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AN EXAMPLE OF A MADDOX TYPE I FLASH FLOOD EVENT IN THE GREAT BASIN

Ed Carle, WSFO Salt Lake City

A good example of a Maddox Type I flash flood event (Maddox et al, 1980) occurred on 7-8 June, 1987. This type of event is particularly important to the forecaster in the Great Basin as it is probably the primary producer of flash floods in that region. The purpose of this paper is to reinforce the forecaster's familiarity with the Maddox Type I flash flood event so he or she can readily recognize the conditions that precede such an event.

It is important that the forecaster recognize that NMC analyses frequently do not depict the weak meteorological characteristics of the Type I pattern very well. This is especially true for weak upper level short-wave troughs. For this reason, it is important that the forecaster either accomplish reanalyses of the NMC analyses or perform his own analyses from the plotted data. An especially quick way to identify weak upper level troughs is to perform hand-drawn streamline analyses at key pressure surfaces such as the 700, 500, and 250 mb levels.

The Maddox Type I western flash flood event consists of the following two main characteristics:

1. A weak 500 mb short-wave trough moving northward up the west side of a long-wave ridge.

2. A very moist and unstable airmass through a deep layer of the troposphere ahead of the short-wave trough.

On June 7, 1987 at 00Z, the 500 mb short-wave trough extended from west central Nevada, east southeastward through southwest Utah to south central New Mexico, while the long-wave ridge was oriented generally northwest to southeast and was centered over the central U.S. (Figures 1 and 2). Note that the hand-drawn streamline analysis makes it a lot easier to identify the system than does the NMC analysis. The short-wave trough kicked off a line of thunderstorms which satellite imagery at 07/0145Z showed to extend from northeast Nevada through extreme northern Utah into southeast Wyoming (Figure 3).

Twenty-four hours later at 08/00Z, the trough had intensified and developed an even stronger line of thunderstorms. Satellite imagery at 07/2345Z showed an impressive line of thunderstorms extending from north central Idaho east southeastward into southeast Wyoming (Figure 4).

Table 1 lists the mean conditions associated with Type I events. Table 2 lists the actual conditions from the June 7/00Z SLC RAOB. Note how close the data from the SLC RAOB is to the mean values listed by Maddox.

Maddox also listed the mean values for the K-Index (KI), lifted index (LI), and precipitable water (PW) for the surface to the 500 mb layer, and the percent of normal of the average monthly climatological PW value. Table 3 lists these values and the actual values at SLC on 07/00Z. Again, note how closely the SLC data matches the data compiled by Maddox.

The models initially did not have a real good handle on the short-wave trough. At 06/12Z, the AVN was best as its 12-hour forecast did indicate at least a weak vorticity lobe moving into northern Utah at 07/00Z (Figure 5). By June 7/00Z, however, all the models were doing a little better in analyzing and forecasting the short-wave trough. The AVN was doing reasonably well. Its 07/00Z analysis and 12 and 24-hour forecast height and vorticity fields were quite accurate (Figure 6).

An excellent depiction of the meteorological characteristics of the Maddox Type I event is readily apparent from the 700 mb height and mean RH fields from the RGL initial (07/12Z), and 12 and 24-hour forecasts. Note the weak trough moving north up the west side of the ridge with significant moisture (hatched 70%) sandwiched between the trough and ridge axis (Figure 7). These three RGL panels looked pretty good. Unfortunately, the ERL and AVN runs can't be compared with the RGL panels as NMC does not provide the all-important 700 mb data except for the AVN after 12 hours.

Conditions in northern Utah did not reach severe proportions as the line of thunderstorms moved through on the afternoon and evening of June 6; at least, there were no reports of severe weather. The heaviest reported precipitation amount was .30 in 5 minutes at Kearns (west side of the Salt Lake Valley) and a total of .59 in 20 minutes. A report of pea-sized hail was received from West Valley (also on the west side of the Salt Lake Valley). The strongest wind recorded was 32 knots and occurred at the Salt Lake International Airport. A report of 20-30 mph winds was received from a flash flood spotter in Tooele (30 miles southwest of Salt Lake City).

The Hill Air Force Base AN/FPQ-21 radar (Air Force equivalent to the NWS WSR-74C) detected the maximum tops of the thunderstorms at 51,000 feet. The associated movement of these thunderstorms was 190°/15 kts. The narrowness of the line of thunderstorms through northern Utah and their relatively moderate speed were probably just enough to preclude any flash flooding in Utah.

Conditions were severe, however, the next afternoon and evening when the line of thunderstorms re-developed, stretching from near the southeast corner of Washington to eastern Wyoming (Figure 4). During that time frame, the Boise WSFO issued a flash flood watch and the Cheyenne WSFO issued a severe thunderstorm warning, tornado warning, and a flash flood warning.

The bottom line for the forecaster is to be able to identify the development of a significant weather event early, so he or she can issue timely watches and warnings. To accomplish this, the forecaster must: 1) be knowledgeable of the meteorological characteristics of the Maddox Type I flash flood event, and 2) reanalyze the NMC analyses or perform his/her own analyses.

Reference:

Maddox, R.A., L.R. Hoxit, and F. Conova, 1980: Meteorological Characteristics of Heavy Precipitation and Flash Flood Events over the Western United States. NOAA Technical Memorandum ERL APCL-23.

TABLE 1

MEAN CONDITIONS ASSOCIATED WITH TYPE I EVENTS

LEVEL		T	Td	Wd	Ws
SFC 1012 mb	Mean	78 (°F)	55 (°F)	115°	10 (kts)
4	Std.Dev.	12	6	81	6
			T-Td		
700 mb		9 (°C)	6 (°C)	180	14
		3	4	60	7
500 mb		-10	5	200	20
		3	4	23	8
300 mb		-36	8	200	31
		4	3	32	16
200 mb		-55	--	215	39
		3	--	36	18

TABLE 2

ACTUAL CONDITIONS FROM THE SALT LAKE RAOB ON JUNE 7/00Z

LEVEL	T	TD	WD	WS
SFC	77(F)	47(F)	170	14(KTS)
700	7(C)	4(C)	170	16
500	-10	1	150	11
300	-37	5	205	10
200	-61	--	205	36

TABLE 3

	MADDOX MEAN VALUES	ACTUAL VALUES AT SLC JUNE 7/00Z
K INDEX	40	35
LI	-4	0
PW	.94	.97
PCT OF NML PW	184 PCT	202 PCT

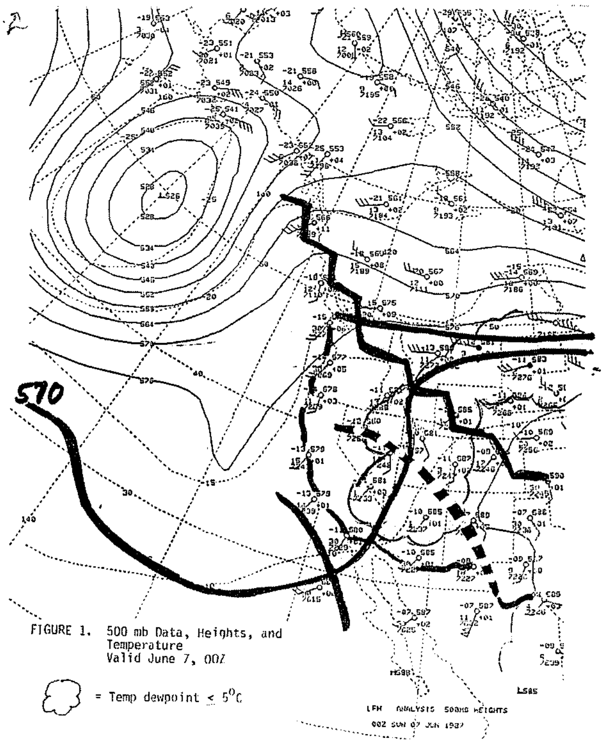

FIGURE 1. 500 mb Data, Heights, and Temperature
Valid June 7, 00Z

= Temp dewpoint ≤ 5°C

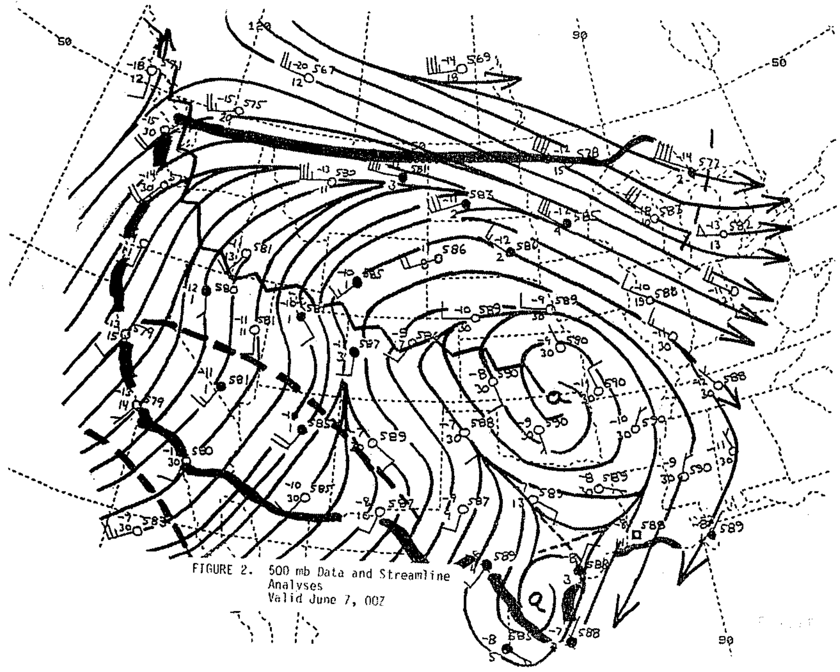

FIGURE 2. 500 mb Data and Streamline Analyses
Valid June 7, 00Z

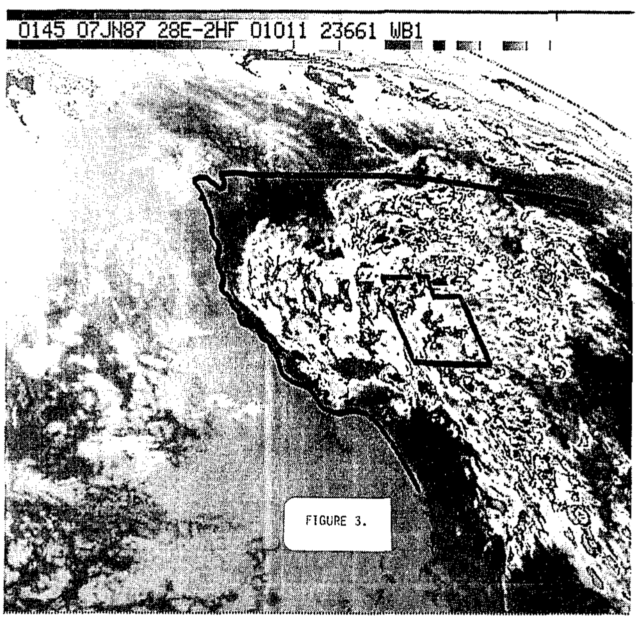

FIGURE 3.

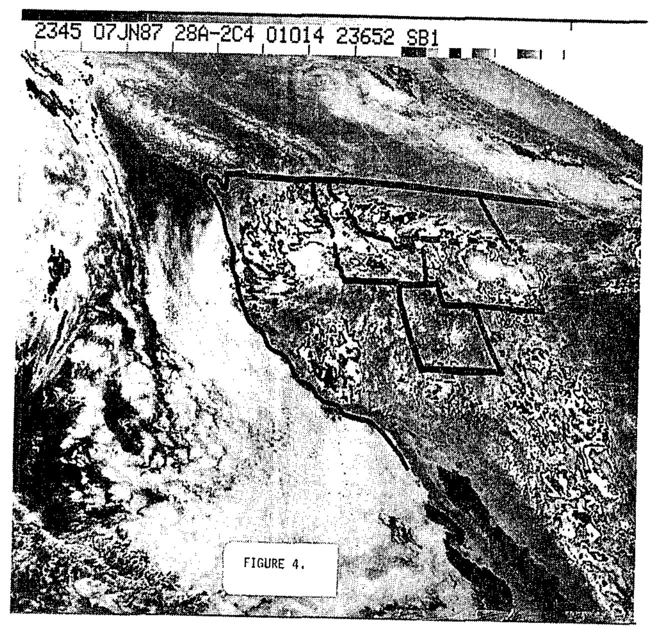

FIGURE 4.

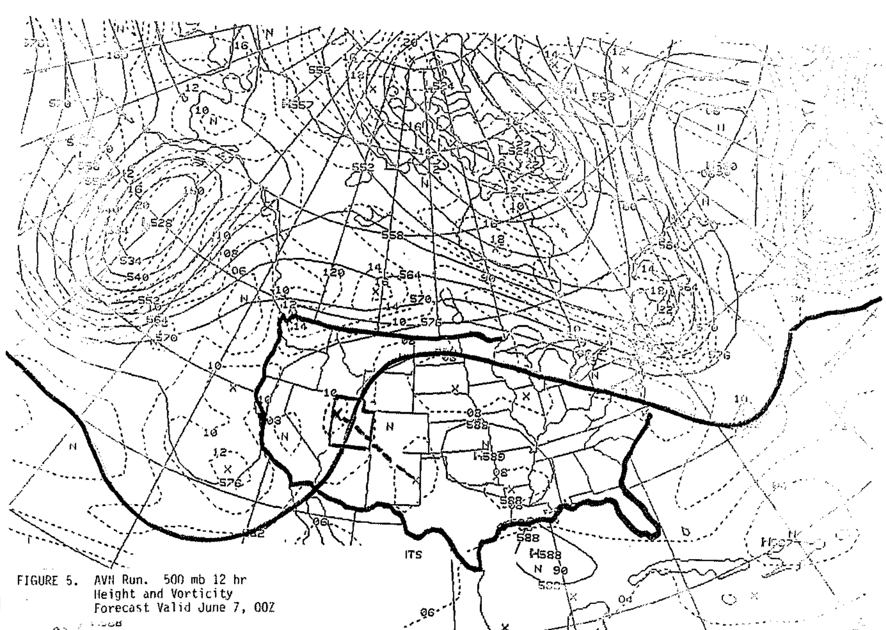

FIGURE 5. AVN Run. 500 mb 12 hr Height and Vorticity Forecast Valid June 7, 00Z

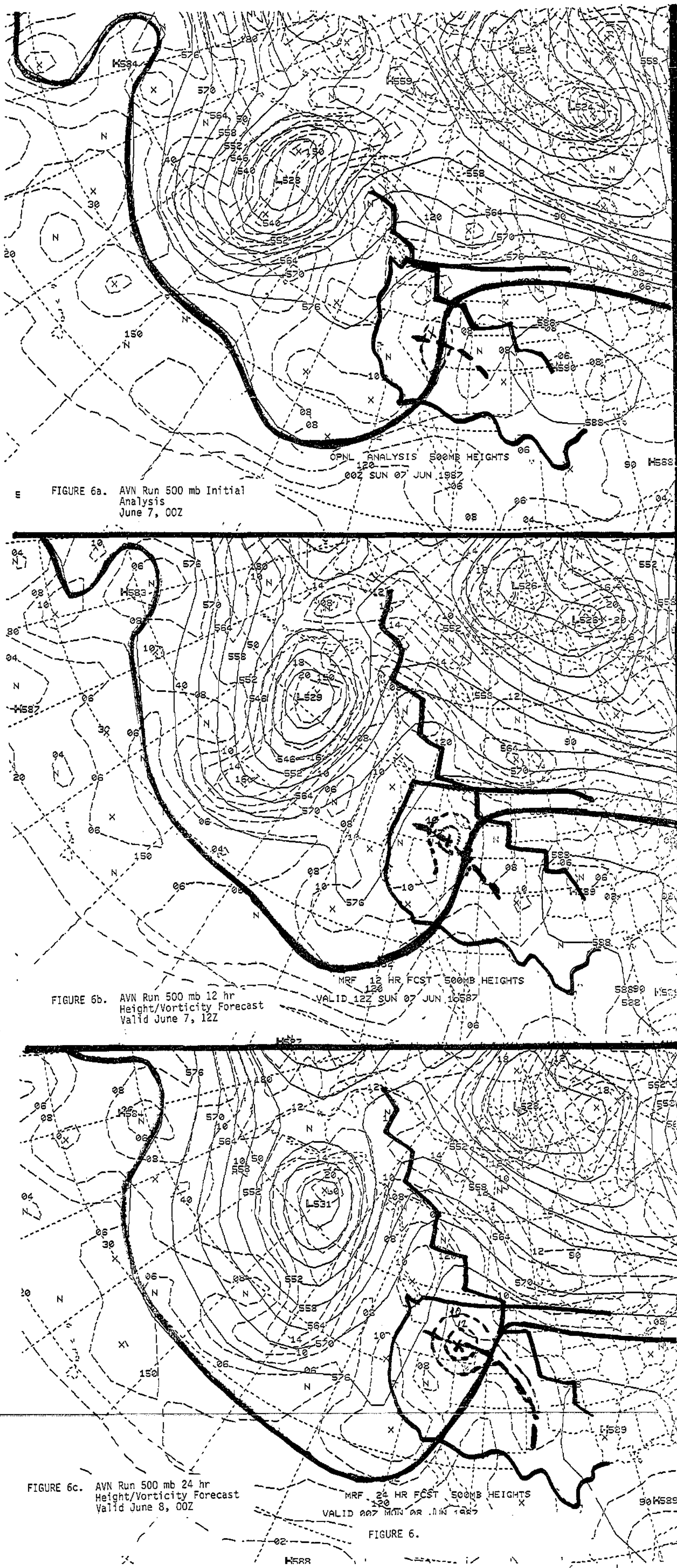

FIGURE 6a. AVN Run 500 mb Initial Analysis
June 7, 00Z

FIGURE 6b. AVN Run 500 mb 12 hr Height/Vorticity Forecast
Valid June 7, 12Z

FIGURE 6c. AVN Run 500 mb 24 hr Height/Vorticity Forecast
Valid June 8, 00Z

FIGURE 6.

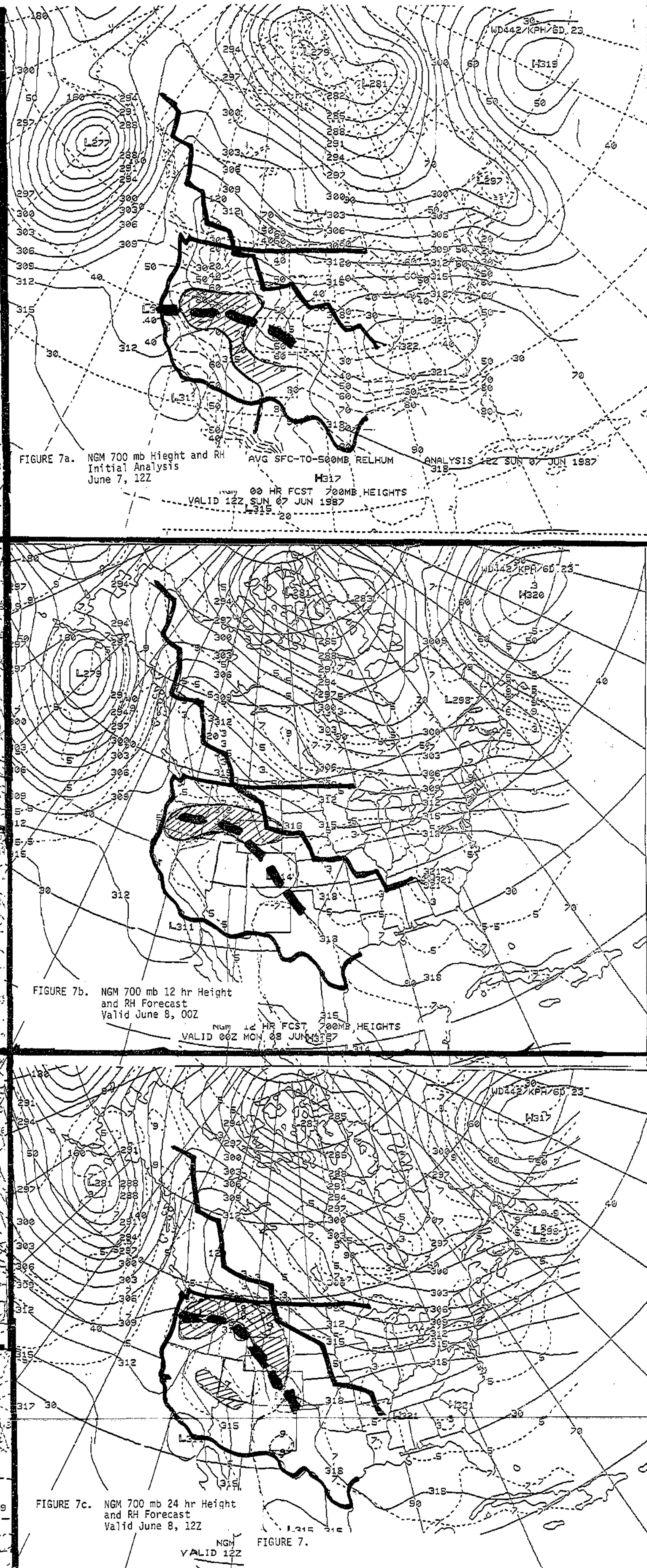

FIGURE 7a. NGM 700 mb Hieght and RH Initial Analysis
June 7, 12Z

FIGURE 7b. NGM 700 mb 12 hr Height and RH Forecast
Valid June 8, 00Z

FIGURE 7c. NGM 700 mb 24 hr Height and RH Forecast
Valid June 8, 12Z

FIGURE 7.