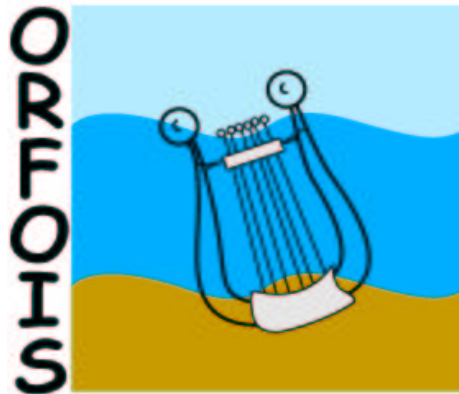


3rd MANAGEMENT REPORT
Confidential

CONTRACT N°: EVK2-CT-2001-00100

PROJECT TITLE: ORFOIS

"ORigin and Fate of biogenic particle fluxes in the Ocean and their Interactions with the atmospheric CO₂ concentration as well as the marine Sediment"



PROJECT CO-ORDINATOR: Bo Riemann (NERI)

CO-ORDINATOR IN CHARGE: Christoph Heinze (MPG.IMET)

- PARTNERS:**
- 1. NERI, Denmark**
 - 2. LSCE/CNRS, France**
 - 3. UBO/CNRS, France**
 - 4. MPG.IMET, Germany**
 - 5. Uni-HH, Germany**
 - 6. NCMR, Greece**
 - 7. NIOO, Netherlands**
 - 8. UEA, United Kingdom**

REFERENCE PERIOD: December 1, 2002 – May 31, 2003

STARTING DATE: December 1, 2001 DURATION: 3 years

Date of issue of this report: June 24, 2003

Project funded by the European Community under FP5.

Project home page: <http://www.pangaea.de/Projects/ORFOIS/>

Sections included:

1. TECHNICAL OVERVIEW

1.1 Objectives of the reporting period

1.2 Overview about technical progress made (milestones and deliverables obtained)

1.3 Comparison of planned activities and actual work accomplished

1.4 Planned activities for the next period

2. MANAGEMENT AND CO-ORDINATION ASPECTS

Appendix A: Updated version of "Participants Information"

Appendix B: Personnel

1. TECHNICAL OVERVIEW

1.1 Objectives of the reporting period

Months 13–18 of ORFOIS were dedicated to workpackages 1–3, 5–6, and 10. In detail, the objectives of the workpackages within the reporting period were:

WP1. Data base compilation of observations:

To provide a synoptic multi tracer data base of existing observations (stocks and fluxes) in surface water, water column, sediment traps, sediments, early diagenesis, and sediment pore waters including level of data access, meta–documentation and referencing information (month 1–18).

WP2. Process parameterisations:

Development and calibration of 1–D biogeochemical model components of (1) a particle flux module which simulates particle interaction, modification and sinking speed (including a surface particle production formulation) and (2) an early diagenesis sediment model (including organic carbon chemistry). The model components simulate parts of the marine carbon, nitrogen and silicon cycles (month 1–15).

WP3. Community model development:

To provide source codes for the model components on particle flux dynamics and early diagenesis which can easily be coupled to various existing 1–D models as well as 3–D Biogeochemical Ocean Circulation Models (BOGCMs) (month 1–15).

WP5. BOGCM implementation:

To implement community models for particle flux and sedimentary reactions in BOGCMs (month 7–18).

WP6. Optimisation of the prognostic system:

To provide optimised runs of BOGCMs I and II (I=HAMOCC/HOPE, II=PISCES), to update the high quality data base of C, N, and Si cycling in the world ocean, to revise process parameterisations of the water column and sediment community modules, and to set up corrected atmospheric forcing fields (month 13–36).

WP10. Coordination:

To ensure timely submission of deliverables, coordinate the project flow, compile the management and scientific reports for the EC, enhance communication between partners, organise work shops, keep in touch with the consultants, promote dissemination of results (month 1–36).

1.2 Overview about technical progress made (milestones and deliverables obtained)

Table: Diagram showing the carried out (O) and planned (X) activities.

<i>WP no.</i>	<i>Workpackage name</i>	<i>Year 1</i>	<i>Year 2</i>	<i>Year 3</i>
1	Data base compilation of observations	O O O O	O O	
2	Process parameterisations	O O O O	O	
3	Community model development	O O O O	O	
4	Compilation of model forcing fields	O O		
5	BOGCM implementation	O O	O O	
6	Optimisation of the prognostic system		O O X X	X X X X
7	Model application and demonstration		X X	X X X X
8	Economic evaluation		X X	X X X X
9	Dissemination			X X X
10	Coordination	O O O O	O O X X	X X X X

Table: Workpackage list. (In the description of work, an error in table WPL for WP 8 must be corrected to be compatible with table WPM, which is correct: person months 9 instead of 8, start month 19 instead of 29. See below under 1.4.)

<i>WP no.</i>	<i>Workpackage name</i>	<i>Lead participant</i>	<i>Person months, total as planned</i>	<i>Person months used up to now</i>	<i>Duration, month from/til</i>
1	Data base compilation of observations	3	63	20	1--18
2	Process parameterisations	4	73	28	1--15
3	Community model development	1	17	6	1--15
4	Compilation of model forcing fields	1	4	3	1--6
5	BOGCM implementation	2	19	0	7--18
6	Optimisation of the prognostic system	2	158	0	13--36
7	Model application and demonstration	1	21	0	19--36
8	Economic evaluation	5	9	0	19--36
9	Dissemination	3	38	1	28--36
10	Coordination	1	3	0.7	1--36

WP1. Data base compilation of observations:

During the last six months data acquisition continued and even intensified. The data sets transferred into the ORFOIS data base now include the JGOFS data (also those from a data rescue activity for JGOFS relevant data) as well as the WOCE data collection. Further data sets were acquired and archived among them the "global diagenetic flux [data collection] of phosphorus from marine sediments to the oceans" and the "ocean primary productivity working group (OPPWG) data"

collection. Some experiments were undertaken to produce a proper, (pre-)final ORFOIS data CD-ROM. In its present form, CD-ROM data are accessible as flat files that finally are of limited use to the scientific community. At best, all ORFOIS data should be presented in a consistent off-line version of the online accessible data base (cf. <http://www.pangaea.de/Projects/ORFOIS>). The latest outcome of the CD-ROM experiment was presented by partner 3 at the ORFOIS data meeting on May 8, 2003, in Hamburg.

Partner 6 carried out a literature review on data related to C, P, N, calcium carbonate (CaCO₃) cycling and sediment accumulation rates in the oceans. Special emphasis was placed on budgeting differences between the open ocean and shallow seas. Relevant data were retrieved and submitted to partner 3 for input to the PANGAEA data base.

The retrieval of CO₂ data made the following progress. The collection of surface water CO₂ data from principal investigators continued through partner 8. Data collection in ORFOIS was presented in a poster at the 2nd general CARINA (CARbon dioxide IN the Atlantic Ocean) meeting. (Copies of the A0 poster and an A4 summary poster are at <http://lgmacweb.env.uea.ac.uk/ORFOIS.htm>.) The aims of the conference were highly relevant to ORFOIS. Database managers of CDIAC, CARINA, CAVASSOO, PICES and ORFOIS attended the meeting, which thus offered an ideal opportunity for discussions on database issues, such as a uniform format for surface water CO₂ data and access to databases. Dorothee Bakker discussed data storage at CDIAC (Carbon Dioxide Information Analysis Center) and WDC-MARE (World Data Centre for Marine Environmental Sciences) with individual scientists at the CARINA meeting. Other European CO₂ scientists were also contacted with a request for data submission on behalf of ORFOIS.

These combined efforts resulted in submission of only one CO₂ data set by French researchers to the CDIAC surface water fCO₂ database. Thus, retrieval of surface water CO₂ data was rather unsuccessful. A possible reason for the low success rate is that many CO₂ data are already in other, scattered databases, which are not always publicly accessible. It has proven difficult to convince scientists of the need for contributing their data to central, publicly accessible databases at CDIAC (surface water CO₂ data) or WDC-MARE (other carbon data). In addition, busy scientists have little time for 'extra' work, which has no immediate benefit to themselves. At present the online, publicly accessible CDIAC database (<http://cdiac.esd.ornl.gov/oceans/pco2inv.html>) for surface water fCO₂ data contains 25 large and small data sets, three of which were contributed through ORFOIS activities through partner 8.

All deliverables have been achieved for the end of month 18. All data acquired, by the end of May some 1700 data sets, are archived in PANGAEA by partner 3 and are available online (<http://www.pangaea.de/PangaVista?query=ORFOIS>; deliverable 1). The flat-file CD-ROM is prepared and available for limited use (Deliverable 2). The project home page, which has been initialised at the very beginning of the funding period, was further updated and includes all results that are available from the partners (Deliverable 3). With respect to data extraction techniques, regular software updates have been produced that become more and more user friendly and rapid in access (Deliverable 4). However, as agreed between the EC commissioner (Dr. C. Brüning) and the coordinator during the first annual ORFOIS workshop on January 20–21, 2003, all data issues will continue until the end of the project funding period, be archived and finally be part of the ORFOIS data collection (cf. deliverable 18).

WP2. Process parameterisations:

The parameterisations of processes relevant for proper simulations of the particle dynamics in biogeochemical ocean models has made good progress. Due to unexpected difficulties with the duration of the laboratory experiments, some work on the parameterisations is still going on. This, however, does not affect the model application as alternative parameterisations can be used meanwhile. Updated process parameterisations will feed into the models throughout the optimisation phase.

Partner 2 has concentrated on improved parameterisations of CaCO₃ dissolution kinetics and on diagenetic modelling for the 1-D model codes. Concerning CaCO₃ dissolution first a re-assessment of existing formulations and data evidence has been carried out. A revised formula for the critical CO₃²⁻-concentration (indicative boundary between dissolution and preservation of CaCO₃) was developed on the basis of a corrected version of the original GEOSECS data collection. Further experimental work on CaCO₃ dissolution was continued. The pH-stat approach presented in the preceding report could not be applied on a routine basis. The reaction rates of marine carbonates proved to be too slow close to equilibrium to be resolved by system. In order to achieve our objectives, we came back to the free-drift approach. It was doubled by an independent approach targeting the solubility. During these long term equilibration experiments, the solid fraction was allowed to equilibrate with artificial seawater starting from supersaturated, respectively undersaturated conditions. We selected surface sediments from three bathymetric transects located in the tropical Atlantic (Sierra Leone Rise and Cape Verde Plateau) and Pacific (Ontong Java Plateau). Data are presently under treatment. First results are presented on the Orfois Web page.

The implementation of the sedimentary Si-cycle within the FEMME 1-D modelling framework of partner 7 was carried out by partner 2. The Si sediment in the model now distinguishes between two classes of biogenic Si with differing dissolution characteristics : a fast and a slowly dissolving phase.

Partner 3 has continued the work on dissolution and degradation of particulate matter, especially on the change of kinetics between isolated opal samples or opal embedded within particle aggregates. In cooperation with the Alfred Wegener Institute (U. Passow) new kinetic constants were derived which now can be used also in the particle dynamics parameterisations of the large scale BOGCMs I and II.

The 1-D modelling framework is working now with improved parameterisations of particle fluxes including particle dynamics (partner 7). Simple parameterizations for enhanced benthic-pelagic coupling in shallow waters have been formulated. This comprises (1) physical filtering through sands, (2) filtering by benthic filterfeeders and (3) benthic primary production. The impact of these modes of sediment-water interactions on the functioning of the pelagic and benthic system is under investigation (Middelburg and Soetaert, paper in prep.). The module describing CaCO₃ production and dissolution in the water column has been tested in a dynamic setting. The 1-D ecological water column model with coupled pH-CO₃ module was run to steady-state under seasonally varying forcing. Results were satisfactory. The calibration of the 1-D model is now proceeding. Partner 7 decided to first calibrate the model on station ALOHA (Pacific). This station has a dataset, suitable for testing in 1-D. All available data have been compiled and put in the required format as forcing functions and observed data files that can be read by the model. Model adjustments were made to accommodate the specific features of this station: The biogeochemical model has been extended

with P-dynamics and a module that describes the dynamics of diazotrophic cyanobacteria has been added (N-fixers).

Partner 6 increased the efforts on improving the process parameterisations on particle fate in shallow waters. These efforts were focused on the collection of new samples for the study of reverse weathering processes and the conversion of biogenic silica to new mineral phases. Samples from the Ganges–Brachmaputra deltaic system were obtained from the archived core collection of BGR in the Geozentrum Hannover in April 2003. Sampling of the archived cores was performed in Hannover by Dr. Michalopoulos. Samples from the nearshore areas of the Mississippi deltaic system were obtained by Dr. Michalopoulos during a field campaign organized by Prof. Mead Allison of Tulane University. The laboratory analysis of the existing and newly acquired samples is in progress. The analytical procedures include chemical composition of sediments, biogenic silica analysis in the sediments, size separations and particle observations with optical and scanning electron microscopy.

WP3. Community model development:

A successful implementation of aggregation (including aggregation, sinking and interaction with biogeochemical components) into the BOGCM I (HOPE–C/HAMOCC) was carried out by partner 4. Respective model source codes were forwarded to partners 1 and 2. The sediment code was refined and an acceleration method for quick equilibration between water column and sediment was tested. A brief documentation and technical description plus some tools for the evaluation of model were provided by partner 4. Writing of detailed model documentation has proceeded. A new visualisation program for BOGCM results was provided by partner 1. A simulation, running with preindustrial conditions for 200 years was carried out at partner 4 for BOGCM I. The results were compared to compiled global data sets of sedimentation and biogeochemical tracers, as well as specific discrete time series observations in various oceanic regions (water column data and sediment traps). Model output has further been analysed with respect to global and basin wide air–sea CO₂ gas exchange. A corresponding model run with BOGCM I over 500 years without particle dynamics (for comparison) was carried out by partner 1. Partner 1 further transferred BOGCM to two Linux clusters (the one at NERI and the Horseshoe Supercluster at the University of Southern Denmark. The model performs well independent of the platform. However, efforts have to be undertaken to make the model optimally suitable for massively parallel systems. A 1–D ecological particle flux model, including basic biogeochemical processes and aggregation was also provided by partner 4 together with a brief documentation (this corresponds to the particle dynamics module as implemented into the 1–D modelling framework of partner 7). Parameterization of disaggregation still requires some further analyses of the relevant processes (zooplankton grazing and movement; turbulent shear) during the optimisation phase.

The original workplan separates the development of community models for particle dynamics and sediments from their implementation into BOGCM II. This sequence could not be completely followed for BOGCM II for technical reasons as discussed in the ORFOIS modelling workshop (at NIOO, Yerseke, March 2002). Partner 2 started the implementation of both components from published non–community versions. These were Kriest and Evans (1999, 2000) for the particle dynamics and Heinze and Maier–Reimer (1999) for the sediment module. The implementation of the advanced particle dynamics scheme based on the work of Kriest and Evans (1999, 2000) was presented in earlier project reports. The sediment module is currently being coupled to BOGCM II. This implies the harmonisation between the in– and outputs of the sediment model and

OPA/PISCES (adaptation to the OPA C-grid configuration, format of in/output files, units, time step of integration etc.). Closely following Heinze et al. (1999), the sediment module describes early diagenetic processes including pore water /solid matter interactions, pore water diffusion, vertical advection of sediment (upward/downward) and bioturbation. The model is tested for the combination of Si as a reactive tracer and clay as an inert phase. It is running off-line within the configuration of BOGCM II and forced with output from PISCES. During the coming weeks, organic matter remineralisation will be added by partner 2. The dominant electron acceptors in open ocean sediments, O₂ and NO₃, will be considered.

WP5. BOGCM implementation:

BOGCMs I and II are running stably for preindustrial conditions at the computing facilities of partners 1, 2 and 4 respectively. The completion of the sediment module for BOGCM II does not affect the successful spin-up of the model within the integration times considered, but will be available for verification purposes of the model later on. BOGCMs I and II are ready for the optimisation phase and subsequent applications. During the optimisation phase, the particle dynamics and sediment codes of BOGCMs I and II will be homogenised as far as possible.

A basic shelf regime parameterisation was developed by partners 1 and 4 for BOGCM I as discussed with partner 6 on a meeting at NERI in December 2002. Corresponding to the solid tracer species which leave the model system through sediment accumulation, riverine input was implemented from the major 50 rivers into the model ocean (C, N, P, Si, alkalinity). Riverine dissolved tracer analogs to the marine dissolved tracers were introduced. Riverine material then can be released according to a given release (or retention) factor which will have to be adjusted correctly during the optimisation phase according to the findings of partner 6.

WP6. Optimisation of the prognostic system:

Optimisation of the prognostic system has started for BOGCMs I and II. Comparison with observations has begun and first deficiencies have been identified. One problem is the still too weak ice cover in the Southern Ocean of BOGCM I. Possibly the problem can be solved through a slight increase in vertical model resolution. Partner 1 has started to speed up the model performance (BOGCM I) through transfer to the Horseshoe Supercluster computer.

Data base activities for optimised data sets of observations are strongly linked to work package 1. The density of global data coverage has been improved for several parameters in the water column and in the sediment. Furthermore, as requested from the ORFOIS modelling community during the first annual workshop on January 20–21, 2003 in Hamburg, the work on multi-tracer data sets for some ten sites has begun timely. This work is coordinated with other efforts at WDC-MARE for a maximum benefit on both sides. Regional gaps of the global data sets will be investigated and partly filled. Most attention is given to key areas in order to minimize the delay between data acquisition and modelling efforts.

WP9. Dissemination:

This WP formally starts in month 28. However, some work on it has been done also during months 13–18. The project related web page was updated and is available (at URL <http://www.pangaea.de/Projects/ORFOIS>). The project label (created by N. Dittert, UBO, and D. Bakker, UEA) is integral part of the web page. It is available at URL <http://www.pangaea.de/Projects/ORFOIS/logo.jpg> .

Poster and oral presentations as well as participation of ORFOIS members in a series of workshops and conferences contributed to a promotion of ORFOIS activities and an awareness of the scientific community for further results from our project.

WP10. Coordination:

Due to the move of Christoph Heinze from Partner 1 (NERI) to partner 4 (MPG.IMET) formally the coordination of ORFOIS stayed at NERI (Prof. Bo Riemann). In fact, Christoph Heinze, however, remains coordinator in charge and carries out all relevant activities concerning ORFOIS coordination in a responsible manner.

This 3rd management report was prepared. Christoph Heinze participated in the 1st workshop ("Ocean carbon observations from ships of opportunity and repeat hydrographic sections") of the International Ocean Carbon Coordination Project (Paris, IOC–UNESCO Headquarters, January 13–15, 2003) in order to ensure the dissemination of ORFOIS activities and to exploit the results later on in future research projects.

The 1st annual ORFOIS workshop was held in Hamburg during January 20–21, 2003. An ORFOIS meeting on observational data was held in Hamburg on May 8, 2003, in order to coordinate the different data acquisition, distribution and archiving activities (also with those partners who were unable to attend the 1st annual workshop). Minutes on both workshops were written by Christoph Heinze and distributed to all partners as well as the European Commission.

Milestones and deliverables obtained:

The following **deliverables** are available (in chronological order of workprogramme):

Deliverable No. 4 – *Data extraction techniques:*

Data are ready for retrieval through project website.

Deliverable No. 5 – *Parameterisation of particle flux dynamics (sinking velocity, coagulation, disaggregation):*

Source code and description available for 1–D and 3–D models.

Deliverable No. 6 – *Parameterisation of the dissolution rate of POC, CaCO₃, and biogenic silicate in the water column and in the sediment:*

Available (source code, description) for BOGCMs I and II from partners 1, 2, and 3.

Available for 1–D modelling framework (source code, description) from partners 2 and 7.

Deliverable No. 7 – *Parameterisation of the conversion of biogenic silicate to other mineral phases in the sediments:*

Analysis of samples from the Danube delta were analysed by partner 7 but unfortunately did not

show the expected conversion. New samples were obtained and results will be expected by November 2003. Meanwhile basic parameterisations (constant, depth dependent, dependent on detritus amount) for opal dissolution in the sediment as available in the sediment codes for BOGCMs I and II will be used in the model runs.

Deliverable No. 7a – *Parameterisation of CaCO₃ dissolution:*

Laboratory experiments for refinements are ongoing but first results are available (see project website).

Deliverables 8–10 are summarised here as one:

Deliverable No. 8 – *1-D ecological/particle flux model;*

Deliverable No. 9 – *1-D sediment early diagenesis model;*

Deliverable No. 10 – *Coupled version of 1-D biogeochemical/particle flux and sediment model:*

Coupled modelling framework is available from partner 7. Refinement of sediment code for Si is available from partner 2 (model source codes and description).

Deliverable No. 11 – *Particle flux dynamics module ready for coupling to BOGCM (community model):*

Source code and description available.

Deliverable No. 12 – *Sediment module ready for coupling to BOGCM (community model):*

Source code and description available.

Deliverable No. 1 – *Storage of data sets in online data base:*

Literature review and retrieval of data related to C, P, N, CaCO₃ cycling and sediment accumulation rates in the oceans as well as submission of retrieved data for input to the PANGAEA data base done by partner 6.

Deliverable No. 2 – *CD-ROM with copy of online data base (basic version):*

CD-ROM available. At end of project update will be issued with additional data acquired during the optimisation phase.

Deliverable No. 3 – *Project home page with references to the data sets (basic version):*

Website with link to data base available.

Deliverables 15–16 are summarised here as one:

Deliverable No. 15 – *Basic BOGCM I version with community model components running for preindustrial conditions;*

Deliverable No. 16 – *Basic BOGCM II version with community model components running for preindustrial conditions:*

BOGCM1 (HAMOCC) is running at the two partners 1 and 4 on three separate machines: 1. The Linux cluster at NERI. 2. The Horseshoe Supercluster at the University of Southern Denmark. 3. The NEC SX-6 supercomputer at Hamburg.

BOGCM2 (IPSL/PISCES) is running at partner 2 (LSCE).

Both BOGCMs include particle dynamics following Kriest and Evans (1999, 2000). BOGCM I is running with interactive sediment. Some finalising work for the basic sediment code is currently being carried out by partner 2 (off-line running with PISCES forcing). After this, the sediment will go fully online with BOGCMII also.

Deliverable No. 17 – Basic shelf regime parameterisation (BOGCM I):

Basic parameterisation for biogeochemical forcing through the major 50 rivers available for BOGCM I.

Deliverable No. 39 – Management report to the EC after 18 months:

Done. This is the present report.

A project website was updated (at URL <http://www.pangaea.de/Projects/ORFOIS>). This website is part of **deliverable No. 35**.

The first annual workshop was held in Hamburg on Jan 20–21, 2003 (**deliverable No. 47**).

Workpackages 1–3 and 5 were finished during the last six months. The obtained **milestones** are:

- Extended observational data sets are available. Data can be extracted from the observational data base for comparison with model results
- Standard 1–d models on particle flux and sediment diagenesis are available
- Standard community models on particle dynamics and early sediment diagenesis are available for coupling to BOGCMs and 1–D models
- Basic BOGCMs I and II with standard community model components are available and ready for subsequent optimisation. Some finalising work on the sediment code of BOGCM II is currently carried out.

Thus the project is ready for optimisation of the prognostic model system and for subsequent application.

1.3 Comparison of planned activities and actual work accomplished

General remark: The project could be continued and the tasks/deliverables are under way as planned with a few exceptions which are not critical to the overall project progress. A slight general delay of the project of about one month was caused by the extremely short notice concerning the start of the project.

The laboratory experiments for an improved parameterisation of CaCO₃ dissolution in the water column were delayed due to longer as anticipated equilibration times (partner 2). The studies on degradation of aggregates (partner 3) was delayed through time constraint for zooplankton production (for in situ experiments) and problems in hiring appropriate personnel in time. The laboratory experiments on reverse weathering so far did not bring the desired evidence (partner 6). So far the study of the Danube sediment samples did not show clear signs of conversion of biogenic silica to new mineral phases. Thus the use of these samples for the parameterization of this process is not appropriate. Due to the lack of evidence from the studied Danube sediment samples and delayed acquisition of new sediment samples for the study of biogenic silica conversion to other mineral phases, the corresponding deliverable 7 has been delayed. The new date of completion is estimated to be in November under the condition that evidence for this process will be observed in Ganges–Brachmaputra and Mississippi delta sediments. In case no new evidence is acquired from the study of these samples, the parameterisation will be restricted to tropical continental shelf deposits on the basis of existing observations from the Amazon deltaic system.

The implementation of the sediment code into BOGCM II is currently been carried out (partner 2). All these issues concerning the sediment part do not affect seriously the general progress of ORFOIS, as the integration time scales considered are relatively short and the sedimentary part of the ocean biogeochemical system reacts comparatively slowly. The sediment simulations and process parameterisations, however, are important for verification of the particle dynamics module implemented. This consistency check will be carried out as soon as better parameterisations are available. The BOGCMs I and II, however, can already be used for application runs as they are, though some optimisation will be carried out on them before doing so.

1.4 Planned activities for the next period

Completion of WP 2. Process parameterisations:

The delayed work especially in laboratory experiments will be carried out with high priority.

WP6. Optimisation of the prognostic system:

The forthcoming 6 months period will be dedicated to optimise the entire ORFOIS prognostic modelling framework including the observational data base for comparison and tuning purposes. Major emphasis will be placed on the compilation of model control runs as foundation for the subsequent application and demonstration runs. For this purposes another 16000 CPU hours were granted for ORFOIS on the NEC SX-6 supercomputer in Hamburg. Observational data will be continuously further acquired and processed especially the critical CO₂ data.

WP7. Model application and demonstration:

Basic distributions for surface ocean CO₂ sources and sinks will be provided as a basis for comparison with scenario runs and sensitivity experiments later on. A reference for further runs will also be provided for all other carbon cycle relevant variables and a respective comparison with the observations will be carried out.

WP8. Economic evaluation:

First thoughts on details concerning the economic evaluation will be carried out. First input data to the evaluations will be derived on the basis of BOGCM results.

WP10. Coordination:

The second annual ORFOIS report and the 4th management report will be prepared.

The project flow including the deliverables due will be checked continuously. Smaller meetings may be arranged to initiate certain model applications and to provide agreement of BOGCM control runs as basis for these experiments. The next ORFOIS annual workshop is planned for early 2004.

2. MANAGEMENT AND CO-ORDINATION ASPECTS

ORFOIS workshops_meetings:

The 1st annual ORFOIS workshop was held at the Max Planck Institute of Meteorology in Hamburg during January 20–21, 2003. Focus of this workshop was a review on the work accomplished and a preparation of the optimisation phase to start on July 1, 2003. Attendees of the workshop: Jørgen Bendtsen, Claus Brüning, Nicolas Dittert, Marion Gehlen, Jim Greenwood, Christoph Heinze, Iris Kriest, Axel Michaelowa, Christophe Rabouille, Olivier Ragueneau, Karline Soetaert, Richard Tol (excused were: Dorothee Bakker, Panagiotis Michalopoulos).

An ORFOIS meeting on observational data was held also in Hamburg on May 8, 2003 (in attendance: Dorothee Bakker – UEA, Iris Kriest and Christoph Heinze – MPG–IMET, Nicolas Dittert – UBO, Panagiotis Michalopoulos –NCMR) in order to coordinate the work on the different data streams within the project and to ensure the data deliverables due.

Further project related meetings:

Nicholas Dittert attended meeting with PANGAEA and WDC–MARE specialists on the ORFOIS data base, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, and the Center for Marine and Environmental Research (MARUM), Bremen, Jan 26, 2003– Feb 2, 2003.

Khalil, K. and C. Rabouille (March 2003): Meeting with partner 7 at NIOO. Coordination of 1D–modelling. Introduction of K. Khalil to the FEMME modelling environment.

Khalil, K. and C. Rabouille (May 2003): Meeting with partner 3 at UBO. Parameterisation and optimisation of Si early diagenesis model.

Panagiotis Michalopoulos (partner 6) visited NERI, Dec 9–10, 2002, for progressing with the shelf seas parameterisation.

Conference attendance, presentations (posters/talks):

Bakker, D.C.E., N. Dittert, A. Kozyr, U. Schuster and A.J. Watson, 2003. Towards better access to and safe keeping of oceanic CO₂ and carbon data: Data collection for the CDIAC and WDC–MARE databases in ORFOIS. Poster. 2nd general CARINA (Carbon dioxide in the Atlantic Ocean) meeting and open science conference. 26 February – 1 March 2003, Maspolomas, Gran Canaria, Spain.

Bakker, D.C.E. Carbon sinks in the North Atlantic and European marginal seas (invited talk). CarboEurope Conference 'The continental carbon cycle'. 19–21 March 2003. Lisbon, Portugal.

Bakker, D.C.E. Participation (upon invitation) in SCOPE (Scientific Committee on Problems of the Environment) – GCP (Global Carbon Project) Rapid Assessment Project: Toward CO₂ stabilization: Issues, strategies and consequences. Ubatuba, Brazil, 1–7 February 2003.

Bendtsen, J., On the regulation of deep-sea refractory dissolved organic carbon, poster presentation at the EGS-EUG Joint Assembly, Nice, France, April 6-11, 2003.

Bendtsen, J., C. Lundsgaard, M. Middelboe and D. Archer, Influence of bacterial uptake on deep-ocean dissolved organic carbon, Poster presentation at the EGS-EUG Joint Assembly, Nice, France, April 6-11, 2003.

Dittert, N., M. Diepenbroek, and H. Grobe. WDC-MARE / PANGAEA: A convenient data- and information management partner with YOU? OCEANS meeting, International Open Science Conference, Paris, January 7-10, 2003. Poster.

Gehlen, M., F. Bassinot and D. McCorkle, The dissolution of marine carbonates: Shedding new light on reaction kinetics and solubility. Ocean biogeochemistry and Ecosystem Analysis, IGBP/SCOR, abstract PS1-4.8, IGBP OCEANS conference, Paris, France, January 2003.

Gehlen, M., Le cycle du carbone oceanique a l'ere de l'anthropocene, Centre Universitaire de Luxembourg, Luxembourg-Ville, January 2003.

Gehlen, M., Reassessing solubility and dissolution kinetics of marine carbonates. Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, Colloquium, December 2002.

Heinze, C., Simulation of the global marine Si cycle - achievements and gaps in our understanding, Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, special seminar, December 2002.

Maier-Reimer, E., I. Kriest, and P. Wetzel, Global sea-air CO₂ flux: seasonal and interannual variability with C-HOPE/HAMOCC. Poster, EGS-AGU Meeting, Nice., April 6-11, 2003

Ragueneau O, Claquin P, Corrin L, Dittert N, Heinze C, Maier-Reimer E, Martin-Jezequel V, Pondaven P. Quantification of Si and C decoupling in the world ocean. OCEANS meeting, International Open Science Conference, Paris, January 7-10, 2003. Poster.

Ragueneau, O., P. Claquin, D.J. DeMaster, N. Dittert, M. Gallinari, C. Heinze, A. Leynaert, V. Martin-Jezequel, P. Pondaven, and P. van Cappellen, Calibration of biogenic silica (BSi) as a paleoproductivity proxy: towards a mechanistic understanding of BSi dissolution/preservation and Si/C decoupling in the world ocean. EGS-AGU-EUG Joint Assembly, Nice, April 6-11, 2003. Oral communication.

Ragueneau, O., M. Gallinari, and B. Moriceau. Etude de l'influence des conditions environnementales et du couplage pelagos-benthos sur la dissolution de l'opale biogene dans les sediments profonds. Actions Thematiques Innovantes (ATI), Colloque de Restitution des Resultats. Paris, January 27, 2003. Oral communication.

Watson, A.J, and R. Valentini. Chairs of Session BG7 'Understanding and quantifying the greenhouse gas budgets of ocean and continental regions', EGS/AGU/EUG Joint Assembly. Nice, France, 6-11 April 2003.

Research cruise:

P. Michalopoulos (partner 6), sediment data acquisition in Mississippi delta (April, May 2003) in cooperation with Tulane University.

Cooperation with other projects/networks (also planned activities in FP6):

Planning meeting for NoE Eur–OCEANS, Paris, April 24–25, 2003, attended by C. Heinze and N. Dittert.

Planning meeting for IP Marcassa, Brussels, April 22–23, 2003, attended by C. Heinze, M. Gehlen, N. Dittert, and A. Watson.

Cooperation with EU projects DANUBS (reverse weathering) and RTN Si–WEBS (Si cycling, continent–ocean coupling) are established.

Publications and manuscripts:

Bakker, D.C.E., 2002. The marine carbon cycle and climate. 23–28. In: Bhattacharya, S.K., T.K. Mal and S. Chakrabarti (eds.) Recent research developments in biotechnology and bioengineering. Special Issue: Biotechnology and bioengineering of CO₂ fixation. Research Signpost, Fort P.O. Trivandrum, India, 183 pp.

Bakker, D.C.E., 2003. Storage of carbon dioxide by greening the oceans? In: SCOPE/GCP Rapid Assessment Project. Towards CO₂ stabilization: Issues, strategies and consequences. Special Issue, submitted. Island Press.

Bakker, D.C.E., Boyd, P.W., Charette, M.A., Mark P. Gall, M.P., Hall, J.A., Nodder, S.D., Safi, K., Singleton R.J., Trull, T.W., Waite, A.M., Watson, A.J., Zeldis, J., Abraham, E.R., Law, C.S. and Tanneberger, K., 2003. A Pelagic carbon budget for the Southern Ocean Iron Enrichment Experiment (SOIREE), February 1999. Submitted to Deep–Sea Research.

Dittert, N., M. Diepenbroek, R. Huber R, 2003, World Data Center for Marine Environmental Sciences provides lessons in marine Geosciences data management. *EOS*, Transactions, AGU, 84(16): 149.

Gallinari, M, O. Ragueneau, D.J. DeMaster, D. Rickert, H. Hartnett, and C. Thomas, Influence of seasonal phytodetritus deposition on biogenic silica dissolution properties in marine sediments – Potential effect on preservation. *Geochimica et Cosmochimica Acta*, submitted.

Kriest, I., 2002, Different parameterizations of marine snow in a 1D–model and their influence on representation of marine snow, nitrogen budget and sedimentation. *Deep–Sea Res. I*, 49, 2133–2162

Middelburg, J., and K. Soetaert, The role of sediments in shelf ecosystem dynamics, Chapter 12 for Vol. 13 of "The Sea", submitted.

Raupach, M., J. Canadell, D.C.E. Bakker, P. Ciais, M.-J. Sanz, J.Y. Fang, J. Melillo, P. Romero Lankao, J. Sathaye, D. Schulze, P. Smith, J. Tschirley, 2003. Interactions between CO2 stabilisation pathways and requirements for a sustainable earth system. In: SCOPE/GCP Rapid Assessment Project. Towards CO2 stabilization: Issues, strategies and consequences. Special Issue, in preparation. Island Press.

Sabine, C.L., M. Heiman, P. Artaxo, D.C.E. Bakker, C.-T.A. Chen, C.B. Field, N. Gruber, C. LeQuere, R.G. Prinn, J.E. Richey, P. Romero Lankao, J. Sathaye, R. Valentini, 2003. Current Status and Past Trends of the Carbon Cycle In: SCOPE/GCP Rapid Assessment Project. Towards CO2 stabilization: Issues, strategies and consequences. Special Issue, in preparation. Island Press.

Hamburg, June 24, 2003

.....
(Christoph Heinze)

Roskilde, June 26, 2003

.....
(Bo Riemann)

Appendix A:**Updated version of "Participants Information" – Table:**

Note changes for partners 6 and 8 !

<i>No.</i>	<i>Institution</i>	<i>Address</i>	<i>PI name</i>	<i>Phone/fax</i>	<i>email</i>
1	National Environmental Research Institute NERI	Frederiksborgvej 399, P.O.Box 358, DK-4000 Roskilde, DENMARK	Dr. Jørgen Bendtsen	P +45 46301863 F +45 4630 1114	che@dmu.dk
2	Laboratoire des Sciences du Climat et de l'Environnement, CEA DSM CEA-DSM	C.E.N. Saclay – Orme des Merisiers Bât. 709, F- 91191 Gif-sur-Yvette CEDEX, FRANCE	Dr. Marion Gehlen	P +33 1 69088672 F +33 1 69087716	gehlen@lsce.saclay.cea.fr
3	Laboratoire des Sciences de l'Environnement Marin (LEMAR), UMR CNRS 6539 UBO	Institut Universitaire Européen de la Mer (IUEM), Place Nicolas Copernic, Technopôle Brest-Iroise, F-29280 Plouzané, FRANCE	Dr. Nicolas Dittert	P +33 298 498673 F +33 298 498645	nicolas.dittert@univ-brest.fr
4	Max Planck Institute of Meteorology MPIG.IMET	Bundesstrasse 55, D-20146 Hamburg, GERMANY	Dr. Ernst Maier-Reimer Dr. Christoph Heinze	P +49 40 41173233 F +49 40 41173298	maier-reimer@dkrz.de
5	Hamburg University, Research Unit Sustainability and Global Change, Centre for Marine and Climate Research Uni-HH	Tropowitzstrasse 7, D-22529 Hamburg, GERMANY	Dr. Richard S.J. Tol Michael Otto Professor of Sustainability and Global Change	P +49 40 428387007 P +49 40 428387008 F +49 40 428387009	tol@dkrz.de
6	National Center for Marine Research Institute of Oceanography NCMR	P.O. Box 712, Anavyssos 19013, GREECE	Dr. Panagiotis Michalopoulos	P +3 0291076337 F +3 0291076323	pmichalo@ncmr.gr
7	Netherlands Institute of Ecology, Centre for Estuarine and Marine Ecology NIOO	Korringaweg 7, P.O. Box 140, NL- 4400 AC Yerseke, NETHERLANDS	Dr. Karline Soetaert	P +31 113 577300 F +31 113 573616	soetaert@cemo.nioo.knaw.nl
8	University of East Anglia, School of Environmental Sciences UEA	University Plain, NR4 7TJ Norwich, UNITED KINGDOM	Dr. Dorothee Bakker	Until 02/2003: P +44 1603 591124 else P +44 1603 592648 F +44 1603 507719	D.Bakker@uea.ac.uk
	<i>Subcontractor to participant 4:</i> Centre for Marine Environmental Sciences (MARUM), University of Bremen	Postfach 330440, D-28359 Bremen, GERMANY	Dr. Michael Diepenbroek	P +49 421 218 7765	mdiepenbroek@pangaea.de

Appendix B: Personnel (continued on following page)

Table: Personnel working in ORFOIS.

<i>Parti-</i> <i>ci-</i> <i>pant</i> <i>No.</i>	<i>Name</i>	<i>position</i>	<i>% of</i> <i>full time</i> <i>employ-</i> <i>ment</i> <i>paid by</i> <i>project</i>	<i>Begin of</i> <i>employment</i>	<i>End of</i> <i>employment</i>
1	Christoph Heinze	Senior scientist	41.6	Dec 1, 2001	Mar 31, 2003
1	Jørgen Bendtsen	Researcher	100	Feb 1, 2002	–
2	Marion Gehlen	Senior scientist	20	Dec 1, 2001	–
2	Christophe Rabouille	Senior scientist	17	Dec 1, 2001	–
2	Benoit Thiebault	Chem. engineer	100	June 16, 2002	–
2	Nadia Emprin	Post doc	100	Nov 12, 2002	–
2	Karima Khalil	Post doc	100	Feb 18, 2003	–
2	Anne Cozic	Comp. Engineer	100	Jan 6, 2003	–
3	Lydie Corinne	Engineer	50	Mar 1, 2002	–
3	Nicolas Dittert	Researcher	100	Dec 1, 2001	–
3	Morgane Gallinari	Post doc	100	Dec 1, 2001	May 31, 2002
3	Sabrina Rousseau	PhD student	100	Mar 1 2002	Apr 30, 2002
3	Aude Leynaert	Senior scientist	–	–	–
3	Philippe Pondaven	Senior scientist	–	–	–
3	Olivier Ragueneau	Senior Scientist	–	–	–
3	Laurent Bopp	Senior scientist	100	Apr 1, 2003	May 31, 2003
4	Iris Kriest	Researcher	100	Feb 1, 2002	–
4	Ernst Maier-Reimer	Senior scientist	–	–	–
4	Christoph Heinze	Senior Scientist	–	–	–
5	Richard S. J. Tol	Professor	–	–	–
6	Panagiotis Michalopoulos	Scientist	100	Jan 1, 2002	–
6	Christos Anagnostu	Senior scientist	15	Jan 1, 2002	–
6	Karageorgis Aristomenis	Scientist	15	Jan 1, 2002	Nov 30, 2003
			6	Dec 1, 2003	–
6	Maria Taxiarki	Technician	18	Jan 1, 2002	–
6	Panagiotis Traxalakis	Technician	20	Jan 1, 2002	May 31, 2002
6	Papageorgiou Alkis	Technician	20	Jun 1, 2002	–
6	Kampourie Georgia	Technician	20	Jun 1, 2002	–
6	Kanellopoulos Theodoros	Res. Associate	52	Mar 1, 2003	–
6	Batris Evangelos	Res. Associate	52	Dec 1, 2002	Dec 31, 2002
7	Henrik Andersson	PhD student	100	Feb 1, 2002	Apr 1, 2002
7	Jasper van Delft	Comput. Progr.	100	Jan 1, 2002	May 1, 2002
7	Jim Greenwood	Post doc	100	May 1, 2002	–
7	Adri Knuyt	Progr. Assist.	100	Sep 1, 2002	Nov 30, 2002
7	Karline Soetaert	Senior Scientist	–	–	–

<i>Parti- cipant No.</i>	<i>Name</i>	<i>position</i>	<i>% of full time employ- ment paid by project</i>	<i>Begin of employment</i>	<i>End of employment</i>
8	Dorothee Bakker	Sen. Res. Assoc.	100	Jan 1, 2002	—
8	Andy Watson	Professor	—	—	—

Appendix C: References

Heinze et al. (1999) "A global oceanic sediment model for long-term climate studies." *Global Biogeochemical Cycles* 13(1): 221–250.

Heinze and Maier-Reimer (1999) The Hamburg Oceanic Carbon Cycle Circulation Model. Version "HAMOCC2s" for long time integrations. Hamburg, Deutsches KlimaRechenZentrum. Technical Report 20.

Kriest and Evans (1999) "Representing phytoplankton aggregates in biogeochemical models." *Deep-Sea Research I* 46: 1841–1859.

Kriest and Evans (2000) "A vertically resolved model for phytoplankton aggregation." *Proc. Indian Acad. Sci. (Earth Planet. Sci.)* 109(4): 453–469.