SCOR Summit of International Marine Research Projects
London, UK
7-9 December 2006

Introduction

The Scientific Committee on Oceanic Research (SCOR) convened a Summit of International Marine Research Projects on 7-9 December 2006 in London (UK). SCOR thanks the Alfred P. Sloan Foundation for its support of this meeting. The purpose of this meeting was to bring together representatives of the major international ocean research and observation projects and programs to discuss common opportunities, issues, and problems. The meeting agenda included several major topics determined in advance to be important inter-project issues, including data management and interactions of projects with World Data Centers; interactions of projects with the Global Ocean Observing System (GOOS); project coordination in the area of Southern Ocean research and bathymetry and International Polar Year activities; project needs for time-series stations; visualization of data; and capacity building. Information about the meeting is available on the meeting Web page (see www.scor-int.org/Project_Summit_2/ProjCoord2).

Meeting participants included representatives from virtually all international marine research projects and programmes (CLIVAR[1], CoML, GEBCO, GEOHAB, GEOTRACES, GLOBEC, iAnZone, IMBER, InterRidge, InterMARGINS, LOICZ, OceanSITES, and SOLAS), and the chairs of the Global Ocean Observing System (GOOS) panels.[2] Two other organizations of the International Council for Science (ICSU) also participated, the International Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Antarctic Research (SCAR). Two World Data Centers (WDCs) were also represented: the World Data Center on Oceanography, Silver Spring and the World Data Center for Marine Environmental Sciences (WDC-MARE).

Profs. Peter Burkill and Bjørn Sundby chaired the meeting on behalf of the SCOR Executive Committee. The meeting was opened by the co-chairs with an explanation of its purpose, followed by a review by Ed Urban of the action items from the previous summit in 2004.

Project Data Management

Presentations were made by SOLAS, IMBER, and GEOTRACES, as the newest SCOR projects, about their data management activities. Peter Burkill asked the projects to tell SCOR what more it could do to help them on this issue.

SOLAS—Jeff Hare reported that SOLAS has formed a data management team, with the incoming chair being Juan Brown of the British Oceanographic Data Centre (BODC). The team includes both scientists and data managers. SOLAS has received a European Cooperation in the Field of Scientific and Technical Research (COST) grant to support the creation of air-sea flux data products for three research areas (parallel to the SOLAS Foci) and create a network of

[1] Acronyms are defined in Appendix I.
[2] Participants are listed in Appendix II.

researchers, conduct workshops, and coordinate meetings. It is expected that this activity will help to

1. Consolidate current knowledge of air-sea interactions.
2. Identify gaps and stimulate new research.
3. Provide a framework into which new data and process understanding can be assimilated.
4. Develop tools for production of global air-sea fluxes of climate-relevant compounds.

SOLAS has developed a Web-based system to track national projects that are endorsed by SOLAS (see www.solas-int.org). The SOLAS IPO will handle only metadata at this point, with national data centers handling the actual data (e.g., WDC-MARE will be handling German SOLAS data). SOLAS data will be divided into three classes: (1) geographically/temporally resolved data; (2) data from experiments and mechanistic studies; and (3) models, model documentation, and model output. Information about SOLAS data management can be found at http://www.uea.ac.uk/env/solas/org/DMTT.html, including SOLAS data management principles.

Beatriz Balino cautioned about relying on distributed data management systems when a global integrated database of specific experiments is needed, based on her experience trying to gather and integrate national data resulting from cruises related to the Joint Global Ocean Flux Study (JGOFS). Bob Gelfeld (WDC Oceanography, Silver Spring) added that the World Data Centers sometimes have trouble getting data from the national oceanographic data centers. Ed Harrison (OOPC) commended SOLAS in emphasizing the development of real-time data management.

GEOTRACES—Gideon Henderson noted that trace metal data are very sparse and thus GEOTRACES is being designed to provide a worldwide survey of surface-to-seafloor concentrations of trace elements and isotopes. Henderson estimated the GEOTRACES will probably collect less than one million data points, so the scope of data management will not need to be as great as for some other projects. GEOTRACES sponsored a data management meeting in December 2005. The meeting resulted in a draft data policy for GEOTRACES, and recommendations about the data management structure for the project (see http://www.ldeo.columbia.edu/res/pi/geotraces/documents/geotr_DataMant4SSC_final_000.pdf for the meeting report). The report recommends the appointment of a Data Liaison Officer in the eventual GEOTRACES International Project Office (IPO) and the establishment of a GEOTRACES Data Management Committee. The report also recommends "end-to-end" data management, in that cruise metadata would be tracked as soon as a cruise is funded and one person on each cruise should serve as a Data Specialist. GEOTRACES is still working out where its international data management center will be placed, although it is clear that the international office will need to work with individual participating nations and their data centers.

IMBER—Raymond Pollard made the presentation about IMBER data management. He had co-chaired the initial GEOTRACES data management meeting and had since become chair of IMBER's Data Management Committee. (Sophie Beauvais was appointed as Data Liaison Officer [DLO] in May 2006.) Since assuming their responsibilities, Pollard and e Beauvais visited BODC to continue IMBER's planning for its data management. Pollard offered his reflections on the fundamental problems in the data management process:

- Data are not sexy
- Scientists easily agree to the need to deliver data, but the published paper takes priority. And then the next proposal takes priority.
- Data managers are viewed as geeks, who can only cajole, not enforce, data delivery.

How can we raise the profile of data management? How can we persuade scientists to take it really seriously? Pollard has concluded that using "carrots" (incentives) is much more useful than using "sticks" (penalties). Funding must be devoted specifically for data management. And, it is necessary to show project scientists how data management can help them.

IMBER is a relatively young project, but has taken early initiatives on data management, particularly building on the work started by GEOTRACES and the recommendations from the GEOTRACES data management meeting. The IMBER Data Management Committee (DMC) was appointed recently. The DMC includes observationalists, modelers (data users), and data specialists, with the membership balanced to improve communication and mutual understanding. The DMC discussions have started by email, but they will eventually need to meet face to face. (A meeting is scheduled for June 2007.) IMBER manages no projects, so strictly owns no data. This implies that IMBER can encourage, but not enforce, improved standards for both metadata and data. The DMC will need to decide whether to emphasize the minimum (basic metadata) or the maximum (streamlined access to raw data); the answer is probably both. One view says it is hard enough to get decent metadata, so if we can achieve this it will be a major step forward. Another view is that we must aim for accessible, high-quality end data, arguing that nothing is more irritating than going through a dozen metadata links only to end up at "data - contact PI" - and of course the PI never answers. Possible ways to achieve this could be

- Seamless access to widely distributed data
- Relatively small number of specialist data centers

One example of a specialist data center (specializing in a particular type of data) is the CLIVAR and Carbon Hydrographic Data Office at the Scripps Institution of Oceanography, which evolved from the WOCE Hydrographic Programme Office. Another is COPEPOD, the global zooplankton database. Are these the way forward? The advantages of specialist data centers are that they (1) gather data from individuals into central archives, (2) have the ability to quality check a particular kind of data, and (3) have specialist experience to help individual PIs. Even so, they are useless without long-term funding. A major goal of specialist data centers must be to get scientists and data managers talking to each other and helping scientists by

- Backing up PIs' data at an early stage, providing security against data loss
- Helping with calibration
- Helping with validation
- Serving as a long-term archive
- Answering requests for data

In summary, the points that IMBER wants to raise for discussion include raising the profile of data management, improving communication (meeting, blogs), developing effective carrots

(funding, recognition, support), creating specialist data centers, creating metadata standards (CSR, DIF), and assuring adequate manpower for data management.

Howard Cattle (CLIVAR) raised the CLIVAR experience that it is extremely difficult to get data from PIs, particularly after the data have gone to the national oceanographic data centers. Suzanne Carbotte (InterMARGINS) commented that to counteract the difficulty of getting data from PIs, systems can be developed so data go directly from ships to data centers. (Obviously, this is not appropriate for all types of data.) Colin Summerhayes (SCAR) noted that the Ocean Observations 99 Conference agreed that data should be released in real time. Tom Malone suggested that we need to get more serious about metadata and at least serve it in real time, adopt metadata standards, make data management more than an afterthought, and set up data management processes before the first measurement is taken. Mark Costello (OBIS) responded that the Marine Environmental Data Inventory (MEDI: http://ioc.unesco.org/medi/) provides information about marine metadata and has online tools "to encourage data collectors and scientists to produce metadata descriptions for their datasets." OBIS has had success in getting data out of the Global Change Master Directory (GCMD). We don't just care about sending data to data centers, as publications are important. Ed Urban brought up the idea of digital object identifiers (DOIs), which is studied by the International Ocean Carbon Coordination Project (IOCCP) for ocean carbon data sets. DOIs make it easier to publish and cite data sets, so the data originators get the credit for their work.

World Data Centers and Their Interactions with Research Projects

WDC on Oceanography, Silver Spring—Bob Gelfeld introduced the discussion of WDCs by stating that there are more than 50 WDCs for different kinds of data, under the auspices of ICSU. The WDC system was established in 1957 to collect and serve data from the International Geophysical Year. The WDCs

1. Operate for the benefit of the international scientific community.
2. Are maintained by a host country or institution.
3. Accept and store data safely and in good condition.
4. Make freely available information on data holdings.
5. Exchange data among themselves and facilitate data availability.
6. Hold no confidential or security-classified data.
7. Honor proprietary use of data by their originators (not to exceed two years).
8. Provide data to scientists in any country free of charge, on an exchange basis or at a cost not to exceed the cost of copying and sending the requested data.
9. Accept any scientist as a visitor to work on-site with data held by WDC.
10. Report to ICSU, as requested.

The WDC for Oceanography, Silver Spring (http://www.nodc.noaa.gov/General/NODC-dataexch/NODC-wdca.html) started at Texas A&M University in 1957 and was brought into the U.S. National Oceanographic Data Center in 1963. Many nations have limited access to modern communication technologies, so this WDC offers many offline products (e.g., CD-ROMs, DVDs, paper media and publications). Integrated Ocean Observing System (IOOS) data are coming on-line now, and this WDC is designing systems to serve satellite data better. The WDC for Oceanography, Silver Spring, now includes about 29,000 data collections on a number of

different parameters. The data are available through Web map services ("rubber banding"). One activity of this data center is the Global Oceanographic Data Archaeology and Rescue (GODAR) project. The goal of GODAR is to "increase the volume of historical oceanographic data available to climate change and other researchers by locating ocean profile and plankton data sets not yet in digital form, digitizing these data, and ensuring their submission to national data centers and the World Data Center system. In addition, data on electronic media that are at risk of loss due to media degradation are also candidates for rescue."[3] To improve data management in the future, it will be important to use time-saving approaches, such as controlled data vocabularies.

Gelfeld listed the kinds of data available from his center, and how these data can be accessed. The World Ocean Database 2005 (WOD05) includes data from almost 8 million stations. Data types delivered include *in-situ* physical, chemical, biological profile and time-series data; satellite products; oceanographic climatologies and analysis products; ecosystem characterization data and information; GIS products; video and still image data; and publications (analog and digital). Requirements for data stewardship include providing content expertise in many different areas (physical, chemical, biological, ecological, satellite…), taking a long-term view, understanding the data management 'big picture', and attending to details. Concerns are that stewardship is time consuming and labor intensive, there often is a lack of resources for stewardship activities, it is difficult to maintain long-term viability of digital files, and metadata management is not for everyone.

World Data Center for Marine Environmental Sciences (WDC-MARE)—Michael Diepenbroek and Hannes Grobe presented information about the World Data Center for Marine Environmental Sciences (WDC-MARE). WDC-MARE is hosted by the University of Bremen Center for Marine Environmental Sciences and the Alfred-Wegener-Institute for Polar and Marine Research. It was established in 2001. WDC-MARE focuses on geo-referenced data related to "biogeochemistry, circulation, and life of present and past oceans," using the system Pangea. The data system operates with an open parameter list. WDC-MARE handles data from international, European Union, and German projects. Diepenbroek and Grobe mentioned some of the recommendations from the Color of Ocean Data meeting (see http://unesdoc.unesco.org/images/0013/001351/135161eb.pdf):

- Close cooperation between stakeholders and data center to ensure that there are no metadata without data and no data without metadata.
- Peer review of datasets becoming part of the curriculum of marine scientists, by giving credit to data providers, by making datasets reviewable and citable, and integrating citations into library catalogs. They provided samples of the use of DOIs for images, distributed samples, ocean profiles and time series. WDC-MARE is participating in Project STD-DOI "Data Publishing" (see http://www.std-doi.de/front_content.php).
- Comprehensive portals that do not lead to metadata nonsense, but directly to data and information (avoid "Error 404"), by using persistent identifiers. It is a time-consuming job to merge datasets, if done after a project is completed; it took one data manager three years to put the JGOFS data into a merged dataset.

[3] http://www.nodc.noaa.gov/General/NODC-dataexch/NODC-godar.html

The FINO and ANTARES (http://home.antares.ws/) projects will have *in-situ* data going directly into data centers. They mentioned the Open Archives Initiative for metadata and management (http://www.openarchives.org/) and made the following recommendations:

- Data centers need to prepare to serve data and metadata for multiple scopes/communities/stakeholders
- Metadata have to ensure re-usage of data (data publication)
- Complete and consistent metadata fulfill most common standards
- De facto standards and protocols build the mainstream of network development
- Data management has to be an integral part of research (user-driven)
- Data centers should operate like publishers and libraries

Species-based Data

Mark Costello, chair of the Ocean Biogeographic Information System (OBIS) spoke about species-based data. The technology for this system has come from the library science community. OBIS caches data monthly and indexes the data geographically and taxonomically. OBIS is making plans for the end of CoML in 2010, as OBIS is intended to be an ongoing legacy of CoML. OBIS would like to serve species-specific data from the research projects. It is developing a World Register of Marine Species (WoRMS) as a master list.

OBIS now publishes more than 13 million location records for 78,000 species from more than 200 datasets. All data can be downloaded at no charge from the OBIS Web site. Data come from all kinds of sources, surveys, fisheries, museums and literature, sampling methods, and habitats. OBIS is a distributed data system, with data being regularly cached, and indexed geographically and taxonomically to facilitate data discovery and exploration online. A recent review of ocean biodiversity informatics has been published that describes the technologies and philosophies involved (http://www.int-res.com/abstracts/meps/v316). It has an expanding Regional OBIS Node (RON) network, some nodes of which are also NODCs, located in Australia, Brazil, Canada, China, Chile, Europe, India, Japan, New Zealand, Republic of Korea, South Africa, and USA, and a RON for Antarctica (SCAR-MARBIN).

The minimum and additional data fields used in OBIS data were summarized and copies of the schema made available on the SCOR Web site. Mandatory fields include species names, latitude, longitude, and collection. Optional fields cover record url, record level source (citation), time and date of collection, collector, higher taxon, country or locality name, depth, temperature, life-stage, sex, abundance, weight, and sample size.

Mapping tools, including environmental range mapping, and open-source maps of countries Exclusive Economic Zones and the International Hydrographic Office seas and oceans, were described. OBIS will be a legacy of CoML and is developing its governance, structure, and functions to ensure long-term sustainability. It welcomes offers of data sets for publication, and for people to inform it of datsets that may be available.

Costello noted that OBIS asks SCOR members to

- promote awareness of its data publication facility;
- identify candidate datsets for publication;
- facilitate the development of its community and technical infrastructure through collaboration and communication;
- comment on OBIS website and portal;
- promote need for OBIS to governments and funding agencies;
- encourage data publication through OBIS; and
- compliment those who have published online.

In addition, OBIS request collaboration with SCOR projects as to how to share data and online tools to provide better services to the marine science community.

Research Vessel Cruise Database

Ed Urban updated meeting participants about the status of the Research Vessel Cruise Database being planned by POGO. This idea had been one of the recommendations of the 2004 SCOR Project Summit around the same time that POGO began discussing it. POGO put out a tender for proposals to develop the database and the SeaDataNet proposal was selected. The Alfred P. Sloan Foundation agreed to support the development of the database. Hannes Grobe expressed concern about a private company managing public data. Ed Urban responded that SeaDataNet was selected because they are already involved in such work for European projects, put in a competitive bid, and got agreement from BODC to maintain the database indefinitely.

Visualization of Data

Murray Brown (IODE Ocean Teacher) presented an introduction to the range of methods for visualization of ocean data. He started by stating that his perspective is that of a teacher, not a researcher. (He has taught students in 52 countries.) For the capacity-building aspects of projects, it is desirable to have simple non-commercial software and to work with PCs rather than Macs, even if Windows is insulting and degrading. The data to work with can be obtained from the IOC Web site (see www.oceanportal.org), as well as other sources.

Brown reminded participants that working with Earth science datasets IS visualization. Both fundamental and complex analyses of the data (and the quality control procedures that precede them) must be viewed graphically in order to understand patterns and relationships, or to identify problems. Brown's credo is that a robust, pre-compiled program that you install with a click and run without hand-holding and grief is a GOOD THING. Loose bits and pieces of source code, requiring licensed platforms, additional libraries, compiling, UNIX system adjustments, de-bugging, INI/BAT file editing, and script writing is BAD. Both fundamental and complex analyses of the data (and the quality control procedures that precede them) must be viewed graphically in order to understand patterns and relationships, or to identify problems.

The visualization paradigm used by IODE OceanTeacher training in Ostend, Belgium is SOURCE->MANAGER->VISUALIZER->YOU. The Source includes datasets "out there" and on hand. The Manager includes dynamic methods to get, subset, re-format, and deliver the source data. The Visualizer is comprised of the user and his/her software. This paradigm comes in three main modes:

Mode I—In this mode, you can actually obtain raw data to work with, often operational data. It is the main paradigm for obtaining data, with no frills. The data sources are typically CDs/DVDs and basic, online collections in basic formats. Visualizers are just about any ocean software with graphics (e.g., Ocean Data View, JOA, GIS ncBrowse, HDFView). With Mode I data, format issues predominate. Climatologies and atlases are a common data source, which often have simple grids, and poor or missing metadata. The data are often in gridded binary format (GRIB), which modelers love, but other oceanographers hate. The data are usually available by some of the worst Web site interfaces on the Web. NetCDF (network Common Data Form) is an interface system to access Mode I data and there are a variety of versions available. NetCDF can be used with Hierarchical Data Format (HDF) but, unfortunately, various versions of HDF are used, even in the same agency (e.g., NASA).

Mode II—In this mode, you can get figures based on the data, but not the actual data that are used to produce the figures. This mode mainly applies with GIS systems. The user has limited control over output, as provided by controls and menus available with the figure. . For example in PNG and JPG figures, the data cannot be captured and underlying shapes and grids ("features") are not exposed. Essentially, the user simply gets pictures of the data from fancy black boxes. Other examples are dynamic "Operational GIS" interfaces based on Open Geospatial Consortium standards, such as the SouthEast Atlantic Coastal Ocean Observing System (SEACOOS) and the OpenIOOS prototypes. Another example are the many java applets that draw maps from underlying, server-side databases. In Mode II, data access issues predominate. There is dominance of a single commercial firm and more copyright hurdles than any other data type, and thus more expense. There is a slow emergence of community "marine GIS", although OpenIOOS and SEACOOS serve as a de facto GIS for now, but for images only. IOC training for Mode II data uses Saga for images and gridding and MapWindow for general use.

Mode III—The source gives you the data (son of OPenDAP). This requires OPeNDAP plus really good client software; all the action is on the client side and there is a nontrivial learning curve. The full potential of OPeNDAP is used for Mode III data. This mode levels the playing field for PCs and work stations, due to stride/step controls. There are data storage and platform capacity issues for model output. Skill and infrastructure issues predominate. The OPeNDAP Data Connector was never completed; some features are available in the Integrated Data Viewer (IDV), but other features are still needed. Catalog maintenance is poor because it's voluntary; the system components are frequently broken. Software solutions tend to be big and complex.

Several technical issues remain in relation to data visualization. There is a need for a basic vector-drawing utility for simple grids **(?)**. Despite the continued heavy use of GRIB by modelers for output, it is time to move on to something more user-friendly. The OPeNDAP cataloging has stalled and National Virtual Ocean Data System (NVODS) maintenance is unfunded now. The principal NASA site for color and SST data (L2,L3) uses HDF4 and not HDF4-EOS. More generally, there is a divide between high-end technical applications in leading laboratories and the visualization needs of compiler- or library-challenged ordinary folks.

Developers need to admit that the Microsoft model is not completely evil. There is an even greater divide between visualization capabilities in advanced institutions and in the developing world. GRIB isn't easy, but it sure does work

In conclusion, Murray Brown stated that format proliferation has slowed down in oceanography, but is not dead. Visualization methods and tools will continue to be scattered and disjointed until we focus on an even smaller family of formats. OPeNDAP-type approaches provide good solutions to MODE 1 and MODE 3 issues. OGC-related work must continue to solve Mode 2 issues. Brown recommended common visualization solutions for the global ocean community, targeting a reasonable computer platform for visualization development. OPeNDAP-type protocols should be robustly supported for all data types. A small family of common formats should be used. A non-proprietary path from data to visualization should be available, even at the expense of early progress. Formal data visualization methods should be taught in all capacity-building activities. All SCOR-sanctioned programs should be involved.

Pat Halpin continued on data visualization, particularly related to a Census of Marine Life activity on this subject. Data and information are not equivalent. Only some information is useful for decision making. We convert data to information to decision support through *analytical workflows*. A data warehouse is not a library. If we want people to use our data we need to convert data warehouses into libraries of useful information and published workflow processes.

Halpin briefly showed the kinds of activities that are carried out under CoML, which shows the scope of data visualization activities needed. OBIS is responsible for CoML data (it also includes data from outside CoML) and is the central system that links CoML projects, Regional OBIS Nodes, and specialized nodes for specific taxons and ecosystem types. Halpin discussed common marine data types and showed examples of how they can be visualized, including instantaneous point observation and effort data; fixed location time-series data; 2-D and 3-D time telemetry tracking; 3D location, time, and environmental sensors telemetry tracking; Photo-ID tracking of individual animals; 3-D passive acoustic location/call data from marine mammals; 3-D animal behavior models; and marine animal habitat models.

Information dissemination and interoperability are important to make it possible to obtain data to visualize. Halpin showed an example of a specialist data center that participates in OBIS, the OBIS-SEAMAP information system. SEAMAP is a world data center for marine mammal, seabird, and sea turtle information. This database includes 185 datasets from 1935 to 2005, including more than 1,100,000 records. The SEAMAP system maintains species data, including natural history information, taxonomic classification, bibliography/Web links, and links to "prey" profiles.

Emerging open-source, open-standards tools provide a functional, open working environment for the ocean biogeographic information community. For example, Internet map service standards are being developed by the Open GIS Consortium. The SEAMAP system provides data discovery metadata, which assists interoperability. Google Map allows quick browsing, easy navigation, and direct access to dataset pages. Google Earth supports any types of data, including effort/telemetry lines. It features informative pop-ups and a link to OBIS-SEAMAP. Halpin

showed integration of Google Earth with OBIS-SEAMAP applications, such as turtle nesting trends and seabird colonies abundance time series. It is possible to overlay environmental data, such as monthly sea surface temperature, over the period of survey. Google Earth provides real-time telemetry tracking tools. Halpin showed from the SEAMAP Web site available time-series animations of telemetry data, sea surface temperature, and user-created animations.

Halpin concluded by demonstrating workflow visualization through an example workflow (the transition from data to information) of marine mammal habitat modeling. The motivation of this process is to translate data on marine mammal distributions into useful information for ocean scientists and managers, to create practical tools for marine mammal avoidance, such as reducing ship-whale interactions in shipping lanes and reducing negative impacts of sonar on marine mammals. Two products are linked to achieve these objectives: (1) the archive of observational data of marine mammal sightings in time and space from 1991 to 2002 (including sampling effort and absence data), and (2) a marine mammal modeling and analysis system. Environmental variables related to sightings are also included in the system, such as sea surface temperature, depth, and distance to shore, the shelf break, and to fronts. Halpin demonstrated how such information could be integrated into a Habitat Modeling Workflow System, using diagnostic tools such as pair plots and histograms, and Receiver-Operator Characteristics curves. Halpin finally discussed GIS Web services for environmental planning, which can yield information such as observations and effort (by dataset and species), range maps, and predictive models. After data have been analyzed, one result can be feedback to data originators, about data quality, gaps in sampling, etc. For example, a "gap analysis" of spatio-temporal data of marine mammals shows, not surprisingly, that data are more plentiful in summer months and that there is a need for more winter data.

Discussion included both Brown's and Halpin's presentations. Ed Harrison noted his view that the first problem is getting data into and out of data archives. We need tools to make integrated databases from data sets. This process should be made more straightforward for more people. Tom Malone also pointed out that many areas of the ocean are still undersampled, so we end up having to fill in the gaps with data generated by models.

Diepenbroek agreed that the general availability of data is the root problem; data that are the basis of many research papers are not available. The distributed aspect of many data is a problem. Data are not delivered to a centralized location in a timely manner and only a few percent of the actual data are archived. Beatriz Balino endorsed this opinion. The main problem is to get data from PIs to data managers. The UK and United States might do a good job at this, but it is more of a problem in other countries. Scientists have to understand the value added by data management. Raymond Pollard suggested that one of the "carrots" to stimulate scientists to put data into data centers would be the provision of good visualization tools. Pollard added that many countries require data resulting from publicly funded research to be archived. Ed Harrison added that we need to get our nations to invest in real-time data management, so that scientists don't bear the cost of this. Tom Malone added that data management should be institutionalized. Jerry Miller gave the example that the U.S. Office of Naval Research-Global requires that data be submitted to a publicly available archive. Michael Diepenbroek suggested that there could be a requirement that data be submitted to an archive before the paper for which the data are used could be published, as is done for molecular data. Mark Costello agreed. We need a system of

data publishing and review. In this case, the carrot would be peer recognition and citation of data sets.

Fred Grassle noted that even the best national oceanographic data centers (NODCs) are not funded to provide access to data. For example, data that resulted from U.S. Minerals Management Service grants are hard to retrieve from the U.S. NODC. When data centers are established and funded, there should be a mandate for data to be publicly available and to provide the ability to update data in data archives.

Robin Raine noted that, in a lot of countries, no "stick" exists. Full and accurate metadata should be included with data and transferred to data centers. Data managers need to know where the data are located. Peter Liss responded that sticks can be very effective. Funding agencies can require that data be turned in to get the next grant. Diepenbroek agreed that a top-down approach is needed. We are having the same discussion we had 15 years ago. Ron O'Dor wondered if it might be more efficient to focus on getting data cruise by cruise, rather than focusing on individual scientists. He suggested that data might be managed starting with research vessels. Ship costs are high and adding data management to them would only cause a relatively small incremental increase in cost. Chris German replied that InterRidge has been trying to keep track of InterRidge cruises, but it has been difficult. Most scientists are protective of their time. The value added by data management must be a benefit to PIs to provide a carrot. It would be good to make people envious that of those whose data are in an archive.

Beatriz Balino stated her belief that every scientist has a moral duty and responsibility to submit the data they generate. Senior scientists should teach this to their students. Howard Cattle suggested that we need to separate data management from information management. CLIVAR holds no data, but they need to provide useful information about CLIVAR data held in national data centers, where they are, and how to get them. We all seem to be re-inventing the wheel. Perhaps we can set out some guidelines to make progress.

Colin Summerhayes noted that the Antarctic science community has the same problem. European Commission grants require data to be put into an archive. IOC signed up to a data policy in 2003, including a clause on open access to data. The countries that agreed need to do what they said they would do. Ed Harrison stated that many nations have entered into agreements in relation to data. Maybe these agreements could be applicable to ocean data.

Tom Malone stated that archives should be set up to allow public access to data. This will have a positive feedback to the scientific community. The Canadian Department of Fisheries and Oceans has implemented a real-time data access capability.

Murray Brown stated that the discussion is covering a lot of different subjects: interoperability, long-term integrity of data, quality control, metadata, versioning, compliance and availability, and infrastructure (methods and manuals). Compliance and availability can be promoted by editors of journals and ship operators.

Fred Grassle stated that there needs to be a method of attribution for each data set. The sticks don't work because some scientists will just go through the motions to meet the minimum

requirements. Peter Liss responded that funding agencies should probably be the ones to apply the sticks. The projects have great difficulty in knowing what is done in their names. It might be appropriate to approach the International Group of Funding Agencies for Global Change (IGFA) about this.

Pat Halpin noted that we need recommendations not only on data that will be collected in the future, but also on data that were collected in the past. Karen Heywood suggested that this meeting should endorse DOIs. Michael Diepenbroek added that WDC-MARE has approached Thompson Publishers about tracking DOI impact factors, as is done for scientific papers.

Manuel Barange cautioned that every data policy needs exception clauses (for situations like commercial fisheries data).

Hannes Grobe made two specific recommendations:

1. Scientific data supplementary to publications: Journal editorial boards should require that data on which each publication is based should be archived. *Marine Micropaleontology* already does this (see http://www.elsevier.com/wps/find/journaldescription.cws_home/503351/authorinstructions).[4]
2. Data that are not used for publications: DOIs solve part of the problem by increasing the value of the data to the scientists who generate the data by making the data citable.

Bjørn Sundby stated that there are high-level obligations that must be filtered down to the scientist level, and we need to address the individual PIs by providing suitable carrots, like education on why archiving data is important and how the PIs could benefit. Michael Diepenbroek added that it is important to teach younger scientists and students, to change the attitudes of the community over time.

Julie Hall responded that SCOR should take a high-level approach. Ed Urban stated that we need to approach projects also, to help encourage their scientists to submit their data. Cisco Werner added that where project scientists edit special issues of journals, they can set certain expectations about archiving data. Michael Diepenbroek responded that it is not only SCOR that should push this idea, but other communities should also be pushing, including urging agencies and scientists to set aside adequate funds for data management. Raymond Pollard responded that previous projects have concluded that 5-10% of the project funding needs to be spent for data management. Tom Malone responded that as much as 20% may be needed for data management for observing systems. Peter Liss again suggested that SCOR go to IGFA to present the issue and discuss how to solve the problem that data need to be shared because the ocean is international. SCOR would need to develop a one- to two-page document for IGFA. Colin Summerhayes responded that this is a broader problem than SCOR. Other organizations, including SCAR, could help. Sundby responded that ICSU could be involved also. Beatriz

[4] "If the original data in the submitted manuscript are not available at an internationally recognized electronic database, they must be submitted as tables or as appendices; the latter will be published electronically only. If the data are available on-line, please provide the url."

Balino agreed that SCOR should join with other organizations, like IGBP, to tackle this issue. Peter Burkill suggested that if we make an approach to IGFA, we should enlist someone involved in IGFA from one of our countries to take the message

The following individuals were requested/volunteered to help with the next step: Murray Brown, Mark Costello, Michael Diepenbroek, Hannes Grobe, Ed Harrison, Peter Liss, Raymond Pollard, and Cisco Werner.

Global Ocean Observing System

Ed Harrison began this session with a presentation about the Ocean Observing Panel for Climate (OOPC). He noted that there is a whole ocean of data available without going to the scientist who generated the data. Harrison is very supportive of the DOI concept. NODCs and WDCs don't get a lot of support. Stronger linkages of projects and data centers should help everyone. The Global Climate Observing System (GCOS) Implementation Plan recommends the following:

- Sustain proven ocean satellite data streams and in situ activities
- Obtain global coverage with initial surface and subsurface systems
- Improve ocean data system, including telecommunications
- Increase effort on ocean analysis and reanalysis
- Maintain strong linkages with research programs for data collection, new technology, pilot projects, new science, etc.

This plan is widely accepted and endorsed (e.g., by the UN Framework Convention on Climate Change, Group on Earth Observations). Unfortunately, present efforts to develop observation systems depend heavily upon ocean research funds, people, and assets. There is a shortage of national institutions for sustained ocean activities National operational global oceanography is in it infancy; there is a limited operational "pull" for such systems. The real-time data system is essential and is developing well. The portion of GOOS related to climate is about 60% complete now. A potentially big problem is the continuation of satellites important for the ocean research community. Harrison was not sure what to recommend for SCOR to do about this. Oceanographers have not made a big-enough issue of this satellite problem.

OOPC is interested in generating interest in near-real time information about the ocean. Climate indices are one route. These are mostly related to ocean surface parameters at present. OOPC is working with CLIVAR on the development of subsurface indices. The *Bulletin of the American Meteorological Society* has an ocean section in their "state of the climate" report and there were 7 ocean indices included in the 2005 report (the goal is 15 parameters). The climate indices Web site (see http://ioc3.unesco.org/oopc/state_of_the_ocean/index.php) can provide parameters important to the projects. This delivers a range of indices, updated weekly, where possible. Most are ocean surface climate indices and there is a need for development of subsurface indices. It is not always simple to agree to indices because indices inevitably oversimplify. This site has the capability to serve additional indices.

There is not clear evidence that the ocean is warming everywhere. Although 96%+ of the cells in the model grid show temperature changes, not all increase. To get a definitive answer, we have to observe the entire ocean for decades. Predicted sea ice extent shows different decreases

depending on the analysis method. The Intergovernmental Panel on Climate Change (IPCC) needs to understand better how large variability is on even decadal time scales. Interannual and decadal variability are large almost everywhere we have observed systematically. Spatial patterns of even multi-decadal trends seem to be complex and roughly balanced in sign. Fifty-year temperature trends are elusive, except at 50 m. Sea ice trends depend on the analysis.

There is no reason anymore to go to sea without checking satellite photos to see if the area is anomalous (e.g., has an eddy passing through it).

Tom Malone reported on developments in coastal GOOS. The purposes of coastal GOOS are to

- Improve the safety and efficiency of marine operations
- Improve forecasts of natural hazards and mitigate their impacts more effectively
- Improve predictions of climate change
- Minimize public health risks
- Protect and restore healthy coastal marine and estuarine ecosystems more effectively
- Sustain living marine resources

The data needed for this system are multi-disciplinary: geophysical, chemical, and biological. Coastal GOOS is seeking interactions with the 12 new GOOS Regional Alliances (GRAs). Coastal GOOS is built from regional GOOS systems and GRAs, to form a Global Coastal Network (GCN). The GRAs, in addition to being the foundation of the GCN, will be research and development incubators, and will set priorities for capacity building within their regions. Members of the GCN will measure common variables (remotely and *in situ*), establish a sparse network of sentinel stations and transects, implement common standards and protocols, and extend and combine coastal observations to basin scales. Malone listed the proposed GCN common variables and the observation requirements for these variables. The implementation of the GCN by the GRAs is just beginning, through two parallel processes: (1) incorporation of existing global programmes (e.g., satellite remote sensing, Global Sea Level Observing Network, Global Coral Reef Monitoring Network) and (2) networking or scaling up of elements developed by GRAs and national GOOS programs (e.g., Continuous Plankton Recorder, harmful algal bloom observing systems, high-frequency radar networks).

The GRAs are taking on five high-priority activities:

1. Engaging industry, academia, and government agencies
    a. In the establishment of a coastal GOOS that
    b. Meets their requirements for data and information
2. Integrating existing assets to meet these requirements
3. Forming partnerships with existing regional efforts that have common interests, for example,
    a. Large Marine Ecosystem Programmes (LMEs)
    b. Regional Seas Conventions
    c. International Council for the Exploration of the Sea
4. Conducting pilot projects that
    a. Build capacity through partnerships between developed and developing nations,

b. Contribute to building the coastal module, and
c. Provide data and information used by decision makers

5. Building the GCN

The 3rd GRA Forum was held in Cape Town, South Africa, on 14-17 November 2006, and helped move the implementation of the GCN forward. Regional partnerships with LMEs is a high priority. A series of pilot projects for implementation by partnerships between developed and developing nations were identified:

- Improve forecasts of susceptibility to, and impacts of, coastal flooding on coastal populations, ecosystems, and resources.
- Serve near-real time, blended ocean color products.
- Improve forecasts of coastal circulation through coupled deep ocean–shelf hydrodynamic models.
- Implement Coastal Ocean Data Assimilation Experiments (CODAE).

Discussion was opened in relation to both GOOS presentations. Cisco Werner asked for more specifics about the satellite situation. Ed Harrison responded that there is an appendix in the GCOS report about the satellite timing. Although it is not primarily SCOR's responsibility to worry about satellites, it would be helpful for SCOR to say something. Some of the value of the Argo measurements will be lost without having good altimetry. Peter Burkill asked what SCOR can do practically. Harrison responded that issuing a statement to CEOS from this group (and perhaps also ICSU) would help. The challenges are even more serious for terrestrial satellites. Ed Urban suggested that SCOR could bring up this issue at the IOC Assembly in June 2007. Tom Malone responded that the effectiveness of working through IOC will require contacting Keith Alverson and national delegations beforehand. Julie Hall asked what has happened with the IGOS documents that discussed this issue. Ed Harrison responded that it is not obvious that the IGOS documents have had any effect on these discussions. Beatriz Balino noted that the ocean color situation does not look good, particularly in terms of continuation of IOCCG ocean color maps. Tom Malone responded that the situation is even worse for Case II waters. Harrison noted that no straightforward summary of the satellite situation has been published.

On a different topic, Ron O'Dor noted that CoML has instrumented animals with sensors that are collecting GOOS-relevant data. Are these data making it into models? Harrison responded that this process has been started, but has not gotten very far yet.

Research programs can input to GOOS through OOPC and the GOOS Scientific Steering Committee.

<u>OceanSITES</u>

Uwe Send gave an update on the progress of the OceanSITES activity. He went through the scientific, operational, and technical applications of ocean time series. OceanSITES is a global ocean time-series observatory system under development internationally. It started as a GOOS/CLIVAR/POGO-sponsored (via OOPC/COOP) activity. The system is multidisciplinary in nature, collecting physical, meteorological, chemical, biological and geophysical time-series observations. The goal is to make the data publicly available as soon as received, and quality-

controlled by the owner/operator. An International Steering Team provides guidance, coordination, outreach, and oversight for implementation, data management, and capacity building. This team includes 18 scientists operating sites, representing all ocean disciplines. A pilot system has been defined consisting of all operating sites and those planned to be established within 5 years, subject to evaluation by the Science Team in terms of the qualifying criteria. Two important definitions that OceanSITES is using to define time series are

1. Sustained in-situ observations at fixed geographic locations of ocean/climate-related quantities at a sampling rate high enough to unambiguously resolve the signals of interest.
2. Only truly Eulerian data, that is, no ship sections or underway data, no surveys with vessels or gliders around a site. But PRODUCTS derived from other systems (e.g., transport time series from ferry ADCP sections) would be included in the database.

International coordination is critical for sharing resources, addressing global issues, standardization and harmonization, attracting and serving the user community, data management, visibility, and advocacy. The plan and vision for global ocean time series includes two global data portals (under construction in OceanSITES). The NetCDF format has been defined in consistency with other/prior programs (e.g., ARGO) and with the U.S. Integrated Ocean Observing System's Data Management and Communications philosophy. Multi-disciplinary data from all (public) deep-ocean time-series sites will be available in real-time, with single queries. This goal will be challenging since several communities need to come together. An important approach will be to add value to data by providing products and indicators, for example

- intensity of processes (air-sea fluxes, critical vertical/horizontal exchanges, productivity)
- state and health of the ocean and atmosphere (physics/climate, ecosystem, inventories, chemicals, populations)
- forecast/warning indicators (El Niño, North Atlantic Oscillation, blooms, pollution, earthquakes)

Since the 2005 meeting of the WMO/IOC Joint Commission on Oceanography and Marine Meteorology (JCOMM) in Halifax, OceanSITES has been a recognized component of the global ocean observing system being integrated under GOOS, JCOMM, etc. OceanSITES involvement in Ocean-United and GEO has been agreed. The OceanSITES Data Team met for the first time in February 2006 and agreed on a wide range of issues, approaches, and architectures:

- A data format has been agreed on, modeled after ARGO, consistent with other international and U.S. efforts, using NetCDF
- conventions on architecture and procedures have been established (data assembly centers [DACs], global data assembly centers [GDACs], portals, etc.)
- Coriolis/IFREMER will be one GDAC; OceanSITES is waiting to hear about a NOAA GDAC.
- Sample data are flowing now from
  - WHOI air-sea flux sites
  - ANIMATE/MERSEA sites

- NOAA/KEO mooring
- Dickey Bermuda mooring
- MOVE moorings
- MBARI moorings (under way)
- ship hydrography from Hawaii/Bermuda (under way)

- OceanSITES plans to expand and invite others, once the data system and format is demonstrated and operational.
- In the future, it will be a requirement to contribute data publicly, in order to be part of OceanSITES, reflected on implementation maps.

Uwe Send issued an invitation from OceanSITES to other projects present to

- express interests and rationales for specific time-series sites (existing or additional ones);
- cooperate on implementation, maintenance, and operation of sites; and
- cooperate on the data system for time series-type data.

Gideon Henderson expressed an interest from GEOTRACES in sites where water samples are actually collected, so that GEOTRACES sections might be passed through those sites. Jeff Hare added that SOLAS would be interested in sites where gas species and nutrients are measured. Peter Burkill asked if it is possible for OceanSITES to add new sensors at existing sites. Uwe Send replied that it might be possible to offer moorings to which sensors could be added. Julie Hall stated that communication between OceanSITES and IMBER is important. Are OceanSITES metadata available? Send responded that metadata will increasingly be available on the OceanSITES Web site. Mike Sparrow commented that OceanSITES and CLIVAR share the desire to have data released as soon as possible. Peter Burkill summarized the discussion by saying that the bottom line is that OceanSITES is up and running and should continue interactions with the projects.

ACTION: Projects to interact with OceanSITES directly in relation to their measurements of interest and their needs for time-series measurements.

Southern Ocean/International Polar Year (IPY)

Each project presented information about their IPY plans. Gideon Henderson stated that two German/Dutch cruises in the Southern Ocean will be a GEOTRACES contribution to IPY. There are also proposals for French, Japanese, Australian, and Spanish cruises in the Southern Ocean as part of GEOTRACES. Manuel Barange reported that there are two clusters of IPY activities related to GLOBEC: ICED in the Southern Ocean and ESSAS in the Arctic Ocean.

For iAnZone, Karen Heywood added that the Synoptic Antarctic Shelf-Slope Interactions Study (SASSI) will start in 2007. SASSI will have a group of short sections (potential interactions with GEOTRACES?) from Antarctica into the Southern Ocean (see http://roughy.tamu.edu/sassi/). The project is targeting Antarctic nations that do not yet do a lot of oceanography on their way to their bases. SASSI is focused on physical oceanography, but is keen to develop collaborations with scientists in other disciplines. In addition to SASSI sections, there will be some moorings, which could link with OceanSITES. Most of the moorings are not funded yet but, if established,

some would return data from under the seasonal ice in winter. Most SASSI activities will collect water samples. SASSI activities are awaiting funding decisions in most of the nations that would like to participate. The hydrographic sections are more likely to be funded than the moorings. One of the rationales for SASSI is to study the significant freshening of the Ross Sea. Heywood invited meeting participants to attend the iAnZone meeting in Bergen, Norway in 2007. Ed Urban asked if there are still berths available on SASSI cruises and Karen Heywood answered that SASSI is encouraging all SASSI cruises with empty berths to make them available to scientists from outside SASSI.

Mike Sparrow presented CLIVAR's plans for IPY. CLIVAR is planning the Climate of Antarctica and the Southern Ocean **(**CASO) project (see http://www.clivar.org/organization/southern/CASO/index.htm). CASO aims to tackle some important unknowns:

- Obtain the first circumpolar snapshot of the Southern Ocean, including physical, ecological and biogeochemical properties.
- Measure the circumpolar extent and thickness of Antarctic sea ice through an annual cycle for the first time.
- Observe the sub-ice ocean circulation, water mass properties, and biological distributions.

They would like to have multidisciplinary transects as part of CASO. They have quite a few funded sections already, particularly northward extensions of SASSI sections. There is some modeling involved. They are working on developing under-ice Argo floats. Many sections won't be done on ice breakers, so the southern extent of the sections will be limited. Using marine mammals as sensors is a promising approach. Their IPY Observing System would include

- Synoptic multi-disciplinary transects
- Sea ice volume
- Enhanced sea ice drifter array
- Ocean circulation under sea ice
- Enhanced Southern Ocean Argo
- Enhanced meteorological measurements
- Ice cores from high-accumulation rate coastal sites
- Process studies

It is intended that there be a Southern Ocean Observing System continued after IPY, including 2- to 5-year repeated sections, 6+ short sections repeated, and moorings/stations on select sections. This system would help to begin to measure the variability of the system.

Chris German reported for InterRidge, which has work on the Gakkai Ridge (Arctic Ocean) planned for summer 2007, using AUVs. There are two ridges in the Southern Ocean and hydrothermal signals have been known from them since 1999-2000. InterRidge and CoML ChEss are planning two joint cruises to the Southern Ocean ridges. It is known that the Atlantic, Pacific, and Indian ocean ridges have very different vent ecosystems, so there is great interest in finding out how the Southern Ocean vent ecosystems relate to the others. These cruises will be

very interdisciplinary and will take place in 2008 and beyond. Paul Tyler is the key contact person. Peter Burkill noted that GEOTRACES would probably be interested in these cruises and German responded the InterRidge is working with GEOTRACES.

Colin Summerhayes suggested that it is useful to summarize ocean-related IPY activities and showed a list of SCAR-related IPY activities (see Appendix III), some of which are components of SCOR-sponsored projects. Mark Costello noted that SCAR-MARBIN has begun publishing biological data through OBIS and can facilitate such publication for scientists working in the Antarctic. Summerhayes continued with a summary of the activities of the SCAR/SCOR Expert Group on Oceanography. This group has established linkages with the projects with planned Southern Ocean research. The intention is to transition the group over time to a fully multidisciplinary group. (It is focused now on physical oceanography.) The results from the group's most recent meeting (July 2006) include

- Web site for data and products;
- More work needed to populate the Web site with data;
- Some progress in collating physical oceanographic data - e.g., Ocean-READER at the British Antarctic Survey;
- Need to maintain the WOCE Southern Ocean atlas database;
- Need to encourage data submission to CLIVAR DACs;
- Good progress developing interdisciplinary research (ICED);
- Need stronger links between ICED, SOLAS and IMBER, and ICED and WCRP;
- Slow progress in bathymetry (IBCSO) (now improving with hire at AWI);
- Need to improve the bathymetric database and data exchange;
- Twenty Southern Ocean programmes accepted as leads for IPY cluster projects;
- Support for proposed SCOR Fe-enrichment working group;
- Need to consider carbon cycling and ocean acidification issue; and
- Need to take a primary role in developing a Southern Ocean Observing System (SOOS) (linking with GOOS, POGO, CCAMLR, JCOMM, etc.).

The work of the Expert Group in 2007 will focus on planning for a workshop in Bremen, October 2007, to draft the SOOS plan. A SOOS is sought as one of the legacies of the IPY. Information will be collected in advance from observation providers about ongoing and possible future activities, gaps, and priorities; as well as from potential users about requirements. The draft plan outline will be completed by the end of March 2008 for review by the wider community at the SCAR OSC in St Petersburg, Russia, in July 2008.

Bathymetry

Karen Heywood stated that accurate bathymetry is an issue for iAnZone for sampling, modeling, and deploying moorings. Tidal models do not work well around Antarctica. Most ships are equipped to take these measurements, but don't collect and report them. Suzanne Carbotte noted that bathymetric data are available from the United States, but often not from other nations. Heywood responded that the Germans are collecting bathymetric data routinely from their ships. Chris German added that the PIs of most cruises won't normally collect multibeam data, but we could encourage them to do so. Can they take slightly different tracks on each transit, so as to cover more bottom area? This would require an international clearinghouse for this data. Colin

Summerhayes responded that such a clearinghouse can be found at http://www.ngdc.noaa.gov/mgg/bathymetry/multibeam.html. Ed Harrison asked if the geoid is known well enough and, if not, should the ships also be routinely collecting gravity data? Colin Summerhayes responded that gravimetry and magnetics are important, but the highest priority is for bathymetry.

ACTION: Peter Burkill asked Summerhayes, German, and Heywood to put together a recommendation on this topic (see Appendix IV for draft recommendations).

Capacity Building

Ed Urban presented SCOR capacity-building activities and then the projects and other organizations were given the opportunity to share what they are doing in capacity building. CoML representatives reported that CoML has submitted a proposal to the Global Environment Facility (GEF) to create marine biodiversity centers of excellence. CoML has regional implementation committees and Ron O'Dor offered CoML assistance in any SCOR capacity-building activities.

ACTION: A suggestion was made that there should be a meeting of people from different organizations responsible for capacity building in the ocean sciences, as well as a catalog of marine capacity-building activities and resources. Murray Brown offered to build a catalog.

The linkages between SCOR and the marine projects needs to be tight in the area of capacity building. SCOR should consider having some project people on its Committee on Capacity Building. The international project offices (IPOs) often have good information and are the front line for capacity building.

Chris German brought up the example of the value of developed country scientists going to developing countries (InterRidge has used this approach) and Ed Urban responded that this approach came up at the SCOR General Meeting a few months ago also and he will seek permission from NSF to use this approach. Jeff Hare stated that is it hard for IPOs to find small amounts of money for its conferences and perhaps SCOR could help by coordinating requests. Ed Urban responded that he did not think this approach would work. Bjørn Sundby noted that Venu Ittekkot, the new chair of the SCOR Committee on Capacity Building, will be the focal point for SCOR capacity-building activities.

Colin Summerhayes reported that SCAR has been developing a capacity-building strategy and has a small committee overseeing this subject. SCAR has a fellowship program to help individuals go from Antarctic institutes in developing countries to similar institutes in developed countries, as well as to participate in Antarctic research during IPY. SCAR is a partner in a virtual university (the International Antarctic University; see http://www.iai.utas.edu.au/). Eventually, this university would like to offer Masters degrees in polar science. SCAR uses its biennial meetings and conferences as another opportunity for capacity building.

Robin Raine reported that one of the more successful activities of GEOHAB to date has been the HABWATCH meeting (see http://www.obs-vlfr.fr/habwatch/). GEOHAB will seek to involve

developing country scientists from Asia in its activities through a special session in conjunction with the March 2007 GEOHAB SSC meeting. Fred Grassle reported that CoML/OBIS has developed nodes in developing countries; these nodes seem to be self-sustaining for now.

Bjørn Sundby shared his experience that getting a small amount of seed money for a meeting in Sri Lanka was difficult, and that it might be easier (for some sources) to ask for a larger amount of funding. Tom Malone added that at the GRA meeting, participants emphasized that capacity building must be in their backyards. Murray Brown responded that IODE has certified instructors in 12 countries and this seems like a good approach. Sundby noted that Chile has been very successful in developing its oceanography system and can be a model and a source of inspiration. Colin Summerhayes mentioned that there are UNESCO Chairs in many developing countries. (There are presently 595 UNESCO Chairs. Some are ocean-related, in Chile, Georgia, Germany, Mozambique, Russia, Spain, and Sudan.)

Bjørn Sundby suggested that the projects deal directly with the SCOR Committee on Capacity Building. Julie Hall responded that IMBER has a small capacity-building committee that has developed a policy for IMBER capacity-building activities. Its goal is to make sure that IMBER activities include capacity building and have coordinated efforts with EUR-OCEANS on summer schools and their Floating University. IMBER has received funding from SCOR to help developing country scientists attend the continental margins open science meeting in 2007. Manuel Barange added that GLOBEC does not have a capacity-building committee or policy. But, there is a network with developing countries through GLOBEC science. Robin Raine noted that, in relation to harmful algal blooms, IOC has run training programs in developing countries and in Denmark, so that people are getting trained in HAB science. Beatriz Balino added that IGBP does its capacity building primarily through the projects, although IGBP would probably be interested in participating in a capacity-building committee. Sundby agreed that SCOR should work with IGBP in this area. CLIVAR does its capacity building through WCRP, according to Howard Cattle, including receiving funding for this purpose. CLIVAR encourages its groups to include members from developing countries, particularly for activities related to monsoon science. The Indian Ocean panel with GOOS has good developing country participation. In Africa, the African Monsoon Multidisciplinary Analyses (AMMA) is co-sponsored by CLIVAR. They recently ran a capacity-building workshop on climate prediction for Africa. CLIVAR meeting organizers encourage participants to bring their data to the workshop to help them analyze it.

Bjørn Sundby summarized. Most or all projects/organizations at this meeting are involved in capacity building. There is a lot of experience we can draw on. We should think broadly and not be patronizing in our approaches. It is a good idea to have a SCOR focal point. How do we fund these activities? It makes sense to have a dual approach of bringing some developing country scientists to developed countries for training, but also to send some teachers to developing countries.

Bob Gelfeld responded that IODE has networks all over the developing world. Bjørn Sundby noted that CoML has regional OBIS nodes and implementation committees. Ron O'Dor added that the CoML NaGISA project is working in many developing countries. Peter Burkill added

that there will be both bottom-up (Murray Brown's Web site) and top-down (the SCOR Committee on Capacity Building) approaches that can be applied.

Project Web sites

Ed Urban presented the results of the review of project Web sites done by Elizabeth Gross (see Appendix V). Bob Gelfeld stated that the current thinking is that it should only take 2 to 3 clicks to find any desired piece of information on a Web site. Murray Brown added that there is a trend for Web sites to be non-hierarchical. But, with such non-hierarchical structures, you don't know if you have seen everything you need to see. Ron O'Dor stated that it is helpful to make Web sites accessible through Google. Manuel Barange reminded participants that there is a difference in Web sites for service providers versus those for projects; the latter are usually more like a reference library. Barange appreciated having objective feedback on the GLOBEC Web site. Referring to science highlights on Web sites, Barange noted the GLOBEC approach of picking some key GLOBEC-related publications from the past year and building a story around a key figure from each publication. Ron O'Dor responded that CoML has also found that one image is worth many words. Colin Summerhayes stated that the culture of SCAR is not to focus on scientific highlights, so he has to encourage SCAR scientists to provide this kind of information for the SCAR Web site. Karen Heywood found the review to be very useful and asked if it could be repeated in a few years. Mark Costello suggested that projects might also want to create entries for Wikipedia. (Some projects, for example GLOBEC, already have Wikipedia entries.) Ed Urban concluded the discussion by stating that Elizabeth Gross can provide more detailed comments to any project wanting these.

ACTION: Repeat Web site review in two to three years.

Marine Habitat Classifications

Mark Costello introduced this topic. OBIS and GEOSS need marine habitat classifications to report on ecosystem conditions. The perspective of habitat and range depend on the type of organism being considered, requiring different sampling methods. OBIS is considering expert-defined regions. Many different regional classification systems have been developed in the past. It will be necessary to develop standard vocabularies and dictionaries, and the creation of semantic ontologies to link terms. Ed Urban noted that GEO has an ongoing Ecosystem Classification Working Group. Julie Hall noted that there has been a tremendous amount of work in LOICZ on coastal classifications. Pat Halpin added that it irks ecologists when the word "habitats" is used when what people mean is "ecosystems." Pelagic habitats are all dynamic. Costello agreed that "habitats" is used loosely; the term "biotopes" is probably better. OBIS has expert defined regions searchable on its website already for EEZ, sea areas, Longhurst pelagic provinces, and other areas; and has more in development.

Bjørn Sundby asked if there were any recommendations. Mark Costello responded that this presentation is primarily to make projects aware of this activity and to provide a chance for feedback from the projects. Pat Halpin remarked that one of the limitations of ecosystem analysis data is the lack of absence and sampling effort data. Ron O'Dor noted that predictive tools combine biological and physical data, which should be reflected in habitat or ecosystem classifications. Julie Hall stated that Marsden Squares are not necessarily a good way to classify areas because many people don't know what these are. OBIS and others should include a

definition of Marsden Squares when they are used. Bob Gelfeld responded that Marsden Squares are used widely by the World Meteorological Organization and each square has a unique code.

Carbon Offsetting for Project Meetings

Ed Urban opened the discussion by stating that this topic has been mentioned increasingly by the projects and is being used by some of them. He asked Manuel Barange to summarize GLOBEC's experience with carbon offsetting. Barange explained that the primary rationale behind carbon offsetting is to put an extra cost on travel to meetings to help meeting organizers and participants consider conducting fewer face-to-face meetings. The secondary rationale is, when organizations feel that it is necessary to have meetings, the carbon dioxide related to participants' travel should be offset by contributions to a reputable organization that is investing in projects that will result in a reduction in CO_2 emissions of a roughly equivalent amount. Jeff Hare responded that he is not sure that this approach will have a significant impact on the rise in atmospheric CO_2. Barange acknowledged this point, but added that the idea is to get scientists thinking more about the carbon emissions of their travel. Chris German expressed an interest in learning how GLOBEC selected the carbon offsetting company it is using. Barange responded that GLOBEC wanted to select a company in the UK so that they could visit the office. About 200 organizations and businesses use the company they use (ClimateCare: http://www.climatecare.org/). Howard Cattle added that WCRP is doing the carbon offsetting centrally for all of its projects. Chris German cautioned that the technology may not be up to the task of replacing large face-to-face meetings with remote methods (e.g., Web cams). Pat Halpin asked why GLOBEC makes participating scientists pay for the offsetting costs, rather than the project paying. Barange responded that it is not clear whether GLOBEC's grants, for example from NSF, would pay for these costs. Ed Urban confirmed this point. Hare asked what has been the response to the GLOBEC approach. Barange responded that 100% of participants in GLOBEC's SSC meeting earlier in the year donated part of their reimbursements to offset the carbon emissions of travel to their meeting. They are still tracking the responses for other meetings.

Conclusions/Recommendations

Peter Burkill began the summary discussion by stating that several items were discussed in the meeting as information items and did not necessarily result in recommendations. Data and satellites seem to be the major issues from this meeting, so they would be dealt with first.

Data—Cisco Werner, Ed Harrison, Mark Costello, and Michael Diepenbroek were assigned to further develop this issue. The major issue seems to be getting data into data centers. The important aspects of this issue are (1) to get journals to instruct their editors that papers will not be published/accepted **(?)** until the data on which the paper is based are placed into an appropriate permanent archive, (2) getting data from cruises into data centers, and (3) the role of IPOs in getting project data into data centers.

The preamble of the recommendation should state why data should be shared. The recommendation should define agency and PI responsibilities and describe the infrastructure needed, and the need to work through journals, agencies, national requirements, and IGFA. The recognition/reward system should ensure that data are available, traceable, accessible, and

citable. The document should recommend a SCOR Panel to develop the DOI idea for marine research projects.

Murray Brown stated that DOIs for data is a long-standing idea. Julie Hall added that this Panel should consider what is being done in the genetics community in relation to data and publications. Gelfeld stated that we need more information about DOIs before recommending that projects adopt them. Peter Burkill responded that the proposed Panel should investigate DOIs. Jeff Hare added that more information is available at www.DOI.org. Jerry Miller noted that one idea that should be discussed is versioning. Mark Costello noted that DOIs are similar to ISSNs and ISBNs. Karen Heywood suggested that model outputs should be included in this approach to make model outputs citable and available. Chris German noted that the electronic journal *Geochemistry, Geophysics, Geosystems* already provides the possibility for publishing "data briefs" that "report previously unpublished data, with appropriate documentation, accompanied by a minimum of interpretation and discussion" (see http://www.agu.org/journals/gc/). It was decided that a recommendation to journal editors would wait until after the Panel has completed its work.

Peter Burkill asked what other organizations should be involved? Colin Summerhayes responded that this is a collective issue. Howard Cattle noted that WCRP is setting up a data management committee. Burkill asked whether there should be a letter to other organizations to inform them about SCOR's plans and ask them if they want to be involved. Summerhayes supported this approach, so that other organizations can address the same issue together. Chris German added that this will also give us an opportunity to find out what other organizations are doing. Fred Grassle mentioned that ICSU has a committee called the Committee on Data for Science and Technology (CODATA) and that we should find out if it is doing anything about DOIs. Robin Raine reiterated his point about the importance of making data sets citable. Funding authorities in the United States and United Kingdom might be amenable to requiring data to be put into data archives, but this will be more difficult to achieve in other countries in Europe and elsewhere, so greater incentives are needed.

ACTION: SCOR to send letter to other organizations regarding their interest in participating on a Panel to make recommendations about data publication, including incentives for data publication[5].

ACTION: Determine what other organizations are doing related to DOIs.

[5] Use of DOIs is only a technical mechanism for reliably referencing electronic resources (and also scientific data). This could be achieved with any type of persistent identifiers (URN, HDL etc.). DOIs provide the advantage of being a brand that is increasingly used. However, the real idea behind DOIs is finding a reliable way of publishing and citing scientific data. The STD-DOI project (www.std-doi.de) has been running now for three years. The DOI registry for scientific data has been working on a routine basis for more than one year. Several World Data Centers and various data providers are using this facility; a recent new "customer" is the International Ocean Drilling Project. The group running the STD-DOI project is very active in spreading the idea of data publication; data publication in the context of DOIs was presented during the most recent IODE meeting in Ostende and will be a topic at the next IODE meeting in Trieste.

The letter to the funding agencies should be written very carefully. NSF does not strictly enforce its policy on data submission, largely because of a lack of staff to monitor compliance. Having DOIs would make the policy easier to enforce. Ed Harrison added that the issue of national policies should be considered, and a percentage of project funds that should be devoted to data management should be specified. Peter Burkill asked whether national funding agencies should be reached through national SCOR committees. He also asked what projects could do to help get data into data archives. IMBER and GEOTRACES have adopted the idea of a Data Liaison Officer, to help make this happen. Manuel Barange responded that it depends on the project. Although it is important to have data archived and available, the fisheries data issue is difficult for GLOBEC, which is why they focus on metadata management. Julie Hall added that IMBER is taking data seriously, by establishing a Data Management Committee and appointing a Data Liaison Officer in the IPO. The IMBER Data Management Committee is debating whether to handle data or only metadata. IMBER may produce data products later. Chris German stated that InterRidge does not have a data policy. InterRidge is a loose federation of national programs that need specialist databases. At the meeting it was thought that the British Oceanographic Data Centre (BODC) does not accept InterRidge-type data from the UK. Subsequently, BODC have confirmed that following a recent reassessment of roles and responsibilities it is its intention to deal with such data in the future. It was noted that the U.S. RIDGE program can now accept international data. It is helpful to have specialist databases spread around the world. Howard Cattle suggested that perhaps one recommendation to the IPOs would be to make their data management activities and data more visible on their Web sites. Manuel Barange added that projects should consider the legacy of their data and should check the metadata links. Robin Raine reported that, because of the multiple different data types, GEOHAB Core Research Projects don't think they can do project-wide data management. Therefore, GEOHAB will establish a centralized metadatabase. Peter Burkill asked Howard Cattle and Manuel Barange to come up with a recommendation to IPOs.

Ed Harrison stated that we need to ensure that the ocean science community has invested in interoperability tools, which will require money and staff to accomplish. Burkill asked how this could be achieved. Murray Brown suggested that this group should recommend that the OPenDAP activity be reinvigorated.

ACTION: Ed Harrison and Murray Brown to speak with Cornillion and Hanken about OPenDAP and report back to Urban on their response.

ACTION: SCOR to form a Panel on DOIs, based on recommendation from Werner et al.

ACTION: A recommendation to IPOs should be developed by Cattle and Barange.

Satellites—Peter Burkill asked whether we should involve organizations beyond SCOR in the letter. The sensors most at risk and most important to the ocean research community are the sensors for altimetry, color, and microwave sea surface temperature **(verify).** Harrison and Urban will develop the letter for review by meeting participants after the meeting. Burkill asked if anyone wanted to add anything to the concerns expressed before. Murray Brown responded that the EOS satellite is important for ocean color and sea surface temperature, so we should say something about it.

Ed Harrison presented a draft statement from this meeting. The statement needs to be reviewed by satellite experts. When completed, it should be sent to GEO, ICSU, the Committee on Earth Observing Satellites (CEOS), the UN Framework Convention on Climate Change (UNFCCC), and satellite agencies worldwide. Colin Summerhayes suggested sending the letter to CEOS national representatives and other key people in the space agencies. Pat Halpin suggested that high-level people in the agencies may not understand the problem of lack of continuity of any given sensor. Bjørn Sundby asked for a list of the appropriate addresses. Jerry Miller stated that the letter could be strengthened by specifying which sensors are most in danger. Murray Brown suggested emphasizing that currently scheduled projects studying climate change will suffer if these sensors are not available. Colin Summerhayes stated that, after an introductory statement, the letter should focus on ocean color and altimetry. Ron O'Dor asked whether such a letter could feed into Oceans.United. There was a consensus that such a letter should be a product of this meeting. Ed Harrison will be the focal point and we will send the draft letter back to the meeting participants. He stated that this would add the international ocean community's voice to the voice of the climate community. Ed Urban offered to help with the letter.

ACTION: Revise letter and send draft to participants.

ACTION: Participants to send addresses of national space agency and other contacts to receive the satellite letter.

Bathymetry—Colin Summerhayes developed a preamble from the SCOR WG 107 report on ocean bathymetry, and from recommendations of the SCAR/SCOR Expert Group on Oceanography that resulted from the group's meeting in Hobart earlier in 2006 (see Appendix IV).

Jerry Miller commented that if he were doing ocean science, he would want to travel on tracks with known bathymetry, rather than deviating the ship's course a bit to cover a new track. Colin responded that that would be an understandable decision. Pat Halpin noted that nothing in the statement speaks to a final product of the data. Manuel Barange asked whether ocean bathymetry is within SCOR's purview. Chris German responded that the SCOR angle is to make the point the having better bathymetry in the Southern Ocean will help SCOR-related projects. IBSCO is pulling together data and we can stimulate the filling in of gaps in observations. Murray Brown cautioned that existing maps have been put together with haphazard data. Fred Grassle suggested that this recommendation should go to POGO also. Dave Monahan commended the work of the people who put together this statement. GEBCO fully supports all the proposed recommendations and is prepared to continue to update its maps and grids of depths through the incorporation of data so submitted.

Capacity Building—Two actions were repeated:

ACTION: The projects and their IPOs should feed information into and interact with the new SCOR Committee on Capacity Building.

ACTION: Murray Brown will develop a Web-based catalog of ocean capacity-building activities.

Other Comments—Jerry Miller noted that he will soon be the editor of *EOS* for ocean science, and would be interested in receiving articles on the issues discussed here. Colin Summerhayes suggested putting a report of this meeting in *EOS*.

ACTION: Circulate a participant contact list after the meeting.

An update on progress on the action items from this meeting is given at http://www.scor-int.org/Project_Summit_2/Action_Items.htm.

This report will be considered by SCOR and will be distributed to SCAR, IOC, IGBP, POGO, and other organizations that could help implement these recommendations.

Appendix I - Acronyms

AUV	autonomous underwater vehicle
AWI	Alfred Wegener Institute for Polar and Marine Research
BODC	British Oceanographic Data Centre
CACGP	Commission on Atmospheric Chemistry and Global Pollution
CASO	**Climate of Antarctica and the Southern Ocean**
ChEss	Biogeography of Chemosynthetic Ecosystems (ChEss) project (CoML)
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CLIVAR	Climate Variability project (WCRP)
CoML	Census of Marine Life
COOP	Coastal Oceans Panel (GOOS)
COST	Cooperation in the Field of Scientific and Technical Research (EU)
DAC	data assembly center
DOI	digital object identifier
EUROCEANS	European Network of Excellence for Ocean Ecosystem Analysis
GCN	Global Coastal Network (GOOS)
GCOS	Global Climate Observing System
GDAC	Global Data Assembly Center
GEBCO	General Bathymetric Chart of the Oceans
GEF	Global Environmental Facility
GEOHAB	Global Ecology and Oceanography of Harmful Algal Blooms Programme
GEOTRACES	an international study of the global marine biogeochemical cycles of trace elements and their isotopes (SCOR)
GIS	geographic information system
GLOBEC	Global Ocean Ecosystem Dynamics Project (SCOR, IGBP, and IOC)
GODAR	Global Oceanographic Data Archaeology and Rescue
GOOS	Global Ocean Observing System
GRA	GOOS Regional Alliance
HAB	harmful algal bloom
HDF	Hierarchical Data Format
iAnZone	International Antarctic Zone Programme
IBSCO	Group on International Bathymetric Chart of the Southern Ocean
ICED	Integrating Climate and Ecosystem Dynamics (IMBER and GLOBEC)
ICSU	International Council for Science
IFREMER	Institut français de recherche pour l'exploitation de la mer (French Research Institute for Exploitation of the Sea)
IGBP	International Geosphere-Biosphere Programme
IGFA	International Group of Funding Agencies for Global Change Research
IHDP	International Human Dimensions of Global Change program (ICSU)
IMAGES	International Marine Aspects of Global Change project
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research Project
InterMARGINS	An international and interdisciplinary initiative concerned with all aspects of continental margin research.
InterRidge	An initiative for international cooperation in ridge-crest studies
IODE	Intergovernmental Oceanographic Data and Information Exchange
IOOS	Integrated Ocean Observing System
IPCC	International Panel on Climate Change
IPO	International Project Office
ISBN	International Standard Book Number
ISSN	International Standard Serial Number
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JGOFS	Joint Global Ocean Flux Study (SCOR and IGBP)
LME	Large Marine Ecosystem

LOICZ	Land-Ocean Interactions in the Coastal Zone project (IGBP, IHDP)
MarBEF	EU Network of Excellence on Marine Biodiversity and Ecosystem Functioning
NaGISA	Natural Geography in Near Shore Areas
NASA	National Aeronautics and Space Administration (USA)
NetCDF	network Common Data Form
NODC	national oceanographic data center
OBIS	Ocean Biogeographic Information System
OceanSITES	A worldwide system of long-term, deepwater reference stations measuring dozens of variables and monitoring the full depth of the ocean from air-sea interactions down to 5,000 meters.
OOPC	Ocean Observations Panel for Climate (GOOS)
OPenDAP	Open-Source project for a Network Data Access Protocol
OpenIOOS	Grass-roots partnership effort to support integration of the various activities involved in collection of observations and making predictions of the coastal environment, including contributions from federal agencies and research institutions, supported by the Integrated Ocean Observing System
POGO	Partnership for Observations of the Global Oceans
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SEACOOS	SouthEast Atlantic Coastal Ocean Observing System
SeaDataNet	Pan-European infrastructure for Ocean & Marine Data Management
SSC	Scientific Steering Committee
SOLAS	Surface Ocean – Lower Atmosphere Study (SCOR, IGBP, WCRP, CACGP)
SOOS	Southern Ocean Observing System
WCRP	World Climate Research Programme
WDC	World Data Centre
WDC-MARE	World Data Center for Marine Environmental Sciences
WOCE	World Ocean Circulation Experiment
WOD05	World Ocean Database 2005
WoRMS	World Register of Marine Species

Appendix II - Meeting Participants

Dawn Ashby	GLOBEC Data Manager
Beatriz Balino	IGBP Deputy Director, Natural Sciences
Manuel Barange	GLOBEC Executive Officer
Sophie Beauvais	IMBER Data Liaison Officer
Emily Breviere	SOLAS IPO
Murray Brown	IODE Ocean Teacher
Peter Burkill	UK SCOR, Meeting Co-chair
Susan Carbotte	U.S. Ridge2000/U.S. MARGINS
Howard Cattle	CLIVAR Director
Mark Costello	Chair, OBIS International Committee
Michael Diepenbroek	World Data Center for Marine Environmental Sciences
Robert Gelfeld	World Data Center on Oceanography, Silver Spring
Chris German	InterRidge
Fred Grassle	CoML Scientific Steering Committee Chair
Hannes Grobe	World Data Center for Marine Environmental Sciences
Julie Hall	IMBER Scientific Steering Committee Chair
Pat Halpin	Census of Marine Life
Jeff Hare	SOLAS Executive Officer
Ed Harrison	GOOS Ocean Observations Panel on Climate
Gideon Henderson	GEOTRACES Scientific Steering Committee Co-chair
Karen Heywood	iAnZone
Peter Liss	SOLAS Scientific Steering Committee Chair
Tom Malone	GOOS
Jerry Miller	Consortium for Oceanographic Research and Education
David Monahan	GEBCO
Ron O'Dor	CoML Senior Scientist
Raymond Pollard	IMBER Data Management Committee Chair
Robin Raine	GEOHAB Scientific Steering Committee Chair
Sylvie Roy	IMBER Executive Officer
Uwe Send	OceanSITES
Mike Sparrow	CLIVAR
Colin Summerhayes	SCAR Executive Director
Bjørn Sundby	SCOR President, Meeting Co-chair
Ed Urban	SCOR Executive Director
Cisco Werner	GLOBEC Scientific Steering Committee Chair

Appendix III - SCAR-Related IPY Projects

Area	No.	Short Title	PI	Body
SO	8	Synoptic Slope Study (SASSI)	K.Heywood	AGCS
	34	Climate and Coastal Communities	D.Abele	EBA
	53	Census of Antarctic Marine Life (CAML)	M.Stoddart	EBA
	66	Antarctic Benthic Deep Sea (ANDEEP)	A.Brandt	EBA, CAML
	70	Upper Ocean: Africa to Antarctica	A.Luis	CASO, AGCS
	83	Marine Biodiversity Information Network (MarBIN)	C. De Broyer	EBA, CAML
	93	ICEFISH	C. Verde	EBA, CAML
	131	Antarctic Marine Ecosystems (AMES)	V.Siegel	EBA, CAML, CCAMLR
	132	Climate-Southern Ocean (CASO)	S.Rintoul	AGCS
	137	Evolution and Biodiversity in the Antarctic (EBA)	G.Di Prisco	EBA, CAML, AMES
	141	Antarctic Sea Ice	S. Ackley	AGCS
	304	Drake Passage Seasonality	V.Alder	CAML, EBA
	329	Polar Ecosystems and Contaminants	W.Pollard	EBA
Bipolar	13	Sea level and Tidal Science	P.Woodworth	AGCS
	23	Atlantic Thermohaline Circulation	T. Gammelsrod	AGCS
	35	Tracer Chemistry (GEOTRACES)	H. de Baar	ICED
	52	Passive Acoustic Observations	J. Hildebrand	EBA, CAML
	71	Aquatic microbiology	G. Bratbak	EBA
	92	Integrated Climate and Ecosystems (ICED)	E. Murphy	EBA, CAML
	153	Marine Mammal Exploration	K Kovacs	CAML, EBA

Appendix IV – Review of Project Web sites

REPORT OF A SUBJECTIVE REVIEW OF WEB SITES OF SCOR-SPONSORED AND AFFILIATED PROGRAMS AND ACTIVITES OF MAJOR PARTNERS FOR THE "OCEAN SUMMIT" MEETING.

Elizabeth Gross

As part of its grant for the project summit meeting, the Sloan Foundation included a small amount of funds for a review of project Web sites. The sites reviewed are those given on the SCOR web site at http://www.jhu.edu/scor/ProjCoord-front.htm.

The idea of this review was not to rank Web sites in comparison with each other - i.e., this is not a contest - but to identify general problems and areas where Web sites could be strengthened to improve their usefulness to a targeted scientific audience and to the ocean science community as a whole. If I cite specific examples for praise or criticism, this is meant to be helpful. I did not take into account the staff and resources available to each program to support Web site development and maintenance. It was obvious to me that some programs had funds and specialized staff to dedicate to Web site development and maintenance, although others do the best they can without jeopardizing the funds they need to support their science activities. Both approaches have merit.

A general criticism is that many of the Web sites do not fit on a standard 800 by 600 pixel screen, so that a user is constantly forced to scroll from side to side to find things. This is especially bad on the IMAGES Web site, which is divided into frames with more than one vertical scroll bar needed to find things. I think this problem arises because Web sites tend to be designed by people who use larger than standard computer screens than most of us. Our departmental computer specialist says this is just bad practice and it frustrates users of poorly designed Web sites.

Another general criticism is that few programs are using their Web sites to promote real science highlights. CoML does this extraordinarily well, right on their home page (by "home page", I mean the main, or front, page of a Web site). GLOBEC does it well too, but their science highlights are buried until a heading called "Products". For some Web sites, perhaps new science highlights are not appropriate (e.g., the observing systems). It may be too soon to expect other programs (e.g., GEOTRACES) to be producing science highlights. In summary, few programs are communicating real excitement about what they are doing!

Another personal pet peeve is the use of large, slow to load pdf files to show very basic information. For example, looking for a simple explanation of LOICZ, the ideal route would seem to be to click on "LOICZ in Brief". After some delay a pdf file of the awkwardly shaped (for a Web site), 2 page LOICZ brochure appears - with the back page first and the looked-for brief explanation hidden until you realize that you need to go to page 1!

A final general comment is that major topic headings can be misleading. To cite one example - there is a very good explanation of the history, rationale and objectives of InterRidge on their Web site, but I only found it by accident, under the link entitled "Organisation". I would usually

look at the organizational link if I wanted information on the structure of the program, membership of the SSC, etc. The InterRidge background information would be better placed under a link called “About InterRidge”. I had many experiences of finding things in unexpected or inappropriate locations, only because I was taking the time to look at Web sites very carefully. A busy scientist might become frustrated and give up, when a more effectively designed Web site could grab his/her interest and provide the general information most people are looking for on their first visit to a Web site.

Another example of this is the LOICZ Data Policy statement. For all programs I looked for a clearly stated policy on data issues. I found it for LOICZ, quite by accident, under a link entitled “How to get involved”. My reasonable expectation was that I would find it under the section on Data. For SOLAS, I found an out-of-date section on data management by clicking on a link in their organizational chart.

During this review I have concluded that all sites should have the following basic headings on their home pages:

- About xxxx - for general background information about the program - the program should be described in brief without requiring a reader to download an entire Science Plan to find out what it’s about
- Organization - for structural and administrative information
- Science - recent research highlights (excitement!) and more detail on the scientific program - here it would be appropriate to link to sections of a detailed Science Plan.
- Data - separate from the Science section. Should include a clear statement on data management policy, clear information as to how to get data from the program, information on cruises, metadata, contacts, etc.
- Contact information - IPO, not the SSC members
- Calendar - for lists of meetings and other events
- News
- Publications (or Products) - can include presentation materials, newsletters, reports

The GLOBEC Web site is a good example of one that has used this format well. So has CLIVAR and others to a greater or lesser extent.

Ideally, all program Web sites should include presentation materials (providing appropriate permissions have been obtained), as well as a section that interprets the program’s findings for the non-scientist - the “public outreach” aspect. Some programs have done a good job of providing educational materials.

We will be sending very brief comments specific to each Web site to the projects; I would be pleased to expand them and send them to you individually if you think this would be helpful. In reading these reviews, please recall that some programs rely completely on the willingness of a volunteer scientist to create and maintain a Web site at no cost, while others have staff and funding for this purpose.

Appendix V – Proposed Recommendations on Southern Ocean Bathymetry

MULTI-BEAM BATHYMETRIC DATA IN SUPPORT OF OCEANOGRAPHY

Bathymetric data are important for geological, geochemical and geophysical analysis, the identification of habitats, and as a critical controlling parameter on the output of advanced ocean circulation and tidal models. Following from that, they provide essential underpinning to many, if not all, SCOR research programs. Bearing this in mind, this SCOR Project Summit makes the following recommendations, which are informed by the deliberations of SCOR Working Group 107 (see http://www.scor-int.org/Publications/WG107Report.pdf), and reinforced by recent recommendations of the SCAR/SCOR Oceanography Expert Group (see http://www.clivar.org/organization/southern/expertgroup/Expt_group_2.pdf). We regard these recommendations as universally applicable to all SCOR-related research, but of particular importance at this time, in the context of the International Polar Year, for the most poorly surveyed seafloors of the Arctic and Southern Oceans.

Recommendations:

1. SCOR should write to funding agencies worldwide to urge that they:

   (i) encourage project scientists to incorporate in their proposals requests to collect and process multi-beam bathymetric data;
   (ii) fund multi-beam bathymetry data acquisition and processing on all research vessels equipped with multi-beam echo-sounders, whether on transit or on location; and
   (iii) work with PIs to ensure that data are subsequently submitted together with track data to the World Data Center for Marine Geology and Geophysics .

2. Project scientists should be urged by their project Scientific Steering Committees to ensure that multi-beam bathymetric data are collected and processed throughout all stages of their research cruises, regardless of the lead priorities of their scientific mission, and made available to the World Data Center for Marine Geology and Geophysics.
3. Recognising that the World Data Center for Marine Geology and Geophysics makes available through the Internet searchable maps showing the distribution of already collected multi-beam data (http://www.ngdc.noaa.gov/mgg/bathymetry/multibeam.html), to assist in future cruise planning and to avoid duplication, project scientists should be encouraged to

   (i) to use such maps in planning cruise tracks so as to further contribute to the building of the bathymetric database, by filling gaps, and
   (ii) (ii) allocate sufficient time on transit for gaps to be filled, for example by steaming a path parallel to but separate from any previously occupied survey line.

The resulting data will be extremely useful to groups compiling bathymetric maps, such as the International Bathymetric Chart of the Southern Ocean (IBCSO), which will contribute to the General Bathymetric Chart of the Oceans (GEBCO).

These recommendations should be taken as SCOR policy on multi-beam bathymetric data collection and exchange, should be conveyed to POGO for the attention of laboratory directors, and should be published in *EOS* along with the other major recommendations of the SCOR Project Summit.