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FORECASTING DENSE FOG AT LA CROSSE, WISCONSIN

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1. Introduction

Dense morning fog, when visibility is 1/4 mile or less, is common in La Crosse, Wisconsin during the late summer and early autumn. Fog formation is greatly enhanced due to cold air drainage over the relatively warm water of the nearby Mississippi River. Because the city of La Crosse and its municipal airport are located in the Mississippi River Valley, dense morning fog can be a problem for motorists, aviators, and boaters. The purpose of this paper is to provide a set of guidelines for forecasting the formation of dense fog and the approximate time it will begin to dissipate. Aviation forecasters, especially, will be able to utilize this information for terminal forecasts. Also, the public forecaster is strongly encouraged to include dense fog in the zone and local forecasts whenever appropriate.

2. Methodology

Guidelines presented in this paper were determined by examining surface observations from the La Crosse airport. Observations were from 1984 to 1992 for July through October, a period in which 32 dense fog events occurred. The actual times when fog dissipation began, plotted in respect to time of day and day of the year, were used to produce Figure 4.

3. Guidelines for Forecasting Dense Fog and its Time of Dissipation

The following are specific factors favorable for the formation of fog at La Crosse during the late summer and early autumn.

(1) High pressure building in, or about stationary over the area.
(2) Clear skies with light or calm wind through 2500 feet above ground level.
(3) Rapid temperature drop after sunset.
(4) Temperature/dew point spread less than or equal to 7°F by 0300 UTC.

The most important factors are the last two. Surface observations from 1984 to 1992 for the period July through October indicated that all dense fog events were preceded by a rapid temperature drop after sunset. The resulting temperature/dew point spread in every case was 7°F or less by 0300 UTC. Forecasting the approximate time dense fog will begin to dissipate at La

Crosse is based on two factors: (1) the thickness of the fog both vertically and horizontally and (2) the day of the year. This will be discussed in more detail later in this paper.

4. Case Studies

The following are two case studies of dense fog events at La Crosse. Both were excellent examples where all of the guidelines listed above proved to be very effective in forecasting both the formation of dense fog and its approximate time of dissipation.

September 14, 1989 and August 28, 1992

Dense fog events on the above dates occurred with clear skies and calm or light winds overnight. Of special importance, though, was the rapid evening temperature drop (Figures 1 and 2) that occurred long before the fog formed. This rapid cooling toward the dew point allowed the air to become quite moist for the balance of the night. Also, the warmer water of the Mississippi River greatly enhanced the available moisture to form dense fog.

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LSE SA 2350 45 SCT 250 -SCT 15 238/63/43/1304/022/ 603  66
LSE SA 0050 45 SCT 250 -SCT 15 237/55/49/1203/022
LSE SA 0150 250 -SCT 15 237/51/48/1104/022
LSE SA 0250 250 -SCT 20 240/50/48/1204/ 303
LSE SA 0550 CLR 20 246/47/46/1105/024/F FRMG OVR RVR/ 103  66
LSE SA 0749 CLR 15 241/45/45/1105/023/GF OVR RVR
LSE SA 0850 CRL 15 237/43/43/1404/022/ F OVR RVR/ 607
LSE SP 0930 W2 X 1/4F 1305/021
LSE SA 0954 W2 X 1/4F 235/43/43/1205/021
LSE SP 1025 W0 X 1/8F 104/021
LSE SA 1049 W0 X 1/8F 235/42/42/0000/022
LSE SA 1352 W2 X 1/8V F 239/44/44/1305/022/VSBY 1/16V1/4
LSE SA 1449 W2 X 1/8V F 240/47/47/1504/022/VSBY 1/16V1/4 SUN
          DMLY VSBL 000
LSE SP 1513 -X 11/4F 0404/022/F9 VSBY INCR RAPIDLY
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Figure 1. Surface observations for September 14, 1989 fog event.

The Limited-area Fine Mesh (LFM) Model Output Statistics (MOS) (Figure 3 - not shown) proved to be extremely valuable in recognizing the rapid evening temperature drop needed for subsequent fog formation. However, MOS was not useful in forecasting restrictions to visibility or low ceilings in these cases.

In both case studies, fog formed over the Mississippi River between 0600 and 0800 UTC. The fog then expanded outward filling virtually all of the river valley. Visibility typically lowers rapidly to 1/4 mile or less in the city of La Crosse, and at the airport usually between 0900 and 1100 UTC.

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LSE SA 2347 100 SCT 15 62/45/0208/008
LSE SA 0051 100 SCT 15 59/47/1004/008
LSE SA 0146 100 SCT 20 57/46/0404/008
LSE SA 0246 CLR 20 54/49/3604/009
LSE SA 0347 CLR 20 53/49/1004/008
LSE SA 0446 CLR 20 50/48/1204/007
LSE SA 0549 CLR 20 49/48/0000/008
LSE SA 0647 CLR 20 49/48/1304/007
LSE SA 0746 CLR 20 47/47/1103/007
LSE SA 0846 -X E40 BKN 12 48/47/1003/007/F6
LSE SA 0946 15 SCT E40 BKN 10 48/47/1003/007
LSE SP 1018 6 SCT 15 SCT 10 3505/006/FBANK SE-SW BLUFF TOPS OBSC
LSE SP 1034 -X E8 BKN 11/2F 3104/006/VSBY REDUCING RPDLY F7
LSE SA 1046 -X E8 BKN 11/2F 48/48/0000/007/VSBY W 3/4
LSE RS 1146 W2 X 1/4F 48/48/0000/007 466 46
LSE SP 1215 W1 X 1/16F 0000/008
LSE RS 1250 W2 X 1/4F 48/48/0000/008
LSE SP 1314 W1 X 1/8F 0000/008
LSE SA 1349 W1 X 1/8F 50/50/0000/008
LSE SP 1401 W1 X 5/8F 2504/008
LSE SP 1410 -X E3 BKN 13/4F 3604/008
LSE RS 1450 E100 BKN 5F 56/51/0000/007/FOG BNK W O/RIVER
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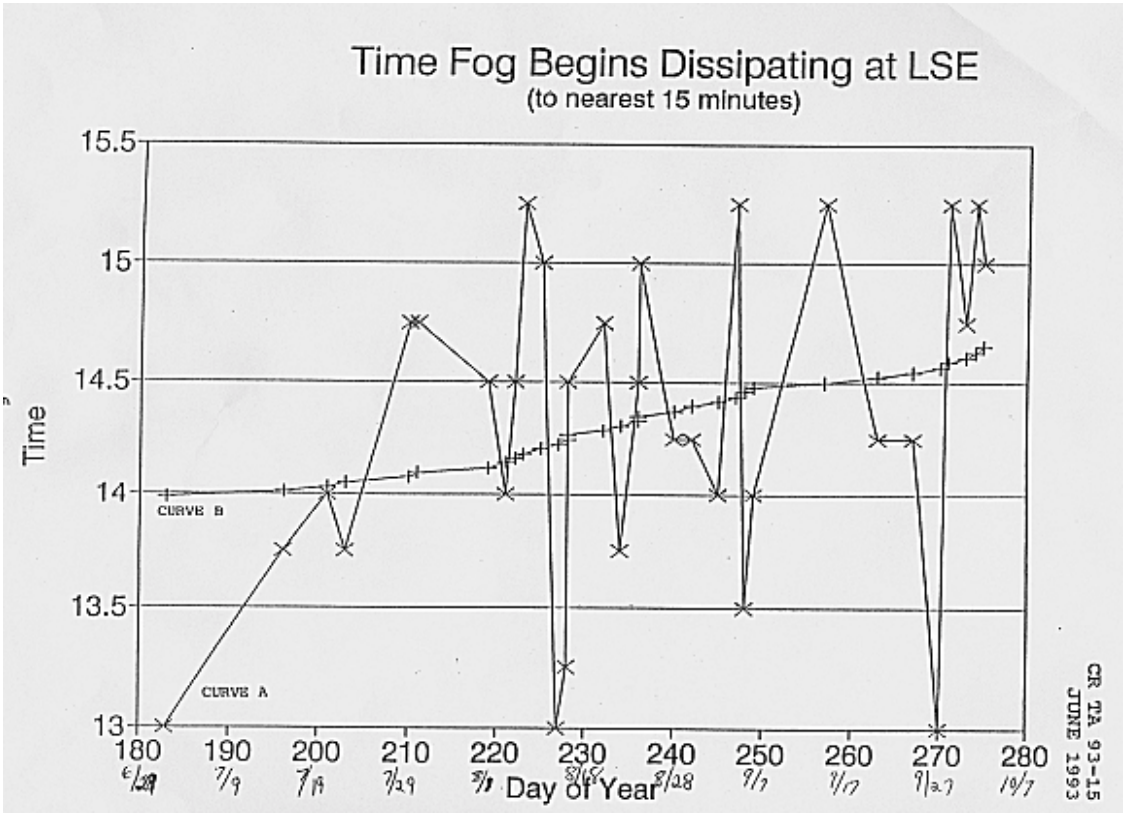
Figure 2. Surface observations for August 28, 1992 fog event.

The graph in Figure 4 can be used to forecast the approximate dissipation time. For example, on August 28, enter the graph at the 240th day of the year and move upward until intersecting curve B. Then, move left until reaching the time-line study of August 28, 1992 (Figure 2), the fog began to dissipate shortly after 1400 UTC. However, in the case study of September 14, 1989 (Figure 1), the fog began to lift around 1515 UTC which was later than the forecast of 1430 UTC from Figure 4.

Note, the graph is based on visibility of 1/4 mile or less and vertical thickness of around 500 feet. Forecasters should be cognizant of the fact that even if visibility should reach 1/4 mile or less, a vertical thickness of considerably more/less then 500 feet will result in dissipation at a later/earlier time. A check of pilot reports, if available, should be done to get an idea of the fog's vertical thickness.

Note that the graph, along with the surface observations in Figures 1 and 2, indicate a direct correlation between time of the year and time of dissipation. Since fog is burned off by the sun's heating for the most part in these cases, it will dissipate at a later time in October than in August due to a lower sun angle and later sunrise.



5. Conclusions

The purpose of this paper has been to provide definite guidelines for forecasting dense fog at La Crosse, Wisconsin, during the late summer and early autumn. A graph has also been provided to estimate an approximate time the fog will begin to dissipate.

The most important factor in dense fog formation at La Crosse is a rapid evening temperature drop with the resultant temperature/dew point spread within 7°F or less by 0300 UTC. Another key factor is that cold air drainage over the relatively warmer water of the nearby Mississippi River greatly enhances the formation of dense fog.

Guidelines in this paper will be especially useful to aviation forecasters in making terminal forecasts. Public forecast products can be enhanced as well. Also, this information will be valuable to those unfamiliar with the La Crosse area when the Weather Service Office upgrades to a Forecast office during the modernization of the National Weather Service.