

UNITED KINGDOM RESEARCH AND INNOVATION

Iceland Science & Port Call

Application for Consent to conduct
Marine Scientific Research

Date: 18 November 2021

1. General Information

1.1 Cruise name and/or number:
DY151

1.2 Sponsoring Institution(s):	
Name:	University of Birmingham
Address:	School of Geography Earth and Environmental Sciences Edgbaston Birmingham B15 2TT
Name of Director:	Jon Oldfield (Head of School)

1.3 Principal Investigator in charge of the Project :	
Name:	Zongbo Shi
Country:	UK
Affiliation:	The University of Birmingham
Address:	School of Geography Earth and Environmental Sciences Edgbaston Birmingham B15 2TT
Telephone:	00447548132896
Fax:	
Email:	z.shi@bham.ac.uk
Website (for CV and photo):	https://www.birmingham.ac.uk/staff/profiles/gees/shi-zongbo.aspx

1.4 Entity(ies)/Participant(s) from Coastal State involved in the planning of the project:	
Name:	N/A
Affiliation:	
Address:	
Telephone:	
Fax:	
Email:	
Website (for CV and photo):	

2. Description of Project

2.1 Nature and objectives of the project:
<p>The overall aim is to reduce the uncertainties in modelling the response of aerosol, cloud condensation nuclei (CCN), and ice nuclei (IN) to changes in anthropogenic emissions and natural environments, so that we can better predict future climate in the Arctic.</p> <p>The cruise is atmospheric focused.</p> <p>The main objectives include:</p> <ul style="list-style-type: none">- To understand the sources and processes of aerosol particles, cloud condensation nuclei and ice nuclei (coarse particles are key)- To elucidate the formation and growth mechanism of new particles- To update a global aerosol model based on mechanistic understanding on particle source and processes from the observations.- To evaluate the new model against pan-Arctic observations- To predict the potential impact of future shipping emissions along the Northwest Passage (likely to be completely open in the summer by 2050) and changing climate on aerosol, CCN, IN and clouds- To understand the impact of high latitude dust deposition on ocean nutrient pool and on

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- phytoplankton growth
To understand the abundance and activity of nitrogen fixing phytoplankton in surface waters through rate measurements and analysis of gene abundance and diversity

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:

N/A

2.3 Relevant previous or future research projects:

N/A

2.4 Previous publications relating to the project:

Arnold S, Law K, Brock C, Thomas J, Starkweather S, von Salzen K, Stohl A, Sharma S, Lund M, Flanner M, Petaja T, Tanimoto H, Gamble J, Dibb JE, Melamed M, Johnson N, Fidel M, Tynkkynen VP, Baklanov A, Eckhardt S, Monks SA, Browse J, Bozem H (2016). Arctic air pollution: Challenges and opportunities for the next decade. *Elementa: Science of the Anthropocene*, 4, 000104-000104.

Baldo, C., Formenti, P., Nowak, S., Chevaillier, S., Cazaunau, M., Pangui, E., Di Biagio, C., Doussin, J.-F., Ignatyev, K., Dagsson-Waldhauserova, P., Arnalds, O., MacKenzie, A. R., and Shi, Z., 2020. Distinct chemical and mineralogical composition of Icelandic dust compared to northern African and Asian dust, *Atmospheric Chemistry and Physics*, 20, 13521–13539

Browse J, Carslaw KS, Mann GW, Birch CE, Arnold SR, Leck C (2014). The complex response of Arctic aerosol to sea-ice retreat. *Atmospheric Chemistry and Physics*, 14(14), 7543-7557.

Browse J, Carslaw KS, Schmidt A, Corbett JJ (2013). Impact of future Arctic shipping on high latitude black carbon deposition. *Geophysical Research Letters*, 40(16), 4459-4463.

Dall'Osto et al., 2017. Arctic sea ice melt leads to atmospheric new particle formation. *Scientific Reports* 7, Article number: 3318, doi:10.1038/s41598-017-03328-1

Reddington CL, Carslaw KS, Stier P, Schutgens N, Coe H, Liu D, Allan J, Browse J, Pringle KJ, Lee LA, et al (2017). The global aerosol synthesis and science project (GASSP): Measurements and modeling to reduce uncertainty. *Bulletin of the American Meteorological Society*, 98(9), 1857-1877.

Song, C., Dall'Osto, M., Lupi, A., Mazzola, M., Traversi, R., Becagli, S., Gilardoni, S., Vratolis, S., Yttri, K. E., Beddows, D. C. S., Schmale, J., Brean, J., Kramawijaya, A. G., Harrison, R. M., and Shi, Z., 2021. Differentiation of coarse-mode anthropogenic, marine and dust particles in the High Arctic islands of Svalbard. *Atmospheric Chemistry and Physics*, 21, 11317–11335.

Wilson TW, Ladino LA, Alpert PA, Breckels MN, Brooks IM, Browse J, Burrows SM, Carslaw KS, Huffman JA, Judd C, et al (2015). A marine biogenic source of atmospheric ice-nucleating particles. *Nature*, 525(7568), 234-238.

Yu, H., Li, W., Zhang, Y., Tunved, P., Dall'Osto, M., Shen, X., Sun, J., Zhang, X., Shi, Z., 2019. Organic coating on sulfate and soot particles in summer Arctic atmosphere. *Atmospheric Chemistry and Physics*, 19, 10433–10446, <https://doi.org/10.5194/acp-19-10433-2019>.

Zhang, C., Shi, Z., Zhao, J., Zhang, Y., Yu, Y., Mu, Y., Yao, X., Feng, L., Zhang, F., Chen, Y., Liu, X., Shi, J., Gao, H., 2021. Impact of air emissions from shipping on marine phytoplankton growth. *Science of the Total Environment*, 769, 145488.

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)

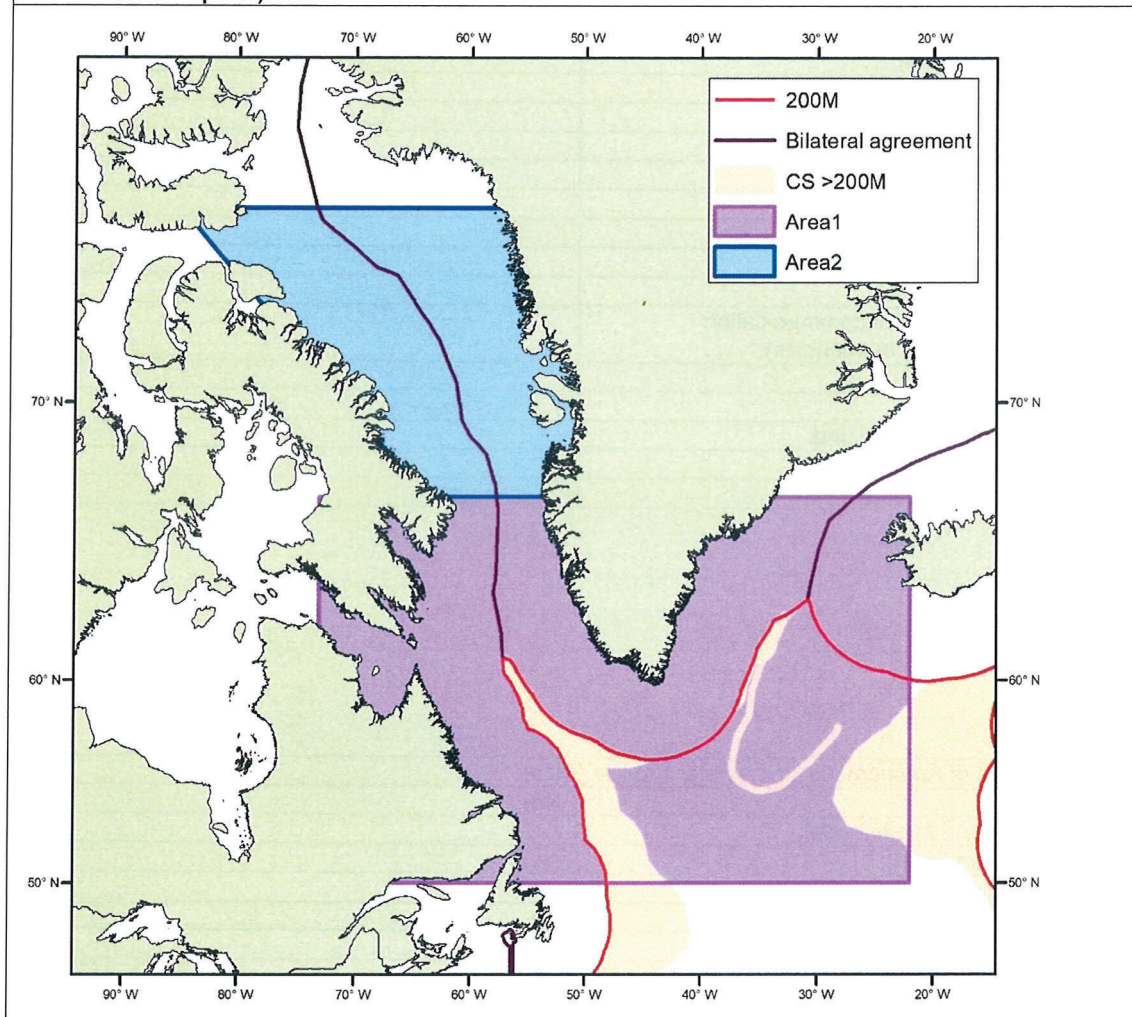
Area 1: ocean area (note excluding land) with the following coordinates
67.00000, - 73.00000; 67.00000, -22.00000
50.00000, - 73.00000; 50.00000, -22.00000

Area 2: ocean area (note excluding land) with the following coordinates
75.00000, -85.00000; 75.00000, -50.00000;
67.00000, - 64.00000; 67.00000, -50.00000

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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 783255483 – Fax 423593533 – Sat C
Name of Master:	TBA

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Number of Crew:	24
Number of Scientists on board:	28

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 (including emergency frequencies):	
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:	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:	

4.4 Particulars of Unmanned Surface Vehicles (USV):	
Name:	Matrice 300 RTK
Manufacturer and make/model:	DJJ
Nationality (Flag State):	UK
Website for diagram & Specifications:	https://store.dji.com/uk/product/matrice-300-rtk-and-dji-care?vid=103131
Owner:	University of Birmingham
Operator:	To be confirmed (a postdoc to be recruited)
Overall length (meters):	0.9 m
Displacement/Gross tonnage:	9 kg
Cruising & Maximum speed:	23 m/s
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:	Matrice 300 RTK
Make/Model:	DJJ
Nationality (flag State):	UK
Website for diagram & Specifications:	https://store.dji.com/uk/product/matrice-300-rtk-and-dji-care?vid=103131
Owner:	University of Birmingham
Operator:	To be confirmed (a postdoc to be recruited)
Overall Length (meters):	0.9 m
Propulsion:	9 kg
Cruising & Maximum speed:	23 m/s
Registration No.:	Not yet purchased
Call Sign:	
Method and capability of communication (including emergency frequencies):	<p>Operating Frequency 2.4000-2.4835 GHz 5.725-5.850 GHz</p> <p>EIRP 2.4000-2.4835 GHz: 29.5 dBm (FCC) 18.5dBm (CE) 18.5 dBm (SRRC); 18.5dBm (MIC)</p> <p>5.725-5.850 GHz: 28.5 dBm (FCC); 12.5dBm (CE) 20.5 dBm (SRRC)</p>
Name of Pilot:	To be confirmed
Number of crew:	To be confirmed
Number of scientists on board:	21 on the ship
Details of sensor packages:	<p>Vision System Obstacle Sensing Range Forward/Backward/Left/Right: 0.7-40m Upward/Downward: 0.6-30m FOV Forward/Backward/Downward: 65° (H), 50° (V) Left/Right/Upward: 75°(H), 60°(V) Operating Environment Surfaces with clear patterns and adequate lighting (> 15 lux)</p> <p>FPV Camera Resolution 960p FOV 145° Frame rate 30 fps</p> <p>Infrared ToF Sensing System Obstacle Sensing Range 0.1-8m FOV 30° (±15°) Operating Environment Large, diffuse and reflective obstacles (reflectivity >10%)</p>
Other relevant information:	

4.6 other craft in the project, including its use:
N/A

4.7 Particulars of methods and scientific instruments:
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Types of samples and Measurements:	Methods to be used:	Instruments to be used:
Particle size distribution 6-500nm	Online observation	Scanning Mobility Particle Sizer
Total particle number conc. >2.5 nm	Online observation	Condensation Nuclei Counter
Particle size distribution 1 -5 nm	Online observation	Particle Size Magnifier
Number concentration of cloud condensation nuclei	Online observation	cloud condensation nuclei counter
Concentration of ions / clusters / Highly oxidised organic matter	Online observation	Api-ToF mass spectrometer
particle distribution ~2 to 40 nm	Online observation	neutral cluster and air ion spectrometer
Cloud condensation nuclei concentration	Online observation	CCN counters
Particulate matter mass / Size distribution	Online observation	FIDAS
NH ₃ concentration	Online observation	NH ₃ analysers
Atmospheric NO _x /CO/O ₃ concentration	Online observation	Gas analysers
Black carbon concentration	Online observation	Aethalometer
Quartz filter 24-hr PM _{2.5} : primary and secondary organic tracer	Sample for offline observation	Digitel PM sampler
PTFE filter 24-hr PM _{2.5} for offline analysis (weight + crustal elements)	Sample for offline observation	Partisol PM sampler
PTFE filter - particle mass size distribution: composition	Sample for offline observation	TSI Med vol impactor PM sampler
Whatman: Nutrients - Fe /P	Sample for offline observation	UEA High vol PM sampler (TBC)
Quartz: C isotope	Sample for offline observation	MSV high vol PM sampler
Quartz: S / N isotope	Sample for offline observation	MSV high vol PM sampler
Polycarbonate: SEM individual particle	Sample for offline observation	MiniVol Low Vol sampler
Aerosol filter samples – chemical composition	Sample for offline analysis	MOUDI samplers
Absorption tubes for VOCs	VOC samples for offline analysis	SVOC auto-samplers
Non-refractory aerosol composition	Online observation	Aerosol Chemical Speciation Monitor
VOC concentration / flux	Online observation	PTR-Qi-ToF mass spectrometer
VOC concentration in sea water	Online observation	PTR-ToF mass spectrometer
N ₂ O and CH ₄ concentration	Online observation	Picarro G2508
Metal concentration in PM _{2.5}	Online observation	Xact - X-ray online aerosol monitor
Metal concentration in PM ₁₀	Online observation	Xact - X-ray online aerosol monitor
Coarse particle Size distribution / sources	Online observation	Aerodynamic Particle Sizer
Single particle composition	Online observation	Single Particle Aerosol mass spectrometer
Size resolved non refractory - PM ₁	Online observation	HR-ToF-Aerosol mass spectrometer
Concentration of HONO	Online observation	LOPAP HONO analyser
Radiation at different	Online observation	Spectral radiometer

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wavelengths		
Concentration of N2O5 gas	Online observation	N2O5 monitor
Concentration of HCHO gas	Online observation	HCHO monitor
Ice nuclei concentration	Online observation	Ice nuclei counter - SPIN
Total particle number conc. >2.5 nm	Online observation	Condensation Nuclei Counter
Size distribution 6-500nm	Online observation	Scanning Mobility Particle Sizer
Trace metals	Sample for offline observation	High Vol PM sampler
Isoprene and DMS concentration	Online observation	iDirac
Single particle composition	Sample for offline observation	Impactor PM samplers
Light scattering	Online observation	nephelometer
SO2 concentration	Online observation	SO2 analyser
Wind observation	Online observation	Anemometers
Ice nuclei numbers	Online observation	PINE chamber
Ice nuclei numbers	Sample for offline observation	Digitel low vol PM sampler
Particle size distribution 10-560 nm	Online observation	Scanning Mobility Particle Sizer
Particle size distribution >300 nm	Online observation	Aerodynamic Particle Sizer
Ice nuclei numbers	Sample for offline observation	Mesalab low vol samplers
Ice nuclei numbers	Sample for offline observation	Cascade impactors: Moudi + SHARK
Vertical distribution of aerosol and clouds	Online observation	Aerosol lidar
Vertical distribution of ozone	Online observation	O ₃ lidar
Bioaerosol number concentration	Online observation	Wideband Integrated Bioaerosol Sensor
Black carbon concentration and size	Online observation	Single particle soot photometer
Black carbon concentration and size	Online observation	Multi Angle Absorption Photometer
Aerosol extinction	Online observation	CAPS spectroscopy
Acidic and alkaline gases, and aerosol ionic composition	Online observation	Online ion chromatography
Acidic and alkaline gases	Offline denuder for absorption of gases	Offline ion chromatography
Organic molecular markers	Offline aerosol sampling	High volume PM sampler
Chlorophyll / nutrient concentration	Offline sampling and lab analysis	Chlorophyll luminoscope and nutrient analyser
Ariable fluorescence by maximum fluorescence	Offline sampling and lab analysis	Luminoscope
CINO2, and halogenated VOCs	Online observation	ToF-CIMS
Rates of nitrogen fixation in surface waters via acetylene reduction	Online observation	FARACAS: measurement of acetylene reduction
Activity and diversity of nitrogen fixing phytoplankton	Offline sampling and lab analysis	¹⁵ N ₂ -gas incubations and genetic analysis of phytoplankton

4.8 Indicate nature and quantity of substances to be released into the marine environment:

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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:
None

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):
None

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: 19 May 2022
Last exit: 28 May 2022

6.2 Indicate if multiple entries are expected:
Yes

7. Port Calls

7.1 Dates and Names of intended ports of call:
Reykjavik, Iceland : 14 May – 19th May 2022 (Embarkation)

7.2 Any special logistical requirements at ports of call:
No

7.3 Name/Address/Telephone of shipping agent (if available):
Nesskip H.F
Nesskip House
Austurstrond 1
172 Selt
Jarnarnes, Reykjavik PC101
Tel: 00 354 5639900
Email: operations@nesskip.is

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:
One berth for an observer from each coastal state is offered in accordance with UNCLOS Art 249 (1a).

8.2 Proposed dates and ports for embarkation/disembarkation:
Embarkation: Reykjavik, Iceland: 19th May 2022 (Start of Cruise)
Disembarkation: Southampton, UK: 27 June 2022 (End of Cruise)

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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:

One week after the completion of the cruise

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

6 months after the completion of the cruise

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/>

Atmospheric and ocean observational data will be accessible via a dedicated depository in BADC: <https://www.badc.ac.uk> and BODC separately.

Atmospheric samples will be archived for potential access by Coastal State.

9.4 Proposed means to provide Coastal State with assessment of data, samples and Research results:

1. Scientific papers and reports
2. Web depositories: BADC (www.badc.ac.uk) and BODC (www.bodc.ac.uk)
3. Presentation at program and other meetings

9.5 Proposed means to provide assistance in assessment or interpretation of data, samples And research results:

1. Scientific papers and reports
2. Web depositories: BADC (www.badc.ac.uk) and BODC (www.bodc.ac.uk)
3. Presentation at program and other meetings

9.6 Proposed means of making results internationally available (to obtain cruise reports these Can be obtained via the BODC weblink see below:

Cruise report will be made publically available via BODC weblink.

<https://www.bodc.ac.uk/resources/inventories/cruiseinventory/search/>

Scientific results will be published in international peer-reviewed journals and presented to international / national conferences / workshops.

10. Other permits Submitted

10.1 Indicate other types of Coastal State permits anticipated for this research (received or Pending):

None

11. List of Supporting Documentation

11.1 List of attachments, such as additional forms required by the Coastal State, etc.:

None

Signature:

Shi Zongbo

Contact information of the focal point:

Name: Zongbo Shi

Country: UK

Affiliation: University of Birmingham

Address: School of Geography Earth and Environmental Sciences

Edgbaston

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UPLOAD YOUR FINAL CRUISE REPORT: https://www.bodc.ac.uk/resources/inventories/cruise_inventory/search/

SEND YOUR FINAL CRUISE REPORT: msrapplcations@fco.gov.uk