



**WESTERN REGION TECHNICAL ATTACHMENT
NO. 97-13
APRIL 8, 1997**

**QUANTITATIVE PRECIPITATION FORECAST ACTIVITIES
OF THE NWSFO RENO DURING THE
DECEMBER 1996 - JANUARY 1997 FLOODING**

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Introduction

Quantitative Precipitation Forecasts (QPFs) issued by the National Weather Service (NWS) are of vital importance during excessive precipitation events. Accurate QPFs allow River Forecast Centers (RFC's) to better predict river rises and the extent of flooding expected with these rises. During the period including 20 December 1996 through 6 January 1997, an extremely wet weather pattern developed over the Eastern Pacific and western United States. The eastern Sierra Nevada Mountains and western Nevada were hit with copious amounts of precipitation. The flooding that resulted was the worst on record over portions of the Carson and Walker River Basins. The Truckee and Susan Rivers also experienced dangerous floods that resulted in millions of dollars in damages.

The Nexrad Weather Service Forecast Office (NWSFO) in Reno, NV issues daily QPFs for Woodfords and Truckee, CA (Fig. 1). These points coincide with RFC forecast points along the Truckee and Carson Rivers. Forecasters at Reno utilize guidance from the National Center for Environmental Prediction (NCEP, Fig. 2), computer model-derived QPFs and forecasts from the Monterey, CA forecast office (Fig. 3) in assembling local QPFs. The QPFs are issued daily by the Reno office at 12 UTC. Updates are issued as warranted. These QPFs are then incorporated into RFC streamflow models to predict stages along the Truckee and Carson Rivers. This paper examines the conditions prior to the major flood event, and reviews the QPFs issued throughout the period.

Antecedent Conditions

The December '96-January '97 flooding resulted from very heavy rainfall on a large snowpack. The resultant runoff filled reservoirs to capacity and brought the area its worst flooding since 1955. A heavy snow event from 20 December through 23 December 1996 brought several feet of snow to the river basins. As much as seven feet fell at Truckee, with three feet at Markleville, CA in the Carson River Basin. The following week a deep and moist southwest flow developed over the eastern Sierra Nevada Mountains and western Nevada. This brought heavy rain to the region during the period of 30 December

1996 through 3 January 1997. Automated sensors in the Sierra Nevada Mountains (Squaw Valley Gold Coast in eastern Placer County) reported nearly 20 in of rain in 24 h from 1 January-2 January. It was during this period that the QPFs were most important as river flooding became severe.

The synoptic pattern from 23 December 1996 through 1 January 1997 began with a weak ridge of high pressure aloft over western Nevada and the Sierra Nevada Mountains of eastern California (Fig. 4). A broad long wave trough developed over the central and Eastern Pacific which lead to the eventual weakening of the ridge. Also note the presence of a strong Hudson Bay low. The jetstream winds over the central Pacific increased to 110-170 kts along the base of the trough. Moisture was provided from the tropics as the jetstream swept near Hawaii. The remains of a typhoon (FRAN) were swept along with the jetstream.

On 29 December, a short wave rode the stream of moisture from Hawaii to California and swept into the eastern Sierra Nevada Mountains and western Nevada. Heavy rain and snow spread over the region and freezing levels began to rise (Table 1). It reached 10,700 ft late in the day on New Year's Eve. Forecasters at Reno recognized the threat of major river flooding at this time. Warm, strong winds increased snowmelt and commenced runoff at lower elevations. These winds limited precipitation amounts in the lee of the Sierra Nevada Mountains at this time.

The synoptic pattern for 31 December (Fig. 5) shows that the Hudson Bay low had moved east to near 60W, allowing the deep, moist southwest flow over the Eastern Pacific to advect into the eastern Sierra Nevada Mountains and western Nevada. A strong short wave moved through the area on New Year's Day. This resulted in locally heavy rains, gale force winds and temperatures that rose well above freezing. The afternoon of 1 January, the Reno atmospheric sounding revealed a freezing level of 11,700 ft (Table 1). Moderate to heavy rains fell over a large, saturated snowpack along the higher elevations of the Sierra Nevada Mountains. The rains soon spread into the lower elevations of the western valleys of Nevada. The resultant runoff flowed in streams from the snow pack across the high Sierra Nevada Mountains into the river basins. The affects of the resultant flooding would be felt across the region for many weeks.

On 2 January, flood crests traveled quickly off the mountains of the Sierras into the river basins. That afternoon a short wave from the Gulf of Alaska (Fig. 6) dropped into the Pacific Northwest and spread colder air across the eastern Sierra Nevada Mountains and western Nevada. Snow levels the morning of the third dropped to 6500 ft ASL. Convection associated with a cold front dropped snow levels locally to 5000 ft ASL that afternoon. Rain changed to snow at the higher portions of the basins. Runoff was reduced over the next couple of days as a colder northwest flow lowered snow levels to the valley floors by 4 January.

QPFs

QPFs for Truckee and Woodfords are examined against observed precipitation in Tables 2 and 3. Observed precipitation for the four major river basins in eastern California and western Nevada is shown in Table 4. It can be seen that during the critical period from 30 December through 3 January, QPFs issued by the NWSFO Reno verified quite well. During this period the Woodfords (Carson River) QPFs issued by Reno forecasters totaled 8.65 in. The gage at Woodfords was washed out during this storm, but the gage at Markleville (Southeast of Woodfords, Fig. 1) recorded 7.25 in during these five days. Within this same time frame, the NWSFO Reno QPFs for Truckee totaled 8.15 in. Precipitation recorded at the Truckee Automated Local Evaluative in Real Time (ALERT) gage from 30 December through 3 January was 9.10 in.

Incremental QPFs issued by NWSFO Reno also performed well during this period. 0-6 h, 6-12 h and 12-24 h QPFs for Truckee and Woodfords are depicted in Tables 2 and 3. Total precipitation was initially underestimated on 1 January for Truckee. An updated QPF issued at 11:45 AM PST that morning performed substantially better (Table 2). A similar analysis of the QPFs issued for the Carson River Basin was performed by examining 6 h SNOTEL data from Spratt Creek, CA, which runs through Markleville. As with Truckee, initial QPFs for Woodfords were underestimated. An update (Table 3) issued at the same time as the Truckee update performed better against actual precipitation.

NCEP guidance was helpful to the staff of NWSFO Reno in assembling local QPFs. NCEP issues daily 24 h QPFs valid through 12 UTC the next day. The initial forecast is issued at 06 UTC, while an update is issued at 10 UTC. These are shown in Figs. 7-13. Initial NCEP 24 h QPF for 30 December was 2-3 in for Truckee and 1-2 in for Woodfords (Fig. 7). The update raised the QPF for Truckee to 3-4 in, while QPF for Woodfords was unchanged (Fig. 8). Actual precipitation for 30 December was 1.35 in at Truckee and 1.21 in at Woodfords. The NCEP QPF overestimated precipitation amounts. It is important to note that observed precipitation is reported over the 24 h period beginning at 7AM LST (15 UTC) and this may cause some confusion in the verification of daily QPFs. Errors in NCEP QPFs can be attributed to the lack of local scale data availability.

Figure 9 shows the initial QPF forecast for 31 December, which was 3-4 in for Truckee and 2 in for Woodfords. The update (Fig. 10) dropped Truckee to 2-3 in and Woodfords to 1 in. This was the correct action as actual precipitation for 31 December was 1.03 in at Truckee and 0.21 in at Woodfords. QPF was again overestimated for 1 January 1997 (Figs. 11 and 12). For 2 January, NCEP QPF was accurate as the initial forecast called for 3-4 in at Truckee (Fig. 13). Actual precipitation for this day was 4.65 in Woodfords QPF was underestimated somewhat at 1 in, compared to 2.90 in of actual rainfall.

NCEP also issues 48 h QPF products. These products generated a wider range of QPF values, but were fairly accurate. A summary of QPF activity for the period 30 December

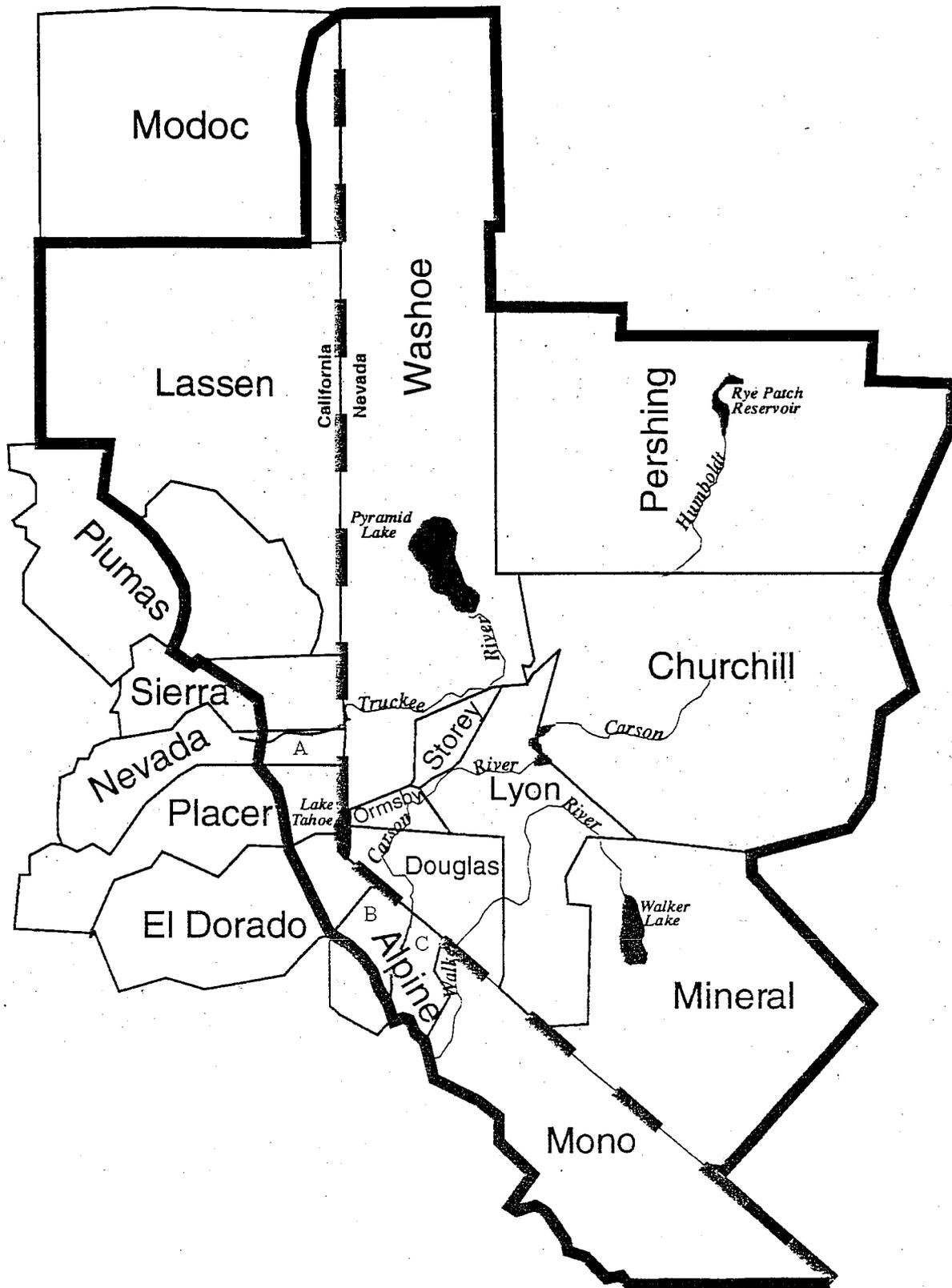
1996 through 3 January 1997 is shown in Table 5. NWSFO Reno overestimated QPF at Woodfords and was within range for Truckee through this period. NCEP guidance overestimated QPF for Truckee. This overestimation was slightly worse with the 10 UTC updates. The 48 h forecasts were actually an improvement for this period. NCEP guidance was within range for Woodfords for both the initial and updated QPFs. It was overestimated somewhat in the 48 h QPF.

Conclusion

QPFs issued by NWSFO Reno were examined for their performance during a major flooding event. In developing local scale QPFs, forecasters at Reno utilized model-derived QPFs and real-time precipitation data obtained from automated gages and spotters. Incorporating a superior knowledge of synoptic and mesoscale weather patterns that effects the eastern Sierra Nevada Mountains and western Nevada, QPF forecasts issued from Reno verified very well. QPFs issued from NCEP were found to overestimate precipitation for this event. This would be expected in that NCEP does not have access to local scale data.

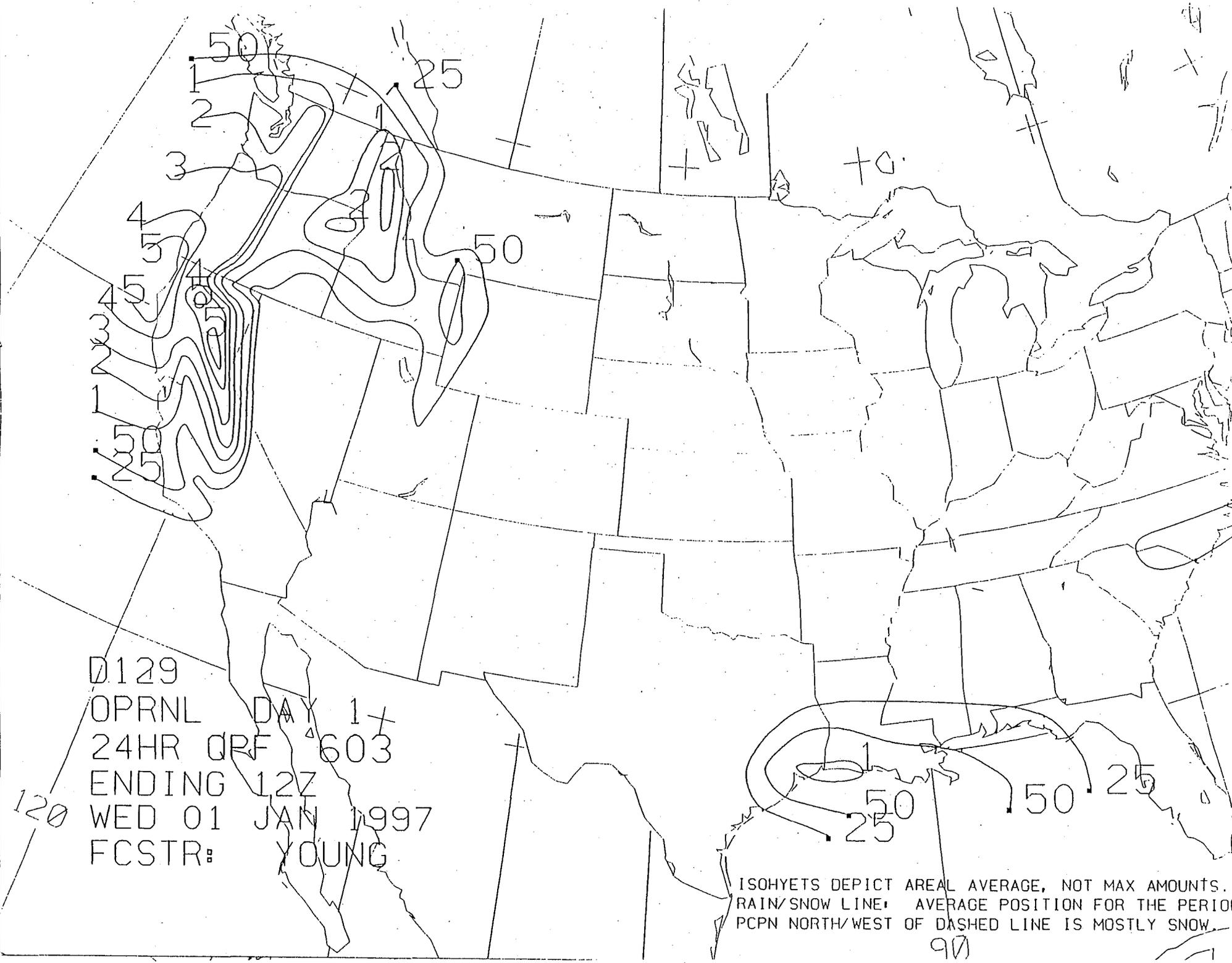
Information critical to forecasters when assembling QPFs includes freezing levels, snowmelt levels and real-time precipitation data. Automated gages must be constantly interrogated to provide the most recent precipitation data. Weather spotters are another good source of data. QPFs must always be monitored for accuracy and should be updated if conditions warrant; RFC streamflow models are highly dependant on accurate QPFs. These models are vital in issuing flood warnings to the public.

Gages must be maintained to perform accurately during times of heavy precipitation as this is the time that they are most needed. Improved gage networks would lead to more accurate QPFs. The NWS could then issue more timely warnings for flooding events and ultimately minimize the loss of lives and property.



- A: Truckee
- B: Woodfords
- C: Markleeville

Fig. 1



D129
 OPRNL DAY 1+
 24HR QRF 603
 ENDING 12Z
 WED 01 JAN 1997
 FCSTR: YOUNG

ISOHYETS DEPICT AREAL AVERAGE, NOT MAX AMOUNTS.
 RAIN/SNOW LINE: AVERAGE POSITION FOR THE PERIOD
 PCPN NORTH/WEST OF DASHED LINE IS MOSTLY SNOW.

<ZCZC SFORRBSFO
 TTA00 KSFO 232014
 NATIONAL WEATHER SERVICE SAN FRANCISCO
 QUANTITATIVE PRECIPITATION FORECASTS (QPF)
 BEGINNING 4 PM 01-23-1997

FFG VALUES APPLY ONLY TO SMALL STREAMS WITHIN THE BASINS LISTED.
 NOT TO THE MAINSTEM RIVERS.

ALL VALUES IN INCHES BASED ON RAINY DAY NORMALS FOR INDIVIDUAL BASINS.
 QPF VALUES COMPUTED USING FORECASTS ON SFOQPSFFO.
 FFG VALUES COMPUTED USING GUIDANCE ON SFOFFGCA1.

.B SFO 0124 DC012/100 PFG/DRH+6/PFG/DRH+12/FPD/PFGCF

:BASIN QPF/FFG VALUES		1ST PD	2ND PD	TOTAL			
		0-6HR	6-12HR	0-24HR	6HR	SNOW	LEVEL
:ID	NAME	QPF	QPF	QPF	FFG	00HR	12HR
CREC1	:SMITH R AB CRESCENT CITY	0.0 /	0.0 /	0.0 /	4.8:	5000	5500
ONSC1	:KLAMATH R AB ORLEANS	0.0 /	0.0 /	0.0 /	2.9:	5100	5700
KLNC1	:KLAMATH R-ORLNS TO KLAMATH	0.0 /	0.0 /	0.0 /	4.1:	5100	5600
KLNC1	:KLAMATH R AB KLAMATH (TRWR)	0.0 /	0.0 /	0.0 /	3.2:	5200	5800
LEWC1	:TRINITY R AB LEWISTON	0.0 /	0.0 /	0.0 /	3.4:	5100	5700
HOOC1	:TRINITY R-LEWISTON TO HOOPA	0.0 /	0.0 /	0.0 /	3.4:	5300	6000
ORIC1	:REDWOOD CREEK AB ORICK	0.0 /	0.0 /	0.0 /	4.7:	5300	6000
ARCC1	:MAD R AB ARCATA	0.0 /	0.0 /	0.0 /	4.4:	5300	6000
FTSC1	:EEL R AB FT SEWARD	0.0 /	0.0 /	0.0 /	3.9:	5500	6300
MRNC1	:SF EEL R AB MIRANDA	0.0 /	0.0 /	0.0 /	5.0:	5400	6100
SCOC1	:EEL R AB SCOTIA	0.0 /	0.0 /	0.0 /	4.5:	5400	6200
BRGC1	:VAN DUZEN R AB BRIDGEVILLE	0.0 /	0.0 /	0.0 /	4.8:	5300	6000
HOFC1	:RUSSIAN R AB HOPLAND	0.0 /	0.0 /	0.1 /	3.9:	5600	6400
HEAC1	:RUSSIAN R AB HEALDSBURG	0.0 /	0.0 /	0.1 /	4.2:	5700	6500
GUEC1	:RUSSIAN R AB GUERNEVILLE	0.0 /	0.0 /	0.1 /	4.4:	5700	6500
SHEC1	:NAPA R AB ST HELENA	0.0 /	0.0 /	0.1 /	4.4:	5700	6500
APCC1	:NAPA R AB NAPA	0.0 /	0.0 /	0.1 /	4.2:	5700	6500
GGTC1	:SAN FRANCISCO BAY STREAMS	0.0 /	0.0 /	0.1 /	2.4:	5900	6800
AROC1	:PAJARO R AB CHITTENDEN	0.0 /	0.0 /	0.1 /	2.2:	6400	7400
BRDC1	:SALINAS R AB BRADLEY	0.0 /	0.0 /	0.1 /	2.6:	6700	7700
SPRC1	:SALINAS R AB SPRECKELS	0.0 /	0.0 /	0.1 /	3.7:	6500	7500
TWIC1	:CUYAMA R AB TWITCHELL DAM	0.0 /	0.0 /	0.1 /	2.9:	7000	8000
SYRC1	:SANTA YNEZ R AB LONFOC	0.0 /	0.0 /	0.1 /	2.6:	7000	8000
FRPC1	:FIT R AB FIT PWR HOUSE 5	0.0 /	0.0 /	0.0 /	1.9:	5300	6000
SHDC1	:SACRAMENTO R AB SHASTA DAM	0.0 /	0.0 /	0.0 /	5.0:	5300	6000
BDBC1	:SAC R-KESWICK TO BEND BR	0.0 /	0.0 /	0.0 /	3.1:	5300	6000
ORFC1	:SAC R-BEND BR TO ORD FERRY	0.0 /	0.0 /	0.0 /	1.9:	5500	6200
BLBC1	:STONY CK AB BLACK BUTTE DAM	0.0 /	0.0 /	0.1 /	3.3:	5600	6500
RMSC1	:CACHE CK AB RUMSEY	0.0 /	0.0 /	0.1 /	4.0:	5700	6500
OROC1	:FEATHER R AB OROVILLE DAM	0.0 /	0.0 /	0.1 /	3.7:	5600	6400
NBRC1	:N YUBA R AB BULLARDS BAR DM	0.0 /	0.0 /	0.1 /	4.3:	5700	6500
HLEC1	:YUBA R AB ENGLEBRIGHT DAM	0.0 /	0.0 /	0.1 /	4.1:	5700	6500
MRYC1	:YUBA R ENGLBRT DM TO MRYSVL	0.0 /	0.0 /	0.1 /	2.9:	5700	6500
CFWC1	:BEAR R AB CAMP FAR WEST DAM	0.0 /	0.0 /	0.1 /	4.4:	5700	6500
FOLC1	:AMERICAN R AB FOLSOM DAM	0.0 /	0.0 /	0.1 /	4.4:	5800	6700
MHBC1	:COSUMNES R AB MICHIGAN BAR	0.0 /	0.0 /	0.1 /	3.6:	6000	7000
CMPC1	:MOKELUMNE R AB PARDEE DAM	0.0 /	0.0 /	0.1 /	3.9:	6000	7000
NHGC1	:CALAVERAS R AB NEW HOGAN DM	0.0 /	0.0 /	0.1 /	3.3:	6000	7000

Fig.3

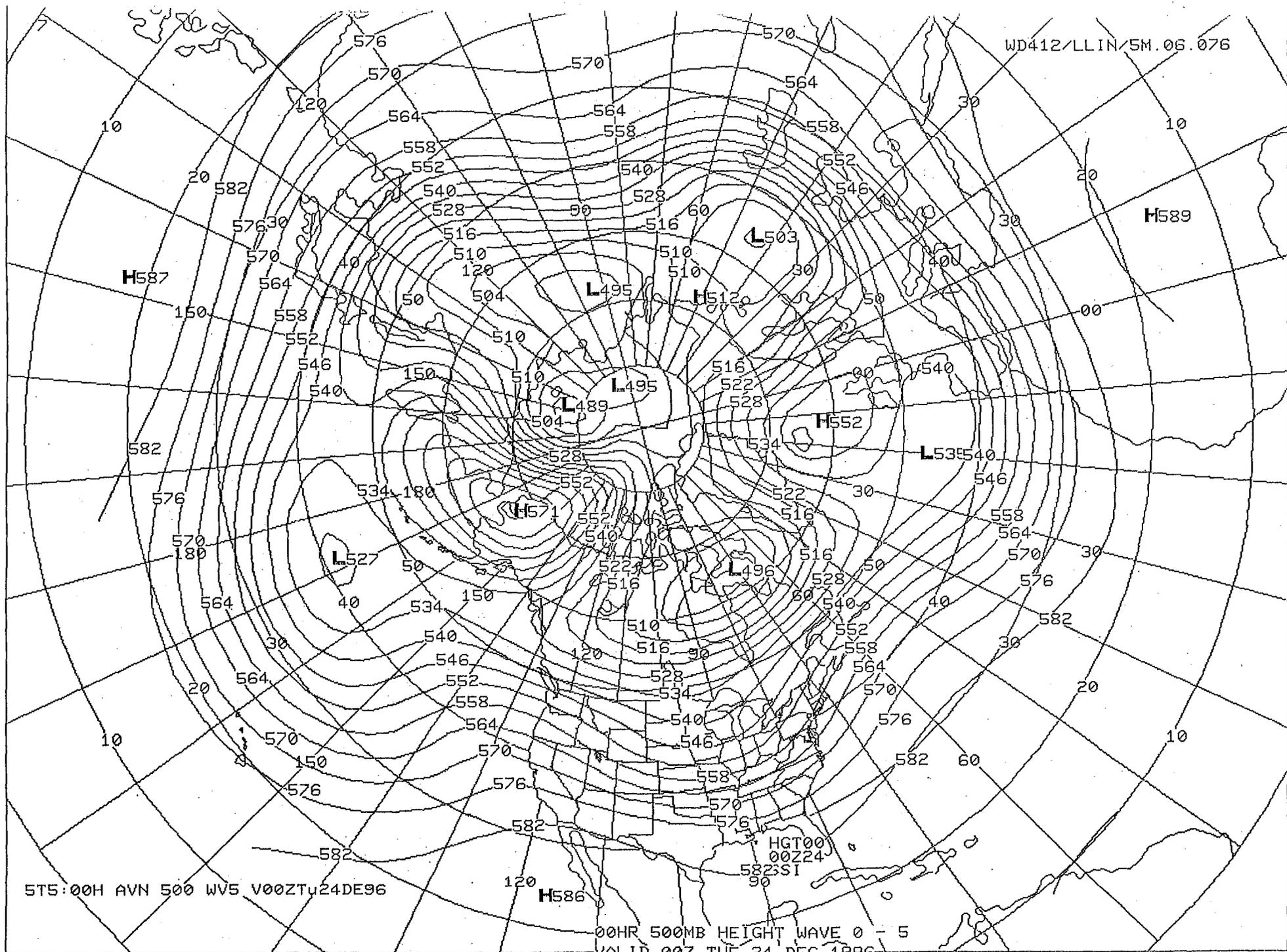


Fig.4

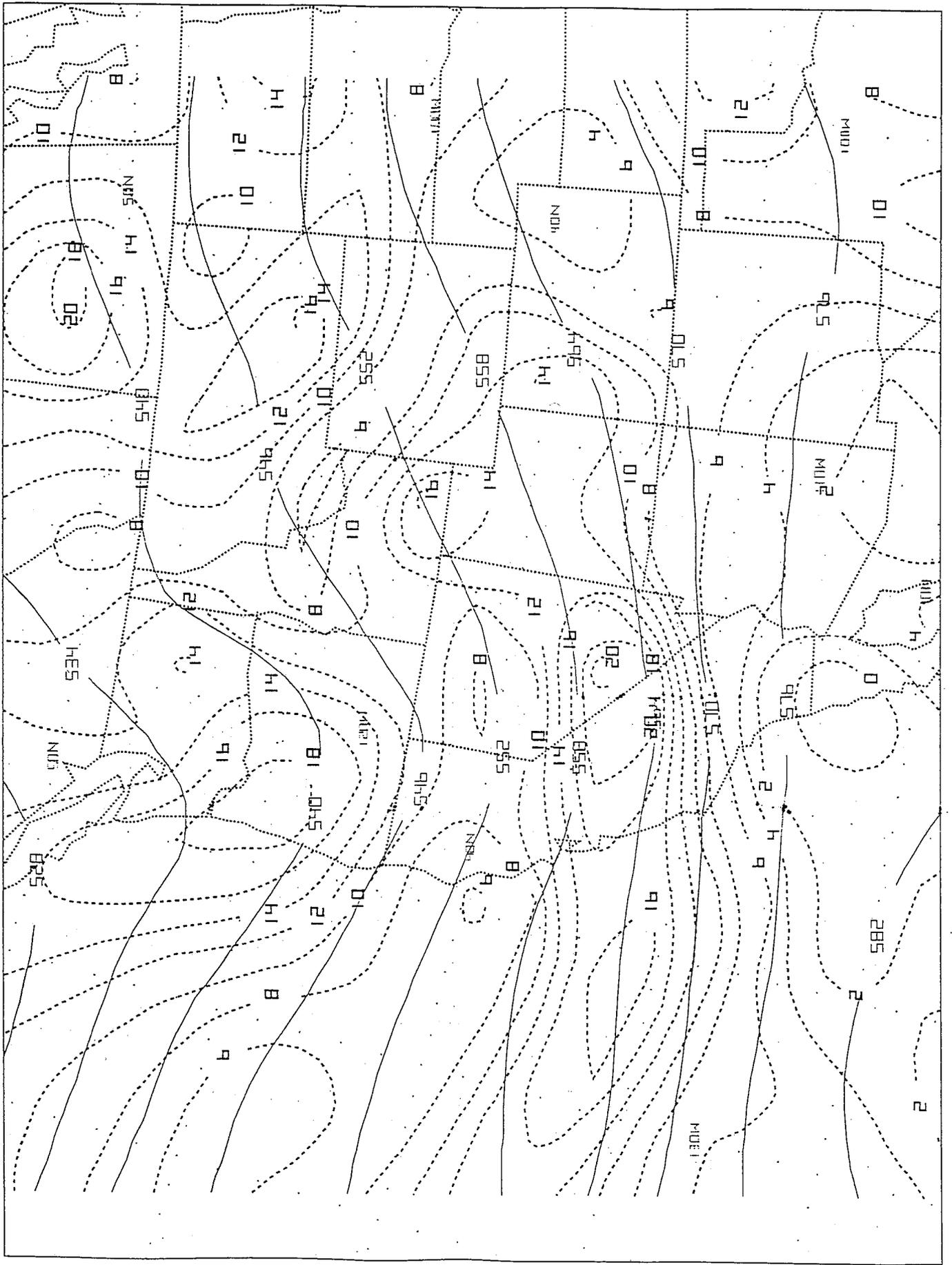


Fig.6

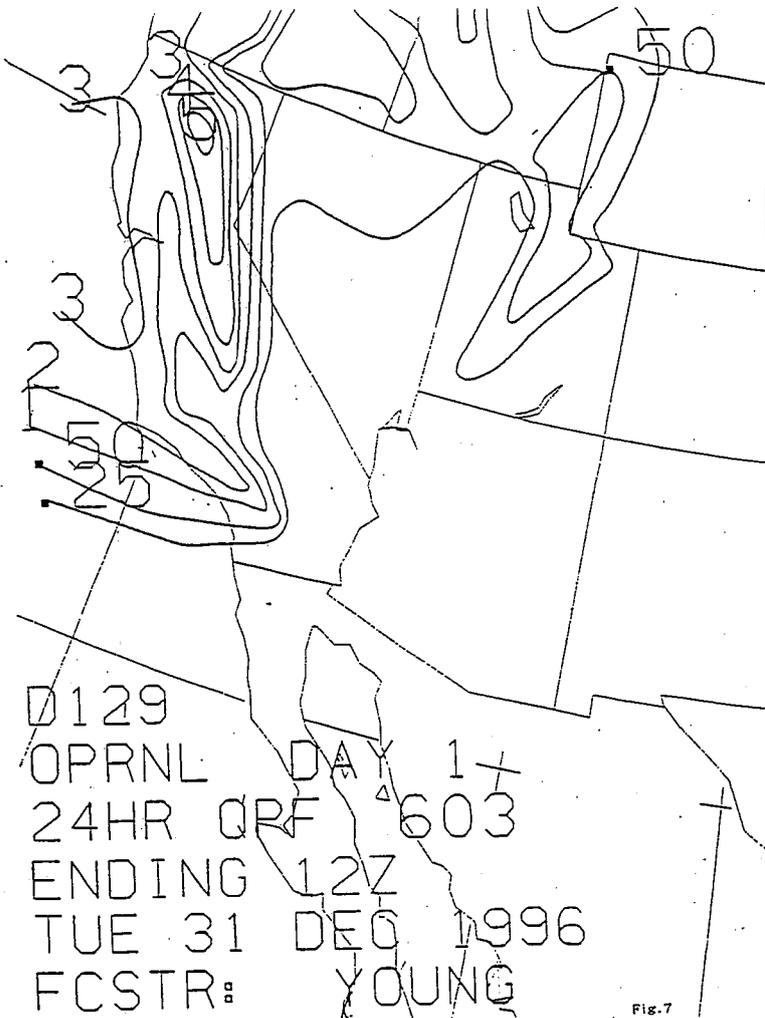


Fig.7

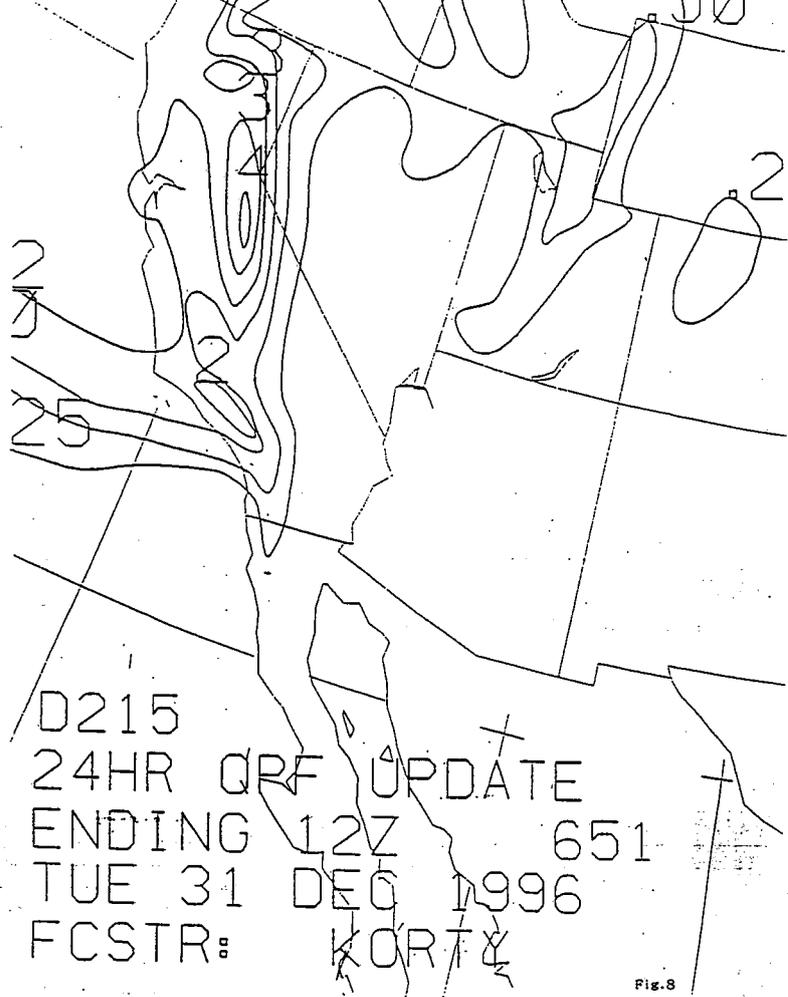


Fig.8

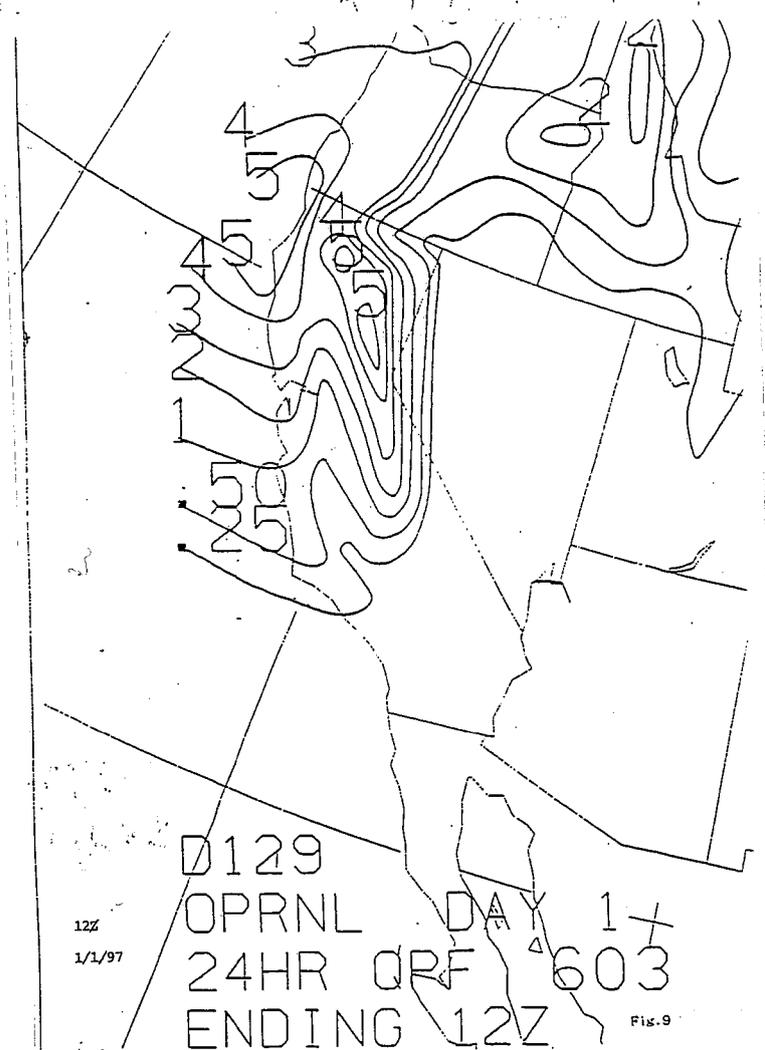


Fig.9

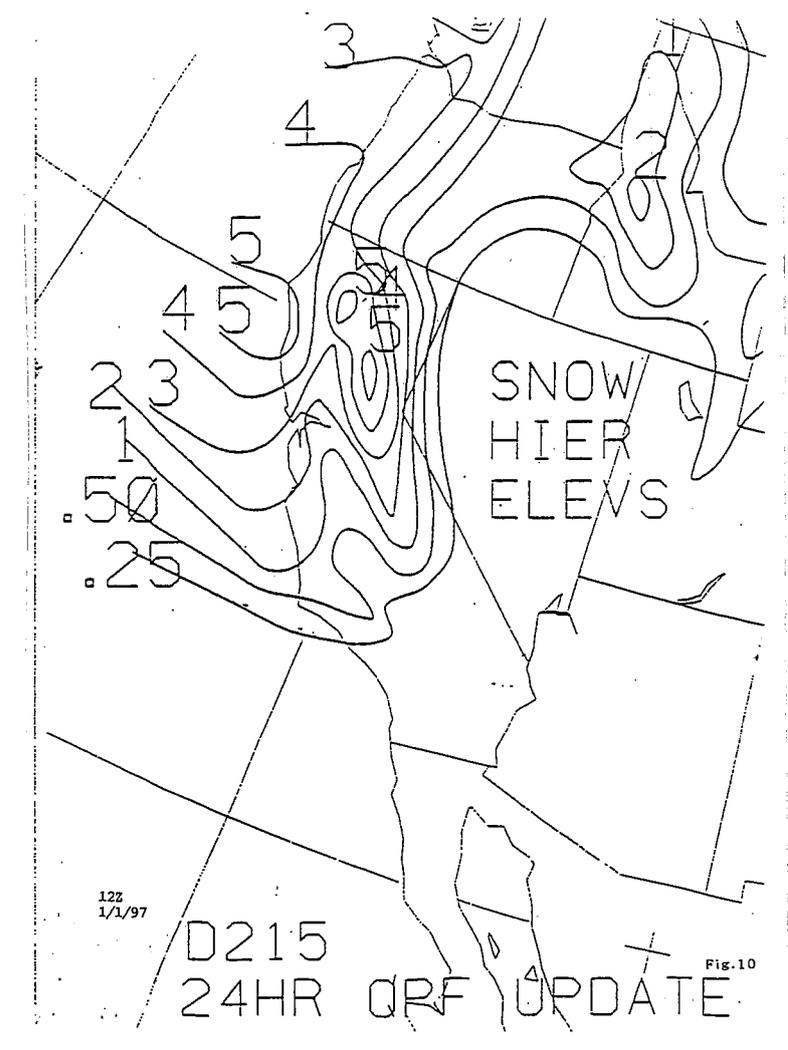
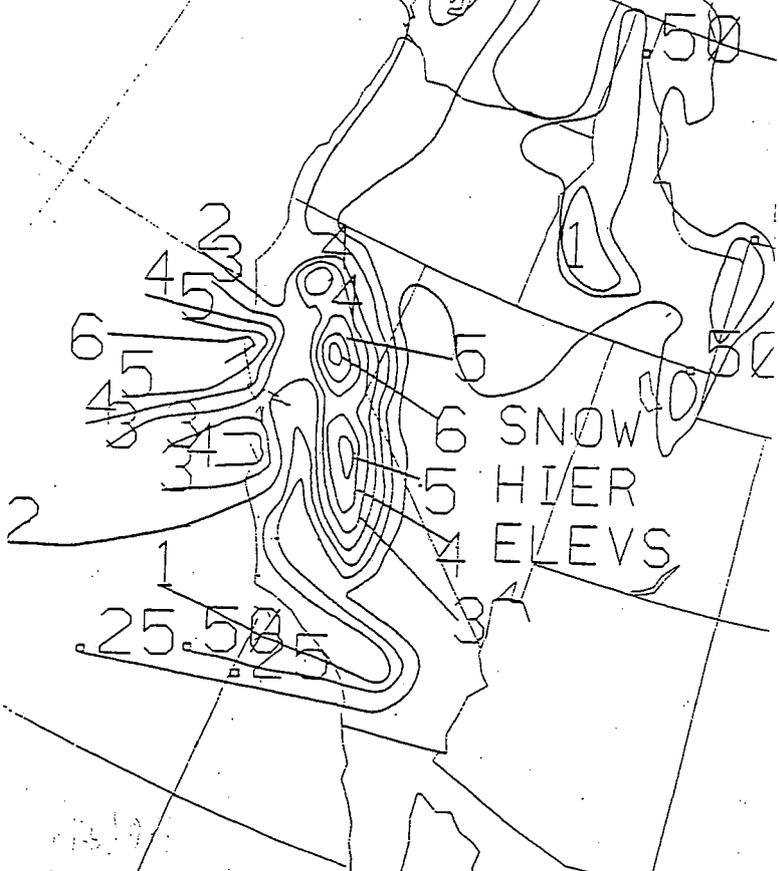
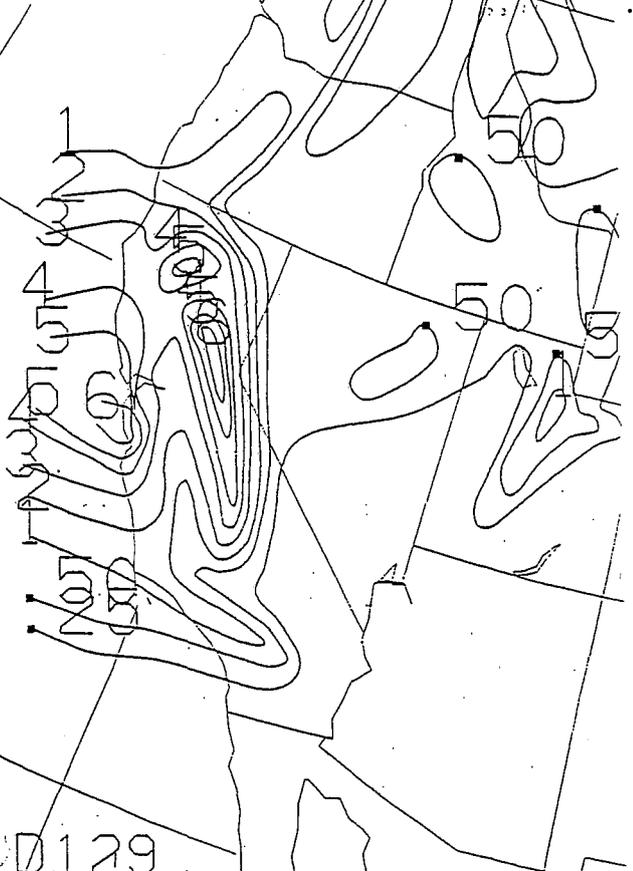


Fig.10

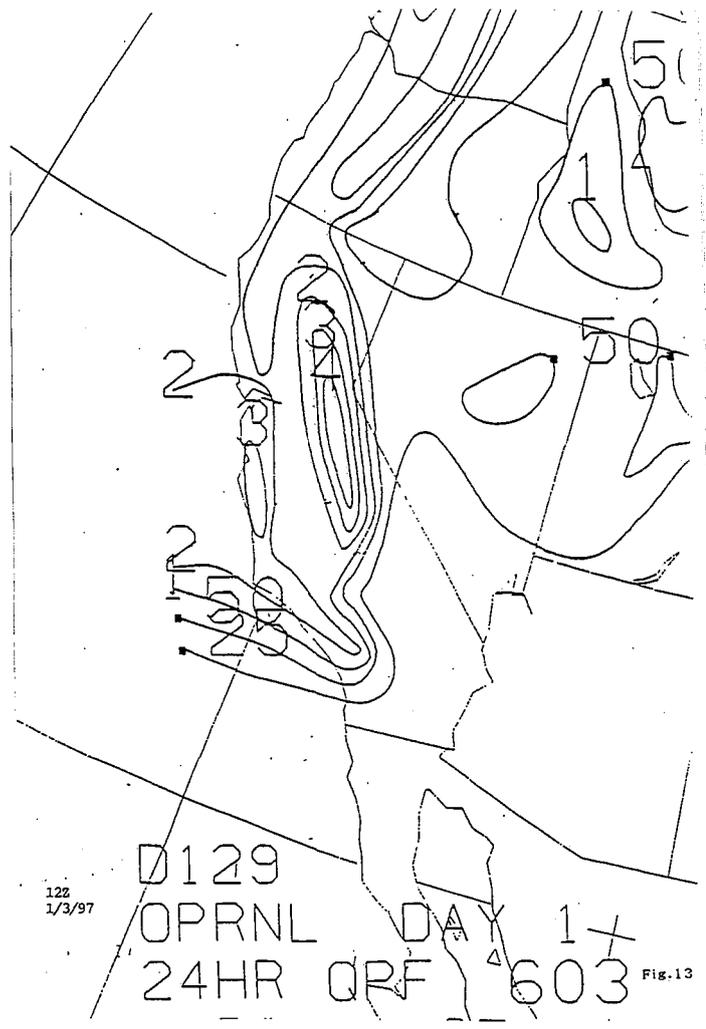
12Z
1/1/97

12Z
1/1/97



12Z
1/2/97
D129
OPRNL DAY 1
24HR QRF 603
Fig.11

12Z
1/2/97
D215
24HR QRF UPDATE
Fig.12



12Z
1/3/97
D129
OPRNL DAY 1
24HR QRF 603
Fig.13

Date	Time (LST)	Wet Bulb Zero at Reno (Ft.)	Freezing Level at Reno (Ft.)	Forecast Snow Level from NWSFO Reno (Ft.)
12/28/96	4 AM	5600	7400	6500
	4 PM	6300	7600	7000
12/29/96	4 AM	9100	9700	8000
	4 PM	8100	8500	8000
12/30/96	4 AM	9000	9600	8000
	4 PM	8800	9700	8000
12/31/96	4 AM	8200	9000	8000
	4 PM	N/A	10700	8500
1/1/97	4 AM	11200	11300	9000
	4 PM	11500	11700	9000
1/2/97	4 AM	10400	10700	9000
	4 PM	9500	10300	8500
1/3/97	4 AM	7200	8000	6500
	4 PM	5700	6700	5000

Table 1: Forecast vs. Observed Freezing Levels at NWSFO Reno From 28 December , 1996 Through 3 January, 1997

TRUCKEE OPF 12/26/96 - 1/3/97

DATE	FORECAST PRECIP.	OBSERVED PRECIP.
December 26, 1996		
0-6 hours (0400-1000 LST)	0.00	0.20
6-12 hours (1000-1600 LST)	0.25	0.30
12-24 hours(1600-0400 LST)	1.00	1.20
24 hour total	1.25	1.70
December 27, 1996		
0-6 hours (0400-1000 LST)	0.25	0.00
6-12 hours (1000-1600 LST)	0.10	0.40
12-24 hours(1600-0400 LST)	0.10	0.00
24 hour total	0.40	0.45
December 28, 1996		
0-6 hours (0400-1000 LST)	0.10	0.10
6-12 hours (1000-1600 LST)	0.10	0.00
12-24 hours(1600-0400 LST)	0.50	0.10
24 hour total	0.70	0.20
December 29, 1996		
0-6 hours (0400-1000 LST)	0.25	0.10
6-12 hours (1000-1600 LST)	1.00	0.90
12-24 hours(1600-0400 LST)	2.00	1.50
24 hour total	3.25	2.50
December 30, 1996		
0-6 hours (0400-1000 LST)	0.25	0.10
6-12 hours (1000-1600 LST)	1.00	0.20
12-24 hours(1600-0400 LST)	1.50	1.00
24 hour total	2.75	1.30

Table 2: NWSFO Reno QPF for Truckee, CA and Recorded Precipitation From 26 December 1996 through 3 January 1997

TRUCKEE OPF 12/26/96 - 1/3/97

December 31, 1996		
0-6 hours (0400-1000 LST)	0.10	0.00
6-12 hours (1000-1600 LST)	0.10	0.10
12-24 hours(1600-0400 LST)	0.75	0.80
24 hour total	0.95	0.90
January 1, 1997		
0-6 hours (0400-1000 LST)	0.50	1.50
6-12 hours (1000-1600 LST)	0.50	1.20
12-24 hours # (1600-0400 LST)	1.00//4.50	2.00
24 hour total #	2.00//5.50	4.70
January 2, 1997		
0-6 hours (0400-1000 LST)	1.00	1.00
6-12 hours (1000-1600 LST)	0.50	0.50
12-24 hours(1600-0400 LST)	0.75	0.50
24 hour total	2.25	2.00
January 3, 1997		
0-6 hours (0400-1000 LST)	0.10	0.00
6-12 hours (1000-1600 LST)	0.10	0.20
12-24 hours(1600-0400 LST)	0.00	0.00
24 hour total	0.20	0.20

A QPF update was issued at 1145 AM on 1/1/97 for the 12 to 24 hour period. Initial and update values are separated by //.

WOODFORDS QPF 12/26/96 - 1/3/97

DATE	FORECAST PRECIP.	OBSERVED PRECIP.
December 26, 1996		
0-6 hours (0400-1000 LST)	0.00	0.00
6-12 hours (1000-1600 LST)	0.10	0.00
12-24 hours(1600-0400 LST)	0.75	0.88
24 hour total	0.85	0.88
December 27, 1996		
0-6 hours (0400-1000 LST)	0.10	0.29
6-12 hours (1000-1600 LST)	0.10	0.00
12-24 hours(1600-0400 LST)	0.00	0.00
24 hour total	0.20	0.29
December 28, 1996		
0-6 hours (0400-1000 LST)	0.00	0.00
6-12 hours (1000-1600 LST)	0.00	0.00
12-24 hours(1600-0400 LST)	0.10	0.00
24 hour total	0.10	0.00
December 29, 1996		
0-6 hours (0400-1000 LST)	0.25	0.00
6-12 hours (1000-1600 LST)	0.75	1.94
12-24 hours(1600-0400 LST)	1.00	0.00
24 hour total	2.00	1.94
December 30, 1996		
0-6 hours (0400-1000 LST)	0.10	
6-12 hours (1000-1600 LST)	0.75	
12-24 hours(1600-0400 LST)	1.50	
24 hour total	2.35	1.21*

Table 3: NWSFO Reno QPF for Woodfords, CA and Recorded Precipitation From 26 December 1996 through 3 January 1997

WOODFORDS OPF 12/26/96 - 1/3/97

December 31, 1996		
0-6 hours (0400-1000 LST)	0.00	
6-12 hours (1000-1600 LST)	0.10	
12-24 hours(1600-0400 LST)	0.50	
24 hour total	0.60	0.21*
January 1, 1997		
0-6 hours (0400-1000 LST)	0.50	
6-12 hours (1000-1600 LST)	0.50	
12-24 hours # (1600-0400 LST)	1.00//3.00	
24 hour total #	2.00//4.00	1.40*
January 2, 1997		
0-6 hours (0400-1000 LST)	1.50	
6-12 hours (1000-1600 LST)	1.00	
12-24 hours(1600-0400 LST)	1.00	
24 hour total	3.50	2.90*
January 3, 1997		
0-6 hours (0400-1000 LST)	0.10	
6-12 hours (1000-1600 LST)	0.10	
12-24 hours(1600-0400 LST)	0.00	
24 hour total	0.20	1.53*

* Woodfords ALERT gage stopped recording precip. 1/1/97. Values are for Markleville, CA, which is about 5 miles south of Woodfords.

A QPF update was issued at 1145 AM on 1/1/97 for the 12 to 24 hour period. Initial and update values are separated by //.

DAILY PRECIPITATION TOTALS
DECEMBER 21 1996-JANUARY 6 1997
Eastern Sierra and Extreme Western Nevada

	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4	1/5	1/6
Susan Basin...																		
Susanville (08)*	0.66	0.48	0.33	0	0	0.10	1.06	0.04	0.16	0.62	1.10	1.37	0	1.16	0	0	0	0
Truckee Basin...																		
Tahoe City (08)	0	2.17	1.77	1.24	0	0	0.08	1.76	0.14	0.05	1.72	1.22	2.43	4.65	1.58	0	0.01	T
Boca (08)	0	2.38	1.95	1.15	0	0	0.02	1.64	0.13	0	1.55	0.86	1.26	2.36	1.10	0	0.03	0
Truckee (08)	0	1.90	1.40	0.88	0	0	0.40	1.85	0.40	0.11	1.35	1.03	1.70	4.60	1.30	0.20	0.10	0
Reno AP (00)	0.06	0.93	0.23	0	0	T	0.18	0.07	0	0.69	T	T	0.36	0.85	T	T	0.03	0
Sparks (16)	0	0.31	0.88	0.16	0	0	0	0.38	0	0	0.39	0	0	0.35	0.53	0	T	0
Stead (07)	0	0.40	0.77	0.10	0	0	0	1.20	0	0	1.57	0	0.19	1.22	0.50	0	T	0
Carson Basin...																		
Markleeville (07)	0	0.83	1.38	0.31	0	0	0.03	0.85	0	T	1.21	0.21	1.40	2.90	1.53	0	0.14	0.08
Virginia City (07)	0.75	1.67	0.80	0	0	0	0.68	T	0	0.36	T	T	T	0.98	0.76	T	T	T
Carson City (17)	0	0.40	0.03	0.67	0	0	0.10	0.47	0	0.33	0.13	T	0.86	1.73	0.65	0	0.03	0
Minden (08)	0.77	1.01	0.13	0	0	0	0.20	0	0	0.67	0	0.33	1.35	1.14	0	0.05	0.03	0
Walker Basin...																		
Bridgeport (16)	0	0.58	2.00	0.35	0	0	T	0.10	0	T	0.37	0	0.03	0.26	1.40	0	0.10	0.20
Topaz Lake (07)	0.59	0.64	0.28	0	0	0	0.16	0	0	0.41	0	0	0.72	1.26	0	0.10	T	0
Smith (18)	0	0.57	0.08	0	0	0	0.05	0	0	0.25	0	0	0.11	0.78	0	0.07	0.03	0
Yerington (08)	T	0.37	0.03	0	0	T	0	0	0	0.03	0	0	0.01	0.79	0	0.02	0	0
Wabuska (08)	0	0.10	0.30	0	0	0	0	0.04	0	0	T	0	0	0.30	0.65	0	0	0

Table 4: Observed Precipitation Over Major River Basins in Eastern California and Western Nevada From
20 December 1996 through 6 January 1997

PRECIP. FROM 12/30/96-1/3/97

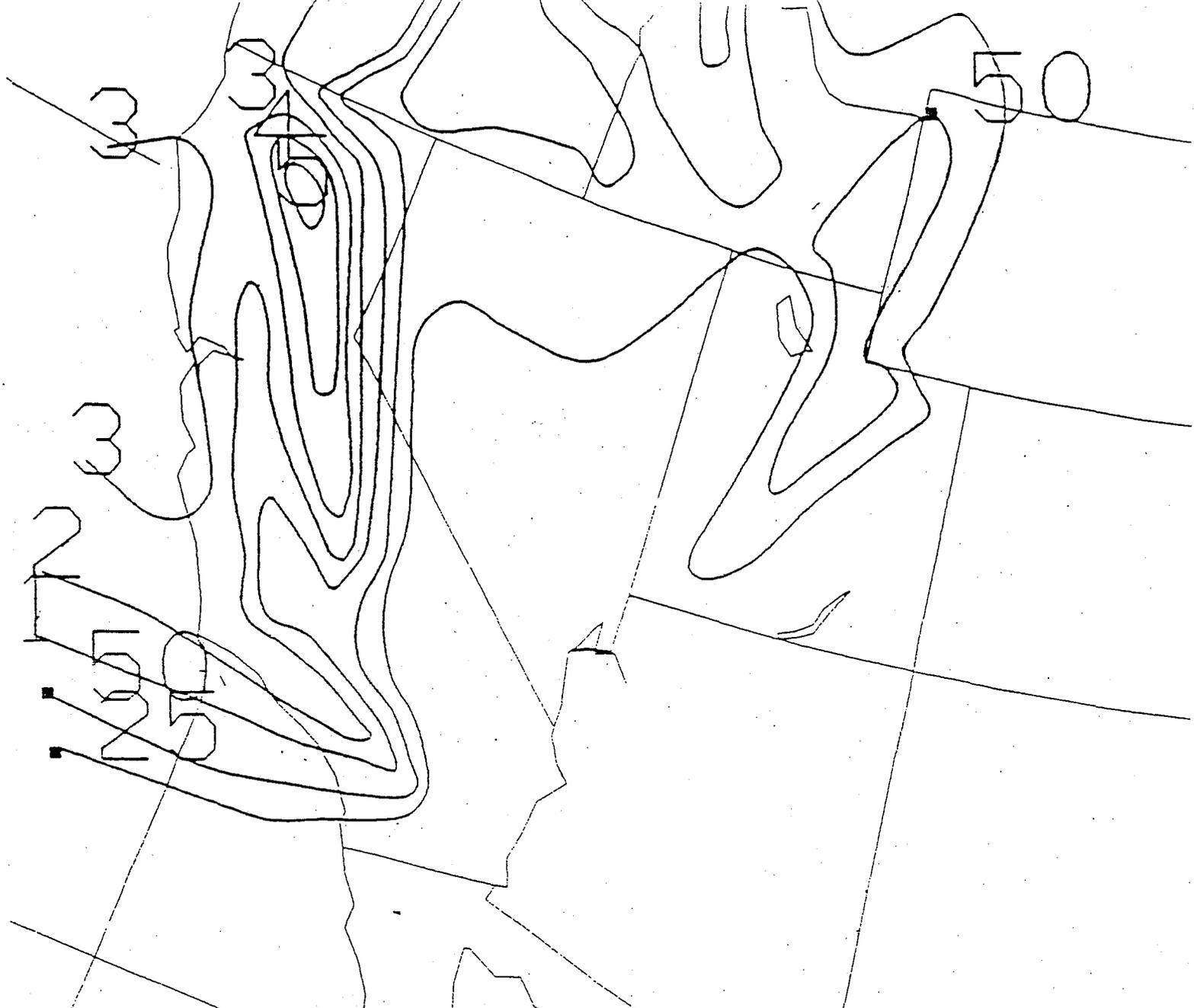
TRUCKEE

NWSFO Reno QPF	8.15"-11.65"
NCEP 1st Forecast (06Z)	12"-17"
NCEP Update (10Z)	13"-18"
NCEP 48 Hour Forecast	10"-18"
ACTUAL PRECIPITATION	9.98"

Woodfords/Markleevile

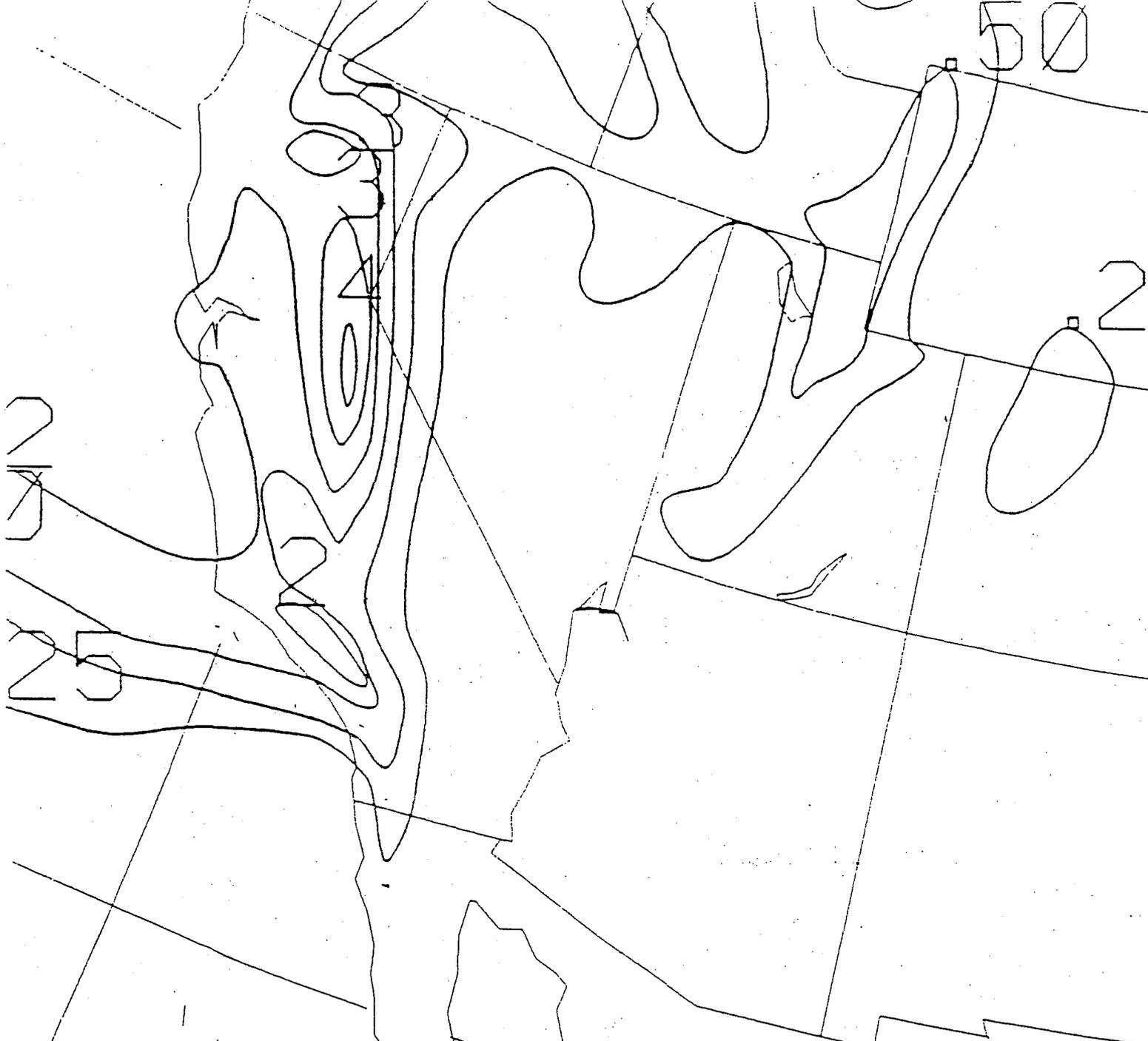
NWSFO Reno QPF	8.65"-10.65"
NCEP 1st Forecast (06Z)	6.5"-9.0"
NCEP Update (10Z)	5.0"-8.0"
NCEP 48 Hour Forecast	7.5"-13.0"
ACTUAL PRECIPITATION	7.25"

Table 5: Comparison of NCEP QPF to NWSFO Reno QPF and Actual Precipitation From 30 December 1996 through 3 January 1997



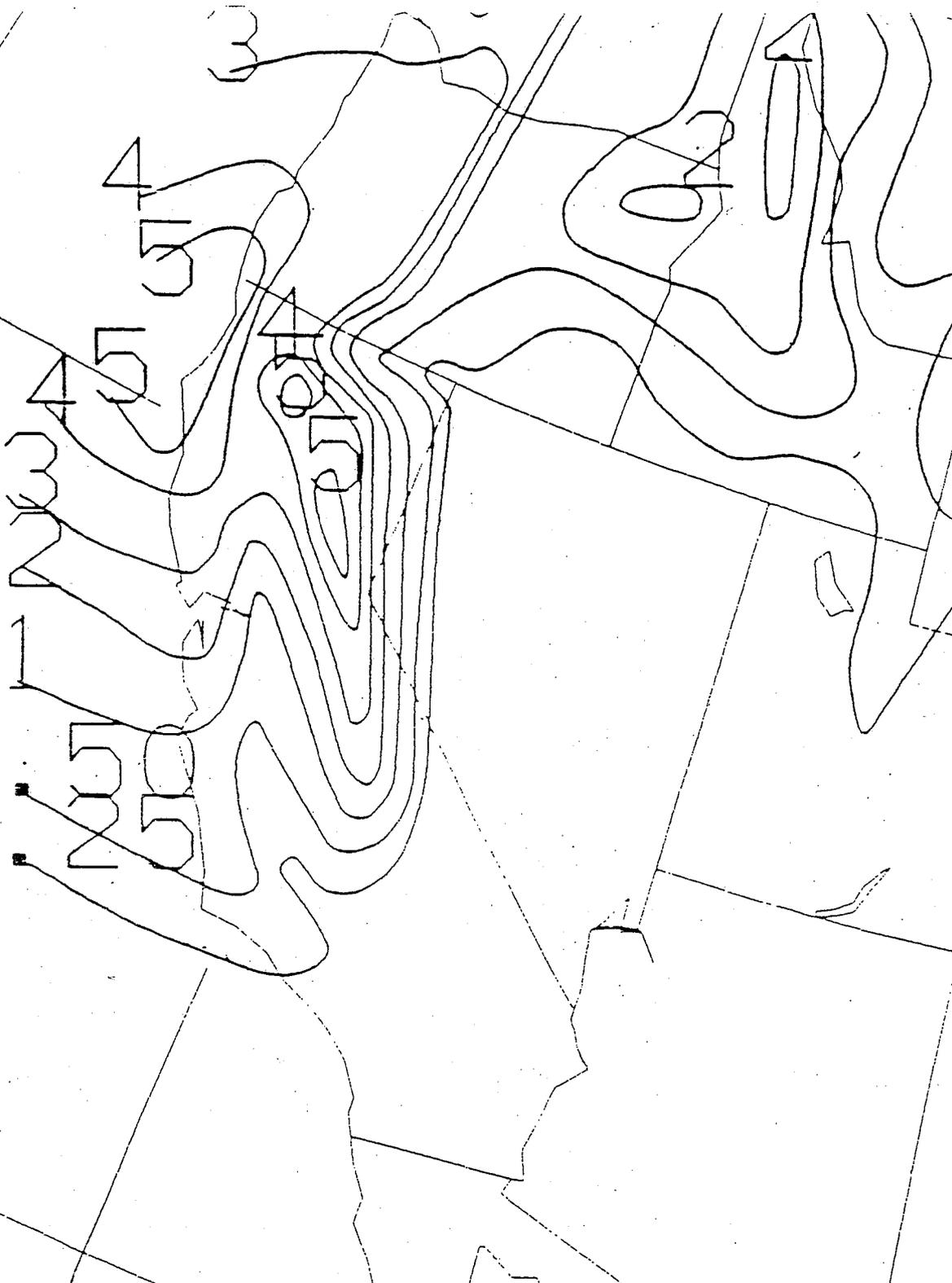
D129
OPRNL DAY 1
24HR QRF 603
ENDING 12Z
TUE 31 DEC 1996
FCSTR: YOUNG

Fig.7



D215
24HR QRF UPDATE
ENDING 12Z 651
TUE 31 DEC 1996
FCSTR: KORTX

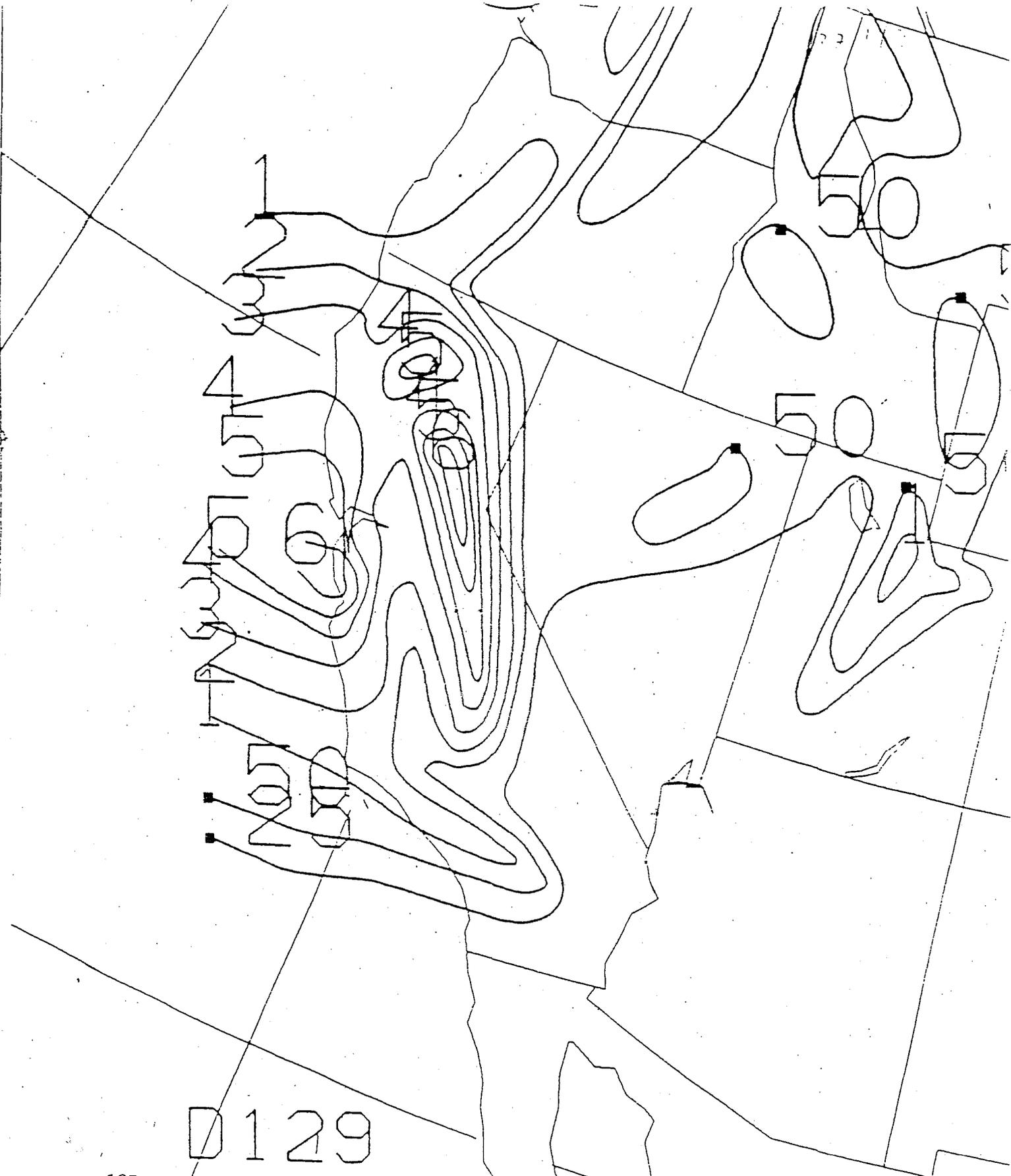
Fig.8



D129
OPRNL DAY 1
24HR QRF 603
ENDING 12Z

12Z
1/1/97

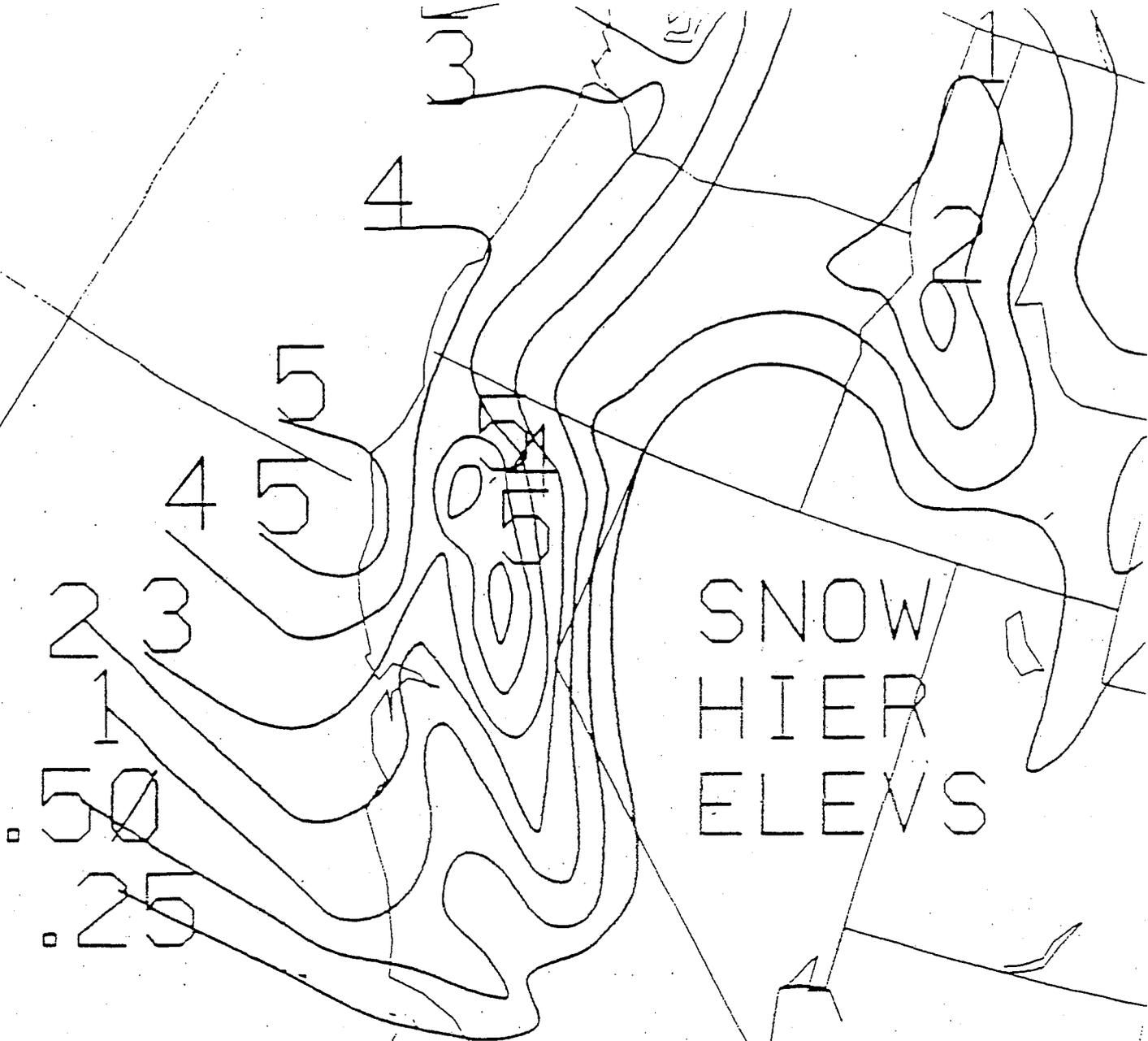
Fig.9



12Z
1/2/97

0129
OPRNL DAY 1
24HR QRF 603
END TIME 1 07

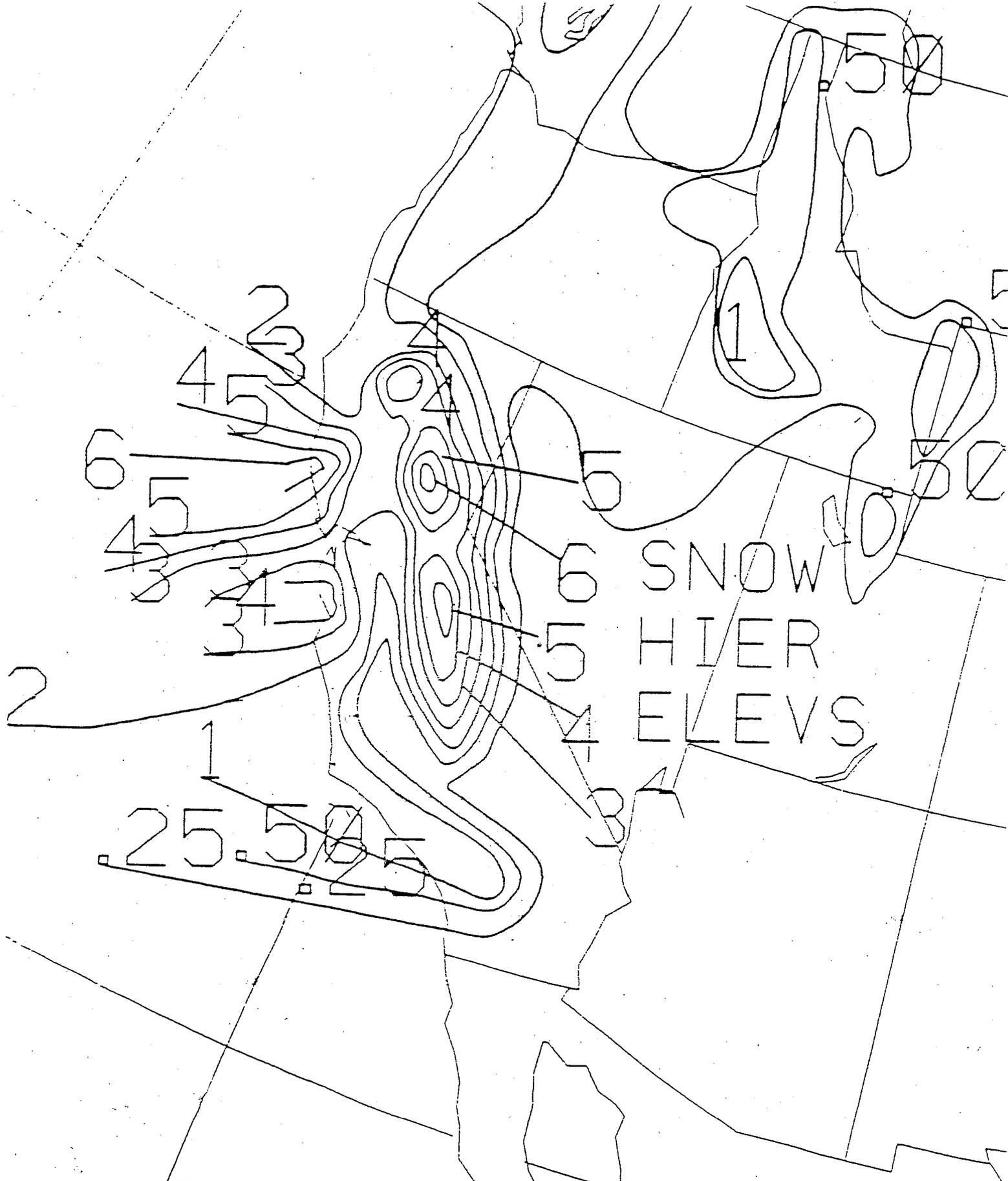
Fig.11



12Z
1/1/97

D215
24HR QRF UPDATE

Fig.10

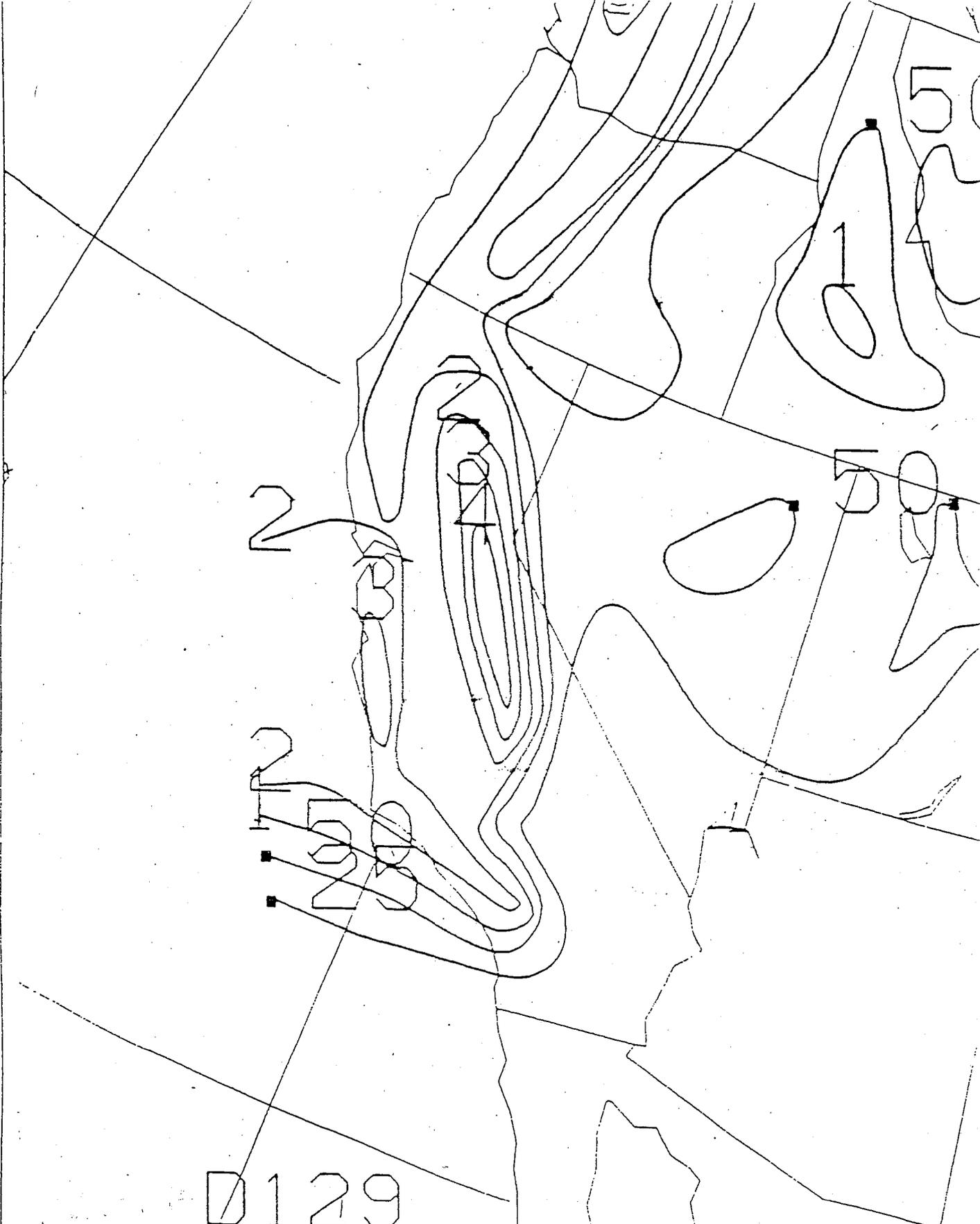


SNOW
HIER
ELEVS

12Z
1/2/97

D215
24HR QRF UPDATE

Fig.12



12Z
1/3/97

D129

OPRNL

24HR

END TIME

DAY

QRF

1 0 7

1

603

Fig.13

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