PROXIES AND NUMERICAL TOOLS FOR ASSESSING ORGANIC CARBON EXPORT FLUX AND DEEP OCEAN PROCESSING

Concerted Actions proposal

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1. What we learned from GOA I (2001-2006)

The subject of GOA I was to contribute to a better understanding of the functioning of the biological carbon pump and of the reprocessing of organic carbon in the subsurface ocean. More specifically, the objectives of the research project were set out to address the following questions:

- What are the relationships between new and export productions?
- How does the carbon flux, determined using the ^{15}N isotope techniques and the Ba proxy, relate to export production?
- What are the advantages, problems, uncertainties (and their magnitudes) on the above methods?
- If they differ, what are the main causes of discrepancy and how can they be resolved?

In pursuit of its goal, GOA I was structured around four research themes, each addressing a number of specific issues. The strategy applied relied on the use of different, proxies of carbon processing, rather than focussing directly on carbon itself. Well selected proxies can be particularly useful since they are more sensitive than the target process or element itself. A drawback, however, often resides in converting the proxy information into accurate carbon terms.

Underway we implemented one further method for assessing carbon export, namely the 234-Th deficit method, and compared its outcome with those obtained via the other proxies mentioned above.

An overview of the ANCH publications related to these key issues is available in section 8.1. The main outcomes to date are the following:

1.1. Theme 1: Compilation of existing data and data acquisition

We have collected and are still collecting information such as relevant literature on the GOA theme. This bibliography, as well as other GOA materials, data and individual publications can be found on our Web site at http://homepages.vub.ac.be/~adebrauw/GOA/.

We first elaborated an archiving and extraction system for data from previous programmes and cruises in which the ANCH group participated. The Ocean Margin Exchange project OMEX (Marine Science and Technology EU programme) was an intensive measurement and modelling study of the exchanges of matter and energy across the ocean margin — the interface between the open Atlantic Ocean and the European continental shelf. The OMEX fieldwork was undertaken along the northwest European shelf break (OMEX I 1993 – 1995) and at the northwest Iberian margin (OMEX II 1997 – 1999). It has a unique database available at http://www.bodc.ac.uk/projects/european/omex/.

Subsequently we participated in several Southern Ocean expeditions in the framework of Federal Science Policy programmes SPSD I and II: 1/ the SAZ'98 cruise (Jan-Mar 1998)

to the Subantarctic Zone and Polar Front Zone at 142-145°E, south of Tasmania; 2/ the ANTARES 4 cruise (Jan.-Feb. 1999) to the Crozet-Kerguelen Basin; 3/ the CLIVAR-SR3 cruise (Nov-Dec 2001), covering the whole Southern Ocean basin and the major frontal systems between Tasmania and Antarctica. All GOA-relevant publications issuing from these studies are listed in section 8.1.

Furthermore, recently accomplished cruises continue to generate results which are progressively transferred and stored in the GOA database. Between 2001 and 2005, ANCH members participated to the following expeditions:

- EIFEX (Jan – Mar 2004): (http://www.awi-bremerhaven.de/AWI/Presse/PM/_pm04-1.hj/040402EIFEX-e.html). The large-scale experiment EIFEX (European Iron Fertilisation Experiment) was conducted in the Antarctic Circumpolar Current to find out the effect of Fe fertilization on the fate of organic matter produced by algae. More specifically, the objective was to find out whether plankton material is converted back into the greenhouse gas carbon dioxide in the surface layer or whether a substantial portion sinks out to the deep ocean which would mean long-term removal of carbon dioxide from the atmosphere.
- VERTIGO I Station ALOHA, Hawaii (Jun-Jul 2004). (http://www.whoi.edu/science/MCG/cafethorium/website/cruises/vertigo.html). The investigation area, north of the island of Oahu is the location of the U.S. Hawaii Ocean Time-series (HOT) program, which has been operating for the past 16 years. The focus was on physical and biogeochemical processes affecting carbon export from the mixed layer and its mineralization in the mesopelagic (also called twilight) zone.
- KEOPS (Jan – Feb 2005): (http://www.obs-vlfr.fr/proof/vt/op/ec/keops/keo_obj.htm and http://www.insu.cnrs.fr/web/article/art.php?art=1325). The general objective of KEOPS was to better understand the response of the Southern Ocean to the global climate change. Particularly, KEOPS studied the effect of natural iron fertilisation of the ocean by the Kerguelen plateau on the biological pump of CO_2 and on the cycles of other chemical compounds relevant for climate.
- VERTIGO II Northeast Pacific Station "K2" area (Jul-Aug 2005). (http://www.whoi.edu/science/MCG/cafethorium/website/cruises/vertigo_K2overview.html).The investigation area was in the cold and nutrient rich waters of the NW Pacific, a region where particle fluxes out of the surface ocean are thought to be among the World's highest. A site called "K2" has been chosen for the second VERTIGO research expedition, since this is where the Japanese already maintain deep ocean sediment traps which capture sinking particles below the twilight zone. At "K2" the High Latitude Time Series (HILATS) Observatory program has been in place since 2001. As for VERTIGO I, focus was on physical and biogeochemical processes affecting carbon export from the mixed layer and its mineralization in the twilight zone.

1.2. Theme 2: Uncertainty and variability in new production as assessed with ^{15}N incubation experiments

The concept of new production is one of the cornerstones of biogeogemistry since it constrains both the sustainable exploitation of marine resources and the role of the oceans in the regulation of excess anthropogenic CO_2 accumulation in the atmosphere. New production is merely defined as the portion of primary production driven by externally supplied nutrients. The resulting ratio of new to total primary production is called the *f* ratio. The determination of ^{15}N nitrogen uptake enables the separation of new from regenerated production – i.e. of primary production sustained by nitrate and N_2 from that sustained by regenerated N-nutrients such as ammonium and amino acids (Dugdale and Goering 1967). Assuming a steady state nutrient budget for the upper ocean and an absence of nitrate regeneration in the euphotic zone, Eppley and Peterson (1979) have linked new production to export production via the use of *f* ratio. Although the concept of *f* ratio is simple, its estimation can be rather complicated and has been controversial (Bronk et al., 1994). Hence new production should be considered as "exportable production" rather than "export production" (Sambrotto and Mace, 2000)

We have improved models and protocols to get more reliable data on new production rates. Our work started with a framework to classify types of uncertainty and variability in assessing new production. Uncertainty is divided in parameter uncertainty, model uncertainty and uncertainty due to choice of a given parameterization. Variability covers changing environmental conditions, i.e. eutrophic *versus* oligotrophic (spatial variability), or steady state *versus* non steady state (temporal variability) conditions. In other words, variability is due to differences in properties between different ecosystems.

Regarding modelling, substantial effort has been spent on: (1) parameter optimization (N uptake and remineralisation rates), (2) model accuracy (agreement between modelled data and observations), (3) model precision (random error propagation through calculations) and (4) model selection (selection of relevant parameters/processes in models of different complexity and choices of parameterization). We investigated the reliability of six increasingly complex models, for estimating flux rates between phytoplankton and dissolved N pools in aquatic ecosystems. The development of these models over the last 40 years reflects increasing realism in the pool and fluxes that constitute the N cycle. Our results show that the likelihood of model failures or biases depends on specific underlying assumptions, but generally increases with duration of the ^{15}N isotope dilution incubation experiments designed to assess N-uptake and release. Decreasing the exposure times is not necessarily the answer because of experimental uncertainties. In short incubation periods the impact of random errors may become overwhelming, especially when the calculation involves a difference. It follows that for a number of models, properties such as accuracy and precision cannot both be optimized under the same conditions, and a compromise must be struck. Nevertheless, these model comparisons do not solve the problem of statistical inference as they do not yield information on the reliability of the solutions. Oversimplified models risk bias when their underlying assumptions are violated, but overly complex models can misinterpret part of

the random noise as relevant processes. Therefore, none of the ^{15}N model solutions can a priori be rejected, but each should carefully be assessed with hypothesis testing. To address this issue, we developed a generic modelling approach based on mass balance differential equations. This approach is well known in chemical engineering and used the so called compartmental analysis. The model structure is categorized as stochastic and any variables in the model can be expressed by a probability distribution (Elskens et al., 2005). Model parameters are then estimated with a weighted least squares technique (de Brauwere et al. 2005a). A model selection strategy based on a statistical interpretation of the cost function (sum of the weighted least squares residual) was subsequently implemented in order to provide optimal solution subsets corresponding to a given data set. It is noted that the procedure improves the accuracy of the parameter values, making them less sensitive to outlying observations and delivers more reliable final model results (de Brauwere et al., 2005b).

When experimental data are used in calculations (e.g. calculation of uptake and remineralisation rates), the experimental uncertainties are transmitted to a greater or lesser extent into the calculated values. With help of Monte Carlo simulations, we investigated how random errors in a particular measured variable can be magnified or suppressed during model calculations. More specifically, we focused on the following questions: how should a reasonable average be calculated for censored samples (data below detection), and what would be a meaningful measure of the associated uncertainty? The influence of censored data was addressed by means of scenario analysis and case studies. In oligotrophic conditions, such as encountered at the ALOHA station off Hawaii, when nutrient concentrations are below the limit of detection (DL), ^{15}N tracer additions can dramatically exceed the ambient level and the abundance of the tracer cannot univocally be determined. There are robust statistical procedures that can assign numerical value for the mean and standard deviation of censored data (Berthouex and Brown, 1994). Obviously, because the measurement error is large relative to the DL value itself, propagation of such uncertainties in the calculations yields a coefficient of variation on the N flux rate that is extremely high (50 to 100%). On the contrary when the nutrient concentrations are well above detection (under repeatability conditions), the coefficient of variation on the model calculations may be less than 5%. *Unreliable estimates of ambient substrate concentrations can, therefore, be considered as one of the most serious drawbacks to our present interpretation of the ^{15}N tracer data*.

New production is calculated as the product of *f* ratio (^{15}N tracer data) with total primary production (PP, ^{13}C tracer data). For expressions involving a simple multiplication, the overall uncertainty is directly proportional to the square of the relative standard deviations of each variable entering into the calculation. Accordingly, the relative uncertainty in the final result is not much larger than the largest relative uncertainty used to calculate it, namely the uncertainty on the ^{15}N tracer data. Yet it was found that experimental uncertainty was not necessarily the most important source of variation on the new production assessment. For example in a series of tracer experiments conducted over a 3 week period in the NW Pacific (VERTIGO II), the most important source of variation on new production was the temporal variability in the phytoplankton

productivity (about 50%) whilst the uncertainty on each replicate measurement were below 10% (Elskens et al., Ocean Sciences Meeting 2006).

To summarize, substantial effort was spent on improving current methods for new production assessment and developing procedures to deal with uncertainty and variability. In general, uncertainty can be reduced by gathering additional information (better data, better models), whereas variability will not change as a result of better or more extensive measurements. Various improvements for further research are given in section 3. These include the (1) determination of ^{13}C-DOC release rates during incubation in order to separate new production into dissolved and particulate fluxes, (2) the combined use of ^{13}C, ^{15}N and ^{30}Si to provide an estimate of total primary production, new production and diatom-sustained production within a single incubation experiment (3) the use of inverse modelling to provide primary production and new production estimates at the ocean basin scale, and (4) the adaptation of ^{15}N models for scenario analyses.

1.3. Theme 3: Comparison of new and export production

Comparison of new and export production was achieved in functionally contrasting ocean settings including the European continental/ocean margin in the North Atlantic, (OMEX phase I), the Southern Ocean (CLIVAR-SR3) and the Pacific Ocean (VERTIGO I and II).

During OMEX phase I, the estimation of new production with ^{15}N tracer data is equivalent to ~ 82 g C m^{-2} y^{-1}, which is half of the estimated annual primary production. This is consistent with the estimated obtained by comparing the grazing pressure with primary production, indicating that 16 to 60% of the primary production is not used by heterotrophs in the surface mixed layer (Joint et al., 2001). For the period April to September, we also estimated new production using remote sensing images and an algorithm relating *f* ratio to the nitrate concentrations (Elskens et al., 1999). The satellite based estimate of new production is 46 g C m^{-2}, which compares reasonably with the 57 g C m^{-2} estimated for the same period (April through September) using ^{15}N as a tracer. This gives credence to the estimated new production obtained from satellite remote sensing and its use to investigate the spatial variability in *f* ratio. During the spring bloom, satellite data suggests that the region of cool water along the shelf break translates into area of elevated *f* ratio (> 0.5, Elskens et al. 1999). From June to winter, new production is low and ammonium the most important nitrogen source for the phytoplankton. This is consistent with the higher heterotrophic activity in this period since with net heterotrophy, ammonium production should be maximised (Joint et al., 2001). The change in nutrient concentration was also used to quantify the potential importance of diatoms in the spring bloom. Winter concentrations of nitrate and silicate were 8.7 µM and 2.8 µM, respectively (Hyde et al., 2001). Assuming that diatoms utilise nitrate and silicate with an atomic ratio of 1, that silicates was depleted in the spring bloom and that silicate was not rapidly recycled, diatoms would account for about 32% of the new production in April and May (Joint et al., 2001).

Finally, how does the material collected in the sediment traps compare with the yearly estimates of new production? Material from the sediment traps was analysed for Ba barite and the data were used to calculate carbon export flux according to the rationale of François et al. (1995). Using the excess Ba fluxes corrected for trapping efficiency and advection (Antia et al., 2001) as well as for the fact that in continental margin settings a smaller amount of Ba-barite is produced per unit particulate organic carbon (POC) exported as compared to open ocean systems, our data suggest particulate carbon export in the OMEX slope region to be of the order 8 to 18 g C m^{-2} y^{-1} (Dehairs et al., 2000). Such values are lower by a factor 3 to 6 than estimates of new production based on the ^{15}N data (80 g C m^{-2} y^{-1}) and suggest that not all of the exportable carbon estimated from new production is exported as a vertical POC flux; part may be exported out of the area by advective transport of either POC and DOC. As a matter of fact both approaches would converge, if a significant fraction of new production ends up as dissolved organic matter (DOM) instead of particulate organic matter (POM). A simulation study has suggested that between 20 to 40% of the total organic matter production should be released as net fluxes of DOM to support the Ba approach (Elskens, 1999). These values were not confirmed because of experimental drawbacks in assessing DOM release rates, but seem compatible with literature information (Bronk et al., 1994). The development of a new automated setup for stable isotope analysis of dissolved organic carbon (Bouillon et al., 2006) will clearly help us to better appreciate this problem in further field works (see also section 3)

During CLIVAR-SR3 in spring 2001, the Antarctic Zone South (AZ-S) and the Seasonal Ice Zone (SIZ) constituted the region of highest new production (up to 240 mg C m^{-2} d^{-1}) while new production in the SubAntarctic Zone (SAZ), the Polar Front Zone (PFZ) and the Inter Polar Front Zone (IPFZ), values reached only about 70 mg C m^{-2} d^{-1}, with SAZ values slightly exceeding those for PFZ-IPZ. The AZ-S and SIZ had highest *f*-ratios, reaching up to 0.61. Lowest *f*-ratios were observed in the SAZ (0.38) and intermediate values (0.56) in the PFZ. The latitudinal trend of new production during spring 2001 along 145°E is similar to the one for the 234Th flux obtained for the same cruise.

Deficit of ^{234}Th activity (relative to its parent ^{238}U) in the upper mixed layer is indicative of particle export. Knowledge of POC/^{234}Th ratios of settling particles gives access to the POC export flux. During spring 2001 (CLIVAR-SR3) ^{234}Th fluxes along 145°E were low in the north (ca. 630 dpm m^{-2} d^{-1}), minimal in the Polar and Inter Polar Front Zones (ca. 300 dpm m^{-2} d^{-1}) and high in the south (ca. 3000 dpm m^{-2} d^{-1}). ^{234}Th export fluxes were converted into particulate organic carbon (POC) flux by multiplying with the POC/^{234}Th ratio of large particles (55-210µm), assumed to represent the sinking particles. During the CLIVAR-SR3 cruise export production ranged from 20 mg C m^{-2} d^{-1} in the PFZ to 670 mg C m^{-2} d^{-1} in the SIZ at 64°S. Our results indicate low particle export in the SAZ and SAF, very low particle export in the PFZ and IPFZ and high export in the AZ-S and SIZ during spring 2001. This latitudinal trend is in quite good agreement with new production data for the same cruise. The very low export production and new production in the PFZ and IPFZ contrast with the widely accepted idea that the Polar Front enhances primary

and export production. This could be specific to the Australian sector because of local hydrodynamic conditions associated with a double front structure.

Iron and ammonium concentrations may strongly affect the relative importance of exportable production vs. total production (i.e. the *f*-ratio). In addition to their individual effects, the combined effect of ammonium and iron on *f*-ratio was investigated during spring 2001 (CLIVAR-SR3, 145°E). In the HNLC areas of the SAZ, PFZ and AZ-S *f*-ratio is lowered by ammonium addition and enhanced by iron addition. It was observed that enhancement of the *f*-ratio due to Fe addition depends on the ambient ammonium concentration and it thus appears that the combined effect of ammonium and iron is not simply cumulative. Our results imply that there is no simple relationship between export production and iron availability. Ammonium appears to counter the effects of iron addition on export production, particularly for HNLC areas such as the Southern Ocean.

We also investigated the effect of large scale in-situ iron amendment on carbon export. The EIFEX iron fertilisation experiment (January – February 2004) took place in a meso-scale eddy pinched off from the meandering Polar Front in the Atlantic sector. The experiment ran until the decrease of the export flux in contrast to other iron experiments in the Southern Ocean which were interrupted before significant export occurred. The eddy was fertilized with Fe and monitored for 36 days afterwards. A phytoplankton bloom dominated by diatoms was induced with chlorophyll contents reaching close to 3 µg l^{-1} three weeks after the iron infusion. The ^{234}Th export fluxes at 100 m first decreased to near zero within the first two weeks after the iron infusion. Subsequently ^{234}Th fluxes increased, reaching values as high as 8000 dpm m^{-2} d^{-1} one month after the Fe infusion. Such a ^{234}Th flux is the highest ever recorded and suggests that the bloom broke up rather fast and sunk massively. During the last four days of the experiment the ^{234}Th flux decreased again to 1400 dpm m^{-2} d^{-1}. When integrated over the full period of export (i.e. days 15 to 36), the sinking of the Fe-induced bloom exported 44700 to 88000 dpm m^{-2} of ^{234}Th. The evolution of ^{234}Th export *versus* time during EIFEX was strikingly similar to the one of mesopelagic Ba_{xs} content, a proxy for mesopelagic mineralisation of organic carbon.

During the VERTIGO I and II expeditions (Station ALOHA, Hawaii, June-July 2004 and Station K2, NE Pacific; July-August 2005, respectively), we had the opportunity to compare our new production estimates with the POC flux obtained from neutrally buoyant sediment traps (NBST) at 150 m (K. Buesseler et al., Ocean sciences meeting, 2006). At the Aloha station, the estimates of new production based on ^{15}N tracer data is equivalent to 18 – 38 mg C m^{-2} d^{-1}, which compare reasonably with the 17 to 21 mg C m^{-2} d^{-1} obtained for the same period with the NBST deployment at 150m. The system was apparently in steady state and the experimental uncertainty of the new production was high because of the extreme oligotrophic conditions encountered over the three week sampling period (see section 1.2). There was a large difference in the magnitude of the export flux between VERTIGO I and II expeditions, with fluxes on sinking particles being much higher at station K2. The POC fluxes obtained with the NBST's at 150m amount to 68 mg C m^{-2} d^{-1} (first week of sampling) and 24 mg C m^{-2} d^{-1} (second week of sampling).

Such values at K2 are 2 to 3 times lower than those obtained for the new production and reaching 150 and 70 mg C m^{-2} d^{-1}, for the first and second week, respectively. While the temporal variability in POC flux is clearly documented by both approaches, it also appears that not all of the exportable carbon estimated from new production is effectively exported as a vertical POC flux. These results corroborate OMEX-I results, discussed earlier, and advocate for a better characterization of DOC release rates when estimating new production.

1.4. Theme 4: The mesopelagic Ba (barite) as tracer of mesopelagic organic matter mineralisation

We assessed mineralization of exported organic carbon using the barium-barite proxy and the algorithm relating particulate Ba with oxygen consumption obtained earlier for the Southern Ocean (Shopova et al., 1996; Dehairs et al., 1997). Excess, non-lithogenic particulate Ba (Ba_{xs}, mainly consisting of barite) is associated with phytoplankton derived particles. In the mesopelagic zone a Ba_{xs} maximum is a recurrent feature which develops over the season and reflects the influx and mineralization of plankton detritus sinking from the mixed layer. During the summer (SAZ'98) and spring (CLIVAR-SR3) cruises along Southern Ocean WOCE SR3 line (145°E) we observed significant zonal differences in mesopelagic Ba_{xs} contents. Compared to the SubAntarctic Zone (SAZ) mesopelagic Ba_{xs} contents during spring 2001 were larger and started to increase at shallower depths south of the Polar Front Zone (PFZ) and the Antarctic Zone (AZ), where diatoms were the dominant component of the phytoplankton community. During summer 1998, when mesopelagic Ba_{xs} accumulations were larger, a similar latitudinal trend was observed (Cardinal et al., 2001). In contrast, the deep ocean flux of Ba_{xs} sampled by moored sediment traps was larger in the nano-phytoplankton dominated SAZ, than in the diatom dominated PFZ, as was observed also for deep particulate organic carbon fluxes. Overall, the results indicate relatively high particulate carbon export and absence of strong mesopelagic mineralisation (7.5–36% of export production) in the SAZ, but relatively low export and strong mesopelagic mineralisation further south in PFZ to SIZ (20-97% of export production). Mesopelagic carbon remineralisation was higher during summer compared to spring. Our findings are supported by results for the ^{234}Th and N-uptake proxies obtained for the same cruise.

Overall highest organic carbon export and mineralization in the Southern Ocean (as reflected by mesopelagic excess Ba) were observed in areas characterized by strongly enhanced productivities. These are the Crozet Kerguelen basin studied during the Antares 4 cruise (Jan – Feb 1999) and the Kerguelen plateau studied during the KEOPS cruise (Jan – Feb 2005). In the former area the merging of three frontal structures and associated currents (Agulhas retroflection; Subtropical front; SubAntarctic front) in a narrow zonal band, results in sharp physico-chemical gradient sustaining enhanced biomass resulting in high export. Above the Kerguelen plateau, natural Fe advection into the euphotic layer occurs through remobilisation of bottom sediments (the water column is ≤600m depth) and possibly internal wave induced upwelling and spilling of Fe-enriched

deep water over the plateau. These are thought to be responsible for enhanced productivities and associated export as well as deep-sea mineralization of organic carbon.

The artificial iron fertilisation of a mesoscale eddy in the Atlantic Polar Front Zone (EIFEX cruise; Jan – Mar 2004) did result in temporarily enhanced particle export (234Th-deficit method) which was paralleled by enhanced mesopelagic excess Ba. The deduced intensity of organic carbon mineralization was, however, not strikingly different from what we observed elsewhere for the natural Southern Ocean. This could possibly reflect more efficient export of organic carbon to the bathypelagic water column, with less under-way mineralization, but final conclusions still have to be drawn regarding these results.

So, overall the mesopelagic particulate Ba_{xs} seems to operate quite well as a proxy of organic matter mineralization in the subsurface, twilight zone. However, till recently, no direct comparison between excess particulate Ba concentrations and productivity of heterotrophic bacteria in mesopelagic waters was attempted. This mainly because bacterial activities below the upper 100m are usually very low and also because of uncertainties concerning effects of hydrostatic pressure relieve during deep sea water sampling and incubations under atmospheric pressure. During the VERTIGO I and II expeditions (Station ALOHA, Hawaii, June-July 2004 and Station K2, NW Pacific; July-August 2005, respectively), focussing specifically on twilight zone processes, we had the opportunity to confront our excess Ba results with bacterial production rates obtained for the upper 1000m of water column (B. van Mooy, K. Casciotti, P. Boyd, pers. communic.). The extreme oligotrophic ALOHA site clearly differentiated from the NE Pacific HNLC site, and a positive correlation became clear between bacterial production and excess particulate Ba in the twilight zone. Furthermore, bacterial carbon utilisation rates assessed from Thymidine incorporation and growth efficiency estimates, proved to be of similar magnitude than carbon demand based on Ba_{xs} contents. Results also compare well with decreases in POC fluxes over the 150 to 500m depth region based on Neutrally Buoyant Sediment Trap derived POC fluxes, though particle settling flux patterns may appear complex with possible impact of zooplankton migration(K. Buesseler & D. Steinberg, pers. communic., VERTIGO meeting, Feb. 2006, Hawaii). These results are highly encouraging to launch further efforts for combining different methodologies to assess twilight zone organic matter respiration. As a first step, we propose to extend our proxy-tool box, by also including assessment of bacterial production at those depths in the upper 1000m, sampled for Ba.

A first opportunity for such a tight proxy tool comparison resides in the upcoming SAZ-SENSE expedition to the SubAntarctic and Polar Front Zone, south of Australia and scheduled for January. February. 2007. Besides the now 'classical' tools including new production, ^{234}Th flux, mesopelagic excess Ba accumulation, we will also systematically assess bacterial production via the thymidine incorporation. We will operate in close collaboration with the "Ecologie des Systèmes Aquatiques" (Université Libre de Bruxelles) team who has long standing experience in assessing bacterial production. Furthermore results will be compared also with direct oxygen consumption measurements from in-situ

incubated parcels of seawaters with electrode monitoring of O_2 evolution and on board long-term BOD incubations, via Winkler titration (P. Boyd, NIWA, University of Otago, New Zealand).

2. Subject and objectives of GOA II

2.1. General context

Most of the efforts in the Joint Ocean Global flux Study (JGOFS) were spent in understanding the upper ocean processes (JGOFS, 2001). An important conclusion of JGOFS was that the twilight zone (100-1000m) is a horizon of considerable significance which remains poorly understood. As a matter of fact, much of the material exported from the upper mixed layer is mineralised or dissolved in the twilight zone with only a small proportion escaping to the abyssal and benthic environments (Aristegui et al., 2005; Buesseler et al., 2006 SCOR). A portion of the compounds released to solution becomes available subsequently to fuel upper ocean production or affect air-sea gas exchange. The magnitude of this reflux depends crucially on the change in flux with depth for the component of interest, on the depth of mixing, on the intensity of upwelling and on eddy activity all of which have large temporal and geographic variability (Sarmiento, and Gruber, 2006).

The role of the twilight zone needs to be considered in order to acquire a realistic understanding of the ocean's role in the global carbon cycle. This is clearly recognised in the science plans of a number of international programmes such as e.g. IMBER, GEOTRACES, IPY-ICED, (see section 2.3). It is necessary to increase our understanding of the processes controlling flux and fate of organic biogenic material through the oceanic water column as well as their spatial and temporal variability. This will inform us on capacity of the ocean to buffer atmospheric CO_2 by sequestering it in the deep sea and on the sequestration time scales involved.

The past few decades, considerable efforts have been invested in methodologies for assessing carbon flux in the ocean's interior. For instance, bottom tethered sediment traps to intercept sinking particles have been in use since about 30 years. Recently, Buesseler et al. (2006 SCOR) have extensively reviewed this methodology. Such systems appear to be efficient in the hydrodynamically more 'calm' bathypelagic waters (>1000m), but much less so in the subsurface and mesopelagic zone, where most of the action concerning organic matter mineralization by heterotrophic bacteria takes place. However, POC fluxes measured by tethered traps deployed at depths >1000m, have been used to infer information on POC fluxes at shallower depths (<1000m) and mineralization depth scales in the mesopelagic zone have been deduced via empirical equations relating POC flux with depth such as the well known Martin et al. (1987) power law. However, such calculated POC-flux profiles are but poorly constrained. The recent introduction of neutrally buoyant sediment traps (NBST) appears to offer a powerful alternative for getting at realistic POC fluxes in the mesopelagic (Buesseler et al., 2000). These traps are designed to sink to predetermined depths via accurate ballasting and to

drift along with the prevailing current, thereby avoiding problems related with flow perturbation typical for bottom and surface tethered traps (Buesseler et al., 2006 SCOR; Peterson et al., 2005). During the VERTIGO I and II cruises (Station ALOHA, Hawaii and NW Pacific K2 site) NBST's have been successfully deployed in mesopelagic waters, yielding high quality data on carbon flux and mineralization depth-scales and illustrating the significant differences between the oligotrophic ALOHA and HNLC K2 sites (Buesseler et al., 2006, OS; Valdes and Buesseler, 2006).

2.2 Objectives and implementation strategy

The general objective of the present proposal is to quantify the particulate organic carbon export from the upper ocean and its fate at depth. Emphasis is put on the processes occurring in the twilight (=mesopelagic) zone (100-1000m) in order to investigate the phytoplankton sources and degradation of organic matter and the regeneration depth scale. Achieving the objectives above will require careful coordination of field works, laboratory experiments and modelling. Specific Objectives are:

1. To better characterize the source material produced in the upper ocean (potentially exportable carbon flux) via direct measurements (Compound Specific Isotope Analysis and ^{13}C, ^{15}N, ^{30}Si stable isotope dilution techniques) and modelling (compartmental analysis).
2. To better constrain the particulate carbon export from the upper mixed layer by identifying the classes of particles involved in carbon export, via POC/^{234}Th ratios in size fractionated suspended matter and sinking material fractionated according to sinking speed using the IRS traps.
3. To determine the regeneration depth scale via direct measurements (Ba stocks and bacterial production) and modelling (empirical and mechanistic model for the reconstruction of the regeneration depth scale using Ba-barite)
4. To estimate seasonally integrated nutrient utilisation and associated export of organic carbon, based on existing nutrient data and Optimum Multi Parameter modelling.

2.3 GOA referenced in international activities

The aims of GOA-II are relevant for the following international programmes:

- *IMBER*, (Integrated Marine Biogeochemistry and Ecosystem Research) sponsored by IGBP (International Geosphere-Biosphere Programme) and SCOR (Scientific Committee on Oceanic Research)
- *GEOTRACES***,** an international study of the marine biogeochemical cycles of trace elements and their isotopes.
- *IPY-ICED,* Integrated analyses of circumpolar Climate interactions and Ecosystem Dynamics in the Southern Ocean–International Polar Year, ICSU, SCAR.

- *SOLAS* (SOLAS -The Surface Ocean - Lower Atmosphere Study) sponsored by IGBP, SCOR, WCRP and CACGP (Commission on Atmospheric Chemistry and Global Pollution)
- *EUR-OCEANS,* EU FP6 Network of Excellence (EURopean network of excellence for OCean Ecosystems Analysis),
- *VERTIGO* (VERtical Transport In the Global Ocean) funded by the U.S. National Science Foundation and Department of Energy and Research Foundation Flanders.

3. Methodology

3.1. Research strategy

The proposed research will be based on 4 work packages, each addressing a number of specific issues. WP 1 is devoted to methodological development and validation. It aims a better characterising the source material produced in the upper ocean and exported down to the deep ocean. Special attention is paid to the development of appropriate quality assurance and quality control procedures. WP 2 is dedicated to data analysis and modelling. It is an important research area in GOA, designed either for the extraction of information from data (data interpolation) or for predictions (data extrapolation). Different modelling tools will be applied involving forward, inverse and empirical models. WP 3 is dedicated to field work and data acquisition. It aims at constraining our estimate of the particle carbon export fluxes using a multi-proxy approach. Finally WP4 is devoted to the synthesis of information and dissemination of the results. The WP4 task will consist in drafting papers and reporting and in organising workshops and meetings relevant to the domain of GOA.

3.2. WP 1: Method development and validation

^{13}C-DOC release **-** The specific objective is to separate new production into its dissolved and particulate fractions. The measurement of stable isotope ratios on dissolved organic carbon (DOC) has long posed analytical problems and limited the use of this powerful tracer in biogeochemical studies in aquatic systems. Recently, Bouillon et al (2006) provided a detailed description of a successful coupling of a custom-modified total organic carbon analyser (Thermo HiperTOC) to an isotope-ratio mass spectrometer (IRMS). The method is based on the wet oxidation of up to ~20 ml of aqueous sample in a closed reactor, whereby complete oxidation is ensured by a combination of sodium persulfate addition, heating, and UV irradiation. The produced CO_2 is carried over a water trap and purification column in a stream of He, and introduced to the IRMS via a conventional open-split interface, enabling both carbon quantification and isotopic ratio analysis.

Isotope enrichment and dilution experiments with combined use of ^{13}C, ^{15}N and ^{30}Si tracers – The specific objective is to provide a combined estimate of total primary production (^{13}C), new production (^{15}N) and diatom based production (^{30}Si) within a single

batch incubation experiment. In collaboration with the LEMAR research group at Insitut Universitaire Européen de la Mer (Paul Tréguer), we elaborated refined experimental designs and protocols for the use of stable ^{30}Si in studying production and dissolution of biosilica in marine waters. Focus was on biogeochemical aspects (Beucher et al., 2004), analytical measurements (Corvaisier et al., 2005), parameter optimization (de Brauwere et al. 2005a) and data analysis (Elskens et al., 2006). This part of the work will be done in close co-operation with D. Cardinal (Royal Museum for central Africa, Tervuren, Belgium) for the determination of the opal and the ^{30}Si isotopic composition, the latter using a High Resolution Inductively Coupled Plasma - Mass Spectrometer, while the modelling part will be tackled by the VUB team (see section 3.3)

Biomarkers and Compound Specific Isotope Analysis - Several isotopic tools will be used: Carbon ($\delta^{13}C$) isotopic signature of specific compounds belonging to the sterol and Phospholipid Fatty Acid (PLFA) classes and which are characteristic of major phytoplankton groups (diatoms, dinoflagellates, coccolithophorids, phaeocystis, .., e.g. Mudge et al., 1998; 1999) and silicon ($\delta^{29}Si$; in collaboration with D. Cardinal). We will first develop and validate a method for coupled sterol and PLFA extraction. Subsequently compound-specific $\delta^{13}C$ analysis will be performed on selected biomarkers of the phospholipids fatty acids (PLFA) and sterol groups. PLFA's (derived from cell membranes of bacteria and eukaryotes) offer an interesting potential as group-specific markers while sterols are frequently used as algal and vascular plant biomarkers. Combining the analysis of these two compound classes will increase the resolving power of the compound-specific approach to differentiate major algal and microbial groups. It also will allow for a better isotopic characterization of the different carbon sources sustaining pelagic heterotrophic communities. The total lipid fraction will be extracted using a modified Bligh and Dyer method and the relevant lipid fractions isolated by separation on silicic-acid columns into different polarity classes for subsequent analysis by GC-IRMS. Once optimised, this tool will be applied during the SAZ-PULSE (starting Oct 2006, ending Dec 2007), SAZ-SENSE (Physical and Biogeochemical Dynamics of the Subantarctic Zone; Jan.-Feb. 2007) and BONUS-GOODHOPE (Biogeochemistry of the Southern Ocean: interactions between nutrient dynamics and ecosystem structures, Nov.-Dec. 2007) expeditions in the Southern Ocean. During these expeditions size fractionated plankton samples from the upper mixed layer, subsurface total suspended matter and deep ocean sinking particles will be collected for comparison of the biomarker presence and isotopic signatures.

Natural abundance of ^{15}N and ^{29}Si nitrate and silicate– The aim is to achieve an integrated view of nitrogen and silicate utilization in the upper ocean and to infer impact of specific metabolic processes (uptake and remineralisation rates). This work will be done in close co-operation with D. Cardinal (Royal Museum for central Africa, Tervuren, Belgium) for the determination of the silicon isotopic composition. Silicon isotope variations are important to estimate silicate utilisation (De La Rocha et al., 1998; Cardinal et al., 2005). Till recently such studies were scarce because of analytical difficulties. These have been partly overcome since the development of Multi-Cup ICP-MS techniques (Cardinal et al., 2003). On the other hand, nitrogen isotope variations are

important to estimate the relative contribution of various N substrates to phytoplankton nutrition. For the determination of ^{15}N in the dissolved inorganic N pool (DIN), ammonium and nitrate must be extracted separately from the sample. Ammonium will be extracted from the filtered water sample according to the diffusion method of Diaconu et al. (2005). We noted that the presence of labile DON can interfere with the correct determination of $\delta^{15}N$ composition of $NH4^+$ and, therefore, care will be taken in evaluating and solving this problem. The extraction of nitrate from the marine water sample will be performed by a method relying on the use of denitrifying bacteria to assume the conversion of NO_3^- to N_2 (Sigman et al., 2001; 2005). We will seek collaboration with Karen Casciotti at WHOI, to implement this method at VUB.

^{234}Th- deficit method - The specific objective is to obtain quantitative particulate carbon export fluxes at the base of the photic zone. In collaboration with Woods Hole Oceanographic Institution (Ken Buesseler) and Alfred Wegener Institute (Michiel Rutgers van der Loeff), we acquired expertise in measuring the ^{234}Th based carbon export flux (e.g. Savoye et al., 2005; Savoye et al., 2006). In the mean time we also acquired the necessary low beta counting equipment for work at sea, via the Research Foundation Flanders. The $^{234Th}/^{238}U$ disequilibrium should be complementary to the new production method described above since it estimates a biogenic particle export from the surface ocean (sinking particles leaving the photic zone). However, there are still several questions to be properly addressed regarding ^{234}Th particle interaction, reactivity, sample collection and analysis, and modelling (see Applications of ^{234}Th in Aquatic Ecosystems Fate conference, 2005 at http://www.geol.sc.edu/cbnelson/ Thmeeting). In particular the choice of a 234Th/POC ratio to convert 234Th fluxes into POC fluxes is still debated. Ideally the selected ratio should the one of settling particles, which need not necessarily be the largest particles but clearly the heaviest ones. A solution to this problem might reside in the analysis of 234Th/POC ratios of particles collected according to their sinking velocity. To that purpose a specially designed sediment trap (Internal Rotating Sphere trap) was purchased for deployment in the subantarctic south of Tasmania during SAZ-PULSE and SAZ-SENSE, 2006, 2007; see below).

Mesopelagic excess Ba - Sampling and analysing for excess particulate Ba is now standard procedure within our group. We will continue this task during upcoming expeditions and will make sure the appropriate depth resolution is always achieved when sampling the mesopelagic waters. Depths sampled will also be investigated for bacterial production (see next section). Selected samples will be investigated by SEM-EMP (co-operation with Anna Worobiec, MiTAC, Universiteit Antwerpen) to document Ba-rich particle composition and morphology and possible associations with plankton organisms. In particular we will look into Ba contents of Acantharia skeletons (consist of celestite, $SrSO_4$) and possible associations of barite with Acantharia spines (Steinberg et al., 2005). Results obtained earlier during the 2004 EIFEX expedition did not corroborate a systematic correlation between excess Ba-barite and Acantharia abundance (Jacquet and Henjes, pers. Communic.) but further investigation is needed to confirm or rule out the role of Acantharia in excess Ba-barite synthesis.

Bacterial production – We will implement the thymidine incorporation method for assessment of bacterial production (e.g. Børsheim, 1998), to deduce organic carbon consumption due to heterotrophic bacterial activity. This carbon demand will be compared with excess-Ba accumulation at same depths, possible opening the way for a more accurate calibration of these different proxies. We will seek assistance from Sylvie Becquevort (Ecologie des Systèmes Aquatiques, ULB) and Ingve Børsheim (Institute of Marine research, Norway). Final computation of organic carbon demand by heterotrophic bacteria is dependent on selecting an appropriate growth efficiency factor for converting thymidine incorporation into carbon demand. Growth efficiency is likely to vary, depending on prevailing conditions such as temperature and pressure, and caution is needed for proper data interpretation and conclusions.

Sediment trap systems - In close co-operation with ACE-CRC (T.W. Trull) we will sample sinking particles via interceptors collecting the particle flux (CLAP traps) and via Internal Rotating Sphere traps (IRS trap), which fractionate particles according to sinking velocity. An IRS trap was purchased via funding obtained from Federal Science Policy and was recently delivered to ACE-CRC, Hobart for inclusion in an existing sediment trap array. The plan is to deploy from October 2006 (SAZ-PULSE Project) a tethered mooring, consisting of combined CLAP and IRS traps in the meso- and bathypelagic regions at 47°S in the Subantarctic Zone. The traps will be deployed at two depths to document changes in flux and particles sinking velocity through the water column. These traps will operate till end of 2007. During the SAZ SENSE cruise in Jan. Feb. 2007, the IRS traps will be recovered for short-term use (days) in free drifting mode at shallow (<500m) depths. They will then join again the tethered mooring system in August 2007 till end of 2007. It will thus be possible to study seasonal evolution of particle (and element) fluxes and also characterise those particles sustaining the overall flux in terms of sinking velocity and composition. From the short-term deployments of IRS traps in free drifting mode (SAZ-SENSE cruise) we hope to gain a better insight in 234Th/POC ratios of particles sustaining carbon export.

3.3 WP 2: data analysis and modelling

Compartmental model analysis (CMA) for tracer experiments - The specific objective is to include the time dimension in the ^{15}N, ^{13}C and ^{30}Si models for scenario analysis. Current tracer models were not designed to extract information from time series measurements or kinetic experiments. They are based on experimental design using an end-point approach. This facilitates data treatment and model analysis because the procedure does not require any assumption about the rate law expression (e.g. first, second order or saturation kinetic). However, in this case, one cannot produce analytical solutions for the time course of the rates (instantaneous rates) between the various nutrient compartments (Elskens et al., 2005). Nevertheless, in simulation or laboratory culture studies, it would be useful to predict the kinetics of substrate uptake from a model, assuming first order or rate-limited processes. Yet these processes introduce non-linearity making the usual method of compartmental analysis powerless (Vandeginste et

al., 1998). Alternatives to compartmental model analysis (CMA) are interval analysis or global optimization method (Jaulin et al., 2001) and statistical moment analysis (Powers, 1990). The former method (GOM) was implemented in the framework of a master thesis (de Brauwere, 2003) and specifically applied to ^{15}N models of increasing complexity. Currently, the main drawback of GOM seems to be the rapid increase of optimization time and computer memory with model complexity and number of parameters to be estimated. It has the advantage to produce a direct probability statement about the estimated parameter in the form of an interval of possible solutions. On the other hand, the statistical moment analysis (SMA) was successfully applied to pharmacokinetic models (Powers, 1990). These models were basically similar to those build up for interpreting our tracer experiments. Yet it was emphasized that the results of SMA strongly depend on the precision of the measurements, which might be, in our cases, a problem (see section 1.2 analysis of censored data). In other words while CMA may fit closely the data using a model that is inadequate, GOM and SMA may provide models which are closer to reality, although less accurate. In view of these limitations, we hope to gain better insight regarding the parameter optimization and provide specific recommendations for our tracer applications. Once the optimization problem is solved the tracer model can be used for scenario analyses either to draw inferences concerning the reaction mechanism of a metabolic process (zero, first or higher order processes) or to study the isotopic discrimination associated with it (variation in natural abundance of the tracer). As a matter of fact, the structure of the tracer model enables us to investigate the intrinsic kinetic isotope effect easily (Elskens et al., 2005).

Optimum MultiParameter (OMP) analysis - The specific objective is to estimate seasonally integrated nutrient consumption at the basin scale using inverse methods. Nutrient deficit integrated over the growth season reflects export of organic carbon. Direct measurements of nutrient uptake based on tracer incorporation just represent snapshots in space and time. Consequently, another approach is needed to estimate primary production over broader space and time scales. Data on seasonal variability of nutrients are numerous and will be utilised for assessing consumption over the growth season for a given area (focus will be on Gulf of Biscay and Southern Ocean because of data availability). The strategy is to calculate a nutrient field as resulting purely from the mixing of selected source waters having well known composition and compare the outcome with observed nutrient values. The difference between these "conservative", "mixing-only" calculated values and the observed concentrations, represents nutrient uptake by the biota and reflects of course primary production and also export of matter from the upper mixed layer. In practice, a mixing model based on OMP analysis (Tomczaki, 1981; Thompson and Edwards, 1981; Machas et al., 1987; Hinrichsen et al., 1993) will be used. The model's basic idea is that the observed variables (temperature, salinity, oxygen, nutrients) are the result of mixing of a number of water masses or "sources" with well known characteristics. As a consequence, all observed variables can be represented by a linear combination of source characteristics. By fitting this model to the observations, the mixing coefficients of the water masses can be estimated. When the model is calibrated using appropriate sources and only conservative variables, these

mixing coefficients accurately describe the mixing in the study area. In a second step they can be used to run the model in forward direction to obtain values for nutrients in case there would only be mixing and no biological processes. Since measurements of nutrients are widely available, detailed maps of consumption (and hence primary production) can be produced. Basin scale estimates can be deduced by assigning a volume-element to each data point and integrating all contributions. By comparing results found using NO_x, PO_4 and H_4SiO_4, information about phytoplankton community (diatoms *vs*. non-diatoms) can be gained. The procedure is comparable for instance to work by e.g. Kumar and Li (1996) who estimate regeneration of silica and ^{226}Ra over the whole water column, and Schneider et al. (2005) who test a similar procedure to determine nutrient regeneration ratios.

Empirical and mechanistic models to characterise the regeneration depth scale - The specific objective is to focus on algorithmic reconstruction for export production and their limitation (e.g. Martin et al., 1987). We shall use the mesopelagic Ba-barite because it is related to productivity in the upper ocean and apparently contains information about mineralisation fluxes in the twilight zones (Elskens and Dehairs, pers. communic.). The method is based on mixed regression models containing combinations of fixed and random effects sometimes refereed as hierarchical linear models or variance component models (Judd and McClelland, 1989). The first part of the algorithm relates the mesopelagic Ba-barite stocks to NP using linear regression models with continuous and categorical predictors. The second part of the algorithm forecasts the regeneration depth scale using the information enclosed in the mesopelagic Ba-barite profile. Preliminary results suggest twofold behaviours: a rapid attenuation of the POC flux at mesopelagic depths, yet less pronounced than the one given by the power law of Martin (1987), and a slow decrease below 1000m. Under these conditions, the overall curvature of the flux profile is best approximated by a modified exponential decay. However, till recently, no direct validation of the algorithmic can be performed. During the VERTIGO I and II expeditions (Station ALOHA, Hawaii, June-July 2004 and Station K2, NW Pacific; July-August 2005, respectively), focussing specifically on twilight zone processes, we had the opportunity to confront these results with bacterial production rates obtained for the upper 1000m of water column (B. van Mooy, K. Casciotti, P. Boyd, pers. communic.), and therefore to test the relevance of our modelling approach.

3.4 WP 3: A multi-proxy approach for the particle carbon export flux.

The different proxy tools and numerical tools outlined above will be applied during three major expeditions in 2007:

SAZ-PULSE (in co-operation with ACE-CRC, Australia; T.W. Trull, CSIRO & ACE-CRC, Hobart, Tasmania): on from October 2006, deployment at 47°S, Subantarctic Zone, of a mooring consisting of a combined system for particle flux and particle velocity sampling at two depths in the water column. Seasonal evolution of particle flux and particle sinking speed through the water column will thus be studied as will of course particle

composition. On recovery of the traps, a few months later, collected particles can be analysed for elemental composition.

SAZ-SENSE: Jan.-Feb. 2007 (in co-operation with ACE-CRC, Australia; T.W. Trull, CSIRO & ACE-CRC, Hobart, Tasmania): Study of the STZ, SAZ, PFZ east and west of the Tasmania longitude, with focus on functioning of the biological carbon pump. For STZ and SAZ there is evidence of enhanced productivity east of Tasmania, probably as a result of larger Fe inputs there, as compared to the area to the west. The purpose is to compare both STZ, SAZ systems in terms of productivity, and strength of biological pump and to assess origin of enhanced iron inputs. We plan to recover temporarily the IRS traps deployed previously during SAZ-PULSE and to use them in free drifting mode during short periods (days). Velocity fractionated particles will be analysed for elemental composition and 234Th/POC ratio. The latter will allow to better constrain carbon export based on upper ocean 234Th-deficit.

BONUS-GOODHOPE: scheduled for end of 2007, early 2008 (co-operation with Institut Universitaire Européen de la Mer and Institut Paul Emile Victor, France). BONUS-GOODHOPE is a multidisciplinary oceanographic research programme organised during the International Polar Year (IPY, 2007-2008). The overall aim is to acquire key data sets on the contemporary dynamics, circulation and biogeochemistry of the Southern Ocean in its Atlantic sector and its exchanges with the Indo-Atlantic connection on the wake of the continental margin south of South Africa. Physicists and biogeochemists will closely co-operate in this multidisciplinary project, linking physical oceanography, multi-tracers, trace metals, marine biology and modeling. BONUS-GOODHOPE will strongly collaborate with the IPY-"ZERO&DRAKE" project which extends the section of BONUS-GOODHOPE on the zero-meridian from the Polar Front towards the Antarctic continent, thus providing for a full section between South Africa and Antarctica. During BONUS we will essentially apply the same proxy tools as applied during SAZ-SENSE, with exception of the sediment trap work.

3.5 WP 4: Results dissemination

We will organise (or participate to) meetings relevant to the GOA themes:

September 2006 – Participation in the VERTIGO workshop at Woods Hole Oceanography Institute, Woods Hole, USA. The objectives are to discuss and interpret results concerning the VERTIGO I and II expeditions in 2004, 2005 and finalise draft papers.

Spring 2007 - Organisation of a workshop on Twilight Zone Processes at Vrije Universiteit Brussel, in the framework of WP5 'Biogeochemistry', from the FP6 NoE EUROCEANS work programme.

In order to promote and maintain interaction with the scientific community at large, the GOA website (http://homepages.vub.ac.be/~adebrauw/GOA/) will be updated and extended. The following pages will be included in this website:

- To describe the objectives and methodology of GOA II and the link to relevant international initiatives (EUR-OCEANS, IMBER, VERTIGO, GEOTRACES)
- To describe the structure of the project and contact points;
- To notify upcoming meetings and other events relevant to GOA II;
- To notify science highlights (outstanding results);
- To disseminate scientific achievements (reports, publications, presentations at international symposia).
- To deliver a restricted access database

4. Time schedule

4.1. Years 1 to 3

The first three years are mainly devoted to method development and validation as well as data treatment (VERTIGO) and acquisition (SAZ-PULSE; SAZ-SENSE and BONUS-GOODHOPE)

WP 1. Method development and validation

- NH_4^+ regeneration: This will be performed in the lab by testing the method of Diaconu et al (2005) on standard samples with various levels of labile DON (for example urea), and on natural samples with known concentrations of DON.
- Nitrification: This will be performed in the lab by adapting and further developing the method of Sigman et al (2001) to separate the NO_3^- from the water matrix. Appropriate strains of marine denitrifying bacteria (obtained from K. Casciotti, WHOI) will be cultured in collaboration with the microbiology department at VUB (P. Cornelis) to be used as biological NO_3^- converters to N_2O gas. The method will be tested and validated on standard $NO3^-$ solutions and on real samples.
- $DO^{13}C$ release rates: The method of Bouillon et al. (2006) will be tested for ^{13}C enrichment and dilution experiments, validated on standard DOC solutions and on real samples.
- Si cycling: This will be realised in collaboration with MRAC by performing test incubation experiments in laboratory and field conditions.
- Biomarkers and Compound Specific Isotope Analysis: Optimisation of extraction procedures for lipids and sterols; identification of group specific biomarkers.

WP 2. data analysis and modelling

- Compartmental model analysis (CMA):
    - Inclusion of the time dimension in the generic tracer model and validation

  - Uncertainty and sensitivity analysis for the different applications (e.g. isotope dilution and uptake of the ammonium pool, isotope dilution and nitrification…)

- Optimum Multi Parameter (OMP) analysis. Adaptation and validation of OMP-type method for PP and NP reconstruction. Application of OMP to OMEX, SR-3 and CIVA data bases.
- Empirical modelling: validation of the Ba transfer function with the VERTIGO database

WP 3. A multi-proxy approach for the particle carbon export flux.

- Deployment of sediments traps (CLAP and IRS traps) during the SAZ-PULSE expedition
- Participation to the SAZ-SENSE expedition (early 2007)
- Participation to the BONUS-GOOD HOPE expedition (late 2007)
- Assessment of new production during SAZ-SENSE.
- Biomarkers and Compound Specific Isotope Analysis: Analysis of size fractionated plankton, suspended matter and sediment trap material during SAZ-PULSE, SAZ-SENSE and BONUS-GOODHOPE
- ^{234}Th-deficit: assessing 234Th flux during SAZ-SENSE and BONUS-GOODHOPE cruises; converting 234Th flux into POC flux based on information on 234Th/POC ratios gained from IRS trap deployment (operating in sinking velocity mode) and size fractionated suspended matter.
- Assessment of bacterial production in the upper 1000m during SAZ-SENSE and BONUS-GOODHOPE.
- Assessment of organic carbon mineralization in the mesopelagic waters from excess Ba proxy during SAZ-SENSE and BONUS-GOODHOPE.

WP 4: Results dissemination

- Finalize papers for publication in peer-reviewed journals (2007)
  - New production at 2 VERTIGO sites
  - Ba proxies during VERTIGO
  - Application of the OMP method to contribute to a better understanding barium biogeochemistry in the Southern Ocean
- Website maintenance
- participation to / organising international conferences & workshops
  - SCAR Open Science Conference (Hobart; July 2006)
  - Goldschmidt conference (Melbourne; August 2006)

- VERTIGO meeting (Woods Hole; September 2006)
- Organisation of a workshop on Twilight Zone Processes at Vrije Universiteit Brussel, in the framework of WP5 'Biogeochemistry', as part of the FP6 NoE EUROCEANS work programme.

4.2. Years 4 to 5

Years 4 to 5 are mainly devoted to data synthesis and results dissemination

WP 2. data analysis and modelling

- Compartmental model analysis (CMA): Use of the tracer model for scenario analyses to draw inferences concerning the reaction mechanism of a metabolic process (isotopic enrichment and dilution experiments) and to study the isotopic discrimination associated with it (variation in natural abundance of the tracer).
- Optimum MultiParameter (OMP) analysis: Further application of OMP to Southern Ocean (CLIVAR, SAZ-PULSE, SAZ-SENSE, BONUS-GOODHOPE) data base for PP and NP reconstruction and validation.

WP 3. A multi-proxy approach for the particle carbon export flux.

- Finalize data analysis and treatment for the SAZ-PULSE, SAZ-SENSE and BONUS-GOODHOPE expeditions
- Participate in one or two more oceanographic expeditions (to be determined)

WP 4: Results dissemination

- Website maintenance
- Participation to international conferences
- Prepare draft paper for the SAZ-PULSE, SAZ-SENSE and BONUS-GOODHOPE expeditions
- Prepare a final report summarizing scientific highlights

5. Analytical equipment available for executing the work

- Continuous-flow ThermoFinnigan delta+XL and 1 continuous-flow ThermoFinnigan delta V IRMS (the latter to be installed during 2006), with the following peripherals
  - Thermo Flash 1112 EA
  - Thermo HiperTOC TOC analyzer ($DO^{13}C$)
  - HP68990 with combustion/pyrolysis interface
- RISO Low Beta counter (^{234}Th deficit)
- HR-ICP-MS, Element 2, ThermoQuest

- ICP-MS VG PQ2+
- Internal Rotating Sphere sediment traps (IRS traps)

6. Budget

All amounts in Kilo Euro

• Personnel		**910**
○ 2 PostDoc during 5 years	780	
○ 1 Doctoral student (grants) during 4 years	130	
• Equipment		**55**
○ Segmented flow AutoAnalyser SKALAR SAN^{++}		
• Consumable, travel and reporting		**120**
○ Chemicals, equipment for isotope enrichment and dilution experiments. Glassware, maintenance, travel, reporting, Software, hardware		
Grand total		**1085**

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8. Annexes

8.1. List of ANCH publications produced in the framework of the GOA I (2001-2006)

1. Cardinal D, Dehairs F, Cattaldo T, Andre L (2001) Geochemistry of suspended particles in the Subantarctic and Polar Frontal Zones south of Australia: Constraints on export and advection processes. Journal of Geophysical Research (Oceans) 106: 31637-31656
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12. Savoye, N., K.O. Buesseler, D. Cardinal and F. Dehairs, 2004. ^{234}Th deficit and excess in the Southern Ocean during spring 2001: Particle export and mineralization, Geophysical Research Letters, 31, L12301, 10.1029/2004GL019744.
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29. Buesseler, K.O., C. R. Benitez-Nelson, S. B. Moran, A. Burd, M. Charette, J. K. Cochran, L. Coppola, N. S. Fisher, S. W. Fowler, W. D. Gardner, L. D. Guo, O. Gustafsson, C. Lamborg, P. Masque, J. C. Miquel, U. Passow, P. H. Santschi, N. Savoye, G. Stewart, and T. Trull (2006). An assessment of particulate organic carbon to thorium-234 ratios in the ocean and their impact on the application of ^{234}Th as a POC flux proxy. Marine Chemistry. In press.
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33. Elskens, M., de Brauwere, A., Beucher, C., Corvaisier, R., Savoye, N., Tréguer, P. and Baeyens, W. Statistical process control in assessing production and dissolution rates of biogenic silica in marine environments. Submitted to Marine Chemistry.
34. Bouillon S., M. Korntheuer, W. Baeyens and F. Dehairs, A new automated setup for stable isotope analysis of dissolved organic carbon, Submitted to Limnology and Oceanography Methods.

8.2. Abstracts of talks & posters presented at international symposia (2001-2006)

1. Savoye N., F. Dehairs, M. Elskens, Interaction of Iron and Ammonium on N-Uptake in the Southern Ocean, South of Australia AGU fall meeting, San Francisco (December 6-12, 2002) OS11A – 0203.
2. Cardinal D., L.Y. Alleman, N. Savoye, F. Dehairs, T.W. Trull and L. André, Si Isotopic Signatures of Diatoms in the Spring Southern Ocean, AGU fall meeting 2004,
3. Jacquet S., T. Cattaldo, D. Cardinal, J. Navez, F. Dehairs, dissolved Ba in the complex frontal system of the Crozet - Kerguelen basin and comparison with other Southern Ocean frontal zones, EGU Annual Assembly, Nice, 2003, Geophysical Research Abstracts, 5, 10128.
4. Cardinal D., L. André, F. Dehairs, M. Elskens, S. Jacquet, N. Savoye, T. Trull, Dynamics of the Ba_{xs} proxy through the water column of the Southern Ocean, EGU Annual Assembly, Nice, 2003, Geophysical Research Abstracts, 5, 14185.
5. Brion N., M. Elskens, F. Dehairs and W. Baeyens, Kinetics of N-utilization by natural phytoplankton assemblages during upwelling events at the N.W. Iberian Shelf, EGU Annual Assembly, Nice, 2003, Geophysical Research Abstracts, 5,09359.
6. Dehairs F., M. Elskens, N. Savoye, D. Cardinal, W. Baeyens, E. Kopczynska, K. Buesseler and T. Trull, Mineralization in the mesopelagic waters of the southern ocean: what can we learn from particulate ba and diatoms? EGU Annual Assembly, Nice, 2003, Geophysical Research Abstracts, 5,10098.
7. Savoye N., K. Buesseler, B. Griffiths, F. Dehairs, S. Wright, S. Pike and T. Trull, Particle fluxes from ^{234}Th measurements during the CLIVAR-SR3 cruise in the Southern Ocean (spring 2001, south of Australia), EGU Annual Assembly, Nice, 2003, Geophysical Research Abstracts, 5, 11034.

8. Jacquet S. H. M., F. Dehairs, D. Cardinal, N. Savoye and T. Trull, Dynamics of dissolved and particulate barium in the mesopelagic waters and fluxes of Ba in the deep sea of the Southern Ocean along 142°E: Clues for the barite formation process and the fate, of exported carbon, EGU Annual Assembly, Nice, 2004, Geophysical Research Abstracts, 6, 03402.
9. Kopczyńska E.E., N. Savoye, F. Dehairs and M. Elskens, Phytoplankton variability versus zonal variation in spring new production in the Southern Ocean, between Australia and Antarctica, SCAR Symposium, 25-31 July, 2004, Bremen.
10. Dehairs F., Cardinal D., Savoye N., Jacquet S., André L. and Elskens M., A trace element and isotope proxy approach for the study of the biological carbon pump: a Southern Ocean case study, The Oceanography Society, 6-10 June, Paris, 2005.
11. Cardinal D., Savoye N., Jacquet S.H.M., André L., Wolf-Gladrow D., Dehairs F., Silicon isotopes, 234Thorium and mesopelagic Barium to constrain the dynamics of a Southern Ocean diatom bloom induced by in situ iron fertilization (EIFEX), AGU – ASLO meeting, Santiago de Compostella, June, 2005.
12. Brion N., Elskens M., Leermakers M., Chevalier E., Baeyens W, Chou L., Van Der Zee C., Roevros N., Schiettecatte L.-S., Borges A. V., Gazeau F., Frankignoulle M., Laane R. W. P. M. A budget approach applied to nutrients (N, P, Si) and DIC in the Southern Bight of the North Sea: results from the CANOPY project. AGU – ASLO meeting, Santiago de Compostella, June, 2005.
13. de Brauwere A., S. Jacquet, F. Dehairs, F. De Ridder, R. Pintelon, J. Schoukens, Refinement of Optimum Multiparameter approach for water mass analysis, EGU Annual Assembly, Vienna, 2005, Geophysical Research Abstracts, Vol. 7, 06424.
14. Cardinal D., L. Alleman, N. Savoye, T. W. Trull, F. Dehairs and L. André, Using silicon isotopes in oceanography: What can we learn from a high-resolution transect in the Southern Ocean? EGU Annual Assembly, Vienna, 2005, Geophysical Research Abstracts, 7, 10975.
15. Brion N., Diaconu C., Elskens M. and Baeyens W. An accelerated NH4+ extraction technique from water samples for the analysis of 15N at enriched and natural abundance levels. EGU Annual Assembly, Vienna, 2005, Geophysical Research Abstracts, 7, 04726.
16. Jacquet S., A. de Brauwere, F. Dehairs, M. Elskens, C. Jeandel, N. Metzl, S. Rintoul, T. Trull, Comparison of dissolved Barium with Nutrients and Physico-chemical Conditions along 30°E and 145°E across the Southern Ocean, EGU Annual Assembly, Vienna, 2005, Geophysical Research Abstracts, 7, 06312.
17. de Brauwere A., 2005. On estimating fractions of mixing water masses, Identification and Control of Complex Systems Workshop, June 2005, Leuven, Belgium.
18. Vöge I., N. Savoye, C. Bertoïa, J. Friedrich and F. Dehairs, ^{234}Th-based export production during the European Iron Fertilization Experiment (EIFEX), Ocean Sciences, Honolulu, Hawaii, 20-24 Febr. 2006.

19. Savoye N., T. Trull, S. Jacquet and F. Dehairs, ^{234}Th-based export production during the KEOPS natural iron fertilization, Ocean Sciences, Honolulu, Hawaii, 20-24 Febr. 2006.
20. Jacquet S. D. Cardinal, N. Savoye and F. Dehairs, Mesopelagic C mineralization under natural and Fe-amended conditions, Ocean Sciences, Honolulu, Hawaii, 20-24 Febr. 2006.
21. Jacquet S.H.M., Dehairs F., Jeandel C., Reyss J-L., Thévenet J., Souhaut M. and P. van Beek, Radium isotopes and dissolved barium to investigate the water mass pathways on the Kerguelen plateau (KEOPS project), Ocean Sciences, Honolulu, Hawaii, 20-24 Febr. 2006.
22. Dehairs F., S. Jacquet, N. Savoye, D. Cardinal, W. Baeyens and J. Bishop, Particulate Ba at station ALOHA during VERTIGO I, Ocean Sciences, Honolulu, Hawaii, 20-24 Febr. 2006.
23. Elskens M., F. Dehairs, N. Savoye and W. Baeyens, Nitrogen uptake regime at station ALOHA during VERTIGO I, Ocean Sciences, Honolulu, Hawaii, 20-24 Febr. 2006.
24. Buesseler K, J Bishop, P Boyd, K Casciotti, F Dehairs, C Lamborg, D Siegel, M Silver, D Steinberg, S Saito, T Trull, J Valdes, B Van Mooy, What we know from VERTIGO, VERtical Transport In the Global Ocean, Ocean Sciences, Honolulu, Hawaii, 20-24 Febr. 2006.
25. Casciotti K L, F Dehairs, T Trull, Nitrogen and oxygen isotopes in nitrate from contrasting sites in the Pacific, Ocean Sciences, Honolulu, Hawaii, 20-24 Febr. 2006.
26. Cavagna A.-J., Tracking type, origin and transformation of biogenic matter settling through the Southern Ocean water column from Si, C, N stable isotope signatures and compound specifics, NoE EUROCEANS, General Assembly meeting, 15-16 March 2006, Barcelona.
27. Dehairs F., Lancelot C., André L., Goosse H., Frankignoulle M., Becquevort S., Borges A., Cardinal D., Delille B., Elskens M., Jacquet S., Lefebvre W. de Montety A., Pasquer B., Savoye N., Schoemann V., BELCANTO: Carbon fluxes and processes in the Southern Ocean: Regional or Global importance, BE-POLES Workshop, 23-25 March, 2006, Brussels.
28. Cardinal D, Savoye N, Jacquet S.H.M., André L., Wolf-Gladrow D. & Dehairs F., Silicon isotopes, 234-Thorium and mesopelagic Barium to constrain the dynamics of a Southern Ocean diatom bloom induced by in situ iron fertilization (EIFEX), BE-POLES Workshop, 23-25 March, 2006, Brussels.
29. Jacquet S., Cardinal D., Savoye N. & Dehairs F., Mesopelagic C mineralization under natural and Fe-amended conditions, BE-POLES Workshop, 23-25 March, 2006, Brussels.
30. de Brauwere A., S. Jacquet, F. Dehairs, F. De Ridder and W. Baeyens (2006). A parametric water mass analysis applied to Southern Ocean data, 16th Annual Goldschmidt Conference, Melbourne, Australia, August-September 2006.

8.3. PhD, DEA and Master theses

PhD theses in progress

1. De Galan S., Biogeochemistry of organic and inorganic nutrients in the marine and estuarine environment.
2. Jacquet S. Southern Ocean barium biogeochemistry (joint promotorship with Université Aix- Marseille II, Luminy).
3. de Brauwere A., Optimisation of multiple end-member mixing models for application to Southern Ocean nutrient sections.
4. Cavagna A.-J., Compound specific isotope analysis of Southern Ocean plankton and particulate matter (PLFA's, sterols, biogenic silica), joint promotorship with Royal Museum for Central Africa (Tervuren, Belgium) & Alfred Wegener Institute, Bremerhaven.

DEA & Master Theses

1. Jacquet S., 2002. Baryum dissous en zone frontale dans le secteur Indien au niveau du bassin de Crozet-Kerguelen, durant la campagne Antares-4, Thèse de DEA, Université de la Méditerranée Aix-Marseille II & Vrije Universiteit Brussel.
2. Pollet S., 2003. Biogenic silica in the Southern Ocean: analyses and determination of vertical fluxes, MSc thesis, Universiteit Gent & Vrije Universiteit Brussel.
3. de Brauwere A., 2003. interpretation of optimization algorithms applies to biogeochemical models, MSc thesis, Vrije Universiteit Brussel.
4. Bertoia C., 2005. Contribution to the assessment of ^{234}Th-based export flux during the European Iron Fertilization experiment (EIFEX) in the Southern Ocean, MSc thesis, Vrije Universiteit Brussel.

8.4. Relevant ongoing collaborations:

National

- Christiane Lancelot, Sylvie Becquevort, Véronique Schoemann, Ecologie des Systèmes Aquatiques, Université Libre de Bruxelles
- Luc André, Damien Cardinal, Musée Royale d'Afrique Centrale, Tervuren
- Hugues Goosse, Institut d'Astronomie et de Géophysique, Georges Lemaître, Université Catholique de Louvain
- Alberto Borges, Bruno Delille, Université de Liège
- Johan Schoukens, Rik Pintelon, ELEC, Vrije Universiteit Brussel
- René Van Grieken, Anna Worobiec, MiTAC, Universiteit Antwerpern

International

- Catherine Jeandel, Pieter van Beek, Observatoire Midi Pyrénées, LEGOS, Toulouse
- Cristophe Monnin, Observatoire Midi Pyrénées, LMTG, Toulouse

- Stéphane Blain, Bernard Quéguiner, Dominique Lefebvre, LOB & LMGEM, Centre d'Océanologie de Marseille, Université Aix-Marseille II
- Nicolas Savoye, Observatoire Aquitain des Sciences de l'Univers, OASU, Bordeaux, Arcachon
- Nicolas Metzl, Cécile Lo Monaco, LOCEAN, Université Paris 6
- Tom Trull, Steve Rintoul, Brian Griffiths, William Howard, ACE-CRC and CSIRO, Hobart, Australia
- Phillip Boyd, Marc Gall, NIWA & University of Otago, Dunedin, New Zealand
- Ken Buesseler, Karen Casciotti, Benjamin Van Mooy, S. Pike, WHOI, Woods Hole, USA
- Jim K.B. Bishop, Lawrence Livermore National Laboratory, Berkeley, USA
- Victor Smetacek, Ulli Bathmann, Michiel Rutgers van der Loeff, Dieter Wolg-Gladrow, Mario Hoppema, Joachim Henjes, Claudia Hanfland, Volker Strass Biosciences / Biological Oceanography, Alfred Wegener Institute, Bremerhaven
- Hein de Baar, Royal NIOZ, Texel, The Netherlands
- Jack Middelburg, Eric Boschker, Britta Gribsholt, NIOO-CEME, Yerseke, The Netherlands
- Elisabeth Kopczynska, Antarctic Ecology, Polish Academy of Sciences, Warsaw
- Eugene Murphy, Nadine Johnston, BAS, Cambridge
- Ricardo Santos, Ana Colaço, Departamento de Oceanografia e Pescas, Azores University, Horta

8.5. ANCH expertise and research strategy

Long term research goals of ANCH:
The long term goals of ANCH (Department of Analytical and Environmental Chemistry of Vrije Universiteit Brussel) are related to a better comprehension of environmental processes and the impact of anthropogenic activities on these processes. To achieve these goals research is carried out in four domains of expertise which are interrelated and under continuous development: (1) stable isotope expertise; (2) ultra-trace and speciation expertise; (3) bio-assay expertise and (4) expertise for algorithm development. This research includes first the development and validation of analytical tools and afterwards their application to address environmental questions.

Biogeochemical processes which drive translocations and transformations of carbon, nitrogen and oxygen in the environment can be assessed by use of natural stable isotope ratios of nitrogen, carbon, oxygen in a variety of matrices, such as biological tissue, specific organic compounds (e.g. lipids, chloropigments), biogenic carbonates, dissolved inorganic carbon, nitrogen and oxygen. Furthermore, to gain insight into rates of carbon and nitrogen transformation processes (such as uptake, ammonification, nitrification, denitrification, anamox,) in the aquatic environment, isotope dilution protocols and isotopic mass balance models are particularly suitable. An Isotope Ratio

Mass Spectrometer (IRMS) represents the central analytical equipment connected to a number of peripherals.

The ocean represents an important repository of anthropogenic carbon dioxide. Primary production (= biological carbon pump) is in part responsible for this uptake. Biologically mediated carbon export from the ocean's surface to the ocean's interior and the sediments is studied via a proxy tool kit. First there is the concept of new or nitrate versus old or ammonia production. These rates are determined by using stable isotopes of nitrogen and carbon. Natural 234Th activity deficit vs. 238U and non-lithogenic particulate Ba distribution are proxies informing on the subtraction of carbon out of the surface layers via sedimenting particles and on their mineralization in the deep ocean. Methods for Ba and 234Th extraction (particulate and dissolved) were developed implying analytical equipment such as ICP-MS and low beta counter + HR-ICP-MS.

Proxy records in accreting biogenic carbonates represent archives of environmental conditions. A micro-sampling tool (automated micro-drill) allows sampling these substrates with high spatial resolution for subsequent stable isotopic composition of O and C as well as trace element analysis via ICP-MS and ICP- HRMS. For in-situ sampling and analysis for major, minor and trace elements in carbonate substrates Laser Ablation ICP-MS methods were developed.

Mercury (Hg(II), Hg(0), MeHg), arsenic (As(III), As(V), MeAs, (Me)2As, Arsenobetaine), tin (Sn (IV), (Bu)3Sn, (Bu) 2Sn,…) exist in various forms in the environment all showing different toxicities. Some of these species are mainly produced in situ, but the transformation rates depend on a series of environmental parameters such as redox, temperature, nature of organic matter… In addition aquatic organisms can accumulate even biomagnificate some of the most toxic of those species. The levels of mercury, arsenic and tin in environmental samples are often low so that speciation of the organometallic compounds is difficult. However, biomagnification effects necessitate analyses in the water column (dissolved and particulate phases) and at the lowest level of the trophic chain. Tools (HS-GCAFS, LC-HGAFS, GCPFPD) and analysis procedures are developed and validated for obtaining reliable data on organometal's speciation.

A major environmental problem in our estuaries and coastal seas is that at this moment we are unable to predict the impact of forthcoming water quality changes on future sediment/water exchange fluxes of metals and nutrients. Moreover, even today's fluxes as well as the related biogeochemical processes in aquatic sediments of rivers, estuaries and coastal zones are poorly quantified. To give an answer to those questions high resolution vertical sediment profiles should be assessed because they allow (1) to estimate epibenthic fluxes; (2) to identify biogeochemical processes and their precise location in the sediment; (3) to calculate process rates via modeling. New tools such as micro-electrodes or diffusion equilibrium techniques (DET) and diffusion gradient techniques (DGT) are promising with respect to the determination of high resolution

profiles in pore water. Also for the solid phase new technologies for hardening and stabilizing the sediment material are necessary. Then they can be analyzed by Laser ablation ICP-MS, thin-window XRF techniques or other sensitive beam techniques. Also micro-drill sampling with the automated micro-drill and subsequent dissolution of the material allows determining high resolution profiles in the solid sediment phase.

With passive samplers time averaged measurements of pollutants in the water column can be made. The above mentioned DET and DGT samplers allow assessing the concentrations in the dissolved phase of hydrophilic compounds (total and labile bound). The analysis of these compounds can be performed with ICP-MS, Ion chromatography … For lipophilic compounds similar passive samplers have to be conceived. The analyses of the organic pollutants can be made by genetically modified genes. For dioxins and dioxin-like compounds for example the CALUX Bio-assay was developed. The recombinant cell line is modified to include a luciferase reporter plasmid responsive to the liganded Ah receptor–Arnt complex. When this complex is present in the cells, they produce luciferase, the light-emitting enzyme found in the common firefly. This activity is quantified as bioluminescence emission that is recorded by an automated luminometer. This assay is very sensitive and can be used to measure subpicogram amounts of the 17 toxic dioxin and furan compounds.

Often we try to extract more information from a dataset than it is possible and we do that in an intuitive way (for example the calculation of plankton uptake and regeneration rates). However, in the presence of measurement errors this can lead to a very poor and even dangerous behavior: the user wouldn't notice that something is going seriously wrong. This is the major motivation for the development of the identification theory. It offers a systematic approach to 'optimally' fit mathematical models to experimental data, eliminating stochastic distortions as much as possible and identifying model errors.
Each measurement (or identification session) consists of a series of basic steps: collect information about the system; select a (non) parametric model structure to represent the system; select the model parameters to fit the model as well as possible to the measurements (this requires a "goodness of fit" criterion); validate the selected model.
Our long term goal is to build measurement based models for environmental systems. Employing the information theory, a 'good' model can be proposed to simulate the real world. Such a 'good' model is not necessarily the most complex one. On the contrary, it only needs that complexity, which is supported by experimental measurements. It has to be able to describe all significant variation in the data, without modeling the stochastic measurement uncertainties. These models are used for three purposes: (i) to extract the maximum amount of significant information out of noisy measurements; (ii) which leads to a better understanding of the processes that drives the model; and (iii) to make future predictions more precise.

Members Academic Personnel (AP-leden) ANCH:

ZAP-leden
BAEYENS, WILLY
DEHAIRS, FRANK
GOEYENS, LEO

Post-docs
ELSKENS, MARC
LEERMAKERS, MARTINE
BRION, NATHALIE
BOUILLON, STEVEN
DE RIDDER, FEDOR
MAZOUA, STEPHANE

PhD-students
DE GALAN, SANDRA
DEBRAUWERE, ANOUK
SCHROIJEN, CARMEN
CAVAGNA, ANNE-JULIE
GAO, YUE
SANCTORUM, HERMES
CHEVALIER, EMILIE
JACQUET, STEPHANIE
MANGINON, PERINNE
BAUWENS, MAITE
QUOC TRAN, BAO
NAHIMANA, DAVID
PRADIT, SIRIPORN
AGA, HOMIRA
DIACONU, CRISTINA

ATP-leden
CLEMENT, JEAN-PIERRE
NAVEZ, JACQUES (50%)
KORNTHEUER, MICHAEL
GOEYENS, KAREN
VAN DE PERRE, GODELIEVE (20%)

PhD ANCH since 2000:

1. Stéphane Mazoua: Cryptosporidium and Giardia: Assessment of the efficiency of a drinking water treatment plant (2005-2006). Promoter Willy Baeyens
2. Loreto De Brabandere: Autotrophic and heterotrophic food sources of copepods in the Scheldt estuary as traced by stable N and C isotopes (2004-2005). Promoter Frank Dehairs

3. David Gillikin: Geochemistry of Marine Bivalve Shells: the potential for paleoenvironmental reconstruction (2004-2005). Promoter Frank Dehairs, copromoter Willy Baeyens
4. Fedor De Ridder: Identification of the Time Base in Environmental Archives (2004-2005). Copromoter Frank Dehairs
5. Hong Lien Nguyen: Biogeochemistry of heavy metals in freshwater ecosystems. Case studies: Lake Balaton and Upper Tisza River, Hungary (2003-2004). Promoter Willy Baeyens
6. Shan Margaret Chen: Suspended Matter and Flocculation in the Estuarine Environment (2003-2004). Copromoter Willy Baeyens
7. Marianne De Gieter: Fate of arsenic in a marine and estuarine ecosystem (2003-2004). Promoter Willy Baeyens
8. Koen Parmentier: Biogeochemical behaviour of trace metals in the Scheldt estuary and the Southern Bight of the North Sea in the period 1995-1998 (2002-2003). Promoter Willy Baeyens
9. John Gichuki: Ecosystem functioning in African tropical freshwater wetlands: Insights from stable isotopes and water quality analysis (Nyanza Gulf, Lake Victoria, Kenya) (2002-2003). Copromoter Frank Dehairs
10. Steven Bouillon: Organic carbon in a southeast Indian mangrove ecosystem: sources and utilization by different faunal communities (2002-2003). Promoter Frank Dehairs
11. Ana Colaço: Trophic ecology of deep-sea hydrothermal vent fields from the Mid-Atlantic Ridge (2001-2002). Doctoral Thesis, Faculdade de Ciencias, Universidade de Lisboa, 2001. Copromoter Frank Dehairs
12. Erika Vander Putten: High resolution distribution of trace elements (analysed by Laser Ablation Microprobe - LA - ICP - MS) in the shell of modern Mytilus edulis: An archive of environmental variations ? (1999-2000) Promoter Frank Dehairs
13. Liesbet Hellings: Origin and fate of dissolved inorganic and particulate organic carbon in a highly polluted estuary (The Scheldt) as traced by stable carbon isotopes (1999-2000). Promoter Frank Dehairs, copromoter Willy Baeyens
14. Ahmed M'Harzi: Phytoplankton community structuring in some areas of the North Sea (1999-2000). Copromoter Leo Goeyens
15. Clavery Tungaraza: Investigation of environmental changes caused by increasing nitrogen inputs and responses of phytoplanktons in the North Sea (1999-2000). Promoter Willy Baeyens, copromoter Nathalie Brion

Publication ANCH since 2001

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Relevant projects (since 2001)

- SWIFT (FP6). EU 189: 2004 - 2006 (40000 EUR)
- STARDUST (Programma INTERREG III - Frankrijk-Wallonië-Vlaanderen). EU163: 2002 -2005 (225000 EUR) (Ministère de la Région Wallonne, INTERREG III)
- STARDUST (Programma INTERREG III Phase2- Frankrijk-Wallonië-Vlaanderen). EU163 2005 – 2007 (173250 EUR) (Ministère de la Région Wallonne, INTERREG III)
- Export and internal fluxes of organic matter and nutrients in the waters of the Brussels region: Impact on the changing waste water management. BRGEOZ25: 2001 – 2004 (218036,24 EUR) (Prospective Research for Brussels)

- Macrophytes and nutrient dynamics in the upper reaches of the Scheldt basin DWTC117: 2002 – 2006 (190000EUR) (PODO)
- Biogeochemical carbon-, nitrogen-and phosphorus fluxes in the North Sea (also in DWTC19). DWTC108: 2002 – 2006 (349000 EUR) (PODO)
- Assessing the sensivity of the Southern Ocean's biological pump to climate change. DWTC65: 2000 - 2005 — 350620,6 EUR (PODO).
- Validation of alternative marine calcareous skeletons as recorders of global climate change. DWTC70: 2000 – 2005 (248389,33 EUR) 84 man months (PODO).
- Analysis of arsenic and mercury derivatives, trace metals and persistent toxic organic compounds in fish from seas, estuaries, rivers and fresh water systems. FVO6: 1998 - 2004 (444658,52 EUR) — 8 man months (Min. Sociale Zaken, Volksgezondheid en Leefmilieu).
- Centre for Health and Environment VLV57: 2001 - 2006 (3839182,07 EUR) (Dept. Welzijn, Volksgezondheid en Cultuur).
- IUC Programme VLIR-SUA (Tanzania, institutional project). Sub-project 5: Faculty of Sciences (Fos) – capacity building 2003 – 2007.
- Sea Scheldt: Research on the consequences of the sigmaplan, dredging activities and port extension in the Sea Scheldt on the environment. 16EI/01/37-Perceel 2): study of the carbon cycle. VLL12: 2002 – 2006 (60572,6 EUR) (Dept. Leefmilieu en Infrastructuur).
- De biologische koolstofpomp in de oceaan: Modellering van koolstofafvoer en mineralisatie. FWOTM307: 2003 – 2005. 24 man months (Aspirant).
- Trophic role and ecologic destination of microbial production and leaf fall in mangrove-ecosystems. FWOAL195: 2002 – 2005 (193034,85 EUR). 24 man months.
- Balance of heterotrophic and autotrophic processes in the Scheldt estuary and impact on the carbon-and nitrogen flows. FWOAL208: 2002 – 2004 (182497,19 EUR) 36 man months.
- Koolstofexport en heterotrofe afbraak van planktondetritus in de oceaan. FWOAL272: 2004 -2007 (90900 EUR).
- The role of freshwater marshes in the sequestration and transformation of nitrogen in an estuary: A whole ecosystem 15N labelling study. FWOAL231: 2002 – 2004 (14873,61 EUR)
- Redistribution of atmospheric CO2 in the ocean's interior via the biological pump: to what extent can top-down and bottom-up approaches converge? GOA22: 2001 – 2006 (1150000 EUR) 102 man months (GOA).
- Koolstof export en heterotrofe afbraak van planktondetritus in de oceaan. OZR949: 2004 – 2004 (5000 EUR).
- Spatial and temporal assessment of high resolution depth profiles using novel sampling techniques. AII16: 2002 – 2005 (25614,75 EUR) (European COPPER institute).

- Impactstudie van radio-elementen in de Laak; de Molse Nete e.a. met behulp van nieuwe technologieën. ANI39 2005 – 2006 (80000 EUR).
- Ontwikkeling van stabiele isotopen technieken voor de studie van biogeochemische cycli in aquatische systemen. FWOAL370: 2006 – 2009 (234400 EUR)
- EuroCLIMATE. FWOAL349: 2005 – 2007 (55500 EUR)
- BELCANTO – Antarctica (DWTC). SD/C1/03A: 2006 - 2007 (189000 EUR)
- CALMARS – Global Change (DWTC). SD/CS/02A : 2006- 2007 (186165 EUR).
- Horizontale Onderzoeksactie (HOA). Klimaatreconstructie: Experimenten, Modellen en Complexiteit. 2005 – 2007 (200000 EUR).

9. Curriculum vitae

WILLY BAEYENS – HEAD OF THE DEPARTMENT OF ANALYTICAL AND ENVIRONMENTAL CHEMISTRY

1. GENERAL INFORMATION:

Address: Vrije Universiteit Brussel (V.U.B.), Analytical and Environmental Chemistry (ANCH), Pleinlaan 2, 1050 Brussels.
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Studies:
-Undergraduate at Antwerp University (R.U.C.A.): 1967-1969
-Graduate at Brussels University (V.U.B.): 1969-1971
-Ph.D. at Brussels University (V.U.B.) in 1977.
Title: "A contribution to the understanding of the transport mechanisms of mercury in an estuary. The development of a two-dimensional, time-depending dispersion model", in Dutch.

Expertise:
-Health and Environment (Coordinator Vlaams Steunpunt Milieu-Gezondheid)

-Development of Novel Analytical Tools to study Environmental and Health related topics
-Aquatic Systems (Productivity and Pollution)
-Biological Pump and Export Production in the Ocean
-Food Quality

Professional
-Full-Professor at V.U.B.

-Head of the Laboratory of Analytical and Environmental Chemistry

Other functions

-President of the Royal Academy of Sciences: Committee of Oceanology.
-Member of the Editorial Board of the International Scientific Journal: "Environmental Science and Policy".
-Vice-president of the Executive Board of the Belgian Institute of Radioactive Waste (NIRAS).
-Member of the Executive Board of the Belgian Nuclear Agency (FANC).

-Member of the commission for "Contract Research", FOD Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu.
-President of BRUEGEL, Brussels Research Unit for Environmental, Geochemical and Life Science Studies. Integration of laboratories of VUB, ULB, KMMA/MRAC and WIV/ISP.

2. TEACHING:

General Chemistry - Analytical Chemistry - Environmental chemistry

3. SCIENTIFIC RESEARCH

SCIENTIFIC PUBLICATIONS: 209 + 11 submitted (see list)

Books:

Regional and Global Mercury Cycles: Sources, Fluxes and Mass Balances, NATO ASI Series, Kluwer, Dordrecht, 1996, 563pp.

Trace metals in the Westerschelde estuary: A case study of a polluted, partially anoxic estuary, Kluwer, Dordrecht, 1998, 170pp.

Analytical methods for comprehensive dioxin assays, Talanta, Vol. 63, No 5, 2004, 1095-1280.

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Researcher at Université Libre de Bruxelles, (Laboratoire de Géochimie; Prof. J. Jedwab).
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Research subjects: Geochemical study of suspended matter from the Atlantic and Pacific Oceans using Scanning Electron Microscope and Electron Microprobe (SEM-EMP) techniques; Study of the biogeochemical cycle of barium in the oceans using SEM-EMP and Instrumental Neutron Activation Analysis (INAA) techniques. This research was conducted in the framework of the GEOSECS Programme, under the promotorship of Dr. R. Chesselet (Centre des Faibles Radioactivités, CNRS, Gif-sur-Yvette, France) and Prof. J. Jedwab (Laboratoire de Géochimie, Université Libre de Bruxelles) and resulted in the presentation of a Doctoral Thesis entitled: "Discrete suspended particles of barite and the barium cycle in the open ocean". Prof. T.M. Church, University of Delaware, Delaware, USA, was invited member of the jury.

1979 - 1980:
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1980 - 1982:
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1982 - 2001:
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Research subjects: The biogeochemistry of metals and trace metals in the North Sea and Scheldt Estuary; Biogeochemical cycling of carbon, nitrogen, silicon, calcium, strontium, barium in oceanic systems; Cycling of biogenic elements in the Southern Ocean; regional and seasonal variability in new and regenerated production in the Southern Ocean; Trophic interactions in riverine, estuarine, mangrove and hydrothermal deep-sea

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- October 1979 and January 1984: Visits to Delaware University in Newark and Lewes, Delaware, USA; Prof. T.M. Church.
- July - October 1990: Stay in the laboratory of Prof. T.M. Church at the Lewes Marine Research Station of the University of Delaware, Delaware, USA. Biogeochemical study of Delaware Estuary and Chesapeake Bay and adjacent salt marsh systems. Barium biogeochemistry. Teaching contribution to the course "Biogeochemical Oceanography; Ocean/Atmosphere Chemical Fluxes"; CMS-867-10.
- September 1995 - June 1996: Sabbatical (Poste Rouge). Observatoire Midi Pyrénées, Toulouse, France ; Unité UMR 5566 (CNRS-CNES); Drs J.F. Minster & C. Jeandel). Barium biogeochemistry in the Southern Ocean.

8. Teaching:

- Biogeochemistry: Stable isotopes, fractionation processes & applications in the environmental sciences (15h); Master in Chemistry, option Environmental Chemistry, Vrije Universiteit Brussel.
- Open Ocean Biogeochemical Processes, The carbonate system; the biological carbon pump (15h); Master in Chemistry, option Environmental Chemistry, Vrije Universiteit Brussel.
- Marine Chemistry (15h): Master in Chemistry, option Environmental Chemistry, Vrije Universiteit Brussel.
- Environmental Seminars (15h): Master in Biology, Geography, Chemistry, Vrije Universiteit Brussel.
- General Ecology (15h): Bachelor in Chemistry, Vrije Universiteit Brussel.
- Marine Physico-Chemistry (15h): Master in Ecological Marine Management (ECOMAMA), Vrije Universiteit Brussel.
- Marine Physico-Chemistry (10h): Master in Advanced studies in Marine and Lacustrine Sciences (MARELAC), Universiteit Gent.

9. Promoter / co-promotor of MSc, DEA theses (since 2000):

1. Fisseha Derseh R., 2000. Use of stable isotopes as a tracer of domestic sewage pollution in the Woluwe brook - Woluwe sewer collector system, MSc thesis, Vrije Universiteit Brussel.
2. Trinh Anh Duc, 2000. Assessment of sewage effluents impact on Woluwe river water quality using dissolved Rb/Sr ratio, MSc thesis, Vrije Universiteit Brussel.
3. Tran Quoc Bao, 2001. Variability of $\square^{15}N$ in the particulate organic matter pool of Scheldt river: role of microheterotrophs during litter decomposition, MSc thesis, Vrije Universiteit Brussel.
4. Vanhevel S., 2001. Migratie van juveniele haring (*Clupea harengus*) tussen de Noordzee en het Schelde estuarium zoals aangetoond met stabiele C en N isotopen, MSc thesis Katholieke Universiteit Leuven.
5. Jacquet S., 2002. Baryum dissous en zone frontale dans le secteur Indien au niveau du bassin de Crozet-Kerguelen, durant la campagne Antares-4, Thèse de DEA, Université de la Méditerranée Aix-Marseille II.

6. Guelinckx J., 2002. Migratie van juveniele haring (*Clupea harengus*) en sprot (*Sprattus sprattus* (L.)) tussen de Noordzee en het Schelde-estuarium zoals aangetoond met stabiele C en N isotopen, MSc thesis, Katholieke Universiteit Leuven.
7. Nguyen Le Phu, 2002. Temporal evolution of C/N ratio and □^{15}N of willow leaves decomposing in Scheldt water, MSc thesis, Vrije Universiteit Brussel
8. Verlinden N., 2002. Stikstofdynamiek en nitrificatie in het estuarium van de Schelde, MSc thesis, Vrije Universiteit Brussel.
9. Overmeere I., 2002. A carbon and nitrogen stable isotope study to trace food web dynamics in two Sri Lankan mangrove ecosystems, MSc thesis, Vrije Universiteit Brussel.
10. Guo Ping, 2002. A stable isotope investigation of the seasonal variability of nutrients and organic matter in the Zenne river, MSc thesis, Vrije Universiteit Brussel.
11. Ulens H, 2003. The potential of the bivalve *Saxidomus giganteus* as a recorder of (paleo)environmental conditions, MSc thesis, Vrije Universiteit Brussel.
12. Pollet S., 2003. Biogenic silica in the Southern Ocean: analyses and determination of vertical fluxes, MSc thesis, Vrije Universiteit Brussel.
13. Steenmans D., 2004. Do marine bivalve shells record paleo-productivity? MSc thesis, Vrije Universiteit Brussel.
14. Li Meng, 2004. Can bivalves be used as archives of anthropogenic carbon input to the marine environment? MSc thesis, Vrije Universiteit Brussel.
15. Mai Than An, 2004. Incorporation of ammonium into different size fractions of suspended particulate matter in freshwater tidal creeks: A contribution to a whole ecosystem ^{15}N labeling study, MSc thesis, Vrije Universiteit Brussel.
16. Bertoia C., 2005. Contribution to the assessment of ^{234}Th-based export flux during the European Iron Fertilization experiment (EIFEX) in the Southern Ocean, MSc thesis, Vrije Universiteit Brussel.

Ongoing:

Adi Nugraha, Modelling of oxygen production and consumption in a small river colonized by macrophytes, MSc thesis, Vrije Universiteit Brussel.

Ralison Harifidy O., Biogeochemistry of the Betsiboka Estuary and Mangroves (Madagascar), MSc thesis, Vrije Universiteit Brussel.

10. Promotor / co-promotor of PhD theses (since 1996):

1. Kazungu J., 1996. Nitrogen transformational processes in a tropical mangrove ecosystem (Gazi Bay, Kenya), Doctoral Thesis, Vrije Universiteit Brussel.
2. Semeneh M., 1997. The relationship between phytoplankton community structure and nitrogen uptake regime in the Southern Ocean, Doctoral Thesis, Vrije Universiteit Brussel.
3. Rao R., 1997. Tracing carbon flow in the mangrove ecosystem of Godavari Delta, India, Doctoral Thesis, Human Ecology, Vrije universiteit Brussel.
4. Marguillier S., 1998. Stable isotope ratios and food web structure of aquatic ecosystems, Doctoral Thesis, Vrije Universiteit Brussel.
5. McCourt J., 1998. A chemical study of trace metals and metallothionein induction in the Baltic clam, *Macoma baltica* from the Western Scheldt estuary, Doctoral Thesis, Vrije Universiteit Brussel.
6. Hellings L., 2000. Origin and fate of dissolved inorganic and particulate organic carbon in a highly polluted estuary (The Scheldt) as traced by stable carbon isotopes, Doctoral Thesis, Vrije Universiteit Brussel.
7. Vander Putten E., 2000. High Resolution distribution of trace elements in the shell of modern *Mytilus edulis*: An archive of environmental variations? Doctoral Thesis, Vrije universiteit Brussel.
8. Colaço A., 2001. Trophic ecology of deep-sea hydrothermal vent fields from the Mid-Atlantic Ridge, Doctoral Thesis, Faculdade de Ciencias, Universidade de Lisboa.

9. Gichuki J., Carbon and nitrogen cycling processes in the payrus dominated wetland ecosystems of Lake Victoria (Kenya): The case of the lower Sondu Miriu swamp, Doctoral Thesis, Vrije Universiteit Brussel.
10. Bouillon S., 2003. Organic carbon in a southeast Indian mangrove ecosystem: sources and utilization by different faunal communities, Doctoral Thesis, Vrije Universiteit Brussel.
11. De Ridder F., 2004. System identification techniques employed for the validation of marine calcareous skeletons as recorders of global climate change, Doctoral Thesis, Vrije Universiteit Brussel.
12. De Brabandere L., 2005.Trophic interactions along an estuarine gradient (the Scheldt estuary) as traced by stable C and N compositions, Doctoral Thesis, Vrije Universiteit Brussel.
13. Gillikin D., 2005. Validation of alternative marine calcareous skeletons as recorders of global climate change, Doctoral Thesis, Vrije Universiteit Brussel.

Ongoing PhD's (titles are tentative)

14. Jacquet S. (joint promotorship with Université Aix- Marseille II, Luminy), Southern Ocean barium biogeochemistry
15. de Brauwere A., Optimisation of multiple end-member mixing models for application to Southern Ocean nutrient sections.
16. Cavagna A.-J., Compound specific isotope analysis of Southern Ocean plankton and particulate matter (PLFA's, sterols, biogenic silica), joint promotorship with Royal Museum for Central Africa (Tervueren, Belgium) & Alfred Wegener Institute, Bremerhaven.
17. Mangion P., Nitrogen processing in East Africa mangrove ecosystems.
18. Riou V. (joint promotorship with Azores University, Horta), Compound specific isotope analysis to resolve between different chemolithotrophy-based trophic dependencies in MAR hydrothermal systems.
19 Quoc Tran B., Stable isotope tools to understand C and N cycling in Mekong delta areas affected by aquaculture practices.
20. Chevalier E., Stable isotope tools to study the C and N cycling in the Scheldt estuary.
21. Bauwens M., Ba and stable isotopes in blue mussel shells as proxies recording changing environmental conditions.
22. Mas R. Trace element and stable isotope proxies in marine biogenic carbonates as proxies of environmental conditions.

11. Member of Scientific Evaluation Committees:

- 1991 – 2001: Member of the Scientific Committee 'Ecology' of Research Foundation Flanders, Belgium.
- 1991 – 2006: Member of the Scientific Committee 'Biologie Animale', Fonds Nationale de la Recherche Scientifique, Belgium.
- 1998-2001: Member of the Scientific Committee 'DORSALES', CNRS-INSU, France.
- 2002-2007: Member of the Flemish– Dutch scientific committee for coastal & estuarine research (Research Foundation Flanders – Netherlands Organization for Scientific Research; FWO - NWO).
- 2002 - 2004: Member of the Scientific Committee 'PROOF', CNRS-INSU, France.

Review and referee tasks (since 2000):

More than 14 research proposals were reviewed on ad-hoc basis, in addition to reviews performed as a member of the scientific committees listed above. I acted as a referee for more than 10 applications for Post Doc positions and Professorships and as a jury member of for 15 PhD and 2 HDR theses.

12. Research interests:

- 1973- 1979: Research in the field of marine biogeochemistry in the framework of the

GEOSECS programme. Contribution to a better understanding of the barium cycle in the ocean and demonstration of the importance of biological control upon this cycle.
- From 1980 to 1985: Research on biogeochemical cycling of heavy metals in the North Sea, the Channel and the Scheldt estuary. EU funding.
- From 1986 - 2007: Study of new and regenerated production, export production, deep-sea organic carbon mineralization, applying a multi-proxy approach (Ba; Biomarkers ^{15}N, ^{13}C natural abundances, isotope dilution experiments, modeling; ^{234}Th-deficit). Focus is on the Southern Ocean, the N.E. Atlantic and the North Pacific. Funding provided by the Federal Science Policy programme (BELSPO, SPSD II & SDD, Global Change and Biodiversity); Research Foundation - Flanders; EU Network of Excellence EUROCEANS. Co-operation with: Université Libre de Bruxelles; Royal Museum for Central Africa, Tervuren; Université de Liège; Université Catholique de Louvain; Université Paris VI; Institut Universitaire Européen de la Mer, Brest; Observatoire Midi Pyrénées, LEGOS, Toulouse; Université Marseille II, Luminy, Alfred Wegener Institute, Bremerhaven; Royal Netherlands Institute for Sea Research, NIOZ, Texel, The Netherlands; CSIRO, Hobart Tasmania; Australian Antarctic Division, Tasmania; Antarctic CRC, University of Tasmania; Polish Academy of Sciences; British Antarctic Survey; Woods Hole Oceanographic Institute, Woods hole, USA; University of Otago, Dunedin, New Zealand, Lawrence Livermore National Laboratory, Berkeley, USA; University of Kiel; Plymouth Marine Laboratories; Southampton Oceanography Centre.
- From 1989 - 2007: Research on East-African (Kenya), Indian (Bay of Bengal) and Sri Lankan mangrove ecosystems. Studies on carbon and nitrogen cycling to assess relative importance of mangrove litter to the aquatic biota in lagoon and coastal area; C & N transfer in the food chain. EU funding. Co-operation with: Universiteit Gent; Centre for Estuarine and Marine Ecology, NIOO-CEME, Yerseke, The Netherlands; Institute of Marine Research, Guia Marine Laboratories, Portugal; Catholic University Nijmegen; University of Stockholm; Kenya Marine and Fisheries Research Institute, Mombasa Kenya; Andhra University, Andhra Pradesh. India; Ruhuna University, Sri Lanka; Institut Français de Pondichéry, India.
- Since 1995: Terrestrial carbon and nitrogen inputs and transformations, trophic relationships in a river system and adjacent wetlands, river Scheldt. Funding by Flanders Regional Government (AMINAL), Research Foundation – Flanders; Federal Science Policy BELSPO, SPSD II, Global Change and Biodiversity. Co-operation with: Institute for Nature Conservation, Brussels; Universiteit Gent; Universiteit Antwerpen; Katholieke Universiteit Leuven; Université Libre de Bruxelles; Centre for Estuarine and Marine Ecology, NIOO-CEME, Yerseke, The Netherlands.
- 1996 – 1999 & 2004-2007: Food chain structure of benthic and pelagic communities from deep-sea hydrothermal vents in the Atlantic (EU funding: AMORES & MOMARNET Projects). Co-operation with: IFREMER Brest; Guia Marine Laboratories, Lisbon & LabHorta, Horta, Azores, Portugal.
- 2001-2007: Biogenic marine carbonates as archives of global climate change (CALMARS I & II). Funding by Federal Science Policy, BELSPO, SPSD II & SSD, Global Change and Biodiversity & Research Foundation - Flanders – ESF (EUROCLIMATE, PALEOSALT project). Co-operation with Universiteit Antwerpen; Université Libre de Bruxelles; Royal Museum for Central Africa, Tervuren; Royal Institute for Natural Sciences, Brussels; Alfred Wegener Institute, Bremerhaven, Germany; Institut Universitaire Européen de la Mer, Brest; Université d'Angers; Hebrew University; Royal Netherlands Institute for Sea Research, Texel, The Netherlands.

13. Ongoing collaborations :

National
- Christiane Lancelot, Sylvie Becquevort, Véronique Schoemann, Ecologie des Systèmes Aquatiques, Université Libre de Bruxelles
- Luc André, Damien Cardinal, Musée Royale d'Afrique Centrale, Tervueren

- Hugues Goosse, Institut d'Astronomie et de Géophysiques Georges Lemaître, Université Catholique de Louvain
- Alberto Borges, Bruno Delille, Université de Liège
- Philippe Dubois, Université Libre de Bruxelles
- Philippe Willenz, Institut Royal des Sciences Naturelles
- Rony Blust, Patrick Meire, René van Grieken, Universiteit Antwerpen
- Tom Moens, Universiteit Gent
- Frans Ollevier, Joachim Maes, Katholieke Universiteit Leuven

International

- Catherine Jeandel, Pieter van Beek, OMP, LEGOS, Toulouse
- Cristophe Monnin, OMP, LMTG, Toulouse
- Stéphane Blain, Bernard Quéguiner, Université Aix-Marseille II
- Yves-Marie Paulet, Laurent Chauvaud, Paul Tréguer, IUEM, Brest
- Nicolas Savoye, OASU, Bordeaux, Arcachon
- Nicolas Metzl, LOCEAN, Paris 6
- Jean-Luc Charlou, Ifremer, Brest
- Mathilde Cannat, IPGP, Paris 6
- Tom Trull, Steve Rintoul, Brian Griffiths, William Howard, ACE-CRC and CSIRO, Hobart
- Phillip Boyd, NIWA University of Otago, Dunedin, NZ
- Ken Buesseler, Karen Casciotti, Ben Van Mooy, WHOI, Woods Hole
- Jim K.B. Bishop, Lawrence Livermore National Laboratory, Berkeley
- Jelle Bijma, Dieter Wolf-Gladrow, Biosciences / Biogeosciences, Alfred Wegener Institute, Bremerhaven
- Peter Swart, Rosenstiel School of Marine and Atmospheric Science, University of Miami
- Victor Smetacek, Ulli Bathmann, Michiel Rutgers van der Loeff, Biosciences / Biological Oceanography, Alfred Wegener Institute, Bremerhaven
- Hein de Baar, Royal NIOZ, Texel, The Netherlands
- Jack Middelburg, Eric Boschker, Britta Gribsholt, NIOO-CEME, Yerseke, The Netherlands
- Elisabeth Kopczynska, Antarctic Ecology, Polish Academy of Sciences
- Eugene Murphy, BAS, Cambridge
- Ricardo Santos, Ana Colaço, Azores University, Horta

14. Research Grants obtained (since 1994):

1. EU-MAST (1994-1996): Ocean Margin Exchange (OMEX), (MAS2*CT93-0069). Co-ordination by Université Libre de Bruxelles. Budget: 127,000€.
2. EU-INCO (1994-1997): An assessment of the ecological importance of mangroves in the Kakinada area, Andhra Pradesh, India (IC1*CT93-0320). Co-ordination by VUB-ANCH. Budget: 99,910€.
3. EU-INCO (1994-1998): Anthropogenically induced changes in groundwater outflow and quality, and the functioning of eastern African nearshore ecosystems (GROFLO), (ERB IC18*CT96-0065). Co-ordination by Centre for Estuarine and Marine Ecology, NIOO-CEME, Yerseke, The Netherlands. Budget: 138,000€.
4. EU-MAST (1996-1998): Azores Mid-Oceanic Ridge Ecosystem (AMORES), Biology of the hydrothermal communities at the vent-field scale: Natural carbon and nitrogen isotopes (MAS3*CT95-0040), Co-ordination by IFREMER. Budget: 78,000€.
5. Flemish Community - AMINAL, OMES 1 (1996-1999): The SIGMA-plan and environmental impact of dredging activity in the Scheldt and harbour of Antwerp (AMIS DS6.3), Budget: 368,122€.
6. Research Foundation - Flanders (1996-1999): Fundamental Ecological aspects of mangrove ecosystems and impact of anthropogenic stress (G.00569N). Budget: 3,600,000 Bfr.

7. Federal Science Policy, OSTC, Antarctica Phase IV (1996-1999): An integrated approach to assess carbon dynamics in the southern ocean, (A4/03/B11). Budget: 19,640,000 Bfr.
8. EU-MAST (1998-2000): Ocean Margin Exchange (OMEX II), The carbon cycle at the Iberian Margin, (MAS3*CT97*0076). Co-ordination by Université Libre de Bruxelles. Budget: 172,000€.
9. EU-INCO (1998-2002): Assessment of mangrove degradation and resilience in the Indian sub-continent (ERB IC18*CT98-0295). Co-ordination by VUB-ANCH. Budget: 196,650€.
10. EU-RTN Marie Curie Research Training Grant (1999-2000): LA-ICP-MS analysis of trace elements in biogenic minerals: Time series recording of environmental changes (ERB*FMBI-CT98-3440). Budget: 148,998€.
11. Research Foundation - Flanders (1999-2002): Biotic interactions in turbid estuarine systems (G.0104.99). Budget: 4,506,000 Bfr.
12. Research Foundation – Flanders (2001-2004): Stable isotope analysis of D/H, 13C/12C, 15N/14N, 18O/16O for application in the Geological, Environmental and Archaeological domains (G.0177.01). Budget: 300,000€ (IRMS equipment).
13. Research Foundation - Flanders – Netherlands Organisation for Scientific Research; Flemish – Dutch co-operation (2002-2004): Tidal freshwater marshes as processors and sinks of nitrogen in estuaries: a whole ecosystem ^{15}N-labeling study (G.0439.02). Co-ordination by Centre for Estuarine and Marine Ecology, NIOO-CEME, Yerseke, The Netherlands. Budget: 14,874€.
14. Research Foundation - Flanders – Netherlands Organisation for Scientific Research, Flemish – Dutch co-operation (2002-2004): The balance between heterotrophic and autotrophic processes in the Scheldt estuary: Consequences for the carbon and nitrogen cycles, (G.0438.02); Co-ordination by Centre for Estuarine and Marine Ecology, NIOO-CEME, Yerseke, The Netherlands. Budget: 89,093€.
15. Research Foundation - Flanders (2001-2005): Trace elements as proxies of biogeochemical processes in aquatic systems (G.0117.02). Budget: 216,659€ (Element 2 HR-ICP-MS equipment).
16. Research Foundation - Flanders (2002-2005): Trophic significance and ecological fate of microbial production and leaf litter in mangrove ecosystems (G.0118.02). Budget: 142,415€.
17. Federal Science Policy, BELSPO, Scientific support Plan for a Sustainable Development policy, SPSD II, Global Change – Antarctica (2000-2004): Assessing the impact of climate change on the functioning of the Southern Ocean biological pump (BELCANTO II) (EV/03/7A). Budget: 350,621€.
18. Federal Science Policy, BELSPO, Scientific support Plan for a Sustainable Development policy, SPSD II, Global Change, (2001-2005): Validation of alternative marine calcareous skeletons as recorders of global climate change (CALMARS), (EV/03/4B). Budget: 248,389€.
19. Flemish Community - AMINAL, OMES 2 (2001-2006): The SIGMA plan and environmental impact of dredging actvities in the Scheldt and harbour of Antwerp. Budget: 156,000€.
20. Research Council Vrije Universiteit Brussel, Concerted Actions (2001-2006): Redistribution of atmospheric CO_2 in the ocean's interior via the biological pump: to what extent can top-down and bottom-up approaches converge? (GOA 22). Budget: 1,150,000€.
21. Research Council Vrije Universiteit Brussel (2002): Impact of climate change on the biological carbon pump in the Southern Ocean. Budget: 37,500€.
22. Federal Science Policy, BELSPO, Scientific support Plan for a Sustainable Development policy, SPSD II, Global Change (2003-2005), Macrophytes and nutrient dynamics in the upper reaches of the Schelde basin (MANUDYN), co-ordination by Universiteit Antwerpen. Budget: 190,000 €.
23. Research Foundation - Flanders (2004–2007). Export of organic carbon from the oceanic surface mixed layer and mineralisation in the twilight zone. Budget: 210,000€ (including equipment: RISO Low Beta counter).

24. Research Foundation – Flanders (2006-2009), Development of stable isotope techniques for the study of biogeochemical cycles in aquatic ecosystems and the reconstruction of (paleo)-environmental conditions. Budget 400,000€ (IRMS equipment & personnel).
25. EU STREP (2005–2008), Peri-urban mangrove forests as filters and potential phytoremediators of domestic sewage in East Africa (PUMPSEA), co-ordination by Guia Marine Laboratories, Lisbon, Portugal. Budget: 82,000€.
26. EU Marie Curie Training Network (2005–2008), MOMARNET. Budget: 109,890€.
27. EU Network of Excellence EUROCEANS (2005–2008). Budget: 83,000€.
28. ESF EUROCLIMATE & Research Foundation – Flanders (2005–2007), PALEOSALT. Budget 18,000€.
29. Federal Science Policy, BELSPO, Science for a Sustainable Development, SSD, (2005-2007), Integrated Study of Southern Ocean Biogeochemistry and Climate Interactions in the Anthropocene (BELCANTO III). Budget: 189,000€.
30. Federal Science Policy, BELSPO, Science for a Sustainable Development, SSD (2005-2007), Critical evaluation of marine calcareous skeletons as recorders of global climate change (CALMARS II). Budget 186,200€.

Projects submitted in 2006; evaluation pending:

Research Foundation – Flanders: A multi-proxy assessment of carbon and nitrogen cycling in tropical and temperate estuaries; 4 years project; Budget requested: 260,000€.

Federal Science Policy, BELSPO, Science for a Sustainable Development, SSD: Macrophytes and nutrient dynamics in the upper reaches of the Schelde basin (MANUDYN II); 2 years project; Budget requested: 125,000€.

15. Contribution to international oceanography programmes and expeditions:

1. 1972 -1979: GEOSECS. *Contribution*: The barium biogeochemistry in the Atlantic Ocean.
2. 1976: ROMANCAP. *Contribution*: Barium biogeochemistry in the Gulf of Guinea.
3. 1985: FLUXATLANTE. *Contribution*: Barium biogeochemistry in the N.E. Atlantic Ocean.
4. 1986-88: DYFAMED. *Contribution*: Effect of atmospheric input and biological activity in surface water on the transport of barium in the water column and on the cycle of barium in the Mediterranean Sea.
5. 1987: R/V Marion Dufresne INDIGO 3. *Contribution*: Barium biogeochemistry in the Southern Ocean (Indian sector) related to mineralisation of exported organic matter.
6. 1988: MEDATLANTE. *Contribution*: Biogeochemical study of "meddies" in the N.E. Atlantic and the Mediterranean outflow.
7. 1988-1989: R/V Polarstern EPOS, LEG-2 (ESF, European Science Foundation). *Contribution*: Barium biogeochemistry in the Scotia-Weddell Confluence area related to mineralization of exported organic matter.
8. 1990: R/V Polarstern ANTARKTIS IX Expedition. *Contribution*: Geochemical cycling of biogenic elements; new, regenerated and export production.
9. 1991: Voyage 6 of R/V Aurora Australis to Prydz Bay, Antarctica. *Contribution*: Geochemical cycling of biogenic elements; new and regenerated production; mineralization of organic matter.
10. 1992: R/V Polarstern ANT X/6 & ANT X/7 Expeditions in the Atlantic sector of the Southern Ocean: *Contribution*: Geochemical cycling of biogenic elements; new and regenerated production.
11. 1992 -1994: KERFIX, a permanent station off Kerguelen in the Indian sector of the Southern Ocean. Geochemical cycling of biogenic elements; new and regenerated production; vertical fluxes.
12. 1993: WOCE (World Ocean Circulation Experiment) sections SR3 & P11S. A meridional section at 143°E between Tasmania and Antarctica. *Contribution*:

Dissolved barium.
13. 1994: ANTARES-2, R/V Marion Dufresne expedition in the Indian sector of the Southern Ocean: *Contribution*: Geochemical cycling of biogenic elements; new and regenerated production; vertical fluxes.
14. 1993 & 1995: CIVA (WOCE) sections 1 & 2. A meridional section at 30°E between South Africa and Antarctica. *Contribution*: Dissolved barium.
15. 1989 - 1998: R/V Belgica: Gulf of Biscay. *Contribution*: Geochemical cycling of biogenic elements; new and regenerated production; vertical fluxes.
16. From 1987 till 1994: Field trips to the mangrove ecosystems of Tudor Creek and Gazi Bay on the Kenyan coast. C & N cycling.
17. August 1997: AMORES project; R/V Atalante – submersible Nautile, MARVEL expedition to the Mid-Atlantic Ridge hydrothermal systems at the Azores Triple Junction; trophic relationships in hydrothermal vent ecosystems.
18. 1994 to 2002: Field trips to the mangrove ecosystems of Gautami-Godavari Estuary, India and West coast of Sri Lanka: C & N cycling and trophic relationships in mangrove ecosystems.
19. January – March 1998: R/V Aurora Australis SAZ'98 expedition: Biological carbon pump and export production in the Sub-Antarctic Zone along 145°E.
20. January – February 1999: ANTARES 4, R/V Marion Dufresne; Subtropical and Subantarctic region north of Kerguelen; Biological carbon pump and export production.
21. November – December 2001: R/V Aurora Australis CLIVAR-SR3: Biological carbon pump and export production along 145°E, in the Southern Ocean.
22. January – March 2004: EIFEX, R/V Polarstern: Iron fertilization experiment in the Polar Front Zone of the Atlantic sector.
23. June – July 2004: VERTIGO I, R/V Kilo Moana, Station HOT Hawaii; Biological carbon pump and export production.
24. January – February 2005: KEOPS, R/V Marion Dufresne: Study of the natural iron fertilization of phytoplankton growth over the Kerguelen plateau.
25. July - August 2005: VERTIGO II, R/V Roger Revelle, Biological carbon pump and export production in the NW Pacific Ocean.
26. Upcoming: 1/ SAZ-SENSE early 2007; Carbon fluxes in SAZ region south of Australia; 2/ BONUS GOOD-HOPE, late2007, early 2008; International Polar Year ICED / GEOTRACES cruise Atlantic sector SAZ, PFZ.

16. Memberships:

- Associated member of the Royal Academy of Sciences, Belgium
- Member of the Belgian National Committee on Antarctic Research
- Member of the Scientific Committee of Flanders Marine Institute
- Member of the Scientific Committee of the International Polar Foundation, Brussels
- Member of the American Geophysical Union
- Member of the European Geophysical Union
- Member of the Oceanographic Society
- Member of the Geochemical Society

17. Publications:

1. Dehairs, F., R. Chesselet and J. Jedwab, 1980. Discrete suspended particles of barite and the barium cycle in the open ocean, *Earth and Planetary Science Letters*, 49, 40-42.
2. Baeyens, W., G. Decadt, F. Dehairs and L. Goeyens, 1982. An automated method for the assessment of mercury adsorption rates, *Oceanologica Acta*, 5, 261-264.
3. Dehairs, F., H. Dedeurwaerder, G. Decadt and W. Baeyens, 1982. Comparative study of different wet mineralisation digestion methods of total mercury in biological samples, *Analusis*, 10, 373-376.

4. Goeyens, L., E. Post, F. Dehairs, A. Vandenhoudt and W. Baeyens, 1982. The use of high pressure liquid chromatography with fluorimetric detection for the measurement of chlorophyll a concentrations in natural extracts of chloropigments and their degradation products, *International Journal of Environmental Analytical Chemistry*, 12, 51-63.
5. Dehairs, F., H. Dedeurwaerder, M. Dejonghe, G. Decadt, W. Baeyens and I. Elskens, 1983. Boundary conditions for heavy metals at the air-sea interface, in: *Hydrodynamic and Dispersion Models; Boundary Fluxes and Boundary Conditions*, eds. J.C.J. Nihoul and R. Wollast, Programmation of Science Policy, Brussels, 1, 223-242.
6. Dedeurwaerder, H., F. Dehairs, G. Decadt and W. Baeyens, 1983. Estimates of dry and wet deposition and resuspension fluxes of several trace metals in the Southern Bight of the North Sea, in: *Precipitation, Scavenging, Dry Deposition and Resuspension,* eds. H. Pruppacher, R.G. Semonin and W.G.N. Slinn, Elsevier, Amsterdam, 1219-1231.
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110. Cardinal, D.B., N. Savoye, T.W. Trull, L. André, E. E. Kopczynska and F. Dehairs, 2005. Particulate Ba distributions and fluxes suggest latitudinal variations of carbon mineralization in the Southern Ocean, *Deep-Sea Research I*, 52, 355-370.
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113. Gillikin, D.P., A. Lorrain, J. Navez, J.W. Taylor, L. André, E. Keppens, W. Baeyens and F. Dehairs, 2005. Strong biological controls on Sr/Ca in aragonitic marine bivalve

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115. Gillikin, D.P., H. Ulens, F. De Ridder, M. Elskens, E. Keppens, W. Baeyens and F. Dehairs, 2005. Environmental and biological controls on oxygen and carbon isotopes in the aragonitic bivalve *Saxidomus giganteus*: Implications for paleoclimatic studies, in review for *Paleogeography, Paleoclimatology Paleoecology*, 228, 70-85.
116. Gillikin, D.P, F. Dehairs, W. Baeyens, J. Navez and L. André, 2005. Inter- and intra-annual variations of Pb/Ca ratios in clam shells (*Mercenaria mercenaria*): a record of anthropogenic lead pollution? *Marine Pollution Bulletin*, 50, 1530-1540.
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118. Guelinckx, J., J. Maes, L. De Brabandere, F. Dehairs, F. Ollevier, 2006. Migration dynamics of clupeoids in the Schelde estuary: a stable isotope approach. Submitted to *Estuarine, Coastal and Shelf Science,* 66, 612-623.
119. Gillikin, D.P., F. Dehairs, A. Lorrain, D. Steenmans, W. Baeyens and L. André, 2006. Barium uptake into the shells of the common mussel (*Mytilus edulis*) and the potential for estuarine paleo-chemistry reconstruction, *Geochimica et Cosmochimica Acta*, 70, 395-407.
120. van Riel M.C., G. Van der Velde, S. Rajagopal, S. Marguillier, F. Dehairs and A. Bij de Vaate, Trophic relationships in the Lower Rhine food web during invasion and after establishment of the Ponto-Caspian invader *Dikerogammarus villosus*, *Hydrobiologia*, in press.
121. Gribsholt B., M. Andersson, H.T.S. Boschker, N. Brion, L. De Brabandere, F. Dehairs, P. Meire, J.J. Middelburg, E. Struyf, A. Tramper, S. Van Damme, Ammonium transformation in a Dutch tidal freshwater marsh: an *in situ* ^{15}N labeling study, *Biogeochemistry,* in press.
122. Gillikin D.P., A. Lorrain, S. Bouillon, P. Willenz and F. Dehairs, δ^{13}C in *Mytilus edulis* shells: relation to salinity, DIC, phytoplankton and metabolism, *Organic Geochemistry*, in press.

Submitted or in review

Jacquet S.H.M., F. Dehairs, N. Savoye, M. Elskens and D. Cardinal. Barium cycling along WOCE SR3 line in the Southern Ocean. In review for *Marine Chemistry*.

Cardinal D., N. Savoye, T.W. Trull, F. Dehairs, E.E. Kopczynska, F. Fripiat and L. André. Possible variation of diatom silicon isotopic fractionation factor in the spring Southern Ocean. In review for *Marine Chemistry*.

Bouillon S, Dehairs F, Korntheuer M, & Borges AV. Carbon biogeochemistry of the Tana estuary and delta (northern Kenya). In review for *Limnology and Oceanography.*

De Ridder, F., A. de Brauwere, R. Pintelon, J. Schoukens and F. Dehairs, Identification of the accretion rate for annually resolved archives, In review for *Biogeosciences*.

De Brabandere L., Brion N., Elskens M., Baeyens W., Dehairs F. δ^{15}N dynamics of ammonium and particulate nitrogen during the growth season of a eutrophic estuary. Submitted to *Biogeochemistry.*

De Brabandere L., Dehairs F., Tackx M., Muylaert K., Baeyens W. Algal and allochthonous organic matter sources supporting pelagic production in the freshwater to mesohaline reaches of the Scheldt estuary, Belgium. Submitted to *Biogeochemistry.*

Gribsholt B., H.T.S. Boschker, E. Struyf, A. Tramper, L. De Brabandere, N. Brion, S. van Damme, P. Meire, F. Dehairs and J. Middelburg. Nitrogen assimilation and short term retention in a nutrient-rich tidal freshwater marsh – a whole ecosystem ^{15}N enrichment study. Submitted to *Freshwater Biology*.

Bouillon S., M. Korntheuer, W. Baeyens and F. Dehairs, A new automated setup for stable isotope analysis of dissolved organic carbon, Submitted to *Limnology and Oceanography Methods.*

ELSKENS MARC

GENERAL INFORMATION

Date of birth: 10 April 1961
Nationality: Belgian
Children: Arthur (son: 08.02.98) and Marion (daughter: 21.04.00)
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EDUCATION

1983-1984 Engineer in Agronomy, Free University of Brussels (ULB), Belgium.
1998-1999 Doctor in Sciences (PhD), Free University of Brussels (VUB), Belgium.

PROFESSIONAL EXPERIENCES

1984-1988: Researcher at the Laboratory of Microbiology, Université Libre de Bruxelles (ULB).
1988-1989: Military service to the Management Unit of the Mathematical Models of the North Sea and the Scheldt Estuary.
1989-2000: Researcher at the Laboratory of Analytical Chemistry, Vrije Universiteit Brussel (VUB).
2000-2002: Programme leader at the Section of Food, department of Pharmaco-Bromatology, Scientific Institute of Public Health (IPH), Brussels.
2002 Senior scientist at the Laboratory of Analytical Chemistry, Vrije Universiteit Brussel (VUB).

RESEARCH INTERESTS

- Research on degradation/detoxification pathways of dithiocarbamate fungicides by micro-organisms
- Research on heavy metals mobilisation/precipitation at the sediment/water interface in aquatic systems. Development of models to extract information from measurements using passive sampling devices (DGT and DET).
- Development and validation of stable isotope techniques applied to the study of the nitrogen, carbon and silicone cycles in aquatic systems.
- Since 2000, more specifically involved in the development of Quality Assurance and Quality Control procedures applied to Analytical and Environmental Chemistry (ISO/IEC 17025). Full method validations for the determination of trace elements in foodstuffs, consumable and pharmaceutical products. Uncertainty, variability and traceability in human and ecologicall risk assessment. Model development and scenario analyses

TEACHING

- Since 2000: Dynamique des nutriments en milieu marin, partim. I : aspects chimiques et biogéochimiques - 7h30 + 7h30 + 10h - Master in Oceanography, ULg.
- Since 2003: Chemische Functionaliteit 15h, 2de jaar licentiat in de Scheikunde. Afstudeerrichting milieu en analytische Chemie, VUB, in collaboration with Prof. L. Goeyens.
- Since 2004: Environmental Chemistry: measuring and modelling 13h HOC + 26h Zelf, 2de jaar licentiat in de Scheikunde. Afstudeerrichting milieu en analytische Chemie, VUB.

TRAINING CURSUS FOR THE INDUSTRY

- Métaux lourds – 1. Qualité de notre environnement et de notre santé publique, un défi pour le XXI siècle. / Zware metalen – 1. Kwaliteit van ons milieu en

volksgezondheid, een uitdaging voor de XXIe eeuw. BELGISCH INSTITUUT VOOR VERPAKKING" (2001)
- Métaux lourds – 2. Méthodes d'analyses / Zware metalen – 2. Chemische Analyse. BELGISCH INSTITUUT VOOR VERPAKKING" (2001)
- Métaux lourds- 3. Utilisation de métaux et de combinaisons métalliques dans le matériel d'emballage / Zware metalen – 3. Gebruik van metalen en metaalverbindingen in verpakkingsmateriaal. BELGISCH INSTITUUT VOOR VERPAKKING" (2001)

THESIS SUPERVISION (SINCE 2001)

- Master theses
  1. Adriano Agnese (2005). Modelling data obtained from field application of diffusional equilibration in thin films (DET) and diffusive gradients in thin films (DGT) techniques. A case study based on the references sites Helkijn (Belgium) and Cogoleto (Italy). Erasmus. University of Genova
  2. Marco Stanton (2005). Modelling data obtained from field application of diffusional equilibration in thin films (DET) and diffusive gradients in thin films (DGT) techniques. A case study based on the references sites Warneton (Belgium) and Cogoleto (Italy). Erasmus. University of Genova
  3. Li Wei (2004) Global C and N cycling in aquatic ecosystems from estuaries to world Oceans. A literature review illustrated by experimental results. Vrije Universiteit Brussel.
  4. Anouk de Brauwere (2003). Interpretation of optimization algorithms applies to biogeochemical models, Vrije Universiteit Brussel.

- PhD
  1. Aga Homira, Total mercury and methylmercury concentrations in fish from the Persian Gulf and Caspian Sea
  2. De Galan Sandra. Biogeochemistry of organic and inorganic nutrients in the marine and estuarine environment.
  3. Mazou Stéphane (2005). Cryptosporidium and Giardia: Assessment of the efficiency of a drinking water treatment plant, Vrije Universiteit Brussel
  4. Sanctorum Hermes, Chemically Activated Luciferace Gene Expression (CALUX) Cell Bioassay Analysis for the Estimation of Dioxin-Like Activity in sediments

MEMBERSHIPS

- Associated member of the National committee of Oceanography, Royal Academy of Sciences, Belgium
- Member of the PRP Indicators Committee, FPS Health, Food chain safety & Environment, Belgium

PARTICIPATION TO INTERNATIONAL PROGRAMMES

- JGOFS: Joint Ocean Global Flux Studies (1991/1995/1998 French and Australian collaboration in Antarctica).
- IGBP (International Geosphere and Biosphere Programme) and Global Change Related Research in Belgium (1990-1995) Royal Academy of Sciences, National IGBP committee.
- OMEX: Ocean Margin EXchange project (1995-2000) within the European Union's Marine Science and Technology (Mast) programme. http://www.bodc.ac.uk/projects/european/omex/
- Vertigo: VERtical Transport In the Global Ocean (2004-2005) within an U.S. National Science Foundation and Department of Energy project. http://cafethorium.whoi.edu
- SWIFT: Screening methods for water data information in support of the implementation of the water framework directive (2003-2006) within the Sixth Framework EU Programme priorities. http://www.swift-wfd.com/

REVIEWED PUBLICATIONS FOR THE FOLLOWING JOURNALS:

Marine Chemistry, Talanta, Journal of AOAC, Accreditation Quality Assurance, Journal of Plankton research, Deep Sea Research II, Progress in Oceanography

PROMOTOR / CO-PROMOTOR OF RESEARCH PROJECTS (SINCE 2001)

- Co-promotor project FWOAL272 (2004 – 2007), 90900 Eur. Koolstoffexport en heterotrofe afbraak van planktondetritus in de oceaan
- Co-promotor poject FWO submitted (2007 – 2010), 260000 Eur. Een 'multi-proxy' benadering voor de studie van biogeochemische cycli van koostof en stikstof in tropische en gematigde estuaria.
- Promotor project BELSPO submitted (2007 – 2011), 211700 Eur. Uncertainty and variability of impact assessment indicators for pesticides and biocides
- Coordinator project FOD submitted (2007 – 2009), 84026 Eur. Impact indicators for Pesticides and biocides

PUBLICATIONS

- **Papers in scientific journals with an international referee-system (Abstract of the papers available on ISI Web of Science under the author name Elskens, M*)**

1. Elskens M., Penninckx M., Vandeloise R. & Vander Donckt E. (1988), Use of Simplex Technique and contour diagrams for the determination of the reaction rate constants between glutathione and thiram in the presence of NADPH; International Journal of Chemical Kinetics, **20**, 837-848.
2. Elskens M., Penninckx M., Vandeloise R., & Vander Donckt E.(1988), Limitations of the Simplex method when applied to the determination of rate constants from concentrations vs time curves; Bull. Soc. Chim. Belg., **97**, 397-398.
3. Baeyens, W., Panutrakul, S., Elskens M., Leermakers, Navez J. & Monteny F. (1991). Geochemical processes in mud and sandy tidal flat sediments; Geo-Marine Letters, **11**, 188-193.
4. Elskens M., Jaspers C., Penninckx M. (1991), Glutathione as an endogenous sulfur source in the yeast *Saccharomyces cerevisiae*.; Journal of General Microbiology, **137**, 637-644.
5. Elskens, M., Leermakers M., Panutrakul, S., Monteny, F. & Baeyens W. (1991). Microbial activity in sandy and muddy sediments; Geo-Marine Letters, **11**, 194-198. (12)
6. Leermakers M., Elskens M. Panutrakul S., Monteny F. & Baeyens W. (1993). Geochemistry of mercury in an intertidal flat of the Scheldt estuary. Netherlands Journal of Aquatic Ecology, **27**, 267-277.
7. Monteny F., Elskens M. & Baeyens W. (1993). The Behaviour of copper and zinc in the Scheldt estuary. Netherlands Journal of Aquatic Ecology, **27**, 279-286.
8. Penninckx, M. & Elskens, M. (1993), Metabolism and functions of glutathione in micro-organisms. Advances in Microbial Physiology, **34**, 239-301.
9. Elskens, M. & Penninckx, M.J. (1995). Enhanced sensitivity of a glutathione-deficient yeast strain to thiram and dimethyldithiocarbamic acid, Journal of Plant Nutrition and Soil Science, **158**, 79-81.
10. Elskens, M. & Penninckx, M.J. (1995). *In vitro* inactivation of yeast glutathione reductase by tetramethylthiuram disulphide, European Journal of Biochemistry, **231**, 667-672.
11. Frankignoulle, M., Elskens, M., Biondo, R., Bourge, I., Canon, C., Desgain, S. & Dauby, P. (1996). Distribution of inorganic carbon and related parameters in surface seawater of the English Channel. Journal of Marine Systems, 7, 427-434.
12. Elskens, M., Baeyens, W. and Goeyens, L. (1997). Contribution of nitrate to the uptake of nitrogen by phytoplankton in an ocean margin environment. Hydrobiologia, **353**: 139-152.

13. Elskens, M.T. and Penninckx, M.J. (1997). Interconversion of thiram and dimethyldithiocarbamic acid in *Saccharomyces cerevisiae*: a plausible metabolic pathway under the control of the glutathione redox cycle. Applied and Environmental Microbiology, **63**: 2857-2862.
14. Baeyens, W., L. Goeyens, F. Monteny & M. Elskens. (1998). Effect of organic complexation on the behaviour of dissolved Cd, Cu and Zn in the Scheldt estuary. Hydrobiologia, **366**: 81-90.
15. Baeyens, W., M. Elskens, G. Gillain & L. Goeyens. (1998). Biogeochemical behaviour of Cd, Cu, Pb and Zn in the Scheldt estuary during the period 1981 - 1983. Hydrobiologia, **366**: 15-44.
16. Baeyens, W., M. Elskens, R. Van Ryssen, & M. Leermakers. (1998). The impact of the Scheldt input on the trace metal distribution in the Belgian coastal area (results of 1981-1983 and 1995-1996). Hydrobiologia, **366**: 91-108.
17. Goeyens L., Kindermans N., Abu Yusuf M. & M. Elskens (1998). A room temperature procedure for the manual determination of urea in sea water. Estuarine, Coastal and Shelf Science, **47**: 415-418.
18. Goeyens L., Semeneh M., Elskens M., Shopova D., Baumann M. E. M. and Dehairs F. (1998). Phytoplanktonic nutrient utilization and nutrient signature in the Southern Ocean, Journal of Marine Systems, **17**:143-158.
19. Semeneh M., Dehairs F., Lancelot C., Baumann M. E. M., Kopczynska E., Elskens M. and Goeyens L. (1998). Nitrogen Uptake Regime and Phytoplankton Community Structure In the Southern Ocean, Journal of Marine Systems, **17**:159-178.
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22. Mengesha S., Dehairs, F., Elskens, M and Goeyens, L. (1999). Phytoplankton nitrogen nutrition in the Western Indian Ocean: Ecophysiological adaptations of neritic and oceanic assemblages to ammonium supply. Estuarine, Coastal and Shelf Science, **48**: 589-598.
23. Péter, A., Tourwé, D., Baumann, MEM., Elskens, M. and Goeyens, L. (1999). High performance liquid chromatographic determination of free amino acids in algae. Journal of Liquid Chromatography and Related Technology, 22: 1077-1093.
24. Dehairs, F., N. Fagel, A. N. Antia, R. Peinert, M. Elskens & L. Goeyens (2000). Export production in the gulf of Biscay as estimated from barium-barite in settling material: A comparison with new production. Deep Sea Research I, **47**: 583-601.
25. Goeyens, L., Elskens, M., Catalano, G., Lipizer, M., Hecq, H. and Goffart, A. (2000). Nutrient depletions in the Ross Sea and their relation with pigment stocks. Journal of Marine Systems, **27**: 195-208.
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27. Joint, I., Wollast, R., Chou, L., Batten, S., Elskens, M., Edwards, E., Hirst, A., Burkill, P., Groom, S., Gibb, S., Miller, A., Hydes, D., Dehairs, F., Antia, A., Barlow, R., Rees, A., Pomroy, A., Brockmann, U., Cummings, D., Lampitt, R., Loijens, M., Mantoura, F., Miller, P., Raabe, T., Salgado, X., Stelfox, C., Woolfenden., J. (2001). Pelagic Production at the Celtic Sea shelf break. A synthesis of results obtained in the OMEX I project. Deep-Sea Research II 48: 3049-3081.
28. Kopczynska E., F. Dehairs, M. Elskens and S. Wright, Phytoplankton variability between the subtropical and Polar Fronts south off Australia: Thriving under regenerative and new production in late summer, Journal of Geophysical Research, 106: 31597.

29. Elskens, M., Baeyens, W., Cattaldo, T., Griffith, B. and Dehairs, F. (2002). N-uptake conditions during the summer in the sub-Antarctic and Polar Frontal Zones of the Australian sector of the Southern Ocean. Journal of Geophysical Research, 107: 3-1–3-11.
30. Van Loco, J., Elskens, M., Croux, C. and Beernaert, H. (2002). Linearity of calibration curves: use and misuse of the correlation coefficient. Accreditation Quality Assurance, 7:281-285.
31. Alvarez-Salgado X.D., Beloso S., Joint I., Nogueira E., Chou L., Perez F.F., Groom S., Cabanas J.M., Rees A.P., and Elskens, M. (2002). New production of the NW Iberian Shelf during the upwelling season over the period 1982-1999. Deep Sea Research Part I, 49, 1725-1739.
32. Van Loco J., Hanot V., Huysmans G., Elskens M., Degroodt JM. and Beernaert H. (2003). Estimation of the minimum detectable value for the determination of PCBs in fatty food samples by GC-ECD: a curvilinear calibration case.Analytica Chemica Acta, 483: 413-418.
33. Smet PW, Elskens M, Bolle F, Dierickx PJ. (2003). The role of oxidative stress on the effect of 1,4,7,10,13,16-hexathiacyclooctadecane on copper and zinc toxicity in HepG2 cells. Human & Experimental toxicology, 22 (2): 89-93.
34. Baeyens, W., Leermakers, M., Papina, T., Saprykin, A., Brion, N., De Gieter, M., Elskens, M. And Goeyens, L. (2003). Bioconcentration and biomagnification of mercury and methylmercury in North Sea and Scheldt estuary fish. Archives of Environmental Contamination and Toxicology, 45(4), 498-508.
35. Rinne De Bont, Marc Elskens, Willy Baeyens, Luc Hens, Nik van Larebeke. (2003). A survey of 3 PCB and dioxin contamination episodes. From contamination of food items to body burdens. Annual Reviews in Food and Nutrition. In press.
36. Brion, N, Baeyens, W., De Galan, Elskens, M. and Laane, R. (2004). The North Sea: source and sink for nitrogen and phosphorus to the Atlantic Ocean. Biogeochemistry, 68, 277-296.
37. Beucher, C., Tréguer, P., Corvaisier, R., Hapette, A.M. and Elskens, M. (2004). Production and dissolution of biosilica, and changing microphytoplankton dominance in a coastal ecosystem of Western Europe. Marine Ecology Progress Series, 267: 57-69.
38. Savoye, N., Dehairs, F., Elskens, M., Cardinal, D., Kopczyńska, E.E., Trull, T.W., Wright, S., Baeyens, W., and Griffiths, B.F. (2004). Zonal variation of spring N-uptake and new production in the Southern Ocean. Geophysical Research Letters, 31 (3): Art. No. L03301.
39. De Galan S., Elskens M., Goeyens L., Pollentier A., Brion N., Baeyens, W. (2004). Spatial and temporal trends in nutrient concentrations in the Belgian Continental area of the North Sea during the period 1993–2000. Estuarine, Coastal and Shelf Science, 61:517-528.
40. De Gieter, M., Elskens, M. and Beayens, W. (2005). Fluxes and major transport routes of arsenic in the Scheldt estuary. Marine Chemistry 95: 15-30.
41. Nguyen, H. L., Leermakers, M., Elskens, M., De Ridder, F., Doan, T.H. and Baeyens W. (2005). Correlations, partitioning and bioaccumulation of heavy metals between different compartments of Lake Balaton. Science of The Total Environment 341: 211-226.
42. de Brauwere A., De Ridder F., Elskens M., Schoukens J., Pintelon R., Baeyens W. (2005). Refined parameter and uncertainty estimation when both variables are subject to error. Case study: Estimation of Si consumption and regeneration rates in a marine environment. Journal of Marine Systems 55: 205-221.
43. Corvaisier R., Tréguer P., Beucher C. and Elskens, M. (2004). Determination of the rate of production and dissolution of biosilica in marine waters by thermal ionisation mass spectrometry. Analytica Chemica Acta 534: 149–155.
44. Baeyens, W., Leermakers, M., De Gieter, M., Nguyen, H.L., Parmentier, K., Panutrakul, S. and Elskens, M. (2005). Overview of trace metal contamination in the Scheldt estuary and effect of regulatory measures. Hydrobiologia 540: 141-154.

45. Gillikin, D. P., H. Ulens, F. De Ridder, M. Elskens, E. Keppens, W. Baeyens and F. Dehairs (2005). Assessing the reproducibility and reliability of estuarine bivalve shells (Saxidomus giganteus) for sea surface temperature reconstruction: implications for paleoclimate studies. Palaeogeography Palaeoclimatology Palaeoecology 228 (1-2): 70-85
46. Verheyden A., Roggemana M., Bouillon S., Elskens M., Beeckmanc H. and Koedama N. (2005). Comparison between $\delta^{13}C$ of α-cellulose and bulk wood in the mangrove tree Rhizophora mucronata: implications for dendrochemistry. Chemical Geology. 219; 275–282.
47. de Brauwere A., De Ridder F., Pintelon R., Elskens M., Schoukens J. and Baeyens W. (2005). Model selection through a statistical analysis of the minimum of a Weighted Least Squares cost function. Chemometrics and Intelligent Laboratory Systems 76: 163–173.
48. Elskens M, Baeyens W, Brion, N, De Galan S, Goeyens L. and de Brauwere, A. (2005). Reliability of N flux rates estimated from ^{15}N enrichment and dilution experiments in aquatic systems. Global Biogeochemical Cycles 19, GB4028, doi:10.1029/2004GB002332.
49. Diaconu, C., Brion, N., Elskens, M., Baeyens, W. (2005). Validation of a dynamic ammonium extraction technique for the determination of ^{15}N at enriched abundances. Analytica Chimica Acta 554 : 113-122
50. Savoye N, Benitez-Nelson C, Burd, A., Cochrand,J., Charette M, Buesselere, K., Jackson G, Roy-Barman, M, Schmidth, S. and Marc Elskens. An overview of techniques used to model 234Th in the water column. Marine Chemistry In Press
51. Elskens, M., de Brauwere, A., Beucher, C., Corvaisier, R., Savoye, N., Tréguer, P. and Baeyens, W. Statistical process control in assessing production and dissolution rates of bio-genic silica in marine environments Submitted to Marine Chemistry

- **Papers in scientific journals with a national referee-system**

1. Baeyens W., Vandenhoudt A., Elskens M. & Mondt W. (1991). Sequential analysis as a tool for the assessment of the environmental impact of contaminated dredged sludge. CATS Congress, 438th event of the European Federation of Chemical Engineers, KVIV, **2**, 25-32.
2. Elskens M., Chou L., Dauby P., Frankignoulle M., Goeyens L., Loijens M. & Wollast, R. (1993). Primary production and nutrient fuxes in the Gulf of Biscay. Progress in Belgian Oceanographic Research. Royal Academy of Belgium. National Committee of Oceanology, p 137-157.
3. Frankignoulle M., Loijens M., Elskens M. & Dauby P. (1993). Seawater pCO2 distribution and air-sea CO2 exchanges on the Atlantic European Shelf. Progress in Belgian Oceanographic Research. Royal Academy of Belgium. National Committee of Oceanology, p159-169.
4. Dauby P., Baeyens W. Biondo R., Bouquegneau JM., Chou L., Collette O., Dehairs F., Elskens M., Frankignoulle M., Loijens M., Paucot, H. & Wollast, R. (1993). Distribution of particulate trace elements in the Northeastern Atlantic. Progress in Belgian Oceanographic Research. Royal Academy of Belgium. National Committee of Oceanology, p 171-201.
5. Penninckx, M.J., Jaspers, C. & Elskens, M. (1993). On glutathione and microbes. In "Proceedings of the first European Workshop on glutathione, Regulation, Cellular defenses & Clinical Aspects". Special Issue of the Bulletin de la Société Luxembourgeoise de Biologie Clinique, p 200-211.

- **Publications without referee-system**

1. Elskens I. & Elskens M. (1989), Handleiding voor de bepaling van nutrienten in zeewater met een Autoanalyser II™ systeem Vrije Universiteit Brussel, 50 pp.
2. Elskens M., Baeyens W., Collette O., Dehairs F. & Goeyens L. (1993). Production, transport and sinks of organic matter and associated elements in marine sytems.

Part II: Nitrogen assimilation in the Gulf of Biscay, regional and seasonal variability. Proceedings of the Belgian Impulse Programme Global Change, Belgian Science Policy Office, 1, p 241-269.
3. Dehairs F, Elskens M., & Goeyens L. (eds), Integrated Marine System Analysis. Proceedings of the second european network meeting (1997). Vrije Universiteit Brussel, Belgium, pp 376.
4. Elskens, M. (1999). Modelling new and regenreated production from ^{15}N-tracer experiments : A case study of the European continental/ocean margin in the North Atlantic. Doctoral thesis, Vrije Universiteit Brussel, Belgium.
5. Elskens, M. (1999). Maîtrise de la complexité, un préalable à une gestion durable. Une étude de cas : le cycle de l'azote. In " A la recherche d'un dialogue durable entre science et politique", Services fédéraux des affaires scientifiques, techniques et culturelles, p 85-89.
6. Elskens, M., Bolle, F., Evrard, C., Degroodt, JM. & Goeyens, L. (2001). Métaux lourds – 1. Qualité de notre environnement et de notre santé publique, un défi pour le XXI siècle. Pack News 133 : 36-39.
7. Elskens, M., Bolle, F., Evrard, C., Degroodt, JM. & Goeyens, L. (2001). Métaux lourds – 2. Méthodes d'analyses. Pack News 134 : 36-41.
8. Elskens, M., Bolle, F., Evrard, C., Degroodt, JM. & Goeyens, L. (2001). Métaux lourds- 3. Utilisation de métaux et de combinaisons métalliques dans le matériel d'emballage. Pack News 135 : 33-40.
9. Prichard E. et al. (2005). Guidelines for laboratories carrying out measurements where the results will be used to implement the Water Framework Directive (2000/60/EC). SWIFT-WFD. Delivrable D12A.

- **Abstracts published in proceedings of congresses and symposia**

1. Elskens M. & Penninckx M. (1984), Effects of dithiocarbamates fungicides on the glutathione status in *Saccharomyces cerevisiae*: A plausible detoxication pathway; Archives Internationales de Physiologie et de Biochimie, **92**, p 117.
2. Elskens M. & Penninckx M. (1986), The effect of depletion of glutathione pool in *Saccharomyces cerevisiae* by L-buthionine-S,R-sulfoximine on sensitivity to dithiocarbamate fungicides; Archives Internationales de Physiologie et de Biochimie, **94**, p 76.
3. Elskens M., Bechet J. & Penninckx M. (1988), Glutathione metabolism: Occurrence of low molecular weight thiols in gsh$^-$ mutants of the yeast *Saccharomyces cerevisiae* ; Archives Internationales de Physiologie et de Biochimie, **137**, p 88.
4. Elskens M., Penninckx M., Vandeloise R. & Vander Donckt E.(1988), Use of a Simplex routine for the determination of the reaction rate constants between glutathione and Thiram; Archives Internationales de Physiologie et de Biochimie, **137**, p 89.
5. Elskens M., Jaspers C. & Penninckx, M. (1989), Glutathione, a possible endogenous source of sulphur in Saccharomyces cerevisiae ; Archives Internationales de Physiologie et de Biochimie, 97, p 143.
6. Elskens M. & Penninckx M. (1992). Regulation of reductive processes by glutathione in the yeast Saccharomyces cerevisiae. Proceedings of the Annual Meeting of the American Society for Microbiology, New Orleans, Louisianna, p 5
7. Elskens M., Dehairs F., Goeyens L. & Baeyens W. (1992). Nutrients in the English Channel and the adjacent Northern Atlantic Ocean during summer. Proceedings of the Channel Symposium, Brest, France, p 17.
8. Leermakers M., Elskens M. & Baeyens W. (1992), Mercury in the English Channel and adjacent Northern Atlantic Ocean during summer. Proceedings of the Channel Symposium, Brest, France, p 25.
9. Dehairs, F., Elskens, M., Goeyens, L. & Vervlimmeren, J. (1994). Bioreactive elements in suspended matter. In"IGBP and Global Change related Research in Belgium II" (ed. O. Vanderborght), Royal Belgian Academies of Sciences, National Committe IGBP, p 125.

10. Baeyens, W., Dehairs, F., Elskens, M. & Clément, J.P. (1994). Production, transport and sinks of organic matter and associated elements in marine systems: nutrient fluxes and new production. In"IGBP and Global Change related Research in Belgium II" (ed. O. Vanderborght), Royal Belgian Academies of Sciences, National Committe IGBP, p 136.
11. Elskens M., Brion N., Joint I. and A. Rees, 2000. Significance and validity limits of N-flux rates over short and long incubation periods: a dilemma, 32nd International Liège Collquium on Ocean Hydrodynamics, 'Exchange Processes at the Ocean Margins', 8-12 May, 2000, Liège.
12. Elskens M., Cattaldo T., Goeyens L and Dehairs F., 2000. Uptake conditions during summer in the Subantarctic region of the Southern Ocean, The Southern Ocean: Climatic changes and the cycle of carbon, International JGOFS Symposium, 9-13 July 2000, Brest-France.
13. Dehairs F., Cattaldo T., Cardinal D., Kopczynska E. and M. Elskens, 2000. Export of organic matter from the Subantarctic and the Polar Front Zone: Confronting the bottom-up Ba proxy and the top-down new production approaches, The Southern Ocean: Climatic changes and the cycle of carbon, International JGOFS Symposium, 9-13 July 2000, Brest-France.
14. Elskens M., Cattaldo T., Cardinal D., Baeyens W. and Dehairs F. 2000. Assessing flux rates from isotope dilution experiments and numerical modelling: Results for 15N and 135Ba tracer experiments. Goldschmidt 2000. Journal of Conference Abstracts, vol. 5(2), p 382.
15. Van Loco, J., Elskens, M., and Beernaert, H. (2002). Linearity of calibration curves: misuse of the correlation coefficient and the impact on the measurement uncertainty. Proceedings of the Workshop on Measurement Traceability and Uncertainty in Analytical Chemistry. Meeting the requirement of ISO/IEC 17025, Luzern, p 18.
16. Van Loco, J., Hanot, V., Huysmans, G., Elskens, M., Degroodt, JM. and Beernaert, H. (2002). Estimation of the minimum detectable value for the determination of PCBs in fatty food samples by GC-ECD: a curvilinear calibration case. Proccedings of the fourth symposium on Hormone and Drug Residues, Antwerp.
17. Savoye, N., Dehairs, F., Elskens, M., Sedwick, P., and Hutchins, D. (2002). Interactions of iron and ammonium of N uptake in the Southern Ocean south of Australia. Proceedings of the AGU (American Geophysical Union) meeting; San Francisco.
18. Baeyens, W., Leermakers, M., De Gieter, M., and Elskens, M. (2002). Trace contaminants in water-column and food-web of the Scheldt estuary. Proceedings of the ECSA local meeting on the Scheldt Estuary, Antwerp.
19. Cardinal, D., André, L., Dehairs, F., Elskens, M., Jacquet, S., Savoye, N., Trull, T. (2003). Dynamic of the Ba_{xs} proxy through the water column of the Southern Ocean. Geophysical Research Abstract, 5: 14185. European Geophysical Society.
20. Brion, N., Elskens, M., Dehairs, F. and Baeyens, W. (2003). Kinetic of N utilization by natural phytoplankton assemblages during upwelling events at the NW Iberian shelf. Geophysical Research Abstracts, 5: 09359. European Geophysical Society.
21. Dehairs, F., Elskens, M., Savoye, N., Cardinal, D., Baeyens, W., Kopczynska, E., Buesseler, K., Trull, T. (2003). Mineralization in the mesopelagic waters of the Southern Ocean: What can be learn from particulate Ba and diatoms? Geophysical Research Abstract, 5: 10098. European Geophysical Society.
22. Kopczynska E.E., Savoye N., Dehairs F. and Elskens M.: Phytoplankton variability versus zonal variation in spring new production in the Southern Ocean, between Australia and Antarctica. XXVIII SCAR Open Science Conference, 26-28 July, Bremen, Germany
23. de Brauwere, A., De Ridder, F., Elskens, M., Schoukens, J., Pintelon, R., Baeyens, W., (2004). Refined Estimate of Total Variation Enables a More Accurate Parameter and Uncertainty Estimation, as Well as a new Model Selection Procedure. Eos Transaction. AGU, 85(47), Fall Meeting, San Francisco.
24. Frank Dehairs, Damien Cardinal, Nicolas Savoye, Stéphanie Jacquet, Luc André and Marc Elskens. (2005). A Trace element and isotope proxy approach for the study of

the biological pump: a Southern Ocean case. TOS Conference, 8-10 June, Paris, France

25. Jacquet, S.; de Brauwere, A.; Dehairs, F.; Elskens, M.; Jeandel, C.; Metzl, N.; Rintoul, S.; Trull, T. (2005). Comparison of dissolved barium with nutrients and physico-chemical conditions along 30°E and 145°E across the Southern Ocean. European Geosciences Union, 24-29 April, Vienna Austria.
26. de Brauwere A., De Ridder F., Pintelon R., Elskens M., Schoukens J. & Baeyens W.: "Which model should I choose?", VLIZ (Flanders Marine Institute), Young Scientist Day 2005, Brugge, Belgium, 25 February 2005.
27. Hermes Sanctorum, Isabelle Windal, Marc Elskens, Leo Goeyens, Willy Baeyens. Analysis of dioxin and dioxin-like activity in sediments and pore water by CALUX. SWIFT Workshop, 5-6 December 2005, Berlin, Germany.
28. M. Elskens, F. Dehairs, N. Savoye and W. Baeyens. Nitrogen uptake regime at station ALOHA during VERTIGO I. Ocean Sciences Meeting (AGU-ASLO-TOS), 20-24 February 2006, Honolulu, Hawaï.

NATACHA BRION (1969)

Bio-engineer 1993 - Université Libre de Bruxelles.
Doctor in Bio-engineering Sciences 1998 - Université Libre de Bruxelles, financed by the Fond de la Recherche pour l'Industries et l'Agronomie (FRIA)

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RESEARCH INTERESTS

Study nitrogen fluxes in aquatic systems (small rivers, lakes, estuaries, coastal marine systems) with a focus on the processes of nitrification, ammonification, and uptake of dissolved inorganic nitrogen; and establishing N-budgets at whole ecosystem scale.
Studied systems: Zenne River, Aa River, Scheldt Estuary, Seine Estuary, Tanganyika Lake, North Sea, North Atlantic Ocean.

Participation to the following funded research projects:
MANUDYN (DWTC-Belgium) (2003-2006) Macrophytes and nutrient dynamics in the upper reaches of the Schelde basin.
CANOPY (DWTC-Belgium) (2002-2006) Nitrogen, carbon and phosphorus budgets in the Southern Bight of the North Sea.
N-SCHORR (Vlaams Nederlandse Samenwerking, FWO-NFWO, Belgium-The Netherlands) (2002-2006). Nitrogen dynamics in a freshwater marsh of the Scheldt Estuary.
N-WATER (Vlaams Nederlandse Samenwerking, FWO-NFWO, Belgium-The Netherlands) (2002-2006). Nitrogen cycling in the Scheldt Estuary.
OM-ZENNE (Prospective Research for Brussels, Brussels Region) (2001-2003). Organic matter and nutrient dynamics in the Zenne River inside the Brussels Region. Study of the impact of the changing wastewater management in the Region.
BIODIVERSITY IN LAKE TANGANYIKA (UNDP) (1998-2000). Nitrogen dynamics in Northern Lake Tanganyika.
DUURZAAM BEHEER VAN DE NOORDZEE (DWTC-Belgium) (1997-2000). Biogeochemical cycles in the North Sea. Nitrogen uptake dynamics in the North Sea
EROS (EC) (1997-1999). Nitrogen dynamics in the Danube River plume of the Black Sea.
OMEXII (EC) (1997-2000). Nitrogen dynamics in the Iberian margin (Atlantic Ocean)
COMWEB (EC) (1997-1999). Nitrogen uptake dynamics in the North Sea during phaeocystis and diatom blooms
PIREN-SEINE (F) (1993-1997). Nitrification in the upstream basins of the Seine River (France)
SEINE-AVAL (F) (1995-1997). Nitrification in the Estuary of the Seine (France).
BINOCULARS (EC) (1995-1997). Nitrification in the river networks of the Seine and Schelde.

EDUCATION

Lectures:
"Coastal and estuarine ecosystems: primary productivity and pollutants" 30 h Willy Baeyens (15h) and Natacha Brion (15h) in the Master of Environmental Science and Technology (Faculty of Science, VUB).

"Nutrient dynamics in coastal and estuarine ecosystems" 15h in the Master of Environmental Chemistry (Faculty of Science VUB).

"Physical and chemical Oceanography" 15 h Frank Dehairs (10 h) and Natacha Brion (5 h) in the Master of Ecological Marine Management (Faculty of Science, VUB).

Promotion of master or PhD thesis

Veerle Van Beek (1999) "Seizoengebonden en ruimtelijke variaties van de stikstofopname door bacteriën en fytoplankton in de Zuidelijke Bocht van de Noordzee". Thesis presented for a master degree "Industriele Wetenschappen en Technologie". Departement van de Hogeschool Antwerpen.

Ali Chahid (1999) "Contribution to the optimisation of an NH4 extraction method for measuring remineralisation rates in marine systems. Thesis presented for a master degree "Ecological Marine Management". Vrije Universiteit Brussel.

Clavery Tungaraza (2000) "Investigation of environmental changes caused by increasing nitrogen and response of phytoplankton in the North Sea". PhD Thesis presented for a degree of Doctor in Science. Vrije Universiteit Brussel.

Nico Verlinden (2002) "Stikstof dynamiek en nitrificatie in het estuarium van de Schelde". Thesis presented for a Master degree "Bioengineer" at the Vrije Universiteit Brussel.

Ken Kersemans (2003) "Stikstof Dynamiek in de Schelde". Thesis presented for a Master degree in Chemistry. Vrije Universiteit Brussel.

David Nahimana (2003) "Optimization of a nitrate extraction technique from aquatic samples in order to determine its nitrogen isotopic composition." Thesis presented for a Master degree "Environmental Science and Technology". Vrije Universiteit Brussel.

Li Wei (2004) "Global C and N cycling in aquatic ecosystems from estuaries to world Oceans. A literature review illustrated by experimental results". Thesis presented for a Master degree "Environmental Science and Technology". Vrije Universiteit Brussel.

Fashoranti Adewole (2005) "A study on the effect of different water sample preservation methods on the measurement of ammonium". Thesis presented for a Masters degree "Environmental Science and Technology". Vrije Universiteit Brussel.

Ana Cabrerizo Pastor (2005) "Nutrient dynamics in a small river with macrophytes". Thesis presented for a Masters degree "Environmental Science and Technology". Vrije Universiteit Brussel.

PUBLICATIONS (peer reviewed)

Brion N. & Billen G. (1998): A reassesment of the $H^{14}CO_3^-$ incorporation method for measuring autotrophic nitrification and its use to estimate nitrifying biomasses. Revue des Sciences de l'Eau 11: 283-302.

Billen G., Garnier J., Brion N., & Sanchez (1998): Les transformations bactériennes de l'azote. In: "La Seine en son Bassin". Edited by Elsevier. pp. 567-592.

Servais P., Garnier J., Demarteau N., Brion N., & Billen G. (1999): Supply of organic matter and bacteria to aquatic ecosystems through waste water effluents. Water Research 33 (16): 3521-3531.

Brion N. & Billen G. (2000): Wastewater as a source of nitrifying bacteria in river systems: the case of River Seine downstream from Paris. Water Research 34: 3213-3221.

Brion N., Billen G., Guezennec L. & Ficht A. (2000): Distribution of nitrifying activity in the Seine River (France) and its estuary. Estuaries 23: 669-682.

Garnier J., Servais P., Billen G., Akopian M., & Brion N. (2001): Lower Seine River and Estuary (France) carbon and oxygen budgets during low flow. Estuaries 24: 964-976.

Leermaekers M., Galletti S., De Galan S., Brion N. & Baeyens W. (2001) Mercury in the southern North Sea and Scheldt estuary. Marine Chemistry 75 (3): 229-248.

Ragueneau O., Lancelot C., Egorov V., Vervlimmeren J., Cociasu J., Déliat G., Krastev A., Daoud N., Rousseau V., Popovitchev V., Brion N., Popa L. & Cauwet G. (2002): Biogeochemical transformations of inorganic nutrients in the mixing zone between the Danube River and the North-Western Black Sea. Estuarine, Coastal and Shelf Science 54: 321-336.

De Brabandere L., Dehairs F., Van Damme S., Brion N., Meire P. & Daro N. (2002): □15N and □13C dynamics of suspended organic matter in freshwater and brackish waters of the Scheldt estuary. Journal of Sea Research 48: 1-15.

Tungaraza C., Rousseau V., Brion N., Lancelot C., Gichuki J., Baeyens W. & Goeyens L. (2003) Contrasting nitrogen uptake by diatom and Phaeocystis-dominated phytoplankton assemblages in the North Sea Journal of Experimental Marine Biology and Ecology 292 (1): 19-41.

Tungaraza C., Brion N., Rousseau V., Baeyens W. & Goeyens L. (2003) Influence of bacterial activities on nitrogen uptake rates determined by the application of antibiotics. Oceanologia 45 (3): 473–489.

Baeyens W., Leermakers M., Papina T., Saprykin A., Brion N., Noyen J., De Gieter M. & Goeyens L. (2003) Mercury speciation in North Sea and Scheldt Estuary fish. Arch. Env. Contam. 45, No. 4, pp. 498-508.

Brion N., Baeyens W., De Galan S., Elskens M. & Laane R.W.P.M. (2004) The North Sea : source or sink for nitrogen and phosphorus to the Atlantic Ocean ? Biogeochemistry 68 (3): 277-296.

Gribsholt B., Boschker H. T. S., Struyf E., Andersson M., Tramper A., De Brabandere L., van Damme S., Brion N., Meire P., Dehairs F., Middelburg J. J. & Heip C. H. R. (2005) Nitrogen processing in a tidal freshwater marsh: A whole ecosystem 15N labeling study. Limnol. Oceanogr. 50: 1945-1959.

Gazeau F., Gattuso J.-P., Middelburg J. J., Brion N., Schiettecatte L.-S., Frankignoulle M. & Borges A. V. (2005) Planktonic and whole system metabolism in a nutrient-rich estuary (The Scheldt Estuary). ESTUARIES 28(6): 868-883.

Tungaraza T. C., Brion N. & Baeyens W. (2005) Comparison of two models in the estimation of nitrogen uptake rates using data from 15-N incubation experiments. Oceanologia 47(3): 387-403.

Diaconu C., Brion N., Elskens M., and Baeyens W. (2005) Validation of a dynamic ammonium extraction technique for the determination of 15N at enriched abundances. Analytica Chimica Acta 554: 113–122.

Elskens M., Baeyens W., Brion N., De Galan S., Goeyens L., de Brauwere A. (2005) Reliability of N flux rates estimated from ^{15}N enrichment and dilution experiments in aquatic systems. GLOBAL BIOGEOCHEMICAL CYCLES, VOL. 19, GB4028, doi:10.1029/2004GB002332.

Andersson M. G. I, Brion N., Middelburg J. J. (2006) Comparison of nitrifier activity versus growth in a turbid, tidal estuary (Scheldt estuary in northern Europe). Aquatic Microbial Ecology 42: 149-158..

Schiettecatte L. S., Gazeau F., Van der Zee C., Brion N. and Borges A. V. (in press) Time series of the partial pressure of carbon dioxide (2001-2004) and net ecosystem production off the Belgian coast. G-Cubed.

Brion N., Nzeyimana E., Goeyens L., Nahimana D., Tungaraza C. T. & Baeyens W. (in press) Inorganic nitrogen uptake and river inputs in Northern Lake Tanganyika. Journal of Great Lakes Research.

Steven Bouillon, ° 1975

Born in Leuven, Belgium
Unmarried, 3 children (° 2000, 2002, 2005)
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EDUCATION AND WORK EXPERIENCE

1993-1998 : Bio-engineering at the Catholic University of Leuven (Belgium), graduated with distinction. Specialisation in 'Soil conservation and Agriculture of the Tropics and Subtropics'.
Thesis on 'Behavioural response of *Tubificidae* to pollutants and changing environmental conditions' (Laboratory of Ecology and Aquaculture, prof. F. Ollevier).

1999 : PhD course in 'Estuarine Ecology' at the Netherlands Institute for Ecological Research (NIOO-Yerseke).

1999-2002 : PhD student at the Department of Analytical and Environmental Chemistry and department of General Botany and Nature Management (Free University of Brussels) on the EC-INCO project 'Assessment of mangrove degradation and resilience in the Indian subcontinent : the cases of Godavari estuary and South-west Sri Lanka'.
PhD defended on 15th October 2002 (greatest distinction) : 'Organic carbon in a southeast Indian mangrove ecosystem : sources and utilization by different faunal communities'. (promotor F. Dehairs)

October 2003 – current : Post-doctoral researcher for the Fund for Scientific Research (FWO-Vlaanderen) at the Dept. of Analytical and Environmental Chemistry, Vrije Universiteit Brussel, Belgium.

Analytical expertise

► Elemental and stable isotope analysis (C, N, O) on various substrates, using a variety of analytical techniques (e.g. solid and headspace EA-IRMS, GC-C-IRMS, own development of TOC-IRMS)
► Lipid analysis (PLFA) for microbial community characterisation : extraction, derivatisation, analysis
► Extensive fieldwork in remote locations, sampling aquatic and benthic systems for physico-chemical, nutrient, and biogeochemical parameters; sampling faunal and floral ecosystem components.

Collaborations (selection)

► Internal at VUB: N. Koedam, F. Dahdouh-Guebas (APNA); Ph. Claeys, E. Keppens (DLGL)
► A.V. Borges (Unité d'Océanographie Chimique, ULg)
► E. Boschker (NIOO-CEMO, Yerseke)
► G. Abril (Université de Bordeaux)
► B. Velimirov (University of Vienna)
► M. Böttcher (Max Planck, Bremen)
► Marine Biology, UGent : T. Moens; A. Vanreusel
► L. André; D. Cardinal (Royal Museum for Central Africa, Tervuren, Belgium)
► M. Van Strydonck (Royal Institute for the Art Patrimonium, Brussels)
► E. Kristensen, M. Holmer, M. Flindt, University of Southern Denmark
► R. Serrão-Santos, A. Colaço, IMAR- Dept. Oceanography and Fisheries-University of the Azores
► J.-C. Charlou, IFREMER, Brest
► J. Bosire, J. Kairo, S. Mwangi, J. Kamau (Kenya Marine and Fisheries Research Institute); A. Macia (Univeristy of Maputo, Mozambique), J. Machiwa, Y. Mgaya (University of Dar es Salaam)

► J. Onyari, J. Nyunja (University of Nairobi).
► A.V. Raman, C. Kalavati (Andhra University, India)
► J. Paula (University of Lisbon)

MISCELLANEOUS ACTIVITIES

- March 2001, April 2002, March 2003, March 2004, March 2006: Teaching of a **practical course** in stable isotope techniques and applications (in the framework of a Plant Physiology course).
- May 2004 and May 2006: **lecturer** in the PhD course on Estuarine Ecology, held at Yerseke, the Netherlands (NIOO-CEMO).
- Overseas field visits and **fieldwork campaigns** :
  - ►Gautami-Godavari estuary, Andhra Pradesh, India:

    field campaigns in February 1999, November-December 1999, May-June 2001
  - ►Sri Lankan coast (short field visits), March 2000
  - ►Pichavaram mangroves (Tamil Nadu, India) : field visit and sample collection, October 2002
  - ►Gazi Bay (Kenya), July-August 2003
  - ►Tana Delta (Kenya), April 2004
  - ►Dar es Salaam mangroves (Tanzania), March 2005, September 2005

- **Participation in workshops and conferences :**
  ►2nd international conference on 'Applications of stable isotope techniques to ecological studies', Braunschweig, Germany, 8-11 May 2000.
  ►International Meeting on Mangrove Macrobenthos (MMM), 7-11 September 2000, Mombasa, Kenya
  ►Young Scientist Day, VLIZ (Flemish Institute for Sea Research), Brugge, Belgium (February 2001).
  ►NECOV symposium on 'Ecological research in the tropical coastal zone', Leiden, The Netherlands, June 21st, 2002.
  ►EC-INCO project workshop, Matara (Sri Lanka), March 2000.
  ►International conference on 'Assessment of mangrove degradation and resilience in the Indian sub-continent', Pondicherry, India, 21-25 October 2002.
  ►First joint assembly of the EGS-AGU-EUG , Nice (France), April 2003.
  ►Gazi Workshop, held at the Kenya Marine and Fisheries Research Institute, Mombasa (Kenya), July 2003.
  ►Preparatory workshop for FP6 STREP-project 'PUMPSEA', Lisbon, June 2003.
  ►Kick-off workshop of FP6-STREP-project 'PUMPSEA', Dar es Salaam, March 2005
  ►Convenor of Biogeosciences session BG2.03 (Application of stable isotopes in biogeosciences) at the 2nd general assembly of the EGU (European Geosciences Union), Vienna (Austria), 25 - 29 April 2005.
  ► ASLO (Advancing the Science of Limnology and Oceanography) 2005 Summer Meeting, Santiago de Compostela (Spain), June 19-24, 2005.
  ►Convenor of Biogeosciences session BG2.03 (Application of stable isotopes in biogeosciences) at the 3rd general assembly of the EGU (European Geosciences Union), Vienna (Austria), April 2006
  ► 2nd International meeting on Mangrove Macrobenthos (MMM2), Queensland, Australia, June 2006 (invited speaker)

- **Project and travel grants received**
  ► Post-doctoral mandate, funded by the Fund for Scientific Research (FWO-Vlaanderen): "Carbon dynamics in mangrove ecosystems and their role in the C

budget of the tropical coastal zone : interactions between intertidal areas and the adjacent aquatic environment, and the role of microbial production." (Oct. 2003-Sept 2006)

► FWO-research grant (contract 1.5.070.05, 35000 €) : "Development of an automated setup for the analysis of concentrations and stable isotope composition of dissolved organic and inorganic carbon: applications in biogeochemical studies of estuarine systems." (Jan. 2005-Dec. 2005).

► Matching fund by VUB research council for the FWO research grant (8400 €)

► Co-promotor of FWO research project: "Development of stable isotope techniques for the study of biogeochemical cycles in aquatic ecosystems and the reconstruction of (paleo)-environmental conditions" (contract G.0632.06, 2006-2009, ~400,000 €)

► Travel grants obtained from FWO-Vlaanderen (Kenya 2003; Austria 2005; Tanzania 2005) and from the Vrije Universiteit Brussel (Germany 2000; Kenya 2000; India 2002; France 2003, Austria 2005).

- **Reviewed publications** (25) for the following journals:
  Limnology & Oceanography (4), *Geochimica and Cosmochimica Acta* (2), *Estuarine, Coastal and Shelf Science* (3), *Journal of Sea Research* (2), *Aquatic Ecology* (2), *Marine Ecology Progress Series* (1), *Oecologia* (1), *Marine Geology* (1), *Marine Chemistry* (1), *Marine and Freshwater Research* (1), *Botanica Marina* (1), *Carribean Journal of Science* (1), *Aquatic Living Resources* (1), *Indian Journal of Marine Sciences* (1), *Western Indian Journal of Marine Sciences* (1), *Earth Interactions* (1), *Journal of Experimental Marine Biology and Ecology* (1).

- **Project reviews** for the Dutch Science Foundation, NWO-WOTRO.

- **Guest editor** (with M. Böttcher) of Organic Geochemistry, Special Issue : "Stable isotopes in biogeosciences" – currently being processed, foreseen 2006.

- Member of **reading commitees** for MSc and PhD theses :

  ►Defever H (2004) Predictions of the consequences of a sea level rise on the mangrove ecosystem of Gazi (Kenya) [in dutch]. MSc thesis, Vrije Universiteit Brussel.

  ►De Schrijver A (2004) The importance of mangroves as nursery habitats for juvenile fish [in dutch]. MSc thesis, Vrije Universiteit Brussel.

  ►Guest M (2004) Movement and assimilation of carbon by estuarine invertebrates. PhD thesis, School of Environmental and Applied Sciences, Griffith University, Australia.

  ►Houthoofd L (2005) Does sediment grain size affect diatom grazing by harpacticoid copepods ? MSc. Thesis, University of Gent

  ►Wyckmans M (2005) Effects of food diversity on diatom selection by harpacticoid copepods. MSc. Thesis, University of Gent.

- **Thesis supervision**: co-supervisor of the following theses:

  ►Overmeer, I (2002). A carbon and nitrogen stable isotope study to trace food web dynamics in two Sri Lankan mangrove ecosystems. MSc thesis in the MareLac program (Ghent University-Vrije Universiteit Brussel).

  ►Van Bruystegem, E (2003) Kleptoplasty in *Elysia* spp. (Mollusca): nitrogen and carbon relationships. [in dutch]. Vrije Universiteit Brussel, 167 pp.

►Teugels, B (2004) Role of kleptoplasty in the carbon and nitrogen metabolism in *Elysia viridis* (Gastropoda: Sacoglossa) [in Dutch]. Vrije Uinversiteit Brussel, 69 pp.

►De Waen, D (2005) Community structure and trophic relationships in an East African coupled mangrove-seagrass ecosystem. MSc thesis in the MareLac program (University of Gent -Vrije Universiteit Brussel).

►Ralison, O.H. (2005-2006) Carbon biogeochemistry of the Betisboka estuary and surrounding mangrove creeks (NW Madagascar). MSc thesis (ECOMAMA, VUB), in progress.

► Phan Viet Khoi (2005-2006) Carbon isotope composition of biomarkers as source indicators of organic matter in mangrove sediments, MSc thesis in Environmental Sciences and Technology (EST, VUB), in progress.

►currently co-supervisor of three PhD students:

►Judith Nyunya (University of Nairobi, VLIR-AQUA project): "Ecology and feeding behaviour of fish communities in Kenyan mangrove and seagrass ecosystems".

►Perrine Mangion (Vrije Universiteit Brussel): "Biogeochemical indicators of domestic sewage inputs in east African mangrove ecosystems".

►Gil Penha-Lopez (University of Lisbon): "Effects of domestic sewage on characteristics of mangrove associated macrofauna communities and their functioning in East Africa".

- Design and maintenance of the website for the department of Analytical and Environmental Chemistry: http://www.vub.ac.be/ANCH

- Maintenance of the Mangrove Mangement Group website, http://www.vub.ac.be/mangrove

PUBLICATIONS 2000-2005 (INCLUDING MANUSCRIPTS SUBMITTED OR IN REVISION)

PEER-REVIEWED PUBLICATIONS IN INTERNATIONAL JOURNALS :

1. Bouillon S, Chandra Mohan P, Sreenivas N, & Dehairs F (2000) Sources of suspended organic matter and selective feeding by zooplankton in an estuarine mangrove ecosystem, as traced by stable isotopes. Marine Ecology Progress Series 208 : 79-92 (SCI: 2.052)

2. Bouillon S, & Dehairs F (2000) Estimating spatial and seasonal phytoplankton $\delta^{13}C$ variations in an estuarine mangrove ecosystem. Isotopes in Environmental and Health Studies 36 : 273-284 (SCI: 0.714)

3. Bouillon S, Koedam N, Raman AV, & Dehairs F (2002) Primary producers sustaining macro-invertebrate communities in intertidal mangrove forests. Oecologia 130 : 441-448 (SCI: 2.899)

4. Bouillon S, Raman AV, Dauby P, & Dehairs F (2002) Carbon and nitrogen stable isotope ratios of subtidal benthic invertebrates in an estuarine mangrove ecosystem (Andhra Pradesh, India). Estuarine, Coastal and Shelf Science 54 : 901-913 (SCI: 1.058)

5. Bouillon S, Dahdouh-Guebas F, Rao AVVS, Koedam N, & Dehairs F (2003) Sources of organic carbon in mangrove sediments : variability and possible implications for ecosystem functioning. Hydrobiologia 495 : 33-39 (SCI: 0.653)

6. Baeyens W, Monteny F, Leermakers M, Bouillon S (2003) Evalution of sequential extractions on dry and wet sediments. Analytical and Bioanalytical Chemistry 376: 890-901 (SCI: 2.098)

7. Bouillon S, Frankignoulle M, Dehairs F, Velimirov B, Eiler A, Etcheber H, Abril G, & Borges AV (2003) Inorganic and organic carbon biogeochemistry in the Gautami Godavari estuary (Andhra Pradesh, India) during pre-monsoon : the local impact of extensive mangrove forests. Global Biogeochemical Cycles 17 (4): 1114, doi:10.1029/2002GB002026. (SCI: 2.864)

8. Bouillon S, Koedam N, Baeyens W, Satyanarayana B, & Dehairs F (2004) Selectivity of subtidal benthic invertebrate communities for local microalgal production in an estuarine mangrove ecosystem during the post-monsoon period. Journal of Sea Research 51: 133-144 (SCI: 1.566)

9. Bouillon S, Moens T, Koedam N, Dahdouh-Guebas F, Baeyens W, & Dehairs F (2004) Variability in the origin of carbon substrates for bacterial communities in mangrove sediments. FEMS Microbiology Ecology 49: 171-179 (SCI: 2.769)

10. Bouillon S, Moens T, Overmeer I, Koedam N, & Dehairs F (2004) Resource utilization patterns of epifauna from mangrove forests with contrasting inputs of local versus imported organic matter. Marine Ecology Progress Series 278: 77-88 (SCI: 2.052)

11. Bouillon S, Moens T, & Dehairs F (2004) Carbon sources sustaining benthic mineralization in mangrove and adjacent seagrass sediments (Gazi bay, Kenya). Biogeosciences 1: 71-78 (recent open access EGU journal - no SCI assigned yet)

12. Verheyden A, Roggeman M, Bouillon S, Elskens M, Beeckman H, & Koedam N (2005). Comparison between □^{13}C of □□cellulose and bulk wood in the mangrove tree *Rhizophora mucronata*: implications for dendrochemistry. Chemical Geology 219: 275-282 (SCI: 3.174)

13. Moens T, Bouillon S, & Gallucci F (2005) Dual stable isotope abundances unravel trophic position of estuarine nematodes. Journal of the Marine Biological Association of the UK 85: 1401-1407 (SCI: 0.781)

14. Bouillon S, & Boschker HTS (2005). Bacterial carbon sources in coastal sediments: a review based on stable isotope data of biomarkers. Biogeosciences Discussions 2: 1617-1644, *in press* for Biogeosciences (recent open access EGU journal - no SCI assigned yet)

15. Gillikin DP, Lorrain A, Bouillon S, Willenz P, & Dehairs F (2006) δ^{13}C in *Mylilus edulis* shells: relation to salinity, phytoplankton and metabolism. *In press* for Organic Geochemistry (SCI: 1.896), special issue on "Stable Isotopes in Biogeosciences".

16. Bouillon S, Dehairs F, Schiettecatte LS, & Borges AV (2006) Biogeochemistry of the Tana estuary and delta (northern Kenya). Limnology & Oceanography (SCI: 3.024), *in press*.

17. Bouillon S, Korntheuer M, & Dehairs F (in review) A new automated setup for stable isotope analysis of dissolved organic carbon. Limnology & Oceanography: Methods (recent journal of the ASLO society, no SCI assigned yet)

ABSTRACTS OF ORAL AND POSTER PRESENTATIONS

1. Bouillon S, Sreenivas N, Chandramohan P, & Dehairs F. Stable carbon isotopes reveal selective feeding by zooplankton under natural conditions in an estuarine mangrove ecosystem. 2nd international conference on 'Applications of stable isotope techniques to ecological studies', Braunschweig, Germany, 8-11 May 2000.

2. Bouillon S, Raman AV, Dahdouh-Guebas F, & Dehairs F. Importance of different primary producers for benthic invertebrates in an estuarine mangrove ecosystem (Andhra Pradesh, India): results from carbon and nitrogen stable isotopes. International Meeting on Mangrove Macrobenthos (MMM), 7-11 September 2000, Mombasa, Kenya

3. Bouillon S, Koedam N, Raman AV, Dahdouh-Guebas F, & Dehairs F. Organic carbon in intertidal mangrove forests: sources and utilization by benthic invertebrates. Poster presented at the Young Scientist Day, VLIZ (Flemish Institute for Sea Research), Brugge, Belgium (February 2001).

4. Bouillon S. Ecological fate of mangrove carbon : where does it all go ? NECOV symposium on 'Ecological research in the tropical coastal zone', Leiden, The Netherlands, June 21st, 2002.

5. Bouillon S, Dehairs F, Borges AV, & Frankignoulle M. Carbon retention in mangrove ecosystems: a comparison of estuarine and lagoonal systems. Presented at the international conference on 'Assessment of mangrove degradation and resilience in the Indian sub-continent', Pondicherry, India, 21-25 October 2002.

6. Bouillon S, Dehairs F, Rao AVVS, Raman AV, Koedam N, & Chandra Mohan P. Carbon dynamics and trophic relationships in the mangrove ecosystems of Coringa (India) and Galle, Pambala (Sri Lanka). Presented at the international conference on 'Assessment of mangrove degradation and resilience in the Indian sub-continent', Pondicherry, India, 21-25 October 2002.

7. Bouillon S. Stable isotopes as natural tracers of organic matter: should we reconsider the role of mangroves in the coastal zone ? [Stabiele isotopen als natuurlijke merkers van organische stof: moeten we de rol van mangroves in de kustzone herzien ?]. Invited speaker at the annual NECOV symposium, Leiden, The Netherlands, January 16th, 2003.

8. Bouillon S, & Dehairs F. A re-evaluation of the role of mangrove ecosystems in the tropical coastal zone. Meeting of the Benelux IRMS user group, Geel, Belgium, March 2003.

9. Bouillon S, N Koedam, AV Borges, M Frankignoulle, & Dehairs F. Carbon dynamics in mangrove ecosystems : interactions between intertidal and subtidal habitats. Oral presentation at the EGS-AGU-EUG Joint Assembly, Nice (France), April 2003.

10. Bouillon S. Stable isotopes as tracers of carbon dynamics in mangrove ecosystems. Oral presentation presented at the Gazi Workshop, held at the Kenya Marine and Fisheries Research Institute, Mombasa (Kenya), July 2003.

11. Verheyden A, Beeckman H, De Ridder F, Dehairs F, Bouillon S, André L, Navez J, & Koedam N. Potential of wood anatomy, stable carbon isotopic ratios and chemical composition of wood for evaluation of ecosystem health in a tropical mangrove forest. Presented at the 8th Eighth Symposium on Biogeochemistry of Wetlands, September 2003, Gent (Belgium).

12. Verheyden A, Beeckman H, De Ridder F, Dehairs F, Bouillon S, André L, Navez J, & Koedam N. Potential of wood anatomy, stable carbon isotope ratios and chemical composition for tropical dendrochronology : a case study on the mangrove tree *Rhizophora mucronata*. Presented at EuroDendro, Conference of the European Working Group for Dendrochronology, Obergurgl (Austria), September 2003.

13. Moens T, Bouillon S, & Middelburg JJ (2003) The importance of microphytobenthos in intertidal food webs. Colloquium "The role of microphytobenthos in the functioning of estuarine environments". Amsterdam, the Netherlands, August 21-23, 2003.

14. Borges AV, Frankignoulle M, Delille B, & Bouillon S (2004) DIC dyanamics in a tropical estuary (Kidogoweni, Kenya). 1st General Assembly of the EGU- European Geosciences Union, Nice (France), 25-30 April 2004.

15. Teugels B, Bouillon S, & Koedam N (2004) The role of chloroplast retention for inorganic N assimilation in the sea slug *Elysia viridis* : indications from ^{15}N-labeling experiments. Young Botanists Day, November 18th 2004, Brussels, Belgium.

16. Bouillon S, & Boschker HTS (2005) Carbon sources driving benthic mineralization in coastal ecosystems: insights from stable isotope analysis of bacterial markers. General Assembly of the EGU- European Geosciences Union, Vienna (Austria), April 2005.

17. Bouillon S, Dehairs F, & Borges AV (2005) Biogeochemistry of the Tana estuary and delta (northern Kenya). General Assembly of the EGU- European Geosciences Union, Vienna (Austria), April 2005.

18. Bouillon S, Dehairs F, Abril G, and Borges AV (2005) Distribution and sources of organic carbon in a mangrove-seagrass ecosystem (Gazi Bay, Kenya). General Assembly of the EGU- European Geosciences Union, Vienna (Austria), April 2005.

19. Borges AV, Kone YM, Schiettecatte LS, Delille B, Frankignoulle M, and Bouillon S (2005) Preliminary results on the biogeochemistry in the Mekong estuary and delta. General Assembly of the EGU- European Geosciences Union, Vienna (Austria), April 2005.

20. Bouillon S, & Boschker HTS (2005) Bacterial carbon sources in coastal sediments: a meta-analysis based on stable carbon isotope data of biomarkers. Oral presentation at the ASLO (Advancing the Science of Limnology and Oceanography) summer meeting, Santiago (Spain), 19-24 June 2005.

21. Paula J, Bandeira S, Bouillon S, Daffa J, Guerreiro J, Kairo J, Kautsky N, Kazungu J, Koedam N, Kristensen E, Kuschk P, Macia A, Machiwa J, Mgaya Y, Ronnback P, Mbwette T, & Vannini M (2005). The PUMSPEA project: Peri-urban mangroves as potential phytoremediators for sewage pollution in east Africa. 4th WIOMSA Scientific Symposium, 29th August - 3rd September 2005, Grand Baie, Mauritius.

22. Bouillon S, & Boschker HTS (2006) The role of local vegetation in sustaining benthic mineralization in seagrass beds, mangroves, and salt marshes. Oral presentation, International Symposium on aquatic vascular plants, Brussels, January 11-14, 2006.

23. Konn C, Charlou JL, Donval JP, Holm NG, Dumont M, Dehairs F, & Bouillon S. Fluids from ultramafic-hosted vents of the Mid Atlantic Ridge : biogenic or abiogenic organic compounds spotted. General Assembly of the EGU, Vienna, April 2006.
24. Charlou JL, Donval JP, Konn C, Jean-Baptiste P, Holm N, Dehairs F, & Bouillon S. Mineral, gases and organic signature of hydrothermal fluids issued from ultramafics on the Mid-Atlantic Ridge. General Assembly of the EGU, Vienna, April 2006.

25. Bouillon S (2006) Resource utilization patterns of intertidal mangrove invertebrate communities in different geomorphological settings and across various spatial scales. Invited keynote speaker at the 2nd Meeting on Mangrove Macrobenthos, held in Queensland, Australia, June 2006.

26. Nyunja J, Bouillon S, Onyari J, Ntiba M, Mavuti K, & Vanreusel A (2006) Carbon sources for nekton in a tropical mangrove-fringed estuary, Gazi Bay, Kenya. 2nd Meeting on Mangrove Macrobenthos, held in Queensland, Australia, June 2006.

27. Guerreiro J, Bouillon S, Vannini M, Mgaya J, Kristensen E, Katima J, Rönnbäck P, & Daffa J (2006). Peri-urban mangroves as potential phytoremediators for sewage pollution in east Africa. 2nd International Conference on Environmental Science and Technology, Houston, USA, August 19-22, 2006.