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ATMOSPHERIC ENVIRONMENT SERVICE

ANALYSIS OF THE WINDS DURING C.O.R.K. 1974

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Kingston, Ontario, was chosen as the site for the Olympic Yachting Event because of its proximity to Montreal and its fine sailing conditions, including the high persistence of the daytime lake breeze. The latter is illustrated in the statistics (1) issued in 1973 as background to the Olympic Sailing Events. Observations taken at Main Duck Island (1944-72), some 20 KM southwest of the Olympic Course, show that during the months of July and August between 72 and 75% of the observed winds blew from the south through west quadrant, and in both cases, the greatest frequency occurred in the 13 to 18 MPH range. It is not difficult to accept these statistics when one observes the long water fetch that these directions enjoy.

In order to study some of these local winds, the Atmospheric Environment Service of Canada installed an instrumented water tower (figure 1) located in approximately the centre of the three proposed Olympic Courses (figure 2). Data from this tower for the summer of 1973 (2) and for the last two weeks in July 1974 (3) are currently available.

The following text includes a brief description of the synoptic weather situation each day during CORK 1974 (August 25 - August 30), accompanied by the synoptic weather map valid at 2:00 p.m. E.D.T. (local time) for each day during that period.

My analysis of the winds during this period is descriptive in the sense that I have chosen in this paper to relate the winds recorded at the water tower to the air temperature difference between that measured at the tower and at the Kingston Airport (figure 2). Since the eastern basin of Lake Ontario is relatively warm in August (approximately 21°C), I

was unable to correlate the traditional water-air temperature difference to yield any degree of understanding about the lake breeze effect upon the synoptic scale winds with such a small sample. This analysis restricts itself to wind observations every half hour and temperature difference measured every hour. Reference will be made to the thermal gradient (ΔT) which is herein defined as the difference between the air temperature (^{o}C) measured at the Kingston Airport and that measured over the race course (i.e. at the tower).

$$\Delta T = T(\text{Airport}) - T(\text{Tower})$$

Thus if ΔT is greater than zero, one assumes some lake breeze contribution whereas with ΔT is less than zero, a land breeze contribution. Graphs are presented with both the thermal gradient and wind speed and direction depicted.

SUNDAY AUGUST 25

Synopsis (figure 3a)

A large ridge of high pressure remained almost stationary over the east end of the lake for the entire day. Since there were no significant winds due to the pressure gradient, thermally induced winds were easily studied.

Analysis (figure 3b)

During the predawn hours a northeast land breeze of 5 to 8 knots was established by a thermal gradient (ΔT) of minus $2C^{o}$. Rapid heating of the land during the early morning reversed the thermal gradient so that, by 8:00 EDT, $\Delta T = +2^{o}C$ favouring a lake breeze. The winds shifted to southeast at 5 knots. However, the next two hours failed to show an

increase in ΔT and the winds remained SE 5. After 1000 EDT, ΔT began to increase towards a maximum of +3.6 by 1500 EDT. The wind direction respond to this gradient with a gradual veer towards west, however no increase in speed was observed. As cooling over the land took place in the late afternoon, the winds backed into the south and decreased.

While the synoptic situation was ideal for the development of the lake breeze, the over land airmass was too stable, as evidenced by the lack of cumulus clouds; thus the cellular circulation associated with a well developed lake breeze was lacking and the winds remained light.

MONDAY AUGUST 26

Synopsis (figure 4a)

A moderate southerly flow was well established by early morning in response to a major storm centred some 900 miles (1400 KM) to the north. This pressure gradient did not increase substantially during the day.

Analysis (figure 4b)

The thermal gradient like the pressure gradient was well defined by early morning (Δ T = 2^{o}C) but failed to yield any additional strength to the wind; slight diurnal veering and backing were, however, observed.

TUESDAY AUGUST 27

Synopsis (figure 5a)

During the night of the 26th and into the early morning of the 27th the winds strengthened to between 15 and 20 knots as a cold front

approached. What appeared to be a squall line ahead of the actual cold frontal passage occurred at 15:30 EDT, accompanied by a brief shower.

Analysis (figure 5b)

While the thunderstorm activity was occurring, the wind remained south-southeast at 14 to 20 knots. With the termination of that type of weather, the winds veered gradually from 200°, becoming steady at between 235° and 240° between 15 and 22 knots. As the cold front approached, the speeds diminished to 12 or 13 knots while visibilities improved to greater than 6 miles from the early morning values of 1 to 2 miles in fog. The cold front passed the tower at 15:30 EDT as the winds shifted to 300° and freshened to 16 knots. The thermal gradient was outweighed by the pressure gradient for most the day.

WEDNESDAY AUGUST 28

Synopsis (figure 6a)

Following the cold front of the 27th, skies cleared during the night and a northwest wind advected cooler air towards Lake Ontario. The cold front stalled just to the south of the lake but the pressure gradient remained northwest.

Analysis (figure 6b)

By the morning a thermal gradient of $\Delta T = -2.4^{\circ}C$ was observed accompanied by a northwest wind of 10 to 13 knots. Between sunrise and 1400 hours the temperature at the airport increased 8°C while at the tower the increase was only 3°C thus the thermal gradient was reversed (i.e. $\Delta T = +2^{\circ}C$). As this gradient passed through the zero point the northwesterly winds died off to a calm. Then as the gradient increased

to a maximum of 2.7°C a lake breeze of 4 to 7 knots was sustained from between 220° and 240°.

Of particular interest is the fact that the maximum temperature at the airport was 21.5°C and at no time did it surpass the water temperature at the tower, which rose from 21.4 to 23.4°C during the day.

THURSDAY AUGUST 29

Synopsis (figure 7a)

A ridge of high pressure had moved east to the north of Lake Ontario during the night and by sunrise a northeast flow of cool air had been established up the St. Lawrence Valley and to the lake. The frontal zone of the past few days remained stationary to the south of the lakes and a weak disturbance was moving along the front towards Lake Ontario. The edge of the middle cloud from this system reached the northern shore resulting in an overcast sky for most of the day.

Analysis (figure 7b)

Thermal equilibrium was evident in the early morning and the northeast winds can be attributed to the pressure gradient caused by the ridge of high pressure. As the low pressure system approached and the thermal gradient became positive the winds veered into the south (160° to 180°). The speed dropped off initially but increased as the pressure gradient strengthened with approach of the low.

FRIDAY AUGUST 30

Synopsis (figure 8a)

A weak northwest flow was evident in the morning as a ridge of high pressure approached from the west. During the morning hours, cloudy skies remained, however as the start of the race approached, the edge of the cloud retreated to the south. By mid-race the ridge had moved east of Kingston and the pressure gradient strengthened from the southwest.

Analysis (figure 8b)

Coincident with clearing skies, the thermal gradient began positive and the winds went calm. The lake breeze sprang up by 1300 EDT and the winds became southwest (240^{o}) and increased to 7 knots. Following that, the thermal gradient ($\Delta T = 2.4^{o}C$) remained constant but the ridge of high pressure had crossed the area and a strengthening southwest pressure gradient caused the further strengthening of the winds to 14 knots. These gradient winds persisted for the 36 hours but, alas, these winds more typical of Kingston arrived too late for CORK '74.

BIBLIOGRAPHY

1. "Background Climatological Information for the 1976 Olympic Sailing Events", CDS #2-73, Atmospheric Environment Service, Canada.

2. "Further Meteorological Data Relevant to the 1976 Olympic Sailing Events" Supplement #1 to CDS #2-73, Atmospheric Environment Service, Canada.

3. "Further Meteorological Data Relevant to the 1976 Olympic Sailing Events" Supplement #2 to CDS #2-73, Atmospheric Environment Service, Canada.

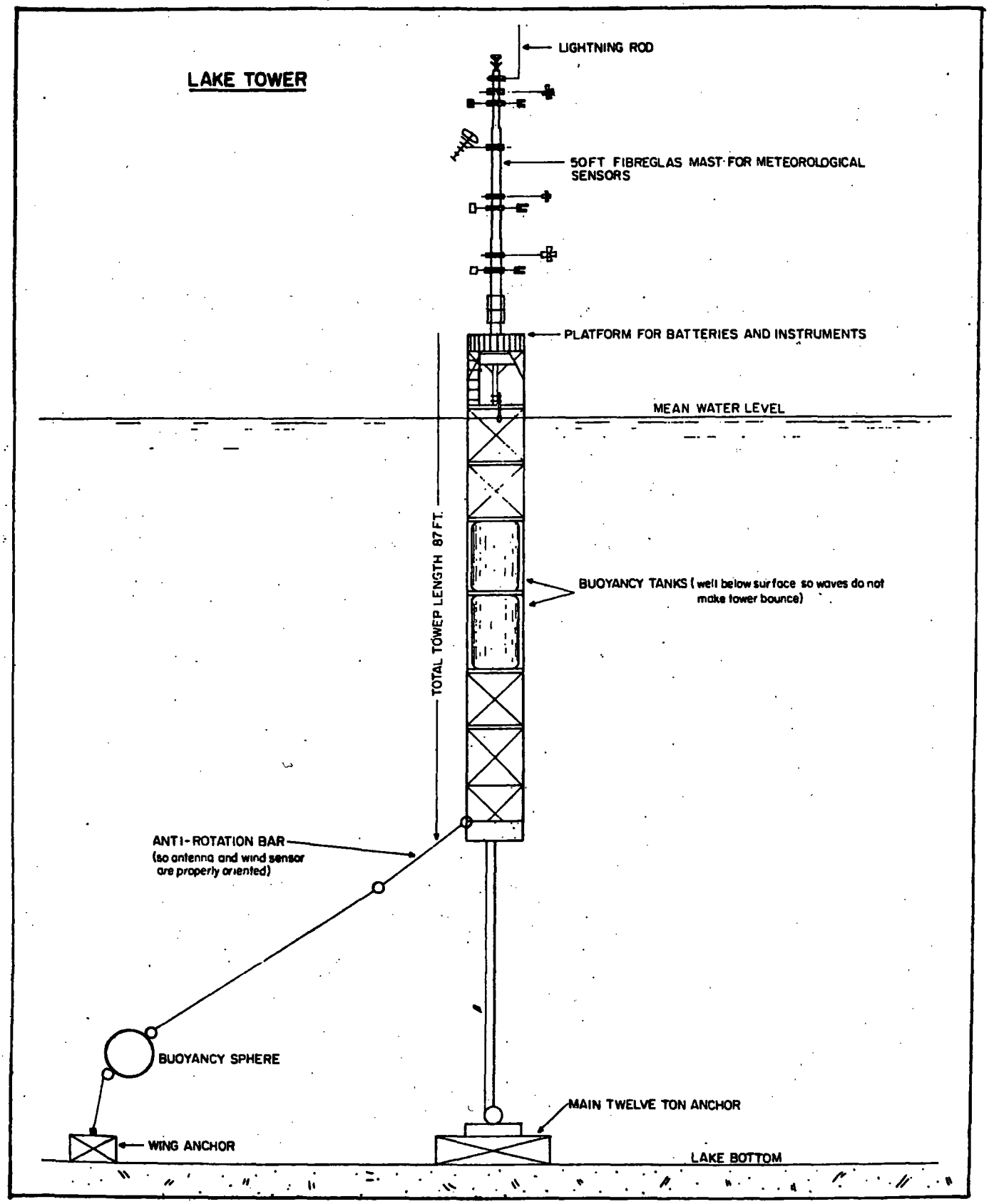

FIGURE 1: **LAKE TOWER STATION AND MOORING SYSTEM**

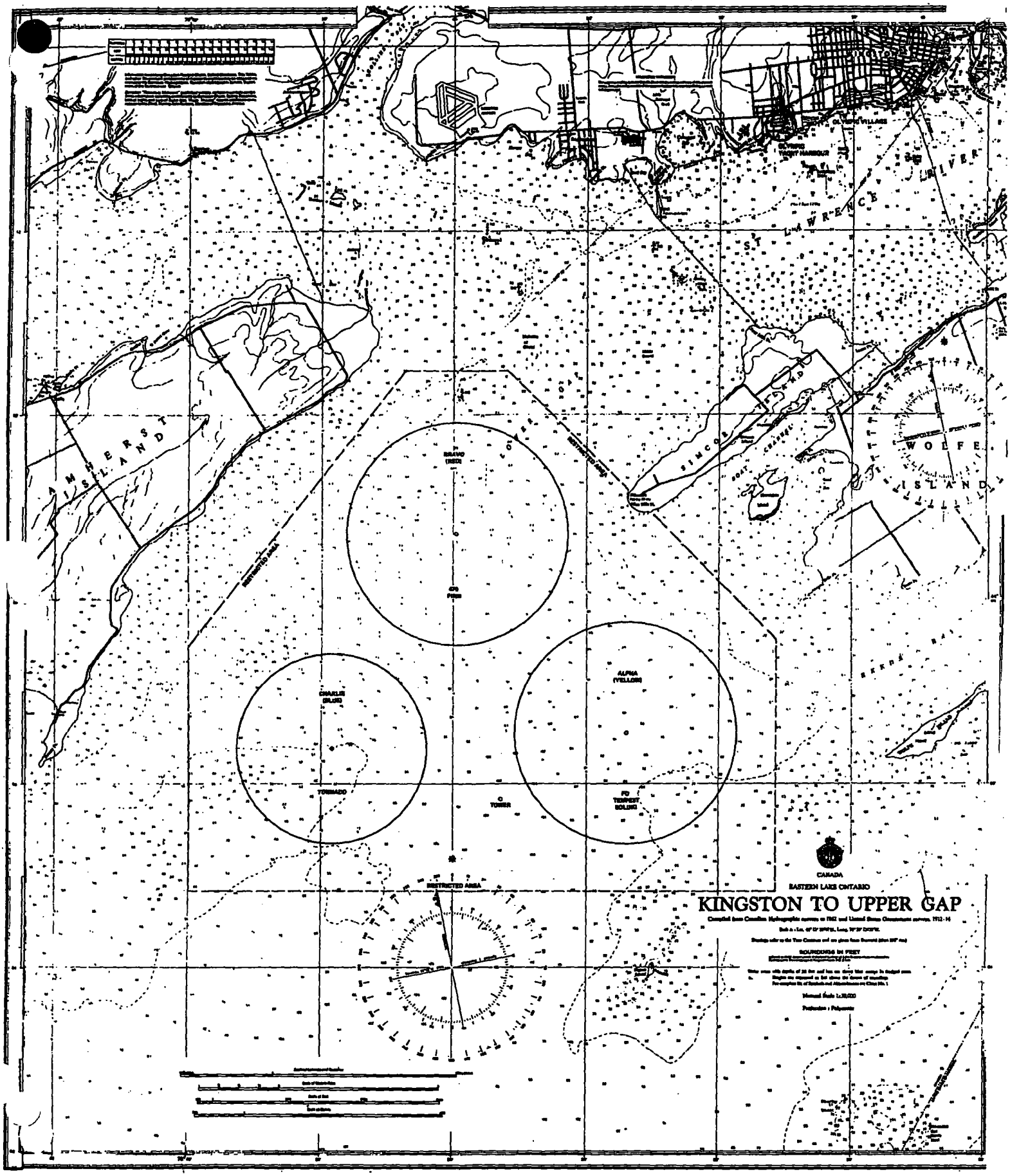

FIGURE 2: MAP OF THE AREA

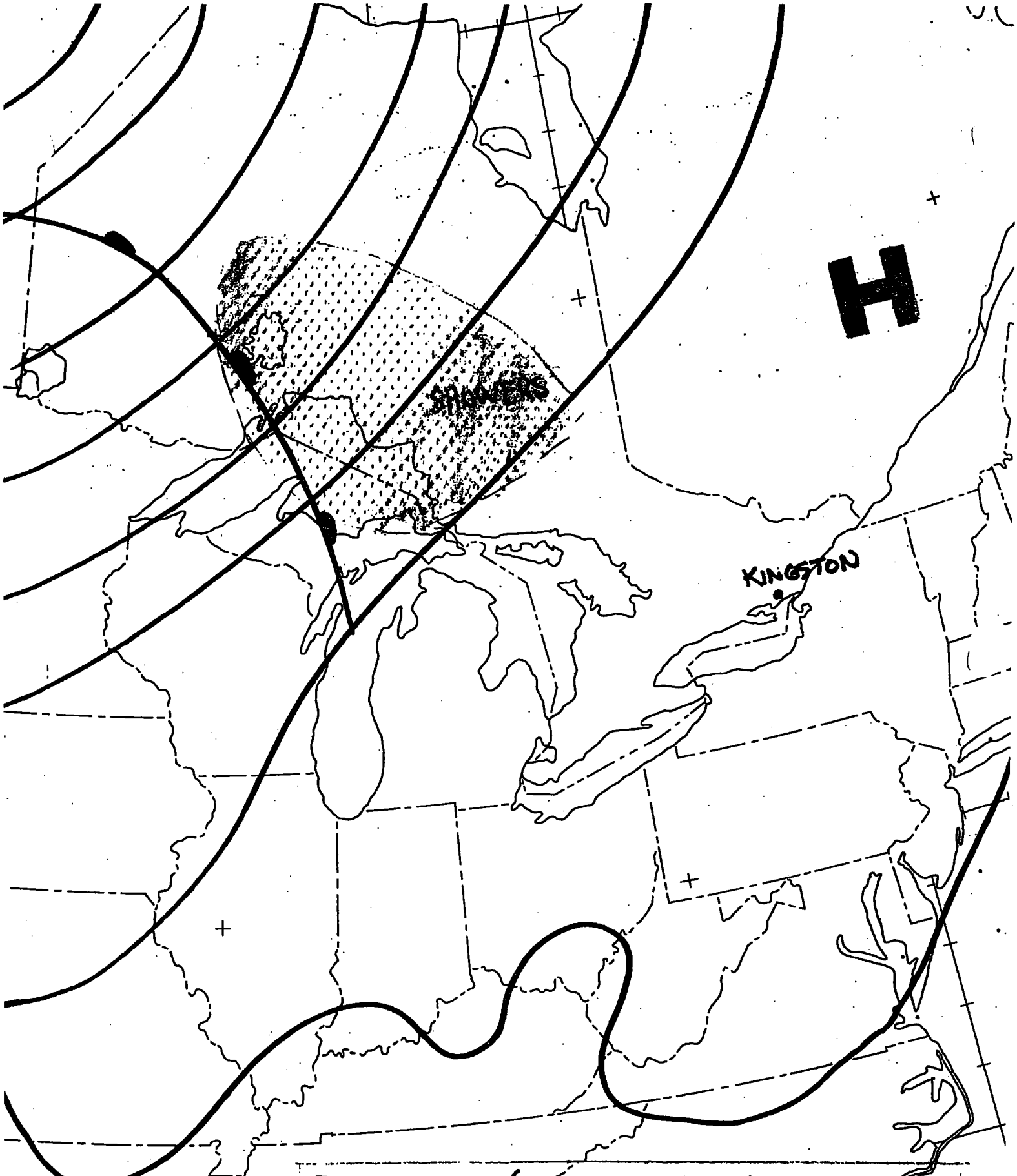

FIGURE 3A (ISOBARS AT 4MB INTERVALS, MAP VALID AT 1400 E.D.T. AUGUST 25

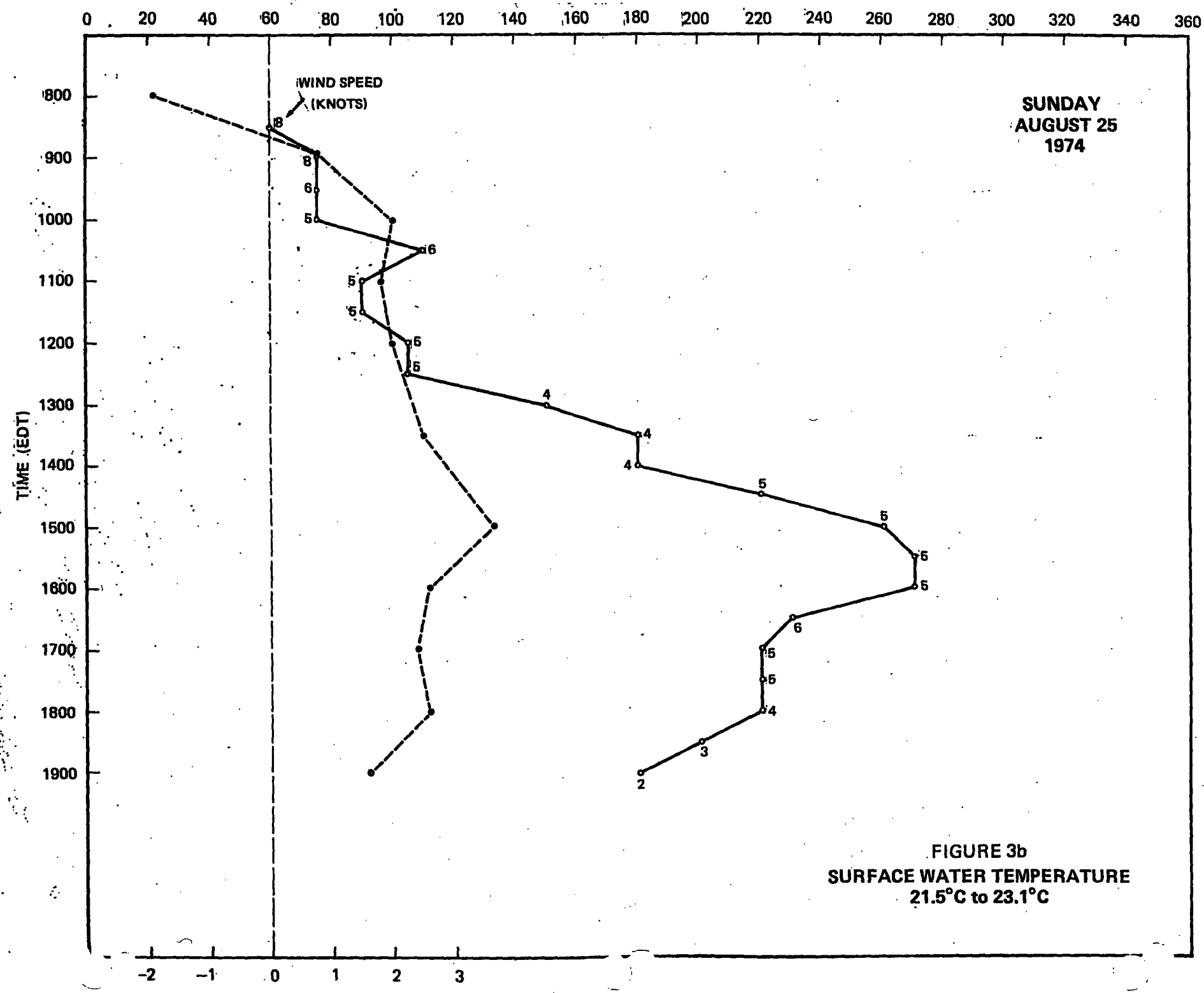

FIGURE 3b
SURFACE WATER TEMPERATURE
21.5°C to 23.1°C

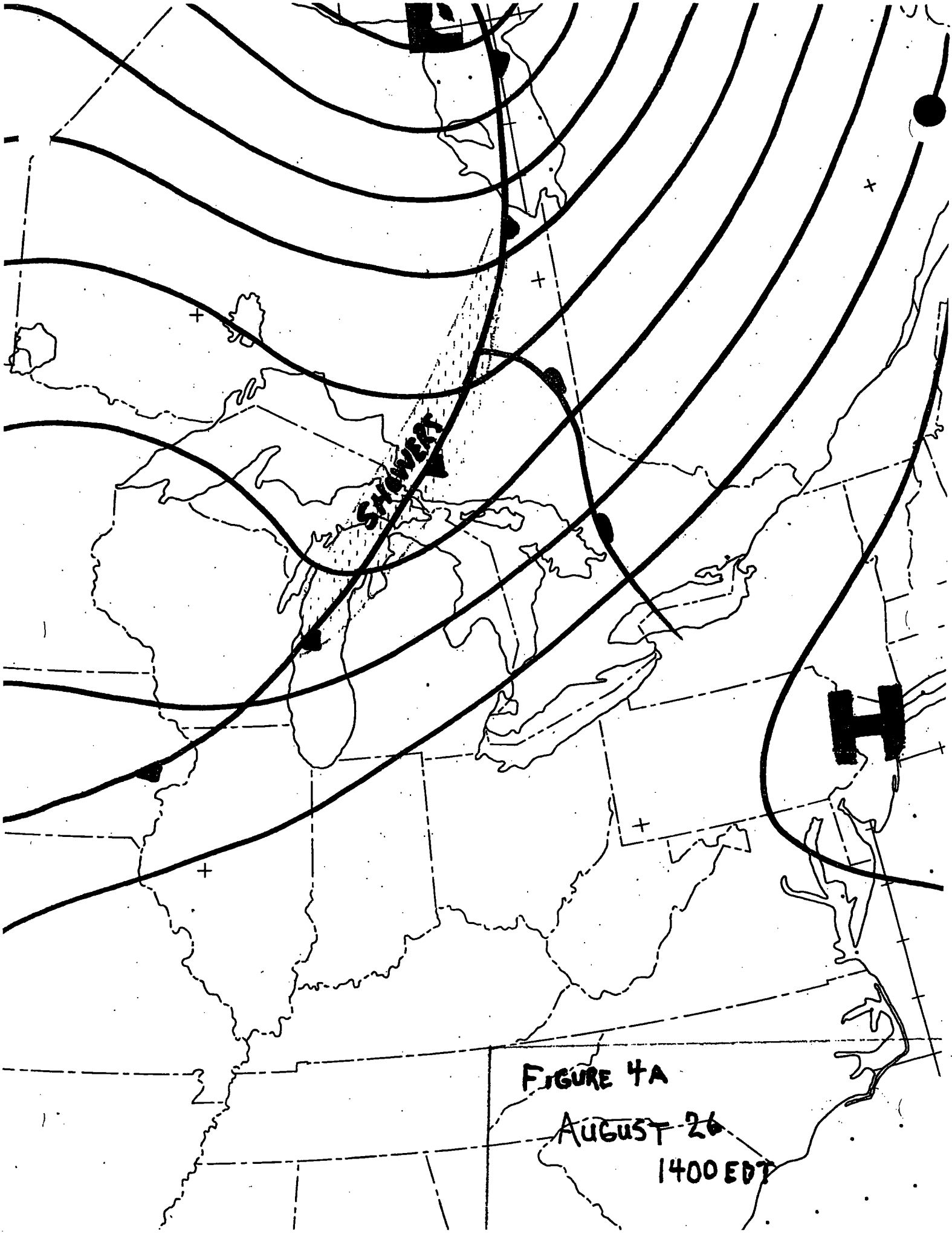

FIGURE 4A

AUGUST 26

1400 EDT

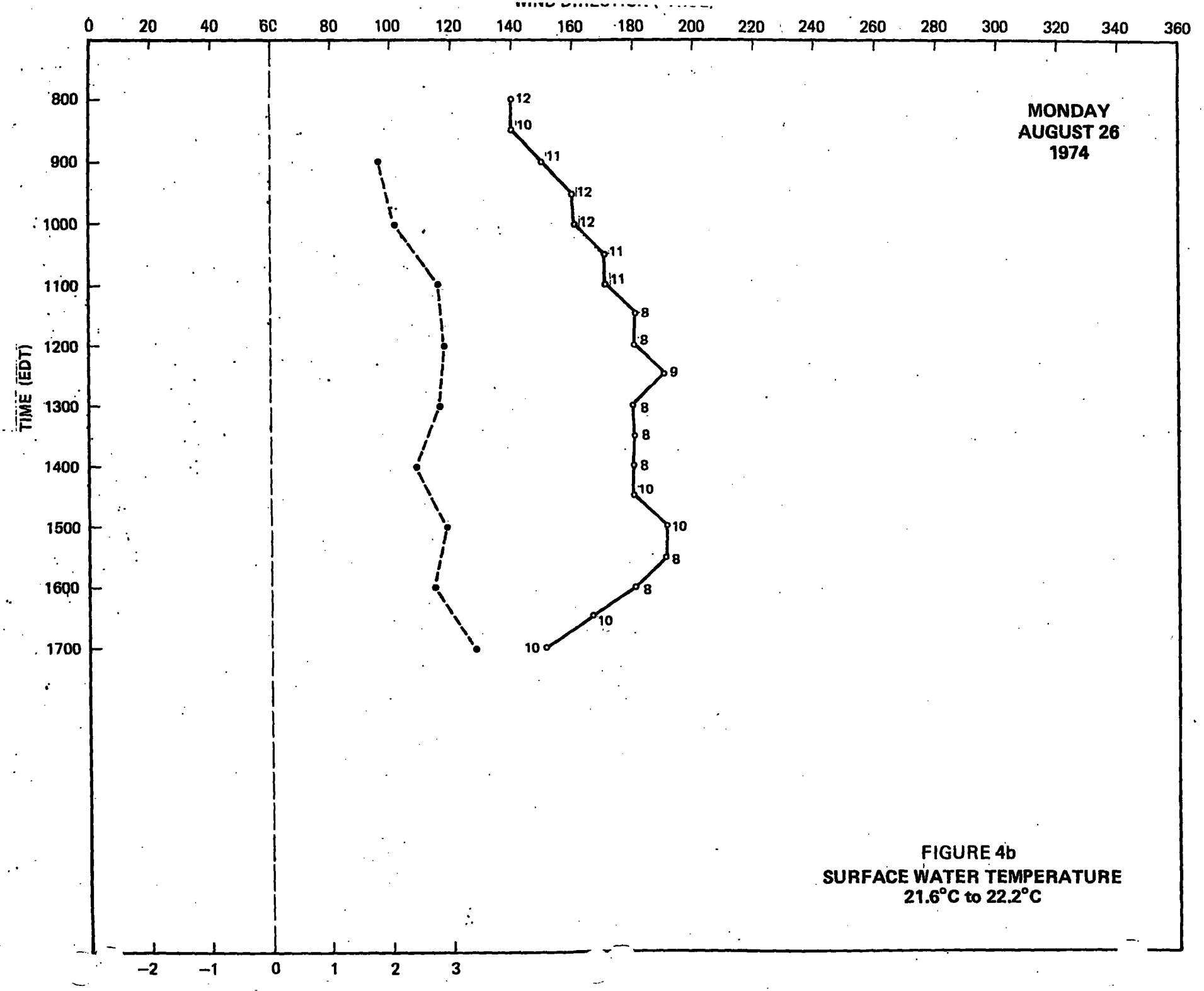

FIGURE 4b
SURFACE WATER TEMPERATURE
21.6°C to 22.2°C

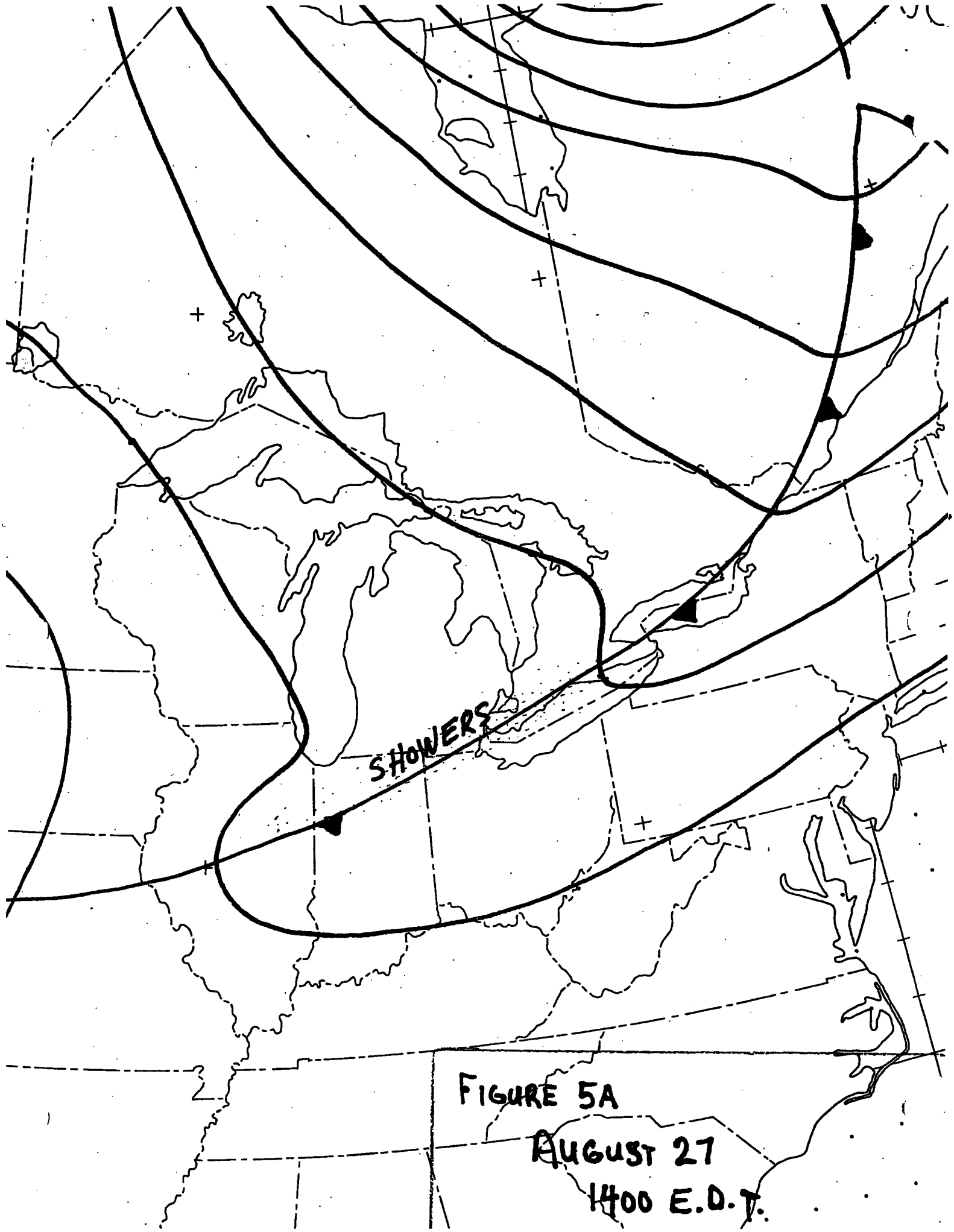

FIGURE 5A

AUGUST 27

1400 E.D.T.

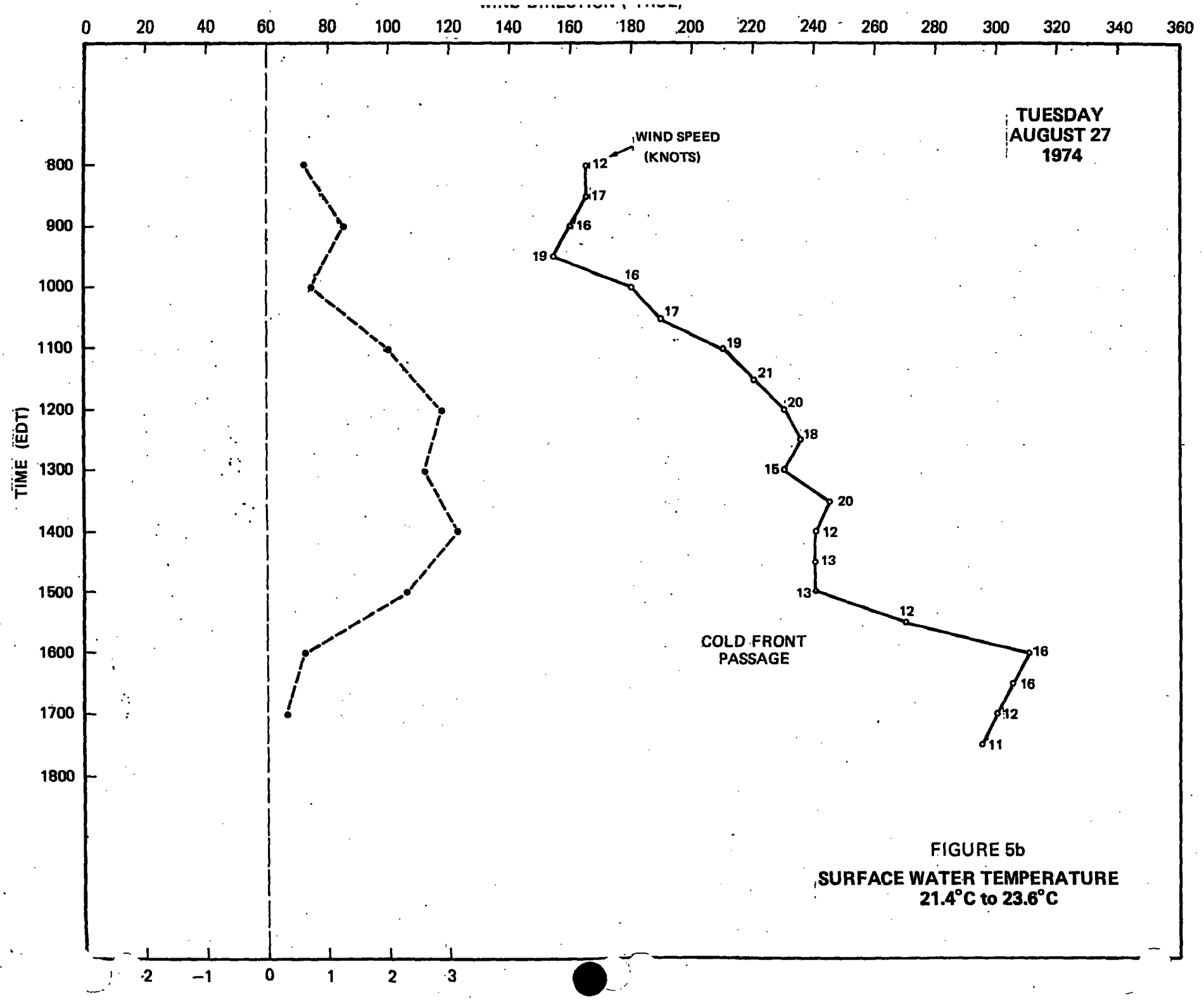

FIGURE 5b

SURFACE WATER TEMPERATURE
21.4°C to 23.6°C

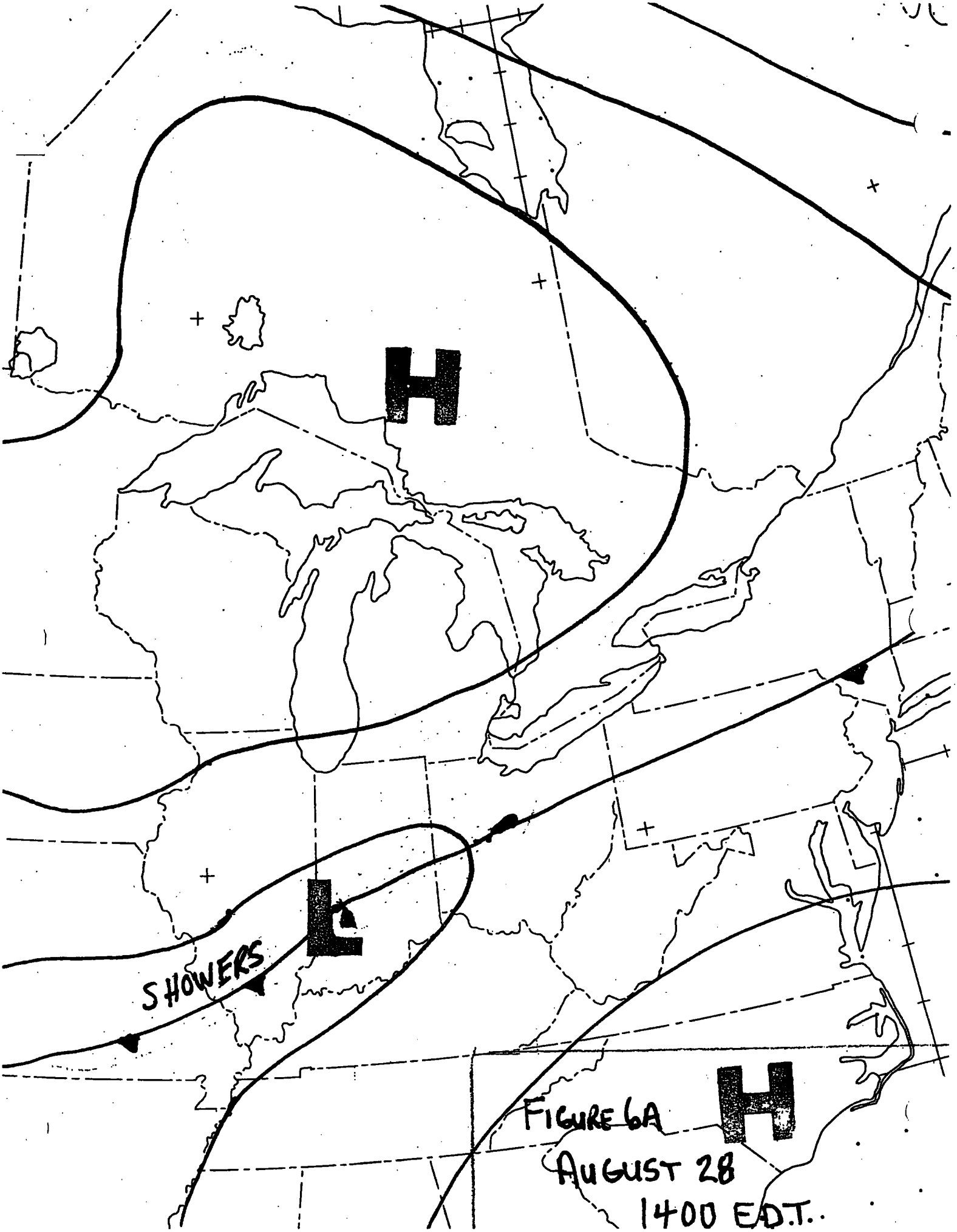

FIGURE 6A
AUGUST 28
1400 E.D.T.

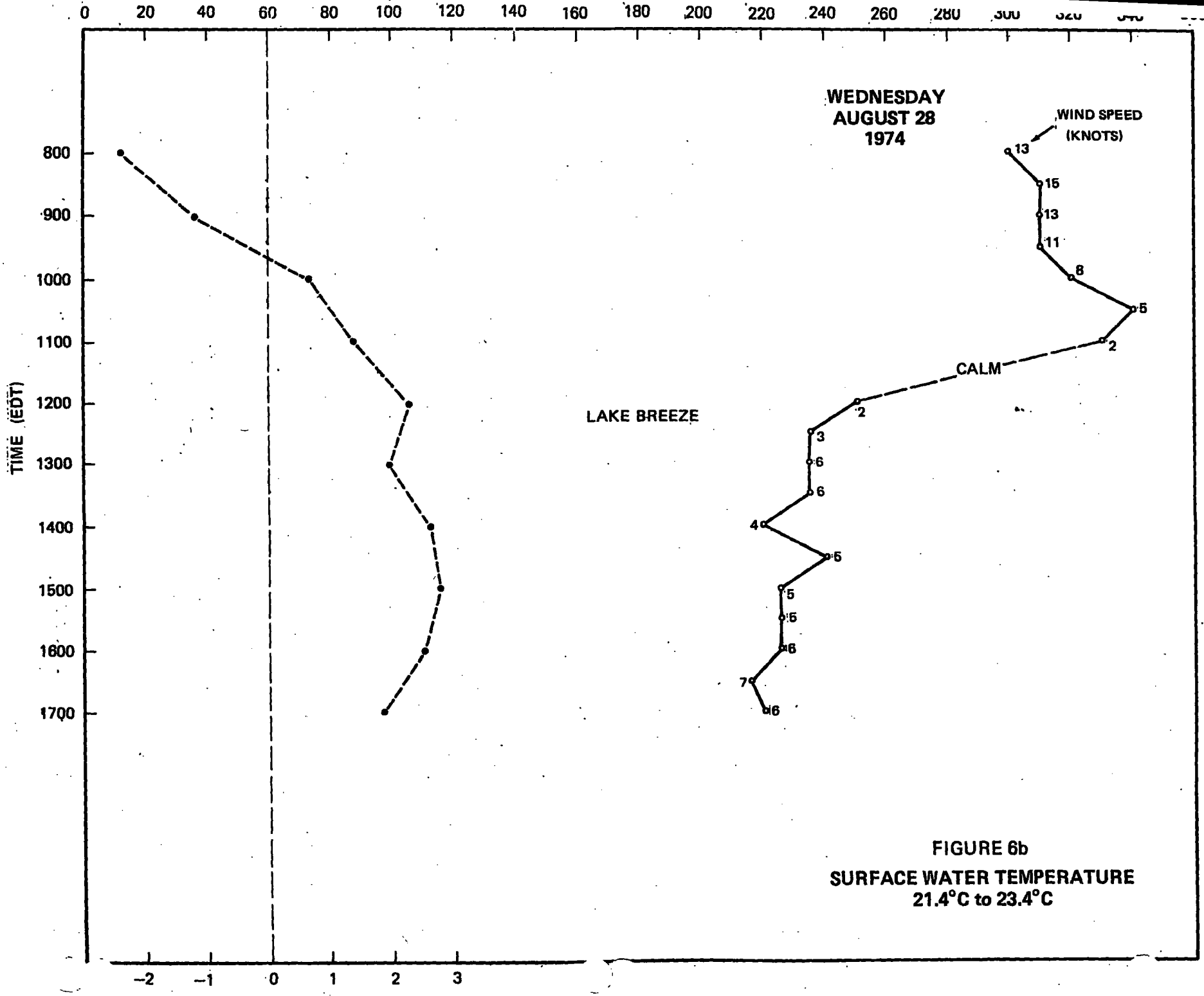

FIGURE 6b

SURFACE WATER TEMPERATURE
21.4°C to 23.4°C

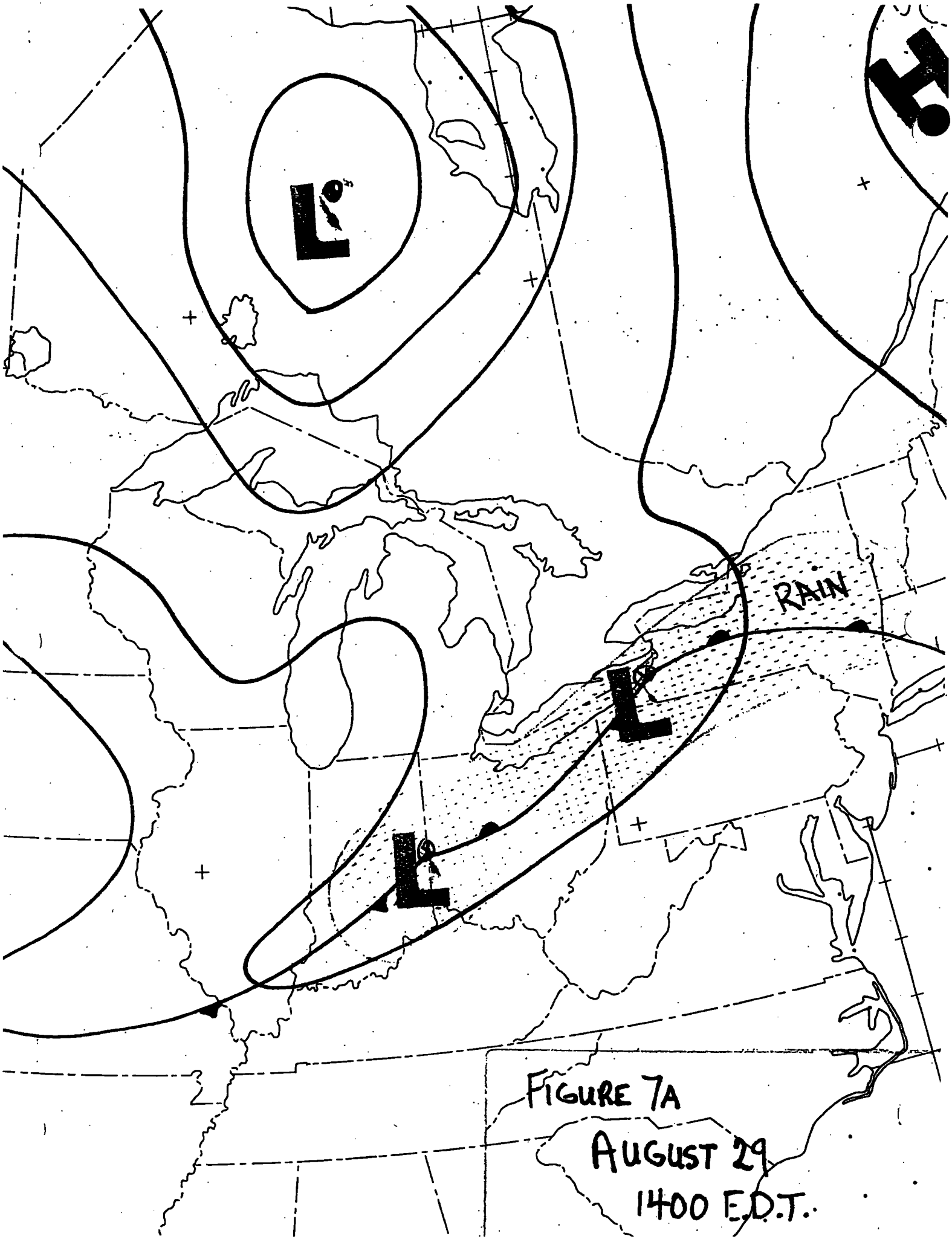

FIGURE 7A

AUGUST 29

1400 E.D.T.

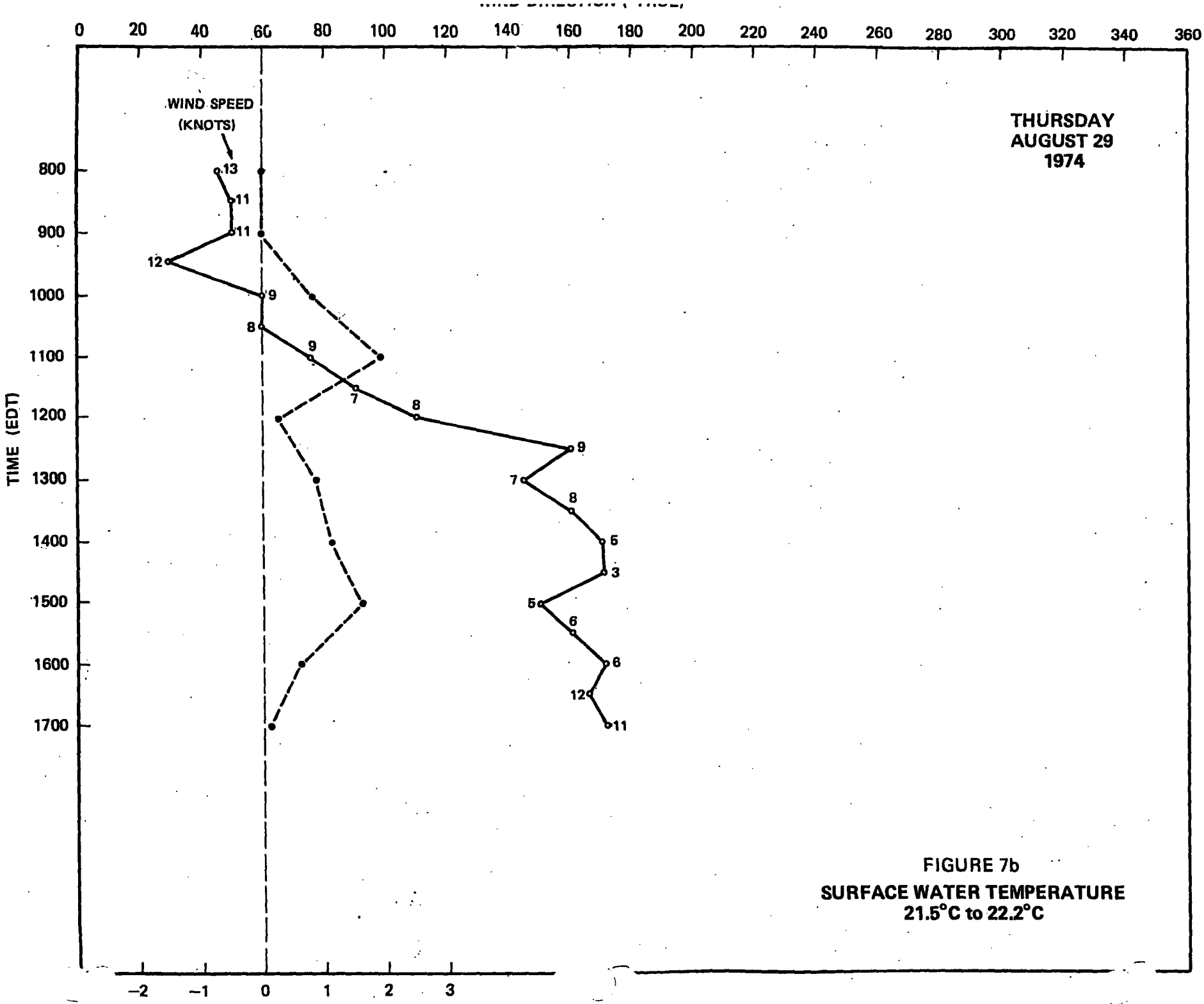

FIGURE 7b

SURFACE WATER TEMPERATURE
21.5°C to 22.2°C

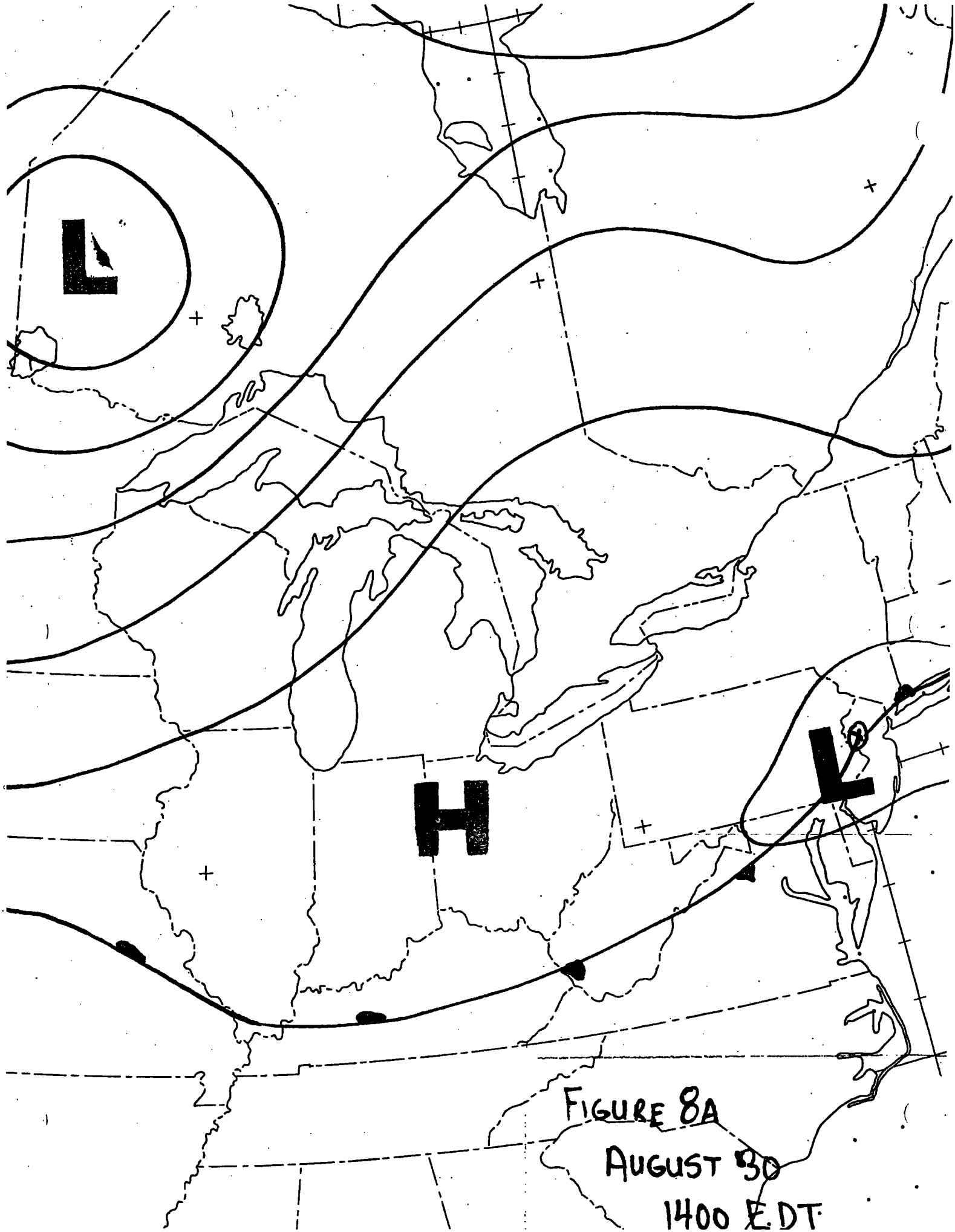

FIGURE 8A
AUGUST 30
1400 E.D.T.

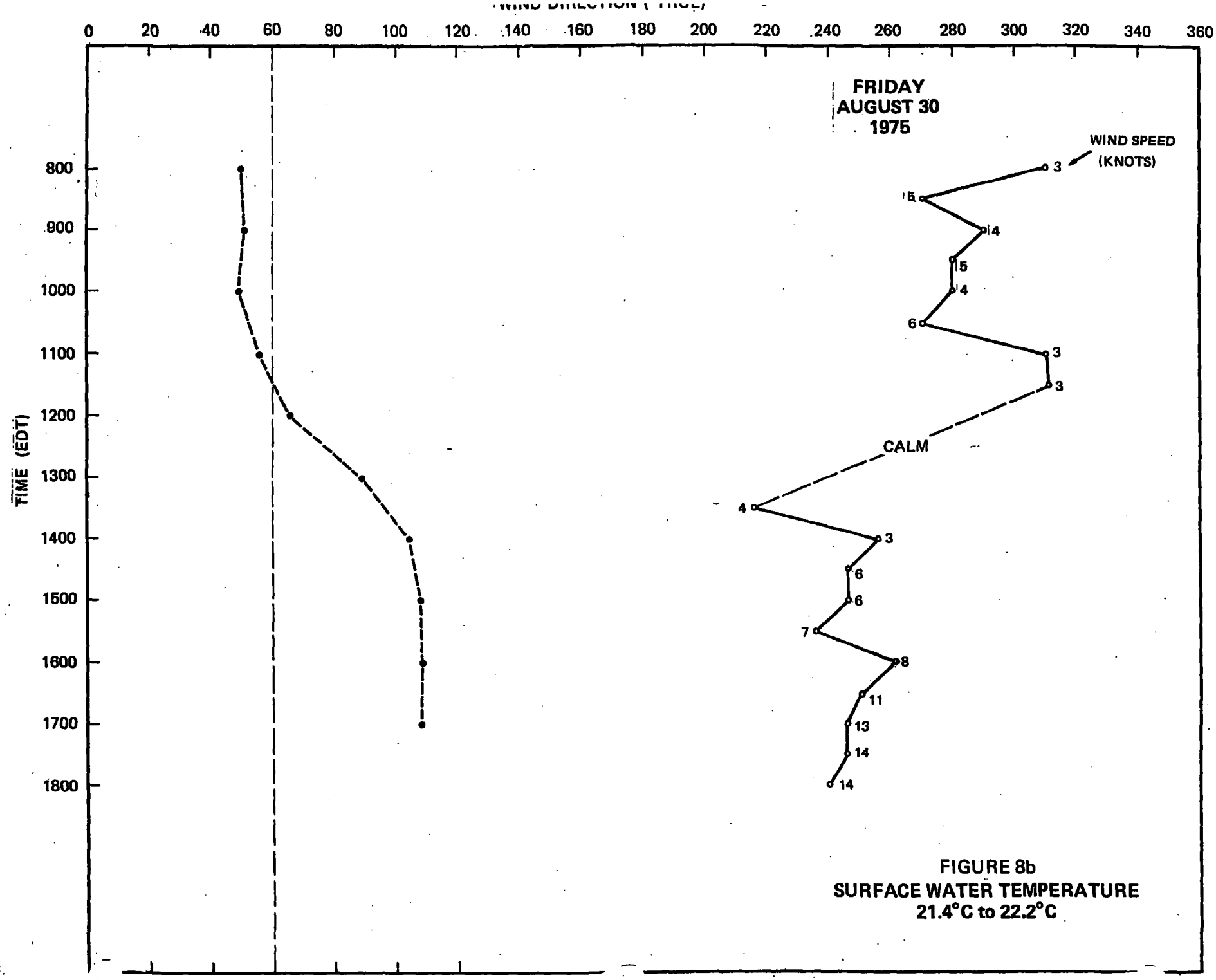

FIGURE 8b
SURFACE WATER TEMPERATURE
21.4°C to 22.2°C