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FORECASTING THUNDERSTORMS IN SOUTHERN NEVADA

Summer 1961

Preliminary Report No. 1

by
Robert O. Weedfall
Weather Bureau Research Station
Las Vegas, Nevada

This study is being carried on under an agreement between the U. S. Weather Bureau and U. S. Atomic Energy Commission, Nevada Operations Office

U. S. Weather Bureau.

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B I B L I O G R A P H Y

1. Jenrette, James P. An Objective Application of Vorticity Principles to Precipitation Forecasting. BAMS, June 1960.

2. AROWA Report, "Vertical Motion and Weather." U. S. Navy Weather Research Facility, USWB MO9.312.

3. Reynolds, R. D. Cumuloform Shower Forecast Technique for Southern Arizona. BAMS, November 1957.

4. Linn, Edward, M., 1st Lt., Nellis AFB, Las Vegas, Nevada. A Modification of the Finnicum Method for Forecasting Cumulus Activity and Thunderstorms in the Nellis Air Force Base Area.

5. Schaefer, V. J. Jet Streams, Thunderstorms, and Project Skyfire. The Munitalp Foundation, Inc.

6. U. S. Weather Bureau, Technical Paper No. 19, "Mean Number of Thunderstorm Days in the United States."

7. AWSM 105-37, "A Digest of Procedures Used by the Air Weather Service Severe Weather Warning (Thunderstorm) Center." November 1, 1952.

8. Riehl, Norquest, Sugg. A Quantitative Method for the Predicition of Rainfall Patterns. 1952, J. of Met., 9-5, 291-298.

9. "Severe Weather Forecasting," USAF, Air Weather Officer's Course No. 2500, Volume 10, November 1959.

A. Introduction

Most of the thunderstorms in the southwestern desert are of the single cell type, usually cover a relatively small area (less than forty miles), and have a ceiling of 5000 feet or above. Their moisture and erractic winds would have an adverse affect on any operations at the Nevada Test Site as would the fluctuating power resulting from their occurrence between the Test Site and Las Vegas.

This study was undertaken in an effort to get a more precise and reliable method that will predict convection between the hours of noon and midnight from 0400 PST data.

B. Why a Vorticity Parameter was not Considered

When plans were made for developing this objective method, it was thought some measure of the vertical motion would be a useful parameter. The appearance of Jenrette's method (1) further confirmed this. However, the use of the vorticity equation in deriving vertical motion has serious limitations. More important, the AROWA publication (2) states that it is not obvious that any relation exists between large-scale computed vertical motion (derived by any of several techniques) and convective-type precipitation. Whether Jenrette's method of computing the advection of vorticity is a valid parameter to use to forecast precipitation is not the scope of this paper; but his method does give more measurable vertical motion values in the Rantoul, Illinois, area where verticity values change rapidly over short distances, as when troughs and ridges replace each other rapidly in succession. Such is to be expected in winter and to a certain extent in summer in the northern states; but not in the far southwest in summer where height gradients are weak over vast areas and computed geostrophic wind values light and questionable. The vorticity advection is, therefore, very small nearly all the time, or, in other words, few migratory storms pass over our area to "kick off" shower activity.

Another possible reason for the use of the vorticity parameter is to indicate the regions of convergence and hence an indication of the stability. However, the AROWA publication states that stability is of relatively less importance--the most important parameter being the moisture content of the lower atmosphere in the morning. In the southwestern desert in the summer, the stability is nearly always close to neutral, neglecting the typically marked but shallow early morning inversion. The approach of a synoptic disturbance, therefore, is not an essential contribution to convective activity. No positive vorticity advection, or its implied increase in instability, is needed.

C. Other Methods Have not Proven Reliable

Several moisture-stability parameters were considered which are available from the 1200 Z. raobs, but were discarded for one reason or another. The Showalter-stability index has shown little correlation with thunderstorm occurrence in this area. Even the Sels index is of little use in this area because of the inherent dryness of the air. The definition of a moist layer less than a six degree difference between the wet bult and the air temperature is often not evident on the 1200 Z. raob soundings on days with strong convective activity.

A method of forecasting convective activity developed by Linn-Finnicum (4) for the U. S. Air Force and modified for Las Vegas was considered too subjective to have much value and did not give good results for the 1960 summer season. The Delta-pressure parameter showed the soundings unstable enough 73% of the days for thunderstorm activity and over 90% of the time for buildups and shower activity. The other, and obviously main, criterion was that the average relative humidity from the surface to 700 mb. be above 20% for thunderstorm occurrence. This does not consider the high level thunderstorm activity, which is mostly what occurs in this region from the influx of humidity above 700 mb. (See Figure 2); nor does it give any measure or index of subsidence aloft or the development of existence of dry Superior air aloft, which can effectively limit convection and thunderstorm activity even with sufficient moisture in the lower levels.

D. Moisture is Essential for Convection in the Desert

The infusion of moisture into an already unstable lapse rate is the essential ingredient for the onset of convective activity and the production of showers and thunderstorms in the southwestern desert. This moisture injection usually comes from the Gulf of Mexico and this type of flow is associated with a southeasterly circulation. The stagnation of a ridge to the east of Southern Nevada for a period of time usually produces a trajectory with sufficient moisture to set off thunderstorm activity. Gulf and West Coast hurricanes can sometimes induce a satisfactory moisture trajectory, even from a more southerly direction. Occasionally, enough moisture for convection moves up from the southwest when sub-tropical storms develop over the Los Angeles basin.

E. Evolution of Moisture Parameters that Foretell Convection

With the above points in mind, it seemed that some sort of moisture-stability parameter in existence at the station plotted against some upstream moisture value might result in a useful scatter diagram, which would show if thunderstorms or convective activity could be expected between noon and midnight. The local moisture-stability parameter, which seemed to cover most of the convective situations in this area, is a modification of the Sels index, but continued on up to higher levels. It is most conveniently worked out on a Skew-T diagram. The average mixing ratio for the lowest 100 mb. is computed, using the equal area method. (Figure 1). This mean mixing ratio line is followed up to where it intersects the air temperature curve. At this point, the convective condensation level (CCL) is followed up a moist adiabat and the temperatures of this moist adiabat at 500, 400, 300, and 250 mb. are noted and subtracted from the corresponding temperatures of the sounding at these levels. These values are then added together algebraically and this "Desert Stability Index" or DSI is plotted as ordinate on a scatter diagram.

F. Upstream Relative Humidity

The corresponding abscissa on the scatter diagram is the average value of the relative humidities at 700 and 500 mb. taken from the 1200 Z. raob for the upstream station. "Upstream" is determined by finding the mean wind vector between 700 and 500 mb. from the 4JA or LAS sounding, whichever is being considered, and going upstream from it (Figure 4). Figure 3 is the scatter diagram for the Las Vegas soundings for the summer of 1960. There was fairly good separation between cases which were arbitrarily divided into three categories:

(1) No appreciable convection (includes towering cumulus however),

(2) Cumulonimbus clouds in the vicinity (30 miles or less), and

(3) Thunderstorms within 30 miles.

It is realized that these cateogires are somewhat subjective, but the definition of a "thunderstorm day" is equally so, and many thunderstorms are undoubtedly missed or not heard because it is not possible to keep the state of the atmosphere under constant surveilance.

The cases which did not fit during the summer of 1960 were noted. Most of these showed less convection than forecast, usually because of a dry trough moving through from the west or northwest. To overcome this, an arbitrary correction factor was introduced during the 1961 season. The height difference at both 700 and 500 mb. levels from the preceeding 1200 Z. raob was added or subtracted to the upstream humidity parameter. A certain amount of physical reasoning justified this procedure, as dry cold air in these situations generally showed large height falls. A return flow of warmer air would show height rises and generally a greater probability of convective activity.

G. Results of 1961 Summer Season

Tables 1, 2, and 3 list the actual figures of the two parameters used in the scatter diagram for the months of June, July, and August for both the Nevada Test Site and the Las Vegas airport station. The errors are also noted. Table 4 attempts to explain these errors, and Table 5A summarizes these errors. It is seen that over two-thirds of the errors occurred because the wrong station was chosen to compute the upstream relative humidity.

Many of these errors appear grouped together and may be explained in a general way. For instance, from July 17 through July 19, and also for both stations on July 24, the errors seemed to be caused by variable humidity concenctrations between 4JA or LAS and the upstream stations. The weak gradients and wind flow also made the correct upstream humidity difficult to determine.

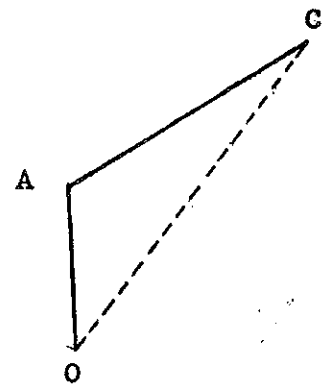
From July 25 through July 27, the errors at LAS seemed to be raob errors. From August 8 through August 11, a group of errors were bunched together as a result of a 500 mb. low offshore southern California. This sub-tropical disturbance sent sporadic impulses northeastward into southern Nevada. The period from August 18 through August 24, was essentially correctly forecast; a weak 500 mb. low existed offshore southern California while a weak high maintained itself over southern Utah. From August 29 through August 31, a 700 mb. low existed offshore San Diego and the humidity appeared to come in below the 700 mb. level, especially on August 29. On the succeeding days, thunderstorms in the vicinity at raob release time may have influenced the wind field so that the incorrect upstream trajectory was indicated. The special situation of August 29 is shown in Figures 5 and 6 and attempts to explain what happened. It also suggests that when computing the DSI from the Skew-T diagram, the 100 mb. layer with the highest average mixing ratio be used, rather than the lowest 100 mb. of the sounding.

Table 5B lists the results in another way and shows 85.7% correct for 4JA and 81.3% for LAS. Subtracting the probability factors due to chance, the corresponding skill scores become 72.1% and 67.4% respectively.

H. Conclusions

As with any objective system, the individual forecaster will have to temper what the system indicates with his own subjective analysis of the situation. A computation of the DSI will, at least, alert a forecaster to any high-level changes which may affect convective activity. The main value of this system, however, is to point out areas of high upstream relative humidity which seem to be the most important factor in convective forecasting.

Since most of the errors in the 1961 summer season were because of the incorrect upstream station, a refinement in this parameter is strongly indicated. Simple streamlined analyses from the previous afternoon raobs for stations surrounding southern Nevada for the 850, 700, and 500 mb. levels, with afternoon and evening thunderstorm activity indicated, show promise of indicating humidity advection and would also make the day's forecast available on completion of the station's raob, which is normally an hour or more earlier than scheduled transmission times. When the raobs from the surrounding areas do become available, all that is necessary is a check for any major changes in the humidity trajectories. These refinements will be tried during the 1962 and succeeding summer seasons.



Example: OA is 700 mb. wind of 180° at 8 knots.
AC is 500 mb. wind of 240° at 15 knots.
Thus: OC is mean vector and measures 220°.
Average Speed is ½OC or 10 knots.

For the station under consideration (either 4JA or LAS), a mean vector is determined from its 700 and 500 mb. winds. This mean vector determines which upstream station's humidity values at 700 and 500 mb. to use. If the speed is between six and ten knots, then these humidities are averaged with those of the base station (4JA or LAS). If the speed is under six knots, then either 4JA or LAS is considered the upstream station.

Mean Vector	Upstream Station
350-020	ELY
020-050	SLC
050-080	GCT
080-110	ABQ
110-160	TUC
160-190	YUM
190-210	SAN
210-240	LAX
240-270	PGU
270-300	FAT or OAK
300-350	WMC

Note: If 4JA is under consideration, the relative humidity at LAS should be considered if the upstream direction is anywhere near 140 degrees.

Figure 4: Instructions for Determining Upstream Relative Humidity.

	4JA					LAS				
Day	DSI	Vector	Upstm R. H.	Fore-Cast	Result	DSI	Vector	Upstm R. H.	Fore-Cast	Result
1	15	1723	10	NC	*				NC	*
2	22	2817	100	NC		18	2707	37	NC	
3	19	3318	100	NC					NC	
4	8½	2710	63	NC					NC	
5	4	2806	12	NC					NC	
6	6	2011	36	NC					NC	
7	1	1505	24	NC					NC	
8	-4½	2012	16	NC					NC	
9	0	1918	0	NC					NC	
10	Missing Data			NC					NC	
11	-½	2107	40	NC					NC	
12	-6	2709	25	NC					NC	
13	½	3405	44	NC					NC	
14	-3	3619	31	NC					NC	
15	0	3618	38	NC					NC	
16	2½	0506	16	NC					NC	
17	14½	1702	45	NC		-10	0904	57	Tstm	
18	9½	2907	33	NC		0	1207	48	Cb	
19	3	2504	20	NC		5	2504	48	NC	
20	5½	0708	14	NC					NC	
21	6½	2603	21	NC					NC	
22	-15½	1909	43	Cb		-8½	1209	21	NC	
23	-2½	1913	52	Cb		-5	1913	45	Cb	
24	4	2706	26	NC	Cb	-6½	1301	27	NC	
25	1	1415	62	Tstm		-18	0402	57	Tstm	
26	-4	2106	10	NC	Cb	-12½	1603	31	Cb	
27	-4½	1920	0	NC					NC	
28	½	2025	22	NC					NC	
29	6	2140	55	NC					NC	
30	17	1817	60	NC		12	1930	10	NC	

* If different from forecast.

NC - No appreciable convection (includes towering cumulus, however)
Cb - Cumulonimbus clouds in vicinity (30 miles or less)
Tstm - Thunderstorm in vicinity (30 miles or less)

Table 1: June 1961 parameters for both 4JA and LAS raob stations which were plotted on a scatter diagram as used in Figure 3. The indicated forecast from the scatter diagram and the resulting errors are also noted.

	4JA					LAS				
Day	DSI	Vector	Upstm R. H.	Fore-Cast	Result	DSI	Vector	Upstm R. H.	Fore-Cast	Result
1	22½	1103	30	NC	*	11½	1712	73	NC	*
2	13	1803	34	NC		-5	1505	53	Tstm	
3	-½	1721	52	Cb		-14½	1714	58	Tstm	
4	-9½	2417	16	NC		-18½	2211	3	NC	
5	-1½	2030	14	NC		-11½	1930	22	NC	
6	1½	2012	29	NC					NC	
7	1	1817	41	NC		3	1823	28	NC	
8	3½	1811	42	NC		8	1709	40	NC	
9	4	2213	29	NC					NC	
10	1	2510	26	NC					NC	
11	5	2905	28	NC					NC	
12	0	2808	32	NC		2	3106	37	NC	
13	-7	2216	44	Cb		-8½	2522	43	Cb	
14	6	2708	8	NC					NC	
15	Missing Data			NC					NC	
16	4½	2015	30	NC		11	1914	30	NC	
17	6	2111	14	NC	Cb	6½	1816	55	NC	Tstm
18	-13½	1705	63	Tstm		-25	1408	34	Cb	Tstm
19	-3	2209	34	NC		-½	1912	49	Cb	NC
20	12½	0000	33	NC					NC	
21	19½	0511	39	NC					NC	
22	15	1606	31	NC					NC	
23	-16	1820	69	Tstm	Cb	-13	1408	65	Tstm	Cb
24	-2	1613	44	Cb		-15	1518	38	Cb	Tstm
25	-8	1909	45	Cb		2	1706	52	Cb	Tstm
26	-5½	1814	32	NC	Cb	5½	1713	45	NC	Tstm
27	6	2404	77	Cb		-16	2011	47	Tstm	
28	4½	1911	52	NC		4	1809	60	NC	
29	11	2014	18	NC		-15½	1711	27	Cb	NC
30	-8	2205	24	NC		-13	1709	70	Tstm	
31	-1½	1606	53	Cb		-11½	1907	64	Tstm	

* If different from forecast.

NC - No appreciable convection (includes towering cumulus)
Cb - Cumulonimbus clouds in vicinity (30 miles or less)
Tstm - Thunderstorm in vicinity (30 miles or less)

Table 2: July 1961 parameters used on scatter diagram, with indicated forecast and resulting errors.

	4JA					LAS				
Day	DSI	Vector	Upstm R. H.	Fore-Cast	Result	DSI	Vector	Upstm R. H.	Fore-Cast	Result
1	4½	1110	73	Cb	*	-12	1308	60	Tstm	*
2	-1½	1009	77	Cb		-3	1210	84	Cb	
3	-1	0908	81	Tstm		1½	0711	87	Tstm	
4	-19	0914	51	Tstm		-11	0915	49	Tstm	
5	-12½	1516	55	Tstm		-15½	1623	56	Tstm	
6	-18½	1813	35	Cb		-19	1909	39	Cb	Tstm
7	-7	Missing Data		NC		-6	1810	41	Cb	
8	-11½	2212	31	Cb	NC	-6	2010	48	Cb	
9	-3	2111	25	NC	Cb	-1	2010	38	NC	Cb
10	3	1813	51	NC	Cb	-13½	1409	58	Tstm	
11	-2½	1716	45	Cb	Tstm	-14	1815	41	Cb	Tstm
12	-16	2014	42	Cb		-15½	1906	55	Tstm	
13	7	2216	17	NC		0	2104	35	NC	
14	2½	1715	52	NC		-2½	1614	63	Tstm	
15	1½	2024	23	NC		-17½	3202	36	NC	
16	-8½	2316	26	NC		-6	2307	23	NC	
17	-7	2114	30	NC		2	2111	33	NC	
18	-10½	1809	56	Tstm		-13½	1308	71	Tstm	
19	-2	1421	78	Tstm		-9	1411	86	Tstm	
20	-11	1809	93	Tstm		-18½	1809	83	Tstm	
21	Missing Data		71	Tstm		-14½	1106	52	Tstm	
22	-17½	1004	60	Tstm		-18	1908	46	Tstm	
23	-9½	2105	50	Tstm		-13	2002	60	Tstm	
24	-9	2507	56	Tstm		-13	2908	58	Tstm	Cb
25	-4½	1913	43	Cb	NC	-7½	2112	34	NC	
26	-6	2315	14	NC					NC	
27	5	2023	21	NC					NC	
28	10	1935	0	NC					NC	
29	1	1931	19	NC	Tstm	6	1927	12	NC	Tstm
30	-2½	2114	7	NC	Cb	-3	2113	0	NC	Tstm
31	-2	2506	46	Cb	NC	-9½	2409	47	Cb	NC

* If different from forecast.

NC - No appreciable convection (includes towering cumulus)
Cb - Cumulonimbus clouds in vicinity (30 miles or less)
Tstm - Thunderstorm in vicinity (30 miles or less)

Table 3: August 1961 parameters used on scatter diagram, with indicated forecast and resulting errors.

6-24	4JA	Incorrect trajectory as southeasterly flow developed due to movement of 500 mb. high to northwest of 4JA by 1600P.
6-26	4JA	Zero amounts of Cb were limited because dry air moved in from the south-southwest, ahead of trough off coast. A minor error.
7-17	4JA and LAS	Unusually large inversion just above 400 mb. did not inhibit convection. Unusual situation as LAS and SAN were the only stations with high afternoon raob humidity.
7-18	LAS	Incorrect trajectory. A dry layer about 50 mb. thick on either side of the 500 mb. level at LAS, YUM, and TUC caused the upstream relative humidity parameter to be too low.
7-19	LAS	Incorrect trajectory as humidity from SAN did not arrive.
7-23	4JA and LAS	Incorrect trajectory as belt of dry air between southern Nevada and TUC, YUM, and LAX limited convection.
7-24	LAS	Incorrect trajectory as YUM would have indicated Tstm. Also raob error as 500 mb. height was too low.
7-25	LAS	Possible raob error as high surface humidity dropped off rapidly.
7-26	4JA and LAS	Possible raob error for LAS, same as 7-25. Also incorrect trajectory as low-level humidity from TUC moved in.
7-29	LAS	Incorrect DSI as rain shower at raob time increased low-level humidity too much.
8-06	LAS	Incorrect trajectory. A simple streamlined plot would have indicated TUC as correct upstream station.
8-08	4JA	Incorrect trajectory as PGU should have been upstream station.
8-09	4JA and LAS	Incorrect trajectory as 500 mb. winds shifted to the southeast after 1800 P., resulting in buildups over Mt. Charleston.
8-10	4JA	Thunderstorms in area at raob time. DSI and average mixing ratio extremely low compared to LAS.
8-11	4JA and LAS	Incorrect trajectories as Tstms in area at raob time influenced wind field. LAX should have been upstream station.
		<u>Note</u>: From 8-08 through 8-11, a low at 500 mb. existed offshore southern California, which was part of a tropical storm which shot sporadic impulses northeastward into southern Nevada.
8-24	LAS	Minor error. An afternoon Tstm probably did occur in the Las Vegas area.

8-25	4JA	Incorrect trajectory, especially at 700 mb. A simple streamlined analysis would have shown dry air moving in from LAX.
8-29	4JA and LAS	Incorrect trajectories. See Figures 5 and 6 for explanation.
8-30	4JA and LAS	Incorrect trajectories because of thunderstorms in the vicinity at raob time.
8-31	4JA and LAS	Same as 8-30 above.

Table 4: Analysis of errors from scatter diagram for both 4JA and LAS 1961.

	DSI Error	Wrong Traj.	Raob Error	Tstms in Vicinity*	Minor Error
4JA	2	10	0	4 @	1
LAS	1	10	3	4 @	1

* at raob time

@ 7 of these 8 cases were also included under "Wrong Traj." because of possible disruption of the wind field.

Table 5A: Analysis of errors by category.

FORECAST FOR LAS

OBSERVED	NC	Cb	Tstm
NC	48	5	0
Cb	0	7	3
Tstm	4	5	19

Percentage correct is 74/91 = 81.3%

Subtracting a factor of 38.9% from both numerator and denominator of the above gives a skill score of 67.4%.

This factory of 38.9% is the number that may be expected to be correct by climatological chance, based on three contingencies.

FORECAST FOR 4JA

OBSERVED	NC	Cb	Tstm
NC	54	3	0
Cb	7	12	1
Tstm	1	1	12

Percentage correct is 78/91 = 85.7%

Subtracting the climatological chance factor of 44.4% gives a skill score 72.1%.

Table 5B: Percentage correct and skill score results.

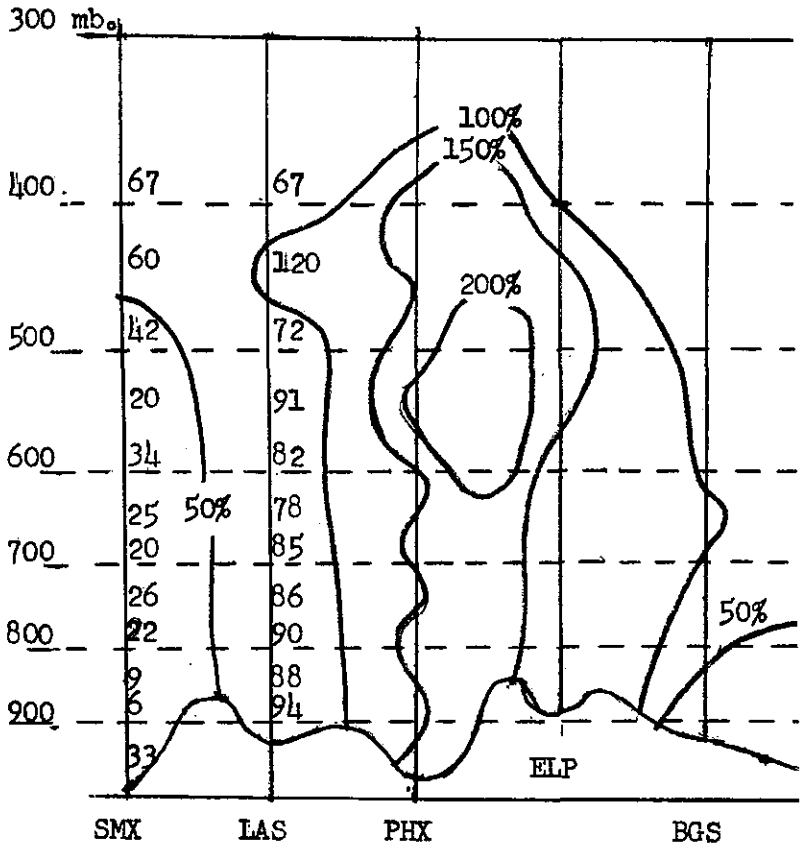
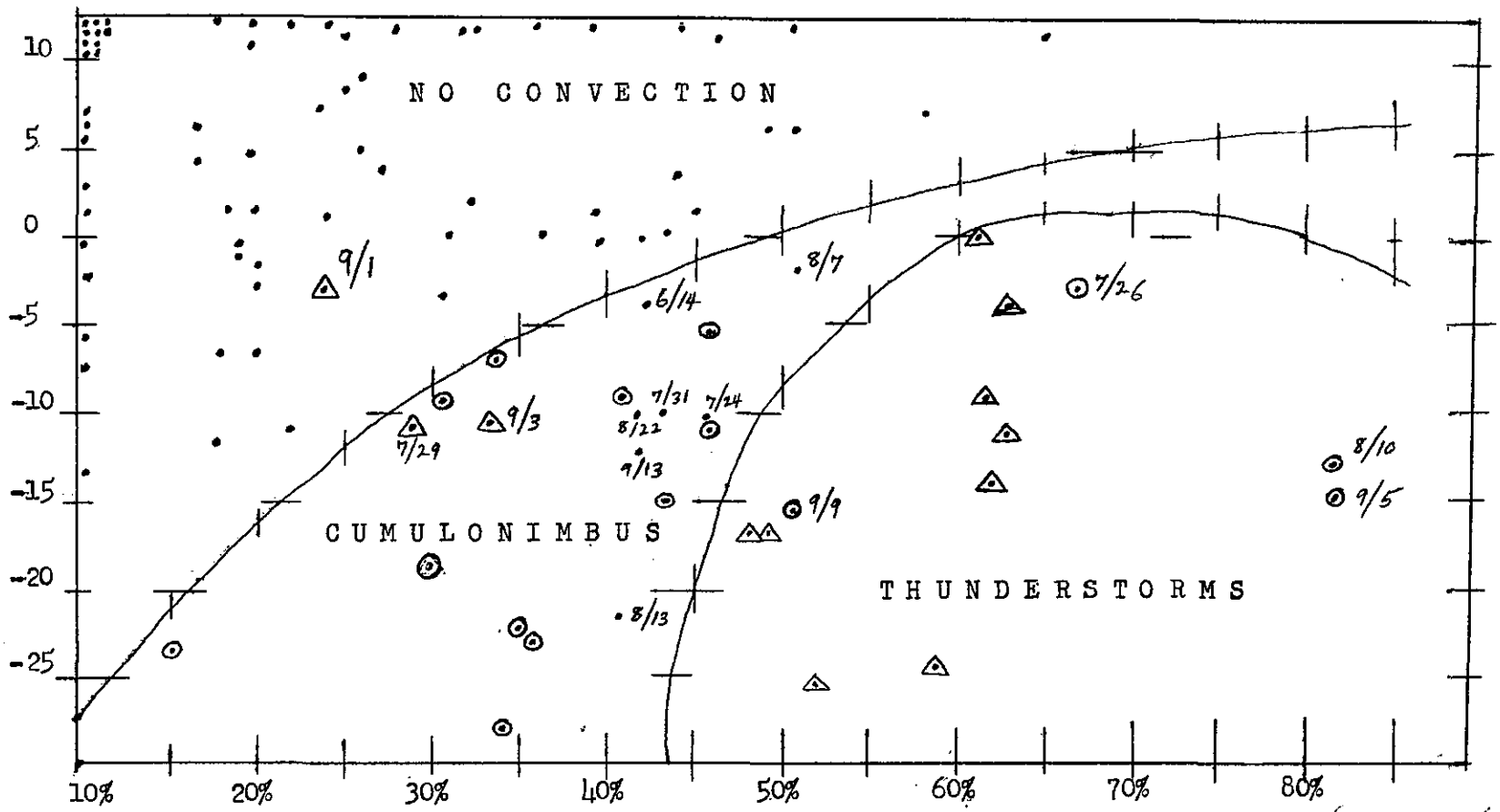


Figure 2. Percentage increase in mean mixing ratio from May to August (gms/kg.). Average is from 1946 to 1955.
(From Cumuloform Shower Forecast Technique for Southern Arizona, Reynolds, R.D., BAMS, November 1957.)



(500-700 mb AVG) 148

Fig. 3. LAS data from 6/1 through 9/15/60. DSI is ordinate; upstream relative humidity is the abscissa. Explanation of errors: 6/14 not quite Cb, just towering Cu; 7/24 heavy Cu only as drier air moved in; 7/26 probably was a tstm.; 7/29 possible raob error at TUC as humidity at 500 mb. was missing; 7/31 dry trough moved inland; 8/7 inversion at 475 mb. limited convection to towering Cu; 8/10 too moist as thick clouds limited convection from surface heating; 8/13 dry air moved in from NW; 8/22 strong duststorm; 9/1 Tstm. was at 4JA, only light showers at LAS; 9/3 incorrect trajectory as low-level humidity moved in from the SE; 9/5 same as 8/10; 9/9 drier air moved in above 500 mb.; 9/13 same as 7/31.

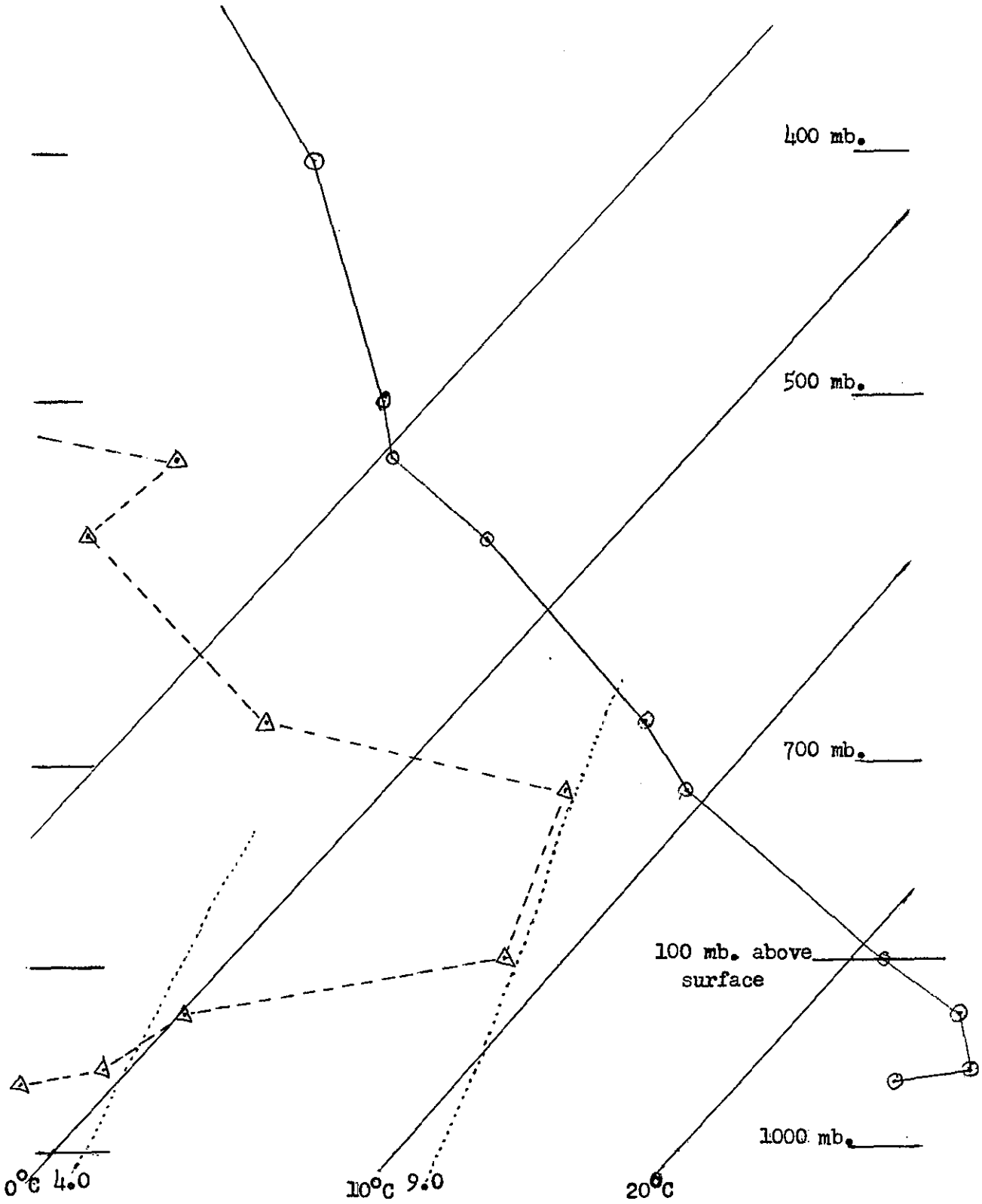


Fig. 5. 1200Z raob from LAS on 8/29/61. Average mixing ratio should have been taken as 8.9 gms. instead of 3.8 gms., using the highest average rather than the average of the lowest 100 mb.

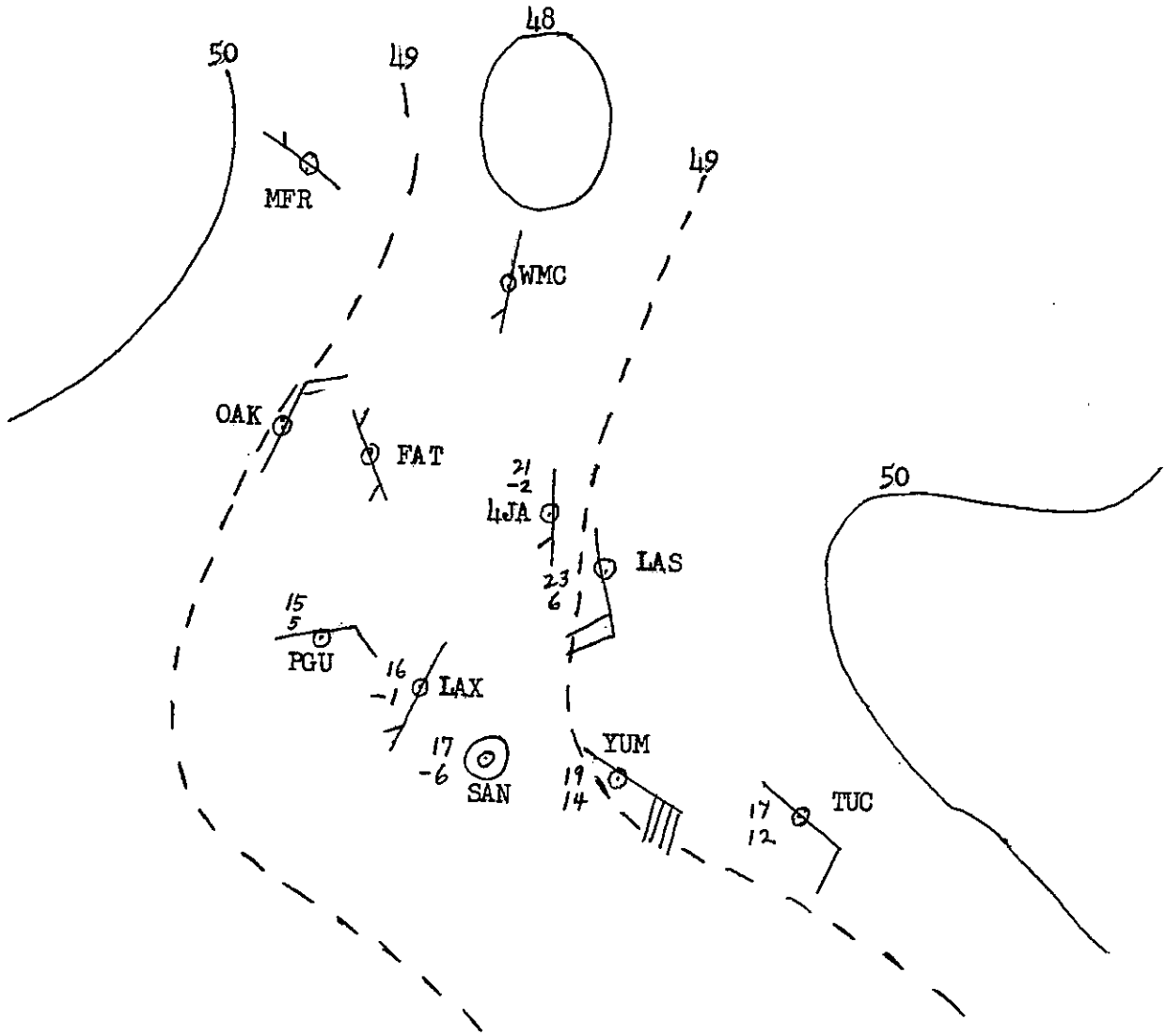


Fig. 6. 850 mb. analysis of conditions at 1200Z on 8/29/61. A rapid influx of humidity into the southern Nevada area is indicated from the Yuma and Tucson reports. The streamlines at 700 and 500 mb. indicated a more south-southwesterly trajectory and drier air, and thus the system did not take into account this rapid jet of moisture moving up from the southeast.