in the Uintas, including a comparison of "Southwesterly" vs. "Northwesterly" events and associated 700-mb temperatures in degrees C

	Nov	Dec	Jan	Feb	Mar	Apr	Total
Total #	10	8	11	14	12	16	71
Avg #	0.9	0.7	1.0	1.3	1.1	1.5	6.5
SW %	50	75	62	56	47	35	52%
NW %	50	25	31	39	41	40	38%
Other %	0	0	7	5	12	25	10%
SW temp	-4 C	-8 C	-6 C	-6 C	-5 C	-4 C	-5 C
NW temp	-11 C	-15 C	-11 C	-11 C	-7 C	-8 C	-10 C

In general, it appears that cloud seeding generators on either side (north or south) of the range would be useful for seeding in the Uintas.

The chart on the following page shows a breakdown of 700 mb flow observed in upper-air soundings (SLC) during the storm periods. The number of events each month is listed, as well as the average of the wind velocity and 700-mb temperature for each category. The categories were determined by dividing 360 degrees into 8 45-degree sectors (S, SW, W, NW, etc). Each cell contains the number observed during that month, the percentage of the total for that month, and the average wind velocity (knots) and temperature (C) for that category (all data at the 700-mb level). The same data is also shown for the entire November-April period in the last column, with sector percentages italicized.

Table 2. Monthly statistics for Uinta storms, based on 700-mb data from SLC upper-air soundings during the storm events.

	Nov	Dec	Jan	Feb	Mar	Apr	Total
Number of Obs	19	10	16	32	21	32	130
S (158-203°)	2, 11%, 24 kts, -2 C	2, 20%, 27 kts, -6 C	6, 38%, 26 kts, -6 C	6, 19%, 30 kts, -5 C	6, 29%, 22 kts, -4 C	10, 31%, 18 kts, -5 C	32, ***25%,*** 23 kts, -5 C
SW (204-248°)	6, 32%, 19 kts, -3 C	6, 60%, 18 kts, -7 C	4, 25%, 22 kts, -7 C	12, 38%, 20 kts, -6 C	4, 19%, 22 kts, -3 C	5, 16%, 18 kts, -3 C	37, ***28%,*** 20 kts, -5 C
W (249-292°)	3, 15%, 19 kts, -9 C	1, 10%, 17 kts, -13 C	2, 12%, 31 kts, -6 C	4, 13%, 19 kts, -9 C	4, 19%, 23 kts, -6 C	4, 13%, 12 kts, -7 C	18, ***14%,*** 20 kts, -8 C
NW (293-337°)	6, 32%, 25 kts, -7 C	1, 10%, 10 kts, -11 C	3, 19%, 12 kts, -10 C	10, 31%, 21 kts, -13 C	3, 14%, 18 kts, -8 C	6, 19%, 18 kts, -7 C	29, ***22%,*** 20 kts, -10 C
N (338-22°)	2, 11%, 7 kts, -11 C	None observed	None observed	None observed	3, 14%, 15 kts, -4 C	1, 3%, 14 kts, -6 C	6, ***5%,*** 12 kts, -7 C
NE (23-67°)	None observed	None observed	None observed	None observed	None observed	1, 3%, 5 kts, -5 C	1, ***1%,*** 5 kts, -5 C
E (68-112°)	None observed	None observed	None observed	None observed	None observed	2, 6%, 16 kts, -6 C	2, ***2%,*** 16 kts, -6 C
SE (113-157°)	None observed	None observed	1, 6%, 9 kts, -8 C	None observed	1, 5%, 5 kts, -8 C	3, 9%, 12 kts, -2 C	5, ***4%,*** 10 kts, -4 C

This chart shows that 700-mb winds were from the "south" approximately 25% of the time during these storm events, from the "southwest" about 28% of the time, from the "west" 14% of the time, from the "northwest" 22% of the time, from the "north" 5% of the time, and from the "northeast", "east", or "southeast" the least often. This also means that the component of the wind perpendicular to the Uinta crest was southerly about 65% of the time, and northerly about 35% of the time during the storm events.