

ANNUAL REPORT



2018

EDITORIAL

BY FRANÇOIS HOULLIER
CHAIRMAN AND CEO OF IFREMER



© Ifremer - S. Lesbats

Since I joined Ifremer at the end of summer 2018, I have been able to fully appreciate the breadth of its disciplinary spectrum and the diversity of its missions – research and management of research infrastructures, scientific expertise to support public policies, partnership and transfers for innovation – as well as its wide range of activities, productions and the resulting impacts. Present along all of the French seafronts, in both metropolitan and overseas France, Ifremer holds a unique place in the marine sciences and technologies landscape: a reference institute in the field, it is at the heart of a densely knit network of partners, where it works collaboratively and interacts with universities, schools and other research bodies, with the administrations of several ministries, with local and regional authorities, economic and industrial players and increasingly, with civil society. In Europe and worldwide, Ifremer is amongst the most visible and influential marine science research institutes.

Without claiming to be exhaustive, this annual activity report naturally reports on the diverse facets of the Institute. I would like to highlight three major events which have made 2018 a singular year in our Institute's history.

Firstly, the unification of the French oceanographic fleet: the outcome of a long process engaged for several years, it has become reality since the 1st of January 2018. My predecessor, François Jacq, actively devoted his efforts to this with a spirit of

open-mindedness, rigour and service. For more than a year now, the fleet has thus been operated by Ifremer, on behalf of and to the benefit of the entire French scientific community concerned, and its management entities are now in place. This new organisation further strengthens the national, European and international visibility and clarity of this very large research infrastructure, the largest for environmental sciences in France. It is already enabling clearer and more efficient management. As for the immediate future, the transfer of CNRS ships and seamen must now be finalised; and above all the change at Genavir must be organised in order to guarantee the continuity of service in this new context. In the medium and the long term, this is a question on ensuring the operational funding for the fleet and preparing its upgrading and renewal: the thought and discussion processes begun as of 2017 will materialise in 2019 in the form of multiannual scheduling.

The second event concerns the transfer of the Institute's headquarters from Paris to Brest. After several years of preparation, the transfer took effect as of the 1st of January 2019. The first, essential, phase of this operation involved accompanying the employees of the Issy-Les-Moulineaux site on the social level: the mobilisation of the human resources division, the State and its public-sector made it possible to find solutions for all staff concerned. The second phase involved real estate: construction of the building intended to host the headquarters on the Plouzané site should be completed by summer 2019. The third phase, that of upgrading the Thalassa research vessel was technically finished in 2017. Above and beyond following through on the successful achievement of this major project, 2019 will open a long period of consolidation, or even the rebuilding, of the divisions in charge of support for research, administration and the general running of the Institute. This means both taking advantage of the new situation to promote Brest as an international pole of attraction in marine sciences and technologies and to inaugurate new ways of functioning that abide by both the Institute's national dimension and the distributed skills and resources of the other sites.

Following its assessment by HCERES in 2017, the collectively drafted new long-term orientation document entitled "Our institute project. Horizon 2030" was finalised in the second semester of 2018. The foundation stone of the new contract of objectives and performance 2019-2023, this strategy outlines the ambitious scientific perspective of "*understanding and predicting changes in the ocean by 2100*" that can measure up to the local, national and global challenges facing the sea and coasts. These include coping with climate disruption, numerous forms of pollution and biodiversity in crisis, and developing the blue economy. These stakes require both improving our knowledge of the ocean, its functional and evolving processes, its resources and their uses, and spurring the inter- and trans-disciplinary approaches which are vital for research to fully contribute to the goals of sustainable development adopted in 2015, several of which concern the sea and maritime activities. Meeting these challenges of knowledge and integration will imply strengthening our capabilities of exploration, observation and modelling, as well as those of managing, sharing and utilising the masses of data produced. This strategy also highlights the need to place marine sciences and technologies marines at the centre of society: by supporting innovation and diversifying the forms of partnerships and transfers to the economic realm, by amplifying the InOcean approach launched in 2018; through renewed support for public policies, carrying on from actions already engaged for several years; and through more collaborative and participatory forms of interaction with citizens. Naturally, this strategy has a strong partnership-based dimension, not only in the framework of site policies and national alliances, but also through stronger collaboration in Europe and through the commitment to global initiatives such as the future 2021-2030 decade of oceanic sciences serving sustainable development.

François HOULLIER

CONTENTS

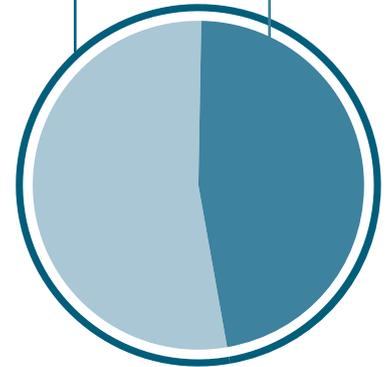
- 2 EDITORIAL BY FRANÇOIS HOULLIER,
CHAIRMAN AND CEO OF IFREMER
- 5 2018, THE YEAR IN PICTURES
- 8 INSTITUTE PROJECT HORIZON 2030
AND CONTRACT OF OBJECTIVES
AND PERFORMANCE 2019-2023
- 9 FRENCH OCEANOGRAPHIC FLEET
- 15 OCEANOGRAPHIC CRUISES
CONDUCTED IN 2018
- 20 SCIENTIFIC POLICY
- Live, from research :**
 - 24 OCEANOGRAPHY
AND ECOSYSTEM DYNAMICS
 - 29 LIVING RESOURCES AND THEIR
ENVIRONMENT
 - 34 DEEP-SEA RESOURCES
AND ECOSYSTEMS
 - 40 RESEARCH INFRASTRUCTURES
AND INFORMATION SYSTEMS
- 44 SUPPORT FOR PUBLIC POLICIES
- 47 INNOVATION AND ECONOMIC
PARTNERSHIPS
- 51 EUROPEAN AND INTERNATIONAL
PARTNERSHIPS
- 55 COMMUNICATIONS
- 58 HUMAN RESOURCES AND SUPPORT
SERVICES FOR RESEARCH
- 62 APPENDICES

Cover photo :
UNDERWATER VIEW OF HROV
DURING ESSHROV MISSION
© Ifremer - O. Dugornay

KEY FIGURES



1474 SALARIED EMPLOYEES
47% WOMEN



647 RESEARCHERS AND ENGINEERS

206 PHD STUDENTS SUPERVISED BY IFREMER RESEARCHERS

90 HOLDERS OF ACCREDITATION TO SUPERVISE RESEARCH (HDR)

66 NEW EMPLOYEES IN 2018

55 POST-DOCTORAL FELLOWS

235 000 000 €
BUDGET

* Since 1 January 2019, Ifremer's headquarters have been located at the Plouzané centre (29).

** The Trinité-sur-Mer station was closed in 2018.

2018 IN PICTURES

JANUARY

Test tank trials for the Nautilus project led by Tecnalia (Spain), to design a semi-submersible support platform for a wind turbine. ©Ifremer - O. Dugornay



FEBRUARY

IBTS* oceanographic cruise in the English Channel-North Sea: after 20 days of cruise, RV *Thalassa* returns to Boulogne-sur-Mer harbour with the data needed to better understand changes in fish communities.

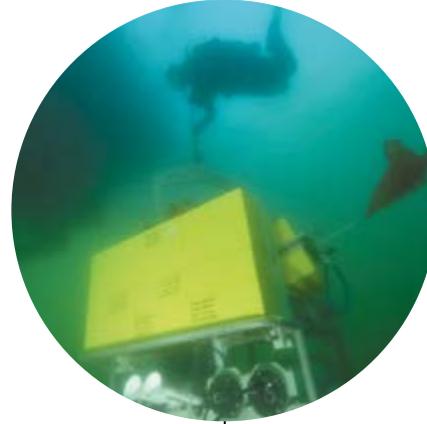
©Ifremer - S. Lesbats



JANUARY-MARCH

BICOSE 2**cruise. A team of scientists coordinated by Ifremer embark aboard the *Pourquoi pas?* research vessel. The objective: to dive to depths of more than 3,500m in the middle of the Atlantic Ocean to study organisms living around hydrothermal vents.

© Ifremer



MARCH-APRIL

Coastal water quality in the Mediterranean is improving overall from year to year and bottom-dwelling fauna and any contaminations must be assessed regularly. On 21 March, 5 scientists boarded Ifremer's research vessel *L'Europe* for a cruise lasting until 12 April, to take new measurements and conduct the monitoring required by European directives aiming to assess the quality of water masses.

©Ifremer - E. Emery

MAY- JUNE

Study on gas seepage from "pockmarks" in the bay of Concarneau - SYPOCO*** cruise.

© Ifremer - O. Dugornay

JULY

Launch of the “Marine Habitats” (Life+ Marha) project to further the implementation of the EU “Habitats-Fauna-Flora” directive defining Natura 2000 policy. Ifremer is taking part in acquiring knowledge, e.g. by monitoring coral reefs found

in some underwater canyons, on the border between the continental shelf and the abyssal plains. Photo: cold-water corals: *Anthotela sp.* (Alcyonacea, purple), gorgonians (Alcyonacea) and feather stars. ©Ifremer

AUGUST

Aqua2018 conference and trade show, world aquaculture gathering in Montpellier, tour of the aquaculture facilities at Ifremer’s Palavas-les-Flots station.

©Ifremer - Drone STUDIO



OCTOBER

The CFOSAT (China-France Oceanography SATellite) satellite was put into orbit around the Earth in 2018 to study wind and waves on the oceans’ surface. These data will make it possible to produce more reliable forecasts of the sea state, and better understand the interactions between the ocean and the atmosphere.

The project is jointly developed by CNES and the Chinese space agency CNSA (China National Space Administration) with Ifremer as one of its notable partners.

© CNES/ihl./SATTLER Oliver, 2017

OCTOBER

Teams from CNRS, Ifremer and Monaco Explorations joined forces to better understand the behaviours of green turtles in Martinique.

Technological developments of shipboard cameras and connected objects were developed by the pilot project for Indian Ocean sea Turtles in the framework of the "Scattered islands research Consortium" in collaboration between CNRS-Inee, IRD, Ifremer, AFB, University of La Réunion, CUFR of Mayotte and the TAAF French southern and Antarctic lands.

©Olivier Borde / Monaco Explorations

DECEMBER

Coral health status mapped in La Réunion. Thanks to so-called “hyperspectral” imaging technology, it has become possible to assess the health status at the surface of reef platforms in Reunion Island.

©Ifremer - M. Duval

- * International bottom trawl survey
- ** Biodiversity Interactions connectivity and symbioses in extreme environments
- *** Sedimentary and pockmarks system in the bay of Concarneau

INSTITUTE PROJECT HORIZON 2030 AND CONTRACT OF OBJECTIVES AND PERFORMANCE 2019-2023

Two major documents which guide Ifremer's studies and organisation were drawn up during 2018. They were the Institute project and the contract of objectives and performance.

The Institute project entitled "Horizon 2030" was created from a collective effort which mobilised over a hundred salaried employees and outside partners. Through this project, our Institute is seeking to define an outlook for the next decade and guide its action over this period. In it, as the project's guiding principal, Ifremer reaffirms the triptych our Institute was founded on, i.e. the triple commitment to research, innovation and support for public authorities, in setting itself four major ambitions:

- be a stakeholder tuned into society;
- understand and predict changes in the ocean by 2100;
- be a driver of innovation, and finally,
- act as a catalyst for French marine sciences and technologies.

The contract of objectives and performance (COP) 2019-2023 between the State and Ifremer ties in with the Institute project's perspective. Drafting this contract drew from the assessment of the previous objectives contract and from exchanges with the Institute's supervisory ministries since the summer of 2018. The new contract is an operational document which sets the objectives and the actions to be conducted, whose regular monitoring is based on calculating indicators.

The contract is organised as follows :

- understanding and predicting changes in the ocean by 2100 (the Institute's scientific orientations);
- mobilising scientific knowledge and developing expertise to support public policies;
- being an innovative organisation, a driver of development for the maritime economy;
- deriving maximum benefit from a unified fleet serving all user, by preparing and implementing a multiannual plan for scheduling and renewing ships and underwater vehicles;
- being a recognised institute on European and international scales, and finally, constructing an approach geared towards improvement in managing the institution and the use of its resources.



FRENCH OCEANOGRAPHIC FLEET

The French oceanographic fleet (FOF) is one of the twenty-two very large French research infrastructures (LRI). At the proposal of the Ministry in charge of research, the fleet has been operated by Ifremer since 2018, to the benefit of the scientific community.

The FOF governance established in January 20018 makes it possible to ensure compliance with the scheduling specifications and associate all of the stakeholders in a balanced manner. Thus, the FOF's general orientations, scheduling and budget are decided on by an executive committee whose members are the Ministry in charge of research, Ifremer, CNRS, IRD and the marine universities group. An independent scientific board made up of French and international scientists advises the executive committee. This scientific guidance board met for the first time in December 2018, chaired by Uwe Nixdorf (Alfred Wegener Institute – Germany). Oceanographic cruises proposed by scientific teams are selected by two independent national commissions, one for the ocean-going fleet and the other for the coastal fleet.

Ifremer conducts the operational management of the Fleet and ensures, based on the available financial resources, that the fleet is engaged annually during 450 days of scientific research activity for the ocean-going vessels and 960 days for the inshore vessels.

The FOF gathers the ships which were managed in the past by Ifremer, CNRS, IRD and IPEV. Thus it has four ocean-going vessels, two vessels based in overseas France, five coastal vessels and seven station boats (managed by CNRS). It also has underwater vehicles, such as the *Victor 6000* and Ariane ROVs, the *Nautilie* submersible and mobile equipment which can be used, for instance, to explore geological structures or the seafloor (seismic streamers, penetrometer, corers).

Although the Fleet is principally used for scientific research, it also fulfils public service, observation and surveillance missions on behalf of the State. It is likewise solicited in the framework of research-industry partnerships with the socio-economic sector. Lastly, it contributes to research training for students.

UNIFICATION OF THE FLEET

INTERVIEW WITH JEAN-MARIE FLAUD (MINISTRY OF HIGHER EDUCATION, RESEARCH AND INNOVATION), CHAIRMAN OF THE FOF EXECUTIVE COMMITTEE.



WHAT WERE THE MOTIVATIONS AND HOW WAS THE UNIFICATION OF THE FLEET LRI CONCEIVED?

The issue of how to optimise the oceanographic fleet had been the subject of debate and discussion for over twenty years. As time passed, awareness of the need for change grew stronger. In 2016, the mission letter sent to François Jacq by the Secretary of State for Higher Education and Research opened a new phase, to go beyond the progress made by the UMS Fleet joint service unit created in 2011. The aim of the mission was to propose concrete solutions enabling this new step to be taken, in the most pragmatic possible way. A team was formed, composed of well-known figures from various horizons. After meeting with the numerous interested stakeholders and setting up a monitoring arrangement with the UMS Fleet joint service unit operators (CNRS, IRD, IPEV, Ifremer), the mission team formed its conviction that the solution of a unified Fleet underpinned by Ifremer was the best option to ensure its lasting use whilst preserving the high-level technological tools it needs. Proposals made by the mission team were approved by the ministry and the organisations which use the Fleet, with the shared conviction that this change would certainly represent an added value.

WHAT WERE THE PRINCIPLES CHOSEN FOR THIS UNIFICATION?

Four principles were selected: unifying the budget, defining the specifications for fleet utilisation, setting up a dedicated organisation within Ifremer, along with dedicated governance, and the unification of scheduling. This meant that the fleet budget became a single budget allocated to Ifremer by the ministry, and monitored separately, within Ifremer's budget. For the FOF scheduling to take account of existing constraints and the interests of users, specifications for the scheduling were drawn up. The executive committee guarantees it will be complied with, decisions are taken unanimously through consensus between the different members.



LE POURQUOI PAS ?, QUAYSIDE.
© Ifremer - Gilles Martin

WHAT LESSONS HAVE YOU LEARNED FROM THE FIRST YEAR OF OPERATION?

We had a short time frame, but the entire framework is now in place. The 2018 schedule displays some very fine scientific cruises, while the more fundamental work, like the renewal plans for the Fleet and underwater vehicles has begun and has been submitted to the FOF's scientific board. We have expressed the wish that the FOF unification will allow for multiannual scheduling, to give the scientific community a better vision of the schedule for coming years. The engagement will be met in 2019, by grouping several scientific cruises in the Pacific, a fine illustration!

OBSERVING THE OCEANIC CRUST THANKS TO THE NEW SEISMIC EQUIPMENT OF THE FRENCH OCEANOGRAPHIC FLEET

INTERVIEW WITH SATISH SINGH, PROFESSOR AT THE INSTITUT DE PHYSIQUE DU GLOBE DE PARIS (IPGP), MARINE GEOSCIENCES LABORATORY.



YOU TOOK PART, AS CHIEF SCIENTIST, IN THE ILAB SPARC¹ CRUISE ABOARD RV POURQUOI PAS? IN SEPTEMBER 2018. WHAT WERE THE MAIN SCIENTIFIC OBJECTIVES OF THIS CRUISE?

The ILAB Sparc cruise is part of an international research programme involving French, British, German, American and Italian laboratories. The studies conducted aim to study the nature and thickness of the lithosphere, as well as the fundamental properties of its lower boundary with the asthenosphere (the "plastic" ductile area of the Earth's mantle). These properties are vital for us to better understand and describe the phenomenon of plate tectonics. The Atlantic Ocean was chosen because it is a region where fractures have left wide corridors of accretion perpendicular to the ridge access intact. So, continuous two-dimensional profiles can be taken there. In this way, the evolution of the lithosphere can be studied from the axis of the ridge (zero-age) to 80 million years near the continental margin. Previous seismic acquisition cruises had been conducted since 2015. The ILAB-Sparc cruise's objective was to complement the data sets already acquired with two large profiles:

one perpendicular to the ridge, which should enable the expansion of the oceanic crust from 8 to 25 million years to be studied, and a transverse profile, which goes through the fracture zones and covers the oceanic lithosphere from 7 to 75 million years.

DURING THIS CRUISE, YOU DEPLOYED IFREMER'S NEW SIS 1 SEISMIC EQUIPMENT. WHAT IS YOUR INITIAL FEEDBACK ON THE QUALITY OF DATA ACQUIRED AND WHAT ARE YOUR EXPECTATIONS FOR EXPLOITING THEM?

For our acquisitions, we deployed the new seismic source with two floaters and sixteen air guns (emitters); the signals are received both with the SIS 1 seismic streamer which is 6,000 metres long, and the *OBS Ocean bottom seismometer* instruments with pressure sensors and accelerometers, deployed on the seafloor. In all, 980 nautical miles of profiles were taken, along with 90 deployments of these seismometers.

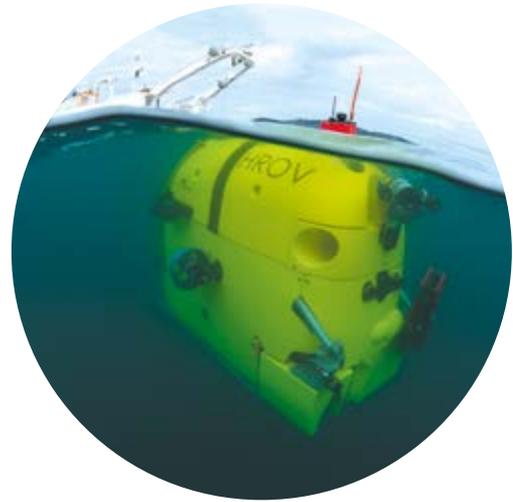
The first data processing showed that the signals emitted by the source were detected by the *OBSs* to distances reaching 750 km, which had never been accomplished before. Such distances could be reached thanks to highly accurate synchronisation of the source's air guns and leaving 300 metres between shots. With this sort of distance achievable, we hope to be able to characterise the mantle to a depth of 80 km, and thus improve our understanding of the phenomena which occur there.

The simultaneous acquisition of seismic reflection data (with the 6,000-metre seismic streamer) and refraction data (with the *OBSs*) will make it possible to map the lithosphere at different scales and resolutions. This combined approach will contribute to a better characterisation of the oceanic crust as well as the upper layer of the mantle.

¹ . see map of offshore oceanographic cruises p. 16

FOLLOWING A DIVE IN REAL TIME FROM A ROOM ON SHORE - THE TELEPRESENCE PROJECT, AND THE OPPORTUNITY FOR STUDENTS TO ACQUIRE OR EXPLOIT OUTSTANDING DATA COLLECTED UNDERWATER

**INTERVIEW WITH FRÉDÉRIQUE LECLERC, RESEARCH
PROFESSOR AT NICE SOPHIA ANTIPOLIS UNIVERSITY,
AFFILIATED WITH THE GÉOAZUR LABORATORY.**



THE HROV SUBMERSIBLE ARIANE
ON A TECHNICAL TRIALS MISSION UNDERWATER
© Ifremer - O. Dugornay

**YOU TOOK PART, AS CO-CHIEF SCIENTIST, IN THE TÉLÉPRÉSENCE²
CRUISE ABOARD RV L'EUROPE WITH THE HROV ARIANE³ IN DECEMBER 2018.
WHAT WERE ITS MAIN OBJECTIVES?**

During the Telepresence cruise, we had two scientific objectives that were part of the study of the tectonic and sedimentary evolution of the Ligurian margin (Mediterranean Sea). We wanted to study the stratigraphy there, thanks to an underwater cliff

² see map of inshore oceanographic cruises p. 16

³ An ROV (*Remotely Operated Vehicle*) is a submersible vehicle operated at a distance by the pilot of a submarine or from the control room aboard a ship. An AUV (*Autonomous Underwater Vehicle*) is submersible vehicle which operates autonomously without being remotely controlled. An HROV *Ariane* (*H - hybrid*) is a vehicle with an on-board energy supply which provides possibilities for deploying it either in remotely operated (ROV) mode or autonomous (AUV) mode. *Ariane* makes 'daily work cycle dives' possible, to depths of 2,500 m, on missions of intervention, sampling, inspection or optical and acoustic mapping. Its propulsion system and navigation sensors allow it to operate on any type of seabed, including very uneven terrains like canyons.

whose walls show a succession of sedimentary layers. Visual observation of this erosion structure was of interest in order to document the way the margin is eroding and how it responds morphologically to various factors. The aim of the second dive focused on the observation of faults discovered in the past few years at the foot of the continental slope, from Nice to Imperia, in Liguria. The nature of these faults is still a subject of discussion and so visual observation along with reconstructing 3D models of the steep slopes from the video taken by HROV *Ariane* should make it possible to answer some of the questions about them.

**DURING THIS CRUISE, YOU TESTED THE TELEPRESENCE CONCEPT.
CAN YOU DESCRIBE WHAT IT PROVIDES?**

We used the telepresence system, between RV *L'Europe* and the conference room at the Géoazur laboratory, where data from HROV *Ariane* were projected in real time, with a video-conference connection with the team located on board.

A permanent communications system between shore and sea was established by the ship's satellite, with a sufficient bit rate to transmit high-quality images. The tools deployed proved to be of very good quality and discussion was easy between the vessel and the Géoazur laboratory. This mission turned out to be a truly educational tool. The students from the Advanced Master 2 programme in geosciences, geohazards and georesources at the University of Nice Sophia Antipolis had the goal of setting up a project on underwater research and observation. They determined the issues and scientific objectives

for the two dives, prepared them in advance, and then took an active part. They were supervised by me on shore and by Christophe Larroque on the vessel. Telepresence enabled group analysis and collective decision-making about how to acquire the data and send them to the HROV's pilots via the scientist in charge on board and as directed by the Chief scientist Olivier Soubigou (Ifremer).

ARE YOU CONSIDERING RENEWING THIS EXPERIENCE ?

Yes, of course. The educational project went very well and the students are now working on exploiting the data. This means that they carried out a scientific project from start to finish, in the framework of a highly innovative project. With the teaching team, we are thinking about the next steps, particularly submitting an application for a cruise as of 2019 to continue exploring the margin with future students, once again using telepresence. We are also considering collaborating with scientific colleagues whose cruises are scheduled with a ROV, so that we could follow their surveys.



L'ATALANTE, ONE OF THE OCEAN RESEARCH VESSELS OF THE FRENCH OCEANOGRAPHIC FLEET LARGE RESEARCH INFRASTRUCTURE

SEARCHING FOR "EXTREME" CLIMATE AND GEOLOGICAL EVENTS IN DEEP-SEA SEDIMENTS OFF TAIWAN

INTERVIEW WITH NATHALIE BABONNEAU, RESEARCH PROFESSOR, GÉOSCIENCES OcéAN LABORATORY, CHIEF SCIENTIST OF THE EAGER⁴ CRUISE, JUNE 2018.



WHAT WERE THE MAIN OBJECTIVES OF THIS CRUISE MADE ABOARD RV MARION DUFRESNE?

The Eager cruise's objective was to find the traces of extreme events which have affected Taiwan: major earthquakes, tsunamis, eruptions, mega-typhoons, in deep marine sediments. The island of Taiwan provides an exceptional setting for this type of study. Its unique geodynamic context shows two subduction zones, leading to some of the highest rates of seismicity in the world. Furthermore, the island is located on the axis of "Typhoon Alley", meaning that it is hit by four typhoons a year on average. Historically, the region has suffered from exceptionally disastrous events like the Chi-Chi earthquake in 1999 or Typhoon Morakot in 2009. The Eager cruise aimed to take core samples to obtain a sedimentary record of extreme events over several thousand years, in order to study the periodicity and variability of these hazards, and *in fine* to draw up predictive models and improve risk prevention.

⁴ see map of offshore oceanographic cruises p. 16

WHY WAS RV *LE MARION DUFRESNE* THE IDEAL VESSEL TO SUCCESSFULLY CONDUCT THIS CRUISE?

The *Marion Dufresne* offers the best deep-sea coring capability worldwide, with long cores of excellent quality, and has numerous facilities for processing samples on board. Thanks to its large accommodation capacity, 49 scientists from eleven different institutions took part, including eleven Master students hosted on a "Floating university".

SIX MONTHS LATER, WHAT IS THE INITIAL SCIENTIFIC ASSESSMENT?

Thirty-two sediment cores reaching up to 46 metres in length, and fourteen interface core samples were taken. They are being analysed and dated in France

and in Taiwan. On all the sites, gravity deposits have been identified as the potential signatures of extreme events and are the first promising results in obtaining event chronologies. To the South of the Ryukyus islands, turbidite deposits show a very distinct origin, suggesting their emplacement during tsunamis. These deposits could thus represent the first marine record of tsunamis documented on land. For the first time in this region, a thick level of volcanic ash from the Pleistocene was identified. To date, the volcanic caldera at the origin of this eruption remains unknown, but geochemical analyses will enable it to be identified. Finally, on two sites, gas hydrates were sampled. This discovery is a first in Taiwanese waters and represents significant stakes for energy resources in Taiwan.



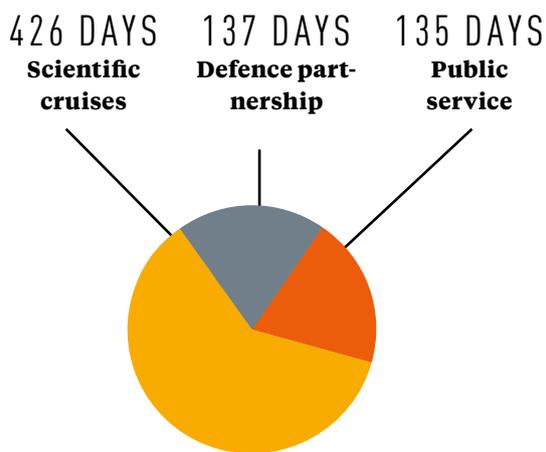
SAMPLING OF A SEDIMENTARY CORE BY TWO IFREMER SCIENTISTS DANIELA ZEPILLI (ON LEFT) AND SOPHIE ARNAUD-HAOND (ON RIGHT) DURING THE AMIGO CRUISE IN 2018 IN THE CONTEXT OF THE "PORQUOI PAS LES ABYSSES?" PROJECT. OBJECTIVE: TO BETTER UNDERSTAND THE BIODIVERSITY OF DEEP SEAFLOORS.

© Ifremer - Gilles Martin

CRUISES 2018

1926 DAYS AT SEA:

OCEAN-GOING VESSELS

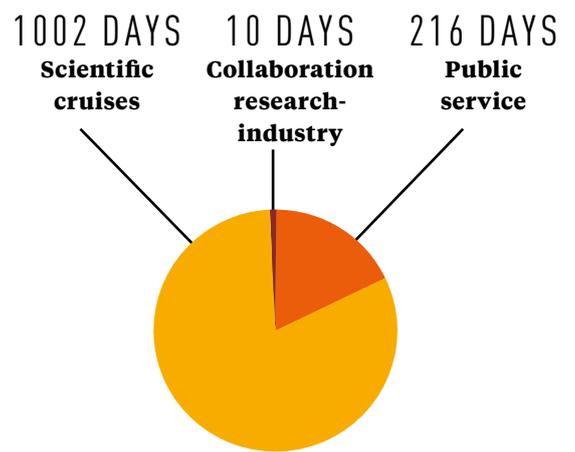


OCEAN-GOING VESSELS

MARION DUFRESNE
POURQUOI PAS ?

L'ATALANTE
THALASSA

COASTAL VESSELS

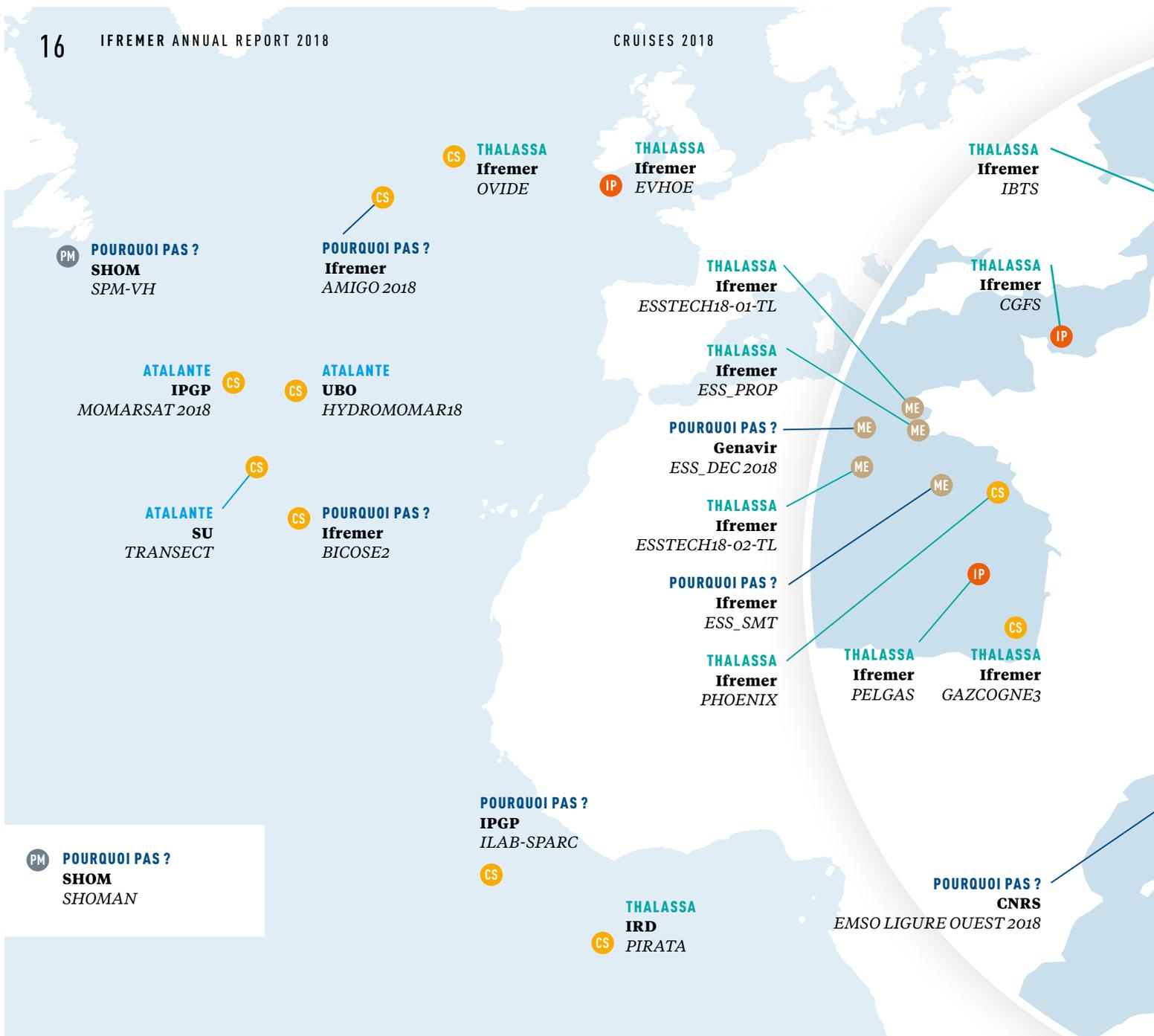


COASTAL VESSELS

L'EUROPE
CÔTES DE LA MANCHE
TÉTHYS II
THALIA
HALIOTIS

SEMI-OFFSHORE VESSELS

ALIS
ANTÉA



OFFSHORE FLEET

MISSIONS

- PM Defense partnership
- IP Public service
- CS Scientific cruises
- ME Technical trials mission

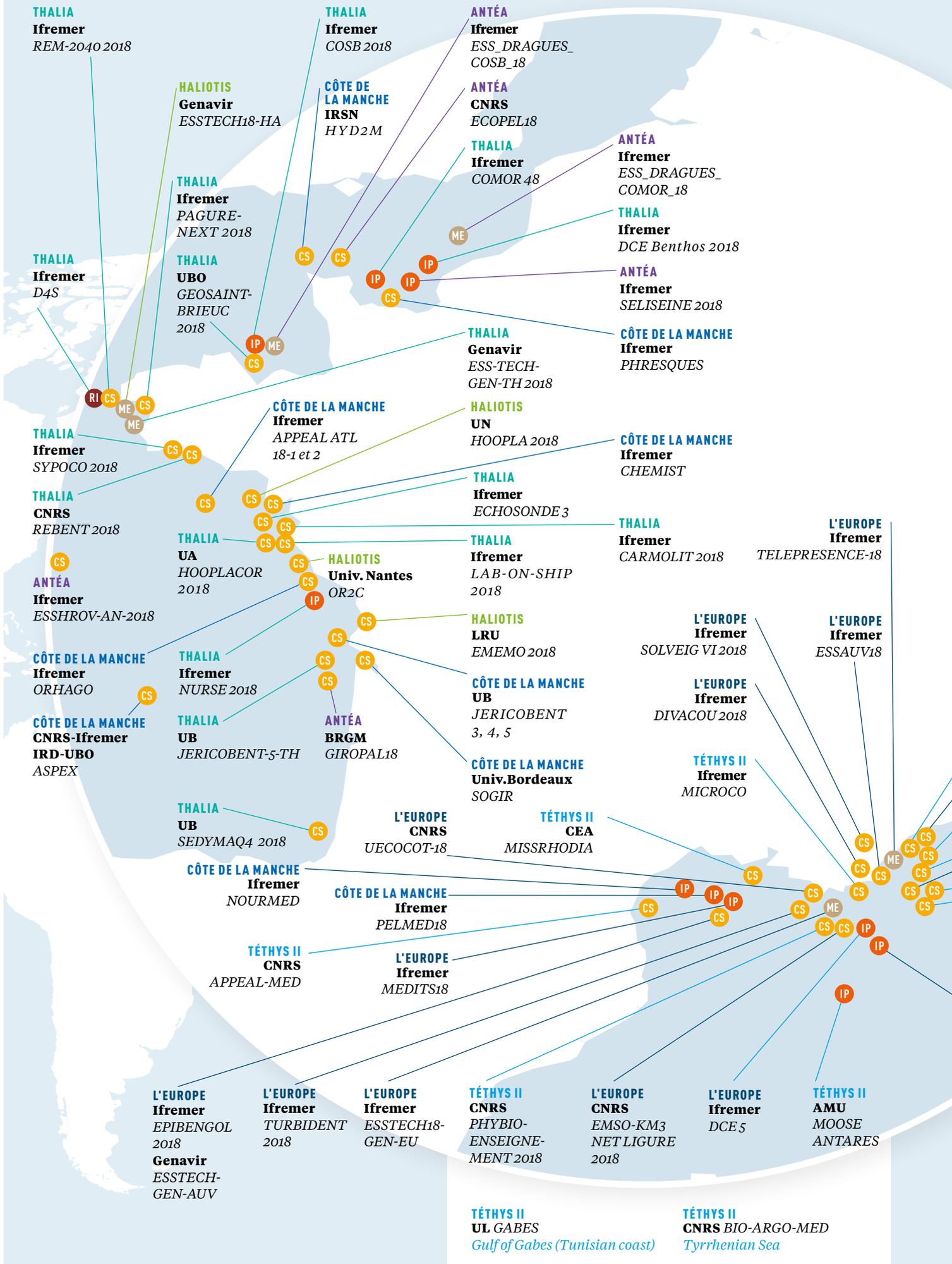
VESSELS

- MARION DUFRESNE
- POURQUOI PAS ?
- L'ATALANTE
- THALASSA

ORGANISATIONS

- CNRS** . . Centre national de la recherche scientifique
- Genavir** Groupement pour la gestion de navires de recherche
- Ifremer** Institut français de recherche pour l'exploitation de la mer
- IPGP** . . . Institut de physique du globe de Paris
- IRD** Institut de recherche pour le développement
- MNHN** . Museum national d'histoire naturelle
- NIOZ** . . . Netherland institute for sea research
- SHOM** . . Service hydrographique et océanographique de la Marine
- SU** Sorbonne Université
- UBO** Université de Bretagne Occidentale
- UPS** Université Paris-Sud





THALIA
Ifremer
REM-2040 2018

THALIA
Ifremer
COSB 2018

ANTÉA
Ifremer
ESS_DRAGUES_
COSB_18

HALIOTIS
Genavir
ESSTECH18-HA

CÔTE DE LA MANCHE
IRSN
HYD2M

ANTÉA
CNRS
ECOPEL18

ANTÉA
Ifremer
ESS_DRAGUES_
COMOR_18

THALIA
Ifremer
PAGURE-
NEXT 2018

THALIA
Ifremer
COMOR 48

THALIA
Ifremer
DCE Benthos 2018

THALIA
Ifremer
D4S

THALIA
UBO
GEOSAIN-
BRIEUC
2018

ANTÉA
Ifremer
SELISEINE 2018

THALIA
Genavir
ESS-TECH-
GEN-TH 2018

CÔTE DE LA MANCHE
Ifremer
PHRESQUES

CÔTE DE LA MANCHE
Ifremer
APPEAL ATL
18-1 et 2

HALIOTIS
UN
HOOPLA 2018

CÔTE DE LA MANCHE
Ifremer
CHEMIST

THALIA
Ifremer
SYPOCO 2018

THALIA
Ifremer
ECHOSONDE 3

THALIA
Ifremer
CARMOLIT 2018

L'EUROPE
Ifremer
TELEPRESENCE-18

THALIA
CNRS
REBENT 2018

THALIA
UA
HOOPLACOR
2018

THALIA
Ifremer
LAB-ON-SHIP
2018

ANTÉA
Ifremer
ESSHROV-AN-2018

HALIOTIS
Univ. Nantes
OR2C

HALIOTIS
LRU
EMEMO 2018

L'EUROPE
Ifremer
SOLVEIG VI 2018

L'EUROPE
Ifremer
ESSAUV18

CÔTE DE LA MANCHE
Ifremer
ORHAGO

THALIA
Ifremer
NURSE 2018

ANTÉA
BRGM
GIROPAL18

CÔTE DE LA MANCHE
UB
JERICOBENT
3, 4, 5

L'EUROPE
Ifremer
DIVACOU 2018

CÔTE DE LA MANCHE
CNRS-Ifremer
IRD-UBO
ASPEX

THALIA
UB
JERICOBENT-5-TH

CÔTE DE LA MANCHE
Univ. Bordeaux
SOGIR

TÉTHYS II
Ifremer
MICROCO

THALIA
UB
SEDYMAQ4 2018

L'EUROPE
CNRS
UECOCOT-18

TÉTHYS II
CEA
MISSRHODIA

CÔTE DE LA MANCHE
Ifremer
NOURMED

CÔTE DE LA MANCHE
Ifremer
PELMED18

TÉTHYS II
CNRS
APPEAL-MED

L'EUROPE
Ifremer
MEDITS18

L'EUROPE
Ifremer
EPIBENGOL
2018
Genavir
ESSTECH-
GEN-AUV

L'EUROPE
Ifremer
TURBIDENT
2018

L'EUROPE
Ifremer
ESSTECH18-
GEN-EU

TÉTHYS II
CNRS
PHYBIO-
ENSEIGNE-
MENT 2018

L'EUROPE
CNRS
EMSO-KM3
NET LIGURE
2018

L'EUROPE
Ifremer
DCE 5

TÉTHYS II
AMU
MOOSE
ANTARES

TÉTHYS II
UL GABES
Gulf of Gabes (Tunisian coast)

TÉTHYS II
CNRS BIO-ARGO-MED
Tyrrhenian Sea

COASTAL AND SEMI-OFFSHORE FLEET

MISSIONS

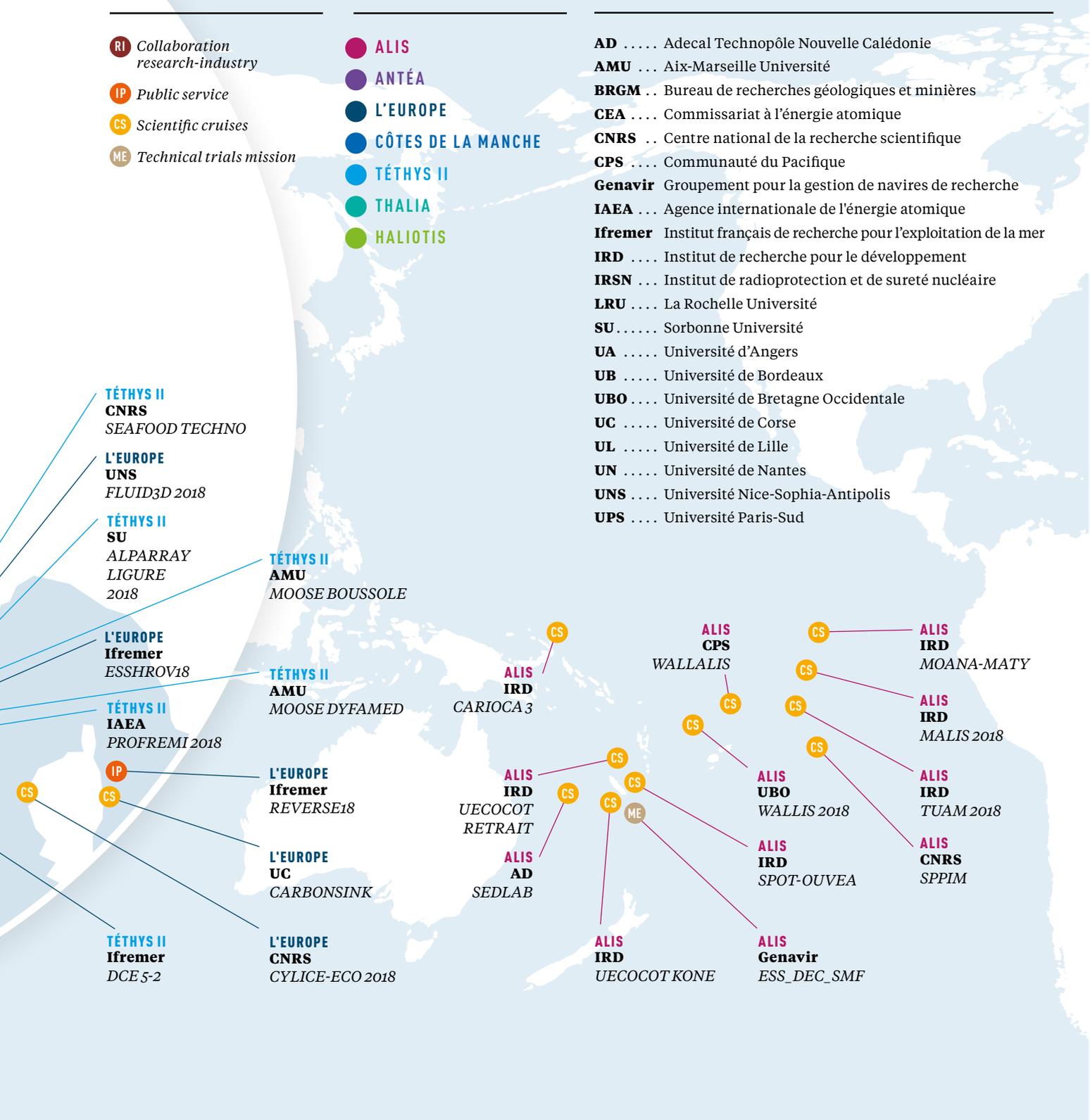
- RI** Collaboration research-industry
- IP** Public service
- CS** Scientific cruises
- ME** Technical trials mission

VESSELS

- ALIS**
- ANTÉA**
- L'EUROPE**
- CÔTES DE LA MANCHE**
- TÉTHYS II**
- THALIA**
- HALIOTIS**

ORGANISATIONS

- AD** Adecal Technopôle Nouvelle Calédonie
- AMU** ... Aix-Marseille Université
- BRGM** .. Bureau de recherches géologiques et minières
- CEA** Commissariat à l'énergie atomique
- CNRS** .. Centre national de la recherche scientifique
- CPS** Communauté du Pacifique
- Genavir** Groupement pour la gestion de navires de recherche
- IAEA** ... Agence internationale de l'énergie atomique
- Ifremer** Institut français de recherche pour l'exploitation de la mer
- IRD** Institut de recherche pour le développement
- IRSN** ... Institut de radioprotection et de sureté nucléaire
- LRU** La Rochelle Université
- SU** Sorbonne Université
- UA** Université d'Angers
- UB** Université de Bordeaux
- UBO** Université de Bretagne Occidentale
- UC** Université de Corse
- UL** Université de Lille
- UN** Université de Nantes
- UNS** Université Nice-Sophia-Antipolis
- UPS** Université Paris-Sud



SCIENTIFIC POLICY

Understanding and predicting changes in the ocean by 2100 requires a proactive scientific policy which is capable of producing the knowledge needed to rise to this challenge and which is in keeping with our announced ambition to position ourselves as a reference institute in the field of marine sciences. To fulfil this ambition, Ifremer is implementing various forms of action directed toward the Institute's teams as well as towards our partners, to open up to new skill sets and disciplinary cultures. These arrangements help support emerging ideas and risk-taking, promote multidisciplinary and interdisciplinarity, and create value from the knowledge produced by our Institute's teams.

EN 2018 :

598

scientific articles

INDEXED IN THE WEB OF SCIENCE
(AUTHOR IS IFREMER EMPLOYEE)

11

**European H2020
projects selected**

1

ERC project selected

(voir p. 25 *Vers une accélération
des changements en Arctique
en raison de l'influence des vagues*)

YOUNG RESEARCHERS

AT THE HEART OF THE SCIENTIFIC POLICY

Ifremer takes part in training future researchers each year by hosting a large number of PhD students who contribute to our Institute's research activities and materialise our links with French and foreign universities. In fact, it is to expand this international reach and prepare the post-doctoral period that Ifremer is proposing a call for mobility. Thanks to this system, in 2018, ten PhD students stayed in American, Norwegian, Italian, German and other laboratories, in order to acquire new skills and initiate partnerships. In 2018, forty people were hired within our own research units and joint research units (UMR), bringing the number of PhD students hosted by Ifremer to 206. These young researchers are overseen by the Institute's 90 research scientists holding an accreditation to supervise research.

A few examples of subjects of the 48 theses defended in 2018 in the 31 doctoral schools which are partners with the Institute include: developing electronic tags to monitor marine species, synthesizing, optimising and qualifying infrared sensors for water pollution, or metabolic adaptation in marine bivalves and the impact of environmental changes.

Finally, the Institute hosts 55 young PhDs in the framework of post-doc contracts whose duration varies from one year to eighteen months. They make a major contribution to resourcing the institute and to its international outreach.

As part of our Institute's project, Ifremer is going to adapt its doctoral and post-doctoral policy to grow its attractiveness to young foreign researchers and thus promote their hosting in our research teams. This policy will strengthen our ties with Germany, as well as with the United States and Japan.

STRONGER SCIENTIFIC PARTNERSHIPS

The Institute's scientific policy is built around three large sites: Brest, Nantes and the Occitania region (Montpellier, Sète, Palavas), from which our Institute carries on existing, lasting partnerships and builds new ones. To promote this structuring, in 2018 Ifremer launched calls for projects aimed at the Institute's teams and their partners:

- The "Site policy" call aims to make Ifremer sites key players in research in the regions in question, by proposing that Ifremer teams work more closely with other regional teams. In 2018, thirteen projects were selected in this way. This was the case for a study on the sexual maturity of fish, molluscs, etc. analysed by quantitative histology, carried out in partnership with the English Channel – North Sea fisheries unit and two teams from the University of Caen Normandy;
- The "Intercentres" call aimed to bring Ifremer teams working on various sites closer together for joint projects, thus strengthening Ifremer's national dimension. In 2018, eleven projects of this type were selected, including one to develop an electrochemical sensor to detect cortisol at trace level (detection of about a nanogramme per litre) in the water of aquaculture ponds, and another to understand the molecular interactions between *Vibrio aesturianus* eubacteria and oysters' immune cells.

In addition, a call for projects specifically designed for the Environment Resources laboratories (LER) was launched to support their research activities and help improve the expert assessments provided by our Institute.

OVERSEAS FRANCE

Ifremer is present in French Polynesia, New Caledonia, la Réunion, Martinique, French Guiana and in Saint Pierre and Miquelon. These regions have significant specificities with respect to metropolitan France in terms of biodiversity or the maritime activities practised there. Various calls for projects from the scientific division make it possible to develop knowledge specific to these regions, as well as strengthening the Institute's positioning by promoting scientific partnerships. In 2018, several winning projects concerned overseas territories. This was true of the IoCT project, conducted by Ifremer and the university of La Réunion, focusing on developing standalone communicating stations to acquire marine and climate data. It is also the case of the Capamax project proposing the use of metatranscriptomics to assess microbiome activity in the batfish (*Platax orbicularis*) and which is based on a partnership between Ifremer's Pacific centre and the Centre for island research and environmental observatory (CRIOBE) in Moorea.



PLATAX TEIRA (FISH FROM
THE EPHIPPIDAE FAMILY),
OFF THE SEYHELLES
(INDIAN OCEAN)

© Ifremer - Marc Taquet

SUPPORTING RESEARCHERS IN CARRYING OUT THEIR REMIT

Ifremer makes various services to support research available to its personnel. This is the case in particular for the documentary services supporting research, which were restructured in 2018. Four specialists in information searches, bibliometrics and science watches work with scientific publications, patents, grey literature, the press and website content. Taking account of needs defined with the requester, a bibliographic state of the art is drawn up and used as the basis of watches, calculation of indicators and bibliometric searches using visualisation tools. Theme-based, geographic and temporal analyses are supplied, as well as foresight studies and positioning studies on collaboration, visibility and impact. Advice and training are proposed for various subject, such as open access, open science, the publishing process, science watch, bibliometrics, and so on.

To give studies by our Institute's researchers greater visibility and facilitate access to them, Ifremer is pursuing its open science policy. This has been a long-standing part of its management of marine databases and the institutional archive of its scientific publications, called Archimer. In 2018, Ifremer further engaged its efforts within the Committee for open science created by the Ministry in charge of research in order to implement the National Plan for Open Science decided on by the Minister Frédérique Vidal in July. The committee's remit is to define the national policy for open science, how it should be developed on national and international scales and the coordination of its implementation in scientific institutions and communities. In 2019, Ifremer should draw up its own plan, in consultation with our partners.

Our Institute also implements support for European project sponsors. Special attention is given to European Research Council (ERC) calls for projects. In 2018, four Ifremer researchers submitted a project and obtained an ERC starting grant.

NEWS ABOUT THE MERLIN PROJECTS "LAUNCHING NEW INITIATIVES FOR OUR OCEANS"

The Merlin projects are the outcome of thought and discussions led at Ifremer to develop and encourage new consensus-building and iconic initiatives for Ifremer, thus enriching its potential for scientific discoveries.

A NEW-GENERATION FISH TAGGING SYSTEM

Today, electronic tags attached to fish are used to record data needed to track their movements, monitor their location and environmental parameters, such as temperature and pressure. This information is then transmitted to a satellite, whence their name of "pop-up satellite archival tags". These tags have helped provide better knowledge about the environments where fish migrate or live, but do not supply information about the fish themselves. Another limitation of the current technology is that since only one-third of the data acquired is transmitted, the entire trajectory of tagged fish cannot be monitored. Moreover, the relatively large size of the tags along with their high cost (4,000 euros per tag) restrict their use.

The Popstar (for Pop-up Satellite Tag for Advancing Research in marine ecology) project is tackling these obstacles, aiming to perfect a smaller and less costly tag which will enable more animals to be marked.

In 2018, significant technological and operational advances were achieved. Technological developments mean that the equivalent of a year's data can be sent in eight hours using the Iridium system to transmit data, the release mechanism to detach the tag from the fish has been made more reliable and the tag's hydrodynamic behaviour is being improved. As for the physiological sensor, the first electronic chip versions are now available. Developing a system of flexible, bio-compatible electrodes to be implanted in a tuna species is progressing well and toxicity and mechanical fatigue tests are being conducted. In June, the Popstar team succeeded in deploying three electronic tags on 200+ kg tuna from the same shoal caught in the Mediterranean Sea, near Malta. Two of these tuna were monitored as far as the Strait of Gibraltar, taking less than a month to leave the Mediterranean. This experiment gives us confidence that deployment on a larger scale will be feasible.

GROWING OUR KNOWLEDGE ABOUT DEEP-SEA BIODIVERSITY

Taking advantage of new molecular biology tools to help assess the biodiversity of the deep sea is the objective of the project called “*Pourquoi pas les Abysses?*” (why not the Abyss?) It was launched in 2016 and is mainly based on sampling and analysing the DNA present in the water and sediments of the deep sea (“environmental DNA”).

Methods and protocols for the various steps of the process were validated in 2018. They are: collecting samples using a “multitube corer” for sediments, the “Salsa” pump for seawater and its plankton, and the “Elfes” hard substrate sampler; selecting genetic probes allowing all the main lineages

to be characterised, and perfecting a bioinformatics software suite for standardised, conservative inventories. Samples collected in various oceans have already improved our knowledge about deep-sea biodiversity. Furthermore, time-series monitoring of ecosystems has assessed their response to anthropogenic impacts, as well as the genetic connectivity of populations for some species associated with the ecosystems most-studied to date (chemosynthetic ecosystems, cold-water corals and seamounts). The project is supported by *France Génomique*, and is now being developed collaboratively with teams from the Génomoscope to perform the large volume of DNA sequencing and the related bioinformatics work.



WORM FROM THE NEREIDIDAE (POLYCHAETA) FAMILY

© Ifremer - Gilles Martin

OCEANOGRAPHY AND ECOSYSTEM DYNAMICS

PREDICTING THE BENTHOS'S RESPONSE TO ENVIRONMENTAL CHANGES

Until now, benthic species distribution has essentially been studied through a descriptive approach. Today, complementary and innovative modelling approaches enable us to better understand and predict the effects of environmental and anthropogenic factors on the biodiversity of benthic organisms (i.e. living near the seabed). The general framework of modelling benthic community dynamics effectively now takes processes at different scales of biological organisation into account. On the scale of the individual, an organism's physiology is modelled to assess its response to environmental changes such as the amount of available food and the temperature. Moreover, the biogeochemical characteristics, the sedimentary substrate and the bathymetry determine the preferred habitats of each species and their assemblages. Finally, on the community scale, species interact with each other, whether through predator-prey relationships, habitat modifications or competition for space and food. The hydrodynamics also play an important role in organisms' ability to colonise ecoregions and this is included in population models as a connectivity matrix.

These models have been developed and applied to several species or ecosystems to answer some major questions about the effect of climate change, dynamics of invasive species, functional biodiversity and assessing ecosystem services.



SEA STARS (*ASTERIAS RUBENS*) FEEDING
ON MUSSELS (*MYTILUS EDULIS*).

© Ifremer - O. Dugornay

In an initial application, it was shown that in the English Channel-Atlantic zone by 2100, the biomasses of two bivalve species of economic interest, the Mediterranean mussel (*Mytilus galloprovincialis*) and the Pacific cupped oyster (*Crassostrea gigas*), which are farmed and present on the Atlantic coasts, will rise due to significant changes in temperatures

(worst-case scenario taken from IPCC studies). On the contrary, blue mussel (*Mytilus edulis*) populations will drop in some geographical sectors.

For an invasive species, the slipper limpet (*Crepidula fornicata*), now abundant along the English Channel-European Atlantic seafront, a population dynamics model integrating colonisation criteria has shown the importance of its spatial competition with the King scallop. The latter is hindered by the slipper limpet's occupation of the seabed, and simulations show that the *Crepidula* invasion of the western European shelf has reduced the abundance of King scallops by about 50%.

Modelling of the biogeographical distribution of the main functional groups in Australian reefs (particularly corals and sponges) predicts that each of these groups will respond differently to climate change in fifty years from now. Some corals will invade areas which are currently temperate and some cold-temperate species, including various sponge morphotypes, will undergo significant decline.

Although several of these approaches are used for predictive purposes, some innovative developments have also been published. Modelling functional groups, gathering species which share common ecological characteristics, appears to be a promising approach to formulate generic interaction rules and thus represent a simplified version of biological diversity in order to simulate cascading effects due to disturbances.

Thomas, Y. and C. Bacher, *Assessing the sensitivity of bivalve populations to global warming using an individual-based modelling approach*. *Global Change Biology*, 2018. 0(0).

Marzloff, M.P., et al., *Differential vulnerability to climate change yields novel deep-reef communities*. *Nature Climate Change*, 2018. 8(10): p. 873-878.

Ménesguen, A., A. Hachet, and T. Grégoris, *Modelling benthic invasion by the colonial gastropod *Crepidula fornicata* and its competition with the bivalve *Pecten maximus*. 2. Coupling the 0D model of colony-forming species to a connectivity matrix for a realistic distributed simulation of benthic invasion*. *Ecological Modelling*, 2018. 375: p. 30-44.

Ménesguen, A. and T. Grégoris, *Modelling benthic invasion by the colonial gastropod *Crepidula fornicata* and its competition with the bivalve *Pecten maximus*. 1. A new 0D model for population dynamics of colony-forming species*. *Ecological Modelling*, 2018. 368: p. 277-287.

Alexandridis, N., et al., *Individual-based simulation of the spatial and temporal dynamics of macroinvertebrate functional groups provides insights into benthic community assembly mechanisms*. *PeerJ*, 2018. 6: p. e5038.

MOVING TOWARDS FASTER CHANGES IN THE ARCTIC DUE TO WAVE INFLUENCE

INTERVIEW WITH PETER SUTHERLAND FROM IFREMER - PHYSICAL AND SPATIAL OCEANOGRAPHY LABORATORY (LOPS) - ABOUT THE ERC PROJECT WAVE-MODULATED ARCTIC AIR-SEA EXCHANGES AND TURBULENCE (WAAXT).



YOU RECEIVED A 2018 STARTING GRANT FROM THE EUROPEAN RESEARCH COUNCIL; WHAT IS THE SCIENTIFIC QUESTION YOU WILL BE ADDRESSING?

The Arctic is linked by complex teleconnections to the climate at lower latitudes, making Arctic sea ice both an indicator and a modulator of global climate change. Summer sea ice extent in the Arctic has decreased by approximately 3 million square kilometres since the beginning of satellite records. That is an area 20% larger than the Mediterranean Sea! This means that, in the summer and fall seasons of recent years, there has effectively been a new “seasonal sea” of open water in the Arctic.

One of the key differences between ice free and ice covered seas is that that surface waves can form on ice-free seas. This is important because we know that waves and wave-driven turbulence control the exchanges of energy, momentum, and gas between the atmosphere and the ocean. Because of this, waves are associated with many complicated feedback mechanisms which could either accelerate or slow the future reductions of sea ice cover in the Arctic. My ERC project, WAAXT, will investigate the physical processes underlying those feedbacks.

WHAT IS INNOVATIVE ABOUT YOUR APPROACH?

A particular challenge associated with the interactions between waves, ice, and upper-ocean turbulence is the range of scales that are physically relevant; from millimetres to hundreds of kilometres! WAAXT is designed to capture the spatial structure and variability of these processes using a combination of satellite and airborne remote sensing, in-situ ship, ice canoe, and buoy-based measurements, and several small autonomous underwater vehicles (AUVs). The AUVs represent a significant step forwards in measurements of wave-driven turbulence; their small size will allow them access to very near the sea surface, and their relatively long range means that previously unreachable parts of the ice edge will be accessible.

Because of the complexity and novelty of the experiment plan, WAAXT fieldwork will start in a natural laboratory on the St. Lawrence Estuary, which I have been developing with collaborators at the *Université du Québec à Rimouski*. As our scientific and technical capabilities improve, we will move to larger-scale studies in the Arctic Ocean.



ICE COVER IN SUMMER
© Ifremer - ARK XIX/3

WHY IS IFREMER A SUITABLE HOST FOR THIS PROJECT?

The physical and spatial oceanography laboratory (*Laboratoire d'Océanographie Physique et Spatiale - LOPS*) at Ifremer is a fantastic home for this project because of the complementary expertise available; LOPS has decades of experience in satellite remote sensing of sea ice and ocean waves, LOPS is home

to one of the strongest wave-modelling groups in the world, Ifremer has a very capable technical group for sea-going instrumentation development. Furthermore LOPS has a growing Arctic oceanography group, and Ifremer is building its capacity for airborne remote sensing. Most importantly, Ifremer allows me the scientific freedom to seek out and address interesting oceanographic questions.

Sutherland Peter, Dumont Dany (2018). *Marginal ice zone thickness and extent due to wave radiation stress*. *Journal Of Physical Oceanography* , 48(8), 1885-1901 . <https://doi.org/10.1175/JPO-D-17-0167.1>

Sutherland Peter, Brozena John, Rogers W. Erick, Doble Martin, Wadhams Peter (2018). *Airborne Remote Sensing of Wave Propagation in the Marginal Ice Zone* . *Journal Of Geophysical Research-oceans* , 123(6), 4132-4152 . Publisher's official version : <https://doi.org/10.1029/2018JC013785>

TOXIC ALGAE IN MEDITERRANEAN LAGOONS

Blooms of harmful and/or toxic phytoplankton have affected marine ecosystems for a long time. These blooms have a detrimental effect on ecosystems and the exploitation of their resources. The lagoons in the Languedoc-Roussillon region have been affected for several decades. And, along with the *Dinophysis* (producing diarrhetic toxins) and *Alexandrium* (paralytic toxins) genera which are associated with health risks, *Vulcanodinium rugosum* was identified in the Ingril lagoon in 2011. This emerging species produces pinnatoxins (neurotoxins).

Results from several studies have highlighted the fact that this microalga is thermophilic (developing in warm waters) and euryhaline (withstanding high variations in seawater salinity) and its growth ranges are comprised between 20 and 30°C. Its ability to grow from an organic nitrogenous source (urea) has also been observed *in vitro*. *V. rugosum*'s life cycle has only been partially elucidated. Temporary cysts seem to be very important stages to take into consideration, seeing their ability to divide and their high abundance on macrophytes. Its spread to several lagoons in Languedoc-Roussillon has been confirmed by the detection of mussels contaminated by "pinnatoxin G". Survival of *V. rugosum* in the digestive system of mussels and oysters indicates that transferring shellfish between farming areas can be a source of contamination to ecosystems not yet affected by this toxic species.



FIRST IDENTIFIED IN A MEDITERRANEAN LAGOON IN 2011, THE MICROALGAE VULCANODINIUM RUGOSUM HAS THE DISTINCTIVE FEATURE OF PRODUCING NEUROTOXINS.

© Ifremer - O. Dugornay

Above and beyond the health aspects for humans – pinnatoxin G's toxicity is currently being evaluated –, new research projects have begun to highlight the impacts this neurotoxin has on the first links of the food chain (mesozooplankton) in the lagoons of Thau and Ingril. These projects should make it possible to determine this toxin's action on the different links, its bioaccumulation and therefore, its impact on ecosystem services and on humans.

Abadie Eric, Chiantella Claude, Crottier Anais, Rhodes Lesley, Masseret Estelle, Bertheaux Tom, Laabir Mohamed (2018). *What are the main environmental factors driving the development of the neurotoxic dinoflagellate Vulcanodinium rugosum in a Mediterranean ecosystem (Ingril lagoon, France)?* Harmful Algae, 75, 75-86. <https://doi.org/10.1016/j.hal.2018.03.012>

SEDIMENT DYNAMICS IN THE SEINE RIVER ESTUARY

Estuaries are highly dynamic zones at the interface between continents and oceans. Rivers carry a large quantity of sediments and nutrients to coastal seas, making estuaries some of the most dynamic and productive areas in the world. However, these ecosystems which are already highly anthropized, are very vulnerable to human (developments, dredging, discharges) and climate (storms, severe floods/low water periods) pressures. Many estuaries are characterised by a "turbidity maximum", indicating an accumulation zone of suspended sediments, which influences both sedimentary transfers along the land-sea continuum and biogeochemical processes. However, the impact of hydrometeorological conditions (tidal currents, waves, river flow) on these sedimentary dynamics are poorly known.

So, a study based on in-situ measurements and realistic numerical modelling of the Seine estuary was made in the framework of the Seine Aval research programme.



SEINE ESTUARY; IMAGE TAKEN BY SPOT SATELLITE ON 27 JULY 1999
© CNES - Spot-image 1999

The results of the MARS-Mustang hydro-sedimentary model, developed at Ifremer, quantify the contribution from tide, waves and river flow to estuarine dynamics. Thus, at low tidal range, the model shows that haline stratification contributes to moving the turbidity maximum upstream by 10 km. The significant increase in sediment in the turbidity maximum is correlated to the intensity of waves at the mouth. Simulating contrasting hydrometeorological scenarios (dry, wet and stormy years) has revealed that fluxes and sedimentary stocks are strongly modulated by the hydrological and meteorological conditions. This means that sediment export towards the coastal sea is greater during stormy periods, and this is associated with a loss of sediment in the estuary. These studies have greatly improved our understanding of the biogeochemical and ecological functioning of estuarine ecosystems.

Grasso, F., Verney, R., Le Hir, P., Thouvenin, B., Schulz, E., Kervella, Y., Khojasteh Pour Fard, I., Garnier, V. (2018). *Suspended sediment dynamics in the macrotidal Seine Estuary (France): 1. Numerical modeling of turbidity maximum dynamics*. Journal of Geophysical Research: Oceans, 123, 558–577. <https://doi.org/10.1002/2017JC013185>

Schulz, E., Grasso, F., Le Hir, P., Verney, R., & Thouvenin, B. (2018). *Suspended sediment dynamics in the macrotidal Seine Estuary (France): 2. Numerical modeling of sediment fluxes and budgets under typical hydrological and meteorological conditions*. Journal of Geophysical Research: Oceans, 123. <https://doi.org/10.1002/2016JC012638>

SAINT-PIERRE ET MIQUELON : A UNIQUE MARINE COASTAL ENVIRONMENT

The coastal environment of the Saint Pierre and Miquelon archipelago was the object of a study conducted by Ifremer with the support of the local authorities, with the aim of developing the farming of the Atlantic deep-sea scallop (*Placopecten magellanicus*) in Miquelon bay. This study highlighted oscillations in temperature near the seafloor of previously undocumented amplitude which are amongst the highest in the world on a continental shelf. At the height of the summer, variations from 2°C to 12°C were measured during the same day at depths between 30 and 60 metres.

By analysing numerous measurements of marine currents and temperatures around the archipelago, it was shown that these oscillations are the result of an amplification of diurnal tidal currents, whereas sea-level variations are semi-diurnal (two high-water and low-water tides per day). The uneven bathymetry of the Grand Banks of Newfoundland and summer stratification strongly influence the tidal propagation. The observations, which are consistent with the models, show that temperature oscillations were maximal near the bottom, that they are trapped around the archipelago, and that they propagate around it in a clockwise direction.

In light of this discovery, a multidisciplinary cruise was made during the summer of 2017 to assess the consequences of this environmental variability on the different compartments of benthic (bottom) and pelagic (water column) ecosystems. Several PhD theses are underway to describe and understand the physics and the response of these ecosystems to variability ranging from a day to the scales of climate change.

Lazure Pascal, Le Cann Bernard, Bezaud Marion (2018). *Large diurnal bottom temperature oscillations around the Saint Pierre and Miquelon archipelago*. Scientific Reports , 8(1), 13882 (12p.). Publisher's official version: <https://doi.org/10.1038/s41598-018-31857-w>

PENETRATION OF ANTHROPOGENIC CARBON IN DEEP OCEAN LAYERS

Surface water becomes saturated with carbon dioxide - CO₂ - as anthropogenic discharges accumulate in the atmosphere. On the global scale, the ocean stores approximately 25% of the CO₂ emitted by human activities, thus playing a role in mitigating climate change, but with a harmful consequence: that of ocean acidification. The new series of measurements taken on the Ovide cruises show that concentrations of dissolved carbon dioxide are increasing, at increasingly great depths, reaching 1,500 metres in 2016 to the East of Greenland. The deepening of the acidification signal could have harmful consequences for deep-water carbonate organisms like the cold-water corals present all along the European Atlantic seafront. And yet, climate models predict a significant slowing of deep-water renewal by 2100, which should limit the deep penetration of anthropogenic CO₂, as well as slowing down the North Atlantic's buffer effect on the increase of this CO₂ in the atmosphere. Comparing one of these climate models with the observations highlights the progress still needed to improve the realism of North Atlantic ocean circulation in this model.

However, scientists acknowledge that it does seem to reproduce the mechanisms responsible for anthropogenic CO₂ storage in the subpolar region correctly. Thus, in the business-as-usual scenario where anthropogenic emissions stay at their current level, it was shown that by the end of the century, the Subpolar Atlantic would continue to act as a sink for anthropogenic carbon, even though significant fluctuations on interannual or decadal scales may create exceptions.

Perez Fiz F, Fontela Marcos, Garcia-Ibanez Maria Isabel, Mercier Herle, Velo Anton, Lherminier Pascale, Zunino Patricia, De La Paz Mercedes, Alonso-Perez Fernando, Guallart Elisa E., Padin Xose A. (2018). *Meridional overturning circulation conveys fast acidification to the deep Atlantic Ocean*. Nature , 554(7693), 515-518 . Publisher's official version: <https://doi.org/10.1038/nature25493> , Open Access version: <https://archimer.ifremer.fr/doc/00426/53783/>

Racape Virginie, Zunino Patricia, Mercier Herle, Lherminier Pascale, Bopp Laurent, Perez Fiz F, Gehlen Marion (2018). *Transport and storage of anthropogenic C in the North Atlantic Subpolar Ocean*. Biogeosciences, 15(14), 4661-4682. Publisher's official version: <https://doi.org/10.5194/bg-15-4661-2018> , Open Access version: <https://archimer.ifremer.fr/doc/00454/56587/>

LIVING RESOURCES AND THEIR ENVIRONMENT

AN OCEAN UNDER PRESSURE, BUT ALSO HOLDING PROMISE FOR THE FUTURE

The ocean is a dynamic system subjected to great variability, particularly involving anthropogenic pressures (exploitation of living resources, contaminant discharges, coastal developments, global change, and so on) which have sharply increased over the past few decades. They have generated major changes in marine ecosystems and in the uses depending on them, especially in coastal zones.

This means that in the marine domain, a key challenge is to reconcile objectives to preserve biodiversity, food safety and the economic and social development of fisheries and aquaculture activities, against a backdrop of population growth, climate change and ecological transition.

Since activities exploiting marine biological resources take place within complex dynamic systems, our Institute's scientific studies aim to identify the drivers of pathways to the sustainable development of fisheries and aquaculture. This research also aims to elucidate the combined effects of multiscale phenomena which constrain the dynamics of these pathways (alteration of marine biodiversity, deterioration of chemical water quality, climate change, globalisation of the seafood trade, growing competition for resources and/or space, resilience of production systems, trends in governance, etc.).

Although it is subjected to numerous pressures, the ocean remains an essential provider of food for the world's population. It represents, moreover, 70% of the biosphere, but only 300,000 marine species out of the 1.8 million species currently known on Earth have been inventoried. These unknown biological resources are a new frontier; they may well be the main sources of new molecules in coming decades.

KNOWLEDGE AND SUPPORT FOR PUBLIC POLICIES, AN INDISPENSABLE DUO FOR SUSTAINABLE FISHERIES

Ifremer collects, generates, gathers, ensures consistency and shares data through a fisheries information system (SIH), a network to observe fisheries resources and related uses. Thanks to the implementation of a wide range of systems to collect data including from research cruises and to developing scientific studies, the Institute's top priority is to assess the "fisheries socio-ecosystem" in all of its biological, environmental, technical and socio-economic components, and to cover the entire fisheries fleet, in all its diversity, over all seafronts of Metropolitan France and French overseas regions. The data thus collected and stored in databases are accessible to State services, the scientific community, and more generally speaking, to civil society on the whole.

To this end, Ifremer particularly uses an ecosystem approach aiming to reconcile conservation and exploitation of fisheries resources and their habitats. The level of exploitation should enable the generation of wealth, to maintain economic activity in the regions. This is indeed one of the stakes for the viability of fisheries, giving rise to a long-term strategic orientation. In the European Union, this is embodied by the Common Fisheries Policy (CFP).

Thanks to its data series, some of which now comprise more than thirty years of data, Ifremer conducts research in fisheries science to meet societal expectations and supplies knowledge which is vital for establishing diagnoses on the status of stocks and fisheries.



FISHING BOAT IN THE BAY OF BREST
© Ifremer - O. Dugornay

Ifremer's scientists contribute to defining the regulations related to data collection by actively participating in European scientific institutions. This historic commitment enables our Institute to provide the public authorities with multidisciplinary expertise allowing them to rise to the social, economic and environmental challenges revolving around maritime fisheries.

The management of French fisheries relies on the CFP. It is constructed on the basis of available fisheries knowledge, with the objective of adapting the fishing capacity deployed by fishermen to the biological potential of resources, for the sustainable exploitation of fish stocks. The latest reform of the CFP came into effect on 1st January 2014. It reasserts the need to have the best available scientific advice for fisheries management in order to guarantee that fisheries stocks are exploited at maximum

sustainable yield (MSY). The collection of scientific data is regulated by the Data Collection Framework (DCF). In France, the DCF's application is coordinated by the Maritime fisheries and aquaculture division (DPMA) and implemented by a consortium of eight public-sector institutions. Ifremer is its main contributor.

A PARTNERSHIP BETWEEN SCIENTISTS AND PROFESSIONAL FISHERMEN TO BETTER INFORM STOCKS OF COMMON SOLE IN THE ENGLISH CHANNEL

The SMAC (Eastern English Channel sole: improving knowledge for better stock management) project brings together scientists from Ifremer, *Agrocampus Ouest* (Rennes) and *UMR Borea*⁵ (Paris), three producer organisations (*From Nord*, *Coopérative maritime étaploise* and *Organisation des Pêcheurs normands*) and finally the two fisheries committees from the Hauts-de-France and Normandy regions, for a duration of four years (2015-2019).

The first line of studies looked at the spatial-temporal dynamics of sole exploitation in the Eastern English Channel, highlighting specificities in fisheries using trammel nets, the main fishing gear employed in the Channel. Analysis of the data particularly showed that large-sized common soles were found more frequently in catches in Normandy, which can be explained both by the gear used and fishing practices and by sole growth dynamics related to quite different environmental conditions.

The spatial-temporal dynamics of biological recruitment (i.e. bringing new "recruits" to the group) were also studied by monitoring the recruitment in three nurseries from aboard inshore fishing vessels. An oceanographic cruise also provided the opportunity to update the mapping of spawning grounds and characterise larval habitats.

And finally, the last study orientation dealt with spatial structuring and exchanges (connectivity) between common sole populations in the English Channel - North Sea. Combined use of several types of "tracers",

⁵ The joint research unit (UMR) for biology of aquatic ecosystems and organisms (Borea) brings together the MNHN, CNRS, Sorbonne University, IRD, University of Caen and the University of the French West Indies

i.e. traits of life history, otolith shape and micro-chemistry and conventional tagging highlighted a stock structuration in the Eastern English Channel in three sub-units (Normandy, North Normandy/ Hauts-de-France and United Kingdom), with apparently limited exchanges of adults between them.

Integrating the knowledge acquired in population dynamics models takes better account of this fish's biology. Various management scenarios will be tested on the EEC common sole stock and on the fleets fishing it.

Du Pontavice Hubert, Randon Marine, Lehuta Sigrid, Vermard Youen, Savina-Rolland Marie (2018). *Investigating spatial heterogeneity of von Bertalanffy growth parameters to inform the stock structuration of common sole, Solea solea, in the Eastern English Channel*. Fisheries Research, 207, 28-36 . <https://doi.org/10.1016/j.fishres.2018.05.009>



SOLE LARVA REARED AT IFREMER'S
BRITTANY CENTRE

© Ifremer - O. Dugornay

MARINE MICROALGAE IN THE ANTIPODES: MULTIFARIOUS POTENTIAL APPLICATIONS

The Amical (aquaculture of microalgae in New Caledonia) project began in 2013, in partnership with Ifremer and the Adecal Technopole science park, with the objective of fostering the emergence of an aquaculture value chain in New Caledonia using locally collected microalgae.

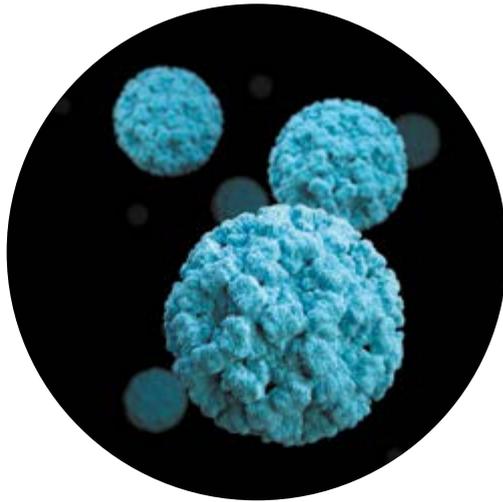
Following a period of bioprospection lasting until 2017, a strain culture collection containing 45 species was created. These species were selected for their rapid growth rate, since they are intended to be used in a biomass production value chain. The species are representative of New Caledonia's remarkable ecosystem, characterised in particular by significant exposure to ultra-violet rays. Locally, numerous plants, including microalgae have developed protection mechanisms which could be developed by biomimicry for valuable utilisations, especially in the cosmetics and pharmaceutical industries for burn treatments and sunscreens.

Studies underway are also focusing on the antioxidant properties of some species in the strain collection. Some encouraging results in the field of nutrition have been obtained by testing feed with a strain of microalgae to farm larval *Litopenaeus stylirostris* shrimp and studies are also being conducted on the nutritional role of microalgae in this shrimp's reproduction. Several other avenues for business developments are also being assessed: working with the Caledonian institute of agronomy (IAC) and CNRS to find bioactive molecules of agronomic interest, with a private-sector laboratory on cardio-metabolic disease prevention and studying photo-protective molecules.

NEW SEQUENCING TECHNIQUES HELPING HUNT ENTERIC VIRUSES OF HUMAN ORIGIN

The European H2020 Compare (Collaborative management platform for detection and analysis of (re-)emerging and foodborne outbreaks in Europe) project is multidisciplinary. Its aim is to develop innovative tools to collect and analyse data based on genome sequencing of microorganisms which are

pathogenic for humans or animals. Ifremer is contributing to the analysis of bacteria from the *Campylobacter* genus and to developing methods to characterise human enteric viruses in water or shellfish. These bacteria and viruses can be responsible for cases of gastroenteritis in humans after the consumption of contaminated shellfish.



BASED ON ELECTRON MICROSCOPIC (EM) IMAGERY, THIS ILLUSTRATION PROVIDES A THREE-DIMENSIONAL (3D), GRAPHICAL REPRESENTATION OF A NUMBER OF NOROVIRUS VIRIONS, SET AGAINST A BLACK BACKGROUND.

© CDC/ Jessica A. Allen

Since human enteric viruses are made up of a small (ranging from 25 to 70 nanometres) capsid protecting a short (approximately 7,000 bases) RNA genome, preliminary work to prepare the sample is necessary for these viruses to be detected using a metagenomic approach in the environmental samples. In the framework of this project, a bioinformatic pipeline (running groups of software in series) enabling preferential assembly of viral genomes was developed (Erasmus Medical University, Rotterdam). This approach made it possible to detect whole genomes of known viruses (noroviruses, astroviruses, rotaviruses), as well as similar genomes to those found in humans, but which have not yet been identified as belonging to known viral species.

One application for these new tools is to analyse why and how Pacific cupped oysters immersed in wastewater-contaminated seawater will specifically capture certain human enteric viruses. Further developments are still necessary, but ultimately, these tools could avoid contaminated shellfish being put on the market and thus protect consumers.

Bosch Albert, Gkogka Elissavet, Le Guyader Soizick, Loisy-Hamon Fabienne, Lee Alvin, Van Lieshout Lilou, Marthi Balkumar, Myrmel

Mette, Sansom Annette, Schultz Anna Charlotte, Winkler Anett, Zuber Sophie, Phister Trevor (2018). *Foodborne viruses: Detection, risk assessment, and control options in food processing*. International Journal Of Food Microbiology , 285, 110-128 . <https://doi.org/10.1016/j.ijfoodmicro.2018.06.001>

SCIENCE IN SOCIETY

OR A BETTER SHARED APPROACH FOR COMPETITIVE AND SUSTAINABLE FISH AQUACULTURE IN THE MEDITERRANEAN

MedAID (Mediterranean Aquaculture Integrated Development) is an H2020 project aiming to improve the competitiveness and sustainability of the Mediterranean fish aquaculture sector by focusing on two fish species, i.e. sea bass and sea bream. The project encompasses all the dimensions of this activity: zootechnics, ecology, genetics, nutrition, health, economics and governance.

Insofar as marine fish aquaculture is competing for use of resources and space with other users of coastal and marine environments, we need to understand the social interactions with other stakeholders. Ifremer facilitates a task group devoted to social acceptability in relation to aquaculture governance. The aim is to better understand the social bottlenecks which contribute to the stagnating development of aquaculture; to support sustainable development of this sector in the Mediterranean through recommendations and best practice guides, and finally, to test participatory protocols to improve the social acceptability of marine finfish aquaculture.

Work and studies are conducted by organising workshops with stakeholders, along with a survey to better understand the factors driving social acceptability. The outputs of the first workshop held in August 2018 will help in drawing up a guide to improve the acceptability of sustainably developing aquaculture in the Mediterranean.

PROJECT SUMMARY:

- Improving the technical performance of the Mediterranean aquaculture Specific Challenge
- Start date: May 2017 – duration: 4 years
- Total budget: 7 million euros
- Project coordinators: Bernardo Basurco, *Instituto Agroconómico Mediterránea de Zaragoza IAMZ* and Dolores Furones, Institute of Agrifood Research and Technology IRTA



10-DAY OLD SEA BASS LARVA, MEASURING ABOUT 2 TO 3 MM,
REARED IN THE AQUACULTURE HALL AT IFREMER'S BRITTANY CENTRE

© Ifremer - O. Dugornay

DEEP-SEA RESOURCES AND ECOSYSTEMS

The ocean holds a treasure trove of living, mining or energy resources which will contribute to our solutions to the major challenges of the future, for food, health, raw materials and power production. One of these challenges is that of energy transition, aiming to reduce the share of fossil fuels and grow that of less-polluting, renewable energy sources. The ocean will help us rise to this challenge via the growing development of production systems which are either adapted from land to sea use, such as wind turbines (whether fixed-bottom or floating) or are specific to the marine realm. Studies carried out at Ifremer on this subject focus on the energies of today, tomorrow and the more distant future.

Concurrently, the outcomes of oceanographic cruises are providing new knowledge about deep-sea environments. Better understanding of how they function will open the path to new solutions and to meeting other challenges, such as understanding climate change as illustrated by the migration of monsoons 400,000 years ago, modelling subsea hazards, finding future drugs or medical treatments inspired by how organisms adapt to extreme deep-sea conditions.

THE OCEAN AND ENERGY TRANSITION

TODAY'S ENERGY: SECURING THE PRODUCTION OF FOSSIL FUEL SOURCES

As on land, fossil energy reserves are dwindling. New discoveries involve deposits which are more difficult to find and to exploit. For instance, frozen

marine sediments trap gas in a solid form and make up potential reserves at depths greater than 500 metres. When they thaw, they release large volumes of gas with the risk of submarine landslides.

Exploring and understanding gas hydrate⁶ dynamics in marine sediments and their impact on seafloor stability fall under the objectives of the GHASS project, launched in 2015 in the Black Sea. The research team exploited and analysed a highly varied data set: acoustics over the entire water column, bathymetry, high- and very high-resolution reflection seismics, geotechnics, sedimentology by core sampling, geochemistry of hydrates and interstitial waters.

The multidisciplinary nature of the team made it possible to demonstrate that part of the methane hydrates detected in the Black Sea is currently melting, and to explain the reasons for this. The geological history of the sea has alternated with fresh-water inputs from rivers and cycles of connection / disconnection with the Mediterranean Sea via the Bosphorus Strait. The variations in water salinity are propagated in the sediments. These processes of sediment salinization are behind the reduction of the stability zone of gas hydrates and lead to their destabilisation on the continental slope (at water depths between 650 and 750 metres). This was the first time in world that this destabilisation was documented. It could lead to current risks of gravity-driven collapse of the seafloor near these active zones.

⁶ Ice made up of gas and stable water at low temperature and high pressure.

It also raises questions about the fate of methane released into the sea. These themes will be specifically addressed in the follow-up to the project with dedicated acquisitions during the next GHASS2 oceanographic mission.

Riboulot, V., Ker, S., Sultan, N., Thomas, Y., Marsset, B., Scalabrin, C., Ruffine, L., Boulart, C., Ion, G., 2018. *Freshwater lake to salt-water sea causing widespread hydrate dissociation in the Black Sea*. Nature Communications 9, 117.

TOMORROW'S ENERGY: MARINE RENEWABLE ENERGY SOURCES

Wind farms now installed on land represent 15 gigawatts (GW), with an objective of sustained growth. On the national level, multiannual energy programming aims for a progressive contribution from offshore wind, with the objective in ten years of 5 gigawatts of installed power, i.e. 4 to 5% of the power from all French renewable energy sources. Fixed or floating offshore wind power is the activity showing the strongest growth for the European Blue economy. The wind at sea has the advantage of being more stable than the wind on land, as well as presenting less of a visual impact on the landscape for farms far from the coast, as is possible for floating wind (see Eolink below and Rotor project in the next chapter). The marine domain also makes a novel contribution to renewable energy sources, through ocean-specific resources: tidal-stream current for stream turbines, the swell and waves for wave power systems (see BLUE FINS project and those of the GEPS-Techno firm) and temperature differences between surface water and deep water for ocean thermal energy conversion.

Tidal stream turbines are the subject of numerous innovative projects, as are new systems like that of Eel Energy supported by Ifremer for undulating membranes, as well as horizontal- or vertical-axis tidal stream turbines. In this way, the MegaWattBlue® project consists in creating a high-performance hydrokinetic tidal turbine demonstrator and testing it in the natural environment. With support from the Brittany regional council, approved by the Brittany Atlantic marine cluster excellence label, the project has three partners: Ifremer, ENSTA Bretagne and the Guinard Énergies firm. The demonstrator is made up of a ducted flow acceleration turbine that doubles the power output and self-oriens naturally in the direction of the current. These two principal innovations endow the project with interesting potential: compact size, varied site possibilities (including in rivers) close to consumers.

Ifremer is taking series of in-situ measurements of marine currents to determine the distribution of their velocities in the water column, the resulting kinetic energy and the natural perturbations characterised by turbulence. The trials zone in the Étel river is sheltered from waves and enables the effects of the current to be analysed accurately. The current measurements were first acquired without the tidal turbine in place, and will be repeated with it present, in order to precisely determine the power output and the wake effects. Acoustic measurements taken during the spring tides period will make it possible to distinguish between the turbine's effects and those of ambient noise. Finally, control samples of paints deployed for a two-year period, will be examined to analyse the growth of biocolonisation in the site's environment and its possible effect on the turbine's performance.

Doisenbant, G, Le Boulluec, M, Scolan, Y-M, Guyot, M. 2018. *Numerical and experimental modeling of offshore wind energy capture: application to reduced scale model testing*. Wind Engineering 42, 108-114 Special Issue 10.1177/0309524X18756967



27 FEBRUARY 2019: SUBMERSION OF THE GUINARD ÉNERGIES P154 MACHINE IN THE ETEL RIA FOLLOWING POSITIVE TRIALS CONDUCTED IN JANUARY IN THE BAY OF BREST. THIS 20KW TIDAL STREAM TURBINE, DEVELOPED IN THE FRAMEWORK OF THE MEGAWATTBLUE PROJECT (GUINARD ÉNERGIES/IFREMER/ENSTA PARTNERSHIP), WAS SET UP ACCORDING TO PLAN AND WILL BE CONNECTED TO THE GRID VERY SOON. CURRENTLY, THE TURBINE IS OPERATING AND IS BEING VALIDATED.

© Ifremer - O. Dugornay

INTERVIEW WITH MARC GUYOT – EOLINK CEO



© Ifremer - O. Dugornay

THE YOUNG SME CALLED EOLINK IS DEVELOPING A FLOATING WIND TURBINE CONCEPT. WHAT ARE ITS INNOVATIVE FEATURES?

Eolink is taking advantage of the mobile floating support structure to rethink the architecture of wind turbines and their tower. The Eolink self-oriens into the wind, like a boat on moorings. This makes it possible to deploy a pyramid-shaped structure which is more compact, rigid and lightweight.

HOW DID YOUR COLLABORATION WITH IFREMER BEGIN, AND WHAT LESSONS WERE LEARNED?

The collaboration with Ifremer started in 2016 with a series of trials on a reduced scale 1:50 model in the Brittany centre's test tank, carried out in the framework of a France Énergies marines ANR project. We were able to experimentally demonstrate that broadside waves do not disturb its correct alignment head on to the wind, that obtaining 12 megawatts (MW) with winds of 10-11 metres-per-second with a 66-m long floater can be realistically expected, and finally, that the movements of the floating structure in a storm are limited. In addition, we were able to confirm our good understanding of its dynamic behaviour and validate our in-house numerical models.

WHY DID YOU THEN RUN SEA TRIALS OF A NEW 1:10 SCALE PROTOTYPE THIS TIME, ON THE SAINTE-ANNE-DU-PORTZIC SITE?

To find funding, a new technology must progressively limit risks, through experimental demonstrations of prototypes that are increasingly close to commercial-sized machines. With the support of the Brittany regional council, these sea trials and their results took the project forward to a higher degree of

technological maturity, which has put Eolink in the Top 7 worldwide in terms of feedback. The scale of 1:10 is directly linked to the wave heights at Sainte-Anne-du-Portzic, which are approximately ten times smaller than waves offshore. *In situ*, there are variations in the wind which push the prototype to its limits: 90 km/h at Sainte-Anne represents 270 km/h at full scale!

For Eolink, this prototype provided the opportunity to design the entire set of components: blades, pales, generators, remote control system, grid connection, moorings and floating structure, a guarantee for properly planning full-scale productions.

WHAT ADVANTAGES ARE THERE TO COLLABORATING WITH IFREMER?

Access to the hydrodynamic test tank with its wind tunnel and to the Sainte-Anne-du-Portzic experimental site is the first key point. The second lies in Ifremer's numerous forms of expertise in materials, hydrodynamics and environmental knowledge (waves, geotechnics).

WHAT ARE YOUR LONG-TERM OBJECTIVES?

Floating wind energy can massively produce clean and local power. Irrespective of the climate stakes, floating wind could make it possible to reindustrialise our regions and reduce tensions related to energy supply. Our roadmap consists in progressively developing this technology by constructing turbines at the scale of 4:5, i.e. 5-6 MW at a cost of 150 euros/MWh, then similar, full-scale turbines producing 12 MW (40-70 euros/MWh) to be built in automated factories in Brest from 2025 on.

ENERGY TOMORROW AND BEYOND: HYDROGEN PRODUCED BY MARINE MICROORGANISMS

Producing energy from living organisms through chemical reactions is also a promising path. In the deep ocean devoid of light, hydrothermal fluids enriched in dissolved gas (hydrogen, carbon dioxide, etc.) sustain complex ecosystems based on microbial communities. The effect of hydrothermal emissions on the carbon cycle in the oceans remains poorly known, although it could contribute to up to 25% of total organic carbon production in the deep sea. Hydrogen is at the crossroads of these chemosynthetic processes and might be the energy source giving rise to at least 50% of the biomass produced in these environments.

During Ifremer's oceanographic cruises Bicose (2014), Hermine (2017) and Bicose2 (2018), a new metabolic process was discovered in some hyperthermophilic microorganisms associated with hydrothermal ecosystems, i.e. the conversion of hydrogen (H₂)

and carbon dioxide (CO₂) to formate (HCO₂⁻). Formate is a simple organic molecule with a high concentration of hydrogen per mass unit. This means that formate production is a mechanism of detoxification enabling these microorganisms to continue to develop, in spite of the presence of hydrogen. This previously unknown process could also play a major role in the carbon cycle. Studied using special sensors and laboratory bioreactors, this metabolic pathway is

present in several archaea (single-celled microorganisms with no nucleus). These microorganisms are also capable of converting organic matter into hydrogen, at high temperatures above 80°C and at high pressure above 300 bars. Therefore, they may be of biotechnological interest for the production and storage of hydrogen.

Le Guellec S, Dulermo R, Courtine D, Godfroy A & Roussel E. *H₂-dependent Formate Production by Hyperthermophilic Thermococcales*. Goldschmidt 2018 (Présentation orale, Boston, USA)



MOORING THE FLOATING WIND TURBINE DEVELOPED BY EOLINK, IN THE BAY OF BREST. THE OBJECTIVE IS TO TEST A CONCEPT REVOLUTIONIZING TRADITIONAL TECHNOLOGIES, UNDER REAL CONDITIONS. IFREMER IS A PARTNER IN DEVELOPING THE DEVICE. © Ifremer - O. Dugornay

MARINE SEDIMENTS

REVEAL THE MIGRATION OF THE ASIAN MONSOON OVER THE PAST 400,000 YEARS

The past evolution of the East Asian monsoon is a controversial subject in paleoclimate sciences. Its history is mainly based on continental archives such as mineralised deposits from caves, called speleothems. And yet, a major difficulty in interpreting speleothems is to differentiate between the intensity of rainfall, on the one hand and their source, on the other. Detailed geochemical analysis of marine sediments deposited off the mouth of the Yangtze River and the Yellow River and recovered from IODP U1429 drilling (samples taken in 732 metres of water), has provided new and independent knowledge on speleothems concerning the past intensity of rainfall in the huge catchment basins of East Asia.

The results demonstrate that for the last 400,000 years, wet summer monsoon conditions prevailed over interglacial periods. It appears that rainfall intensity and/or the duration of the rainy season rose notably over the past five interglacial episodes. This outcome, coupled with the growing contribution in the northern regions of the Yangtze River catchment basin seen in the sediments studied, could explain the gradual northward shift of the inter-tropical convergence zone (ITCZ) over the last interglacials. This study, while contributing to better understanding of the Asian monsoon with respect to climate change, also demonstrates the relevance of the "land-sea sedimentary transfers" approach for paleo-environmental and paleoclimate reconstructions.

Beny, F., Toucanne, S., Skonieczny, C., Bayon, G., Ziegler, M. 2018. *Geochemical provenance of sediments from the northern East China Sea document a gradual migration of the Asian Monsoon belt over the past 400,000 years*. *Quaternary Science Reviews*, 190, 161-175. <https://doi.org/10.1016/j.quascirev.2018.04.032>

SMALL MINERALS

BEHIND A LARGE SUBMARINE LANDSLIDE

Submarine landslides are a major source of geological hazards, since they can affect underwater infra-structures as well as coastal and shore zones (regressive erosion, tsunami waves, etc.). However, the processes controlling underwater slope instability and landslides have still not been well identified. The study highlighted the presence of a weak sediment layer in the Corsica Trough (northern Tyrrhenian Sea) that formed the failure surface of a submarine landslide some 45,000 years ago. Thanks to mapping of the landslide using a multibeam echosounder and a high-resolution seismic system, geotechnical and geochemical analyses of sediment cores and numerical modelling of the slope stability, this study demonstrates that zeolites are the source of the sedimentary instability. Zeolites are minerals formed by the alteration of volcanic rocks and, even in very small quantities (2-4%), alter the mechanical properties of muddy sediment by making it potentially unstable. There may be worldwide implications for these results, since zeolites are frequently-found minerals on continental margins, especially near volcanic zones.

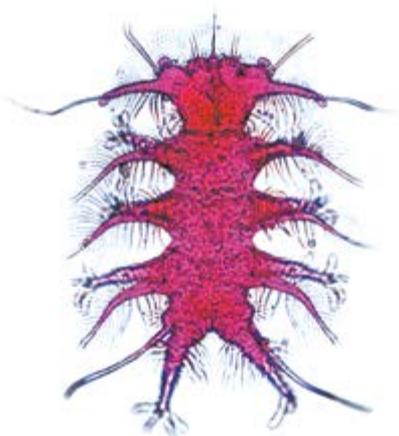
Miramontes E., Sultan N., Garziglia S., Jouet G., Pelleter E., Cattaneo A., 2018. *Altered volcanic deposits as basal failure surfaces of submarine landslides*. *Geology* 46: 663-666. doi: <https://doi.org/10.1130/G40268.1>

MEIOFAUNA IN EXTREME MARINE ENVIRONMENTS

Extreme marine environments (mangroves, submarine caves, polar ecosystems, hyper-saline areas, environments with little or no oxygen, hydrothermal vents, cold seeps, whale falls/wood falls, underwater canyons and depths below 6,000 m) cover more than 50% of the Earth's surface. Sometimes associated with short-lived and unstable ecosystems, extreme marine environments host abundant meiofauna (organisms ranging in size from 20 microns to 1 millimetre) whose species are often endemic and well-adapted.

Twelve institutes from nine countries worked together to present an integrated view of the biodiversity, ecology and physiological responses of marine meiofauna living in extreme environments.

The following results were obtained in this hallmark study supported by LabexMer⁷, the TOTAL foundation and Ifremer: (1) Foraminiferans, nematodes and copepods are abundant in almost all of these habitats and are dominant in deep-sea ecosystems; (2) human activities generate stressful conditions, including deoxygenation, acidification and rises in temperature, even at great depths.



THIS NEOSTYGARCTUS OCEANOPOLIS
LIVES IN EXTREME ENVIRONMENTS
AS DEEP AS 1,900 M .
© Ifremer - D. Zeppilli

Thus, the behaviour and physiology of various meiofaunal species can provide vital information on how organisms may respond to these changes and can provide a warning signal for anthropogenic impacts. Furthermore (3), from an evolutionary perspective, the discovery of new meiofauna taxa from extreme environments very often sheds light on the phylogenetic relationships which are the source of life. Finally (4), there are impressive potential economic benefits to be gained from biological and physiological studies of meiofauna in extreme environments.

Zeppilli D., Leduc D., Fontanier C., Fontaneto D., Fuchs S., Gooday A., Goineau A., Ingels J., Ivanenko V., Kristensen R., Neves R., Sanchez N., Sandulli R., Sarrazin J., et al. 2018. *Characteristics of meiofauna in extreme marine ecosystems: a review*. *Marine Biodiversity* 48, 35-71. <http://doi.org/10.1007/s12526-017-0815-z>

UNRAVELLING THE SECRETS OF A MARINE MICROORGANISM, A CHAMPION OF DNA REPAIR!

Deep-sea hydrothermal edifices shelter strange microorganisms which are adapted to high pressures and temperatures. They are generally hyperthermophilic archaea which can develop at temperatures above 85°C. To grow under these extreme conditions, these microorganisms have efficient strategies to safeguard their genome integrity. Thanks to this study, we better understand the mechanisms of adaptation and especially the importance of DNA repair by its recombination (a function common to all living organisms, essential for both their survival and for species to evolve by developing adaptation processes).

This is illustrated by a hyperthermophilic archaeon, *Pyrococcus furiosus*, for which this study describes the interaction between the Mre11-Rad50 (MR) enzyme complex, a key player in repairing DNA breaks, and the PCNA protein, whose ring-shaped form enables it to slide along the DNA. Our model explains the mechanics of how the MR enzyme's activity is regulated at the breaks. The significance of this study lies in the fact that the MR complex plays an important role in repairing DNA breaks in Eukaryotes and that its dysfunction leads to multiple genetic disorders, such as the onset of cancers. Describing how these proteins, which are also present in humans, function could contribute to better knowledge about the causes behind the appearance of genetic disorders.

Hogrel G., Lu Y., Laurent S., Henry E., Etienne C., Duy Khanh Phung, Duclermo R., Bosse A., Pluchon P., Clouet-D'Orval B., Flament D., 2018. *Physical and functional interplay between PCNA DNA clamp and Mre11-Rad50 complex from the archaeon Pyrococcus furiosus*. *Nucleic Acids Research* 46, 5651-5663. <http://doi.org/10.1093/nar/gky322>

⁷ LabexMER "A changing ocean" is a part of the laboratories of excellence selected during the first wave of the "Investments for the future" funding programme. It brings together 12 research units in western France: University of Western Brittany (UBO), University of Southern Brittany (UBS), University of Nantes, Ifremer, CNRS, IRD and École centrale Nantes. In 2018, It has become a component of the ISblue Interdisciplinary graduate School for the blue planet.

RESEARCH INFRASTRUCTURES AND INFORMATION SYSTEMS

The concentration of IT infrastructures promoted by cloud-based development policies can be somewhat disconcerting for scientists who must each within their own theme, control their data, from observation to publication. European data-sharing projects like Seadatacloud, Copernicus *in situ* TAC and EMODnet are working towards the technical definition of a consensus between the two viewpoints, which could fulfil the need for pooling of the knowledge brought by on-line services and data, whilst preserving the independence of decision-making and operation for each scientific community.

GEOGRAPHICAL DATA

THE MERIGEO SYMPOSIUM

With the objective of promoting and disseminating studies on geomatics applied to the marine environment, in an approach closely linked to the European Directives for the Marine Strategy (MSFD) and Maritime Spatial Planning (MSP), Ifremer, AFB and Shom organise a national "merIGEO" symposium every two years, aiming to rally round a shared issue: the study and management of the ocean, from the seashore to the deep sea. It was held in Aix-en-Provence in 2018.

Public institutions, research bodies, universities, State services, local and regional authorities, consultancies and associations exchanged and compared their knowledge, thoughts and experiences on innovative scientific applications for geomatics in the fields of the sea and seashore. All marine geographic information themes were addressed,

from imagery for coastal and marine environmental monitoring, geosciences, fisheries and aquaculture, studying maritime traffic and shipping, including recreational boating, accumulated pressures and impacts, to information systems and geographical reference sets.

REFERENCING

GEOLOGICAL SAMPLES

The IGSN (International Geo Sample Number) is a global implementation organisation which issues unique identifiers for geological samples and specimens. Ifremer became a member in 2018 in order to set up a service to record IGSN codes and a service to harvest and make available the metadata associated with marine samples or specimens. All geological samples, sedimentary or rock cores and deep-water biological samples are referenced in a shared database, called the Biology and Geology Ocean Database or Bigood.

These IGSN codes are used to identify, locate and cite a physical sample. Thus, the IGSN number is provided as a barcode on the labels of geological samples classified in the lithotheque at Ifremer's centre in Brest. For the first time, a scientific article from Ifremer has already used this code to cite samples collected during a cruise. The IGSN codes are inventoried by Archimer, Ifremer's institutional archive, just like the cruise identifiers. This now makes it possible to find all published articles which used a given sample, to find the analyses performed

or to know about other samples of the survey which it was collected for.

Discussions are underway to generalise this traceability approach to all samples and specimens at Ifremer, particularly as related to regulatory requirements resulting from the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS).



THE CORE COLLECTION OF THE RESOURCE CENTRE FOR MARINE ARCHIVE SAMPLES (CRM) AT IFREMER IN PLOUZANÉ. NEARLY 32,000 CASES ARE STORED AND THUS CONSERVE A WEALTH OF DATA FOR SCIENTISTS .

© Ifremer - M. Rovere

A NEW-GENERATION EUROPEAN MARINE DATA NETWORK

The H2020 SeaDataCloud project aims to make a large-scale marine data management infrastructure reliable and to extend it. It is being constructed continuously through projects in the SeaDataNet family, with more than 110 data centres currently connected.

Like its predecessors, SeaDataCloud is coordinated by Ifremer. It is advancing marine data interoperability by developing vocabulary reference and, setting the thematic scope of data management, whilst relying on the European Open Science Cloud (EOSC) to disseminate finalised data sets.

Every two years, since 2005, Ifremer's Simer service and its partners in the SeaDataNet network organise the IMDIS International conference on marine data and information systems. In 2018 the event was organised by the local Marine technology unit of the Spanish CSIC research council and held in Barcelona, where 184 participants from 34 pays made their contribution.

YEARS	NAMES OF PROJECTS IN THE SEADATANET FAMILY
ANNÉES 90	Medar/MedAtlas data and metadata
2002 - 2005	Sea-Search (FP5) metadata repositories
2006 - 2011	SeaDataNet (FP6)
2011 - 2015	SeaDataNet II (FP7)
2016 - 2020	SeaDataCloud (H2020)

SHARING AN INFRASTRUCTURE FOR DATA COMPUTATION AND STORAGE

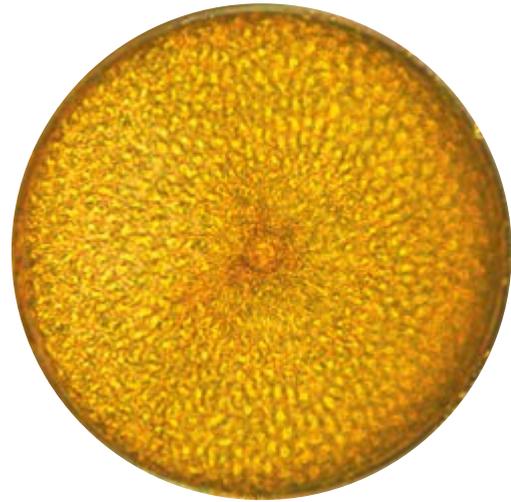
The Datarmor data/processing/supercomputing infrastructure is the cornerstone of the organisational strategy for storage resource sharing in order to cope with the requirements of exponentially growing data volumes. The "data" task group (GT Data) is made up of scientific experts representing the major scientific fields using data and data managers. It was created when Datarmor was launched and works on governance of storage spaces with the aim of pooling data sets of common interest. The distinct spaces set up on Datarmor correspond to different uses, i.e. "reference data" (Dataref), "workspaces" (Datawork) and temporary space (« Scratch »). The users have fully understood the interest of factorizing all amenable data. Following several requests, the choices made by Data task group have been extended beyond the Datarmor perimeter proper, to backup storage spaces and the permanent archiving system.

A "reference datum" must be enduring and stable over time. It may have been produced by activities involving Ifremer (such as Oceanographic fleet data or results of interpretations by research teams) or by another organisation (meteorology models), and may have been used within Datarmor or on another machine in the network. Depending on its degree of visibility, it will be shared by all users or by a more limited community. The data are used for processing, interpretation or dissemination.

In 2018, over 90 voluminous data sets have been made available via the Datarmor reference data space, for immediate use "without other copy" on Datarmor or on other systems. There are several objectives for this approach, but above all they aim to present users with a range of the most relevant and comprehensive scientific data possible, with the goal of:

- facilitating access to them;
- promoting exchanges and interactions between projects and teams;
- avoiding the multiplication of copies and wasting space, especially for voluminous data.

The catalogue of reference data is available on Sextant, accessed via https://www.ifremer.fr/sextant_doc/pages/DATARMOR.html



COSCINODISCUS WAILESII - BAY OF VILAINE

© Ifremer - N. Neaud-Masson. 2015

ILICO SEASHORE AND COASTAL RESEARCH INFRASTRUCTURE

The ILICO seashore and coastal research infrastructure was created in March 2016 and is co-facilitated by CNRS/INSU and Ifremer, federating eight label-certified observation services. This national RI structures a network of over 300 observation points for physical, biogeochemical and biological parameters in marine coastal and shore environments distributed along the seafronts of Metropolitan France and Overseas French territories. It mobilises more than 90 people in Full-time equivalent employment from all French research bodies interested by the seashore and coastal environment. ILICO makes it possible to observe and understand changes in this environment, both over the long term (including the consequences of climate change) and the short term (for instance, the impact of extreme events).

In 2018, the first version of a scientific strategy was produced, drawing on the recommendations of its international scientific board which met in Paris in the spring. Moreover, several of the infrastructure's observation networks were approved as "national observation services" by INSU and Ifremer, upon the recommendation of the CSOA special ocean-atmosphere commission at INSU. These labelled networks are: PhytObs for the observation of micro-phytoplankton and CoastHF which is made up of fixed instrumented platforms to make high-frequency *in-situ* measurements of key parameters in coastal waters (conductivity, wave direction, wind direction, fluorescence, relative humidity, dissolved oxygen, etc.).

EMSO: EUROPEAN MULTIDISCIPLINARY SEAFLOOR AND WATER COLUMN OBSERVATORY

INTERVIEW WITH JUAN JOSÉ DAÑOBEITIA, DIRECTOR GENERAL, EUROPEAN MULTIDISCIPLINARY SEAFLOOR AND WATER COLUMN OBSERVATORY (EMSO).

The "European Multidisciplinary Seafloor and water column Observatory", EMSO, an ERIC (European Research Infrastructure Consortium) gathering eight countries, aims to explore the oceans, to gain a better understanding of phenomena happening within and below them, and to explain the critical role that these phenomena play in the broader Earth systems.

YOU HAVE BEEN APPOINTED AS DIRECTOR GENERAL OF THE EMSO ERIC FOR ONE YEAR. WHICH ARE THE CHALLENGES YOU HAVE TO TAKE UP?

One of the EMSO ERIC's main services is to provide the EMSO ERIC user with an infrastructure as the focal point of a powerful, new European high-tech marine "Innovation Platform" empowered by a rich set of tools. A big challenge we face in effectively monitoring and collecting high quality environmental data stems from the difficulties collecting such a large number of essential ocean variables (EOVs) at high sampling rates in very diverse environmental locations such as deep ocean zones, mid-ocean ridges, plate collisions, intraplate volcanism and anoxic seas.



WHAT ARE THE FUTURE GOALS AND YOUR VISION TO FULFIL THE SCIENTIFIC AND SOCIETAL DEMANDS AT A EUROPEAN AND WORLDWIDE LEVEL?

EMSO ERIC is increasingly taking a leading role in tackling the major environmental issues which most threaten European Seas and Polar regions and which can impact the lives of millions of people worldwide. This will moreover boost our already-strong contribution to the implementation of the United Nations' key Sustainable Development Goals (No 14 Life below water) in terms of sustainability and cleaning of oceans 1) reduction of marine litter and particularly of plastics, minimisation of oil-rig decommissioning marine pollution and damage, and understanding and mitigating large biodiversity threats, 2) influence society by demonstrating continuous monitoring of sensitive parameters, including forewarnings of warming, acidity and other ocean anomalies once a critical threshold is exceeded.

WHAT ARE THE SCIENTIFIC PERSPECTIVES, NUMBER OF OBSERVATORIES, AND RELATIONSHIP TO OTHER RESEARCH INFRASTRUCTURES IN THE MARINE DOMAIN?

A key step is EMSO's ongoing program to significantly increase the number of its fixed-point observatories, thereby further improving our ability to guarantee continuous, top-quality ocean data, to allow a better assimilation of the oceanic variables to generate integral biogeochemical models, to produce a multi-disciplinary approach for the "health status assessment" of our oceans and seas almost in real-time, to provide data on seismic, volcanic and tsunami activity in active zones; and to take actions to mitigate the damage caused by natural hazards.

To encourage true cooperation and complementarity between the environmental RIs by working together on projects such as ENVRI FAIR and others. To take advantage of opportunities offered by the Decade of Ocean Science for Sustainable Development (2021-2030 promoted by UN). Outreach and communication are crucial to convince new generations of the benefits of a blue and sustainable growth.

WHAT IS THE COLLABORATION BETWEEN EMSO ERIC AND IFREMER?

France is a founding Member country of EMSO and Ifremer, as France's foremost reference institution along with CNRS, has consistently played a seminal role in bringing the infrastructure from just a loose partnership idea in the late 90s to the reality of the ERIC and the world stage today. Indeed, with its long tradition and international renown for excellence in marine research, its world-class facilities, scientists and technicians, Ifremer is a top protagonist, team-player and leading driver of the EMSO success story. Last but not least are my many positive personal experiences and memories shared with so many Ifremer scientists and technicians, comrades and friends who have always been a joy to work with throughout my 35-year career.



LAUNCHED IN THE FRAMEWORK OF THE EUROPEAN SEAFLOOR OBSERVATORY (EMSO), THE GENERIC INSTRUMENT MODULE (EGIM), DEVELOPED BY IFREMER, IS A STANDARDISED MEASUREMENT TOOL EMBEDDED WITH NUMEROUS SENSORS AND IS USED TO FIT SUBSEA OBSERVATION STATIONS.

© Ifremer - O. Dugornay

SUPPORT FOR PUBLIC POLICIES

Ifremer supports the State in drawing up maritime public policies based on the best available knowledge, and also acts as expert on an *ad-hoc* basis in responding to referrals for advice issued by the State's services. These missions are part of our Institute's DNA, and represent one third of the Institute's activity. They mobilise Ifremer staff in every field of our research: the environment (European WFD and MSFD directives), mineral resources (aggregate extraction, permits to prospect for deep mineral resources), the extension of the EEZ⁸, health and animal health quality of shellfish (European Union reference laboratory and national reference laboratory for marine mollusc pathologies) and the sustainable exploitation of fish stocks (EU Common Fisheries Policy).

2018, THE YEAR OF HEALTH MONITORING TRANSFER

After several years of preparation, on 1st January 2018, the responsibility for health monitoring of shellfish production areas was transferred. Pursuant to its 2013-2018 objectives contract, Ifremer wanted to hand over the operational implementation of health monitoring, and in particular the REMI (microbiological monitoring) and REPHYTOX (marine phycotoxin monitoring) networks.

⁸ The Exclusive Economic Zone (EEZ) is a maritime area between territorial waters and international waters, over which a State has sovereign rights for the purpose of exploring and exploiting resources.

The transfer involved sampling and analysis tasks which were transferred to county level analysis laboratories, with Ifremer keeping some tasks as project manager (managing alerts, databasing) and more generally positioning ourselves to assist the State contracting authority to design the monitoring system.



MUSSEL BEDS - BRITTANY
© Ifremer - O. Dugornay

The transfer is unfolding smoothly and the initial indicators of results show that both monitoring systems are being operated correctly: 97% of samples are taken in compliance with the Statement of works. The significant effort supplied to train operators (2017) and coach them (2018) appears to worked well.

This transfer will allow Ifremer to refocus its activities on systems that are capable of developing the monitoring of the future, by taking account of innovations from the world of research (integrated microbiological observatory, environmental DNA, and so on) and of the emergence of new risks (exotic species, global warming).

2018, THE YEAR OF THE GOOD ENVIRONMENTAL STATUS ASSESSMENT

2018 was a landmark year for the implementation of the Marine Strategy Framework Directive. It was effectively the year of the second assessment of Good Environmental Status and showed the stepping up of the scientific pilot team's expertise. Compared to that of 2012, the assessment has become much more quantitative, based more on statistical indicators than on an expert's opinion. However challenges do remain for the scientific community: to mobilise the different sources of data to reduce uncertainties; ensure the convergence of assessments performed under different directives (WFD and MSFD in particular) for better ownership of the results by stakeholders, and so on. So many challenges, showing that the scientific community will continue to mobilise its forces in coming years.



SPINY LOBSTER
© Ifremer - O. Dugonay

INTERVIEW WITH THIERRY VATIN, DIRECTOR OF WATER AND BIODIVERSITY



IFREMER ENSURES THE COORDINATION OF THE ASSESSMENT AND DEFINITION OF GOOD ENVIRONMENTAL STATUS UNDER THE MARINE STRATEGY FRAMEWORK DIRECTIVE (MSFD). FROM THE POINT OF VIEW OF THE DEB DIRECTORATE FOR WATER AND BIODIVERSITY, WHAT HAVE BEEN THE MOST SIGNIFICANT ADVANCES MADE SINCE THE FIRST ASSESSMENT IN 2012?

The initial assessment of marine environmental status conducted in 2012 during the first cycle of the MSFD was, to a fairly large extent, qualitative. This was due to both the lack of an assessment method and the lack of sufficient data. The assessment produced in 2018 shows that significant progress has been made, thanks to the buy-in of the scientific community to move towards a quantitative approach. The advances will also take on a concrete form in a ministerial order presenting a more operational definition of Good Environmental Status. Ifremer's coordination has made it possible to structure an efficient interface between science and policy.

HOW ARE THE RESULTS FROM THIS ASSESSMENT USED IN PUBLIC POLICIES?

The assessment is an integral part of a planning document drawn up for each of the seafronts of Metropolitan France, called the strategic seafront document. The document's objective is to consider the development of human activities and the blue economy, in a simultaneous and coherent manner, along with the imperative need to achieve Good Environmental Status of marine waters. Based on this assessment, environmental objectives have been developed to reduce pressures which have been identified as being incompatible with achieving GES and to better protect the components of biodiversity made more vulnerable by human activities.

The strategic seafront documents will be the subject of a public consultation from 4 March to 4 June 2019 at: <https://www.merlittoral2030.gouv.fr/>. The consultation provides an opportunity for one and all to give their opinion on the documents' content. The strategic seafront documents should then be adopted mid-2019.

WHAT ARE YOUR EXPECTATIONS WITH RESPECT TO IFREMER IN THE FRAMEWORK OF THE NEW ORGANISATION OF SCIENTIFIC AND TECHNICAL SUPPORT TO THE MINISTRY FOR THE IMPLEMENTATION OF THE MSFD?

The new organisation for providing scientific and technical support to the MSFD has especially emphasized bringing monitoring and assessment closer in organisational terms, mobilising a broader group of experts, progressive structuring of networks, as well as the linkages of the MSFD with other directives and marine policies (Water Framework Directive, Habitats - Birds Directive, Common Fisheries Policy and Regional seas conventions). In this context, the DEB would like Ifremer to pursue its commitment in the national scientific and technical coordination of the MSFDM, to expand its thematic involvement to fields where its expertise is acknowledged and to support the development of a shared monitoring strategy. This echoes the Institute's stated positioning in its contract of objectives and performance as a reference institute in marine sciences, and its orientations structured by the "research – innovation – support for public policies" triptych. Ifremer will have a determining role to play in accompanying the State towards the marine waters assessment of 2024.

STUDYING ENVIRONMENTAL IMPACTS FROM MARINE AGGREGATE EXTRACTION

The Mining code grants special jurisdiction to our Institute for the assessment of the environmental impacts that marine aggregate extraction activities have on the environment. This means that Ifremer provides the State's services with its expertise for each extraction project. This local support is accompanied by more general sharing of expertise to the benefit of the Ministry of Ecological and inclusive transition. Following studies conducted in 2017, Ifremer made a proposal to the State to update the protocols recommended by the Institute in the 1990s for morphobathymetric and biosedimentary monitoring – and in 2011 – for fisheries monitoring; in order to meet regulatory requirements for describing and monitoring the marine environment.

These new protocols will help the promoters of projects to establish a baseline state before carrying out work and to set up environmental monitoring of extraction sites based on data acquisition cruises or the use of models (thus assisting economic players).

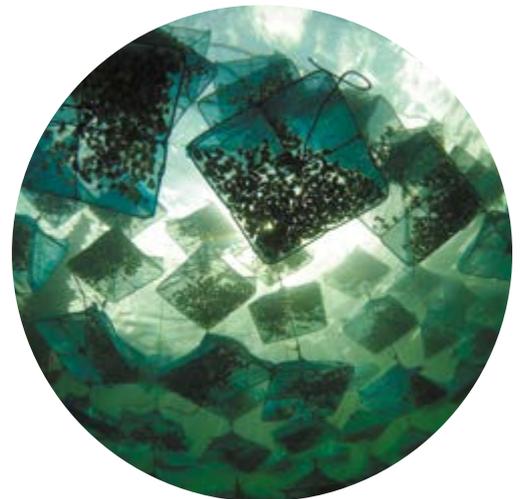
In addition, Ifremer is assisting State services with template documents that should be supplied in order to better control and manage extraction activities (thus assisting public authorities) and harmonise environmental monitoring practices at the national level. This harmonisation work will, in fine, give the scientific community access to good quality, comparable data (thus assisting research). This is an example of how the three-pronged triptych approach that Ifremer promotes in its new Institute project is implemented.

INNOVATION AND ECONOMIC PARTNERSHIPS

Two 2018 milestones were the successful completion of the Institute's horizon 2030 project and the launch of the InOcean approach aiming to better integrate innovation within Ifremer's practices. The approach should encourage researchers and engineers to take better account of the needs and expectations of the socio-economic sector and of society. The first discussions about biotechnologies, marine renewable energy sources and optical communications led us to examine our existing practices and the first actions resulting from the "Focus Innovation" workshops were launched this year. The initial results, some of them presented below, are very encouraging.

SEA AND HEALTH

During the SeaTech Week in Brest, Ifremer organised the first "Sea and Health" symposium on 8 & 9 November with the support of UBL, UBO and the Finistère county council, aiming to energise research done at the interfaces of marine biology and human health and share the feedback from industrial firms in the sector. The symposium was placed under the patronage of Pr. Denis Allemand, the scientific director of the Scientific centre of Monaco and a member of Ifremer's scientific board, and gathered 58 scientists from various research institutions (Ifremer, Inserm, CNRS, universities, engineering schools, CHU teaching hospital and *Cancéropôle Grand-Ouest*) and a dozen industrial firms and start-ups (Greensea, Polymar, Manros Therapeutics, Hemarina, etc.) for 25 lectures. The next "Sea and Health" event will be held in 2020 in Monaco.



PEARLNETS (STRUCTURES FOR SPAT GROW-OUT) HANGING UNDERNEATH AN OYSTER CULTURE TABLE

© Ifremer - J. Oheix

A CLOSE-UP ON MARINE RENEWABLE ENERGIES

BLUE FINS: THE FIRST PROJECT TO DEVELOP AN IFREMER TECHNOLOGY FOR WAVE POWER

Producing wave power is a high-potential sector still in the maturation phase, and Ifremer's expertise has been requested for it in numerous projects. Thanks to the InOcean approach, Ifremer has chosen to launch its first innovative technology development project called BLUE FINS. The novelty of the BLUE FINS system lies in several points, particularly the

use of fins to recover wave energy and relieve the efforts on moorings, or the use of innovative composite materials to reduce the weight and the cost.

The first tank trials were made at Ifremer's Brittany centre in August, on a 1:16 scale model. This series of trials made it possible to calibrate the numerical models of the behaviour of the entire system, which will be used to estimate the amount of energy produced for a given sea state. Structural resistance studies also made it possible to make the preliminary sizing of the prototype on the scale of 1. A new series of trials on a more functional mini-prototype, still at the 1:16 scale, will take place in 2019 in the test tank of the Ifremer centre in Brest.

Olivier Giusti, who is involved in the project, is also working on creating a start-up based on this technology. The project has already been selected by the evaluation committee of the Emergys business incubator to benefit from their support.



QUALIFICATION TRIALS FOR ROTOR PROTOTYPE
IN TEST TANK AT IFREMER BREST

© Ifremer - O. Dugornay

THE ROTOR FLOATING WIND TURBINE: JUST LIKE THE BIG ONES

Rotor is a collaborative research project to develop a tool that can test and optimise, in the test tank, all of the structural and functional elements of a floating wind turbine, thanks to an innovative blade-plus-rotor assembly that can be adapted to any type of floating turbine. Supported by the Brittany regional council, it was conducted by Ifremer and Nass&Wind Industrie between 2016 and 2018. In 2018, a patent for the Rotor system was filed with the National institute for industrial property (INPI).

The Rotor system can provide power and speed regulation for the turbine over the entire operating range by making blades rotate around their axes either in groups or separately. In particular, Rotor enables the interactions between the turbine and its floating structure to be tested. Rotor2 will complement this study in order to optimise and qualify the systems being developed by using numerical modelling and experimental validation by hydrodynamic and aerodynamic trials in the test tank with a wind tunnel with the floating wind turbine prototype developed.

Rotor is the successful example of innovation born from the complementary expertise of a research lab and a company

ACQUISITION OF HOLDINGS IN THE GEPS TECHNO START-UP

In the framework of InOcean, Ifremer wanted to increase its support for the innovative firm GEPS Techno (company with a payroll of twelve in 2018), by transforming its expertise contribution into acquisition of a stake in the firm's equity and taking a seat on its strategic board on 26 November 2018.

Ifremer has been collaborating in GEPS Techno developments since 2013, through various research projects and CIFRE-funded PhD theses. In 2018, Michel Répécaud from Ifremer's Detection, sensors and measurements laboratory was awarded the FIEEC-F2I⁹ applied research prize for his work in collaboration with this start-up. Each year this prize rewards researchers whose studies have been applied and developed in relation with an SME-MSB with the perspective of generating growth and jobs.

⁹ FIEEC Federation of electric, electronic and communication industries ; F2I Fund for innovation in industry



INAUGURATION OF THE WAVEGEM AUTONOMOUS BUOY WHICH GENERATES ITS OWN ELECTRICITY USING WAVE POWER. A LONG-TERM PARTNER IN THE PROJECT, IFREMER ACQUIRED FINANCIAL INTEREST IN THE SHARE CAPITAL OF GEPS TECHNO COMPANY WHICH CREATED THE CONCEPT

© Ifremer - O. Dugornay

INOV'DAYS

The first InOv'days devoted to innovation and entrepreneurship were organised at Ifremer in the second semester of 2018. Over the three days, more than 110 employees met up on the Nantes, Sète and Brest sites to talk about innovation, learn about intellectual property and discuss the opportunities that creating a start-up can hold. On the programme were round tables with local stakeholders in Innovation, first-hand accounts from researchers who have embarked on the adventure of creating a company and a co-creation workshop based on an innovative Ifremer technology, that of marine observatories. These days were facilitated in partnership with the CURIE network and the "Les Innopreneurs" programme.

PROMOTING INNOVATION WITHIN THE INSTITUTE

INTERVIEW WITH JEAN-PIERRE BENQUÉ

Former deputy managing director of EDF and passionate about innovations and their disruptive power, Jean-Pierre Benqué is working for Ifremer to promote innovation inside the Institute.



WHAT ROLE DID YOU PLAY IN THE INOCEAN APPROACH?

First of all, I tried to meet the researchers and learn about their main subjects of study. I quickly saw that they all shared a significant *affectio societatis* commitment to Ifremer and that they promoted their research through publications and patents. The realm of start-ups was a far cry from Ifremer! The InOcean approach, and particularly the Focus innovation workshops, were launched, starting with three topics which deserved special attention: biotechnology, MREs and underwater communications. On these three subjects, we have identified innovations to promote, several actions have been launched and there are others to come. Communication about them has been disseminated and will continue in 2019. The results are truly highly encouraging. There are still many other innovations in our laboratories and we will be establishing new discussions on them in the near future.

WHO IS CONCERNED BY THE INOCEAN APPROACH?

For this difficult process to succeed, everyone has to feel concerned by it. Of course the division in charge of innovation has a special role to play, since it must provide its expertise for implementing processes to transfer knowledge and turn it into something of economic value.

But detecting innovations that can be developed within the economic realm is an ongoing process which starts with the choices of scientific orientations and must be examined *a minima* annually by Ifremer's management.

ONCE INNOVATIONS HAVE BEEN DETECTED, HOW DO YOU PROCEED?

The best way of turning an innovation into a valuable business development is rarely limited to a patent or a license. By limiting itself to that, Ifremer leaves practically all the value-building developments to others, who may be pursuing diametrically-opposed objectives to those of our Institute. A company can buy a license, precisely so that it will not be developed! Ifremer has decided to go further and play a role in setting up a start-up or in a partnership with an existing firm in which Ifremer could hold shares. I am only too happy to see Ifremer take on a greater role in the value chain.

DO YOU HAVE ADVICE TO GIVE THE INSTITUTE?

The entire approach relies on the women and men who must want to experience this adventure. So the desire to create and develop start-ups has to be nurtured. It is often a difficult decision to make and may seem risky. Ifremer is supporting the approach and has entrusted the Development, business development and economic partnerships division with helping researcher-entrepreneurs to develop their initiative. The division provides them with support to carry out a market analysis, create a business model, consider the barriers to market entry and to supply the additional skills needed to manage a start-up (people often overestimate the difficulty). I would urge researchers, whatever their age, to take advantage of the spin-off opportunities offered by Ifremer, if they have detected an innovation that there is a market for and if the analysis performed with the management shows that an enterprise is viable. It is certainly a paradox that the Ifremer universe which proposes support not often so easily found elsewhere, motivates so few researchers to embark on an adventure which, in any case, will be a very enriching experience!



EUROPEAN AND INTERNATIONAL PARTNERSHIPS

Ifremer's visibility and recognition both in Europe and internationally are attested to by the wide range of its partnerships and cooperation agreements. Ifremer contributes to the Joint Programming Initiative JPI Oceans and continues to play an important role in European and international organisations by holding positions of responsibility. In 2018, Ifremer was involved in regional-scale coordination initiatives and through its role in facilitating the joint Franco-Japanese sub-committee contributed to the maritime dialogue established between the two countries.

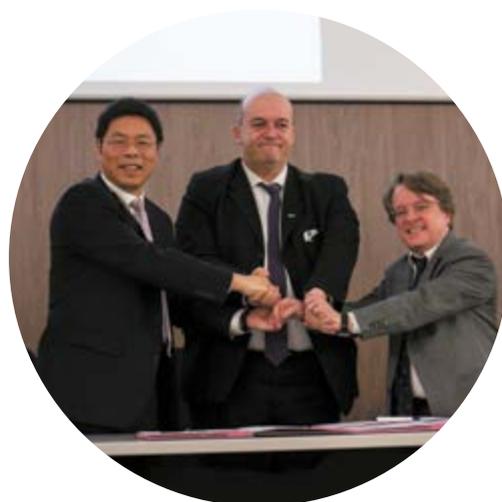
research unit (CNRS, UBO university of western Brittany and Ifremer) studying extreme environments and a Chinese marine biogenetic resources laboratory based in Xiamen.

European partnership is vital for Ifremer, and especially the Horizon 2020 framework programme (2014-2020). In 2018, our Institute submitted 34 H2020 projects, twelve of which have been accepted and six still being evaluated.

IFREMER'S VISIBILITY AND RECOGNITION IN EUROPE AND INTERNATIONALLY

The Institute upholds its cooperation actions both towards countries with strong technical and scientific capabilities (G7 countries) and towards countries that are potential clients for our expertise (BRIC, emerging countries, neighbours). In 2018, Ifremer renewed its agreements for another five years with the National Oceanic and Atmospheric Administration (NOAA) and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC).

Partnerships with China have developed recently in tangible outcomes like the creation of an international associate laboratory (LIA) in marine microbiology. This LIA lab was created in November 2018 following 10 years of scientific cooperation between a joint



FENG CAI, DIRECTOR OF THE THIRD INSTITUTE OF OCEANOGRAPHY OF THE STATE OCEANIC ADMINISTRATION OF CHINA, MATTHIEU GALLOU, PRESIDENT OF UBO AND PATRICK VINCENT, DEPUTY CHIEF EXECUTIVE OFFICER INAUGURATING THE FRANCO-CHINESE ASSOCIATED INTERNATIONAL LABORATORY FOR DEEP SEA MICROBIOLOGY (MICROBSEA). © S. Hervé/IUEM

EUROPEAN UNION INTEGRATED MARITIME POLICY

The integrated maritime policy is a comprehensive approach to all of the European Union policies related to the sea. The EU considers that it can draw higher returns from seas and oceans with less impact on the environment by coordinating its policies. It proposes a maritime basin-based strategy whose agendas are established by CSAs (Coordination and Support Actions). Ifremer is involved in regional-scale coordination initiatives and bases this work on the European Union's foreign policies. Today, Ifremer is present in all of the CSAs: North Atlantic, South Atlantic, Mediterranean, English Channel/North Sea, Baltic Sea, and the Black Sea in preparation. Ifremer is thus taking part in constructing and implementing the European maritime policy, and doing so over the long-term. The Institute brings a cross-cutting approach thanks to its knowledge of all the basins, thus creating overall coherence between the various levels in question (regional, national, European and international).

FRANCO-JAPANESE COOPERATION IN A TIME OF 'MARITIME DIALOGUE'

In 2018 a coherent series of events highlighted the importance of Franco-Japanese cooperation in marine sciences and technologies:

- A two-day workshop between Ifremer, CNRS, JAMSTEC and various other Japanese organisations to brainstorm on research in the deep sea and about organising metadata in a global context. This workshop followed on from two preparatory workshops held in 2015 and 2017 between France, Japan, the South Pacific Commission (SPC) and the International Seabed Authority (ISA). It recommended that a joint project for seafloor observatories be constituted in the South Pacific with the aim of deploying stand-alone (EMSO-type) observatories which could, following the example of the collaborative Abyse/Spy programme, enable participatory sciences to develop by raising awareness of local populations in New Caledonia and in other island States in the Oceania region.
- These recommendations were officially conveyed during the 27th joint Franco-Japanese sub-committee on oceanography coordinated by Ifremer for the French part and covering some forty collaborative

projects in marine science. On the French side, all of these projects are conducted by researchers from CNRS, IPEV, IRD, Ifremer and universities.

- The final major event (in December 2018) was Ifremer's participation in the kick-off seminar to launch a "maritime dialogue" combining security, the environment and development in the Indo-Pacific area, on the initiative of both governments who expressed their will to strengthen the exceptional bilateral partnership in order to work in reinforcing Franco-Japanese cooperation serving the development of "a peaceful, prosperous and inclusive Indo-Pacific area" where marine research will play a major role.



CRINOIDS AND CORAL
IN THE PACIFIC OCEAN
© Ifremer

L'IFREMER AU SEIN DE L'EUROPEAN MARINE BOARD

INTERVIEW WITH JAN MEES, GENERAL DIRECTOR OF THE FLANDERS MARINE INSTITUTE IN BELGIUM

A part-time professor in marine biology and ecology at Ghent University, Jan Mees has been the general director of the Flanders Marine Institute (VLIZ, Oostende, Belgium) since it was established in 1999. Since 2014 he has been the Chair of the European Marine Board (EMB), a unique strategic pan-European forum for seas and ocean research and technology. The EMB develops marine research foresight, initiates state-of-the-art analyses and translates these into clear policy recommendations to European institutions as well as national governments.



© JJ Soenen S,V & Co

AS THE CHAIR TO THE EUROPEAN MARINE BOARD, HOW DO YOU ENVISION ITS ROLE AS A THINK TANK IN MARINE SCIENCE POLICY FACING THE OCEAN ENDEAVOURS TODAY?

The European Marine Board is the leading European think-tank in marine science policy and occupies an important place in the advisory process that underpins the marine research agenda in Europe. The Board provides a platform for its members to play an active foresight role in generating high-quality policy advice that is ready-to-use by decision makers and research programme managers at European and national level. Our rigorous procedures for science foresight form the service we provide to science, to society, and of course, to our members. As an independent non-governmental advisory body, the EMB transfers knowledge between the scientific community and decision makers, promoting Europe's leadership in marine research and technology.

Bridging the gap between science and policy is done using different approaches. We strategically identify scientific challenges and opportunities through foresight activities, analysis and studies, and providing high-level recommendations; The EMB brings together European marine research stakeholders to share knowledge, identify common priorities, develop common positions and collaborate.

Ifremer has been a member of the Board since its creation in 1995, and continued to take part actively when EMB became an independent non-profit organization in 2016 and onwards.

HOW WOULD YOU VALUE IFREMER'S MEMBERSHIP IN THE EUROPEAN MARINE BOARD?

Representing the major organisations involved in marine research in Europe, the Board's member organisation delegates: provide a high-level overview of national science policy priorities, guarantee multidisciplinary and high-quality scientific expertise for the Board's activities, and ensure high-level uptake of the Board's strategic recommendations at national and European levels. Throughout the EMB's history, Ifremer has played this role excellently, and has been a loyal and constructive member, taking responsibility in the Board's governance (Chairs, Vice-Chairs).

Ifremer is one of the leading oceanographic institutes of Europe, and even globally. It is absolutely essential that the institute is at the heart of the EMB network, and that we can draw from the expertise of its researchers. We hope – to our mutual benefit – for the long-lasting future continuation of this strong partnership.

IN THAT RESPECT, WHAT ARE YOUR EXPECTATIONS FROM IFREMER IN SHAPING THE FUTURE RESEARCH AGENDA, THE HORIZON EUROPE, FOR EXAMPLE?

It is important that integrated marine science be placed at the core of Europe's Research and Innovation Agenda. This depends on national efforts, the EMB and other European networks, and Ifremer is an acknowledged ambassador in this field.

It is now time for a collective effort to highlight the importance of the Sea and Oceans in the future budget for Horizon Europe and to call for a Mission on the Ocean, embedded in the broader agenda for marine science and innovation in Europe. It is clear that without sustainable sea and ocean farming, fisheries and mariculture, resilient marine ecosystems and appropriate ocean governance, we will not be able to feed the 7-9 billion people on the

planet, or appropriately use the ocean space over the next decades. The Blue value-chain and multiple uses of the marine space will only be valorised through well-maintained research and innovation funding projects. This will yield a strong European circular economy and future innovations that will impact and improve the lives of European citizens.

The EMB Flagship Policy Document, Navigating the Future V (NFV) will be launched at the UNESCO headquarters in Paris next June. This document will highlight the research needed to understand the four-dimensional ocean (how the 3D ocean changes over time) and the role that the ocean plays in climate

mitigation and adaptation, the impact of multiple human stressors, the impact of extreme events and how to monitor and model these changes, as well as the importance of sustainability science.

All of these themes are part of the broad lines of the Horizon Europe proposal for Sea and Oceans, and we therefore advocate for making sure that the seas and oceans are not forgotten in the parliamentary debates and choices made for Horizon Europe. Through the EMB, Ifremer is presently assisting in the writing of NFV; after the launch we hope for similar efforts to help implement its ambitious research priorities



THE OCEAN-BLUE COLOUR OF THE EARTH,
AS SEEN BY NASA'S TERRA SATELLITE

COMMUNICATIONS

IFREMER AT THE ECONOMY OF THE SEA CONGRESS

Ifremer was present at the 2018 Economy of the Sea event, a major gathering for those in the maritime realm. François Houllier introduced the event with a series of questions and answers, to present the Institute's strategic project and its main orientations to the institutional and economic partners. Several researchers from the Institute took part in the round-table sessions, with a presentation by Pierre-Marie Sarradin on deep-sea environments and one by Pascal Larnaud on innovation in fishing gear to improve selectivity. The Institute marked its presence with its new corporate film more in keeping with its new missions and enabled the participants to test two innovative immersive devices on its stand. In one of them, the user sees virtual content on a small screen with a remote display during the exploration of hydrothermal smokers in the deep sea. The other is the Donvor capsule, one of the creative formats developed with the "Teatr Piba" theatre company.

examine societal issues. In 2018, four topics were dealt with. Amongst them, Ifremer supplied elements to put the ICES advice on electrical pulse fishing trawls into perspective, and also dealt with the subject of plastics discarded at sea. This experimentation will be assessed to determine whether it will be a permanent feature.



INFORMING THE PUBLIC DEBATE

The Institute endeavours to provide its expertise and take part in raising the level of societal stakeholders' competence. Informing public discussion by supplying up-to-date, summarised and relevant scientific knowledge, that is the goal of the new section on Ifremer's website for the general public. Called "*Décryptage*" (decoding), it gives the media, but also the citizens, keys to understand and

IMAGE PRESENTING THE SHIFTED REALITY DEVICE AROUND THE LUCKY STRIKE HYDROTHERMAL SMOKER SITE. IT ENABLES MEMBERS OF THE PUBLIC TO EXPERIENCE A DEEP SEA DIVE FOR THEMSELVES © SO

IFREMER PRESENT IN NEW MEDIA

Some fine success stories: at the request of the Youtuber Marie Wild, Stanislas Dubois presented honeycomb worm reefs, constructed by marine worms. The video was viewed more than 8,000 times. Stanislas also presented honeycomb worms at the *Fête de la Science* festival in Paris.

A video by an Ifremer scientist, Charlotte Corporeau on the theme "can the oyster help us fight cancer?", first published on the Thalassa TV show's Facebook page, then shared by another page with a big audience (*M. Mondialisation*) generated more than 420,000 views! The distribution of the web series called "It's sea time" on YouTube helped grow the number of subscribers to the Institute's channel, while showcasing its various scientific activities.

AQUAKULTOR: AQUACULTURE IN A SERIOUS GAME!

François Allal, Ifremer researcher at the MARBEC (Marine biodiversity, exploitation and conservation) joint research unit, is behind designing genome chips to develop the genomic selection of sea bass. Working in collaboration with Mathieu Besson, a post-doc fellow at INRA, and also a video-game fan, François Allal developed a free-to-use "serious game". The game is financed in great part from his research budget and was produced with TheOneManArmy Game Studio, born from the desire to make aquaculture, and the contribution that genetics can make to a sustainable value chain, better known to a much broader audience than that of more traditional media. Players can use genetic selection to improve the economic yields and reduce the environmental impact of their aquaculture farm. Without claiming to be realistic, the game is based on zootechnical and genetic knowledge acquired at the Ifremer centre in Palavas-les-Flots, as well as during Mathieu Besson's PhD thesis. Aquakultor has already been downloaded more than 6,400 times since 24 August! This entertaining media tool is being considered for use as an educational tool at James Cook University in Singapore and will allow thousands of people to familiarise themselves with the concepts of aquaculture, genetics and sustainability.

AWARD FOR THE SHORT FILM "CLIMATHUITRE"

Élodie Fleury, head of the invertebrate physiology laboratory (LPI), received an award from the international scientific film festival *Pariscience*, for her short film "*Le réchauffement climathuitre*" (oyster/climate warming), produced in collaboration with the director Étienne Husson. When Élodie was contacted to enter the competition for the Symbiose prize, she saw it as a novel opportunity to transmit her passion for her work, to take the way people see the job of scientist off its pedestal and to popularize her overall view of the studies carried out in her lab. A well-met challenge since this video film produced in less than 48h let Élodie clearly explain, in less than 5 minutes, results obtained at the LPI over several years. In it, an oyster tells about its daily life with her as its lab scientist, its role as an "environmental blotter" and the impact that environmental changes have on its species. A funny and offbeat way of sharing the concerns related to climate challenges to new audiences and to raise young people's awareness about scientific careers.

ARTISTS AND SCIENTISTS

BROUGHT TOGETHER BY THE ABYSS

For over twenty years, Pierre-Marie Sarradin, head of the Deep ecosystem study unit (EEP) and Jozée Sarrazin, researcher in the Deep-sea environment laboratory (LEP) have explored the mosaic of habitats making up the deep sea with the same feeling of wonder and strong emotions still intact. The desire to share these experiences, to make the deep sea better known and help contribute to protecting it are the reasons behind a novel form of collaboration with the Teatr PIBA theatre company in Brest. In 2017, a laboratory format called SPLUJ resulted from this artistic-scientific collaboration which will develop over the long term. Two years of artists/scientists in residence during ocean cruises (on a transit leg and on the Momarsat cruise aboard the *Pourquoi pas?* research vessel) and of theatrical experiences led to this 25-minute immersive form in which the spectators are invited to share the first stage of a poetic, fantasy voyage to the deepest depths of the abyssal plains. The SPLUJ holds the seeds of the creation of a future show, and has been presented several times at multidisciplinary festivals, creative workshops in schools and universities and events like the *Cabaret de la Science* in Paris during the science festival event *Fête de la Science 2018*.

The outcome of this novel experience where "art and science" work together will be a show called DONVOR ("deep thoughts" in the Breton language) to start in January 2020.

The Teatr PIBA company will invite the audience to join in a unique radio and sensory theatrical adventure, animated by the narrative of the author David Wahl (www.donvor.blog) and his associates, which will take us to the deep seafloors at the outermost bounds of the western world.



A HYDROTHERMAL SMOKER ON THE LUCKY STRIKE SITE. MOMAR 2008 CRUISE. LOCATED OFF THE AZORES, THIS IS ONE OF THE MOST EXTENSIVE HYDROTHERMAL SITES WHICH HAVE BEEN VISITED TO DATE IN THE WORLD OCEAN. ITS AVERAGE DEPTH IS 1,700 METRES. THE HYDROTHERMAL FLUIDES EJECTED THERE HAVE TEMPERATURES RANGING BETWEEN 170 AND 324°C.

HUMAN RESOURCES AND SUPPORT SERVICES FOR RESEARCH

THE INSTITUTE'S ORGANISATION A YEAR OF TRANSITION

Indeed, important milestones in 2018 were the preparation and support for the transfer of our headquarters from Issy-les-Moulineaux to Brest and the closing of the Trinité-sur-Mer research station.

TRANSFERRING THE HEADQUARTERS TO BREST

The Institute pursued the outplacement assistance efforts engaged as of 2017 for the staff from the Issy-les-Moulineaux site, only 14 of whom have moved to Brest. Thanks to the mobilisation of the human resource division teams and the commitment from the French State and public-sector operators, a solution was found, in financial and human terms, for each of the people in question.

Construction work on the future headquarters building at Ifremer began on 1st February 2018 and will last 18 months. It involves a complete renovation and an extension to the Centre's old office building. The new building will comply with "High environmental quality" standards and use photovoltaic energy production to cover 15% of its electricity requirements. It will accommodate some 170 people from central services and from the Brittany centre's management staff. Structural work on the building's shell was completed in October 2018. Along with this operation, the company restaurant and the building at the site's entrance were renovated and returned to service in October 2018. During the period of work, the staff members

whose services will be located in the new building are being accommodated in temporary facilities.



AERIAL VIEW OF THE NEW BUILDING UNDER CONSTRUCTION
AT THE IFREMER HEADQUARTERS IN BRITTANY

© Ifremer - S. Lesbats

CLOSING THE LA TRINITÉ-SUR-MER STATION

In the framework of reorganising the Institute's regional arrangement, the decision to close the research station located at La Trinité-sur-Mer in Morbihan county was taken in 2017 and implemented in 2018. In order to accommodate the staff who chose an in-house move to the station in Lorient, work was undertaken to fit out the premises. The "Morbihan – Pays de la Loire" Environment-Resources laboratory is now located on two sites, in Nantes

and in Lorient. A hangar designed to hold sampling equipment was also set up on the Lorient Station site.

In this context, the Human Resources division had several challenges to meet. As well as accompanying staff transfers, it had to recreate the central management teams (only one person out of 19 moved to Brest), while continuing to carry out its remit with respect to other Institute stakeholders. In terms of social dialogue, priority was given to ensuring the regular functioning of staff representative organisations and to the annual wage negotiation which led to the signing of an agreement, before determining an ambitious social agenda for 2019.

STAFF, HIRING AND TRAINING

As of 31 December 2018, Ifremer's staff numbered 1,474 salaried employees, including 647 researchers and engineers. The proportion of women within the Institute remains fairly stable: they make up 46.68% of the total payroll.

In 2018, hiring activity involved assimilating 66 new employees, 79% of them in supervisory positions. Exceptionally, 50% of these recruitments involved support function jobs to accompany the transfer of the headquarters, setting up a new organisation for the administrative, legal and financial division and creating the oceanographic fleet management division. Concurrently, in compliance with our human resource policy promoting professional career development for our salaried employees, 11 of them benefited from a career change in the framework of our in-house mobility system.

In 2018, skills development remained a strong orientation for the Institute, with a budget devoted to professional training which is much higher than that required by law (i.e. 2.59% of the gross payroll, whereas the legal obligation is 1%). The largest share of this budget was devoted to scientific and technical training courses, our Institute's core business.

Furthermore, an incentive-based policy encouraged salaried employees to mobilise their CPF personal training account and significantly increased the number of beneficiaries, mainly for foreign language courses. Our Institute also stepped up its proactive policy for sandwich courses alternating work and study periods by taking on 38 new employees on apprenticeship or professionalisation contracts, a rise of 65% compared to the previous year.

BRINGING IFREMER INTO COMPLIANCE WITH THE GENERAL DATA PROTECTION REGULATION (GDPR)

From the start of 2018, our Institute wanted to best prepare for the 25 May 2018 deadline (date of GDPR implementation) and appointed a special team, drew up a project management plan and set up a specific action plan including conducting training sessions for the team and drawing up the initial record of processing activities for each of the Institute's divisions. As of May, the record of processing activities was completed, a GDPR Intranet site developed and a data-protection officer appointed.

Several actions were undertaken to raise staff awareness:

- Training for personnel directly concerned by the GDPR (Human Resources division, Support cluster, etc.) was provided
- The record of processing activities was put on line on the GDPR intranet,
- A note explaining the GDPR legal framework at Ifremer was disseminated,
- An informative letter specifying the context of personal data processing at Ifremer was sent by post.

Other actions related to putting the GDPR into application have begun, including the reviewing the IT charter, creating an Information system security policy (ISSP), creating a secure assistance portal for requests for help or information, reviewing the contractual clauses related to outsourcing or subcontracting of PD processing and improving the signposting of areas under video surveillance. Ifremer also contacted other research institutes to promote synergies and practices. Exchanges were established to this end with partners like the IFPEN, IRSN, Shom and Cirad in particular.

QUALITY: AFNOR CERTIFICATION RENEWED

Eight years after the first certification and following the successful transition to new requirements of the 2015 version of the ISO 9001 standard, the Quality approach at Ifremer has adapted to the in-house organisation, becoming simpler and more mature. The documentation for several processes was revised to adopt a simpler approach taking changes noted - for instance, the InOcean approach - into account and assimilating the results from audits. Concurrently, the eight main risks facing the Institute were defined, formally stated, then evaluated. The relevant actions to master these risks were begun. This exercise was then applied in turn to each process. Thanks to these adaptations, the quality system established has achieved greater maturity and adoption by users.

Two new projects launched in 2018 will further reinforce this maturity:

- The first focuses on setting up electronic management of the Institute's reference documents.
- The second deals with creating a single quality system dedicated to laboratories with ISO 17025 standard accreditation, in response to the regulatory context of Ifremer's mission to support public policies

Following an audit which mobilised the teams from two overseas sites and five sites in metropolitan France, the certificate of compliance with the ISO 9001 standard was renewed for a three-year period, running to 2021. Some of Ifremer's strong points notably identified by the auditors were the dynamic drive shown in implementing and improving processes, along with strong leadership.

BUDGET AND FINANCIAL FIGURES

The budget performance showed a positive balance with a 17.8 million-euro surplus and a contribution of 11.4 million euros to the working capital.

FUNDS

The overall income of the Institute was 235.4 million euros for the 2018 financial year:

- Public subsidies (for public service responsibilities and operation expenses from the State and other public entities) amounted to 204.7 million euros. This is up from 2017 and due, in particular, to the oceanographic fleet's becoming part of the Institute from 2018 on;
- Direct income from activities reached 15.2 million euros, compared to 14.6 million euros in 2017;
- In addition, Ifremer posted 10.8 M euros in investment grants intended to contribute to financing our Institute's projects

EXPENDITURES

The overall expenditure of the Institute was 217.6 million euros for the 2018 financial year:

- Expenses directly related to the activity reached 88.0 million euros;
- Payroll costs amounted to 98.4 million euros. The staff numbers represented 1,521 FTE positions;
- Other expenses related to operating the Institute (operation, intervention and financial costs) reached 12.3 million euros;
- Depreciations amounted to 19.8 million euros;
- Investment spending also amounted to 22.3 million euros.

THE PROPERTY ASSETS SITUATION

The balance sheet total assets were 355.7 million euros at the end of 2018. The main points to retain are:

- A cash flow established at 66.1 million euros;
- Accounts receivable for financiers and clients amounting to 61 million euros, up by 4 million from 2017. This situation can be explained by requests to wind up grants for large projects which had not been completed by the end of the financial year;
- Net fixed assets valued at 228.5 million euros, an increase of 6 million euros;
- Trade accounts payable were evaluated at 20.1 million euros, which is down from 2017 figures.

BUDGETARY OUTCOME FOR THE 2018 FINANCIAL YEAR

EXPENDITURE	BR3 2018		CF 2018	
	CA	PA	CA	PA
Staff	135,749,000	135,749,000	131,545,022	131,410,355
<i>including employer contributions to special appropriation account for pensions</i>	771,600	771,600	620,374	620,374
Operation	72,368,112	76,354,922	67,976,740	72,854,963
Intervention				
Investments	31,481,430	27,560,065	30,341,909	26,741,824
TOTAL EXPENSES CA (A) PA (B)	239,598,542	239,663,987	229,863,671	231,007,142
BUDGET BALANCE (surplus) (D1 = C - B)		5,501,056		8,646,554

The commitments authority (CA) established in 2018 reached 229.9 million euros, i.e. an overall performance of 96% of the forecast. Payment appropriations (PA) were used to the amount of 231.0 million euros, making 96% of the budget forecast.

REVENUES		
BR3 2018	CF 2018	
223,209,162	227,743,071	Aggregated revenues
167,177,545	167,177,545	Subsidies for public service responsibilities
14,253,753	12,838,652	Other State funding
-	-	Allocated taxation
34,152,598	33,100,245	Other public funding
7,625,266	14,626,629	Own resources
21,955,881	11,910,624	Earmarked revenues*
8,816,357	1,047,625	Earmarked State funding
13,139,524	10,863,000	Other earmarked public funding
		Earmarked own revenues
245,165,043	239,653,696	TOTAL REVENUES (C)
-	-	BUDGET BALANCE (deficit) (D2 = B - C)

Revenues collected reached 239.7 million euros, i.e. 98% of the forecast. This means the budget balance shows a surplus of 8.6 million euros for 2018. The budget distribution by major fields of the Institute is broken down as follows:

BUDGET	EXPENDITURE									
	Staff		Operation		Intervention (if necessary)		Investments		Total	
	CA	PA	CA	PA	CA	PA	CA	PA	CA (A)	PA (B)
D01 SCIENCES	87,049,600	86,941,495	21,910,312	25,865,470			7,571,085	12,229,040	116,530,996	125,036,005
D02 SUPPORT	21,388,791	21,362,229	16,145,353	19,739,088			10,419,851	9,306,608	47,953,996	50,407,925
D03 OTHER			589,736	978,385			6,767,339	2,779,672	7,357,075	3,758,057
D04 FLEET	23,106,631	23,106,631	29,331,340	26,272,020			5,583,634	2,426,504	58,021,605	51,805,155
TOTAL	131,545,022	131,410,355	67,976,740	72,854,963	-	-	30,341,909	26,741,824	229,863,671	231,007,142

It should be noted that the line called "Sciences" represents 51% of Ifremer's budget, the Fleet represents 25% and support functions 24%.

In conclusion, Ifremer's financial situation is healthy. The Institute has the financial tools needed to pursue its real estate projects launched and sufficient financial reserves to ensure both the continuation of scientific projects underway and the launching of new projects.

APPENDICES

BALANCE AT CLOSING BEFORE ALLOCATION OF PROFIT OR LOSS

BALANCE SHEET - ASSETS	2018			2017		TREND
	GROSS	DEPRECIATION	NET	NET		
FIXED ASSETS						
INTANGIBLE ASSETS						
Preliminary and formation expenses	13,270.16	13,270.16	0.00	0.00	-	
Research and development costs	0.00	0.00	0.00	0.00	-	
Concessions and similar rights, patents, licences, brands, processes, software, fees and similar assets	38,614,465.03	33,473,145.03	5,141,320.00	6,107,301.00	-15.8 %	
Purchased goodwill	0.00	0.00	0.00	0.00	-	
Other intangible assets	208,522.16	208,522.16	0.00	0.00	-	
Intangible assets in progress	6,104,762.45		6,104,762.45	5,980,724.06	2.1 %	
Advances and prepayments for intangible asset orders	6,408,210.67		6,408,210.67	5,003,325.16	28.1 %	
TOTAL - INTANGIBLE ASSETS	51,349,230.47	33,694,937.35	17,654,293.12	17,091,350.22	3.3 %	
TANGIBLE FIXED ASSETS						
Land, developments and land improvements	8,424,187.24	1,661,404.18	6,762,783.06	6,824,219.06	-0.9 %	
Buildings	120,240,990.42	77,738,178.42	42,502,812.00	43,714,555.00	-2.8 %	
Technical facilities, equipment and tools	345,697,813.46	267,654,133.46	78,043,680.00	81,812,298.00	-4.6 %	
Collections	872,856.49		872,856.49	872,856.49	0 %	
Historical and cultural property	0.00	0.00	0.00	0.00	-	
Other tangible fixed assets	30,974,731.10	29,633,441.10	1,341,290.00	1,839,532.00	-27.1 %	
Fixed assets under concession	0.00	0.00	0.00	0.00	-	
Tangible assets in progress	8,541,478.31		8,541,478.31	8,496,395.41	0.5 %	
Advances and prepayments for tangible asset orders	65,414,297.80		65,414,297.80	53,429,645.34	22.4 %	
Tangible fixed assets (livestock and living organisms)	0.00	0.00	0.00	0.00	-	
TOTAL - TANGIBLE ASSETS	580,166,354.82	376,687,157.16	203,479,197.66	196,989,501.30	3.3 %	
FINANCIAL ASSETS						
Securities	861,941.68	85,981.68	775,960.00	487,692.08	59.1 %	
Other forms of investment (Quae)	125,000.00	4,470.38	120,529.62	125,000.00	-3.6 %	
Loans to group companies	0.00	0.00	0.00	0.00	-	
Investments	0.00	0.00	0.00	0.00	-	
Loans	5,783,610.65	0.00	5,783,610.65	5,860,301.28	-1.3 %	
Deposits and guarantees paid	640,399.76	0.00	640,399.76	640,399.76	0 %	
TOTAL FINANCIAL ASSETS	7,410,952.09	90,452.06	7,320,500.03	7,113,393.12	2.9 %	
TOTAL FIXED ASSETS	638,926,537.38	410,472,546.57	228,453,990.81	221,194,244.64	3.3 %	
CURRENT ASSETS						
TOTAL INVENTORY AND WORK-IN-PROGRESS	0.00	0.00	0.00	0.00	-	
TOTAL ADVANCES AND PREPAYMENTS MADE ON ORDERS	4,231,535.86		4,231,535.86	393,147.90	976.3 %	
ACCOUNTS RECEIVABLE						
Customer and related accounts receivable	5,585,584.42	1,057,445.51	4,528,138.91	8,182,546.54	-44.7 %	
Accounts receivable on public entities (State, other public entities) international bodies and the European Commission	52,025,212.93		52,025,212.93	56,198,992.81	-7.4 %	
Accounts receivable on tax owed (income from earmarked taxes)	0.00		0.00	0.00	-	
Accounts receivable corresponding to operations on behalf of third-parties (intervention plans)	0.00		0.00	0.00	-	
Accounts receivable on other debtors	383,561.96	0.00	383,561.96	227,821.91	68.4 %	
TOTAL ACCOUNTS RECEIVABLE	57,994,359.31	1,057,445.51	56,936,913.80	64,609,361.26	-11.9 %	
CASH						
Shares (listed securities)	0.00	0.00	0.00	0.00	-	
Other securities	0.00	0.00	0.00	0.00	-	
Banking	66,076,732.78		66,076,732.78	46,303,976.02	42.7 %	
<i>incl. private banks</i>	135,613.00		135,613.00	23,116.19	486.7 %	
<i>incl. Public finances general directorate</i>	65,941,119.78		65,941,119.78	46,262,292.28	42.5 %	
Cash account	19.56		19.56	19.56	0 %	
Accounts payable department	40,700.00		40,700.00	43,449.87	-6.3 %	
Accounts receivable department	0.00		0.00	0.00	-	
TOTAL CASH ASSETS	66,117,452.34	0.00	66,117,452.34	46,347,445.45	42.7 %	
ACCRUALS						
Prepaid expenses	0.00		0.00	0.00	-	
Unrealised foreign exchange losses	-428.90		-428.90	-0.23	186378.3 %	
TOTAL ACCRUALS	-428.90	0.00	-428.90	-0.23	186378.3 %	
TOTAL CURRENT ASSETS	128,342,918.61	1,057,445.51	127,285,473.10	111,349,954.38	14.3 %	
TOTAL ASSETS	767,269,455.99	411,529,992.08	355,739,463.91	332,544,199.02	7 %	

BALANCE AT CLOSING BEFORE ALLOCATION OF PROFIT OR LOSS

BALANCE SHEET - LIABILITIES	2018	2017	TREND
LIABLE EQUITY CAPITAL			
CAPITAL			
FUNDING RECEIVED			
State funding not related to assets	0.00	0.00	-
State funding related to assets	124,714,671.20	131,072,975.14	-4.9 %
Asset funding by third-parties other than the State	30,915,921.75	25,944,995.59	19.2 %
<i>incl. write-off in funding income</i>	383,522,782.54	381,198,024.49	0.6 %
TOTAL - FUNDING RECEIVED	155,630,592.95	157,017,970.73	-0.9 %
TOTAL - REVALUATION DIFFERENCES	16,299,666.98	16,299,666.98	0 %
RESERVES			
Legal reserve	0.00	0.00	-
Regulated reserves	0.00	0.00	-
Other reserves	35,510,661.75	35,510,661.75	0 %
<i>incl. optional reserves</i>	35,510,661.75	35,510,661.75	0 %
TOTAL - RESERVES	35,510,661.75	35,510,661.75	0 %
RETAINED EARNINGS	30,096,353.68	11,172,693.73	169.4 %
FINANCIAL YEAR PERFORMANCE (PROFIT OR LOSS)	17,765,173.22	18,923,659.95	-6.1 %
REGULATED PROVISIONS	0.00	0.00	-
TOTAL LIABLE EQUITY CAPITAL	255,302,448.58	238,924,653.14	6.9 %
PROVISIONS			
Provisions for contingencies	3,999,742.91	2,200,820.00	81.7 %
Provisions for expenses	16,299,930.48	15,741,582.87	3.5 %
<i>incl. provisions for pensions and similar obligations</i>	12,814,948.26	12,894,957.10	-0.6 %
<i>incl. provisions for job-loss and severance pay allocations</i>	2,610,276.33	1,868,828.91	39.7 %
<i>incl. other provisions for expenses - others</i>	874,705.89	977,796.86	-10.5 %
TOTAL PROVISIONS	20,299,673.39	17,942,402.87	13.1 %
LIABILITIES			
FINANCIAL LIABILITIES			
Loans and related liabilities	0.00	31,323.00	-
<i>incl. deposits and bonds received - deposits</i>	0.00	31,323.00	-
Holding-related liabilities	3,448.41	3,448.41	0 %
<i>incl. liabilities related to joint ventures - Tahiti</i>	3,448.41	3,448.41	0 %
TOTAL FINANCIAL LIABILITIES	3,448.41	34,771.41	-90.1 %
NON-FINANCIAL LIABILITIES			
Trade accounts payable and related accounts	20,111,863.61	26,116,404.83	-23 %
Tax and social security payable	24,636,481.24	24,058,645.18	2.4 %
<i>incl. staff and related account liabilities</i>	10,837,224.72	10,505,591.39	3.2 %
<i>incl Social security and social organisations</i>	11,720,456.23	9,671,165.63	21.2 %
Advances and prepayments received	26,359,318.77	22,337,132.45	18 %
Accounts receivable corresponding to operations on behalf of third-parties (intervention plans)	227,578.24	151,800.53	49.9 %
Other non-financial liabilities	8,614,332.64	2,723,941.38	216.2 %
TOTAL NON-FINANCIAL LIABILITIES	79,949,574.50	75,387,924.37	6.1 %
CASH FLOW			
Elements of passive cash flow	9.95	478.69	-97.9 %
TOTAL CASH FLOW	9.95	478.69	-97.9 %
ACCRUALS			
Deferred income	184,309.08	253,968.54	-27.4 %
Accrual and deferral accounts	0.00	0.00	-
TOTAL ACCRUALS	184,309.08	253,968.54	-27.4 %
TOTAL LIABILITIES	80,137,341.94	75,677,143.01	5.9 %
TOTAL UNREALISED EXCHANGE PROFIT	0.00	0.00	-
TOTAL LIABILITIES	355,739,463.91	332,544,199.02	7 %

PROFIT AND LOSS (€) - PART 1

	2018	2017	TREND
TOTAL OPERATING AND INTERVENTION COSTS			
OPERATING COSTS			
Purchases	0.00	0.00	-
Consumption of goods and supplies, performance of work and direct consumption of services by the organisation for its activities as well as expenses related to change in stock	88,063,411.36	65,040,044.81	35.4 %
Salaries and fringe benefits	98,446,226.97	96,150,114.96	2.4 %
Salaries, appointments and misc. payments	66,385,328.40	64,276,858.81	3.3 %
Social contributions	26,938,946.79	26,970,852.57	-0.1 %
Employees' profit sharing	0.00	0.00	-
Other staff expenses	5,121,951.78	4,902,403.58	4.5 %
Other operating costs	11,173,069.70	10,495,906.65	6.5 %
Depreciation, provisions and net book value of assets sold	19,804,143.11	16,741,125.59	18.3 %
TOTAL OPERATING COSTS	217,486,851.14	188,427,192.01	15.4 %
INTERVENTION COSTS			
For intervention on own behalf	41,077.87	1,429,356.72	-97.1 %
Transfers to households	0.00	0.00	-
Transfers to companies	0.00	0.00	-
Transfers to local or regional authorities	0.00	0.00	-
Transfers to other authorities	41,077.87	1,429,356.72	-97.1 %
Charges due to exercise of Institute's guarantee	0.00	0.00	-
Depreciation and provisions for loss in value	0.00	0.00	-
TOTAL INTERVENTION COSTS	41,077.87	1,429,356.72	-97.1 %
TOTAL OPERATING AND INTERVENTION COSTS	217,527,929.01	189,856,548.73	14.6 %
OPERATING INCOME			
Income without direct consideration (or subsidies, grants and similar income)	204,712,348.36	177,797,957.92	15.1 %
Subsidies for public service responsibilities	172,137,404.33	154,384,174.00	11.5 %
Operating subsidies from the State and other public-sector entities	32,509,944.03	23,386,783.92	39 %
Subsidies from the State and other public-sector entities specifically earmarked to cover certain intervention costs	0.00	0.00	-
Donations and legacies	65,000.00	27,000.00	140.7 %
Income from earmarked taxes	0.00	0.00	-
Income with direct consideration (or direct income from activity)	15,192,034.81	14,616,431.54	3.9 %
Sale of goods or services	13,472,931.80	12,420,273.97	8.5 %
Gains from sales of assets	5,500.01	310,000.00	-98.2 %
Other management income	1,713,603.00	1,064,292.42	61 %
Inventories and capitalised production	0.00	821,865.15	-
Other income	15,156,848.66	16,079,634.86	-5.7 %
Write-off of depreciations and provisions (operating income)	2,724,773.39	2,968,426.46	-8.2 %
Write-off of financing related to an asset	12,432,075.27	13,111,208.40	-5.2 %
TOTAL OPERATING INCOME	235,061,231.83	208,494,024.32	12.7 %

PROFIT AND LOSS (€) - PART 2

	2018	2017	TREND
FINANCIAL EXPENSES			
Interest fees	24,393.88	14,751.65	65.4 %
Net loss from sale of securities	0.00	0.00	-
Exchange losses	22,428.39	14,282.61	57 %
Other financial charges	0.00	0.00	-
Depreciation and financial provisions	21,409.66	0.00	-
TOTAL FINANCIAL EXPENSES	68,231.93	29,034.26	135 %
FINANCIAL INCOME			
			-
Income from shares in and loans	281,189.24	273,167.25	2.9 %
Net proceeds from sale of financial fixed assets			-
Interests on non-fixed receivables	0.00	0.00	-
Proceeds from investment securities and cash flow	0.00	0.00	-
Proceeds from sale of securities	0.00	0.00	-
Exchange gains	20,929.89	21,812.37	-4 %
Other exceptional revenues	0	0	-
Write-off of depreciations and financial provisions	3,857.20	87,480.00	-95.6 %
TOTAL FINANCIAL INCOME	305,976.33	382,459.62	-20 %
Corporate income taxes	5,874.00	67,241.00	-91.3 %
GROSS PROFIT OR LOSS	17,765,173.22	18,923,659.95	-6.1 %
TOTAL - INCOME	235,367,208.16	208,876,483.94	12.7 %
TOTAL - EXPENSES	217,596,160.94	189,885,582.99	14.6 %
PROFIT (+) OR LOSS (-)	17,765,173.22	18,923,659.95	-6.1 %

BOARD OF DIRECTORS ON 31 DECEMBER 2018

CHAIRMAN

François HOULLIER, Chairman and CEO

MEMBERS REPRESENTING THE STATE

**MINISTRY OF HIGHER EDUCATION,
RESEARCH AND INNOVATION**

Bernard COMMÈRE
Alternate: **Didier MARQUER**

MINISTRY OF ECOLOGICAL AND INCLUSIVE TRANSITION

Fabienne RICARD
Alternate: **Isabelle TERRIER**

Laurent BERGEOT
Alternate: **Marie-Laure BAILLY MAITRE**

MINISTRY OF AGRICULTURE AND FOOD

Laurent BOUVIER
Alternate: **Benoît ARCHAMBAULT**

MINISTRY OF DEFENCE

Contre-amiral Nicolas VAUJOUR
Alternate: **Capitaine de vaisseau Lionel PILLAN**

MINISTRY OF THE ECONOMY AND FINANCE

Nicolas HENGY

MINISTRY IN CHARGE OF INDUSTRY

Guillaume LACROIX
Alternate: **Robert DJELLAL**

MINISTRY OF EUROPE AND FOREIGN AFFAIRS

Clélia Chevrier KOLACKO
Alternate: **Anisse BEN YOUNES**

MEMBERS CHOSEN FOR THEIR EXPERTISE IN FIELDS CLOSE TO THOSE OF IFREMER

Julien LAMOTHE, National association
of Producer Organisations

Michel EDDI, President of the CIRAD

Françoise MÉCHIN, IFP Énergies nouvelles

Stéphanie THIÉBAULT, Director of the Ecology
and environment Institute, CNRS

MEMBERS ELECTED BY IFREMER PERSONNEL

CFDT UNION

Jean TOURNADRE
Loïc LE DEAN
Catherine SATRA LE BRIS
Cathy TRÉGUIER
Loïc PETIT DE LA VILLEON

CGT UNION

Carla SCALABRIN
Joël KNOERY

MEMBERS VOTING IN ADVISORY CAPACITY

CHAIRMAN OF IFREMER'S SCIENTIFIC COMMITTEE

Patrick LANDAIS

MINISTRY OF OVERSEAS TERRITORIES

Christiane LAURENT-MONPETIT

GOVERNMENT COMMISSIONER

Damien ROUSSET

GENERAL COMPTROLLER FOR FINANCE AND ECONOMICS

Philippe DEBET

HEAD ACCOUNTANT OF IFREMER

Yves JANIN

SECRETARY GENERAL FOR THE SEA

Vincent BOUVIER

COMITÉ SCIENTIFIQUE AU 31 DÉCEMBRE 2018

CHAIRMAN

Patrick LANDAIS

Executive director at ANDRA innovation and development division

EXECUTIVE DIRECTOR AT ANDRA INNOVATION AND DEVELOPMENT DIVISION

Denis ALLEMAND

Scientific director of the Scientific centre of Monaco

Chris BOWLER

Research director at CNRS, École Normale supérieure, director of the Environmental and evolutionary genomics section

Francesco CHIOCCI

Professor at La Sapienza university, Earth Sciences department, Rome

Pascale DELÉCLUSE

Director of INSU at CNRS

Marion GEHLEN

Research director at CEA, laboratory of environmental and climate sciences, Gif-sur-Yvette

Peter HERMAN

Senior Adviser, Deltares, Delft, The Netherlands

François LALLIER

Director of UMR Adaptation and diversity in the marine environment, Pierre & Marie Curie university, Roscoff

Marina LÉVY

Research director at CNRS, Oceanography and climate laboratory: experiments and numerical approaches Institut Pierre Simon Laplace, Paris

Jean-Marie MOUCHEL

Professor, Pierre & Marie Curie university, Paris, director of Piren Seine programme

Fabienne PETIT

Professor, University of Rouen, director of Federation for Applied environmental sciences

Edwige QUILLET

Research director at INRA, head of Aquaculture genetics team, UMR GABI, Jouy-en-Josas

Hélène REY-VALETTE

Research director at INRA, head of Aquaculture genetics team, UMR GABI, Jouy-en-Josas

MEMBERS ELECTED BY IFREMER PERSONNEL

Jean-François PÉPIN, full member

Marie-Anne CAMBON BONAVITA, Alternate

Caroline MONTAGNANI, full member

Christophe DESBOIS, Alternate

Julien NORMAND, full member

Ricardo DA SILVA JACINTO, Alternate

PERMANENT GUEST MEMBERS

François CARLOTTI

Sea task group facilitator, CNRS/INSU Atmosphere and sea

Thomas CHANGEUX

Mer AllEnvi task group, Overseas France committee, IRD

Jacqueline GARNIER-LAPLACE

Risques AllEnvi task group, Director of Research and expert assessment of environmental risks department, Institute for radioprotection and nuclear safety

Didier GASCUEL

Mer AllEnvi task group, Director of Agrocampus Ouest fisheries science cluster

Yves-Marie PAULET

Mer AllEnvi task group, Professor, University of western Brittany, Brest

Sylvie REBUFFAT

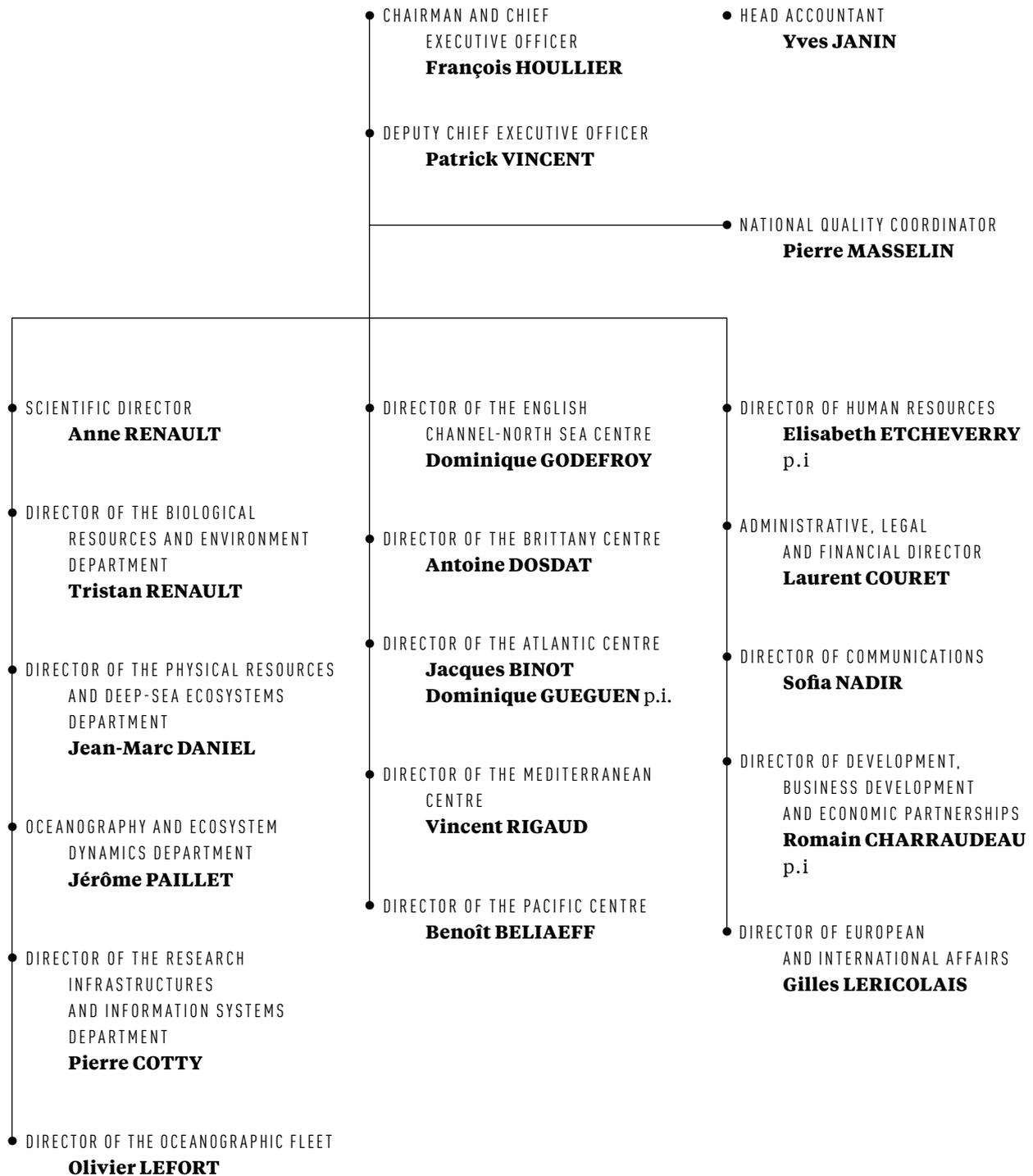
Professor, Museum of natural history, AllEnvi scientific steering committee

SCIENTIFIC COMMITTEE SECRETARY

Anne RENAULT

Scientific director

SCIENTIFIC COMMITTEE AS OF 1ST JANUARY 2019





1625 route de Sainte-Anne
zone industrielle de la pointe du diable
29280 Plouzané

tél. 02 98 22 40 40
www.ifremer.fr



Our thanks go to all those in Ifremer's research units and departments who contributed to creating this document.

Graphic design:
Jérémy Barrault

Printing:
Stipa (Imprim'vert & ISO 14001 certified)

This document is printed on paper made from sustainably managed forests Oikos 150 g et 100 g (50% FSC, 50% recycled)

