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**ANNEXES**

## 1. OPENING OF THE MEETING AND WELCOME BY LOCAL HOSTS

1. The Twenty-second Meeting of the joint IOC-IHO General Bathymetric Chart of the Oceans Sub-Committee on Digital Bathymetry (SCDB XXII) was held at the Deutsches Schiffahrts Museum (German Maritime Museum), Bremerhaven, Germany. The Committee convened formally on 14th and 16th June 2006 and hosted a Science Day of talks, poster presentations and informal discussions on 15th June.

2. Those present, in addition to Walter Smith, the Chairman, were Bob Anderson, Juan Brown, Etienne Cailliau, Norman Cherkis, Ray Cramer, Robin Falconer, Chris Fox, José Frias, Hugo Gorziglia, John Hall, Colin Jacobs, Ki-Suk Lee, Paolo Lusiani, Ron Macnab, Dave Monahan, Taisei Morishita, Tony Pharaoh, Walter Reynoso, John von Rosenberg, Bill Ryan, Hans-Werner Schenke, Shereen Sharma, Steve Shipman, Karlapati Srinivas, Shin Tani, Paula Travaglini, Nataliya Turko, Gleb Udintsev, Pauline Weatherall, Bob Whitmarsh and Harry Yeh. In addition the first day was attended by Prof. Kortum (IfM-GEOMAR) and Dr Eric Moussart (Ifremer).

3. Dr Schenke briefly welcomed all the GEBCO participants on behalf of Professor Jörn Thiede, the Director of the Alfred Wegener Institute. Dr Schenke then invited Dr Albrecht Sauer, Director of the Museum, to outline the work of the Museum.

4. The Chairman, Dr Walter Smith, began the business of the meeting at 1008.

## 2. CONDUCT OF THE MEETING

### 2.1 Tour de table.

5. Those present briefly introduced themselves.

### 2.2 Tabling of documents.

6. No documents were tabled.

### 2.3 Adoption of the Agenda

7. The Chairman presented an Agenda which was adopted (Annex 1).

### 2.4 Scheduling of oral and poster scientific and technical presentations.

8. A brief discussion took place about the scheduling of oral and poster scientific and technical presentations for the following day.

## 3. ACTIONS ARISING FROM SCDB XXI.

9. Actions from the last meeting were briefly reviewed.

## 4. REVIEW OF ON-GOING ACTIVITIES AND CURRENT PRODUCTS

### 4.1 Report of the GEBCO Bathymetric Editor

*10.* Mr Jacobs, the Bathymetric Editor presented his report (Annex 2). In the run-up to January 2006, when he had taken over the job, the previous incumbent, Mr Hunter, had 1) worked with Ms Weatherall on refining the World Map being published by a Spanish company for educational purposes, 2) prepared a gridded bathymetric dataset of the Clarion Fracture Zone, East Pacific for a third party and 3) hosted a Year 1 Nippon Foundation student from UNH at the National Oceanography Centre, Southampton (NOCS).

*11.* Mr Jacobs said he had had to accept a steep learning curve although his previous project had been based on bathymetry and involved the compilation of multibeam bathymetry. He had also attended a one-day meeting on shallow-water mapping at NOCS and been involved in the production of the new World Map in Sweden. He reported that he had begun to seek out new data. He said he had found that although many scientists were unwilling to submit their data to NGDC they would donate it to GEBCO provided it was not made available to the general public. Some commercial companies had the same attitude.

*12.* Mr Jacobs continued that he regarded map scale, or grid size, as an urgent issue. If GEBCO was going to move away from the concept of a 1' grid it needed to decide on the ultimate resolution. He saw no point in re-gridding data once it had been ingested.

*13.* Finally he stated that he sometimes found his affiliation with the NOCS to be a hindrance to obtaining data. It was better, he thought, to use GEBCO emails and GEBCO business cards.

*14.* The Chairman thanked Mr Jacobs and responded that the question of scale depended on the resolution of the original data and was not really a technical problem but possibly more of a manpower problem. The questions of scale and resolution would be discussed later.

*15.* Dr Fox said he supported the comments about proprietary data because they tallied with the experience of NGDC which works on a case by case basis. NGDC likes to make all derived products free. Mr Jacobs responded that people will donate (x,y,z) data if the raw data are not immediately used but are to be used in derived products in a few years time.

*16.* The Chairman asked if GEBCO needed to define what it wanted to which Mr Jacobs replied that a policy decision was needed. A decision was also needed about how rapidly to update the grid. He said that personally he would like to see relatively rapid updates, at least annually. The Chairman responded that he agreed about the updates. He remarked that updates had previously been slow because they depended on hand-drawn contours which were then digitised and gridded but now the situation was reversed with grid-driven contours which should be a quicker process. Dr Fox concurred and added that it was better not to acquire geographically random data sets.

*17.* Dr Brown said he endorsed a lot of what had been said. He added that copyright was a real issue too even for the present GDA, and it should not be glossed over. He remarked that he was struggling with the resolution problem; he asked was it better to ingest the best available data or to continue to create a 1 arc-minute GDA? He asked whether there was a way of ingesting data, collected at various resolutions, in a consistent way?

*18.* Mr Monahan said he wanted the SCDB to report to the Guiding Committee with recommendations on the subject of how to ingest new data because it was a core issue that also impacted on ingesting commercial data too.

*19.* The Chairman responded that in past meetings there had been opposing technical views on the issue and members had not gone away with a clear action plan for the following year. He believed that the Sub-Committee, even now, was still trying to understand the technical issues.

20. Mr Anderson returned to Mr Jacobs comment about the lack of a GEBCO presence and a GEBCO address. For example, he described the problems encountered in trying to obtain data from the US Navy for the IBCNA. The US Navy had queried the reality of the IBCNA because it exists only in cyberspace. He thought that it was an urgent problem. The Permanent Secretary concurred that the IBCNA was not visible either on the GEBCO web site (www.gebco.net) or on the CGOM or IOC web sites.

21. Dr Ryan noted that all grids also need full metadata about their constituent data sets.

22. Mr Jacobs added that the current regional mapping efforts reflected activity on the original contoured maps. Ideally all data should be in a single global digital database or atlas, if not delays occurred. The Chairman agreed but said that there were historical reasons for the delays in CGOM passing data from the regional products to GEBCO's global grid. Dr Fox noted that it was useful to have regional teams because they held specialised local knowledge and knew whom to contact.

23. Dr Cramer asked what should be done with 'old' contours; should they be rejected or integrated? The Chairman said that historically GEBCO wanted to rapidly update the hand-drawn contours but now we were in the era of grid-driven contours. There should be versioning of these contours. What did the users want? Dr Cramer replied that he didn't know but he thought that if contours were thrown out that resolution might be lost. The Chairman said the Sub-Committee should return to this topic later. Mr Jacobs noted that he assumed that adding new data always improved the grid but even so errors do creep in so he favoured versioning. Mr Tani concluded that GEBCO had to accept any sort of data but that it had to be careful to obtain good metadata too. It was not always clear that new data were better than old so he suggested that both old and new data should be archived.

### 4.2 Report of the GDA Manager

24. The GEBCO Digital Atlas Manager presented her report (Annex 3). She said that the highlights were the following. First, the development of software at BODC which allows the extraction of bathymetry from ENC files obtained by IHB. Second, the very recent delivery of the GEBCO One Minute Grid via the internet. Third, the development at BODC and release of software that allows grid patches to be applied to the One Minute Grid. Finally, the development of Version 2.0 of the GDA software interface which addresses some bugs in the original software but also supplies some new features.

25. The Chairman asked Mr Pharaoh to comment on the report. He replied that Ms Weatherall and Dr Cramer had done an excellent job but even so there was a long way to go and a lot more data to be had from ENCs. The Chairman asked whether individual soundings were coded with a quality factor. Mr Pharaoh replied that groups of soundings were assigned a quality factor.

26. Mr Pharaoh described how he had approached a number of Hydrographic Offices with requests for data. He had requested data from Italy for two different navigational purposes. Lots of data sets were available from the Baltic but none was in the GDA. In Australia he had asked for soundings and ENCs which had been provided to the IHB but with a restrictive copyright contract. Peru had sent a CD but it had not yet arrived. Argentina and Ecuador did not receive a CD sent by the IHB. Examples of the acquired data are given in Annex 4.

27. In summary, he recommended that the following action were taken,
- Produce a sample gridded data set including both shallow and deep water bathymetry.
- Produce a report that includes,
  - the status of data collection

- an outline of the improvements over the previous grid (for the sample area).

● Issue the report to Member States via an IHB Circular Letter that also requests feedback and invites Member States to contribute shallow-water bathymetry
● Establish who is using the GEBCO grid (and GDA)
● Send the report to the GEBCO user community requesting feedback/comment

28. Finally he expressed the opinion that GEBCO should generate status reports which show the changes in the grids as they occur but also ask for more data. He wondered who was actually using the present grid. Mr Pharaoh agreed to write up his experiences **[Action Mr Pharaoh].**

29. Dr Fox said that he had a copy of the data extraction tool and he, or a student, would use it to compare NGDC data with data derived from ENCs.

30. Mr Monahan congratulated Mr Pharaoh on an excellent report and said it was good to see how the project had evolved. He asked Mr Pharaoh to re-visit Durham, NH and to talk to the PCOB students again.

31. Dr Cramer noted that BODC could handle data in the Australian format if required. The Chairman noted that the Australia 1996 datum was unusual but he had discovered a web site that showed how to convert the data.

### 4.3 Report of the IHO Data Centre for Digital Bathymetry (DCDB) including a Report of the WDC for Marine Geology & Geophysics Boulder and a Report on NGDC activities in support of IOC/GEBCO.

32. Dr Fox presented the annual report from the DCDB (Annex 5). He reported that the DCDB continues to grow apace and to be sent increasing amounts of multibeam data. Much of the DCDB can be accessed on-line. NGDC continues to enhance the GEODAS software management system which can now automatically create shape files.

33. Dr Fox continued that the WDC for Marine Geology & Geophysics had worked with several organisations outside the scope of GEBCO and the IOC Regional Mapping Projects. NGDC was working to correct artefacts and discrepancies discovered in the original ETOPO2 dataset and to incorporate a new Coastal Relief Model. New web-accessible animations of relief imagery mainly for educational use have been prepared.

34. Finally, Dr Fox noted that NGDC has also been active in the support of IOC Regional Mapping Projects and GEBCO by supporting the maintenance of the GEBCO web site. A prototype 'network link' has been developed to display undersea feature names from the SCUFN Gazetteer in GoogleEarth. NGDC has also been active in supporting modelling of tsunamis around the coasts of the USA.

35. In answer to a question from Mr Cherkis, Dr Fox replied that NGDC was receiving US survey data. Dr Fox confirmed that it was possible to browse NGDC's metadata. Dr Ryan noted that his laboratory was trying to add metadata to its bathymetric holdings and to create a database of metadata. Dr Schenke agreed that making metadata accessible was very important and he envisaged that in future GEBCO might be able to provide such data to assist cruise planning. Dr Moussart added that ICES also collects some metadata which is held by ICES DataNet coordinated by Ifremer. Dr Brown mentioned that Roy Lowry in his laboratory was setting up a dictionary of oceanographic terms. He concluded that ROSCOP Forms are still used in the UK.

36. Mr Tani noted that the problem of vertical datums, whereby chart datums vary with location, had been considered by NOS but he considered this was essentially a problem for shallow-water

bathymetry. Dr Fox said that there were issues that the Sub-Committee should consider and make recommendations on to the Guiding Committee.

*37.* The Chairman concluded that the Sub-Committee might need to create a sub-group on scale and grid size for the next GEBCO product and one on metadata too. He asked the Sub-Committee for its advice on what other sub-groups were needed. Dr Falconer interjected that GEBCO was still finding out what the key elements might be in the way forward and it might be better to see what ideas turned up along the way.

*38.* Dr Udintsev asked whether the data acquired by NGDC were reaching GEBCO because Dr Fox had not mentioned this in his report. Dr Fox replied that it was better to send data direct to GEBCO.

**4.4 Reports of liaisons with IBCs, regional data centres and SCUFN**

*39.* There was no discussion of this Agenda item.

**4.5 Review of bathymetric mapping worldwide**

*40.* The Chairman regretted that there was not time for a round-table review of data from around the world and this item had to be passed over.

**4.6 Review of known problems and planned updates to GEBCO's products**

*41.* The Chairman asked whether there was any major issue to be addressed under this heading such as a 6th Edition of GEBCO. Dr Brown said he wanted to know what was the plan for the development of the GDA to which the Chairman replied that the main issue was how to ingest new data. He continued that currently the GDA is a Windows-based product but the aim should be for platform independence. The question of the future portals that could access GEBCO had to be discussed. Dr Brown responded by asking whether GEBCO wanted to maintain a definitive grid. The Chairman replied that GEBCO needed to separate the issue of the grid from the future of the GDA.

**4.7 The World Map**

*42.* Mr Anderson described the background to the new World Map. At a Nippon Foundation-GEBCO Project Management Committee meeting two years ago Dr Jakobsson had suggested that two PCOB students should visit his laboratory in Stockholm to start work on a map of the world based on the GDA-CE. Two months ago these students had returned to Stockholm to finish off the map. An Editorial Board had been formed consisting of Dr Hall, Mr Monahan, himself, Dr Jakobsson, Mr Jacobs and the two students Mr Montoro and Lt Cdr Mustafa. He reported that Dr Hall had provided funding for printing 5000 laminated maps and 5000 folded copies. The new map would also be able to be generated using a print-on-demand feature. However, he added, the distribution costs promised to be greater than the printing costs. The first print-run was intended to be for the benefit of schools and LEDCs. Dr Jakobsson planned to write an article about the map for publication in EOS and the National Geographic magazine. The Chairman welcomed this news and said that there was a need to get information about the map to the teachers of 'young' children.

*43.* Mr Monahan asked whether the new map could be blown up to around 1:9 million scale for display on a large wall. Mr Anderson confirmed that, following a request for a replacement for the 5th Edition maps, it was feasible to print the map on four sheets at 1:17.5 million scale. Mr Tani then asked whether the new map was a *de facto* 6th Edition. The Chairman replied that this was a

matter for the Guiding Committee; it was better to look on the new map as an update of the GDA-CE. The Chairman continued by asking whether it was possible to divide the new map into 16 tiles with even more labelling. Mr Anderson replied the Editorial Board had tried to avoid any mention of a 6th Edition because of the histories of earlier editions. He added that print-on-demand is much more expensive when small numbers are printed. Mr Monahan enquired what was meant by print-on-demand, whether it meant a small print-run on a central printer or a one or more copies printed by a remote user. Mr Anderson replied that the second option was not really economical. The Chairman added that the original concept of a gridded dataset did not lend itself to the concept of a 6th Edition set of paper charts.

*44.* Finally Dr Cramer asked whether the files of feature names that had been created for the World Map could be made available to others to save work. The Chairman responded that this was a good example of how SCUFN and the SCDB should liaise.

## 5. SCIENTIFIC AND TECHNICAL OPPORTUNITIES AND CHALLENGES AHEAD

*45.* The Sub-Committee agreed to break up into sub-groups to consider a small number of topics. Potential topics were Shorelines, Vertical datums, Mining shallow-water soundings, Variable-sized grids, Confidence limits and metadata, Data exchange, Ingestion of data, Acting as a One-stop Shop for bathymetry and Education and outreach.

*46.* Dr Ryan pointed out that that with regard to 'Mining shallow-water soundings' Dr Jeff Sacks, an economist and the Director of Columbia University's new Earth Institute, had already formed the opinion that coastal states have to consider releasing near shore data into the public domain simply to save lives. He continued that he hoped that the Guiding Committee would formally request Dr Sacks to obtain such data. Dr Fox responded that the technology and expertise required to ingest near shore data was still being developed in MEDCs. He agreed that LEDCs would soon realise that they needed access to such assistance. In his opinion GEBCO was the international organisation with the expertise to address the problem.

*47.* Dr Ryan commented that with regard to 'Confidence limits and metadata' a three-layer grid was already used for bathymetric data in his laboratory. The three layers were depth, beam number (for multibeam data) and a quality control factor. In his opinion it was much more valuable to keep raw 'ping' files and he believed that GEBCO should consider this as essential.

*48.* Mr Cherkis noted that with regard to 'Education and outreach' Microsoft were very interested in using the GDA in their Virtual Earth. He reminded the Sub-Committee that he had asked them to talk to Microsoft a year ago. While the Chairman confirmed that he had encouraged such an approach it had not proved possible to find a Guiding Committee member to talk to Microsoft. In a similar vein Dr Schenke informed the Sub-Committee that he had been using Google Earth to show the effects of future sea-level rise. It was possible to use a special software tool on the SRTM data that resided in Google (see http://www.floodfiretree.net). The Chairman concluded that this was a great way to reach out to the public and for scientists to see the implications of their predictions.

*49.* Mr Pharaoh noted with regard to 'Variable-sized grids' that he had a proposal to adopt a common framework based on a variable cell-sized structure for the next GEBCO grid. He then explained his proposal.

*50.* The Chairman asked if there would be a problem if there was only one depth value per cell. He said that he was concerned to deal with the step pattern or terracing that was a feature of the GDA.

*51.* The Sub-Committee closed its discussions and reconvened the next morning when the following two Break-out Groups were proposed by the Chairman, 1) GEBCO as a web-based One-stop Shop for bathymetry and 2) The design of the next grid. There was a short discussion about possible additional groups as follows.

*52.* Mr Tani emphasised the need for version control and the Chairman agreed it was required both for input and output data. Dr Falconer said he wanted to ensure that shallow-water data, ENCs and tsunami modelling should be included in the discussions. The Chairman responded that GEBCO first needed to gain experience of using ENC data. He foresaw big problems in building high-resolution grids that allowed for variable vertical datums. He also thought it important to include variable-sized grids. Dr Falconer responded that variable-sized grids and shallow-water areas were subjects in their own rights. They would need to be addressed eventually even if not immediately. The Chairman said that he was concerned to consider topics that could be solved in the next 12 months; if things went well the other topics could then be addressed in turn.

*53.* Mr Pharaoh said he considered that the topics for the break-out groups were right however he would like to see metadata and products being included as well. He was also interested in contours. He was aware that SCUFN was going to produce shape files and GIS files of undersea feature names but such files could have limitations. He would like to see properly documented data files with information on metadata, multibeam geometry and formats in order to create products useful to a wide range of users at which point services would need to be considered too. The Chairman responded by asking whether a One-stop Shop could cover all needs. Mr Pharaoh replied that he envisaged gridded and contoured datasets as separate products. He thought the main question was how to deal with services such as web-map services. He thought that GEBCO needed to step back and consider the structure that would handle the data to ensure that it produced properly documented products. Dr Brown agreed. He thought that the choice was between 1) a 'flashy' product and 2) just delivering a bathymetric grid. GEBCO needed to consider whether it wished to derive an income from its products and whether in fact it has the resources to deliver a 'flashy' product. The Chairman responded that the generation of revenue was a policy issue for the Guiding Committee but the choice of product type was important and had to be considered in the light of competing products.

*54.* The Break-out groups then received their instructions which were to,
- examine the subject
- identify issues, both technical and policy
- make recommendations for actions or work plans, either short-term or long-term, with milestones and indications of who will do what.

*55.* In a final discussion, Mr Anderson added that he thought GEBCO needed a more significant web presence and that this needed to be planned. He suggested that the Sub-Committee should recommend to the Guiding Committee that more effort was required in this area. Dr Fox asked what exactly was required to satisfy the need. He stated that that had to be determined first before the issue of resources could be addressed.

*56.* Dr Fox also noted that the Guiding Committee has a big decision to make regarding the degree of GEBCO's involvement in mapping areas that were less than 200 m deep. He asked the Sub-Committee to tell the Guiding Committee the technical implications of moving into shallow water. The Chairman responded that in his opinion GEBCO had already moved into shallow water as illustrated by its interest in obtaining the most accurate shorelines.

*57.* Dr Ryan said that he wanted to see named volunteers to take on short-term and long-term projects. He also would like to see project milestones being set up. Mr Macnab added that

GEBCO was in a position to persuade governments to divert resources even to cover technical issues.

58. The Chairman suggested that a 'map of maps' or even building a high resolution grid with the majority of cells empty might show how much of the ocean remained to be mapped. Mr Macnab responded that GEBCO needed to indicate the direction in which it wished to move.

59. Dr Ryan suggested that the PCOB students could be involved in the collection of new data for example on cruise liners of opportunity. The Chairman noted that the Sub-Committee had considered this option in the past and that one major problem was that such ships tended to reoccupy the same tracks time and time again. Dr Hall concurred and said that from his own experience it was better to devote resources to the SSPARR buoys. When Mr Cherkis suggested that non-traditional 'adventure' cruises might be tried the Chairman said he was willing to evaluate the project but it needed a volunteer. Capt. Gorziglia noted that the IHO Committee on the Antarctic had worked with IAATO who had offered ship time. He added that he was not sure if such ships had suitable echo-sounders installed but ship details were being circulated to see if the project was feasible. He concluded that IHB was happy to be of assistance if it could help.

60. Ms Weatherall asked whether the ingestion of new data, quality assurance and the proactive location and acquisition of new data sets would be included in the discussions. The Chairman confirmed that these topics should be covered.

61. At this point the Chairman ended the discussion and asked those present to break into two groups, of 12 to 15 persons each, to consider 'Products, services, users etc.' and ' Data acquisition'.

62. The Sub-Committee reconvened after the Break-out groups had met. The Groups' recommendations were as follows,

*Products, services, users etc.(Rapporteur, Dr Falconer)*

63. How to get at data easily? Comparison was made with Ifremer which operated a One-stop Shop for bathymetry. Dr Fox said that he and others would arrange within about 12 months for GEBCO.net to access data from institutions around the world. This would include access to metadata as well. He would work with Mr Pharaoh, Dr Ryan and others **[Action Dr Fox et al.].**

64. Products. This topic involved various levels of detail. There was a need to update a grid of all the data but meanwhile users would wish to provide data in grids of different sizes. It had been decided that a group led by Dr Ryan would investigate the problem with a view to providing nested grids **[Action Dr Ryan].** Other features would include sun shading and the drawing of track lines and profiles as already happens in the GDA. It had also been recognised that feature names were adequate but could do with some improvement possibly with the help of a PCOB student. The group suggested that the Guiding Committee be asked to instruct SCUFN to do this; Mr Pharaoh had already volunteered his assistance.

65. Education and outreach. A comparison was drawn with Italy where an astronomical magazine had circulated 40,000 CDs of the stars. However the group had not reached a clear definition of what was required nor who would do it. Nevertheless there was a consensus that the Guiding Committee should be told that Education and Outreach were necessary. Regarding the use of GEBCO bathymetry by Google Earth it had been decided that 'depths' may well be protected by copyright. Nevertheless it was technically easy to do as was mounting the GDA on the web.

66. Quality control of new data. It had been agreed that, in principle, GEBCO needed to use some form of quality assurance but the actual decision process to be followed had not been established.

*67.* Technological drivers. It had been mentioned that S100 provided standards to be followed in ENCs but as far as GEBCO was concerned it was GEBCO's role to impose new standards.

*The acquisition of new data (Rapporteur, Permanent Secretary)*

*68.* Short-term objectives included the following,

- demonstration that the addition of ENC gridded data actually improves the GDA
- experiment in limited areas with the use of a finer grid size
- form a new hybrid product that consists of the existing 1' grid which is updated with old and new data and also contains uncertainty data. It might also include altimetry data and soundings (in an x,y,z format), whether from NGDC or from web portals.
- define the possible choices of software
- it was urgent to start updating soon.

It was also recognised that advice was needed from the Guiding Committee about the setting up of User Groups.

*69.* Long-term objectives. Set up a Working Group to study the technical feasibility of a 0.1 arc-second (or similar) grid.

*70.* Who will do it? It was recognised that GEBCO would have to depend on Hydrographic Offices, the IHO and BODC for shallow-water data but in other cases who would do the work depended on the task. The Group queried whether the Gridders' Group still functioned.

*71.* The Chairman thanked the rapporteurs and asked for suggestions for Actions. None was forthcoming.

## 7. ANY OTHER BUSINESS

*72.* There was no other business.

## 8. SCIENCE DAY

*73.* On 15th June, in between the two days of Sub-Committee meetings, the Sub-Committee hosted a day of talks and posters presented by many speakers some of whom had previously had no connection with GEBCO. Abstracts of the talks and figures from one talk are given in Annexes 6 and 7, respectively.

## 9. CLOSURE OF THE MEETING

*74.* The Chairman thanked the German hosts of the meeting for their very good logistical arrangements and the speakers on the previous day for their excellent presentations. There being no other business the Chairman closed the meeting at 1752.

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# ANNEX 1

**Twenty Second Meeting of the GEBCO Sub-Committee on Digital Bathymetry**

**German Maritime Museum, Bremerhaven, 14-16 June 2006**

**AGENDA**

1. OPENING OF THE MEETING AND WELCOME FROM LOCAL HOSTS
   1.1 German Maritime Museum welcome: Dr Albrecht Sauer
   1.2 Alfred Wegener Institute welcome: Dr-Ing Hans-Werner Schenke

2. CONDUCT OF THE MEETING
   2.1 Tour de table
   2.2 Tabling of documents
   2.3 Adoption of the Agenda
   2.4 Scheduling of oral and poster scientific and technical presentations

3. ACTIONS ARISING FROM SCDB XXI
   See Action Paper from SCDB XXI

4. REVIEW OF ON-GOING ACTIVITIES AND CURRENT PRODUCTS
   4.1 Report of the GEBCO Bathymetric Editor
   4.2 Report of the GEBCO Digital Atlas Manager
   4.3 Report of the IHO DCDB
   4.4 Report of liaisons with IBCs, regional data centres and SCUFN
   4.5 Review of bathymetric mapping worldwide
   4.6 Review of known problems and planned updates in our products
   4.7 New World Map
   4.8 IHB Circular Letter on mining data from ENCs

5. SCIENTIFIC AND TECHNICAL OPPORTUNITIES AND CHALLENGES AHEAD
   5.1 High resolution coastlines and land elevation data
   5.2 Mining shallow-water soundings from DNCs and ENCs
   5.3 Other new sources or contributions of data
   5.4 Tsunami propagation and run-up models
   5.5 Characterising quality or confidence limits in the grids, contours and contributed data
   5.6 Data exchange
   5.7 Google Earth and other browsers, servers and visualisers
   5.8 Education and outreach

6. SCIENCE DAY
   6.1 Welcome from AWI Director

7. HOW SHALL WE WORK TOWARD FUTURE GOALS AND PRODUCTS?
   7.1 Breakout groups to discuss
      7.1.1 Variable grid technical issues
      7.1.2 Data exchange (web based?)

# ANNEX 2

## Report of the GEBCO Bathymetric Editor and International Liaison

***July 2005 – December 2005 (Peter Hunter)***

Peter Hunter worked with Pauline Weatherall on refining a World Map for a Spanish company who wanted to produce a map largely for educational purposes.

Peter Hunter also reworked the area between the Clarion and Clipperton Fracture Zones in the mid-Pacific Ocean. This effort was initiated by an external (to GEBCO) requirement and once it has been delivered and completed Peter sees no reason why it may not be included in an updated GEBCO grid.

Peter (amongst others) hosted Taisei Morishita, one of the 2005 Nippon Foundation/GEBCO students from the University of New Hampshire, at NOC Southampton for a couple of weeks in summer 2005.

***January 2006 – June 2006 (Colin Jacobs)***

This has been a new venture with a steep learning curve. Whilst I have been very happy to join the GEBCO project, I have also been finishing previous scientific commitments. These have largely been bathymetry based, and that has enabled me to contribute slightly more in this early stage of my participation than I had at first anticipated.

I have been working on an area of the NE Atlantic to the west of Scotland, collecting new, and compiling all available, multibeam bathymetry. This has included material from the UK and France. Other countries (notably Spain) also have data in this area but obtaining that data is another matter.

To the southwest of the UK I have been given permission to incorporate some limited industry (cable survey) data into GEBCO. I plan to target the cable industry over the next few months to see how/if it will be possible to obtain the release of more of their data to populate the global multibeam coverage of the world's oceans.

I am also on a committee that has just submitted a plan to the UK government for mapping the entire UK-claimed continental shelf with multibeam. The project, the UK Seabed Survey, is a very ambitious plan and is in its earliest stages.

I attended an international meeting hosted by Southampton University on "Shallow Water Mapping", with a series of presentations by individuals from the UK, France, and Canada amongst others looking at the variation in current approaches to mapping in shallow waters (which incidentally was defined by the various individuals at the meeting as anything between 100 metres and 0.5 metres).

I attended an international conference in Edinburgh, GeoHab2006, presenting some initial results of multibeam, sonar and photographic data collected in the NE Atlantic in the summer of 2005.

I played a small part in the editing of the latest version of the GEBCO world map currently being prepared for printing in Sweden by Martin Jakobsson.

I am still expected to play a role in science within the National Oceanography Centre, Southampton, as well as my GEBCO duties, and as such am involved in a large multiyear proposal to first map, and then study, biodiversity over some of the seamounts to the west of the UK.

Some initial points to raise, areas of concern and/or guidance that I would like are as follows:

a) some individuals are not particularly happy to give their multibeam datasets to NGDC and thus allow "free access" to all and sundry, especially where they have not yet published all that they wish from those datasets. Yet they seem more willing to give to GEBCO if they are then assured that such data will be published within a global grid in X or Y years time with full acknowledgement of the data source.

b) with the huge amount of multibeam available we need to increase the resolution of the grid – what should we be aiming for? This should be viewed as a single opportunity exercise in that if we decimate a donated dataset to 500 m it is unlikely that we'll have the time to re-decimate the same dataset to 200 m in 5 or 10 years time.

c) should GEBCO be continuing with its own bespoke software or should we be aiming to make the GEBCO grid fully available as, for example, an ESRI grid, which contains its own pyramidal structure and will let the user determine their required resolution rather than have the GEBCO community worry about what others may or may not want?

d) I think that having a GEBCO business card and GEBCO email address would prove very useful in differentiating to potential collaborators that I am from GEBCO and <u>not</u> NOCS. This should also in the long term save money as email addresses on flyers and the like would never go out of date (e.g. Chairman GEBCO or Secretary GEBCO) as opposed to some GEBCO flyers that I have which are still useful but have, for example, Sir Anthony Laughton's email address.

# ANNEX 3

## Report of the GEBCO Digital Atlas Manager (July 2005 – June 2006)

This report covers the work carried out at the British Oceanographic Data Centre (BODC) for the GEBCO project between July 2005 and June 2006.

### 1. Extraction of shallow water bathymetry data from Electronic Navigation Charts (S-57 format)

At the GEBCO meetings in 2005 discussions took place on the extraction of shallow water bathymetry data from Electronic Navigation Charts (ENC). It was decided to investigate the possibility of developing software that could be supplied to Hydrographic Offices which would allow them to extract data from ENC files into simple ASCII format files. This data could be used by GEBCO to improve the GEBCO grid in shallow water regions. This work was led by Tony Pharaoh at the International Hydrographic Bureau (IHB).

Software (DecodeENC) was developed at BODC which allowed the extraction of bathymetry and quality assurance data from ENC files (S-57 format files) into simple ASCII format files.

The software application extracts data from the following GEO object and Meta object classes as defined in the S-57 documentation (acronyms in bold text):

GEO Object Classes:

Coastline (**COALNE**), Depth contour (**DEPCNT**) and Sounding (**SOUNDG**)

Meta Object Classes:

Vertical datum of data (**M_VDAT**); Sounding datum (**M_SDAT**) and Quality of data (**M_QUAL**)

The software application will extract all available attributes for these objects.

The application is a user-friendly wrapper for a software programme called **ogrinfo**. This is part of a set of Open Source Geographic Information System (GIS) tools (http://fwtools.maptools.org).

The software and accompanying documentation were finalised in April 2006 and were sent out on CD-ROM by the IHB to Member States. Member States were asked to send any reformatted data to the IHB. This data is then passed on to BODC.

To date, the following data sets have been received:

Data extracted using the DecodeENC software

1. Bathymetric sounding point data, bathymetric contour, coastline and quality of data information for the area around United States of America provided by the US National Ocean Service. The bathymetric sounding point data set consists of 202273 data points.
2. Bathymetric sounding point data, coastline, vertical datum information and quality of data information for the area around Sweden provided by the Swedish Maritime Agency. The sounding point data set consists of 23331 data points.
3. Bathymetric sounding point data, coastline, bathymetric contour and quality of data information for the area off Poland. The sounding point data set consists of 5062 points.
4. Data for the area around Korea supplied by the National Oceanographic Research Institute, Republic of Korea. The sounding point data set consists of 110050 points.
5. Bathymetric sounding point data, coastline, bathymetric contour and quality of data information for the area around Italy, supplied by the Istituto Idrografico Della Marina.The sounding point data set consists of 52498 data points.

Data delivered in the supplier's own format

1. Bathymetric sounding point data for the area around Australia provided by the Australian Hydrographic Service (AHS). The data were provided in the AHS's own Hydrographic Transfer Format. The data set consists of over 1291800 data points, which have accompanying metadata. The data are relative to the Australian Geodetic Datum 1966.

Preliminary processing of the data has been carried out to view the data sets in a GIS.

**2. Delivery of the GEBCO One Minute Grid via the internet**

In January 2004 BODC launched a web application for delivering data from the GEBCO One Minute Grid as a series of 20 degree square data tiles in netCDF along with accompanying images for each tile. Over 4900 downloads have been made from this web application since its launch.

Further work has now been done to enhance the delivery of the GEBCO One Minute Grid via the internet. This has been carried out in two stages:

1. The original application was modified to allow the user to download as many 20 degree square data tiles as required per user session. This revised web application was launched in January 2006.

2. Work began in March 2006 on the development of a new web application which would allow the user to:

- Download data for a user-defined geographic area using either an interactive map or by typing in the co-ordinates in a form.
- Download the complete global grid file.
- Download the data in the form of 20 degree square tiles.

The data will be delivered in netCDF along with accompanying documentation.

This application is scheduled for launch in June 2006. It will be available via the following web link: http://www.bodc.ac.uk/data/online_delivery/gebco/

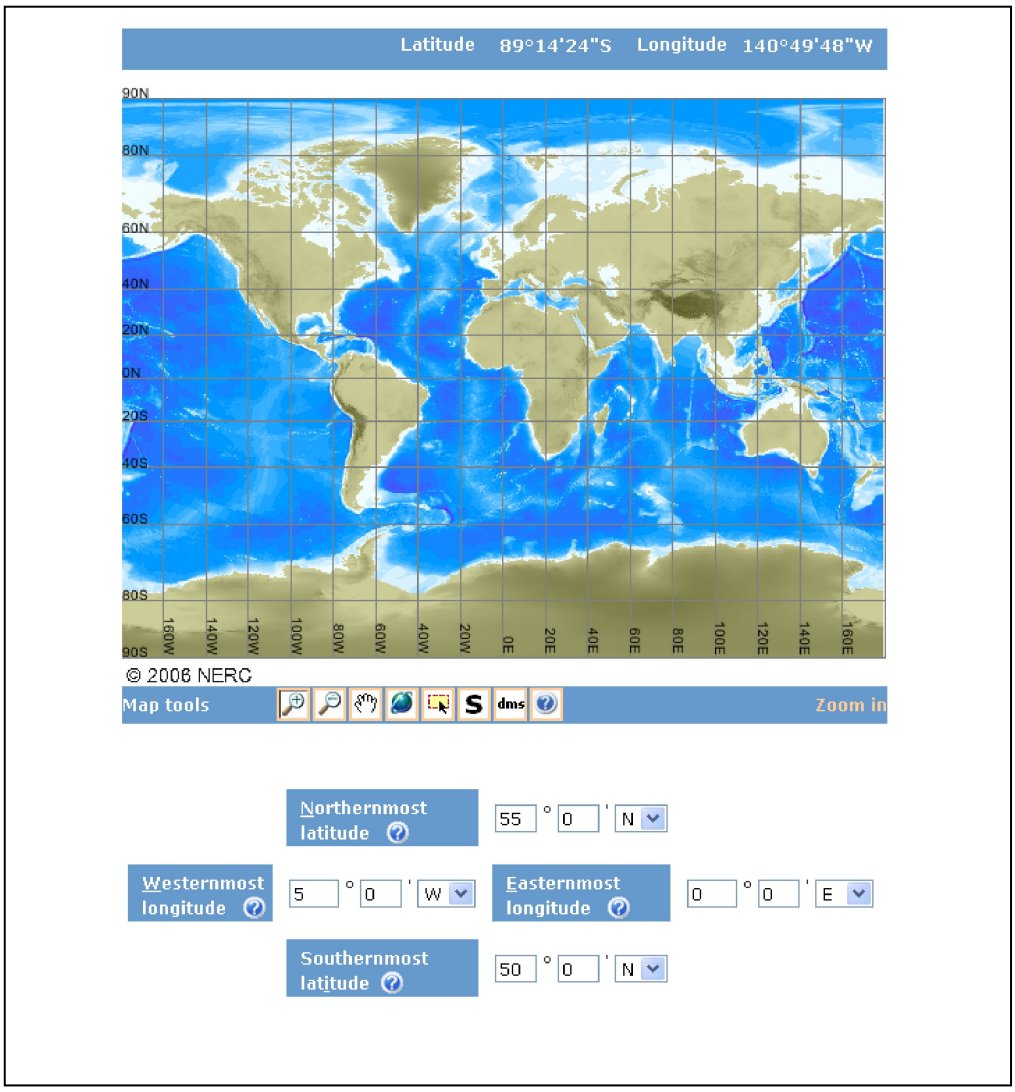



*Image shows the interactive map - part of the web application for access to the GEBCO One Minute Grid*

## 3. Grid patches and grid patch software for the GEBCO One Minute Grid

As reported at the GEBCO meetings in 2005, software has been developed at BODC to allow grid patches to be applied to the GEBCO One Minute Grid to fix bugs in the grid file. Grid patches have been supplied to fix bugs in the grid for the Hudson Bay area and the section off the west coast of Africa by William Rankin of the US Naval Oceanographic Office. The software, grid patches and accompanying documentation have been made available from BODC's web site at: http://www.bodc.ac.uk/help_and_hints/errata/gebco.html. This link is also available from the GEBCO web pages at NGDC.

A note has been included with current mailings of the GDA CD-ROM to inform users that these bug fixes are available.

An email list consisting of the email addresses of users of the GEBCO Digital Atlas has been setup. The information is taken from the GDA customer database held at BODC. A number of users who originally did not supply email addresses were written to and asked to provide details if they wished to be contacted about GEBCO project developments.

An email was sent round to inform GDA users that the bug fixes are now available.

Additional grid patches have been supplied by Bill Rankin to fix lines of discontinuity in the GEBCO One Minute Grid in the area around 65°N, 12°W.

## 4. Development of version 2.0 of the GDA Software Interface

Reported bugs in version 1.0 of the GDA software interface have been fixed. In addition, a number of new software features have been included:

- The user can add data from their own files of data points for display. The data points can be accompanied by attribute information which can be displayed on screen.
- Select to display the position of features from the IHO/IOC Gazetteer of Geographic Names of Undersea Features by feature type. For example, the user can select to display the position of just seamounts or just seamounts and ridges.
- Select to display the name text of one and two point features from IHO/IOC Gazetteer of Geographic Names of Undersea Features
- Use a 'magnify' tool to visualise areas of the map display at higher display resolution.

It is intended that the software and accompanying documentation will be made available from BODC's web site at the end of July 2006 from the 'Hints, bugs and fixes' pages (http://www.bodc.ac.uk/help_and_hints/errata/gebco.html).

## 5. User support and CD-ROM orders

During the year 73 enquiries relating to the GDA and its data sets have been received and answered and 127 CD-ROM orders have been processed.

**DISTRIBUTION/SALES OF THE CENTENARY EDITION OF THE GEBCO DIGITAL ATLAS**
**(March 2003 – 31 May 2006)**

| | SECTOR | | | | | |
|---|---|---|---|---|---|---|
| **Country** | **Gov** | **Univ** | **Comm** | **Other** | **Total** | **(sold)** |
| Algeria | 1 | - | - | - | 1 | (0) |
| Angola | 1 | - | - | - | 1 | (0) |
| Argentina | 4 | 1 | - | - | 5 | (1) |
| Australia | 10 | 11 | 8 | 2 | 31 | (27) |
| Austria | - | 1 | - | - | 1 | (1) |
| Bangladesh | 1 | - | - | - | 1 | (0) |
| Barbados | 1 | 1 | - | - | 2 | (1) |
| Belgium | 5 | 1 | - | 28 | 34 | (2) |
| Benin | 1 | - | - | - | 1 | (0) |
| Brazil | 2 | 1 | - | - | 3 | (2) |
| Cameroon | 1 | 1 | - | 1 | 3 | (0) |
| Canada | 12 | 10 | 9 | 2 | 33 | (22) |
| Chile | 4 | 1 | - | 3 | 8 | (0) |
| China | 3 | 2 | - | 2 | 7 | (2) |
| Colombia | 3 | - | - | - | 3 | (0) |
| Comoros | 1 | - | - | - | 1 | (0) |
| Congo | 1 | - | - | - | 1 | (0) |
| Cote d'Ivoire | 2 | - | - | - | 2 | (0) |
| Croatia | 1 | - | - | - | 1 | (0) |
| Cuba | 1 | - | - | - | 1 | (0) |
| Denmark | 3 | 3 | 1 | 2 | 9 | (8) |
| Dominica | 2 | - | - | - | 2 | (0) |
| Dominican Rep. | 1 | - | - | - | 1 | (0) |
| Ecuador | 2 | - | - | - | 2 | (0) |
| Egypt | 1 | - | - | - | 1 | (0) |
| Estonia | 2 | - | - | 2 | 4 | (0) |
| Faeroes | 2 | - | - | - | 2 | (0) |
| Finland | 2 | 1 | 1 | - | 4 | (2) |
| France | 18 | 3 | 7 | 10 | 38 | (21) |
| Gabon | 1 | - | - | - | 1 | (0) |
| Germany | 17 | 13 | 4 | 9 | 43 | (36) |
| Ghana | 1 | - | - | 1 | 2 | (0) |
| Greece | 1 | - | - | 1 | 2 | (1) |
| Guinea | 2 | - | - | - | 2 | (0) |
| Hong Kong | - | 1 | 1 | - | 2 | (2) |
| Iceland | 2 | - | - | - | 2 | (0) |
| India | 4 | - | - | 1 | 5 | (2) |
| Indonesia | 1 | - | 1 | 2 | 4 | (1) |
| Ireland | 1 | 3 | - | 4 | 8 | (7) |
| Israel | 1 | - | - | - | 1 | (0) |
| Italy | 8 | 3 | 1 | 10 | 22 | (10) |
| Jamaica | 1 | - | - | - | 1 | (0) |

| | SECTOR | | | | | |
|---|---|---|---|---|---|---|
| **Country** | **Gov** | **Univ** | **Comm** | **Other** | **Total** | **(sold)** |
| Japan | 8 | 14 | 11 | 3 | 36 | (28) |
| Kenya | 1 | - | - | 1 | 2 | (0) |
| Korea | 2 | 2 | - | - | 4 | (4) |
| Madagascar | 1 | - | - | - | 1 | (0) |
| Mauritania | 1 | - | - | - | 1 | (0) |
| Mauritius | 3 | - | - | - | 3 | (0) |
| Mexico | 6 | - | - | - | 6 | (0) |
| Monaco | - | - | - | 46 | 46 | (0) |
| Morocco | 2 | 3 | - | - | 5 | (0) |
| Mozambique | 3 | - | - | - | 3 | (0) |
| Namibia | 2 | - | - | 1 | 3 | (2) |
| Netherlands | 5 | 3 | 4 | 6 | 18 | (12) |
| New Zealand | 4 | - | 2 | 1 | 7 | (4) |
| Nigeria | 1 | - | - | - | 1 | (0) |
| Norway | 10 | 2 | 9 | 3 | 24 | (16) |
| Oman | - | 1 | - | - | 1 | (1) |
| Pakistan | 2 | - | - | 1 | 3 | (0) |
| Panama | 1 | 1 | - | - | 2 | (0) |
| Peru | 4 | - | - | 2 | 6 | (0) |
| Philippines | 1 | 1 | - | 3 | 5 | (2) |
| Poland | 3 | - | - | 1 | 4 | (0) |
| Portugal | 5 | 3 | - | 3 | 11 | (5) |
| Russia | 4 | - | - | 5 | 9 | (1) |
| Saint Lucia | 1 | - | - | - | 1 | (0) |
| Senegal | 1 | - | - | - | 1 | (0) |
| Seychelles | 4 | - | - | - | 4 | (1) |
| South Africa | 3 | 1 | 2 | 2 | 8 | (4) |
| Spain | 13 | 8 | 9 | 4 | 34 | (32) |
| Sudan | - | - | - | 1 | 1 | (0) |
| Sweden | 4 | - | - | - | 4 | (2) |
| Switzerland | 1 | 1 | 1 | 2 | 5 | (4) |
| Tanzania | 1 | - | - | - | 1 | (0) |
| Togo | 2 | - | - | - | 2 | (0) |
| Trinidad & Tobago | 1 | - | - | - | 1 | (0) |
| Tunisia | 1 | - | - | - | 1 | (0) |
| Ukraine | 1 | - | - | 1 | 2 | (0) |
| UK | 45 | 38 | 97 | 35 | 215 | (139) |
| USA | 31 | 62 | 73 | 47 | 213 | (147) |
| Venezuela | 1 | - | - | - | 1 | (1) |
| Vietnam | - | - | - | 1 | 1 | (0) |
| TOTAL | 307 | 197 | 241 | 249 | 994 | (553) |

*Figures above refer to total number of copies sold or distributed up to 31 May 2006. GOV = Government/Public funded organisation; UNIV = University; COMM = Commercial organisation. Number in parenthesis refers to total number of copies sold as opposed to complimentary copies.*

# DISTRIBUTION/SALES OF GEBCO DIGITAL ATLAS – SUMMARY STATISTICS (up to 31 May 2006)

a) Total number sold/distributed = 994 copies
Total number sold = 553 copies
Number of complimentary copies = 441 copies

b) Copies sold/distributed to 82 countries

c) Breakdown of copies sold/distributed by sector:

| | |
|---|---|
| Government bodies | 307 copies |
| University groups | 197 copies |
| Commercial bodies | 241 copies |
| Other organisations | 249 copies |

d) Distribution of 441 complimentary copies:

| | |
|---|---|
| GEBCO Centenary Conference: | 104 copies |
| Distributed by IHB on request from IHO member states: | 64 copies |
| Distributed to UNCLOS Commissioners on request: | 10 copies |
| Customers purchasing GEBCO-97 from 1 January 2002: | 21 copies |
| International and UK national exchange: | 197 copies |
| IODE training programmes | 45 copies |

e) Sales/distribution by month:

| | Sold | Gratis | Total |
|---|---|---|---|
| *2003* | | | |
| Jan | - | - | - |
| Feb | - | - | - |
| Mar | - | 4 | 4 |
| Apr | 25 | 114 | 139 |
| May | 44 | 46 | 90 |
| Jun | 34 | 9 | 43 |
| Jul | 23 | 28 | 51 |
| Aug | 14 | 1 | 15 |
| Sep | 22 | 39 | 61 |
| Oct | 14 | 16 | 30 |
| Nov | 10 | 1 | 11 |
| Dec | 11 | 1 | 12 |
| Total | 197 | 259 | 456 |

| | Sold | Gratis | Total |
|---|---|---|---|
| *2004* | | | |
| Jan | 22 | 1 | 23 |
| Feb | 11 | 2 | 13 |
| Mar | 7 | 2 | 9 |
| Apr | 7 | 9 | 16 |
| May | 13 | - | 13 |
| Jun | 19 | 5 | 24 |
| Jul | 11 | 23 | 34 |
| Aug | 10 | 2 | 12 |
| Sep | 7 | 2 | 9 |
| Oct | 3 | 10 | 13 |
| Nov | 14 | 4 | 18 |
| Dec | 8 | 1 | 9 |
| Total | 132 | 61 | 193 |

| | Sold | Gratis | Total |
|---|---|---|---|
| *2005* | | | |
| Jan | 19 | - | 19 |
| Feb | 11 | - | 11 |
| Mar | 12 | 2 | 14 |
| Apr | 11 | 13 | 24 |
| May | 7 | - | 7 |
| Jun | 6 | - | 6 |
| Jul | 4 | - | 4 |
| Aug | 4 | 40 | 44 |
| Sep | 11 | 2 | 13 |
| Oct | 8 | 1 | 9 |
| Nov | 6 | 19 | 25 |
| Dec | 13 | 1 | 14 |
| Total | 112 | 78 | 190 |

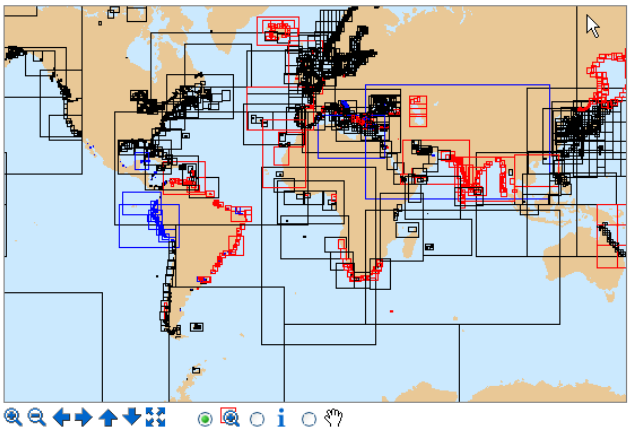
| | Sold | Gratis | Total |
|---|---|---|---|
| *2006* | | | |
| Jan | 7 | - | 7 |
| Feb | 15 | 12 | 27 |
| Mar | 73 | 1 | 74 |
| Apr | 12 | - | 12 |
| May | 8 | 27 | 35 |
| Jun | x | x | x |
| Jul | x | x | x |
| Aug | x | x | x |
| Sep | x | x | x |
| Oct | x | x | x |
| Nov | x | x | x |
| Dec | x | x | x |
| Total | 115 | 40 | 155 |

**ANNEX 4**

# 22nd SCDB Meeting

## June 2006 Bremerhaven Germany

## Collection of Shallow Water Bathymetry



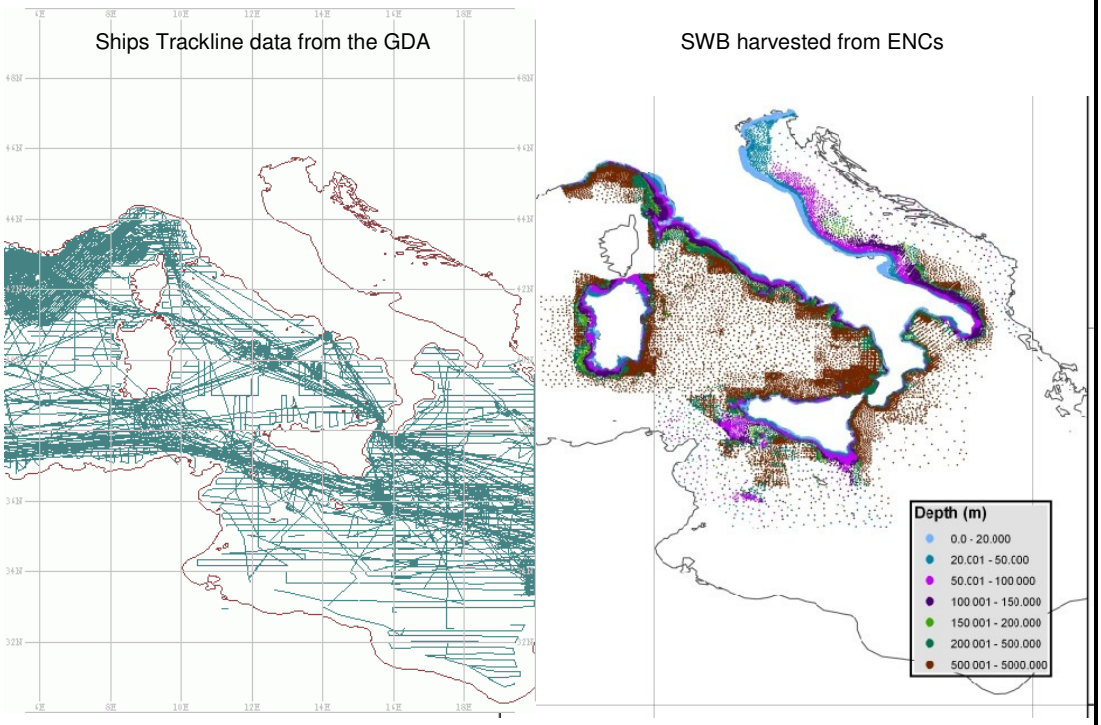
by

Tony Pharaoh, International Hydrographic Bureau, Monaco

## Italy

Ships Trackline data from the GDA

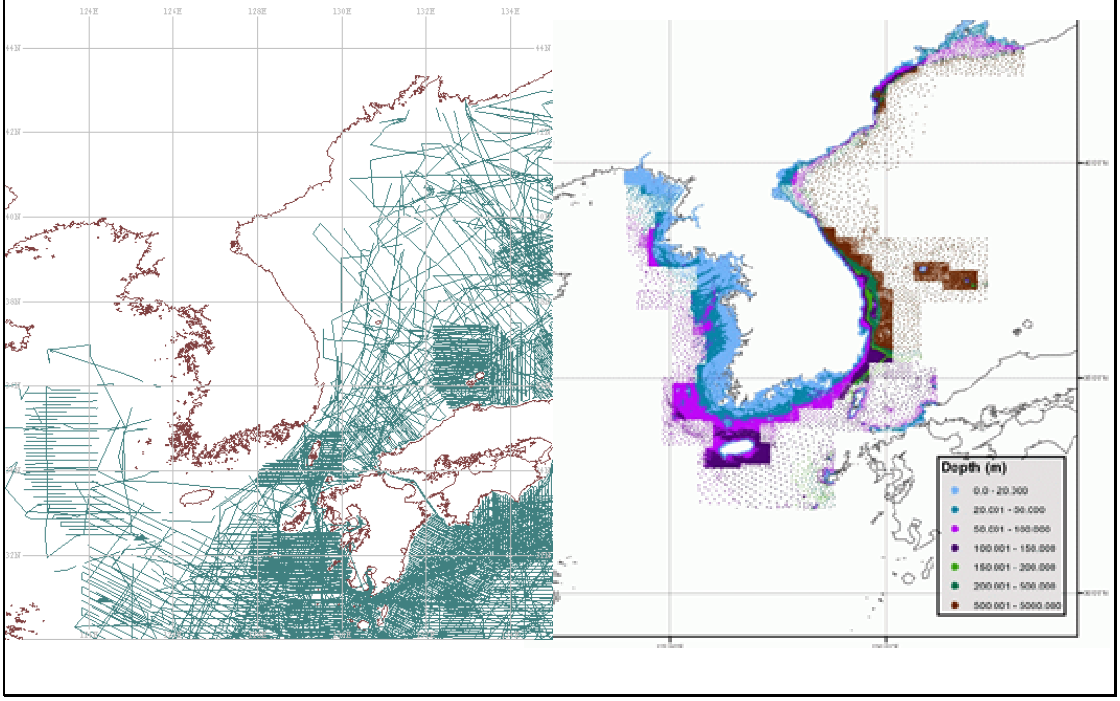
SWB harvested from ENCs

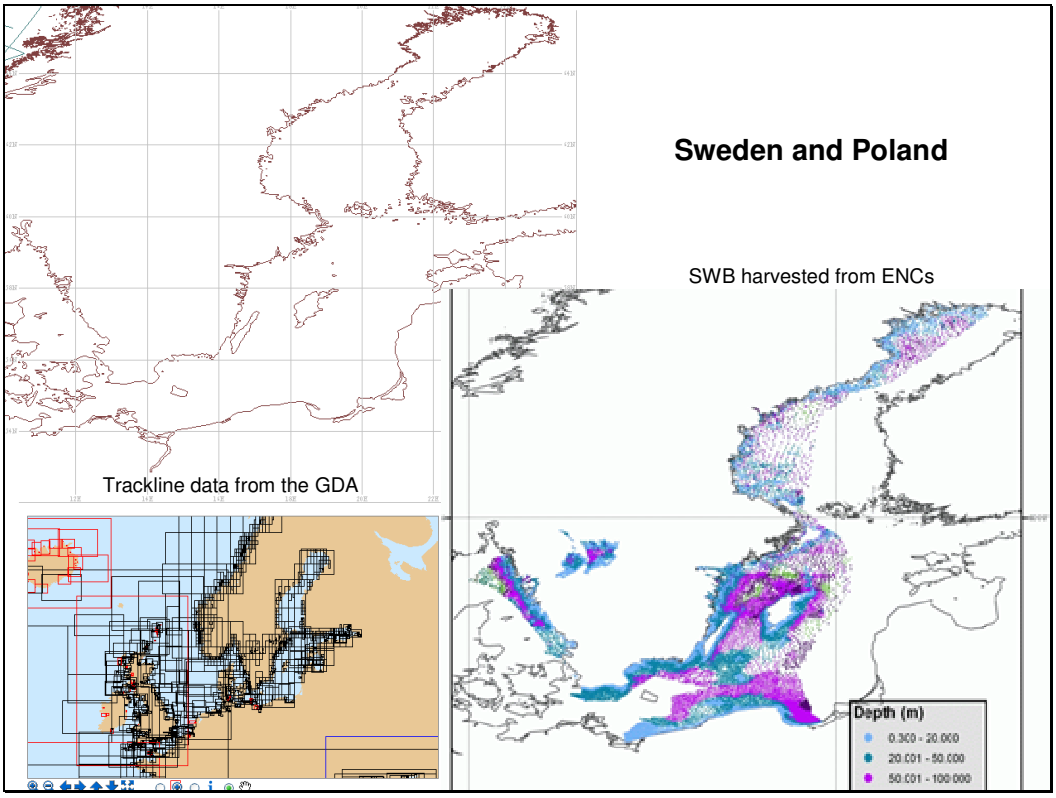


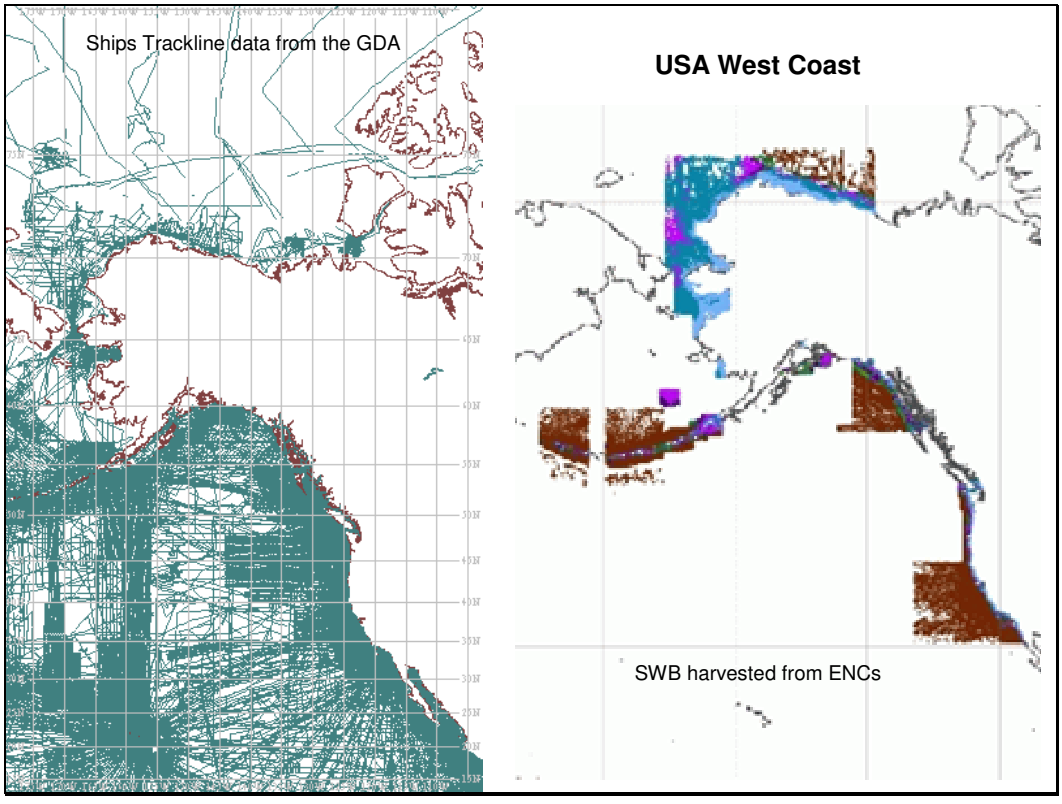

## Republic of Korea

Trackline data from the GDA

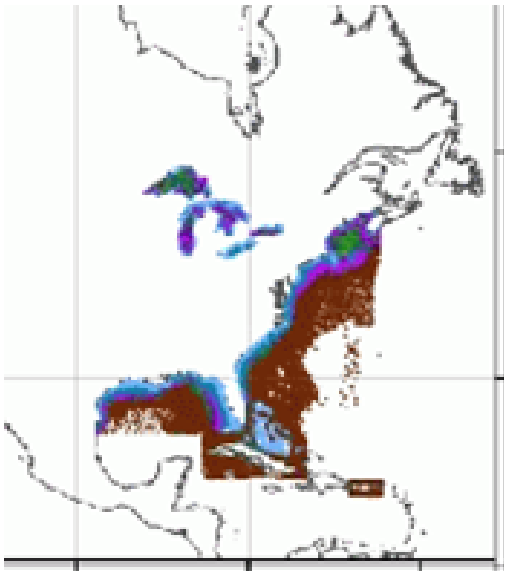
SWB harvested from ENCs



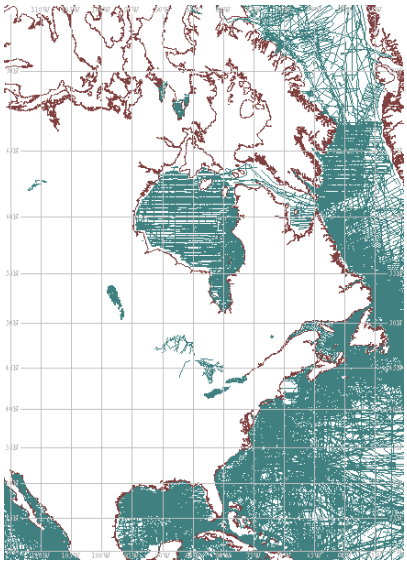

Sweden and Poland
SWB harvested from ENCs
Trackline data from the GDA
Depth (m)
0.300 - 20.000
20.001 - 50.000
50.001 - 100.000


Ships Trackline data from the GDA
USA West Coast
SWB harvested from ENCs

**USA West Coast**



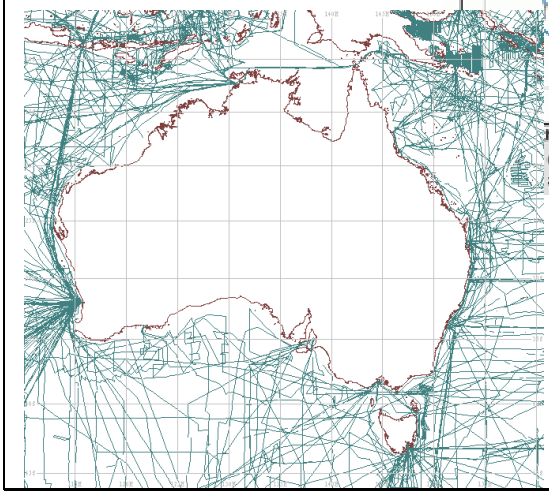
Ships Trackline data from the GDA

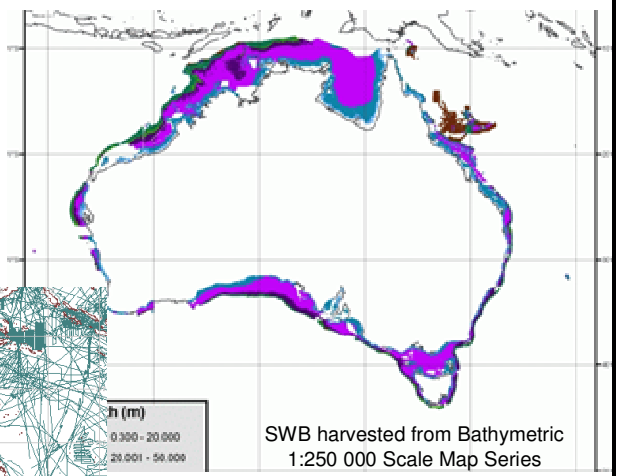


SWB harvested from ENCs

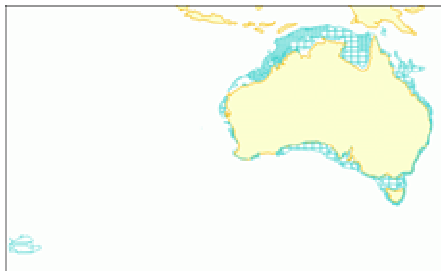
**Australia**

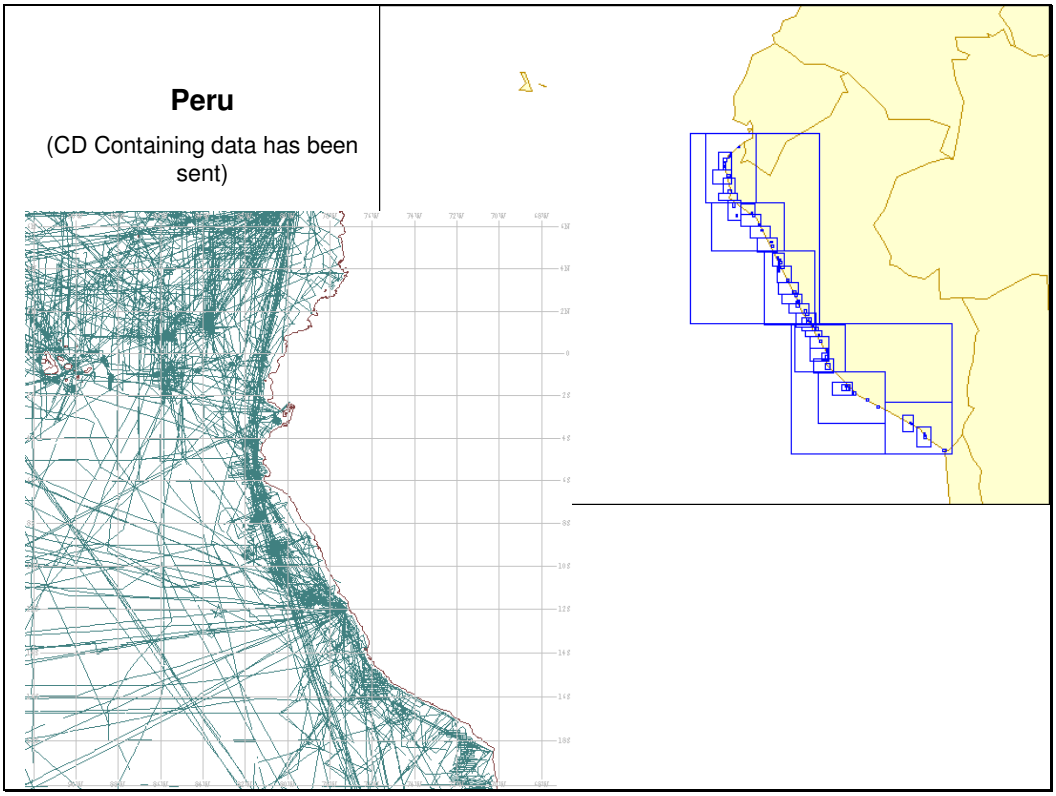
Trackline data from the GDA

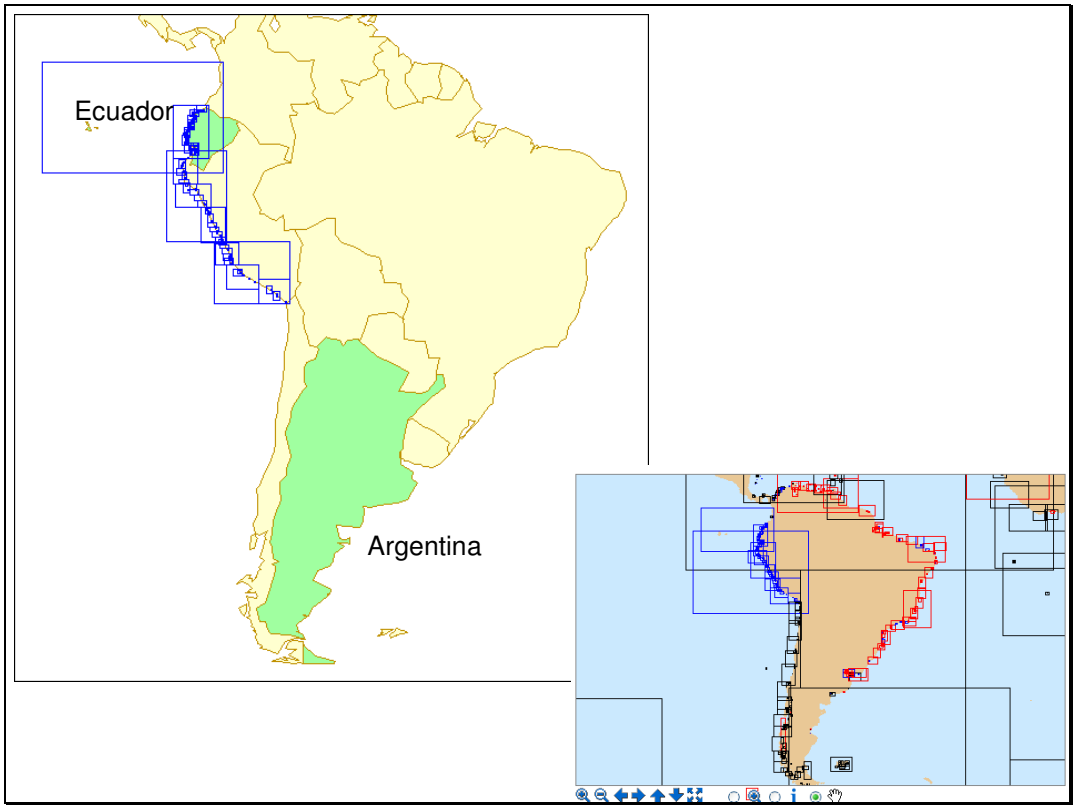




SWB harvested from Bathymetric 1:250 000 Scale Map Series




Peru
(CD Containing data has been sent)


Ecuador
Argentina

**Follow up Action ??**

Produce a sample gridded data set including both shallow and deep water bathymetry.

Produce a report that includes

- the **status** of data collection

- an **outline of the improvements** over the previous grid (for the sample area).

**Issue the report to Member States via CL**

– requesting **feedback** inviting MS to **contribute SWB**.

Need to establish who is using the GEBCO grid (and GDA)

Send the report to user community requesting feedback/comment

# ANNEX 5

International Hydrographic Organization Data Center for Digital Bathymetry /
World Data Center for Marine Geology and Geophysics at Boulder /
National Geophysical Data Center

# Reports to GEBCO

June 2006

**Bremerhaven, Germany**

# I. REPORT OF THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION DATA CENTER FOR DIGITAL BATHYMETRY (IHO DCDB)

## I-A. Bathymetric Data Holdings and Global Database Management

Since the July 2005 Meeting of the GEBCO Sub-Committee on Digital Bathymetry, the National Geophysical Data Center (NGDC) has responded to 44 international requests for marine geology and geophysics data from 19 countries of which 13 are IHO Member States. This contrasts with over 352 total sales requests within this category from the U.S. over the same time. The overall number of requests is dropping, as is expected due to NGDC placing more data online for direct download.

Version 4.1.23 of the global Marine Trackline Geophysics data set became available in October 2005 on a single DVD-ROM, which may be ordered online at http://www.ngdc.noaa.gov/mgg/fliers/03mgg02.html. The new release contains an additional 97,000 nautical miles of bathymetry, magnetics, and gravity from 40 surveys added since Version 4.1.22. Also provided on the DVD is GEODAS search and retrieval software, which runs under MS Windows®, UNIX Xwindows, and Macintosh OS-X. NGDC's global Marine Trackline Geophysics database continues to grow and now includes 43.7 million soundings from over 4,600 cruises. During this reporting period, 274,000 soundings were assimilated, originating from 13 cruises covering over 40,000 nautical miles.

Over the reporting period, NGDC received a total of 370 gigabytes of deep-water multibeam bathymetric data from over 60 surveys. The University of South Florida sent the majority of this data (190 gigabytes). Other significant contributions include 81 gigabytes of data from NOAA/NOS and 33 gigabytes downloaded from the Scripps Institution of Oceanography. The Multibeam Bathymetric Database now holds 623 gigabytes of data from 840 cruises.

NGDC continues to offer online access to its multibeam bathymetric data holdings using an interactive mapping tool with query capabilities at http://map.ngdc.noaa.gov/website/mgg/multibeam/. The queries can be conducted using several parameters including ship, source (institution), and survey name. In addition, NGDC has provided an interactive website, which allows the user to generate color relief maps (with contours, if desired) and grids of the data using NOAA/PMEL's AutoChart, Generic Mapping Tools (GMT), and MBSystem software. The maps and grids are provided in Postscript and GMT formats, respectively, and users have the option to download the source data. Over the reporting period, the map received an average of 6,362 hits/month.

NGDC's U.S. coastal database contains data collected during National Ocean Service (NOS) hydrographic survey operations. Over the reporting period, the database grew by 458 surveys including 2,239,589 soundings and 109,401 features. The database now contains over 77 million soundings and features from 6,684 surveys, providing valuable input to bathymetric base maps, Geographic Information Systems, geophysical exploration, coastal engineering studies, and seafloor habitat mapping. This database is the primary data source for NGDC's Coastal Relief Model efforts.

NGDC continues to archive digital sidescan sonar data and imagery collected as part of NOS survey operations. These data contain digital files of sidescan sonar data and cleaned, mosaiced imagery of the seafloor. NGDC is offering these large images for download over the internet, and is working to develop products derived from these data. Over 4 terabytes of sidescan sonar data have been archived. The shear volume of the data is providing IT challenges in the areas of data archive, access, and product generation.

NOS hydrographic survey data is accessible to the public through an interactive map service maintained at NGDC. The NOS Hydrographic Survey Data Map Service at http://map.ngdc.noaa.gov/website/mgg/nos_hydro/ is a data discovery and download tool that allows the user to quickly and easily make spatial or textual searches for surveys of interest, then download survey-related data products. NGDC is now archiving numerous digital data files of survey data, including metadata documents, survey plots, sounding data in XYZ and HYD93 formats, sidescan sonar mosaics, shaded-relief images, and gridded data in text form. Over 8,700 NOS Descriptive Reports containing detailed survey metadata are currently available, in addition to over 23,400 final smooth sheet images scanned from original plots of the survey area using corrected hydrographic data. The map service enables NGDC to deliver these products, including high resolution multibeam and sidescan sonar data, over one interactive, web-based system. The site gained in popularity over the last year, receiving an average of 11,579 hits/month.

### I-B. GEODAS Software Development

NGDC continues to enhance the GEODAS software management system. Originally developed to manage marine geophysical trackline data, GEODAS has evolved into a universal software management tool, which can handle a variety of data formats and types including single-beam/multibeam, trackline/survey, and gridded bathymetric/topographic data. The software serves users both as a desktop application on various NGDC CD and DVD products, and as an online search, display, and retrieval system. GEODAS software runs under Microsoft® Windows™ for PCs, Xwindows for UNIX™, and Mac OS-X for Macintosh platforms. The window driven interfaces simplify data searches, guide users with a context-sensitive help system, and support color postscript and screen plotting capabilities.

The latest development in GEODAS functionality is the automated creation of shape files for use in other spatial applications. Shape files are generated on-demand for soundings, survey outlines, shoreline, and metadata. This allows data from GEODAS to be imported easily into GIS systems such as ArcGIS.

Another recent development is the addition of links to view individual cruise plots and metadata for data sets in a list of search results. This feature offers a quick and convenient means of examining the spatial extent of a particular cruise through a PDF plot, and viewing header metadata on an HTML page. The links are presented following each cruise in a list of GEODAS search results, and are labeled ‘metadata’ and ‘plot’.

On-line users can create and download custom grids of NGDC gridded datasets ETOPO2, Coastal Relief Model, and Great Lakes Bathymetry. Output to several formats with various grid parameter options is offered using the GEODAS Grid Translator page at http://www.ngdc.noaa.gov/mgg/gdas/gd_designagrid.html.

A customized version of the standard GEODAS interface is also available, which produces output in the form of the IHO B-4, Information Concerning Recent Bathymetric Data publication. The IHO data search and retrieval utility is accessible from the following link: http://www.ngdc.noaa.gov/mgg/gdas/iho/gd_sys.html. The advantages to using this interface are the ability to search the database using GEBCO or British plotting sheet boundaries as a reference, the production of individual and composite plots of survey tracklines, and the display of cruise metadata in a standard, B-4 format.

# II. REPORT OF THE WDC FOR MARINE GEOLOGY & GEOPHYSICS, BOULDER

NGDC, in its capacity as the World Data Center for Marine Geology and Geophysics (WDC MGG), Boulder, promotes excellence in archiving, managing, and exchanging data obtained from measurements of the seafloor, and works with national and international groups on many projects outside the scope of the IHO DCDB, GEBCO, and the IOC Regional Mapping Projects.

Although the WDC MGG, Boulder manages all types of data from the ocean floor including descriptions and analyses of seafloor samples, deep drilling data, underway geophysical measurements, and derived gridded data sets, only those areas dealing with bathymetry will be mentioned in this report.

## II-A. U. S. – Canada Cooperation on New Bathymetry for the Great Lakes

New bathymetry for the Great Lakes has resulted from a long-term international cooperative effort between NOAA/ NGDC, NOAA/ Great Lakes Environmental Research Laboratory (GLERL), and the Canadian Hydrographic Service. Bathymetry is complete for lakes Erie, St. Clair, Michigan, Ontario, and Huron, and is progressing steadily for Lake Superior.

NGDC maintains web pages for Great Lakes bathymetry at http://www.ngdc.noaa.gov/mgg/greatlakes/greatlakes.html. These pages provide direct links to the web of related external organizations including NOAA/GLERL, the Canadian Hydrographic Survey, and the Great Lakes Information Network. An online, interactive map service is available featuring the Great Lakes, and is accessible from the Great Lakes web page. The map includes a coastline for the entire Great Lakes as well as bathymetric contours for Lakes Ontario, Michigan, Erie, St. Claire, and Huron. The map service received an average of 2,262 hits/month over the reporting period. Grids of Great Lakes data can be downloaded from the Great Lakes web page using GEODAS software for Lakes Michigan, Erie, and St Claire by clicking on the lake of interest and then clicking on the 'Create and download a custom grid of …' link.

## II-B. U. S. – Japan Cooperative Program in Natural Resources (UJNR)

A UJNR Sea-Bottom Surveys Panel Meeting of the U.S.-Japan Cooperative Program in Natural Resources has not taken place since the 32nd Meeting held in February 2004. This panel continues as one of the principal mechanisms by which Japan and NGDC exchange technologies and marine geophysical data, including bathymetry.

## II-C. WDC MGG, Boulder, On-Line Activities

The web pages of the WDC MGG, Boulder, collocated with those of the NGDC's Marine Geology and Geophysics Division, averaged 2,208,608 hits/month during the period from June 2005 through April 2006, compared with 2,013,684 hits/month over the last reporting period. Over this reporting period, users downloaded an average of 1,597 gigabytes of data from the MGG website each month, compared with 357 gigabytes per

month during 2004-2005. NGDC's web software no longer reports unique users or countries at the MGG divisional level, as identified in some previous reports. The WDC MGG website can be found at http://www.ngdc.noaa.gov/mgg/aboutmgg/aboutwdcmgg.html.

### II-D. ETOPO2

In September 2001, NGDC released a high-resolution global topography and bathymetry database, ETOPO2, based primarily on the work of Smith and Sandwell between the 72° north and 72° south, the GLOBE elevations for the land masses, the IBCAO bathymetry and Greenland topography and DBDB5 and DBDBV for a few small areas. ETOPO2 was a 2 arc-minute latitude-longitude grid of elevations and depths, compiled from these source databases.

Since that release, a number of artifacts have been detected by users, including mis-registration, false features, and feature scaling. NGDC is currently working with colleagues to revise the database, correcting these and other discrepancies uncovered during quality assessment investigations. We have resampled the GLOBE data, accounting for differing grid registrations, and have eliminated the one-cell, westward mis-registration in the original ETOPO2 compilation. The Smith and Sandwell database was resampled to remove some small north-south errors in the conversion to latitude-longitude and will be correctly positioned in the east-west direction. In addition, the fruits of our Coastal Relief Model and Great Lakes data will be incorporated along with Russian shoreline and contours of the Caspian Sea. The revised, ETOPO2v2, database will have its consistent, new protocol documented and made available with the data along with complete descriptions of the source data sets. Preliminary versions of ETOPO2v2 are currently out to reviewers for a critical quality assessment before being publicly posted on the web.

### II-E. New Educational Visualizations of Global Relief

Additional animations of relief imagery have been posted on http://www.ngdc.noaa.gov/mgg/image/diveanimations.html, consisting of new videos of Puerto Rico Trench and Marianas Trench dive animations, all accessible via the general images links at http://www.ngdc.noaa.gov/mgg/image/images.html.

### II-F. NOS Bathymetric Fishing Maps

The NOS Bathymetric Fishing Maps continue to be a popular product. Over the reporting period, the online map service averaged 12,036 hits/month. There were no major changes to the web page featuring an ArcIMS interface with links to preview map images. Map layers include state boundaries, shaded relief, all maps or map types individually as bathymetry, fishing, preliminary, and topo/bathy. All full resolution map images are available online in PDF format. Preview versions of the color bathymetry and color fishing maps were slightly degraded in resolution to speed up image loading times. Customers can order paper copies of the maps and the scanned images on CD-ROM. For more information and a link to the ArcIMS map interface, please see: http://www.ngdc.noaa.gov/mgg/bathymetry/maps/nos_intro.html

# III. REPORT OF NGDC ACTIVITIES IN SUPPORT OF IOC / GEBCO

## III-A. IOC Regional Mapping Projects

In addition to participation in GEBCO, NGDC staff continues to take an active role in the IOC regional bathymetric mapping projects. Dr. George Sharman continues as a member of record on the Editorial Board of the IBCWP and Lisa Taylor is a working participant of the IBCCA. Most recently, NGDC has been involved with the following mapping projects.

### 1. Gulf of Mexico and Caribbean (IBCCA)

NGDC is using the IBCCA contours and other bathymetric data to construct topographic/bathymetric grids for use in tsunami modeling at the US NOAA Center for Tsunami Inundation Mapping Efforts (TIME). The IBCAA contours contributed to the development of a 9 arc-second grid of the Caribbean Sea and the Gulf of Mexico and were used in the compilation of a 3 arc-second inundation grid for Puerto Rico in deep water areas.

### 2. Arctic Ocean (IBCAO)

NGDC published the color shaded relief poster for the International Bathymetric Chart of the Arctic Ocean (IBCAO) in August 2004, as part of NGDC's Research Publication series. To date, 662 copies of the poster have been distributed. The poster, designed to replace or augment GEBCO Sheet 5-17, portrays the bathymetry and topography of the Arctic region in a Polar Stereographic projection at a scale of 1:6,000,000 at 75º North.

## III-B. GEBCO Reviewers Report:

### 1. North-East Pacific Ocean

While there are no ongoing and major regional mapping programs in the Northeast Pacific; there continue to be numerous small-scale studies and a host of ship activity. Of note in terms of small-scale mapping are the continuing activities of the Monterey Bay Aquarium Research Institute (MBARI) and the California State University (CSUMB), Monterey Bay, Seafloor Mapping Lab (SFML). The focus at both these institutions is coastal waters and the southern California Borderland, with no coverage in the deep ocean. Most of this activity consists of patches of multibeam bathymetry, which ultimately will provide sufficient coverage to influence the regional picture.

### 2. Caribbean Sea and Gulf of Mexico

While there are no major mapping programs in the Caribbean, there is significant ship activity. U.S. institutions, Universities, and NOAA all have vessels that periodically work in the area, and as this data becomes available, it may be incorporated into the bathymetric databases of the region.

## III-C. Related Activities Supporting IOC / GEBCO Programs and Projects:

### 1. GEBCO On-Line Activities

#### 1A. GEBCO Web Pages

The GEBCO web pages continue to be updated on a regular basis. The GEBCO alphabetical contact list was updated continuously, as were committee/working group membership lists on the web site. Email addresses on the web pages continue to be protected by a scripting mechanism to prevent them from being harvested. Access to the GEBCO webpages at http://www.ngdc.noaa.gov/mgg/gebco/gebco.html has increased over the last year, averaging 24,568 hits per month, up from 18,242 per month in the previous reporting period. Note that these figures include web crawlers and robots.

#### 1B. IBC Web Pages

Table I shows the web activity over this reporting period for the International Bathymetric Chart web sites hosted by NGDC.

**Table I: Web Activity for Regional Mapping Project Sites**

| IBC | Updates | Average Hits/Month |
|---|---|---|
| IBCWIO | None | 1,558 |
| IBCAO | None | 14,439 |
| IBCM | None | 2,182 |
| IBCCA | None | 19,256 |
| IBCEA | None | 3,156 |

#### 1C. GEBCO List Servers

NGDC continues to maintain the GEBCO Folk List Server to facilitate communication between members of the GEBCO personality list (gebco_folk@mailman.ngdc.noaa.gov). List servers for the IBCAO, IBCCA, IBCEA, IBCSO, SCDB, SCUFN, GEBCO Guiding Committee, and GEBCO Gridders are also maintained by NGDC. The GEBCO_Guiding, SCDB, and SCUFN list information pages are linked to the corresponding committee web pages to facilitate their use by committee members. NGDC welcomes comments from the GEBCO community on how we can improve or enhance these services.

### 2. Coastal Relief Model Development

The Coastal Relief Model (CRM) is now comprised of ten volumes: U.S. East and Gulf Coasts (Volumes 1-5), U.S. West Coast (Volumes 6-8), Puerto Rico (Volume 9), and Hawaii (Volume 10). All CRM data are available online at http://www.ngdc.noaa.gov/mgg/coastal/coastal.html, on a single DVD-ROM, or on ten CD-ROM volumes. All NOS data were converted to a common horizontal datum, NAD83, while the vertical datum for individual surveys was retained. The development of the CRM for Alaska is underway with data quality control activities currently being performed.

### 3. Online IHO B-4 Development

The IHODCDB has historically been responsible for providing content for the IHO B-4, Information Concerning Recent Bathymetric Data. The bathymetric trackline plots that the IHODCDB has assembled for the B-4 were a special product that utilized GEODAS to create small plots and manipulate data stored in MGD77 format. In order to increase the functionality of GEODAS for IHO users, the IHODCDB offers the capability to search and select bathymetric trackline data using 5th edition GEBCO or British plotting sheet limits as a spatial reference. These data may then be displayed and downloaded free of charge over the internet. Metadata for the area of interest is also available from GEODAS. Contrasted with prefabricated and static PDF forms, GEODAS allows the user to perform custom queries, and ensures that the most recent data are available. The IHO data search and retrieval utility is accessible from the following link, http://www.ngdc.noaa.gov/mgg/gdas/iho/gd_sys.html, and could potentially be made available through the IHO web site.

### 4. Gazetteer of Undersea Feature Names

A prototype 'network link' has been developed by NGDC to display undersea feature names from the SCUFN Gazetteer in GoogleEarth. This capability is a direct result of a previous NGDC effort to populate a geospatially enabled Oracle database with the SCUFN Gazetteer undersea feature names. Inclusion of the undersea feature names in this heavily visited site has the potential to give broad exposure to the Gazetteer and the work of SCUFN. As the view in GoogleEarth is changed (zoom/pan), the extent of the new window is passed to the Oracle database server. The server then extracts point features falling within that window and returns them to GoogleEarth for display. Further development of the GoogleEarth network link will require that the primary Gazetteer database be maintained in a geospatially enabled format. This format would also support the ArcIMS interactive on-line map (http://mapdevel.ngdc.noaa.gov/website/mgg/undersea_1.0/), remote data management and online feature name submittal capabilities developed as prototypes by NGDC.

### 5. Bathymetric Modeling for the NOAA Tsunami Forecasting and Warning System

NOAA has primary responsibility for providing tsunami warnings to the Nation, and a worldwide leadership role in tsunami observations and research. Detailed bathymetry is crucial to forecasting the potential effects of a tsunami and for the protection of life and property. NGDC has developed a system of overlapping, Atlantic basin (1 arc-minute), and Atlantic, Caribbean, and Gulf of Mexico (9 arc-seconds) grids in support of the U.S. National Tsunami Hazard Mitigation Program. NGDC is also generating high resolution near-shore bathymetric/topographic grids for 72 US coastal areas to be used to model tsunami propagation and inundation for the NOAA Tsunami Forecasting and Warning System. These inundation grids are referenced to Mean High Water and will be made available to the public via NGDC's website. The areas have been chosen by the tsunami modelers based on tsunami threat, data availability, population, and other factors.

# Appendix I

**Sources of bathymetric data contributed to the NGDC during this reporting period:**

University of South Florida
NOAA National Ocean Service
Scripps Institution of Oceanography
U.S. Geological Survey
Lamont-Doherty Earth Observatory
Woods Hole Oceanographic Institute
Integrated Ocean Drilling Program
Antarctic Multibeam Synthesis
NOAA Pacific Marine Environmental Laboratory
NOAA National Marine Fisheries Service
NOAA Office of Ocean Exploration

# Appendix II

**Number of NGDC Marine Geology and Geophysics data requests fulfilled, by country during this reporting period:**

| Requests | Country |
|---|---|
| 2 | Argentina |
| 3 | Austria |
| 1 | Brazil |
| 18 | Canada |
| 2 | China Rep (Taiwan) |
| 1 | El Salvador |
| 1 | Finland |
| 3 | France |
| 3 | Gabon |
| 1 | Germany |
| 1 | India |
| 1 | Israel |
| 1 | Italy |
| 1 | New Zealand |
| 1 | Norway |
| 1 | Republic of Korea |
| 1 | Saudi Arabia |
| 1 | Spain |
| 1 | Zambia. |

# Appendix III

**Number of cruises with bathymetry added to the Marine Trackline Geophysics database or Multibeam Bathymetry Database this reporting period:**

| | |
|---|---|
| Woods Hole Oceanographic Institution | 22 |
| Scripps Institution of Oceanography | 18 |
| Antarctic Multibeam Synthesis | 10 |
| Japan Hydrographic Department | 5 |
| U. S. Geological Survey | 5 |
| University of Rhode Island | 2 |
| NOAA National Ocean Service | 2 |
| NOAA National Marine Fisheries Service | 1 |
| NOAA Pacific Marine Environmental Laboratory | 1 |
| Total | 66 |

**Number of cruises with bathymetry received during this reporting period:**

| | |
|---|---|
| USA | 59 |
| Total | 59 |

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# ANNEX 6

## Finding the Depth of the Oceans
## - Comments on Early Endeavours mainly in Polar Regions

by

Dr. Reinhard A. Krause, Dipl. Phys., AWI Bremerhaven

**Abstract**

The depth and the character of the bottom of the epicontinental seas was important for navigation since ancient times. The question of the depth of the oceans originated with the beginning of the intercontinental voyages in the 16th century. With the scientific circumnavigations from the middle of the 18th century, the first attempts at deep sea measurement were discussed. But it was James Clarke Ross (1800-1862) who first performed systematic deep-sea soundings on his Antarctic campaign from 1839 to 1843.

In connection with the laying of telegraph cables between Europe and North America from 1854 onward, deep-sea sounding became commercially important. The sounding techniques improved significantly when, in 1855, Matthew F. Maury (1806-1873) published a bathymetric chart of the North Atlantic Ocean. A chart of this area, using new data collected by the expeditions with the vessels “Challenger” and “Gazelle,” followed in 1876. A first attempt to characterize the topography of the seafloor of the Pacific was given by August Petermann (1822-1878) in 1877.

Global bathymetric presentations were published by John Murray (1841-1914) as well as by Alexander Supan (1847-1920) in 1899. Prince Albert I de Monaco (1848-1922) made it possible for the first GEBCO edition consisting of twenty-four sheets to be printed in 1905.

Beginning in about 1773, there were indications that the Arctic Ocean was a deep-sea basin. This assumption was supported by soundings in 1827 and 1868 and proved by Fritjof Nansen (1861-1930) about 1895. The general character of the Antarctic as a continent was determined beyond question ten years later.

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## Otto Krümmel (1854- 1912)
## German Pioneer of Oceanography and Contributor to the first GEBCO Edition

by

Prof. Dr. Gerhard Kortum, IfM-GEOMAR, ret.

**Abstract**

Otto Krümmel was born in Exin (Western Prussia, today Poland) 152 years ago. He studied geography and geology at the universities of Göttingen, Leipzig and Berlin. In 2004, 150 years after his birth, the IFM-GEOMAR Leibniz Institute of Marine Sciences at the University of Kiel organized an exhibition open to the general public presenting manuscripts, letters, books and some of the few personal items that have survived the times. Parts of this exhibition are now presented at the GEBCO meeting 2006 in Bremerhaven.

Today only a few students (and professors) of marine sciences are aware of the fact that it was Otto Krümmel who established oceanography (in the framework of geography) as an academic discipline at the University of Kiel. Because of his early interests in marine sciences and early publications, Krümmel was appointed professor of Geography in 1884. He joined V. Hensen's famous *Plankton Expedition* aboard the research vessel "National" in 1889 and wrote the narrative and the geophysical report of this first Kiel blue water enterprise. He became a member of the Royal Prussian Commission for Marine Research in the German Seas and was one of the German representatives at the ICES from 1899 onward. Furthermore he was engaged in the planning and construction of the German research vessel "Poseidon" and organized the annual monitoring cruises for ICES in the North and Baltic Seas. Although mainly occupied with many academic duties as professor of Geography at the University of Kiel and lecturing for 27 years, Otto Krümmel was head of the Physical Division of the International Marine Laboratory which was established for German contributions to the ICES activities. In this function he became interested in the development of new instruments as well, such as water samplers and advanced aerometers. Due to his special interest in the morphology of the sea floor and a universal nomenclature of subsurface features he contributed to the discussions on the 7th International Congress of Geographers in Berlin in 1899 and he became a member of the important Wiesbaden Commission preparing the first GEBCO edition as suggested by Albert I of Monaco in Berlin. The letters he sent to J. Richard concerning this matter have survived and give us a deeper insight into the early history of the GEBCO project.

Most of Krümmel`s more than 100 publications are about marine issues, such as tides, ocean currents, morphology of the sea floor and "Meereskunde" in general. His most important work, "Handbuch der Ozeanographie" (2 vols. 1907/ 1911), remained a standard reference work for a long time.

Main reference:
Ulrich, Johannes and Gerhard Kortum (1997), Otto Krümmel (1854- 1912): Geograph und Wegbereiter der modernen Ozeanographie. Kieler Geographische Schriften 93, Kiel.

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## PANGAEA - Open Access library for georeferenced data

by

Dr. Hannes Grobe, Rainer Sieger,
Alfred Wegener Institute for Polar and Marine Research, Bremerhaven

Michael Diepenbrock,
Nicolas Dittert,
Uwe Schindler
MARUM, University Bremen

**Abstract**

PANGAEA - Publishing Network for Geoscientific and Environmental Data (http://www.pangaea.de) is a unique information system which is operated as an Open Access library for georeferenced data from basic research on Earth and environment. Data are archived with related meta-information following ISO19115 standards in a relational database. Data are distributed via web services with OAI protocol in XML-format e.g. to serve portals. Data are also accessible through various clients and a search engine on the Internet. Data-set descriptions include a bibliographic citation and are persistently identified using Digital Object Identifier (DOI); the citation with DOI is mirrored in public library catalogues. The system provides data from institutes and international projects, covering all fields of Earth system research with a main focus on the marine environment.

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## Application of geographical information standards and internet technologies to distributed marine data management systems : Example of the Ifremer/Sismer Data Portal.

by

Dr. Eric Moussat
Benoît Loubrieu,
Gilbert Maudire
Mikael Treguer
IFREMER, Plouzané, France
(http://www.ifremer.fr/nautilus/)

**Abstract**

Ifremer has had a long experience of developing and operating major facilities to collect, manage and archive data for a wide variety of topics:

Monitoring and sustainable use of coastal seas, fisheries, biodiversity, ecosystems, ocean circulation and forecasts, exploration and exploitation of ocean floors. Data come from various sources: ships, networks of automatic observatories and satellites and are transmitted from sea to shore, checked, archived and distributed to users in real time or in delayed mode. More than 14 million $km^2$ of oceans and seas have been surveyed and mapped. Some of the most recent results of swath-mapping programs of Ifremer will be given as examples.

Acting as the French national oceanographic data centre (F-NODC), Ifremer is in charge of the long term preservation of French marine data and is involved in various projects at national, European and international levels. To support the users, it was decided to build the Ifremer data portal so as to provide a unique entry point for all users requesting data without changing existing systems. Considering that all existing data management systems share common requirements based on geographical positioning of observations, standards related to geographical information have been extensively used as the foundation of this portal.

This portal is now available both on Ifremer internal and external web sites.

**(See Annex 7 for a fuller explanation and some figures**)

Open Science Day – Abstracts - June 15th, 2006

## Exploring Global Bathymetry via the WEB

by

Dr. William B. F. Ryan, LDEO of Columbia University, WIA

**Abstract**

New WEB interactive applications such as Google Earth, GeoMapApp and Open GIS using Web Services now allow users at their desktop to view and explore ocean floor bathymetry across a wide scale of resolutions. This ability will be demonstrated along with descriptions of the methods used to get the bathymetry into viewable formats and file structures. These applications then allow a large variety of data sets to be superimposed on the bathymetry. I will show examples from seafloor photography, nephelometry, sediment core lithology, deep-sea drilling stratigraphy, submersible dive observations, physical oceanography, paleoceanography, gravity, magnetics, and heat flow.

Open Science Day – Abstracts - June 15th, 2006

## Ten years as a Bathymetric Data Centre at the Bundesamt fuer Seeschifffahrt und Hydrographie (BSH) – Status and Outlook

by

Dr. Volkmar Leimer, BSH, Rostock

**Abstract**

Beginning in the 1990s, the situation concerning the management of bathymetric data sets and their accessibility by the national and international maritime research community became very difficult. During a meeting at the BSH in 1995, representatives from the German maritime scientific community discussed the status of national bathymetric data management as well as the German contribution to international data collections. The BSH proposal to establish a bathymetric database at the BSH was accepted.

Now, 10 years later, the Bathymetric Data Centre includes about 250 bathymetric data sets mainly from cruises of the German research vessels METEOR and SONNE. Presently the quantity of data is about 300 Gbyte acquired by multibeam equipment e.g., ATLAS HYDROSWEEP DS or SIMRAD EM120. Meta-information about these data sets provided by the chief scientists is provided on the BSH web site. The data sets themselves can be obtained upon informal request. This offer has been used by interested parties from all parts of the world. Over the last decade there has been a mean number of 15 data requests a year.

Another expectation concerning the operation of the Bathymetric Data Centre at the BSH was to increase the German contribution to international bathymetric data collections. Ten data sets were submitted to the IHO-DCDB and included in the GEODAS inventory in 1996. Because of inconsistencies with ETOPO2 bathymetry, an additional 11 data sets sent in 1999 could not be included by the IHO-DCDB.

In the near future the Bathymetric Data Centre at the BSH will remain mainly an archive of German bathymetric data sets. Resources to “clean” the non-processed data sets are not expected. Gathering of processed data sets from the scientific community will be needed to increase the German contribution to IHO-DCDB.

Open Science Day – Abstracts - June 15th, 2006

## Bathymetric - Topographic Data for Visualizations: Engaging the Public

by

Dr. Christopher Fox, Dr. Peter W. Sloss,

National Geophysical Data Center, USA

**Abstract**

Bathymetric data in its raw forms is not very interesting to the general public. However, assembling the data and projecting it on a globe or developing synthetic video excursions over the seafloor provide visual and contextual presentations that are both engaging and artistic.

Two such presentations are made here. Recognizing the World Cup Games in Germany, we have projected the GEBCO topography from the 2003 Centenary Edition of the GEBCO Digital Atlas onto a traditional football. Provided in a cut-out-and-assemble form, it is a challenge of dexterity and geographical skill. Secondly, the new ETOPO2.v2 topography was input to graphic visualization software to produce three computed videos of submarine dives on 1) the Mariana Trench, 2) the Puerto Rico Trench, and 3) the Java Trench. Eventually with increased hardware and software power, bathymetry and topography will be made easily accessible to the general public in exciting, entertaining, and visually appealing, interactive forms.

Open Science Day – Abstracts - June 15th, 2006

**How rapidly can we respond to an urgent need?**
**Producing a bathymetry map of the 2004 tsunami area**

by

Mr. David Monahan, MS,

Michelle Weiratmueller, CCOM, UNH, USA

Brian Heap, NGA USA

Muhammad Bashir, Jorge Luis Heredia Bustamante, Djoko Hartoyo, Apolonio Monreal Lagonsin, Tsuyoshi Yoshida, Nippon Foundation/GEBCO-students at CCOM, UNH, USA

## Abstract

As part of the scientific effort to help understand the earthquake which caused the 26 December 2004 tsunami in the Indian Ocean, and perhaps ameliorate the effects of subsequent tsunamis, several cruises collected multibeam data in the area of the epicentre. Each suite of bathymetric data collected during the scientific and hydrographic community's response represents an important scientific resource. The value of these individual data sets would be multiplied if they were combined into a single cohesive data set from which a bathymetric map of the larger region could be produced. This project proposes an international project that will assemble the data from these individual cruises, adjust them to a common datum, and produce a bathymetry map of the entire area. The project seeks to enlist the participation of organizations in France, Germany, Indonesia, Japan, United Kingdom and the United States who will be fully credited for their data, and will have access to the entire results. GEBCO, the Nippon Foundation and the University of New Hampshire are jointly training younger scientists and hydrographers in a postgraduate program in ocean bathymetry. The current class chose to investigate constructing a map of the earthquake area. It found that new MBES data has been collected on at least five cruises, but, except for this project, there is no apparent attempt to combine the data sets: indeed, some of the data are being treated as confidential. None has to date been submitted to NGDC. The group has already identified hopefully all relevant recent sounding data within and adjacent to the study region, as well as legacy data sets, and stands ready to assemble, assess for quality, incorporate into a data management system, reduced to a consistent set of processing parameters, and correct blunders.

Were the data sets combined, then a holistic interpretation could be carried out, resulting in a uniform grid of depths, printed maps that portray bathymetry in isobaths and raster.

Achieving the goal of producing a bathymetric map which will provide a comprehensive and integrated view that can promote understanding of geological processes, increase public safety by offering high resolution depth data for

modelling wave behaviour, and add to the deeper understanding of the sea and the Earth as a whole, will require the participation of several organizations. Participating organizations will not only be contributing data to this project, they will be actively fostering the education, the exchange of knowledge and ideas for a new crop of hydrographers and scientists.

Open Science Day – Abstracts - June 15th, 2006

## Integration of bathymetric data into existing digital terrain models (DTM)

by

Dip.-Ing. Ingo Kruse, Institut für Kartographie und Geoinformatik, Universität Hannover

**Abstract**

The expedition Antarctica XIX/5 (Lampos) took place aboard RV “Polarstern”' from April 3, 2002 to May 5, 2002. Biological inquiries were the principal goals. Our project was to take depth measurements at two different sites with the multibeam Hydrosweep DS-2 system.

The data gained were processed on board with TASH (Topographical Analysis System Hannover). We discovered a discrepancy between our newly gained data and the data of earlier expeditions.

In our work we found a way to integrate the extremely precise new measured data with the existing digital terrain models (DTM), (GEBCO, ETOPO 2).

First, we analyzed the deviations of the measurements. Then we developed an algorithm by updating the imprecise global data and adapting it to the highly precise local bathymetric data to allow a fluid transition of the contour lines at the intersections.

The developed program uses the principal of moving surfaces with adjustment of observation equations.

Finally, the results will be reported for presentation to ESRI's Geo Informationsystems ArcView .

Open Science Day – Abstracts - June 15th, 2006

## Bathymetric mapping of the Cape Verde Basin with the use of different data sources

by

Dr. Nataliya Turko, Geological Institute of the Russian Academy of Sciences

**Abstract**

In 2006 the Geological Institute of the Russian Academy of Sciences carried out the survey on board of the R/V "Akademik Nikolaj Strakhov".

One of the surveyed areas was on the border of an abyssal basin south of the Cape Verde islands, where the Geological Institute has carried out investigations since 2000. The subject of research is the junction of continental and oceanic structures. On the "predicted topography" map there appears to be a cross-cutting of sub-latitudinal structures of the basin by structures of NNW-SSE lineation.

The surveys were carried out, in 2000 using a Simrad EM12 multibeam echo sounder and TOPAZ acoustic profiler, in 2002-2004 using an Echos XD echo sounder and Parasound profiler and in 2006 using a Reson SeaBat 8150 echo sounder and Edgetech 3300 profiler. The wide dissemination of volcanic and tectonic features, and indicators of neotectonic movements as well, were detected as the results of these researches. Deep-sea channel and other unusual depressions were discovered in the western part of the area. In the eastern part, the structures of the basin approach the continental slope of Africa and the Sierra Leone Rise where uplift and tectonic deformations appear.

A possible result of this junction is the formation of the volcanic seamounts of the Sierra Leone Rise and the Bathymetrists and Grimaldi seamounts. Unfortunately, bathymetric mapping of deep-sea basins is practically absent. The results of our surveys show modern tectonic-magmatic activity there. This requires a revision of our ideas concerning seafloor processes.

Open Science Day – Abstracts - June 15th, 2006

## Convergent Continental Margin Tectonics Revealed by Bathymetric Mapping

by

Dr. Wilhelm Weinrebe, Leibniz-Institute of Marine Sciences IFM-GEOMAR

**Abstract**

Oceanic lithospheric plates, formed by ascending magma at mid-ocean ridges and transported towards the continents by internal convective forces, collide with continental plates at convergent margins and are subducted beneath them. This is a phenomenon accompanied by violent geological processes such as earthquakes, volcanic eruptions, submarine landslides and tsunamis.

The speed of drift of the plates is on the order of several centimetres per year, too slow to be observed directly. Still, these processes shape the surface of the ocean bottom and submarine morphology records these forces acting on the sea-floor. Imaging the morphology helps both in recognising and understanding the action of these tectonic processes and in visualising the dynamic history of the ocean floor.

The research unit "Dynamics of the Ocean Floor" of IFM-GEOMAR has carried out extensive swath-mapping of large areas along convergent continental margins around the Pacific Ocean and Indian Ocean. The data from surveys in Central America, Chile and Indonesia display a great variety of subduction styles. The examples demonstrate that information on the geological and tectonic history preserved in ocean floor morphology can be revealed by bathymetric measurements. Compressional, extensional and shear movements of the subsurface, as well as uplift or subsidence, shape the ocean floor in a specific way. Seafloor soundings allow us to derive information on the geological history of the oceans and contribute to our understanding of global geodynamics.

Open Science Day – Abstracts - June 15th, 2006

## The Yermak Slide, Arctic Ocean

By

Dr. Daniel Winkelmann, W. Jokat, F. Niessen, R. Stein,

AWI Bremerhaven

**Abstract**

The Yermak slide is an impressive, large-scale slope failure north of Spitsbergen first described by Cherkis et al. (1999). We present the true geometry and age of the event. Its volume of ca. 2400 $km^3$ and area of more than 10,000 $km^2$ puts the slide among the largest exposed submarine slides worldwide. Thus, the Yermak Slide north of Svalbard constitutes one of the first detailed mapped bathymetric features in the Arctic Ocean.

Open Science Day – Abstracts - June 15th, 2006

## Harmonizing data of different origins as an optimal way to model ocean floor geomorphology

by

Dr. Gleb B.Udintsev, Vernadsky Institute of Geochemistry, Moscow

Dr. Hans Werner Schenke, AWI Bremerhaven

**Abstract**

The method of harmonizing data from different origins has been used for modelling the floor of the Scotia Sea, in the Southern Ocean. The most informative data obtained during a box survey by multibeam echo-sounding were combined with data obtained by other underway sounding techniques.

The tracks planned for underway sounding were selected using the bathymetry preliminarily compiled using a data bank of all available data measured by ships. That map was corrected according to a comparison with the gravity map and map of predicted bathymetry by Smith and Sandwell. Further harmonizing was done by comparing the corrected map with the results of seismic profiling, with underway gravity measurements, with results of dredging rocks from exposed basement and with a Bouguer anomaly map. Additional information was obtained from statistical analyses for the recognition of a network of lineations of the small topography forms and their averaging into planar surfaces.

Open Science Day – Abstracts - June 15th, 2006

## Development of a Tsunami Computational Portal

by

Dr. Harry Yeh, Dr. Cherri Pancake, Oregon State University, Corvallis, OR, USA

**Abstract**

A tsunami is a long wave, i.e., its wavelength is much longer than the water depth. A typical tsunami wavelength in deep water is on the order of several tens to hundreds of kilometres. Hence even the propagation of a tsunami across a 4000-m deep abyssal plain, and its evolution, are strongly affected by the bottom bathymetry. This is not the case for storm generated waves, which are typically less than 500 m long: waves having wavelength less than twice the depth are not affected by the presence of the ocean bottom. Once a tsunami approaches a shore, its amplitude increases by shoaling due to the decrease in water depth. It is evident that, unlike other ocean-related topics, tsunami analyses require integrated bathymetric data for the entire ocean basin plus information on the sub-aerial coastal topography: we need data that includes areas with more than 10,000 m deep ocean trenches, 4,000 m deep abyssal plains, 200 m deep continental shelves and coastal topography above sea-level.

Currently, we are developing the tsunami computational portal, which is a shared website where tsunami simulations can be executed. The portal will allow researchers to collaboratively refine existing techniques for predicting tsunami effects. A number of high-quality simulation models exist, but are currently in the hands of individual researchers located at various institutions throughout the world. The tsunami computational portal will provide an arena for collaborative efforts to install the models, to convert and properly align the input data, and to accurately interpret simulation results. It is a community forum where the areas of expertise come together in support of tsunami research and mitigation.

Because the simulation models require high-resolution data near the shore, the bathymetic data are often digitized “manually” from ‘paper’ marine charts (e.g. DMA, the Admiralty Hydrographic Office, and JODC) for shallow-water regions, which are then combined with the global data set (e.g. GEBCO or

ETOPO2) for deep water. Up to the present, individual tsunami modellers make such efforts and the resulting digitized shallow-water data are seldom shared with other researchers. The tsunami computational portal will change this practice: the portal will provide an opportunity for systematic collection of the digitized shallow-water bathymetry data for future use. With community reviews, the collaborative portal can also provide a function to ensure the quality of digitized bathymetic data.

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## Tsunami Inundation Grid Development

by

Dr. Christopher Fox, Lisa A. Taylor, Barry W. Eakins, Robin W. Warnken, Kelly S. Carignan, George F. Sharman, David C. Schoolcraft, and Peter W. Sloss,

National Geophysical Data Center, USA

**Abstract**

The National Geophysical Data Centre (NGDC), an office of the U.S. National Oceanic and Atmospheric Administration (NOAA), is developing bathymetric/topographic digital elevation models (DEMs) of selected U.S. coastal areas for the Pacific Marine Environmental Laboratory (PMEL), NOAA Centre for Tsunami Inundation Mapping Efforts (TIME). The 1 to 1/3 arc-second (~10 to 30 meters) elevation grids are being generated from numerous, diverse digital datasets obtained from local, state and federal government agencies, academia and private companies.

The grids will be used as input to the Method of Splitting Tsunami (MOST) Model (http://www.pmel.noaa.gov/pubs/PDF/tito1927/tito1927.pdf) developed by PMEL to simulate tsunami generation, propagation and inundation. Basin-wide 1-minute and intermediate 9 arc-second bathymetric grids are also being developed by NGDC for input to the MOST Model. This presentation provides an overview of the data sources, processing procedures, gridding methodology, and data quality assessment techniques used in developing the inundation grids.

Open Science Day – Abstracts - June 15th, 2006

## Training and education of hydrography

by

Dr. Heinrich Hinze, TECHAWI / GhyCoP, AWI Bremerhaven

**Abstract**

Training and education in hydrography are responses to the challenges to perform precise and efficient hydrographic surveys. The scheduled “Training & Education Centre of Hydrography” in Bremerhaven, Germany, is based upon a concept closely related to hydrographic practice and the use of portable measurement and processing systems.

The content of the training is fitted to the demands of the trainees. Three main topics are presented: hydrographic surveying and mapping and integrated applications with some examples for shallow water survey, dredging, acoustic harbour monitoring, deep sea / UNCLOS mapping.

Open Science Day – Abstracts - June 15th, 2006

## History and Value of Multibeam Echo-Sounder Surveys around Japan -Some Scientific Outcomes and Ship-of-Opportunity Experiences

by

Mr Shin Tani, Government of Japan, Tokyo, Japan

**Abstract**

Japanese multibeam surveying began in 1983, for UNCLOS data acquisition, earthquake research, volcanic research, tsunami prediction and safety of navigation. Five deep sea MBES's are in operation. The swath angle at the very beginning of the swath survey was 42 degrees and made full coverage very difficult. Actually, for a long time, full swath surveying was not possible because of ship-time constraints. Once full swath data became available, we did not want to return to striped surveys anymore. Full swath bathymetry sometimes led to discoveries of previously unknown features, sometimes beyond imagination. Some examples will be demonstrated.

During the operation of survey ships of the Japanese Hydrographic Office, careful management of the footprints made it possible to arrange a passage track to as to have full swath coverage of the area where no surveys were originally planned. Examples and their values will be introduced for discussion.

# ANNEX 7

## Application of geographical information standards and internet technologies to distributed marine data management systems : example of Nautilus, the Ifremer Data Portal.

**Eric MOUSSAT(1), Benoît LOUBRIEU(2), Gilbert MAUDIRE (1), Mickael TREGUER(1)**

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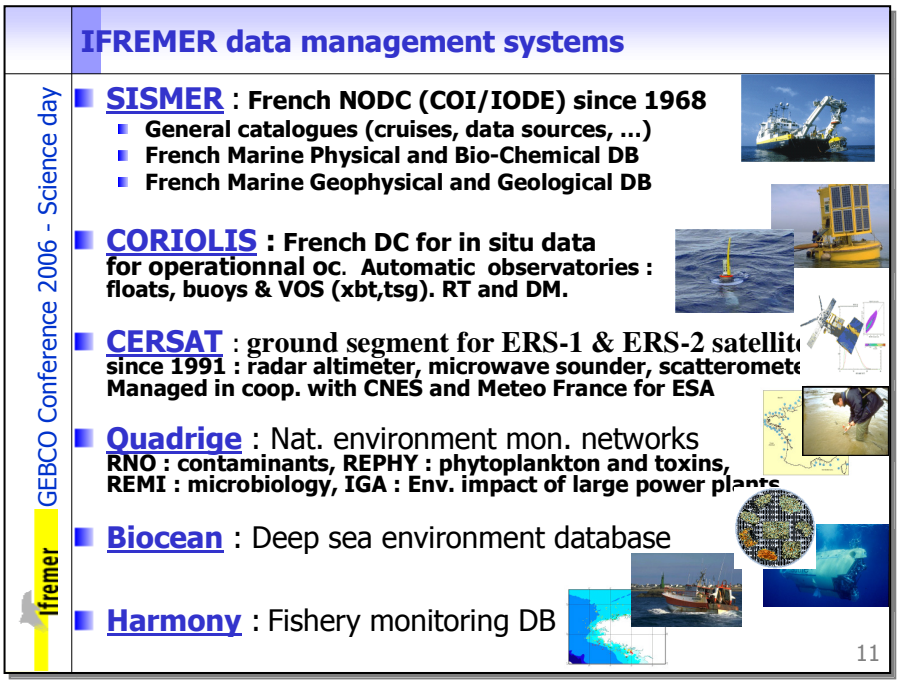
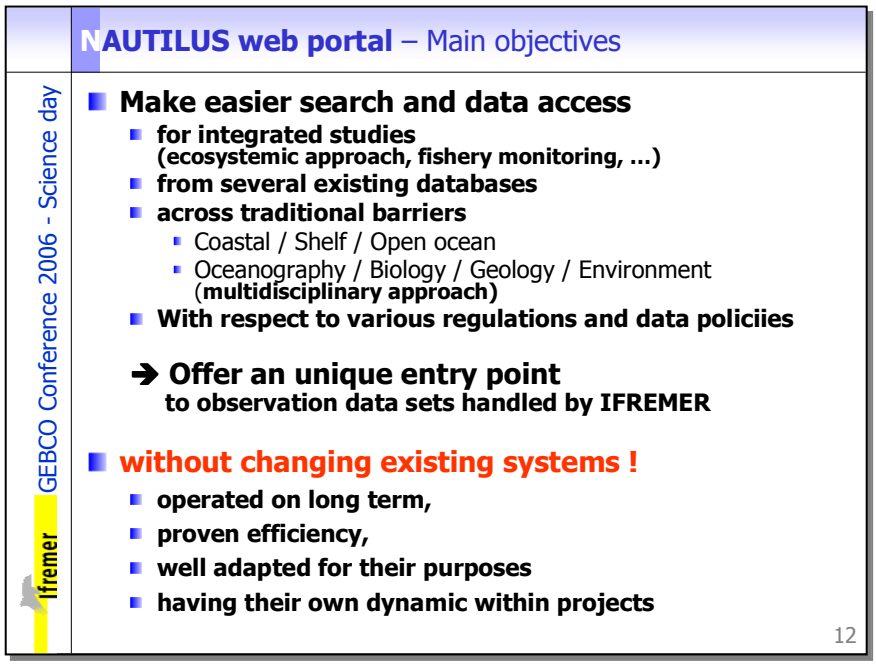
Benoit.Loubrieu@ifremer.fr




Ifremer, the French Research Institute for the Exploitation of the Sea, has a long experience in developing and operating major facilities to collect, manage and archive data for a wide variety of topics : monitoring and sustainable use of coastal seas ; fisheries ; biodiversity, ecosystems, ocean circulation and forecasts ; exploration and exploitation of ocean floors.

Some of the recent results obtained in this last domain, and presented during the GEBCO Science Day in Bremerhaven, can be consulted on //www.ifremer.fr/drogm : such as survey of the French continental shelf, French EEZ mapping program, investigation of the potential claims of extended continental shelf beyond the present EEZ, compilations carried out in cooperation with French and foreign Institutions (Mediterranean Sea, NE Atlantic).

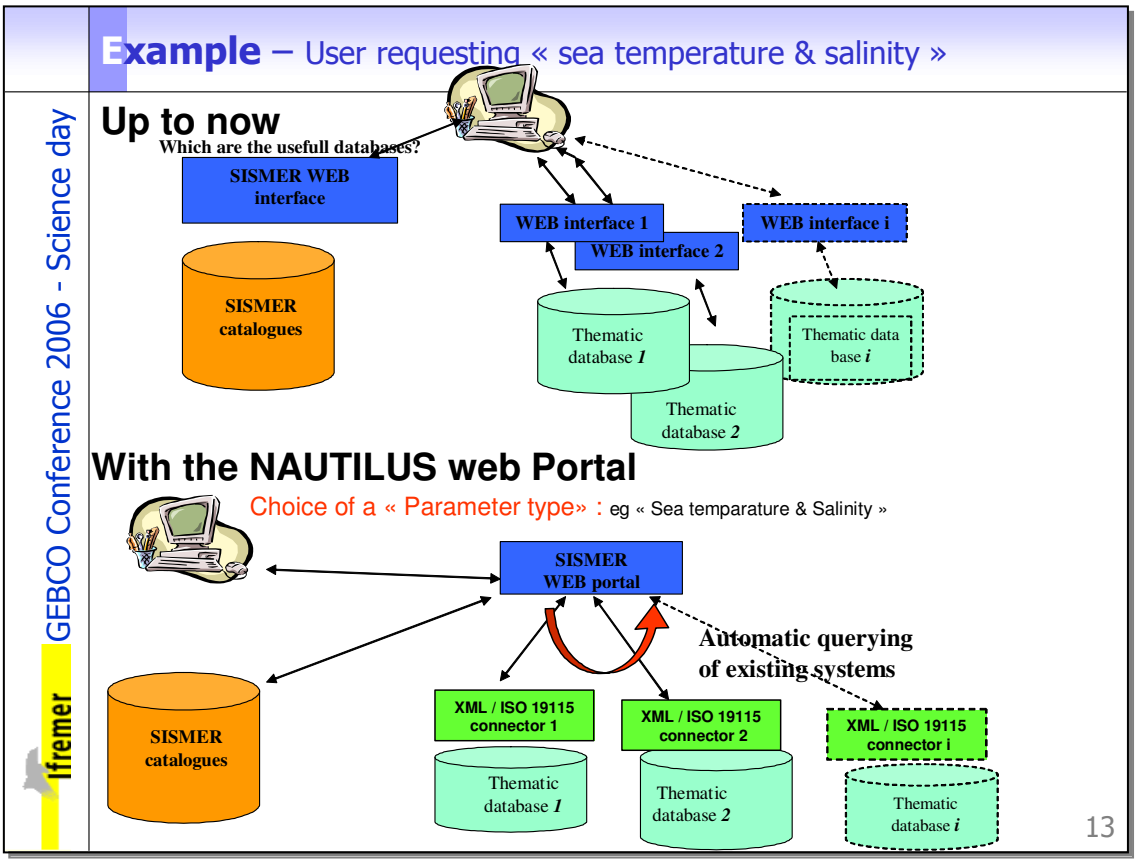
In order to manage of these various data sets, several data management systems have been developed year after year, dedicated to thematic fields of activity and/or to



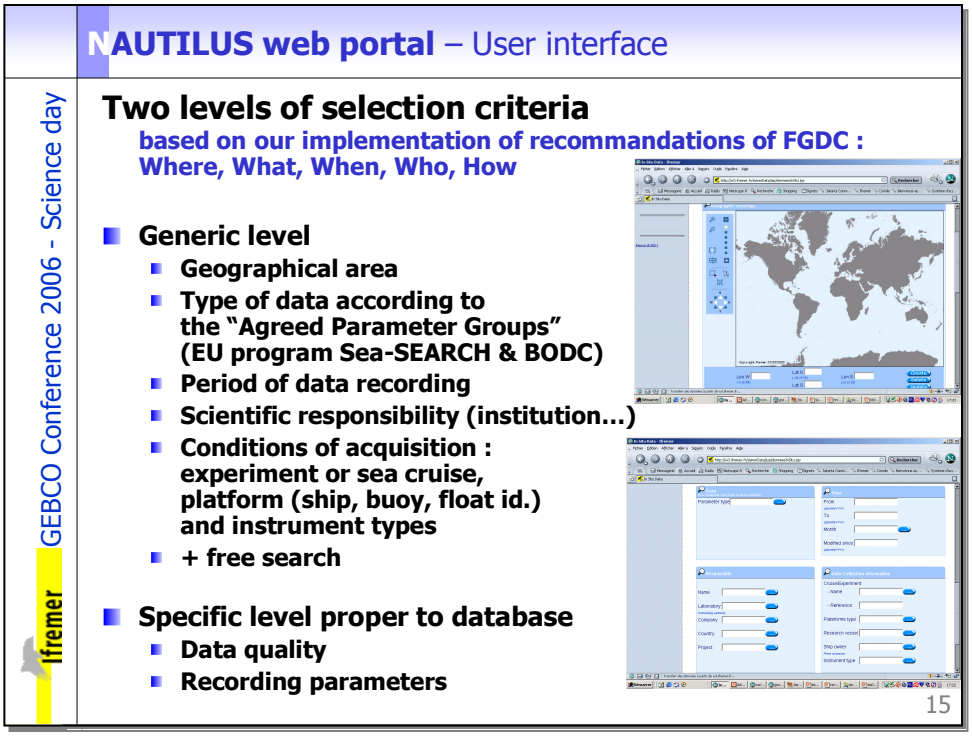
observation systems.

Multidisciplinary studies which must deal with several interfaces to get data are increasing now in marine sciences : ecosystem studies, integrated management of the coastal areas, nested models (hydrological and biological). Many more users are now requiring interfaces which provide transparent access to multidisciplinary data sets which are distributed among several existing systems operated in different locations by several teams.

To meet the needs of users, Ifremer decided as the National Oceanographic Data Centre to build a data portal, Nautilus, supplying a unique entry point to all the users requesting data, with a main goal : to base the portal on existing systems without changing them.

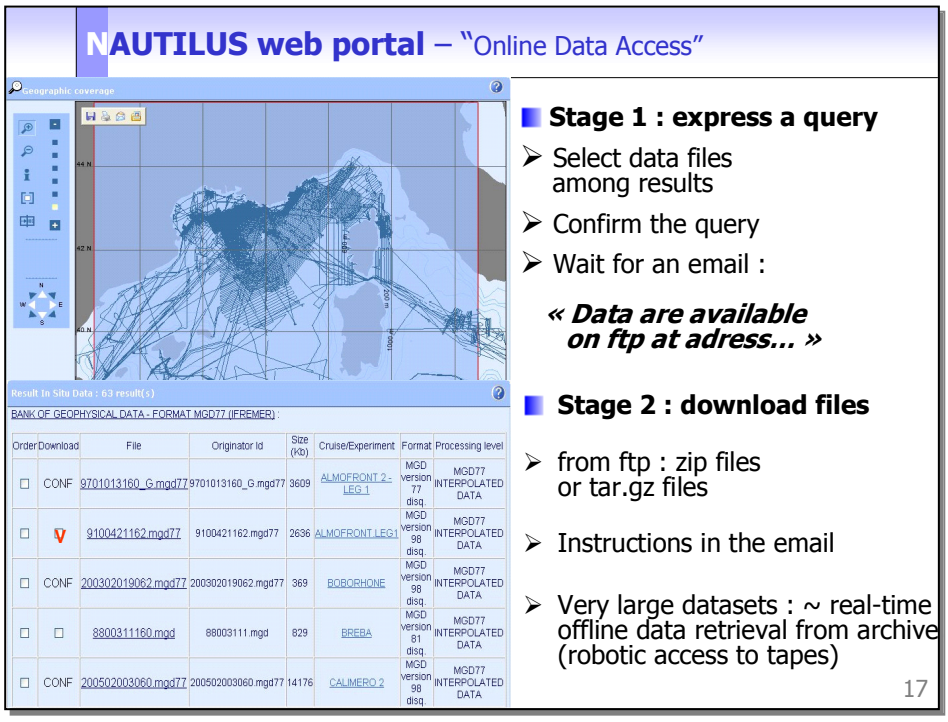



Considering that all existing data management systems share common requirements based on geographical positioning of observations, standards related to geographic information have been extensively used as the foundation of this portal : ISO 19115 standard to describe data sources and datasets and OpenGIS standards to visualize dataset geographical locations. In addition, *de facto* standards like NetCDF data format, OpenDAP data access protocol, SOAP for web-based services were used to network the existing systems and transport users' queries and results.




The Nautilus portal is now available both on Ifremer Internal and External web sites. Nautilus gives access to the following catalogues : French cruise summary reports (or Roscop) ; French databases directory (EDMED) ; French permanent observatories inventory (EDIOS) and to the databases of :

* SISMER, the National Oceanographic Data Centre managed by IFREMER
* the Coriolis data centre.



The next databases which will be connected will be :

* Cersat (2007)
* Quadrige
* Harmony (fishery environmental data only)

## Conclusions

New technologies have been used so there are still some limitations such as the total size per query due to available network bandwidth and disk space per user, the number of results per query (1000 data files), the response time for complex queries, the restricted access to some data sets due to various regulations (especially in geosciences) which requires preliminary agreements. But the Nautilus portal is opened (**//www.ifremer.fr/nautilus**), the feasibility of querying several databases is demonstrated and that is real progress for the users.

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# ANNEX 8

## List of Displayed Charts and Posters

The following bathymetric and other charts were displayed at the meeting.

1. North Fiji Basin, Nippon Foundation/GEBCO student project contour chart, 1:250,000, CCOM/UNH based on data provided by Ifremer [Sharma, 2005]
2. Rottnest Island, Western Australia, preliminary habitat map, 1:12,500, Fugro [Sharma, 2006]
3. Tonga Kermadec Arc, submersible dives on the Brothers Volcano, poster [C. de Ronde et al., 2006]
4. SW Pacific Ocean, New Zealand's EEZ and extended UNCLOS claim area [GNS Science, 2006]
5. Tsunami inundation grid development, principally Bathymetry and topography of Myrtle Beach, South Carolina, poster. [Lisa Taylor et al., 2006, NGDC/NOAA]
6. GEBCO World Ocean Bathymetry, Mercator 1:30,000,000 [Editorial Board, Jakobsson et al.]
7. ETOPO2 v2 (β), Miller projection on a sphere, May 2006 [NGDC/NOAA]
8. How rapidly can we respond to an urgent need? Producing a bathymetry map of the 2004 tsunami area, poster. [Bashir et al., NF/GEBCO students, CCOM/JHC, UNH]
9. The Mediterranean Sea as you have never seen it: results from recent systematic swath mapping, poster. Maps of the Western and Eastern Mediterranean Sea. Data on 500m grid, plotted at 1:2,000,000 scale . [Jean Mascle et al., France]
10. How well can satellite altimetry resolve seamounts? Poster. [KM Marks and WHF Smith, NOAA]
11. Nautilus web portal: a gateway to Ifremer observation data, poster. June 2006. [Ifremer, Brest, France]
12. Cartography of the Bay of Douarnenez (Brittany, France), poster. [CS Le Bris, C Augris and J-P Mazé, Ifremer, Brest, France]
13. Bathymetry of the North-east Atlantic. Scale 1:2,400,000. 2004? [S Monti, J-C Sibuet, B Loubrieu and J-P Mazé, Ifremer, France]

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# ANNEX 9

Acronyms

| | |
|---|---|
| AWI | Alfred Wegener Institut |
| BODC | British Oceanographic Data Centre |
| CGOM | Consultative Group on Ocean Mapping |
| DCDB | Data Center for Digital Bathymetry |
| ENC | Electronic Navigational Chart |
| EOS | Newsletter of the American Geophysical Union |
| GDA-CE | GEBCO Digital Atlas – Centenary Edition |
| GIS | Geographical Information System |
| IAATO | International Association of Antarctica Tour Operators |
| IBCNA | International Bathymetric Chart of the North Atlantic |
| ICES | International Council for the Exploration of the Sea |
| IfM-GEOMAR | Institut für Meereskunde and Forschungszentrum für marine Geowissenschaften, Kiel, Germany |
| Ifremer | Institut français de recherche pour l'exploitation de la mer |
| IHB | International Hydrographic Bureau |
| IHO | International Hydrographic Organization |
| IOC | Intergovernmental Oceanographic Commission |
| LEDC | Less Economically Developed Country |
| MEDC | More Economically Developed Country |
| NGDC | National Geophysical Data Center, Boulder, USA |
| NH | New Hampshire |
| NOCS | National Oceanography Centre, Southampton, UK |
| NOS | National Ocean Service of National Oceanographic and Atmospheric Agency, USA |
| PCOB | Postgraduate Certificate in Ocean Bathymetry |
| ROSCOP | Report of Observations/Samples collected by Oceanographic Programmes, ICES |
| SCDB | Sub-Committee on Digital Bathymetry |
| SCUFN | Sub-Committee on Undersea Feature Names |
| SRTM | Shuttle Radar Topography Mission |
| SSPARR | Seafloor Sounding in Polar and Remote Regions |

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