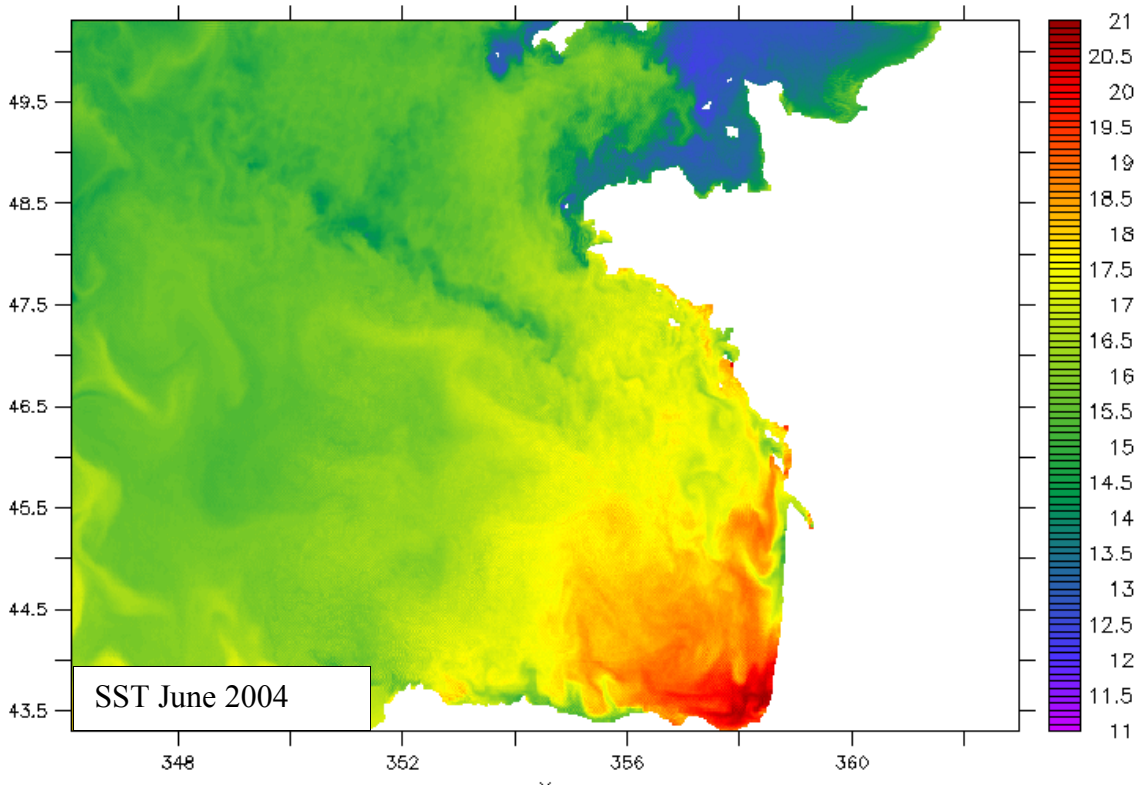
Acronyme/short title	**EPIGRAM**
Titre du projet *(en français)*	Etudes Physiques Intégrées en Gascogne et Région Atlantique-Manche
Titre du projet/Proposal title *(en anglais)*	STUDY OF PHYSICAL PROCESSES IN THE BAY OF BISCAY AND THE CHANNEL



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Synthèse (en français)

Résumé du projet

Le projet EPIGRAM concerne la dynamique des régions marginales et côtières françaises de la région Atlantique (golfe de Gascogne et Manche). Il est notable que la plupart des recherches sur la dynamique de l'océan se sont principalement concentrées sur l'océan profond et les basses fréquences (climat). La région côtière a récemment remobilisée les recherches scientifiques en dynamique océanique, grâce au développement de l'océanographie opérationnelle côtière et au besoin de suivi temps réel de cette région pour des raisons économiques, de santé publique ou militaires. Un des retards scientifiques principaux est associé aux observations à la mer : il n'existe pas de campagnes à la mer "d'envergure" sur cette région et la plupart des données scientifiques ont été obtenues il y a 15 ans ou plus. C'est pourquoi nous proposons la mise en place d'un programme d'observation de grande envergure, basé sur l'observation des processus majeurs sur cette zone.
Les processus océaniques étudiés dans ce projet vont de la haute fréquence à la variabilité saisonnière au plus. Nous nous concentrerons sur des études hydrodynamiques et le but scientifique principal est d'améliorer notre compréhension des processus dynamiques principaux de la plate-forme continentale et des marges dans les régions « Manche » et « Golfe de Gascogne », ainsi que la capacité des modèles numériques à les représenter.
Le projet rassemble 14 laboratoires océanographiques publics et environ 50 personnes.
Le projet EPIGRAM s'étendra sur quatre années.

Objectifs scientifiques

Les objectifs scientifiques sont :

- La réalisation de quatre campagnes importantes à la mer et la collecte de données, mises à disposition des chercheurs participants au projet, pour tous les processus choisis.
- L'analyse scientifique des données recueillies (sur la base de diagnostics pour tous les processus choisis).
- La mise en place de modèles numériques réalistes et leur validation sur la zone d'étude (les résultats seront comparés aux observations à la mer).
- Une amélioration de notre compréhension des processus physiques majeurs de la zone.

Programme de travail

Le projet est divisé en 5 axes majeurs, pour lesquels une trentaine de sujets d'étude sont identifiés :

- Effets de la marée.
- Marée interne.
- Processus saisonniers de grande échelle et échange côte/large.
- Influence du forçage atmosphériques et des rejets de rivière sur la dynamique du plateau.
- Influence des vagues sur la circulation du plateau.

Les études sont basées sur :

- La définition, la réalisation et l'exploitation de campagnes à la mer, exécutées par l'IFREMER, le CNRS/INSU et le SHOM, dans les région Manche et golfe de Gascogne.
- La construction de modèles numériques réalistes de la zone et leur comparaison avec les observations à la mer, sur la base d'études de processus.

Retombées

Les résultats acquis seront important pour la communauté scientifique océanographique en général: le projet apportera des observations sur une zone dont la physique est extrêmement riche. EPIGRAM sera donc d'un intérêt majeur pour la connaissance de notre environnement marin proche en général. Il permettra de plus la construction et l'amélioration de systèmes opérationnels temps réel, les résultats d'EPIGRAM seront bénéfiques pour :

- la lutte contre les pollutions marines de diverses origines,
- la dérive d'objets,

- l'évaluation des capacités du milieu marin en matière d'énergie renouvelable (vagues, courants, énergie thermique, de l'eau de mer, ...).

Demandes budgétaires

Le tableau ci dessous résume les demandes budgétaires à l'ANR (et recense celles obtenues par le programme national LEFE/IDAO) :

Année	*2008*			*2009*			*2010*			*2011*		
Origines du financement	IDAO	**ANR**	*Tot.*	IDAO	**ANR**	Tot.	IDAO	**ANR**	*Tot.*	IDAO	**ANR**	*Tot.*
post docs	0	**120000**	*120000*		**240000**	*240000*		**120000**	*120000*			*0*
Assemblées EPIGRAM	16850	**7150**	*24000*			*0*	24000		*24000*	15150	**8850**	*24000*
Colloques scientifiques	0	**0**	*0*	9500	**1500**	*11000*	6000	**5000**	*11000*	6000	**15000**	*21000*
Publications	0	**0**	*0*	5000	**12500**	*17500*	14500	**3000**	*17500*	5000	**37500**	*42500*
Instruments	0	**0**	*0*	22000	**51800**	*73800*	11500	**45600**	*57100*	0	**11500**	*11500*
Frais de gestion (LEGOS)	1150	**0**	*1150*	2500	**0**	*2500*	4000	**0**	*4000*	1850	**0**	*1850*
Total	18000	**127150**	145150	39000	**305800**	344800	60000	**173600**	233600	28000	**72850**	100850

Le budget total (non consolidé) du projet EPIGRAM est ainsi : **679.400,00€ (ANR)** + 145.000,00€ (LEFE/IDAO) =824. 400,00 €

Critères d'éligibilité

- Le Coordinateur du projet n'est pas membre du comité d'évaluation du programme.
- Son implication dans le projet est de plus de 40% (>30%).
- La durée du projet est de 4 ans (fin 2008 à fin 2012).
- Les partenaires du projet sont des laboratoires publics (CNRS/INSU, Universités, IFREMER, SHOM, Météo-France-CNRM, laboratoire de Coet Quidan).

Abstract

The EPIGRAM project concerns the dynamics of the French Atlantic marginal and coastal areas (Bay of Biscay and Channel). It is indeed noticeable that most of the researches on the dynamics of the ocean have concentrated on the deep ocean, and its low frequency (climate) variability. The coastal area has only driven back our attention in this field recently, thanks to the development of coastal operational oceanography, and the need for a better monitoring of this area for economical, health or military purposes. One of the main scientific lag is associated with observations at

sea: there do not exist "heavy" campaigns at sea covering this area, and most of the scientific data were collected 15 years ago or more. The project is therefore based on:

- The definition, realisation and exploitation of campaigns at sea, performed by IFREMER, CNRS/INSU and SHOM.
- The construction of realistic numerical models of the area, and their comparison with observations at sea, on the basis of process studies.

The processes selected for this project are high frequency to seasonal variability at the most. We will concentrate on hydrodynamical studies and the main scientific goal is to **improve our comprehension of the main dynamical processes of the continental shelf and margins in the "Manche" (Channel) and "Golfe de Gascogne" (Bay of Biscay) and the ability of the numerical models to represent them**.
The project gathers **14 oceanographic public laboratories** with about 50 people.

The expected outcomes of the project are:

- The realisation of four important campaigns at sea and the collection of data for all selected processes.
- The scientific analysis of the collected data (furniture of diagnostics for all selected processes).
- Validated realistic numerical models of the area (whose results will be compared to -and limits will be assessed from comparison with- observations at sea).
- An improved understanding of the major physical processes of the area.

In summary**, the present project is proposed for a four years period. It concentrates on the physics of the Bay of Biscay and the Channel, in particular on the continental shelf and margin dynamics. It is based on the definition and exploitation of campaigns at sea and numerical modelling studies. The general goal being to improve our understanding and modelling capacity of selected physical processes.**
These results will be of primary importance for the oceanographic scientific community in general and for nowcast/forecast operational systems.
Finally the chosen approach (built on the analysis of oceanic processes) will also facilitate the extension of the results gathered on the present project to other regions.

1. Programme scientifique / Description du projet
Technical and scientific description of the proposal

1.1 Problème posé/Rationale

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1.2 Contexte et enjeux du projet/Background, objective, issues and hypothesis

Historical background

- The present project has been motivated by the IFREMER/INSU letter of the 28th of September 2005, which was an incitement to the creation of a scientific program on the dynamics of the "Golfe de Gascogne" (Bay of Biscay) area, based on campaigns at sea and including possibly all the French oceanographic institutes.
- The INSU national ocean/atmosphere colloquium of prospective organised by the French CSOA (November 2005) identified the French coasts as areas of major scientific challenges, and in particular the Bay of Biscay for which there does not exist recent campaigns at sea allowing a complete understanding of the main dynamical regimes of the area, whereas the socio-economical needs and risks are important. Most of the research themes and the list of focus processes of the EPIGRAM project are based on the outcome of this colloquium.
- A letter of intent has been presented in 2006 to the LEFE/IDAO national program.
- **The project has been built with the goal to obtain funds from the ANR agency (main funding) and LEFE/IDAO program. It was submitted to LEFE/IDAO in September 2007, and accepted in December 2007. The granted LEFE funds are 145 k€ (2008: 18k€; 2009: 39k€; 2010: 60k€; 2011:**

28k€). This grant is contingent on the ANR (co)funding. In addition, CNRS has funded (in January 2008) the post doctoral position we requested for in the framework of the project.

Socio-economical stakes

The French coastal region in the north eastern Atlantic (Channel, bay of Biscay) is the site of many activities:

- economical (fishery, aquaculture, maritime transport, harbours, ...),
- tourism (nautical tourism, Oceanopolis in Brest, protected natural reserves, ...),
- scientific (existence of many scientific centres along the coast, IFREMER's observational network, ...),
- military (Navy's harbours, military operations at sea, ...),
- ...

These activities also give rise to some risks, that have to be assessed, and sometimes accidents, for which special operations at sea have to be undertaken:

- pollutions of different origin that can drift or be concentrated in some areas,
- oil slicks in case of accidents,
- object or body drift,
- ...

Another subject of particular interest is the use of the sea as a source of renewable energy:

- energy from the swell and waves,
- energy from tides (localised strong currents, and tidal dams),
- energy from mean currents,
- thermal energy from the sea water,
- …

All these activities would benefit from an enhanced monitoring of the oceanic environment.
Several institutes have put up projects (PREVIMER, MOUTON, REDEO ...) which will improve the operational tools providing environmental information needed for decision making and the management of the resources of the area. These **tools will be based on numerical models and real time observations of the ocean**. They will give the best estimate of the ocean state and of its evolution (real time nowcast/forecast systems). They will deliver products adapted to the needs described above. Regional and local systems are generally initialised and forced at their boundaries by basin scale or even global systems which already exist (in France, the MERCATOR system).

The development and exploitation of all these global to regional to local services is the mandate of some national institutions and already has a European framework: GMES and the Marine Core Services program, in particular the MYOCEAN project, where a main component concerns the IBI (Irish, Biscay and Iberian) area. However the validation and improvement of the information systems on which these services will be based is not (or only partially) addressed by the previous programs. This is the goal of the present EPIGRAM project: imagine the scientific studies that are necessary to assess the quality of the tools used in the information systems and improve them, build links between the scientific community and the operational centres to accelerate the transfer from research to developments and applications.

Several institutes responsible for the furniture of environmental information participate to the EPIGRAM project (IFREMER, MERCATOR, METEO-FRANCE, and SHOM) and links with some international projects (GODAE, GMES, and IBIROOS) also exists. The tools used (tested, validated and improved) in EPIGRAM will be the (pre) operational tools developed by these institutes. **Thus, the participation of these institutes to the EPIGRAM project guarantees the transfer of tools and expertise from research to operational systems** and ensures that the results of the EPIGRAM project will benefit to operational systems.

Another important aspect is associated with the national scientific fleet which represents a major mean for the oceanographic community. The French investment in the renewal of the oceanographic ships is justified by the fact that in situ observation is the main source of knowledge and progress in the understanding of our environment. **The EPIGRAM project proposes to use part of the French scientific ship potential for the observation of physical processes in a region of primary interest: the national (Atlantic) coasts.** The interest in this region is shared with other nations (UK, Spain and Ireland in particular), so that international cooperation is possible (and will be sought for when the project is launched at a national level).

Finally this project will allow maintaining a top level ability in numerical modelling and physics of coastal area for French laboratories. This is important in the context of GMES and the development of coastal operational oceanography in general (for the benefit of French scientific teams, but also –on a longer term- for the access to market shares for the new generation of services associated with regional or coastal operational oceanography).

Scientific stakes, State of the art and existing results

Generalities

In the deep ocean and for basin scale or global systems, the MERCATOR project is a good example of what can be done. The EPIGRAM project could be the base of a similar step for regional and local applications, in particular for the coastal areas. **IFREMER and SHOM have recently initiated some discussions on this aspect (REDEO plan) and discussions between the EPIGRAM community and the operational groups will be organised during the general assemblies of the project.**

In the coastal area, the development of real time nowcast/forecast systems can not rely on a simple transposition of what exists for the deep ocean. Indeed, the dynamics is dominated by much higher frequencies, due to the extreme sensitivity of the coastal region to atmospheric or hydrologic forcings, and the strong influence of the tide, at least in the northern part of the north eastern Atlantic. Their observation is therefore problematic for most sensors (satellites for instance), and little attention has been paid to them in the past years since the focus was to achieve a system for the larger scale, low frequency processes.

A main axis of progress for the development of information systems in coastal areas of interest is therefore to improve our understanding of the high frequency dynamics on the continental shelf and margins, based on observation and numerical modelling.

As far as observations are concerned, the major campaigns at sea in the Biscay/Channel area have been performed in the early 90s at the latest (see Koutsikopoulos and Le Cann 1996, for a review). These previous campaigns and studies are of high interest for the EPIGRAM project as they have identified most important processes. These existing observations have yielded qualitative results that, even though of primary importance for the preparation of the present campaigns at sea or even the qualitative validation of numerical models, **have to be complemented by new observations**, to deepen our understanding of the physical processes at stake or to construct quantitative diagnostics to validate models more precisely. Indeed, much still has to be learned as far as tidal rectification, internal tide generation and propagation, tidal fronts, residual currents, effect of the bottom topography (in particular the shelf break) or islands on currents, margin currents, mixed layer dynamics, … are concerned. These are the processes on which the EPIGRAM project will concentrate.

Let us also finally notice that the previous observations have also revealed that the dynamics of the area is dominated by small scale, high frequency processes and driven in particular by the tide, mixing, ocean/atmosphere fluxes and winds. The observation of such high frequency (and often small scale) features is difficult but can benefit from the recent instrumental developments which will be tested and used during this project (HF radars, SMOS, SEASOAR in shallow areas, …).

As far as numerical modelling is concerned, there exist academic studies on the processes selected for EPIGRAM but no study describes realistic modelling covering the whole area, if it is not for pure barotropic tidal models (see some examples below) or basin scale circulation models, for which coastal circulation is not addressed.

IFREMER/DYNECO has however a numerical model –MARS3D- covering the coastal area which is able to represent some features at least qualitatively. This model does not take into account interactions with the deep ocean and shelf break currents: a coupling with a basin scale model is underway to do so. Other models have been applied recently to the area (HYCOM at SHOM, SYMPHONIE at LA and OPA/NEMO at MERCATOR.) or are under development with the aim of participating to the present project (HUGO3D at LEGOS). All have shown that other processes are qualitatively represented (internal tide fronts, deep/coastal ocean exchanges …). Even though these results are mainly qualitative, they are encouraging and allow us to be optimistic for the ability of numerical models to be ready for quantitative confrontations with observations in the area. The lack of adequate data is currently the main, if not the only, limiting factor for such an exercise, **collecting data and analysing them in terms of diagnostics for the most significant processes is again the main objective of the EPIGRAM project**. The following sections give a brief overview of the existing results forming the ground of the EPIGRAM project.

Large scale features

Koutsikopoulos and Le Cann (1996), Puillat et al (2004) or Lazure et al (2008) have summed up our knowledge on large scale features and the most prominent seasonal variations:

In winter, cooling and mixing by atmospheric fluxes and the wind homogenises the water column on the shelf. So that the temperature gradient is predominantly large scale and North-South. Particular conditions can however modify this general scheme when a hot and intense coastal current ("Navidad", see Frouin 1990) flows along the northern Spanish coast and penetrates northward following the shelf break (see Pingree et Le Cann, 1989, Garcia-Soto et al, 2002, Garcia-Soto, 2004).
During spring and summer the upper layers gain heat and the seasonal thermocline is formed in most of the area. Again there exists a large scale thermal structure in the surface waters with a hot water pool located in the south-eastern corner of the bay of Biscay. Below this seasonal mixed layer, the cold winter waters are insulated from the atmospheric fluxes and keep their -large scale- thermohaline characteristics forming a cold pool midway between the shelf break and the coast (see Vincent et Kurc 1969 ; Le Cann 1982. See also Houghton et al 1982 for observations of the mid-Atlantic bight).
Fall is a transitional season during which the summer situation is transformed back into the winter one, but this transition is generally pretty brutal (dominated by the effect of storms in particular) and accompanied by several spectacular events. In particular, the hot water pool formed in the south-eastern corner above the "plateau des Landes" can be released and rapidly penetrates northward as a hot tongue flowing on the shelf up to the Channel and following the margin (see Vincent et Kurc 1969, Lazure et al 2007).
To be noticed also is the existence of a recent climatology of the area that will be useful for the initialisation and validation of numerical models (see Charraudeau R., F. Vandermeirsch, 2006) and a general analysis of mean currents in the bay of Biscay (see van Aken 2002) but only concerning the surface.

Eddies and margin currents

Many satellite and in situ observations have primarily focussed their attention in the open/deep ocean and focused on the dynamics of vortices and eddies in the bay of Biscay and the so-called Swoddies (slope water eddies; see Pingree and Le Cann, 1990, 1992a, 1992b, Serpette et al 2006). While the structure, lifetime and even dynamics of these features is now quite well known (see Colas, 2003; Serpette et al 2006 and references therein), much remains to be revealed as far as their generation and interaction with the shelf is concerned, these processes being of great importance for the coastal/deep ocean exchanges in the area. The generation of Swoddies is related to the instabilities of currents along the margin (in particular the Navidad current), but the establishment of the latter, their vertical structure and their (seasonal) variations is still a matter of debate and of challenge as far as modelling is concerned (see Colas 2003; Friocourt, 2006; Friocourt et al, 2007; see also Csanady, 1988, for theoretical approaches), and again a major process as far as deep/coastal ocean exchanges are concerned (see Pingree et al, 1999). In particular, the data gathered for these processes drastically lack of dynamical measurements (currents) at long term and for specific observations involving deep/coastal ocean exchanges. The only low frequency analysis based on long term current observations date back to Pingree and Le Cann (1989) and their analysis relies on measurements obtained in the mid 80s for most of them.

Tides and their consequences

The area is well known as a one of the regions with the most important tides in the world. The general dynamics of tides and in particular the associated variations of the sea surface height (ssh) has thus been largely studied and is well documented and understood, and its modelling is no longer considered a major challenge in the area (see Le Cann,, 1990) at least for the most energetic components (such as M2 or even non linear ones such as M4). The associated currents are however much more difficult to represent as bottom friction or influence of internal waves can be important and are not properly understood and represented in models. This is of primary importance for applications (drift of pollutants, objects or bodies for instance), in particular for mean -residual- tide currents for which much remains to be done as far as observation and modelling are concerned (see an existing attempt in Salomon and Breton, 1991 for instance).
In addition, as already discussed above tides are responsible for the generation of fronts, associated with mixing in the bottom boundary layer, covering the entire water column in shallow areas where there exist very high tidal currents. These fronts are dominant features in spring and summer and are clearly visible on sst observations, but disappear in winter. The frontal regions associated with these thermal gradients are also very active dynamically -and are subject to instabilities- and biologically. The dynamics of these fronts and their instabilities are indeed the main drivers of the circulation in some areas (Iroise sea, southern part of the Channel) and even though there exist some observations in some areas (see Loder et al 1993, for the George bank area) most of them relate to satellite observations and there is a lack of in situ high resolution data to describe this process quantitatively in the iroise sea. Models are able to represent some qualitative features (see Mariette and Le Cann, 1984, Le Fèvre 1986) but the modelling of tidal fronts still remains a challenge.

Internal waves

The internal tide is also responsible for the formation of fronts, but its propagation inside the Bay of Biscay and on the shelf is not well documented in the scientific literature. Observations at fixed points exist (see Pingree et al, 1986) and have revealed that the thermocline variations associated with internal tides on the shelf can reach from 4 to 50 meters. Despite some very recent results (see van Aken et al 2007) most observations are again from space (see Pingree and New, 1995) and only concern the surface (New and Da Silva 2002 have for instance evidenced the formation of solitons in the area). There is thus a lack of in situ data at high frequency in particular for current measurements.
Modelling this process is a major challenge, as in particular the generation is taking place along the shelf break, for which the transition between deep and shallow waters is generally problematic for numerical models. Recent advances are encouraging (see Jézequel et al, 2002; Pichon and Corréard, 2006) and seem to show that models could be able to represent these features, but quantitative comparison is now necessary to go forward. Most recent studies identify the process as a main source of energy transfer from tides and for mixing a detailed observations of its characteristics (amplitude and propagation) in the area is therefore necessary.
In summary the generation, propagation, in particular on the shelf where it is eventually dispersed into solitary waves, of internal tide in the bay of Biscay and possibly the Channel is also a major observational and modelling challenge that will be addressed in EPIGRAM.

Upwellings and river discharge

Even though there does not exist strong continuous along-shore winds in the bay of Biscay and the Channel, there can exist transient upwellings in the area whose sensitivity to the wind is well established. Indeed even if strong upwelling can not be generated, the influence of Kelvin currents, generated by winds, on the dynamics of currents close to the coast, and in particular river discharges, has been revealed by numerical studies and SST observations from space (see Lazure et Jégou 1998). River discharges also impose short scale haline structure mainly in the form of narrow coastal current possibly releasing fresh water lenses offshore (see Puillat et al 2004).

Recent campaigns

Many existing campaigns at sea are related to the present project and will be exploited scientifically in EPIGRAM. In particular:

- MOUTON2004: is a SHOM campaign whose goal was to observe the dynamics of internal waves on the continental shelf.
- MOUTON2005: is a SHOM campaign whose goal was to observe the dynamics of internal waves on the continental shelf, the tidal front in the Iroise sea and the coastal-deep ocean exchange in the area of the “plateau des Landes”.
- MOUTON2006: is a SHOM campaign whose goal was to observe the dynamics of internal waves in the deep ocean and above the continental margin.
- MOUTON2007: is a SHOM campaign whose goal was to observe the tidal fronts, the formation and penetration of the seasonal thermocline and the tidal and general circulation in the “Manche” area.
- MODYCOT: is a series of IFREMER/SHOM campaigns whose goal was to observe the river plumes of the Loire and Gironde.
- CAROLS cruises (Cote de la Manche) in autumn 2007. These short cruises in the south-eastern part of the Bay of Biscay are mostly aimed at the validation of the band-L radar measurements by the airborne CAROLS instrument and investigation of near-surface salinity distributions, in preparation of the ESA SMOS satellite mission.
- FROMVAR2007: is an IFREMER/UBO campaign whose goal was to study the structure of the Ushant thermal front.

The data from these existing campaigns at sea at least partly remain to be exploited scientifically, and EPIGRAM is the framework chosen to do so. Data from these previous campaigns will thus be shared between the partners working on a common study and will serve as a basis for the planned new campaigns.

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1.3 Objectifs et caractère ambitieux/novateur du projet/Specific aims, highlight of the originality and novelty of the project

General objectives

There exist different projects in the French oceanographic community involving teams with top level skills on numerical modelling, in situ or spatial observations or on process studies. Different projects have been launched by the existing institutes (as far as campaigns at sea are concerned, MOUTON, ASPEX and GOGASMOS projects are based on observation at sea prepared by SHOM, IFREMER and CNRS/INSU respectively). A main common national project would enhance the exchanges, the full and rapid exploitation of the data, and help bridge the gap between scientific teams and operational centres.
One goal of the EPIGRAM project is therefore to **define a framework at the national level to enhance cooperation and exchanges between the different regional poles of expertise** on environmental sciences –in particular oceanography- ("Europôle mer" in Brest, "pôle Terre Vivante et Espace" in Toulouse, …) **and between the existing institutional projects**. A common global project being the most efficient mean to achieve this.

As far as the scientific objectives are concerned, we will concentrate on hydrodynamical studies and the main scientific goal is to **improve our comprehension of the main dynamical processes of the continental shelf and margins in the "Manche" (Channel) and "Golfe de Gascogne" (bay of Biscay) and the ability of the numerical models to represent them**. We will focus on the most significant processes of the area whose scales range from hourly to monthly variability and from about 100m to 50km spatial (horizontal) variability. Studies will be based on analysis of campaigns at sea and numerical modelling. Specific campaigns will be organised to gather data, but existing data will also be exploited.
Obviously, given the needs mentioned above, physics is not the only subject which requires attention in the area, but it is a prerequisite and the national community being ready to propose a project the present proposal concentrates on this subject. We will however open the EPIGRAM project to the biogeochemical, climate and data assimilation scientific community with the goal of extending the objectives of the present project, and we will pursue our –already existing- dialog with these communities during the project. Also, links and possible cooperation with foreign institutes will be assessed during the project.
In summary**, the present project is proposed for a four years period. It concentrates on the physics of the bay of Biscay and the Channel, in particular on the continental shelf and margin dynamics. It is based on the definition and exploitation of campaigns at sea and numerical modelling studies. The general goal being to improve our understanding and modelling capacity of selected physical processes.**

Objectives for campaigns at sea

Most of the processes that we wish to study will require observations at sea, some of them will also rely on the use of new instruments that have to be calibrated or at least tested. The applications for ship time will be done by representatives of the institutes participating to the project, but the "campaigns at sea transverse axis" aims at organising and optimising all observations.
Existing campaigns for which data will be scientifically exploited during EPIGRAM are presented in the previous chapter.

Planned new campaigns

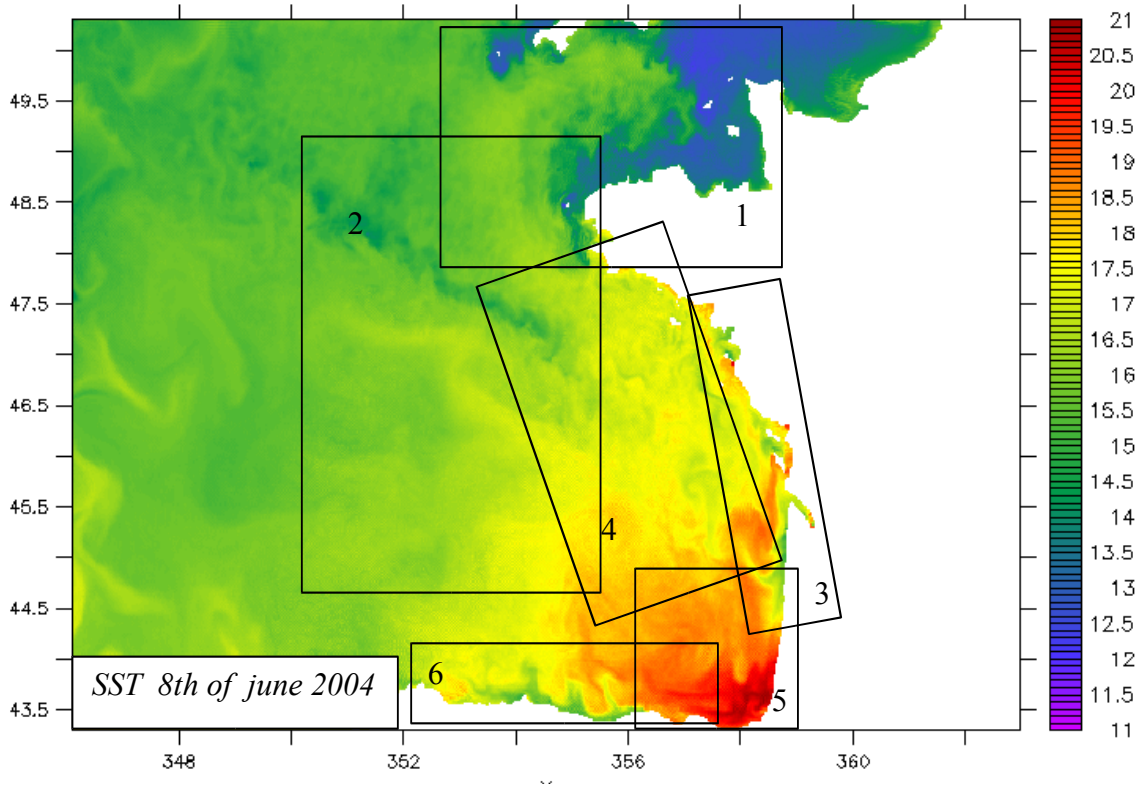
New campaigns based on existing programs or specific to the EPIGRAM project will take place as soon as 2008 :

- MOUTON2008, MOUTON-FO2009 : are SHOM campaigns devoted to the observation of physical processes in the Manche and Golfe de Gascogne. Their precise objectives will be discussed in the framework of EPIGRAM for instance for the test of new instruments (turbulence profiler) and for the study of mixing processes (internal tides, mixed layer). About 30 days at sea are planned each year for these campaigns in association with the EPIGRAM project. New campaigns at sea could be programmed in 2010 and 2011 in the framework of the future PROTEVS SHOM project. The MOUTON2008 campaign at sea is planned in the Iroise sea (tide, tidal fronts, mixed layer dynamics and influence of atmospheric fluxes), above the continental slope (general dynamics of internal waves) and over the South Brittany shelf (river plumes, transient upwelling, circulation on the shelf). Part of the cruise will also be mutualized with the ASPEX campaigns (see below) and preliminary ASPEX moorings will be deployed during MOUTON2008.
- GOGASMOS (Suroit) and CAROLS/SMOS (Côte de la Manche) 2009 cruises. These spring cruises (April to early June) will be devoted to the SMOS calibration phase and the EPIGRAM project, focusing in particular on

area 5 and processes of freshwater exchanges between the southern shelves, the Landes plateau and the interior (deeper part) of the Bay of Biscay. This will include CTD/LADCP S-ADCP surveys near the shelf-breaks, following fresh water in Lagrangian experiments (close link sought with the LATEX project), fine studies of the vertical processes controlling salinity stratification near the surface (including air-sea fluxes), possible air-born surveys (L-band radars) of surface salinity… The cruises could also be used for deployments/recoveries of gliders, drifters, moorings for the EPIGRAM project. A 25 days cruise is requested for the Suroit, and 3 and 5 days cruises will be requested for the Cotes de la Manche.

- FROMVAR cruise (Côtes de la Manche) in autumn 2008. The FroMVar project aims at studying the structure, dynamics and variability of the Ushant tidal front, in the Iroise area. A mooring (300 kHz ADCP lander) will be deployed during the summer season, and a CTD survey will be conducted at recovery in the autumn.
- ASPEX cruises. The ASPEX program, intended to be the Ifremer contribution to the EPIGRAM in-situ data collection effort, will involve the deployment for two consecutive years of a large array of moorings, instrumenting the inner and outer parts, as well as the slopes, of the Aquitaine and Armorican shelves. This mooring array will be complemented by CTD surveys and Lagrangian instruments deployment. The deployment cruises will take place in august and the recovery cruises will take place in march. The number of days at sea for the entire ASPEX campaign is 30 days. A prior test phase involving a reduced mooring array is also planned and will be taken into account by the MOUTON2008 campaigns.
- *ARCADINO cruises in spring and summer 2008. ARCADINO is a joint IFREMER/ EPOC (Bordeaux University) project and is not directly linked to the EPIGRAM project. A CTD survey will however be conducted off Arcachon with the aim of investigating the relation of the hydrological structure with biology (Harmful Algal Blooms). The physical data will be of interest for the EPIGRAM project.*

Additional observations during these campaigns will be discussed and proposed during the project.
Specific observation tools or strategies will be required for some processes (river run offs, cold pool, transient upwellings, ...). New technologies (Seasoar for shallow waters, PAGODE profilers) will also be tested when possible and adequate. The exploitation of campaigns at sea to provide data to validate realistic models will be at the core of the project and will require some means (post doc grants in particular).
The following plot represents a general view of the areas we plan to survey. The “Manche” and “Golfe de Gascogne” area is divided into 6 –indicative- zones where the selected processes have a significant signature.



Zone 1 :
Tidal currents and tidal fronts
Mixing associated with tidal currents
Hydraulic jumps
Mixed layer and formation of the seasonal thermocline, O/A interactions
Mixed layer and surface waves
General circulation on the shelf (+ zone 2 and 4)

Zone 2 :

Internal tides and internal waves on the shelf
Internal tides and mixing (margin and open ocean)
Dense water formation

Zone 3 :
Currents generated by winds (+ zone 6)
River plumes

Zone 4 :
Northward seasonal curent (+zone 5)
Cold pool
Margin currents

Zone 5 :
Exchanges between the deep ocean and the coastal area

Zone 6 :
Navidad curent

Objectives for technological studies

As mentioned above, the project will be an interesting framework to test the adequateness of new sampling strategies or new instruments. Indeed, measurements in the area can be complicated by the superimposition of many physical processes (for instance, near Brittany, the tide is the main dynamical signal and masks the mean currents. Internal waves can be so important that it can spoil the geostrophic analysis from hydrological data). The contrasts between the upper layer and lower layer is so important that it can cause some problems for measurements (the thermocline thickness is around often 10 m and the temperature jump can reach almost 10°C). The haline contrast in fronts (river plumes) has strong dynamical consequences and a precise measurement of salinity is needed to complement the SST observations. To isolate and to obtain pertinent diagnostics for each physical process, particular measurements and data analysis have to be developed and tested. Several studies and testing of new instruments are also proposed in the present project, which are detailed below. Technological studies are attached to the main defined below as the instrument or data analysis technique developed is sometimes beneficial to some specific study.

Objectives for process studies

As exposed above, the validation of circulation models over the area will be based on the study of selected processes. This allows a more precise analysis of the limits of the numerical models and a more rigorous approach for the comparison of models (indeed implementation choices in models are usually adapted to the representation of several processes). Application of a model to other areas is also facilitated if its optimisation and validation is based on process analysis. **We have thus selected some physical processes that are essential for the dynamics of the area and for which there are scientific challenges concerning their understanding and representation in numerical models.**
For all physical processes listed below, apart from the assessment of the existing data and the existing numerical studies, the goal is thus **to improve our knowledge on their characteristics (localisation, spatial scales, time scale, magnitude, ...), their origin and their evolution and to evaluate and improve the ability of numerical models to represent them**.
All the studies will be based on the exploitation of in situ observations and most of them will be confronted with results from numerical models. Interaction between processes will be addressed too, even though, for readability of the project, they are not always mentioned here. Finally, the campaigns at sea will be organised globally.
We have grouped all selected processes into five main axes:

Axis 1: Effects of the tide on the shelf
- Tidal currents
- Mixing associated with tidal currents
- Tidal fronts
- Hydraulic jumps associated with tidal currents

Axis 2: Internal tide
- Internal tides generation and solitons at a seasonal thermocline
- Internal tides and internal waves on the shelf
- Internal tides and mixing

Axis 3: Large scale seasonal processes and deep-sea/coastal exchanges
- General circulation of the shelf

- Northward seasonal current
- Cold pool
- Continental slope processes
- Slope currents
- Exchanges between the deep ocean and the coastal area
- Dense water formation
- Navidad current

Axis 4: Atmospheric and river plume influences on the shelf dynamics

- Currents generated by winds
- Mixed layer and seasonal thermocline
- Extreme atmospheric events
- River plumes

Axis 5: Influence of waves on the shelf dynamics

- Mixed layer and surface waves
- Surf zone - inner shelf transition

For each process a briefing docket detailing the study is given below (next section).

Objectives for numerical modelling

The cooperation put up for the present project also aims at taking advantage of the rich variety of existing modelling tools. This variety is associated with different choices for numerical schemes and parameterizations and will allow to assess the various implementation choices with respect to their ability to accurately represent the processes on which we will concentrate. Finally the existing variety will also help evaluating the accuracy and the limits of numerical modelling for the ocean. The variety of existing models, researches on new numerical schemes or new models is the main engine of progress in numerical modelling.
Intercomparison between different models (SYMPHONIE, NEMO-OPA, MARS, HYCOM, and HUGO3D) will thus be at the heart of the present project. **This will be based on realistic modelling of (part of) the area and the comparison of models in the light of common diagnostics coming from process studies** (essentially observation at sea). Numerical modelling can benefit from some mutualizations listed below.

Input modelling data base

Numerical modelling also depends on the availability and accuracy of some physical fields which can be mutualized among the community. In particular:

- High resolution (250 m) bottom topography
- Rivers run offs (transport and when available temperature and salinity at the river mouth)
- Data base for initial conditions
- Interpolation technique (horizontal and vertical extrapolation), in particular for boundary forcing
- Tidal forcing at boundaries
- Low frequency forcing at boundaries (from climatology or from MERCATOR (re)analysis)
- High frequency and high resolution atmospheric forcing

Data exchanges

A common format for the exchanges and comparisons of numerical outputs will be used based on existing common formats and partner uses. It will be applied to observations and model outputs.

Diagnostics

The definition of diagnostics from observations will be discussed among partners depending on observations available and planned and on processes studied. This work will be the major role of the post docs hired for the project. The work done in the framework of GODAE and the ongoing comparison/validation exercise will be the starting point of this reflection.

Further common developments

From these comparisons and validation of models some studies concerning regional modelling and common to all numerical models can rise up. These could concern :

- Hydrological data base (climatology)
- Interpolation tools
- Diagnostics from observations that can be useful for the validation of all models
- …

1.4 Description des travaux : programme scientifique/For each specific aim: a proposed work plan should be described

As mentioned above, we have defined five main axis divided into individual (process and technological) studies. A briefing docket describing each study is given below. **There will obviously be interactions and exchanges between individual studies (common campaigns at sea, realistic models, and exchange of scientific information when studying processes interactions), but they are not described here for the sake of simplicity and readability of the project.** A general management axis/task is also defined.
Notice that some individual studies are mentioned but no teams are in charge of the work. In this case, no means is requested. We have kept them as a memory of studies that would be beneficial for the project, with the possibility of finding teams to do the work in the future.

Management

Different coordinators have been appointed for the project:

- Yves Morel (SHOM): general coordinator of the project, coordinator of axis 4 (Atmospheric and river plume influences on the shelf dynamics) and co-coordinator of the transverse axis "campaigns at sea".
- Pascal Lazure (IFREMER/DYNECO): general management of the project (steering committee) and coordinator of axis 3 (Large scale seasonal processes and deep-sea/coastal exchanges).
- Pierre De Mey (CNRS/INSU/LEGOS): general management of the project (steering committee).
- Pascale Bouruet-Aubertot (UPMC/LOCEAN): coordinator of axis 2 (internal tides).
- Florent Lyard (CNRS/INSU/LEGOS): coordinator of axis 2 (Effects of the tide on the shelf).

Transverse axes have been defined too for realistic numerical modelling and campaigns at sea (including technological studies) with coordinators:

- Guillaume Reffray (MERCATOR): coordinator of the transverse axis "realistic numerical experiments".
- Louis Marié (IFREMER/LPO): co-coordinator of the transverse axis "campaigns at sea" (responsible for the ASPEX campaigns).
- Gilles Reverdin (CNRS/LOCEAN): coordinator of the transverse axis "technological studies".

Notice that the participation of Gilles Reverdin (who is part of the ANR scientific committee) to the project is associated with the GOGASMOS campaigns at sea, which have been entirely funded through the LEFE/IDAO grant. His role as coordinator of the transverse axis has however been kept here for completeness of the project, but the studies he is involved in do not require additional funding from ANR.

The role of the coordinators is to participate to the project construction and its evolution and to synthesize the results for their axis every year. The axis coordinators will also supervise a post doc involved in the exploitation of the campaign at sea (and whose funding is requested from ANR for axis 1, 2, 3 and 4; INSU having funded the axis 5 post doc).

Axis 1: Effects of the tide on the shelf

Tidal currents

Participants :

Florent Lyard (CNRS/INSU/LEGOS) : numerical modelling+data and model analysis
Post doc 1 (LEGOS) : data and model analysis
Rémy Baraille (SHOM) : numerical modelling
Annick Pichon (SHOM) : numerical modelling+data and model analysis
Stéphanie Louazel (SHOM) : numerical modelling+data and model analysis
Yves Morel (SHOM) : campaign at sea + data and model analysis
Lucia Pineau-Guillou (SHOM) : numerical modelling
Louis Marié (IFREMER-LPO) : campaign at sea+data analysis
Steven Herbette (UBO-LPO) : campaign at sea+data analysis
Pascal Lazure (IFREMER-DYNECO) numerical modelling+data and model analysis
Franck Dumas (IFREMER-DYNECO): numerical modelling+data and model analysis

Goal :

One of the dominant characteristics of the Bay of Biscay area is the presence of extremely strong tidal currents in the mouth of the English Channel. These currents decrease southward, and reach very low values in the south-eastern corner of the Bay. They are however the dominant current signal over most of the continental shelf, and act as a forcing influence in many of the physical processes of interest for EPIGRAM (mixing at shelf-break fronts and tidal fronts, internal tides, hydraulic jumps, ...).

The goal of this study is to improve numerical models in their ability to represent tidal currents (instantaneous and rectified) at large to small scale. The influence of the bottom topography, of the bottom friction and of the bottom boundary layer parameterisation will be assessed. Downscaling will also be studied in particular the sensitivity to lateral boundary layer forcing.

The long-term (4 months) high temporal resolution data acquired by the FROMVAR mooring during the summer of 2007 will provide an in-situ basis for comparison.

Numerical modelling :

This process is one of the main which will be taken into account for the evaluation of realistic numerical models.

An interesting aspect of the study is the use and comparison of different numerical models, based on different numerical approaches, in particular finite element codes (HUGO, TELEMAC) and finite difference ones (MARS, HYCOM), theses codes having also different approaches in terms of bottom friction parameterisation. In addition to the planned campaigns at sea, validation will also be based on the use of HF radars (Iroise sea) and tide gauges (along the French coast).

Observation at sea :

Existing measurements MOUTON2005,2007, FROMVAR2007.

Means :

Campaign at sea :

The FROMVAR 2008 cruise will involve a 300 kHz ADCP mooring and a 2 weeks CTD survey (Côtes de la Manche).

2 INSU ADCPs (300kHz) could be available for moorings in 2009 to study tidal currents (internal waves and shelf margin currents too).

Use of HF radars and tide gauges.

Drifters : existing drifters in the Channel and Iroise sea, should be complemented by 3 SLDMB and 3 Surdrift-75 in the south-east of Brittany = 3*2300+3*3600 = 17.700,00 € TTC

About 4 days of in situ observation required.

Time period :

2008-2012

Mixing associated with tidal currents

Participants :

Florent Lyard (CNRS/INSU/LEGOS) : numerical modelling+data and model analysis
Post doc 1 (LEGOS) : data and model analysis
Rémy Baraille (SHOM) : numerical modelling
Yves Morel (SHOM) : campaign at sea+ data and model analysis

Goal :

Close to the coast waters are homogenised all year round where the tidal currents are strong enough. This is due to the development of the bottom boundary layer and the process gives raise to the tidal fronts in the Manche.

The goal is to study the influence of the tidal currents on the mixing and homogenisation of the water column in numerical models. The influence of the bottom boundary layer parameterisation will be addressed.

Numerical modelling :

Comparison of realistic configuration with different PE models to assess the sensitivity to parameterization and specificity of the numerical models.

Observation at sea :

Exploit the existing data, exploit satellite observations. New observations will be planned if necessary.

Means :

Campaign at sea :

New campaigns at sea will be planned but coupled to the tide and internal tide on the shelf observations. A priori same observations, no additional days required.

Time period :

2009-2012

Tidal fronts

Participants :

Florent Lyard (CNRS/INSU/LEGOS) : numerical modelling+data and model analysis
Post doc 1 (LEGOS) : data and model analysis
Rémy Baraille (SHOM) : numerical modelling
Stéphanie Louazel (SHOM) : numerical modelling+data and model analysis
Yves Morel (SHOM) : campaign at sea + PhD advising
Louis Marié (IFREMER-LPO) : campaign at sea+data analysis
Steven Herbette (UBO-LPO) : campaign at sea+data analysis
Franck Dumas (IFREMER-DYNECO) : numerical modelling+data and model analysis

Goal :

The dynamic equilibrium between re-stratification due to atmospheric forcing and mixing due to tidal currents is at the origin of the existence of several tidal fronts in the Bay of Biscay area. The Ushant front, discovered in the late 60's, is a major structure which bears a strong influence on the hydrology of the Iroise area during the summer, but smaller, more localised instances can also be found in the vicinity of the islands of the Atlantic façade (Belle-Ile, Noirmoutier, Rochebonne).

This study aims at improving our understanding of the mechanisms involved in tidal fronts formation and dynamics: influence of tide amplitude, influence of wind stress, sensitivity to mixed layer and bottom layer parameterisation, influence of bottom topography. The characteristics and variability of the mean current developing at the front will be studied as well as the nature and structure of the instabilities that develop along the front and their role on the extension and equilibrium of the front. This study will use the high-resolution CTD surveys conducted during the 2005 and 2007 MOUTON cruise, as well as the more limited survey conducted during the FROMVAR 2007 cruise. Lagrangian drifter data collected by IFREMER/DYNECO will be a complementary source of insight.

Numerical modelling :

The process will be taken into account for the evaluation of realistic numerical models.

Observation at sea :

MOUTON2005, MOUTON2007, FROMVAR 2007.

Means :

Campaign at sea :

New campaigns at sea will be planned (2*4 days of measurements required, with seasoar if possible and in late spring/summer). No specific needs, existing drifters data.

Time period :

2008-2012

Hydraulic jumps associated with tidal currents

Participants :

Florent Lyard (CNRS/INSU/LEGOS) : numerical modelling+data and model analysis
Post doc 1 (LEGOS) : data and model analysis
Yves Morel (SHOM) : physical analysis+coordination+ campaign at sea
Louis Marié (IFREMER-LPO) : theoretical and physical analysis+ PE modelling+ campaign at sea
Steven Herbette (UBO-LPO) : physical analysis+ PE modelling+ campaign at sea
Francis Auclair (UPS/POC/LA) : physical analysis+ PE and NH modelling
Alexandre Paci (CNRM) : Laboratory experiments (Toulouse Stratified Flume).
Jean-Christophe Canonici (CNRM): management of the Toulouse stratified flume.
Olivier Eiff (IMFT): Laboratory experiments (Toulouse Stratified Flume).
Dominique Astruc (IMFT): Laboratory experiments (Toulouse Stratified Flume).

Goal :

Recent observations on the north eastern Atlantic shelf at the beginning of spring 2007 have revealed the existence of strong perturbations of the seasonal thermocline and of mixing above sand dunes. This observation was done at a period of strong tides, and the perturbations and mixing were possibly associated with the development of an internal hydraulic jump. The presence of strong tidal currents and of the bottom topography can indeed generate strong baroclinic currents. When the Richardson number becomes critical, internal hydraulic jumps can be generated and mixing can take place.

The resolution of the observation was very high (thanks to the use of SEASOAR and vessel mounted ADCP) which will allow a detailed analysis of the Richardson number and structure of the hydraulic jump.

The goal of the study is therefore to understand the observed mixing and to evaluate if it is indeed associated with the

development of a hydraulic jump. The importance of this phenomenon on the shelf will be evaluated using realistic barotropic tides, stratification and topography.

Numerical modelling :

An embedded modelling based on a realistic bathymetry of the region will be achieved. *LES* modelling at larger scale will be downscaled to smaller *NH* scales though mass and momentum conservation embedded modelling with the variational platform VIFOP (Auclair et al., 06). The Symphonie (Marsaleix et al., 07) and Symphonie-NH codes will be used respectively for *LES* and *NH* modelling while basin scale barotropic tides will be supplied by TUGO-M.

In order to provide a clear understanding of the observed mechanisms, several aspects will be more particularly developed through academic numerical studies:

- Simplified academic configuration with PE models to evaluate the possibility of generation of subcritical currents ($Ri < 1/4$) and evaluate the sensitivity to different parameters (current strength, stratification and seamount height).
- Simplified academic configuration with a NH model will be used to evaluate the realism of the mixing in this kind of model, for such a process. If it is the case the rate of mixing in different context will be evaluated from LES and will be used to evaluate the realism of turbulent closure schemes in PE models.

Realistic modelling will provide amplitude of tidal currents to evaluate the regions where this phenomenon can take place, and if it can represent an important source of mixing.

Observation at sea :

Exploit the existing data. New observations will be planned if necessary (possibly 2*2 days). The measurement takes about 12h00 (SEASOAR+VMADCP).**Laboratory experiments :**

The Toulouse Stratified Flume will be used to perform laboratory experiments on this phenomenon.

This contribution will be particularly relevant for the validation of the numerical studies in academic cases.

The study will focus in particular on the conditions leading to the hydraulic jump (e.g. the influence of the density profile) and on the processes involved in the observed mixing.

Means :

Campaign at sea : no specific needs, existing data will first be used. The necessity of complementary measurements will be assessed during the study.

Time period :

2008-2011.

Technological studies / Instrumental testing associated with axis 1

Detiding

Participants :

Florent Lyard (CNRS/INSU/LEGOS) : numerical modelling+data and model analysis

Post doc 1 (LEGOS) : data and model analysis

Goal :

Test the usability of the shelf S-ADCP measurements during cruises. S-ADCP current data are regularly collected and processed from cruises on the Bay of Biscay shelves (in particular, R.V. Thalassa cruises, or the MOUTON cruises). The data are difficult to use because of specific processing issues (bottom reflection, diffusing matter/particles), but also because currents result from fast processes that can be of interest for process studies as envisioned during EPIGRAM. Currently, the data are not regularly used, mostly because of processing issues in decomposing “regular” barotropic tidal currents from the other time-varying signals. The goal of the present study is to define a method to distinguish the high frequency tide signal from the lower frequency one. The possible relationships between the thermohaline structure and the velocity field (geostrophic equilibrium for instance) will be used to separate high and low frequency signatures.

Means :

Campaign at sea : all existing data on the shelf near Brittany in particular.

Time period :

2008-2012.

HF radars

Participants :

Philippe Forget, Yves Barbin (LSEET): improvement of measurement and exploitation of data

Alexei Sentchev (LOG): improvement of measurement and exploitation of data

Fabrice Ardhuin (SHOM): access to data

Pascal Lazure (IFREMER/DYNECO) : data interpretation and exploitation

Goal :

HF radars are now commonly used to measure surface currents in coastal ocean area up to 150 km offshore. Such a system has been deployed by SHOM and covers the Iroise sea. The radar signals are routinely processed and the radial components of the 2 stations are merged to provide maps of the surface velocity vector on a regular grid. These maps will be useful for the modeller community of EPIGRAM for validation of the models (this is one of the main outcome of EPIGRAM).

LSEET has developed a specific algorithm allowing a high azimuthal resolution. Such high resolution is required, typically, in the region of Ouessant Island where very intense and localised tidal currents take place. The radar data will be reprocessed during periods defined with the modellers for model inter-comparison in this region. These data could also be useful for the validation of new method for measuring surface currents from space developed at IFREMER and Boost-

Technologies.
Furthermore, a variational interpolation of radial velocities during the periods of interest will be performed by LOG. This will make maximal use of available data, avoid the additional step and associated errors of creating gridded horizontal vector currents from radial data, provide a controllable level of spatial smoothing and an estimation of accuracy of interpolated velocities.
The analysis of tidal and baroclinic circulation derived from HF data will be performed. These data will also be used in applications such as the computation of trajectories and the identification of coherent structures which are of primary importance in transport and mixing processes. Comparison with drifting buoy trajectories (MOUTON experience, 2005-07) will be done.
In 2009, a radar system will be deployed by AZTI along the south-eastern corner of the Bay of Biscay (for 2009). There too, there will be a need for validation of the current dynamics simulation in a region where tidal forcing is weaker.
Means :
Campaign at sea :
SHOM radars in the Iroise sea to be continued after 2008, data available for scientific exploitation (SLDMB drifters launched during MOUTON2005-2007).
AZTI radars planned for 2009.
Time period :
2008-2010

Coastal altimetry
Participants :
Florence Birol (LEGOS) with expert support from N. Ayoub (LEGOS), F. Lyard (LEGOS).
Goal :
Satellite altimetry has received much attention in the open oceans, its coastal applications, potentially manifold, are still largely unexplored. The transition to routine use of satellite altimetry in coastal areas requires dedicated studies of both the measurement quality and the observability problem. The first problem is the accuracy of data on shelf areas. For some years, a dedicated data processing system has being implemented by the MAP (Margins Altimetry Project) group. Among other improvements, since the global ocean models cannot account for the extreme, rapid and high resolution processes occurring in coastal zones, it uses the much higher resolution regional model for the HF de-aliasing of the altimeter data. The editing strategy has also been re-defined. The processing is now at a validation stage in different shelf areas. The first analyses have shown a substantial increase in both the number of valid data in the coastal domain and their accuracy. Other issues concern the gap in data next to the coast (10-40km) and the resolution. Where available, coastal tide gauge data could be used to bridge the coastal gap in data. A multi-mission and multi-data approach, combined with appropriate data analysis techniques should then enable to optimize the spatial and temporal sampling.
The goal of this study is to analyze the potential of satellite altimetry in observing and monitoring the major physical processes of the Bay of Biscay.
Means:
Campaign at sea : existing data.
Time period :

2008-2009

Axis 2: Internal tide

The Bay of Biscay is one of the most powerful generation areas of internal tides over the world oceans. In this area, under particular conditions, these large amplitude internal waves give birth to internal solitary waves (solitons) and internal bores with trailing soliton-like waves (solibores).
In the last decades, several dedicated cruises (MICADO 2000, PRECOCE 97/98, MINT 93/94…) have focused on this particular type of internal waves. At the present time, both the PEA of the SHOM and the 3-year LEFE-IDAO project on "Internal Waves" (ending in 2009) contribute to the study of the internal tides in the Bay of Biscay. Our purpose is to pursue these studies in the framework of the EPIGRAM project with the aim of providing advanced knowledge into the dynamics of the internal tides and of the induced processes such as solitons and solibores. An original aspect will be the investigation of the mechanisms leading to mixing and energy dissipation.

Internal tides generation and solitons at a seasonal thermocline

Participants

Pascale Bouruet-Aubertot (LOCEAN, UPMC) : numerical modelling + in situ-measurements and data analysis.
Post doc 2 (LOCEAN) : data and model analysis
Yannis Cuypers (LOCEAN, UPMC): NH modelling (OOFS code), in situ-measurements and data analysis.
Valérie Garnier (IFREMER) : PE modelling (Mars 3D).
Annick Pichon (SHOM): situ-measurements and data analysis, PE modelling (HYCOM code).

Goal

The region of the shelf break is a key area for internal tide studies. As well, the abyssal plain deserves a particular attention as it is an area of intense propagation and of the generation of solitary waves. Several mechanisms will be more particularly investigated.

- In the neighbourhood of the generation area, the first downward internal ray propagating off shore is known to be powerful and is associated to increased dissipation.
- The interaction of the internal tidal beams generated at the shelf break with a seasonal thermocline may generate solitons, thereby transferring a possibly substantial part of their energy to strongly non-linear propagating structures. We will more particularly concentrate on the conditions of occurrence of the solitons, their generation mechanism and their characteristics as a function of those of the internal tide. An important outcome of this study will be the ability to predict where the solitons should be observed, which will guide the measurement campaigns.
- The NH components of the internal tides (associated for instance to the vertical component of the Coriolis acceleration).

In situ observations will be carried out during the MOUTON cruises by the SHOM, LPO and LOCEAN/UPMC teams.
Realistic configurations focusing on the first downward propagating ray and on solitary waves will be addressed numerically by the POC/LA/UPS team, guided by the analysis of in-situ observations and by the conclusions of the academic studies. The location in space and time of the high resolution zoom(s) will be chosen based on the results of the MOUTON experiments.

Numerical modelling

Realistic numerical experiments will be based on embedded modelling with the MARS3D, HYCOM, OPA, SYMPHONIE.

Observations at sea

Most measurements will be performed during the MOUTON cruises scheduled in 2008 and 2009 (possibly PROTEVS in 2010):

- Repeated CTD/ LADCP profiles at fixed point stations,
- Turbulence measurements using microstructure profilers, (VMP5500 and SCAMP see section 6.2.2).

Means

Campaign at sea: no specific requirement for this study.

Time period

2008- 2012.

Internal tides and internal waves on the shelf

Participants :

Pascale Bouruet-Aubertot (LOCEAN, UPMC) : numerical modelling + in situ-measurements and data analysis.
Post doc 2 (LOCEAN) : data and model analysis
Yannis Cuypers (LOCEAN, UPMC): NH modelling (OOFS code), in situ measurements and data analysis.
Bruno Ferron (LPO): in situ-measurements and data analysis.
Valérie Garnier (IFREMER): numerical modelling (Mars 3D), in situ-measurements and data analysis.
Annick Pichon (SHOM): in situ-measurements and data analysis, PE modelling (HYCOM code).
Yves Morel (SHOM) : exploitation of previous campaigns at sea

Goal :

In the region of the continental shelf, we will more particularly investigate the propagation of the internal wave and evaluate its amplitude on the shelf (in particular its dynamical signature). Its dispersion into non linear waves and their transformations into solitons, solibores, especially through the interaction of internal tides with the seasonal pycnocline,

will also be studied. Solitons on the shelf could play a role on the ecosystem through their transport properties, especially for primary production.
Two complementary contributions are associated to these studies:

- In situ observations will be carried out during the MOUTON cruises by the SHOM, LPO and LOCEAN/UPMC teams. As well, previous campaigns from IFREMER will be analysed to detect the occurrence and characteristics of solitons.
- Realistic configurations in the context of the Bay of Biscay will be addressed numerically by the SHOM team with the HYCOM code and by the POC/LA/UPS team with the SYMPHONIE code. They will be guided by the conclusions the analysis of the MOUTON cruises.

Numerical modelling
Realistic numerical experiments will be based on the SYMPHONIE and SYMPHONIE-NH codes, and the HYCOM code (internal waves only).
Observations at sea
Most measurements will be performed during the MOUTON cruises, scheduled in 2008 and 2009:

- Repeated CTD/ LADCP profiles at fixed point stations,
- Turbulence measurements using microstructure profilers (VMP5500 and SCAMP, see sections 6.2.2),
- Moorings equipped with high-frequency sensors that resolve the inertial range, one will be deployed during MOUTON 2008 and ideally "long-life" mooring that would be maintained every year during EPIGRAM.

Previous campaigns by IFREMER will also be analysed : measurements consist in Echosounder and ADCP data gathered during HABIT6 cruise over the Armorican shelf. Three new short cruises are scheduled during summer 2008 to assess the propagation of solitons in shallow depth (around 50-70m) at the south of Belle Isle. Further investigations could be pursued depending on this first assessment.
Means :
Campaign at sea :

New campaigns at sea will be planned (2*3 days of measurements required). No specific needs, existing drifters data.

Time period :
2008-2012

Internal tides and mixing
Participants :
Pascale Bouruet-Aubertot (LOCEAN, UPMC) : numerical modelling + in situ-measurements and data analysis.
Post doc 2 (LOCEAN) : data and model analysis
Jean-Christophe Canonici (CNRM): management of the Toulouse stratified flume.
Yannis Cuypers (LOCEAN, UPMC): in situ-measurements and data analysis, NH modelling (OOFS code).
Olivier Eiff (IMFT): Laboratory experiments (Toulouse stratified flume).
Bruno Ferron (LPO): in situ-measurements and data analysis.
Frédéric Moulin (IMFT): Laboratory experiments (Toulouse stratified flume).
Alexandre Paci (CNRM): Laboratory experiments (Toulouse stratified flume).
Annick Pichon (SHOM): in situ-measurements and data analysis, PE modelling (HYCOM code).
Goal :
It is now widely acknowledged that tides could provide about 1 TW to sustain the ocean stratification through mixing and the Bay of Biscay is often presented as one of the areas where the largest energy rate is transferred from barotropic to internal tides.
A clear understanding and a quantitative evaluation of the amount of energy that is transferred into internal tides and the lifetime of these internal tides is the main purpose of the present study. It thus involves different stages and processes that will eventually lead to mixing and energy dissipation:

- In the generation area: impact of the turbulent bottom boundary layer on internal tide generation (energy budget), non-linear effects, canyons, ...
- Dissipation in the bottom boundary layer where the internal tidal beam reflects,
- Energy dissipation and mixing through breaking, both on the shelf and off-shore, with a focus on the pycnocline (soliton, solibores, ...) and on the thermocline structure.
- Increased turbulent mixing associated to the propagation and the breaking of non-linear waves such as solitons and solibores. The objectives are the understanding of the physical mechanisms involved and the improvement of their parameterisation in the PE models.

An overall objective is to propose a closed energy balance, at least for the area of internal tide generation, of the form:
Energy rate lost by barotropic tides =Energy rate radiated out by internal tides + Mixing rate + kinetic energy dissipation.

To answer these questions four specific but complementary approaches will be combined:

- In situ observations of turbulent microstructures will be carried out during the MOUTON cruises by the SHOM, LPO and LOCEAN/UPMC teams.
- Simplified academic experiments will be carried out by the CNRM and IMFT teams.
- Numerical experiments based on idealised configurations will be considered by the LOCEAN/UPMC team, focusing on the interaction of the barotropic and internal tides with the bottom boundary layer as well as on the interaction between the internal tidal beam and the pycnocline.

Rates of energy transfers will be estimated numerically through realistic modelling by the POC/LA/UPS team. Post-treatment will be achieved through the combination of Wavelet and Principal Component Analysis.

Numerical modelling

The non-hydrostatic OOFS code will be used by the LOCEAN/UPMC team for high resolution academic studies.

Realistic numerical experiments will be based on Embedded modelling with the SYMPHONIE and SYMPHONIE-NH codes, the downscaling being obtained through the use of the variational platform VIFOP.

Observations at sea

Most measurements will be performed during the MOUTON cruises, scheduled in 2008 and 2009:

- Repeated CTD/ LADCP profiles at fixed point stations,
- Turbulence measurements using microstructure profilers, (VMP5500 and SCAMP see section 6.2.2)
- Moorings equipped with high-frequency sensors that resolve the inertial range, one will be deployed during MOUTON 2008 and ideally "long-life" mooring that would be maintained every year during EPIGRAM.

Means

Campaign at sea :

New campaigns at sea will be planned (2*7 days of measurements required, with seasoar if possible and in late spring/summer)

Time period

Starting 2008, ending 2012 (CNRM: 2009-2012)

Technological studies / Instrumental testing associated with axis 2

Measurements of kinetic energy dissipation rates

Participants:

Pascale Bouruet-Aubertot (LOCEAN, UPMC) : in situ-measurements and data analysis.
Post doc 2 (LOCEAN) : data analysis.
Yannis Cuypers (LOCEAN) : : data analysis.
Bruno Ferron (LPO) : data analysis.
Fabrice Ardhuin (SHOM) : data analysis.

Goal :

- Obtaining vertical shear and high frequency temperature measurements using an autonomous microstructure turbulence profiler, VMP5500 (LPO/LOCEAN) deployed during campaigns, as well as measurements with SCAMP (tethered profiler, top 100m of the water column)
- Obtaining reliable current measurements that resolve the inertial subrange: Sontek ADV; this sensor mounted on a mooring allows long-term measurements

There is a need to develop appropriate analysis tools to process the data and remove instrumental noise from the geophysical signal to be retrieved. Experimental strategy needs also to be tested.

Means :

Campaign at sea : Mouton cruise 2008, Gogasmos cruise (2009), Mouton 2010

Time period :

2008-2010

Turbulence Profilers

Participants :

Pascale Bouruet-Aubertot (LOCEAN, UPMC) : in situ-measurements and data analysis.
Post doc 2 (LOCEAN) : data analysis.
Yannis Cuypers (LOCEAN) : : data analysis.
Bruno Ferron (LPO) : data analysis.
Annick Pichon (SHOM) : in situ-measurements and data analysis.

Goal :

The VMP5500 profiler (funded by ANR, LPO/LOCEAN) is an autonomous vertical profiler that can perform measurements down to 5500m, and is equipped with microstructure sensors for both vertical shear and temperature, else a SBE for fine scale CTD measurements;
SCAMP is a tethered profiler equipped with high frequency sensors for temperature and conductivity, its working depth is limited to 100m and it can be used in a profiling mode.
This should provide important information of mixing both on shelves and along the continental slopes, in relation to surface or bottom-induced turbulent mixing, internal wave breaking.
The use of these instruments is rather new for the French community and there is need for learning more about their

performances, and how to use them most appropriately. When operational, these instruments will be used for the Mixing studies described below.

Means :

Campaign at sea. Financial support for the SCAMP (LOCEAN) was requested to CNRS (young scientist support). If not granted, other source of funding will be searched. This instrument will be deployed during planned cruises. In 2008, 3 days of ship-time are planned during MOUTON2008 for this purpose.

Time period :

2008-2010.

Axis 3: Large scale seasonal processes and deep-sea/coastal exchanges

General circulation on the shelf

Participants :

Pascal Lazure (IFREMER – DYNECO) : campaigns at sea+data and model analysis
Louis Marié (LPO – IFREMER) : campaigns at sea+data analysis
Post doc 3 (IFREMER/DYNECO) : data and model analysis
Post doc 4 (SHOM) : data and model analysis
François Batifoulier (PhD EPOC / IFREMER-DYNECO) : numerical modelling + campaign at sea
Rémy Baraille (SHOM) : numerical modelling
Stéphanie Louazel (SHOM) : numerical modelling+data and model analysis
Yves Morel (SHOM) : campaign at sea
Bernard Le Cann (LPO – CNRS) : campaigns at sea+data analysis

Goal :

Though a vital influence in problems ranging from fishery to accidental pollution, the general circulation of water masses on the shelf remains very poorly known, due to the difficulty of maintaining current-meters moorings in an area of very high fishing activity. It expresses the balance between the influences of nearly all of the processes of interest for EPIGRAM.

The above-mentioned forcing mechanisms have widely differing characteristic scales, and we can thus expect the general circulation on the shelf to display a wide spectral range. While obtaining a general description of its spatial and temporal structures is a most formidable task, the data collected by the ASPEX mooring array will help quantify the circulation processes associated with some selected features such as the cold pool, the autumnal seasonal current and the Navidad and slope currents, and provide validation information for realistic modelling studies aimed at studying finer scale details such as the influences of islands or bays.

The aim of this study is therefore to improve our knowledge and understanding of the general circulation on the shelf, its seasonality, the influence of islands or bays, retention areas, evaluation of the importance and role of mesoscale turbulence, with focus on the "Aquitaine" area. The ASPEX project will be particularly dedicated to this aspect.

Low frequency analysis will be performed using the moorings in ASPEX (and will be the work of post doc 3), high frequencies (and the influence of the wind) will be analyzed using drifters launched for other processes (will be the work of post doc 4).

Numerical modelling :

This process will be taken into account for the evaluation of realistic numerical models.

The. new and comprehensive data set of current measurements will be used for the validation of model circulation. This work will focus of current variability at time scale from meteorological event(one week or less) to seasonal circulation. The influence of boundary condition and meteorological forcing will be assessed.

Observation at sea

Glider observations are planned on the Aquitaine plateau and plateau des Landes.

ASPEX

MOUTON

Means :

Campaign at sea :

New campaigns at sea will be planned (2*5 days of measurements required, with seasoar if possible and in late spring/summer).

Drifters : 3 SLDMB and 3 Surdrift-75 on Biscay shelf close to the coast = 3*2300+3*3600 = 17.700,00 € TTC

Time period :

2009-2012

Northward seasonal current

Participants :

Pascal Lazure (IFREMER – DYNECO) : campaigns at sea+data and model analysis
Louis Marié (LPO – IFREMER) : campaigns at sea+data analysis
Post doc 3 (IFREMER/DYNECO) : data and model analysis
Rémy Baraille (SHOM) : numerical modelling
Stéphanie Louazel (SHOM) : numerical modelling+data and model analysis
Yves Morel (SHOM) : campaign at sea
Bernard Le Cann (LPO – CNRS) : data analysis

Goal :

During the summer season, satellite SST observations show that hot waters accumulate in the south-eastern corner of the Bay of Biscay. In early autumn, these waters are seen to abruptly start flowing in the northern direction in the form of a warm tongue, centred on the 100 m isobaths, which reaches the entrance of the Channel. Lagrangian measurements show that current velocities as swift as 30 cm/s are involved. The dynamical origin of this current remains unclear, and progress in its study is hindered by the lack of in-situ data. One of the aims of the ASPEX project is to obtain a description of the hydrological structure of this current in the horizontal and the vertical, as well as measurements of the vertical and temporal

structure of the velocity field. To achieve this, moorings (2 300 kHz ADCPs) will be deployed, and CTD surveys will be conducted.

Numerical modelling :

This process will be taken into account for the evaluation of realistic numerical models.

Observation at sea

Means :

Campaign at sea : ASPEX

Time period :

2009-2012

Cold pool

Participants :

Pascal Lazure (IFREMER – DYNECO) : campaigns at sea+data and model analysis
Louis Marié (LPO – IFREMER) : campaigns at sea+data analysis
Post doc 3 (IFREMER/DYNECO) : data and model analysis
Bernard Le Cann (LPO – CNRS) : data analysis

Goal :

Another dominant feature of the hydrology of the Bay of Biscay is the presence of a "cold pool" of water on the Armorican shelf. This structure, discovered and described in the 1967 article of Vincent and Kurc, is formed at the beginning of spring when the seasonal stratification isolates the bottom waters from atmospheric influences. Its temperature remains nearly constant throughout the summer. At the end of autumn, intense atmospheric perturbations lead to enhanced mixing, stratification breakdown, and the disappearance of the cold pool. Its study is rendered difficult by the fact that it remains hidden from satellite observation. In particular, many questions remain regarding the associated circulation, its interactions with river plumes and the adjacent shelf-break front and the inter-annual variability in its extent and properties.
The cold pool is in fact iconic in that it is affected by nearly all the processes of interest to EPIGRAM (mixing, internal waves, river plumes, tidal currents,…)
The study of the cold pool will be an important part of the ASPEX program, and will be addressed through CTD surveys, mooring deployments on its shoreward and ocean ward sides.
Numerical experiments will be conducted to highlight the role of local (breakdown of stratification) and non local forcing (Mesoscale circulation, Navidad).

Means :

Campaign at sea : ASPEX

Time period :

2009-2012

Slope currents

Participants :

Post doc 3 (IFREMER/DYNECO) : data analysis
Bernard Le Cann (CNRS/LPO): campaign at sea + data analysis
Louis Marié (IFREMER/LPO): campaign at sea + data analysis
Frédéric Vandermeirsch (IFREMER/DYNECO) : campaign at sea + data analysis

Goal :

Historical current-meter data (Pingree and Le Cann 1989 and 1990) and Lagrangian data collected in the framework of the ARCANE project (Colas 2003) point to the existence on the Bay of Biscay slopes of a poleward slope current. This current is considered to be mainly driven by the open-ocean meridional density gradient. It has not yet been the subject of a focussed experimental effort. As part of the ASPEX program, three moorings (75 kHz ADCP landers) will be deployed on the 500 m isobaths at 44°20'N, 46°N and 47°N, with the aim of studying its intensity, variability and vertical structure. Study of the correlations between the signals recorded at the different locations will also provide information regarding propagative signals. CTD / VMADCP transects will be conducted at deployment and recovery.

Numerical modelling :

This process will be taken into account for the evaluation of realistic numerical models.

Observation at sea :

Exploit the existing data (PELGAS, PELACUS, ….)
ASPEX moorings and cruise data.

Means :

Campaign at sea :

- A total of 21 days of the ASPEX cruises will be devoted to the deployment and recovery of the 3 moorings and to the associated CTD transects over the 3 years duration of the ASPEX program.
- 3 IFREMER 75 kHz ADCPs (+ Seacat or Microcat P,T,S recorders).
- VMADCP (75 Hz)

Time period :

2008-2011

Exchanges between the deep ocean and the coastal area

Participants :

Pascal Lazure (IFREMER – DYNECO) : campaigns at sea+data and model analysis
Louis Marié (LPO – IFREMER) : campaigns at sea+data analysis
Post doc 3 (IFREMER/DYNECO) : data and model analysis
Bernard Le Cann (LPO – CNRS) : data analysis
Rémy Baraille (SHOM) : numerical modelling
Yves Morel (SHOM) : campaign at sea + data analysis
Jacqueline Boutin (LOCEAN) : campaign at sea + data analysis
Anne Petrenko (LOB): campaign at sea + data analysis
Frédéric Vandermeirsch (IFREMER/DYNECO) : campaign at sea + data analysis + numerical modelling

Goal :

In contrast to the northern part of the slope, near the English Channel Entrance, the Aquitaine shelf is marked by very weak M2 barotropic tides, but can witness episodes of strong meso-scale activity (Swoddies detachment or Navidad current events, for instance). It is thus a good site to study the influence such oceanic mesoscale turbulence phenomena bear on cross-slope exchanges, and the area will be heavily instrumented with moorings in the framework of the ASPEX program.
In addition, we intend to perform a drifter dispersion experiment following the methodology developed by the LATEX team (IDAO-supported project) in order to gain a complementary Lagrangian view of cross-shelf exchanges in the area.
In collaboration with the GOGASMOS and CAROLS/SMOS 2009 cruise, TOSCA (for SMOS) and the LATEX team, we plan to borrow GPS-positioned drifters from LATEX (1 with Iridium or HF transmission, and 5 with Argos transmission) measuring currents (at 5m depth if possible) and temperature, and attach to them small surface salinity drifters (paid by SMOS/TOSCA/ESA) and do release them in selected filaments.
The filaments would be located from space imagery (ocean colour; SST) as well as during the cruise, upon indications from satellite altimetry or real-time modelling operational products, and seeding of the drifters will be done based on a strategy developed by LATEX. The drifters will be recovered after 5-7 days. Shallow CTD casts will be done upon deployment and recovery of the drifters. The release experiment will be done if possible twice. The drifters recovered will be reused during the LATEX planned release experiment (focusing on coherent eddy on the shelf of the Gulf of Lion) in September 2009.
The lagrangian dispersion data thus collected will be complemented by the long current time-series.

Numerical modelling :

Sensitivity study of the exchanges to different parameters (margin slope, current strength and vertical structure, stratification, ...) in both academic and realistic configurations.

Observation at sea :

Exploit the existing data (MOUTON2005, PELGAS, PELACUS, ….) .
New observations will be made: to cover the slope of zone 4, 5 and 6 with a VMADCP (75Hz) by making at least 7 radials repeated over 4 years.

Means :

Campaign at sea :

- 2 x 7 days at sea (with a Seasoar if possible, in late/spring or summer) will be required for the drifter dispersion experiment.
- Complementary VMADCP transects (a total of 7 cross-slope transects covering the slopes of zones 4,5 and 6, ideally repeated over 4 years).

Drifters : 3 SLDMB and 3 Surdrift-75 on Biscay shelf close to the coast = 3*2300+3*3600 = 17.700,00 € TTC
Drifter dispersion experiments (2009): 6 LATEX drifters (6*1.7 k€= 10.2 k€; cost for the holey socks, for refitting the Surface drifters and for localisation cost of Iridium drifter)

Time period :

2009-2011

Navidad current

Participants :

Post doc 3 (IFREMER/DYNECO) : data analysis
Bernard Le Cann (CNRS/LPO): campaign at sea + data analysis
Louis Marié (IFREMER/LPO): campaign at sea + data analysis

Goal :

The “Navidad” current (Pingree et Le Cann, 1989, 1990, 1992a&b, Pingree, 1994, Garcia-Soto *et al*, 2002, Garcia-Soto, 2004) is a poleward current that follows the Cantabrian and Armorican slopes on certain winters, and carries a very strong positive temperature anomaly. Its waters can be exported to the open ocean under the form of anticyclonic “SWODDIES”, but some follow the Armorican slope and can intrude over the better part of the southern Armorican shelf. It can thus be considered as a major contributor to the inter-annual variability of the southern and eastern margins of the Bay of Biscay. Its spatial structure along the Cantabrian slope has been well documented (in terms of currents and hydrology) during the winter of 2006 in the framework of the CONGAS program (Serpette and Le Cann, in preparation).
One aim of the ASPEX program is to document the vertical and temporal structure of the Navidad current in its lower course, where it flows along the Aquitaine and Armorican slopes. A moorings transect will be located along 44°20N, which will consist of two 300 kHz ADCP landers on the shoreward side of the current, also roughly at the starting point of the

autumnal warm water tongue, one 150 kHz ADCP lander on the 200 m isobaths near the shelf break, one of the above-mentioned 75 kHz ADCP landers on the 500 m isobaths, and two mooring lines each comprising 3 current-meters and a 75 kHz ADCP located further offshore. The study will also benefit from the installation by AZTI of two instrumented (ADCPs, thermistor chains, meteorological parameters) buoys off San Sebastian and Bilbao on the 500 m isobaths. The planned moorings array should ideally be complemented by continuous CTD monitoring of some sort. Due to the rough seas encountered in the area during the winter period, frequent ship-based surveys do not seem a practical solution. Alternative solutions, such as the use of gliders or PAGODE profilers, will be sought.
This series of moorings will serve a number of additional purposes, which justify the need to maintain it year-long: year-round, it will measure the fluxes of waters in and out of the Armorican shelf through its southern boundary, thus providing good quality boundary conditions for studies of shelf circulation dynamics. In the autumn, it will help document the vertical structure and dynamics of the seasonal warm water tongue near its origin. It will also provide time series useful for the study of cross-slope exchanges in the area, as detailed in the following section.
It is planned to deploy during a first winter a reduced array, comprising only the 500 m isobaths lander, one 300 kHz lander and the first mooring line. This year will provide a first opportunity to observe a Navidad event, and will also allow technical issues such as sampling parameters or fishing–gear protection devices to be settled before deployment of the full-blown mooring array. Cooperation with the SMOS cal/val team is sought to perform this deployment during a CAROLS/SMOS cruise in the early autumn of 2008, and the recovery during a joint GOGASMOS cruise during the summer of 2009 (see section 6.2.2).
The full moorings array will then be deployed year-round during the two following winters. It is planned to recover the array during the intermediate summer. The three necessary cruises will be the subject of a separate request to the OPCB commission.

Observation at sea
ASPEX moorings data.
AZTI buoys data.

Means :
Campaign at sea :

- ASPEX cruises will be devoted to the deployment and recovery of 3 landers and two mooring lines and to the associated CTD transects over the 3 years duration
  of the ASPEX program.
- 3 IFREMER 75 kHz ADCPs (+Seacat or Microcat P,T,S recorders), including one of those mentioned in the "slope currents" section.
- 1 IFREMER 150 kHz ADCP (+Seacat or Microcat P,T,S recorder)
- 2 IFREMER 300 kHz ADCPs (+Seacat or Microcat P,T,S recorder)
- 6 IFREMER acoustic current meters (Aanderaa RCM11 or Aquadopp 2000)

Time period :
2008-2011

<u>Dense water formation</u>
Participants :
To be defined
Goal :
Study of the formation of cold dense water in winter along the continental margin and its cascading on the continental slope, sensitivity to details of the bottom topography (canyons). Influence on the current structure.
Formation and evolution of the cold tongue on the shelf (influence of mean current and meso-scale dynamics).
Influence of the dense water on the export of coastal waters to the deep ocean.
Numerical modelling
Observation at sea
Banc de la Chapelle.
Gliders.
Means :
Campaign at sea : To be defined
Time period :
To be defined

Technological studies / Instrumental testing associated with axis 3

<u>PAGODE, ECOPESCA and halieutic cruises</u>
Participants :
Pascal Lazure (IFREMER – DYNECO) : data and model analysis
Post doc 3 (IFREMER/DYNECO) : data analysis

Frédéric Vandermeirsch (IFREMER/DYNECO) : data analysis
Xavier André (IFREMER) : technical work
Michel Repecaud (IFREMER) : technical work

Goal :

PAGODE is a free profiler is designed for in situ measurements on the continental shelves (T, S, P), or other parameters to be adapted on the profiler. It is designed to last over a few seasons. The prototypes have bee developed with ARGOS transmission and tested over different depths. The long-time at the surface required for ARGOS transmission proved to be too long, and a new prototype based on the ARVOR-C profiler is designed with GPS and iridium transmission that needs to stay only a couple of minutes at the surface. First attempts to use it will be done in 2008 (probably during the spring or summer). A more complete version of the profiler with option for more sensors will be designed for deployment in 2009. The quality of the measurements and an assessment of their potential usage for coastal dynamic and ecosystem modelling will need to be carried. EPIGRAM can provide a coordinated environment for these investigations, and will likely also benefit from the data collected by these test PAGODE profilers.

REPOSCA is an IFREMER project for which instrumentation has been implement on the trawls of different fishing vessels and halieutic research vessel to provide measurements of T,S, P, albeit with a reduced precision compared to PROVOR floats or CTD casts. Currently, a fleet of nearly 12 equipped vessels is at work in the Bay of Biscay or near the Channel region that regularly provide profiles. Plans are to expand it in this area to at least 20 vessels by the end of 2008. There will be a need to assess how accurate the measurements are, how they contribute to the sampling of the shelves (find advantages and limitations with respect to other more regular hydrological sampling during cruises) and how they can be used in numerical modelling (assimilation) or analysis in support to dynamical or ecosystemic research.

In addition, link with halieutic cruises (PELGAS, PELACUS, EVHOE) on the R.V. Thalassa or more local cruises or transects on the R.V. Côtes de la Manche should be reinforced to make sure that usable hydrographic/velocity data can be recovered from the cruises (already some CTD profiles are collected and transmitted in near real time during these cruises). This requires some coordination, and possibly the inclusion of the Côtes de la Manche within the Coriolis perimeter to fully establish these links. It could also be interesting to equip the Côtes de la Manche with an S-ADCP at the end of 2008. EPIGRAM and a reinforced sampling for dynamical studies might be a right frame in which this can be carried, as complementarity/cost effectiveness studies can then be done. The data of PAGODE, RECOPESCA and halieutic cruises will also contribute to this sampling required for process studies, as envisioned by EPIGRAM.

Means :

Campaign at sea : - These studies will be achieved by IFREMER. The insertion here is to emphasise the fact that mutualisation with the EPIGRAM project will be sought, namely the PAGODE, RECOPESCA and halieutic measurements will be an opportunity to access to additional data for EPIGRAM and EPIGRAM can contribute to the validation of the instruments.

Time period :

2008 - 2012

<u>Gliders</u>

Participants :

First Pierre Testor, Laurent Mortier (LOCEAN), but should be expanded to DT-INSU and LPO later on : deployment
Post doc 3 (IFREMER/DYNECO) : data analysis

Goal :

Warning : This study is to be planned in details. At the present stage, we are not sure there will be an opportunity for the deployment of glidders.

Testing how repeated glider sections contribute together with mooring array and occasional ocean-going cruises to better sample the transports over the shelves and exchanges over the shelf breaks and continental slope area. It could also for the off-shore area contribute to the SMOS cal/val by sampling a pixel from SMOS off the Landes Plateau, in order to estimate effect from sub-pixel variability on the SMOS radiometric signal. The first testing-bed for this should be the relatively narrow shelves of the southern Bay of Biscay and the deeper plateau des Landes region, which can be accessed from Arcachon. The difficulty is in navigation over the shallow part of the shelves, fishing gear and how to organise adequate logistics from land-based facilities and occasional oceanographic cruises. A shallow glider version should be first used.

Means :

Campaign at sea: Oceanographic cruises (all), as well as rental of coastal vessels: to be defined after preliminary studies.
Shallow SLOCUM glider from LOCEAN, at first.
A 4 month test is planned in 2009, for which a 6.000,00€ funding is requested (based on a cost of 1.500,00€/month evaluated from the EGO campaigns).

Time period :

2009-2010 (possibly expanded after and in regions further north (Banc de La Chapelle) once LPO team gets involved.

<u>Lagrangian drifters</u>

Participants :

Jacqueline Boutin (LOCEAN), Anne Petrenko (LOB/COM): expertise for lagrangian drifts of floats.

Goal :

Use Lagrangian technology with near-surface drifters (LATEX project) to estimate cross-shelf exchanges of heat, freshwater for specific well-sampled events (most likely to be done during late spring 2009). The technology (use of inexpensive HF or ARGOS-tracked Lagrangian drifters) is tested by the LOB/COM group in 2008 (in particular acquisition of an HF receiver and test drifters). Such experiments can be used to identify patterns of dispersion, kinematics

to support studies of cross-shelf exchanges, and to provide a Lagrangian database for comparison with model simulations planned in EPIGRAM. The structures sampled will probably not be coherent (a difference with LATEX in the Gulf of Lion), but more filament-like, and specific studies will have to be dedicated on how to optimise the Lagrangian sampling of such a structure.

Means :

Campaign at sea : GOGASMOS (2009) and CAROLS/SMOS (2009)

Time period :

2009 (Bay of Biscay)

Axis 4: Atmospheric and river plume influences on the shelf dynamics

Currents generated by the winds

Participants :

Yves Morel (SHOM) : campaign at sea+ data and model analysis
Rémy Baraille (SHOM) : numerical modelling
Post doc 4 (SHOM) : data and model analysis
François Batifoulier (PhD EPOC / IFREMER-DYNECO) : numerical modelling + campaign at sea

Goal :

Satellite SST measurements indicate the presence of transient upwelling episodes in the coastal areas adjacent to the Atlantic coast of the Bay of Biscay (southern coast of Brittany, Vendée, Landes). The study of these phenomena is however hampered by the lack of in-situ data. From a theoretical and numerical standpoint, transient upwelling and downwelling currents developing along the coast (or along a relief impinging into the mixed layer) will be addressed. Related to the previous subject and of particular interest is also the development of the Ekman spiral close to a coast. The Ekman theory is indeed only valid for a 1D ocean. When there exist a coast, its influence is felt up to the external radius of deformation for the barotropic part of the current and up to the internal radius of deformation for the baroclinic part. Indeed advection of water yields modification of the hydrology near a coast (there exists divergence/convergence of water which in turn generates geostrophic currents) This drastically modifies the Ekman currents. The role of the bottom topography, bottom drag, geometry of the coast are important factors for this process which has not attracted a lot of attention up to now, despite its obvious implication for the drift of objects.

Numerical modelling:

This process will be taken into account for the evaluation of realistic numerical models. The Mars model will be use to assess its ability to reproduce upwelling events along the coast of Landes. Comparison with other realistic models in this area will be done. A collaboration is expected with AZTI institute (Basque country), at which a high resolution model (ROMS) of the SE corner of the Bay of Biscay is run operationally.

Observation at sea

ARCADINO (2008), MOUTON-FO

Means :

Campaign at sea :

New campaigns at sea will be planned (2*4 days of measurements required, with seasoar if possible and in late spring/summer).
Drifters : 3 SLDMB and 3 Surdrift-75 on Biscay shelf close to the coast = 3*2300+3*3600 = 17.700,00 € TTC

Time period :

2009-2012

Mixed layer and seasonal thermocline

Participants :

Yves Morel (SHOM) : campaign at sea + PhD advising
Rémy Baraille (SHOM) : numerical modelling + PhD advising
Cecile Rena dies (CNRM/SHOM, PhD): numerical modelling + data analysis
Gwen Elle Hello (CNRM): atmospheric modelling+ PhD advising
Here Giordano (CNRM): atmospheric modelling+ PhD advising
Frédéric Vandermeirsch (IFREMER) : campaign at sea + data analysis + numerical modelling

Goal :

The uncertainties which affect the parameterizations of the surface fluxes and the vertical mixing in the ocean are stronger when the surface heat budget is positive and the wind is weak. These surface conditions induce a shallowing of the mixed layer depth and are called restratification regimes. Consequently the mixed-layer is not still well resolved by numerical models especially at submesoscale and during restratification periods. The goal is thus to improve the parameterizations of the ocean mixing and identify the coupled ocean-atmosphere processes in such conditions.

The exceptional in-situ data set provided by numerous campaigns at sea is an unprecedented opportunity to identify and document carefully the ocean during restratification regimes at high spatio-temporal resolutions. The radiative and turbulent (heat and momentum) surface fluxes provided by the atmospheric model AROME will be evaluated in comparison with the satellite radiative fluxes and the surface fluxes derived from measured atmospheric parameters (ship) and advanced parameterizations. The atmospheric structures during the selected restratification periods will be documented from the analyses provided by the ALADIN forecasting-analysis system.

Modelling :

The modelling strategy is based on 1D simulations of the oceanic mixed-layer and the atmospheric boundary layer. First, these simulations will be forced at the surface (with the observed SSTs for the atmosphere and the surface fluxes for the ocean) and second will be performed in a coupled mode in order to assess the ability of the coupled system to forecast realistic SSTs and oceanic/atmospheric structures. The mixed-layer parameterization of Gaspar (1990), based on the turbulent kinetic energy closure, will be used to simulate the observed mixed-layer restratifications. The model errors will be analysed in terms of surface forcing uncertainties and shortcomings of the vertical mixing parameterization. Some solutions could be proposed to overcome these shortcomings. The same strategy will be used for the atmosphere with the 1D-version of the AROME model. Given that no observed atmospheric radio-soundings were performed onboard the ships, AROME-1D will be initialised from the operational analyses. The model ability to catch the observed daily cycle of the

boundary layer will be analyzed. Still here the sources of the simulations shortcomings will be identified. The boundary layers (ocean and atmosphere) sensitivity to the surface forcing frequency distribution will be also evaluated. Finally, the same investigation will be conducted with the 1D coupled Ocean-Mixed-Layer-AROME models.

Means :

Campaign at sea :

New campaigns at sea will be planned (2*2 days of measurements required).

A mooring with chain of thermistor, sensors of salinity and a ADCP (150KHz) on the bottom (4 x 1 month)

In addition, air-sea flux data will be obtained during the proposed (Suroit) GOGASMOS cruise in the spring 2009, and possibly also on the CAROLS2008 and CAROLS/SMOS2009 Cotes de la Manche cruises (a partially-equipped flux mast has been tested during the September 2007 CAROLS2007 cruise on the Côtes de la Manche up to force 6 wind with up to 3.5m waves).

Time period :

2008-2011

Influence of extreme atmospheric events

Participants :

Nadia Ayoub (LEGOS): numerical modelling + data analysis
Patrick Marsaleix (LA): numerical modelling
Florent Lyard (LEGOS): numerical modelling
Pierre De Mey (LEGOS): stochastic (numerical) modelling+ data analysis
Florence Birol (LEGOS): satellite data analysis

Goal:

Extreme meteorological events (such as storms or tempests) are expected to generate large local perturbations on the ocean circulation and hydrology. For example, high winds cause intense vertical mixing to develop, low pressure impacts the sea level, heavy rains can modify the surface T/S properties. Our objective is to identify the signature of the local and remote impact of an extreme meteorological event on observed variables, namely SST and sea level (SL), and on non-observed (or poorly observed) ones. For these latter, we will focus on the thermohaline structure and mixing related variables such as mixed-layer depth and vertical mixing parameters. The work will be based on the analysis of satellite data for SST and SL, of T/S profiles from floats or cruise data (when available), and a numerical simulation. The ocean model is Symphonie, and the atmospheric forcing stems from ARPEGE/ALADIN fields. The sensitivity of the simulated ocean response to the storm/tempest as represented in the atmospheric fields used to force the model will then be studied by performing at least another run using a different atmospheric forcing product.

Numerical modelling:

A realistic configuration will be set up with the SYMPHONIE model, in its hydrostatic version. The Bay of Biscay area will be represented with a resolution of 3km and using 43 levels. The sensitivity of the model to change in atmospheric forcing fields will be addressed using different atmospheric products, an ensemble of simulations will also be constructed with slightly perturbed atmospheric fields.

Means:

Data from existing campaign at sea will be used for comparison with the simulations.

Time period:

2008-2010

River plumes

Participants :

Yves Morel (SHOM) : campaign at sea+ data and model analysis
Rémy Baraille (SHOM) : numerical modelling
Post doc 4 (SHOM) : data and model analysis
Stéphanie Louazel (SHOM) : numerical modelling+data and model analysis
Jacqueline Boutin (LOCEAN): campaign at sea (spring 2009)
Thierry Pichevin (DGA) : theoretical analysis
Pascal Lazure (IFREMER-DYNECO) : numerical modelling+data and model analysis

Goal :

The aim is to study the off-shore spreading of river plumes which play a major role in the circulation over the shelves, in particular in late winter to early summer when flow is maximum and salinity contrast highest. The river plumes often originate from broad estuaries (for Garonne and Loire, Charentes, less so for the Adour) and mixing in these estuaries or at their exit between fresh river and shelf salt water is rather important. The influence of inertial and instability processes of the plume outflows and of wind-induced currents have certainly also dominant roles on how the plume spread over the shelves. In addition the influence of the density contrast in association with the seasonal variations and the interaction with tidal currents has to be evaluated too.

The approach will first be theoretical and associated with numerical experimentation. Dedicated observation will be

devoted to the water plumes of the Garonne (and possibly Adour) in the spring 2009 (see below). In addition, data from both the GOGASMOS (Suroit) cruise, and (Côtes de la Manche) CAROLS/SMOS2009 cruises in the spring 2009 will be used, as well as data from air-plane surveys (CAROLS instrument) for SMOS cal/val. All the other regular data sets will be used (regular Thalassa cruises, Côtes de la Manche observations, in particular if an S-ADCP is implemented n the ship)

Means :

Campaign at sea :

Halieutic cruises which describe the hydrology on the shelf during late spring and autumn will be used

New campaigns at sea will be planned (2*4 days of measurements required, with seasoar if possible and in late spring/summer).

Drifters : 4 SLDMB and 2 Surdrift-75 on Biscay shelf close to the coast = 4*2300+2*3600 = 16.400,00 € TTC

Taking advantage of planned GOGASMOS and CAROLS/SMOS 2009 cruises, as well as associated CAROLS flights to map/survey extent of shelf fresh water lenses.

Equipment for a mooring off the Gironde with two Microcat sensors (1 to be purchased: 6 k€ TTC), possibly associated with a directional wave buoy mooring (likely over 100m isobaths, 1 k€ for additional cost for that mooring).

Deployment of simple Argos-tracked salinity drifters (surfact) for 1 week period

Time period :

2009-2010 (spring 2009 for the campaigns at sea)

Technological studies / Instrumental testing associated with axis 4

SEASOAR

Participants :

Yves Morel (SHOM) : campaign at sea+ data and model analysis
Post doc 4 (SHOM) : data and model analysis
Bernard Croguennoc (SHOM) : design/improvement of navigation tool + testing at sea
Louis Marié (IFREMER) : design/improvement of navigation tool

Goal :

In the coastal area, the dynamics is often dominated by small scale and high frequency processes. Their in situ observation is then problematic as it requires high spatial resolution to be done in a short time period. The SEASOAR is a tool that can achieve this : the measurements are done while the ship is moving at 8 knots and the spatial resolution that can be achieved for measurements from the surface to a depth of 100m or so can reach 0.25Nm. The problem concern the navigation in shallow areas and the risk of collision with the bottom or fishing nets. An adequate control system has to be developed and tested for this. This is the goal of the present study.

Means :

Campaign at sea : 2 days planned for testing during the future SHOM campaigns.

Time period :

Mostly 2007-2009, but then used for the following MOUTON campaigns.

Salinity evaluation

Participants :

Yves Morel (SHOM) : campaign at sea+ data analysis
Post doc 4 (SHOM) : data analysis
Vigan Mensah (SHOM) : analysis+tests at sea+tests in laboratory
Marc Le Menn (SHOM) : analysis+ tests in laboratory
Nathalie Daniault (UBO) : analysis

Goal :

The seasonal thermocline on the shelf of the North Eastern Atlantic offers one of the strongest contrast between the surface mixed layer and the deeper water column : temperature gradients can reach up to 1° C/m. In contrast, the salinity variation is quite reduced away from region of river plume influence. The density field and dynamics is therefore mostly controlled by thermal fronts which can be accurately measured. However, salinity is an important quantity has it can be used as a tracer (useful for the spreading of frontal instabilities, intrathermocline subduction, etc...). Salinity is not directly measured but estimated from conductivity measurements. The latter is mostly dependent on temperature, and the conductivity probe of a Seasoar, for example, has a rather strong thermal capacity (relaxing time ~10 sec.). The evaluation of salinity is therefore problematic as the needed precision required for the analysis is difficult to achieve. The existing filters have proven to be of limited use for this region, but it seems possible to improve them to achieve a better estimation of the salinity.

The goal of the study is to improve the calculation of salinity from conductivity measurements in the presence of a strong thermocline.

Means :

Working group meetings : general assembly, video-conference otherwise.
Presentation of results :
Publication : 1 publication
Campaign at sea :

Existing data but possibly 24h00 of specific measurement at sea during new MOUTON campaigns.

Time period :

2008 - 2009

SMOS
Participants :
Jacqueline Boutin (CNRS/LOCEAN) : data analysis
Goal :
The project will overlay with the SMOS cal/val effort planned in the Bay of Biscay, in particular during the spring 2009. This can provide opportunities to test the mapping abilities of surface salinity by airplane borne band-L radiometers (CAROLS or EMIRAD). CAROLS will also be coupled with a scatterometer radar (STORMS), which can contribute to better model waves and swells over the relatively shallow shelf waters of the Aquitaine plateau (in addition to in situ measurements and model efforts). Demonstration flights are planned in 2007 and 2008 together with in situ data (Côtes de la Manche cruises and surface drifters). The better sampling envisioned for EPIGRAM can provide a full-blow test of the ability of the airplane-borne instrument to retrieve large salinity signals on the shelves: river plumes, filaments over the Landes plateau. Dedicated flights should therefore be envisioned during the period of intensified measurements (funding for them will be requested to CNES/TOSCA).
Means :
Campaign at sea : CAROLS cruises 2007-2008; GOGASMOS (2009)
taking advantage of the cal/val SMOS, CAROLS and GLOSCAL activities planned by ESA and TOSCA/CNES.
Time period :
2008-2012

Axis 5: Influence of waves on the shelf dynamics

Axis 5 aims at studying the influence of waves on the general circulation of the shelf through their effects on the mixed layer and the generation of mean boundary currents along the shore.

Mixed layer and surface waves

Participants :

Fabrice Ardhuin (SHOM) numerical modelling
Pascale Bouruet-Aubertot (LOCEAN/UPMC) microstructure measurements + data analysis
Bruno Ferron (LPO) microstructure measurements + data analysis
Jean-François Filipot (PhD, SHOM) numerical modelling

Goal :

Wave and surface turbulence observations support the hypothesis that the energy flux from waves to upper ocean turbulence is a major source of mixing for the mixed layer, in particular for diurnal thermoclines. The depth penetration of this energy is still an open question but may be relevant, via Langmuir circulations, to the formation of the seasonal thermocline. We will combine numerical wave models based on a proper statistical description of wave breaking with in situ microstructure measurements of TKE dissipation. The observations will be taken with the same instrument used to probe deeper mixing processes, focusing on shallow thermoclines and strong wind forcing conditions in stable stratified cases.

Numerical modelling:

The latest version (3.12) of the wave model WAVEWATCH III will be ran over the entire Bay of Biscay and English Channel with variable resolutions from 10 to 1km. Estimations of the wave to ocean TKE flux and the under water roughness length will be performed based on calibrations against SHOWEX (1999) and FAIRS data. Further validation against the measured TKE dissipation profile will be attempted. These fluxes will be provided as forcing fields for all ocean circulation models.

Observation at sea

Microstructure measurements performed with available microstructure profilers, VMP5500 and SCAMP.

Means :

Campaign at sea : Microstructure measurements performed during various cruises especially from the MOUTON -but also GOGASMOS- campaigns will be analysed.

Time period :

2008-2010

Inner shelf transition zone

Participants :

Philippe Bonneton (CNRS/EPOC) : numerical modelling + participation in field campaigns+ data analysis
Bruno Castelle (CNRS/EPOC): numerical modelling + data analysis
Fabrice Ardhuin (SHOM): theoretical work + numerical modelling+ data analysis
Jean-François Filipot (PhD, SHOM) : parameterization of wave breaking from deep to shallow water
Post doc 5 (EPOC) : numerical modelling+ data analysis
Rudy Magne (SHOM): numerical modelling+ data analysis
Franck Dumas (Ifremer): data analysis
Yann Leredde (Géosciences Montpellier): numerical modelling+ data analysis
Patrick Marsaleix (LA): numerical modelling+ data analysis
Rodrigo Pedreros (BRGM, to be confirmed) : numerical modelling + participation in field campaigns

Goal :

The inner shelf is a poorly known buffer zone between the shelf and the surf zone with a wide variety of wave and tide-driven dynamical features. Our aim is to investigate the mass transport of tracers in this area using a combination of Lagrangian floats, ADCP and wave measurements, in particular during storm events. The link between wave driven currents and ocean circulation models will be analysed.

Numerical modelling :

Wave-current coupled models covering of the order of 10 by 10 km will be developed and implemented on the instrumented site. Such coupled models have or are being developed in 2DH (MARS+SWAN, at Ifremer and BRGM), or 3D (ROMS forced by WAVEWATCH III at SHOM, Symphonie forced by Refdif at GM and LA).

Observation at sea :

Existing measurements MOUTON2005, 2007

Means :

Campaign at sea :

- 2 SHOM Nortek AWACs
- 2 SHOM directional Waverider buoys
- 2 SHOM 1 MHz Nortek Aquapro
- 1 or 2 GM and LA RDI Teledyne 600 kHz w-ADCP
- Drifters: 5*2 SLDMB drifters or equivalent will be necessary and are requested for funding 10*2.300,00€ = 23.000,00€ TTC.

Time period :

Start in winter 2009-2010-2012.

1.5 Résultats escomptés et retombées attendues/Expected results and potential impact

The scientific outcomes of the project will be:

- The realisation of four important campaigns at sea and the collection of data for all selected processes.
- The scientific analysis of the collected data (furniture of diagnostics for all selected processes).
- Validated realistic numerical models of the area (whose results will be compared to -and limits will be assessed from comparison with- observations at sea).
- An improved understanding of the major physical processes of the area.

These results will be of primary importance for the oceanographic scientific community in general and for the institutes having operational missions, based on the exploitation of nowcast/forecast systems. EPIGRAM will allow the construction, validation and improvement of the latter.
On the longer term socio-economical benefits are therefore expected (see section 1.2), even-though they cannot be measured directly at the end of this scientific project. Notice that the participation of operational institutes will allow a short transition time between research and applications.
Finally the chosen approach (built on the analysis of oceanic processes) will also facilitate the extension of the results gathered on the present project to other regions.

1.6 Organisation du projet/*Project flow*

Organisation and responsibilities

General coordinator:

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Steering committee:

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Axes coordinators:

As already mentioned, the project is divided into main axes/tasks with coordinators:

- Axis 1 : Effects of the tide on the shelf. Coordinator: Florent Lyard, CNRS/LEGOS.
- Axis 2 : Internal tide. Coordinator: Pascale Bouruet Aubertot, UPMC/LOCEAN.
- Axis 3 : Large scale seasonal processes and deep-sea/coastal exchanges. Coordinator: Pascal Lazure, IFREMER/DYNECO.
- Axis 4 : Atmospheric and river plume influences on the shelf dynamics. Coordinator: Yves Morel, SHOM.
- Axis 5: Influence of waves on the shelf dynamics. Coordinator: Fabrice Ardhuin, SHOM.

Each axis has been divided into studies with identified partners. We refer to section 1.4 for a full description of the participants and their implications.

In addition, we have identified transverse axes with coordinators:

- Numerical modelling. Coordinator: Guillaume Reffray, MERCATOR.
- Campaigns at sea. Coordinators: Louis Marié, IFREMER/LPO, and Yves Morel, SHOM.
- Technological studies. Coordinator: Gilles Reverdin, CNRS/LOCEAN.

For each study, we will also design pilots during the first meeting of the project who will be the main contacts and animators of the study.
There exist transverse connexions between all studies of the project which are associated with :
Realistic numerical modelling of the area, whose success will be measured on the basis of realistic (qualitative and quantitative) representations of the chosen physical processes. Each study will thus provide diagnostics for the validation of these realistic numerical models.
Apart from their validation, the improvement of realistic numerical models will also be possible thanks to the results of each process study : understanding the physics of all processes taking place will indeed help identify limits of numerical models and –hopefully- find way to improve them.
Campaigns at sea, which will be organised so as to optimize the required observations (mutualisation between planned campaigns) and feed the process studies. Technological studies being a support for the campaigns. The ASPEX campaigns at sea will for instance be prepared (experimental moorings to be deployed) during the MOUTON2008 campaign.

Planning and milestones

The duration of the project is 4 years, and we wish to start it at the end of 2008 (2008-2012).
Campaigns at sea will start in summer 2008 on the basis of existing campaigns.
The following table synthesizes the main milestones of the project (the expected time period for each study is given in section 1.4).

Tasks	Coordinator	*Year 0 : 2008*		*Year 1 : 2009*		*Year 2 : 2010*		*Year 3 : 2011*		*Year 4 : 2012*	
				start of ANR project							
				6	12	18	24	30	36	42	48
Arrival of ANR funds			**127.150,00€**	**315.800,00 €**		**163.400,00€**		**72.850,00€**			**End of project**
Campaigns at sea	Louis Marié + Yves Morel	*ARCADINO*	MOUTON2008 FROMVAR	GOGASMOS/CAROLS	ASPEX - MOUTON-FO		ASPEX	*PROTEVS*	ASPEX		
Post doc 1	Florent Lyard										
Post doc 2	Pascale Bouruet-Aubertot										
Post doc 3	Pascal Lazure										
Post doc 4	Yves Morel										
Post doc 5 (for memory, insu project)	*Philippe Bonneton+ Fabrice Ardhuin*										
EPIGRAM Meetings	Yves Morel+Pascal Lazure+Pierre De Mey		Kick off meeting				Meeting			Meeting	
Deliverable	Yves Morel+Pascal Lazure+Pierre De Mey+ axes coordinators				annual report		annual report		annual report		final report

Risks management

One of the risk to achieve the present project is associated with the campaigns at sea, 3 of which (representing about 100 days at sea) have not been accepted yet: ASPEX, GOGASMOS, PROTEVS. In addition, campaigns at sea are obviously subject to some risks (storms, ship or instrument problems). The project can be resized, and the budget revised, in case the expected campaigns are not obtained, but notice that there already exists more than 100 days of observations to be exploited and that one campaign is already programmed for 2009 (MOUTON-FO).

Another risk is associated with the difficulty to find post docs and to keep them for two years. If we find it too difficult to find post docs, we propose to use the post doc grants to hire PhDs, in the limit of the duration of the project (PhDs will thus

not start later than January 2010). Notice also that the salary we will propose to post docs is attractive and that the present project will give them some interesting formation and responsibilities in a major scientific project, which should be an incentive to stay till the end of the project.

The management of a big project such as EPIGRAM, involving many laboratories and people, is also difficult in particular to maintain a general coherence and a fair and efficient distribution of the means obtained for the project. We have proposed to centralise the travel and publication budget which will allow the steering committee to manage the means obtained from ANR (and LEFE). The distribution of responsibilities among 5 main axes and the creation of a general steering committee will help manage the means (human and funding) for the benefit of the project. Several general assemblies are also planned to gather the whole EPIGRAM community and sustain the exchanges between all participants.

1.7 Organisation du partenariat/*Consortium organisation*

1.7.1 Pertinence des partenaires/*Consortium relevance*

Main partners

In the present project we have gathered the national scientific community interested in the dynamics of the north eastern Atlantic (in particular shelf and margin processes). All the main national laboratories having skills in the processes or technological studies identified here participate to the present project (see publication list below). The participation of the laboratories in these studies is detailed in section 1.4. The main partners are:

1. Main partner 1: SHOM. *Attached axes*: Axis 4 (Atmospheric and river plume influences on the shelf dynamics) and Axis 5 (effects of the tide on the shelf), MOUTON campaigns at sea.
2. Main partner 2: IFREMER/DYNECO. *Attached axes*: Axis 3: Large scale seasonal processes and deep-sea/coastal exchanges, ASPEX campaigns at sea.
3. Main partner 3: LEGOS. *Attached axes*: Axis 1 : effects of the tide on the shelf.
4. Main partner 4: LOCEAN. *Attached axes*: Axis 2 (Internal tide), GOGASMOS campaigns at sea.

The laboratories and participants of the project are (alphabetical order, involvement in man.month/year – mmy-):

CNRM :
Gwenaelle Hello : 1 mmy
Hervé Giordani : 1 mmy
Jean-Christophe Canonici : 1 mmy
Alexandre Paci : 2.5 mmy
Cécile Renaudie (PhD, CNRM and SHOM) : 6 mmy

CNRS/INSU and University laboratories :

EPOC
Philippe Bonneton : 0.5 mmy
Bruno Castelle : 2.5 mmy
François Batifoulier (PhD EPOC / IFREMER-DYNECO) : 6 mmy
Post doc 5 : 12 mmy

GM (Géosciences Montpellier)
Yann Leredde : 2 mmy

IMFT
Olivier Eiff (prof.) : 1.5 mmy
Frédéric Moulin : 1 mmy
Dominique Astruc (prof.) : 1 mmy

LA
Patrick Marsaleix : 1 mmy
Francis Auclair : 0.75 mmy

LEGOS
Nadia Ayoub : 2.5 mmy
Florence Birol : 0.5 mmy
Florent Lyard : 3.5 mmy
Pierre De Mey : 0.5 mmy
Post doc 1 : 12 mmy

LOCEAN
Jacqueline Boutin : 2 mmy
Pascale Bouruet-Aubertot (assist. Prof.): 8 mmy
Yannis Cuypers: 4.5 mmy
Laurent Mortier (participation associated with the use of gliders, to be defined): 1mm in 2009
PierreTestor(participation associated with the use of gliders, to be defined): 1 mm in 2009
Post doc 2 : 12 mmy

LOG
Alexei Sentchev: 1 mmy

LPO
Louis Marié : 12 mmy
Steven Herbette (assist. prof.): 2.5 mmy
Bernard Le Cann: 1.5 mmy
Bruno Ferron: 2.5 mmy
Nathalie Daniault: 0.5 mmy

LSEET
Philippe Forget: 0.5 mmy
Yves Barbin: 0.5 mmy

IFREMER
Pascal Lazure: 4.5 mmy
Franck Dumas: 1 mmy
Frédéric Vandermeirsch: 6 mmy
Valérie Garnier: 2 mmy
Michel Repecaud (tech.) : 0.5 mmy
Xavier André (tech.): 0.5 mmy
Post doc 3 : 12 mmy

MERCATOR
Guillaume Reffray : 1 mmy

SHOM
Yves Morel : 5 mmy
Stéphanie Louazel: 1.5 mmy
Rémy Baraille: 2.5 mmy
Vigan Mensah (tech.) : 1 mmy
Marc Le Menn (Ing.) : 0.5 mmy
Bernard Croguennoc (tech.) : 0.5 mmy
Fabrice Ardhuin : 3 mmy
Rudy Magne : 2 mmy
Gaël Morvan : 1 mmy
Annick Pichon : 2 mmy
Lucia Pineau-Guillou : 1 mmy
Jean-François Filipot (PhD) : 6 mmy
Post doc 4 : 12 mmy

Laboratoire de Coet Quidan:
Thierry Pichevin : 1.5 mmy

The following table summarizes the attachement of each laboratory (and participants) to one of the main partners:

Main partner 1 and associates	Main partner 2 and associates	Main partner 3 and associates	Main partner 4 and associates
SHOM –CNRM – MERCATOR – EPOC-GM Lab. Coet Quidan	**IFREMER/DYNECO**-LPO	**LEGOS**-LA-LOG-LSEET	**LOCEAN**-IMFT

For memory (not part of the present demand): expected collaborations with other known projects:
Theoretical studies on internal tides and solitons are not addressed here as EPIGRAM focuses on in situ –oceanic- observations and realistic modelling of internal waves in oceanic general circulation models. Theoretical studies will however be addressed in a separate project "Physics of Internal waves for Oceanography" (PIWO). Interactions and discussions between the EPIGRAM and PIWO consortiums are planned during the general assemblies and are funded by the LEFE/IDAO grant.

Participant publication list (2005-2007)

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1.7.2 Qualification du coordinateur du projet et des partenaires/*Principal investigator and partners : résumé and CV*

See Annexe.

1.8 Accès aux grands instruments/Access to large facilities

This project relies on several campaigns at sea.
MOUTON campaigns (on board Beautemps-Beaupré and Pourquoi Pas? ships) are conducted by SHOM, they have been accepted by the "commission campagne à la mer du SHOM".
FORMVAR is a LPO short campaign at sea which has been accepted by CIRMAT (CNRS/INSU commission).
ASPEX are IFREMER campaigns which have been submitted to the OPCB commission in 2008.

GOGASMOS are LOCEAN campaigns at sea dedicated to the validation of the SMOS instrument, their funding has been obtained from LEFE/IDAO and is not part of the present proposal, but some results (observed physical processes) will be of interest and exploited in the framework of EPIGRAM. They have been submitted to OPCB in 2008, complementary campaigns may also be planned on board the Côtes de la Manche, for which a proposal will be sent to CIRMAT.
Gliders can possibly be used in the present project. This deployment is still under discussion, and it could provide additional data of interest for EPIGRAM. However, if the deployment is not possible, it will not modify the present proposal.
PROTEVS are SHOM campaigns, planned to start in 2010. Announced in 2007, they will be submitted to the "commission campagne à la mer du SHOM" in 2008 and confirmed in 2009.

1.9 Stratégie de valorisation et de protection des résultats/*Data management, data sharing, intellectual property strategy, and exploitation of project results*

Data collected at sea are the property of the institute responsible of the campaign at sea. For their scientific exploitation, the data will be shared with collaborating laboratories for the benefit of the common studies mentioned in the present project. At the end of the project (and process studies) the data will be managed by the institute to whom they belong. In practice, most of the data will be collected by IFREMER and SHOM, institutes that have agreements for the management of oceanographic data, and most of the data should then be put in the SISMER database, for which an access is possible for the entire scientific community.
Project materialised by common publications, and the intellectual property will be naturally shared by all participants.

Collez ici le tableau de récapitulatif des données financières de la fiche budgétaire.

FICHES BUDGÉTAIRES - Blanc

Fiche Partenaire 1

Nom Complet du partenaire	Catégorie de partenaire	Base de calcul pour l'assiette de l'aide
Service Hydrographique et Océanographique de la Marine	Organismes de recherche+Fondation de recherche	Coût marginal

Données financières (montant HT en € incluant la TVA non récupérable)

EQUIPEMENTS (€)	Personnels						Prestations de service externe (€)	Missions (€)	Autres dépenses (€)	Dépenses justifiées sur facturation interne (€)	Totaux (€)
	permanents		non permanents à financer par l'ANR		Autres non permanents						
	personne. mois	Coût (€)	*personne. mois*	Coût (€)	*personne. mois*	Coût (€)					
63 300	*129,00*	774 000	*24,00*	120 000	*60,00*	240 000	-	-	-		1 197 300
Montant maximum des frais de gestion/ frais de structure (€)				7 332		0	<--Frais de gestion / frais de structure demandés (€)-->				7 332
Uniquement pour laboratoire d'organisme public de recherche ou fondation financé au coût marginal, indiquer le taux d'environnement									Frais d'environnement (€)		-
									Coût complet (€)		**1 204 632**
									Coût éligible pour le calcul de l'aide : Assiette (€)		**183 300**
1							Taux d'aide demandée)-->	100%	***Aide demandée (€)***		***183 300***

Fiche Partenaire 2

Nom Complet du partenaire	Catégorie de partenaire	Base de calcul pour l'assiette de l'aide
Institut francais pour la recherche et l'exploitation de la MER	Organismes de recherche+Fondation de recherche	Coût marginal

Données financières (montant HT en € incluant la TVA non récupérable)

EQUIPEMENTS (€)	Personnels						Prestations de service externe (€)	Missions (€)	Autres dépenses (€)	Dépenses justifiées sur facturation interne (€)	Totaux (€)
	permanents		non permanents à financer par l'ANR		Autres non permanents						
	personne. mois	Coût (€)	*personne. mois*	Coût (€)	*personne. mois*	Coût (€)					
45 600	*134,00*	804 000	*24,00*	120 000	*0,00*	-					969 600
Montant maximum des frais de gestion/ frais de structure (€)				6 624			<--Frais de gestion / frais de structure demandés (€)-->				6 624

Uniquement pour laboratoire d'organisme public de recherche ou fondation financé au coût marginal, indiquer le taux d'environnement		Frais d'environnement (€)	-
		Coût complet (€)	**976 224**
		Coût éligible pour le calcul de l'aide : Assiette (€)	**165 600**
1	Taux d'aide demandée)--> 100%	***Aide demandée (€)***	***165 600***

Fiche Partenaire 3

Nom Complet du partenaire	Catégorie de partenaire	Base de calcul pour l'assiette de l'aide
CNRS/INSU-LEGOS	Organismes de recherche+Fondation de recherche	Coût marginal

Données financières (montant HT en € incluant la TVA non récupérable)

1

EQUIPEMENTS (€)	Personnels						Prestations de service externe (€)	Missions (€)	Autres dépenses (€)	Dépenses justifiées sur facturation interne (€)	Totaux (€)
	permanents		non permanents à financer par l'ANR		Autres non permanents						
	personne. mois	Coût (€)	*personne. mois*	Coût (€)	*personne. mois*	Coût (€)					
	43,00	258 000	*24,00*	120 000				37 500	53 000		468 500
Montant maximum des frais de gestion/ frais de structure (€)				8 420			<--Frais de gestion / frais de structure demandés (€)-->				8 420

Uniquement pour laboratoire d'organisme public de recherche ou fondation financé au coût marginal, indiquer le taux d'environnement		Frais d'environnement (€)	-
		Coût complet (€)	**476 920**
		Coût éligible pour le calcul de l'aide : Assiette (€)	**210 500**
1	Taux d'aide demandée)--> 100%	***Aide demandée (€)***	***210 500***

Fiche Partenaire 4

Nom Complet du partenaire	Catégorie de partenaire	Base de calcul pour l'assiette de l'aide
CNRS/INSU-LOCEAN	Organismes de recherche+Fondation de recherche	Coût marginal

Données financières (montant HT en € incluant la TVA non récupérable)

1

EQUIPEMENTS (€)	Personnels						Prestations de service externe (€)	Missions (€)	Autres dépenses (€)	Dépenses justifiées sur facturation interne (€)	Totaux (€)
	permanents		non permanents à financer par l'ANR		Autres non permanents						
	personne. mois	Coût (€)	*personne. mois*	Coût (€)	*personne. mois*	Coût (€)					
	74,00	444 000	*24,00*	120 000							564 000
Montant maximum des frais de gestion/ frais de structure (€)				4 800			<--Frais de gestion / frais de structure demandés (€)-->				4 800

Uniquement pour laboratoire d'organisme public de recherche ou fondation financé au coût marginal, indiquer le taux d'environnement		Frais d'environnement (€)	-
		Coût complet (€)	**568 800**
		Coût éligible pour le calcul de l'aide : Assiette (€)	**120 000**
1	Taux d'aide demandée)--> 100%	***Aide demandée (€)***	***120 000***

Récapitulatif des données financières

	EQUIPEMENTS (€)	Personnels						Prestations de service externe (€)	Missions (€)	Autres dépenses (€)	Dépenses justifiées sur facturation interne (€)	Totaux (€)
		permanents		non permanents à financer par l'ANR		Autres non permanents						
		personne. mois	Coût (€)	*personne. mois*	Coût (€)	*personne. mois*	Coût (€)					
Partenaire 1	63 300	129	774 000	24	120 000	60	240 000	-	-	-	-	1 197 300
Partenaire 2	45 600	134	804 000	24	120 000	-	-	-	-	-	-	969 600
Partenaire 3	-	43	258 000	24	120 000	-	-	-	37 500	53 000	-	468 500
Partenaire 4	-	74	444 000	24	120 000	-	-	-	-	-	-	564 000
	108 900	**380,00**	**2 280 000**	***96,00***	**480 000**	**60,00**	**240 000**	**-**	**37 500**	**53 000**	**-**	**3 199 400**

Frais de gestion / frais de structure demandés (€)-->	27 176
Frais d'environnement (€)	-
Coût complet (€)	**3 226 576**
Coût éligible pour le calcul de l'aide : Assiette (€)	**679 400**
Aide demandée (€)	***679 400***

2 Justification scientifique des moyens demandés/*Requested budget : detailed financial plan*

2.1 General rules and funding management

This project will be achieved thanks to the mutualisation of the means and project of several partners (human, observation capabilities and funding) and **complementary funding from ANR agency (and LEFE program) to make this mutualisation possible and extend the objectives of each partner to the present much more ambitious scientific project**.
The funding will be dedicated to mutual aspects, such as general and working group meetings, common publications, funding required for the common campaigns at sea (expendable materials in particular) and their exploitation (PhD and post doc) for mutual benefits.
We will plan three general meetings (including a kick off meeting, if possible at the end of 2008) and several working group meetings (at least one per year, with the aim of using the videoconference capabilities).
As far as publications are concerned, the rule is to constitute working groups on selected topics with the aim of materialising the cooperation by a common publication. A Special issue gathering the main findings is planned at the end of the project.
As mentioned above the funding requested to ANR will serve mutual actions and will be dedicated to:

- General EPIGRAM meetings and general presentation of the project in scientific meetings (IBIROOS meetings typically).
- Publication of mutualised studies.
- Funding of mutualised observation tools (expendable materials and instruments that can be mutualised, and for which collected data during the campaigns will be available for the participants).
- Several Post docs for mutualised studies (mostly exploitation of campaigns at sea) are requested from ANR; Post docs or PhDs on selected topics/studies are requested from INSU with a label from the EPIGRAM project.

If the project is accepted and funded, we wish to centralise the "meetings and publication" money at one place, to simplify the general management. The LEGOS laboratory will play this role.
The post docs will be attached to a laboratory to which the post-doc grants must be attributed.
Funding of instruments for campaigns at sea will be attributed to the laboratories conducting the campaigns.

All funds will be managed rigorously by the coordinators of the project, in particular we will make sure that the granted funds will be effectively used for the benefit of the project as planned here (with possible reorientation if needed, but which will be subject to funding agency agreements in this case). Notice that some funding has been obtained from the LEFE program, which essentially concern the general assemblies of the project. **ANR funding represents the most important part (funding of manpower, expendable instruments for campaigns at sea, final publication) and this mutual project can obviously not be sustained without it.**
We first detail the means required for the EPIGRAM project, before describing the distribution between all partners of the project.

2.1.2 Equipement/*Large equipment*

The funding of campaign at sea (scientific ships and crews) and scientific instruments (CTDs, ADCPs, SEASOAR, ...) will be generally supported by the institutes participating to the EPIGRAM project and is evaluated in section 1.4. However, a participation for the funding of specific tools (expendable drifters, gliders, ...) of mutual benefit is requested here to both the LEFE/IDAO and ANR programs. Some LEFE funds are dedicated to the GOGASMOS (and gliders) campaigns.

The following briefing dockets describe the additional materials that are necessary for the planned observations at sea. The requested funding concerns

- Drifters : 26 SLDMB + 14 surdrifts-75 + 6 LATEX (process studies tidal currents, current generated by the wind, river plumes, general circulation on the shelf, exchange between deep ocean and coastal zone, surf zone) = 26*2.300,00€+14*3600€ +6*1.700,00€= 120.400,00 €. The repartition of these drifters are :
    - 3 SLDMB and 3 Surdrift-75 : for "tidal current" study (MOUTON2009)
    - 3 SLDMB and 3 Surdrift-75 : for "general circulation on the shelf" study (ASPEX2010)
    - 3 SLDMB and 3 Surdrift-75 and 6 LATEX drifters : for "Exchanges between the deep ocean and the coastal area" study (ASPEX2010)
    - 3 SLDMB and 3 Surdrift-75 : for "currents generated by the wind" study (MOUTON2009)
    - 4 SLDMB and 2 Surdrift-75 : for "river plumes" study (MOUTON2009)
    - 5*2 SLDMB : for "inner shelf transition" study (PROTEVS2010-2011)
- *For memory (taken into account by the LEFE grant) small equipments (mainly installation of a meteorological*

mast for GOGASMOS in 2009): 16.000,00€

- *For memory (taken into account by the LEFE grant) Gliders : 4 months of deployment in 2009 = 4*1.500=6.000,00€*

Recapitulation :

year	2008	2009	2010	2011
MOUTON (SHOM)		51.800,00€ (10 SLDMB+ 8 surdrifts)	11.500,00€ (5 SLDMB)	11.500,00€ (5 SLDMB)
ASPEX (IFREMER)			45.600,00€ (6 SLDMB +6surdrifts+6LATEX)	
GOGASMOS+GLIDERS (for memory funded by LEFE)		*22.000,00€*		
Total cost	0,00€	73.800,00€	57.100,00€	11.500,00€

2.1.3 Personnel/*Manpower*

The study of physical processes based on the exploitation of campaigns at sea is at the base of the project as it will improve our understanding of these processes and will provide diagnostics for the validation of realistic numerical models.
We have identified 19 different physical process studies and 11 technological studies and many developments of general interest for the numerical models (construction of a high resolution bathymetry of the area, high resolution atmospheric forcing, mesoscale forcing at the open ocean boundaries, river run offs, …) that needs to be addressed in the framework of the project.
There exist more than 100 days of measurements that has to be exploited and that we plan to complement by more than 150 days of future campaigns. This represents tens of thousands hydrological profiles (a typical MOUTON campaign represents about 3000 vertical profiles, thanks to the use of the seasoar), hundreds of days of moorings, tens of drifters, etc… to be exploited.
This is a huge amount of data that the EPIGRAM community has to exploit to meet all the challenges of the project. Most of the participants plan to devote a significant amount of his research time to the project (about 20% on average, ranging from a few % to 100%), but since the skills are distributed over different laboratories, and since there is a large number of data to be analysed, it is necessary that a few people spend their full time on the project, to gather the skills coming from different laboratories and exploit the data. That is why a project like EPIGRAM requires several post doc grants: without such a support much more than 4 years would be necessary to meet the present goals (notice also that the data would then not be released to the entire scientific community, which would also limits their exploitation).

The post doc grants requested from ANR are thus of fundamental importance for the project: it is the only way to scientifically exploit the data collected during EPIGRAM in a decent time period (4 years). The funding of EPIGRAM will also allow the emergence of a major project in Europe on coastal and shelf dynamics, instead of several independent institute projects.

We have identified 4 main axes for the process studies for each of which we need 2 years of post doc:
Post doc 1 (LEGOS): effects of the tide on the shelf. Start in January 2009.
Post doc 2 (LOCEAN): Internal tide. Start in January 2010.
Post doc 3 (IFREMER/DYNECO): Large scale seasonal processes and deep-sea/coastal exchanges. Start in January 2010.
Post doc 4 (SHOM): Atmospheric and river plume influences on the shelf dynamics. Start in January 2009.

The role of the post docs is to be the principal actors of the mutualisation and cooperation between the participating laboratories and to exploit the data collected at sea concerning their processes. They are attached to a laboratory but their work will be to prepare and validate the existing data, participate to the planning and realisation of the new campaigns, and exploit the data in collaboration with the laboratories participating to their theme, in particular participate to the writing of scientific articles. The definition of diagnostics from observations will be discussed among partners depending on observations available and planned and on processes studied. This work will be the major role of the post docs hired for the project.
The collection, exploitation and analysis of in situ data, possibly accompanied by theoretical or numerical modelling, is an excellent formation for young researchers (PhDs or post-docs), the participation of many laboratories is also beneficial as it increases the number of publications for the post doc. Coordination will also be planned and animated by researchers from participating institutes: the coordinators of the main axes will be responsible for the general coordination of his axis and will help plan the detailed work of the post doc, if necessary (will be discussed in the opening meeting of the project) for each study we will also identify a principal contact.

To achieve their role and work, the Post docs have to last (at least) 2 years. They can be transformed into 3 years of PhD for some topics (same amount of money and same amount of work expected to be achieved). Each grant is evaluated on the basis of a **60.000,00€/year (including salary and a provision for a workstation and missions for two years).**

Recapitulation :

year	2008	2009	2010
Means for EPIGRAM post-docs	120.000,00 €	240.000,00€	120.000,00 €

Additional grants, not directly related to the exploitation of campaigns at sea but connected to the project and of high publication potential, will also be requested from INSU. For 2008 a LEFE/IDAO-EPIGRAM label has been obtained for:

For memory (funded by CNRS): Post doc 5: Influence of waves on the shelf dynamics. Start in 2008.

2.1.4 Missions/*Travels*

EPIGRAM meetings

Three general EPIGRAM meetings are planned (Two full days of meetings), one at the beginning in 2008 and two additional meetings (at a period of two years between the meetings). Colleagues from the operational and other scientific community (REDEO, SHOM, IFREMER, Météo-France, MERCATOR) will be invited to the EPIGRAM meetings in order to establish links with this research project. Working group meetings will use the available visioconference facilities.

The funds required to organise these meetings are : 3 * 40 (on the basis of 30 people attending the meeting -out of 50 registered in the project- and 10 invited partners from operational/ecosystem/assimilation/… communities) * 600 € = 72.000,00 € TTC
2008 : 24.000,00 €
2009 : 0,00 €
2010 : 24.000,00 €
2011 : 24.000,00 €

The funding of the EPIGRAM meetings is funded by the LEFE/IDAO program for the most part.

Recapitulation :

year	2008	2009	2010	2011
Means for EPIGRAM meetings	*24.000,00* €	0,00€	*24.000,00 €*	*24.000,00 €*

Presentation to scientific meetings

The funding for the presentation of the results during scientific meetings will start in 2009 and has been reduced to a minimum. It is associated with general presentation of the project in international meetings: 1 presentations per year (general presentation of the project) = 1000€/year (2009, 2010, 2011).
In addition a provisional budget for the presentation of specific studies to international conferences is **requested, on the basis of about 10 presentations per year (including general axis presentation by coordinators) in 2009 and 2010 and 20 presentations over 2011/2012 at the end of the project which represents 10.000,00+10.000,00+20.000,00 = 40.000,00€**.

Recapitulation:

year	2008	2009	2010	2011
Means for publications	0,00€	11.000,00€	11.000,00€	21.000,00€

Travel funds are also needed for the presentation of the project results during LEFE/IDAO or ANR meetings, but we have considered that this will be directly funded by the national programs and has not to be taken into account here.
Travel funds for the work of the post doc is part of the post doc grant and is not taken into account here.

2.1.5 Autres dépenses de fonctionnement/*Other expenses*

*Toute dépense **significative** relevant de ce poste devra être justifiée.*

Publications

The funding of publications in international scientific journals has also been reduced to a minimum : 2 mutual publications and 5 more specific publications are expected in 2009, 2010, 2011.
In addition, a special EPIGRAM issue in a journal with several articles is planned at the end of the project (planned for 2012, funded in 2011) and for which we ask for the funding of 10 publications.
The funds requested for publications are based on a cost of 2.500,00€ per publication which is a good estimate for most international oceanographic journals (J. Phys. Oceanogr., Tellus, J. Geophys. Res., Dyn. Atmos. Ocean)

Recapitulation :

year	2008	2009	2010	2011
Means for publications	0,00€	17.500,00€	17.500,00€	42.500,00€

We think additional funding will be required for publications during the project but we have kept a lower bound for the present ANR proposal.
I twill also be necessary to buy workstations for post doc, but these are included in the post doc grant and not repeated here.

2.1.6 Récapitulation/*Recapitulation*

As mentioned previously, the EPIGRAM project has been submitted to the LEFE/IDAO national program for funding of the GOGASMOS and Gliders campaigns at sea, the main meetings, mutual publications and a share for expendable instruments. The funding of the four post docs and most of the scientific equipments being part of the ANR proposal.

The budget obtained from LEFE/IDAO is 145.000,00€ (+ post doc-5):
2008 : 18.000,00 € (+post doc)
2009 : 39.000,00 € (+post doc, possibly)
2010 : 60.000,00 €
2011 : 28.000,00 €
A 7% overhead will be withdrawn from the LEFE/IDAO contribution for the overhead of the CNRS laboratories managing the funds.

These limited funds were distributed as best as we could over the different requirements. To meet the needs evaluated above, some complementary funding (however limited) is requested from ANR for these mutual tasks too so that no strict and logical distribution is possible between the LEFE/IDAO and ANR grants.

The following table recapitulates the requested funding for the EPIGRAM project (**in bold the ANR grant**):

Year	*2008*			*2009*			*2010*			*2011*		
Funding programs	IDAO	**ANR**	*Tot.*	IDAO	**ANR**	Tot.	IDAO	**ANR**	*Tot.*	IDAO	**ANR**	*Tot.*
post docs	0	**120000**	*120000*		**240000**	*240000*		**120000**	*120000*			*0*
EPIGRAM meetings	16850	**7150**	*24000*			*0*	24000		*24000*	15150	**8850**	*24000*
Scientific meetings	0	**0**	*0*	9500	**1500**	*11000*	6000	**5000**	*11000*	6000	**15000**	*21000*
Publications	0	**0**	*0*	5000	**12500**	*17500*	14500	**3000**	*17500*	5000	**37500**	*42500*
Instruments	0	**0**	*0*	22000	**51800**	*73800*	11500	**45600**	*57100*	0	**11500**	*11500*
overhead gestion LEGOS	1150	**0**	*1150*	2500	**0**	*2500*	4000	**0**	*4000*	1850	**0**	*1850*
Total	18000	**127150**	145150	39000	**305800**	344800	60000	**173600**	233600	28000	**72850**	100850

The total funds requested for the present project is therefore: 145.000,00€ (LEFE/IDAO)+ 679.400,00€ (ANR) =824. 400,00 €

The funding of Post doc-INSU n° 1 (by CNRS/INSU) has not been counted in the previous table, it represents a budget of about 60.000,00€ for one, possibly two, years (total of 120.000,00 €) to be added to the INSU contribution to the project.

To be in phase with the expected milestones (kick off meeting, campaigns at sea) it is important that the grant, if accepted, arrives as soon as possible in 2008, and at the beginning of each following years (2009-2010-2011, see section 1.5).

Consolidated budget and participation

In addition to the requested funds, the consolidated budget of the project has to take into account the participation of the institutes in terms of campaigns at sea (ship + instruments) and human resources, as they are known at the present stage. The following table is an estimate of the latter and is based on a cost of campaigns at sea (ship + instruments) of 4.000,00€/day for the "Côte de la Manche" and an average of 25.000,00€/day for other ships and a cost of human resources of 300,00€/day.

Institutes	CNRS/Universities Laboratories	Météo-France	IFREMER	MERCATOR	SHOM
Campaigns at sea	200.000,00€	0,00€	1.250.000,00€	0,00€	2.000.000,00€
Human resources (total cost)	1104.000.000,00€	132.000,00€	636.000,00€	24.000,00€	624.000,00€

The consolidated cost of the project is therefore about 3.450.000 (campaigns)+2.520.000 (human)+ 824.400,00 (requested funds from ANR and LEFE) = 6.794.400 € over 4 years.

The human resources amounts to about **140 man*month/year (including ANR post docs)** and involving **14 laboratories and about 50 people.**

The investment of the main project manager is estimated to be 5 man.month/year, representing more than 40% (and more than the 30% limit requested by ANR rules).
If we add the investment of the other coordinators (general management and coordinators of the main axes), we get 460 days/year for the investment of the managing team representing 7 people. This gives an average investment of 33% for the people involved in the coordination of the project.
The total numbers of days at sea requested for the scientific cruises amounts to about 250 days (100 days already existing).

Some individual funds (for instance missions and publications) related to EPIGRAM and funded by the institutes are not evaluated here. The post docs that will eventually be funded by INSU are not counted.

Funding for 2008

The funding requested for the project from LEFE/IDAO and ANR programs concern the organisation of a kick-off meeting (to define the campaigns at sea and exploitation of existing data. The mutualisation of data for the numerical models -construction of a common high resolution bottom topography, ... - will also be discussed) and the funding of two post-docs by ANR.
The funding for 2008 is 18.000,00€ TTC € for LEFE/IDAO and **127.150,00 € for ANR (120.000,00€ for post docs + a complement of 7.150,00€ for the organisation of the kick off meeting, which could not be entirely funded by LEFE for 2008).**

Again, the funding –in 2008- of the Post doc – 5 (CNRS/INSU) has not been counted here, it represents a budget of 60.000,00€ for year 2008 to be added to the INSU contribution to the project.

For the sake of simplicity for the management of the project funds and readability of the present paper, we have identified four main partners, responsible for the coordination of an axis, and grouped all other laboratories under one of the main partner. However, laboratories are often involved in several axes. The LEFE/IDAO grant will be centralised at LEGOS, the ANR money will be centralized by the four main partners. The details are given below.

2.2 Partenaire 1/*Partner 1: SHOM*

Equipement/equipment

year	2008	2009	2010	2011
ANR grant	0,00€	51.800,00€	0,00€	11.500,00€

Personnel/Manpower

year	2008	2009	2010	2011
ANR grant	60.000,00€	60.000,00€	0,00€	0,00€

Missions/travels

Centralised at LEGOS (except travel funds for post doc included in post doc grant).

Autres/Other expenses

Centralised at LEGOS (except funds for post doc included in post doc grant).

TOTAL:

year	**2008**	**2009**	**2010**	**2011**
ANR grant	**60.000,00€**	**111.800,00€**	**0,00€**	**11.500,00€**

2.3 Partenaire 2/*Partner 2 : IFREMER/DYNECO*

Equipement/equipment

year	2008	2009	2010	2011
ANR grant	0,00€	0,00€	45.600,00€	0,00€

Personnel/Manpower

year	2008	2009	2010	2011
ANR grant	0,00€	60.000,00€	60.000,00€	0,00€

Missions/travels

Centralised at LEGOS (except travel funds for post doc included in post doc grant).

Autres/Other expenses

Centralised at LEGOS (except funds for post doc included in post doc grant).

TOTAL:

year	**2008**	**2009**	**2010**	**2011**
ANR grant	**0,00€**	**60.000,00€**	**105.600,00€**	**0,00€**

2.4 Partenaire 3/*Partner 3 : LEGOS*

Equipement/equipment

None.

Personnel/Manpower

year	2008	2009	2010	2011
ANR grant	60.000,00€	60.000,00€	0,00€	0,00€

Missions/travels

Centralised here for the benefit of all participants (travel funds for legos post doc is included in post doc grant).

year	2008	2009	2010	2011
ANR grant	7.150,00€	1.500,00€	5.000,00€	23.850,00€

Autres/Other expenses (publications)

Centralised here for the benefit of all participants (funds for legos post doc is included in post doc grant).

Year	2008	2009	2010	2011
ANR grant	0,00€	12.500,00€	3.000,00€	37.500,00€

TOTAL:

year	**2008**	**2009**	**2010**	**2011**
ANR grant	**67.150,00€**	**74.000,00€**	**8.000,00€**	**61.350,00€**

2.5 Partenaire 4/*Partner 4 : LOCEAN*

Equipement/equipment

None.

Personnel/Manpower

year	2008	2009	2010	2011
ANR grant	0,00€	60.000,00€	60.000,00€	0,00€

Missions/travels

Centralised at LEGOS (except travel funds for post doc included in post doc grant).

Autres/Other expenses

Centralised at LEGOS (except funds for post doc included in post doc grant).

TOTAL:

year	**2008**	**2009**	**2010**	**2011**
ANR grant	**0,00€**	**60.000,00€**	**60.000,00€**	**0,00€**

Annexes : Biographies/Résumés and CV (personnel investi à plus de 3 mois/an, cf. § 1.7.2)

CURRICULUM VITAE : Yves MOREL (coordinateur du projet)

I – DONNÉES PERSONNELLES

Nom : MOREL Yves
Date de naissance : 12 février 1967
État civil : vie maritale, trois enfants

II – DIPLOME - FORMATION

diplômé de «l'Ecole Polytechnique »
diplômé de «l'Ecole Nationale Supérieure des techniques Avancées»
diplômé de l'Université de Paris VI (DEA), mention très bien.
Thèse universitaire de «l' université Joseph Fourier » (titre de la thèse : « Déplacement des tourbillons géophysiques. Application aux Meddies »), félicitation du jury.

Habilité à diriger des recherches (habilitation délivrée par l'Université de Bretagne Occidentale en 2005).

III - CURSUS PROFESSIONNEL

1995-2001 : Ingénieur de recherches «Centre Militaire d'Océanographie» (responsable de la section recherche en océanographie à partir de 2000).
2002-2003 : Séjour comme chercheur au « Nansen Environmental and Remote Sensing Center » (NERSC, Bergen, Norvège). Mise en place d'un système opérationnel sur le golfe du Mexique.
Depuis 2004 : **Chef du département de recherche de la division** «Hydrographie Océanographie et Météorologie militaire» de la direction des opérations du SHOM (SHOM/DO/HOM/REC). **Chef du site SHOM-Toulouse**.
Responsable du processus qualité « recherche » du SHOM (certifié iso9001 depuis 2005).

IV – RESPONSABILITÉS SCIENTIFIQUES

Responsable du programme « Modélisation Océanique d'un Théâtre d'Opérations Navales» (MOUTON). Le but de ce programme est de contribuer au développement de système d'analyse et prévision de l'océan pour les besoins de la Marine, en particulier pour le domaine côtier. Ce programme mobilise plus de cinquante personnes (SHOM et sous traitance) et des moyens scientifiques lourds (observations en mer, supercalculateurs, …).
Membre du consortium international HYCOM (groupe scientifique international basé sur l'utilisation et le développement de modèles d'océan en coordonnées hybrides).
Directeur scientifique de campagnes à la mer (plus de 200 jours de mer depuis 1996).
Directeur de thèse (actuellement deux étudiants).

Membre des comités scientifiques :
Programme européen «grands instruments scientifiques – Hydralab »
Comité scientifique de l'IFREMER
Comité scientifique MERCATOR-CORIOLIS

VI - PUBLICATIONS (5 dernières)

1. Herbette S., Y. Morel and M. Arhan, 2004. Surface vortex subduction under an outcropping front. J. Phys. Ocean. 34, pp. 1610-1627.
2. Herbette S., Y. Morel and M. Arhan, 2005. Erosion of a surface vortex by a seamount on the beta-plane. J. Phys. Ocean., 35, pp. 2012-2030.
3. Chérubin L., Y. Morel and E. Chassignet, 2006. Loop Current ring shedding: the formation of cyclones and the effect of topography. J. Phys. Ocean., 36, pp.569-591.
4. Y. Morel, D. Darr and C. Taillandier, 2006. Possible sources driving the potential vorticity structure and long-wave instability of coastal upwelling and downwelling currents. J. Phys. Ocean., 36, No. 5, pp. 875–896.
5. Winter N., Y. Morel and G. Evensen, 2007. Efficiency of high order numerical schemes for momentum advection. J. Mar. Res., 67, pp. 31–46

Curriculum vitae : Pascal Lazure

Name: **Pascal Lazure**
Work address:
DYNECO/physed
Ifremer centre de Brest
BP 70
29280 Plouzané
France
Date of Birth: 9 August 1961
Marital Status: marital life, 4 children

Education
1983 Brest University Msc. Physical oceanography

Professional employment
1986-1987 Military service at the French Meteorological Institute (Météo France)
Since 1987 Research scientist at IFREMER

Research Interests and applications
Modelling
A Complete 2D and 3D models (MARS) has been developed and are currently improved by the team. These models are semi implicit finite difference models. Free surface is considered and allows studies of tides, wind and density induced circulation at regional to local scale.
Physical Oceanography applications
Regional modelling of the French coasts at time scale from the hour to the decade.
Local high resolution models (grid size of 100 m or less) studies.
Biogeochemica, ecological applications
Dispersion of the dissolved cadmium of the Gironde river. Many applications within the framework of physical-biological interactions studies: toxic plankton (HAB), primary production, fish recruitments (anchovy and sole).

Publications (5 last)

1. Allain G., Petitgas P., **Lazure P**., 2007. The influence of environment and spawning distribution on the survival of anchovy (Engraulis encrasicolus) larvae in the Bay of Biscay (NE Atlantic) investigated by biophysical simulations. Fish. Oceanog. , 16, 506-514.
2. Zinc S., Boutin J., Waldteufel P., Vergely J., Pellarin T., **Lazure P**., 2007. Issues about retrieving sea surface salinity in coastal areas from SMOS data. IEEE Trans. Geos. And Rem. Sens. ,47, 2061- 2072.
3. Allain G., Petitgas P., **Lazure P**., Grellier P., 2007. Biophysical modelling of larval drift, growth and survival for the prediction of anchovy (Engraulis encrasicolus) recruitment in the Bay of Biscay (NE Atlantic). Fish. Oceanog. , 16, 489-505.
4. **Lazure P**., Dumas F., 2008. An external-internal mode coupling for a 3D hydrodynamical model at regional scale (MARS). Adv. Wat. Res., 31, 233-250.
5. **Lazure P**., Dumas F., Vrignaud C., 2008. Circulation on the Armorican shelf (Bay of Biscay) in autumn. J. Mar. Sys. (under press).

Curriculum vitae Florent LYARD

Laboratoire LEGOS
OMP
14, Av. E. Belin
31814 Toulouse
France

🗐 : (0) 5 61 33 29 88
Email : Florent.Lyard@cnes.fr

44 ans – Célibataire

Chargé de recherche CR1/CNRS depuis Octobre 1997

Coresponsable du Pôle d'Océanographie Côtière de Toulouse et du réseau international UGO

Expériences professionnelles

Project leader du projet TOSA « ALBICOCCA » (2001-2005)

PI T/P et JASON, membre du comité scientifique WATER-HM, PI projet ANR « AMANDES », responsable scientifique du projet ESA « GOCEAN »

WP leader/participant dans plusieurs projets nationaux et européens (MFSTEP, MERSEA, ECCOP, INSEA)

Formation

1992 : **Doctorat de Mécanique** (mention très honorable, avec les félicitations du jury)	**LEGI/IMG**, **U**niversity **J**oseph **F**ourier, Grenoble I
1988 : **DEA de Mécanique** (mention bien)	**I**nstitut **N**ational **P**olytechnique de **G**renoble I
1987 : **Maîtrise de Mécanique** (mention assez bien)	**U**niversité **J**oseph **F**ourier, Grenoble I
1983/85 : **1ère et 2ème Années d'école d'ingénieur généraliste**	**ENSAE**, Toulouse
1980/83 : **Classes préparatoires de Mathématiques**	Lycée Berthollet, Annecy

Publications choisies:

1. Le Provost C., Lyard F., Energetics of the semi-diurnal M2 ocean tide, *Prog. Oceanog, Special issue on tidal science in honour of David E. Cartwright*, 40, pp. 37-52, M. V. Angel and R. L. Smith ed., 1998.
2. Lyard F., Data assimilation in a wave equation: a variational representer approach for the Grenoble tidal model, J. Comp. Physics, 149, 1-31, 1999.
3. Carrère L. and F.Lyard, Modeling the barotropic response of the global ocean to atmospheric wind and pressure forcing – Comparisons with observations, Geophys. Res. Let., 30, 6, 1275, 2003
4. Lyard F., Lefevre F., Letellier T., Francis O., 2006, Modelling the global ocean tides: modern insights from FES2004 *Ocean Dynamics* http://dx.doi.org/10.1007/s10236-006-0086-x
5. Mourre B., De Mey P., Ménard Y., **Lyard F.** and Le Provost C., 2006, Relative performances of future altimeter systems and tide gauges in controlling a model of North Sea high frequency barotropic dynamics. *Ocean Dynamics* DOI: 10.1007/s10236-006-0081-2

Curriculum vitae : Bouruet-Aubertot Pascale

43 ans, Maître de conférences- HDR au LOCEAN/UPMC
Teaching: Physics, Fluid dynamics and oceanography

cursus :
1988- Ingénieur de l'Ecole Nationale de Techniques Avancées, DEA Océanologie et Météorologie de l'Université Pierre et Marie Curie
1994- Phd in physical oceanography
1995-1996- Postdoc, Southampton Oceanography centre, UK
1997.1998-Postdoc, Depart of Applied Mathematics and Theoretical Physics, Cambdrige, UK
1999- present Assistant Professor at LOCEAN, Université Pierre et Marie Curie

2005-present- Co-organizer (with W.R. Young, SIO, and J.I. Yano, CNRM, Toulouse) of an international summer school, in the series "Alpine summer schools" « Atmosphere- Ocean convection in Climate Dynamics» held in June 2007 in Valasavranche, Aosta, Italy
2005-2006- Field experiments in the Storfjorden (with J.C. Gascard PI of the project "Storfjord" funded by IPEV)
2006- Field experiment in the mid-Atlantic (ridge), Graviluck campaign (PI V. Ballu, IPGP, Paris)

Member of several French scientific steering committees:
CNRS : LEFE/IDAO,
Commission de spécialistes (section 37) de l'Université Pierre et Marie Curie et à l'Ecole Normale Supérieure

Thesis supervisor for 2 Phd students
Invited speaker at the AGU 2006, fall meeting "Ocean mixing" session: "Breaking of inertia-gravity waves as inferred from in-situ measurements and direct numerical simulations"

Main 5 References during the last 5 years, total 19 :

1. Bozec A., P. Bouruet-Aubertot, D. Iudicone, M. Crépon, 2008. « Impact of penetrative solar flux on water mass transformation in the Mediterranean Sea » *J. Geophys. Res.*, to appear
2. Koch-Larrouy A., G. Madec, P. Bouruet-Aubertot, T. Gerkema, R. Molcard, L. Bessières, 2006
3. " Influence of internal tidal mixing on water mass transformations in the Indonesian Throughflow", *Geophys. Res. Lett.*, 34, L04604, doi:10.1029/2006GL028405 (pdf)

A. Bozec, P. Bouruet-Aubertot, K. Béranger, M. Crépon, 2006. Mediterranean oceanic response under interannual high resolution atmospheric forcing: a focus on the Aegean Sea, J. Geophys. Res., , vol.111, C11013, doi:10.1029/2005 JC003427

4. P. Bouruet-Aubertot, H. Mercier, F. Gaillard, P. Lherminier, 2005. « Evidence of strong inertia-gravity wave activity during the POMME experiment » J. Geophysical Research, 110, doi: 10.1029/2004JC002747
5. P. Bouruet-Aubertot, J. Sommeria, B. Le Cann, C. Koudella 2004. "Intermittency of vertical density gradients at finescale and link with mixing processes", Deep Sea Research II, 51, 2919-2941.

More details can be found on http://www.locean-ipsl.upmc/~pba

CURRICULUM VITAE : Louis Marié

Louis MARIE,
Né le 26/02/1977.
Formation :

1996-1999 : Elève ingénieur civil à l'Ecole des Mines de Paris.
1999-2000 : DEA « Dynamique des Fluides et des Transferts » de l'université Paris-XI (Orsay).
2000-2003 : Thèse de doctorat au CEA de Saclay, sous la direction de F. Daviaud (CEA/SPEC) et S. Fauve (ENS/LPS). « Transport de moment cinétique et de champ magnétique par un écoulement tourbillonnaire turbulent : influence de la rotation ». Soutenue le 30/09/2003.
2003-2004 : Stage post-doctoral à l'Institut de Recherche de l'Ecole Navale, sous la direction d'H. Djéridi.
Thème de recherche : Influence des effets d'épaisseur sur les performances de profils portants.
2004-2005 : Stage post-doctoral au Laboratoire de Physique des Océans, sous la direction de A. Colin de Verdière et M. Ollitrault. Thème de recherche : Simulations numériques de la dispersion relative de paires de particules lagrangiennes passives dans un écoulement quasi-géostrophique turbulent.
Emploi:
Embauché à l'IFREMER comme ingénieur chargé de recherche, campagnes en mer/marges continentales, depuis le 1er février 2006.
Embarquements :
Au cours de mes deux premières années à l'IFREMER, j'ai embarqué à bord du Pourquoi Pas ? sur un certain nombre de campagnes organisées dans le Golfe de Gascogne par des chercheurs du SHOM/CMO (CONGAS 2 (chef de mission : A. Serpette), MOUTON 2006 (chef de mission : A. Pichon) et CONGAS 3 (chef de mission : A. Serpette) en 2006, pour un total d'environ 8 semaines de mer, le premier leg de MOUTON 2007 (chef de mission : Y. Morel), pour un peu moins de trois semaines de mer en 2007).
J'ai été chef de la campagne FroMVar 2007 (relevage d'un mouillage courantométrique, mesures CTD), puis de la campagne M2OCPHYS 2007 (campagne d'enseignement M2 PMMC/UBO) qui ont eu lieu en Iroise du 13 au 15, puis du 19 au 22 septembre 2007 sur le R. V. Côtes de la Manche.
Organisation de campagnes :
Lors de ces deux années, j'ai monté, en collaboration avec S. Herbette (LPO/UBO) le projet FroMVar d'étude du front de marée d'Ouessant.
Notre première demande de campagne, jugée non prioritaire, à été réduite à 3 jours en 2007.
Nous avons demandé et obtenu le soutien du programme LEFE/IDAO de l'INSU (soutien accordé jusqu'en 2009).
Nous avons obtenu 2 semaines sur le « Côtes de la Manche », programmés pour début septembre 2008.

Publications :

1. Dubrulle, B., L. Marié, C. Normand, D. Richard, F. Hersant, J.-P. Zahn, 2005. An hydrodynamic shear instability in stratified disks. *Astronomy & Astrophysics*, 429, 1—13
2. Marié, L., C. Normand and F. Daviaud, 2006. Galerkin analysis of kinematic dynamos in the von Kármán geometry. *Physics of Fluids*,18, 017102.
3. Berhanu, M., R. Monchaux, S. Fauve, N. Mordant, F. Pétrélis, A. Chiffaudel, F. Daviaud, B. Dubrulle, L. Marié, F. Ravelet, M. Bourgoin, P. Odier, R. Volk, J.-F. Pinton, 2007. Magnetic field reversals in an experimental turbulent dynamo. *Europhysics Letters*, 77, 59001.
4. Monchaux, R, M. Berhanu, M. Bourgoin, M. Moulin, P. Odier, J.-F. Pinton, R. Volk, S. Fauve, N. Mordant, F. Pétrélis, A. Chiffaudel, F. Daviaud, B. Dubrulle, C. Gasquet, L. Marié, F. Ravelet, 2007. Generation of a magnetic field by dynamo action in a turbulent flow of liquid sodium. *Phys. Rev. Lett.*, 98, 044502.

CURRICULUM VITAE : ARDHUIN Fabrice

Né le 23 avril 1975

Formation:
Ecole Polytechnique (94), Ingénieur du Corps de l'Armement (option recherche 97)
Doctorat: Ph. D. en océanographie – Naval Postgraduate School, Monterey, Californie (2001)
Habilitation à diriger des recherches – Université de Bretagne Occidentale - 2005

Situation actuelle (depuis 2001):
Ingénieur d'études et recherches au Service Hydrographique et Océanographique de la Marine (Brest)

Autres fonctions :
- membre du « Steering Comittee » du groupe « Waves in Shallow Environements » depuis 2004.

Publications:
25 articles publiés ou sous presse, dont 2 dans Journal of Fluid Mechanics, 6 dans le Journal of Physical Oceanography, 5 dans le Journal of Geophysical Research, en particulier,

Ardhuin, F., T. H. C. Herbers, G. Ph. van Vledder, K. P. Watts, R. Jensen et H. Graber, **2007**, Slanting fetch and swell effects on wind wave growth, *JPO*, **37** (4) , 908—931

Ardhuin, F., et Magne, R., **2007**, Current effects on scattering of surface gravity waves by bottom topography, *J. Fluid Mech.*, **576**, 235—264.

Rascle, N., F. Ardhuin, et E. A. Terray, **2006**, Drift and mixing under the ocean surface. Part 1: a coherent one-dimensional description with application to unstratified conditions, *J. Geophys. Res.*, **111**, C03016, doi:10.1029/2005JC003004.

Ardhuin, F., N. Rascle et K. A. Belibassakis, **2008**, Explicit wave-averaged primitive equations using a Generalized Lagrangian Mean, *OM*, **20**, 235—264.

Chapron, B., F. Collard et F. Ardhuin, **2005**, Direct measurements of ocean surface velocity from space: interpretation and validation, *J. Geophys. Res.*, **110**, C07008.

Prix, distinctions

1999: "outstanding student paper award", Fall AGU general assembly, San Francisco for work on wave dissipation due to bottom friction.

2000: "outstanding student paper award", Fall AGU general assembly, San Francisco for work on the scattering of waves by random bottom topography.

2008: "Prix Fofonoff 2008", prix du meilleur jeune chercheur en océanographie, décerné par l'Americal Meteorological Society, "For theoretical and observational research on the interaction of ocean surface waves with the sea floor and ocean currents, and developing accurate coastal wave prediction models."

2008: Journal of Physical Oceanography 2008 Editor's Award "For many well-considered, constructive, and timely reviews."

CURRICULUM VITAE : Frédéric VANDERMEIRSCH-LAMBERT

Français, 39 ans
Docteur en Océanographie physique

IFREMER DYNECO/PHYSED - BP 70 - 29280 PLOUZANE – France
Tel : 02 98 22 48 02

Depuis 2001 **Chercheur IFREMER** à Brest en océanographie physique : Couplage de modèle physique à partir des équations primitives – Evolution climatique du golfe de Gascogne (observations et modélisations) – Atlas climatologie en température et salinité – Modélisation des interactions d'échelles sur des fortes pentes – Mesures et filtrages des courantomètres de coque.

2005 Campagne en mer Pelgas sur la Thalassa (15 jours). Acquisitions et analyse de mesures d'ADCP de coque.

2004 Campagne en mer Pelgas sur la Thalassa (15 jours). Acquisitions des données bathysonde et d'ADCP de coque.

1999 Vacataire à l'Ecole Nationale Supérieure des Ingénieurs des Etudes et Techniques d'Armement (ENSIETA) à Brest. Cours de modélisation numérique en océanographie physique.

1997 Campagne en mer Arcane sur la Thalassa (25 jours). Analyses scientifiques de trajectoires des flotteurs Marvor, Rafos et Surdrift.

1995 Campagne en mer sur le Charles Darwin (40 jours). Responsable de la salinité et du traitement des données bathysonde.

PUBLICATIONS (5 principales)

1. Blanchard, F., Vandermeirsch, F., 2005 : Warming and exponential abundance increase of the subtropical fish Capros aper in the Bay of Biscay (1973-2002) ; Comptes-rendus de l'académie des sciences, C.R. Biologies 328(2005)505-509.
2. Vandermeirsch F.O, Carton X.J and Morel Y.G , 2003 : Interaction between an eddy and a zonal jet: Part II. Two-and-a-half layer model. Dynamics of Atmospheres and Oceans. 36 (4) : 271-296.
3. Vandermeirsh, F., Morel, Y. and Sutyrin, G.G., 2002 : Resistance of a coherent vortex to a vertically shear. J. Phys. Oceanogr., 32, 3089-3100.
4. Vandermeirsch, F., Morel, Y. and Sutyrin, G.G., 2001 :The net advective effect of a vertically sheared current on a coherentvortex. J. Phys. Oceanogr., 31,2210-2225.
5. Vandermeirsch F., Carton X. and Morel Y., 1999 : The interaction of a vortex with a stable jet, in "Simulation and Identification of Organized Structures in Flows"; Proceedings of the 1997 IUTAM/SIMFLOW Symposium in Lyngby, Denmark.

CURRICULUM VITAE : Yannis CUYPERS

Yannis CUYPERS
30 ans
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SITUATION ACTUELLE ET CURSUS

*Depuis septembre 2006***:** Maitre de Conférences au LOCEAN , Université Pierre et Marie Curie
2005-2006 : Post-doc CNRS au CEREVE, ENPC, université Paris XII. Onde internes et mélange dans un lac sub-alpin.
2001-2004 **:** Thèse en dynamique des fluides et transferts au laboratoire PMMH ESPCI « Turbulence produite par l'explosion d'un vortex »
2000-2001 : DEA Dynamique de fluides et transferts

PRINCIPALES PUBLICATIONS

1. Y. Cuypers, P. Bouruet Aubertot « Numerical study of internal tide transformation and dissipation » XXIV IUGG General Assembly, July 2-13, 2007.
2. Y. Cuypers, B. Vinçon Leite, B. Tassin & M. Poulin « Non linear internal seiches degeneration in a deep sub-alpine lake » Proceedings of the 10th European Workshop on Physical processes in Natural Water. 2006
3. Y. Cuypers, A. Maurel & P. Petitjeans « Characterization of an experimental turbulent vortex in the physical and spectral spaces*» Journal of Turbulence 7, 7, 2006*
4. Y. Cuypers, A. Maurel & P. Petitjeans «Comparison between an experimental turbulent vortex and the Lundgren vortex *» Journal of Turbulence* ***5****, 30, 2004*
5. Y. Cuypers, A. Maurel & P. Petitjeans «Vortex burst as a source of turbulence» *Phys. Rev. Letters,* ***91****, 194502, 2003*

10 publications dans des journaux et actes de congrès à comité de lecture