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Sea Ice Conditions, and Meteorological and Oceanographic Observations at Saroma-ko Lagoon, Hokkaido, November 2001 - December 2002*,**

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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, humidity, wind direction 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 November 2001 through December 2002. Freeze-up, breakup and duration of complete ice coverage of the lagoon were also reported during the period from 1964 through 2002.

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。2001年11月から2002年12月までの気温、湿度、風向・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

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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 such as freeze-up and breakup days and complete ice coverage at the lagoon since 1964. Year-to-year changes in the duration of complete ice coverage shows a decreasing trend since 1979, corresponding to the opening of the second inlet (Fig. 2) (Shirasawa and Leppäranta, 2003). Here the duration of complete ice coverage of the lagoon is defined as the period in days during the entire surface of the lagoon is covered with sea ice. The duration has drastically decreased since 1988, and no complete ice coverage developed in winters 1988/89, 1990/91, 1992/93, 1996/97 and 2001/02. It is apparent that the freeze-up day of complete ice coverage has shifted from mid-December in the sixties to late January/early February in the nineties. The initiation of sea ice formation in the lagoon and coastal areas depends on cooling processes after the air temperature becomes lower than the surface water temperature. This happens sometime late August or early September and continues till the ice breakup at early or mid-April. It appears that the onset of the cooling period might get slightly earlier and the cooling period might get longer for the last decade.

The ice coverage day at Saroma-ko seems to be well correlated to the ice day along the Okhotsk Sea coast observed by the sea-ice radar in Abashiri (Fig. 2). The duration of ice coverage at Saroma-ko can be used as an indicator to discuss long-term variability in ice conditions in the coastal landfast ice region in the southern Okhotsk Sea. The annual mean air temperature in Abashiri shows an increasing trend while the ice coverage day at Saroma-ko shows a decreasing trend (Fig. 2).

The Saroma Research Center has been 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 November 2001 through December 2002 are shown. Time series data of meteorological variables were reported for the periods from December 1991 through December 1992 by Shirasawa *et al.* (1993), from January 1993 through November 1995 by Shirasawa *et al.* (1995), from December 1995 through November 1996 by Shirasawa *et al.* (1996), from November 1996 through November 1997 by Shirasawa *et al.* (1997), from December 1997 through November 1998 by Shirasawa *et al.* (1998), from December 1998 through November 1999 by Shirasawa *et al.* (1999), from November 1999 through November 2000 by Shirasawa *et al.* (2000) and from November 2000 through November 2001 by Shirasawa *et al.* (2001).

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 direction, air temperature, humidity and solar radiation during the period from November 2001 through December 2002 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 3 m were collected at sampling intervals of 10-30 min. Time series of air and water temperatures together with ice conditions are shown in Fig. 3. The complete ice coverage was not observed during the winter 2001/02, but the maximum ice extent was observed on 10 February with an extensive open water area near the first inlet. Ice breakup was observed on 7

April.

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

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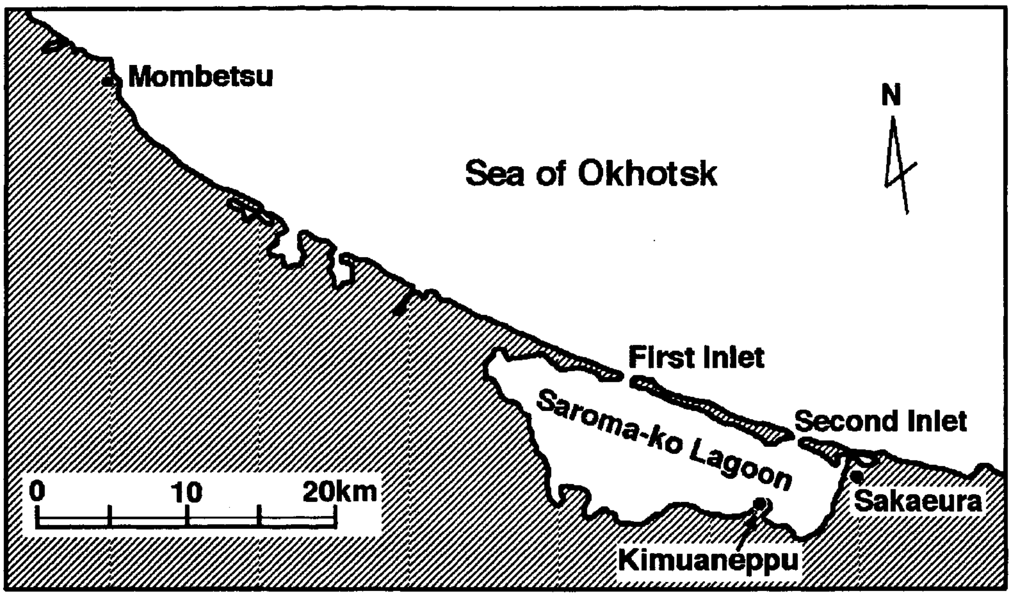


Fig. 1. A location map of Saroma-ko Lagoon.

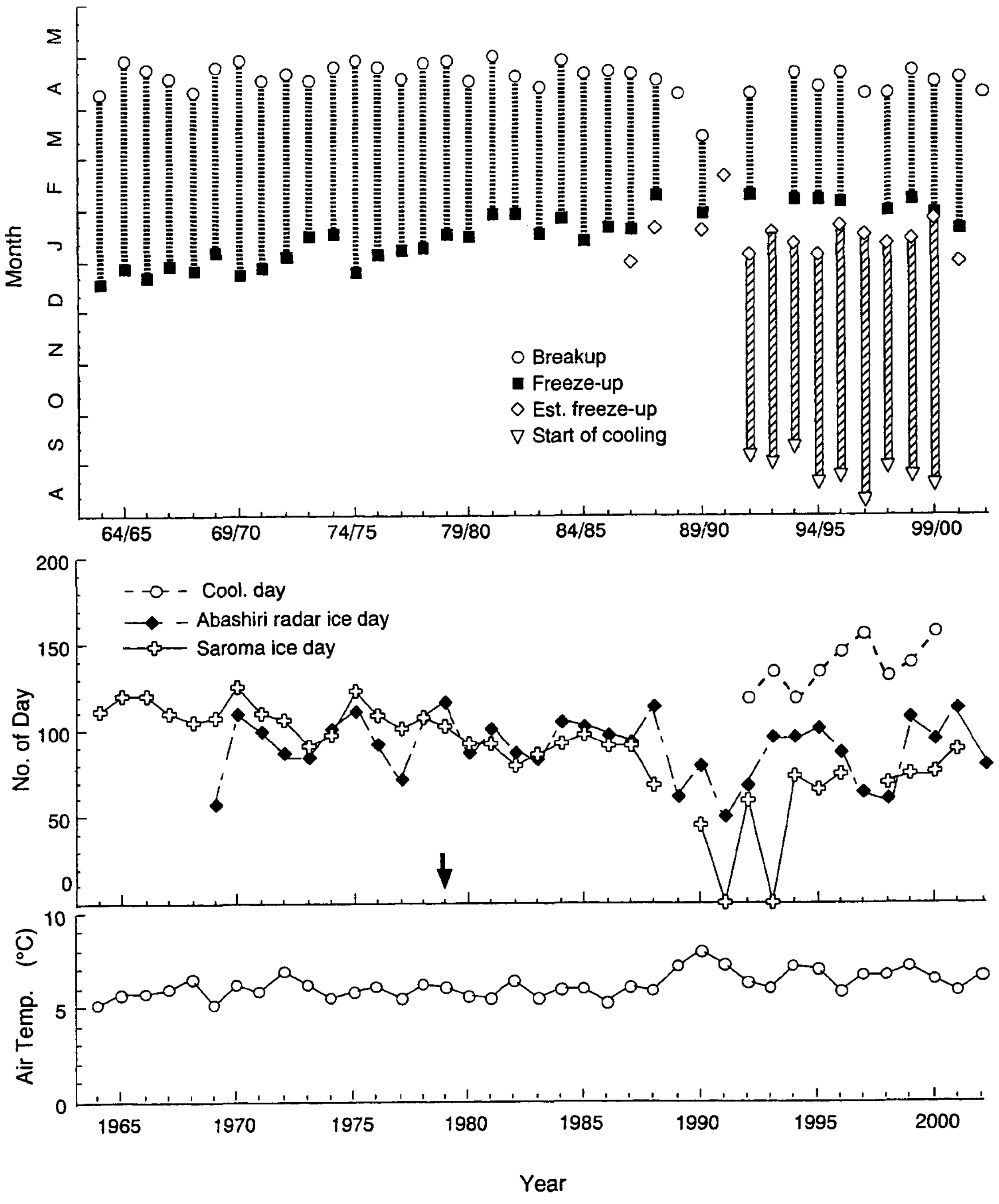


Fig. 2. Freeze-up, breakup and duration of complete ice coverage and cooling day at Saroma-ko lagoon, ice day and annual mean air temperature in Abashiri, from 1964 through 2002. The arrow indicates the date of the opening of the second inlet in December 1978.

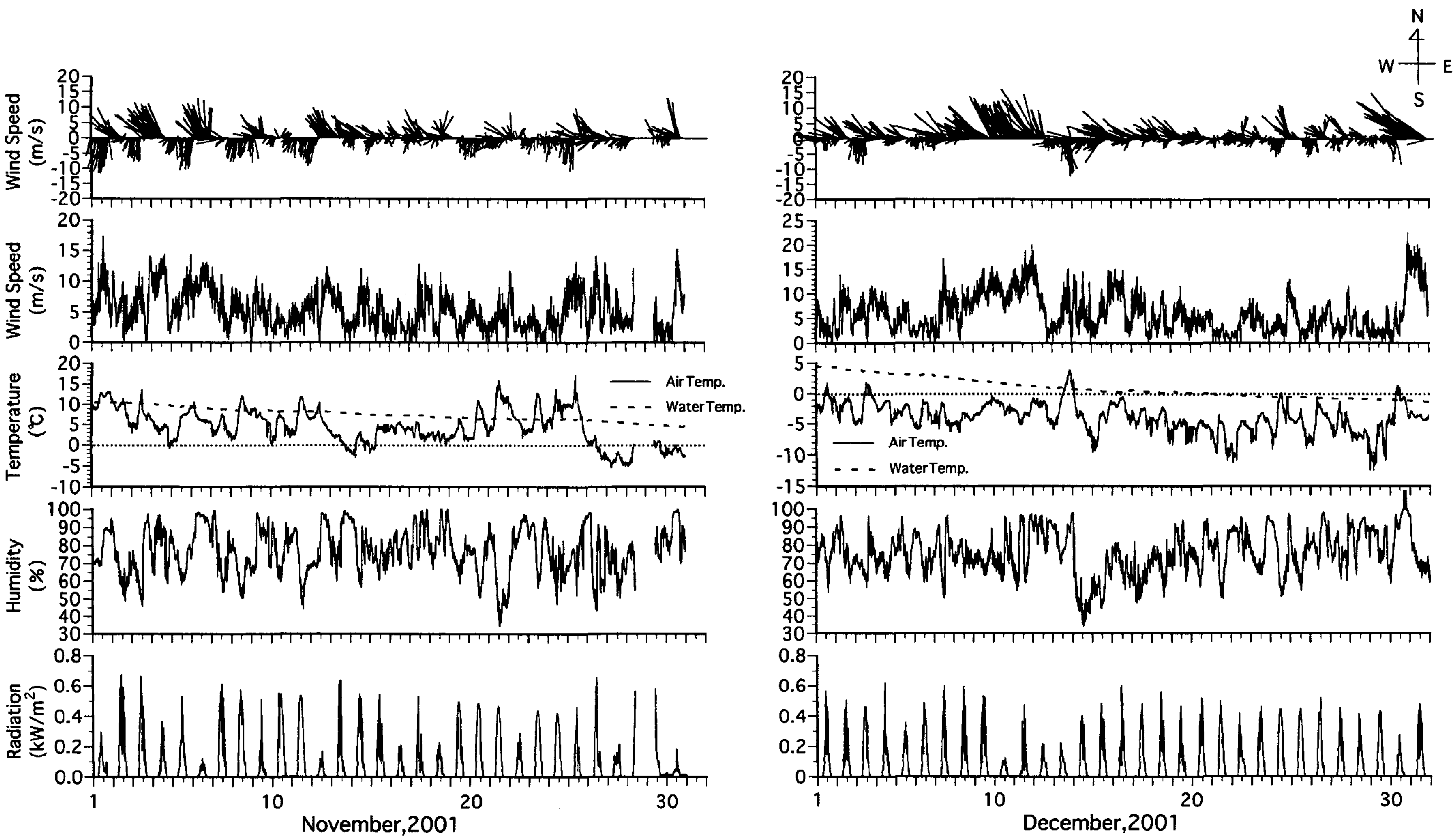
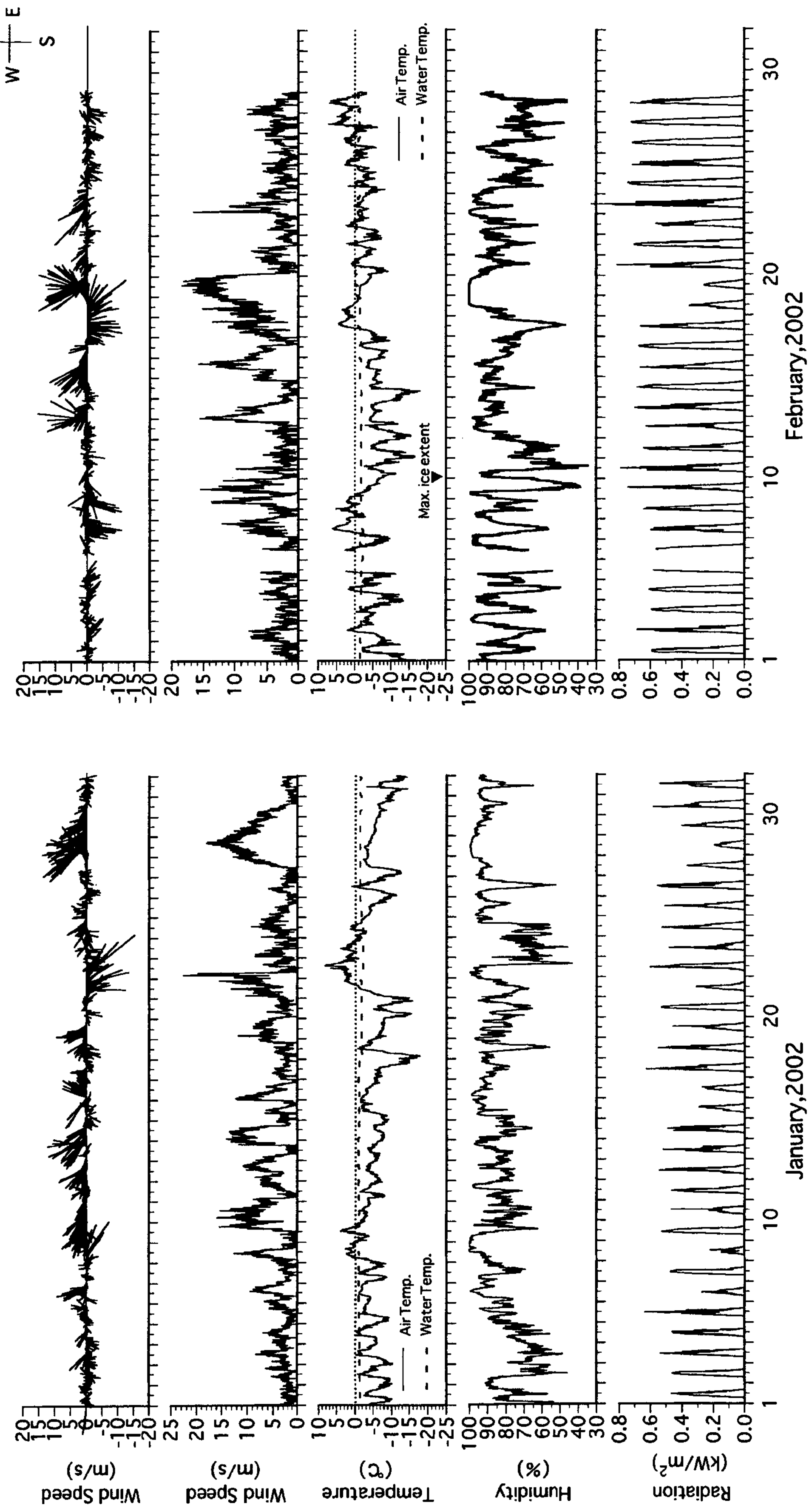
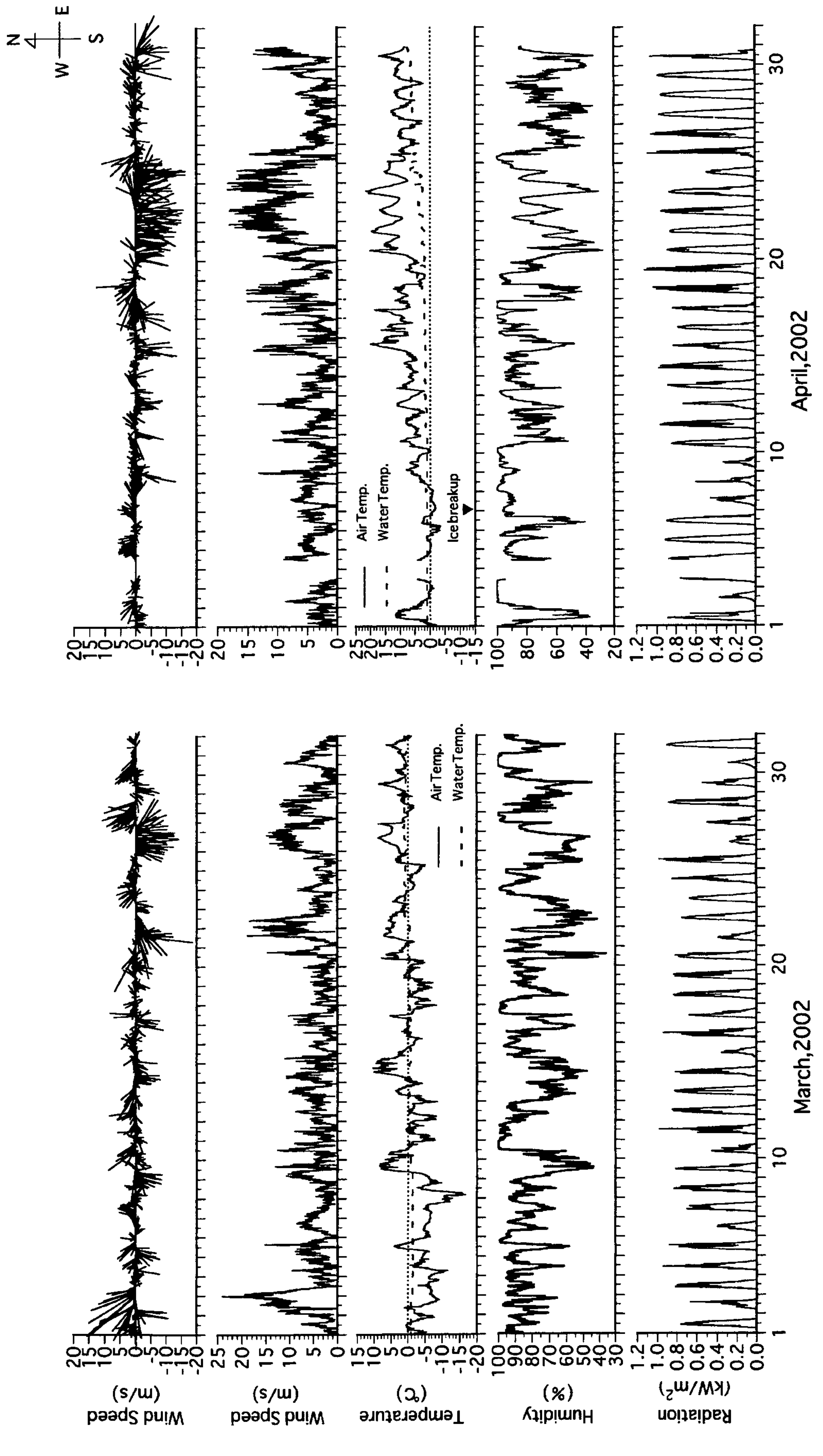
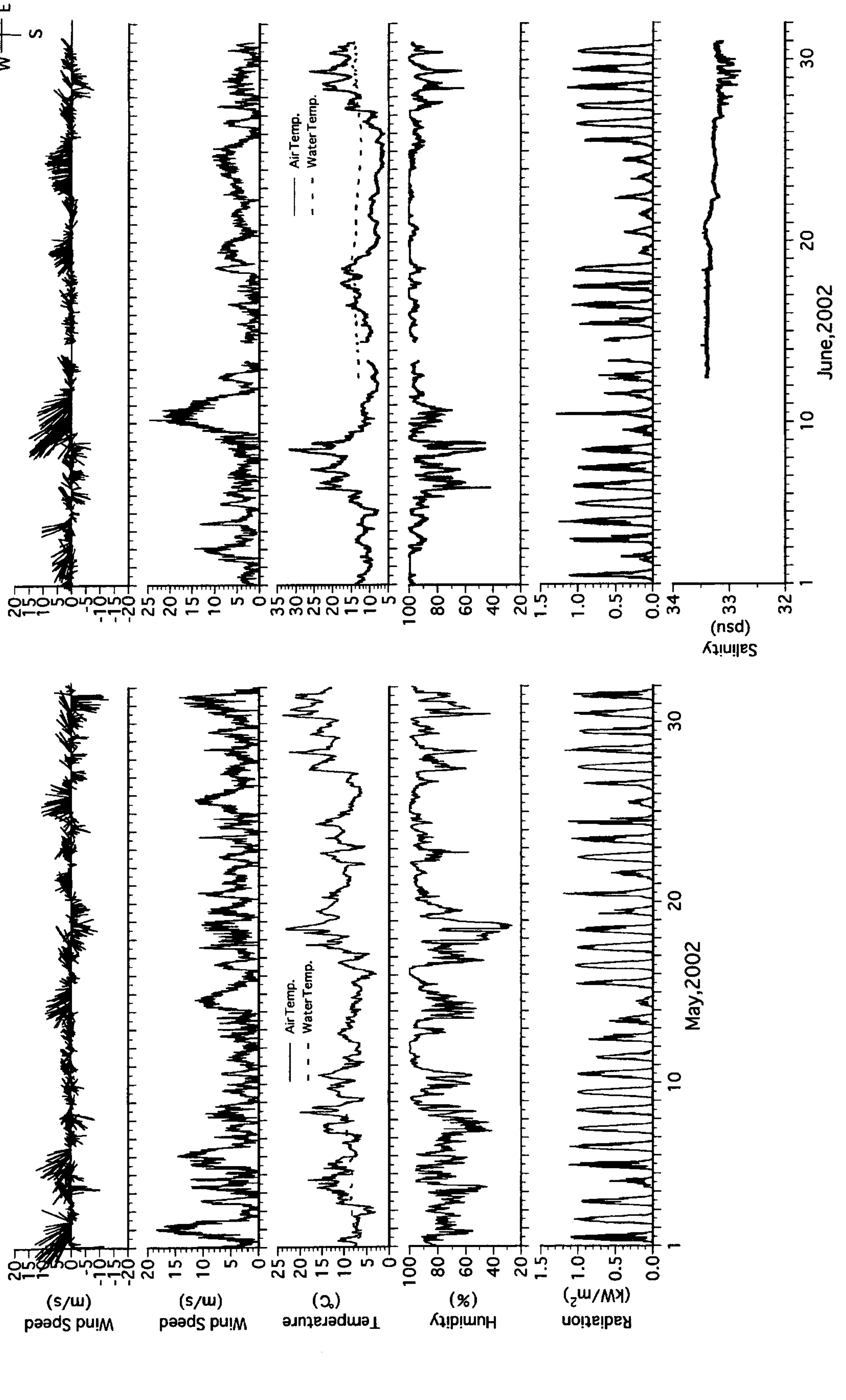
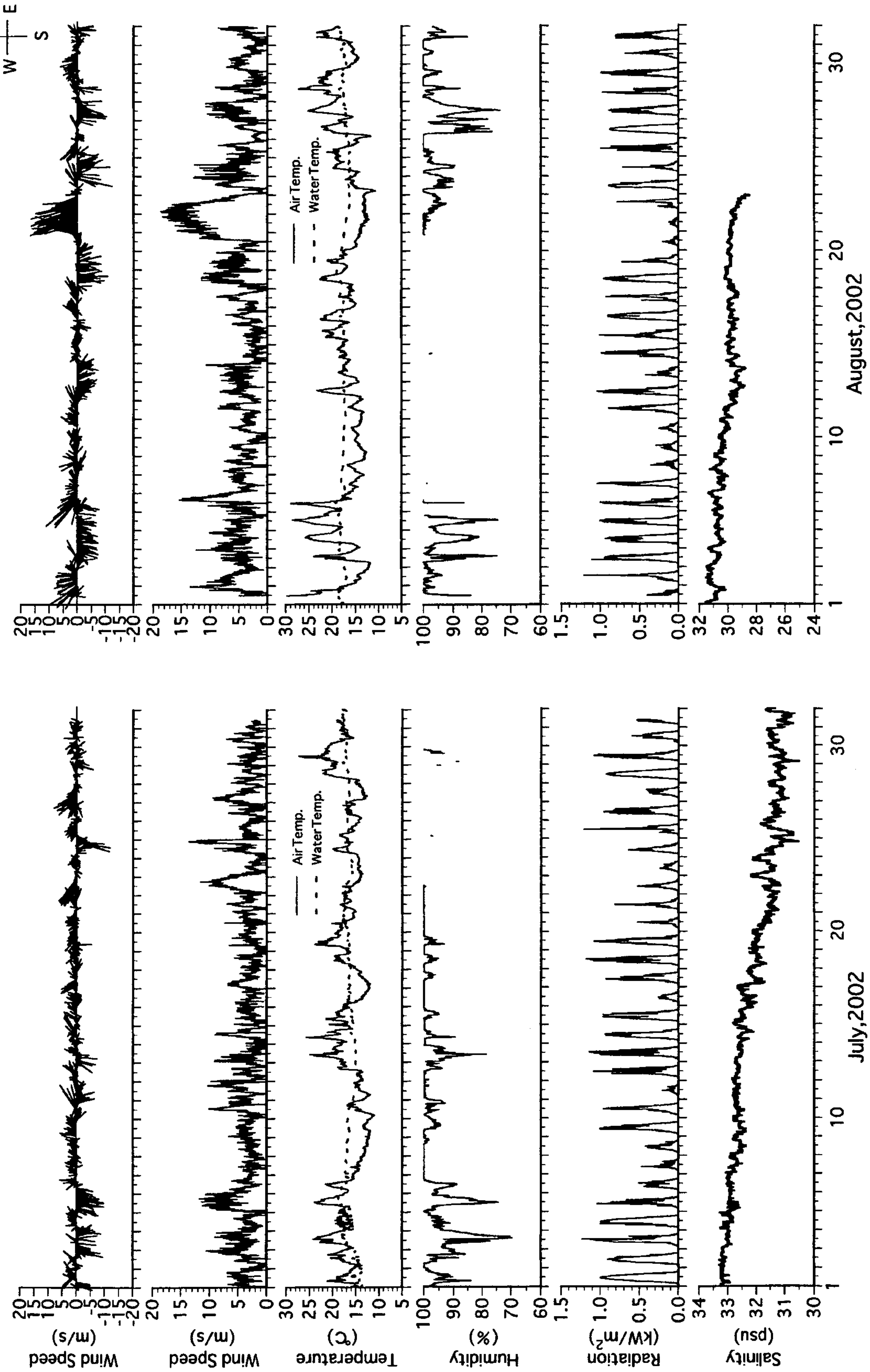


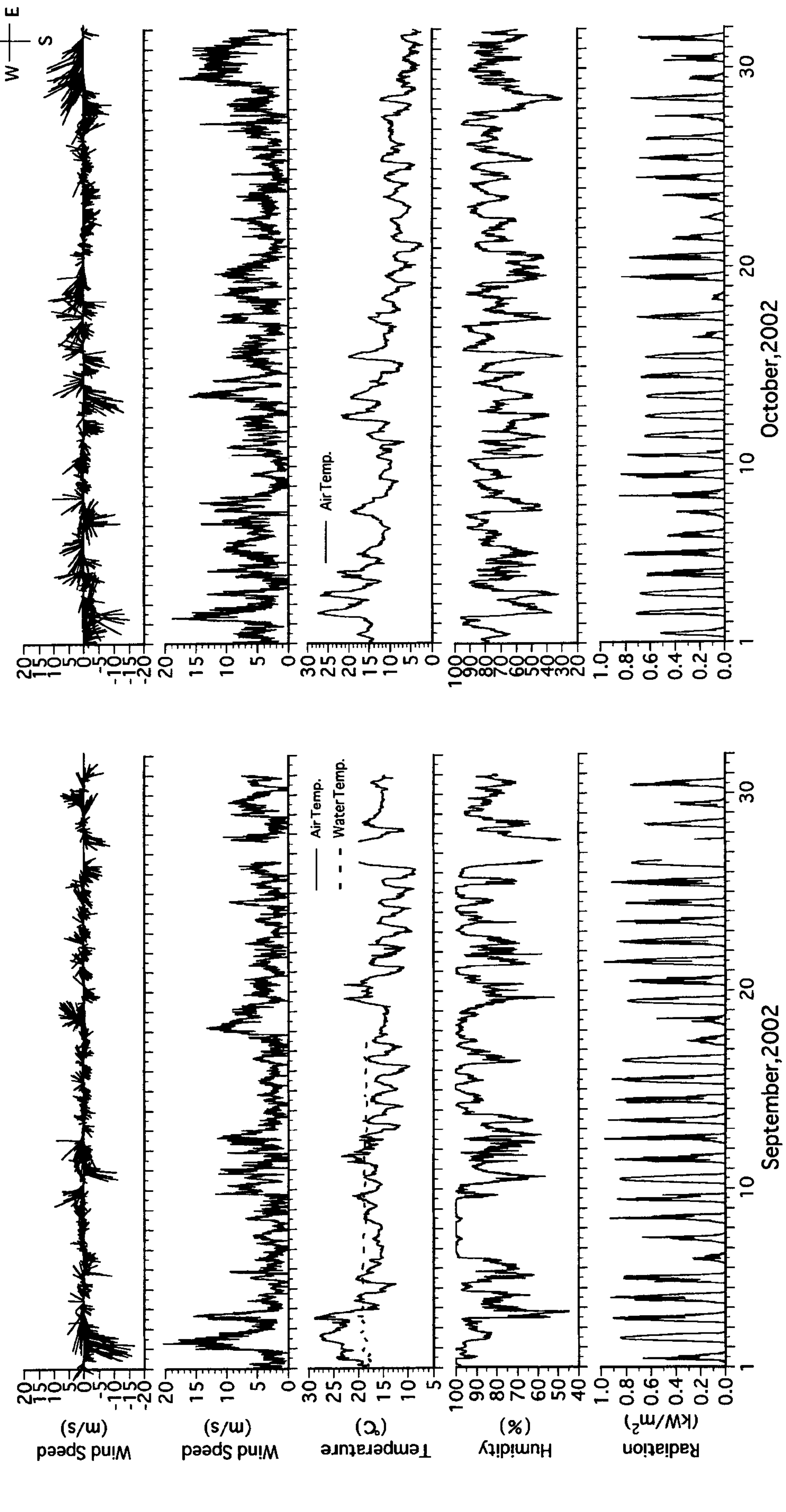
Fig. 3. Wind speed, air and water temperatures, humidity, solar radiation and salinity during the period from November 2001 through December 2002.

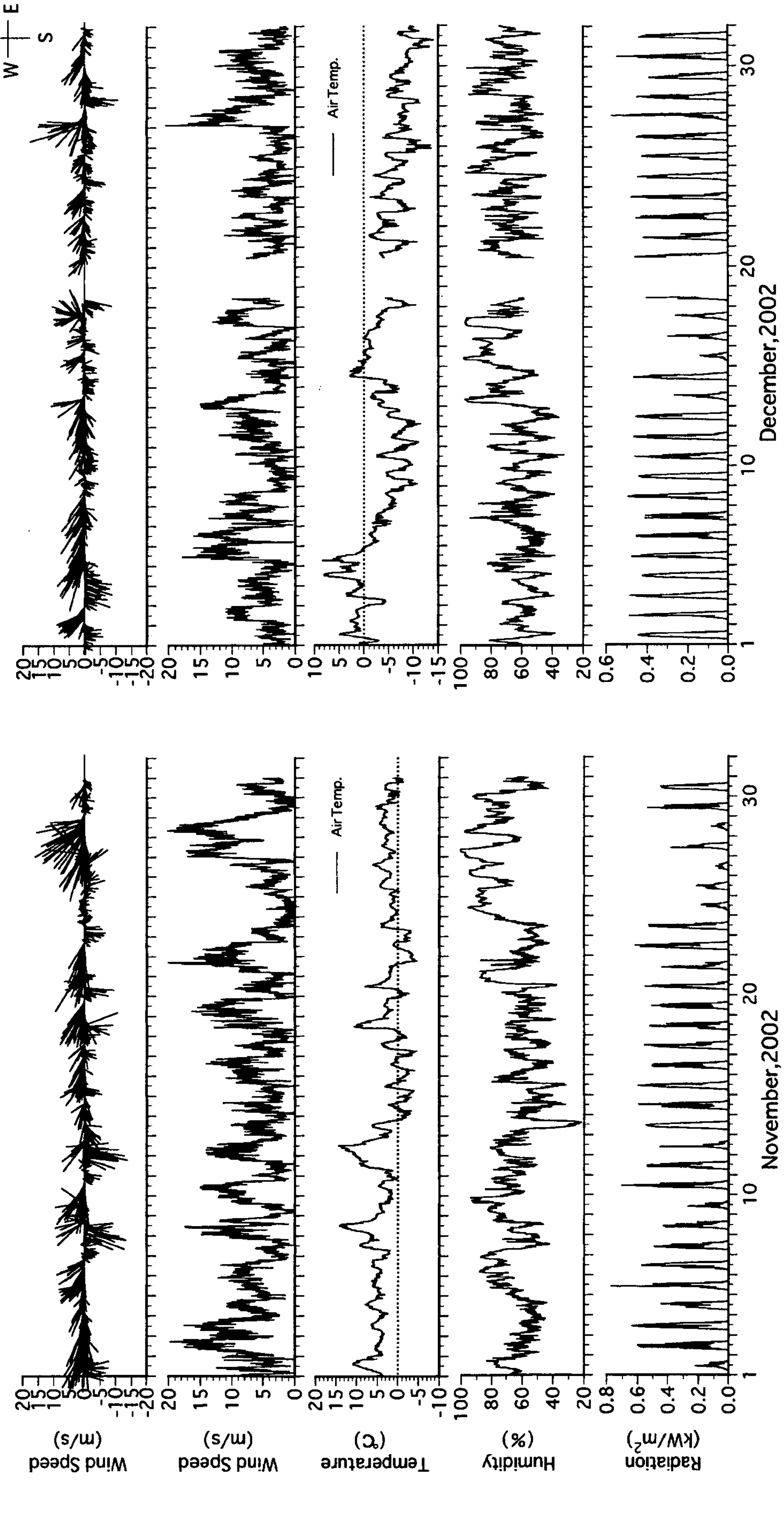

Wind Speed (m/s)
Temperature (°C)
Humidity (%)
Radiation (kW/m²)
Air Temp.
Water Temp.
Max. ice extent
N
E
S
W
January,2002
February,2002


N
E
S
W
Wind Speed (m/s)
Wind Speed (m/s)
Temperature (°C)
Humidity (%)
Radiation (kW/m²)
Air Temp.
Water Temp.
Ice breakup
March,2002
April,2002


Wind Speed (m/s)
Wind Speed (m/s)
Temperature (℃)
Air Temp.
Water Temp.
Humidity (%)
Radiation (kW/m²)
Salinity (psu)
May,2002
June,2002
N
E
S
W


Wind Speed (m/s)
Wind Speed (m/s)
Temperature (℃)
Humidity (%)
Radiation (kW/m2)
Salinity (psu)
Air Temp.
Water Temp.
July,2002
August,2002
N
E
S
W


Wind Speed (m/s)
Wind Speed (m/s)
Temperature (℃)
Humidity (%)
Radiation (kW/m²)
Air Temp.
Water Temp.
September,2002
October,2002
N
E
S
W


Wind Speed (m/s)
Wind Speed (m/s)
Temperature (℃)
Air Temp.
Humidity (%)
Radiation (kW/m²)
November,2002
December,2002
N
E
S
W

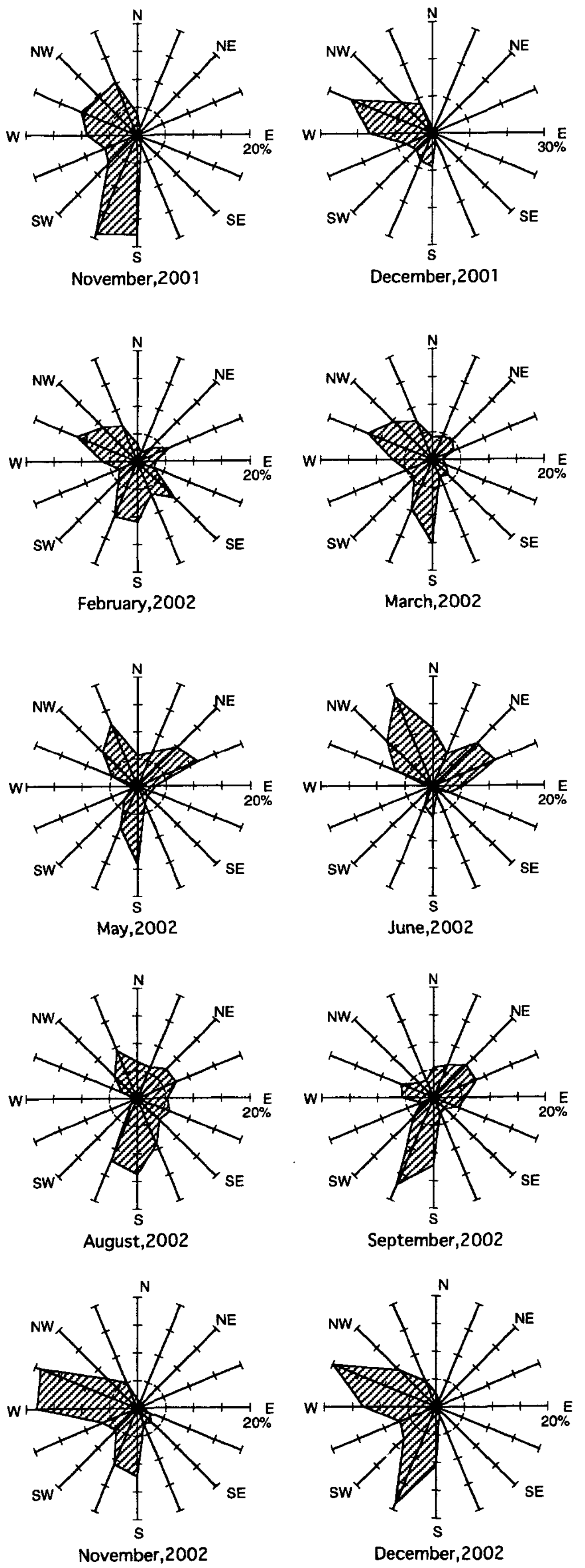


Fig. 4. Wind roses for each month during the period from November 2001 through December 2002 at Kimuaneppu.