Marine Sensors Proof of Concept

Announcement of Opportunity

Issued on 20 June 2017
Full Proposals deadline: 16.00 BST on 24 August 2017

1 Summary

Proposals are invited for submission to a new jointly funded activity between funding agencies in the UK and Japan that will deliver 'proof of concept' projects that will underpin exploration and testing of new innovative and disruptive approaches that could, with further development (not funded under this Announcement of Opportunity), provide a step change in the technology available to make autonomous biogeochemical and biological observations in the marine and aquatic environment.

This programmes aims to build on recent research investments in novel marine technologies in the UK and Japan and deliver proof of concept projects for high-risk high-reward innovative sensing technologies.

It is expected that this announcement will lead to the funding of three projects, with a maximum cost of £300K per project.

Proposals for this call are invited from eligible UK (see NERC Grants Handbook for standard eligibility criteria) and Japanese researchers. Each proposal must include at least one Principal/Co Investigator from each of the funding partner countries and contributions from each partner must be substantive.

The closing date for full proposals is 16:00 on 24 August 2017

2 Background

The oceans play a crucial role in the prosperity and future of civilisation, but their biogeochemical variations remain a challenge to measure limiting quantitative understanding and our predictive capabilities. Oceans provide essential natural resources such as offshore energy resources, locations for carbon sequestration capture and storage, fish, tourism, minerals, and a route for global transport of goods and resources. Natural biogeochemical cycles in the oceans provide "ecosystem services" valued at US$19 trillion p.a. in 1997,

equivalent to the global GNP[1]. For example in 2012, marine fisheries and aquaculture produced 80 and 25 million tonnes respectively[2]. The oceans also play a key role in climate regulation[3], arguably the most important environmental issue facing humankind[4]. However, they are undergoing changes with unknown consequences via processes such as ocean acidification, ocean warming and sea level rise[5].

Much of the ocean environment, including the deep sea, remains unexplored or poorly characterized. To understand, predict, protect and manage ocean processes and resources requires a step change in the available data from this environment. This is particularly true for biogeochemical cycling of oxygen, carbon, nutrients and metals and the resultant microbiological response that dominate ocean productivity and influence fisheries and carbon sequestration potential. These processes vary widely over geographic and temporal scales from the coast to remote-ocean (productive) surface, to (the sequestering) deep sea. Therefore ocean scientists and stakeholders need vast numbers of measurements to study processes leading to effective models, understanding and effective management and exploitation of these fragile yet valuable environments.

Despite the critical requirements for widespread marine biogeochemical and biology observations, most data is currently acquired following laboratory assessment of samples, typically collected by the traditional methods, such as nets and the Niskin bottle. Due to cost and availability of suitable research ships able to collect such samples, and because it is difficult to perform in adverse weather conditions, these techniques deliver infrequent (<1 year is common) and spatially sparse (typically a few tracks per ocean basin) observations. However, because the samples can be subject to a myriad of high performance laboratory analytical techniques, the quality of data and the number of parameters that can be measured is high. The exception is for parameters, such as ammonia, which are difficult to sample because the sample degrades rapidly, or is contaminated by the sampling or analysis process (bottle effects).

Autonomous sensors are well placed to address this capability gap as the immediacy of their analysis avoids bottle effects, and enables widespread year-round deployments on autonomous platforms, such as sea gliders and Argo floats, and on existing traditional infrastructure for extended time series, such as the RAPID North Atlantic observing system or GO-SHIP. However, whilst there have been considerable advances in recent years in the operational use of autonomous marine physics sensors, the operational use of autonomous biogeochemistry and biology sensors remains in its infancy. There is therefore a critical need to develop the next generation of biogeochemistry and biology autonomous sensors, that can be deployed in numbers (e.g. on the Argo float array) and deliver the step change in data density both temporally and spatially.

This is required to move forward with science in a number of key areas, including:

1. *Response of ocean biogeochemistry and biology in a warming and acidifying future*. Current predictions are that stratification and acidity of the oceans will increase with a resulting decrease in productivity and carbon sequestration. Sensing of the ocean carbonate system with high accuracy (pH to <0.002 or equivalent) and the

[1] Costanza, R., et al., The value of the world's ecosystem services and natural capital. Nature, 1997. 387(6630): p. 253-260.
[2] Food and Agriculture Organization of the United Nations, The State of World Fisheries and Aquaculture: Opportunities and challenges. 2014.
[3] Watson, R.T., et al., Climate Change 2001: Synthesis Report. , in The Third Assessment IPCC. 2001, IPPC: Geneva. p. 184.
[4] King, D., Climate change: the science and the policy. Journal of Applied Ecology, 2005. 42(5): p. 779-783.
[5] Orr, J.C., et al., Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature, 2005. 437(7059): p. 681-686.

biogeochemical and biology context will dramatically improve our understanding of local trends and variability and will improve the accuracy of our predictions.

2. *Understanding impacts of biogeochemical cycles and their variability on the ocean carbon pump.*
   Sensing of chemistry (e.g. nutrients, carbonate system), biology (including phytoplankton and zooplankton) and key biogeochemical fluxes (e.g. particulate carbon export, air-sea CO2 flux) over wide spatial and temporal scales will provide data for new understanding of processes, and calibration and validation of models and parameterisations. Crucially variability, and its affect will be captured and our understanding and predictive capabilities improved.

3. *Distribution sources and fate of chemical elements, harmful organisms and alien species*.
   Tracking can be used to identify polluters and risks to ecosystems or human health, or to study newly discovered (e.g. hydrothermal inputs, norovirus) or changed sources and transmission (e.g. due to natural or anthropogenic change). Tracking will be facilitated by the immediacy of sensor data making real time plume tracking possible, and by ensuring episodic or spatially variant features are effectively characterised.

The creation of sensors with performance sufficient for scientific applications for biogeochemical and biological parameters is however challenging. This challenge is compounded by the requirements for marine sensors that include: pressure resistance (typically to 60MPa); wide operating temperature range (-2 to + 35 ^{0}C); tolerance to biofouling, particles and turbidity; long duration (typically > 6 months), small size (typically <2 L); and low-power (typically <1 W). It is these challenges that have limited operational biogeochemical and biology sensing. Whilst systems for nitrate, methane, carbon dioxide and complex biological measurements are commercially available, it is only oxygen, pH, and fluorescence (a low quality proxy for chlorophyll a content) that are routinely operational.

Sensors research in the UK and Japan includes the development of high Technology Readiness Level (TRL) sensors and is starting to address this operational capability gap. For example, the recent NERC Marine Sensor Development Capital Call promises to deliver a raft of nutrient, carbonate system parameter, chlorophyll and biology imaging sensors at TRLs 8-9, integrated with marine autonomous platforms (including sea gliders and Argo floats). However, by nature, projects focused on delivering high TRL sensors are only able to further develop mature sensor technologies and consequently these projects are incremental rather than disruptive. This is why there remains a need for continued development of high-risk high-reward lower TRLs transformative and disruptive technologies.

3 Scope of Call

3.1 Programme Objectives

This programme aims to build on recent research investments in novel marine technologies in UK and Japan and deliver proof of concept projects for high-risk high-reward innovative sensing technologies.

The development of world class marine autonomous sensors is a major strength of scientists in the UK and Japan. Whilst there have been considerable advances in recent years in the operational use of autonomous marine physics sensors, the operational use of autonomous biogeochemistry and biology sensors remains in its infancy. This capability gap limits our ability to move forward with science in a number of key areas, including: the response of ocean biogeochemistry and biology in a warming and acidifying future; understanding

impacts of biogeochemical cycles and their variability on the ocean carbon pump; and, the distribution, sources and fate of chemical elements, harmful organisms, and alien species.

Recent advances in sensor technology promise to close the capability gap for some biogeochemistry and biology Essential Ocean Variables (EOV). However, for a wide range of high priority biogeochemistry and biology EOVs there is either no, or poor, sensing capability available, and this capability gap is the subject of this Announcement of Opportunity.

Fundamental and disruptive innovations at TRLs 2-4 coming through from world-class research communities in both the UK and Japan have the potential to deliver a step change in capability in terms of, for example, miniaturisation, accuracy, and robustness, and this is the focus of this research programme. The development of these new capabilities will enable the prolonged and large scale deployments of biogeochemistry and biology sensors on Marine Autonomous Systems platforms, such as the Argo float array, that will deliver the data density (temporally and spatially) that is required for science.

A key outcome of this programme will be a number of innovative and disruptive approaches using technologies that will ideally be at TRL 4 by the end of the programme. This outcome will help to bridge the biogeochemistry-biology capability gap for autonomous observation of the oceans, and will ultimately help to move away from research ship dependence by accelerating the wider use of autonomous observing technologies. In time this will lead to improved understanding of marine ecosystem by taking the use of novel marine observing technology beyond proof of concept to proof of delivery.

3.2 Proposal Requirements

This joint programme is specifically for high-risk, high-reward proof of concept studies for the development of low TRL transformative and disruptive marine sensor technologies that focus on biogeochemistry and biology EOVs, and that will ideally be at TRL 4 by the end of the programme.

Proposals must include a Principal/Co Investigator from each of the funding partner countries. An individual may appear on no more than two proposals, only one of these may be as Principal Investigator. Each proposal must involve a substantive and integrated contribution from the UK and Japanese applicants.

The Case for Support document for all proposals must include a description of each partners contribution to the work being proposed.

The required Justification of Resources document should only include information on the resources being requested by UK applicants. A justification of resources for the requested Japanese funding should be included as a separate attachment (see section 6).

3.3 Programme Funding

This call aims to fund up to three proof of concept projects, with a maximum cost of £160k (cost to NERC) for the UK component and ¥19.5M for the Japanese component of each proposal.

All costs associated with proposals must be covered by the funding available. No additional funding will be available to cover any additional costs.

The UK funding contribution will be 80% of FEC. All costs must be included with the maximum available funding. Indexation at the prevailing rate will be applied at the time of award.

The funding for the Japanese component will be provided in support of research, travel and personnel costs, as well as indirect costs (up to a maximum of 30% of direct costs). The cost to JST for the Japanese component will depend on the budget of each fiscal year. Support to the Japanese component of funded projects will be provided on the basis of individual funding contracts between JST and Japan based Principal/Co Investigator's Institutions. Further guidance can be found on the JST website.

Proposals should present a work plan for up to 36 months.

All grants will be required to start and to have returned their starting certificate no later than **April 2018**.

4 Programme Requirements

4.1 Implementation and Delivery

All proposals are required to involve at least one Principal/Co Investigator from each funding partner country.

Proposals may be up to 36 months in duration and will be required to start and to have returned their Start confirmation by April 2018. Please note that as a result of this requirement, the normal three month start period rules (outlined in RCUK Terms and Conditions GC4) do not apply in this instance.

All proposals must include milestones and deliverables to ensure that the programmes funders can monitor the delivery of the science outputs.

4.2 Knowledge Exchange and Impact

Knowledge exchange (KE) is vital to ensure that environmental research has wide benefits for society, and should be an integral part of any research.

All applicants must consider how they will or might achieve impact outside the scientific community and submit this with their application as a Pathways to Impact statement, with associated delivery costs where relevant. Pathways to Impact activities do not have to be cost-incurring; it is not a requirement to include funded activities. Any funds required to carry out any proposed, outcome-driven activities identified within the Pathways to Impact **must** be fully justified within the Justification of Resources statement.

The Pathways to Impact will identify those who may benefit from or make use of the research, how they might benefit or make use of the research, and methods for disseminating data, knowledge and skills in the most effective and appropriate manner.

An acceptable Pathways to Impact is a condition of funding. Grants will not be allowed to start unless unacceptable Pathways to Impact are enhanced to an acceptable level within 2 months of notification of the panel outcome.

All funded projects may also be required to engage with programme-wide KE activities, in which case appropriate funding for which will be provided by the programme.

4.3 Data Management

The NERC Data Policy must be adhered to, and an outline data management plan produced as part of proposal development. NERC will pay the data centre directly on behalf of the programme for archival and curation services, but applicants should ensure they request sufficient resource to cover preparation of data for archiving by the research team.

Japanese applicants should take note of the JST Open Science Policy.

4.4 NERC Facilities

Prior to submitting a proposal, applicants wishing to use a NERC service or facility must contact the facility to seek agreement that they could provide the service required. Applicants wishing to use a NERC facility will need to submit a mandatory 'technical assessment' with their proposal (including aircraft but excluding ships and HPC). For NERC, this means a quote for the work which the facility will provide. A full list of the Facilities requiring this quote can be found here on the NERC website. The costs for the service or facility (including NMF costs) must be included within the Directly Incurred Other Costs section of the Je-S form and also within the facilities section of the Je-S form. Further information on NERC services and facilities can be found on the NERC website. All costs associated with the use of any NERC service or facility (e.g. the 100% cost) must be included within the cost of the proposals, no additional funding will be made available to cover these costs.

4.5 Reporting

A final report will be required at the conclusion of the programme. The reports should highlight the results and output of whole projects including publishable summaries.

Additional reporting to funding agencies may also be necessary depending on national regulations.

4.6 Intellectual Property

The participating research institutions are expected to enter into a formal agreement for collaborative research to set the basis of collaboration between the institutions including ownership of intellectual property and rights to exploitation.

5 Eligibility

This opportunity is open to individuals and organisations eligible for:

- NERC research grant funding, i.e. applicants based in UK Higher Education Institutions (HEIs), NERC Research & Collaborative Centres (please refer to the NERC Grants Handbook for details), and Independent Research Organisations (IROs) (RCUK eligibility for Research Council funding).
- Japan Science and Technology Agency funding, any independent researcher personally affiliated with a domestic Japanese research institution (universities, independent administrative institutions, national/public testing and research institutions, specially authorized corporations, public-service corporations and enterprises, etc. that satisfy predetermined requirements specified by the Ministry of Education, Culture, Sports, Science and Technology in Japan).
- Further instructions and guidance for Japanese applicant can be found on the JST website.

Potential applicants should contact NERC well in advance of the submission deadline if they have any queries concerning their eligibility. Individuals are limited to involvement in no more than two proposals submitted to this call; only one of these may be as the lead PI.

6 Application Process

Full Proposals
Closing date: 24 August 2017

Full proposal must be submitted using the Research Councils' Joint Electronic Submission system (Je-S). Applicants should select Proposal Type - 'Standard Proposal' and then select the Scheme – 'Directed' and the Call – 'Marine Sensor Proof of Concept August 2017'.

Applicants must ensure that their proposal is received by NERC by 4pm on the closing date. There is a system cut-off and proposals will not submit after 4pm. Applicants should leave enough time for their proposal to pass through their organisation's Je-S submission route before 4pm on this date. Any proposal that is incomplete, or does not meet NERC's eligibility criteria or follow NERC's submission rules (see NERC Grants Handbook), will be returned to the applicant and will not be considered.

All attachments, with the exception of letters of support and services/facilities/equipment quotes, submitted through the Je-S system must be completed in single-spaced typescript of minimum font size 11 point (Arial or other sans serif typeface of equivalent size to Arial 11), with margins of at least 2cm. Please note that Arial narrow, Calibri and Times New Roman are not allowable font types and any proposal which has used either of these font types within their submission will be rejected. References and footnotes should also be at least 11 point font and should be in the same font type as the rest of the document. Headers and footers should not be used for references or information relating to the scientific case. Applicants referring to websites should note that referees may choose not to use them.

Applicants should ensure that their proposal conforms to all eligibility and submission rules, otherwise their proposal may be rejected without peer review. More details on NERC's submission rules can be found in the NERC research grant and fellowships handbook and in the submission rules on the NERC website.

Proposals for this call should be submitted in **Standard** format following the requirements outlined in Section F of the NERC research grant and fellowships handbook.

The UK applicant should list all international collaborators as Project Partners (PP). The PP is the organisation and there might be multiple collaborators from each PP. If this is the case the PP need only be entered once naming only one collaborator. The required organisation letter should confirm the names of all others involved. PP entries should indicate the value of the non-UK requested funding in the project partner in-kind support section of the proposal form.

The following additional attachments must be provided on the lead proposal :

- CVs for each of the named Japanese collaborators (maximum 2 pages per person) should be combined into one document as attachment type 'Non-UK Components'.

- a breakdown of funding required for Japanese collaborators (maximum 2 pages of A4) as attachment type 'Non-UK Components'. The Japanese applicant should detail the costs being incurred by the Japanese organizations in each eligible cost category including direct costs (facilities, equipment and consumables/travel costs/personnel costs/other costs) and Indirect costs (30% of direct costs)) with justification for the funding requested.

Please note that on submission to council ALL non PDF documents are converted to PDF, the use of non-standard fonts may result in errors or font conversion, which could affect the overall length of the document.

Additionally where non-standard fonts are present, and even if the converted PDF document may look unaffected in the Je-S System, when it is imported into the Research Councils Grants System some information may be removed. We therefore recommend that where a document contains any non-standard fonts (scientific notation, diagrams etc), the document should be converted to PDF prior to attaching it to the proposal.

No associated studentships can be requested under this call.

Japanese applicants need to apply separately to JST via the Cross-Ministerial R&D Management System - e-Rad

7 Assessment Process

Proposals will be internationally peer-reviewed and final funding recommendations made by a moderating panel consisting of independent experts and members of the NERC Peer Review College where possible. Experts nominated by JST will be involved in the peer review and decision-making process throughout. Guidance for the review of strategic research will be provided to reviewers and panel members. Applicants will **NOT** be given the opportunity to provide a written response to peer review comments prior to the moderating panel.

The assessment criteria to be used for the full proposal stage will be as follows:

- Research Excellence
- Fit to Programme Requirements

Feedback will be provided on proposals unsuccessful at the full proposal stage.

8 Timetable

Opening date for full proposals: 20 Jun 2017
Closing date for full proposals: 24 August 2017
Decision communicated to applicants: December 2017

Projects are required to commence no later than April 2018.

9 Contact

For all enquiries, please contact:

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