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ANALYSIS OF RADIOSONDE DATA FOR SPOKANE, WASHINGTON

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U.S. DEPARTMENT OF COMMERCE

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UNITED STATES
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TABLE OF CONTENTS

ANALYSIS OF RADIOSONDE DATA FOR SPOKANE, WASHINGTON

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Abstract

Radiosonde parameters were assembled into a 36-year climatology. Monthly minima, maxima, and averages of height, temperature, and dew point were computed from 0000 UTC and 1200 UTC soundings. Average Skew-T diagrams and stability indices were derived from the data. UTC and Z, abbreviations for what is also known as Greenwich Mean Time (GMT), are used interchangeably. Spokane is in the Pacific Time Zone and therefore 0000 UTC is 4 PM Pacific Standard Time (PST) and 1200 UTC is 4 AM PST or 8 hours behind UTC time.

I. INTRODUCTION

Radiosonde data from Spokane, Washington (WMO ID 72785) from December 1, 1957 through December 31, 1994 comprising of height, temperature and dew point were used for this atmospheric climatology. Maximum, minimum, averages, and standard deviations were calculated for mandatory levels of 1000, 850, 700, 500, 400, 300, 250, 200, 150, and 100 mb. A surface level varying between 930mb and 933mb was included and was derived from the surface data of the radiosonde flights. The soundings were obtained from the Radiosonde Data of North America CD-ROM Version 1.0 (1995). Tables and graphs were computed using Quattro Pro spreadsheets. The radiosonde site originally at the Spokane International Airport (also known as Geiger field) is about 6 miles west-southwest and some 400 feet higher than the downtown business district. This site at the airport appears to have been moved 8 or 9 times according to the station history provided by the National Climatic Data Center (NCDC) but the moves appear to be quite small and negligible as latitude, longitude, and station elevations remain almost the same. The last and quite substantial move listed on the NCDC station history occurred July 30, 1996. This was a move to the current National Weather Service office in Spokane approximately 5 miles northwest of the airport. The station now has a new location identifier (WMO ID 72786). It should be noted that this study does not utilize any sounding data from the current office location.

II. HOW THE DATA WAS COMPILED AND ANALYZED

Using RAOB access software (Govett 1998) 0000 UTC and 1200 UTC mandatory level sounding data were extracted and stored in two rather large text files on an IBM PC. These text files were then FTP'd to a UNIX workstation. Using a few UNIX utilities, namely SED and AWK, the data was sorted into individual files by month and pressure level. This resulted in 264 distinct ASCII text files. The files were then FTP'd back into an IBM PC. Using Corel Quattro Pro 8 (1997) the data was imported, parsed,

and then analyzed using the statistical utilities available in the Quattro Pro 8 software. As each data field had quite a number of entries, for example there were 2094 individual 1000mb height values for the month of January, the use of such a statistical analysis program was invaluable. Indeed, I doubt I would have continued on with this endeavor if I did not have use of this program. Averages were calculated using the traditional method of adding up the sum of each data field and dividing by the number of data entries. Thus, each average listed in this study is derived from approximately 1000 data entries (1000 entries for 0000 UTC and 1000 entries for 1200 UTC). Standard deviations were handled in a similar fashion using each individual entry in the calculation. Thickness averages were computed using the calculated pressure height averages listed in Table 2.

III. DATA

a. Geopotential Height and Surface Pressure

Average geopotential heights (Tables 3 and 4) show quite a bit of variation throughout the atmosphere with a peak during the summer months and a minimum during the month of March through all but the 932mb and 1000mb surfaces. It is theorized that these two levels suffer from exaggerated virtual temperature errors in the hypsometric equation used to calculate geopotential height as these surfaces are at and below the ground. This is also mimicked somewhat at the surface by the surface pressure averages (Tables 7 and 8). It is quite interesting to note that the minimums in geopotential heights and surface pressure occur in March through all but the 932mb and 1000mb surfaces. It is theorized that this reflects the transition period from winter to spring in which low-pressure systems move closer to Eastern Washington.

b. Temperature and Thickness Averages

As expected average temperatures at just about every level are cooler during the winter months and warmer during the summer months and taper up and down in spring and fall respectively (Tables 1 and 2). Average temperatures show more variability at the 200mb level which is reflected in the somewhat higher standard deviations throughout the year for this level (Table 16). It is theorized that this is due to the raising and lowering of the tropopause and associated warming due to intrusion of stratospheric air into this layer. From the surface up to 700mb the minimum average temperatures occur in January, however from 500mb up to 300mb the minimum temperatures occur in March. This reflects the transition period from winter to spring similar to the drop in geopotential heights as described in part a of this study. Thickness averages show the "thinnest" values, which imply the coldest temperatures, in January (Tables 5 and 6).

c. Dew Point

Maximum dew points occur during the summer months of June, July, and August for levels from the surface (~932mb) up to 400mb. Due to the dry nature of the atmosphere over the Pacific Northwest and radiosonde limitations, dewpoint data is cut off above 400mb.

d. Average Skew-T Diagram

Average monthly Skew-T diagrams and derived parameters (Figures 1 through 24) were produced using the GEMPAK graphics program (1995). Average 1200 UTC mandatory level temperatures and dew point data were plotted from the surface (~922mb) up to 100mb. Since surface data is included, low-level inversions associated with 12Z soundings are present. Indeed these low-level inversions appear to be more pronounced during the summer months as radiational processes cool the surface temperature while leaving the layers at and above 850mb relatively unaffected. Soundings during the winter months are stable through a deeper layer reaching up to 700mb. The annual variation of temperature is reflected in these sounding as they shift to the cold temperatures to the left on the Skew-T diagram during the winter months and to the right during the summer months. As noted in previous work by Saucier (1955), several peculiarities of the sounding results from the averaging process and are misleading when interpreted in terms of typical daily soundings. First, since the height of the tropopause oscillates locally with time, particularly in middle latitudes, the tropopause region is shown by rounded changes in slope of the mean sounding. Another result of averaging is that only the more permanent features of the curve are retained: the stable stratosphere above the tropopause region, the rather large lapse rates in the middle troposphere, and the strong low-level stability in the 1200 UTC soundings due to the time of the day in which these soundings were taken. Further study of the soundings will show that the lapse rate through the middle troposphere is larger during the summer months than the winter months. This implies that one should generally expect non-convective processes producing the bulk of precipitation during the winter months and mainly convective processes producing precipitation during the summer months. Other indices listed to the top of each Skew-T imply this change in stability as well.

e. Indices

Indices were produced using the GEMPAK graphics program (1995) and are listed at the top of each individual sounding (Figures 1 through 24). Table 19 contains a key listing abbreviations used for these indices. These indices will be more important in analysis of 0000 UTC data as the 1200 UTC soundings have low-level inversions which will produce misleading stability indices. One parameter computed which is quite useful is precipitable water. Average precipitable water values range from a January minimum of 7mm (0.27 in) to a July maximum of 16mm (0.63 in). This is due to the warmer nature of the summer months where the atmosphere can hold more water vapor. It should be noted that the wettest month climatologically is December and most of the precipitation falls as snow. Examining the spread between temperature and dew point traces on the soundings, one can see that the winter months, especially December, has a smaller spread which implies a higher relative humidity during the winter months when compared with the larger spread of the summer months.

IV. CONCLUSION

This data set provides insight into the typical atmosphere over Spokane, Washington. Skew-T diagrams and tables of maxima, minima, and averages will allow forecasters to assess atmospheric deviations from the average. This may be helpful for forecasting atypical events. The data provide a baseline and may also be used to determine maximum and minimum record events in the atmosphere.

V. ACKNOWLEDGMENTS

Thanks to Ronald Miller for his helpful constructive feedback and hints and help with GEMPAK scripts and to Don Moore for additional feedback.

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Table 1. 12Z Temperature averages from 1 Dec 1957 through 31 Dec 1994 f or Spokane, WA in degrees celsius.

millibars	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
100	-57.2	-56.2	-55.4	-55.6	-55.2	-55.2	-56.5	-57.3	-58.6	-59.9	-58.2	-57.4
150	-55.0	-54.2	-53.8	-54.3	-54.0	-53.4	-54.4	-55.1	-56.9	-58.2	-56.4	-55.6
200	-57.2	-57.0	-56.3	-56.3	-55.4	-54.3	-53.2	-53.2	-54.9	-56.6	-56.4	-56.6
250	-55.8	-56.6	-56.2	-54.9	-52.8	-50.4	-48.6	-48.7	-49.7	-51.6	-53.6	-54.6
300	-49.7	-50.6	-50.8	-49.2	-46.1	-42.7	-40.2	-40.3	-41.6	-44.0	-47.4	-48.9
400	-36.3	-36.9	-37.3	-35.3	-31.6	-27.6	-24.8	-24.7	-26.4	-29.3	-34.0	-35.6
500	-25.2	-25.3	-25.8	-23.8	-20.0	-15.9	-12.9	-12.9	-14.8	-17.9	-22.9	-24.5
700	-9.8	-9.4	-9.7	-7.5	-3.6	-0.4	4.0	4.2	1.2	-2.2	-7.4	-9.3
850	-3.3	-1.4	0.0	3.1	7.3	11.6	15.7	15.7	11.3	6.3	0.1	-2.7
932	-3.8	-1.4	0.6	3.5	7.3	11.2	14.4	14.3	9.9	4.6	0.3	-3.0

Table 2. 00Z Temperature averages from 1 Dec 1957 through 31 Dec 1994 f or Spokane, WA in degrees celsius.

millibars	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
100	-56.5	-55.4	-54.4	-54.6	-54.3	-54.6	-55.7	-56.4	-57.6	-59.2	-57.9	-57.0
150	-54.6	-53.6	-53.1	-53.5	-53.3	-52.9	-53.6	-54.3	-56.2	-57.6	-56.2	-55.3
200	-56.9	-56.6	-55.7	-55.8	-54.8	-53.8	-52.6	-52.6	-52.2	-56.2	-56.3	-56.4
250	-55.4	-56.0	-55.5	-54.3	-52.1	-49.7	-47.9	-47.9	-49.1	-51.1	-53.3	-54.5
300	-49.3	-50.2	-50.2	-48.5	-45.4	41.8	-39.5	-39.5	-41.0	-43.4	-47.0	-48.8
400	-36.1	-36.4	-36.7	-34.7	-30.9	-26.9	-24.1	-24.1	-25.9	-28.8	-33.5	-35.3
500	-25.0	-24.9	-25.3	-23.2	-19.4	-15.3	-12.3	-12.2	-14.2	-17.4	-22.5	-24.3
700	-9.7	-9.1	-9.3	-7.0	-3.1	1.0	4.3	4.7	1.6	-1.7	-7.4	-9.2
850	-3.2	-1.1	0.7	4.5	9.0	13.5	17.7	17.8	13.0	7.2	0.2	-2.5
932	-1.0	3.4	7.7	12.5	17.6	22.4	27.3	27.1	21.7	14.2	4.4	-0.4

Table 3. 12Z Height averages from 1 Dec 1957 through 31 Dec 1994 for Spokane, WA in meters.

millibars	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
100	16029	16032	16025	16108	16266	16438	16561	16545	16422	16270	16106	16056
150	13450	13442	13429	13515	13670	13839	13979	13973	13868	13730	13543	13482
200	11619	11605	11586	11677	11827	11990	12128	12125	12037	11912	11716	11651
250	10206	10195	10173	10259	10400	10550	10681	10678	10597	10483	10293	10233
300	9030	9024	9003	9079	9206	9341	9459	9458	9383	9280	9105	9052
400	7092	7093	7074	7135	7233	7336	7431	7430	7368	7288	7148	7107
500	5506	5510	5494	5542	5615	5691	5768	5766	5716	5657	5548	5518
700	2984	2986	2974	3002	3037	3072	3116	3113	3086	3060	3002	2988
850	1463	1460	1446	1460	1471	1481	1503	1499	1495	1492	1466	1465
932	721	721	721	721	721	721	721	721	721	721	721	721
1000	171	156	132	131	122	111	115	115	129	153	154	169

Table 4. 00Z Height averages from 1 Dec 1957 through 31 Dec 1994 for Spokane, WA in meters.

millibars	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
100	16048	16064	16068	16154	16318	16488	16615	16601	16470	16307	16130	16067
150	13463	13465	13461	13552	13712	13882	14023	14019	13906	13760	13563	13488
200	11628	11624	11614	11708	11865	12028	12167	12166	12070	11938	11735	11656
250	10214	10211	10195	10287	10433	10586	10714	10714	10625	10507	10310	10236
300	9036	9037	9021	9104	9236	9373	9489	9489	9408	9300	9120	9054
400	7096	7102	7088	7155	7257	7361	7456	7455	7388	7303	7158	7109
500	5509	5516	5504	5558	5635	5712	5788	5787	5732	5668	5556	5517
700	2984	2988	2980	3012	3051	3086	3131	3128	3098	3066	3007	2987
850	1464	1461	1450	1466	1479	1490	1513	1509	1502	1496	1471	1463
931	721	721	721	721	721	721	721	721	721	721	721	721
1000	165	144	116	109	99	86	87	84	102	130	148	160

Table 5. 12Z Thickness averages from 1 Dec 1957 through 31 Dec 1994 f or Spokane, WA in decameters.

Thickness	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
500/1000	533.5	535.4	536.2	541.1	549.3	558.0	565.3	565.1	558.7	550.4	539.4	534.9
850/700	152.1	152.6	152.8	154.2	156.6	159.1	161.3	161.4	159.1	156.8	153.6	152.3
1000/850	129.2	130.4	131.4	132.9	134.9	137.0	138.8	138.4	136.6	133.9	131.2	129.6
1000/700	281.3	283	284.2	287.1	291.5	296.1	300.1	299.8	295.7	290.7	284.8	281.9

Table 6. 00Z Thickness averages from 1 Dec 1957 through 31 Dec 1994 f or Spokane, WA in decameters.

Thickness	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
500/1000	534.4	537.2	538.8	544.9	553.6	562.6	570.1	570.3	563.0	553.8	540.8	535.7
850/700	152.0	152.7	153.0	154.6	157.2	159.6	161.8	161.9	159.6	157.0	153.6	152.4
1000/850	129.9	131.7	133.4	135.7	138.0	140.4	142.6	142.5	140.0	136.6	132.3	130.3
1000/700	281.9	284.4	286.4	290.3	295.2	300	304.4	304.4	299.6	293.6	285.9	282.7

Table 7. 12Z Surface pressure averages from 1 Dec 1957 through 31 Dec 1994 f or Spokane, WA in decameters.

sfc pres	933.4	932.2	930.0	930.5	930.5	930.3	931.5	931.1	932.0	933.3	932.4	933.4

Table 8. 00Z Surface pressure averages from 1 Dec 1957 through 31 Dec 1994 f or Spokane, WA in decameters.

sfc pres	933.2	931.9	929.6	930.1	930.2	930.0	931.2	930.8	931.5	932.8	932.6	932.9

Table 9
12Z average of surface data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.
All temperature data in degrees Celsius. All height values in meters. Surface pressure in millibars.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-3.8	6.0	-29.4	8.9
FEB	-1.4	4.6	-23.3	10.0
MAR	0.6	3.7	-18.3	10.6
APR	3.5	3.6	-6.1	18.3
MAY	7.3	3.9	-2.2	19.4
JUN	11.2	3.7	0.9	22.2
JUL	14.4	3.4	4.4	25.0
AUG	14.3	3.6	2.8	26.2
SEP	9.9	3.9	-2.2	20.6
OCT	4.6	4.0	-9.8	18.3
NOV	0.3	4.5	-20.0	11.7
DEC	-3.0	5.5	-28.9	12.2

DWPT

	AVG DWPT	ST DEV	MIN	MAX
JAN	-6.1	6.9	-36.4	6.2
FEB	-3.8	5.5	-30.6	8.1
MAR	-2.5	4.5	-28.3	8.3
APR	-0.6	3.9	-13.2	12.4
MAY	2.8	3.9	-10.5	13.3
JUN	6.0	3.7	-7.4	15.5
JUL	6.5	3.7	-6.8	16.8
AUG	5.9	4.1	-12.2	16.1
SEP	3.8	4.2	-21.8	15.4
OCT	0.8	4.2	-17.2	12.5
NOV	-1.7	4.8	-23.0	10.5
DEC	-4.8	6.0	-35.4	10.1

SURFACE HEIGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	721	3.5	720	810
FEB	721	3.2	720	816
MAR	721	0.9	720	722
APR	721	1.9	720	773
MAY	721	4.7	720	871
JUN	721	3.1	720	792
JUL	721	0.9	720	722
AUG	721	0.9	720	722
SEP	721	0.9	720	722
OCT	721	0.9	720	722
NOV	721	0.9	720	722
DEC	721	3.5	720	812

SURFACE PRESSURE

	AVG PRES	ST DEV	MIN	MAX
JAN	933	9	902	958
FEB	932	8	905	950
MAR	930	7	907	948
APR	931	6	912	949
MAY	930	5	907	945
JUN	930	4	914	942
JUL	932	3	922	942
AUG	931	3	918	944
SEP	932	5	908	950
OCT	933	6	906	951
NOV	932	8	908	956
DEC	933	9	905	954

Table 10
12Z average of 850mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.
All temperature data in degrees Celsius. All height values in meters.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-3.3	5.6	-25.3	13.9
FEB	-1.4	4.9	-29.2	11.8
MAR	0.0	4.5	-27.9	13.1
APR	3.1	4.6	-6.2	20.5
MAY	7.3	5.0	-4.6	24.4
JUN	11.6	4.9	1.2	26.1
JUL	15.7	4.8	3.2	27.2
AUG	15.7	4.9	-1.1	28.1
SEP	11.3	5.3	-4.0	26.6
OCT	6.3	5.2	-10.6	24.0
NOV	0.1	4.8	-18.4	14.2
DEC	-2.7	5.4	-27.5	11.9

DWPT

	AVG DWPT	ST DEV	MIN	MAX
JAN	-8.6	6.8	-32.8	8.3
FEB	-7.6	6.2	-35.3	5.9
MAR	-7.2	5.5	-30.5	5.4
APR	-5.7	4.9	-23.4	8.5
MAY	-2.5	4.5	-16.3	9.2
JUN	0.4	4.4	-12.2	12.7
JUL	1.4	3.9	-11.2	13.7
AUG	1.6	3.9	-10.5	13.1
SEP	-0.3	4.2	-13.7	10.1
OCT	-3.3	5.0	-21.3	9.1
NOV	-5.8	6.0	-26.7	9.4
DEC	-7.6	6.3	-33.9	6.7

HGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	1463	73	1182	1626
FEB	1460	67	1233	1609
MAR	1446	61	1228	1595
APR	1460	54	1295	1620
MAY	1471	45	1328	1594
JUN	1481	37	1359	1589
JUL	1503	32	1393	1593
AUG	1499	33	1362	1596
SEP	1495	47	1276	1623
OCT	1492	58	1241	1646
NOV	1466	68	1258	1647
DEC	1465	73	1217	1626

Table 11
12Z average of 700mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.
All temperature data in degrees Celsius. All height values in meters.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-9.8	5.6	-28.0	2.9
FEB	-9.4	5.1	-27.2	3.2
MAR	-9.7	4.7	-25.2	2.1
APR	-7.5	4.9	-19.0	7.1
MAY	-3.6	4.8	-14.8	10.8
JUN	-0.4	4.5	-10.5	12.8
JUL	4.0	4.0	-7.7	13.5
AUG	4.2	4.2	-8.3	15.0
SEP	1.2	5.2	-14.1	13.1
OCT	-2.2	5.5	-21.2	10.1
NOV	-7.4	5.1	-24.0	7.8
DEC	-9.3	5.6	-29.3	4.3

DWPT

	AVG DWPT	ST DEV	MIN	MAX
JAN	-16.9	8.0	-40.4	-0.4
FEB	-17.0	7.5	-41.1	-1.5
MAR	-16.9	7.0	-36.7	-2.3
APR	-15.0	6.6	-32.4	0.2
MAY	-11.5	6.4	-29.1	1.7
JUN	-7.9	6.3	-27.0	6.5
JUL	-6.9	6.0	-23.4	7.2
AUG	-6.6	5.9	-23.7	6.1
SEP	-9.5	6.3	-26.7	3.5
OCT	-12.6	7.0	-32.5	1.0
NOV	-15.2	7.5	-35.3	3.5
DEC	-16.8	7.7	-44.5	0.8

HGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	2984	86	2726	3202
FEB	2986	79	2762	3188
MAR	2974	71	2756	3182
APR	3002	64	2823	3180
MAY	3037	59	2871	3204
JUN	3072	50	2916	3207
JUL	3116	46	2944	3226
AUG	3113	48	2938	3240
SEP	3086	61	2842	3251
OCT	3060	74	2789	3245
NOV	3002	78	2783	3193
DEC	2988	85	2727	3198

Table 12
12Z average of 500mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.
All temperature data in degrees Celsius. All height values in meters.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-25.2	5.9	-41.8	-11.9
FEB	-25.3	5.3	-44.8	-15.1
MAR	-25.8	5.1	-44.6	-13.8
APR	-23.8	5.1	-39.0	-12.2
MAY	-20.0	4.7	-35.0	-7.8
JUN	-15.9	4.0	-29.3	-5.3
JUL	-12.9	3.2	-25.2	-6.0
AUG	-12.9	3.2	-26.3	-5.5
SEP	-14.8	4.6	-30.1	-3.7
OCT	-17.9	5.4	-37.6	-6.0
NOV	-22.9	5.8	-41.2	-7.1
DEC	-24.5	6.0	-43.0	-12.3

DWPT

	AVG DWPT	ST DEV	MIN	MAX
JAN	-32.7	8.0	-53.2	-14.7
FEB	-33.3	7.3	-53.7	-15.8
MAR	-33.9	7.2	-51.6	-16.8
APR	-32.5	7.2	-50.0	-14.2
MAY	-29.7	7.1	-49.0	-12.4
JUN	-26.6	6.9	-43.7	-10.5
JUL	-25.3	6.6	-41.3	-8.2
AUG	-25.5	6.3	-40.8	-9.5
SEP	-26.6	6.7	-51.6	-11.8
OCT	-28.0	7.4	-48.3	-12.1
NOV	-31.2	8.2	-54.1	-8.4
DEC	-32.5	8.2	-66.9	-13.9

HGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	5506	132	5151	5829
FEB	5510	118	5159	5802
MAR	5494	108	5126	5797
APR	5542	101	5309	5826
MAY	5615	97	5354	5872
JUN	5691	83	5447	5881
JUL	5768	74	5524	5928
AUG	5766	76	5516	5954
SEP	5716	101	5418	5978
OCT	5657	119	5306	5927
NOV	5548	120	5188	5838
DEC	5518	130	5168	5849

Table 13
12Z average of 400mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.
All temperature data in degrees Celsius. All height values in meters.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-36.3	5.5	-53.3	-23.6
FEB	-36.9	5.0	-52.8	-25.6
MAR	-37.3	4.8	-52.6	-23.2
APR	-35.3	4.8	-49.6	-24.5
MAY	-31.6	4.6	-45.9	-20.8
JUN	-27.6	4.1	-43.1	-17.9
JUL	-24.8	3.2	-38.1	-17.3
AUG	-24.7	3.1	-37.2	-17.2
SEP	-26.4	4.4	-42.9	-16.5
OCT	-29.3	5.2	-50.8	-17.7
NOV	-34.0	5.7	-52.2	-16.5
DEC	-35.6	5.6	-51.9	-22.5

DWPT

	AVG DWPT	ST DEV	MIN	MAX
JAN	-41.4	5.9	-68.9	-25.0
FEB	-42.7	5.6	-56.5	-28.1
MAR	-43.2	5.4	-59.1	-29.1
APR	-42.1	5.6	-54.5	-26.5
MAY	-40.3	6.2	-57.8	-23.5
JUN	-37.6	6.1	-52.9	-21.3
JUL	-36.4	5.7	-51.1	-18.0
AUG	-35.9	5.7	-51.5	-19.7
SEP	-37.1	6.1	-53.8	-21.5
OCT	-38.3	6.1	-53.8	-23.5
NOV	-40.7	6.7	-58.6	-21.0
DEC	-41.4	6.2	-63.3	-25.4

HGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	7092	165	6645	7481
FEB	7093	147	6620	7438
MAR	7074	136	6589	7442
APR	7135	129	6839	7471
MAY	7233	124	6896	7559
JUN	7336	106	7010	7579
JUL	7431	91	7126	7623
AUG	7430	93	7127	7644
SEP	7368	127	6986	7681
OCT	7288	150	6803	7612
NOV	7148	152	6686	7510
DEC	7107	163	6690	7516

Table 14
12Z average of 300mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.
All temperature data in degrees Celsius. All height values in meters.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-49.7	3.6	-65.0	-39.0
FEB	-50.6	3.3	-59.8	-39.6
MAR	-50.8	3.2	-60.6	-39.6
APR	-49.2	3.3	-59.6	-40.4
MAY	-46.1	3.4	-56.9	-34.2
JUN	-42.7	3.4	-53.1	-33.9
JUL	-40.2	2.7	-49.5	-32.9
AUG	-40.3	2.8	-49.8	-30.7
SEP	-41.6	3.4	-56.1	-32.7
OCT	-44.0	3.7	-56.7	-34.9
NOV	-47.4	4.0	-60.3	-27.3
DEC	-48.9	3.8	-61.5	-29.9

HEIGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	9030	197	8508	9503
FEB	9024	176	8499	9426
MAR	9003	162	8476	9446
APR	9079	158	8707	9463
MAY	9206	152	8814	9609
JUN	9341	132	8927	9648
JUL	9459	111	9106	9606
AUG	9458	113	9080	9714
SEP	9383	155	8884	9752
OCT	9280	183	8691	9683
NOV	9105	186	8558	9620
DEC	9052	195	8564	9548

Table 15
12Z average of 250mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-55.8	4.0	-65.5	-42.1
FEB	-56.6	4.1	-66.7	-38.8
MAR	-56.2	4.1	-64.3	-41.6
APR	-54.9	3.6	-65.5	-42.6
MAY	-52.8	3.6	-60.7	-38.6
JUN	-50.4	3.1	-58.7	-39.5
JUL	-48.6	2.6	-56.5	-39.2
AUG	-48.7	2.8	-55.3	-35.6
SEP	-49.7	2.8	-59.0	-37.1
OCT	-51.6	3.4	-61.6	-34.9
NOV	-53.6	3.8	-63.1	-35.7
DEC	-54.6	4.2	-64.8	-35.2

HEIGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	10206	201	9686	10709
FEB	10195	178	9706	10614
MAR	10173	163	9688	10648
APR	10259	162	9885	10661
MAY	10400	158	10002	10838
JUN	10550	141	10153	10890
JUL	10681	118	10326	10948
AUG	10678	122	10288	10961
SEP	10597	164	10064	10992
OCT	10483	192	9915	10928
NOV	10293	192	9747	10910
DEC	10233	199	9751	10766

Table 16
12Z average of 200mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.
All temperature data in degrees Celsius. All height values in meters.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-57.2	6.7	-70.2	-40.6
FEB	-57.0	6.6	-72.1	-40.0
MAR	-56.3	6.5	-71.4	-40.6
APR	-56.3	6.2	-69.5	-36.4
MAY	-55.4	5.8	-67.8	-39.4
JUN	-54.3	5.5	-65.9	-40.6
JUL	-53.2	4.3	-63.3	-40.8
AUG	-53.2	4.1	-62.5	-39.6
SEP	-54.9	4.7	-65.8	-39.5
OCT	-56.6	5.1	-67.1	-41.4
NOV	-56.4	5.7	-69.4	-41.9
DEC	-56.6	6.5	-72.4	-37.1

HEIGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	11619	184	11121	12113
FEB	11605	159	11194	12013
MAR	11586	143	11135	12003
APR	11677	143	11335	12064
MAY	11827	142	11476	12285
JUN	11990	130	11644	12348
JUL	12128	115	11820	12411
AUG	12125	120	11761	12433
SEP	12037	157	11535	12445
OCT	11912	185	11406	12390
NOV	11716	180	11202	12430
DEC	11651	182	11199	12185

Table 17
12Z average of 150mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-55.0	4.7	-75.4	-43.1
FEB	-54.2	4.3	-72.7	-41.6
MAR	-53.8	4.0	-69.1	-43.8
APR	-54.3	4.1	-65.7	-44.5
MAY	-54.0	4.2	-69.6	-43.0
JUN	-53.4	4.1	-67.1	-43.3
JUL	-54.4	3.7	-68.9	-44.4
AUG	-55.1	3.6	-69.0	-45.8
SEP	-56.9	4.3	-71.1	-47.0
OCT	-58.2	4.7	-76.0	-45.9
NOV	-56.4	4.7	-75.1	-45.2
DEC	-55.6	5.1	-75.1	-40.9

HEIGHT

	AVG HGHT	ST DEV	MIN	MAX
JAN	13450	160	12996	13904
FEB	13442	137	13033	13836
MAR	13429	123	12967	13796
APR	13515	117	13213	13820
MAY	13670	114	13370	14081
JUN	13839	102	13557	14147
JUL	13979	95	13739	14254
AUG	13973	101	13657	14243
SEP	13868	132	13426	14250
OCT	13730	160	13294	14197
NOV	13543	154	13049	14290
DEC	13482	156	13051	14010

Table 18
12Z average of 100mb data from 1 Dec 1957 through 31 Dec 1994 for Spokane, Washington.
All temperature data in degrees Celsius. All height values in meters.

TEMP

	AVG TEMP	ST DEV	MIN	MAX
JAN	-57.2	4.5	-70.5	-45.0
FEB	-56.2	4.1	-68.3	-43.6
MAR	-55.4	3.5	-69.8	-44.0
APR	-55.6	3.4	-68.6	-45.0
MAY	-55.2	3.1	-65.7	-47.8
JUN	-55.2	3.1	-66.0	-45.7
JUL	-56.5	3.0	-64.3	-46.5
AUG	-57.3	3.0	-65.0	-49.0
SEP	-58.6	3.7	-70.4	-48.9
OCT	-59.9	4.3	-72.8	-48.1
NOV	-58.2	4.1	-71.7	-47.5
DEC	-57.4	4.7	-73.0	-43.7

HEIGHT

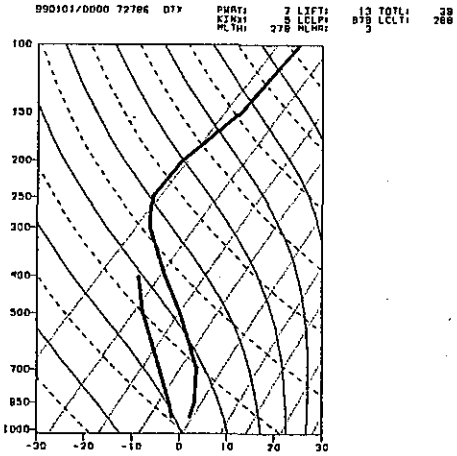
	AVG HGHT	ST DEV	MIN	MAX
JAN	16029	144	15549	16436
FEB	16032	122	15639	16364
MAR	16025	110	15529	16337
APR	16108	97	15831	16389
MAY	16266	95	16009	16563
JUN	16438	78	16228	16684
JUL	16561	66	16376	16757
AUG	16545	74	16300	16747
SEP	16422	100	16063	16731
OCT	16270	122	15880	16650
NOV	16106	124	15610	16750
DEC	16056	130	15666	16620

Table 19
Abbreviations for Skew-T diagrams and indices

X-axis is in degrees Celsius
Y-axis is in millibars

PWAT- Precipitable water in mm
LIFT - Lifted Index
TOTL- Total Totals index
KINX - K Index
LCLP- Pressure in millibars at the LCL from the surface
LCLT- Temperature in Kelvin at the LCL from the surface
MLTH- Mean mixed layer potential temperature in lowest 500 meters
MLMR- Mean mixed layer mixing ration in g/kg in lowest 500 meters

Fig. 1 Jan 00Z



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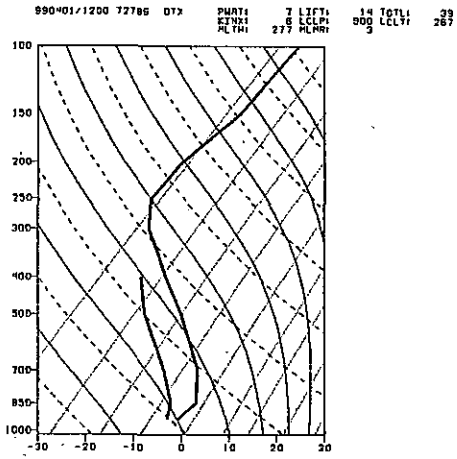

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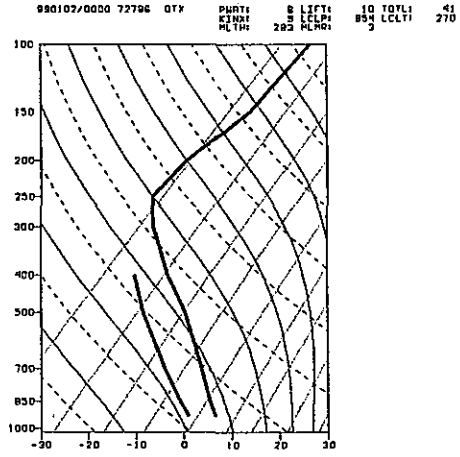

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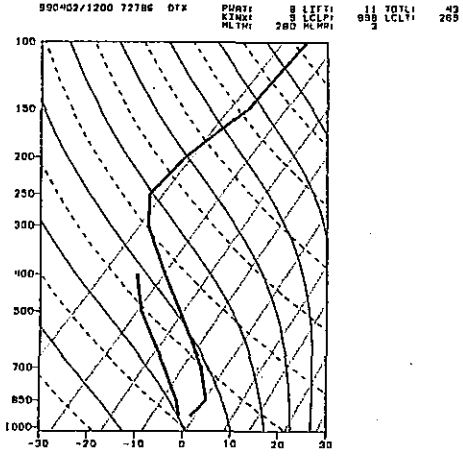

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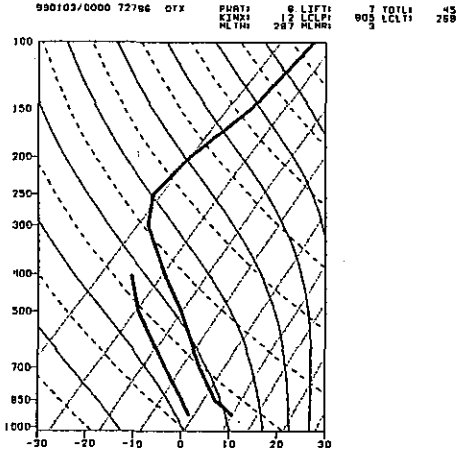

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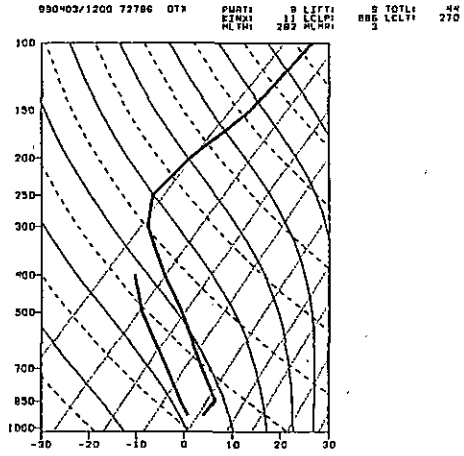

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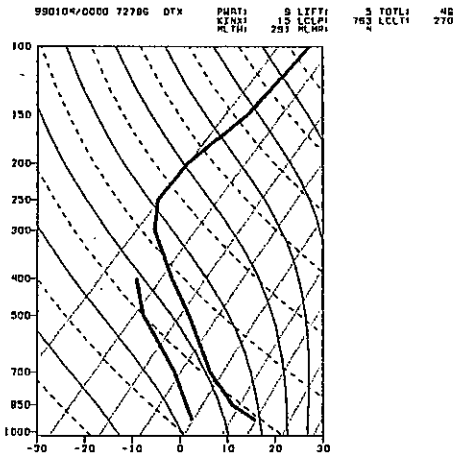

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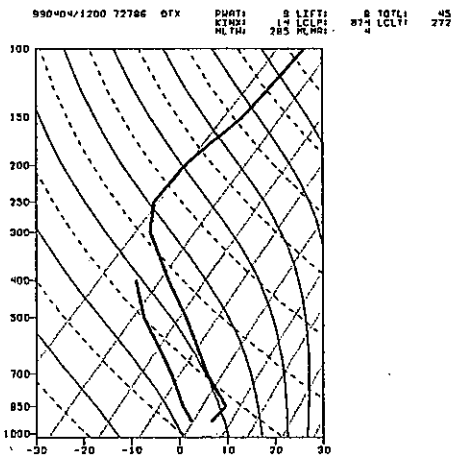

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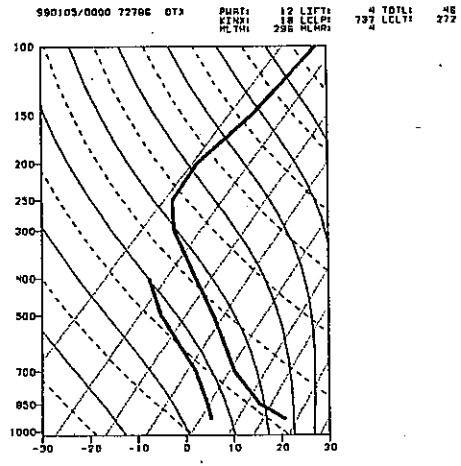

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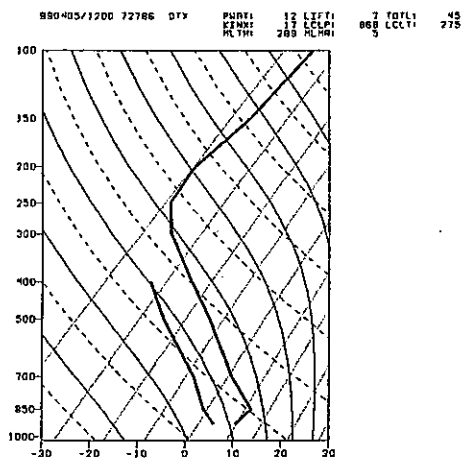

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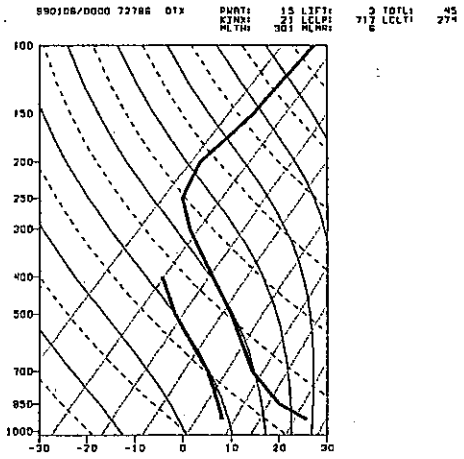

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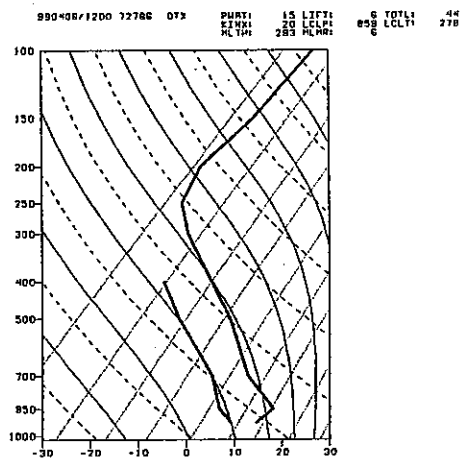

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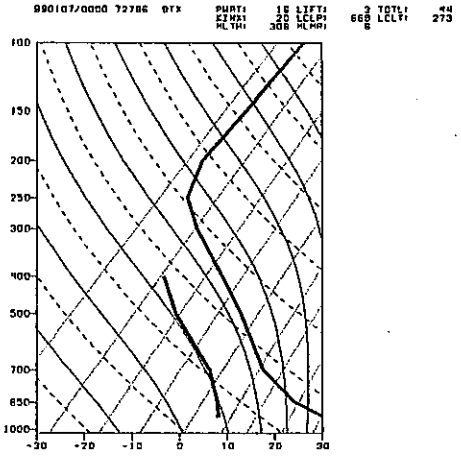

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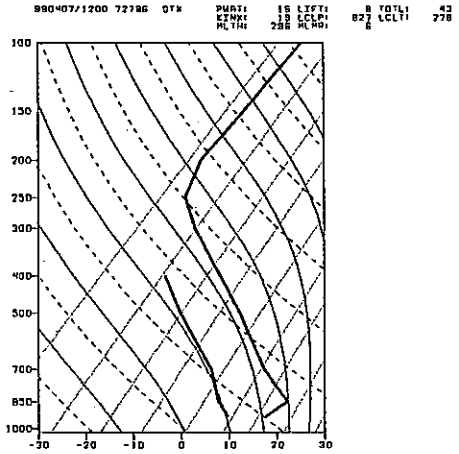
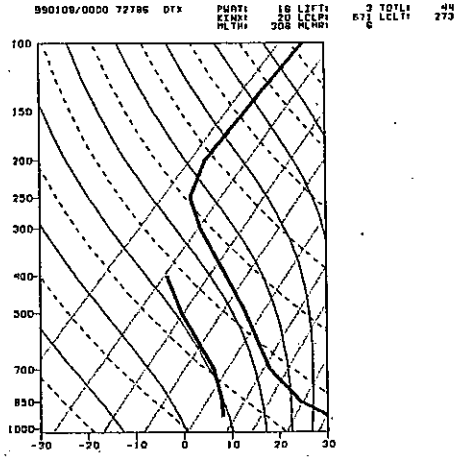


Fig. 15 Aug 00Z



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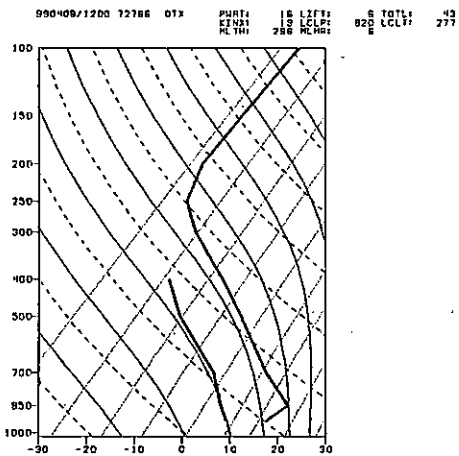

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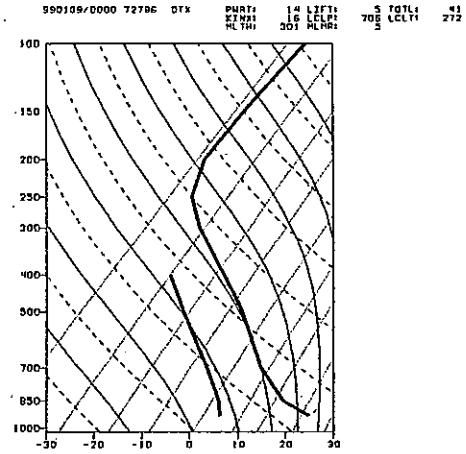

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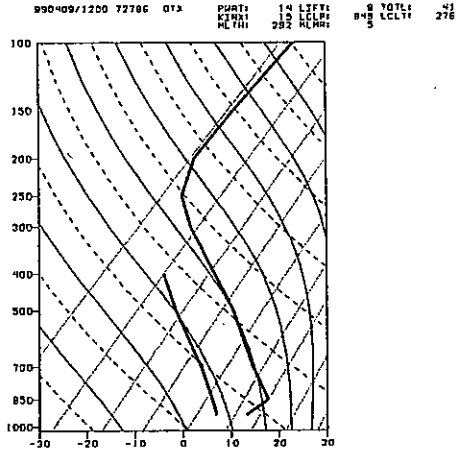

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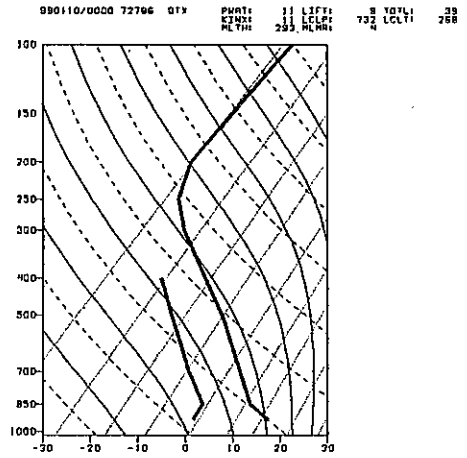

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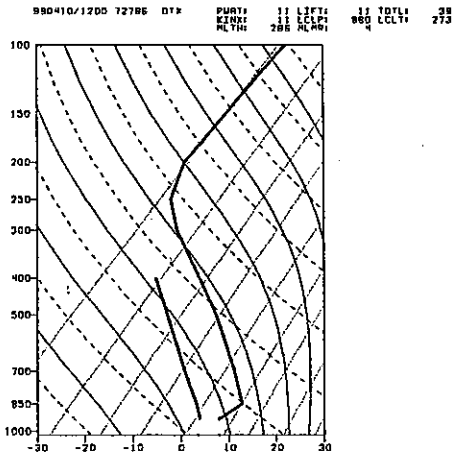

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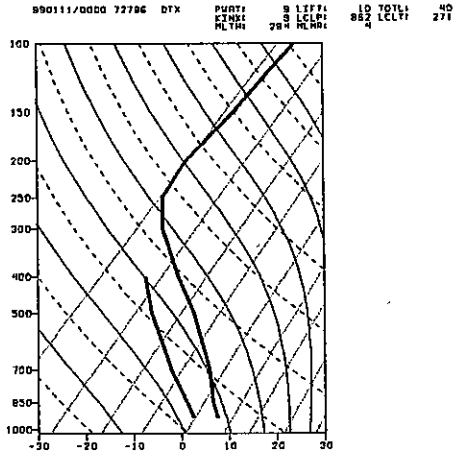

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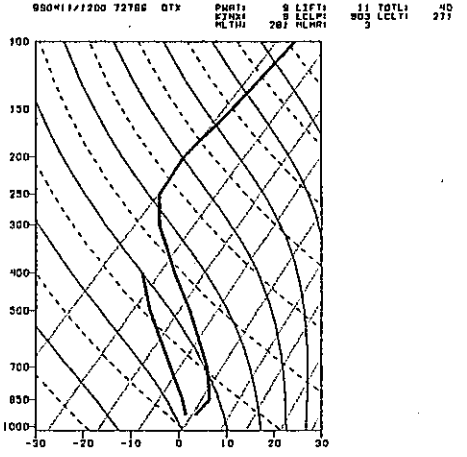

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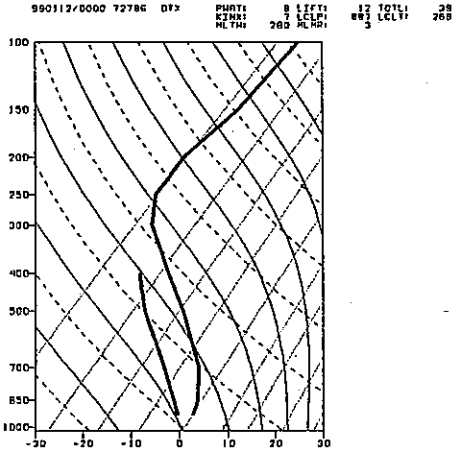

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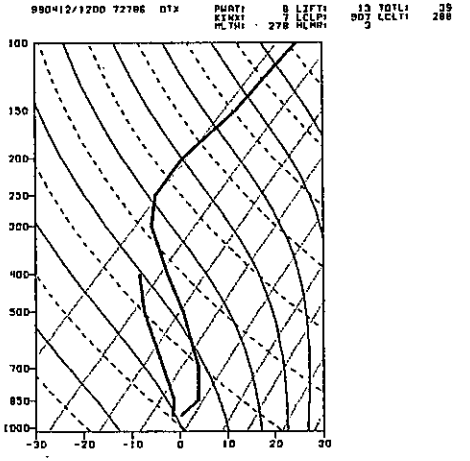

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