# UNITED KINGDOM RESEARCH AND INNOVATION

Application for Consent to conduct
Marine Scientific Research
Iceland

Date: __07/12/2023___

1. General Information

| 1.1 Cruise name and/or number: : DY180 22/1849 spring 2024 and 22/1854 BIO-Carbon NZOC science mission |
|---|
| |

| 1.2 Sponsoring Institution(s): | |
|---|---|
| Name: | National Oceanography Centre |
| Address: | European Way, Southampton, SO143ZH |
| Name of Director: | Prof Ed Hill |

| 1.3 Principal Investigator in charge of the Project : | |
|---|---|
| Name: | Adrian Martin |
| Country: | UK |
| Affiliation: | National Oceanography Centre |
| Address: | European Way, Southampton, SO14 3ZH |
| Telephone: | 02380 596342 |
| Fax: | N/A |
| Email: | adrian.martin@noc.ac.uk |
| Website (for CV and photo): | https://noc.ac.uk/n/Adrian+Martin |

| 1.4 Entity(ies)/Participant(s) from Coastal State involved in the planning of the project: | |
|---|---|
| Name: | Hildur Petursdottir |
| Affiliation: | Icelandic Marine and freshwater Institute |
| Address: | Fornubúðir 5, 220 Hafnarfjörður |
| Telephone: | +354 5752059 |
| Fax: | |
| Email: | hildur.petursdottir@hafogvatn.is |
| Website (for CV and photo): | |

2. Description of Project

| 2.1 Nature and objectives of the project: |
|---|
| The ocean stores huge amounts of carbon dioxide (CO2) that could otherwise be in the atmosphere. Marine organisms play a critical role, but emerging evidence indicates that climate models are not fully accounting for their impact. This programme will deliver the new understanding of the role of marine life that is needed to make robust predictions of future ocean carbon storage.<br><br>To do so BIO-Carbon will address 3 major challenges:<br>Challenge 1:<br>How does marine life affect the potential for seawater to absorb CO2, and how will this change?<br>The ability of the oceans to absorb CO2 is determined by alkalinity. Biological production and dissolution of calcium carbonate influence alkalinity but estimates of global ocean calcium carbonate production, vertical transport and dissolution vary considerably.<br><br>Challenge 2:<br>How will the rate at which marine life converts dissolved CO2 into organic carbon change?<br>CO2 is removed from the ocean by conversion to organic matter through primary production by marine phytoplankton. Estimates of global primary production and how it will be altered by climate change are very uncertain due to insufficient knowledge about key processes and how these processes vary in different ocean environments.<br><br>Challenge 3:<br>How will climate change-induced shifts in respiration by the marine ecosystem affect the future ocean storage of carbon? |

Respiration of marine organisms converts organic carbon back to CO2. To determine the speed at which this CO2 is returned to the atmosphere, we need to understand how respiration varies with depth, location and season and understand how environmental changes affect respiration.

The fieldwork will seek to address these challenges using a combination of ship-based and autonomous activity. This SME covers a ship-based component of that fieldwork including multiple glider deployments.

2.2 If designated as part of a larger scale project, then provide the name of the project and the Organisation responsible for coordinating the project:

This cruise and glider deployment would be carried out by 3 projects (CHALKY, IDAPro and PARTITRICS) as part of the BIO-Carbon programme (https://bio-carbon.ac.uk/) which is funded by NERC. Adrian Martin is the Champion for BIO-Carbon and Jess Surma is the NERC programme manager. The 3 projects within BIO-Carbon include a number of scientists and partner organisations from UK and internationally, many of them in addition to those involved directly in the fieldwork.

2.3 Relevant previous or future research projects:

There is a linked ALR deployment (22/1854 – BIO-Carbon NZOC science mission) and an autumn 2024 cruise (22/1850 – BIO-Carbon – autumn). The ALR mission will be contemporary to DY180. It is planned to deploy the ALR from Iceland from where it will travel to the central study site to rendez-vous with DY180 for ~5 days before continuing to NW Scotland where it would be recovered. The autumn cruise will be to a similar location as DY180 and will additionally aim to recover the 4 gliders deployed by DY180 and which will have been sampling in that area in the intervening time.

2.4 Previous publications relating to the project:

There is a web-page describing the programme and its component projects: https://bio-carbon.ac.uk/

## 3. Geographical Areas

3.1 Indicate geographical areas in which the project is to be conducted (with reference in

Latitude and longitude, including coordinates of cruise/track/way points)

The main study site will be 60N -24.5W in the Iceland Basin. This is in international waters. The majority of cruise activities will take place in a ~25km radius of this location. That radius is chosen on the basis of the likely distance drifted by floating platforms that will be deployed for short (2-3 day) periods (see section 4.7 for details of those platforms) and which will be used as focal points for ship activities. In addition to the activities at the central site it is intended to do short (3 day) forays to investigate areas experiencing coccolithophore blooms. These can be identified real-time from remote sensing. Although they are often local, rather than covering the basin, they can occur anywhere within the central and eastern side of the northern Atlantic and their location cannot be predicted in advance. For that reason we also indicate in 3.2 the wider area which we would like permission to explore if necessary. The boundaries of that region are set by the distance that can be steamed (assuming 10 kts) in 1.5 days while excluding shelf areas; the focus of BIO-Carbon is on deeper water areas. This broader area extends into EEZ's of Iceland and Greenland. For all ship activities, the majority of sampling will be done over the top 2000m of the water column though deeper, possibly full depth, CTD casts may be taken as reference.

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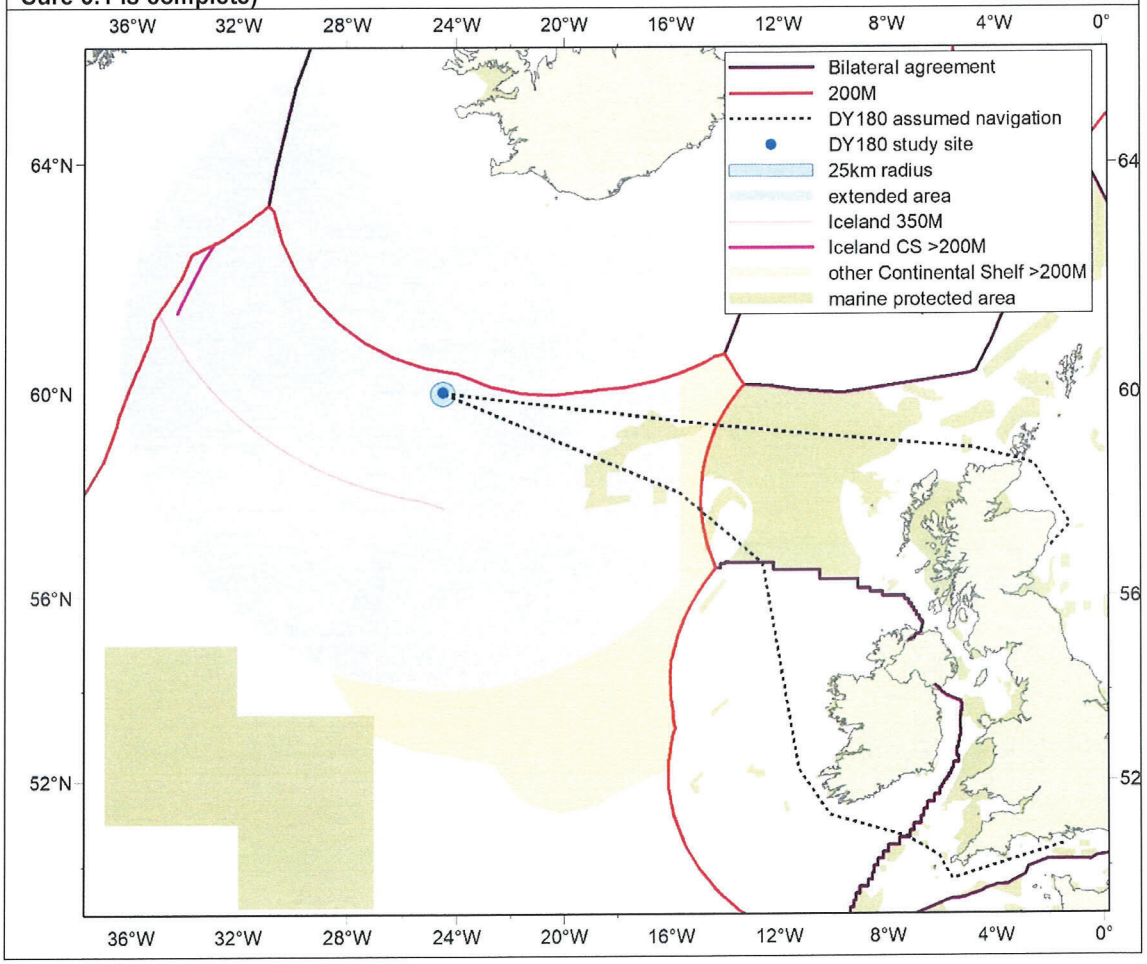
3.2 Attach chart(s) at an appropriate scale (1 page, high-resolution) showing the geographical Areas of the intended work and, as far as practicable, the location and depth of sampling Stations, the tracks of survey lines, and the locations of installations and equipment. **(NB: make Sure 3.1 is complete)**




4. Methods and means to be used

| 4.1 Particulars of vessel: | |
|---|---|
| Name: | RRS Discovery |
| Type/Class: | Lloyds Register Lloyd's +100A1 Oceanographic Research Vessel, IWS, Ice Class 1D +LMC, UMS, DP(AM), Green Passport, Shipwright (SERS) |
| Nationality (Flag State): | British |
| Identification Number (IMO/Lloyds No.): | 9588029 |
| Owner: | United Kingdom Research & Innovation |
| Operator: | National Marine Facilities |
| Overall length (meters): | 99.70 Metres |
| Maximum draft: | 6.60 Metres |
| Displacement/Gross Tonnage: | Net Tonnage: 1785 Gross Tonnage: 5952 |
| Propulsion: | Diesel Electric |
| Cruising & maximum speed: | 12 Knots & 15 Knots Max Speed |
| Call sign: | 2FGX5 |
| INMARSAT number and method and capability of communication (including emergency frequencies): | 773238856 – Voice<br>783255483 – Fax<br>423593533 – Sat C |
| Name of Master: | TBA |
| Number of Crew: | 24 |
| Number of Scientists on board: | 30 |

| 4.2 Particulars of Aircraft: | |
|---|---|
| Name: | N/A |
| Make/Model: | |
| Nationality (flag State): | |
| Website for diagram & Specifications: | |
| Owner: | |
| Operator: | |
| Overall Length (meters): | |
| Propulsion: | |
| Cruising & Maximum speed: | |
| Registration No.: | |
| Call Sign: | |
| Method and capability of communication<br><br>(including emergency frequencies): | N/A |
| Name of Pilot: | |
| Number of crew: | |
| Number of scientists on board: | |
| Details of sensor packages: | |
| Other relevant information: | |

| 4.3 Particulars of Autonomous Underwater Vehicle (AUV): | |
|---|---|
| Name: | Slocum Glider |
| Manufacturer and make/model: | Teledyne Webb Research Slocum G2 |
| Nationality (Flag State): | UK |
| Website for diagram & Specifications: | https://www.teledynemarine.com/en-us/products/Pages/slocum-glider.aspx |
| Owner: | NOC |
| Operator: | NOC |
| Overall length (meters): | 1.5 |
| Displacement/Gross tonnage: | 60kg |
| Cruising & Maximum speed: | 0.3metres/sec & 0.5 metres/sec |
| Range/Endurance: | 4000km/6 months |
| Method and capability of communication (including emergency frequencies): | RF Modem (902-928MHz), Iridium (RUDICS), ARGOS |
| Details of sensor packages: | Seabird CTD, Aanderaa Oxygen optode, WETLabs fluorometer, Biospherical PAR |
| Other relevant information: | |

| 4.4 Particulars of Unmanned Surface Vehicles (USV): | |
|---|---|
| Name: | N/A |
| Manufacturer and make/model: | |
| Nationality (Flag State): | |
| Website for diagram & Specifications: | |
| Owner: | |
| Operator: | |
| Overall length (meters): | |
| Displacement/Gross tonnage: | |
| Cruising & Maximum speed: | |
| Range/Endurance: | |
| Method and capability of communication (including emergency frequencies): | |
| Details of sensor packages: | |
| Other relevant information: | |

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| 4.5 Particulars of Unmanned Air Vehicles (UAV) : | |
|---|---|
| Name: | N/A |
| Make/Model: | |
| Nationality (flag State): | |
| Website for diagram & Specifications: | |
| Owner: | |
| Operator: | |
| Overall Length (meters): | |
| Propulsion: | |
| Cruising & Maximum speed: | |
| Registration No.: | |
| Call Sign: | |
| Method and capability of communication (including emergency frequencies): | |
| Name of Pilot: | |
| Number of crew: | |
| Number of scientists on board: | |
| Details of sensor packages: | |
| Other relevant information: | |

4.6 other craft in the project, including its use:

See also section 4.7 for drifting samplers that will be deployed for 1-3 days at the central site before recovery.

None of the following floats will be recovered.

NOC float (x1)

- Full BGC Argo (no non-standard sensors)
- Non-standard profiling strategy (first 6 months):
  - Day 0-2 – 2000 m profiles (Standard)
  - Day 3 – 1000 m profiles (non-standard)
  - Day 4-5 – 2000 m profiles (Standard)
  - Day 6 – 1000 m profiles (non-standard)
  - Day 7-9 – 2000 m profiles (Standard)
  - Day 10 – cycle repeats

LOV floats (x3)

- Standard BGC Argo sensors, plus
  - Hydroptic UVP6 particle and plankton camera
  - Seabird C-Rover Transmissometer
  - (1 of 3 floats) hyperspectral Trios RAMSES ACC-VIS downwelling irradiance
    - Replaces "standard" 4-channel radiometer
  - (1 of 3 floats) Trios RAMSES ARC-VIS hyperspectral upwelling radiance
- Non-standard profiling strategy (full float lifetime)
  - Day 0 – 2000 m profile (Standard)
  - Day 0-2 – Park at 200 m (non-standard)
  - Day 2-5 – Park at 500 m (non-standard)
  - Day 5-10 – Park at 1000 m (standard)
  - Day 10 – Cycle repeats

UoS float 1:

- Standard BGC Argo sensors (CTD plus O2 only)
- Non-standard profiling strategy
  - Dusk-dawn pairs of profiles to 1000 m
  - Profile frequency variable
    - Pair of profiles daily during key periods (e.g. autumn ML deepening)
    - May reduce to one pair of profiles every 2-4 days in winter to conserve energy
  - Expected float lifetime ≤1 year

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UoS float 2:

- Full BGC Argo (no non-standard sensors)
- Non-standard profiling strategy (first 6 months):
  - Day 0-2 – 2000 m profiles (Standard)
  - Day 3 – 1000 m profiles (non-standard)
  - Day 4-5 – 2000 m profiles (Standard)
  - Day 6 – 1000 m profiles (non-standard)
  - Day 7-9 – 2000 m profiles (Standard)
  - Day 10 – cycle repeats

| 4.7 Particulars of methods and scientific instruments: | | |
|---|---|---|
| Types of samples and Measurements: | Methods to be used: | Instruments to be used: |
| Salinity, nutrients, inorganic carbon | Water sample | CTD frame bottles (vertical profiles) and underway supply (surface) |
| Oxygen concentration | Water sample | CTD frame bottles |
| Salinity, conductivity, oxygen, fluorescence | Electronic sensor | CTD frame (vertical profiles) and underway sensors (surface) |
| Meteorological data | Electronic sensors | Ship meteorological package |
| Sinking particulate material - chemical composition (carbon, nitrogen, silicon), biological composition (type, size, morphology) | Water sample | Discrete particle collection device: Marine Snow Catcher, deployed from ship |
| Plankton and particle images (type, size, morphology), particle concentration, | Camera systems | Optical and imaging systems: Red Camera Frame, deployed from ship. |
| Particle composition and sinking velocity | Camera system/water sample | Drifting optical and water sampler: DriftCam, drifting array recovered after 24 hours |
| Microbial respiration | Water sample | Drifting water sampler: RESPIRE, drifting array recovered after 3 days |
| Microbial respiration | Water sample | Discrete water sampler: ISMI, deployed from ship |
| Zooplankton composition and biomass | Water samples | Net deployments: Mammoth and Bongo systems, deployed from ship |
| Plankton composition (inc. viruses, phytoplankton, microzooplankton) | Water samples | flow cytometry, pigments, imaging systems |
| Primary Production, Calcite Production | Water samples, incubations | incubators, isotopes |
| Growth and mortality rates | Water samples, nets, incubations | incubators, filtered samples, |
| Bio-optical properties of seawater | Optical sensors, profiling and free-floating rig, underway water | Irradiance sensors, hyperspectral sensors, planar and scalar irradiance meters, AC9+,BB9, BBFL2; acid-labile and non-labile particulate material; transmittometer |
| Dissolved trace metals | Water samples | CTD frame bottles (vertical profiles) and underway supply (surface) |
| Nutrient uptake and recycling | Water samples, incubations | incubators, isotopes |
| Nutrient limitation status | Water samples, incubations | incubators |
| See also sensors on permanently deployed floats and gliders listed in sections 4.3 and 4.6 respectively | | |

| 4.8 Indicate nature and quantity of substances to be released into the marine environment: |
|---|
| None |

| 4.9 Indicate whether drilling will be carried out. If yes, please specify: |
|---|
| None |

| 4.9.1 Indicate whether explosives will be used. If yes, please specify type and trade name, Chemical content, depth of trade class and stowage, size, depth of detonation, frequency of Detonation, and position in latitude and longitude: |
|---|
| No |

5. Installations and Equipment

| Details of installations and equipment (including dates of laying, servicing, method and Anticipated timeframe for recover, as far as possible exact locations and depth, and Measurements): |
|---|
| The temporarily deployed floating platforms described in section 4.7 will be deployed for up to 3 days. Within this time they are likely to travel ~25km from the deployment site (so within the central site area on the chart) before being recovered. It is not possible to give precise recovery locations in advance because of the drifting nature of the floats.<br>4 gliders will be deployed at the main site and recovered, hopefully at the same site on cruise 22/1850 in September 2024. After deployment the gliders will collect data sampling around the central site before recovery on the autumn cruise. Because gliders are slow moving it cannot be ruled out that they may be pushed into Iceland EEZ waters by currents during that time. |

6. Dates

| 6.1 Expected dates of first entry into and final departure from the research area by the research vessel and/or other platforms: |
|---|
| First entry - 26/5/2024<br>Last departure - 25/6/2024 |
| 6.2 Indicate if multiple entries are expected: |
| N/A |

7. Port Calls

| 7.1 Dates and Names of intended ports of call: |
|---|
| None planned in Iceland |

| 7.2 Any special logistical requirements at ports of call: |
|---|
| N/A |

| 7.3 Name/Address/Telephone of shipping agent (if available): |
|---|
| N/A |

8. Participation of the representative of the Coastal State

| 8.1 Modalities of the participation of the representative of the Coastal State in the research Project: |
|---|
| Hildur Petursdottir of the Icelandic Marine and freshwater Institute is a project partner for two of the projects (PARTITRICS and IDAPro) involved in the BIO-Carbon cruise |

| 8.2 Proposed dates and ports for embarkation/disembarkation: |
|---|
| Southampton, UK – embarkation 17 – 21 May 2024<br>Aberdeen, UK – disembarkation 27 June – 03 July 2024 |

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9. Access to Data, Samples and Research Results

| 9.1 Expected dates of submission to Coastal State of preliminary report, which should include The expected dates of submission of the data and research results: |
|---|
| 6 months after cruise completion |

| 9.2 Anticipated dates of submission to the Coastal State of the final report **(This must be w 1 year of completion of the cruise)** |
|---|
| Within 1 year of cruise completion |

| 9.3 Proposed means for access by Coastal State to data (including formal) and samples as per BODC Weblink: **https://www.bodc.ac.uk/resources/inventories/cruiseinventory/search/** |
|---|
| BODC website |

| 9.4 Proposed means to provide Coastal State with assessment of data, samples and Research results: |
|---|
| Via peer-reviewed publications and BODC website |

| 9.5 Proposed means to provide assistance in assessment or interpretation of data, samples And research results: |
|---|
| Via verbal briefings |

| 9.6 Proposed means of making results internationally available (to obtain cruise reports these Can be obtained via the BODC weblink see below: |
|---|
| BODC website and peer-reviewed publications |

10. Other permits Submitted

| 10.1 Indicate other types of Coastal State permits anticipated for this research (received or Pending): |
|---|
| Greenland - the need to follow coccolithophore blooms real-time using satellite data means that it may be required to sample in Greenland EEZ as marked on chart.<br>Ireland – as the cruise is likely to transit through Ireland EEZ en route to the study site. Iit may be useful to be running sensors and underway water sample collection in transit to have wider context data and equipment fully ready by arrival at the study site. |

11. List of Supporting Documentation

| 11.1 List of attachments, such as additional forms required by the Coastal State, etc.: |
|---|
| N/A |

Signature:

Contact information of the focal point:
Name:
Country:
Affiliation:
Address:
Telephone:
Email:

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