Draft 3: Minutes: POGO – 9 Meeting,

Dates: 09 – 11 Jan, 2008

Venue: BIOS, Bermuda

The participants met at an informal, ice-breaker reception at BIOS on the evening of 8th January. On the morning of 9th January, the POGO Executive Committee held a meeting, while the other participants were taken on a tour of BIOS facilities.

The annual meeting started on the afternoon of 09 January, after lunch at BIOS.

Note: All actions agreed at the meeting are provided in an Appendix to the Minutes.

09 Jan, Wednesday, Afternoon

Inaugural Session

The inaugural session was chaired by Tony Knap. The meeting began with Dr. Knap, host of the meeting, welcoming all participants. He introduced key faculty and staff members of BIOS, and drew attention to new initiatives in BIOS, notably the NF-POGO Centre of Excellence.

Tony Haymet, Chairman of POGO, then welcomed all to the meeting, and introduced new member, Peter Burkill, representing SAHFOS. He asked for approval of the Minutes of POGO-8. The minutes were accepted without any change. In introducing the agenda for the meeting, he noted that GEO (Group on Earth Observations) had been largely the focus of POGO activities in 2007. The agenda was adopted without change. The participants then introduced themselves, and Tony Knap provided logistical information.

Follow up to Actions from POGO-8: Chair Howard Roe

Howard Roe chaired the next session, which began with Tony Haymet reporting on progress on action items from POGO-8. He reported that POGO had made significant progress on most actions decided on, at POGO-8. On action items which were GEO-related, considerable progress had been made. This was also true of action items related to increasing advocacy at national levels for continued, sustained and expanded ocean observations for societal benefits. The action item related to development of cost-benefit analyses for Argo and CoML was on hold. Ed Harrison reported on progress related to action on collecting and disseminating information on available software and other resources to facilitate prompt transmission of data for operational use. Some technical inputs were needed from experts on CTD data to take this action further.

Tony Haymet then briefed the members on changes in the POGO Secretariat over the previous year. Chris Reid had resigned and Shubha Sathyendranath, Jan de Leeuw and Howard Roe had stepped in to fill the gap and see POGO through this difficult phase. The Executive Committee had decided that it was not desirable to have a Secretariat that moved with the Chair of POGO, as that would not have the necessary ingredient of continuity. Instead, the Executive Committee wished to propose that the Secretariat remain in the UK, which is a central location for POGO activities. One of the important considerations was establishing the Secretariat close to Shubha Sathyendranath (who has a part-time position at PML) and Howard Roe.

The Executive Committee also recommended that POGO dues be collected in Euro or currencies closely aligned with it, because of the poor performance of the US dollar against other currencies last year, and in view of the proposed location of the POGO Secretariat in the UK. He promised to return to these issues over the course of the next two days.

Howard Roe then reported on POGO activities in 2007 related to GEO. The presentation was a summary of earlier reports that had been prepared and distributed earlier. The presentation touched upon discussions on a new GEO coastal initiative, GEO Task Force 2 to which POGO made significant contributions, GEO-related outreach activities, and the GEO IV meeting in Cape Town followed by the GEO Ministerial. POGO-8 meeting had been an extremely successful meeting that set many GEO-related activities in motion. POGO members were nominated to many GEO task teams. The idea of setting up a new GEO coastal initiative emerged in the course of the year, and was be reported on in more detail, later on in the meeting. The Task Force 2 had produced the "GEO Report on Progress 2007" and a document entitled "The First 100 Steps to GEOSS", which was an excellent summary of various elements of GEOSS. Members of the Task Force and others from the ocean community also contributed to the book "The Full Picture", which outlined various observing elements and their applications.

Talking of outreach activities, he mentioned the enormous role played by Terry Collins in preparing a POGO press release, and subsequently setting up various interviews with the press the world over. National and international media interviews prior to, and during, the GEO Ministerial led to reports in 9 languages in 34 countries, 162 on-line stories, 28 newspaper or magazine articles, 4 television and radio networks and 18 news wire stories. This resulted in a high profile for oceans at the Cape Town meeting. An interesting article contrasting the blue lobby (for oceans) and the green lobby had appeared in *The Economist*. John Field helped organise media events in Cape Town, in association with GEO IV. A short video on ocean observation was also produced by POGO, with much support from the Sloan Foundation and Jesse Ausubel. A sister video on biodiversity was produced by Census of Marine Life (CoML). A new POGO brochure was produced, and others updated and reprinted. The videos and the brochures were used at the GEO exhibition. Many members of Ocean United: POGO, CoML, GOOS, Argo, JASON, ChloroGIN and SAHFOS came together to produce the Ocean United Exhibit at Cape Town. The exhibition also contained two Magic Planets (courtesy of Global Imagination and Maire Hanley- El Ajimi, their Director for Europe, Middle East and Africa; and Adam Corrie, their Technical Manager), which were very spectacular. The exhibition was hugely successful, because the community was there as a united group, speaking with a common voice, and addressing GEO societal benefit areas. The conclusion that the exhibition was an enormous success was based on responses received during the meeting itself, and subsequently.

The GEO IV meeting in Cape Town itself approved the Progress Report, on-going activities and finalised the Cape Town Declaration. The Ministerial which followed adopted the Cape Town Declaration and led to national messages of continuing support to GEO. Participating organisations were invited to speak briefly at the ministerial, and the text of Howard Roe's words on behalf for POGO was distributed to members. The Cape Town Declaration contained words that were important for POGO, communicating messages of sustainability and enhancement that POGO had been advocating for. Some photos of the Ocean United exhibition were shown. POGO owed a lot to Chris Reid and

colleagues, who put in considerable work to put the exhibition together, and to get it to Cape Town and back.

In conclusion, Howard Roe mentioned that 2007 had been a very successful year for POGO, Ocean United and GEO. Cape Town events produced commitments to continued and sustained ocean observations. Through POGO's leadership, the profile of the oceans and the need for ocean observations has been significantly raised. The international ocean community has been brought together and had delivered a common message: this was the single most important thing that was noticed at the Cape Town Ministerial exhibition. The media events had been tremendously successful, and the videos were important new resources. These developments raised issues for the future: the world's media were aware of POGO and what POGO was trying to achieve, as never before. It was important to maintain, develop and take advantage of that momentum. He acknowledged the many people who had made it all possible. He concluded with a presentation of the POGO and CoML videos.

During discussions that followed, Karen Wiltshire offered her institute's services to translate the text of the video into German. Jacky Wood asked whether POGO members could use the video, and the response was that all members were encouraged to use the videos as widely as possible. Howard Roe drew attention to the additional sum of 2-3 billion dollars that was needed to complete an ocean observation system, as stated in the press release. He felt that POGO had delivered in Cape Town on its goal, developed almost ten years ago, to work as a common voice for the oceans, and to provide advocacy for oceans. Bill Suk sought further details on OBIS which was highlighted in the video, and Jesse Ausubel provided further details. Ralph Rayner asked how the GOOS initiative on outreach could be cross-linked with the POGO efforts. There was a possibility to show the Ocean United display at the Oceanology exhibition in London. Howard Roe responded that the link between GOOS and POGO outreach activities could be achieved through the POGO News and Information Group. Some discussions followed on the practical issues associated with re-using the Ocean United display material at other venues.

Peter Burkill agreed with Howard Roe that the GEO Ministerial had been a great success for the ocean community. He argued that in some ways, what had been done was the easy part: it remained yet to deliver on the promise of ocean observations, taking into account the cost of not doing ocean observations. Howard Roe agreed, which brought the attention back to the need for a cost-benefit analysis.

José Achache then made a few remarks. He began by thanking Howard Roe for his words, and said that he was extremely grateful to POGO for all its contributions to the GEO Ministerial the previous year. POGO was among the few organisations that supported the GEO ministerial whole-heartedly and it was extremely helpful for GEO. The ocean part of the exhibition was very significant and very important. He mentioned the GEO exhibition highlighted the GEOSS elements that were already in place or being put into place. GEO's contribution was mostly to providing the links between the various observing elements. He cautioned that POGO should not forget the rest of the Earth, nor give the impression that the ocean observations existed in isolation from the other elements. He stressed that links to elements outside of oceans were important to address societal benefit areas. He felt that the *Nature* article on Earth Observations was negative on GEO. He added that the green lobby and the blue lobby had to work together to achieve the GEO vision. He hoped that POGO would continue to work with GEO to

complete the whole of GEOSS and not only the ocean elements. Howard Roe reiterated that POGO had always had the vision that the interactions between oceans and the rest of the Earth System was a key reason for having ocean observations and that these links were spelt out in the presentational material at Cape Town.

This was followed by a presentation on the POGO Cruise Information Database by Jan de Leeuw. He began with a short introduction, outlining the history of the international cruise information database and website. The initiative was started in 2006, and was made possible through funding from the Sloan Foundation and NOAA. The project was executed by a subset of the SeaDataNet group, which included the British Oceanographic Data Centre (housed in the POL, Proudman Oceanographic Laboratory), BSH, MARIS and EurOcean. The dedicated website developed under this project (www.pogo-oceancruises.org) was launched in May 2007. At present, the website focused on research vessels of greater than 60 m length and incorporated 3 major databases. The first was a research vessel directory, which began with the EurOcean directory, but had then been expanded to include some 149 research vessels worldwide. In June 2007 new functionality was added enabling RV operators to edit and maintain the details of their RV's themselves *via* an online content management system. All identified operators had been contacted twice, inviting participation; not all operators had responded. Action by RV operators was required to complete the validation of the RV's included. He requested all members to support this action. The second database was a cruise programme database, in which information on planned cruises were provided for each research vessel and operator. Response from operators to requests to contribute cruise plans and to keep them updated should be improved. Operators sometime returned incomplete forms which necessitated extra work by BODC before they could be loaded into the database. Action by RV operators was required to provide information on more cruises and to provide complete cruise programmes. In fact, POL had provided additional manpower support to overcome the bottlenecks in uploading available information to the website. Planned changes to the functionalities of the website would make it easier for operators to provide up-to-date information on cruise plans. The third database was of Cruise Summary Reports (CSR) that provided details of completed cruises and a first-level inventory of oceanographic measurements made and samples taken. The reports were based upon the Report of Observations and Samples Collected by Oceanographic Programmes, conceived by IOC/IODE in the late 1960's. It was revised in the 90's b ICES and since then named Cruise Summary Report. He outlined the benefits of the database and website, and concluded with a request to all members to support the initiative with more prompt and complete inputs to the website.

Charlie Kennel asked if information on the availability of berths was provided through the website, and Jan de Leeuw responded in the positive. Ed Urban encouraged all to visit the site. It was a very good system, and contained a lot of useful information. Jan de Leeuw mentioned that a planned addition to the website was information on availability of entire ships during particular intervals. Andrew Willmott added that Lesley Rickards had requested help from all POGO members to populate the website.

This was followed by another presentation by Jan de Leeuw on the Nippon Foundation – POGO Centre of Excellence, which was a new programme initiated last year. This programme could be seen as a follow-up and extension of the NF-POGO Visiting Professorship Programme, which concluded last year. Following discussions with the Nippon Foundation, a proposal was submitted by POGO to the Foundation in January 2007; the project was approved in March; and the call for submission of proposals to host

the Centre went out in April to all POGO members, with a deadline in August for submissions. The goal was to set up an NF-POGO Centre of Excellence in Oceanography for training 5-10 persons per year to promote sustained capability for ocean observations in developing countries. He outlined the selection criteria and the structure of the proposals that were invited. The ceiling in the annual budget available for the Centre was $475,000. Seven proposals were received, from UCT (South Africa), VLIZ (Belgium), Scripps (USA), BIOS (Bermuda), NOCS (UK), NIOZ (the Netherlands) and PML (UK). All proposals were excellent, and the decision was a very difficult one for the selection committee in which Ed Urban from SCOR participated. The committee finally selected the proposal from BIOS as the successful proposal. Jan de Leeuw then provided an overview of the activities envisaged under this programme and the time lines for execution. It was hoped that the programme would continue for 5 years.

Gerry Plumley then followed with a presentation with further details on what BIOS was doing within the programme. He pointed out that BIOS was home to a number of time series stations on a variety of subjects. In addition to off-shore work, BIOS also had many near-shore observing programmes. The training programme was built on existing programmes and expertise available at BIOS. Among the facilities available was a state-of-the-art ship with a dedicated student lab. BIOS had a strong educational base of summer courses for students from around the world: year-round, semester-based academic credit courses, internships and PhD programmes. The Centre of Excellence planned to provide a lot of ship-board training; a course on core skills for scientific writing, oral communication and numeracy; training on observational oceanography with state-of-the-art instrumentation; course work on many related topics; workshops led by NF-POGO Visiting Professors (Trevor Platt and Robert Frouin) and guest lecturers. Up to 10 trainees were expected to be trained each year, and he outlined the selection criteria.

Jacky Wood then asked if the trainees would get a formal academic qualification at the end of the training programme. Gerry Plumley replied that the trainees would certainly get a certificate, but suggestions on other options were welcome. John Field pointed out that the scope of the proposed format was in between that of graduate modules and that of a graduate degree. Tony Knap added that this was perhaps a new way of doing things. Tony Haymet elaborated that the applications for hosting the centre had fallen into two categories: professional training and academic training, and finally, the decision fell in favour of the professional training offered by BIOS.

Tony Haymet then introduced the POGO budget. Rick Spinrad asked if the budget reflected the need to exploit emerging opportunities to engage different groups in POGO activities. Tony Haymet replied out that the answer was partially positive. In addition to liaising with other groups outside of POGO's normal realm, there was also a need to revamp POGO communication and outreach, including a redesign of the POGO website. He requested the members to consider the suggestion that POGO collect dues in Euros instead of US dollars, in view of the proposed location of the Secretariat in the UK and the poor performance of the US dollars in 2007 year against other currencies in the world market. Tony Haymet clarified in response to a question from Jacky Wood that the POGO Executive Committee did not envisage an increase in dues in 2008.

Tony Knap then introduced Nick Bates, who had a lot of experience on ocean acidification issues, and was a long-time faculty member of BIOS, who then gave a lecture on ocean time-series observations near Bermuda. Nick Bates began with an overview of various relevant space and time scales in ocean processes. Time-series data,

augmented with satellites and gliders, would span many scales of variability. Bermuda Atlantic Time-series Study (BATS) was set up in 1988 as part of JGOFS (Joint Global Ocean Flux Study) and continues to this day. Its counterpart in the Pacific was the station ALOHA. The Hydrostation –S had been maintained since 1954; the Bermuda Testbed Mooring since 1994; the Oceanic Flux Programme since 1978 and atmospheric sampling was carried out at the AEROCE Tower. The Oceanic Flux programme collected time-series data on sediment traps. He presented data that showed long-term trends in temperature and salinity in the waters around Bermuda, using time series data going back to 1950's. The primary production showed a lot of variability, but it was difficult to identify trends. The processes that provide new nitrogen to the euphotic zone were a complicated story with many unanswered questions. BIOS was involved in a new project to study variability in winter, and also another study was underway on the impact of mesoscale eddies on summer production and ocean biogeochemistry. He mentioned the importance of nitrogen fixation and the relative roles of nitrogen and phosphorus. Nick Bates mentioned the links between climate, dust deposition and nitrogen fixation. His work focused on ocean sinks and sources of carbon. Bermuda had a long time-series of partial pressure of carbon dioxide and other related variables. Ocean observations showed decreasing seawater pH at several sites. The BATS time-series station was an ocean sink for CO_2 in the winter time, and a source of CO_2 in the winter. Net effect at the annual scale was uptake of CO_2. Increased wind speed in the area over the last two decades has actually increased the capacity of the oceans to take up CO_2. The wind-speed changes were linked to the North Atlantic Oscillation. He also spoke about changes in the mode water formation and related changes to the role of oceans in carbon storage. A recent publication had drawn attention to the role of acid rain in augmenting ocean acidification in a small way. The changes in ocean pH could have serious impact on various marine organisms including coccolithophores and corals. There was a direct impact of ocean acidification on coral formation off Bermuda. He summarised by saying that the BATS time series station allowed BIOS to leverage a variety of process studies that were very relevant to many of the issues of the day.

The meeting closed the day after some questions and answers on Nick Bates' presentation.

10 Jan, Thursday

GEO and Coastal Initiatives: Chair Tony Knap

José Achache set the scene for the session with a thought-provoking presentation on how POGO and GEOSS could be mutually beneficial. He began with an overview of the Cape Town GEO IV Meeting and the Ministerial which followed it. The Cape Town events were a great success by any standards: the attendance of some 500 participants was very high compared with previous meetings. The Summit allowed to highlight early progress of GEO and key achievements in the implementation of GEOSS; to bring emerging priorities to the attention of ministers; and for ministers to commit to GEOSS. The Global Earth Observation System of Systems requires all the societal benefit areas to be addressed. Priorities of the 2008-2010 timeframe are: harmonisation of portals (data and services); ensuring sustainability of observing systems; bringing new funding; cost-benefit analysis and Iridium NEXT.

The association with POGO has been very beneficial in this context. But much work remained to be done. Private companies and European Union had shown interest in contributing to the development of the GEO portal. The goal was to have the portal

operational in 2008. The concept was to have a portal that would be the professional analogue of Google Earth. If the ocean community was developing a portal, then GEO and POGO had to work together to ensure compatibility. Another issue was associated with funding. It was essential to get new funding to enhance observing systems to demonstrate that GEO was working. One of the things that could be done jointly by GEO and POGO in 2008 was a cost-benefit analysis. It would be a lot of work and it was a difficult subject, but it had to be done, though it was not quite clear how to tackle the problem. The recent Bangladesh disaster associated with a cyclone, and how Earth observations and associated early warning systems and supporting mechanisms in place saved a lot of lives, was a clear demonstration of the benefits of earth observations.

He mentioned Iridium NEXT, which is a constellation comprising 66 satellites in a near polar low earth orbit at 780 km altitude. Six planes of 11 vehicles in near-circular polar orbits provided global coverage. The suggestion was to piggy pack earth observation satellites on spare capacity on the constellation. But the schedule is very tight. Ocean observation satellites such as altimeter, optical imager, radiometer and GPs occultation (for atmospheric water vapour content) were possibilities. The altimeters envisaged were not Jason class, and were meant to complement Jason series and not replace it. The concept was very appealing and cost was modest, at 1.8 billion dollars. Including operational costs, the expense could be closer to 2 billion Euros over 20 years. The need to have such a system was strong, but one had to bear in mind that there were additional requirements for other observing elements, such as the 3 billion dollars needed for elements of an ocean observing system. Therefore the requirement for a fully-implemented GEOSS would be several billion dollars. It would be simplistic to assume that the total funding requirement was modest. The task was huge, but GEO had to contribute to identifying and exploring possible mechanisms. This might involve GEO itself acting as the host of a trust fund; or World Bank and charitable organisations might be other possibilities. Public-private alliances also had to be explored.

He then introduced a coastal areas management project. The idea of a coastal areas management was an attempt to address a number of needs, while, at the same time, coordinating several parallel initiatives. Such a coastal programme should federate all ongoing efforts. Given the limited community resources, the highest and best use of GEO in this area was to find ways to implement existing recommendations and action plans (IGOS-P Coastal Theme report, IOC report) through existing bodies (PICO, CZCP). GEO can also contribute by supporting workshops focussing on the recommendations and gaps identified in existing reports (e.g., Greece, June 2008). He then handed the microphone to Mike Rast, who elaborated on the GEOCoast concept.

The coastal area was home to over a billion people, and yet was a very vulnerable area. Hazard and disaster mitigation was a priority for many services (eg. NOAA Coastal Services Center, African Marine Atlas, New South Wales Coastline Management Manuel, Mercator Ocean). Coastal resource management was also a priority. Urbanisation, hydrological and biogeochemical cycles were also of concern. Ocean observations such as sea surface temperature and altimeter observations were key to disaster predictions. Many agencies and organisations were involved in coastal management, but it was not clear that all these entities were coordinating well with each other. The issues involved included going from research mode to operational mode; and going from regional to global-scale coordination. Extended Antares leading to ChloroGIN was a real success story for GEO; it incorporated the services provided by the remote sensing group of the Plymouth Marine Laboratory (PML); ChloroGIN Africa,

ChloroGIN-Antares; the South African Remote Sensing Server for Marine Sciences; and the African Marine Information System. A possible next step might be link to sea surface temperature. Eighty percent of pollution in the oceans had a land source. The proposed river discharge baseline network HARON had a clear link to ocean observations. The Census of Marine Life would also be a key in an integrated coastal observation system. The success of GEOS will depend on data and information providers accepting and implementing a set of interoperability arrangements, including technical specifications for collecting, processing, storing and disseminating shared data, metadata and products.

Tony Knap followed with a short presentation that summarised his involvement in the development of concepts for coastal observation systems, especially within GOOS and IOC. He had been the chairman of the Health Of The Oceans (HOTO) panel of GOOS. Eventually this was combined with Living Marine Resources Panel and the Coastal Panel to form the panel for Coastal Ocean Observation System (COOP), which actually produced an implementation strategy for a coastal observation system. The report was produced after a great deal of work and extensive reviews, and was well received. A lot of coordinating work had gone on for several years, but the outputs were stagnating for lack of funds.

Paul diGiacamo followed with a presentation that highlighted many activities that had gone on in the past that required resources for implementation. His overview covered the IGOS Coastal Theme which attempted to bring together data providers and data users in support of coastal research and applications across land-sea interface. It focused on user-driven issues of coastal hazards; coastal development and urbanisation; coastal hydrological and biogeochemical cycles; and ecosystems. The goal of the coastal theme was to develop a strategy for integrated global observations that would provide improved understanding of the Earth System. Existing global observing assets from space provided inadequate spatial, temporal and spectral resolution, according to the IGOS-P report. Lack of continuity was also a problem. The report also identified various challenges and priorities for coastal observations and integration. Specific approaches to data integration were noted in the report. The report recommended the formation of a Joint Panel for Integrated Coastal Observations (J-PICO), which would bring together coastal interests of GOOS and GTOS. In moving towards J-PICO, a GOOS Panel for Integrated Coastal Observations has been formed, which was a sub-committee of the GOOS Scientific Steering Committee. Paul diGiacommo and José Muelbert were co-chairs of PICO and would liaise with GEO. The IGOS Coastal Theme was now being transitioned into GEO; details were awaited.

He pointed out that GOOS had two interdependent modules: coastal and global. Integrated Design Plan recommended observations at a hierarchy of scales. The GOOS Regional Alliances (GRA's) were the corner stones to the implementations strategy, and the various GRA's were in various stages of implementation. Common variables that would form part of the Global Coastal Network were identified in the report.

GOOS Panel for Integrated Coastal Observations (PICO) was recently established. The terms of reference included providing advice and liaison at various levels.

The GEO Coastal Zone Community of Practice (CZCP) was brought together to engage coastal users; evaluate current and projected observational capabilities; promote the development of proof-of-concept pilot projects; to promote development or strengthening of networks and to advise GEO User Interface Committee. The community was end-user driven. He outlined recent activities and plans of the CZCP, which included a series of

regional workshops, the first of which was scheduled to take place in Greece in June 2008. The CZCP planned to have coastal-related special sessions and workshops at various scientific meetings.

He informed participants of a plan to transition IGOS Coastal Theme into CZCP. The CZCS and PICO would provide the primary support and guidance to GEO on coastal matters. He concluded with a diagram that showed how these various elements devoted to coastal observations were interlinked and integrated.

During discussions, Mike Sinclair suggested that POGO member institutions could work on implementation of the coastal observations, and share experience with other POGO members. Bob Weller also suggested various ways in which POGO members could help, including analyses of how global modes and regional modes interacted with each other. John Field clarified that PICO was formed instead of J-PICO because of the recognised need to move quickly. He also noted that, in GOOS, there was an effort to bring together the coastal and ocean components, working regionally to develop implementation and then integrating globally. Tony Knap pointed out the need to find sustained resources for many regions to make implementation a reality. Tony Koslow felt that there were slight differences in the various recommendations, and that POGO members could help standardise measurement protocols around the world. Tony Knap pointed out that some efforts had gone on in the past to develop standard protocols (e.g. JGOFS), but there was indeed room for more work in that area.

After the coffee break, John Field informed the participants about ChloroGIN (Chlorophyll Globally Integrated Network). It was a combined GEO-GOOS initiative, and the first non-physical pilot study for GOOS. He provided the background to the development of ChloroGIN. The motivation for formation of ChloroGIN was that stewardship of the oceans relied on an ecosystem-based approach to management. Combining satellite data with in situ observations was key to success. The need to establish a network of observations that relied on existing technology was recognised. The products envisaged were maps of ocean chlorophyll and sea-surface temperature, with light penetration at some in situ sites. These were three of the essential co-variables identified by the coastal GOOS panel. The initiative had regional nodes, and each region set its own priorities. For southern Africa, the priorities included harmful algal blooms that had a huge impact on mussels and other coastal living resources. Red tides tended to be caused by large cells, and Stewart Bernard (UCT) had developed an algorithm that identified large cells by remote sensing. The web portal for Africa provided ocean-colour data at various scales. The Benguela Current Large Marine Ecosystem (BCLME) had an extensive in situ observation programme, which included profiles of chlorophyll. Self-oranising maps had been used to classify the profiles, and then used in combination with ocean-colour data to compute primary production. The ChloroGIN-Antares was designed for Latin America, with current participation from a number of countries from South and North America. The Indian node of ChloroGIN used satellite data for identifying potential fishing zones, which benefited some six million fishermen. The main goal was to minimise search times for finding fishing zones. The PML node in ChloroGIN also provided various services. He suggested that ChloroGIN had to go global. There was a need to integrate in situ and remote observations into a single network and to work towards timely delivery of data and information for societal benefit, bearing in mind the regional differences in needs and capabilities. The GEO DEVCO-cast was a recent development that facilitated provision of information to users. He concluded with a brief overview of MA-RE Institute, a new institute developed within the University of Cape

Town. He informed the participants of recent developments to observe Benguela Niños. Deep-sea observations were also being initiated near oil rig operations off Angola, sponsored by British Petrol. The pilot study ChloroGIN was part of the GOOS system.

José Achache mentioned that ChloroGIN concept was one which GEO had found worked very well: the concept involved building on existing local capabilities. Jan de Leeuw asked a question related to contribution of prokaryotes to oceanic primary production. John Field replied that for some practical applications, operational products based on chlorophyll provided very useful, though many research questions still remained open. Tony Knap enquired about training requirements and possibilities within ChloroGIN and John Field replied that over the last several years, Trevor Platt and Shubha Sathyendranath had provided the appropriate training in many developing countries, which had benefited the formation of ChloroGIN. The possible links that could be established between ChloroGIN-related training and the proposed activities of the NF-POGO Centre of Excellence at BIOS were discussed.

Andrew Willmott then made a presentation on the Liverpool Bay – Irish Sea Coastal Observatory, which was put together by Roger Proctor and his team at the Proudman Oceanographic Laboratory (POL). Coastal and shelf seas were under pressure due to migration of people into the coastal zone and climate change. This led to a range of diverse issues, including changes in shorelines and nearshore bathymetry, increased coastal flooding, habitat modification, loss of biodiversity, eutrophication, increased probability of harmful algal blooms, chemical contamination, reductions in the abundance of exploitable resources and public health problems associated with water quality and pollution. He introduced the concept of marine spatial planning, which combined models with field data (often real-time) with applications such as reconstructing changes over recent decades (hindcasting); generating climatologies and spatial maps of the occurrence of extreme events; nowcasting the present state of the coast oceans; and short-term forecasting. There was a world-wide development of coastal observatories (38 sites) that operated at various ranges of scales and complexity. POL was a member of the GODAE Coastal and Shelf Seas Working Group. The justifications for establishing and maintaining an observatory included the large human impact, focus of government activity in the coastal zone such as the biodiversity action plans; EU water framework and other directives; offshore renewable energy and the UK and EU Marine Bills. The area suffered from nutrient loading and eutrophication. Appropriate policy decisions for control mitigation required adequate data. The Liverpool Bay Coastal Observatory was started in 2002 and was planned to continue to 2012 and beyond. The POLCOMS (Proudman Oceanographic Laboratory Coastal Ocean Modelling System) was used in this area at a variety of scales, ranging from 1/9 degree to 200 m. Since operating the observatory for the last 5 years, much had been learned about the physical and biochemical function of the region. The model outputs were used to inform policy decisions. New technologies such as gliders were being introduced. The data collected at the observatory were exploited through a dedicated website. Over the last two years, there had been a steady increase in the number of users of the site. The observatory had facilitated coupling between hydrodynamic and bio-geochemical models, in collaboration with PML. The observatory provided a means to test model outputs rigorously: comparison between model and observation helped identify deficiencies in model performance. Assimilation of in situ and satellite data also helped improve model predictions. Development plans included more new technology and wider-area coverage, which included the use of coastal X-band radar to study bathymetry and gliders to

complement satellite data. Actions to facilitate the involvement of wider community and enhance stakeholder engagement were envisaged. The work was oriented towards policy relevance. Sustainability was key to success, and this would require that stakeholders contribute to the cost of the system, which would allow the system to be maintained without support from research grants.

Karen Wiltshire remarked that there were many lessons to be learned from the POL experience. Tony Knap suggested that this could be a suitable site for a pilot economic analysis, and Ed Hill pointed out that some work had already been carried out in this direction and published by IACMST in the UK. Participants noted that POGO could take the initiative in carrying out some such analyses in selected areas. Mike Sinclair asked if analyses had been done to determine the minimum set of observations essential to provide the services envisaged. Andrew Willmott said that such analyses had indeed been done. Einar Svendsen spoke about Norwegian experiences with operationalising similar sets of observations through paying stake-holders.

Kiyoshi Suehiro then talked about Geohazards, beginning his talk with a summary of his presentation on the topic at POGO-9. Geohazard events occurred in very short time-scales, but often the events were separated by very long time scales. He illustrated the issues using studies off Sumatra and Japan. Improved and faster predictions required enhanced observational networks on the sea floor. The system concept was real-time, upgradable, extendable, expandable, sustainable, interoperable, cutting edge science that engaged the public by giving daily status reports and forecasts. Geohazards included volcanic activities, earthquakes, slope failures and tsunamis that were generated by such geological activities. It was essential to monitor the activities and anticipate the impact. Volcanic activities around islands of Hawaii and Krakatau (1883 eruption led to loss of 36,000 lives) were used to illustrate some of the issues. In Japan, the Mayumaya collapse in 1792 and the related tsunami led to loss of 10,000 people. Seismic information on earthquake magnitude was essential but not sufficient information to predict tsunami magnitude. Earthquakes generated turbidity currents, and core data that allowed extension of data over very long time scales showed evidence of deep-water seismo-turbidites, and it was essential to have such information over all risk areas. Earth-quake generated slope failures can cause deep-water cable fault disrupting communications, but this information was not widely known. University of Tokyo had developed a GPS buoy offshore of Japan to monitor earthquakes and associated tsunamis. The GPS buoy detected the tsunami several minutes before a tide gauge at the same location, in a particular earthquake event off Hokkaido. He showed simulation of propagation of ground shaking across the globe after an earthquake event. Such simulations as well as predictions of tsunami propagation could be improved when local geological data were available. Seafloor and borehole sensors real-time networks were also being developed. Such systems were expensive, but essential. Geodesy on the seafloor had to develop, but this was becoming possible with recent developments, and 5 cm accuracy had been achieved in experiments. By 2010, dense sea-floor long-term networks (DONET) were anticipated around Japan.

The risks from geohazards were many, and there were many gaps in our information. Mitigation also was very important, and should include public education in coastal areas. He summaried by noting that causes of past catastrophes were not always clear; historical records of geohazards were short and undersampled; risk of geohazards was thus not very clear; and so more surveys were needed to assess risk. Where high risk was anticipated, real-time and repeated surveys were required and seafloor geodesy had to be established.

Once an event occurred, real-time monitoring and broadcasting precise warnings to localities under threat was important. In relation to mitigation, it was important to improve public education in coastal areas; prepare hazard map and evacuation drill; and construct tsunami defence structures such as bay break-water, river-mouth gate, town seawall, river dike; and to have a relief and recovery programme. Kiyoshi Suehiro concluded that 3-D crustal structure for strong motion wave propagation modelling had to be available; plate geometry and kinematics had to be known sufficiently for earthquake cycle modelling; seafloor seismo-geodetic network covering the fault area and its surroundings had to be in place; and borehole observatories provided critical monitoring of *in situ* deformation processes.

Peter Herzig enquired about the cost of some observing elements off Japan. Robert Nigamatulin commented on some of the intricate kinematics of earthquakes. José Achache enquired about the possibilities for using perturbations in the ionosphere as a mechanism for detecting tsunamis.

Jesse Ausubel followed with a short presentation illustrating links between ocean observations and terrestrial observing systems. The example came from Pacific Ocean Shelf Tracking Network. In 2005 a sturgeon was tracked a long distance along the North American Pacific Coast. Experiments have started to track migrating smolts through rivers and shelves, and will soon be extended to open oceans. Discussion followed on the effect of the density of the tracking network on the inferred tracks.

Tony Knap led the discussion on what POGO could do to help with enhancing coastal ocean observations. He noted that that one of the key issues and a common thread was sustainability. Jim Baker suggested that POGO could lead a fund-raising effort with governments and charitable foundations. A success story from such an effort was Argo. Bill Suk pointed out that there were a number of databases available, but there was a need for monitoring toxins in the coastal systems which could be funded by governments concerned about human health. Tony Knap mentioned Rapid Assessment of Marine Pollution (RAMP) as an example of a local effort to monitor ecosystem health. Rick Spinrad suggested that POGO had to improve communications with the broader community. Tony Haymet agreed that POGO had to take collective action to promote government commitments to oceans. Charlie Kennel added that POGO could also promote public-private partnerships. Discussion followed among José Achache, Jim Baker and Tony Haymet on the value of a detailed cost-benefit analysis in this context.

GEO and Time Series Observations: Chair Sun Song

The session began with a presentation by Bob Weller, who first summarised the increasing recognition of oceans and ocean observations at the global scale, within GEO. There were many references to oceans and ocean-related activities in the GEO document "The First Hundred Steps to GEOSS". The GEO task CL-06-06 was dedicated to global ocean observation system, and the goal was to enhance and improve coordination of coastal and marine climate observations in support of a global ocean observation system. Activities within this task would include: improve the global coverage and data accuracy of the climate-monitoring system and coastal observing systems, as well as management and archival of the resulting data; contribute to the implementation of a global coastal network using the mechanism of GOOS Regional Alliances; and establish an Argo Program Office to ensure the ongoing implementation of the Argo global array of profiling floats in the ocean. Bob Weller was also member of the GEO Science and

Technology Committee. The committee recognized that GEOSS both depended on, and contributed to, scientific and technological progress. The recent documents produced by the committee recognized the value of long time-series observations. They also highlighted the need for cross-calibration and linkages across oceanic, terrestrial and space networks.

He then moved on to describing recent developments in establishing time-series measurements in the ocean. Formal, international support for time-series observations was growing: since the JCOMM meeting in Halifax in 2005, OceanSITES was recognised as a component of global ocean observation system, being integrated under GOOS and JCOMM. The JCOMMOPS website showed some 434 moored sites reporting data. The EuroSITES consortium was made up of 13 partners and maintained some 9 deep ocean (> 1000 m) platforms. There were also time-series sites maintained by CSIRO (Australia) in the Southern Ocean; the "Climode" surface mooring off Cape Cod; the U.S. National Science Foundation Ocean Observatories Initiative (OOI), which envisaged three long-term global sites at high latitudes (Irminger Sea, Southern Ocean, and Gulf of Alaska); and the Kuroshio Extension Observatory to which NOAA and JAMSTEC contributed. There was more progress to report in a number of countries, including China and India, and not all were covered in the presentation.

POGO had been, and should continue to be, a proponent of blue-water time-series stations. At present, the need was for POGO to help clarify for the broader community the value of long time series ocean observatories; and for the institutions of POGO to nurture and sustain the time series observatories. Arguments why POGO should make an extra effort on time series included unique observations with high resolution in time and in the vertical dimension; multidisciplinary capabilities sampling from the sea floor to the air-sea interface, driving discovery and insight (climate-related change); improved understanding of processes and mechanisms, resolution of events and their impacts; and critical in situ monitoring, validation, and verification of satellite observations and models.

This was the 50th anniversary of the Keeling time series station measuring carbon dioxide on Mauna Loa, Hawaii. Sustaining such long time series was not easy, nor was it cheap. But they were essential for reducing uncertainties in model predictions. In the Indian Ocean, an area of critical importance to climate variability, model predictions had, regionally and basin-wide, a high uncertainty in the estimated net surface heat flux. The challenge in the Indian Ocean was not unique: there were also high errors in model predictions of heat flux in the South-eastern Pacific. Non-linearities in upper-ocean dynamics and in the feedbacks between atmosphere and oceans highlighted the need for high temporal resolution in the data. Compared with the GCOS Implementation Plan, the initial global ocean observation system was at 57% of target. There were also issues of sustainability. Issues related to sustainability also exist for other observing elements such as Argo and IOCCP.

Moving on to repeat hydrography, Bob Weller mentioned that an international group (GO_SHIP) had been constituted to oversee repeat hydrography measurements under CLIVAR/IOCCP. The formation of the group was an outgrowth of a workshop hosted in Shonan Village, Japan, in November 2005. The group had just had their first meeting and a report was available (IOCCP Newsletter 18, Nov. 2007, UNESCO). One urgent issue was to encourage the submission of international data to a central site. Presently, this was working effectively only for the US and Japanese hydrographic lines. Without more

general access, it will be impossible to assess basin-wide changes in any ocean, except the N. Pacific.

Time series observations were a critical, recognised part of the global ocean observing system. A start had been made on data management and on intergovernmental organisation. However, national contributions were not nationally coordinated or nationally recognised. Ocean time-series stations were a substantial commitment that would be stronger if POGO institutions coordinated on operations, training and capacity building (ship time, technology, cyber-infrastructure and data sharing) and demonstration of the value and utility of long-time series observatories. POGO could also spotlight time series science and impacts.

Discussion followed based on a question from Mike Sinclair on criteria used for selecting the sites for locating time series stations. It was acknowledged that the cruise information database would be very useful for facilitating servicing of the time-series stations and reducing costs. Ed Harrison suggested that POGO could help share technology and sensors to improve the range of measurements at time-series stations. Charlie Kennel pointed out the importance of inter-calibration and enquired whether there was a list of fiducial sites of long-time environmental observations that could be identified as world heritage centres. Mike Rast noted that harmonisation of validation and calibration procedures across disciplines and regions was another difficult issue.

Silvio Pantoja then made a presentation on time series observations off Chile. The area of their research was south-east of Chile. It is a very productive coastal zone with strong upwelling. Another interesting characteristic was the permanent oxygen minimum zone at depth in the ocean. The time-series station was a multidisciplinary effort in the Eastern Pacific, which included physical oceanography, biogeochemistry, biologic and paleo studies. An ADCP (Acoustic Doppler Current Profiling) mooring was to be initiated soon, with a chain of temperature sensors and an oxygen sensor. He showed some of the very interesting results that had emerged from the previous five years of observations. All the time-series data were on the COPAS website for internal use, but the goal was to establish one for general public use. The work had led to three special issues in Deep-Sea Research. The time series also served as a platform for concurrent projects including a monitoring programme for fisheries applications. Another related project used high-frequency radars. Deep sediment trap stations had also been started off Iquique, Coquimbo and Concepción. Chile had also deployed several Argo floats. COPAS also made use of several opportunities to collaborate and participate in many international oceanographic cruises. Chilean government had committed to procuring a multipurpose research vessel (72 m long) by 2010.

The next speaker was Masao Fukasawa, who spoke about the JAMSTEC plan and vision for time-series observations. An overarching objective of research in IORGC (Institute of Observational Research for Global Change) of JAMSTEC was to seek answers to questions: What is the climate forcing? How does it affect dynamics, biogeochemical and ecosystem structures of the ocean? The goal of time-series observations was to know the frequency and magnitude of phenomena without possible contamination from the aliasing effect, and to estimate the reality of ongoing synoptic variations. OceanSITES was a powerful and practical component of GEOSS. He added that JAMSTEC maintained buoys in the equatorial arrays in the Pacific and the Indian Ocean. There were plans to extend those stations. There was also the Kuroshio Extension Surface Flux Station. Improvements were planned for that site as well. A third one was the High-

Latitude Biogeochemical Station, which had been maintained since 2003, and which incorporated many innovative sensors. JAMSTEC had also maintained the Western North Pacific Transport Section between Hawaii and Japan since 2002.

Challenges included development of new sensors and platforms that would enable increasing the number of stations and making each station as multi-purpose as possible. Another challenge was to link with fields other than oceanography to enhance the sustainability of the sites. Plans included developments of an in situ carbon dioxide sensor and an underwater winch system for profiling primary production in the water. Another challenge was developing a new method of time series observations using ocean bottom seismic array. In the plan, transmission units were also located on the sea bottom. This offered the possibility to monitor 3D current structure with turbulence information through an inverse method, which was to be developed. In concluding, he noted that time-series stations can only collect local information. So it was necessary to link these stations to regional studies, which could then be networked globally. This would be a big contribution to GEO and GEOSS from the ocean community.

After coffee break, Peter Burkill made a presentation on the Continuous Plankton Recorder (CPR) survey. He started with an overview of marine research institutions in Plymouth and the Plymouth Marine Sciences Partnership that brought together the seven marine organisations in Plymouth. The CPR survey maintained by Sir Alister Hardy Foundation for Ocean Sciences (SAHFOS) was several decades long. The reasons for maintaining the survey included monitoring climate and biodiversity. The role of phytoplankton in the global carbon cycle was well recognised, but the role of zooplankton was less-well appreciated. The CPR survey also provided information on the distribution of various planktonic taxa in the ocean. Ocean acidification was a threat to may key taxa. The other reason for plankton survey was to understand the marine food web: fisheries resources relied on plankton as food. In their programme, Continuous Plankton Recorders, which filtered plankton on to a roll of silk, were towed by merchant ships. The surveys had been going on the North Sea since 1931, the North Atlantic since 1946, and the North Pacific since 1998. The database included information on some 500 taxa of plankton. About a million samples had been analysed, from over 5 million sampled miles. Based on the survey, ecological status reports and information on occurrence of harmful algal blooms were produced. The surveys had led to discoveries of significant changes in the North Sea phytoplankton over the last 50 decades. Similar analyses for the North Atlantic also showed changes in the pattern of plankton distribution over the long term. Some of the changes were associated with the North Atlantic Oscillation. Another discovery was changes in zooplankton and cod in the North Sea. The data also revealed that biodiversity changes in plankton impacted the marine food web. Relative proportion of different species had changed over the years. A most recent discovery was that Pacific species of plankton had started appearing in the Atlantic, which was associated with the opening up of the Arctic due to reduced ice cover. The impact of these changes on global carbon cycle was not yet known. Issues for the CPR survey included globalisation *via* sensitive regions, and funding (~ 7 million dollars per annum would be required). It would be desirable to integrate biological observations with the forcing variables. SAHFOS had a free data policy that adhered to GOOS and OBIS principles. Sustainability was an issue, since funding was typically assured only from one year to another. Discussion followed on possibilities to extract DNA information from CPR data.

Tony Koslow gave the final presentation for the day, on the California Cooperative Oceanic Fisheries Investigations (CalCOFI). Its historical roots were in the collapse of the Pacific sardine fishery several decades ago. CalCOFI was implemented on the basis of a unique partnership of state and federal governments and the academia and had a focus on fisheries and oceanography. It was also unique in its large spatial dimension. Current reduced coverage was from Southern California Bight to Pt Conception. Sampling was at 66 standard stations plus 9 near-shore stations. Hydrography and basic biological and chemical measurements were made along with three different net tows. Characteristics of the time series have changed over the years. These measurements were carried out in conjunction with other time series observations. Partners included SCCOOS, Point Reyes Bird Observatory and Office of Naval Research. Observations showed the impact of El Niño on the zooplankton of the area. As the length of the time series grew, it had become evident that some of the oscillations had a decadal time scale. The satellite data showed similar links to El Niño in the phytoplankton distribution. The data showed 1^{o}C warming of SST over 50 years. Modelling was used to examine mechanisms for observed change: an eddy-permitting ocean model hindcast captured the observed SST and thermocline variations. Models had revealed that decline in chlorophyll, consistent with zooplankton decline, was related to deepening thermocline. The balance between nitrogen and phosphorus in the CALCOFI domain was shifting, suggesting a shift in the balance between nitrogen fixation and denitrification. The time series also allowed study of variations in the distribution of eggs of various commercial fishes. The data were used in ecosystem-based management of fisheries resources. Vision included expansion and integration of observations from Canada to Mexico. They were also looking for integrating CALCOFI within a dynamic research programme.

After the presentation, Ed Harrison enquired about the ideal sampling frequency. The response was that the frequency of existing observations was not ideal for some applications, but was dictated by funding and resources. The annual budget was about 2 million for running the programme. Difficulties with identifying fish eggs were discussed.

Sun Song opened the session to discussions, noting that more and more people, even in developing countries, were beginning to recognise the importance of long time series data. He outlined some of the related issues in China. Tony Haymet then reminded the attendees of several common threads that had emerged during the presentations. One was the need to optimise the use of platforms and other resources. Peter Burkill noted that in addition to research vessels, it was also essential to exploit the use of ships of convenience. Shubha Sathyendranath mentioned ongoing discussions with the Nippon Foundation for organising a workshop that would bring together scientists and the shipping industry to promote ocean observations. The need to add to the POGO database information related to mooring servicing was mentioned as a way to reduce transit time and servicing costs. A need to have a balance between global and coastal emphasis was noted. Charlie Kennel suggested that the berth bartering model could be developed further. POGO directors could discourage their scientists from sailing with empty berths. Sun Song pointed out the problems of sharing berths on cruises in exclusive economic zones. Jesse Ausubel suggested that it might be useful to have a POGO branding of activities that were recognised as contributions to ocean observations, and hence part of GEOSS. Certain criteria would have to be met to obtain the certification. Maureen Conte informed participants that UNOLS had a plan to advertise empty berths, especially for use of students. Einar Svendsen emphasised the need to consolidate and optimise the resources, for example by ensuring that data are converted to information and promoting

all the exciting results that had emerged from time-series data. Sustainability was identified again as an issue. Ed Hill suggested identifying iconic time series. Tony Haymet brought the discussions to a conclusion by re-emphasising the need for coordinated advocacy for promoting ocean observations.

This brought the formal part of the meeting to a close, for the day. This was followed by an exhibition of art work at BIOS, prepared by school children of Bermuda on the theme of "On the rock". Prizes were given out in various categories, and BIOS hosted a reception to the students and teachers who participated in the exhibition, sponsors, local dignitaries and POGO participants.

11 Jan, Friday

Director's Forum: Chairs Tony Haymet and Kiyoshi Suyehiro

Kiyoshi Suyehiro chaired the first part of the discussions. Jim Baker set the stage for the discussions with a talk on improving international mechanisms for ocean observations. He focused on possible roles for POGO that might frame a discussion. There were three main intergovernmental organisations that support ocean observations: Intergovernmental Oceanographic Commission; World Meteorological Organisation; and the Group on Earth Observations. The merged objectives of IOC/WMO were met through JCOMM. These objectives included warnings, mitigation and adaptation; management and policy. GEO had a clear focus on societal benefits. Intergovernmental organisations were driven by their objectives and how member states implemented them. They worked as well as the support they get from member states. Member states responded to perception of societal risk and economic benefit. The ocean community needed to communicate risk and benefit in the context of clearly relevant societal issues. Some examples: Atlantic hurricanes / El Niño and long-term regional climate change forecasts (forecasts were seriously wrong or non-existent and too much was being claimed); sea-level change forecasts (preparing society for the inevitable); carbon emission reductions (a 500 billion Euro market); ice-free Arctic routes/resource extraction (a globally-changed economy). In the case of the first example, there was need for information on basic state of the ocean from Argo, OceanSITES, satellite altimetry and scatterometry. For the sea level, we needed satellite altimetry and surface gauges. For carbon-emission reductions, satellite ocean-colour in situ observations and study of ocean ecosystem were needed. For studying the ice-free Arctic, satellite constellations and sea-floor geological measurements were needed. There was room for much improvement in hurricane forecasting. The difference between prediction and reality was attributed to: "In the latter part of the season, increased wind shear in the tropics (read El Niño) allowed only short-lived storms to develop." A recent trend was long-term (multi-decadal) forecasts. Confidence in such forecasts was low. They were oversold. Oceans were a key element of the uncertainty in predictions. Rate of change of global sea level was predicted to be modified significantly. In examining confidence, uncertainty and decision-support relevance, he quoted from Strainforth et al. (2007) that media and policy makers were calling out for local climate predictions. Providing direct quantitative answers to such calls was important for engaging the public in the issue and therefore the task of mitigation. It was also critical for adaptation and decision making by businesses, governments and individuals.

What needed to be done? The Argo float array was key. Argo successes included improved estimates and forecasts of sea-level rise caused by thermal expansion of

seawater; and the array data were playing a key role in improving seasonal climate forecast and hurricane prediction. But it was a challenge to maintain the Argo array's size and global coverage in the coming decades to enable Argo to build on these achievements and establish a system for monitoring and forecasting our seas similar to that operated and used by meteorologists. Moorings (OceanSITES) were an important complement to Argo. Upper ocean density fields from Argo floats and sea-surface topography from satellite altimetry were two fundamental state variables that were necessary for understanding the dynamics of the oceans, assessing their role in climate and developing an operational forecast capability. CEOS had prepared charts for a satellite constellation to study ocean-surface topography. Significant improvements in marine warnings and forecasts for the world's oceans could be achieved using global satellite observations of surface vector winds, especially in combination with significant wave height from the Ocean Surface Topography Constellation. The challenge for ocean satellites was effective worldwide coordination of ocean satellite observations of topography and winds. CEOS was filling that role for the ocean satellite component of GEOSS, and POGO could be of immense help. The role for POGO on regional climate forecasts was: to work with Argo, OceanSITES, and satellite infrastructure to help ensure sustainability; bring the sustainability needs to governments' attention; and to bring ocean achievements and its role in climate forecasting to the public's attention.

Carbon markets loomed on the horizon and were worth about 500 billion Euro. An interesting question was whether voluntary markets would overtake the CDM (Clean Development Mechanism). Ocean fertilisation was being spoken of as an effective carbon sequestration mechanism to mitigate anthropogenic emissions. There were many uncertainties here. Yet it was proposed as a mechanism to buy ecosystem restoration credits and to shrink carbon footprint. This possibility had to be considered in combination with other strategies such as energy efficiency, renewable energy and carbon capture with geological storage. It has been suggested that ocean fertilization could remove quantities of CO_2 that were comparable to other strategies. Iron fertilization was also being promoted as a way of generating carbon offsets, whereby CO_2 polluters could buy "ecosystem restoration credits" and shrink their carbon footprint. A logical next step was to increase the scale of project iron-fertilisation patches to a moderate size to learn whether/how much carbon can be sequestered.

Regarding ocean colour radiometry and in situ ecosystem science programmes, Jim Baker said that there was a need for a sustained fundamental climate data record of water-leaving radiances and derived products such as chlorophyll a, as well as a means to monitor coastal ecosystem health and long-term changes. It was also necessary to have a strong in situ ecosystem science program to complement satellite observations. Ocean-colour observations were relevant to many societal benefit areas identified by GEO: health, ecosystems, energy, water and climate. In this context, he suggested that the role of POGO could be: to establish a team to put together an institutional strategy for dealing with ocean carbon sequestration; to help find support for the necessary satellite and in situ programmes; and to connect with the private sector and carbon market experts.

Turning to the ice-free Arctic routes and resource extraction, he pointed out that global warming was seen first in the Arctic; the changes were associated with human impacts superimposed on natural fluctuations; new routes were possible, new ships being built to exploit this opportunity; and disputes over territory and minerals were real threats. There was a need for comprehensive observations and monitoring of the regional physics, chemistry, biology and geology. The role for POGO in this context was to set up a team

to develop a strategy for dealing with the oceanographic aspects of a changing Arctic. The effort had to be multi-disciplinary, including economics and social science.

It was important to communicate the benefit of ocean observations and the risk of not making the observations. A business case had to be made to show the economic benefits of better ocean observations and document the risks to society of not observing the oceans. The message had to be communicated often and to multiple audiences. We had to communicate our uncertainty in climate predictions in a manner analogous to weather forecasts. Time-delayed, abstract and often statistical nature of the risks of global warming did not evoke strong visceral reactions, suggesting that we should find ways to evoke strong reactions towards the risk of global warming, perhaps through simulations of its concrete future consequences for people's home or other places they visit or value. Increasing personal evidence of global warming and its potentially devastating consequences could be counted on to be an extremely effective teacher and motivator. Unfortunately, such lessons might arrive too late for corrective action.

Video games could be a way to communicate the threats of climate change. Digital worlds (such as second life) could also be used to communicate the message. POGO films for the GEO summit were a great first step (thanks to José Achache and Jesse Ausubel). We could emulate Al Gore – go to Hollywood – films and video games could be used to communicate the message. The overall need was a massively increased communications effort comparable to corporate marketing commitments. A small step would be to buy a camcorder to record meeting proceedings for good ideas. It was important to encourage data exchange – the cost-free way to get more ocean observations.

During discussions, Tony Koslow asked for further details on the issues associated with iron fertilisation. Jim responded that there were many open issues, hence the need for a committee. Peter Herzig added that there were also other plans for using the ocean for carbon dioxide storage. Further discussions highlighted the urgency of addressing many of these issues. José Achache suggested that the public understood the uncertainties in climate predictions better than one might give them credit for. He also outlined efforts and difficulties in implementing the GEO data policy. It suffered from lack of participation. Jim Baker expressed his opinion that making progress on such difficult issues required commitment at the highest level. Einar Svendsen asked about the link between the Arctic action item proposed by Jim and related actions in the GOOS context. Jim Baker responded that there were many commercial interests at play, and POGO directors had to evaluate prospects and implications, sooner rather than later. Ed Hill used the analogy of the medical field to illuminate how issues related to environmental health and climate change might be approached. Tony Knap pointed out that many of the far-fetched ideas were being promoted because they were very cheap to implement. Ed Harrison drove home the importance of developing reference material, standards and common practices in the measurements of ocean carbon and ecosystem properties. Howard Roe suggested that the single key to progress was outreach and effective communication. Tony Knap pointed out that there was no effective method to measure carbon sequestration in the ocean.

Mike Sinclair brought the discussion back to the question of recognising ongoing observations maintained by various institutes as part of a global system. Once the existing elements were clearly identified, the members could discuss issues related to integration and sustainability. Participants felt that there was some confusion about which observations were recognised part of the global ocean observation system. Ed Harrison

highlighted the need for champions to promote recognition of certain types of observations as part of observing elements. Shubha Sathyendranath suggested that criteria could be developed that would have to be met before POGO would recognise certain observations as part of the observing system, and these criteria to a large extent might be based on data provision and quality. Stan Wilson stressed the need to sustain satellite observations and to improve data sharing. He also highlighted the importance of basing the push for enhanced ocean observations on societal benefits rather than on research needs. José Achache wondered if mechanisms could be established for trading data in the context of carbon trading. Compliance monitoring was at the top of the priority for marine observations in the UK. Masao Fukasawa raised the issue of bridging the gap between science and operations. Ed Hill brought the discussion back to sea-level measurements and sea-level rise and predictability of sea-level rise in shelf seas. Einar Svendsen mentioned that fisheries concerns were the underlying justification of extensive, sustained hydrographic observations carried out from Norway.

Suggestions from the floor included: ask POGO members to respond to a questionnaire about sustained observations maintained by individual institutes; improve data exchange; improve communications with operational agencies and outreach to the general public; and establish small committees to promote the need for effective observation systems in the ocean, in the context of (a) various plans to use the ocean for various carbon sequestration plans; and (b) various interests (commercial and otherwise) that have followed the opening up of the Arctic.

The discussions continued after a coffee break, under the chairmanship of Tony Haymet. He informed members that there was an opportunity to obtain funds to prepare POGO communication material to flesh out the idea put forward in 2007 that there was a need for an additional 3 billion dollars to complete an initial implementation of an ocean observation system. There were different possibilities for the scope of the material. Time scales and target audience were also open to discussion. There was also a need to discuss Cape Town-like targets for outreach in 2008-09.

José Achache informed participants that the major theme for the G8 meeting in June-July in Japan was climate change. There were also plans for an associated GEO Asia-Pacific symposium in April which will also focussed on climate change. He mentioned the potential use of a coastal theme as a vehicle to address various societal benefit areas. It was important to highlight the economic benefits. Jesse Ausubel suggested the need for creating an image gallery, power point presentations and perhaps movies with a consistent POGO look and feel. Using images rather than words as the primary medium of communication would facilitate multi-national communication. It was also important to highlight the evolution of the ocean observation system over the past several years, and provide projections into the future. Paul diGiacomo suggested that the issues should drive the discussion as opposed to the observing system per se and duplication of efforts by other groups such as GOOS and IGOS-P had to be avoided.

Uwe Send said that the circulation element was missing in the physical component of the present system. There were also issues associated with observations along the margins of coasts and open oceans. Ed Hill asked where the cabled observatories fitted in with the current thinking on observing systems.

Bob Weller requested capacity building on development of sensors for non-physical variables. Charlie Kennel and John Gunn suggested a focus on the role of the oceans in climate in the communication material prepared this year. Tony Haymet clarified the

scope and detail of the envisioned communication material, and initiated a discussion on the level of economic benefit analyses that could be undertaken. The general consensus was that it would be better to focus on particular case studies rather than attempt a comprehensive analysis that would be beyond reach. José Achache suggested that an Arctic theme would also be an appropriate theme for GEO. Mike Purdy cautioned that regional plans should be embedded in a broader, global plan. John Gunn highlighted the importance of an integrated vision. Silvio Pantoja noted the need to focus on societal benefits. Einar Svendsen was of the opinion that current achievements had to be highlighted, to promote enhancement. Mike Sinclair emphasised the need for observations to improve predictions. Further discussion raised the importance of endorsement of on-going ocean observations, and John Field was of the opinion that a focus on promotion rather than on endorsement would avoid duplication of GOOS efforts. He also suggested that POGO should nominate a member to the GOOS Scientific Committee.

Regarding the target audience for the ocean observation promotional material, Jan Seys suggested a focus of outreach on potential sources of funding, governments and policy makers. Einar Svendsen added the importance of reaching the public. Discussion followed on effective mechanisms to increase outreach. The need to have effective champions who speak for the cause was mentioned. Ed Harrison noted that ocean observations were infrastructure for ocean science, and Jan de Leeuw wondered if the material should mention capacity building.

Suggestions from the floor on topics for discussion at POGO-10 included cabled observatories and non-physical sensors.

POGO Business. Chair: Kiyoshi Suyehiro

The afternoon session was preceded by a viewing of the Galatée oceans movie courtesy of Jesse Ausubel. He expressed hope that POGO institutes would work with the French film makers to orchestrate public relations andoutreach activities around the launch of the film (anticipated in 2009). All the movie shots would be available to scientists for studying animal behaviour.

Shubha Sathyendranath spoke first in the session summarising various capacity building activities. A detailed written report had been distributed to participants. Since other presentations at the meeting had focussed on the NF-POGO Centre of Excellence and the POGO-related capacity building activities at the University of Concepción, her presentation focussed on the other activities. The POGO-SCOR Fellowship Programme, which was initiated in 2001, was continuing. In 2007, 13 fellowships had been provided under the programme. The NF-POGO Visiting Professorship Programme was concluded in 2007, after three years of successful operation. In 2007, Visiting Professors had gone to Tunisia and Vietnam, and both training programmes had been very successful. Discussions were underway with the Nippon Foundation on how best to use the balance of some US $ 50K that remained in the project. Silvio Pantoja and Missy Feeley had been co-chairs and Shubha Sathyendranath a member of an international committee of the National Research Council of the US National Academies on capacity building. The committee had produced a report in 2007 entitled “Increasing Capacity for Stewardship of Oceans and Coasts: A Priority for the 21st Century”. POGO was the sponsor of a training course at the Iranian National Centre for Oceanography, on “Coastal oceanography of southern Caspian Sea: Forcing and Structure” on 1-15 December, 2007.

Dr. Charitha Pattiaratchi from the School of Environmental Systems Engineering, University of Western Australia had been the main professor at the training course. In 2007, POGO had also cosponsored a teacher-training workshop in Cook Islands under the SEREAD programme, in which science teachers from Rarotonga, Aitutaki, Manai, participated. The workshop was completed in November, and a full report was awaited. She concluded her presentation with proposals for capacity building activities in 2008, which included continuation of the Fellowship Programme, continued support of the Austral Summer Institute at the University of Concepción, continued support of the SEREAD programme, support of a proposed meeting on the Southern Ocean Observation System, and a new POGO graduate studentship tenable at the University of Cape Town, which would be open to non-South African students.

Silvio Pantoja then spoke about capacity building at the University of Concepción, which targeted Chile and South America. There were three main activities: Agreement WHOI/UDEC/Fondacion Andes; UNESCO IOC Chair in Oceanography; and the Ministry of Education – Chile project. There were seven sources of funding, including POGO. Some 370 students have participated in those activities. Some 20% of those students from Latin-American countries (non-Chilean) were funded by POGO to attend the courses. Original goal was to strengthen education in all areas of oceanography. There was a bias in favour of biology, but there was a slow increase in the trend of the other branches of oceanography. For the next Austral Summer Institute, the focus was on Applied Coastal Oceanography.

Silvio Pantoja, in his role as deputy director of COPAS, also extended a warm invitation to hold POGO-10 in Chile, hosted by the University of Concepción. The University was founded in 1919, with some 20,000 students. The University has a beautiful campus. The main campus was home to the school of natural and oceanographic sciences. The department also had a marine biology station in Dichato, a fishing village approximately 50 km from downtown Concepción. The city also boasted many attractive tourist locations in nearby locations. It was recommended that the next POGO meeting be held on 7-9 January, 2009.

Cindy Clark then reported on the activities of the News and Information Group. She suggested that in 2007 POGO had reached new levels in effective communications, thanks to GEO-related activities. The group was small but effective. The highlights of 2007 included populating the “ocean news” web page on the POGO website. CSIRO (Australia) and AWI (Germany) were most active last year in contributing news items to the site. There was also a very successful coordinated effort to promote the Argo 3000th float milestone in autumn 2007. The N&I Group also focused on GEO Ministerial-related activities in 2007. They updated original POGO brochure; created a 2-page overview flyer on societal benefits of ocean observations; contributed video/animation to the European Commission’s video; advised and contributed to POGO’s Ocean Observation Overview video and to the exhibit content; and assisted Terry Collins with news release distribution/media interviews. She highlighted the value of procuring the professional services of Terry Collins for effective outreach. The options for 2008 were a) business as usual; b) POGO secretariat staff contributes to N&I activities (web maintenance, photos, templates, writing, media, etc.) or c) a big step forward by investing real investment in communications and outreach as a POGO priority. If the first scenario were followed, then the N&I Group would propose to be involved in updating the POGO design look, create a 10-year overview communiqué and revamp the POGO web site. She also proposed creating a communications plan for building further on the existing momentum.

The group recommended hiring a POGO PR professional. Ralph Rayner briefed participants about GOOS outreach activities, and requested that the GOOS efforts and POGO efforts in outreach be coordinated.

Dealing with the POGO budget, Tony Haymet recommended that members paying now in US dollars to change to Euros with exchange rate as of Jan 2, 2008. Motion was carried. Proposed budget was approved.

Jesse Ausubel suggested that POGO try to get a clear picture from IOC and GOOS leadership on what can be expected from IOC and GOOS to enhance ocean observations.

Tony Haymet led the discussion on POGO Action Items for 2008. The approved action items are provided as Appendix A to the minutes.

Chairman Tony Haymet then brought the formal part of the meeting to a conclusion, after thanking Tony Knap and his colleagues for hosting POGO-9, and for all their warm welcome, efficient help and hospitality throughout the meeting.

The participants then met for dinner at the beautiful residence of Brian and Nancy Duperreault**.** Brian is Chairman of the BIOS Board of Directors. Three POGO Stalwarts were recognised at the dinner: Charlie Kennel (presented by Tony Haymet), Howard Roe (presented by Jan de Leeuw) and Jesse Ausubel (presented by Shubha Sathyendranath). All three Stalwarts received original Nansen bottles courtesy of Tony Knap and BIOS . The souvenirs had been stripped and polished to highlight the brass and copper components of the bottles. The POGO Nansen awards were presented by Michael Douglas, Hollywood star, and resident of Bermuda. All three recipients made short acceptance speeches. All the presentations and the acceptance speeches, especially that of Charlie Kennel, highlighted the brief but illustrious history of POGOand the vision that led to the formation and building of POGO. All participants came away with warm memories of Bermudian welcome and hospitality.

Names and Acronyms:

AEROCE	Atmosphere/Ocean Chemistry Experiment
ALOHA	A long-term, deep-ocean research site 100 km north of Oahu, Hawaii
Argo	Not an acronym, but the name of a global array of temperature/salinity profiling floats
AWI	Alfred Wegener Institute
BATS	Bermuda Atlantic Time-series Study
BCLME	Benguela Current Large Marine Ecosystem
BIOS	Bermuda Institute of Ocean Studies
BODC	British Oceanographic Data Centre
BSH	Bundesamt fuer Seeschiffahrt und Hydrographie (Federal Maritime and Hydrographic Agency)
CALCOFI	California Cooperative Oceanic Fisheries Investigations
CEOS	Committee on Earth Observation Satellites
ChloroGIN	Chlorophyll Globally Integrated Network
CLIVAR	Climate variability and predictability
CPR	Continuous Plankton Recorder
CoML	Census of Marine Life
COOP	Coastal Ocean Observation System
CSIRO	Commonwealth Scientific and Industrial Research Organisation

CSR	Cruise Summary Report
COPAS	Center for Oceanographic Research in the eastern South Pacific
CZCP	Coastal Zone Community of Practice
DONET	Dense sea-floor long-term networks
EurOcean	An European Centre for Information on Marine Science and Technology
GCOS	Global Climate Observation System
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GODAE	Global Ocean Data Assimilation Experiment
GOOS	Global Ocean Observation System
GRA	GOOS Regional Alliance
GTOS	Global Terrestrial Observation System
HARON	Hydrological Applications and Run–Off Network
HOTO	Health Of The Oceans
ICES	International Council for the Exploration of the Sea
IGOS-P	Integrated Global Observing Strategy - Partners
IOC	Intergovernmental Oceanographic Commission
IOCCP	International Ocean Carbon Coordination Project
IODE	International Oceanographic Data and Information Exchange
IORGC	Institute of Observational Research for Global Change
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
Jason	Not an acronym but the name of a joint French/US altimeter mission
J-PICO	Joint Panel for Integrated Coastal Observations
JCOMM	Joint Commission on Oceanography and Marine Meteorology
JGOFS	Joint Global Ocean Flux Study
LMR	Living Marine Resources
MA-RE	Marine Research Institute
MARIS	MARine Information Service
NIOZ	Royal Netherlands Institute for Sea Research (Koninklijk Nederlands Instituut voor Zeeonderzoek)
NOCS	National Oceanography Centre, Southampton
NODC	National Oceanographic Data Centre
NOAA	National Oceanographic and Atmospheric Administration (USA)
OBIS	Ocean Biogeographical Information System
OceanSITES	A worldwide system of long-term, deepwater reference stations
Ocean United	Name of an informal consortium of international organisations participating in GEO-related activities
OOI	Ocean Observatories Initiative
OOPC	Ocean Observations Panel for Climate
PICO	Panel for Integrated Coastal Observations
PML	Plymouth Marine Laboratory
POL	Proudman Oceanographic Laboratory
POLCOMS	Proudman Oceanographic Laboratory Coastal Ocean Modelling System
RAMP	Rapid Assessment of Marine Pollution
SAHFOS	Sir Alister Hardy Foundation for Ocean Science
SCCOOS	Southern California Coastal Ocean Observing System
SCOR	Scientific Committee on Oceanic Research
SeaDataNet	Name of a major Pan-European and EU-funded project, undertaken by the National Oceanographic Data Centres

SEREAD	Scientific Educational Resources and Experience Associated with the Deployment of Argo profiling floats in the South Pacific Ocean
SIO (Scripps)	Scripps Institution of Oceanography
UCT	University of Cape Town
UdeC	University of Concepción
UNOLS	University-National Oceanographic Laboratory System
VLIZ	Flanders Marine Institute (Vlaams Instituut voor de Zee)
WHOI	Woods Hole Oceanographic Institution
WMO	World Meteorological Organisation

Appendix: Proposed Action Items from POGO-9

1. Support POGO capacity- building activities, especially the new NF-POGO Centre of Excellence.
2. Continue increasing POGO - GEO interactions for mutual effectiveness
3. Write proposal to seek funds for the “document” and visual materials
4. Help GEO explore case studies for narrative of “benefit” and “impact” from POGO supported activities
5. Support Flanders Marine Institute revamping of POGO website
6. POGO to nominate a person to join outreach and GOOS advocacy
7. POGO to nominate observer on GOOS scientific steering committee
8. POGO directors to lobby their national representatives on IOC reform working group
9. POGO directors to ramp up advocacy at national levels for continued, sustained and expanded ocean observations for societal benefits
10. POGO directors to support additions to International Cruise Database by providing regular updates on planned cruises and related activities
11. POGO directors to promote media reports on ocean observations, for example by taking media people to sea
12. POGO to take up advocacy of value of time series observations of various types, and support such observations, for example through coordinated proposals, and by POGO support of OceanSITES (OceanSITES to draft a letter for POGO to sign)
13. POGO Executive committee to engage a new Executive Director for POGO
14. For now, POGO to hire communicator(s) on project-by-project basis
15. POGO to seek synergies with seafloor observatories
16. POGO-10 to be held in Chile (hosted by University of Concepción) in first week of January 2009
17. Potential Themes for POGO-10:
    1. How to sustain successes of IPY –related observations
    2. Cabled observatories
    3. Year of the earth, biodiversity (IGU)
    4. Non-physical (biological) sensors – report from white papers to be produced from mid March 2008 meeting on the topic