International Council for the
Exploration of the Sea

CM 1997/EE:08
Environmental Factors (EE)

A simple system for recording time series of data from a mobile platform as a function of its position

By

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ABSTRACT

By installing recording instruments on board, Inst. of Marine Research has since 1935 collected temperature and salinity data from waters being trafficed by passenger ships from Bergen to Kirkenes and and from cargo ships travelling the North Sea between Bergen and Newcastle. The methods used to acquire data have changed with the available technology, and several technical updates have been made since the start of this service.
Until recently a good way to continuously record the ship`s position has been missing.
The introduction of the satellite based Global Positioning Service (GPS) has solved this problem.
Via GPS the position of most moving platforms can now be recorded in a simple way.

This paper describes a general GPS- based system for recording of data from the sea surface as a function of time and position which has ben applied to the Bergen- Kirkenes coastal express. The system can acquire GPS-position and environmental directly or by merging GPS - time information from one recorder with environmental data /time information from other recorders.

Keywords: GPS, data logger, mobile observation platform.

INTRODUCTION

Mobile platforms like drifters or ships of convenience can be very cost efficient tools for acquisition of data from the marine environment.
The basic remedy for success is a functional system for simultaneous recording of environmental data,time and position and efficient procedures for data processing and quality assurance.
Since 1935 Inst. of Marine Research in Bergen has used the Norwegian Coastal Express line from Bergen to Kirkenes and a cargo line from Bergen to Newcastle to collect temperature and salinity. The frequency of observations is about one scan per week. Data from this highly useful service is exploited to monitor the actual sea water surface conditions and to study long term climatic changes in the water masses entering the Norwegian coast in order to correlate the abundance and quality of living species with climatic factors.

Fig. 1 shows the fixed acquistion trace for the Norwegian Thermographic Service ("NTS").
A typical temperature track along the coast is shown on fig. 2.
Fig. 3 shows a processed product from this service demonstrating the annual variations in water temperature along the Norwegian coast.
Before the introduction of the Global Positioning Service (GPS), positional data from a ship of convenience had to be supplied manually from the ship`s crew. Position data from a drifter can be supplied via ARGOS, but not to the precision currently available from GPS.
The GPS system which is operated by the US Department of Defence utilizes a network of 24 satellites in precicely controlled orbits about 17.000 km up in space. The excact position of each GPS satellite is known at any time.
Each GPS receiver measures the travel time of the signals from each available satellite and calculates its own distance from the satellite by multiplying the observed travel time with the speed of light. By locking into the signals from three satellites and measure their respective distances, a GPS receiver can triangulate its own latitude and longitude with high precision.
If a fourth satellite is available, it can also calculate the altitude.
GPS is supplied via two transmission codes: "P" and "S/A". The "P" code (Precision code) is only available for US military service, while "S/A" (Selective availability) is transmitted to all civilian GPS receivers.
To make "S/A" unuseful for enemy attacks against USA interests, "S/A" based signals are randomly degraded to an accuracy of 100 m or less in 95% of the time. However, typical accuracies for most users average between 20 and 50 m for the majority of the time.
The accuracy of S/A- coded transmisssions can be improved to within a few meters by differential GPS (DGPS). DGPS adds a land based reference receiver located at an accurately surveyed site to the system. The land based receiver has information about the excact distance to all satellites at any time. The difference between the the excaxt (theoretical) distance to a satellite and the distance measured by S/A represents the "error" in the satellite`s signal caused by S/A. The DGPS station calculates and transmits this error information to the DGPS receivers which use it to correct their own measurements.
This paper describes a new GPS based system for acquisiton of data from mobile platforms which is presently being tested.. It has been designed for use inside NTS,but the system can be generally used for all kinds of ships and drifters.

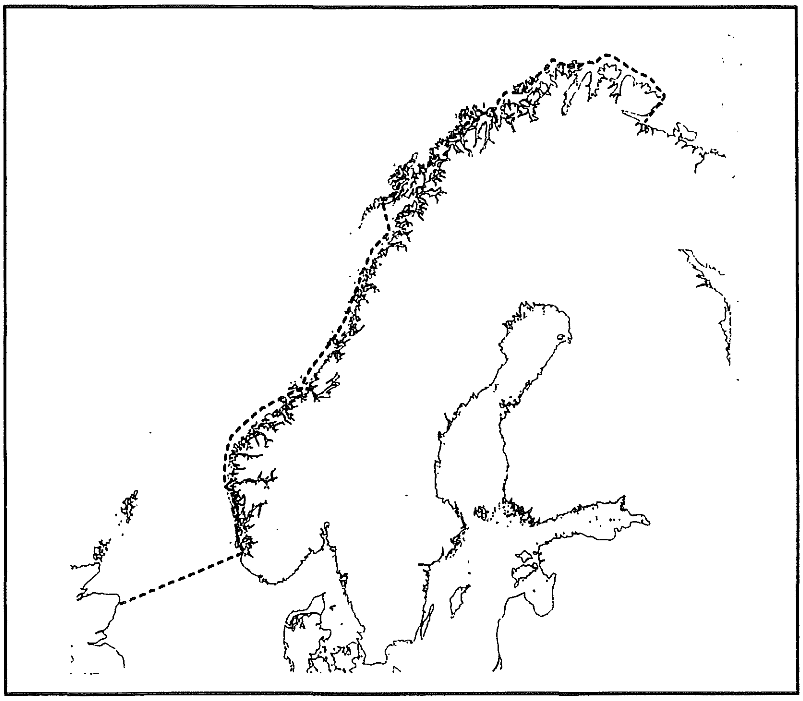

Fig1 Data acquisition track for the NorwegianThermographic Service System

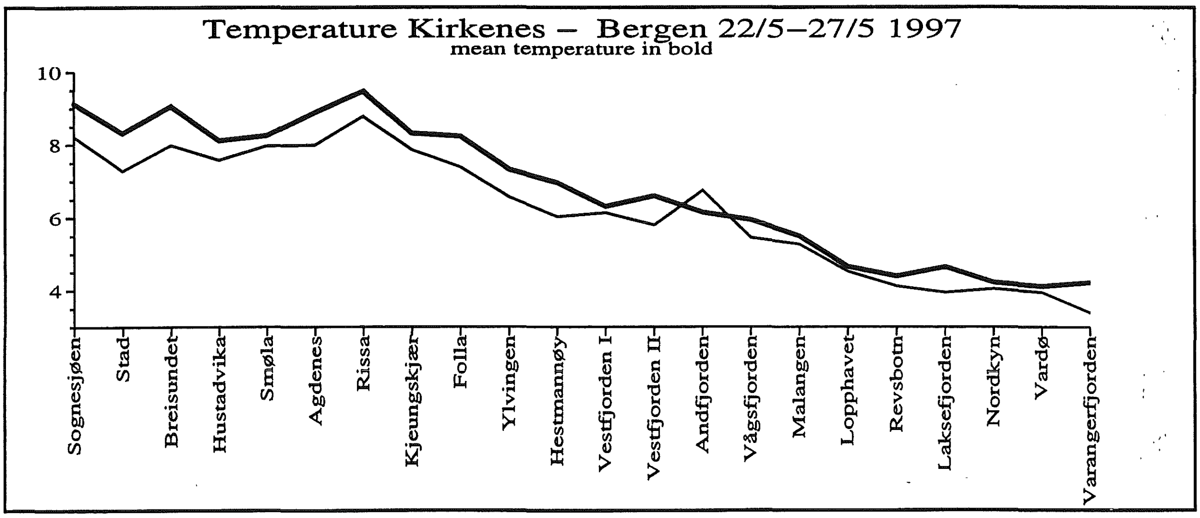

Fig. 2 Temperature variations along Norwegian coast during May 1997

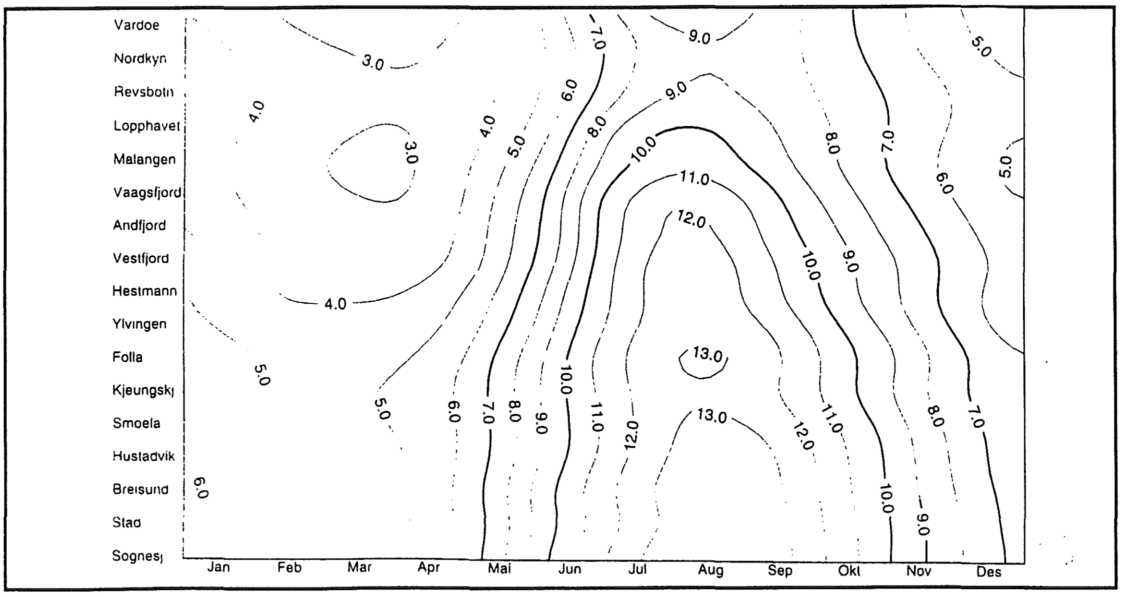

Fig 3 Annual variations in temperature along the Norwegian coast (1993)

SYSTEM DESCRIPTION

To record time series of envirnomental data with position one needs:

- A GPS recording system
- A data recording system
- A data processing system

Fig 4 shows a block diagram for the recording system. It can be used for GPS only or with GPS as one of the sensors. The present system has capacity for 6000 records of GPS + one environmental parameter. The data capacity can be increased when needed.

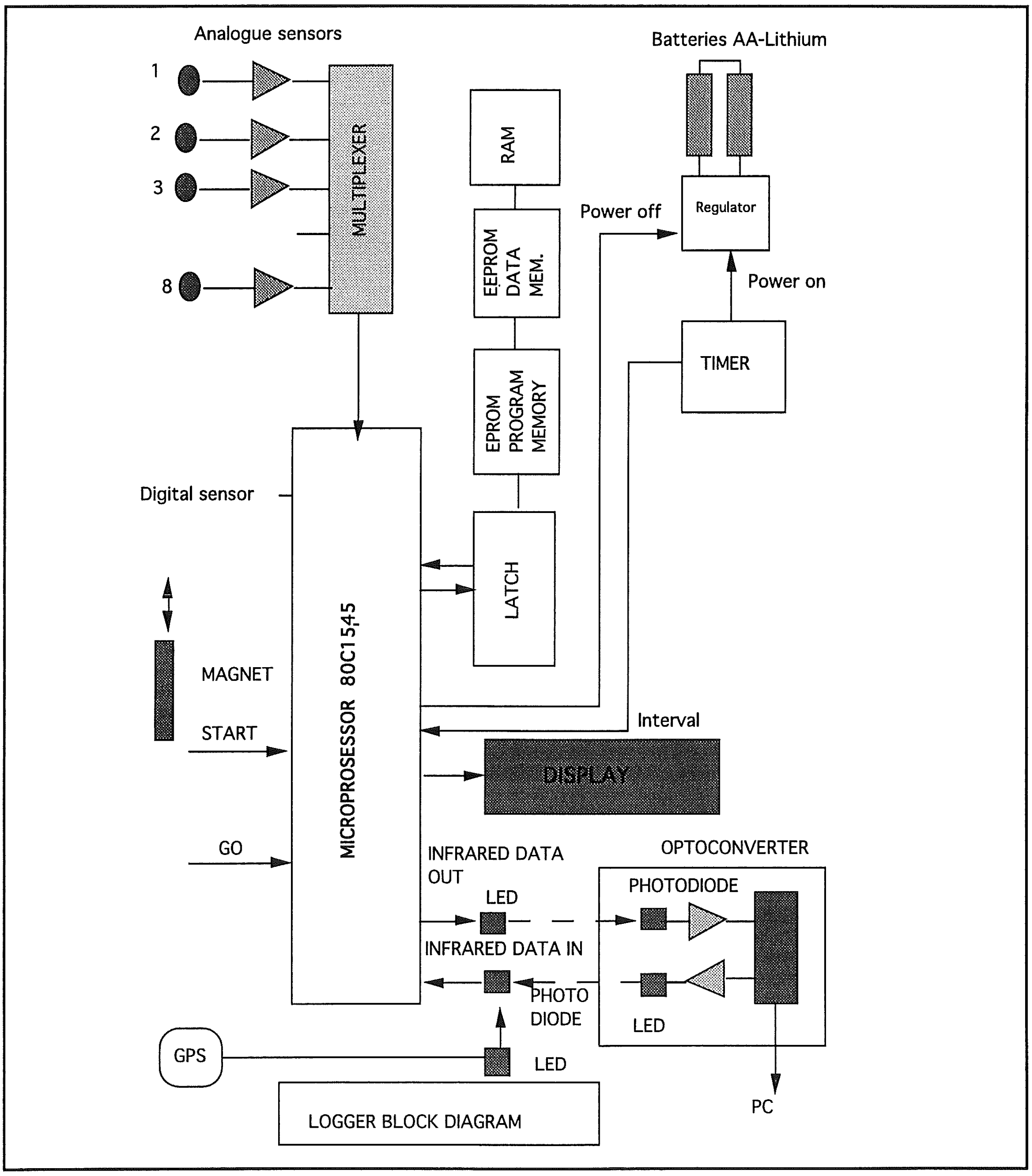

Fig. 4 General block diagram for the data recording system.
Analogue or digital data originating from the surrounding sea or atmosphere is entered to a central microprocessor and recorded in non volatile EEPROM memory The logger is encapsulated in a transparent pressure tube and communicates with external PC via an infrared based interface.
Data from GPS- receiver is entered as ASCII coded infrared signals. The observer can start and stop the logger by holding a magnet outside its transparen pressure tube.

The logger contains a BASIC programmable microprocessor which can import data through RS-232 ports,via a digital input gate or via an eight channel analogue multiplexer.
In order to avoid leakage of water, the logger is encapsulated in a transparent acryle plastic tube and designed to communicate with the outer world via infrared light or via magnetism. The logger pressure tube has an with outer diameter 5 cm and is appr. 35 cm long. The transparent housing makes it easy to read logger feedback data from a built in display. All communication with computer goes through the instrument top cap via infrared light. Interface to PC is hasndled by an optoconverter which is placed on top of the logger unit during communication. Communication involves instructions, programming and data readout.
Fig. 5 illustrates the principle for communication between logger and PC.

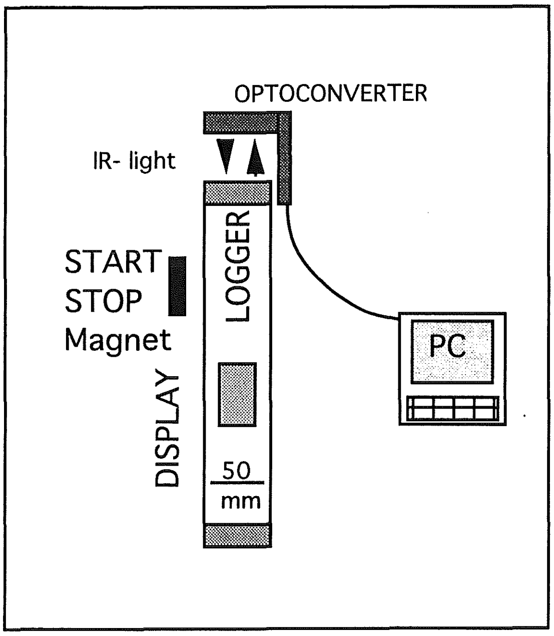

Fig. 5
Communication between
PC and logger

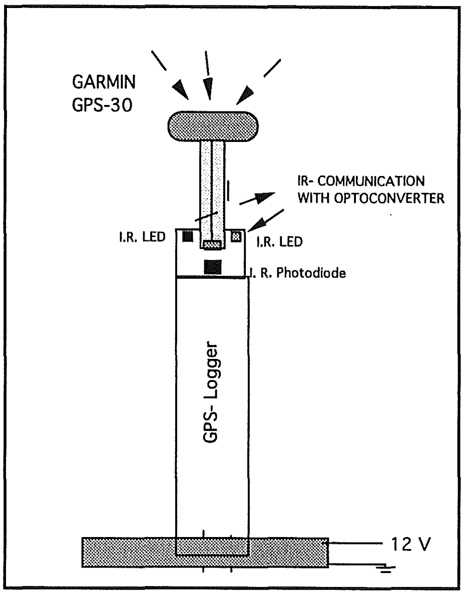

Fig. 6
Deck mounted GPS-
receiver with logger unit

The GPS selected for the system is a GARMIN GPS- 30 receiver (1).
In GPS 30 both antennae and the processing unit have been combined in one water protected housing . When powered with 10-30 V DC, the GPS- 30 emits one ASCII string per second with information about:

1 Latitude/ longitude/ altitude
2 Velocity
3 Date/ time
4 Error estimates
5 Satellite and receiver status

Fig. 6 shows how GPS- 30 has been mounted on top of a GPS only logger.
The GPS unit is connected to an infrared LED- lamp which converts the ASCII coded electric output signals to equivalent strings with ASCII coded infrared signals.
When in use, the GPS logger is programmed to import and record one string of latitude/ longitude data from via an infrared photodiode at given intervals - f. inst each 5. minute. Then it records a combined YY,MM,DD,HH,MM (Year,Month,Date,Hour,Minute) time file from its internal clock and a DDMM,MMMM (Degrees Minutes,Minutes decimals) position file from the GPS receiver.

SEPARATE LOGGER FOR GPS AND ENVIRONMENTAL DATA

On a ship of convenience, temperature and salinity data will normally be acquired from the engine cooling water far down in the engine room.
In order to detect positional data from the satellites, the GPS receiver has to be placed in a position with free vision to the horizon. Normally the best position for the GPS- logger will be as high up as possible on the upper deck.
On a modern passenger ship there is a considerate distance between the upper deck and the engine room. Installation of extra cables for communication between a deck mounted GPS logger and an engine room mounted sensor may be practically impossible. However- installation problems can be avoided by using two loggers: One GPS only logger on deck and one data logger mounted in the engine room. On the Coastal express passenger line this procedure is followed:
A GPS only logger on deck records a file containing real time data (generated by the internal logger clock) and positional data generated by the GPS receiver.
The data logger in the engine room records one file with real time (generated by the internal clock) and one file with environmental data originating from the sensors.

After syncronizing their internal clocks the two loggers are set to record with the same repetition rate T. Then the loggers are started simultaneously or with a time difference equal to a multiplum of T. In this way the loggers will record position and environmental data respectively simultaneously within a few seconds. When the recording period is finished,(when the actual ship returns to Bergen) data from each logger is downloaded to a portable PC as two separate data files. Then the logger memories are cleared and new series are started. The two downloaded files are merged into one common file using a specially written merging program.
Fig. 7 shows the principle.

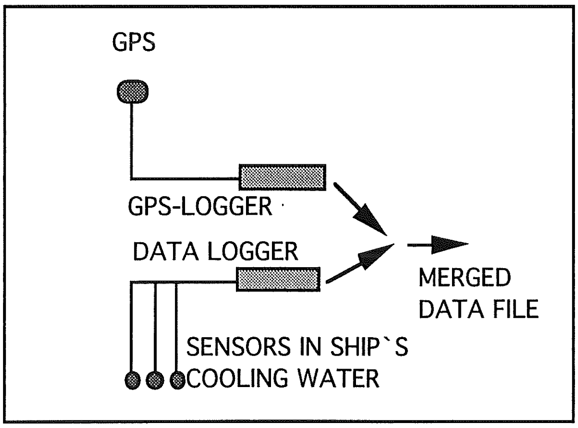

Fig. 7 Merging of data files from a syncronized data logger and GPS- logger into one PC file. Special PC software imports and syncronizes data files from diferent loggers and generates a new file containing time, position and environmental data information.

Data processing
A WINDOWS program for communication with the logger in order to set time, set calibration coefficients, set data recording intervals and for downloading data to PC has been written for the system. The program also merges data- and GPS files into one common time-position-environmental data ASCII table suitable for export to other computing systems.
Typical readout time is 30 s. At the Inst. of Marine Research the PC generated files are finally transferred to an UNIX machine for quality assurance before transfer to the Institute data base.

Results.

The new system has been tested on the Coastal Express between Bergen and Kirkenes. During the tests a GPS logger and a data logger of the type shown on fig 4 equipped with one temperature sensor was used. However, all types of data loggers that record data at regular intervals and output it in a standard data format can in principle be used.
Fig. 8 shows an excample of processed data based on merged information from a separate temperature logger and a GPS logger.
The merged files were exported to UNIMAP which is a general tool under the main UNIRAS system (2) . UNIMAP can display a function in up to three dimensions and can also add analogue colors to the presentation. To position the information on a map,the data was Mercator transformed and coastlines from the GEBCO digital atlas (3) were added.

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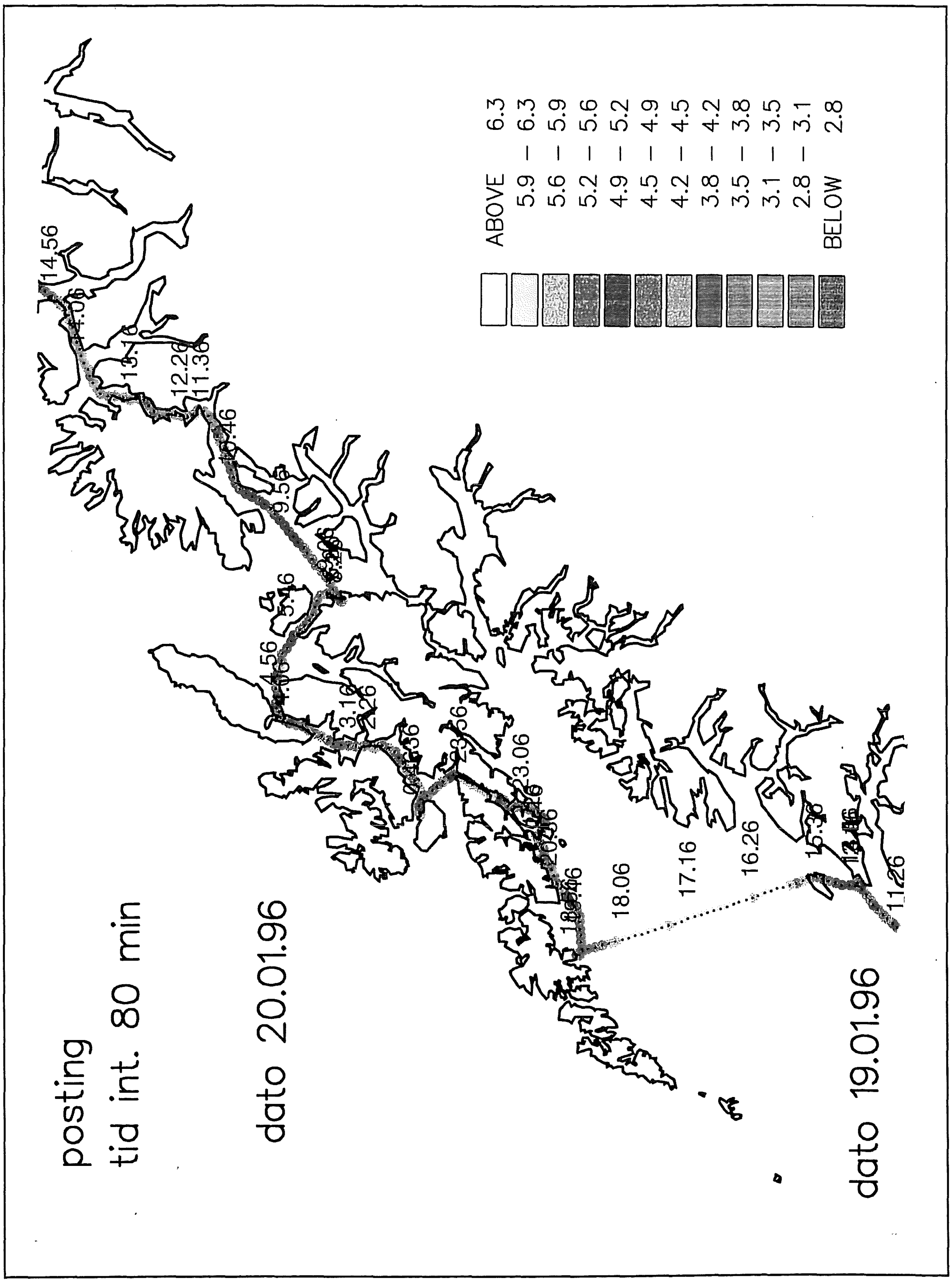

Fig. 8 Temperatures measured at 4 m depth from a Coastal Express line ship passing the Lofoten region in North Norway. The presentation was made by processing merged data from a separate GPS logger and a temperature logger in UNIMAP adding coastlines from GEBCO digital atlas.