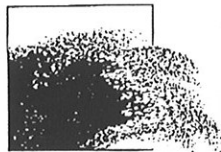


**Management Unit of the North Sea  
Mathematical Models**

# **RV BELGICA CRUISE 99/12 PROVESS**

MUMM contribution  
trackplots and sampling stations  
STD- profiles and  
horizontal profiles (S,T, fluorescence, meteo)  
discrete salinity and chlorophyll data



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## CONTENTS

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1.	INTRODUCTION .....	2
2.	COMPUTER LOGGED OCEANOGRAPHIC, NAVIGATIONAL AND METEOROLOGIC DATA .....	4
2.1	Navigational instrumentation	
2.2	Oceanographic instrumentation	
2.3	Meteorological instrumentation	
3.	THE DATA ACQUISITION SYSTEM .....	7
3.1	ODAS II data acquisition and processing system	
3.2	STD - Horizontal profiling system	
3.3	STD - Vertical profiling system	
3.4	Data file inventory	
4.	REMARKS CONCERNING DATA ACQUISITION AND DATA VALIDITY .....	9
4.1	Position data	
4.2	Salinity measurements versus analysed discrete salinity water samples	
4.3	Fluorescence measurements versus analysed discrete chlorophyll a samples	
4.4	ODAS II data quality monitoring	
5.	Data transfert to BODC .....	11
6.	SUMMARY OF TABLES AND PLOTS .....	12
Appendix 1.	Position STD stations and track plot	
Appendix 2.	Horizontal profiles of the meteorologic data	
Appendix 3	Horizontal profiles of the oceanographic data	
Appendix 4	Sea-Bird SBE09plus data at the sampling depths	
Appendix 5	Sea-Bird SBE09plus data vertical profiles	
Appendix 6	Comparison Sea-Bird SBE09plus versus Guildline Portasal salinometer data	
Appendix 7	Evaluation of Turner Designs fluorescence data versus analysed discrete chlorophyll a samples.	

## R/V BELGICA CRUISE 99/12 - PROVESS

### MUMM contribution - Trackplots and sampling stations STD- profiles and horizontal profiles (S,T, fluorescence, meteo) Discrete salinity and Chlorophyll data.

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#### 1. INTRODUCTION.

The RV BELGICA Cruise 99/12 "PROVESS - Southern North Sea Experiment" was executed in the frame of the EEC MAST III project "PROVESS" Process of Vertical Exchange in Shelf Seas - an interdisciplinary study of the vertical fluxes of properties through the water column and the surface and bottom boundaries. The PROVESS project is founded on the integration of experimental, theoretical and modelling studies of vertical exchanges in the shelf seas, including the joint analysis and interpretation of measurements and model calculation.

The Belgica Cruise 99/12 took place from Monday 17<sup>th</sup> of May until Friday 21<sup>th</sup> of May 1999. Details about this successful cruise can be found in the RV BELGICA 99/12 cruise report. The positions of the STD-Stations and the general and detailed cruise tracks are given in appendix one of this report.

The following "PROVESS" partners have participated to the Belgica cruise 99/12:

- **Proudman Oceanographic Laboratory (POL)**

The objectives of POL during this cruise were to recover ten moorings laid from the Netherlands research vessel "PELAGIA" during the first PROVESS II campaign in the southern North Sea, during 29<sup>th</sup> and 30<sup>th</sup> March 1999. Five of these moorings were laid at the "main" site, located at 52° 18' North, 04° 18' East, the others were laid along two arms extending generally North and West from this position. Parameters measured include pressure, current strengths and directions, sediment and chlorophyll concentrations, and seawater chemistry.

- **HYDROMOD Scientific Consulting, WEBEL, GERMANY.**

The objectives of HYDROMOD were to measure the turbulence properties of the water column using the MICSOS innovative free sinking and rising multi-parameter probe equipped with high resolutions microstructure (temperature) and turbulence (current shear) sensors and precision CTD sensors.

- **Management Unit of the North Sea Mathematical Model , MUMM, Brussels, Belgium.**

MUMM has contributed to this cruise by carrying out the data acquisition and logging of the meteorological data (wind speed and direction, barometric pressure, air temperature, solar radiation, ....), navigational data (DGPS position, bathymetric depth, ....) and the oceanographic data (thermosalinograph data, fluorescence,...), with the ship-board automatic data acquisition system, as well as the STD -measurements and water sampling with the Sea-Bird SBE9plus STD profiler integrated with the Sea-Bird carousel water sampling system SBE32.

These measurements provided valuable background oceanographic data for the evaluation of the MICSOS measurements (HYDROMOD), the suspended material measurements (UWB) and the calibration of the parameters obtained from the instrumented moorings (POL).

- **School of Ocean Sciences, University of Wales, Bangor (UWB)**

The UWB objectives were to measure:

- the particle concentration of surface and near-bed water samples taken from the STD and filtered for gravity determination,
- the regression analysis of SPM concentration against beam attenuation will yield an equation that will be used to convert beam attenuation measured by the moored transmissometers into SPM concentration. The data will also be used for the calibration of the optical backscatter sensor of the Belgica CTD,
- the particle size and shape with two instruments, a LISST (Laser In-Situ Scattering Transmissometer) particle sizer mounted on the STD-frame to obtain in situ profiles of particle size (1-250 microns). The second instrument, Galai, was laboratory-based and required water samples from the CTD to be passed through it,
- the particle settling velocity by deploying QUISSIT (Quasi In-Situ Settling Tubes) tubes for determination of particle settling velocity distributions at the surface and bed.

The present report describes the computer logged oceanographic, meteorological and navigational data as well as the STD-measurements gathered by MUMM during the cruise. Also the results of MUMM's laboratory analyses of discrete salinity and chlorophyll samples are included in the report.



## 2. COMPUTER LOGGED OCEANOGRAPHIC, NAVIGATIONAL AND METEOROLOGICAL DATA.

### 2.1. Navigational instrumentation

During this cruise, the data from the following navigational instruments connected to the shipborn computer system were logged by the Oceanographic Data Acquisition Software system "ODASII" :

- \* SERCEL NR103 DGPS positioning system with an accuracy of 3 to 5 m using the Sercel beacons for differential corrections (dgps lat, dgps lon).
- \* MAGNAVOX 200MX DGPS positioning system with an accuracy of ca. 5 m using IALA beacons for the differential correction .
- \* Anshutz STD12 Gyro Compass (ship's heading).
- \* Raytheon DSN450 Doppler speed log and bathymetric depth (fo /af speed).
- \* Atlas Deso 22 Scientific Echosounder.  
The Atlas Deso 22 is equipped with 2 transducers (33 kHz and 210 kHz). The 33 kHz transducer has a depth range of ca. 1500 m in good conditions.
- \* TSS 320B Heave Compensator.  
The data of the Atlas Deso 22 echosounder are corrected for the heave by the TSS 320B (tss depht-1, tss heave).
- \* Furuno Echosounder FCV381.  
The Furuno is also equipped with 2 transducers (28 kHz and 88 kHz). Only the 28 kHz transducer with a depth range of ca. 2000 m in good weather conditions is used .

### 2.2. Oceanographic instrumentation

The sea surface temperature was measured continuously with the remote temperature sensor of the Sea-Bird SBE21 thermosalinograph (sbe 21 temp) as well as with a Sea-Bird SBE38 temperature sensor (sbe 38 temp), both installed at the inlet of the non-toxic seawater circuit situated at the bow of the vessel.

The Sea-Bird SBE21 thermosalinograph, installed in the wet lab, is also connected to the non-toxic seawater circuit. The salinity (sbe 21 salin) was measured continuously using a personal computer with a dedicated software package from Sea-Bird. The processed data were continuously (every 6 sec.) transmitted to the HP1000/A400 data acquisition computer. The specifications of this thermosalinograph are found in table 1.

Parameter	Units	Range	Accuracy
TEMPERATURE	°C	-5 - +35	0.01 °C / 6 months
CONDUCTIVITY	S/m	0 - 7	0.001 S / m / month

Table 1. Sea-Bird SBE21 thermosalinograph specifications.

Salinity and density are calculated from conductivity, temperature and depth, in accordance to the 1978 Practical Salinity Scale from the IEEE Journal of Oceanic Engineering, January 1980.

A Turner Designs 10-AU-005 fluorimeter, also connected to the non-toxic seawater circuit, was used to measure chlorophyll concentrations during the full campaign. The data were also transmitted to the HP1000/A400 data acquisition computer.

STD vertical profiles have been taken with the Sea-Bird SBE09*plus* STD profiler integrated with the Sea-Bird carousel water sampling system SBE32. The specifications of this STD profiling system are given in table 2.

Parameter	Units	Range	Accuracy (guaranteed)
DEPTH	m	0 - 3000	0.1 % of full scale range
TEMPERATURE	°C	-5 - +35	0.01 °C / 6 months
CONDUCTIVITY	S/m	0 - 6	0.001 S / m / month
DIS. OXYGEN	µmol/kg	0 - 600	5 µmol / kg / day

Table 2. Sea-Bird SBE09*plus* specifications.

### 2.3. Meteorological instrumentation

Following parameters were measured by the Friedrichs meteorological station :

- wind speed (in-wind speed)
- wind direction (in-wind dir.)
- air temperature (air temp. dry)
- atmospheric pressure (atm. pressure)

In addition a solar radiation (sol. rad.) measuring device from Kipp & Zonen was installed.

The outputs of these sensors are analogous signals that are measured with the Hewlett Packard HP44701A 4 ½ digit digital voltmeter incorporated in the ODAS II system. Table 3 gives a summary of the specifications of the meteorologic sensors.

Parameter	Units	Range	Precision
WIND SPEED	m/s	0 - 41	0.2
WIND DIRECTION	degrees	0 - 360	2
ATMOSPHERIC PRESSURE	mbar	950 - 1050	1.5
AIR TEMPERATURE	°C	-35 - +45	0.2
SOLAR RADIATION	Watt/m <sup>2</sup>	0 - 1000	10

Table 3. Meteorologic sensor specifications.

The meteorologic sensors as well as the digital voltmeter are calibrated at least once a year.

### 3. DATA ACQUISITION SYSTEM.

#### 3.1. ODASII data acquisition and processing system.

A Hewlett Packard HP1000 Model A400 real-time minicomputer system with 26 RS-232 interfaces and a Hewlett Packard HP3852A data acquisition system (for analogous signals) were used to acquire meteorological, hydrological and navigational data at a 10 seconds interval.

The HP1000/A400 minicomputer is implemented as a black box. All input devices are connected through RS232 type interfaces to this real-time computer. The data acquisition software collects the sensor data and delivers this raw data to the data processing software implemented on a HP9000/748i-100 UNIX workstation. This on-line data processing software converts the raw data from the different input devices into physical units and stores the data in an Informix relational database.

The data presentation software is based on a Client Server model. The oceanographic data in the Informix database on the UNIX workstation are obtained on personal computer through a local area network (thin ethernet LAN). These personal computer presentation units are installed in the labs, in the computerroom and on the bridge and are accessible by all scientists on board for the production of real-time listings, graphs and trackplots.

#### 3.2. STD - Horizontal profiling system.

The Sea-Bird SBE21 thermosalinograph data were recorded continuously to obtain horizontal salinity and water temperature profiles during the trajectories or time profiles at the fixed stations. The sensors are interrogated every 6 seconds using the dedicated Sea-Bird data acquisition and presentation software installed on a personal computer. The converted values were transmitted in real-time to the ODASII system.

#### 3.3. STD - Vertical profiling system.

The Sea-Bird SBE09*plus* STD system measures the depth of the sensor package, water temperature, conductivity and dissolved oxygen at a rate of 24 samples per second. These data were averaged in the Sea-Bird deck unit over a 0.5 sec. time interval.

The averaged data are plotted in real-time on the PC display, allowing for an immediate decision of the water sampling depths. The Sea-Bird STD software also allows to mark the STD data when water bottle samples are taken so that the STD and related parameters are known at the exact depth.

### 3.4. Data file inventory.

The underway data acquired with the ODASII system are stored in an Informix relational database and they have the following name :

Filename	Acquisition rate	Type of data	Duration
st9912an9910s1	10"	navig. + meteo + oceano.	Full campaign.

Table 4.1 Data file inventory.

The data files created with the Sea-Bird STD systems during the BELGICA cruise 99/12 have the following file names.

Filename	Acquisition rate	Type of data	Duration
cast_01.DAT to cast_46.DAT stat_g, stat_d, stat_h,stat_t, stable_, stable1	0.5"	STD  vertical  profile	Stations 01A to 47A.  and g, d, h, t and stable

Table 4.2 Data file inventory. (for a complete list see appendix 1)

These file names or derivatives occur on the different listings and plots.

#### 4. REMARKS CONCERNING DATA PROCESSING AND DATA VALIDITY.

##### 4.1. Navigational data.

During the whole Belgica cruise 99/12, the DGPS based navigation system Sercel NR103 was used as the primary positioning instrument. The Magnavox MX200 DGPS system was used as a backup system.

##### 4.2. Salinity measurements and discrete salinity water samples.

During the campaign vertical STD profiles have been taken with the SBE model 09plus STD system. The SBE09plus STD system was equipped with a SBE-3 temperature sensor and a SBE-4 conductivity sensor.

At different locations and multiple depths water samples have been taken to validate the salinity data of the SBE09plus system. The water samples have been analysed in MUMM's laboratory at Oostende with a Guildline Portasal Model 8410 laboratory salinometer.

The Guildline Portasal salinometer is calibrated using IAPSO standard seawater capsules obtained from Oceanographic Scientific International Ltd.(UK).

The results of the Guildline Portasal salinometer have been compared with the Sea-Bird SBE09plus salinity measurements (see Appendix 6).

	Standard deviation ppt	Mean error ppt	Corrolation coeff.
SBE09plus - Guildline	0.037	0.0096	0.980

During the first part of the campaign the water column was well mixed due to the heavy weather conditions. For this data set the variability of the differences between the salinity data from the SBE09 in-situ measurements and the analysis of discrete water samples is small.

In the second part of the campaign the wind was moderate and gradients in temperature and salinity occurred in the water column.

Due to these gradients the variability of the differences between the salinity data from the in-situ measurements and the analysis of the samples increased and consequently the overall standard deviation value is greater then the expected standard deviation.

#### 4.3 Fluorescence measurements and discrete chlorophyll a samples.

The fluorescence data obtained from the Turner Designs fluorimeter connected to the non-toxic seawater circuit has been evaluated using the analysis of the discrete chlorophyll samples taken at regular intervals during this cruise.

A total of 24 chlorophyll samples have been analysed at MUMM's laboratory using the "Lorenzen" method.

The evaluation of the fluorescence data versus the laboratory chlorophyll a analyses and the regression output is given in appendix 7.

#### 4.4. ODAS II data quality monitoring.

One of the features of the ODASII package is the quality monitoring of all subsystems, instruments and parameters interrogated.

To each parameter value, subsequently logged in the ODASII database, two bytes are added to take into account these data validity checks.

The validity is also shown on the data listings and transferred to the ASCII files. The following code is used :

Code	Meaning
M	Malfunction of a subsystem.
U	No update of the data since the previous logged value.
V	Data not valid (e.g. test on data string format failed).
D	Range error of the DVM subsystem.
R	Lower/upper range test.
G	Gradient test.
=	Not used.
S	Suspected data indication given by e.g. a positioning system.

## 5.. DATA TRANSFERT TO BODC.

The data files related to the Belgica cruise 99/12 have been put on MUMM's ftp-server <ftp.mumm.ac.be/pub/mummjb/provess9912> for retrieval by "BODC" except for the discrete salinity and chlorophyll a data which have been transmitted to BODC by e-mail.

- **provess9912\_underway.zip**

This zip file contains the ASCII files **provess9912\_meteo.tab** en **provess9912\_position\_and\_oceano.tab**. These 2 files contain resp. the meteorological and the position + oceanographic data during the whole cruise with a 10 sec. interval.

The file **provess9912\_meteo.tab** contains the parameters :

- dgps latitude, dgps longitude
- atmospheric pressure
- air temperature. dry
- in-wind direction
- in-wind speed (m/s and Beaufort)
- solar radiation
- humidty

The file **provess9912\_position\_and\_oceano.tab** contains the parameters :

- dgps latitude, dgps longitude
- TSS depth-l, TSS heave
- FO/AF speed
- ship heading
- seawater temperature SBE21 and SBE38
- SBE21 salinity

- **provess9912\_CTD\_vertical\_profiles.zip**

This file contains the 55 Sea-Bird SBE09plus vertical profiles.  
Data are averaged over a 0.5 m depth interval.

Casts 01 to 14 were taken during the 13 h cycle at the center position.  
Casts 15 to 20 were taken during the 6h cycle at the center position.  
Casts 21 to 46B were taken at the center position during the 25 h cycle.

- **provess9912\_CTD\_time\_profiles\_5m.zip**

This file contains the 4 Sea-Bird SBE09plus time profiles at stations G, H, T and stable



## 6. SUMMARY OF LISTINGS AND PLOTS IN APPENDICES.

### APPENDIX 1 :

Table 1 gives the position, the water depth, the date and the time of the STD vertical profiles. All these profiles have been taken with the Sea-Bird SBE09*plus* STD system.

Figure 1 gives a map with a view of the cruise trajectory and all the sampling stations, while figure 2 shows a detail of the trajectory of cruise 99/12.

### APPENDIX 2 :

The instantaneous averaged wind speed and direction, the air temperature, the solar radiation and the atmospheric pressure are plotted in function of time. These data were acquired with the Friedrichs meteo system.

### APPENDIX 3 :

The surface water temperature, the salinity and the fluorescence are plotted in function of time. These data were acquired with the Sea-Bird SBE21 thermosalinograph and the Turner Designs fluorometer.

### APPENDIX 4 :

Table 2 gives the values of the oceanographic parameters at the STD water sampling points.

### APPENDIX 5 :

The vertical profiles of the temperature, the salinity, the density, the dissolved oxygen and the backscatterance are shown for all stations.

### APPENDIX 6 :

An evaluation report shows the comparison of the results of the Guildline Portasal salinometer with Sea-Bird SBE*plus* salinity measurements in a table and a figure.

### APPENDIX 7:

Evaluation report of the fluorescence data, obtained from the Turner Designs fluorimeter connected to the non-toxic seawater circuit, versus the analysed discrete chlorophyll samples.

## Appendix 1

### Position of STD stations and trackplot

SERCEL NR 103 : DGPS POSITION

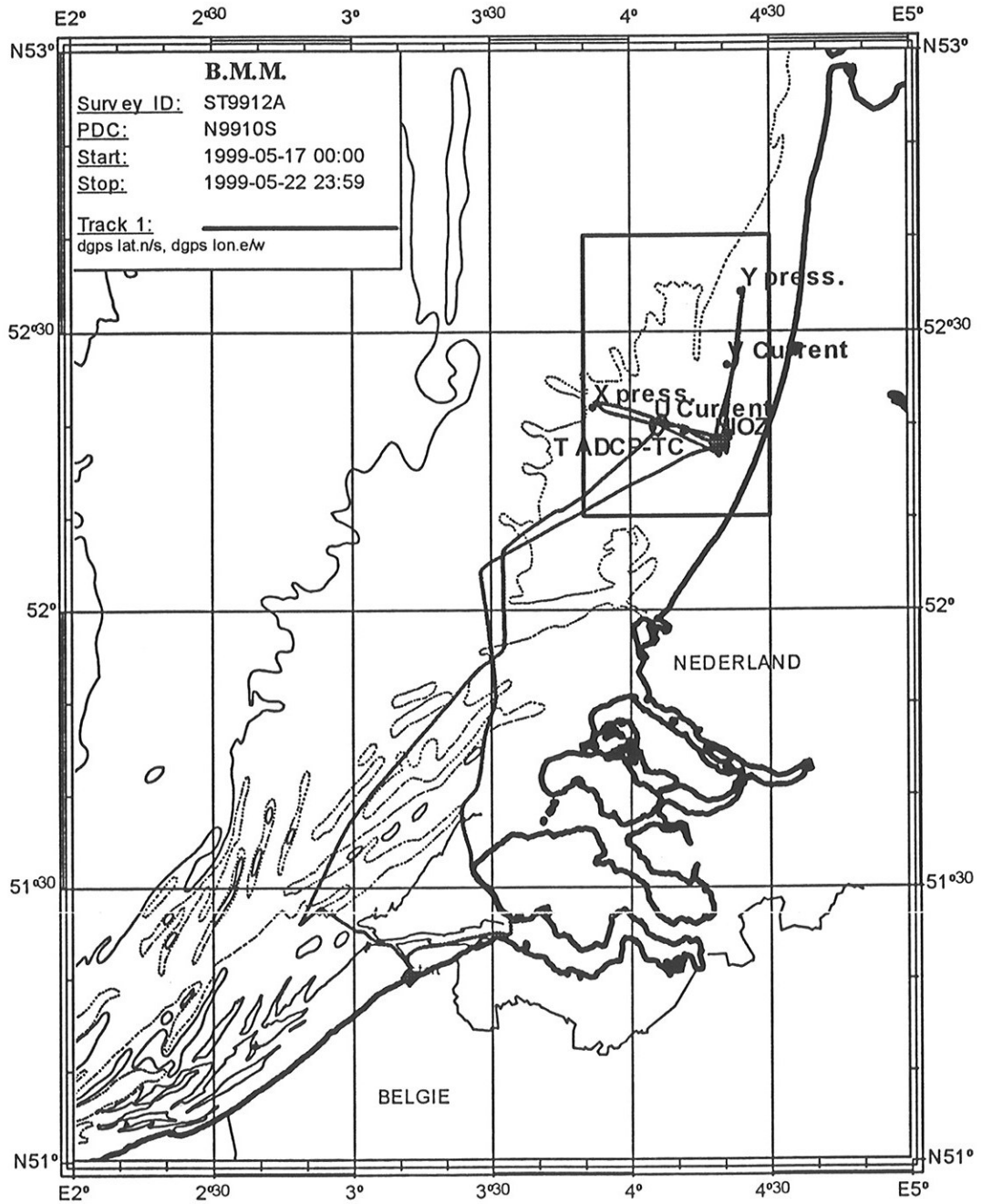
Table 1. Position SCTD stations PROVESS 99/12.

Station	Cast	Date 1999	Time of V.P.( <sup>1</sup> )	Latitude	Longitude	Water Depth [m]	Data file
centre	01	17.05	20:12 pm	N 52 18 14.08	E 4 20 21.61	17	cast_01.cnv
	02	17.05	21:51 pm	N 52 18 24.50	E 4 19 37.06	18	cast_02.cnv
	03	17.05	23:02 pm	N 52 17 55.94	E 4 19 11.47	18	cast_03.cnv
	03B	17.05	23:06 pm	N 52 17 59.86	E 4 19 16.13	18	cast_03B.cnv
13 h	04	18.05	00:03 am	N 52 18 04.15	E 4 19 13.69	18	cast_04.cnv
	05	18.05	01:04 am	N 52 18 14.32	E 4 19 36.05	17	cast_05.cnv
	06	18.05	01:57 am	N 52 17 55.52	E 4 18 48.38	17	cast_06.cnv
cycle	07	18.05	02:53 am	N 52 17 57.08	E 4 19 11.81	19	cast_07.cnv
	08	18.05	03:56 am	N 52 18 02.81	E 4 18 47.12	20	cast_08.cnv
	08B	18.05	04:04 am	N 52 18 04.15	E 4 19 13.69	20	cast_08B.cnv
	09	18.05	04:55 am	N 52 17 24.67	E 4 19 02.18	18	cast_09.cnv
	10	18.05	06:04 am	N 52 17 45.46	E 4 18 52.76	19	cast_10.cnv
	11	18.05	07:00 am	N 52 18 35.86	E 4 20 50.04	18	cast_11.cnv
	12	18.05	08:05 am	N 52 18 17.34	E 4 19 07.38	17	cast_12.cnv
	13	18.05	08:58 am	N 52 18 13.32	E 4 20 45.04	17	cast_13.cnv
	14	18.05	09:59 am	N 52 17 50.20	E 4 19 28.00	18	cast_14.cnv
G		18.05	11:41 am	N 52 17 49.61	E 4 17 49.64	18	cast_g.cnv
D		18.05	12:43 pm	N 52 18 07.31	E 4 17 35.61	17	cast_d.cnv
H		18.05	13:59 pm	N 52 17 59.06	E 4 17 57.05	18	cast_h.cnv
T		18.05	15:51 pm	N 52 19 21.44	E 4 12 15:53	20	cast_t.cnv
centre	15	18.05	20:32 pm	N 52 18 27.58	E 4 20 28.90	18	cast_15.cnv
	16	18.05	21:51 pm	N 52 18 34.15	E 4 20 18.51	18	cast_16.cnv
6h	17	18.05	23:03 pm	N 52 17 50.63	E 4 18 58.04	17	cast_17.cnv
	18	19.05	00:04 am	N 52 18 45.26	E 4 20 30.24	17	cast_18.cnv
cycle	19	19.05	01:01 am	N 52 17 47.53	E 4 18 37.54	18	cast_19.cnv
	20	19.05	01:59 am	N 52 18 32.03	E 4 20 06.35	17	cast_20.cnv
stable		19.05	08:47 am	N 52 18 49.04	E 4 18 10.39	19	stable.cnv
stable		19.05	09:07 am	N 52 18 53.00	E 4 18 13.21	19	stable1.cnv
centre	21	19.05	10:01 am	N 52 18 23.93	E 4 20 42.13	17	cast_21.cnv
	22	19.05	10:59 am	N 52 17 24.40	E 4 19 49.20	17	cast_22.cnv
	23	19.05	11:59 am	N 52 17 24.17	E 4 19 20.19	17	cast_23.cnv
	24	19.05	13:00 pm	N 52 17 18.03	E 4 19 06.43	17	cast_24.cnv
	25	19.05	14:06 pm	N 52 17 54.68	E 4 19 42.09	17	cast_25.cnv
25 h	26	19.05	14:59 pm	N 52 18 23.15	E 4 19 52.14	18	cast_26.cnv
	27	19.05	16:14 pm	N 52 17 59.60	E 4 19 14.08	19	cast_27.cnv
	28	19.05	17:01 pm	N 52 18 40.93	E 4 19 41.85	19	cast_28.cnv
cycle	29	19.05	18:04 pm	N 52 17 33.67	E 4 19 16.98	19	cast_29.cnv
	30	19.05	19:00 pm	N 52 18 48.79	E 4 20 37.29	18	cast_30.cnv
	31	19.05	20:01 pm	N 52 17 06.47	E 4 18 22.84	18	cast_31.cnv
	32	19.05	21:01 pm	N 52 18 59.65	E 4 20 40.63	19	cast_32.cnv

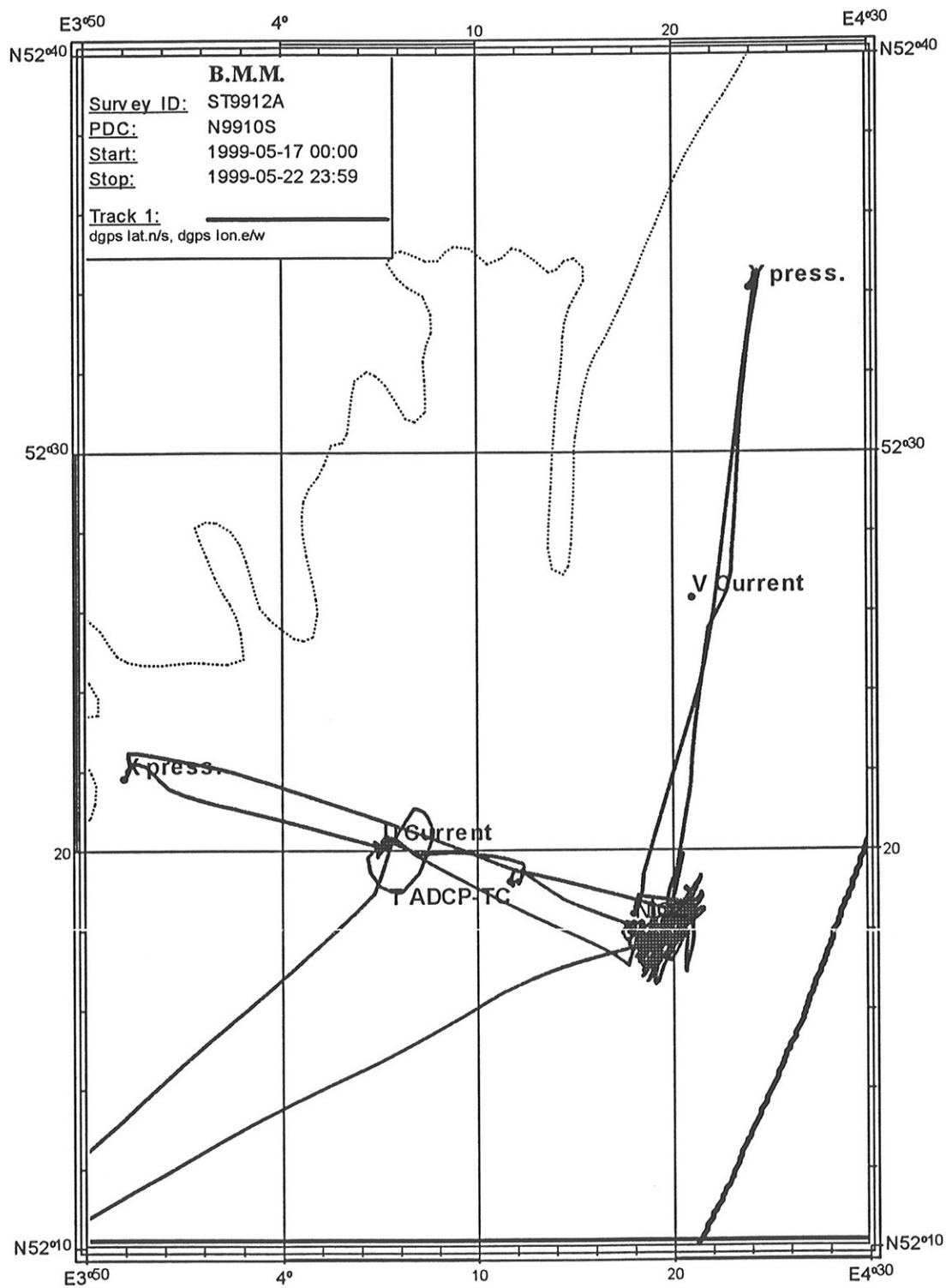
Station	Cast	Date 1999	Time of V.P. <sup>(1)</sup>	Latitude	Longitude	Water Depth [m]	Data file
center	33	19.05	22:01 pm	N 52 18 48.89	E 4 20 54.46	18	cast_33.cnv
	34	19.05	22:59 pm	N 52 17 43.72	E 4 20 59.27	18	cast_34.cnv
	35	20.05	23:58 pm	N 52 17 53.93	E 4 20 43.65	17	cast_35.cnv
	36	20.05	01:02 am	N 52 18 44.04	E 4 20 37.01	17	cast_36.cnv
	37	20.05	02:04 am	N 52 18 45.54	E 4 21 13.46	17	cast_37.cnv
25h	38	20.05	03:01 am	N 52 18 55.63	E 4 21 26.43	17	cast_38.cnv
	39	20.05	04:01 am	N 52 17 45.97	E 4 20 02.09	18	cast_39.cnv
	40	20.05	05:02 am	N 52 17 24.23	E 4 19 43.61	19	cast_40.cnv
	41	20.05	06:03 am	N 52 18 00.05	E 4 20 11.57	18	cast_41.cnv
	42	20.05	07:03 am	N 52 17 52.04	E 4 20 11.69	18	cast_42.cnv
	43	20.05	08:02 am	N 52 18 09.15	E 4 20 35.42	18	cast_43.cnv
	44	20.05	09:03 am	N 52 18 05.70	E 4 20 36.68	18	cast_44.cnv
cycle	45	20.05	09:59 am	N 52 18 43.39	E 4 20 21.16	19	cast_45.cnv
	46	20.05	11:03 am	N 52 18 00.84	E 4 20 31.79	18	cast_46.cnv
	46B	20.05	11:13 am	N 52 17 50.99	E 4 20 29.64	17	cast_46B.cnv

Remarks: <sup>(1)</sup> The time noted is the starttime (GMT) of the vertical profile.

**Figure 1 General Cruise Track**



**Figure 2 Detailed Cruise track**



## Appendix 2

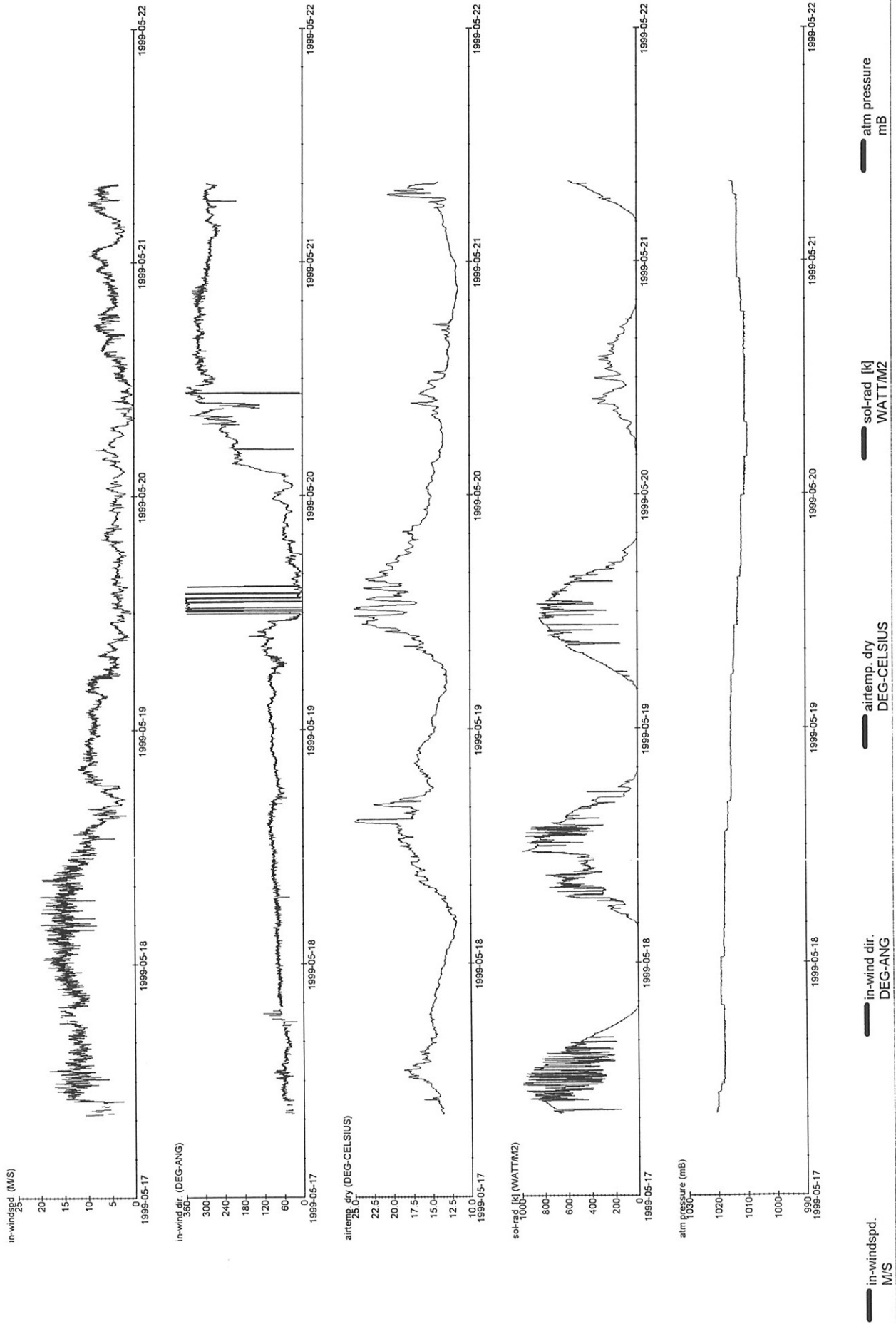
### Horizontal profiles of the meteo data

FRIEDRICHS : wind speed, wind direction, air temperature, atmospheric pressure

KIPP & ZONEN : solar radiation

# RV BELGICA - CRUISE 99/12 PROVESS

17.05.1999 - 21.05.1999





### Appendix 3

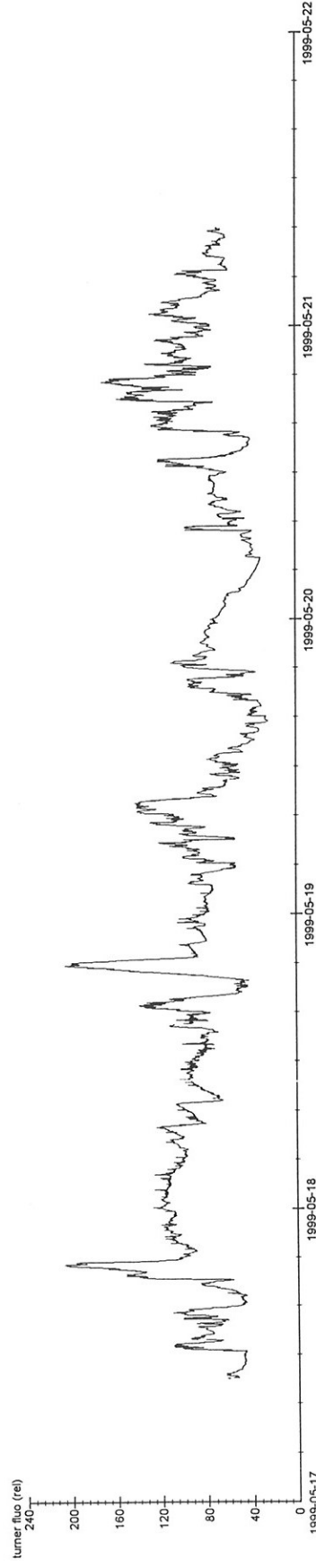
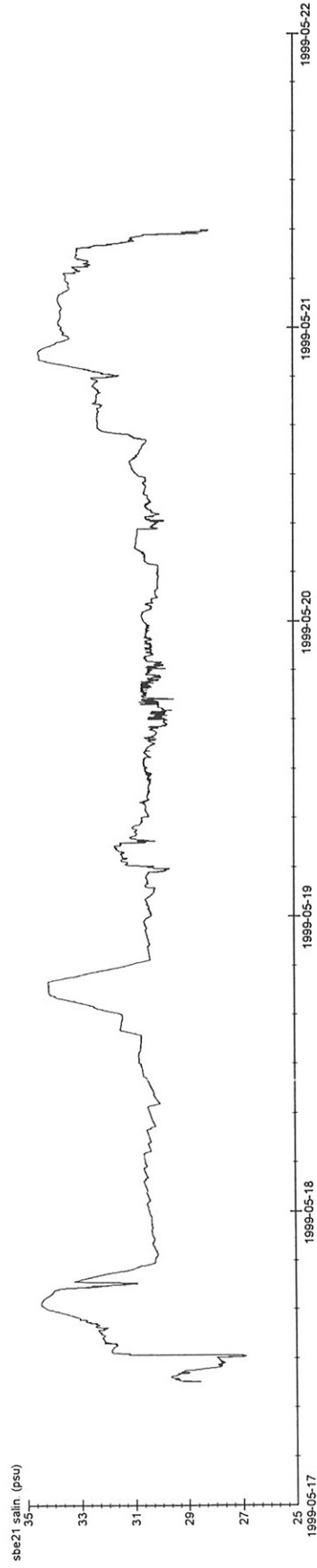
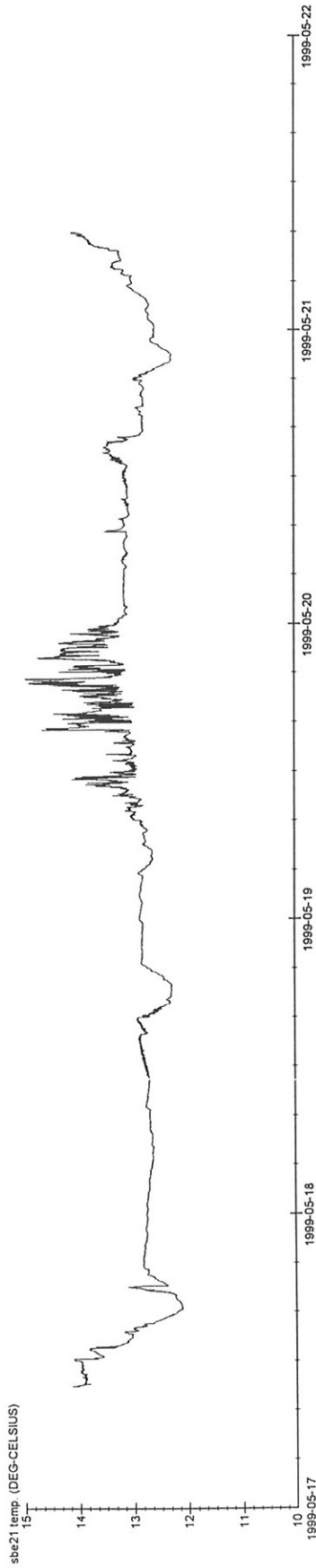
#### Horizontal profiles of the oceanographic data

SEA-BIRD SBE21 : water temperature, salinity

TURNER DESIGNS : fluorescence

# RV BELGICA - CRUISE 99/12 PROVESS

17.05.1999 - 21.05.1999



— sbe21 temp.  
DEG-CELSIUS

— sbe21 salin.  
PPT

— turner fluo.  
UG/L

## Appendix 4

### Sea-Bird SBE09plus data at the sampling depths

SEA-BIRD SBE09plus : salinity, water temperature, density, D.O.,  
backscatterance

Table 2 SCTD Data.

Station number	Data file	Bottle Depth (m)	Bottle Number(s)	CTD Pressure (db)	CTD Salinity (PSU)	CTD Temp. (°C)	CTD Density (Sigma-Th)	CTD OBS (FTU)
1	Cast_01	15.0	1,3,4	15.1	30.303	12.829	22.790	14.4
		3.1	6,7,9,10,12	3.2	30.273	12.820	22.769	7.0
2	Cast_2	15.6	1	15.8	30.397	12.778	22.873	11.2
		2.9	7,12	3.0	30.349	12.771	22.837	7.4
3	Cast_3		--					
3B	Cast_3B	15.2	1	15.4	30.415	12.766	22.889	6.9
		3.1	7,12	3.1	30.414	12.764	22.888	6.8
4	Cast_4	15.1	1	15.2	30.526	12.755	22.977	6.6
		3.0	7,12	3.0	30.503	12.745	22.961	6.5
5	Cast_5	15.1	1	15.2	30.526	12.755	22.977	6.6
		3.0	7,12	3.0	30.503	12.745	22.961	6.5
6	Cast_6	14.3	1	14.4	30.640	12.723	23.071	6.3
		2.8	7,12	2.8	30.635	12.714	23.069	6.4
7	Cast_7	16.8	1,2	17.0	30.647	12.708	23.080	7.3
		2.7	7,8	2.8	30.625	12.694	23.065	6.4
8	Cast_8	17.7	1	17.9	30.658	12.672	23.095	8.0
8B	Cast_8B	3.0	7,12	3.0	30.655	12.656	23.095	7.3
9	Cast_9	16.6	1,2	16.8	30.459	12.647	22.946	13.1
		3.2	7,8	3.2	30.452	12.639	22.942	9.7
10	Cast_10	15.7	1,2	15.8	30.507	12.647	22.983	16.5
		2.4	7,8	2.4	30.498	12.651	22.975	10.1
11	Cast_11	15.8	1,2	15.9	30.329	12.662	22.842	11.7
		2.8	7,8	2.9	30.284	12.694	22.802	7.3
12	Cast_12	15.3	1,2	15.3	30.517	12.653	22.990	8.9
		2.8	7,8	2.8	30.479	12.699	22.951	7.3
13	Cast_13	14.7	1,2	14.8	30.319	12.680	22.932	12.2
		2.5	7,8	2.5	30.198	12.750	22.724	6.2
14	Cast_14	14.5	1,2	14.6	30.482	12.671	22.959	15.3
		2.7	7,8	2.8	30.410	12.715	22.894	7.5
G	STAT_G	5.2	1	5.2	30.774	12.744	23.171	8.2
D	STAT_D	15.3	1	15.4	30.889	12.739	23.261	8.5
H	STAT_H	4.6	1	4.6	30.784	12.842	23.160	5.8
T	STAT_T	5.0	1	5.1	31.533	12.766	23.754	5.6

Table 2 SCTD Data.

Station number	Data file	Bottle Depth (m)	Bottle Number(s)	CTD Pressure (db)	CTD Salinity (PSU)	CTD Temp. (°C)	CTD Density (Sigma-Th)	CTD OBS (FTU)
15	Cast_15	15.4	1,2	15.6	30.455	12.847	22.905	8.8
		3.0	7,8	3.1	30.440	12.834	22.895	6.5
16	Cast_16	15.7	1,2	15.8	30.563	12.857	22.987	29.6
		2.9	7,8	2.9	30.499	12.824	22.943	5.9
17	Cast_17	14.9	1,2	15.1	30.683	12.828	23.085	17.6
		2.8	7,8	2.8	30.570	12.811	23.000	6.0
18	Cast_18	15.1	1,2	15.2	30.661	12.836	23.067	10.3
		2.8	7,8	2.8	30.396	12.867	22.855	6.2
19	Cast_19	15.1	1,2	15.2	30.758	12.811	23.146	7.5
		2.8	7,8	2.8	30.559	12.834	22.987	5.9
20	Cast_20	15.3	1,2	15.5	30.582	12.836	23.005	8.3
		2.9	7,8	2.9	30.270	12.865	22.758	5.4
STABLE	STABLE_	17.2	7	17.4	30.846	12.741	23.228	7.7
		2.8	8	2.8	30.591	12.965	22.987	6.4
STABLE	STABLE1	16.8	1,2	16.9	30.858	12.738	23.238	8.0
		2.3	7,8	2.4	30.648	12.917	23.040	6.4
21	Cast_21	14.9	1,2	15.1	30.517	12.804	22.961	20.2
		2.8	7,8	2.8	30.502	12.848	22.941	5.9
22	Cast_22	14.8	1,2	15.0	30.516	12.813	22.959	12.1
		3.3	7,8	3.3	30.466	13.404	22.805	6.2
23	Cast_23	14.7	1,2	14.8	30.667	12.825	23.073	13.6
		2.8	7,8	2.8	30.563	13.090	22.942	6.1
24	Cast_24	15.2	1,2	15.4	30.714	12.861	23.102	13.8
		2.9	7,8	2.9	30.511	13.025	22.914	5.9
25	Cast_25	15.5	1,2	15.6	30.733	12.883	23.113	9.1
		3.2	7,8	3.3	30.538	12.929	22.953	5.9
26	Cast_26	15.7	1,2	15.8	30.639	12.943	23.029	7.5
		3.2	7,8	3.2	30.116	13.256	22.564	5.6
27	Cast_27	16.1	1,2	16.3	30.878	12.890	23.224	10.2
		2.9	7,8	2.9	30.408	13.009	22.838	5.6
28	Cast_28	17.4	1,2	17.5	30.933	12.866	23.271	11.1
		3.1	7,8	3.1	30.389	13.061	22.812	5.6
29	Cast_29	16.5	1,2	16.7	30.829	13.003	23.164	19.8
		2.8	7,8	2.9	30.700	13.409	22.985	8.7
30	Cast_30	17.5	1,2	17.6	30.737	13.019	23.090	19.8
		2.9	7,8	3.0	30.716	13.127	23.053	8.7
31	Cast_31	16.6	1,2	16.7	30.725	12.904	23.103	19.0
		3.1	7,8	3.1	30.584	13.059	22.964	7.9
32	Cast_32	16.3	1,2	16.4	30.727	13.082	23.070	7.8
		2.7	7,8	2.7	30.696	13.230	23.017	6.4
33	Cast_33	15.5	1,2	15.7	30.658	13.103	23.013	8.2
		3.1	7,8	3.2	30.665	13.179	23.003	6.5

Table 2 SCTD Data.

Station number	Data file	Bottle Depth (m)	Bottle Number(s)	CTD Pressure (db)	CTD Salinity (PSU)	CTD Temp. (°C)	CTD Density (Sigma-Th)	CTD OBS (FTU)
34	Cast_34	15.6	1,2	15.7	30.542	13.077	22.928	17.0
		3.2	7,8	3.2	30.558	13.312	22.895	6.6
35	Cast_35	15.2	1,2	15.4	30.658	13.200	22.994	15.6
		2.7	7,8	2.8	30.664	13.280	22.982	7.7
36	Cast_36	14.7	1,2	14.8	30.748	13.054	23.092	11.3
		3.0	7,8	3.0	30.354	13.129	22.772	5.9
37	Cast_37	16.3	1,2	16.5	30.564	13.089	22.943	20.2
		2.8	7,8	2.8	30.176	13.140	22.633	6.1
38	Cast_38	15.7	1,2	15.8	30.556	13.084	22.938	10.5
		2.9	7,8	2.9	30.121	13.147	22.589	6.4
39	Cast_39	16.3	1,2	16.4	30.775	13.021	23.119	12.1
		2.7	7,8	2.7	30.091	13.136	22.568	5.9
40	Cast_40	17.4	1,2	17.6	30.891	13.016	23.210	15.1
		2.9	7,8	2.9	30.612	13.163	22.965	5.9
41	Cast_41	17.0	1,2	17.2	30.956	13.115	23.241	12.4
		2.7	7,8	2.8	30.960	13.119	23.242	8.7
42	Cast_42	15.7	1,2	15.8	30.888	13.102	23.190	22.5
		2.6	7,8	2.7	30.877	13.091	23.184	9.1
43	Cast_43	15.7	1,2	15.8	30.833	13.100	23.149	14.6
		2.8	7,8	2.8	30.035	13.126	22.526	7.5
44	Cast_44	16.1	1,2	16.3	30.768	13.093	23.100	9.0
		2.9	7,8	2.9	30.427	13.052	22.844	6.8
45	Cast_45	16.8	1,2	17.0	30.883	13.106	23.186	8.0
		3.0	7,8	3.0	30.491	13.107	22.883	6.8
46	Cast_46	15.5	12	15.7	30.763	13.129	23.089	20.4
		3.0	78	3.0	30.632	13.095	22.994	6.5
46B	Cast_46B		---					

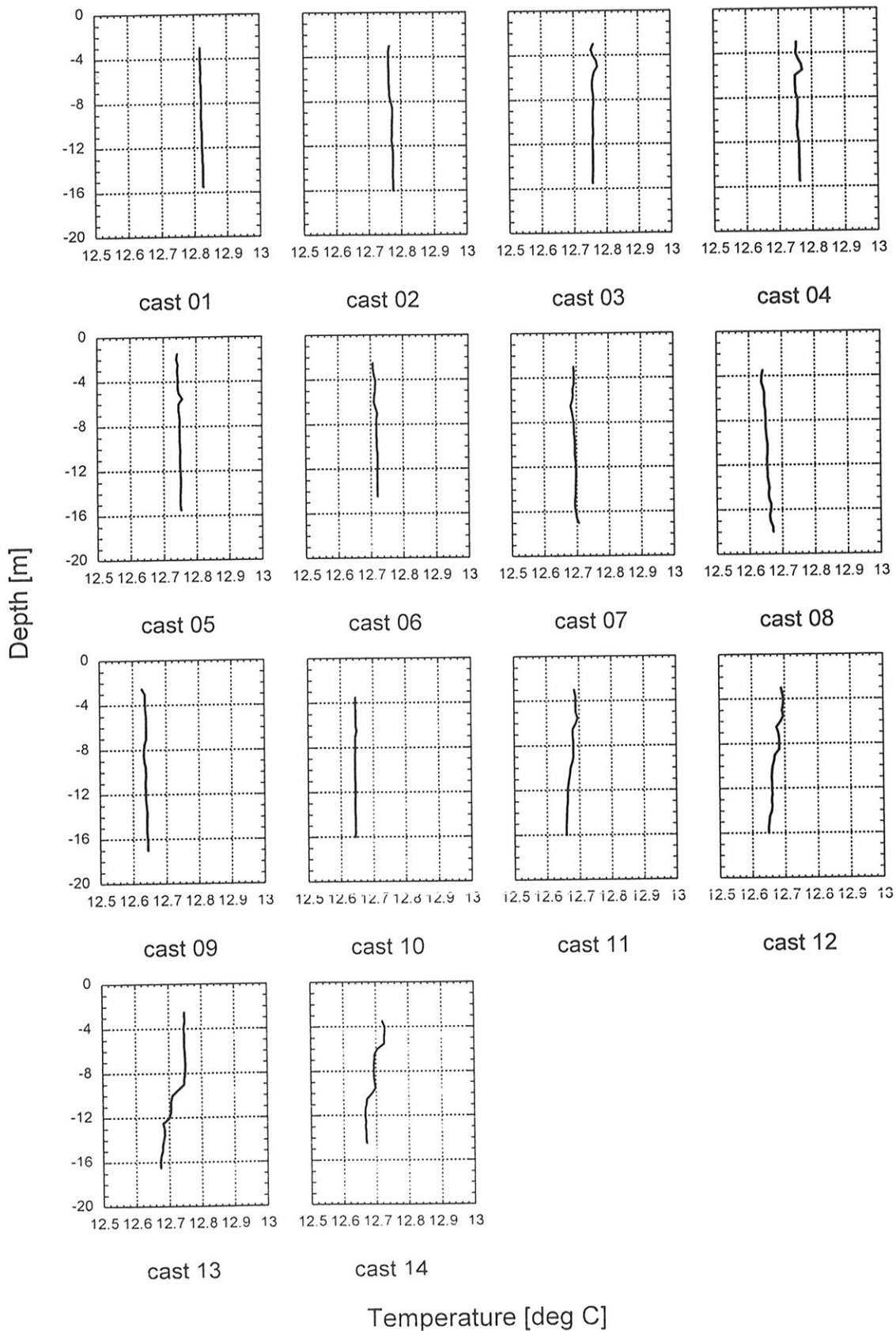
## Appendix 5

### Sea-Bird SBE09plus data vertical profiles

SEA-BIRD SBE09plus : salinity, water temperature, density, D.O.,  
backscatterance

# CTD Profiles cruise 99/12 PROVESS

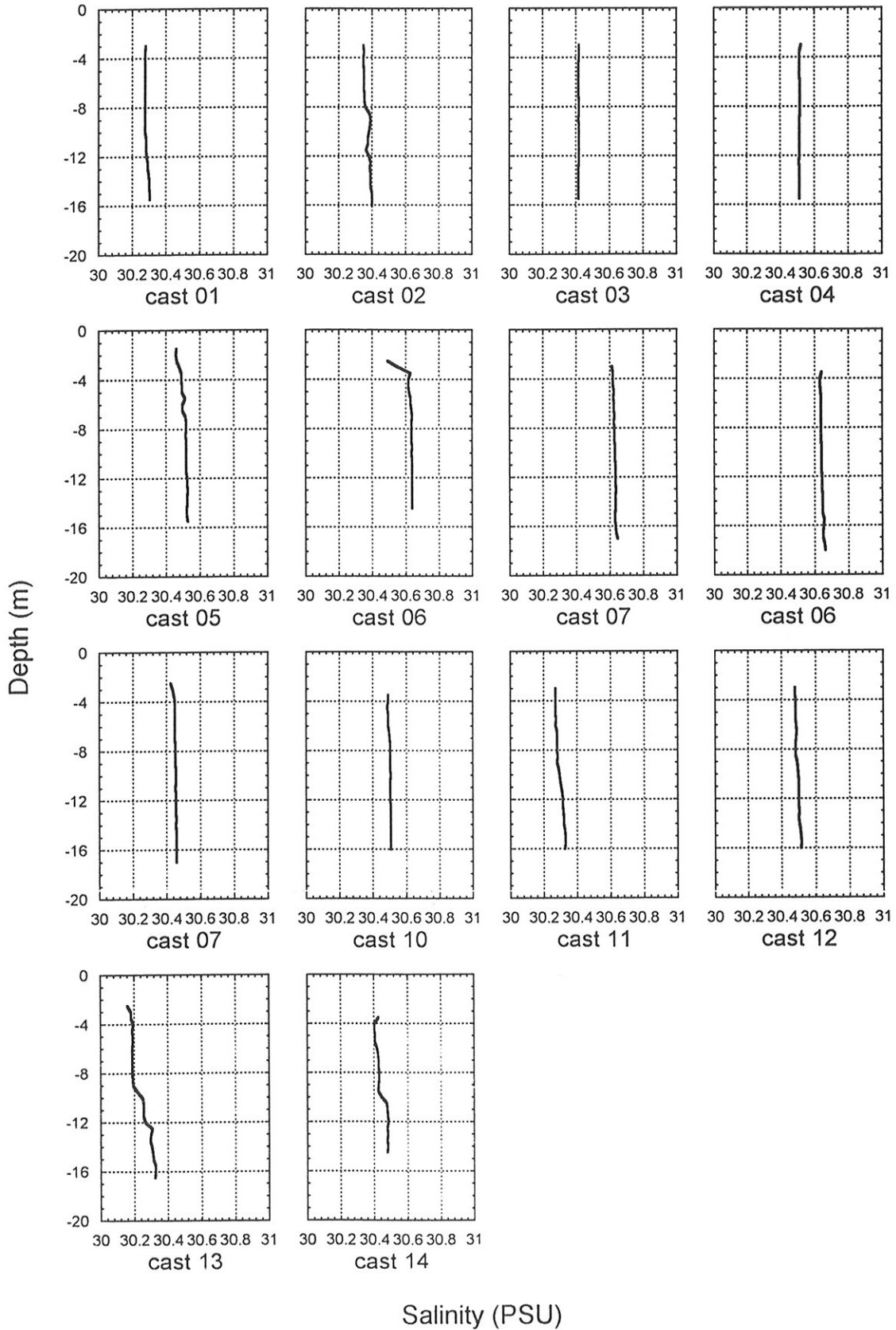
13 hour cycle : casts 01 - 14





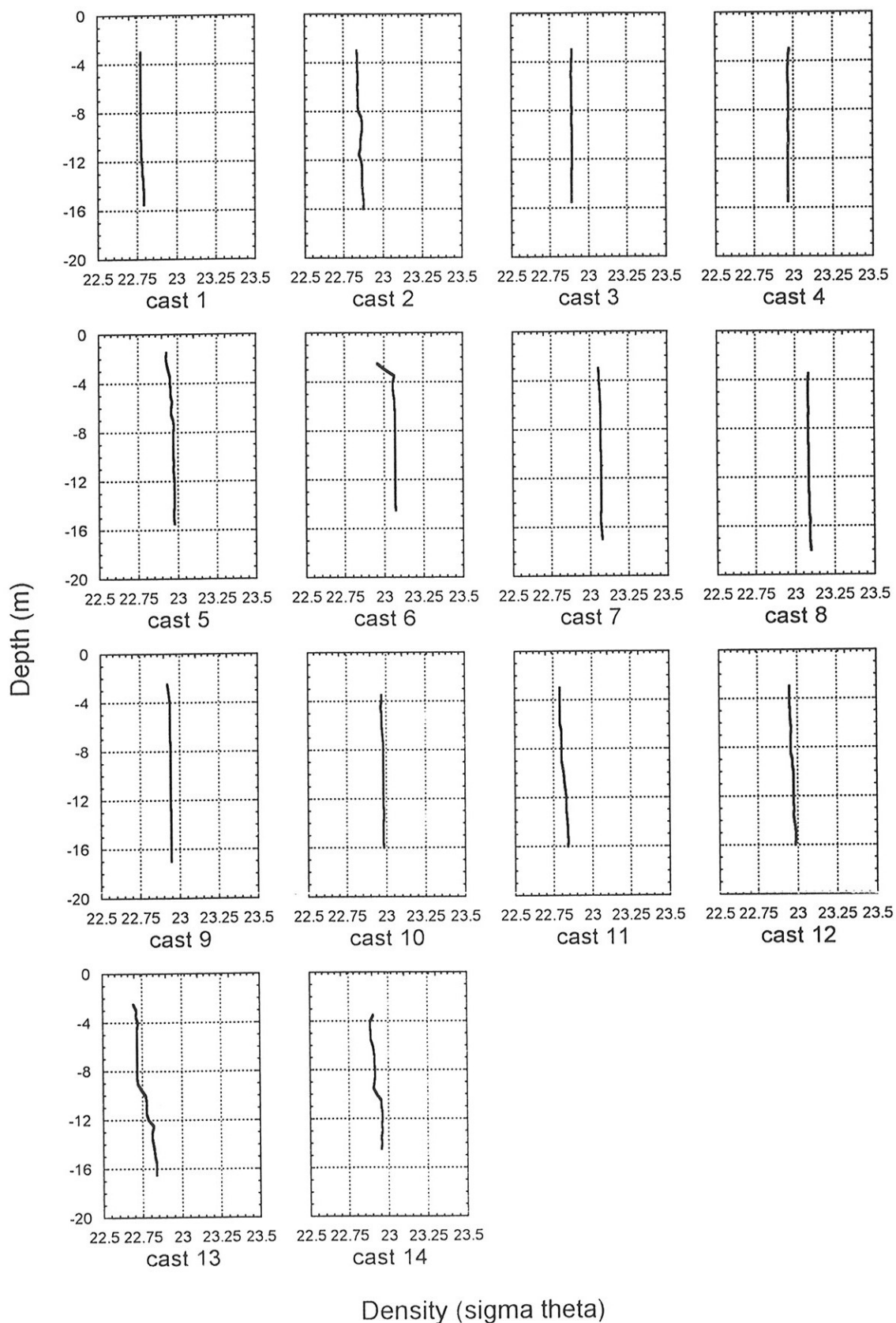
# CTD Profiles cruise 99/12 PROVESS

13 hour cycle : casts 01 - 14



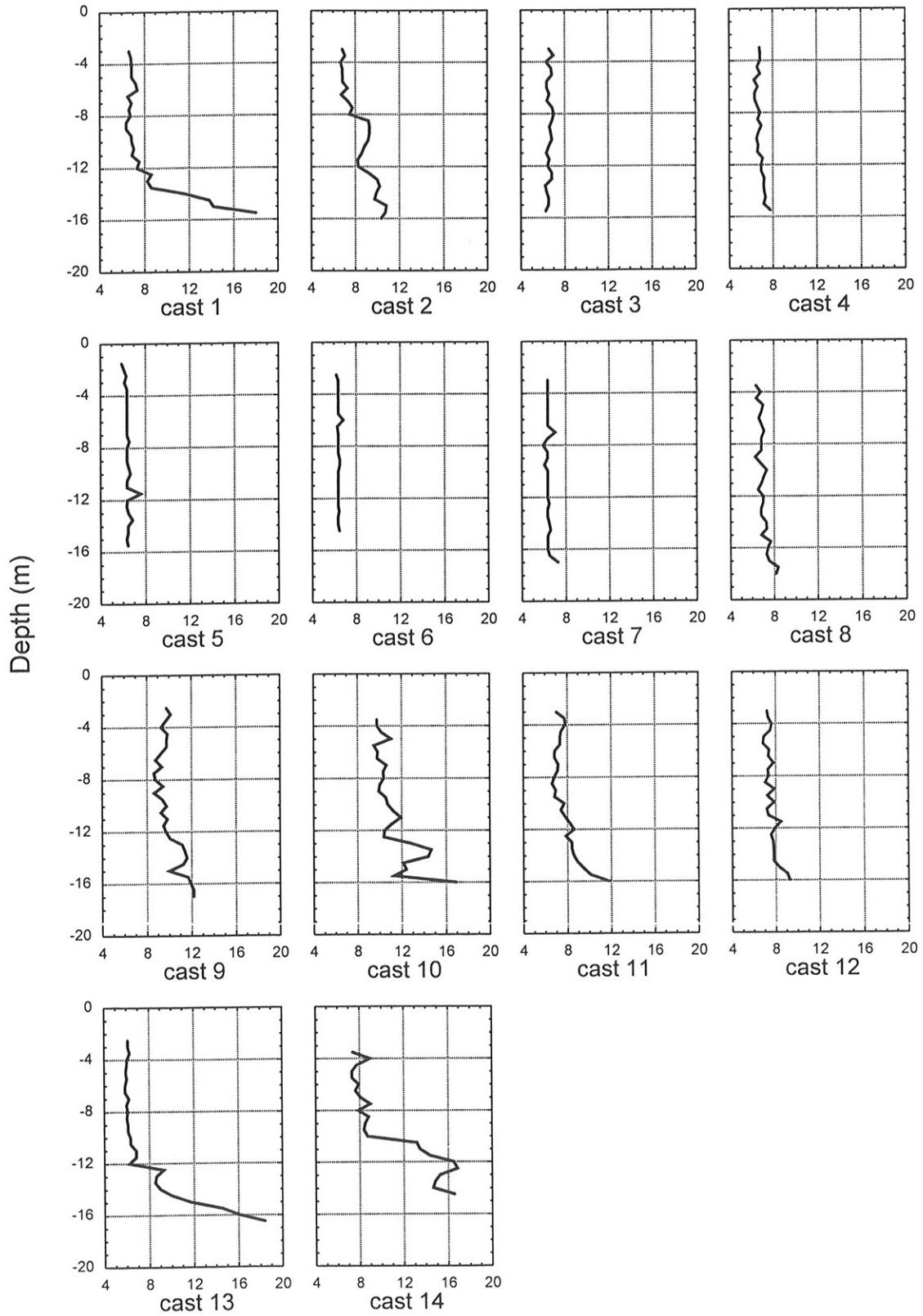
# CTD Profiles cruise 99/12 PROVESS

13 hour cycle :casts 01 - 14



# CTD profiles cruise 99/12 PROVESS

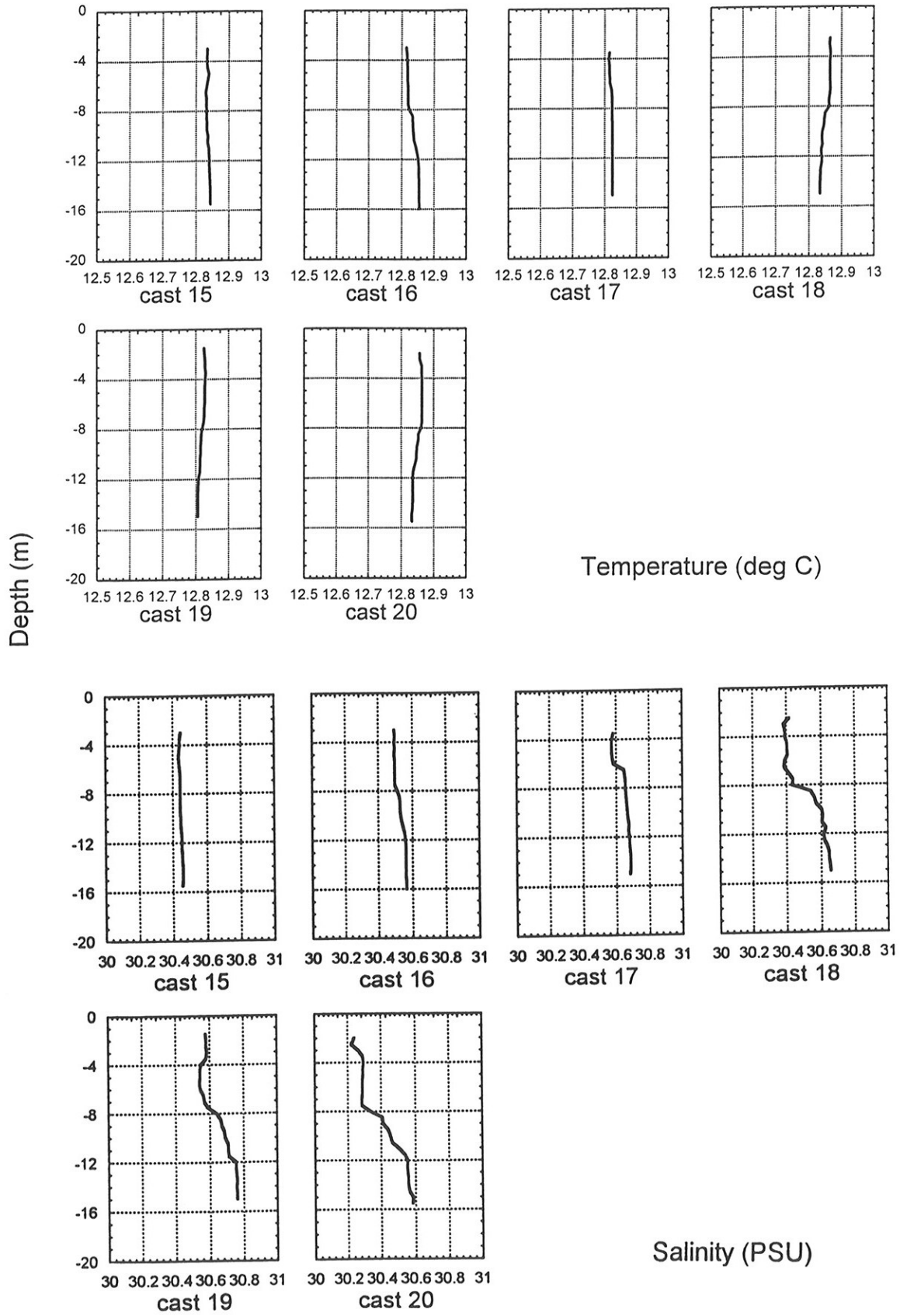
13 hour cycle : casts 01 - 14



Backscatterance (OBS)

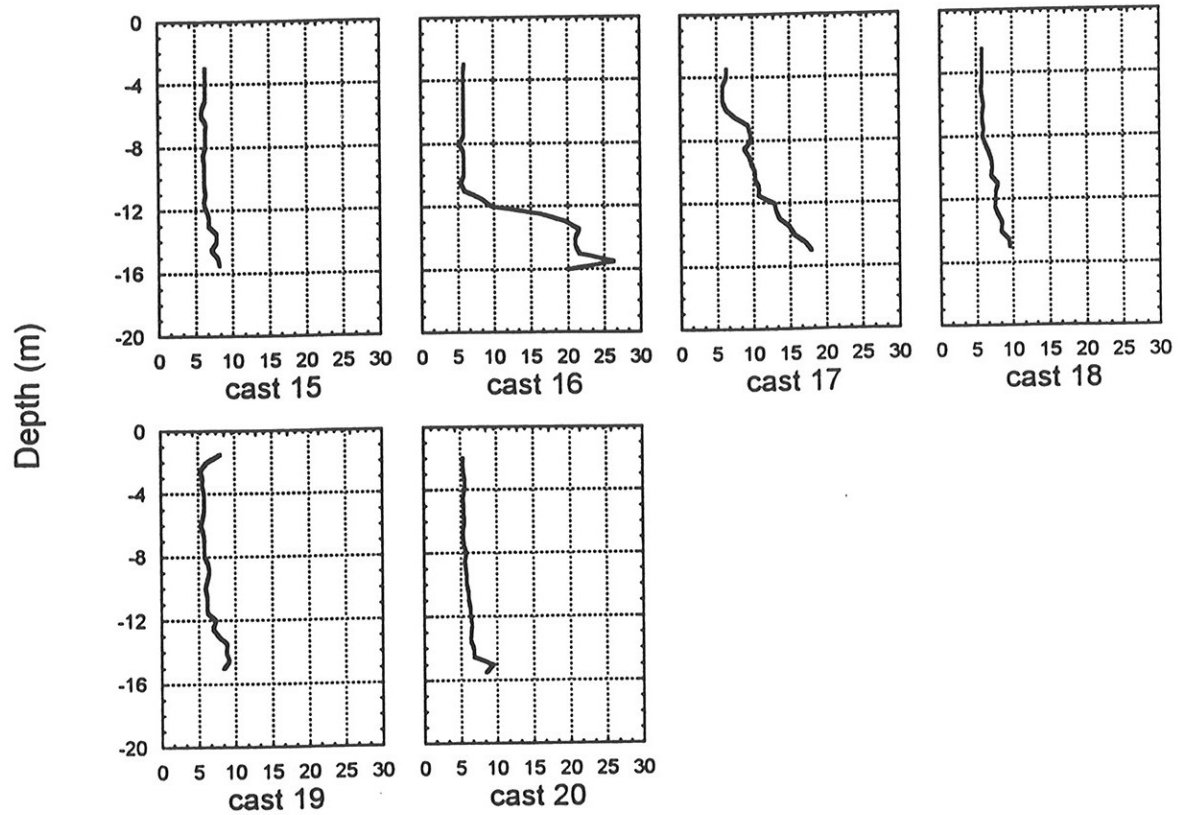
# CTD Profiles cruise 99/12 PROVESS

6 hour cycle casts 15 - 20



# CTD Profiles cruise 99/12 PROVESS

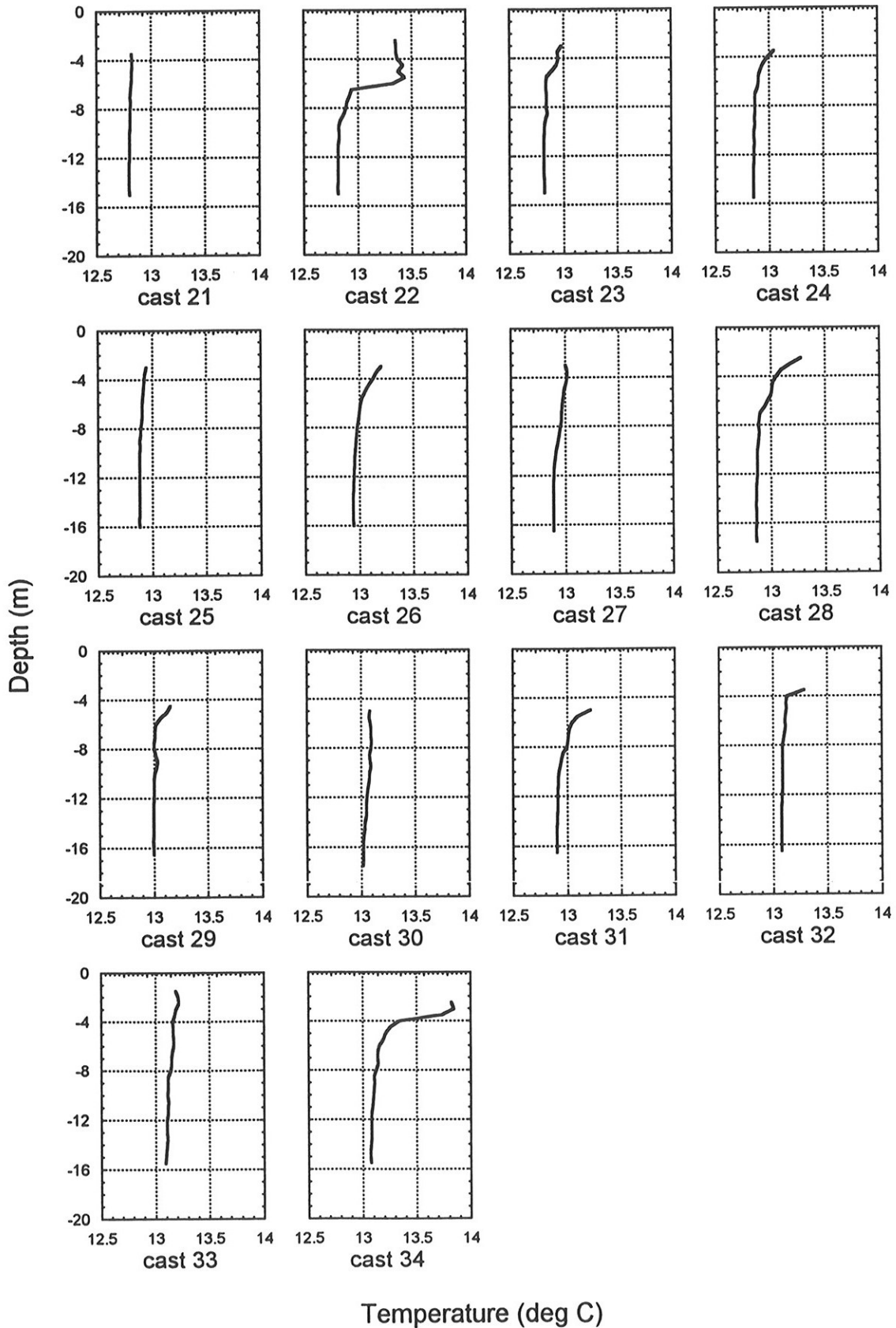
6 hour cycle casts 15 - 20



Backscatterance (OBS)

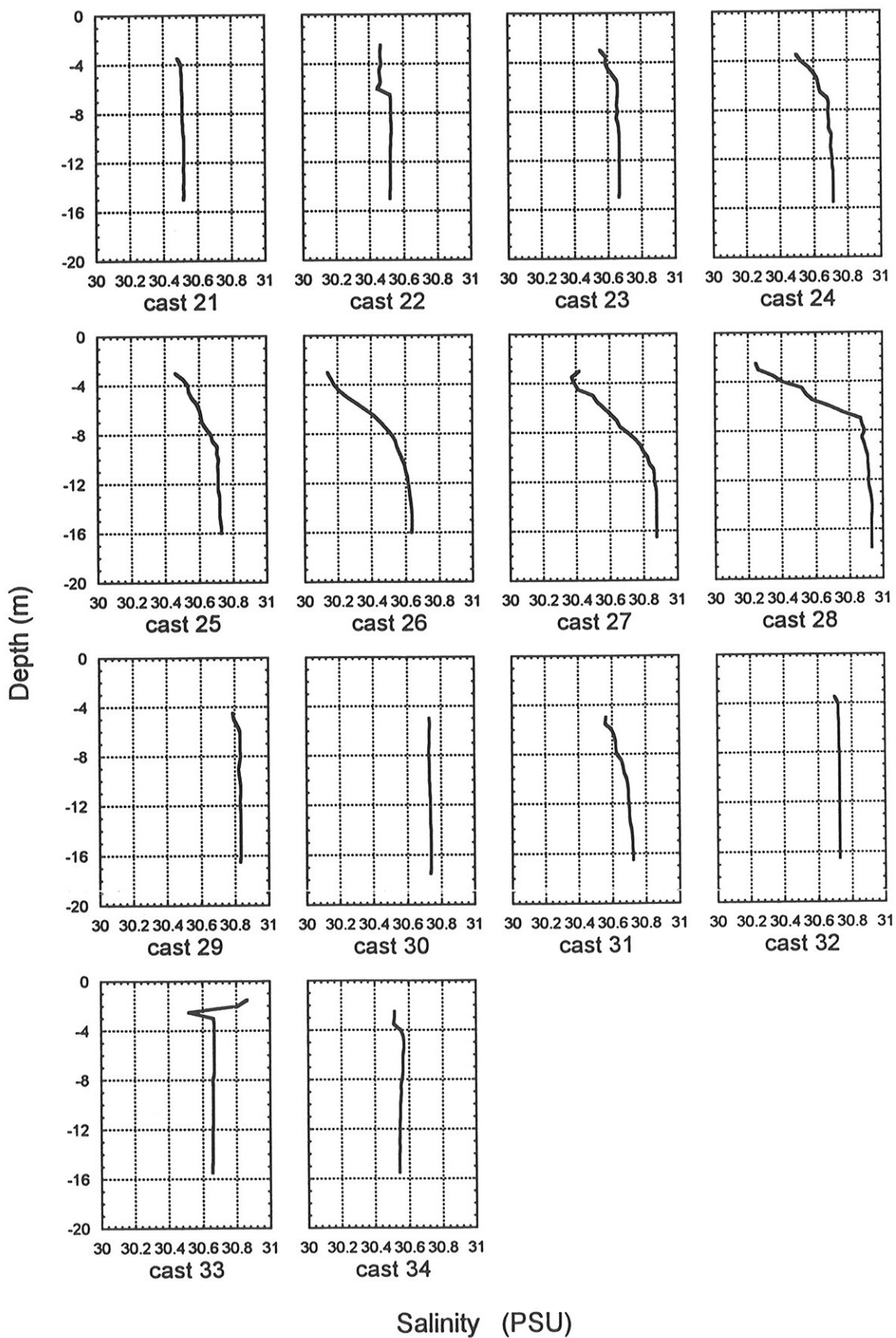
# CDT Profiles cruise 99/12 PROVESS

25 hour cycle casts 21 - 34



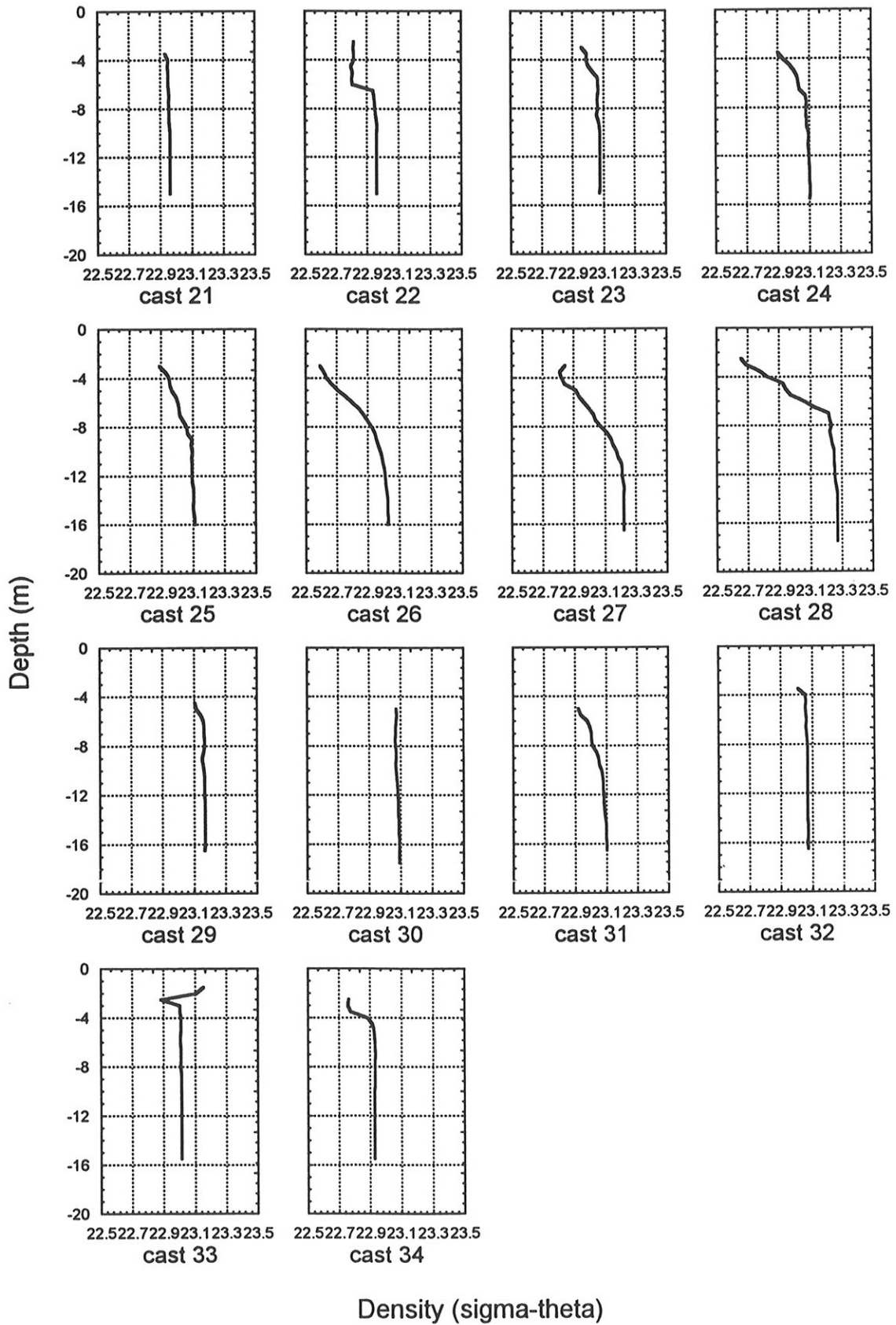
# CTD Profiles cruise 99/12 PROVESS

25 hour cycle casts 21 - 34



# CTD Profiles cruise 99/12 PROVESS

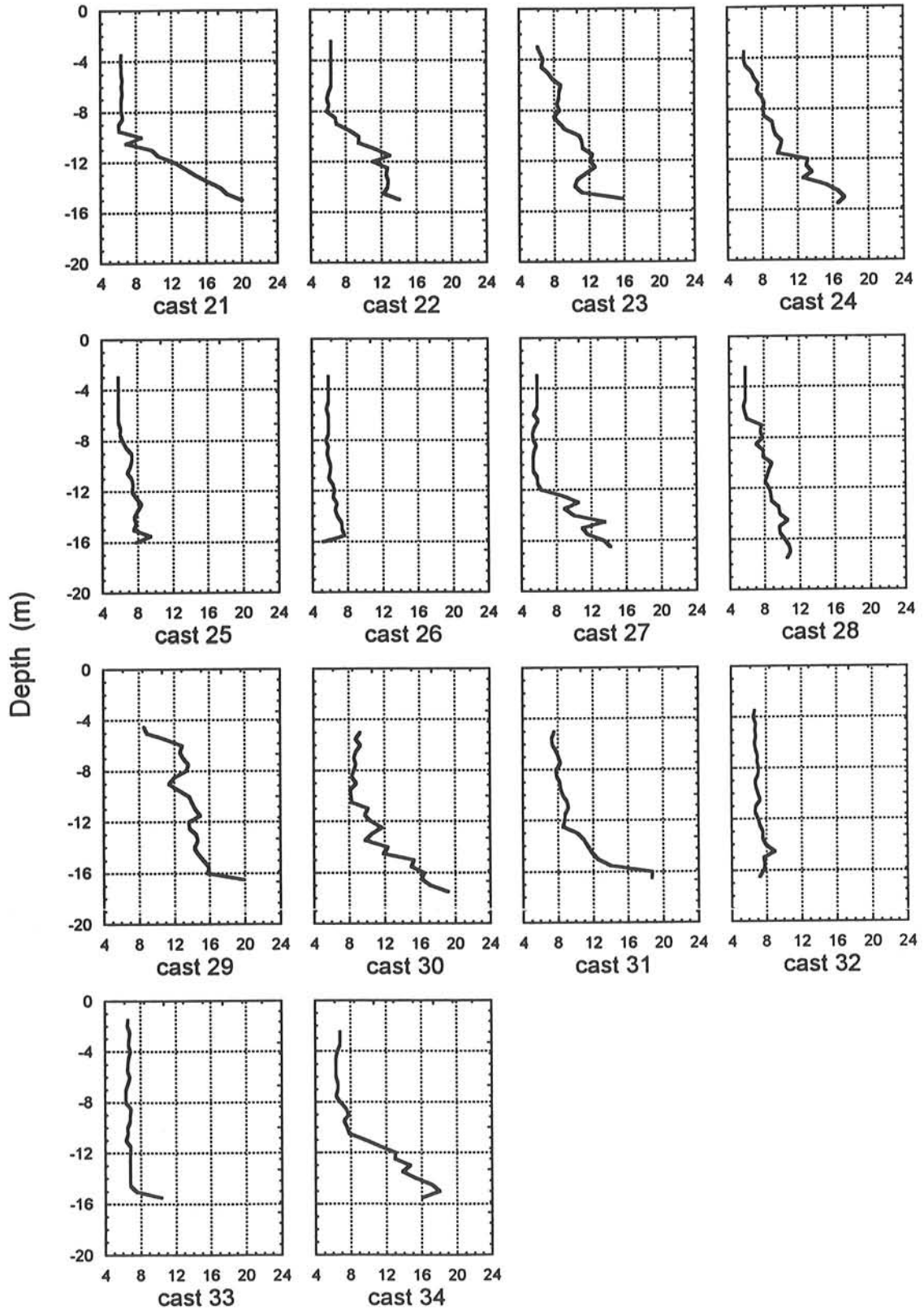
25 hour cycle casts 21 - 34





# CTD Profiles cruise 99/12 PROVESS

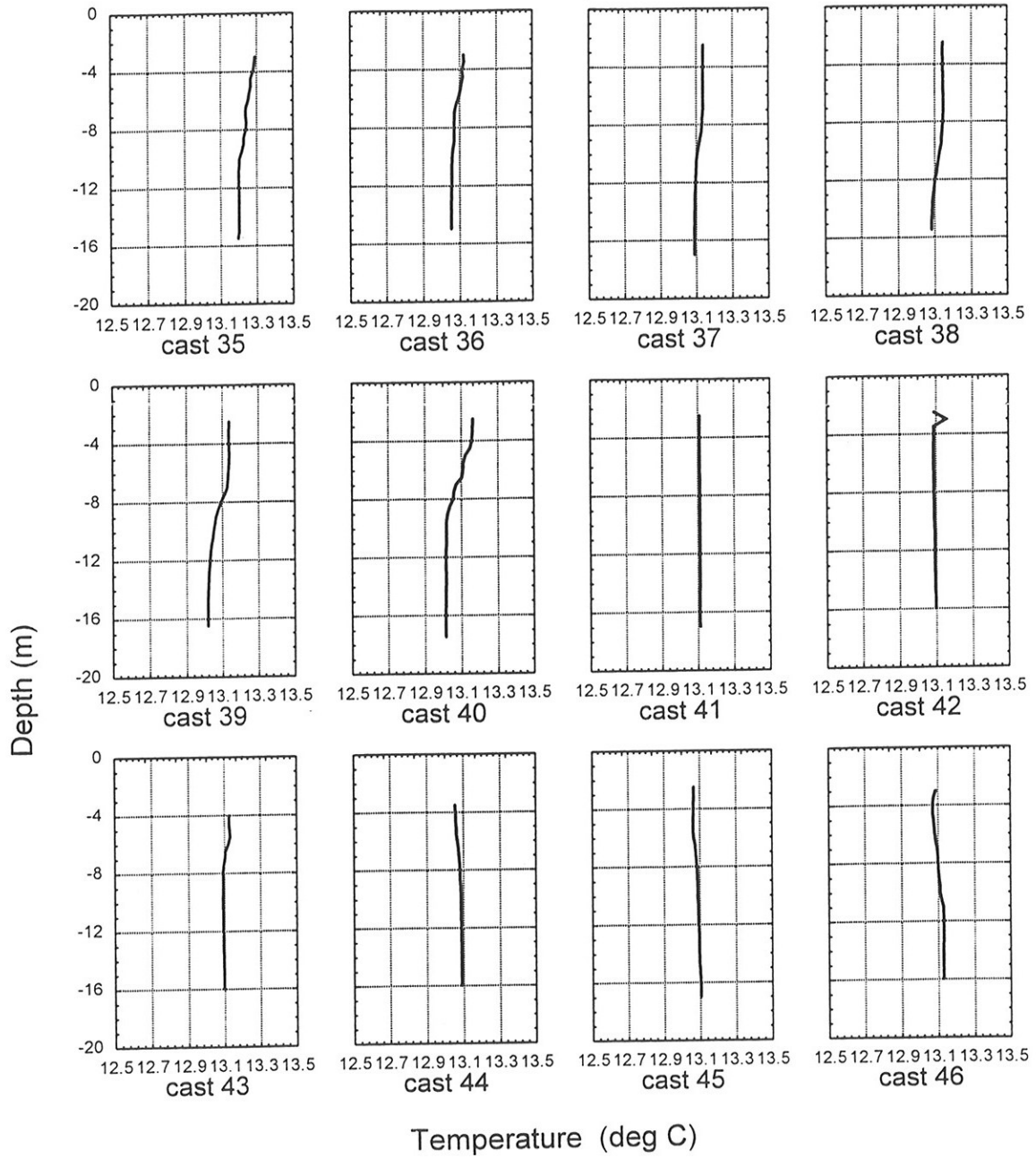
25 hour cycle casts 21 - 34



Backscatterance (OBS)

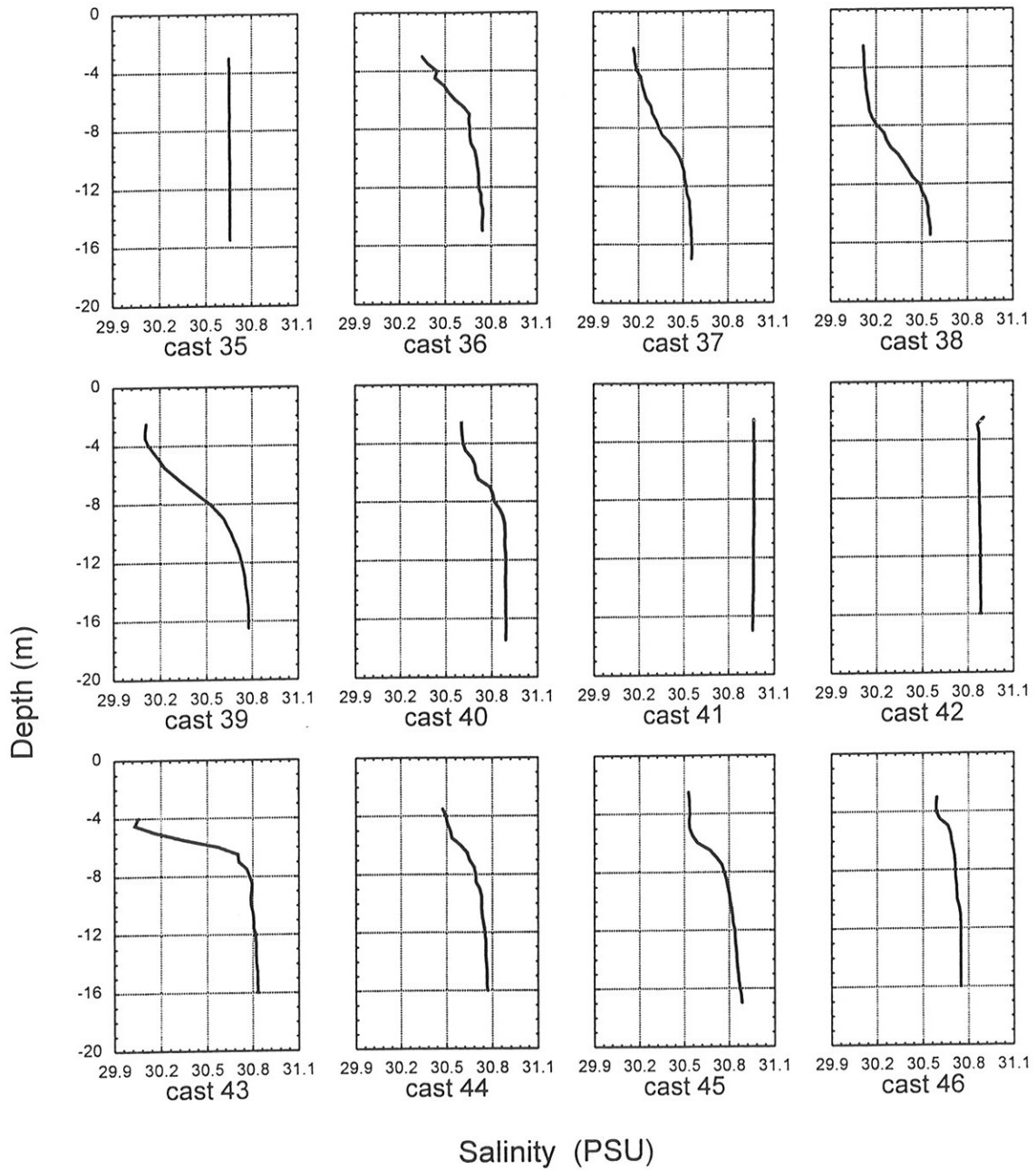
# CTD Profiles cruise 99/12 PROVESS

25 hour cycle casts 35 - 46



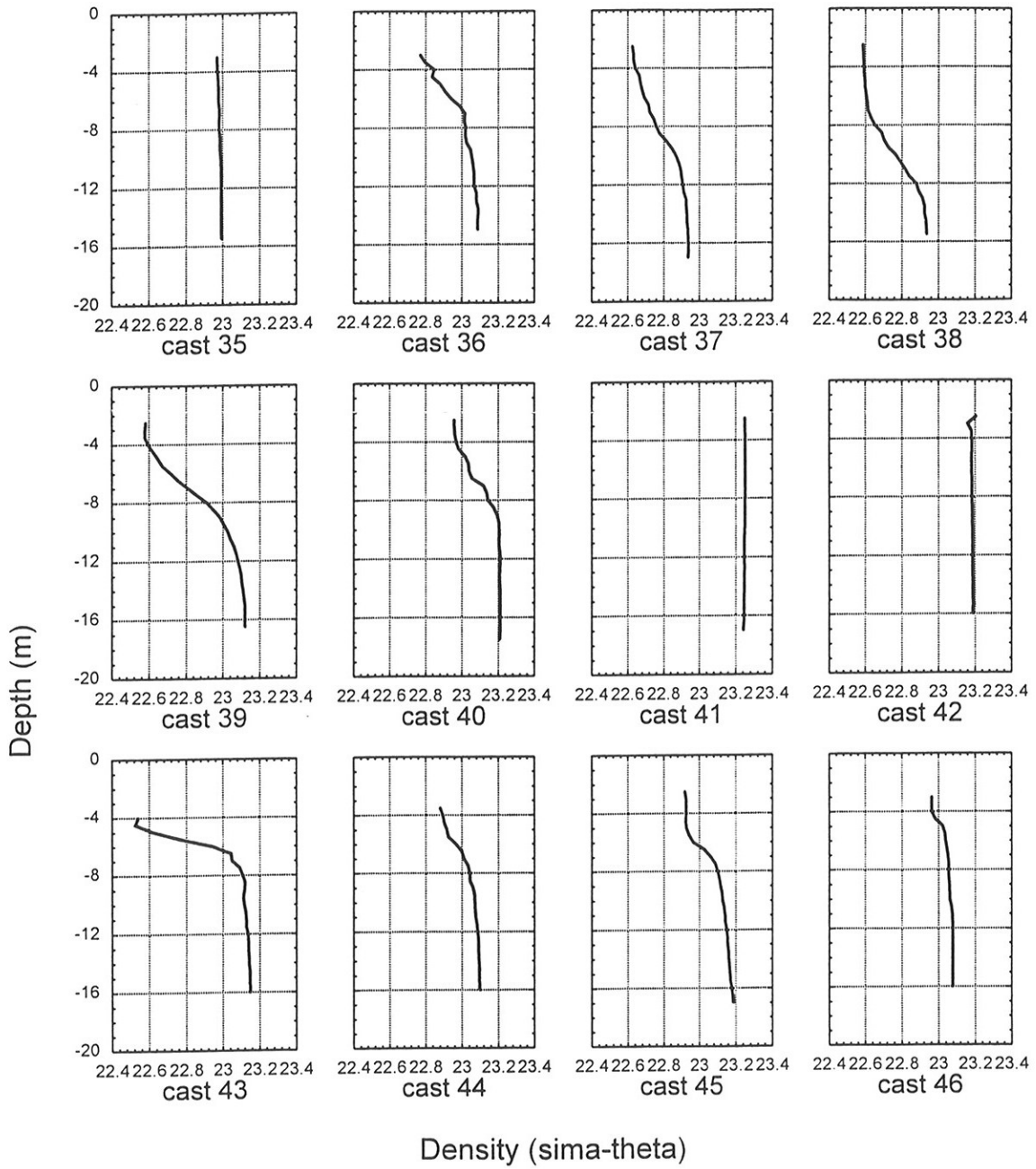
# CTD Profiles cruise 99/12 PROVESS

25 hour cycle casts 35 - 46



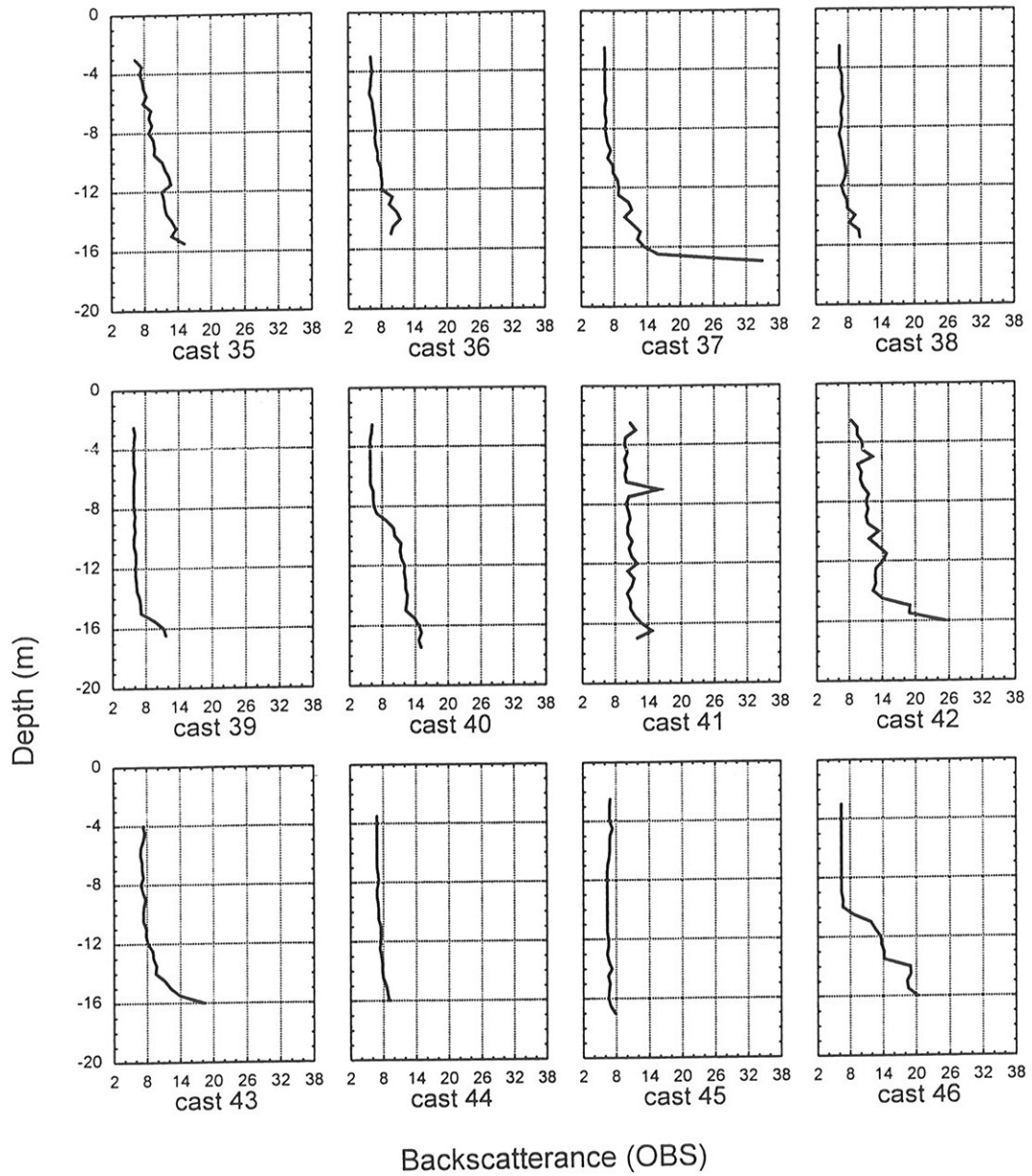
# CTD Profiles cruise 99/12 PROVESS

25 hour cycle casts 35 - 46



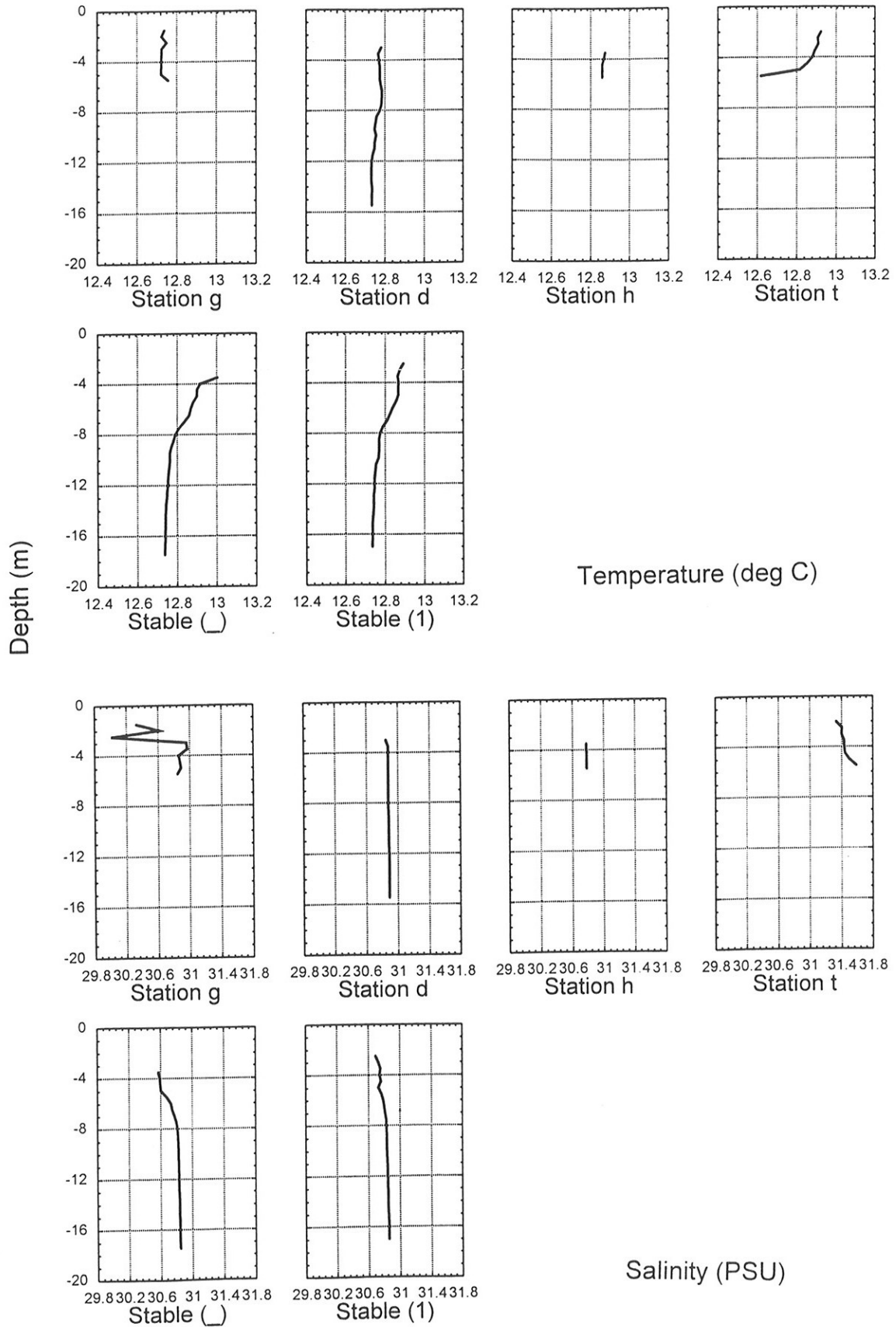
# CTD Profiles cruise 99/12 PROVESS

25 hour cyclc casts 35 - 46



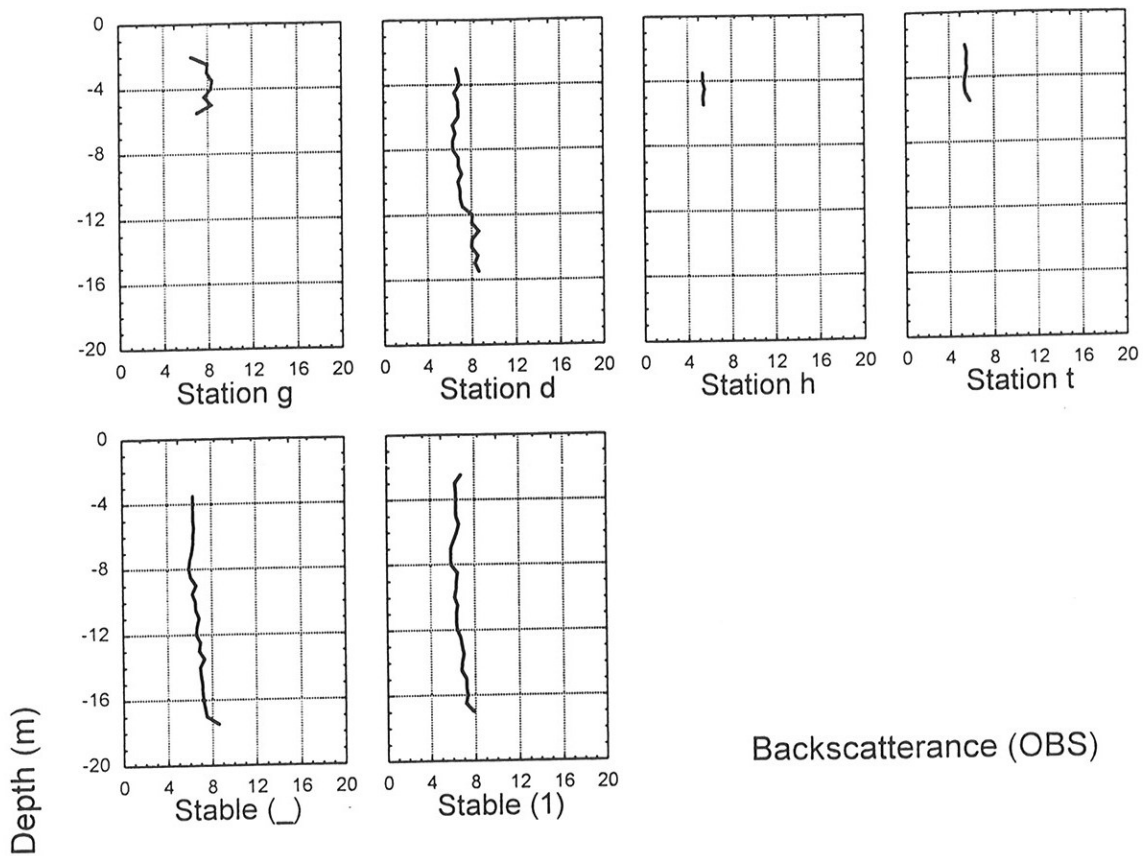
# CTD Profiles cruise 99/12 PROVESS

Mooring stations g, d, h, t, Stable



# CTD Profiles cruise 99/12 PROVESS

Mooring stations g, d, h, t, Stable



## Appendix 6

### Comparison Sea-Bird SBE09plus versus Guildline Portasal salinometer data



Vessel : R/V BELGICA  
 Cruise number : 1999/12  
 Project : PROVESS

Comparison Salinity Guildline Portasal 8410 - Sea-Bird SBE 09 CTD

Station	Cast	Niskin	Date	Time (UTC)	Salinity Guildline portasal	Salinity SBE 09	Difference Guildline SBE 09
center	1	6	17-May-99	20h15	30.282	30.273	-0.009
	2	7	17-May-99	21h55	30.3558	30.349	-0.0068
	3	7	17-May-99	23h05	30.4213	30.414	-0.0073
	4	1	18-May-99	00h05	30.5221	30.526	0.0039
	5	7	18-May-99	01h02	30.5122	30.503	-0.0092
	6	7	18-May-99	02h00	30.6409	30.635	-0.0059
	7	7	18-May-99	03h10	30.6342	30.625	-0.0092
	8B	7	18-May-99	04h05	30.66	30.655	-0.005
	9	7	18-May-99	05h00	30.4582	30.452	-0.0062
	10	7	18-May-99	06h05	30.5058	30.498	-0.0078
	11	7	18-May-99	07h04	30.2903	30.284	-0.0063
	12	7	18-May-99	08h00	30.4876	30.479	-0.0086
	13	7	18-May-99	09h00	30.1975	30.198	0.0005
	14	7	18-May-99	10h00	30.4152	30.41	-0.0052
G	stat_G	1	18-May-99	11h45	30.7817	30.774	-0.0077
H	stat_H	1	18-May-99	14h08	30.7847	30.784	-0.0007
T	stat_T	1	18-May-99	15h58	31.5257	31.533	0.0073
center	15	7	18-May-99	20h32	30.4459	30.44	-0.0059
	17	7	18-May-99	23h03	30.5928	30.57	-0.0228
	18	7	19-May-99	00h00	30.4229	30.396	-0.0269
	19	7	19-May-99	01h04	30.5708	30.559	-0.0118
	20	7	19-May-99	02h00	30.298	30.271	-0.027
Stable	stable1	1	19-May-99	09h10	30.857	30.858	0.001
	stable1	7	19-May-99	09h10	30.6599	30.648	-0.0119
center	21	7	19-May-99	10h04	30.5098	30.502	-0.0078
	22	7	19-May-99	11h04	30.4898	30.466	-0.0238
	23	7	19-May-99	12h05	30.6026	30.563	-0.0396
	24	7	19-May-99	13h06	30.5708	30.511	-0.0598
	25	1	19-May-99	14h06	30.705	30.733	0.028
	28	1	19-May-99	17h00	30.7931	30.933	0.1399
	29	1	19-May-99	18h00	30.8376	30.829	-0.0086
	30	1	19-May-99	19h05	30.7448	30.737	-0.0078
	31	1	19-May-99	20h05	30.7065	30.725	0.0185
	32	7	19-May-99	21h00	30.7144	30.696	-0.0184
	33	7	19-May-99	22h00	30.6707	30.665	-0.0057
	34	7	19-May-99	23h00	30.5509	30.558	0.0071
	35	7	20-May-99	00h05	30.6701	30.664	-0.0061
	36	7	20-May-99	01h00	30.4245	30.354	-0.0705
	37	1	20-May-99	02h00	30.5478	30.564	0.0162
	39	7	20-May-99	04h00	30.2485	30.091	-0.1575
	41	1	20-May-99	06h03	30.968	30.956	-0.012
	42	7	20-May-99	07h00	30.8824	30.877	-0.0054

During the analysis of the seawater samples, a control standard is analysed too.  
 Control standard : IAPSO standard seawater Ocean Scientific  
 sal : 30.071 cond : 0.87348 (27°C)

Analyse results : 30.0714 30.0712 30.0720 30.0715

1. Comparison salinity Guidline autosal - SBE 09

a. Mean - Standard Deviation - Confidence interval

The Mean	-0.00957
Standard deviation	0.03668
Confidence interval	0.06379
-0.08292 to	

b. Regression

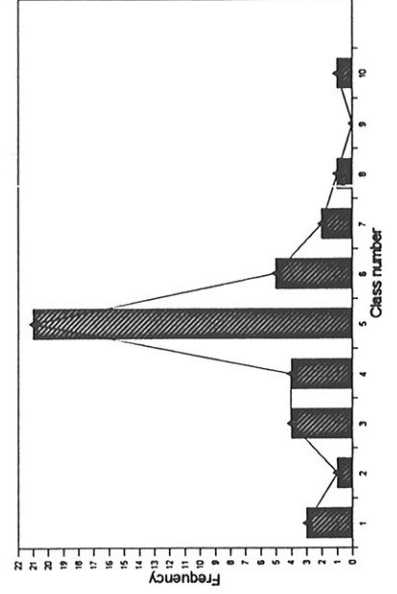
Regression Output:	
Constant	-1.63292
Std Err of Y Est	0.035421
R Squared	0.980214
No. of Observations	42
Degrees of Freedom	40
X Coefficient(s)	1.053061
Std Err of Coef.	0.023656

c. Frequency distribution table

Frequency Distribution Table

Class number	Class boundary	frequency
1	< -0.04	3
2	-0.04	1
3	-0.03	4
4	-0.02	4
5	-0.01	21
6	0.00	5
7	0.01	2
8	0.02	1
9	0.03	0
10	> 0.04	1

CP 1999/12 PROVISS  
 Comparison Guidline - SBE 09



## Appendix 7

### Evaluation of Turner Designs fluorescence data versus analysed discrete chlorophyll a samples.

Vessel : R/V BELGICA  
 Cruise number : 1999/12  
 Project : PROVESS

Evaluation of fluorescence data versus chlorophyll a analysis (Lorenzen method)

Station	Date	Time (UTC)	Fluorescence	Chlorophyll a µg/l	Regression µg/l	Residual µg/l
UW 1	17-May-99	15:00	87	5.31	5.72323692	-0.413237
UW 2	17-May-99	17:00	54	2.05	3.27824478	-1.228245
UW 3	17-May-99	19:00	158	11.03	10.9836746	0.046325
UW 4	17-May-99	21:25	111	7.52	7.50141302	0.018587
Cast 4	18-May-99	00:05	121	7.71	8.24231973	-0.53232
Cast 7	18-May-99	03:10	109	6.89	7.35323168	-0.463232
Cast 10	18-May-99	06:00	105	9.56	7.05686899	2.503131
Cast 13	18-May-99	09:00	70	4.6	4.46369551	0.136304
UW 5	18-May-99	12:00	90	6.63	5.94550893	0.684491
UW 6	18-May-99	15:10	93	7.01	6.16778094	0.842219
Stat_x	18-May-99	18:00	45	1.02	2.61142874	-1.591429
Cast 15	18-May-99	20:32	89	5.31	5.87141826	-0.561418
Cast 18	19-May-99	00:00	82	3.48	5.35278356	-1.872784
Cast 20	19-May-99	02:00	74	3.27	4.7600582	-1.490058
UW 7	19-May-99	07:18	121	7.52	8.24231973	-0.72232
Cast 22	19-May-99	11:04	51	5.48	3.05597277	2.424027
Cast 25	19-May-99	14:06	38	2.76	2.09279405	0.667206
Cast 28	19-May-99	17:02	32	2.25	1.64825002	0.60175
Cast 31	19-May-99	20:05	99	8.79	6.61232497	2.177675
Cast 34	19-May-99	23:00	80	3.88	5.20460222	-1.324602
Cast 39	20-May-99	04:00	36	3.27	1.94461271	1.325387
Cast 43	20-May-99	08:10	54	2.56	3.27824478	-0.718245
Cast 46	20-May-99	11:16	73	4.8	4.68596753	0.114032
UW 8	20-May-99	14:22	43	1.84	2.4632474	-0.623247

Regression Output:	
Constant	-0.72265145
Std Err of Y Est	1.253958273
R Squared	0.789335474
No. of Observations	24
Degrees of Freedom	22
X Coefficient(s)	0.074091
Std Err of Coef.	0.008161