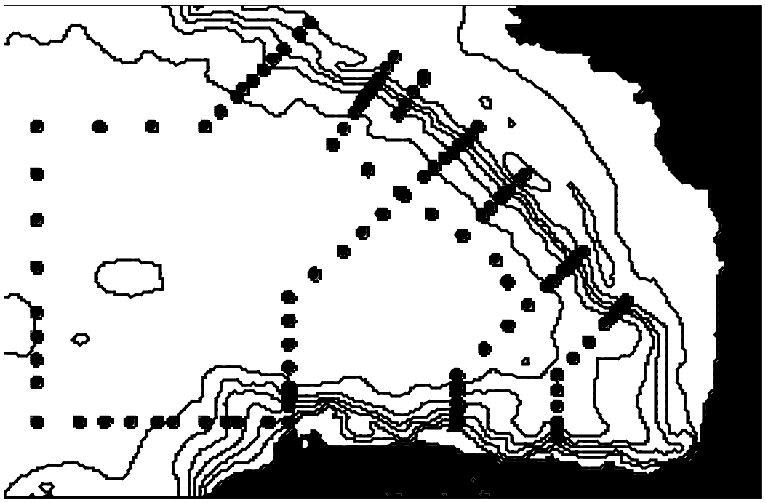
RV Pelagia Cruise Report:

Cruise 64PE95N/1, Project TripleB,

WHP repeat area AR12

H.M. van Aken
Chief Scientist



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NIOZ, Texel, 1996

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The research reported here was funded by the Foundation for Geological, Oceanographic and Atmospheric Research (GOA), subsidiary of the Netherlands Organization for Scientific Research (NWO)

1 Cruise Narrative

1.1 Highlights

a: WOCE Repeat Section AR12, RV Pelagia cruise 95N/1 in the Bay of Biscay

b: Expedition Designation (EXPOCODE): 64PE95N/1

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d: Ship: RV Pelagia, Call Sign: PGRQ
length 66 m.
beam 12.8 m
draft 4 m
maximum speed 12.5 knots

e: Ports of Call: Texel, the Netherlands to Brest, France

f: Cruise dates: July 18, 1995 to August 14, 1995

1.2 Cruise Summary Information

Cruise Track

The cruise was carried out in the Bay of Biscay east of 12°W. The cruise track is shown in figure 1.

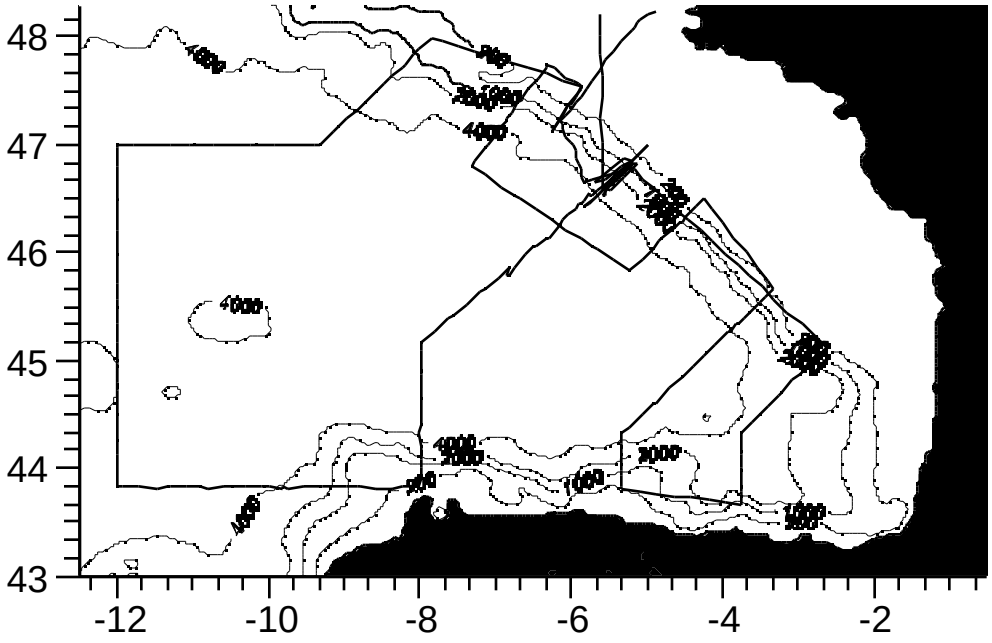

Figure 1. Cruise track in the Bay of Biscay. The topography of the ocean basin is indicated with isobaths, depth im m.

Number of Hydrographic Stations

A total of 106 CTD/rosette casts (figure 2) were occupied along sections A to I, using a General Oceanics rosette, equipped with 24 10-litre NOEX water sample bottles, and a SBE 911+ CTD, equipped with a SensorMedic oxygen sensor, a Sea Tech Inc. 0.25 m path transmissometer and a Chelsea fluorometer. Additional to these CTD-rosette casts 7 CTD-casts were recorded for test purposes, an two CTD-yo-yo stations were occupied. A bottom switch with the weight at 4 m below the CTD sensors was used to indicate the proximity of the bottom.

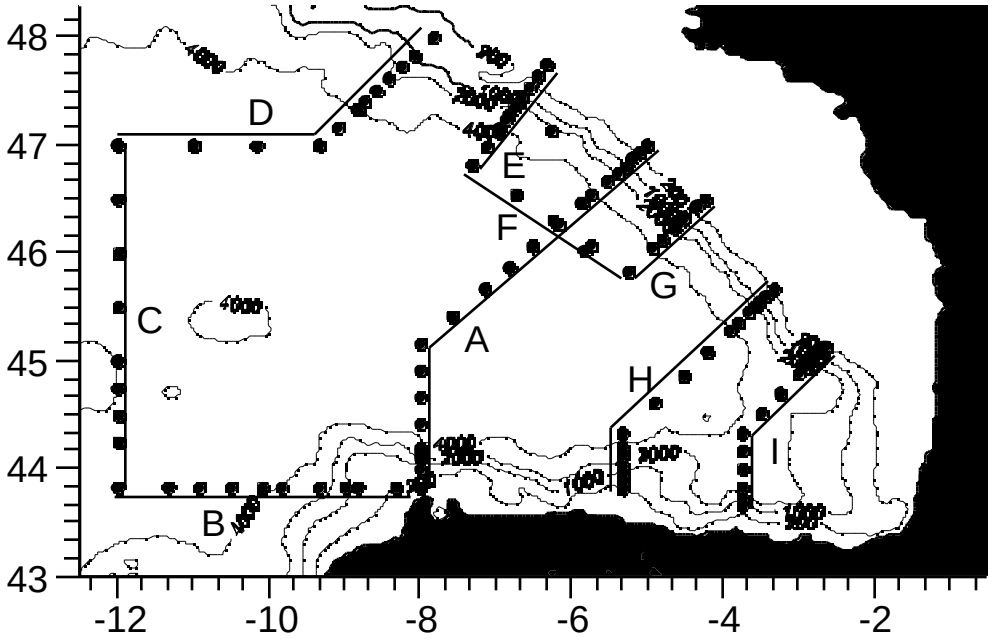

Figure 2. Positions of CTD sections and stations.

Hydrographic Sampling

A total of 1990 water samples was collected. The following water sample measurements were made: salinity, oxygen, silica, nitrite, nitrate, and phosphate. The vertical distance between the samples amounted to 250 m or less, depending on the total water depth (figure 3). The deepest sample from each cast was collected within 10 m from the bottom. On sample bottles 2, 4, 6, and 8 racks with SIS reversing electronic thermometers and pressure sensors were mounted for calibration purposes.

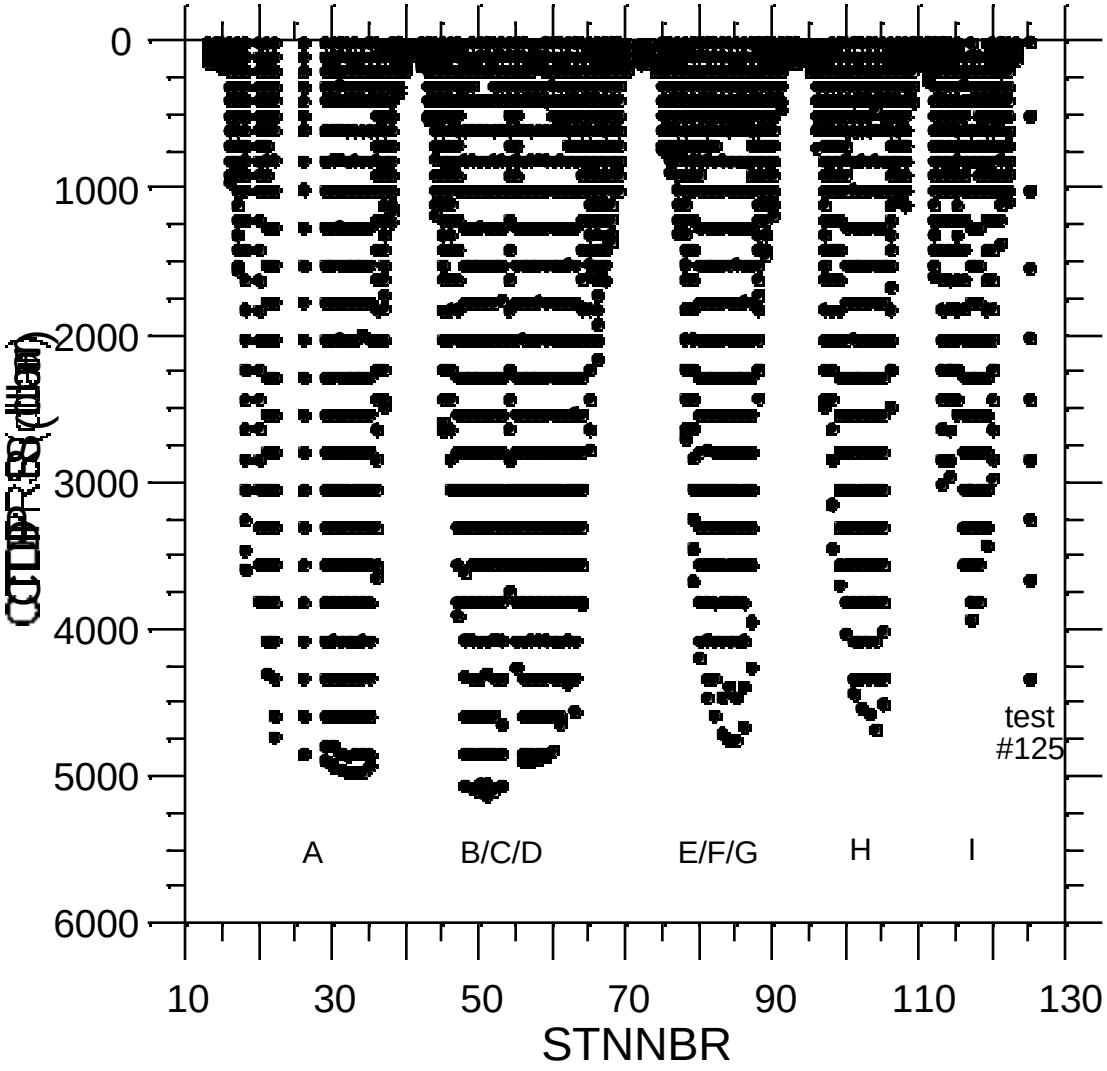

Figure 3. Location of the 10 litre water samples collected during the cruise.

Drifters and Moorings

A total of 10 ARGOS mixed layer surface drifters was deployed (figure 4). These drifters were drogued with a holey sock drogue, centred at de depth of 15 m.

A total of 8 long term current meter moorings were deployed for an intended period of one year (BB1 to BB8). Additional a benthic lander fitted with 2 ADCPs and two thermistor string moorings (T1

and T2) were deployed and recovered for periods of 24 days and 1.5 days respectively. The positions of these moorings is shown in figure 5.

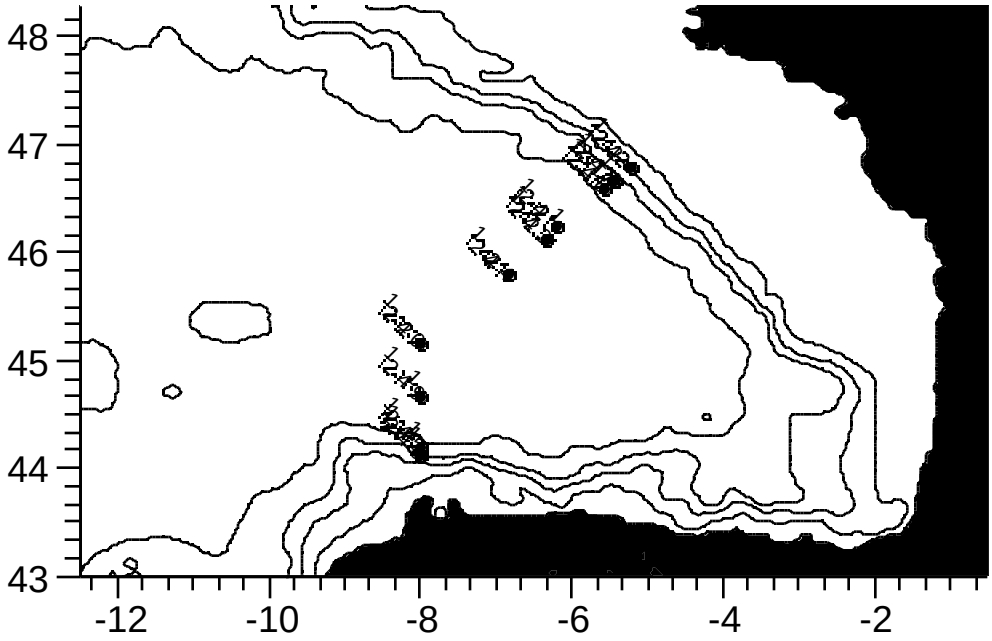

Figure 4. Deployment positions of the ARGOS surface drifters. The labels give the PTT numbers.

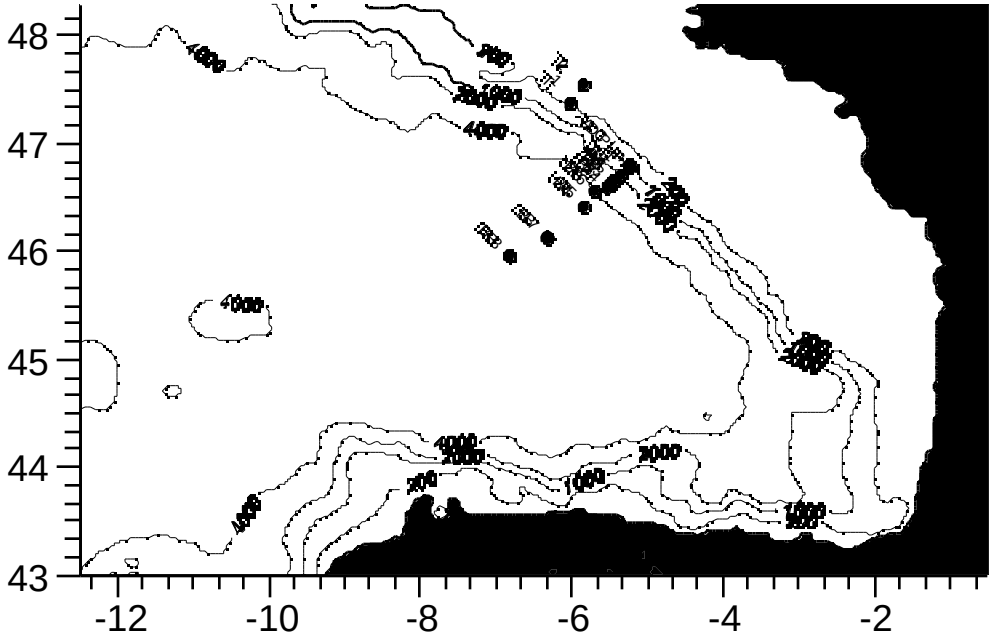

Figure 5. Positions of the moorings, deployed during the cruise. The labels show the mooring identification as used in the *.SUM file.

***.SUM file**

A hard copy of the preliminary *.SUM file describing all stations is added in the appendix B.

1.3 List of Principal Investigators

Name	Responsibility	Affiliation
Dr. H.M. van Aken	Ocean hydrography, ARGOS drifters.	NIOZ/Texel
Drs. C. Veth	Current measurements.	NIOZ/Texel
Ing. S. Ober	CTD & rosette-technology	NIOZ/Texel
Dr. J. van Haren	Boundary mixing	NIOZ/Texel
Drs. F.-P. Lam	Tide-topography interaction	NIOZ/Texel

J. van Haren and F.-P. Lam did not participate during the cruise, but they are responsible for the data processing and interpretation.

1.4 Scientific Programme and Methods

The goal of the research carried out during the cruise was to establish the structure, course and transport of the eastern boundary current in the Bay of Biscay, as well as the hydrographic structure of the Bay of Biscay and the nearby eastern North Atlantic, as it is affected by the eastern boundary current. For this purpose a hydrographic survey has been carried out in the Bay of Biscay up to 12_W, 8 long term current meter moorings and 10 ARGOS surface drifters have been deployed. The hydrographic survey covers a large part of the WOCE Hydrographic Research Programme repeat area AR12.

The CTD-rosette frame was weighted in order to secure a fast enough falling rate. This package was lowered with a velocity between 1 and 1.5 m/s, except in the lowest 100 m, where the veering velocity was reduced. Measurements during the down-cast went on to within 4 m from the bottom, until the bottom switch indicated the proximity of the bottom. During the up-cast water samples where taken at prescribed depths, when the CTD winch was stopped. After each cast the CTD/rosette frame was placed on deck. Subsequently water samples were drawn for the determination of dissolved oxygen, salinity and nutrients, and the readings of the electronic reversing thermometers and pressure sensor were recorded.

Additional to the main hydrographic research programme ADCP observations have been carried out by means of a benthic lander to study the low frequency turbulent mixing over the continental slope. Short term high frequency temperature observations have been performed with moored thermistor strings and with CTD yo-yos at two different locations to study internal solitons and other internal waves in the seasonal thermocline as well as in the bottom boundary layer over the continental slope, generated by tide-topography interaction.

At test stations previous to station 13 a new type of rosette sampler, fitted with a new type of the NOEX sample bottles underwent its first field test. During part of the CTD-casts the CTD was additionally fitted with a new type of SBE temperature sensor which should reduce the heating of the temperature probe by dissipation in the viscous sub-layer around the sensor. Also experiments have

been carried out with a new type SBE electronic reference thermometer (SBE35) which, in the future, should be the main temperature reference for the CTD temperature sensor.

Preliminary Results

As an example of the hydrography of the Bay of Biscay, observed during the Pelagia cruise we present here the results, as observed along section A from the French continental shelf towards the Spanish shelf. The distribution of the potential temperature (THETA) shows some eddy activity in the permanent thermocline (figure 6). The lowest observed potential temperatures were slightly above 2°C.

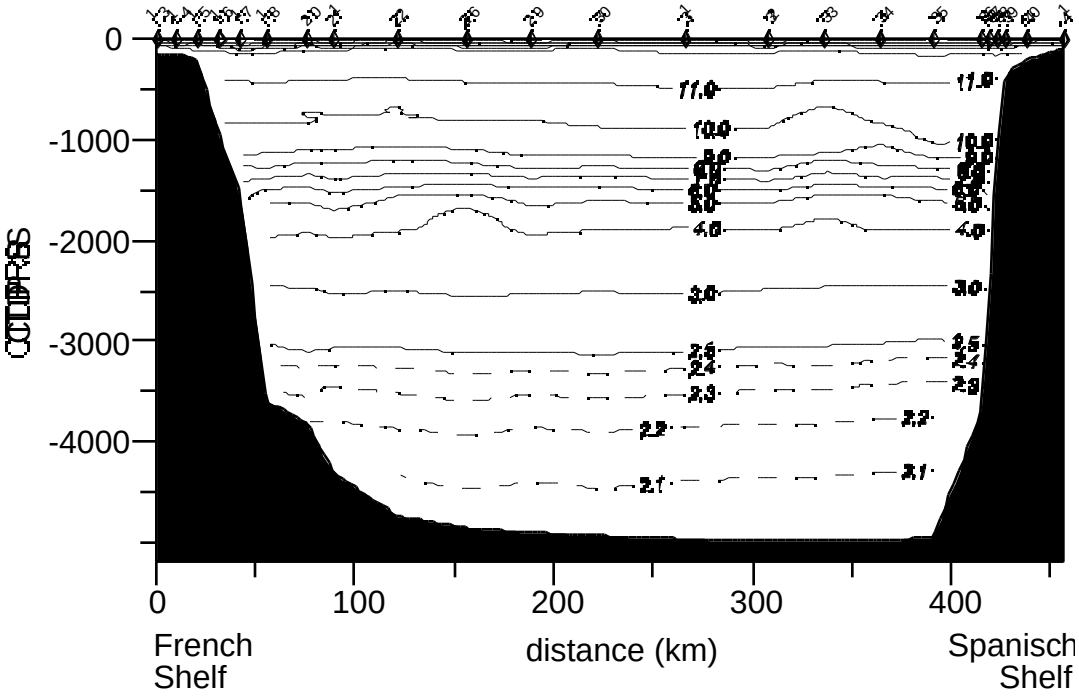

Figure 6. Distribution of potential temperature (THETA) along section A.

The salinity distribution (CTDSAL, figure 7) clearly shows a high salinity core (>35.6) at a pressure of about 1000 dbar, connected with the presence of a core of Mediterranean Sea Water. At about 2000 dbar occasionally low salinity cores are observed (<35.0), connected with the presence, in the north-western part of the Bay of Biscay of cores of Labrador Sea Water.

The geostrophic velocity relative to the γ_Θ=27.88 kg m^{-3} potential density anomaly surface across section A (figure 8) shows a sub-surface eastward inflow over the Spanish continental slope with typical velocities of several tens of cm/s, coinciding with salinities over 35.85 in the Mediterranean Water core. Over the French continental slope a similar sub-surface velocity core is observed, here directed in north-western direction. North of the Spanish continental slope a near surface anti-cyclonic eddy is observed which was already present there about one month earlier (B. Le Cann, pers. comm.).

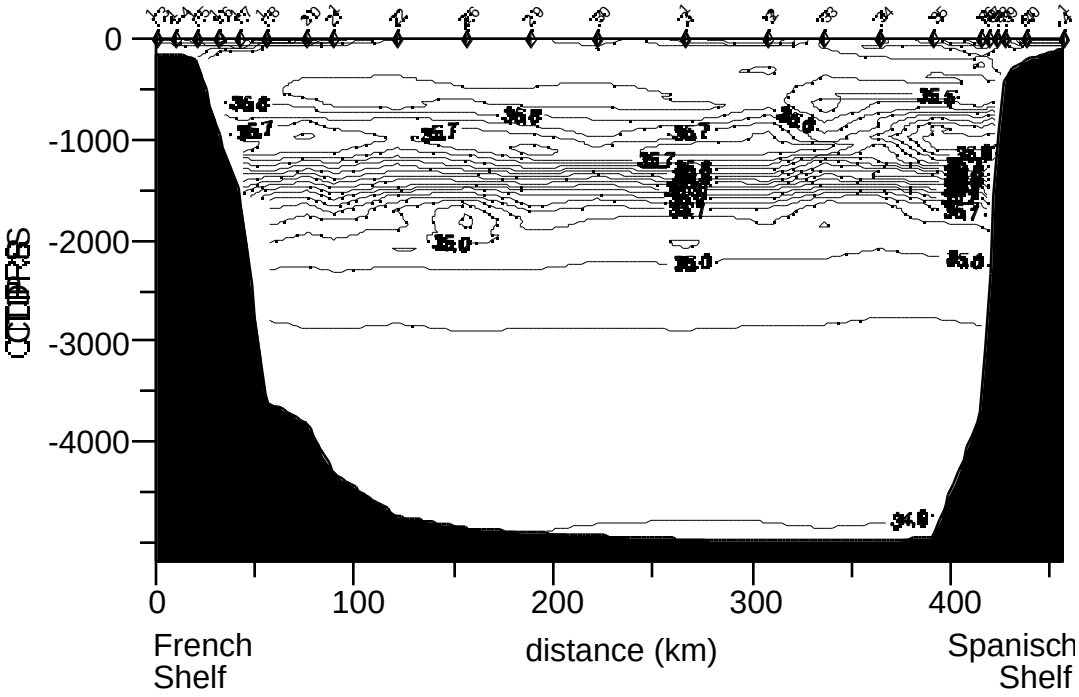

Figure 7. Distribution of salinity (CTDSAL) along section A.

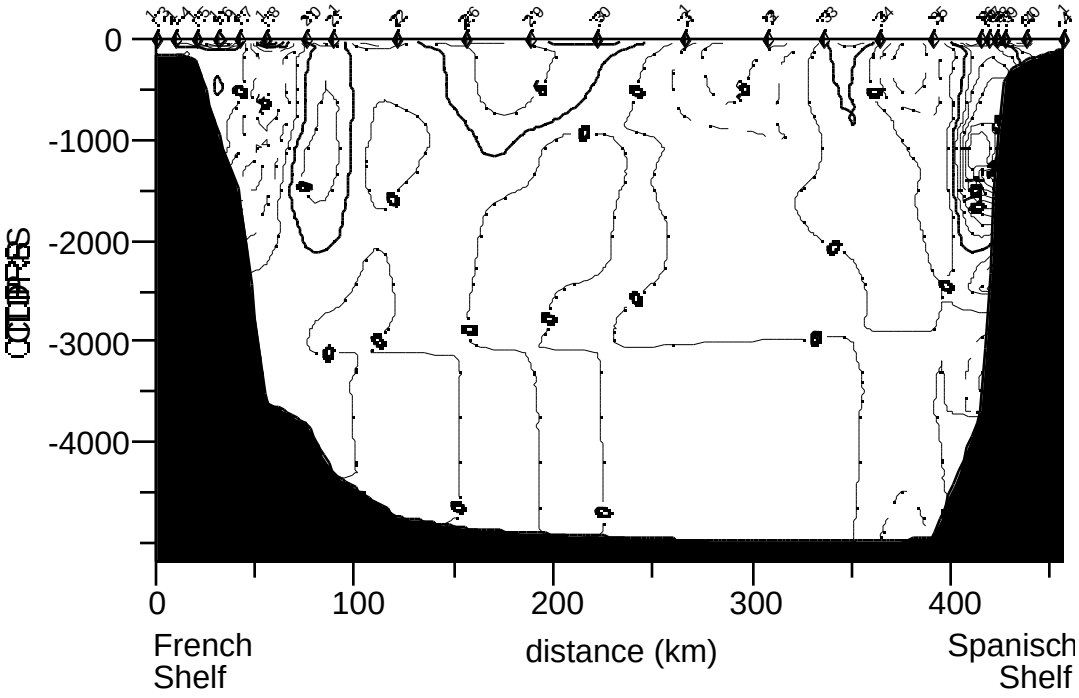

Figure 8. Geostrophic velocity across section A (cm/s), relative to the γ_Θ=27.88 kg/m^3 surface. Positive velocities (full line) are eastwards, negative velocities (dashed lines) are westwards. Contour spacing is 2.5 cm/s.

The distribution of dissolved oxygen (OXYGEN, figure 9) shows minima, connected with the Mediterranean Sea Water core and maxima, connected with the low salinity Labrador Sea water core. The nutrients silica and nitrate (SILCAT & NITRAT, figures 10 and 11) do not show any sub-surface extremes related to either Mediterranean Water or Labrador Sea Water

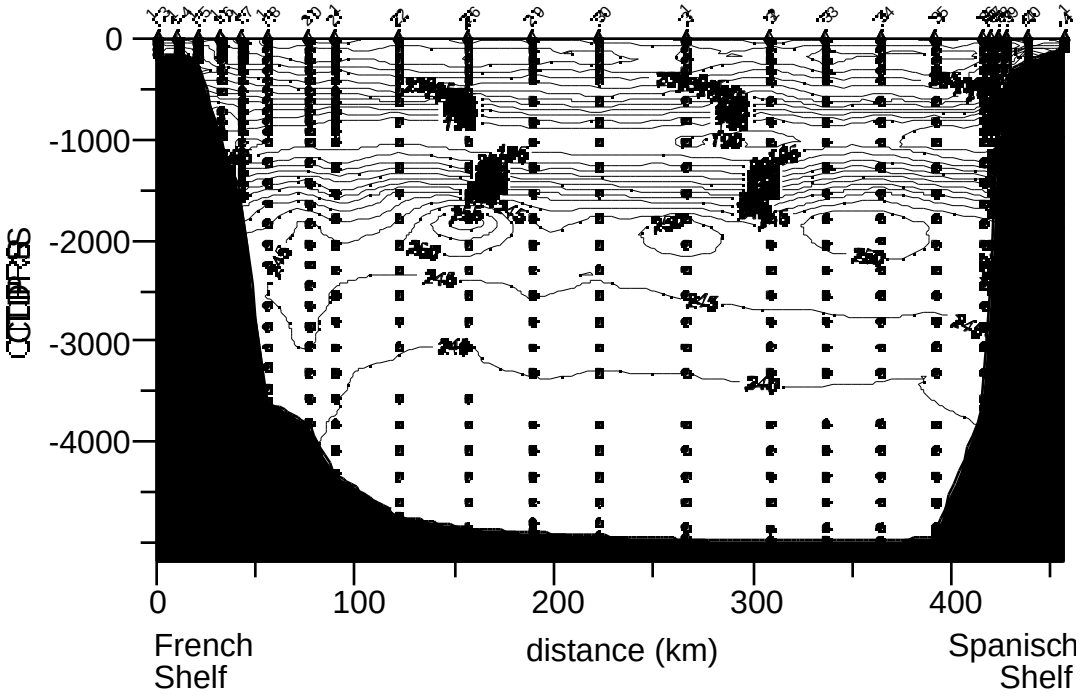

Figure 9. Distribution of dissolved oxygen (average of OXYGEN and CTDOXY) in µmol/kg from water samples along section A.

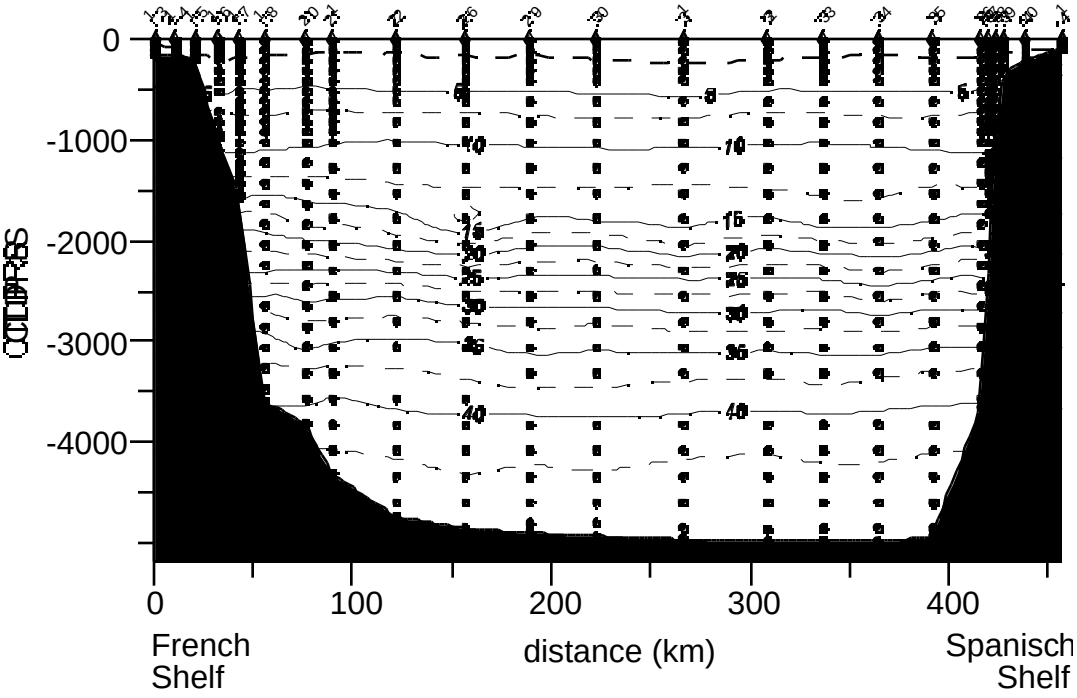

Figure 10. Distribution of dissolved silica (SILCAT) in µmol/kg from water samples along section A.

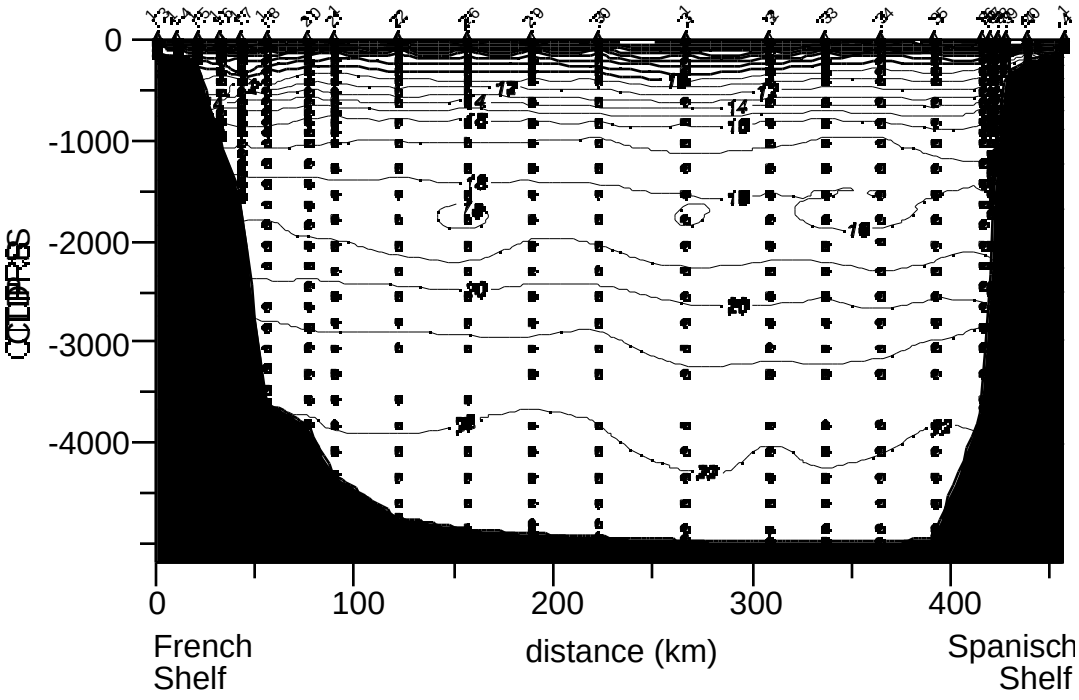

Figure 11. Distribution of dissolved nitrate (NITRAT) in µmol/kg from water samples along section A.

The water mass structure as observed during the cruise can also be discerned from the potential temperature-salinity plot (figure 12) and other potential temperature-property plots (figure 13). Whereas both Mediterranean water and Labrador Sea Water can be recognized from the salinity and oxygen extremes, such maxima and minima are not observed in the nutrients. However the THETA-nutrient

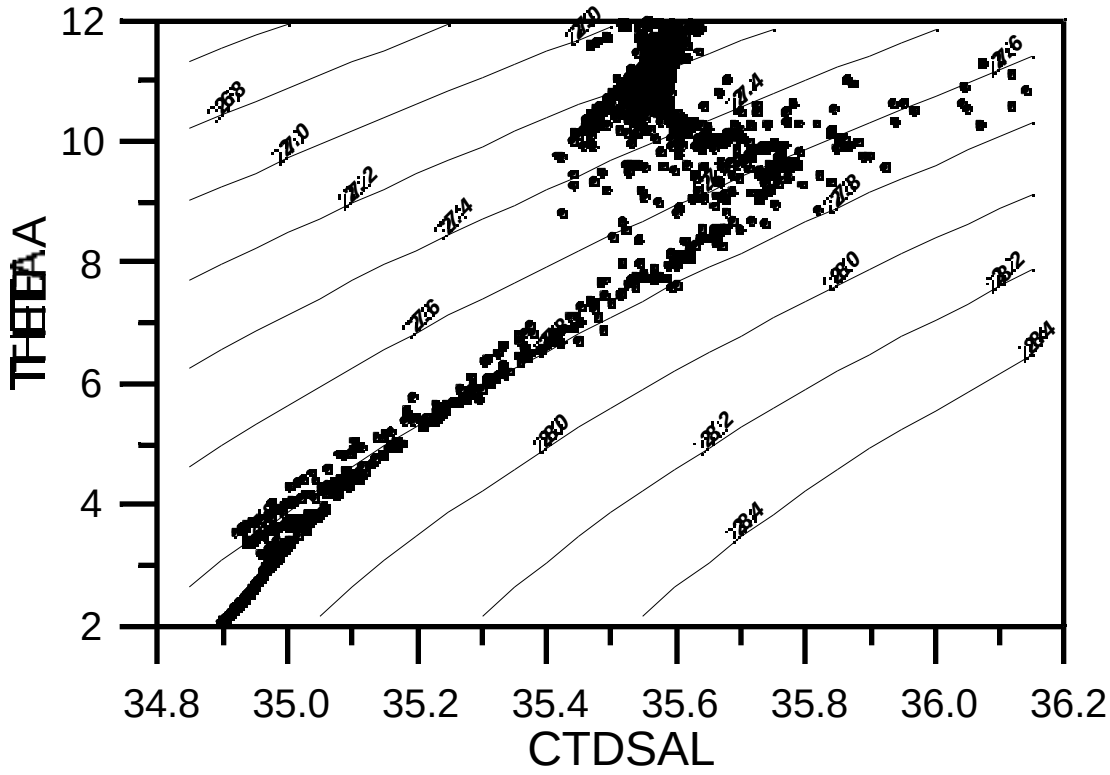

Figure 12. Potential temperature (THETA)-salinity (CTDSAL) diagram for all water samples.

plots still show clear property cores, connected with these water types. The distributions of nitrate and phosphate are highly correlated (figure 13 c, d) but the water below the Labrador Sea Water core, that is Lower Deep Water with a high Antarctic Bottom Water content, have a lower N/P ratio than the shallower water types, well above the canonical Redfield ratio of 16 (figure 14).

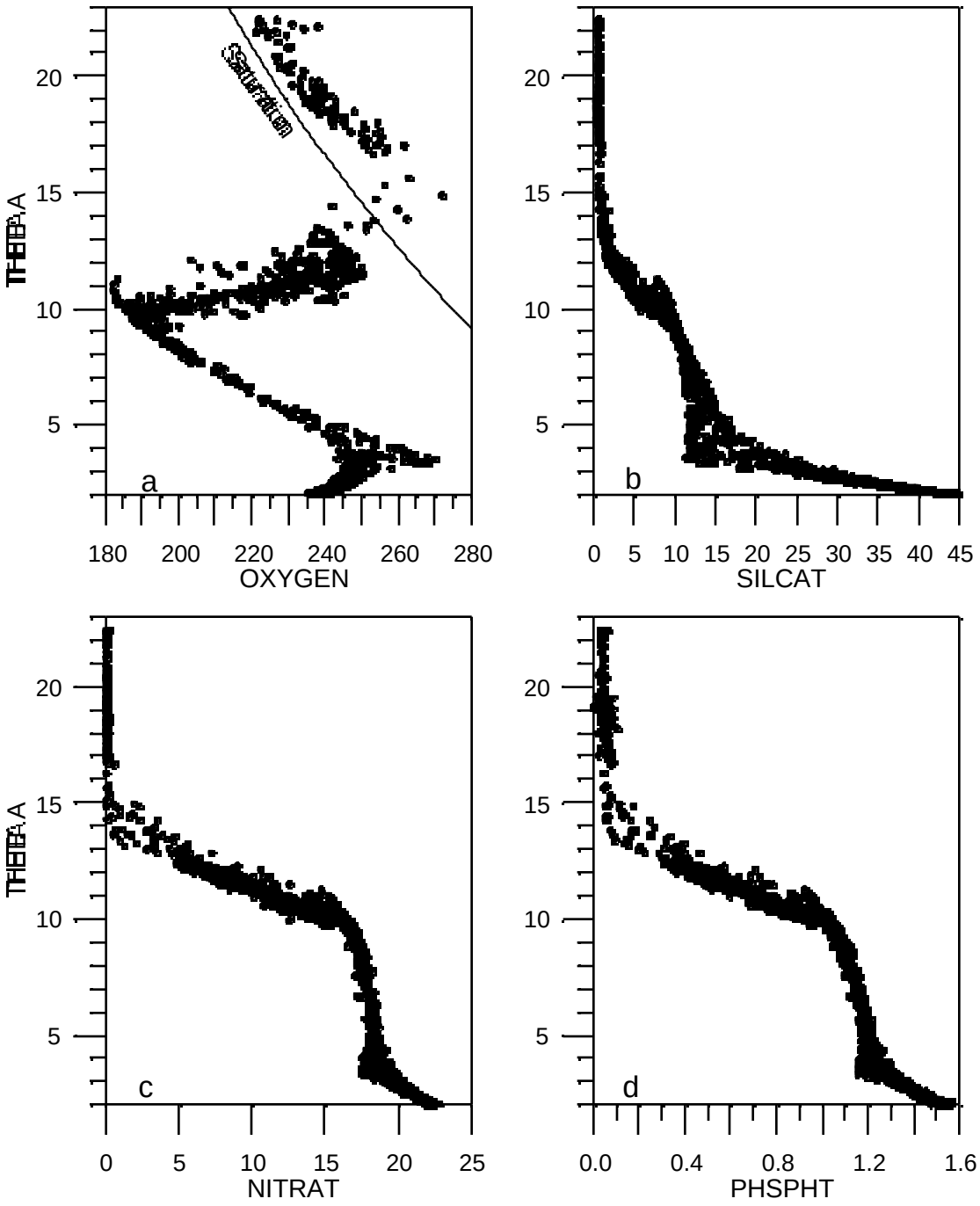

Figure 13. Dissolved oxygen and nutrients in µmol/kg (a, OXYGEN; b, SILCAT; c, NITRAT; d, PHSPHT) versus potential temperature (THETA).

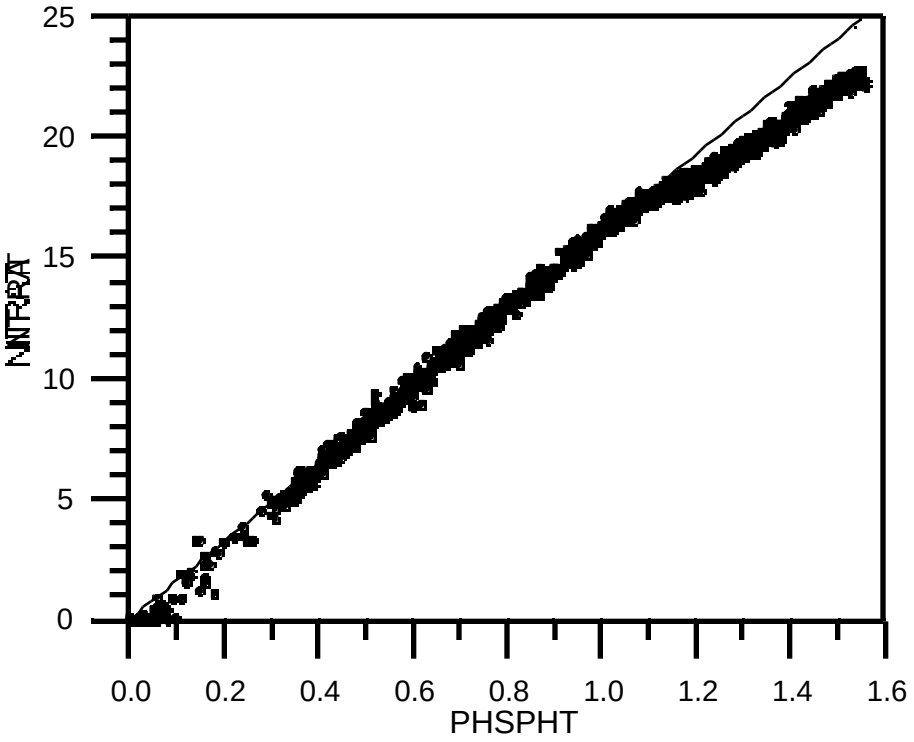

Figure 14. Nitrate (NITRAT) versus phosphate (PHSPHT) for all samples. The dashed line shows the canonical Redfield ratio N/P=16.

1.5 Major Problems Encountered during the Cruise

No major problems were encountered during the cruise. The fair weather during our four weeks in the Bay of Biscay limited the strain on the instrumentation as well as on the personnel.

One of the minor problems was the fact that the shipboard computer network was not completely compatible with the NIOZ network. Recent updates of software, already implemented at NIOZ, were missing aboard Pelagia. The software, generating on-line PC-readable files from the ABC data logging system produced erroneous results on some days, while the format of these file sometimes changed from day to day. This problem was solved by generating dumps of the ABC data under UNIX, which were consecutively transformed to DOS files and reduced to 1 minute average readings, readable by EXCEL, by means of some specially written applications.

A second problem we encountered was the deformation of one of the sides of the newly acquired cable drum of the CTD winch. Due to the partial widening of the spooling width on the drum (~8 mm) the spooling of the cable was not as smooth as wished, but no serious damage to the cable was observed.

1.6 Additional Observations

In order to study the generation of internal solitons in the seasonal thermocline two moorings. fitted with thermistor string (T1 and T2, see figure 5) were moored on the continental shelf, while over the continental slope a 25 hours CTD yo-yo station was occupied on august 1 and 2. Two trains of solitons were observed to pass the yo-yo site, with a time difference of the first soliton of precisely one semi-diurnal tidal period.

A deep CTD yo-yo, covering the lowest 400 m over the continental slope below the Mediterranean Water Core was performed for 12.5 hours on August 12. The ship was kept in position with a RMS distance to the central point of about 100 m. The bottom slope amounted about 20%. Strong temperature observations were observed with the character of an internal tidal wave, shoaling on the continental slope.

1.7 Lists of Cruise Participants

Scientific crew

person	**responsibility**	**Institute**
H.M. van Aken	Chief Scientist/ARGOS drifters	NIOZ
C. Veth	Current Measurements/Hydro Watch	NIOZ
J. Thieme	Preparation Current Meters and Lander/Hydro Watch	NIOZ
S. Ober	$CTDO_2$ sytem/Hydro Watch	NIOZ
M. Manuels	Oxygen Determination	NIOZ
M. Hiehle	Salinity Determination/Data Management	NIOZ
K. Bakker	Nutrients	NIOZ
E. van Weerlee	Nutrients	NIOZ
J. Derksen	Data Logging System/Acoustic Releases/Hydro Watch	NIOZ
E. Bos	Mooring Deployment/CTD Winch Operations	NIOZ
C. Willems	Mooring Deployment/CTD Winch Operations	NIOZ
W. Kwak	Oxygen determination	IMAU
M. Zachariasse	Hydro-Watch	IMAU
M. de Graaf	Hydro-Watch	IMAU
C. Reijmer	Salinity Determination	IMAU

Ships crew

A Souwer	captain
M. van Duyn	first mate
A. Schoo	second mate
J. Pieterse	first engineer
J. Seepma	second engineer
C. Stevens	technician
P. Saalmink	technician
D. Benne	cook
R. van der Heide	able seaman

2 Underway Measurements

2.1 Navigation

RV Pelagia has several different navigational systems. We used the Differential GPS receiver for the determination of the position. The data from this receiver were recorded every second in the ABC data logging system. After removal of a few spikes these data were reduced to one minute average positions.

2.2 Echo Sounding

The 3.5 kHz echo sounder was used on board to determine the water depth. The uncorrected depths from this echo sounder was recorded in the ABC data logging system. Over the steepest parts of the continental slope the depth digitizer was occasionally not able to find a reliable depth. Preceding the deployment of the benthic ADCP lander and the current meter moorings on the continental slope a small echo sounder survey was carried out to determine the exact deployment locations.

The SIMRAD EK 500 multiple frequency echo sounder was used to observe the variations in the depth of the scattering layer due to internal waves in the seasonal thermocline. Whenever the ship was near the continental slope data from this instrument were recorded on the ship's computer as well as on a colour printer.

2.3 Thermo-Salinograph Measurements

The Sea Surface Temperature and Salinity (figures 15 and 16) were measured with an AQUAFLOW thermo-salinograph with a water intake at a depth of about 3 m. The primary

calibration of the salinity sensor water samples were taken three times per day. From the salinity determined from these samples a calibration for the cruise has been determined. The RMS value of the difference of the calibrated AQUAFLOW salinity and the water sample salinity amounted to 0.03.

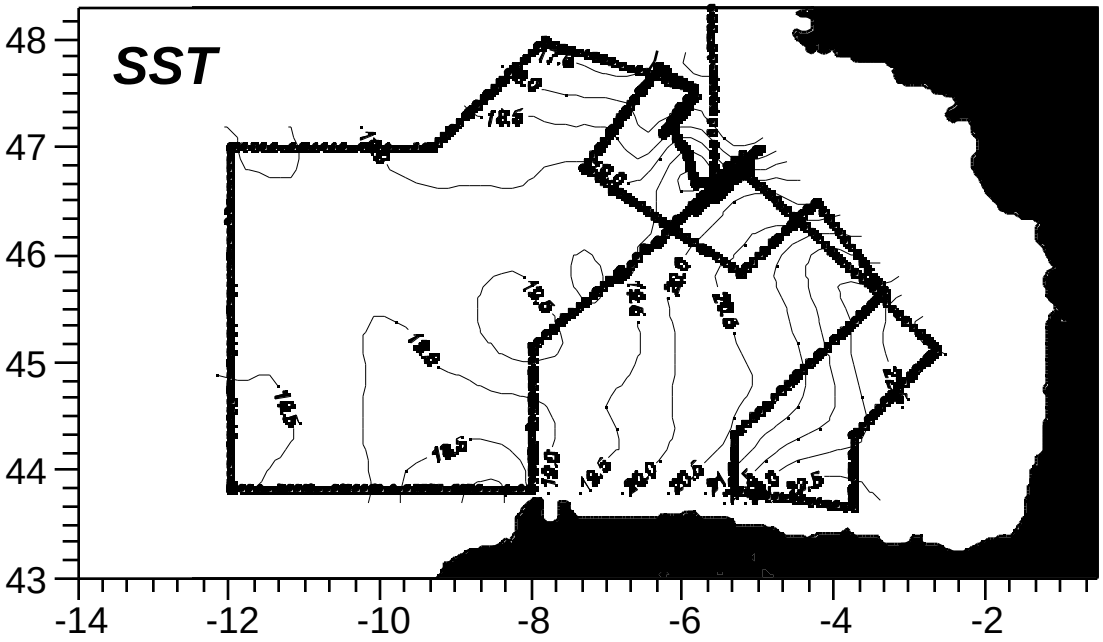

Figure 15. Horizontal distribution of the sea surface temperature, as recorded with the thermo-salinograph. The dots give the ship's position every 30 minutes.

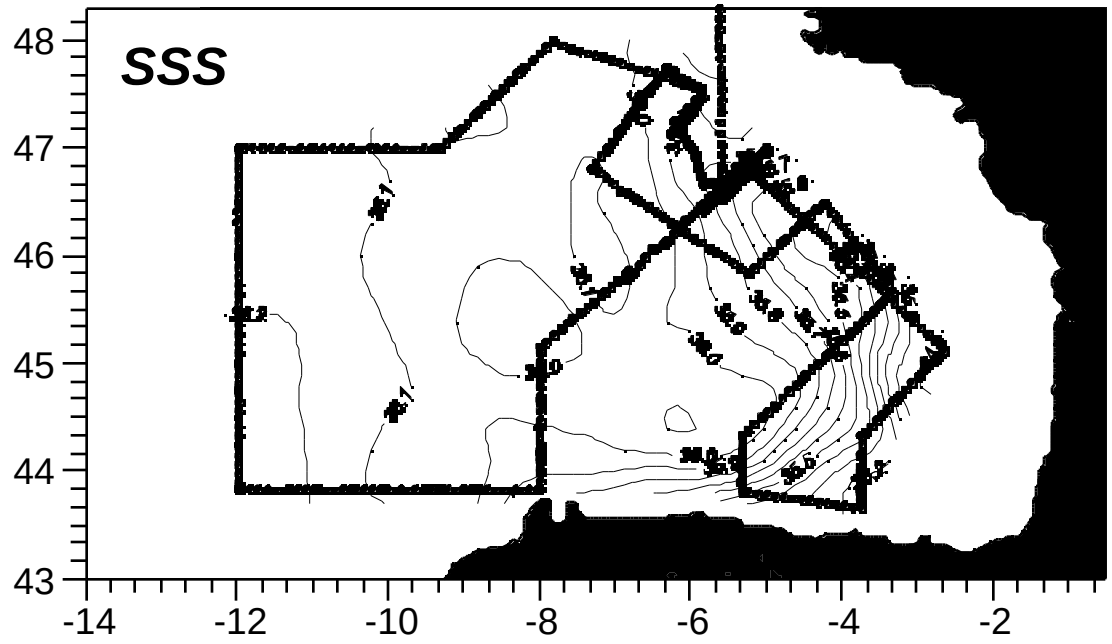

Figure 16. Horizontal distribution of the sea surface salinity, as recorded with the thermo-salinograph The dots give the ship's position every 30 minutes.

The sea surface temperature (SST, figure 15) and the sea surface salinity (SSS, figure 16) as recorded with the thermo-salinograph, show the effects of the very shallow salinity stratification over

the shelves in the south-eastern Bay of Biscay due to river runoff from Spanish and French rivers. Due to the resulting salinity stratification seasonal warming was restricted to a thin surface layer.

3 Hydrographic measurements - Descriptions, Techniques, and Calibrations

3.1 Rosette Sampler and Sampler Bottles

A General Oceanics 24 position rosette sampler was used, fitted with 10 litre NOEX sampler bottles. Their general behaviour was good, but a number of bottles had to be replaced during the cruise. This was mainly because of failure of the silicon rubber tubes of the closing system causing failures of closing in time. The sampling had a resulting failure rate of 6 percent because of malfunctioning of the bottles. No errors in the functioning of the rosette sampler itself could be detected.

3.2 Temperature Measurements

On sampler bottles 2, 4, 6, and 8 thermometer racks were mounted, fitted with SIS electronic reversing thermometers with a numerical resolution of 1 mK. These thermometers were calibrated before as well as after the cruise at the water triple point as well as at a number of other temperatures in the intermediate and deep water temperature range. During the cruise a number of these thermometers were checked in a specially developed water triple point cell. The differences between the radings of paired SIS reversing thermometers amounted to 1.9 mK, suggesting a precision of individual readings of 1.3 mK and of the average of paired readings of about 1.0 mK. The duplicates are given in table 1.

For a total of 334 samples temperatures (REVTMP) were obtained with the SIS electronic reversing thermometers. Of these 53 had to be discarded as outliers, generally connected with either bad duplicates (quality flag 4) or a high background temperature gradient (quality flag 3). The resulting temperatures were in the range from 2.47 to 13.51°C, and were obtained from the sub-surface layer (~50 m) to below 5 km depth. From the comparison of REVTMP and the raw CTDTMP values a pressure dependent calibration was determined of the form:

$$CTDTMP=CTDTMP(raw) - 0.0038 - 1.8\ 10^{-7}*CTDPRS \quad (1)$$

The resulting correction was larger than the manufacturers calibration. This is possibly caused by heating of the temperature probe due to viscous dissipation in a thin sub-layer along the probe in the flushed sensor system. For some time an extra non-flushed temperature sensor was added to the system. The latter gave temperatures which were systematically 3 to 4 mK lower than those from the flushed probe. And also the the SBE35 reference thermometer indicated similar differences. According to the

manufacturer part of the temperature probes may have a slight pressure dependence as we have observed. The manufacturer's calibration is performed without flushing of the sensor.

CTDTMP in all CTD casts was corrected according to (1). The resulting difference between REVTMP and CTDTMP had an RMS value of 2.1 mK (281 samples, figure 17). When only those samples were considered, obtained in the low gradient part of the water column below the Mediterranean Sea Water (CTDPRS > 2500 dbar), the RMS value of the difference was reduced to 1.8 mK (187 samples)

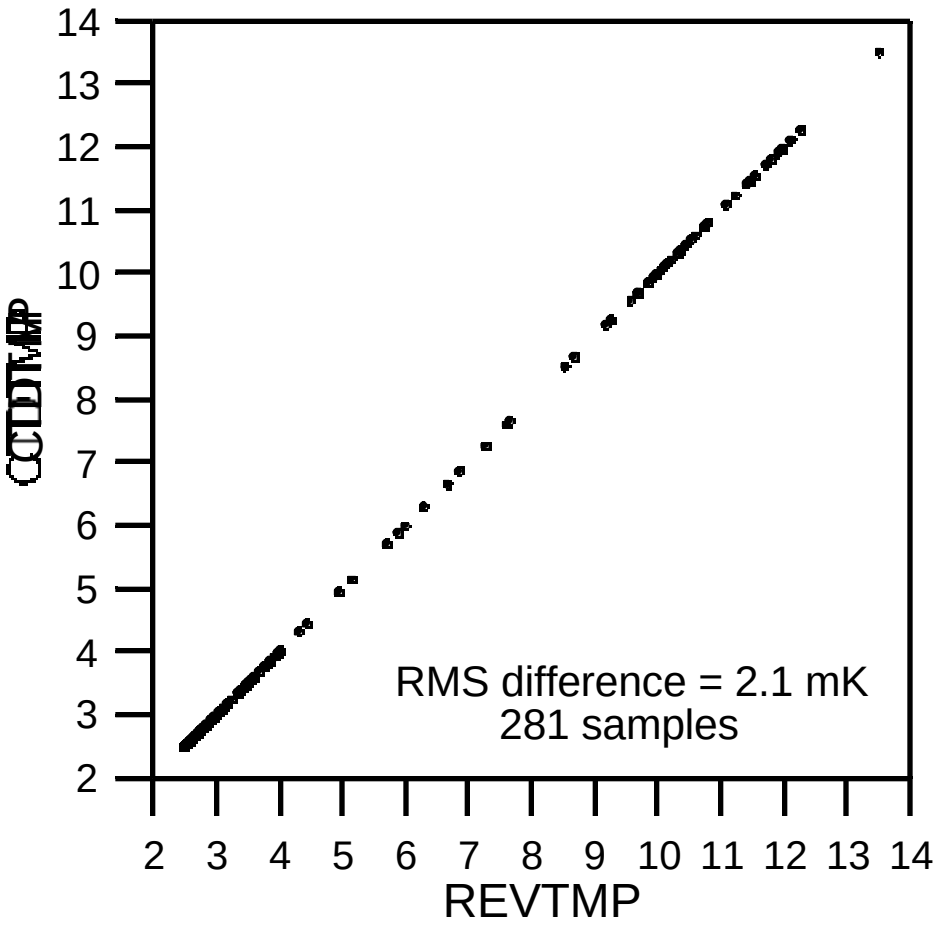

Figure 17. Plot of CTDTMP versus REVTMP for al samples with quality flags 2 or 6.

3.3 Pressure Measurements

In each of the thermometer racks, mounted on sampler bottles 2, 4, 6, and 8, also a SIS electronic reversing pressure sensor was placed. Before as well as after the cruise these sensors were calibrated by the manufacturer. A total of 326 reliable pressures were obtained. The difference between the pressure, as measured with the electronic reversing pressure sensor (REVPRS) and with the CTD (CTDPRS) had a RMS value of 3.3 dbar (figure 18), a value of the order of the manufacturers specification of the accuracy of the SIS reversing pressure sensors after correction for temperature effects. No further correction of the pressure was applied.

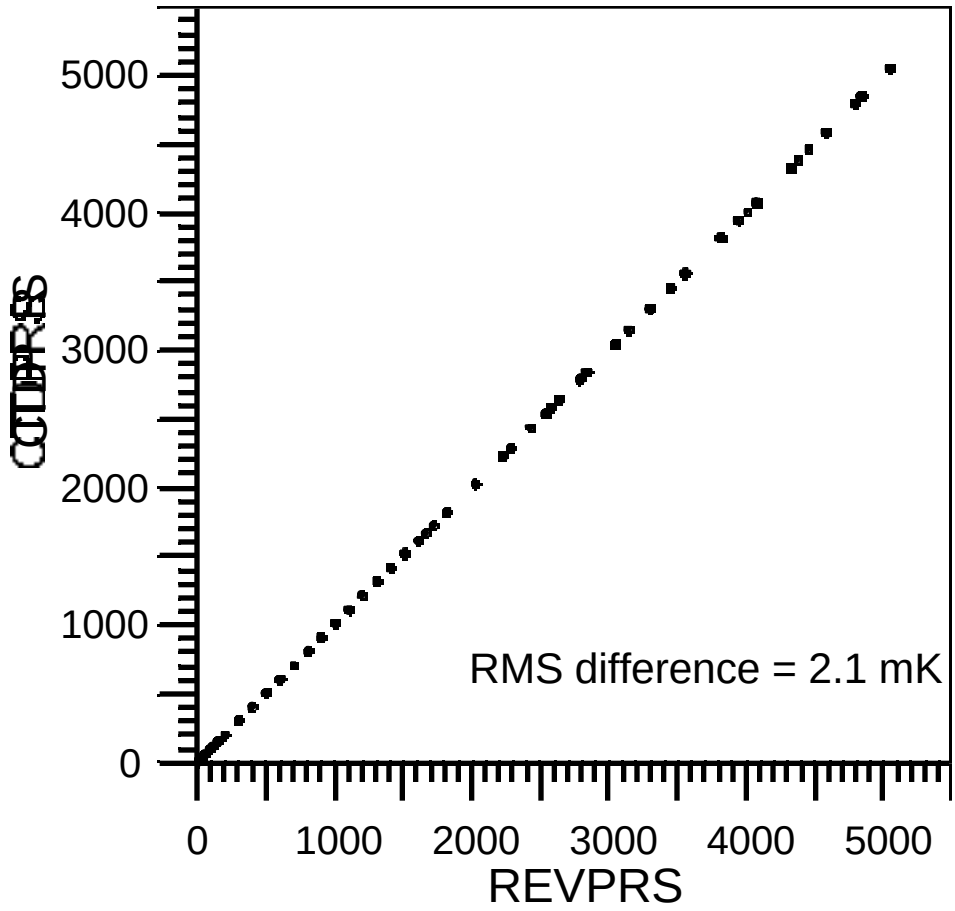

Figure 18. Plot of CTDPRS versus REVPRS for all samples with quality flag 2.

3.4 Salinity Measurements

Water was drawn from the samplers into a 0.5 litre glass sample bottle for the salinity determination after 3 times rinsing. The sample bottles had a massive rubber stopper as well as a screw lid. Salinity of water samples (SALNTY) was determined by means of an Guildline Autosal 8400A salinometer. The readings of the instrument were performed by computer, giving the average and statistics of 10 consecutive readings. For each samples 3 salinity determinations were carried out. The standard water used was from batch P119 with a K_{15} ratio of 0.99990

From each deep CTD/rosette cast an extra duplicate sample was drawn. Salinity determinations from the duplicate samples were used to determine the reproducibility of the salinity determination (table 2). The RMS value the salinity difference between the duplicate samples amounted to 0.0005 (94 samples).

From comparison of CTDSAL with SALNTY 994 samples were available over the whole water column, with values between 34.40 and 36.14. It appeared that the error in CTDSAL was both time (station number) and pressure dependent. Therefore a correction for CTDSAL was applied of the form of:

CTDSAL = CTDSAL(raw) + a + b*CTDPRS + c* STNNBR (2)

For stations 13 to 80 the correction constants a, b an c were -0.0029, 4.4 10^{-7} $dbar^{-1}$ and 7.1 10^{-5} respectively. For stations 81 to 125 no time dependence was found (c=0.0) while a and b amounted to +0.0024 and 4.4 10^{-7} $dbar^{-1}$ respectively. This correction was applied to all CTD salinities. Comparison of the corrected CTDSAL with SALNTY gave a RMS for the difference of 0.0016 (figure 19).

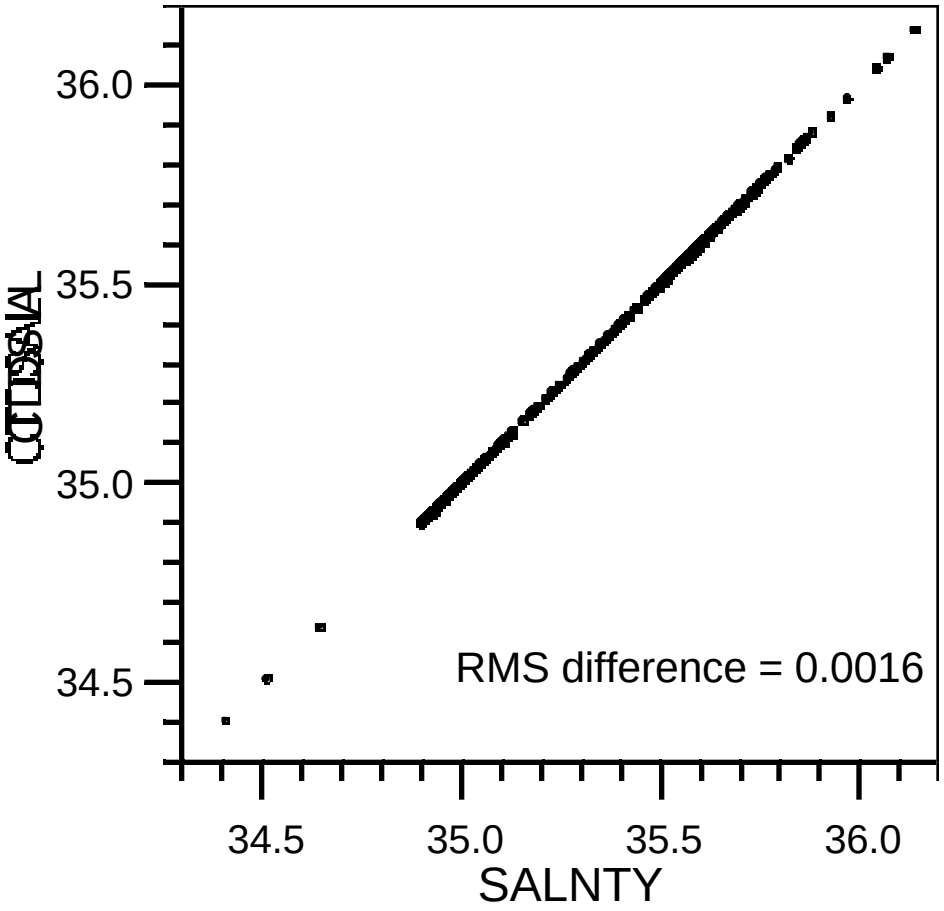

Figure 19. Plot of CTDSAL versus SALNTY for all samples with CTDSAL quality flags 2 and SALNTY quality flags 2 or 6.

3.5 Oxygen Measurements

For the oxygen determination water samples were drawn in volume calibrated 120 ml pyrex glass bottles. Before drawing the sample each bottle was flushed with at least 3 times its volume. When the samples were drawn the temperature of the sample was determined. The determination of the volumetric dissolved oxygen concentration of water samples was carried out by means of a high precision automated oxygen Winkler titration system, based on an optical end point determination. For the conversion of the volumetric concentration O_{2vol} to the densimetric concentration O_{2den} the following conversion was used:

$O_{2den}=O_{2vol} / \rho$

where ρ is the density of sea water at the sample temperature, the salinity of the sample, and at zero pressure.

At each cast duplicate samples were drawn from the deepest an shallowest water sampler, and at a number of stations also from an intermediate sampler (table 3). The difference between the duplicate samples had a RMS value of 0.26 µmol/kg.

The available NOEX sampler bottles in use at NIOZ are equipped with flexible hollow ball formed lids, made of silicon rubber. Because of the known permeability of this material for gases and the high partial oxygen pressure in the remaining air in these balls which occurs when they are under pressure in sea, we suspected these balls to have an adverse effect on the quality of the oxygen samples, due to introduction of oxygen from the balls into the sampler bottle. To study this effect we had acquired a number of newly developed sampler lids, made of PETP, which is known to have a much lower gas

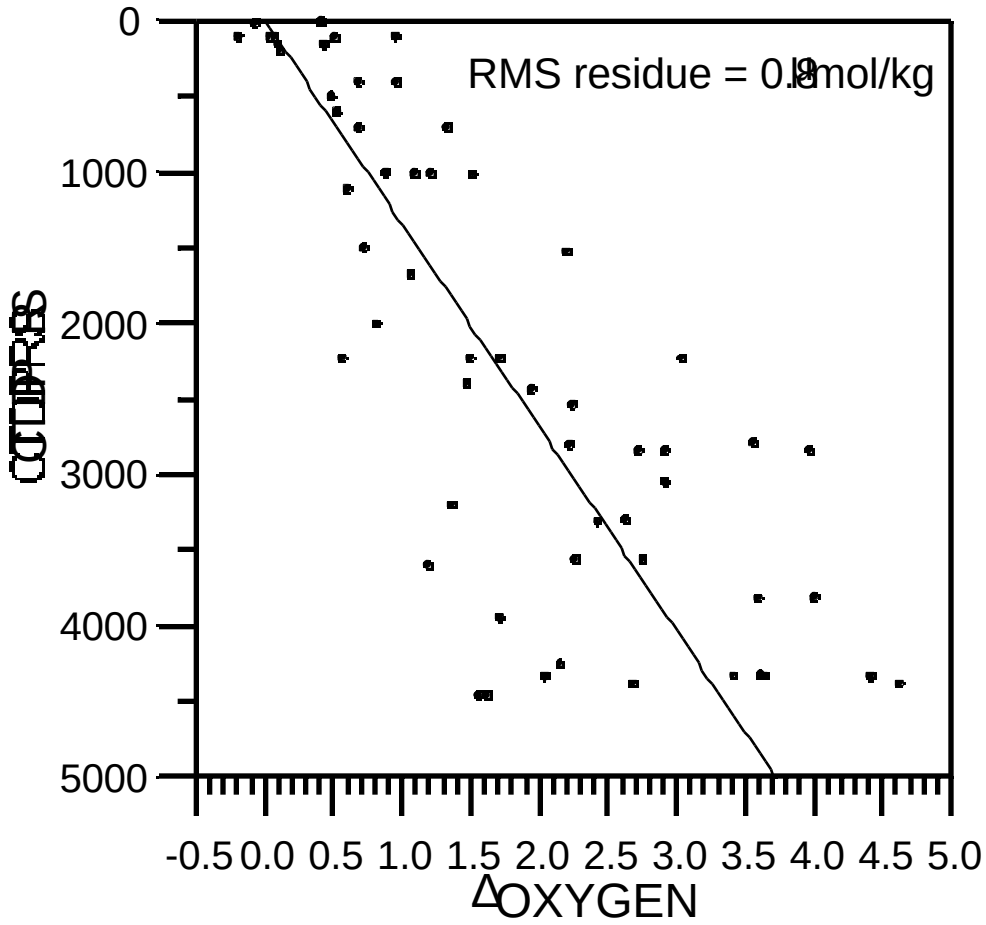

Figure 20. Difference of the oxygen concentration from water sampled with the NOEX sampler fitted with the silicon rubber ball lids water sampled with NOEX samplers with PETP lids. Plotted versus the sample pressure. The line gives the linear regression.

permeability. At a number of stations samples were taken with the NOEX sampler bottles with the suspected silicon lids and with the PETP lids at the same depth. At the final test station (#125) three Niskin sampler bottles were added to this procedure. The samples from the Niskin bottles and from the NOEX bottles with PETP lid did not show any significant difference in oxygen content. However the samples from the NOEX sampler bottles with silicon rubber ball lids clearly showed a pressure dependent excess in oxygen content, compared with the samples from the Niskin bottles and the NOEX bottles with PETP lid (figure 20). This dependence was modelled with a linear regression and appeared to amount to 1 µmol/kg per 1345 dbar. After correction with the resulting regression line the RMS value of the remaining differences between the bottles with the different lids had a RMS value of 0.8 µmol/kg. All oxygen samples taken with the NOEX samplers fitted with the ball lids have been corrected by subtracting the value of the regression line from the determined concentration.

For each CTD/rosette cast also 1 to 3 samples were taken for the determination of the sea water blank value. In the surface layer (upper 50 dbar) the sea water blank amounted 0.58 (_0.05) µmol/kg, in the sub-surface layer (50 to 250 dbar) the sea water blanks had a value of 0.69 (_0.03) µmol/kg, deeper

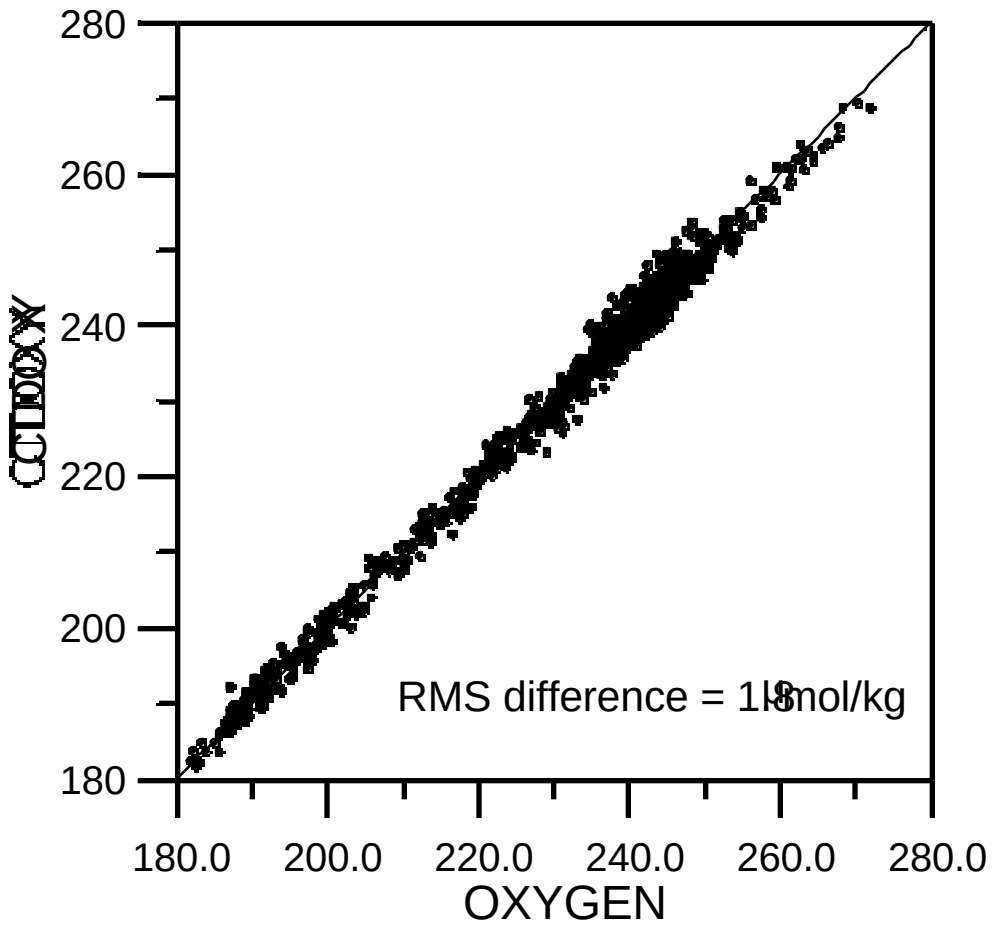

Figure 21. Plot of CTDOXY versus OXYGEN for all samples with quality flag 2 for CTDOXY and quality flags 2 or 6 for OXYGEN.

sea water blanks had a value of 0.74 (_0.03) µmol/kg. The final densimetric oxygen concentration, OXYGEN was calculated by subtracting the sea water blanks from the determined densimetric oxygen concentration.

The calibration of the oxygen sensor, fitted on the CTD system was determined by comparison of the raw CTDOXY values determined according to the manufacturers calibration with the OXYGEN values, taken at the same depth. On average the raw CTDOXY values were about 60 µmol/kg too low. It appeared that the calibration differed from station to station, and also between down-cast and up-cast. Therefore for each station, and for down-cast and up-cast separately the calibration of the oxygen sensor was determine with a multiple regression of OXYGEN versus the raw CTDOXY value, and the logarithms of CTDTMP and CTDPRS. The raw CTDOXY values for each cast were corrected according to the resulting calibration in order to get the final CTDOXY. The RMS value of the resulting difference for the up-casts amounted to 1.8 µmol/kg (figure 21).

3.6 Nutrient Measurements

From al sampler bottles samples were drawn for the determination of the nutrients silica, nitrite, nitrate and phosphate. The samples were collected in polyethylene sample bottles after three times rinsing. The samples were stored dark and cool at 4°C. All samples were analysed for the nutrients silicate, phosphate, nitrate and nitrite within 10 hours with an autoanalyzer based on colorimetry. The lab container was equipped with a Technicon TRAACS 800 autoanalyzer. The different nutrients were measured colorimetrical as described by Grashoff (1983). The samples, taken from the refrigerator, were directly pored in open polyethylene vials (6ml) and put in the auto sampler-trays. A maximum of 60 samples in each run was analysed. Because of the large differences in nutrient content between the upper ocean and the deep water, the analyses were carried out in two different calibration ranges. A low concentration range for the samples from the upper 1500 m, and a high concentration range for the samples collected deeper than 1500 m. For the first ten stations on shallow- and deep-waters, the samples were filtered over a 0.45 µm filter and analysed, both filtered and unfiltered. Since no significant difference in nutrient-contribution from e.g. algae between the filtered and unfiltered samples was found, the analysis was continued without filtration.

The different nutrients were measured colorimetrical as described by Grashoff (1983);

- Silicate reacts with ammoniummolybdate to a yellow complex, after reduction with ascorbic acid the obtained blue silica-molybdenum complex was measured at 800nm (oxalic acid was used to prevent formation of the blue phosphate-molybdenum).
- Phosphate reacts with ammoniummolybdate at pH 1.0, and potassiumantimonyltartrate was used as an inhibitor. The yellow phosphate-molybdenum complex was reduced by ascorbic acid to blue and measured at 880nm.

· Nitrate was mixed with a buffer imidazole at pH 7.5 and reduced by a copperized-cadmium coil (efficiency> 98%) to nitrite, and measured as nitrite (see nitrite). The reduction-efficiency of the cadmium-column was measured in each run.

· Nitrite was diazotated with sulphanilamide and naftylethylenediamine to a pink coloured complex and measured at 550nm.

· The difference of the last two measurements gave the nitrate content

Standards were prepared by diluting stock solutions of the different nutrients in the same nutrient depleted surface ocean water as used for the baseline water. The standards were kept dark and cool in the same refrigerator as the samples. Standards were prepared fresh every two days. Each run of the system had a correlation coefficient for the standards off at least 0.9998. The samples were measured from the surface to the bottom to get the smallest possible carry-over-effects. In every run a mixed nutrient standard containing silicate, phosphate and nitrate in a constant and well known ratio, a so-called nutrient-cocktail, was measured in duplicate. This cocktail is used as a guide to check the performance of the analysis. The reduction-efficiency of the cadmium-column in the nitrate lane was measured in each run.

The autoanalyzer determined the volumetric concentration at a standard temperature of 20°. In order to calculate the densimetric concentration in µmol/kg the volumetric concentrations were divided by the density of sea water at 20°C, sample salinity and zero pressure.

For each CTD/rosette cast duplicate nutrient samples were measured in separate runs (tables 4 to 7) to assess the precision of the analysis. The resulting RMS value of the differences for silica (SILCAT), nitrite (NITRIT), nitrate (NITRAT), and phosphate (PHSPHT) amounted to 0.14, 0.02, 0.11, and 0.02 µmol/kg respectively.

3.7 Transmissometer Measurements

The Sea Tech transmissometer was mounted in the rosette rack next to the CTD probe. During the cruise the instrument has been calibrated, following the manufacturers instructions. The zero output with a blocked light path has been measured as well as the output by transmission in air.. The zero output had not changed since the purchase of the instrument (December 1992), but the output with transmission in air was reduced with 8%, compared with the manufacturers calibration, probably due to ageing of the light source. After correction a 100% output should be equivalent to the transmission of clean pure water. From comparison of the transmission in the relatively clear deep water it however appeared that the calibration of the transmissometer differed from cast to cast causing differences in transmission in the deep water of several percent between successive casts. Thereupon it was decided to apply a shift in the individual transmission profiles in order to get matching transmission values in the clear deep water. The resulting transmission therefore contains an unknown scaling constant relative to the transmission of clear pure water.

3.8 CTD Data Collection and Processing

For the data collection the Seasave software, produced by SBE, was used. The CTD data were recorded with a frequency of 24 data cycles per second. After each CTD cast the data were copied to a hard disk of the ship's computer network, and a back-up copy was made on another disk. At the end of the cruise back up copies were made on tape, and brought to NIOZ, together with the hard disk unit, containing all data. On board the up-cast data files were sub-sampled to produce files with CTD data corresponding to each water sample, taken with the rosette sampler. On board the CTD data were processed with the preliminary calibration data, and reduced to 1 dbar average ASCII files, which were used for the preliminary analysis of the data.

Afterwards the raw CTD data from the down-casts were processed with the Seasoft software. Corrections were applied for the sampling time difference due to the forced flushing of the water along the different sensors, for the heating of the water in the flushing system between the temperature sensor and the conductivity sensor, and the different response times of the sensors. A time series of mean values of the readings were determined for 0.5 s intervals, equivalent with 0.5 to 0.75 dbar intervals. Consecutively the parameters were determined in physical units, using the calibration constants determined as described above. For the fluorometer data the manufacturers calibration was used, giving chlorophyll equivalent values in mg/m^3.

It appeared that in the very strong vertical gradients of the seasonal thermocline and below the Mediterranean Sea Water still salinity spikes were found which could not be removed by altering the constants in the Seasoft correction modules. Thereupon it was decided to apply a median filter over 5 consecutive time bins in order to remove these spikes. Consecutively the time series was filtered by means of a running mean over 5 consecutive time bins. Finally the time series was interpolated on equidistant 1 dbar intervals, only using the first downward crossing of the interpolation pressure by the time series. Since no pressure bin averaging was applied, the parameter NUMBER OF OBS. in the CTD files was set to 12, the number of individual data point used to obtain the time series 0.5 s averages which were used for the interpolation at equidistant pressure intervals.

Appendix A

Tables with duplicate samples

Table 1.

Readings of pairs of reversing electronic thermometers

REVTMP1	*REVTMP2*	*REVTMP1*	*REVTMP2*
10.216	10.217	11.052	11.052
9.507	9.511	3.515	3.516
2.711	2.712	2.839	2.838
3.676	3.675	5.144	5.145
2.823	2.825	2.531	2.529
3.065	3.063	2.654	2.655
3.586	3.585	3.452	3.451
2.558	2.558	2.515	2.517
2.749	2.750	2.497	2.495
3.143	3.144	2.536	2.537
2.523	2.523	2.649	2.652
2.616	2.619	2.512	2.513
2.786	2.789	2.500	2.498
2.491	2.492	2.564	2.564
2.536	2.540	2.711	2.714
2.499	2.500	2.530	2.531
2.544	2.548	2.494	2.493
2.668	2.671	2.498	2.497
2.491	2.491	2.573	2.576
2.528	2.532	2.534	2.535
2.633	2.636	2.498	2.497
2.492	2.492	2.514	2.515
2.531	2.535	2.584	2.587
2.643	2.646	2.520	2.520
2.526	2.530	2.509	2.509
2.641	2.639	2.561	2.562
2.482	2.484	2.690	2.694
2.622	2.620	2.517	2.518
2.479	2.479	2.488	2.487
2.608	2.607	2.535	2.536
2.718	2.720	2.651	2.653
3.029	3.033	2.556	2.557
3.469	3.468	2.753	2.752
11.416	11.416	3.031	3.030
11.231	11.231	3.495	3.497

REVTMP1	*REVTMP2*	*REVTMP1*	*REVTMP2*
2.559	2.556	2.939	2.939
2.593	2.594	3.410	3.408
2.762	2.763	4.008	4.004
3.094	3.096	7.594	7.595
2.532	2.531	9.571	9.571
2.521	2.520	7.253	7.257
2.544	2.545	8.677	8.676
2.660	2.661	10.174	10.173
2.533	2.531	9.678	9.676
2.510	2.510	10.040	10.038
2.554	2.555	10.471	10.469
2.681	2.682	9.180	9.180
2.531	2.529	10.094	10.091
2.510	2.510	10.374	10.372
2.554	2.554	3.766	3.765
2.690	2.692	6.659	6.656
2.506	2.505	2.593	2.592
2.513	2.513	2.683	2.684
2.594	2.595	3.020	3.019
2.788	2.789	3.445	3.445
2.501	2.501	2.484	2.484
2.504	2.502	2.514	2.513
2.753	2.754	2.901	2.897
2.490	2.489	2.485	2.484
2.552	2.550	2.905	2.907
2.686	2.686	2.490	2.489
2.954	2.957	2.492	2.492
2.505	2.503	2.568	2.568
2.560	2.560	2.488	2.486
2.712	2.710	2.497	2.497
2.968	2.968	2.568	2.568
2.523	2.521	2.491	2.492
2.694	2.693	2.501	2.501
2.921	2.919	2.604	2.603
3.375	3.373	2.681	2.682

REVTMP1	*REVTMP2*	*REVTMP1*	*REVTMP2*
2.496	2.495	2.489	2.489
2.504	2.504	2.555	2.556
2.581	2.581	2.746	2.747
2.748	2.750	2.488	2.487
2.499	2.495	2.569	2.570
2.560	2.559	2.749	2.749
2.742	2.743	2.496	2.497
3.747	3.747	2.575	2.576
5.984	5.981	2.775	2.776
9.255	9.251	3.857	3.856
9.701	9.700	9.940	9.939
10.152	10.149	10.433	10.431
10.602	10.600	10.746	10.743
11.408	11.407	9.981	9.980
11.716	11.715	10.419	10.417
11.909	11.908	10.784	10.782
13.511	13.510	11.905	11.901
11.980	11.979	12.275	12.272
10.805	10.803	11.934	11.930
5.885	5.884	3.469	3.467
2.906	2.905	3.914	3.910
3.242	3.242	3.012	3.010
3.917	3.916	3.552	3.551
2.629	2.630	5.703	5.699
2.932	2.930	3.185	3.185
3.510	3.510	3.563	3.563
2.553	2.553	2.726	2.726
2.730	2.727	2.965	2.964
3.101	3.100	2.632	2.631
2.475	2.475	2.891	2.890
2.548	2.548	3.113	3.112
2.720	2.720	3.168	3.168
2.500	2.500	3.462	3.462
2.574	2.575	3.502	3.501
2.796	2.797	3.839	3.840

REVTMP1	*REVTMP2*
9.235	9.234
9.672	9.668
9.976	9.972
10.321	10.317
10.533	10.529

Table 2

Duplicates of sample salinity.

SALNTY1	*SALNTY2*	*SALNTY1*	*SALNTY2*
35.4996	35.4992	34.9039	34.9037
35.5391	35.5395	34.9017	34.9022
35.6688	35.6691	34.9116	34.9113
35.3437	35.3442	34.9512	34.9515
34.9195	34.9196	34.9983	34.9984
34.9115	34.9116	35.0960	35.0962
34.9014	34.9020	35.4069	35.4072
34.9005	34.8997	35.6597	35.6598
34.9010	34.9007	35.5468	35.5472
34.8993	34.8992	35.5094	35.5104
34.8993	34.8996	35.5034	35.5032
34.8993	34.8993	35.5436	35.5435
34.8974	34.8984	35.6296	35.6298
34.8989	34.8991	35.6838	35.6839
34.8984	34.8976	35.5344	35.5348
34.9782	34.9789	34.9505	34.9508
35.7144	35.7153	34.9149	34.9154
35.6772	35.6773	34.9055	34.9060
36.0663	36.0661	34.9032	34.9033
34.9691	34.9694	34.9021	34.9024
34.9393	34.9396	34.9025	34.9032
34.9104	34.9103	34.9015	34.9023
34.8987	34.8989	34.9021	34.9025
34.8986	34.9001	34.9032	34.9035
34.8987	34.8991	34.9048	34.9053
34.8980	34.8985	34.9604	34.9605
34.8980	34.8973	35.3129	35.3134
34.9004	34.8996	35.6600	35.6611
34.9170	34.9168	35.5800	35.5806
34.9137	34.9134	35.5403	35.5399
34.9006	34.9000	35.5218	35.5217
34.8998	34.9003	35.5565	35.5570
34.9013	34.9014	35.5788	35.5788
34.9003	34.9001	35.6824	35.6825
34.9004	34.9006	34.9781	34.9780

SALNTY1	*SALNTY2*
34.9222	34.9224
34.9118	34.9118
34.9050	34.9053
34.9014	34.9014
34.9023	34.9034
34.9007	34.9013
34.9004	34.9013
34.9010	34.9010
34.9699	34.9700
35.7584	35.7587
35.7401	35.7408
35.5886	35.5885
35.5972	35.5974
35.5961	35.5969
35.1748	35.1751
34.9369	34.9375
34.9405	34.9412
34.9763	34.9757
34.9163	34.9168
34.9089	34.9095
34.9091	34.9098
34.9250	34.9264
34.9357	34.9357

Table 3

Duplicates of sample oxygen concentration

OXYGEN1	*OXYGEN2*	*OXYGEN1*	*OXYGEN2*
229.64	229.48	217.51	217.54
251.01	251.33	238.17	238.05
246.92	246.93	214.01	214.23
231.30	231.64	228.41	228.39
245.43	245.22	206.23	206.17
196.63	196.52	206.65	206.65
245.08	244.73	251.64	251.90
241.47	241.67	187.43	187.39
236.36	236.28	242.38	241.99
239.95	240.12	250.06	250.09
242.62	242.60	241.73	241.59
240.34	239.95	246.77	246.63
238.59	238.60	241.32	241.76
240.43	240.21	242.89	243.01
239.06	239.13	242.86	242.91
238.96	238.47	245.32	245.50
240.98	240.91	243.72	243.50
233.18	233.31	236.88	236.72
242.58	242.48	243.33	243.33
242.29	242.07	236.56	236.68
242.63	242.35	243.18	242.79
236.06	236.09	233.70	233.94
242.04	241.83	243.12	243.01
234.39	234.29	252.59	252.64
243.88	243.64	233.53	233.27
238.38	238.56	242.04	242.31
250.88	250.96	251.86	251.78
201.02	201.00	237.31	237.23
237.35	237.56	242.41	242.87
198.90	198.41	254.39	254.66
237.82	237.82	241.79	242.01

OXYGEN1	*OXYGEN2*	*OXYGEN1*	*OXYGEN2*
264.50	264.71	246.13	246.20
242.92	243.04	249.91	250.01
264.57	264.70	216.97	217.18
239.44	239.53	255.06	254.93
254.38	254.79	197.07	197.13
242.74	242.79	255.07	255.18
240.67	240.77	234.70	234.52
267.88	267.98	233.17	233.96
241.09	241.00	233.23	233.44
252.96	252.89	201.21	201.35
234.95	234.64	261.46	261.54
241.41	241.37	195.17	195.31
261.01	260.91	256.32	256.06
240.32	240.63	207.73	207.93
239.55	239.40	256.93	256.88
255.90	255.95	250.24	250.38
239.40	239.59	243.56	243.74
240.01	240.12	250.53	250.36
268.63	268.56	241.40	241.16
241.26	241.50	247.91	247.85
248.89	248.12	242.33	242.48
266.54	266.66	237.03	237.12
240.21	240.30	242.21	242.19
241.34	241.34	233.31	233.24
243.55	243.56	236.18	236.01
245.02	245.39	240.71	241.46
233.60	233.64	250.46	250.48
254.18	253.49	241.54	241.38
248.91	248.92	236.99	236.96
234.09	234.07	240.69	240.42
241.64	241.79	247.95	248.37

OXYGEN1	*OXYGEN2*	*OXYGEN1*	*OXYGEN2*
227.56	227.31	243.15	243.21
242.37	242.42	226.12	226.07
233.30	233.24	241.48	241.36
240.64	241.09	231.09	230.78
242.15	241.54	241.47	241.33
240.49	240.24	241.97	242.07
247.91	248.49	229.98	230.22
230.24	230.18	243.19	243.17
245.89	245.90	232.31	232.21
233.90	233.83	230.13	229.85
238.30	238.06	242.29	242.11
197.78	198.01	244.47	244.41
244.84	245.58	228.55	228.55
226.53	226.79	251.07	250.61
231.08	230.69	192.91	192.80
228.23	228.09	229.70	229.52
231.74	231.74	193.05	193.05
236.46	236.51	193.88	194.26
192.89	192.84	226.13	226.57
247.24	247.55	223.23	223.15
190.43	190.78	227.42	226.70
229.70	229.30	212.44	211.91
243.78	243.55	231.73	231.68
188.76	188.69	237.60	237.86
224.16	224.11	233.60	233.88
241.82	241.68	247.00	247.02
223.75	223.48	221.72	221.57
241.97	241.62	248.33	248.99
205.98	205.96	197.04	197.05
224.33	224.01	229.10	229.18
240.35	240.25	243.89	244.05

OXYGEN1	*OXYGEN2*
246.45	246.74
243.32	243.15
243.45	243.25
203.42	203.39
222.47	222.37
245.50	244.94
246.32	246.03
231.15	230.33
217.77	217.98
221.30	221.38
190.61	190.47
222.30	222.44
233.90	233.69
221.32	220.95
246.55	246.46
247.18	247.26
246.39	246.32
231.40	231.25
232.41	232.22
231.70	231.67
190.96	191.11
195.66	195.06
191.82	191.41
228.20	228.13
228.67	228.93
230.40	229.95
230.80	230.96

Table 4

duplicates of dissolved silica samples

SILCAT1	*SILCAT2*	*SILCAT1*	*SILCAT2*
3.22	3.11	4.40	4.42
3.08	3.09	3.76	3.77
2.99	3.08	2.90	2.99
0.65	0.68	2.14	2.12
2.77	2.63	0.67	0.62
2.89	2.91	43.92	43.85
1.70	1.70	44.18	44.17
0.64	0.68	44.29	44.51
3.36	3.20	44.28	44.64
3.37	3.37	44.48	44.23
2.62	2.64	44.31	44.26
2.22	2.24	44.27	44.17
1.80	1.81	44.18	44.15
0.69	0.74	44.15	44.41
14.44	14.67	44.02	43.88
39.81	39.98	40.11	40.11
41.39	41.26	26.42	26.46
39.34	39.38	10.34	10.29
38.14	38.03	4.76	4.64
34.34	34.30	4.85	4.73
32.90	32.96	2.22	2.29
30.42	30.50	4.71	4.80
27.52	27.55	5.90	6.06
24.03	24.04	9.29	9.55
21.04	20.97	27.78	27.56
16.60	16.75	34.07	33.94
15.15	15.21	44.21	44.18
12.99	13.03	43.77	43.62
11.36	11.29	43.81	43.73
9.56	9.59	43.92	44.01
8.88	8.89	43.56	43.65
8.31	8.36	40.24	40.18
7.62	7.58	41.67	41.57
6.57	6.58	44.07	43.81
5.48	5.45	43.89	43.94

SILCAT1	*SILCAT2*	*SILCAT1*	*SILCAT2*
44.17	44.14	43.39	43.33
44.59	44.28	44.81	44.47
42.06	41.98	44.46	44.34
34.44	34.33	44.48	44.36
25.63	25.85	44.07	44.07
15.98	15.95	43.88	44.20
12.76	12.88	28.00	28.27
10.01	10.06	9.68	9.97
3.62	3.83	9.99	10.05
2.72	2.75	4.59	4.64
2.71	2.66	4.86	4.83
3.38	3.28	3.27	3.24
8.00	7.96	15.95	15.73
9.02	9.10	34.98	34.91
11.82	11.85	34.26	34.34
34.34	34.33	27.64	27.70
40.96	41.12	40.06	40.20
44.20	44.25	41.95	41.72
44.42	44.29	37.63	37.64
44.46	44.41	35.69	35.89
44.06	44.05	12.74	12.70
43.94	44.23	9.98	9.98
44.01	44.36	3.21	3.25
43.22	43.53		
31.68	31.85		
14.66	14.80		
10.92	11.06		
4.29	4.40		
2.77	2.92		
2.87	2.96		
2.59	2.68		
2.92	3.02		
8.27	8.12		
39.26	39.45		
41.57	41.47		

Table 5

duplicate of dissolved nitrate samples

NITRAT1	*NITRAT2*	*NITRAT1*	*NITRAT2*
8.24	8.19	13.40	13.28
7.90	7.86	11.81	11.82
7.81	7.91	10.90	10.81
0.09	0.07	8.98	9.00
7.54	7.54	7.02	7.04
7.64	7.74	0.04	0.03
5.02	5.04	22.37	22.59
0.25	0.05	22.32	22.54
9.14	8.97	22.48	22.47
9.13	9.13	22.23	22.35
7.62	7.59	22.15	22.11
6.41	6.45	22.08	22.15
4.92	5.01	22.27	22.28
0.02	0.00	22.23	22.14
16.50	16.65	21.91	21.75
18.41	18.37	19.63	19.79
21.88	21.91	17.14	16.90
22.01	22.03	12.06	11.93
21.83	21.90	11.42	11.37
21.79	21.67	7.02	7.24
21.03	21.13	11.09	11.26
21.03	20.90	13.58	13.66
20.53	20.68	15.69	15.78
20.22	20.12	19.59	19.46
19.65	19.67	20.63	20.55
19.26	19.16	22.01	22.11
18.58	18.61	22.28	22.16
18.55	18.47	22.27	22.12
18.22	18.24	22.42	22.34
17.72	17.64	22.23	22.17
16.87	16.97	22.05	22.22
16.64	16.70	21.65	21.73
16.18	16.24	21.86	21.96
15.63	15.61	22.56	22.31
14.51	14.54	22.23	22.30

NITRAT1	*NITRAT2*	*NITRAT1*	*NITRAT2*
22.58	22.33	21.70	21.59
22.21	22.25	22.07	21.89
22.29	22.30	22.25	22.07
22.06	22.23	22.44	22.35
22.27	22.38	22.47	22.47
21.88	22.01	22.41	22.26
20.87	20.66	22.20	22.03
19.60	19.73	19.92	19.87
18.41	18.25	16.80	16.88
17.93	17.84	16.89	16.96
16.74	16.76	11.77	11.82
9.81	9.70	10.61	10.63
7.22	7.18	9.20	9.25
7.11	7.11	18.65	18.46
9.01	8.82	21.01	21.02
15.70	15.35	20.93	20.89
16.26	16.19	19.90	19.90
17.43	17.47	21.78	21.75
20.86	20.64	21.72	21.62
22.29	22.12	21.82	21.71
22.03	22.09	21.21	21.19
22.17	22.38	21.02	20.84
22.15	22.28	17.99	17.94
22.23	22.28	17.00	17.02
22.07	22.21	9.51	9.50
20.49	20.57		
18.30	18.20		
17.32	17.35		
11.30	11.34		
7.59	7.53		
7.50	7.47		
7.17	7.21		
8.63	8.68		
15.97	15.90		
20.13	20.10		

Table 6

duplicates of dissolved nitrite samples

NITRIT1	*NITRIT2*	*NITRIT1*	*NITRIT2*
0.05	0.14	0.02	0.03
0.01	0.05	0.01	0.01
0.04	0.06	0.02	0.03
0.01	0.03	0.01	0.01
0.04	0.09	0.03	0.01
0.07	0.05	0.00	0.01
0.10	0.10	0.01	0.04
0.00	0.00	0.01	0.03
0.04	0.05	0.02	0.03
0.05	0.10	0.08	0.04
0.07	0.09	0.01	0.04
0.07	0.07	0.00	0.03
0.10	0.10	0.04	0.04
0.00	0.02	0.02	0.02
0.01	0.03	0.02	0.05
0.00	0.05	0.03	0.02
0.00	0.02	0.04	0.04
0.04	0.03	0.03	0.03
0.01	0.02	0.02	0.00
0.02	0.03	0.05	0.03
0.00	0.01	0.06	0.04
0.02	0.02	0.11	0.14
0.00	0.02	0.02	0.03
0.02	0.03	0.02	0.03
0.00	0.03	0.02	0.02
0.01	0.03	0.01	0.03
0.01	0.03	0.01	0.02
0.02	0.02	0.00	0.02
0.00	0.02	0.02	0.03
0.01	0.02	0.00	0.04
0.00	0.03	0.02	0.04
0.02	0.03	0.05	0.03
0.01	0.02	0.02	0.02
0.02	0.02	0.03	0.03
0.01	0.02	0.02	0.02

NITRIT1	*NITRIT2*	*NITRIT1*	*NITRIT2*
0.05	0.01	0.05	0.09
0.03	0.01	0.04	0.03
0.04	0.04	0.04	0.02
0.02	0.05	0.04	0.03
0.02	0.04	0.02	0.03
0.02	0.02	0.04	0.02
0.01	0.02	0.02	0.04
0.02	0.02	0.03	0.05
0.00	0.02	0.01	0.06
0.00	0.01	0.00	0.05
0.00	0.01	0.02	0.05
0.02	0.02	0.05	0.04
0.02	0.01	0.01	0.02
0.01	0.01	0.01	0.03
0.05	0.05	0.05	0.02
0.04	0.05	0.04	0.00
0.04	0.04	0.04	0.04
0.03	0.03	0.04	0.06
0.04	0.04	0.07	0.04
0.02	0.02	0.01	0.00
0.03	0.02	0.01	0.02
0.03	0.01	0.02	0.01
0.01	0.01	0.02	0.00
0.03	0.01	0.01	0.02
0.02	0.01	0.05	0.06
0.01	0.00	0.02	0.04
0.03	0.01	0.01	0.03
0.03	0.02	0.02	0.01
0.01	0.02	0.01	0.04
0.02	0.01	0.02	0.01
0.02	0.01	0.01	0.05
0.02	0.06		
0.04	0.05		
0.02	0.03		
0.07	0.08		

Table 7

duplicates of dissolved phosphate samples

PHSPHT1	*PHSPHT2*	*PHSPHT1*	*PHSPHT2*
0.53	0.51	0.63	0.63
0.49	0.51	0.52	0.52
0.49	0.52	0.41	0.41
0.03	0.04	0.01	0.01
0.49	0.49	1.51	1.54
0.50	0.51	1.55	1.54
0.35	0.36	1.53	1.57
0.05	0.06	1.55	1.53
0.59	0.57	1.51	1.51
0.50	0.51	1.51	1.54
0.42	0.44	1.51	1.54
0.33	0.34	1.51	1.52
0.04	0.05	1.58	1.54
1.07	1.02	1.53	1.50
1.17	1.16	1.49	1.48
1.48	1.49	1.32	1.34
1.47	1.49	1.09	1.08
1.47	1.43	0.76	0.76
1.42	1.39	0.75	0.74
1.39	1.41	0.46	0.47
1.37	1.35	0.72	0.71
1.34	1.34	0.86	0.86
1.31	1.27	0.99	0.97
1.26	1.27	1.33	1.31
1.21	1.19	1.41	1.41
1.18	1.18	1.52	1.51
1.15	1.12	1.51	1.51
1.09	1.08	1.52	1.52
1.03	1.01	1.51	1.53
1.00	1.03	1.52	1.51
0.98	0.97	1.52	1.50
0.94	0.94	1.48	1.47
0.87	0.86	1.51	1.49
0.81	0.79	1.55	1.52
0.69	0.69	1.50	1.52

PHSPHT1	*PHSPHT2*	*PHSPHT1*	*PHSPHT2*
1.52	1.49	1.00	1.00
1.51	1.50	1.36	1.37
1.53	1.52	1.48	1.49
1.51	1.50	1.49	1.50
1.52	1.52	1.52	1.53
1.49	1.50	1.55	1.54
1.43	1.41	1.53	1.55
1.31	1.26	1.53	1.54
1.22	1.21	1.53	1.53
1.16	1.16	1.51	1.53
1.07	1.07	1.36	1.36
0.61	0.62	1.02	1.03
0.47	0.47	1.05	1.05
0.47	0.48	0.76	0.73
0.98	0.97	0.69	0.68
1.02	1.03	0.58	0.58
1.12	1.12	1.21	1.21
1.41	1.39	1.41	1.42
1.49	1.46	1.40	1.40
1.51	1.49	1.32	1.34
1.51	1.51	1.47	1.48
1.52	1.50	1.48	1.49
1.49	1.50	1.49	1.50
1.52	1.49	1.44	1.44
1.52	1.50	1.43	1.43
1.51	1.50	1.15	1.12
1.52	1.50	1.06	1.05
1.38	1.37	0.57	0.55
1.19	1.18		
1.10	1.10		
0.70	0.71		
0.48	0.49		
0.47	0.48		
0.45	0.46		
0.53	0.55		