



Oceans

EUR-OCEANS
CONSORTIUM

2009
~
2013

report

Building scenarios for marine ecosystems under anthropogenic and natural forcings in the XXI Century

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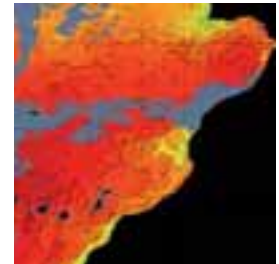
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□ The text of this brochure has been produced, adapted or assembled from diverse and numerous documents linked to EOC scientific activities and originally written by their respective leaders (activity proposals, programmes or reports), as well as from scientific strategy documents produced within EOC.

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CREDITS



OVERVIEW

□ Goal and focus

The aim of the EUR-OCEANS Consortium (EOC) is to favour joint initiatives between key Research Performing Organisations (RPOs) and Research Funding Organisations (RFOs) across Europe, to help the community make significant jumps in marine sciences during the next decades.

This is implemented by organising and sponsoring activities which focus on hot topics only and can lead to wider European projects (e.g., under Horizon 2020 or JPI Oceans funding schemes). These activities include flagship programmes, Gordon-like conferences, foresight workshops, advanced courses and public outreach.

The focus of the Consortium is on the impact of climate / global change on marine ecosystems and biogeochemical cycles, and the construction of scenarios relevant to the International Platform on Biodiversity and Ecosystem Services (IPBES).

□ Background

EOC builds on the legacy of the EC-funded, FP6 EUR-OCEANS European Network of Excellence (EO NoE), which contributed to the scientific expertise and dissemination of knowledge on marine ecosystems in the context of climate / global change from 2005 to 2008.

The EUR-OCEANS acronym stands for EUROpean research on Ocean Ecosystems under Anthropogenic and Natural forcingS. The NoE was used to design and launch European Commission (EC) funded programmes, including: METAOCEANS, SESAME, EUROSITES, MEECE, MESOAQUA, EPOCA, and EURO-BASIN.

Launched in 2009, EOC is a non-legal entity funded by its Member Research Organisations. It includes a subset of the 66 organisations that belonged to the former NoE, plus several new Member Organisations. The annual contributions are used to fund a project office and competitively selected scientific activities led by one or more Member Organisations.

□ Results and perspectives

In 2014, after five years (2009-2013) of successful operation under the coordination of IRD (*Institut de Recherche pour le Développement*), and after having organised or funded 42 scientific meetings or programmes, EOC will put an end to its activities in order to leave the way to EuroMarine+. This new consortium will encompass and integrate a wider scientific community (including two other former NoEs in addition to EUR-OCEANS: MarBEF and Marine Genomics Europe, which in brief respectively focus on biodiversity and genomics), thus representing a single marine science network at European level.

The present document aims at providing an overview of EOC operation and results, and at helping to pave the way for the integration of the EUR-OCEANS community and of EOC *modus operandi* into the future EuroMarine+ consortium.

Philippe CURY *IRD* Scientific coordinator
of the EUR-OCEANS Consortium

During the last decades, marine ecosystems have been changing at surprising rates. Under strong and increasing anthropogenic pressures, the complexity of dynamic interactions (e.g., between climate change, deoxygenation, acidification, overexploitation, species interactions, fish migrations) challenges our ability to understand, predict and manage marine resources. Building scenarios can help in integrating state-of-the-art science to deliver plausible evaluations about ecosystem responses to global change. The EUR-OCEANS Consortium (EOC) represented a 'natural' follow-up of the EUR-OCEANS Network of Excellence (NoE): the activities carried out and the scientific experience acquired in the NoE had to be continued and strengthened. The reason for this was quite simple: it was an incredible and timely opportunity to develop multidisciplinary approaches to properly address the complex issues that are facing marine ecosystems in a global change context. Thus EOC has built a long-term scientific strategy for responding to the challenge of the newly launched IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), through the collaborative work of outstanding and dedicated scientists from many institutions in Europe and in the South. Through the organisation of foresight workshops, conferences and flagships, EOC has also greatly contributed to implement this strategy by producing significant scientific results and developing multidisciplinary and novel scientific approaches. EOC definitely has contributed to an integrated European dynamics for defining and maintaining healthy marine ecosystems.



Paul TRÉGUER *INSU-CNRS and UBO* Scientific Director of the former EUR-OCEANS NoE,
Executive Committee member of the EUR-OCEANS
Consortium

Progress in the fast-moving field of marine science is continuously revealing new challenges in the basic science needed to assess, project, and manage flows, services and changes of marine ecosystems. The *raison d'être* of the EUR-OCEANS Consortium (EOC) is to address such challenges and to help pave the way for new integrated approaches at European or international level. From 2009 to 2013 EOC has been addressing three major scientific challenges of particular relevance to the chemical oceanography component of the EOC scientific community:

- the influence of meso- and sub-mesoscale ocean dynamics on the global carbon cycle and marine ecosystems, a key topic which is identified as part of the 'the next big climate challenge';
- the consequences of global warming on the dissolved oxygen concentration of the world oceans, also called the 'deoxygenation problem';
- the polar marine ecosystems, which serve as model systems for developing methods for global application and as early indicators of the effects of global change.

As a chemical oceanographer and marine biogeochemist, I judge very positively the focus put on these 'hot topics' which are key to our understanding of changing oceans, and on the significant progress achieved through EOC-funded activities. I am confident that the latter will translate in larger projects in the coming years.



Pierre-François BAINÉE *IRD*
Executive Director of the EUR-OCEANS Consortium

Implementing the decisions that were made under the EUR-OCEANS Network of Excellence (NoE) in order to see this scientific network, not only survive as a new Consortium beyond its funding period by the European Commission, but also collect significant resources from its members in order to fund ‘frontier science’ activities that would conserve and strengthen the networking and integration impetus while allowing significant progress in marine sciences, was a challenging task. It notably required efforts from numerous departments at IRD, in order to completely revise the legal framework of the Consortium towards its adaptation to the rather unusual scheme that imposed itself to the EUR-OCEANS Consortium (EOC): no firm resource allocation plan could pre-exist; resources could only be secured on an annual basis; budgets and



activity plans had however, under this strong constraint, to be open-ended, to evolve dynamically with the priorities and scientific strategy of the Consortium under a 10-year horizon, and to be implemented through competitive calls. Has EOC succeeded in finding its ‘niche’ in a European landscape where structures, projects and programmes are plethora? One can find indications that the answer is positive in the following observations:

- EOC has maintained its membership and budget in difficult financial times.
- Within the limits of its modest budget (roughly 1 M€ over its five years of existence), EOC has funded or co-funded 42 activities,

many of which – that could probably not have existed without the impulse of EOC – led to lasting international collaborations and new projects.

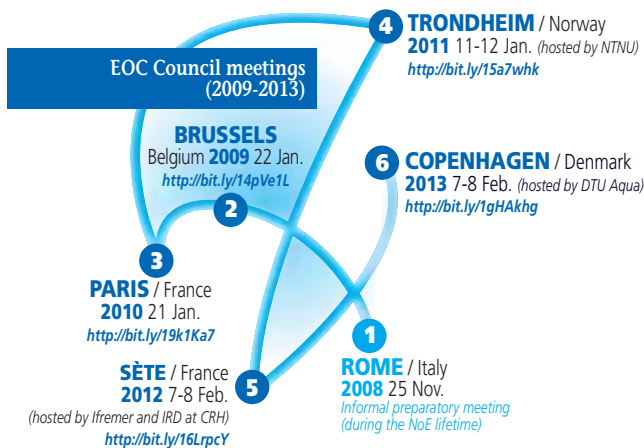
- Many EOC members have advocated for the adoption by the future EuroMarine+ Consortium of activity programmes similar to those run by EOC.

From a personal perspective, I think that the bottom-up orientation of the Consortium, and a blend of senior scientists – well aware of, or engaged in, the elaboration of scientific strategies at their organisation or country level – and younger scientists in the governance bodies, contributes to explain why both individual scientists and member organisations seem to have found value in their engagement in EOC.

Legal framework, governance and management

The EUR-OCEANS Consortium (EOC) is a non-legal entity ruled by a consortium agreement signed by its members (which must be research organisations with legal personality). It was established for an initial term of four years (2009-2012), which was renewed in 2012 for a second (2013-2016) term.

The coordination of the consortium was entrusted to *Institut de Recherche pour le Développement* (IRD), initially for a period of two years, with Philippe Cury acting as Scientific Coordinator and a Project Office hosted at *Centre de Recherche Halieutique* (CRH), a joint Ifremer-IRD research centre based in Sète, France. This coordination mandate was renewed for 2011, 2012 and 2013. Pierre-François Baisnée was selected by the Consortium and hired by IRD as Executive Director in April 2009. Anne-Catherine Gandrillon and Pierre Lopez (IRD) respectively provided administrative assistance and graphic design services.



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EUR-OCEANS NoE public outreach website (archive):

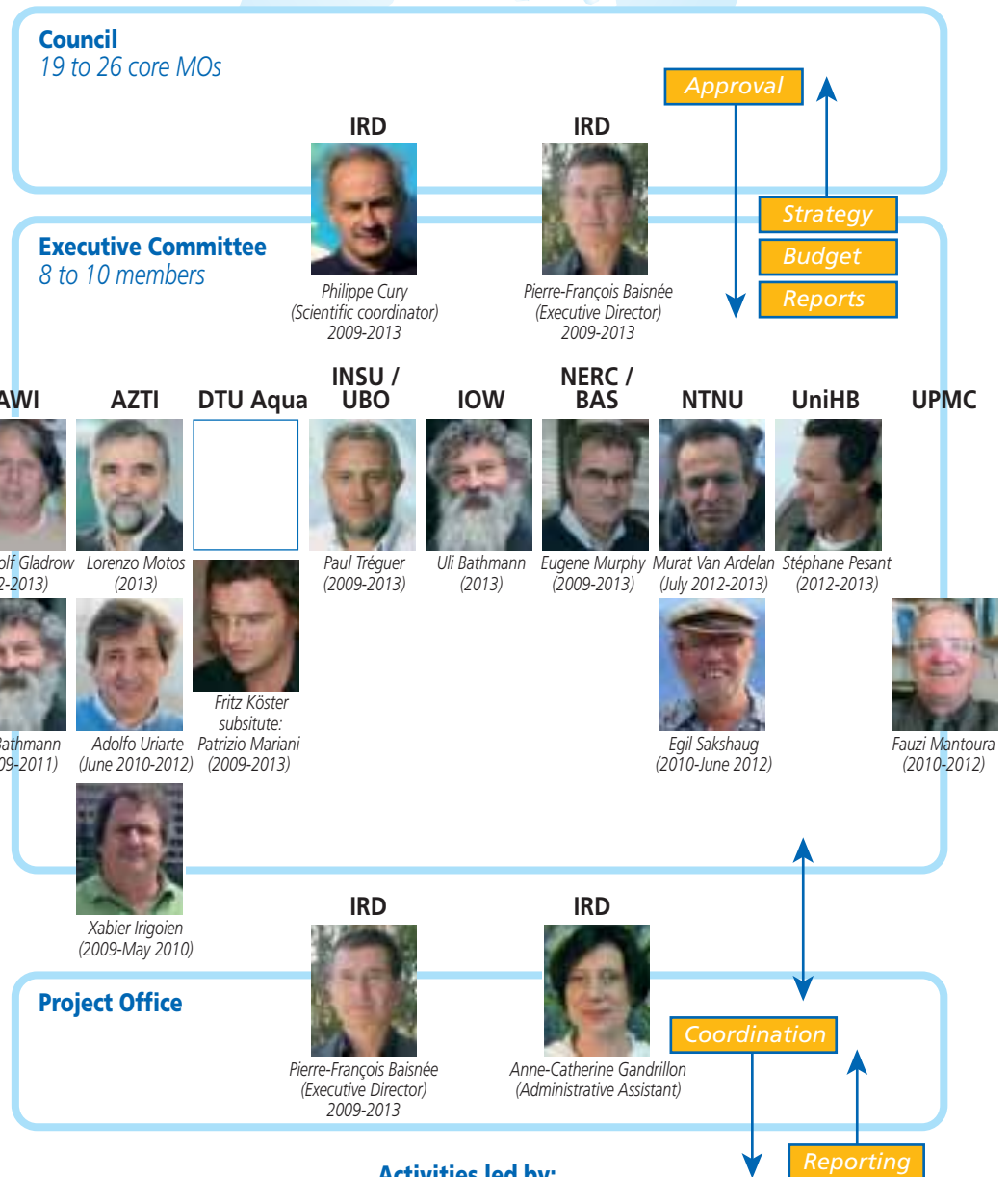
<http://www.eur-oceans.info>

The launch of EOC activities and the management of its finances proved challenging: whereas in research projects in which consortium agreements are usually used there exists a predetermined, multi-year plan of activities for which funding is secured and spending planned, EOC had to rely on variable annual financial contributions to organise competitive calls for proposals and dynamically develop its research strategy through annual programmes of activities. A complete revision (finalized in November 2010) of the initial agreement proved indispensable to let all candidate members join the consortium and let IRD collect contributions and redistribute funds to activity leaders on a sound basis.

EOC adopted a simple governance scheme. The EOC Council determines the scientific strategy; it meets annually to discuss and approve annual budgets, activity plans and reports. It is composed of representatives from each and every member organisation (MO) that brings a financial contribution to the consortium. The Executive Committee comprises up to 10 scientists chosen amongst, and elected by the Council. It submits proposals to the Council and is responsible for the implementation of Council decisions. The Project Office is in charge of daily management and reporting. In the absence of a scientific committee, the selection of proposals submitted to EOC calls relies on their overall ranking by a scientific panel involving all EOC MOs, as well as on their separate external reviews, the final decision resting with the Executive Committee.



ORGANIGRAM



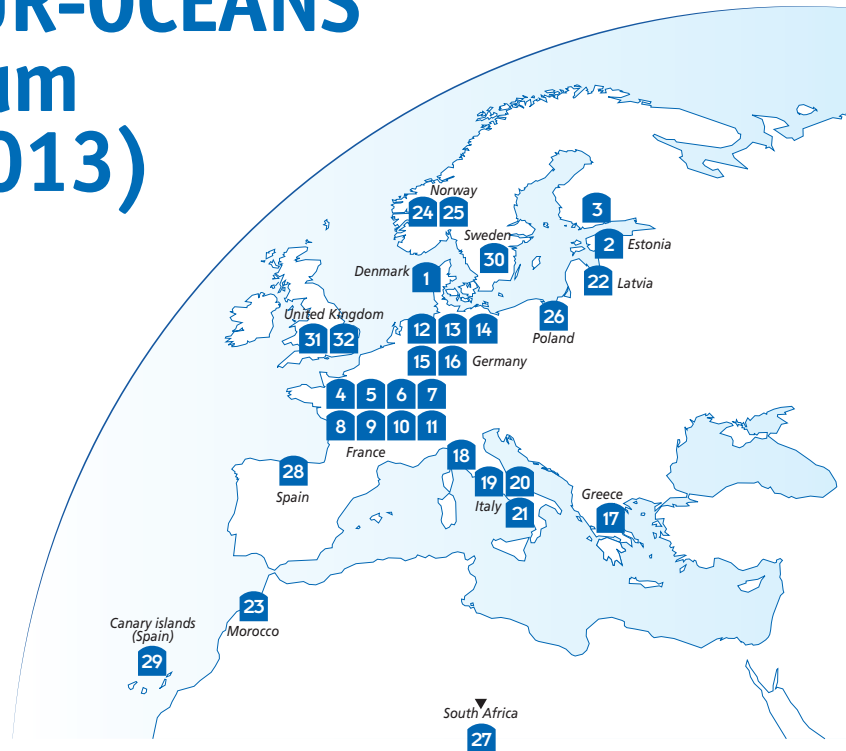
Activities led by:

ad hoc Clusters

Flagship institutions

- Foresight workshops
- EUR-OCEANS conferences
- Flagship programmes
- Workshops
- Advanced courses
- Outreach

Membership of the EUR-OCEANS Consortium (2009-2013)



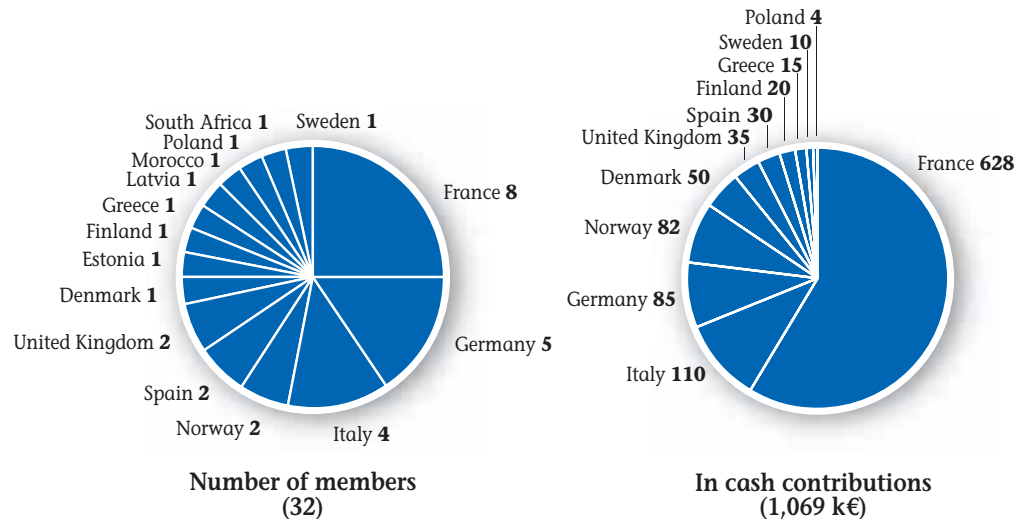
As was the case with the former Network of Excellence, EUR-OCEANS Consortium (EOC) membership is at institutional level. Organisations that have a legal personality, such as universities or research institutes, become member by engaging – as a whole or on behalf of some of their departments or laboratories – in a (contractual) ‘Consortium Agreement’.

‘Core Members’ contribute to the annual budget, either in kind or in cash, at a minimum level of 5 k€ per year. They take part in Council decisions, which are usually reached by consensus; voting rights (which are proportional to financial contributions) can however be used when necessary. In-kind contributions that can count towards Core membership are restricted: clearly specified and valued, relevant to EOC activities, truly open to EOC Members, they must be submitted to and approved by the Council on a yearly basis.

‘Invited Members’ do not contribute to the budget. They can participate in Council meetings but cannot take part in Council decisions. They cannot receive EOC funds or lead EOC activities. Each Member Organisation (MO) can revise the level of its financial commitment or its membership category annually.

Despite the prospect that instead of receiving European funding, they would become contributors to a common pot (with annual contributions ranging from 5 k€ to 40 k€ per member in practice, totalling over 1 M€ over five years), 29 of the 66 organizations that formed part of the EUR-OCEANS NoE (i.e., 44%) chose to join the new, self-funded Consortium. As shown in the following Table, they were joined by three newcomers. In total, EOC has counted 32 member organisations from 15 countries over the 2009-2013 period, 31 of which are current 2013 members.

□ EOC Membership. The table lists all EOC Member Organisations (MOs) showing their respective annual Core or Invited status and their overall contribution to the budget of the Consortium. Pie charts show the weight of each country in terms of number of MOs and share of the budget. The map shows the distribution of MOs in Europe and beyond.



Country	Organization	Full name	2009	2010	2011	2012	2013	Total 2009-2013 contributions (€)	
								in kind	in cash
Denmark	1 DTU Aqua ^{1*}	National Institute of Aquatic Resources	C	C	C	C	C	10,000	50,000
Estonia	2 EMI *	Estonian Marine Institute, University of Tartu	C	I	I	I	I	5,000	
Finland	3 SYKE ^{2*}	Suomen ympäristökeskus / Finnish Environment Institute		C	C	C	C	0	20,000
France	4 AMU ³	Aix-Marseille Université	C	C	C	C	C	0	25,000
	5 CLS *	Collecte Localisation Satellites	C	C	C	C	I	0	20,000
	6 IFREMER *	Institut Français de Recherche pour l'Exploitation de la Mer	C	C	C	C	C	0	174,000
	7 INSU-CNRS *	Institut National des Sciences de l'Univers - Centre National de la Recherche Scientifique	C	C	C	C	C	0	174,000
	8 IRD *	Institut de Recherche pour le Développement	C	C	C	C	C	0	180,000
	9 Océanopolis *	Océanopolis	C	C	C	C	C	30,000	
	10 UBO *	Université de Bretagne Occidentale	C	C	C	C	C	0	25,000
	11 UPMC *	Université Pierre et Marie Curie	C	C	C	C	I	0	30,000
	Germany	12 AWI *	Alfred Wegener Institut	C	C	C	C	C	20,000
13 GEOMAR ⁴		Helmholtz-Zentrum für Ozeanforschung Kiel			C	C	I	0	10,000
14 IOW *		Leibniz Institute for Baltic Sea Research, Warnemünde					C	0	5,000
15 UniHB *		Universität Bremen	C	C	C	C	C	30,000	20,000
16 UniHH *		Universität Hamburg	C	C	C	C	I	10,000	20,000
Greece	17 HCMR *	Hellenic Center for Marine Research	C	C	C	I	I	0	15,000
Italy	18 CNR *	Consiglio Nazionale delle Ricerche	C	C	C	C	C	0	25,000
	19 CoNISMa *	Consorzio Nazionale Interuniversitario per le Scienze del Mare	C	C	C	C	C	0	25,000
	20 OGS *	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale	C	C	C	C	C	0	40,000
	21 SZN *	Stazione Zoologica 'A. Dohrn'	C	C	C	C	C	0	20,000
Latvia	22 BIOR ^{5*}	Institute of Food Safety, Animal Health and Environment		I	I	I	I	0	
Morocco	23 INRH *	Institut National de la Recherche Halieutique	I	I	I	I	I	0	
Norway	24 NTNU *	Norwegian University of Science and Technology	C	C	C	C	C	0	62,000
	25 UiO/CEES **	University of Oslo / Centre for Ecological and Evolutionary Synthesis		C	C	C	C	0	20,000
Poland	26 IO PAS *	Institute of Oceanology	C	C	C	I	I	11,000	4,000
South Africa	27 UCT *	University of Cape Town	I	I	I	I	I	0	
Spain	28 AZTI *	Fundación AZTI	C	C	C	C	C	5,000	25,000
	29 PLOCAN **	Oceanic Platform of the Canary Islands			C	I	I	0	5,000
Sweden	30 USU/BNI **	University of Stockholm / Baltic Nest Institute		C	C	I	I	0	10,000
United Kingdom	31 NERC / BAS & NOC *	National Environmental Research Council / British Antarctic Survey & National Oceanography Centre	C	C	C	C	C	40,000	30,000
	32 PML *	Plymouth Marine Laboratory	C	C				5,000	5,000
Total								166,000	1,069,000

1 Formerly: DIFRES, Danish Institute for Fisheries Research. 2 Formerly: FIRM, Finnish Institute of Marine Research.

3 Formerly: UnivMed, Université de la Méditerranée. 4 Formerly: IFM-GEOMAR, Leibniz- Institut für Meereswissenschaften.

5 Formerly: LATFRA, Latvian Fish Resources Agency.

* Former NoE member (directly or through ancestor or umbrella organization).

** Not a former NoE member.

Toolbox

To implement its scientific strategy, the EUR-OCEANS Consortium (EOC) relies on three main categories of 'tools':

EUR-OCEANS 'flagships' are awarded competitively, for a period of one or two years, to the institute/university (or cluster of the latter) which coordinates the Joint Programme of Activities (JPA) of a set of institutes/universities acting together to allow significant advances on an important topic of marine science. EUR-OCEANS funds represent a co-financing of the JPA and can be used as deemed appropriate by the JPA leader(s). They have notably been used to organise meetings, to write papers, or to hire post-doctoral scientists.

EUR-OCEANS conferences rely on invited lectures, offer plenty of time for discussion, and provide a multi-disciplinary science arena to discuss the state of the art and to build a unified research agenda across disciplines.

EUR-OCEANS 'foresight workshops' (FWS) focus on emerging and important topics in marine ecosystem studies, which address EOC scientific themes or priorities and require European-wide coordination. They generally aim at establishing a scientific vision or a roadmap at the scale of a decade and may notably (but not exclusively) be used upstream of future EOC 'flagships' or conferences or to pave the way for larger projects. Foresight workshops can also focus on review exercises of particular relevance to EOC priorities (such as the science-governance interface and scenario construction).

Beyond such specifically formatted events or programmes, EOC also funds events of a different, more 'standard' format, provided they are relevant to its scientific or regional priorities. This includes:

Workshops (e.g. for the coordinated development of ecosystems models around the Mediterranean basin)

Conferences or Conference Sessions (e.g. on scaling up from 'the molecular life of diatoms' to Oceanography)

Advanced courses (e.g. on the application of the theory of networks economics to integrate economy and ecology in scenario building for marine ecosystems).

Annual **Competitive Calls** for proposals have determined the usage of most of the EOC budget and the selection of most of the 42 scientific activities that have been funded from 2009 to 2013. In such calls, any topics addressing EOC themes and priorities (as specified in its strategic views documents) could be proposed. In general, the corresponding project had to be led (or co-led) by a Core (paying) Member of the Consortium. However, in order to favour collaborations relevant to the future EuroMarine+ consortium, this constraint was relaxed in 2012 and the submission of proposals by members of MarBEF or Marine Genomics Europe was encouraged.



□ The EOC Hot Topics Conference 'A Changing Ocean' (Telde, Gran Canaria, Spain) aims at showing progress and perspectives on selected 'hot topics' in marine sciences and also intends to pave the way for the integration of the EUR-OCEANS community in the future EuroMarine+ Consortium.

TOOLBOX



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Pictures taken during EOC courses

The two upper pictures were taken in Iceland during a 2013 advanced course on 'Primary production, food-web processes and vertical flux in changing oceans'. The bottom picture was taken in France during a 2010 advanced course in economic and ecological modelling drawing on the theory of network economics ('Economic versus ecological networks: integrating economy and ecology in scenario building for marine ecosystems').

Flyers or posters of some EOC activities

From left to right: a foresight workshop on 'trait-based approaches to ocean life'; a EUR-OCEANS Conference on meso- and submescale ocean dynamics and its influence on the global carbon cycle and marine ecosystems.



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Interest for scientists and Member Organisations

Member Organisations find in the EUR-OCEANS Consortium (EOC) a way to participate at European or international level in the elaboration and promotion of new coordinated scientific initiatives, in accordance with their own scientific strategy and that of EOC. Individual scientists generally value the opportunities that the annual competitive calls provide to obtain (full, seed or co-) funding for activities whose format, topics or foresight dimension often make difficult to finance. The following statements, gathered from beneficiaries of EOC funds, exemplify this.



Eugene MURPHY (NERC/BAS, UK)
Co-leader of the EOC 'Polar' Flagship programme

'The polar oceans are changing rapidly and understanding the impacts on ecosystems is a major scientific challenge that requires an unprecedented level of scientific collaboration. Building on EUR-OCEANS networking activities, EOC has allowed the continued development of a community of European polar scientists to address that challenge. Bringing together scientists working on both Arctic and Antarctic ecosystems, the EOC Foresight workshop on polar ecosystems identified the current key scientific issues. The workshop outputs provided the basis for the EOC Flagship programme on Polar Ecosystem Change that has focussed particularly on linking biogeochemical cycles and food-webs, which is a priority activity in developing analyses and models of polar ocean ecosystems and their responses to change. EOC has allowed us to bring together a wide range of scientists with very different backgrounds and multidisciplinary skills to start to generate integrated understanding of the response of polar organisms and ecosystems to the rapid changes that are already occurring. That understanding is urgently required to generate robust projections of the impacts of future change in these ecosystems and to enable the development of sustainable management procedures.'



Lynne SHANNON (UCT, South Africa)
Co-leader of the IndiSeas initiative

'Indiseas is a scientific programme which evaluates the effects of fishing on the health status of marine ecosystems. A panel of indicators is provided on the IndiSeas website, characterizing the ecological status of exploited resources, their environment, and the human dimension of fisheries.

EUR-OCEANS provided the glue money to facilitate scientific networking that was vital to core activities within IndiSeas, which by its very nature (global and comparative of ecosystems), depends on active collaboration among experts across the World's marine ecosystems.'



**Ivonne MONTES Post-doctoral scientist
under the EOC 'Ocean deoxygenation' Flagship programme**

'I had a great opportunity to be funded by a EUR-OCEANS flagship over a year of my two-year post-doc, which has taken place in France, Germany and Peru, the complement being brought by GEOMAR. Being a physical oceanographer, it was a unique chance to interact with marine biogeochemists performing coupled physical-biogeochemical modelling. Under this flagship, a coupled physical-biogeochemical model configuration of the Eastern tropical Pacific was developed and used to investigate the maintaining mechanisms of the Oxygen Minimum Zones off Peru. This regional model is much more skilful than global models in simulating many characteristics of the biogeochemical environment (e.g., oxygen content, nutrients). Consequently, its sensitivity to the equatorial circulation, to specific biogeochemical reactions (e.g., interplay between anammox and denitrification as leading processes for the nitrogen loss), or to meso and submesoscale activity that act as a conduit for the exchange of water mass properties between nearshore and off-shore regions, could be investigated. It has also been used as a platform for multidisciplinary studies at regional scale (e.g., benthic interaction).'



**Tristan ROUYER (Ifremer, France)
Co-leader of a EUR-OCEANS Foresight Workshop on the 'Effect
of fishing-induced alterations in population structure and life
history traits on the response of worldwide fisheries to
climate'**

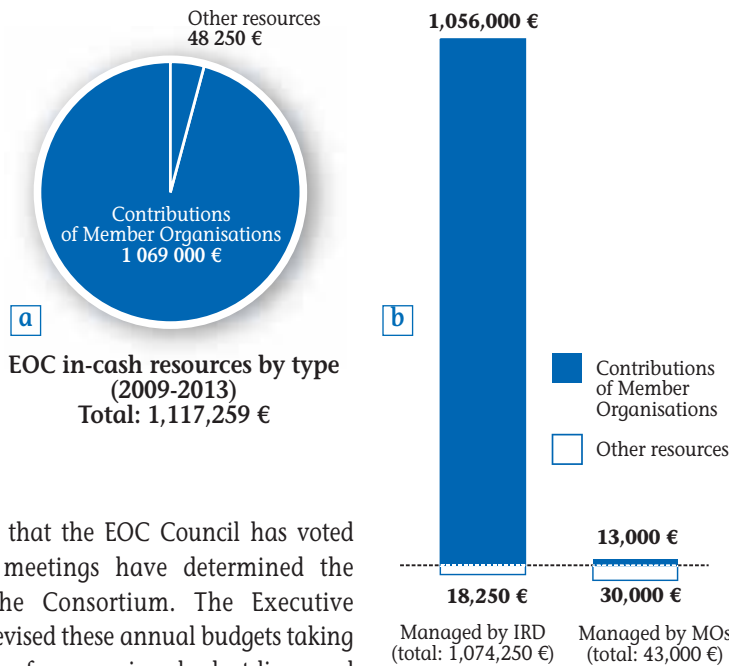
'As a post-doctoral scientist at CEES and the University of Oslo, and jointly with a Spanish colleague, I applied for and obtained EOC funding in 2011. The idea was to build a worldwide fisheries database and to gather scientists from different backgrounds in order to analyze it and test some scientific hypotheses highly relevant to conservation and management issues. Nowadays, such a gathering of data and experts is often a necessary preliminary step before one can test the merits of a theory or an assumption; it also enables to develop a 'thematic' network of scientists and build future collaborations. Publishing and, possibly, following up with larger projects only comes at a later stage. While multiple funding sources exist for projects whose cost ranges from a hundred thousand Euros to several million Euros, only a few opportunities can provide funding for small meetings (about 10-15 scientists, for a typical cost of 10-15 k€) or programmes. EOC therefore bridges a gap by funding workshops and flagships and I see this as its most valuable feature. In our case, the workshop led to a publication in a high impact factor journal (Rouyer *et al.*, 2012) and resulted in lasting collaborations.'

Financial summary

Resources

On top of the contributions of Member Organisations (MOs), the EUR-OCEANS Consortium (EOC) could mobilise budget remainders from the former Network of Excellence or other projects, through CNRS and IRD. Because it was soon realised in 2009 that the initial EOC Consortium Agreement did not represent a sound enough basis to enable the Coordinator to easily collect and redistribute funds among MOs, such additional resources proved essential to launch the activities of the Project Office and to organise the first scientific activities without delay. For the same reason some EOC MOs, which had been awarded EOC funds in 2009, were authorized to withdraw those funds from their yet-uncollected 2009 contribution. From 2010 on, and when a revised Consortium Agreement entered into force, all funds have been collected by IRD before being redistributed.

The total in-cash resources of the Consortium amounted to 1,117,259 €, which represents in average 223,450 € per year, and 9,715 € per paying MO and per year. IRD managed 96% of these funds; the remaining 4% have been managed directly by three MOs. The figure below provides details on these resources and their management.



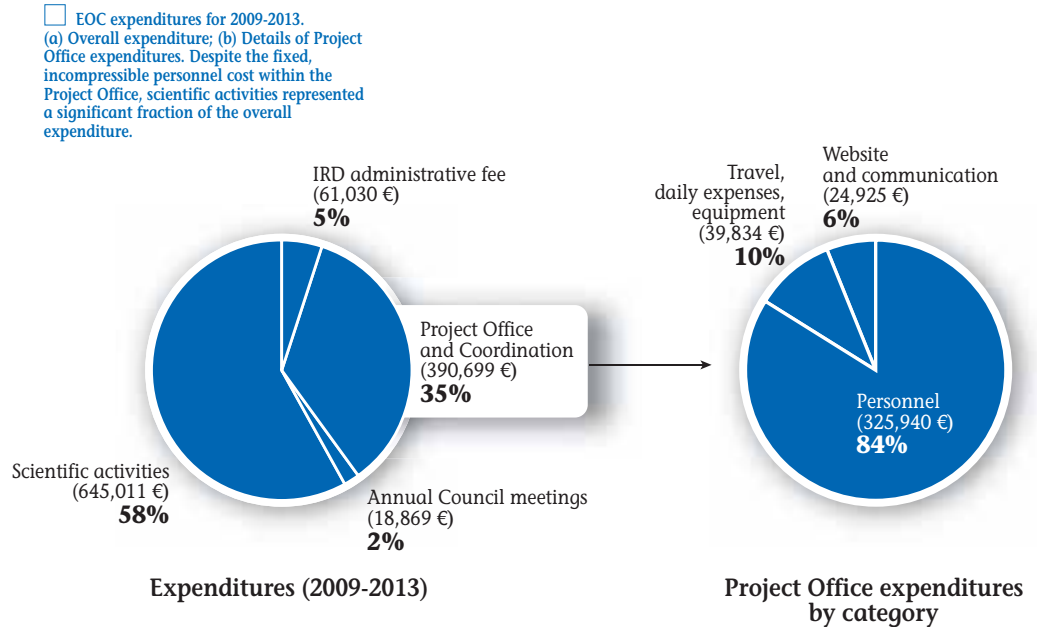
Expenditures

The general budgets that the EOC Council has voted during its yearly meetings have determined the expenditures of the Consortium. The Executive Committee has however revised these annual budgets taking advantage of both leftovers from previous budget lines and new contributions that were not yet secured at the time the initial budgets had been voted. Remainders from both scientific activities and the Project Office have thus continuously been redirected to the 'common pot' in order to fund new scientific activities.

At the time of this writing (October 2013), six planned EOC activities have not yet taken place (and two of them are planned for 2014). In addition, a number of recent activities have not yet closed their accounts. Therefore, the figures pre-

EOC resources by management (central or peripheral)

EOC in-cash resources for 2009-2013 amount to 1,117,259 €, of which 1,069,000 € (96%) correspond to contributions of Member Organisations and 48,250 € (4%) to budget remainders graciously put at the disposal of EOC by their respective CNRS and IRD managers (as shown in [a]). Due to initial difficulties in the collect and redistribution of funds within EOC, part of these resources (4%) could not be collected by IRD, but were instead managed directly at MOs (as shown in [b]).



sented here, while based on final expenditures for the most part, also include amounts that have been budgeted, engaged, but not yet fully spent. It is expected that the final remainders that will appear for recent or upcoming activities will be relatively insignificant. It is therefore envisaged that such remainders will be left to the corresponding activity leaders or IRD (as Coordinator), with instruction to spend them on new activities related to EOC 'hot topics' or the launch of EuroMarine+. IRD will produce final, certified EOC accounts in March 2014. The financial reporting constraints bearing on activity leaders or IRD will be relaxed for residual remainders as well as for one activity that will take place after March 2014.

The above figures provide details on the expenditures of the Consortium.

Total expenditures or recent engagements amount to 1,115,610 €, which, compared to total resources (1,117,259 €) leaves a balance of 1,640 € only.

IRD retained as an administrative fee 7% of the contributions that were collected for 2009-2012 and 10% of those that were collected for 2013.

The Project Office and the Coordination represent 35% of the total expenditure. This includes the total cost of one salary, fully charged to the EOC budget, which represents 84% of the Project Office expenditures. The rest corresponds to travel, daily expenses and equipment for 10%, and website (initial development, hosting and maintenance) and communication (printed documents) for the remaining 6%.

Scientific activities represent 58% of the total expenditure. The difference between the total amount spent or engaged (645,011 €) and that initially awarded (663,400 €; see page 16) results from the fact that some activities did not use up their entire budget. This slight difference (between awards and final expenditures) put apart, the pie charts provided on page 16 show how the scientific budget was distributed amongst the main hot topics and categories of activities.

Strategy

Aim, topics and priorities

The aim of the EUR-OCEANS Consortium (EOC) is to favour joint initiatives between key Research Performing Organisations (RPOs) and Research Funding Organisations (RFOs) across Europe, to help the community make significant leaps in marine sciences during the next decades. The focus of the Consortium is on the impact of climate / global change on marine ecosystems and biogeochemical cycles, and the construction of robust scenarios of future marine ecosystems dynamics. The activities or 'tools' EOC relies on, which are described on page 8, include flagship programmes, Gordon-like conferences, foresight workshops, advanced courses and public outreach. These activities, which are generally competitively selected, focus on 'hot topics', as identified during Council meetings and as specified by ad hoc working groups. While a few topics could not be addressed within EOC, most topics that have been identified as 'hot' have been targeted by a number of activities, as shown in pages 16-21. These topics include:

- Hot topic 1: Ocean deoxygenation & acidification (and other new frontiers of knowledge in biochemistry)
- Hot topic 2: High resolution ocean
- Hot topic 3: Rapid change in polar oceans
- Hot topic 4: Models, indicators and scenarios for changing oceans
- Hot topic 5: Links between marine ecology, biodiversity and genomics
- Hot topic 6: Plasticity, epigenetics, adaptativeness

The above topics are introduced on pages 22 to 31. They structure the programme of the EUR-OCEANS hot topics conference – a changing ocean (hosted by PLOCAN on 6-8 November 2013 in Gran Canaria, Spain) which intends to pave the way for the integration of the EUR-OCEANS community in the future EuroMarine+ Consortium.

The key regions for EOC include the Nordic seas and the North Atlantic Ocean and its shelf seas, the Arctic and Southern Oceans, the Mediterranean Sea and adjacent Black Sea, and the Eastern Boundary Upwelling Systems, all highly relevant for European society.

Cooperation and insertion in the European Research Area

Many scientists involved in EOC also take part in a number of other structures or projects, which facilitated the insertion of EOC in the European Research Area. EOC has notably developed links with SeasERA (the EC FP7 ERA-Net, whose mandate includes the development of joint programming initiatives in the marine domain among Member States), ICES (the International Council for the Exploration of the Sea), the IGBP (International Geosphere Biosphere Programme) ocean-related programmes SOLAS (Surface Ocean-Lower Atmosphere Study) and IMBER (Integrated Marine Biogeochemistry and Ecosystem Research, initially called OCEANS), and IMBER regional programmes CLIOTOP (CLimate Impacts on Oceanic TOP Predators) and ICED (Integrating CLimate and Ecosystem Dynamics in the Southern Ocean). The support and active scientific input of EOC into the IMBER IMBIZO meetings have been particularly important in ensuring their success and in enhancing European input into scientific analyses to address the current major challenges in global ocean ecosystem science.

Many organisations and several programmes or projects beyond EOC have benefited indirectly from EOC funds as co-organisers of activities co-led by EOC members. An indicative list is provided below, to illustrate that EOC activities federated scientists beyond the strict perimeter of the EOC membership.





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Some pointers to additional information

- EOC Consortium strategic views, 2011:
<http://www.eur-oceans.eu/strategy2011>
- List of EOC calls for activity proposals:
http://www.eur-oceans.eu/?q=calls_funding_int
- EOC hot topics conference - a changing ocean:
http://www.eur-oceans.eu/hot_topics_conf
- List of organisations, programmes or projects that have co-led (with an EOC Member Organisation) the activities that EOC has funded.

Organisations, programmes or projects

International	BONUS (Science for a better future of the Baltic Sea region) ICES (International Council for the Exploration of the Sea) IMBER (Integrated Marine Biogeochemistry and Ecosystem Research) IUCN (International Union for Conservation of Nature) MedSea (Mediterranean Sea Acidification in a changing climate) MerMex (Marine Ecosystems Response in the Mediterranean Experiment) PICES (North Pacific Marine Science Organization) SOLAS (Surface Ocean Lower Atmosphere Study)
Belgium	ULg (University of Liège) UNamur (University of Namur)
Canada	DFO (Department of Fisheries and Oceans)
Chile	COPAS (Centre for Oceanographic Research in the eastern South Pacific)
China	ECNU (East China Normal University) XMU (Xiamen University)
France	Collège de France (Collège de France) ENS (Ecole Normale Supérieure)
Germany	GKSS (GKSS Research Centre Geesthacht)
Iceland	Hólar University College (Hólar University College)
India	NIO (National Institute of Oceanography)
Israel	BIU (Bar Ilan University)
Italy	U. Trento (The Microsoft Research / University of Trento)
New Zealand	NIWA (National Institute of Water and Atmospheric Research)
Norway	IMR (Institute of Marine Research)
Peru	IMARPE (Instituto del Mar del Perú) LMI DISCOH (Laboratorio Mixto Internacional sobre Dinámicas del sistema de la Corriente de Humboldt)
Spain	CSIC (Consejo Superior de Investigaciones Científicas / Institut de Ciències del Mar) IEO (Instituto Español de Oceanografía) UAB (Universitat Autònoma de Barcelona)
Sweden	U. Gothenburg (University of Gothenburg)
Swiss	ETH Zurich (Eidgenössische Technische Hochschule Zürich)
Taiwan	NCU (National Central University)
UK	QMUL (Queen Mary University of London) SAHFOS (Sir Alister Hardy Foundation) UEA (University of East Anglia) UOP (University of Plymouth)
USA	Duke (Duke University) MIT (Massachusetts Institute of Technology) MSU (Mississippi State University) Towson U. (Towson University)

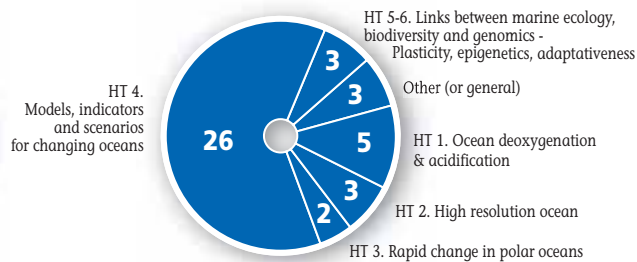
List of EOC activities

From 2009 to 2013, the EUR-OCEANS Consortium (EOC) has funded 42 scientific activities (listed in the following pages) on top of its annual Council meetings. EOC has also endorsed six workshops, conference sessions or courses (not listed). Activities were selected for funding following calls for proposals (29 cases), direct decisions made by the Council during one of its meetings (3 cases), or direct decision of the Executive Committee (mandated by the Council for early 2009 decisions, late 2013 decisions or other exceptional circumstances; 10 cases). EOC was a key funder (as sole funder, as one of the biggest single funders, or as the first funder – thus enabling the leverage of complementary funds) in 35 instances. It brought co-funding to 10 activities (courses and conferences). In two additional cases, it only brought in-kind organisational support and / or remainders of previous budgets put at the disposal of EOC. Funds awarded to scientific activities range from 4 k€ to 55 k€ and amount to 663 k€ in total.

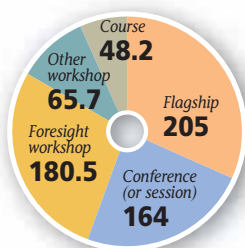
Number of activities in each category



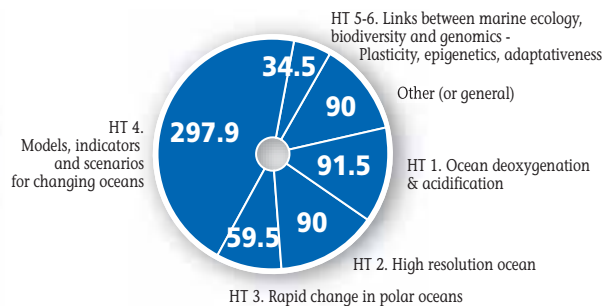
Number of activities per hot topic



Budget (k€) per type of activity



Budget (k€) per hot topic



The above pie charts show the distribution of activities and budget by type of activity and by 'hot topic'. Hot topic 4 (Models, indicators and scenarios for changing oceans) received approximately three times more funds (but with twice or thrice less funds per activity in average) than the other hot topics, which the broadness of this particular topic and the high number of proposals received explain. At the other extreme, hot topics 5 and 6 (Links between marine ecology, biodiversity and genomics; Plasticity, epigenetics, adaptativeness), which clearly intersect with disciplines best represented in the Marine Genomics and MarBEF communities, rank last in terms of funding (and number of proposals received).

Activities are listed and numbered in the following pages by type and by chronological order. The map shows where the activities took place (or where they were coordinated from in the case of flagship programmes). The hot topic corresponding to each activity is indicated in an abbreviated way: HT 1: Deoxygenation & acidification; HT 2: High resolution ocean; HT 3: Polar; HT 4: Models; HT 5 and HT 6: -Omics; General or other: General.



1 FLAGSHIP

Models (HT 4) 55,000 € ●●●●
on 2009-10 budget after Jun. 2009 call managed by UiO/CEES

'Scenarios' Flagship: Developing seasonal and spatial foodweb models through novel statistical modelling - tools for constructing scenarios under future global change (EcoScenarios)

Nils-Christian Stenseth, Marcos Llope (UiO/CEES), Christian Möllmann (UniHH), Thorsten Blenckner (USU/BNI), Martin Edwards (SAHFOS)

1 Sept. 2010-31 Aug. 2012
Norway, Sweden

<http://www.eur-oceans.eu/?q=node/22197>

2 FLAGSHIP

High resolution ocean (HT 2) 55,000 € ●●●●
on 2009-10 budget after Jun. 2009 call managed by UPMC/LOCEAN

'Submesoscale' Flagship: Impact of submesoscale on particulate export

Marina Lévy (CNRS, UPMC), Adrian Martin (NERC/NOC)

1 Sept. 2010-31 Aug. 2012
France, UK

<http://www.eur-oceans.eu/?q=node/22196>

3 FLAGSHIP

Deoxygenation & acidification (HT 1) 47,500 € ●●●●
on 2011 budget after Feb. 2011 call managed by IRD/LEGOS

'Deoxygenation' Flagship: Ocean deoxygenation in Eastern Boundary Upwelling Systems

Aurélien Paulmier (IRD/LEGOS), Andreas Oschlies (GEOMAR), Michelle Graco (IMARPE and LMI DISCOH)

1 Sept. 2011-31 Aug. 2013
France, Germany, Peru

<http://www.eur-oceans.eu/?q=node/25934>

4 FLAGSHIP

Polar (HT 3) 47,500 € ●●●●
on 2011 budget after Feb. 2011 call managed by AWI, NERC/BAS

'Polar' Flagship: Polar Ecosystem Change and Syntheses (PECS)

Dieter Wolf Gladrow (AWI), Eugene Murphy, Rachel Cavanagh (NERC/BAS)

1 Nov. 2011-31 Oct. 2013
Germany, UK

<http://www.eur-oceans.eu/?q=node/25935>

5 CONFERENCE

High resolution ocean 20,000 € ●●●●
on 2009 budget after Dec. 2008 call managed by UBO

EUR-OCEANS - Europole Mer conference - The next big climate challenge: Influence of meso- and submesoscale ocean dynamics on the global carbon cycle and marine ecosystems

Pascal Rivière (UBO), Marina Lévy (CNRS, UPMC), Adrian Martin (NERC/NOC), Raffaele Ferrari (MIT)

31 May-2 June 2010
Aber Wrach, France

<http://www.eur-oceans.eu/?q=node/22185>

6 CONFERENCE

Models 10,000 € ●●●●
on 2009 budget after Dec. 2008 call managed by IMBER

Integration of Biogeochemistry and Ecosystems: Comparison across Regional Programs - IMBIZO II

Julie Hall (NIWA), Jing Zhang (ECNU), Coleen Moloney (UCT), Wajih Naqvi (NIO)

10-14 Oct. 2010
Heraklion, Crete, Greece

<http://www.eur-oceans.eu/?q=node/22198>



7 CONFERENCE

Models 10,000 € ●●●●
on 2009-10 budget
after Dec. 2008 call
managed by IRD/EME

EUR-OCEANS Conference on Indicators for an ecosystem-based fisheries management (EBFM) – ‘Comparing the status of marine ecosystems in a changing world’ (Launch of indiSeas II)

Yunne-Jai Shin (IRD), Lynne Shannon (UCT),
Alida Bundy (DFO)

29 Nov.-2 Dec. 2010, Paris, France

<http://www.eur-oceans.eu/?q=node/22199>

8 CONFERENCE

Models 5,000 € ●●●
on 2011 budget
after Ex. Com. decision
managed by PICES

5th (PICES-ICES) International Zooplankton Production Symposium – Population Connections, Community Dynamics, and Climate Variability

Julie Keister (PICES), Delphine Bonnet (ICES), Rubén Escribano (COPAS)

14-18 March 2011, Pucón, Chile

<http://www.eur-oceans.eu/?q=node/23128>

9 CONFERENCE

Deoxygenation & acidification 30,000 € ●●●●
on NoE budget remainders
after Ex. Com. decision
managed by CNRS/LEGOS

EUR-OCEANS Conference – Ocean deoxygenation and implications for marine biogeochemical cycles and ecosystems

Aurélien Paulmier, Boris Dewitte (IRD/LEGOS), Véronique Garçon (CNRS/LEGOS), Hervé Claustre (CNRS), Carol Robinson (UEA), Francisco Chavez (MBARI)

24-26 Oct. 2011, Toulouse, France

<http://www.eur-oceans.eu/?q=node/23128>

10 CONFERENCE

Models 15,000 € ●●●
on 2012 budget
after March 2012 call
managed by IMBER

IMBER IMBIZO III – The future of marine biogeochemistry, ecosystems and societies. Multi-dimensional approaches to the challenges of global change in continental margins and open ocean systems

Alida Bundy (DFO), Kon-Kee Liu (NCU)

28-31 Jan. 2013, Goa, India

<http://www.eur-oceans.eu/?q=node/28835>

11 CONFERENCE

General 60,000 € ●●●●
on 2013 budget after Council decision
and 10 k€ increase by Ex. Com.
managed by IRD/EME, PLOCAN

EUR-OCEANS hot topics conference – a changing ocean

Philippe Cury (IRD), Paul Tréguer (UBO), Guillem Chust (AZTI), Eric Delory (PLOCAN), Véronique Garçon (CNRS), Marina Lévy (CNRS), Patrizio Mariani (DTU Aqua), Bernard Quéguiner (AMU), Maurizio Ribera d'Alcalà (SZN), Sabrina Speich (UBO)

6-8 Nov. 2013, Telde, Gran Canaria, Spain

http://www.eur-oceans.eu/?q=hot_topics_conf

12 CONFERENCE

Deoxygenation & acidification 4,000 € ●●●
on 2013 budget
after Ex. Com. decision
managed by ULg

Low oxygen environments in marine, estuarine and fresh waters

Marilaure Grégoire (ULg), Jean-Pierre Descy (UNamur), Arthur Capet, Alberto Borges (ULg), Véronique Garçon (IRD/LEGOS), Steve Ashby (MSU)

5-9 May 2014, Liège, Belgium

<http://www.eur-oceans.eu/?q=node/34482>

13 CONFERENCE SESSION

Models 5,000 € ●●●
on 2009 budget
after Ex. Com. decision
managed by IRD/EME

Joint ICES & EUR-OCEANS Session F (Tuesday, 22 September) during ICES Annual Science Conference: How does fishing alter marine populations' and ecosystems' sensitivity to climate?

Benjamin Blanque (IMR), Miguel Bernal (IEO)

22 Sept. 2009, Berlin, Germany

<http://www.eur-oceans.eu/?q=node/22192>

14 CONFERENCE SESSION

Omics 5,000 € ●●●
on 2012 budget
after March 2012 call
managed by UPMC

Molecular life of diatoms

Angela Falciatore (UPMC), Chris Bowler (ENS), Jacques Livage (Collège de France), Thomas Mock (UEA)

24-28 June 2013, Paris, France

<http://www.eur-oceans.eu/?q=node/29127>

15 FORESIGHT WORKSHOP

Models 12,000 € ●●●●
on 2009 budget
after Jun. 2009 call
managed by IMBER/SCOR

CLIOTOP into the future – Building scenarios for oceanic ecosystems in the XXI Century

Olivier Maury (IRD/EME), Patrick Lehodey (CLS)

8-11 Feb. 2010, Paris, France

<http://www.eur-oceans.eu/?q=node/22052>



16 FORESIGHT WORKSHOP

Models 12,000 € ●●●●
on 2009 budget
after Jun. 2009 call
managed by UniHH

Comparative analysis of European marine ecosystem reorganizations – a largescale approach to develop the basis for an ecosystem-based management of marine resources

Christian Möllmann (UniHH), Nils Christian Stenseth (UiO/CEES), Martin Edwards (SAHFOS), Alessandra Conversi (CNR)

1-3 Nov. 2010, Hamburg, Germany

<http://www.eur-oceans.eu/?q=node/22195>

17 FORESIGHT WORKSHOP

Omics (HT 5-6) 15,000 € ●●●●
on 2010 budget
after Feb. 2010 call
managed by SZN

Ocean Science meets -omics

Maurizio Ribera d'Alcalà (SZN), Patrizio Mariani (DTU Aqua), Fauzi Mantoura (UPMC), Marcus Weinbauer (CNRS)

7-10 Nov. 2010, Naples, Italy

<http://www.eur-oceans.eu/?q=node/22300>

18 FORESIGHT WORKSHOP

Polar 12,000 € ●●●●
on 2009 budget
after Jun. 2009 call
managed by AWI

Global Change in Polar Systems

Uli Bathmann (AWI), Eugene Murphy (NERC/BAS)

15-17 Nov. 2010, Bremerhaven, Germany

<http://www.eur-oceans.eu/?q=node/22170>

19 FORESIGHT WORKSHOP

Models 15,000 € ●●●●
on 2010 budget
after Feb. 2010 call
managed by IRD/EME

Food security for land-breeding, marine top predators: towards an ecosystem approach for managing forage resources

Philippe Cury (IRD/EME), Lynne Shannon (UCT)

9-12 March 2011, Cape Town, South Africa

<http://www.eur-oceans.eu/?q=node/22301>

20 FORESIGHT WORKSHOP

Models 15,000 € ●●●●
on 2010 budget
after Feb. 2010 call
managed by IMR

Toward a global observation and modelling system for studying the ecology of the open ocean using acoustics

Nils Olav Handegard (IMR), Nils Christian Stenseth (UiO/CEES), Olivier Maury (IRD/EME)

4-6 May 2011, Bergen, Norway

<http://www.eur-oceans.eu/?q=node/22302>

21 FORESIGHT WORKSHOP

Models 10,000 € ●●●●
on 2011 budget
after Feb. 2011 call
managed by UiO/CEES

Effect of fishing-induced alterations in population structure and life history traits on the response of worldwide fisheries to climate

Tristan Rouyer, Manuel Hidalgo (UiO/CEES)

12-14 Sept. 2011, Oslo, Norway

<http://www.eur-oceans.eu/?q=node/25936>

22 FORESIGHT WORKSHOP

Models 15,000 € ●●●●
on 2011 budget
after Feb. 2011 call
managed by IRD/EME

Spatial management of pelagic ecosystems with marine protected areas: Visions for the future

David M. Kaplan (IRD/EME), Patrick N. Halpin (Duke), Patricio Bernal (IUCN), Daniel C. Dunn (Duke)

26-30 March 2012, Sète, France

<http://www.eur-oceans.eu/?q=node/25937>

23 FORESIGHT WORKSHOP

Omics 14,500 € ●●●●
on 2012 budget
after March 2012 call
managed by AWI

Evolutionary Potential in Marine Populations

Lisa Shama, Mathias Wegner (GEOMAR & AWI)

17-21 Sept. 2012 AWI

Wadden Sea Station, List auf Sylt, Germany

<http://www.eur-oceans.eu/?q=node/28917>

24 FORESIGHT WORKSHOP

High resolution ocean 15,000 € ●●●●
on 2012 budget
after March 2012 call
managed by UBO

A satellite and in-situ field experiment in a turbulent ocean: Diagnosis of vertical exchanges associated with submesoscales. Impacts on air-sea exchanges and ecosystems

Patrice Klein (Ifremer), Sabrina Speich (UBO)

28-29 Nov. 2012, Brest, France

<http://www.eur-oceans.eu/?q=node/29037>

25 FORESIGHT WORKSHOP

Models 15,000 € ●●●●
on 2012 budget
 after March 2012 call
 managed by IRD

Evaluating the status of marine ecosystems in a changing world (indiSeas II, third (2012) meeting)

Yunne-Jai Shin (IRD), Lynne Shannon (UCT),
 Alida Bundy (DFO)

3-7 Dec. 2012, Paris, France

<http://www.eur-oceans.eu/?q=node/29023>

26 FORESIGHT WORKSHOP

Models 15,000 € ●●●●
on 2012 budget
 after March 2012 call
 managed by DTU Aqua

Trait-based approaches to Ocean Life

Tomas Bohr, Ken H. Andersen, Patrizio Mariani,
 Thomas Kiørboe (DTU Aqua)

26-28 August 2013, Copenhagen, Denmark

<http://www.eur-oceans.eu/?q=node/29022>

27 FORESIGHT WORKSHOP

Models 15,000 € ●●●●
on 2012 budget
 after March 2012 call
 managed by IRD/EME

Building scenarios for global oceanic ecosystems and associated fisheries

Olivier MAURY (IRD/EME), Laurent Bopp (CNRS),
 Haritz Arrizabalaga (AZTI), Liam Campling (QMUL)

25-29 Nov. 2013, Sète, France

<http://www.eur-oceans.eu/?q=node/29163>

28 WORKSHOP

Models 2,160 € ●●●
in kind support and NoE budget remainders
 after Ex. Com. decision
 managed by IRD/EME

Joint EUR-OCEANS & MEECE WS: OSMOSE model: parameterization, calibration, coupling

Yunne-Jai Shin, Morgane Travers (IRD/EME)

14-15 May 2009, Sète, France

<http://www.eur-oceans.eu/?q=node/22191>

29 WORKSHOP

Models ●
in kind support only
 after Ex. Com. decision
 managed by IRD/EME

indiSeas II, second (2011) meeting

Yunne-Jai Shin (IRD), Lynne Shannon (UCT),
 Alida Bundy (DFO)

15-18 Nov. 2011, Paris, France

<http://www.eur-oceans.eu/?q=node/28832>

30 WORKSHOP

Models 8,000 € ●●●●
on 2012 budget
 after March 2012 call
 managed by IRD/EME

Ecosystem modelling in the North-West Mediterranean Sea

Claire Saraux (Ifremer), Daniela Banaru (AMU),
 Marta Coll (CSIC)

26-28 March 2013, Sète, France

<http://www.eur-oceans.eu/?q=node/29116>

31 WORKSHOP

Models 7,500 € ●●●●
on 2012 budget
 after March 2012 call
 managed by IMBER

Impact of climate change on marine ecosystems

Mehera Kidston, Laurent Bopp (CNRS), Meike Vogt,
 Nicolas Gruber (ETH Zurich)

4-6 March 2013, Paris, France

<http://www.eur-oceans.eu/?q=node/29115>

32 WORKSHOP

General 15,000 € ●●●●
on 2012 budget
 after March 2012 call
 managed by AMU

International MerMex

Richard Sempéré, Xavier Durrieu de Madron, Cecile Guieu
 (CNRS), Ivane Payraud (Ifremer)

16-19 June 2013, Zagreb, Croatia

<http://www.eur-oceans.eu/?q=node/30110>

33 WORKSHOP

General 15,000 € ●●●●
on 2013 budget
 after Council decision
 managed by UniHB

Workshop on data integration in marine science – Collaborations between journal and data publishers/databases

Stéphane Pesant (UniHB/MARUM)

4-5 Nov. 2013

Telde, Gran Canaria, Spain

<http://www.eur-oceans.eu/?q=node/34356>

34 WORKSHOP

Models 10,000 € ●●●●
on 2013 budget
 after Ex. Com. decision
 managed by IRD

IndiSeas II, fourth (2013) meeting

Yunne-Jai Shin (IRD), Lynne Shannon (UCT),
 Alida Bundy (DFO)

9-13 Dec. 2013, Paris, France

<http://www.eur-oceans.eu/?q=node/34478>

35 WORKSHOP

Models 8,000 € ●●●●
on 2012 budget
after March 2012 call
managed by IRD/EME

Tracking marine top foragers

Nicolas Bez (IRD/EME), Stéphanie Mahévas (Ifremer)

15-17 Jan. 2014, Paris, France

<http://www.eur-oceans.eu/?q=node/29167>

36 COURSE

Models 8,000 € ●●●●
on 2009 budget
after Ex. Com. decision
managed by DTU Aqua

Climate impacts on the Baltic Sea - from science to policy – Advanced summer course (NMA / EUR-OCEANS / DTU-Aqua)

Brian MacKenzie, Keith Brander (DTU Aqua),
Marcus Reckermann (GKSS), Anders Omstedt
(U. Gothenburg)

27 Jul.-5 Aug. 2009,
Nexø, Bornholm, Denmark

<http://www.eur-oceans.eu/?q=node/22188>

37 COURSE

Models 5,000 € ●●●●
on 2009 budget
after Ex. Com. decision
managed by OGS

Summer school of the HMAP program (History of Marine Animal Populations)

Ruthy Gertwagen (U. Haifa), Cosimo Solidoro,
Simone Libralato, Donata Melaku Canu (OGS),
Sâsa Raicevich, Tomaso Fortibuoni, Otello Giovanardi
(ISPRA)

31 Aug.-4 Sept. 2009, Trieste, Italy

<http://www.eur-oceans.eu/?q=node/22187>

38 COURSE

Models 10,242 € ●●●●
5 k€ on 2009 budget, and NoE budget remainders
after Ex. Com. decision
managed by IRD/EME

Economic versus ecological networks: integrating economy and ecology in scenario building for marine ecosystems – An advanced course in economic and ecological modelling drawing on the theory of network economics

Christian Mullon (IRD/EME), Brian Fath (Towson U.),
Pierre Fréon (IRD/EME), Ferenc Jordán (Microsoft Research
& U. Trento), Gorka Merino (PML)

24-26 Nov. 2009, Sète, France

<http://www.eur-oceans.eu/?q=node/22189>

39 COURSE

Models 5,000 € ●●●●
on 2010 budget
after Mar. 2010 call
managed by DTU Aqua

Advanced school: Complexity, adaptation and emergence in marine ecosystems

Andy Visser (DTU Aqua), Cosimo Solidoro (OGS), Uffe
Thygesen, Patrizio Mariani (DTU Aqua)

18-27 Oct. 2010, Trieste, Italy

<http://www.eur-oceans.eu/?q=node/22203>

40 COURSE

Deoxygenation & acidification 5,000 € ●●●●
on 2011 budget
after Feb. 2011 call
managed by OGS

Use of natural analogues in ocean acidification research

Marco Milazzo (CoNISMa), Jason Hall-Spencer (UOP),
Maoz Fine (Bar Ilan University (BIU),
Patrizia Ziveri (UAB)

25-27 May 2011, Vulcano, Italy

<http://www.eur-oceans.eu/?q=node/25938>

41 COURSE

Models 10,000 € ●●●●●
on 2012 budget
after March 2012 call
managed by DTU Aqua

From bloom to gloom – Primary production, food-web processes and vertical flux in changing oceans

Sigrún Jónasdóttir, Jörg Dutz (DTU Aqua), Erla Björk
Örnólfsdóttir (Hólar University College)

29 Jul.-09 Aug. 2013, Hólar, Iceland

<http://www.eur-oceans.eu/?q=node/29097>

42 COURSE

Deoxygenation & acidification 5,000 € ●●●●
on 2013 budget
after Council decision
managed by SOLAS

6th SOLAS summer school

Minhan Dai (XMU), Véronique Garçon (CNRS)

23 Aug.-2 Sept. 2013, Xiamen, China

<http://www.eur-oceans.eu/?q=node/28986>

Some pointers to additional information

- Online list of EOC activities: http://www.eur-oceans.eu/eoc_activity_summary

HT 1 Ocean deoxygenation and acidification

In 2012, EUR-OCEANS scientists collaborated to the writing of a report on the research strategy for the future EuroMarine+ Consortium. One of six important emerging fields identified therein is titled 'Effects of global warming, acidification, sea level rise, hypoxia and biodiversity change on ecosystems'; it is introduced as follows:

One of the major lessons learnt over the past few decades of research is that the evolution of climate and global environmental quality in the next century will be intimately linked to biogeochemical interactions and to human activities as drivers of biogeochemical fluxes. Our ability to manage and improve the quality of both natural and human systems will depend ultimately on our understanding of these interactions. The scientific basis of forecasts of future climate, climate variability, and quantitative estimates of uncertainty in future projections will only be provided by a continuous merging of fundamental science in ocean physics, biogeochemistry, biology, ecology and atmospheric physics and chemistry.¹

Under this wide field of research, EUR-OCEANS has contributed to the exploration of new frontiers of knowledge to better understand and predict the effect of increased atmospheric CO₂ levels and global warming on ocean acidification (a decreased ocean pH which results from the uptake of CO₂ and which – among other consequences – lowers the availability of carbonate ions needed by many marine life forms to build shells and skeletons), and ocean deoxygenation (a decrease of the oceans dissolved oxygen content, or trend towards 'hypoxia', which can reach levels that are detrimental to many marine organisms, and which results both from a decreased O₂ solubility at higher water temperature and from an increased stratification – or reduced mixing of ocean superficial and deep waters – caused by global warming, which reduces the supply of O₂ to the ocean interior).

Ocean deoxygenation could be compensated by a decreased primary production (hence a reduced oxygen consumption) in a more stratified ocean. Currently, we do not know if the two processes (reduced supply or reduced consumption) would balance or if one of them would dominate. However, current ocean models predict declines of 1-7% in the global ocean O₂ inventory in the next century, with further declines continuing for 1,000 years or more into the future. An important consequence could be an expansion, in area and volume, of the so-called Oxygen Minimum Zones (OMZ), where O₂ levels are too low to support most macrofaunal life and where profound changes in biogeochemical cycling occur. If this is verified, there are profound implications for ocean productivity, nutrient cycling, carbon cycling, and marine habitats, in particular the coastal ones.

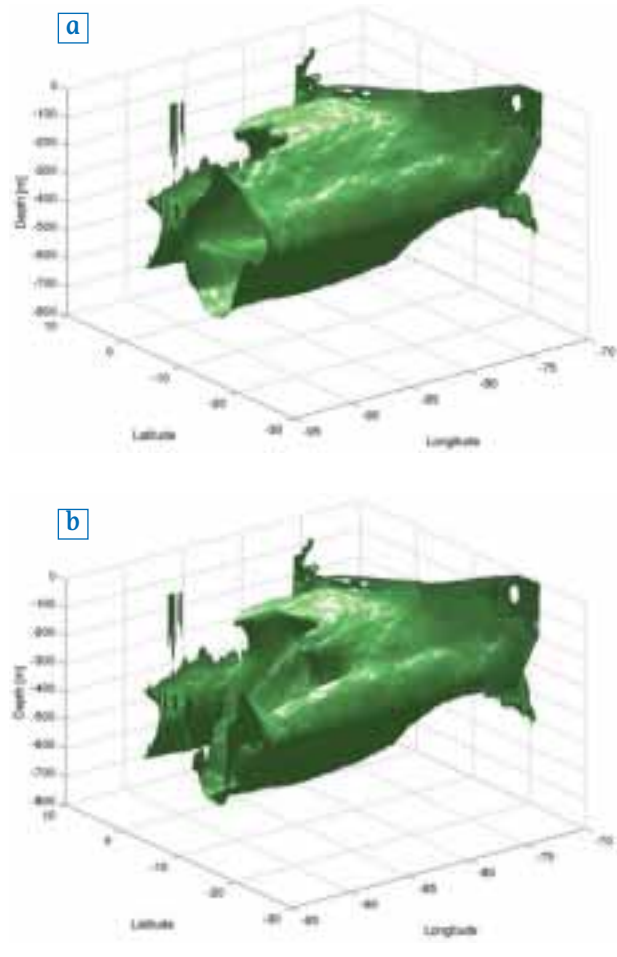


Figure. Volume of Oxygen Minimum Zone (OMZ) core (where O₂ concentrations are lower than 20 μmol/l) off the coast of Peru as simulated by the ROMS-BIOEBUS physical-biogeochemical model. In (b) the oxygen concentrations are multiplied by a factor 4 at the western boundary of the domain between 5° and 10°S, as compared to (a) (Ivonne Montes, pers. com.).

1. Boyen, C., C. Heip, P. Cury, P.-F. Baisnée, and others, EuroMarine Research Strategy Report (Deliverable 3.2 Seventh Framework Programme Project EuroMarine - Integration of European Marine Research Networks of Excellence. FP7-ENV-2010.2.2.1-3. Contract Number 265099), 2012 <http://www.euromarineconsortium.eu/downloads/key-documents?download=176:euromarine-research-strategy-report>



EOC Deoxygenation conference, Toulouse, October 2011 © Lisa Maddison



EOC Deoxygenation conference and flagship

Under Hot Topic 1, the EUR-OCEANS Consortium (EOC) notably funded (as the first and major sponsor) a conference on ‘Ocean deoxygenation and [its] implications for marine biogeochemical cycles and ecosystems’, and a flagship programme on ‘Ocean deoxygenation in Eastern Boundary Upwelling Systems’. The **conference**, held in 2011, was attended by more than 90 scientists from 19 countries. Co-sponsors included IRD, INSU-CNRS, the French *Académie des Sciences*, LEGOS, *Observatoire Midi Pyrénées*, the French embassy in Washington DC (USA), and both international projects IMBER and SOLAS. The conference brought together biological, biogeochemical, and physical oceanographers to discuss the issue of deoxygenation in the world ocean and its implications for ocean productivity, nutrient cycling, carbon cycling, and marine habitats. The goal was to provide a science arena to discuss the state of the art of our knowledge on all topics, and to build a unified research agenda across the full range of oceanographic disciplines. The talks provided a multidisciplinary overview with three main foci: 1) description and control mechanisms of deoxygenation and of OMZ and hypoxia sites; 2) deoxygenation impacts on the biogeochemical cycles, climatic gases, microbial activity and ecosystems; and 3) deoxygenation in the past ocean. Beyond its impact in terms of publications, the conference represented an important step in building and maintaining over time tight scientific exchanges between key experts of various disciplines, towards an international coordination (of objectives, approaches) for observations (e.g. O_2), experiments (e.g. protocols) and modelling efforts (e.g. numerical tools) and inter-comparisons of the major OMZs systems. The (2011-2013) **flagship programme** focused on modelling exercises (coupling the hydrodynamical model ROMS with BioEBUS, a biogeochemical model developed for the Eastern Boundary Upwelling Systems) to determine the respective contributions of physical and biogeochemical processes involved in transport and maintaining of the OMZ off Peru.

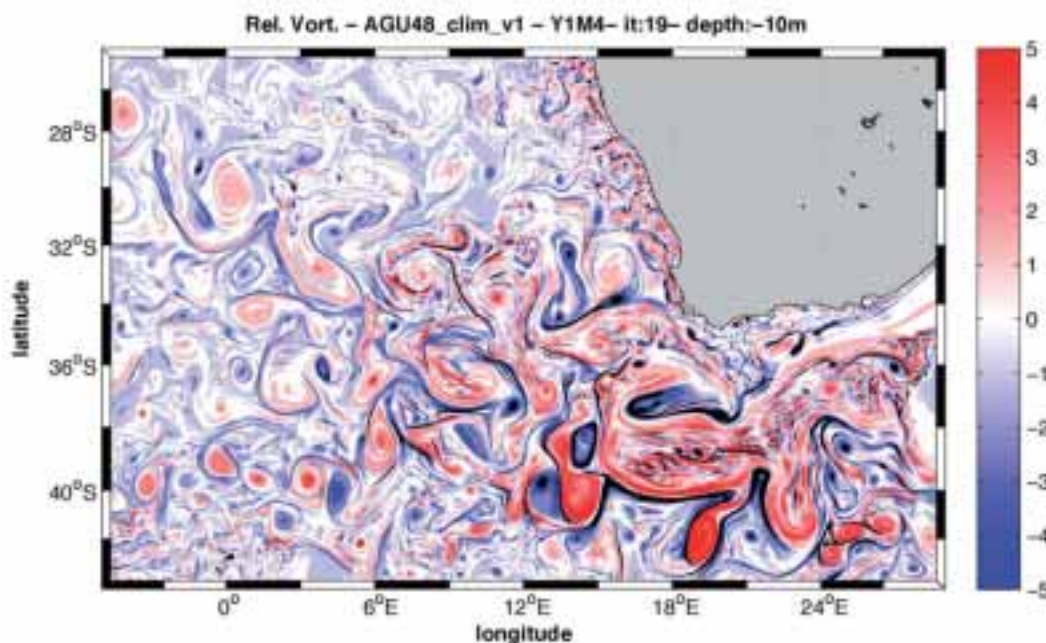
Some pointers to additional information

See *EOC activities* 3, 9, 11, 40, 42 in pages 16-21 and links therein.

- *Ocean Acidification: the other half of the CO₂ problem*, EUR-OCEANS Fact Sheet No. 7, May 2007, <http://www.eur-oceans.eu/?q=node/18117>
- *20 Facts about Ocean Acidification*, Fact Sheet by the U.S. Ocean Carbon and Biogeochemistry (OCB) program, with support from the UK Ocean Acidification Research Programme (UKOA), October 2013, <http://www.whoi.edu/fileserver.do?id=165564&pt=2&p=150429>

HT 2 High resolution ocean

One of the most exciting scientific challenges of the decade is to better describe, understand, and model the heterogeneity of the ocean at different scales. In the upper 500 m of the ocean, submesoscales (such as 10-km-wide filaments that are ubiquitous on high-resolution satellite images) explain more than 50% of the vertical velocity field, that is so important for nutrient transfer from depth and thus for ocean biological systems. Evidence is growing that small scale interactions and processes (with time scales of the order of a day) play a crucial role in energy transfer in the ocean, strongly affect carbon export – not only at local but also at global scale – and shape habitats for ocean life from plankton to top predators. Existing satellite altimetry data is unable to resolve the smaller scales (20-100 km) that are a major feature in high resolution optical, infrared and radar images. However, the SWOT (Surface Water Ocean Topography) mission involving NASA and ESA will soon address this need which will enable a much improved description and quantification of oceanic processes at the submesoscale.

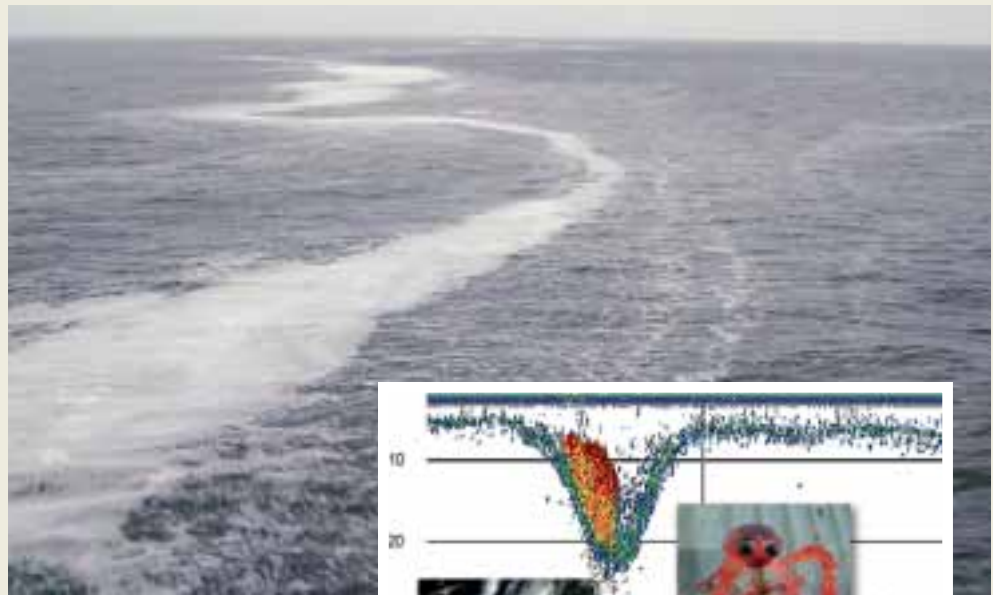


EOC activities

In 2009, the EUR-OCEANS Consortium (EOC) organised – along with Europe Mer – a **conference** titled ‘Influence of meso- and submesoscale ocean dynamics on the global carbon cycle and marine ecosystems’. In May-June 2010, this conference gathered 80 scientists to discuss the initial evidence for the importance of submesoscale processes (for the carbon pump, ocean dynamics, primary production, the global climate system, ecosystems structure and biodiversity) as well as related observational, technological and instrumentation issues. The conference resulted in an invited topical review in *Geophysical Research Letters*, and some major

Relative vorticity (a measure of local spinning motion) of the ocean in the Cape Basin (South Africa) as simulated by a ROMS (Regional Ocean Modeling System) model of ocean dynamics at $1/48^\circ$ (i.e. at ca. a 2-km resolution). Blue and red colours respectively indicate cyclonic (clockwise) and anticyclonic (anticlockwise) motions. Scales of ocean circulation are varied, ranging from the retroflection of the Agulhas current (ca. 500 km) to mesoscale eddies (100-200 km) and to whirling structures and associated filaments that fall in the submesoscale (2-10 km) domain (Sabrina Speich, pers. com.).





□ The foam line marks on the ocean surface a (submesoscale) frontal zone between two water bodies off Peru. 3D acoustic profiles (right), which can differentiate fish such as anchoveta (red) from zooplankton such as munida (blue), show that planktonic organisms are concentrated in such areas, which attracts predators (fish, but also birds and mammals). (A. Bertrand, pers. com.)

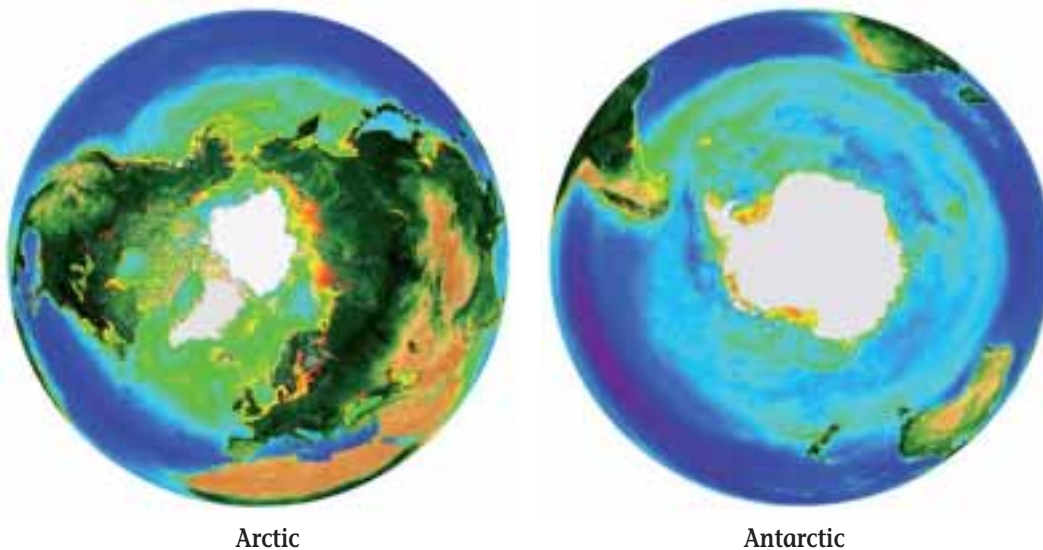
conclusions were drawn: (1) submesoscale dynamics dominates larger scale dynamics in terms of vertical motion (which challenges previous hypotheses at mesoscale); (2) submesoscale dynamics is therefore crucial to better understand large scale dynamics, especially as regards vertical rates; challenges for the future mainly concern the role of vertical motions in export, their vertical penetration and their interactions with stratifications that may play an equally important role; (3) the coordinated use of autonomous underwater systems and of very high resolution remote sensing will be required in the next decade to correctly describe the ocean at submesoscale (in this direction, the conference has initiated an international cooperation around sea experiments for the preparation of the SWOT project); because of the important links between submesoscale dynamics and stratification, observation and modelling at submesoscale level in the vertical dimension is another important challenge; (4) ecosystem diversity has proven to be very sensitive to submesoscale dynamics; describing the structure and functioning of marine ecosystems at that scale is however challenging and will require new modelling approaches and a new generation of miniaturized sensors (going beyond chlorophyll) associated with gliders and floats; (5) while recent progress in the parameterisation of submesoscale physical processes has been achieved, a parallel approach for biological processes is still required. EOC also funded a (2010-12) 'submesoscale' **flagship programme** focusing on the 'Impact of submesoscale on particulate export'. The flagship used modelling exercises to investigate the conditions under which (sub)mesoscale variability in surface primary production can induce similar variability in the flux arriving at the benthos. Lastly, in 2012, EOC funded a **foresight workshop** titled 'Diagnosis of vertical exchanges at submesoscales and their impact on ecosystems, from integrated satellite and in-situ observations'. During this workshop, scientists who had previously conducted experiments at sea on small oceanic scales met for the first time to prepare a future experiment for 2016-17. This experiment will be specifically designed to monitor the dynamical interactions between submesoscale structures and mesoscale eddies, and the consequences on the biomass (in terms of dominant species).

Some pointers to additional information

See *EOC activities 2, 5, 24* in pages 16-21 and links therein.

HT 3 Rapid Change in Polar Oceans

Polar ocean ecosystems are integral to the Earth System, influencing global climate and biogeochemical cycles and maintaining unique biodiversity and ecosystem services, including fisheries (e.g., targeting cod, herring, capelin, toothfish and krill). They provide unique records and insights on past changes, serve as a barometer of the current state of the planet, and act as an indicator for future change (for instance, because ocean acidification is especially strong in cold waters, the observation of its effects in polar regions can provide insights on how it will affect the rest of the world's oceans in the future). Their international political and economic significance is rising; there is mounting pressure for expansion of fisheries to provide food security and, in the Arctic, exploitation of oil, gas and minerals. They are currently undergoing unprecedented, rapid and dramatic climate-driven changes, with far reaching consequences for the rest of the globe. Detection, projection and management of their responses to change, including fisheries-driven change, is crucial for effective stewardship and predicting effects on the Earth System.



EUROCEANS 'Polar' foresight WS and flagship

The EUR-OCEANS NoE (2005-08) has been a catalyst for developing a solid sub-network of research scientists in Southern Ocean (Antarctic) science. The development of the 10-year international 'Integrating Climate and Ecosystem Dynamics in the Southern Ocean' programme (ICED, the first regional programme of IMBER) and ICED involvement in the International Polar Year 2007-2008 (ICED-IPY) were in large part due to the foresight and financial and administrative help of EUR-OCEANS.

The focus within the EUR-OCEANS Consortium (EOC) has been to favour and promote coordination and comparative exercises between Arctic and Antarctic research. Indeed, while rapid changes occurring in the Arctic are clearly a high

Composite NASA SeaWiFS ocean colour illustrations of Antarctic and Arctic average summer chlorophyll concentrations (red: high; blue: low). Comparisons of these ecosystems are being explored with a focus on foodweb structure and controls on productivity. In both regions strong seasonality and associated sea-ice processes are dominant influences. In the Southern Ocean the Antarctic Circumpolar Current connects regional ecosystems, with the Polar Frontal Zone acting as a barrier to the north. Productivity can be high where iron is not limiting, and although details vary, there is a general similarity of foodweb structure. Currents connect the Arctic Ocean with areas further south, while productivity is dependent on macro-nutrients, resulting in a more heterogeneous foodweb structure.



AWI research vessel Polarstern in the Arctic © AWI, Stefan Hendricks, 2013

priority for the Northern Hemisphere, the Southern Ocean is one of the few areas where there is sufficient knowledge across a range of spatial, temporal and trophic scales (e.g. from microbes to whales, from local to circumpolar scales) to understand whole ecosystem operation. Analyses conducted in the Antarctic have relevance to Arctic and global ocean ecosystems. Through comparative studies of both oceans (such as illustrated in the Figure on the opposite page, which prefigures an integrated, comparative approach of polar plankton ecology), the scientific community can significantly advance knowledge about the Polar Regions, their influence on global cycles and ecosystems, their responses to change, and their effective stewardship. In 2009, EOC funded a **foresight workshop** (FWS) on 'Rapid change in polar oceans' which was held in 2010. The FWS focused on key changes, key ecosystem responses, key regions and key data requirements (both historical and future) for detecting change (e.g. long-term physical and biological monitoring data, biodiversity data). Following on from the FWS, EOC awarded in 2010 a **2-year flagship** to scientists at the British Antarctic Survey (BAS) and Alfred-Wegener-Institute for Polar and Marine Research (AWI). The central scientific theme of the flagship programme has been to further the work highlighted by the FWS on polar ecosystem change, with a particular focus on the role of both Arctic and Antarctic ecosystems in polar and global nutrient cycles, how key biogeochemical and food web processes are linked, and how these may be affected by change. The flagship also had a strong focus on coordination, integration and leadership of bipolar marine ecosystem science within Europe, including the development of a Strategy for European polar marine ecosystem research. It is envisaged that this strategy will inspire future calls and be implemented through future European-wide projects, notably within Horizon 2020 (the 2014-20 EU Framework Programme for Research and Innovation).

Some pointers to additional information

See *EOC activities* 4, 11 and 18 in pages 16-21 and links therein.

- Strategy produced by the EOC flagship for Polar Ecosystem Change & Syntheses (PECS) : <http://bit.ly/17RTv6P>
- ICED: www.iced.ac.uk
- ICED-IPY: www.ipy.org/?ipy/detail/iced
- Smetacek, V., and S. Nicol, 'Polar Ocean Ecosystems in a Changing World', *Nature*, 437 (2005), 362–368
- Murphy *et al.*, 'Developing Integrated Models of Southern Ocean Food Webs: Including Ecological Complexity, Accounting for Uncertainty and the Importance of Scale', *Progress in Oceanography*, 102 (2012), 74–92.

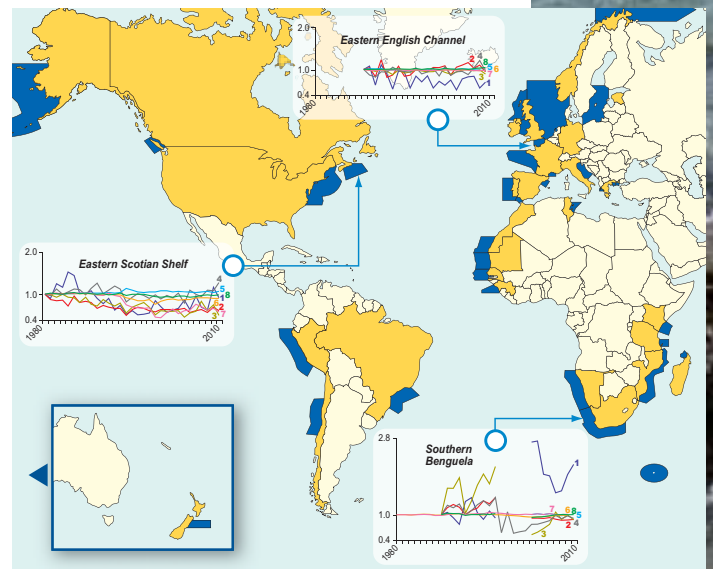
HT 4 Models, indicators and scenarios for changing oceans

Loss of biodiversity is seen as a major threat to the resources and processes that the world's ecosystems supply or perform, and which ultimately determine the sustainability of human communities from regional to global level. Such resources and processes have been termed 'ecosystem services'¹, an expression defined and popularised by the United Nations 2005 Millennium Ecosystem Assessment. In the marine domain, the 2002 Johannesburg World Summit set the targets of restoring fish stocks to maximum sustainable yield by 2015 and of significantly reducing the rate of biodiversity loss. Policy drivers such as the European *Marine Strategy Framework Directive* (2008) and the Convention on Biological Diversity *Aichi Targets* (2010) call for effective ecosystem-based fisheries management to be in place by 2020 in order to reconcile conservation and exploitation of renewable resources under an ecosystem perspective. In this context, there is an urgent need to better predict possible marine ecosystem responses to anthropogenic and climate change, and to develop methodologies to efficiently manage human impacts on marine biodiversity and the numerous services that marine ecosystems provide.

Models that integrate data or knowledge from a wide range of disciplines and that are endowed with predictive capabilities under various future conditions and over long time horizons (50-100 years) are central to such an enterprise. 'Statistical' models can reveal plausible future changes within the range of past variations captured in the data that served to build them.

'Mechanistic' models that explicitly represent natural or anthropogenic processes can go beyond and reveal plausible evolutions in response to foreseeable but yet-unprecedented environmental changes, as far as they correctly describe key processes and their interactions. Challenges are multiple: 'end-to-end' models of ecosystems (from microbes or plankton to top predators) must be coupled with environmental, biogeochemical and socio-economical models. New modelling approaches need to be experimented and compared. New key processes must be identified and taken into account at multiple time and spatial scales. Model uncertainties must be assessed and possibly reduced.

Equally important to these core scientific and technical challenges is the development of efficient science-governance interfaces. Easy-to-grasp 'indicators' of the state or trends of marine ecosystems must be devised and applied in data-rich as well as in data-poor situations. 'Scenarios' that integrate across the social, economic and governance dimensions should tell 'stories' about fundamental trends, desirable targets, policy options or trade-offs among ecosystem services, so that models can be used to predict plausible future states or explore pathways towards assigned objectives. Recognising the central and integrating role of such story-telling exercises, EOC has placed its activity under the motto 'Building scenarios for marine ecosystems under anthropogenic and natural forcing in the 21st century'.



□ Marine ecosystems addressed by the IndiSeas network (in blue) and participating countries (in yellow). Examples of time series of standardized ecological indicators collated by IndiSeas: 1: total biomass surveyed; 2: mean length of fish in the community; 3: proportion of predatory fish; 4: mean lifespan; 5: intrinsic vulnerability index of the catch; 6: trophic level of the landings; 7: Marine Trophic Index; 8: trophic level of the surveys. Data source: EEC-IFREMER, France; ESS-Maritimes Region, DFO Canada; SB-DAFF South Africa (from Shin *et al.* 2012).

1. Criticised by some for the utilitarian view of nature that the term 'service' connotes, this expression is praised by others precisely because it invites to engage in recognizing and valuating ecosystem services, and to take into account the cost of their degradation in decision making.



FWS led by DTU Aqua, Copenhagen, August 2013 © Centre for Ocean Life

EOC activities

The activities funded by the EUR-OCEANS Consortium (EOC) under Hot Topic 4 are too diverse and numerous (26) to be listed or summarized here. EOC was the sole or a key funder in 18 cases, and brought co-funding or organizational support in eight additional cases. To give but a few examples: The '**EcoScenarios**' **flagship** programme used long-term monitoring data to build seasonal and spatial ecosystem models for the Black Sea and the Baltic Sea using novel statistical modelling. The purpose was: (a) to explore how different external forces (e.g. climate change, harvesting) could cause regime shifts (abrupt changes in species composition), and whether such changes could be reversed; and (b) to link these ecosystem models with simple economic models to address policy questions.

The **IndiSeas initiative** is making significant progress towards effective ecosystem-based fisheries management by developing and testing, in many of the world's marine ecosystems, indicators designed to track and evaluate the ecosystem effects of fishing, as well as the effectiveness of management measures to maintain resources in a sustainable form. Multiple drivers are considered, including the human dimension and climate forcing that interact with ecological processes in complex ways. A comparative approach among diverse ecosystems allows for the determination of reference points for an effective use of these indicators, in support of management and conservation practices. Launched in 2005 under the auspices of EUR-OCEANS, subsequently supported by EOC for several of its annual meetings, IndiSeas is now endorsed by IOC/UNESCO and represents a network of 72 researchers from 32 countries and 44 research institutes.

A **foresight workshop**, convened to gather and jointly analyse long time-series for fisheries and land-breeding, **marine top predators** worldwide, led to an influential paper which suggests a simple ecosystem-based management rule for fisheries: the biomass of forage fish on which such top predators prey should not decrease below one third of its maximum level observed in long-term studies.

An **advanced course** in economic and ecological modelling drawing on the theory of network economics led to a book and made possible the constitution of a thematic network and lasting collaborations, as well as the use of such modelling technique in various projects.

Several **workshops** addressed other important topics such as: new observation needs and techniques; progress required in mechanistic or other models; coordinated implementation of ecosystem models in specific regions, notably the Mediterranean; marine protected areas for the open ocean; or the construction of scenarios for global oceanic ecosystems and their fisheries.

Some pointers to additional information

- See *EOC activities* 1, 6, 7, 8, 10, 11, 13, 15, 16, 19, 20, 21, 22, 25, 26, 27, 28, 29, 30, 31, 34, 35, 36, 37, 38, 39 and 41 in pages 16-21 and links therein
- IndiSeas website: www.indiseas.org

HT 5 Links between marine ecology, biodiversity and genomics

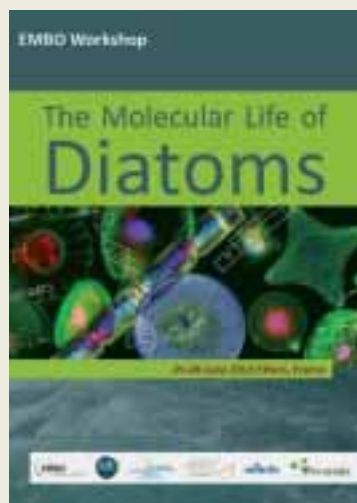
HT 6 Plasticity, epigenetics, adaptativeness

Our climate is changing at an unprecedented rate, and nowhere is this more apparent than in the world's oceans. Climate change is not only modifying the physics (temperature, stratification, circulation), but also the chemistry (dissolved gas concentrations, acidification, transfer of nutrients and contaminants) and the biology (impacts on primary production and life history traits, shifts in trophic structures and sensitivity to anthropogenic stressors) of the ocean from global to very localised scales. The biological responses (depending for instance on genetic or evolutionary factors) to the drivers of change are likely to control key higher organisational levels (e.g., behavioural traits, trophic interactions, life cycles). They are thus essential factors for understanding the impacts of rapid change and increased anthropogenic pressures on marine ecosystems, and for implementing end-to-end ecosystem models that could be used to predict and explore future ecosystem functioning under such change and pressure. However, the links between processes that occur at molecular and sub-cellular level and those occurring at the level of organisms or communities are the conundrum of ecosystem dynamics. Because of the existing gaps in our knowledge, macroscopic patterns observed at a higher organizational level (e.g., a community) are seldom related to processes occurring at a lower organizational level (e.g., organisms) and almost never described on the basis of the underlying molecular processes. Rapid progress in genomics, proteomics, genetics, and molecular biology on selected model species, together with novel resources derived from metagenomics (the study of genetic materials recovered from environmental samples instead from a single organism) and modern oceanographic observational techniques, produce a wealth of new data and knowledge which enable new attempts to bridge the gap between molecular and higher organisational levels (and marine ecology). Because species could adapt to new ranges of conditions, the above mentioned genetic and evolutionary factors, and an improved understanding of the adaptation potential of marine species, are essential.



Flabellina affinis (a species of sea slug). Mediterranean Sea © IRD, Thomas Changuex





EOC activities

Under hot topics 5 and 6, EOC has funded two foresight workshops and one conference session. The first **foresight workshop**, titled 'Ocean Science meets -omics', was held at Stazione Zoologica Anton Dohrn (Naples, Italy) on 7-10 November 2010. Its aim was to contribute to bridge the gaps between recent developments in molecular biology (genomics and proteomics) and marine ecology. It focused on crucial questions in marine science, analyzing to what extent -omics can contribute to find answers, and connecting evolution with ecology. Key issues that were addressed include: the role of biodiversity in shaping plankton communities; biodiversity and mechanisms of speciation in the marine

environment; importance and mechanisms of information flow in marine communities; life histories in marine protists and metazoans; and evo-devo (evolutionary developmental biology) potential contribution to marine ecology. The second **foresight workshop**, titled 'Evolutionary Potential in Marine Populations', was held at AWI Wadden Sea Station on 17-21 September 2012. While the rate and scale of climate change and its ecological consequences have potentially serious consequences for marine ecosystems (e.g. change in food webs, species distributions, prevalence of biological invasions and disease), evolutionary adaptation could help species counter stressful conditions or even flourish in the face of these environmental changes. The workshop addressed the key question of whether marine species will be able to adapt fast enough to keep pace with changing environments (and as a corollary, which species could be evolutionary winners). Different adaptation mechanisms were considered: 'phenotypic' plasticity (by which populations adjust to changed conditions through a change in the expression of genes – without altering their genetic composition); genetic change (microevolution), and epigenetic inheritance (inheritable changes in gene expression). Within the **conference** 'Molecular life of diatoms' (held in Paris, France, 24-28 June 2013), EOC has funded an 'oceanography' session. Diatoms are gaining increasing attention in different areas, ranging from ecology to materials science, and from academic research to industry (e.g. nanotechnology, biofuel, food industry, waste-water management). They are arguably the most species-rich group of phytoplankton, thrive in almost all aquatic habitats and have a dominant role in upwelling and coastal systems. They play a major role in global biogeochemical cycles, with a high impact on silicon and carbon cycles and consequences on climate. The conference focused on new opportunities to understand diatom biology and ecology and to exploit diatoms for biofuels and nanotechnology. The EUR-OCEANS session focused on their impact on the functioning of marine ecosystems and biogeochemical cycles.

Some pointers to additional information

- See *EOC activities* 11, 14, 17, 23 in pages 16-21 and links therein

List of publications

Other outputs

Publications and the impact factor of their journals are a common way of assessing the outcome of scientific projects or networks. We provide below a list of articles that can be considered as outputs of the EUR-OCEANS Consortium (EOC), as collected from leaders of EOC-funded activities. This list includes some pieces of work that are in preparation, submitted or under revision. It is non exhaustive, notably because several activities have not been carried out yet at the time of this writing, or are too recent to have resulted in publication plans. In spite of this, the tentative list assembled below includes five special issues and 69 peer reviewed articles or books of which 46 are published, eight are under revision or discussion and 15 are submitted or in preparation. It is worth noting that several activities – notably some foresight workshops and flagships – did not directly target publication. Instead, they were meant to initiate thematic networks or collaborations, or to prepare common strategies to address scientific questions falling under one of the EOC ‘hot topics’, with the medium-term objective of helping to generate appropriately designed funding streams and projects (this is notably the case of the ‘Polar’ flagship). More hindsight would be needed to tangibly measure the medium-term outcomes of such activities.

EOC, as successor to the EUR-OCEANS Network of Excellence, had the overall task to keep its scientific community networked and alive. EOC chose to do so primarily through the organization of integrative activities on its so-called ‘hot topics’. An indication that this goal has been reached can be found in the number, diversity and quality of projects that have been submitted to EOC calls. Last but not least, the fact that the EOC membership and corresponding in-cash contributions maintained themselves throughout the five years of existence of the Consortium and despite the difficult budgetary times that many countries and organisations were going through can be taken as a testimony that EOC has fulfilled its role and brought added-value to its member organisations, thus finding its niche in a complex and populated landscape of European marine structures and projects.

Selected publications

The list below is limited to peer-reviewed articles and books (excluding any reports or meeting accounts published in newsletters). It contains some but not all articles contained in the following published or confirmed special issues

- Bundy, A., and others, ed., Special Issue of Journal of Regional Environmental Change (in preparation, 13 papers confirmed)
- Drinkwater, K. F., R. R. Hood, and N. Mihalopoulos, eds., *Large-scale Regional Comparisons of Marine Biogeochemistry and Ecosystem Processes - Research Approaches and Results*, Special Issue of Journal of Marine Systems, 2013
- Liu, K.-K., and others, *Biogeochemistry-ecosystems Interaction in Changing Continental Margins in the Anthropocene*, Special Issue of Journal of Marine Systems (in preparation, 20 papers confirmed)
- Robinson, C., F. Azam, N. Jiao, and H. Thomas, eds., *The Impact of Anthropogenic Perturbations on Open Ocean Carbon Transformation, Export and Sequestration*, Special Issue of Biogeosciences (in preparation)
- Slomp, C. P., H. Brinkhuis, B. Dewitte, and A. Paulmier, eds., *Low Oxygen in Marine Environments from the Cretaceous to the Present Ocean: Driving Mechanisms, Impact, Recovery*, Special Issue jointly organized between Biogeosciences Discussions and Climate of the Past, 2012

Articles, in preparation or submitted (15)

- Bettencourt, J., C. López, E. Hernández-García, I. Montes, J. Sudre, B. Dewitte, and others, ‘Mesoscale Eddies and Fronts as Barriers to Mixing in the Eastern Tropical Pacific Oxygen Minimum’, *Submitted*
- Blenckner, T., M. Llope, M. Casini, C. Möllmann, and N. C. Stenseth, ‘Back to the Past or into an Uncertain Future: Climate Determines Ecological and Economic Baselines for Recovery of Overfished Marine Ecosystems’, *Submitted*
- Bonhommeau, S. and others, ‘A Method for Detecting the Responsiveness of Indicators to Fishing’, *In preparation*
- Bundy, A., and others, ‘Quantifying the Human Dimension of EAF with Management, Governance, Economic, and Social Indicators’, *In preparation*
- Chuenpagdee, R., and others, ‘How Is Your Ecosystem Doing? Comparative Analysis of Fisheries “impacts” Using Composite Indicators’, *In preparation*
- Coll, M., and others, ‘Prioritizing Biodiversity and Conservation-based Indicators in a Comparative Framework to Evaluate the Exploitation Status of Marine Ecosystems’, *In preparation*
- Houle, J. E., and others, ‘Which Indicators Are More Specific to Fishing Pressure?’, *In preparation*
- Large, S., and others, ‘Assessing the Relative Importance of Climate and Fishing in the Trends of Indicators’, *In preparation*
- Llope, M., T. Blenckner, G. M. Daskalov, and N. C. Stenseth, ‘Resilience of the Trophic Cascades in the Black Sea and Baltic Sea Regime Shifts– Lessons from Their Recent History’, *Submitted*

- McManus, L., L. Maddison, and E. Hofmann, 'The Future of Marine Biogeochemistry, Ecosystems, and Societies', *In preparation*
- Montes, I., A. Oschlies, E. Gutknecht, A. Paulmier, I. Dadou, and V. Garçon, 'A Model-based Assessment of Whether Anammox or Denitrification Is the More Important Nitrogen-loss Process in the Eastern Tropical Pacific', *In preparation*
- Reygondeau, G., and others, 'Comparison of Phenological Indicators in Marine Ecosystems', *In preparation*
- Shannon, L. J., M. Coll, A. Bundy, Y.-J. Shin, D. Gascuel, K. Kleisner, and others, 'Are Trophic Level-based Indicators Helpful in Tracking Fishing Effects and Biodiversity Changes Across Marine Ecosystems?', *Submitted*
- Shin, Y.-J., and others, 'Testing Indicators Sensitivity Using Multiple Models Across Marine Ecosystems', *In preparation*
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Launch of EuroMarine+

From February 2011 to July 2013, the EuroMarine project (coordinated by Mike Thorndyke at the University of Gothenburg) has produced a plan to launch EuroMarine+, a new, single European consortium for marine sciences. In 2014, EuroMarine+ will replace the three former Networks of Excellence EUR-OCEANS, MarBEF and Marine Genomic Europe and their follow-up structures. The business plan encompasses scientific research, education, training, mobility, data management, use of infrastructure and outreach. A research strategy report has identified key challenges and priorities. The legal framework consists of a consortium, complemented by a legal entity in charge of daily management under the strict control of the governance bodies of the Consortium. At present (October 2013), a call for bids to host and coordinate EuroMarine+ is open. It is planned that the signatories of the Memorandum of Understanding for the launch of EuroMarine+ will select the successful proposal. The future Coordinator and secretariat will be entrusted with the finalization of the legal framework, its implementation and the actual launch of EuroMarine+.

Some pointers to additional information

- EuroMarine website: www.euromarineconsortium.eu
- EUR-OCEANS page on the launch of EuroMarine+ (including key scientific, organisational or legal documents): www.eur-oceans.eu/?q=node/33363

POINT OF VIEW 1

Philippe CURY (IRD, France) - Scientific Coordinator of the EUR-OCEANS Consortium

■ By merging the three major European marine FP6 Networks of Excellence (EUR-OCEANS, MarBEF and MGE) into EuroMarine+, Europe is developing an integrated vision on marine research and a common research strategy based on scientific excellence. With EuroMarine+, a strong marine R&D leadership should soon be born in Europe. EuroMarine+ will become a marine focal point for IPBES. It will contribute to the 'Blue Growth' agenda and will support the European Marine Strategy Framework Directive. This is an incredible challenge for scientists, who have today a responsibility to assemble the scientific knowledge to perform integrated and multidisciplinary analyses and to communicate the results to stakeholders in an appropriate manner. EuroMarine+ constitutes a long-term and challenging project to sustain our marine living resources and to ensure a good environmental status for our changing marine ecosystems.

- The scientific strategy for EuroMarine+ recognises the existence of key scientific challenges and questions that are common to the three broad communities that merge into the new consortium. It points out that the initial resources of EuroMarine+ could be used to address a number of 'emerging fields' in the so-called 'trading zones' (the areas where the interests of the three communities intersect, as represented in blue in the above schematic) to favour integration, synergy and new scientific progress.



POINT OF VIEW 2

**Paul TRÉGUER (INSU-CNRS and UBO),
Scientific Director of the former EUR-OCEANS NoE,
Executive Committee member of the EUR-OCEANS
Consortium**

■ In 2004-2005, while deciding to fund three Networks of Excellence (NoEs) in the marine area, the European Commission (EC) called the member organisations (MOs) involved in these NoEs to elaborate on the concept of a future, common and permanent 'virtual laboratory' that would prolong the NoEs beyond their EC funding period. The idea was to favour long-term convergence on research programmes and access to shared integrated infrastructures. At the end of the NoEs funding period by the EC, it however became clear that key MOs of major European nations were not ready to go along this line. Consequently, the three NoEs went their separate ways to keep their respective scientific communities networked: the MarBEF NoE continued as the MarBEF+ association, Marine Genomics Europe invested in EMBRC (an ESFRI-inspired initiative), and the EUR-OCEANS NoE became the EUR-OCEANS Consortium (EOC). With a limited amount of funds (in average: 214 k€/year provided by more than 20 paying members), EOC did a great job from 2009 to 2013 to organise convergence on hot scientific topics, not only within its MOs, but also with international partners. In accordance with the EC wish of seeing a common structure emerge, EOC is now dissolving and merging within the EuroMarine+ consortium. It is clear that this new consortium focuses on marine biology. However, within the framework of the new consortium, many of the EOC MOs will continue to develop a multidisciplinary approach (including physics, chemistry and biogeochemistry) that is needed to successfully address major scientific challenges related to the response of marine systems to global change.

POINT OF VIEW 3

**Véronique GARÇON (CNRS/LEGOS, France) - Co-leader
of EUR-OCEANS Ocean Deoxygenation Flagship**

■ I think that the EUR-OCEANS Network of Excellence and Consortium have been instrumental in structuring and shaping European research on marine biogeochemical cycles and marine ecosystems within the context of global change. As Future Earth is emerging as an international programme that will deliver enhanced knowledge for societies to face challenges inherent in global environmental change, and to invent the transition routes towards global sustainability, the upcoming EuroMarine+ organization has a tremendous role to play. The future research carried out within EuroMarine+ should elucidate how the global change pressures (such as climate, hypoxia, acidification, sea-level rise) currently impact, directly or indirectly, on marine ecosystem structure and functioning and delivery of marine ecosystem services, or how they will do so in the future. Furthermore, EuroMarine+ should commit to capacity building to transmit knowledge since education is the only answer to Earth climate issues.



In February 2013, Carlo HEIP, who has led the MarBEF Network of Excellence and played a key role in the definition and course of the EuroMarine project (among many more European or international initiatives related to the science and cause of biodiversity), passed away before he could see the launch of the EuroMarine+ Consortium. He was enthusiastic about the emergence of a single European marine science network in which every scientist could have a voice. He will be remembered as an outstanding scientist and a warm, friendly and optimistic person, whom the future consortium will miss.

© Isabel Pinto (picture taken in May 2012 during a EuroMarine meeting in Paris).



Abbreviations

Abbreviations of EUR-OCEANS Member Organisations are listed and explained on page 7. Abbreviations of some other organisations, projects or programme that have co-led activities funded by EUR-OCEANS are listed and explained on page 15. Other abbreviations used (and explained) only once are not reproduced below.

EC	European Commission of the European Union
EMBRC	European Marine Biological Resource Centre
EOC	EUR-OCEANS Consortium
EPOCA	FP7 project: European Project on Ocean Acidification
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructure
EU	European Union
EURO-BASIN	FP7 project: European Union Basin-scale Analysis, Synthesis and Integration
EUR-OCEANS	EUropean research on OCean Ecosystems under Anthropogenic and Natural forcingS (an FP6 marine Network of Excellence)
EUROSITES	FP7 project: Integration and enhancement of key existing European deep-ocean observatories
FP6	Sixth Framework Programme (of the European Union) for Research and Technological Development
FP7	Seventh Framework Programme (of the European Union) for Research and Technological Development
Horizon 2020	Name of the Eighth Framework Programme (of the European Union) for Research and Innovation
IOC	Intergovernmental Oceanographic Commission
IPBES	Intergovernmental Platform for Biodiversity & Ecosystem Services
JPI Oceans	Joint Programming Initiative Healthy and Productive Seas and Oceans
MarBEF	Marine Biodiversity and Ecosystem Functioning (an FP6 marine Network of Excellence)
MEECE	FP7 project: Marine Ecosystem Evolution in a Changing Environment
MESOAQUA	FP7 project: Network of leading mesocosm facilities to advance the studies of future aquatic ecosystems from the Arctic to the Mediterranean
METAOCEANS	FP6 project: Elucidating the structure and functioning of marine ecosystems through synthesis and comparative analysis
MGE	Marine Genomics Europe (an FP6 marine Network of Excellence)
MO	Member Organisation
NASA	National Aeronautics and Space Administration
NoE	Network of Excellence
OMZ	Oxygen Minimum Zones
RFO	Research Funding Organisation
ROMS	Regional Ocean Modeling System
RPO	Research Performing Organisation
SESAME	FP6 project: Southern European Seas: Assessing and Modelling Ecosystem changes
SWOT	Surface Water Ocean Topography (mission)
UNESCO	United Nations Educational, Scientific and Cultural Organization



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