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THE MILWAUKEE FLASH FLOOD OF 6 AUGUST 1986

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INTRODUCTION

Nearly stationary thunderstorms unleashed a once-in-a-100 year (or greater) flood over the urban area of Milwaukee, Wisconsin on 6 August 1986. Six inches of rain fell in 2 1/2 hours with over 1 inch falling in only five minutes. The torrential rain falling mainly on pavement and over a small area caused a disastrous flash flood. The flash flood caused two deaths and 30 million dollars damage. This technical attachment will focus on two main concerns: thunderstorm development and lack of movement of the storms.

SYNOPTIC SITUATION

At 12Z Wednesday, 6 August, a 500 mb low was in eastern Iowa near Cedar Rapids (see Fig. 1), with an upper level vorticity maximum situated over west-central Illinois. The 500 mb vorticity maximum was forecast to move to northwestern Indiana by 00Z (see Fig. 2), about an 18 knot movement.

At the surface (Fig. 3) at 12Z a weak low was located in southeastern Iowa with a warm front extending east, while high pressure was located over Ontario.

These features had spread light rain and a few thunderstorms across southern Wisconsin during the night and into the morning hours.

The model QPF charts for Wednesday from the 00Z runs were not readily available for use in this technical attachment, but the 00-12 hr charts from the 12Z run for the period ending at 00Z 7 August are shown in Fig. 4. The ERL model gave only a few hundredths for MKE, while the RGL was a bit better with .46" near MKE. Certainly the NWP QPF's weren't in the right ball park.

East-northeast winds north of the front had intensified to 17 knots at MKE by 16Z. This increase in the surface wind field signalled the potential for increasing low level convergence along and north of the front. Between 16 and 17Z a rainfall observer reported 4 inches of rain at Burlington, Wisconsin, about 20 miles southwest of MKE. This was an omen of things to come.

At 17Z northeast winds increased further at MKE gusting to 21 knots. The combination of the blocking high to the north and the approaching low to the south (Fig. 5) evidently established a strong low level gradient across southeast Wisconsin. The middle and upper level system was closing off at this time, thus accounting for the slow movement. A further enhancement of the low level gradient occurred, apparently leading to intense convergence along and north of the warm front.

Strong low level convergence maintained continued generation of overrunning thunderstorms. Heavy rain spread slowly north and northwest around the pivot point of the closed upper system. Torrential rain fell in the MKE area between 17Z and 19Z as the storms stalled. A total of 5.24 inches of rain fell in this two hour period. The rain area was small and narrow as indicated in Fig. 6. At 19Z the warm front passed to the north of MKE and the heavy rain ended.

DISCUSSION

Radar data gave no hint of a flash flood in the making. Radar sites from Madison, Wisconsin, Neenah, Wisconsin, and Marseilles, Illinois all indicated rainfall rates of VIP 2 and 3 and maximum tops no higher than 25,000 feet. This was certainly nothing that would raise concern. The low VIP level was probably due to the fact that MKE was nearly outside the 75 mile hydrologic range of the radar.

Satellite imagery suggested nothing out of the ordinary as the thunderstorm tops were warm. But this flash flood did fit a known flash flood pattern, called SHARS (Subtle HeAvy Rainfall Signatures) and discussed by Spayd and Scofield (1983). One characteristic of this type of flash flood event is that it occurs with a synoptic scale cyclonic circulation at 500 mb. The circulation is either quasi-stationary or very slow moving in an east or northeast direction.

We suggest that the thunderstorms that formed over MKE stalled because of a deformation zone (studied by Parke, 1986) which formed north of MKE in conjunction with the upper low southwest of MKE.

Fig. 7 shows what we think the streamline analysis of the upper level flow pattern would look like if holding the weather system stationary. Note the position of the deformation zone just north of the city. Storms that formed near the surface front tried to move northward, but were not able to penetrate any further than the deformation zone axis. Therefore, new storms that formed "ran into" previous storms on the axis, effectively squeezing much of the available moisture out of the stalled storms. This scenario was graphically illustrated on a time lapse radar sequence furnished by a local television station.

It was noted on satellite imagery that the thick cloud edge north of the low remained nearly stationary over eastern Wisconsin even though there were strong easterly winds present (Fig. 8). This illustrates that clouds follow the trajectory of the air, not the streamlines. If the wind speed around a circulation center is of the same magnitude as the eastward propagation velocity of the feature itself, the trajectories differ markedly from the streamlines. The western limit of the flow will move eastward very slowly and clouds caught in the backside of the circulation will create an almost stationary east-west line. This is possibly why the thunderstorms which formed over Milwaukee exhibited so little movement.

SUMMARY

This flash flood event occurred as thunderstorms producing torrential rain stalled over Milwaukee. Our contention is that the lack of movement of the storms may have been due to the position of an adjacent upper level deformation zone and the slow translational speed of the upper system. The fact that the rain fell in an area with a lot of pavement certainly contributed to the severity of the flash flood.

ACKNOWLEDGEMENTS

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REFERENCES

Spayd, L.E., Jr., and R.A. Scofield, 1983: Operationally detecting flash flood producing thunderstorms which have subtle heavy rainfall signatures in GOES imagery. Preprints, Fifth Conf. on Hydrometeorology (Tulsa, OK), Amer. Meteor. Soc., 190-197.

Parke, P.S., 1986: Synoptic Analysis, Chap. 2: Satellite Imagery Interpretation for Forecasters. Weather Service Forecasting Handbook No. 6, 1986. National Weather Service Headquarters, Office of Meteorology.

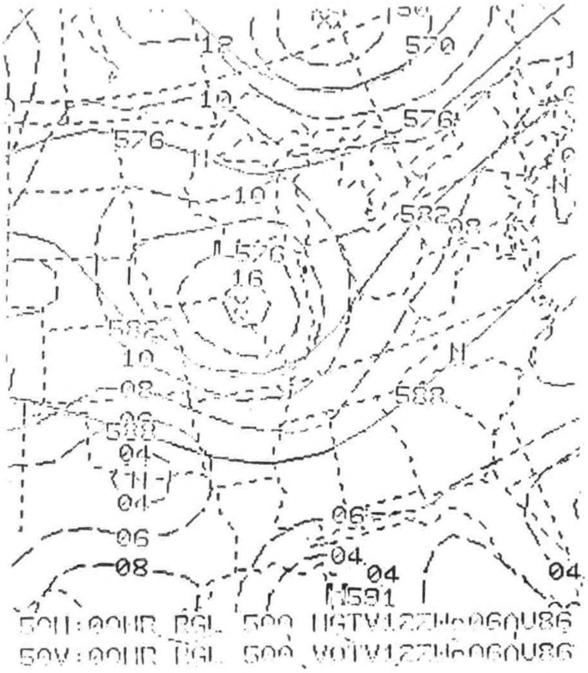

Fig. 1.

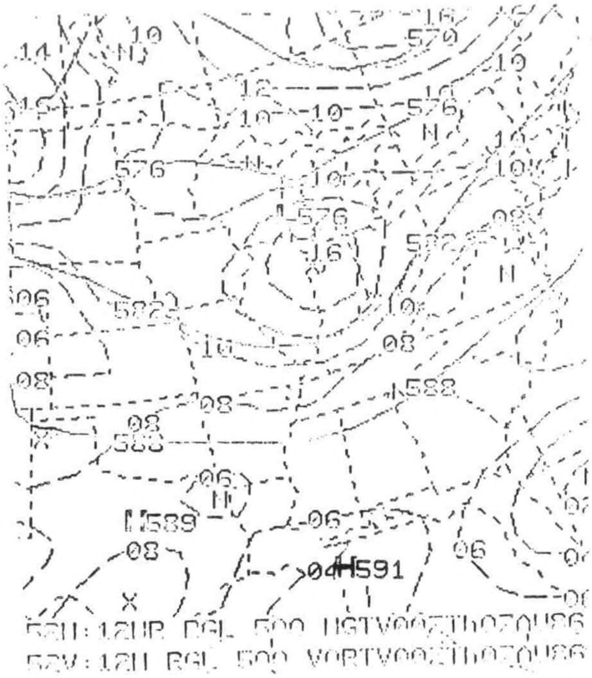

Fig. 2.

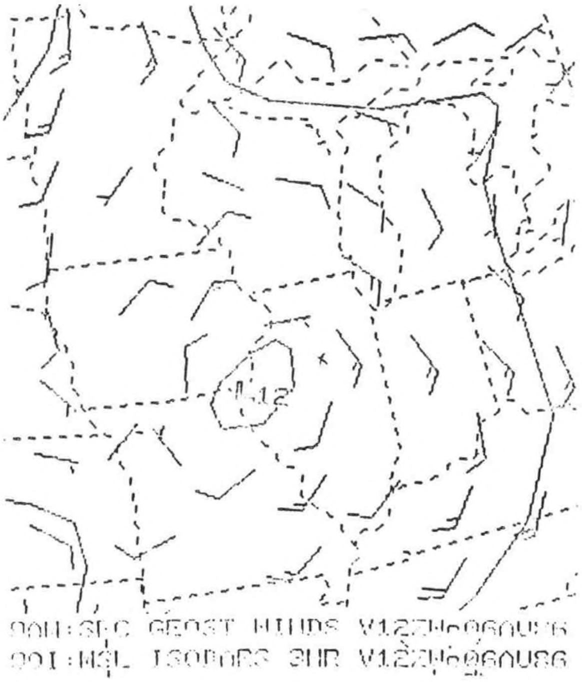

Fig. 3.

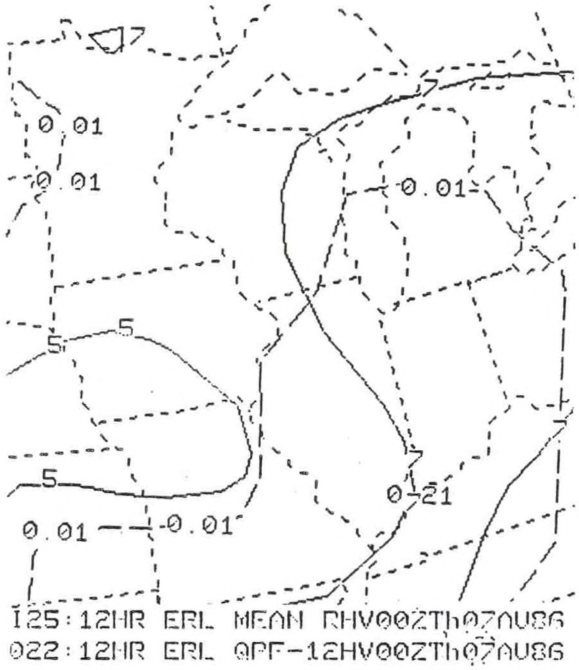

Fig. 4a.

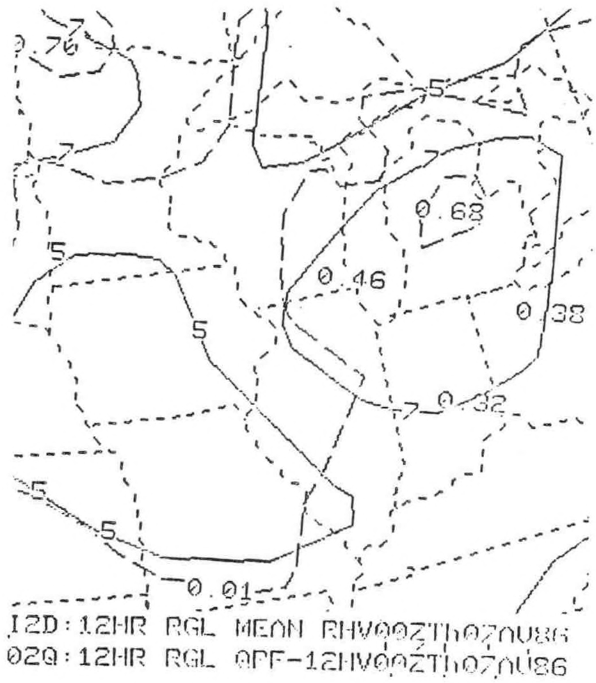

Fig. 4b.

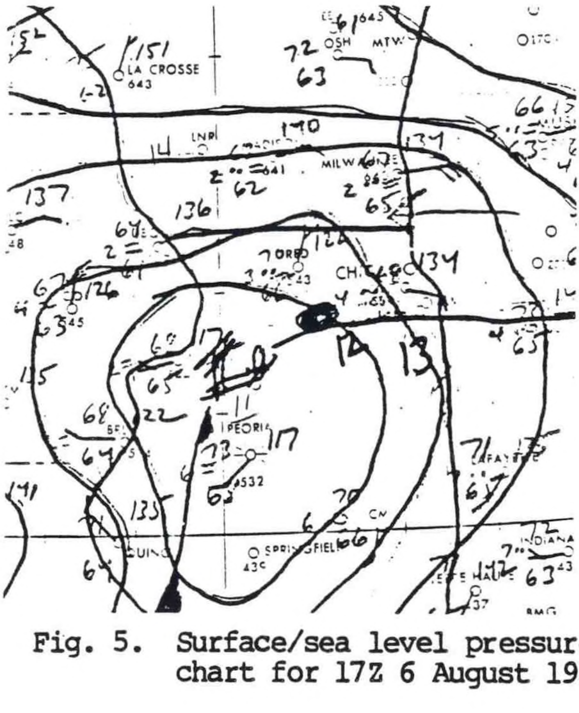

Fig. 5. Surface/sea level pressure chart for 17Z 6 August 1986.

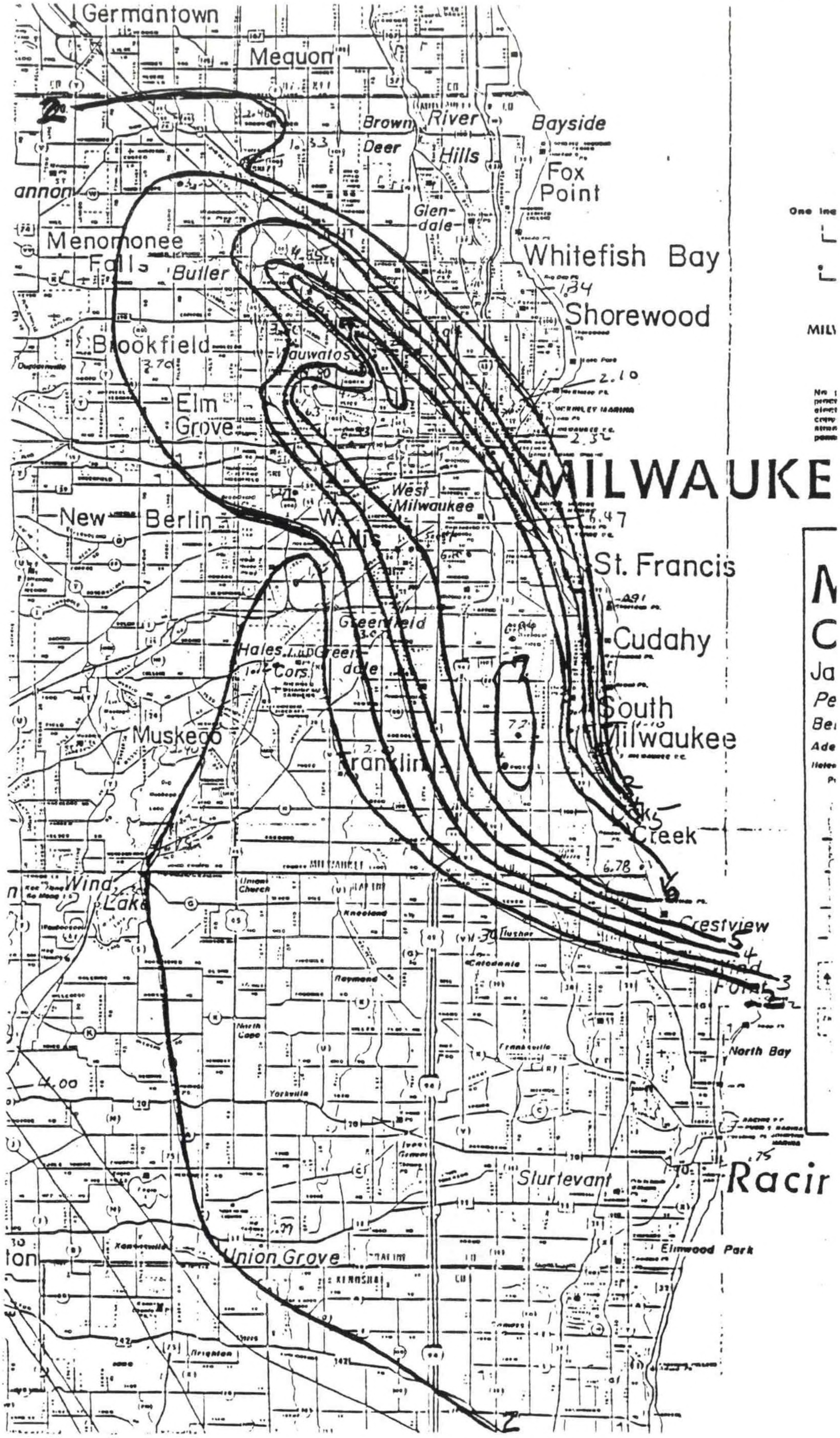

Fig. 6. Storm total rainfall for Milwaukee area on 6 August 1986.

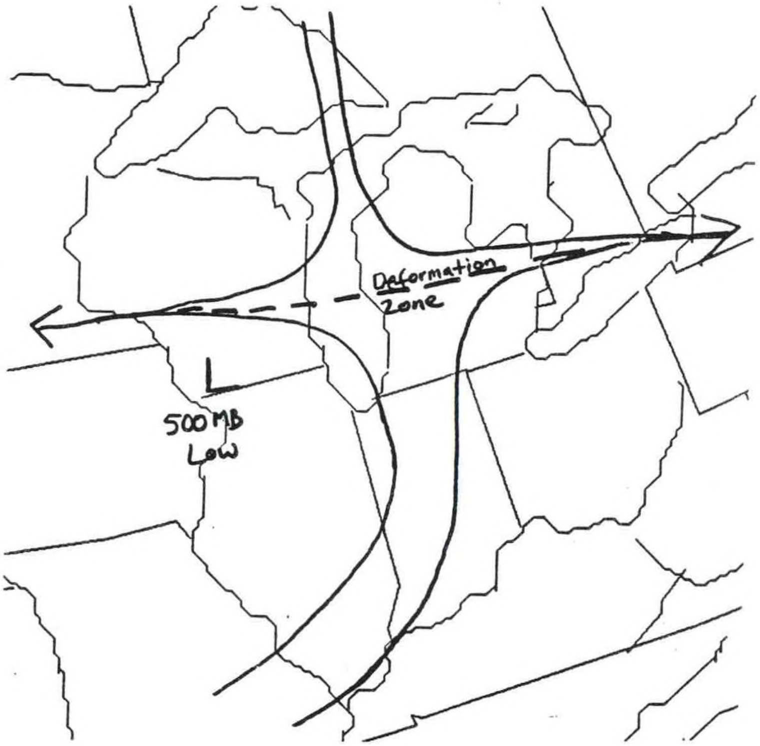

Fig. 7. Confluent asymptote and deformation zone locations at 12Z 6 August 1986.

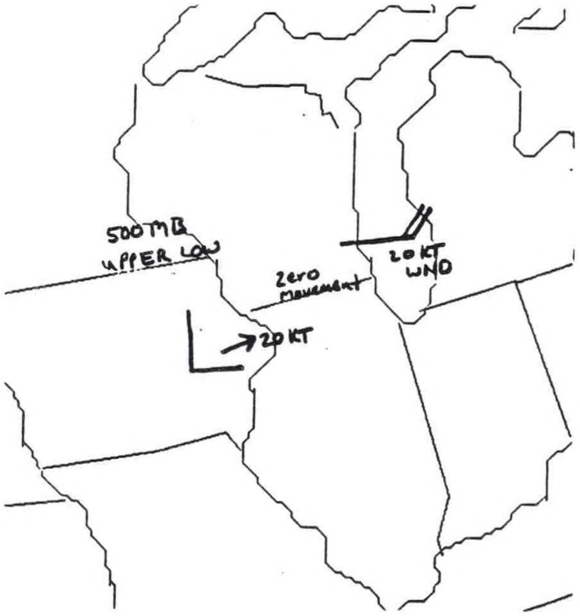

Fig. 8. Movement of upper low in relationship to the upper winds at 12Z 6 August 1986.