Kunio SHIRASAWA, Masao ISHIKAWA, Toru TAKATSUKA, Takaharu DAIBO, Masaaki AOTA and Yoshihiro FUJIYOSHI 1999 Sea Ice Conditions, and Meteorological and Oceanographic Observations at Saroma-ko Lagoon, Hokkaido, December 1998 - November 1999. *Low Temperature Science*, **Ser. A., 58.** *Data Report.*

Sea Ice Conditions, and Meteorological and Oceanographic Observations at Saroma-ko Lagoon, Hokkaido, December 1998 - November 1999 *, **

Kunio SHIRASAWA, Masao ISHIKAWA, Toru TAKATSUKA,
Takaharu DAIBO, Masaaki AOTA
(Institute of Low Temperature Science, Hokkaido University)
and
Yoshihiro FUJIYOSHI
(Saroma Research Center of Aquaculture, Tokoro, Hokkaido)
(Received December 1999)

Abstract: Long-term meteorological data have been collected at a permanently installed 5-m tower at a cape of Saroma-ko Lagoon to characterize the general meteorological and climatological features at the lagoon. Time series of air temperature, wind azimuth and speed, and solar radiation obtained from the meteorological tower, together with water temperature and salinity obtained from a mooring station were reported during the period from December 1998 through November 1999. Freeze-up, breakup and duration of complete ice coverage of the lagoon were also reported.

要旨: サロマ湖は毎年冬期間結氷する。サロマ湖のキムアネップ岬に設置された5 mの気象塔で通年の気象観測が行われている。また、湖の中央部付近には水温、塩分計が設置され、通年で観測が行われている。1998年12月から1999年11月までの日平均気温、風速、日射量、水温、塩分観測について報告する。また、1964年から観測されている湖面の結氷状況についても報告する。

Key words: Meteorological and Oceanographic Variables, Sea Ice, Saroma-ko Lagoon
キーワード: 気象・海洋要素, 海氷, サロマ湖

* 北海道大学低温科学研究所業績 第3957号
** 北海道大学低温科学研究所 流氷研究施設 研究報告 第158号

I. Introduction

Saroma-ko Lagoon located on the Okhotsk Sea coast of Hokkaido is 149.2 km^2 in area, 19.5 m in maximum depth and 14.5 m in mean depth (Fig. 1). The lagoon has two inlets which are connected to the Sea of Okhotsk. About 90 % of the total inflow from the sea to the lagoon passes through the first inlet opened in 1927. The remainder passes through the second inlet which was built in December, 1978. The opening of the inlets might have caused changes in the water mass and current circulation of the lagoon, and in the exchange processes of the water between sea and lagoon waters. Also, freshwater input which is mainly supplied by two major rivers causes a reduction of salinity to less than 32 PSU. During winter most of the lagoon surface is covered with sea ice. The Saroma Research Center of Aquaculture in Sakaeura has been monitoring ice conditions at the lagoon for thirty five years. It is shown from year-to-year changes in the duration of complete ice coverage in the lagoon that the trend of variations appears to decrease for the past ten years (Fig. 2). In winters 1988/89, 1990/91, 1992/93 and 1996/97 the lagoon surface was not completely covered with sea ice. The Saroma Research Center has been also operating a 5-m meteorological tower at the cape of Kimuaneppu (Fig. 1) in cooperation with the Sea Ice Research Laboratory of Hokkaido University to characterize the general meteorological and climatological features at the lagoon. In this report, time series of meteorological and oceanographic variables during the period from December 1998 through November 1999 are shown. Time series data of meteorological variables were reported for the period from December 1991 through December 1992 by Shirasawa et al. (1993), for January 1993 through November 1995 by Shirasawa et al. (1995), for December 1995 through November 1996 by Shirasawa et al. (1996), for November 1996 through November 1997 by Shirasawa et al. (1997) and for December 1997 through November 1998 by Shirasawa et al. (1998).

II. Meteorological and Oceanographic Observations

A location map of the meteorological tower at Kimuaneppu (44°06.08'N 143°56.12'E) is shown in Fig. 1. A thermometer, a pyrheliometer and a wind sensor were installed at the heights of 2.9, 4.2 and 5.0 m, respectively, of the 5-m tower set up at the cape of Kimuaneppu in 1989. Instantaneous values of those sensors were recorded at every 10 min and stored in a data acquisition system (Intelligent Data-Stocker DS-64K2 and LM-30K, Kona Sapporo Co.). The threshold value for the wind speed was 2 ms^{-1}. Time series of wind speed and azimuth, air

temperature and solar radiation during the period from December 1998 through November 1999 at each month are shown in Fig. 3. Values for those graphs were obtained at a sampling interval of 10 min except for stick diagrams of wind vector on the uppermost frame in the figure, which were produced by data at a sampling interval of one hour.

A mooring system to monitor the water temperature and salinity was installed at the east side of the central part of the lagoon (44°07.77'N 143°52.17'E) (Fig. 1). The water temperature and salinity measured at the depth of 3m were collected at sampling intervals of 10-30 min. Time series of water temperature and salinity are shown in Fig. 3, together with the period of complete ice coverage of the lagoon surface. It appears that the water temperature reached to almost freezing temperature at mid-January, but there was a time lag between the freeze-up day of complete ice coverage and the freezing temperature at the central lagoon. In general, at the beginning of freeze-up of the lagoon, frazil ice is formed at the surface and destroyed mainly caused by atmospheric forcing. This phenomenon repeats for some period before ice becomes more stable and the lagoon surface is completely covered with a level ice sheet.

Shown in Fig. 4 is a time series of wind rose at each month, indicating that the WNW wind along the Okhotsk Sea coast is predominant during the period from December through March. The southerly wind gets more frequent from April through November.

Acknowledgments. We wish to thank the Saroma Research Center of Aquaculture in Sakaeura for their kind offers to use their facilities. Funding for this work was partly obtained from the Japanese Ministry of Education, Science and Culture (Monbusho) through grants-in-aid for Scientific Research, from the Japan Society for the Promotion of Science and from the Sasakawa Scientific Research Grant from the Japan Science Society.

References

Shirasawa, K., Ikeda, M., Takatsuka, T., Ishikawa, M., Aota, M., Ingram, G., Belanger, C., Peltola, P., Takahashi, S., Matsuyama, M., Hudier, E., Fujiyoshi, Y., Kodama, Y., and Ishikawa, N. (1993) Atmospheric and oceanographic data report for Saroma-ko Lagoon of the SARES (Saroma-Resolute Studies) Project, 1992. *Low Temperature Science*, **Ser. A., 52.** *Data Report.* 69-167.

Shirasawa, K., Ikeda, M., Ishikawa, M., Takatsuka, T., Aota, M., and Fujiyoshi, Y. (1995) Meteorological observation data report for Saroma-ko lagoon, Hokkaido, January 1993 -

November 1995. *Low Temperature Science*, **Ser. A., 54.** *Data Report.* 19-80.

Shirasawa, K., Ikeda, M., Ishikawa, M., Takatsuka, T., Aota, M., and Fujiyoshi, Y. (1996) Sea ice conditions and meteorological observations at Saroma-ko lagoon, Hokkaido, December 1995 – November 1996. *Low Temperature Science*, **Ser. A., 55.** *Data Report.* 47-77.

Shirasawa, K., Ikeda, M., Ishikawa, M., Takatsuka, T., Aota, M., and Fujiyoshi, Y. (1997) Sea ice conditions and meteorological observations at Saroma-ko lagoon, Hokkaido, November 1996 – November 1998. *Low Temperature Science*, **Ser. A., 56.** *Data Report.* 9-34.

Shirasawa, K., Ishikawa, M., Takatsuka, T., Ikeda, M., Daibou, T., Aota, M., and Fujiyoshi, Y. (1998) Sea ice conditions and meteorological observations at Saroma-ko lagoon, Hokkaido, December 1997 – November 1998. *Low Temperature Science*, **Ser. A., 57.** *Data Report.* 63-79.

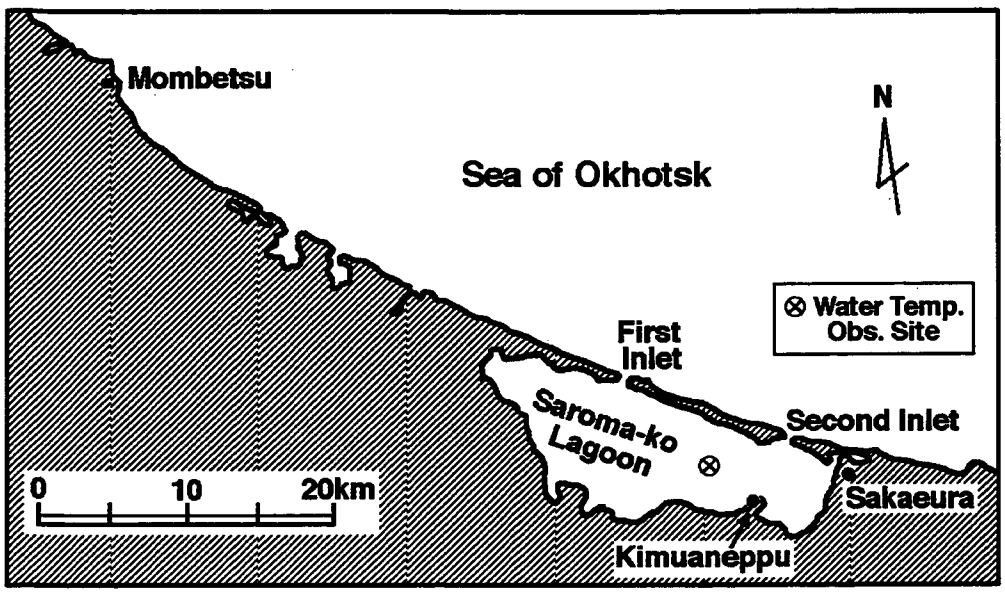


Fig. 1. A location map of Saroma-ko Lagoon.

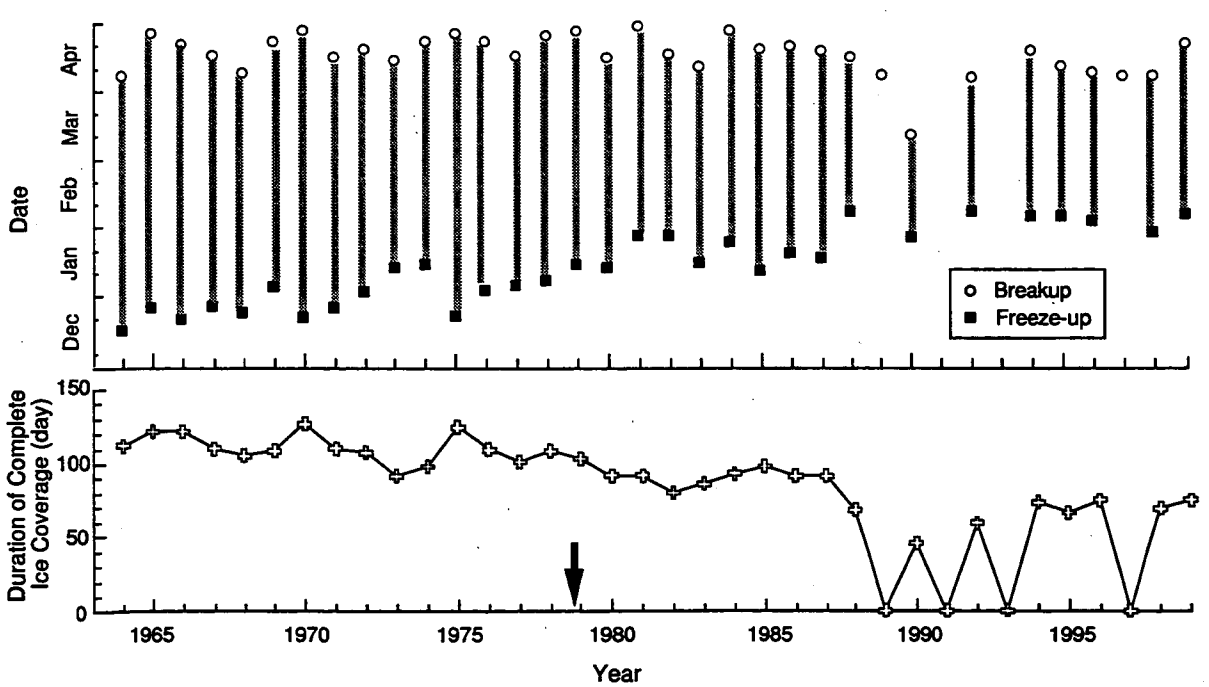


Fig. 2. Freeze-up, breakup and duration of complete ice coverage at Saroma-ko lagoon during the period from 1964 through 1999. The arrow indicates the date of the opening of the second inlet in December 1978.

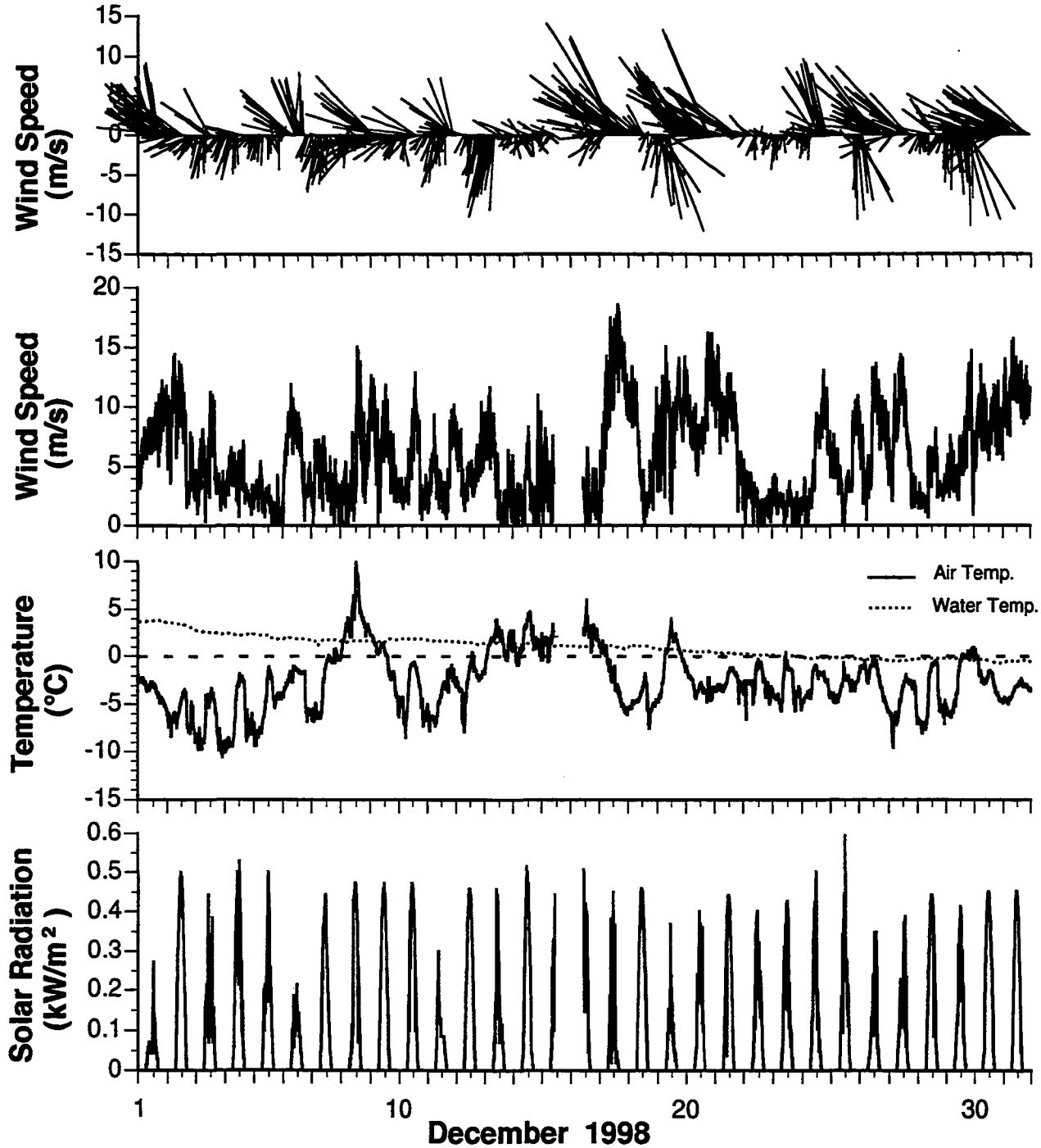
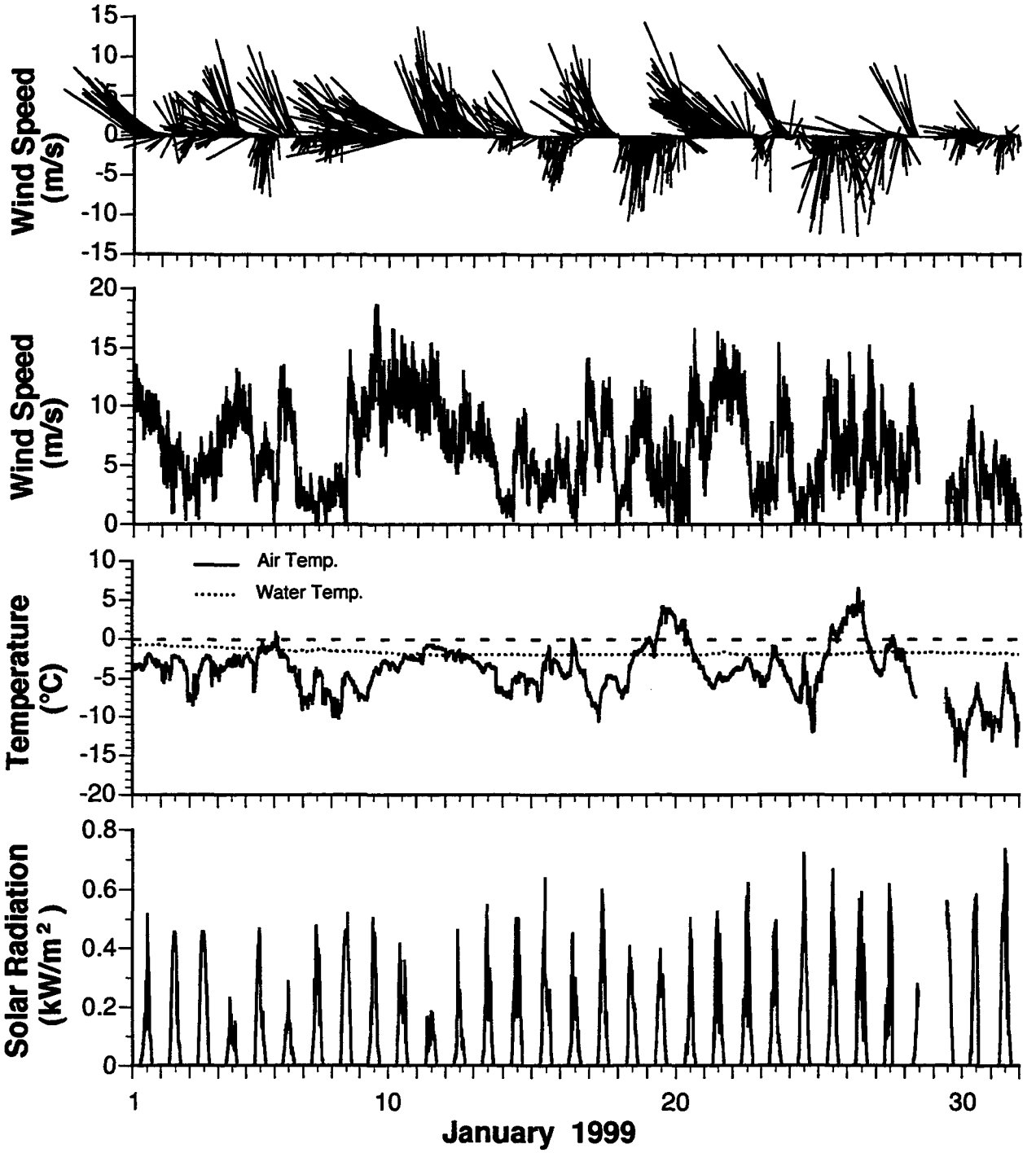
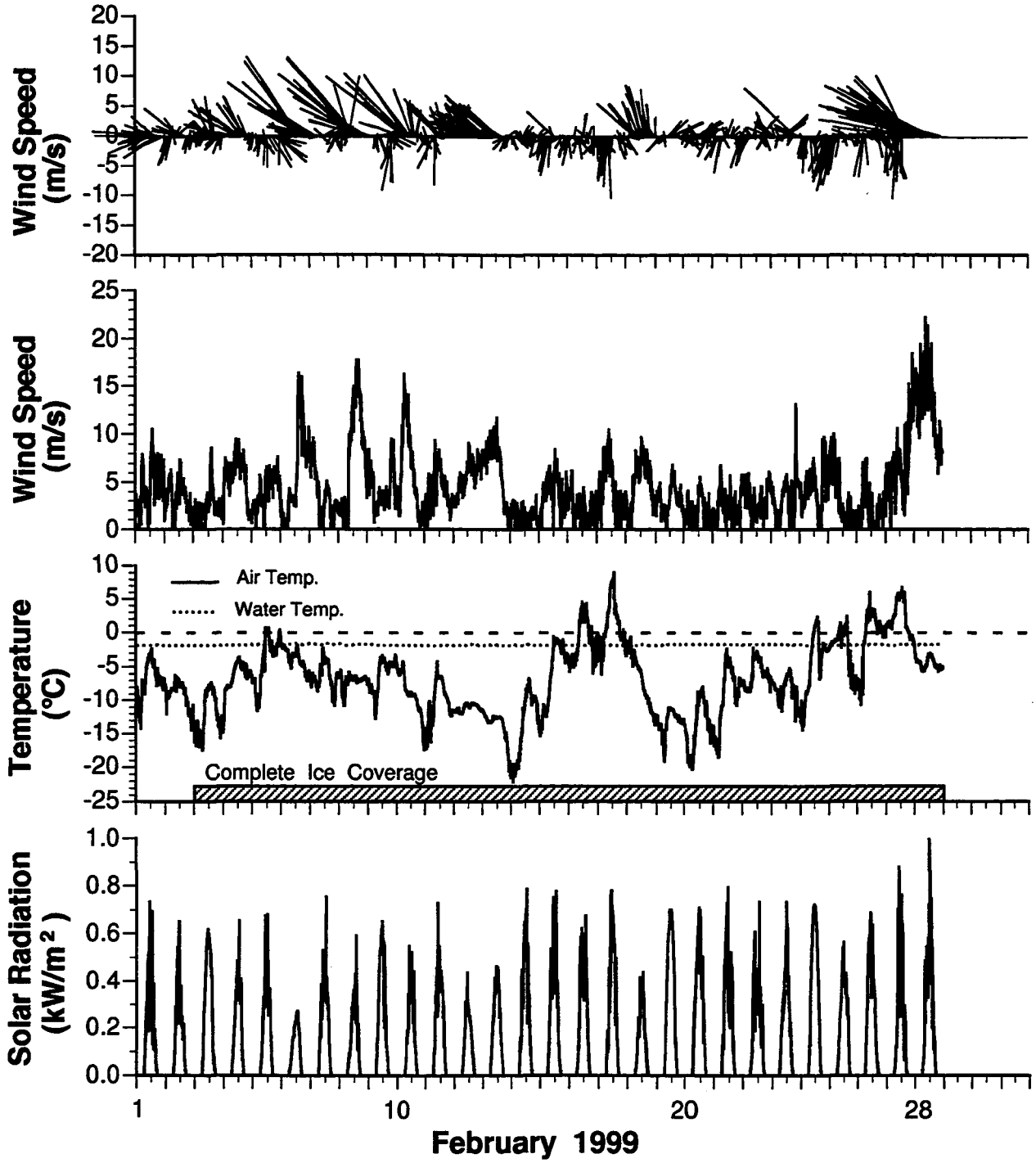
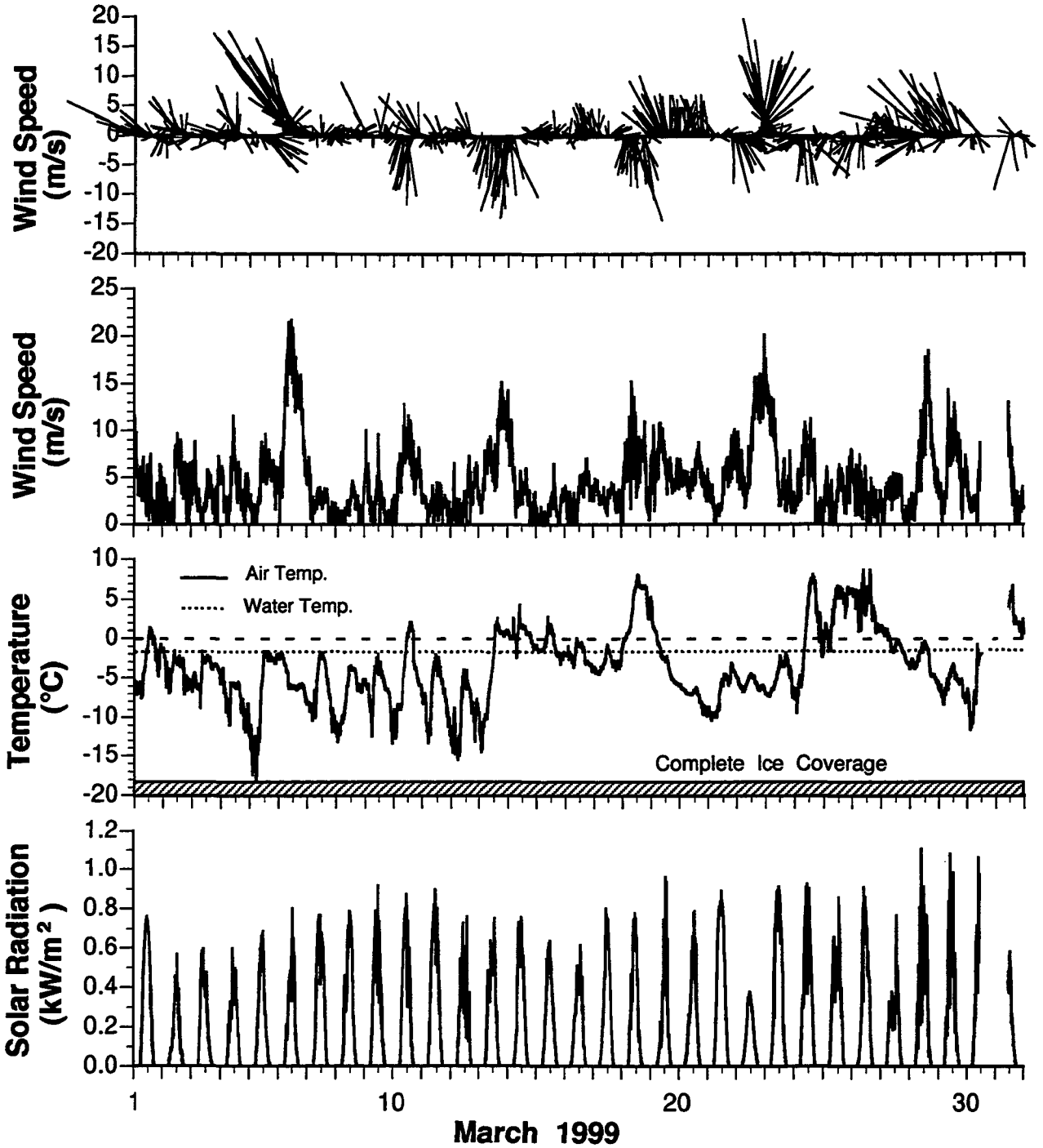
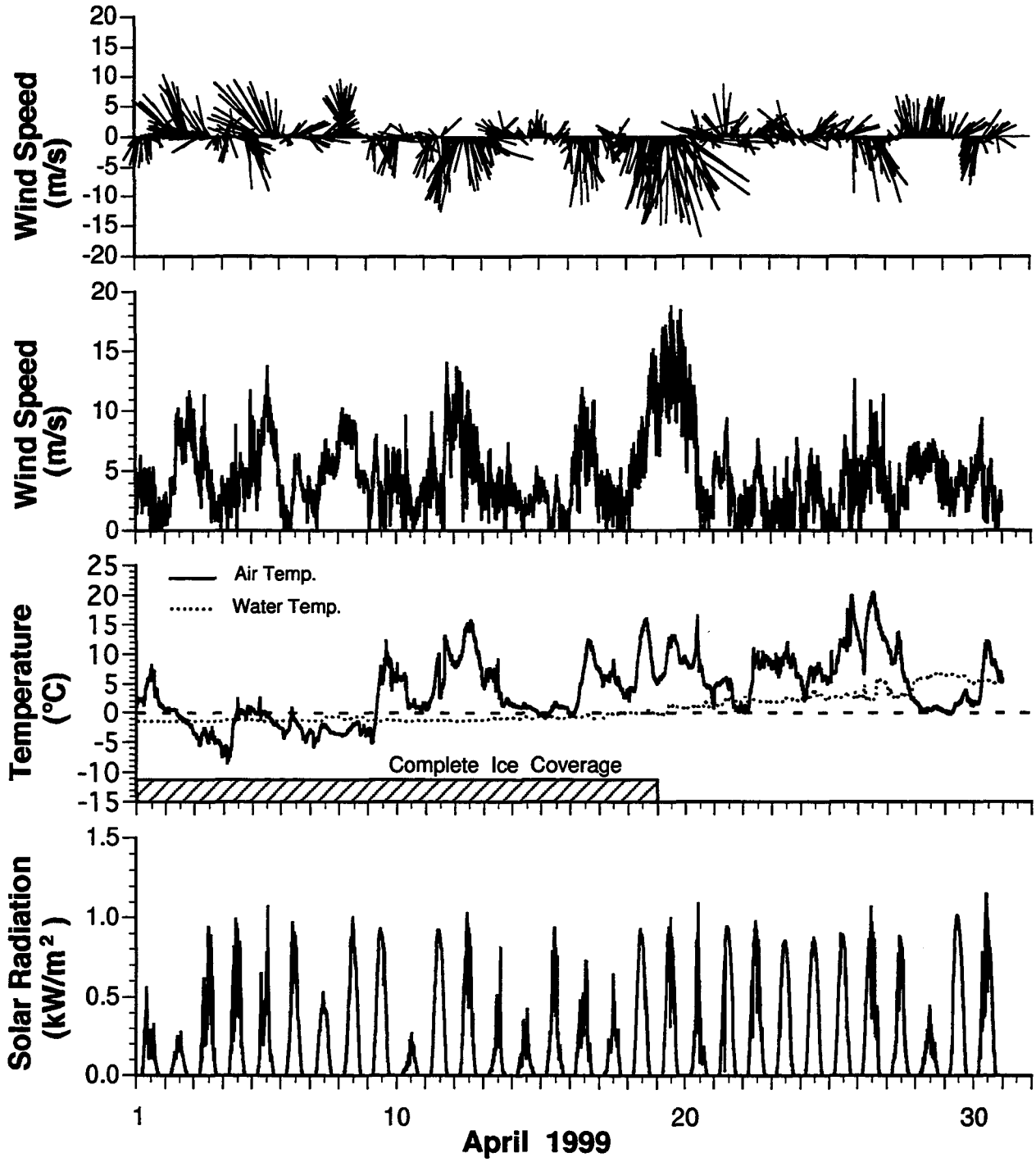


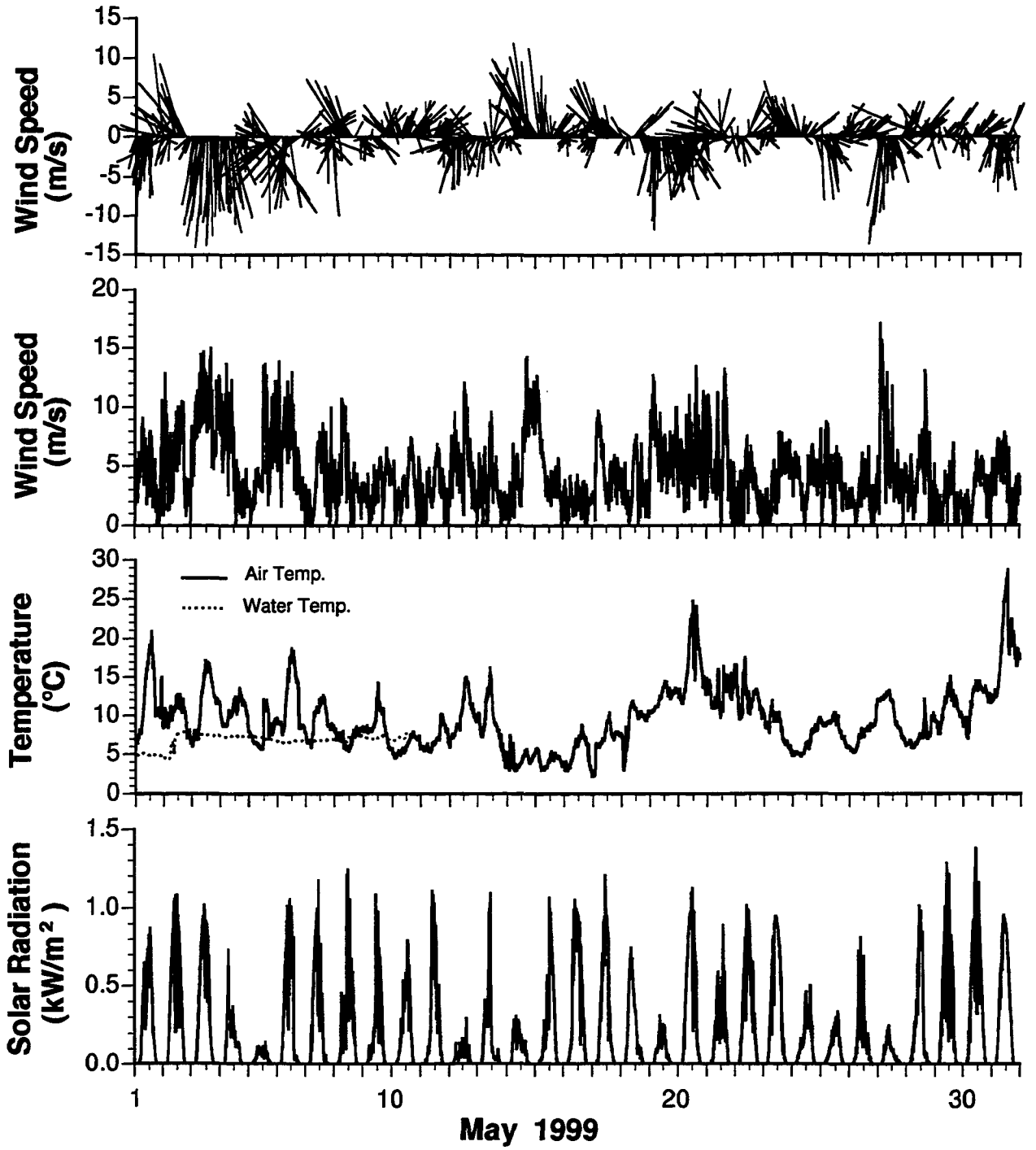
Fig. 3. Wind speed and azimuth, solar radiation, air and water temperatures, salinity and duration of complete ice coverage during the period from December 1998 through November 1999.

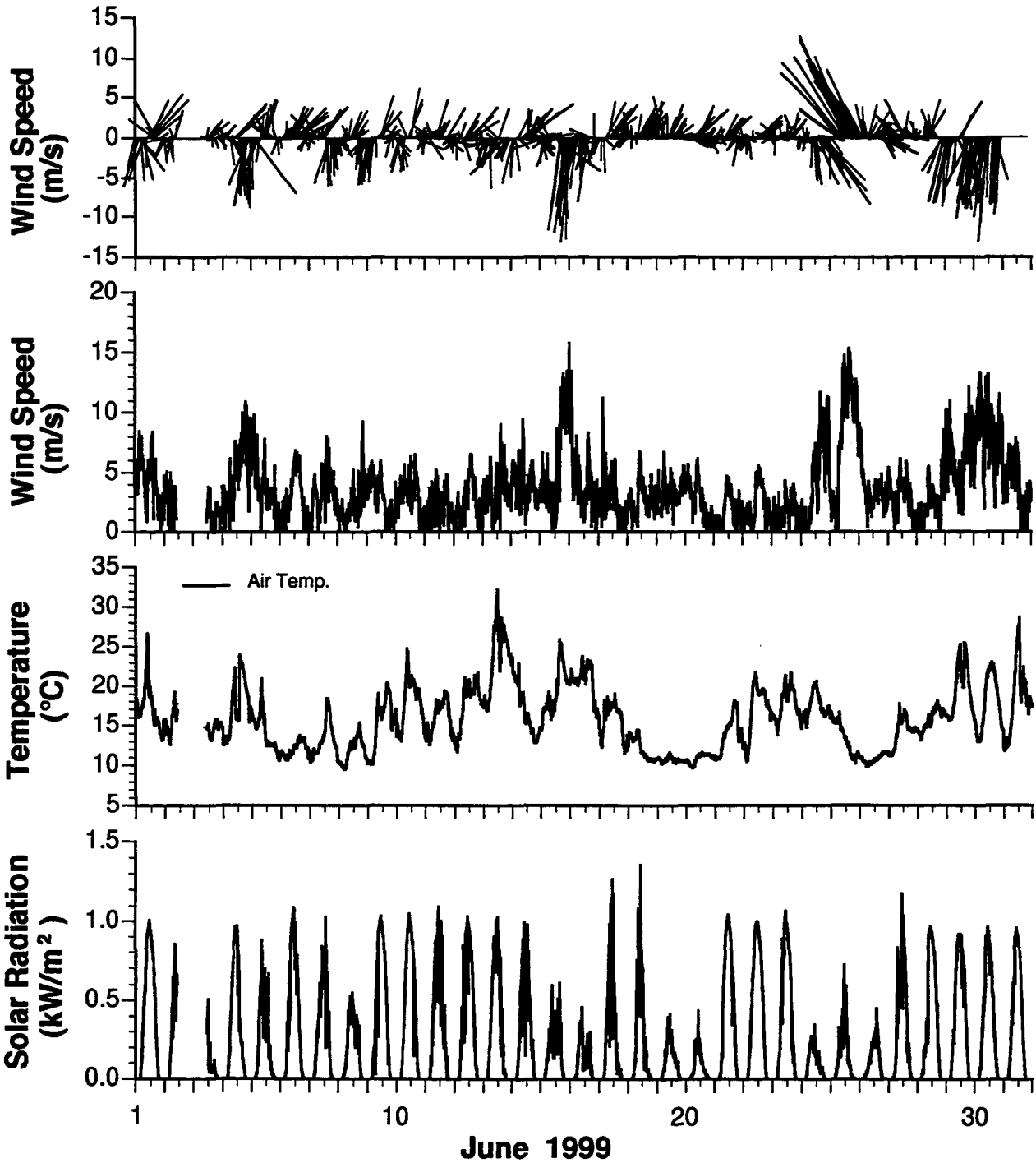

Wind Speed (m/s)
15
10
0
-5
-10
-15
Wind Speed (m/s)
20
15
10
5
0
Temperature (°C)
Air Temp.
Water Temp.
10
5
0
-5
-10
-15
-20
Solar Radiation (kW/m²)
0.8
0.6
0.4
0.2
0
1
10
20
30
January 1999

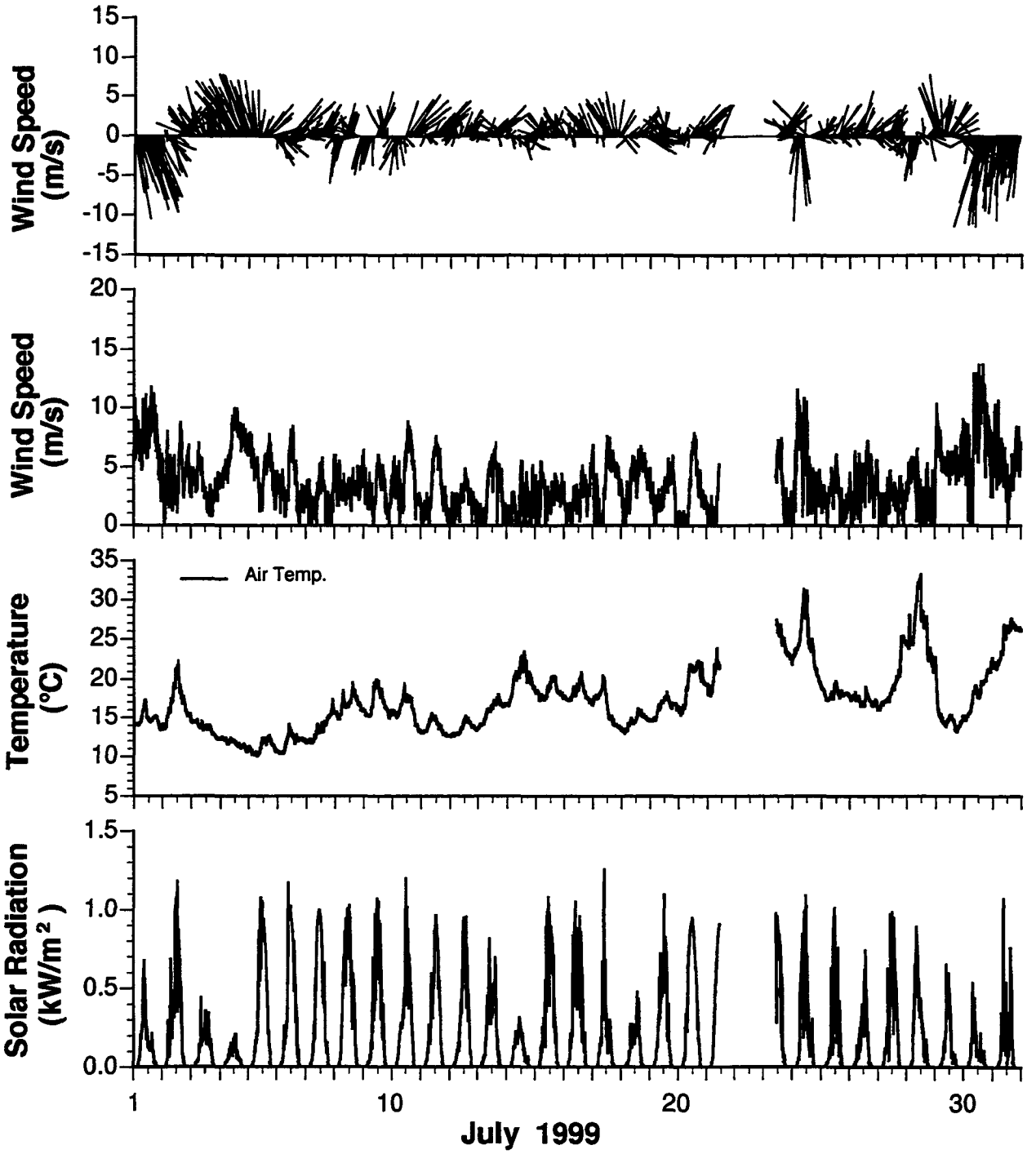

Wind Speed (m/s)
20
15
10
5
0
-5
-10
-15
-20
Wind Speed (m/s)
25
20
15
10
5
0
Temperature (°C)
10
5
0
-5
-10
-15
-20
-25
Air Temp.
Water Temp.
Complete Ice Coverage
Solar Radiation (kW/m²)
1.0
0.8
0.6
0.4
0.2
0.0
1
10
20
28
February 1999

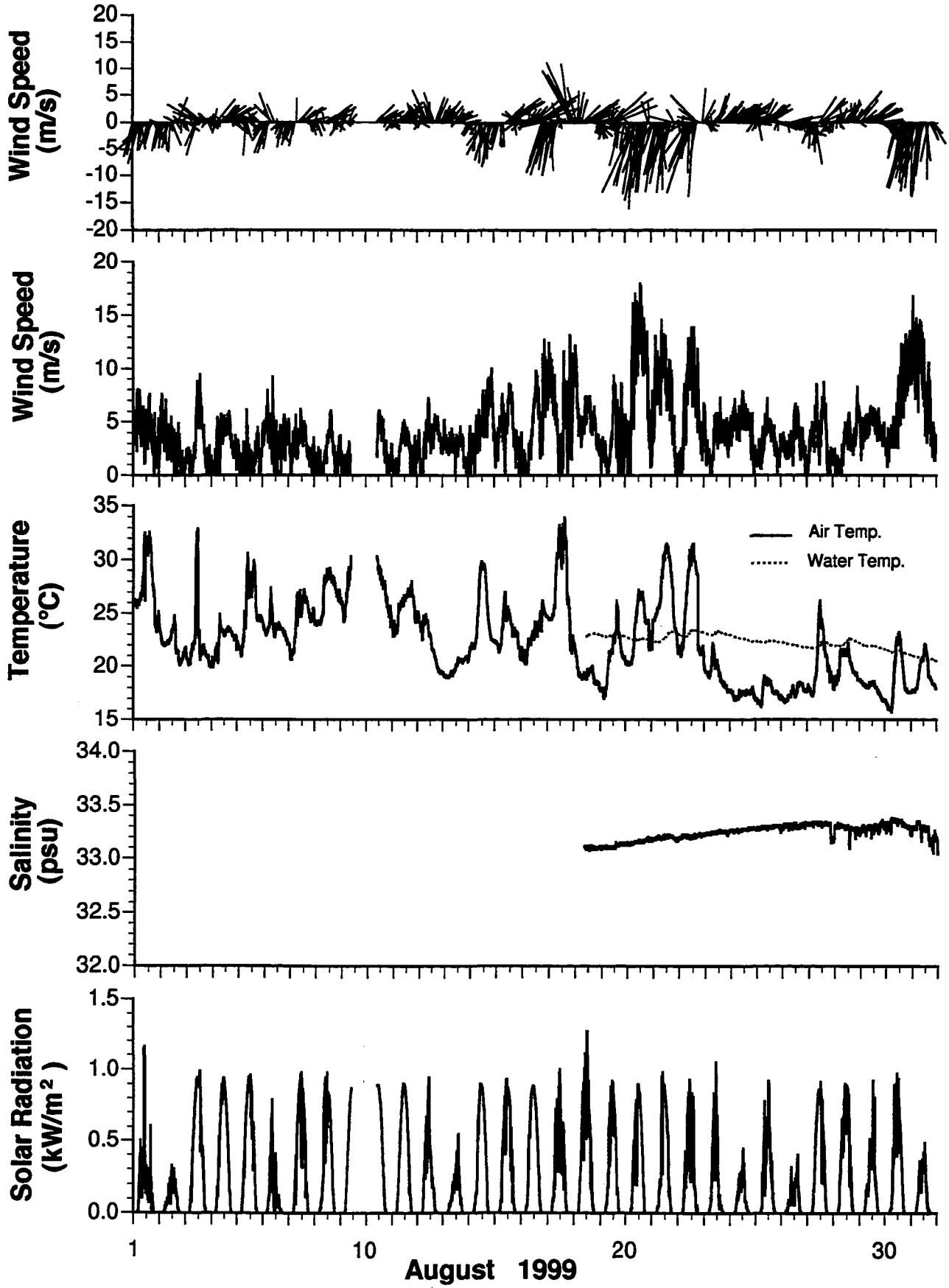

Wind Speed (m/s)
20
15
10
5
0
-5
-10
-15
-20
Wind Speed (m/s)
25
20
15
10
5
0
Temperature (°C)
10
5
0
-5
-10
-15
-20
Air Temp.
Water Temp.
Complete Ice Coverage
Solar Radiation (kW/m²)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1
10
20
30
March 1999

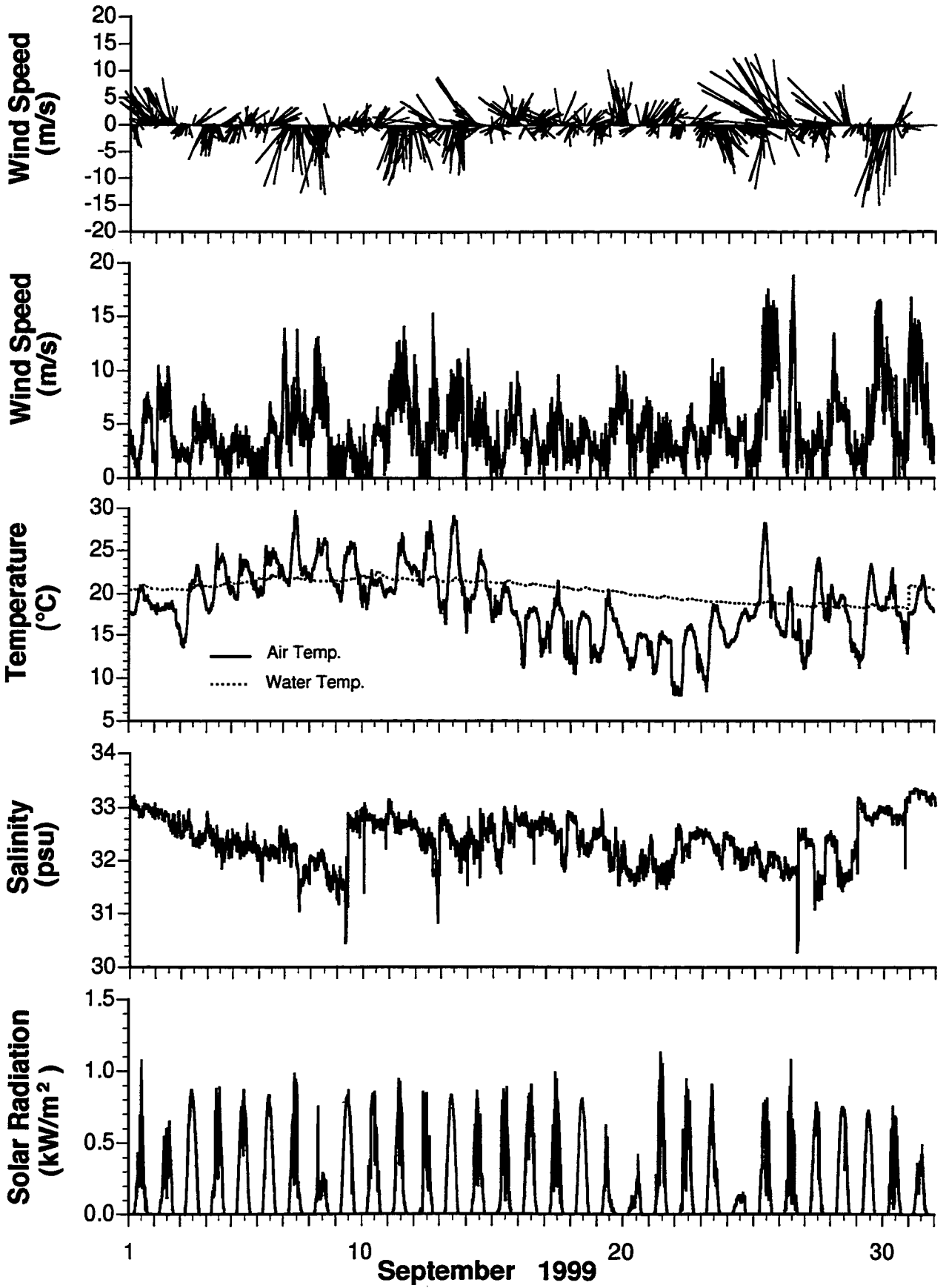

Wind Speed (m/s)
20
15
10
5
0
-5
-10
-15
-20
Wind Speed (m/s)
20
15
10
5
0
Temperature (°C)
25
20
15
10
5
0
-5
-10
-15
Air Temp.
Water Temp.
Complete Ice Coverage
Solar Radiation (kW/m²)
1.5
1.0
0.5
0.0
1
10
20
30
April 1999

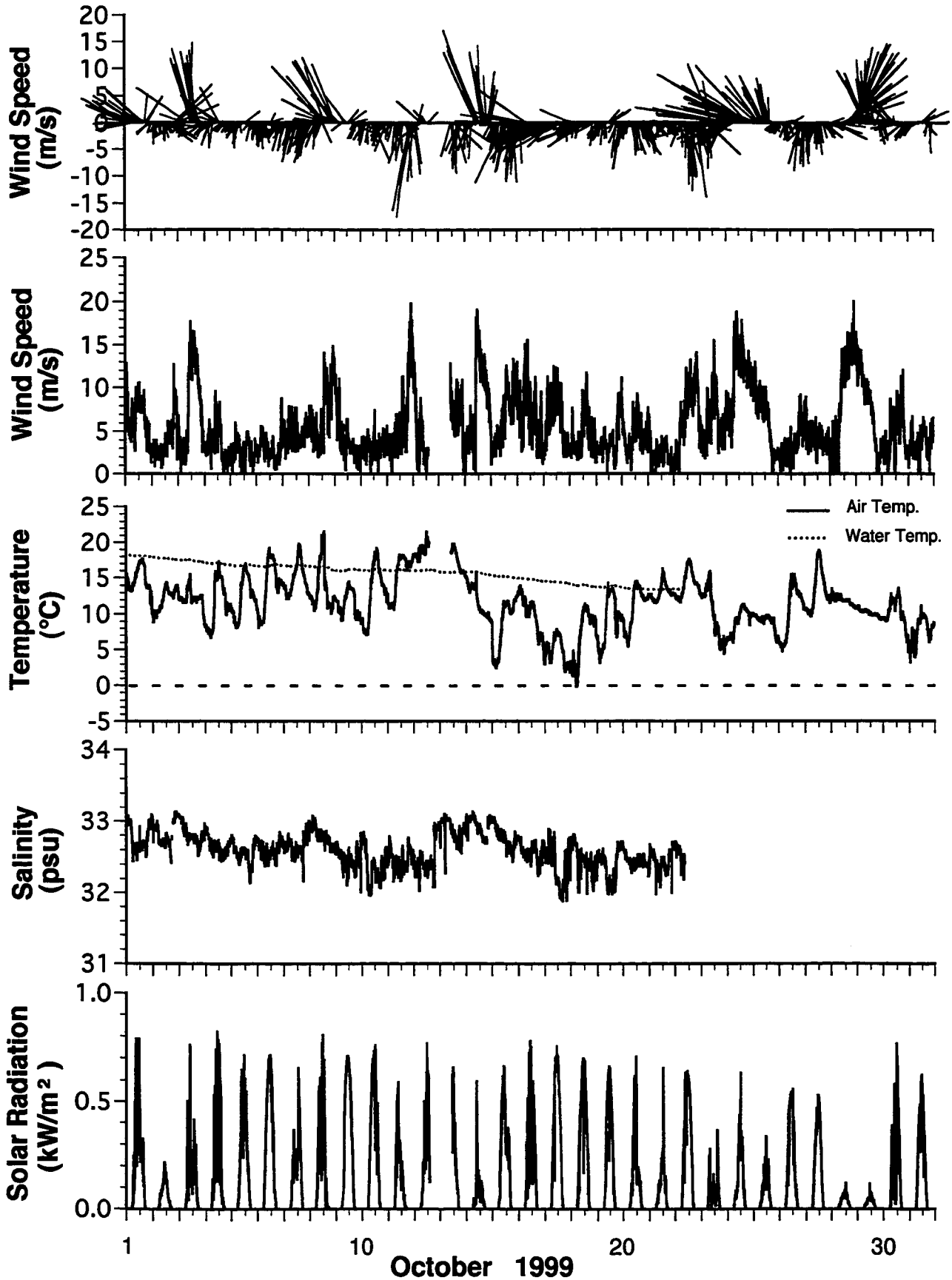

Wind Speed (m/s)
15
10
5
0
-5
-10
-15
Wind Speed (m/s)
20
15
10
5
0
Temperature (°C)
30
25
20
15
10
5
0
Air Temp.
Water Temp.
Solar Radiation (kW/m²)
1.5
1.0
0.5
0.0
1
10
20
30
May 1999

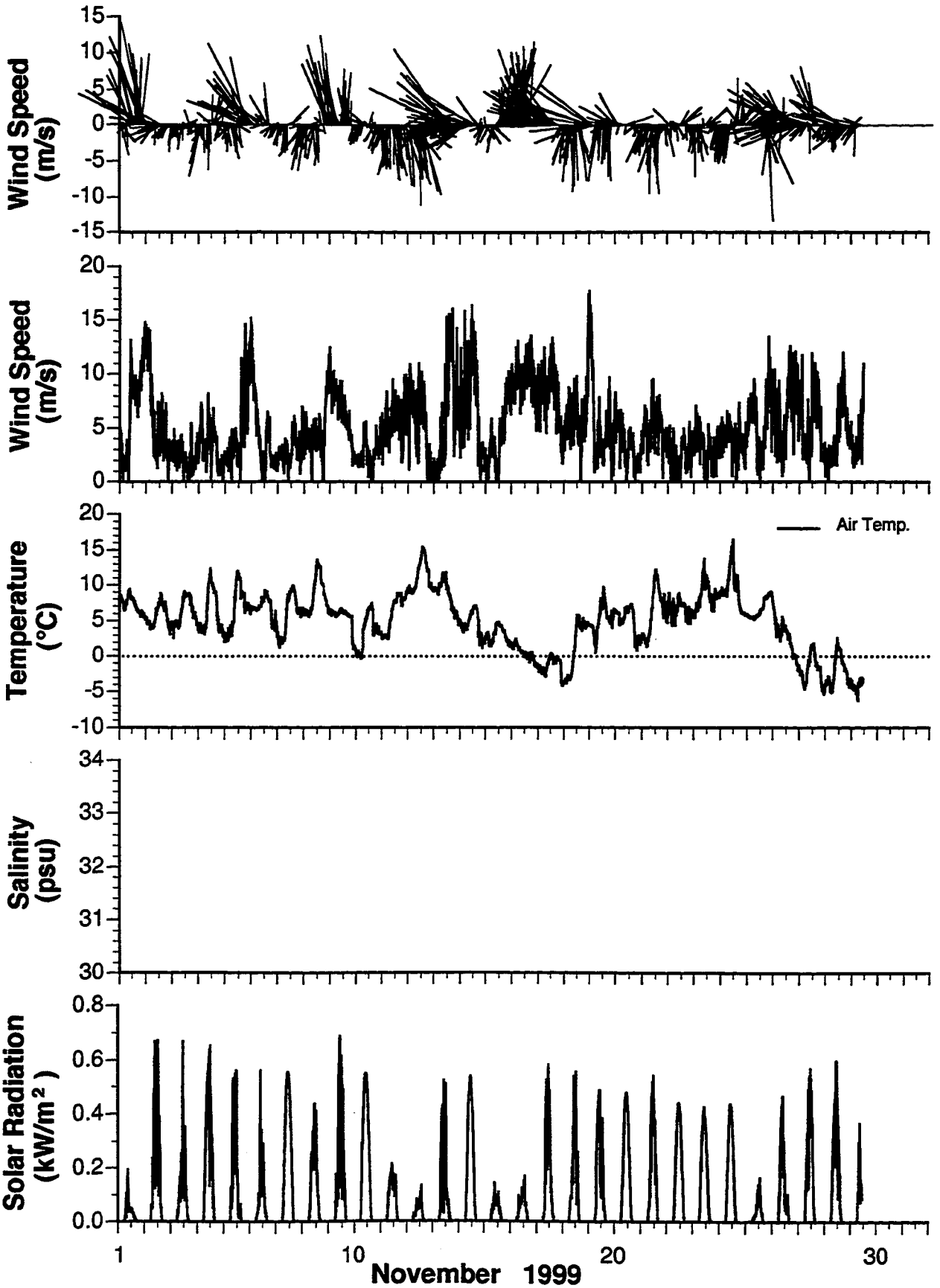

Wind Speed (m/s)
15
10
5
0
-5
-10
-15
Wind Speed (m/s)
20
15
10
5
0
Temperature (°C)
Air Temp.
35
30
25
20
15
10
5
Solar Radiation (kW/m²)
1.5
1.0
0.5
0.0
1
10
20
30
June 1999


Wind Speed (m/s)
15
10
5
0
-5
-10
-15
Wind Speed (m/s)
20
15
10
5
0
Temperature (°C)
Air Temp.
35
30
25
20
15
10
5
Solar Radiation (kW/m²)
1.5
1.0
0.5
0.0
1
10
20
30
July 1999


Wind Speed (m/s)
20
15
10
5
0
-5
-10
-15
-20
Wind Speed (m/s)
20
15
10
5
0
Temperature (°C)
35
30
25
20
15
Air Temp.
Water Temp.
Salinity (psu)
34.0
33.5
33.0
32.5
32.0
Solar Radiation (kW/m²)
1.5
1.0
0.5
0.0
1
10
20
30
August 1999


Wind Speed (m/s)
20
15
10
5
0
-5
-10
-15
-20
Wind Speed (m/s)
20
15
10
5
0
Temperature (°C)
30
25
20
15
10
5
Air Temp.
Water Temp.
Salinity (psu)
34
33
32
31
30
Solar Radiation (kW/m²)
1.5
1.0
0.5
0.0
1
10
20
30
September 1999


Wind Speed (m/s)
20
15
10
5
0
-5
-10
-15
-20
Wind Speed (m/s)
25
20
15
10
5
0
Temperature (°C)
25
20
15
10
5
0
-5
Air Temp.
Water Temp.
Salinity (psu)
34
33
32
31
Solar Radiation (kW/m²)
1.0
0.5
0.0
1
10
20
30
October 1999


Wind Speed (m/s)
15
10
5
0
-5
-10
-15
Wind Speed (m/s)
20
15
10
5
0
Temperature (°C)
Air Temp.
20
15
10
5
0
-5
-10
Salinity (psu)
34
33
32
31
30
Solar Radiation (kW/m²)
0.8
0.6
0.4
0.2
0.0
1
10
20
30
November 1999

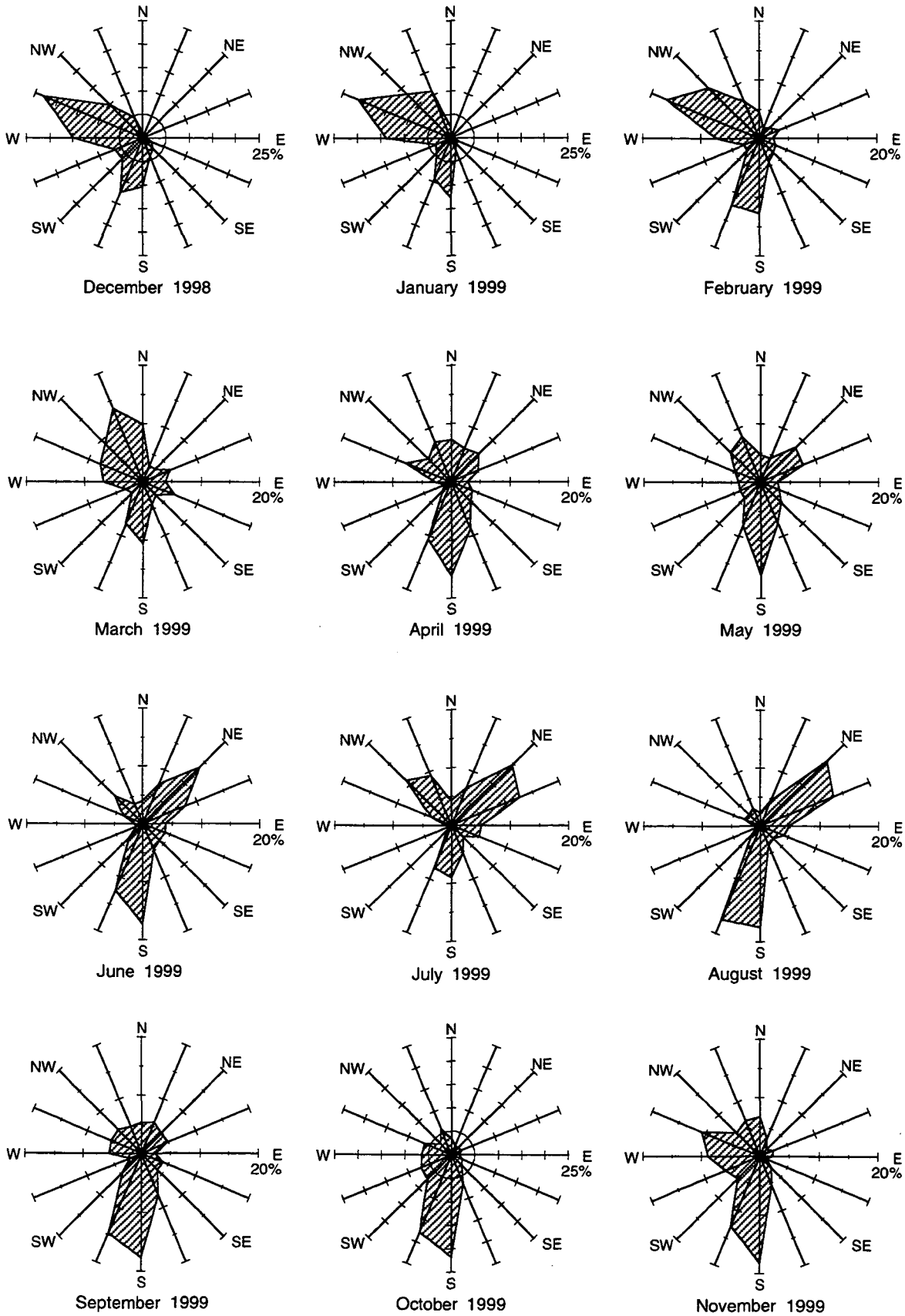


Fig. 4. Wind roses for each month during the period from December 1998 through November 1999 at Kimuaneppu.