A METEOROLOGICAL STUDY OF THE HIGH SULPHATE AND NITRATE WET DEPOSITION EPISODES IN ONTARIO

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A METEOROLOGICAL STUDY OF THE HIGH SULPHATE AND NITRATE WET DEPOSITION EPISODES IN ONTARIO

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Ministry of the Environment

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APPENDIX II

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Summary

This is Volume 3 of the report titled ' A Meteorological Study of the High Sulphate and Nitrate Wet Deposition Episodes in Ontario', number ARB-164-91, published in three volumes.

This volume contains Appendix II and Appendix III of the report.

Appendix II describes the narratives of 33 (#2.1 to 2.33) high $SO_4^=$ and NO_3^- wet deposition episodes in 1986 at Chalk River, Dorset, Longwoods (AES) and Longwoods (MOE). Each narrative describes the meteorological conditions yielding various types of precipitation in the area of the station(s), 72-hour backward air trajectories at 1000 mb, 925 mb, 850 mb and 700 mb levels and a brief summary. Surface synoptic maps at the beginning (mostly at 12Z on the starting day) and the end of the episodes (mostly at 12Z on the termination day), precipitation plots giving types, intensity and duration, and backward trajectories at the synoptic hours (12Z, 18Z, of the first day and 00Z, 06Z and 12Z of the following day) at the four levels are included.

Appendix III includes the transport index which was attempted in this study to quantify the source-receptor analysis. The attempt was not successful.

Volume 1 contains the discussion of these episodes and includes the main text of the report.

2.1 January 19-20, 1986, Chalk River

This episode ranked the second highest (2/8) for NO_3^- top 25% wet deposition episodes but did not count in the list of SO_4^{--} episodes.
A wave near Sudbury with the warm front north of Chalk River and the cold front in a southerly direction over Georgian Bay and southern Ontario and a low pressure centre, 1001 mb, near West Virginia-Ohio-Kentucky border associated with a frontal system was observed on January 19, at 12Z, as shown in Fig. 2.1.1,. The cyclone moved slowly and affected the weather at the station. On Jan 20, at 12Z, the low centre was over NE Pennsylvania with the warm front just E of the station as shown in Fig. 2.1.2. The continuous precipitation region around Chalk River on Jan 19, 12Z, increased in size as the cyclone moved near Ontario and very light rain & rain showers and light drizzle, rain, and rain showers were observed in the area for most of the duration as shown in Fig. 2.1.3.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for Jan. 19, 12Z, 18Z and Jan. 20, 00Z, 06Z and 12Z are shown in Figures 2.1.4, 2.1.5, 2.1.6, 2.1.7, and 2.1.8 respectively.
Air parcels arriving at the 1000 mb level could have carried NO_x from the high emission source regions in Pennsylvania and Maryland as indicated in Figs. 2.1.4-6. No highest emission source area is involved in the pollution transport at this level.
Air trajectories at the 925 mb level show that, although no transport from any highest NO_x emission source area occurred, NO_x from its high emission regions in Pennsylvania, Ohio and West Virginia (Figs. 2.1.4-7) could have been carried to the station.
Air parcels arriving at the 850 mb level could have transported NO_x from its highest emission New York City area (Fig. 2.1.8) and high emission Cleveland(Fig. 2.1.4-5), Pennsylvania and Maryland (Fig. 2.1.6-7) areas. It should be noted that although the trajectory does not actually pass over New York City, it is close enough to indicate probable transport of NO_x.
Air trajectories at the 700 mb level show that NO_x transport from its highest emission areas was not possible at this level. However, NO_x from its high emission Detroit (Fig. 2.1.4), Pennsylvania (Fig. 2.1.6-7) and Maryland (Fig. 2.1.8) could have been transported.
A cyclone influenced the weather at Chalk River and frontal systems hovered around in the area giving very light and light rain, rain showers and drizzle at the nearby weather station for most of the duration(>18 hrs). Low and high level transport of NO_x from a number of high emission areas and high level (850 mb) transport from the highest emission source area in New York City region was probable during the episode.

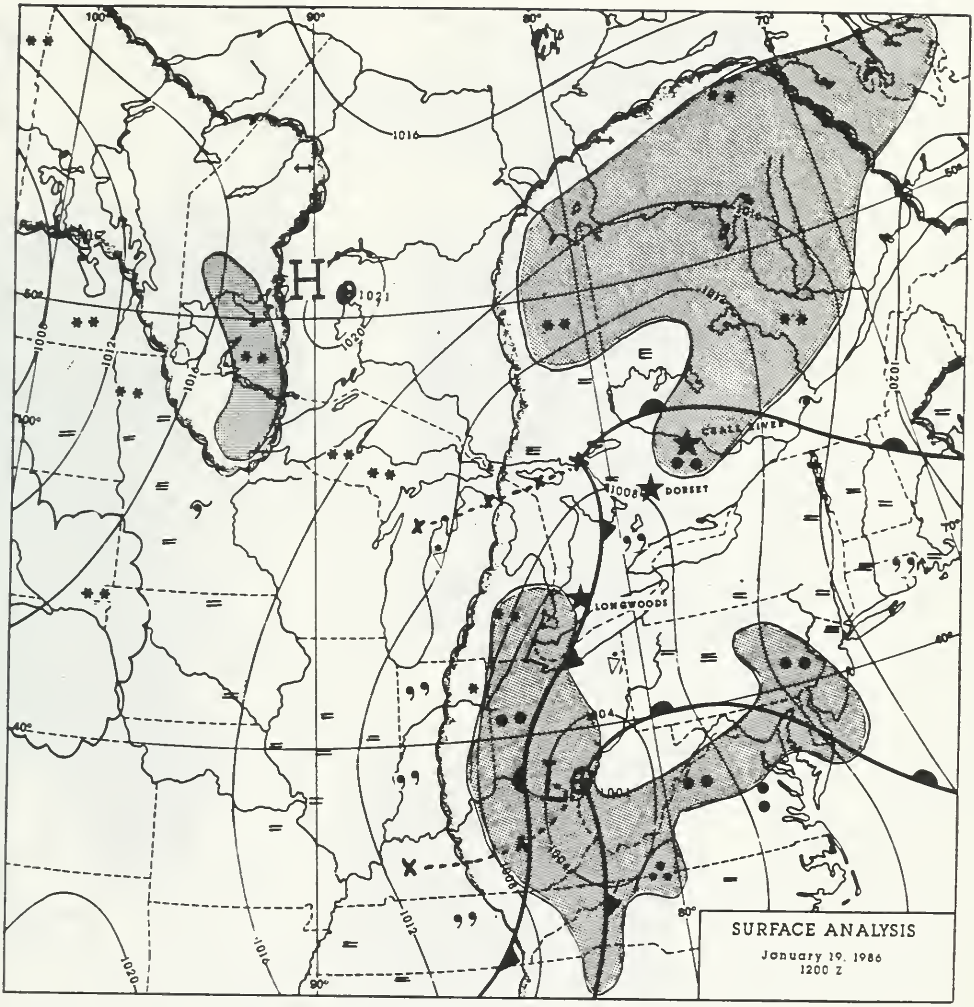

SURFACE ANALYSIS
January 19, 1986
1200 Z
LONGWOODS
DORSET
CHALK RIVER

FIGURE 2.1.1

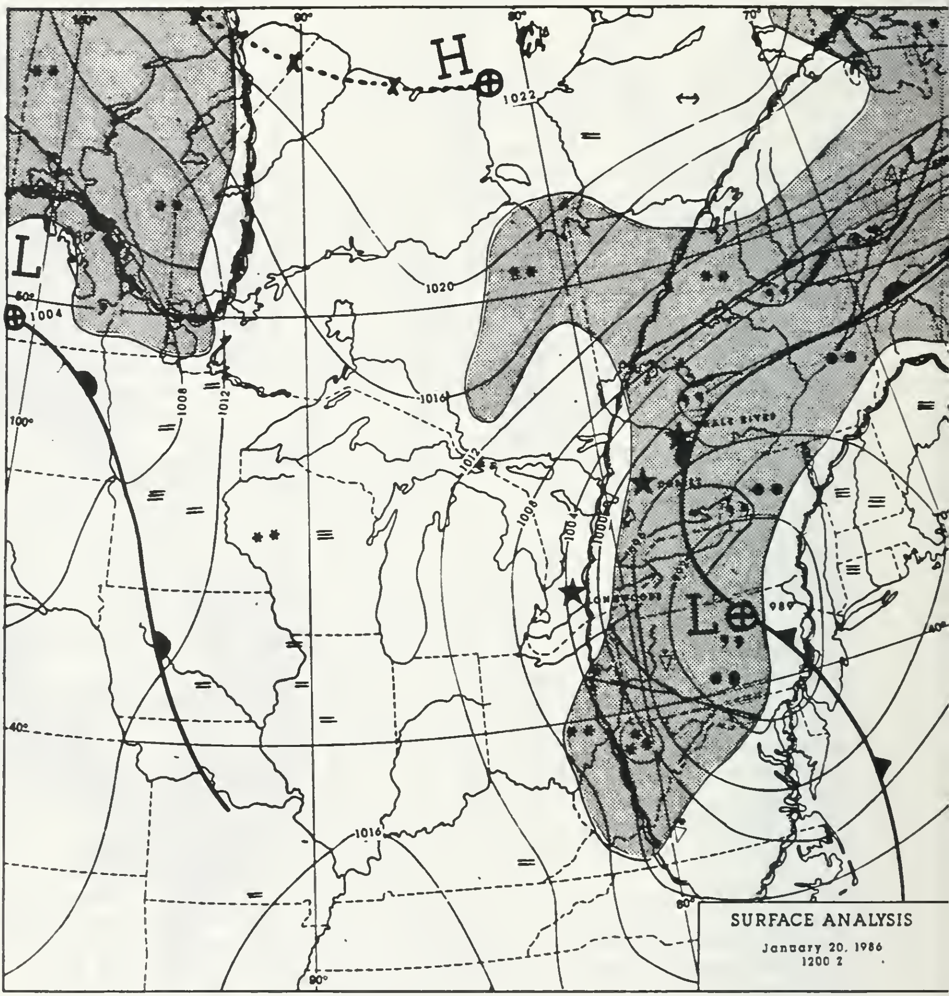

H
1022
1020
L
1004
1016
1008
1012
1008
1004
1000
L
989
1016
SURFACE ANALYSIS
January 20, 1986
1200 Z

FIGURE 2.1.2

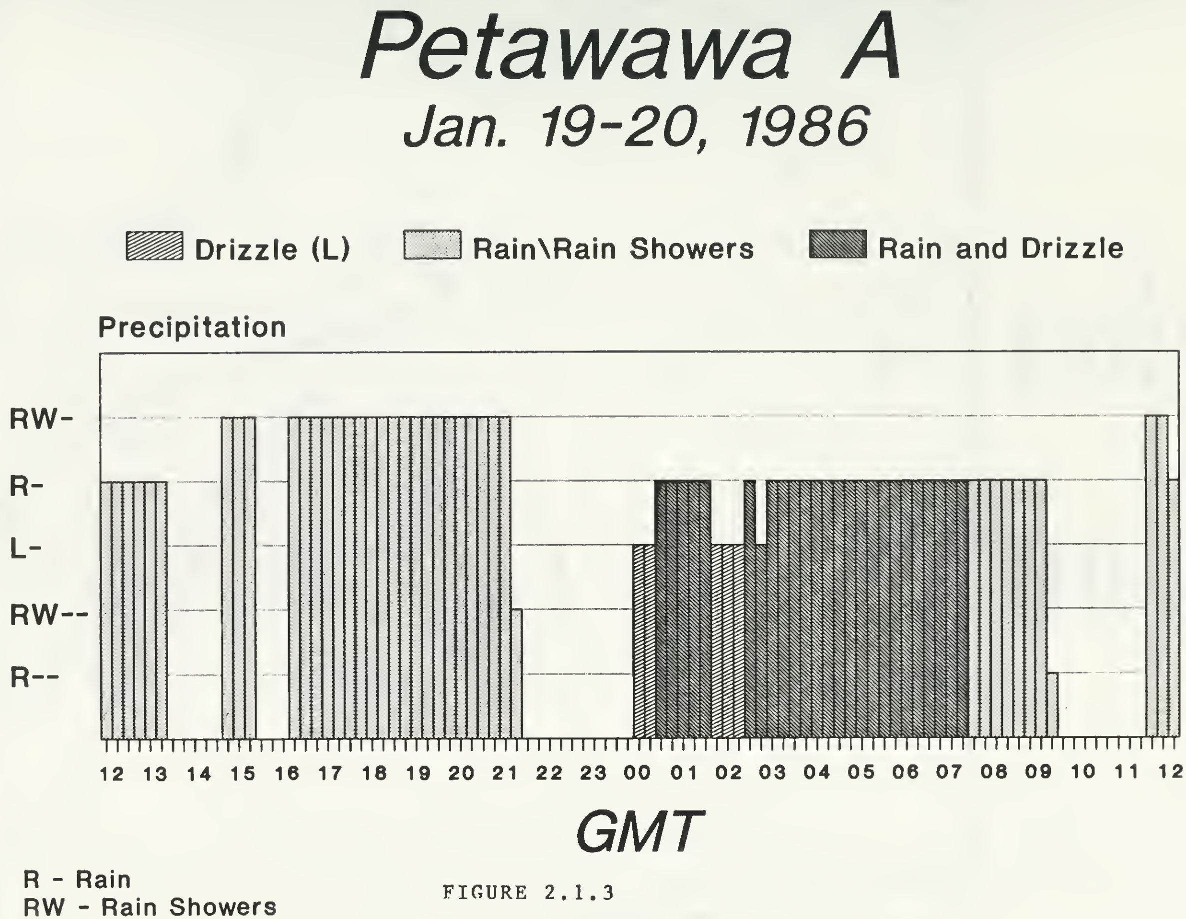

Petawawa A
Jan. 19-20, 1986
Drizzle (L)
Rain\Rain Showers
Rain and Drizzle
Precipitation
RW-
R-
L-
RW--
R--
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
R - Rain
RW - Rain Showers

FIGURE 2.1.3

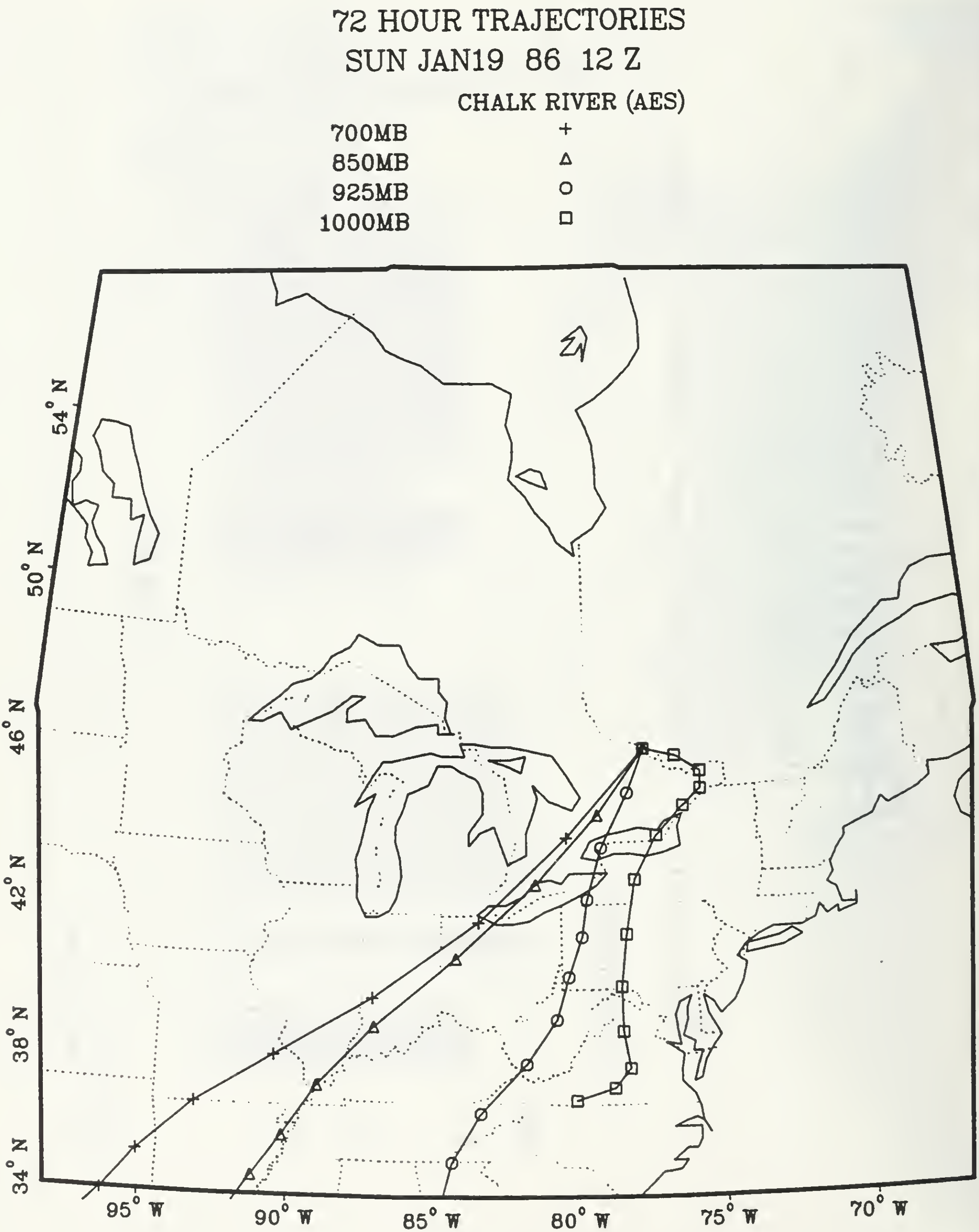

72 HOUR TRAJECTORIES
SUN JAN19 86 12 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.1.4

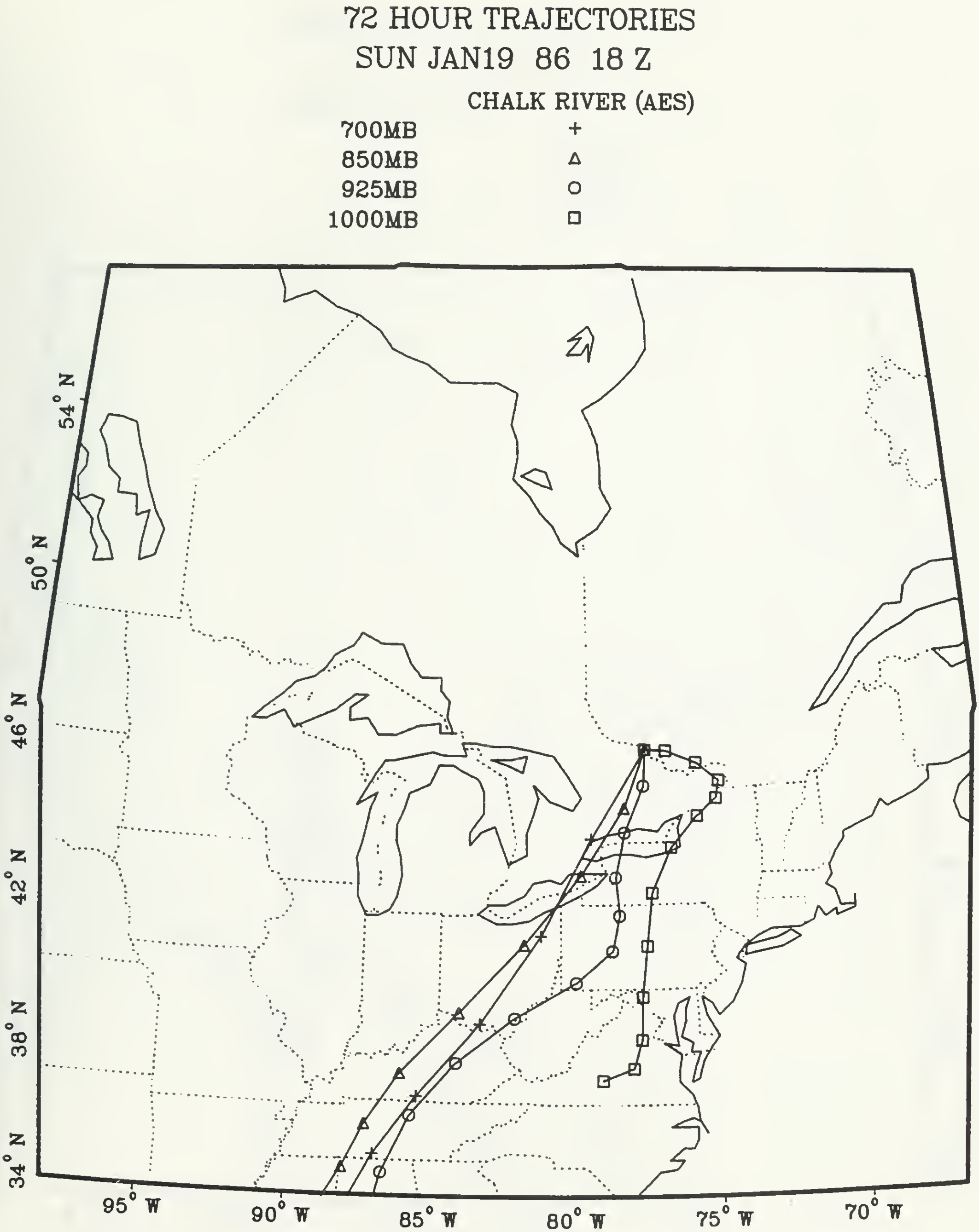

72 HOUR TRAJECTORIES
SUN JAN19 86 18 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.1.5

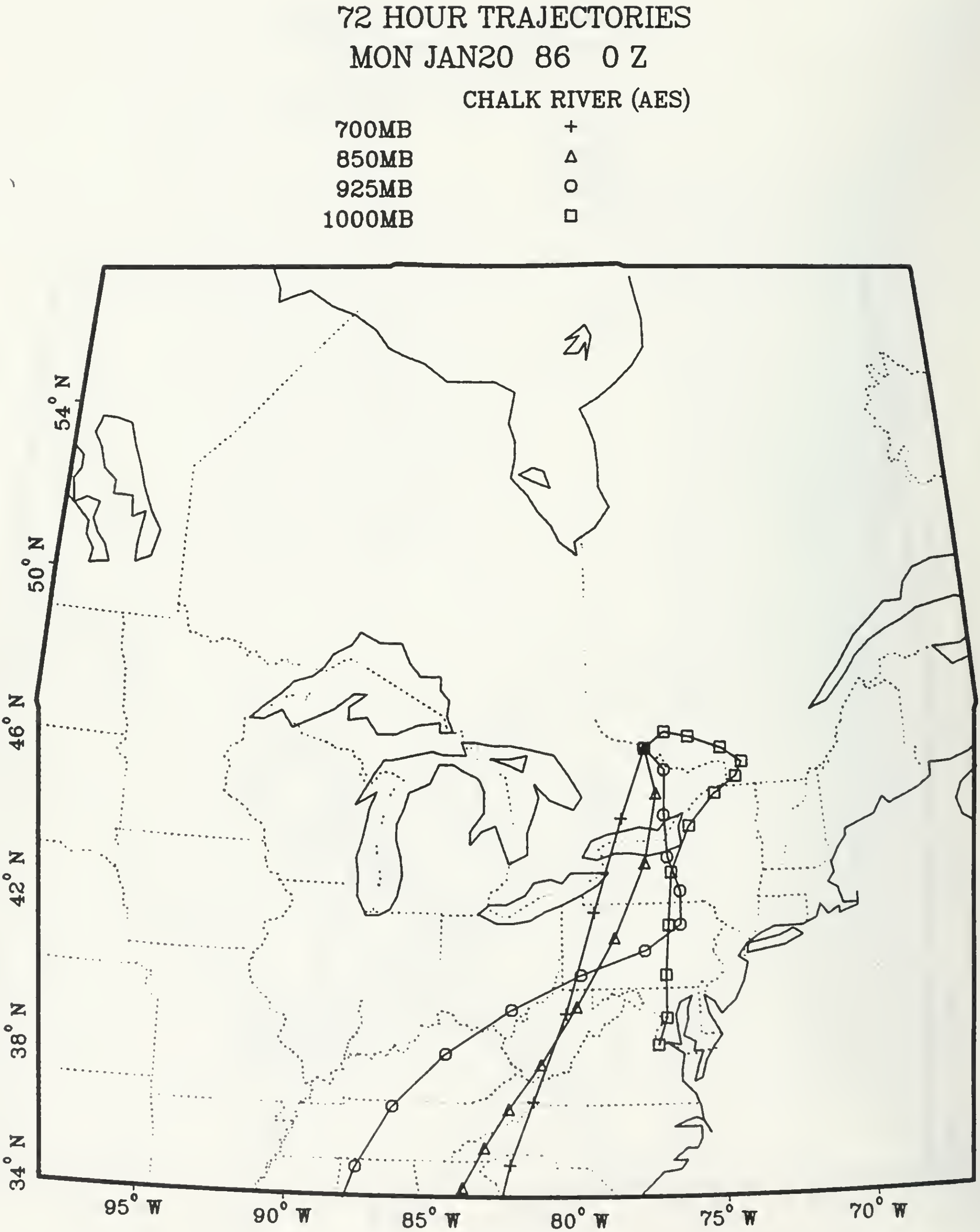

72 HOUR TRAJECTORIES
MON JAN20 86 0 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.1.6

72 HOUR TRAJECTORIES
MON JAN20 86 6 Z

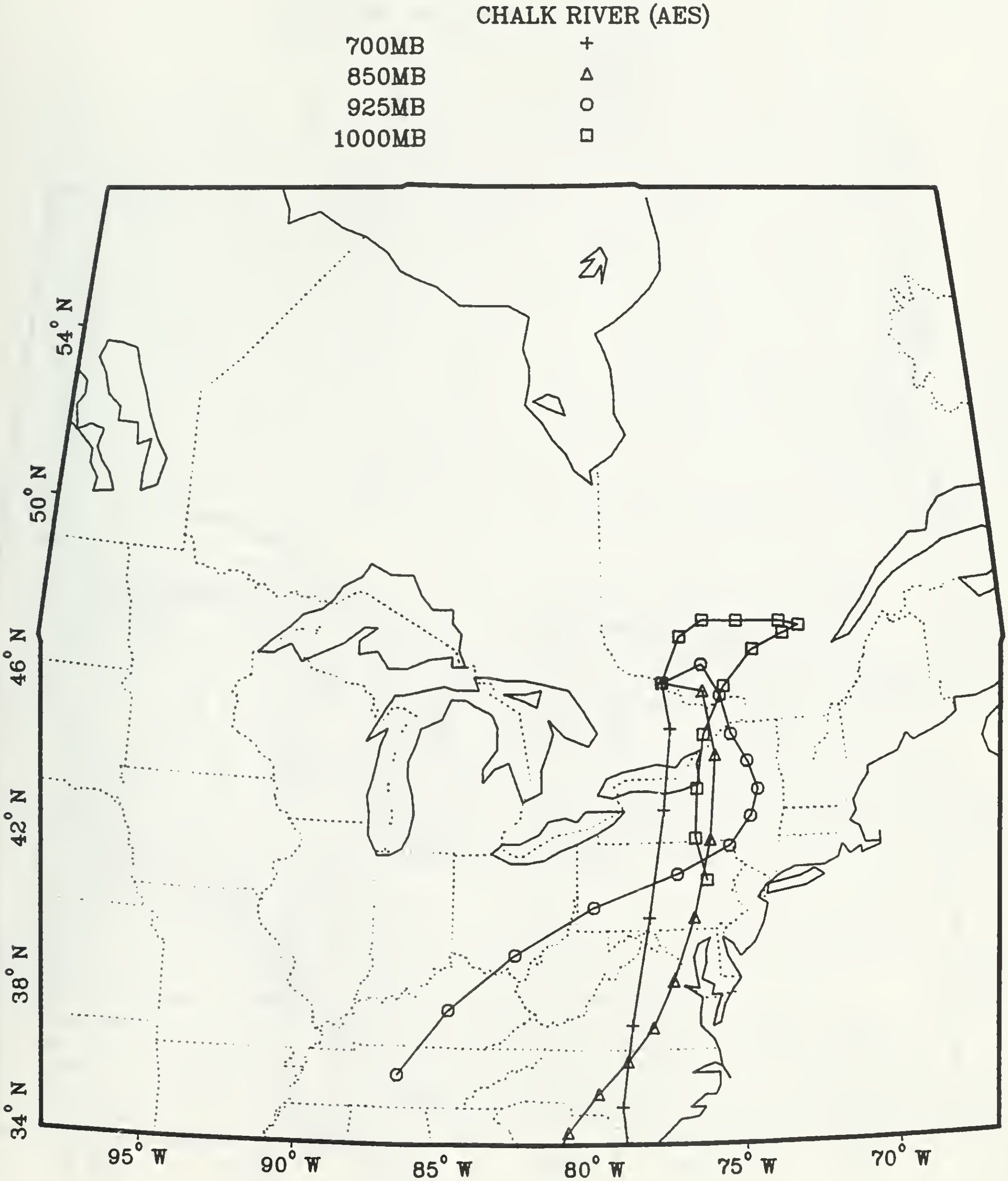


FIGURE 2.1.7

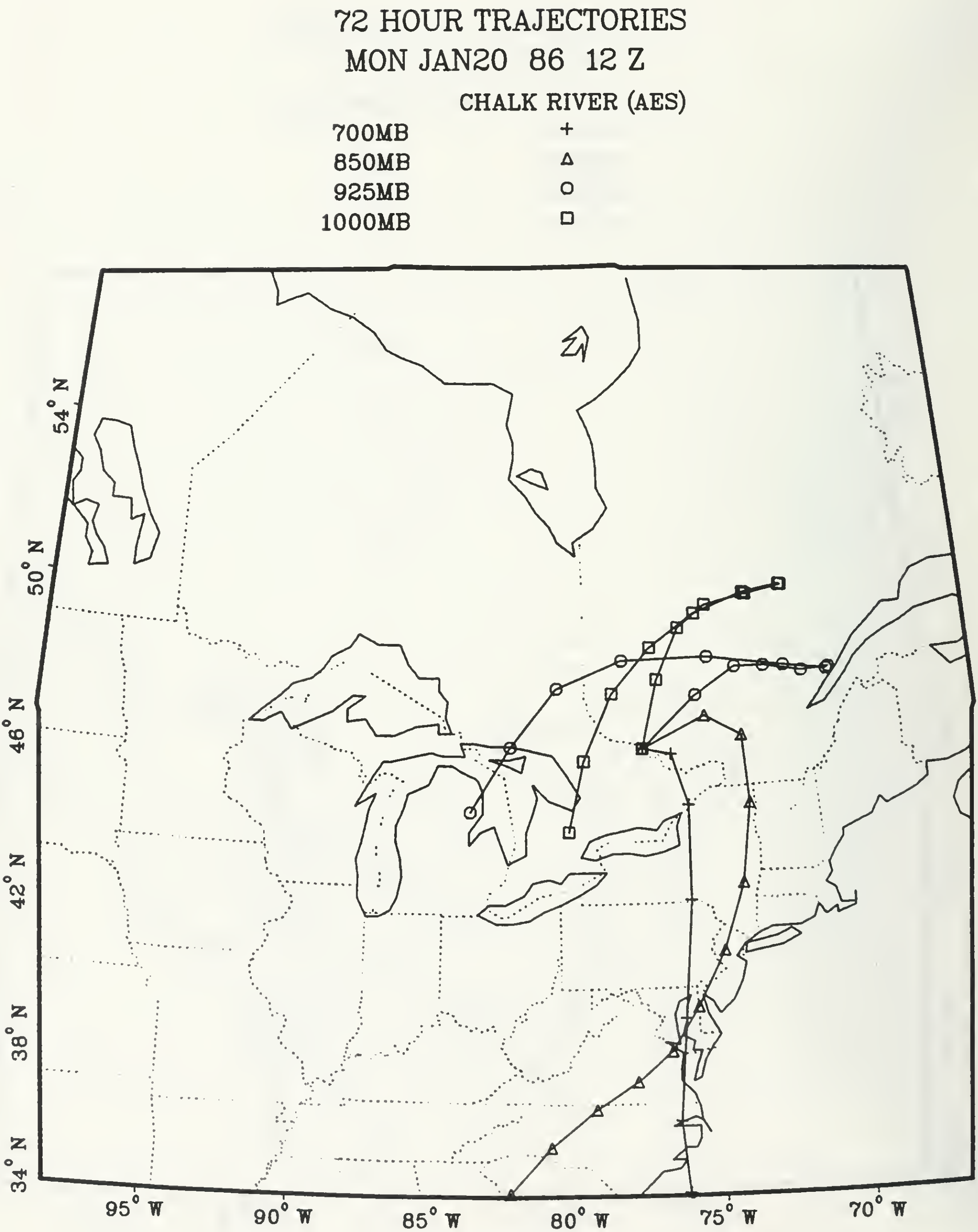

72 HOUR TRAJECTORIES
MON JAN20 86 12 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.1.8

2.2 January 25-26, 1986 Dorset

This episode ranked first (1/10) for NO_3^- and 6th (6/7) for $SO_4^=$ wet deposition events.
A low pressure centre, 998 mb, near Thunder Bay with the warm front over the station were observed on January 25, at 12Z, as shown in Fig. 2.2.1. As exhibited in the figure, a wave over Michigan with a frontal system and a trowl associate with a frontal system in the southern USA were analyzed. The cyclone moved slowly in a ENE direction such that the warm front moved northwards and the cold front remained over Lake Huron gradually approaching Dorset. The trowl associated with the southern front also passed over the station. On Jan 26, at 12Z, the cyclone moved over northern Quebec, as shown in Fig. 2.2.2, with the cold front over Lake Huron and a wave near Sudbury. The large continuous precipitation area on Jan 25, at 12Z, surrounded the station for the duration of the episode. Prior to the arrival of trowl over the station, as it remained in the warm sector, light snow with moderate intensity for about half an hour were observed at the closest weather station Muskoka as shown in Fig. 2.2.3. Light snow grains, rain and drizzle were recorded as the trowl passed over. Light snow showers were recorded as the cold front approached. Unfortunately precipitation data for the whole period are not available but it is likely that the precipitation also fell during the missing period in Fig. 2.2.3.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for Jan. 25, 12Z, 18Z and Jan. 26, 00Z, 06Z and 12Z are shown in Figures 2.2.4, 2.2.5, 2.2.6, 2.2.7, and 2.2.8 respectively.
Air trajectories for the 1000 mb level show that NO_x from its highest and SO_2 from it high emission New York City area could have been transported at this level as shown in Fig. 2.2.8.
Air trajectories for the 925 mb level show that SO_2 from its highest emission areas in Pennsylvania, Ohio-West Virginia (Figs. 2.2.5-7) and possibly SO_2 & NO_x from its highest emission Chicago area could have been transported. Transport of pollutants from high emission regions was also exhibited (Fig. 2.2.5-8).
Air parcels arriving at the 850 mb level show that SO_2 from its highest emission Pennsylvania-Ohio-West Virginia (Figs. 2.2.4-5), Detroit (Fig. 2.2.6), and SO_2 & NO_x from their highest emission Chicago area (Fig. 2.2.7) could have been transported. As shown in the figures, transport from several high emission source regions was also probable.
Air trajectories for the 700 mb level show that transport of SO_2 from its highest emission areas in Detroit, Michigan and Illinois (Fig. 2.2.5) and SO_2 & NO_x from their highest emission Chicago area (Fig. 2.26-8) for about 12 hours was likely.
Summarizing, a cyclone movement in the region affected the weather at Dorset. The station appears to have remained in the warm sector with a trowl from a different frontal system passing over it. Light snow with moderate intensity for about half hour, light snow showers, snow grains, rain and drizzle were observed for most of the period (>15 hrs). Transport of NO_x at low level (1000 mb) from New York City area and at low (925 mb) and high

level (850 mb & 700 mb) from Chicago area as well as of SO_2 at low and high level from Pennsylvania, Ohio, West Virginia, Detroit, Chicago were probable during this episode.

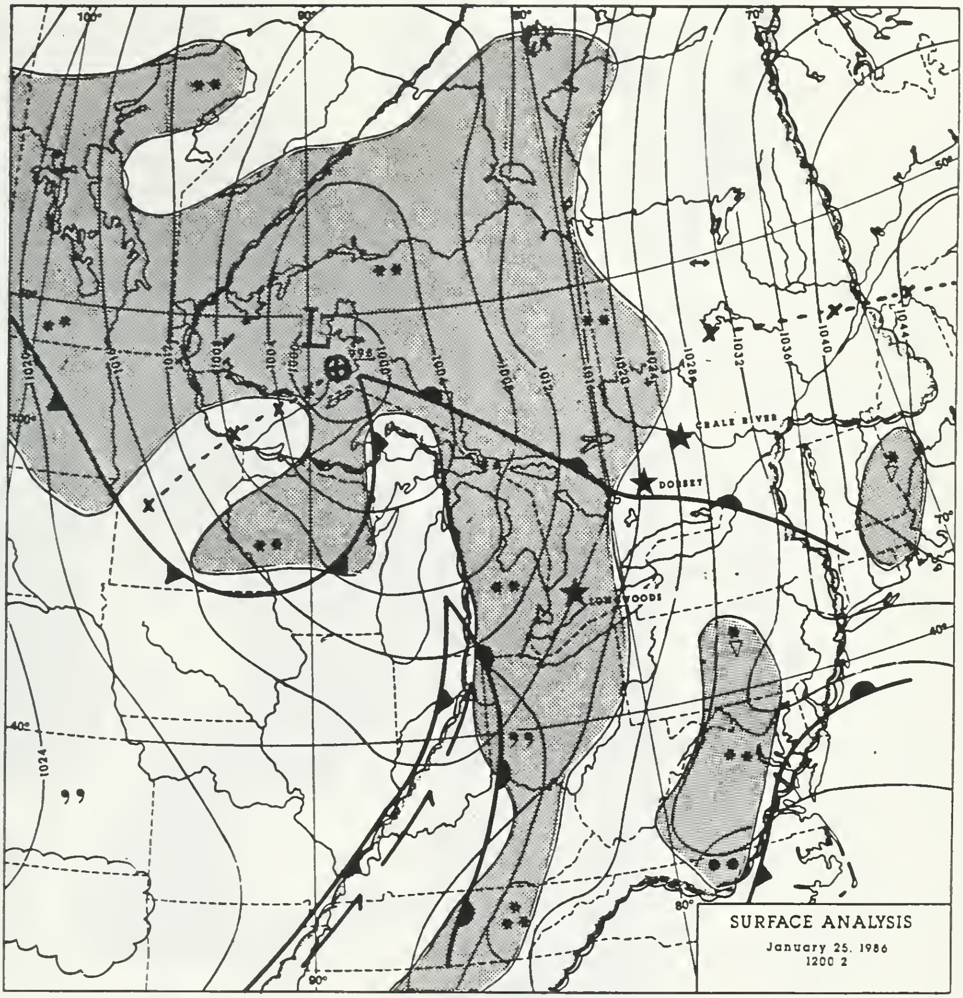

SURFACE ANALYSIS
January 25, 1986
1200 Z
DORSET
LONGWOODS
EAGLE RIVER

FIGURE 2.2.1

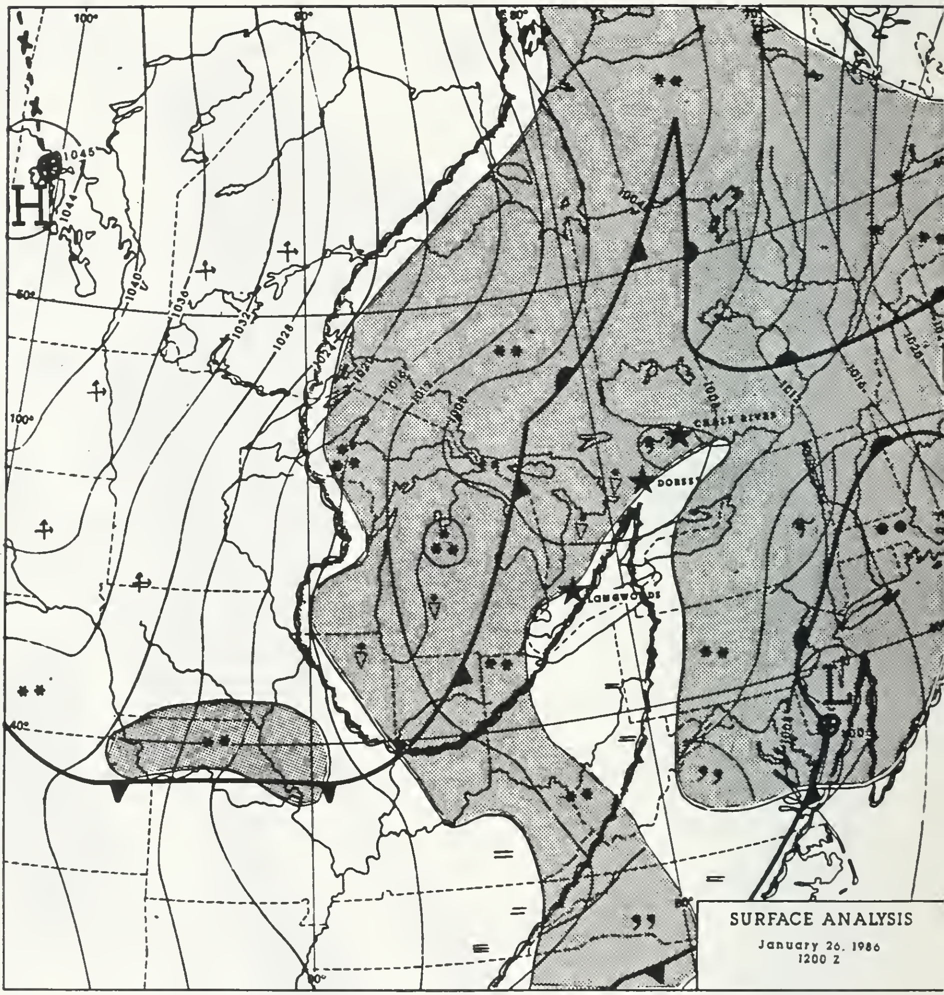
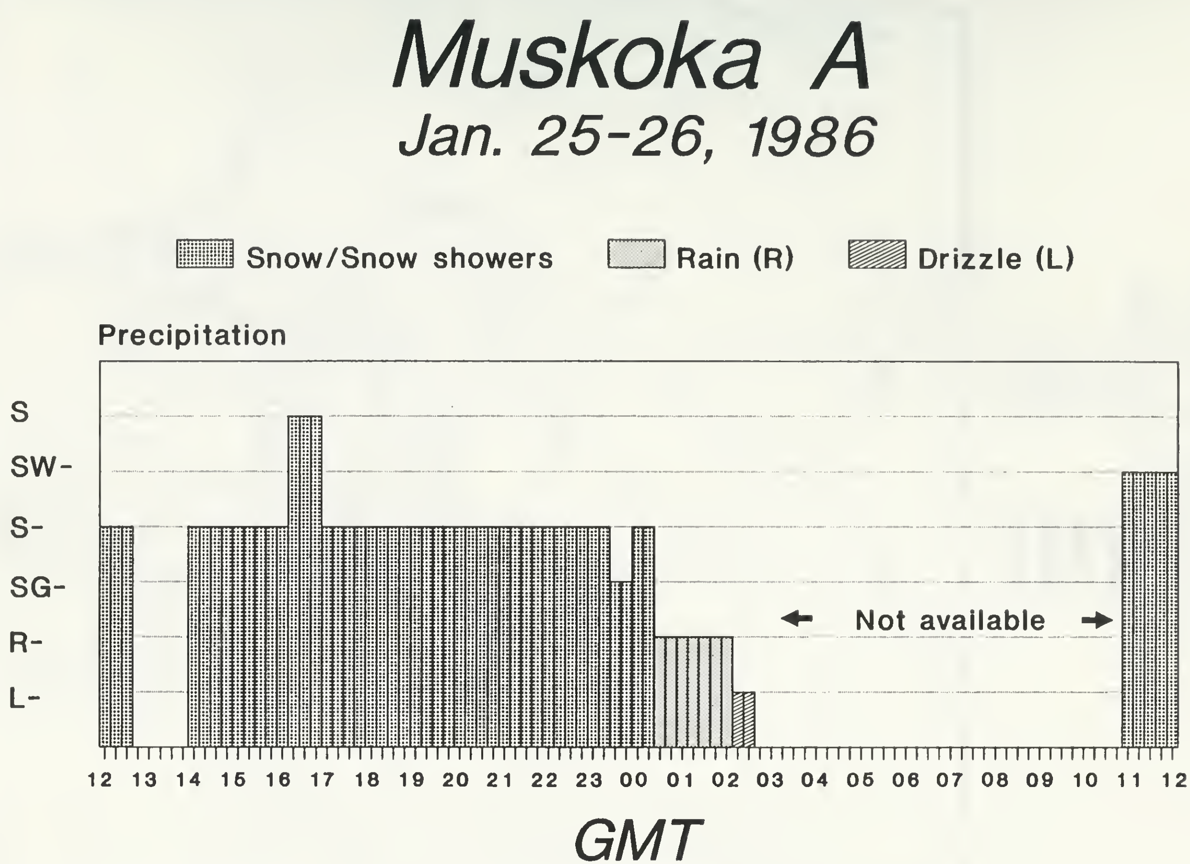

SURFACE ANALYSIS
January 26, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS

FIGURE 2.2.2



SG - Snow Grains
S - Snow, SW - Snow Showers

FIGURE 2.2.3

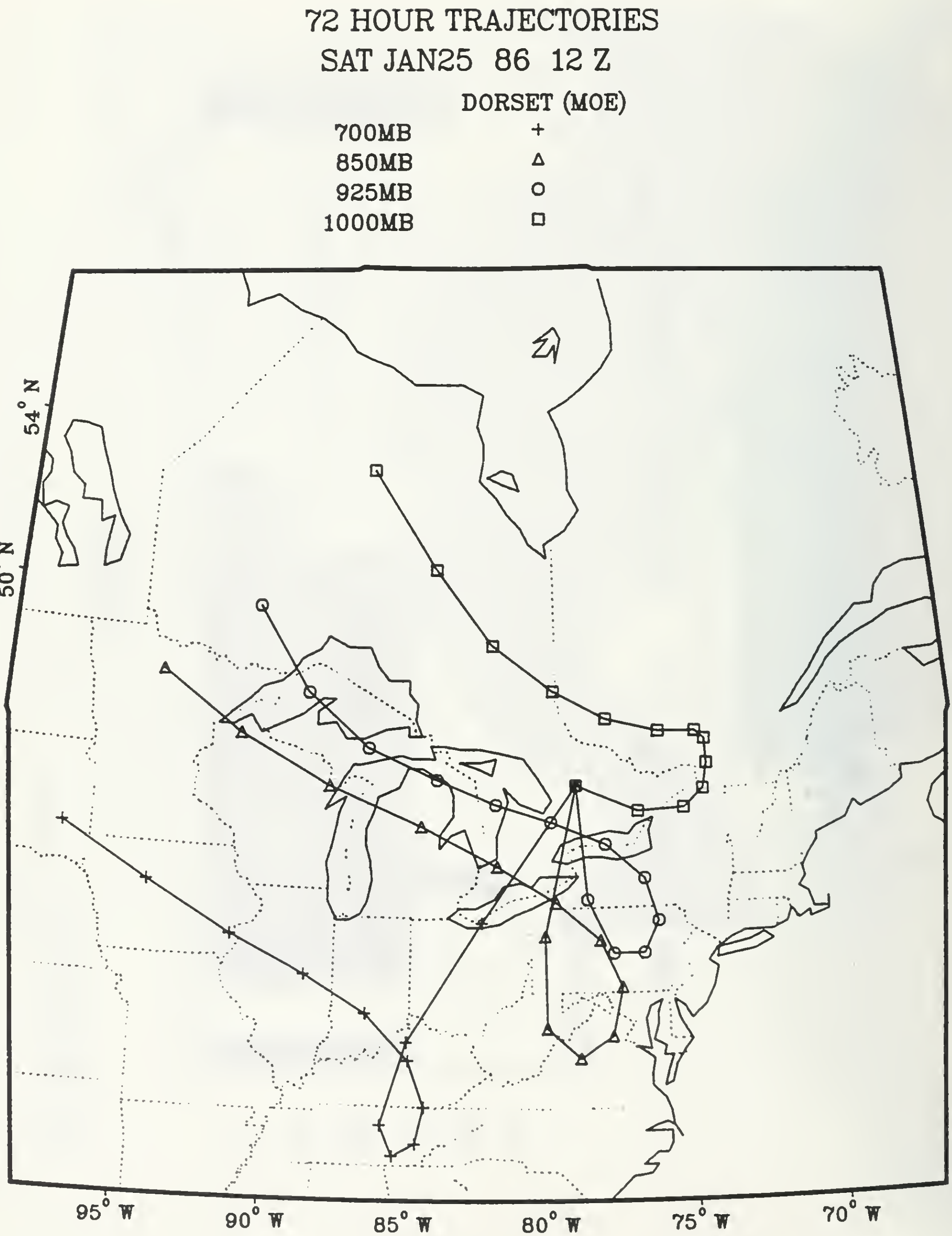

72 HOUR TRAJECTORIES
SAT JAN25 86 12 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.2.4

72 HOUR TRAJECTORIES
SAT JAN25 86 18 Z

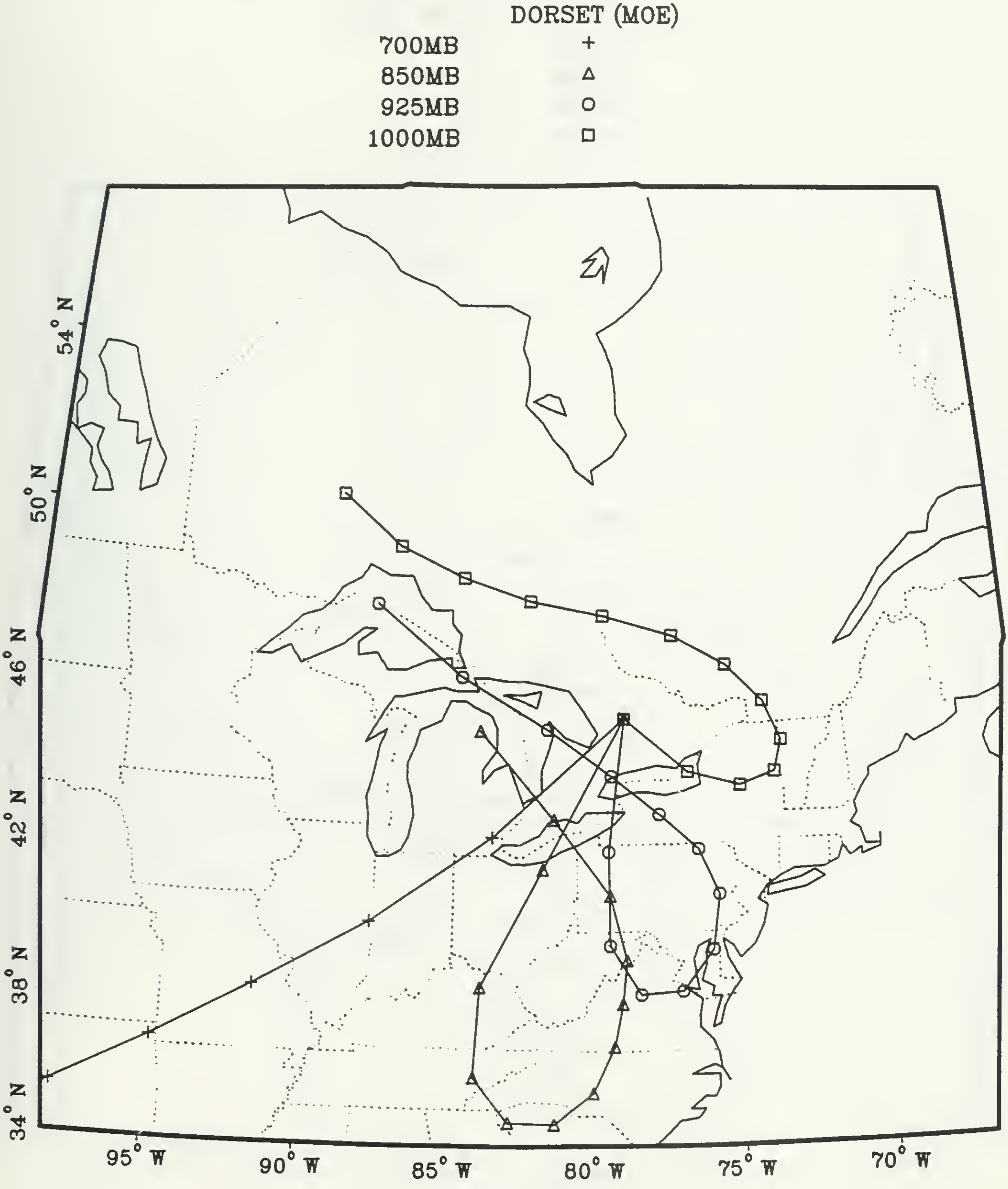


FIGURE 2.2.5

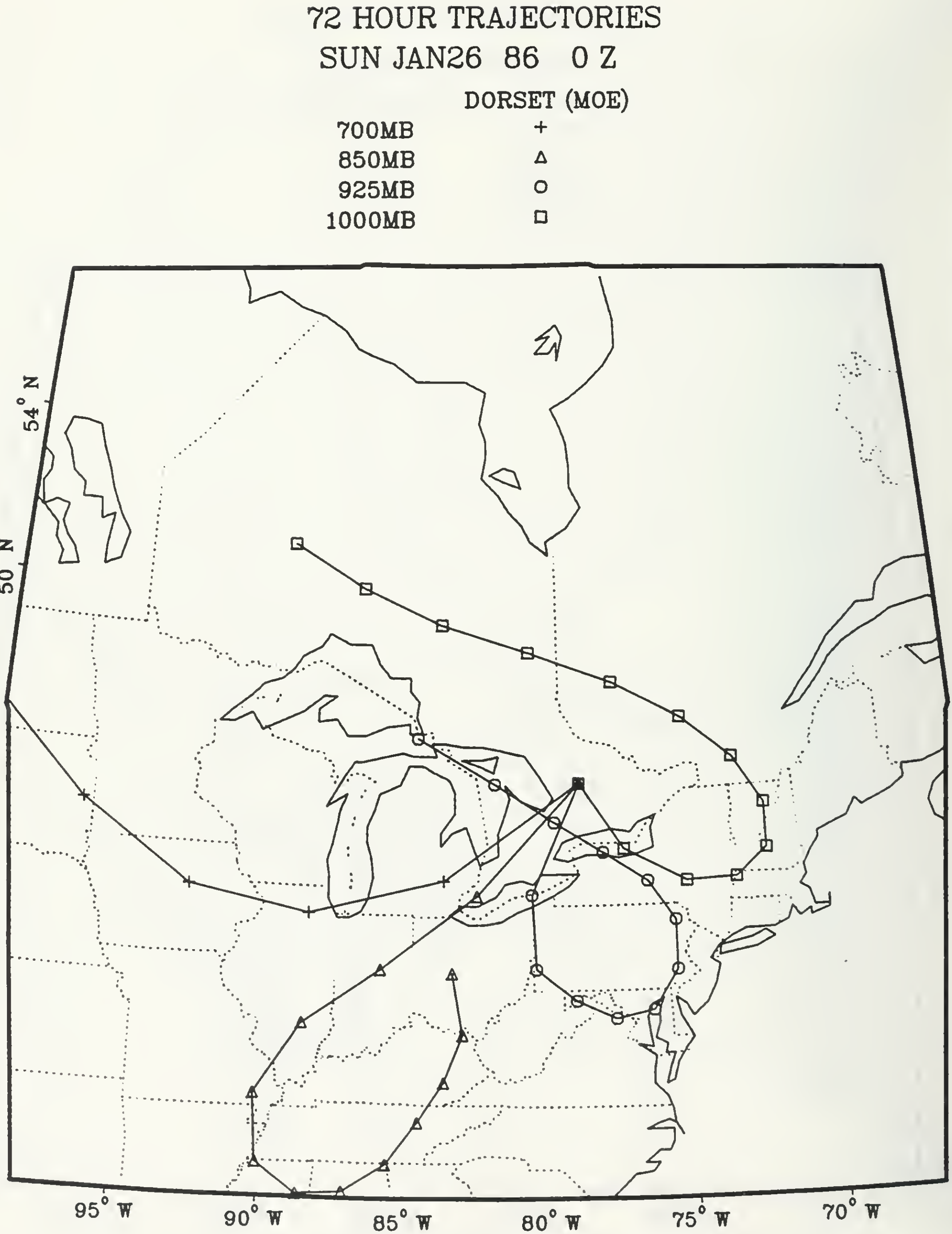

72 HOUR TRAJECTORIES
SUN JAN26 86 0 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.2.6

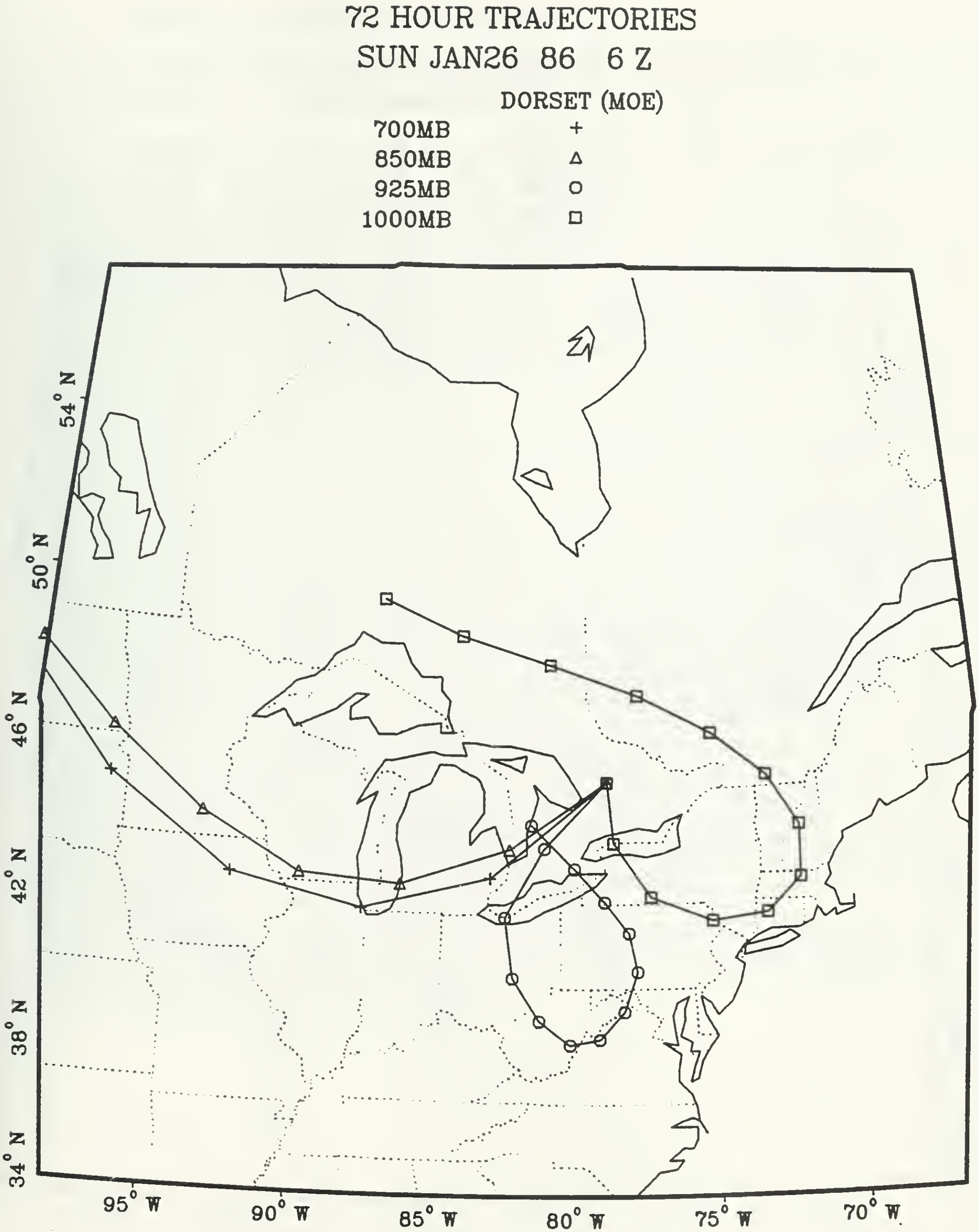

72 HOUR TRAJECTORIES
SUN JAN26 86 6 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.2.7

72 HOUR TRAJECTORIES
SUN JAN26 86 12 Z

	DORSET (MOE)
700MB	+
850MB	Δ
925MB	O
1000MB	□

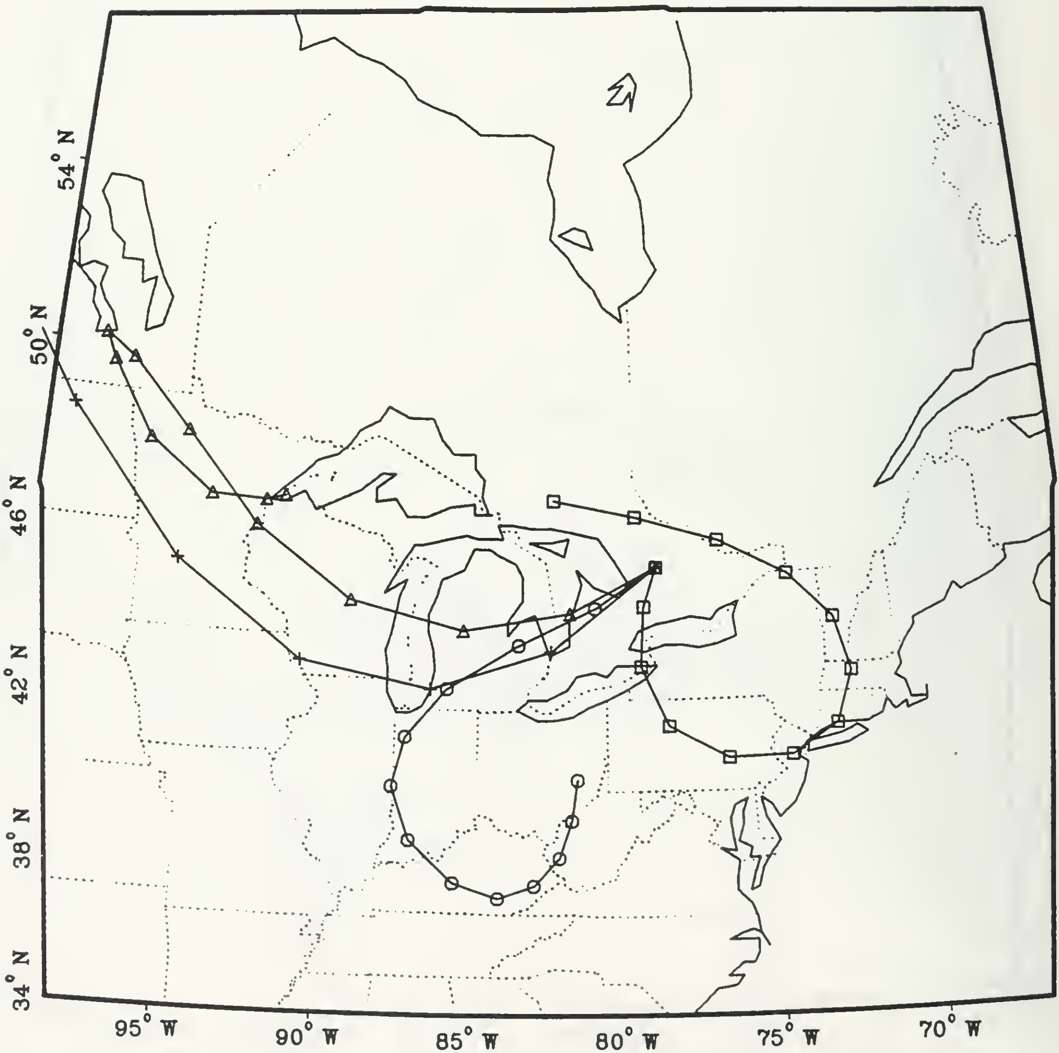


FIGURE 2.2.8

2.3 <u>February 7-8, 1986, Longwoods (AES)</u>

It was ranked fourth (4/10) in the NO_3^- top 25% wet deposition events for Longwoods (AES). The sampler of the Longwoods (MOE) malfunctioned and therefore no observation was made.

A low pressure centre, 1002 mb, over Cleveland, Ohio, associated with frontal systems on Feb 7, at 12Z as shown in Fig. 2.3.1, moved slowly south of Longwoods in a NE direction to lie near Buffalo, New York on Feb 8, at 12Z as shown in Fig. 2.3.2. The continuous precipitation area associated with the low covered the station for almost the whole duration of the episode and snow fell at the station for about 23.5 hours as shown in Fig. 2.3.3. Moderate and heavy snow in the beginning changed to light and very light snow as the low centre moved away from Longwoods.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for Feb. 7, 12Z, 18Z and Feb. 8, 00Z, 06Z and 12Z are shown in Figures 2.3.4, 2.3.5, 2.3.6, 2.3.7, and 2.3.8 respectively.
Air trajectories for the 1000 mb level show that they did not pass over any high emission sources and therefore no significant transport occurred.
Air trajectories for the 925 mb level show that NO_x from the highest emission New York City area could have been transported for some hours as exhibited in Fig. 2.3.5.
Air parcels arriving at the 850 mb level could have carried NO_x from its high emission areas in New Jersey, Pennsylvania, Maryland, West Virginia and Ohio (see Figs. 2.3.4-8) throughout this episode. No highest emission source area is involved.
Air trajectories for the 700 mb level show that NO_x from its high emission areas in Ohio, West Virginia and Pennsylvania could have been transported for most of the period. No highest emission source area is involved.
In summary, a low pressure centre tracked nearby south of Longwoods slowly and yielded snow for almost the entire duration of the episode. Moderate & heavy snow occurred for about three hours and light and very light snow fell for the remaining period. Transport of NO_x at low level (925 mb) from its highest emission New York area and at high level (850 mb & 700 mb) from high emission area in New Jersey, Maryland, Pennsylvania, West virginia and Ohio was likely.
It is interesting to note that although SO_2 also would have been transported from a number of highest emission areas, this episode did not rank high for sulphate events. It is likely due to snow not depositing sulphate efficiently.

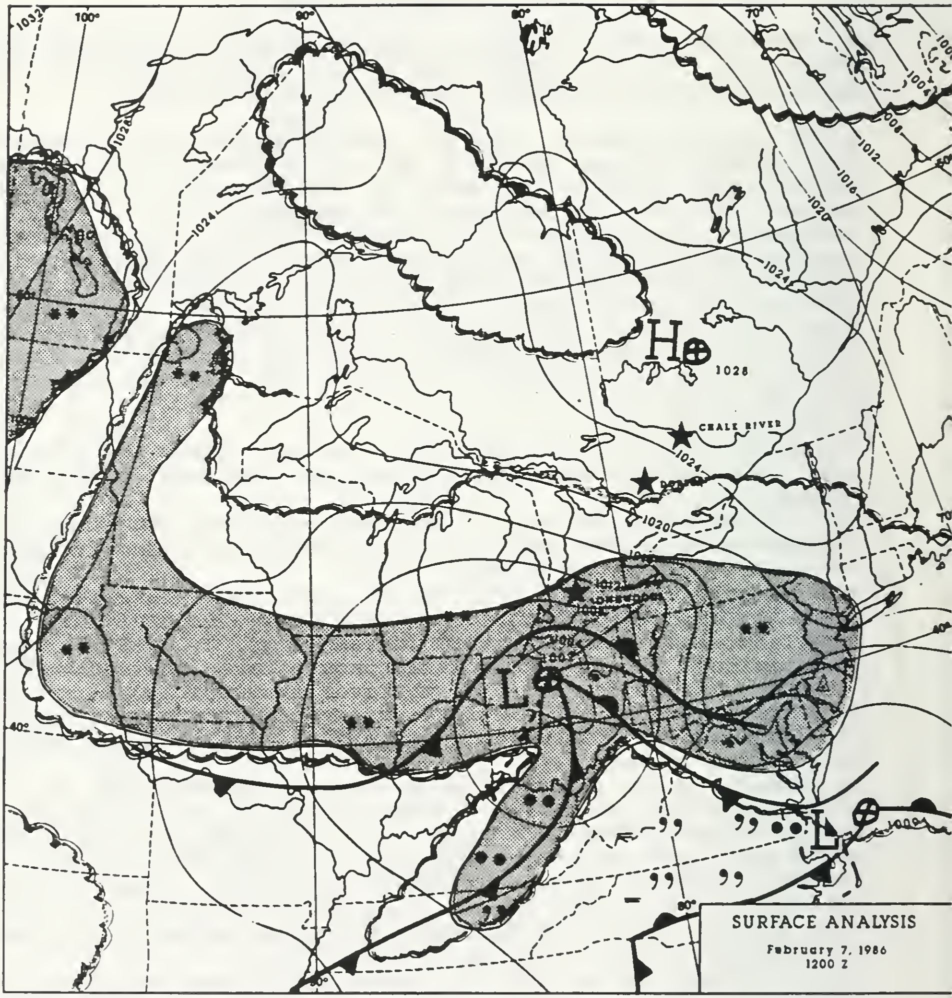


FIGURE 2.3.1

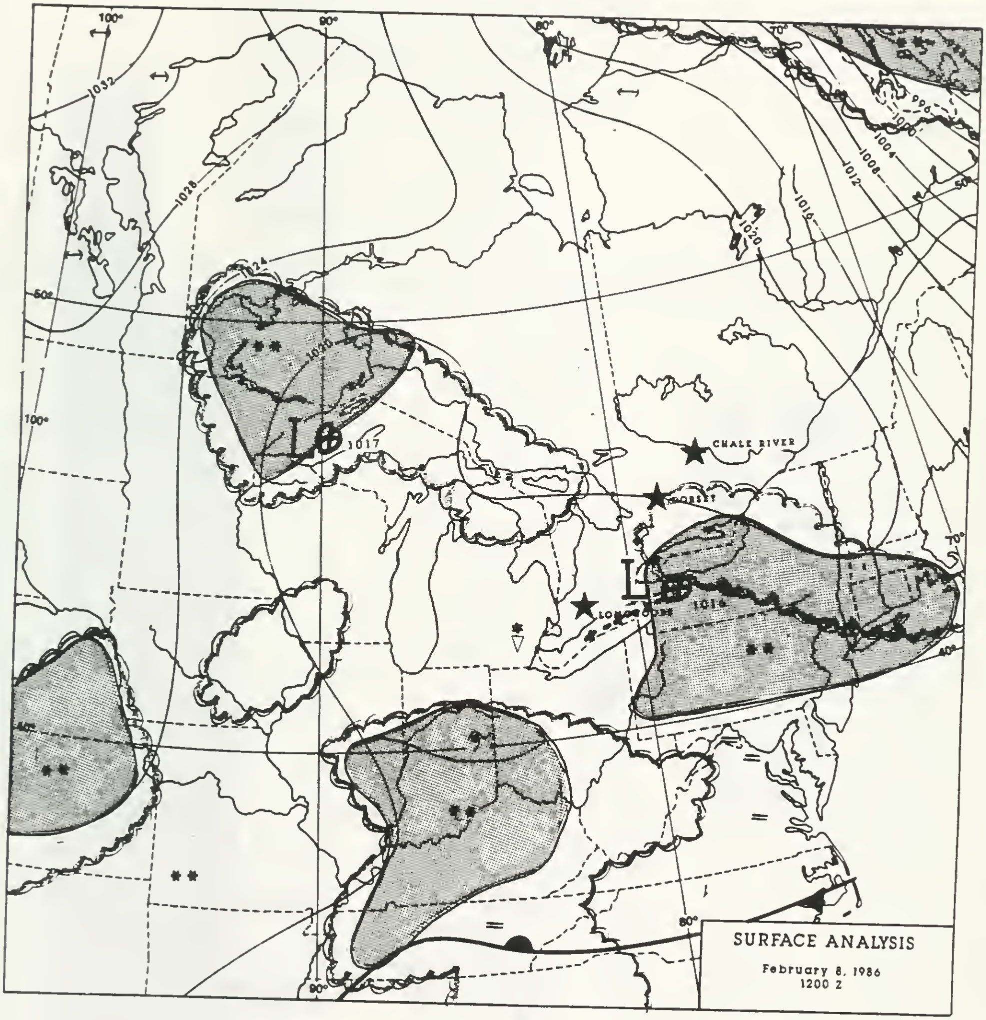

SURFACE ANALYSIS
February 8, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1032
1028
1024
1020
1016
1012
1008
1004
1000
996
1017
1014
100°
90°
80°
70°
50°
40°

FIGURE 2.3.2

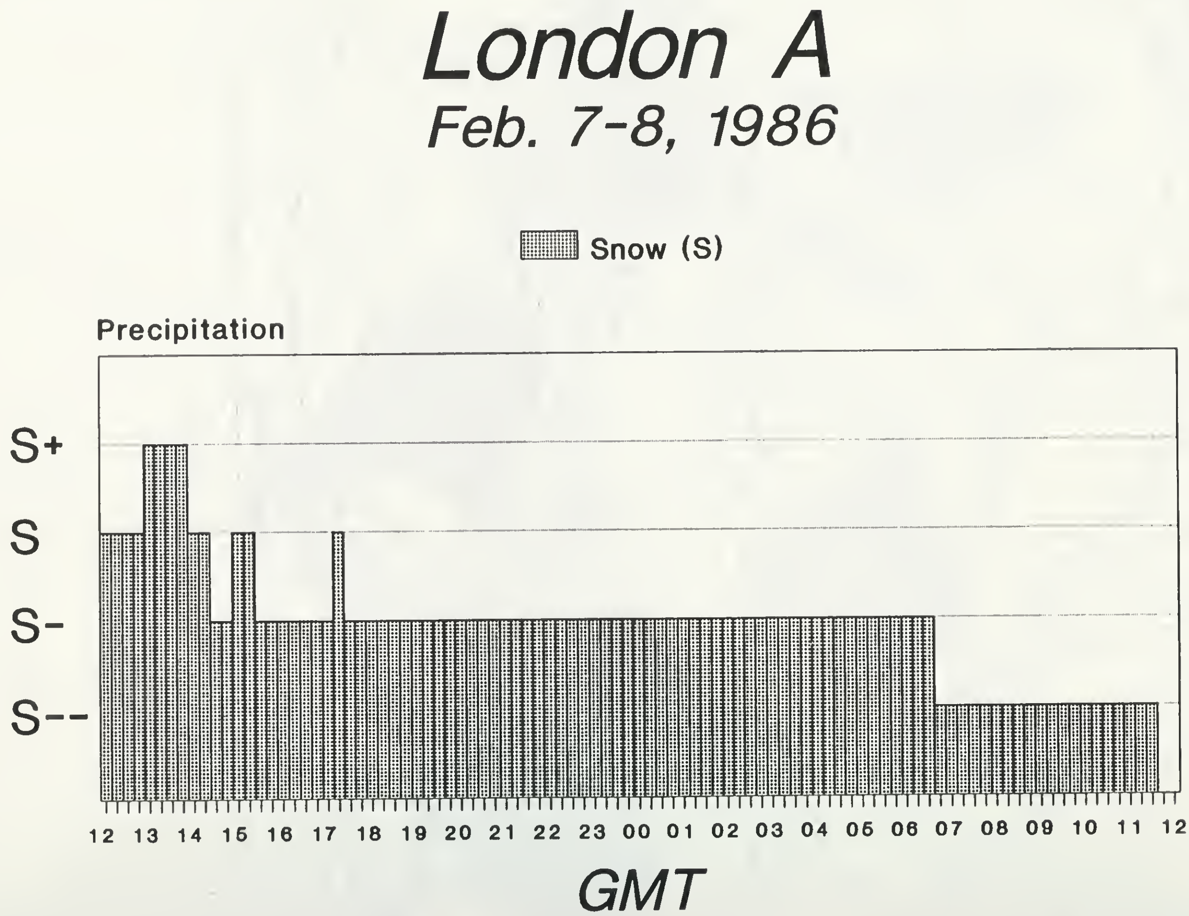
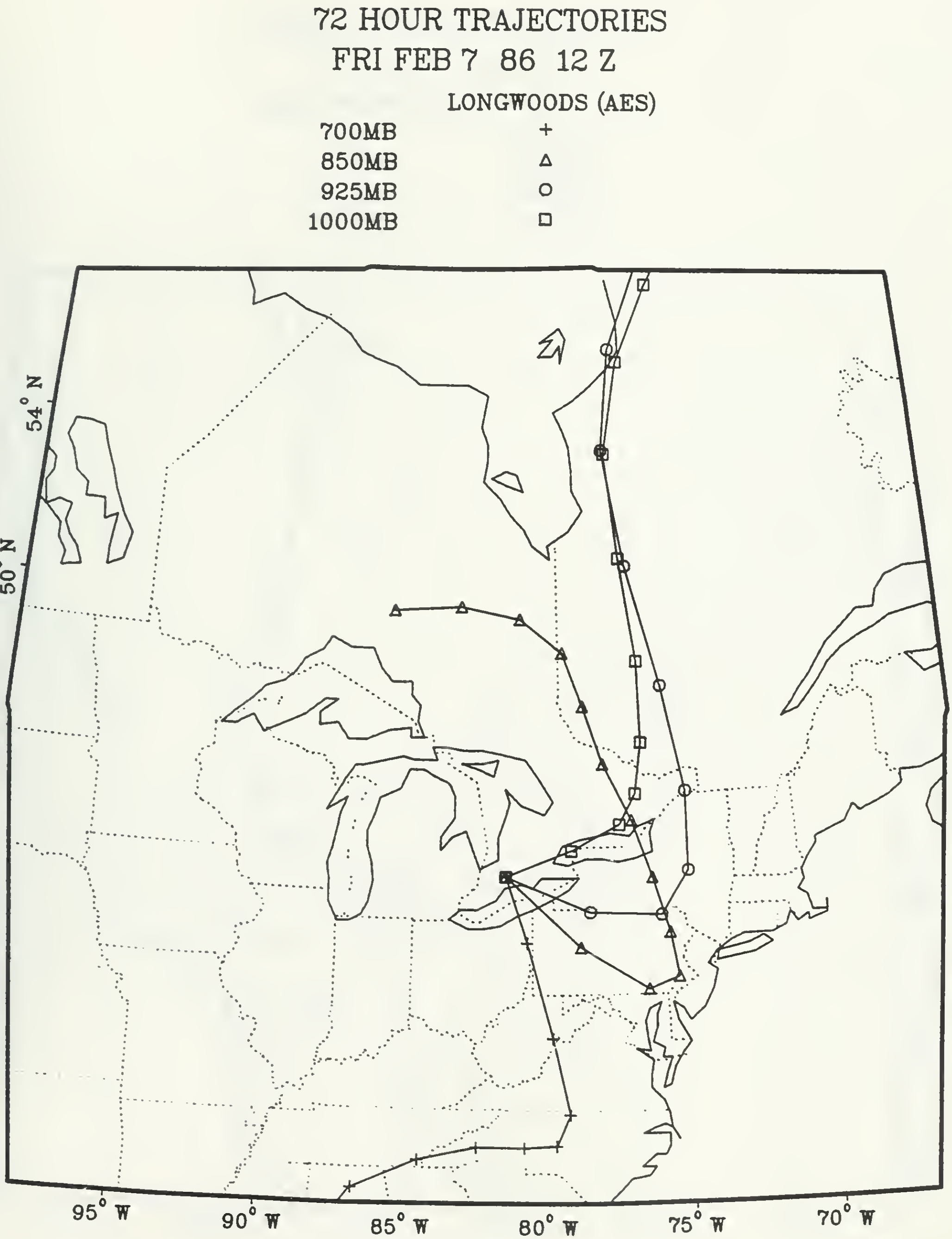

London A
Feb. 7-8, 1986
Snow (S)
Precipitation
S+
S
S-
S--
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT

FIGURE 2.3.3



72 HOUR TRAJECTORIES
FRI FEB 7 86 12 Z
LONGWOODS (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.3.4

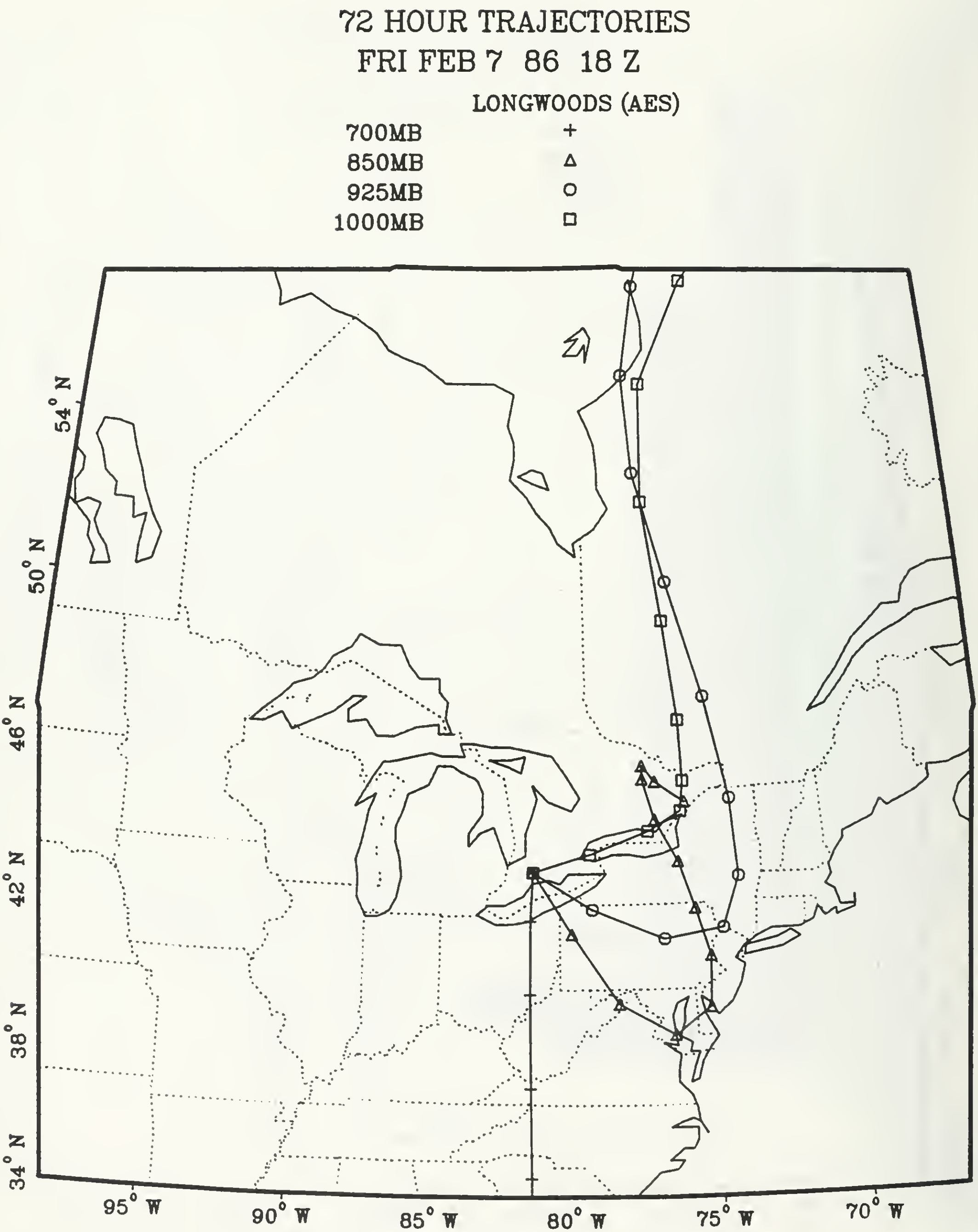

72 HOUR TRAJECTORIES
FRI FEB 7 86 18 Z
LONGWOODS (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.3.5

72 HOUR TRAJECTORIES
SAT FEB 8 86 0 Z

	LONGWOODS (AES)
700MB	+
850MB	△
925MB	○
1000MB	□

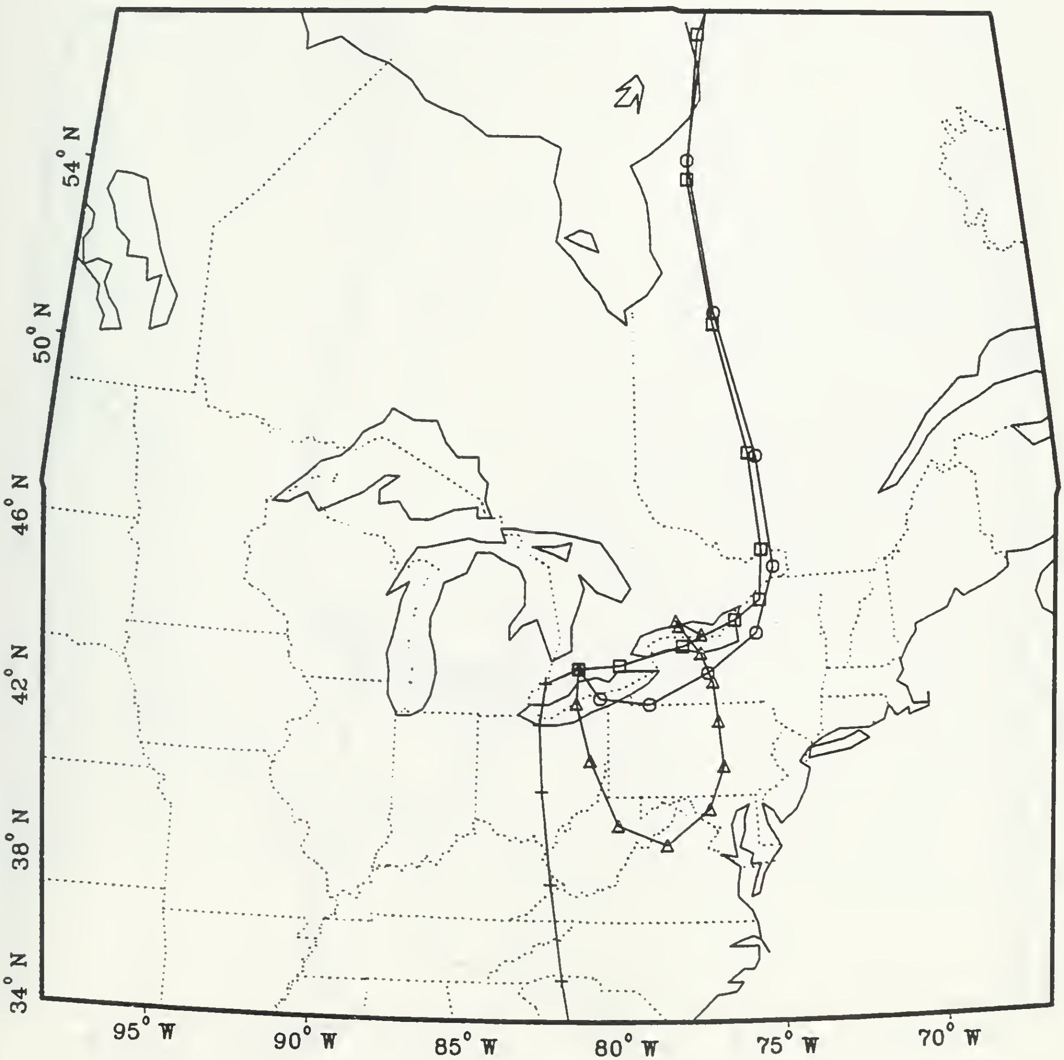


FIGURE 2.3.6

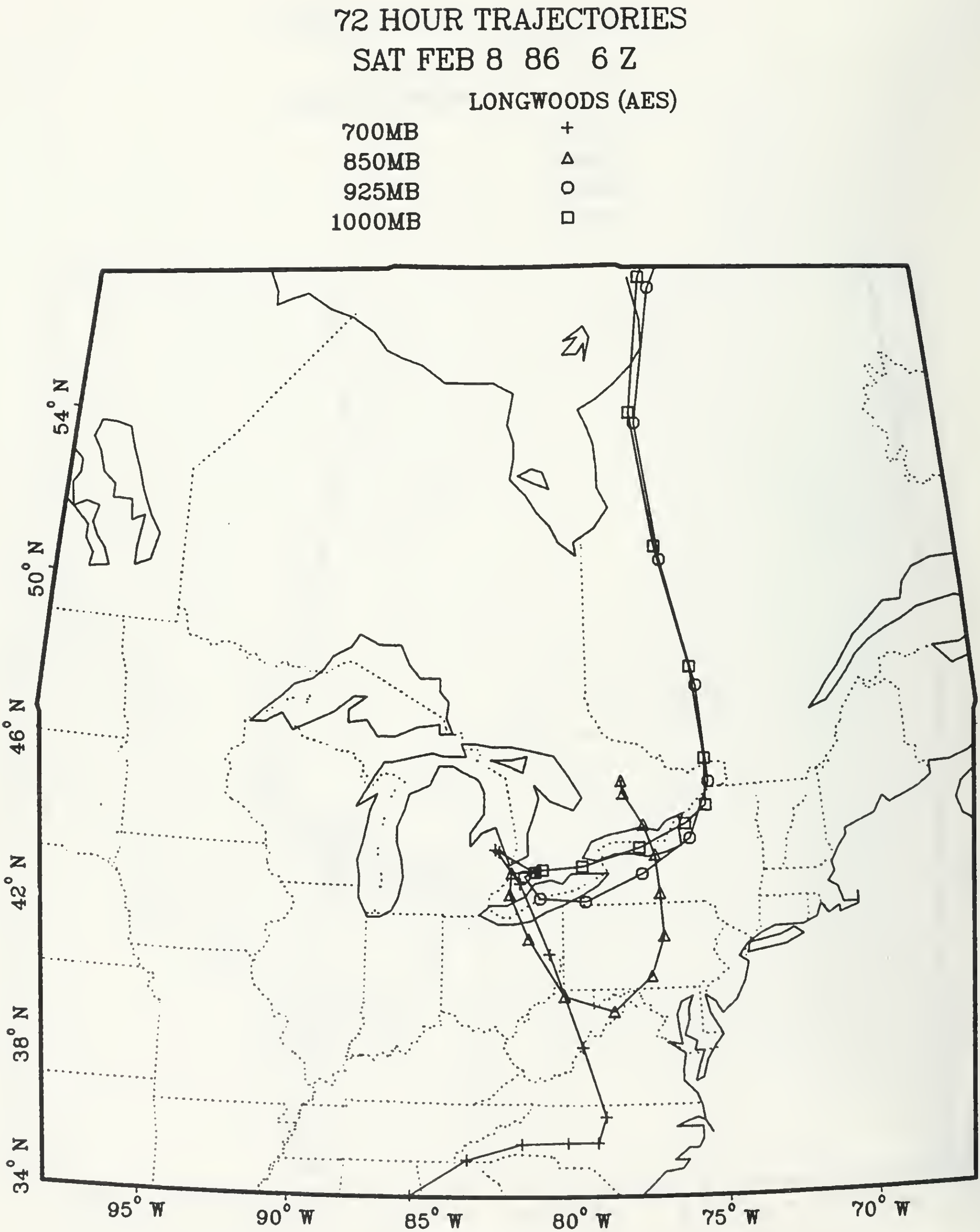

72 HOUR TRAJECTORIES
SAT FEB 8 86 6 Z
LONGWOODS (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.3.7

72 HOUR TRAJECTORIES
SAT FEB 8 86 12 Z

	LONGWOODS (AES)
700MB	+
850MB	△
925MB	○
1000MB	□

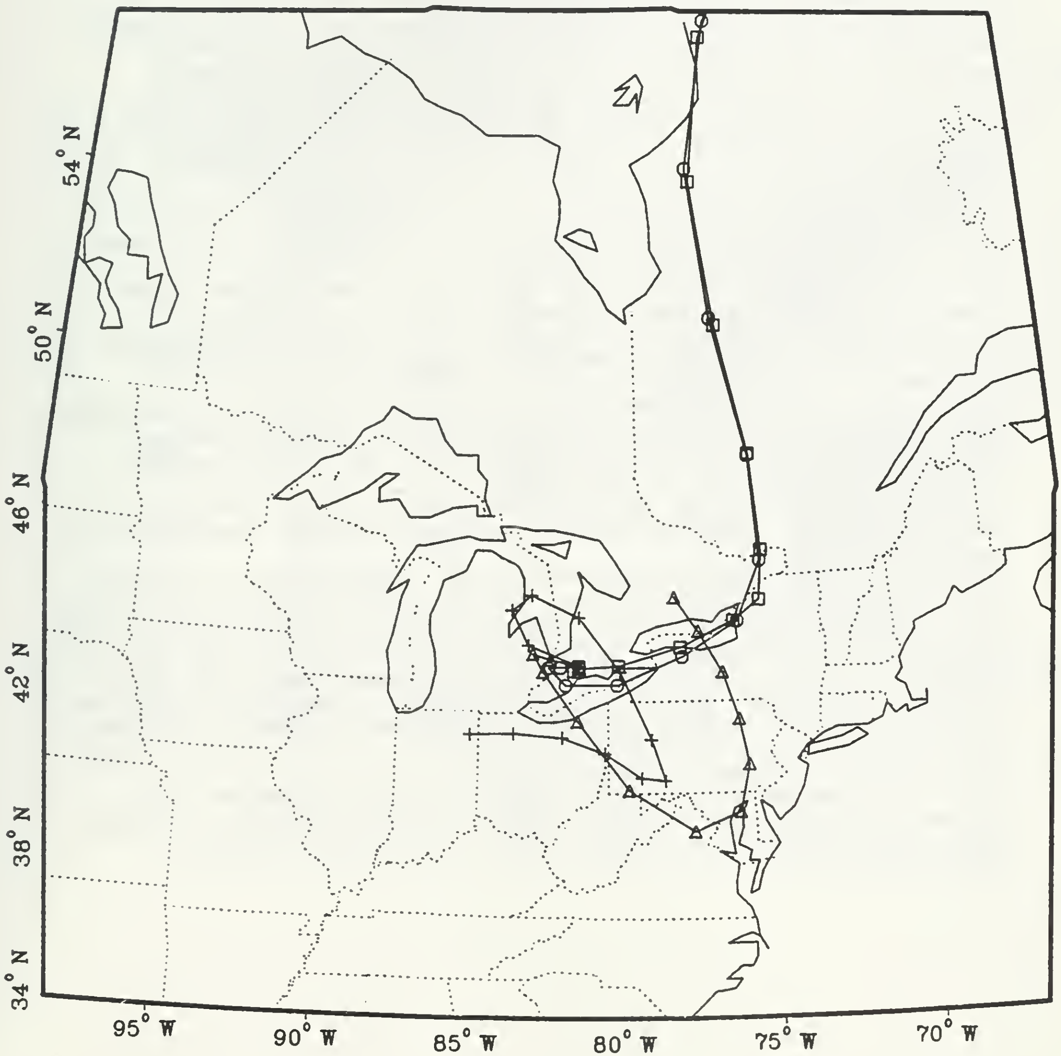


FIGURE 2.3.8

2.4 February 18-19, 1986, Chalk River

This episode was ranked eighth (the last) in the NO_3^- top 25% wet deposition list.

On Feb 18, at 12Z, a front north of Chalk River and a frontal system in the southern Ontario were analyzed as shown in Fig. 2.4.1. The synoptic situation during the next 24 hours was such that a front to the north of the station and a system in the southern Ontario remained. The synoptic condition on Feb 19, at 12Z, is shown in Fig. 2.4.2. Due to these frontal systems, freezing precipitation in the form of snow grain, freezing rain and freezing drizzle was recorded at the nearest weather station Petawawa A as illustrated in Fig. 2.4.3. Except for two small breaks, as shown in the figure, lasting for about an hour, precipitation occurred at the station for about 23 hrs.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for Feb. 18, 12Z, 18Z and Feb. 19, 00Z, 06Z and 12Z are shown in Figures 2.4.4, 2.4.5, 2.4.6, 2.4.7, and 2.4.8 respectively.
Air trajectories for the 1000 mb level show that no significant transport of NO_x occurred as the trajectories did not pass over any significant emission source areas.
Air trajectories for the 925 mb level show that NO_x could have been transported from its high emission areas in Ohio, Pennsylvania and Maryland (Fig. 2.4.4-5), and in Ohio and West Virginia (Fig. 2.4.6-8) states. No highest emission area is involved.
Air parcels arriving at the 850 mb level show that NO_x could have been transported from its high emission St. Louis, Missouri (Fig. 2.4.5-8) and Detroit, Michigan (Fig. 2.4.6-8) areas. No highest emission area is involved.
Air trajectories at the 700 mb level show that NO_x could have been transported from the highest emission Chicago area for a few hours (Fig. 2.4.6).
In summary, synoptic situation was such that, although no front passed over the station, frontal presence in the region gave rise to freezing precipitation for about 23 hours in the form of very light snow grain, very light and light freezing rain and freezing drizzle. NO_x from the highest emission Chicago area could have been transported at high level (700 mb) for a few hours. High and low level transport from several high emission areas in Maryland, Pennsylvania, Ohio, West Virginia, Detroit, St. Louis was likely for a longerr period of time.
It is interesting to note that despite likely transport from a number of highest SO_2 emission areas, the episode was not ranked high enough and this is likely due to the freezing type of precipitation.

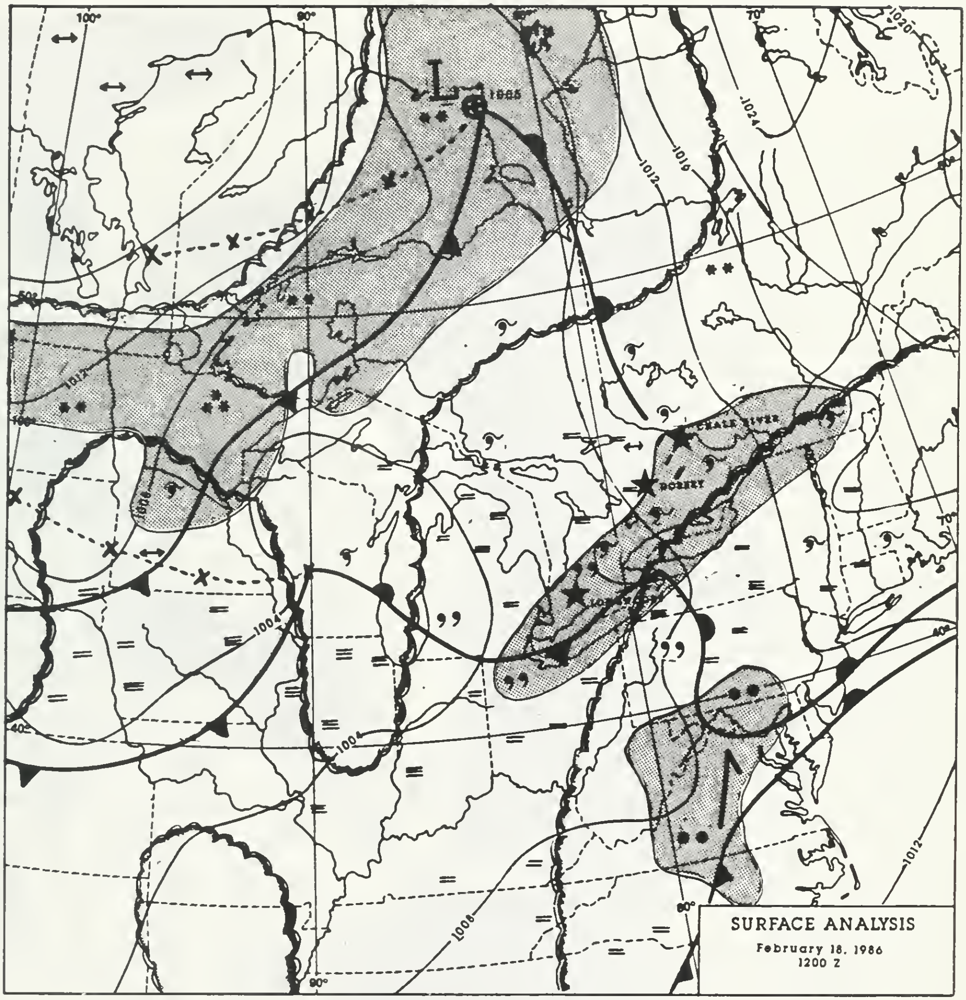


FIGURE 2.4.1

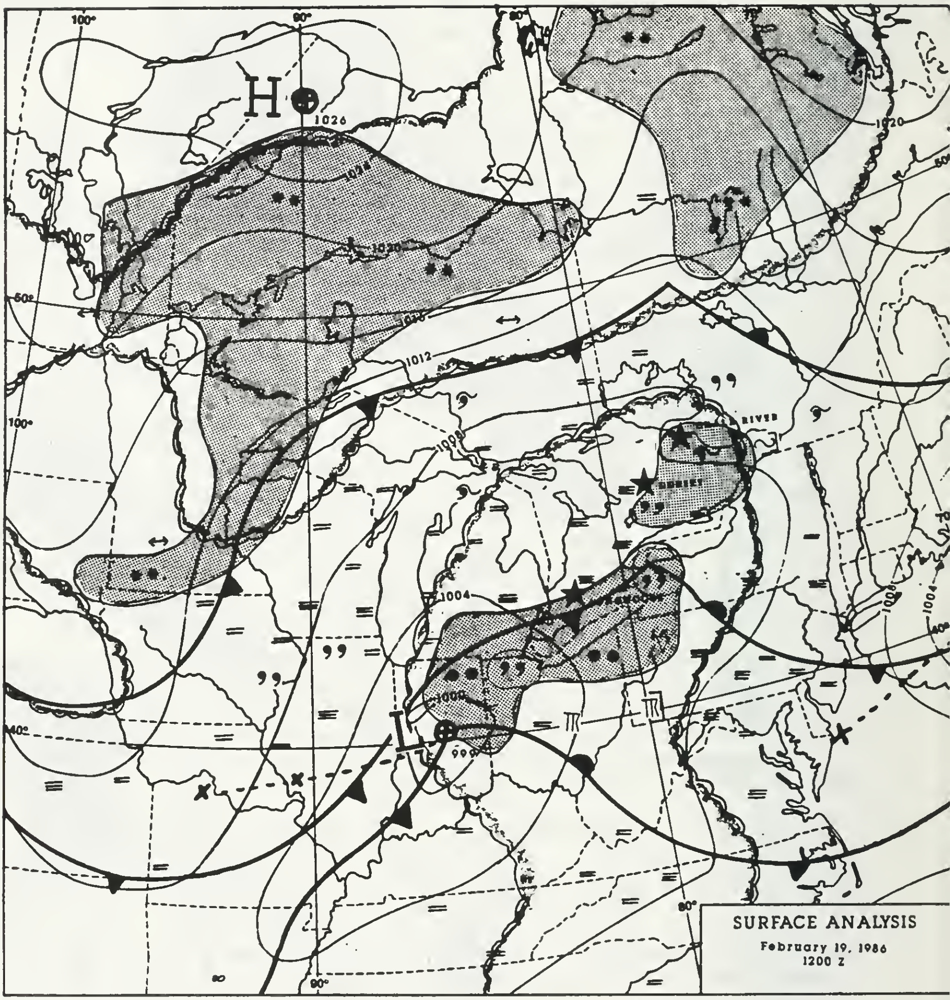
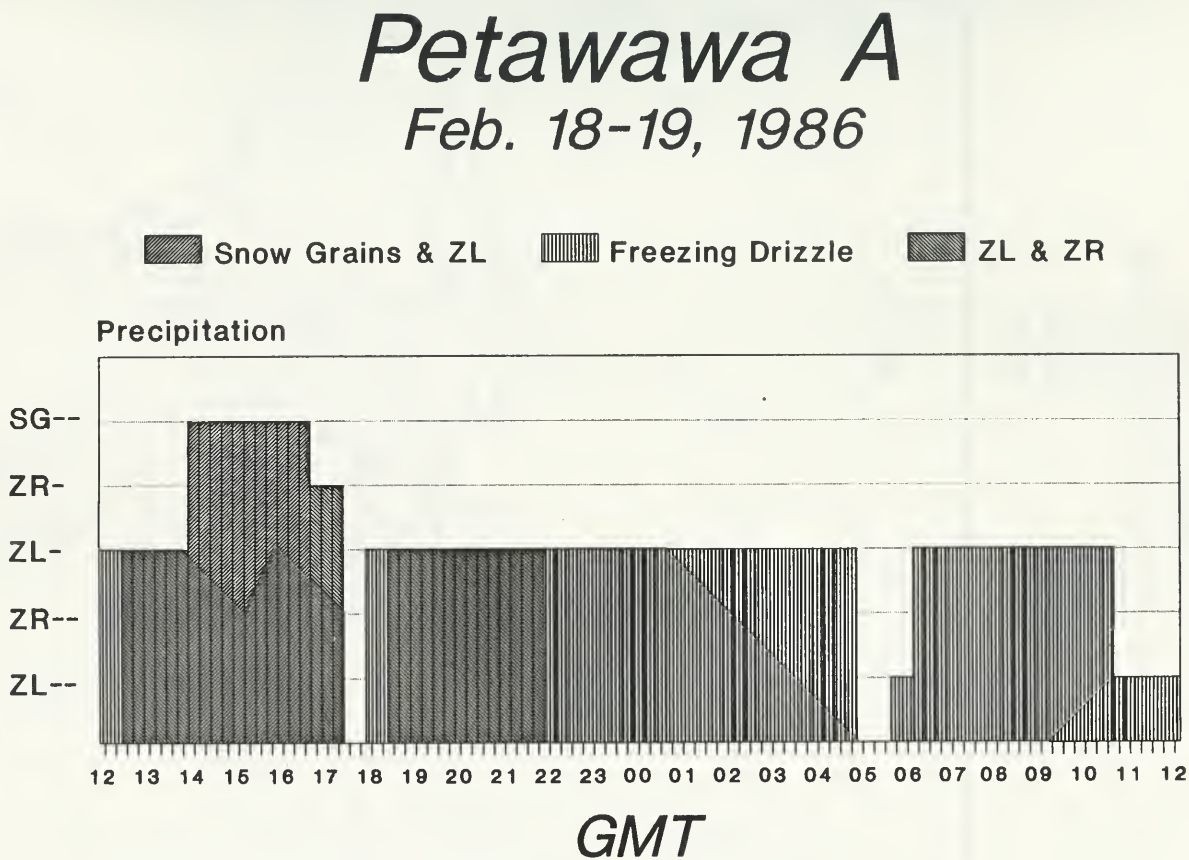

SURFACE ANALYSIS
February 19, 1986
1200 Z
H
L
1026
1024
1020
1016
1012
1008
1004
1000
999
60°
100°
90°
80°
40°
RIVER

FIGURE 2.4.2



SG - Snow Grains, ZR - Freezing Rain
ZL - Freezing Drizzle

FIGURE 2.4.3

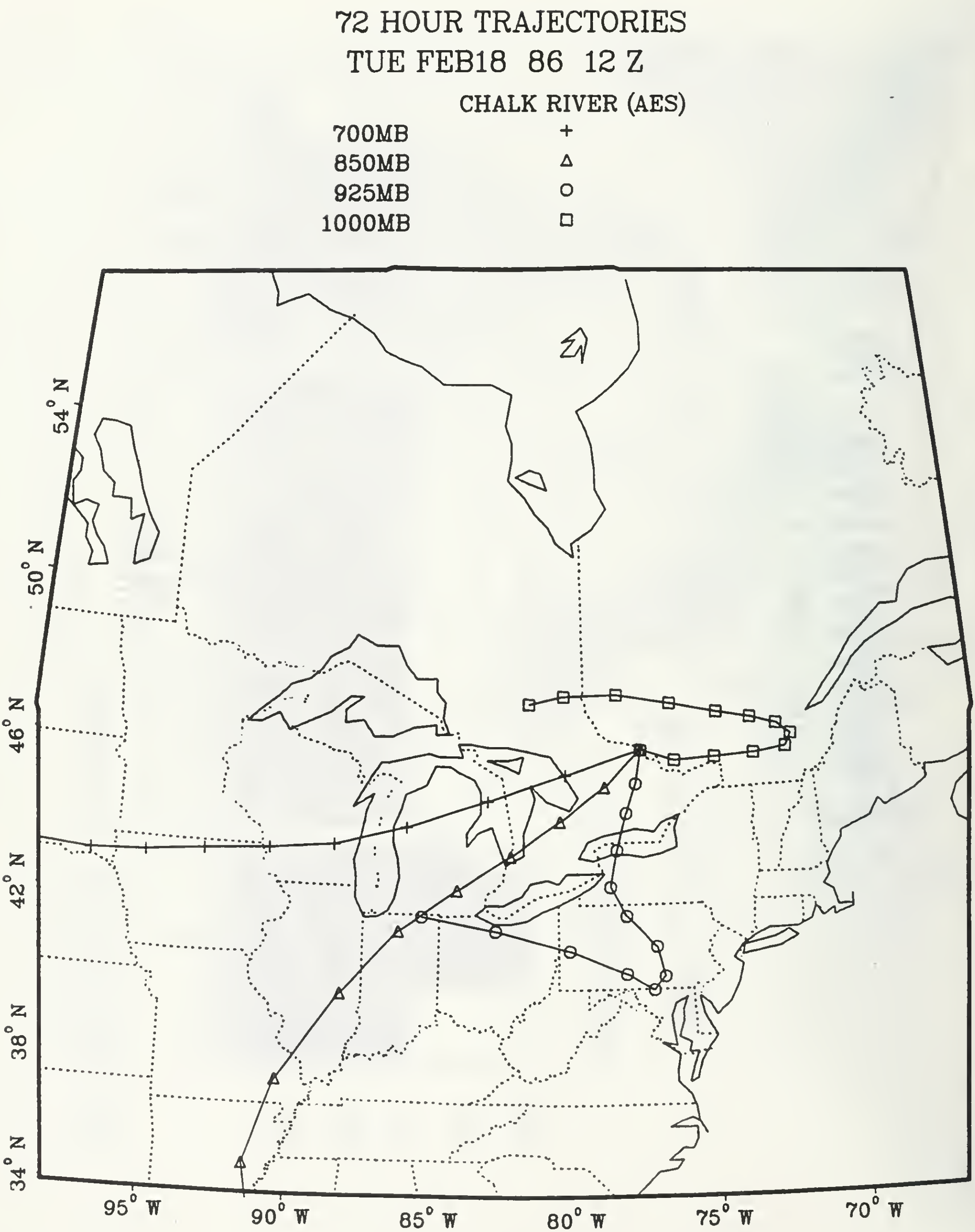

72 HOUR TRAJECTORIES
TUE FEB18 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.4.4

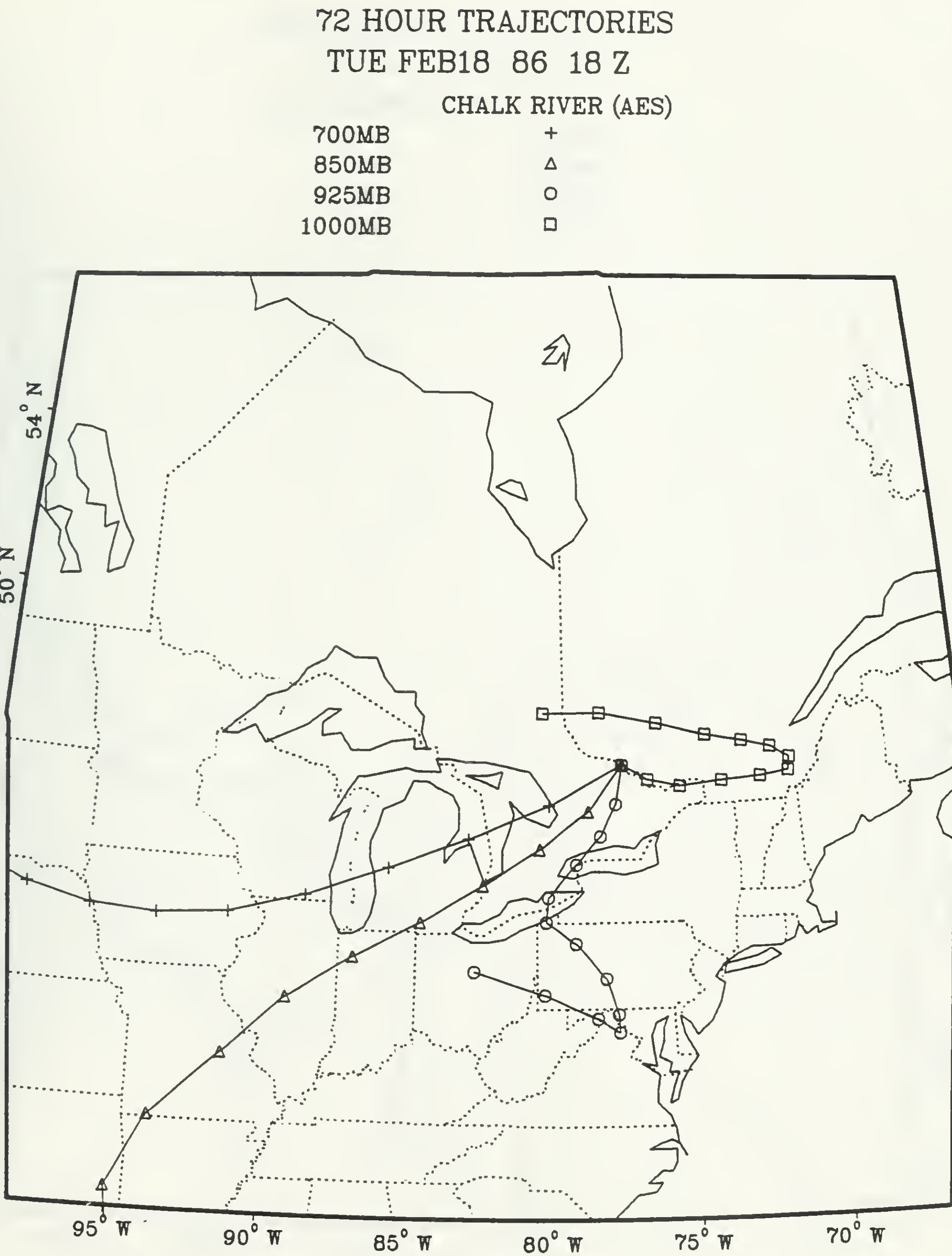

72 HOUR TRAJECTORIES
TUE FEB18 86 18 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.4.5

72 HOUR TRAJECTORIES
WED FEB19 86 0 Z

CHALK RIVER (AES)

700MB	+
850MB	Δ
925MB	O
1000MB	□

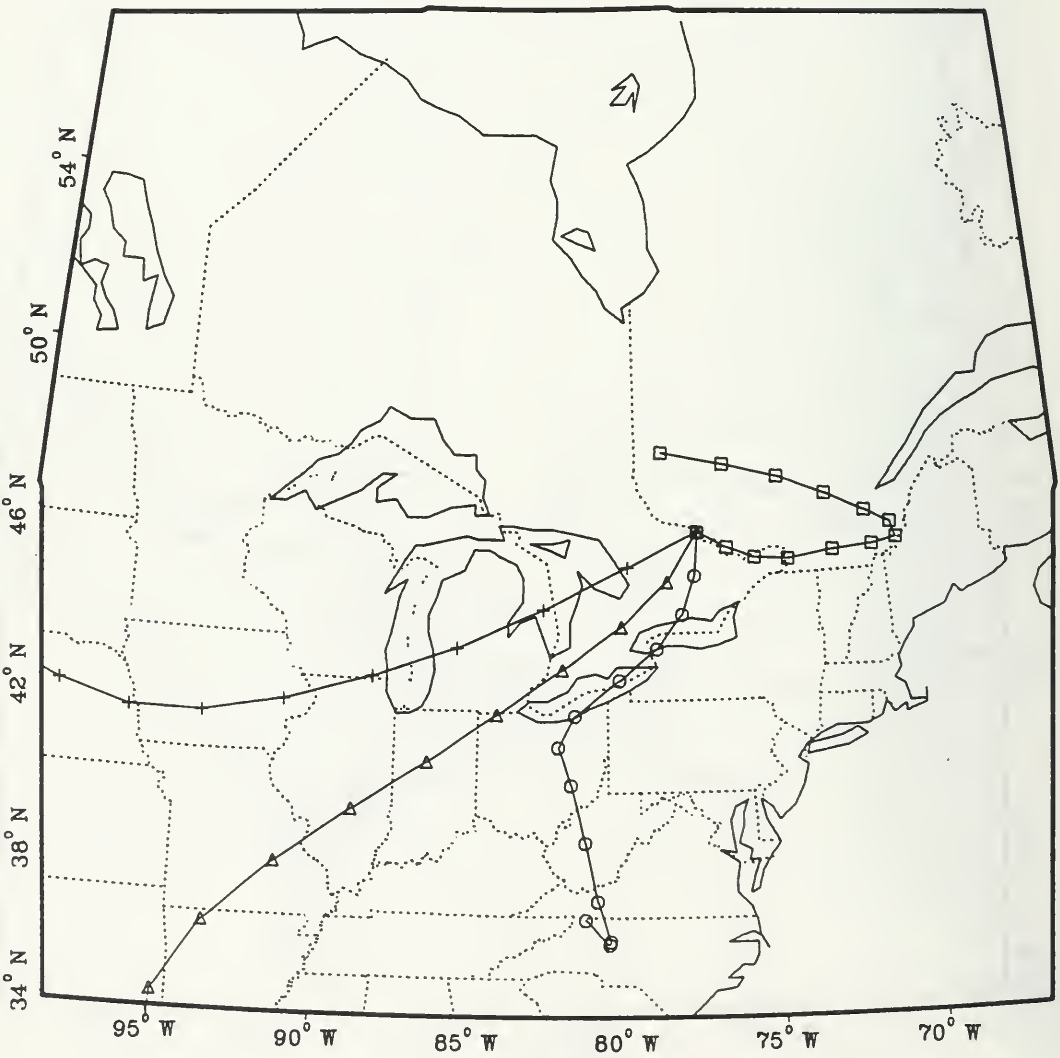


FIGURE 2.4.6

72 HOUR TRAJECTORIES
WED FEB19 86 6 Z

CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

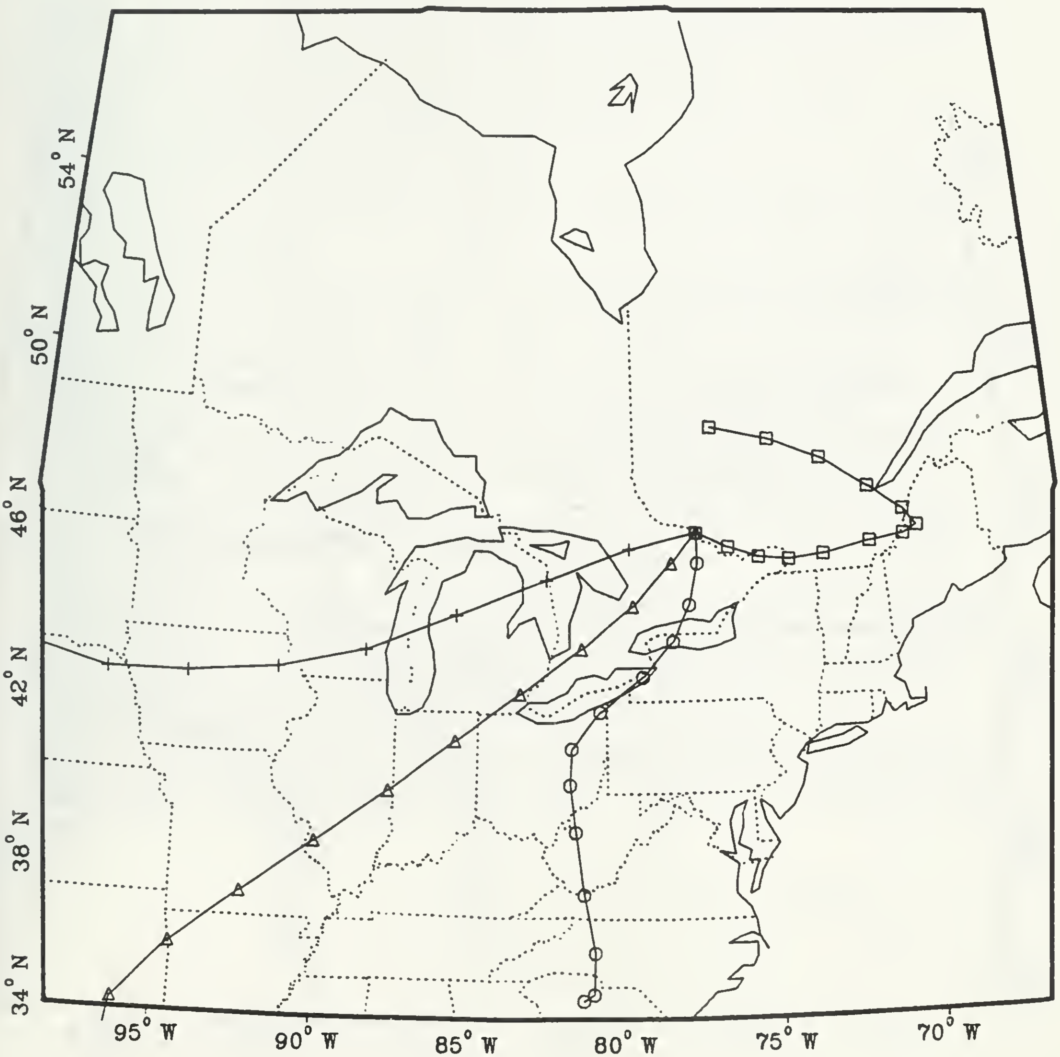


FIGURE 2.4.7

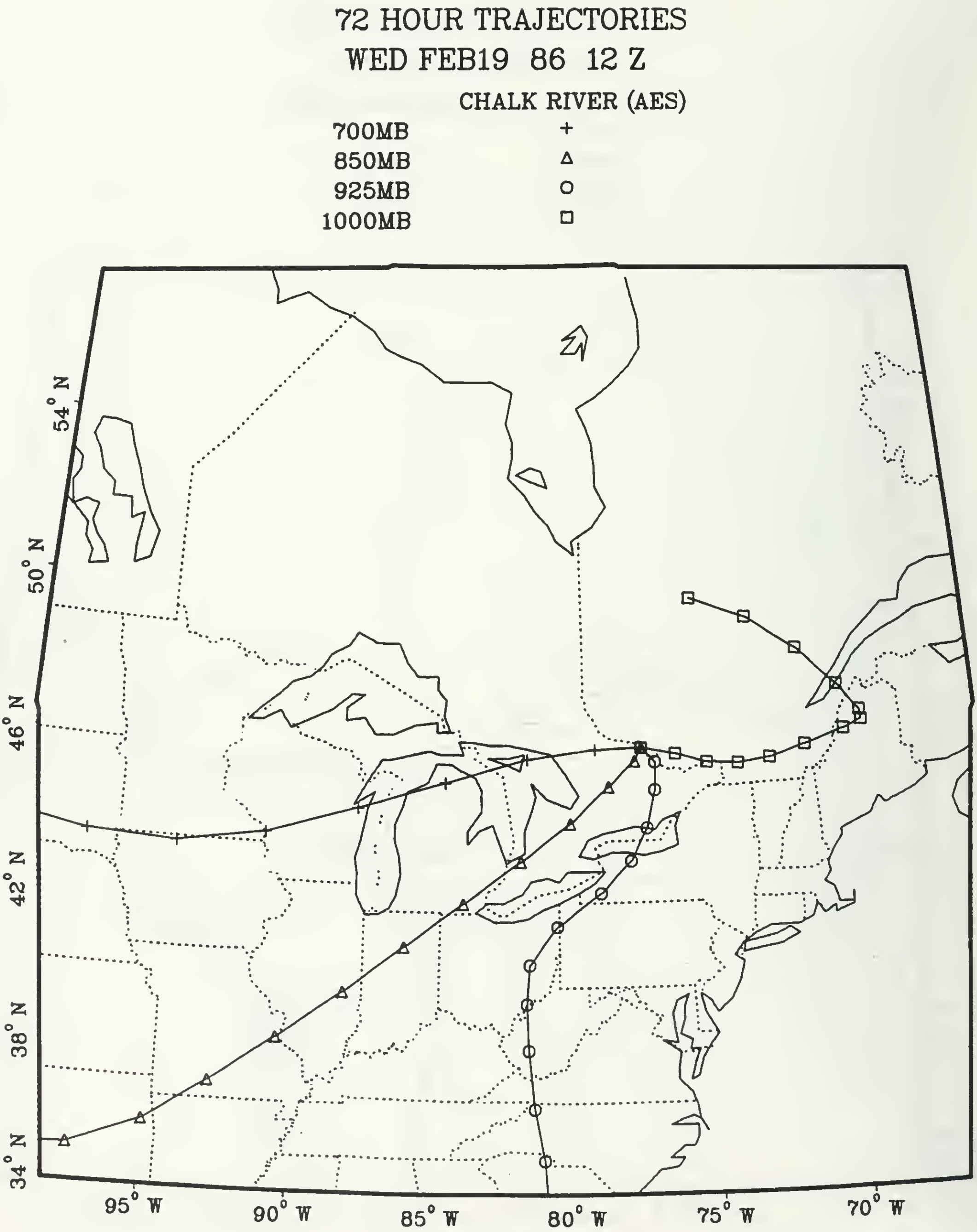

72 HOUR TRAJECTORIES
WED FEB19 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.4.8

2.5 March 5-6, 1986, Longwoods (AES & MOE)

This episode ranked 7th (7/10) and 9th (9/10) in the NO_3^- wet deposition events at Longwoods (AES) and Longwoods (MOE) respectively.

A low pressure centre, 1002 mb, over Wisconsin-Minnesota border with the warm front over Lake Huron was observed on Mar 5, at 12Z as shown in Fig. 2.5.1. As exhibited in the figure, a wave near Minnesota-Iowa-Wisconsin border associated with a frontal system was also analyzed. The low moved ESE and on Mar 6, at 12Z, was located close to the station with the warm front lying over it as shown in Fig. 2.5.2. As the low approached Longwoods, the warm front moved southward and the system picked up moisture from the Great Lakes and dumped them in the region in form of snow as illustrated in Fig. 2.5.3. Snow with very light, light and moderate intensity were recorded for about 12 hrs and the moderate intensity was associated with the passage of warm front and the nearby low pressure centre.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for Mar. 5, 12Z, 18Z and Mar. 6, 00Z, 06Z and 12Z are shown in Figures 2.5.4, 2.5.5, 2.5.6, 2.5.7, and 2.5.8 respectively.

Air parcels arriving at the 1000 mb level show that NO_x could have been carried from its highest emission Chicago area for most of the period as shown in Figs. 2.5.5-8, and from high emission Detroit and Cleveland areas (Figs. 2.5.6-8).

Air trajectories at the 925 mb level show that NO_x from its highest emission Chicago (Fig. 2.5.6) area and high emission areas in Ohio (Figs. 2.5.6-8) could have been transported.

Air parcels arriving at the 850 mb level could have carried NO_x from its highest emission Chicago (Fig. 2.5.6) area for a short period and from high emission Detroit-Cleveland areas(Figs. 2.5.6-8) for a longer duration.

Air trajectories for the 700 mb level illustrate that NO_x from its highest emission Chicago (Fig. 2.5.6) area could have been transported.

Summarizing, there passed a low pressure centre in the vicinity and a warm front over the station yielding very light, light and moderate snow for about 12 hours. Low (1000 mb & 925 mb) and high (850 mb & 700 mb) level transport of NO_x from its highest emission Chicago area and from high emission Detroit and Cleveland area were likely.

It is to be noted that despite a probable transport of SO_2 from its highest emission areas, this episode did not count in the top 25% events and it is likely to be due to the frozen precipitation snow.

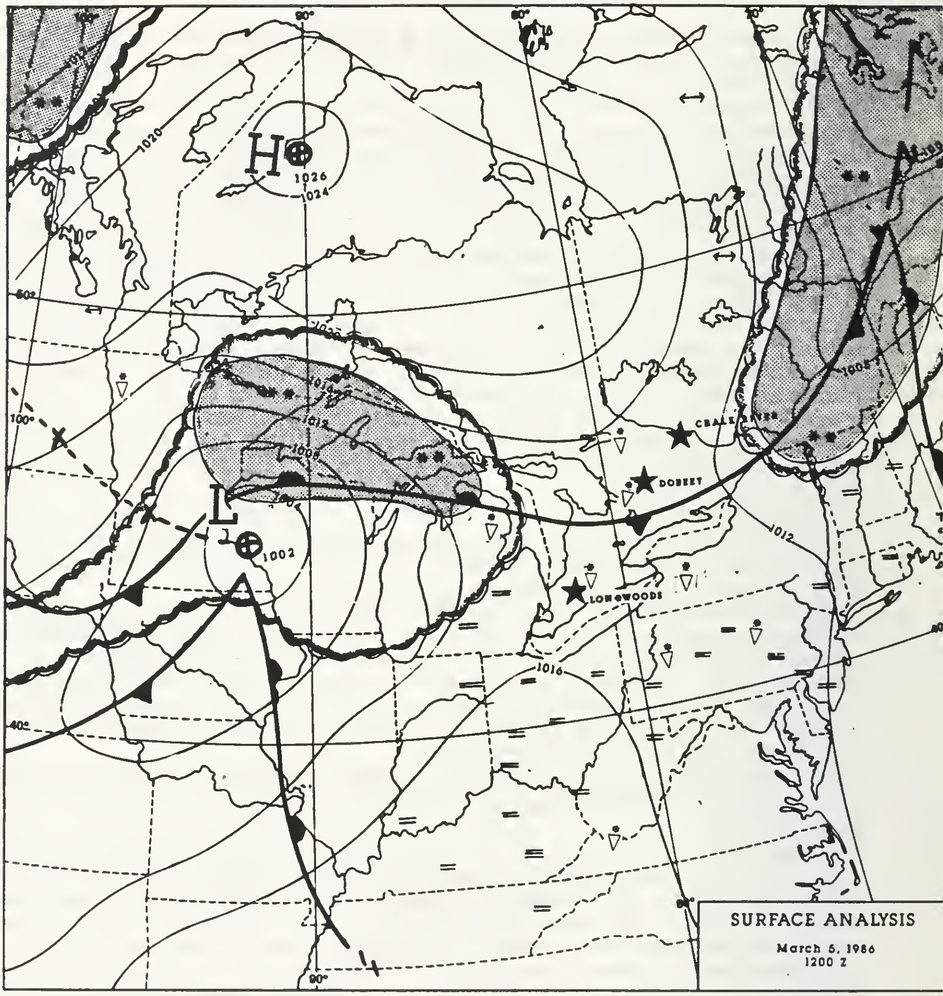

SURFACE ANALYSIS
March 6, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1026
1024
1020
1002
1012
1016

FIGURE 2.5.1

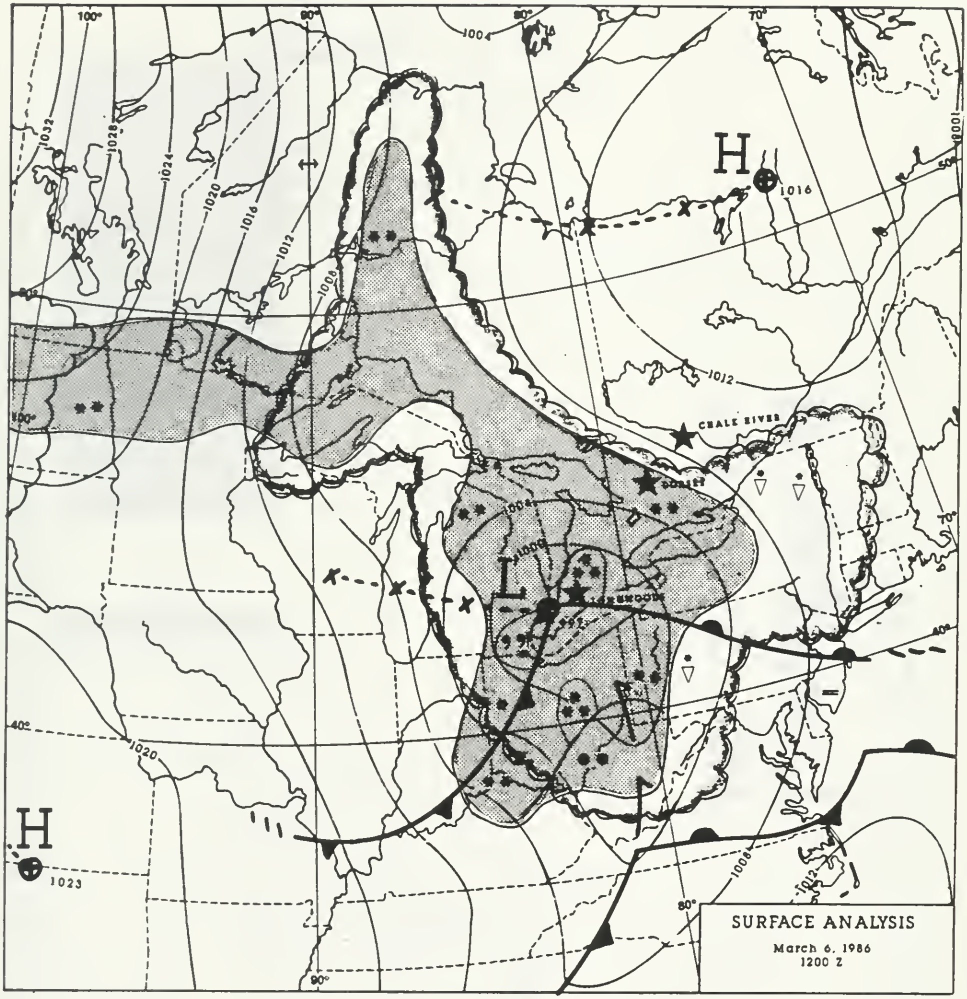

SURFACE ANALYSIS
March 6, 1986
1200 Z
H
1016
H
1023
L
CHALK RIVER
1004
1012
1008
1020
1024
1028
1032

FIGURE 2.5.2

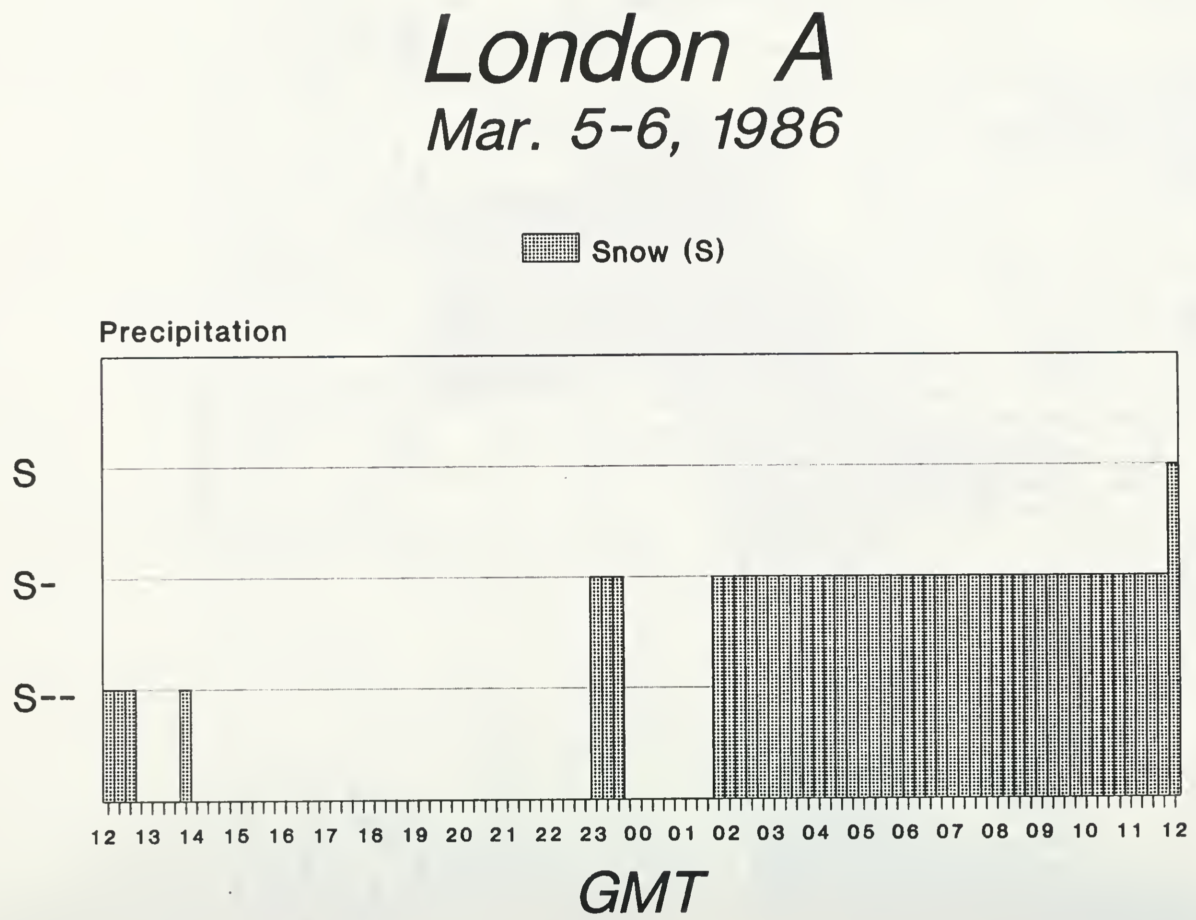

London A
Mar. 5-6, 1986
Snow (S)
Precipitation
S
S-
S--
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT

FIGURE 2.5.3

72 HOUR TRAJECTORIES
WED MAR 5 86 12 Z

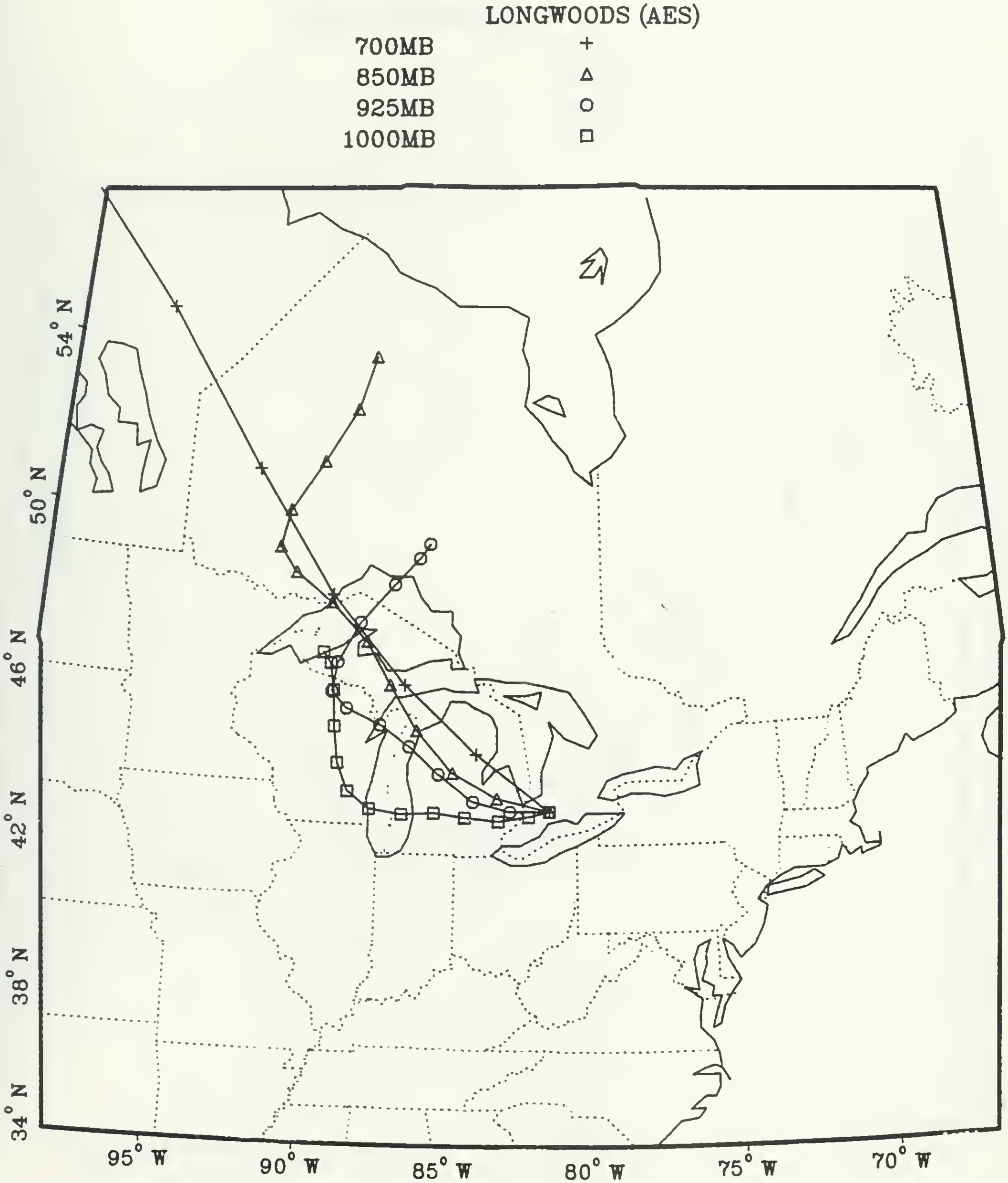


FIGURE 2.5.4

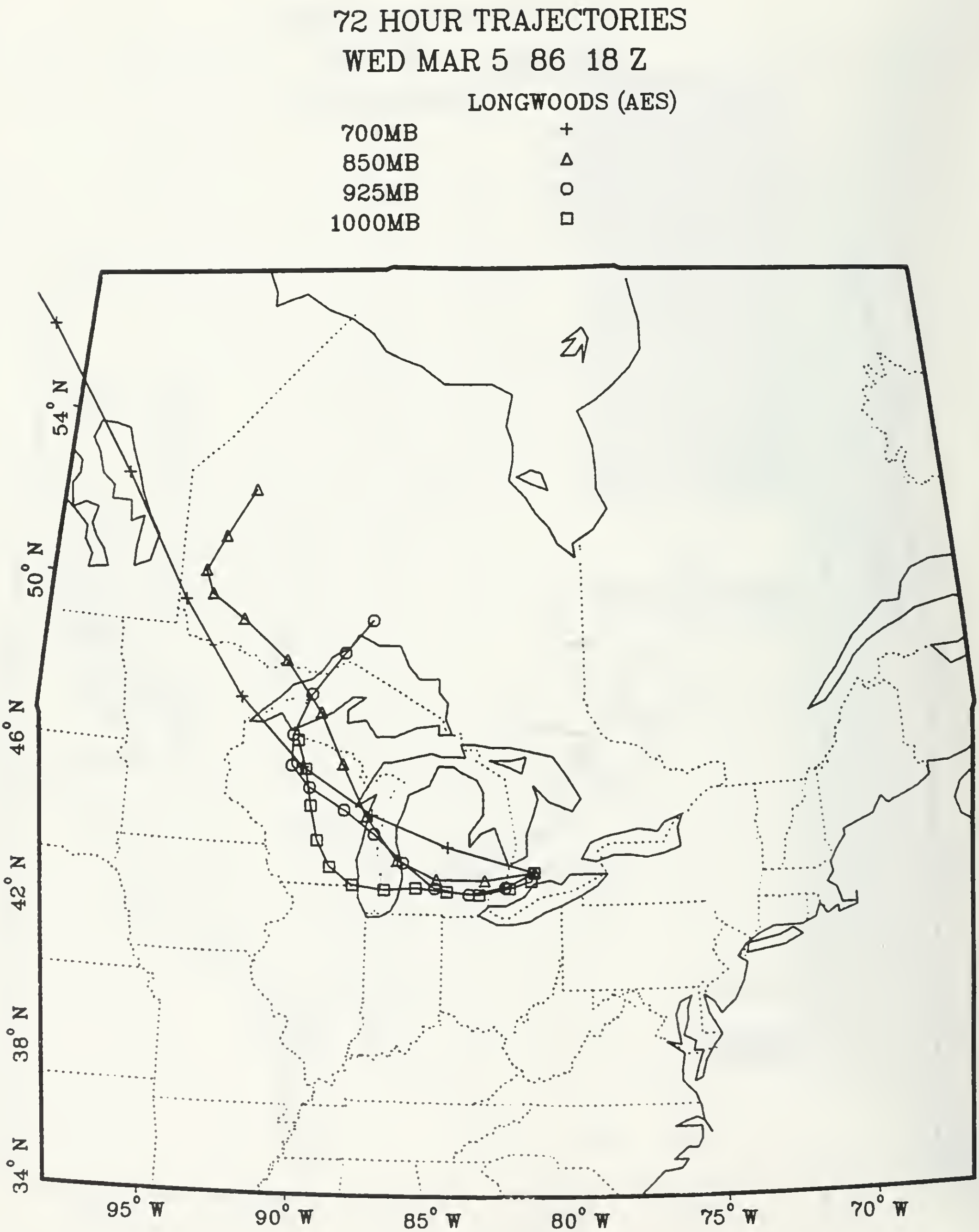

72 HOUR TRAJECTORIES
WED MAR 5 86 18 Z
LONGWOODS (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.5.5

72 HOUR TRAJECTORIES
THU MAR 6 86 0 Z

	LONGWOODS (AES)
700MB	+
850MB	△
925MB	○
1000MB	□

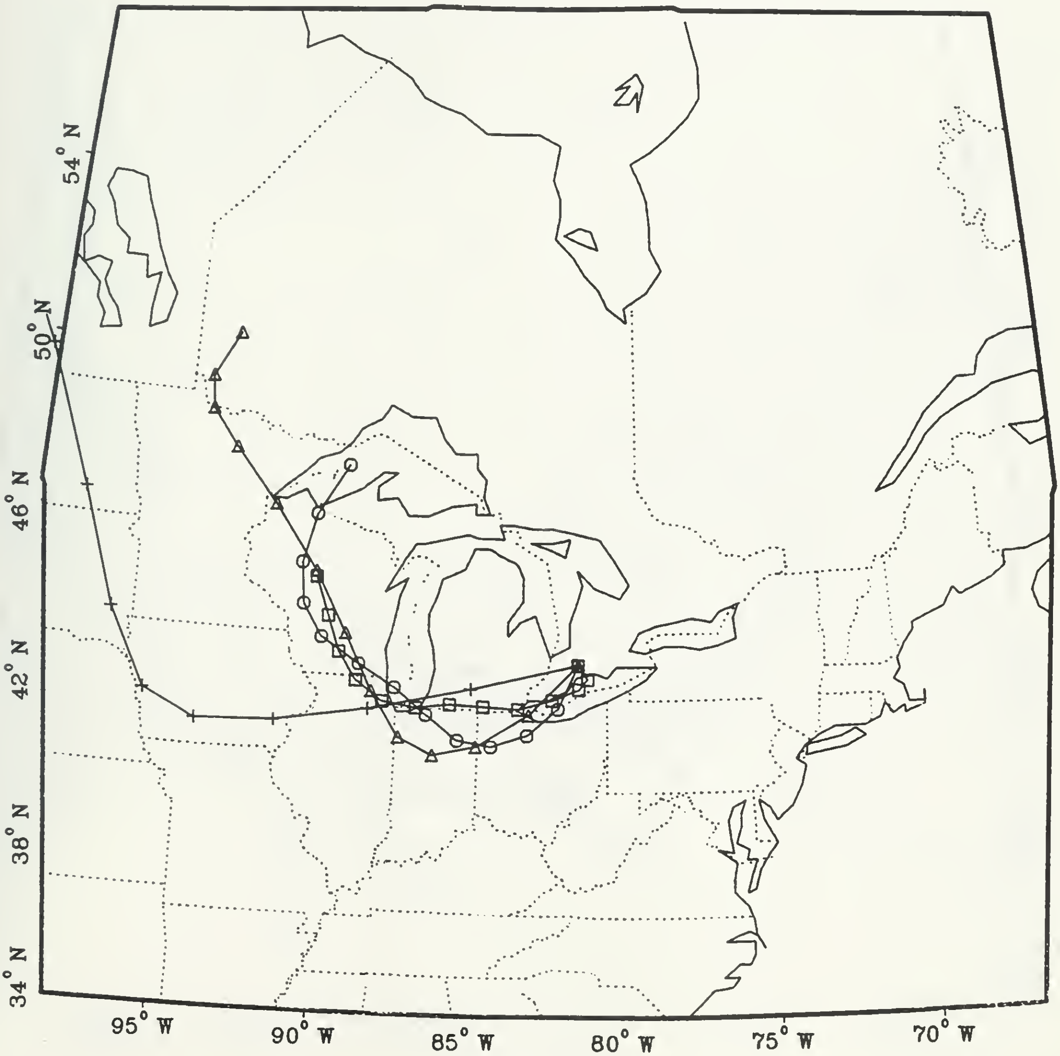


FIGURE 2.5.6

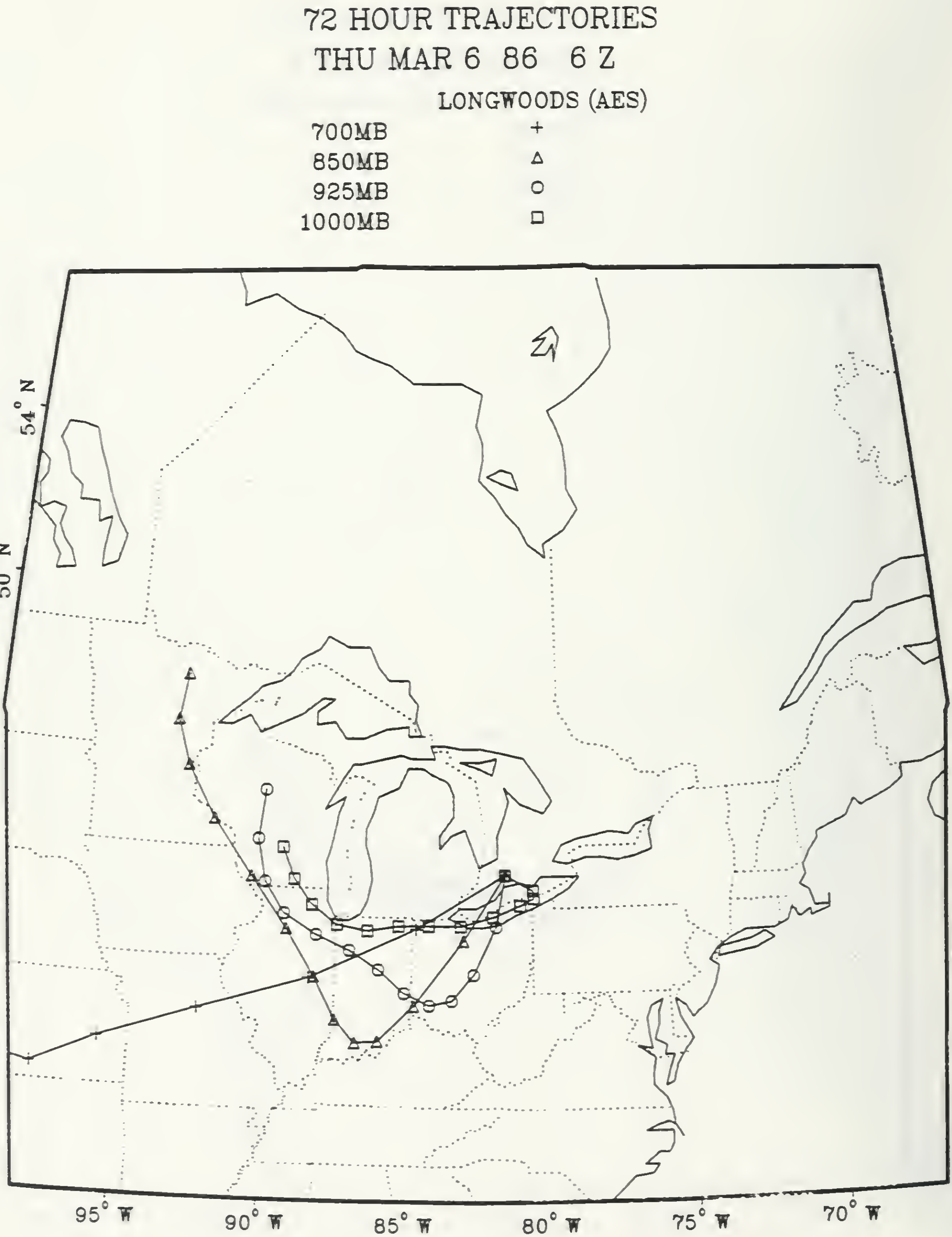

72 HOUR TRAJECTORIES
THU MAR 6 86 6 Z
LONGWOODS (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.5.7

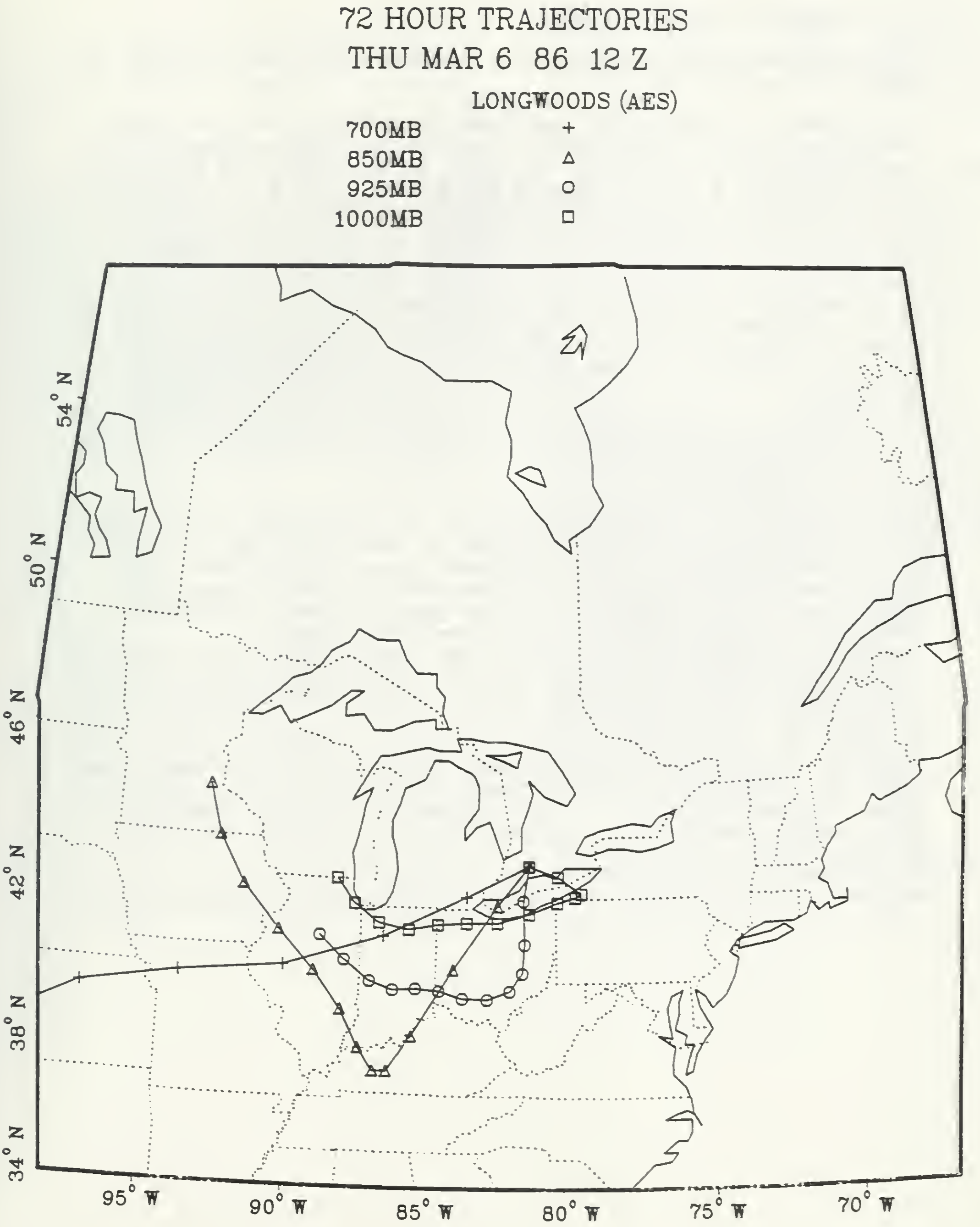

72 HOUR TRAJECTORIES
THU MAR 6 86 12 Z
LONGWOODS (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.5.8

2.6 March 6-7, 1986, Dorset

This episode ranked eighth (8/10) in the list of NO_3^- top 25% wet deposition events.

A low pressure centre, 997 mb, near London with the warm front extending to Erie, Pennsylvania and further to New Jersey, was observed on Mar. 6, at 12Z as shown in Fig. 2.6.1. A wave, over Virginia, with a frontal system and trowal were also analyzed but these did not affect significantly the weather at the station. The low first filled and then deepened while moving eastward. On Mar. 7, at 12Z, it deepened to 977 mb and was situated near Yarmouth, Nova Scotia, outside the map boundary of Fig. 2.6.2. A continuous precipitation area associated with the system gave snow at Dorset. As the system moved eastward, light snow fell as shown in fig. 2.6.3 for a long period of time but due to the missing precipitation information, it is not certain when the snow ended.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for Mar. 6, 12Z, 18Z and Mar. 7, 00Z, 06Z and 12Z are shown in Figures 2.6.4, 2.6.5, 2.6.6, 2.6.7, and 2.6.8 respectively.

Air parcels arriving at 1000 and 925 mb levels could not have carried any significant NO_x since the trajectories did not pass over any high emission source areas as shown in Figs. 2.6.4-8.

Air trajectories for the 850 mb level show that NO_x from its high emission Detroit and Cleveland areas for some short time during Mar 6, 12Z - Mar 7, 00Z, and possibly from the highest emission Chicago area could have been transported.

Air trajectories for the 700 mb level show that NO_x from its high emission Detroit (Fig. 2.6.5) and for some short duration from the highest emission Chicago (Figs. 2.6.6-7) area could have been transported.

In summary, a low pressure centre with warm and cold fronts moved south of the station. A continuous precipitation area associated with the system yielded light snow for over 12 hours. Only high level transport (850 mb & 700 mb) from Detroit and Cleveland and for a short time from the highest emission Chicago area was probable during this episode.

It is again noted that the episode did not rank high for the $SO_4^=$ deposition and this is likely due to frozen precipitation snow.

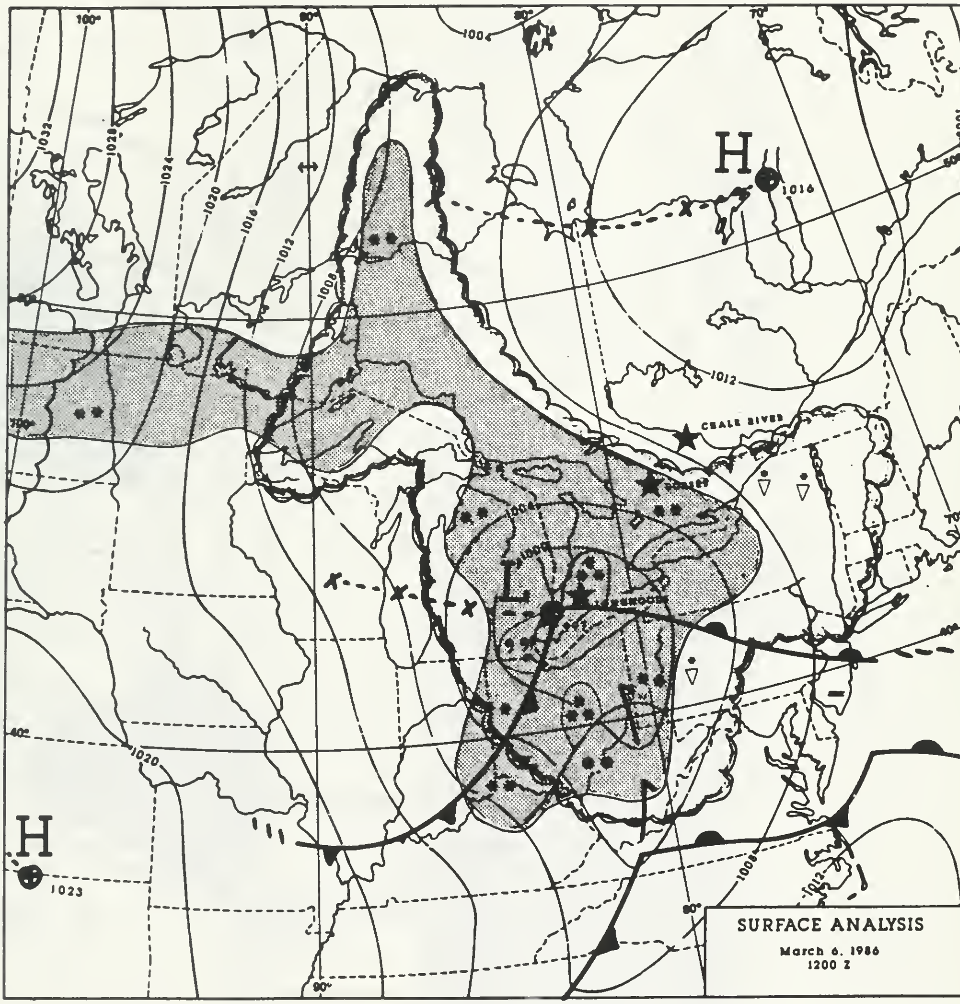

SURFACE ANALYSIS
March 6, 1986
1200 Z
H
1016
H
1023
L
CHALE RIVER
1012
1020
1008
1004
1016
1024
1028
1032
100°
90°
80°
70°
60°
50°
40°

FIGURE 2.6.1

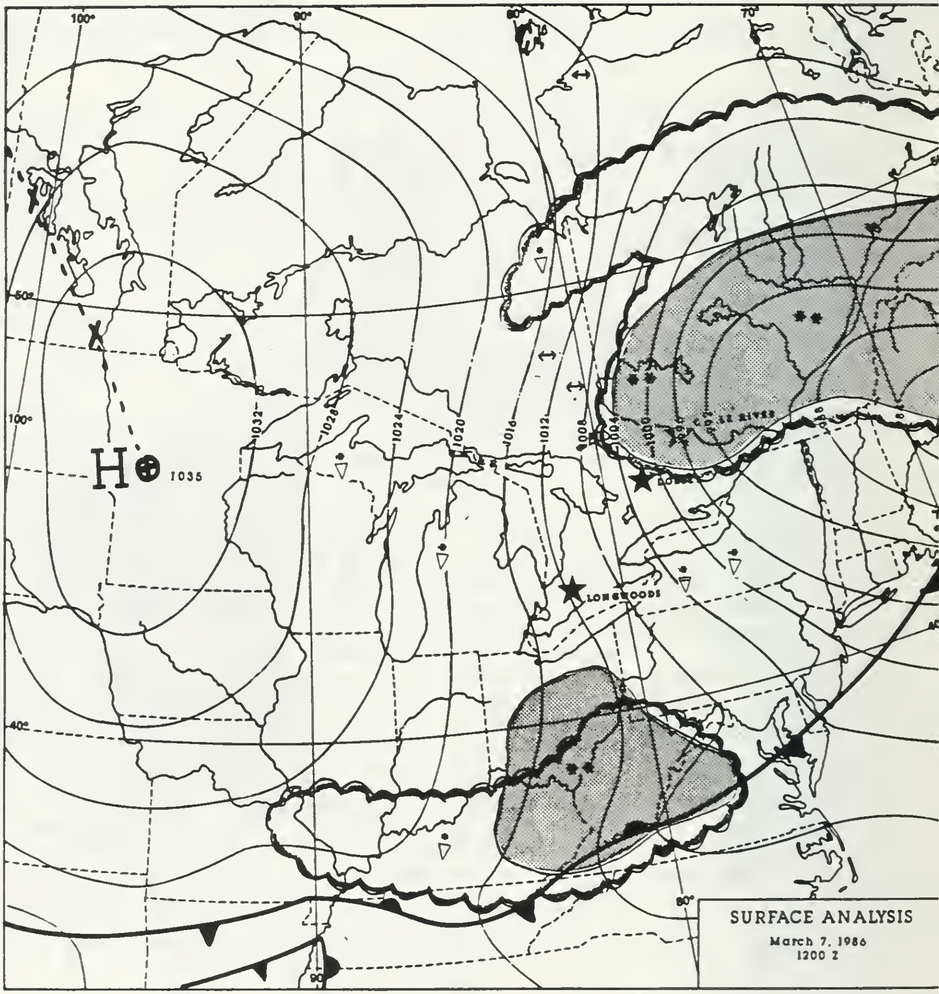
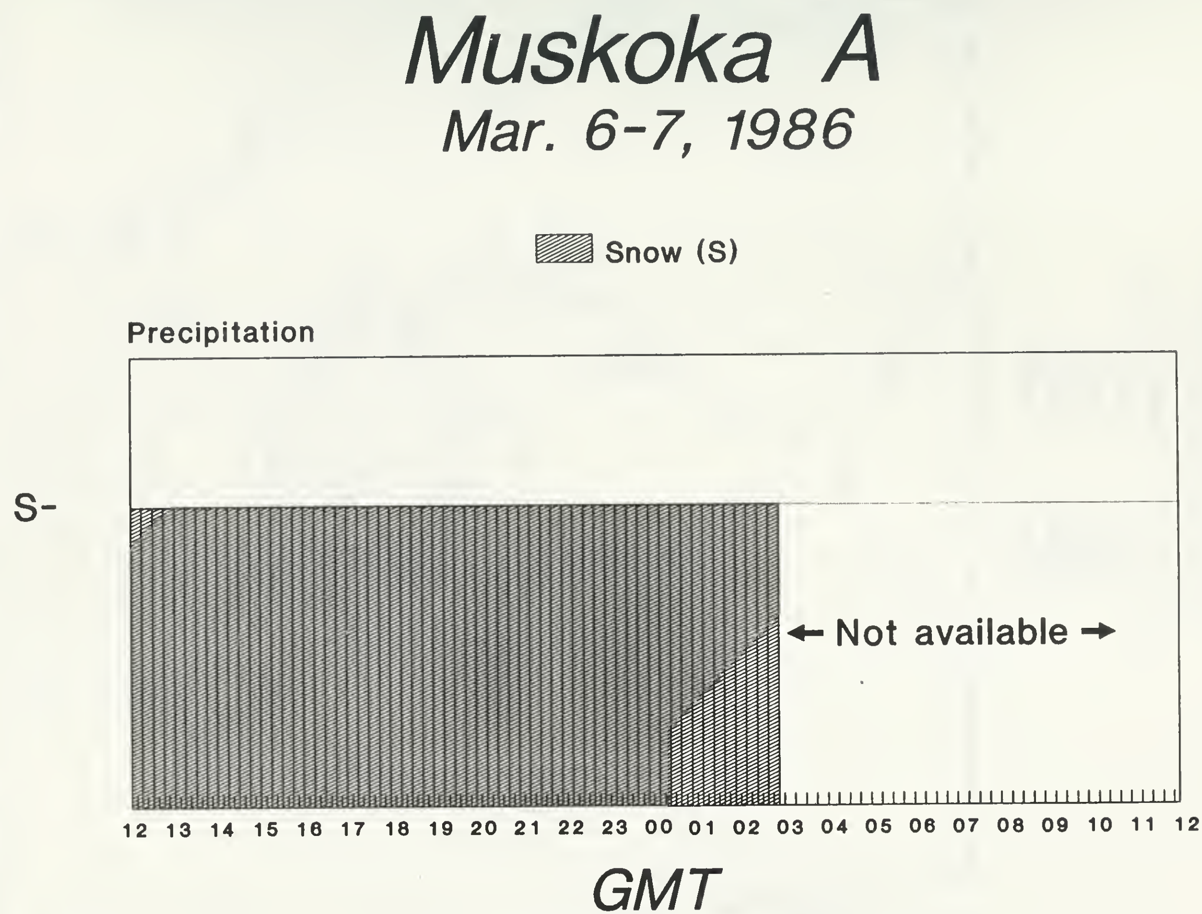


FIGURE 2.6.2



Muskoka A
Mar. 6-7, 1986
Snow (S)
Precipitation
S-
← Not available →
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT

FIGURE 2.6.3

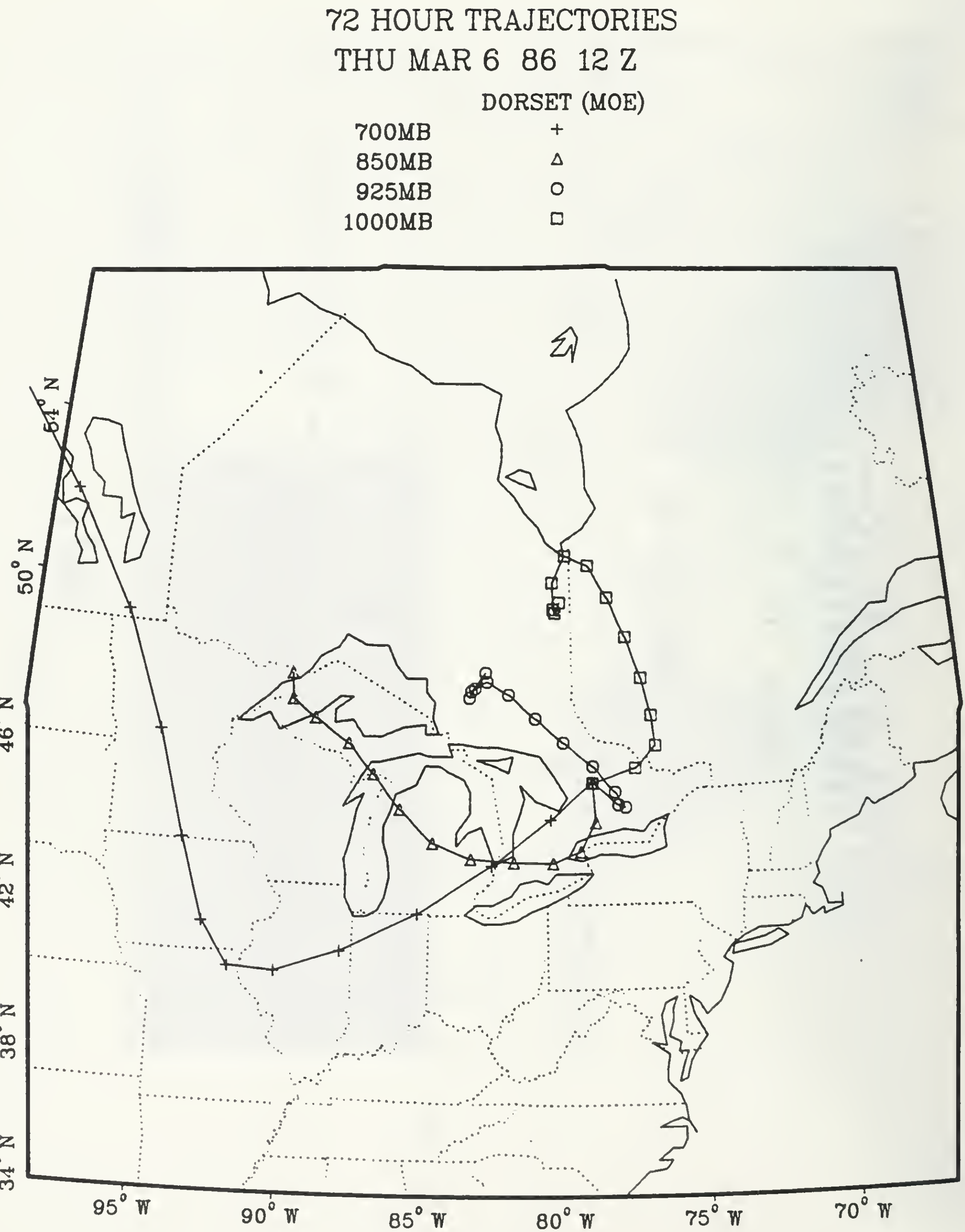

72 HOUR TRAJECTORIES
THU MAR 6 86 12 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.6.4

72 HOUR TRAJECTORIES
THU MAR 6 86 18 Z

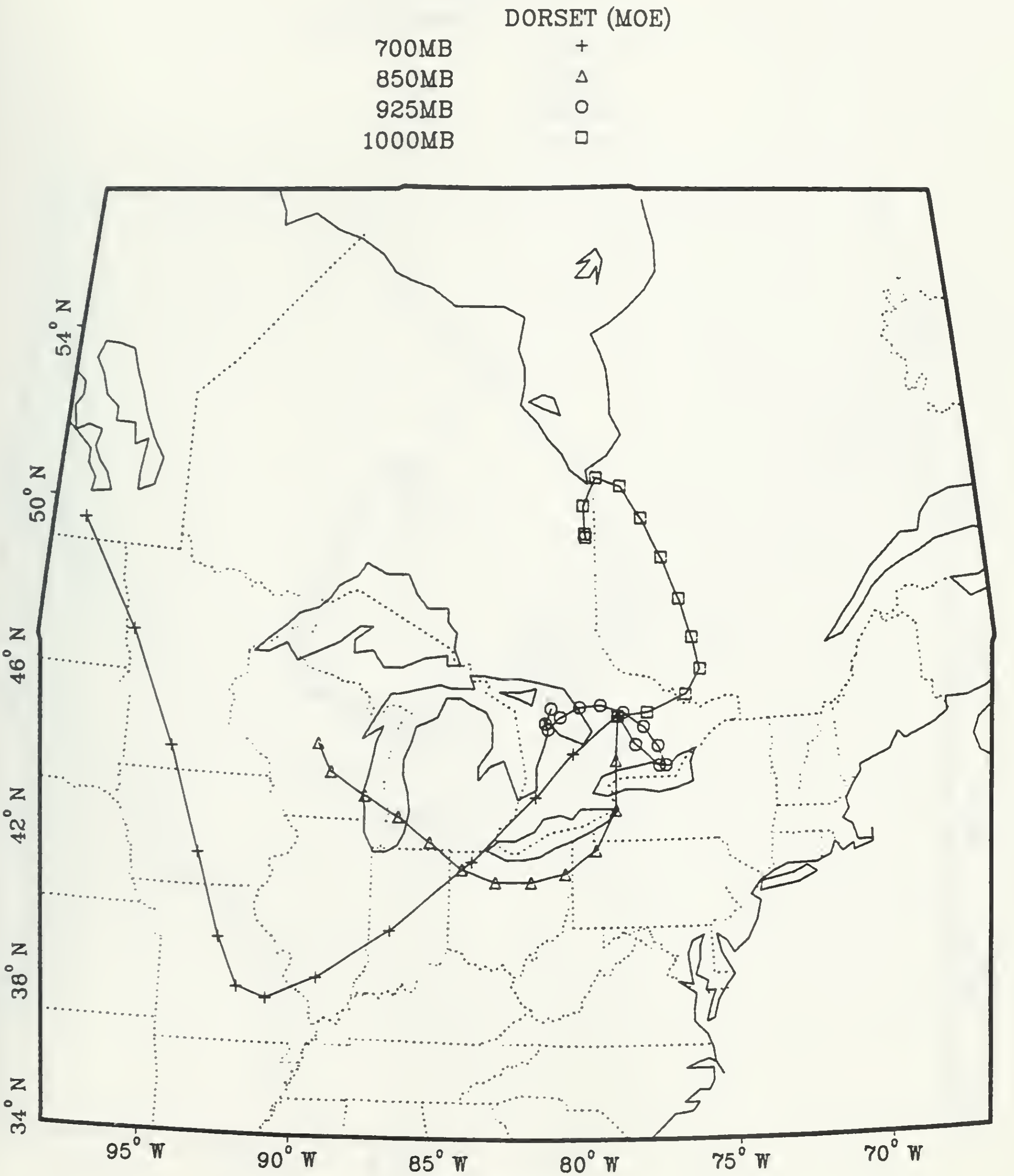
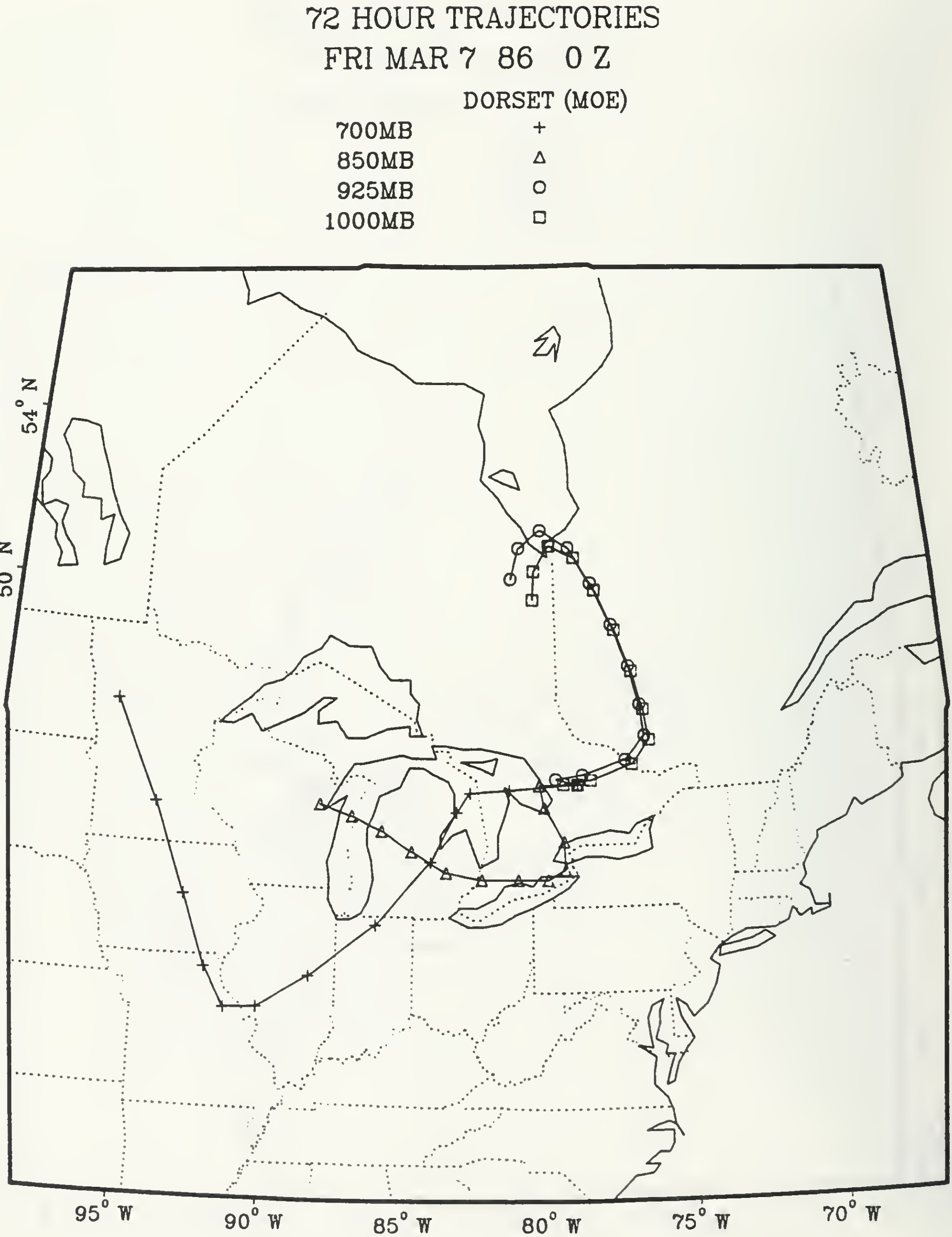


FIGURE 2.6.5



72 HOUR TRAJECTORIES
FRI MAR 7 86 0 Z
DORSET (MOE)
700MB
850MB
925MB
1000MB
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.6.6

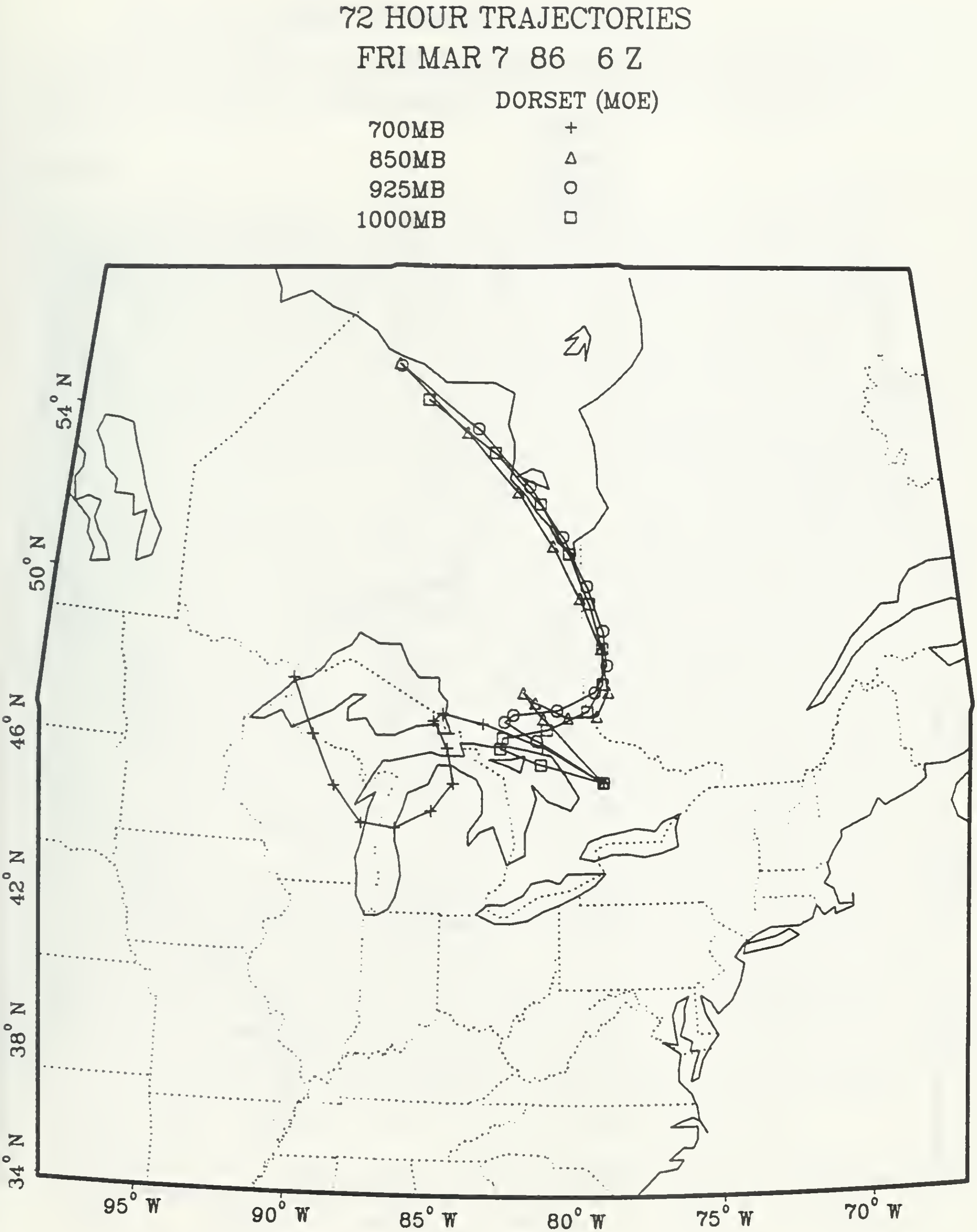

72 HOUR TRAJECTORIES
FRI MAR 7 86 6 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.6.7

72 HOUR TRAJECTORIES
FRI MAR 7 86 12 Z

	DORSET (MOE)
700MB	+
850MB	Δ
925MB	O
1000MB	□

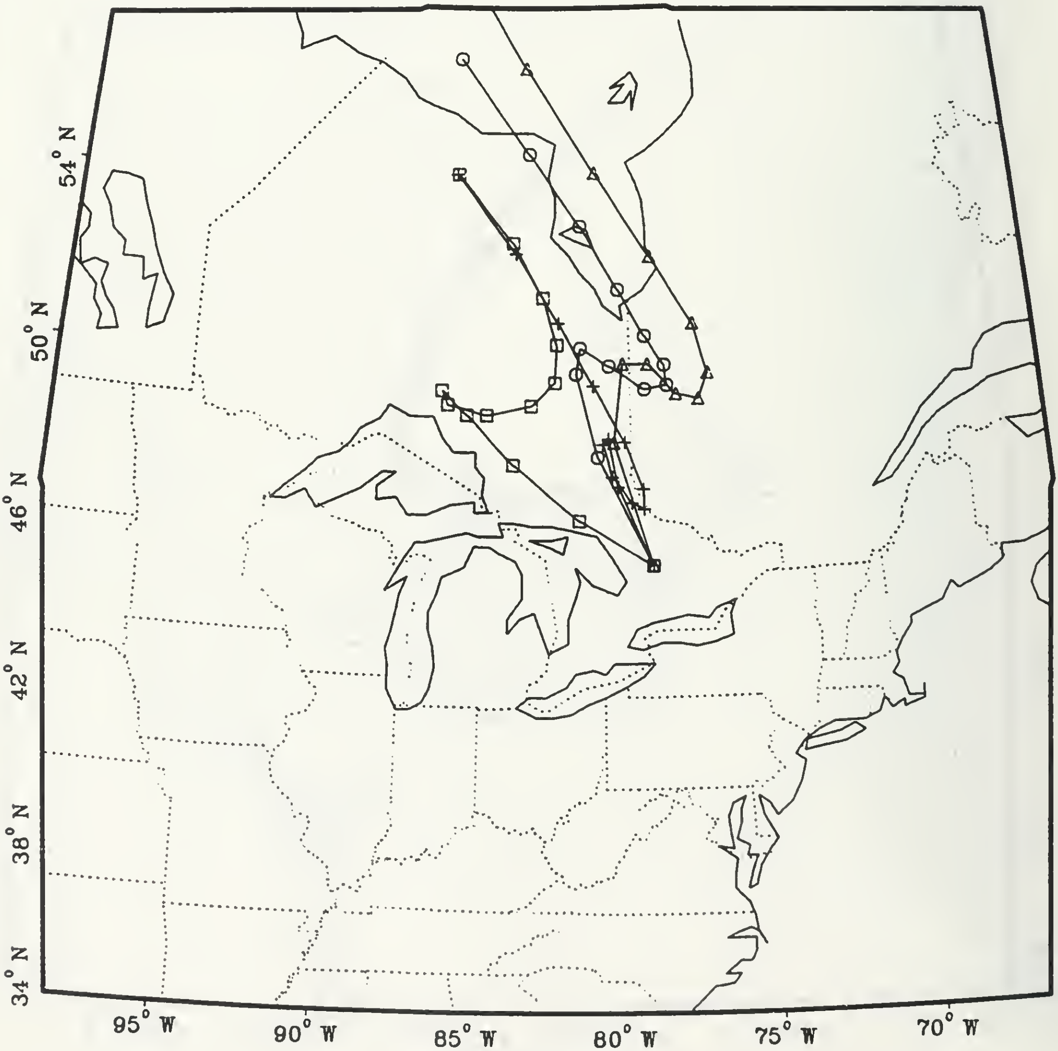


FIGURE 2.6.8

2.7 March 10-11, 1986, Dorset and Chalk River

This episode at Dorset ranked 3rd (3/7) and 2nd (2/10) for $SO_4^=$ and NO_3^- respectively. At Chalk River, it ranked 3rd (3/8) for NO_3^- .Following are separate narratives for Dorset and Chalk River:

Dorset

A low pressure centre, 992 mb, over Wisconsin and three frontal systems were analyzed on Mar. 10, at 12Z as shown in Fig. 2.7.1. As illustrated in the figure, A warm front laid over Dorset and another extended from the low to Lake Huron and then to Toronto. The system moved ENE and on Mar. 11, at 12Z, the low was situated near Montreal, deepening slightly to 990 mb, with the fronts as exhibited in Fig. 2.7.2. As this cyclone moved in the region, firstly the upper front moved north of Dorset, secondly the middle warm front associated with the low and then the low passed over the station such that it did not remain in its warm sector, and lastly the upper cold front crossed over Dorset. The lower frontal system associated with the wave did not significantly affect the weather in the region. As shown in Fig. 2.7.3A, the upper front remained north of Dorset and as the middle warm front and the low approached and passed over it, light and very light rain showers were recorded in the region. Unfortunately, continuous precipitation records are not available, but it is evident from the synoptic records that precipitation also fell during the missing period. Precipitation changed to snow with the passage of upper cold front.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for Mar. 10, 12Z, 18Z and Mar. 11, 00Z, 06Z and 12Z are shown in Figures 2.7.4, 2.7.5, 2.7.6, 2.7.7, and 2.7.8 respectively.

Air trajectories for the 1000 mb level show that SO_2 could have been transported from its highest emission areas in Pennsylvania (Figs. 2.7.6-7) and Sudbury (Fig. 2.7.8). Transport of SO_2 from its high emission Toronto-Buffalo (Fig. 2.7.6-7) area and NO_x from Maryland (Fig. 2.7.5) and Pennsylvania (Fig. 2.7.6-7) was also likely.

Air parcels arriving at the 925 mb level show that SO_2 and NO_x from their respective highest and high emission Detroit (Fig. 2.7.5) region, West Virginia-Ohio-Pennsylvania (Figs. 2.7.5-7) areas could have been transported.

Air trajectories at the 850 mb level show that SO_2 from its highest emission Detroit (Fig. 2.7.4&6) area and areas in Ohio-West Virginia (Fig. 2.7.7) and Sudbury (Fig. 2.7.8) could have been transported. Transport of NO_x from its high emission in most of these areas was also likely.

Air trajectories for the 700 mb show that SO_2 and NO_x from their highest emission Chicago area (Fig. 2.7.4-5&8) and SO_2 from its high emission Sudbury (Fig. 2.7.8) area could have been transported.

In summary, two warm fronts, a low pressure centre and a cold front passed over the station yielding light and very light rain showers and light snow. Precipitation lasted for more than 12 hrs. Transport of SO_2 at low and high levels from the highest emission Sudbury, Detroit, and areas in Pennsylvania, Ohio, West Virginia and of SO_2 & NO_x at high level (700 mb) from Chicago were probable. Transport from a number of high emission sources was also exhibited during this episode.

Chalk River

The weather system which affected Dorset also influenced Chalk River as shown in Figs. 2.7.1-2. However, the upper warm front on Mar 10, at 12Z as shown in Fig. 2.7.1, passed over the station and on Mar 11, at 12Z, the cold front also had just moved over to E of Chalk River as exhibited in Fig. 2.7.2. As the low pressure centre and the middle front remained south of the station, only freezing and frozen precipitation fell in the region as shown in Fig. 2.7.3B. Freezing precipitation occurred in the form of very light and light ice pellets, light freezing drizzle and very light, light and moderate freezing rain and light snow also fell. Total duration of precipitation was about 20 hrs.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for Mar. 10, 12Z, 18Z and Mar. 11, 00Z, 06Z and 12Z are shown in Figures 2.7.9, 2.7.10, 2.7.11, 2.7.12, and 2.7.13 respectively.

Air parcels arriving at the 1000 mb level could have carried NO_x from its high emission area in Maryland-Virginia as shown in fig. 2.7.12. No highest emission area is involved.

Air parcels arriving at the 925 mb level could have carried NO_x from its high emission areas in Pennsylvania-Ohio as shown in Fig. 2.7.8.11-12. Again, no highest emission area is involved.

Air trajectories for the 850 mb level show that NO_x from its high emission Detroit area (Fig. 2.7.11) for some time and other areas in Ohio-West Virginia and Pennsylvania (Fig. 2.7.9&12-13) could have been transported. No highest emission area is involved.

Air parcels arriving at the 700 mb level could have carried NO_x from its highest emission Chicago area (Fig. 2.7.9-10&13).

Summarizing, a warm front and a cold front passage yielded freezing(ice pellets, freezing drizzle and freezing rain) and frozen (snow) precipitation lasting for about 20 hrs. Transport of NO_x from the highest emission Chicago area at high level (700 mb), and from several high emission areas at high and low levels were likely.

In the last it should be noted that although the same system affected both Dorset and Chalk river, the episode did not rank high at Chalk river for $SO_4^=$ wet deposition. It is likely due to the occurrence of only freezing and frozen precipitation at Chalk River. On the other hand, rain showers were observed at Dorset and it was included in the top 25% $SO_4^=$ wet deposition events.

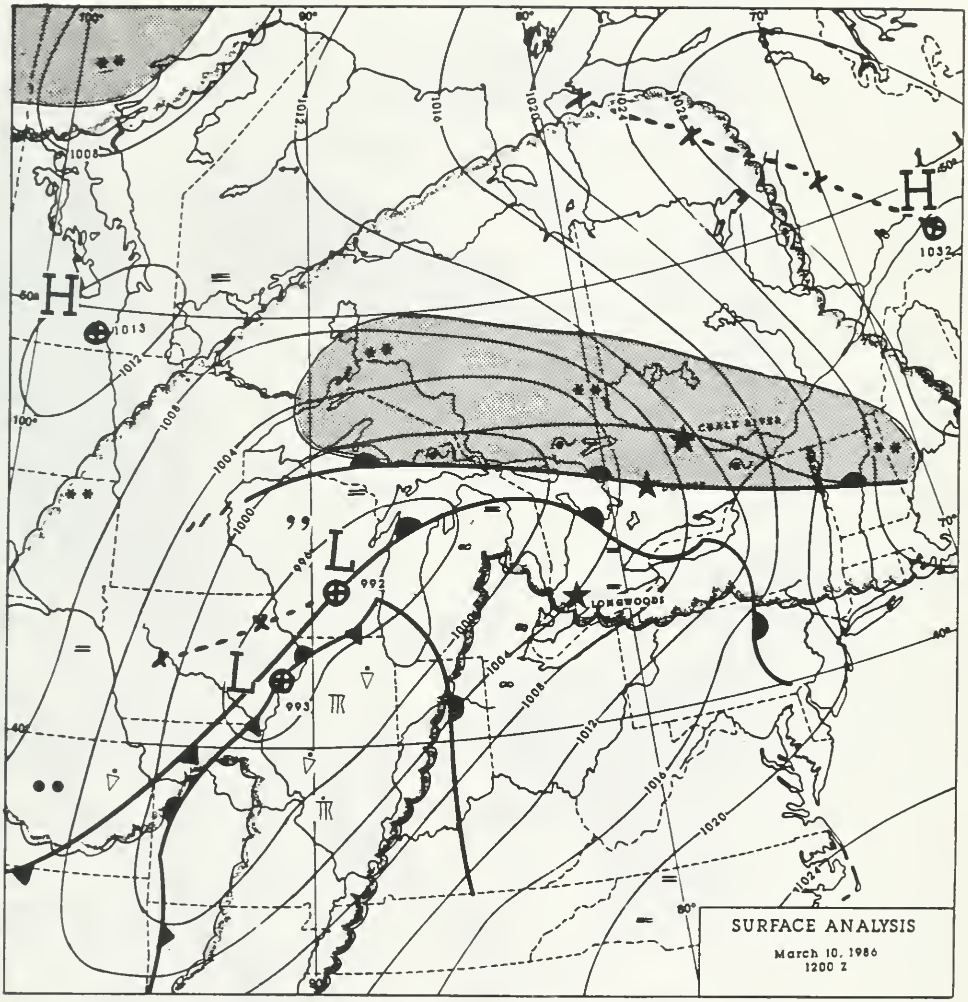

SURFACE ANALYSIS
March 10, 1986
1200 Z
LONGWOODS
CHALK RIVER
H
L
1013
1032
992
993
1008
1012
1016
1020
1024
1028
1004
1000
996

FIGURE 2.7.1

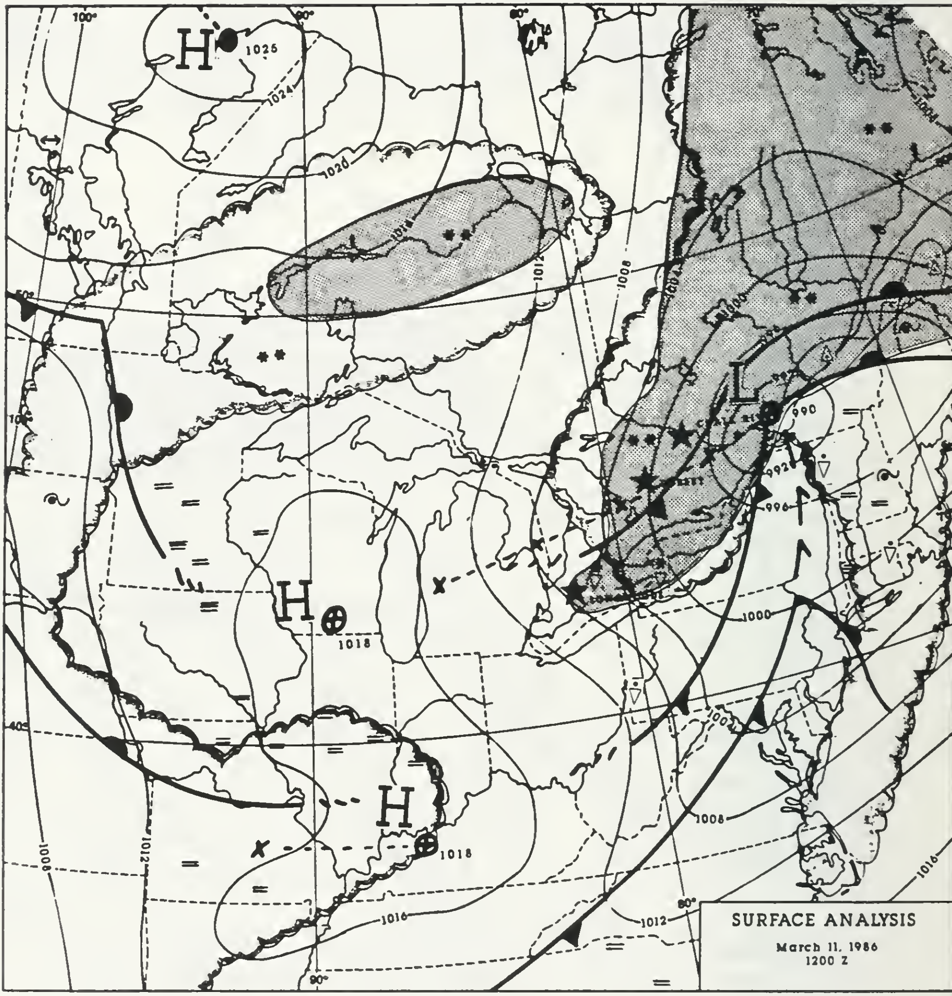

SURFACE ANALYSIS
March 11, 1986
1200 Z
1026
1024
1020
1018
1016
1012
1008
1004
1000
996
992
990
1018
1006

FIGURE 2.7.2

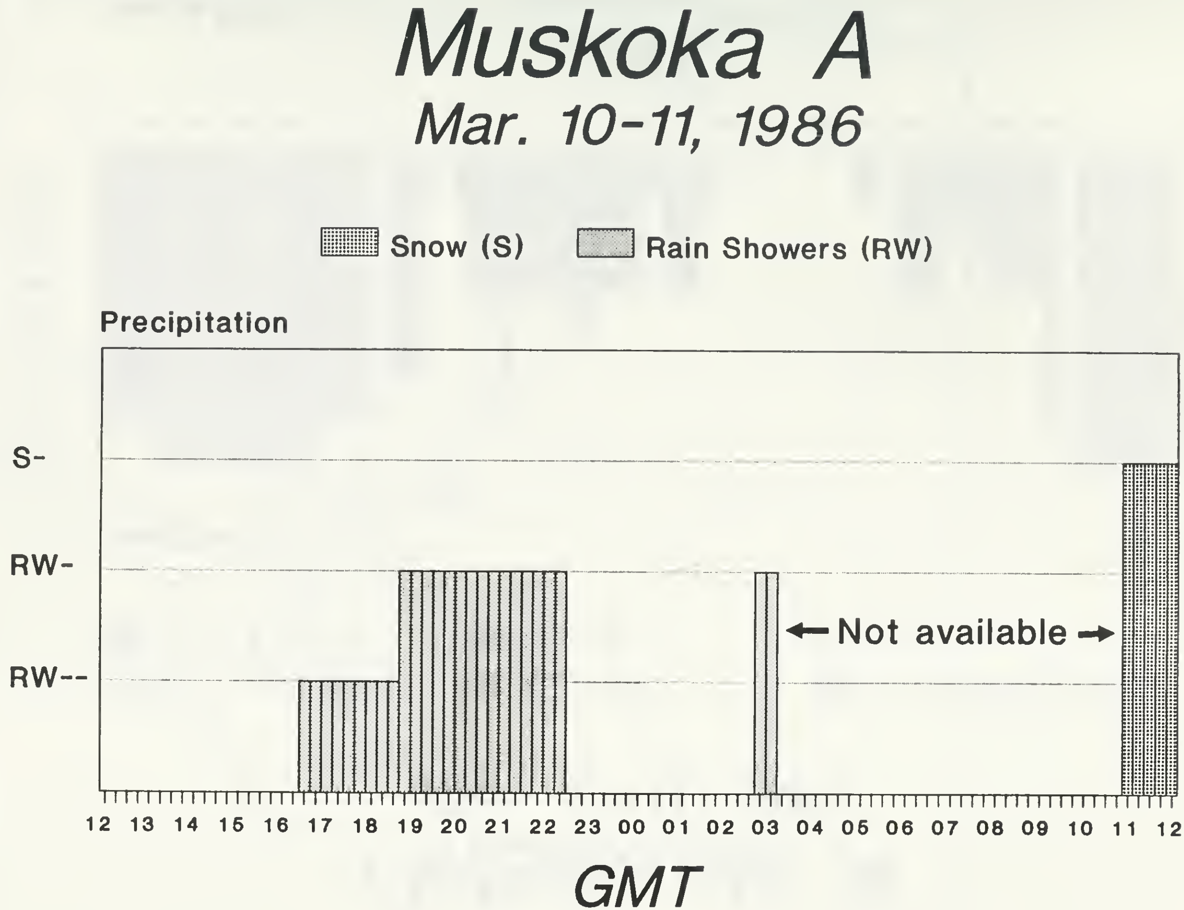

Muskoka A
Mar. 10-11, 1986
Snow (S)
Rain Showers (RW)
Precipitation
S-
RW-
RW--
Not available
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT

FIGURE 2.7.3A

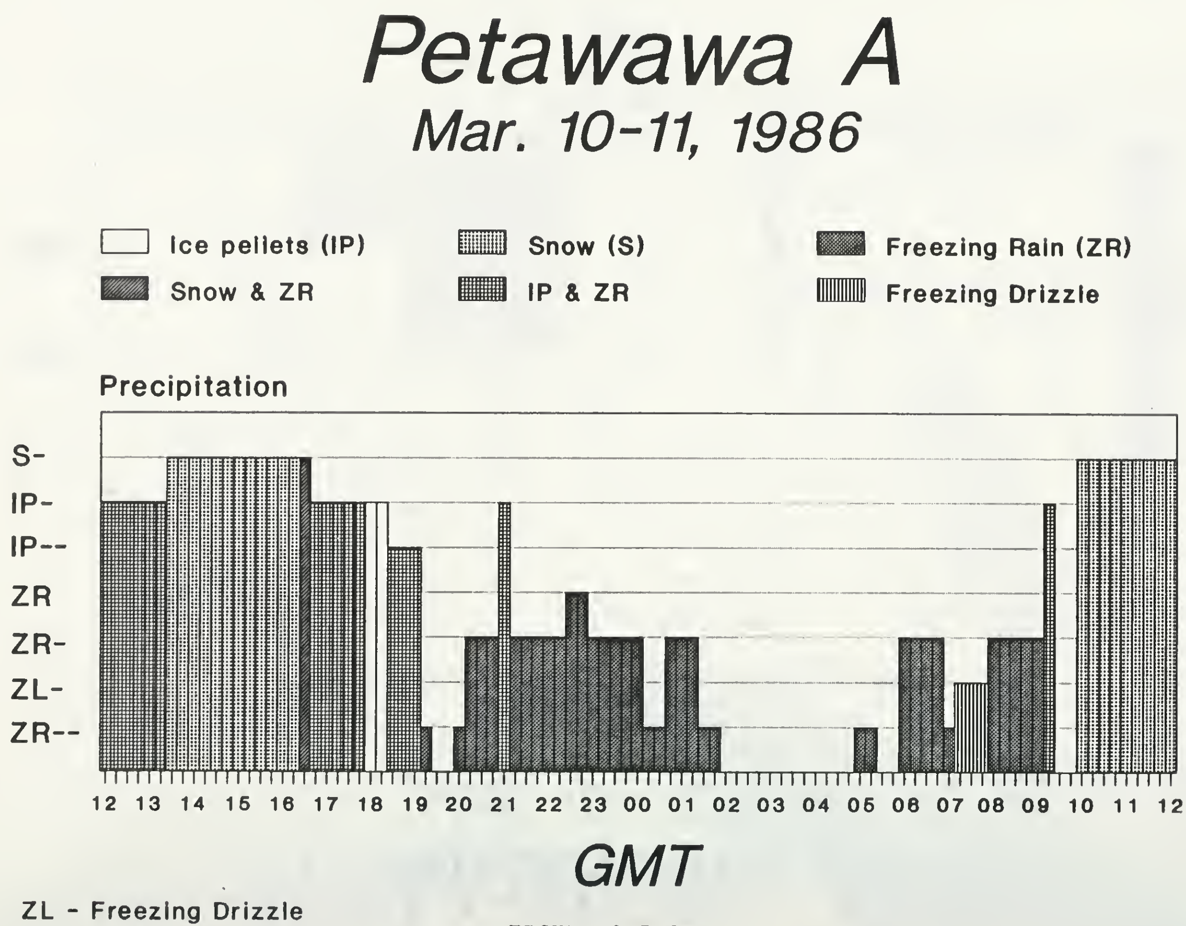

Petawawa A
Mar. 10-11, 1986
Ice pellets (IP)
Snow (S)
Freezing Rain (ZR)
Snow & ZR
IP & ZR
Freezing Drizzle
Precipitation
S-
IP-
IP--
ZR
ZR-
ZL-
ZR--
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
ZL - Freezing Drizzle

FIGURE 2.7.3B

72 HOUR TRAJECTORIES
MON MAR10 86 12 Z
DORSET (MOE)

700MB	+
850MB	Δ
925MB	○
1000MB	□

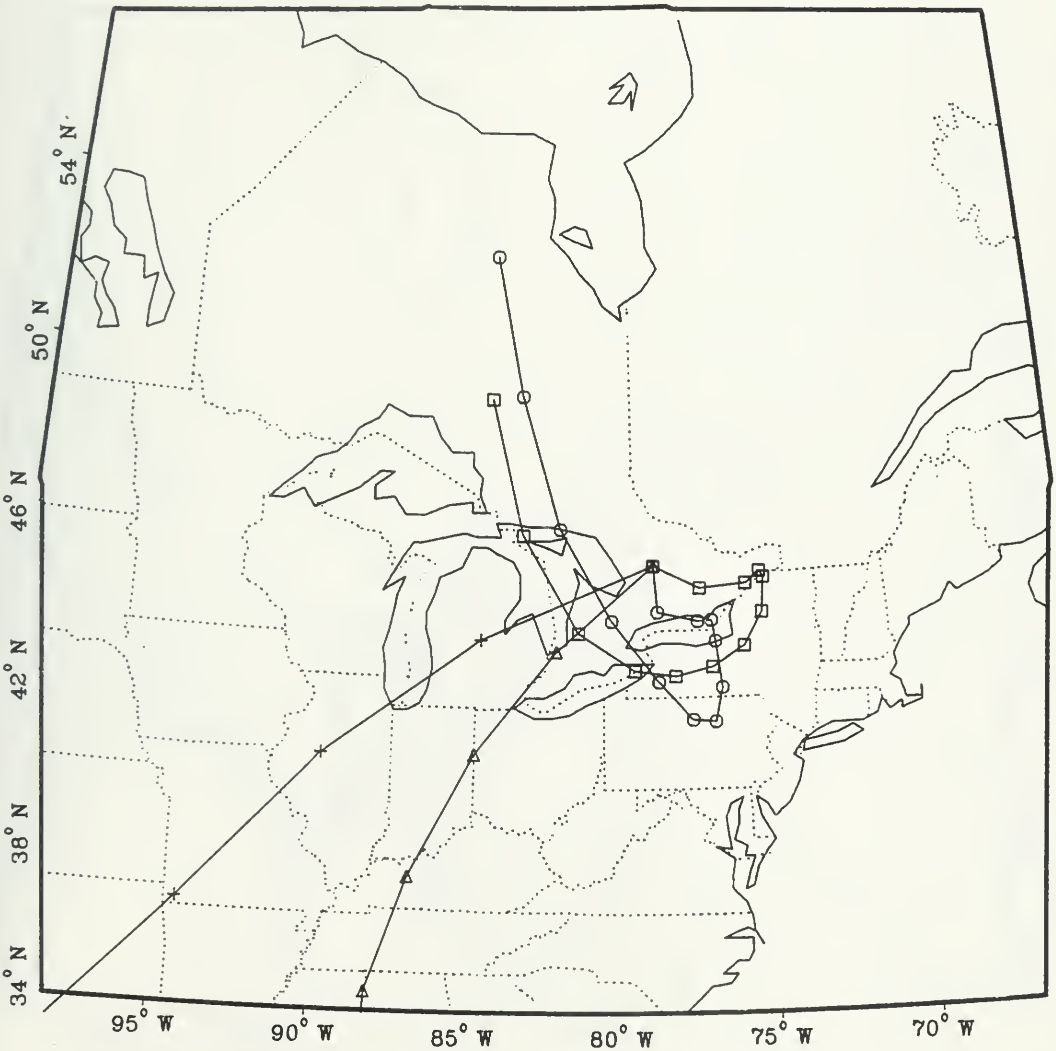


FIGURE 2.7.4

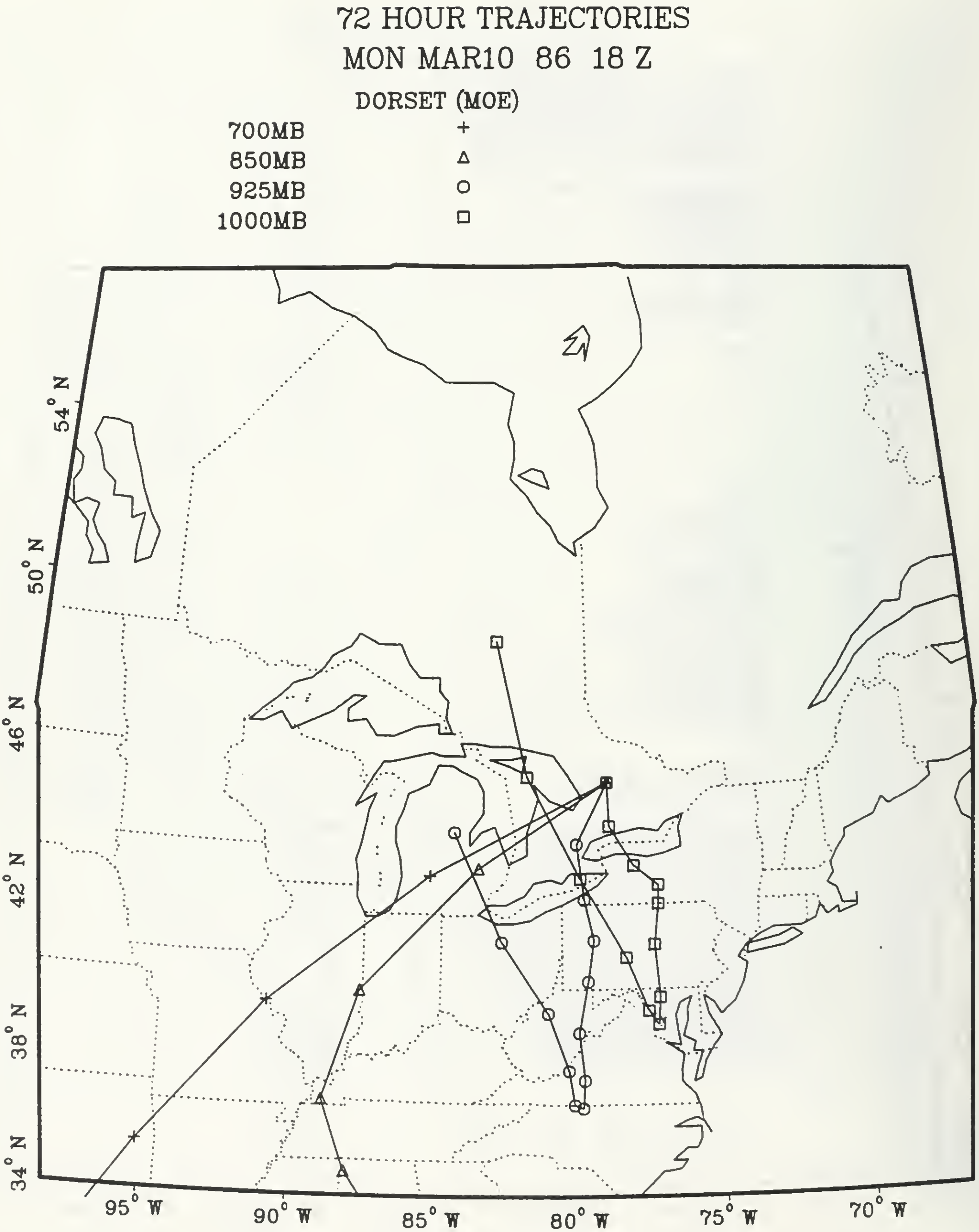

72 HOUR TRAJECTORIES
MON MAR10 86 18 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.7.5

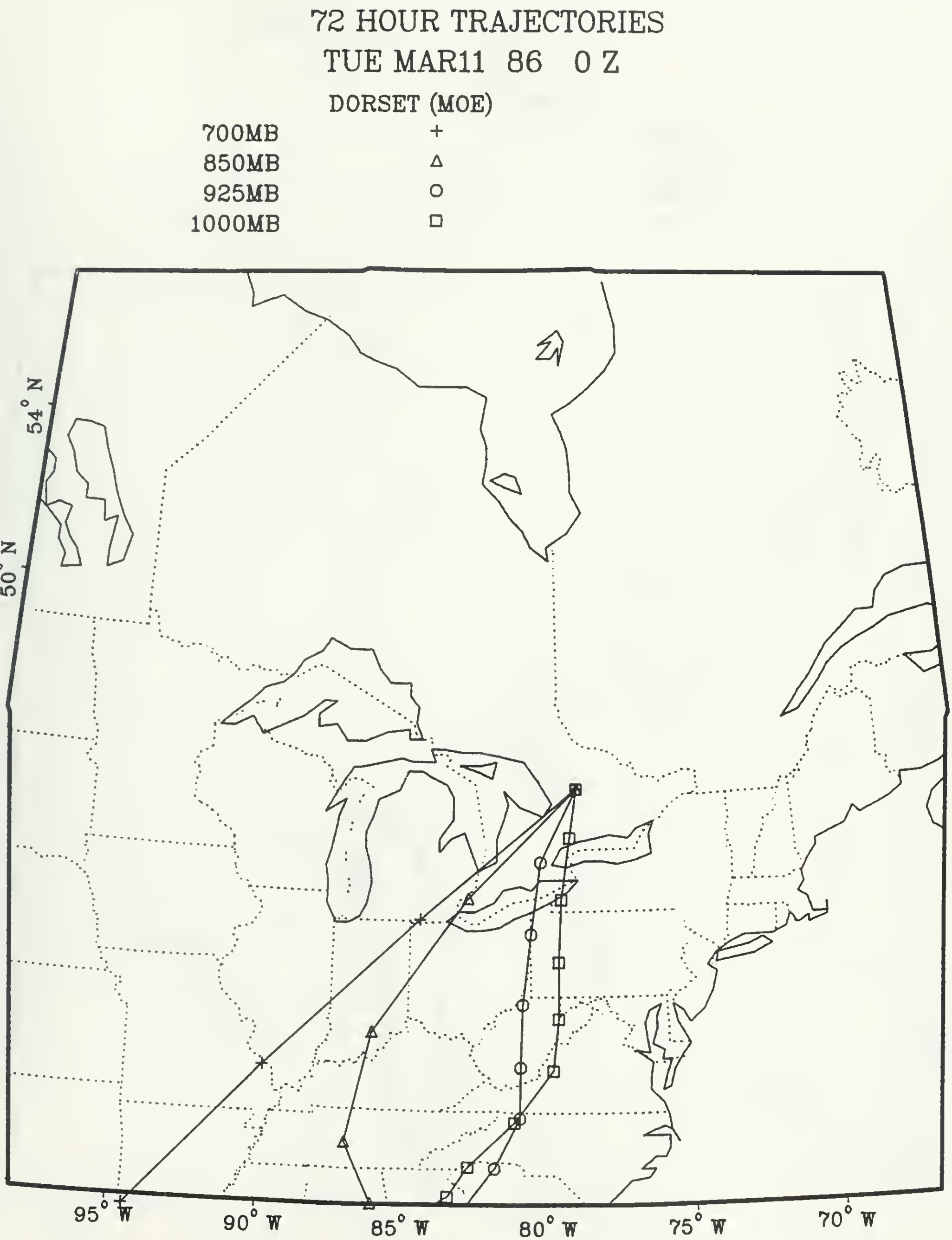

72 HOUR TRAJECTORIES
TUE MAR11 86 0 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.7.6

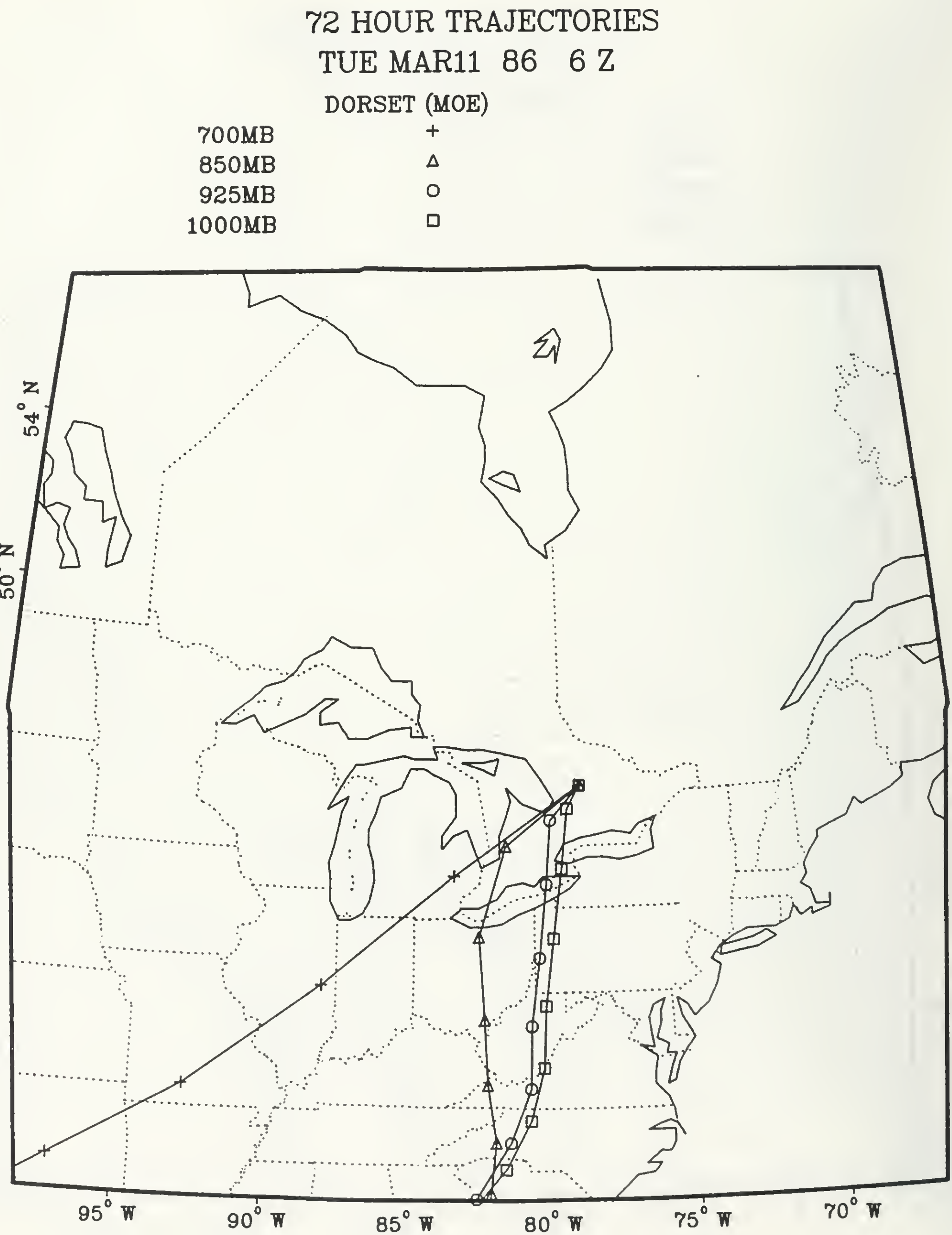

72 HOUR TRAJECTORIES
TUE MAR11 86 6 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.7.7

72 HOUR TRAJECTORIES
TUE MAR11 86 12 Z

DORSET (MOE)

700MB	+
850MB	Δ
925MB	O
1000MB	□

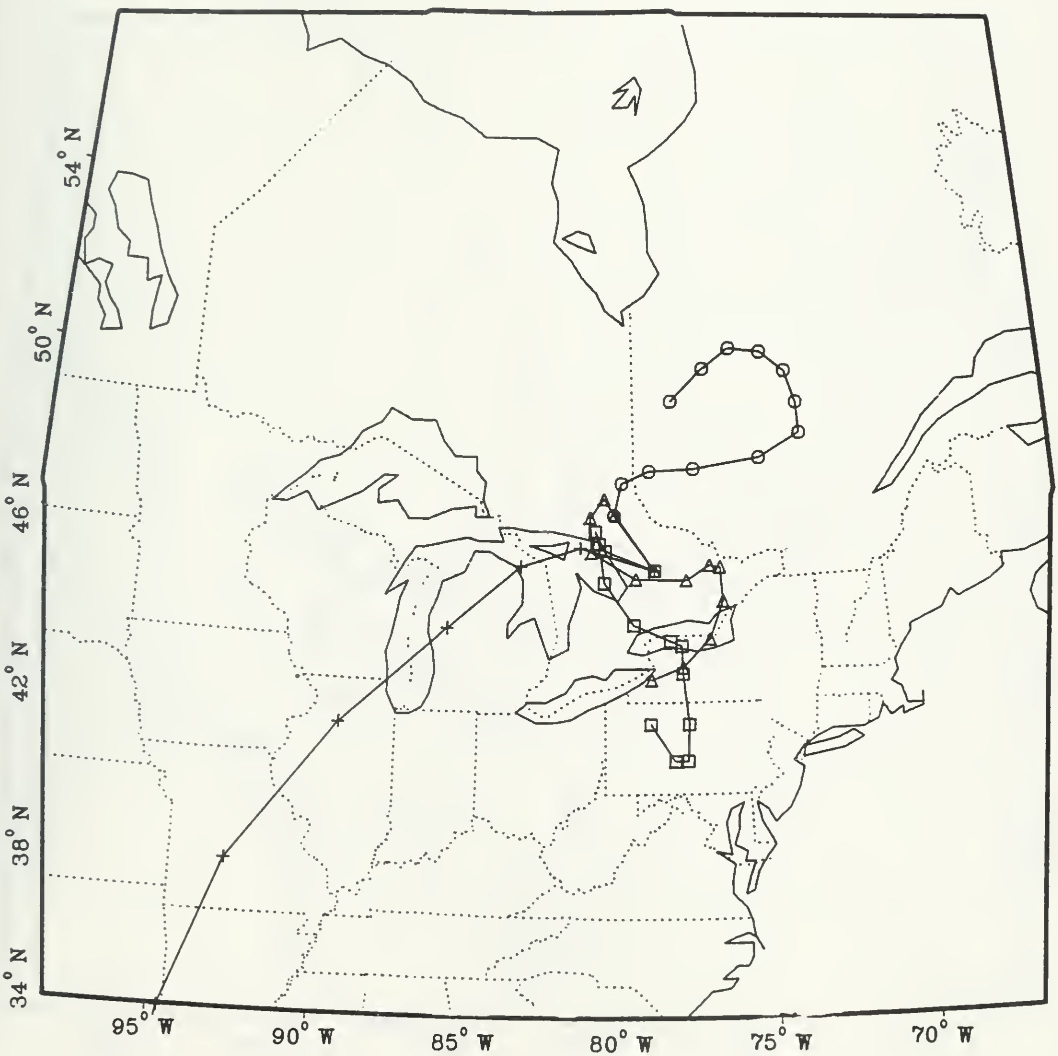


FIGURE 2.7.8

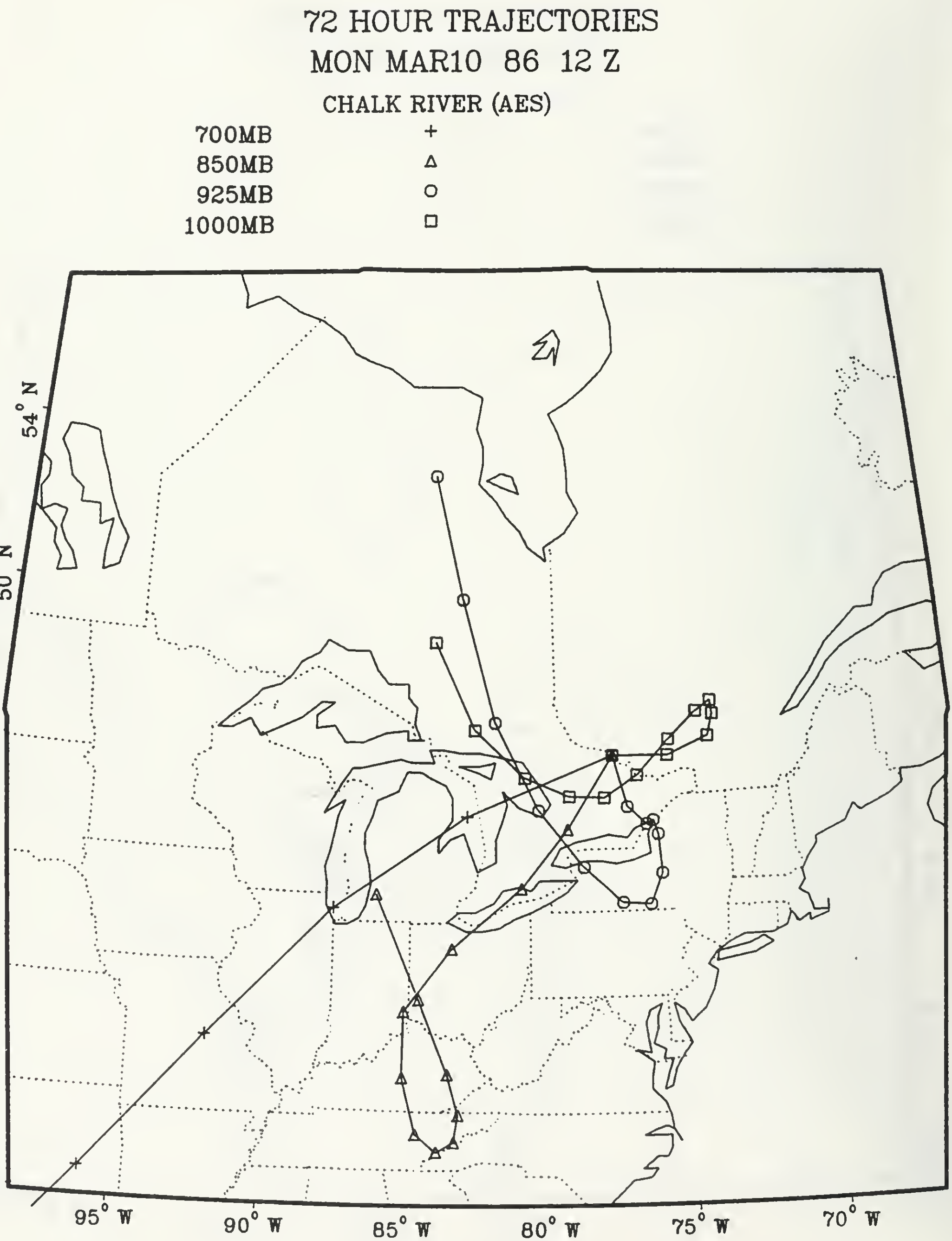

72 HOUR TRAJECTORIES
MON MAR10 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.7.9

72 HOUR TRAJECTORIES
MON MAR10 86 18 Z

CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

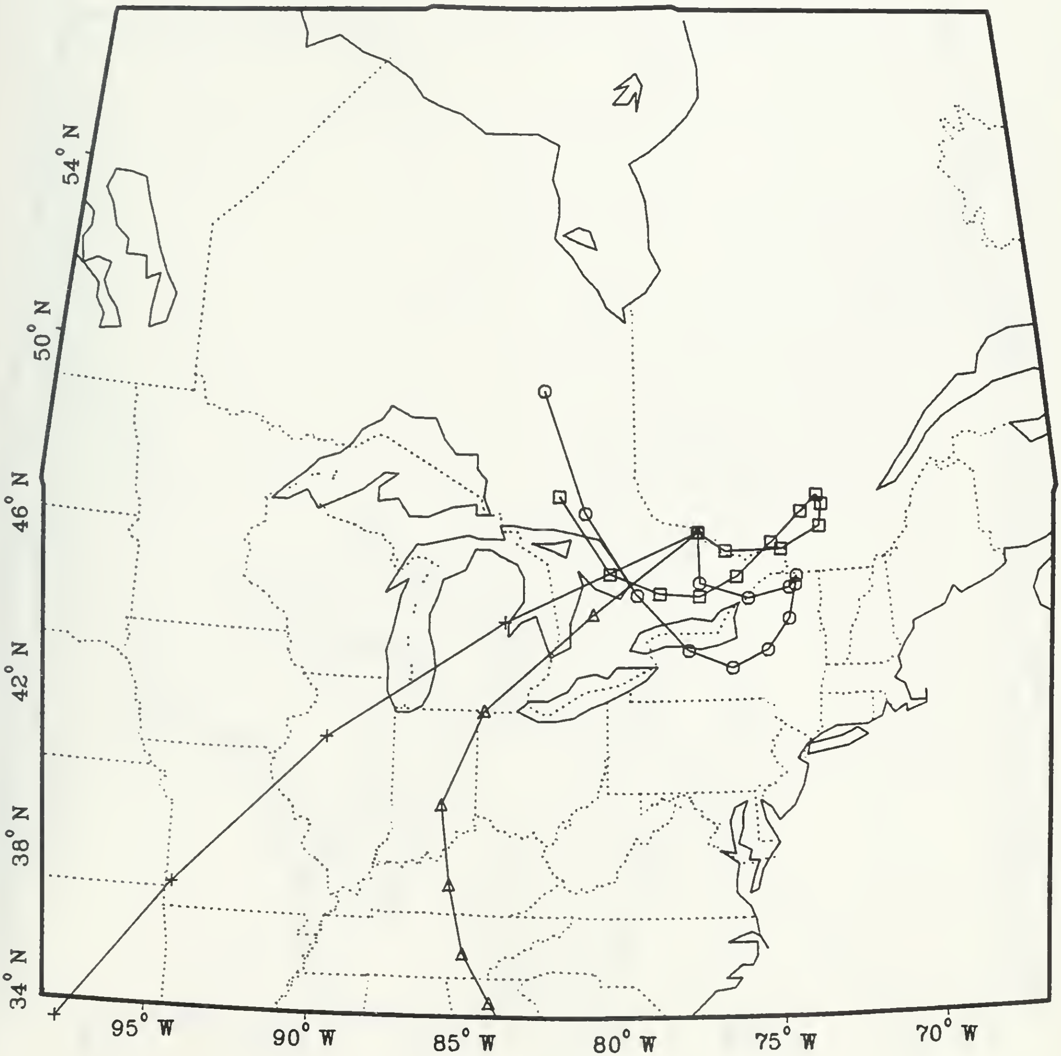


FIGURE 2.7.10

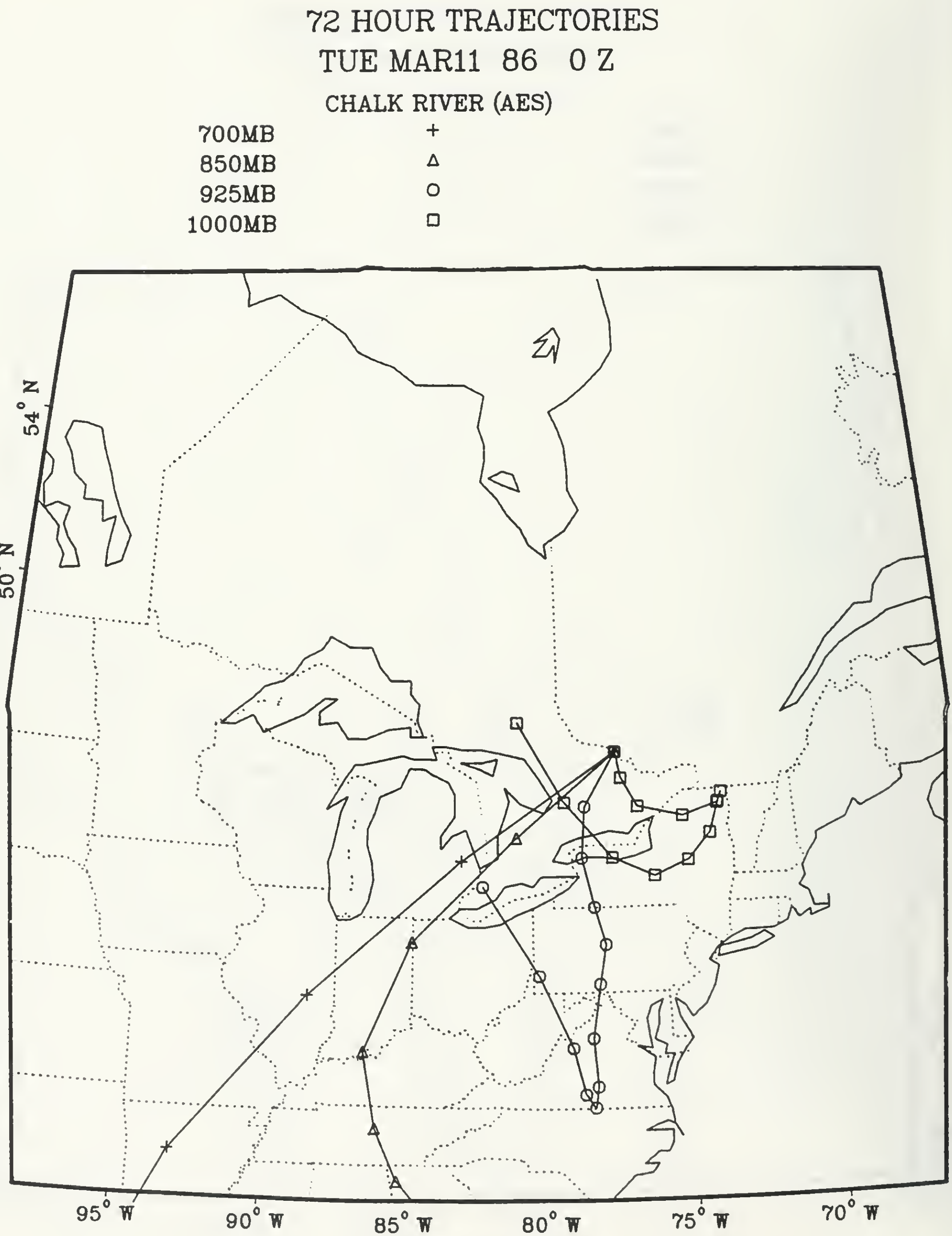
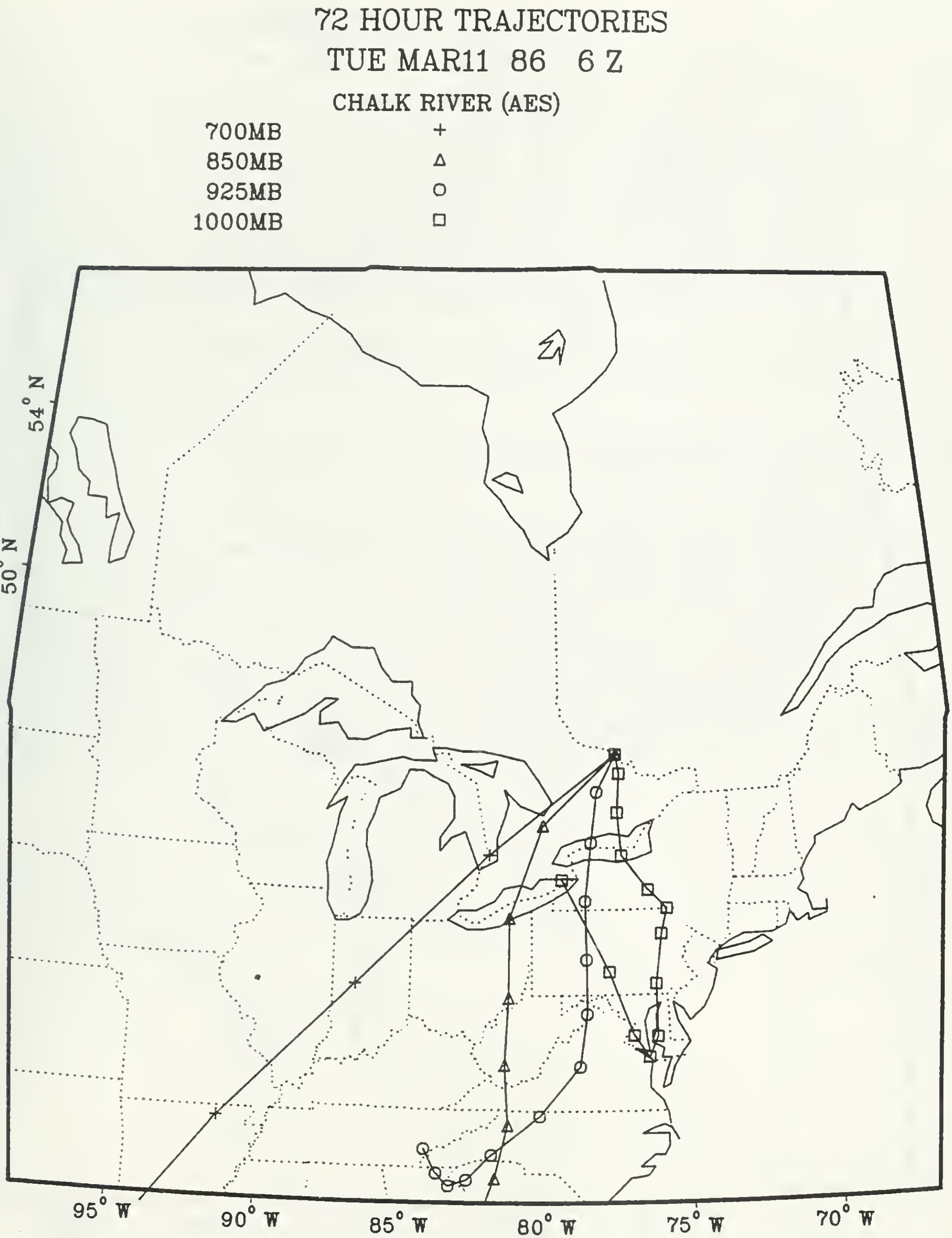

72 HOUR TRAJECTORIES
TUE MAR11 86 0 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.7.11



FIGURES 2.7.12

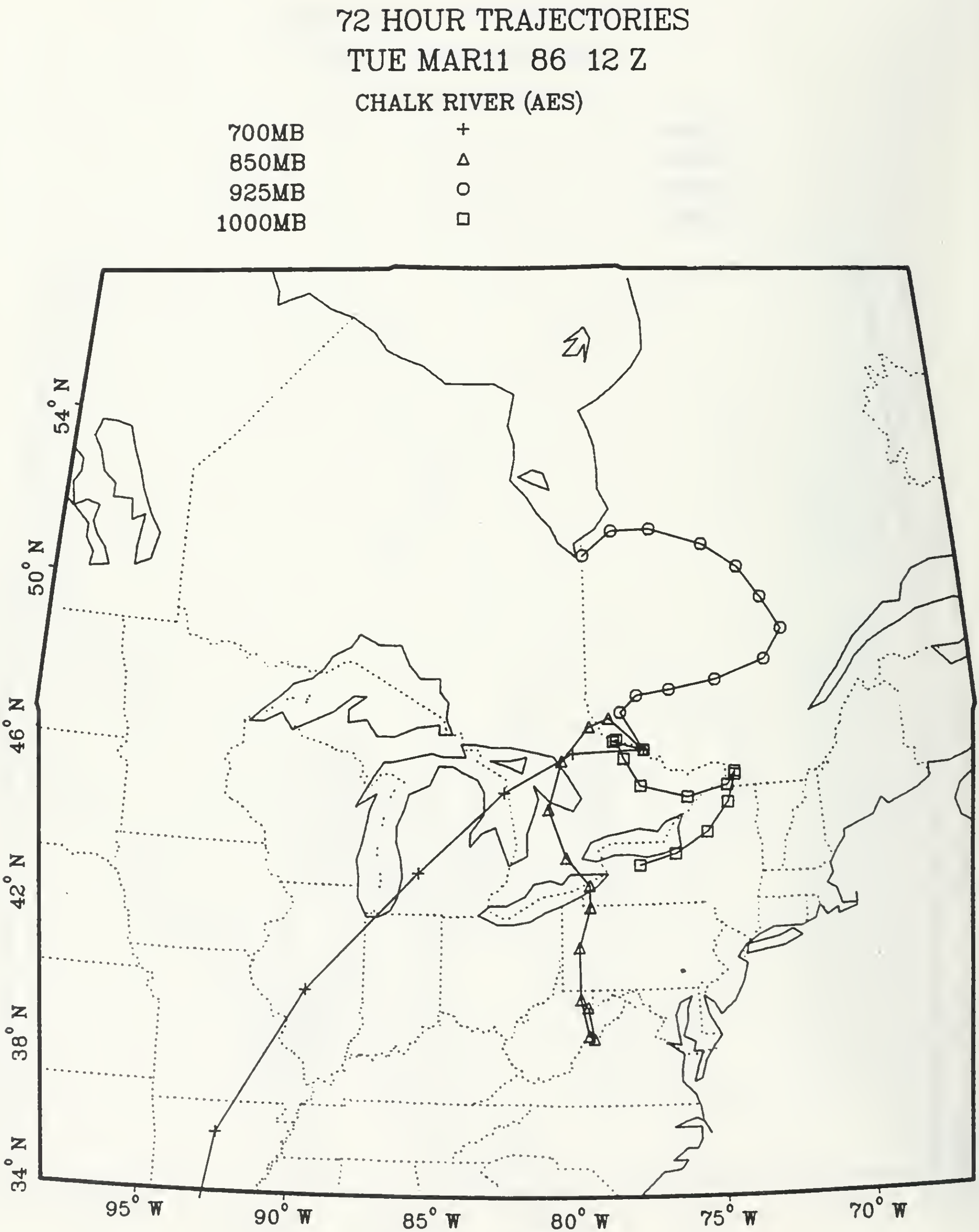

72 HOUR TRAJECTORIES
TUE MAR11 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.7.13

2.8 March 18-19, 1986, Dorset

This episode ranked 6th (6/10) for only NO_3^- wet deposition.

A low pressure centre, 992 mb, over Kansas was associated with frontal systems on Mar 18, at 12Z as shown in Fig. 2.8.1. This system moved NE and on Mar 19 at 12Z , the low had deepened to 980 mb and was situated E of Saul Ste Marie. As the system moved NE, a warm front passed over Dorset and another laid in the vicinity and the continuous precipitation area covered the station for some time. Unfortunately, continuous precipitation observations are not available as shown in Fig. 2.8.3. but it is certain that precipitation fell for some time around 06Z, during the missing period. From the synoptic maps, it appears that rain fell at Dorset.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for Mar. 18, 12Z, 18Z and Mar. 19, 00Z, 06Z and 12Z are shown in Figures 2.8.4, 2.8.5, 2.8.6, 2.8.7, and 2.8.8 respectively.

Air trajectories for the 1000 mb level show that NO_x from its high emission Detroit area could have been transported for about half period as shown in Figs. 2.8.6-8. No highest emission sources are involved.

Air trajectories for the 925 mb level show that transport of NO_x from Chicago area was possible since the trajectories are close to it (see Figs. 2.8.7-8), although they did not cross over it.

Air trajectories for the 850 mb and 700 mb levels show that they did not pass over any significant NO_x emission area and therefore no significant transport was likely.

In summary, a warm front passed over the station and the other was close to it and these yielded rain for a short duration and low level transport of NO_x from high emission Detroit was probable for about 12 hours. Some transport from Chicago area is also possible at low level for a short duration.

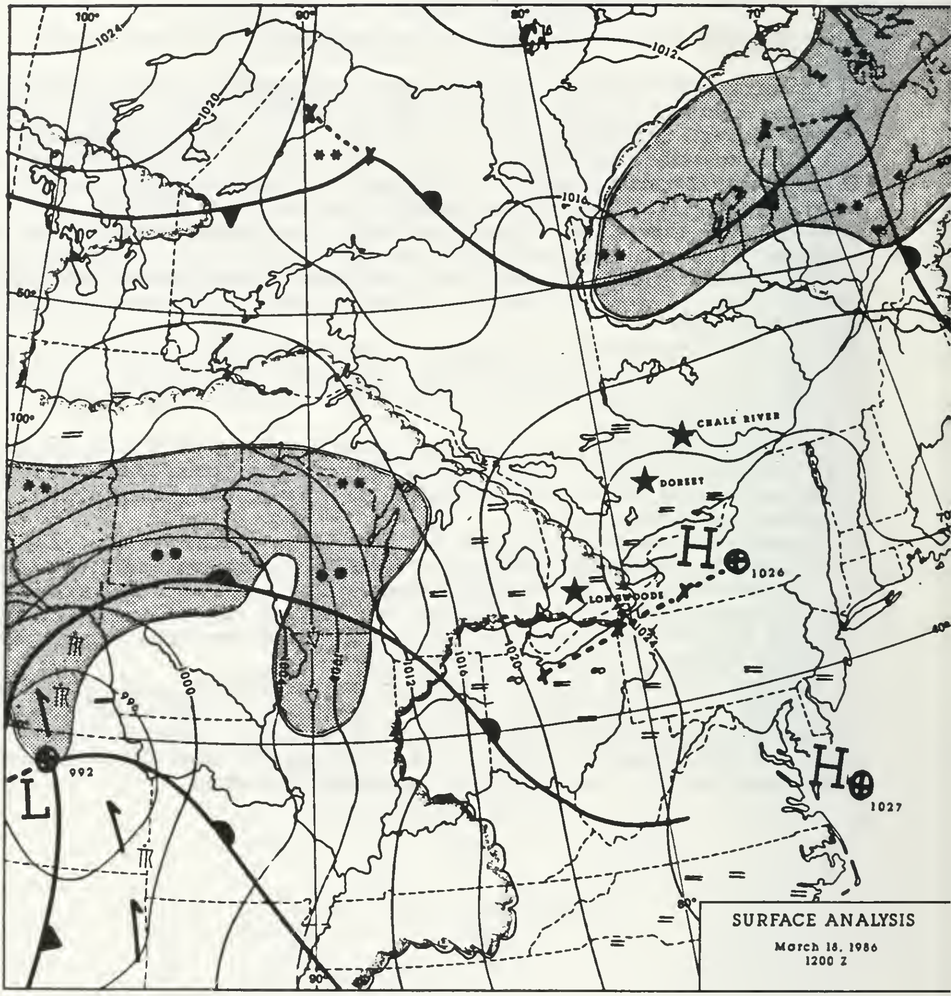
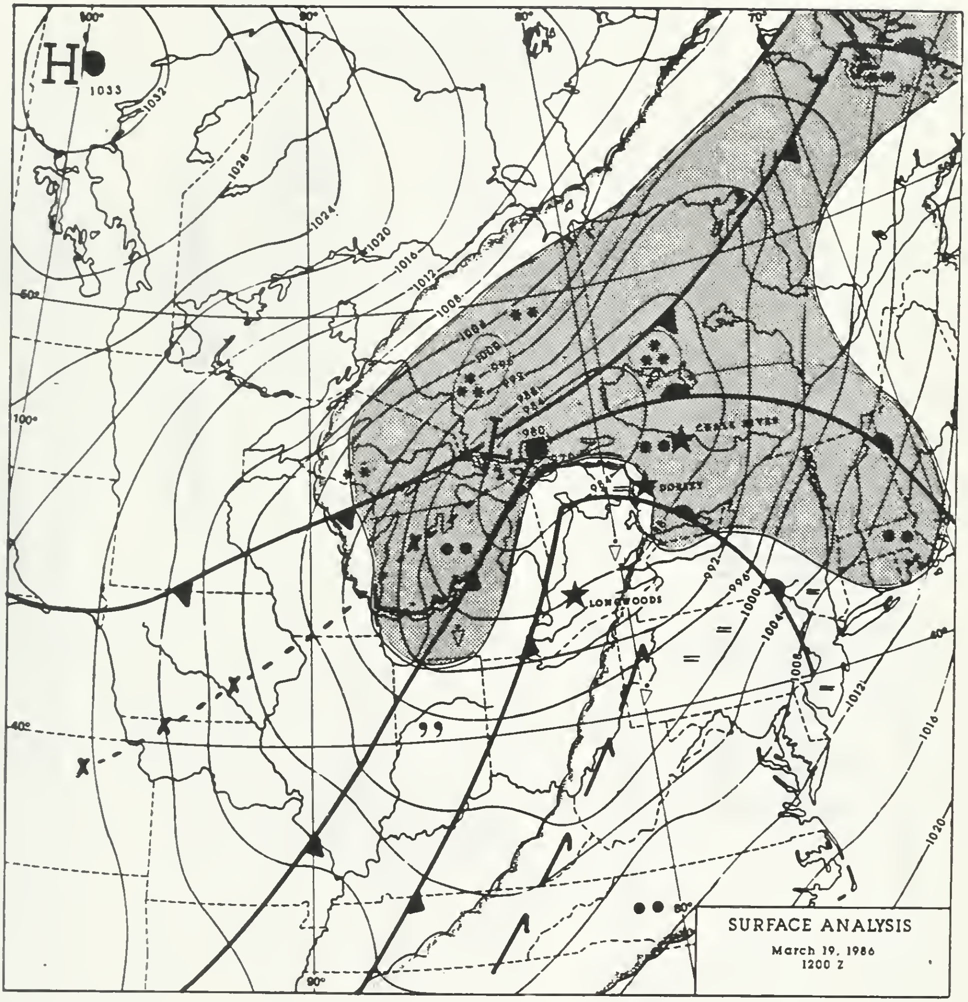

SURFACE ANALYSIS
March 18, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
H
1026
H
1027
L
992
1024
1020
1016
1012
1000
90°
80°
70°
100°
60°
40°

FIGURE 2.8.1



SURFACE ANALYSIS
March 19, 1986
1200 Z

FIGURE 2.8.2

Muskoka A

Mar. 18-19, 1986

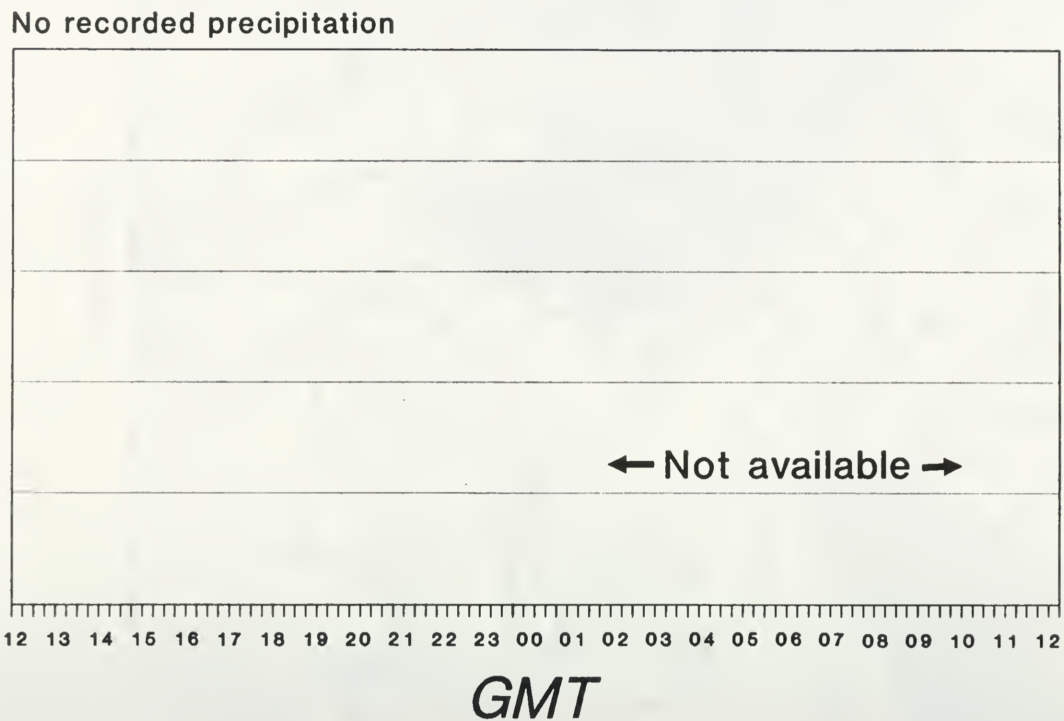


FIGURE 2.8.3

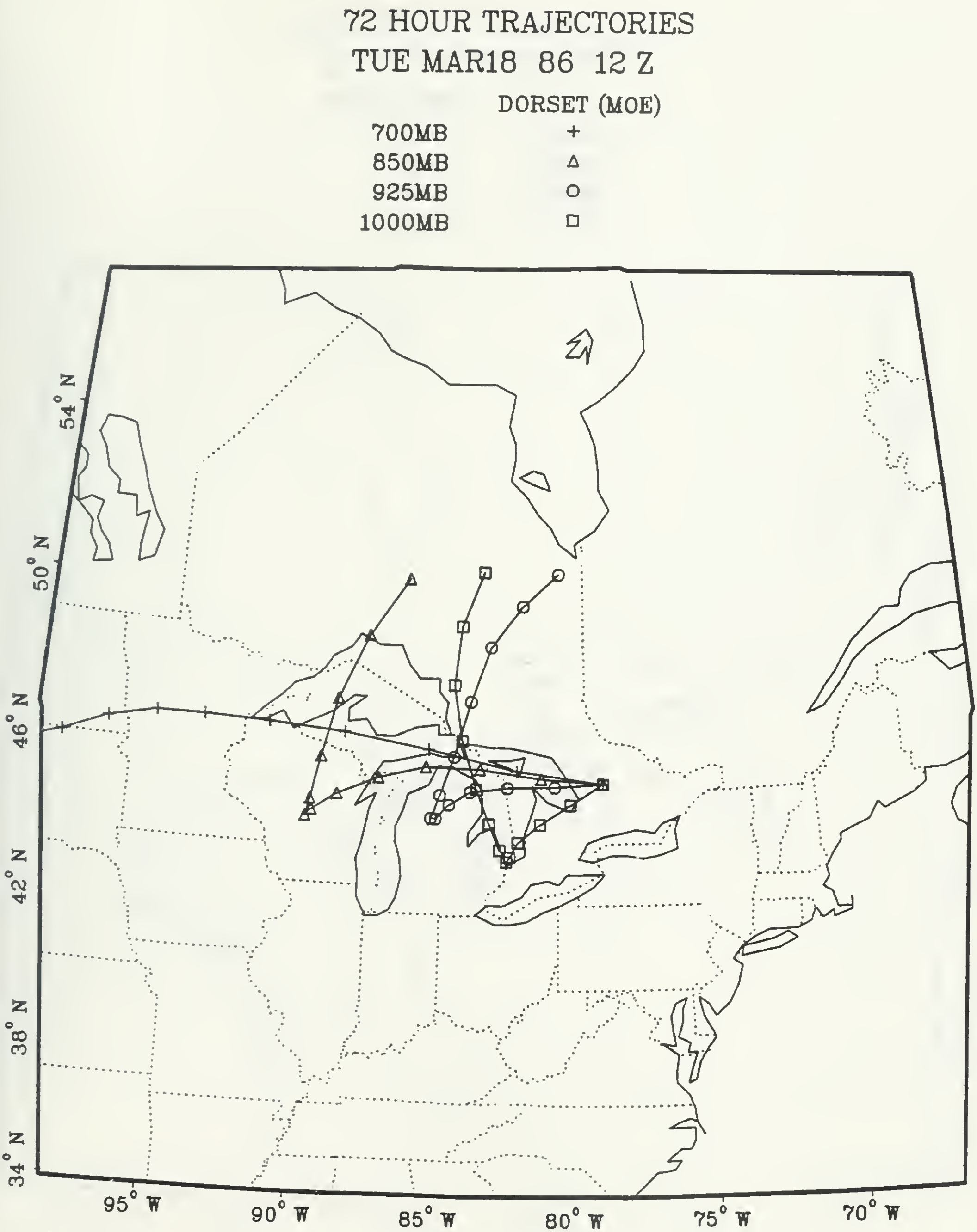

72 HOUR TRAJECTORIES
TUE MAR18 86 12 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.8.4

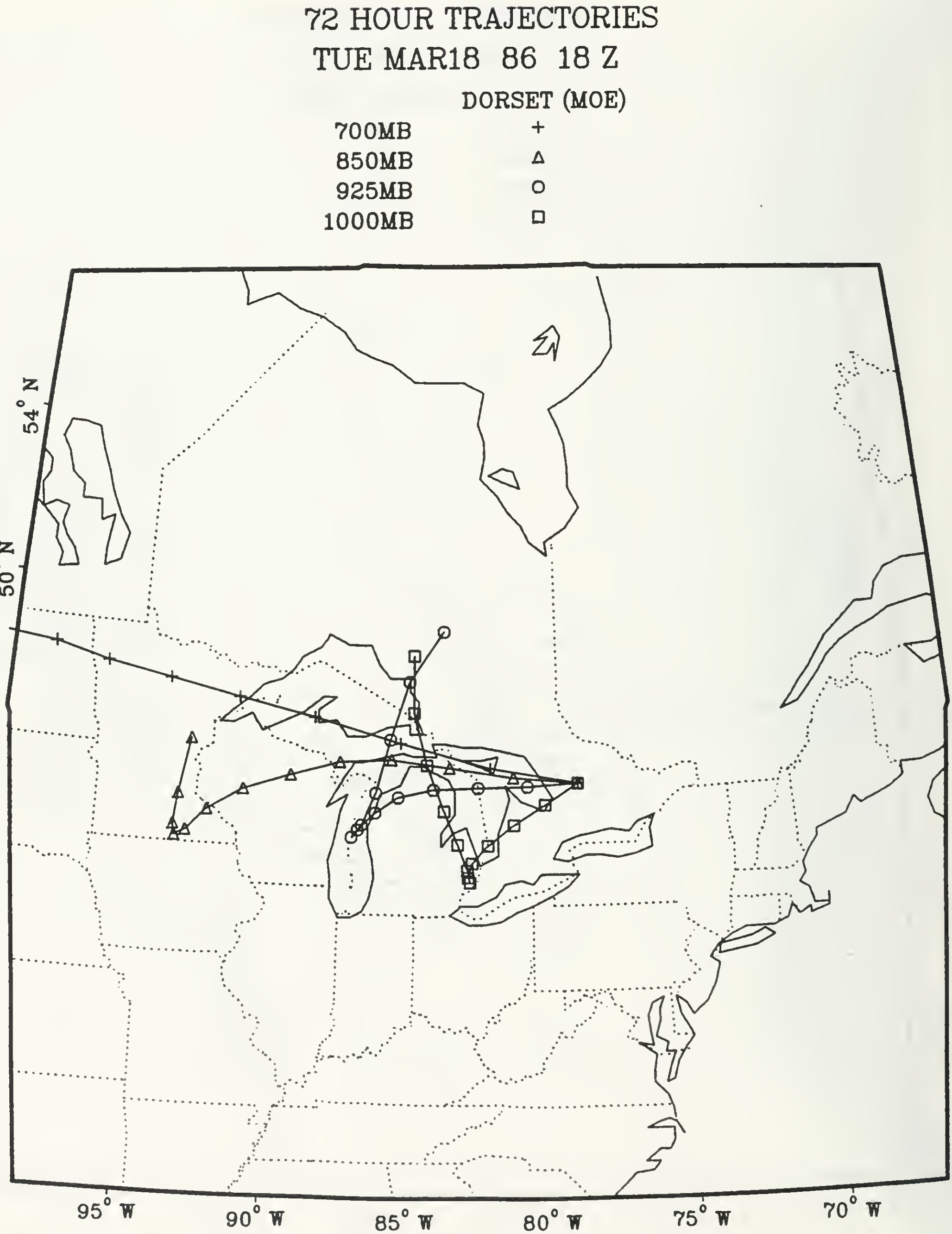

72 HOUR TRAJECTORIES
TUE MAR18 86 18 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.8.5

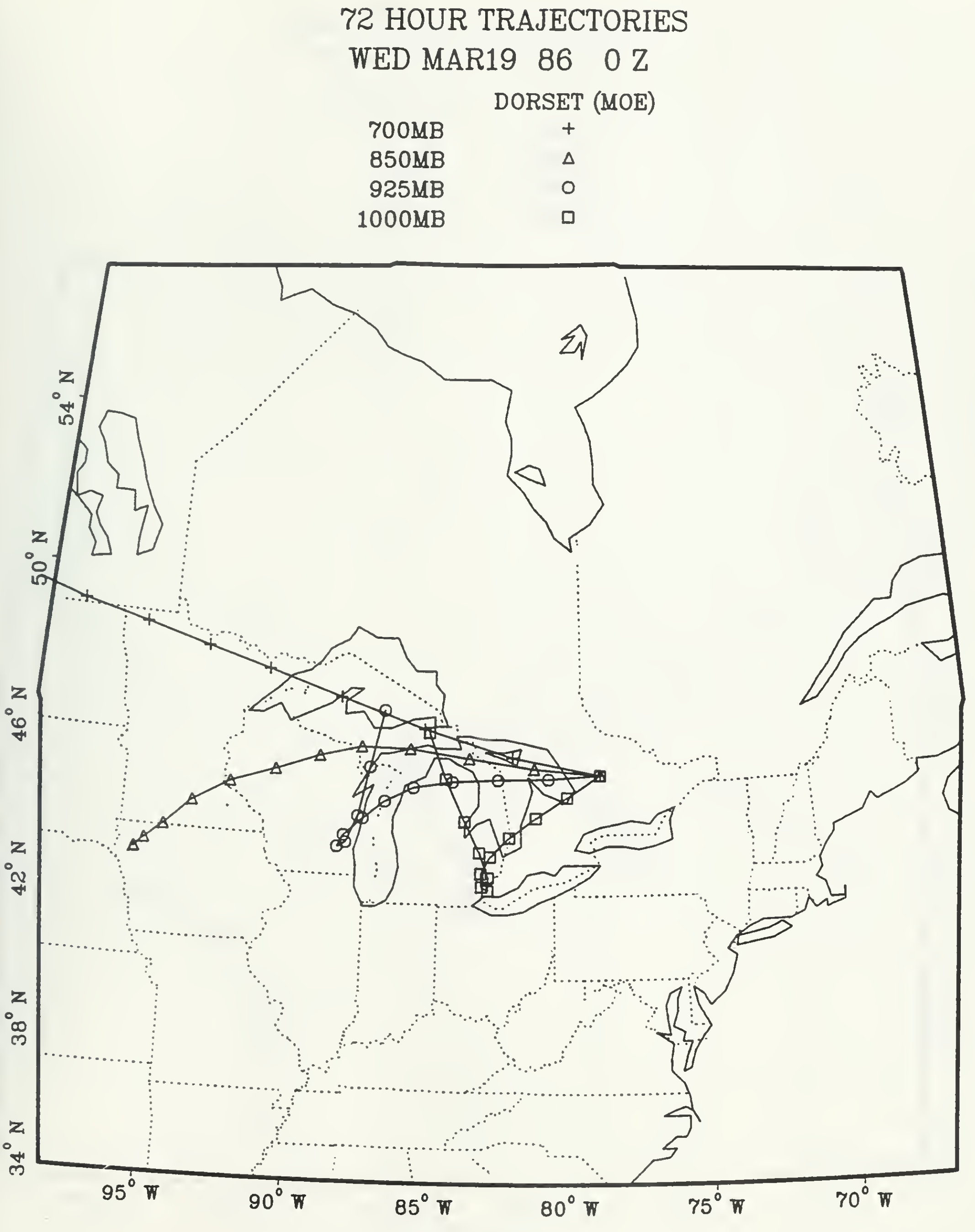
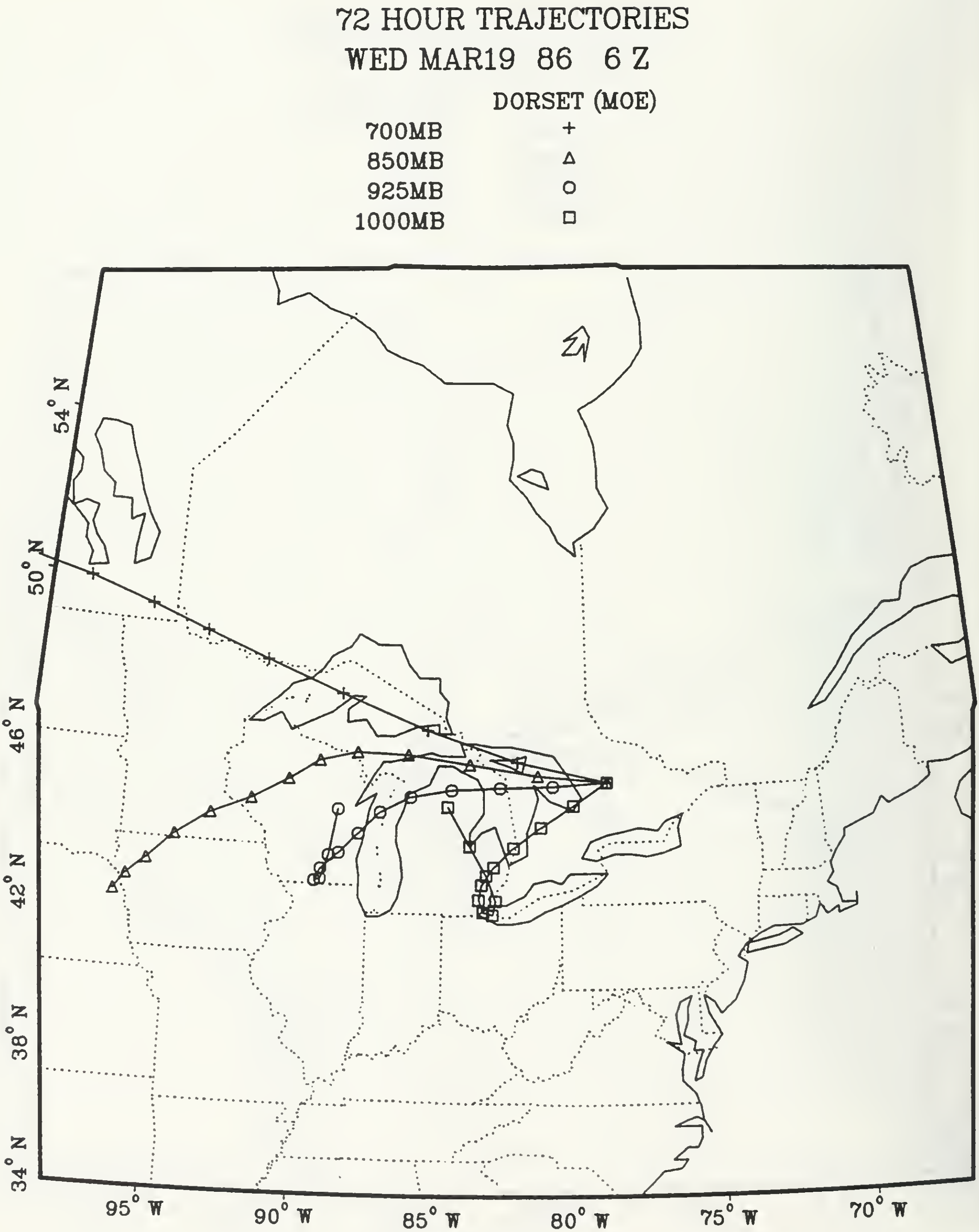

72 HOUR TRAJECTORIES
WED MAR19 86 0 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.8.6



72 HOUR TRAJECTORIES
WED MAR19 86 6 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.8.7

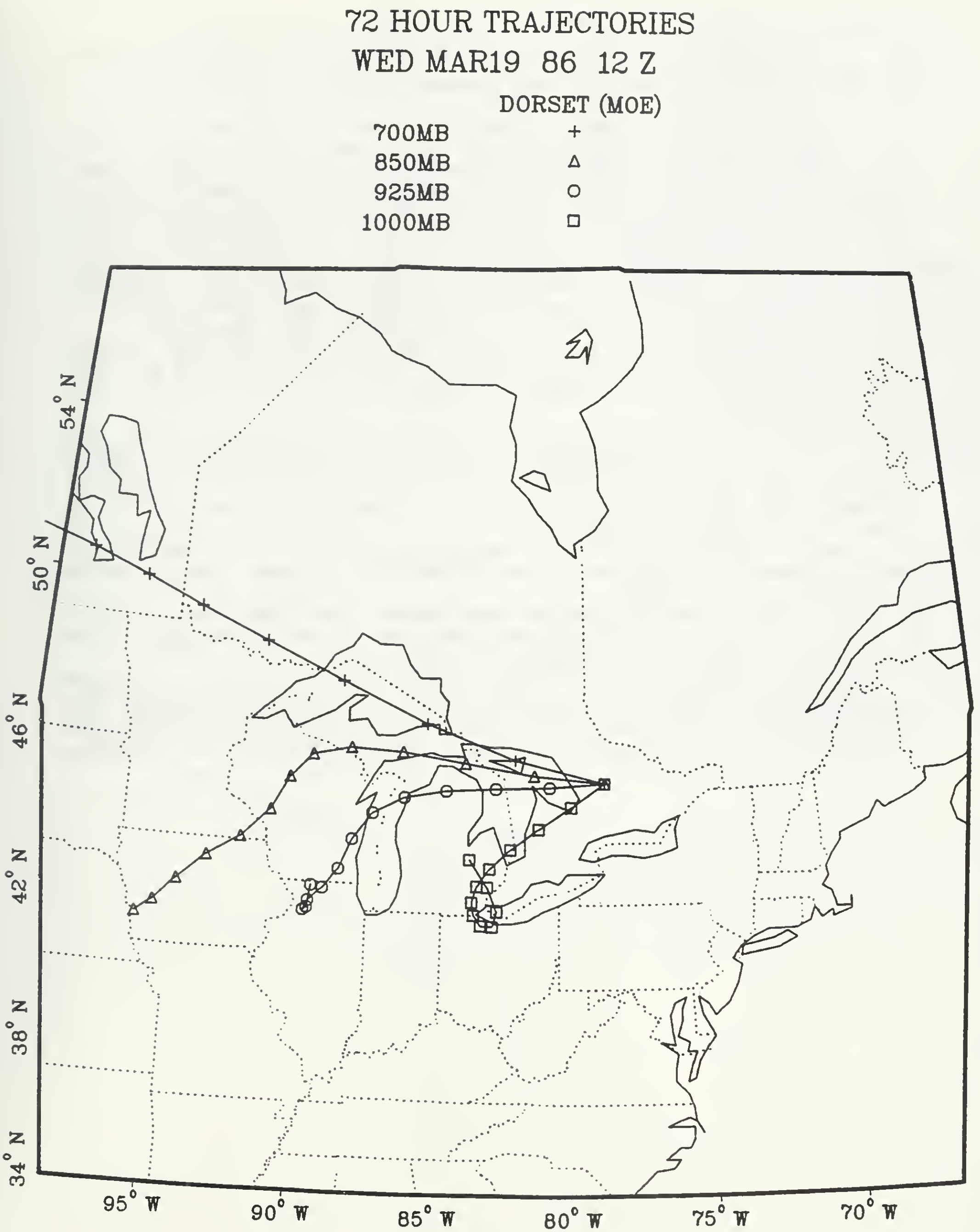

72 HOUR TRAJECTORIES
WED MAR19 86 12 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.8.8

2.9 April 7-8, 1986, Longwoods (AES & MOE)

This episode ranked 9th (9/10) and 8th (8/10) for only NO_3^- wet deposition at Longwoods(AES) and Longwoods(MOE) respectively.

A cold front over Longwoods on April 7, at 12Z as shown in Fig. 2.9.1, first moved northward and then southward during this episode. A wave with a trowal developed in the frontal system over southern USA in Fig. 2.9.1, and the trowal also was observed first north of the station and then moved south of the station. On April 8, at 12Z, as illustrated in Fig. 2.9.2, frontal systems had moved far from the station. Drizzle of very light intensity for a short time on April 7 and rain showers and thundershowers were observed with the passage of trowal and the cold front over the station on April 8 as exhibited in Fig. 2.9.3. Lightning was observed.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for April 7, 12Z, 18Z and April 8, 00Z, 06Z and 12Z are shown in Figures 2.9.4, 2.9.5, 2.9.6, 2.9.7, and 2.9.8 respectively.
Air parcels arriving at the 1000 mb level show that NO_x from the highest emission Chicago area could have been transported on April 8, during 00-06Z, as shown in Figs. 2.9.6-7. Transport from the high emission Detroit area was also exhibited for some time as shown in Fig. 2.9.6.
Air parcels arriving at the 925 mb level show that NO_x could have been transported the Chicago area on April 8 for some time as shown in Fig. 2.9.6.
Air trajectories for the 850 mb and 700 mb show (see Figs. 2.9.4-8) that no significant transport occurred at these levels as the trajectories did not pass over any high emission area.
In summary, passage of a cold front and a trowal yielded thundershower lasting for about two hours. Lightning was observed. Low level transport (1000 mb & 925 mb) of NO_x from Chicago area was likely. High level transport was insignificant during this episode.

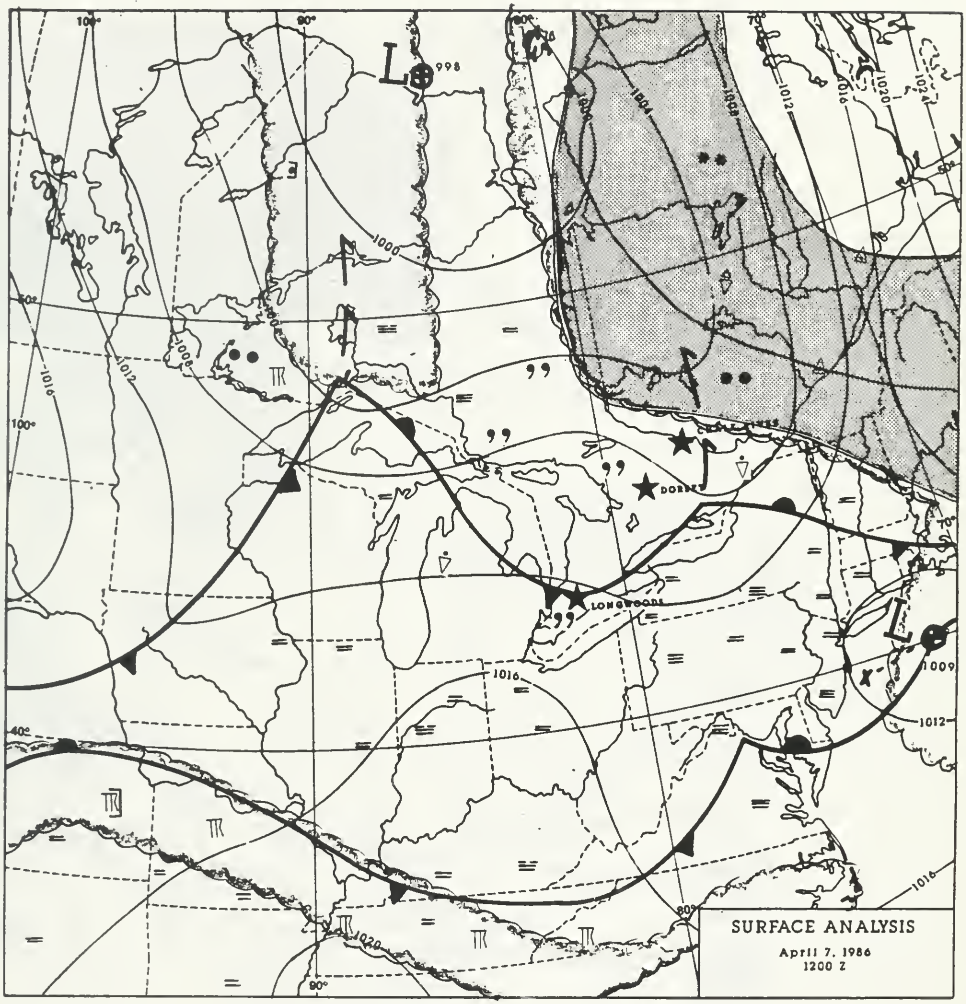

SURFACE ANALYSIS
April 7, 1986
1200 Z
998
1009
1000
1004
1008
1012
1016
1020
1024
LONGWOODS
DORSET
40°
50°
60°
70°
80°
90°
100°

FIGURE 2.9.1

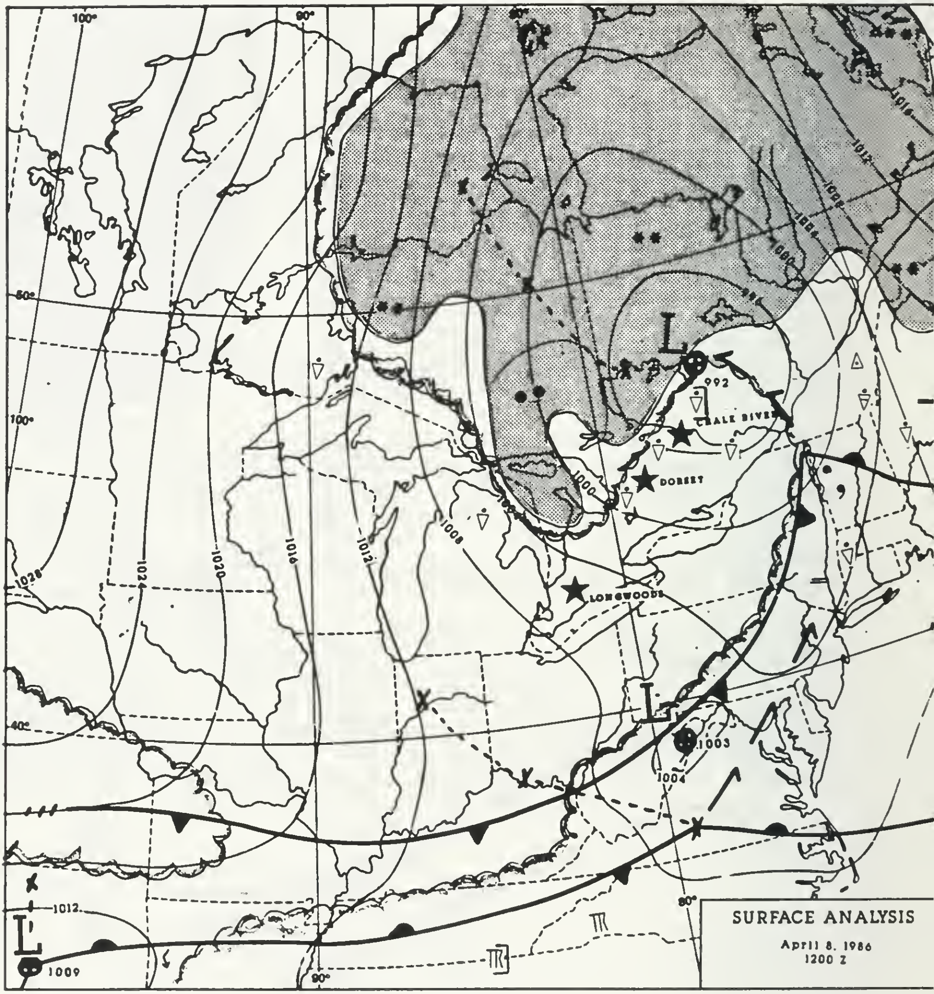

SURFACE ANALYSIS
April 8, 1986
1200 Z
LONGWOODS
DORSET
CHALK RIVER
992
1000
1003
1004
1008
1009
1012
1016
1020
1024
1028
100°
90°
80°
50°
40°

FIGURE 2.9.2

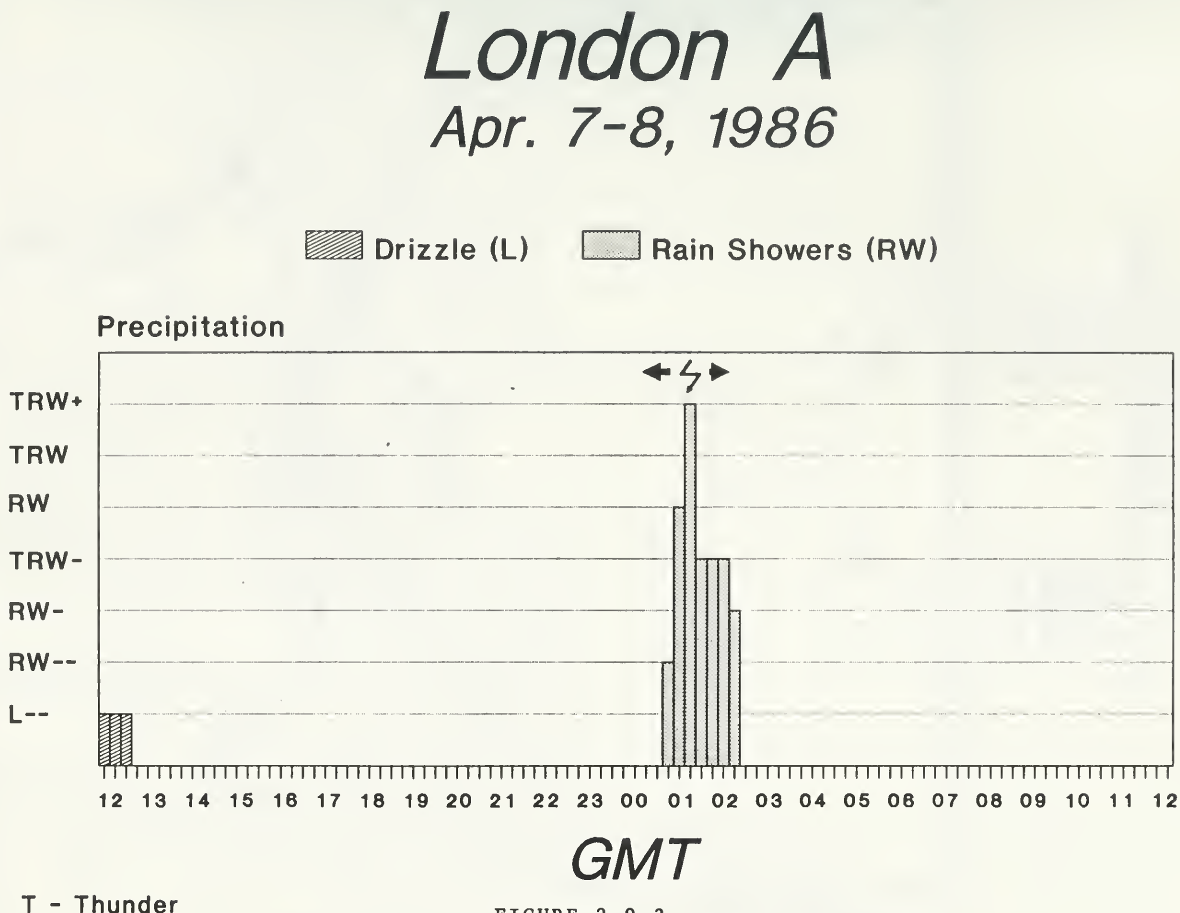

London A
Apr. 7-8, 1986
Drizzle (L)
Rain Showers (RW)
Precipitation
TRW+
TRW
RW
TRW-
RW-
RW--
L--
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
T - Thunder

FIGURE 2.9.3

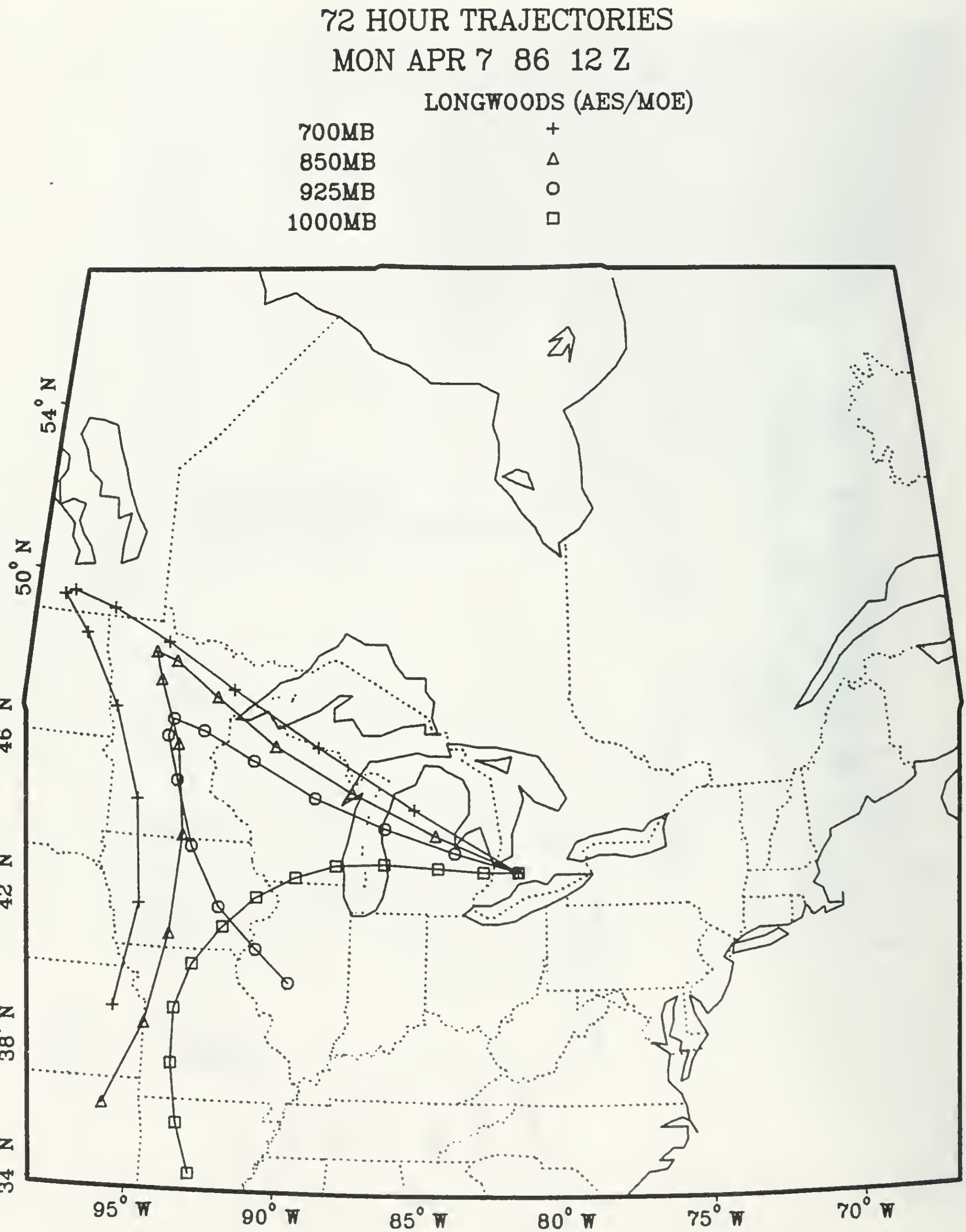

72 HOUR TRAJECTORIES
MON APR 7 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.9.4

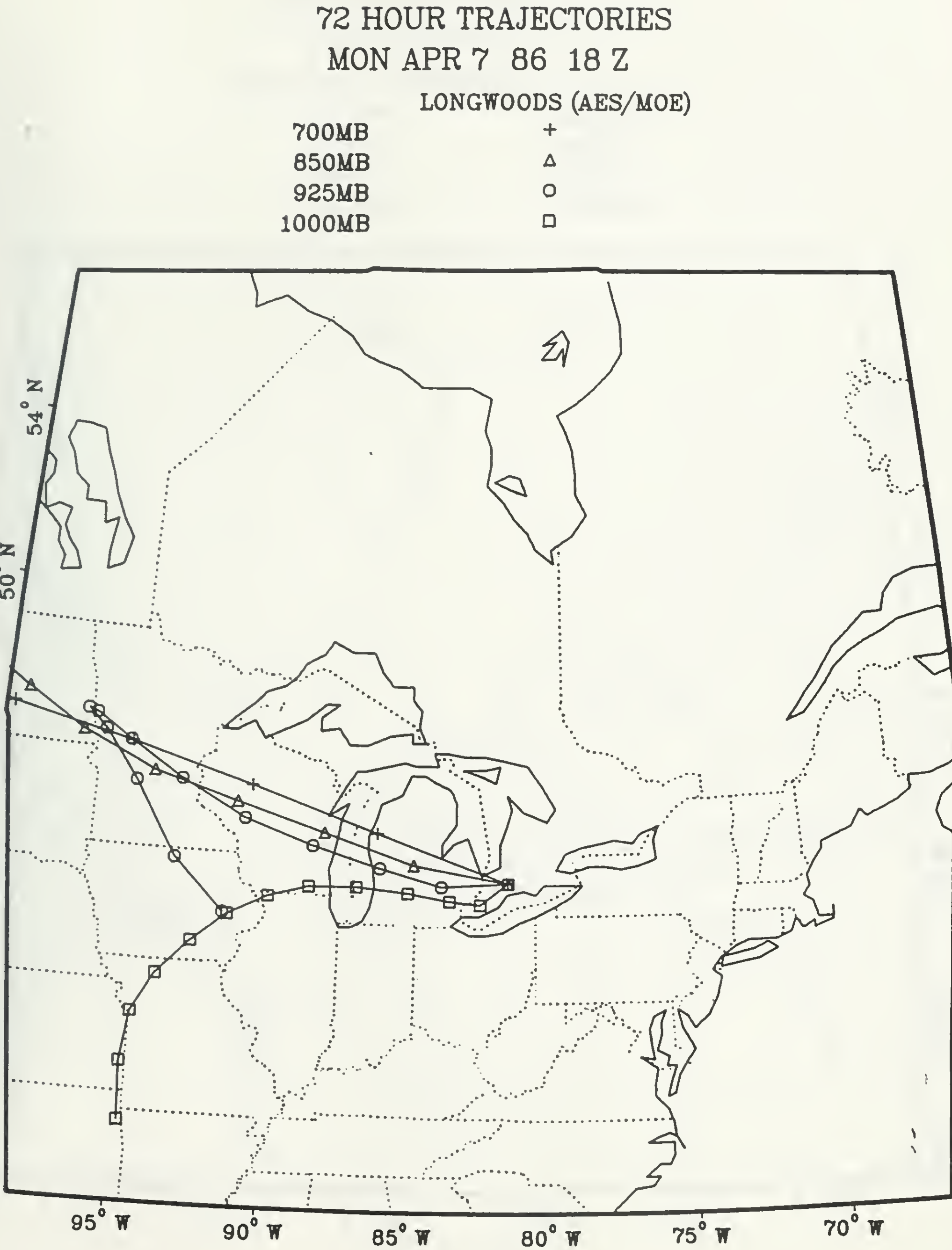

72 HOUR TRAJECTORIES
MON APR 7 86 18 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.9.5

72 HOUR TRAJECTORIES
TUE APR 8 86 0 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	Δ
925MB	O
1000MB	□

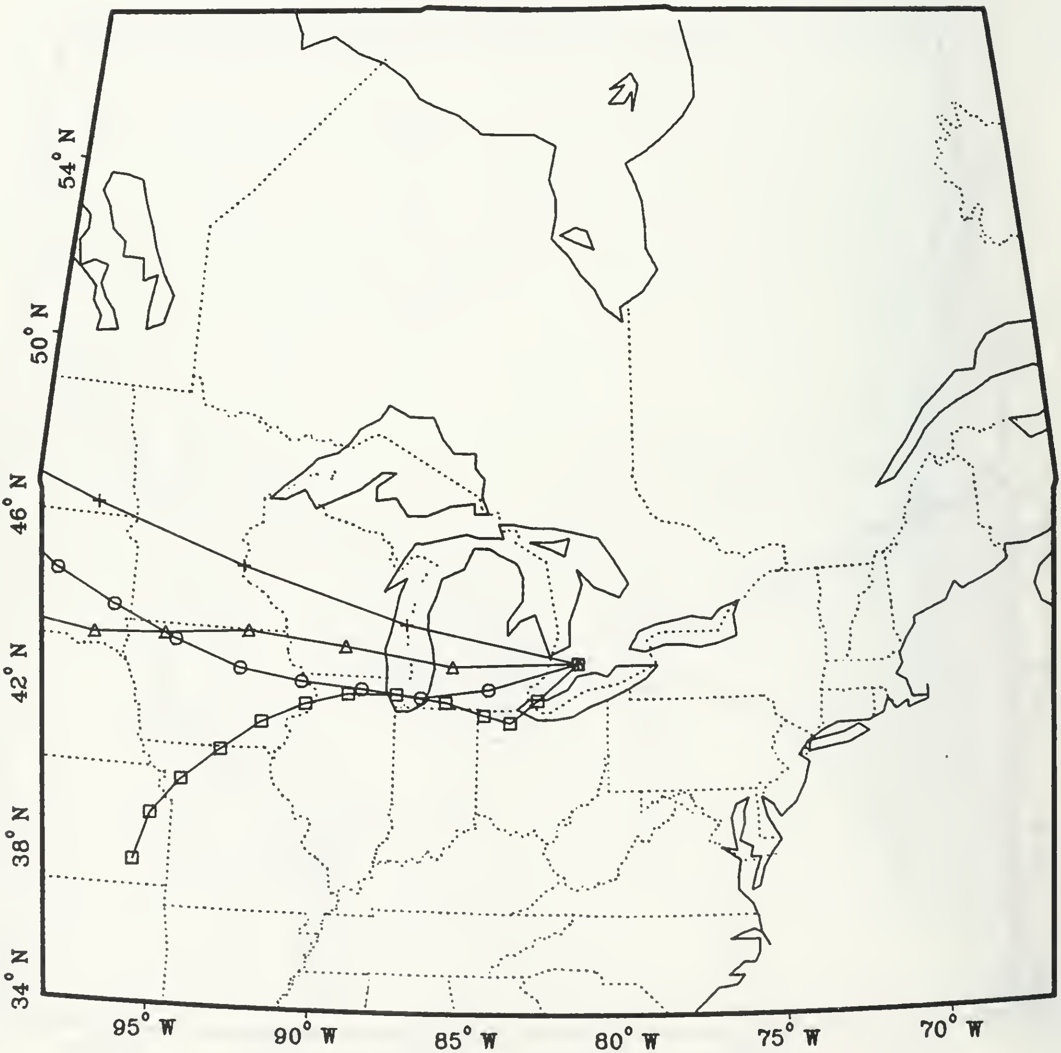


FIGURE 2.9.6

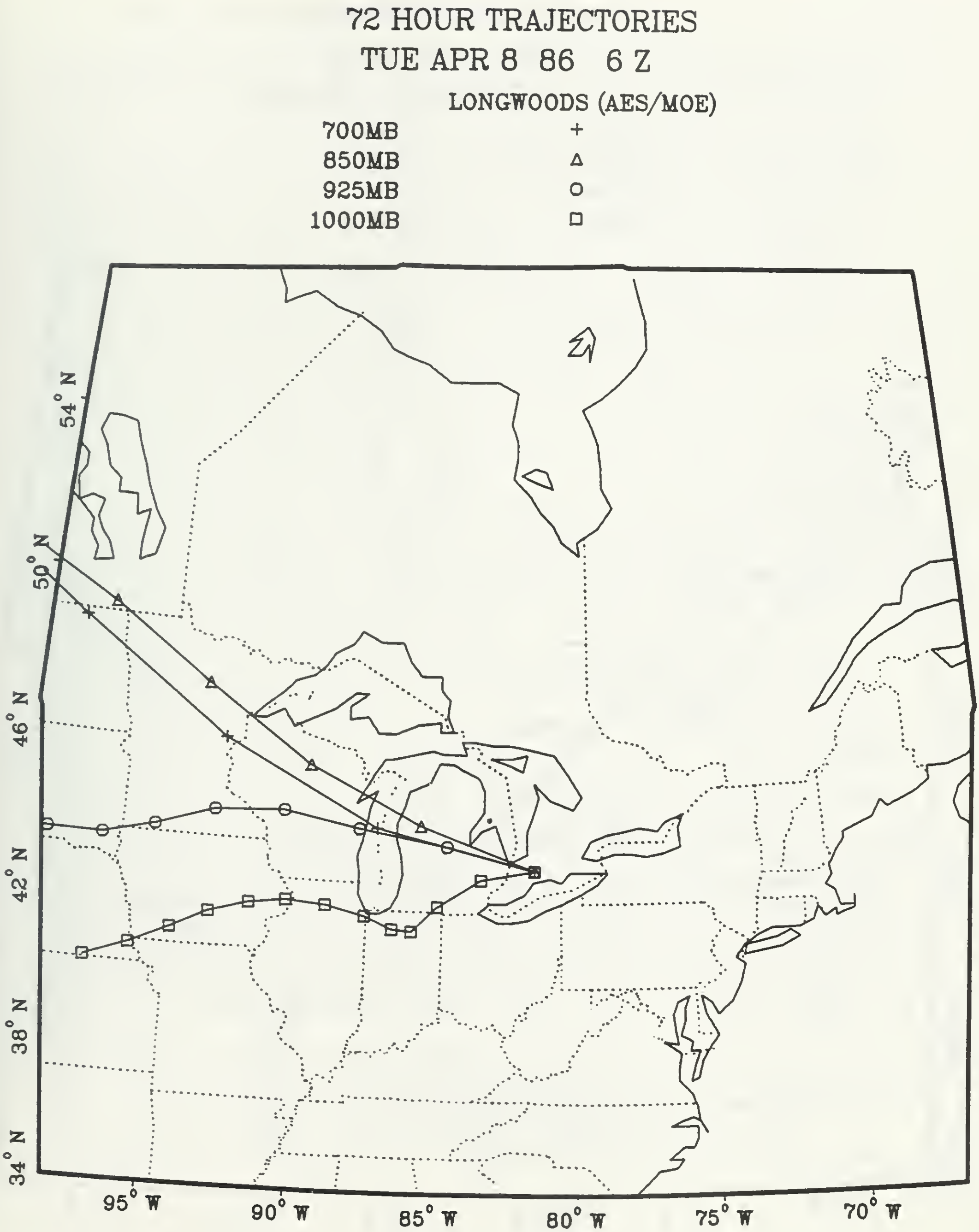

72 HOUR TRAJECTORIES
TUE APR 8 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.9.7

72 HOUR TRAJECTORIES
TUE APR 8 86 12 Z
LONGWOODS (AES/MOE)

700MB	+
850MB	Δ
925MB	O
1000MB	□

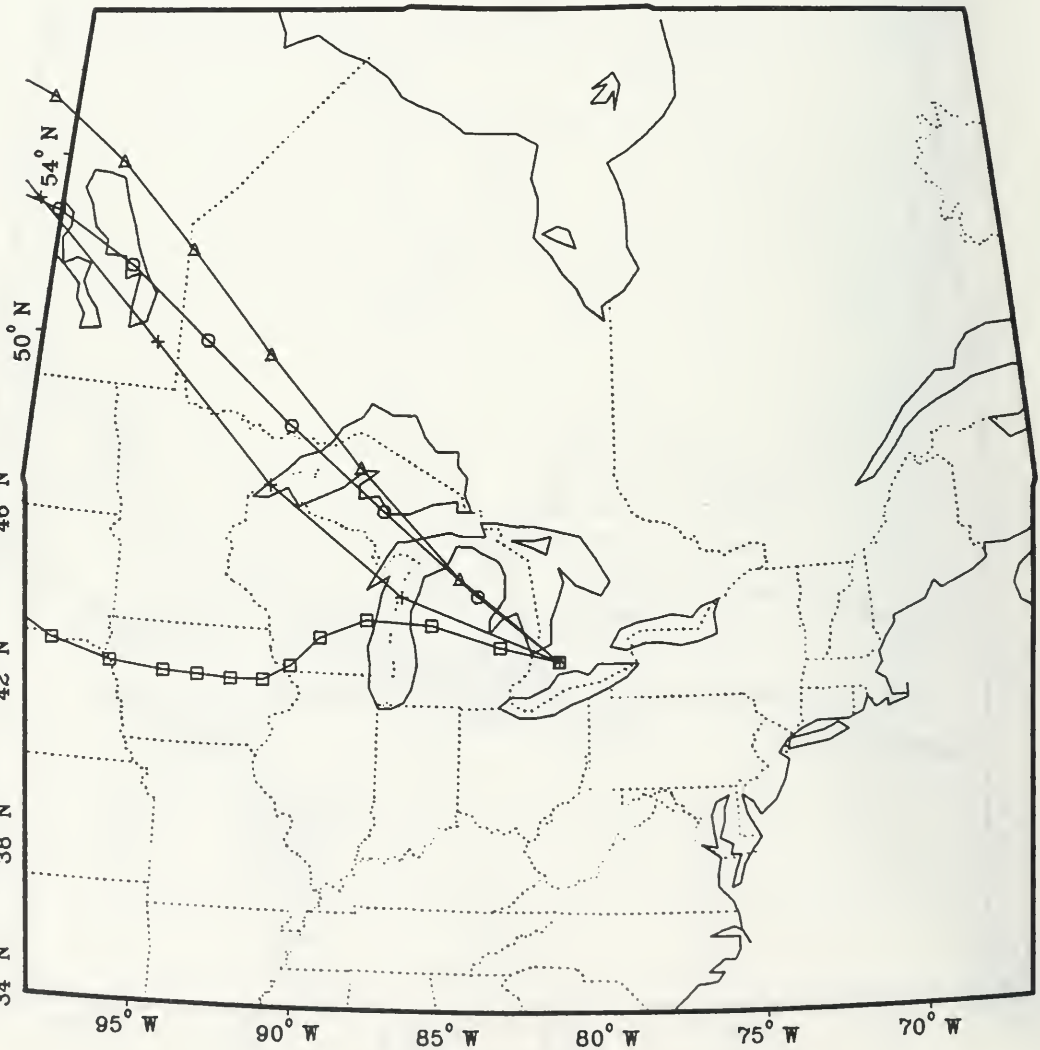


FIGURE 2.9.8

2.10 April 15-16, 1986, Longwoods (AES & MOE)

This episode ranked 1st (1/10) and 3rd (3/10) for the NO_3^- wet deposition top 25% events at Longwoods (AES) and Longwoods (MOE) stations, respectively.

On April 15, at 12Z, a frontal system with the cold front over the station and two low pressure centres, one over Chicago and the other near Traverse City and a trof, as shown in Fig. 2.10.1, were observed. During the next 24 hours, these low centres moved eastward and filled and on April 16, at 12Z, only a frontal system with a wave over Lake Huron and the cold front east of the station were analyzed as illustrated in Fig. 2.10.2. With the movement of the low centres, trof and the cold front in the region, very light and light rain showers, light rain were recorded on April 15 for about an hour before midnight and on April 16 for about five hours at the end of the episode as exhibited in Fig. 2.10.3. As shown in the figure, very light drizzle were also observed for about 15 minutes.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for April 15, 12Z, 18Z and April 16, 00Z, 06Z and 12Z are shown in Figures 2.10.4, 2.10.5, 2.10.6, 2.10.7, and 2.10.8 respectively.

Air trajectories for the 1000 mb level show that they did not cross over any significant NO_x emission source area and therefore pollution transport at this level would be negligible.

Air parcels arriving at the 925 mb level show that NO_x could have been transported from its high emission areas in Pennsylvania, Ohio (Figs. 2.10.4-5), West Virginia (Figs. 2.10.6-7), and Maryland (Figs. 2.10.6-8).

Air trajectories at the 850 mb level show that NO_x could have been transported from its high emission areas in Ohio (Figs. 2.10.4&8) for some time.

Air trajectories at the 700 mb level show that transport of NO_x could have occurred from Ohio (Figs. 2.10.4 & 7-8), West Virginia and Pennsylvania (Figs. 2.10.8).

Summarizing, cold front passage over the station and the presence of the low pressure centres and trof in the region yielded sporadic rain showers of light and very light intensity, rain of light intensity at the nearest weather station. the total duration of the precipitation was about 6 hours. Low level (925 mb) and high level (850 mb & 700 mb) transport of NO_x from high emission areas in Ohio, West Virginia, Pennsylvania and low level transport (925 mb) also from Maryland were probable. It is interesting to note that no transport from any highest emission area occurred during this highest deposition episode at Longwoods (AES). Also, the ranking is only third at the Longwoods (MOE) station.

The sample for this episode was a multi-day collection for two days, viz., April 14 -16, and although most precipitation fell on April 15-16, a transport from the highest emission source areas took place on April 14-15 as evident from Figs 2.10.9-11. Transport was likely from the highest NO_x emission Chicago area at 700 mb level during April 14 18Z - April 15, 00Z (see Figs. 2.10.9-10) and at 850 mb level during April 15, 00Z - April 15, 06Z. Transport of NO_x at 925 mb level from high emission areas in Pennsylvania and Ohio was also likely on April 15 during 06Z - 12Z as stated earlier. This explains that even though NO_x transport from the highest emission Chicago area did not take place during April 15, 12Z to April 16, 12Z, it did occur earlier at high levels and could have contributed to its highest ranking.

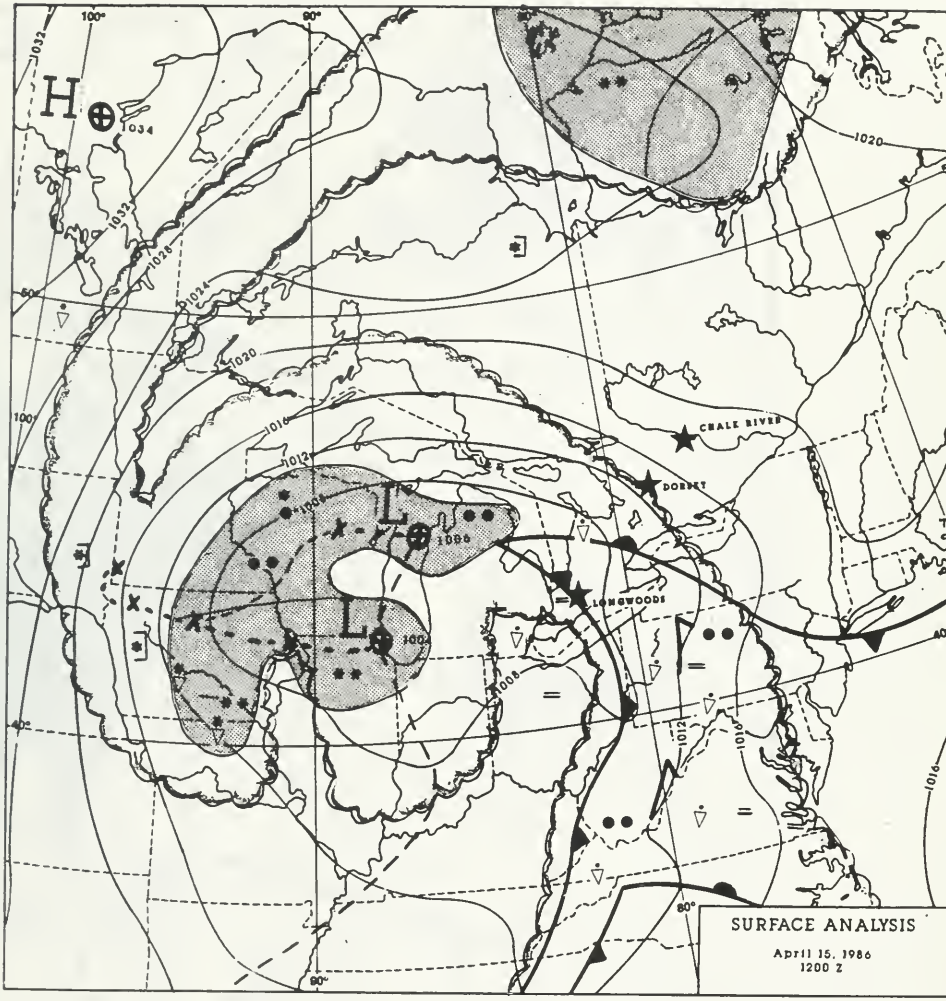

SURFACE ANALYSIS
April 15, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
H
L
L
1034
1032
1028
1024
1020
1016
1012
1008
1006
1004
1016
100°
90°
80°
70°
60°
50°
40°

FIGURE 2.10.1

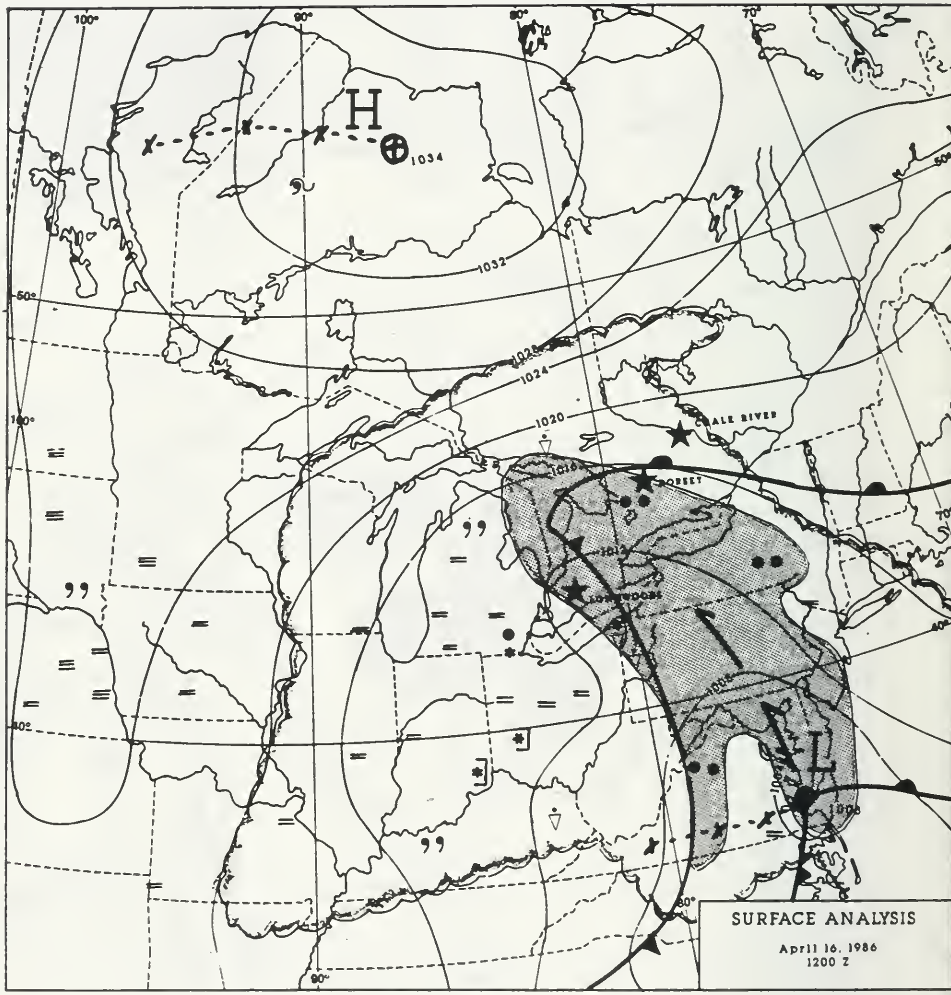

H
1034
1032
1028
1024
1020
L
SURFACE ANALYSIS
April 16, 1986
1200 Z

FIGURE 2.10.2

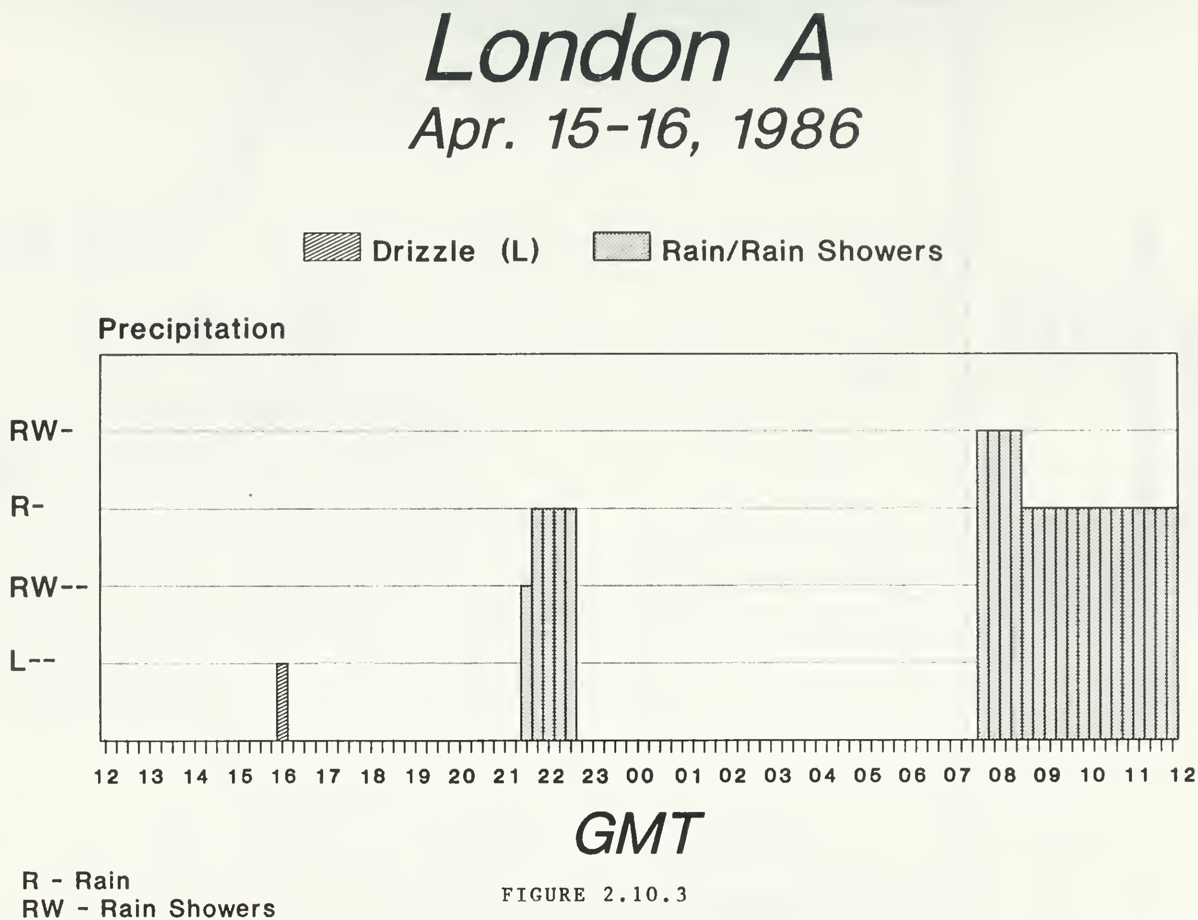

London A
Apr. 15-16, 1986
Drizzle (L)
Rain/Rain Showers
Precipitation
RW-
R-
RW--
L--
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
R - Rain
RW - Rain Showers

FIGURE 2.10.3

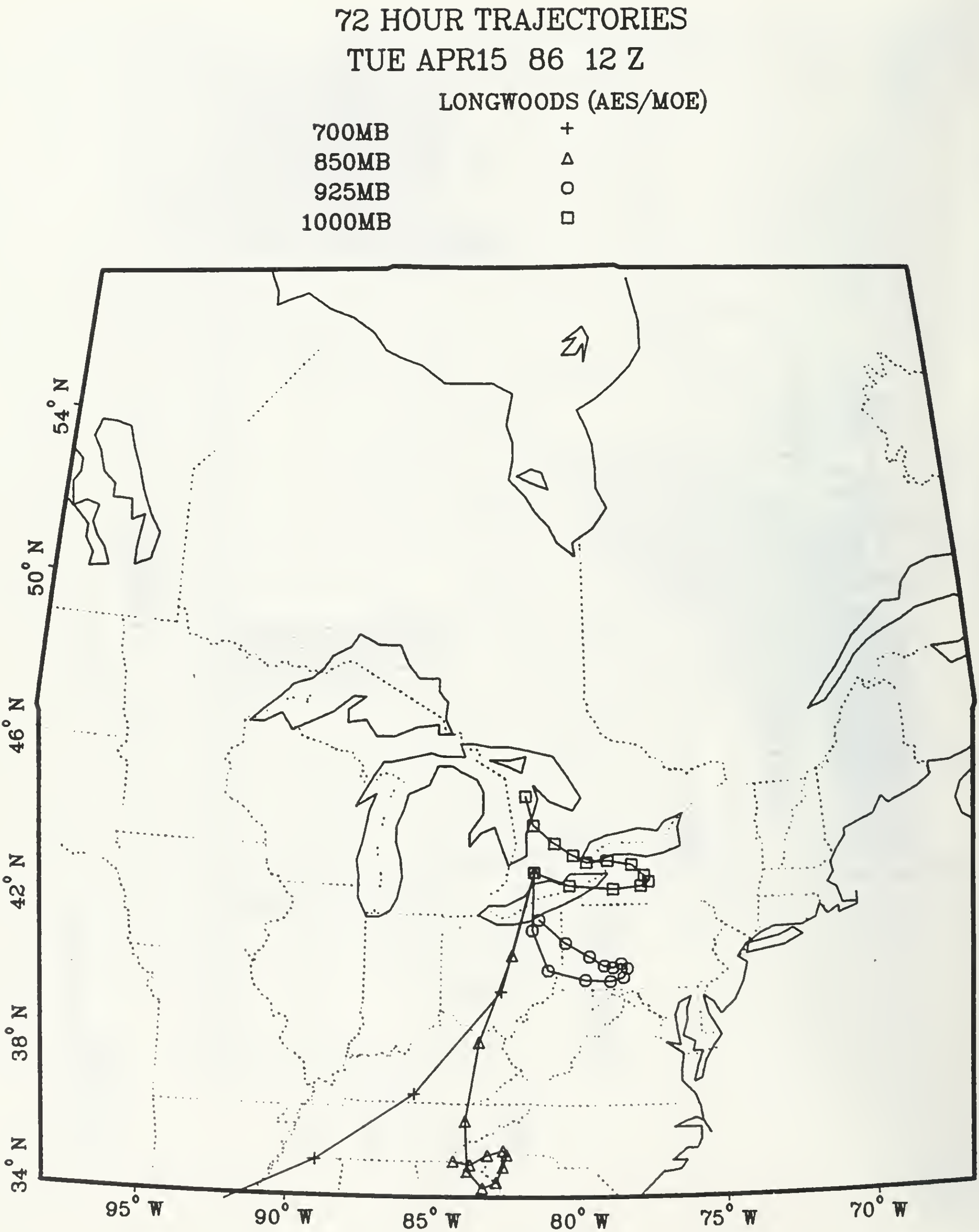

72 HOUR TRAJECTORIES
TUE APR15 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.10.4

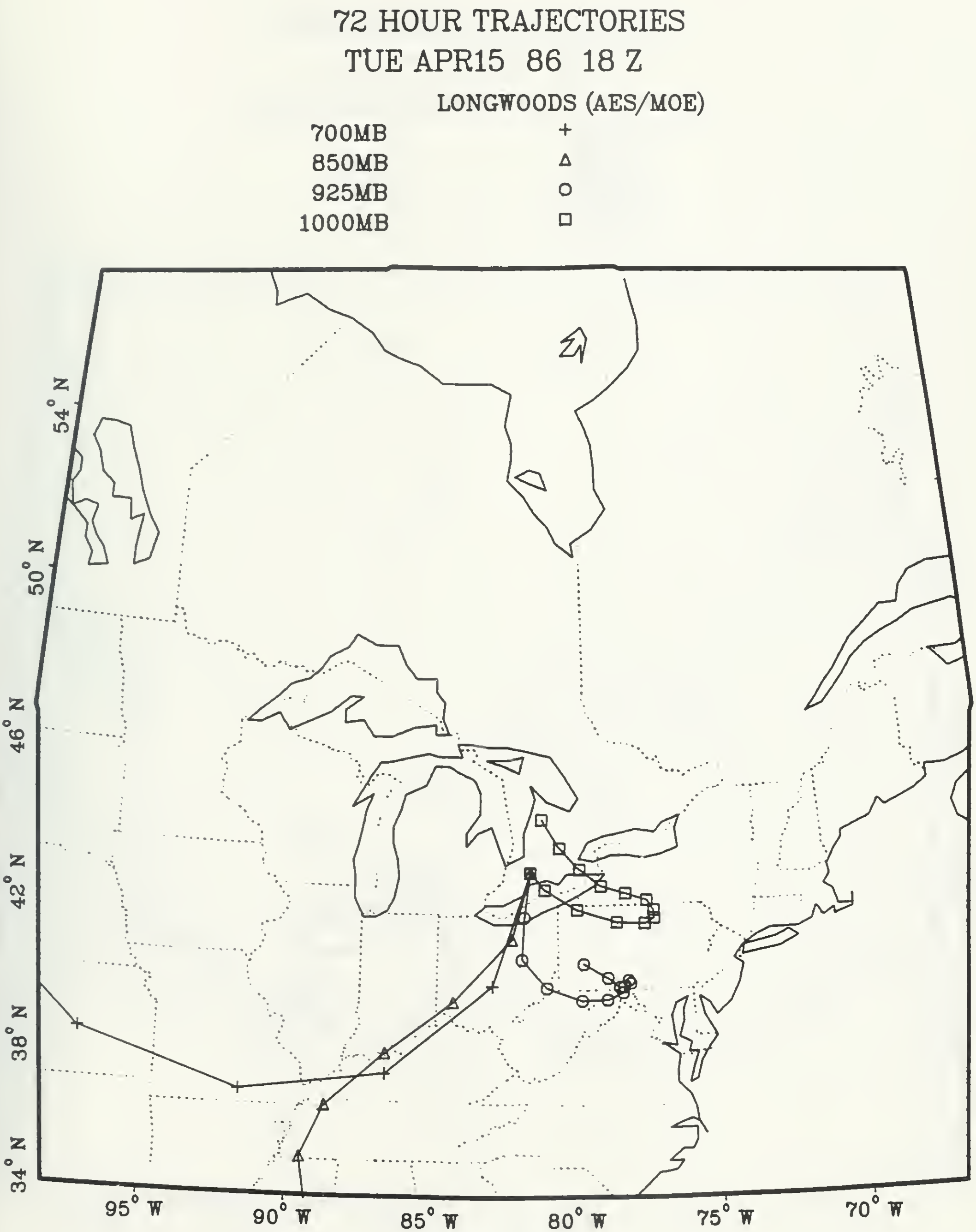

72 HOUR TRAJECTORIES
TUE APR15 86 18 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.10.5

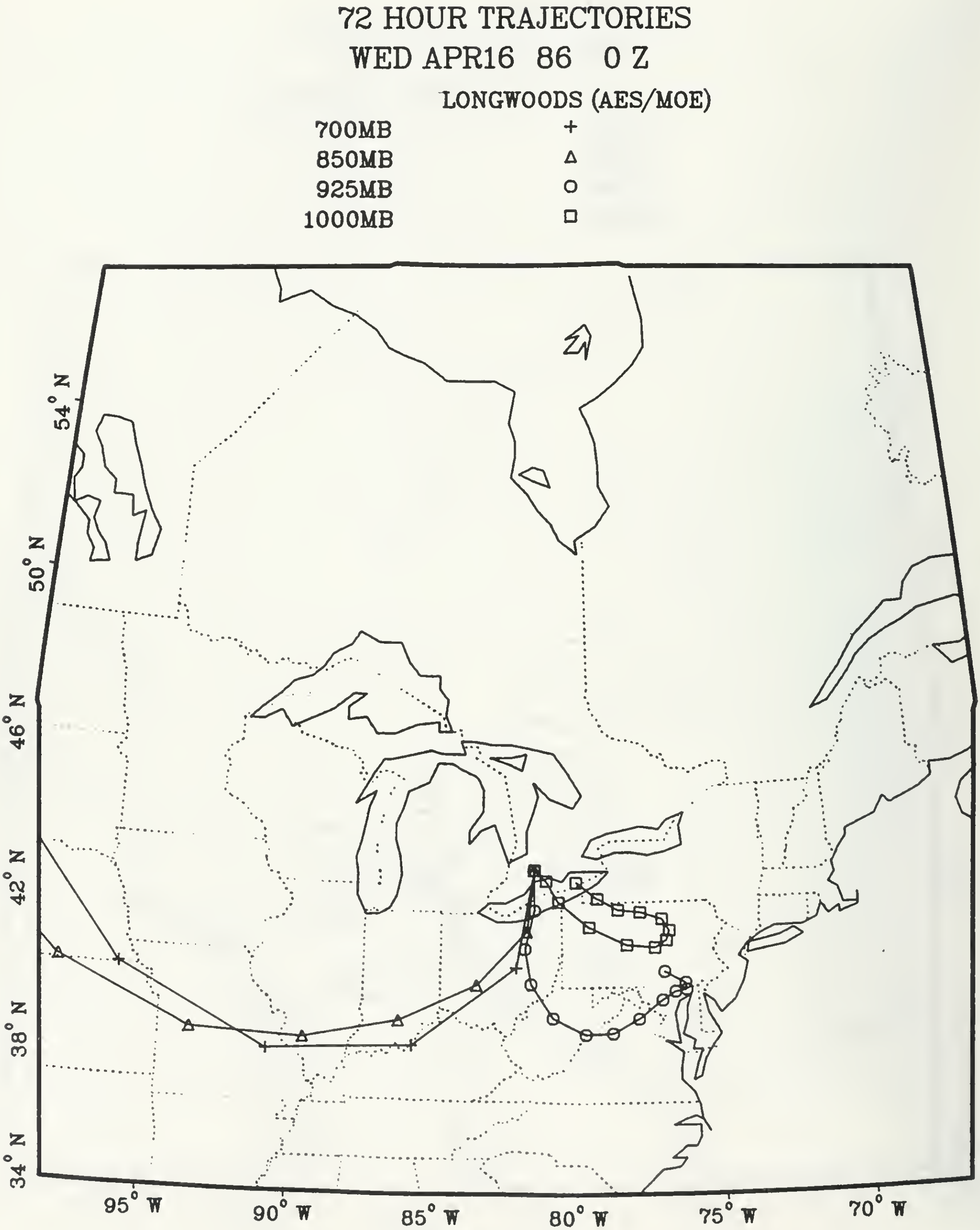

72 HOUR TRAJECTORIES
WED APR16 86 0 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.10.6

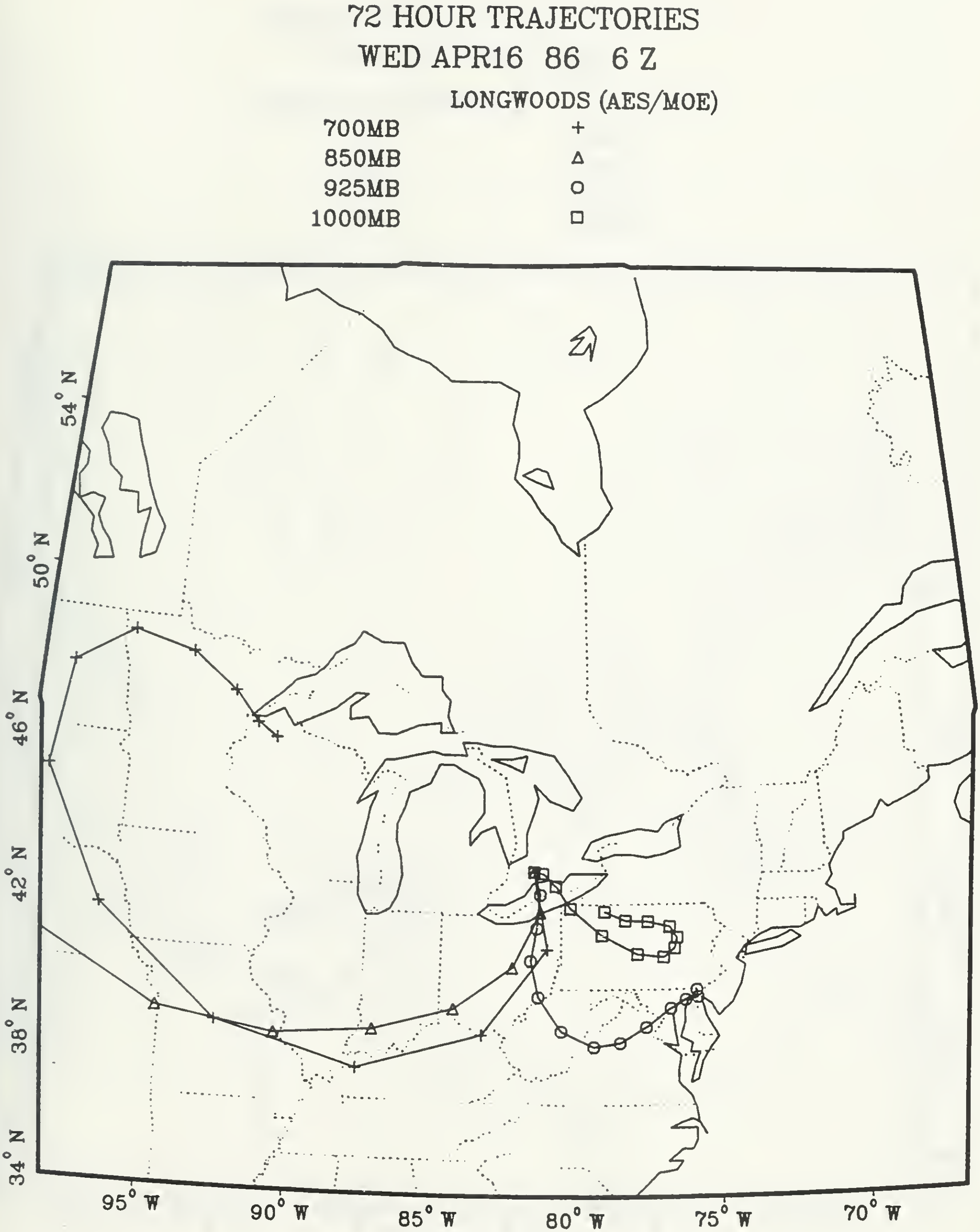

72 HOUR TRAJECTORIES
WED APR16 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.10.7

72 HOUR TRAJECTORIES
WED APR16 86 12 Z

LONGWOODS (AES/MOE)

700MB +
850MB △
925MB ○
1000MB □

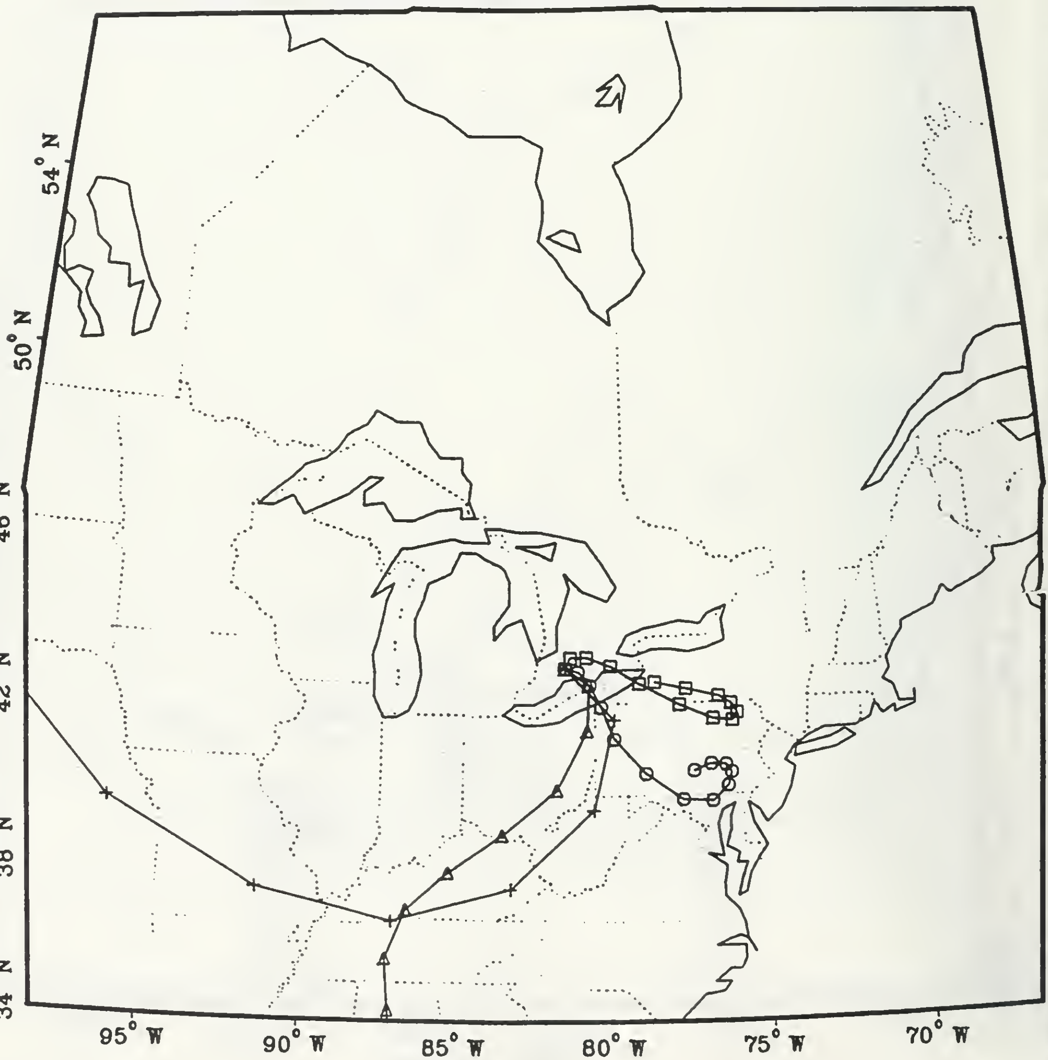


FIGURE 2.10.8

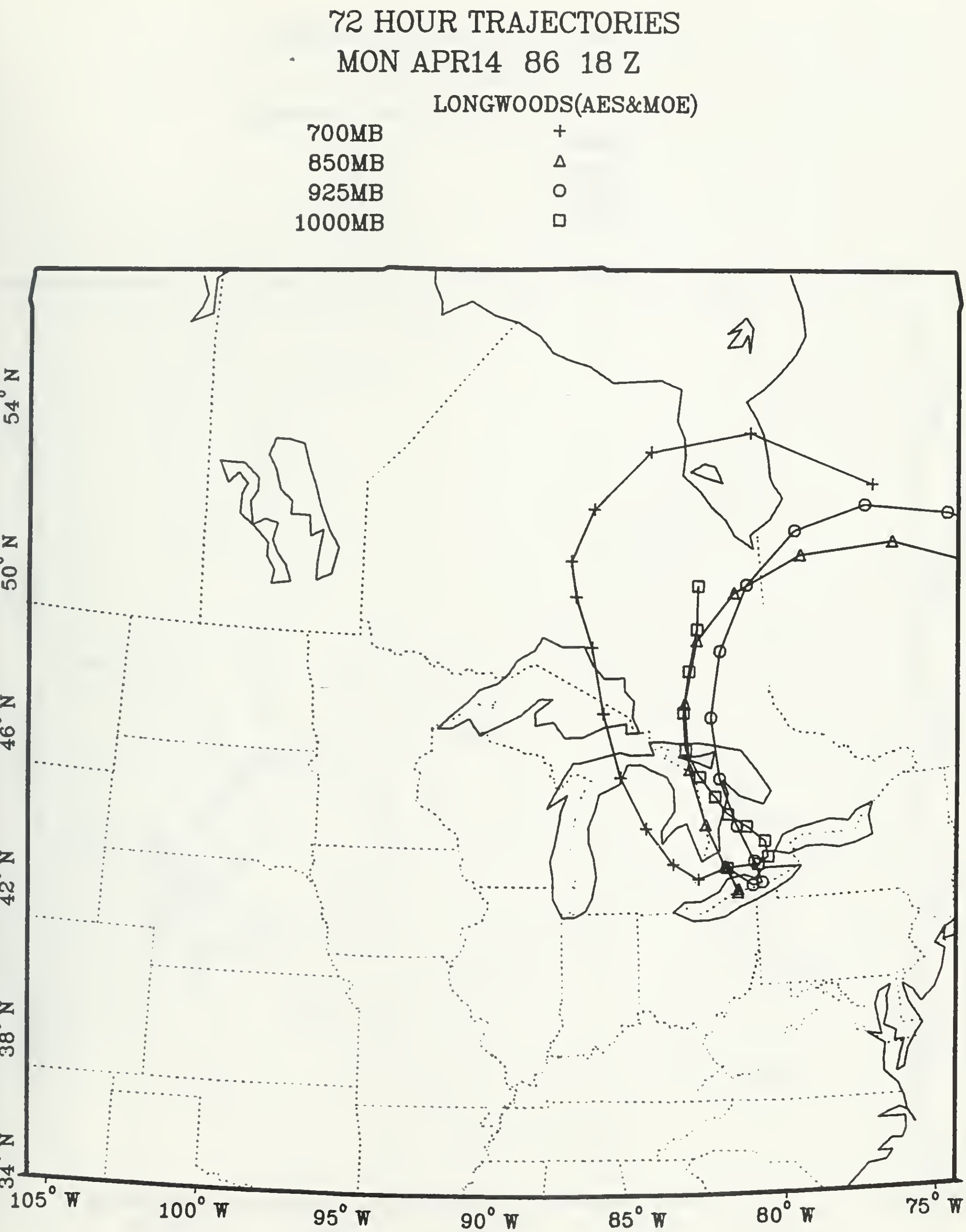

72 HOUR TRAJECTORIES
MON APR14 86 18 Z
LONGWOODS(AES&MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
105° W
100° W
95° W
90° W
85° W
80° W
75° W

FIGURE 2.10.9

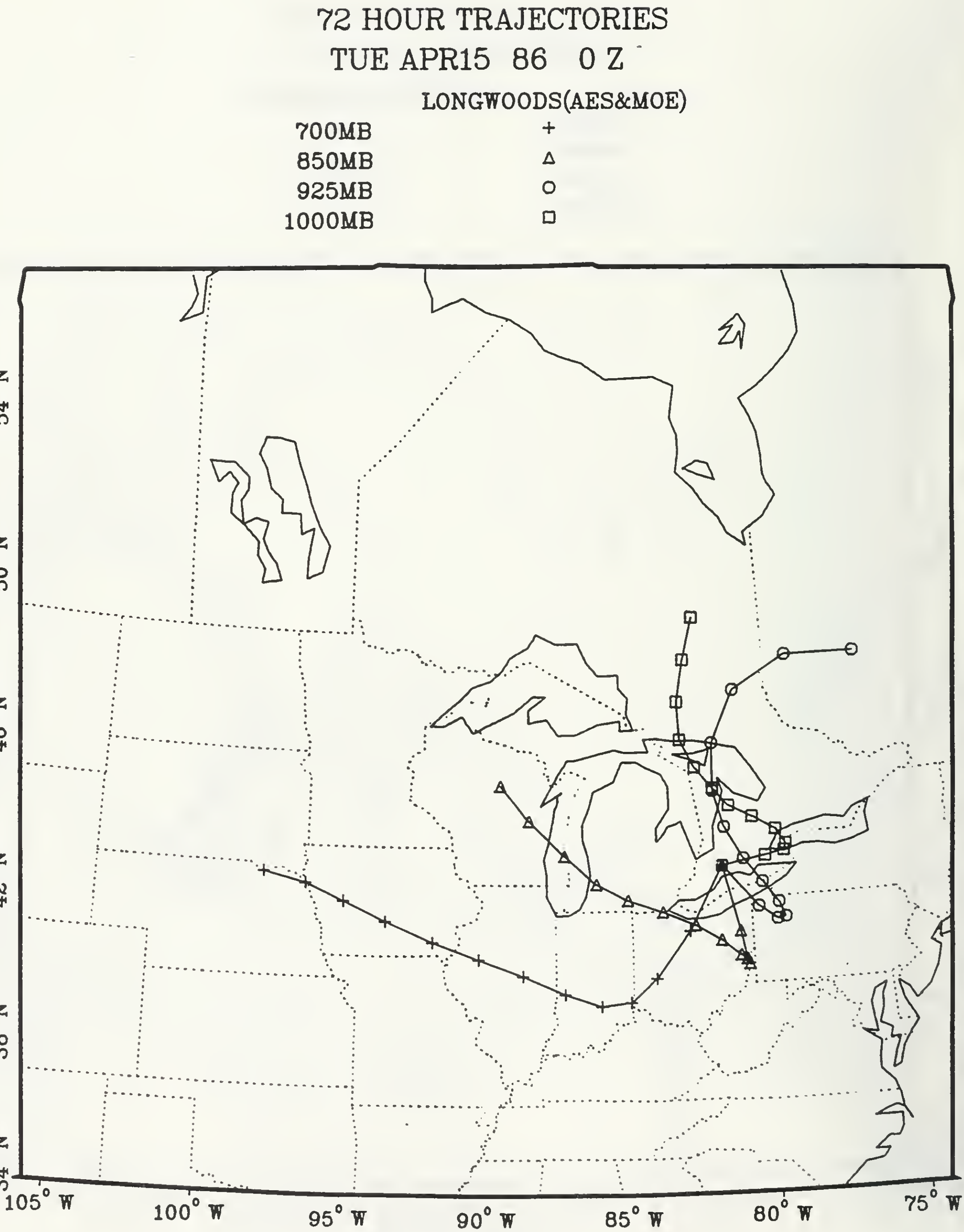


FIGURE 2.10.10

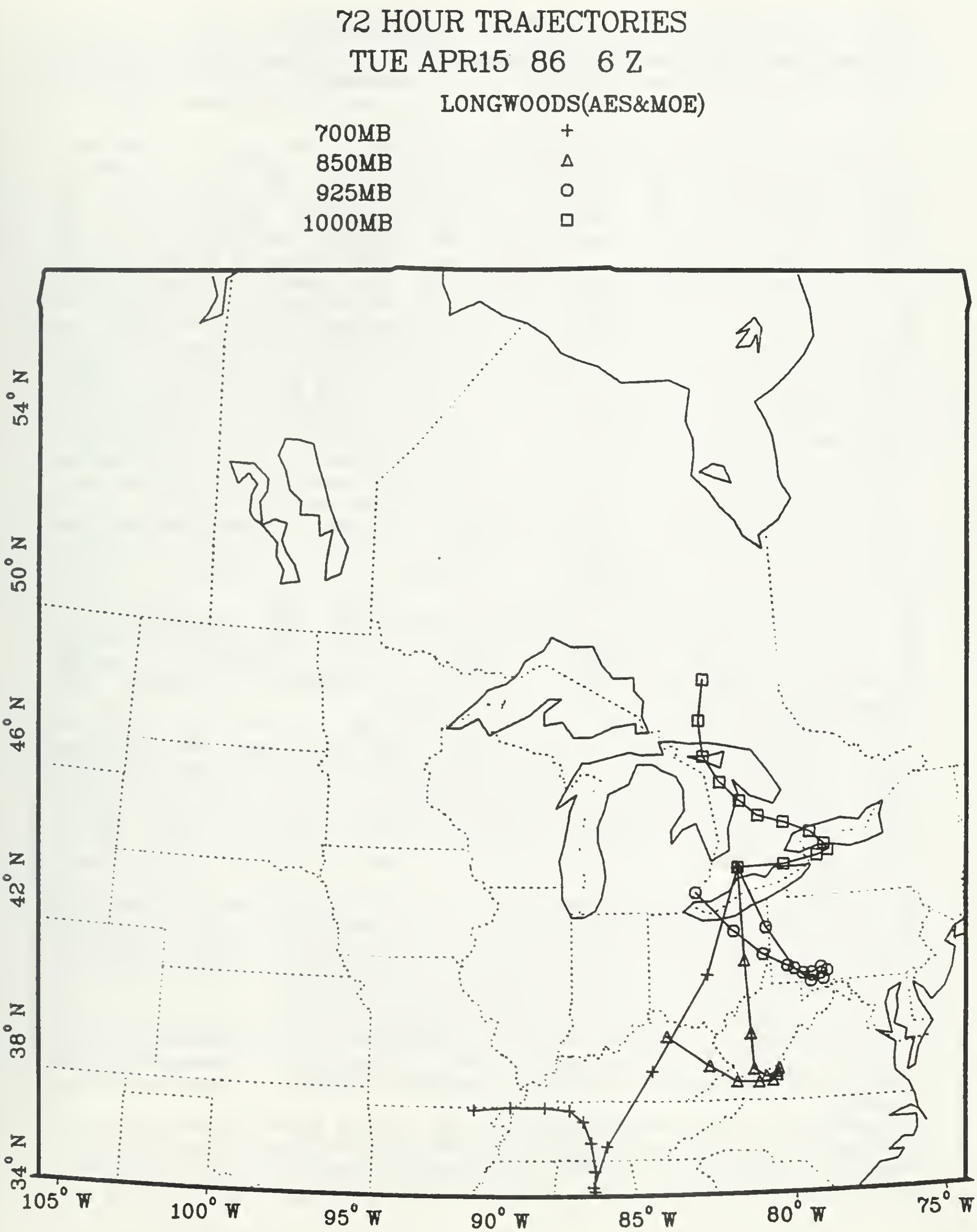


FIGURE 2.10.11

2.11 April 20-21, 1986, Longwoods (AES & MOE)

This episode ranked 8th (8/8) and 10th (10/10) for $SO_4^=$ and NO_3^- in the top 25% wet deposition events at Longwoods (AES). At Longwoods (MOE), it ranked 7th (7/10) for only NO_3^- wet deposition events.

A frontal system associated with a low pressure centre, 1006 mb, over Arkansas and a wave over Quebec-Ontario border near Chalk River was observed on April 20, at 12Z as shown in fig. 2.11.1. A cold front was also observed over NW Ontario as shown in the figure. During this episode, the low deepened and moved in a NE direction and on April 21, at 12Z, as illustrated in Fig. 2.11.2, it laid over Ontario near Dorset with the associated cold front over Toronto in a southerly direction. The front over NW Ontario in Fig. 2.11.1 moved eastward and was analyzed over Lake Huron as shown in Fig. 2.11.2. As the low moved close to Longwoods, the continuous precipitation area covered the station and very light rain showers and light, moderate and heavy rain fell at the nearest weather station as shown in Fig. 2.11.3. Moderate to heavy rain occurred as the low pressure centre passed in the vicinity and drizzle, rain mixed with drizzle and rain showers were recorded as the low and the cold front moved eastward away from the station. The total duration of the precipitation was about 14 hours.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for April 20, 12Z, 18Z and April 21, 00Z, 06Z and 12Z are shown in Figures 2.11.4, 2.11.5, 2.11.6, 2.11.7, and 2.11.8 respectively.
Air trajectories for the 1000 mb level show that a transport of SO_2 and NO_x from their respective highest and high emission areas in Detroit region on April 20 (Figs. 2.11.4-5) and for a brief period on April 21 (Figs. 2.11.7-8), Ohio-West Virginia and Pennsylvania (Figs. 2.11.4-7) was likely.
Air trajectories for the 925 mb level show that SO_2 and NO_x from their highest emission Chicago area could have been transported (Fig. 2.11.4) on April 20. Also, transport of the SO_2 and NO_x from their respective highest and high emission areas in Detroit region (Fig. 2.11.5), Pennsylvania and West Virginia (Figs. 2.11.7) could have taken place. Pollution transport from Detroit region for a brief period was also likely at the end of episode (see Figs. 2.11.7&8).
Air parcels arriving at the 850 mb level could have carried SO_2 and NO_x from their highest areas at the beginning and at the end of the episode (Figs. 2.11.4&8). Also, transport of SO_2 from its highest and of NO_x from its high areas in Detroit (Fig.2.11.5&7), and Cleveland (Fig.2.11.6) regions was probable.
Air parcels arriving at the 700 mb level show that SO_2 and NO_x from their respective highest and high emission Detroit region (Figs. 2.11.5&7) could have been transported. Transport of these pollutant from their respective highest emission Chicago area was also possible.
In summary, a low pressure centre and a cold front moved over the station yielding very light rain showers and rain up to heavy intensity, and light drizzle and drizzle mixed with rain. the total precipitation duration was about 14 hrs. Transport of SO_2 and NO_x

at low (925 mb) and high (850 mb & 700 mb) levels from the highest emission Chicago area was likely. Also, SO_2 from its highest and NO_x from its high emission Detroit area at low and high levels, and from Ohio, West Virginia and Pennsylvania at low levels could have been transported.

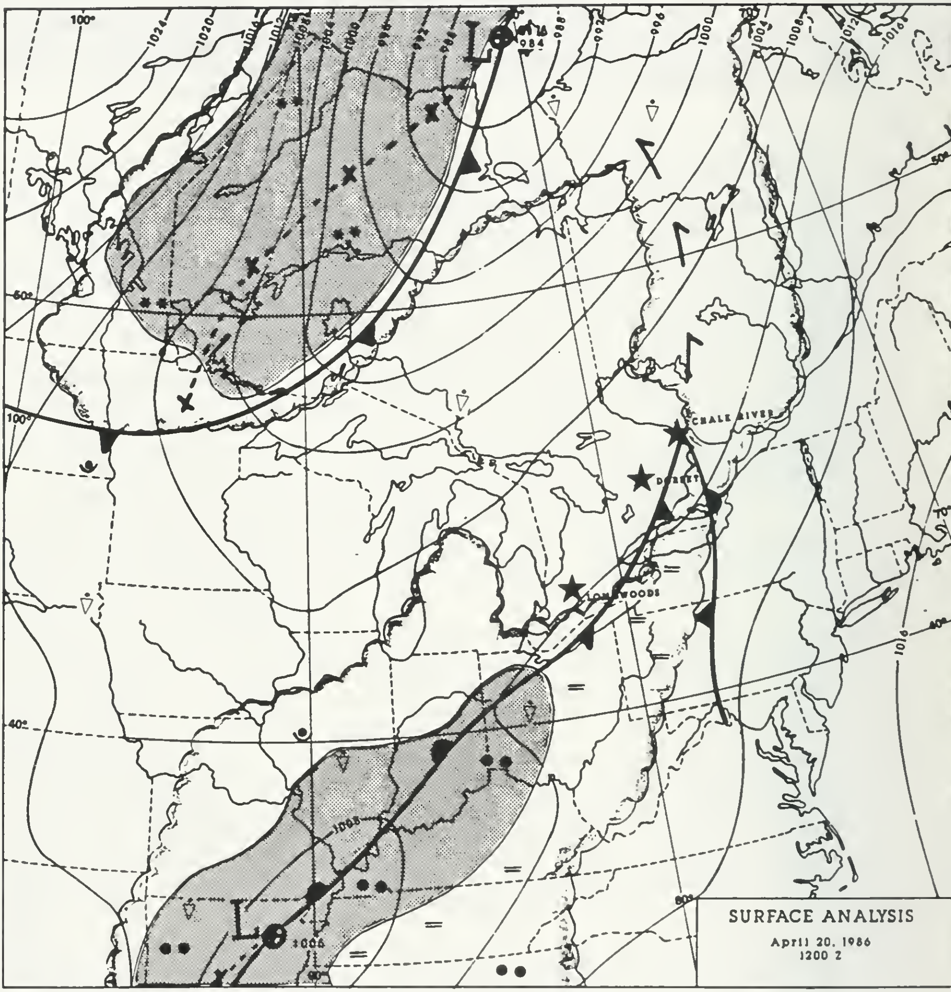

SURFACE ANALYSIS
April 20, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1024
1020
1016
1012
1008
1004
1000
996
992
988
984
996
1000
1004
1008
1012
1016
100°
60°
50°
40°
70°
90°
80°

FIGURE 2.11.1

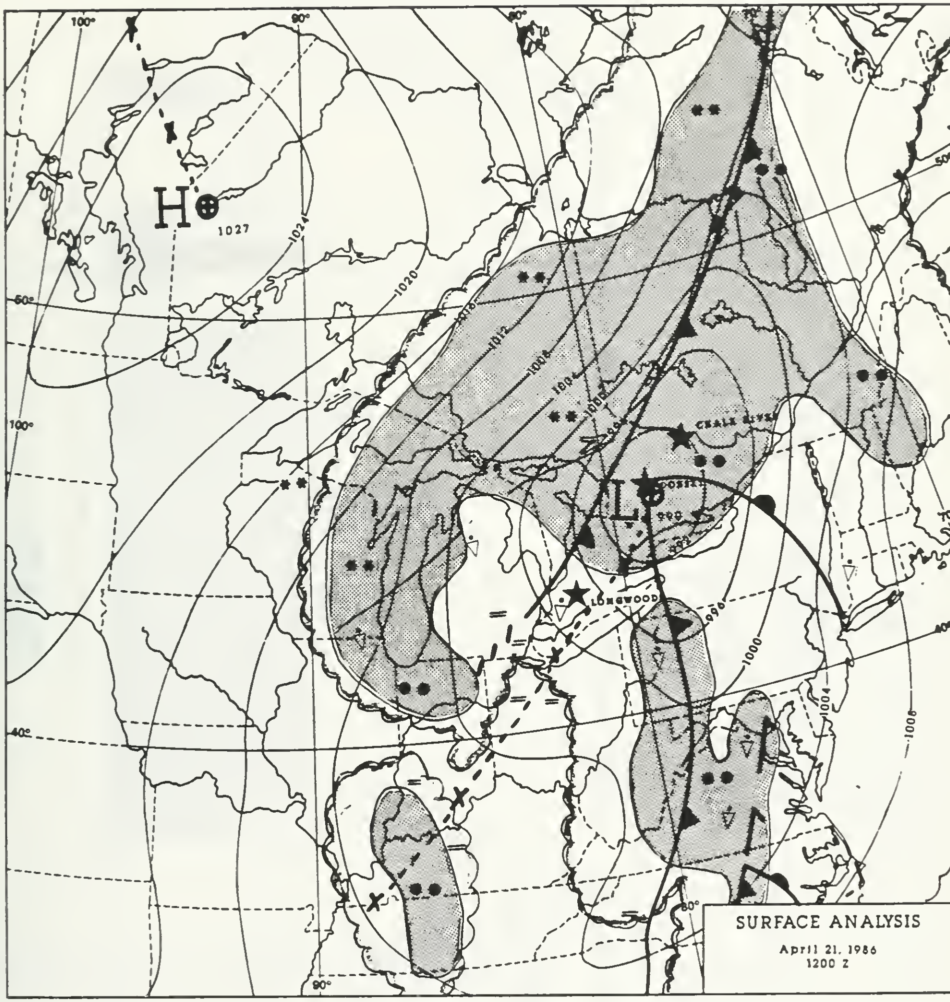

SURFACE ANALYSIS
April 21, 1986
1200 Z
H
1027
L
LONGWOOD
1024
1020
1016
1012
1008
1004
1000
996
1000
1004
1008

FIGURE 2.11.2

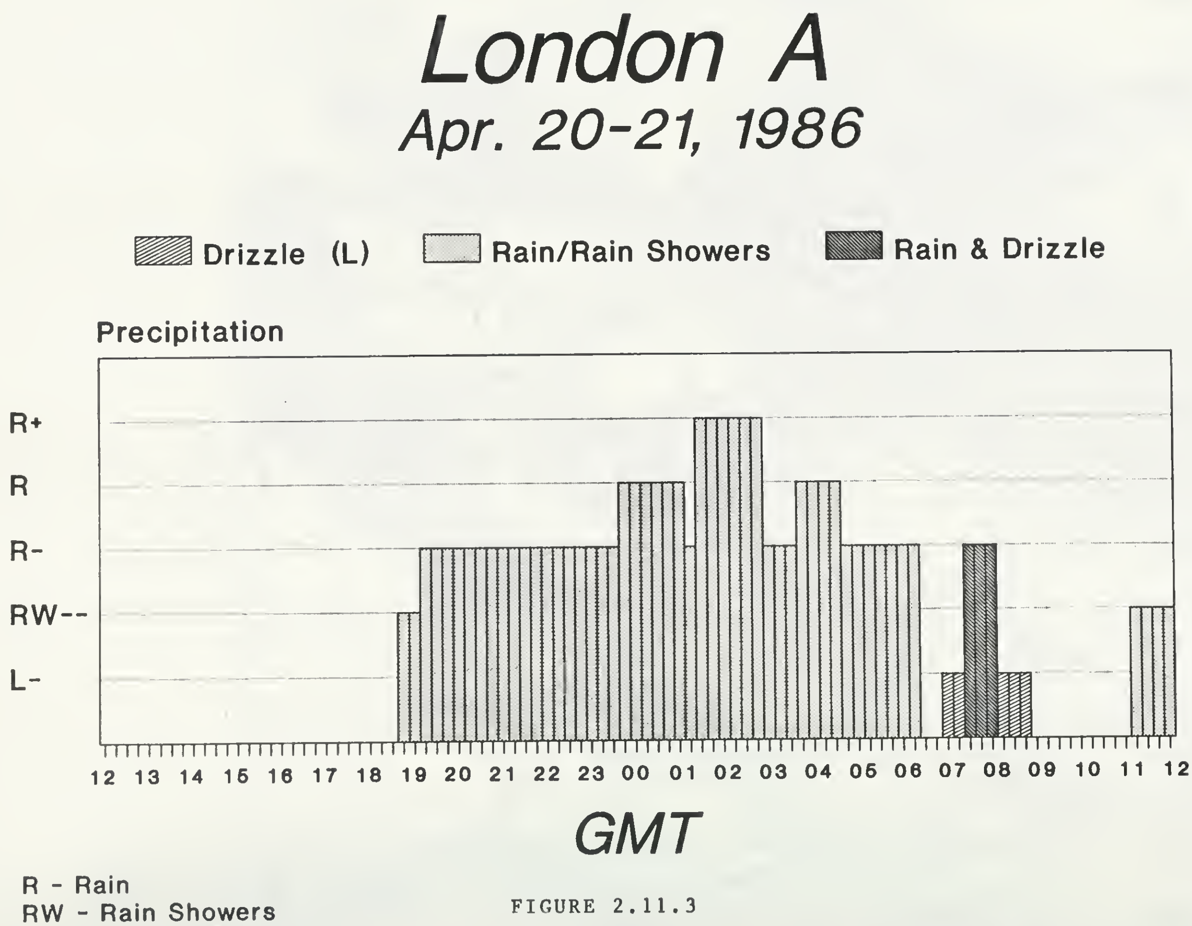

London A
Apr. 20-21, 1986
Drizzle (L)
Rain/Rain Showers
Rain & Drizzle
Precipitation
R+
R
R-
RW--
L-
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
R - Rain
RW - Rain Showers

FIGURE 2.11.3

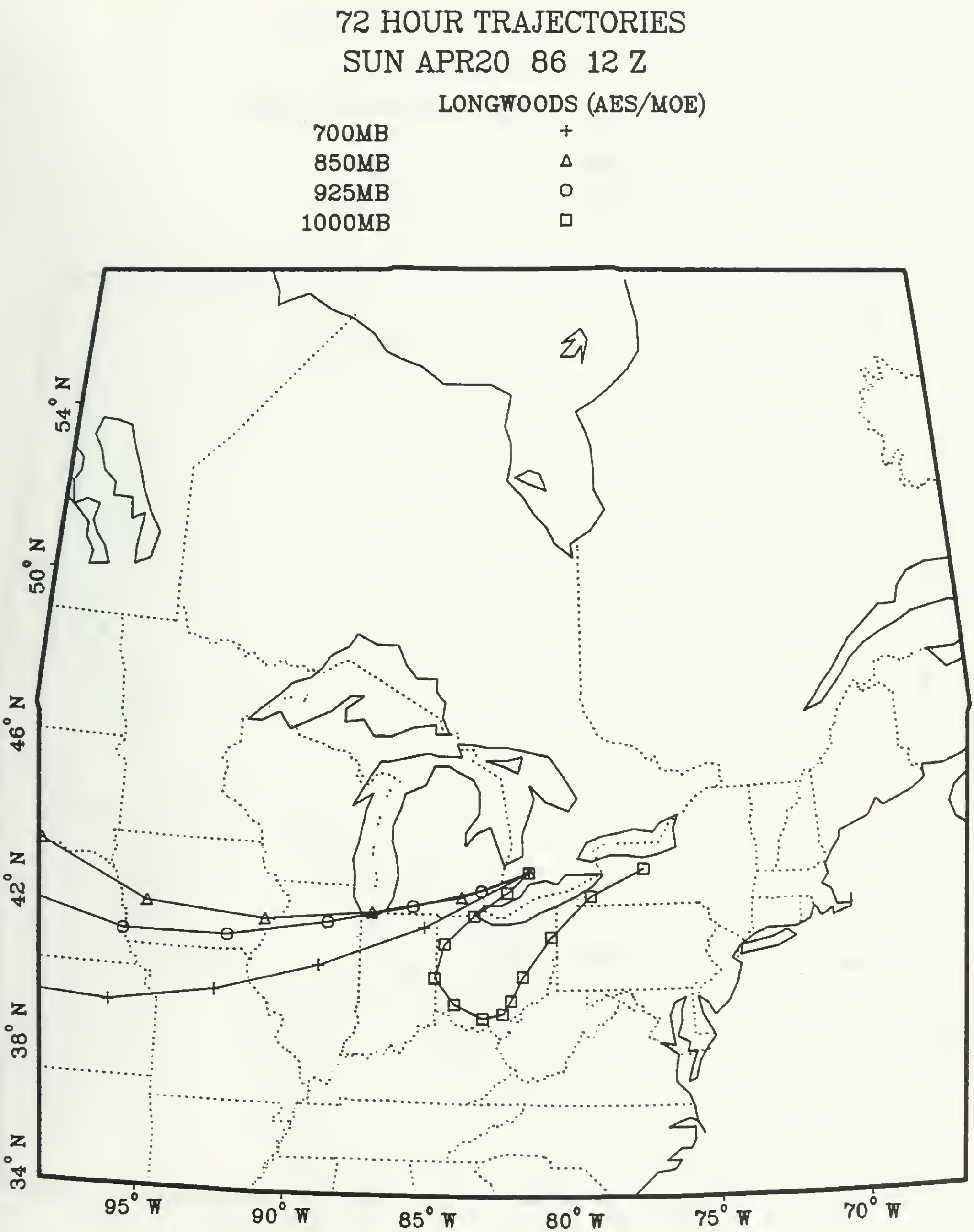

72 HOUR TRAJECTORIES
SUN APR20 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.11:4

72 HOUR TRAJECTORIES
SUN APR20 86 18 Z

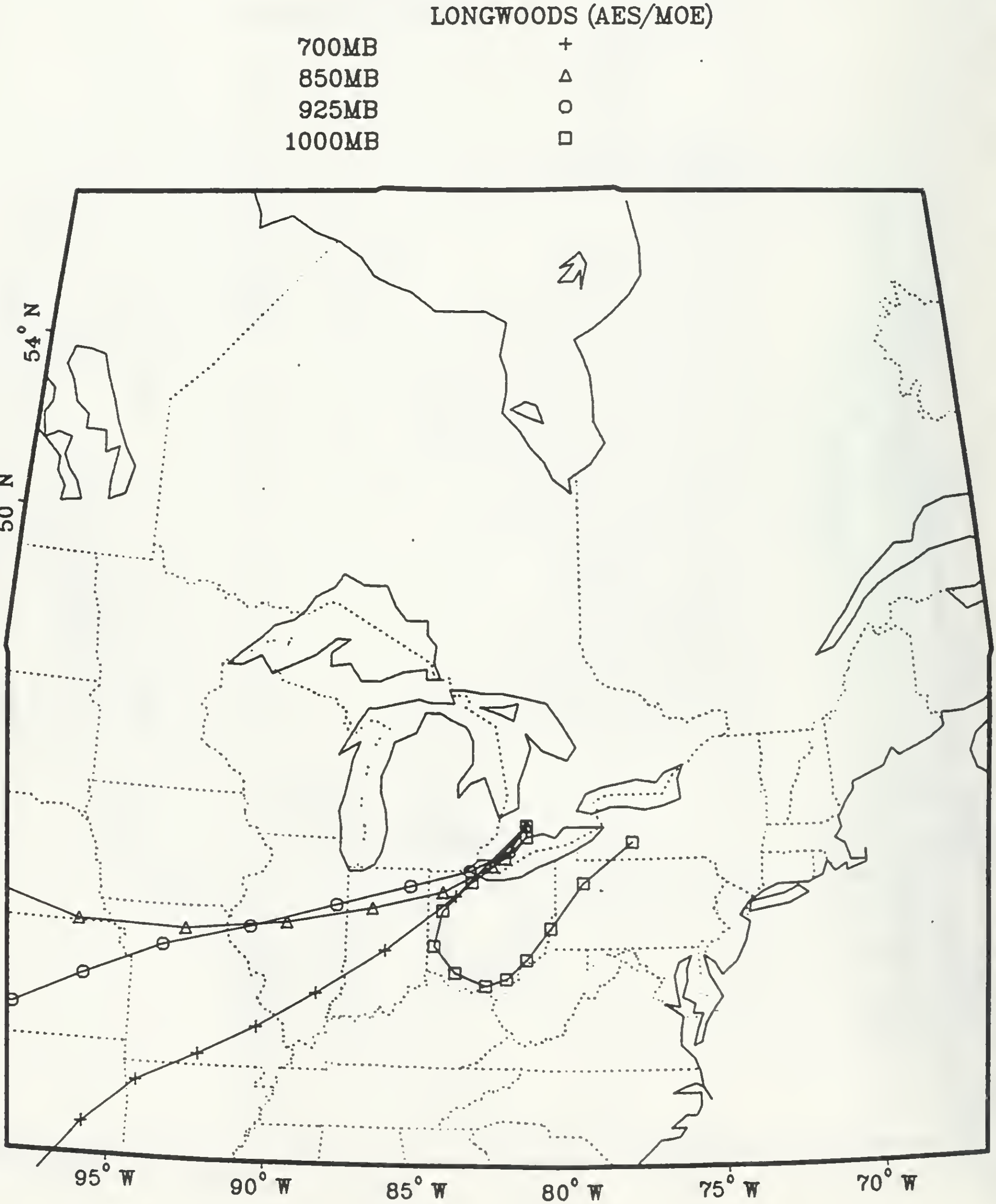


FIGURE 2.11.5

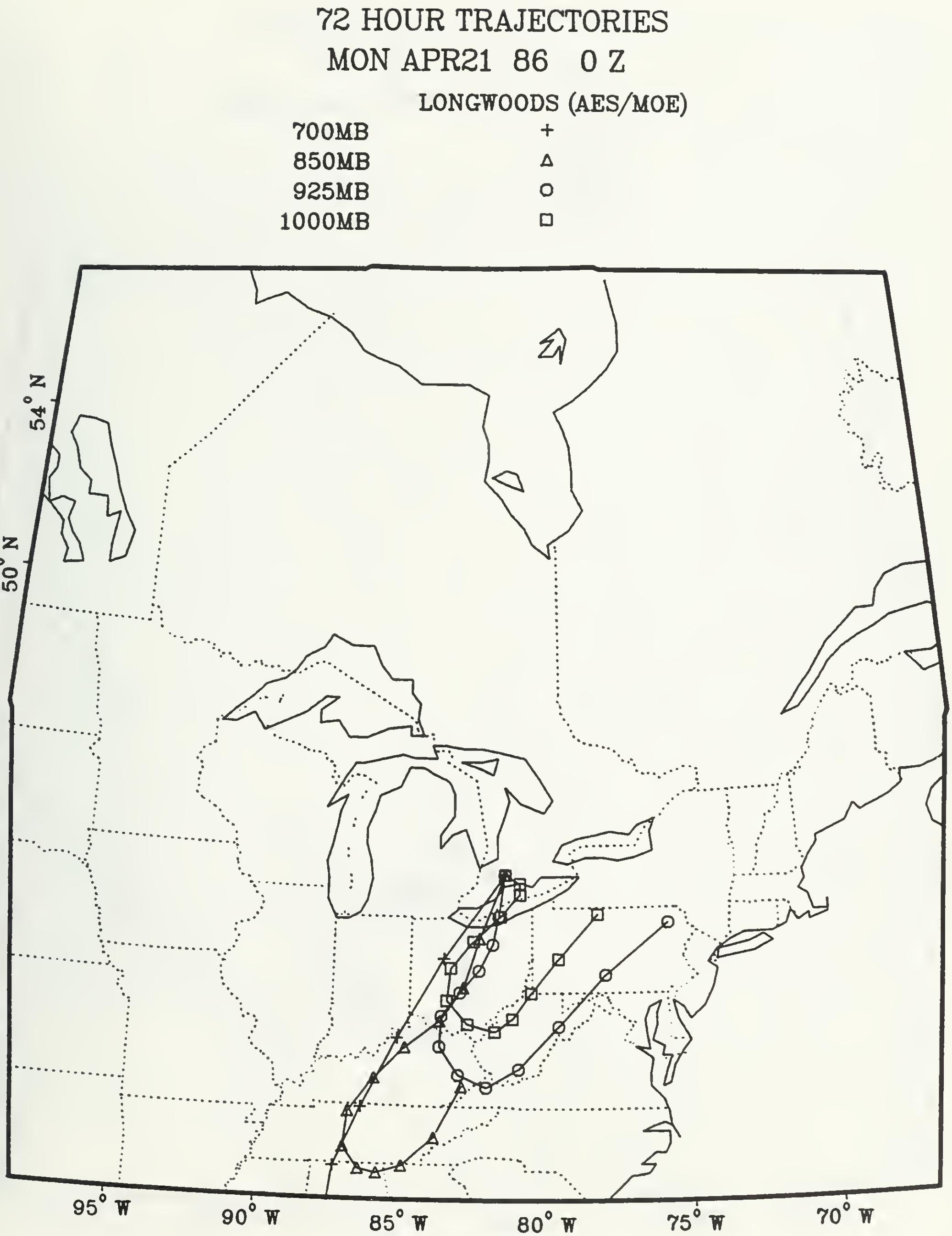

72 HOUR TRAJECTORIES
MON APR21 86 0 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.11.6

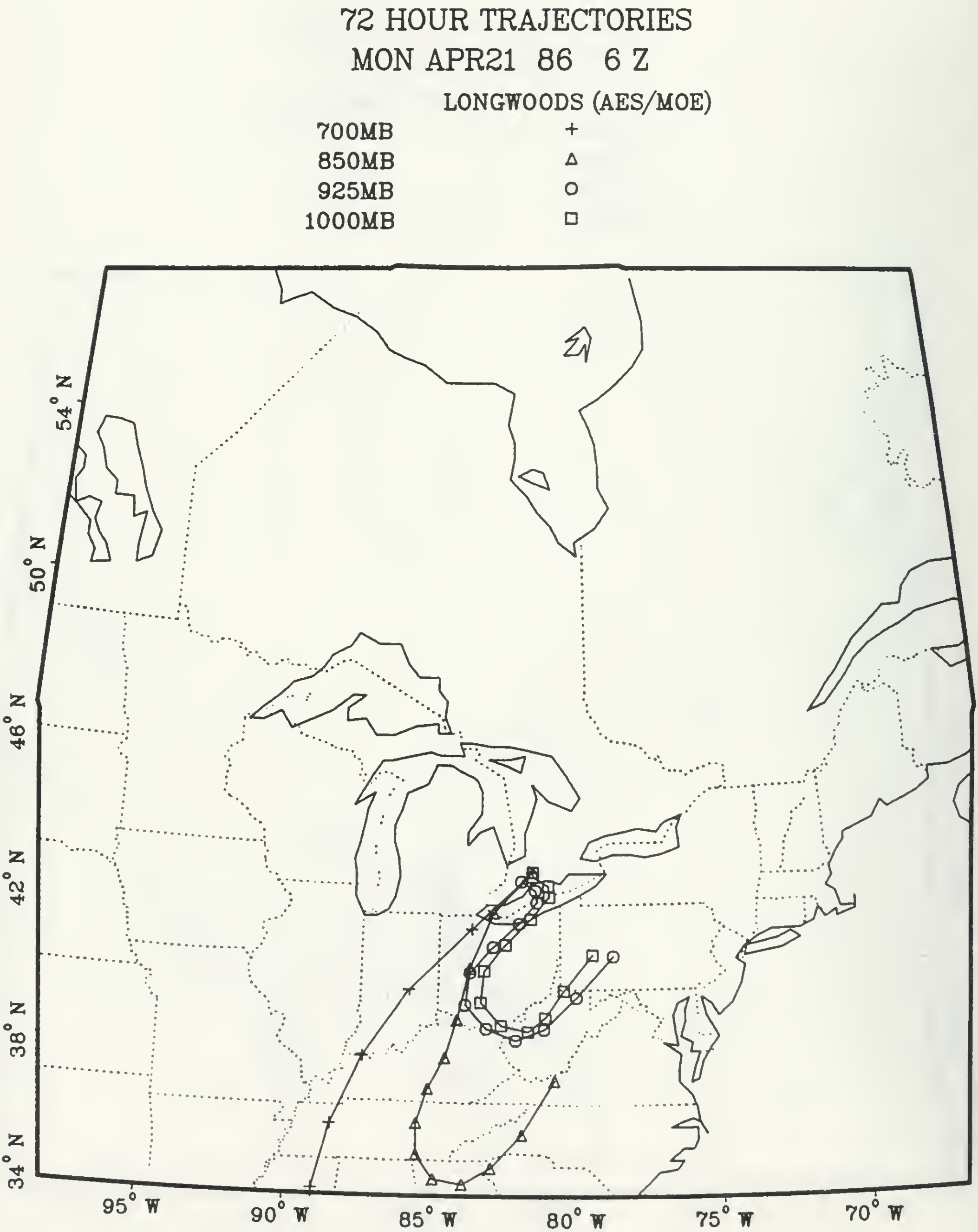

72 HOUR TRAJECTORIES
MON APR21 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.11.7

72 HOUR TRAJECTORIES
MON APR21 86 12 Z
LONGWOODS (AES/MOE)

700MB	+
850MB	△
925MB	○
1000MB	□

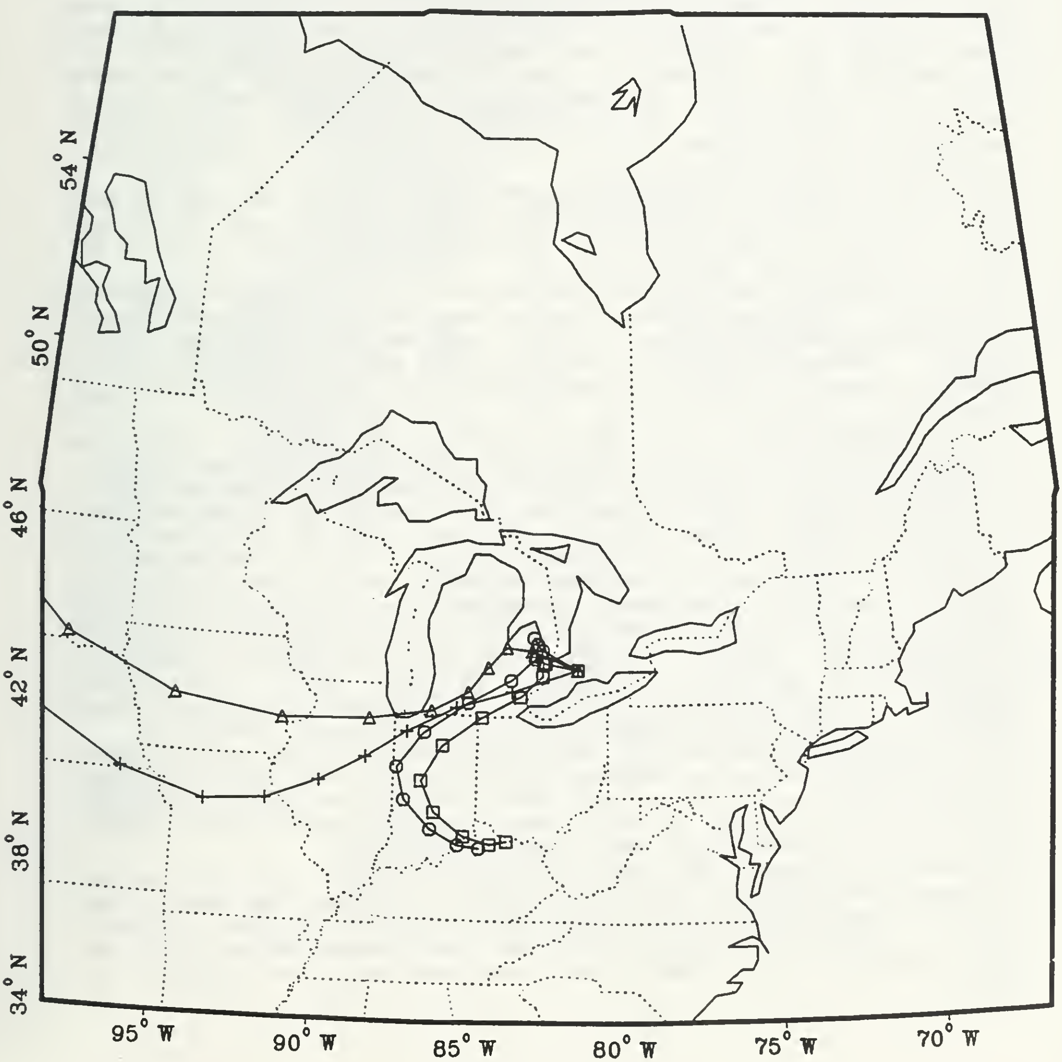


FIGURE 2.11.8

2.12 April 28-29, 1986, Longwoods (AES & MOE)

This episode ranked 5th (5/8) and 6th (6/10) for $SO_4^=$ and NO_3^- wet deposition top 25% events respectively at Longwoods (AES). It ranked 5th (5/7) and 4th (4/10) for $SO_4^=$ and NO_3^- deposition events respectively at Longwoods (MOE).

Two frontal systems, one associated with a low pressure centre, 995 mb, over Wisconsin-Minnesota border and the other with a wave over Minnesota near International Falls, were observed on April 28, at 12Z, as shown in Fig. 2.12.1. As shown in the figure, a trowal over Tennesse and Kentucky, associated with a frontal system with a wave over Mississippi (outside the map of Fig. 2.12.1) was also analyzed. During this episode, the systems moved such that a cold front and a trowal passed over the station. On April 29, at 12Z, as shown in Fig. 2.12.2, the cold front and the trowal were located E of Longwoods. As the trowal and the cold front passed over, very light and light thundershowers and rain showers were recorded at the nearest weather station London, as shown in Fig. 2.12.3, for about four hours.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for April 28, 12Z, 18Z and April 29, 00Z, 06Z and 12Z are shown in Figures 2.12.4, 2.12.5, 2.12.6, 2.12.7, and 2.12.8 respectively.

Air parcels arriving at the 1000 mb level could have transported SO_2 and NO_x from their respective highest and high emission areas in Pennsylvania-Ohio (Fig. 2.12.7) and Detroit, Michigan (Fig. 2.12.8). Transport of SO_2 and NO_x from their respective high emission areas in Cleveland region was also likely for some time (figs. 2.12.7-8).

Air trajectories for the 925 mb level show that SO_2 from its highest and NO_x from its high emission areas in Pennsylvania, Ohio, and West Virginia (Figs. 2.12.5-6) and Detroit, Michigan (Fig. 2.12.7) could have been transported. Also, SO_2 & NO_x transport from their respective highest emission Chicago (Fig. 2.12.8) and high emission Cleveland for a brief period (Fig. 2.12.6-7) was probable.

Air parcels arriving at the 850 mb level could have carried SO_2 and NO_x from their respective highest emission Chicago area (Figs. 2.12.4&8) at the beginning and at the end of the episode. Transport of SO_2 from its highest and NO_x from its high emission Detroit, Michigan (Fig. 2.12.4), Ohio-West Virginia (Fig. 2.12.5) was probable. Also transport of these pollutants from their high emission Cleveland area (see Figs. 2.12.4-5&7) was likely.

Air trajectories for the 700 mb level show that SO_2 and NO_x from their highest emission Chicago (Fig. 2.12.4) and high emission Cleveland (Fig. 2.12.8) and from their respective highest and high emission Detroit (Fig. 2.12.4), and possibly West Virginia-Ohio (Fig. 2.12.6) areas could have been transported.

In summary, a passage of a cold front and a trowal over the station yielded thundershowers and rain showers lasting for about four hours. Transport at low and high level of SO_2 & NO_x from Chicago, Detroit, Cleveland area,at low level from Pennsylvania, Ohio and West Virginia and at high level from Ohio and West Virginia was likely.

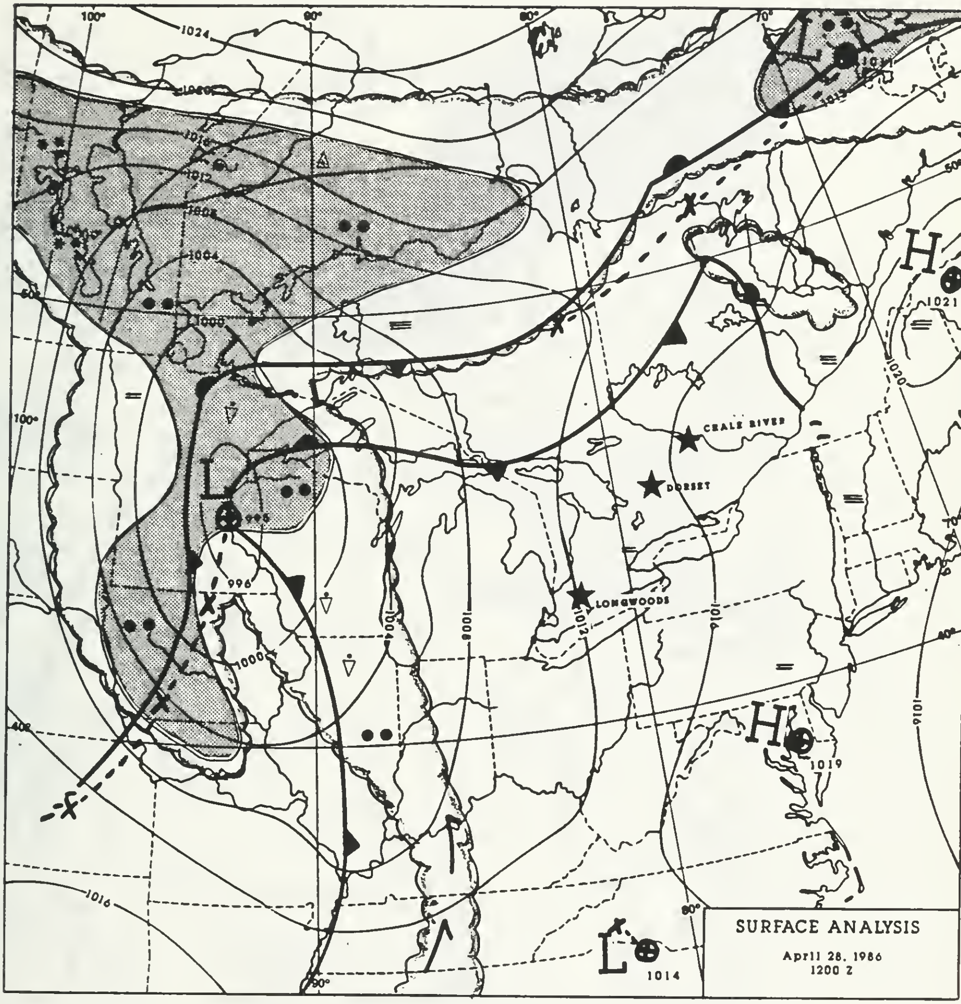

SURFACE ANALYSIS
April 28, 1986
1200 Z
DORSET
LONGWOODS
1024
1021
1020
1019
1016
1014
1012
1008
1004
1000
996

FIGURE 2.12.1

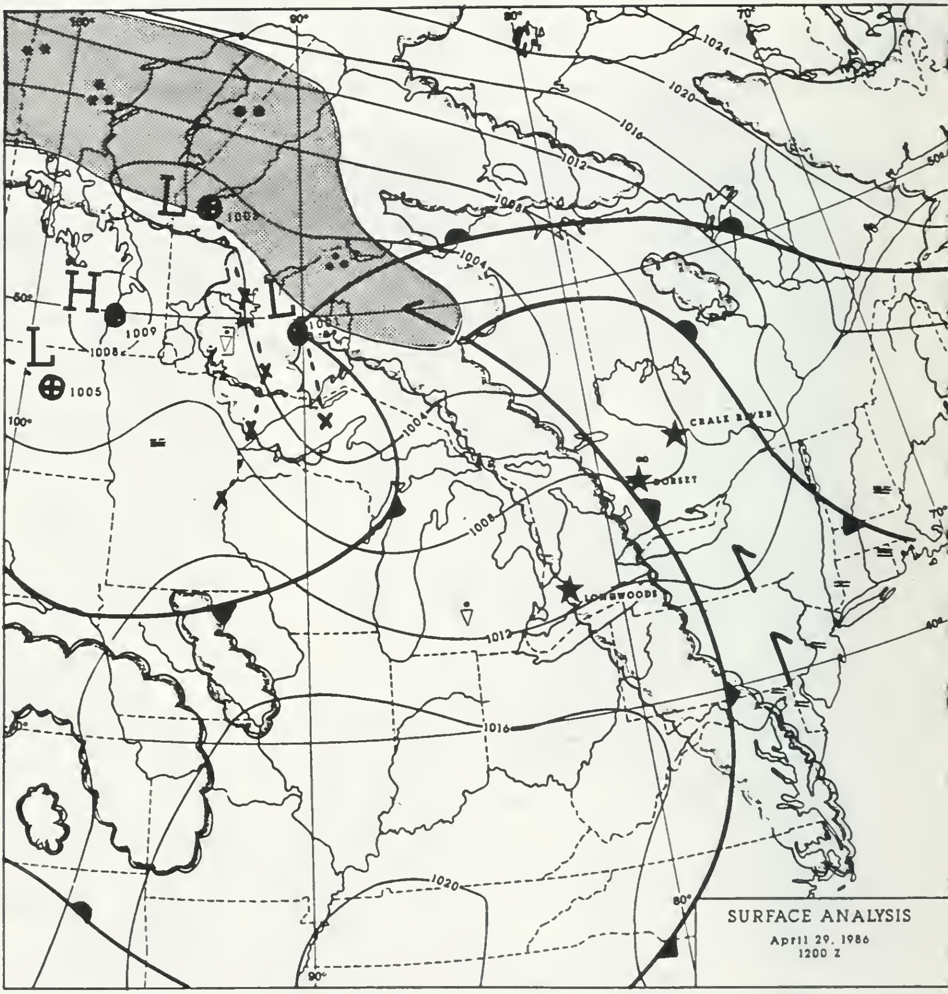
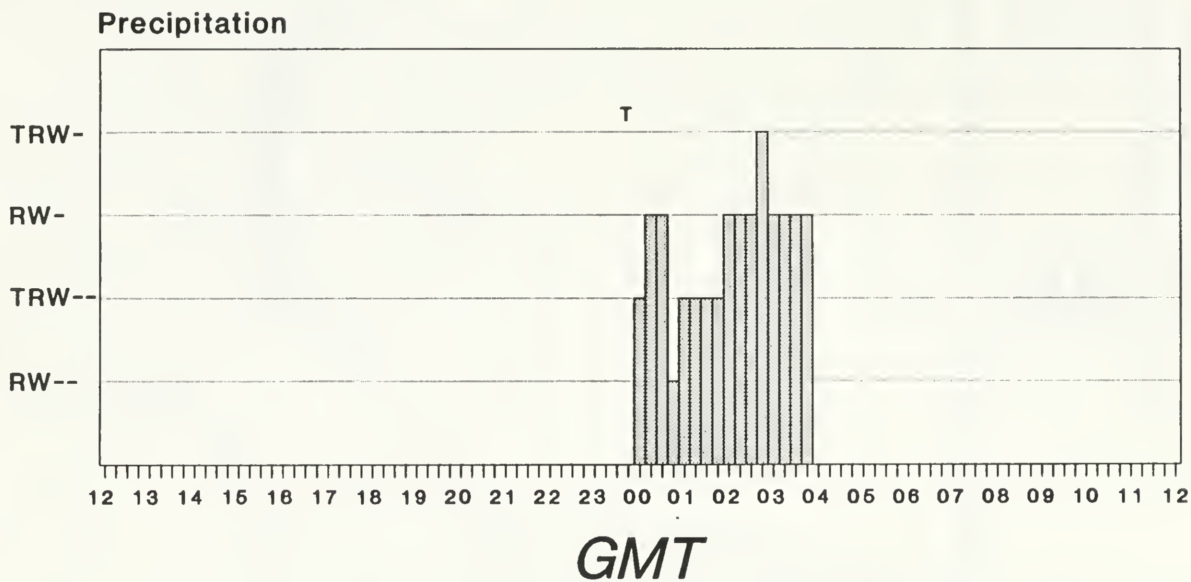

SURFACE ANALYSIS
April 29, 1986
1200 Z
DORSET
LONGWOODS
1024
1020
1016
1012
1008
1004
1009
1005

FIGURE 2.12.2

London A

Apr. 28-29, 1986

Rain Showers (RW)



T - Thunder

FIGURE 2.12.3

72 HOUR TRAJECTORIES
MON APR28 86 12 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	△
925MB	○
1000MB	□

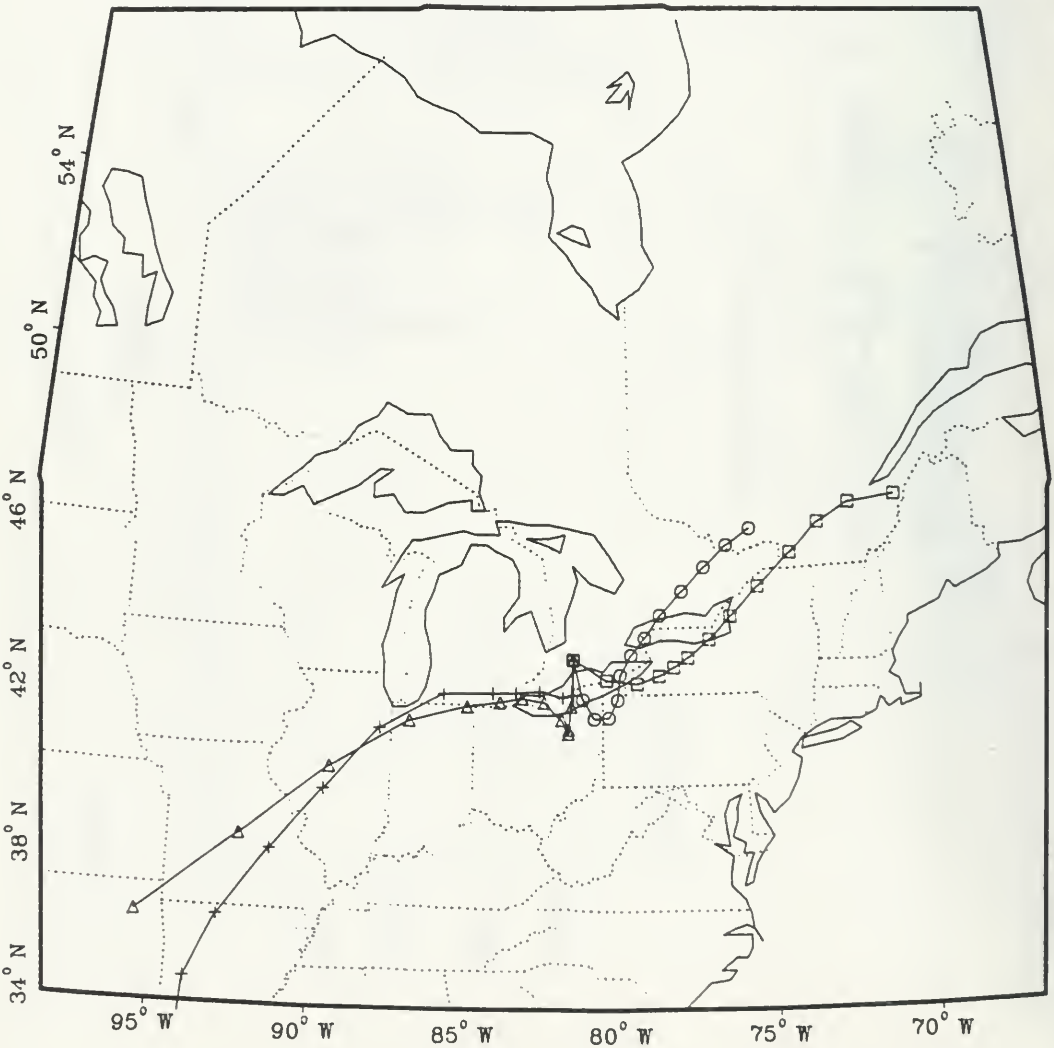


FIGURE 2.12.4

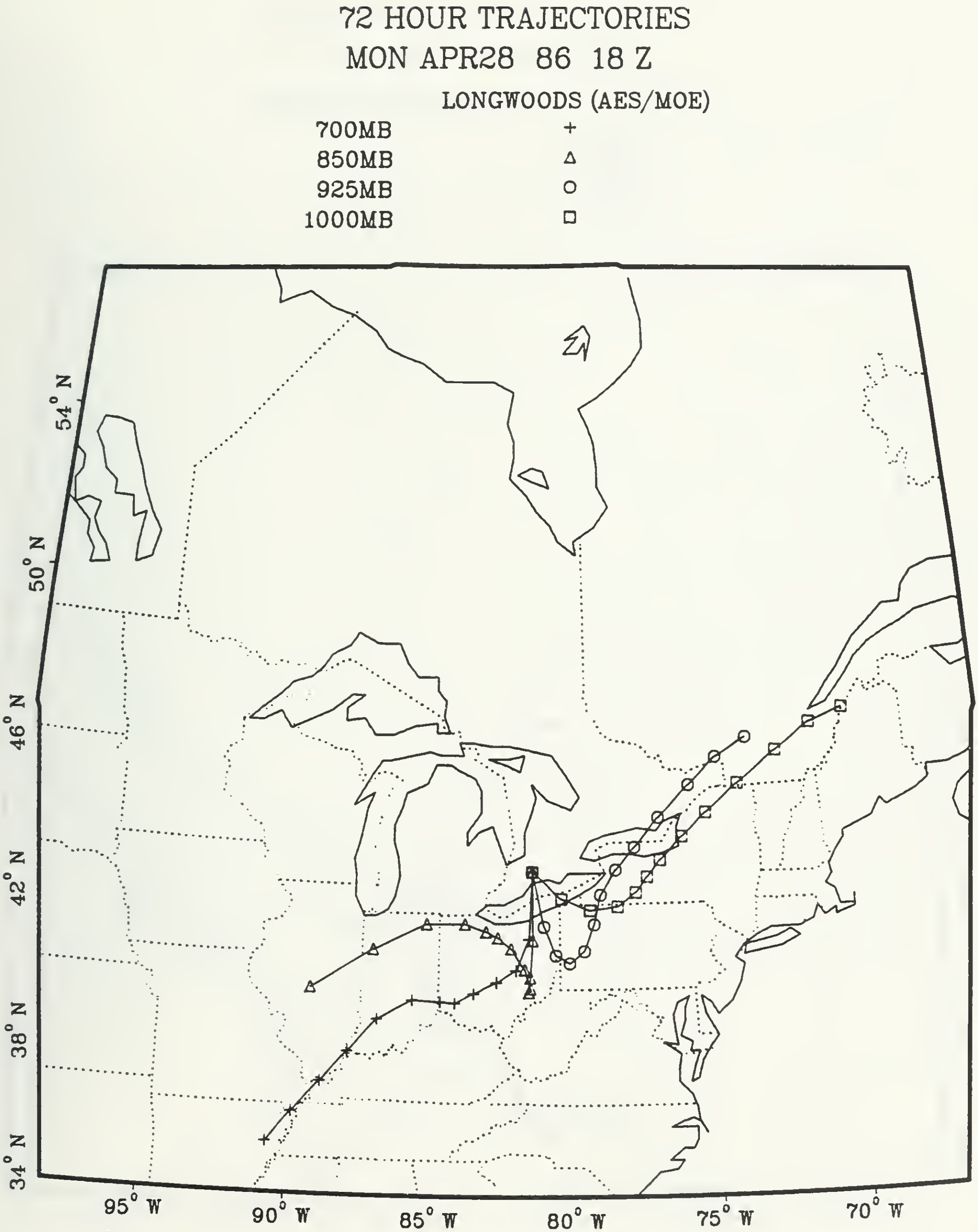

72 HOUR TRAJECTORIES
MON APR28 86 18 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.12.5

72 HOUR TRAJECTORIES
TUE APR29 86 0 Z

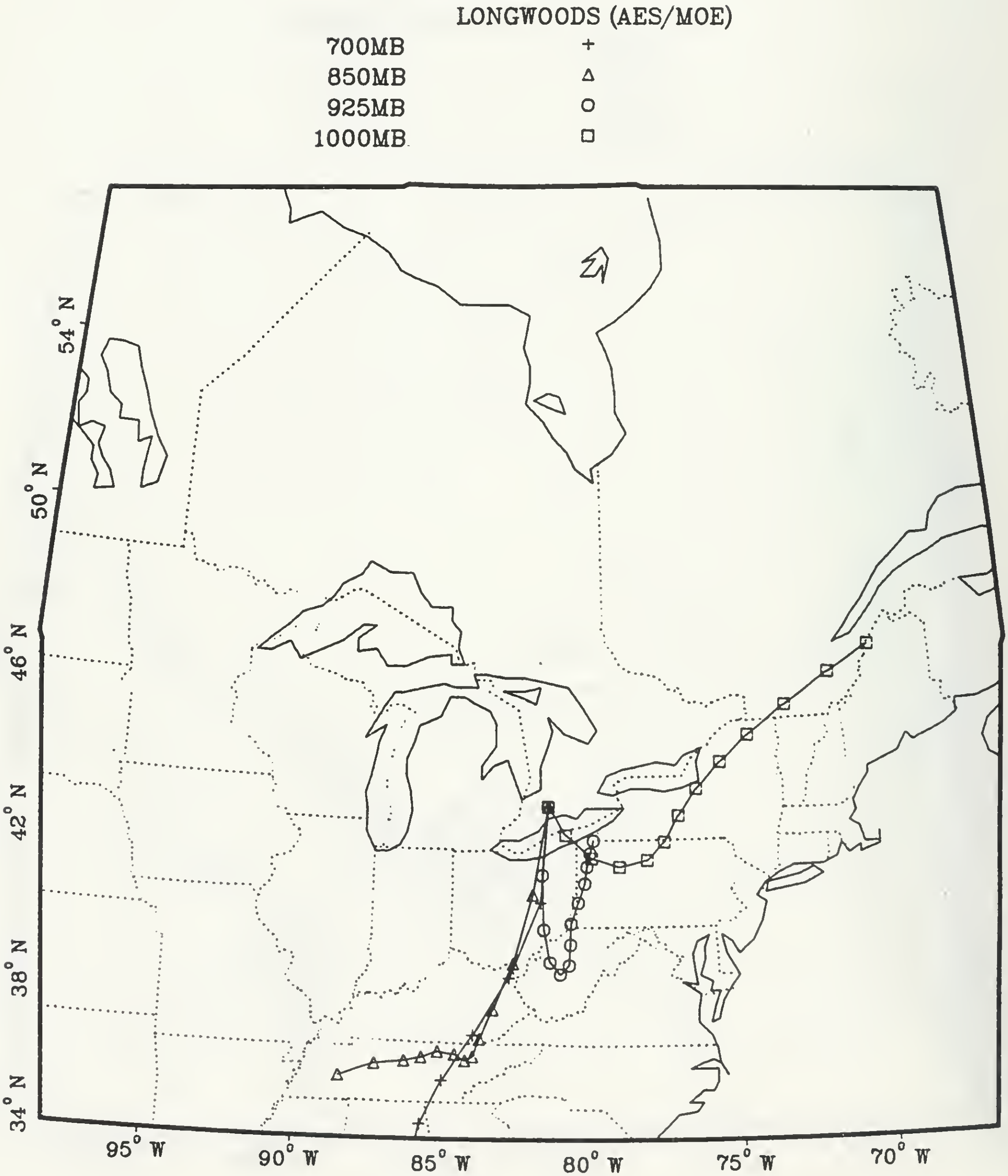


FIGURE 2.12.6

72 HOUR TRAJECTORIES
TUE APR29 86 6 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	Δ
925MB	O
1000MB	□

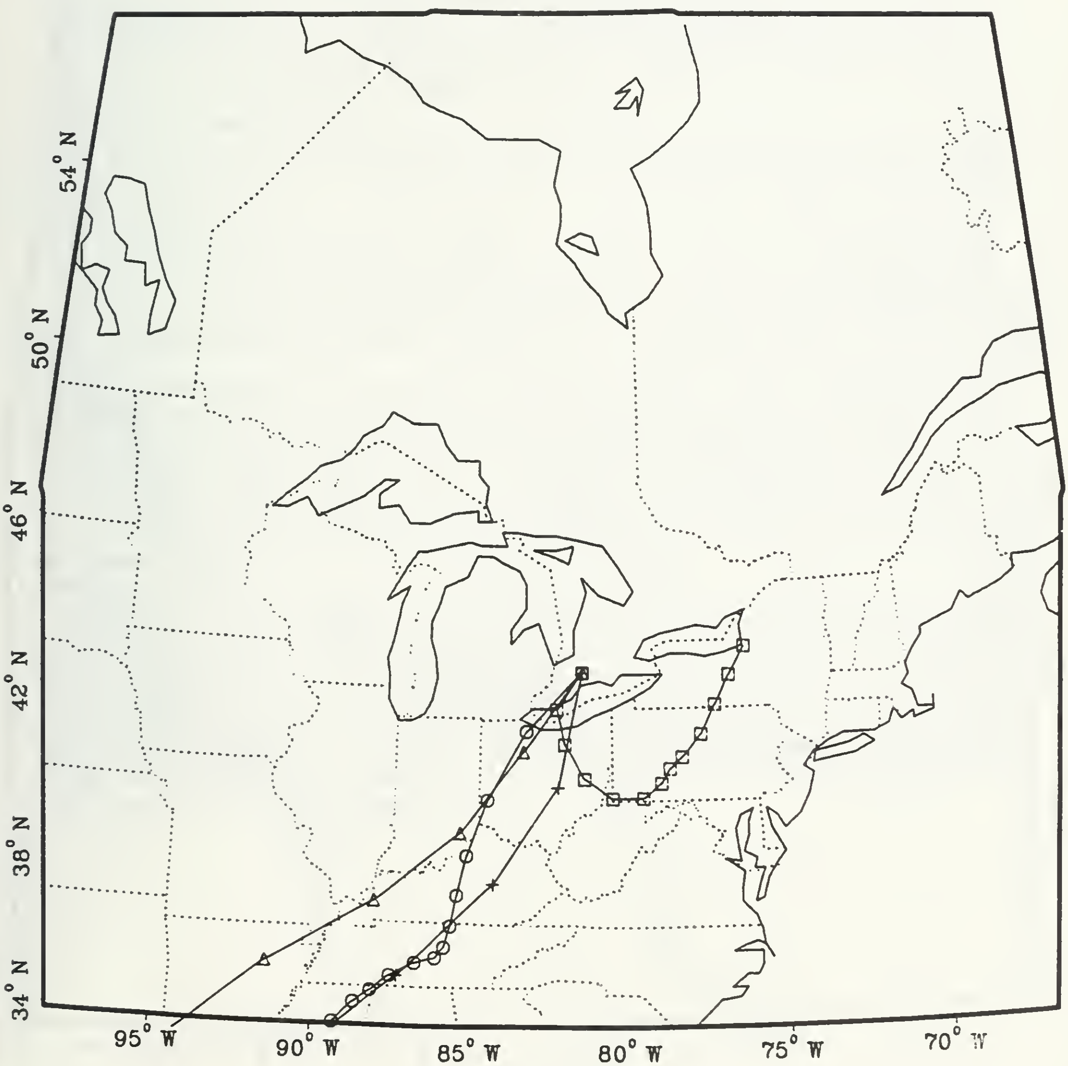


FIGURE 2.12.7

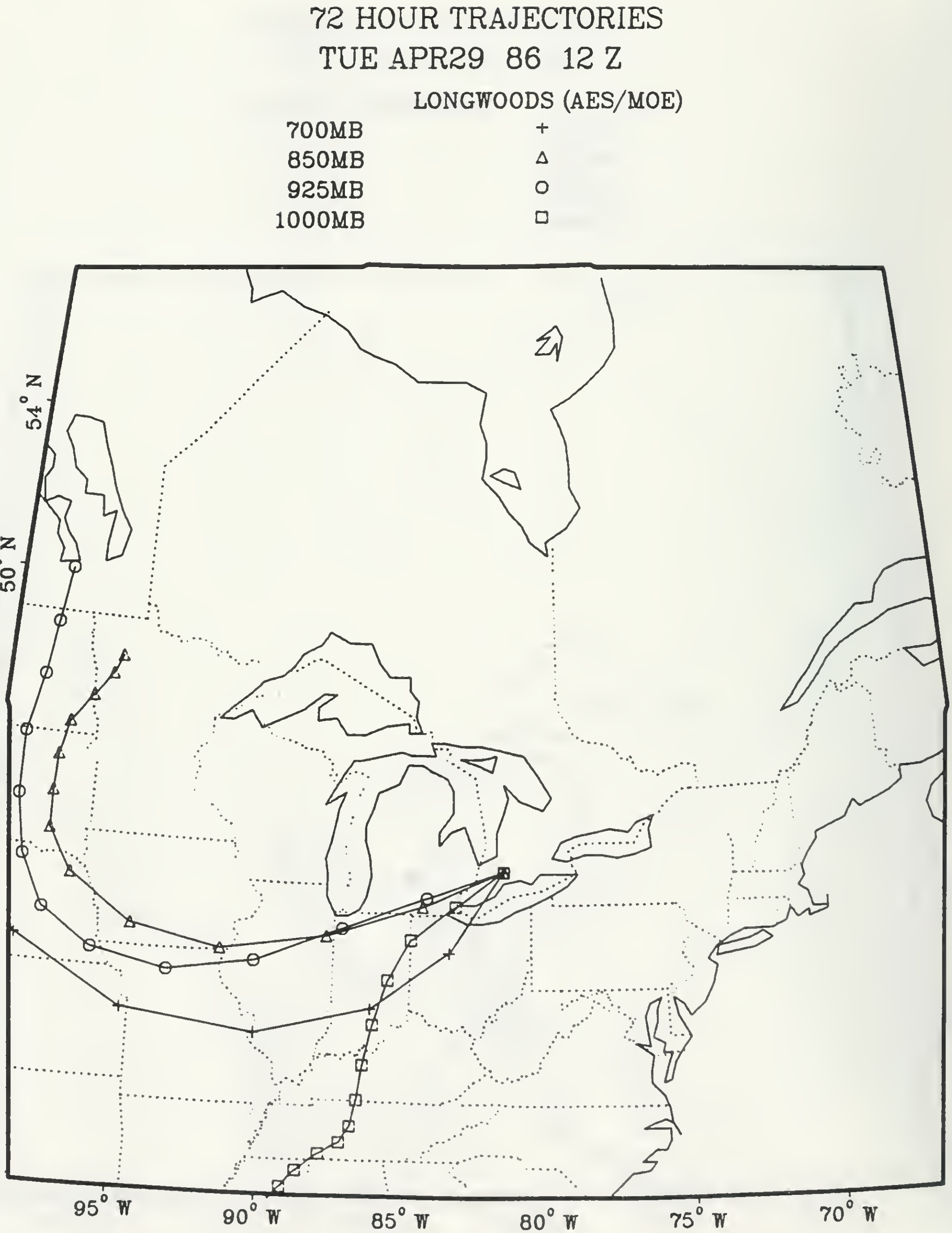

72 HOUR TRAJECTORIES
TUE APR29 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.12.8

2.13 May 5-6, 1986, Chalk River

This episode ranked 4th (4/6) and 6th (6/8) among the top 25% wet deposition events respectively for $SO_4^=$ and NO_3^- .

On May 5, at 12Z, as shown in Fig. 2.13.1, two quasi-stationary frontal systems associated with a cyclone in North Dakota were observed in central and eastern Ontario. The low pressure centre, 983 mb, over North Dakota moved slowly and laid over SE corner of Manitoba with warm front over Chalk River on May 6, at 12Z as illustrated in Fig. 2.13.2. The two fronts hovered around the station yielding very light, light and moderate rain showers occurring throughout the episode as exhibited in Fig. 2.13.3. Very light drizzle was observed for a very short duration at the end.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for May 5, 12Z, 18Z and May 6, 00Z, 06Z and 12Z are shown in Figures 2.13.4, 2.13.5, 2.13.6, 2.13.7, and 2.13.8 respectively.

Air trajectories for the 1000 mb level show that SO_2 from its highest emission Detroit area (Fig. 2.13.5) and SO_2 & NO_x from their high emission Sarnia area (Fig. 2.13.6) for some time could have been transported.

Air parcels arriving at the 925 mb level could have carried SO_2 from its highest emission Sudbury (Fig. 2.13.4&6), Detroit (Fig. 2.13.7) area and high emission Sarnia (Fig. 2.13.7) and Cleveland (Fig. 2.13.8) areas. Also, NO_x could have been transported from its high emission Detroit, Sarnia and Cleveland (Fig. 2.13.7&8) regions.

Air trajectories for the 850 mb level show that SO_2 from its highest Sudbury ((Fig. 2.13.6), Chicago (Fig. 2.13.7) and briefly from the other high emission area in Illinois(see Figs. 2.13.7-8) could have been transported. Transport of NO_x from its highest emission Chicago (Fig. 2.13.7) and high emission St. Louis (Fig. 2.13.7-8) area was also probable.

Air trajectories for the 700 mb level show that SO_2 from its highest emission Sudbury (Figs. 2.13.7-8) could have been transported.

In summary, slow moving fronts across the station yielded rain showers of very light, light and moderate intensities throughout the episode. The total precipitation duration is about 12 hours. Transport of SO_2 at high and low levels from Sudbury, at low level from Detroit, Sarnia and Cleveland and at high levels from Chicago and other area in Illinois was likely. Also, transport of NO_x from its highest emission Chicago area at high level, at low levels from high emission Sarnia, Detroit and Cleveland and at high level from St. Louis area was probable.

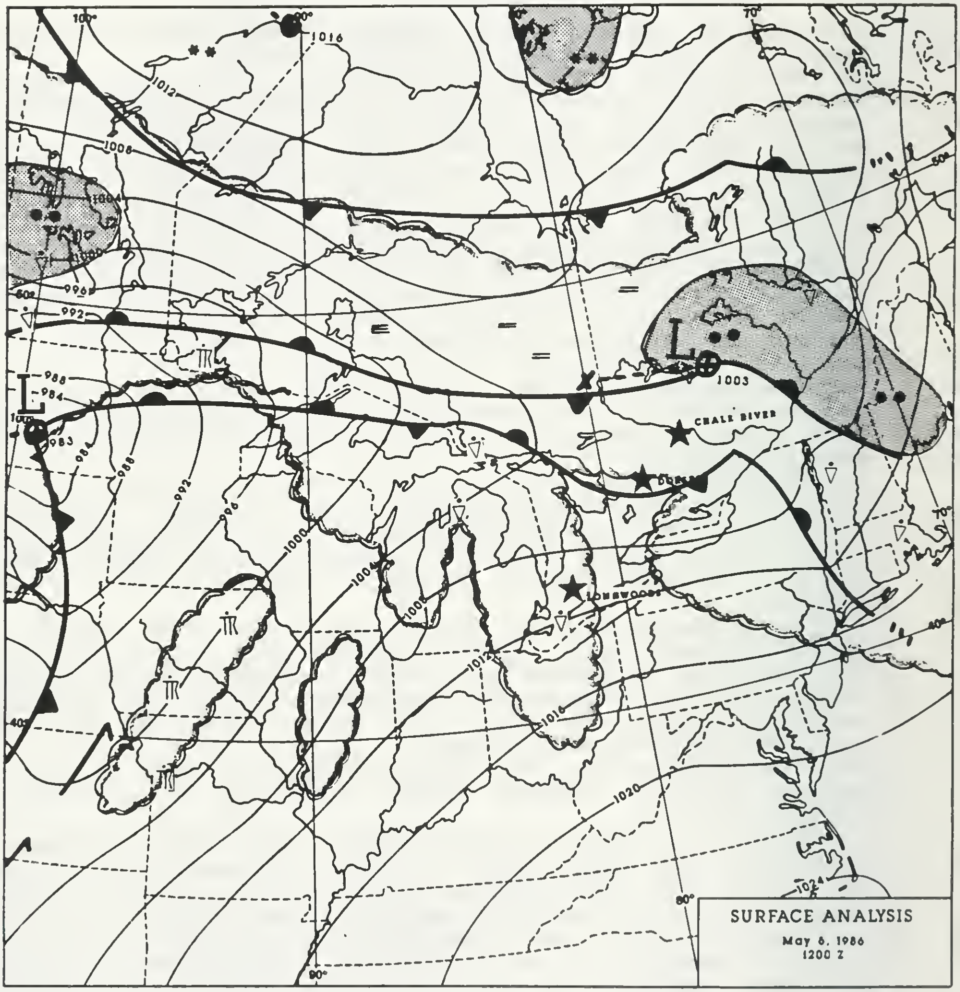

SURFACE ANALYSIS
May 6, 1986
1200 Z
CHALK RIVER
1003
1016
1012
1008
1004
1020
1024

FIGURE 2.13.1

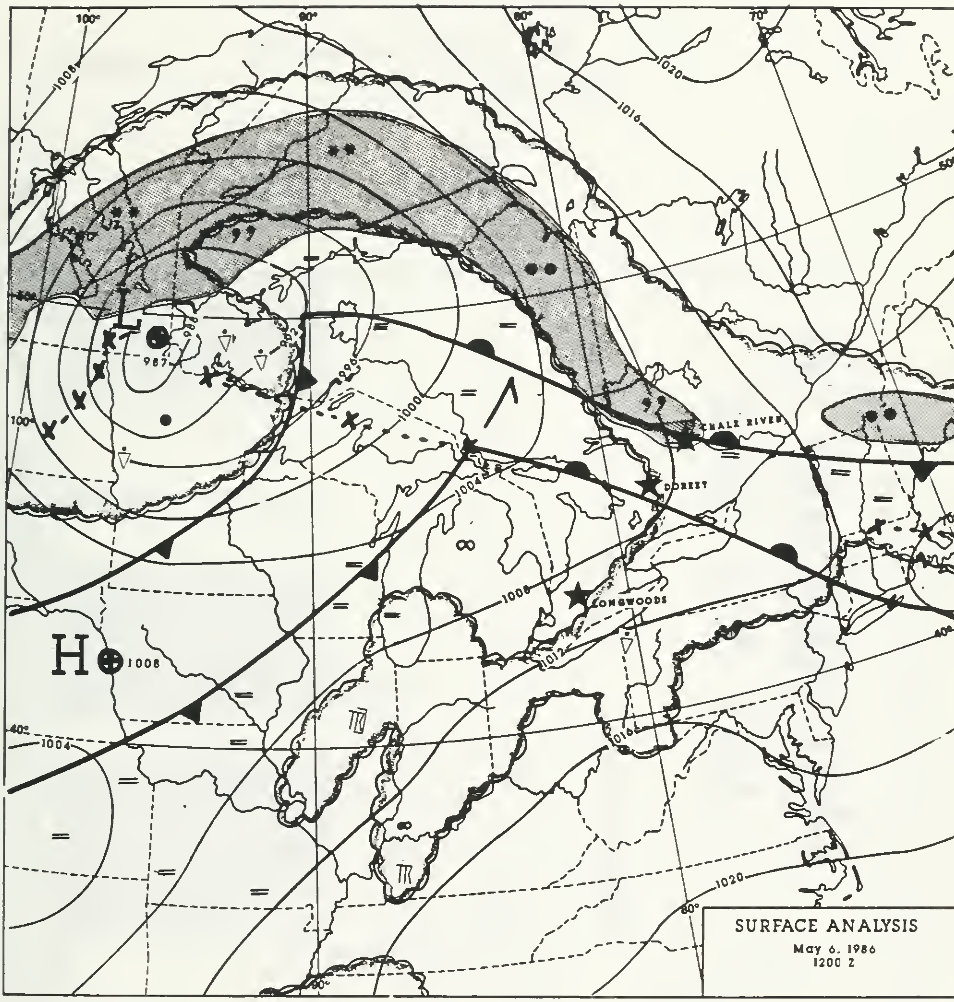
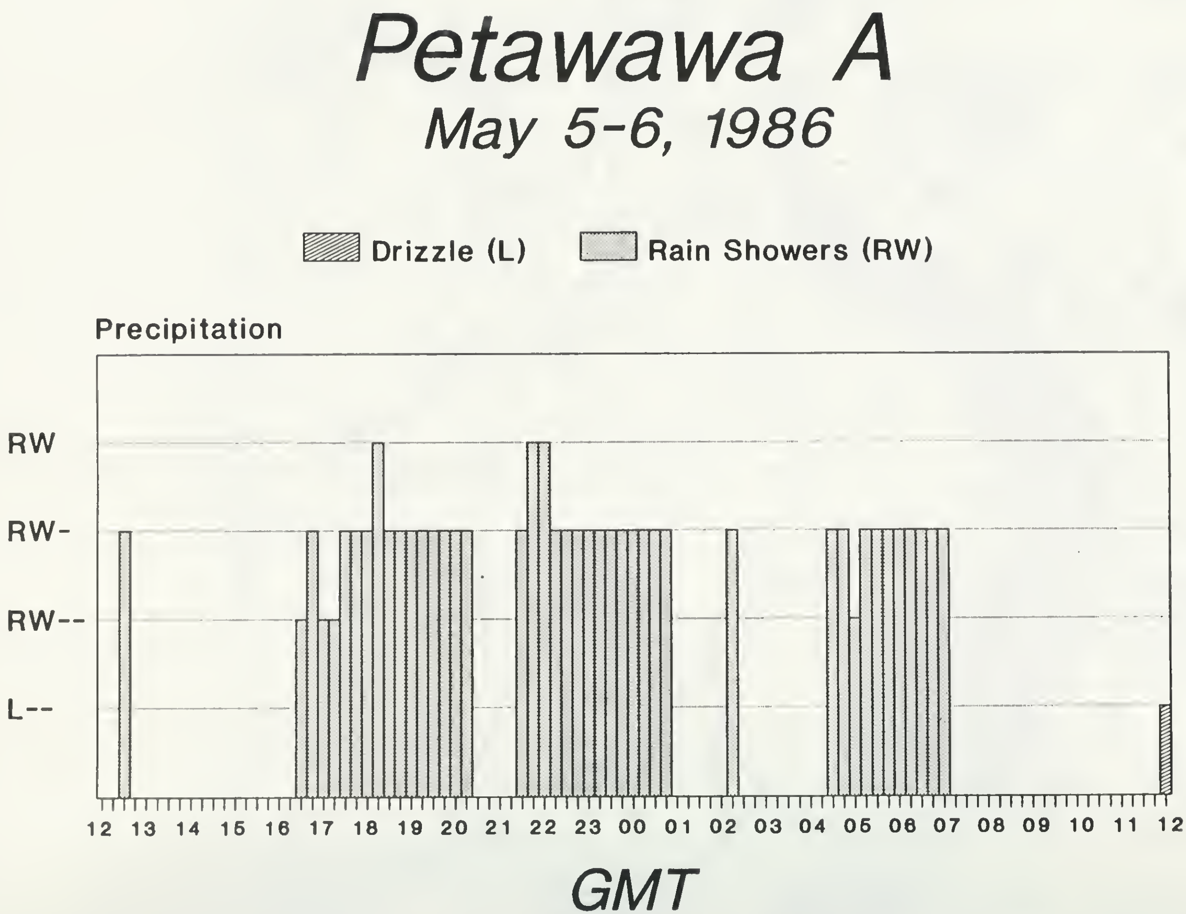

SURFACE ANALYSIS
May 6, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
H
1008
987
1020
1016
1004
1012
1000
996
992
100°
90°
80°
70°
60°
40°

FIGURE 2.13.2



Petawawa A
May 5-6, 1986
Drizzle (L)
Rain Showers (RW)
Precipitation
RW
RW-
RW--
L--
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT

FIGURE 2.13.3

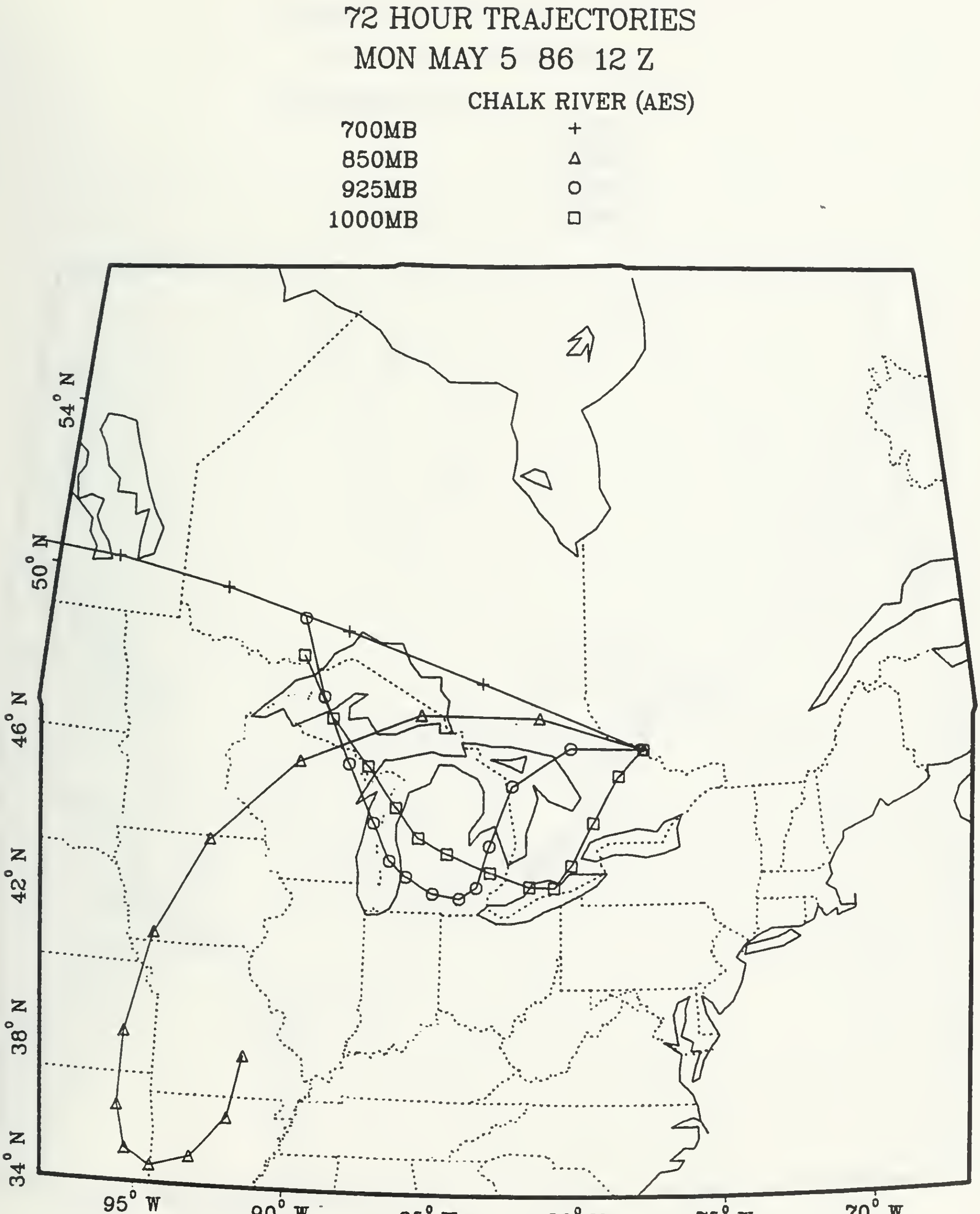

72 HOUR TRAJECTORIES
MON MAY 5 86 12 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.13.4

72 HOUR TRAJECTORIES
MON MAY 5 86 18 Z

	CHALK RIVER (AES)
700MB	+
850MB	Δ
925MB	O
1000MB	□

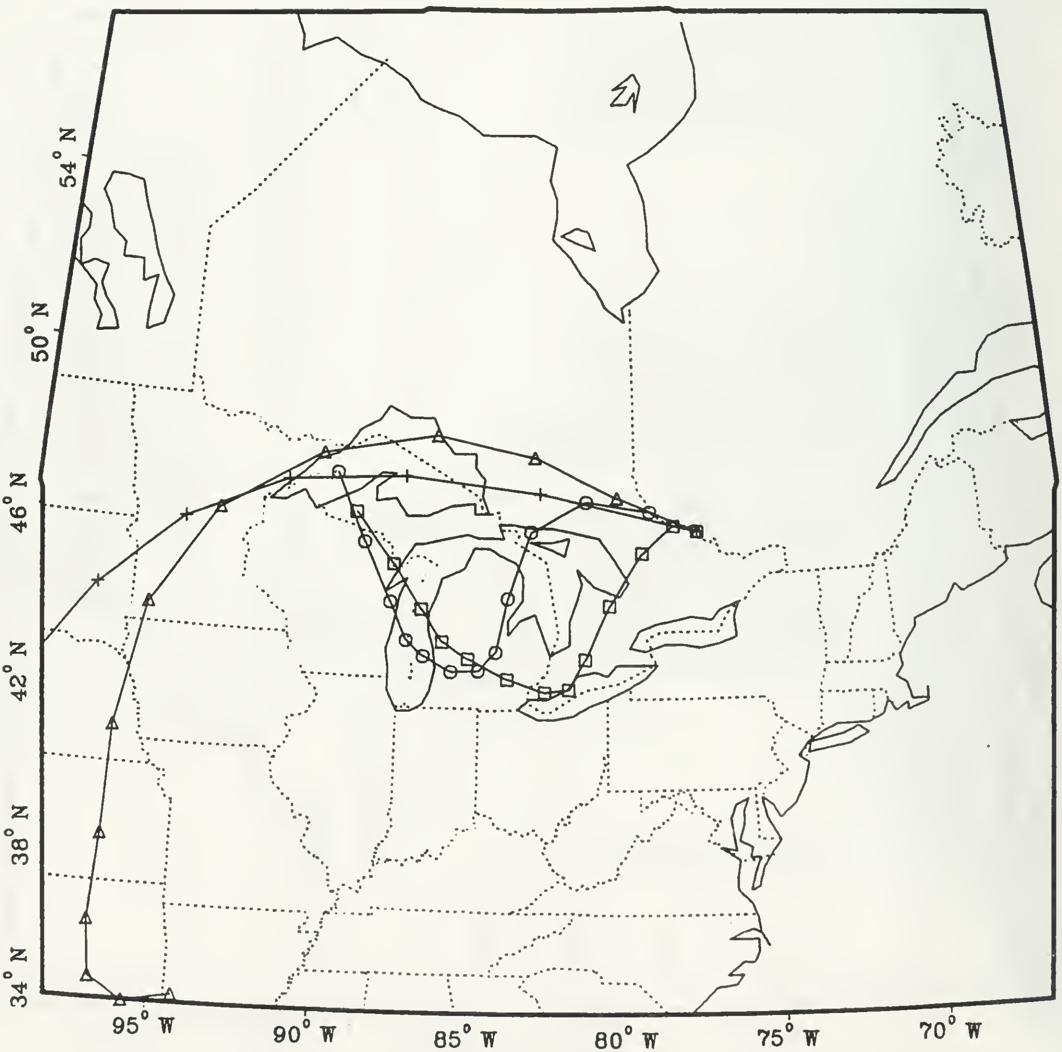


FIGURE 2.13.5

72 HOUR TRAJECTORIES
TUE MAY 6 86 0 Z

CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

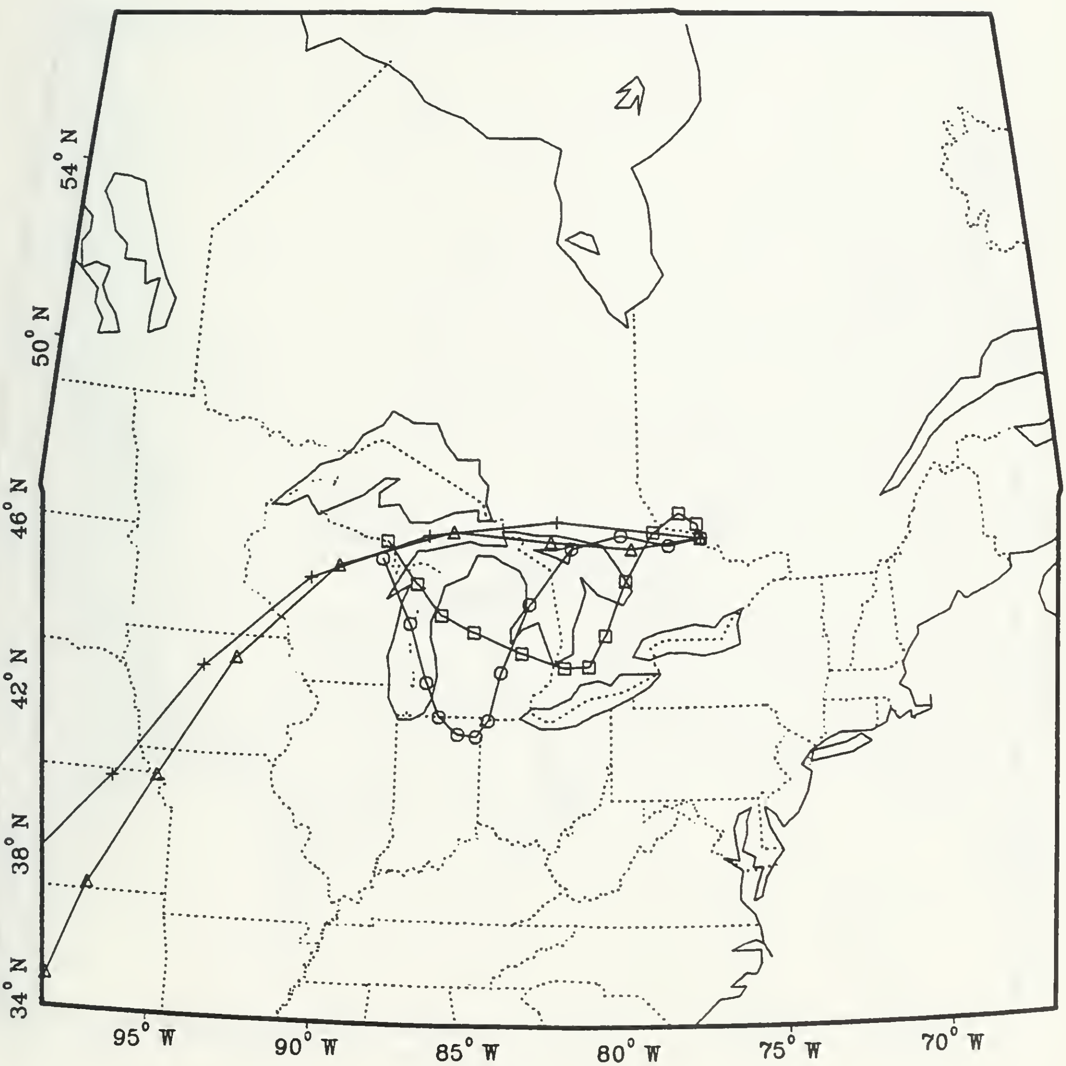


FIGURE 2.13.6

72 HOUR TRAJECTORIES
TUE MAY 6 86 6 Z

	CHALK RIVER (AES)
700MB	+
850MB	Δ
925MB	○
1000MB	□

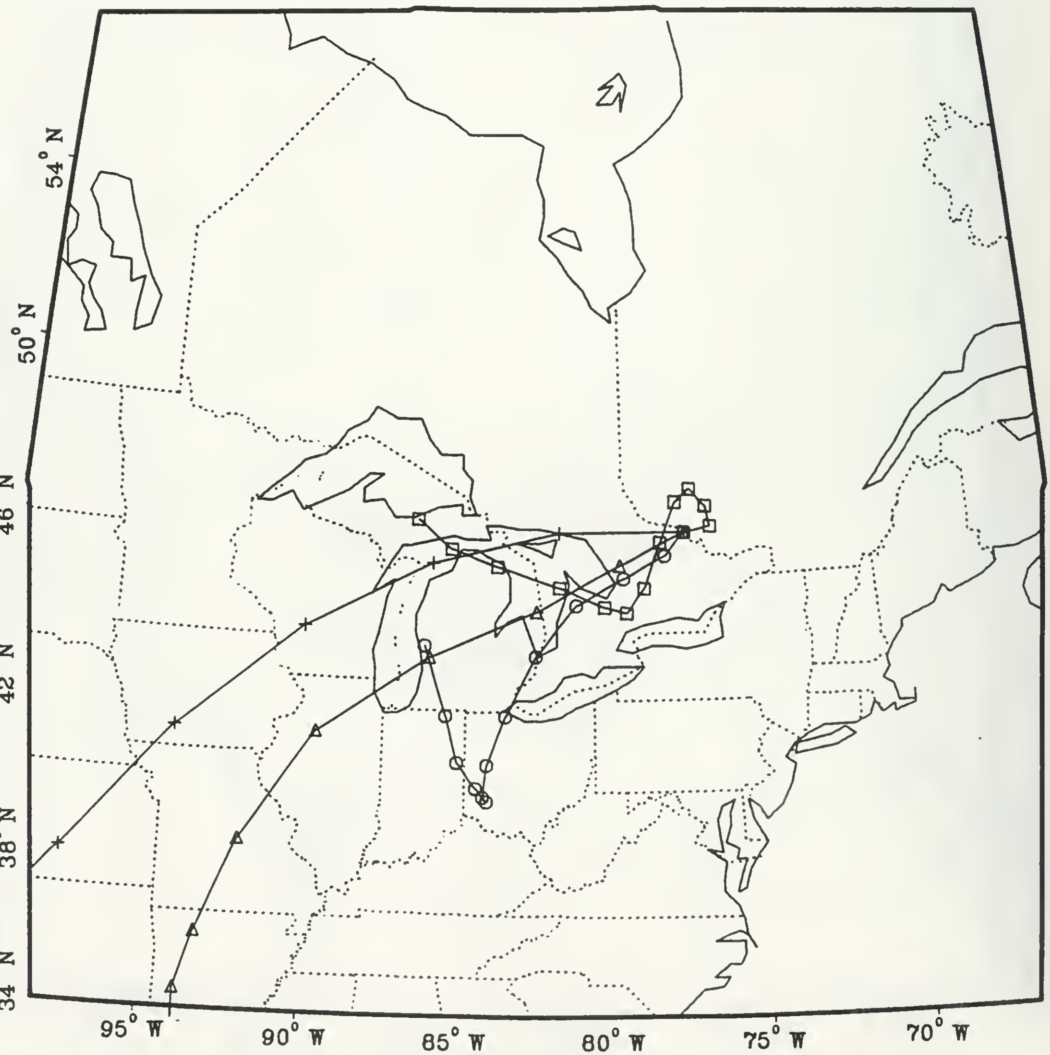


FIGURE 2.13.7

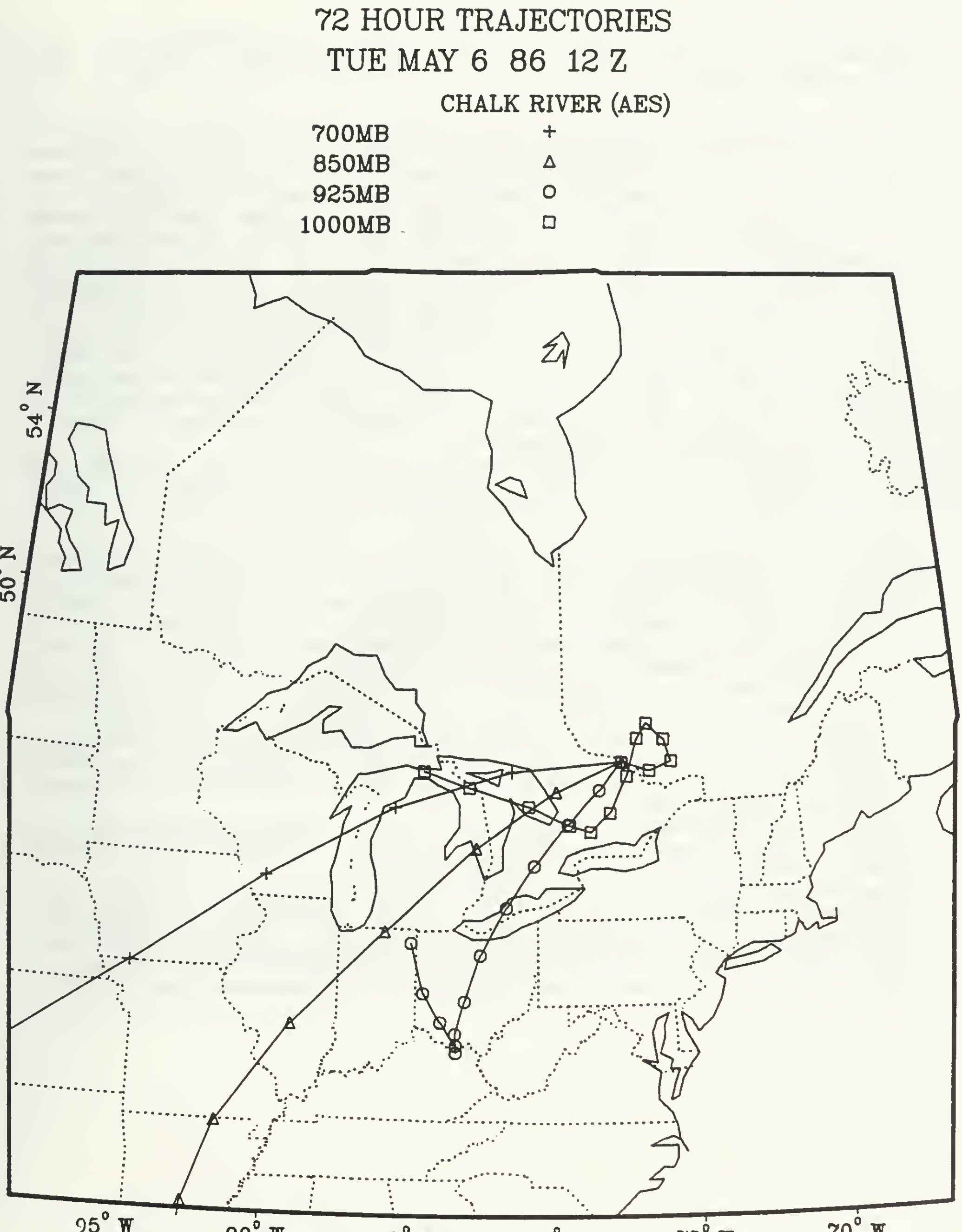

72 HOUR TRAJECTORIES
TUE MAY 6 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.13.8

2.14 May 17-18, 1986, Chalk River

The episode ranked only 7th (7/8) for the NO_3^- top 25% wet deposition events.

A low pressure centre, 1004 mb, over SW corner of Missouri, associated with two quasi-stationary frontal systems, one over Lake Huron E of Sault Ste Marie to Northern Quebec and the other one south of the Great Lakes in the USA, were observed on May 17, at 12Z, as shown in Fig. 2.14.1. During this episode, the low moved in a NE direction and deepened to 1001 mb, new lows developed and the fronts moved close to Chalk River. On May 18, at 12Z, three low centres are analyzed and one front over Georgian Bay in Lake Huron - North Bay direction and the other one associated with a wave over Dorset and south of the station were analyzed as illustrated in Fig. 2.14.2. Although no frontal passage over Chalk river took place, proximity of the low and a wave triggered thunderstorms and, as shown in Fig. 2.14.3, very light, light and moderate rain showers and light thundershowers were observed lasting for about two hours. Lightning was observed.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for May 17, 12Z, 18Z and May 18, 00Z, 06Z and 12Z are shown in Figures 2.14.4, 2.14.5, 2.14.6, 2.14.7, and 2.14.8 respectively.
Air trajectories for the 100 mb level show that NO_x from its high emission in Pennsylvania-Ohio (Figs. 2.14.4-5), West Virginia (Fig. 2.14.6), Cleveland (Fig. 2.14.6-7) and Detroit (Fig. 2.14.8) could have been transported. No highest emission source is involved.
Air parcels arriving at the 925 mb level show that NO_x from its high emission areas in Maryland and Pennsylvania (Fig. 2.14.4) for some time and from Cleveland (Fig. 2.14.5) could have been transported.
Air trajectories for the 850 mb level show that NO_x from its high emission Detroit area (Fig. 2.14.8) and for a short duration from the highest emission Chicago area (see Figs. 2.14.4-5 & 6-8) could have been transported.
Air parcels arriving at the 700 mb level could have carried NO_x from its highest emission Chicago (Fig. 2.14.7) and high emission Detroit (Fig. 2.14.8) area to the station.
Summarizing, a proximity of a low and wave with fronts yielded rain and thundershowers lasting for two hours. Lightning was observed. Transport of NO_x at high levels from Chicago, at high and low levels from Detroit and at low levels from Maryland, Pennsylvania, Ohio, West Virginia and Cleveland region was probable during this episode.

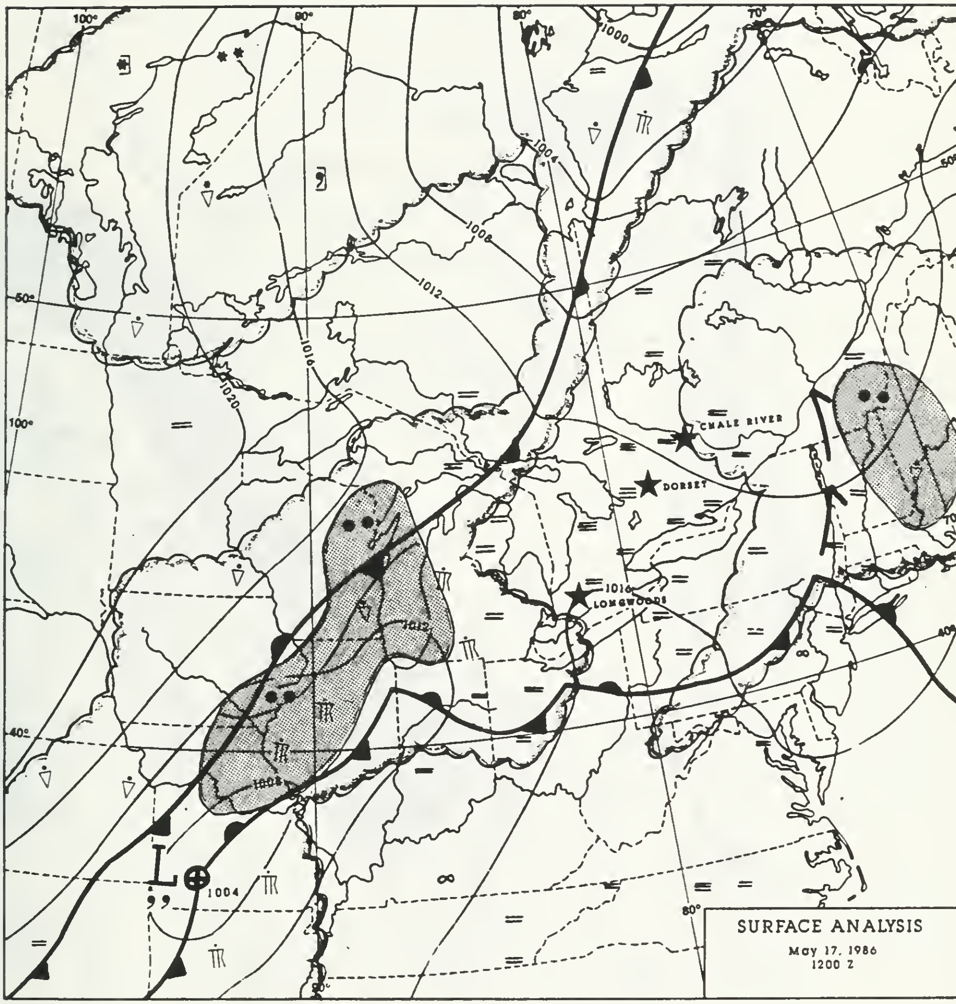

SURFACE ANALYSIS
May 17, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1000
1004
1008
1012
1016
1020
L
100°
90°
80°
70°
50°
40°

FIGURE 2.14.1

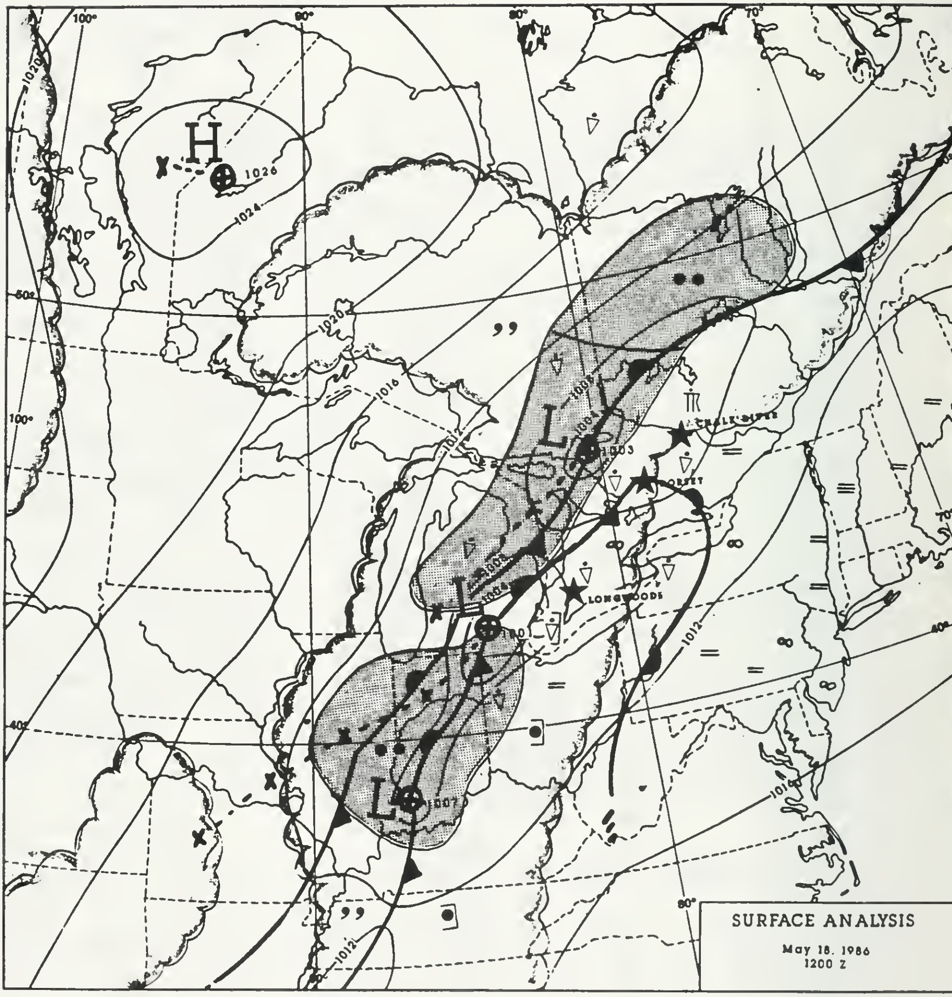

SURFACE ANALYSIS
May 18, 1986
1200 Z
H
L
L
1026
1024
1020
1016
1012
1010
1003
1007
CHALK RIVER
DORSET
LONGWOODS
100°
90°
80°
70°
60°
40°

FIGURE 2.14.2

Petawawa A
May 17-18, 1986

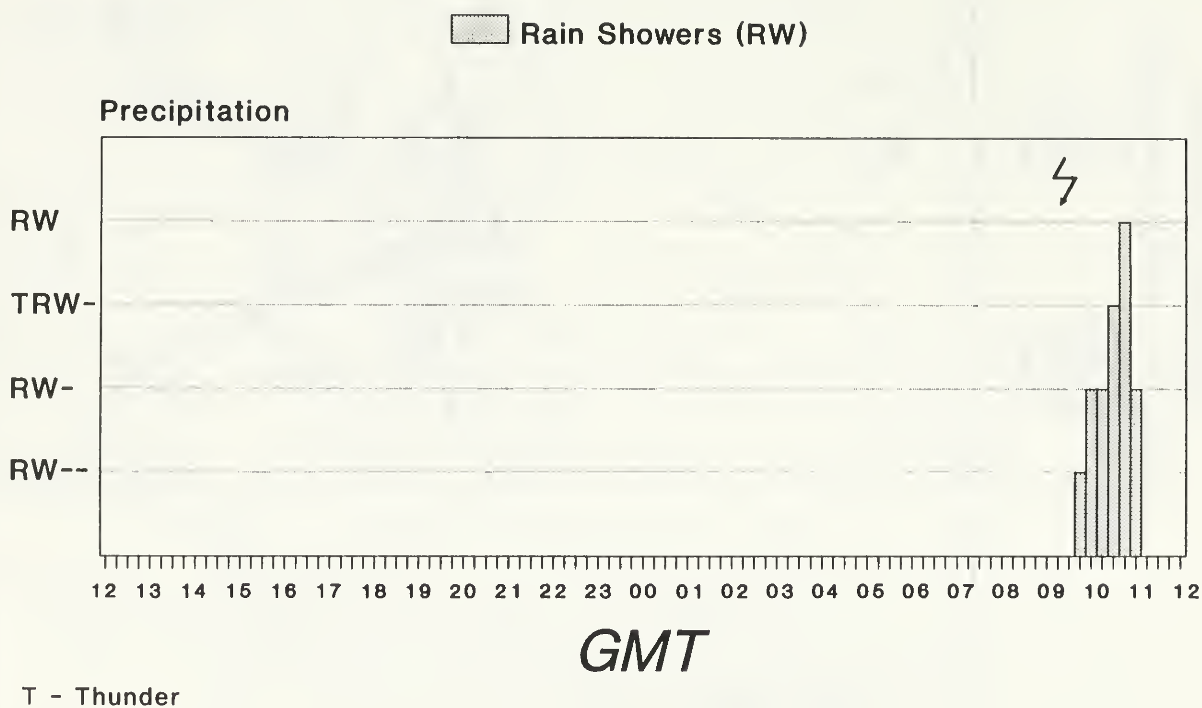


FIGURE 2.14.3

72 HOUR TRAJECTORIES
SAT MAY17 86 12 Z

CHALK RIVER (AES)

700MB	+
850MB	Δ
925MB	○
1000MB	□

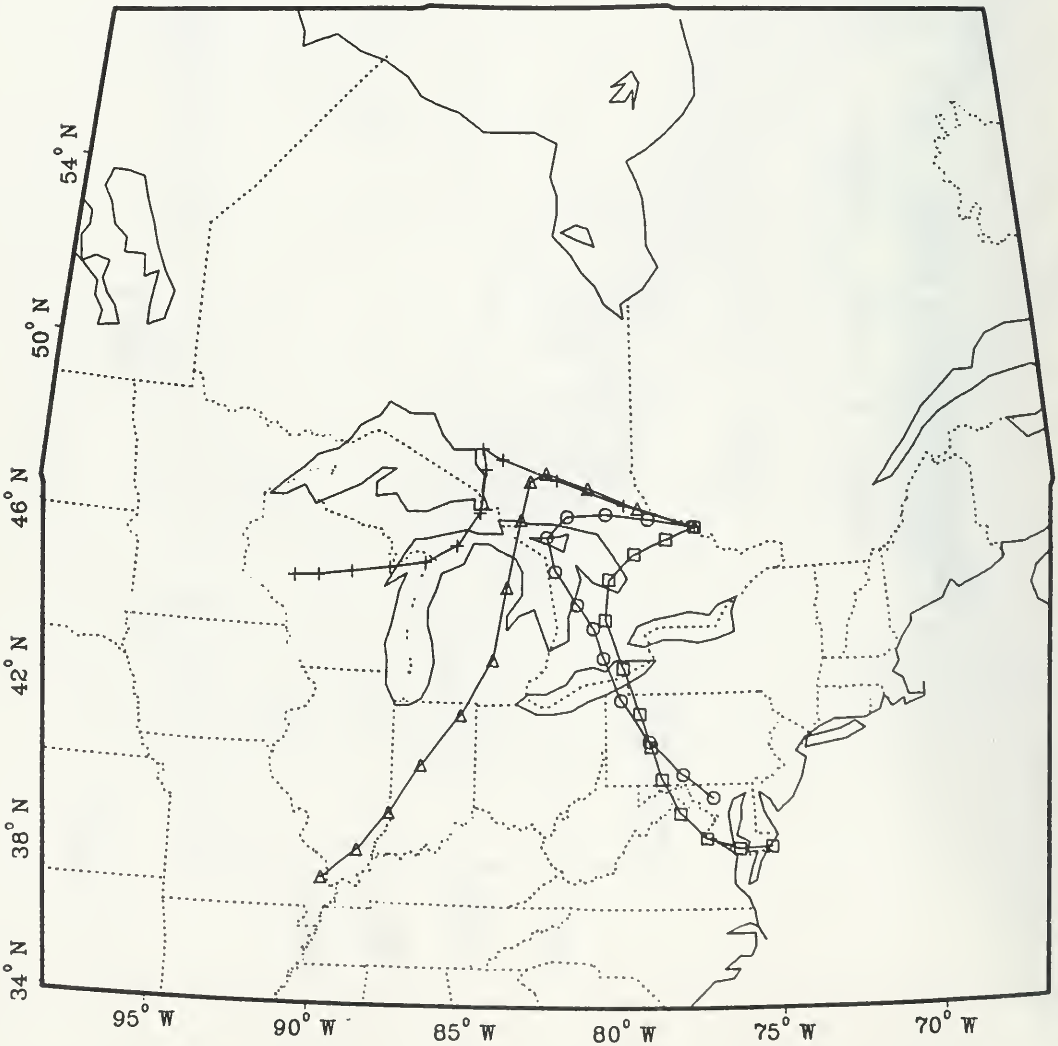


FIGURE 2.14.4

72 HOUR TRAJECTORIES
SAT MAY17 86 18 Z

	CHALK RIVER (AES)
700MB	+
850MB	△
925MB	○
1000MB	□

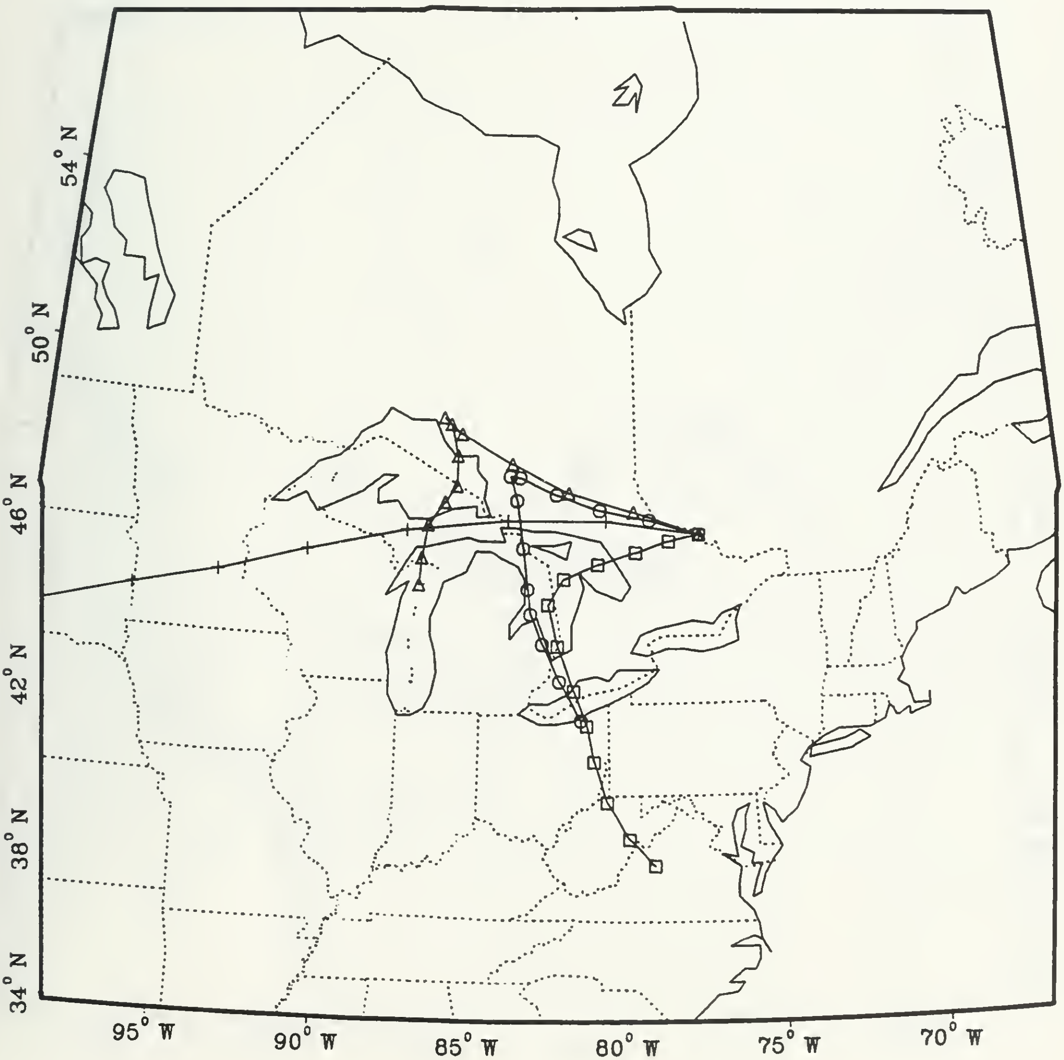


FIGURE 2.14.5

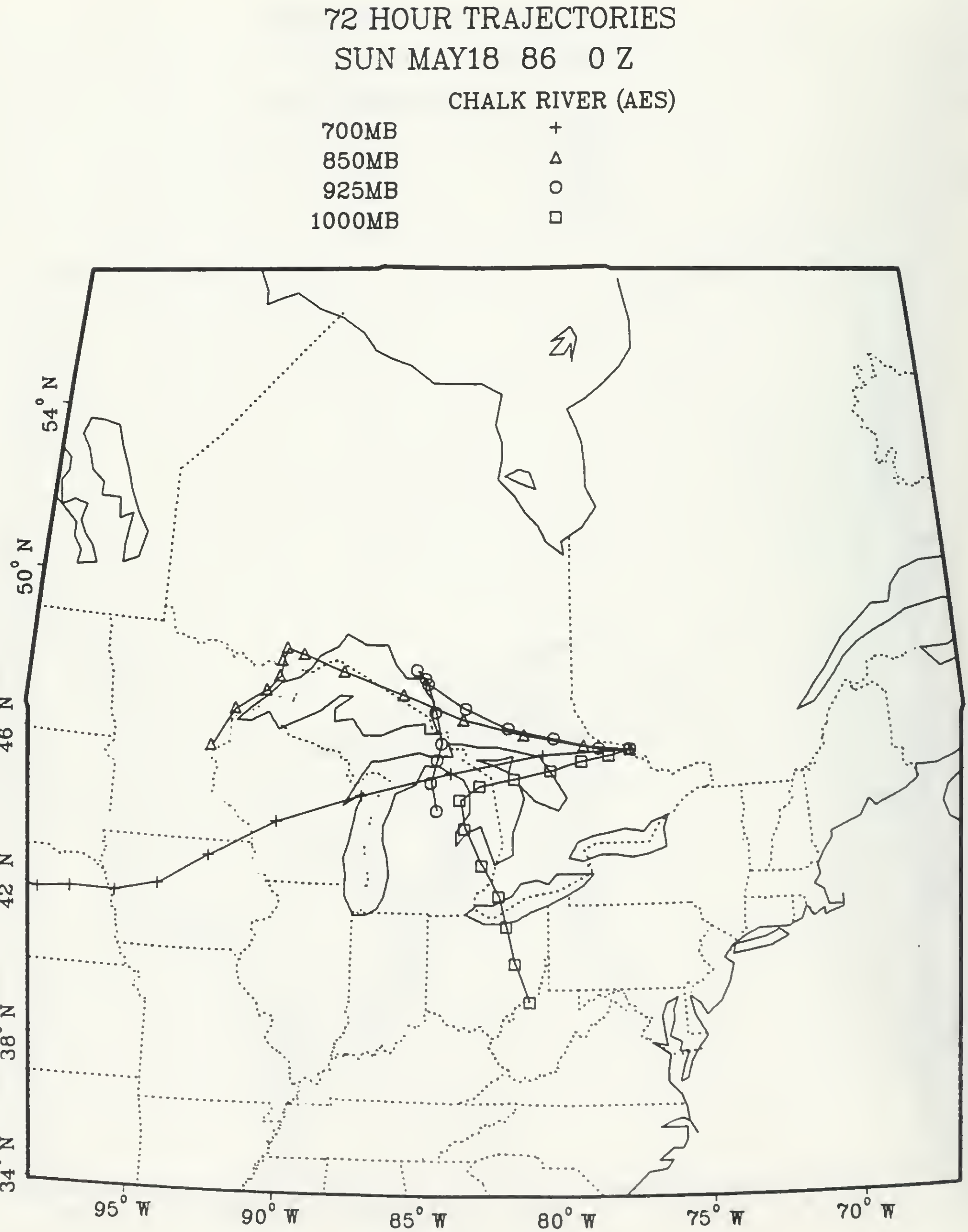

72 HOUR TRAJECTORIES
SUN MAY18 86 0 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.14.6

72 HOUR TRAJECTORIES
SUN MAY18 86 6 Z

CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

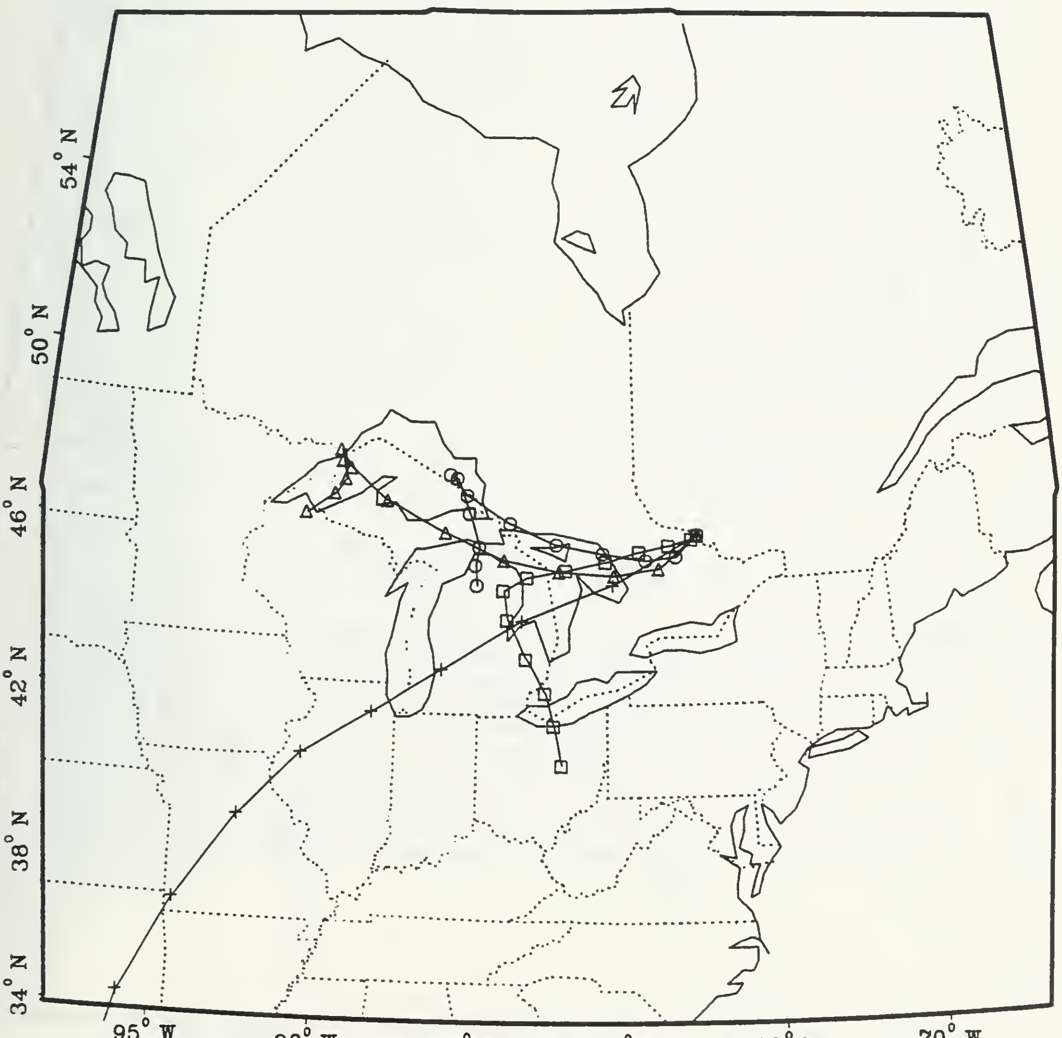


FIGURE 2.14.7

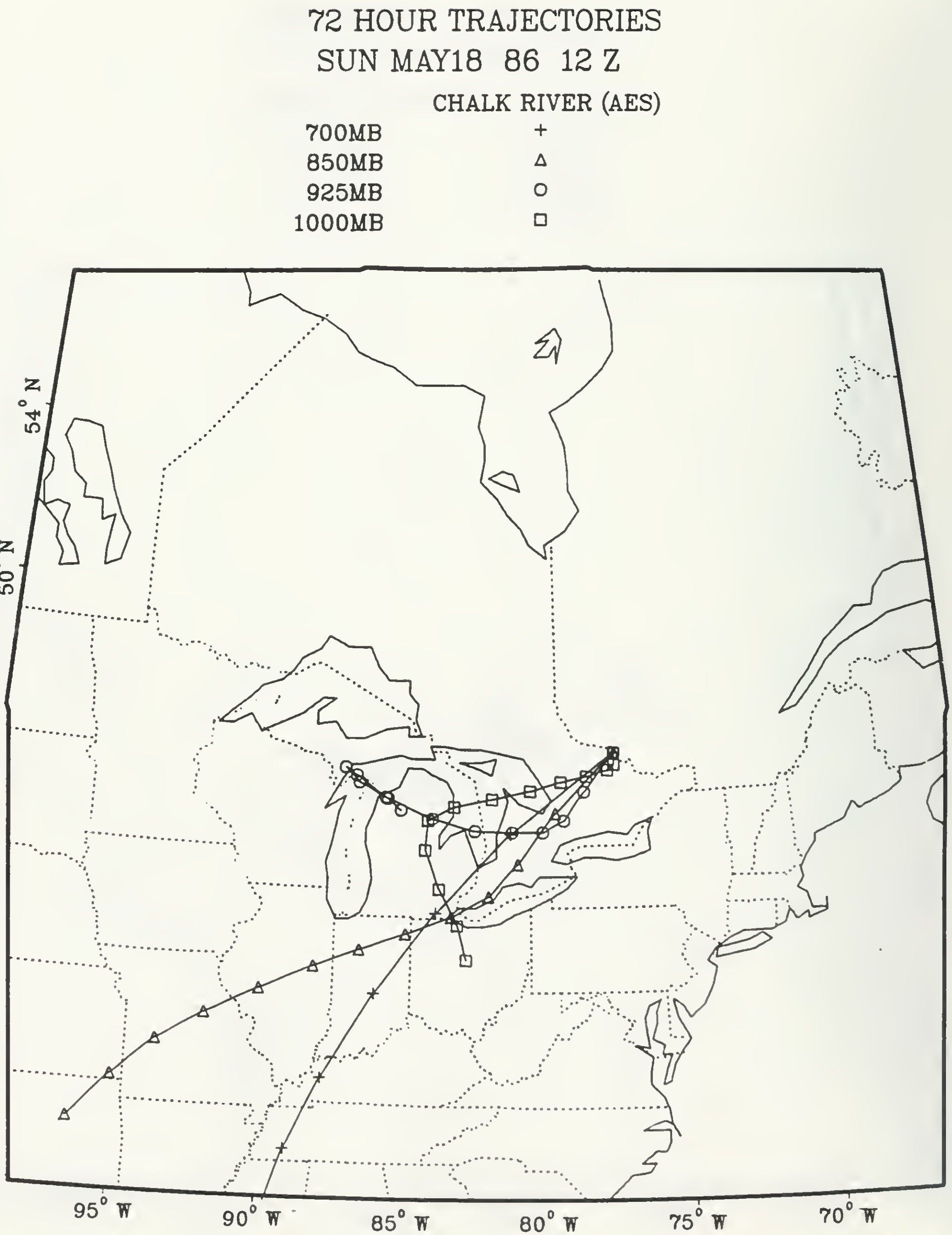

72 HOUR TRAJECTORIES
SUN MAY18 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.14.8

2.15 May 31 - June 1, 1986, Chalk River

This episode ranked 1st for both $SO_4^=$ (1/6) and NO_3^- (1/8) wet deposition episodes at Chalk River.

Two frontal systems over southern Ontario with a low pressure centre, 1007 mb, near Toronto, and a low over Saskatchewan (outside the map), 1006 mb, were analyzed on May 31, at 12Z as shown in Fig. 2.15.1. During this episode the low over Saskatchewan deepened and moved ESE. On June 1, at 12Z, as shown in Fig. 2.15.2, it laid over Lake Huron and two frontal systems still extended over southern and central Ontario. The warm front moved closer to Chalk river but still remained south of the station. The low and the warm front yielded thunderstorms during this episode and rain and thunder showers was observed at the nearest weather station on June 1 during 09-12Z as shown in Fig. 2.15.3. As exhibited in the figure, lightning was observed and very light, light and moderate rain showers and moderate to heavy thundershowers were recorded for about 3 hours.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for May 31, 12Z, 18Z and June 1, 00Z, 06Z and 12Z are shown in Figures 2.15.4, 2.15.5, 2.15.6, 2.15.7, and 2.15.8 respectively.

Air trajectories for the 1000 mb level show that pollution transport at this level was insignificant.

Air parcels arriving at the 925 mb level could have carried SO_2 from its highest emission Abitibi area (Fig. 2.15.4-5). No significant NO_x transport occurred at this level.

Air trajectories for the 850 mb level show that transport of SO_2 from its highest emission Abitibi (Fig. 2.15.4-6) and Sudbury (Fig. 2.15-7-8) area could have taken place. No significant NO_x transport is likely at this level.

Air parcels arriving at the 700 mb level show that SO_2 could have been transported from Sudbury area (Fig. 2.15-7-8). Again no NO_x transport is likely.

In summary, a low pressure centre and a warm front in the region triggered thundershowers and rain showers up to moderate intensity, and moderate to heavy thundershowers were observed for about 3 hours. Transport of SO_2 at low (925 mb) and high (850 mb & 700 mb) levels from Abitibi area and at high levels from Sudbury area was likely. It is noteworthy that, even though it is the highest NO_3 deposition event, transport of NO_x from any significant emission sources was not observed. However, as noted earlier, thunderstorms, associated with a low pressure centre, were observed and lightning was recorded near the station during the episode.

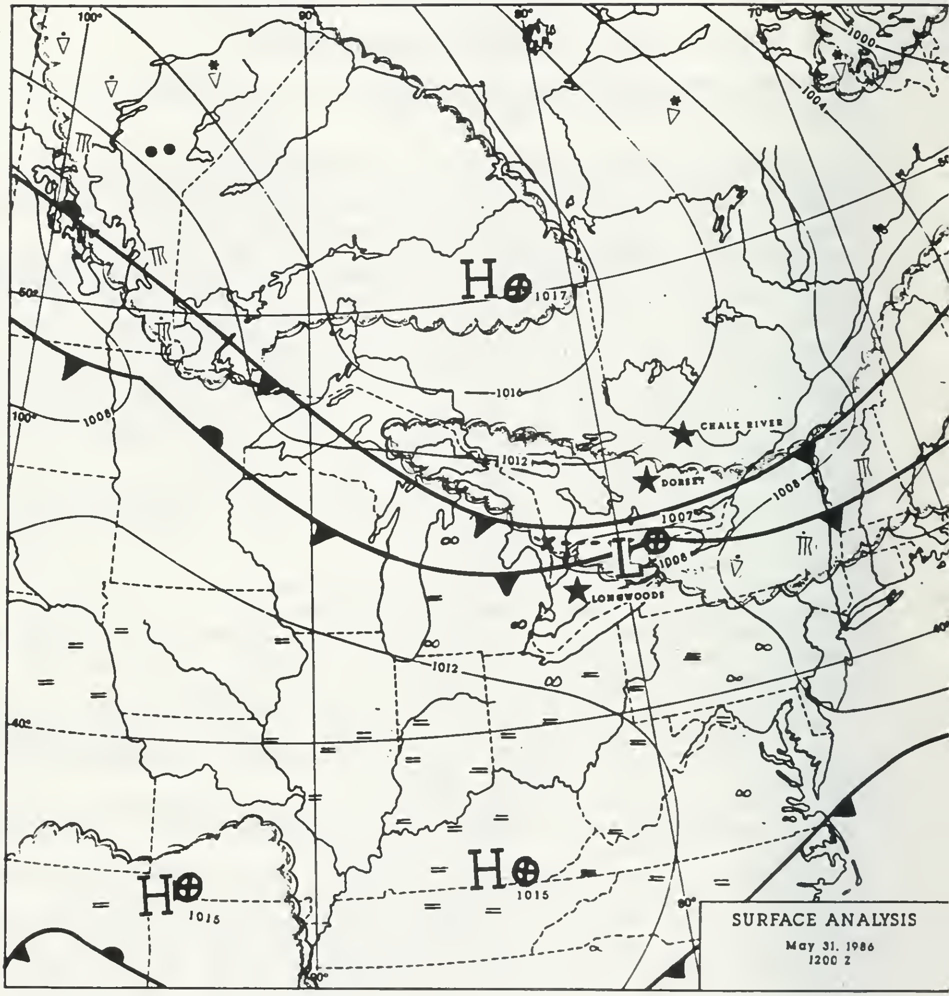

SURFACE ANALYSIS
May 31, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
H
L
1017
1016
1012
1008
1007
1006
1004
1000
1015
100°
90°
80°
70°
50°
40°

FIGURE 2.15.1

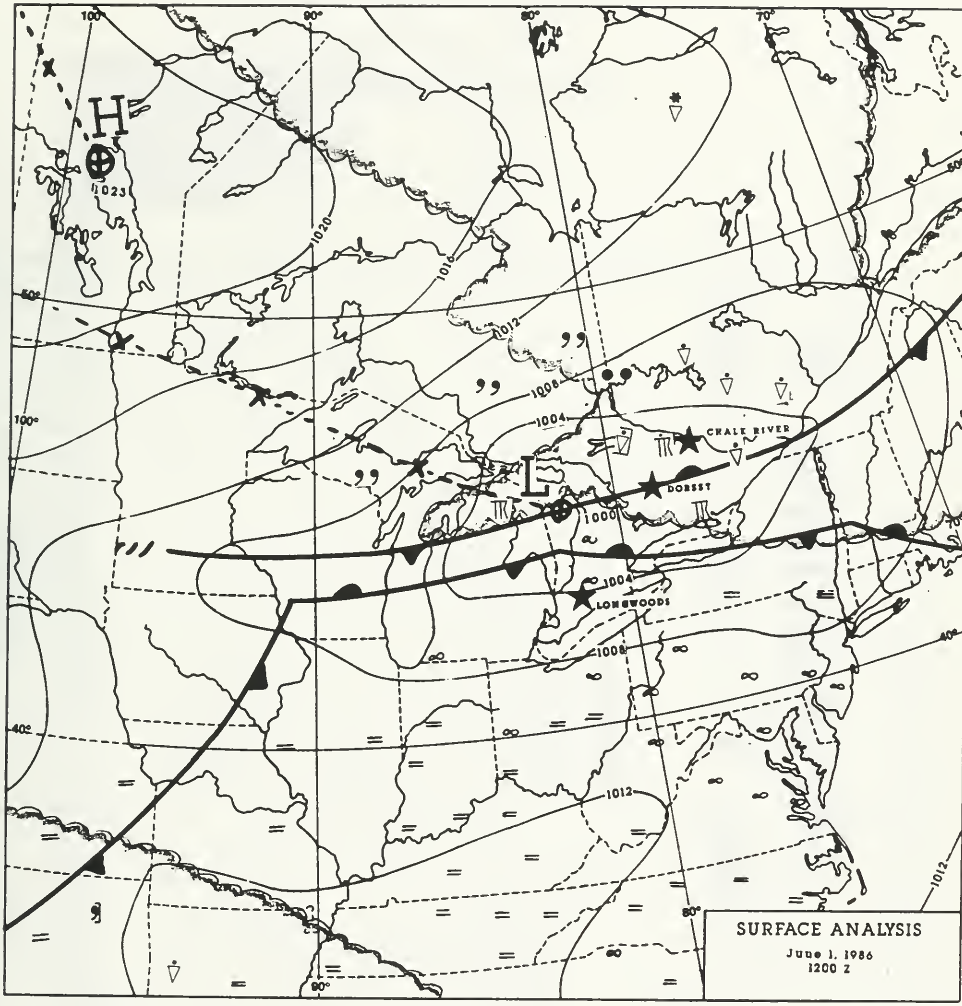

SURFACE ANALYSIS
June 1, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1023
1020
1016
1012
1008
1004
1000

FIGURE 2.15.2

Petawawa A

May 31 - June 1, 1986

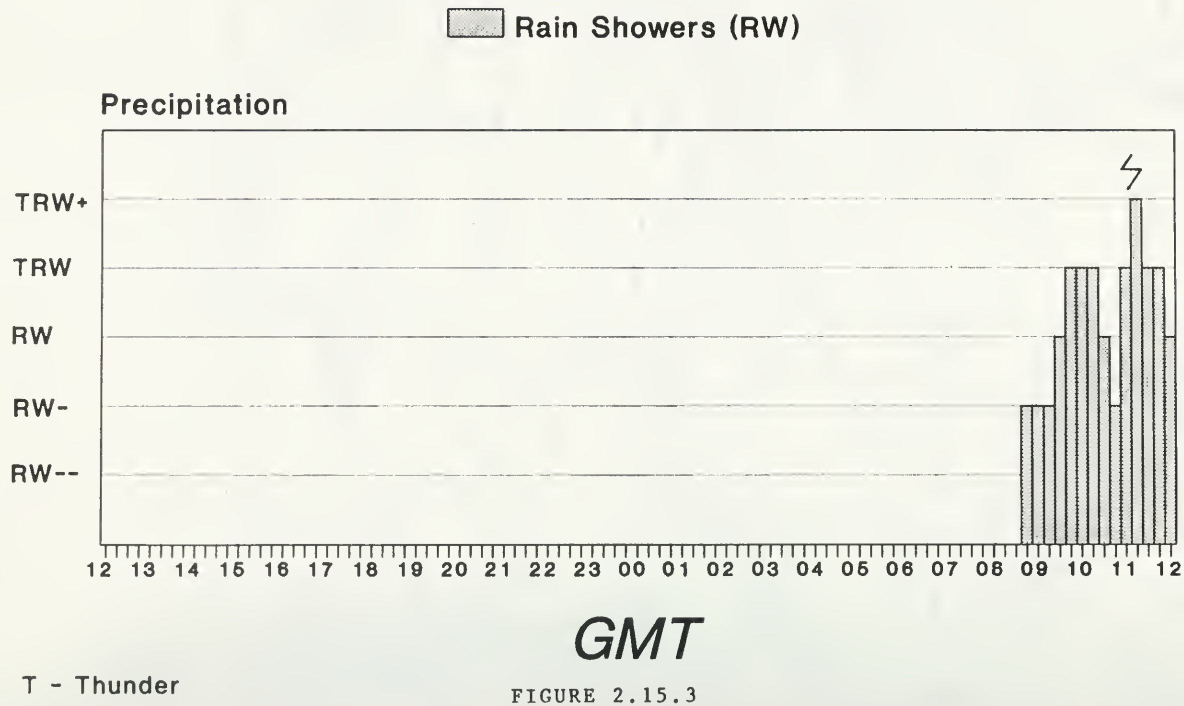


FIGURE 2.15.3

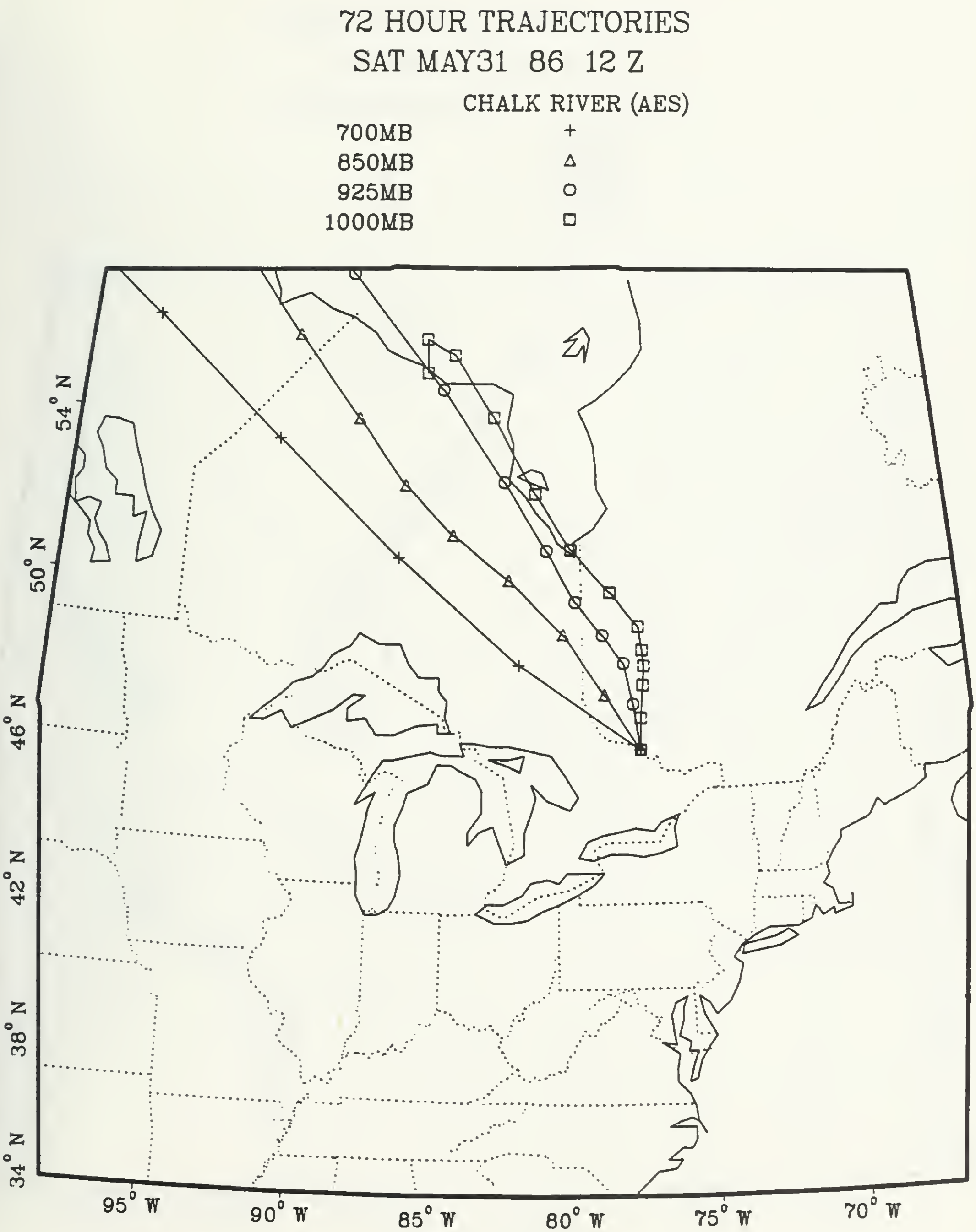

72 HOUR TRAJECTORIES
SAT MAY31 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.15.4

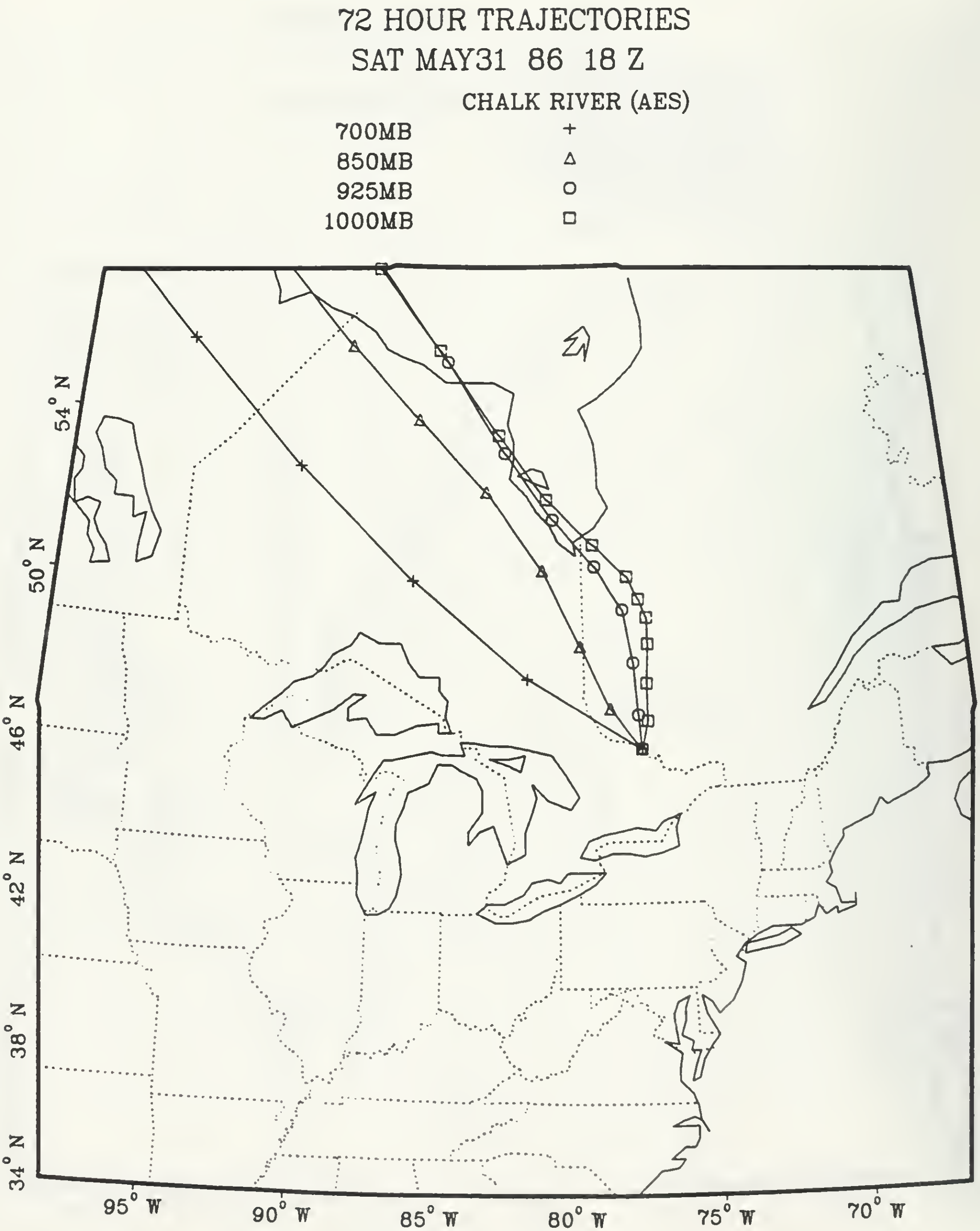

72 HOUR TRAJECTORIES
SAT MAY31 86 18 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.15.5

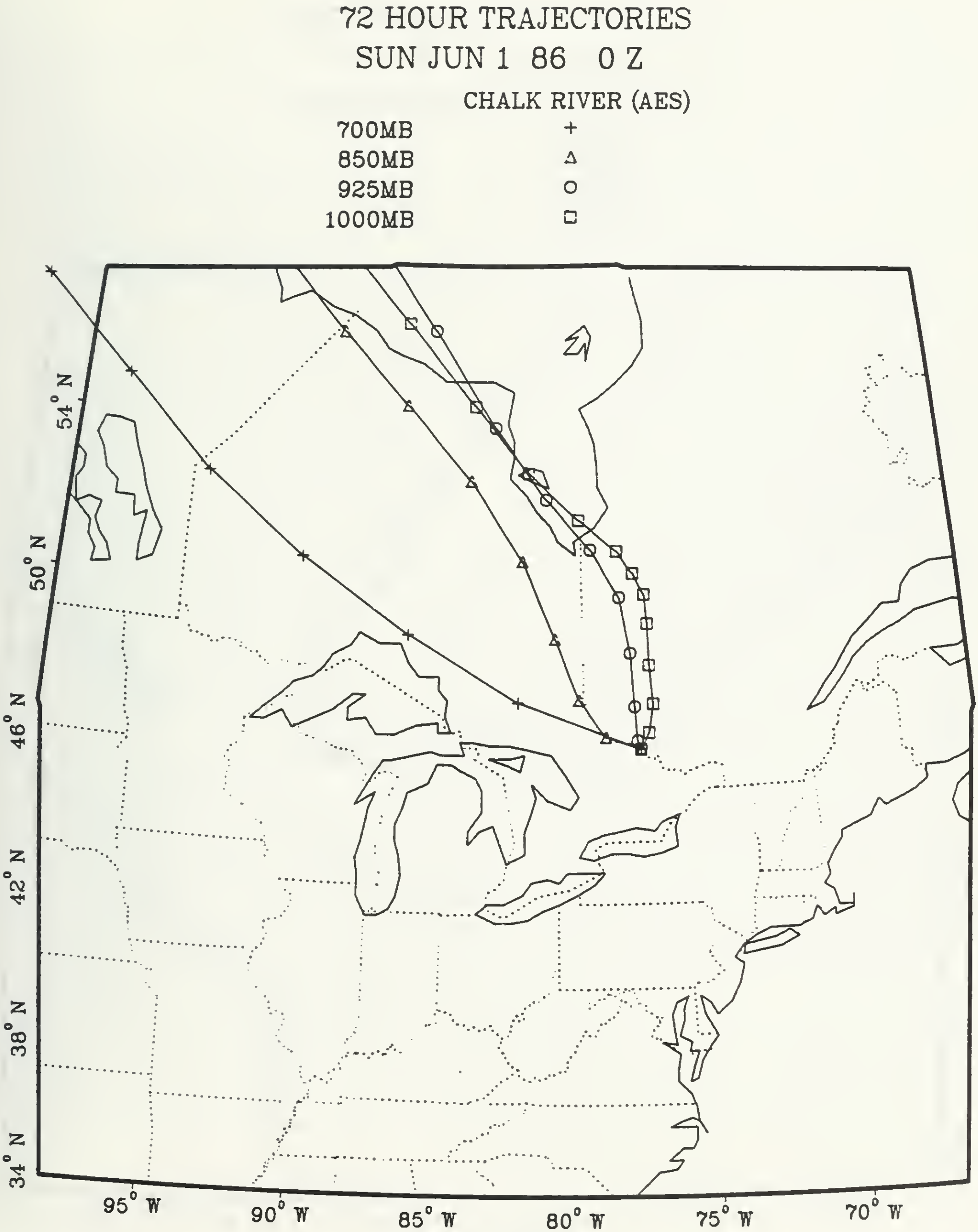

72 HOUR TRAJECTORIES
SUN JUN 1 86 0 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.15.6

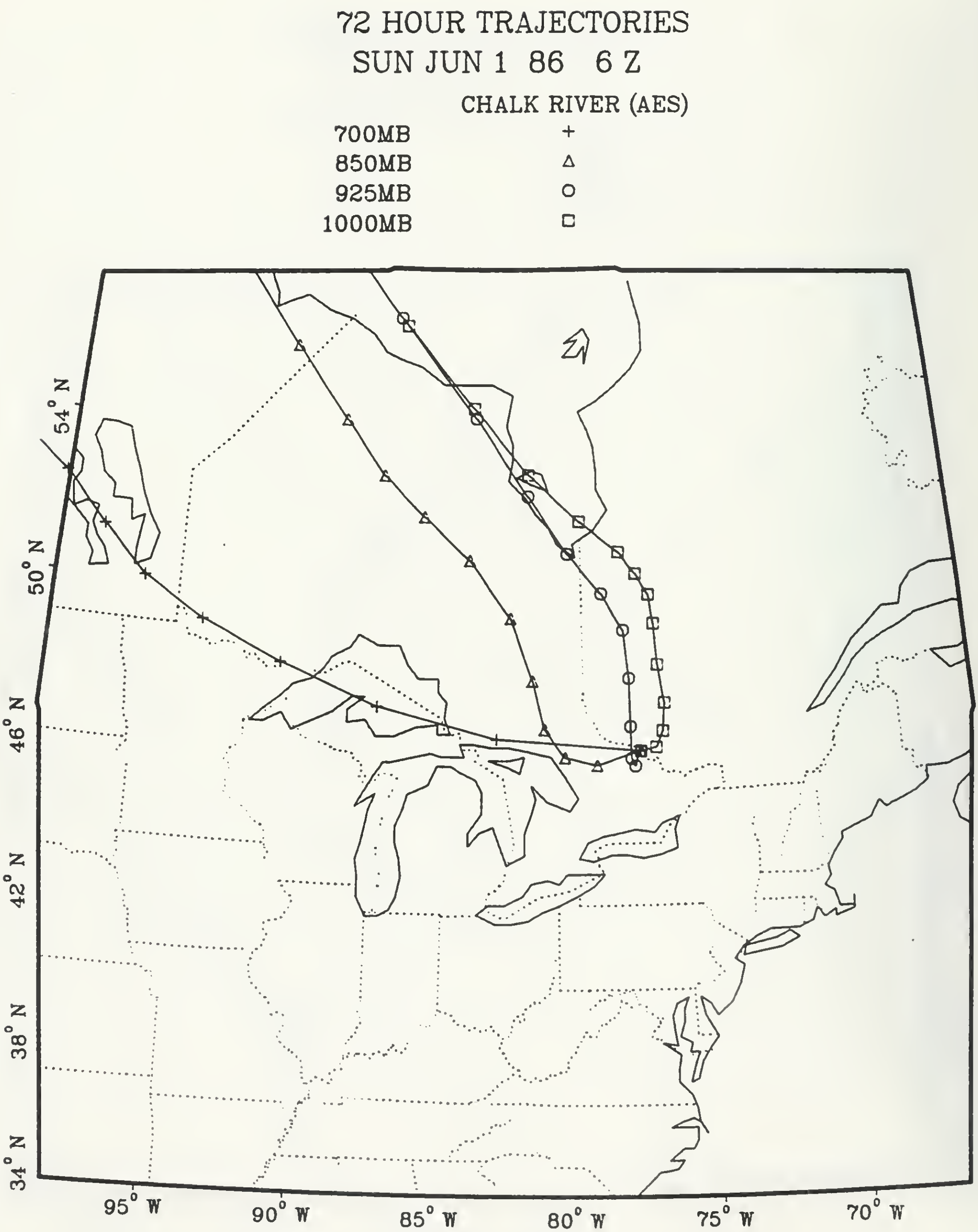

72 HOUR TRAJECTORIES
SUN JUN 1 86 6 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.15.7

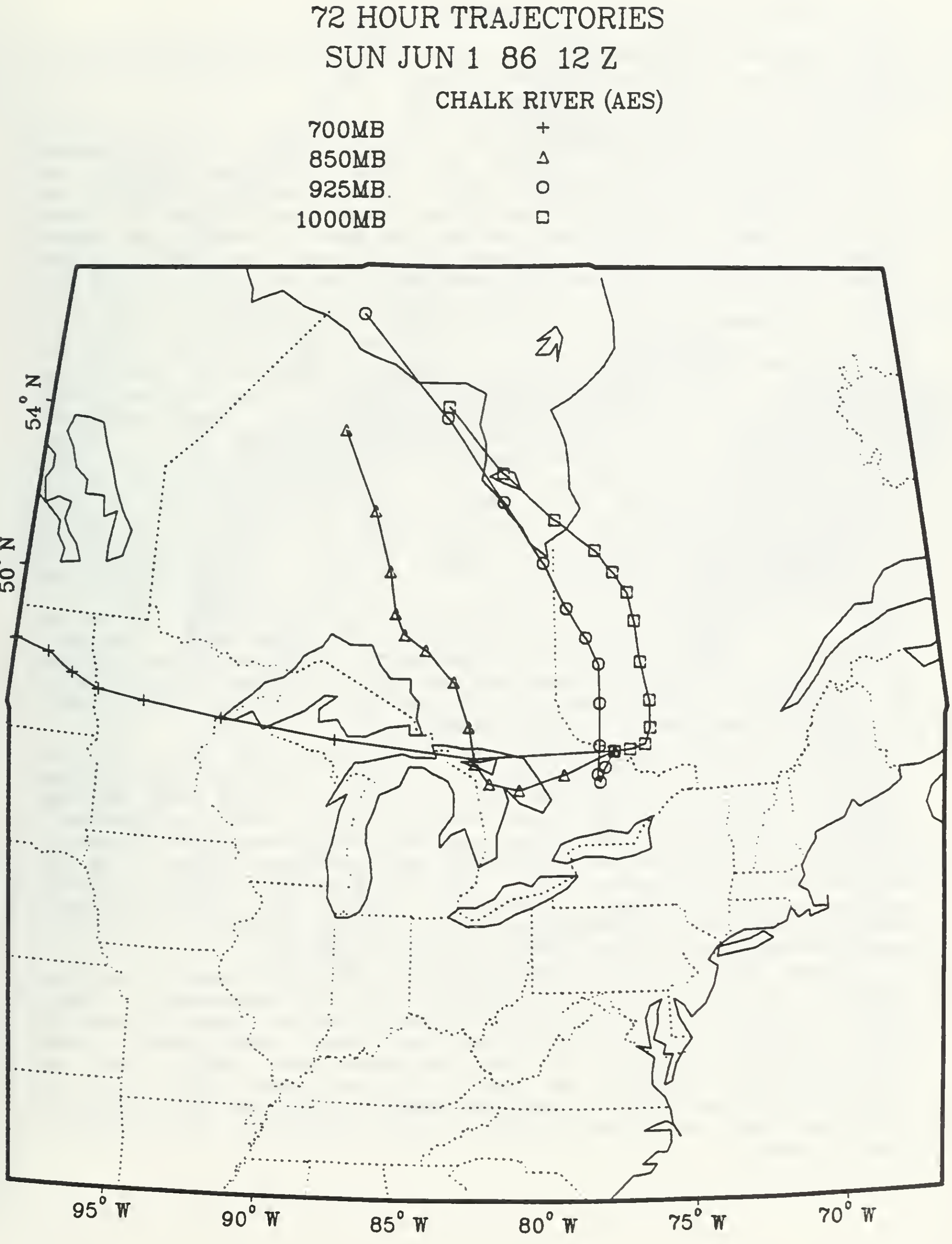

72 HOUR TRAJECTORIES
SUN JUN 1 86 12 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.15.8

2.16 June 11-12, 1986, Longwoods(AES & MOE)

This episode at Longwoods(AES) ranked 7th (7/8) for wet deposition of $SO_4^=$, and at Longwoods (MOE) ranked 6th (6/7) and 10th (10/10) for $SO_4^=$ and NO_3^- events, respectively.

On June 11, at 12Z, as shown in Fig. 2.16.1, two fronts were analyzed over southern Ontario. The lower front laid over Longwoods and was associated with waves over New York near Buffalo and Wisconsin NW of Milwaukee. The upper front was associated with lows over New York near Syracuse, Iowa near Des Moines and over Wisconsin west of Green Bay. During the next 24 hours, the system moved slowly such that first the fronts moved southward and the upper cold front was situated over Longwoods at 18Z and then the lower warm front existed over the station at 00Z on June 12. The Iowa low first deepened and then filled moving NE and on June 12, at 12Z as shown in Fig. 2.16.2, it laid over Michigan with the upper front over Lake Huron and Toronto. The lower warm front associated with a wave over Michigan laid over the station. With the passage of two fronts over the station, very light and light rain and rain showers and thundershowers of very light, light, moderate and heavy intensities were recorded as shown in Fig. 2.16.3. Lightning was also observed and thunder heard. the total precipitation duration is almost 12 hours. The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for June 11, 12Z, 18Z and June 12, 00Z, 06Z and 12Z are shown in Figures 2.16.4, 2.16.5, 2.16.6, 2.16.7, and 2.16.8 respectively.

Air parcels arriving at the 1000 mb level could have carried SO_2 from its highest emission sources in Ohio-West Virginia-Pennsylvania (Fig. 2.16.4-8) for the entire duration of the episode and from high emission cleveland for about 12 hours (Fig. 2.16.4-6). Transport of NO_x from its high emission sources in Ohio- West Virginia-Pennsylvania was also probable.

Air trajectories for the 925 mb level show that SO_2 from its highest emission Detroit (Fig. 2.16.4&5-6), high emission Sarnia (Fig. 2.16.4-5) and Cleveland (Fig. 2.16.7-8) and NO_x from its high emission Detroit and Cleveland area could have been transported.

Air trajectories for the 850 mb and 700 levels are quite close and similar and indicate that SO_2 could have been transported from its highest emission Chicago (Fig. 2.16.4-5), Detroit (Fig. 2.16.6-8) region and other Illinois area(Fig. 2.16.6). NO_x could also have been transported from its highest emission Chicago (Fig. 2.16.4-5) and high emission Detroit (Fig. 2.16.6-8) areas.

In summary, two frontal systems hovered around and passed over the station yielding rain, rain showers and thundershowers of very light to heavy intensities and the precipitation lasted almost 12 hours. Transport of SO_2 and NO_x at high levels from Chicago , and from Detroit at high and low (925 mb) levels was likely. Also, SO_2 from Ohio-West Virginia at low levels and from other areas in Illinois at high levels could have been transported. NO_x transport from Cleveland, Ohio-West Virginia- Pennsylvania at low levels was also probable.

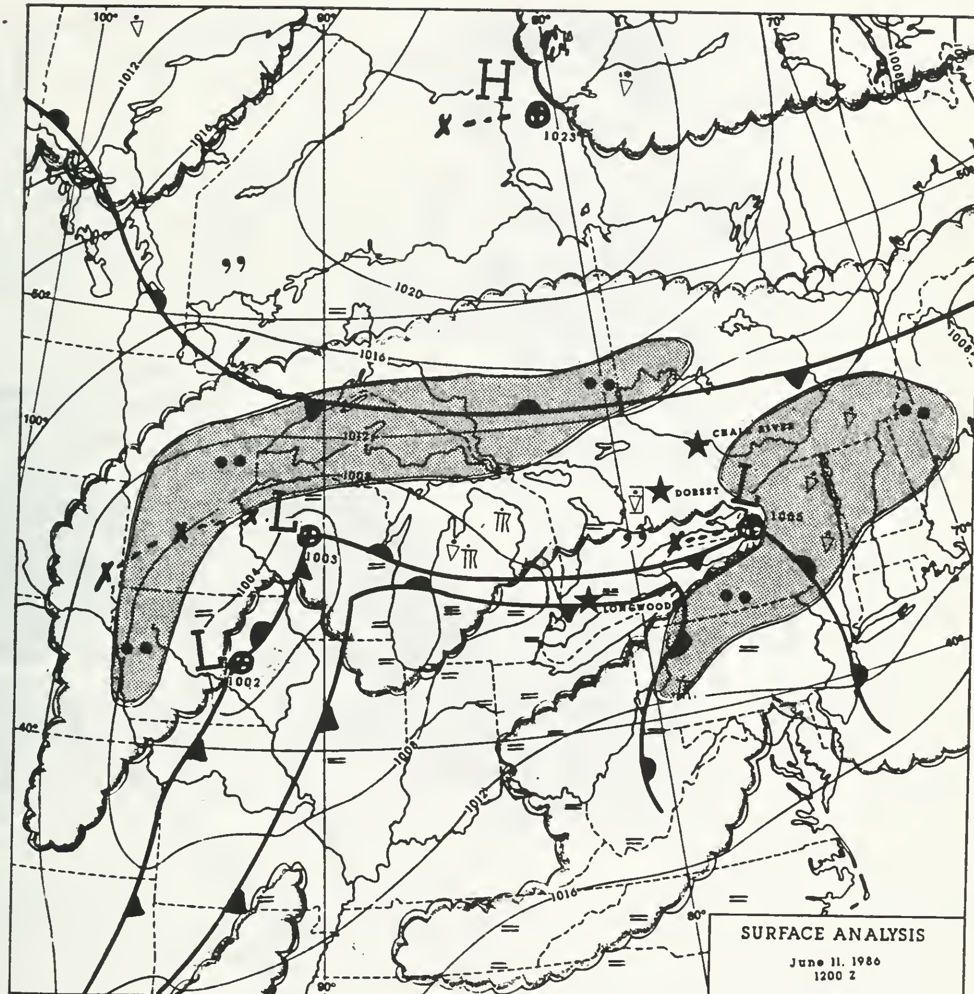

SURFACE ANALYSIS
June 11, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOOD
H
L
L
L
L
1023
1003
1002
1005
1020
1016
1012
1008
1004

FIGURE 2.16.1

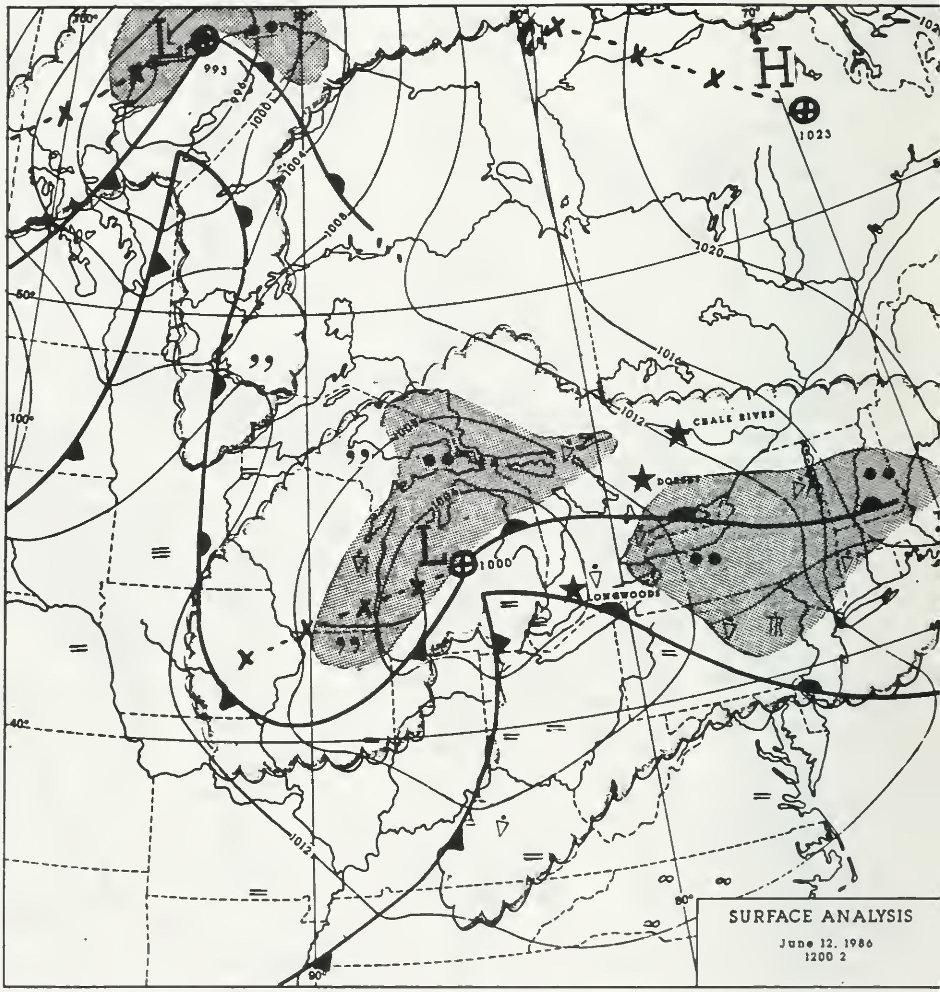

SURFACE ANALYSIS
June 12, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
993
1000
1023
1020
1016
1012
1008
1004
50°
40°
100°
90°
80°
70°

FIGURE 2.16.2

London A
June 11-12, 1986

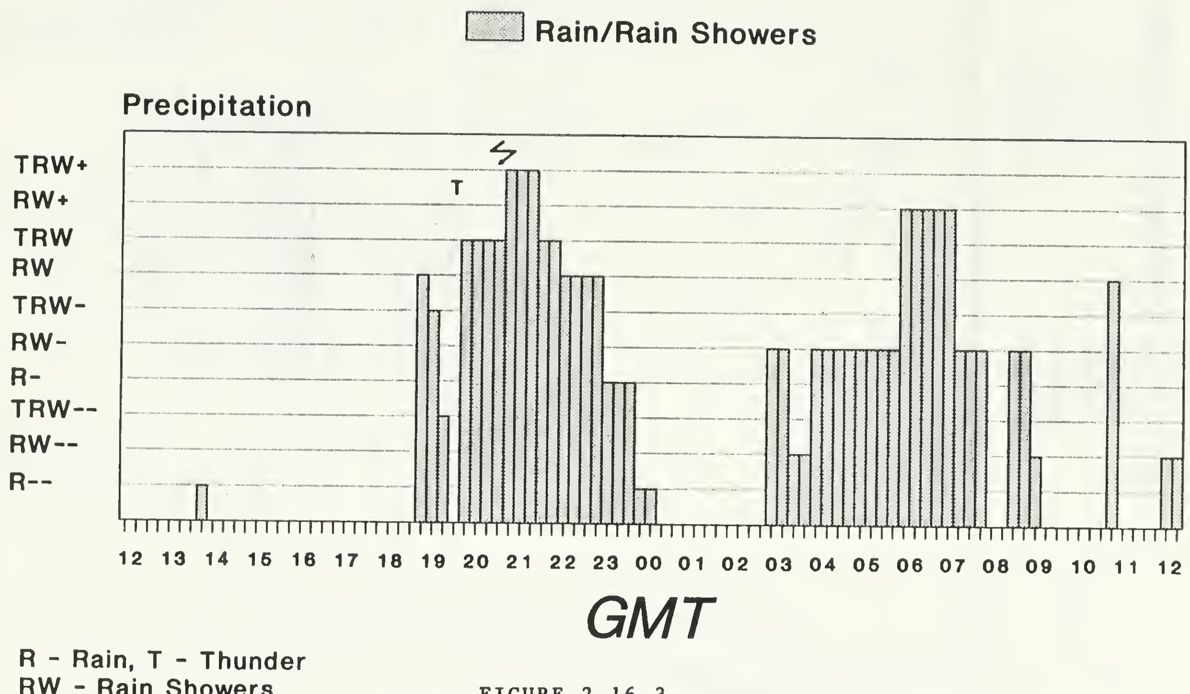


FIGURE 2.16.3

72 HOUR TRAJECTORIES
WED JUN11 86 12 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	Δ
925MB	O
1000MB	□

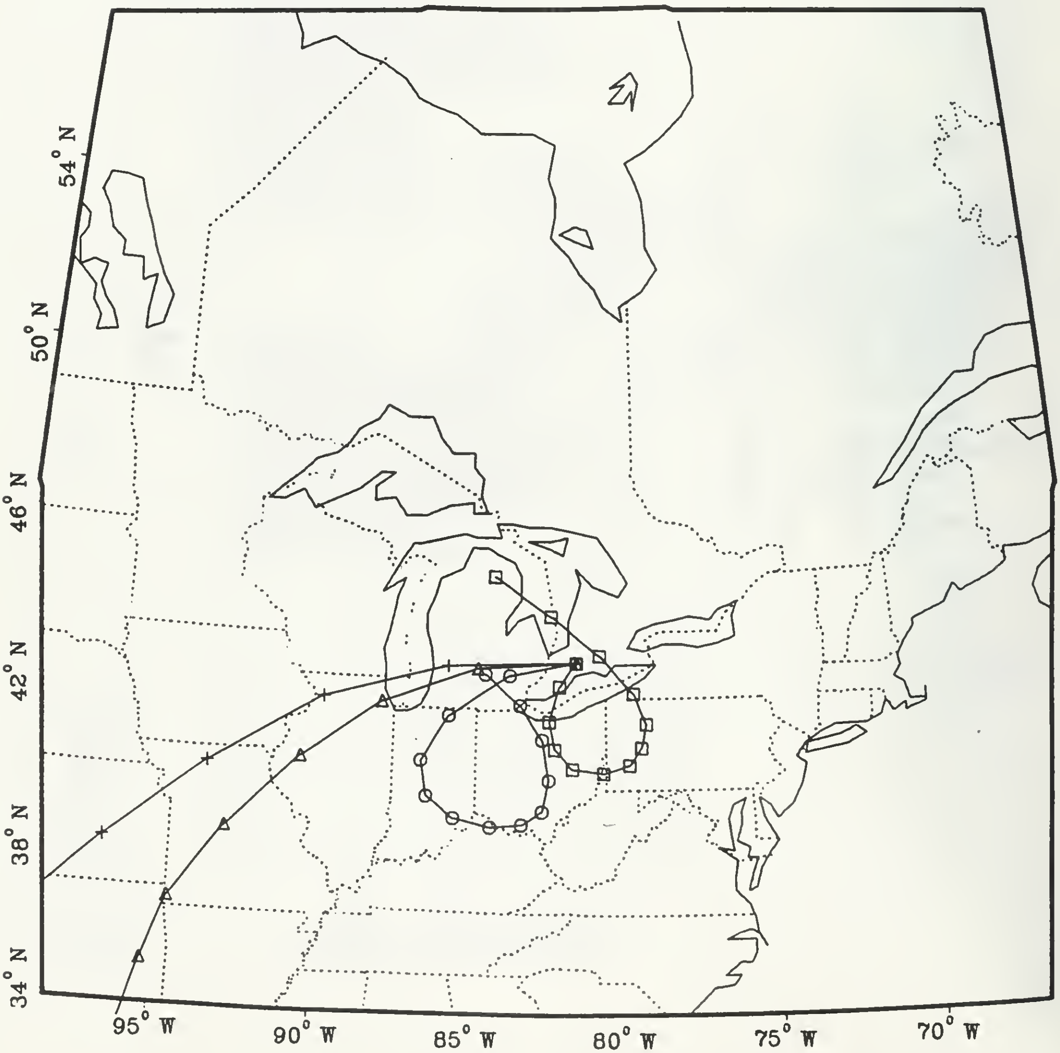


FIGURE 2.16.4

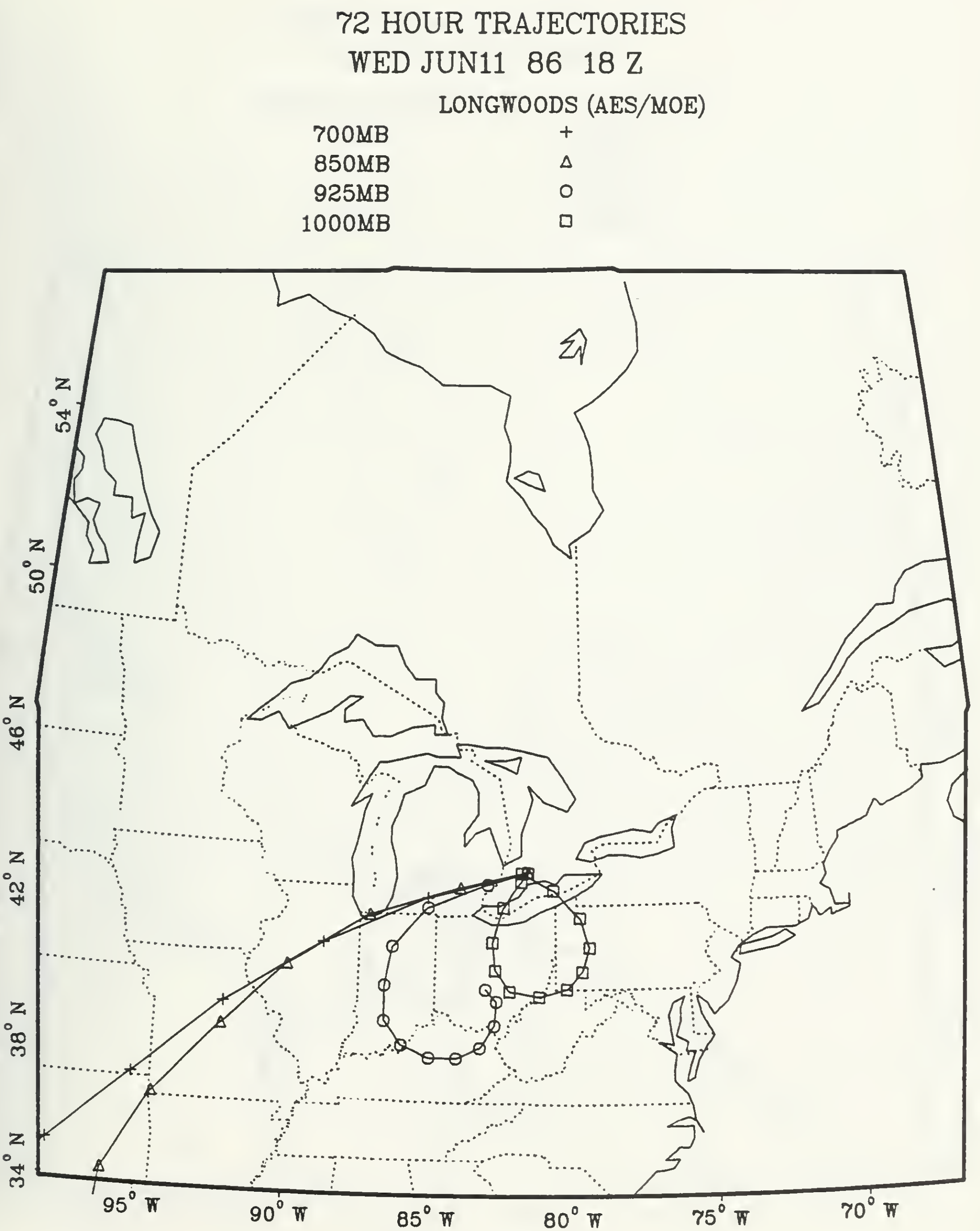

72 HOUR TRAJECTORIES
WED JUN11 86 18 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.16.5

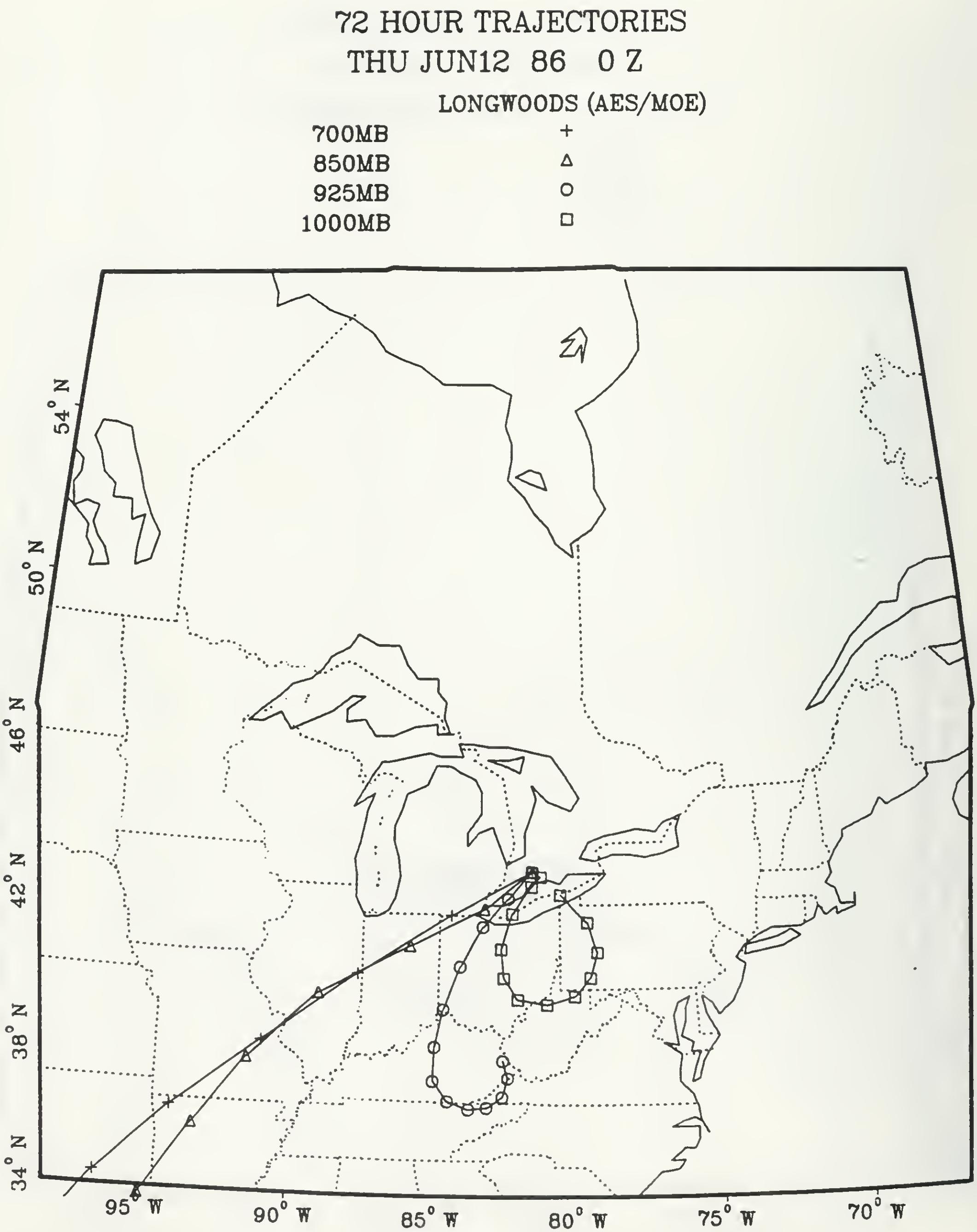

72 HOUR TRAJECTORIES
THU JUN12 86 0 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.16.6

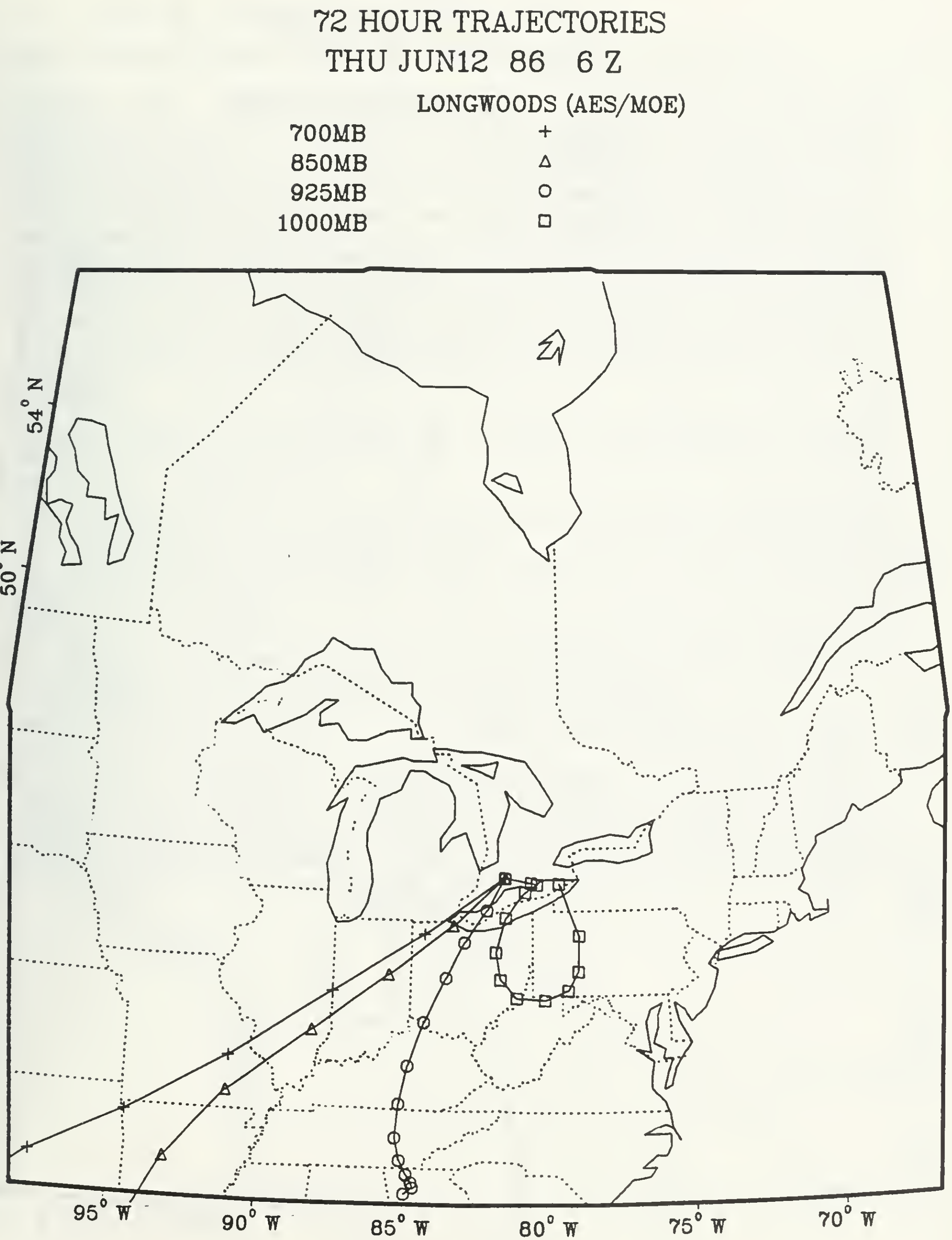

72 HOUR TRAJECTORIES
THU JUN12 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.16.7

72 HOUR TRAJECTORIES
THU JUN12 86 12 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	Δ
925MB	○
1000MB	□

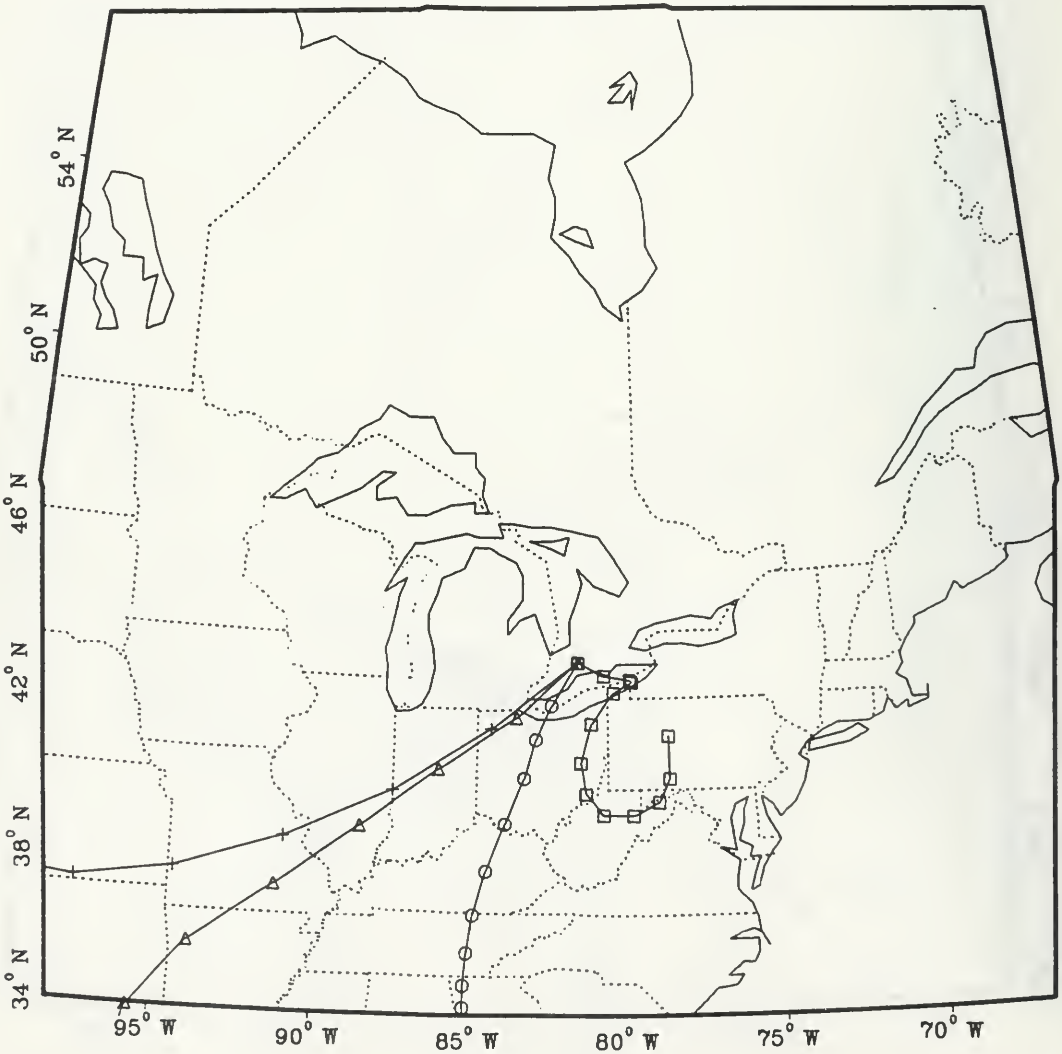


FIGURE 2.16.8

2.17 June 16 - 17, 1986, Dorset

This episode ranked 9th (9/10) for only NO_3^- wet deposition.

A wave over northern Michigan near Traverse City with the associated warm front over SW Ontario and another frontal system in northern Ontario with two low pressure centres, one over Lake Superior and the other in northern Ontario, were analyzed on June 16, at 12Z as shown in Fig. 2.17.1. A third frontal system with a wave over northern Quebec was also analyzed. The wave over Michigan moved eastward and at 18Z, it existed near Dorset. The frontal systems moved SE and a cold front passed over the station. On June 17, at 12Z as exhibited in Fig. 2.17.2, the system had moved such that the fronts were situated in southeastern USA. The proximity of the wave and passage of a cold front over Dorset yielded light rain showers and light, moderate and heavy thundershowers as shown in Fig. 2.17.3. lasting about 3 hours. Lightning and thunder were observed.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for June 16, 12Z, 18Z and June 17, 00Z, 06Z and 12Z are shown in Figures 2.17.4, 2.17.5, 2.17.6, 2.17.7, and 2.17.8 respectively.

Air trajectories for the 1000 mb level show that NO_x could have been transported from its high emission Detroit and Cleveland (Fig. 2.17.4-6) area for a short duration.

Air trajectories for the 925 mb level show that NO_x could have been carried from its high emission Detroit (Fig. 2.17.4) and Cleveland (Fig. 2.17.5) areas.

Air parcels arriving at the 850 mb level could have transported NO_x from its highest emission Chicago (Fig. 2.17.5) and high emission St. Louis, Missouri (Fig. 2.17.4) areas.

Air trajectories for the 700 mb level did not cross over any high emission area and therefore any pollution transport at this level would be insignificant.

In summary, a wave near the station and a cold front passage over the station yielded showery weather. Light rain showers and light, moderate and heavy thundershowers lasting about three hours were recorded and lightning was observed at the nearest weather station. Transport of NO_x at high level (850 mb) from Chicago and St. Louis, and at low levels from Detroit and Cleveland was likely.

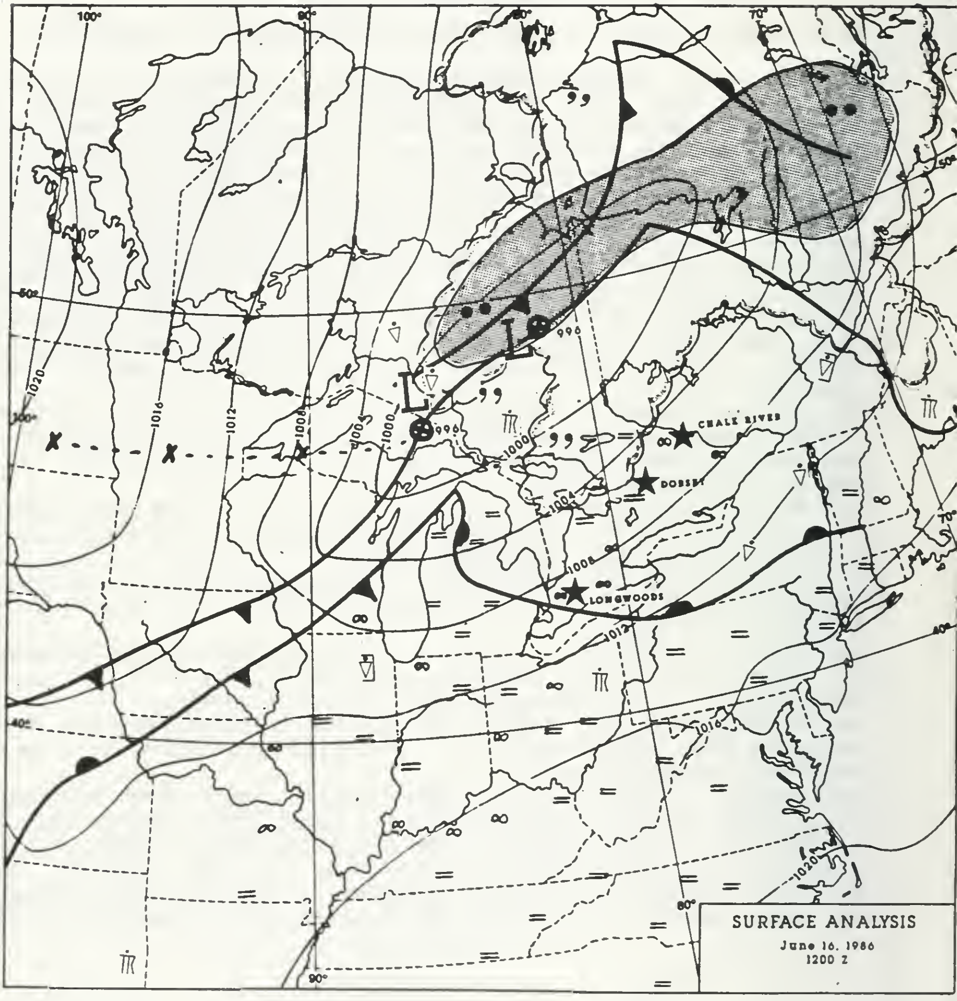

SURFACE ANALYSIS
June 16, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
996
1000
1004
1008
1012
1016
1020

FIGURE 2.17.1

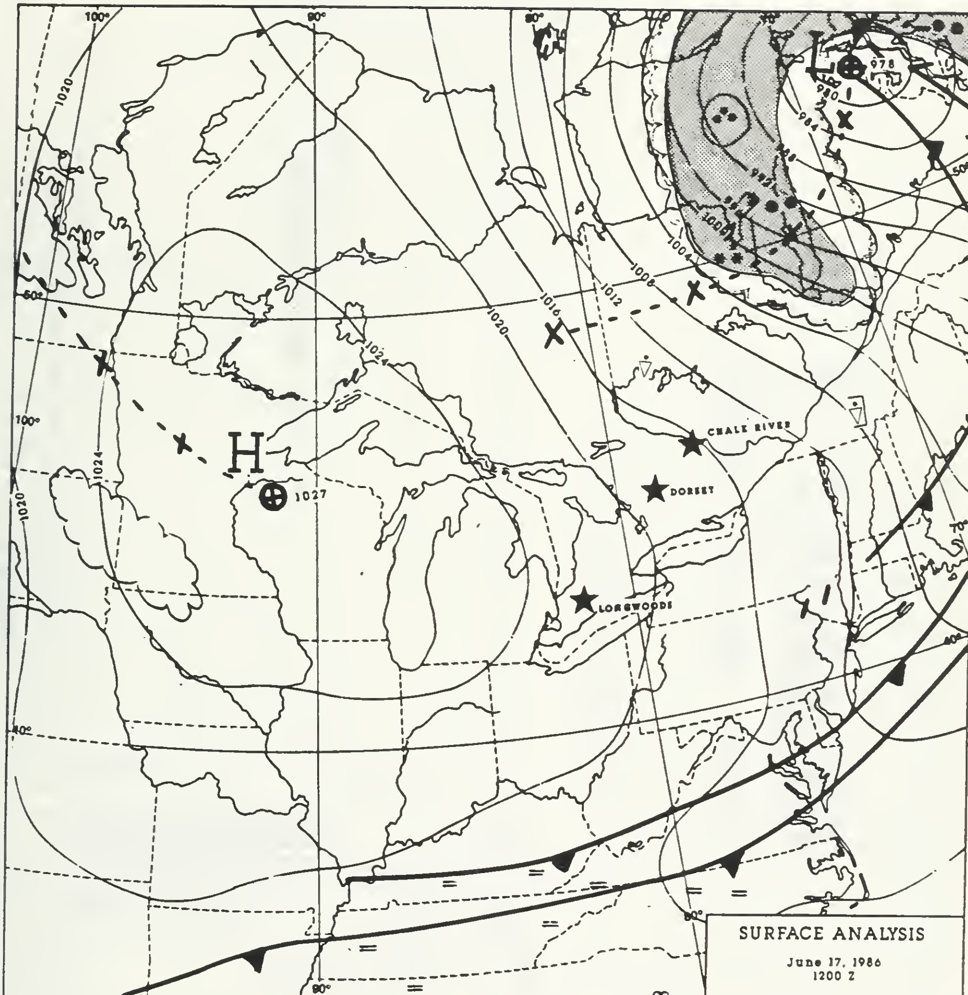
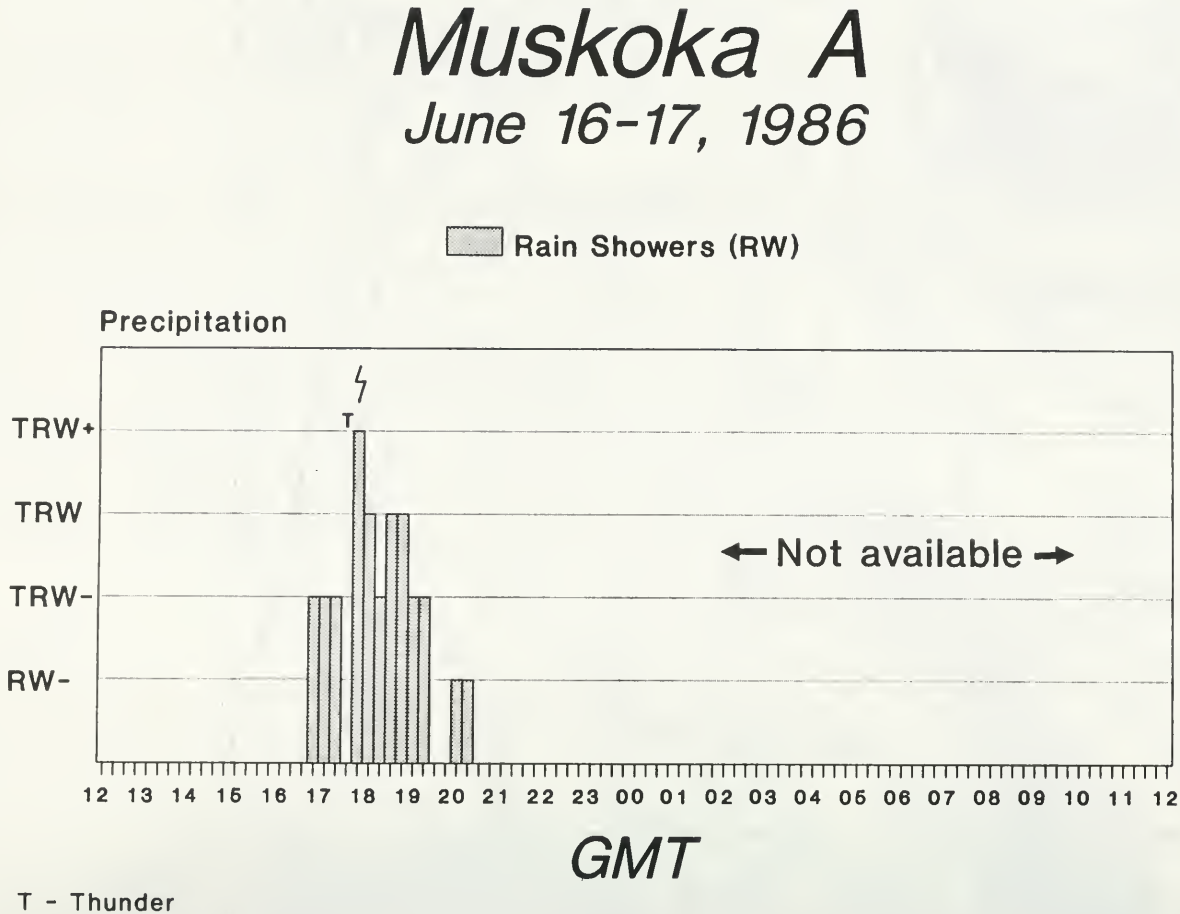

SURFACE ANALYSIS
June 17, 1986
1200 Z
H
1027
L
978
CHALK RIVER
DORSET
LONGWOODS

FIGURE 2.17.2



Muskoka A
June 16-17, 1986
Rain Showers (RW)
Precipitation
TRW+
TRW
TRW-
RW-
T
← Not available →
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
T - Thunder

FIGURE 2.17.3

72 HOUR TRAJECTORIES
MON JUN16 86 12 Z

	DORSET (MOE)
700MB	+
850MB	△
925MB	○
1000MB	□

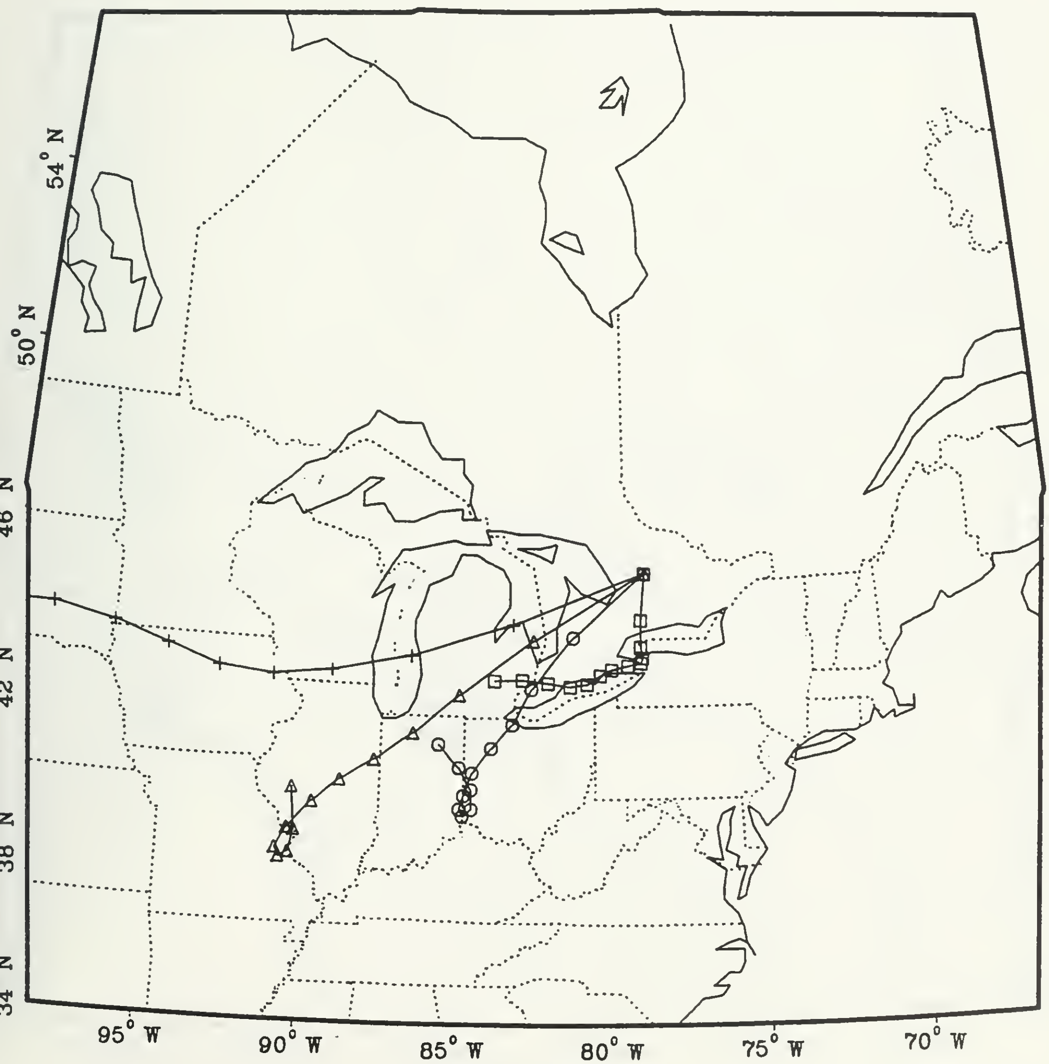


FIGURE 2.17.4

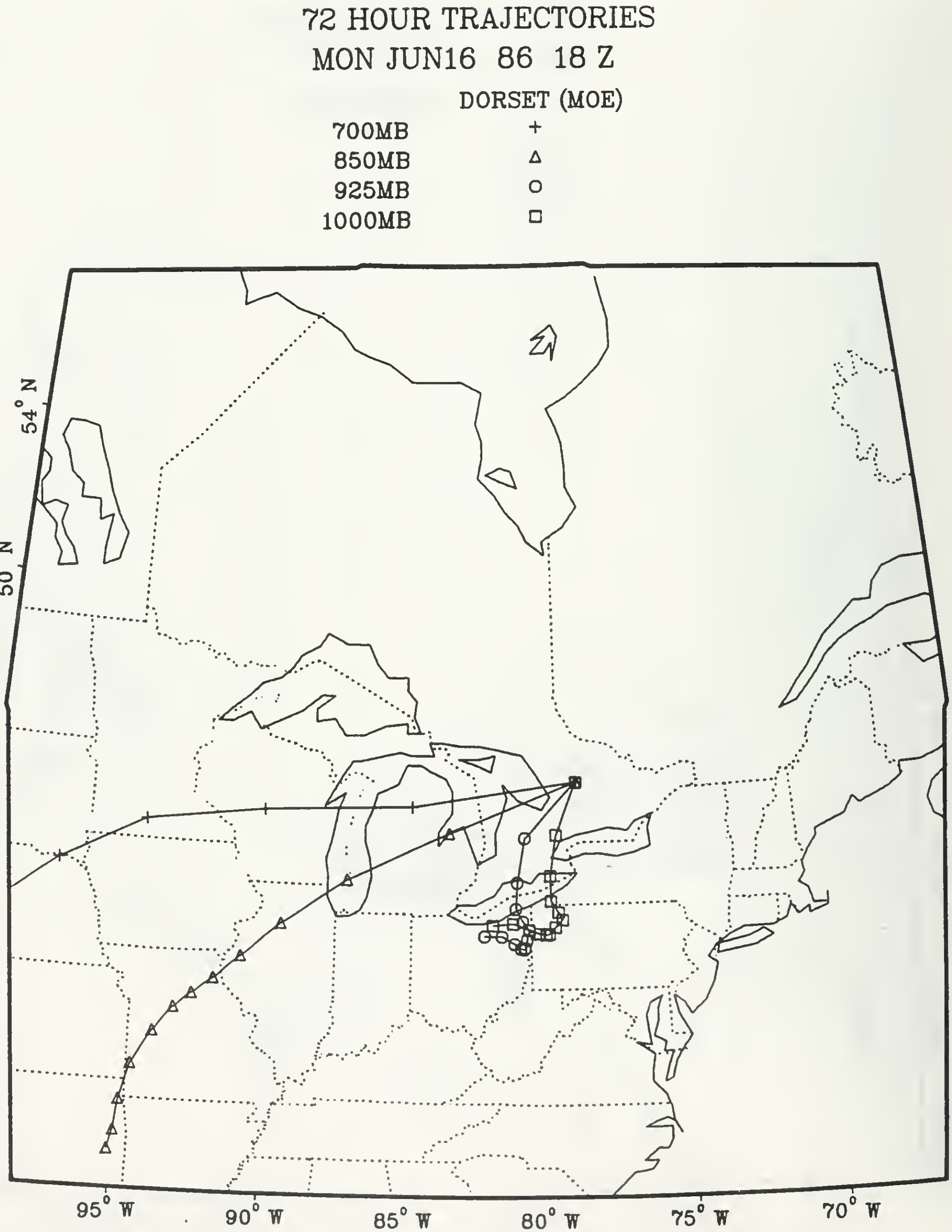

72 HOUR TRAJECTORIES
MON JUN16 86 18 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.17.5

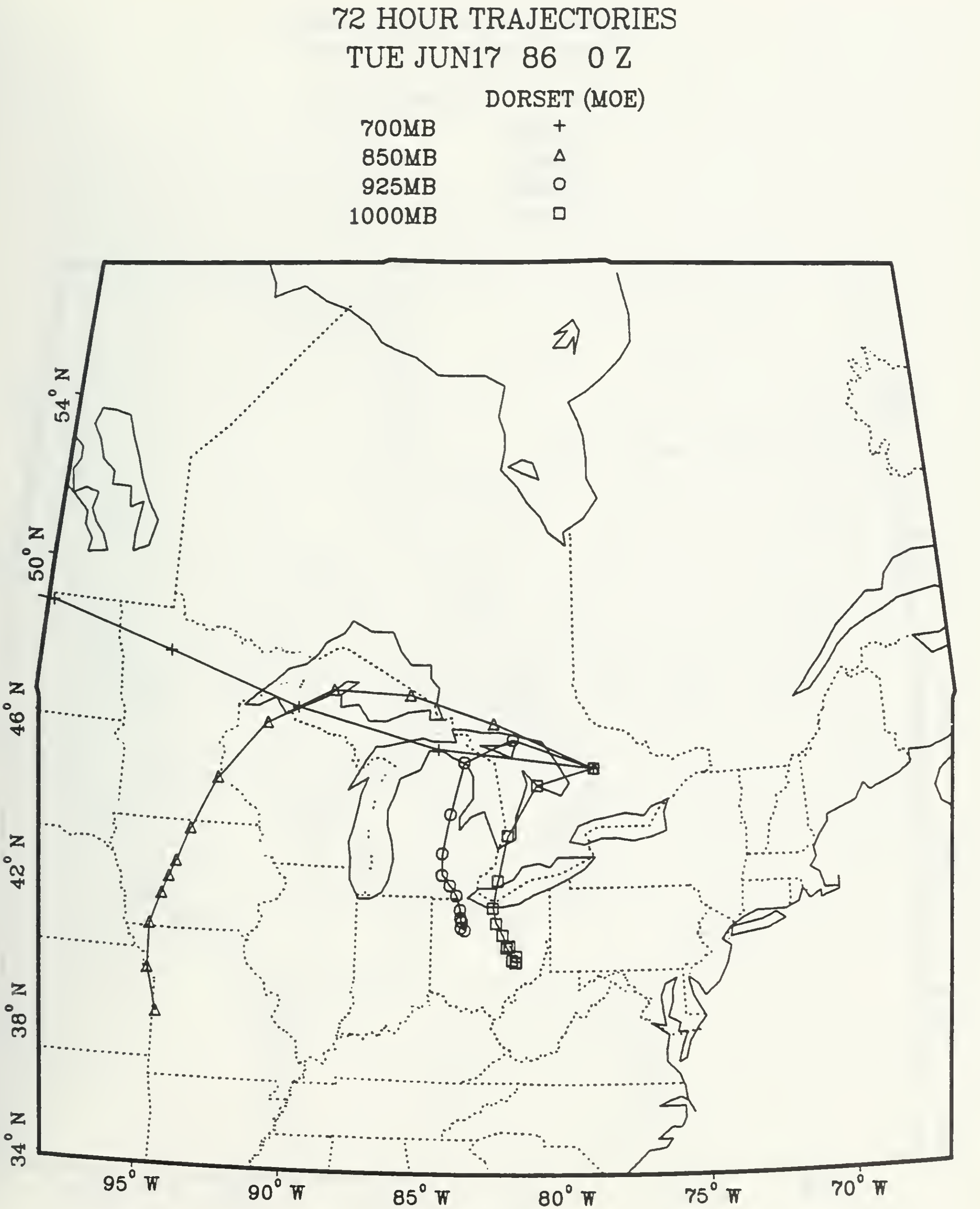

72 HOUR TRAJECTORIES
TUE JUN17 86 0 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.17.6

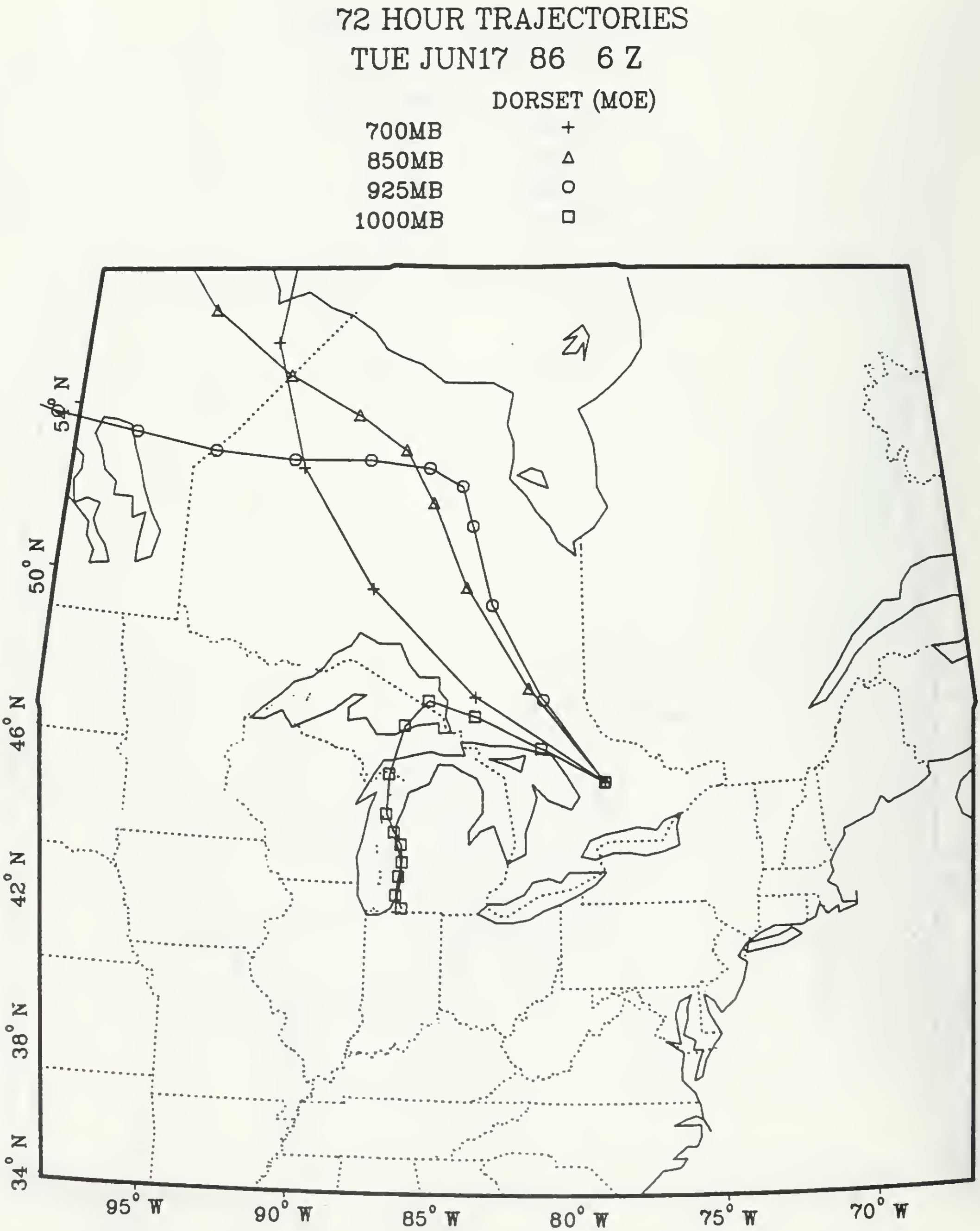

72 HOUR TRAJECTORIES
TUE JUN17 86 6 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.17.7

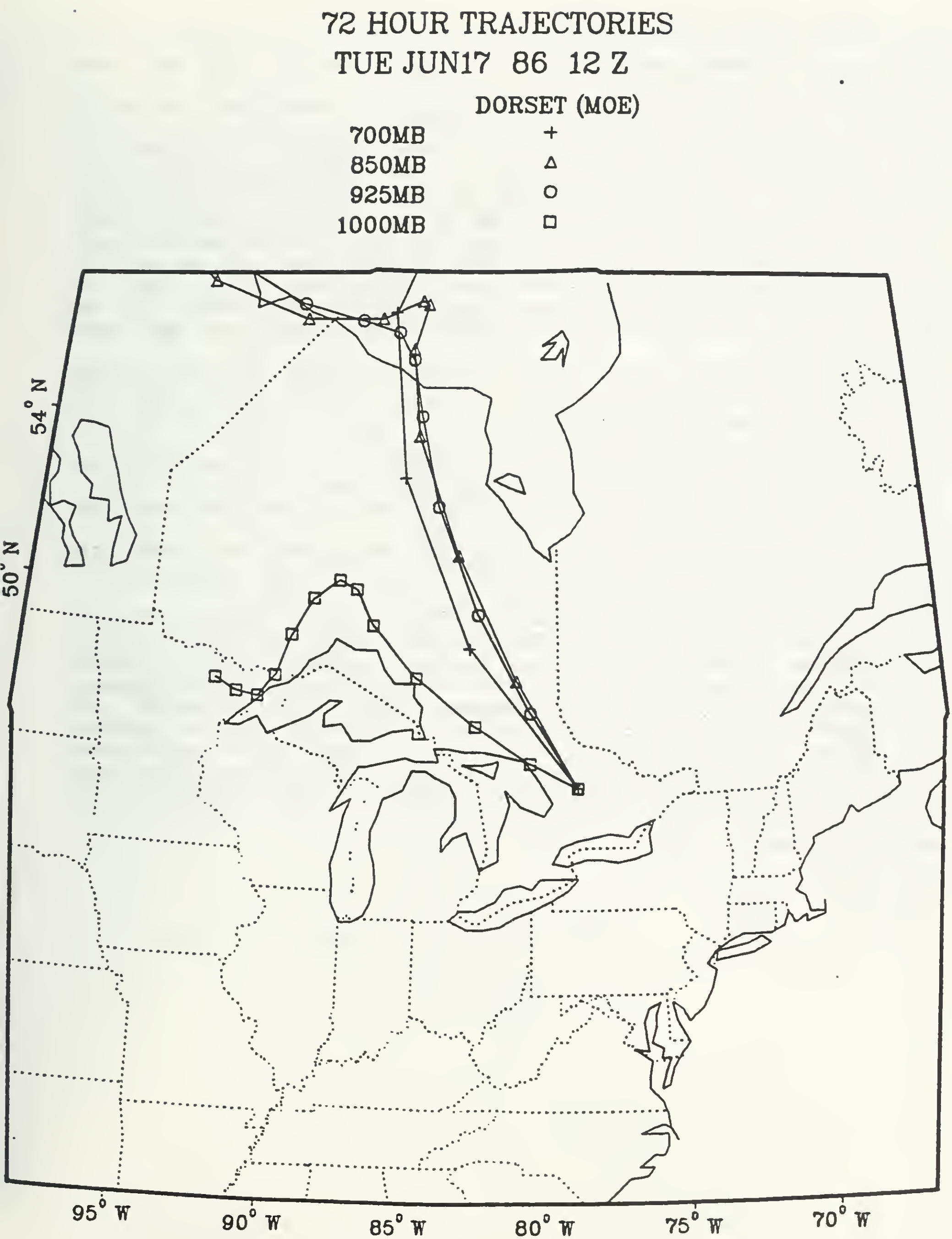

72 HOUR TRAJECTORIES
TUE JUN17 86 12 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.17.8

2.18 June 22-23, 1986, Dorset

This episode ranked the last 7th (7/7) in the top 25% $SO_4^=$ wet deposition episodes.
On June 22, at 12Z, as shown in Fig. 2.18.1, a wave south of Sault Ste Marie over Lake Michigan with a warm front over Michigan, Ohio and Kentucky states and a cold front over Wisconsin was observed. This wave first moved NNE and the warm front passed over the station. Then the wave moved SE and the cold front lied over Dorset on June 23, at 00Z. By June 23, 12Z, this cold front and an other cold front associated with a low over northern Quebec passed east of the station as exhibited in Fig. 2.18.2. The passage of the first cold front yielded showers and thundershowers as shown in Fig. 2.18.3. Heavy thundershowers were observed at about 21Z on June 22 as illustrated in the figure. Lightnings were seen and thunder heard.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for June 2, 12Z, 18Z and June 23, 00Z, 06Z and 12Z are shown in Figures 2.18.4, 2.18.5, 2.18.6, 2.18.7, and 2.18.8 respectively.
Air parcels arriving at the 1000 mb could have transported SO_2 from its highest emission Detroit area as shown in Fig. 2.18.8. Transport from high emission Toronto-Hamilton-Buffalo area was also likely (Fig. 2.18.5-7).
Air trajectories for the 925 mb level show that SO_2 from its highest emission Detroit (Fig. 2.18.4) and Chicago (Fig. 2.18.6) areas could have been transported.
Air trajectories for the 850 mb and 700 mb levels (Fig. 2.18.4-8) show that no significant transport at this level took place as the trajectories do not pass over any highest emission area, although they did come close to Chicago (2.18.6) and Sudbury (2.18.8) areas.
In summary, a cold front passage gave rain showers and thundershowers during this episode with total precipitation lasting for about two hours (It should be noted that continuous precipitation observations are not available). Lightnings and thunder were observed. Low level transport of SO_2 from Detroit and Chicago was likely. No significant transport at high levels was exhibited.

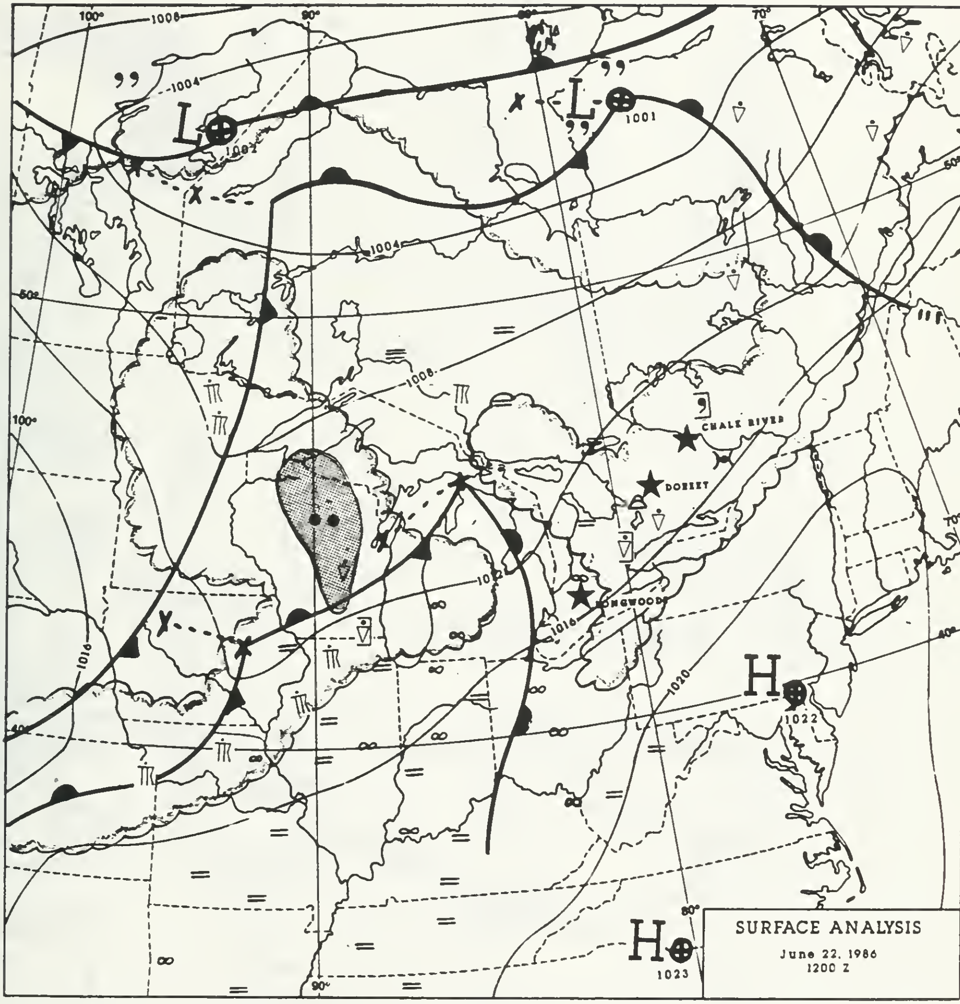

SURFACE ANALYSIS
June 22, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOOD
1001
1002
1004
1008
1012
1016
1020
1022
1023

FIGURE 2.18.1

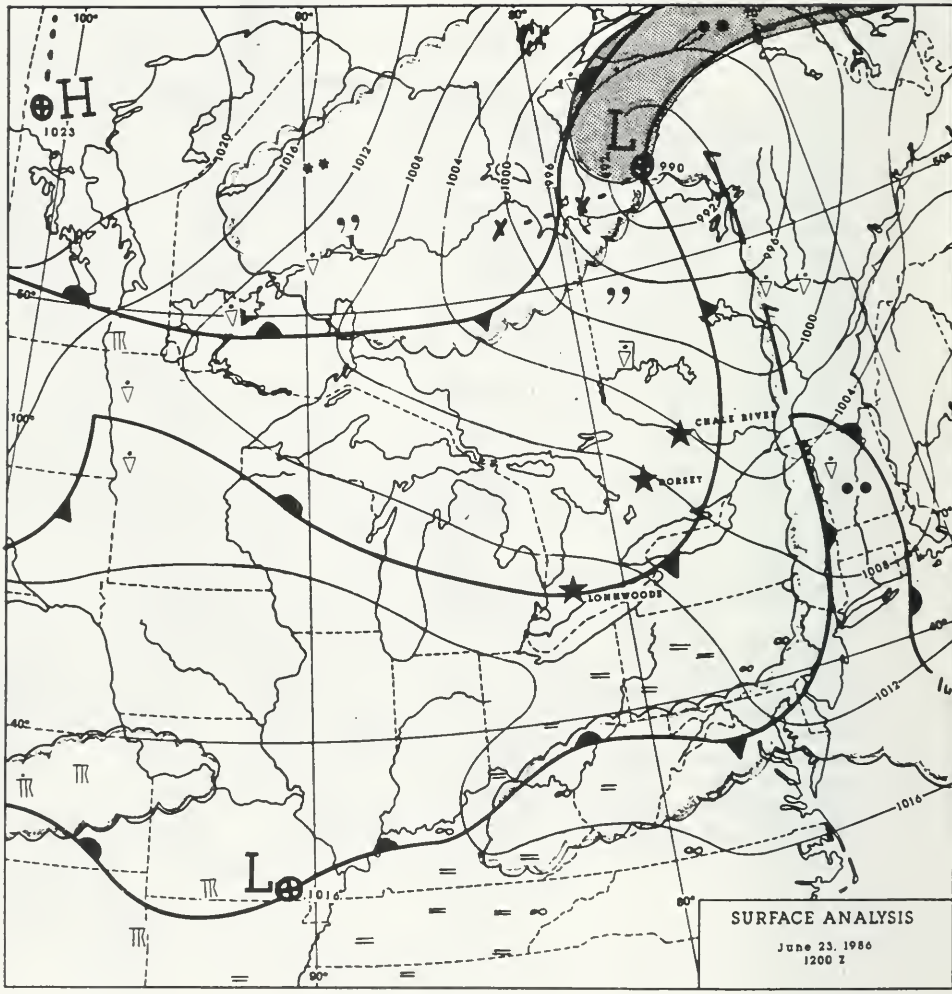

SURFACE ANALYSIS
June 23, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
H
1023
L
990
L
1016
1020
1016
1012
1008
1004
1000
996
992
60°
100°
40°
80°
90°

FIGURE 2.18.2

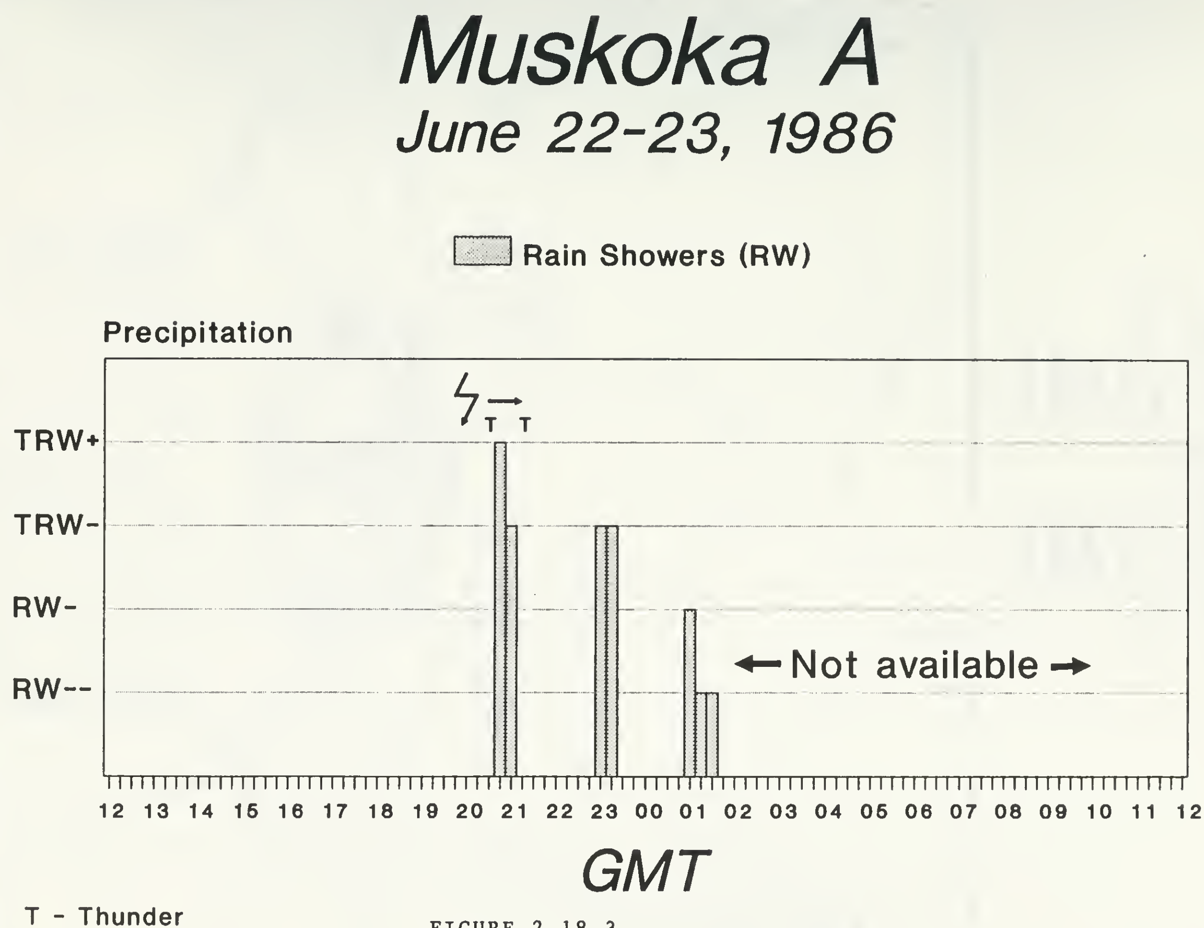

Muskoka A
June 22-23, 1986
Rain Showers (RW)
Precipitation
TRW+
TRW-
RW-
RW--
T T
← Not available →
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
T - Thunder

FIGURE 2.18.3

72 HOUR TRAJECTORIES
SUN JUN22 86 12 Z

	DORSET (MOE)
700MB	+
850MB	Δ
925MB	O
1000MB	□

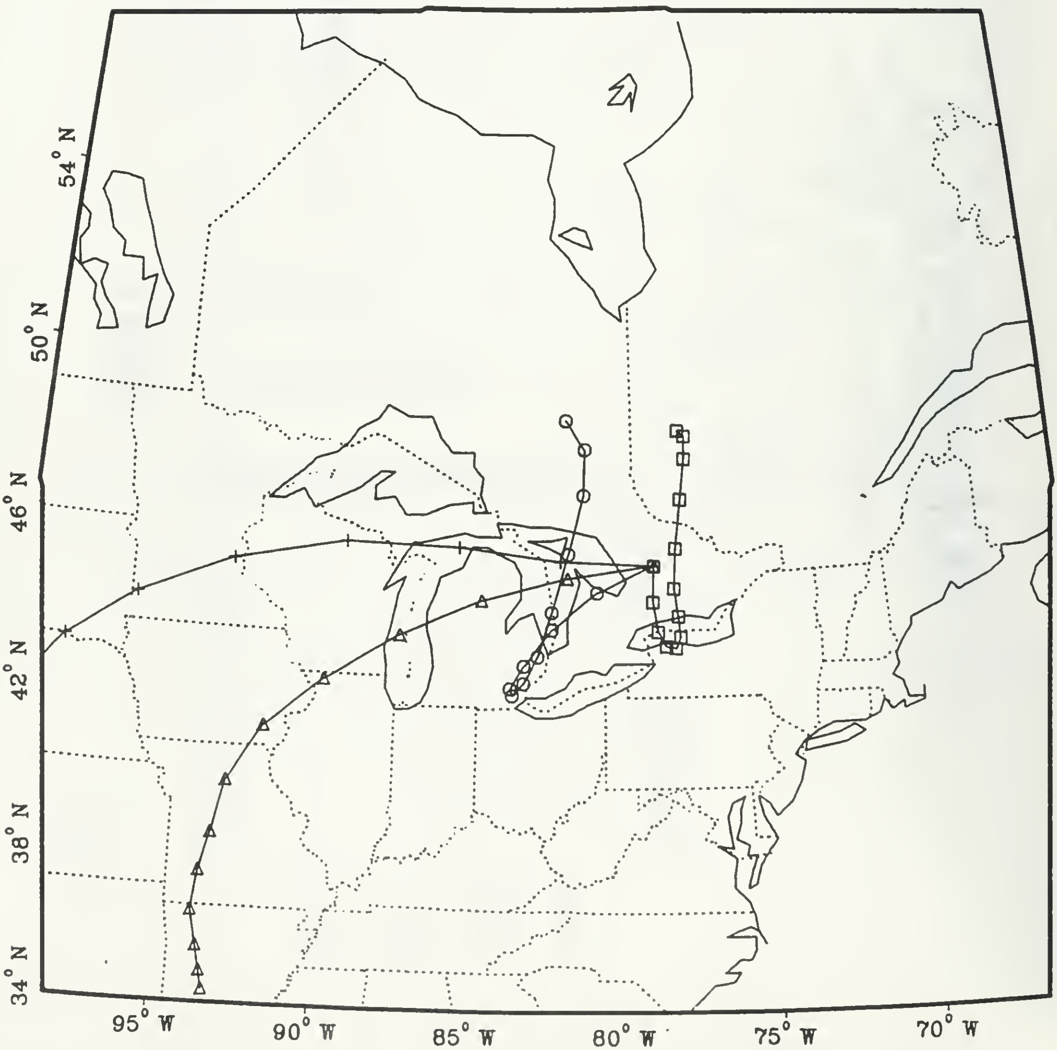


FIGURE 2.18.4

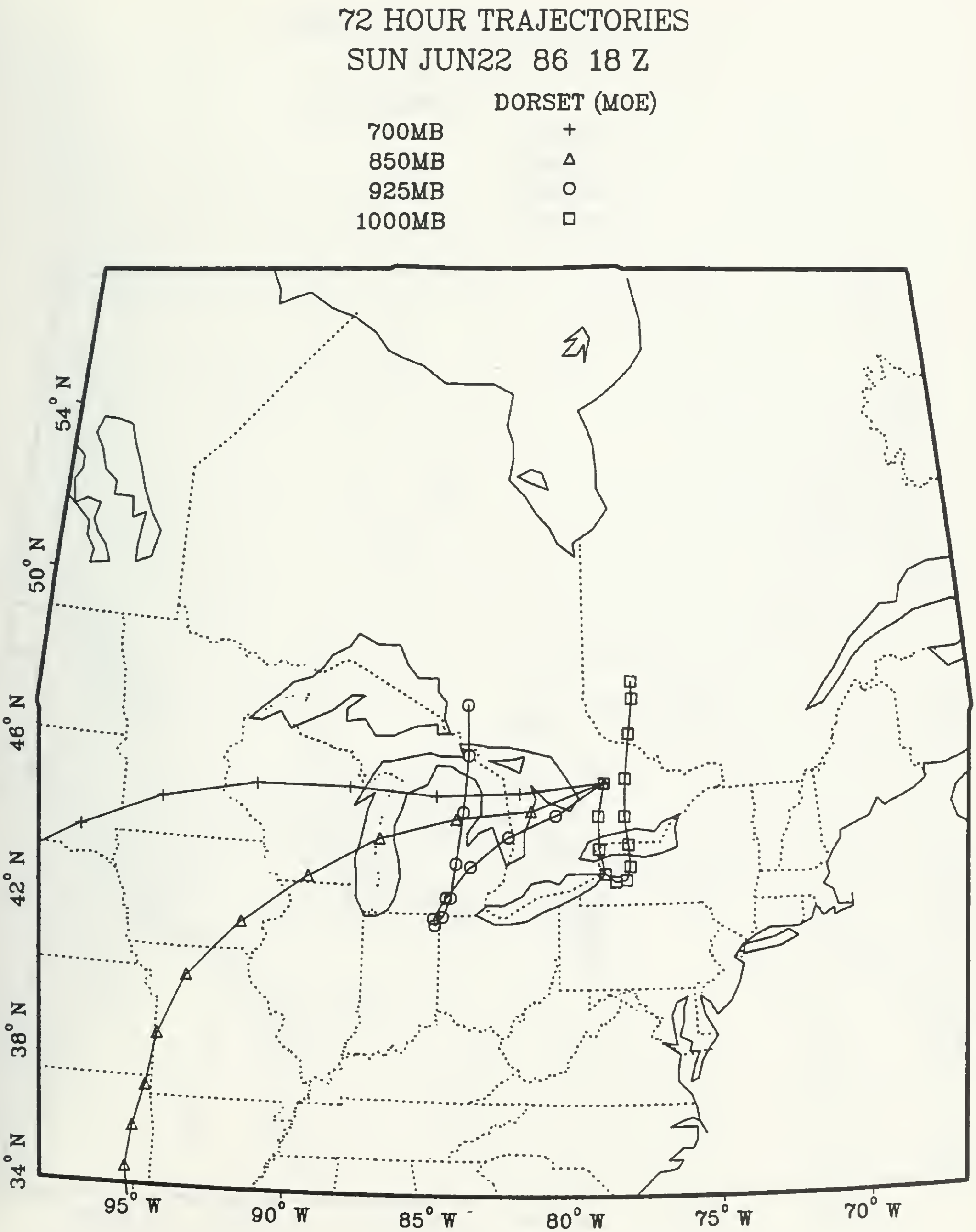

72 HOUR TRAJECTORIES
SUN JUN22 86 18 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.18.5

72 HOUR TRAJECTORIES
MON JUN23 86 0 Z

DORSET (MOE)

700MB	+
850MB	Δ
925MB	o
1000MB	□

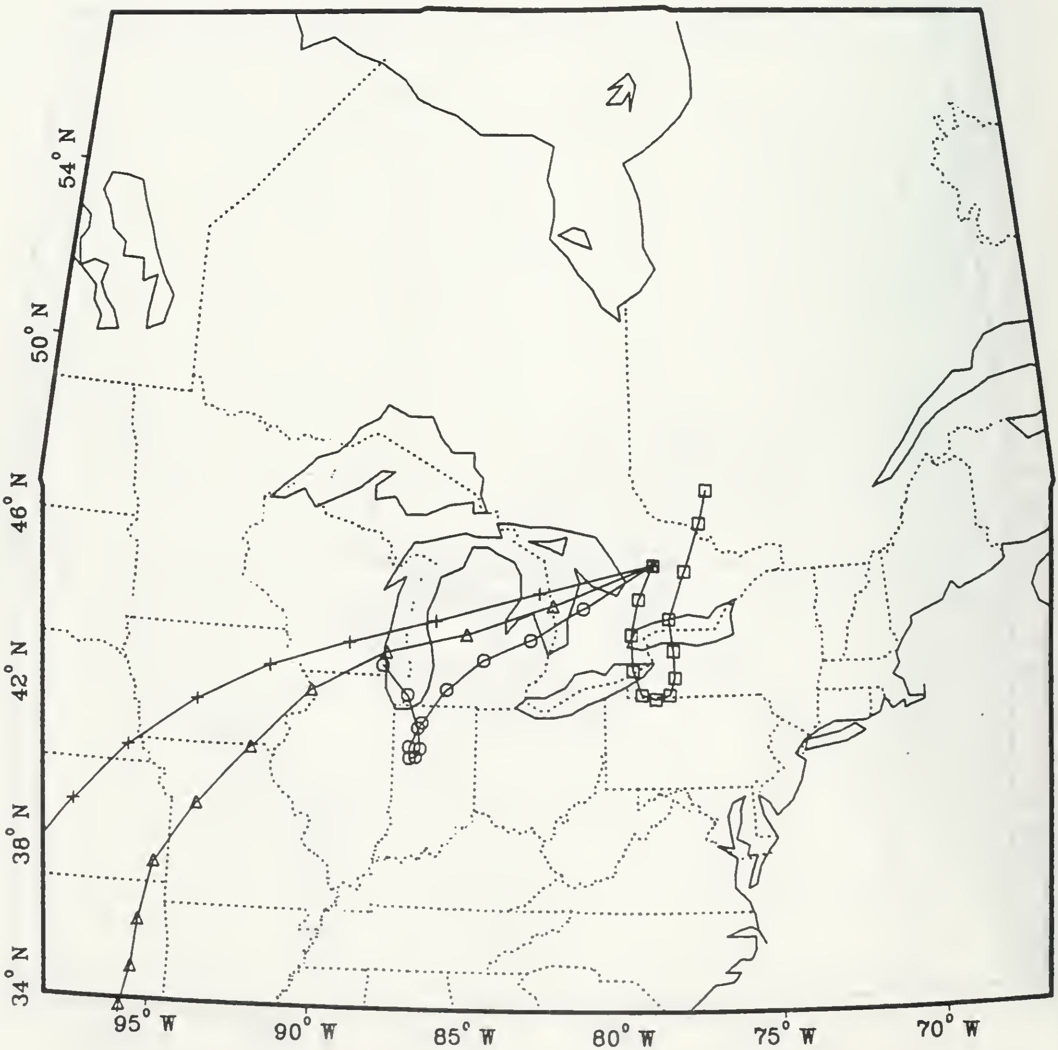


FIGURE 2.18.6

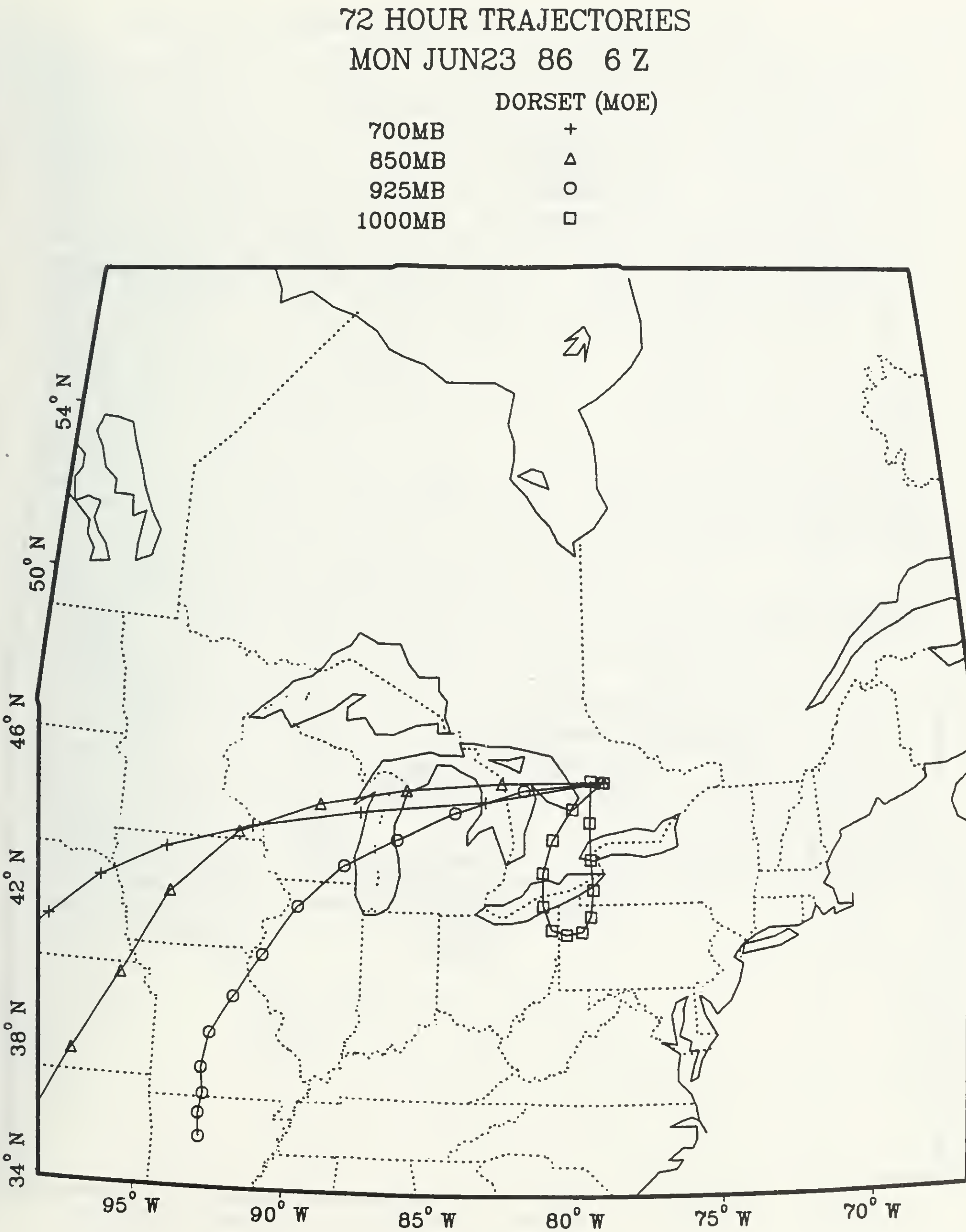

72 HOUR TRAJECTORIES
MON JUN23 86 6 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.18.7

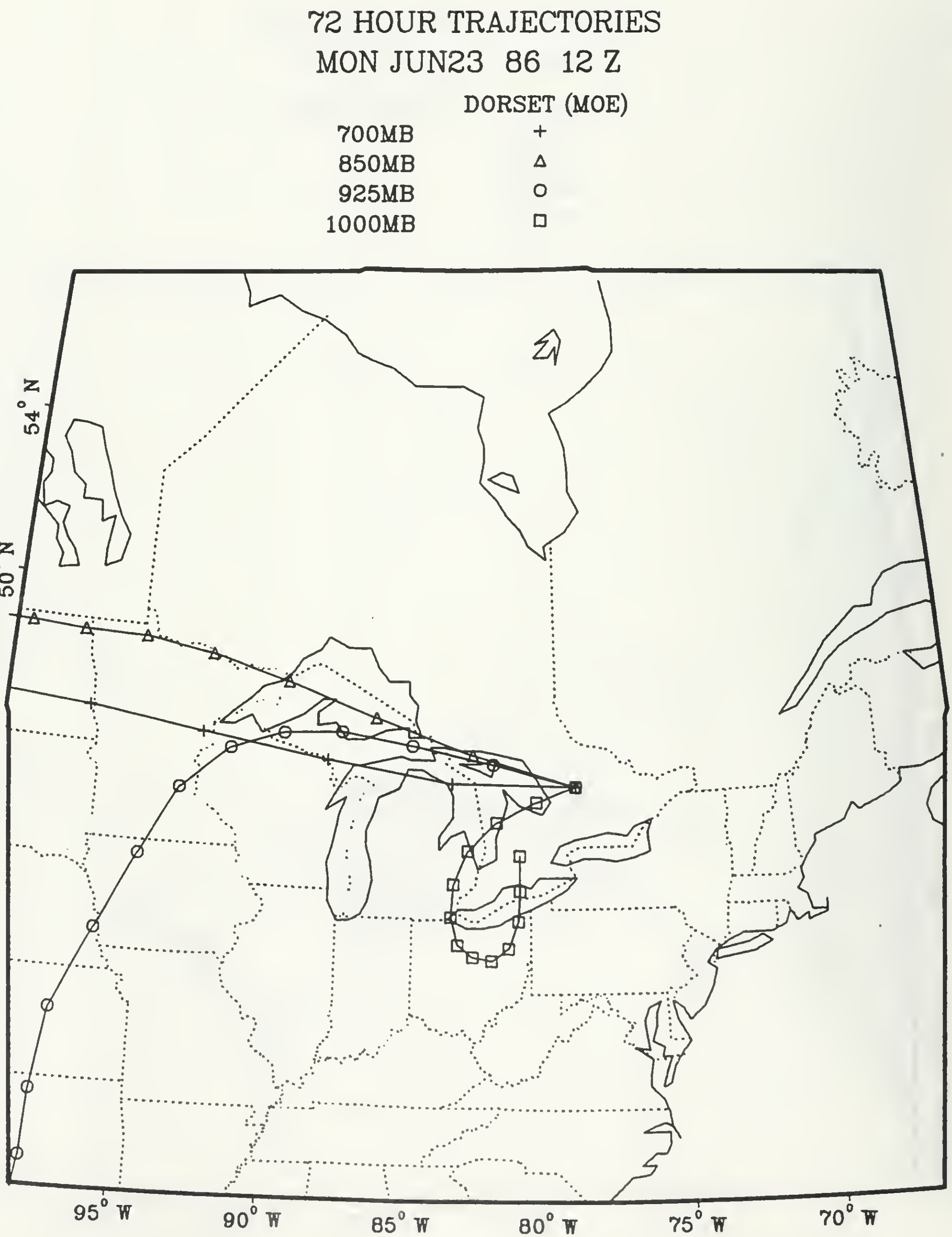

72 HOUR TRAJECTORIES
MON JUN23 86 12 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.18.8

2.19 July 11-12, 1986, Longwoods(AES) & Longwoods(MOE)

This episode ranked 4th in the top 25% $SO_4^=$ wet deposition events at both Longwoods stations. (For AES, it was 4/8 and MOE 4/7)
On July 11, at 12Z, a continuous precipitation area associated with two frontal systems as shown in Figure 2.19.1 was observed. The showery precipitation area covered the Longwoods stations. During the next 24 hours these quasi-stationary fronts slowly moved to southern Ontario and lingered on in the region. On July 12, at 12Z, a low over Hamilton with associated front and a wave near Buffalo with associated front and a continuous precipitation area were observed as shown in Fig. 2.19.2. Rain from very light to heavy intensity and rain showers of very light and light intensity were recorded at the nearest weather station London Airport as illustrated in Fig. 2.19.3. The total duration of precipitation was about 17 hours.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for July 11, 12Z, 18Z and July 12, 00Z, 06Z and 12Z are shown in Figures 2.19.4, 2.19.5, 2.19.6, 2.19.7, and 2.19.8 respectively.
Air parcels arriving at the 1000 mb level could have transported SO_2 from its highest emission Sudbury (Fig. 2.19.7-8) and high emission Toronto-Hamilton-Buffalo (Fig. 2.19.6-8) areas.
Air parcels arriving at the 925 mb level show that SO_2 could have been carried from its highest emission Detroit (Fig. 2.19.8) and high emission Sarnia (Fig. 2.19.4-6) areas.
Air trajectories for the 850 mb level show that SO_2 from its highest emission Detroit (Fig. 2.19.5-8) area and for a brief period from Chicago area between 18Z on June 11 and 00Z on June 12 (Figs. 2.19.5-6) and from other Illinois area (Fig. 2.19.6-7&8) could have been transported to Longwoods.
Air parcels arriving at the 700 mb level could have carried SO_2 from its highest emission Chicago (Figs. 2.19.5-8) area.
Summarizing, two quasi-stationary fronts hovered around Longwoods yielding rain and rain showers for about 17 hours. Very light and light rain showers and very light, light, moderate and heavy rain were recorded in the area. Low level transport of SO_2 from the highest emission Sudbury , low and high level transport from Detroit and high level transport from Chicago and other Illinois area were likely. Transport from high emission Toronto-Hamilton-Buffalo and Sarnia areas was also probable.

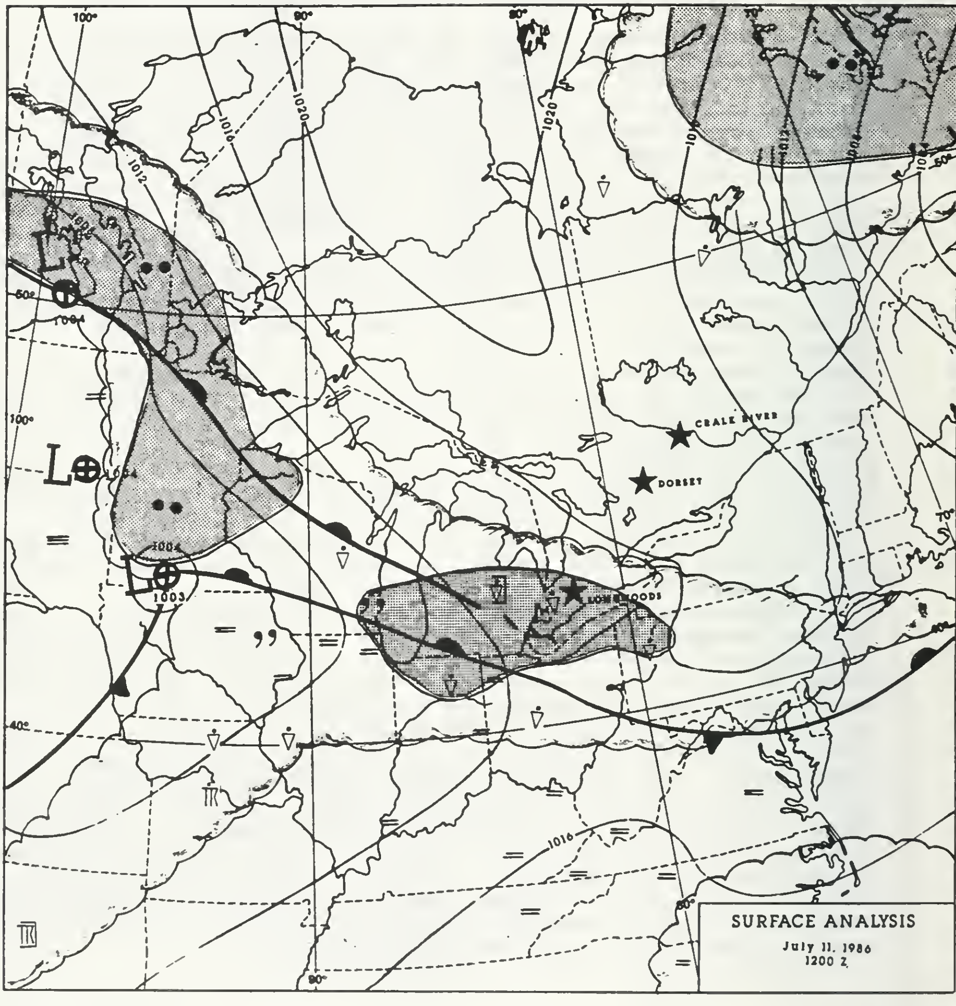
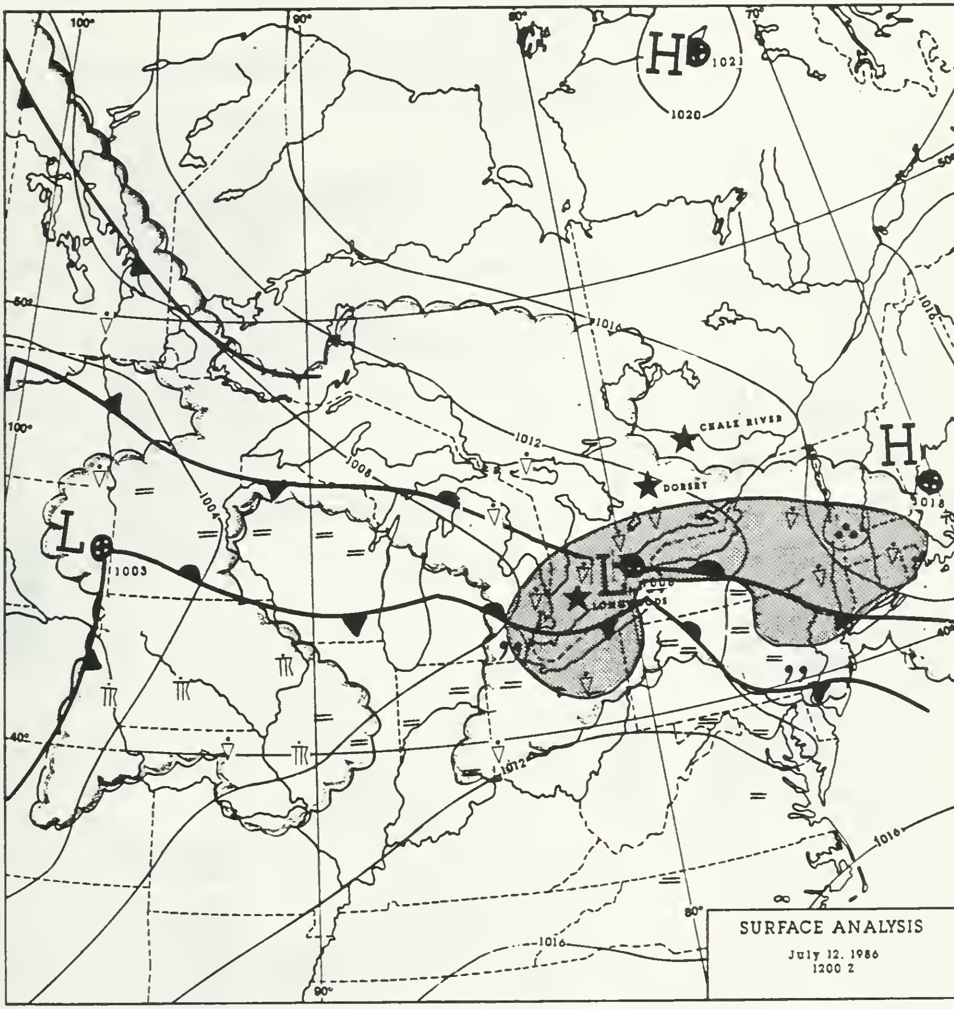

SURFACE ANALYSIS
July 11, 1986
1200 Z
CRALE RIVER
DORSET
LONG WOODS

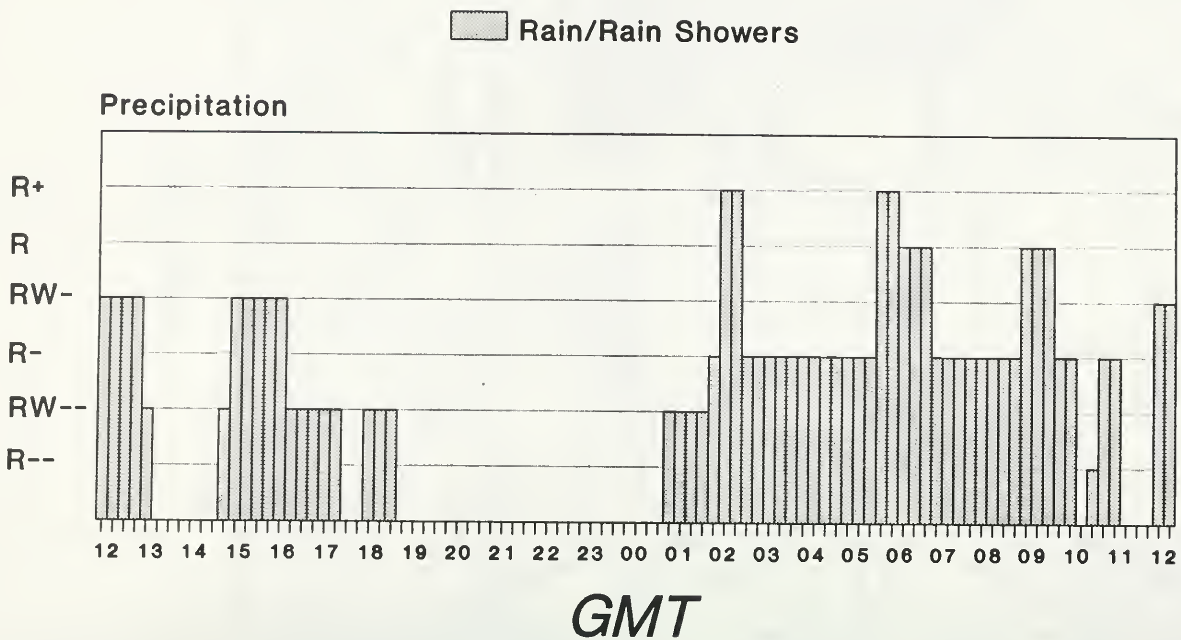
FIGURE 2.19.1



H
1021
1020
1016
1012
1008
1004
1003
L
L
H
1018
1016
1012
1016
1016
CHALK RIVER
DORSET
SURFACE ANALYSIS
July 12, 1986
1200 Z
100°
90°
80°
70°
50°
40°

FIGURE 2.19.2

London A
July 11-12, 1986



R - Rain
RW - Rain Showers

FIGURE 2.19.3

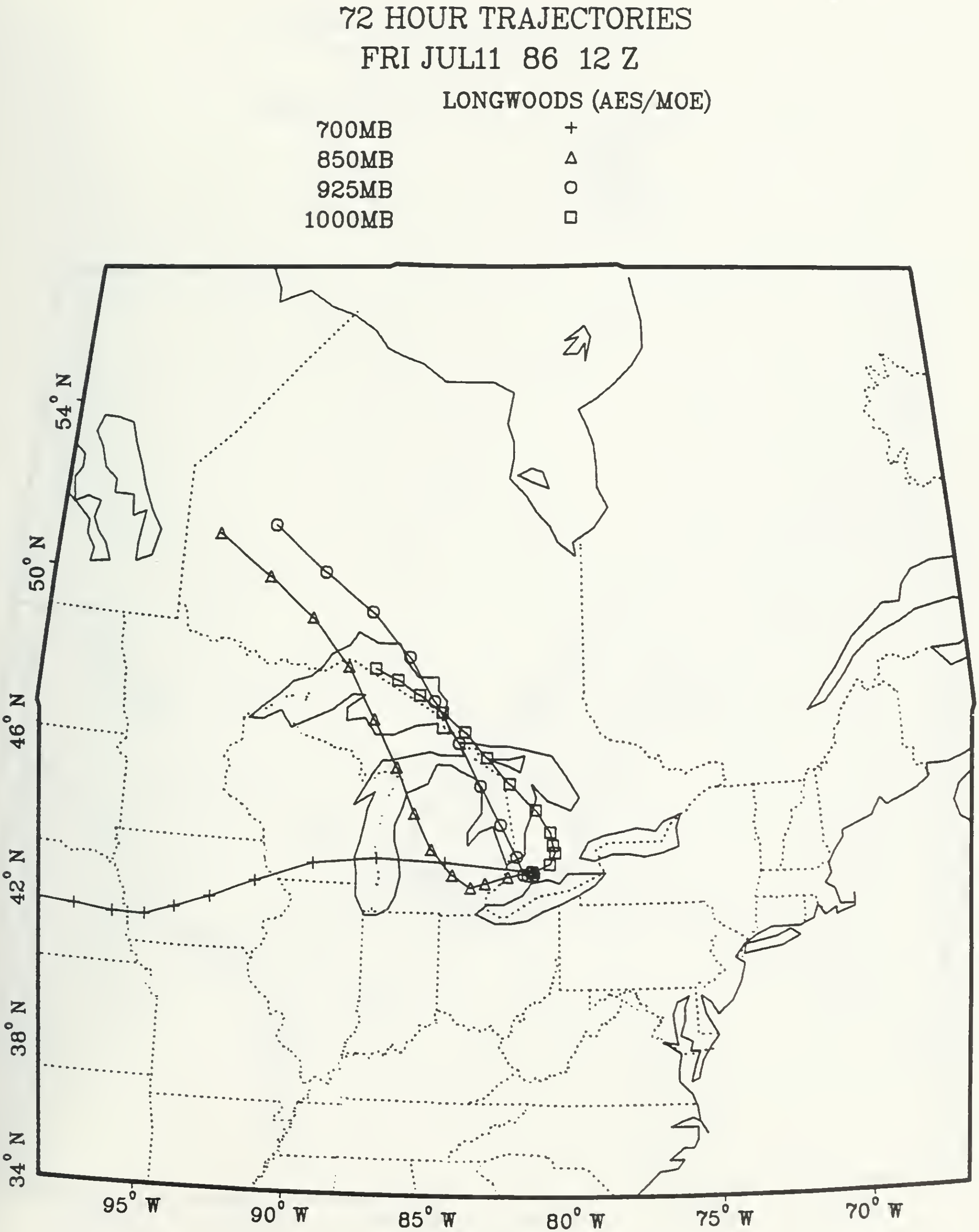

72 HOUR TRAJECTORIES
FRI JUL11 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.19.4

72 HOUR TRAJECTORIES
FRI JUL11 86 18 Z
LONGWOODS (AES/MOE)

700MB	+
850MB	△
925MB	○
1000MB	□

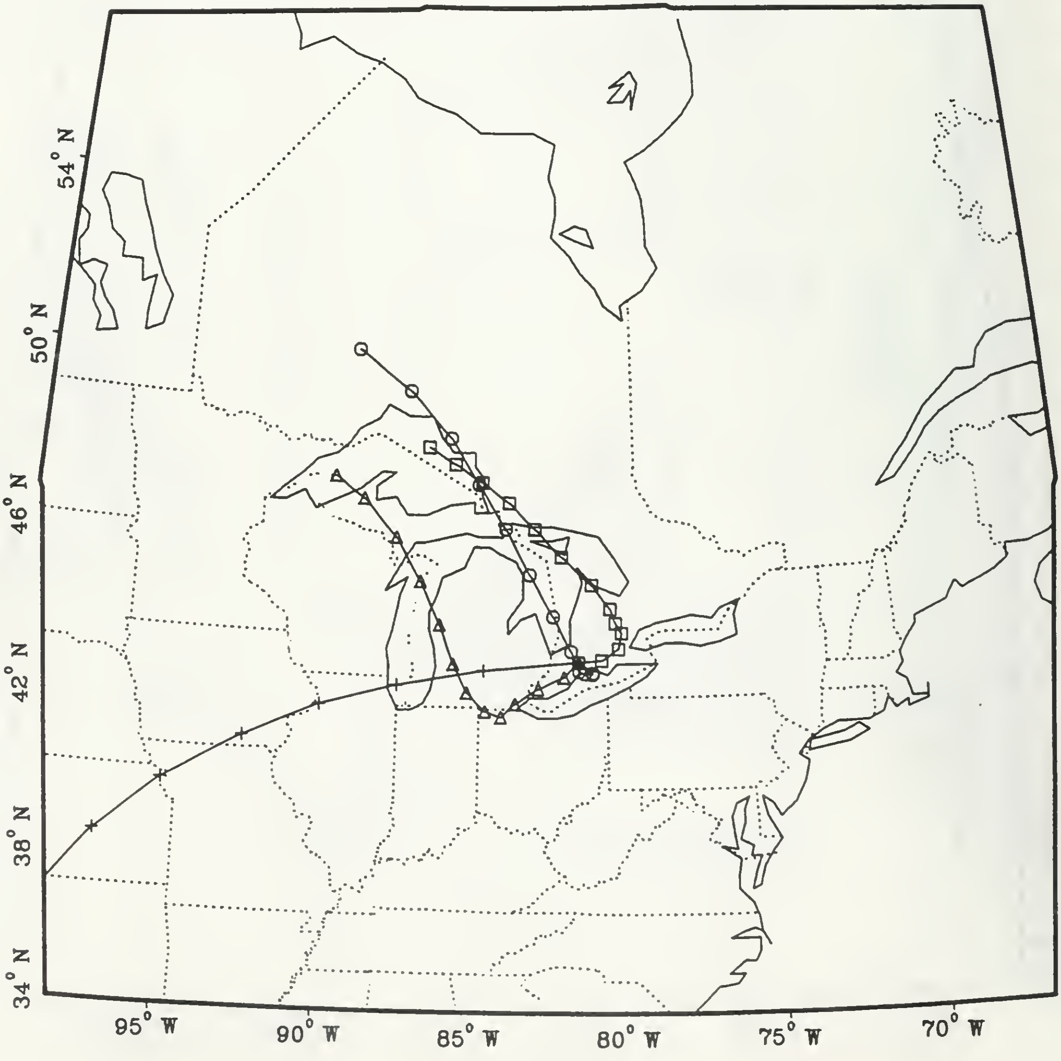


FIGURE 2.19.5

72 HOUR TRAJECTORIES
SAT JUL12 86 0 Z
LONGWOODS (AES/MOE)

700MB	+
850MB	△
925MB	○
1000MB	□

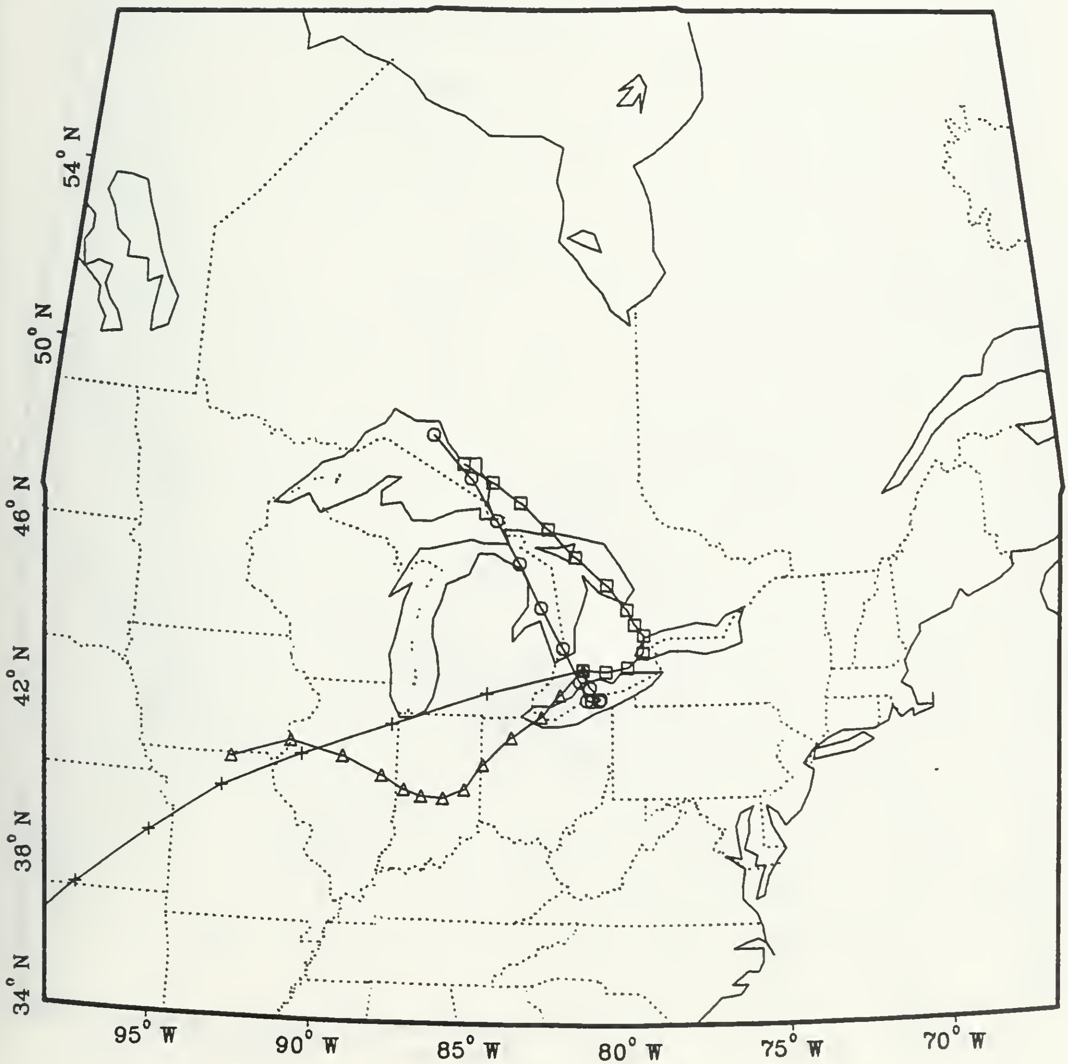


FIGURE 2.19.6

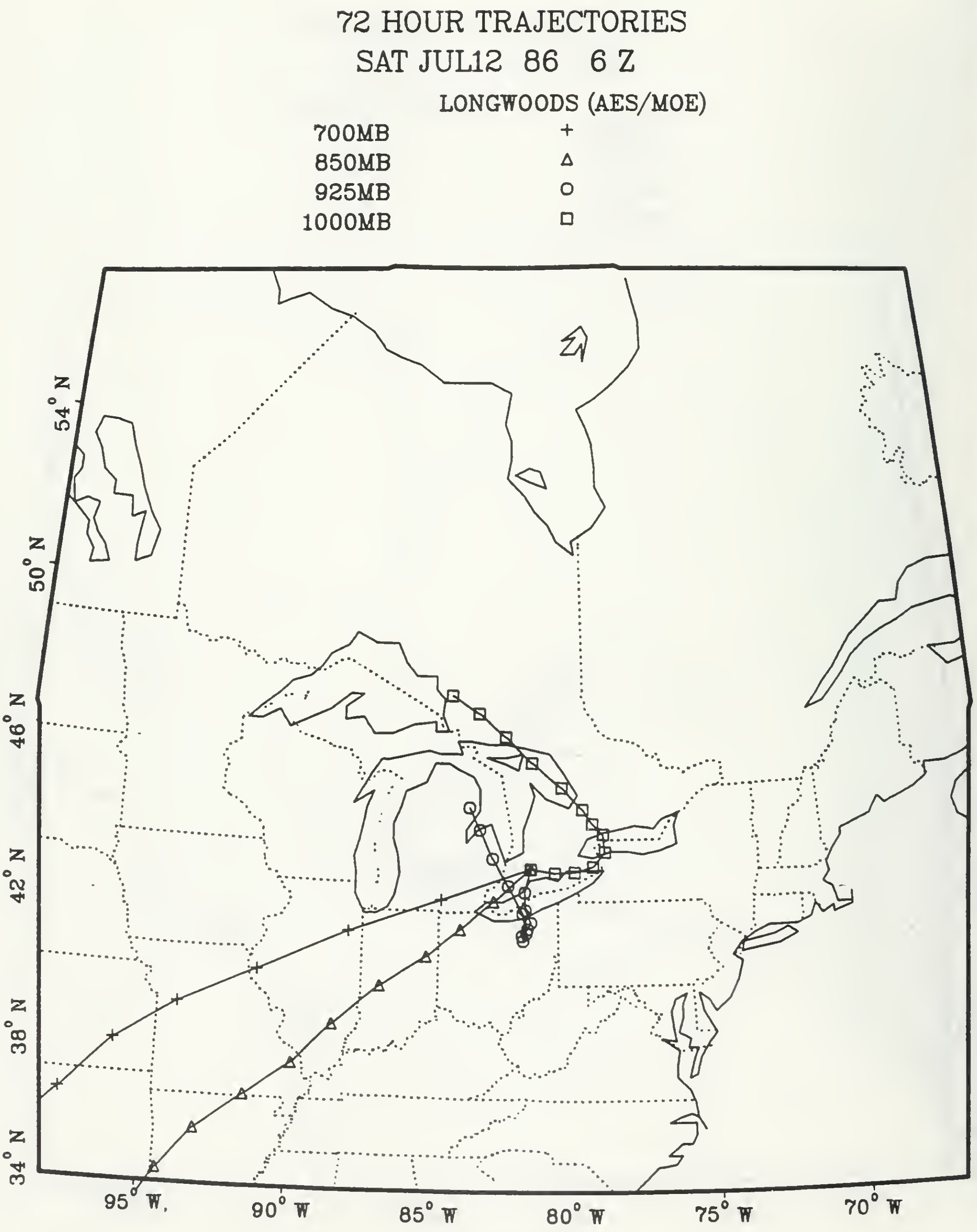

72 HOUR TRAJECTORIES
SAT JUL12 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.19.7

72 HOUR TRAJECTORIES
SAT JUL12 86 12 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	△
925MB	○
1000MB	□

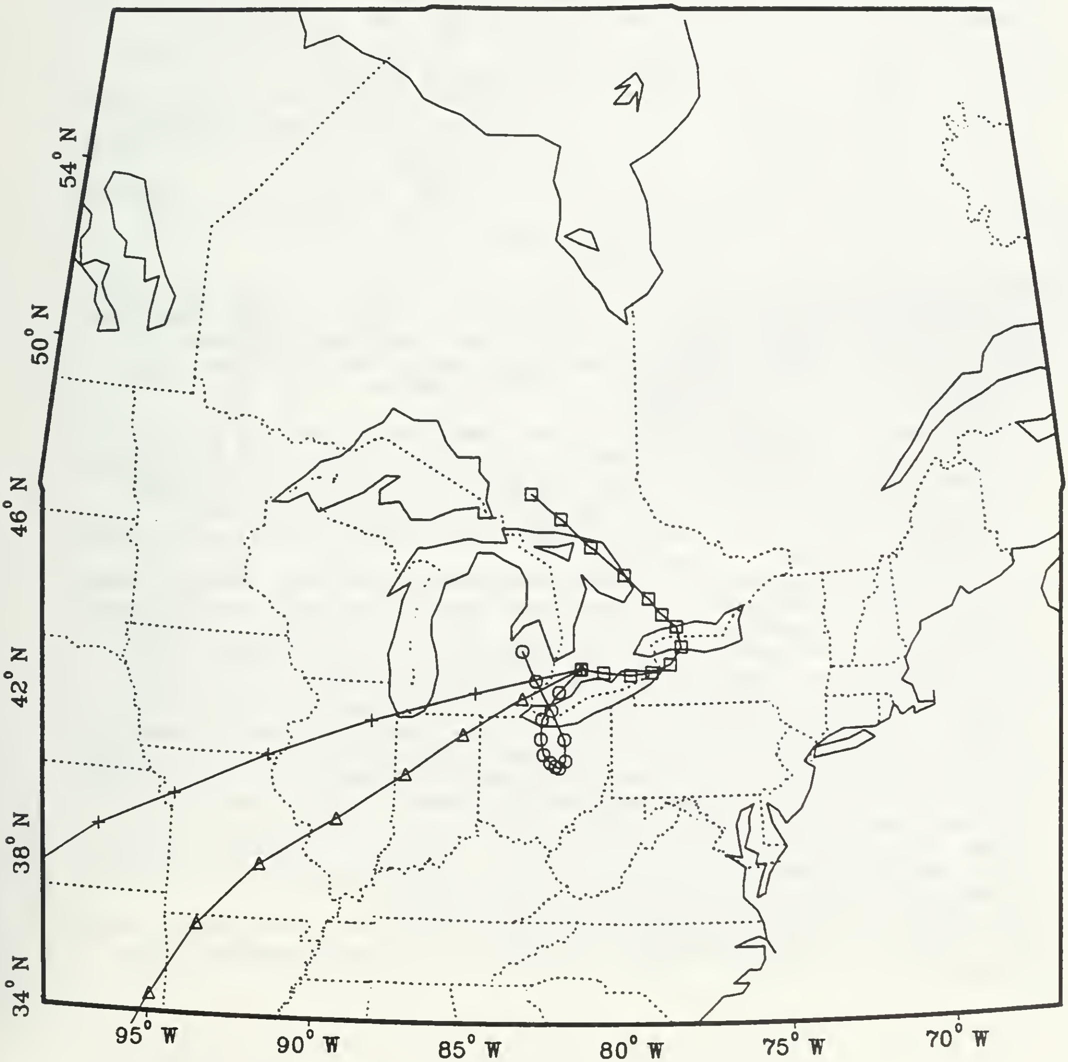


FIGURE 2.19.8

2.20 July 12-13, 1986, Longwoods(AES) & Longwoods(MOE)

This episode ranked 3rd(3/8) and 8th(8/10) in the respective lists of $SO_4^=$ and NO_3^- top 25% wet deposition episodes at Longwoods (AES). For Longwoods (MOE) the corresponding ranking was 3rd(3/7) for $SO_4^=$ and 6th(6/10) for NO_3^-.
On July 12, at 12Z, a quasi-stationary front south of Longwoods and another north of the station were observed as shown in Fig. 2.20.1. As illustrated in the figure, a continuous (showery) precipitation area was associated with these systems and enclosed the station. The frontal systems moved slowly northward with the southern front crossing over the station, but both frontal systems remained in southern Ontario. On July 13, at 12Z, as shown in Fig. 2.20.2, the frontal systems and the showery precipitation area had moved NE of the station. The slowly moving quasi-stationary front yielded rain showers from very light to heavy intensities and light drizzle as shown in Fig. 2.20.3. The total precipitation duration was about eight hours.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for July 12, 12Z, 18Z and July 13, 00Z, 06Z and 12Z are shown in Figures 2.20.4, 2.20.5, 2.20.6, 2.20.7, and 2.20.8 respectively.
Air parcels arriving at the 1000 mb level show that SO_2 from its highest emission Sudbury area (Fig. 2.20.4-5) and high emission Toronto-Hamilton-Buffalo area could have been transported.
Air trajectories for the 925 mb level show that SO_2 form its highest and NO_x from its high emission Detroit (Fig. 2.20.7-8) could have been transported.
Air parcels arriving at the 850 mb level show that SO_2 and NO_x from their respective highest emission Chicago area (2.20.5-6&8) and SO_2 from its highest Detroit area (Fig. 2.20.4) and other Illinois area (Fig. 2.20.4) and NO_x form its high emission Detroit (Fig. 2.20.4) and St. Louis area (Fig. 2.20.4) could have been transported.
Air trajectories for the 700 mb level show that SO_2 and NO_x from their highest emission Chicago area could have been transported throughout the entire duration (Fig. 2.20.4-8) of the episode.
In summary, a slowly moving quasi-stationary front passed over the station and remained in its vicinity yielding very light, light, moderate and heavy rain showers and light drizzle. The duration of the total precipitation was about 8 hours. Transport of SO_2 at low level from its highest emission Sudbury (1000 mb) and high emission Toronto-Hamilton-Buffalo area, at low and high level from Detroit (925mb and 850 mb) and at high level from Chicago and other Illinois areas was likely. Transport of NO_x at high levels (850 mb & 700 mb) from its highest emission Chicago area and high emission St. Louis area and at high and low levels from high emission Detroit area was probable.
It should be noted that the same meteorological disturbance which gave rise to high deposition on July 11-12, also produced this episode.

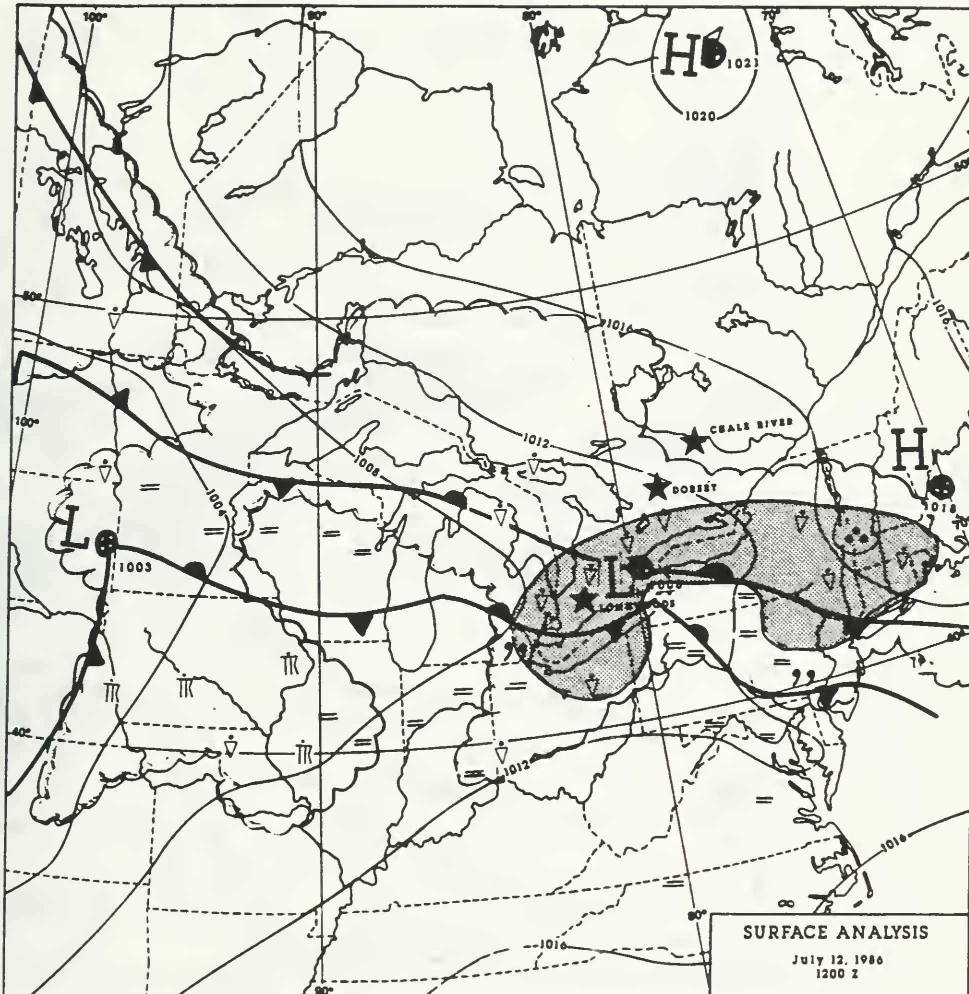
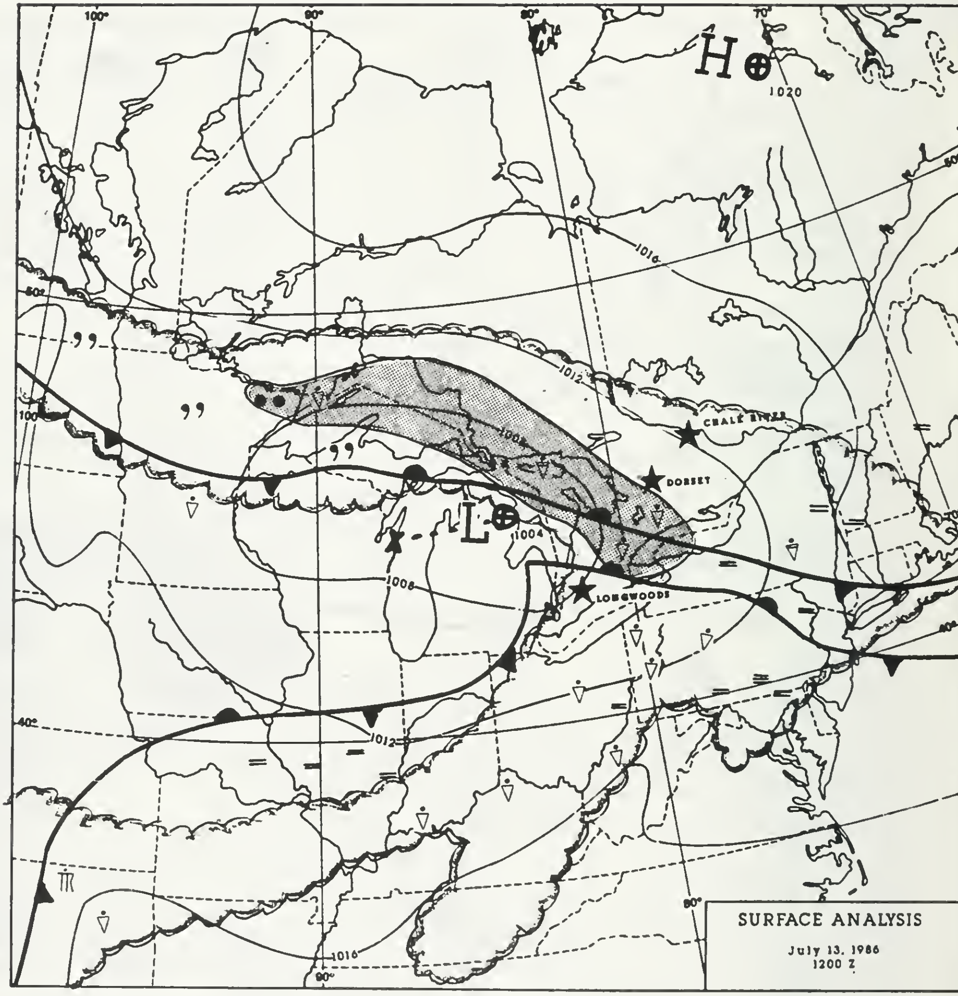

SURFACE ANALYSIS
July 12, 1986
1200 Z
CEALE RIVER
DORSET
1003
1008
1012
1016
1020

FIGURE 2.20.1



H
1020
1016
1012
1008
1004
1012
1016
L
CHALK RIVER
DORSET
LONGWOODS
100°
90°
80°
70°
50°
40°
SURFACE ANALYSIS
July 13, 1986
1200 Z

FIGURE 2.20.2

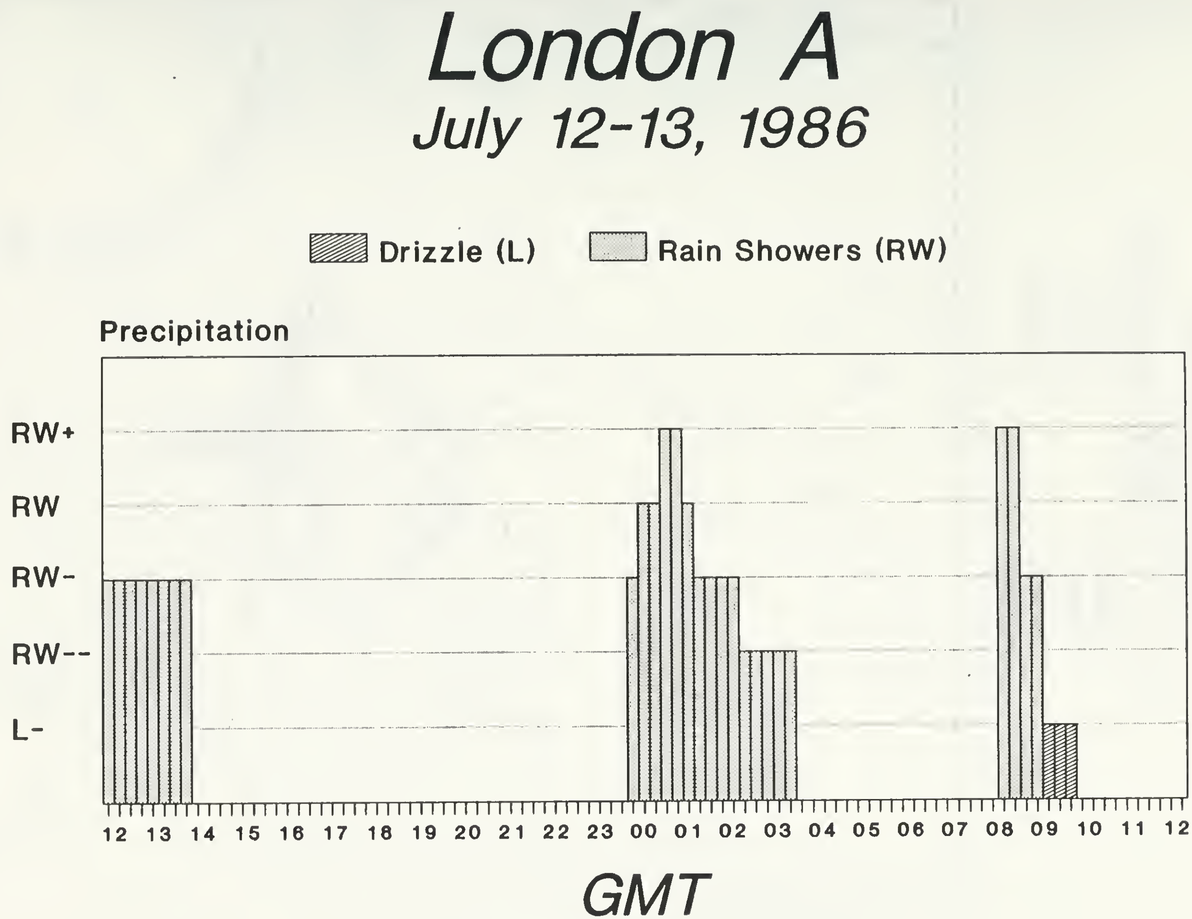

London A
July 12-13, 1986
Drizzle (L)
Rain Showers (RW)
Precipitation
RW+
RW
RW-
RW--
L-
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT

FIGURE 2.20.3

72 HOUR TRAJECTORIES
SAT JUL12 86 12 Z

LONGWOODS (AES/MOE)

700MB +
850MB △
925MB ○
1000MB □

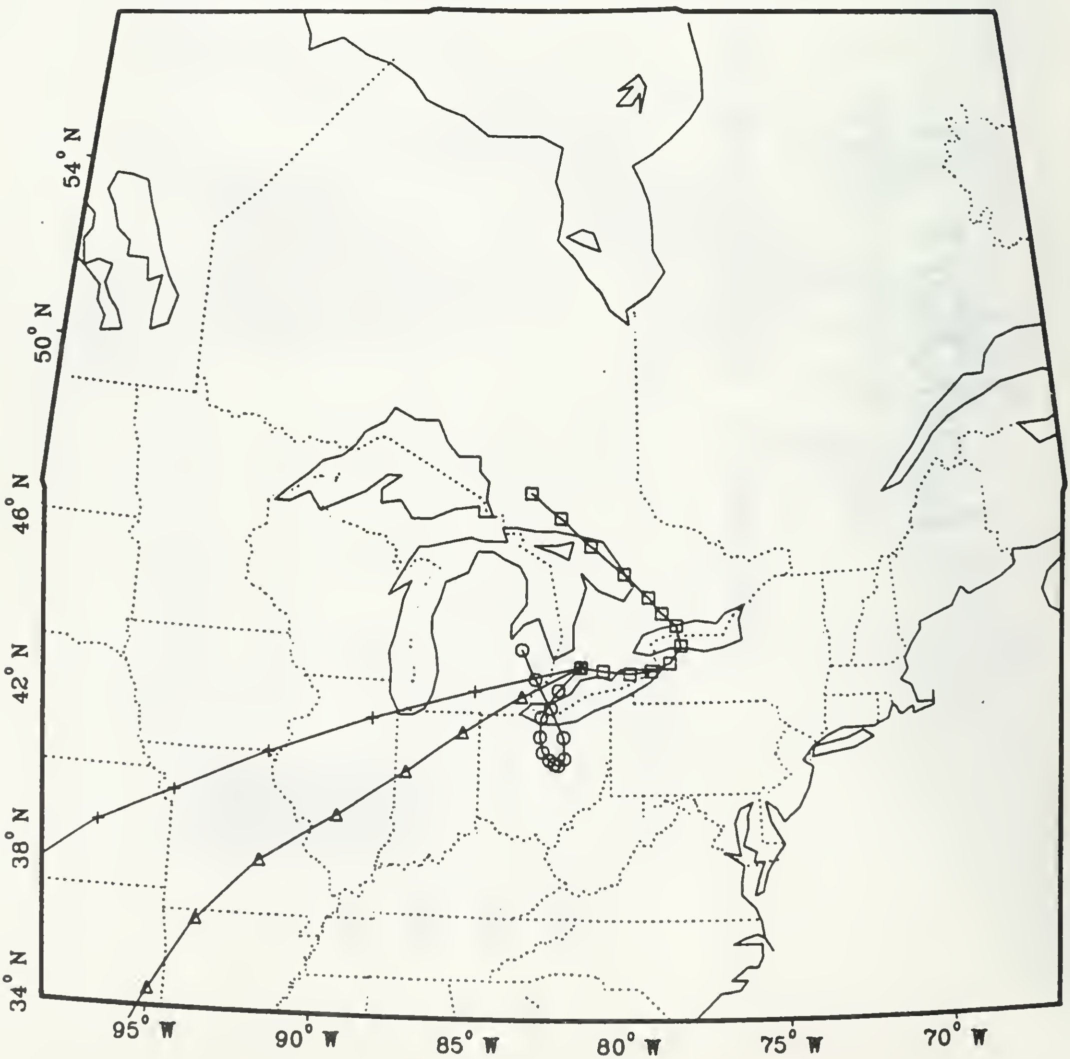


FIGURE 2.20.4

72 HOUR TRAJECTORIES
SAT JUL12 86 18 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	Δ
925MB	O
1000MB	□

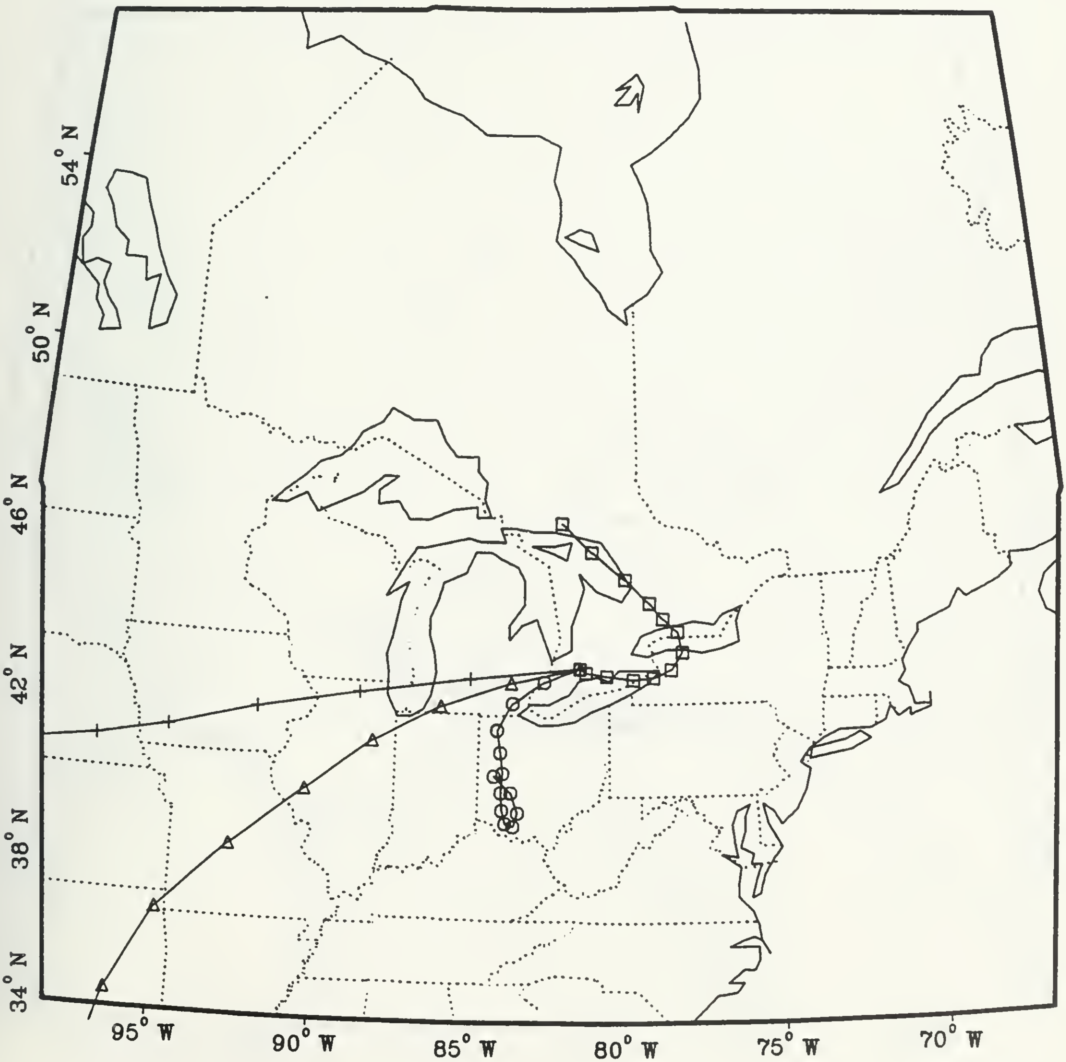


FIGURE 2.20.5

72 HOUR TRAJECTORIES
SUN JUL13 86 0 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	△
925MB	○
1000MB	□

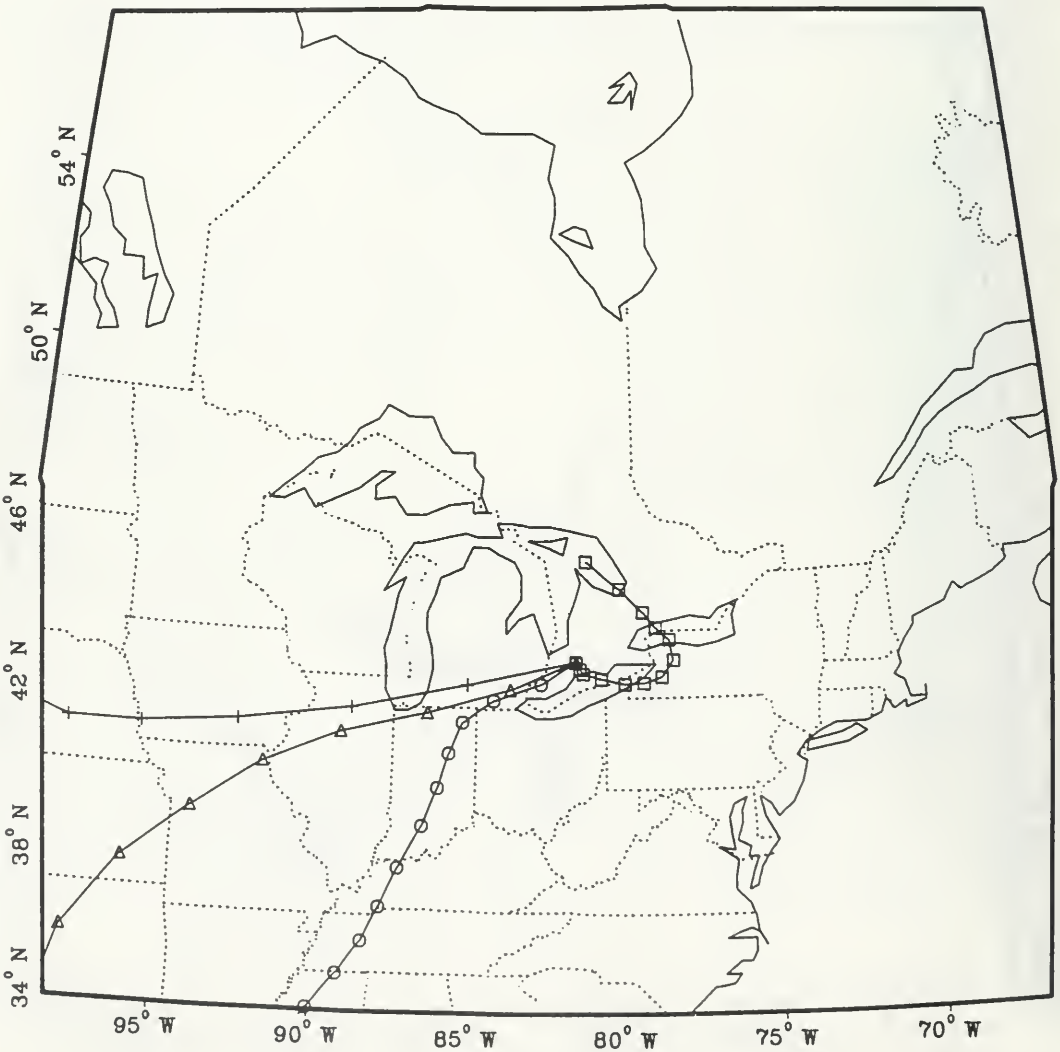


FIGURE 2.20.6

72 HOUR TRAJECTORIES
SUN JUL13 86 6 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	△
925MB	○
1000MB	□

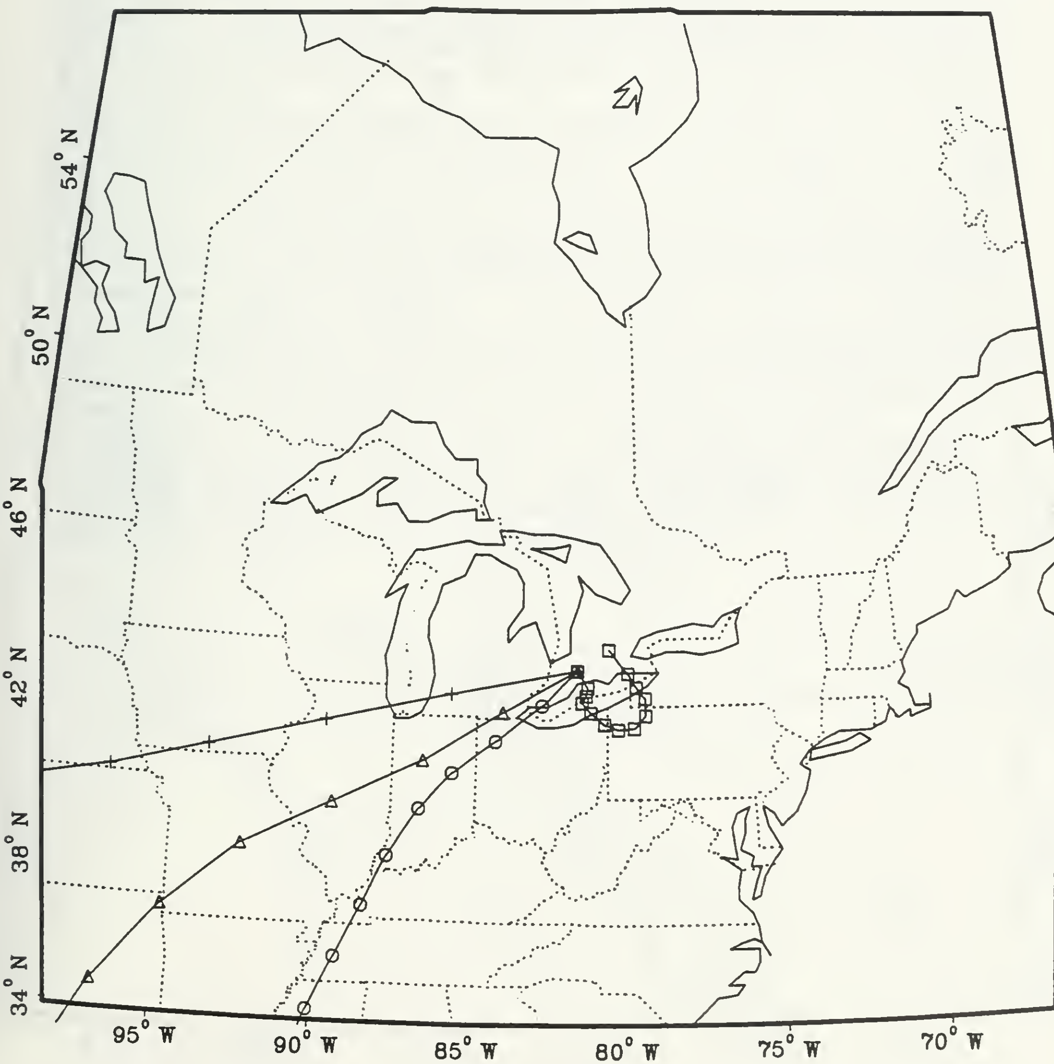


FIGURE 2.20.7

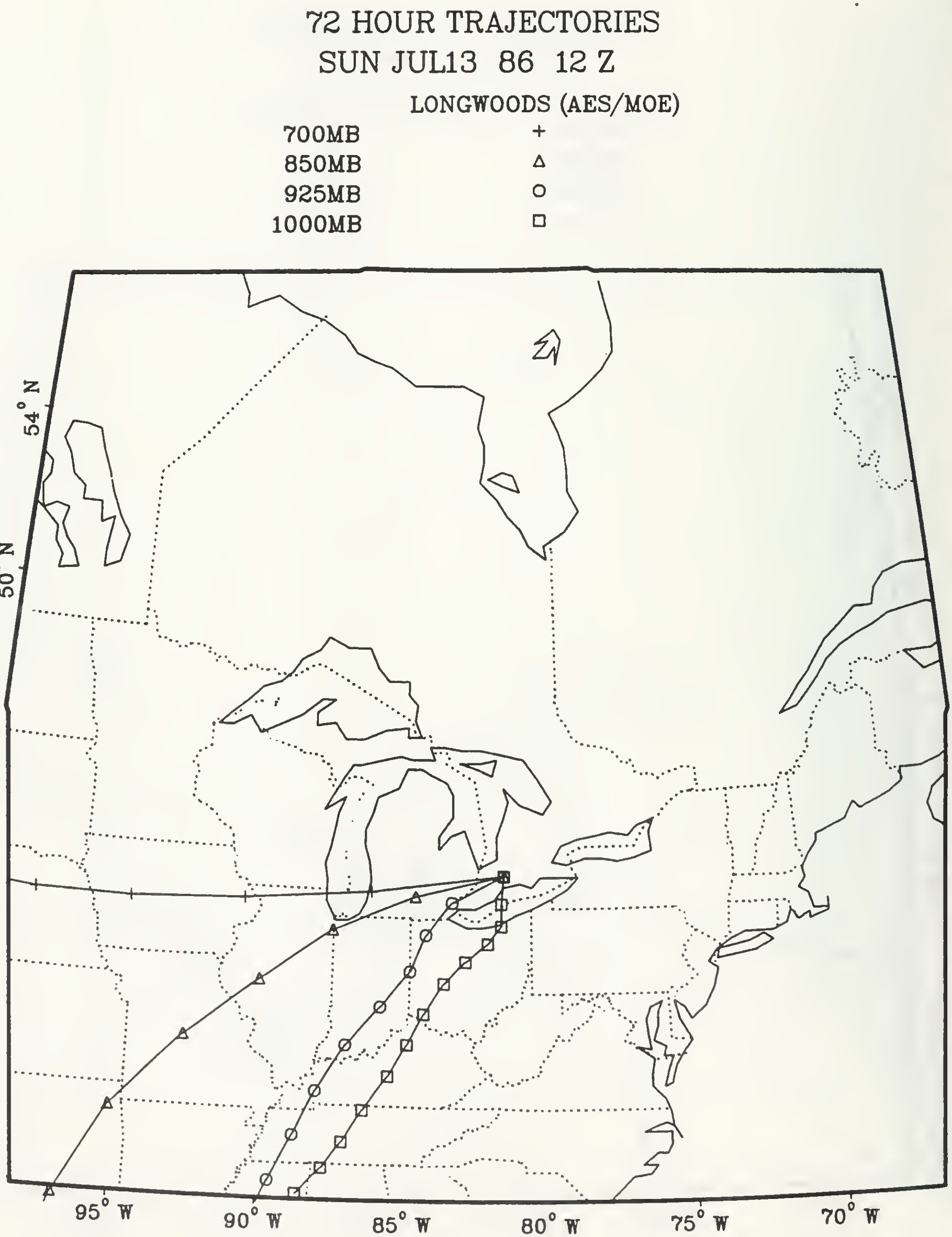

72 HOUR TRAJECTORIES
SUN JUL13 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.20.8

2.21 July 19-20, 1986 Dorset

This was ranked 4th(4/10) only in the top 25% NO_3^- wet deposition episodes.
On July 19, at 12Z, a low pressure centre, over Wisconsin north of Green Bay, and associated with a warm front over Windsor as shown in Fig. 2.21.1. were observed. During the next 24 hours, the low disappeared due to cyclolysis and a wave associated with the frontal system approached Dorset. On July 20, at 00Z the wave was SW of Dorset and a TCU was observed at the nearest weather station Muskoka. On July 20, at 12Z, a wave, just east of Dorset, and associated frontal system and a TROWL were analyzed as shown in Fig. 2.21.2. Unfortunately, due to discontinuous observation at Muskoka, no precipitation was observed but the observer indicated rain showers during the missing period in his manual observation log (Form 2322).
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for July 19, 12Z, 18Z and July 20, 00Z, 06Z and 12Z are shown in Figures 2.21.3, 2.21.4, 2.21.5, 2.21.6, and 2.21.7 respectively.
Air parcels arriving at the 1000 mb level could possibly have transported NO_x from its high emission Detroit(Fig. 2.21.8) area.
Air trajectories for the 925 mb level show that NO_x could have been transported from its highest emission Chicago (Fig. 2.21.7-8) area for several hours on July 20.
Air trajectories for the 850 mb and 700 mb levels (see Figs. 2.21.4-8) show that no significant transport of NO_x could have taken place during this episode since no highest or high emission source areas are involved.
In summary, a wave with a frontal system and a trowl possibly yielded rain showers at Dorset for a brief period. Low level transport of NO_x from the highest emission Chicago (925 mb) area and high emission Detroit (1000 mb) area were likely. No significant transport at high level was probable.

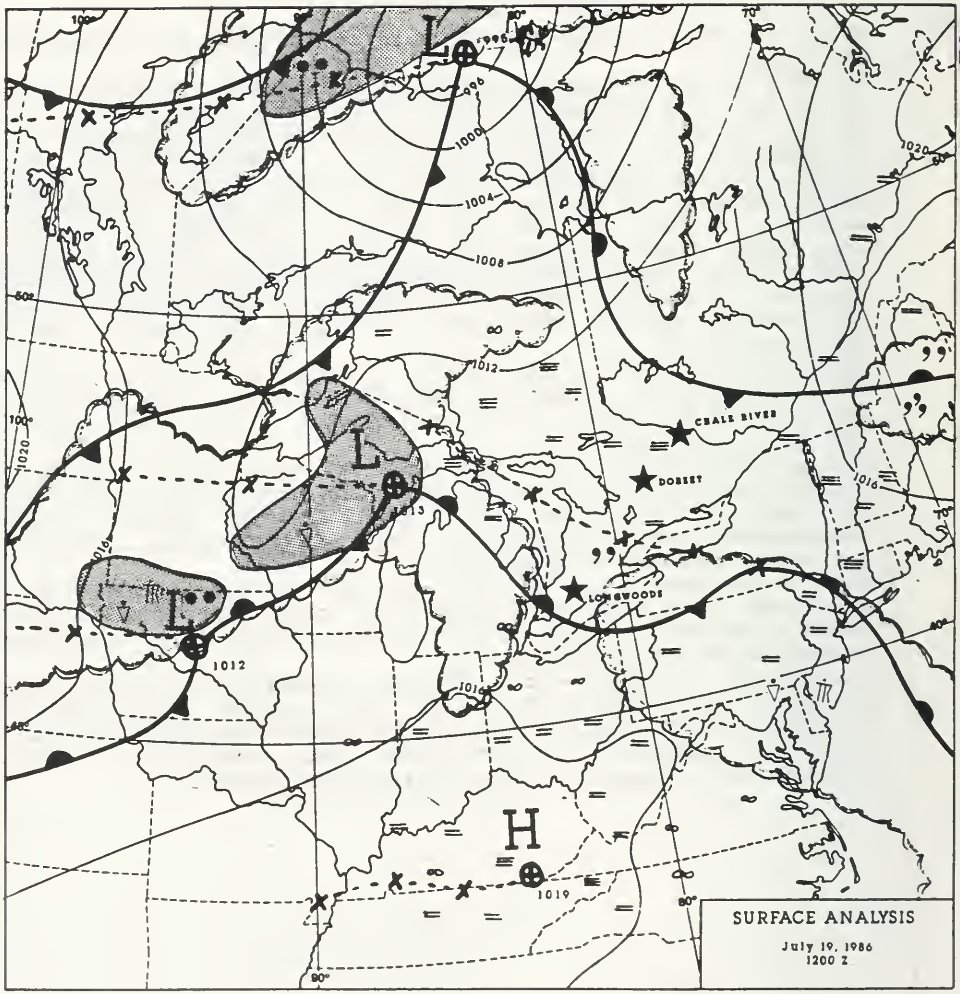

SURFACE ANALYSIS
July 19, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1020
1016
1012
1008
1004
1000
996
1013
1019

FIGURE 2.21.1

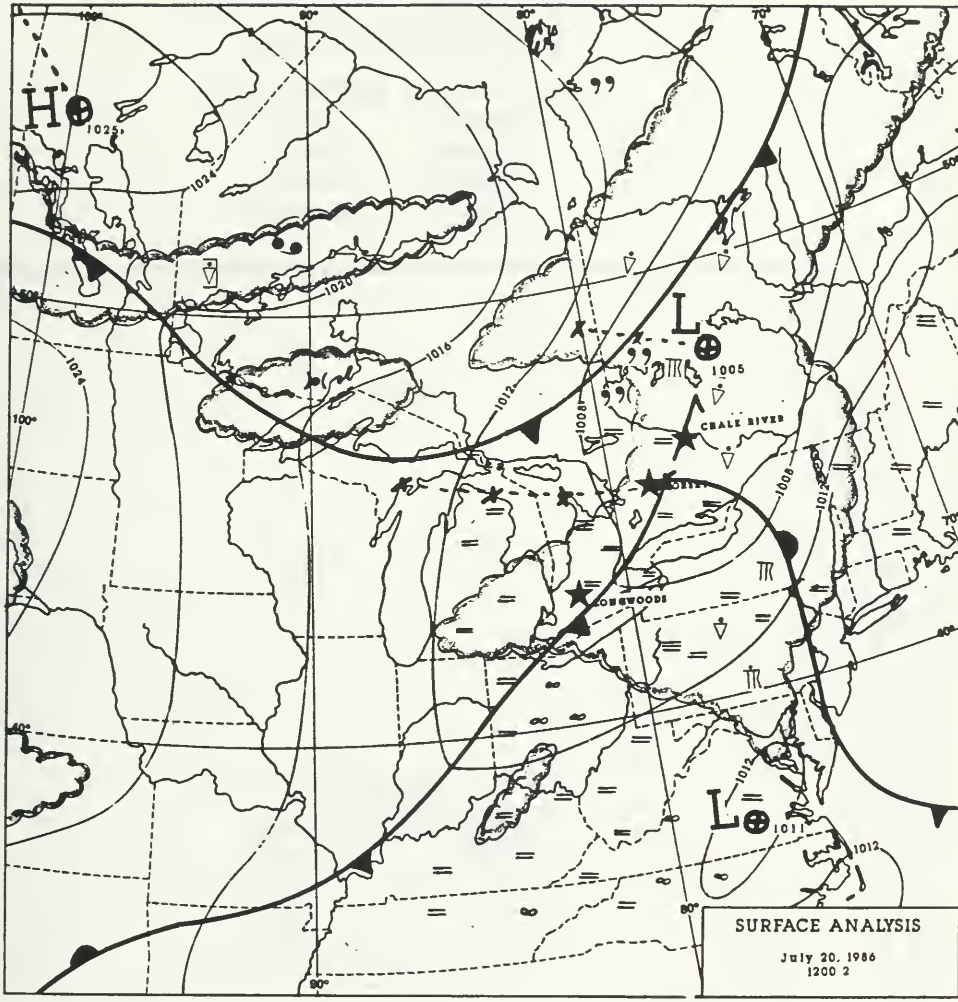

SURFACE ANALYSIS
July 20, 1986
1200 Z
CHALK RIVER
LONGWOODS
1025
1005
1011
1024
1020
1016
1012
1008

FIGURE 2.21.2

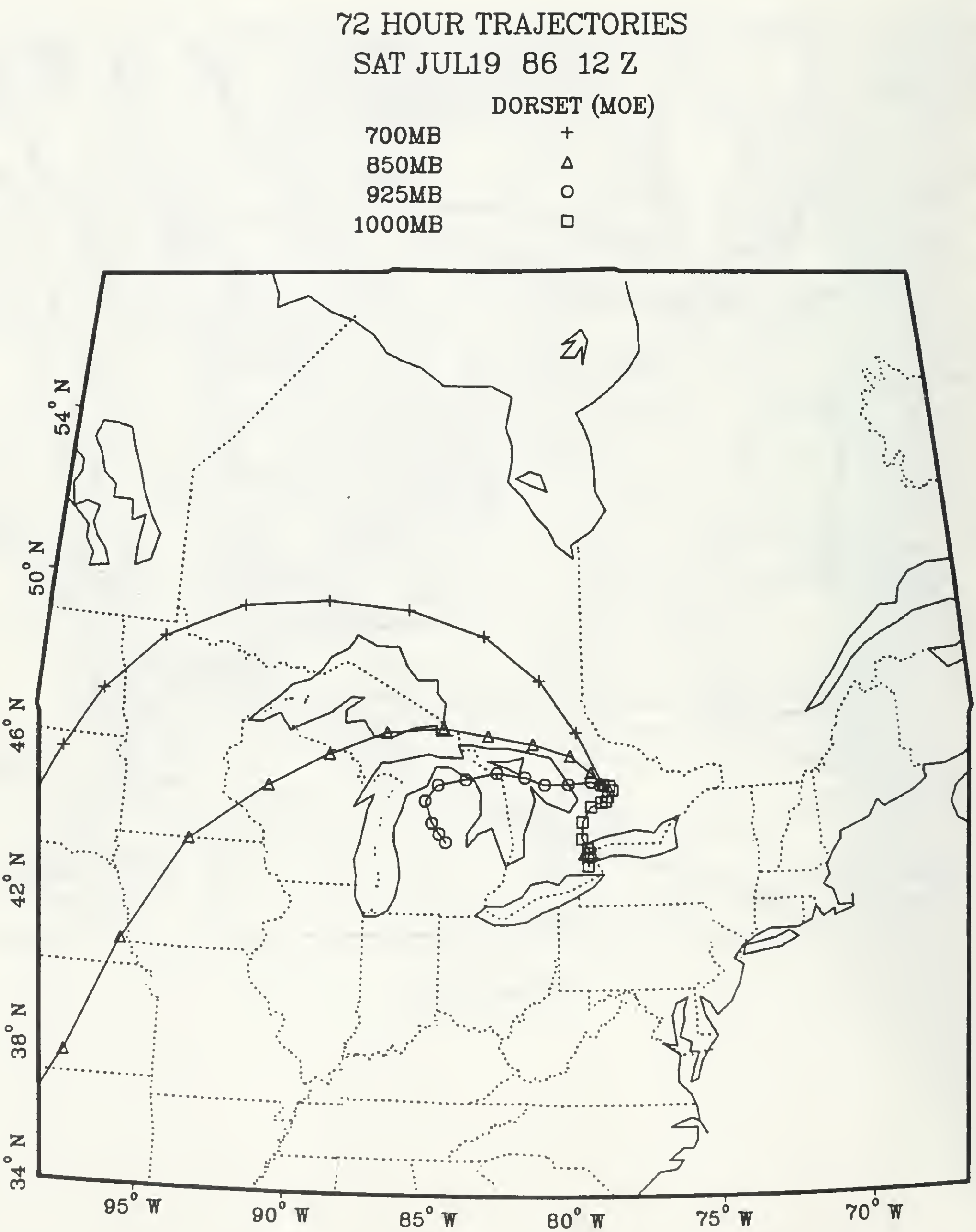

72 HOUR TRAJECTORIES
SAT JUL19 86 12 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.21.3

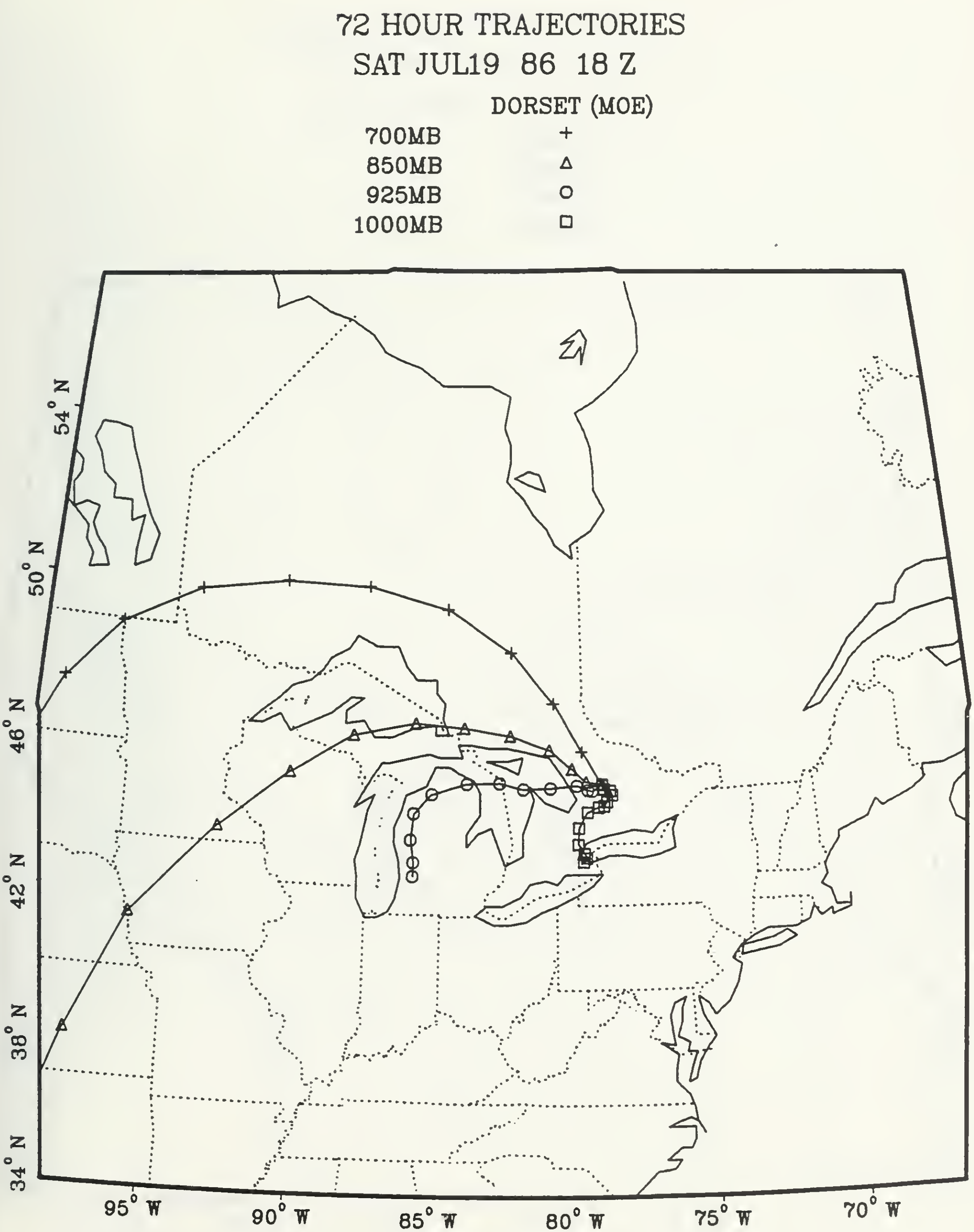

72 HOUR TRAJECTORIES
SAT JUL19 86 18 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.21.4

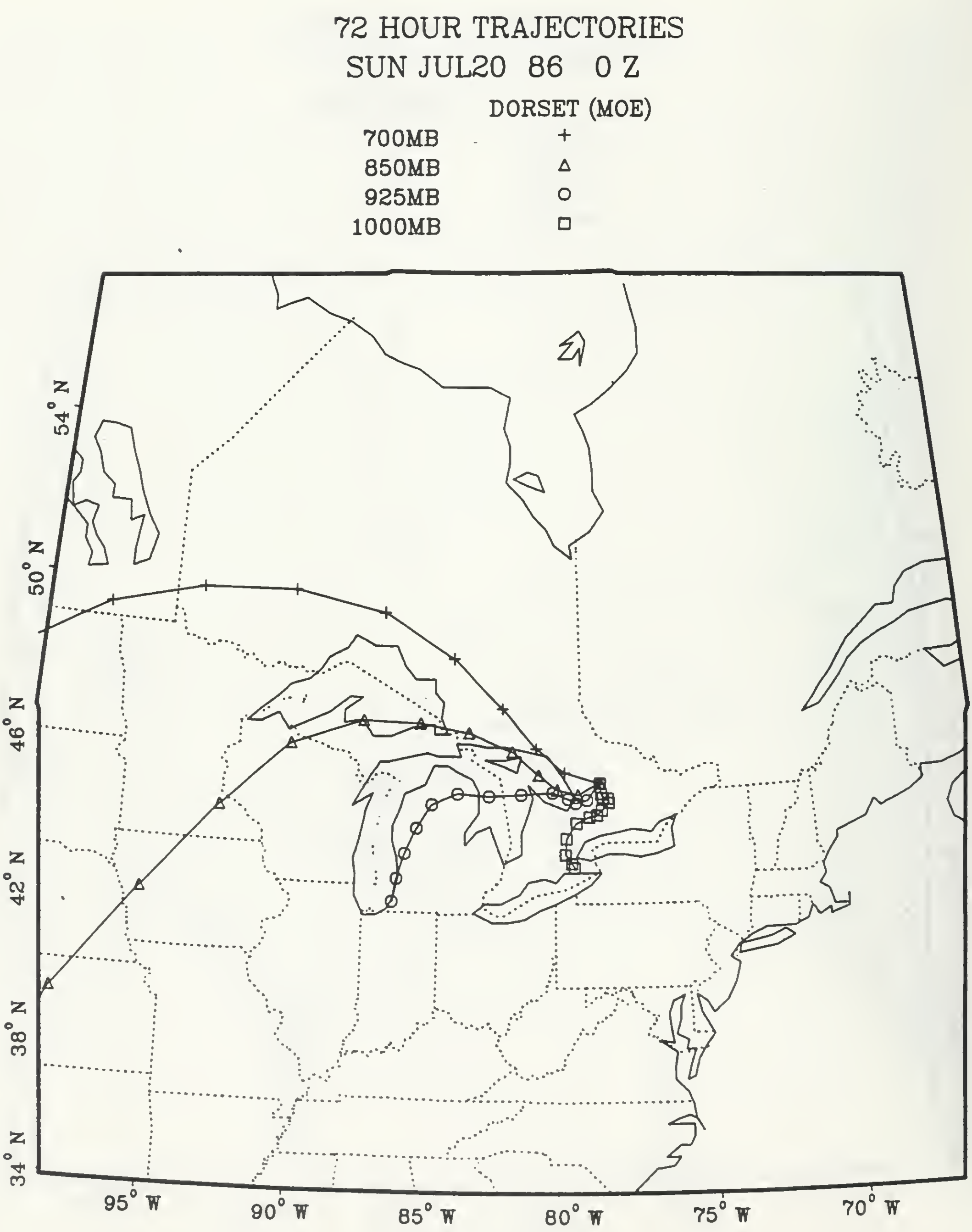

72 HOUR TRAJECTORIES
SUN JUL20 86 0 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.21.5

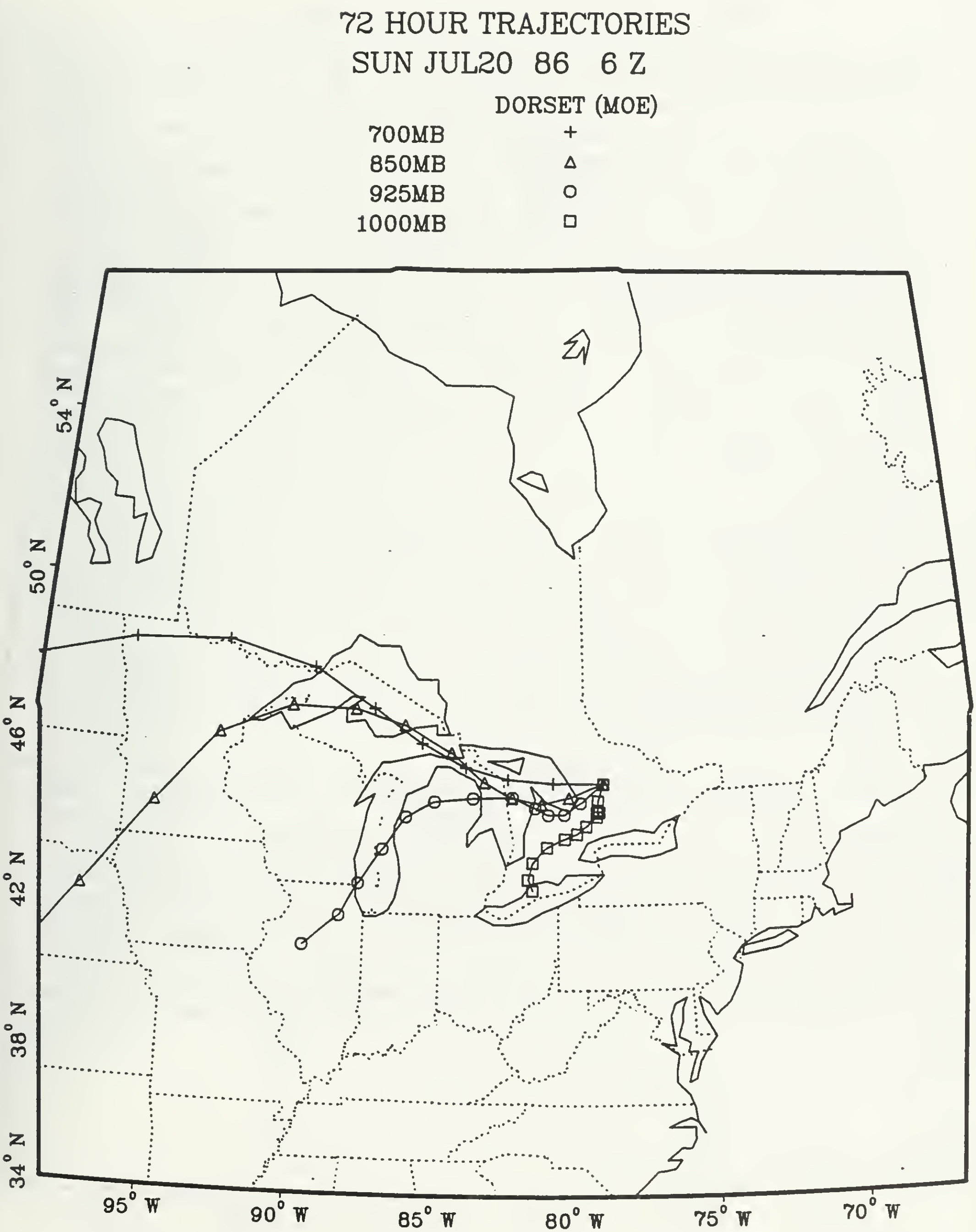

72 HOUR TRAJECTORIES
SUN JUL20 86 6 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.21.6

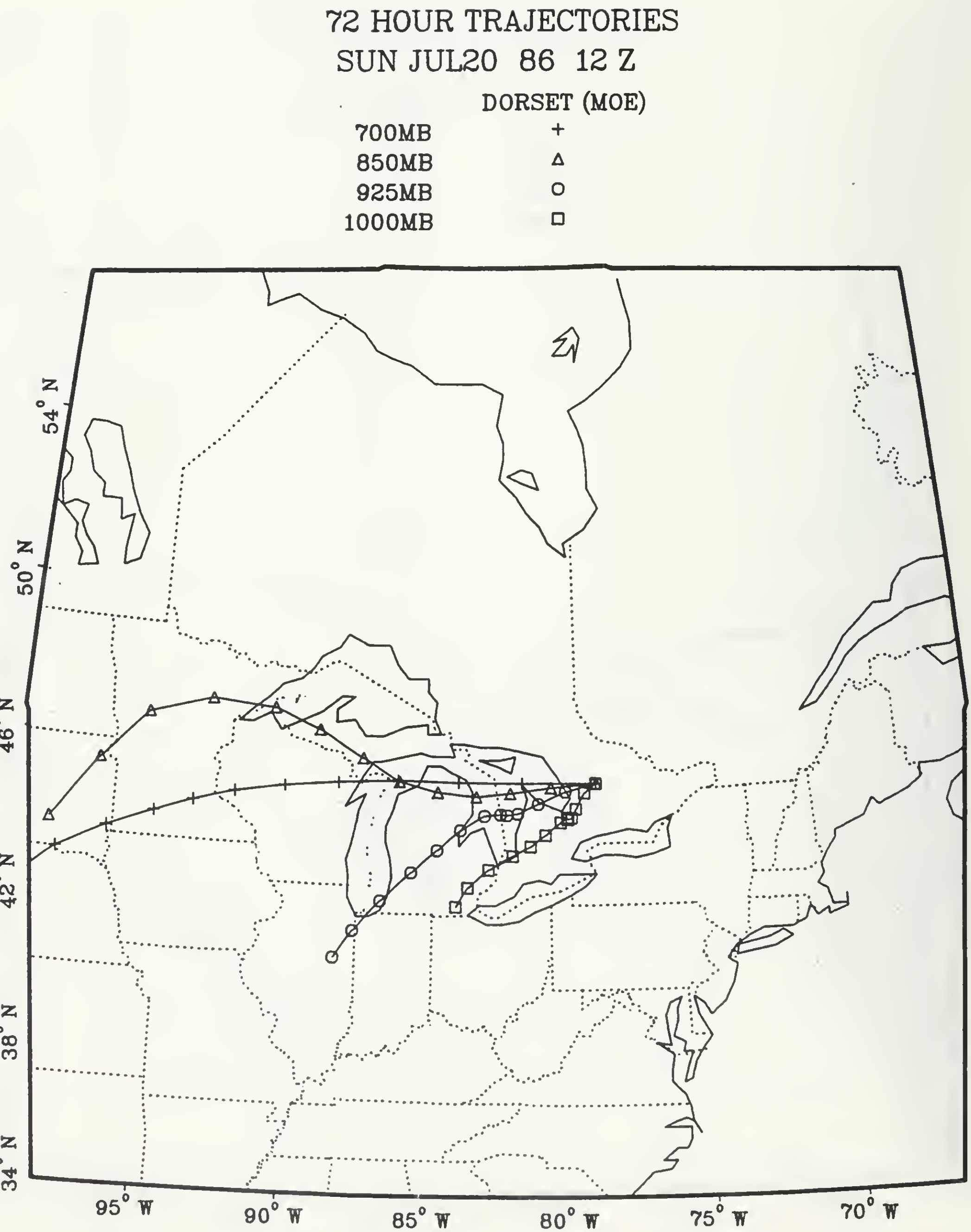

72 HOUR TRAJECTORIES
SUN JUL20 86 12 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.21.7

2.22 July 25-26, 1986, Longwoods(AES) & Longwoods (MOE)

At Longwoods (AES) this episode ranked 2nd(2/8) and 3rd(3/10) in the respective lists of the top 25% $SO_4^=$ and NO_3^- wet deposition episodes. At Longwoods (MOE), the respective rankings were 2nd (2/8 for $SO_4^=$ and 2/10 for NO_3^-) for both pollutants.

On July 25, at 12Z, a low pressure centre, 1009 mb, over Wisconsin near Milwaukee, associated with a frontal system was observed as illustrated in Fig. 2.22.1. A band of rain showers and thundershowers was associated with this system. During the course of this event, the low moved eastward and the cold front passed over Longwoods on July 26, at about 06Z. By 12Z on July 26, the low had moved to the eastern Ontario and the cold front lied over Lake Erie as shown in Fig. 2.22.2. Rain showers and thundershowers from very light to heavy intensities were recorded at the nearest weather station London Airport as exhibited in Fig. 2.22.3. as the front moved over the station. Lightnings were observed and the total duration of precipitation was about 7 hours.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for July 25, 12Z, 18Z and July 26, 00Z, 06Z and 12Z are shown in Figures 2.22.4, 2.22.5, 2.22.6, 2.22.7, and 2.22.8 respectively.

Air parcels arriving at the 1000 mb level could have transported SO_2 and NO_x from their respective highest and high emission areas in Pennsylvania-Ohio-West Virginia (Figs. 2.22.4-8) throughout the entire episode and Detroit, Michigan (Fig. 2.22.8) for some time. Air trajectories for the 925 mb level show that SO_2 & NO_x from their respective highest and high emission Detroit (Fig. 2.22.4-7) and West Virginia (Fig. 2.22.7-8) areas could have been transported . Air parcels arriving at the 850 mb level show that SO_2 and NO_x from their highest Chicago area (Fig. 2.22.8) and SO_2 from its highest emission area in Illinois (Fig. 2.22.4-6) and NO_x from its high emission St. Louis, Missouri (Fig. 2.22.4-6) area could have been transported.

Air trajectories for the 700 mb level show that SO_2 and NO_x from their highest emission Chicago area could (Fig. 2.22.4-6) have been transported.

In summary, a cold front passage over the station yielded rain showers and thundershowers from very light to heavy intensities with the precipitation lasting for about 7 hours. Lightnings were observed. Transport of SO_2 at low levels from the highest emission Detroit, Michigan, and areas in Pennsylvania, Ohio and West Virginia and at high levels from Chicago and other area in Illinois was likely. Also transport of NO_x at high levels from its highest emission Chicago area and at low levels from high emission Detroit area and areas in Pennsylvania, Ohio and West Virginia was probable.

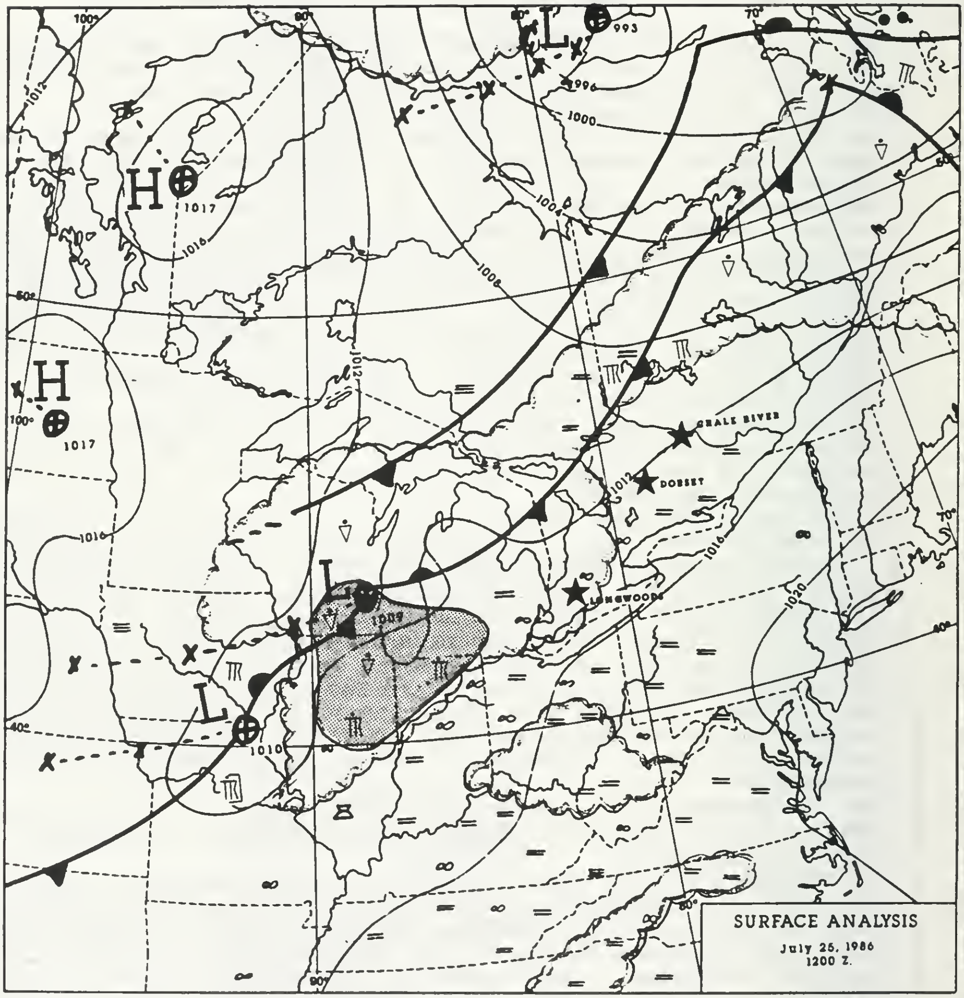

SURFACE ANALYSIS
July 25, 1986
1200 Z.
GRALE RIVER
DORSET
LONGWOOD
993
996
1000
1004
1008
1012
1016
1017
1010
1020

FIGURE 2.22.1

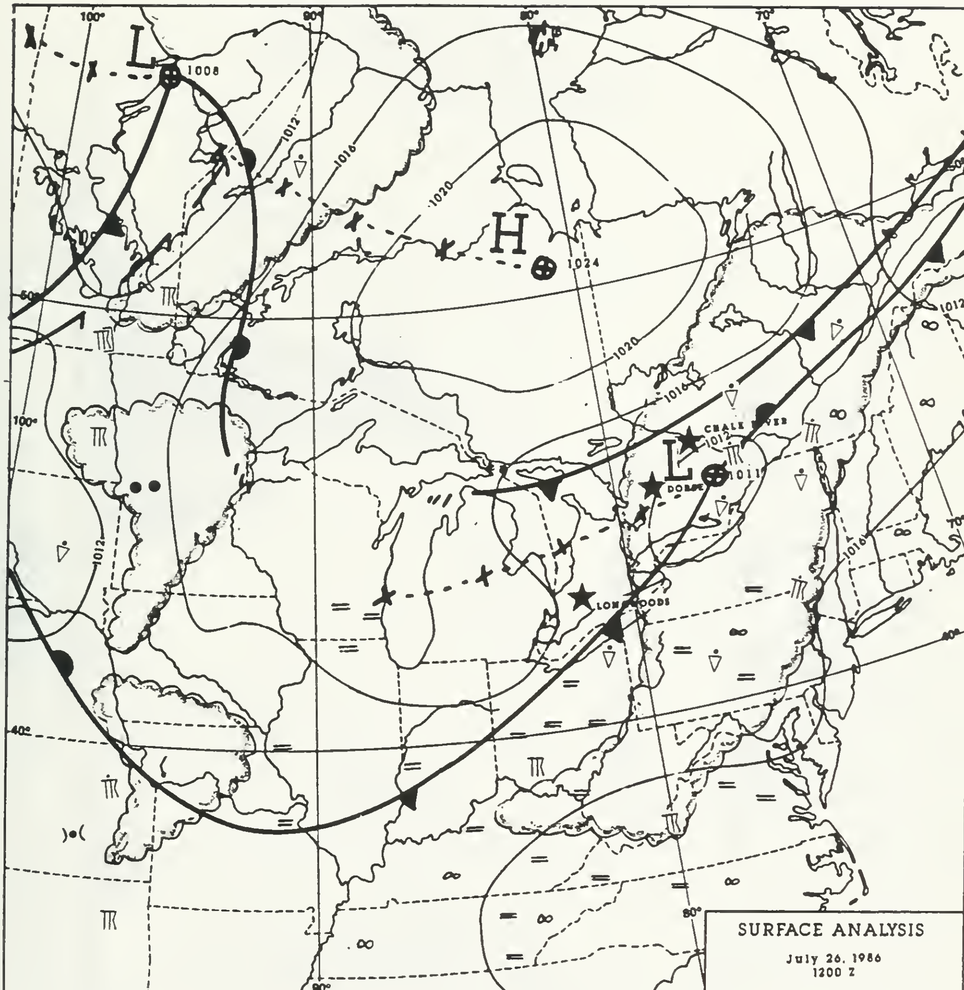
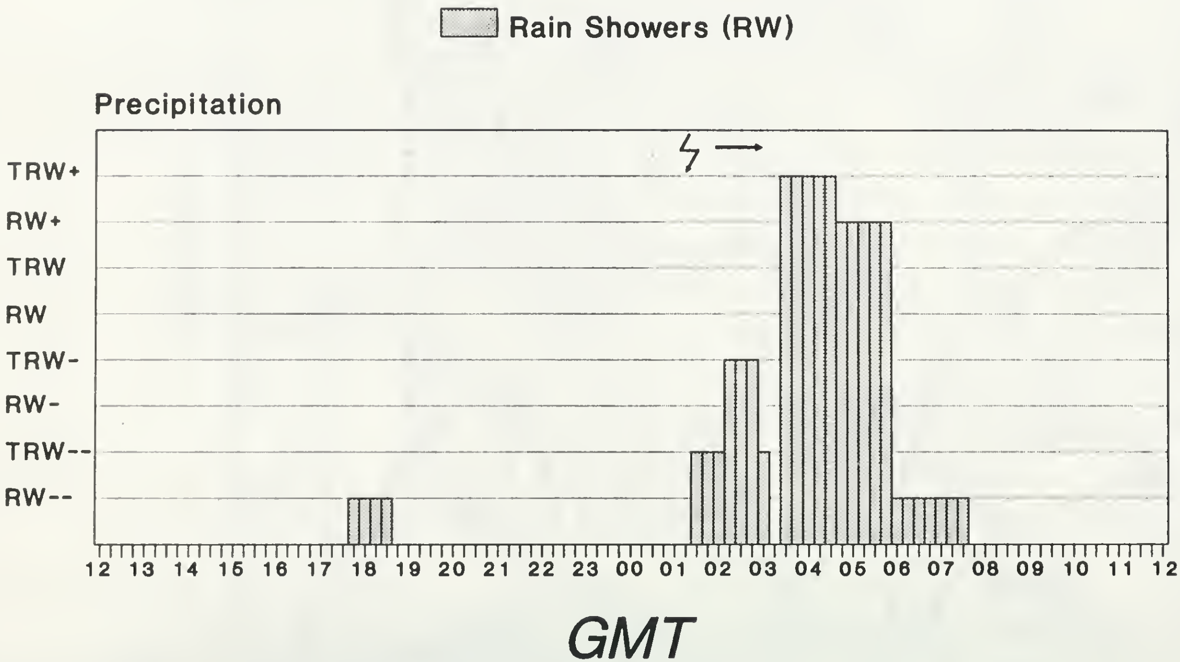

SURFACE ANALYSIS
July 26, 1986
1200 Z
CHALK RIVER
DORSET
LONG WOODS
1008
1012
1016
1020
1024
1011
100°
90°
80°
70°
50°
40°

FIGURE 2.22.2

London A
July 25-26, 1986



T - Thunder

FIGURE 2.22.3

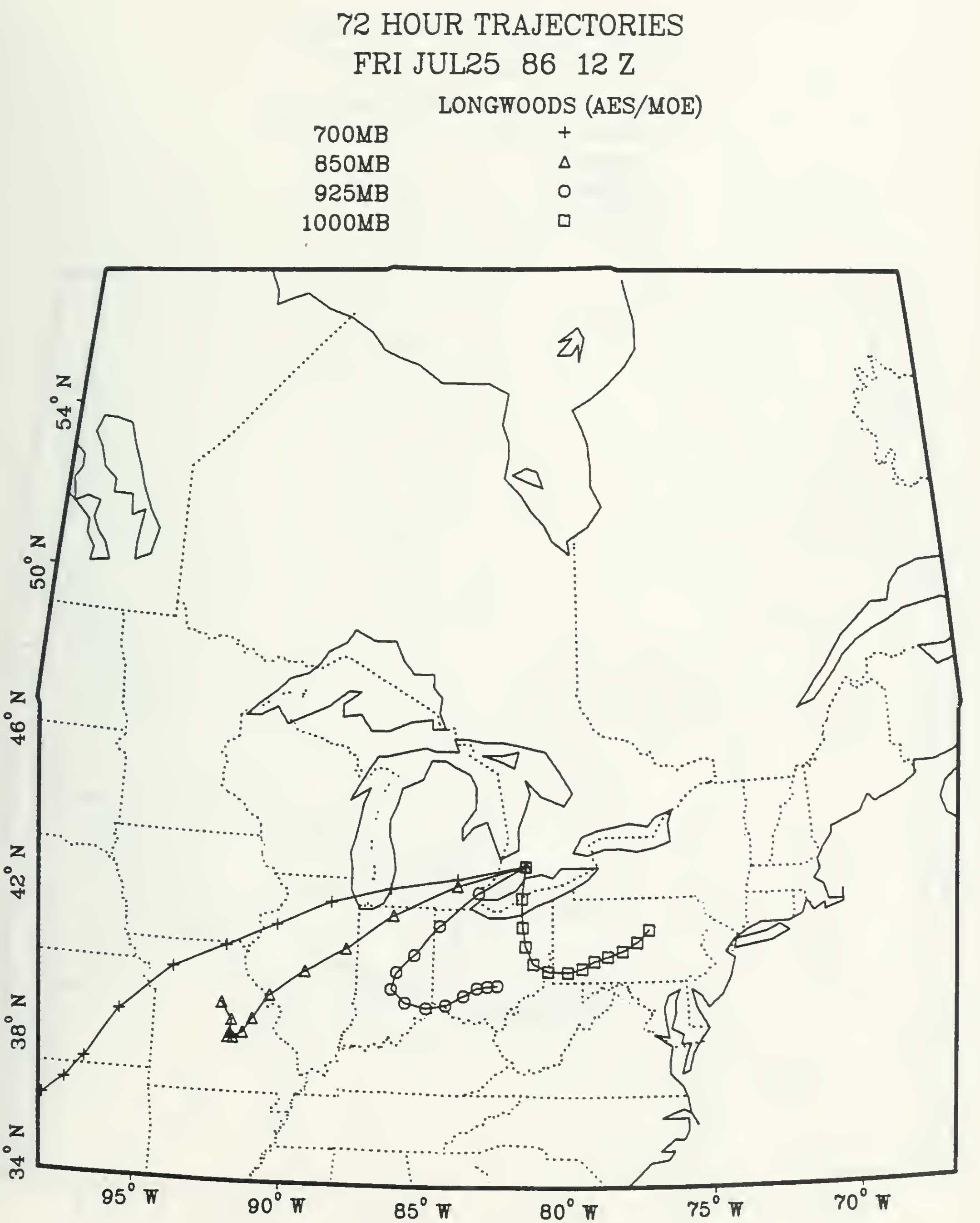

72 HOUR TRAJECTORIES
FRI JUL25 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.22.4

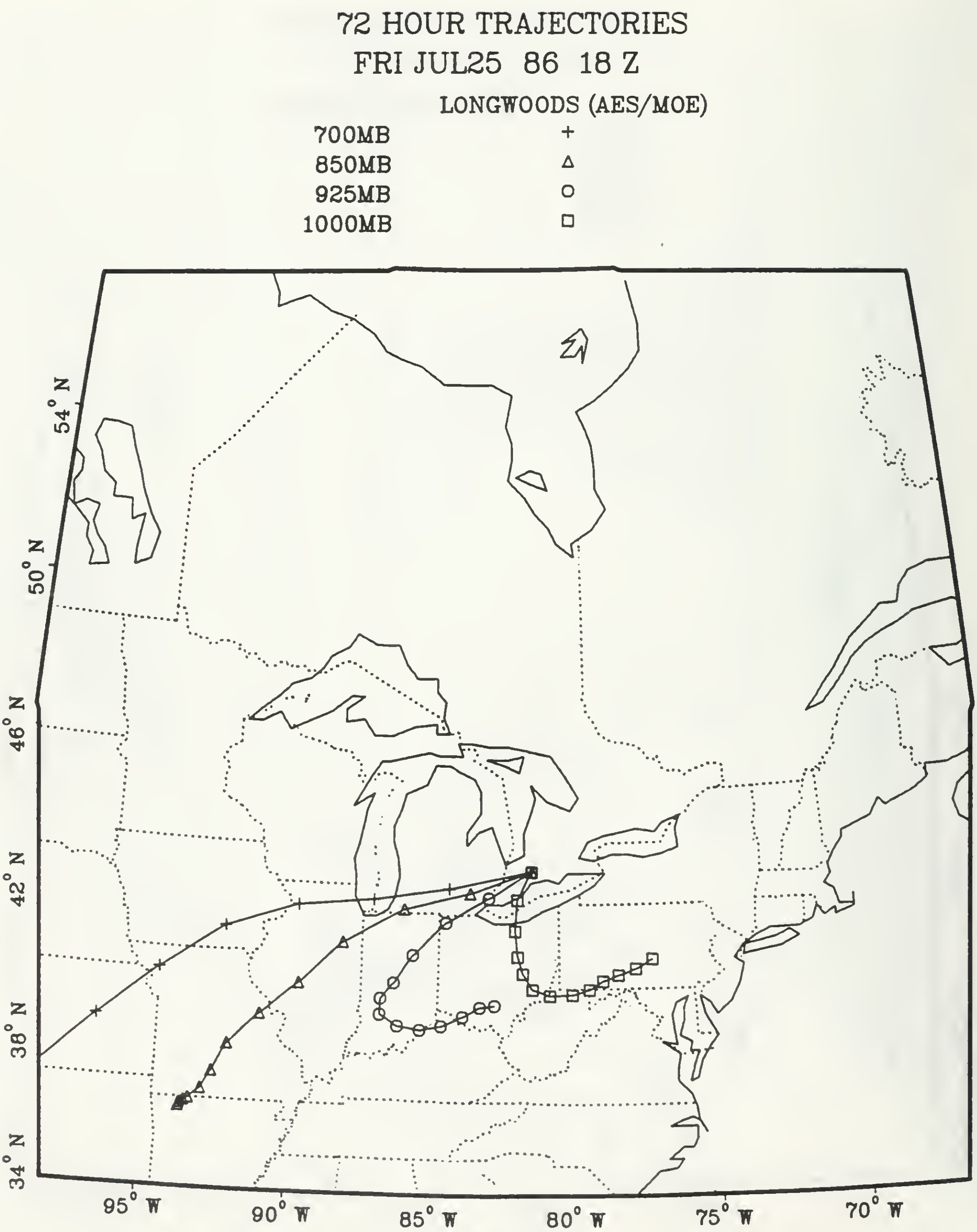

72 HOUR TRAJECTORIES
FRI JUL25 86 18 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.22.5

72 HOUR TRAJECTORIES
SAT JUL26 86 0 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	△
925MB	○
1000MB	□

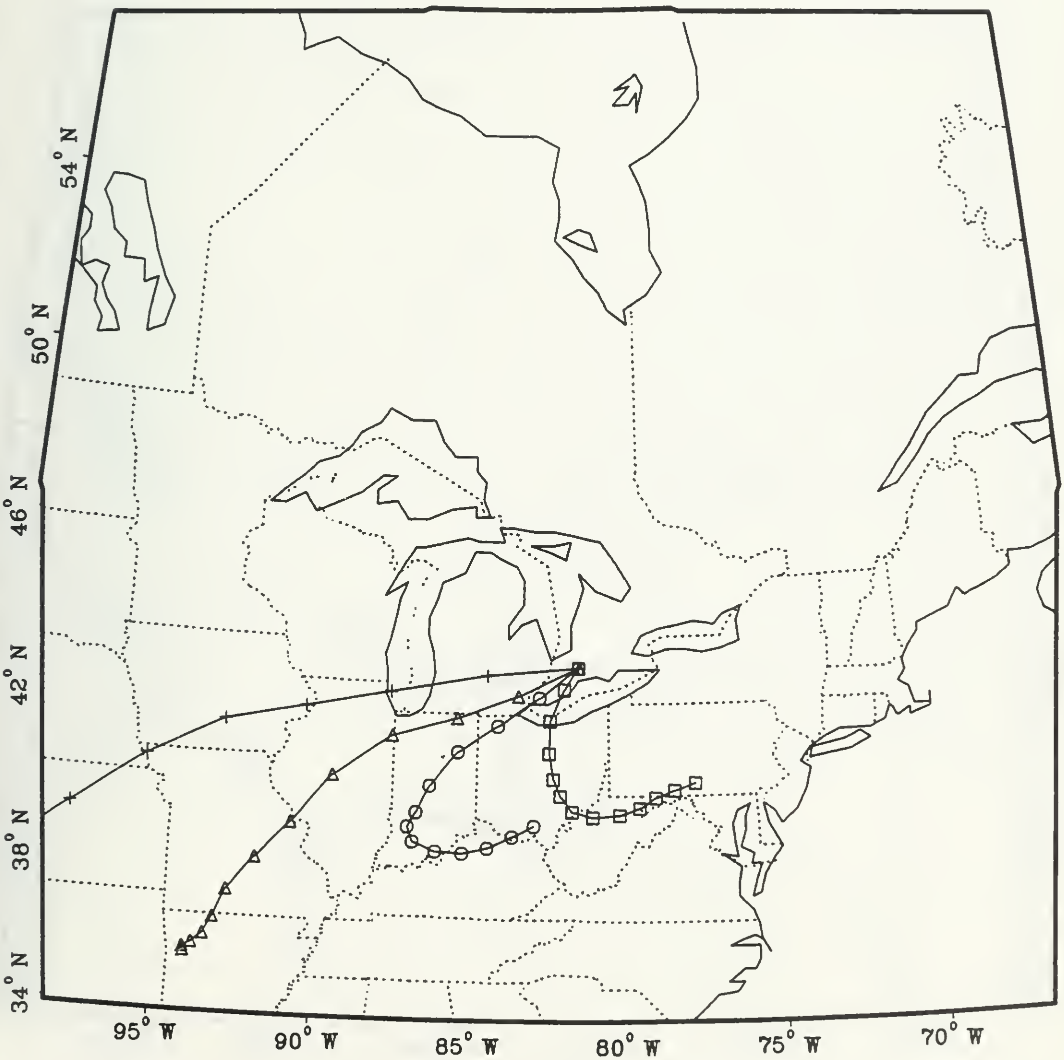


FIGURE 2.22.6

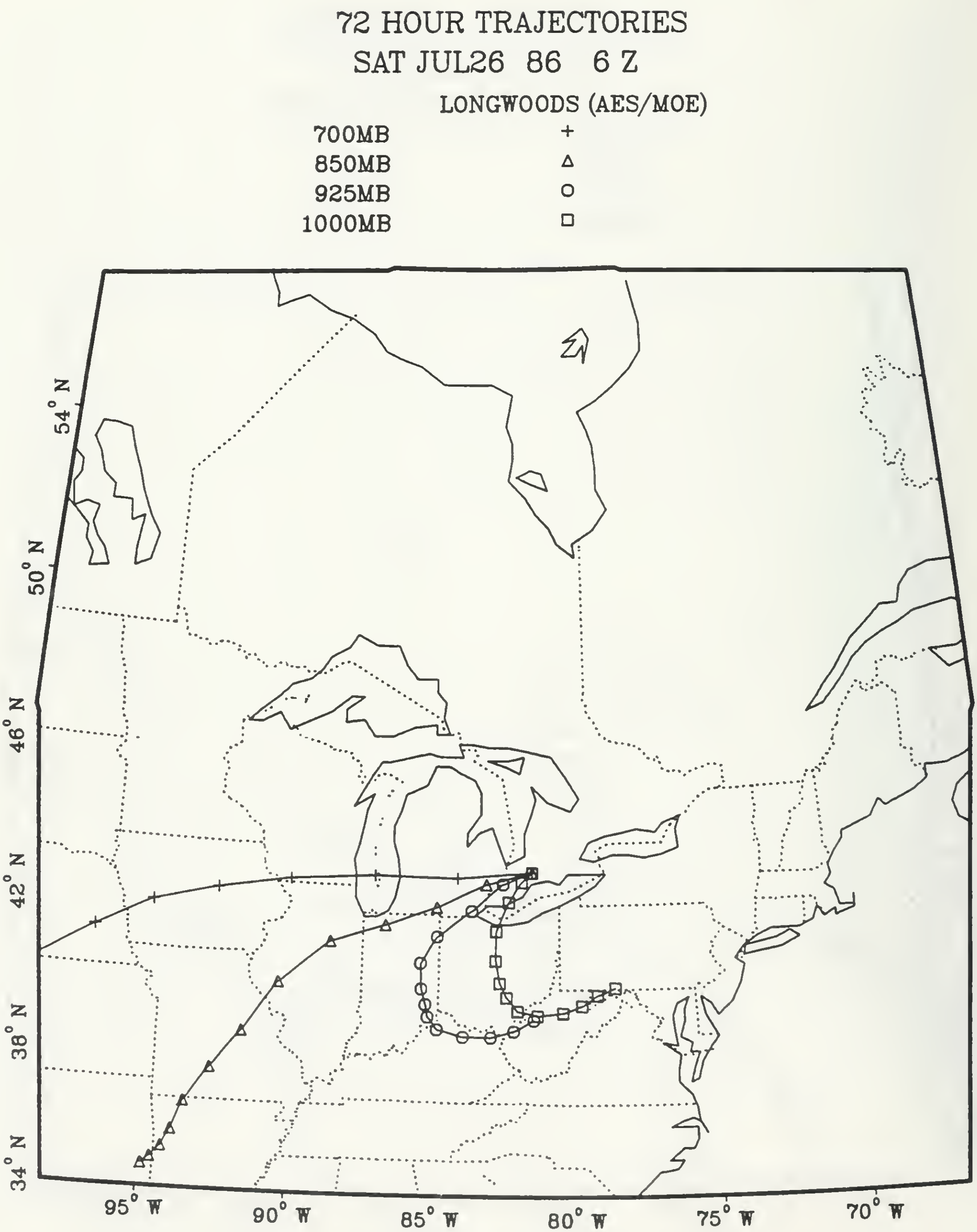

72 HOUR TRAJECTORIES
SAT JUL26 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.22.7

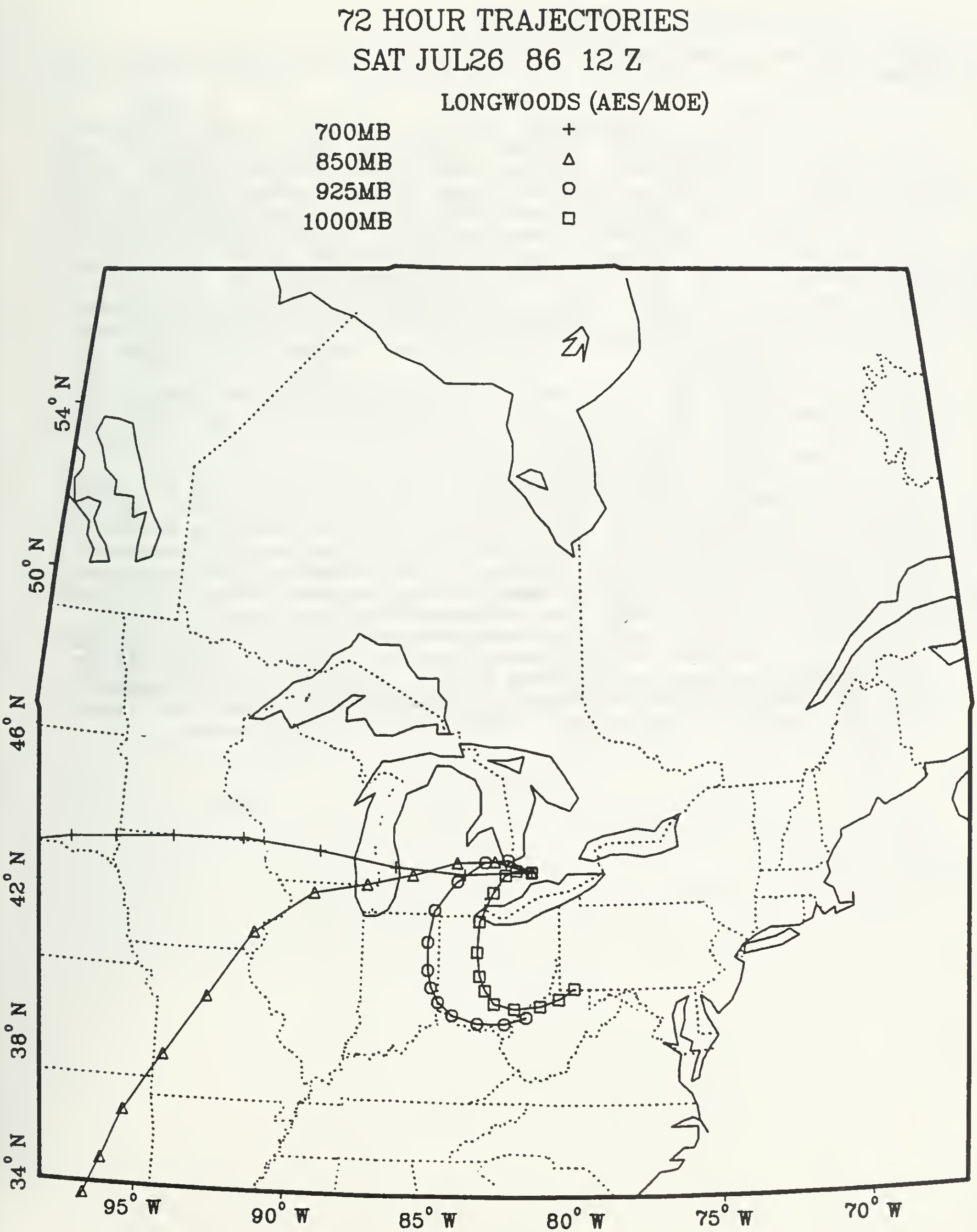

72 HOUR TRAJECTORIES
SAT JUL26 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.22.8

2.23 July 28-29,1986, Chalk River

This episode ranked 5th(5/8) only in the top 25% NO_3^- wet deposition events.

On July 28, at 12Z, a low pressure centre, 1007 mb over Lake Huron with associated frontal system as shown in Fig. 2.23.1 was observed. Thunderstorms were widely associated with this disturbance. During the next 24 hours the low moved eastward and on July 29, at 12Z, it laid near Chalk River as exhibited in Fig. 2.23.2. As the low approached the station it triggered thunderstorm activity and rain showers and thundershowers were observed as illustrated in Fig. 2.23.3 with precipitation lasting for about 7 hours. As shown in the figure, very light and light rain showers and very light, light, moderate and heavy thundershowers were recorded at the Petawawa Airport weather station. Lightning and thunder were observed.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for July 28, 12Z, 18Z and July 29, 00Z, 06Z and 12Z are shown in Figures 2.23.4, 2.23.5, 2.23.6, 2.23.7, and 2.23.8 respectively.

Air trajectories for all four levels show that they did not pass over any highest, high or moderate emission source region of NO_x and thus transport of NO_x from any anthropogenic sources would be insignificant. However, it is possible that the natural source of lightning might have contributed to this episode. Thunderstorms were associated with this system and intracloud, cloud to cloud and cloud to ground lightnings were observed for several hours.

In summary, a low pressure centre associated with a frontal system yielded rain showers and thundershowers up to heavy intensities. Lightnings were seen and thunder heard. No significant transport form any man made source region was observed. It appears likely that the lightning contributed to this high NO_3^- episode.

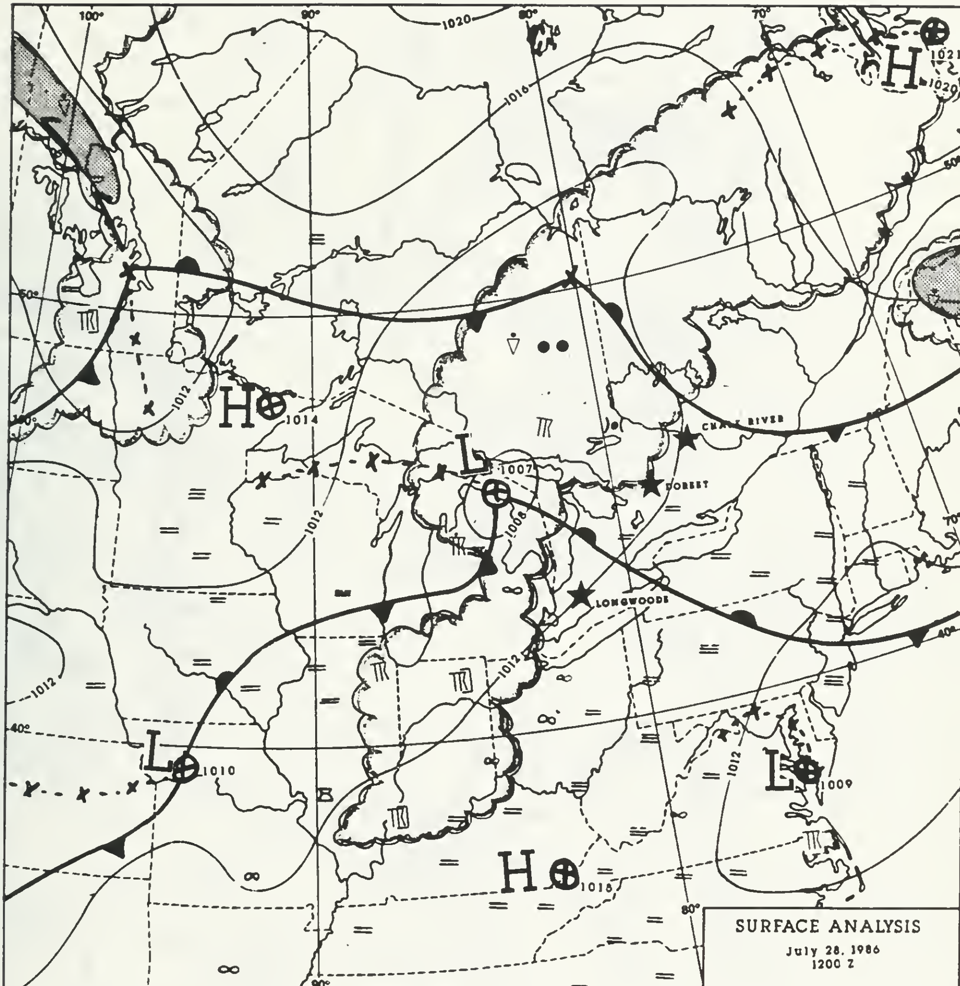

SURFACE ANALYSIS
July 28, 1986
1200 Z
1020
1016
1014
1012
1007
1006
1010
1009
1018
1021
1020
LONGWOODS
DORSET
CHALK RIVER
100°
90°
80°
70°
50°
40°

FIGURE 2.23.1

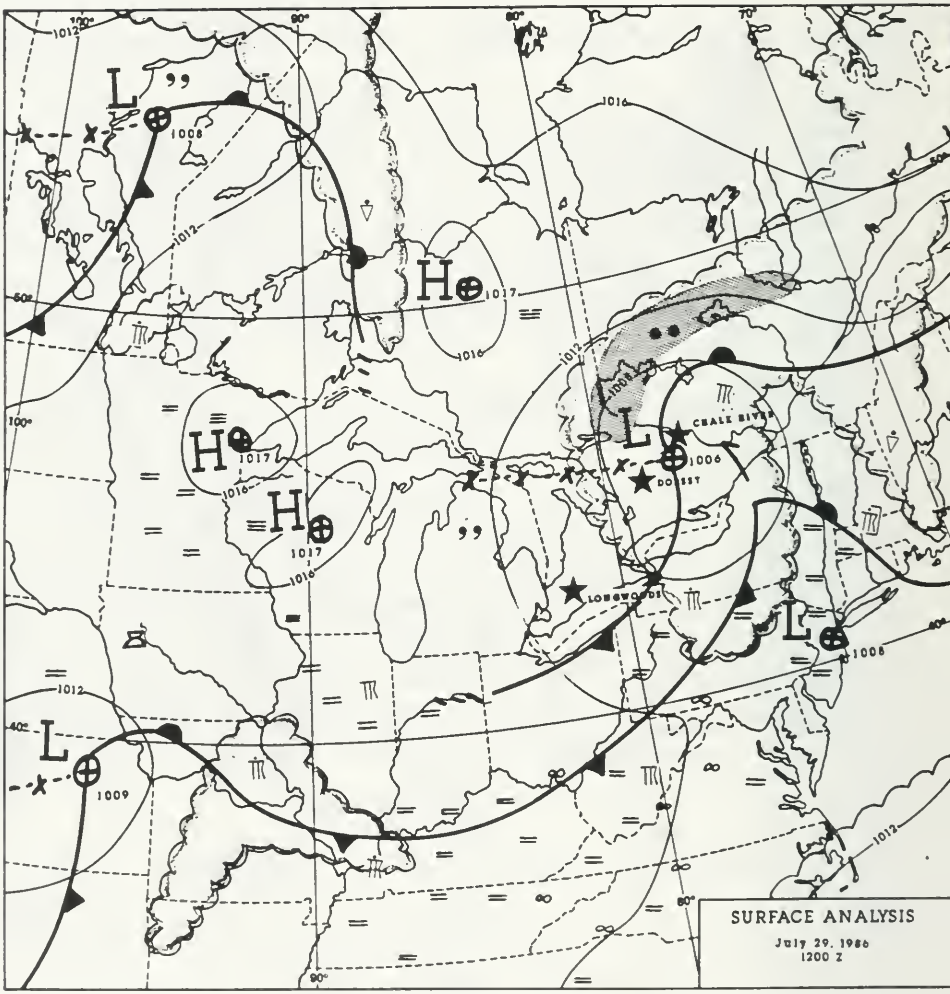

SURFACE ANALYSIS
July 29, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1008
1017
1016
1012
1006
1009

FIGURE 2.23.2

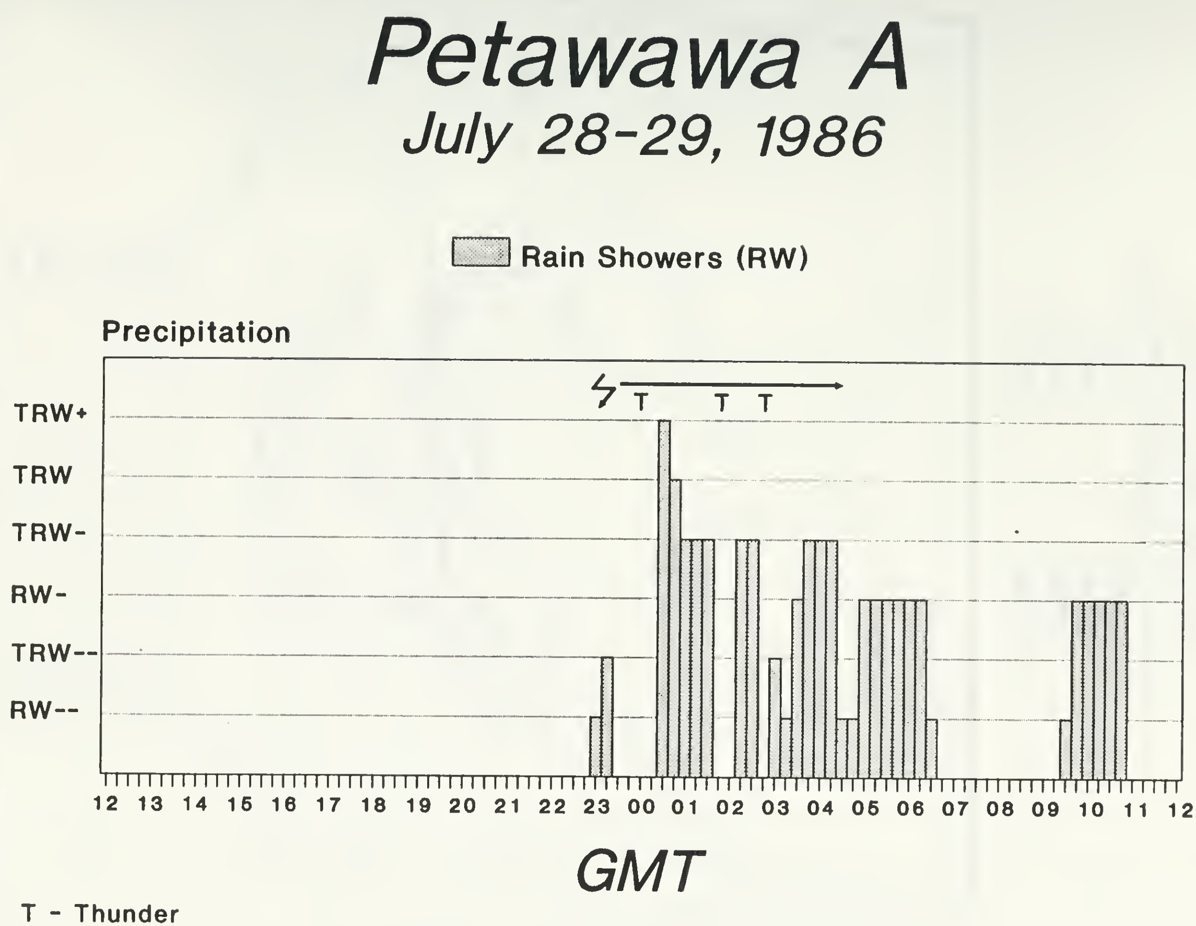

Petawawa A
July 28-29, 1986
Rain Showers (RW)
Precipitation
TRW+
TRW
TRW-
RW-
TRW--
RW--
T
T
T
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
T - Thunder

FIGURE 2.23.3

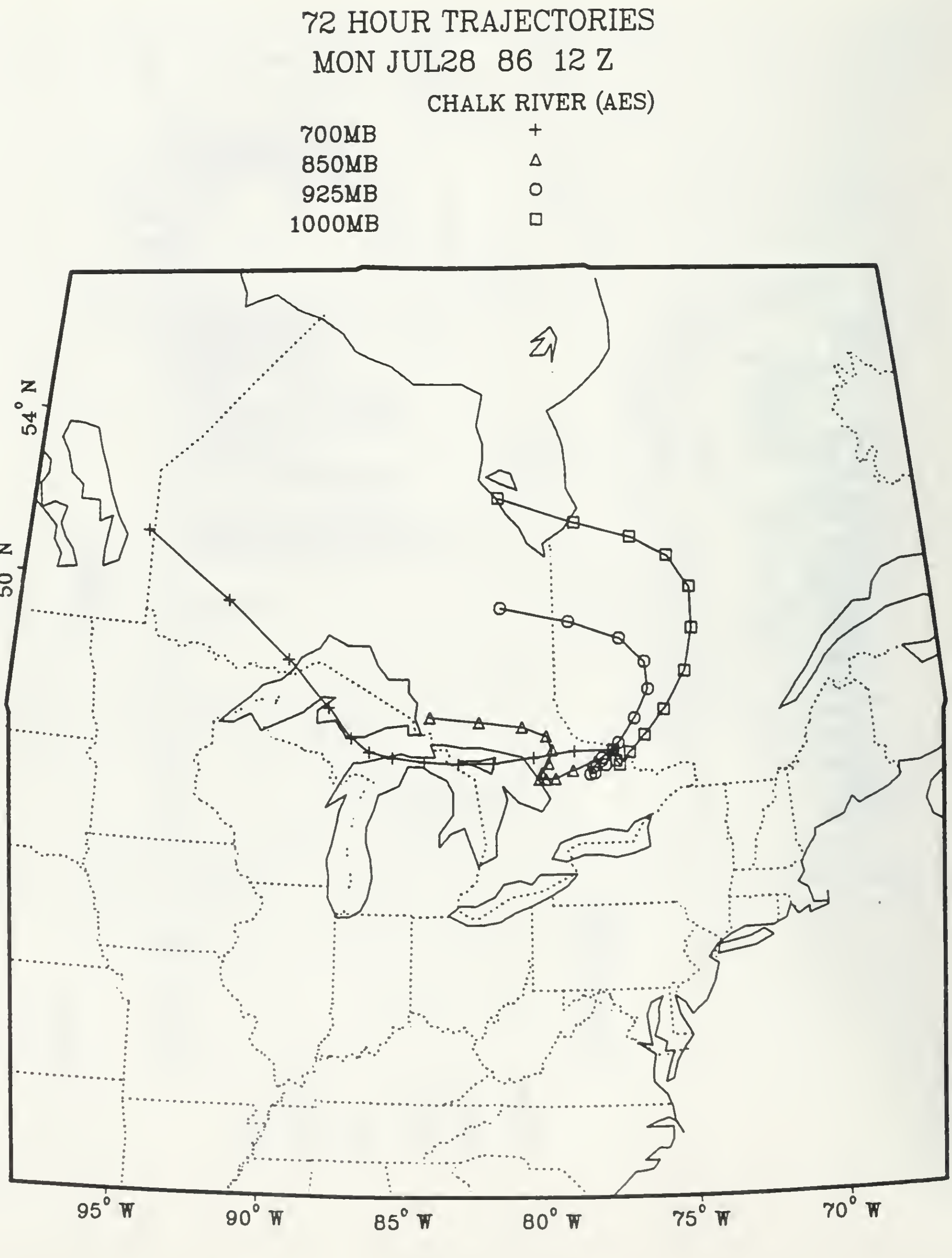

72 HOUR TRAJECTORIES
MON JUL28 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.23.4

72 HOUR TRAJECTORIES
MON JUL28 86 18 Z

CHALK RIVER (AES)

700MB	+
850MB	Δ
925MB	O
1000MB	□

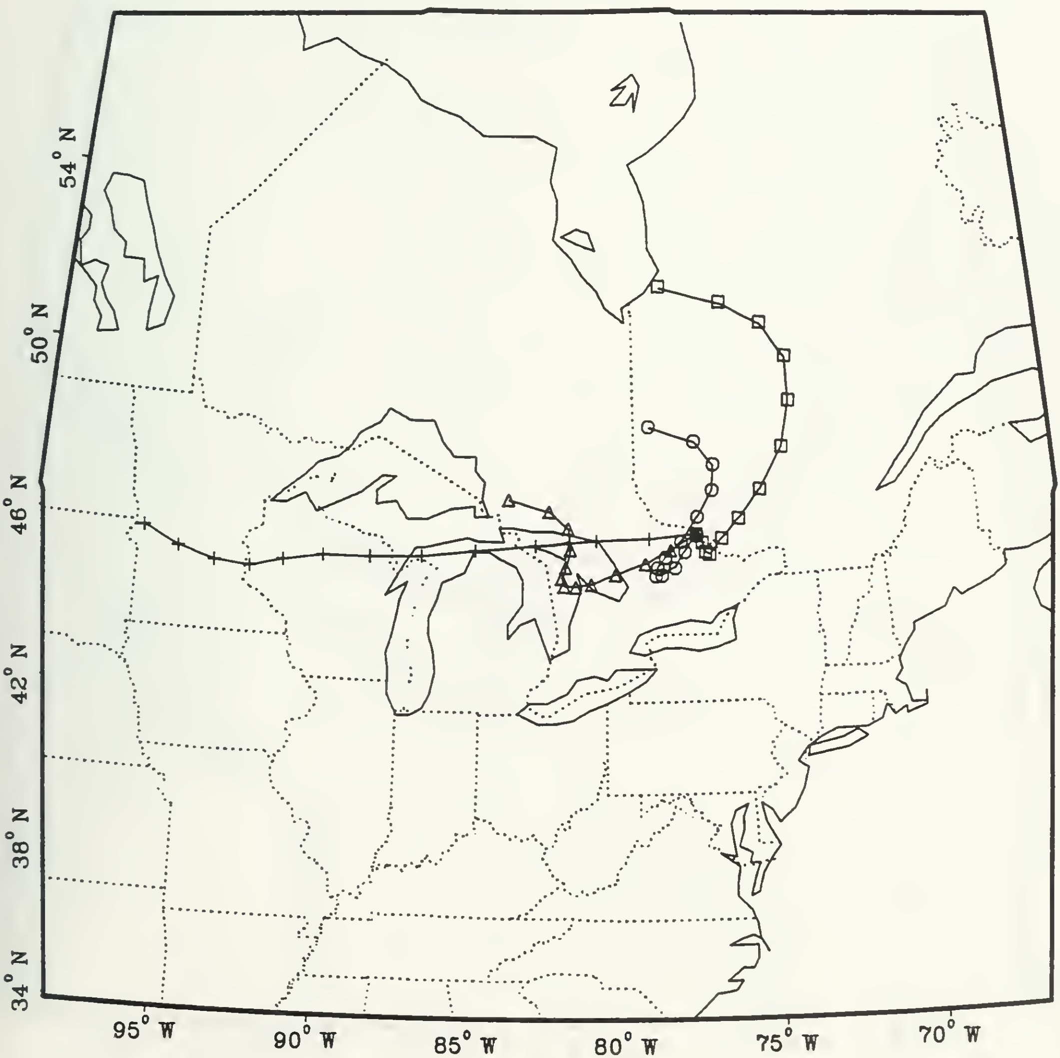


FIGURE 2.23.5

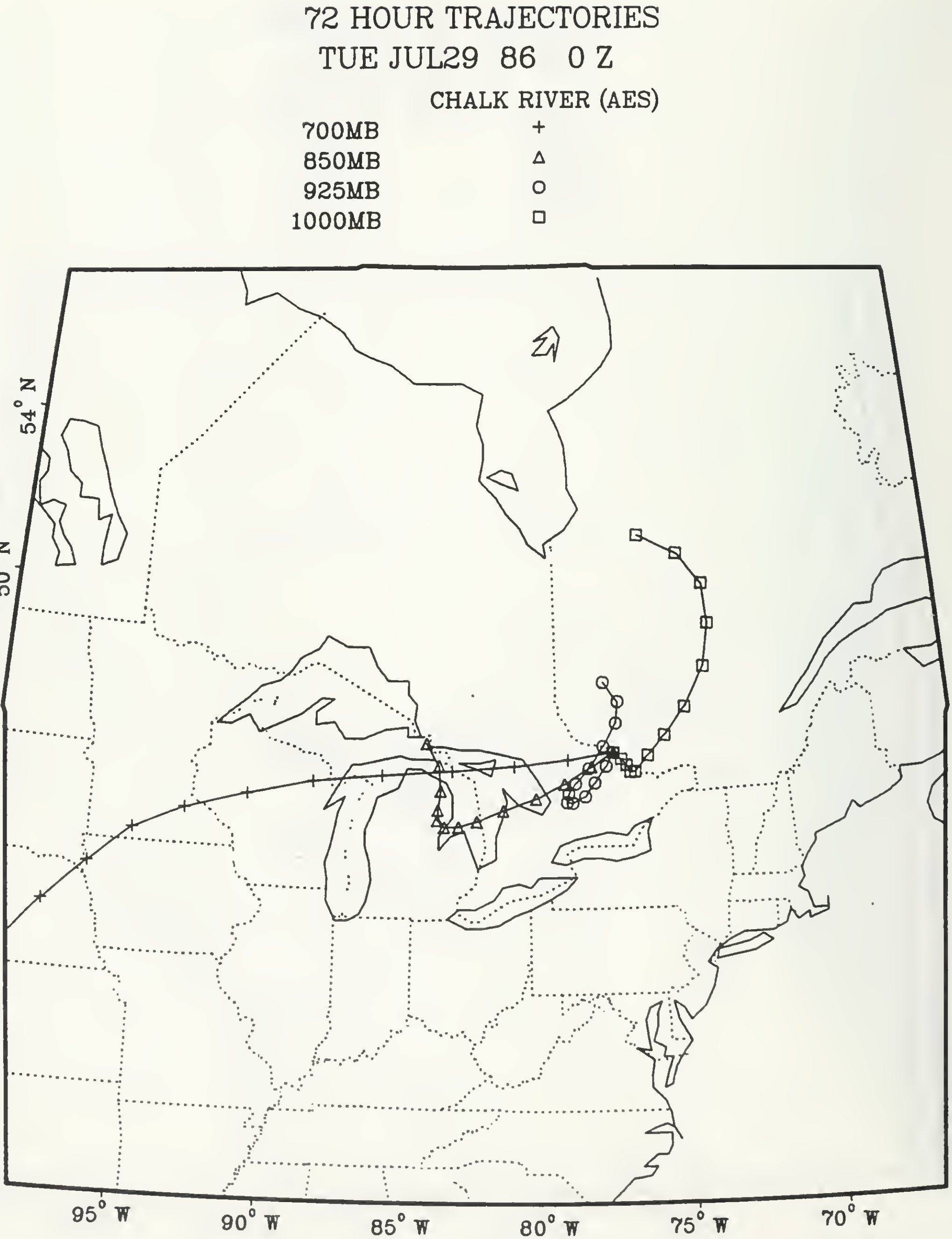

72 HOUR TRAJECTORIES
TUE JUL29 86 0 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.23.6

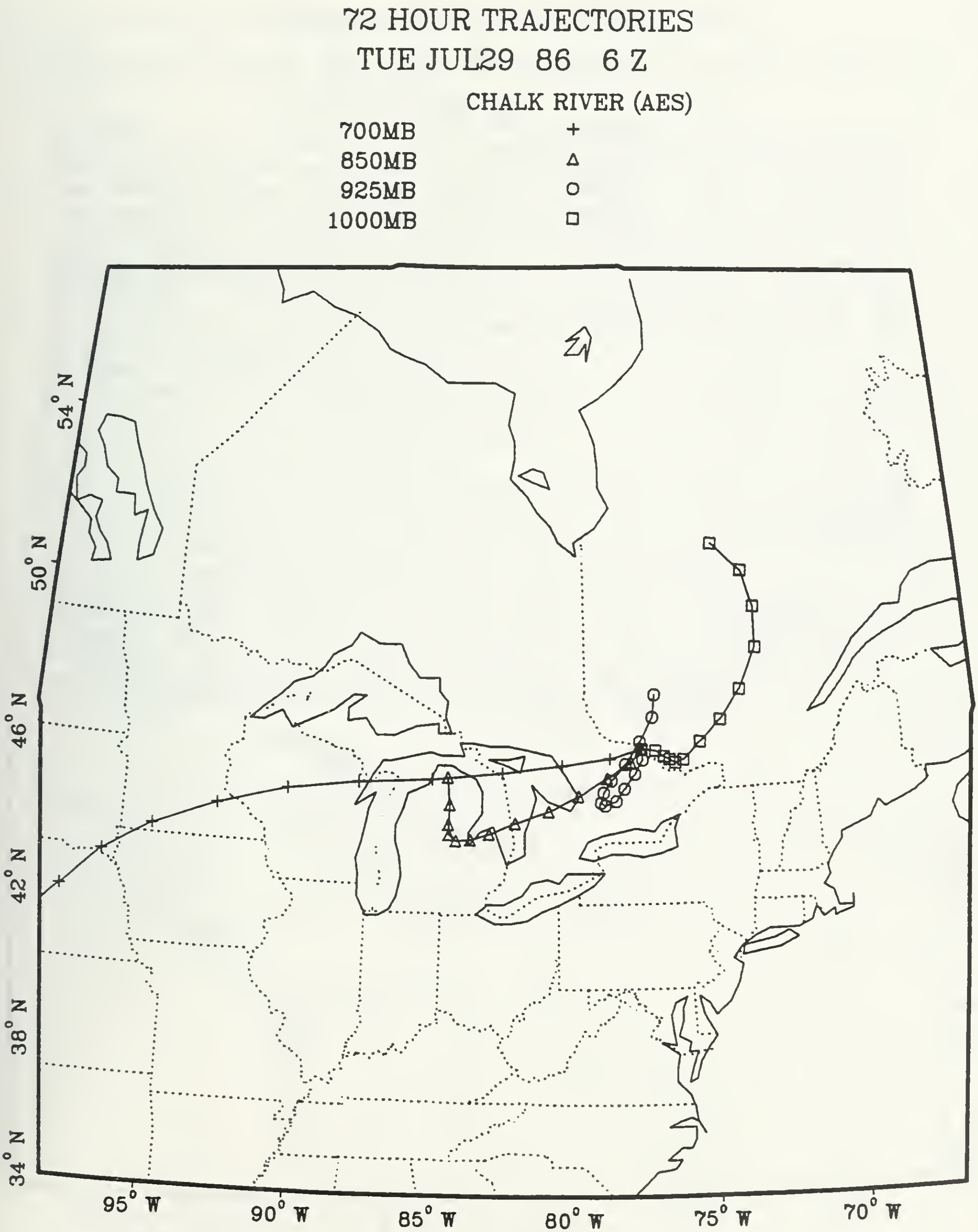

72 HOUR TRAJECTORIES
TUE JUL29 86 6 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.23.7

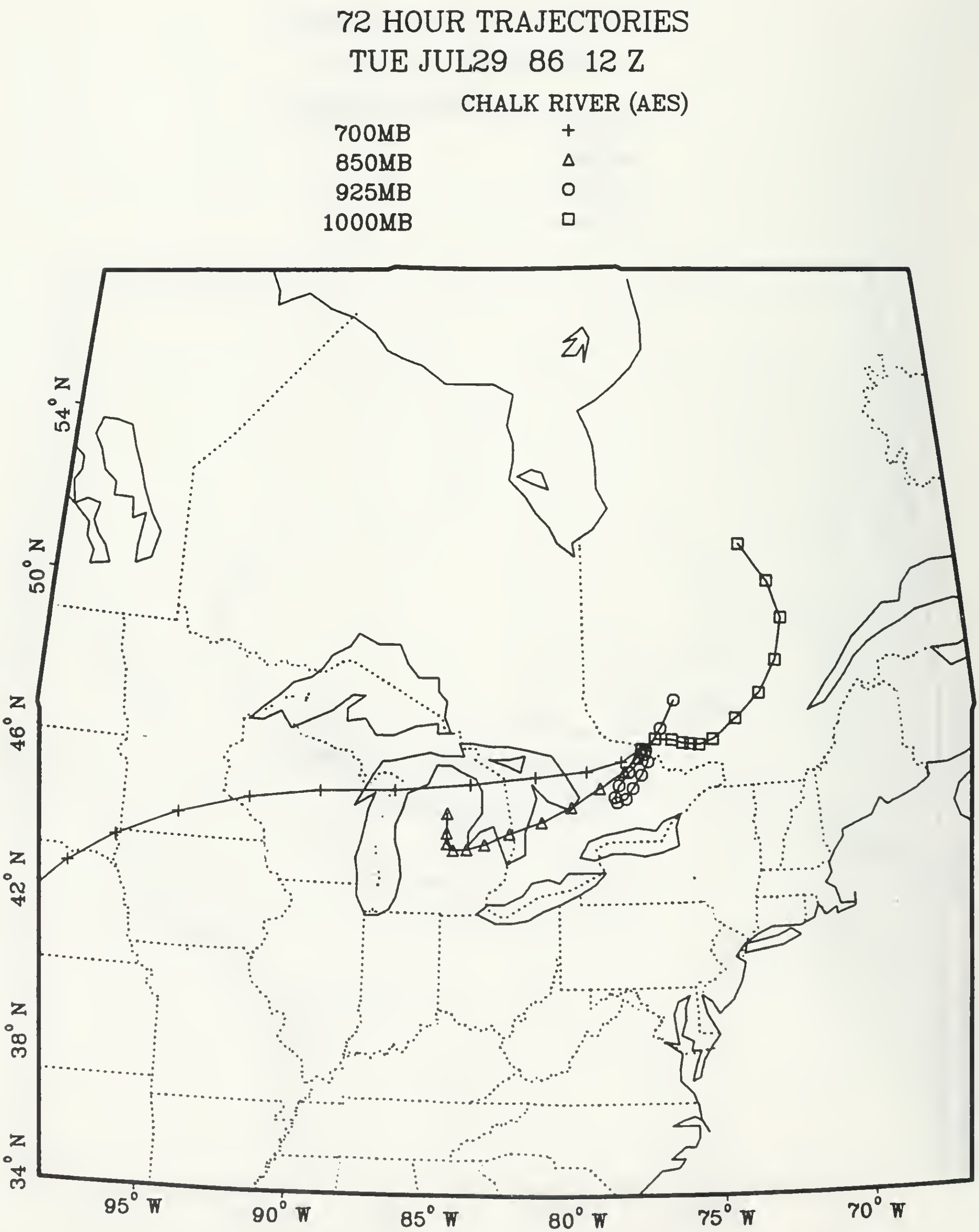

72 HOUR TRAJECTORIES
TUE JUL29 86 12 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.23.8

2.24 <u>August 2-3, 1986, Longwoods(AES) & Longwoods(MOE)</u>

This episode ranked 5th (5/10) at both stations in only the NO_3^- top 25 % wet deposition events.

On August 2, at 12Z, the synoptic weather conditions were as shown in Fig. 2.24.1. During the next synoptic period cyclogenesis and frontogenesis occurred and a new low centre south of James Bay on the Ontario-Qubec border associated with a cold front near Longwoods was observed at 18Z. This low moved very slowly eastward and on August 3, at 12Z it was located in Quebec as shown in Fig. 2.24.2. The associated cold front also moved eastward to lie near Buffalo as shown in the figure. The passage of the cold front between Aug. 2, 18Z - Aug. 3, 00Z yielded rain, rain shower and thundershowers for about 3 hours as exhibited in Fig. 2.24.3. As shown in the figure, thundershowers up to moderate intensity were recorded. Lightning were observed.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for August 2, 12Z, 18Z and August 3, 00Z, 06Z and 12Z are shown in Figures 2.24.4, 2.24.5, 2.24.6, 2.24.7, and 2.24.8 respectively.
Air trajectories for <u>all four levels</u> show that they did not pass over any highest or high NO_x emission source areas. Trajectories (specially for the 700 mb and 1000 mb) did pass over moderate emission Milwaukee area (see Figs. 2.24.4-8). This and the natural source of lightning likely caused this high episode.
Summarizing, a cold front passage yielded rain, rain showers and thundershowers lasting for about three hours. Lightnings were observed. No highest or high emission source area was involved during this episode. Transport of NO_x from its moderate Milwaukee region combined with natural production due to lightnings appear to be responsible for this high deposition episode.

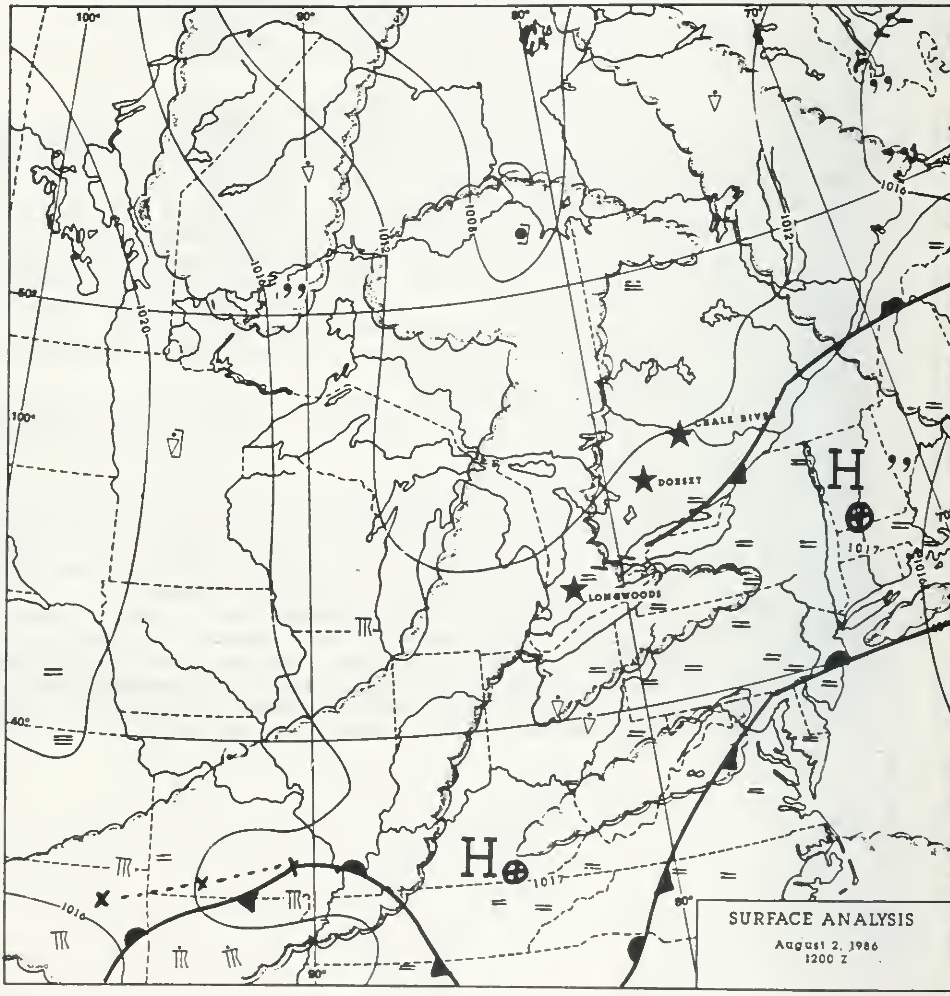

SURFACE ANALYSIS
August 2, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
H
H
1017
1017
1016
1012
1008
1020
100°
90°
80°
70°
50°
40°

FIGURE 2.24.1

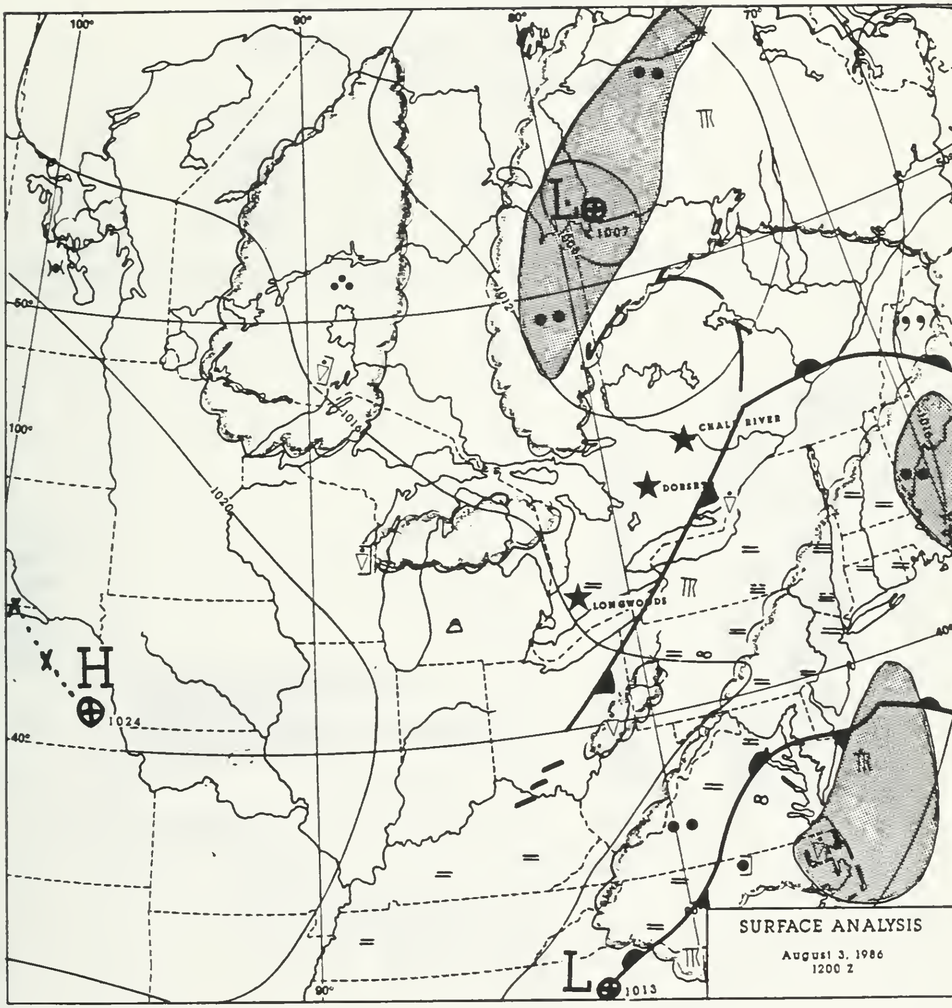

SURFACE ANALYSIS
August 3, 1986
1200 Z
CHALK RIVER
DOBSRT
LONGWOODS
1007
1024
1013
1020
1016
100°
90°
80°
70°
50°
40°

FIGURE 2.24.2

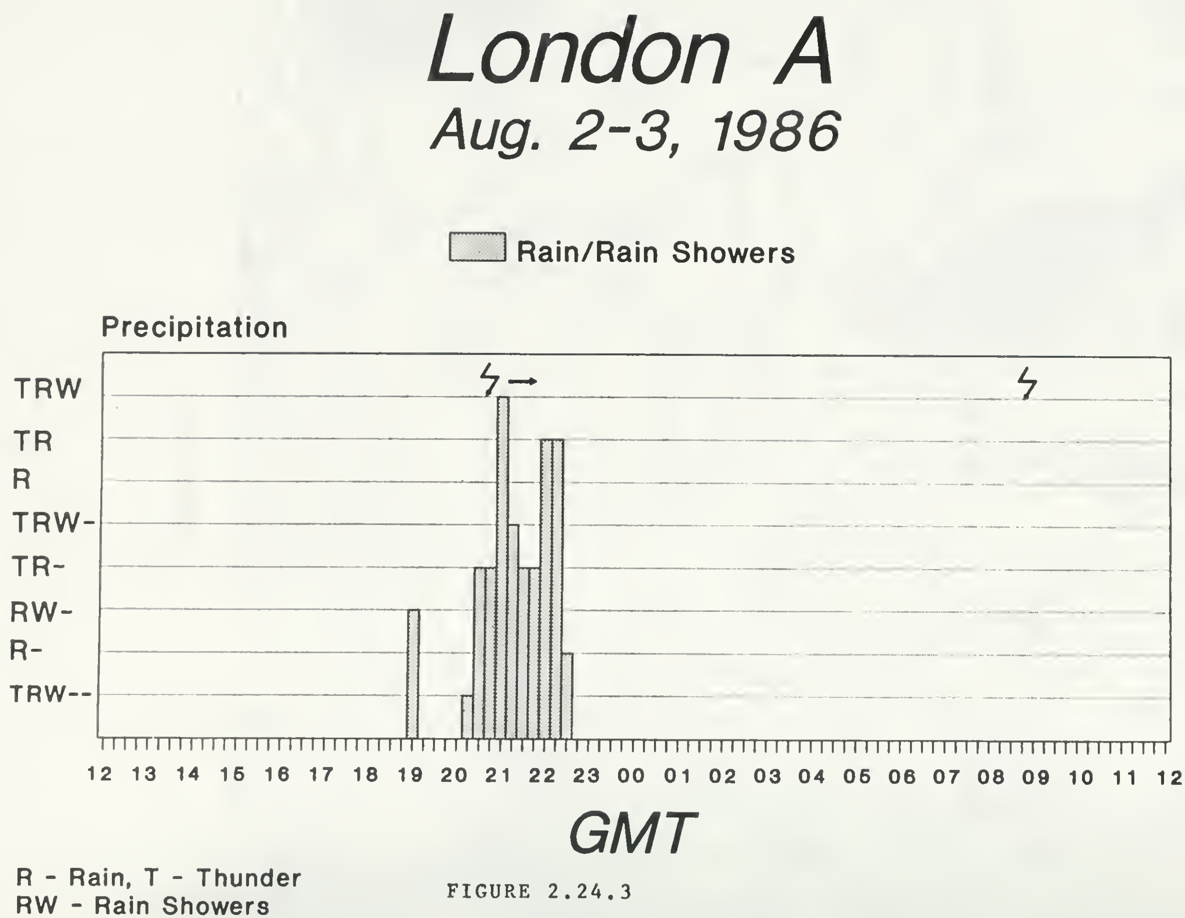

London A
Aug. 2-3, 1986
Rain/Rain Showers
Precipitation
TRW
TR
R
TRW-
TR-
RW-
R-
TRW--
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
R - Rain, T - Thunder
RW - Rain Showers

FIGURE 2.24.3

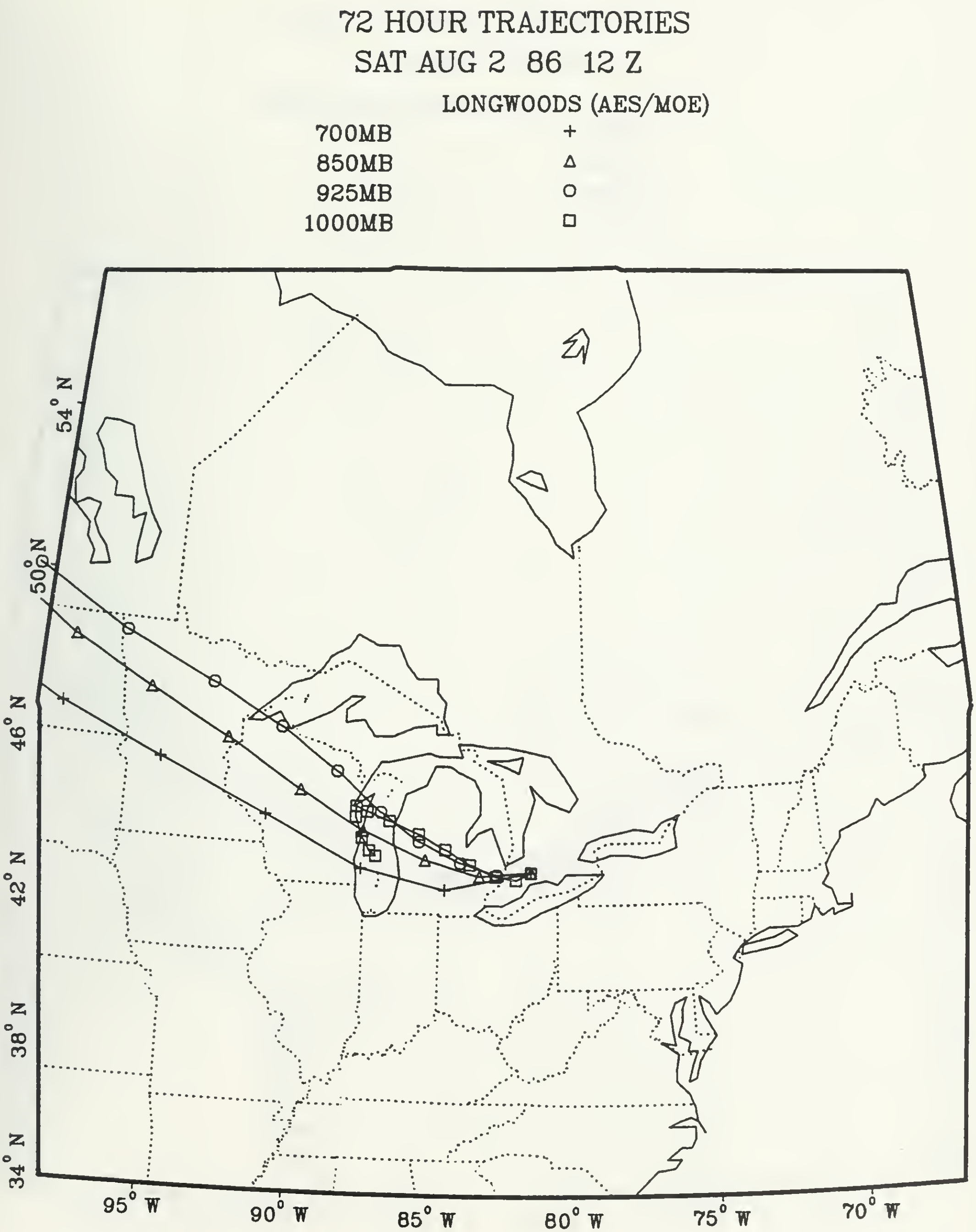

72 HOUR TRAJECTORIES
SAT AUG 2 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.24.4

72 HOUR TRAJECTORIES
SAT AUG 2 86 18 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	Δ
925MB	○
1000MB	□

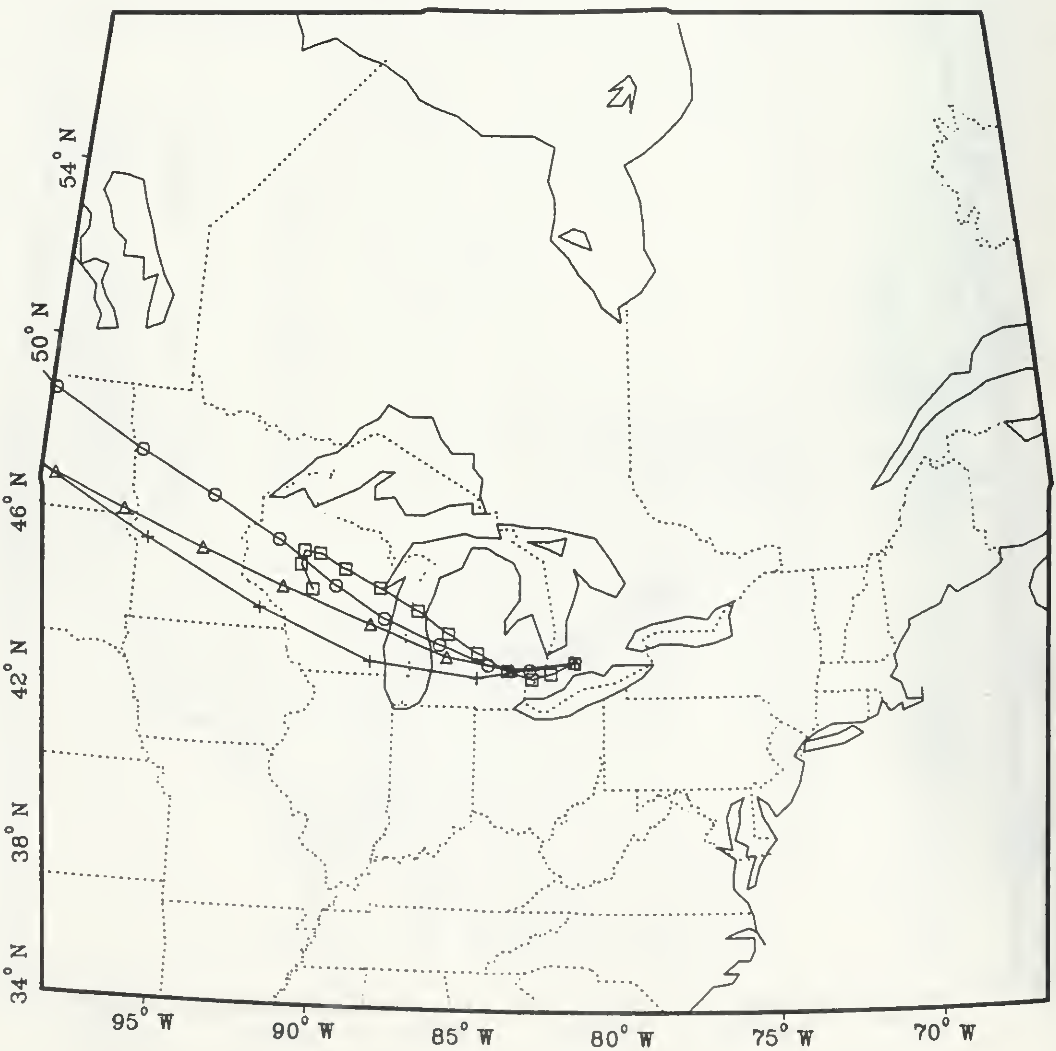


FIGURE 2.24.5

72 HOUR TRAJECTORIES
SUN AUG 3 86 0 Z

LONGWOODS (AES/MOE)

700MB	+
850MB	Δ
925MB	○
1000MB	□

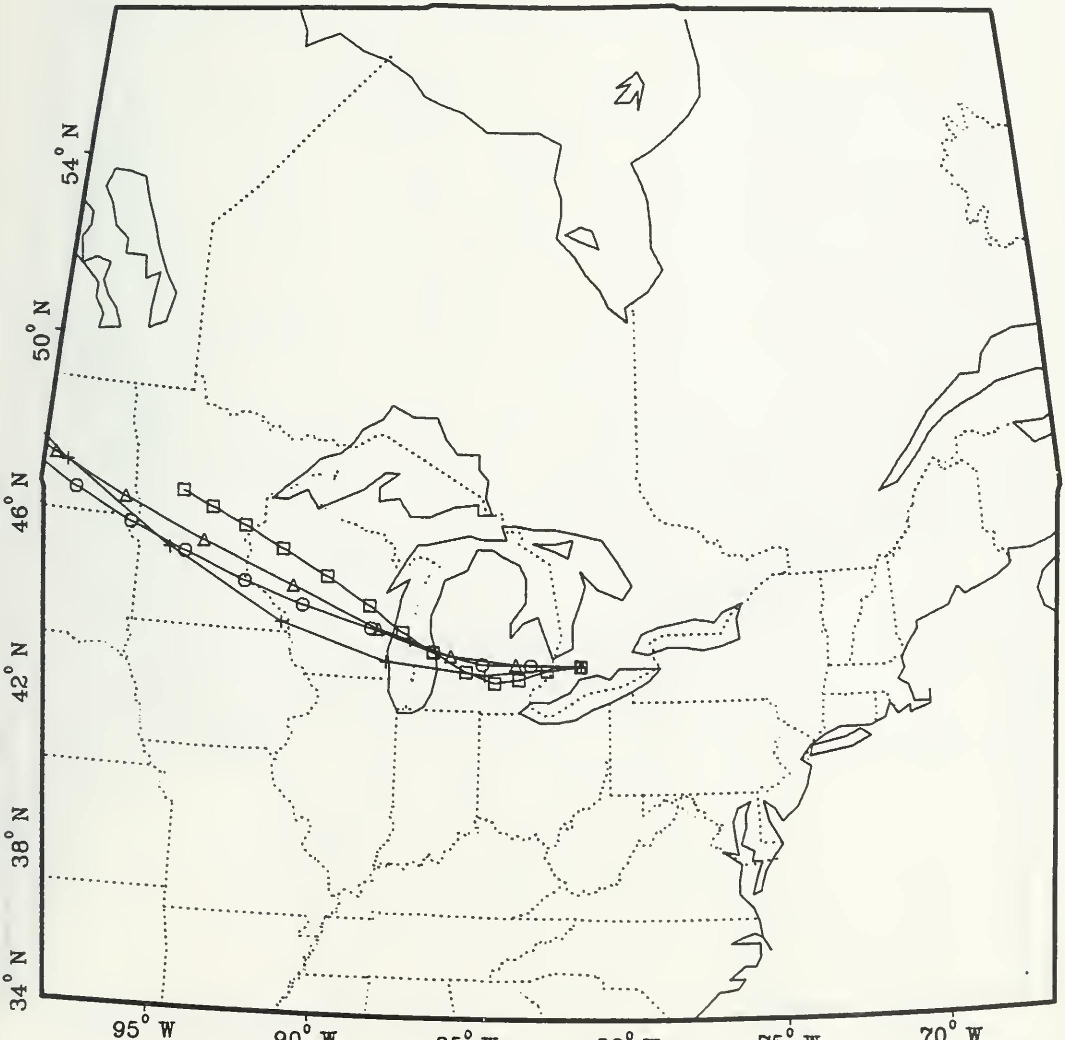


FIGURE 2.24.6

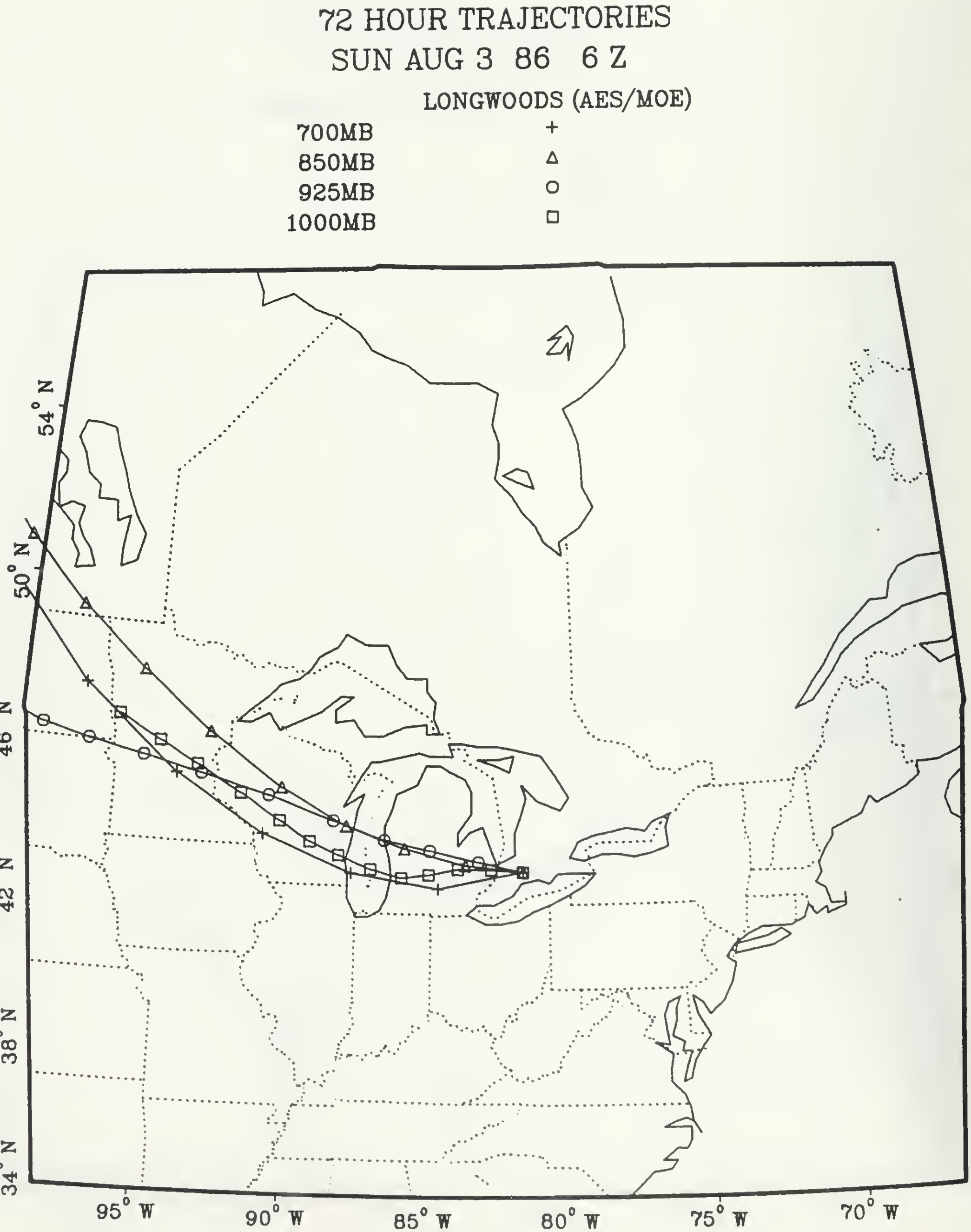

72 HOUR TRAJECTORIES
SUN AUG 3 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.24.7

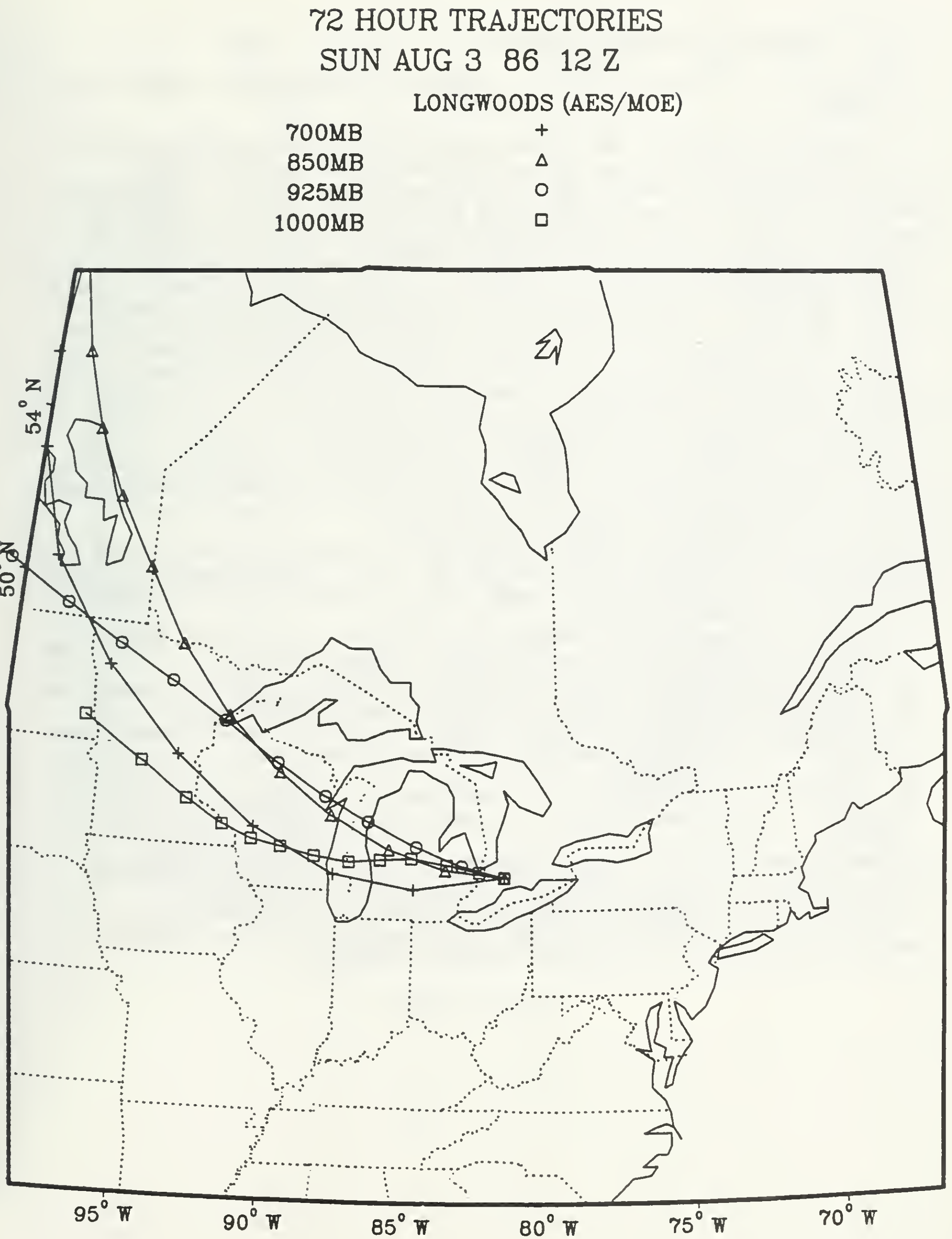

72 HOUR TRAJECTORIES
SUN AUG 3 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.24.8

2.25 August 8-9, 1986, Dorset

This episode ranked 5th (5/7) in the top 25% $SO_4^=$ wet deposition events.

On August 8, at 12Z, two frontal systems, one associated with a wave east of Chicago and a low over Buffalo, and the other associated with a wave over Lake superior and a low over Quebec-Labrador border were analyzed in the surface weather chart as shown in Fig. 2.25.1. As exhibited in the figure, trowls were associated with both waves and thunderstorms were observed widely. During the next 24 hours, the lower system first moved NE with the result that the warm front crossed over Longwoods by 18Z. The lower wave which lied over Lake Huron at this time then moved eastward and the cold front passed over the station. Also, the upper system first moved SE and then eastward and the cold front laid over Longwoods as shown in Fig. 2.25.2. The passage of two cold fronts over Dorset yielded very light and light rain showers, and light and moderate thundershowers as shown in Fig. 2.25.3. Since continuous observations are not available, it's not possible to estimate the total duration of the precipitation but it's clear that rain showers at the end of the episode are associated with the second cold front.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for August 8, 12Z, 18Z and August 9, 00Z, 06Z and 12Z are shown in Figures 2.25.4, 2.25.5, 2.25.6, 2.25.7, and 2.25.8 respectively.
Air trajectories for the 1000 mb level show that transport of SO_2 from any of its highest emission area was not likely.
Air trajectories for the 925 mb level also show that transport of SO_2 from any of its highest emission area was unlikely.
Air parcels arriving at the 850 mb level show that SO_2 could have been carried from the highest emission Detroit (Fig. 2.25.4-5) area.
Air parcels arriving at the 700 mb level show that transport of SO_2 from its highest emission Chicago (Fig. 2.25.4) area was probable.
Summarizing, two cold fronts passed over the station yielding very light and light rain showers and light and moderate thundershowers. Thunder was heard during this episode. Significant transport of SO_2 at high levels from its highest emission Detroit and Chicago area was likely.

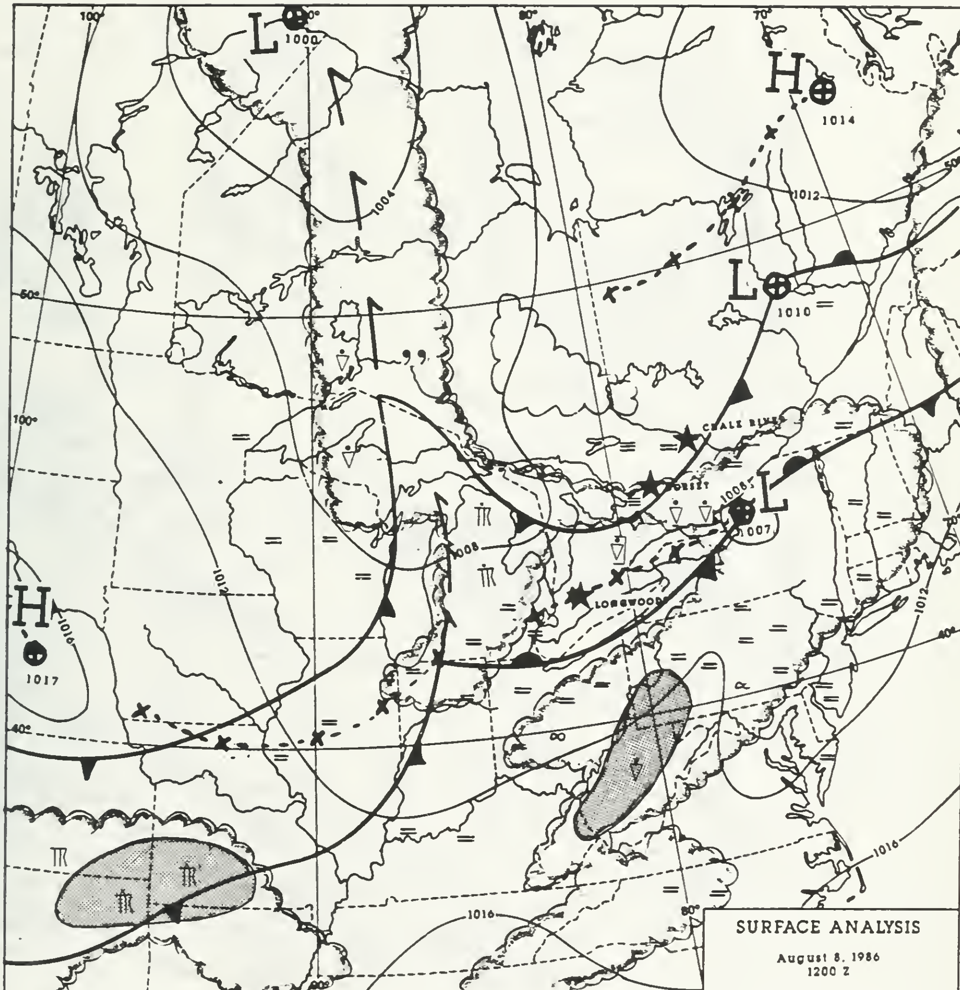

SURFACE ANALYSIS
August 8, 1986
1200 Z
CHALK RIVER
LONGWOOD
1000
1004
1008
1012
1014
1010
1007
1016
1017

FIGURE 2.25.1

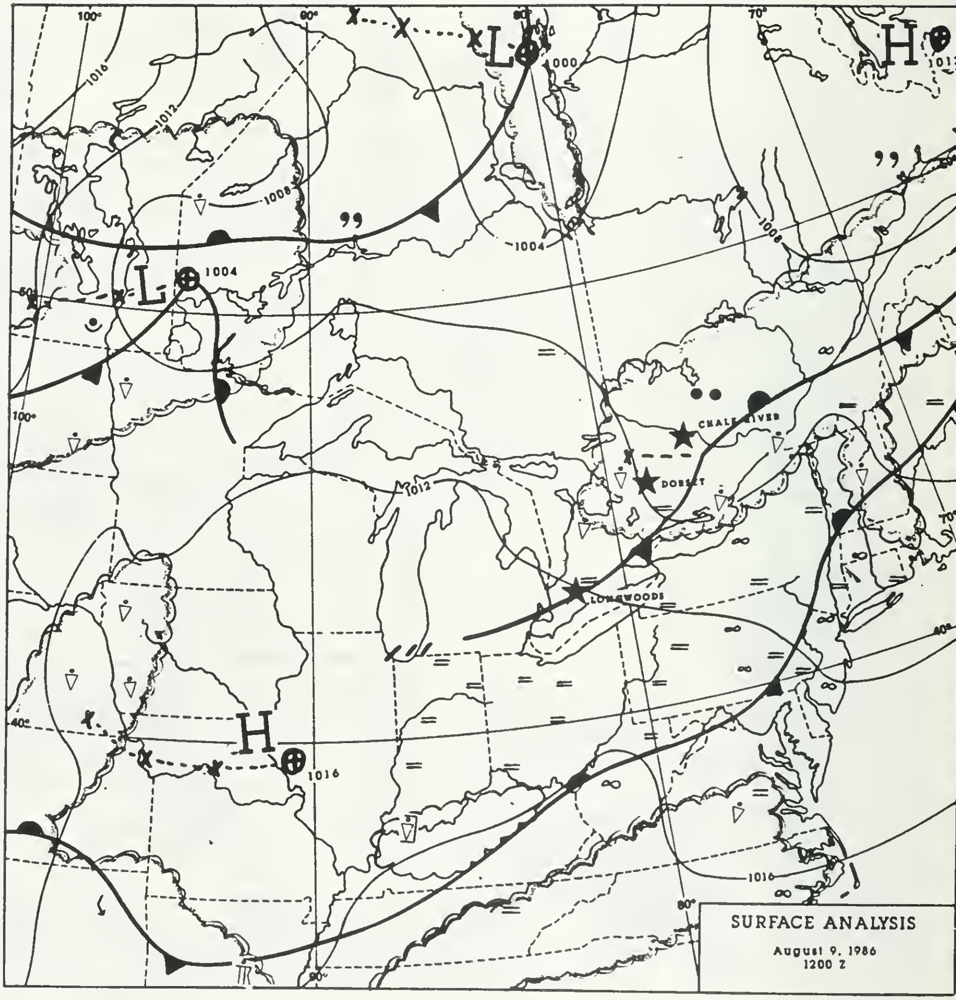
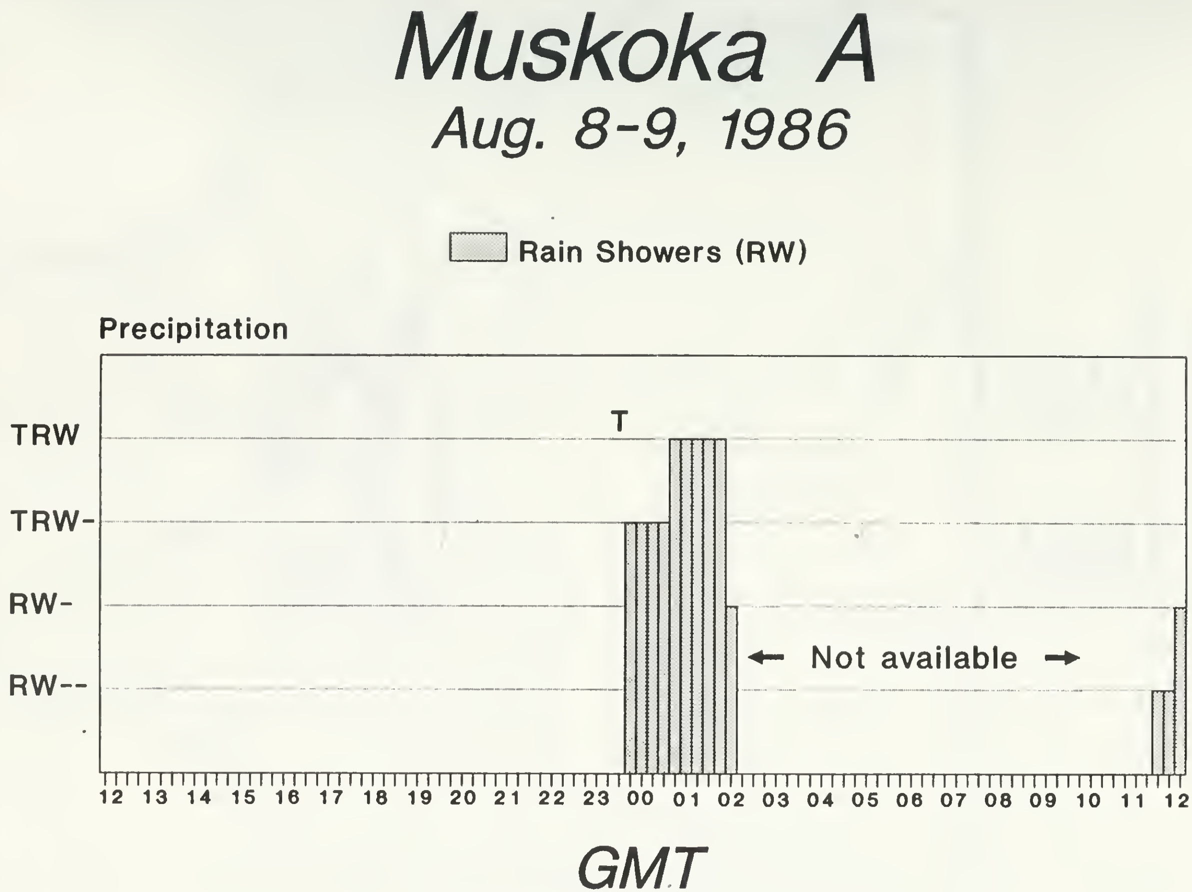

SURFACE ANALYSIS
August 9, 1986
1200 Z
DORSET
1004
1000
1008
1012
1016

FIGURE 2.25.2



Muskoka A
Aug. 8-9, 1986
Rain Showers (RW)
Precipitation
TRW
TRW-
RW-
RW--
T
← Not available →
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
T - Thunder

FIGURE 2.25.3

72 HOUR TRAJECTORIES
FRI AUG 8 86 12 Z

	DORSET (MOE)
700MB	+
850MB	Δ
925MB	○
1000MB	□

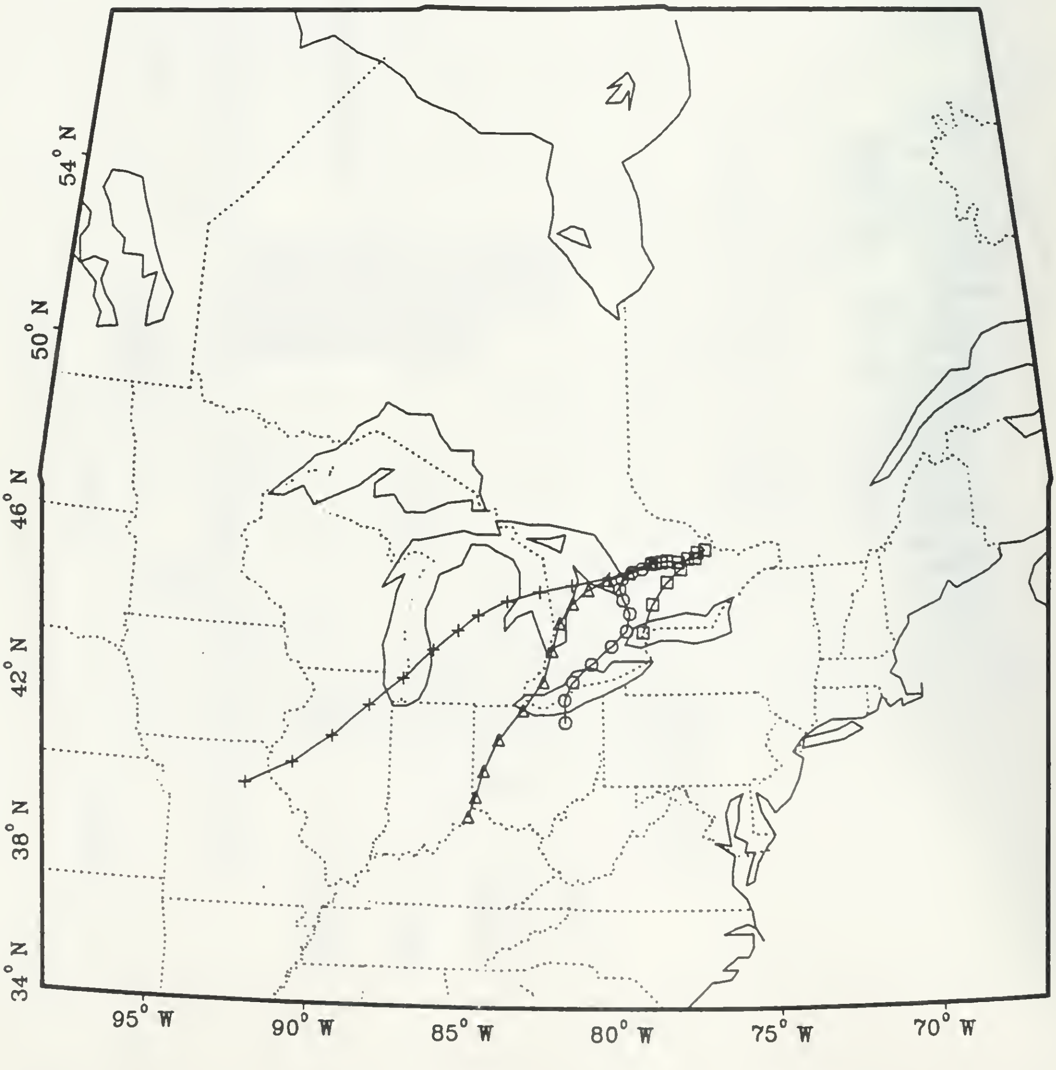


FIGURE 2.25.4

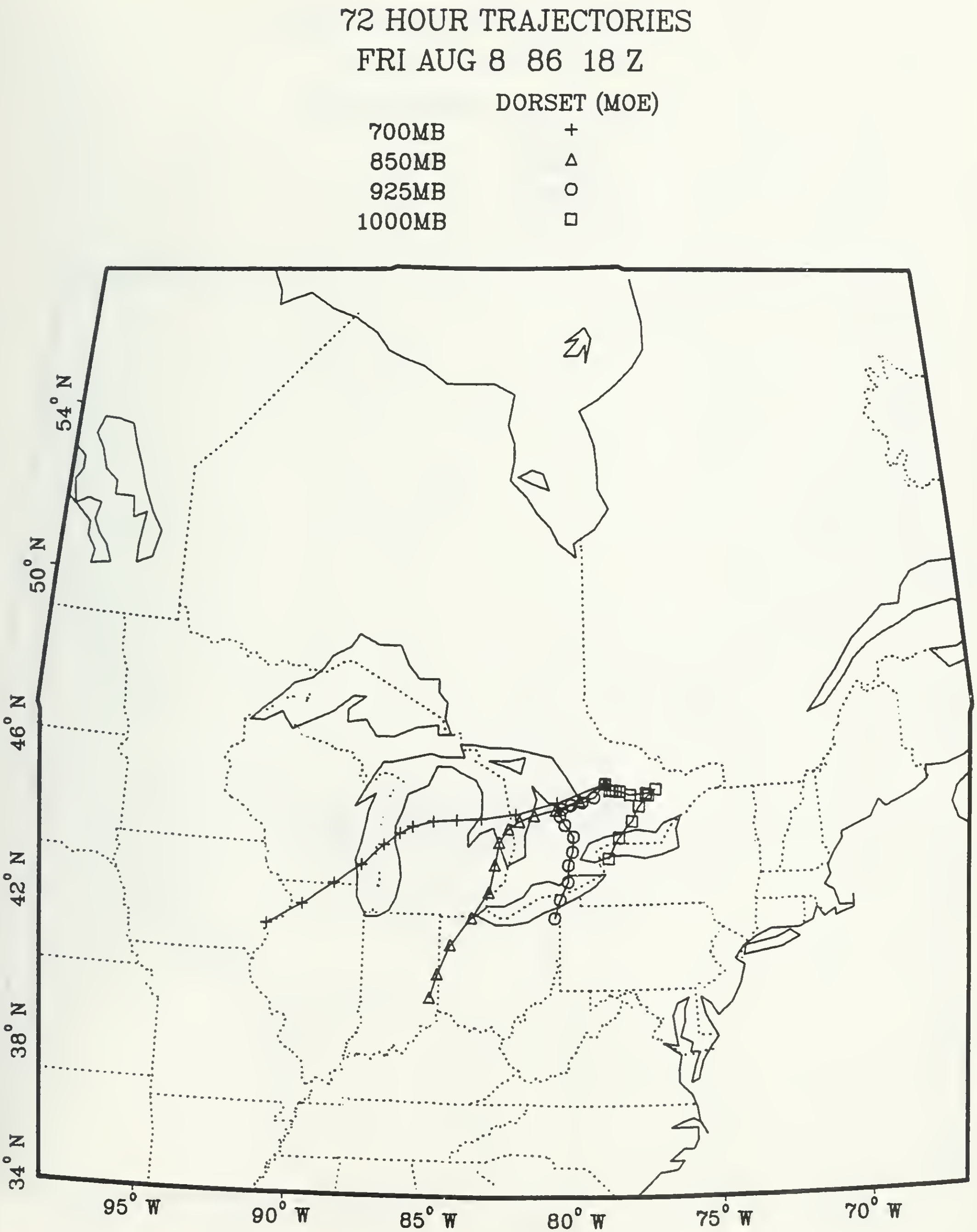

72 HOUR TRAJECTORIES
FRI AUG 8 86 18 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.25.5

72 HOUR TRAJECTORIES
SAT AUG 9 86 0 Z

	DORSET (MOE)
700MB	+
850MB	Δ
925MB	O
1000MB	□

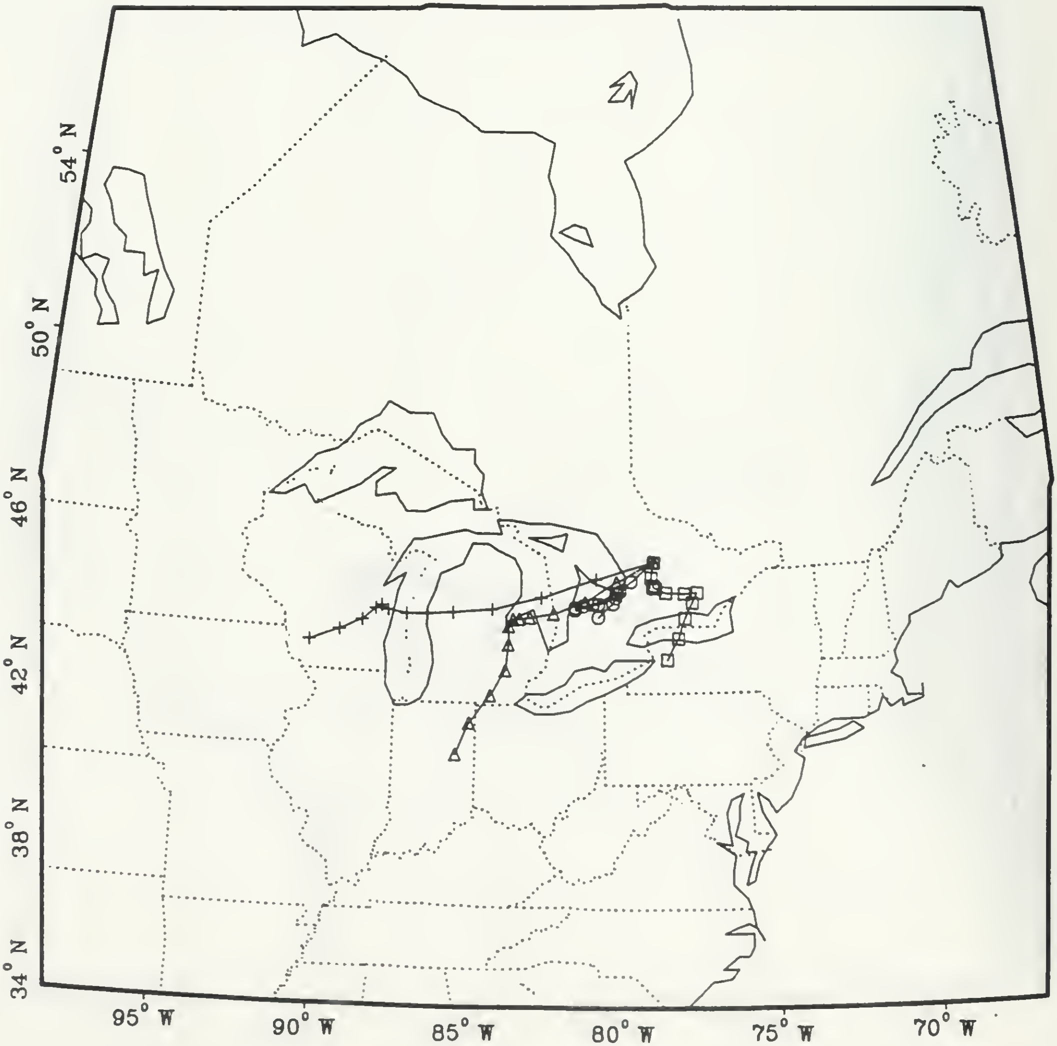


FIGURE 2.25.6

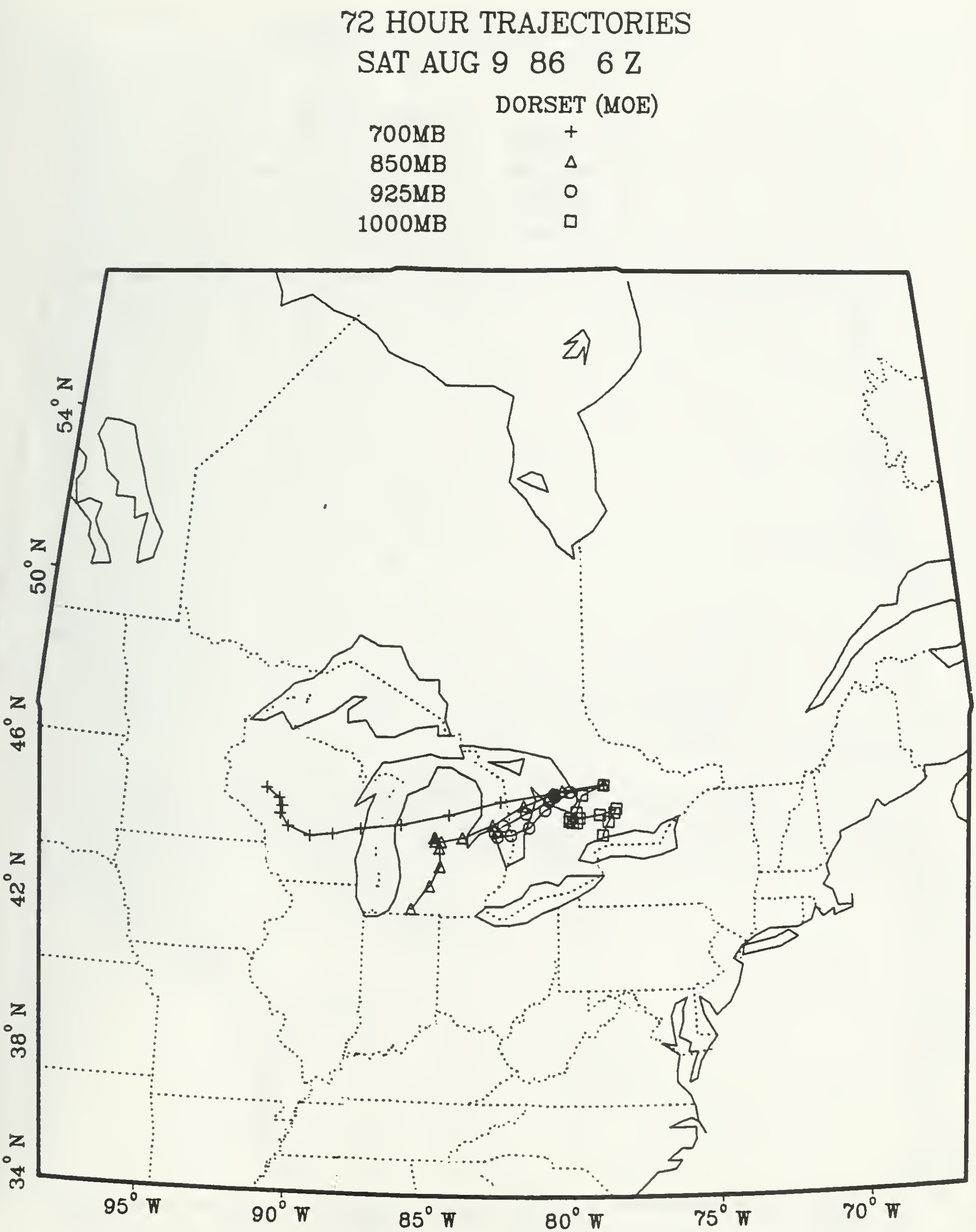

72 HOUR TRAJECTORIES
SAT AUG 9 86 6 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.25.7

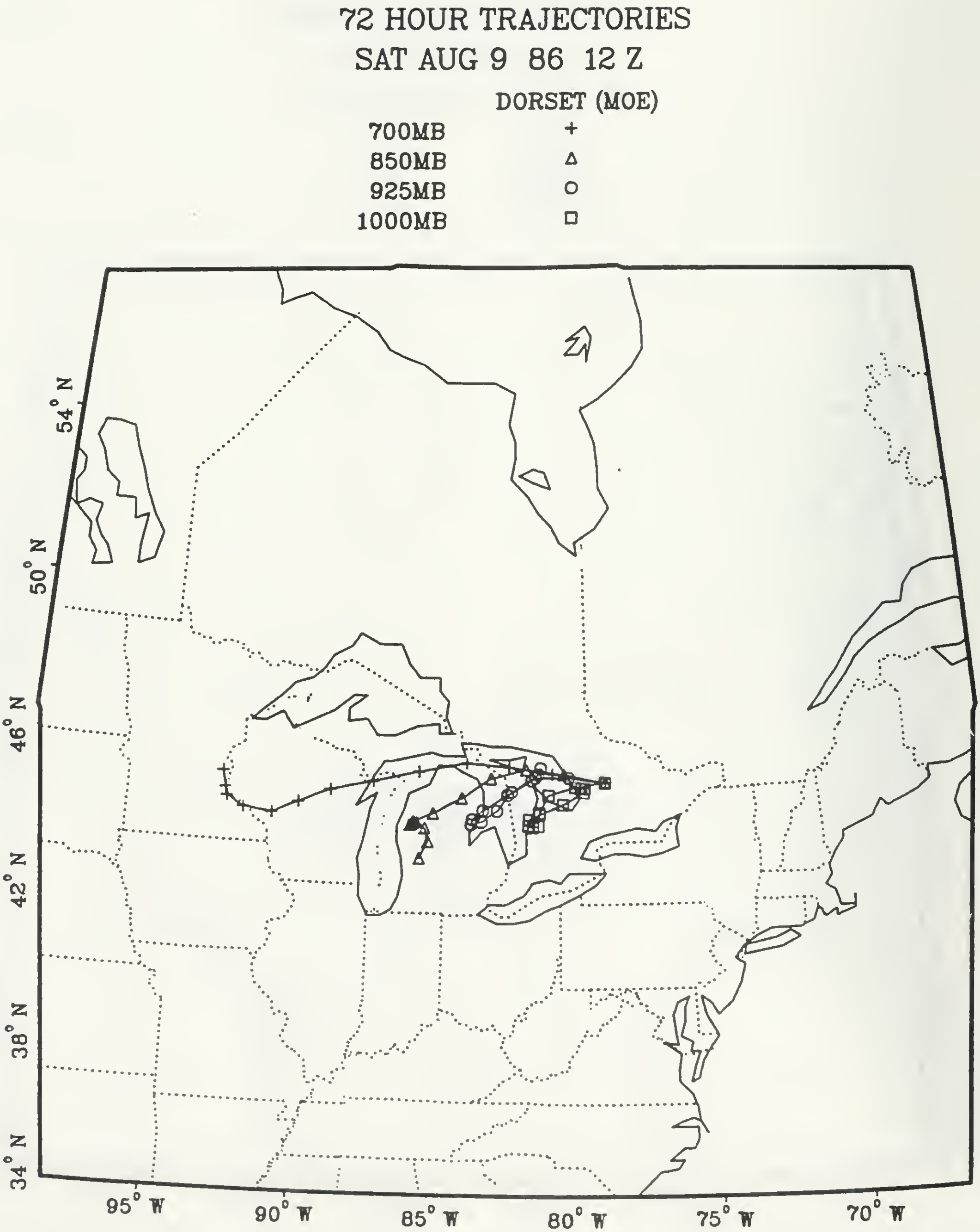

72 HOUR TRAJECTORIES
SAT AUG 9 86 12 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.25.8

2.26 August 10-11, 1986, Chalk River

This episode ranked 5th (5/6) in only the top 25% $SO_4^=$ wet deposition events.
On August 10, at 12Z, as shown in Fig. 2.26.1, a low pressure centre, 1009 mb, over Indiana- Illinois border, associated with a frontal system in USA and a trowl and a continuous precipitation area was observed. Another two frontal systems in a NNE-SSW direction over northern Ontario and Wisconsin, Iowa and Minnesota in USA were also observed as shown in the figure. Continuous precipitation areas were also associated with these systems. During the next 24 hours, the indiana-Illinois low went through cyclolysis and the wave passed south of Chalk River and the trowl crossed over the station. Cyclogenesis developed on the upper system and a low was observed at 18Z near Sault Ste. Marie. This low moved approximately NE and on August 11, at 12Z, it was located over Quebec with the cold front just east of Chalk river. The trowl and the wave gave light rain and very light and light rain showers lasting for about three hours as shown in Fig. 2.26.3.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for August 10, 12Z, 18Z and August 11, 00Z, 06Z and 12Z are shown in Figures 2.26.4, 2.26.5, 2.26.6, 2.26.7, and 2.26.8 respectively.
Air parcels arriving at the 1000 mb level show that SO_2 from its highest emission Chicago (Fig. 2.26.6-7) area could have been carried.
Air trajectories for the 925 mb level show that SO_2 from its highest emission Sudbury (Fig. 2.26.4), Detroit (Fig. 2.26.7) and Chicago (Fig. 2.26.7) areas could have been transported.
Air trajectories for the 850 mb level show that SO_2 from its highest emission Sudbury (Fig. 2.26.4), Detroit (Fig. 2.26.7) and Chicago (Fig. 2.26.7) areas could have been transported.
Air parcels arriving at the 700 mb level could have transported SO_2 from its highest emission Sudbury (Fig. 2.26.4&8) and Chicago (Fig. 2.26.7) areas.
In summary, a passage of a trowl over the station and a wave in the vicinity yielded very light and light rain showers and light rain lasting for about three hours. High level and low level transports of SO_2 from Sudbury, Detroit and Chicago areas were likely.

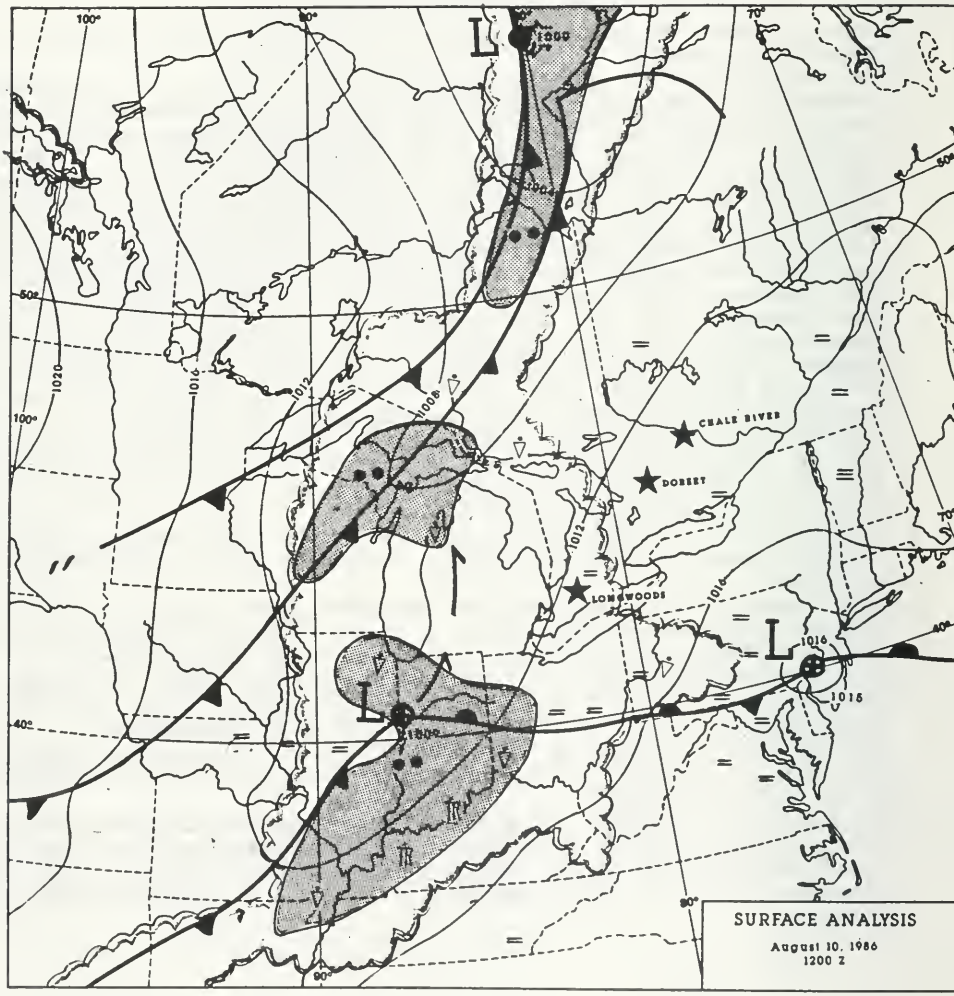

SURFACE ANALYSIS
August 10, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS

FIGURE 2.26.1

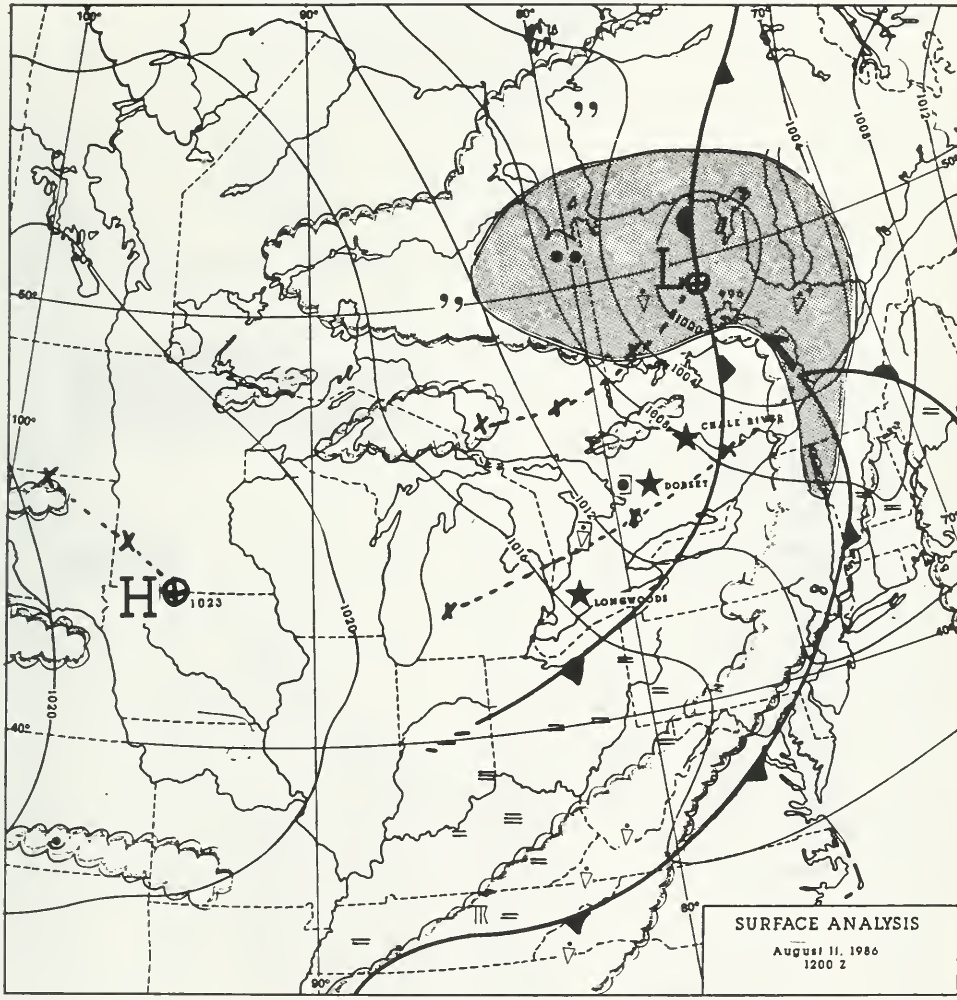

SURFACE ANALYSIS
August 11, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1023
1020
1016
1012
1008
1004
1000
996

FIGURE 2.26.2

Petawawa A

Aug. 10-11, 1986

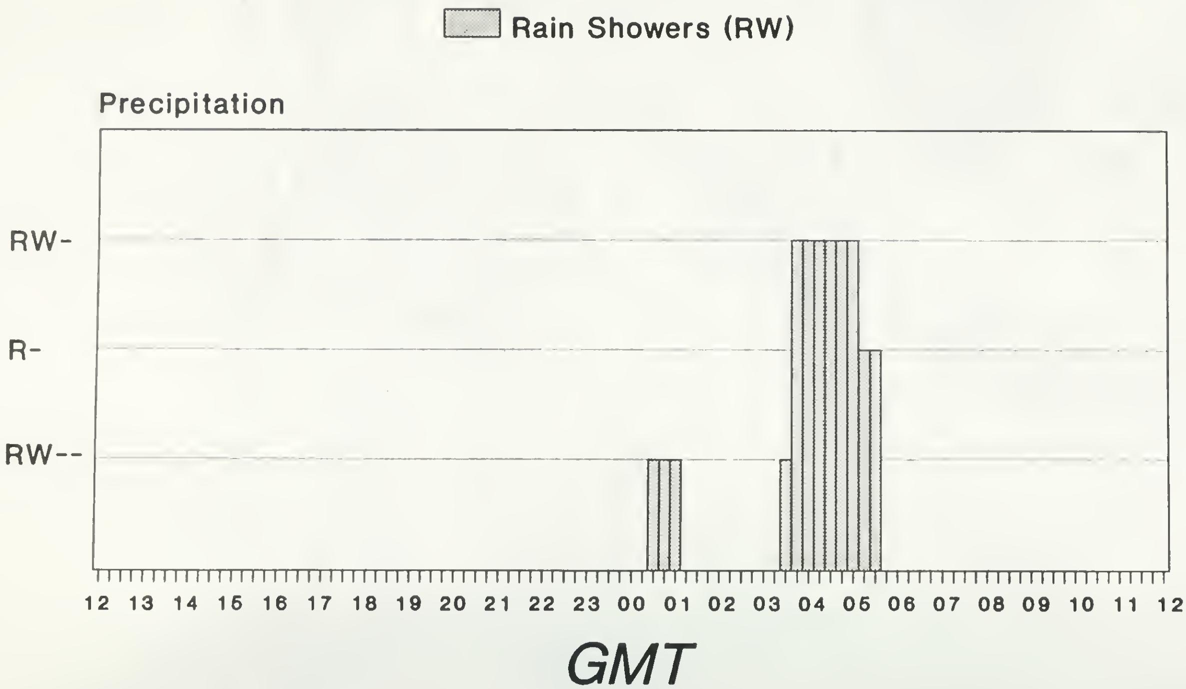


FIGURE 2.26.3

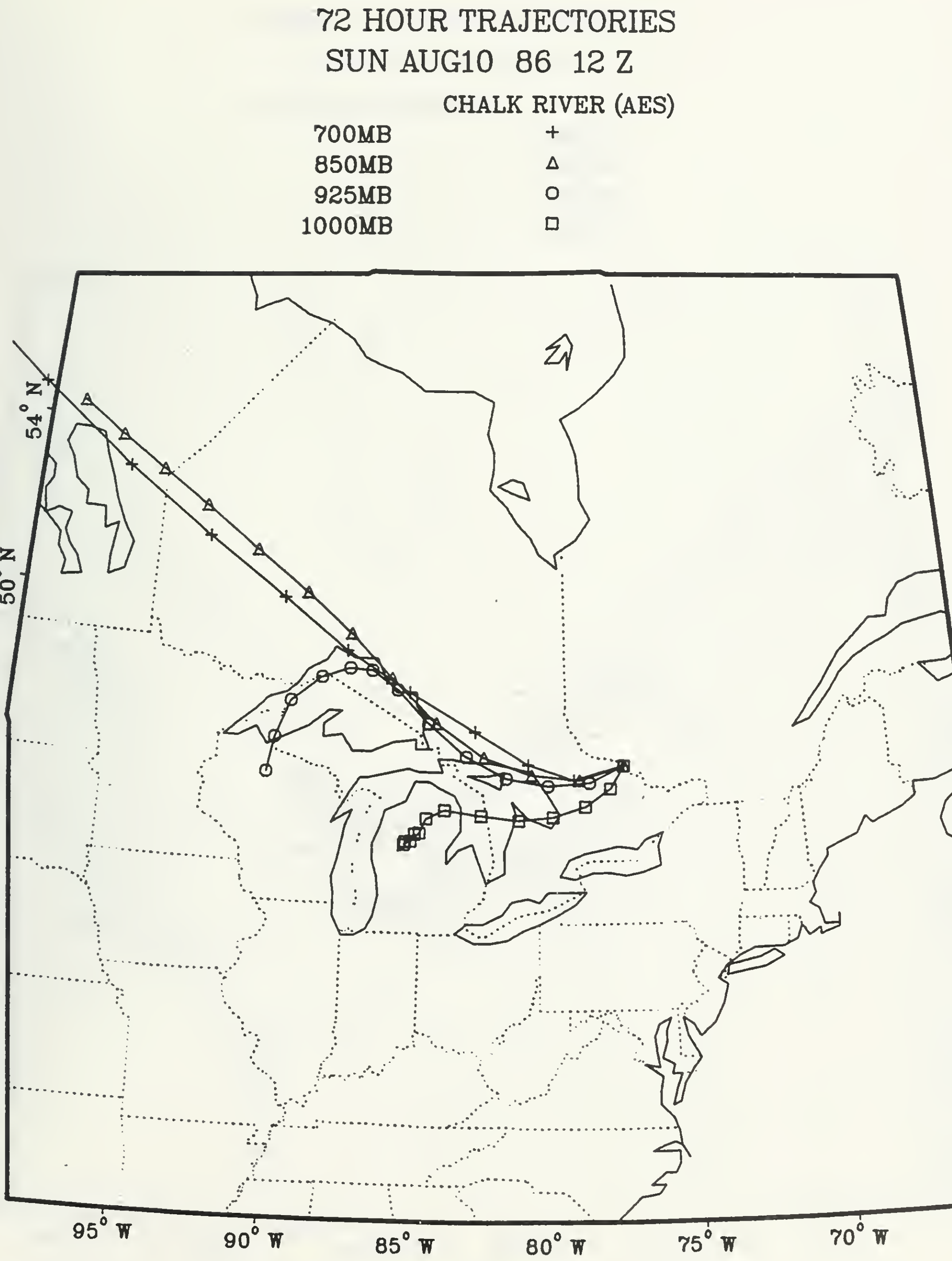

72 HOUR TRAJECTORIES
SUN AUG10 86 12 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.26.4

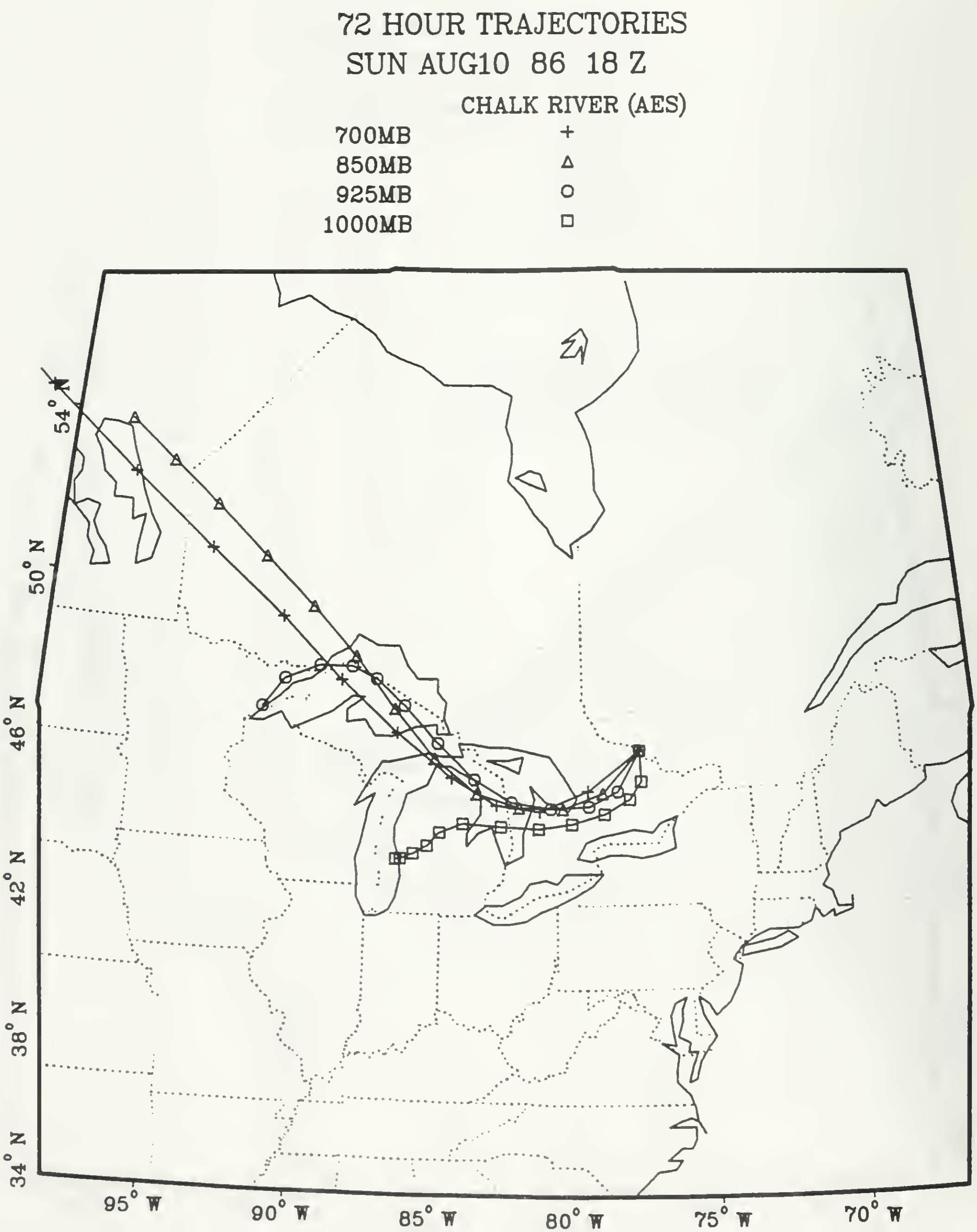

72 HOUR TRAJECTORIES
SUN AUG10 86 18 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.26.5

72 HOUR TRAJECTORIES
MON AUG11 86 0 Z

CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

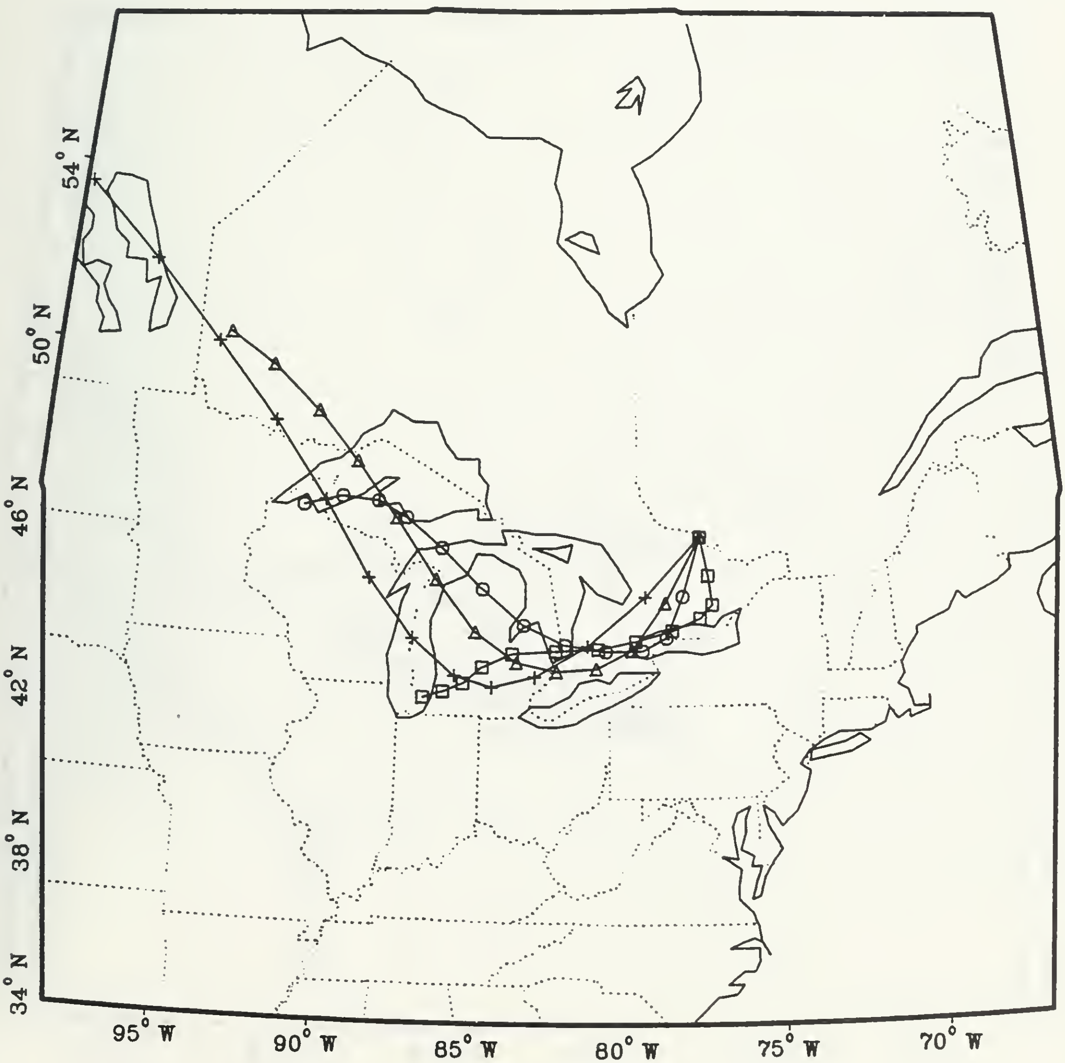


FIGURE 21.26.6

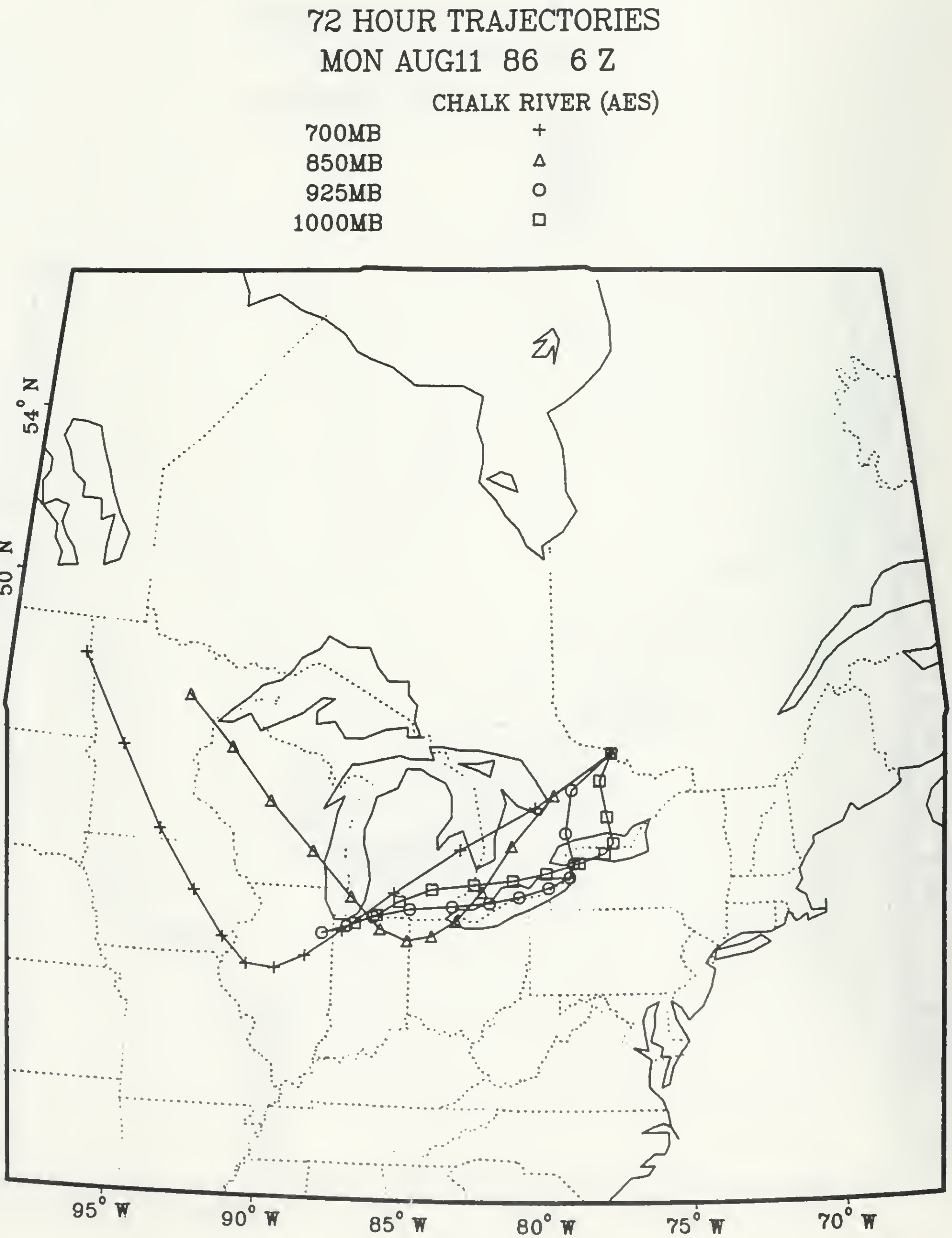

72 HOUR TRAJECTORIES
MON AUG11 86 6 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.26.7

72 HOUR TRAJECTORIES
MON AUG11 86 12 Z

CHALK RIVER (AES)

700MB +
850MB △
925MB ○
1000MB □

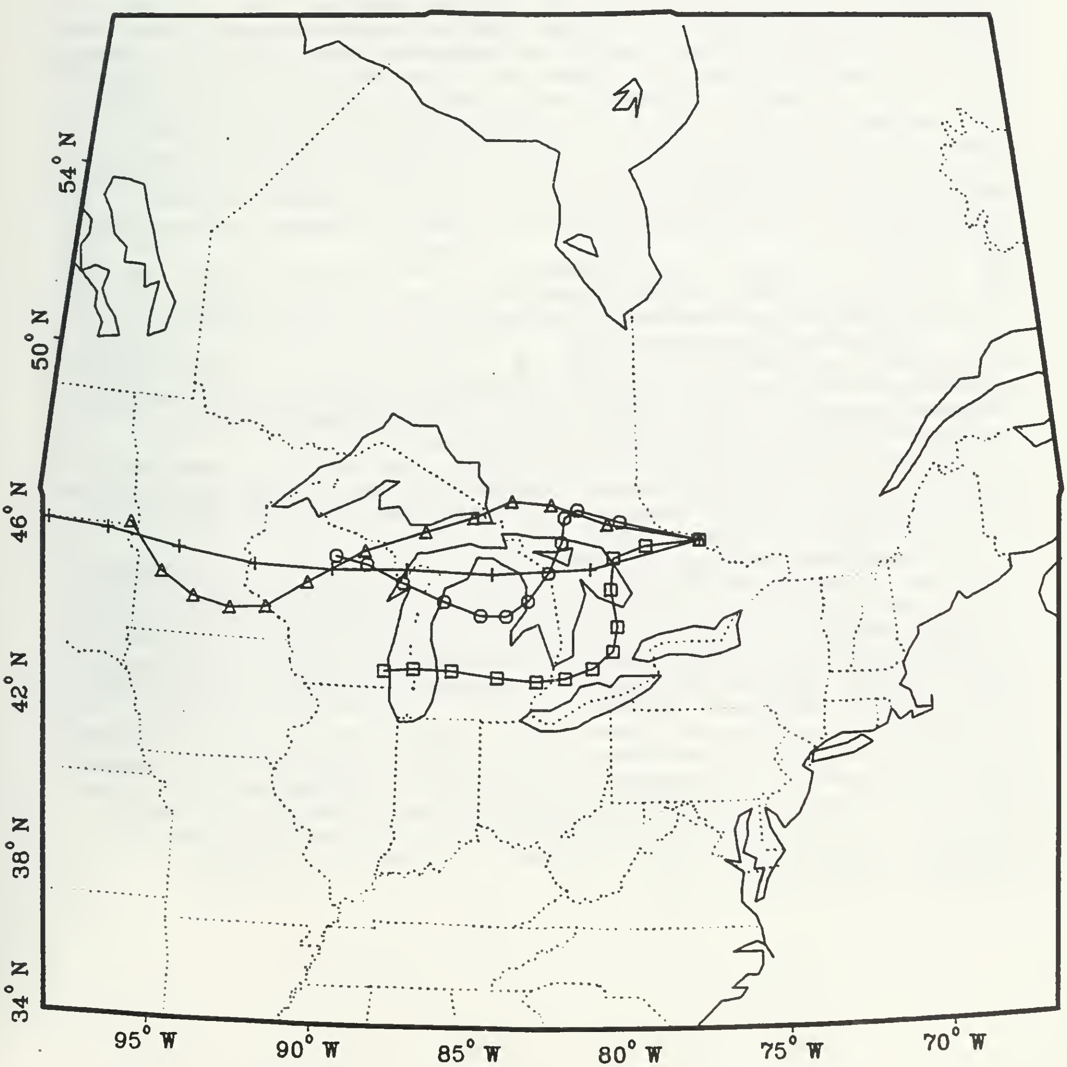


FIGURE 2.26.8

2.27 August 14-15, 1986, Dorset & Chalk River

This episode at Dorset ranked 2nd(2/7) and 5th(5/10) for SO_4^- and NO_3^- respectively. At Chalk River, it ranked 3rd(3/6) and 4th(4/8) for SO_4^- and NO_3^- respectively. Following are separate narratives for Dorset and Chalk River:

Dorset:

On August 14, at 12Z, a wave over Iowa associated with a frontal system and a trowal was observed as shown in Fig. 2.27.1. The system was associated with a wide band of thunderstorms as exhibited in the figure. During the next 24 hours, the wave moved NE. The wave with the trowal were over Dorset on Aug. 15 at 00Z and at 12Z, as shown in Fig. 2.27.2, the wave had moved to lie over eastern Ontario. As the wave moved close to the station, light rain and rain shower and very light thundershowers were recorded at Muskoka as shown in Fig. 2.27.3A. Thunder was heard. Unfortunately continuous observations are not available for Muskoka and therefore the duration of precipitation could not be estimated.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for August 14, 12Z, 18Z and August 15, 00Z, 06Z and 12Z are shown in Figures 2.27.4, 2.27.5, 2.27.6, 2.27.7, and 2.27.8 respectively.
Air parcels arriving at the 1000 mb level could not have carried significant SO_2 from any of its highest emission areas since the trajectories did not pass over them. Also no significant transport of NO_x would have taken place.
Air parcels arriving at the 925 mb level show that SO_2 and NO_x could have been transported from their respective highest and high emission areas in Pennsylvania-Ohio-West Virginia (Fig. 2.27.7-8) and Detroit, Michigan (Fig. 2.27.8).
Air trajectories for the 850 mb level show that SO_2 and NO_x could have been transported from their highest emission Chicago area (Fig. 2.27.8). Transports of SO_2 from its highest and NO_x from its high emission Detroit (Fig. 2.27.5-7) area were also likely.
Air trajectories for the 700 mb level show that SO_2 and NO_x from their highest emission Chicago area could have been transported (Fig. 2.27.6) for some time.
In summary, a passage of a wave and a trowal over Dorset yielded light rain and rain shower and very light thundershowers. Thunder was heard indicating presence of lightning. Transports of SO_2 and NO_x at low level (925 mb) from areas in Pennsylvania-Ohio-West Virginia, at low and high levels (925 mb & 850 mb) from Detroit, Michigan and at high levels (850 mb & 700 mb) from Chicago, Illinois were likely.

(2.27 August 14-15, 1986 continued)

Chalk River

The system that affected Dorset earlier influenced the weather later at Chalk River. A wave over Iowa associated with a frontal system and a trowal was observed on Aug. 14, at 12Z as shown in Fig. 2.27.1. The system was associated with a wide band of thunderstorms as exhibited in the figure. During the next 24 hours, the wave moved NE. On Aug. 15, at 12Z, as shown in Fig. 2.27.2, the wave had moved to lie over eastern Ontario. As the wave moved close to the station, very light and light rain showers and light thundershowers were recorded at Petawawa A as shown in Fig. 2.27.3B. Lightning was observed. The total duration of precipitation was approximately 5 hours. As shown in the figure, the precipitation started at about 1:30 am on Aug. 15 while at Muskoka it started about 2 1/2 hours earlier at approximately 10 pm on Aug. 14 (see Fig. 2.27.3A).

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for August 14, 12Z, 18Z and August 15, 00Z, 06Z and 12Z are shown in Figures 2.27.9, 2.27.10, 2.27.11, 2.27.12, and 2.27.13 respectively.

Air trajectories for the 1000 mb level did not pass over any highest or high emission source area of SO_2 or NO_x and therefore any pollution transport at this level would have been insignificant.

Air trajectories for the 925 mb level show that SO_2 and NO_x from their respective highest and high emission areas in Pennsylvania-Ohio (Fig. 2.27.13) could have been transported.

Air parcels arriving at the 850 mb level could have carried SO_2 and NO_x from their respective highest emission Detroit area and possibly the area in West Virginia (Fig. 2.27.12).

Air trajectories for the 700 mb level show that SO_2 and NO_x from their highest Chicago area (Fig. 2.27.11-12) could have been transported.

Summarizing, a wave near the station yielded very light, light rain showers and light thundershowers lasting for about five hours. Lightning was observed near the station. Transports of SO_2 and NO_x at low level(925 mb) from Pennsylvania and Ohio, and at high levels from Chicago, Illinois, Detroit, Michigan and West Virginia were likely.

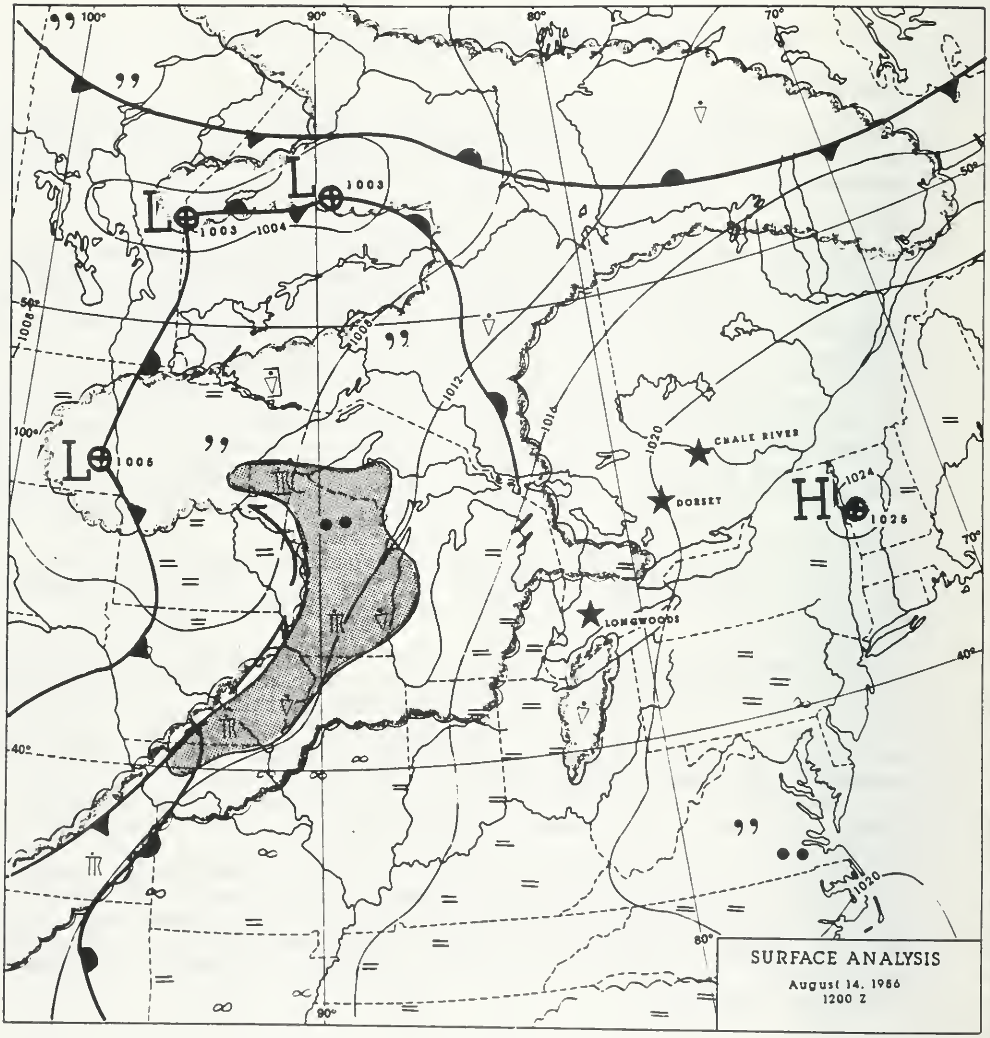

SURFACE ANALYSIS
August 14, 1956
1200 Z
CHALK RIVER
DORSET
LONGWOODS
L
H
1003
1004
1005
1008
1012
1016
1020
1024
1025
100°
90°
80°
70°
50°
40°

FIGURE 2.27.1

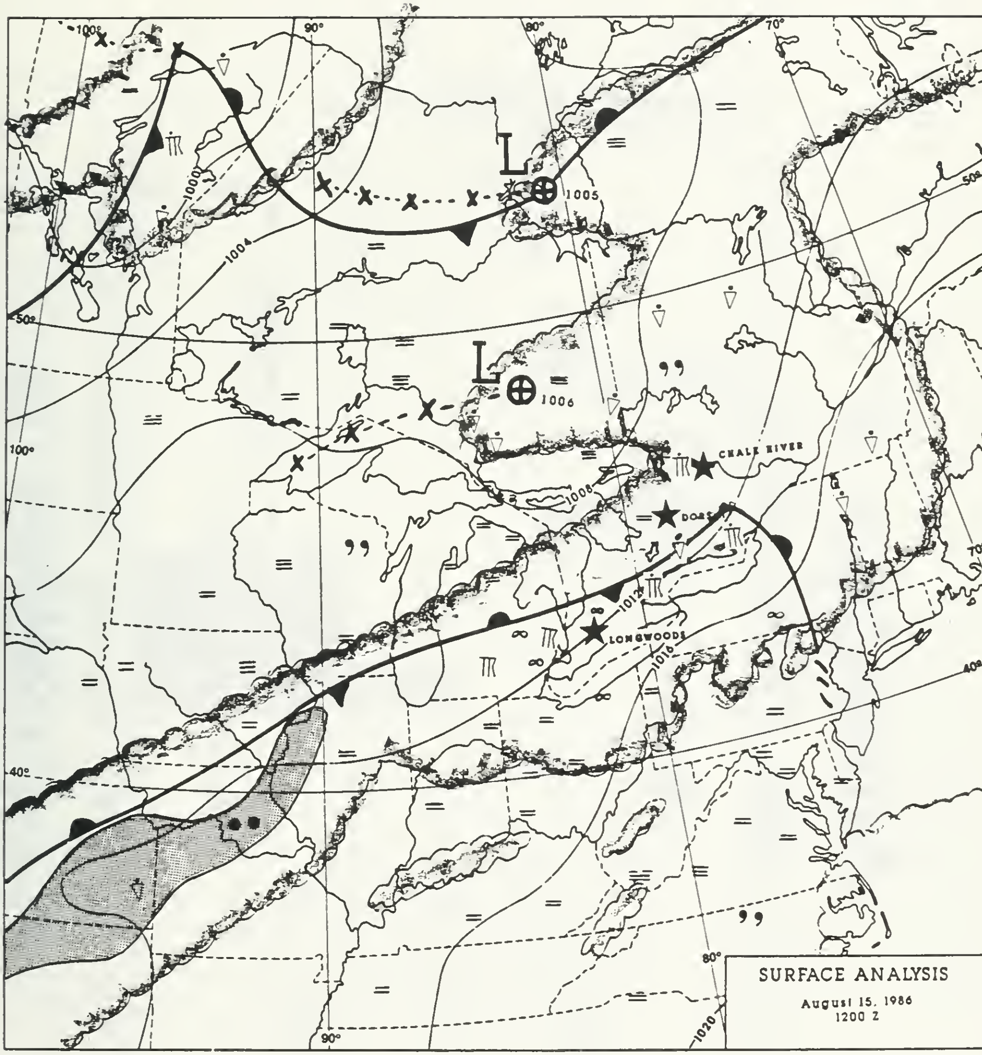

SURFACE ANALYSIS
August 15, 1986
1200 Z
CHALK RIVER
LONGWOODS
L
L
1005
1006
1000
1004
1008
1012
1016
1020
100°
90°
80°
70°
50°
40°

FIGURE 2.27.2

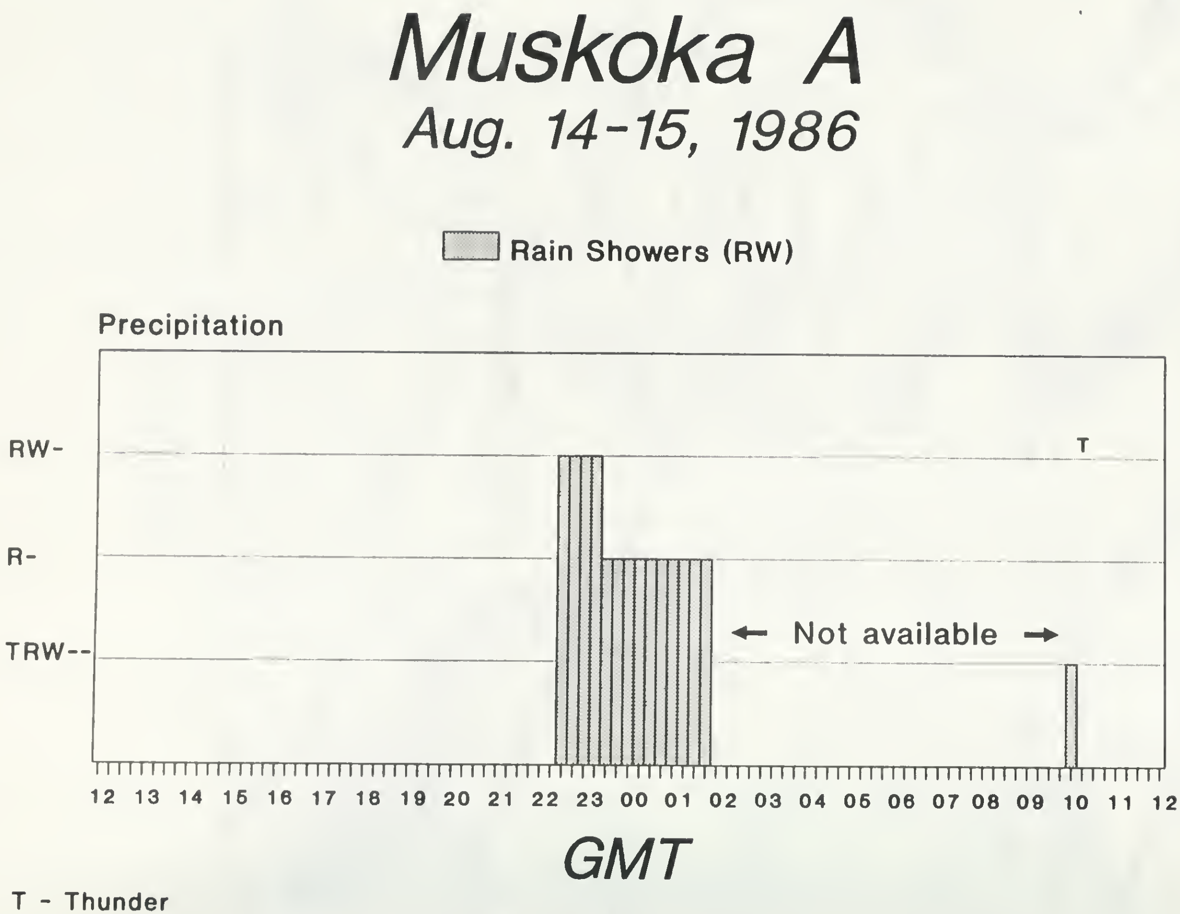


FIGURE 2.27.3A

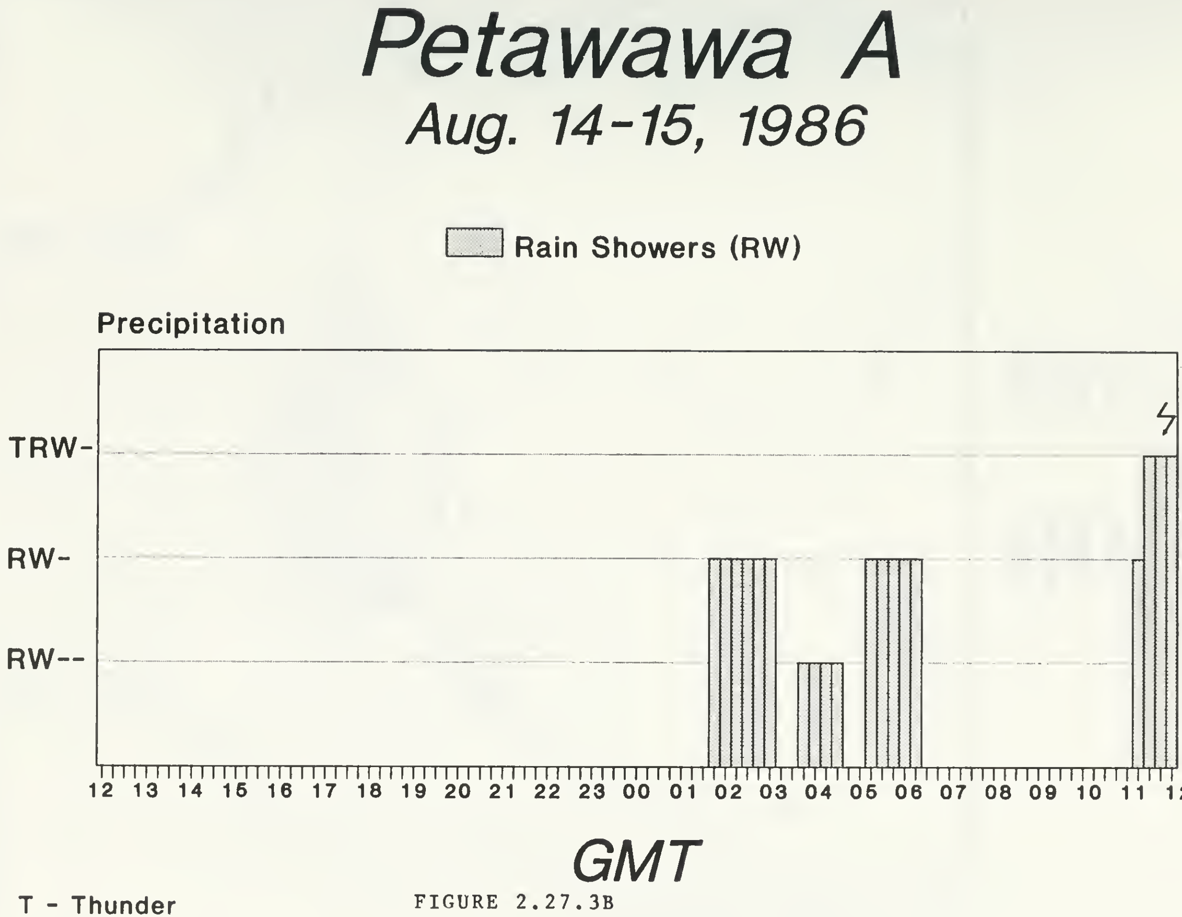


FIGURE 2.27.3B

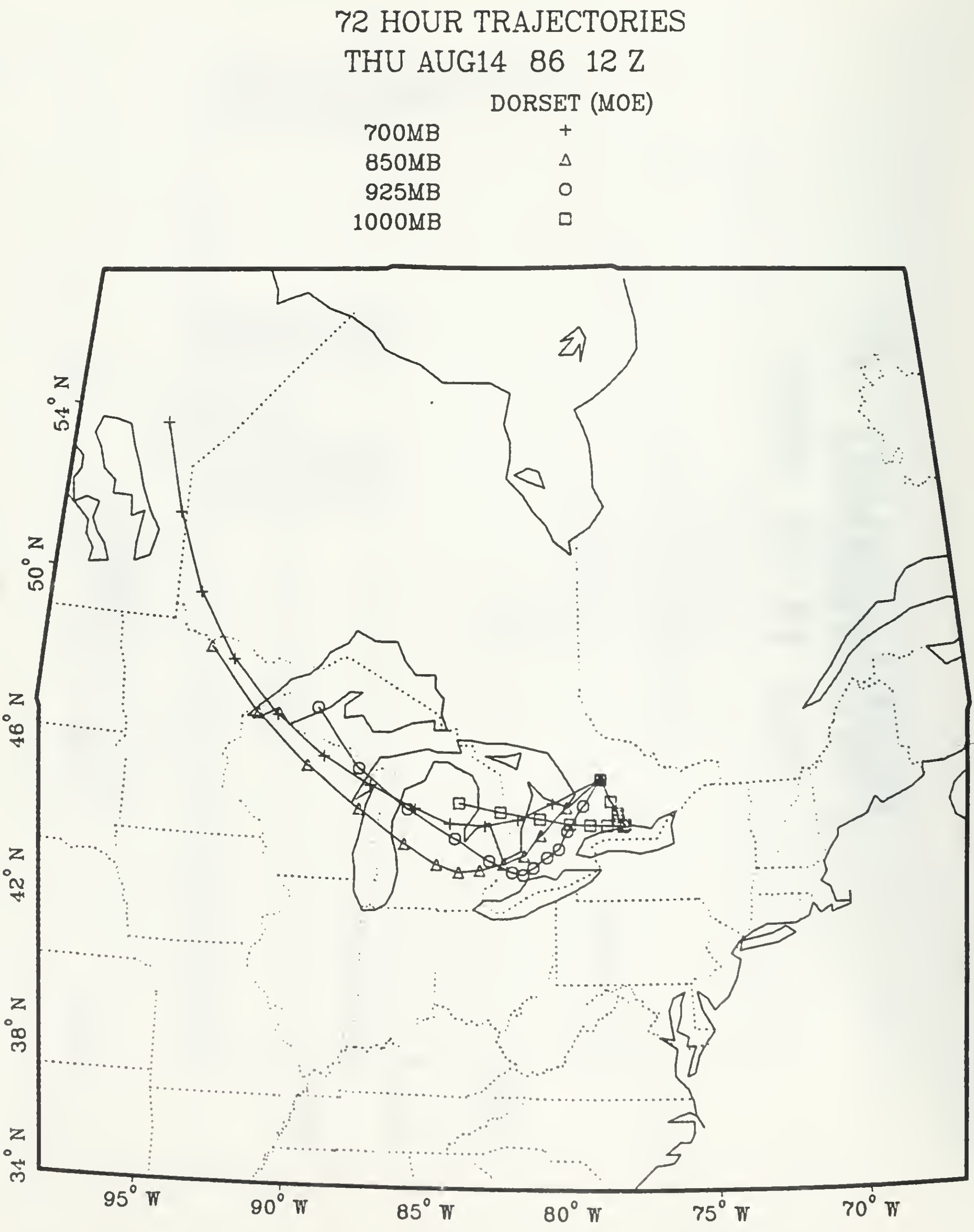

72 HOUR TRAJECTORIES
THU AUG14 86 12 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.27.4

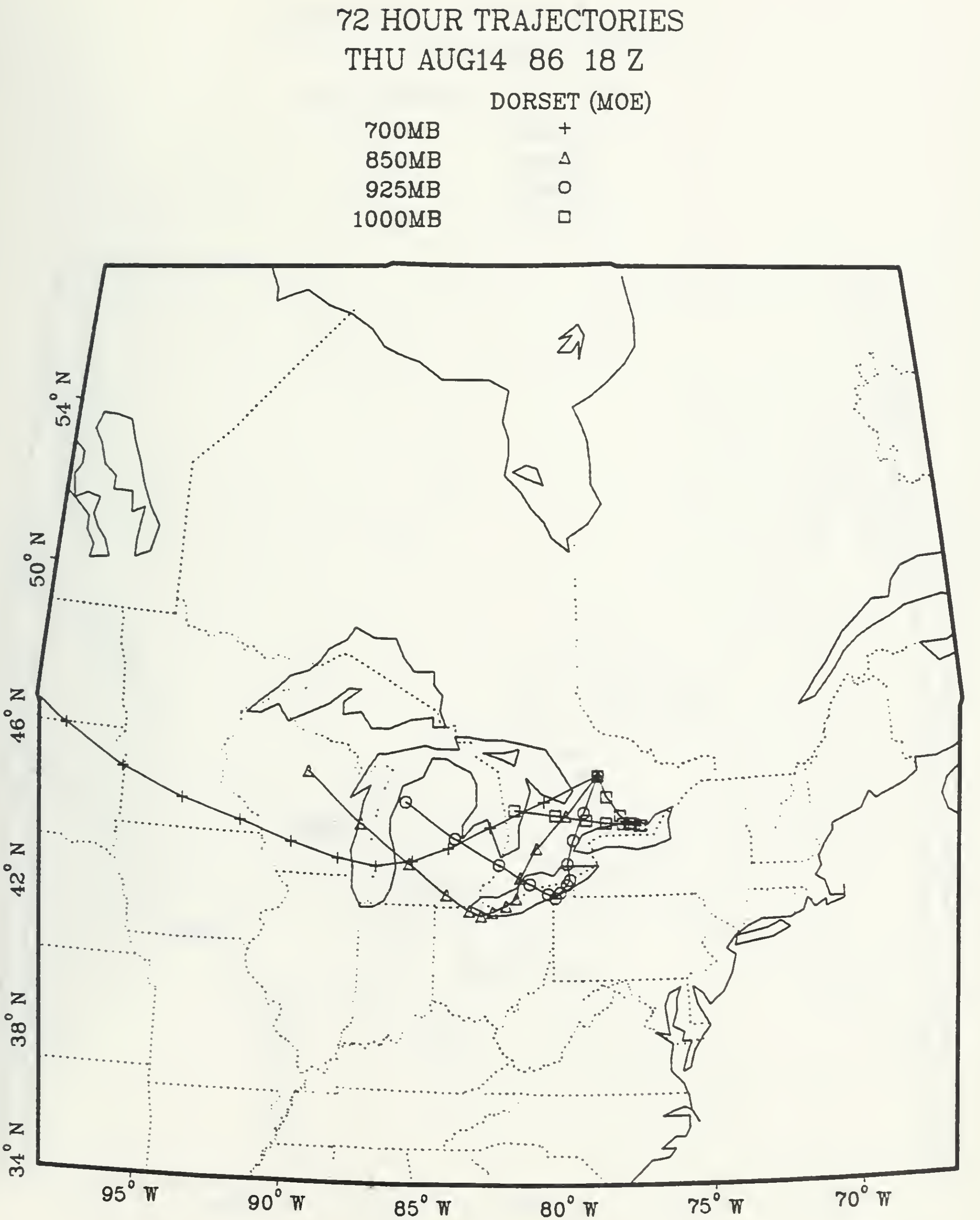

72 HOUR TRAJECTORIES
THU AUG14 86 18 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.27.5

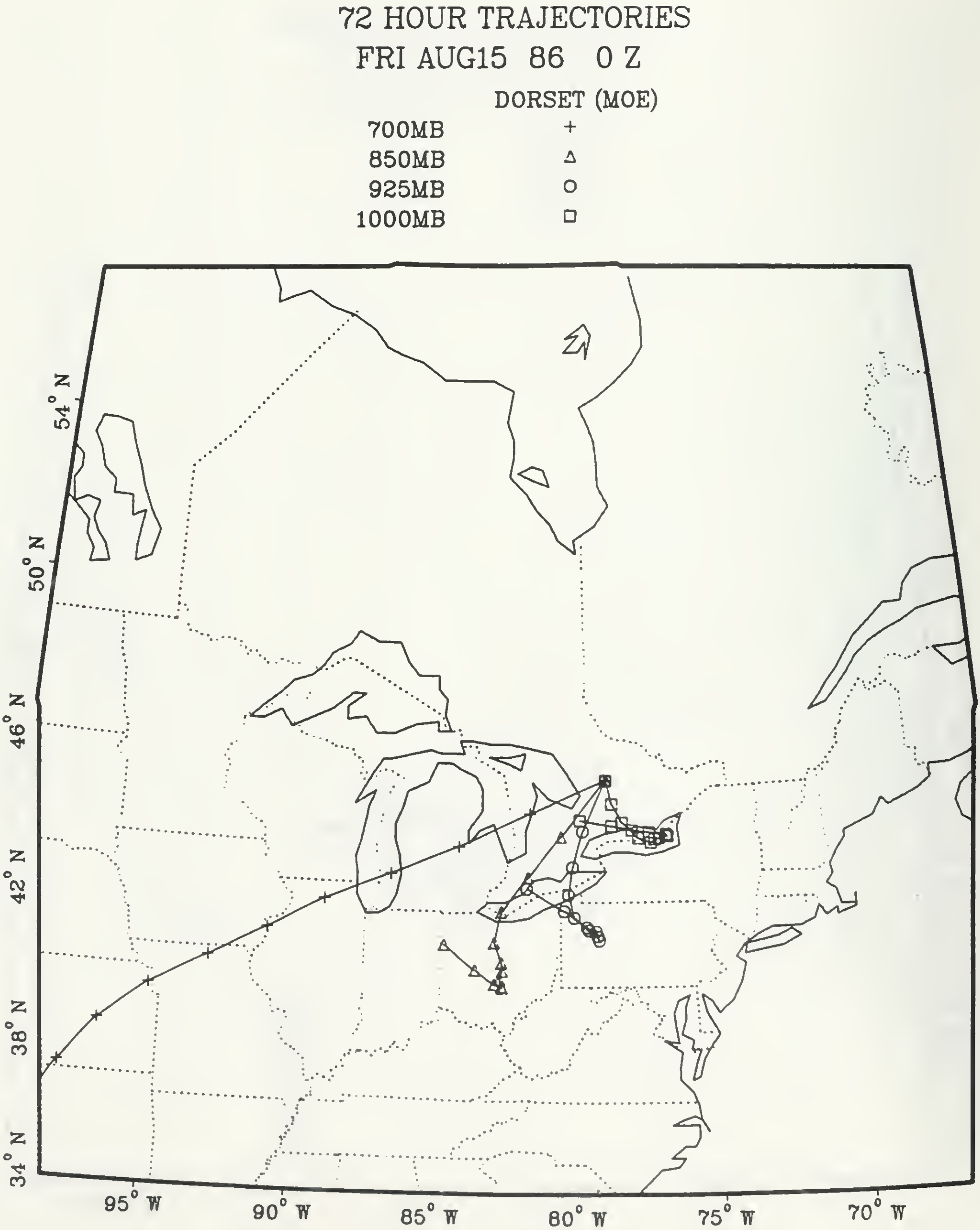

72 HOUR TRAJECTORIES
FRI AUG15 86 0 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.27.6

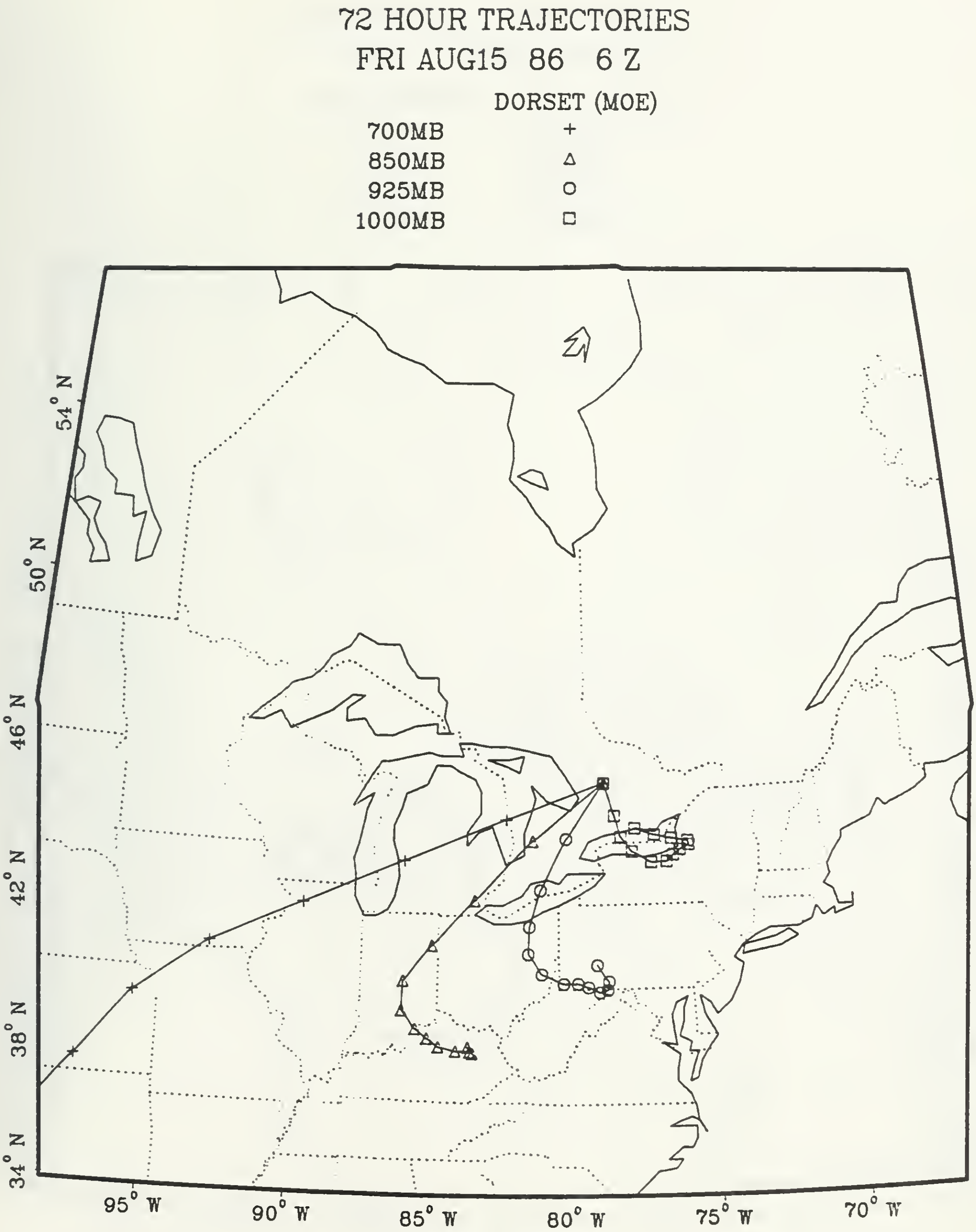

72 HOUR TRAJECTORIES
FRI AUG15 86 6 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.27.7

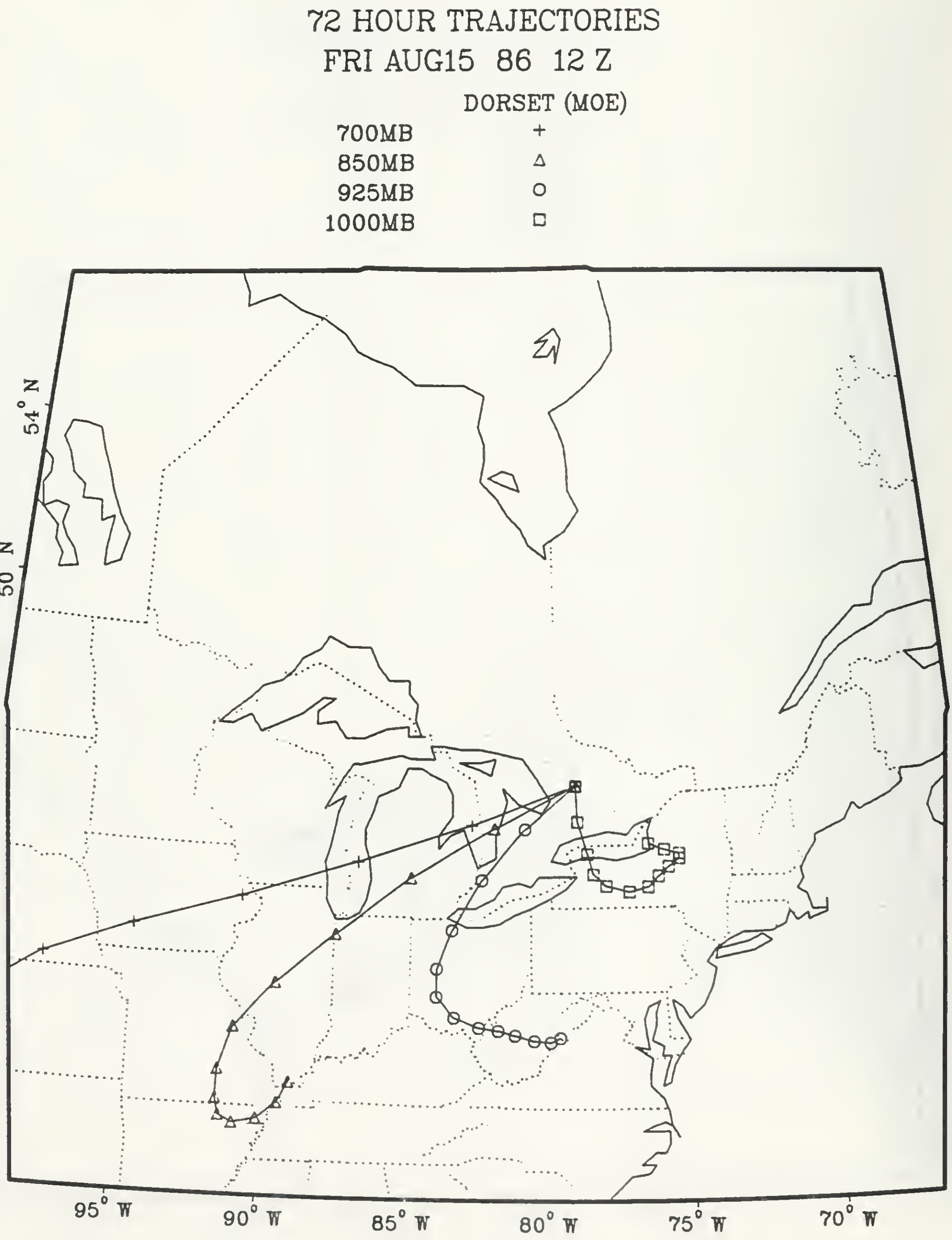

72 HOUR TRAJECTORIES
FRI AUG15 86 12 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.27.8

72 HOUR TRAJECTORIES
THU AUG14 86 12 Z

	CHALK RIVER (AES)
700MB	+
850MB	Δ
925MB	O
1000MB	□

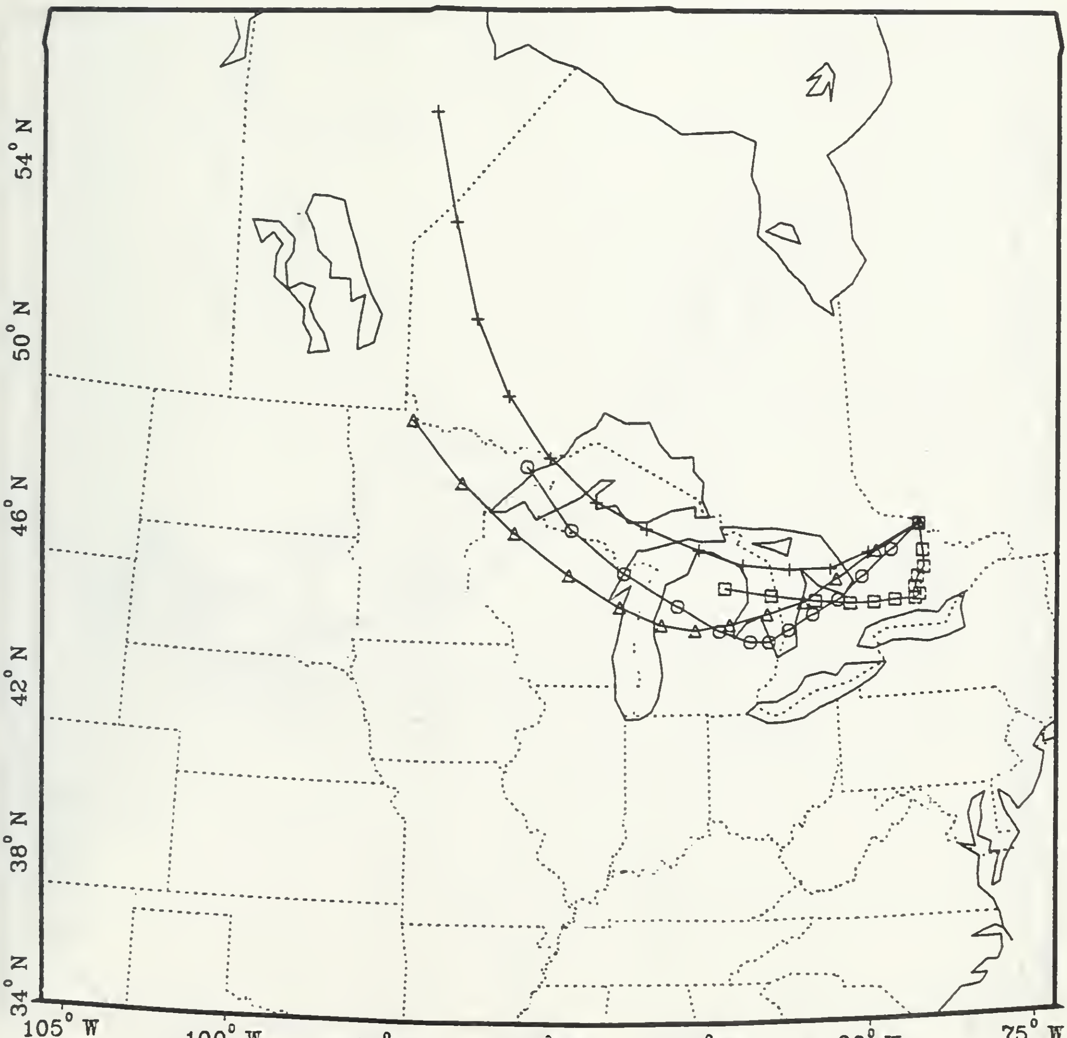


FIGURE 2.27.9

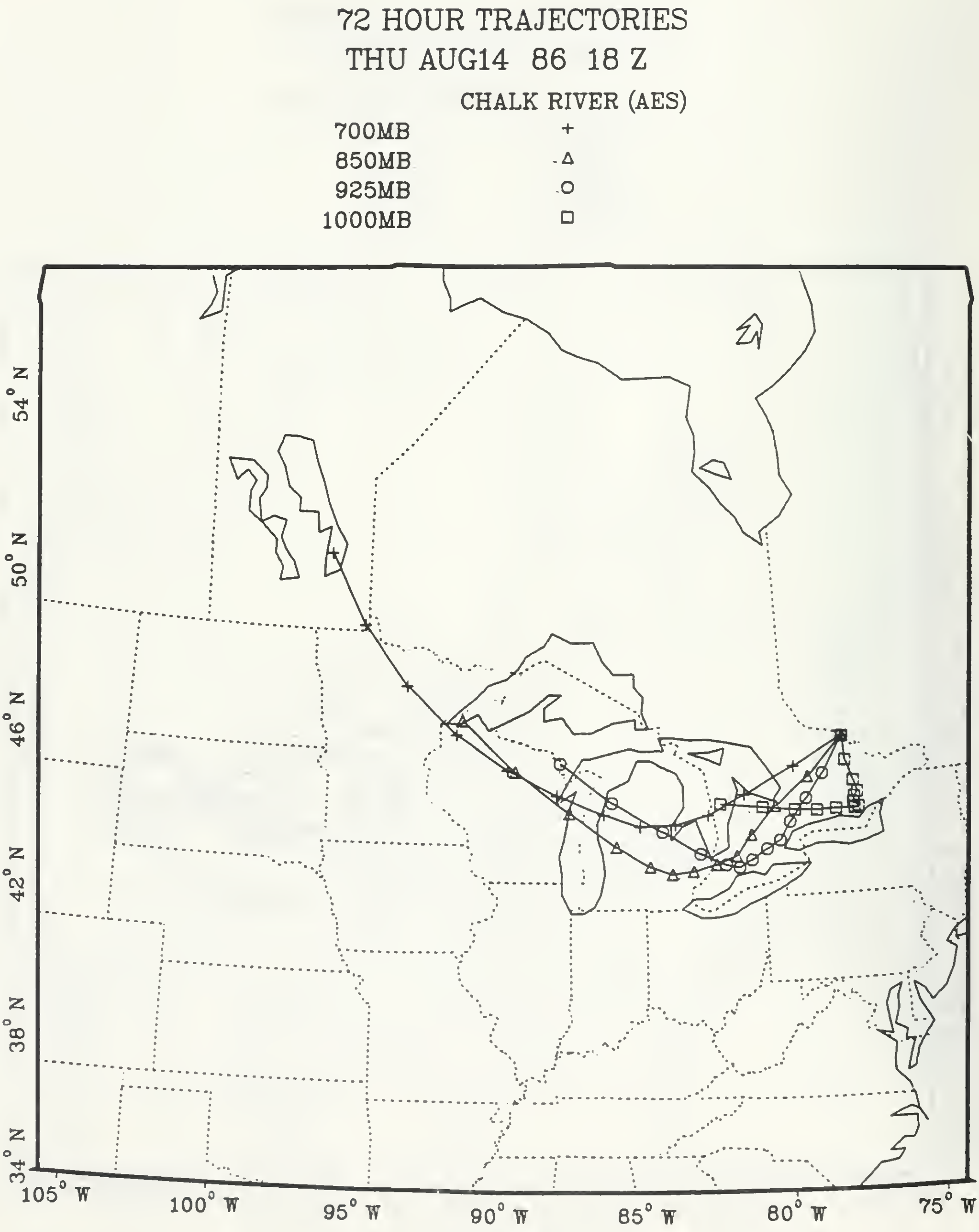


FIGURE 2.27.10

72 HOUR TRAJECTORIES
FRI AUG15 86 0 Z

CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

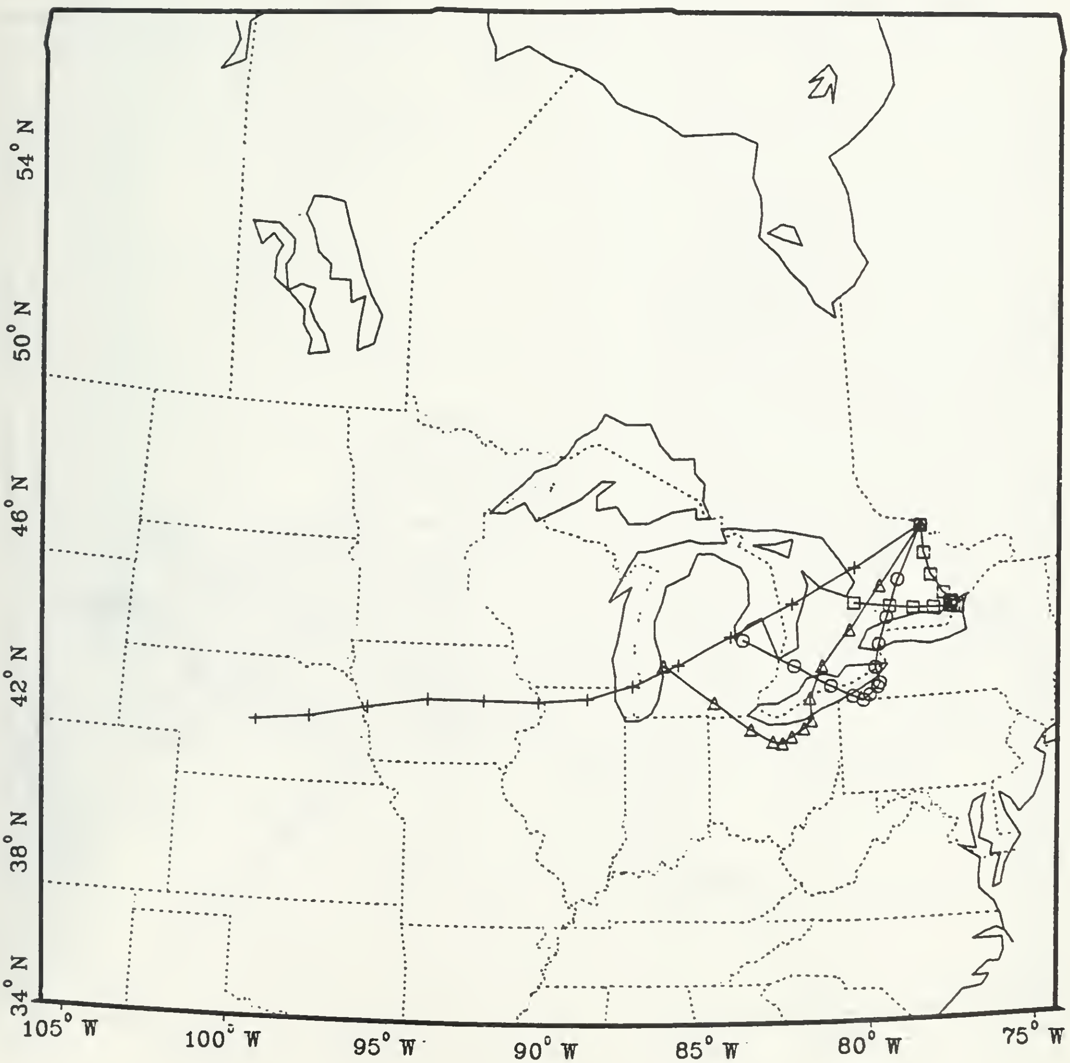


FIGURE 2.27.11

72 HOUR TRAJECTORIES
FRI.AUG15 86 6 Z

CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

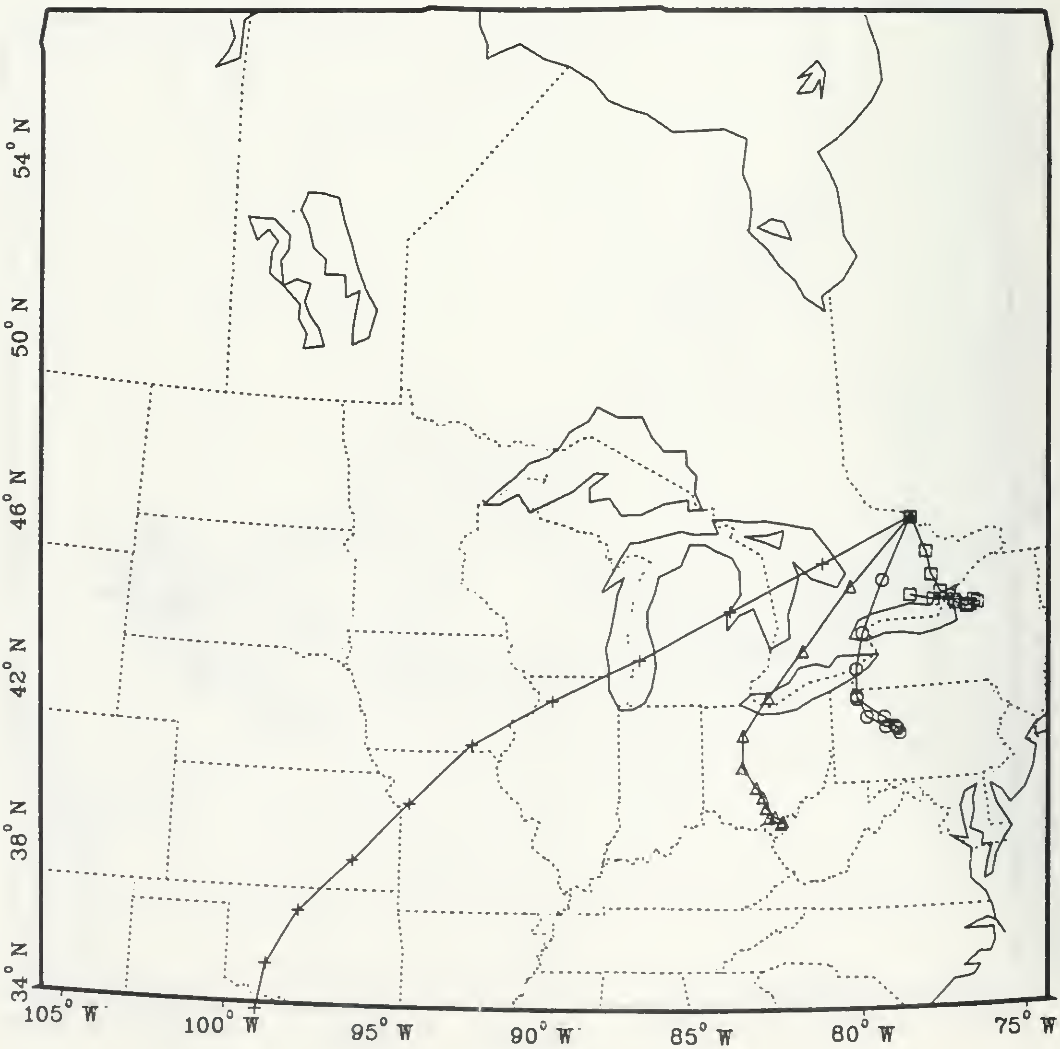


FIGURE 2.27.12

72 HOUR TRAJECTORIES
FRI AUG15 86 12 Z

CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

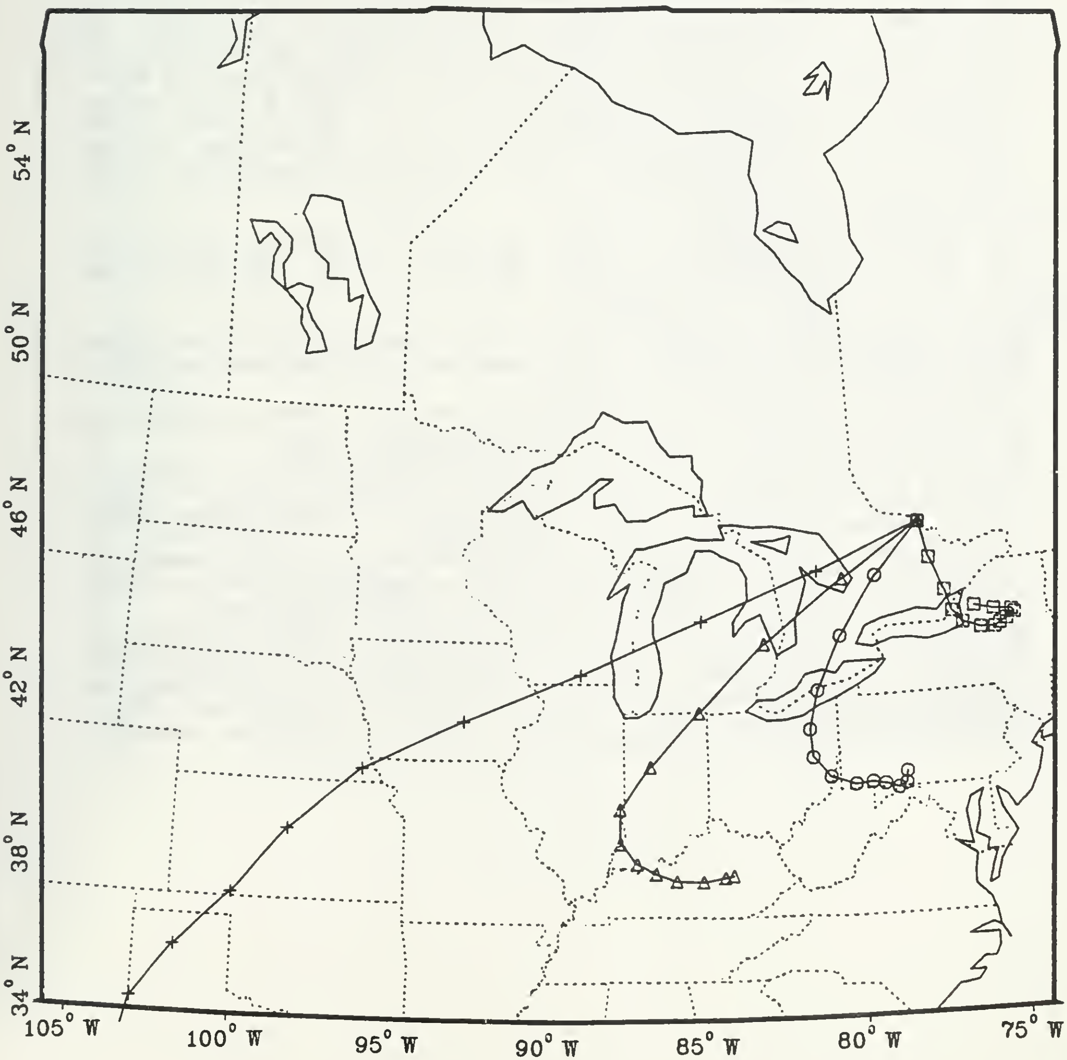


FIGURE 2.27.13

2.28 August 23-24, 1986, Chalk River

This episode ranked 6th and the last (6/6) in the top 25% $SO_4^=$ wet deposition events.

A low pressure centre, 1006 mb, over northern Ontario near Chapleau, associated with a frontal system was observed on Aug. 23, at 12Z as shown in Fig. 2.28.1. An other frontal system associated with a wave over Lake Huron as well as a trowal were also analyzed. As shown in the figure, a large area of continuous precipitation was very close to Chalk River. During this event, the low deepened and moved eastward. On Aug. 24, at 12Z, as exhibited in Fig. 2.28.2, the low had deepened to 995 mb and located over Quebec with the frontal system lying as shown in the figure. The wave also moved approximately eastward tracking south of Chalk River and was outside the map area of Fig. 2.28.2. As the systems moved eastward, a warm and cold front and a trowal passed over the station and the continuous precipitation area covered Chalk River giving very light and light rain showers and light drizzle as shown in Fig. 2.28.3. The total duration of precipitation was about 11 hours.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for August 23, 12Z, 18Z and August 24, 00Z, 06Z and 12Z are shown in Figures 2.28.4, 2.28.5, 2.28.6, 2.28.7, and 2.28.8 respectively.

Air trajectories for the 1000 mb level show that SO_2 could have been transported from its high emission Abitibi-Noranda Mines (Figs. 2.28.4,7&8) area.

Air parcels arriving at the 925 mb level could have carried SO_2 from its highest emission Abitibi-Noranda Mines area.

Air trajectories for the 850 mb level show that SO_2 from its highest emission sources in Abitibi-Noranda Mines (Fig. 2.28.7&8), Sudbury (Fig. 2.28.6-7), Detroit (Fig. 2.28.5) and Chicago (Fig. 2.28.6) areas could have been transported.

Air trajectories for the 700 mb level show that SO_2 could have been transported from its highest emission sources in Sudbury (Fig. 2.28.6) and Abitibi-Noranda Mines (Figs. 2.28.7&8) areas.

In summary, a passage of a warm and a cold front and a trowal over the station yielded very light and light rain showers and light drizzle in the area. The total precipitation duration was approximately 11 hours. Transports of SO_2 at low and high levels from Abitibi-Noranda Mines, and at high levels from Sudbury, Detroit, and Chicago areas were likely.

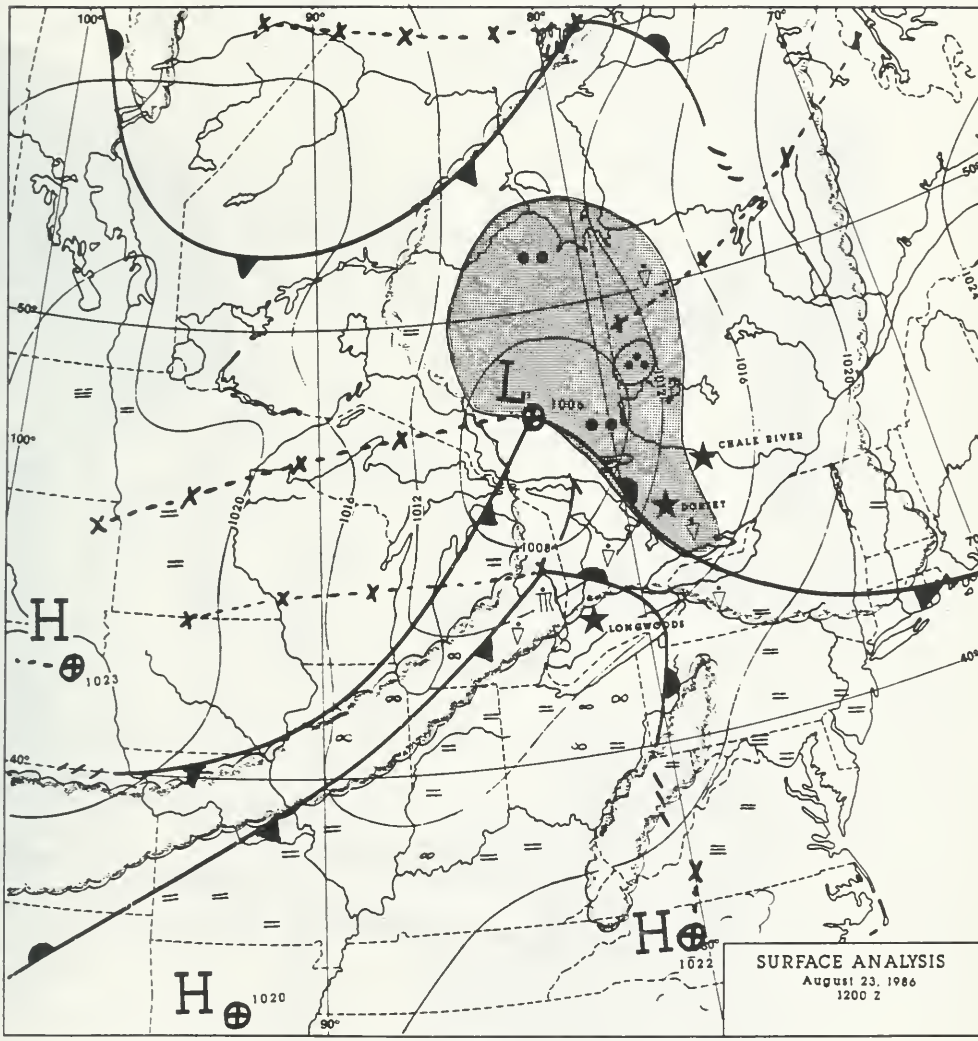

CHALK RIVER
DORSET
LONGWOODS
SURFACE ANALYSIS
August 23, 1986
1200 Z

FIGURE 2.28.1

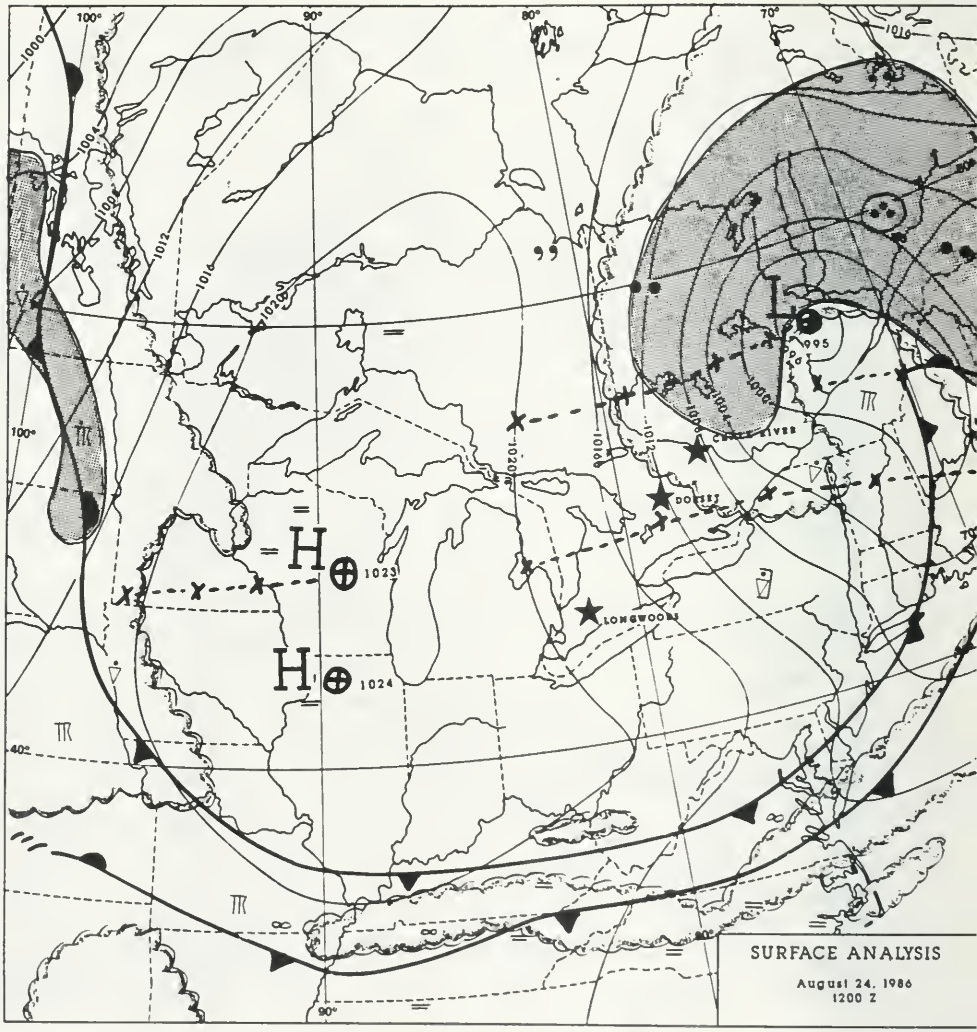

SURFACE ANALYSIS
August 24, 1986
1200 Z
LONGWOODS
DORSET
CHALK RIVER
1023
1024
995

FIGURE 2.28.2

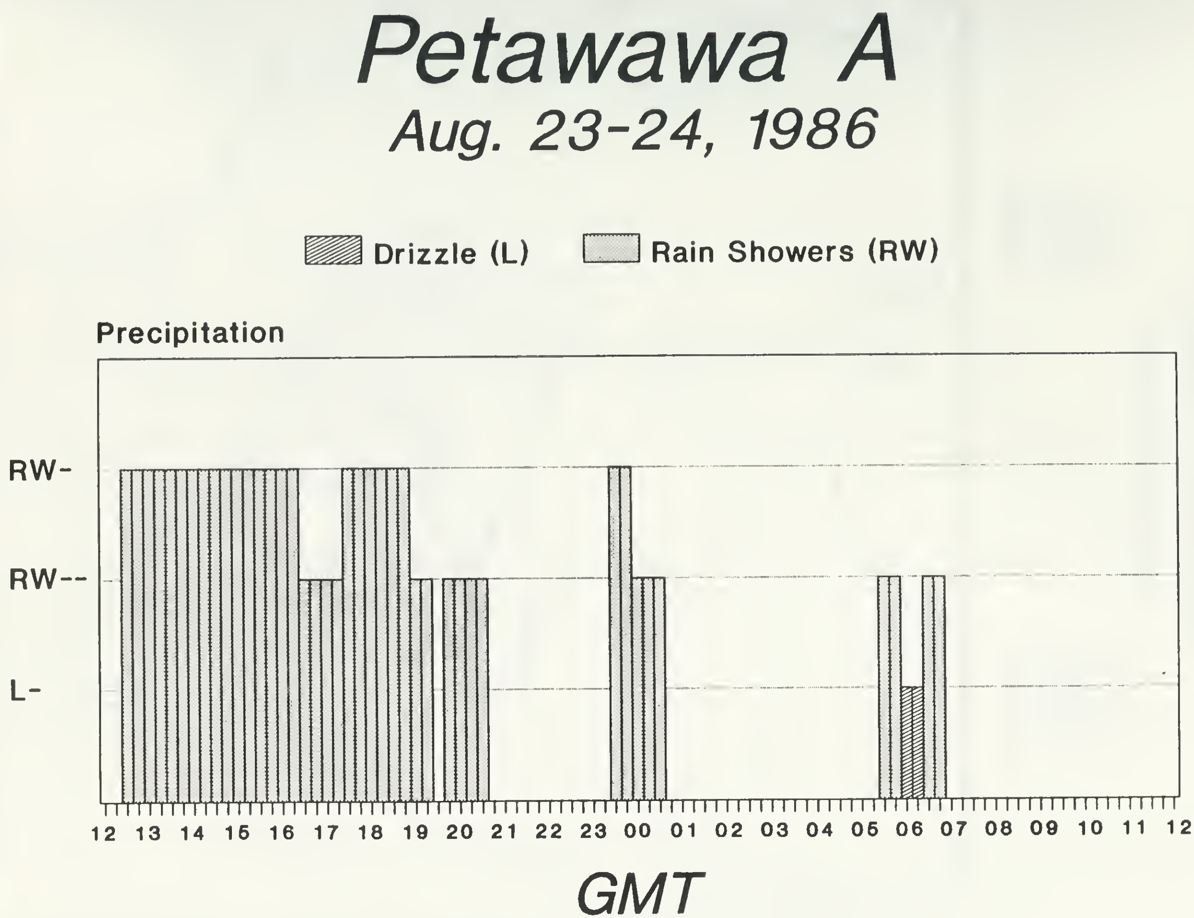
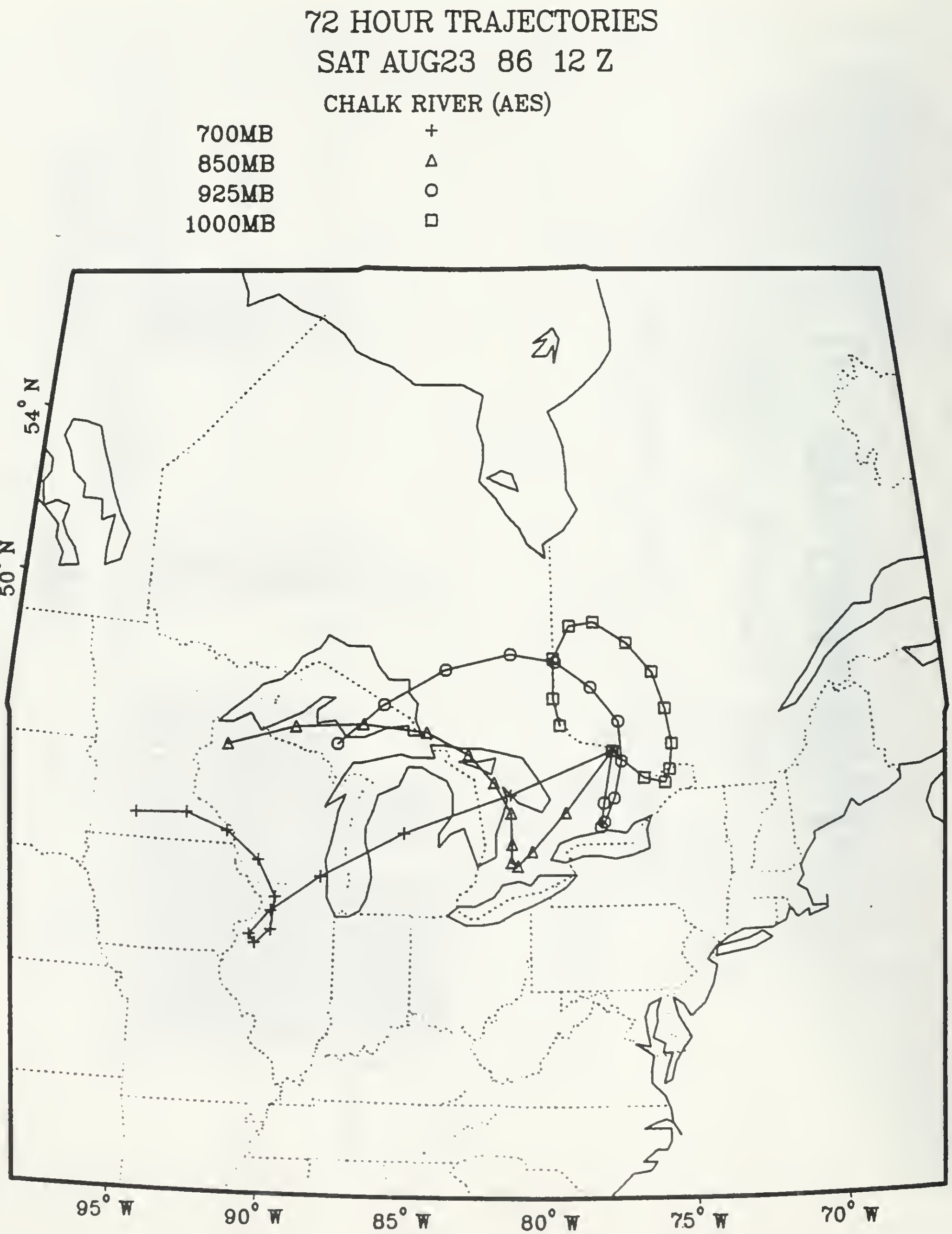

Petawawa A
Aug. 23-24, 1986
Drizzle (L)
Rain Showers (RW)
Precipitation
RW-
RW--
L-
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT

FIGURE 2.28.3



72 HOUR TRAJECTORIES
SAT AUG23 86 12 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.28.4

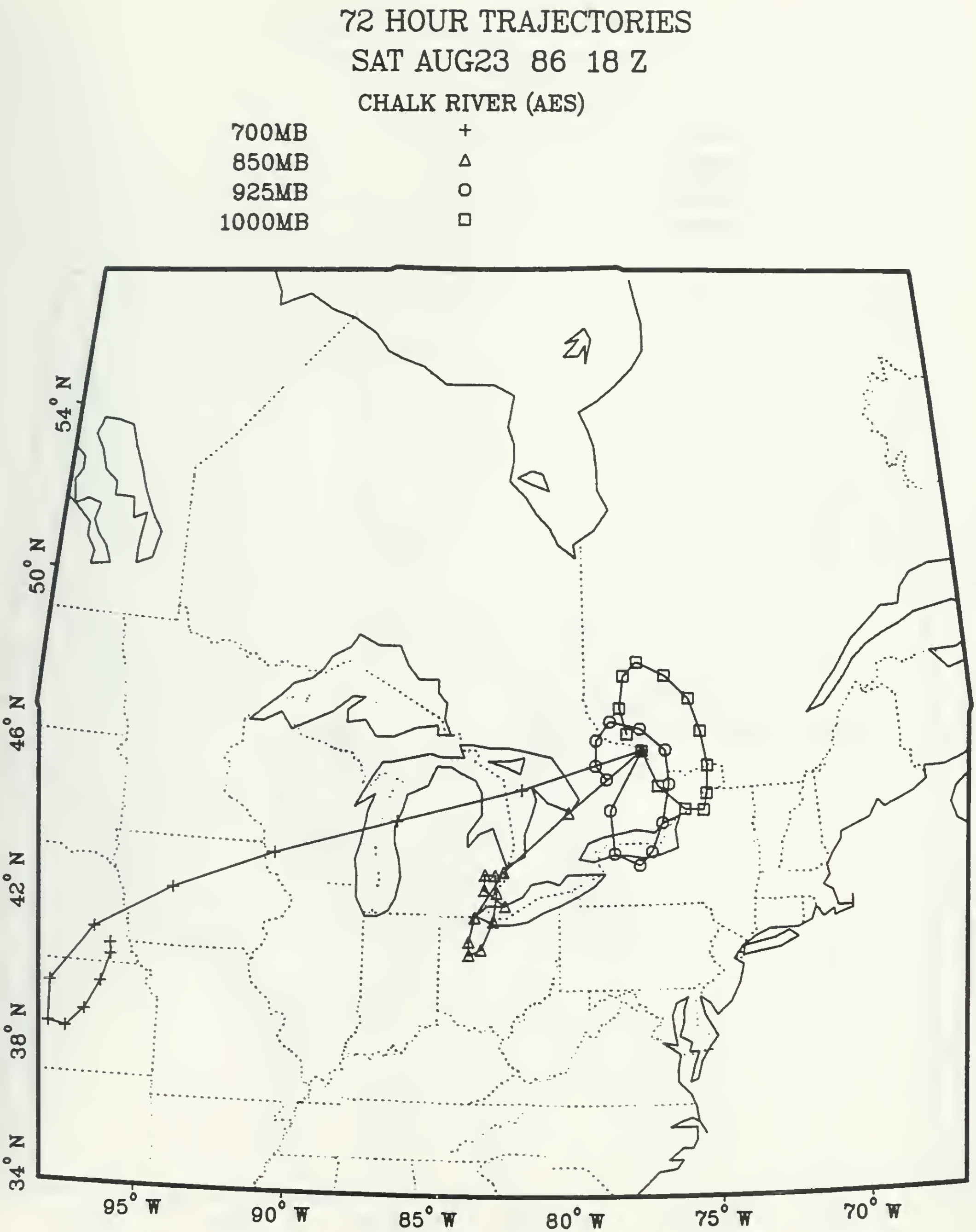

72 HOUR TRAJECTORIES
SAT AUG23 86 18 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.28.5

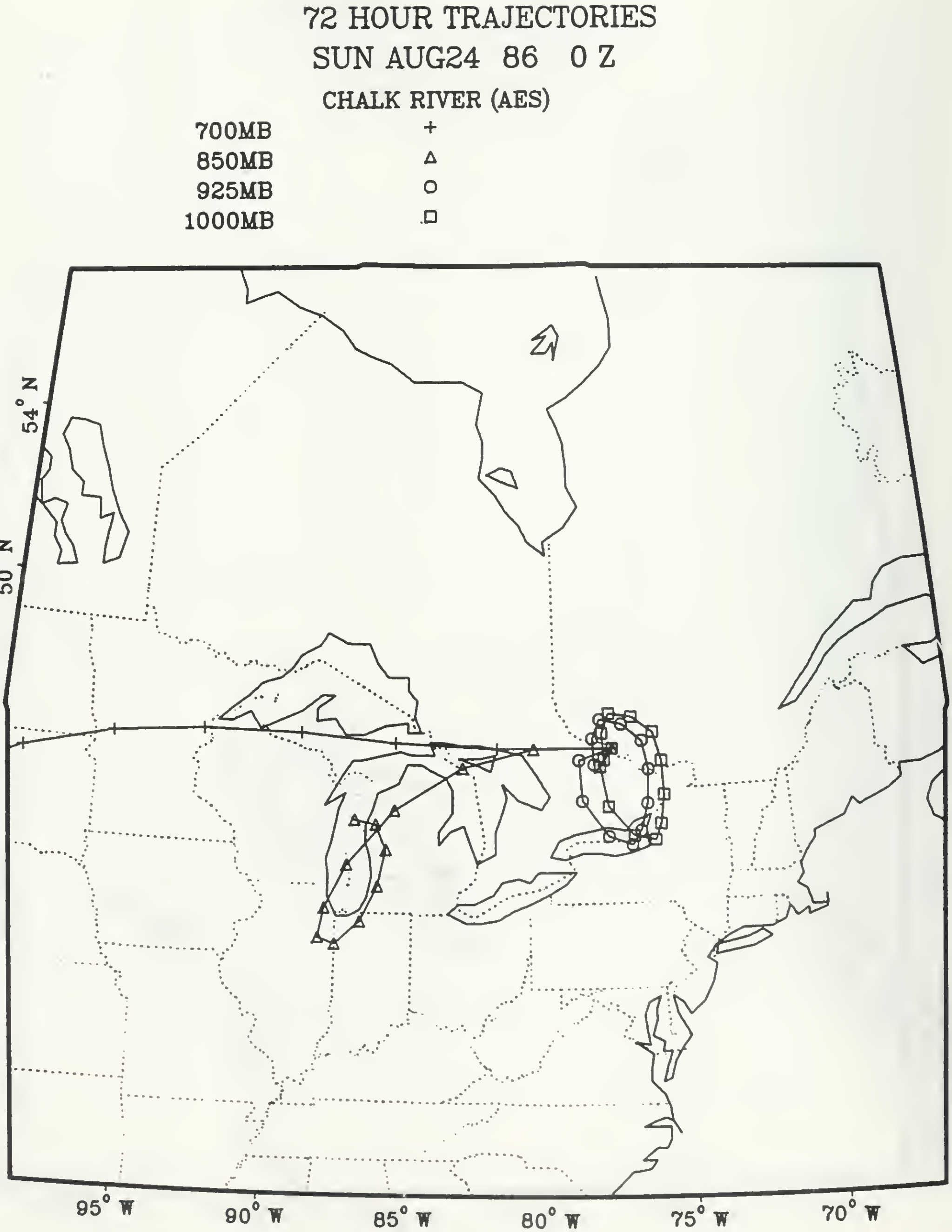

72 HOUR TRAJECTORIES
SUN AUG24 86 0 Z
CHALK RIVER (AES)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.28.6

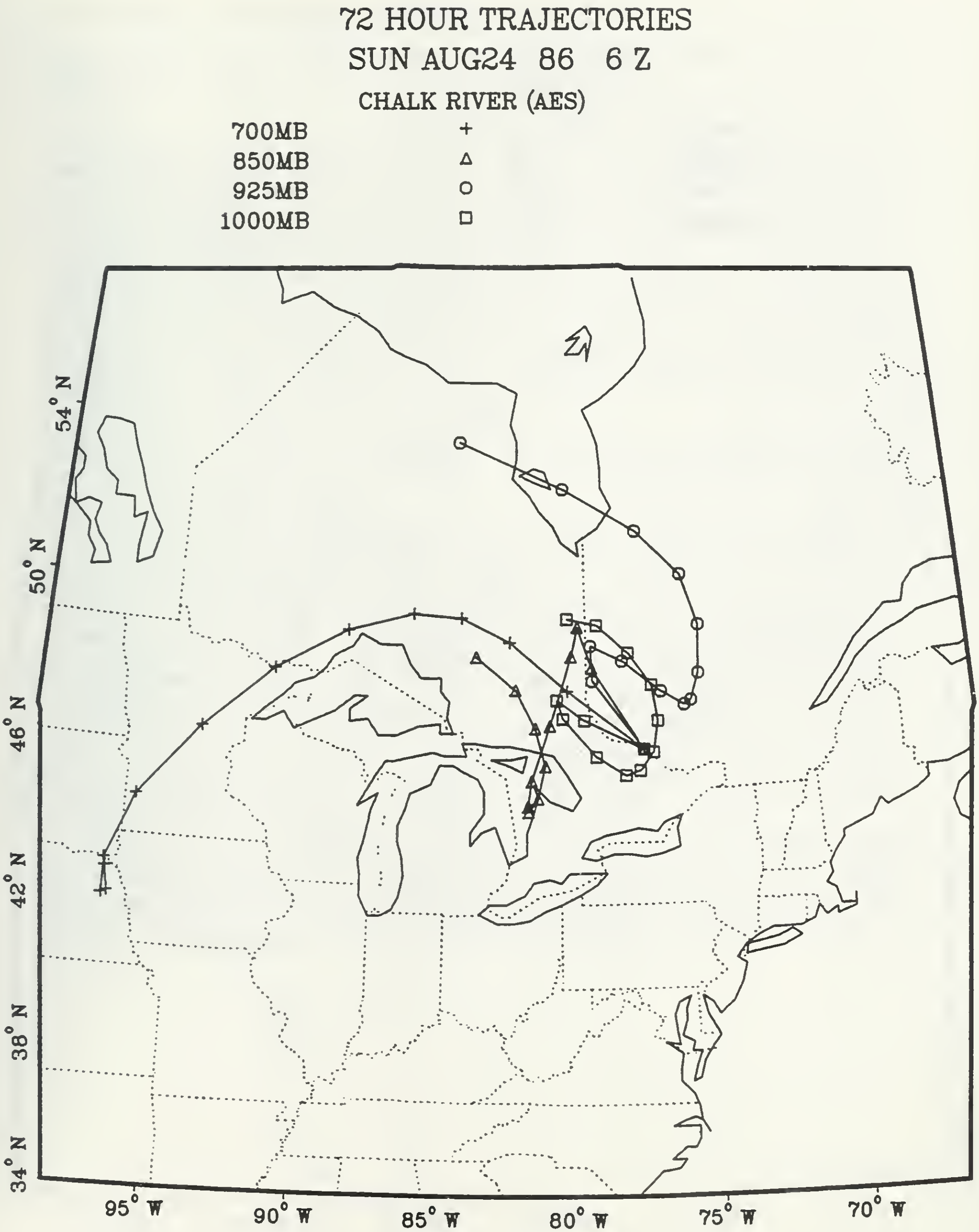

72 HOUR TRAJECTORIES
SUN AUG24 86 6 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.28.7

72 HOUR TRAJECTORIES
SUN AUG24 86 12 Z
CHALK RIVER (AES)

700MB	+
850MB	△
925MB	○
1000MB	□

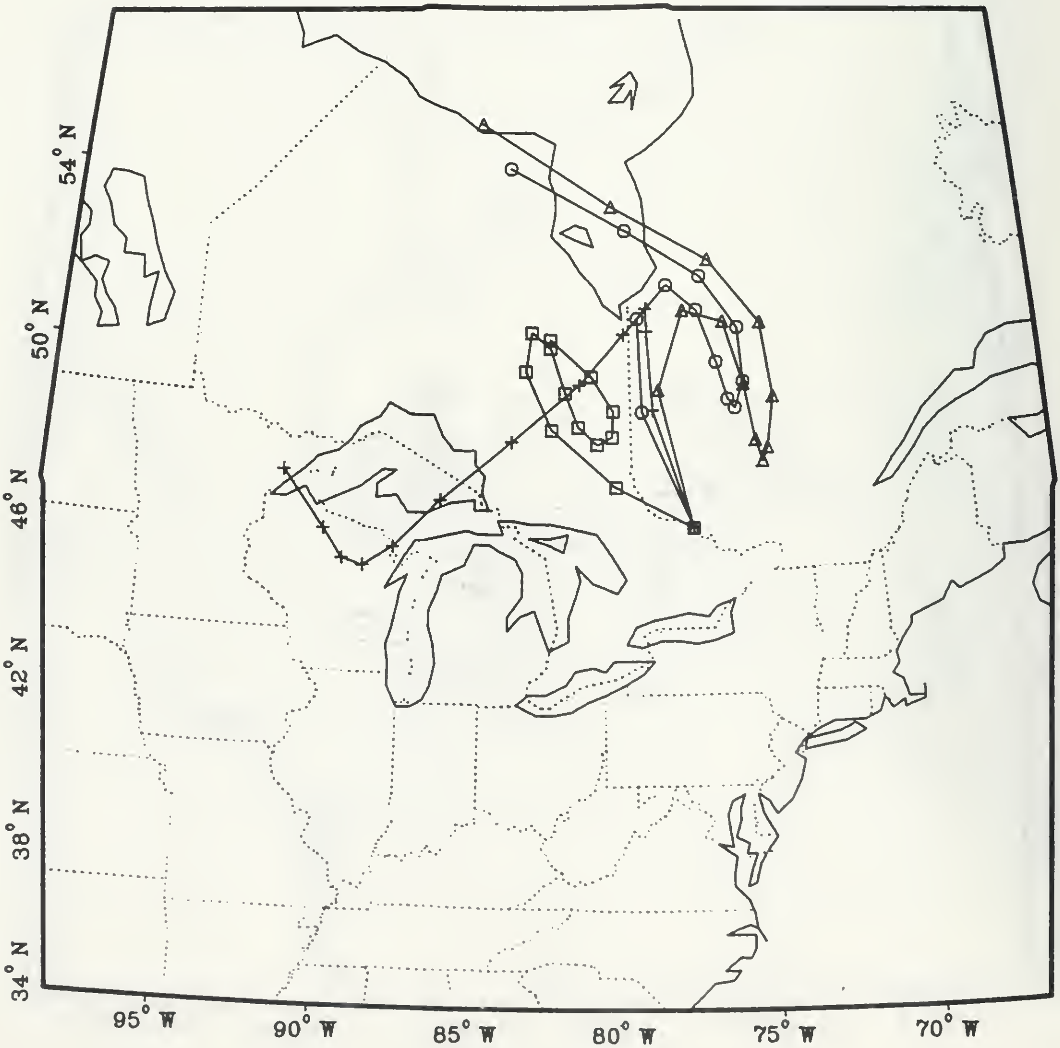


FIGURE 2.28.8

2.29 August 26-27, 1986, Dorset

This episode ranked 4th (4/7) and 7th (7/10) in the top 25% wet deposition events of $SO_4^=$ and NO_3^- respectively.

On Aug. 26, at 12Z, a low pressure centre, 1009 mb, over Iowa, associated with a frontal system and a trowal over Michigan and Lake Huron, and two more frontal systems over northern Ontario were analyzed as shown in Fig. 2.29.1. During the course of this event the low deepened moving ENE, the frontal systems moved eastward, two cold fronts passed over the station and the low moved in the vicinity of Dorset. On Aug. 27, at 12Z, as shown in Fig. 2.29.2, the low, 999 mb, was over Quebec and a cold front laid over the station. As the low moved close to Dorset, a continuous precipitation area covered the station on Aug. 27, at 00Z. As shown in Fig. 2.29.3, light rain and light and moderate rain showers were recorded at the nearest weather station Muskoka. Since the continuous observations are not available, duration of precipitation could not be estimated.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for August 26, 12Z, 18Z and August 27, 00Z, 06Z and 12Z are shown in Figures 2.29.4, 2.29.5, 2.29.6, 2.29.7, and 2.29.8 respectively.

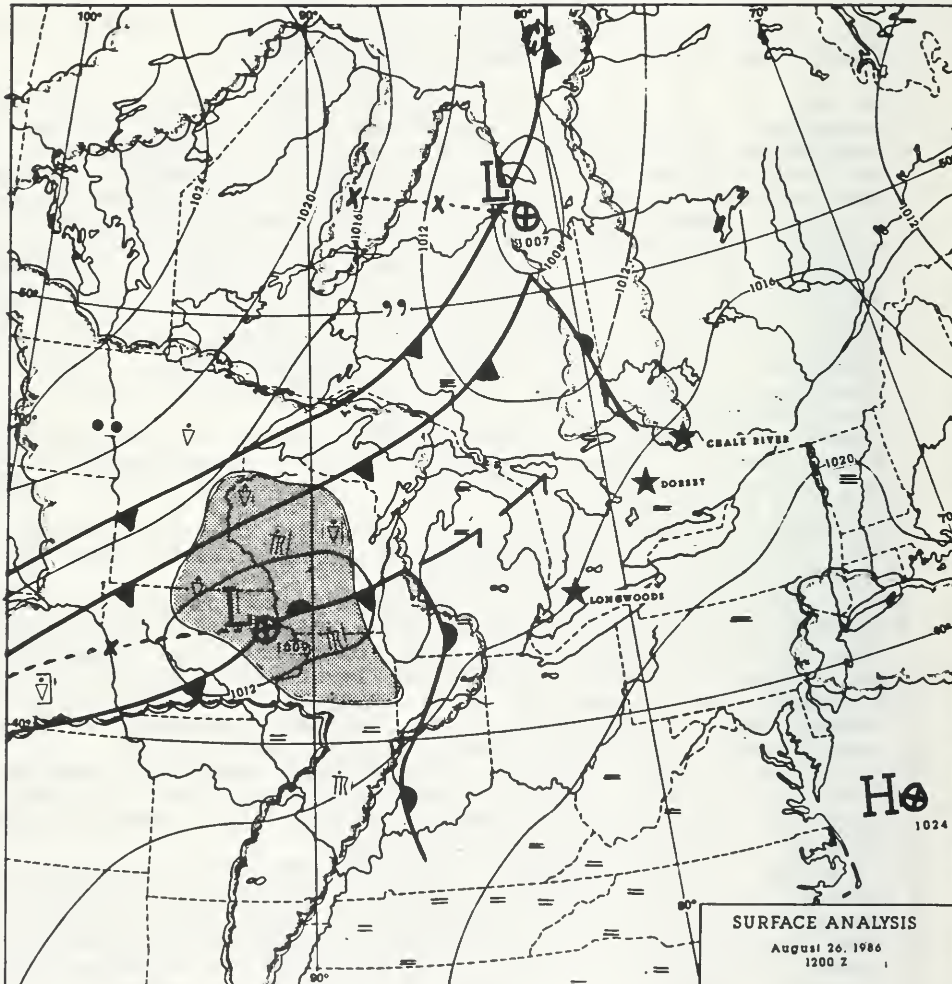
Air parcels arriving at the 1000 mb level could have carried SO_2 from its highest Detroit and Sudbury (Fig. 2.29.8) areas and NO_x from its high emission Detroit area.

Air trajectories for the 925 mb level show that SO_2 its highest and high emission Detroit and Sudbury (Fig. 2.29.8) areas and NO_x from it high emission Detroit area could have been transported.

Air trajectories for the 850 mb level show that SO_2 from its highest emission Sudbury (Fig. 2.29.8) area could have been transported. NO significant NO_x transport occurred since its highest or high emission areas are not involved.

Air parcels arriving at the 700 mb level could have carried SO_2 from its highest emission Sudbury (Fig. 2.29.4-5) area. NO significant NO_x transport occurred at this level since its highest or high emission areas are not involved.

In summary, a low pressure centre movement in the vicinity and passage of two cold fronts over Dorset yielded light rain and light and moderate rain showers. Transports of SO_2 and NO_x at low level from Detroit and of SO_2 at low and high levels from Sudbury were likely. It is to be noted that no highest NO_x emission area is involved for pollution transport during this episode.



DORSET
LONGWOODS
1024
1020
1016
1012
1007
SURFACE ANALYSIS
August 26, 1986
1200 Z

FIGURE 2.29.1

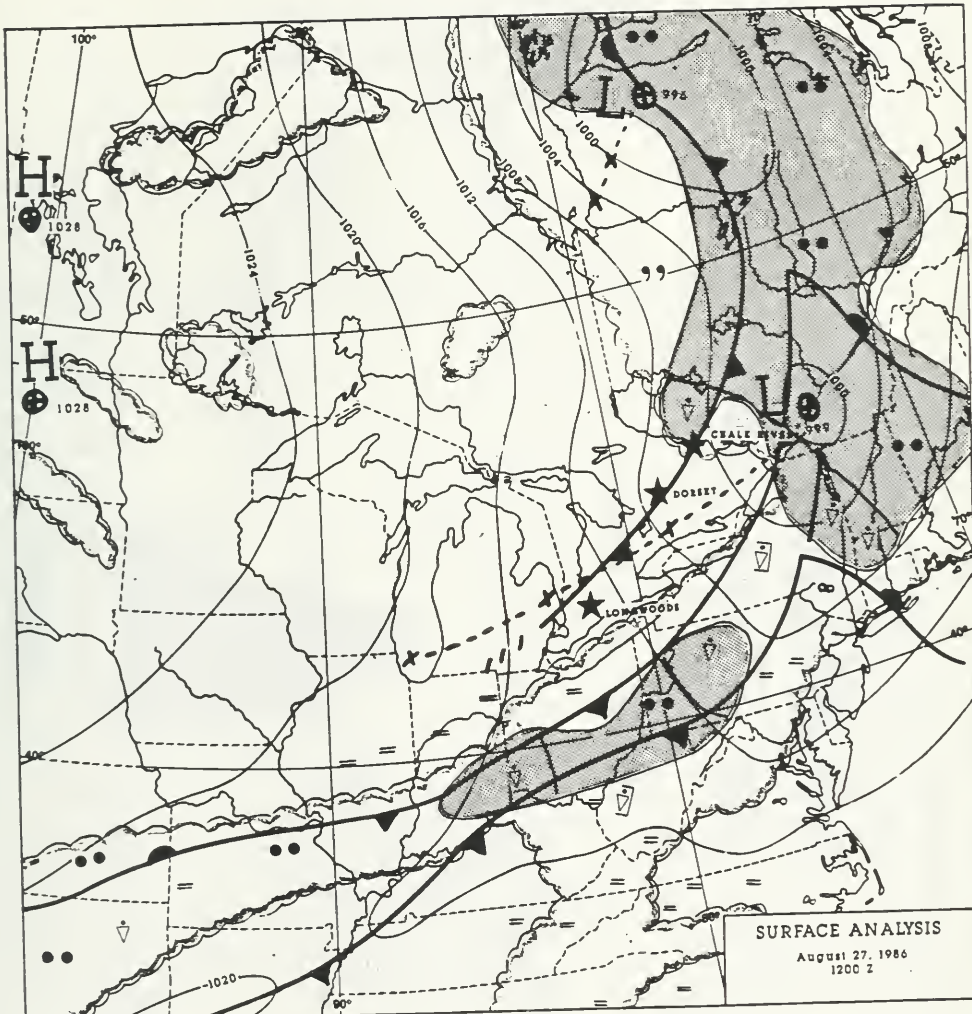
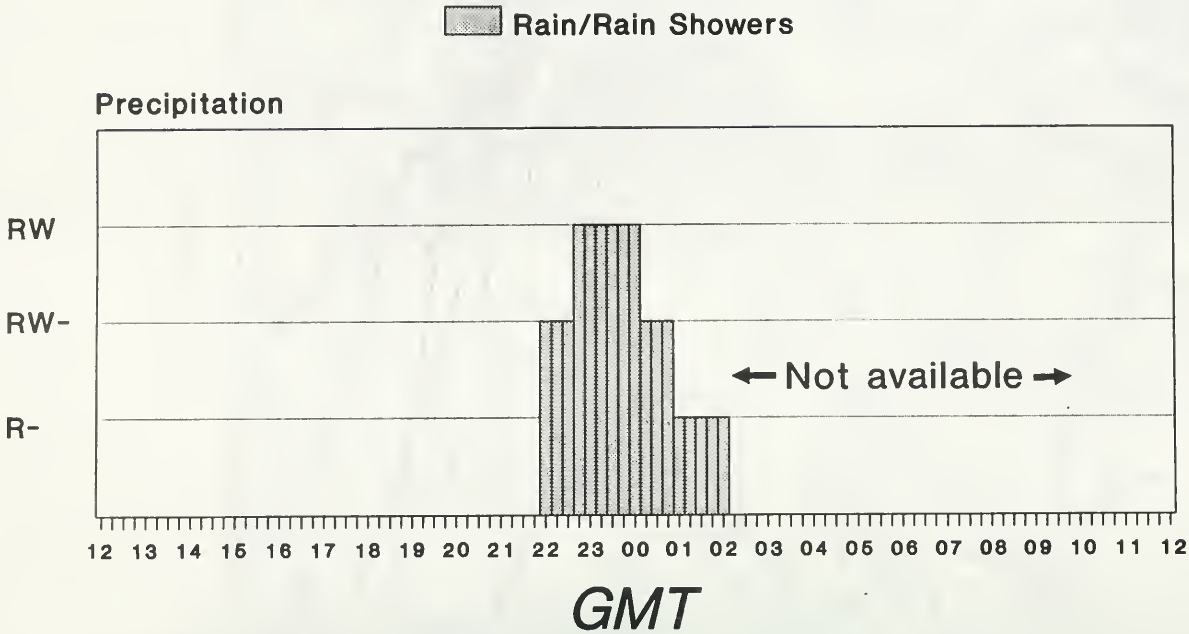

SURFACE ANALYSIS
August 27, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1028
1028
1024
1020
1016
1012
1008
1004
1000
1020

FIGURE 2.29.2

Muskoka A
Aug. 26-27, 1986



R - Rain
RW - Rain Showers

FIGURE 2.29.3

72 HOUR TRAJECTORIES
TUE AUG26 86 12 Z

	DORSET (MOE)
700MB	+
850MB	Δ
925MB	O
1000MB	□

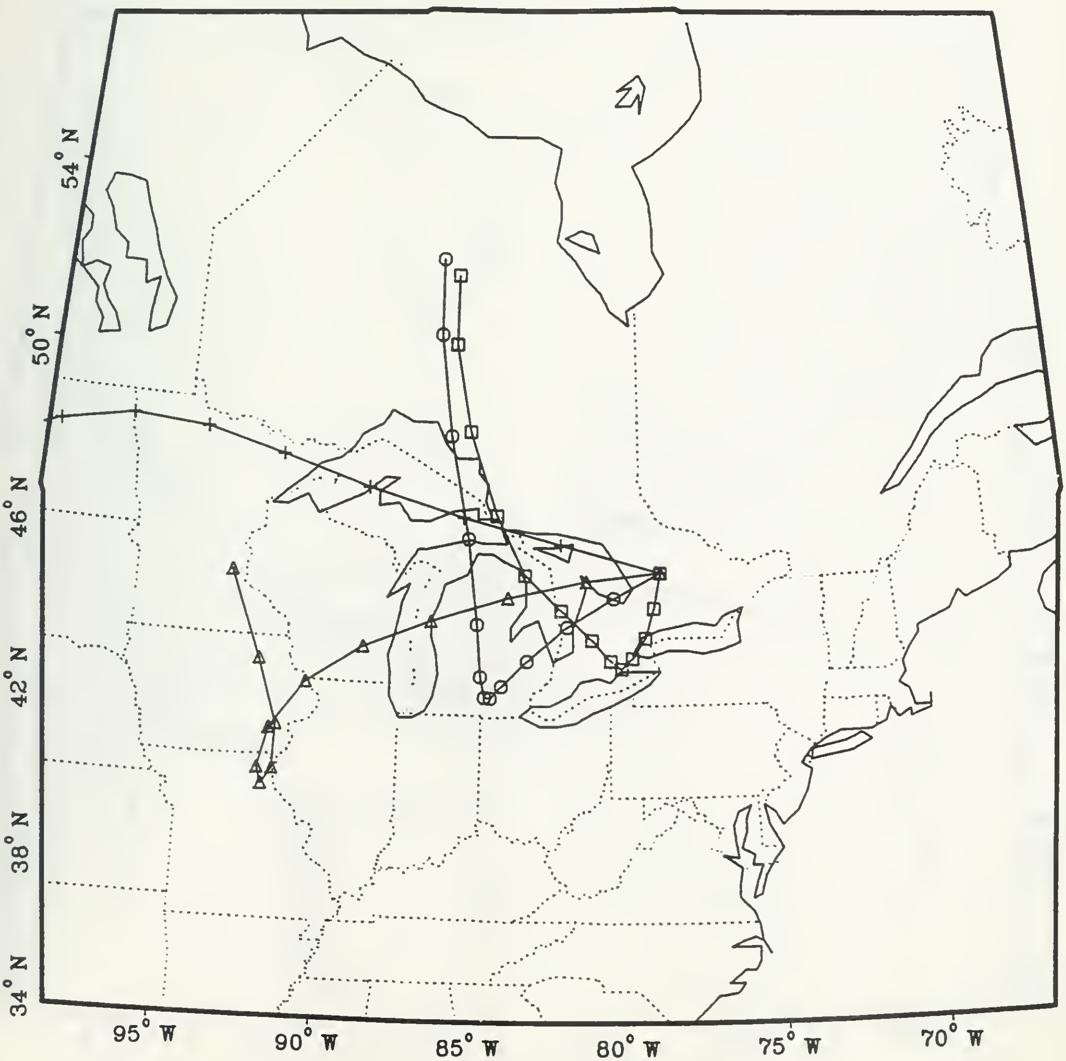


FIGURE 2.29.4

72 HOUR TRAJECTORIES
TUE AUG26 86 18 Z

DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □

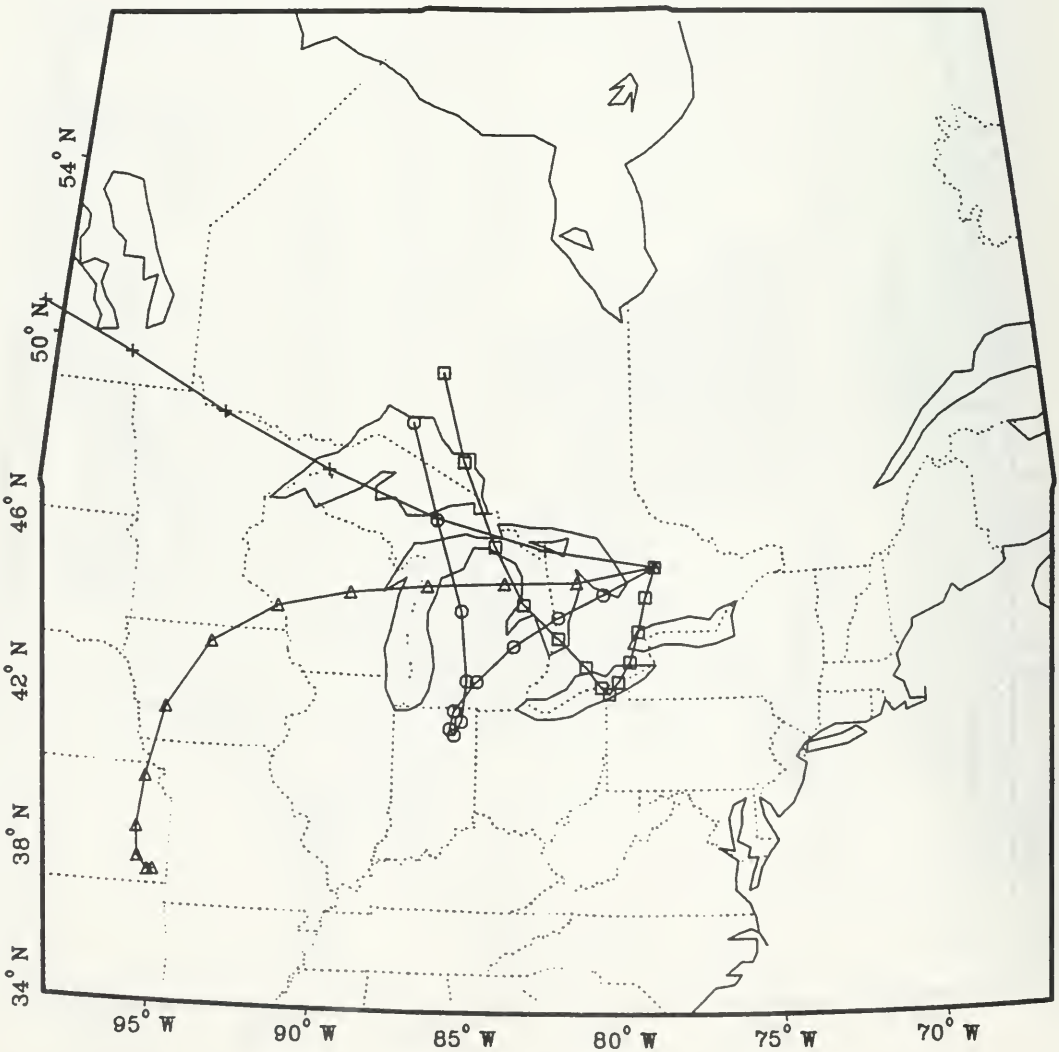


FIGURE 2.29.5

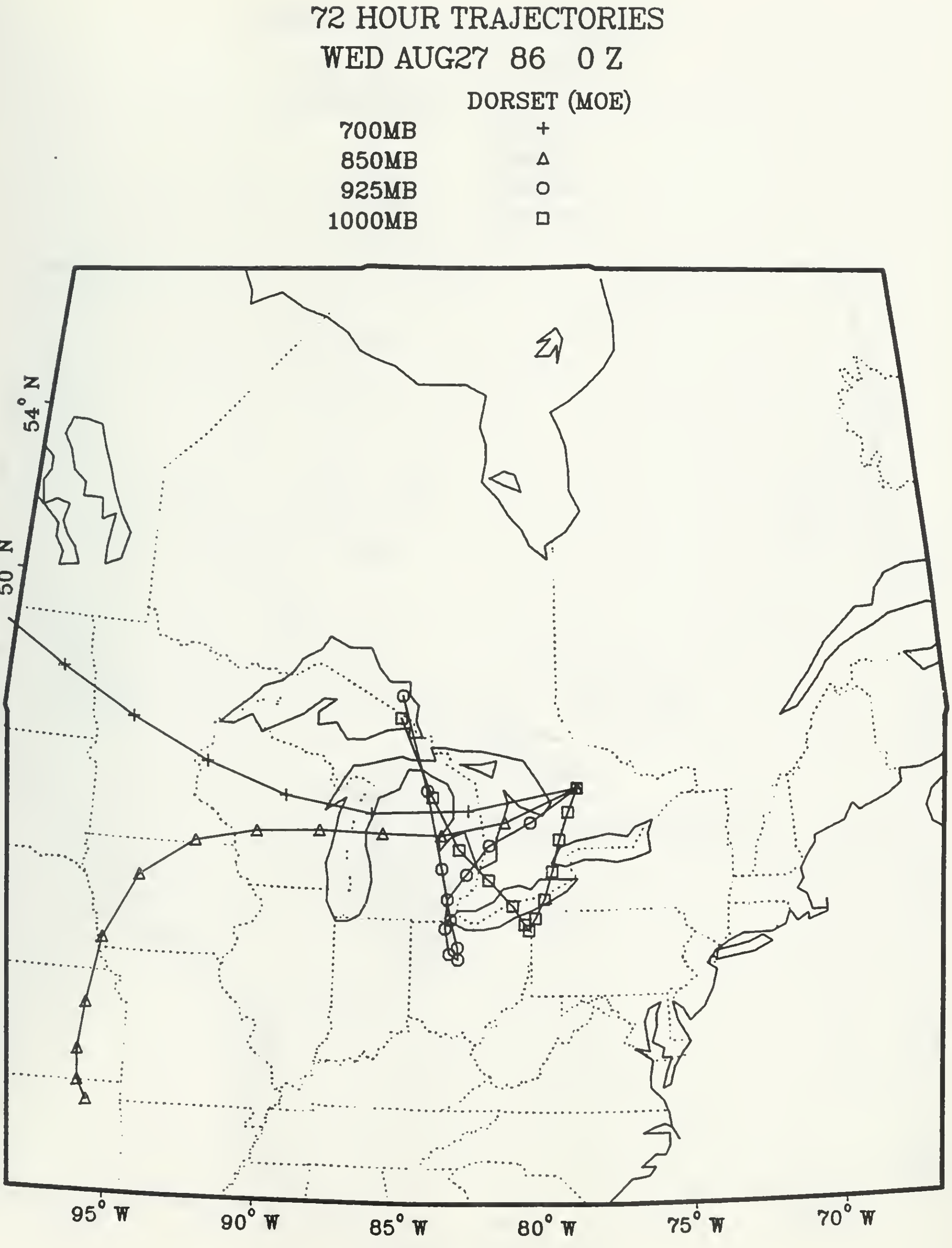

72 HOUR TRAJECTORIES
WED AUG27 86 0 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.29.6

72 HOUR TRAJECTORIES
WED AUG27 86 6 Z

DORSET (MOE)

700MB	+
850MB	Δ
925MB	O
1000MB	□

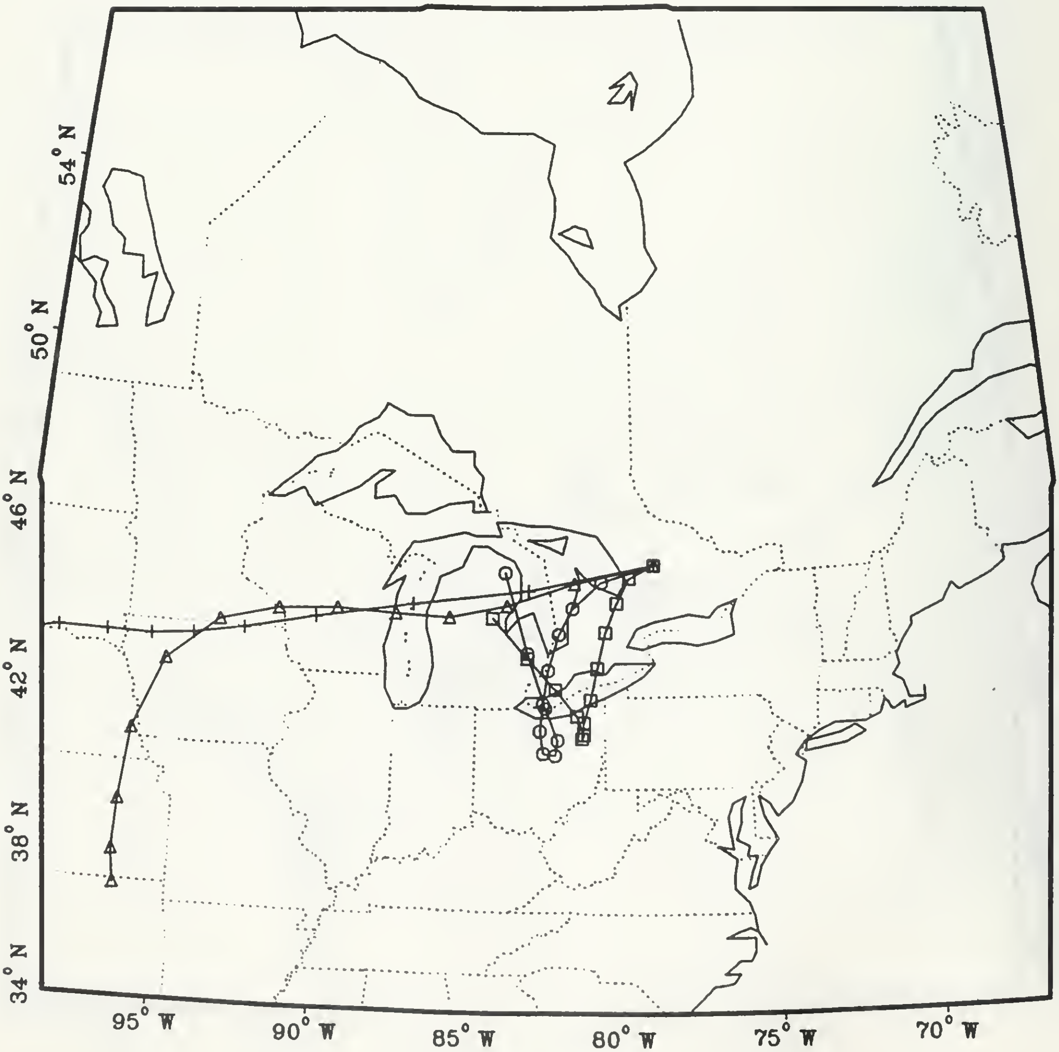


FIGURE 2.29.7

72 HOUR TRAJECTORIES
WED AUG27 86 12 Z

	DORSET (MOE)
700MB	+
850MB	Δ
925MB	O
1000MB	□

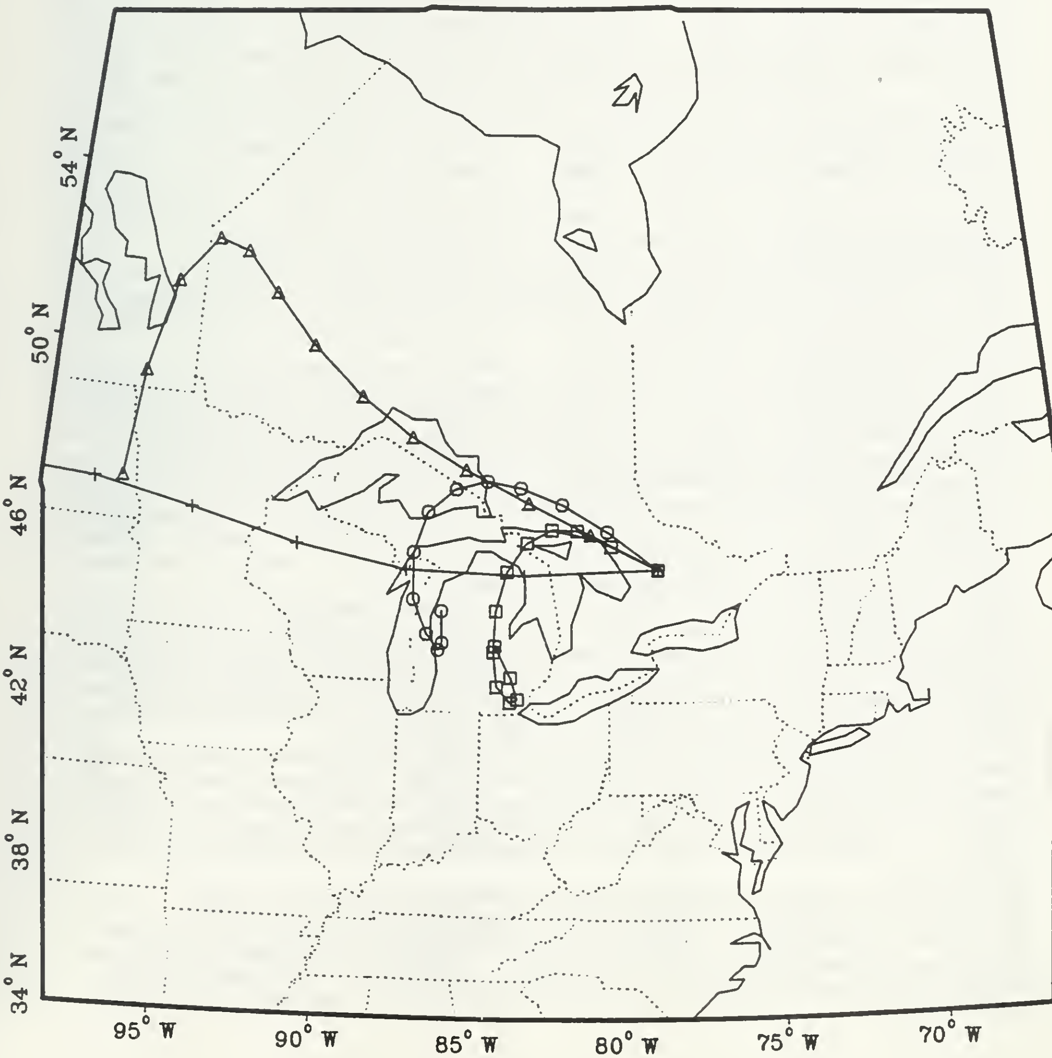


FIGURE 2.29.8

2.30 September 4-5, 1986, Dorset & Chalk River

This episode at Dorset ranked 1st(1/7) and 3rd(3/10) for $SO_4^=$ and NO_3^- respectively. At Chalk River, it ranked 2nd(2/6) for $SO_4^=$ only. Following are separate narratives for Dorset and Chalk River:

Dorset:

On September 4, at 12Z, a wave, over Lake Superior south of WAWA, associated with a warm front over Sault Ste. Marie - Lake Huron and southwest Ontario and a cold front over Traverse City - Lake Michigan - Chicago and a trowal over northern Ontario were observed as shown in Fig. 2.30.1. During the duration of this episode, the wave moved ESE and first the warm front and then the cold front passed over the station. On Sept. 5, at 12Z, as shown in the Fig. 2.30.2., the system had moved eastward with the cold front lying over eastern Ontario and Quebec. The passage of the frontal system and the trowal yielded very light and light rain showers and very light thundershowers that began at about 21Z on Sept. 4 as shown in Fig. 2.30.3A. Although continuous precipitation observations were not available, the estimated total duration of the precipitation was about two hours as shown in the figure.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for September 4, 12Z, 18Z and September 5, 00Z, 06Z and 12Z are shown in Figures 2.30.4, 2.30.5, 2.30.6, 2.30.7, and 2.30.8 respectively.
Air trajectories for the 1000 mb level show that NO_x could have been transported from its highest New York - New Jersey emission area as shown in Figs. 2.30.6&7. No highest SO_2 emission source appeared to be involved in pollution transport at this level.
Air parcels arriving at the 925 mb level could have transported SO_2 and NO_x from their respective highest and high emission areas in Pennsylvania-Ohio-West Virginia (Figs. 2.30.4-7) and Detroit, Michigan (Fig. 2.30.7). Transport of SO_2 and NO_x from their highest emission Chicago, Illinois area (Figs. 2.30.7-8) would also have taken place for a short period of time.
Air trajectories for the 850 mb level show that SO_2 and NO_x from their respective highest and high emission areas in Ohio-West Virginia (Fig. 2.30.4) and Detroit (Fig. 2.30.5-6) could have been transported. Both pollutants could also have been transported from their highest emission Chicago (Figs. 2.30.6-7) and high emission Cleveland (Figs. 2.30.5) areas for some time.
Air parcels arriving at the 700 mb level could have carried SO_2 from its highest emission Detroit (see Figs. 2.30.4-5) and Chicago (see Figs. 2.30.5-6) areas for a brief period. NO_x from its highest emission Chicago (Figs. 2.30.5-6) and high emission Detroit (Figs. 2.30.4-5) could also have been transported for a short period of time.
In summary, a warm and cold front passage yielded very light rain showers and light rain showers and thundershowers lasting for about two hours. Transports of NO_x from New York-New Jersey and of NO_x and SO_2 from Pennsylvania at low levels, of NO_x & SO_2 from Chicago, Detroit and areas in Ohio and West Virginia at low and high levels were likely.

Chalk River

The weather system (see Figs. 2.30.1&2) which yielded rain showers and thundershowers at Dorset earlier passed near Chalk River and gave light, moderate and heavy rain showers and thundershowers beginning at about 23Z on Sept. 4, and lasting for about three and half hours as illustrated in Figs. 2.30.3B. As shown in the figure, lightning was observed at the nearest weather station.

The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Chalk River for Sept. 4, 12Z, 18Z and Sept. 5, 00Z, 06Z and 12Z are shown in Figures 2.30.9, 2.30.10, 2.30.11, 2.30.12, and 2.30.13 respectively.

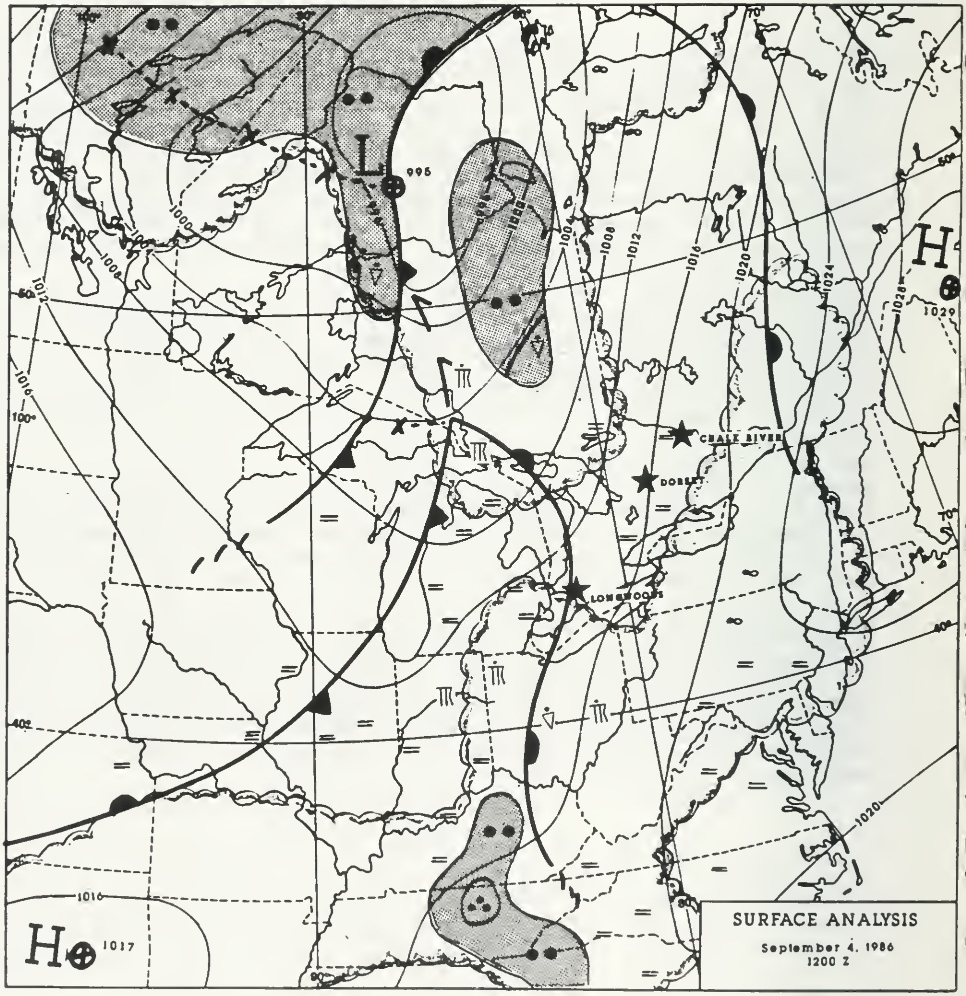
Air trajectories for the 1000 mb level do not cross over any highest or high SO_2 emission area and therefore pollution transport at this level would have been insignificant.

Air parcels arriving at the 925 mb level could have carried SO_2 from its highest emission areas in Pennsylvania- Ohio - West Virginia (see Figs. 2.30.9&11-13) and Detroit, Michigan (Fig. 2.30.13).

Air trajectories for the 850 mb level show that SO_2 from its highest emission areas in Pennsylvania-Ohio-West Virginia (Figs. 2.30.9-11) and from Detroit and Chicago areas for some short period of time (see Figs. 2.30.11-12) could have been transported.

Air parcels arriving at the 700 mb level could have carried SO_2 from its highest emission Detroit (Fig. 2.30.10) and Chicago (Fig. 2.30.11) areas.

Summarizing, a wave associated with warm and cold fronts and a trowal that crossed over Dorset earlier yielded light, moderate and heavy rain showers and thundershowers at Chalk River. Lightning was observed near the station. Transports of SO_2 at low and high levels from Detroit and areas in Pennsylvania, Ohio and West Virginia, and at high levels from Chicago were likely during this episode.



995
1000
1004
1008
1012
1016
1020
1024
1028
1029
1017
CHALK RIVER
DORSET
LONGWOODS
SURFACE ANALYSIS
September 4, 1986
1200 Z

FIGURE 2.30.1

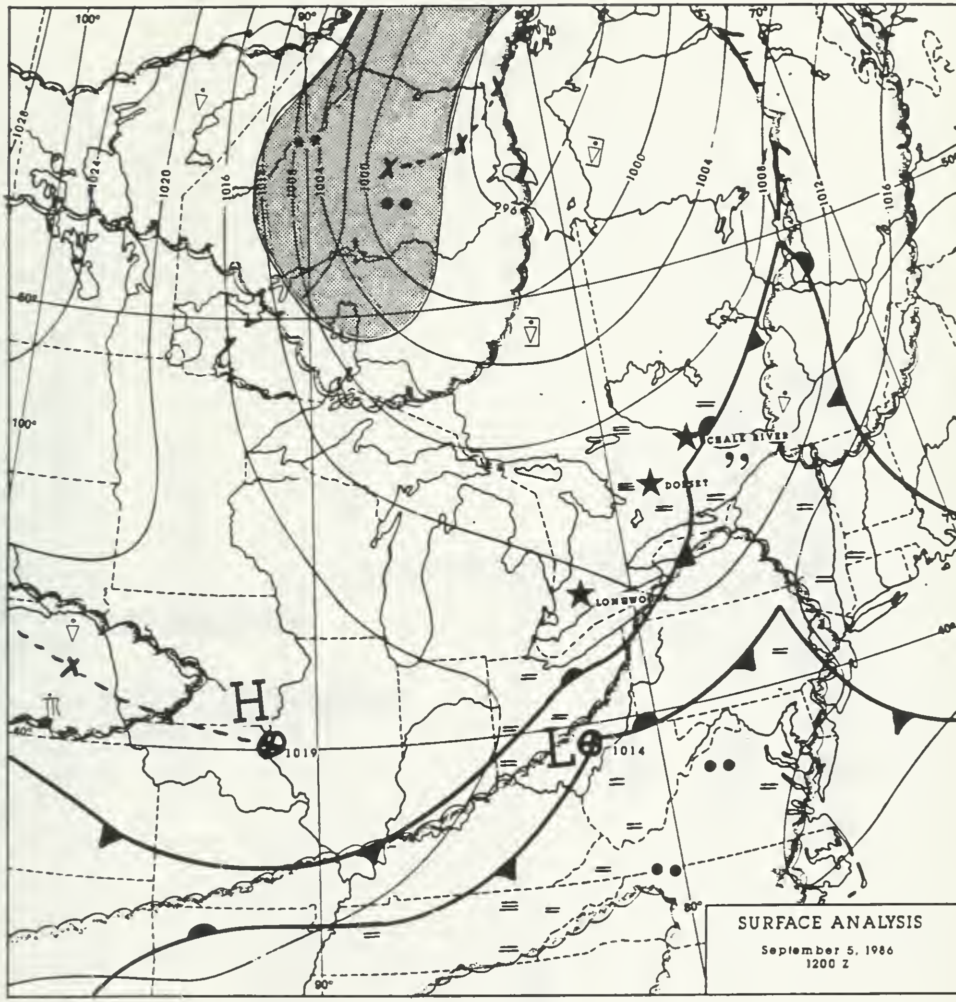

SURFACE ANALYSIS
September 5, 1986
1200 Z
CHALK RIVER
DORSET
LONGWO
H
L
1019
1014
1028
1024
1020
1016
1012
1008
1004
1000
996
100°
90°
80°
70°
60°
50°
40°

FIGURE 2.30.2

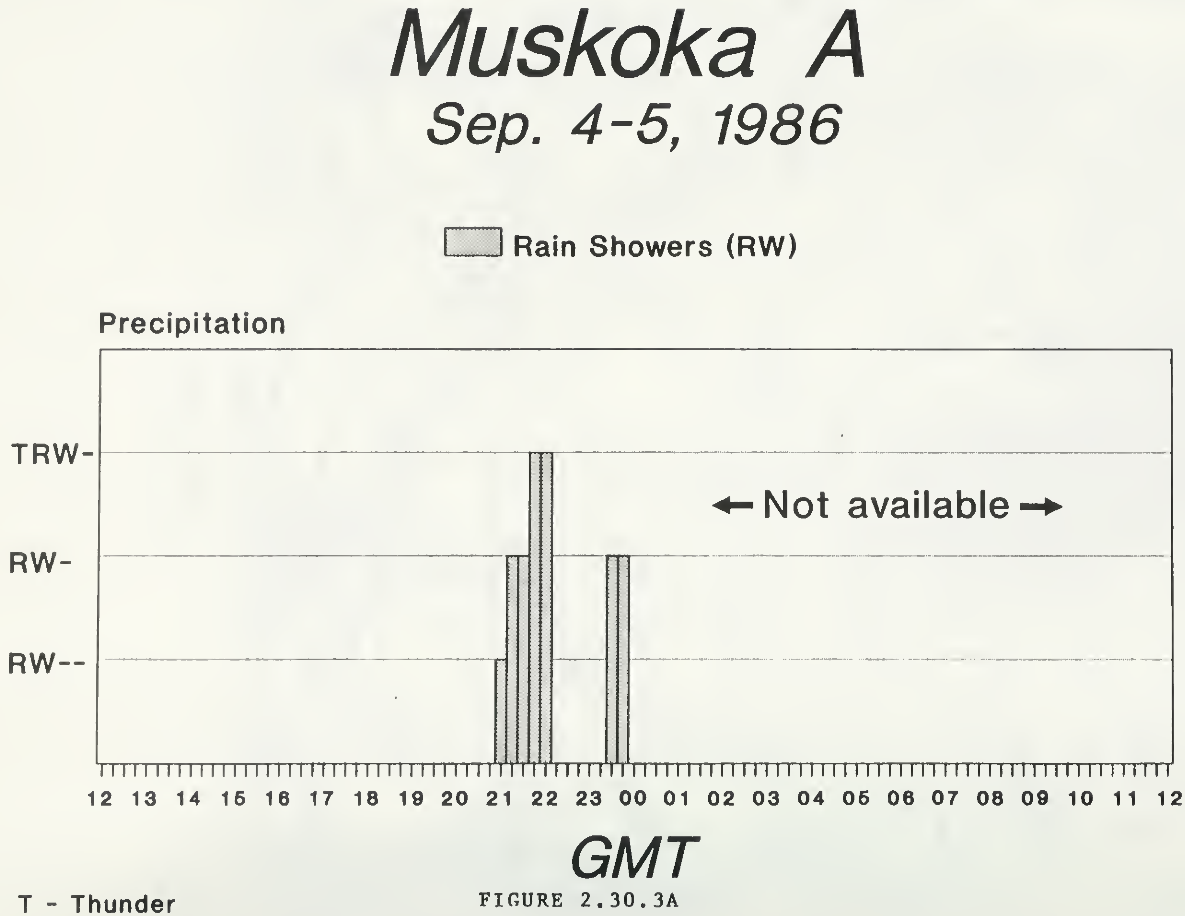
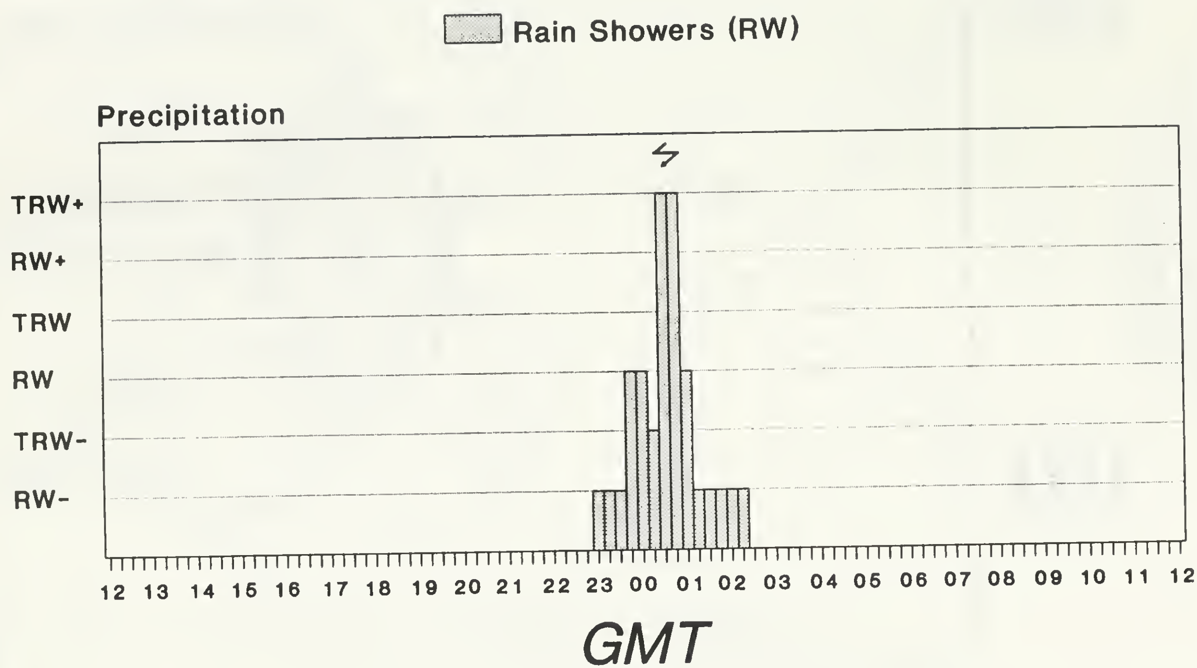


FIGURE 2.30.3A

Petawawa A
Sep. 4-5, 1986



T - Thunder

FIGURE 3.30.3B

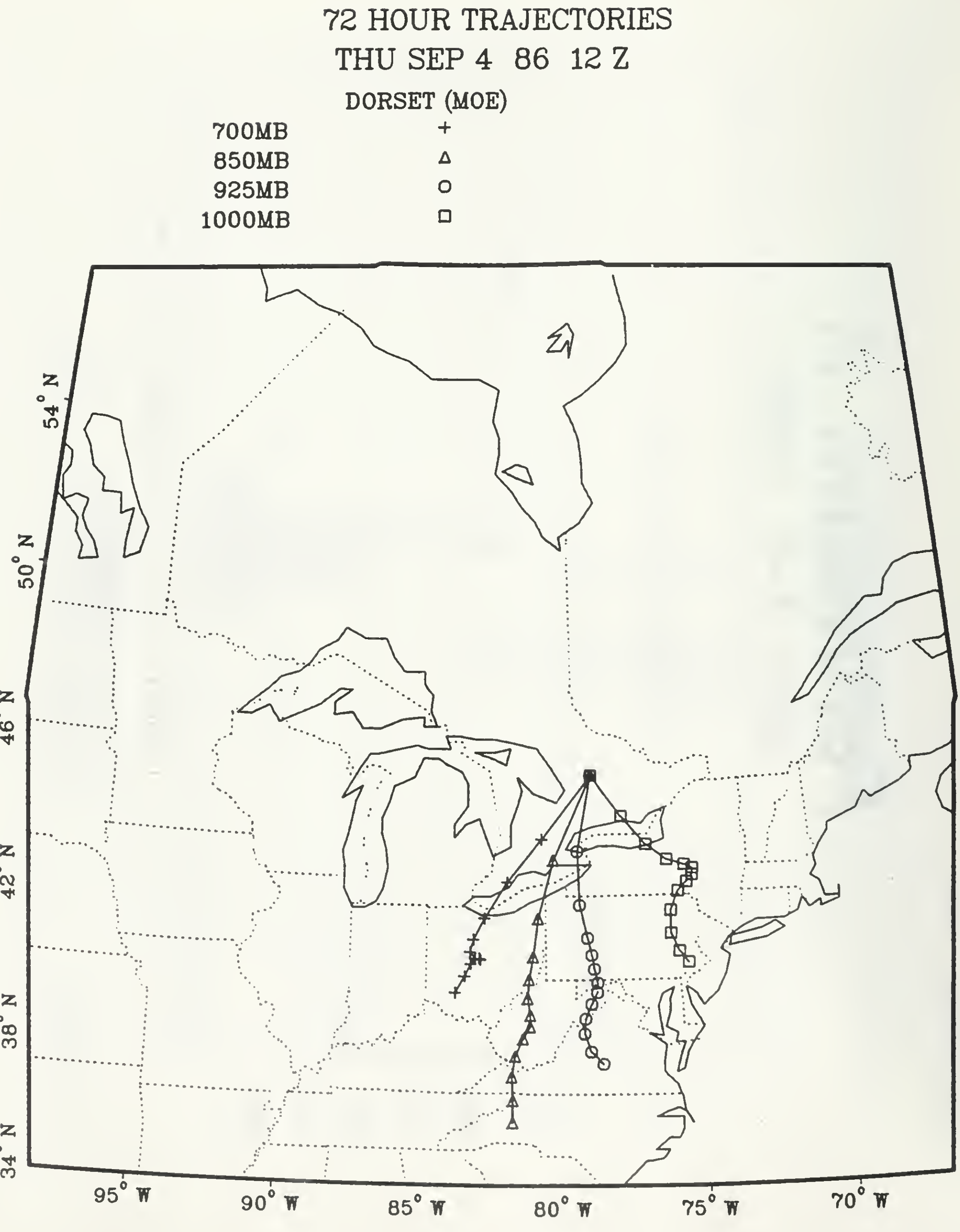

72 HOUR TRAJECTORIES
THU SEP 4 86 12 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.30.4

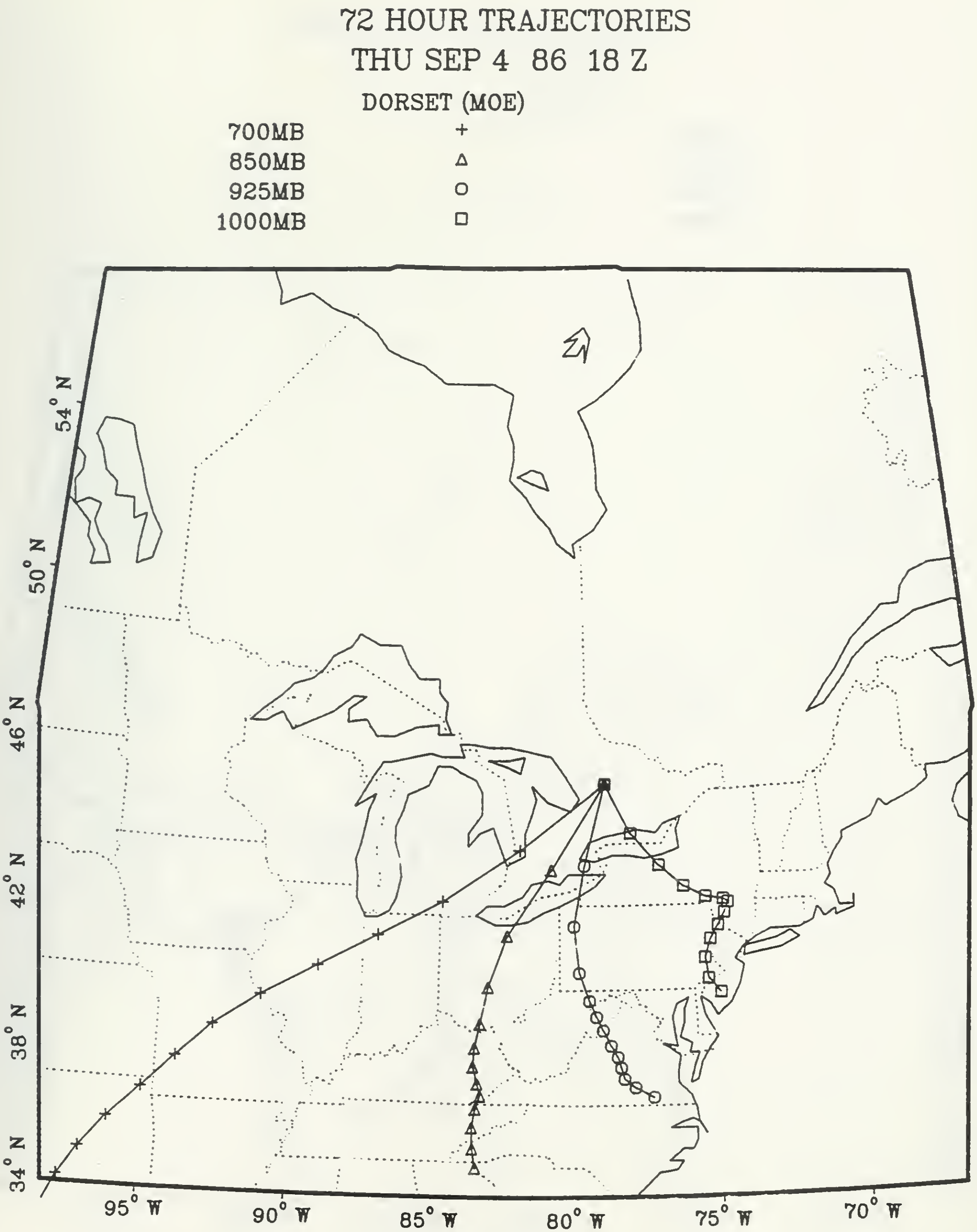

72 HOUR TRAJECTORIES
THU SEP 4 86 18 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.30.5

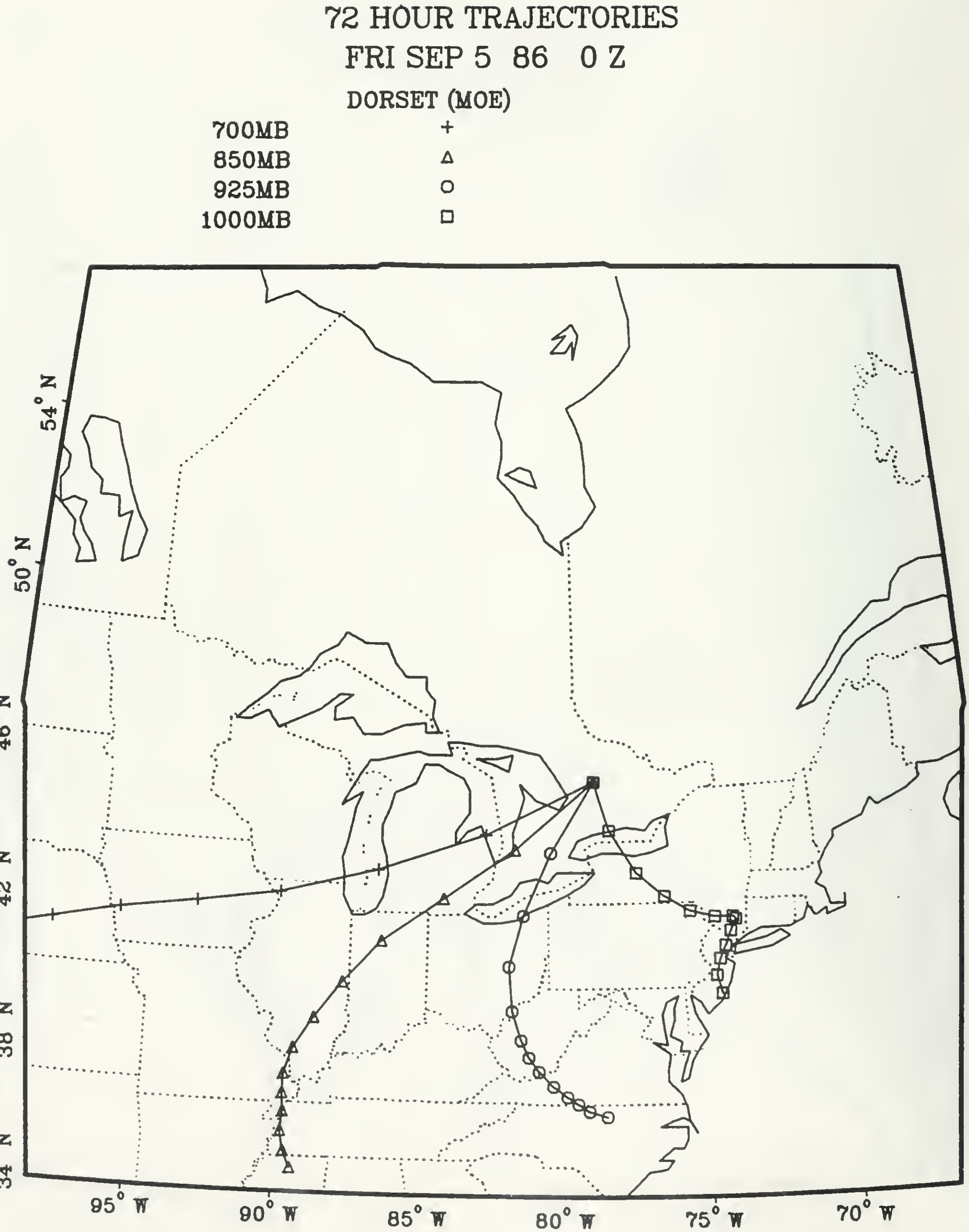

72 HOUR TRAJECTORIES
FRI SEP 5 86 0 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.30.6

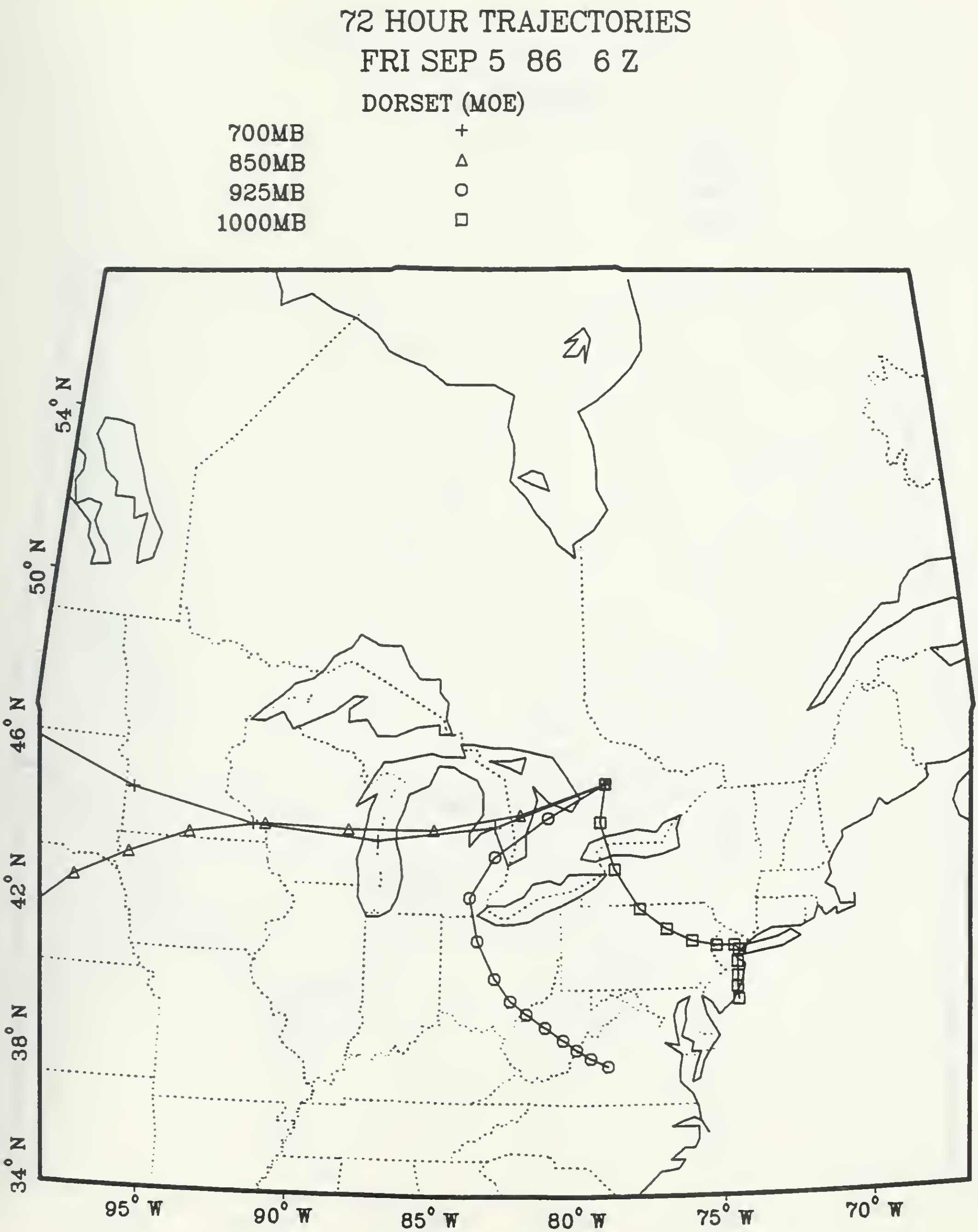

72 HOUR TRAJECTORIES
FRI SEP 5 86 6 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.30.7

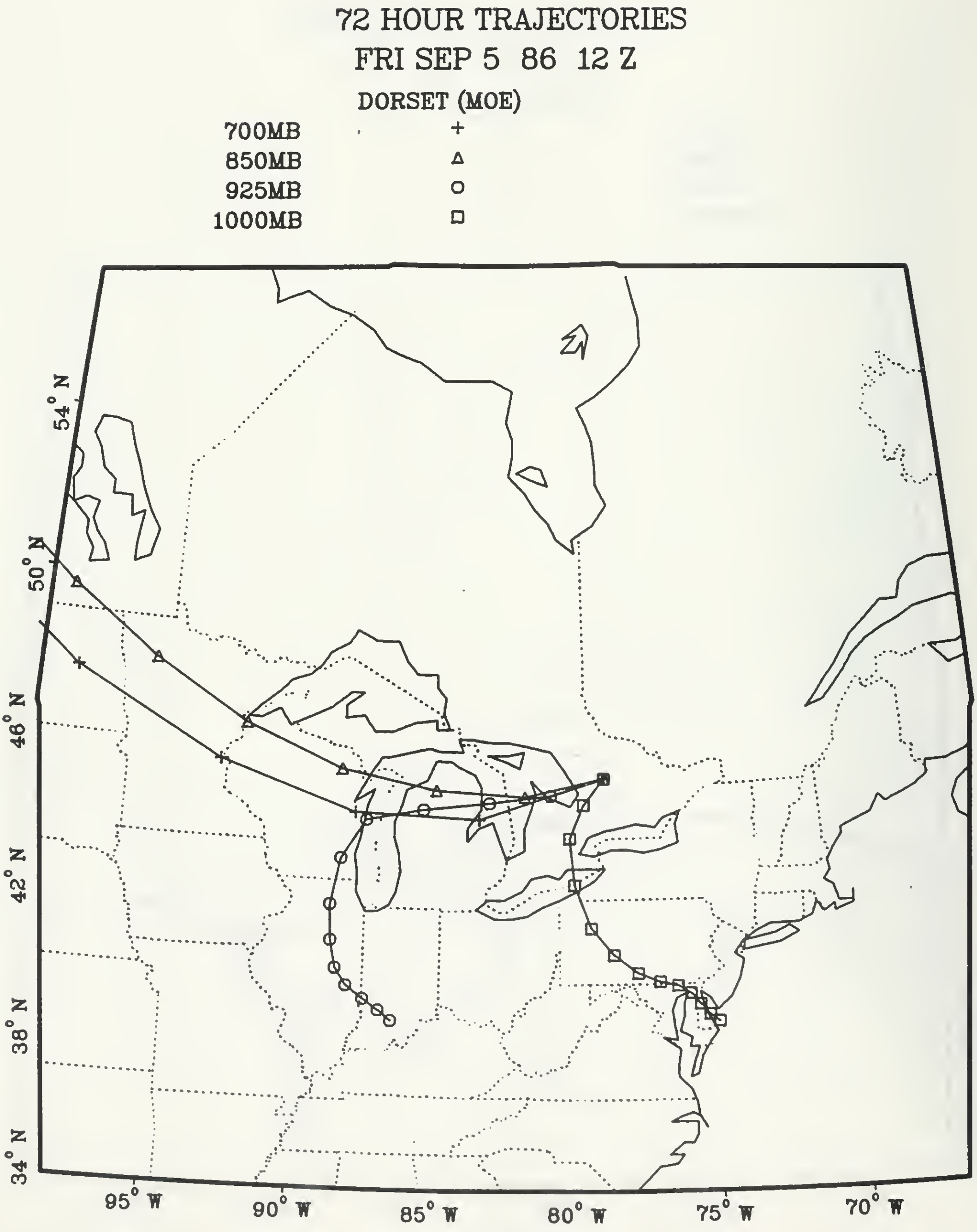

72 HOUR TRAJECTORIES
FRI SEP 5 86 12 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.30.8

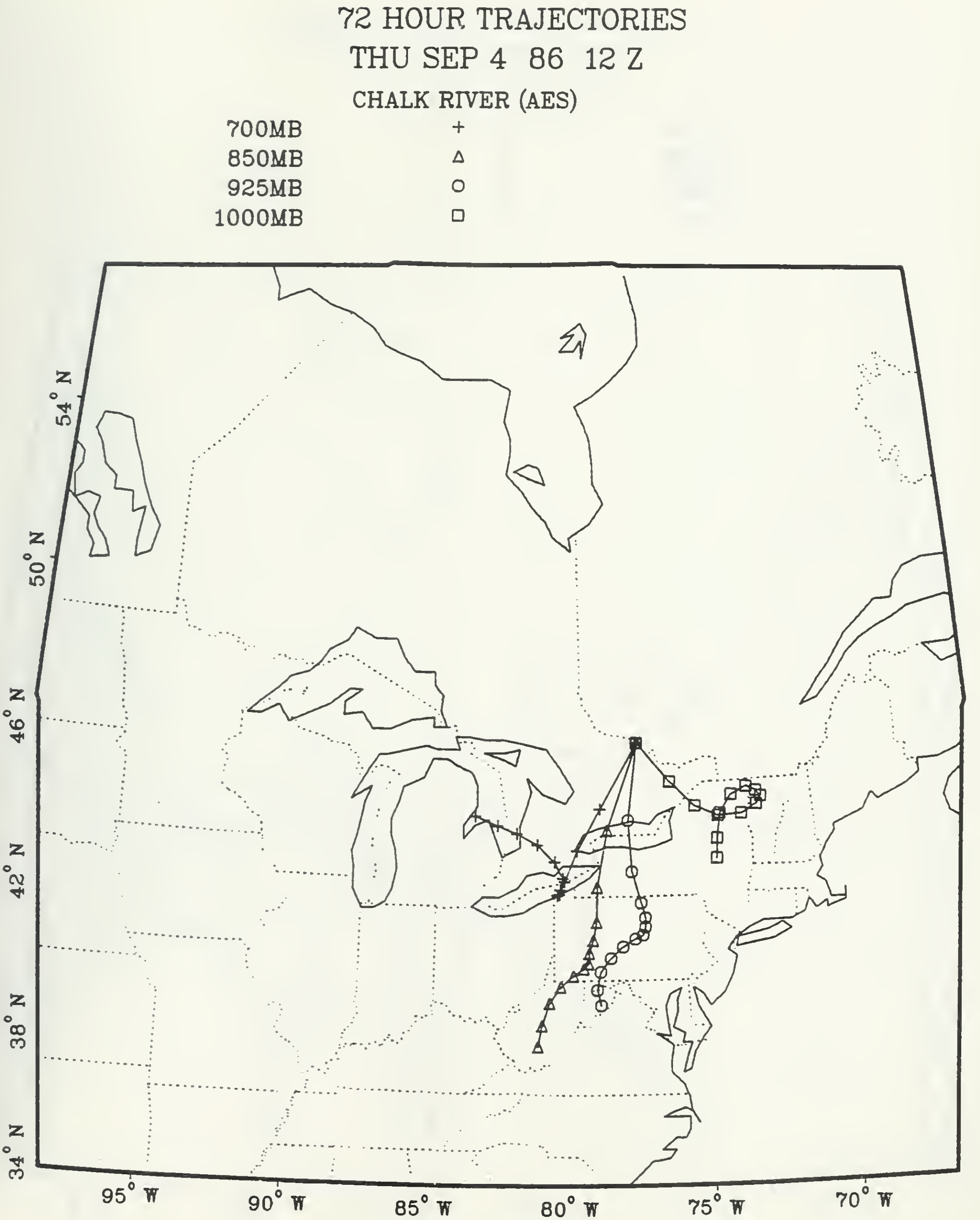

72 HOUR TRAJECTORIES
THU SEP 4 86 12 Z
CHALK RIVER (AES)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.30.9

72 HOUR TRAJECTORIES
THU SEP 4 86 18 Z

CHALK RIVER (AES)

700MB	+
850MB	Δ
925MB	O
1000MB	□

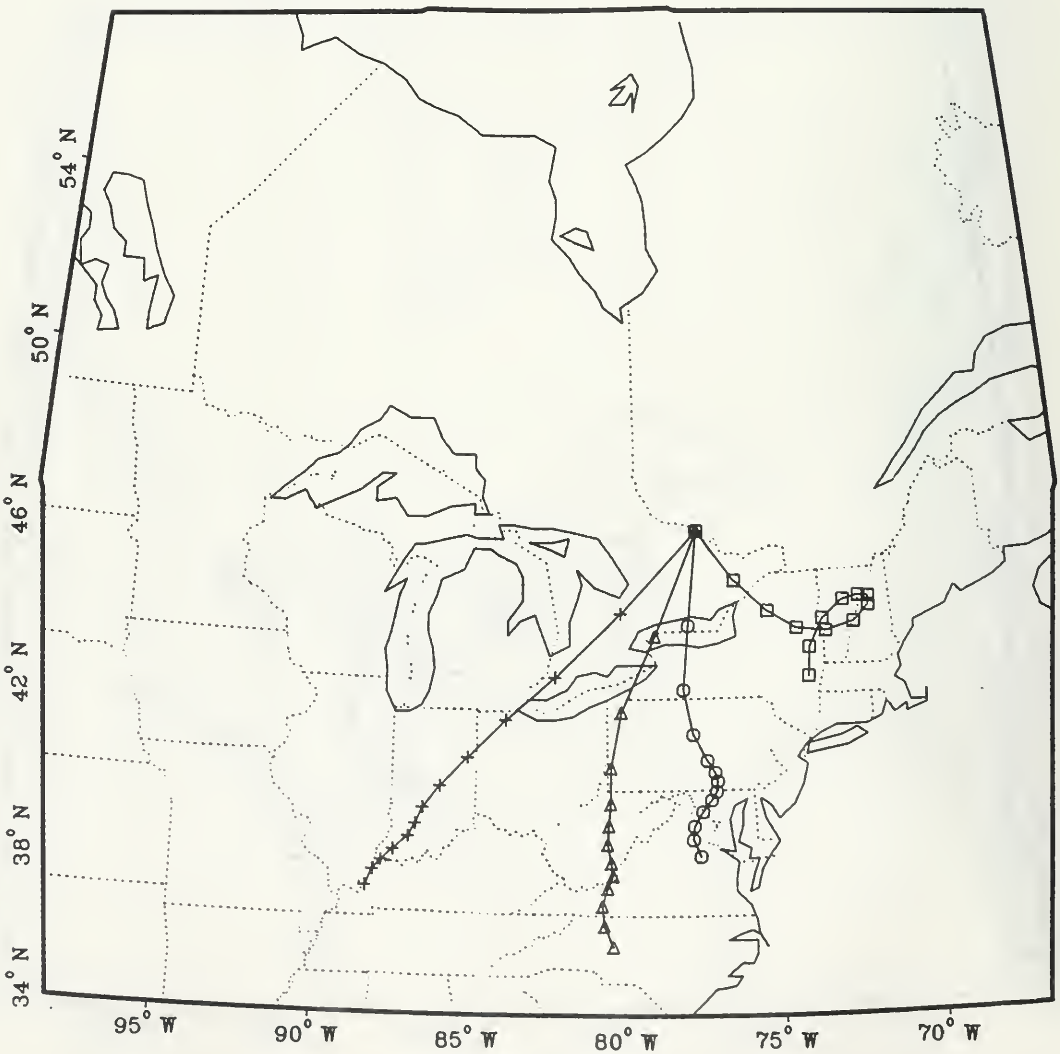


FIGURE 2.30.10

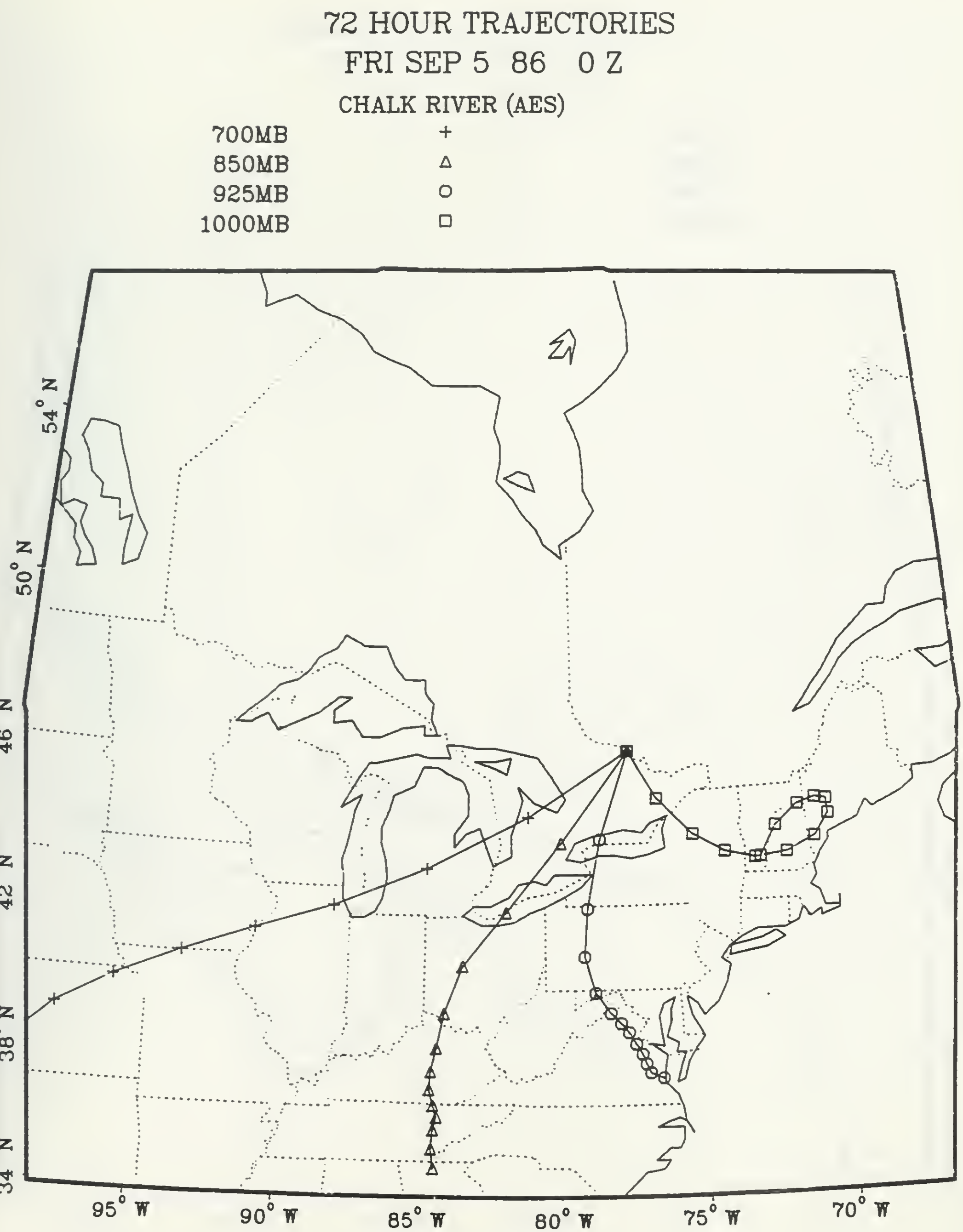


FIGURE 2.30.11

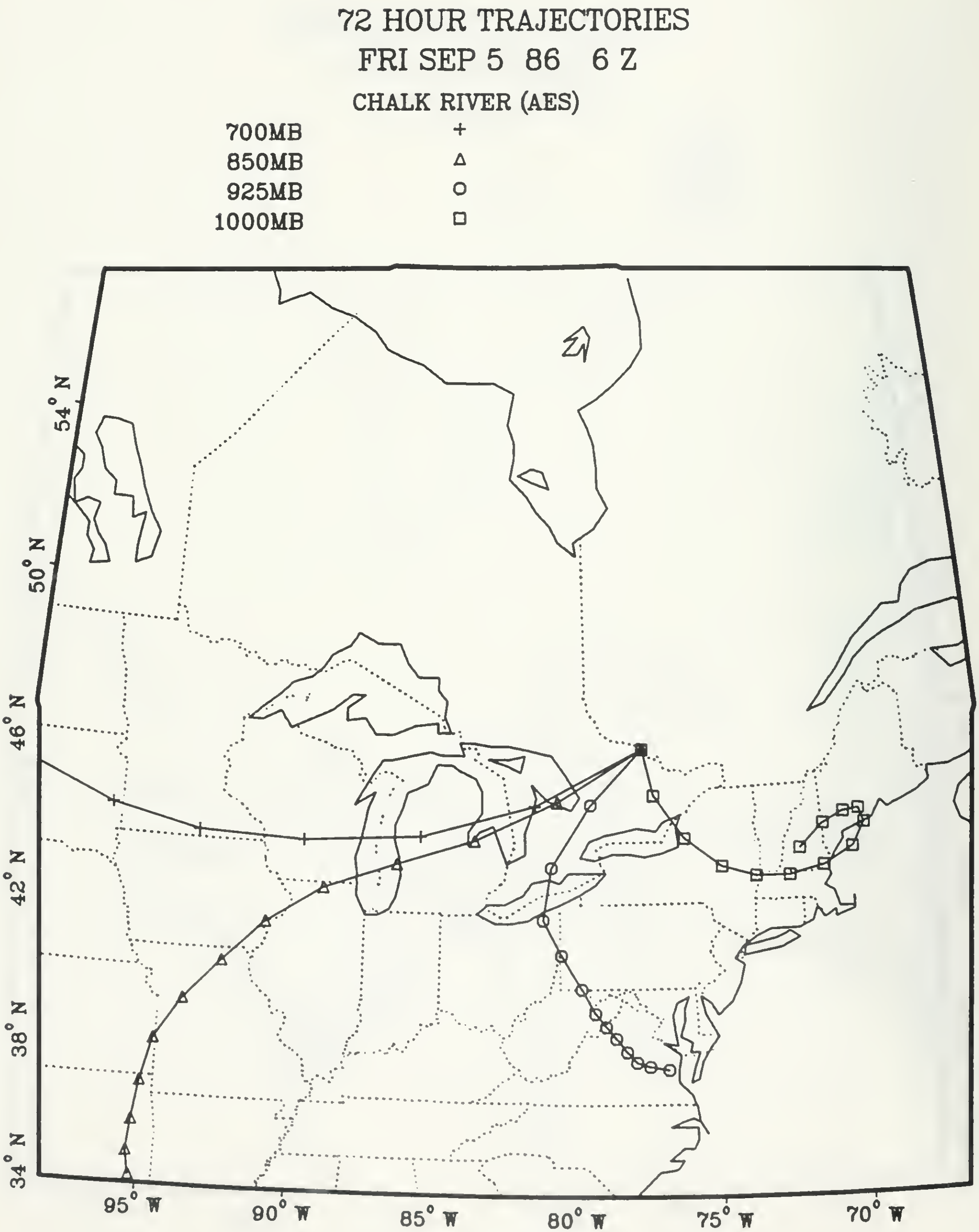


FIGURE 2.30.12

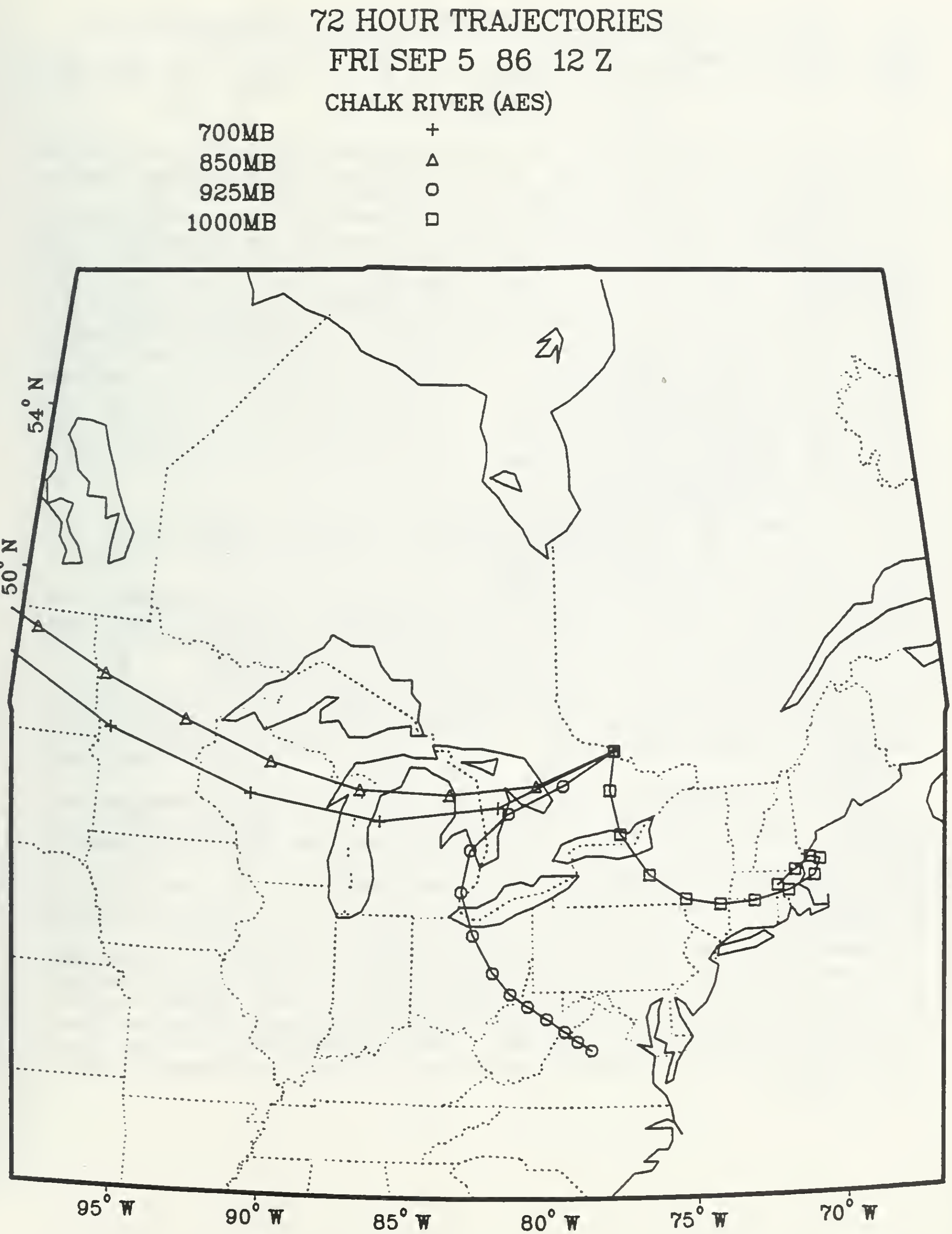


FIGURE 2.30.13

2.31 <u>September 10-11, 1986, Longwoods (AES) & Longwoods (MOE)</u>

This episode ranked 1st (1/8) for $SO_4^=$ and 2nd (2/10) for the NO_3^- wet deposition events at Longwoods (AES). It ranked 1st for both $SO_4^=$ (1/7) and NO_3^- (1/10) at Longwoods (MOE).

A low pressure centre, 998 mb, over Nebraska, and a wave over Lake Michigan near Traverse City, each associated with a frontal system were observed on Sept. 10, at 12Z as shown in Fig. 2.31.1.
A stationary front over northern Ontario was also observed as shown in the figure, but it did not affect the weather at Longwoods. The low centre slowly moved ENE and slightly filled and the wave had dipped SE. On Sept. 11, at 12Z, as shown in Fig. 2.31.2, the low centre, 999 mb, had moved to lie over Wisconsin and the cyclonic flow had intensified. Thunderstorm activity was widely associated with this weather system. With the movement of the wave and fronts near Longwoods, thundershowers occurred at the nearest weather station London Airport as shown in Fig. 2.31.3. As illustrated in the figure, rain of very light, light and moderate intensity and rain showers and thundershowers from light to heavy intensity were observed. Lightnings were seen and thunder was heard. Total precipitation duration was about 14 hours.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for Sept. 10, 12Z, 18Z and Sept. 11, 00Z, 06Z and 12Z are shown in Figures 2.31.4, 2.31.5, 2.31.6, 2.31.7, and 2.31.8 respectively.
Air trajectories for the 1000 mb level show that SO_2 from its highest and NO_x from its high emission Detroit (Fig. 2.31.4) area and other areas in Ohio-West Virginia-Pennsylvania (Figs. 2.31. 4-8) could have been transported throughout the episode.
Air trajectories for the 925 mb level show that SO_2 from its highest and NO_x from its high emission Detroit (Fig. 2.31.5&8) area could have been transported. Both pollutants from their high emission Cleveland (Fig. 2.31.4,6,7) area could also have been transported.
Air parcels arriving at the 850 mb level could have carried SO_2 and NO_x from their respective highest and high emission Detroit, Michigan (Fig. 2.31.4,6,7) and other area in Illinois-Missouri states.
Air parcels arriving at the 700 mb level show that SO_2 and NO_x from their highest emission Chicago (Fig. 2.31.5) area could have been transported.
In summary, fronts in the vicinity yielded very light to moderate rain and light to heavy rain showers and thundershowers lasting for about 14 hours. Lightnings were observed and thunder heard. Transports of SO_2 and NO_x from areas in Pennsylvania, Ohio and West Virginia at low level (1000 mb), from Detroit at low and high levels and from Chicago and other area in Illinois-Missouri states were likely.

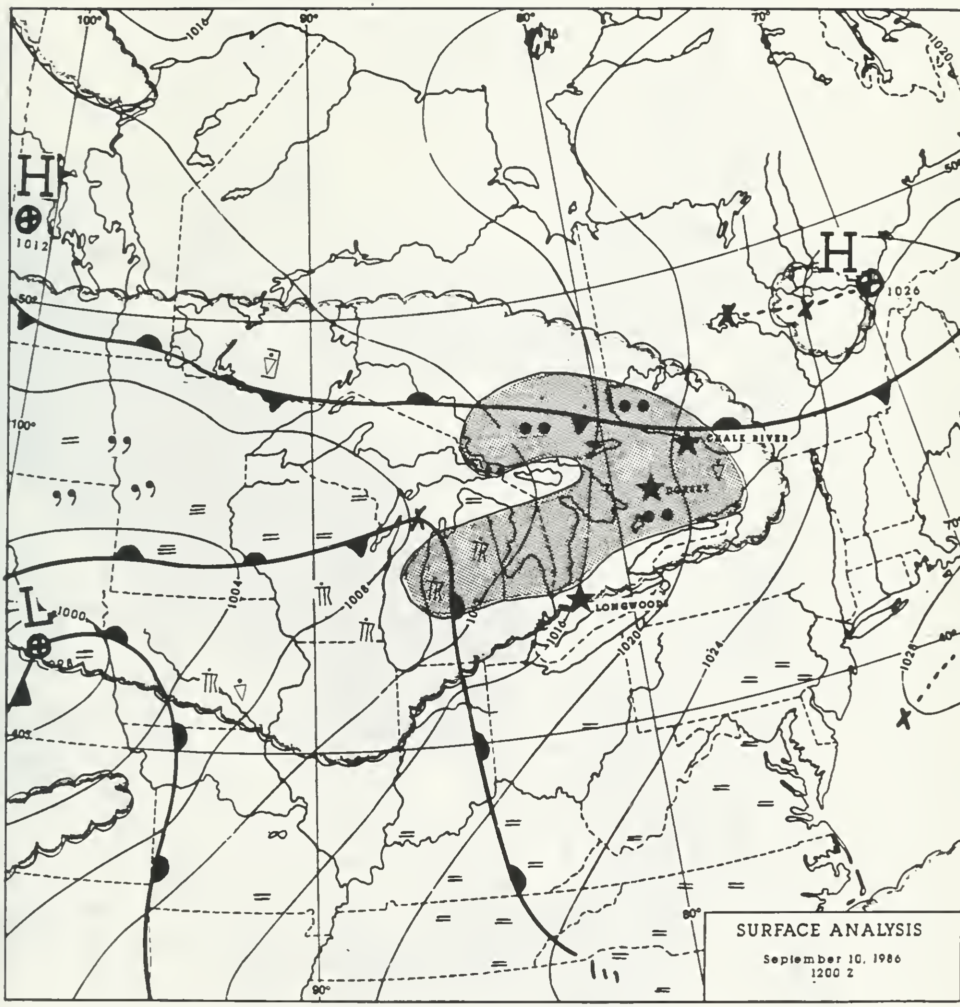

SURFACE ANALYSIS
September 10, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1012
1026
1000
1004
1008
1016
1020
1024
1028

FIGURE 2.31.1

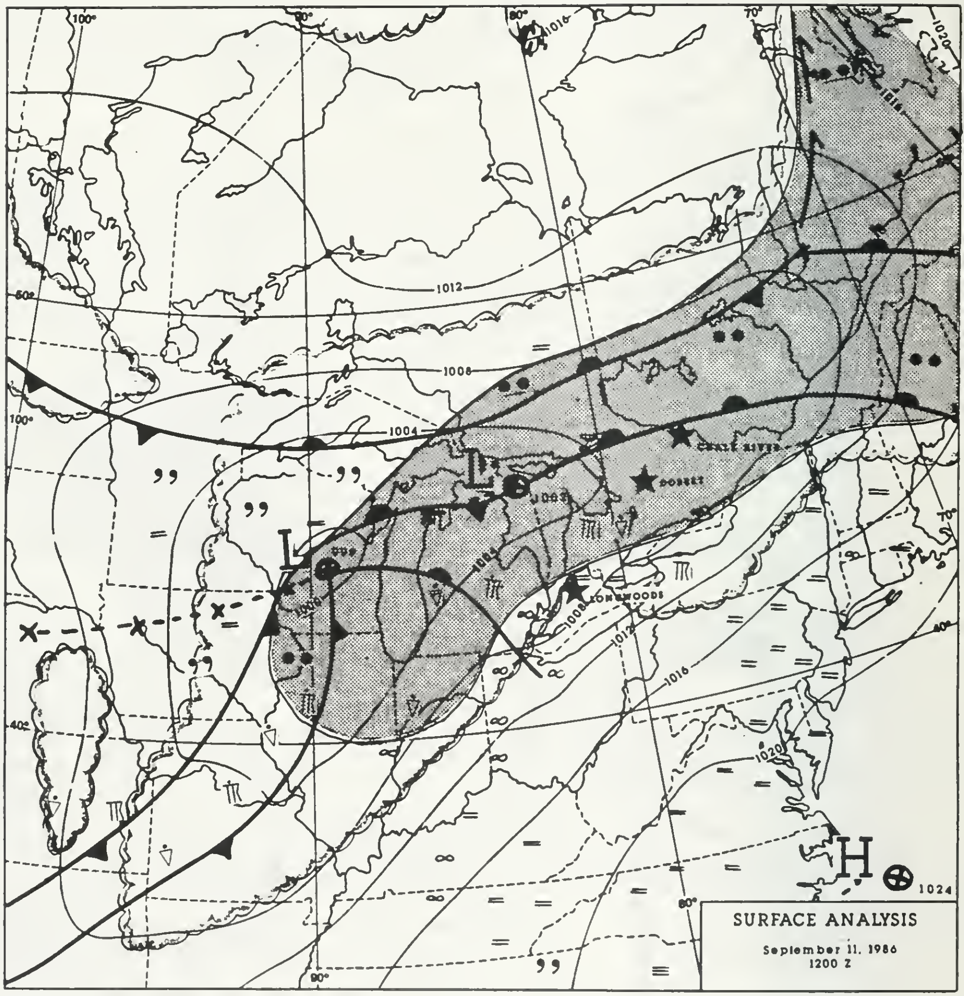
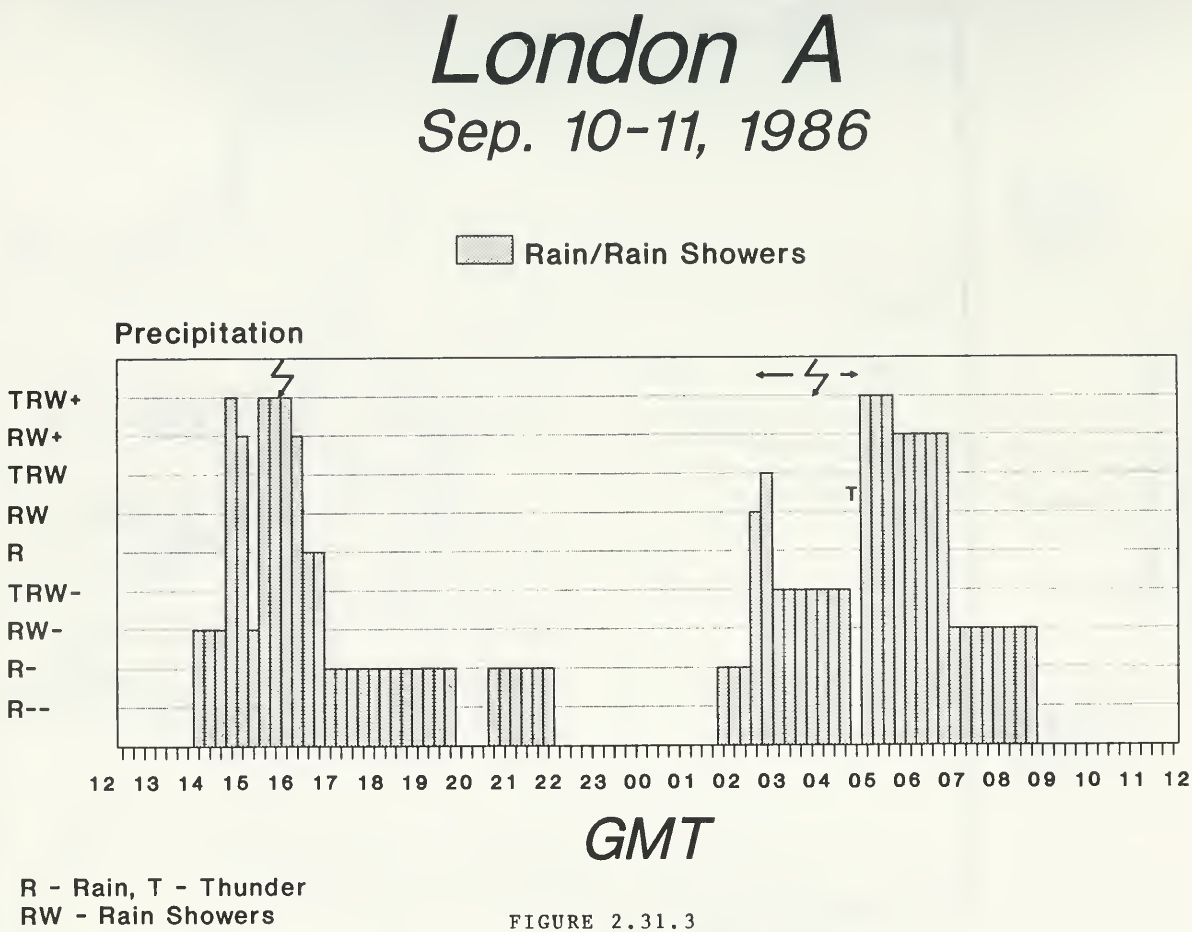

SURFACE ANALYSIS
September 11, 1986
1200 Z
1024
1020
1016
1012
1008
1004
H
L
CHALK RIVER
DORSET
LONGWOODS

FIGURE 2.31.2



London A
Sep. 10-11, 1986
Rain/Rain Showers
Precipitation
TRW+
RW+
TRW
RW
R
TRW-
RW-
R-
R--
T
12 13 14 15 16 17 18 19 20 21 22 23 00 01 02 03 04 05 06 07 08 09 10 11 12
GMT
R - Rain, T - Thunder
RW - Rain Showers

FIGURE 2.31.3

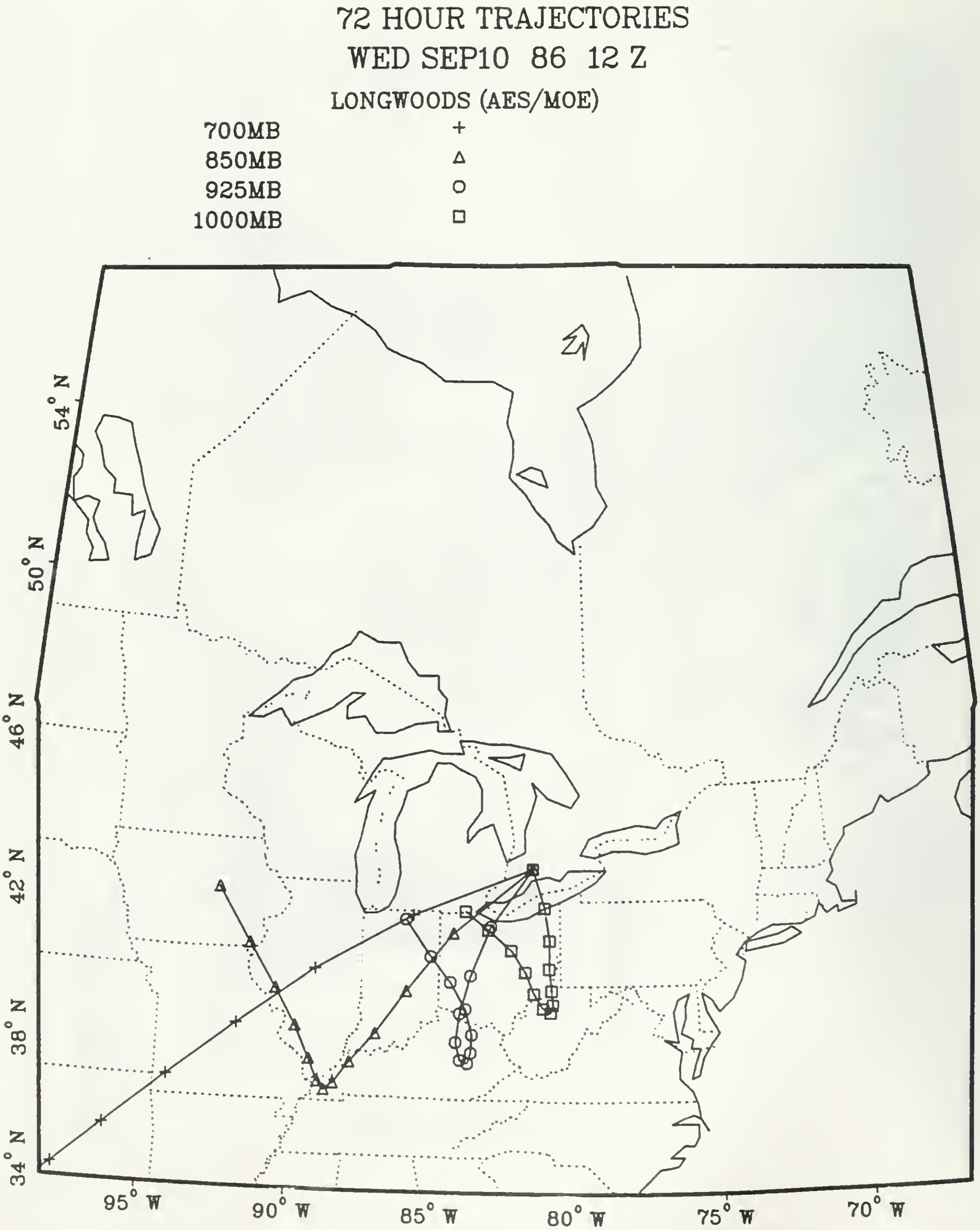

72 HOUR TRAJECTORIES
WED SEP10 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.31.4

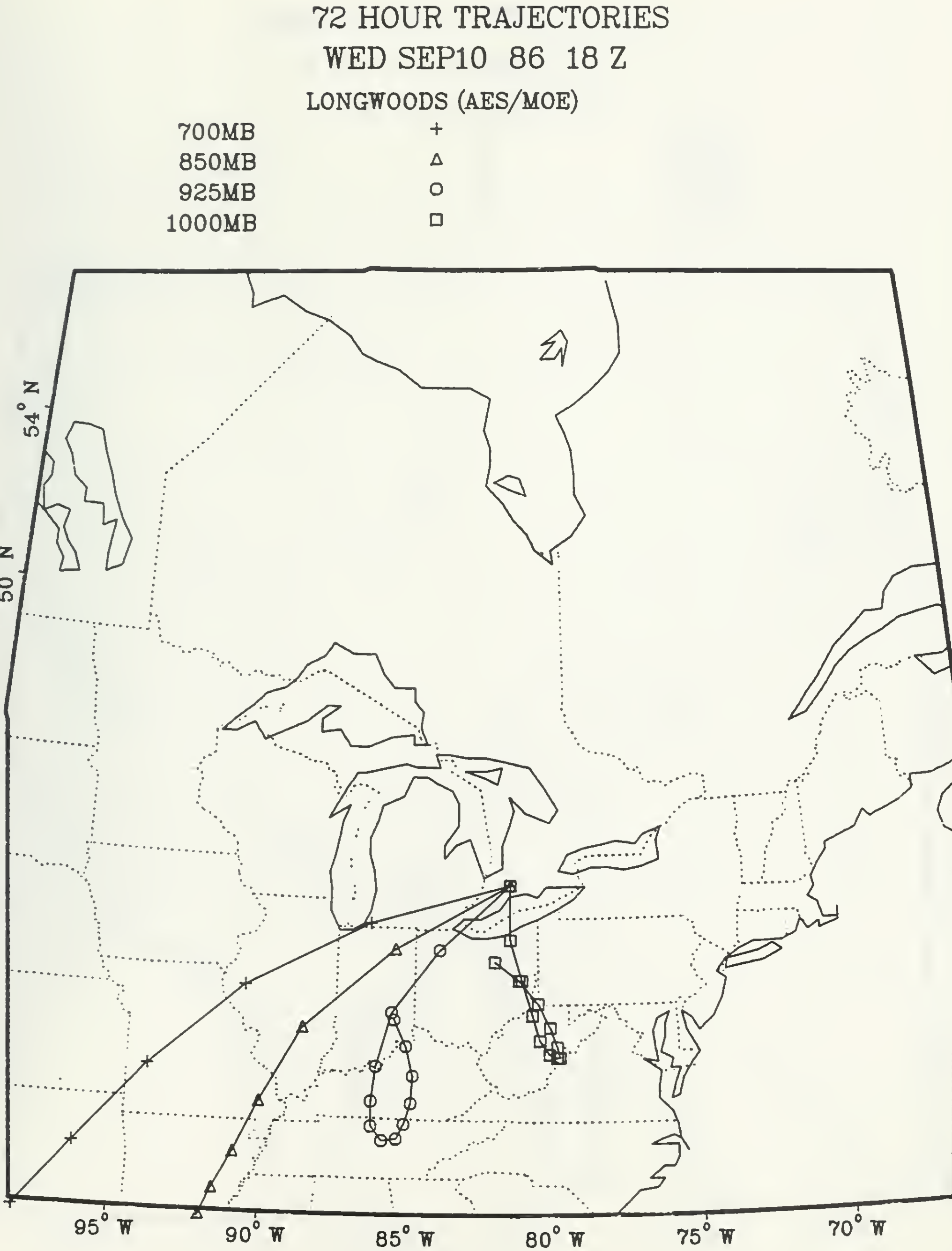

72 HOUR TRAJECTORIES
WED SEP10 86 18 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.31.5

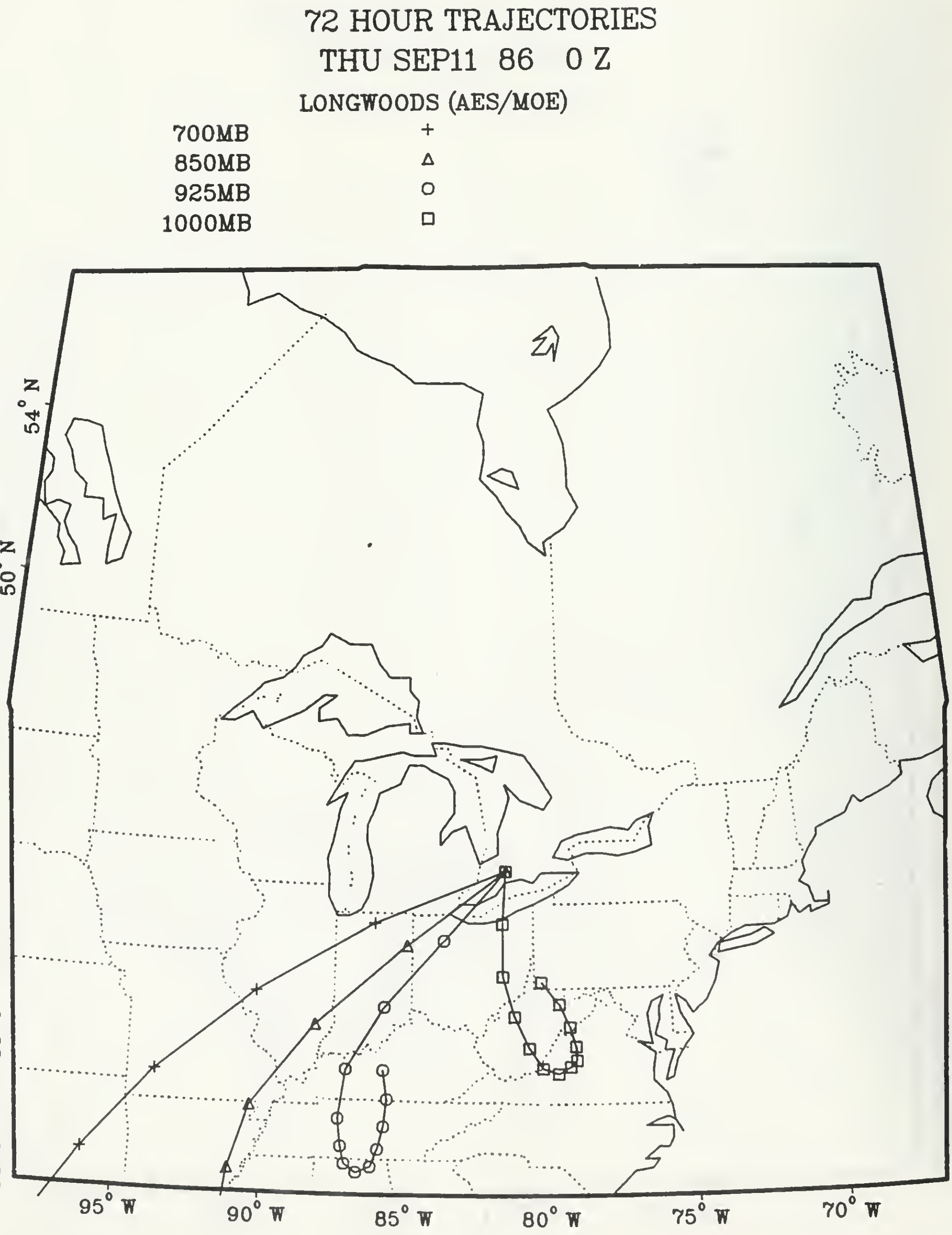

72 HOUR TRAJECTORIES
THU SEP11 86 0 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.31.6

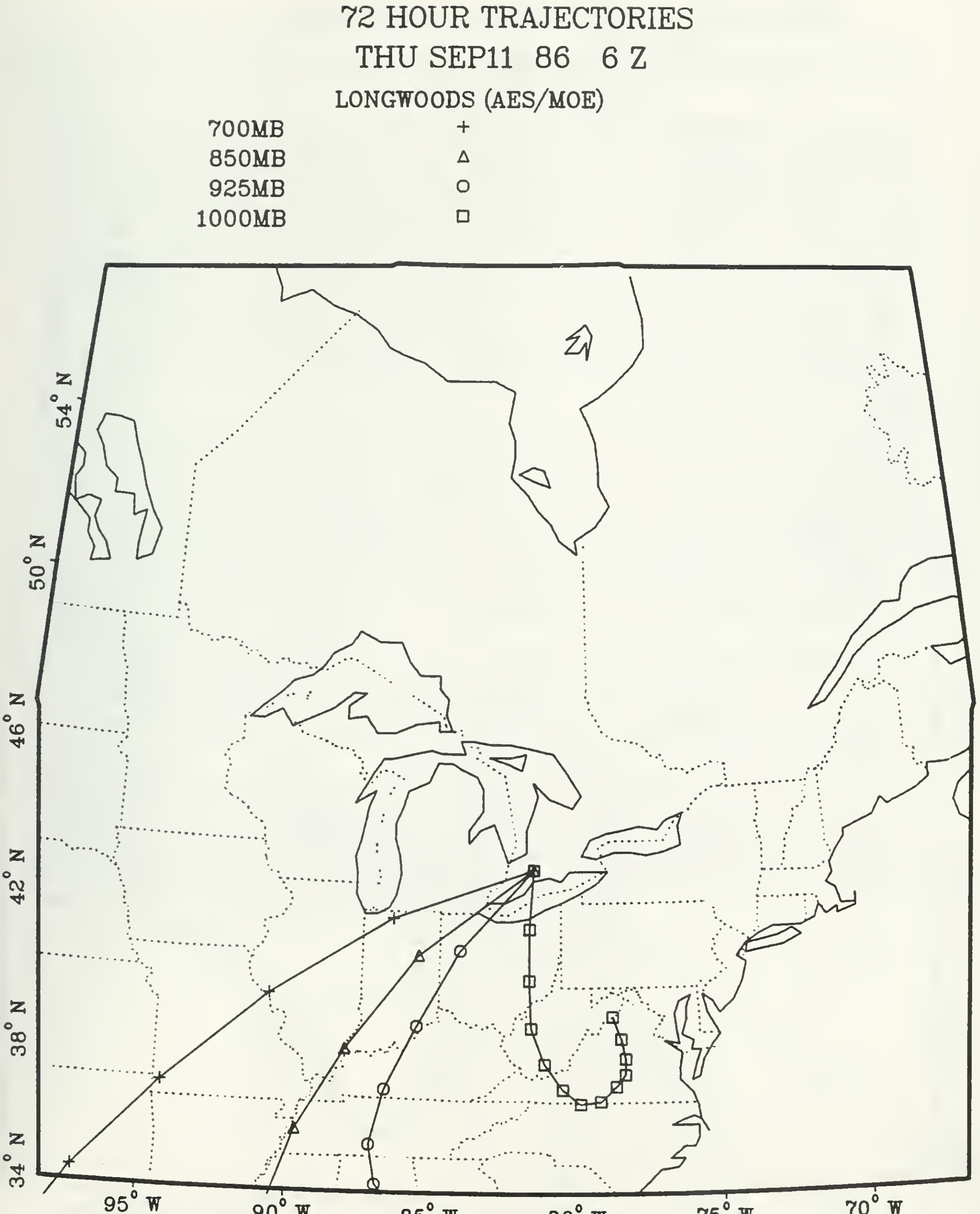

72 HOUR TRAJECTORIES
THU SEP11 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.31.7

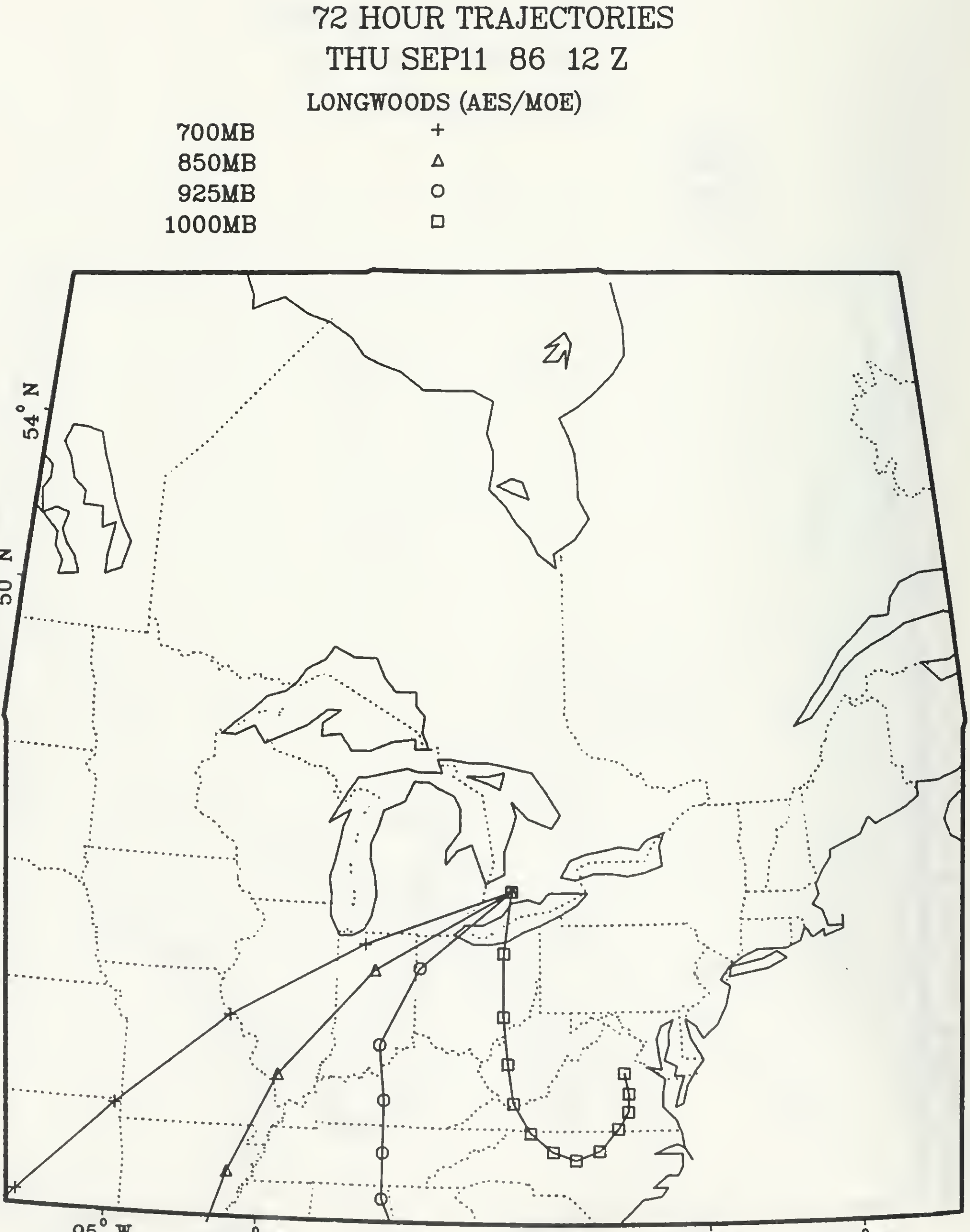
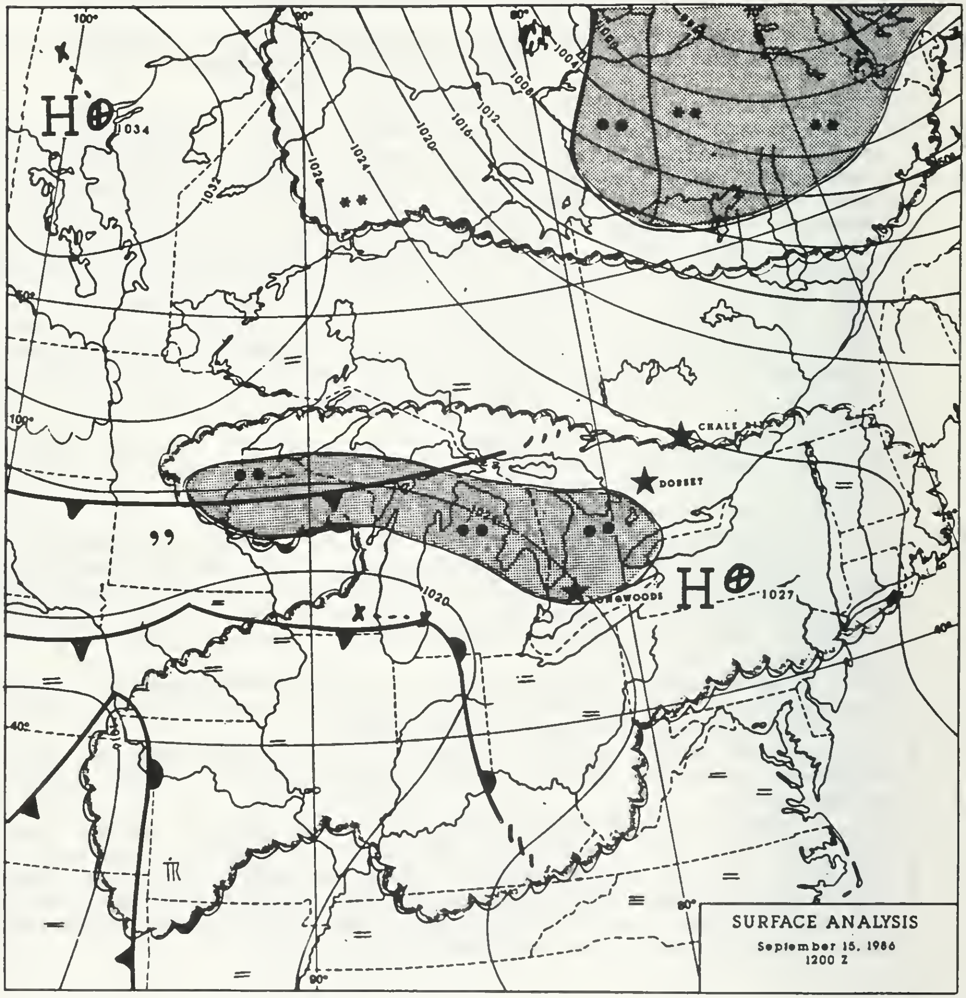

72 HOUR TRAJECTORIES
THU SEP11 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.31.8

2.32 <u>September 15 - 16, 1986, Longwoods(AES) & Longwoods(MOE)</u>

This episode ranked 6th (6/8) only in the $SO_4^=$ wet deposition events at Longwoods (AES) and last 7th (7/7) at Longwoods (MOE).

Three frontal systems were analyzed on Sept. 15, at 12Z as shown in Fig. 2.32.1 with the middle frontal system having a wave located east of Chicago. During the next synoptic hour cyclogenesis developed and a low centre moved rapidly eastward passing near the station on Sept. 15 with the result that a warm and a cold front crossed over Longwoods during the episode. On Sept. 16, 12Z, the low had moved to lie over the Atlantic Ocean and was outside the map area of Fig. 2.32.2. A continuous precipitation area covered the station at 12Z on September 15. With the movement of the low near the station and the passage of a warm and cold front over it, very light to heavy rain and light to moderate rain showers were recorded at the nearest weather station London Airport as shown in Fig. 2.32.3. The total duration of the precipitation was about 7 hours.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Longwoods for Sept. 15, 12Z, 18Z and Sept. 16, 00Z, 06Z and 12Z are shown in Figures 2.32.4, 2.32.5, 2.32.6, 2.32.7, and 2.32.8 respectively.
Air trajectories for the 1000 mb level show that they did not cross over any highest or high emission area of the SO_2 and therefore any pollutant transport at this level would have been insignificant.
Air parcels arriving at the 925 mb level show that SO_2 from its highest emission Detroit area (Figs. 2.32.4-6) could have been carried to the station.
Air trajectories for the 850 mb level show that SO_2 from its highest emission Detroit (Fig. 2.32.4) and Chicago area (Fig. 2.32.4-6) could have been transported.
Air parcels arriving at the 700 mb level show that SO_2 from its highest emission Chicago area (Fig. 2.32.4-5) could have been transported.
In summary, cyclogenesis occurred on a frontal system and the movement of a low centre near the station and a warm and cold front passage over it yielded very light to heavy rain and light to moderate rain showers lasting for about 7 hours. Transports of SO_2 at low and high levels from Detroit and at high levels from Chicago were likely during the episode.



H
1034
1032
1028
1024
1020
1016
1012
1008
1004
1000
CHALK RIVER
DORSET
LONGWOODS
H
1027
1020
1024
100°
90°
80°
50°
40°
SURFACE ANALYSIS
September 15, 1986
1200 Z

FIGURE 2.32.1

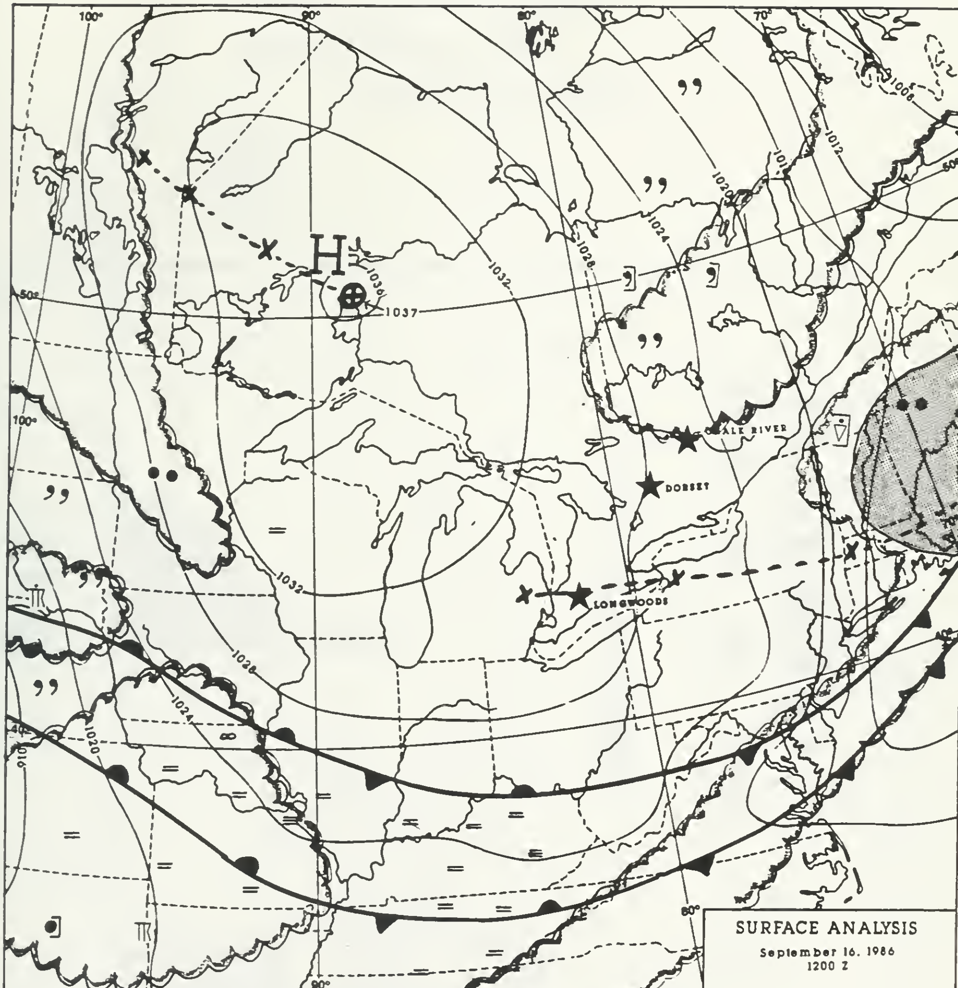

SURFACE ANALYSIS
September 16, 1986
1200 Z
H
1037
1032
1028
1024
1020
1016
1012
1008
LONGWOODS
DORSEY
WHALE RIVER
100°
90°
80°
70°
50°
40°

FIGURE 2.32.2

London A
Sep. 15-16, 1986

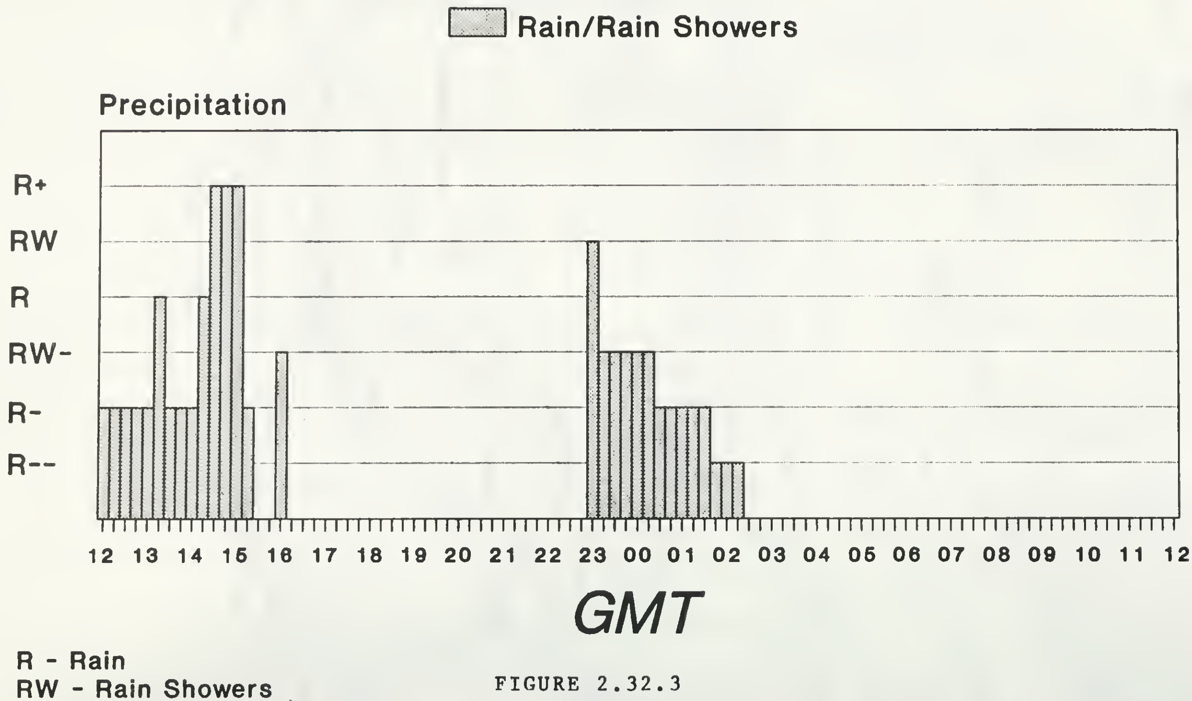


FIGURE 2.32.3

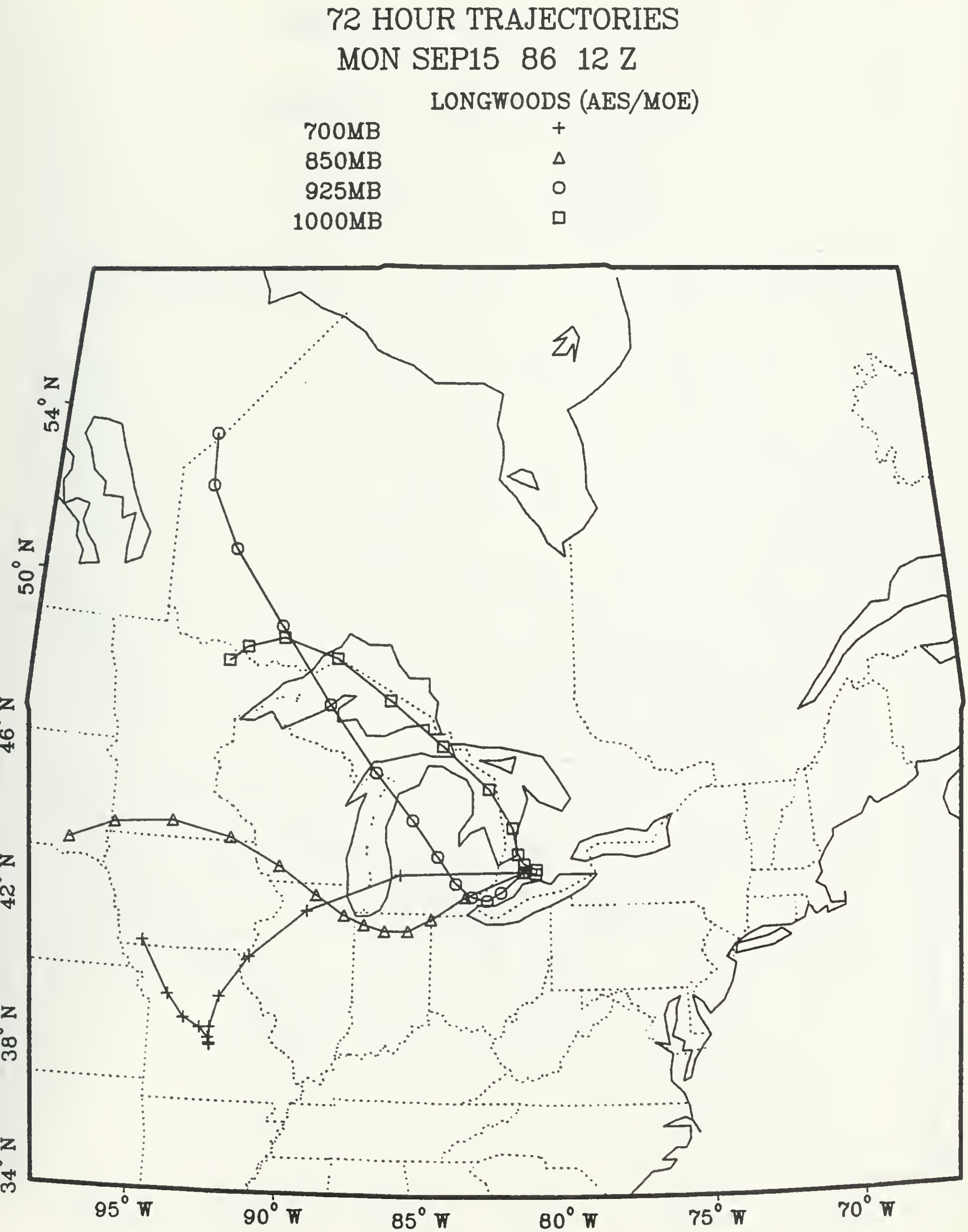

72 HOUR TRAJECTORIES
MON SEP15 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.32.4

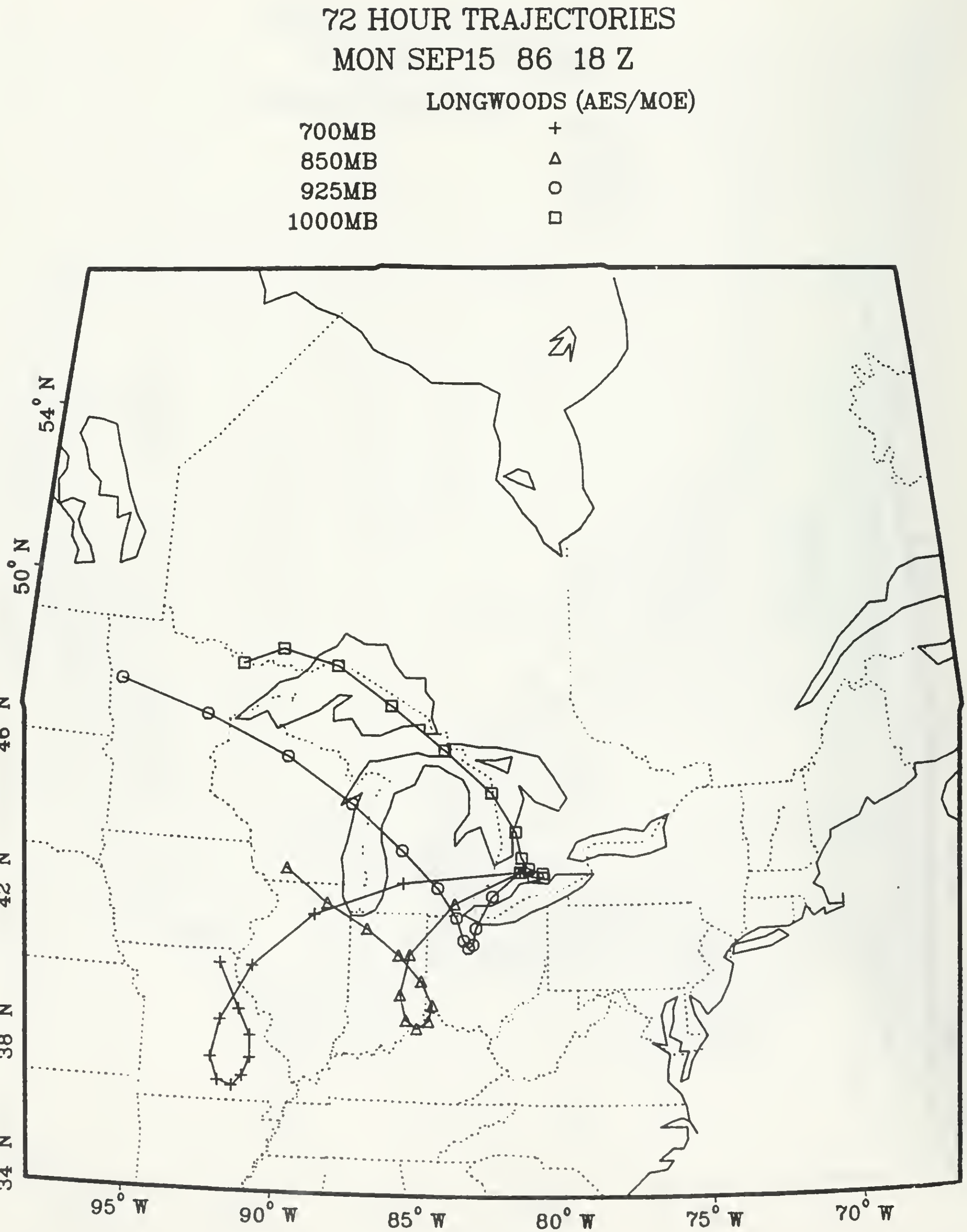

72 HOUR TRAJECTORIES
MON SEP15 86 18 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.32.5

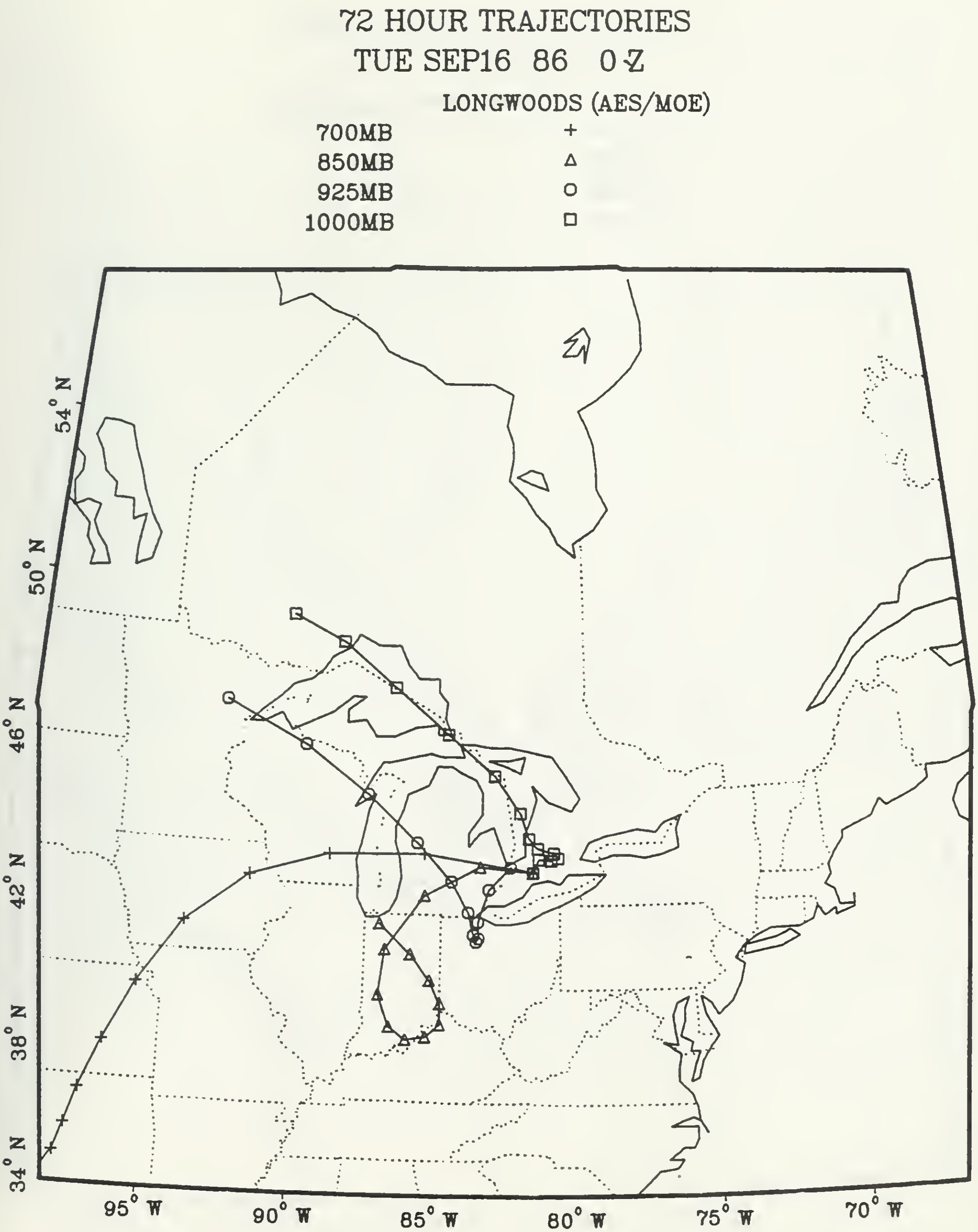

72 HOUR TRAJECTORIES
TUE SEP16 86 0 Z
LONGWOODS (AES/MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.32.6

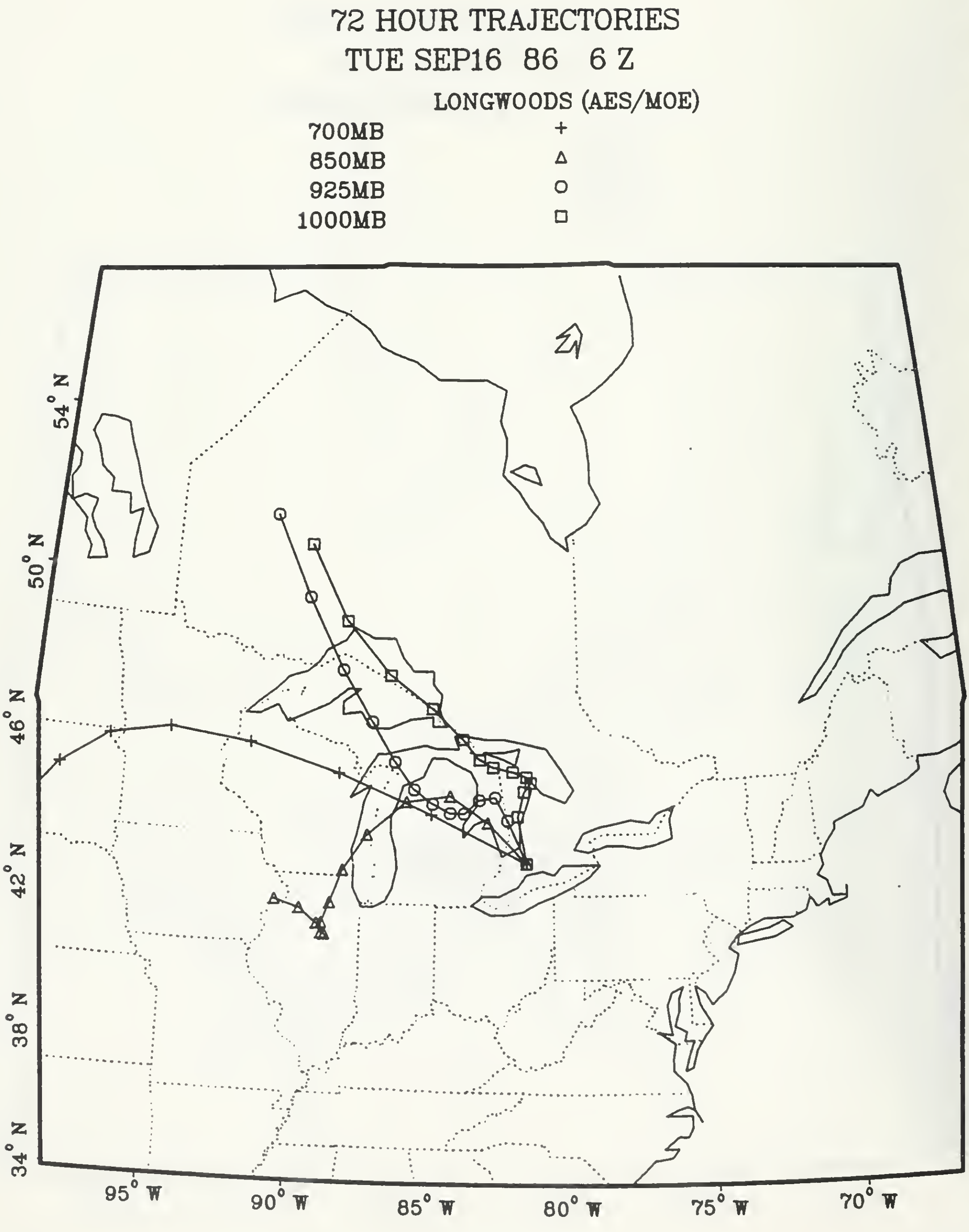

72 HOUR TRAJECTORIES
TUE SEP16 86 6 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.32.7

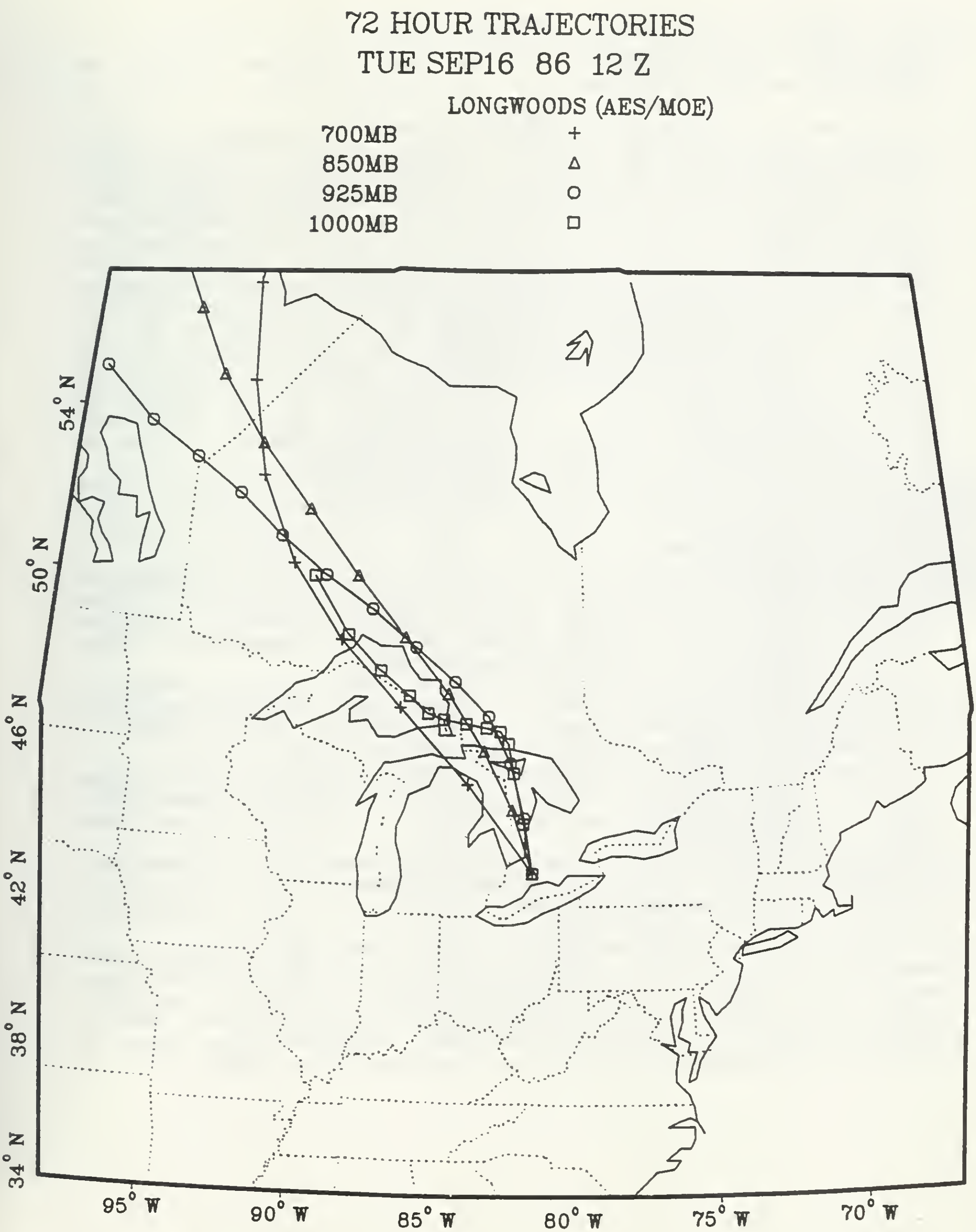

72 HOUR TRAJECTORIES
TUE SEP16 86 12 Z
LONGWOODS (AES/MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.32.8

2.33 October 14 - 15, 1986, Dorset

The episode ranked the last 10th (10/10) in the NO_3^- top 25% wet deposition events at Dorset.

On October 14, at 12Z, three frontal systems were analyzed as shown in Fig. 2.33.1 and a low pressure centre, 1002 mb, rapidly moving to the NE was located just over the station. During this episode, the low deepened and the cyclonic circulation intensified. On Oct. 15, at 12Z, the low had deepened to 987 mb and was located over Labrador outside the map area of Fig. 2.33.2, the fronts were on the east coast and a trough was over the station. The passing of the low centre and a cold front and a trof over the station yielded precipitation wide spread during this episode as shown in Fig. 2.33.3. First light drizzle was observed in the wake of the low centre, but as this moved further NE, very light and light rain showers were observed and then with the cold front ice pellet and rain showers were recorded. Light rain showers at the end of the period were likely due to the trough. Since continuous precipitation observations were not available, the total duration of the precipitation could not be estimated.
The 72 hour backward trajectories for 1000 mb, 925 mb, 850 mb and 700 mb levels at Dorset for October 4, 12Z, 18Z and October 5, 00Z, 06Z and 12Z are shown in Figures 2.33.4, 2.33.5, 2.33.6, 2.33.7, and 2.33.8 respectively.
Air parcels arriving at the 1000 mb level could have transported NO_x from its highest emission Chicago (Figs. 2.33.5-6, 7,8) area and for a short period from its high emission Detroit, Michigan (Fig. 2.33.4-5) area and the areas in Ohio, Pennsylvania, West Virginia and Maryland and Illinois- Missouri.
Air trajectories for the 925 mb level show that NO_x from its highest emission Chicago (Fig. 2.33.5) area and high emission Detroit (Fig. 2.33.4-5) area and the area in Illinois-Missouri could have been transported for a short period of time.
Air parcels arriving at the 850 mb level could have transported NO_x for a short period from its highest emission Chicago (Fig. 2.33.5-6) area and high emission Detroit (Fig. 2.33.4-5) and other area in Illinois-Missouri.
Air trajectories for the 700 mb level show that NO_x could have been transported from its highest emission Chicago (Fig. 2.33.6-7,8), and from its high emission Detroit (Fig. 2.33.5) and other area in Illinois -Missouri (Fig. 2.33.6).
In summary, a low pressure centre, a cold front and a trough passed over the station yielding light drizzle, very light and light rain showers and light ice pellet showers widely during the episode. High and low level transports of NO_x from Chicago, Detroit, and the area in Illinois-Missouri and low level transports from areas in Ohio-Pennsylvania-West Virginia and Maryland were likely.

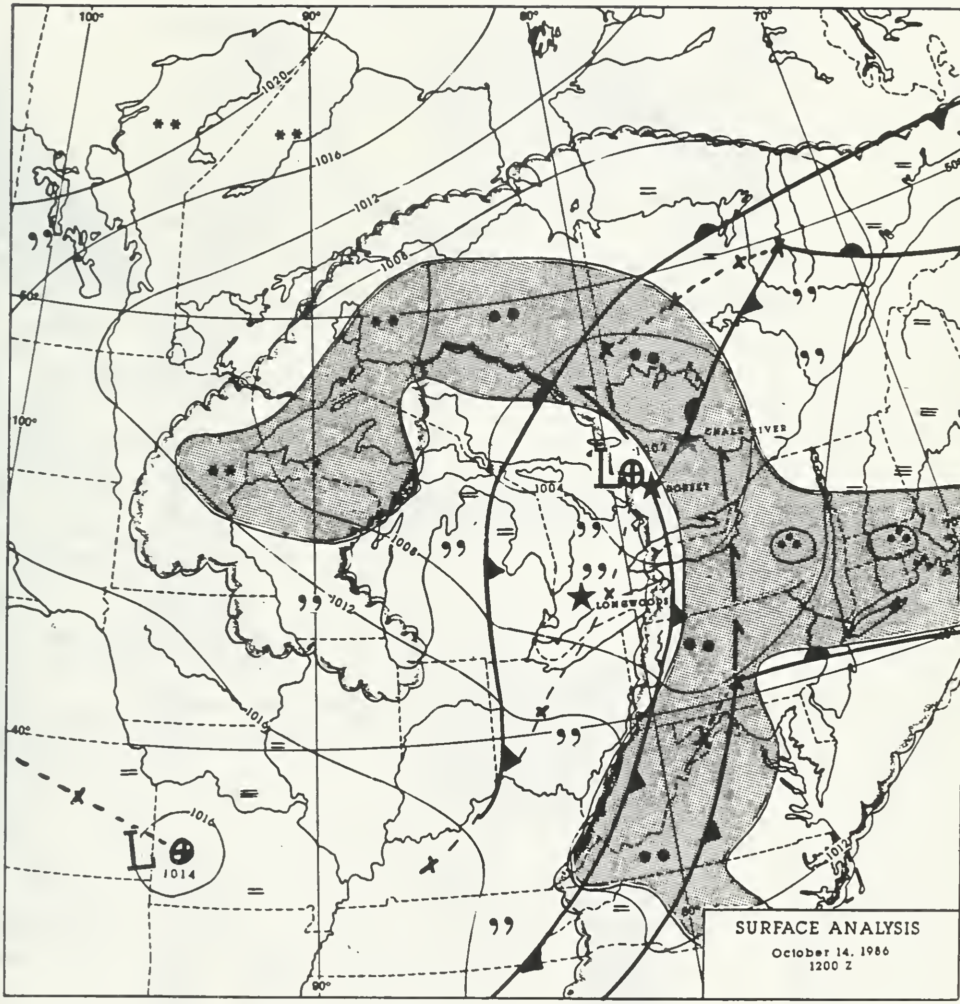

SURFACE ANALYSIS
October 14, 1986
1200 Z
1020
1016
1012
1008
1004
1014
100°
90°
80°
70°
60°
50°
40°
LONGWOODS
ROSSET
EHALS RIVER

FIGURE 2.33.1

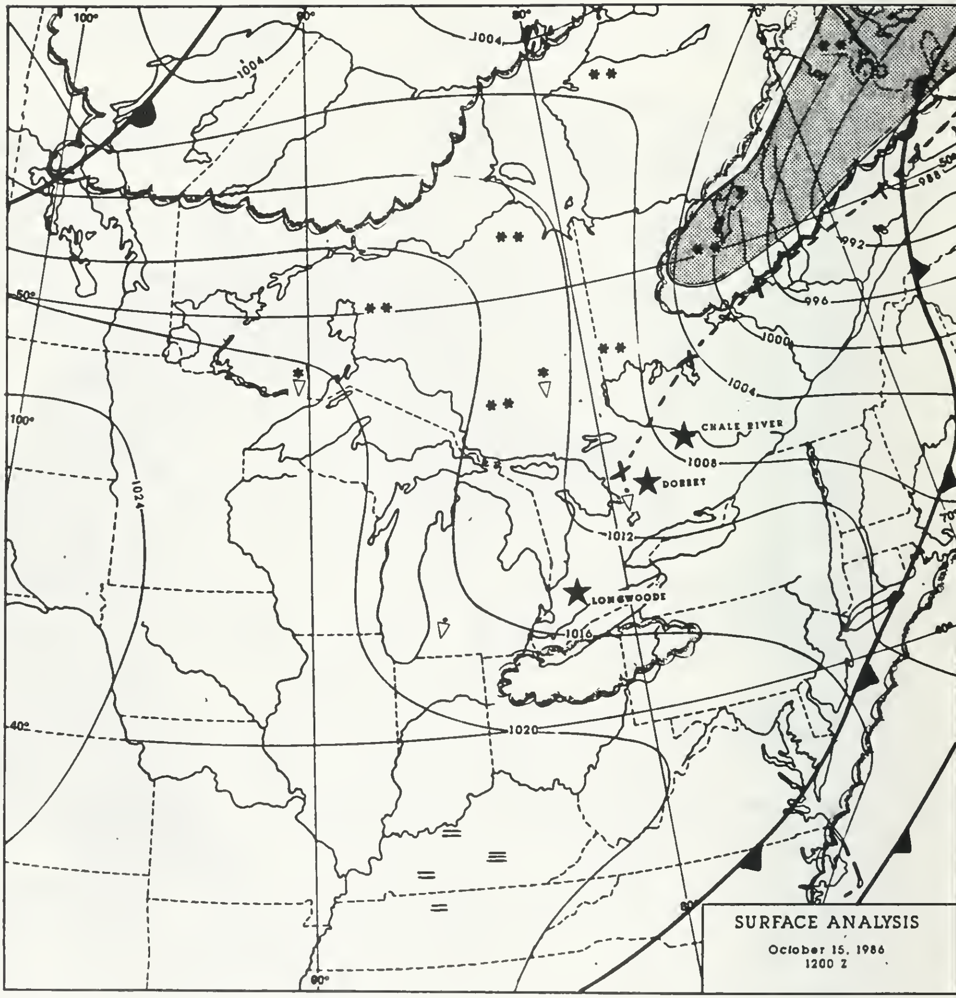
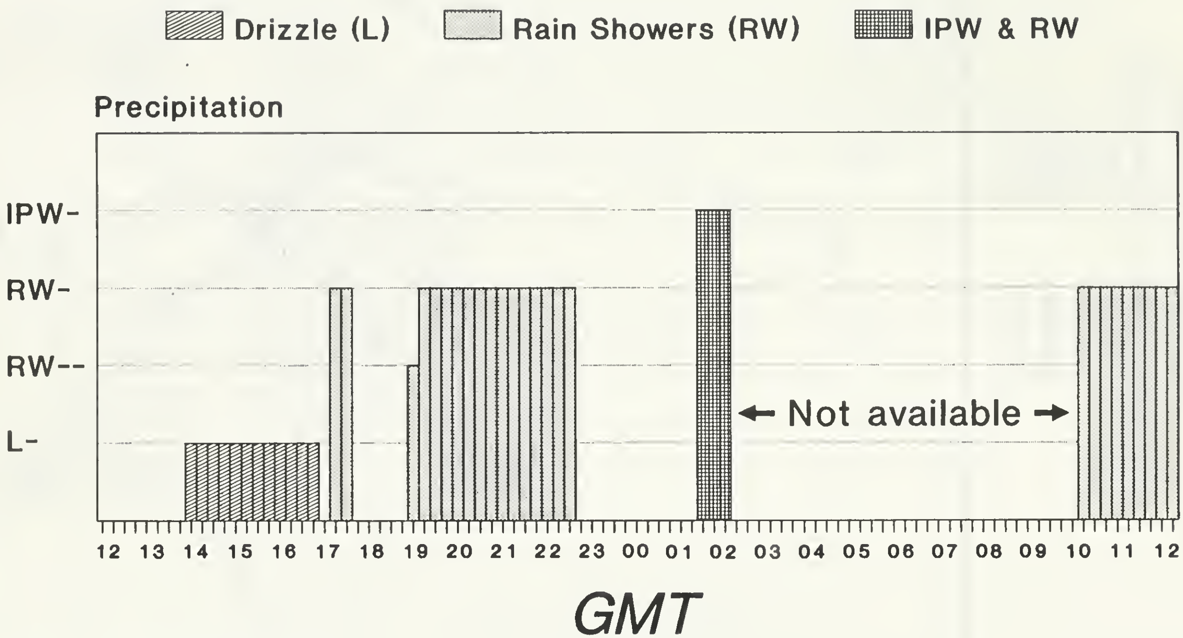

SURFACE ANALYSIS
October 15, 1986
1200 Z
CHALK RIVER
DORSET
LONGWOODS
1004
1008
1012
1016
1020
1024
988
992
996
1000

FIGURE 2.33.2

Muskoka A
Oct. 14-15, 1986



IPW - Ice Pellet Showers
RW - Rain Showers

FIGURE 2.33.3

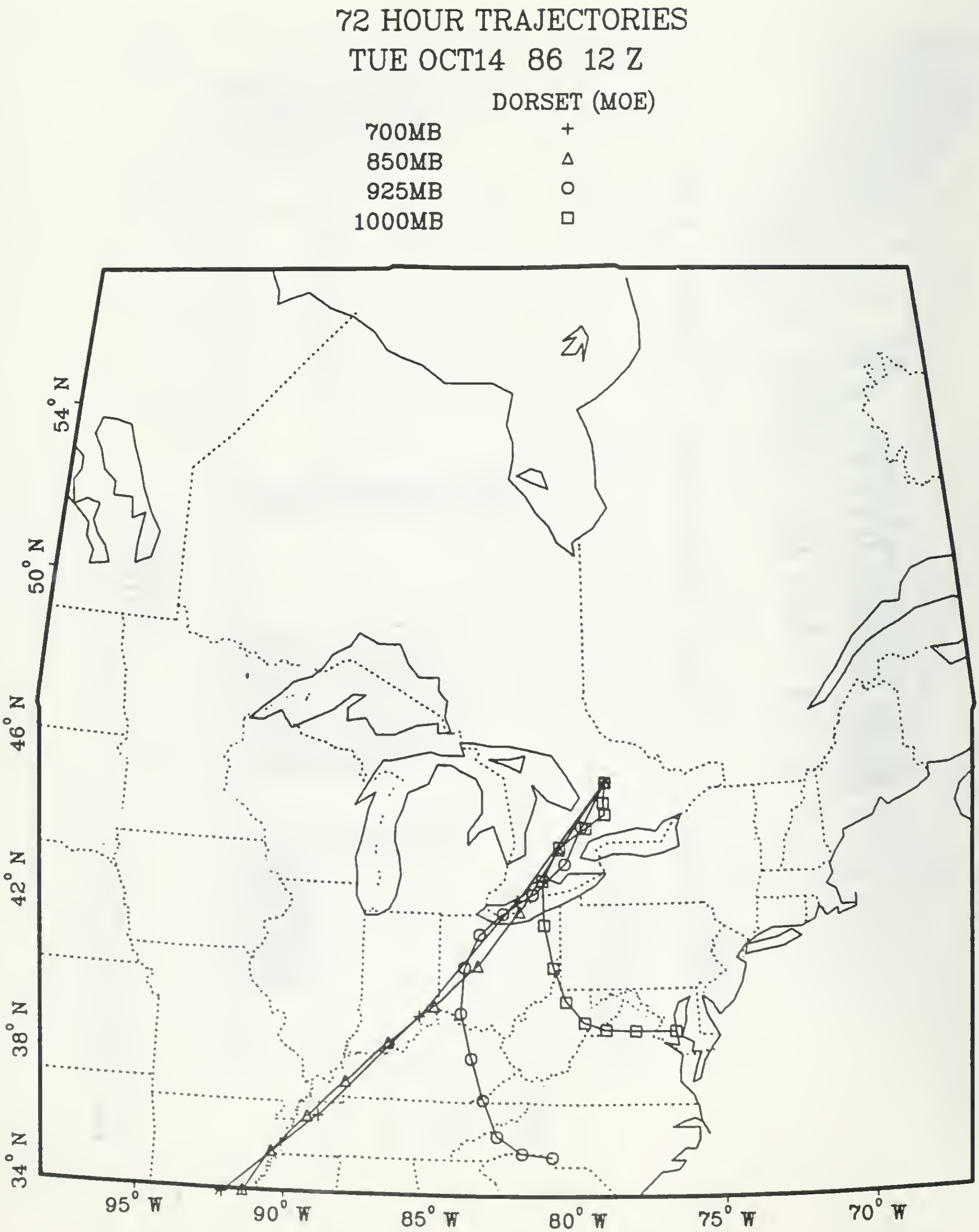

72 HOUR TRAJECTORIES
TUE OCT14 86 12 Z
DORSET (MOE)
700MB +
850MB Δ
925MB O
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.33.4

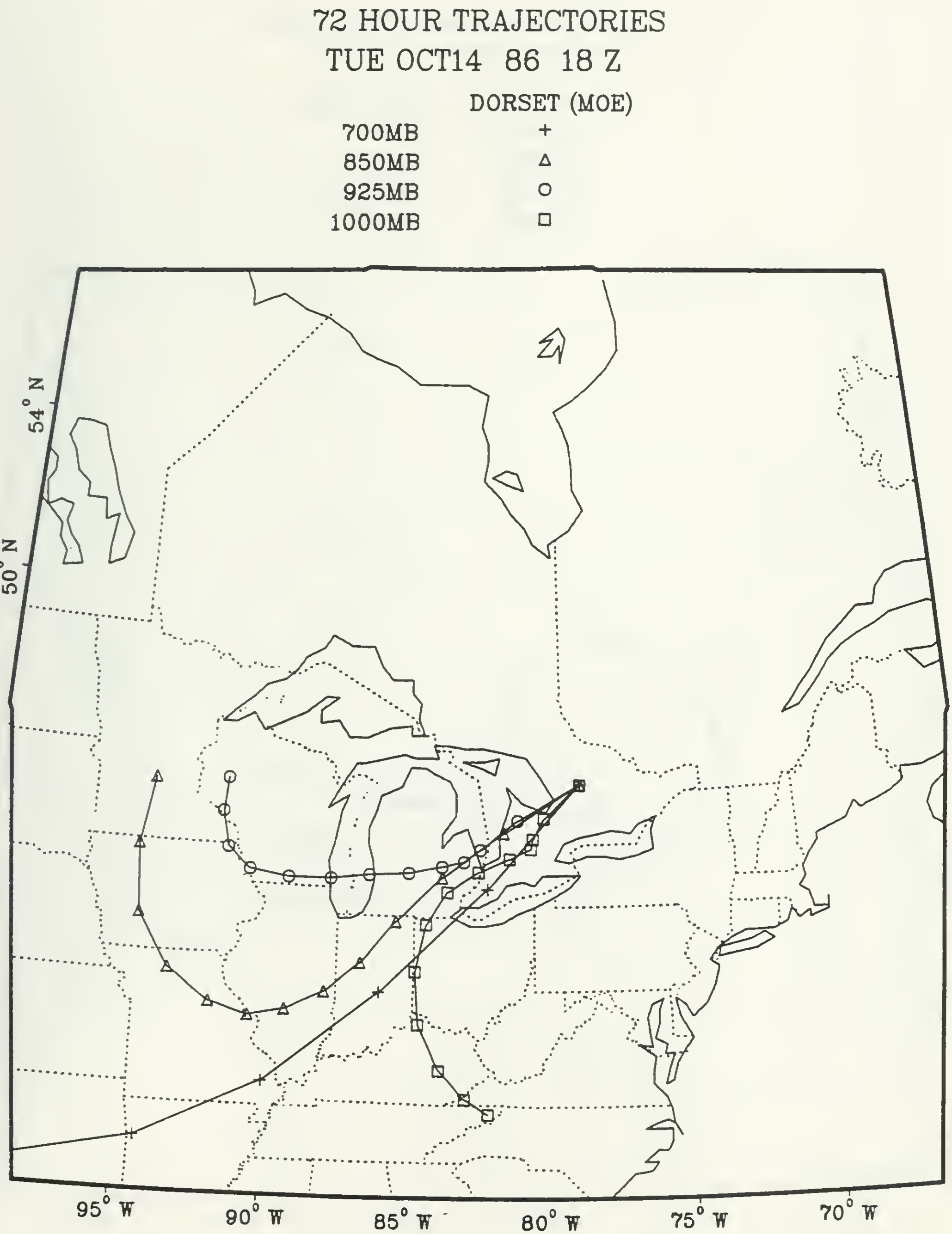

72 HOUR TRAJECTORIES
TUE OCT14 86 18 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.33.5

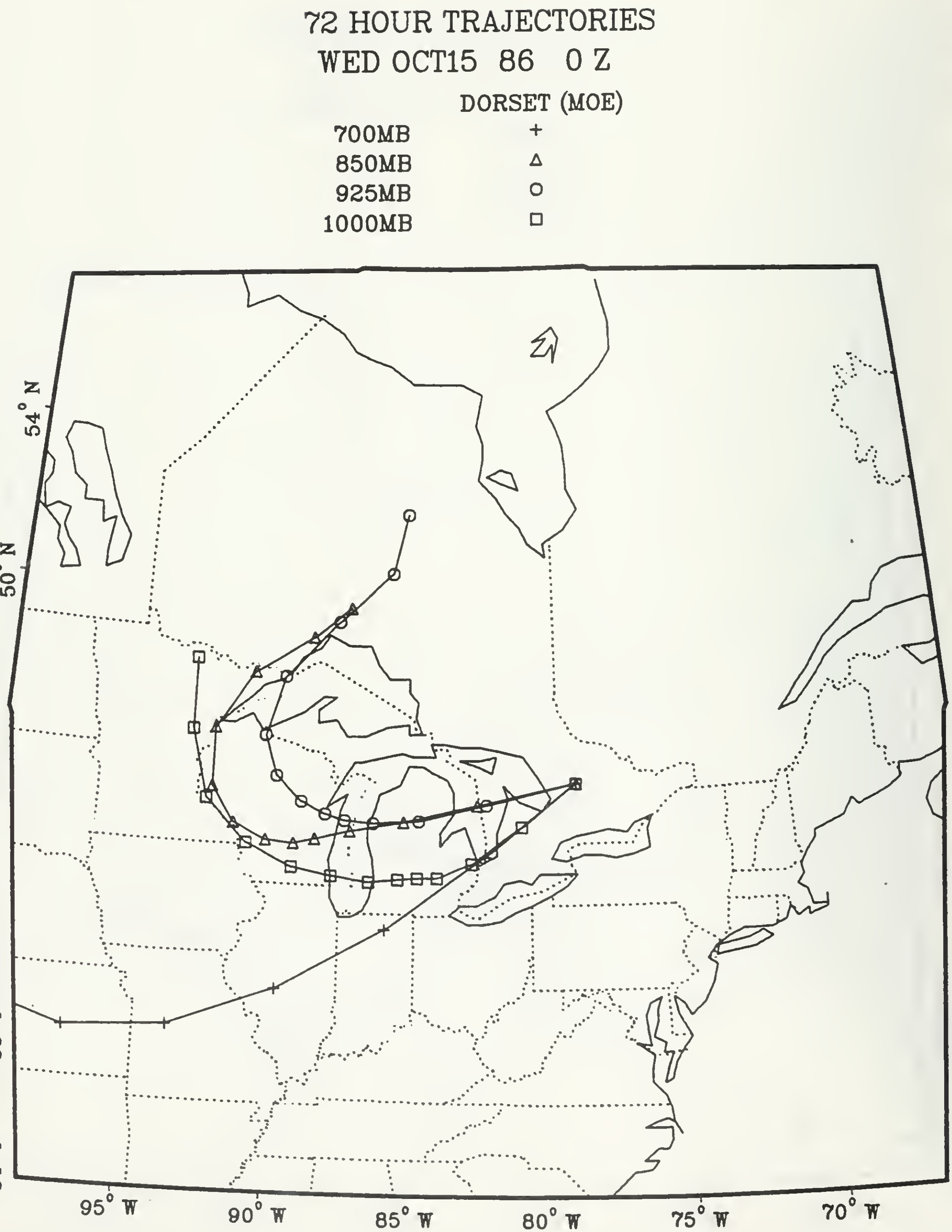

72 HOUR TRAJECTORIES
WED OCT15 86 0 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.33.6

72 HOUR TRAJECTORIES
WED OCT15 86 6 Z

	DORSET (MOE)
700MB	+
850MB	△
925MB	○
1000MB	□

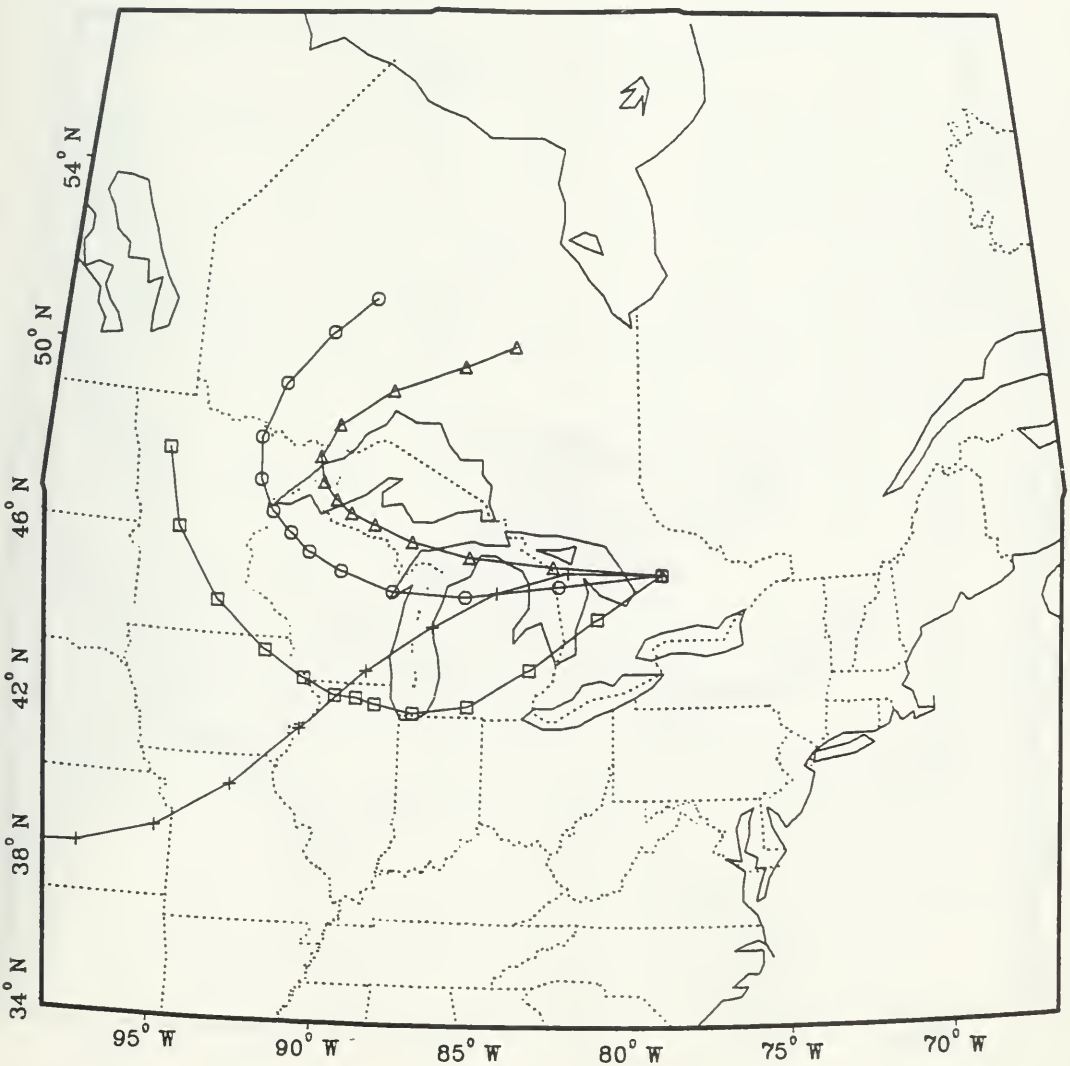


FIGURE 2.33.7

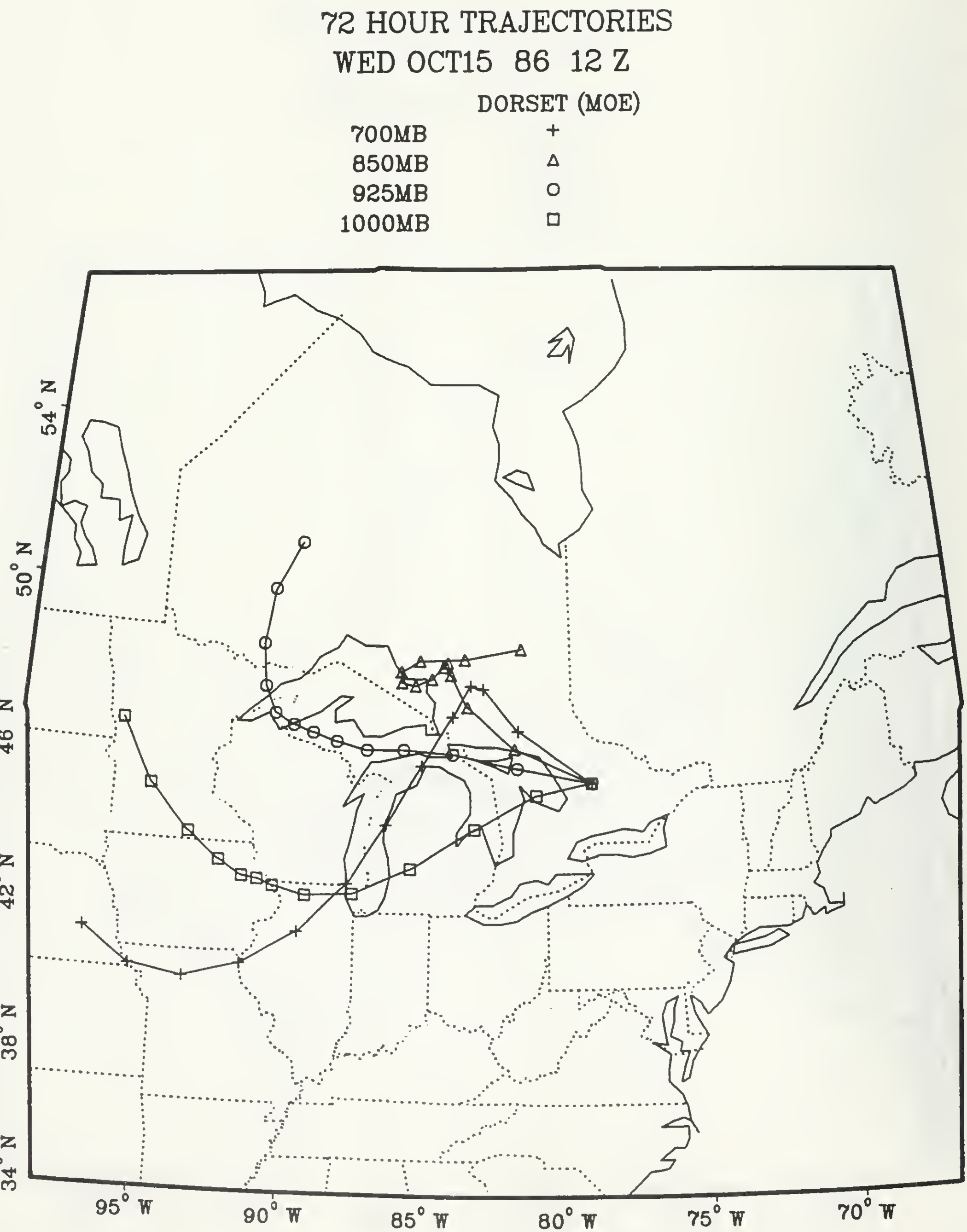

72 HOUR TRAJECTORIES
WED OCT15 86 12 Z
DORSET (MOE)
700MB +
850MB △
925MB ○
1000MB □
54° N
50° N
46° N
42° N
38° N
34° N
95° W
90° W
85° W
80° W
75° W
70° W

FIGURE 2.33.8

APPENDIX III

Transport Indexing

APPENDIX III

TRANSPORT INDEXING

3.1 Methodology

The objective of transport indexing is to create an "index" which provides a quantitative estimate of the amount of a pollutant carried by an air parcel to a receptor site (for the preceding 72 hours) from emissions sources.

Indexing has been applied to the results from the AES trajectory model.

North American SO_2 and NO_x emissions maps for 1980 (Figures 2 and 3 in the text) show the emissions in kilotonnes (kt) per 127x127km grid (emissions square). Maps for 1980 were used as more recent maps were unavailable. Emissions had been transposed to the trajectory map scale in order to provide an identical base from which to do the appropriate indexing.

Each emissions square has been designated by a range of emissions on the initial maps, namely 0-49 kt, 50-99 kt, 100-199kt, 200-399kt and over 400kt. In order to simplify the index, weights were assigned to the ranges on transformation to trajectory map scale as shown below:

Weight	Range
0	0-49kt
1	50-99kt
2	100-199kt
4	200-399kt
8	> -400kt

It is evident from the above that each weight increases by a multiple of two over the previous.

Transport indexing has been conducted as follows:

1. Each 6hr trajectory segment (for a particular pressure level, synoptic hour and pollutant) is divided into grid length units (GLUs) of length 5 mm (used for ease of weighting, ≈ 100km on trajectory plots, ≈ 127km dimensions of emissions squares) and the number of GLUs counted.

2. Each GLU is assigned the highest weight of the emissions squares through which it passes, to give a GLU weight. However, if the last portion of the trajectory segment is a fraction of one GLU, its weight is multiplied by that fraction. ($0 \leq$ GLU weight ≤ 8).

3. For each trajectory segment, the GLU weights are summed and divided by the number of GLUs to give a segment weight. However, if the first trajectory segment does not begin on the plot, it is assumed that it has the same number of GLUs as the second segment, unless the first is obviously longer in which case the number of segments on the plot is taken. ($0 \leq \Sigma$GLU weights $\div$ #GLUs ≤ 8).

4. The segment weights are then summed over the duration of the trajectory shown on the plot to give a trajectory index. ($0 \leq \Sigma$segment weights ≤ 96).

5. Steps 1-4 are repeated for each synoptic hour (12Z, 18Z, 00Z, 06Z and 12Z) and pressure level (1000mb, 925mb, 850mb and 700mb).

6. For each level, the trajectory indices are averaged over the episode to give a **<u>Level Transport Index</u>** (LTI). ($0 \leq \Sigma$trajectory indices $\div 5 \leq 96$).

7. For the episode, the LTIs are averaged to give an **<u>Episodic Transport Index</u>** (ETI). ($0 \leq \Sigma$level transport indices $\div 4 \leq 96$).

8. Step 7 is repeated for SO_2 and NO_x for all episodes.

   By using the above method, an index within the range of 0 to 96 is realized. As is evident from Steps 4, 6 and 7, the trajectory indices, LTIs and ETIs each fall within this range.

3.2 Results

Tables I, II, III and IV list each sulphate and nitrate episode's rankings, dates, depositions, LTI's for each pressure level and ETI's for Chalk River, Dorset, Longwoods (AES) and Longwoods (MOE) respectively for 1985 and 1986 separately.

No relationship between Episode rankings (or episode deposition) and LTI's or ETI's is evident in these tables.

TABLE I *Transport Indices - Chalk River (AES)*

SO_4^{--}								NO_3^-							
Rank	Date	LTI 1000	LTI 925	LTI 850	LTI 700	ETI	Dep.	Rank	Date	LTI 1000	LTI 925	LTI 850	LTI 700	ETI	Dep.
1985															
1	Aug. 18-19	8	15	25	16	16	116.8	1	Apr. 13-14	0	1	6	7	4	69.98
2	July 5-6	22	37	22	16	24	112.6	2	Aug. 18-19	0	9	12	9	8	48.21
3	Apr. 13-14	0	5	12	13	6	83.3	3	July 5-6	10	20	12	10	13	44.19
4	Aug. 26-27	0	9	24	23	14	68.8	4	June 23-24	15	8	1	0	6	41.43
5	Sep. 30-1	14	28	24	11	19	65.1	5	Sep. 30-1	6	17	13	5	10	39.68
								6	Apr. 14-15	2	9	9	7	7	39.41
								7	Sep. 26-27	4	12	13	7	9	38.28
1986															
1	May 31-1	0	4	7	2	3	127.1	1	May 31-1	0	0	0	0	0	70.86
2	Sep. 4-5	8	26	23	13	18	78.3	2	Jan. 19-20	4	11	10	5	7	60.72
3	Aug. 14-15	1	28	25	4	14	74.3	3	Mar. 10-11	5	5	10	4	6	44.89
4	May 5-6	9	21	5	4	10	73.5	4	Aug. 14-15	1	14	13	2	8	37.40
5	Aug. 10-11	13	15	11	8	12	61.8	5	July 28-29	0	0	0	1	0	34.86
6	Aug. 23-24	6	9	22	6	11	61.2	6	May 5-6	5	9	2	0	4	34.27
								7	May 17-18	8	3	3	3	4	32.43
								8	Feb. 18-19	2	17	9	1	7	29.31

TABLE II *Transport Indices - Dorset (MOE)*

		SO_4^{--}								NO_3^-					
Rank	Date	LTI				ETI	Dep.	Rank	Date	LTI				ETI	Dep.
		1000	925	850	700					1000	925	850	700		
							1985								
1	Aug. 18-19	11	27	26	16	20	99.45	1	Feb. 18-19	18	9	2	2	8	13.73
2	Oct. 12-13	11	14	16	5	12	76.56	2	Sep. 30-1	21	20	11	6	15	12.14
3	Sep. 3-4	23	11	10	7	13	75.60	3	Aug. 18-19	5	13	14	8	10	11.90
4	May 5-6	11	26	20	1	15	69.54	4	Apr. 5-6	3	7	17	5	8	11.76
5	Aug. 29-30	14	6	8	2	7	69.36	5	May 5-6	7	18	10	0	9	11.71
6	Apr. 5-6	4	14	31	7	14	67.62	6	Nov. 18-19	14	12	5	4	9	11.14
7	Sep. 30-1	34	35	21	16	27	64.17	7	Mar. 4-5	0	1	8	8	4	10.56
8	Aug. 6-7	22	23	17	12	19	63.36	8	May 15-16	1	12	13	9	9	9.82
								9	Sep. 3-4	10	7	4	5	6	9.45
								10	Oct. 4-5	5	19	14	8	11	9.07
								11	Feb. 21-22	15	20	5	3	11	9.05
								12	Aug. 6-7	17	13	10	5	11	8.45
							1986								
1	Sep. 4-5	23	28	18	9	19	128.0	1	Jan. 25-26	6	16	7	6	9	17.34
2	Aug. 14-15	7	34	28	5	19	114.7	2	Mar. 10-11	8	8	5	3	6	14.02
3	Mar. 10-11	18	18	11	6	13	73.9	3	Sep. 4-5	23	28	18	9	19	13.12
4	Aug. 26-27	23	21	5	1	13	68.7	4	July 19-20	10	7	0	1	5	11.02
5	Aug. 8-9	2	7	13	10	8	65.8	5	Aug. 14-15	5	18	14	2	10	10.37
6	Jan. 25-26	12	26	15	11	16	65.2	6	Mar. 18-19	16	3	1	0	5	9.39
7	June 22-23	18	15	6	2	10	59.0	7	Aug. 26-27	12	10	1	1	6	9.27
								8	Mar. 6-7	0	0	7	6	3	7.74
								9	June 16-17	11	9	6	0	7	6.15
								10	Oct. 14-15	13	5	4	4	6	6.14

TABLE III *Transport Indices - Longwoods (AES)*

		SO_4^{--}								NO_3^-					
Rank	**Date**	**LTI**				**ETI**	**Dep.**	**Rank**	**Date**	**LTI**				**ETI**	**Dep.**
		1000	**925**	**850**	**700**					**1000**	**925**	**850**	**700**		
							1985								
1	Sep. 7-8	40	17	15	10	21	164.1	1	Aug. 23-24	7	22	13	8	12	133.7
2	Aug. 23-24	25	34	26	14	25	162.7	2	Sep. 7-8	18	13	9	6	12	106.6
3	Mar. 4-5	13	19	11	5	12	94.7	3	Oct. 18-19	29	15	11	7	15	86.4
4	Oct. 18-19	55	30	20	12	29	89.0	4	Nov. 9-10	17	15	7	3	11	60.9
5	Oct. 12-13	22	34	19	9	21	82.6	5	Feb. 23-24	11	9	5	4	7	46.5
6	Aug. 26-27	29	31	29	21	28	82.5	6	Mar. 4-5	7	9	6	3	6	44.2
7	Feb. 23-24	21	17	11	8	14	70.2	7	Aug. 24-25	23	22	13	10	17	42.9
8	Aug. 14-15	48	31	20	14	28	65.7	8	May 26-27	17	18	14	3	13	42.4
								9	Aug. 26-27	13	17	16	10	14	42.1
								10	Aug. 14-15	25	17	10	7	15	41.4
							1986								
1	Sep. 10-11	37	24	17	9	22	209.4	1	Apr. 15-16	10	27	9	6	13	70.78
2	July 25-26	57	43	26	12	35	158.5	2	Sep. 10-11	20	12	7	5	11	70.59
3	July 12-13	23	34	18	10	21	85.2	3	July 25-26	31	21	14	9	19	62.24
4	July 11-12	12	26	26	12	19	79.4	4	Feb. 7-8	4	4	15	13	9	60.75
5	Apr. 28-29	27	31	29	23	27	67.9	5	Aug. 2-3	11	4	4	5	6	59.50
6	Sep. 15-16	9	21	28	11	17	63.8	6	Apr. 28-29	13	16	16	12	14	58.70
7	June 11-12	52	30	15	12	27	61.8	7	Mar. 5-6	23	15	9	4	13	58.54
8	Apr. 20-21	50	27	19	15	28	61.5	8	July 12-13	14	17	9	6	12	50.57
								9	Apr. 7-8	13	5	3	1	5	49.40
								10	Apr. 20-21	24	14	11	7	14	47.59

TABLE IV *Transport Indices - Longwoods (MOE)*

		SO_4^{--}								NO_3^-					
Rank	Date	LTI 1000	LTI 925	LTI 850	LTI 700	ETI	Dep.	Rank	Date	LTI 1000	LTI 925	LTI 850	LTI 700	ETI	Dep.
1985															
1	Sep. 7-8	40	17	15	10	21	177.6	1	Aug. 23-24	7	22	13	8	12	32.40
2	Aug. 23-24	25	34	26	14	25	160.2	2	Sep. 7-8	18	13	9	6	12	24.86
3	Oct. 18-19	55	30	20	12	29	102.3	3	Oct. 18-19	29	15	11	7	15	18.09
4	Oct. 12-13	22	34	19	9	21	88.5	4	Dec. 10-11	12	20	13	5	13	10.01
5	Aug. 26-27	29	31	29	21	28	78.8	5	Aug. 26-27	13	17	16	10	14	9.25
6	Mar. 4-5	13	19	11	5	12	78.7	6	Sep. 5-6	16	10	7	6	10	9.05
7	Aug. 14-15	48	31	20	14	28	62.7	7	Feb. 23-24	11	9	5	4	7	8.61
8	Sep. 5-6	29	20	13	13	19	60.6	8	Feb. 26-27	21	11	9	5	12	8.50
								9	Aug. 24-25	23	22	13	10	17	8.47
								10	Aug. 14-15	25	17	10	7	15	8.44
1986															
1	Sep. 10-11	37	24	17	9	22	211.8	1	Sep. 10-11	20	12	7	5	11	16.18
2	July 25-26	57	43	26	12	35	163.4	2	July 25-26	31	21	14	9	19	15.20
3	July 12-13	23	34	18	10	21	85.9	3	Apr. 15-16	10	27	9	6	13	15.00
4	July 11-12	12	26	26	12	19	79.7	4	Apr. 28-29	13	16	16	12	14	13.89
5	Apr. 28-29	27	31	29	23	27	70.1	5	Aug. 2-3	11	4	4	5	6	13.86
6	June 11-12	52	30	15	12	27	66.3	6	July 12-13	14	17	9	6	12	11.75
7	Sep. 15-16	9	21	28	11	17	65.0	7	Apr. 20-21	24	14	11	7	14	10.75
								8	Apr. 7-8	13	5	3	1	5	10.40
								9	Mar. 5-6	23	15	9	4	13	9.67
								10	June 11-12	27	14	8	8	14	9.50