NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N980

NAFO SCR Doc. 85/30

SCIENTIFIC COUNCIL MEETING - JUNE 1985

Short Time Variability in Hydrographic Conditions off Fyllas Bank, West Greenland

by

M. Stein

Bundesforschungsanstalt für Fischerei, Institut für Seefischerei
Palmaille 9, D-2000 Hamburg 50, Federal Republic of Germany

and

E. Buch

Greenland Fisheries and Environmental Research Institute
Tagensvej 135, 1, DK-2200 Copenhagen N, Denmark

Abstract

Based on repeated CTD profiles during a 15 hours time station the variability of the thermohaline stratification at the NAFO Oceanographic Standard Station 4 off Fyllas Bank is analysed. Due to changing wind direction advective processes are observed which lead to cooling of the surface layer. The influence of the tidal motion is mostly expressed in the deep layers of the water column.

Narrative

On the large-scale the thermohaline circulation steers the flow of water masses of West Greenland. Aside that, on the meso- and small-scale wind induced surface circulations play an important role in the local pattern of water mass distribution. During the last century oceanographic work off West Greenland was most frequently done at the shelf break off Fyllas Bank at 63°53'N, 53°22'W, a station which is known as NAFO Standard Oceanographic Stations 4 of the Fyllas Bank section (c.f. ICNAF Selected Papers NO. 3, 1978). To the authors knowledge the short time variability of the environmental parameters like temperature, salinity, soundvelocity and currents has not been described before for this area off West Greenland. Therefore, during West German/Danish investigations off West Greenland (fig. 1) the authors decided to map the short time variation by means of a time-station. On October 28, 1984 RV "Walther Herwig" during her oceanographic cruise to East- and West Greenland started an observation programme which was scheduled for at least 24 hours.

Data and Methods

At 19.23 GMT on October 28, 1984 the first CTD profile was launched. It was followed by a current profiler of Aanderaa type which started at 20.18 GMT. Thus, about every two hours a CTD profile with rosette water sampler was achieved. Due to increasing wind the current profiling had to be terminated after seven profiles at 07.45 GMT on October 29, 1984. Since the weather changed for the worse the time station had to be stopped at 10.00 GMT on October 29, 1984. In the present paper only the CTD data are displayed (figs. 2 to 4), the current profiles will be delt with elsewhere. The Kiel Multisonde CTD equipped with sensors for depth, temperature, conductivity and soundvelocity was used to map the hydrographic fields. Calibration of the conductivity sensor was achieved by means of a Guidline laboratory salinometer. The CTD was lowered down to 5 metres above the bottom. The raw data were stored on floppy disks. Processing of the data was performed in the way described by Cornus and Stein (1979). From the final data set profiles (fig. 2), θ,S-diagrams (fig. 3) and isopleths of potential temperature (fig. 4) were plotted.

Results and Discussion

The mean temperature distribution (based on 20 years of observation) at station 4 of the Fyllas Bank section as published by Stein and Buch (1985) yields a surface layer with temperatures less than 2°C. Below 50m depth temperature exceeds 2°C. There is a maximum between 400m and 500m depth which represents the Irminger component of the West Greenland Current ($T > 5°C$). Below that, temperature drops to values less than 4°C. Within the upper 150 m the r.m.s. deviation of the given data is about 1°C. For the deep layers, below 400 m, the variation is less than 0.4°C. The vertical profiles of potential temperature, soundvelocity, salinity, and potential density are displayed in fig. 2 showing the second CTD-profile at 21.08 GMT on October 28, 1984. The depth scale is given in pressure units (1 MPa = 100 dbar $\approx$ 100 m). Below the cold, diluted near-surface layer the temperature and salinity gradients mark the transition to the warm, saline layers inhabited by the Irminger component of the West Greenland Current. Whereas the temperature decreases after having reached its maximum at about 300 m depth, the salinity remains more or less constant ($34.89 * 10^3$). The soundvelocity increases from 1446 m/sec (surface layer) to 1479 m/sec (bottom layer), density ranges from $1.02605 * 10^3$ kg m^{-3} at the sea surface to $1.02774 * 10^3$ kg m^{-3} within the near bottom layer. The θ,S-diagrams (fig.3) reveal a very uniform thermohaline picture at the site of the time station. To facilitate the reading of the diagrams the time and depth are displayed. Whereas within the upper 200 m at every dbar a data point is plotted, the deeper portion of the diagram displays θ,S values at 10 dbar intervalls. An interesting feature arises in the warm deep layer, the core layer of the Irminger component. The temperature maximum is twofold, a feature which is not seen in fig. 4. The more or less constant salinity of the deep layers down to the bottom confirm the reading of the profile (fig.2). Changes occur at 02.02 GMT when the sea surface layer gets colder than 0°C.

The short time variability of the temperature field at station 4 is mapped in fig. 4 (upper part). The lower part of fig. 4 displays the time series of wind direction, air pressure and the time series of the geopotential anomaly at the sea surface relative to the 7.5-MPa surface in 10^{-1} m^2 sec^{-2}. Note the change in depth scale below 200 dbar. The isopleths show very little variation during the 15 hours of observation. Only for the near surface layer a cooling is recorded to start before 02.02 GMT on October 19, 1984. Temperature of the upper 20 m of the water column drops below 0°C. Within the deep layers the vertical displacement of isotherms indicate internal tidal motion which is expressed most at the 3.5°C isotherme. During the observation period wind changed direction from 340° to 150°, air pressure dropped by 9 mbar to 999 mbar. The geopotential anomaly indicates rising of the sea surface which is expressed most between 23.02 GMT and 02.02 GMT. This refers to increasing baroclinic flow which changes direction after having reached the peak value at 02.02 GMT on October 29, 1984. Since the major part of the water column remains nearly undisturbed in its thermohaline composition, it is assumed that the influence of the wind affects only the upper 20 to 30 metres. This is in correlation with the theoretical value for the depth of frictional influence for a pure drift current (39 m at the station site). For the greater-most part of the water column the semi-diurnal tides are responsible for the short time variation. From the geopotential anomaly calculation the conslusion is drawn that the tidal influence generates changing baroclinic flow at the station site.

References

Cornus, H.P., and M. Stein, 1979: Antarctic Expedition of the Federal Republic of Germany 1977/78 Oceanographic Data Report Part I. Mitt. Inst. Seefisch. 27 (1979) I-XLIII; 1-381.

Stein, M., and E. Buch, 1985: 1983: An unusual year off West Greenland ? Arch Fischwiss 36 (1/2): 81-95.

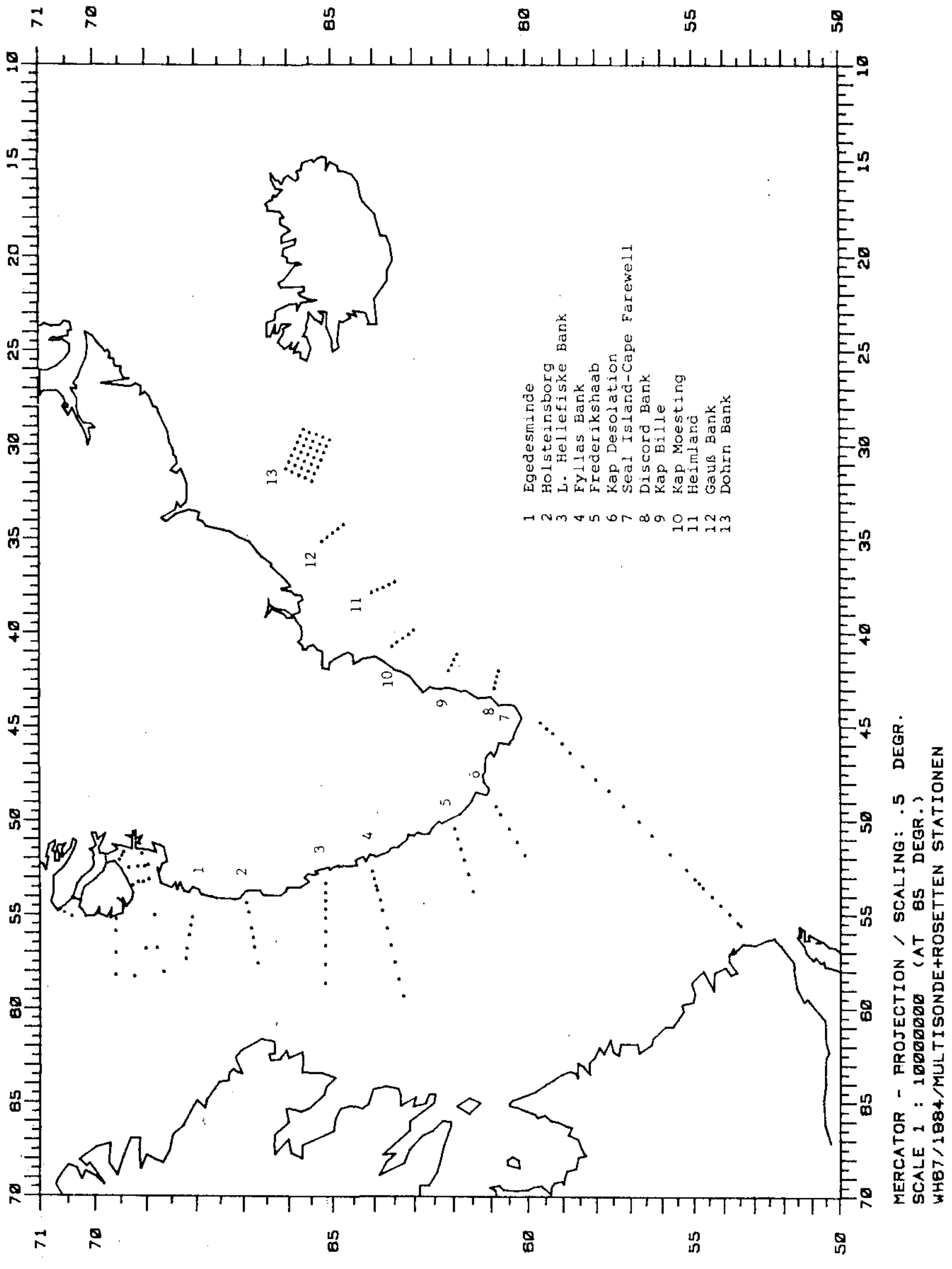

Fig. 1 Station grid during cruise 67 of RV "Walther Herwig"

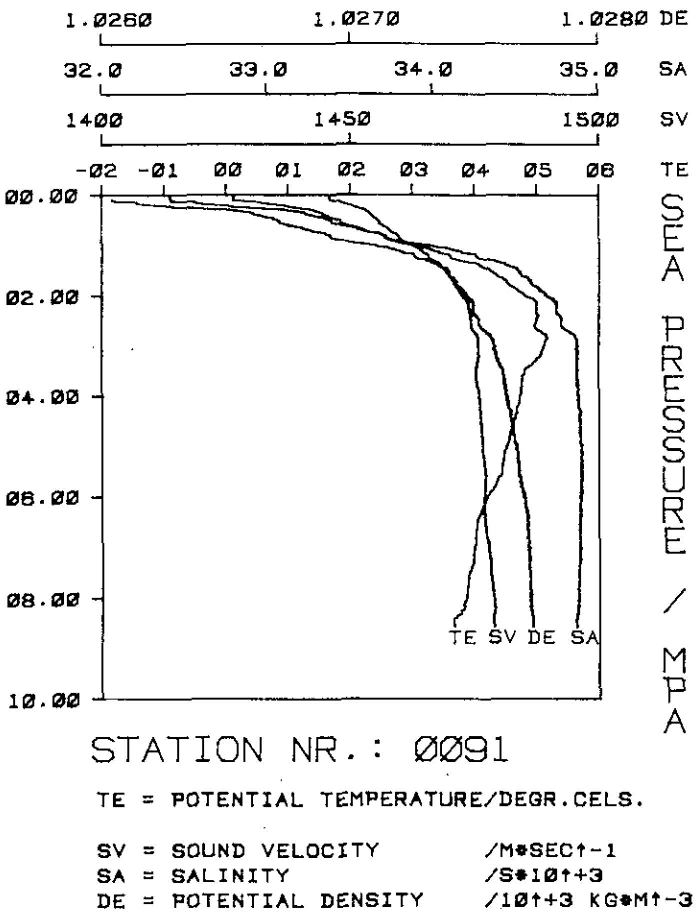

Fig. 2 CTD profiles at 21.08 GMT

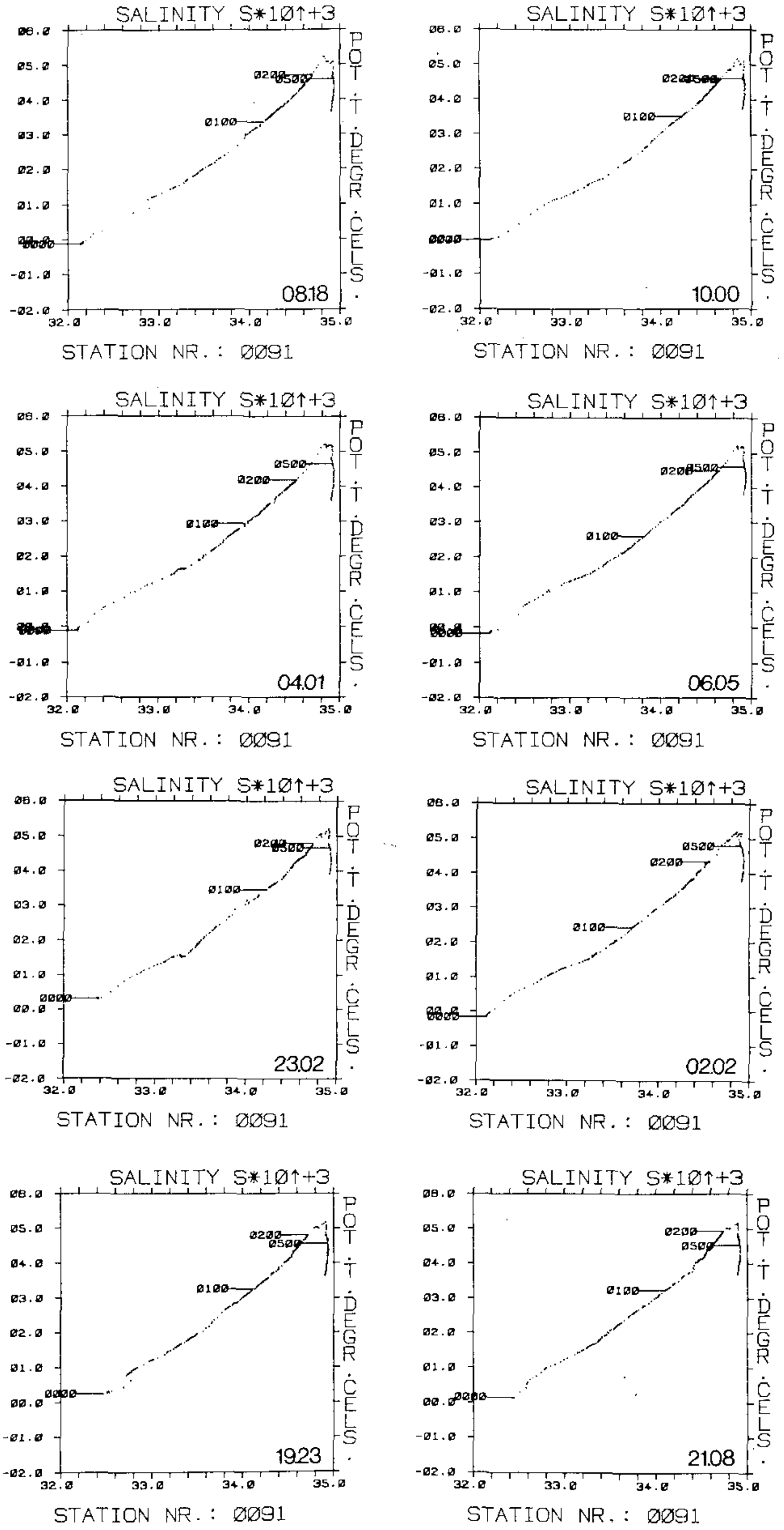

Fig. 3 θ,S-diagrams at the time station

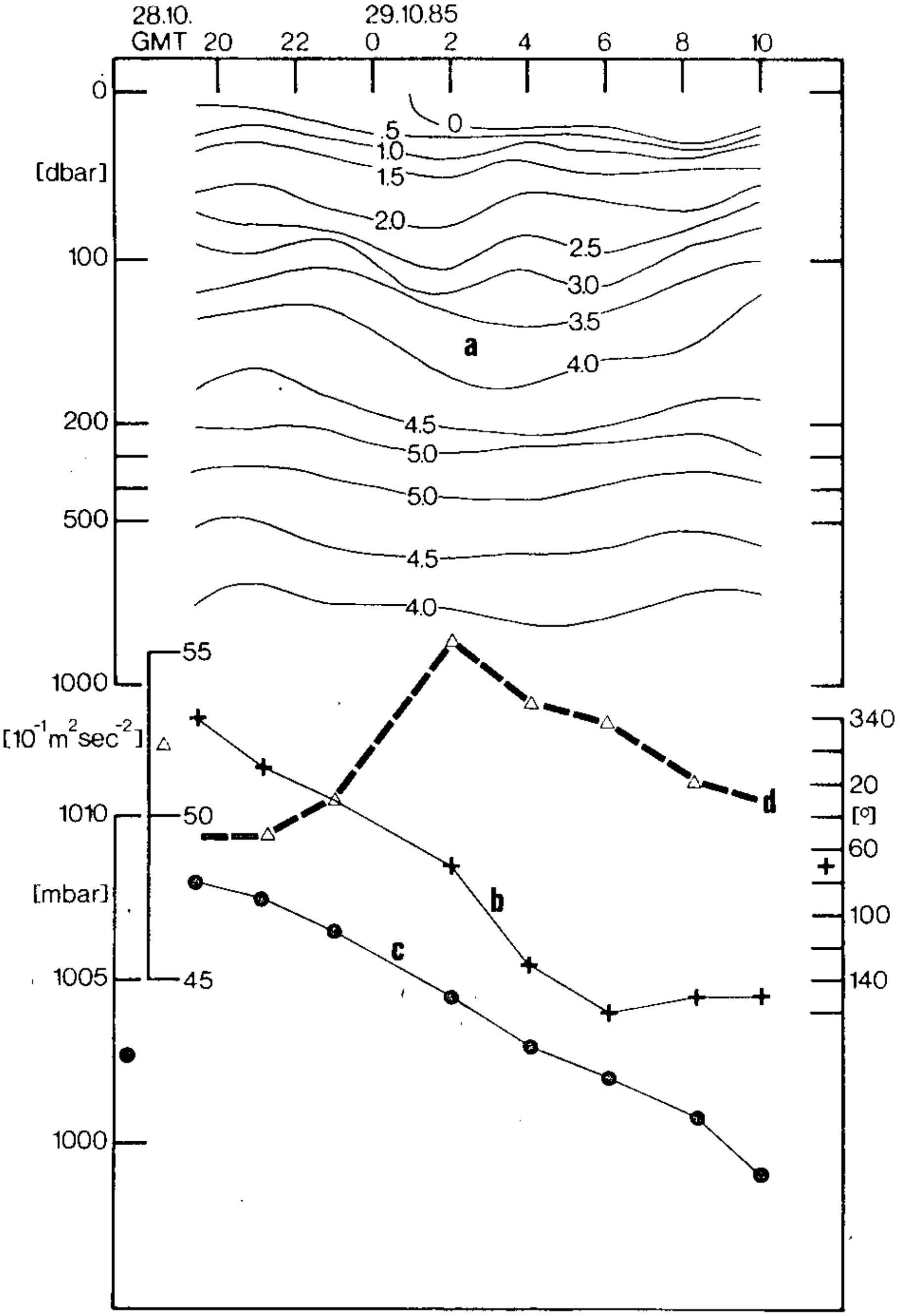

Fig. 4 Time series of temperature (a), wind direction (b), air pressure (c) and geopotential anomaly at the sea surface relative to the 7.5-MPa surface in $10^{-1} m^2 sec^{-2}$ (d)