HEAVY SNOW CLIMATOLOGY AND SYNOPTIC PATTERNS FOR THE WEST CENTRAL MOUNTAINS- IDAHO ZONE 11

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INTRODUCTION

Snowfall statistics and common synoptic patterns that produce heavy snowfall were examined over a 50 year period from 1950 to the present time (2000) in the Idaho West Central Mountains. Events used in the study were those that produced heavy snowfall or criteria needed to warrant the issue of winter storm warnings. The **NMC DRAW GRID POINT DATA SET** and the **DAILY WEATHER MAP SERIES** were used in databasing and analyzing synoptic patterns for each event. A total of 43 cases were selected to represent the database during the study period. The data sets included 500 MB constant pressure charts and surface analysis for all years in the study. In later years starting in 1965, also included in the data was 850 MB heights and temperatures, 700 MB heights, and 250 MB heights and Jet Stream analysis. Snowfall observation data was taken mostly from cooperative observers throughout the zone. The purpose of the study is to determine the mean atmospheric conditions needed for heavy snowfall. This will allow WFO Boise Meteorologists to better understand these high impact events and to issue more timely and accurate Winter Storm Warnings.

TOPOGRAPHY AND GEOGRAPHY OF ZONE 11

Zone 11 (figure A) includes the counties of Valley, Adams and Washington in West Central Idaho. In general, the zone increase in elevation from southwest to northeast (or even just west to east), making a southwest to west flow component the most favorable for up slope precipitation. The elevations range from near 1800 feet msl close to the Snake River in the west to 8000-9000 feet msl in the high mountainous terrain in the eastern and northern part of the zone.

Two major valleys run north-south in the zone. The westernmost and larger valley contains the towns of **Council** and **Cambridge** and is roughly in the 2500-3000 foot range, though if you include **New Meadows**, the high end of the elevation range jumps to around 4000 feet. The Long/Round valley is higher and east of the Council Valley. It contains the towns of **McCall, Donnelly,** and **Cascade.** Elevations here are around 5000 feet msl. A small north-south range of mountains that rise up to around 7500-8000 feet msl separate these two main valleys.

The eastern half of the zone is made up of mostly high mountain terrain. Some narrow but significant river valleys can be seen cutting through these eastern mountains such as the valley along the South Fork of the Salmon River just east of McCall and the valley along then Middle Fork of the Salmon River along the eastern zone boundary. On the westernmost edge of the zone, the canyons along the Snake River provide the lowest terrain. Finally, to the west of the Council Valley exists a broken north-south range that includes the Cuddy Mountains. Peaks here rise to around 7500 feet msl in this part of the zone.

In general, precipitation and thus snowfall varies greatly across the West Central mountains. From an annual maximum of 187 inches at **Deadwood** to a minimum of 18 inches at **Brownlee Dam** and everything in between. Obviously, elevation plays an important role in snowfall over zone 11 but there are important exceptions. Mesoscale differences produce significantly varying snowfall totals, even among stations at approximately the same elevation. Upslope plays an important role here.

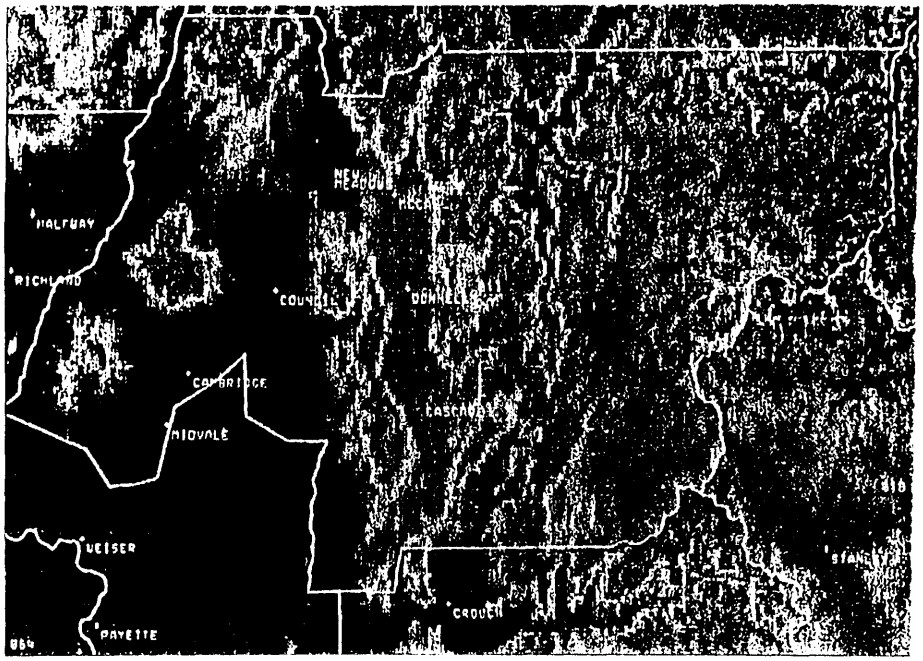


figure A

METHODOLOGY

1. Number of events-	43 (most cases in 1950's, 60's, 70's)
2. Sampling years-	1950-present
3. Time frame-	October-March
4. Definition of an event-	8-10 inches of snow in a 24 hour period occurring at two locations or 20 inches at a single station.
5. Definition of a big event-	at least two locations receiving a foot or more in a 12 hour period.
6. Sampling locations-	McCall, Cascade, Deadwood, Yellow Pine, Council, New Meadows
7. early season defined-	October-mid November
8. mid season defined-	mid November-mid February
9. late season defined-	mid February-March

10. Breakdown by month and frequency of occurrence in percentage

October-	2 events	4%	
November-	5	12%	
December-	8	19%	
January-	12	28%	(highest percentage chance of an event)
February-	8	19%	
March-	8	18%	

11. Breakdown of big events by month (17 cases)

October-	1 event	5%
November-	0	0%
December-	2	12%
January-	11	65%
February-	0	0%
March-	3	18%

TYPES OF SYNOPTIC PATTERNS AND MEAN METEOROLOGICAL PARAMETERS ASSOCIATED WITH HEAVY SNOWFALL

1. Warm air advection (overrunning)-	22 events for 51%
2. Cold frontal/westerly flow-	19 events for 44%
3. Upper closed low/surface cyclogenesis-	2 events for 5%

Average 500 MB height for all events-	540 decameters (lower heights needed earlier in the season and higher heights late in the season can produce heavy snow)
Average 850 MB temperature for all events-	+1.0 C
Average MSL surface pressure-	1009 MB.

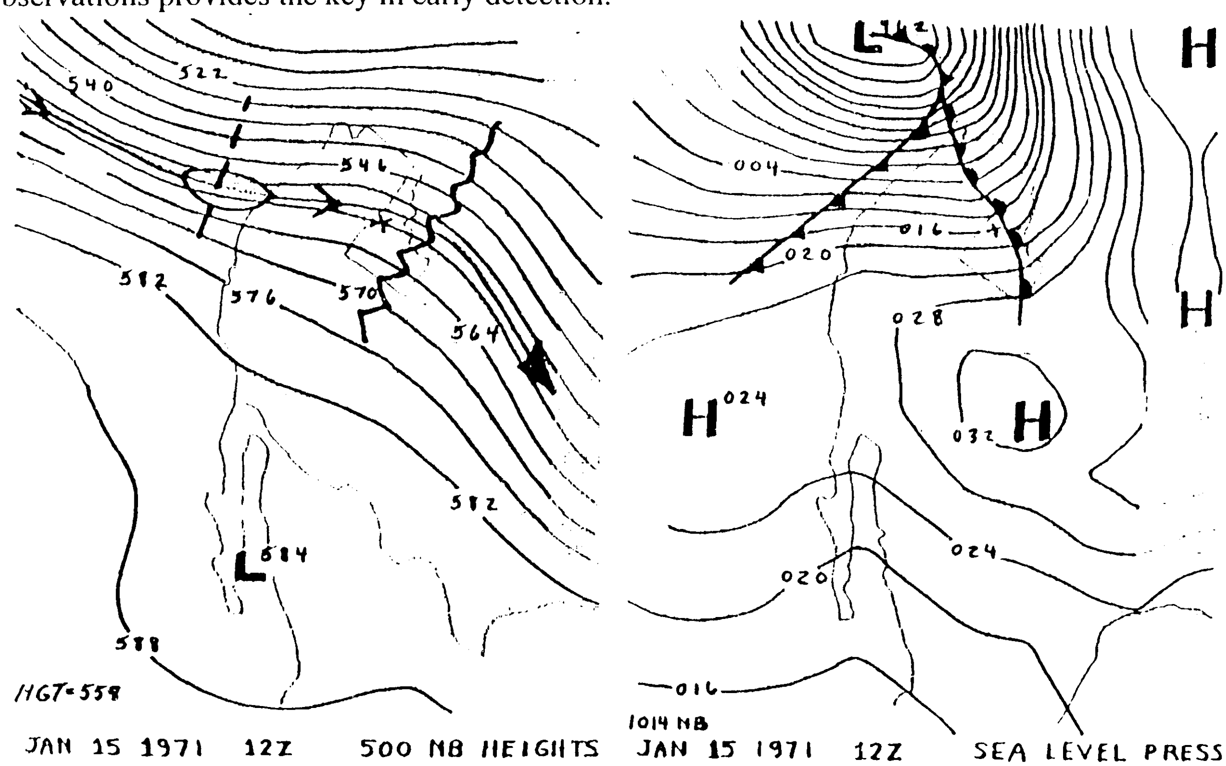
WARM AIR ADVECTION - figures B

This meteorological pattern accounts for the largest number of big event snowfalls (22 cases for 51%) than any other pattern in the study. Because of the mountainous terrain in the zone, it is felt that the 700 MB level more clearly represents mean conditions of temperature advection, wind fields, and available moisture than the 850 MB or 500 MB levels. Interestingly, the mean 500 MB height and 850 MB temp do not show a tendency to lower values and in fact more cases show higher values than one would expect. This indicates that actual surface temperature is more critical in producing heavy snow than the standard upper level parameters. Ideal wind flow patterns are from the southwest through west across the zone. Things to look for on the analysis and model progs:

1. Warm air advection
2. Available moisture supply
3. Increasing wind fields upstream
4 Trigger or disturbance moving through the flow into the area in question (short wave trof or a jetstreak)

The southwest flow warm air advection pattern is typically produced by the combination of a polar or arctic high over Montana or Northern Idaho and an open wave structured frontal system moving through Northern California and Southern Oregon. This system usually comes into the coast strong then weakens as it moves into the interior high plateau and Intermountain region. The pattern usually has an ample supply of moisture and may have a tropical connection as well. If this is the case, then heavy precipitation is probable but snow/freezing levels will be rising making for difficult decisions concerning levels where heavy snow will occur. .

The westerly flow type pattern is very similar to the southwest flow pattern but usually the surface system is farther north along the Oregon and Washington coasts and may well be into it's occluding stage. Again, a deep supply of moisture is present with a long overwater trajectory of pacific air. This pattern is even more favorable to Idaho zone 11 because of the enhanced upslope component on west facing slopes of the forecast area. In either wind direction case, the patterns are critical to both public and aviation interests because of the rapid deterioration of weather over a large area. Weather conditions often go down quickly from high overcast to snow ceilings of 1000 feet and 1 mile visibility within an hour or two. In many instances the computer models will be to slow in developing this pattern. Close and careful examination at upstream observations provides the key in early detection.

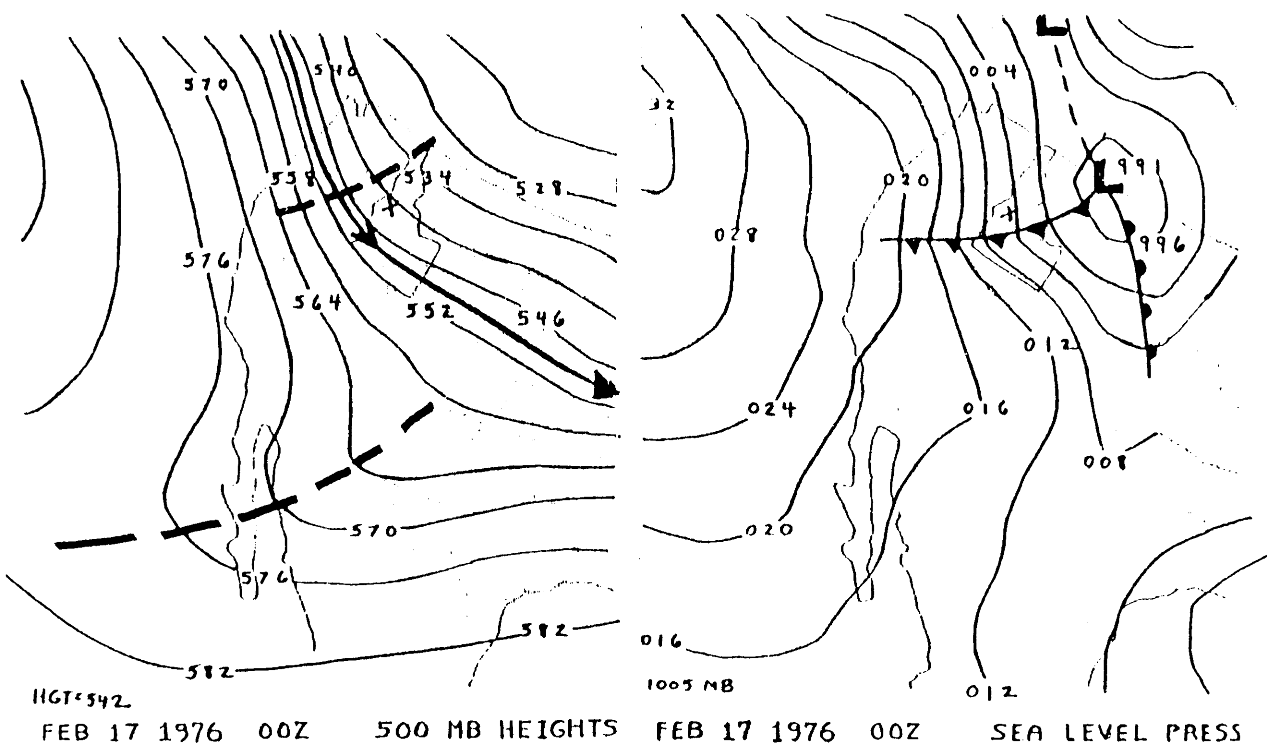


figures B

COLD FRONTAL/WESTERLY FLOW - figures C

This synoptic pattern accounts for the second highest number of big snow events (19 for 44 % of the sampling). The pattern sets up actually behind or 12-24 hours after the warm advection scenario has ended and can be thought of more of a westerly flow orographic event rather than a frontal case since just the simple passage of a cold front does not produce much snowfall in itself. At least not to the extent of issuing winter storm warnings or a snow advisory for that matter. This pattern sometimes is followed by another warm advection case quickly on it's heels, then another cold front case etc ,etc. This scenario of course is highly dependent on maintaining an ample supply of pacific moisture in a long stretched baroclinic zone with a series of embedded open waves within the band. An example of this was the devastating floods and mudslides that occurred during the winter of 1995/1996 over the West Central Mountains.

Windflow in this pattern is generally from the west through northwest which provides the best upslope component. Cold advection is now occurring at the 700 MB level but is quickly replaced by alternating fields of rising and descending vertical motion ahead of the next disturbance. Precipitation tends to be more localized in bands of snow and snow showers in contrast to the widespread areal distribution of stratiform snow and low ceilings associated with the warm air advection cases. Thus, local orographics play a more important role in producing heavy snowfall than in other synoptic patterns. Because of the localized nature to heavy snowfall, only parts of the zone may be affected by locally heavy snow while other nearby locations may receive very little.

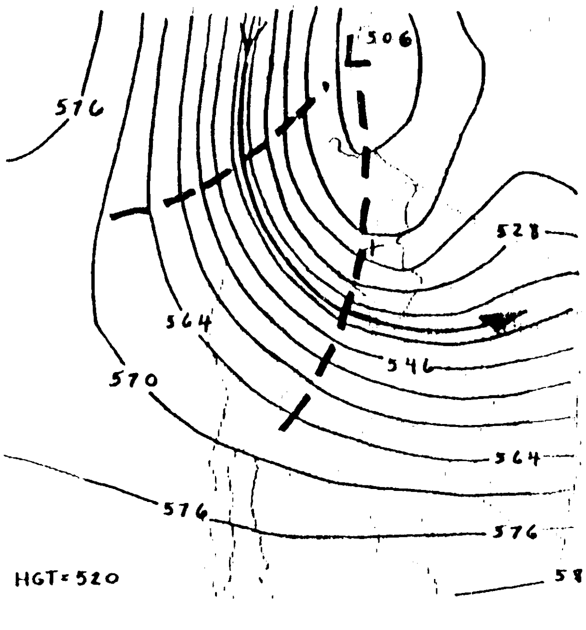


figures C

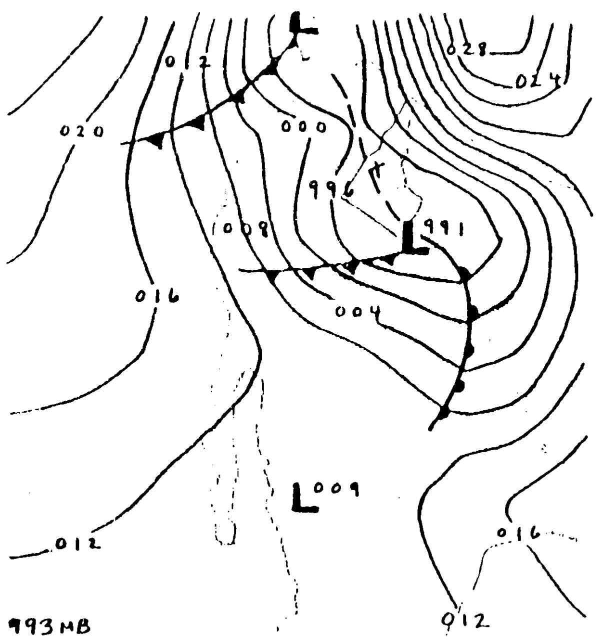
CLOSED UPPER LOW/SURFACE CYCLOGENESIS - figures D

The final synoptic snow pattern is not as common as the others but tends to produce snow in more areas including lower valleys and even to the Snake River Plain. This pattern occurs earlier and later in the season but is more common later in the season under low index flow patterns (closed low seasons in the west) across North America than under high index westerly flow patterns which produce the other two common patterns. Because the pattern lacks an abundant tap of moisture and is more continental in character, big snow totals are the exception but snowfalls in the lower end 3 to 6 inch range are common. Because of the limited amount of moisture, the pattern only accounted for 2 events or 5% of the total in the study period.

The cold upper low pattern is produced in a pool of cold unstable air through a deep layer in a general blocky flow pattern over North America. For this reason, both 500 MB heights and 850/700 MB temperatures are much lower than in the other patterns. A typical case would show a cold upper low either closed off or in the process of closing off just west of Vancouver Island. The low then moves southeast toward the Oregon/Idaho border. At the surface the area remains under the influence of a retreating cold high pressure dome. A weak surface low then forms in Northern Nevada or Southern Oregon. As the upper low drifts over the area and a cyclonic jet streak rounds the base of the cold upper trof, we then have rapid cyclogenesis taking place east of the Boise CFA. This usually occurs somewhere in the vicinity of Pocatello or Salt Lake City. Much heavier snow falls in these eastern areas while Idaho Zone 11 and the rest of Southwest Idaho stays in a zone of lighter snows, wind, and deepening cold advection. This occurs along an inverted trof extending westward from the parent and developing storm system to the east.



MAR 5 1951 12Z 500 MB HEIGHTS



MAR 5 1951 12Z SEA LEVEL PRESS

figures D

CONCLUSION AND SUMMARY

Heavy snowfall occurs over favored areas of the Boise CWFA. Idaho zone 11 (West Central Mountains is one of these areas). Local topography and geography play an important role in the production of heavy snow over zone 11. The zone has complex terrain ranging from mountain valleys less than 2000 feet MSL to high peaks in the 8000-9000 feet MSL range. The north-south oriented ranges with west facing aspects receive considerably more snow than other locations in the zone. Some of these locations are relatively close to each other. This shows the importance of elevation and local orographics to precipitation production. The zone is influenced by many synoptic weather patterns but three synoptic patterns have been identified in producing heavy snowfall. They are:

1. **WARM AIR ADVECTION (OVERRUNNING)**
2. **COLD FRONTAL/WESTERLY FLOW**
3. **UPPER CLOSED LOW/SURFACE CYCLOGENESIS**

Warm air advection accounts for the largest number of heavy snowfall events of 8-10 inches or more with the primary months of occurrence being late December through mid February. Terrain orientation and elevation play a key role where heavy snow falls. A long fetch of westerly flow from the pacific produces the ideal condition needed for heavy snow. This is especially true if the flow has a tropical connection. Upper 500 MB heights and 850 MB temperatures are not a true indicator in snow forecasting for this zone. A more reliable parameter is surface temperature combined with orographics and available moisture supply.

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