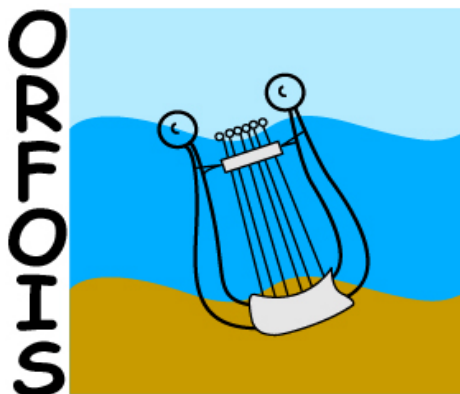


2nd MANAGEMENT REPORT Confidential

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: Christoph Heinze, NERI

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: June 1, 2003 - November 30, 2003

STARTING DATE: December 1, 2001 DURATION: 3 years

Date of issue of this report: January 11, 2004

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

1. TECHNICAL OVERVIEW

1.1 Objectives of the reporting period

Months 19-24 of ORFOIS were dedicated to workpackages 6, 7, 8 and 10. In detail, the objectives of the workpackages within the reporting period were:

WP6. Optimisation of the prognostic system.

To (a) provide optimised runs of BOGCMs I and II, (b) update the high quality data base of C, N, and Si cycling in the world ocean, (c) revise process parameterisations of the water column and sediment community modules, (d) set up corrected atmospheric forcing fields.

WP7. Model application and demonstration.

To (a) provide an improved simulation of surface ocean CO₂ sources and sinks and a closed biogeochemical budget for the preindustrial ocean, (b) assess modifications in surface ocean production patterns and associated changes in particle fluxes for climatic warming scenarios, (d) assess first order effects for anthropogenic carbon sequestration scenarios.

WP8. Economic evaluation.

To (a) estimate regional emission reduction cost differentials for the optimized marine carbon cycle representations of WPs 6 and 7, (c) estimate the costs of sequestering carbon in the ocean, [(d) deleted, see kick-off meeting].

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).

Special emphasis during the reporting period was placed on WP6.

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 O O	X X X X
7	Model application and demonstration		O O	X X X X
8	Economic evaluation		O O	X X X X
9	Dissemination			O X X
10	Coordination	O O O O	O O O O	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

WP6. Optimisation of the prognostic system:*6.1 Comparison between BOGCM outputs and observations, identification of the crucial disagreements to be removed (partners 1, 2, 3, 4, 6, 7, 8).*

A series of integrations with BOGCMs I (HAMOCC) and II (PISCES) has been carried out for various parameterisations of the vertical particle flux (different complexities of the particle flux). Results were compared with observational data on surface chlorophyll, sediment trap data about POC, CaCO₃, and BSi fluxes in the water column, and surface pCO₂ (please, see 2nd annual progress report).

6.2 Tune BOGCMs optimally using an SVD technique (partners 1, 2, 4).

Originally, it was planned to carry out the model tuning of the BOGCMs systematically through a-SVD technique as applied in Heinze et al. (2003). This method allows quasi-objective tuning of complex BOGCMs with respect to observed data. The method requires, that the respective BOGCMs are computed into quasi-equilibrium several times with small perturbations in the parameters to be optimized. Given the long integration times of BOGCMs I and II, this method proved to be not applicable in our case. Alternative tuning methods were therefore applied. The first method is based on global bulk numbers. The models are first tuned so that global bulk numbers for biological production and sedimentation are satisfied giving then at least correct large scale rates of throughput of matter from continent-derived input at the sea surface to output by sediment accumulation (“loss to the lithosphere”). The second tuning method uses gridded start fields for modelled variables on the basis of measurements. It is then followed how quickly the modelled results diverge from the observed arrays. Model parameters can then either successively adjusted or in severe cases then models have to be initialized newly with corrected parameter choices.

6.3 Fill in gaps in data coverage for model verification (partners 3, 6, 8).

Additional observational data sets were included in the data base. So far 5,149 ORFOIS relevant data sets were compiled in the data base and are available online. See:

<http://www.pangaea.de/Projects/ORFOIS/Results/>

or

<http://www.pangaea.de/PangaVista?query=ORFOIS>

As during the report periods before, several institutes and laboratories were visited successfully. International meetings led to personal contacts that helped to advance distinctly. Among them were the IGBP OCEANS Open Science Conference, Paris, January 7-10, 2003, (now IMBER), the potential FP6 Network of Excellence Eur-OCEANS (ex-ECCO) initiative meeting, Paris, April 24-25, 2003, and the Chapman Conference on the role of diatom production and Si flux and burial in the regulation of global cycles, Paroikia, Paros, Greece, September 22-26, 2003. Always very fruitful and helpful are and were the meetings at AWI and MARUM to solve problems and to discuss specific efforts to be undertaken with respect to the relational data base management and information system PANGAEA / WDC-MARE.

Partner 6 completed the collection of archived and new sediment samples from major deltaic depositional systems.

6.4 Revise atmospheric forcing (e.g., for ACC strength adjustment) (partners 1, 2).

Building on WP4, the atmospheric forcing fields for the global warming scenarios to be carried out were refined.

Comparisons between the OMIP-air temperature and the ECHAM4/OPYC3 - air temperature after interpolation onto the HAMOCC5-grid showed minor differences in the yearly averaged values, except for polar areas where differences in sea ice cover results in relatively large temperature differences (see enclosed figure). The transient change in the global forcing fields has been analysed, and they show a gradual increase in the global averaged surface air temperature from 1860 to 2050, with a pronounced change in the northern polar and subpolar areas (see enclosed animation of the GHG-experiment).

6.5 Quality check of the observations (partners 3, 6, 8).

Consistency checks and quality tests were made with all data which were fed into the data base.

6.6 Revise process parameterizations through 1-D modeling and feed these improvements into the community model components as used by BOGCMs Ia and II (through use of the ClearCase source code control system including the test of the 1-D codes in selected case studies) (partners 2, 3, 4, 6, 7, 8).

Several simulations have been conducted by partner 7 in order to tune and optimise parameterizations for biological and biogeochemical processes in the water column, and to check the general consistency of the 1-D code. A 1-D physical representation of the upper 1000m, with a resolution of 10m, has been tuned for station ALOHA in the sub-tropical North Pacific based on a well tested turbulent mixing scheme. A 1-D steady-state re-mineralisation model has been used to make a preliminary examination of the major processes affecting the vertical distribution of hydrogen ion concentration, dissolved inorganic carbon and oxygen below the euphotic zone between 150m and 1000m at ALOHA. A coupled physical-biogeochemical 1-D dynamic model has also been applied and tested for the upper 1000m at station ALOHA.

A method that allows the identification of parameter combinations that can be estimated from given observations, so-called “identifiability analysis”, was implemented by partner 7. This technique calculates both the sensitivity of the model to single parameters and the near-linear dependence of parameter subsets. Both measures then give guidance in the selection of identifiable parameter subsets used for parameter identification.

Partner 8 has conducted two studies on surface pCO₂ uptake parameterisations: *Pelagic Carbon budget for SOIREE* - A full pelagic carbon budget has been made for the Southern Ocean Iron Release experiment. In particular, it was possible to assess to what extent closure of this budget was achieved, a primary objective of biogeochemical ocean programmes, such as Joint Global Ocean Flux Study (JGOFS). A manuscript describing the budget is in revision after an initial submission to Deep-Sea Research (Bakker et al., 2003). *Storms influence oceanic CO₂ uptake*. A comparison of the results from the SOIREE and EisenEx experiments highlight how differences in meteorological and hydrological forcing influence CO₂ uptake upon iron fertilization (Bakker et al., in preparation).

WP7. Model application and demonstration:

7.1 Final integration of the preindustrial reference runs with BOGCMs I and II using the optimized prognostic system (partners 1, 2).

Preindustrial reference runs were carried out with BOGCMs I and II. These runs were repeated iteratively until the best possible version within the given time frame was available (see WP 6).

7.2 Integration of greenhouse gas induced warming scenarios restarting from preindustrial conditions (partners 1, 2).

The integrations of the greenhouse gas induced warming scenarios has been prepared, and the setup of the experiments has been initiated.

7.3 Integration of Fe-fertilisation scenario introducing additional iron input to areas with high preformed nutrient surface concentrations (restart from modern conditions, few hundred years) (partners 1, 2).

New parameterizations of iron fertilisation have been tested with BOGCM I. Both BOGCMs (I and II) are ready for these scenarios.

7.4 Integration of deep ocean CO₂ disposal scenario through CO₂ injection into selected CaCO₃ rich deep sea areas (partners 1, 2).

These scenarios were prepared for BOGCMs I and II. Exact configurations of respective experiments will be discussed on the 2nd annual ORFOIS meeting in Gif-sur-Yvette (location of partner 2).

7.5 Integration of glacial ocean scenario (partner 4).

The glacial ocean scenario is being prepared through selection of the most suited model/forcing data combination. It may be advisable to carry out the glacial scenario with the already tested fast HAMOCC version based on the LSG model dynamics rather than to use BOGCM I, which is computationally quite expensive. Details on this alternative will be discussed on the 2nd annual ORFOIS meeting in Gif-sur-Yvette (location of partner 2).

7.6 Compilation of results for economic evaluation (partners 1, 2).

Values for the preindustrial ocean are available.

WP8. Economic evaluation:

8.1 Adoption of already existing models for the specific purpose of the project (partner 5).

The first task, adoption of the *FUND* model, has been completed by partner 5, allowing us to turn to the scientific objectives of the project.

The *FUND* model has been extended to include a richer representation of climate change (e.g., sulfur dioxide), and the spatial resolution (16 instead 9 regions) has been increased, allowing for a more careful regional assessment of climate change impacts and greenhouse gas emission reduction costs. Additional climate change impacts (e.g., diarrhea) have been included, and other greenhouse gases (methane, laughing gas) have been added. This will allow for more accurate estimates of the impact of marine carbon fluxes.

8.2 *Estimate differences in carbon fluxes due to the alternative representation of the marine carbon cycle and estimate impact on the costs of meeting certain emission reduction targets (partner 5).*
This activity was planned for after month 24.

8.3 *Estimate (based on previous step) (1) effects on atmospheric CO₂ concentrations, climate change and sea level rise, and (2) differences in the impacts of climate change and sea level rise (partner 5).*
This activity was planned for after month 24.

8.4 Complementation of the impact estimates of marine carbon sequestration on carbon cycle and ecology of WP7 with estimates of the costs of marine carbon sequestration (partner 5).
This activity was planned for after month 24.

[8.5 Omitted, see kick-off meeting.]

WP9. Dissemination:

Formally, this WP formally starts in month 28. However, additional work on it has been done also during months 19-24. The project related web page was updated. It 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. Also a series of publication resulting out of ORFOIS research is available (see below).

WP10. Coordination:

This report was prepared. The project work for the first year was summarised in the more scientifically oriented 1st annual progress report covering the period Dec 1, 2001 – Nov 30, 2002. The coordinator took part in the conference “European Research 2002” in order to receive most actual information about the status of European funded research, to keep contact with the European Commission, and to prepare the exploitation of ORFOIS results in a proposal for an integrated project on the marine carbon cycle within FP6. All ORFOIS members were invited to the first annual workshop to be held in Hamburg, Germany, during Jan 20-21, 2003.

Milestones and deliverables obtained:

All planned deliverables are available with the exception of the 2nd annual workshop which will take place soon during February 26-27, 2004, at Gif-sur-Yvette (at location of partner 2). All participants, consultants, and the EC officer were invited to this workshop.

Distributions of surface ocean CO₂ sources and sinks and oceanic biomass for the preindustrial ocean are available for BOGCMs I and II (deliverable 24)

The project website was updated (at URL <http://www.pangaea.de/Projects/ORFOIS>). This website is part of deliverable 35.

This report (deliverable 40) is finished.

The 2nd (scientific) annual progress report was provided (deliverable 44).

The 2nd annual workshop – deliverable 48 – will follow on Feb 26-27, 2004.

1.3 Comparison of planned activities and actual work accomplished

The project progresses as anticipated. A few minor delays are listed below. None of these delays affects the project flow in a significant way. Overall the working discipline in the project was very good and all partners communicated in a very constructive and friendly manner.

The implementation of a sediment module in BOGCM II by partner 2 was delayed due to the maternal leave of N. Emprin. M. Gehlen visited partner 4 (MPI in Hamburg) on November 28, 2003, in order to discuss several technical details for the finalising of the implementation. Partners 4 and 2 are in contact for accomplishing the sediment coupling.

Due to the late acquisition of samples for the study of biogenic silica conversion to new mineral phases and reverse weathering processes the progress of deliverable #7 has been delayed. The data from the Ganges-Brahmaputra system indicate the existence of conversion processes for biogenic silica. In addition, the first results from the Mississippi delta system also point to the existence of biogenic silica conversion. The laboratory work on the existing samples will be completed in January 2004 and a synthesis of the results will be available in February 2004.

1.4 Planned activities for the next period

WP6. Optimisation of the prognostic system.

6.1 Comparison between BOGCM outputs and observations, identification of the crucial disagreements to be removed (partners 1, 2, 3, 4, 6, 7, 8).

6.2 Tune BOGCMs optimally using an SVD technique (partners 1, 2, 4).

6.1-6.2: Comparison of model results and observations will be continued. Model parameters will be

adjusted using different tuning techniques. The SVD technique had to be abandoned in our case due to excessive integration times of the sophisticated BOGCMs. For the next 6 months some further experiments with BOGCM I are planned regarding the effects of different parameterizations of organic matter production, degradation and sedimentation.

6.3 *Fill in gaps in data coverage for model verification (partners 3, 6, 8).*

6.4 *Revise atmospheric forcing (e.g., for ACC strength adjustment) (partners 1, 2).*

6.5 *Quality check of the observations (partners 3, 6, 8).*

6.3-6.5: Data bases for forcing data and in situ measurements will be continuously updated and improved. The acquisition, processing, and quality check of observational data sets (former WP1) will continue in the WDC-MARE / CDIAC framework. The pCO₂ data formatting work due the expected new data format definition for the CDIAC data base will continue. The acquisition of archived samples for the study of reverse weathering processes in continental margin environments will continue. The literature review for the compilation of data sets regarding the role of continental margins in nutrient cycling will continue.

Special emphasis will be placed on a *uniform data format*: A uniform data format for surface water fCO₂ data is essential for data access by ORFOIS modellers. Unfortunately planned work on a uniform data format for the CDIAC surface water fCO₂ database by Dr. Andrew Dickson (Scripps Institute for Oceanography) has been delayed. As ORFOIS modellers need access to surface fCO₂ data, Dorothee Bakker has defined a 'temporary' uniform format for fCO₂ data. Work is in progress to put surface water fCO₂ data from the CDIAC database into this temporary format. The 'temporary' uniform format incorporates recommendations by Andrew Dickson, the PICES community and CARINA scientists. Putting the surface water fCO₂ data at CDIAC into a uniform format requires a considerable amount of work and will be completed in early 2004. A workshop on ocean surface pCO₂, data integration and database development will take place on 14-17 January 2004 in Tsukuba, Japan. Dorothee Bakker will participate in the meeting, where she will give a short presentation on the ORFOIS project and uniform data formatting issues, which will open a larger discussion on data formats for underway pCO₂ measurements. The objectives of the meeting include:

- To reach agreements on best practices for metadata information and data formats for underway pCO₂ measurements and to publish a technical paper / best practices guide describing the proposed data format and metadata structure;
- To discuss collaborations for regional and global data integration and database development for surface pCO₂ measurements.

The realization of the first objective will be an important driver towards an international uniform data format for surface water CO₂ data in major databases. Hopefully the meeting will also convince more marine CO₂ scientists that they should make their data publicly accessible. Participants include US, European, Japanese, Australian and New Zealand scientists. The sponsors of the meeting are the National Institute for Environmental Studies (NIES), the International Ocean Carbon Coordination Project (IOCCP), and the North Pacific Marine Science Organization (PICES) Working Group 17.

Access of surface water fCO₂ data at CDIAC from WDC-MARE - The WDC-MARE will implement ANSI/NISO Z39.50 protocol (<http://www.cni.org/pub/NISO/docs/Z39.50-brochure/>) for the PANGAE database by the end of 2003. If CDIAC were to implement the

same protocol, this would ensure direct data exchange between the WDC-MARE and CDIAC databases for CO₂ data. In this case mirroring of CDIAC's surface water fCO₂ data at WDC-MARE would become superfluous. Mr Alex Kozyr, data manager of marine CO₂ data at CDIAC, is presently looking into the matter.

6.6 Revise process parameterizations through 1-D modeling and feed these improvements into the community model components as used by BOGCMs I and II (through use of the ClearCase source code control system including the test of the 1-D codes in selected case studies) (partners 2, 3, 4, 6, 7, 8).

During the coming months, partner 2 will test the current model version of the 1-D Si early diagenesis model under non steady state conditions. In the course of a sensitivity study, different scenarios describing the Si cycle in surface sediments will be investigated. In a first scenario, the precipitation of Si with Al will be included, the saturation concentration of BSi dissolution will be constant and different from the Si asymptotic concentration. This model will contain one type of BSi. The dissolution rate will vary with depth. In a second scenario, the model will include precipitation, the Si dissolution rate will be constant. This model will contain one type of BSi. The saturation concentration of BSi dissolution will vary with depth or with the ratio SiDetrital/SiBiogenic. The model output of these case studies will be compared to data. Finally, the apparent Si dissolution rate constant, the saturation concentration of BSi dissolution, the dissolved Si reprecipitation rate constant and the saturation concentration for Si reprecipitation will be related to the ratio SiDetrital/SiBiogenic.

Partner 2 will couple a model of carbonate diagenesis to the 1-D diagenetic model of sedimentary C and N cycles developed by partner 7. The module is developed by partner 2 in collaboration with partner 7.

The laboratory experiments on calcium carbonate dissolution kinetics were successful and resulted in a large data set. The coming months will be devoted to the in-depth treatment of experimental results.

The implementation and optimisation of the sediment module in BOGCM II will be continued.

During the coming months partners 1, 2, and 4 will compare model output for different types of the parameterisation of particle fluxes in the water column. The model output data comparison will benefit with the comprehensive data base collated within ORFOIS. Special emphasis will be put on the feedback of water column remineralization of organic carbon on surface ocean pCO₂.

1-D model output will continue to be compared with the data base of observations. Explicit bacterial dynamics and calcification will be added to the existing 1-D simulation at ALOHA to examine the influence of DOM and CaCO₃ precipitation/dissolution on biological and biogeochemical output. Parameterisation of 1-D pelagic silica dynamics has also been planned in collaboration with partner 3 (UBO) using BATS data. Ongoing degradation experiments in collaboration with partner 3 (UBO) will be completed. Coupling of the pelagic and benthic 1-D components will proceed in close collaboration with partner 2 (LSCE) and partner 3 (UBO).

In the next six months the following activities will be carried out by partner 6: (i) Continuation of laboratory analysis of existing and acquired samples with regard to biogenic silica conversion to other mineral phases and cation uptake by continental margin sediments. (ii) Synthesis of results and quantification of biogenic silica conversion in deltaic environments. (iii) Microscopic investigation of "reverse weathering" products from Mississippi river sediments with the SEM. Partner 7 will place more work on the following issues: (i) Parameterisation of particle flux

dynamics (sinking velocity, coagulation, disaggregation) for the Iberian shelf system (deliverable 5). (ii) Parameterisation of the dissolution rate of POC, CaCO₃, and biogenic silicate in the water column was provided (deliverable 6). (iii) Full compilation of 1-D ecological/particle flux model code was provided (deliverable 8)

WP7. Model application and demonstration.

7.1 Final integration of the preindustrial reference runs with BOGCMs I and II using the optimized prognostic system (partners 1, 2).

Selected preindustrial runs will be repeated after optimisation of the prognostic system.

7.2 Integration of greenhouse gas induced warming scenarios restarting from preindustrial conditions (partners 1, 2).

The transient climate change scenarios will be carried out based on the prepared forcing fields for the period 1860 - 2050. The development of the BOGCM1 for integration on parallel machines will be continued.

7.3 Integration of Fe-fertilisation scenario introducing additional iron input to areas with high preformed nutrient (restart from modern conditions, few hundred years) (partners 1, 2).

Model set ups and scenarios for these experiments will be discussed and established during the forthcoming second annual ORFOIS workshop. Model integrations will be carried out in the middle of 2004.

7.4 Integration of deep ocean CO₂ disposal scenario through CO₂ injection into selected CaCO₃ rich deep sea areas (partners 1, 2).

Model set ups and scenarios for these experiments will be discussed and established during the forthcoming second annual ORFOIS workshop. Model integrations will be carried out in the middle of 2004.

7.5 Integration of glacial ocean scenario (partner 4).

The setup of the glacial scenario and suitable model configurations will be discussed during the second annual ORFOIS workshop. The glacial run will be carried out by J. nSegschneider at MPI Hamburg during 2004.

7.6 Compilation of results for economic evaluation (partners 1, 2).

Preliminary fields for setting up the economical evaluation are available. Final assessments will be made after all optimizations (WP6) have been finished. Procedures will be discussed and agreed on during the second annual ORFOIS workshop.

WP8. Economic evaluation:

8.1 Adoption of already existing models for the specific purpose of the project (partner 5).

Done.

8.2 Estimate differences in carbon fluxes due to the alternative representation of the marine carbon cycle and estimate impact on the costs of meeting certain emission reduction targets (partner 5).

8.3 Estimate (based on previous step) (1) effects on atmospheric CO₂ concentrations, climate change and sea level rise, and (2) differences in the impacts of climate change and sea level rise (partner 5).

8.4 Complementation of the impact estimates of marine carbon sequestration on carbon cycle and ecology of WP7 with estimates of the costs of marine carbon sequestration (partner 5).

For 8.2-8.4: In the next period, we will apply the adopted FUND model to estimate the effects of marine carbon flows on climate change, climate change impacts, greenhouse gas emission reduction targets, and costs of emission abatement.

[8.5 Omitted, see kick-off meeting.]

WP9. Dissemination:

9.1 Data base of observations including user manual: (1) CD-ROM, (2) on the Internet (partners 3, 6, 8).

Preliminary data products are available upon request. Final data products will be provided by end of project.

9.2 Community models (ecological/particle flux dynamics and early diagenesis modules): (1) On the Internet, (2) publication on paper as technical report (partners 1,2,3,4,6,7).

Documentations and models will be made available.

9.3 BOGCMS I and II plus output from preindustrial, climate change, and carbon sequestration runs: (1) Electronic online publication on the Internet, (2) publication on paper as technical report within an established report series, (3) storage of model results in online data base and forwarding of meta information to European and overseas data centers (partners 1,2).

Will be available at end of project. Issue will be discussed during second annual ORFOIS workshop.

9.4 Publication of results including economic evaluation as handout for the public (schools, universities, policy makers, fisheries agencies, energy and life science enterprises, and other end users) (all partners).

Will be done at end of project. Issue will be discussed during second annual ORFOIS workshop.

9.5 Update of project's web page (partner 3 with contributions from all partners).

The website is being continuously updated until end of project.

9.6 Final project workshop, which will be advertised to the scientific and end user community

(partner 1, with contributions from all partners).

The date and logistical details about the workshop will be issued in due time. At this stage it is planned to hold the workshop in Bergen, Norway, in early 2005. Details will be discussed at second annual ORFOIS workshop.

WP10. Coordination:

10.1 Contact partners early to receive results in time.

10.2 Gather contributions of participants for management and scientific reports and compile these reports for submission to the EC.

The 5th management report will be written. The project flow including the deliverables due will be checked continuously.

10.3 Contact participants regularly to discuss problems and solve them jointly.

10.4 Invite participants and consultants to workshops and meetings.

The second annual ORFOIS workshop will be held in Gif-sur-Yvette during February 26-27, 2004.

2. MANAGEMENT AND CO-ORDINATION ASPECTS

The ORFOIS coordinator, Christop Heinze, started a professorship for global carbon cycle modeling at the University of Bergen (Geophysical Institute, Bjerknes Centre for Climate Research) by January 1, 2004 (see new address in PI table below). Christoph Heinze will continue to act as coordinator in charge of the project. The logistical support (travel money, money for inviting advisers to meetings, etc.) will be funded through part of the grant shifted from NERI to MPI of Meteorology through an amendment in the contract. The glacial run within ORFOIS will be performed at MPI and not at NERI according to this amendment.

Overall the project went smoothly and all partners should high commitment to the project.

ORFOIS workshops/meetings:

First annual ORFOIS workshop, MPI f. Meteorology, Hamburg, January 20-21, 2003.

Meeting of partners 2 and 3 at LSCE. Parameterisation and optimisation of Si early diagenesis model. October 2003.

The **second annual ORFOIS workshop** will be held in Gif-sur-Yvette, February 26-27, 2004. A corresponding invitation has been submitted to all people involved in ORFOIS and to the European Commission.

Further project related meetings:

N. Dittert, C. Heinze, O. Ragueneau, B. Moriceau, M. Gallinari: Chapman Conference on the role of diatom production and Si flux and burial in the regulation of global cycles, Paroikia, Paros, Greece, 22-26 September 2003.

M. Diepenbroeck, N. Dittert: Annual data base meeting, AWI Bremerhaven, Germany, 29 October – 05 November 2003.

Conference attendance, presentations (posters/talks):

Talks:

Bakker, D.C.E, M. Hoppema, A.J. Watson, Y. Bozec and H.J.W de Baar. The Southern Ocean a key player in the global carbon cycle (invited speaker). International Union of Geodesy and Geophysics 2003. 4 July 2003. Sapporo, Japan.

Bakker, D.C.E, M. Hoppema, A.J. Watson, Y. Bozec and H.J.W de Baar. The Southern Ocean a keyplayer in the global carbon cycle. Progress in Chemical Oceanography (PICO) meeting. 18 July 2003. University of East Anglia, Norwich.

Bakker, D.C.E, Watson, A.J., Nightingale, P.D., Law, C.S., Bozec, Y., Goldson, L., Messias, M-J., de Baar, H.J.W., Liddicoat, M. and Skjelvan, I. Inorganic carbon changes in two Southern Ocean iron release experiments: effects of iron, hydrography and meteorology; followed by a discussion on 'Carbon storage by greening the oceans'. 5 January 2003. Evening seminar on R.V. *Polarstern*.

Bendtsen, J., 12. september 2003: Oral presentation at a ecological modelling seminar at the Danish Hydraulic Institut, "Modelling marine ecosystems".

Bendtsen, J., 12. november 2003: Presentation at internal seminar at NERI, "Transient climate change experiments".

Bopp L. , Particle flux dynamics in BOGCM, Dynamical Green Ocean Model Project, Third Workshop, Villefranche-sur-Mer, 20-22 October, 2003.

Greenwood J. and Soetaert K. 1D Pelagic Modeling of Carbon Dioxide Geochemistry in the Open Ocean. Gordon Conference for Chemical Oceanography, USA, August 2003.

Heinze, C., The effect of Diatoms and Si on the carbon cycle, oral presentation, AGU Chapman Conference, on the role of diatom production and Si flux and burial in the regulation of global cycles, Paroikia, Paros, Greece, 22-26 September 2003, invited contribution.

Heinze, C., Simulating the response of the CaCO₃ counter pump to climate change, oral presentation, Seminar on Biogeochemistry and high latitudes, Bjerknes Centre for Climate Research, Bergen, November 6-7, 2003, invited contribution.

Heinze, C., Partikel-reaktive Metalle als ozeanische Tracer, Colloquium of the ICBM, University of Oldenburg, November 26, 2003, invited contribution.

Khalil, K., C. Rabouille, K. Soetaert, J. Greenwood and O. Ragueneau, 1-D sediment early diagenetic model in global perspective. Summer school Si-Webs, Athens, Greece, June 2003.

Ragueneau, O. Calibration of Biogenic Silica (BSi) as a paleo productivity proxy: towards a mechanistic understanding of BSi dissolution/preservation and Si/C decoupling in the world ocean. AGU, Chapman Conference on "The Role of Diatom Production and Si Flux and Burial in the Regulation of Global Cycles", Paros (Greece), September 22-26, *invited communication*.

Posters:

Bakker, D.C.E, Watson, A.J., Nightingale, P.D., Law, C.S., Bozec, Y., Goldson, L., Messias, M-J., De Baar, H.J.W., Liddicoat, M. and Skjelvan, I. Inorganic carbon changes in two Southern Ocean iron release experiments: effects of iron, hydrography and meteorology. Poster at: The Role of the Southern Ocean in global processes: an Earth science system approach, 15 July 2003, Royal Society, London.

Bakker, D.C.E., P.W. Boyd, M.A. Charette, M.P. Gall, J.A. Hall, S.D. Nodder, K. Safi, R.J. Singleton, T.W. Trull, A.M. Waite, A.J. Watson, J. Zeldis, E.R. Abraham, C.S. Law and K. Tanneberger. A pelagic carbon budget for the Southern Ocean Iron enrichment Experiment (SOIREE), February 1999. Poster at: The Role of the Southern Ocean in global processes: an Earth science system approach, 15 July 2003, Royal Society, London.

Bakker, D.C.E, Watson, A.J., Nightingale, P.D., Law, C.S., Bozec, Y., Goldson, L., Messias, M-J., De Baar, H.J.W., Liddicoat, M. and Skjelvan, I. Inorganic carbon changes in two Southern Ocean iron release experiments: effects of iron, hydrography and meteorology. Poster at: Frontiers in Geochemical and Isotopic Cycles in the Ocean, 29-30 September 2003. Geological Society, Burlington House, London.

Bendtsen, J., and C. Heinze, 3. june 2003: Poster presentation the Danish Center for Scientific Computing seminar day, H. C. Oersted Laboratory, University of Copenhagen, "Modeling the global marine carbon cycle".

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

Gallinari, M., Ragueneau, O., DeMaster, D.J., Rickert, D., Hartnett, H., L. Corrin, and Thomas, C. Influence of seasonal deposition of phytodetritus on BSi dissolution properties in marine sediments. Potential effect on BSi preservation? AGU, Chapman Conference on "The Role of Diatom Production and Si Flux and Burial in the Regulation of Global Cycles", Paros (Greece), September 22-26, *Poster*.

Greenwood J. and Soetaert K. 1D Pelagic Modeling of Carbon Dioxide Geochemistry in the Open Ocean. Gordon Conference for Chemical Oceanography, USA, August 2003.

Moriceau, B., Garvey, M., Passow, U. and Ragueneau, O. Evidence of a low biogenic silica

dissolution rate in diatom aggregates. AGU, Chapman Conference on "The Role of Diatom Production and Si Flux and Burial in the Regulation of Global Cycles", Paros (Greece), September 22-26, *Poster*.

Activities for the public understanding of science

Bakker, D.C.E. Summer in the Southern Ocean. Presentation to the Norfolk Hill Walking Club, Norwich. 9 October 2003.

Visiting scientist:

Bendtsen, J., Visit to Max-Planck Institute for Meteorologie, Hamburg, 18 - 20 August 2003, on optimization of BOGCM1.

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

Proposal for NoE EUR-OCEANS EU FP6: Several ORFOIS PIs take part in this pending proposal, which will exploit ORFOIS results (data, models).

Proposal for CARBOOCEAN IP EU FP6: Several ORFOIS PIs contribute to this initiative for an integrated project which builds on current EU FP5 projects. Christoph Heinze and the Bjerknes Centre for Climate Research are coordinating the proposal.

Ocean Carbon Coordination Project (Maria Hood, IOC; Chris Sabine, USA): Contributions from ORFOIS scientists to data management, data collection, process studies and modeling.

Nicolas Dittert: IMBER (ex OCEANS), IGBP, coordinated by Julie Hall, cooperation in data management.

Olivier Ragueneau / Brivaëla Moriceau: Dissolution of aggregates, AWI/Bremerhaven, Dept. of Pelagic Ecosystems and Marine Carbon Fluxes, Uta Passow

Olivier Ragueneau / Brivaëla Moriceau: Dissolution of aggregates, University of Utrecht, Dept. of Earth Sciences / Geochemistry, Philippe van Cappellen

Olivier Ragueneau / Brivaëla Moriceau: joint degradation experiments on BSi and POC

- MEDFLUX @ State University of New York, Marine Sciences Research Center, Cindy Lee and Robert Armstrong
- University of Marseille, Laboratoire de Microbiologie Marine, Madeleine Goutx

Olivier Ragueneau / Morgane Gallinari: Si, C, N and Fe decoupling during grazing

- University of Marseille, G. Slawick
- Station Biologique de Vimereux, Dorothee Vincent
- Station Biologique de Roscoff, Stefane L'Helguen

P. Michalopoulos (partner 6):

Cooperation with the EU DANUBS project has been already established. In addition cooperation with the new EU project Si-Webs in the fields of TEM observations of biogenic silica and

laboratory kinetic experiments of biogenic silica conversion processes will be initialized in the next 6 months. During the last six months, a Si-Webs post doc (Dr. Massimo Presti) has been trained on reverse weathering processes and biogenic silica conversion processes on the samples collected and analyzed for ORFOIS.

Forthcoming: Bakker, D.C.E. (by invitation) Workshop on Ocean Surface pCO₂, data integration and database development. Sponsors: National Institute for Environmental Studies (NIES), International Ocean Carbon Coordination Project (IOCCP), and North Pacific Marine Science Organization (PICES) Working Group 17. 14-17 January 2004, Tsukuba, Japan.

Publications:

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: C. Field et al. SCOPE/GCP Rapid Assessment Project of the Carbon Cycle. Towards CO₂ stabilization: Issues, strategies and consequences. Special Issue, in press. Island Press.

Bakker, D.C.E., P.W. Boyd, M.A. Charette, J.A. Hall, S.D. Nodder, K. Safi, R.J. Singleton, T.W. Trull, A.M. Waite, A.J. Watson, J. Zeldis, E.R. Abraham, C.S. Law, and K. Tanneberger (2004) A Pelagic Carbon Budget for the Southern Ocean Iron RElease Experiment (SOIREE), February 1999. In revision after initial submission to Deep-Sea Research.

Bakker, D.C.E., Y. Bozec, P.D. Nightingale, L.E. Goldson, M.J. Messias, H.J.W. de Baar, R. Bellerby, C.S. Law, V. Strass, and A.J. Watson (2004) Storms influence inorganic carbon changes upon iron fertilisation in the Southern Ocean - Results from SOIREE and EisenEx. In preparation.

Rangama, Y., J. Boutin, J. Etcheto, L. Merlivat, T. Takahashi, B. Delille, M. Frankignoulle, and D.C.E. Bakker (2004) Variability of net air-sea CO₂ flux inferred from in situ and satellite measurements in the Southern Ocean south of Tasmania and New Zealand. In preparation.

Bozec, Y., D.C.E. Bakker, C. Hartmann, R.G.J. Bellerby, P.D. Nightingale, U. Riebesell, A.J. Watson, and H.J.W. de Baar (2004). The CO₂ system in a Redfield context during an iron enrichment experiment in the Southern Ocean. In revision after initial submission to Marine Chemistry, Special Issue.

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

Dixit, S., Gallinari, M., Van Cappellen, P. and Ragueneau O. What controls opal preservation in marine sediments? *Global Biogeochemical Cycles*, in prep.

Gallinari, M., Ragueneau, O., Corrin, L., DeMaster, D.J. et Tréguer, P. (2002). The importance of water column processes on the dissolution kinetics of biogenic silica in deep-sea sediments. I. Solubility. *Geochimica et Cosmochimica Acta*, 66 (15): 2701-2717.

Gallinari, M., Ragueneau, O., DeMaster, D.J., Rickert, D., Hartnett, H. and Thomas C. Influence of seasonal phytodetritus deposition on biogenic silica dissolution properties in marine sediments – Potential effect on preservation. Deep-Sea Research, submitted.

Gehlen, M., F. C. Bassinot, L. Chou and D. McCorkle (submitted). Reassessing the dissolution of marine carbonates : I. Solubility. *Geochimica Cosmochimica Acta*.

Heinze C, in prep., The marine silicon cycle on long time scales, manuscript for SCOPE book on global marine Si cycle (edited by V. Ittekkot, ZMT Bremen)

Leynaert A., Bucciarelli E., Claquin P., Dugdale R.C., Martin-Jézéquel, V., Pondaven P., Ragueneau O. Effect of iron deficiency on diatom cell size and silicic acid uptake kinetics. *Limnology and Oceanography*, in press.

Middelburg, JJ and K. Soetaert, 2004. The role of sediments in shelf ecosystem dynamics. In: *The Sea*, Vol.13 chapter 12

Moriceau, B., Garvey, M., Passow, U., Van Cappellen, P. and Ragueneau, O. Reduced biogenic silica dissolution rates in diatom aggregates. *Marine Ecology Progress Series*, In prep.

Ragueneau, O., Dittert, N., Corrin, L., Tréguer, P. et Pondaven, P. (2002). Si:C decoupling in the world ocean: is the Southern Ocean different ? *Deep-Sea Research II*, 49 (16): 3127-3154.

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, and J. Tschirley (2003) Interactions between CO₂ stabilisation pathways and requirements for a sustainable earth system. In: C. Field et al. SCOPE-GCP Rapid Assessment of the Carbon Cycle. Towards CO₂ stabilization: Issues, strategies and consequences. Special Issue, in press. Island Press.

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

Tréguer P, Legendre L, Rivkin RT, Ragueneau O, Dittert N (2003) Water column biogeochemistry below the euphotic zone. In: Fasham MJR (Ed.) *Ocean biogeochemistry: a synthesis of the Joint Global Ocean Flux Study (JGOFS)*: 145-156.

Updated version of "Participants Information" - Table:

<i>No.</i>	<i>Institution</i>	<i>Address</i>	<i>PI name</i>	<i>Phone/fax</i>	<i>email</i>
	Workplace of coordinator, University of Bergen, Geophysical Institute, Bjerknes Centre for Climate Research	Allégaten 70, N-5007 Bergen, Norway	Dr. Christoph Heinze Prof. for Global Carbon Cycle Modelling	P +47 5558 9844 F +47 5558 9883	heinze@gfi.uib.no
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	job@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@lscce.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	P +44 1603 592648 F +44 1603 591327	D.Bakker@uea.ac.uk

Table: Personnel working in ORFOIS.

<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>
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	Benoît Thiebault	Chem. engineer	100	June 17, 2002	June 16, 2003
2	Nadia Emprin	Post doc	100	Nov 12, 2002	Jan 11, 2004
2	Karima Khalil	Post doc	100	Feb 18, 2003	Nov 30, 2004
2	Anne Cozic	Comp. Engineer	100	Jan 6, 2003	Oct 5, 2004
2	Morgane Gallinari	Post doc	100	Jul 1, 2003	Dec 31, 2003
2	Gwenaëlle Phillipon	Student Trainee	100	Sep 29, 2003	Nov 2, 2003
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	Post doc	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	-	Apr 1, 2003	-
4	Joachim Segschneider	Senior Scientist	50	(Jan 1, 2004)	-
5	Richard S. J. Tol	Professor	-	-	-
6	Panagiotis Michalopoulos	Scientist	85	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	7	Jun 1, 2002	-
6	Kampourie Georgia	Technician	40	Jun 1, 2002	-
6	Kanellopoulos Theodoros	Res. Associate	68	Mar 1, 2003	Aug 31, 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	-	-	-
8	Dorothee Bakker	Sen. Res. Assoc.	100	Jan 1, 2002	-
8	Andy Watson	Professor	-	-	-

Bergen, January 11, 2004

.....
(Christoph Heinze)