

Please check our [wiki](#) for help on navigating the form.

Horizon 2020

Call: H2020-MSCA-IF-2019

(Marie Skłodowska-Curie Individual Fellowships)

Topic: MSCA-IF-2019

Type of action: MSCA-IF-EF-RI
(Reintegration panel)

Proposal number: 891512

Proposal acronym: DEplete

Deadline Id: H2020-MSCA-IF-2019

Table of contents

Section	Title	Action
1	General information	
2	Participants & contacts	
3	Budget	
4	Ethics	
5	Call-specific questions	

How to fill in the forms

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the steps in the submission wizard.

Proposal Submission Forms

Proposal ID **891512**

Acronym **DEplete**

1 - General information

Topic MSCA-IF-2019

Type of Action MSCA-IF-EF-RI

Call Identifier H2020-MSCA-IF-2019

Deadline Id H2020-MSCA-IF-2019

Acronym DEplete

Proposal title DEEP LEarning in the Twilight zonE: observation-based predictions of mesopelagic ecosystems

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Duration in months 24

Scientific Area ENV - Environmental and Geosciences (ENV)

Please select up to 5 descriptors (and at least 3) that best characterise the subject of your proposal, in descending order of relevance.

Descriptor 1 Oceanography, marine science, coastal engineering

Descriptor 2 Environmental, marine and freshwater biology

Descriptor 3 Machine learning, data mining, statistical data processing and applications

Descriptor 4 Aquaculture, fisheries

Descriptor 5 Clean exploration and exploitation of natural resources

Free keywords Marine ecosystems, Earth Sytem Models, Mesopelagic, Fisheries, Deep Learning, Blue Growth

Please choose the scientific area and descriptors carefully, and in order of importance, since this will guide the REA in the selection of experts for proposal evaluation and the allocation of proposals to experts. To help you select the most relevant area for your proposal, please consult the Guide for Applicants which provides a breakdown of each scientific area into a number of descriptors.

Proposal Submission Forms

Proposal ID **891512**

Acronym **DEplete**

Abstract*

The ocean volume between 200 and 1,000m depth, known as the Mesopelagic Zone, hosts the largest amount of fish in the Global Ocean. These animals sustain the highest levels of the marine trophic chain and contribute to the sequestration of atmospheric carbon. During the last decade, Mesopelagic Biomass (MB) has attracted attention by its potential as a source of high-nutritional value food for human consumption and aquaculture. However, deeper insights on this still untamed ecosystem are urgently needed in order to guarantee a sustainable exploitation. Our current knowledge on the MB is founded on ship-based acoustical surveys, which are limited in space and time and costly to acquire. The Action proposed here intends to overcome such constraints by bringing together acoustic observations, groundbreaking Artificial Intelligence (AI) techniques and Earth System Models (ESM); with the aim to predict the past, present and immediate future of MB. This goal will be achieved following three stages: (1) complementing acoustical observations with biogeochemical vertical profiles to characterise the environmental conditions of mesopelagic habitats, (2) implementing an AI algorithm able to estimate MB based only on environmental variables; and (3) embedding the algorithm in an ESM to produce seasonal-to-decadal predictions of the MB. The outcomes of this innovative approach will be a better understanding of the mesopelagic ecosystems and a new technique to resolve marine ecosystems in ESMs, while circumventing the complexity and computational costs of current approaches. Importantly, our project will also have a social impact as it will engage with marine stakeholders and the private sector to contribute to the much-needed transition towards a sustainable management of marine resources.

Remaining characters

194

Has a similar proposal in terms of research objectives been submitted to a Horizon 2020 Marie Skłodowska-Curie Individual Fellowship call?

☐ Yes ☒ No

Proposal Submission Forms

Proposal ID **891512**

Acronym **DEplete**

Declarations

1) The applicant (future beneficiary) declares to have the explicit consent of all partner organisations (if applicable) on their participation and on the content of this proposal.	<input checked="" type="checkbox"/>
2) The information contained in this proposal is correct and complete.	<input checked="" type="checkbox"/>
3) This proposal complies with ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct).	<input checked="" type="checkbox"/>
4) The applicant (future beneficiary) hereby declares:	
- it is fully eligible in accordance with the criteria set out in the specific call for proposals; and	<input checked="" type="checkbox"/>
- it has the financial and operational capacity to carry out the proposed action.	<input checked="" type="checkbox"/>
The applicant (future beneficiary) is only responsible for the correctness of the information relating to his/her own organisation. Where the proposal to be retained for EU funding, the applicant (future beneficiary) will be required to present a formal declaration in this respect.	

Note:

For **multi-beneficiary applications**, the coordinator vouches for its own organization and that all other participants confirmed their participation and compliance with conditions set out in the call. If the proposal is retained for funding, each participant will be required to submit a formal declaration of honour confirming this.

False statements or incorrect information may lead to administrative sanctions under the Financial Regulation 2018/1046.

Personal data will be collected, used and processed in accordance with Regulation 2018/1725 and the [Funding & Tenders Portal privacy statement](#).

Please be however aware that, to protect EU financial interests, your data may be transferred to other EU institutions and bodies and be registered in the EDES database. Data in the EDES database is also subject to Regulation 2018/1725 and the [EDES privacy statement](#).

Proposal Submission Forms

Proposal ID **891512**

Acronym **DEplete**

2 - Participants & contacts

#	Participant Legal Name	Country	Action
1	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION	Spain	

Proposal ID **891512**

Acronym

DEplete

Short name **BSC**

2 - Administrative data of participating organisations

Future Host Institution

PIC	Legal name
999655520	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION

Short name: *BSC*

Address

Street Calle Jordi Girona 31

Town BARCELONA

Postcode 08034

Country Spain

Webpage www.bsc.es

Specific Legal Statuses

Legal person yes

Academic Sector yes

Non-profit yes

International organisation no

International organisation of European interest no

Secondary or Higher education establishment no

Research organisationyes

Small and Medium-sized Enterprises (SMEs)no

Public bodyyes

Proposal Submission Forms

Proposal ID **891512**

Acronym

DEplete

Short name **BSC**

Department(s) carrying out the proposed work

Department 1

Department name ☐ not applicable

☐ Same as proposing organisation's address

Street

Town

Postcode

Country

If the location of the Department carrying out the proposed work is not the same as the location of the Host Institute, please note that although the proposal submission system calculates the budget of the project based on the location of the Host Institute, the budget of the project for the grant agreement will be calculated by using the country coefficient of the location of the Department carrying out the proposed work.

Proposal Submission Forms

Proposal ID **891512**

Acronym

DEplete

Short name **BSC**

Researcher

The name and e-mail of the Researcher and Supervisor are read-only in the administrative form, only additional details can be edited here. To give access rights and contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Last Name*	Llort Jordi	Last Name at Birth	
First Name(s)*	Joan	Gender*	<input checked="" type="radio"/> Male <input type="radio"/> Female
Title	Dr.	Country of residence*	Spain
Nationality*	Spain	Nationality 2	
Date of Birth (DD/MM/YYYY)	14/01/1983	Country of Birth*	Spain
		Place of Birth	Barcelona

Contact address

Current organisation name	BSC		
Current Department/Faculty/Institute/ Laboratory name	Earth Sciences Department - Climate Prediction Group		
	<input checked="" type="checkbox"/> Same as organisation address		
Street	Calle Jordi Girona 31		
Postcode/Cedex	08034	Town	BARCELONA
Phone	+34 934137716	Country	Spain
Phone2 / Mobile	+xxx xxxxxxxxx		
E-Mail*	llort83@gmail.com		
ORCID	0000-0003-1490-4521		
Researcher ID	<input type="text" value="0"/>	<input type="text" value="2162"/>	<input type="text" value="2017"/>
<small>The maximum length of the identifier is 11 characters (ZZZ-9999-2010) and the minimum length is 9 characters (A-1001-2010).</small>			
Other ID	<input type="text" value="Please enter the type of ID here"/>		<input type="text" value="Please enter the identifier number here"/>

Proposal Submission Forms

Proposal ID **891512**

Acronym

DEplete

Short name **BSC**

Qualifications

Doctorate Date of (expected) award

Select the exact date
(DD/MM/YYYY)

09/01/2015

Doctorate start date

Select the exact date
(DD/MM/YYYY)

03/10/2011

University Degree giving access to PHD*

Date of award (DD/MM/YYYY)

23/06/2011

Place of activity/place of residence (previous 5 years - most recent one first)

Indicate the period(s) and the country/countries in which you have legally resided and/or had your main activity (work, studies, etc) during the last 5 years up until the deadline for the submission of the proposal.

Please fill in this section without gaps. Short stays (as defined in the Guide for Applicants) shall not be listed in this box.

Period from	Period to	Duration (days)	Country
01/07/2019	11/09/2019	73	Spain
22/11/2015	30/06/2019	1317	Australia
11/09/2014	21/11/2015	437	France
Total		1827	

Proposal Submission Forms

Proposal ID **891512**

Acronym

DEplete

Short name **BSC**

Supervisor

The name and e-mail of the Researcher and Supervisor are read-only in the administrative form, only additional details can be edited here. To give access rights and contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title

Dr.

Sex

☒ Male

☐ Female

First name* **Pablo**

Last name* **Ortega**

E-Mail* **portega@bsc.es**

Position in org.

Climate Prediction Group Co-leader

Department

Earth Sciences Department - Climate Prediction Group

☒ Same as organisation address

Street

Calle Jordi Girona 31

Town

BARCELONA

Post code

08034

Country

Spain

Website

<https://www.bsc.es/ortega-montilla-pablo>

Phone

+34 934137679

Phone 2

+XXX XXXXXXXXXX

Fax

+XXX XXXXXXXXXX

Other contact persons

First Name	Last Name	E-mail	Phone
Dorota	Jouet	dorota.jouet@bsc.es	+34 934134082
Raffaele	Bernardello	raffaele.bernardello@bsc.es	+34 934137679

Proposal Submission Forms

Proposal ID **891512**

Acronym **DEplete**

3 - Budget

Is the Researcher eligible for family allowance?* ☒ Yes ☐ No

Participant Number	Organisation Short Name	Country	Country Coefficient	Number of Months	Researcher Unit Cost			Institutional Unit Cost		Total
					Living Allowance	Mobility Allowance	Family Allowance	Research, training and networking costs	Management and Overheads	
1	BSC	ES	0,954	24	111732,48	14400,00	12000,00	19200,00	15600,00	172932,48
Total					111732,48	14400,00	12000,00	19200,00	15600,00	172932,48

4 - Ethics

1. HUMAN EMBRYOS/FOETUSES		Page
Does your research involve Human Embryonic Stem Cells (hESCs) ?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Does your research involve the use of human embryos?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Does your research involve the use of human foetal tissues / cells?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
2. HUMANS		Page
Does your research involve human participants?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Does your research involve physical interventions on the study participants?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
3. HUMAN CELLS / TISSUES		Page
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
4. PERSONAL DATA		Page
Does your research involve personal data collection and/or processing?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Does your research involve further processing of previously collected personal data (secondary use)?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
5. ANIMALS		Page
Does your research involve animals?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
6. THIRD COUNTRIES		Page
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Do you plan to import any material - including personal data - from non-EU countries into the EU?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Do you plan to export any material - including personal data - from the EU to non-EU countries?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
In case your research involves low and/or lower middle income countries , are any benefits-sharing actions planned?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Could the situation in the country put the individuals taking part in the research at risk?	<input type="radio"/> Yes <input checked="" type="radio"/> No	

Proposal Submission Forms

Proposal ID **891512**

Acronym **DEplete**

7. ENVIRONMENT & HEALTH and SAFETY		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
Does your research involve the use of elements that may cause harm to humans, including research staff?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
8. DUAL USE		Page
Does your research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
9. EXCLUSIVE FOCUS ON CIVIL APPLICATIONS		Page
Could your research raise concerns regarding the exclusive focus on civil applications?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
10. MISUSE		Page
Does your research have the potential for misuse of research results?	<input type="radio"/> Yes <input checked="" type="radio"/> No	
11. OTHER ETHICS ISSUES		Page
Are there any other ethics issues that should be taken into consideration? Please specify	<input type="radio"/> Yes <input checked="" type="radio"/> No	

I confirm that I have taken into account all ethics issues described above and that, if any ethics issues apply, I will complete the ethics self-assessment and attach the required documents. ☒

[How to Complete your Ethics Self-Assessment](#)

Proposal Submission Forms

Proposal ID **891512**

Acronym **DEplete**

5 - Call specific questions

Eligibility Researcher (future fellow)

1. Were you in the last 5 years in military service? ☐ Yes ☒ No

2. Did you spend time on procedures for obtaining refugee status (according to the 1951 Geneva Refugee Convention and the 1967 Protocol) in a Member State or Associated Country? ☐ Yes ☒ No

3. Are you a national of a Member State or Associated Country? ☒ Yes ☐ No

Country

Other Questions

1. For communication purposes only, the European Commission REA asks for permission to publish the name of the researcher (future fellow) should the proposal be retained for funding. Does the researcher (future fellow) give this permission? ☒ Yes ☐ No

2. Some national and regional public research funding authorities run schemes to fund MSCA applicants that score highly in the MSCA evaluation but which cannot be funded by the MSCA due to their limited budget. In case this proposal could not be selected for funding by the MSCA, do the researcher and supervisor consent to the European Commission disclosing to such authorities the results of its evaluation (score and ranking range) together with their names and contact details, non-confidential proposal title and abstract, proposal acronym, and host organisation? ☒ Yes ☐ No

3. Is there a secondment in Member States or Associated Countries envisaged in Part B of this proposal? ☒ Yes ☐ No

In which sector is the secondment in Member States / Associated Countries foreseen?

☒ Academic ☐ Non Academic

Do you already know the organisation to which this secondment will be? ☒ Yes ☐ No

Name

Country

Proposal Submission Forms

Proposal ID **891512**

Acronym **DEplete**

In which sector is the secondment in Member States / Associated Countries foreseen?

☐ Academic ☒ Non Academic

Do you already know the organisation to which this secondment will be?

☒ Yes ☐ No

Name

AZTI

Country

Spain

Proposal Submission Forms

Proposal ID **891512**

Acronym **DELETE**

Extended Open Research Data Pilot in Horizon 2020

If selected, applicants will by default participate in the [Pilot on Open Research Data in Horizon 2020](#)¹, which aims to improve and maximise access to and re-use of research data generated by actions.

However, participation in the Pilot is flexible in the sense that it does not mean that all research data needs to be open. After the action has started, participants will formulate a [Data Management Plan \(DMP\)](#), which should address the relevant aspects of making data FAIR – findable, accessible, interoperable and re-usable, including what data the project will generate, whether and how it will be made accessible for verification and re-use, and how it will be curated and preserved. Through this DMP projects can define certain datasets to remain closed according to the principle "as open as possible, as closed as necessary". A Data Management Plan does not have to be submitted at the proposal stage.

Furthermore, applicants also have the possibility to opt out of this Pilot completely at any stage (before or after the grant signature). In this case, applicants must indicate a reason for this choice (see options below).

Please note that participation in this Pilot does not constitute part of the evaluation process. Proposals will not be penalised for opting out.

We wish to opt out of the Pilot on Open Research Data in Horizon 2020.

☐ Yes

☒ No

Further guidance on open access and research data management is available on the Funding & Tenders portal:

http://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm and in general annex L of the Work Programme.

¹ According to article 43.2 of Regulation (EU) No 1290/2013 of the European Parliament and of the Council, of 11 December 2013, laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006.

1. Excellence

1.1 Quality and credibility of the research/innovation project; level of novelty, appropriate consideration of inter/multidisciplinary and gender aspects

Introduction and state-of-the-art

During the last decade, the scientific community, the fishing industry and the European Commission have put much attention to a largely unknown and unexploited marine ecosystem: the mesopelagic. Also known as the Twilight Zone, the mesopelagic is defined as the water volume between ~200m and 1000m depth, **and hosts the largest biomass of fish in the world**¹. These animals play a critical role in sustaining the trophic chain that supports larger species, including economically viable species (e.g. tuna) and marine mammals; and contribute to the ocean's capacity to store carbon in its interior². But the interest for the Twilight Zone goes far beyond ecology. Several countries around the world, including in the EU, are currently considering this massive stock of fish **as an opportunity to obtain high nutritional value food for human consumption and aquaculture**³. A sustainable exploitation and management of this resource could contribute to meet several UN sustainability goals⁴ by reducing malnutrition, securing fisheries economic viability and recovering marine ecosystems through a reduction in the fishing pressure on endangered species. The latest report of EU's Marine Board qualified the exploitation of mesopelagic fish as *imminent*⁵, and policy changes currently underway will enable the economic viability of such industry⁶. However, our knowledge of mesopelagic ecosystems falls short to define how a *sustainable exploitation* should be^{7,8}. It is therefore a critical and timely matter to develop new tools to further our understanding on this ecosystem before an uninformed exploitation starts. **Failing to do so would be extremely dangerous for life in the ocean, and represent yet another missed opportunity to reach the UN's Sustainable Development Goals.**

Our current understanding of the vertical and global distribution of mesopelagic biomass is mainly based on data from underwater acoustics⁹. These data are collected by ships equipped with a sonar that emit an acoustic signal towards the ocean interior. This signal is backscattered by mesopelagic animals such as zooplankton, fish and marine mammals; yet, most of the signal arises from zooplankton and micro-nekton, small fish on the order of ~1cm. Acoustical measurements have shown that, throughout the day, both zooplankton and micro-nekton (hereinafter referred as Mesopelagic Biomass, MB) **migrate between the surface of the ocean and the mesopelagic zone, a phenomenon known as the Diel Vertical Migration**¹⁰, constituting the largest animal migration of the planet. The accumulation of MB at particular depths during daylight produces a strong acoustic echo known as the Deep Scattering Layer (DSL), which is observed across the World Ocean. Several works based on acoustic data have shown that environmental conditions might determine both the depth of the DSL and the MB concentration at the DSL. For instance, at a global scale the spatial distribution of MB is correlated with primary production^{1,11}; while light intensity, oxygen concentration and temperature characterise the depth of the DSL^{12,13}. **This is a powerful conclusion implying that both MB and the DSL can be inferred from physical and biogeochemical characteristics of the water column.**

Acoustical surveys have proven to be a useful tool to estimate MB but they can only be obtained from ships, thus they are costly and have a limited spatial and temporal coverage. Such limitations hinder a comprehensive global assessment of the role that MB plays in ocean ecosystems and global biogeochemistry. This understanding is nevertheless critical to ensure a sustainable exploitation of mesopelagic resources. Moreover, observations alone cannot be used to predict changes in the future, a critical insight for policy-makers and marine

¹ Irigoien, X., Klevjer, T.A., Røstad, A., Martinez, et al. 2014. Large mesopelagic fishes biomass and trophic efficiency in the open ocean. *Nature Communications*

² Anderson, T.R., Martin, A.P., Lampitt, R.S., Trueman, C.N., Henson, S.A., Mayor, D.J., 2019. Quantifying carbon fluxes from primary production to mesopelagic fish using a simple food web model. *ICES Journal of Marine Science* 76, 690–701.

³ European Commission, 2018. Horizon 2020 - Work Programme 2018-2020. Ch 9. Food security, sustainable agriculture and forestry, marine, (...)

⁴ <https://www.un.org/sustainabledevelopment/>

⁵ Boero, F., Treguier, A.M., Philippart, C., Huse, G., et al., 2019. Navigating the Future V: Marine Science for a Sustainable Future. Zenodo.

⁶ Prelezo, R., 2019. Exploring the economic viability of a mesopelagic fishery in the Bay of Biscay. *ICES J Mar Sci* 76, 771–779.

⁷ van Hoof, L., Fabi, G., Johansen, V., Steenbergen, J., Irigoien, X., Smith, S., Lishjerg, D., Kraus, G., 2019. Food from the ocean; towards a research agenda for sustainable use of our oceans' natural resources. *Marine Policy* 105, 44–51.

⁸ St. John, M.A., Borja, A., Chust, G., Heath, M., et al., 2016. A Dark Hole in Our Understanding of Marine Ecosystems and Their Services: Perspectives from the Mesopelagic Community. *Front. Mar. Sci.* 3.

⁹ Trenkel, V.M., Handegard, N.O., Weber, T.C., 2016. Observing the ocean interior in support of integrated management. *ICES J Mar Sci* 73, 1947–1954.

¹⁰ Bianchi, D., Mislan, K.A.S., 2016. Global patterns of diel vertical migration times and velocities from acoustic data. *Limnology and Oceanography* 61, 353–364.

¹¹ Proud, R., Cox, M.J., Brierley, A.S., 2017. Biogeography of the Global Ocean's Mesopelagic Zone. *Current Biology* 27, 113–119.

¹² Aksnes, D.L., Røstad, A., Kaartvedt, S., Martinez, U., Duarte, C.M., Irigoien, X., 2017. Light penetration structures the deep acoustic scattering layers in the global ocean. *Science Advances*.

¹³ Bianchi, D., Galbraith, E.D., Carozza, D.A., Mislan, K.A.S., Stock, C.A., 2013. Intensification of open-ocean oxygen depletion by vertically migrating animals. *Nature Geoscience* 6, 545–548.

stakeholders. During the last few years several projects have addressed these issues by explicitly modeling the intermediate trophic levels of marine ecosystems^{2,14}. These models are an important advance but their complexity and high number of variables make them computationally expensive, highly sensitive to parameters and dissociated from observations¹⁴. More importantly the technical requirements of these ecosystem models preclude their incorporation in Earth System Models (ESM), the large scale models used for Climate prediction. **The present Action proposes a groundbreaking approach to circumvent such handicaps by bringing together, for the first time, underwater acoustics, ESM models and the latest advances in Artificial Intelligence**, the so-called Deep Learning (DL) algorithms¹⁵. The project proposed here, called DEplete, is thus timely, novel, interdisciplinary and clearly oriented to societal needs.

Specific Objectives

The overarching goal of DEplete is to provide a powerful tool to predict the present and future state of the mesopelagic ecosystem at timescales relevant for conservation, policy changes and commercial exploitation (i.e. seasonal to decadal). The Action will focus on the construction and application of such tool, and will fulfill three complementary objectives:

- Obj. 1** Curate a comprehensive dataset of acoustical surveys and environmental conditions.
- Obj. 2** Create a DL algorithm able to estimate mesopelagic biomass from environmental conditions.
- Obj. 3** Provide seasonal-to-decadal predictions of mesopelagic biomass.

DEplete ambition

DEplete will improve our understanding and explore the predictive capability of mesopelagic ecosystems with a pioneering strategy: combining the latest observational products in acoustic, physical and biogeochemical ocean variables with a DL algorithm to identify their covariability and exploit it for reconstruction purposes of the mesopelagic. The DL algorithm, called the Mesopelagic Fish Surveyor (MeFiS), will use marine environmental variables typically simulated in ESMs as inputs. This will enable its subsequent coupling to the ESM version of EC-Earth (the model developed and used at the Barcelona Supercomputing Centre, BSC, for climate prediction purposes), to develop the first DL hybrid model applied to marine ecosystems. More importantly, it will provide a computationally efficient marine ecosystem model able to produce seasonal-to-decadal predictions, and therefore be used as a management tool for a sustainable exploitation of mesopelagic fish.

DEplete will bring together my skills on ocean biogeochemistry and marine data, BSC's expertise on both seasonal-to-decadal predictions and machine-learning applied to Earth Sciences; and the knowledge on mesopelagic ecosystems from both the private (AZTI) and the public (ICES) sector. Altogether, the synergies between these partners will guarantee the success and impact of the outcomes, and will strengthen my profile as a specialist of a growing field with high social and scientific impact.

Research methodology and approach

The Action will be divided into five work packages (WPs). The first three packages (WP1, 2 and 3) will fulfill Obj.1, Obj. 2 and Obj. 3, respectively. A fourth work-package, WP4, will disseminate and communicate the project's outcomes. Finally, WP5 will cover the project management and Career Development activities. While all WPs are detailed in Section 2, the following paragraphs describe the research associated with WP1 to WP3.

WP1 Assembling a global and comprehensive dataset of the mesopelagic

During the last decade, several works have presented acoustic datasets covering large extensions of the global ocean^{1,10,11}. However, these databases were often biased towards low-latitudes or large ocean areas (such as subtropical gyres) and did not contain any data from the Mediterranean Sea (of high relevance for Europe) or the Southern Ocean. In consequence, their conclusions might not fully represent the geographical variability of mesopelagic ecosystems. **The first part of WP1 will focus on bringing together a comprehensive global database of acoustic data.** The database will primarily derive from data provided by NOAA's National Centre for Environmental Information (NCEI) and the International Council for the Exploration of the Sea (ICES), complemented with available databases covering the Southern Ocean (e.g. EU-funded project MESOPP) and the Mediterranean Sea. Altogether these sources provide large amounts (i.e., several Terabytes) of raw acoustical measurements that require a thorough Big Data analysis in order to extract coherent signals that can be translated

¹⁴ Aumont, O., Maury, O., Lefort, S., Bopp, L., 2018. Evaluating the potential impacts of the diurnal vertical migration by marine organisms on marine biogeochemistry. *Global Biogeochemical Cycles*

¹⁵ Reichstein, M., Camps-Valls, G., Stevens, B., Jung, M., Denzler, J., Carvalhais, N., Prabhat, 2019. Deep learning and process understanding for data-driven Earth system science. *Nature* 566, 195–204

into actual knowledge. BSC's computational power, software tools and expertise to archive and exploit large datasets will be fundamental in successfully assembling and processing such a massive dataset.

The second part of WP1 will create a dataset of the oceanic environmental conditions concomitant to the acoustical records (Obj. 1). Vertical sections of the acoustic signal will be associated to vertical profiles of the marine environment (i.e. light, oxygen and primary production); at the time and place where the acoustics surveys were taken. As most of these surveys do not contain vertical profiles of the environmental properties, the latter will be obtained by using **cutting-edge profile reconstruction techniques** such as SOCA¹⁶. These techniques allow reconstructing the vertical distribution of a particular ocean property for a given geographical position at a given day of the year, based on a surface imprint of the property. Reconstruction techniques, exclusively based on observations, provide the global coverage of satellite observations and the vertical variability of ocean models. This part of WP1 will be done during the secondment at the Laboratoire d'Océanographie de Villefranche-Sur-Mer (LOV), in collaboration with the creators of SOCA: Dr. Raphaëlle Sauzède and Dr. Hervé Claustre. Applying these **recently developed techniques to study mesopelagic ecosystems represents a step forward in the characterisation of DSL's environmental drivers** as prior works were either based on satellite^{2,10} or ocean model data¹³. **The main deliverable of WP1 will be a comprehensive dataset, linking acoustics to a wide array of environmental variables, which will be shared with ICES researchers in the framework of the EU-funded MEESO project¹⁷.** This collaboration will mainly take place remotely but short visits to ICES headquarters in Copenhagen (Denmark) are also envisaged.

WP2 MeFiS model: establishing statistical relationships between fish and environmental conditions

WP2 will constitute the technical core of the DEplete as it will be entirely dedicated **to the creation of the Mesopelagic Fish Surveyor model (MeFiS), a DL algorithm able to estimate mesopelagic biomass from marine environmental conditions (Obj. 2).** DL algorithms are machine-learning techniques adapted to analyse multi-dimensional and time-varying data, such as the data handled in Earth Sciences¹⁵. Among their multiple applications, DL techniques can be used to reconstruct a variable or field (in our case MB) from a given set of input variables/fields (e.g. environmental drivers). MeFiS will be built with an Artificial Neural Networks (ANN), a particular type of DL technique that has already been successfully applied to determine the environmental variables controlling freshwater fish species distribution¹⁸. The advantage of ANN is that they do not require a mechanistic or behavioural understanding for each one of the fish species, as they build the knowledge from the relationships identified in the observations. More importantly, once the DL algorithm has identified the key environmental drivers, **this insight can be used to estimate fish species distribution (or MB in our case) in a new dataset where only environmental variables are known.** As an example, we could expect to learn about the abundance of MB by simply using the time of the year, oxygen and temperature as input for the DL algorithm.

In order to release the full potential of this approach, MeFiS will follow a training-validation-testing protocol, typical of ANN¹⁹, based on the dataset curated in WP1. 60% of the data will be used to *train* MeFiS, i.e., to adjust the weights of the different nodes of the ANN quantifying how strong is the influence of each environmental driver on the DSL and abundance of MB. A second subset (20%) will be used for the *validation* phase, a key stage to prevent overfitting, which occurs when the ANN model includes spurious drivers to fit the training data more accurately, leading to a loss of generalisation of the network. Once trained and validated, MeFiS development will enter a phase of *testing*, to confirm the actual performance of MeFiS with an independent data sample. This will be done using the remnant 20% of WP1's dataset. An additional evaluation of the exportability of MeFiS will be done using new sources of input data (not used to train or validate the DL algorithm) as part of my secondment at LOV. These data will consist in vertical profiles of both marine environmental variables and zooplankton acquired by autonomous floats (BGC-Argo). Although BGC-Argo floats are already in operation across the global ocean²⁰, a new generation of float sensors is being developed to make the floats capable of estimating zooplankton abundance, which in turn can be used to estimate MB applying trophic efficiency relationships¹. The validation and exploitation of these data constitute one of the goals of the ERC-Advanced REFINE, led by Dr. Hervé Claustre, the supervisor during my secondment at LOV. **The combination of MeFiS with new generation BGC-Argo floats holds strong potential for my career post-fellowship** because, once fully

¹⁶ Sauzède, R., Claustre, H., Uitz, J., Jamet, C., et al., 2016. A neural network-based method for merging ocean color and Argo data to extend surface bio-optical properties to depth: Retrieval of the particulate backscattering coefficient. JGT: Oceans. <https://doi.org/10.1002/2015JC011408>

¹⁷ <https://www.ices.dk/explore-us/projects/Pages/MEESO.aspx>

¹⁸ Franceschini S, Gandola E, Martinoli M, et al (2018) Cascaded neural networks improving fish species prediction accuracy: the role of the biotic information. Sci Rep 8:4581. doi: 10.1038/s41598-018-22761-4

¹⁹ Korjus, K., Hebart, M.N., Vicente, R., 2016. An Efficient Data Partitioning to Improve Classification Performance While Keeping Parameters Interpretable. PLoS ONE 11, e0161788.

²⁰ Claustre, H., Johnson, K.S., Takeshita, Y., 2020. Observing the Global Ocean with Biogeochemical-Argo. Annual Review of Marine Science 12, null.

operational, the BGC-Argo concomitant measurements of the ocean environment and zooplankton, will provide a comprehensive set of high-quality vertical profiles to train future versions of MeFiS.

The second outcome of WP2 will be a high-impact peer-reviewed article describing the statistical links identified by MeFiS (D4.3). The article will report, for the first time, how MB's environmental drivers change by season and ocean basins. The database used and MeFiS code will be available online through GitLab, under an open-access license to ensure reproducibility and widespread use.

[WP3 Predicting mesopelagic biomass](#)

In this WP, MeFiS will be coupled to a numerical climate model with the aim to predict the evolution of past and future marine ecosystems. The inclusion of this sophisticated statistical module (MeFiS) in the ocean component of a fully coupled prognostic model (the Earth System Model version of EC-Earth) will result in a powerful *hybrid model* based on DL techniques¹⁵. This groundbreaking approach will produce a computationally efficient alternative to extend climate forecast systems towards ecosystems, while circumventing the complexity of explicit ecosystem modelling.

The main research outcome of WP3 will be the first seasonal-to-decadal predictions of MB (Obj. 3), the analysis of which is also expected to lead to a high-impact publication. This task will strongly benefit from the CPG expertise in climate prediction using ESM. Natural synergies will occur between WP3 and the TRIATLAS project (PI at BSC: Dr. P. Ortega, amongst others), which aims to provide predictions of marine ecosystems in the Atlantic Ocean. In particular, MeFiS will provide a tool for representing marine ecosystems (or specific species of interest) in climate models, something that it is not currently possible with other modelling approaches. Lastly, WP3 will also explore **MeFiS applications as a product of interest for marine stakeholders**. The potential for ecosystem forecasts to be transformed in end-user services will be explored in collaboration with the Earth System Services group at the BSC and researchers from ICES. In addition, a case study of the applicability of these **predictions in the Bay of Biscay will be developed during the secondment in one of the most important Spanish private companies dedicated to marine resources, AZTI**, where I will be mentored by Dr. Xabier Irigoien, a world-renowned specialist in mesopelagic ecosystems.

[Originality, interdisciplinarity and relevance of the action](#)

The originality of the proposed project is to produce seasonal-to-decadal prediction of the MB by assembling an observations-based DL algorithm and a state-of-the-art Earth system model. **Such novel and original methodology will push forward our capacity to assess marine ecosystems** extending our current predictive capability (limited to plankton ecosystems) to micro-nekton; bridging the gap between primary producers and top predators. These estimates of marine intermediate trophic levels **are expected to have a major impact on marine stakeholders**, with the potential to be used as a surveyor of a key global ecosystem. The project is interdisciplinary in its core as it is founded on the marriage of three disciplines: underwater acoustics, machine-learning applied to Earth Sciences and seasonal-to-decadal climate prediction.

DEplete is timely, not only because it is based on emerging technologies, but also because it is focused on understanding one of the few well preserved marine ecosystems, yet threatened by human pressure⁷. The years to come will define the mesopelagic ecosystem either as an example of sustainable exploitation or as the ultimate collapse of the trophic level that sustains most marine fauna¹. The pathway we follow will critically depend on our ability to predict **the health of this ecosystem in relation to natural variability and human activities**.

[1.2 Quality and appropriateness of the training and of the two way transfer of knowledge between the researcher and the host](#)

As MSCA-IF Fellow, I will join the team of Dr. Pablo Ortega, the Climate Prediction Group (CPG), which is part of BSC's Earth Sciences Department. The CPG is internationally renowned for their expertise in climate prediction from one month to several years into the future (i.e. seasonal-to-decadal predictions) and from regional to global scales using Earth System Models (ESM). This expertise has been achieved thanks to a strong effort in performance analysis, as well as code profiling and data management in High-Performance Computing (HPC). Moreover, part of DEplete will involve the Computational Earth Sciences group (CES), in particular Dr. Carlos Gomez, whose research is focused on applying AI techniques to Earth Sciences. **The potential for training-through-research is therefore extraordinary**. The expertise in seasonal-to-decadal prediction of ocean physical and biogeochemical fields will be essential to achieve robust predictions of the MB, and the human and technical workforce at the BSC will ease the challenges of putting together a global database, developing MeFiS and coupling it to an ESM. Additionally, CES group's knowledge on code and data management will be helpful throughout the whole project and will train me on tools and procedures (AI techniques, software packages, data

pre-processing, HPC environments) that will strongly improve my future career prospects. I will make the most out of this environment thanks to the expertise, competences and skills that I obtained during my previous roles, in particular my proven ability to extract relevant signals from large observational and model datasets^{21,22}.

The transfer of knowledge will also occur in the opposite direction, as I will bring new competences to the team, the institution and to my country of origin after ten years of developing my career in France and Australia. In particular, I will provide expertise on the coupling between ocean dynamics, primary production and export of organic matter at the seasonal and inter-annual scales, with a particular focus on the Southern Ocean. Such expertise will be of **special interest for the projects ORCAS (Dr. Galí) and DeCUSO (Dr. Bernardello) currently developed in the Ocean Biogeochemistry Research Team.** In terms of skills, I will also provide expertise on how to work with remote (autonomous floats and satellite) and ship-based observations. DEplete outcomes will represent an important part of my contribution to CPG, with impacts that are expected to continue well beyond the duration of the fellowship. In particular, the approach used for developing MeFiS can be adapted to model any type of fish species as far as enough data are available to train the DL algorithm. Hence, **MeFiS will equip the CPG with an innovative tool to extend their climate models towards marine ecosystems.** Lastly, I will broaden BSC's international network through continuous collaborations with my former colleagues in the EU, US and Australia.

The BSC has an excellent record in participation and coordination of staff development activities with a dedicated unit of education and training that is in charge of organizing specialized sessions to improve their employees' soft and technical skills. The program covers career progression and development activities such as leadership, project management and teamwork. **These courses will not only strengthen my current personal skills but more importantly, they will help me identify and improve the aspects needed to advance towards a fully autonomous research.** The integrity of the training and its alignment with my short (1 year) and mid-term (3-5 years) career goals will be achieved thanks to BSC's Professional Development Programme, which provides each researcher with a personalised development plan, including a system of annual objectives and a training plan. Both the individual and the project objectives are agreed between the researcher and their group leader (Dr. Ortega in my case) at the beginning of each year and **evaluated in regular career plan meetings (~every 6 months).** Dr. Ortega and Dr. Bernardello have experience on using these tools and training postdoc researchers thanks to their supervision of a MSCA-IF (NeTNPPAO) and a Junior Leader Fellowship (ORCAS, LaCaixa Foundation), amongst others.

While the host institution will provide most of the training and development, this support will be complemented by secondments at **two partner organisations: LOV with Dr. Hervé Claustre and AZTI (Bilbao, Spain) with Dr. Xavier Irigoien.** During the former, I will acquire critical scientific skills for the project, as well as transferable competences on both new sensors development and public outreach. Dr. Hervé Claustre has recently been awarded an **ERC-Advanced (REFINE)** to study the surface ocean and the mesopelagic realm with new sensors embarked in autonomous floats. DEplete and REFINE are expected to complement each other by comparing in-situ novel observations with model predictions from MeFiS. As detailed in Section 2, the secondment at LOV will also be dedicated to training in outreach activities. The second secondment, with Dr. Irigoien at AZTI, will provide an excellent opportunity for **intersectoral mobility**, allowing me to learn how marine research can be transformed into services for the marine sector and applying MeFiS outputs to a “real-world” case, such as the potential for mesopelagic fisheries in the Bay of Biscay.

1.3 Quality of the supervision and of the integration in the team/institution

The researcher in charge of this fellowship will be **Dr. Pablo Ortega**, one of the two co-leaders of the CPG at the BSC. Dr. Ortega is a Ramon y Cajal fellow (RYC-2017-22772) expert in decadal climate variability and prediction and has more than **10 years of experience as a climate modeller and oceanographer.** The research excellence of Dr. Ortega is proven by 23 articles in journals of the first quartile (5 of which in *Nature Publishing Group*; accumulating 454 citations and a h-index of 12), his experience as a supervisor (2 PhD students and 9 postdocs, including a MSCA-IF fellow) and his work as coordinator of CPG contributions to **4 international research projects**, including 3 H2020 projects: APPLICATE as work package leader, INTAROS and TRIATLAS. **The latter is particularly relevant for DEplete, as it focuses on the predictability of marine ecosystems in the Tropical and South Atlantic Ocean, combining both ESM and Marine Ecosystem Models outputs.** Dr. Ortega's expertise on decadal variability and Climate prediction will be crucial to help me interpret the outputs of

²¹ Llort, J., Langlais, C., Matear, R., Moreau, S., Lenton, A., Strutton, P.G., 2018. Evaluating Southern Ocean Carbon Eddy-Pump From Biogeochemical-Argo Floats. *Journal of Geophysical Research: Oceans*.

²² Llort, J., Lévy, M., Sallée, J.-B., Tagliabue, A., 2015. Onset, intensification, and decline of phytoplankton blooms in the Southern Ocean. *ICES Journal of Marine Science: Journal du Conseil* 72, 1971–1984.

MeFiS and to identify signs of anthropogenic pressure hidden by natural variability. Moreover, during his career as an independent researcher Dr. Ortega has showed an extraordinary capacity to succeed on interdisciplinary topics where ocean, atmosphere and climate forcings overlap. Although we do not expect to leave the ocean domain during DEplete, Dr. Ortega's transversal view and proven capacity to discriminate the drivers of variability from perturbations will be crucial to understand the multiple mechanisms influencing mesopelagic ecosystems. Equally important are the leadership and managing skills that characterise Dr. Ortega's career as these will provide me with a day-to-day example of how to prioritise tasks and lead a team, while developing a solid track record and research outcomes relevant for society.

To complement Dr. Ortega expertise on Climate variability, the fellowship will be **co-supervised by Dr. Raffaele Bernardello**, leader of the team that will host me: the Ocean Biogeochemistry Research Team of the CPG. Dr. Bernardello expertise on Primary Production, biogeochemical models and the ocean carbon cycle will provide a bottom-up support to the Action, **reinforcing my background on ocean biogeochemistry in critical steps of the projects such as the reconstruction of biogeochemical profiles or the coupling between MeFiS and the biogeochemical component of EC-Earth**. Besides, I will also receive support from the rest of the members of the Ocean Biogeochemistry Research Team (composed of 1 PhD student, 3 senior researchers, and 1 research engineer) and I will actively advice and potentially collaborate with some of the ongoing projects in the group (see 1.2 for details). Collaborations are also expected to develop beyond the CPG. Actually, one of the most exciting opportunities triggered by DEplete will be the collaboration of the applicant with Dr. Carlos Gomez, an expert in machine-learning applied to Earth Sciences, who has recently joined the Computational Earth Sciences and the High Performance Artificial Intelligence group of the BSC.

In addition, in order to maximize my chances to succeed in my future endeavours, during the implementation of this fellowship, Dr. Ortega and Dr. Bernardello will provide opportunities to foster all the different facets of my scientific profile. These include promoting my internalization through the dissemination of my past and current research in the relevant European projects in which the CPG is involved, inviting world-leading researchers in my field through the Severo Ochoa Mobility program available at the BSC, supervising master and co-supervising PhD students; allowing me to teach in any of the two neighbouring Universities (UB and UPC) or organising side events, workshops and sessions in international conferences; and encouraging a leading role in the writing of new research projects both at the national (MINECO Retos) and international (e.g. H2020 and Horizon Europe) level. Part of these activities will be possible thanks to the work of the Training, the HR and the Management teams at BSC; which have an extended experience on supporting researchers as shown by the 14 MSCA-IF fellows that the centre has hosted so far and the award-winning human resources strategy (European Commission's Human Resources Strategy for Researchers award, HRS4R, renewed in 2017 for BSC).

1.4 Potential of the researcher to reach or re-enforce professional maturity/independence during the fellowship

My relatively short career as researcher (4 years post-PhD) shows a **remarkable autonomy and creativity and a natural ability to foster collaborations**. A good example of such skills is the novel approach I created to tackle a classical question in biological oceanography (the dynamics of phytoplankton spring blooms in high-latitude²³); or the thorough analysis I performed of the Southern Ocean primary production trends in climate model projections²³. The expertise in high-latitude marine biogeochemistry and the international network developed during my PhD allowed me to obtain a post-doc position at the Institute for Marine and Antarctic Studies (IMAS), University of Tasmania, Australia. This position has enhanced my development as an independent researcher. I have expanded my research interests towards remotely sensed data (satellite and BGC-Argo floats data) and atmosphere-ocean interactions (dust deposition and marine primary production). **These advancements have opened new research lines at IMAS and helped to define two proposals that have recently received funding** (ARC Discovery grant, ~290,000€, and IMOS BGC-Argo sub-facility, ~1 million€). Moreover, I am co-supervising three PhD students and leading two small research projects, with partners from Canada, France and South Africa. I initiated these collaborations and further enabled them by attracting funding for two visiting scholars at IMAS.

DEplete represents a step forward in terms of the breadth and depth of my research landscape, my independence of thinking, and my capacity to manage projects with a diversity of partners. In terms of research, DEplete will widen my expertise with a novel approach **to reveal the links between ocean biogeochemistry (my expertise so far), mesopelagic ecosystems (new field of research) and climate variability (my educational background) using machine-learning (new technical skills)**. I am prepared to address these challenges since

²³ Llort, J., 2015. Bloom phenology, mechanisms and future change in the Southern Ocean. (PhD thesis). Université Pierre et Marie Curie - Paris 6.

multidisciplinary approaches and the development of innovative techniques have been a constant throughout my career^{21,22}. These assets, together with the expertise and support from Dr. Ortega and Dr. Bernardello, will guarantee the success of DEplete outcomes.

Succeeding in the research aspects of DEplete will push forward my autonomy as a researcher as I will become a specialist in a high-potential field of research, and I will speak with my own voice in some of the most relevant meetings for the oceanographic community (ICES Annual Science Conference, European Geosciences Union General Assembly or the Ocean Sciences Meeting). These advancements in my career development will happen in parallel with the training offered by the BSC. The latter is expected to boost my strengths but, importantly, it will also help me identify and work on the aspects that need improving. **A careful design and regular evaluation of my career development plan, with the support of my supervisors, will guarantee that both DEplete and my autonomy evolve in parallel.** For instance, a key asset that I will acquire is the ability to fully develop and implement a research project from conception to final evaluation, a natural step in my career after the experience acquired driving small projects during my postdoc (see details in Section 4). During the fellowship I will also experience first-hand how to digest results into relevant information for stakeholders. The secondment at AZTI and the collaboration with ICES will be both crucial to acquire the necessary skills and competences to transfer research results into policy recommendations or commercial products. Lastly, the fellowship will support my reintegration to the EU and Spain's oceanographic community under the best conditions of supervision, within an innovative and socially relevant project.

2. Impact

2.1 Enhancing the future career prospects of the researcher after the fellowship

Academia is drastically changing and the key for success is not anymore solely based on the quality and prestige of published science, but also on the capacity to transform research into actions relevant for the society. Thanks to my experience as a researcher I have learnt how to produce and communicate high-quality research but always keeping distance with immediate societal needs. DEplete will provide an opportunity to close the gap between Science and Society, while boosting my profile and career prospects. Such critical career shift will be possible thanks to:

1. The specialisation in a critical field of research (mesopelagic fish) that will attract both private and public funds given a likely commercial exploitation in the near-future.
2. The acquisition of technical skills in Machine Learning and HPC environments. Proficiency in these two elements is mandatory to take the most of the Big Data era and will help my profile stand out in future grants applications and job offers.
3. DEplete will place me as catalyst of a multi-institutional and intersectoral collaboration between the BSC, the LOV, AZTI and ICES. The contacts, insights and experience of leading such collaboration will extend and diversify the sources of funding after the fellowship.

In the mid-term, realistic career pathways include ICES or the EU Commission as a policy assistant, or as a researcher focused on modelling marine ecosystems combining BGC-Argo observations (which will grow in number and in variables in the years to come) with Deep-Learning techniques and data assimilation models. My chances to reach these positions will be strengthened by the innovative tasks associated to DEplete's work packages. For instance, the use of zooplankton observations during my secondment at LOV (WP2) will represent a first attempt to bring together ecosystem modelling and BGC-Argo data; a line of research that, albeit out of the scope of DEplete, holds strong potential for my post-fellowship career. During the final year of DEplete, the Project Management Office (PMO), and in particular the people dedicated to Research Support, will keep me informed of new opportunities and calls arising, and will support me in the preparation of new applications. Special attention will be paid to funding in the areas of prediction of fish stocks and marine ecosystem health that can help consolidate the research line started with DEplete within the CPG. Lastly, the secondment with AZTI will give me the opportunity to develop new projects with the private sector and seek for alternative sources of funding (e.g. H2020 Industrial Leadership programme).

2.2 Quality of the proposed measures to exploit and disseminate the project results

The dissemination of the project results will constitute a fundamental part of the action, as detailed in the Gantt chart in Section 3.1. Four types of dissemination actions are planned:

1. Peer-reviewed articles in high-impact journals

I will submit at least two peer-reviewed articles as first author. The first article will present a global assessment of MB habitats and the insights acquired applying DL techniques (WP1 and WP2). The second article

will address the predictability of marine ecosystems using an hybrid ocean model (EC-Earth + MeFiS). These papers will be submitted to recognised specialized journals of the first quartile (such as Biogeosciences or Journal of Geophysical Research: Oceans), and, subject to progress, top-ranked journals will also be targeted (Nature Publishing group or PLoSone). Articles will be always published along with a plain language summary, which will appear in the project website (see point 4 in this Section). According to the Open Access policies in Horizon 2020, and other recommendations for getting wider dissemination and maximizing visibility and impact of the research results of the fellowship, all the publications will be deposited in UPCommons²⁴, the institutional repository used by the BSC in order to guarantee their long-term preservation and free accessibility.

2. Oral and poster presentation at international conferences

I will attend at least one international conference per year to present project results. Oral presentations will be prioritized, when possible. Conference attendance will vary depending on the calendar and the project progress but mainly relevant international meetings with broad audience will be considered: the European Geosciences Union or the American Geosciences Union annual meetings and the biannual Ocean Sciences Meeting. I will also attend smaller but more specific events such as ICES annual assembly or ICES and IMBER working groups.

3. Seminars and lectures

Results and project approach will be presented as seminars at the BSC, in other oceanographic research centers in Barcelona (ICTA-UAB and ICM-CSIC) and during the visits to other research groups. Part of the project will be also included in lectures to specialised summer schools that might have interest on the topic of my project (e.g. Ramon Margalef Summer School, in which I lectured in 2017's edition). I will also engage in a series of public lectures upon joining BSC, and participate as a lecturer to the yearly training courses organised through the PRACE Advanced Training Course (PATC). The scientific and applied aspects of the project will also be shared with the private sector thanks to the secondment at AZTI (Pasaia, Spain).

4. Online distribution

The dataset issued from WP2 (acoustical measurements + reconstructed BGC properties) will be distributed online and published in Earth System Science Data. MeFiS algorithm code will be written in Python (open source software) and updated in BSC's GitLab online repository, where code can be cloned and adapted by any user. In addition, the project, its major results and updates of MeFiS outputs will be presented in a dedicated website and in my ResearchGate account. In addition, since the outcomes of DEplete are of great relevance to the TRIATLAS project, I will also utilize the dissemination options it offers in order to maximize the potential audience, marine stakeholders in particular.

2.3. Quality of the proposed measures to communicate the project activities to different target audiences

A key element of this project is that its impacts have a significant social and environmental dimension. It is therefore an excellent opportunity to engage with the general public on why ocean research matters (i.e. Ocean Literacy), on why public money is invested in supporting researchers' projects and deploying robotic floats and powerful supercomputers. Design and execution of the communication activities will be done with the support of the BSC's Communication and Earth System Services groups. These two teams have wide experience in showcasing research projects and results and making them appealing for all types of audiences using a wide range of formats. With every achieved milestone, we will prepare press releases, fact sheets and visualizations addressed to the general public. We will exploit three types of communication activities:

1. Online general public communications

The project will have an online presence by means of its own dedicated website. The website will be created at the very beginning of the fellowship and will contain a short (2-3 minutes) video explaining the project and its goals in plain language, as well as updates on the main project results, a general presentation of myself and my career; and links to all the partners, funding sources and associated projects. The website will target a general public audience (from ~10 years old to adults) but also university students considering a future career in Oceanography. Website updates will be shared by means of the BSC and my own twitter and LinkedIn accounts.

2. Adjust AdoptAFloat program to Spanish schools after training at LOV

Researchers at LOV have developed a successful communication program to engage with primary school students to the science done with BGC-Argo floats. The fundamental concept of the program (called *AdoptAFloat*) is that students follow an existing float by regularly checking the position and observations it provides. My aim is to translate *AdoptAFloat* to Spanish and Catalan in conjunction with the LOV's staff members that created the program, who will also train me during my secondment to LOV's. I will apply the program to at least two Spanish school groups during the second part of the grant. This will strongly benefit from my own experience as science

²⁴ <https://upcommons.upc.edu/handle/2117/23714>

communicator for students and general public (10-months full-time work experience in Barcelona's Science Museum COSMOCAIXA).

3. Outreach events

The city of Barcelona, where the BSC is located, has a thriving cultural scene and is fully engaged in building a knowledge-based economy. Part of this scene is dedicated to science communication. Some examples are the Festival de la Ciència, the DataBeersBCN and the European Researchers' Night events, both addressed to an adult audience; or the 48-hour Open House Barcelona, in which the BSC regularly participates showcasing its ongoing research activities to high school and graduate students. During the fellowship, I will engage with several of these events, taking advantage of my former experience as a professional science communicator.

3. Quality and Efficiency of the Implementation

3.1 Coherence and effectiveness of the work plan, including appropriateness of the allocation of tasks and resources

As described in Section 1.1, three work packages will compose the research component of the project. The Gantt chart in this page details the planned timing for each of these work packages throughout the 24 months of duration of the fellowship.

	First Year												Second Year											
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WP1			M 1.1			D 1.1	M 2.2		D 1.2															
WP2													M 2.1			D 2.1	D 2.2							
WP3																		M 3.1		D 3.1	D 3.2	M 3.2		
WP4	D 4.1	M 4.1					M 4.2					D 4.2		D 4.6			D 4.3			D 4.2			D 4.5	D 4.4
WP5	D 5.1				M 5.1	M 5.3			M 5.2			M 5.3	D 5.1					M 5.3					M 5.3	D 5.1
Sec.							L															A		

WP1 Acoustical + rBGC database
M1.1: Visit at ICES to collaborate with MEESO project
M2.2: Secondment at LOV
D1.1: Global acoustical dataset of mesopelagic biomass
D1.2: rBGC dataset corresponding to the acoustical observations

WP2 MeFiS model development
M2.1: Upload of MeFiS code on GitLab
D2.1: First stable version of MeFiS (available on GitLab)
D2.2: Testing MeFiS with zooplankton observations

WP3 MeFiS for prediction
M3.1: Handling EC-Earth model and coupling to MeFiS
M3.2: Secondment at AZTI
D3.1: MeFiS-ESM hybrid model first outputs
D3.2: First mid-term predictions of MB

WP4 Dissemination and public outreach
M4.1: Attending EGU2020 to present DEplete (poster)
M4.2: Training on <i>AdoptAFloat</i> at LOV
D4.1: Project website and updates
D4.2: Deliver <i>AdoptAFloat</i> workshop in Spanish or Catalan (2 times)
D4.3-4: Peer-reviewed publications in open-access high-impact journals
D4.5-6: Oral presentation at EGU2021 and OSM2022

WP5 Project Management and Career Development
M5.1-2: Attendance to BSC's training on transferable competencies
M5.3: Career Development regular meetings
D5.1: Career Development Plan and evaluation

Secondments
L: Secondment at LOV, France
A: Secondment at AZTI, Spain

The timing has been designed considering both research and managing aspects of the project. For instance, nine person-months (PMs) have been allocated for WP1 to take into account the time invested on managing (such as setting up my work environment in BSC computers, develop the career plan, prepare a website for the project), in addition to the time-consuming tasks related to WP1's research. The secondment at LOV (marked with an L in the Gantt Chart) has been placed on month 7 to fit with WP1's research plan and to train on the *AdoptAFloat* outreach activity during the first year. The latter will leave enough time to adapt and deliver the activity in two Spanish schools during the second year of the fellowship (D4.2). Eight PMs have been allocated to WP2, all of them based at the BSC as this WP will need a significant time investment on training in machine-learning techniques and collaborating with the experts at the BSC (Dr. Carlos Gomez in particular). The last seven months have been allocated to WP3. The technical aspects in this WP are less time-consuming as the coupling between

EC-Earth and MeFiS is technically very similar to the work regularly done at the CPG. Hence WP3 will be partly devoted to complete the communication and outreach activities initiated in precedent WPs (address paper #1 reviews, submit paper #2, *AdoptAFloat*, evaluation of the career development plan), and to the 1PM secondment at AZTI (marked with an A in the Gantt Chart). The activities related to communication and managing extend throughout the duration of the project to ensure that the project communicates effectively (WP4), remains on track and can be adjusted quickly to meet any changing circumstances (WP5). Particularly important is the career development plan, its continued tracking (fortnightly, not detailed in the Gantt Chart) and regular evaluation meetings (~6months, M5.3), and the delivery of evaluation reports (every 12 months, D5.1).

3.2 Appropriateness of the management structure and procedures, including risk management

In terms of the successful implementation of the fellowship, I will be supported by the PMO with regard to financial and administrative matters. In order to gain autonomy and managing skills, the PMO will give me access to the reporting system where I will be able to monitor the project budget. Such monitoring will be part of the regular discussions with my supervisors and will help planning the project needs/expenses. In addition, BSC will provide services from the Technology Transfer Manager (orientation/help with science exploitation, and seeking new opportunities), Communications Team (outreach activities, organization of events and press releases), Legal Assessment, and Education and Training unit.

The research and career plan aspects of the project will be monitored on fortnightly meetings with Dr. Ortega and Dr. Bernardello. These small format working meetings will allow identifying unexpected difficulties as soon as they arise to ensure a seamless evolution of the project. In addition, every 6 months a formal meeting will be organised with the two co-supervisors and other collaborators at the CPG to evaluate both the advancement of the project and propose the next 6 months plan. Despite these efforts, the implementation of such an innovative project as DEplete does not come without risk. The most important expected risks and their corresponding contingency plans are described in the following table:

Risk	WP	Likelihood	Contingency plan
Insufficient acoustic data	1	Low	Regions of economic and conservation interest will be targeted
Unsuccessful validation of MeFiS outputs	2	Medium	1. Develop basin/season dependent algorithm 2. Use simpler statistical methods (e.g. multivariate correlations)
New BGCsensors are unstable and quality data not available	2	Low	MeFiS validation in the Mediterranean Sea will be done using existing databases of zooplankton (e.g. COPEPOD and ZooNets)

3.3 Appropriateness of the institutional environment (infrastructure)

The outstanding HPC infrastructures (detailed in Section 5), computational resources (including an AI dedicated cluster), curated storage, and IT support at BSC will be made available to me, and will be crucial to ensure a successful accomplishment of DEplete. Moreover, BSC will facilitate immediate access to a personal workstation, laptop, conference rooms, and other services (library, online access to journals, sports facilities) offered by the Universitat Politècnica de Catalunya, at which BSC is associated.

Support and infrastructures in the secondments institutions

Laboratoire d'Océanographie de Villefranche-sur-Mer (LOV), Villefranche-sur-Mer, France

Dr. Hervé Claustre will provide the candidate with (1) access to the biogeochemical data collected by BGC-Argo floats, and to all the scientific environment of the team for the analysis and use of data, including the new sensors under development, (2) the introduction to other international scientists in the field of BGC-Argo to foster new collaborations and widely disseminate the results of DEplete; and (3) benefit from the experience of the team in outreach activities, especially related to the *AdoptAFloat* program.

AZTI, Bilbao, Spain

Dr. Xabier Irigoien will support the candidate in an advisory role throughout the project but paying particular attention to understanding mesopelagic ecosystems and potential technological developments. He will further host the candidate in his lab for detailed discussion and developments during a 1-2 months secondment, and he will introduce him to other AZTI researchers working on the different aspects of the mesopelagic ecosystem (genetics, trawls, acoustics). AZTI will provide to the fellow a desk and working space with access to the Internet during the secondment and will support him on the organisation and logistics of the temporal relocation.

Part B-2 Section 4 - CV of the experienced researcher

NAME AND SURNAMES

Joan Llort Jordi

PROFESSIONAL EXPERIENCES

31/05/2019 01/07/2018	Postdoc Fellowship at Antarctic Gateway Partnership. Collaborators: P.Strutton and P.Boyd . <i>Winter primary production and biological carbon pump phenology from biogeochemical floats</i>	UTAS-IMAS, Hobart, AUS
31/06/2018 01/12/2015	Research associate at ARCCSS (post-doctoral fellowship) collaborating with P. Strutton, R.Matear and A.Hogg <i>Southern Ocean biogeochemistry: interactions with ocean dynamics.</i>	UTAS-IMAS Hobart, AUS
31/08/2015 01/04/2015	Postdoctoral position in LOCEAN-IPSL under the supervision of J.B.Sallée . <i>Understanding the regional distribution of bloom phenology in the Southern Ocean</i>	UPMC (SU) Paris, FR
30/03/2015 03/10/2011	PhD in Oceanography at LOCEAN-IPSL under the supervision of M.Lévy and J.LeSommer . <i>Bloom phenology, mechanisms and future change in the Southern Ocean.</i>	UPMC (SU) Paris, FR
30/04/2009 30/06/2008	Full-time scientific communicator (workshops, lectures and hands-on experiments) at Barcelona's science museum COSMOCAIXA	COSMOCAIXA Barcelona, SP
01/10/2006 01/05/2007	Part-time scientific communicator (workshops and hands-on experiments) at primary and secondary schools with Ciència de Butxaca.	Various Barcelona, SP
01/10/2005 30/05/2006	Internship on GIS software and mapping in the Geological Institute of Catalunya (IGC). Development of applications for ArcGIS (ESRI).	IGC-ICC Barcelona, SP

EDUCATION AND TRAINING

2016-2018	Career Development workshops: - Career tips for Early Career Researchers (1 day) - Increasing the quality and academic impact of your research (1 day) - Scientific paper writing (3 days)	UTas, Hobart, AUS
12/07/2016 30/07/2016	Third Summer Series Lectures on ocean bio-optics and ocean colour remote sensing at Lab. d'Océanographie de Villefranche	LOV Villefranche, FR
02/09/2013 23/08/2013	6th International SOLAS summer school 2013 , State Key Laboratory of Marine Environmental Science (Xiamen University), China	MEL Xiamen CH
26/06/2011 15/09/2009	2-yr MSc in Oceanography and Climate Master SDUEE <i>Océan, Climat, Atmosphères et Observations Spatiales (OACOS)</i>	UPMC (SU) Paris, FR
23/06/2008 01/02/2003	BSc in Physics in <i>Universitat de Barcelona (UB)</i>	UB Barcelona, SP

PUBLICATIONS

Published in peer-reviewed journals (all in first quartile):

- **Llort, J., Lévy, M., Sallée, J.B., Tagliabue, A., 2019. Non-monotonic Response of Primary Production and**

Export to Changes in Mixed-Layer Depth in the Southern Ocean, Geophysical Research Letters 46, 3368–3377, doi: 10.1029/2018GL081788, Citations: 1

- Patel, R., Philips, H., Strutton, P., Lenton, A., **Llort, J.**, 2018. *Meridional Heat and Salt Transport across the Subantarctic Front by Cold-Core Eddies*. JGR-Oceans, doi: 10.1029/2018JC014655, Citations: 1
- **Llort, J.**, Langlais, C., Matear, R., Moreau, S., Lenton, A., Strutton, P., 2018. *Evaluating Southern Ocean carbon eddy-pump from biogeochemical Argo floats*. JGR-Oceans, SOCCOM special issue. doi: 10.1002/2017JC012861, Citations: 9
- Moreau, S., Penna, A.D., **Llort, J.**, Patel, R., Langlais, C., Boyd, P.W., Matear, R.J., Phillips, H.E., Trull, T.W., Tilbrook, B., Lenton, A., Strutton, P.G., 2017. *Eddy-induced carbon transport across the Antarctic Circumpolar Current: Eddy-Induced Carbon Transport*. Global Biogeochemical Cycles. doi:10.1002/2017GB005669, Citations: 9
- Nicholson, S.A., Lévy, M., **Llort, J.**, Swart, S., Monteiro, P.M.S., 2016. *Investigation into the impact of storms on sustaining summer primary productivity in the Sub-Antarctic Ocean*, Geophys. Res. Lett. 2016GL069973. doi:10.1002/2016GL069973, Citations: 11
- **Llort, J.**, Lévy, M., Sallée, J.-B., Tagliabue, A., 2015. *Onset, intensification, and decline of phytoplankton blooms in the Southern Ocean*. ICES J. Mar. Sci.; fsv053. doi:10.1093/icesjms/fsv053, Citations: 14
- Sallée, J.B., **Llort, J.**, Tagliabue, A., Lévy, M. *Characterisation of distinct bloom phenology regimes in the Southern Ocean*. ICES J. Mar. Sci., doi:10.1093/icesjms/fsv069, Citations: 11
- C Lo Monaco, N Metzl, F D'Ovidio, **J Llort**, C Ridame, *Rapid establishment of the CO₂ sink associated with Kerguelen's bloom observed during the KEOPS2/OISO20 cruise*, Biogeosciences Discussions 01/2014; 11(12):17543-17578. DOI:10.5194/bgd-11-17543-2014, Citations: 6

Dissertations:

- **Llort, J. (2015)** *Bloom phenology, mechanisms and future change in the Southern Ocean*. PhD thesis, UPMC (Paris 6), France. doi: 10.13140/RG.2.1.1922.0003 (1 citation)

SCIENTIFIC PRESENTATIONS (international level)

09/07/2019	IAPSO-IUGG2019 - Oral presentation <i>Decadal Changes In Phytoplankton Induced By Drought-Enhanced Dust Storms</i>	Palais des Congrès, Montréal, CA
20/05/2019	Invited seminar at NIWA <i>The use of Bio-Argo to investigate the Biological Carbon Pump</i>	NIWA, Wellington, NZ
10/04/2018	MEASO 2018 - Oral presentation <i>On the influence of stratification over Southern Ocean primary production</i>	C3CC, Hobart, AUS
12/02/2018	Ocean Sciences Meeting 2018 - Poster <i>Occurrence of subduction events across the Southern Ocean and its contribution to the biological carbon pump</i>	Conf Centre Oregon, USA
10/10/2017	Invited speaker at the International Workshop on Biogeochemical-Argo Technology and Application . Organised by F.Chai and X.Xing <i>Southern Ocean eddy-pump observed from bgcArgo floats</i>	SOED Hangzhou, CH

04/07/2017	Invited lecturer at the Ramon Margalef Summer Symposia <i>Exploring physical-biological interactions with BGC-Argo floats</i>	ICM-CSIC Barcelona, SP
08/02/2017	AMOS 2017 - Oral presentation <i>Mesoscale subduction pathways detected from autonomous O2 measurements</i>	ANU Canberra, AUS
30/06/2015	IUGG-IAPSO 2015 – Oral presentation <i>Characterization of distinct bloom phenology regimes in the Southern Ocean.</i>	Conf Centre Prague, CR
24/02/2014	Ocean Sciences Meeting 2014 – Oral presentation <i>Bloom onset in the Southern Ocean: sensitivity to vertical mixing and iron</i>	HCC Honolulu, USA
12/10/2012	Invited seminar at CSIR-UCT laboratory <i>Bloom dynamics in the Southern Ocean</i>	CSIR Capetown, SA

SCIENTIFIC CRUISES

16/05/2016	EDDY (PIs: Dr. Trull, Dr. Strutton, Dr. Boyd)	South Tasmania,
14/04/2016	Main tasks: Mesoscale eddy real-time tracking, sampling strategy Vessel: <i>RV Investigator</i>	Southern Ocean
02/12/2011	KEOPS 2 – OISO 20 (PIs: Dr. Blain, Dr. LoMonaco)	Kerguelen Is.
05/10/2011	Main tasks: Atmosphere/ocean surface pCO ₂ , T, S, O ₂ and Chl in continuum. Vessel: <i>RV Marion Dufresne</i>	Southern Ocean
02/06/2011	MOOSE 2011 - leg 1 (PIs: Dr. Testor, Dr. Mortier)	Toulon, FR
28/05/2011	Main tasks: CTD profiles-Niskin bottles sampling for Chl, Nutrients Vessel: <i>RV TethysII</i>	Mediterranean Sea
20/06/2010	MOOSE 2010 - leg 2 (PIs: Dr. Testor, Dr. D'Ortenzio)	Toulon, FR
30/06/2010	Main tasks: CTD profiles-Niskin bottles sampling for Chl, Nutrients Vessel: <i>RV TethysII</i>	Mediterranean Sea

GRANTS AND FUNDING

ARC Discovery Project: *Dust to the ocean: Does it really increase productivity?*

Aims: Postdoc researcher on link between dust deposition and ecosystem productivity (Obj 1)

Awarding entity: Australian Research Council (ARC), University of Tasmania

Conferral date: 30/11/2018, **Duration:** 6 months

Entity where activity will be carried out (September 2019): BSC, Spain

Amount: ~38,800€

UTAS Visiting Fellow Scholarships

Aims: Visiting fellow

Awarding entity: University of Tasmania

Conferral date: 14/02/2018, **Duration:** 1 month

Entity where activity was carried out: University of Tasmania, IMAS, Australia

Amount: ~5,500€

Participation grant for Third IOCCG Summer Lectures on ocean bio-optics and ocean colour remote sensing

Aims: Post-doctoral training on ocean colour

Awarding entity: International Ocean Colour Coordinating Group (IOCCG)

Conferral date: 11/07/2016, **Duration:** 19 days

Entity where activity was carried out: Laboratoire d'Optique de Villefranche - Sorbonne Université (LOV-SU), France

Amount: ~2,500€

Participation grant for SOLAS summer school

Aims: Pre-doctoral training on ocean-atmosphere interactions I

Awarding entity: Surface Ocean Lower Atmosphere Study (SOLAS) - International

Conferral date: 20/08/2013 Duration: 10 days

Entity where activity was carried out: Xiamen State Key Laboratory of Marine Environmental Science, China

Amount: ~2,500€

PhD scholarship

Aims: Funding for 3 years PhD

Awarding entity: French Ministry of Research and Education

Conferral date: 01/09/2011 Duration: 3.5 years

Entity where activity was carried out: Université Pierre et Marie Curie - Sorbonne Université, France

Amount: ~100,000€

STAYS IN SCIENTIFIC INSTITUTIONS

- 3 months stay at LGGE, Université de Grenoble, France
- 8 weeks stay at CSIR, University of Cape Town, South-Africa
- 1 week stay at British Antarctic Survey, Cambridge, UK

PARTICIPATION IN RESEARCH PROJECTS**Dust to the ocean: Does it really increase productivity?**

Position: Postdoctoral Researcher

Institutions: Institute of Marine and Antarctic Studies, University of Tasmania (Australia); BSC (Spain)

Dates: 01/01/2019 - Present

Type: International (Australia and Spain)

Funding: Australian Research Council (Public) / Competitive call

Relevant results: Dust transported from Australia between 2003 and 2011 tripled the annual phytoplankton accumulation in the southern part of the Tasman Sea. Dust increase was associated to long-lasting drought in the Australian continent.

Contribution: Analysis of phytoplankton activity and atmospheric dust using satellite and reanalysis data. Mechanistic understanding of the dust impact on phytoplankton activity using a biogeochemical ocean model that represents a single water column (1D model) throughout a seasonal cycle. Bibliographical research on the relationship between atmospheric dust, continental droughts in Australia and Tasman Sea phytoplankton variability.

Southern Ocean eddies and plankton phenology

Position: Postdoctoral Researcher, coordinator of the international collaboration network

Institutions: CSIR Southern Ocean Carbon & Climate Observatory (SOCCO); Institute of Marine and Antarctic Studies (IMAS); University of Tasmania, ARC Centre of Excellence for Climate System Science, Université de Bretagne Occidentale (UBO)

Dates: 16/04/2018 - Present

Type: International

Funding: University of Tasmania (Public) / Non-Competitive call

Relevant results: Southern Ocean mesoscale eddies alter plankton phenology: anticyclonic eddies delay phytoplankton blooms while cyclonic eddies advance them in time.

Contribution: I initiated the collaboration between Fanny Chenillat (UBO, Brest, France), Sarah Nicholson (CISR-SOCCO, Capetown, South-Africa) and myself. I secured funding from the UTAS Visiting Fellow Scholarship (~8000 euros) to cover the stay of Dr. Fanny Chenillat in Hobart during April 2018 - Analysed ocean model outputs and applied eddy detection algorithm to obtain average properties of eddies. Fanny Chenillat and myself wrote the first report of the project (June 2018). I planned and manage the project timing to ensure that outcomes and deliveries are in schedule.

Using BGC-Argo floats to study the biological carbon pump phenology in the Southern Ocean

Position: Postdoctoral Researcher, initiate and coordinate the international collaboration network

Institutions: Institute of Marine and Antarctic Studies, University of Tasmania, Antarctic Gateway Partnership, ARC Centre of Excellence for Climate System Science, Takuvik Joint Lab - University of Laval (CA)

Dates: 01/02/2018 - Present

Type: National (Australia)

Funding: Australian Research Council (Public) / Non-Competitive call

Relevant results: Two autonomous floats deployed in the iron-limited waters in the Pacific Sector of the Southern Ocean. We apply innovative methodologies to evaluate the phytoplankton activity during winter and the succession of the mechanisms contributing to the biological carbon pump.

The role of Southern Ocean Carbon cycle under CLimate change (SOCCLI)

Position: Visiting Scientist

Institutions: LOCEAN-IPSL-UPMC-SU and CNRS (France), Southern Ocean Carbon & Climate Observatory - CSIR, University of Cape Town, University of Bergen

Dates: 01/09/2012 - 01/11/2012

Type: International

Funding: European Union - MSCA-RISE Staff Exchange (Public) / Competitive call

Relevant results: Analysis of changes in Southern Ocean primary production in CMIP5 model projections. Development of an automated algorithm to run hundreds of small ocean simulations.

STUDENTS CO-SUPERVISION

Present 01/10/2018	C. Vives (PhD student) <i>Spatial variability of Southern Ocean spring bloom initiation</i> Co-supervisors: Phillip W. Boyd, Christina Schallenberg, Pete Strutton	UTAS-IMAS, Hobart, AUS
Present 29/05/2018	K. Baldry (PhD student) <i>Subsurface chlorophyll in the Southern Ocean and the associated implications for estimations of carbon flux</i> Co-supervisors: Phillip W. Boyd, Nicole Hill, Pete Strutton	UTAS-IMAS, Hobart, AUS
05/01/2018 20/11/2017	Y. Wang (MSc student) <i>Subtropical Front dynamics in the Tasman Sea</i> Co-supervisors: Pete Strutton	UTAS-IMAS, Hobart, AUS
Present 01/12/2015	R. Patel (PhD student) <i>Physical and Bio-optical Structure of Southern Ocean Eddies</i> Co-supervisors: Andrew Lenton, Helen Phillips, Pete Strutton	UTAS-IMAS, Hobart, AUS

RESEARCH COMMUNITY

- Adjunct Associate at the University of Tasmania, Australia
- Associate Investigator at the ARC Centre for Climate Extremes (CLEX)
- Support team 4th International Symposium on the Ocean in a High-CO₂ World, Hobart, AUS
- Reviewer for Biogeosciences and JGR journals (4 reviews)
- Co-organizer of the first annual meeting of Marine Sciences ECRs in Hobart, AUS
- Reviewer of undergrad MSc thesis and internship applications

SKILLS AND COMPETENCES

Software and data Science

- Ability to work with large data sets issued from modeling and observational data sources
- Intermediate user of UNIX, Fortran, MatLab and HPC environments
- Knowledge on control version tools such as GitLab and GitHub
- Advanced user of scientific Python and Ferret

Experimental techniques and sea-going experience

- Experience on research cruises in remote areas.
- Knowledge on high precision sampling techniques for salinity, oxygen, Chl-a and organic/inorganic carbon
- Knowledge on continuous pCO₂ equilibrator and sea-water alkalinity measurements
- Advanced knowledge on satellite-based lagrangian techniques for real-time sampling strategies

Languages

- Catalan and Spanish (mother tongue)
- French and English: advanced level

Part B-2 Section 5 - Capacity of the Participating Organisations

List of participating organisations

Participating organisations	Legal Entity Short Name	Country	Supervisor	Role of partner organisation
Barcelona Supercomputing Centre - Centro Nacional de Supercomputación	BSC	Spain	Dr. Pablo Ortega	Beneficiary
<i>Partner Organisation 1</i>				
Laboratoire d'Océanographie de Villefranche-sur-Mer Sorbonne Université	LOV-SU	France	Dr. Hervé Claustre	Partner organisation for secondment
<i>Partner Organisation 2</i>				
AZTI	AZTI	Spain	Dr. Xabier Irigoien	Partner organisation for secondment

Barcelona Supercomputing Centre - Centro Nacional de Supercomputación, BSC, Spain	
General Description	The Barcelona Supercomputing Center - Centro Nacional de Supercomputación (BSC) is the national supercomputing facility of Spain. BSC's mission is to develop and manage information technology in order to facilitate scientific and technological progress. The BSC is also an important research center, with more than 600 scientists and students who conduct research in Computer Sciences, Life Sciences, Earth Sciences and Computational Applications in Science and Engineering. BSC has been accredited since its first call (2011) as a Severo Ochoa Centre of Excellence. This award is given by the Spanish Government as recognition for leading research centres in Spain that are internationally well known institutions in their respective areas (only 11 research centres across the country). In June 2019, the EuroHPC selected Barcelona Supercomputing Center as entity to host one of the largest European supercomputers. MareNostrum 5, the future BSC's supercomputer, is one of the pre-exascale machines. It will have a peak performance of 200 petaflops (200 x 10 ¹⁵ floating-point operations per second) and will come into operation on 31 December 2020.
Academic organisation	Yes
Role and profile of key persons (supervisor)	<p>The researcher in charge of the candidate will be Dr. Pablo Ortega, one of the two co-leaders of the Climate Prediction Group (CPG) at the BSC. Dr. Ortega is a Ramon y Cajal fellow (RYC-2017-22772) expert in decadal climate variability and predictability and has more than 10 years of experience as a climate modeller and oceanographer. His current work involves the direct supervision of the work of 9 postdocs, 2 PhD students and 1 undergraduate student. He has already been the official supervisor of a Marie Curie fellowship, and is the PI of two PhD scholarships. The scientific quality and relevance of his research is supported by 24 publications in journals of the first quartile (9 as a first author), including 5 in high-impact journals. These articles have received a total of 550 citations (451 since the beginning of 2017), and have a h-index of 12 (all metrics from Scopus, September 2019). Dr. Ortega also coordinates the CPG contributions to the EC-Earth Consortium and acts as PI at the BSC in 4 international research projects (TRIATLAS, APPLICATE, INTAROS and PARAMOUR) and an ESA contract (CMUG-CCI+).</p> <p>The fellowship will be co-supervised by Dr. Raffaele Bernardello who leads all activities related to the global carbon cycle within CPG. Dr. Bernardello has a wide experience in the use and development of Earth System Models, particularly on the ocean biogeochemical aspect. He joined BSC in 2017 after obtaining a Marie Skłodowska-Curie fellowship to investigate the decadal predictability of ocean biogeochemical properties. Dr. Bernardello acts as PI on one national project (DeCUSO) and as co-investigator in the project ORCAS (funded by LaCaixa foundation). Moreover, he is the PI for BSC (and WP2 co-leader) of the H2020 project CCiCC, to investigate the predictability of the global carbon cycle on decadal timescale. At present, Dr. Bernardello supervises two postdoctoral researchers and one research engineer. The scientific quality and relevance of his research is supported by 13 publications in peer-reviewed journals (11 of the first quartile, 4 as first author, 3 as second author). These articles have received a total of 270 citations (173 since the beginning of 2017) and his h-index is 8 (all metrics from Scopus, September 2019).</p>
Dept./Division/Laboratory	The applicant will be hosted by the Climate Prediction Group (CPG) , one of the four Research groups at the BSC Earth Sciences Department . The CPG currently has 23 employees (4 senior researchers, 13 postdocs, 2 technicians, 2 PhD students, 1 master student and 1 undergraduate student) that undertake advanced research to forecast climate variations from one month to several years into the future (also known as seasonal-to-decadal predictions) and from regional to global scales. Other important scientific topics covered by the group are the impact of Arctic sea ice decline on climate variability and predictability in the mid-latitudes, the predictability of ocean productivity and global carbon cycle, the prediction of tropical cyclones and the inter-basin teleconnections, among others.
Key Research Facilities, Infrastructure and Equipment	BSC hosts and manages a range of HPC systems, including MareNostrum 4, with 148,176 cores and 13.7 Pflops capacity. Additionally, BSC manages Minotauro, a Sandy Bridge cluster with NVIDIA GPUs, providing more than 100 TFlops.
Independent research premises?	Yes
Previous and current involvement in research and training Programmes	<p>The CPG has an active involvement in national and international scientific projects, both as project leaders and contributors. Some examples are:</p> <p>APPLICATE (Ref: 727862) is a H2020 project (call H2020-BG-2016-2017, PI at BSC: P. Ortega) Start: 11/2016 Duration: 48 months Total funding: 8,715,066€ BSC funding: 698,144€</p> <p>TRIATLAS (Ref: 817578) is a H2020 project (call H2020-BG-2018-2020, PI at BSC: P. Ortega) Start: Spring 2019, Duration: 48 months, Total funding: 1,000,000€, BSC funding: 258,000€</p> <p>CCiCC (Ref: 817578) is a H2020 project (call H2020-BG-2018-2020, PI at BSC: R. Bernardello) Start: Spring 2019, Duration: 48 months, Total funding: 7,784,750€, BSC funding: 795,000€</p> <p>ORCAS La Caixa Junior Leader fellowship (Grantee: M. Gali, Supervisor: R. Bernardello) Start: 01/07/2018, Duration 35 months, Total funding BSC: 305,700€</p> <p>NeTNPPAO (Ref: 708063, 2015 call) is a MSCA IF (Grantee: R. Bernardello; Supervisor: P. Ortega) Start: 01/02/2017, Duration: 24 months</p>
Relevant Publications and/or research/innovation products	<ol style="list-style-type: none"> 1) Moat B., B. Sinha, S.A. Josey, J. Robson, P. Ortega, et al., Insights into Decadal North Atlantic Sea Surface Temperature and Ocean Heat Content Variability from an Eddy-Permitting Coupled Climate Model, <i>Journal of Climate</i> 32, 6137-6161, 2019 2) Thornalley D., D. Oppo, P. Ortega, et al., Anomalously weak Labrador Sea convection and Atlantic overturning during the past 150 years, <i>Nature</i> 556, 227-230, 2018 3) Robson J., P. Ortega and R. Sutton, A reversal of climatic trends in the North Atlantic since 2005; <i>Nature Geoscience</i> 9, 513-517, 2016 4) Ortega P., F. Lehner, D. Swingedouw, V. Masson-Delmotte, et al., A model-tested North Atlantic Oscillation reconstruction for the past millennium. <i>Nature</i> 523, 71-74, 2015 5) Bernardello, R., Marinov, I., Palter, J.B., Sarmiento, J.L., Galbraith, E.D., Slater, R.D., 2013. Response of the Ocean Natural Carbon Storage to Projected Twenty-First-Century Climate Change. <i>J. Climate</i> 27, 2033-2053.

Laboratoire d'Océanographie de Villefranche-sur-Mer, Sorbonne Université, LOV, France	
General Description	The first secondment will be held at the Laboratoire Océanographique de Villefranche-sur-Mer (LOV) , one of the laboratories of Sorbonne University (SU). LOV is devoted to science and medicine, and is the largest in France: 6,700 professor-researchers and researchers and 4,900 administrative and technical staff members, 4400 PhD candidates, 100 laboratories, 55300 students, 700 scientific PhD delivered per year (www.upmc.fr). SU has a wide experience of EU contracts through previous framework programmes. Its "European Affairs Office" has been involved in more than 150 projects in FP7 and already 91 projects in H2020. It will provide support for all administrative, legal and financial aspects of the project's management. SU has also adopted the European Charter for Researchers and the code of conduct for the recruitment of Researchers. Within LOV the main objective of the OAO (Oceanic Autonomous Observation) team is to contribute to the development of integrated observation systems relying on in situ robotic measurements, remote sensing and modelling. Specifically a large emphasize is presently dedicated to profiling floats of the biogeochemical-Argo (BGC-Argo) network. Thanks to major funding sources (e.g. national funding, ERC Advanced grant RemOcean-PI: Dr. H. Claustre, other FP7 and H2020 projects), the team is contributing to float development and improvement and to the setting of an efficient data quality and distribution system.
Academic organisation	Yes
Role and profile of key persons (supervisor)	Dr. H. Claustre will provide to the MC Fellow (1) access to the biogeochemical data collected by BGC-Argo floats with the latest data quality control developed in his lab and all the scientific environment of the team for the analysis and use of data including machine learning-base methods, (2) the introduction to other international scientists in the field of BGC-Argo for him to become a potential Spanish leader in the field; and (3) benefit from the experience of the team in outreach activities especially related to the <i>Adopt A Float</i> program.
Dept./Division/Laboratory	Marine Optics & Remote Sensing Lab
Key Research Facilities, Infrastructure and Equipment	The LOV has all the required facilities (computing, modelling, statistical tools) for data management and analysis of remote sensing as well in situ data. In particular, LOV leads the international effort for the production of quality-controlled BGC-Argo data making the latest improvements of these prototype dataset quickly available for collaborators.
Independent research premises?	Yes. LOV owns all the facilities and the research premises. They are wholly independent from other partner organizations.
Previous and current Involvement in Research and Training Programmes	<u>Previous:</u> <ul style="list-style-type: none"> • PI of the ERC Advanced grant project RemOcean (2010-2016): remotely sensed Biogeochemical cycle in the Ocean • Involved in various science topics and outreach and dissemination for SIDERI, GROOM, OSS2015 FP7 Projects • Mentoring several PhDs (14) and post-doc (13) as part of EU and national projects <u>Current:</u> <ul style="list-style-type: none"> • PI of ERC-Advanced grant REFINE (2020-2025) • Leader of the WP3 of the H2020 project AtlantOs • Co-chair of the international Biogeochemical-Argo program • Teaching at master level, teaching at IOCCG summer school • Current advisor of 3 PhD and 5 post-docs
Relevant Publications and/or research/innovation products	<ol style="list-style-type: none"> 1) Boyd, P.W., Claustre, H., Levy, M., Siegel, D.A., Weber, T., 2019. Multi-faceted particle pumps drive carbon sequestration in the ocean. <i>Nature</i> 568, 327. 2) Ardyna, M., Lacour, L., Sergi, S., d'Ovidio, F., Sallée, J.-B., Rembauville, M., Blain, S., Tagliabue, A., Schlitzer, R., Jeandel, C., Arrigo, K.R., Claustre, H., 2019. Hydrothermal vents trigger massive phytoplankton blooms in the Southern Ocean. <i>Nat Commun</i> 10, 1–8. 3) Bittig, H., Steinhoff, T., Claustre, H., Fiedler, B., Williams, N.L., Sauzede, R. Körtzinger, A. and J.-P. Gattuso (2018). An alternative to static climatologies: Robust estimation of open ocean CO2 variables and nutrient concentrations from T, S and O2 data using Bayesian neural networks. <i>Frontier in Marine Science</i> 4) Mignot, A., Ferrari, R. and H. Claustre. Floats with bio-optical sensors reveal what processes trigger the North Atlantic bloom, <i>Nature Communications</i>, 9, doi: 10.1038/s41467-017-02143-6 5) Sauzede, R., H. Claustre, J. Uitz , C. Jamet, G. Dall'Olmo, F. D'Ortenzio, B. Gentili , A. Poteau and C. Schmechtig (2016). A neural network-based method for merging ocean color and Argo data to extend surface bio-optical properties to depth: Retrieval of the particulate backscattering coefficient. <i>Journal of Geophysical Research</i>, 121

AZTI, Spain	
General Description	<p>AZTI is a non-profit private foundation committed to the social and economic development of the marine environment and food sector. With more than 30 years of experience, the organisation has developed an important network of collaborating centres both at national and international level, promoting more than 2,000 projects with industries and public institutions, including 35 European projects running at present. With a team of 235 professional (27 doctorate students), 3 laboratories and a turnover of 18.8 million € in 2016, as research and innovation centres, AZTI is structured in two business divisions: Marine Research and Food Research. Its main activity is focused on its applied research projects, new products and services, scientific advice and business revitalisation and addressed to private companies, scientific organisations, professional associations as well as local, national and international administrations. In the last 10 years, 2007-2017, AZTI has obtained 19 million € in 90 EU projects. In order to give the best service to its more than 400 national and international private and public clients, AZTI counts on the required technological equipment and its researchers participate as leaders and collaborators in the most relevant scientific committees regarding their expertise area. AZTI investigates to achieve a sustainable fishing activity by an economically competitive fleet, with responsible fishing practices. Our research team works in physical and biological oceanography, marine dynamics and modelling of the marine ecosystems as well as the implementation of the EU Directives and its impact on local economies, aiming at more sustainable fisheries through scientific stock assessment, development and transfer of innovative technologies for a more efficient fishing industry.</p>
Academic organisation	No
Role and profile of key persons (supervisor)	<p>Dr. Xabier Irigoien will support the fellow in an advisory throughout the project but paying a particular attention to understanding mesopelagic ecosystems and potential technological developments. He will further host the fellow in his lab for detailed discussion and developments during a 1-2 months secondment.</p> <p>Dr. Irigoien is a PhD in Biological Oceanography by the University of Bordeaux (France), with expertise in plankton ecology and physics-plankton-fish interactions. Since 1994 successively worked in Instituto de Ciencias del Mar (CSIC, Barcelona), Plymouth Marine Laboratory (NERC, Plymouth) and Southampton Oceanography Center (NERC, Southampton) and AZTI. During his career he has been appointed as:</p> <ul style="list-style-type: none"> • Head of the Biological Oceanography & living resources section in the Marine Research Division of AZTI foundation from 2004 to 2011 • Director of the Red Sea Research Center in KAUST from 2011 to 2016 • KERBASQUE Research Professor and Scientific Director at AZTI since 2016 <p>Over 160 publications in international journals including Nature, Nature Communications, Science Advances and PNAS, with more than 3600 citations and h-index=40.</p>
Dept./Division/Laboratory	Scientific and Technological Innovation
Key Research Facilities, Infrastructure and Equipment	AZTI has fully equipped fish biology and genomics labs and owns different sampling equipment (nets, trawls, niskin bottles, acoustic equipment). AZTI will provide the fellow with a desk and working space with access to the Internet during the secondment.
Independent research premises?	Yes
Previous and current Involvement in Research and Training Programmes	Dr. Irigoien was the leader of the Early Stage Training programme META-OCEANS. Funded by: EU, Marie Curie Actions. He has supervised 12 PhD students and taught at MSc level at the Master MARE (joint master in marine science by the Universities of the Basque country, University of Southampton and University of Bordeaux, 2007-2008), Master on Marine Science University of Cadiz (2009, 2010) and KAUST Master in Marine Biology.
Relevant Publications and/or research/innovation products	<p>1) van Hoof, L., Fabi, G., Johansen, V., Steenbergen, J., Irigoien, X., Smith, S., Lisbjerg, D., Kraus, G., 2019. Food from the ocean; towards a research agenda for sustainable use of our oceans' natural resources. Marine Policy 105, 44–51</p> <p>2) Olivar, M.P., González-Gordillo, J.I., Salat, J., Chust, G., Cózar, A., Hernández-León, S., Puellas, M.L.F. de, Irigoien, X., 2016. The contribution of migratory mesopelagic fishes to neuston fish assemblages across the Atlantic, Indian and Pacific Oceans. Mar. Freshwater Res. 67, 1114–1127</p> <p>3) Aksnes, D.L., Røstad, A., Kaartvedt, S., Martinez, U., Duarte, C.M., Irigoien, X., 2017. Light penetration structures the deep acoustic scattering layers in the global ocean. Science Advances 3, e1602468.</p> <p>4) Irigoien, X., Klevjer, T.A., Røstad, A., et al., 2014. Large mesopelagic fishes biomass and trophic efficiency in the open ocean. Nature Communications 5.</p> <p>5) Cozar, A., F. Echevarria, J.I. Gonzalez-Gordillo, X. Irigoien et al. 2014, Plastic debris in the Global Ocean PNAS 111: 10239-10244.</p>

Part B-2 Section 6 - Ethical Issues

No ethical issues were flagged in the Ethics Issues Table, and thus the proposal meets the EU and national legal and ethics requirements.



This electronic receipt is a digitally signed version of the document submitted by your organisation. Both the content of the document and a set of metadata have been digitally sealed.

This digital signature mechanism, using a public-private key pair mechanism, uniquely binds this eReceipt to the modules of the Funding & Tenders Portal of the European Commission, to the transaction for which it was generated and ensures its full integrity. Therefore a complete digitally signed trail of the transaction is available both for your organisation and for the issuer of the eReceipt.

Any attempt to modify the content will lead to a break of the integrity of the electronic signature, which can be verified at any time by clicking on the eReceipt validation symbol.

More info about eReceipts can be found in the FAQ page of the Funding & Tenders Portal.

(<https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/support/faq>)