Work Package I

Temporal evolution of surface production and fate of organic matter

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Introduction

WP I had a most productive 12-24 months period. The most important event was the successful, highly integrated and efficient cruise *CD114*, despite of the lack of sufficient berths. *CD114* prepared the base for probably the most complete and balanced data set of an upwelling situation on a shelf, firmly guided and supported by remote sensing temperature and chlorophyll imagery. Processes both in a filament developing off the shelf edge as well as on the shelf were investigated. Due to the lack of space on board not all partners were able to partake with the desirable number of participants and some activity was moved to the WP II cruise with RV *Prof. Shtokman*. But all together most of the goals for the upwelling cruise were obtained by WP I participants although a few mitigations were necessary due to the limited space on board.

The period following *CD114* was intensely applied to work up and make available the wealth of data derived during the cruise. Almost all data from *CD114* have been worked up. WP I members participated in several workshops (see below), some of them where modelling work was the focus. Most of the WP I participants took place in the OMEX workshop in Plymouth and WP I results were significant for the discussions for the cross-work package theme sessions.
The management report follows the structure of the Technical Annex objectives. The most important, summarising statement of the subsequent management report is as follows: **virtually all deliverables at month 24 have been met and considerable progress made towards future deliverables.**

Personnel

J. F. Kjeld from RISØ finished his Ph.D. and left the project. H. E. Jørgensen has stepped in instead. C. Wexels-Riser from UITØ has been employed since August 1998 by UITØ-a. Kalle Olli was employed from July to September 1998 by UITØ-a. M. E. Inall left the UWB on 2nd Oct. 1998 to take up employment with the Highlands and Islands University Project at Oban. However, he is still working for OMEX, although in a reduced capacity, concentrating on turbulence measurements on the shelf. Turbulence measurements in the filament were conducted by R. Torres, who is working for UWB-a, with T. Sherwin providing additional support to both activities.

Workshops

WP I participants have been rather active to interact and were involved in many workshops. WP I had 2 specific meetings devoted to modelling in Trondheim: 9-10 July 1998 and 18-21 February 1999. The WP I modellers participated also at a specific cross OMEX WP modelling workshop in Galway 29-30 November 1998. UWB hosted a physics group meeting at Menai Bridge 24-25 November 1998. Most WP I participants partook at the Plymouth 25-27 March 1999.

Missing ship time and changes in the Technical Annex

Although much progress has been made, the lack of ship time for a downwelling cruise created some problems, which were discussed intensively by the various WP I participants, also in concert during the Trondheim meeting in February 1999. It was decided that written statements from each WP I partner should be submitted to UITØ-a in order to clarify the implications of lacking ship time for the progress of the work of each specific partner. The 13 answers fell into 4 categories:

• Some of the WP I participants, such as SINTEF, IST, NSS-NERC and RISØ were not constrained by the lack of ship time.
• UWB offered only basic CTD support for the downwelling cruise, as most of their work was intended to be carried out during the upwelling cruise. Their deliverables are thus almost not influenced by a lacking winter cruise.
• ULg, PML-a, PML-b, PML-c, UAL, IIM and SAHFOS participated separately in various winter cruises in order to compensate for the lacking downwelling samples. The statements of these partners imply that they independently have lived up to the demands of the Technical Annex. Thus every now and then reference is made to non-WP I cruises in the present management report.
• UITØ-a and UITØ-b suggested additional deliverables in their written statements regarding the Technical Annex to compensate for the lacking downwelling or winter cruise. See their scientific 12-24 months report for these new specific deliverables.

Despite of the unfortunate lack of ship time, which is a consequence of lacking ship support by member states or lack of financial support for some surprisingly low additional cost from MAST, not an inactive attitude of the WP I participants, most WP I partners, except UITø-a, UITø-b and SAHFOS, have successfully compensated for the unfortunate lack of opportunity to live up in the best possible manner to the original plans. With the great scientific success of *CD114* and the following work-up of the data, significant progress can be made, although an equivalent downwelling cruise was not carried out in concert.

A revision of the technical annex involving UITø-a, UITø-b and SAHFOS is in progress and is being currently reviewed by the Coordination Office.

Future activities and publication of results
Following intense discussions regarding the future activities in WP I, in particular with regard to presentations, publications and integrative measures such as modelling, a decision was made to plan a series of publications in a specific WP I volume, based primarily on the unique *CD114* data set. A principle number of potential publications has been suggested (see appendix). The final number will probably be reduced when overlapping data sets will find a well-balanced representation in publishable manuscripts. It was decided that manuscripts should be written during the autumn period. The various authors mentioned in the appendix will stay in close contact to each other in order to find approved co-operative forms for the manuscripts under the dedicated leadership of UITØ-a. A new WP I meeting has been scheduled for 27-29 January 2000 at the Instituto de Ciències del Mar in Barcelona where all WP I participants will stay at the Consejo Superior de Investigaciones Científicas residence. At this meeting the various manuscripts and results will be presented. Written outlines will be asked for distribution among participants. Final changes and amendments will be taken care of at the end of January. Steps will be taken to discuss the deadline for manuscript submitting which will be approximately around the final OMEX Workshop / Liège Colloquium period. The final reports will be based upon the publications and additional presentations of data sets, which did not fit into them. Thus by the end of the OMEX II-II period an entire volume of WP I manuscripts will be submitted.

WP I has been approached by NIOO partner K. Soetaert and P. Herman with the wish to co-operate. NIOO wishes to apply an ecological model to the two Lagrangian experiments of *CD114*. NIOO is very welcome to join forces with WP I participants. The necessary data for the modelling work will be taken directly from BODC and messages will be sent to WP I members to supply BODC as fast as possible with all *CD114* data, in case not done already. While SINTEF continues to model the physical, chemical and biological oceanography in the OMEX region 3-D, NIOO will model the Lagrangian drift. This combination has found enthusiastic support by SINTEF and UITØ-a. The contribution of NIOO will be of momentous significance for an in-depth interpretation of the WP I´s strongest outcome, the *CD114* data set. WP I data will now be interpreted through a multitude of modelling exercises, which give the original plans more depth and stamina.

UITØ-a will approach journals in order to get an acceptance for a specific volume. So far 3 journals have been discussed: *Progress in Oceanography, Journal of Marine Systems* and *Sarsia*. Several participants argued to go for a journal that had the highest citation frequency. The final choice will take care of this demand, but a multitude of aspects, among those editing procedures, speediness of publication, volume size, a general permission to submit a volume and the criteria of citation frequency must be carefully evaluated in months to come. The basic editing will be carried out by P. Wassmann as part of additional deliveries compensating for the lack of the downwelling cruise. The work will be carried out in concert with P. Herman.

Task I.1 On-, off- and along-shelf transport of water, filament transport and turbulence
Partners: UWB (06a) responsible, UWB (06b), NSS (09)
Objectives:

(a) To measure the net transport associated with an upwelling filament
The description of the 3-D structure of the 42°N upwelling filament was the major component. This was completed during the *CD114* cruise fulfilling our original objectives, like determination of the 3-D structure and flow regime of the filament, its net transport, mixing and Lagrangian observations within the filament structure. Participated in two cruises, one in summer (*CD114*) and one in winter (*Meteor M43/2*) therefore completing our commitments in terms of the observational tasks
Deliverables have been met.

(b) To measure turbulent dissipation in the upper 250 m and quantify vertical mixing
Deliverables have been completed with exception that the *CD114* data have yet to be sent to BODC, although the raw data will be banked by the end of June, as required.
Deliverables have been met.

(c) Continuous data processing of AVHRR and SeaWiFS data for observation of upwelling episodes, filaments, fronts, eddies and currents and surface phytoplankton pigment concentrations.
Processed daily satellite images of SST and chlorophyll, and weekly and monthly SST composites. Disseminated all data to OMEX partners via web site.
Deliverables have been met,

(d) Support ships at sea with near-real time remote sensing images from AVHRR and SeaWiFS.
Disseminated all data to OMEX partners via web site.
Deliverables have been met,

(e) Analysis of archived Coastal Zone Colour Scanner data
Processed daily satellite images of SST and chlorophyll, and weekly and monthly SST composites. Disseminated all data to OMEX partners via web site.
Deliverables have been met

(f) Detection, classification and statistical analysis of surface temperature and ocean colour phenomena
To be approached in the final year.

(g) Analysis of Synthetic Aperture Radar imagery from ERS-1/2
SAR data were supplied during this cruise to locate the internal waves for investigation and comparison with measurements using the FLY turbulence probe.
Deliverables have been met

Task I.2 Inorganic carbon biogeochemistry and atmospheric CO_2 uptake and release
Partners: ULg (22) responsible, RISØ (10), SINTEF (18)
Objectives:

(a) To understand the inorganic carbon dynamics and identify sources/sinks for atmospheric CO_2
Surface mapping of dissolved pCO_2, atmospheric pCO_2, pH and dissolved oxygen was accomplished during the *CD114a* and *b* cruise. Vertical profiles of pH, Total Alkalinity and AOU were carried out at 33 stations and Niskin sampling at 229 depths. Data is processed and banked at BODC. Discussions with SINTEF, IST, NIOO and RISØ concerning modelling aspects of subsurface pCO_2 distribution and air-sea exchange of CO_2 across the air-sea interface at daily and seasonal time scales.
Deliverables have been met

(b) To convert measured pCO_2 values to air-sea fluxes.
Theoretical work has been carried out in order to calculate the exchange of CO_2 between air and sea. A basis to model air-sea fluxes of especially CO_2 has been created.
Deliverables have been met

(c) To establish a coupled hydro-biological model.
This work will be carried out in the forthcoming year.
In progress

Task I.3 Nutrient dynamics, primary production, biomass and phytoplankton
Partners: IIM (13) responsible, PML (04a and 04c), UITØ (03a).
Objectives:

(a) To determine the nutrient availability in the surface layer during a Lagrangian experiment
Analysis of 5 nutrients (NO_3, NO_2, NH_4, PO_4 and Si) on frozen samples has been done during the *CD114a* and the data have been submitted to BODC.
IIM investigated other opportunities to participate on downwelling cruises of WP II, in order to fulfil the requirements of the WP I Technical Annex. IIM participated in two WP II cruises: on *CD110* from 5 to 16 January 1998.
Deliverables have been met

(b) To determine the utilisation of nitrate, ammonia, phosphate and silicate by phytoplankton assemblages and to estimate new production,
Analysis of samples from cruise *CD114* by PML-c is complete. Calculations mostly ready, but still going on.
Deliverables have been met

(c) To assess the importance of nitrification and ammonia regeneration
Analysis of samples from cruise *CD114* by PML-c is complete. Calculations mostly ready, but still going on.
Deliverables have been met

(d) To evaluate the role of the short-time phytoplankton species succession and the corresponding suspended organic matter concentrations on primary production.
Phytoplankton counts of samples taken during *CD114a* are already finished and the data have been submitted to BODC. Phytoplankton abundance from *CD114b* is currently being analysed by microscopy. POC, PON, DOC and DON samples from *CD114a* and *b* were analysed and submitted to BODC.
Deliverables have basically been met. A few delays.

(e) To characterise the photosynthetic response of phytoplankton as a function of underwater light field, nutrient availability and phytoplankton composition.
Spectral light profiles, absorption spectra of phytoplankton, detritus and total particles from *CD114a* have been determined and the data already submitted to BODC. Photosynthetic parameters, integrated primary production and phytoplankton carbon-specific growth rates have been determined and submitted to BODC.
Deliverables have been met
(f) to estimate the short time scale variability on primary production and phytoplankton growth rates as induced by upwelling
Analysis of samples from cruise *CD114* by PML-c is complete. Calculations mostly ready, but still going on.
Deliverables have been met

(g) to estimate what is the importance of dissolved organic carbon on the total carbon budget during exchange processes.
Analysis of samples from cruise *CD114* by IIM is complete.
Deliverables have been met

(h) To investigate the fluxes of chlorophyll and carotenoid pigment distribution, production, sedimentation and degradation across the NW Iberian shelf
Analysis of samples from cruise *CD114* is complete (PML-a). Chlorophyll *a* and phaeopigment vertical flux data delivered.

(i) Undertake surface pigment and mapping for ground truthing remotely sensed ocean colour satellite data.
Data delivered.

Task I.4 Zooplankton and microbial cycling
Partners: PML (04b) responsible, UAL (14a), UITØ (03b), SAHFOS (12), SINTEF (18)
Objectives:

(a) To estimate bacterial biomass, production, respiration and growth during short-term Lagrangian experiments.
Bacterial abundance, biomass, production and respiration were determined during *CD114*. A total of 105 and 66 samples were collected during Leg a and b, respectively. Due to shortage of berths it was not possible to set up large bottle experiments to evaluate bacterial growth efficiency and bacterivory. However, these experiments were performed on board a simultaneous WP II cruise.
Bacterial abundance, mean cell volume, frequency of dividing cells and bacterial biomass were determined. Microscopic analysis is still in progress. Bacterial growth efficiency was determined on board *Prof. Stockman* cruise (August 1998) with sub-surface water from four different stations The relationship between biomass increment and DOC uptake will provide estimates of bacterial growth efficiency.
Bacterial production was evaluated with the addition of saturating concentrations of ^{14}C leucine followed by incubation in a water bath at 15 ± 1°C. The effect of incubation time (2-4 h) was tested at several stations. An intercalibration exercise using ^{3}H-thymidine (I. Joint) and ^{14}C-leucine (A. Barbosa) was performed. Final filtration and/or scintillation counting of samples were undertaken in IIM and UAlg laboratories. Bacterial respiration was based on the recovery of $^{14}CO_2$ produced after additions of ^{14}C-leucine. Investigation of the fraction of respired leucine in relation to total bacterial respiration is currently being evaluated with simultaneous use of micro-electrodes and ^{14}C-leucine respiration in water samples from different marine systems.
Deliverables have basically been met. A few delays

(b) To quantify the role of bacteria and grazing on bacteria for the carbon flux on temporal and regional scales.
Bacterivory by nano-protists was evaluated. Grazing rates will be calculated as the difference between bacterial specific growth rate (<0.8 µm) and bacterial apparent growth rate (<10 µm). The growth rate of aplastidic flagellates was determined in the <10 µm fraction. DOC analysis will be performed by PML and are still in progress. Most of this work will be carried out in the forthcoming period.
Deliverables have basically been met. A few delays.

(c) To experimentally quantify the trophic impact of microzooplankton grazing on phytoplankton using short term shipboard experiments.
12 grazing experiments were carried out. Preliminary regression analysis of grazing data has been completed but increases in the relative density of grazers during the experimental incubations have meant that further microscopical analyses have to be carried out before we can be sure that the data will not change. Hence there will be a delay of 1-2 months in sending this data set to BODC.
Deliverables have basically been met. Some delay

(d) To quantify microzooplankton distribution and standing stocks associated with Lagrangian drift experiments
Microzooplankton samples (both Lugols and glutaraldehyde slide preparations) have been collected from 13 CTD vertical profiles. Analysis of all heterotrophic nanoflagellate (HNAN) slide preparations is complete. Information on abundance and biomass of HNAN will be deposited with BODC by the end of July. Analysis of Lugols fixed samples for microzooplankton biomass and abundance has been completed for all surface samples (5 and 10 m).
In light of the fact that there has not been a second WP I cruise we have participated in a WP II cruise (*Poseidon P237/1*) in March 1998 and carried out WP I activities (as reported in previous management report). In addition, because further microscopical analyses have been necessary for interpretation of *CD114* grazing data further information such as specific growth rates and gross growth efficiencies of microzooplankton will be generated.
Deliverables have been met.

(e) To quantify the copepod community in terms of biomass and standing stock during short-term Lagrangian experiments
Mesozooplankton species and size category distribution during *CD114* was investigated. Mesozooplankton was collected with a WP-2 plankton net, approximately every six hours. For *CD114a*, 3 integrated hauls were made at each station (bottom-surface, 100 m - surface and 50 m - surface) in order to assess the vertical distribution of the copepods. For *CD114b* (filament), one integrated haul was made at each station (200 m - surface). Due to problems with the cable, the MOCNESS could not be applied during this cruise. Thus the intensity of sampling had to be reduced.
Deliverables have been met.

(f) To quantify the role of mesozooplankton grazing for the carbon flux both on temporal and regional scales.
Experimental procedures for grazing studies were completed prior to *CD114b*. Mesozooplankton grazing rates of different size categories of mesozooplankton obtained and analysed. Grazing model concept delivered to modellers. There is an overlap between WP I and WP II deliverables with regard to grazing which is difficult to assess from the WP I point of view only.
Deliverables have basically been met.

(g) Collect CPR samples each month on and off the Iberian shelf and analyse for phyto- and zoo-plankton species abundance.
From May 1997 to May 1999 there have been 24 tows, of which 3 have not produced data owing to bad weather or mechanical failure. Analysis of plankton species is in hand and data to the end of July 1998

have been banked at BODC. Analysis is complete for the remainder of the 1998 samples, they are undergoing quality control and will be transferred to BODC imminently.
Deliverables have been met

(h) Derive mesozooplankton biomass and grazing rates from CPR samples
Samples have been obtained from several cruises to derive biomass values. Further measurements have been made in year 2, conversion of CPR abundances and estimates of grazing will be produced in year 3.
Deliverables have been met. In progress

(i) Experimentally determine mesozooplankton grazing of microzooplankton.
Six experiments were successfully carried out on *CD114* to determine the mesozooplankton grazing of microzooplankton. The results have been banked with BODC. An allometric relationship between copepod size and ingestion rate has been calculated and copepod community grazing has been estimated from samples obtained by UITØ-b. The heterotrophic nanoplankton have also been enumerated from the experiments carried out on *CD114*. This is in addition to the experiments originally planned and will allow us to determine whether or not these are a contributor to the diet of copepods. Work to be carried out in year 3 includes the examination of inter-specific grazing rates for the small copepods to enhance the description of copepod community grazing rates. The measured rates will also be applied to meso- and microzooplankton standing stocks determined on other cruises throughout the upwelling/down welling seasons to compensate for the absence of a second WP I cruise.
Deliverables have been met. In progress

Task I.5 Suspended matter, aggregation potential, faecal pellet production and vertical flux
Partners: UITØ (03a) responsible, IIM (13), PML (04a and 04b), UITØ (03b), SINTEF (18)
Objectives:

(a) Estimate the short-term vertical flux of organic matter and phytoplankton during the Lagrangian experiments and compare these with the suspended standing stock of organic matter and phytoplankton.
Vertical export was investigated *CD114* during short term exposure (24 hours) of drifting sediment traps at 30, 40 and 50 m (4 times on Leg a) and 30, 40, 50, 60, 90, 120, 150 and 200 m (6 times on Leg b). Pigments, POC, PON, pico-, nano- and microplankton (PNM) carbon and faecal pellet (FP) were analysed in the 60 samples. FPC and PNMC were calculated applying volume:carbon conversion factors. Comparison with the suspended standing stock of organic matter and phytoplankton will be carried out in the forthcoming period. Data ready, but not sent to BODC as yet.
Deliverables have basically been met.

(b) Describe and quantify the spatial and temporal distribution of the zooplankton faecal pellet production with the goal to determine their role in material cycling and evaluate the role of zooplankton grazing and flux mediation
The suspended biovolume of various categories faecal pellets (FP) was estimated at 9 station and 3-8 depths on both legs. The suspended FP data were analysed. The FP production rate for the larger and dominating mesozooplankton species was quantified in specific defecation chambers on *CD114b* and partly analysed. Due to time consuming microscopical work, which first of all was used for the analysis of (a), some samples till need to be analysed, followed by a calculation of FP production rates and submitting to BODC.
Deliverables have basically been met. A few delays

(c) Estimate the amount of transparent exopolymeric particles (TEP) in the water column and the sediment traps; compare TEP concentrations with diatom distribution and vertical flux of phytoplankton cells and POC.

TEP in the water column and the sediment traps was quantified on both *CD114a* and *b*. A study of the composition, size and configuration of sedimented aggregates inside sediment traps by exposure of acrylamid dishes was not carried out due to the limited number of berths on board of *CD114*. TEP samples were analysed, but are not yet calculated and plotted.
Deliverables have basically been met. A few delays

(d) Evaluate the role of the short-time phytoplankton species succession and the corresponding suspended organic matter concentrations on primary production and on vertical flux of carbon
To be evaluated in the forthcoming period

(e) Validate the physical and biological model of the Iberian margin on the basis of available and new data of nutrients, phyto- and zoo-plankton and vertical flux of organic matter.
Input with regard to vertical export algorithms to SINTEF. Model description and results from the first primary production, zooplankton and vertical flux test runs. To be primarily carried out in the forthcoming period.
Deliverables have been met. In progress.

Task I.6 Two-way nested submodel, Lagrangian particle-tracking and ecological model
Partners: IST (11) responsible, SINTEF (18), UWB (06a and 06b), NSS (09)
Objectives:

(a) Development of a nested 3-D model allowing a resolution of the order of 1 km for the Galician area
The work carried out has been submitted to SINTEF and joint discussion has been carried out to solve the border conditions for 3-D and nested models. Results have been presented to WP I and OMEX audience.
Deliverables have been met.

(b) Development of particle-tracking model and its use in conjunction with an ecological model in order to obtain a Lagrangian ecological formulation.

A Lagrangian particle-tracking model was coupled to the hydrodynamic model and run for summer months. Particles to be tracked can have a large number of properties (*e.g.*, water volume, concentrations of ammonia, nitrate and phytoplankton). During the second year of OMEX a non-dimensional biochemical model was coupled to the particle-tracking model using a OMEX I-developed prototype interface. The system of coupled models (hydrodynamic, particle tracking and ecological) was run for summer months.
In the near future, comparison of model results with available *in situ* data will make it possible to assess the accuracy of the model. After the "validation" phase, estimations of material export by filaments will be undertaken.
Deliverables are well on track.

Task I.7 Three-D nested model for the Galician shelf: ecological response and interannual variation in the carbon export
Partners: SINTEF (18) responsible, IST (11), UITØ (03a and 03b), PML (04a and 04b), IIM (13), NSS (09), SAHFOS (12).
Objectives:

(a) Implement the existing SINTEF nested 3-D model in order to (*i*) establish a coupled hydro-biological model early in the project period, (*ii*) investigate, in co-operation with IST, the optimal way to establish the coupling between the hydrodynamical and the ecological models.

Decisions on which coupling strategy to follow in order to make the most efficient biophysical coupling. It was found that a spatial resolution of 2 to 3 km was sufficient to produce realistic filament structures. This has been confirmed during the simulations from SINTEF. The nesting technique using fixed nested boundary limits will be used in this project. The 3-D nested, biophysical model was established. First results from the 3-D ecological model discussed in relation to available data. Model description and results from first primary production, zooplankton and vertical flux test runs.
Deliverables have been met.

(b) Simulate response of the ecosystem as a consequence of wind events for the periods when data becomes available
First runs of the hydrodynamical model indicate clearly how wind influences the current regime in the region. Implementing the wind field during *CD114* produced a filament at the site were it was found during the cruise. The data were shown in public during a recent OMEX meeting in Plymouth.
Deliverables have been met.

(c) Calculate possible variations in carbon export due to annual variation on wind forcing.
To be carried out in the forthcoming year

(d) Establish a mathematical model for meso-zooplankton in the Galician shelf area that can be used in as well as large scale as nested ecosystem models.
Model description and first results from the primary production, zooplankton and vertical flux tests
Deliverables have been met.

Tentative titles for a separate volume derived from WP I

"Surface production and fate of organic matter during upwelling and relaxation"

Applying Lagrangian observations on the shelf and in upwelling filament off the NW coast of Galicia

1. Introduction (Wassmann)

2. Surface production and fate of organic matter during upwelling and relaxation on the shelf off Galicia: a general overview over the field investigation (Joint)

3. Remote sensing and surface pigments (Groom, Smith, Cummings...)

4. Structure, mixing and Lagrangian observations of an upwelling filament off Galicia (Torres-Almarza, Barton)

5. Primary production (Joint, Figueiras etc.)

6. Nutrients and new production (Rees, Woodward and Joint)

7. Remote sensing of primary and new production (Groom, Joint, Rees, Figueiras...)

8. Air-Sea flux of CO_2 (Borges, Frankignoulle...)

9. C/N stoechiometry of different C and N pool (Joint, Salgado...)

10. Phytoplankton, suspended biomass and composition of different carbon pools (Salgado, Figueiras...)

11. Bacterial biomass and bacterial production (Galvão, Barbosa)

12. The herbivorous impact of microzooplankton during two short drift experiments off the NW coast of Galicia (Fileman, Burkill)

13. The contribution of microzooplankton to the mesozooplankton diet in an upwelling filament off Galicia (Batten, Fileman...)

14. Diet and feeding rates of mesozooplankton in an upwelled filament off Galicia (Halvorsen, Hirst and Batten)

15. A stage-structured cohort model for *Acartia clausii*: a high resolution temporal and spatial grazing model for the Galician shelf (Pedersen, Slagstad, Halvorsen and Tande)

16. Vertical export of biogenic matter and mesozooplankton faecal pellet production off the NW coast of Galicia (Wexels-Riser, Wassmann, Olli, Ratkova and Arashkevich)

17. Modelling of the carbon and nitrogen dynamics during a Lagrangian experiment off the NW coast of Galicia (Herman, Soetaert, Slagstad)

18. Seasonal dynamics of carbon flux off the NW coast of Galicia: a model approach (Slagstad, Wassmann, Herman)

19. Temporal evolution of surface production and fate of organic matter during upwelling and relaxation on the shelf off Galicia: a synthesis. (Wassmann)