NOTE OF MEETING: UNITED KINGDOM AND MOSAiC: OPPORTUNITIES, FUNDING AND NEXT STEPS

Workshop held on Monday 17 July, Aurora Innovation Centre, British Antarctic Survey, Cambridge

Overview of MOSAiC, including: recent logistic and science planning developments; timelines; and approval procedure

Klaus Dethloff (MOSAiC co-cordinator, AWI) gave a detailed presentation on the latest logistical and science planning for the programme. The presentation has been circulated alongside this note of the meeting. Further information is also available on the MOSAIC website: www.mosaic-expedition.org A number of points were made, including:

- Logistical planning is well advanced, with virtually all the support vessels and other assets confirmed or about to be confirmed. There will be six legs, each two months long. In addition to Germany, the United States, China, Norway, Russia, and now the UK were confirmed funding partners.
- Interested partners need to contact the MOSAIC office and the appropriate MOSAIC project board member (slide 46) in the first instance. Working groups have been set up and it is important to register interest as soon as possible.
- The daily berth fee is approximately 1500 euros/day.
- The approvals process (slides 47-51) will be depend on the level of support required – berth or equipment space only etc. Getting the right approval at the appropriate stage is important.
- Although some participants are already confirmed, there are still definitely berth spaces on the vessel.
- The science coordination meeting in St Petersburg (13-16 November) will be an important opportunity to begin to shape the eventual look and content of the programme and will have a major role in issuing the next editions of the science and implementation plans. UK-based researchers wanting to be part of the programme should be present at this meeting if possible.

UK engagement in MOSAiC: funding opportunities and timelines

Henry Burgess, the Head of the NERC Arctic Office gave an overview of the UK's planned engagement and support. The presentation has been circulated alongside this note. Key points included:

- Through an MOU signed between BEIS and AWI, the UK is now a formal partner in the programme.
- Up to £500,000 is available to UK-based researchers to cover their berth/bench fees to take part in the programme – the equivalent of one year-long berth on board the vessel, or other combination of different legs/berths.

- The UK will be represented on the Executive Steering Committee by the NERC Arctic Office. Access to data from the vessel will be in line with the procedures to be established and on the same basis as other participants.
- The process for allocating berth-fee funds remains to be finalised, but will be in line with NERC procedures and is likely to include an Expert Panel.
- It was recognised that berth fees along will not provide sufficient support to fully enable UK participation. A NERC Joint Strategic Response bid will be submitted to seek to provide the 'science' funding element required. If approved, the Announcement of Opportunity will be made by September, with other timings to follow, but with a likely close in December and with decisions by March 2018.
- If the JSR bid is successful, the intention will be to wrap-up the allocation of the berth and science funding within the same overall assessment process.
- Other potential funding routes included NERC Standard Grants; the NERC Changing Arctic Ocean Programme International Call; EU funding – with a targeted opportunity for MOSAiC support.

Discussion session: logistics and science planning

A number of points were raised in discussion:

- Klaus Dethloff said that AWI are considering a proposal for the EU element of the funding and there may be potential opportunities for partners. This would be for salary, equipment etc., not berth fees.
- It would be positive if the JSR bid was able to support travel to the St Petersburg coordination meeting.
- The whole focus of MOSAiC is in the multi-disciplinary nature of the programme – those considering putting forward proposals should ensure they reflect this as far as possible, whilst also filling the niches available. Projects that shed light on the 'coupled' nature of systems and processes are especially welcome.
- There remain significant gaps on the ecosystem/biological/biogeochemical sides – a potentially fruitful area for the UK.
- It was recognised that, if JSR bid is successful, it may be possible to start supported projects before April 2019.
- There is the potential for the vessel to take equipment without direct one to one support, but these are likely to be limited, because of space and personnel. The earlier interested parties can connect to the science working groups the better.

Feedback from UK representatives within the MOSAiC science committees

There are five main MOSAiC science committees: atmosphere; ocean; sea ice; biogeochemistry; and ecosystems. Each group has science leads (slide 46 of the AWI presentation). Points raised included:

- There is already good UK involvement in the atmosphere committee, and emerging engagement in the biogeochemistry committee. In the others there is a pressing need to engage effectively.

- These committees meet by conference call and consider the provision of core measurements; register interest and potential projects; look at gaps etc. Each is producing a spreadsheet which sets out these provisions and is the basis for their elements of the overall science plan.
- Atmosphere committee - Ian Brooks, Steve Arnold and Chawn Harlow are all connected. Issues identified include: looking at coupled systems and processes, including boundary processes and turbulent mixing; options for the use of UAVs to address spatial variability in the vicinity of the vessel, and for surface mapping; the use of aircraft for surface and trace gases, and to produce vertical profiles; and ice nucleation measurements, where the UK may have specific skills to offer; the challenge of regular profiling for long-range pollution assessment in the boundary layer was noted.
- Biogeochemistry committee – James France and Markus Frey are connected. A spreadsheet similar to the Atmosphere's is in preparation, but there is much less which is certain/funded. There are significant opportunities for engagement. There are still legs that need to be filled, for example about half of the allocated spaces for biogeochemistry group are still to be filled.
- Oceans/Sea ice/Ecosystems committees: much less awareness from workshop attendees on the status and outputs of these committees and the level of UK engagement was not as clear.
- Key point – it is really important to be engaged in the discussions in the science committees – conference calls are held regularly. Also noted that important for modellers to be included in the discussions at an early stage.

Roundtable and discussion session: comments from attendees on potential UK proposals; opportunities to fill gaps in existing programmes; and likely collaboration activities

In discussion of the six broad areas – five science committees, plus modelling – the following broad points were made:

<u>Atmosphere</u>

- Opportunities for a turbulence measuring mast at least 500m from the vessel and 15-20m tall. Options for active remote sensing of the boundary layer through LIDAR and SODAR. Plus links to ocean heat flux, and turbulence and mixing measurements. Mast and related instrumentation requires someone to check every day or two and to do backups etc. Expected to be done in collaboration with colleagues. A berth would be required for installation at the start of the programme. (Ian Brooks).
- Potential for the mast to also be used for black carbon measurements? (Jo Browse).
- Terrain-following UAVs, flying 5-10 metres above the surface to record turbulence measurements. Significant opportunity as the instrument stays stable and gives direct measurements, with swift results. Payload on the UAV – turbulence sensor and temperature sensor. Flying 3kg instrumentation with a 7 kg UAV, with options for wi-fi links. (Phil Anderson)

- UAV robotics would need someone to pilot but the pilot could be shared. Crew going on ship should take two to three days training to build skill. Klaus Dethloff noted that it was important to bring these skills onto the vessel, not to rely on others, without significant planning and training.
- Blowing snow and aerosols to the atmosphere – potential to look at chemical make-up and also physical properties, to fill in measurement gaps in connection with vertical profiling. Could aim for one berth over two legs, with instrumentation on the vessel for as long as possible. (Markus Frey)

Ocean

- Ocean mixing – of significant interest, in particular mixing from the middle layers into the upper ocean layer. Potential to link with Norwegian approach, where proposals are already in development. Competition between energy into ocean from atmosphere and fluxes, in addition to how this connects with ecosystems. Unique opportunity to study how instruments are impacted on by drift from the ship. Potential to link to NERC Changing Arctic Ocean Programme International call. Possibility for one-two people on up to two of the legs to look at measurement from the surface down to 250-500 metres. (Yuenn Lenn)

Sea ice

- New sensor tech for in ice radiation profiles - to operate continuously and deploy at start and get semi-continuous measurements and changes during the seasons. In discussion with the ecosystem groups primarily, including looking at biogeochemical stressing – effect on sea ice biological communities. Potential to link with NERC Changing Arctic Ocean Programme international call. Berth required for initial deployment – potentially the second half of the programme - but then option to be autonomous. (James France)
- Scope to have instrumentation just on the re-supply vessels that will visit the programme vessel every two months? Klaus Dethloff confirmed this may be possible, but it will depend on the resupply ship. It would need to be part of the MoU signed with the supplier. Vital to inform the organisers as soon as possible so these can be written into the MoUs if feasible. (Ed Blockley)
- Noted that the new polar research vessel, RRS *Sir David Attenborough*, is planned to have a short initial testing season in the Arctic July-September 2020, of up to 50 days. Details to be finalised, but there could be scope to coordinate measurements with the MOSAiC programme. Further details to be confirmed in due course. (Ian Brooks)

Biology/biogeochemistry

- Biogeochemistry of melt ponds – potential to look at the albedo effect, plus processes influencing early development, as possible source of trace gases, metabolism changes in the community at the molecular level (Phil Anderson, Jo Browse, Jonathan Todd)

- Potential for ammonia measurements and links to ice nucleation? (Jo Browse)
- Berth requirements not yet clear, but only needed from early spring 2020 onwards if related to melt ponds.

Ecosystems

- Use of the vessel's own echo-sounders – for observations of top 1000m – look at how change/vertical migrations/ lunar migrations operate and link to global meso-pelagic geography? Focused on small fish and zooplankton. Link to ecosystem model. Unlikely to be a berth requirement. (Roland Proud)

Modelling

- Sampling errors and understanding uncertainty constraints - there are new methods being developed, but models in the Arctic are not comprehensive and these become more uncertain during winter/spring months. Long range transport processes are still uncertain. Opportunity to develop detailed case studies to contribute better understanding. (Jo Browse)
- Significant opportunities to help refine and develop the Earth System Model, especially in relation to the volume budget of snow and sea-ice, and the overall energy budget (Ed Blockley)
- Vertical profiling opportunities presented by MOSAiC – especially important to help develop an Arctic System Model which copes effectively with the speed and specificity of sampling needs. One-year data sets in this region offer real value. (Steve Arnold)
- Data portal? Klaus Dethloff confirmed that there will be a data portal and further details about this will be given at the Workshop held in St Petersburg later this year.

Summary and next steps

Actions identified:

1. Outreach version of Klaus Dethloff and Henry Burgess presentations and meeting summary note to be circulated to meeting participants and made available through the NERC Arctic Office website – **NERC Arctic Office**
2. Joint Strategic Response bid to be refined as needed and submitted for discussion and decision. Meeting participants and the wider community to be informed of the outcome as soon as possible – **Helen Beadman & NERC Arctic Office**
3. Science committees contact details and the MOSAiC e-mail list to be circulated – **NERC Arctic Office**
4. Engage with the appropriate science committees to: flag UK engagement and interest; identify any gaps; and then to put in a proposal to address the gap – **All**
5. Maintain overview of UK-based researchers' potential projects and interest in participating in MOSAiC – **All and NERC Arctic Office.**
6. Inform Klaus Dethloff as soon as possible if you think there is a need to have instrumentation on board the resupply ships so this can be written into the MoUs – **All**

7. Circulate details of the St Petersburg workshop as soon as possible and ensure ongoing information sharing – **NERC Arctic Office**
8. Keep under review the requirement for follow-on MOSAiC workshop and associated promotional and coordination events **- NERC Arctic Office**

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Annex - Participants

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