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# MESOSCALE ANALYSIS OF A FLASH FLOOD PRODUCING THUNDERSTORM COMPLEX IN SOUTHERN NEVADA

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## INTRODUCTION

The explosive development of a flash flood producing thunderstorm complex was observed and analyzed using several new tools available to the operational meteorologist in the past few years. Primary among these was the mesoanalysis application program run in the background partition of AFOS. Radar, satellite and lightning detection (ALDS) data were also helpful in determining movement and change in storm intensity. The AMOS Station at Caliente, Nevada, was put to the test and provided some ground truth for the quantitative precipitation estimate (QPE). The storm system not only produced flash flooding in Lincoln County near Caliente, but also went on to generate a wind gust to 59 m.p.h. at McCarran Airport in Las Vegas later that evening. (See Storm Report Figure 1)

## STORM SYNOPSIS

Antecedent conditions during the morning of June 30, 1984, were extremely favorable for the formation of heavy thunderstorms in southern Nevada. Previous convective activity on the 29th and light southerly wind flow had left the airmass moist and potentially unstable as noted on the 12Z Desert Rock sounding (Figure 2). Precipitable water values over one inch and other indices also suggested a high flash flood potential. At 700 mb, a weak deformation zone extended across southern Nevada into southern Utah (Figure 3). In addition, an upper level trough was sweeping across northeast Nevada and northern Utah with an associated surface frontal boundary extending from northeast Utah to southeast Nevada. This frontal boundary had triggered a line of thunderstorms by early afternoon from northeast Utah to southwest Utah near Cedar City (Figure 4).

Several dynamic events on various scales of motion came together over southern Nevada on the evening of June 30th which resulted in the explosive development of this thunderstorm complex. These thunderstorms were clearly different from typical "airmass" thunderstorms which dissipate rapidly after sunset. The important question is, "What dynamic processes allowed this thunderstorm complex to reach severe proportions and last from late afternoon into the early morning hours?" The mesoanalysis program provided the primary explanation in terms of the dynamic and kinematic fields. The 250 mb mesoscale divergence analysis (Figure 5) indicated a very strong area of upper level divergence over southeast Nevada. The obvious separation of flow aloft over southern Nevada was mostly induced by a sharp trough axis over Utah in the northeast quadrant of an upper level deformation zone analyzed over extreme southern Nevada. The strong vertical motion field was further concentrated by low level convergence at the surface (Figure 6) and 850 mb. The 700 mb convergence field was not available at 00Z; however, the 12Z field indicated weak divergence. The surface convergence field (Figure 6) was equally as impressive as the corresponding upper divergence field over southern Nevada. Surface streamline analysis also graphically illustrates the strong inflow into this storm (Figure 7). Another factor attributable to the rapid development of these cells was the converging outflow boundaries produced by neighboring thunderstorms which formed earlier in the afternoon over northwest

Arizona and southwest Utah. Although no clouds can be seen, which is probably due to insufficient low level moisture, Figure 8 shows a new cell developing in the clear area surrounded by other thunderstorms. Satellite quantitative precipitation (QPES) estimates from Synoptic Analysis Branch at 0215Z (Figure 9) noted merging cells with spectacular growth. The .75 inch per hour QPE was far short of the 1.28 inches actually received at Caliente (P38) in the one hour period ending at 03Z. Strong surface heating also played a role in the late development and potential energy of these thunderstorms. Satellite pictures showed relatively clear skies over southern Nevada early in the day which allowed strong surface heating to occur. This was verified by the 850 mb temperature field at 00Z which indicated a 30 degree C temperature at DRA (Figure 11). In the latter stages of this storm (Figures 11, 12), a wind gust to 59 m.p.h. was recorded at the McCarran Airport with unofficial gusts to 75 m.p.h. over Lake Mead. These strong gusts were primarily due to the large temperature difference between the potential wet bulb temperature and the warm ambient temperature outside the precipitation shaft. (See Fawbush and Miller, Pettersen Volume II, page 167). Lightning detection ALDS (Figure 13) and the Las Vegas ARAP charts were useful in detecting movement of the severe thunderstorms into the Las Vegas area, along with the change in intensity. Note, however, that the ALDS direction finder in the Las Vegas area failed during the height of the activity, and also recall that the ALDS data strike counts were incorrectly reduced to 1/3 of actual values during this period.

## SUMMARY

The interaction of several dynamic and kinematic features at various scales of motion were involved in the formation of this thunderstorm complex. Several new programs and techniques are available to the meteorologist to detect and analyze potentially severe and flash flood producing thunderstorms. Primary among these tools are the AFOS mesoanalysis application program, especially the divergence and streamline fields. Satellite, radar, and ALDS can provide further information on the changes in movement and intensity of the existing storm. The surface convergence field is often times more informative than the 700 mb convergence field when dealing with triggering mechanisms associated with fronts and thunderstorm outflow boundaries. This points out the importance of determining the level in the atmosphere which has the greatest potential for producing convergence and upward vertical motion. Analyzed fields of convergence and streamlines can then be used to locate and assess the convective trigger.

RWSLDBLVS
WOUS99 KLAS 031500
STORM REPORT
NATIONAL WEATHER SERVICE LAS VEGAS, NV
10:14 AM PDT JUL 02 1984

THE STORM COMPLEX THAT MOVED ACROSS SOUTHERN NEVADA SATURDAY NIGHT...
JUNE 30, 1984 ...CAUSED THE FOLLOWING DAMAGES.

IN CLARK COUNTY...
1. GENERAL TREES WERE UPROOTED AND POWER OUTAGES TO ABOUT 11 THOUSAND INDIVIDUALS. WINDS REACHED 59 MPH AT MCCARRAN AIRPORT AT 1019 PM PDT.
2. LAKE MEAD...LAS VEGAS WASH MARINA HAD MINOR DAMAGES TO THEIR DOCK FACILITIES. WINDS ESTIMATED AT 60 MPH.
CALLVILLE MARINA REPORTED 8 TELEPHONE POLLS UPROOTED AND ESTIMATED WINDS OVER 75 MPH.
3. ONE HOUSEBOAT SANK IN LAS VEGAS BOAT HARBOUR.
**4. PRECIPITATION RANGED FROM .10 TO .50 OF AN INCH IN CLARK COUNTY. MINOR STREET FLOODING IN OVERTON.**
**IN LINCOLN COUNTY**
1. WINDS ESTIMATED AT 40 MPH IN THE CALIENTE AND PIOCHE AREAS.
2. SEVERAL HIGHWAYS CLOSED DUE TO HIGH WATER.
3. POWER OUTAGES THROUGHOUT LINCOLN COUNTY.
4. PRECIP ESTIMATES RANGED FROM 1.5 TO 3.0 INCHES IN THE CALIENTE/PIOCHE/EAGLE VALLEY AREAS.
5. NO MAJOR DAMAGES OR FATALITIES DURING THIS STORM.
TAYLOR/1730Z

FIGURE 1.

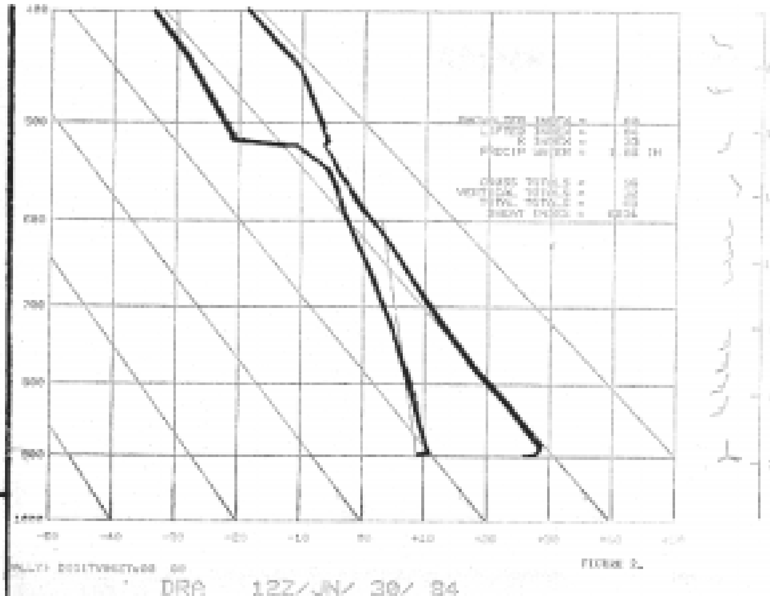


FIGURE 2.

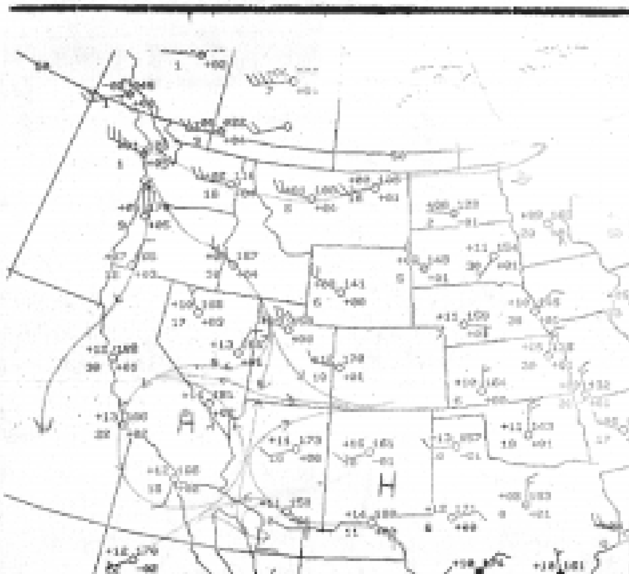

FIGURE 3. 700 mb plot, 12Z, June 30, 1984.


FIGURE 4. Combined enhanced IR and visible satellite picture, 2045Z, June 30, 1984.

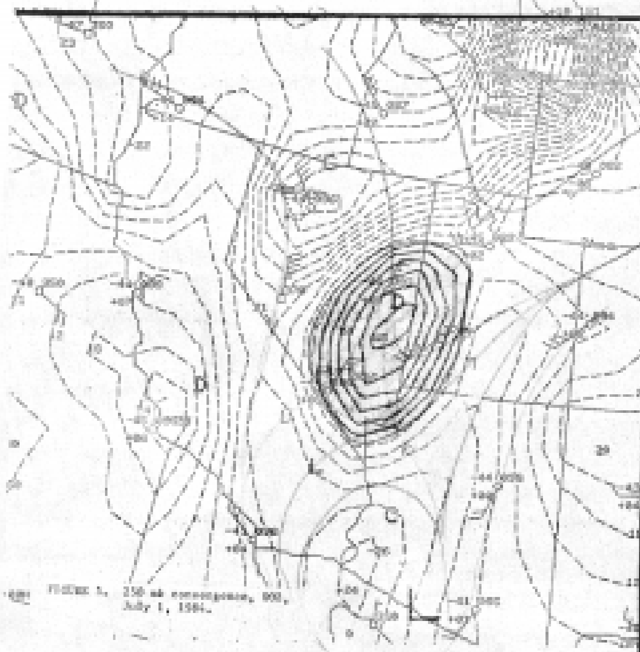

FIGURE 5. 250 mb convergence, 00Z, July 1, 1984.

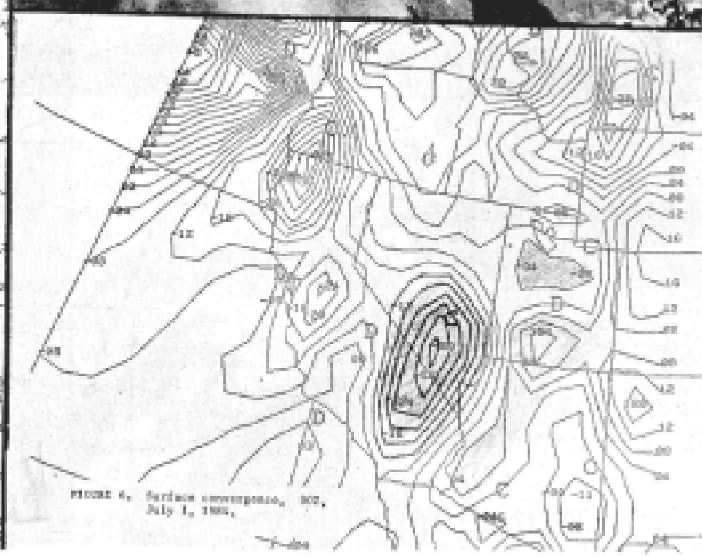

FIGURE 6. Surface convergence, 00Z, July 1, 1984.

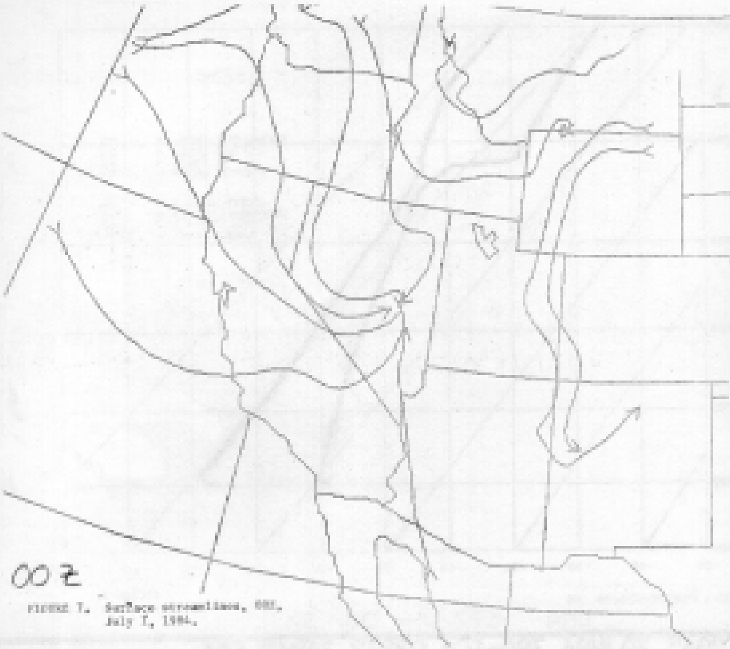


FIGURE 7. Surface streamlines, 00Z, July 1, 1984.

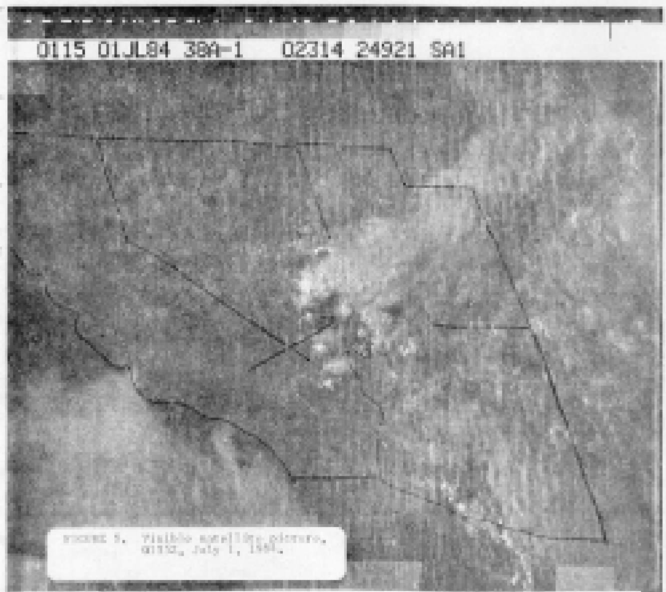


FIGURE 8. Visible satellite picture, 0115Z, July 1, 1984.

NFDSPENV
WOUS88 KWBC 0?0?0?

SATELLITE PRECIPITATION ESTIMATES JULY 1 1984-0245Z
PREPARED BY SYNOPTIC ANALYSIS BRANCH/NESDIS TEL. 763-8444

SATELLITE OPP IS THE LARGEST RAINFALL ESTIMATED IN A PARTICULAR AREA USING THE SCOFIELD/OLIVER TECHNIQUE FOR CONVECTION, AND THE SCOFIELD WINTER STORM TECHNIQUE FOR EXTRATROPICAL CYCLONES. OROGRAPHIC EFFECTS NOT TAKEN INTO ACCNT.
SK

DATE/TIME OF LATEST DATA USED: 01/0215Z

| LOCATION | HR RATE | TOTALS | TIME | REMARKS |
|---|---|---|---|---|
| UTAH COUNTIES | | | | |
| EXT SE MILLARD | 0.60" | | 0115-0215Z | |
| IRON | 0.75 | .75"-1.0" | 0015-0215Z | |
| N SEVIER/S SANPETE | 0.60" | | 0115-0215Z | |
| NV COUNTY | | | | |
| SE LINCOLN | 0.75" | | 0115-0215 | MERGER AND SPECTACULAR GROWTH PAST HR |

FIGURE 9.

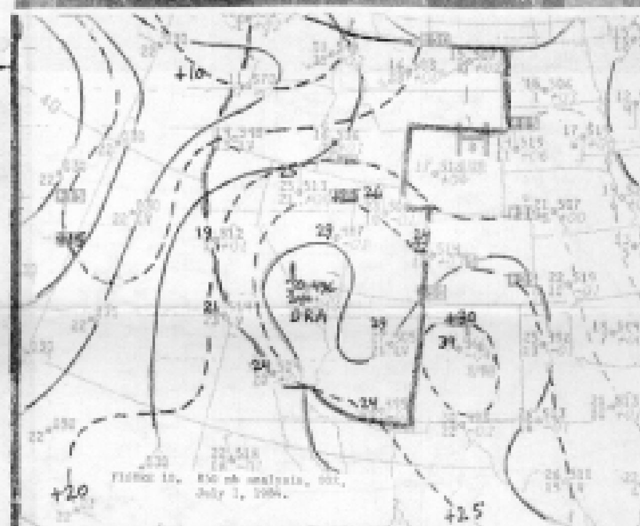


FIGURE 10. 500 mb analysis, 00Z, July 1, 1984.

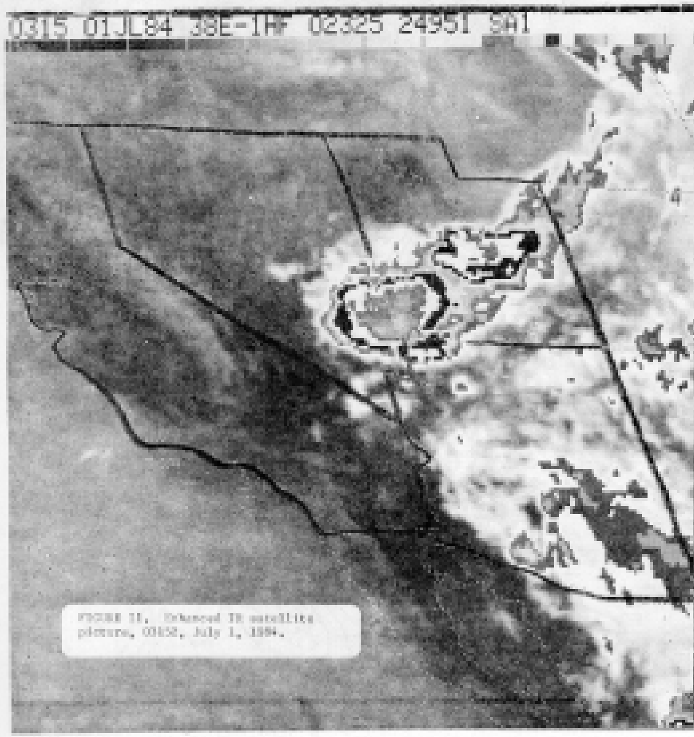


FIGURE 11. Enhanced IR satellite picture, 0315Z, July 1, 1984.


FIGURE 12. Enhanced IR satellite picture, 0615Z, July 1, 1984.

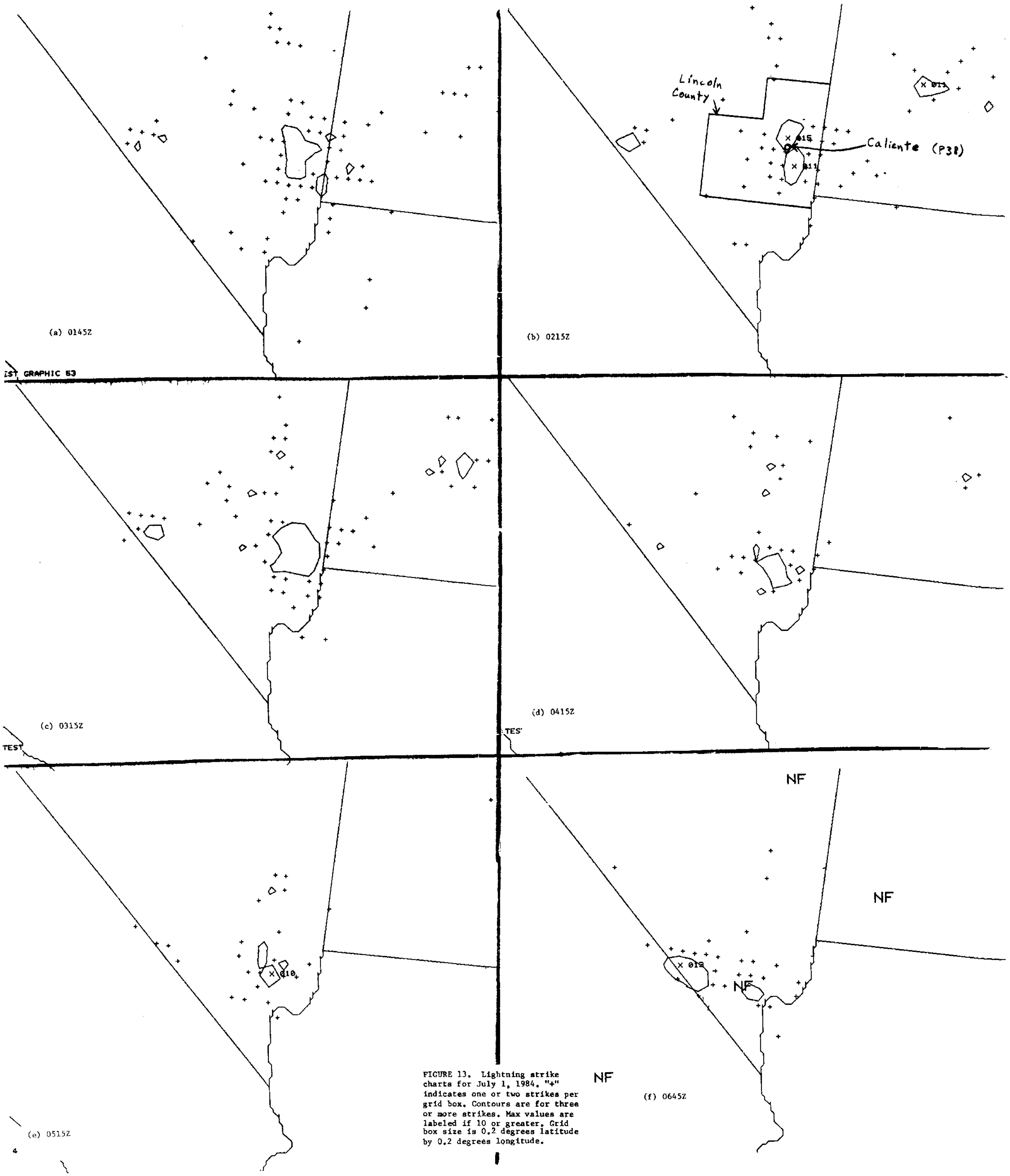


FIGURE 13. Lightning strike charts for July 1, 1984. "+" indicates one or two strikes per grid box. Contours are for three or more strikes. Max values are labeled if 10 or greater. Grid box size is 0.2 degrees latitude by 0.2 degrees longitude.