Arctic-Antarctic Seafloor Mapping Meeting 2011

Stockholm May 3-5

Meeting Report

Hosted by the Department of Geological Sciences, Stockholm University

Stockholm University

Summary

The First Arctic-Antarctic Seafloor Mapping Meeting was held at Stockholm University between May 3 and 5, 2011. The aims of the meeting were to bring together key actors conducting bathymetric mapping in Arctic and Antarctic waters for the purpose of coordinating mapping activities, improve the International Bathymetric Chart of the Arctic Ocean (IBCAO) compilation, move forward towards a first bathymetric compilation of the International Bathymetric Chart of the Southern Ocean (IBCSO), and discuss the uses and technical requirements of regional bathymetric compilations as well as data sharing and acknowledgment of bathymetric data sources. In total, 44 participated in the meeting from 15 countries.

The meeting was opened with a keynote presentation by IOC Executive Secretary Dr Wendy Watson-Wright titled "Why do we need to learn more about the Arctic and Southern Oceans?". This was followed by 23 talks by the meeting participants as well as posters presented at a poster session. These presentations filled the meeting agenda for one and half day. The second part of the meeting was devoted to two breakout sessions: one focused on the IBCAO while the other focused on IBCSO. A substantial amount of new bathymetric data to be included in future versions of these two regional mapping projects were identified during these breakout sessions.

A new Editorial Board (EB) for IBCAO was established during the meeting, although additional EB members may still be appointed after the meeting. In addition to the new EB, an Advisory Board will be established. The next version of IBCAO, Version 3.0, was scheduled to be released during the late fall of 2011. This version will increase the bathymetric grid resolution from present 2 km to 500 m, and include all the new bathymetric data identified during the meeting that can be made available before end of July 2011.

IBCSO aims to produce and release a first gridded bathymetric compilation within one year from this meeting. This Version 1.0 will stretch as far north as 60°S.

The Arctic Antarctic Seafloor Mapping Meeting in Stockholm brought to the attention that this type of venue is needed as a forum to coordinate and progress seafloor mapping of the two Polar regions. It was therefore decided to organize a Second Arctic Antarctic Seafloor Mapping Meeting in 2012 and the Marine Center in Seward, Alaska, offered to host such a venue.

This meeting report contains the final meeting agenda including titles of presented talks, notes from the breakout sessions, submitted abstracts and a list of meeting attendants.

Meeting organizers

Martin Jakobsson, Stockholm University

Hans-Werner Schenke, Alfred Wegener Institute for Polar and Marine Research

The meeting was supported by Stockholm University and the General Bathymetric Chart of the Oceans (GEBCO)

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Meeting Agenda

Tuesday, 3th of May 2011. Preliminary Program – Day 1

09:00	**Registration**
09:30	**Conference opening** : **Welcome, practical information, meeting scope and goals -** Martin Jakobsson, Stockholm University and Hans Werner Schenke, Alfred Wegener Institute for Polar and Marine Research (AWI)
09:45-10:15	**Why do we need to learn more about the Arctic and Southern Oceans?** Wendy Watson-Wright, IOC Executive Secretary
10:15-10:45	**Health Break and Coffee**
10:45-12:00	**Oral Presentations on Arctic Seafloor Mapping**
10:45-11:00	**Arctic Surveys: A Canadian perspective, past, present and future** – Steve Forbes, Canadian Hydrographic Service
11:00-11:15	**Status of US Arctic ECS mapping activities** – Larry Mayer, Center for Coastal and Ocean Mapping/ Joint Hydrographic Center
11:15-11:30	**Bathymetric data acquisition in Arctic waters within the Danish Continental Shelf Project** – Christian Marcussen, Geological Survey of Denmark and Greenland (GEUS)
11:30-11:45	**Arctic Seafloor Mapping : Norwegian Hydrographic Service** – Øyvind Tappel, Norwegian Mapping Authority, Hydrographic Service
11:45-12:00	**Arctic cruises of R/V "Academik Nikolaj Strakhov" 2006 – 2010** – Yulia Zarayskaya, Geological Institute of Russian Academy of Science
12:00-13:30	**Lunch**
13:30-14:30	Cont. **Oral Presentations on Arctic Seafloor Mapping**
13:30-13:45	**The MAREANO-program – Mapping of Seabed topography, sediments and bottom fauna in Norwegian waters** – Hanne Hodnesdal, Norwegian Mapping Authority, Hydrographic Service
13:45-14:00	**Important role of bathymetry in polar sea ice formation and evolution** – Son V. Ngheim, NASA Jet Propulsion Laboratory
14:00-14:15	**Collecting, managing and distributing bathymetric, backscatter and sub-bottom data from within the Canadian Arctic Archipelago** – Ian Church, Ocean Mapping Group, University of New Brunswick
14:15-14:30	**Initial cross-over analysis of Amerasian Basin gravity and bathymetry dataset –** Berhard Coakley, University of Alaska Fairbanks
14:30-15:00	**Health Break and Coffee**
15:00-15:30	**Oral presentations on Arctic/Antarctic Seafloor Mapping**
15:00-15:15	**Arctic and Antarctic multibeam mapping with Swedish icebreaker Oden** – Martin Jakobsson, Stockholm University
15:15-15:30	**OLEX system** – Olex Hestvik, Olex AS

15:30-18:00 **Posters and Refreshments**

Wednesday, 4th of May 2011. Preliminary Program – Day 2

09:00-09:15 **Cont. Oral Presentations on Arctic Seafloor Mapping**

09:00-09:15 **Seafloor Morphology of the Storfjorden and Kveithola Palaeo-Ice Streams (NW Barents Sea): joined Italian and Spanish dataset** – Michele Rebesco, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)

09:15- Oral presentations on Antarctic Seafloor Mapping

09:15-09:30 **Production of Navigational Chart INT-905 – Northern Weddell Sea** – Ralf Krocker, Alfred Wegener Institute for Polar and Marine Research (AWI)

09:30-09:45 **The Antarctic and Southern Ocean Data Synthesis and its use for bathymetric compilations** – Frank Nitsche, Lamont-Doherty Earth Observatory

09:45-10:00 **Status of Hydrographic Surveying and Nautical Charting in Antarctica** – Hugo Gorziglia, International Hydrographic Organization (IHB)

10:00-10:15 **Compiling a bathymetry map of the Ross Sea and adjacent Southern Ocean** – Jenny Black, Institute of Geological and Nuclear Sciences (GNS)

10:15-10:45 **Health break and coffee**

10:45-11:00 **Neotectonic and Glacial History of the McMurdo Sound Region, southwestern Ross Sea, Antarctica: Enhanced Interpretation from Integrated Seafloor Bathymetry and Terrestrial DEMs** – Terry Wilson, School of Earth Sciences, Ohio State University

11:00-11:15 **Overview of bathymetric data collected by the British Antarctic Survey - acquisition, management and dissemination** – Alex Tate, British Antarctic Survey (BAS)

11:15-11:30 **Describing work involved in the South Georgia bathymetry compilation and upcoming regional efforts around the South Sandwich Islands and the South Shetlands** – Peter Fretwell, British Antarctic Survey (BAS)

11:30-11:45 **Oral presentations on new data compilation methods**

11:30-11:45 **Gridding heterogeneous bathymetric data sets with stacked continuous curvature splines in tension** – Benjamin Hell, Stockholm University

11:45-12:00 **Status of Regional and Global Mapping Project**

11:45-12:00 **General Bathymetric Chart of the Oceans (GEBCO)** - Robin Falconer, GEBCO

12:00-13:30 **Lunch**

13:30-13:45 **International Bathymetric Chart of the Arctic Ocean (IBCAO)** – Martin Jakobsson, Stockholm University

13:45-14:00 **International Bathymetric Chart of the Southern Ocean (IBCSO)** – Hans Werner Schenke, Alfred Wegener Institute for Polar and Marine Research (AWI)

14:00-16:30 **Arctic breakout session**

14:00-16:30 **Antarctic breakout session**

15:00-15:30 **Health Break and Coffee**

18:30 **Boat Trip and Meeting Dinner:** M/S Riddarfjärden embarking 18:15-18:30 sharp from Skeppsbron, Stockholm (see map)

Thursday, 5th of May 2011. Preliminary Program – Day 3

09:30-12:00 cont. **Arctic breakout session:** Chaired by Martin Jakobsson

09:30-12:00 cont. **Antarctic breakout session:** Chaired by Hans Werner Schenke

10:15-10:45 **Health Break and Coffee**

12:00-13:30 **Lunch**

13:30-14:00 **Summary and Discussion in Plenum: Arctic breakout session** – Martin Jakobsson

14:00-14:30 **Summary and discussion in Plenum: Antarctic breakout session** – Hans Werner Schenke

Meeting Closing

Notes from Breakout Sessions

1. International Bathymetric Chart of the Arctic Ocean EB (3 May)

Attendees: Bernard Coakley, Robin Falconer, Luciano Fonseca, Stephen Forbes, Boris Fridman, Hanne Hodnesdal, Martin Jakobsson, Larry Mayer, Riko Noormets, Richard Pedersen, Hans-Werner Schenke, Noralf Slotsvik, Bob Whitmarsh (Minutes), Yulia Zarayskaya.

Introduction Robin Falconer, Chairman of GEBCO, explained the background to the meeting. IBCAO has been endorsed and supported by the IOC, IHB and IASC (International Arctic Science Committee). Ron Macnab, formerly Chairman of the IBCAO Editorial Board, wished to step down and the present meeting and workshop were intended in part to work out a future path for IBCAO. Robin Falconer emphasised that some formal structure, such as an Editorial Board, was needed if only to help some participants obtain visas and travel funds. Ron Macnab and Robin formed an appointment board and those gathered at this breakout had all been nominated as potential members of a new IBCAO EB. It was therefore reasonable to consider those present as an interim Editorial Board.

Martin Jakobsson said he was happy to continue to host the IBCAO database and lead the compilation work in Stockholm, but he was not seeking to become Chairman in order to spread the IBCAO organizing activities internationally.

He asked if any potential participants had been missed? It was not a rule to have one member per active country. It was noted that Hugo Gorziglia (IHB) was not present as he was missed to be informed about this breakout. Hans-Werner Schenke also noted that he would retire at the end of 2011 and he hoped that another person from AWI could represent German interests since the *F.S. Polarstern* would work in the Arctic too in future. It was also mentioned that nominated EB members from Italy (Michele Rebesco) and UK (Julian Dowdeswell) were missing and that members from Republic of Korea, Japan and Iceland remains to be appointed if there is an interest from these countries.

In response to a question about the function of the Editorial Board, Martin Jakobsson said that the previous Board had had no Terms of Reference; it had met every one to two years and had spent time discussing and presenting data. He also noted that the whole Editorial Board had authored articles about the IBCAO which helped to market the project and obtain funding.

Robin Falconer pointed out that if the Editorial Board was as large as 15-20 it may need an Executive Board just to make decisions.

Martin Jakobsson proposed that,

The interim board should become the Editorial Board

A Chairman of the Editorial Board was needed

Scientific Advisers could be added to include those not on the EB

It was discussed whether members of the Editorial Board should represent their country or their organisation such as the IOC, the IHB, GEBCO and NGOs such as IASC. It was also suggested that the IBCAO could seek 'ambassadors', such as Prince Albert of Monaco, who could promote its activities.

Martin Jakobsson concluded that Arctic and Antarctic breakout sessions were planned for the next day which might include,

The creation of a list of new sources of (mainly) multibeam data
Discussion of the grid resolution of future editions of the IBCAO
Advertising IBCAO's products
Creation of an action plan towards a next version of the IBCAO grid
Discussion of the boundaries of the compilation area
Rejuvenation of the IBCAO web site
Sources of funding

2. IBCAO breakout meetings (4-5 May)

Attendees: Gerard Abich (5 May), Paul Bienhoff, Ian Church, Bermard Coakley, Hanne Hodnesdal, Martin Jakobsson, Christian Marcussen, Larry Mayer, Dave Monahan, Axel Meiton (5 May), Son Nhgiem, Riko Noormets, Richard Pedersen, Michele Rebesco, Noralf Slotsvik, Orvind Tappel, Bob Whitmarsh (Minutes), Roy Wollvik, Yulia Zarayskaya.

2.1 Editorial Board and Advisers. Martin Jakobsson began by explaining that since Ron Macnab was retiring from being Chairman of the IBCAO Editorial Board a new Editorial Board was being considered to be assisted by a group of Scientific Advisers, at least one per country actively involved in mapping. Following an earlier meeting the following had been nominated to the EB:

Martin Jakobsson (Sweden) as interim Chairman
Hans-Werner Schenke (Germany) but he retires at the end of 2011
Bernard Coakely and Larry Mayer (USA)
Yulia Zarayskaya and Boris Fridman (Russian Federation)
Steve Forbes (Canada)
Richard Petersen (Denmark)
Hanne Hodnesdal (Norway)
Riko Noormets (Norway/Svalbard)
Michele Rebesco (Italy)
Julian Dowdeswell (UK)
A.N. Other (Rep. of Korea)
A.N. Other (PR China)
A.N. Other (Japan)

As Advisors the following had been suggested:

Norm Cherkis (USA), Bob Anderson (USA), Ron Macnab (Canada), Dave Monahan (Canada), George Newton (USA), Paul Bienhoff (USA), Christian Marcussen (Denmark), Roy Wollvik (Norway) and German Naryshkin (Russian Federation).

It was emphasised that the Editorial Board members would be expected to have a key role in releasing data. The IBCAO was not seen to be in competition with the Arctic Hydrographic Commission, on the contrary, IBCAO is a complement and a close cooperation is desired.

2.2 Future meetings were discussed. It was recognised that several Editorial Board members and others had interests in both the Arctic and Antarctic areas and there were overlaps in the science, data acquisition and processing, the remoteness of the areas and the vessels used. Therefore it would be advantageous to hold a single annual joint meeting, Arctic and Antarctic. It was estimated that meeting participants will be around 50. It was agreed that May was an optimum time, for IBCAO participants. Finally, the Marine Center in Seward, Alaska, part of the University of Alaska, Fairbanks, was chosen as the preferred venue with Fairbanks, Alaska as an alternative venue.

2.3 Grid resolution. Martin Jakobsson emphasised that IBCAO is a regional compilation and as such, we cannot aim for "full multibeam resolution" over the whole Arctic. What was needed was a new target resolution to aim for; currently the grid was 2 km but 500 m would be better to capture some more details of multibeam surveys. In answer to a question Martin Jakobsson agreed that Benjamin Hell's algorithm could be used to estimate the optimum resolution and letting the source data density decide. Nevertheless he concurred that 500 m was feasible and also practical because not all data providers wished to supply data at the best possible resolution. He said he would like to grid at multiple resolutions if possible. Larry Mayer pointed out that standards in hydrography were evolving and there was a move to use the BAG (Bathymetry Attributed Grid) standard which also provided an estimate of uncertainty. Martin Jakobsson agreed it would be useful to look into using BAG. Finally, it was agreed to adopt 500 m as the target grid resolution, although the areas with less dense source data will be gridded at much lower resolution using Benjamin's new algorithm.

Continued 5 May 2011

2.4 Available or potentially available data. Lists were created of data sets that already existed, and were available (Table 1) or potentially available (Table 2), and of data sets that would be collected in the near future (Table 3).

Son Nghiem asked what was the definition of the Arctic coast. Martin Jakobsson replied that mean high water was used and this had not posed problems at the resolution used so far for the IBCAO. SN said that he could map multi-year ice along the coasts of the Arctic. He promised to ask NASA how to obtain relevant satellite data collected over 30 years with a resolution of 25 km.

It was noted that all Article 76 UNCLOS (United Nations Convention on the Law of the Sea) claims by states bordering the Arctic Ocean would contain bathymetry and other data which might be relevant to the IBCAO. It was suggested that the UNCLOS Commissioners should be regularly asked about data availability as nation's claims were processed. It was also noted that the IBCAO was likely to have been used, and would be used in future, as a reference to analyze claims and therefore should be updated on a regular basis.

2.5 Timetable to create IBCAO version 3.0. Martin Jakobsson outlined his plan to produce a new gridded dataset in time for the Fall 2011 AGU meeting. In that case he would need all the data by the end of July, preferably transmitted by ftp although other formats are possible. Any data that missed the deadline would be carried over to the next version of the IBCAO. Martin Jakobsson noted that time was needed to edit the data whereas creating a new grid, using a new spline routine, was relatively fast. Martin Jakobsson explained that it would not be possible to print a new chart in time for the AGU meeting although one could be shown on a poster. He added that he planned to write a paper for a peer-reviewed journal to be authored by the whole Editorial Board under groups author IBCAO. He also suggested that a summary of the present meeting was published in EOS together with an announcement, later, of the availability of the new grid.

2.6 IBCAO web site. It was agreed that the web site, currently hosted by NGDC, needed to be updated. Martin Jakobsson noted that he had bought the URL ibcao.org. A revised site could be hosted in Stockholm or NGDC.

2.7 Feature names. If a new chart was created then undersea feature names would be carried over from the previous version.

2.8 A new printed chart. It was agreed that any printed chart should acknowledge the names of the Editorial Board and Scientific Advisors.

2.9 Funding the IBCAO. Martin Jakobsson felt that it would be good to work with GEBCO on this matter. Should funds be constantly available or should funds be found on an ad hoc basis for each meeting? Bernard Coakley suggested that, to help with funding, the group could be broadened to include those interested in Arctic gravity. He added that the US National Geospatial Intelligence Agency was keen to obtain more data and so might provide IBCAO with funds over a number of years.

Martin Jakobsson said he had obtained funds on a one-off basis from Stockholm University. Larry Mayer agreed that it was feasible to work on a case by case basis provided people kept a lookout for new sources. For example, any new projects created by the IOC. Michel Rebesco suggested trying the IGCP of UNECSO.

3. IBCSO breakout meetings (4-5 May)

Attendees: Jenny Black, Robin Falconer, Peter Fretwell, Hugo Gorziglia, José Gianella Herrera, Benjamin Hell, Priyantha Jinadasa, Ralf Krocker, Dave Monahan, Frank Nitsche, Hans-Werner Schenke, Alex Tate, Rochelle Wigley (Minutes), Terry Wilson.

3.1 Agenda: The Agenda was accepted. Hans-Werner Schenke provided information on the status of the final draft report written by Norbert Ott. He noted that the report had not been shared with other board members yet and it needed to be reviewed. Hans-Werner Schenke provided a list of current working board structure from this report as originally approved by SCAR.

3.2 Structure and membership of the Board(s): SCAR requires one member from each country on the editorial board. This is seen to benefit Board members as an official position helps them to acquire funding. The argument was that more members on the committee, the better chance of getting data.

Need to decide whether to have one large committee (with all SCAR countries represented) or two boards – one political SCAR board and a second active board with the benefits of a small working group.

Currently the political IBSCO Board is appointed by their national SCAR delegation and includes as per the original SCAR invitation:

- Italy (Michele Rebesco, who attended IBCAO Breakout Meeting)
- Spain (Jesus Galindo-Salvador)
- Sweden (Martin Jakobsson, who attended IBCAO Breakout Meeting)
- GEBCO (A.N. Other from TSCOM – possibly Martin Jakobsson in dual role)
- IHO (A.N. Other from HCA)
- IOC (Dimitri Travin)
- SCAR (Colin Summer Hayes/Mike Sparrow)

Robin Falconer suggested that the political board should be left in place. Terry Wilson suggested that a new invitation letter be sent out for [each member].

It was decided to keep the current two-board structures but recognised the need to adjust some member names. A new scientific editor will have an administrative role to manage the political board and issue new invitations. Alex Tate and Robin Falconer noted that Board Members need to be active with a single representative per state.

It was noted that the following changes must be accommodated in the editorial board:
Suzanne Carbotte to replace Frank Nitsche
Fred Davey to be removed and maybe moved to the political board
Alex Tate to replace Tara [who?]

Check Chile's membership (said HG)
Keep Ukraine's representation
Japan and Phillip O'Brien are still active
Vaughan Stagpoole to stay assisted by Jenny Black
Gleb [Udintsev] to remain but with reduced activity
Find a Swedish delegate, possibly Martin Jakobsson

Hugo Gorziglia proposed that a suitable person from Brazil should be included as Brazil becomes more active in the Southern Ocean. It was decided that Luciano Fonseca should find the best delegate.

Hans-Werner Schenke will not be able to attend the next SCAR meeting (10-16 July), although those there (Frank Nitsche, Terry Wilson, Alex Tate) will be able to identify possible data sources. In parallel, Hans-Werner Schenke will seek new Board members by email.

Hans-Werner Schenke noted that an IBCSO mailing and discussion list is offered and operated at NGDC and anyone interested in joining it can apply to NGDC to be added to mailing list.

Frank Nitsche said that Board members need to check that other Board members want to stay active, perhaps enquire at the ISAES meeting 10-16 July 2011 in Edinburgh, Scotland.

3.3 Parent Organisations (SCAR/IHO/IOC/GEBCO). Hans-Werner Schenke indicated that he hoped SCAR would keep IBSCO as expert group. There was a need to maintain an active relationship because support is strong, largely as the demand for maps is high. Hans-Werner Schenke showed a letter sent to all SCAR EXCOM and AWI directorate which emphasized the necessity for full time editorial board person to replace Norbert Ott.

HG said that IHO see regional projects (IBCs) as feeding into GEBCO. IHO sees bathymetry as very important and they will support all bathymetric programmes. He commented that liaison is currently strong and he wants to keep this going. Noted that IHO works on a 5-year programme cycle and if a programme gets onto this – maybe some funding [can be made available] amongst some subcommittees (e.g. GEBCO's SCRUM) – then existing commission members will be in a position to assist and facilitate data exchange. IBSCO can flag needs and then may be able to utilize IHO for assistance. HG made the point that the new IBCSO board members will have to set realistic targets, mostly because human resources are short.

Hans-Werner Schenke said he was pleased with talk by Wendy Watson-Wright as she seems to be supportive of both IBCAO and IBCSO. This suggested that there was a need to work on national IOC committees in order to get delegates successfully to bring up issues within IOC assemblies and councils. Hugo Gorziglia noted that all international delegates need to be briefed about the significance of bathymetric projects.

Robin Falconer commented that IBCSO is seen as one of the official GEBCO regional mapping programmes which will then appear on all funding requests to the Nippon Foundation (GEBCO regional programmes are managed by Martin Jakobsson through SCRUM). GEBCO argues that working on real projects is the best way to develop map making skills.

3.4 Liaison with other organizations: Hans-Werner Schenke asked if there were other contacts to be made other than with SOOS (Southern Ocean Observing System) and GOOS. Alex Tate agreed that there was a need to identify these kind of organizations and to obtain their support. Hans-Werner Schenke replied that there was a need to keep loose connections with both marine biologists / fisheries and oceanographers. Frank Nitsche noted that Peter O'Brien was involved in habitat classification. The question was asked how to persuade biologists to collect bathymetric data. The general opinion was that it was more likely that biologists would always be the users of bathymetry and not the collectors of data.

The conclusion was that IBSCO needs to stay in touch with biologists.

3.5 Data exchange with Institutions, Centres, Archives, Universities: It was considered that LDEO covers the area from the Ross Sea to the Antarctic peninsula, BAS covers a similar area from the South Sandwich Islands (but less in Weddell Sea), AWI covers the Weddell Sea and further east, and GNS could extend the area beyond the Ross Sea. France and Russia were mentioned too. About half of the Australian grid is NSB data.

It was concluded that well distributed datasets exist but there is a need to compile existing data but this relies on employing a new editor. Robin Falconer said that GEBCO could potentially provide some funding[1] (from €20-30k from Nippon Foundation funds for this regional programme) like a post-doc / research position for one year – but that there would have to be a product / wall chart finished to show Nippon Foundation after the year. Robin Falconer stipulated that there would also need to be some effort to include other people as part of capacity building as a Nippon Foundation requirement. It was noted that a budget would need to include some travel funds.

It was recognized that finding funding for the editor needed to be organized fairly promptly and a small task team was set-up to outline a work plan and budget for the new IBCSO editor (Alex Tate,

[1] Note for the Task Team:

WHAT WOULD GEBCO EXPECT TO SEE IN SCIENTIFIC EDITOR FUNDING APPLICATION DOCUMENTATION?

GEBCO would like to see an outlined work plan showing to demonstrate that the general idea of what needs to be done is understood. Robin Falconer indicated that any budget needs to include funds for travel and should be detailed enough so that no surprises appear at a later stage. Robin Falconer noted that part of the funding would need to be used to run a workshop within the first year. This would be one way to ensure that capacity building is incorporated. GEBCO expects as a "final product" for version 1 a nice colour map up to 60°S and a grid of this data for scientists to use.

Frank Nitsche, AWI and Australia). Terry Wilson suggested getting Italian involvement too. It was decided to hold preliminary discussions between Hans-Werner Schenke, Alex Tate and RN outside the meeting.

Finally, it was agreed that all data supplied to IBCSO version 1 must consist of two digital products:
1. Track lines (data sources) and associated metadata
2. Gridded data

3.6 Data archive (Type, Brand, form, Formats, etc): It was agreed that technical details could be discussed outside the meeting. Hans-Werner Schenke commented that AWI were thinking of converting to GSF format like UNH. It was generally recommended that no common format was needed for project at the moment.

3.7 Raw data, Metadata, processed data, grid, contour maps, digitized no's: It was agreed that rastered data would be produced. It was said that GEBCO would be happy to take topographic data from anywhere. Possibly data from BAS and BedMAP 2 could be incorporated seamlessly into the bathymetric grid.

Alex Tate agreed to provide information on quality assessment/control (metadata) of BAS data and Frank Nitsche may look into US data and what information is available on the quality of data.
It was noted that IBCSO needs to consider using ice sheet data from NASA.

3.8 Processing Centre: It was noted that Lamont, BAS and AWI have most of the Southern Ocean data. Effort could be distributed between then to start with, and new editor would need to move amongst these institutes to ensure an integrated effort. Permanent location to be discussed by the newly set-up task team, but location may depend on the editor's personal circumstances.

3.9 Technical Parameters (Scale, coverage, resolution): It was recommended that,
1) The IBCSO version 1 grid should extend as far north as 60°S within first year frame; with a work plan to extend to 50°S in version 2 or 3.
2) IBCSO should aim at a 2 km grid, but potentially to be amended as new data are collated by new editor.

It was commented that the grid spacing needs to be the same or less than that of the GEBCO grid (currently 1' but moving to 30 arcsec). It was noted that the IBCAO grid is now 2 km and but is aiming for 500 m. It was agreed that the projection to be used should be decided by the editor at later stage.

3.10 Update Strategies: Version 2 will most likely get better information and can make improvements based on skills learnt through producing version 1.

3.11 Contingency: What happens if there is no Scientific Editor? This question was raised by Alex Tate before knowledge of the offer of GEBCO funds, so is now less of an issue, at least in the

short-term. The longer-term future would probably evolve through operational areas over the next year. This issue needs to be addressed later once the GEBCO funds come to an end.

4 Plenary Session (5 May)

The plenary session heard reports from Martin Jakobsson (IBCAO) and Hans-Werner Schenke (IBCSO).

4.1 IBCAO. Martin Jakobsson summarised the discussions by the IBCAO/Arctic group.

- An Editorial Board consisting of members from Canada, Germany, USA, Russian Federation, Denmark, Sweden, Finland, Norway, Iceland, Italy and the UK with additional advisers had been set up. Additional advisers from Rep. Of Korea, PR China and Japan were also being sought.
- the IBCAO version 3.0 grid would have a targeted resolution of 500 m
- a spline pyramid would be used for gridding
- the grid would be released at Fall 2011 AGU meeting with an abstract
- a lot of new data had been identified and listed
- any data for the new version would have to be submitted to him by the end of July 2011
- an article would be written for G-Cubed and co-authored by the whole group
- additional products would include a source resolution grid and the coastline of permanent ice
- a meeting note would be published in EOS
- the grid release would be published in EOS too
- there had been some discussion about working with the Arctic gravity community
- a new map would be printed after the v.3 grid release
- it was proposed to hold the next meeting in May 2012 jointly with IBCSO at Seward, Alaska hosted by Bernard Coakely, Larry Mayer and Dan Oliver.

4.2 IBCSO. Hans-Werner Schenke summarised the discussions by the IBCSO/Antarctic group.

- Resolution was not yet approaching 500 m.
- The membership of the Editorial Board had been confirmed
- The IBCSO fell under the IOC and IHO parent bodies but also liaised with other groups such as SOOS, GOOS and GEBCO …
- Data exchange took place with many organisations
- The group had discussed grid processing techniques and technical parameters
- No product was yet in sight and the IBCSO needed advice on how to proceed from the parent organisations.

The following decisions had been made,

- The Editorial Board would keep its dual structure i.e. there would be a 'political' Board and a Board of the active members
- SCAR would be asked to propose additional delegates
- Close links should be maintained with the IHO
- No formal link existed with the IOC but Luciano Fonseca was ready to help
- Chairman GEBCO had offered support for about one year to print the first IBCSO map
- This new chart would contain contributions from the Weddell Sea, Scotia Sea (BAS), the Bellingshausen and Amundsen Seas (LDEO), the Ross Sea (NZ) and southern Indian Ocean countries. An experienced cartographer was needed to assemble the new chart and interpolate between surveys
- After people from the three main centres had met (LDEO, BAS and AWI) it was agreed to seek someone to scout for data
- It would be a challenge to produce a new chart in 3 months
- The group would next meet at the IASC Conference in Edinburgh in 2012
- The limits of the IBCSO had been revised back to 60°S from 50°S to reduce (halve) the area covered and the work involved
- The IBCSO plans to aim for a 2 km grid
- It was hoped to obtain funding from the IHB, SCAR, GEBCO etc.
- The IBCSO/Antarctic group was happy to meet again with the IBCAO/Arctic group in 2012.

Table 1. NEW ARCTIC OCEAN DATA THAT ARE AVAILABLE

Area of cruise/cruise name	Date	Ship	Contact, organisation	Restrictions (if any)	Notes	Source contact
Canadian waters	2010		UNB	Nil	200 m grid available now	Church
LOMROG II	2009	N/A	GEUS, DaMSA		Helicopter soundings	Marcussen
LOMROG II	2009		GEUS, DaMSA		Multibeam data already held by MJ	Marcussen/Jakobsson
		Oden	CHS/SU		Multibeam data already held by MJ	Forbes/Jakobsson
		Louis S. St-Laurent	CHS		Single beam data	Forbes
E Greenland	2008		Statoil	Already at SU, 2-yr embargo		Wollvik
Barents Sea small surveys			Statoil	Nil	Data already at NHO, can be collected	Wollvik
KVEITE Hola and Storfjorden			OGS		500 m grid OK but 200 m preferred	Rebesco
21 cruises listed in email from Larry Mayer to Martin Jakobsson including			CCOM/JHC			Mayer
…. 4 cruises		Mirai	Japan	Permission required		Mayer
.... 2 cruises		Palmer		2-yr embargo now expired		Mayer
Barents Sea, Norwegian Sea (Mareano project)					500 m grid available	Hodnesdal
Arctic Ocean, Norwegian Sea			Olex	Nil	Will provide 200 m grid	Jakobsson

Table 2. EXISTING ARCTIC OCEAN DATA WHICH ARE POTENTIALLY AVAILABLE

Area of cruise	Date	Ship	Contact, organisation	Restrictions (if any)	Notes	Source contact
Arctic Ocean	Up to 2005	US submarines	US Navy		Data presently not locatable	Bienhoff
Beaufort and Mackenzie shelves			Oil companies	Not embargoed, non-exploration data	Already compiled by LM??	Mayer/Coakley (LM to ask Steve Shipman, IHB)
Chukchi and Beaufort			Oil company		3-D seismic centre beam	Mayer
e.g. Baffin Bay, NE Greenland			Oil company	Open file	bathymetry from 2-D seismic	Marcussen
Arctic Ocean	2010	Polarstern	AWI + others		Some multibeam	Marcussen
Norwegian margin?			Norwegian Petroleum Directorate			Hodnesdal
Jan Mayen			Norwegian Petroleum Directorate			Hodnesdal
??			Russian Petroleum Directorate		Contact Morten Sand in NPD	Hodnesdal
Greenland-Faeroes			Cable company			Rebesco
Greenland-Canada			OGS		Sparse multichannel survey. MR will investigate	Rebesco
Area E of Svalbard and other areas		Strakhov cruises 24 (2006) and 25 (2007)	Russian Petroleum Directorate	3-yr embargo ended		Zarayskaya

Lomonosov Ridge, both flanks			Russian Federation. CM to provide LM with name		LM will ask during St Petersburg visit in May 2011	Marcussen
*N Svalbard			Norway		Single beam	Bienhoff
Arctic Ocean			Russian Federation		Data used to construct the 1:2.5 million chart of Arctic Ocean. Source data may be available.	Fridman
*Arctic Ocean			Russian Ministry of Natural Resources, Moscow		IBCAO Ed. Board should write formally to request data. Zarayskaya to translate.	Fridman
		Sonne	AWI		Some mid-latitude data available if PIs agree	Abich
Svalbard 'Mirian' cruise			Herr Kueppers, Shipping company Briese in Leer, Germany			Abich

* UNCLOS supporting data

Table 3. PLANNED CRUISES THAT WILL COLLECT ARCTIC OCEAN

Area of cruise	Date	Ship	Contact, organisation	Restrictions (if any)	Notes	Source
Alaska cable survey	Summer 2011		Don Hussong, cable company			Coakley
Chukchi shelf and borderland	Sept2011	Langseth	UAF	Nil	data available at end of cruise	Coakley
Canadian archipelago and Beaufort slope	Sept2011		UNB	2-year embargo,	Some shallow water, but possibly 500m grid OK	Church
Canada Basin	Summer 2011					Church
NE Greenland (Eager)	2011		GEUS			Marcussen
LOMROG III	2012		GEUS			Marcussen
Storfjorden (Deglabar)	2012		Barcelona group			Rebesco
Makarov basin	2011	Healy	CCOM/JHC			Mayer
Nautilus Basin/ S Mendeleev Basin?	2012	Healy	CCOM/JHC			Mayer
Barents Sea, Norwegian Sea (Mareano project)	2011		NMA/HS			Hodnesdal
Barents Sea, Norwegian Sea (Mareano project)	2012		NMA/HS			Hodnesdal
Kamchatka, S of Bering Straits	Summer 2012	Sonne	AWI			Abich

5. Submitted Abstracts

Compiling a bathymetry map of the Ross Sea and adjacent Southern Ocean

Jenny Black[1], Derek Woodward[1], Vaughan Stagpoole[1], Stuart Henrys[1], Fred Davey[1]

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A new bathymetry map for the Ross Sea and adjacent Southern Ocean between 140°E and 120°W and south of 60°S combining ship-borne bathymetry and gravity inversion data is planned for production in 2011. It will use all available bathymetric data in the region, including over 50 recent multi-beam bathymetric surveys that are controlled spatially by GPS or DGPS navigation. All bathymetry data is carefully checked for consistency with adjacent surveys and cleaned to remove any anomalous points.

In some regions ship-borne data are several hundred kilometers apart. Water depth in these gaps is estimated by an inversion of 1-minute resolution satellite derived gravity data. The inversion uses triangular networks of the water layer (constrained by the ship-borne bathymetric data) and a deep 'lower crustal' layer. The deeper layer incorporates the gravity effects of varying crustal density, crustal thickness and sediment thickness across the region. The inversion of gravity data to obtain bathymetry is a large least squares problem with three sets of weighted equations. One set is for the gravity data, the second for the ship-borne bathymetry data, and the third is used to apply smoothing and control over the variation in depth between the corners of each facet in the triangular networks. The inversion proceeds by iteration using a high smoothing factor on the bathymetry layer to create a good fit for the deeper layer, followed by a second set of iterations where the deeper layer is fixed and the smoothing factor in the bathymetry decreased.

Once a satisfactory inversion is achieved the grid of gravity derived bathymetry is combined with the grid of ship-borne bathymetry to generate a bathymetric map of the Ross Dependency and adjacent region.

Collecting, managing and distributing bathymetric, backscatter and sub-bottom data from within the Canadian Arctic Archipelago

Ian Church[1], John Hughes Clarke[1], Doug Cartwright[1], Steve Brucker[1], James Muggah[1], and Steve Blasco[2]

[1]Ocean Mapping Group, University of New Brunswick, Fredericton, NB, Canada
[2]Geological Survey of Canada, Dartmouth, NS, Canada

The Ocean Mapping Group, at the University of New Brunswick, has been collecting multibeam and sub-bottom echosounder data within the Canadian Arctic Archipelago since 2003 aboard the CCGS Amundsen. The Amundsen is a 100 metre Coast Guard ice breaker and multidisciplinary science platform used by the ArcticNet research program. The ship is equipped with an EM302 multibeam sonar and Knudsen 320R sub-bottom profiler and has been used as the platform for a number of small multibeam-equipped survey launches for shallow water mapping. The Amundsen is the only Canadian ice-breaker equipped with a multibeam echosounder and has been the primary bathymetric mapping platform within the archipelago.

The Amundsen works primarily within the bounds of the Canadian Archipelago, in water depths of less than 1000 metres, and only rarely goes into the Arctic basin. As part of the ArcticNet program, the Amundsen traditionally spends four and a half months per year in the north and the Ocean Mapping Group collects echosounder data throughout its entire journey, 24 hours a day, 7 days a week. The majority of data collection has been from transit corridors rather than systemic surveys, although this has recently begun to change as partnerships with industry in the Beaufort Sea have been developing. Recent extended dedicated surveys, performed in collaboration with oil and gas companies, have lead to substantial multibeam coverage along a growing percentage of the Canadian Beaufort slope. Shallow, high resolution mapping has been accomplished with survey launches aboard the Amundsen. These surveys have been used for change detection on fjord deltas, shoal investigations in conjunction with the Canadian Hydrographic Service, exploring uncharted waters and aiding in rescue operations.

The majority of data post-processing in performed in near real time aboard the Amundsen. After the cruise, data is reprocessed for sound speed using contemporaneous and archived casts as well as empirical models (based on oceanographic climatologies). Once completed, all data is gridded and put online in a variety of formats for distribution. To handle the large volumes of transit sounding data, two distribution formats were chosen. All multibeam bathymetry and backscatter data is gridded with previous years into a series of 10m resolution basemaps which cover the Canadian Arctic. Each basemap encompass a 15 minute by 30 minute footprint and users are able to navigate through them with an HTML web interface and download the gridded data as ESRI grid files. The sub-bottom data is presented along-track, broken up into 25km long georeferenced strips with a combined vertical section and multibeam bathymetric and backscatter surface. An HTML web interface is used to display the strip maps, allowing the users to follow each year of the ship's track. A recent addition to these formats has included an intuitive and dynamic Google Maps interface which adds the option to view the data at multiple scale levels with contextual satellite background imagery. Gridded data collected from the CCGS Amundsen has been primarily used by geologists at Canadian Universities and within the Federal Government.

The shallow water within Canada's Arctic, along with the dual-ping and water column imaging capability of the EM302, equates to high ping rates and large data volumes. As these data volumes increase each year, the Ocean Mapping Group has been working towards partnering with alternate distribution channels to ensure data integrity and to improve the availability of data. At present, the group's main focus is on data distribution methods to ensure that data sets are used to their full potential.

Arctic Basemaps:
http://www.omg.unb.ca/Projects/Arctic/basemaps/index.html

Arctic Stripmaps:
http://www.omg.unb.ca/Projects/Arctic/stripmaps/index.html

Arctic Google Maps Interface:
http://www.omg.unb.ca/Projects/Arctic/google/index.html

Initial cross-over analysis of Amerasian Basin gravity and bathymetry dataset

Bernard Coakley[1] and Larry Mayer[2]

[1]Geophysical Institute, University of Alaska
[2]Center for Coastal and Ocean Mapping/Joint Hydrographic Center, University of New Hampshire

The acquisition of useful underway data relies on the continuous function of properly calibrated instruments and correct treatment of the data post-cruise. There are few opportunities to evaluate errors while at sea. In the absence of obviously spurious measurements and instrument error indicators, data are assumed to be of good quality. Post-cruise evaluation through cross-over error analysis is one means to confirm both instrument performance and data reduction and, by the estimation of scale and time-varying errors, facilitate the integration of data from multiple sources into gridded data products.

Cross-overs error analysis is based on the comparison of measurements collected at track crossings, which should, if errors are inconsequential, be identical. In practice, differences, sometimes negligible, are observed. By examining the structure of these differences in time and making comparisons within a particular cruise or to other cruises, the cause of errors can be isolated and, ideally, the errors themselves corrected or minimized.

Prior to the onset of 7/24/365 GPS positioning, cross-over errors were also a test of navigational quality. With GPS positioning, the uncertainty in position (~10 meters) is less than the area of the seafloor sampled by a particular measurement. In the absence of overt problems with GPS positions, the navigation can be treated as "True." the focus shifts to errors of sensor operation, calibration and data processing.

	HLY-04	HLY-05	HLY-08 -221	HLY-08 -222	HLY-09 -221	HLY-09 -222	HLY-10 -221	HLY-10 -222
HLY-04	0.22	0.4	-2.33	-2.48	-2.6	-2.44	-2.33	-218
HLY-05	-0.4	0.43	-2.34	-2.56	-2.38	-2.30	-2.55	-2.30
HLY-08 -221	2.33	2.34	0.1	NA	-0.13	-0.16	-0.17	0.06
HLY-08 -222	2.48	2.56	NA	0.14	0.13	0.10	0.03	0.26
HLY-09 -221	2.6	2.38	0.13	-0.13	0.0	NA	0.05	0.23
HLY-09 -222	2.44	2.3	0.16	-0.10	NA	0.02	-0.13	0.05
HLY-10 -221	2.33	2.55	0.17	-0.03	-0.05	0.13	0.09	NA
HLY-10 -222	2.18	2.3	-0.06	-0.26	-0.23	-0.05	NA	0.05

	HLY-04	HLY-05	HLY-08	HLY-09	HLY-10
HLY-04	2.32	12.21	-3.98	-3.57	0.38
HLY-05	-12.21	0.69	-0.67	-0.22	19.88
HLY-08	3.98	0.67	-0.32	0.05	1.87
HLY-09	3.57	0.22	-0.05	0.15	0.66
HLY-10	-0.38	-19.88	-1.87	-0.66	2.63

Tables – Gravity anomaly cross-over errors from USCGC Healy. **Left:** Mean errors are given in mGals for each cruise pair. **Right:** Mean cross-over errors for bathymetry. Mean errors are in meters.

Gravity data have been collected from USCGC Healy in the Arctic Ocean and during transits with Bell BGM-3 gravimeters during the entire 2004, 2005 and 2008-2010 field seasons. Since early 2008, Healy has had dual Bell BGM-3s working side by side. Gravity anomaly data quality is sensitive to the calibration of the systems, proper corrections for drift (based on pre and post-cruise gravity ties) and proper reduction of the raw measurements, using appropriate filters and correct application of the proper corrections for ship's position (latitude correction) and motion across a rotating earth (Eötvos correction).

Internal cross-over errors from each cruise are quite good, showing near-zero means (0.0 to 0.4 mGals) and low standard deviations. The external cross-overs are somewhat more complicated, breaking into two distinct groups. The 2004 and 2005 cruise data have a low mean (0.4 mGals). So does the 2008-2010 data, from each gravimeter (0.0 to 0.2 mGals). The external cross-overs between these two groups have a relatively large mean (2.2 to 2.6 mGals), suggesting a consistent offset, which may be explain by the difference in how the gravity ties were accomplished.

Ignoring blunders in how the data are logged and how the swath bathymetry system is set up, the bathymetric cross-overs are probably most vulnerable to changes in how the sound velocity profile is estimated cruise by cruise. The bathymetry mean cross-overs seem reasonable, but not as consistent as the gravity anomaly cross-overs. This may be due to variable cleaning of the center beam bathymetry that was used for this study.

Arctic Surveys; A Canadian Perspective, Past, Present and Future

Stephen Forbes[1] and Ron Macnab[2]

[1]Canadian Hydrographic Service
[2]Retired

Canada has a long history of Arctic exploration prior to and after confederation in 1867. The presentation will provide a brief historical review of Canada's Arctic bathymetric surveys conducted up to the present time and the motivation for Arctic exploration. The current status of Canada's Arctic bathymetric data sets will be discussed including those collected under the auspices of the Law of the Sea Project and in collaboration with other Arctic nations.

The implementation of new data collection platforms and technology ; i.e. Autonomous Unmanned Vehicles (AUV) for under the ice surveys, the systematic automated conversion of historical data sets from analog to digital structure with the necessary attribution and meta-data preserved and the requirement for additional Arctic bathymetric surveys are also addressed.

Status of Hydrographic Surveying and Nautical Charting in Antarctica

Hugo Gorziglia[1]

[1]International Hydrographic Organization (IHO)

The International Hydrographic Organization (IHO), through its Hydrographic Commission on Antarctica (HCA) has the responsibility to promote technical co-operation in the domain of hydrographic surveying, marine cartography, and nautical information within the Antarctic Treaty region.

While a scheme of international nautical charts for the Antarctic Treaty region has been agreed by the IHO, the availability of reliable nautical chart coverage in the region issued by volunteer National Hydrographic Offices is far from being completed, thus affecting operations in Antarctica, including marine scientific research.

The presentation offers initiatives for discussion on the way the situation could be improved in a cooperative and collaborative approach.

The MAREANO program – Mapping of Seabed topography, sediments and bottom fauna in Norwegian waters

Areas that have been covered so far and plans for the future

Hanne Hodnesdal[1]

[1]Norwegian Mapping Authority, Hydrographic Service

The MAREANO-program was established in 2005. The aim of the program is to fill gaps in knowledge about seabed condition, habitats and biodiversity through detailed mapping of depth, sediments, bottom fauna and pollutants. The results are used as input to management plan for Barents sea and Lofoten, and are also available at the website www.mareano.no. The MAREANO-program is coordinated by the Institute of Marine Research (IMR) working in collaboration with Geological Survey of Norway (NGU) and Norwegian Mapping Authority, Hydrographic Service (NHS). NHS is responsible for seabed topography mapping with multibeam echo sounder. Areas that have been covered so far is outside Lofoten, Vesterålen and Troms. In the seabed topography we are looking for corals, sand waves, pockmarks, iceberg plough marks and other terrain details. The seabed topography is further used to model biotopes between the biological and geological samples.

Arctic Seafloor Mapping – Norwegian Hydrographic Service

[1]Øyvind Tappel

[1]Norwegian Mapping Authority, Hydrographic Service

The presentation will include areas where Norway is responsible for hydrographic surveying. Will be looking into the status and quality of Svalbard (Spitsbergen and more) surveys. This include which equipment and vessels that are used. The role as national hydrographic data manager(compiling data from other sources).

Production of Navigational Chart INT-905 – Northern Weddell Sea

Ralf Krocker[1], Sylvia Spohn[2]

[1]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven;
[2] Bundesamt für Seeschifffahrt und Hydrographie, Rostock

The production of the paper chart and the corresponding ENC of navigational chart INT-905 is a joint project by the German Federal Maritime and Hydrographic Agency (BSH) as national HO, and the Alfred Wegener Institute for Polar and Marine Research (AWI), which holds much of the bathymetric source data for this region. Chart specifications are given by IHO. The charts boundaries are defined to be 59°10'S – 71°00'S, 59°00'W – 11°00'W covering the northern and central part of the Weddell Sea, which is not covered by hydro acoustic measurements at all. Raw and processed depth data of different sources were compiled to map the sea floor topography. In addition, soundings and contour lines from adjacent overlapping INT charts were used for inter chart adjustments. The labeling of land and undersea features rely on GEBCO SCUFN and SCAR CGA gazetteers. Besides navigational themes like lights and magnetic variations, the mean sea ice extension for several seasons will be incorporated.

Important Role of Bathymetry in Polar Sea Ice Formation and Evolution

Son V. Nghiem[1], Pablo Clemente-Colón[2], Ignatius Rigor[3], and Gregory Neumann[1]

[1]Jet Propulsion Laboratory, California Institute of Technology; [2] National Ice Center, National Oceanic and Atmospheric Administration; [3]Applied Physics Laboratory, University of Washington

Bathymetry has a profound role in both Arctic and Antarctic sea ice formation and seasonal evolution. This is because bathymetry controls warm and cold waters mass transport and distribution that govern sea ice growth and decay processes. Moreover, sea ice dynamics forced by surface winds is guided by the bathymetry along certain preferential direction such as the Transpolar Drift in the Arctic Ocean and the Circumpolar Drift in the Southern Ocean. Here, we use data from multiple satellite sensors together with buoy measurements to reveal the bathymetry control on sea ice growth and dynamics. For the Arctic, bathymetric effects on sea ice formation are clearly observed in the conformation of sea ice patterns and bathymetric characteristics. In certain cases, sea ice appears as an "imprint" of the regional isobaths as seen in QuikSCAT satellite maps of sea ice overlaid on IBCAO bathymetry in the Barents Sea (Nghiem et al., 2005). In the Bering Sea, the maximum marginal ice zone is restrained approximately along the continental shelf break that directs ocean surface currents such as the Aleutian North Slopes, the Anadyr, and the Kamchatka currents off the shelf break where warm waters prevent further advance of the ice edge by lateral and undersurface melting. The bathymetric control is not necessarily restricted to local features and can be seen across regional extent covering the entire Arctic basin. We present the large scale correlation between bathymetry and patterns of different synoptic sea ice classes (seasonal and perennial sea ice) by an animation that gradually fades the satellite sea ice map into IBCAO bathymetry pattern in the Arctic Ocean. Arctic perennial sea ice, the class of old and thick sea ice important to the stability of the Arctic ice cover, has been drastically lost by a half in just in the last decade. Ice dynamics has a crucial role in the perennial ice loss due to the Polar Express phenomenon, driven by the atmospheric dipole anomaly pattern that compresses ice into the Transpolar Drift and accelerates the ice transport across the Arctic Basin influenced by bathymetric divide such as the Lomonosov Ridge. Finally, sea ice is exported mainly through the Fram Strait down to the warm Greenland Sea where the ice melts.

In the Southern Ocean, bathymetry can affect ice calving processes (Martin et al., 2010). Effects of bathymetry on sea ice formation and evolution around Antarctica are also observed. The identification of the major role played by bathymetry in the formation and distribution of sea ice has several key implications. First, it indicates that there is a geologic signature in addition to climatic signature in the variability of sea ice. This means that the stability of geologically-influenced geophysical parameters such as the maximum ice extent, which can only grow to the limit of the shoreline or the bathymetric-control line (e.g. shelf break), should not be used to conclude that the climatic change is weak. Second, since bathymetry does not change significantly for many years or even centuries, sea ice patterns can be recurrent around certain bathymetric features such

as the Bear-Island ice tongue, the Svalbard sea ice barrier, etc., that can help in improving sea ice forecast and outlook. Third, coastal bathymetry determines the grounding line of fast ice and ice shelf that are critical to may geophysical processes such as lead formations as floating ice detaches from fast ice and ice calving from ice shelves.

From these observations, the IBCAO and IBCSO bathymetry datasets can me more useful when: (1) the data are not artificially limited along a certain latitudinal line, (2) more accurate data in the peripheral seas for a better understanding of sea ice processes in the marginal ice zone, and (3) inclusion of detailed measurements along coastal regions. Conversely, our sea ice mapping products, derived from NASA and international satellite data, can identify areas occupied by the thinner first-year ice where it is more accessible so that bathymetry measurement missions can be carried out more efficiently. As an example, in February-March 2011, our daily updated sea ice maps detected a large region off the northeast coast of Greenland where winds opened up the perennial ice pact and created an ocean area in which new ice formed. This region is historically occupied by the inaccessible perennial ice, and its opening offers the first rare accessible opportunity for scientific measurements. Thus, these sea ice mapping products can contribute in facilitating seafloor measurements.

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The Antarctic and Southern Ocean Data Synthesis and its use for bathymetric compilations

Frank O. Nitsche[1], S. Carbotte[1], V. Ferrini[1], and W.B.F. Ryan[1]

[1]Lamont-Doherty Earth Observatory of Columbia University

The Antarctic and Southern Ocean Data Synthesis (ASODS) is part of the Marine Geoscience Data System (www.marine-geo.org) supported by the U.S. National Science Foundation and hosted by the Lamont-Doherty Earth Observatory. The main goals of the ASODS are to preserve multibeam bathymetry and other oceanographic and marine geophysical data collected on NSF-supported research vessels (mainly *NB Palmer, L. Gould)* and make these data easily accessible to the public and the scientific community. In 2010 we began an expansion of the system to include data from the Arctic collected with the USCG *Healy*.

In addition to sophisticated search tools for data discovery, we provide visualization tools that allow exploration and analysis of the full detail of the original bathymetry data. These tools include GeoMapApp (www.geomapapp.org), which provides two-dimensional map-based data browsing and visualization in Mercator, South Polar and North Polar projections, as well as the three-dimensional virtual globe application VirtualOcean (www.virtualocean.org). Our Global Multi-Resolution Topography (GMRT) synthesis is the basis for all visualization tools (Ryan et al., 2009), and includes a compilation of multibeam data collected aboard U.S. academic research vessels.

While data access and visualization are important for many scientific applications, overviews that can be used as the basis for models require spatially continuous maps and grids. We have been working with colleagues from various institutions including the British Antarctic Survey, Alfred Wegener Institute, and University of Stockholm to produce regional bathymetry compilations such as for the Amundsen Sea, West Antarctica. These regional maps show main morphological features of the continental margins, especially the distribution of cross-shelf troughs and sediment distribution along the continental slope and rise. Here we present the latest status and development plans of the system.

References

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Surveying and bathymetric charting activities of the Russian Federation in Arctic and Antarctic

Leonid G.Shalnov[1] and Viktor V.Kovalyonok[1]

[1]Oceanographic section of Department of Navigation and Oceanography of the Russian Federation Ministry of Defense

The presentation include a brief excursion to the history of surveying and bathymetric charting of Arctic and Antarctic seas. The following main Arctic mapping projects and activities will be presented:

- Bottom relief of the Arctic Ocean, scale 1:5,000,000
- Central Arctic Basin, RU 175, admiralty number 91115, scale 1:2,500,000
- Main results of the "North-2011" expedition
- Activities in the international project IBCAO
- Surveying and bathymetric charting activities in Antarctic.
- Proposals for re-establishing a new Editorial board for IBCAO

Neotectonic and Glacial History of the McMurdo Sound Region, southwestern Ross Sea, Antarctica: Enhanced Interpretation from Integrated Seafloor Bathymetry and Terrestrial DEMs

Terry Wilson[1], Jamey Stutz[1], William Magee[1], Christopher Gordon[1], and Stuart Henrys[2]

[1]The Byrd Polar Research Center at The Ohio State University
[2] GNS Science, Lower Hutt, New Zealand

The recent geologic history of the southwestern Ross Sea can be reconstructed from a unique, integrated data set including seafloor and terrestrial elevation data, terrestrial mapping, seismic reflection profiles, sediment and sedimentary rock cores, and dated dredge samples from the seafloor. Neogene-active volcanism produced terrestrial and seafloor volcanoes, seamounts, and ridges. Seafloor bathymetry reveals new aspects of the overall extent and architecture of the volcanic province. A regional en echelon array of volcanic ridges extends NNW from Beaufort Island toward Drygalski Ice Tongue. Within this zone, seafloor volcanic ridges and an elongate seamount cluster trend NNE, subparallel to mapped fault trends in this sector of the Neogene-active? Terror Rift. This geometry is compatible with right-lateral transtension along this zone, as previously proposed for the Terror Rift as a whole. We are completing a detailed analysis of orientation patterns and cross-cutting relations between faults and volcanic seamounts and their feeder systems to test this model for Neogene rift kinematics.

Marine bathymetric features document the extent and style of glacial behavior in the region. The most striking bathymetric features in southwestern McMurdo Sound are channel forms cutting the western shelf and slope, many emanating from the fjords of the Transantarctic Mountains. On the eastern edge of McMurdo Sound, broad, anastomosing, N-S trending channels appear in >800 m of water and represent conduits for material being transported from beneath the McMurdo Ice Shelf. No megascale glacial lineations, drumlins or other features typical of a grounded ice sheet are observed in McMurdo Sound, but lineations become prominent near the northern limit of the sound offshore of the Mackay Glacier in Granite Harbour. This suggests that at the LGM, the McMurdo Ice Sheet was not grounded throughout the whole of McMurdo Sound. Our integrated DEM allows the seafloor features to be connected with mapped glacial features on land. We are constructing an improved model of LGM ice volume by combining terrestrial and seafloor evidence on glacial limits. Improved understanding of the LGM glacial record in McMurdo Sound can help provide a template for regional reconstructions of ice sheet behavior.

Arctic cruises of R/V "Academik Nikolaj Strakhov" 2006 - 2010

Yulia Zarayskaya[1]

[1]Geological Institute of Russian Academy of Science

The Geological Institute of Russian Academy of Science in collaboration with the Norwegian Petroleum Directorate is working on the International Polar Year project "Late Mesozoic – Cenozoic Tectono-Magmatic History of the Barents Sea Shelf and Slope as a Clue to Paleodynamic Reconstructions in the Arctic Seas" (leaders A.V. Zayonchek and H. Brekke). During the 2006-2010 years four cruises of R/V "Academic Nikolaj Strakhov" were carried out in the regions of the North Atlantic Ocean and the Barents Sea.

R/V "Akademic Nikolaj Strakhov" is equipped with deep-water multibeam sonar system SeaBat 7150 and shallow-water multibeam sonar system SeaBat 8111. Multibeam data were collected and processed during the surveys. The total length of the bathymetric profiles is 11491 nautical miles. One of the results of this project are the gridded bathymetric data sets of the Knipovich Ridge region in the North Atlantic, the Ornen (Kvitoya) Through, and the Storfjorden Through regions in the Barents Sea. The transits data is also collected. The materials of the 24th cruise were presented on GEBCO meeting in 2007 where undersea feature names were approved.

The bathymetric and geophysical data sets were used to explore the structure of the Continent-Ocean transition zone of the Western Barents margin north of the Bear Island, and North-West Barents margin to the North of Ornen (Kvitoya) Through (Zayonchek et al., 2010). The other important question to investigate was tectonics and evolution of the Knipovich Ridge (Peive, Chamov, 2008). The comparison of the bathymetric data sets of the Knipovich Ridge with the results of a physical modeling for this region gave a key for understanding of the geodynamical factors of the structure-forming on the ridge (Kokhan et al., 2010).

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Bathymetric data acquisition in Arctic waters within the Danish Continental Shelf Project

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Bathymetric data are the most important data type in relation to extension of the continental shelf according to Article 76 of the United Nations Convention on the Law of the Sea (UNCLOS), since bathymetric data are needed to define the Foot of the Slope (FOS) and the 2500 m isobath.

Within the Continental Shelf Project of the Kingdom of Denmark there are three areas of interest around Greenland: south, north-east and north of Greenland. Acquisition of bathymetric data in the area off South Greenland is undertaken by commercial contractors using multibeam echo sounders and is therefore more or less straightforward.

However both in the area off North-East Greenland and especially in the area off North Greenland data acquisition is hampered by the sea ice conditions in these areas. Due to other logistical difficulties (access,

remoteness, weather) it soon became obvious that cooperation with other countries, with previous experience in acquiring bathymetric data would be beneficial.

In spring of 2006 and in cooperation with Canada bathymetric data were acquired using a single beam echo sounder with the transducer placed on the ice surface. Means of transportation were small helicopters flying out of the Canadian military station Alert. The distance between measurements was approximately three kilometres. Due to unfavourable weather conditions only few data points were collected. A new attempt in 2007 by the Canadian Hydrographic Service (CHS) was unsuccessful due to fog conditions however; the 2009 spring season based on a main camp at Ward Hunt Island was successful due to very stable weather conditions. Operations showed that due to the limited range of the helicopters it is not possible to acquire data more than 200 nautical miles from the base camp.

In 2007 and in 2009 the LOMROG I and II cruises were carried out in order to acquire bathymetric data in the more central parts of the Arctic Ocean. The cruises were organized in cooperation with the Swedish Polar Research Secretariat. Multiple Swedish institutions participated as well as CHS. Oden was in 2007 equipped with the state of the art Kongsberg EM120 financed by grants to a consortium of scientists with lead PI Martin Jakobsson (Stockholm University). Due to very heavy ice conditions in 2007 and despite the support of the Russian nuclear icebreaker 50 Years of Victory acquisition of high quality multibeam data was very difficult. However, at the end of the cruise Martin Jakobsson developed the “Pirouette” surveying method where bathymetric data was collected during a 360° spin of Oden. Prior to the 2009 LOMROM cruise the EM120 was upgraded to the EM122 with a better resolution and better bottom detection algorithm. The “Pirouette” surveying method was used very successfully during LOMROG II cruise in 2009 with six crossings of the Lomonosov Ridge.

Further data acquisition is planned during the EAGER 2011 cruise with Oden to the area off North-East Greenland and in 2012 hopefully to the area north of Greenland during the LOMROG III cruise.

The data acquisition activities within the Continental Shelf Project of the Kingdom of Denmark have proven that acquisition of high quality bathymetric data is possible even under very severe ice condition. Essential for successful data acquisition has been a very close cooperation with many institutions. All acquired bathymetric data will be available to update the existing IBCAO map.

Seafloor bathymetry in Southern Ocean and Antarctica from the Italian Antarctic National Research Program (PNRA 1988-2006)

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Italy acquired seafloor bathymetry data in the Southern Ocean within the Programma Nazionale di Ricerche in Antartide (PNRA) since 1988. Before the employment of MultiBeam EcoSounder (MBES), batymetric information were collected essentially along tracks of multichannel and single channel seismics and in spots investigated by coring and oceanographic sampling. The investigated areas concentrated mainly in the Ross Sea, western Antarctic Peninsula, northwestern Weddell Sea and Scotia Sea. These data were collected on board the geophysical RV OGS-Explora and on board the RV Italica, mainly devoted to the Italian station supply and Oceanography. During these years, compilations of bathymetry maps (using all internationally available soundings) were performed by OGS in the Ross Sea (Brancolini et al., 1995), western Antarctic Peninsula (Rebesco et al., 1998) and

Conversely, several cruises conducted between 2004 and 2006 employed the Reson MBES systems installed on board OGS-Explora. These cruises encompassed the southern Scotia Sea, the South Shetland Trench, the southwestern Antarctic Peninsula, the eastern and western Ross Sea, the Oats Land and Wilkes Land margins. Such MBES bathymetry are partly already published (e.g. Beaman et al,2011; De Santis et al., 2007; Rebesco t al., 2007; Tinivella et al., 2008) and partly being analyzed jointly with other geophysical data.

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Seafloor Morphology of the Storfjorden and Kveithola Palaeo-Ice Streams (NW Barents Sea): joined Italian and Spanish dataset

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IPY Activity N. 367 focusing on Neogene ice streams and sedimentary processes on high- latitude continental margins (NICE-STREAMS) resulted in two coordinated cruises on the adjacent Storfjorden and Kveithola trough-mouth fans in the NW Barents Sea: SVAIS Cruise of *BIO Hespérides*, summer 2007, and EGLACOM Cruise of Cruise *R/V OGS-Explora*, summer 2008. The objectives were to acquire a high-resolution set of bathymetric, seismic and sediment core data in order to decipher the Neogene architectural development of the glacially-dominated NW Barents Sea continental margin in response to natural climate change.

The acquired 15,340 km^2 of multi-beam bathymetry cover nearly the entire mid-upper continental slope, the continental shelf edge, and parts of the continental shelves of the feeding glacial troughs. In particular, the bathymetric surveys, complemented by core and seismic data, illustrate the following:

1) the morphologic effect of paleo-ice streams that drained ice from southern Spitsbergen, Spitsbergen Bank, and Bear Island. Mega-scale glacial lineations overprinted by transverse grounding-zone wedges in the Kveithola trough are diagnostic of episodic ice stream retreat (Rebesco et al., 2011).

2) the development of the Storfjorden and Kveithola Trough-Mouth Fans (TMF) on the continental slope, dominated by straight gullies in the upper part, and deposition of debris lobes on the mid and lower parts (Pedrosa et al., 2011).

3) the presence of several relatively recent, shallow submarine landslides detached from the upper continental slope at the boundary between the adjacent Storfjorden and Kveithola TMF (Rebesco et al., in press, Lucchi et al., in press).

4) the origin, at the shelf edge of the inter-TMF area between the Kveithola and Bjørnøya TMFs, of a dendritic pattern of deep, V-shaped incisions likely converging into the INBIS channel system on the lower continental slope (Rebesco et al., in press).

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Last name	First name	Email	Affiliation	Country	Presentation	Title
Abich	Gerald		RF Forschungsschiffahrt GmbH	Germany	Poster	Mapping capabilities of RV Sonne
Backman	Jan		Stockholm University	Sweden		
Bienhoff	Paul		John Hopkins University Applied Physics Laboratory	USA		
Biuw	Martin		Swedish Polar Research Secretariat	Sweden		
Black	Jenny		Institute of Geological and Nuclear Sciences (GNS)	New Zeeland	Talk	Compiling a bathymetry map of the Ross Sea and adjacent Southern Ocean
Cherkis	Norman		Five Oceans Consultants	USA		
Church	Ian		Ocean Mapping Group/University of New Brunswick	Canada	Talk	Collecting, managing and distributing bathymetric, backscatter and sub-bottom data from within the Canadian Arctic Archipelago
Coakley	Bernard		University of Alaska Fairbanks	USA	Talk	Initial cross-over analysis of Amerasian Basin gravity and bathymetry dataset
Eriksson	Björn		Stockholm University	Sweden		
Falconer	Robin		Widespread Ener	New Zeeland		
Fonseca	Luciano		Intergovernmental Oceanographic	France/Brazil		

			Commission (IOC)			
Forbes	Steve		Canadian Hydrographic Service	Canada	Talk	Arctic Surveys; A Canadian Perspective, Past, Present and Future
Fridman	Boris		North-West center of geoinformation	Russian Federation		
Fretwell	Peter		British Antarctic Survey (BAS)	UK	Talk	Describing work involved in the South Georgia bathymetry compilation and upcoming regional efforts around the South Sandwich Islands and the South Shetlands
Gianella	Jose		Peruvian Navy Hydrographic Office	Peru		
Gorziglia	Hugo		International Hydrographic Organization (IHB)	Chile	Talk	Status of Hydrographic Surveying and Nautical Charting in Antarctica
Greenwood	Sarah		Stockholm University	Sweden		
Hell	Benjamin		Stockholm University	Sweden	Talk	Gridding heterogeneous bathymetric data sets with stacked continuous curvature splines in tension

Hestvik	Ole		Olex AS	Norway	Talk	
Hodnesdal	Hanne		Norwegian Mapping Authority, Hydrographic Service	Norway	Talk/Poster	The MAREANO-program – Mapping of Seabed topography, sediments and bottom fauna in Norwegian waters. Areas that have been covered so far and plans for the future
Jakobsson	Martin		Stockholm University	Sweden	Talk/Poster	Arctic and Antarctic multibeam mapping with Swedish icebreaker Oden/ IBCAO
Jinadasa	Priyantha		National Aquatic Resources Research and Development Agency	Sri Lanka		
Krocker	Ralf		Alfred Wegener Institute for Polar and Marine Research (AWI)	Germany	Talk	Production of Navigational Chart INT-905 – Northern Weddell Sea
Marcussen	Christian		Geological Survey of Denmark and Greenland (GEUS)	Denmark	Talk	Bathymetric data acquisition in Arctic waters within the Danish

						Continental Shelf Project
Mayer	Larry		Center for Coastal and Ocean Mapping/Joint Hydrographic Center, University of New Hampshire	USA	Talk	Status of US Arctic ECS mapping activities
Meiton	Axel		Swedish Polar Research Secretariat	Sweden		
Mohammad	Rezwan		Stockholm University	Sweden		
Monahan	David		Center for Coastal and Ocean Mapping/Joint Hydrographic Center, University of New Hampshire	Canada		
Newton	George		U.S. Arctic Research Commission	USA		
Nitsche	Frank		Lamont-Doherty Earth Observatory	USA	Talk	The Antarctic and Southern Ocean Data Synthesis and its use for bathymetric compilations
Noormets	Riko		UNIS, the University Center of Svalbard	Norway/Svalbard		
Pedersen	Richard		Danish Maritime Safety Administration (DaMSA)	Denmark		
Rebesco	Michele		Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)	Italy	Talk/Poster	Seafloor Morphology of the Storfjorden and Kveithola Palaeo-Ice Streams (NW Barents Sea): joined Italian and Spanish dataset
Schenke			Alfred Wegener Institute for Polar and Marine Research (AWI)	Germany		IBCSO

Slotsvik	Noralf		Norwegian Mapping Authority, Hydrographic Service	Norway		
Son V.	Nghiem		NASA Jet Propulsion Laboratory	USA	Talk	**Important role of bathymetry in polar sea ice formation and evolution**
Tappel	Øyvind		Norwegian Mapping Authority, Hydrographic Service	Norway	Talk	Arctic Seafloor Mapping – Norwegian Hydrographic Service
Tate	Alex		British Antarctic Survey (BAS)	UK	Talk	Overview of bathymetric data collected by the British Antarctic Survey - acquisition, management and dissemination
Watson-Wright	Wendy		Intergovernmental Oceanographic Commission (IOC)	France	Talk	Intergovernmental Oceanographic Commission (IOC)
Whitmarch	Bob		National Oceanography Centre	UK		
Wigely	Rochelle		Council for Geoscience	South Africa	--	
Wilson	Terry		School of Earth Sciences, Ohio State University	USA	Poster	Neotectonic and Glacial History of the McMurdo Sound Region, southwestern Ross Sea, Antarctica: Enhanced Interpretation from Integrated Seafloor

						Bathymetry and Terrestrial DEMs
Wollvik	Roy	_____	Statoil, ASA	Norway	--	
Zarayskaya	Yulia	_____	Geological Institute of Russian Academy of Science	Russian Federation	Talk	Arctic cruises of R/V “Academik Nikolaj Strakhov” 2006 - 2010