

# Database of the JGOFS expedition ANT X/6 aboard *R.V. Polarstern*

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U.V. Bathmann† and V. Smetacek†.

## INTRODUCTION

The enclosed CD-ROM contains the actual database of measured variables as well as various background information on the expedition and the methods and other descriptions directly related to each reported variable. The CD-ROM was mastered in a format that can be read by both Macintosh and PC computers. It is organised in a hierarchical structure by folders containing both text files in MS-Word for Windows 2 format and datafiles in either Excel 4.0 or ACCESS format. Software with such formats is not included but available from Microsoft. In addition the textfiles have been converted to PostScript format and the datafiles have been converted to simple ASCII formats and placed on the CD-ROM as well.

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## BACKGROUND INFORMATION

### *Textfiles*

- Participating scientists (affiliations, phone, fax, internet).
- Participating institutes (postal addresses).
- JGOFS core activities (responsible scientists).
- Other activities (with scientists).
- Shipboard experiments (with scientists).
- Description of methods.
- Structure CD-ROM / MS ACCESS relational database.

### *Tabulations*

- Listing of 123 stations (with geartype deployment).
- Listing of 211 measured variables in rosette bottles (units, description).

## DATABASE

- CTD sensors downcasts records of 229 CTD casts.
- Rosette bottles from 229 hydrocasts of 24 samplers each (station, cast, bottle number).
- Natural radioisotopes from Gerard barrel casts.
- Trace metals and nutrient data from Kevlar wire Go Flo sampling.
- Metal-biota interaction experiments.

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Incubations primary productivity and  $^{15}\text{N}$  ammonia uptake.  
Net sampling results: mesozoo-, phytoplankton and mesozooplankton grazing.  
 $\text{CO}_2$  system, meteorology, chlorophyll: underway in surface waters.  
Ice cover observations.  
Wind velocities.  
Benthic observations.  
Ice biology.

## ELECTRONIC MAIL UPDATES

Further updates of the ANTX/6 database will become available by electronic mail through ftp-servers at the Alfred Wegener Institute (<ftp://ftp.awi-bremerhaven.de/pub>).

## ENQUIRIES

Queries about certain parts of the data can be addressed directly to the relevant scientist(s). For this purpose a listing of names and addresses including internet identities is provided in the file STAFF.DOC. Enquiries relating to the CD-ROM are to be made to Joop Rommets at NIOZ ([rommets@nioz.nl](mailto:rommets@nioz.nl)) and all questions related to the electronic updates are to be made to Ulrich Bathmann at AWI ([ubathmann@awi-bremerhaven.de](mailto:ubathmann@awi-bremerhaven.de)).

## DATA POLICY

The data contained in this CD-ROM have been produced jointly by the participants of the JGOFS expedition ANT X/6 and the data management staff of the Netherlands Institute for Sea Research (NIOZ). Users of the data are free to process these as deemed useful, provided that in any report or publication arising from such use the source of the data is acknowledged by referring either to the relevant individual research article(s) in this issue of *Deep Sea Research II* or to:

Rommets, J.W., M.H.C. Stoll, R.X. de Koster, T.F. de Bruin, H.J.W. de Baar, U.V. Bathmann and V. Smetacek (1997) Database of the JGOFS expedition ANT X/6 aboard RV 'Polarstern'. *Deep-Sea Research II*, **44** (1-2), and CD-ROM Appendix.

When in such case the used ANT X/6 data is a substantial part of the report or publication, one is expected to extend the courtesy of informing the respective investigators, or on their behalf one of the guest editors (Smetacek, de Baar, Bathmann, Lochte or Rutgers van der Loeff) of this issue or the editor Rommets of the CD-ROM. This allows the option of consideration of joint authorship.

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## REFERENCES

Bathmann, U.V., V. Smetacek, H.J.W. de Baar, E. Fahrbach and G. Krause (1994). The expeditions ANTARKTIS X/6-8 of the Research Vessel *Polarstern* in 1992/1993. *Berichte zur Polarforschung*, **135**, 4-126.

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## **JGOFS CORE ACTIVITIES**

- 1. Meteorology and positioning**  
Herbert Köhler (DWDS), Heinz Hill (DWDS), Cees Veth (NIOZ)
- 2. CTD, O<sub>2</sub>-probe, fluorometry, turbidity**  
Cees Veth (NIOZ), Sven Ober (NIOZ), Ronald de Koster (NIOZ)  
**Underway salinity, temperature, fluorometry**  
Uli Bathmann (AWI)
- 3. Dissolved Oxygen**  
Rinus Manuels (NIOZ).
- 4. Nutrients**  
Karel Bakker (NIOZ), Peter Fritsche (IFM). Ammonia by Jacques Poncin (IEM)
- 5. Optics**  
Sylvie Mathot (ULB), Cees Veth (NIOZ), Bernard Queguiner (IEM), Laetitia Teissier (IEM).
- 6. Carbondioxide system**  
Dorothee Bakker (NIOZ), Joop Rommets (NIOZ), Michel Stoll (NIOZ), Hein de Baar (NIOZ).
- 7. POC and PON**  
Uli Bathmann (AWI), Bernard Queguiner (IEM)
- 8. DOC and DON by HTCO methods**  
Avan Antia (SFB), Paul Kšhler (SFB)
- 9. Chlorophyll and Pigments**  
Uli Bathmann (AWI), Bärbel Bolt (FBB), Doris Meyerdierks (FBB), Bernard Queguiner (IEM), Ilka Peeken (SFB), Maria van Leeuwe (NIOZ).
- 10. Bacteria biomass and production**  
Karin Lochte (AWI), Peter Bjørnsen (MBL), Alexandra Nielsen (MBL), Anke Weber (UOS/IFM), Sylvie Becquevort (ULB), Thierry de Henau
- 11. Mesozooplankton (incl. egg production)**  
Santiago Gonzalez (NIOZ), Bouwe Kuipers (NIOZ).
- 12. Microplankton abundance; autotrophs, heterotrophs; incl. nanoplankton**  
Dick Crawford (AWI), Friedel Hinz (AWI) Renate Scharek (AWI), Christine Klaas (AWI), Andrea Detmer (IFM), Sylvie Becquevort (ULB), Sylvie Mathot (ULB), Frank Jochem (IFM), Peter Bjørnsen (MBL).
- 13. Primary production by 14C**  
Sylvie Mathot (ULB), Bernard Queguiner (IEM), Frank Jochem (IFM)
- 14. Primary production by O<sub>2</sub>**  
Frank Jochem (IFM) with Rinus Manuels (NIOZ)
- 15. New Production by 15N and Export Production by 234Th**  
Marita Wunsch (SFB), Wolfgang Koeve (SFB), Frank Dehairs (VUB), Leo Goeyens (VUB), Michiel van der Loeff, Jana Friedrich, Heike Hölzen (all AWI).
- 16. Autotrophic pico/nano-plankton (including cyanobacteria)**  
Andrea Detmer (IFM)
- 17. Grazing by Mesozooplankton**  
Corinna Dubischar (AWI), Uli Bathmann (AWI).
- 18. Grazing by Microzooplankton and Nanozooplankton**  
Christine Klaas (AWI), Sven Reitmeier (SFB), Sylvie Becquevort (ULB), Thierry de Henau (ULB)
- 19&20. Sediment traps**  
Uli Bathmann (AWI)

## **SOUTHERN OCEAN JGOFS CORE ACTIVITIES**

- 21. Ice coverage.**  
Jan van Franeker (IBN)
- 22. Ice physics**  
Cees Veth (NIOZ)
- 23. Ice biology**  
Uli Bathmann (AWI), Renate Scharek (AWI), Sylvie Becquevort (ULB),  
Sylvie Mathot (ULB), Ilka Peeken (SFB), Frank Jochem (IFM)
- 24. Silica biogeochemical cycling** (incl. mathematical modeling)  
Bernard QuŽguiner (IEM), Laetitia Teissier (IEM), Pascal David (CNRS)
- 25. Iron-plankton interactions** (incl. trace element distributions)  
Maria van Leeuwe (NIOZ), Renate Scharek (AWI), Jeroen de Jong (NIOZ),  
Bettina Lšscher (NIOZ), Hein de Baar (NIOZ).

## **OTHER ACTIVITIES**

- 26. Top predators (birds, marine mammals)**  
Jan van Franeker (IBN)
- 27. Ecophysiology of ice algae: DMSP**  
Doris Meyerdierks (FBB), BŠrbel Bolt (FBB)
- 28. Biogeochemistry of Barium**  
Frank Dehairs (VUB)
- 29. <sup>13</sup>C in surface water particulate organic matter**  
Frank Dehairs (VUB)
- 30. Benthic processes**  
Michiel Rutgers van der Loeff, Ola Holby, Jana Friedrich, Heike Hölzen, Karin Lochte (all  
AWI)



## **ANT X/6: SHIPBOARD EXPERIMENTS**

9. Effect of declining light conditions on phytoplankton, pigments and bacteria. (Peeken, Lochte, Crawford). Data available upon request.
10. Experiments for calibration of bacterial production measurements and for assessment of bacterial consumption of DOC (Kähler, Bjørnsen, Manuels, and others). Data available upon request.
10. Effect of temperature on bacterial production and primary production. (Lochte, Bjørnsen, Mathot). Data available upon request.
12. Growth potential of heterotrophic dinoflagellates (< 20µm). (Bjørnsen). Data available upon request.
12. Phytoplankton cultures isolation, electron microscope fixation and shipboard experiments. (Crawford, Scharek)
12. Growth and grazing experiments with natural microplankton populations (Klaas). Data available upon request.
17. Mesozooplankton grazing other than "in" the field. (Dubischar, Bathmann, Peeken). Data available upon request.
24. Silica dissolution experiments (Quéguiner and others). Data available upon request. Related data in this bottle casts report.
25. Fe/biota experiments (vanLeeuwe, Scharek and others). Data available upon request.

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH



**J G O F S**



**JOINT GLOBAL OCEAN FLUX STUDY**

A Core Project of the International Geosphere-Biosphere Programme

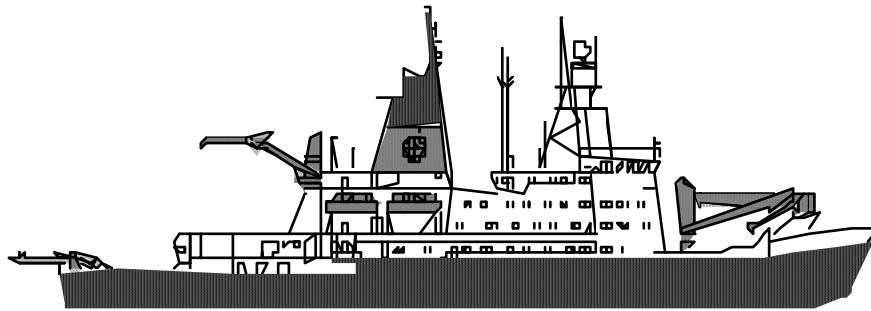
Frühling im Eis

R.V. Polarstern Cruise ANT X/6

Punta Arenas to Capetown

29 September - 29 November 1992

V. Smetacek, chief scientist



Bottle Casts Databases

(CTD/Rosette - Gerard Barrels - KevlarWireGoFlo)

edited by

J.W. Rommets, M.H.C Stoll, R. Dapper

H.J.W. de Baar and C. Veth

## **METHODS**

Investigators (brackets for those not actually taking part in the cruise)  
{Acronyms of variables as in Rosette database}

### **1. Meteorology and positioning**

Herbert Köhler (DWDS), Heinz Hill (DWDS), Cees Veth (NIOZ)  
{Data will appear in other report.} Automated INDAS system aboard R.V. 'Polarstern'

For positioning of the research vessel use is made of the Global Positioning System (GPS).

Standard meteorological observations according to World Meteorological Organization (WMO) recommendations have been done at 3 hour intervals as prescribed by JGOFS. Parameters measured every 3 hours are:

Position; Speed; Heading; Air temperature; Dew point, humidity; Wind velocity; Wind direction; Air pressure; Tendency of air pressure; Visibility; Cloud base; Cloud type; Water temperature; Wave height; Wave period; ice concentration

Automatic recording takes place of the following parameters (Every 5 minutes): Position; Speed; Heading; Air temperature; Dew point; Wind velocity; Wind direction; Air pressure; Tendency of air pressure; Global radiation; Visibility; Cloud base; Water temperature; Salinity.

### **2a. CTD, O<sub>2</sub>-probe, fluorometry**

Cees Veth, Sven Ober, Ronald de Koster (all NIOZ)  
{CTD.press, CTD.temp, CTD.sal, CTD.O2.sens, CTD.Fluor, CTD.Trans}

At each station CTD-casts have been done. Standard cast depths were 1500 m and regularly to 200 m for incubation purposes. At a number of stations casts to the bottom were performed.

#### **CTD-type**

Seabird SBE 9 plus. with deckunit SBE 11plus (sample freq. 24 Hz)

T-sensor: type Seabird SBE 3

C-sensor: type Seabird SBE 4

Pressure sensor: Paroscientific high resolution pressure sensor

DO<sub>2</sub> (dissolved oxygen): Seabird SBE 13

Submersible Pump Seabird SBE

#### **Accuracy and precision**

Accuracy temperature: 0.001 degrees C and precision 0.0005 deg C

Accuracy salinity: 0.002 PSU and precision 0.001 PSU (deep )  
0.004 PSU and precision 0.001 PSU (surface)

Accuracy pressure: 2 dbar and precision 0.5 dbar

DO<sub>2</sub>-sensor is calibrated with bottle analysis (see 3. Dissolved oxygen)

Accuracy and precision "better than 1%"

#### **Calibrations procedures**

##### **Temperature**

Pre cruise calibration by Sea-Bird Electronics Inc.

In situ calibration with SIS electronic reversing thermometers  
(calibrated against triple point of water)

Post cruise calibration by Sea-Bird Electronics Inc.

##### **Salinity / Conductivity**

Pre cruise calibration by Sea-Bird Electronics Inc.

Calibrated with bottle analysis, with a Guildline 8400 Salinometer using standard sea water ampoules.

Post cruise calibration by Sea-Bird Electronics Inc.

## Pressure

Pre cruise calibration by Paroscientific Inc.  
In-situ calibration with SIS electronic reversing pressure meter  
Post cruise calibration by Paroscientific Inc.

## Fluorometer

Chelsea Instruments Aquatracka (deep sea version).

## Transmissometer

type Sea-Tech 25 cm beamlength, (wavelength: 660 nm)  
Accuracy better than 1%, precision 0.1 %.

## Rosette

General Oceanics 24 positions stepper motor  
Rosette sample bottles:  
NOEX and NISKIN for standard sampling  
GoFlo for ultra clean sampling  
Rosette frame: Teflon coated stainless steel for ultra clean sampling.

## **2b. Underway salinity, temperature, fluorometry**

Uli Bathmann (AWI)

{No data in this report}

## **3. Dissolved Oxygen**

Rinus Manuels (NIOZ)

{Oxy1, Oxy2, Oxy, OxyT}

Oxygen samples have been collected and analyzed in duplicate according to the Winkler method, following recommendations of the Woce Hydrographic Program (WHP) except for the calibration of the sodiumthiosulphate solution which was done gravimetrically (rather than with pipettes) for better accuracy. The photometric high precision oxygen titrator provides reproducibility better than 0.1 percent, well exceeding the 0.5 % WHP requirements. Because of the very cold seawater in the Antarctic region gas bubbles were seen to escape from the samples after having been acidified under normal laboratory conditions. In order to avoid this outgassing all samples were stored and analyzed at 4.5 °C in a thermostatted waterbath.

### Abbreviations:

Oxy1 = 1st replicate  
Oxy2 = 2nd replicate  
Oxy = Mean (excluding possible outliers)  
OxyT = Sample temperature on closing bottle

Culberson, C.H. (1991) Dissolved Oxygen, chapter in: WHP Operations and methods - July 1991.

## **4. Nutrients**

Karel Bakker (NIOZ), Peter Fritsche (IFM), Jacques Poncin (IEM)

### **Nitrate, nitrite, phosphoric acid, orthosilicic acid**

Karel Bakker, Peter Fritsche

{Silicate, Nitrate, Nitrite, Phosphate}

Samples were collected by Niskin, NOEX or Go Flo bottles and as soon as possible taken for nutrients in polyethylene bottles. Measurements were carried out within 12 hours after collection;

meanwhile samples were kept cool at 2 °C and dark in a refrigerator. Volumetric flasks for dilution of nutrients stocks were precalibrated giving linearity with correlation coefficients of at least 0.999 for 4 calibration points. Baseline water obtained by dissolving 34g NaCl / l dem iwater (18 MOhm) is used as washwater between the samples and as a carrier for the diluted stocks in order to avoid matrix problems on an autoanalyzer. Blank measurements of this water obtained values of zero µM for phosphate, nitrate, nitrite and silicate. For the CTD samples the maximum sample value is compared with the full scale standard value so to obtain the best resolution of the system. With every run of CTD samples we put in a stable nutrient-cocktail containing all the parameters as an independent check standard.

The samples were measured on a Technicon AA-II autoanalyzer with a sample rate of 30 hr<sup>-1</sup> using 80 seconds sample-time and 40 seconds washing-time to reach a steady state level. Calculations were done with an attached PC correcting for baseline and gain drift.

The chemical methods used for the various nutrients were:

*Silicate*: Measured as the reduced molybdenum blue complex at 660 nm, with ascorbic acid as reductant; using oxalic acid to eliminate the phosphate interference.

*Ortho-phosphate*: Formation of the reduced molybdo-phosphate complex at pH 0.9-1.1 whereby potassium-antimonyl tartrate is used as a catalyst and ascorbic acid as the reductant. The developed color is measured at 880 nm. Method described first by Murphy and Riley (1962). At the end of the cruise all hydrographic data were corrected upwards by multiplication with a factor 1.04 based on the overall offset observed through two months versus the absolute standard. Data provided for several shipboard experiments is to be corrected accordingly.

*Nitrate and nitrite*:

Method described by Grasshoff (1983). Nitrate is first reduced into nitrite using a copperized cadmium coil (reduction > 95%) with imidazole as buffer agent. Used are two channels, one for nitrate plus nitrite with the cadmium coil in the first stage sample line, and the other for nitrite alone using the same color reagent for both. The pink colour formed after diazotation with sulphanylamide and naphthylethylenediamine is measured at 550 nm for both channels nitrate is obtained by substracking the nitrite values from the first channel.

The overall statistics for this cruise were:

	detection limit [µM]	accuracy at typical value [µM]
silicate	0.4	0.8 at 100
o-phosphate	0.02	0.05 at 2
nitrite	0.005	0.01 at 0.5
nitrate	0.3	0.6 at 30

N.B. see also project 24. for separate measurements of orthosilicic acid.

## Ammonia

Jacques Poncin

{NH<sub>4</sub>}

Ammonia is determined by the manual method of Koroleff (1976). Standards are realized with freshly prepared deionized water. Blanks are determined by using seawater samples taken at 1000-1500 m depth.

Koroleff (1976). Determination of ammonia. In: Grasshoff, K. (ed.) Methods of seawater analysis. Verlag Chemie, Weinheim, 126-133.

## 5. Optics

Sylvie Mathot (ULB), Cees Veth (NIOZ), Bernard Quéguiner (IEM), Laetitia Teissier (IEM)

Incident Photosynthetically Active Radiation (PAR) was continuously recorded (one value every two minutes) by means of a cosine Li-Cor sensor set up on the upper deck of the ship.

## 6. Carbondioxide system

Dorothee Bakker, Joop Rommets, Michel Stoll, Hein de Baar (all NIOZ)

### Partial pressure of CO<sub>2</sub> in atmosphere and ocean

Dorothee Bakker

{pCO<sub>2</sub>.GC-cm}

*The partial pressure of CO<sub>2</sub> of discrete samples.*

Discrete samples of 600 ml were taken in glass bottles with a screw cap containing a rubber septum from 1500, 1000, 500, 300, 200, 150, 100, 80, 60, 40, 20 and 10 meter from the CTD at all whole degree stations. Also all depths in deep casts to the bottom were sampled. Samples were poisoned by adding 0.1 ml of a saturated mercury chloride solution and put in a waterbath of 4.5 to 5 C for a minimum of one hour. 20 ml of water in each bottle was replaced by calibration gas of 473 ppmv CO<sub>2</sub> in artificial dry air. After at least another hour in the waterbath the headspace of the sample was injected into the gaschromatograph. A GC-run typically consisted of one discrete sample and calibration gas of 473 ppmv CO<sub>2</sub> by volume. The temperature of the waterbath was registered continuously. The temperature correction of Copin-Montegut (1988, 1989) was applied. Results were checked by comparing them with measurements of alkalinity and total CO<sub>2</sub>.

Copin-Montegut, C., 1988. A new formula for the effect of temperature on the partial pressure of CO<sub>2</sub> in seawater. *Marine Chemistry*, **25**, 29-37.

Copin-Montegut, C., 1989. Corrigendum. *Marine Chemistry*, **27**, 143-144.

*Continuous measurements of the partial pressure of CO<sub>2</sub> in surface water and marine air.*

Seawater was pumped continuously from 12 meter below sealevel to an equilibrator. The temperature difference between water at the intake and in the equilibrator was typically less than a degree. Every 10 minutes the CO<sub>2</sub> content of the headspace of the equilibrator was measured by a gaschromatograph. Marine air was pumped from 22 meter above sea level. Calibration gases of 259, 361 and 473 ppmv in artificial dry air by BOC, UK were used. Each GC-run consisted of two calibration gases, an equilibrator sample, followed by marine air and a second equilibrator sample. CO<sub>2</sub> was converted to methane by a nickel catalyst and detected by an FID-detector. The temperature correction of Copin-Montegut (1988, 1989) was used.

Files are per day with nomenclature CO2Dmmdd.XLS and CO2Smmdd.XLS

- Files containing the suffix D contain ONLINE data per 10 minute interval
- Files containing the suffix S contain ONLINE data and air-sea fluxes computed with different methods.
- mm stands for the month
- dd stand for the day

CO2D????	Explanation	Unit	Parameterisation	Skin temperature difference	Length wind interval	Length atmospheric pressure
Date	Date	m/d/yr	-	-	-	-
Time	Time	hh:mm	-	-	-	-
Wvel	wind velocity	m·s-1	-	-	-	-
AirTemp	air temperature	°C	-	-	-	-
Humidity	humidity	%	-	-	-	-
Latitude	Latitude	N+, S-	-	-	-	-
Longitude	Longitude	E+, W-	-	-	-	-
SpeedAh	speed ahead	m·s-1	-	-	-	-
Air pressure	atmospheric pressure	hPa	-	-	-	-
Glob rad	global radiation	W·m-2	-	-	-	-
Visibility	visibility	m	-	-	-	-
Cloud base	cloud base	m	-	-	-	-
Depth	water depth	m	-	-	-	-
DewPoint	dew point	°C	-	-	-	-
Wdir	wind direction	°	-	-	-	-
Chlorophyll	chlorophyll a content	mg·m-3	-	-	-	-

CO2S????	Explanation	Unit	Parameterisation	Skin temperature difference	Length wind interval	Length atmospheric pressure
Date	Date	m/d/yr	-	-	-	-
Wanted time	Time	hh:mm	-	-	-	-
xCO2DryAir	dry volume fraction of CO2 in dry air	$\mu\text{mol}\cdot\text{mol}^{-1}$	-	-	-	-
fCO2Air	fugacity of CO2 in with water saturated air	$\mu\text{atm}$	-	-	-	-
fCO2Eq	fugacity of CO2 in the equilibrator	$\mu\text{atm}$	-	-	-	-
fCO2w	fugacity of CO2 in water	$\mu\text{atm}$	-	-	-	-
Gamma eq	fugacity coefficient of CO2 for the equilibrator	-	-	-	-	-
K0_Air	solubility of CO2 at the sea surface	$\text{mol}\cdot\text{kg}^{-1}\cdot\text{atm}^{-1}$	-	-	-	-
K0_H2O	solubility of CO2 in bulk water	$\text{mol}\cdot\text{kg}^{-1}\cdot\text{atm}^{-1}$	-	-	-	-
Cair	concentration of CO2 at the sea surface	$\mu\text{mol}\cdot\text{kg}^{-1}$	-	-	-	-
Cwater	concentration of CO2 in bulk water	$\mu\text{mol}\cdot\text{kg}^{-1}$	-	-	-	-
Tempeq	temperature of the equilibrator	$^{\circ}\text{C}$	-	-	-	-
TskTemp	Water temperature bow salinometer	$^{\circ}\text{C}$	Bow salinometer			
TPyro	Uncorrected Pyrometer signal	$^{\circ}\text{C}$	Detected signal (before correction)			
TPyroCorr 40°	Corrected pyrometer temperature 40°	$^{\circ}\text{C}$	Detected and corrected to 40°			
TskSal	Salinity bow salinometer		-	-	-	-
Density	Density of seawater	$\text{kg}\cdot\text{m}^{-3}$	-	-	-	-
TWVel	wind velocity	$\text{m}\cdot\text{s}^{-1}$	-	-	-	-
AirTemp	air temperature	$^{\circ}\text{C}$	-	-	-	-
Humidity	humidity	%	-	-	-	-
PosLat	Latitude	N+, S-	-	-	-	-
PosLon	Longitude	E+, W-	-	-	-	-
SpeedAh	speed ahead	$\text{m}\cdot\text{s}^{-1}$	-	-	-	-
SpeedAc	speed across	$\text{m}\cdot\text{s}^{-1}$	-	-	-	-
Airpressure	atmospheric pressure	hPa	-	-	-	-
GIRad	global radiation	$\text{W}\cdot\text{m}^{-2}$	-	-	-	-
Vis	visibility	m	-	-	-	-
CloudBase	cloud base	m	-	-	-	-
SysDepth	water depth	m	-	-	-	-
DewPoint	dew point	$^{\circ}\text{C}$	-	-	-	-
WDir	wind direction	$^{\circ}$	-	-	-	-
Chloro	chlorophyll a content	$\text{mg}\cdot\text{m}^{-3}$	-	-	-	-
Flux LMno skin	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Liss-Merlivat	none	10 min	10 min
Flux LM meas	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Liss-Merlivat	detected	10 min	10 min
Flux LMskin02	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Liss-Merlivat	0.2°C	10 min	10 min
Flux LM1002	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Liss-Merlivat	none	10 min	6 weeks
Flux LMwind	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Liss-Merlivat	none	6 weeks	10 min
Flux Wno skin	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	none	10 min	10 min
Flux W meas	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	detected (40°)	10 min	10 min
Flux Wskin02	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	0.2°C	10 min	10 min
Flux W1002	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	none	10 min	6 weeks
Flux Wwind	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	none	6 weeks	10 min
Flux Hasse	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	Skin effect, Hasse	10 min	10 min
Flux Saun8	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	Skin effect, Saunders, I=8	10 min	10 min
Flux Saun var	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	Skin effect, Saunders, I=variable	10 min	10 min
Flux Schnacht	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	Skin effect, Schlüssel et al, night	10 min	10 min
Flux Schtot	CO2 air-sea flux	$\text{mmol}/(\text{m}^2\cdot\text{d})$	Wanninkhof	Skin effect, Schlüssel et al, day+night	10 min	10 min



Flux Soloviev	CO2 air-sea flux	mmol/(m <sup>2</sup> ·d)	Wanninkhof	Skin effect, Soloviev and Schlüssel	10 min	10 min
dTsch-D	Skin temperature difference	°C	Model Schlüssel et al, day	-	-	-
dTsch-N2	Skin temperature difference	°C	Model Schlüssel et al, night	-	-	-
dTsch-tot	Skin temperature difference	°C	Model Schlüssel et al, day+night	-	-	-
dTsa, l=8	Skin temperature difference	°C	Model Saunders, labda =8	-	-	-
dTsa, l=var	Skin temperature difference	°C	Model Saunders, variable labda	-	-	-
dThasse	Skin temperature difference	°C	Model Hasse	-	-	-
dTso-tot	Skin temperature difference	°C	Model Soloviev and Schlüssel	-	-	-

## **Total Carbondioxide**

Michel Stoll  
{TCO2.C}

Total carbon dioxide in discrete samples was determined by the Coulometric method (Johnson et al., 1987). Samples were poisoned with 0.05 - 0.1 ml of saturated mercury(II) chloride solution to prevent changes due to biological activity. They were then analyzed with an automated extraction line. A subsample is acidified with 8.5% phosphoric acid and bubbled through with CO<sub>2</sub>-free nitrogen gas. The released CO<sub>2</sub> gas is captured in ethanol-amine solution with an indicator which is photometrically backtitrated. Standards reference seawater as supplied by Dickson were determined regularly as a quality control check. Accuracy and precision amounts to  $\pm 1.5 \mu\text{mol/kg}$ .

Johnson K.M., P.J. LeB. Williams, L. Brändström and J. McN Sieburth (1987). Coulometric total carbon dioxide analysis for marine studies: Automatization and calibration. *Marine Chemistry*, **21**, 117-133.

## **Alkalinity**

Joop Rommets  
{Alk.A}

For the determination of the alkalinity 125 ml sea water samples were titrated at 20 °C with 0.1 M hydrochloric acid in a closed cell modified after Bradshaw and Brewer (1988). A Gran plot was made of the data points after the second equivalent point. For the calculation the constants of Goyet and Poisson (1989) were used. About five samples could be analysed in one hour with an accuracy of 1 micro-aequivalent per kg seawater. Most of the samples were taken at the full degree mesostations at 20, 40, 60, 80, 100, 150, 200, 300, 500, 1000 and 1500 metres, occasionally until the bottom.

Bradshaw, A.L. and P.G. Brewer (1988) *Marine Chemistry*, **34**, 155-162.  
Goyet, C. and A. Poisson (1989) *Deep-Sea Research*, **36**(11), 1635-1654.

## **7. POC and PON**

Uli Bathmann (AWI), Bernard Quéguiner (IEM), Laetitia Teissier (IEM), Jacques Poncin (IEM), Pascal David (CNRS)

### **Particulate Organic Carbon and Nitrogen**

U. Bathmann  
{POC, PON}

Shortly after taken water samples from CTD-rosette, 1 to 4 L of seawater were filtered through a precombusted (550 °C, 12 hours) Whatman GF/F glassfibre filter and shortly rinsed with distilled water. Filters were stored frozen (-25°C) until measurement at the laboratory at AWI. Before measurements filters were exposed to fumed HCl for 24 hours, then rinsed shortly with distilled water and dried (60 °C, 2 hours). The measurements were done by means of an Perkin-Elmer CHN Analyzer. Values are given in mg POC / m<sup>3</sup> or mg PON / m<sup>3</sup>.

### **Particulate Organic Carbon and Nitrogen** (in relation to project 24.)

Bernard Quéguiner, Laetitia Teissier, Jacques Poncin, Pascal David.  
{Biog.Si.POC, Biog.Si.PON}

2.5-l seawater were filtered through 25mm Whatman GF/F filters (precombusted at 450 °C) using Pyrex filter towers (Millipore). Filters were stored frozen in closed glass pill-boxes. POC and PON analyses were performed in the laboratory. After elimination of inorganic carbon remaining on the GF/F filters by fuming with concentrated HCl, POC and PON were measured by a combustion method (Strickland and Parsons, 1972), using a modified Carlo Erba model N 1500 analyser.

Strickland J.D.H. & Parsons T.R. 1972. A practical handbook of seawater analysis, 2nd edition. Bull. Fish. Res. Bd. Canada, 167 : 310 pp.

## **8. Dissolved Organic Carbon and Dissolved Organic Nitrogen**

Avan Antia (SFB), Paul Kähler (SFB)  
{DOC, DON}

The contents of dissolved organic carbon (DOC) and nitrogen (DON) are measured by High Temperature Catalytic Combustion similar to the method presented by Sugimura and Suzuki (1988). 10 ml of sample are filled into glass ampoules from the Niskin bottle, acidified with 60 µl concentrated phosphoric acid, and the ampoules sealed. Acidified samples may be stored for prolonged periods (months). Before measurement the water is sparged of (inorganic) CO<sub>2</sub> (i.e. all carbonates at the low pH) by bubbling with argon in the opened ampoules for 10 to 20 minutes. 100 µl of the sample is injected into a quartz tube containing 20 g of platinumized aluminum oxide beads (5% Pt content) covered with 2 g of Pt gauze and kept at a temperature of 900 °C. A stream of oxygen (or 10% oxygen in argon for combined DOC/DON measurements) carries the water vapor and combustion gases through several water traps (5 °C.-trap, ice bath, Mg-perchlorate tube) and adsorption traps for sulphur- and chlorine-containing gases (tin, zinc and bronze) to an infrared adsorption CO<sub>2</sub>-detector. In one of three such set-ups a chemoluminescence detector for the measurement of NO (to measure total dissolved nitrogen compounds) is in line after the infrared detector. Calibration is against glucose and urea dissolved in seawater at appropriate concentrations. The obtained values of total organic carbon (TOC) and total dissolved nitrogen (TDN) are converted to DOC and DON by the subtraction of particulate C, particulate N and inorganic dissolved N-compounds respectively. We measure water column values of odd stations on board, even-numbered stations at home. Additionally, we measure DOC and DON in ice, porewater, and water from various experiments.

Values are given in µmol C and N per litre.

Sugimura, Y. and Suzuki, Y. (1988) A high temperature catalytic oxidation method of non-volatile dissolved organic carbon in seawater by direct injection of a liquid sample. *Marine Chemistry*, **16**, 83-97.

## **9. Chlorophyll and Pigments**

Uli Bathmann (AWI), Bärbel Bolt (FBB), Doris Meyerdierks (FBB), Bernard Quéguiner (IEM), Laetitia Teissier (IEM), Jacques Poncin (IEM), Pascal David (CNRS), Sylvie Mathot (ULB), Ilka Peeken (SFB), Maria van Leeuwe (NIOZ)

### **Determination of chlorophyll *a* and phaeopigments by fluorometric technique**

U. Bathmann  
{Chlorophyll}

Shortly after taken water samples from CTD-rosette, 0.5 to 2 L of seawater water was filtered through a Whatman GF/F glasfibre filter. Filters were stored frozen (-25 °C) until extraction which was normally performed within one day by adding 10 ml of 90% acetone/water (v/v) and grinding (plankton and filters) with glass beads. The extract was measured for chlorophyll *a* and phaeopigments (the latter

after adding two drops of 1M HCl) with a Turner Design fluorometer according to the method described by Evans et al. 1982. The fluorometer was calibrated by using pure chlorophyll extract obtained from Sigma Chemical Company and checked by the photometric method described by Strickland and Parsons (1972). Values are given in mg chl. a/ meter<sup>3</sup> or µg chl.a /l.

**Chlorophyll *a* and phaeopigments** (in relation to project 24).

Bernard Quéguiner, Laetitia Teissier, Jacques Poncin, Pascal David  
{Biog.Si.Chla}

1-l samples are filtered through 25mm Whatman GF/F filters. Filters are placed in Pyrex tubes and kept frozen until analysis in the laboratory. Analysis is performed using the fluorometric method (Neveux, 1976).

Neveux J. 1976. Dosage de la chlorophylle a et de la phéophytine par fluorométrie. *Ann. Inst. Océanogr.*, **52**, 165-174.

**Chlorophyll *a*** (in relation to project 27.)

Doris Meyerdierks, Bärbel Bolt  
{DMSP.Chla}

After prefiltration through a 200 µm nylon net to remove larger zooplankton, phytoplankton was concentrated by filtration (< 150 m bar) of 1 - 4 L seawater onto glass fibre filters (Whatman GF/F, 47 mm diameter). For chlorophyll *a* analysis, filters were stored frozen (-25 °C) in polyethylene tubes until extraction within the next two days. They were then homogenized in 5 ml of 90 % acetone, centrifuged and the supernatant was determined fluorometrically using a Chlorophyll-Fluorometer (biosens Hannover, Germany) calibrated against chlorophyll *a* standard (Sigma Chemicals) which was checked photometrically according to Jeffrey and Humphrey (1975).

**Chlorophyll *a*** (in relation to projects 12. and 13.)

Sylvie Mathot  
{Data available upon request}

For below study on "Phytoplankton: chlorophyll, proteins, lipids, carbohydrates" (see section 12.) a small dataset of Chl *a* values was produced. This is not in the database but available upon request.

**Pigments**

Ilka Peeken  
{Pigments, 19-but, 19-hex, allox, chla, chla/allo, chla/epi, chlb, chlc1+2, chlc3, chllda, diadino, fuco, lut/zeax, peridin, phorba, phphyta, prasinox, pyrophorb, pyrphyta}

Seawater samples (2-8 l) were filtered onto 25 mm Whatman GF/F filters with a pressure of less than 120 m bar. After filtration, the filters were folded and stored in 2 ml micro centrifuge tubes (Eppendorf cups) at -30 °C until analysis.

Samples from transects 2, 3, 5, 6 and 7 were measured on board by means of a HPLC-system, equipped with a Perkin Elmer pump (series 400), an LS1 fluorescence detector, a spectroflow 757 UV-Vis detector and a Waters integration system. Samples from transect 11 were measured in the laboratory 4 months after the cruise, where the UV-Vis detector was replaced by a diode array spectrophotometric detector (Waters 995).

For analytical preparation, 50 µl internal standard (canthaxanthin) and 2 ml acetone were added to each filter sample and then homogenised for 3 minutes in a cell mill. After centrifugation, the supernatant liquid was placed in Eppendorf cups and stored at -30 °C until analysis within the next 12

hours. Just prior to analysis, an aliquot (100-200  $\mu\text{l}$ ) of the sample was premixed with water (HPLC-grade) in the ratio 1:1 (v/v) and injected onto the HPLC-system. The pigments were analysed by reverse-phase HPLC, using a C<sub>18</sub> spherisorb ODS 3  $\mu\text{m}$  (4.0x125mm) Pharmacia column and HPLC-grade solvents (Biomol). Solvent A consisted of 80% methanol and 20% 0.5 M ammonium acetate and solvent B contained 80% methanol and 20% acetone. The gradient was run from A to B in 30 minutes and then held for 10 minutes at B, with a continuous flowrate of 1.5 ml min<sup>-1</sup>. Eluting pigments were detected by absorbance (436 nm) and fluorescence (Ex: 410 nm, Em: > 600 nm).

Pigments were identified by comparing their retention times with those of pure standards and algal extracts. Additional confirmation for each pigment was done with the remaining extracts of representative samples from all transects using on-line diode array absorbance spectra between 390-750 nm. Pigment concentrations were quantified based on peak areas of external standards, which were spectrophotometrically calibrated using extinction coefficients published by Bidigare (1991). For correction of experimental losses and volume changes, the concentrations of the pigments were normalised to the internal standard canthaxanthin.

Bidigare, R. R. (1991). Analysis of algal chlorophylls and carotenoids. In *Marine particles: Analysis and Characterisation*, vol. Geophysical Monograph (ed. D. C. Hurd and D. W. Spencer), pp. 119-123: American Geophysical Union.

#### **Pigments** (in relation to project 25.)

Maria van Leeuwe

{Var3.Pigments}

Seawater was collected typically at 80m and 40m depths as to coincide with the sampling depths for particulate trace metals (see below 25). At least 10 l of sea water was filtered over glass fibre filters (Whatman GF/F). Filters were immediately placed into a dewar-container holding liquid nitrogen, in which they will be stored until HPLC-analysis at home.

### **10. Bacteria biomass and production**

Karin Lochte (AWI), Peter Bjørnsen (MBL), Anke Weber (UOS/IFM), (Hanna Giesenhagen, IFM), Alexandra Nielsen (MBL), Sylvie Becquevort (ULB).

#### **Bacterial abundance**

Anke Weber (Hanna Giesenhagen)

{Bact.CellNum.AO}

5-10 ml of formalin fixed sample filtered onto Irgalanblack pre-stained 0.2  $\mu\text{m}$  Nuclepore filters, a second membrane filter was placed underneath to facilitate dispersion of the bacteria over the filter. After four minutes of staining by acridine orange, the counts were made under blue-light excitation using a Zeiss epifluorescence microscope (1000x) with ICS-optics. The shipboard dataset will be written up in collaboration with H. Giesenhagen (IFM).

#### **Bacterial Biomass**

Anke Weber (Hanna Giesenhagen)

{Bact.BM.AO}

Mean bacterial cellular biomass was estimated by measuring 50 randomly selected cells (from filters prepared as described above) and calculating mean bacterial biovolume by comparison to a New Portion grid which was calibrated by comparison with standard size fluorescent beads. Calculation of the mean bacterial cellular carbon content was done according to Simon & Azam, Mar. Ecol. Prog. Ser. 51, 201-213, 1989. Bacterial biomass was calculated by multiplying cell numbers and mean cellular carbon

content. No correction was made for possible shrinkage as a result of sample preparation. The shipboard dataset will be written up in collaboration with H. Giesenhagen (IFM).

### **Bacterial biomass**

S. Becquevort, Th. De Henau

{Bact.CellNum.DAPI, Bact.BM.DAPI}

Bacteria were enumerated by epifluorescence microscopy after 4',6-diamidino-2-phenylindole (DAPI) staining (Porter & Feig, 1980) and by flow cytometry after DAPI staining (De Henau, 1992). Biovolumes were estimated on enlargements of microphotographs. Conversion into carbon biomass was done using the biovolume dependent C/ biovolume ratio proposed by Simon & Azam (1989).

### **Bacterial production**

Peter K. Bjørnsen, Karin Lochte

{Bact.TTI, Bact.LEU}

Production of bacterial biomass is determined by incorporation of [<sup>3</sup>H]-labelled thymidine and leucine into macromolecules which are precipitated by cold trichloroacetic acid (TCA) as described below. The dependence of substrate incorporation on incubation time and concentration of the respective substrate was investigated in different water bodies throughout the cruise. The data in the database are the basic (and most reliable) data of substrate incorporation given in pmol thymidine l<sup>-1</sup> day<sup>-1</sup> or in pmol leucine l<sup>-1</sup> day<sup>-1</sup>, respectively. The conversion factors to convert these incorporation rates to production of bacterial cells or biomass carbon are established in experiments with 0.8µm filtered water samples, in which the production of new cells is monitored parallel to [<sup>3</sup>H]-thymidine and [<sup>3</sup>H]-leucine incorporation.

In order to convert the substrate incorporation into bacterial production the following conversion factors were determined in the experiments: 1 pmol of tritiated thymidine incorporation (TTI) corresponds to a bacterial production of 1x10<sup>-6</sup> cells; for leucine (LEU) 1 pmol leucine incorporated corresponds to a net carbon production of 3 ngC. Carbon content of the bacterial cells was determined as 1.87x10<sup>-5</sup> ngC cell<sup>-1</sup>. Carbon conversion efficiency of bacteria was assumed as 30%.

Incubations were carried out at a fixed temperature of 0 °C. Experiments showed that temperature has an effect of up to 15 % per degree C on incorporation rates. Corrected incorporation rates which take into account in situ temperatures will be supplied later.

#### *Thymidine:*

Four 10 ml aliquots of water sample are dispensed into plastic vials; one of these subsamples is fixed by addition of 100 µl 39% formalin amended with cold thymidine and serves as a blank. Each sample receives methyl-[<sup>3</sup>H]-thymidine, specific activity 3.11 TBq/mmol (Amersham), to a final concentration of 2nM. The samples are incubated for 2 to 3 hours at 0 °C and the incubation is stopped by addition of 100 µl 39% formalin amended with cold thymidine. The samples are filtered through 0.22 µm poresize cellulose acetate filters, pre-soaked in a cold thymidine solution, and rinsed 10 times with 2 ml 5% ice cold TCA. The filters are placed in 5 ml plastic scintillation vials and 4.5 ml scintillation cocktail (Lumagel SB, Baker Chemicals) are added. The radioactivity incorporated in the cold TCA precipitable material on the filter is measured on board by a Packard Liquid Scintillation Counter.

#### *Leucine:*

The procedure is identical to the thymidine incorporation method described above except for the following differences: The samples receive a final concentration of 10 nM L-[4,5-<sup>3</sup>H]-leucine (Amersham), specific activity 0.522 TBq/mmol. After incubation the samples are filtered through 0.2 µm poresize polycarbonate filters (Nuclepore).

**11. Mesozooplankton** (incl. egg production)  
 Santiago Gonzalez, Bouwe Kuipers (all NIOZ)  
 {} NETSTR??XLS

Zooplankton samples were collected with two Hydro Bios Multinet, mounted with five nets of 64 and 200 µm mesh-size respectively.

The Multinets were lowered vertically and covered with the five successive nets the next depths strata:

Net nr	Depth stratum	approx. volume filtered
1	500-200 m	75 m <sup>3</sup>
2	200-100 m	25 m <sup>3</sup>
3	100-50 m	12.5 m <sup>3</sup>
4	50-25 m	6.25 m <sup>3</sup>
5	25-0 m	6.25 m <sup>3</sup>

*Treatment of samples*

The contents of the nets were washed into the FOLSOM plankton splitter and splits into two equal halves.

From the 64 micron mesh size net one half was concentrated on 50 µm sieve and preserved in 4% formalin for counting and species determination. In accordance with the JGOFS core measurement recommendations the other half was screened into two size fractions (0.2-1 and 1-20 mm) which were rinsed with distilled water and sucked dry on tared Whatman GF/C filters. The filters were stored at -27°C and weighted after 18 h at 60 °C and 2 h at 550 °C subsequently to estimate ashfree dry weight (AFDW).

Counting and species determination was made for Transect 2, 5 and 11. AFDW for the JGOFS protocol was determined for Transect 1, 2, 3, 4, 5, 6, 11 and 12.

Some remarks:

- S Species index and name
- D Density per M<sup>3</sup>
- B Dry weight per M<sup>3</sup> in milligram
- G Mean dry weight in microgram
- L Mean length in 100 µ

**12. Microplankton abundance; autotrophs, heterotrophs; incl. nanoplankton**

Dick Crawford (AWI), Friedel Hinz (AWI), Renate Scharek (AWI), Christine Klaas (AWI), Andrea Detmer (IFM), Sylvie Becquevort (ULB), Sylvie Mathot (ULB), Thierry de Henau (ULB), Frank Jochem (IFM), Peter Bjørnsen (MBL), Alexandra Nielsen (MBL), Santiago Gonzalez (NIOZ), Bouwe Kuipers (NIOZ)

**Microplankton & nanoplankton, mostly flagellates**

S. Becquevort, Th. De Henau  
 {Auto.Flag.}

Nanoplanktonic auto- as well as heteroflagellates were enumerated by epifluorescence microscopy after DAPI staining (Porter & Feig, 1980). The lengths and widths of 100 flagellates were determined visually by comparison with an ocular micrometer. Cell volumes were estimated using the equation of a prolate spheroid. Nanoplankton biomass was calculated assuming a carbon density of  $0.11 \text{ pgC } \mu\text{m}^{-3}$  (Edler 1979).

### **Phytoplankton and protozoa enumeration**

Sylvie Mathot

{muPhyt.CellNum, muPhyt.BM} (no data)

Several water sub-samples were taken for microscopic examination of the planktonic communities and preserved with appropriate (i.e. for reliable identification and abundance determination) fixatives immediately after collection. Thus samples for phytoplankton (mainly diatoms and dinoflagellates) and protozoan (ciliates and dinoflagellates) carbon biomass calculation were preserved either with glutaraldehyde-25% (final conc. 0.5%) or with a glutaraldehyde-lugol cocktail (35 o/oo, v/v; final conc. 1%). Carbon biomass was calculated from cell counts and cellular biovolume measurements under an inverted microscope (Utermöhl technique), by using appropriate carbon/cell biovolume conversion factors of  $0.11 \text{ pgC} \cdot \mu\text{m}^{-3}$  (Edler, 1979) for dinoflagellates (auto- and heterotrophic) and diatoms, and  $0.08 \text{ pgC} \cdot \mu\text{m}^{-3}$  (Beers and Stewart, 1970) for ciliates. Autotrophs were discriminated from heterotrophs by their red chlorophyll autofluorescence. Details concerning this procedure are extensively described in Becquevort et al. (1992).

Becquevort, S., Mathot, S. and Lancelot, C. (1992) Interactions in the microbial community of the marginal ice zone of the northwestern Weddell Sea through size distribution analysis. *Polar Biol.*, **12**: 211-218.

### **Phytoplankton: chlorophyll, proteins, lipids, carbohydrates**

Sylvie Mathot

{Cell.Const.Proteins, CellConst.Lipids, Cell.Const.CarbHydr.RES,  
Cell.Const.CarbHydr.TOT}

These measurements were done in conjunction with the project on photosynthetic assimilation rates (see below 13.), only at selected stations. Water samples were collected for chlorophyll a measurements, for phytoplankton biochemical determination (i.e. proteins, total and reserve carbohydrates, lipids) and for cell enumeration. All these variables will be measured in the home laboratory.

#### *Chlorophyll a measurement:*

1 to 2 liters of water were filtered onto 47 mm diameter Whatman GF/F glass-fiber filters. Filters are kept frozen in the dark until analysis. Chlorophyll a will be determined following either the spectrophotometric method of Lorenzen (1967) or the fluorometric method of Yentsch & Menzel (1963). The dataset is quite small and not part of the database, yet available upon request.

#### *Phytoplankton biochemical composition:*

For stocks determination, 1 to 2 liters of water were filtered on pre-ashed ( $512^\circ\text{C}$ ) 47 mm diameter Whatman GF/F glass-fiber filters. Phytoplankton cellular constituents were estimated by regression analysis of measurements of particulate proteins, carbohydrates and lipids on Chl-a concentrations as proposed by Lancelot-Van Beveren (1980). Thus quantitative measurements of proteins in solution were performed with the Folin-Ciocalteu reagent (Lowry et al, 1951) following the experimental procedure developed by Hewitt (1958). For total carbohydrates, a modified form of the



phenol-sulphuric acid method of Dubois et al (1956) was used. Total lipids were extracted with a chloroform-methanol solution, carbonized with concentrated sulphuric acid, and the amount of carbon was spectrophotometrically measured (Marsh & Weinstein, 1966). Experimental procedures are extensively described in Lancelot-Van Beveren (1982).

Lancelot-Van Beveren, C. (1982) Etude ecophysiologique du phytoplancton de la zone côtière belge. These de doctorat, Université Libre de Bruxelles, 221p.

### **Autotrophic Pico- and Nanoplankton Abundance**

Andrea Detmer

{PPML.ANP.C, PPML.UNID.C, PPML.ANP.M, PPML.APP.M.}

Autotrophic pico- and nanoplankton cell numbers (ANP.C) and numbers of unidentified cells/particles (UNID.C) as estimated by flow cytometry under blue-light excitation (430-490 nm) on a Fluvo II cytometer, triggered for red autofluorescence normally characteristic for chlorophyll. Chlorophyll-containing as well as phycoerythrin-containing particles were observed. Also 50-100 ml of sample fixed with glutaraldehyde (1%) were filtered onto Irgalanblack pre-stained 0.2 µm Nuclepore filters, stained by Proflavine and stored frozen (-28 °C) for counting with epifluorescence microscopy (ANP.M, APP.M). These methods also apply to observation of cyanobacteria (JGOFS activity 16.)

### **Heterotrophic Pico- and Nanoflagellate Abundance**

Frank Jochem

{PPML.HNF10-20, PPML.HNF<10, PPML.HPF, PPML.HPP}

Cell numbers of heterotrophic nanoflagellates 10-20 µm (HNF10-20) and less than 10 µm (HNF<10) in size, and heterotrophic picoflagellates (HPF) less than 2 µm. 50-100 ml of sample filtered onto Irgalanblack pre-stained 0.2 µm Nuclepore filters, stained by Proflavine and Hoechst 33342, counted under blue-light excitation on a Zeiss epifluorescence microscope (200x and 1000x) with ICS-optics; suspect cells checked for nucleus presence under UV-excitation using Hoechst stain. Relying on these methods cyanobacteria were also observed (JGOFS activity 16.).

### **Abundance and biomass of heterotrophic dinoflagellates smaller than 20 µ**

(in relation to experiments on growth potential)

Peter K. Bjørnsen and Alexandra C. Nielsen

{Bact.SHD.Cellnum and Bact.SHD.BM}

Ten ml samples were fixed by 150 µl of 25% glutaraldehyde, stained with proflavin hemisulphate (10 ppm final concentration) and filtered onto black polycarbonate filters of 0.2 µm pore size. More than 50 small heterotrophic dinoflagellates (SHD) were counted and sized under an epifluorescence microscope at 600 x magnification and blue excitation. Only dinoflagellates smaller than 20 µm were included in these counts. Biovolume was converted into biomass assuming a carbon density of 0.12 pg C per µm<sup>3</sup>.

### **Diatoms**

Dick Crawford, Friedel Hinz

{Diatoms}

Apstein net (20µm mesh) from surface 20m and Multinet (64µm mesh) from 5 depths down to 300m were examined live for floristic assessment. Samples were preserved and prepared for a permanent slide collection to provide a detailed taxonomic account and relative frequency figures for the floral composition.

## **Microplankton and nanoplankton**

Renate Scharek, Christine Klaas

{muPhyt.Prot.CellNum, muPhyt.Prot.Phyto, muPhyt.Protozoa, muPhyt.Protists}

Species composition and biomass of the microplankton assemblage are obtained by counting fixed material with the Utermöhl technique on:

a) Water bottle 200ml samples.

b) 10 l water bottle samples concentrated to 200ml by reverse filtration through 2.0 µm filters.

c) Multinet samples (64 µm mesh).

Abundances will be given in cells/l. Biomass are given in nanogram s/l for protistan carbon (PRC), and comprises a phytoplankton carbon fraction (PPC) and protozooplankton carbon (PZC).

Video recordings were taken for identification of living heterotrophic protozoans.

## **Microzooplankton**

Bouwe Kuipers, Santiago Gonzalez

{Microzoo}

At all meso- and most microstations samples were taken from 20, 40, 80, 200 and 300 m. Niskin or NOEX bottles (three stations above and two under the usual thermocline) and preserved immediately in 2 % Lugol-A solution. At NIOZ numbers per ml. of tintinnids, other ciliates, large heterotrophic flagellates, rotifers and other groups will be counted by settlement inverted microscopy for size-categories <20, 20-60, 60-100 and >100 µm. The purpose is to check whether there are -similar to recent North Sea observations -significant numerical responses in these small grazers at the onset of blooms. Diatom numbers counted in the same samples could illustrate how because of microzooplankton size selective grazing larger algae can become dominating during blooms notwithstanding the much higher µ-max of the smaller microzooplankton algal prey-species.

## **13. Primary production by 14C**

Sylvie Mathot (ULB), Frank Jochem (IFM), Bernard Quéguiner (IEM)

### **Primary Production**

Frank Jochem

{PPML.TOTPP, PPML.PP>20, PPML.PP5-20, PPML.PP2-5, PPML.PP<2}

Size-fractionated primary production from 12 hrs. in-situ incubation (stn 885 only) or 24 hrs. in-situ simulated deck incubation using neutral density filters in a seawater-cooled deck incubator (see below description by S. Mathot, ULB Bruxelles). Added activity = 50 µCi per 250 ml polycarbonate bottle; subsamples of 45 ml for measurements in size fractions of "total" (untreated), "<20" (net gauze), "<5" and "<2" (by 5.0 µm and 2.0 µm Nuclepore filters, respectively), fractionated subsamples filtered onto 0.2 µm membrane filters, dissolved in Lumagel SB and measured in a Beckman LS-1800 liquid scintillation counter. Two bottles treated with 1.5 x 10<sup>-5</sup> nM DCMU were used as «dark bottles» and subtracted from the light bottle values. The unfractionated value {PPML.TOTPP} is the JGOFS variable and compatible with below {PP.Prim.Prod}.

### **Primary production**

Sylvie Mathot

{PP.Prim.Prod}

Assessments according to JGOFS protocols with the exception of using deck incubators rather than in situ incubation. 250 ml samples were collected from depths closer to 100%, 70%, 45%, 22%, 10%, 4.5%, 1.5%, and 0.5% (neutral density screens) of incoming PAR. An additional sample was taken and kept in the dark as «dark bottle» for which then the value was subtracted from the values of the light bottles. Samples were incubated for 24 hours in the "in-situ simulated deck-incubator", in polycarbonate bottles with  $\text{NaH}^{14}\text{CO}_3$  at a rate of 10  $\mu\text{Ci}$  per 100 ml sample (Amersham, specific activity = 56  $\text{mCi}\cdot\text{mmol}^{-1}$ ).

Samples were filtered on Whatman GF/F filters at the end of incubation time. Two drops of HCl 0.5N were added to the filters to release unassimilated  $^{14}\text{CO}_2$ . Scintillation cocktail was added to the filters prior to their radioactivity assaying in a Packard 1900CA Tri-Carb Liquid Scintillation Counter. Occasionally, size-fractionation was also performed onto 10  $\mu\text{m}$  and 0.8  $\mu\text{m}$  Poretics filters.

### **Photosynthetic assimilation rate, phytoplankton growth and respiration.**

Sylvie Mathot

{PP.AssimRT, Phyto.GrowthRT}

This project was done in relation with above "Phytoplankton: chlorophyll, proteins, lipids, carbohydrates", see section 12. The experimental determination of physiological parameters characteristic of phytoplankton involved two kind of tracer experiments conducted in parallel under simulated *in-situ* conditions. For all these incubations, 100 to 250 ml seawater sample, which amount was chosen according to phytoplankton biomass, were incubated in polycarbonate bottles with  $\text{NaH}^{14}\text{CO}_3$  at a rate of 10  $\mu\text{Ci}$  per 100 ml sample (Amersham, specific activity = 56  $\text{mCi}\cdot\text{mmol}^{-1}$ ).

Experimental determination of photosynthetic parameters involved short-term (4 hours)  $^{14}\text{C}$  incubations (based on the Steemann-Nielsen standard method), performed at various fractions of light intensity, either in an "in-situ simulated inside incubator" (0, 1, 4, 6, 10, 15, 20, 30, 40, 60, 80, 100%; Philips 500W halogen lamps) or in an "in-situ simulated deck-incubator" (0, 0.5, 1.5, 4.5, 10, 22, 45, 70, 100% of incoming PAR), both cooled by running seawater. Filters were treated as described above. Photosynthetic parameters  $K_{\text{max}}$ ,  $a$ , and  $b$  were calculated by mathematical fitting of the data relative to the photosynthesis-light relationship using Platt et al.'s equation (1980).

Experimental determination of phytoplankton growth (net primary production) and respiration parameters was performed through long-term (24 hours) light-dark kinetics of  $^{14}\text{C}$  assimilation into 4 pools of cellular constituents easily separable by biochemical procedure: small metabolites (composed of monomeric precursors for the synthesis of macromolecular compounds), lipids and polysaccharides (constituting together the reserve products of the phytoplankton cell), and proteins. Incubations were conducted at *in-situ* temperature under saturating illumination (100-170  $\mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ ). The light-dark cycle was fixed at 14:10 to simulate environmental conditions. Two drops of HCl 0.5N were added to the filters to release unassimilated  $^{14}\text{CO}_2$ . Scintillation cocktail was added to the filters prior to their radioactivity assaying in a Packard 1900CA Tri-Carb Liquid Scintillation Counter. Occasionally, size-fractionation was also performed onto 10  $\mu\text{m}$  and 0.8  $\mu\text{m}$  Poretics filters. Filters for biochemical fractionations were kept frozen until analysis in the home laboratory. Details on experimental procedure and biochemical fractionation are described in Lancelot and Mathot (1985). Phytoplankton growth and respiration parameters were estimated by mathematical fitting of the data relative to the kinetics assimilation of  $^{14}\text{C}$  into proteins and storage products, using the equations described in Lancelot et al. (1991).

Lancelot, C. and Mathot, S. (1985) Biochemical fractionation of primary production by phytoplankton in Belgian coastal waters during short- and long-term incubation with  $^{14}\text{C}$ -bicarbonate. I. Mixed diatom population. *Mar.Biol.*, 86(3): 219-226.

Lancelot, C., Veth, C., and Mathot, S. (1991) Modelling ice edge phytoplankton bloom in the Scotia-Weddell Sea sector of the Southern Ocean during spring 1988. *J.Mar.Syst.*, 2: 333-346.

## **Carbon primary production** (in relation to project 24.)

Bernard Quéguiner  
{Biog.Si.PP}

250-ml samples were collected from depths closer to 100%, 25%, 10%, 3%, 1% and 0,1% incident PAR. Samples were spiked with 10 $\mu$ Ci (370 kBq) NaH <sup>14</sup>CO<sub>3</sub> and incubated during 24-h in a deck incubator maintained at sea surface temperature. Just after spiking, 100 ml is removed and immediately counted by liquid scintillation to determine the specific activity of each sample. After incubation samples were filtered onto 0.4  $\mu$ m Nuclepore filters. Non-incorporated NaH <sup>14</sup>CO<sub>3</sub> remaining on the filter is eliminated by adding a few ml of 0.01 N HCl in 0.4  $\mu$ m -filtered seawater. Filters were then counted by liquid scintillation method.

## **14. Primary production by O<sub>2</sub>**

Frank Jochem (IFM), Rinus Manuels (NIOZ)

Except for one in situ incubation at drift station no data.

## **15. New Production by <sup>15</sup>N and Export Production by <sup>234</sup>Th**

Marita Wunsch (SFB), (Wolfgang Koeve, SFB), Frank Dehairs (VUB), (Leo Goeyens, VUB), Michiel van der Loeff (AWI)

### **Nitrate assimilation**

Marita Wunsch, (Wolfgang Koeve)  
{<sup>15</sup>NO<sub>3</sub>.Uptake}, no data.

New Production here is defined as phytoplankton growth based on the assimilation of nitrogen in the form of NO<sub>3</sub> as opposed to Regenerated Production, which is based on ammonia uptake (EPPLEY etc. 19..). We measure NO<sub>3</sub> uptake with <sup>15</sup>NO<sub>3</sub> as a tracer.

4.5-litre samples of seawater from various depths (corresponding to 66, 52, 13 and 1% light levels) are filled into transparent polycarbonate bottles, spiked with <sup>15</sup>NO<sub>3</sub> at a concentration of about 10% of the ambient nitrate concentration and incubated on deck at surface water temperature for 24 hours. The respective light levels are attained by covering the bottles with appropriate light absorbing foils. After this incubation two to four litres (depending on Chl.-a content) of the water are filtered over GF/F-filters (200 bar suction) which are stored frozen then dried at 60 °C and later analyzed for particulate <sup>15</sup>N by mass spectrometry.

NO<sub>3</sub> uptake of various size classes is determined by additional sequential filtration over 20, 5, and 2  $\mu$ m pore-size filters respectively. In these cases, sample depths and incubation light levels are 100, 30, and 1% of the surface light level

Values are given in  $\mu$ mol NO<sub>3</sub> uptake per day and m<sup>2</sup>.

### **New Production by <sup>15</sup>N**

Frank Dehairs, (Leo Goeyens)  
{<sup>15</sup>NH<sub>4</sub>.Uptake, <sup>15</sup>NO<sub>2</sub>.Uptake, <sup>15</sup>NH<sub>4</sub>.Mineralisation}

### Uptake of ammonium

#### *Sampling and spiking:*

4.5 l seawater was sampled in a Nalgene bottle. Spike solution (1.7 ml <sup>15</sup>N-NH<sub>4</sub>Cl solution: 11.6 mg l<sup>-1</sup>; 99% <sup>15</sup>N) was added. The bottle was gently shaken and subsampled for the initial ammonium content. The spike addition was calculated to increase an original ammonium content of 1  $\mu$ mol l<sup>-1</sup> by

about 10%. Since during ANT X/6 natural ammonium concentrations never reached that level, spike additions were generally  $\gg 10\%$  of the original content.

*Incubations:* During the transects samples from -10 and -30m were incubated for 24 hours in the on-deck incubator, respectively at 100% and 30% of incoming radiation using a neutral density screen.

During the drift station (from October 22 to 24), day incubations (06.00 to 18.00) and night incubations (18.00 to 06.00) were done. Day incubations concerned samples from -7, -20, -40, -60 and -80 m depth. The first day of the drift station experiment these samples were set out in-situ. On day 2 and day 3 the samples were incubated in the on-deck incubator, respectively at 100%, 66%, 30%, 13% and 1% of incoming light, using neutral density screens.

Night incubations were done on samples from -10 and -60m. These samples were incubated in the dark in the cold room at 1 °C or in the on-deck incubator.

At the end of the incubation period, subsamples were taken for determination of the final ammonium content. Another subsample is taken for assessment of the ammonium mineralisation rate (see point 2 below).

For cases where Chl-a content  $\geq 0.3 \mu\text{g l}^{-1}$ , one fraction of the seawater sample was passed over a 20  $\mu\text{m}$  screen to assess ammonium uptake by the  $\leq 20 \mu\text{m}$  sized phytoplankton. The other fraction was directly filtered (approx. 0.2 bar underpressure) on precombusted (450 °C) Whatman GF/F filters to assess ammonium uptake by the total phytoplankton population.

For situations with low Chl-a content ( $< 0.3 \mu\text{g l}^{-1}$ ) no size fractionation was performed.

GF/F filters are oven dried (50 °C) and sealed in plastic petri dishes for later analysis in the home laboratory.

### Mineralisation of ammonium

Mineralisation of ammonium is assessed during the same experiment as ammonium uptake. After the incubation and before the filtration (see point 1 above), 10 ml of the sample are transferred to a serum vial, and spiked with 500  $\mu\text{l}$  of an unlabeled ammonium carrier solution ( $\text{NH}_4\text{Cl}$ : 54.15  $\text{mg l}^{-1}$ ) for the entrainment of  $^{15}\text{N}$ -ammonium. Ammonium from this solution is extracted by adding 500  $\mu\text{l}$  of strong base (KOH: 50%) and the produced ammonia is captured on aluminium oxide beads coated with sulphuric acid (0.25 M) and suspended in a tin cup above the solution. After  $\geq 48$  hours the tin cup is retrieved and sealed in a plastic envelope for later analysis in the home laboratory.

### Uptake of nitrite

#### *Sampling and spiking:*

Sampling of the seawater from -10 m, in a 4.5 l Nalgene bottle. Addition of 2 ml spike solution ( $^{15}\text{N}$ - $\text{KNO}_2$ : 4.8  $\text{mg l}^{-1}$ ; 99%  $^{15}\text{N}$ ). The bottle is gently shaken and subsampled for the initial nitrite concentration.

#### *Incubation:*

The sample is incubated for 24 hours in the on-deck incubator at 100% of incoming light. After the incubation a subsample is taken for the determination of the final nitrite concentration. The remaining solution is filtered on precombusted Whatman GF/F and oven dried at 50 °C. Samples are sealed in plastic petri dishes for later analysis in the home laboratory.

### Determination of $^{15}\text{N}$ abundance (home laboratory)

The  $^{15}\text{N}$  abundance is determined by emission spectrometry (JASCO NIA- $^{15}\text{N}$  analyzer) after conversion of particulate nitrogen and extracted ammonia into dinitrogen by means of an oxidation with  $\text{CuO}$ . This conversion is performed in quartz discharge tubes at 750 °C. Specific and absolute uptake

rates are computed using mathematical expressions based on the isotope dilution law and on a constant transport model (the latter assumes no significant biomass build up during the incubation)

### **Export Production by $^{234}\text{Th}$ , including $^{210}\text{Po}$ and $^{210}\text{Pb}$**

Michiel Rutgers van der Loeff, Heike Hölzzen, Jana Friedrich

{S, 234Th.diss, 234Th.part, 234/238.diss, 234/238.part, 234/238.removed, Si, NO<sub>2</sub>, NO<sub>3</sub>, PO<sub>4</sub>}

RADIOISO.XLS

(Michiel Rutgers van der Loeff, Heike Hölzzen, Jana Friedrich)

Samples were taken with 270-l Gerard bottles. On shallow casts samples were collected at 6 depths, usually 20m, 60m, 100m, 200m, 400m and 600m. Some samples from deep casts had to be discarded because silicate analyses, compared with the silicate profile obtained from CTD-Rosette casts, indicated leakage during retrieval due to insufficient closure of the covers. The water was pumped by a centrifugal pump through a 142mm 1 $\mu$  nuclepore filter. Filtered volume was measured with a KENT flow meter. A 20-kg aliquot of filtrate was weighed, acidified with 20 ml of HNO<sub>3</sub>, and spiked with  $^{230}\text{Th}$ ,  $^{208}\text{Po}$  and stable Pb yield tracers. 250 mg of Fe was added, and after 1 day isotope equilibration, NH<sub>3</sub> was added to a pH of 8.5, thus coprecipitating Th, Po and Pb with Fe(OH)<sub>3</sub>. The hydroxide was collected by settling and centrifugation, and dissolved in a minimum amount of 9M HCl. After complexing Fe with ascorbic acid, Po was plated on silver planchets according to Fleer and Bacon (1984) based on the procedure of FLYNN (1968). After evaporation with some HNO<sub>3</sub> to decompose the ascorbic acid, Th was isolated by ion exchange and electroplated according to Anderson and Fleer (1982).  $^{234}\text{Th}$  was counted by anticoincidence low-level beta counting (background 0.15 dpm) on-board ship, whereas the  $^{230}\text{Th}$  and Po was counted in the home laboratory.

The filter samples were decomposed by microwave acid digestion in a mixture of 10 ml HNO<sub>3</sub>, 0.5 ml HF and 2 ml H<sub>2</sub>O<sub>2</sub>. Organic residues were destroyed by adding 2 ml HClO<sub>4</sub> after spiking with  $^{230}\text{Th}$ ,  $^{208}\text{Po}$  and stable Pb yield tracers. Radionuclide analysis of the filter samples was performed following the same procedures as for the water samples.

$^{210}\text{Pb}$  of water and filter samples was determined through the ingrowth of  $^{210}\text{Po}$ . The solution remaining after the first Po plating, which still contained the Pb fraction, was stored for about one year to allow new  $^{210}\text{Po}$  to grow from decay of  $^{210}\text{Pb}$ . Then Po was extracted again by the method mentioned above. The silver planchets with the Po fraction were measured by alpha counting on silicon surface barrier detectors (EG&G Ortec).  $^{210}\text{Pb}$  and  $^{210}\text{Po}$  activities are decay-corrected to the time of sampling according to FLEER & BACON (1984). Error estimates (1-sigma) include counting errors and uncertainties in blanks, spike activities and sample volume.

The  $^{226}\text{Ra}$  activity was calculated from the silica concentration of the water from the relationship of KU & LIN (1976). Salinity is obtained from corresponding CTD casts, and used to calculate  $^{238}\text{U}$  from the relationship given by Chen et al. (1986).

Anderson, R. F., and A. P. Fleer (1982) Determination of natural actinides and plutonium in marine particulate material. *Anal. Chem.*, **54**, 1142-1147.

Chen, J. H., L. R. Edwards, and G. J. Wasserburg (1986)  $^{238}\text{U}$ ,  $^{234}\text{U}$  and  $^{232}\text{Th}$  in seawater. *Earth Planet. Sci. Lett.*, **80**, 241-251.

Fleer, A. P., and M. P. Bacon (1984) Determination of  $^{210}\text{Pb}$  and  $^{210}\text{Po}$  in seawater and marine particulate matter. *Nuclear Instruments and methods in Physics Research*, **223**, 243-249.

Flynn, W. W. (1968) The determination of low levels of Polonium-210 in environmental materials. *Anal. Chim. Acta*, **43**, 221-227.

Gardner, W. D., I. D. Walsh, and M. J. Richardson (1993) Biophysical forcing of particle production and distribution during a spring bloom in the North Atlantic. *Deep-Sea Res. II*, **40**, 171-195.

Ku, T. L., and M. C. Lin (1976)  $^{226}\text{Ra}$  distribution in the Antarctic Ocean. *Earth Planet. Sci. Lett.*, **32**, 236.

## **16. Autotrophic pico/nano-plankton (including cyanobacteria)**

Andrea Detmer, Frank Jochem (both IFM)

{PPML.SYN}

See above core activity 12., for our methods for autotrophic and heterotrophic pico- and nanoplankton.

## **17. Grazing by Mesozooplankton**

Corina Dubischar (AWI), Uli Bathmann (AWI)

{No samples from bottle casts. Data will appear in other report.}

Mesozooplankton grazing experiments with copepods were carried out at several stations in order to assess the *in situ* grazing rates of the dominant species. Following the suggestions of the JGOFS protocol for the core parameters, the gut fluorescence technique was applied. Immediately after capture of the species with a Bongo net (sealed cod end), lots of 10 to 15 individuals each, of the dominant species (*Rhincalanus gigas*, *Calanus propinquus*, *Calanoides acutus*) were placed in buckets (1 liter) containing filtered sea water. One lot was deep frozen (-25 °C) at once, the others in time intervals of 20, 40, 60, 120, 150 minutes. Three to five replicates were taken for each time step. After each series of such gut evacuation experiment, chlorophyll *a* and phaeopigment content were determined by means of a Turner Design Fluorometer. Data are given in chlorophyll *a* equivalents as the sum of chlorophyll *a* and phaeopigments. According to theory, the initial slope should represent the gut evacuation rate *in situ*; the reverse representing the gut passage time (minutes).

## **18. Grazing by Microplankton**

Christine Klaas (AWI), Sven Reitmeier (SFB), Sylvie Becquevort (ULB), Thierry de Henau (ULB)

### **Grazing by microplankton & nanoplankton**

S. Becquevort, Th. De Henau

{NanoZoo.Grazing}

Protozoan grazing on phytoplankton and bacteria specifically were measured by the method proposed by Sherr et al (1987) based on the uptake of fluorescent - labelled prey (FLA *fluorescent - labelled algae*, Rublee & Gallegos 1989; FLB *fluorescent - labelled bacteria*, Sherr et al 1987).

### **Grazing**

Christine Klaas

{Dinoflag}

From abundance's of dinoflagellates (see above 12.) it is conceivable to derive an estimate of grazing rates, in which case these rates will also be brought into the database.

### **Microzooplankton Grazing**

Sven Reitmeier

{Var2.k, Var2.g, Var2.Regr, Var2.Init.Chla, Var2.PICG, Var2.ChlADoubl, Var2.CG}

Microzooplankton Grazing (MZP-grazing) is measured by a procedure similar to that described by LANDRY and HASSETT (1982). Diluting a water sample with filtered seawater will also reduce the grazing pressure on planktonic algae, while the phytoplankton growth rate is not affected. Water from the Niskin bottle (or Gerard Water Sampler) is pre-screened over a 100 µm gauze and then diluted to 20,

40, and 70% with 0.2  $\mu\text{m}$ -filtered seawater. 2.5 litres of each of these dilutions, and of undiluted seawater, are incubated in transparent polycarbonate flasks in triplicate at ambient temperature on deck for 24 hours, the light level of the sampling depth being attained by a cover with an appropriate light absorbing foil.

Chlorophyll-a is determined fluorimetrically before and after incubation for each dilution after filtration of 1-2 litres onto a GF/F filter, and acetone extraction. Before and after incubations there are also samples taken for phytoplankton and microzooplankton microscopic analysis. These samples are fixed with Lugol's solution and analysed by the Utermöhl technique. The natural logarithms ( $\ln$ ) of the quotient between initial and final Chl.-a values (Phytoplankton apparent growth rate, AGR) are plotted against the dilution (fractions of 1), the grazing coefficient ("g") is read from the slope of the line and "k" (y-axis intercept) is the phytoplankton growth coefficient.

Values of "g" and "k" are given (dimensionless), describing the function of the linear regression like:  $y=k+gx$ . Once the C/Chl. ratio is established from the analysis of POM, the grazing rates can also be expressed in carbon units.

Additionally, samples were taken for later pigment analysis by HPLC in order to obtain information on the selectivity of MZP-grazing.

## **19/20. Sediment traps**

Uli Bathmann (AWI)

{No data in this report.}

## **21. Ice coverage.**

Jan van Franeker (IBN)

Icecover is an important parameter in JGOFS studies because of its influence on the light regime, stability and salinity of the underlying water, all strongly affecting growth conditions for phytoplankton. Furthermore, the ice contains important communities of ice algae. Methods for ice observations have been developed in the "Protocol for ship- and airborne observations on the structure, physical properties and coverage of sea ice in the framework of Southern Ocean (SO) JGOFS activities. (Ackley S.F, Eicken H., van Franeker J.A., and Wadhams P. 1992). Following these methods ice observations during SO-JGOFS were conducted at every station position, and when thought useful, in between station positions. Results have been summarized in an ice database (ICESUM\_ANTX/6. available in MAC Excel3, and MS\_DOS Lotus3 or ASCII file).

Parameters listed in the database are:

- SO-JGOFS stationnumber and transectnumber. Observations at intended but cancelled station positions have station number 0, and underway observations have no number. Positions of ice edge crossings have been included as "edge". Edge positions given are for the outer ice edge, that is the most northern border of loose bands or fields of ice.
- date, time and position (minutes of latitude/longitude expressed in decimals!)
- Range (in km) around position for which observations are considered valid. It was attempted to give a description of icecover in a larger (5 to 10 km) area, but visibility or other circumstances sometimes reduced the area of observation.
- Percentages of open water and total icecover. Within total icecover a subsequent distinction is made between coverage by:
  - Floes: relatively flat pieces of first-year or older ice, covered by snow. - New ice: new ice types (grease/slush; pancake ice; dark nilas; light nilas; and grey/greywhite ice) were recorded separately when possible but have been combined in one figure in the database. New ice generally has no or little snowcover.
  - Brash ice: defined as small fragments of the wreckaged forms of other forms of ice.
- Floediameter lists the estimated average diameter of floes dominating in icecover (in meters).



- Additional to the sea ice cover the total number of icebergs in a 12 nautical mile range around the ship was counted from the ships radar.
- For each station, the distance in km's from the ice edge was calculated (latitudinal difference between ship position and edge position).
- Finally the database lists temperature and salinity of the surface water, and air temperature (10 minute average from Polarstern INDAS datasystem).

Filenames have the following convention:

- ICE10-??XLS: These contain 10 minute observations of the various parameters. Some files are combined which are designated by both transect numbers (e.g. ICE10-78.XLS, has the data of transect 7 and 8). Exceptions are ICE10-11.XLS and ICE10-12.XLS, respectively transect 11 and 12.
- ICEJGOFS.XLS: Ice observation data according to JGOFS protocol.

Some further parameters were recorded during JGOFS observations, such as thickness of icefloes and snowcover, different types of young ice, frequency of rafted floes and frequency of brown ice. These have not been included because they were considered too specific, hardly variable or of low reliability.

In addition to the standard JGOFS observations, ice conditions were estimated on a much finer scale during each ten-minute period of top predator observations in a narrow transect band (including minimum-maximum figures for icecover and floesize). Part of these observations will be included in the database of the surface registration group.

If such data are required please obtain further information from Jan van Franeker, see address list.

## 22. Ice physics

Cees Veth (NIOZ)

{No data in this report.}

## 23. Ice biology

Uli Bathmann (AWI), Renate Scharek (AWI), Sylvie Becquevort (ULB), Sylvie Mathot (ULB), Frank Jochem (IFM)

{No data in this report.}

## 24. Silica biogeochemical cycling

Bernard Quéguiner (IEM), Laetitia Teissier (IEM), Jacques Poncin (IEM), Pascal David (CNRS)

{Biog.Si.BM, Biog.Si.Prod, Biog.Si.Silicate}

### Biogenic silica biomass

1-l seawater is filtered onto 47 mm Nuclepore membranes (0.4 mm at each depth and size-fractionation : 0.4-10 mm at selected depths). Filters are dried for at least 24h at 60 °C and stored in plastic Petri dishes. Biogenic silicate [ $\mu\text{mol Si}\cdot\text{m}^{-3}$ ] analyses are performed in the laboratory using the NaOH digestion method of Paasche (1973) as modified by Nelson et al. (1989).

Nelson D.M., Smith W.O., Muench R.D., Gordon L. I., Sullivan C.W. & Husby D.M. 1989. Particulate matter and nutrient distributions in the ice-edge zone of the Weddell Sea : relationship to hydrography during late summer. *Deep-Sea Res.*, **36**, 191-209.

Paasche E. 1973. Silicon and the ecology of marine plankton diatoms. 1. *Thalassiosira pseudonana* (*Cyclotella nana*) grown in a chemostat with silicate as the limiting nutrient. *Mar. Biol.*, **19**, 117-126.

### Biogenic silica production

PSi is determined by the  $^{30}\text{Si}$  stable isotope method of Nelson and Goering (1977). The tracer solutions had been passed through Chelex resin before the cruise to limit possible trace metal contamination. 1-l samples are collected from depths closer to 100%, 25%, 10%, 3%, 1% and 0.1% incident PAR. Samples are then drawn in 1-l acid (HCl 0.1 N)-cleaned polycarbonate bottles that had been previously covered with neutral-density nickel screens. Under a laminar flow hood, samples are spiked with 20  $\mu\text{m}$ oles of  $\text{Na}_2^{30}\text{SiO}_3$  and placed in a plexiglas incubator maintained at sea surface temperature by constant flow of surface water. After a 24-h incubation the samples are filtered under a laminar flow hood through 47mm Nuclepore membranes (0.4 $\mu\text{m}$  at each depth and size-fractionation : 0.4-10 $\mu\text{m}$  at 100% and 0.1% depths). Filters are dried for at least 24h at 60 °C and stored in plastic Petri dishes. The determination of the rates of orthosilicic acid uptake (PSi) is performed in the laboratory by mass spectrometry.

Nelson D.M. & Goering J.J. 1977. A stable isotope tracer method to measure silicic acid uptake by marine phytoplankton. *Anal. Biochem.*, **78**, 139-147.

### Biogenic silica dissolution

At some stations, Diss Si is determined in parallel to PSi by the  $^{30}\text{Si}$  stable isotope method of Nelson et al. (1991). 1.6-l samples are collected from depths closest to 100%, 25%, 10%, 3%, 1% and 0.1% incident PAR. Under a laminar flow hood, samples are spiked with 32  $\mu\text{m}$ oles of  $\text{Na}_2^{30}\text{SiO}_3$ . 1-l of each sample is immediately transferred into acid-cleaned polycarbonate bottles and allowed to incubate during 24-h in a deck incubator maintained at sea surface temperature. 0.6-l remaining are immediately filtered through 0.4  $\mu\text{m}$  Nuclepore filter. The filter is retained for BSi analysis and the filtrate treated to collect the dissolved silicic acid for isotopic analysis. 37.5 ml of Sephadex-cleaned ammonium molybdate/hydrochloric acid reagent are added to the filtrate. The silicomolybdate complex is then extracted on a Sephadex column. After 24-h incubation the 1-l sample is filtered onto 0.4  $\mu\text{m}$  Nuclepore filter. The filter is retained for PSi analysis and the filtrate is treated as described above.  $^{28}\text{Si}/^{30}\text{Si}$  ratios are determined in the laboratory by mass spectrometry. The difference between  $^{28}\text{Si}/^{30}\text{Si}$  ratios in the dissolved phase before and after incubation allows to calculate the rate of dissolution of biogenic silica.

Nelson D.M., Ahern J.A. & Herlihy L.J. 1991. Cycling of biogenic silica within the upper water column of the Ross Sea. *Mar. Chem.*, **35** : 461-476.

### Orthosilicic acid concentrations

$\text{Si}(\text{OH})_4$  concentrations are determined using a Technicon autoanalyzer. The analytical procedure is based on the reduction of silicomolybdate in acid solution to molybdenum blue by a methyaminophenol sulfate (Metol) and sodium sulfite solution (Mullin & Riley, 1975 ; Strickland & Parsons, 1972).

Mullin J.B. & Riley J.P. 1955. The spectrophotometric determination of silicate-silicon in natural waters with special reference to sea water. *Anal. Chim. Acta*, **12** , 162-170.

Strickland J.D.H. & Parsons T.R. 1972. A practical handbook of seawater analysis, 2nd edition. *Bull. Fish. Res. Bd. Canada*, **167** : 310 pp.

N.B. This is independent from the orthosilicic acid measurements done for the hydrographic work (core activity 4).

## **25. Iron-plankton interactions (incl. trace element distributions)**

Maria van Leeuwe (NIOZ), Renate Scharek (AWI), Jeroen de Jong (NIOZ), Bettina Löscher (NIOZ), Hein de Baar (NIOZ)

## Iron as growth limiting factor

Maria van Leeuwe, Renate Scharek, Jeroen de Jong, Hein de Baar

At several stations large batches of seawater were collected with precleaned, modified GoFlo samplers mounted either on the all-teflon coated CTD/Rosette frame or on a 10mm kevlar hydrowire. Immediately upon recovery the samplers were attached to the outside of the thermally insulated clean air incubation van. Then teflon tubing was connected as to lead the seawater inside the clean environment where it was collected into acid cleaned, seawater preconditioned, polycarbonate culture vessels of various sizes ranging from 1 to 20 liters.

The data presented in the files BIOMETA?.XLS hold the results of the chlorophyll a and nutrient analyses belonging to the experiments described in the paper by van Leeuwe et al. on "Iron enrichment experiments in the Southern Ocean ...". These data were used to calculate nutrient uptake rates and rates of chlorophyll a synthesis.

Some remarks:

- "control" stands for the unamended control bottles, "Fe" stands for the bottles enriched with 2 nM Fe.
- Chlorophyll a data are expressed in  $\mu\text{g} \cdot \text{dm}^{-3}$ .
- Nutrient data are expressed in  $\mu\text{mol} \cdot \text{dm}^{-3}$ .
- Phosphate data have to be corrected by multiplication with a factor of 1.04

Uptake rates and rates of synthesis were calculated by linear regression of a semi-log plot of chlorophyll a concentrations and nutrient consumption during exponential growth versus time. The slope of the semi-log regression provides the desired rate ( $d^{-1}$ ) of chlorophyll a synthesis and nutrient uptake respectively.

## Distributions of dissolved and particulate trace metals

Bettina Löscher, Jeroen de Jong, Hein de Baar

{Trace.Met} METALS.XLS

{Nom.Depth, Diss.Met., Part.Met., Si, NO<sub>3</sub>, PO<sub>4</sub>} METALS.XLS

Seawater samples were taken with precleaned GoFlo samplers (12 L) mounted either on a 10 mm kevlar hydrowire (40 - 400 m), or on an all-Teflon coated CTD/Rosette frame (> 400 m). At each full degree, six samples were collected with kevlar wire at standard depths (40-60-100-150-200-400 m), corrected afterwards for wire angle, using an SIS pressure sensor at the deepest (400 m) sampler. Water deeper than 400 m was collected with the CTD/Rosette frame. Surface water samples (~10 m; unfiltered) were taken from a walking bridge extending 10 metres beyond the bow of the slowly upwind steaming ship, using a 2 l GoFlo sampler on a small winch with 6 mm kevlar wire. Upon recovery, the sampler was wrapped in plastic bags, transferred into a Class-100 clean air laboratory van, and drained into a precleaned storage bottle. Particulate matter was collected by filtering 30 to 60 l of seawater through 142 mm NUCLEPORE filters with a pore size of 0.2  $\mu\text{m}$ . The seawater had been taken with a suite of 3-6 12L GoFlo samplers on the CTD/Rosette frame.

Immediately upon recovery, the large 12 L GoFlo samplers were attached to the outside of the clean air laboratory van. Teflon tubes were connected to lead the seawater into the clean laboratory. Pressure lines, with high purity nitrogen gas passing over fine particle arrestance filters, were attached to the top of the samplers, to allow for filtration by an overpressure of < 1 bar. Inside the clean laboratory, seawater was filtered over acid-cleaned NUCLEPORE or PORETICS membrane filters (47 mm, 0.4  $\mu\text{m}$ ), mounted in all-Teflon (PTFE) filter holders. In addition, seawater samples were taken without filtering. The filtered or unfiltered seawater was collected into 1 or 2 l hot-acid-cleaned PE bottles, acidified to pH 2 with quartz distilled HNO<sub>3</sub> and stored. ZHUANG et al. (1990) reported an increasing

dissolution of Fe in marine aerosols with decreasing pH of seawater. Hence, for the unfiltered samples it is assumed that the approximately one year storage at pH 2 would allow dissolution of at least some, if not most biogenic fractions and surface oxyhydroxides coatings. Only the most refractory component of land-derived minerals (clays, sand, etc.) would still be excluded from the analysis.

At the ice stations, surface snow, ice and brine samples were collected using acid-cleaned plastic ware. The samples were placed in a laminar flow clean air bench for melting, then acidified, and transferred into PE bottles and stored.

In the clean laboratory onshore, the samples were pre-concentrated (167x) by an APDC/DDDC chloroform extraction in Teflon separatory funnels, according to BRULAND and FRANKS (1979). The back extraction step was omitted. The extract was evaporated to dryness and the residue dissolved in diluted HNO<sub>3</sub>. The reagents used were cleaned by four-fold subboiling distillation in quartz stills. The final analyte was measured using a Perkin Elmer 5100 PC Graphite Furnace Atomic Absorption Spectrophotometer with Zeeman background correction.

In the home laboratory the trace metals Fe, Cd, Cu, Ni, Zn, (Co), (Pb), (Ag) have been analyzed. The first step is a twohundredfold preconcentration and purification by selective complexation with APDC/DDDC followed by solvent extraction into chloroform. The extract is then evaporated to dryness and the residue dissolved in dilute HNO<sub>3</sub>. The final analyte was measured using a Perkin Elmer 5100PC Graphite Furnace Atomic Absorption Spectrophotometer (GFAAS) with Zeeman background correction.

## **26. Top predators (birds, marine mammals)**

Jan van Franeker (IBN)

## **27. Ecophysiology of ice algae: Dimethylsulfoniumpropionate (DMSP) content during ice melt**

Doris Meyerdierks and Bärbel Bolt (FBB)

{DMSP.DMSP, DMSP.Chla}

After prefiltration through a 200 µm nylon net to remove larger zooplankton, phytoplankton was concentrated by filtration (< 150 m bar) of 1 - 4 L seawater onto glass fibre filters (Whatman GF/F, 47 mm diameter). The particulate DMSP was determined as gaseous Dimethylsulfid (DMS) using the specific reaction that cleaves DMSP 1:1 into DMS and acrylic acid upon the addition of a strong base. After base (25 % NaOH) was added the filters were incubated in gastight vials and headspace gas analysis was performed at least 4 hours later, after complete liberation of DMS, using a gas chromatograph (Shimadzu 8A) with flame photometric detector. For calibration, DMSP standards (Research Plus, Bayonne, NJ, USA) were treated and analysed in the same way.

## **28. Biogeochemistry of Barium**

Frank Dehairs (VUB)

{diss.Ba, Part.Ba.Part.Ba, Part.Ba.Part.Ca, Part.Ba.Part.Al, Part.Ba.Part.Si, Part.Ba.Part.Sr}

### Particulate Barium

During the north-south transects along 6° W total suspended matter samples were taken at every 2 degrees of latitude for particulate Ba-barite determination. The upper 600m of water column were sampled to document on the mesopelagic accumulation of Ba-barite.

### *Sampling*

Depths were -10, -50, -100, -150, -200, -250, -300, -350, -425, -500 and -600m. Between 10 and 20 l seawater were filtered under pressure on Nuclepore membranes of 0.4 µm porosity. After filtration

filters were rinsed with about 10 ml of Milli-Q type water and dried at 50 °C. They were then stored in plastic petri dishes at room temperature for further analysis in the home laboratory.

#### *Determination of Barium*

Filter samples are transferred to platinum crucibles. After careful combustion of the Nuclepore substrate and of the organic matter at ~ 400 °C, the remaining particulate matter is fused for 1 hour at 1100 °C with LiBO<sub>2</sub> as the flux. The fused pearl is redissolved in 4% hot nitric acid. This solution is brought to 10 ml volume. The analysis is carried out by inductively coupled plasma optical emission spectrometry (ICP-OES). Other elements such as Ca, Sr, Si and Al are analysed simultaneously.

### **29. <sup>13</sup>C in surface water particulate organic matter**

Frank Dehairs (VUB)

{Part.Ba.13C}

When sampling for particulate barium, during the north-south transects along 6° W, the -10 and -50m depths were sampled for <sup>13</sup>C determination in POM. Occasionally samples were also taken from 20m and 60m depths sampled with the Gerard bottles. About 20 l of seawater are filtered under pressure on precombusted (450 °C) Whatman GF/F filters. Filters are dried at 50 °C and stored at room temperature till later analysis in the home laboratory.

#### *Analysis of <sup>13</sup>C natural abundance*

Filters are left for 1 hour in HCl vapour for elimination of carbonates. Subsamples are combusted in a CN analyzer (Carlo Erba NA 1500) and the produced CO<sub>2</sub> is automatically trapped in a trapping-box (Finnigan-Mat) for preconditioning the gas sample before introduction into the on-line mass spectrometer (Delta-E, Finnigan Mat). CO<sub>2</sub> mass measurements are relative to that of CO<sub>2</sub> reference gas (from marble standards, standardized relative to NBS CaCO<sub>3</sub> standards). Final results are expressed as <sup>13</sup>C abundance (<sup>13</sup>C) relative to the PDB reference.

### **30. Benthic processes**

Michiel Rutgers van der Loeff, Jana Friedrichs, Haike Hölzen, Ola Holby, Karin Lochte (all AWI), Bettina Löscher (NIOZ)

#### **Sediment data**

The sediment data were determined in undisturbed sediment cores obtained by multiple corer at the stations indicated.

Microbiological data are given in the file **Bentbact.xls**

*Variables:*

1. station = station numbers following the ship's protocol
2. bottom depth = depth of water column (m)
3. sediment layer = sediment horizon sampled (cm)
4. bact.numb. = bacterial numbers (10e8 cells/ml)
5. phospholipids = concentration of phospholipids (nmol/ml)
6. FDA = hydrolysis rate of fluorescein diacetate (micromol/l/hr)

Variables 3)-6) were provided by

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Methods (Karin Lochte):

1. See ships protocol
2. See ships protocol
3. Sediment layer: Sediment cores were segmented into 0.5 cm layers from 0 to 2 cm sediment depth; from 2 to 6 cm they were segmented into 1 cm layers; from 6 to 10 cm they were segmented into 2 cm layers. The sediment layer depth gives the mean depth of the sample.
4. Bacterial numbers: Bacteria were counted microscopically in the sediment samples which had been stored fixed in 2% formaldehyde solution and kept refrigerated at 4 °C. The samples are diluted 1:10000 with filtered seawater, homogenized briefly by ultrasonication, stained 5 min with acridine orange (0.01%), washed with citrate buffer (pH 4) and filtered onto black 0.2 µm pore size polycarbonate filters (Nucleopore). The filters are mounted on microscopic slides in Cargille immersion oil and viewed at 1000x magnification (Zeiss Axioscope20, filter system BP450-490/FT510/LP520, oil immersion objective Plan-Neoflar 100). At least 200 cells per sample were counted.
5. Phospholipids: Phospholipids were extracted from the sediments and analysed as described in: Boetius, A., Lochte, K. (1994) Regulation of microbial enzymatic degradation of organic matter in deep-sea sediments. *Mar.Ecol.Prog.Ser.* 104, 299-307.
6. Hydrolysis rate of fluorescein diacetate: The rate of hydrolysis of fluorescein diacetate was determined in the sediment samples as described in: Meyer-Reil, L.-A., Köster, M. (1992) Microbial life in pelagic sediments: the impact of environmental parameters on enzymatic degradation of organic material. *Mar.Ecol.Prog.Ser.* 81, 65-72.

Pore water data are given in the file **Bentpore.xls**

*Variables*

- A) Station, station numbers following the ships protocol
- B) AWI, AWI core number
- C) Sediment layer, mean depth of sediment horizon sampled (cm)
- D) Concentration of nitrite in porewater (µM)
- E) Concentration of nitrate in porewater (µM)
- F) Concentration of ammonium in porewater (µM)
- G) Concentration of phosphate in porewater (µM)
- H) Concentration of reactive silicate in porewater (µM)

I) Flux of oxygen into the sediment ( $\text{mmol/m}^2 \text{ d}$ )

Variables C)-I) provided by

Ola Holby

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Methods (Ola Holby)

C) Sediment layer: Sediment cores were segmented into layers from 0-0.5, 0.5-1, 1-2, 2-3, 3-5, 5-7 and 7-10 cm. Below 10 cm the cores were segmented into 5 cm layers. The sediment layer depth gives the mean depth of the sample.

D)-H) The porewater concentrations of  $\text{NO}_2$ ,  $\text{NO}_3$ ,  $\text{NH}_4$ ,  $\text{PO}_4$  and Si, were analysed directly on board with an auto analyser according to Grasshoff et al. (Methods of Seawater Analysis, Verlag Chemie, Weinheim, 419 pp, 1983). No precaution was taken to avoid contact with air.

I) The flux of oxygen into the sediment was calculated with Fick's first law, using oxygen profiles obtained in the ships refrigerated lab with home-built Clark style electrodes (Revsbech, N. P., In situ measurements of oxygen profiles of sediments by use of oxygen microelectrodes. in *Polarographic Oxygen Sensors: Aquatic and Physiological Applications*, edited by E. Gnaiger, and H. Forstner, pp. 265- 273, Springer, 1983)

Further pore water data (alkalinity and pH) as well as data of porosity and sediment composition (Th-234 excess activity, organic carbon and biogenic silica content) and fluxes between sediment and overlying water are available upon request.

### **Metals concentration in sediments**

Bettina Löscher (NIOZ)

BENTMETA.XLS

The particulate matter samples on 142  $\mu\text{m}$  filters were subjected to a sequential chemical leaching treatment in the clean laboratory. They were immersed in 4.5 M Q-acetic acid for 4 h at room temperature, to dissolve adsorbed cations, carbonate phases and reactive oxyhydroxides (LANDING and BRULAND, 1980; 1987). This was followed by a digestion in 2 M Q-HCl/1 M Q-HNO<sub>3</sub> for again 4 h at room temperature to dissolve the more resistant Fe (III) oxyhydroxides (LEWIS and LANDING, 1991). The residual refractory material was taken in clean digestion vessels and totally digested with 3 ml Q-HCl, 1 ml Q-HNO<sub>3</sub> and 1 ml ultra clean HF. After digestion in a microwave oven they were diluted with 5 ml saturated H<sub>3</sub>BO<sub>3</sub> to neutralise the strong acid HF (Merck). The last digestion step was tested for total destruction with the reference material calcareous loam (BCR No. 141) and light sandy soil (BCR No. 142) for the metals Cu and Ni. The obtained values agreed with the certified values within the 95% confidence interval. The blanks of Fe ranged between 0.43 and 5.67 pM, and between 0.07 and 1.07 nM for the acetic acid leaching step and the total destruction step, respectively. The blanks for the second leaching step were smaller than 0.01 nM. The detection limits, based on three times the standard deviation of the blanks, ranged between 1.57 and 3.15 pM, 0.6 and 7.8 pM, and 20 pM and 0.88 nM for the acetic acid leaching step, the second leaching step and the total destruction, respectively.

For the total particulate Al data, the seawater samples were collected independently by F. Dehairs in the upper 600 m using an all-Teflon coated CTD/Rosette frame with NOEX samplers. Typical depths were 10, 50, 100, 150, 200, 250, 300, 350, 425, 500 and 600 m. The seawater was transferred to 30-l acrylic (perspex) filtration units for filtration on Nuclepore membranes (47 mm, 0.4 µm porosity) using pressure of filtered air. In general between 5 and 24 litres seawater were filtered per sample. After filtration, membranes were dried at 50°C and stored frozen in Millipore petri dishes until later analysis. At every station one blank membrane was dried and stored as done for the sample membranes. In the home laboratory filter samples were mineralised using a lithium metaborate (LiBO<sub>2</sub>; Specpure, Johnson & Matthey) fusion technique described in detail in DE HAIRS et al. (1990, 1991). Prior to the fusion of the samples in platinum crucibles at 1100°C, the polycarbonate matrix of the membrane filters was gently combusted at 400°C. After fusion the samples were redissolved in hot (80°C) HNO<sub>3</sub> (Merck, Suprapure) under constant stirring. Final sample solution (10 ml) was 8% in HNO<sub>3</sub> and 5% in LiBO<sub>2</sub>. Al was analysed by simultaneous inductively coupled plasma optical emission spectrometry (Jobin-Yvon 48). Standards were prepared in a similar HNO<sub>3</sub>/LiBO<sub>2</sub> matrix as the samples.





Appendix: All variables present in ROSETTE.XLS listed in the following table.

Variables	Unit	Availability after ...	Months	INSTIT	INVESTIGATOR	Description	JGOFS
Station	Identification			NIOZ	J. Rommets		
Cast	Identification			NIOZ	J. Rommets		
Bottle	Identification			NIOZ	J. Rommets		
Depth (Nominal)	m			NIOZ	J. Rommets		
CTD.press	dbar			NIOZ	S. Ober	CTD pressure	2
CTD.temp	deg. C			NIOZ	S. Ober	CTD temperature	2
CTD.sal	no dimension			NIOZ	S. Ober	CTD Salinity (PSU, dimensionless)	2
CTD.O2.sens	cm3.dm-3			NIOZ	S. Ober	CTD Oxygen sensor	2
CTD.Fluor	ug chloroph.dm-3			NIOZ	S. Ober	CTD Fluorescence	2
CTD.Trans	%			NIOZ	S. Ober	CTD Transmissometer	2
15NH4.Mineralisation	nmol.dm-3.d-1		8	VUB	F. Dehairs	15N Ammonia mineralization rate	15
15NH4.Uptake	nmol.dm-3.d-1		6	VUB	F. Dehairs	15N Ammonia uptake rate	15
15NO2.Uptake	nmol.dm-3.d-1		6	VUB	F. Dehairs	15N Nitrite uptake rate	15
15NO3.Uptake	nmol.dm-3.d-1		'6/12	SFB313	M. Wunsch/N. Koeve	15N Nitrate uptake rate	15
19-but	ng.dm-3			SFB313	I. Peeken	19'-butanoyloxyfucoxanthin	9
19-hex	ng.dm-3			SFB313	I. Peeken	19'-hexanoyloxyfucoxanthin	9
%PPCflag	%			AWI	Scharek	% Phytoplankton Carbon flagellates	12
%PPCidia	%			AWI	Scharek	% Phytoplankton Carbon sea-ice diatoms	12
%PPCpdia	%			AWI	Scharek	% Phytoplankton Carbon pelagic diatoms	12
%PPCtdia	%			AWI	Scharek	% Phytoplankton Carbon total diatoms	12
Al Hac	pmol.dm-3			NIOZ	B. Loscher	particulate aluminium, soluble in Hac	25
Al HCl	pmol.dm-3			NIOZ	B. Loscher	particulate aluminium, soluble in HCl	25
Al ref	nmol.dm-3			NIOZ	B. Loscher	particulate aluminium, digested HCl/HNO3/HF	25
Alk.A	µeq.kg-1			NIOZ	J. Rommets	Alkalinity	6
allox	ng.dm-3			SFB313	I. Peeken	Alloxanthin	9
AOU	µmol.kg-1			NIOZ	M.W. Manuels	Apparent Oxygen Utilisation	3
Auto.Flag.BM	µg C.dm-3		0/2	ULB	S. Becquevort	Autotrophic Flagellates, Biomass	12
Auto.Flag.CellNum	cells.dm-3			ULB	S. Becquevort	Autotrophic Flagellates, Cell number	12
Ba.UptakeRT	pmol.dm-3.d-1		6	VUB	F. Dehairs	135Ba uptake rate	27
Bact.BM.AO	ng C.dm-3			IFM	A. Weber	Bacteria Biomass (by Acridine orange)	10
Bact.BM.DAPI	µg C.dm-3			ULB	S. Becquevort	Bacteria biomass (by D.A.P.I. staining)	10
Bact.CellNum.AO	cells.cm-3			IFM	A. Weber	Bacteria cell number (by Acridine orange)	10
Bact.CellNum.DAPI	cells.dm-3			ULB	S. Becquevort	Bacteria cell number (by D.A.P.I. staining)	10
Bact.LEU	pmol.dm-3.d-1			AWI/M BL	K. Lochte/P. Bjornsen	Leucine incorporation	10
Bact.SHD.BM	µg C.dm-3		0	MBL	P. Bjornsen	Small Heterotrophic Dinoflagellates Biomass	10
Bact.SHD.CellNum	cells.cm-3		0	MBL	P. Bjornsen	Small Heterotrophic Dinoflagellates cell number	10
Bact.TTI	pmol.dm-3.d-1			MBL/A WI	P. Bjornsen/K. Lochte	Thymidine incorporation	10
Biog.Si.BSi	µmol.dm-3		6	IEM	B. Queguiner	Biogenic Silica Biomass	24
Biog.Si.Chla	µg Chla.dm-3			IEM	B. Queguiner	Chlorophyll a	9
Biog.Si.Phae	µg .phaeo.dm-3			IEM	B. Queguiner	Phaeophytin	9
Biog.Si.POC	µmol.dm-3			IEM	B. Queguiner	POC	7
Biog.Si.PON	µmol.dm-3			IEM	B. Queguiner	PON	7
Biog.Si.PP	µg C.dm-3.d-1			IEM	B. Queguiner	Primary production (deck incubation)	13
Biog.Si.PSi	µmol.dm-3.d-1		12	IEM	B. Queguiner	Biogenic Silica Production	24
Biog.Si.Silicate	µmol.dm-3			IEM	B. Queguiner	Silicate	24
Cd dis	pmol.dm-3			NIOZ	B. Loscher	Dissolved cadmium	25
Cd Hac	pmol.dm-3			NIOZ	B. Loscher	Particulate cadmium, soluble in Hac	25
Cd HCl	pmol.dm-3			NIOZ	B. Loscher	Particulate cadmium, soluble in HCl	25
Cd ref	pmol.dm-3			NIOZ	B. Loscher	Particulate cadmium, digested HCl/HNO3/HF	25
Cd tot	pmol.dm-3			NIOZ	B. Loscher	Total cadmium	25
Chaet.bulb/dich	cells.dm-3			AWI	Scharek	Chaetoceros bulbosum/dichaeta	12
Cell.Const.CarbHydr.R ES	µg C.dm-3		6	ULB	S. Mathot	Cell constituents, Carbohydrates, reserve	13

Cell.Const.CarbHydr.T OT	µg C.dm-3	6	ULB	S. Mathot	Cell constituents, Carbohydrates, total	13
Cell.Const.Lipids	µg C.dm-3	6	ULB	S. Mathot	Cell constituents, Lipids	13
Cell.Const.Proteins	µg C.dm-3	6	ULB	S. Mathot	Cell constituents, Proteins	13
chla	µg .dm-3		SFB313	I. Peeken	Chlorophyll a	9
chla/allo	µg .dm-3		SFB313	I. Peeken	Chlorophyll a allomer	9
chla/epi	µg .dm-3		SFB313	I. Peeken	Chlorophyll a epimer	9
chlb	ng.dm-3		SFB313	I. Peeken	Chlorophyll b	9
chlc1+2	ng.dm-3		SFB313	I. Peeken	Chlorophyll c1+c2	9
chlc3	ng.dm-3		SFB313	I. Peeken	Chlorophyll c3	9
chllida	ng.dm-3		SFB313	I. Peeken	Chlorophyllide a	9
Chlorophyll	µg Chla.dm-3		AWI	U. Bathmann	Chlorophyll a	9
Coccolithophorideae	cells.dm-3		AWI	Scharek	Coccolithophorideae	12
Corethron criophilum	cells.dm-3		AWI	Scharek	Corethron criophilum	12
Corethron criophilum, empty	cells.dm-3		AWI	Scharek	Corethron criophilum, empty	12
Corethron criophilum forma inerme	cells.dm-3		AWI	Scharek	Corethron criophilum forma inerme	12
Corethron criophilum forma inerme, empty	cells.dm-3		AWI	Scharek	Corethron criophilum forma inerme, empty	12
Cu dis	nmol.dm-3		NIOZ	B. Loscher	Dissolved copper	25
Cu Hac	pmol.dm-3		NIOZ	B. Loscher	Particulate copper, soluble in Hac	25
Cu HCl	pmol.dm-3		NIOZ	B. Loscher	Particulate copper, soluble in HCl	25
Cu ref	pmol.dm-3		NIOZ	B. Loscher	Particulate copper, digested HCl/HNO3/HF	25
Cu tot	nmol.dm-3		NIOZ	B. Loscher	Total copper	25
Cyano	cells.dm-3		AWI	Scharek	Cyano's	12
Density	kg.m-3		NIOZ	S. Ober	density	2
Density20	kg.dm-3		NIOZ	S. Ober	density at 20 C	2
diadino	ng.dm-3		SFB313	I. Peeken	Diadinoxanthin	9
diat t e	cells.dm-3		AWI	Scharek	numbers of total empty diatoms	12
diat t f	cells.dm-3		AWI	Scharek	numbers of total full diatoms	12
Diatoms	%	'12/24	AWI	R. Crawford	% Composition of diatom flora by species	12
Dinoflag	µg C.dm-3	12	AWI	C. Klaas	Dinoflagellates	12
diss.Ba	nmol.dm-3		VUB	F. Dehairs	Dissolved Barium	28
DMSP.Chla	µg Chla.dm-3		FBB	B. Bolt/D. Meyerdierks	Chlorophyll a	27
DMSP.DMSP	nmol.dm-3		FBB	B. Bolt/D. Meyerdierks	DMSP	27
DOC	µmol C.dm-3		SFB313	A. Antia/P. Kahler	Dissolved Organic Carbon	8
DON	µmol N.dm-3		SFB313	A. Antia/P. Kahler	Dissolved Organic Nitrogen	8
F ker	cells.dm-3		AWI	Scharek	Fragilariopsis kerguelensis	12
F ker e	cells.dm-3		AWI	Scharek	Fragilariopsis kerguelensis, empty	12
Fe dis	nmol.dm-3		NIOZ	B. Loscher	Dissolved iron	25
Fe Hac	pmol.dm-3		NIOZ	B. Loscher	Particulate iron, soluble in Hac	25
Fe HCl	nmol.dm-3		NIOZ	B. Loscher	Particulate iron, soluble in HCl	25
Fe ref	nmol.dm-3		NIOZ	B. Loscher	Particulate iron, digested HCl/HNO3/HF	25
Fe tot	nmol.dm-3		NIOZ	B. Loscher	Total iron	25
fuco	ng.dm-3		SFB313	I. Peeken	Fucoxanthin	9
isp.CO2	µmol.kg-1		NIOZ	J. Rommets	H2CO3 in situ T and p	6
isp.CO32	µmol.kg-1		NIOZ	J. Rommets	CO3-- in situ T and p	6
isp.HCO3	µmol.kg-1		NIOZ	J. Rommets	HCO3- in situ T and p	6
isp.pCO2	µatm		NIOZ	J. Rommets	pCO2 in situ T and p	6
isp.pH			NIOZ	J. Rommets	pH in situ T and p	6
kg.Ammonium	µmol.kg-1		NIOZ	J. Poncin	Ammonium per kg	4
kg.Nitrate	µmol.kg-1		NIOZ	K. Bakker/P. Fritsche	Nitrate per kg	4
kg.Nitrite	µmol.kg-1		NIOZ	K. Bakker/P. Fritsche	Nitrite per kg	4
kg.Phosphate	µmol.kg-1		NIOZ	K. Bakker/P. Fritsche	Phosphate per kg	4
kg.Silicate	µmol.kg-1		NIOZ	K. Bakker/P. Fritsche	Silicate per kg	4
lut/zeax	ng.dm-3		SFB313	I. Peeken	Lutein + Zeaxanthin	9
Mesdi	cells.dm-3		AWI	Scharek	Mesodinium	12
Microzoo	individuals cm-3	24	NIOZ	B. Kuipers	Microzooplankton	12
Mn Hac	pmol.dm-3		NIOZ	B. Loscher	Particulate manganese, soluble in Hac	25

Mn HCl	pmol.dm-3		NIOZ	B. Loscher	Particulate manganese, soluble in HCl	25
Mn ref	pmol.dm-3		NIOZ	B. Loscher	Particulate manganese, digested HCl/HNO3/HF	25
muPhyt.BM	µg C.dm-3	12	ULB	S. Mathot	microphytoplankton, Biomass	12
muPhyt.CellNum	cells.dm-3	12	ULB	S. Mathot	microphytoplankton, Cell number	12
muPhyt.Prot.CellNum	cells.dm-3	6	AWI	Scharek,Crawford, Klaas	Protists species composition, cell number	12
muPhyt.Prot.Phyto	ng C.dm-3	6	AWI	Scharek,Crawford, Klaas	Protists species composition, phytoplankton Carbon	12
muPhyt.Protists	ng C.dm-3	6	AWI	Scharek,Crawford, Klaas	Protists species composition, Protists Carbon	12
muPhyt.Protozoa	ng C.dm-3	6	AWI	Scharek,Crawford, Klaas	Protists species composition, Protozoa Carbon	12
N prol	cells.dm-3		AWI	Scharek	Nitzschia prolongatoides, cell number	12
N prol e	cells.dm-3		AWI	Scharek	Nitzschia prolongatoides empty, cell number	12
NanoflaC	ng.dm-3		AWI	Scharek	Phytoplankton Carbon of total nanoflagellates	12
Nanoflag	cells.dm-3		AWI	Scharek	number of total nanoflagellates	12
NanoZoo.BM	µg C.dm-3	2	ULB	S. Becquevort	Nanozooplankton, Biomass	12
NanoZoo.CellNum	cells.dm-3		ULB	S. Becquevort	Nanozooplankton, Cell number	12
NanoZoo.Graz	µg C.dm-3.h-1	2	ULB	S. Becquevort	Nanozooplankton grazing rate	18
NH4	µmol.dm-3		IEM	J. Poncin	Ammonia	4
Ni dis	nml.dm-3		NIOZ	B. Loscher	Dissolved nickel	25
Ni tot	nmol.dm-3		NIOZ	B. Loscher	Total nickel	25
Ni.turg/Lin.hei.	cells.dm-3		AWI	Scharek	Nitzschia turgidula/Lineola heimii	12
Nitrate	µmol.dm-3		NIOZ/IF M	K. Bakker/P. Fritsche	Nutrient	4
Nitrite	µmol.dm-3		NIOZ/IF M	K. Bakker/P. Fritsche	Nutrient	4
Nitz clos	cells.dm-3		AWI	Scharek	Nitzschia closterium	12
Nitz clos e	cells.dm-3		AWI	Scharek	Nitzschia closterium, empty	12
O2.proc	0/0		NIOZ	R. Manuels	Oxygen saturation in procent	3
O2.sat	µmol.kg-1		NIOZ	R. Manuels	Oxygen saturation	3
Oxy	µmol.dm-3		NIOZ	R. Manuels	Oxygen mean	3
Oxy.kg	µmol.kg-1		NIOZ	R. Manuels	Oxygen per kg	3
Oxy1	µmol.dm-3		NIOZ	R. Manuels	Oxygen	3
Oxy2	µmol.dm-3		NIOZ	R. Manuels	Oxygen	3
OxyT	deg. C		NIOZ	R. Manuels	Closing temperature of oxygen bottles	3
p1.CO2	µmol.kg-1		NIOZ	J. Rommets	H2CO3 in situ T and p=1	6
p1.CO32	µmol.kg-1		NIOZ	J. Rommets	CO3-- in situ T and p=1	6
p1.HCO3	µmol.kg-1		NIOZ	J. Rommets	HCO3- in situ T and p=1	6
p1.pCO2	µatm		NIOZ	J. Rommets	pCO2 in situ T and p=1	6
p1.pH			NIOZ	J. Rommets	pH in situ T and p=1	6
PAR	µE.m-2.s-1				Mean incident PAR	
Part.Ba.13C	0/00 vs PDB		VUB	F. Dehairs	Particulate organic delta 13C vs PDB	29
Part.Ba.Part.Al	nmol.dm-3		VUB	F. Dehairs	Particulate Aluminium	28
Part.Ba.Part.Ba	pmol.dm-3		VUB	F. Dehairs	Particulate Barium	28
Part.Ba.Part.Ca	nmol.dm-3		VUB	F. Dehairs	Particulate Calcium	28
Part.Ba.Part.Si	µmol.dm-3		VUB	F. Dehairs	Particulate Silicon	28
Part.Ba.Part.Sr	pmol.dm-3		VUB	F. Dehairs	Particulate Strontium	28
pCO2.GC-cm	µatm		NIOZ	D. Bakker	Partial pressure of CO2, t in situ, P=1	6
pCO2.GC-tp	µatm		NIOZ	D. Bakker	Partial pressure of CO2, t in situ, P in situ	6
peridin	ng.dm-3		SFB313	I. Peeken	Peridinin	9
phorba	ng.dm-3		SFB313	I. Peeken	Phaeophorbide a	9
Phosphate	µmol.dm-3		NIOZ/IF M	K. Bakker/P. Fritsche	Nutrient	4
phphyta	ng.dm-3		SFB313	I. Peeken	Phaeophytin a	9
Phyto.GrowthRT	d-1		ULB	S. Mathot	Phytoplankton Growth rate from model	13
Pigments	ng.dm-3		SFB313	I. Peeken	Pigments, HPLC	9
POC	µmol C.dm-3		AWI	U. Bathmann	Particulate Organic Carbon	7
PON	µmol N.dm-3		AWI	U. Bathmann	Particulate Organic Nitrogen	7
Pot.Temp	deg. C		NIOZ	S. Ober	Potential temperature	2
PPC tot	ng.dm-3		AWI	Scharek	Total phytoplankton Carbon	12
PPCflag	ng.dm-3		AWI	Scharek	Phytoplankton Carbon flagellates	12
PPCidia	ng.dm-3		AWI	Scharek	Phytoplankton Carbon sea-ice diatoms	12

PPCpdia	ng.dm-3		AWI	Scharek	Phytoplankton Carbon pelagic diatoms	12
PP.AssimRT	µg C.µg Chla.h-1	0	ULB	S. Mathot	Photosynthetic assimilation rate	13
PP.PrimProd	mg C.m-2.d-1		ULB	S. Mathot/B. Queguiner	Primary production (deck incubation)	13
PPML.ANF<10	cells.cm-3		IFM	F. Jochem	Autotroph. Nanoflagellates <10 µm cell number	12
PPML.ANF10-20	cells.cm-3		IFM	F. Jochem	Autotroph. Nanoflagellates 10-20 µm cell number	12
PPML.ANP.C	cells.cm-3		IFM	A. Detmer	Autotrophic Nanoplankton cell number by cytometry	12
PPML.ANP.M	cells.cm-3		IFM	A. Detmer	Autotrophic Nanoplankton cell number by microscopy	12
PPML.APP	cells.cm-3		IFM	F. Jochem	Autotroph. Pico Plankton	12
PPML.APP.M	cells.cm-3		IFM	A. Detmer	Autotrophic Picoplankton cell number by microscopy	12
PPML.CENTR	cells.cm-3		IFM	F. Jochem	Centrics cell number	12
PPML.CRYP	cells.cm-3		IFM	F. Jochem	Cryptos cell number	12
PPML.DIATOMS	cells.cm-3		IFM	F. Jochem	Diatoms cell number	12
PPML.HNF<10	cells.cm-3		IFM	F. Jochem	Heterotr. Nanoflagellates <10 µm cell number	12
PPML.HNF10-20	cells.cm-3		IFM	F. Jochem	Heterotr. Nanoflagellates 10-20 µm cell number	12
PPML.HPF						
PPML.HPP	cells.cm-3		IFM	F. Jochem	Heterotr. PicoPlankton(<2 µm) cell number	12
PPML.NITZ	cells.cm-3		IFM	F. Jochem	Nitzschia cell number	12
PPML.PP<2	µg C.dm-3.d-1		IFM	F. Jochem	Primary production in size class < 2 µm = pico	13
PPML.PP>20	µg C.dm-3.d-1		IFM	F. Jochem	Primary production in size class > 20 µm = micro	13
PPML.PP2-5	µg C.dm-3.d-1		IFM	F. Jochem	Primary production in size class 2-5 µm = small nano	13
PPML.PP5-20	µg C.dm-3.d-1		IFM	F. Jochem	Primary production in size class 5-20 µm = large nano	13
PPML.SYN	cells.cm-3		IFM	F. Jochem	Synechococcus abundance (cell number)	16
PPML.TOT.PP	µg C.dm-3.d-1		IFM	F. Jochem	Total particulate Primary production (C_14)	13
PPML.UNID.C	cells.cm-3		IFM	A. Detmer	Unidentified cells/particle number by cytometry	12
prasincox	ng.dm-3		SFB313	I. Peeken	Prasincoxanthin	9
pyrophorb	ng.dm-3		SFB313	I. Peeken	Pyrophaeophorbide a	9
pyrphphyta	ng.dm-3		SFB313	I. Peeken	Pyrophaeophytin a	9
Rare.Elem	nmol.dm-3	12	NIOZ	B. Loscher	Rare Earth Elements	25
Salinity	no dimension		NIOZ	C. Veth	Practical Salinity Unit (dimensionless)	2
SigmaT			NIOZ	S. Ober	at in situ temp	2
SigmaTheta	kg.m-3		NIOZ	S. Ober	at potential temp	2
Silicate	µmol.dm-3		NIOZ/IFM	K. Bakker/P. Fritsche	Nutrient	4
TCO2.C	µmol.kg-1		NIOZ	M. Stoll	Total Carbon Dioxide	6
Thal nitz	cells.dm-3		AWI	Scharek	Thalassionema nitzschioides	12
Thal nitz e	cells.dm-3		AWI	Scharek	Thalassionema nitzschioides, empty	12
Tha spp	cells.dm-3		AWI	Scharek	Thalassionema others	12
Trace.Met	nmol.dm-3		NIOZ	B. Loscher	Trace Elements	25
Var2.CG	µg Chla.dm-3.d-1		SFB313	S. Reitmeier	Chla grazed	18
Var2.ChlADoubl	d-1		SFB313	S. Reitmeier	Chla Doublings	18
Var2.g	no dimension		SFB313	S. Reitmeier	g= MicroZoo grazing coefficient	18
Var2.InitChla	µg Chla.dm-3		SFB313	S. Reitmeier	Initial Chla concentration in 100% FUW	18
Var2.k	no dimension		SFB313	S. Reitmeier	k= Phytoplankton growth coefficient	18
Var2.PICG	d-1		SFB313	S. Reitmeier	Percent Initial Chla Concentration Grazed	18
Var2.Regr	no dimension		SFB313	S. Reitmeier	Regression Coefficient	18
Var3.Pigments	ng.dm-3	12	NIOZ	M. van Leeuwe	Pigments	9
Var4.Chla<20um	µg Chla.dm-3		AWI	U. Bathmann	Chlorophyll a fractionated < 20 um	9
Var4.Chla<2um	µg Chla.dm-3		AWI	U. Bathmann	Chlorophyll a fractionated < 2 um	9
Var4.Chla<5um	µg Chla.dm-3		AWI	U. Bathmann	Chlorophyll a fractionated < 5 um	9
Zn dis	nmol.dm-3		NIOZ	B. Loscher	Dissolved zinc	25
Zn tot	nmol.dm-3		NIOZ	B. Loscher	Total zinc	25

## DATA POLICY STATEMENT.

The data contained in this CD-ROM have been produced jointly by the participants of the JGOFS expedition ANT X/6 and the data management staff of the Netherlands Institute for Sea Research (NIOZ). This database is freely available for the general use by the scientific community. Further updates of the ANTX/6 database will become accessible by electronic mail through ftp-servers at the Alfred Wegener Institute (<ftp://ftp.awi-bremerhaven.de/pub>). Queries about certain parts of the data can be addressed directly to the relevant scientist(s), for the overall CD-ROM contents to J. Rommets at NIOZ, and for the further updates to U. Bathmann at AWI, Germany. For this purpose a listing of names and addresses including internet identities is provided in the file STAFF.DOC.

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Rommets, J.W., M.H.C. Stoll, R.X. de Koster, T.F. de Bruin, H.J.W. de Baar, U.V. Bathmann and V. Smetacek (1997) Database of the JGOFS expedition ANT X/6 aboard RV 'Polarstern'. *Deep-Sea Research II*, **44** (1-2), and CD-ROM Appendix.

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## **Overview and structure of the MS ACCESS database**

### **Preface**

This text provides you with

- an overview of required hard and software
- a description of the database
- an explanation of the included example queries

### **Requirements.**

*For ACCESS for Windows 95:*

PC 80486 or higher  
MS Windows 95  
MS ACCESS for Windows 95

*For ACCESS version 1.1:*

PC 80386 or higher  
MS Windows 3.1 or higher  
MS ACCESS 3.1

Data is also accessible by:

- MS WORD most versions
- MS EXCEL most versions

## Description of the database

### *Data set.*

CTD data and CTD sample data

**Not included** in the database are the following parameters:

INVESTIGATOR	variable_id
B. Kuipers	Microzoo
B. Loscher	Rare.Elem
B. Queguiner	Biog.Si.BSi
B. Queguiner	Biog.Si.PSi
C. Klaas	Dinoflag
D. Bakker	pCO2.GC-tp
F. Dehairs	15NH4.Uptake
F. Dehairs	15NO2.Uptake
F. Dehairs	Ba.UptakeRT
F. Dehairs	15NH4.Minerali
F. Dehairs	diss.Ba
M. van Leeuwe	Var3.Pigments
M. Wunsch/N. Koeve	15NO3.Uptake
P. Bjornsen	Bact.SHD.BM
P. Bjornsen	Bact.SHD.Cell
R. Crawford	Diatoms
S. Becquevort	Auto.Flag.BM
S. Becquevort	NanoZoo.BM
S. Becquevort	NanoZoo.Graz
S. Mathot	muPhyt.BM
S. Mathot	Cell.Const.Lipi
S. Mathot	Cell.Const.Car
S. Mathot	Cell.Const.Car
S. Mathot	muPhyt.CellNu
S. Mathot	PP.AssimRT
S. Mathot	Cell.Const.Prot
Scharek,Crawford,Klaas	muPhyt.Prot.C
Scharek,Crawford,Klaas	muPhyt.Prot.P
Scharek,Crawford,Klaas	muPhyt.Protist
Scharek,Crawford,Klaas	muPhyt.Protoz



## ***Tables.***

### Parameter

*contains the parameters that reside in the database.*

- variable\_id Identity field for the parameter, acronym of the parameter
- Unit The unit in which the parameter value is stored
- INSTITUTE The institute or organisation of the principal investigator/data owner
- INVESTIGATOR The principal investigator(s)
- Description Describes the parameter
- JGOFS JGOFS code
- Occurrences Number of occurrences of the parameter in the database

Primary key on variable\_id

Indexes on -INSTITUTE  
-INVESTIGATOR

## Cast

*contains the metadata of the CTD casts*

- station\_id Identity field
- cast\_id Identity field
- date\_start Date of start of cast (GMT)
- date\_end Date of end of cast (GMT)
- time\_start Time of start of cast (GMT)
- time\_end Time of end of cast (GMT)
- latitude\_start Latitude at start of cast (“dd:mm.m”)
- longitude\_start Longitude at start of cast (“ddd:mm.m”)
- lat\_dec\_start Latitude at start of cast (decimal number)
- lon\_dec\_start Longitude at start of cast (decimal number)
- latitude\_end Latitude at end of cast (“dd:mm.m”)
- longitude\_end Longitude at end of cast (“ddd:mm.m”)
- lat\_dec\_end Latitude at end of cast (decimal number)
- lon\_dec\_end Longitude at end of cast (decimal number)
- depth\_start Echo depth at start of cast (m)
- depth\_end Echo depth at end of cast (m)

Primary key on station\_id, cast\_id

Indexes on -date\_start, time\_start  
-lat\_dec\_start, lon\_dec\_start

## Sample

*contains the metadata of the bottles*

*this table can join the table Cast with the table Values in case of queries that want both measured data values and cast metadata.*

- station\_id Identity field (see table Cast)
- cast\_id Identity field (see table Cast)
- sample\_id Identity field (see table Values)
- bottle\_nr bottle number
- CTD\_pres pressure measured by CTD in dbar (redundant: also resides in table Values)

Primary key on sample\_id

## Values

*contains the measured values*

*links to table Parameter through field 'variable\_id'*

*links to table Cast through field 'sample\_id' (first 4 positions)*

- sample\_id Identity field (see table Sample)  
composed out of station\_id (3 positions) cast\_id (1 position) and  
BottleNumber (2 positions)
- variable\_id Identity field (see table Parameter)
- value Measured value

Indexes on -sample\_ID  
-variable\_ID

### Explanation of example queries.

The database contains some example queries.

#### **Example**      All pressures

*Provides an overview of all the bottles present in the database.*

*Column 'sample\_id' shows the bottle identification: the first three positions represents the station, the fourth position the cast and the last 2 positions the bottle number.*

*(875103= station 875, cast 1, bottlenumber 3)*

*Column 'CTD\_pres' ('value') shows the measured CTD pressure in dbar.*

```
SELECT DISTINCTROW sample_id, value as CTD_pres  
FROM [VALUES]  
WHERE variable_id like "CTD.Pres*";
```

#### **Example**      All parameters of station 945

*selects all the parameters measured at all the casts of station 945.*

*Column 'sample\_id' identifies the station, the cast and the bottle number*

*Column 'variable\_id' identifies the parameter*

*Column 'value' shows the measured value*

*Since the 'sample\_id' is constructed out of station\_id followed by successively cast\_id and bottle\_number (sample\_id = station\_id \* 1000 + cast\_id \* 100 + bottle\_number) in this example we include all casts and bottles of station 945 by selecting all sample\_id's in between 945000 and 946000.*

```
SELECT DISTINCTROW VALUES.sample_id, VALUES.variable_id, VALUES.value  
FROM [VALUES]  
WHERE (((VALUES.sample_id)>945000)) and (((VALUES.sample_id)<946000));
```

### **Example**      **Poc1 and Poc2**

these two examples show how to extract two parameters from the data set derived from the same bottles. In this example we query for the parameter 'POC' and the related 'Depth'

'Poc1' queries for all the bottles that contain the parameter 'POC' and results in one column with the desired sample\_id's (wich is station, cast, bottle number) and one column with the measured values.

```
SELECT sample_id, value as POC  
FROM [VALUES]  
WHERE variable_id = "POC";
```

You can easily limit the result of 'poc1' to one or several casts by specifying the casts in the WHERE clause. The station and cast are identified by 'sample\_id' (sample\_id= station\_id \* 1000 + cast\_id \* 100 + bottle\_number). So the sample\_id's of all the bottles of station 878 cast 1 are in between 878100 and 878200. Which would look like this:

```
SELECT sample_id, value as POC  
FROM [VALUES]  
WHERE (variable_id = "POC")  
AND ((sample_id > 878100) AND (sample_id < 878200));
```

You can query like this for any parameter by substituting the variable\_id in the WHERE clause with the desired variable\_id and the label 'as POC' by a more appropriate one..

'Poc2' joins the result of 'poc1' with the table 'values' to add a third column with the Depth's of the same bottles.

```
SELECT DISTINCTROW poc1.*,  
VALUES.value AS Depth  
FROM [VALUES]  
INNER JOIN poc1 ON VALUES.sample_id = poc1.sample_id  
WHERE VALUES.variable_id = "Depth"  
ORDER BY poc1.sample_id;
```

*You can use these examples as a base to query more than two parameters as well.  
To add a third parameter you*

1. copy 'poc2'
2. edit it to query the results of 'poc2' and the third parameter from table Values

*'Poc3' is an example of this and adds a column containing the values of the PON parameter:*

```
SELECT DISTINCTROW      poc2.*,  
                        VALUES.value AS PON  
FROM [VALUES]  
INNER JOIN poc2 ON VALUES.sample_id = poc2.sample_id  
WHERE      VALUES.variable_id = "PON"  
ORDER BY poc2.sample_id;
```

*In this way you can expand the query with as many parameters as you want.*

***NOTE: YOU ONLY HAVE TO RUN THE LAST QUERY the preceding queries will be triggered by the last one.***

A more complete query also retrieves the cast metadata from the table Cast together with the measured data.

**Example      Full1 and Full2**

'Full1' is the more complex equivalent of 'poc1' and contains some metadata of the cast and the bottle, in this example the query is limited for all casts of stations 878 until 911:

```
SELECT DISTINCTROW    CAST.cast_id,  
                      SAMPLE.bottle_nr,  
                      SAMPLE.sample_id,  
                      CAST.latitude_start,  
                      CAST.longitude_start,  
                      CAST.station_id,  
                      SAMPLE.CTDpressure,  
                      VALUES.value as POC  
FROM                (CAST INNER JOIN SAMPLE ON (CAST.cast_id = SAMPLE.cast_id)  
                      AND (CAST.station_id = SAMPLE.station_id))  
                      INNER JOIN [VALUES] ON SAMPLE.sample_id = VALUES.sample_id  
WHERE                ((CAST.station_id >= 878) AND (CAST.station_id <= 911))  
                      AND (VALUES.variable_id="POC")  
  
ORDER BY CAST.cast_id, SAMPLE.bottle_nr;
```

'Full2' is identical to 'poc2' except that it accesses 'full1' in stead of 'poc1' and it expands the query with another parameter column (parameter Depth in this example).

```
SELECT DISTINCTROW    full1.*,  
                      VALUES.value AS Depth  
FROM [VALUES] INNER JOIN full1 ON VALUES.sample_id = full1.sample_id  
WHERE VALUES.variable_id = "Depth"  
ORDER BY full1.sample_id;
```

You can also extend this query with more columns in a way equivalent as explained in example 'poc3'

# The CD-ROM Database of the JGOFS expedition ANT X/6 aboard RV 'Polarstern'

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## INTRODUCTION

The enclosed CD-ROM contains the actual database of measured variables as well as various background information on the expedition and the methods and other descriptions directly related to each reported variable, as well as a statement on data policy, citation and copyright. The CD-ROM was mastered in a format that can be read by both Macintosh and PC computers. It is organised in a hierarchical structure by folders containing both text files in MS-Word for Windows 2 format and datafiles in either Excel 4.0 or ACCESS format. Software with such formats is not included but available from Microsoft. In addition datafiles have also been converted to simple ASCII formats and placed on the CD-ROM as well.

## CONTENTS OF THE FOLDERS

<i>Description</i>	<i>File Name</i>
README	README.DOC
REGULAR JGOFS ANTX/6 FOLDERS	JGOFSX6
<b><u>Background information</u></b>	GENERAL
Structure of the CD-ROM contents	README.DOC
Data policy statement	POLICY.DOC
Participating scientists (affiliations, phone, fax, internet)	STAFF.DOC
Participating institutes (postal addresses)	INSTIT.DOC
Listing JGOFS Core and other activities (with scientists)	CORE.DOC
Listing shipboard experiments (with scientists)	EXPS.DOC
Methods description	METHODS.DOC
<b><u>Stations Database</u></b>	STATDATA
Listing of stations (with deployment of gear)	STSLIST.XLS
Bentic observations	BENTIC
Methods bentic observations text	BENTIC.DOC
Bentic data	BENBACT.XLS
	BENTMETA.XLS
	BENTPORE.XLS
CTD/Rosette sampling	CTDROS
CTD sensors	CTD
CTD sensors text	CTD.DOC
CTD sensors downcasts records of 229 CTD casts	



Rosette with 24 samplers	ROSETTE
Methods text	ROSETTE.DOC
Listing of measured variables (units, description)	VARIABLES.XLS
Structure relational database for ACCESS	STRUCT.DOC
Data from 229 hydrocasts of 24 samplers at 123 stations (station, cast, bottle number)	ROSETTE.ACC
Trace Metals	METALS
Kevlar wire GoFlo sampling	KEVLARGF
Methods trace metals and biota	METALS.DOC
Kevlar wire/GoFlo metals, Ba and nutrients	METALS.XLS
Metal-Biota interactions	BIOMETAL
Methods Metal-Biota text	BIOMETAL.DOC
Incubations data	BIOMETAL.XLS
Net sampling results	NETS
Net collection text	NETS.DOC
Mesozooplankton, phytoplankton and Mesozoo grazing	NETS.XLS
Incubations primary productivity and 15N uptake	PRODUCT
Ammonia uptake rates	NH3PRPR
Ammonia uptake rates text	NH3PRPR.DOC
Ammonia uptake rates	NH3PRPR.XLS
Primary productivity	PRIMARY
Primary production methods text	PRIMARY.DOC
Primary production at stations	PRPROD.XLS
	PRODINT.XLS
Size fractionated prim productivity	SIZEFRPP.XLS
Natural Radioisotopes from Gerard samplers	RADIOISO
Methods radioisotopes text	RADIOISO.DOC
Radioisotopes data	RADIOISO.XLS
<b><u>Underway Database</u></b>	WAYDATA
Wind	WIND
Windtext	WIND.DOC
Wind velocities (INDAS) over 10 minute intervals	WIND10.XLS
Ice and Top Predators	ICEPRED
Icetext	ICE.DOC
Ice cover, chlorophyll, top predators, one value every 10 minutes	ICE10.XLS
Ice cover in JGOFS protocol format	ICEJGOFS.XLS
CO2 surface waters	CO2SURF
CO2 surface waters text	CO2SURF.DOC
CO2 and ancillary data, fluxes, etc.	
Excel files for every day	CO2S????XLS
	CO2D????XLS

JGOFSASC DIRECTORY(Contents as above)

#### ELECTRONIC UPDATES

Further updates of the ANTX/6 database will become available by electronic mail through ftp-servers at the Alfred Wegener Institute (<ftp://ftp.awi-bremerhaven.de/pub>).

#### ENQUIRIES

All enquiries relating to the CD-ROM are to be made to Joop Rommets, NIOZ, ([rommets@nioz.nl](mailto:rommets@nioz.nl)) and all questions related to the electronic updates are to be made to Ulrich Bathmann, AWI, ([ubathmann@awi-bremerhaven.de](mailto:ubathmann@awi-bremerhaven.de)).

#### ACKNOWLEDGEMENTS

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#### REFERENCES

Bathmann, U.V., V. Smetacek, H.J.W. de Baar, E. Fahrbach and G. Krause (1994). The expeditions ANTARKTIS X/6-8 of the Research Vessel "POLARSTERN" in 1992/1993. *Berichte zur Polarforschung*, 135:4-126.

#### ENCLOSED in BACKCOVER

CD-ROM containing Database of the JGOFS expedition ANTX/6 aboard RV 'Polarstern'