Western Region Technical Attachment
No. 95-06
March 7, 1995

COMPOSITE MAPS OF SELECTED RAINFALL EVENTS IN SAN DIEGO

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Introduction

This study was done in an effort to help the incoming forecasters and existing staff at the spin-up office in San Diego become familiar with the synoptic characteristics associated with past significant rainfall events. A rainfall event was considered significant if one inch or more of rain was received on a calendar day. This study also shows the utility of composite mapping using gridpoint data.

Methodology

The data used to compile the composites of this study were obtained from a CD-ROM entitled "NMC Grid Point Data Set" which was prepared by the University of Washington (Mass 1987). Additional software used with the CD-ROM, NMCDraw, allows users to retrieve and view gridded data along with producing composites. A recent study involving the use of composites in identifying significant weather events in North Dakota (Fors and LeBlang 1993) has shown the usefulness of this technique.

The NMC Grid Point Data Set contains data for several significant levels, covering different spans of time for each level. The time span for this study is limited to the years of 1965-1989 due to the lack of data at all significant levels beyond these dates.

To determine which dates had significant rainfall events during the years of 1965-1989, the daily extreme precipitation record found on a National Climatic Data Center (NCDC) CD-ROM was reviewed along with station precipitation records. Forty-two days having significant rainfall events were identified.

The 1200 UTC 500 mb and 850 mb charts associated with the selected dates were then viewed using NMCDraw. This was done to note three items: the 500 mb synoptic pattern, the 500 mb height and the 850 mb temperature at San Diego.

Forty of the cases, found between the months of November and May, showed a winter-type synoptic pattern which included a trough of low pressure off of the California coast. One unique event occurred in August and was of subtropical origins. This singular event was excluded from the study as was one other date that could not be accessed on the NMC Grid Point Data Set CD-ROM.

Examination of the 500 mb synoptic pattern versus the 850 mb temperature over San Diego revealed that the 40 winter-type cases could be subdivided into two types; i.e., warm and cool cases (Fig. 1). This division served to limit the masking of significant meteorological signatures found within the numerous cases.

After the two different synoptic patterns were classified, composite maps were made of each type. This was done at 1200 UTC on the day the rain occurred and 1200 UTC of the day preceding the significant rainfall day.

Results

Cool Events

A rainfall event was considered cool if the 850 mb temperature at San Diego was less than or equal to 5° C. The 500 mb heights over San Diego for these events ranged from 542 dam to 563 dam (Fig. 1) Review of the composites of the significant levels revealed several interesting features. The mean 500 mb pattern showed a sharp, negatively tilted trough over the West Coast. Over time, the West Coast trough deepened with little movement. At the same time, a secondary area of low pressure was found over northern Canada, which weakened slightly as the low near the coast developed. The mean pattern at 250 mb (Figs. 2d and 3d) showed a tendency for the development of a jet maximum just south of San Diego. Jet dynamics likely contributed to the enhancement of vertical motion.

The West Coast lows from the composites at the various levels were nearly vertically superimposed with a small degree of tilt at the upper levels toward the cold air (Figs. 2a-c, 3a-c). The nearly vertical stacking of the systems indicates that the composited cyclones were near full development. The slow movement of the mature cyclones is likely to be the largest factor contributing to the significant rainfall events.

Warm Events

A rainfall event was considered warm if the 850 mb temperature at San Diego was greater than 5° C. The 500 mb heights over San Diego for these events ranged from 553 dam to 578 dam (Fig. 1). Review of the composite maps of the warm events revealed some similarities and differences as compared to the cool events. As with the cool events, there was a slow moving trough off the West Coast. The mean 500 mb pattern of the warm composites showed a neutrally tilted and less amplified trough just off the coast of California than for the cool events (Fig. 5c). Like the cool events, the systems were nearly vertically stacked. A secondary area of low pressure was again found over northern Canada, but was much deeper and centered farther south over Hudson Bay with a trough extending over the northeast United States, for the warm events. The deeper northern Canadian low in the warm cases may have prevented the West Coast trough from deepening considering the short wavelength between the two systems. The mean pattern at 250 mb (Figs. 4d and 5d) also showed the development of a jet stream maximum near southern California. This jet was located much closer to San Diego but was much weaker than the mean 250 mb jet in the cool cases.

Conclusions

Composite mapping has made it possible to identify the synoptic characteristics of selected significant rainfall events in San Diego. The composite maps showed most notably the positioning of a negatively to neutrally tilted trough along the coast of California that deepened over time. A jet maximum was evident near San Diego in both the cool and warm cases.

The features noted in the composites were also seen in the individual maps and were not a peculiarity of the compositing. As an interesting side note, the average rainfall for both the cool and warm cases was 1.44 inches.

The composite maps in this study should only be considered as a method to give forecasters a "heads-up" to potential heavy rainfall. To use these composites as a real forecasting tool, it would be necessary to determine the number of events, if any, with a similar pattern that did not produce heavy rain (so called "null" events).

While the gridded data on the CD-ROM is quite useful, it would also be very advantageous to have relative humidity included among the data. As it was, sufficient moisture for heavy rainfall was assumed to be present.

There are many studies that could be done in the future for San Diego using composite mapping. Some of these might include thunderstorms, snow events, Santa Anas, and frost/freeze events.

Acknowledgements

Data retrieval from CD-ROM software and compositing software was developed by Mark Albright of the University of Washington. The graphical display and data retrieval software (NMCDraw) was developed by Richard LeBlang, WSFO Bismarck. Daily extreme precipitation data was found on a CD-ROM from Naval Oceanography Command Detachment Asheville, North Carolina.

Reference

Fors, J.R. and R.S. LeBlang, 1993: Synoptic Composites of Three Significant Weather Types in North Dakota Using NMC Gridded Data on CD-ROM. American Meteorology Society Weather Analysis and Forecasting Conference, Vienna, VA.

Figure 1.

Dates of Significant Rainfall

Cool Cases

Date	Rainfall (in.)	500 mb. Height (M)	850 mb. Temp (C)
11/11/85	1.64	5660	5
11/28/81	1.32	5560	5
12/10/65	2.15	5540	4
12/14/65	1.05	5450	2
12/16/87	1.36	5590	4
12/18/67	1.12	5580	3
01/04/74	1.02	5510	2
01/06/77	1.27	5530	3
01/31/79	2.57	5520	1
02/02/88	1.17	5630	4
02/10/76	1.10	5590	3
02/20/80	1.41	5520	4
03/01/81	1.64	5580	4
03/05/81	1.18	5420	-1
03/17/82	2.03	5540	4
04/08/65	1.21	5580	3
04/21/88	1.33	5500	4
05/08/77	1.49	5590	4

Warm Cases

Date	Rainfall (in.)	500 mb. Height (M)	850 mb. Temp (C)
11/15/65	1.07	5750	11
11/16/65	1.25	5740	10
11/17/86	1.08	5780	13
11/21/67	1.22	5670	9
11/22/65	1.53	5740	11
11/25/85	2.04	5630	10
12/05/66	1.34	5740	11
12/09/65	1.30	5630	8
12/17/78	1.32	5700	8
01/09/80	1.02	5610	7
01/14/78	2.12	5720	10
01/22/67	1.53	5660	6
01/29/80	1.92	5560	7
02/08/76	1.71	5700	9
02/15/86	1.55	5690	11
02/28/70	1.64	5600	7
03/02/83	1.49	5530	7
03/06/75	1.44	5660	6
03/08/68	1.33	5590	7
03/11/78	1.14	5630	6
03/14/82	1.20	5640	7
04/20/88	1.42	5620	8

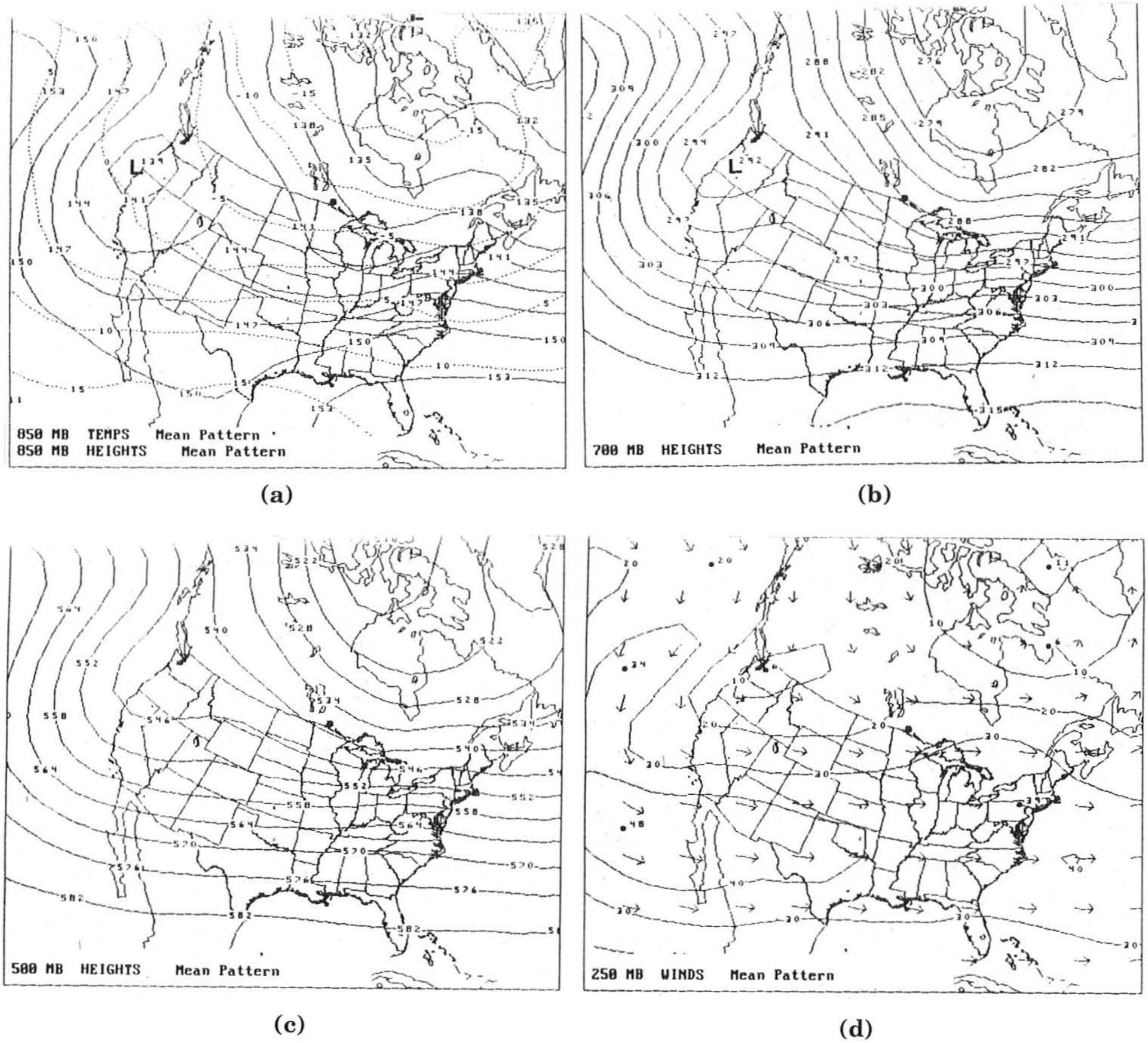


Fig. 2 **Composite fields for cool season cases 24 hours prior to the day of the rain events for: a) 850 mb heights, contoured every 3 dam, and temperature, contoured every 5° C; b) 700 mb heights, contoured every 3 dam; c) 500 mb heights, contoured every 6 dam; and d) 250 wind vectors and isotachs, contoured every 10 m s^{-1}.**

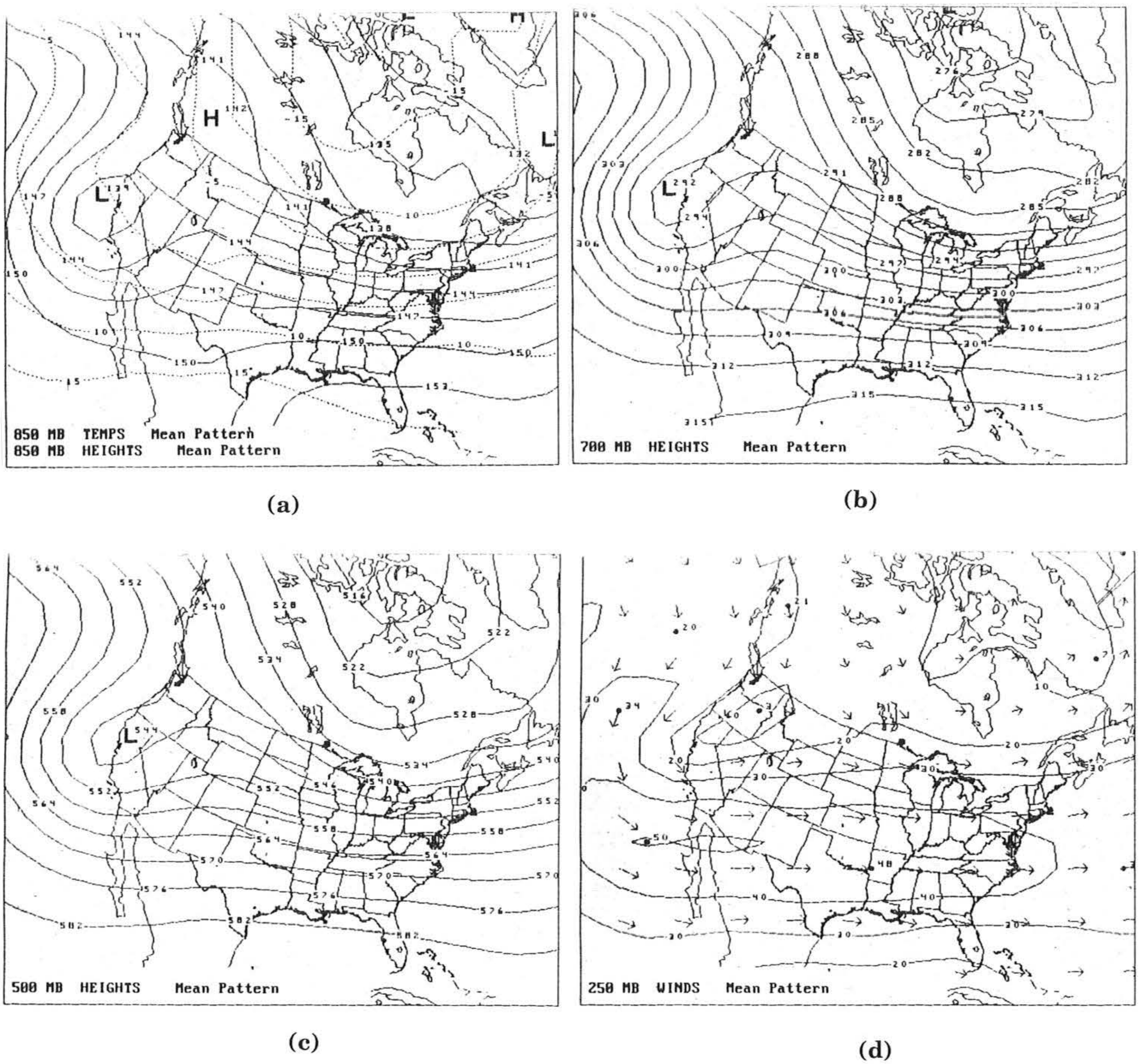
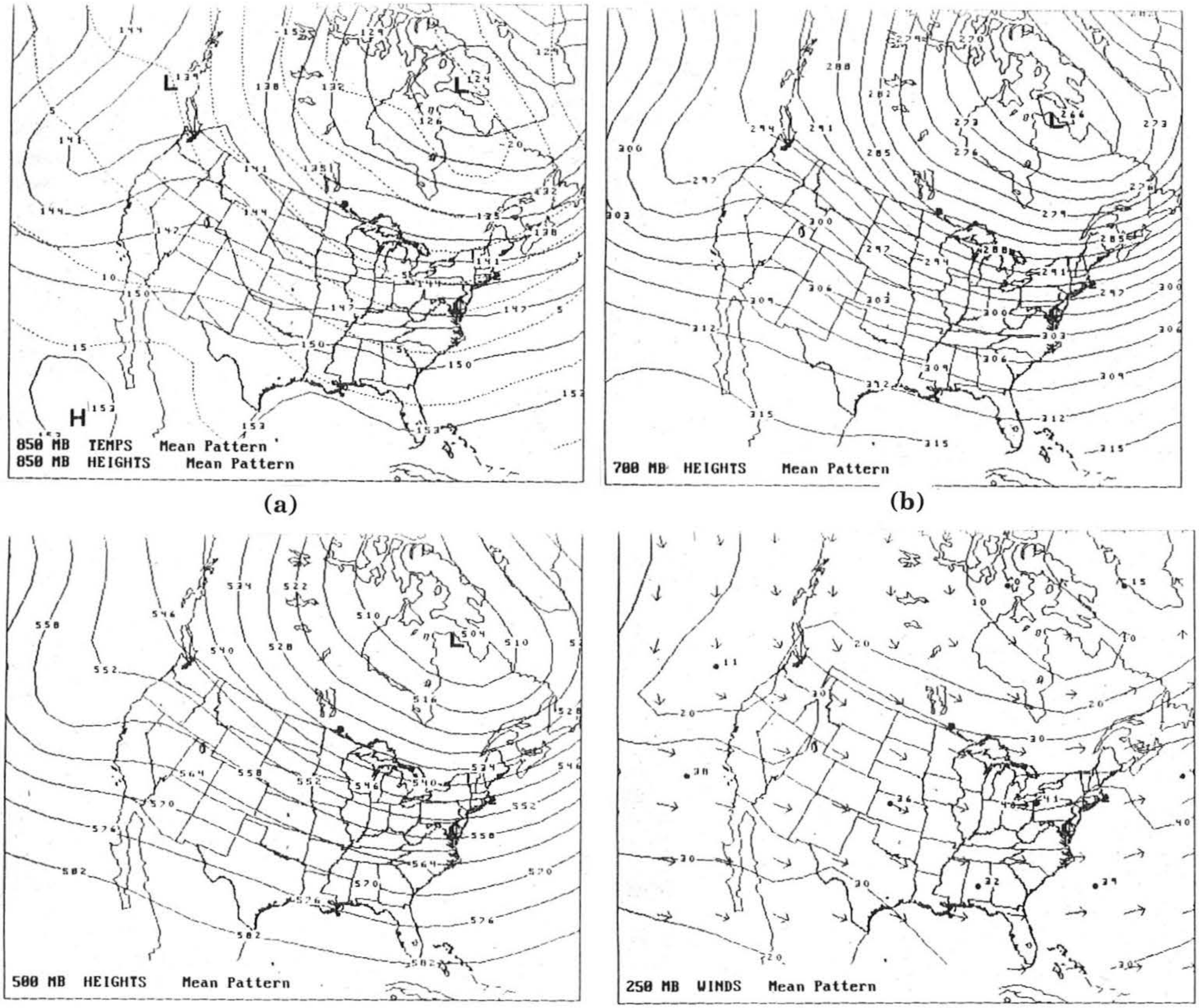


Fig. 3 **Composite fields for cool season cases at 1200 UTC the day of the rain events for: a) 850 mb heights, contoured every 3 dam, and temperature, contoured every 5°C; b) 700 mb heights, contoured every 3 dam; c) 500 mb heights, contoured every 6 dam; and d) 250 wind vectors and isotachs, contoured every 10 m s^{-1}.**



(a) (b) (c) (d)

Fig. 4 **Composite fields for warm season cases 24 hours prior to the day of the rain events for: a) 850 mb heights, contoured every 3 dam, and temperature, contoured every 5°C; b) 700 mb heights, contoured every 3 dam; c) 500 mb heights, contoured every 6 dam; and d) 250 wind vectors and isotachs, contoured every 10 m s^{-1}.**

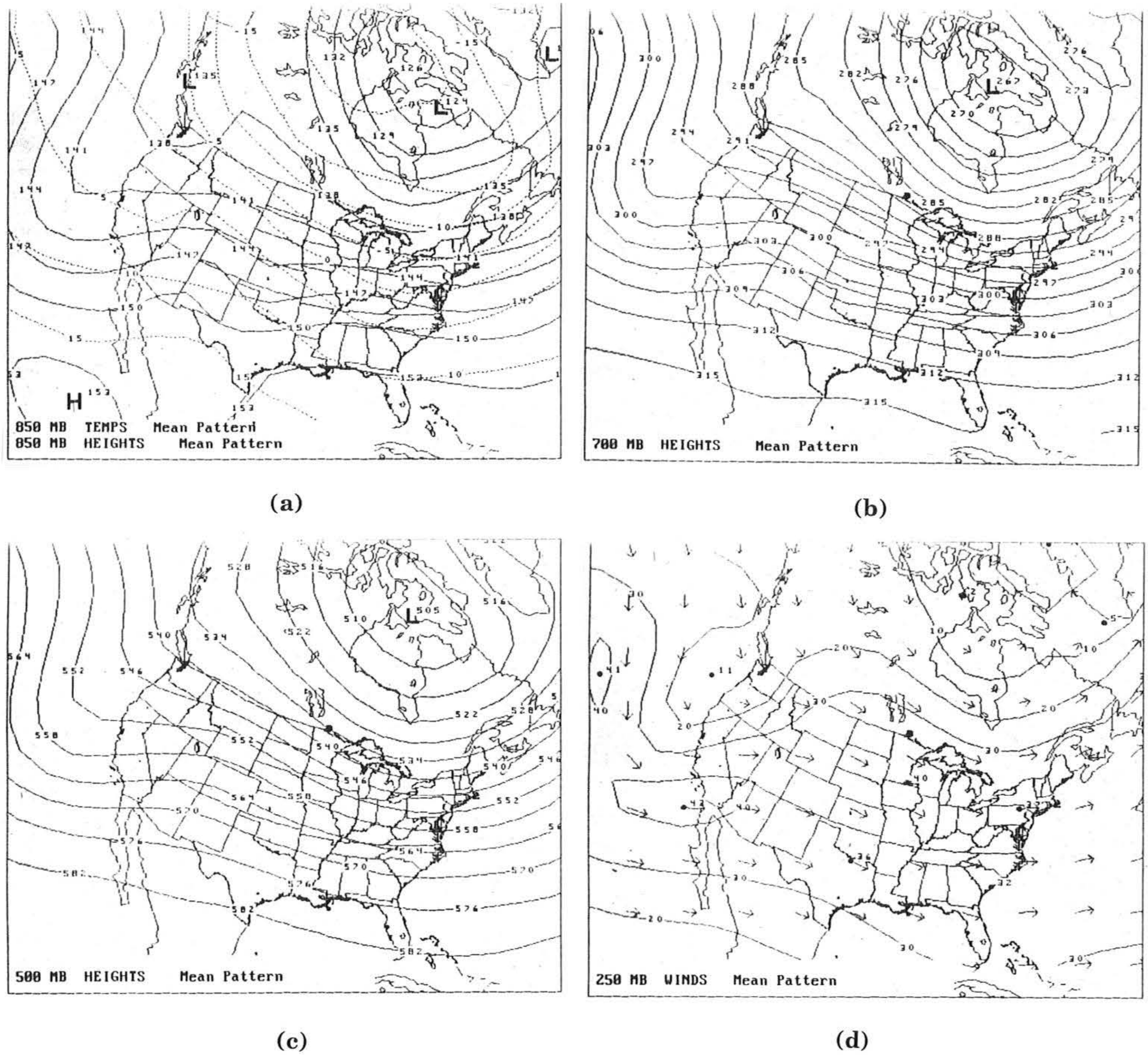


Fig. 5 **Composite fields for warm season cases at 1200 UTC the day of the rain events for: a) 850 mb heights, contoured every 3 dam, and temperature, contoured every 5°C; b) 700 mb heights, contoured every 3 dam; c) 500 mb heights, contoured every 6 dam; and d) 250 wind vectors and isotachs, contoured every 10 m s^{-1}.**