Global Ocean Observing System

Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

Joint GCOS-GOOS-WCRP Oceans Observations Panel for Climate (OOPC)
Eighth Session

Ottawa, Canada
3 - 6 September 2003

GCOS Report No. 89
GOOS Report No. 140
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GCOS-GOOS-WCRP/OOPC-VIII/3
Paris, March 2004
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1. OPENING AND WELCOME

The Chairman of the OOPC, Ed Harrison, opened the meeting and introduced Joan Keene-Howie, Director-General of the Canadian Department of Fisheries and Ocean Science, who welcomed the Panel to Ottawa and spoke to the importance of good ocean information for decision-making. The Co-President of the Joint Commission on Oceanography and Marine Meteorology, and Director, Canadian Marine Environmental Data Service, Savi Narayanan, then welcomed the participants to MEDS, offered its facilities to support the Panel, and said that a tour of the facility would be arranged for later in the week.

The Chair thanked the hosts for their hospitality and noted OOPC's continuing advocacy for the importance of effective marine data management and services, toward which goal MEDS has worked for many years. He welcomed the CLIVAR Basin Panel representatives (Bob Weller, Martin Visbeck, Kevin Speer) and spoke to the importance of the panels in the continuing evaluation and evolution of recommendations for the sustained global observing system, as well as to ensuring that maximum scientific benefit is obtained from the data produced by the system. He also welcomed invited speakers, Allyn Clarke and James Morison; GOOS-COOP co-chair, Tony Knap; Chair of the JCOMM Observations Coordination Group, Mike Johnson, and the other guests. The list of participants is in Annex II.

The Chair noted that the ocean domain recommendations of the GCOS Second Report on the Adequacy of the Global Climate Observing System (2AR), prepared for the UN Framework Convention on Climate Change, were largely those developed by OOPC, CLIVAR and their partners over the past five years (the "Next Steps" toward an initial global ocean observing system) and welcomed the level of international endorsement (GOOS SC, GCOS SC, JSC, SBSTA) of these recommendations that had developed since OOPC-VII. He noted that the challenges ahead for OOPC include developing recommendations for ocean information products (including indices) and for an ongoing process of evaluation and evolution for the recommendations, as well as continued advocacy of a system approach to the implementation of the recommended "Next Steps" observing efforts (satellite and in situ). Advocacy of improvement of the ocean data system and of an enhanced effort in ocean analysis and reanalysis also will be needed.

2. REVIEW AND ADOPTION OF THE AGENDA

The Chair introduced the provisional Agenda and noted that the scheduling of some items might have to be changed to accommodate the expected arrival times of certain speakers. After limited discussion the Agenda (Annex I) was adopted.

3. OOPC REVIEW 2002-2003

The Chair reviewed the status of action items from OOPC-VII and a brief summary of intersessional activities and meetings attended by Panel members on behalf of OOPC. He noted that excellent progress has been made but that several of the Action Items required further discussion by the Panel at the present session and would be addressed later in the Agenda. Agenda items from last session that have not yet been addressed will be integrated into the new agenda item list. A major activity for this intersessional period revolved around the Second Report on the Adequacy of the Global Observing System for Climate and on developing a strategy for the “next steps” toward the development of the global ocean climate observing system. Interactions with COOP and JCOMM have increased substantially, and CLIVAR has sent representatives from the Basin Panels to the OOPC. A new OOPC website was developed at the beginning of the year on the IOC server and will continue to be developed in parallel with the “next steps” to provide a central source of information about the global ocean climate observing system. Interactions with the Pilot Projects GODAE, Argo, and the Ocean Information Technology project. During the intersessional period, OOPC continued its work: with the WCRP Working Group on Satellites; CEOS; the IGOS-P satellite requirements for ocean climate research; the Global Eulerian Observatories project; the Surface Drifting Buoy Array; VOSClim; SOOP; and GLOSS.

SUMMARY OF OOPC-7 ACTION ITEMS

Action No.	Report Ref.	Action Description and Responsible Person(s)
1	1.	Need nominations to GSC to replace Smith and Zenk. (Harrison, Hood) **Status**: To be discussed at OOPC-VIII.
2	3.1	A second OceanObs'99 Conference for an update (perhaps with JCOMM) should be considered at OOPC-VIII. (OOPC, Harrison). **Status**: To be discussed at OOPC-VIII.
3	3.1	Improve OOPC interactions with PICES and ICES. (Harrison, Keeley) **Status**: Completed/on-going. coordination with PICES on ocean carbon via a joint intercomparison exercise for underway pCO2 systems, a follow-up workshop on data formats for underway pCO2 measurements, and the joint publication of a Guide of Best Practices, late-2004 (Hood); Communication with ICES via GOOS on ocean climate reports. And with CLIVAR Panel representatives (Harrison)
4	3.1	Strengthen ties with operational sea-ice activities. (Reynolds)
5	3.2.1	Assist with Second Adequacy Report. (Smith, Harrison) **Status:** Completed/on-going. Harrison, Dickey, and Hood wrote several sections of the parameter annex. Harrison and Hood (for ocean carbon) to attend writing-team meeting, Geneva, 12-14 March.
6	3.2.2	Increase OOPC's attention to polar issues. (Harrison) **Status**: Will be taken up as Special Topics at OOPC-VIII
7	3.2.4	AOPC requests made to the SST/Sea-Ice Working Group. (Reynolds)
8	3.4	Review COOP's Strategic Design Plan. (Dickey, Johannessen, Weller, Zenk, Keeley) **Status:** Completed. Circulated to members but no formal review by the group was prepared.
9	3.4	Participate in next COOP meeting. (Dickey, Harrison) **Status:** Completed.
10	3.4.2	Make National Reports available to B. Thompson (Alexiou, Hood) **Status:** Completed.
11	3.5	Assist WCRP in forming a group to push for specific satellite observations. (Johannessen) **Status:** Completed. Trip Report available on web.

12 13	3.6 3.6	Develop items for POGO meeting scheduled 22 Jan 2003, Hobart. (Weller, Harrison) **Status:** Completed. Smith presented material from OOPC. Increase OOPC Travel budget to reflect increasing coordination demands.. (Hood) Done. **Status:** Completed. 2003 Budget to cover travel demands.
14	4.2	Pass OOPC thoughts on Tropical Mooring Review to managers (Harrison) **Status:** Completed.
15	4.3	Send letter to JSC and CLIVAR SSG re air–sea fluxes' importance. (Harrison, Taylor) **Status:** Completed. Discussed at JSC-24
16	4.4	Remind JCOMM and other meteorological groups of importance of VOSClim. (Harrison and Taylor) **Status**: Completed. Discussed at SOT-2.
17	4.5	Develop items for CLIVAR reanalysis workshop (Harrison, Michida and Reynolds) **Status:** On-going. Discussion underway with CLIVAR.
18	4.6	Develop outline for a state-of-the-ocean report based on indices.(Harrison, Reynolds) **Status:** On-going. To be discussed at OOPC-VIII.
19	4.7	Invite Vasily Smolyanitsky and/or Nick Rayner to attend OOPC-VIII. (Reynolds, Hood) **Status**: Completed. Could not be arranged; Jamie Morison attended to address ice issues.
20	4.8	Letter to Kamel Puri (WGNE) emphasizing OOPC's undiluted interest in SURFA. (Weller, Harrison) **Status:** Completed. Discussed with Puri.
21	4.10.1& 8.	Prepare a paper outlining a CO_2 pilot project. (Dickey et al). **Status:** On-going. Dickey and Hood participated in the 1st workshop of the International Ocean Carbon Coordination Project – a pilot project of IOC, SCOR, and the IGBP-IHDP-WCRP Global Carbon Project. The IOCCP has made plans to develop an implementation strategy for underway pCO_2 measurements.
22	5.2	Consider OOPC-VII comments in organizing the South Atlantic Workshop. (Campos) **Status:** Completed. Campos modified agenda of SACOS using OOPC input. Meeting report pending.
23	6.3	Review ToR to accommodate CLIVAR Ocean Basin Reps at OOPC meetings. (Harrison, Hood) **Status**: On-going. To be discussed at OOPC-VIII
23	6.3.1	OOPC-VIII agenda should address CLIVAR reanalysis workshop. (Harrison, Hood) **Status:** Completed.
24	6.3.2	Offer assistance to CLIVAR SSG on data management. (Keeley, Smith) **Status:** On-going. To be taken up with CLIVAR. Argo "regional centers" could be core.
25	8.	Draft a strategy document for sea ice. **Status:** On-going. To be discussed at OOPC-VIII

The Chair presented the list of meetings attended by OOPC Panel members during the intersessional period.

Meeting	Dates	Member
GCOS Adequacy Report, Boulder, Colo.	Aug 12-14, 2002	Harrison
COOP IV Meeting, Cape Town	Sept 24-27, 2002	Harrison, Dickey
WCRP working group on satellites, Geneva	Nov 6-7, 2002	Johannessen
Indian Ocean GOOS, Mauritius	Nov 1-9, 2002	Harrison, Smith
GCOS Adequacy Report, Farnham, UK	Nov 17-21, 2002	Harrison
GODAE High-Resolution Sea-Surface Temperature Pilot Project	Dec 2-4, 2002	Reynolds
POGO 4, Hobart	January 22-24, 2003	Smith
International Ocean Carbon Coordination Project, Paris	Jan 13-15, 2003	Dickey, Hood
PIRATA-9/South Atlantic Climate Workshop, Angra dos Reis, Brazil	Feb 3-8, 2003	Picaut, Campos
JCOMM MAN II, Paris	Feb 5-8, 2003	Harrison
GODAE ST 7, Darmstadt	Feb 17-20, 2003	Harrison
GOOS SSC 6 Capetown	Feb 26-28, 2003	Harrison, Dickey
Argo SST 4, Hangzhou, China	March 4-6, 2003	Keeley
GCOS Adequacy Report, Geneva	March 12-14, 2003	Harrison, Hood, Smith
WCRP JSC, Reading, UK	March 17-21, 2003	Harrison, Hood
GCOS Steering Committee, Melbourne	April 7-11, 2003	Harrison
Coupled DA for S-I, Portland, Ore.	April 21-23, 2003	Harrison
CLIVAR SSG-12, Victoria, B.C.	May 5-9, 2003	CLIVAR Reps
US GODAE SC, Arlington, Va.	June 17-18, 2003	Harrison
AOPC-9, Asheville, N.C.	June 22-27, 2003	Harrison, Reynolds
US GOOS SC, Arlington, Va.	June 25-27, 2003	Harrison
IOC Assembly, Paris	June 24-July 4, 2003	Hood, Smith
JCOMM ET on Waves and Surges, Halifax, N.S.	June 2003	Harrison prepared materials
VOSClim, London	July 21-22 2003	Taylor
JCOMM SOT II, London	July 28-1 Aug, 2003	Harrison/Hood prepared materials
OOPC-VIII, Ottawa	Sept, 2003	All
PICES Annual Meeting 12, Pusan, Korea	Oct 10-18, 2003	Smith

4. SCIENCE

The Chair introduced this session, noting that it was a departure from previous OOPC agendas. This first-day session is dedicated to looking into the state of the ocean since OOPC-VII and scientifically interesting anomalies revealed by existing ocean observations and analysis products, to highlight the latest ocean climate events, to discuss specific issues in-depth with invited experts, and to identify possible new areas needing attention from the OOPC and its partner organizations.

4.1 OCEAN AND CLIMATE 2003-2004

The Chair introduced this item by pointing out that the role of the Panel includes seeking to determine what ocean information is needed for climate forecasting, as well as assessing what existing data tell us (and fail to tell us) about ocean climate phenomena. The Panel has been asked to develop ocean climate indices – simple quantities that can be evaluated from ocean data and/or analysis products – which can be used to describe climate variability and change and that will be easily understood by the general public. In order to meet these goals and to better communicate the needs for ocean observations to understand and forecast climate, it is appropriate that the Panel begin with a review of what was observed during the previous year and selected efforts that were made to forecast what subsequently occurred.

The Chair noted that present efforts to forecast seasonal to interannual weather anomalies make heavy use of statistical relationships between measures of the recurring patterns of atmosphere/ocean climate variability. Indicators of the degree to which patterns in such phenomena as ENSO, PDO, NAO, the Arctic oscillation and the Antarctic oscillation exist were reviewed briefly. Overall, 2003 was rather “neutral” for seasonal average measures of each of these recurring patterns, once the El Niño of 2002 terminated in early-2003.

4.1.1 **El Niño**

Michael McPhaden reported on the evolution of the 2002-2003 El Niño event in the tropical Pacific, using satellite and in situ observations from the El Niño/Southern Oscillation (ENSO) Observing System. The 2002-2003 El Niño was of moderate intensity and, though not as strong as the 1997-1998 El Niño, had significant impacts on patterns of weather variability worldwide. A build up of oceanic heat content along the equator starting in 2000 established conditions favorable for the occurrence of an El Niño, while the precise timing of onset coincided with two zonally extensive westerly wind events during May-June 2002. Maximum anomalies occurred for most variables during October-December 2002 with anomalous rainfall near the dateline peaking in January 2003. Demise of warm conditions ensued in early 2003 with cold SST anomalies in excess of 1°C appearing in the eastern Pacific in May 2003. Further development of La Niña conditions predicted by some forecasters was arrested however by a zonally extensive westerly wind event in May-June 2003 that led to a brief re-emergence of warm SST anomalies along the equator. At the time of OOPC-VIII (early September 2003), conditions in the tropical Pacific were near normal.

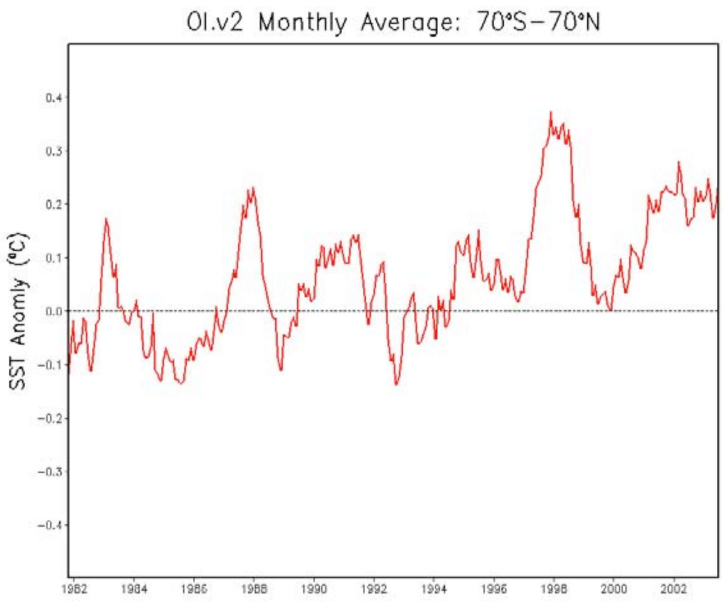
The observations from the ENSO Observing System underscore the importance of both episodic atmospheric forcing and large-scale low-frequency ocean-atmosphere dynamics in the evolution of climatic conditions in the tropical Pacific during 2002-2003. In particular, the data can be interpreted to support the hypothesis that ENSO is a stable or weakly damped oscillator requiring atmospheric noise in the form of weather fluctuations like westerly wind bursts to initiate and sustain warm events. From this perspective, the ENSO cycle consists of a series of warm episodes separated by periods of near-normal or cooler than normal equatorial Pacific temperatures, rather than a self-sustained instability of the coupled ocean–atmosphere system oscillating freely between warm, neutral, and cold phases.

4.1.2 **Extra-tropical SSTs from June 2002 to August 2003**

Reynolds presented this item. Three changes in SST were discussed. The first is the long-term global change from 1982 to 2003, which shows the global SST anomaly with respect to a 1971-2000 climatological base period. The anomaly time-series shows an overall SST increase of roughly 0.1ºC/decade. In addition, the three major El Niño events of 1982-1983, 1986-1987, and 1997-1998 are evident as relatively short periods of additional warming. A period of cooling in early 1992 corresponds to the decrease in incoming solar radiation due to the presence of stratospheric aerosols from the 1991 eruptions of Mt Pinatubo.

The second change is the difference between the winter anomalies of 2001-2002 and 2002-2003. This difference shows the impact of the 2002-2003 El Niño which is expressed as a warming in the tropical Pacific and associated warming along the west coast of North America. Examination of the North Atlantic does not show any strong change in the North Atlantic Oscillation between the two winters. There is a big change in the SST anomaly in the eastern south Pacific along 60ºS. However, there is no clear explanation for this change.

The third change is the development of a strong positive anomaly in summer 2003. This anomaly occurred north of 30ºN in the Atlantic and in the Mediterranean Sea. This anomaly began in June 2003 and persisted through August 2003. The anomaly is the oceanic response to the summer's European heat wave which resulted in the deaths of thousands of elderly people, especially in France. The figure below shows the Optimum Interpolation version 2 (OI.v2) monthly SST anomaly for November 1981-July 2003.



4.2 INVITED PRESENTATIONS

The Chair noted the considerable interest in evaluating variability and change in higher latitude ocean conditions and the development of recommendations for the initial sustained observing system for sea ice, the Arctic and Antarctic Oceans and for the oceanic overturning circulation. The invited science talks this year were to provide overviews of existing knowledge and existing observing efforts, and to begin the discussion of recommendations for sustained observations.

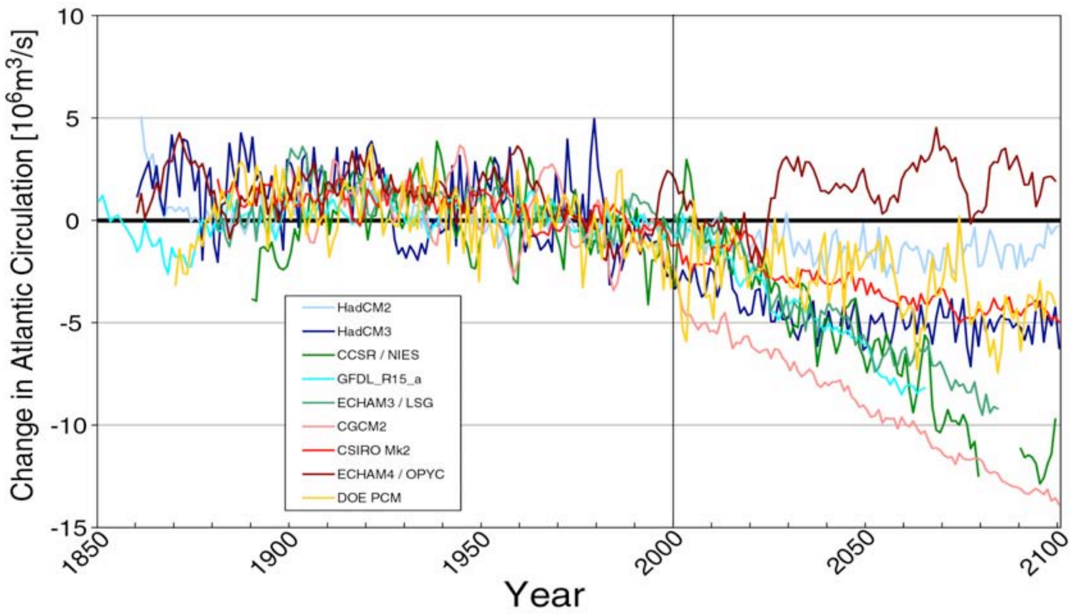
4.2.1 **The Meridional Overturning Circulation (MOC)**

The Chair introduced Allyn Clarke. To view the presentation associated with this lecture, please visit the OOPC-VIII website: http://ioc.unesco.org/oopc/oopc8/

Why is the MOC important to climate? The MOC is believed to be associated with the shifts between glacial and interglacial climate states. During interglacial climate states, deep- and intermediate-water formation takes place in the North Atlantic and in the Southern Ocean, whereas during glacial states the North Atlantic branch of the MOC is absent. Coupled atmosphere/ocean/land models run for the IPCC Third Assessment using the historical atmospheric composition plus the business-as-usual projection and nearly all show a decay of the MOC with time starting in the near future.

Since the Atlantic MOC is around 25-30 Sv, these changes are approaching 50% of the magnitude of the present signal. Ice cores, and marine and freshwater sediment cores suggest that the switches between glacial and interglacial climate states take place very rapidly (less than a century); likely faster than is simulated by these models.

The Atlantic MOC was first mapped by the Meteor expedition 1925-27. This expedition consisted of a series of zonal sections across the South Atlantic over three calendar



years. The annual station maps show that the Meteor expedition was unique for the period. There are few other deep-sea hydrographic stations over these years. Wüst (1935) created three synthetic longitudinal sections that stretched the length of the entire Atlantic using historical data from the North Atlantic going back to 1908. He identified tongues of water on these sections marked by salinity, temperature and oxygen maximums and minimums. Wüst then created horizontal property maps on the surfaces defined by these tongues. This analysis shows some evidence of spreading through deep western boundary currents but indicates the importance of mixing as well as advection.

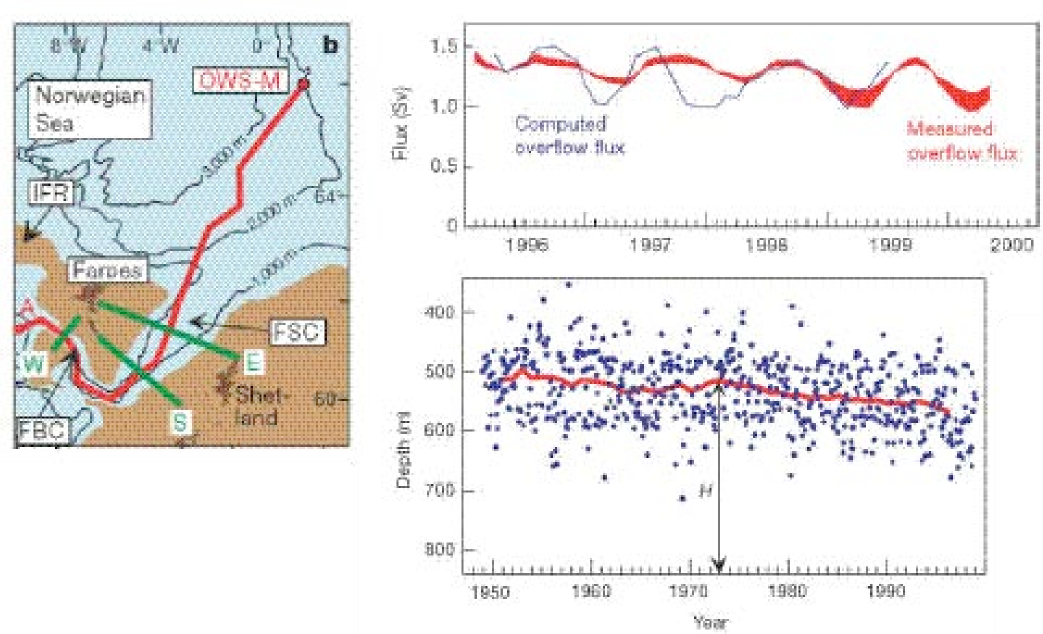
The next large-scale mapping of the Atlantic MOC was the International Geophysical Year (IGY)1957/58 occupation of 12 zonal sections across the Atlantic and the winter and summer surveys of the subpolar gyre organized by ICES. This constituted a notable increase in hydrographic data in general from the 20°S latitude. Worthington and Wright (1970) identified the various intermediate, deep and bottom waters of the North Atlantic from the historical data up to the mid-1960s.

Following IGY, there were several surveys of the MOC: GEOSECS (1972), TTO/Long Lines (1981-1984) and finally WOCE (1990s). In addition to using T, S, and dissolved oxygen to map water masses, one is also using nutrient concentrations (especially silicate) and transient tracers such as tritium/helium-3, CFCs and other chemical species and radioisotopes. Transient tracers are particularly useful because they can be used to look at time-scales of variability of the circulation over periods of years to a few decades. The CFC data collected in the North Atlantic up to 2000 shows that most of the CFC-11 inventory in the North Atlantic is still to be found in the subpolar gyre. Much of this is also found in the Labrador Sea Water. Wecan also use the history of CFC concentrations in the atmosphere, with the ocean CFC observations, to estimate the time at which a water mass was last at the sea surface. The age analysis of the various water masses reveals the youngest water in the subpolar gyres strong mixing through the subpolar gyre and the youngest water in the western boundary layers, especially as the water flows south of 40°N into the subtropical gyre and on through the tropics into the South Atlantic.

Magnitude of MOC transport. By the mid-1980s, there were direct measurements of the transport of the various elements of the MOC in the subpolar North Atlantic. North Atlantic Deep Water (NADW) enters the North Atlantic through various passages and gaps in the ridges linking Norway–Shetlands–Faeroes–Iceland–Greenland. Northeast Atlantic Deep Water passes through the very narrow Faeroe Banks Channel. Saunders measured this transport in the 1970s with a currentmeter array as 1.7 Sv. Using measurements from the Overflow 73 project, Meinke estimated that another 0.5 Sv might pass through various passages on the Faeroe–Iceland ridge, as well as another 0.5 Sv through a channel just to the east of Iceland. A Bedford Institute of Oceanography currentmeter array in Denmark Strait measured a transport of 2.7Sv for a total transport of water across the sills of about 5 Sv. Dickson determined the combined transport of 10.7 Sv for these flows along the East Greenland slope, half way between Denmark Strait and Cape Farewell, showing that entrainment is very important in the formation of the MOC. Clarke measured a transport of 13.3 Sv at Cape Farewell showing that mixing and entrainment continue through the entire pathway from Denmark Strait and Cape Farewell. In addition, there is an additional 4 Sv of Labrador Sea Water in the central west Labrador Sea which contributes to the MOC. Although currentmeter arrays are the traditional way to measure MOC transport, moored ADCPs plus T/S chains are particularly useful. By the 1990s, the belief was that the MOC transports were relatively steady for time periods greater than topographic wave periods of 2-20 days.

Lagrangian methods. The large number of profiling floats deployed in the subpolar gyre in 1996-1997 have provided a new picture of the circulation of upper Labrador Sea Water in the subpolar gyre. Lagrangian floats are probably not the best tool to measure strong narrow boundary currents, since they spend such brief times in these flows. In spite of this caveat, the float trajectories do identify the strong boundary currents. What was new and surprising was the appearance of the tight re-circulation gyres offshore of the boundary currents. This suggests that water is being continually exchanged between boundary currents and gyre interior.

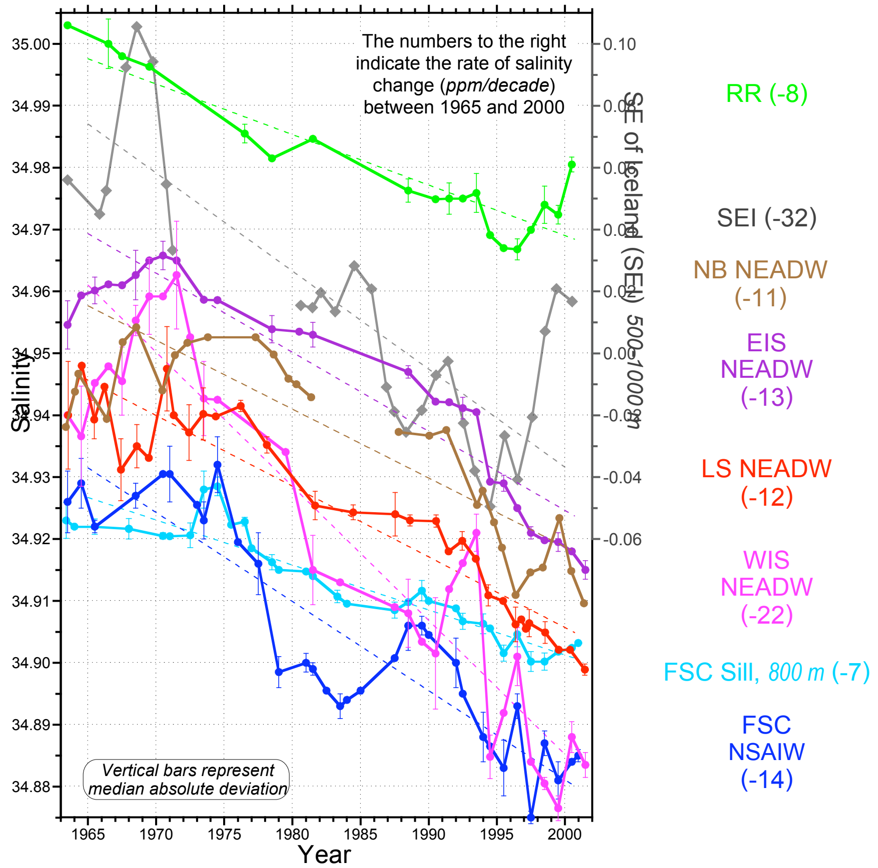
Is the transport of the MOC changing? Hansen et al. (2001) had a currentmeter array in the Faeroe Bank Channel from 1996 through 2000. Three moored ADCPs effectively covered the throughflow just downstream of the sill.



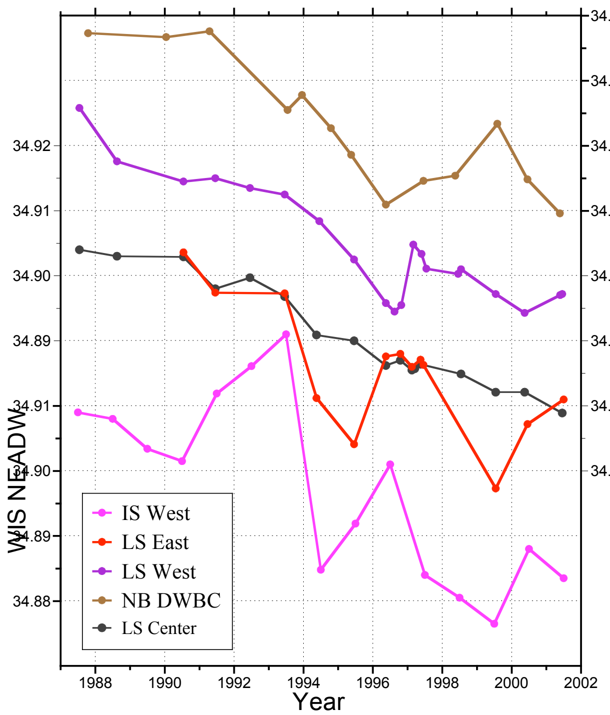
Note that the flow is only 10 km wide and 200 meters thick. The transport has a seasonal cycle and declines from 1.4 Sv in 1996 to 1.2 Sv in 2000. (recall that Saunders' earlier estimate was 1.7 Sv). It seems clear that the transport of NEADW has been decreasing since at least the 1980s. Because of the narrowness of the channel, the flow through the channel should be controlled by the hydraulic head at the mouth of the channel. Hydrographic observations have been taken at OWS Mike in the Norwegian Sea since the 1950s. If it is assumed that the hydraulic head is a function of the depth of the 1028.0 isopycnal at OWS Mike, the transport through the Faeroe Bank Channel can be back-calculated to the 1960s. This back-calculation also shows a decrease in transport over the last 4-5 decades.

MOC transports south of the subpolar gyre. A 22-month mooring array measured the transport of the MOC at 42°N. In the mean, the MOC flows southward in a deep western boundary current stretching along the continental slope from 1000 to 4500 meters with the strongest flows deeper than 3000 meters. The deep western boundary current on the mean lies beneath the inshore edge of the North Atlantic Current which extends to the bottom offshore of the deep western boundary current. Looking at the flow across the mooring section averaged over overlapping 10-day segments, one can see that there is considerable variability in the position and strength of all of these currents. The mean transport of the MOC from this array is 25 Sv. During WOCE, MOC transport was measured at various key sites all the way down the Atlantic to 30°S.

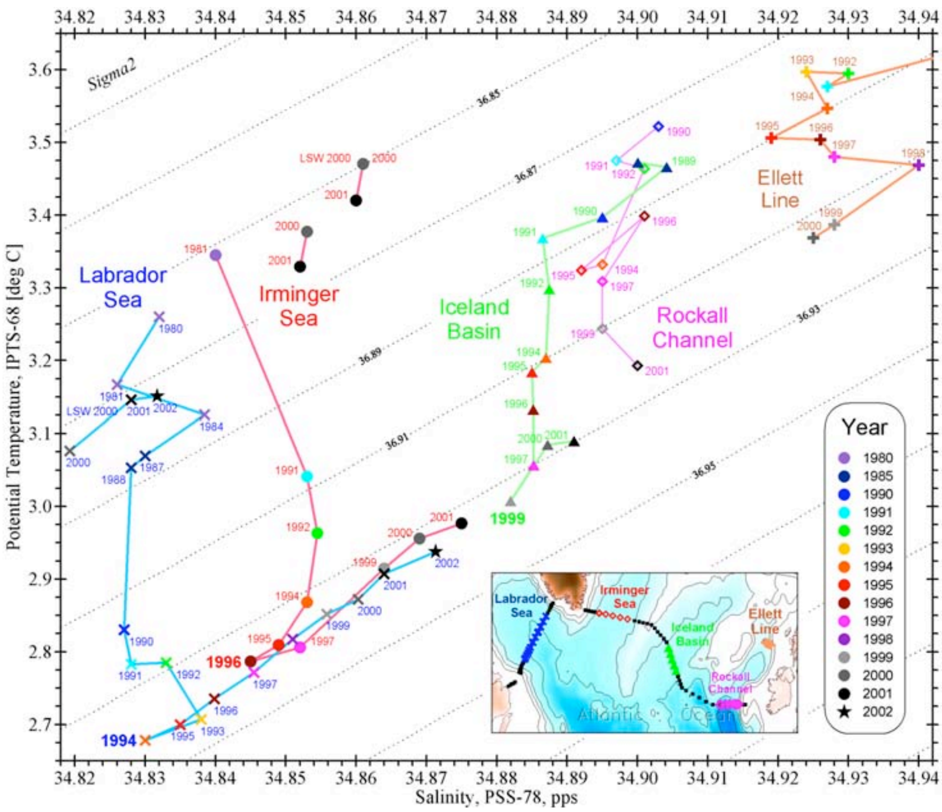
Changes in the properties of the water masses of the MOC. The central Labrador Sea is a good location to measure the changes in the deep and intermediate water masses of the North Atlantic. All these water masses have been getting colder and fresher since the 1960s. This represents an of 5 meters of fresh water everywhere over the entire subpolar gyre.



Note the temporal changes in salinity of the NEADW over the past four decades at various locations as it moves in the boundary current from the Faeroe Bank Channel to 42°N. The NEADW first becomes saltier as it moves around the Iceland Basin and then freshens in the Irminger and Labrador Seas by entraining water that is saltier or fresher than itself. In spite of all this mixing, the NEADW exhibits similar salinity decreases with time (within a factor of 2) at all locations. This is because the water masses that it is mixing with also have decreasing their salinities.



Looking in detail at the 1990s, one sees interannual changes in the NEADW which also appear to be propagated around the gyre in the boundary currents. These interannual changes are not seen in the center of the Labrador Sea even though they are seen on both the eastern and western boundaries. Similar trends and features are seen in the Denmark Strait Overflow Water from Denmark Strait to 42°N. Here the interannual variation seems to propagate through the Irminger Sea and around the Labrador Sea but has not continued past Flemish Cap into Newfoundland Basin. The LSW figure shows the movement of LSW eastward in the southern part of the subpolar gyre. Changes have also been seen in the deep waters of the subtropical gyre interior off Bermuda and in the Antarctic Bottom Water entering the Brazil Basin of the South Atlantic.



Variability or change? Records are too short and too irregularly spaced in time to address this question. We can link this observed variation to the NAO index, but we do not understand the dynamics of that phenomenon. What we can say at present is that there appears to be a multi-decadal freshening of the entire subpolar gyre of the North Atlantic – the equivalent of 5 meters of freshwater accumulation over the past three decades. Deep and intermediate water masses vary their properties and formation rates. The processes affecting the MOC take place at small scales often associated with complex topography or extreme events. Present technology allows these changes to be observed, but they are still a challenge to ocean and climate modelers.

*Discussion***.** The Arctic/Subarctic Ocean Fluxes (ASOF) program will be repeating many of the mooring arrays across the MOC in the subpolar gyre. This will help determine whether the transport is changing or not. Mooring arrays should remain in the research community through ASOF, after which time a sustained monitoring strategy might be developed. The repeat hydrography that has been specified by CLIVAR Atlantic and the OOSDP will capture the changes in T, S and transient tracers. This repeat hydrography should be part of the OOPC plans. Harrison asked what components need to be maintained. Clarke stated that repeat hydrography (ASOF) is necessary (see the lines identified in the repeat hydrography/carbon inventory sections of CLIVAR), and that Argo helps in intermediate but not deep water. Climate reference stations are needed with mid-gyre (Labrador Sea) measurements required every 30 years. In the IPCC report there is much interest in sudden climate change. How does this link with MOC? Clarke stated that ASOF is enough for this, but over the long-term something sustained in the spirit of the Marotzke-led RAPID effort will also be needed.

4.2.2 **The Study of Environmental Arctic Change (SEARCH)**

The Chair introduced Jamie Morison, who presented a report on The Study of Environmental Arctic Change (SEARCH) Distributed Marine Observatories and the North Pole Environmental Observatory

The Arctic has undergone a complex of significant, interrelated, atmospheric, oceanic, and terrestrial changes in recent decades. These changes are affecting every part of the Arctic environment and are having repercussions on society. There is evidence that these changes are connected with the positive trend in the strength of the polar vortex, often characterized by the Arctic Oscillation (AO) index. The physical changes in the marine environment potentially affect global climate by decreasing high-latitude albedo and by inhibiting global thermohaline circulation through freshening of the outflow to the subarctic seas. Modeling and retrospective studies indicate that the changes could be characteristic of global warming. In any event, observations suggest that the impact at high latitudes is substantial. The Study of Environmental Arctic Change (SEARCH) is intended to gain an understanding of these changes through long-term observation, analysis, and modeling. The SEARCH Science Plan and Draft Implementation Strategy are at http://psc.apl.washington.edu/search/index.html. The Draft Implementation Strategy includes SEARCH activity areas for, among others, Distributed Large-Scale Observatories, Distributed Terrestrial Observatories, Distributed Marine Observatories, and an Arctic System Reanalysis. The Distributed Marine Observatories activity area includes oceanographic moorings along key pathways and in main regions of the Arctic Ocean and subarctic seas, repeated hydrographic surveys, and automated stations drifting with the sea ice. The North Pole Environmental Observatory (NPEO) exemplifies the type of activities needed to implement the Distributed Marine Observatories and demonstrates their feasibility. NPEO is an international effort to maintain a distributed observatory centered on the North Pole. It includes annual installation of an automated drifting station and deep-ocean mooring near the Pole, as well as repeated hydrographic surveys radiating from the Pole. NPEO observations in this critical region have shown that the ocean and ice have relaxed somewhat toward climatology, but are to a significant extent still in the changed condition characteristic of the 1990s. Because the changes in the Arctic affect and are affected by global ocean conditions, long-term observation of the Arctic Ocean and adjoining seas should be part of any global ocean observing system, particularly a system focused on climate. The SEARCH Distributed Marine Observatories activity is intended to provide such long-term observations in the Arctic.

Discussion: Morrison told the OOPC that there will be a SEARCH open science meeting in Seattle, from 27 to 30 October 2003 and that they are seeking more international interest. Needs include more Arctic Buoys (30% of international arctic observations goal exist), repeat hydrographic sections, ASOF Arctic moorings to monitor flux between the Arctic Ocean and subarctic seas, ocean pathway bottom moorings along continental slopes, basin moorings, shelf–basin interaction moorings, and automated drifting stations.

The NPEO has three elements: automated drifting stations, moorings (first in 2001), and airborne hydrographic sections. There are pumping projects for ecosystems and biological experiments (five collaborative projects in next proposal). Types of buoys used and general results were discussed.

Approximate annual cost is $25 million for everything. Data will be available from the web site in near real time. They are still working on climatological data products, excluding Russian data.

SEARCH is a US program but moving toward international work; ASOF is an international effort, which is part of SEARCH. An MOU is needed between CliC and SEARCH. A question arose as to whether there needs to be an international CLIVAR panel for the Arctic.

4.3 SCIENCE REQUIREMENTS FOR OCEAN CLIMATE

The Chair noted that one of the goals of the ocean climate community in the next few years is to develop information products on ocean climate that support decision-making by policy-makers. The case for sustaining a global ocean climate observing system depends on making these connections. This is a significant challenge for OOPC and other ocean climate programs, because the historical record, as well as the present observing system, is seriously incomplete in many regions. It may be that the development of many useful products will depend on successful pilot project data collection and analysis efforts, and will be worked out over the next decades. The challenge must be taken up in order to develop better relationships at the policy-making level of governments, and may lead to the development of interesting new science questions and useful statistical relationships for seasonal weather forecasting.

4.3.1 **Ocean information for forecasting**

The issue here is identification of the data needed: to make useful forecasts of the phenomenon of interest; to evaluate the precision of existing forecasts, and to improve forecasting skill. Forecasts are made on short (days to weeks), seasonal to interannual, and multi-year time-scales. The present paucity of ocean data means that each new piece of information will be made use of in forecasts at each time-scale. Longer time-scale data needs involve high-accuracy information on the full water column; shorter time-scale needs involve primarily upper-ocean information which may be of reduced quality for some applications.

Examples of quantities of forecast interest include:

Short term: monsoon variability, tropical cyclones, winter storm intensification, coastal SST, sea ice, coastal water level, surface waves and currents, eddies and fronts, conditions favoring ship icing, air–sea fluxes of momentum, heat, and fresh water, harmful algal blooms

Seasonal to interannual: SST, sea ice, regional wind stress, regional heat content/sea level, regional mixed layer/seasonal thermocline, upper ocean salinity, currents and wave state, carbon fluxes, biogeochemical variability, ocean productivity/blooms, air-sea fluxes

Longer term: sea ice, SST, sea level, SLP variability patterns and trends, Meridional Overturning Circulation variability, carbon and pH, heat and freshwater distributions and changes, changes in gyre circulation, biogeochemical variability and changes, air–sea fluxes, wave-state in the open ocean

4.3.2 **Ocean climate indices**

The Chair referred the Panel to a 2002 JGR paper by Peterson et al. on Recent changes in climate extremes in the Caribbean region (reference document 1, http://ioc.unesco.org/oopc/oopc8/) as an example of climate indices that have proven useful.

The development of subsurface ocean indices is in its infancy. Measures of ocean transport (e.g. Gulf Stream transport between Florida and the Bahamas) are not widespread but some have been available for some years. Measures of oceanic trends are available from sea level stations and over some ocean regions, but are not computed routinely or made widely available. Early atmospheric-column measurements were used to estimate the zonal-average state of the atmosphere vs. pressure (e.g., Lorenz, 1967 WMO #218, TP 115 The general circulation of the atmosphere), and similar estimates will soon be sensible for the ocean as the Argo array and XBT sections are more fully carried out. The Chair showed some very rough estimates for the different domains; substantial anomalies appear in some regions, but are likely the result of limited sampling at this time. No uncertainty estimates for such results are available at present.

The Chair led a discussion on possible indices of the state of:

- Recurring climate patterns (SST, SLP, wind)
- Sea ice
- Sea level
- Freshwater cycle
- Heat content
- Carbon content and surface flux
- Gyres
- Ocean transport
- Ecosystem
- Air–sea fluxes

The CLIVAR basin panels have been asked to make the discussion of basin-scale regional indices part of their annual meetings. OOPC members and guests are requested to submit suggestions for, and to provide time-series of, indices. They are also requested to seek suggestions for indices from the broader communities in which they are engaged.

McPhaden noted interest in the volume of the western tropical Pacific warm-water pool, and agreed to make this available to the OOPC web site.

5. SPONSORS’ REPORTS AND INTERSESSIONAL ACTIVITES

5.1 GLOBAL CLIMATE OBSERVING SYSTEM (GCOS)

The Chair referred the Panel to the Second Report on the Adequacy of the Global Observing System for Climate (http://ioc.unesco.org/oopc/oopc8/), and introduced GCOS Project Office director, Dr. Alan Thomas, who provided an update on GCOS activities related to OOPC.

Thomas briefly reviewed the GCOS program strategy and presented recent developments, especially those related to the Second Adequacy Report. Decision 5/CP.5 of the Conference of Parties (COP) of the UN Framework Convention on Climate Change (UNFCCC) has had a major influence on the GCOS program strategy and has led to:

- Preparation of the Second Adequacy Report, as an analysis based on all available information, including the national plans on systematic observation prepared by Parties for the UNFCCC
- Organization of regional workshops to identify priority capacity-building needs and deficiencies in climate observing systems and the preparation of Regional Action Plans
- Resource mobilization efforts related to the request from the COP for Parties to address deficiencies in observing systems, capacity-building needs and funding options.

Major conclusions of the report were:

- Full implementation of integrated global observing systems for climate, sustained on the basis of a mix of high-quality satellite and *in situ* measurements, dedicated infrastructure and targeted capacity-building will require commitment of all Nations
- Achieving global coverage and climate-quality observations for the essential climate variables is essential to meet the needs of the UNFCCC and IPCC
- Three critical elements for system:
    1. Adherence to the principles of free and unrestricted exchange of data, particularly for the Essential Climate Variables
    2. Adherence to the GCOS Climate Monitoring Principles for global climate observations both from *in situ* networks and satellites
    3. Observations and associated metadata, including historical observations, are available at international data centers.

The Essential Climate Variables outlined in the report are:

Atmospheric
Surface – air temperature, precipitation, air pressure, surface radiation budget, wind speed and direction, water vapour; Upper Air – earth radiation budget (including solar irradiance), upper-air temperature (including MSU radiances), wind speed and direction, water vapour, cloud properties;Composition – carbon dioxide, methane, ozone, other long-lived greenhouse gases, aerosol properties

Oceanic
sea-surface temperature, sea-surface salinity, sea level, sea state, sea ice, current, ocean colour (for biological activity), carbon dioxide partial pressure; subsurface temperature, salinity, current, nutrients, carbon, ocean tracers, phytoplankton

Terrestrial
river discharge, water use, ground water, lake levels, snow cover, glaciers and ice caps, permafrost and seasonally frozen ground, albedo, land cover (including vegetation type), fraction of absorbed photosynthetically active radiation (FAPAR), leaf area index (LAI), biomass, fire disturbance

The Subsidiary Body on Scientific and Technological Advice (SBSTA) to the UNFCCC/COP has noted that the Second Adequacy Report (2AR) “provides an opportunity to build momentum among governments to improve the global observing systems for climate" and has agreed to consider the four primary recommendations on:

- data exchange and availability
- integrated global climate-quality products
- capacity building and system improvements in developing countries
- data and product standards, especially for terrestrial domain.

SBSTA emphasized that high-quality data were essential to the Convention and urged Parties to address, as a high priority, the availability of data. Specific problems discussed include the fact that many data collected are not being received by global data centers, and that valuable historical data sets exist, but are not digitized or quality-controlled. SBSTA invited the GCOS Secretariat, with WMO, to prepare an analysis of specific data problems and options for SBSTA-20 (June 2004). SBSTA also noted that the global observing systems for climate are not designed to meet all needs for climate-change impacts, and encouraged GCOS to examine the potential to enhance links with, or establish, specialized networks in regions vulnerable to climate change.

GCOS is now embarking on an implementation plan based on the conclusions arising from the 2AR, preparing additional analyses for SBSTA and developing a GCOS funding mechanism for global climate observations. GCOS sought OOPC consideration and participation in these three activities. The GCOS Secretariat will report to SBSTA-21 (December 2004) on the development of the implementation plan.

The OOPC signaled their intention to continue working with GCOS on the follow-up activities of the 2AR and developments of the implementation plan.

5.2 GLOBAL OCEAN OBSERVING SYSTEM

5.2.1 **GOOS Coastal Ocean Observations Panel**

The Chair and Dickey attended the COOP-IV meeting in Cape Town, South Africa. They reported that roughly the first half of the meeting was devoted to finalizing the writing of the COOP Science Plan, while the second half focused on the organization and outlining of the COOP Implementation Plan. Dickey felt that good progress was being made on each task. There are several difficult and unique issues facing COOP. For example: (1) definition of the role and involvement of national and regional programs in COOP appear quite challenging; (2) needs and variables differ widely from one coastal region to another (e.g., harmful algal blooms may be the highest priority for one region, while another may see coastline erosion as its highest priority and another may have greatest need in the fisheries area); (3) the coastal zone will need more variables of a biological and chemical nature, with presently little capability at present to measure many of these autonomously (Dickey suggested the Encyclopedia of Oceanography as a good source for describing variables, the related requirements and uses, and measurement methods as a starting point for documentation); (4) present capacity varies widely from region to region, resulting in an uneven patchwork; (5) integration of existing and overlapping sampling programs is needed, but there are potential sources of disagreement and conflict (Dickey suggested utilization of an approach analogous to that of the Liege Colloquium on Coastal Oceanography, which resulted in a volume of *The Sea* that reviewed current capabilities inmethodology for the coastal ocean and presented reviews on each of the world oceans' coastlines, region by region; this is similar to the successful St. Raphael Ocean Obs'99 approach); (6) funding of coastal GOOS programs will be driven by national and regional funding sources, but the advantages of tying into an international coastal GOOS program need to be clearly demonstrated (MedGOOS appears to be a good example at this point); (7) data telemetry and distribution, as well as modeling, will be key issues that will likely be tuned regionally. The two OOPC participants felt that their participation in COOP-IV was genuinely appreciated by the COOP SC and set the stage for future interaction and collaboration in several different areas, including interdisciplinary measurements, model development, data synthesis and modeling (GODAE), and capacity-building.

OOPC–COOP biogeochemical and bio-optical collaborative activities. The primary purpose of Dickey's participation in COOP-IV was to discuss potential interaction and collaboration between the OOPC and COOP in biogeochemical and bio-optical sampling. To this end, he outlined the current status of sensors and platforms for biogeochemical and bio-optical observations, as well as deployment strategies. The biogeochemical and bio-optical variables needed for both programs have been generally articulated; some additional variables may need to be added as new processes are deemed to be of importance based on process, time series, and survey programs. Among the key variables are carbon parameters (partial pressure of carbon dioxide, dissolved organic and inorganic carbon, and particulate organic carbon), dissolved oxygen, nutrients (nitrate, phosphate, nitrite, silicate, trace elements: e.g., iron), inherent and apparent optical properties (e.g., spectral beam-attenuation and absorption coefficients and diffuse-attenuation coefficient). COOP consensus was that carbon was important, but that several other kinds of biogeochemical measurements were critical as well. Sensors either exist or are being developed for each of the variables mentioned above. Some are available commercially and in principle can be deployed from autonomously sampling platforms (e.g., moorings, drifters, profiling floats, autonomous underwater vehicles, and underway sampling ships). Testbed sampling projects are being used to bring new sensors and platforms on line for the global ocean observing system. Joint sampling and modeling testbed programs are still required.

The OOPC sampling plans for utilizing Argo profiling floats and time-series sites were described along with prototype interdisciplinary sampling systems for each. Several examples of interdisciplinary data sets were given to emphasize the utility and readiness for such measurements. The underlying theme of Dickey's presentation was exploration of common areas of interest and need for the OOPC and COOP. Some of these appear to include: (1) development and testing of new biogeochemical and bio-optical sensors, identification of useful proxy measurements (e.g., beam-attenuation coefficient at 660 nm is correlated with concentration of particulate organic carbon); (2) determination of optimal sampling strategies based on existing and future knowledge of spatial and temporal de-correlation and coherence scales (using *in situ* and remotely sensed data sets with ocean sampling system experiments); (3) sharing of interdisciplinary data and model open-ocean information for use in establishing open boundary and initial conditions for the coastal ocean and vice-versa; (4) generally comprehensive sampling of both the open and coastal ocean (expanded spatial and temporal coverage and resolution).

Discussions at COOP-IV indicated that COOP views the biogeochemical variables as "shared" variables with OOPC. There was support for joint work between a subset of COOP and OOPC committee members (external members may be invited to participate as well). There appear to be no disagreements between OOPC and COOP in terms of the direction of biogeochemical and bio-optical observational programs and cooperation is seen to be beneficial to both. Since COOP is presently finalizing its science planning document and beginning to outline the elements and organization of its implementation plan, timing is appropriate for initial discussions of plans for both OOPC and COOP interdisciplinary sampling activities. The Global Ocean Carbon Observing System Background Report prepared byDoney and Hood (2002) was discussed and Dickey indicated that it provides an excellent starting point.

It was generally agreed that OOPC and COOP would cooperate in the development of biogeochemical and bio-optical observations (J.Cullen, J.Hall, T.Knap, T. Dickey and other OOPC members and affiliates). No formal committee was deemed necessary at this point, particularly since COOP implementation is in its nascent stage. Dickey volunteered to work with COOP committee members in the development of sampling plans, particularly, in defining scales of variability that need to be resolved for in situ and remotely sensed variables.

The Co-Chairman of the Coast Ocean Observations Panel, Tony Knap, presented an update of the work of the Panel. The Design Plan underwent extensive peer review and was professionally edited. It is now printed and is also available on the IOC web page at http://ioc.unesco.org/goos/gsc6/COOP-Design-Plan.doc. The Panel next meets in Mazatlan, Mexico, where it will start on the Implementation Plan with the aim of completing it by May 2005. One important suggestion was on how COOP and OOPC could work together on a joint Pilot Project, and there were many areas of interest. One area where it was felt that there could be quick progress would be a Pilot Project on Sea Level. The Co-Chair agreed to take this to the next meeting of COOP. Regarding communication between the two Panels, it was felt that representation in meetings such as this and vice-versa (an OOPC representative at COOP) was adequate to make sure that the programs have sufficient information. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/.

After discussion, it was decided that the OOPC should continue collaboration with COOP, including the development of joint COOP–OOPC pilot projects, perhaps on sea level.

5.2.2 GOOS Steering Committee

The report of the Sixth Session of the GOOS Steering Committee is available as GOOS Report No. 129 from the IOC web page http://ioc.unesco.org/goos/docs/doclist.htm.

The Steering Committee noted the progress of OOPC and accepted its specific recommendations for the observational activities identified as the “Next Steps” toward an initial global ocean climate observing system. These recommendations were passed to the Intergovernmental GOOS Panel and JCOMM, for implementation.

The various liaison activities undertaken by OOPC were noted.

A considerable list of action items, calling for OOPC action and/or support was requested of OOPC (see starting following page).

OOPC noted these requests. Discussion of a number of them is included in the Agenda of the present Panel session.

GSC-VI, ANNEX V **(July 2003 version)**

LIST OF ACTIONS RECOMMENDED BY THE SIXTH SESSION OF THE GOOS STEERING COMMITTEE (GSC-VI) (Red = still to be done)

Action No.	Action Proposed	Person Responsible	Target Date	Progress
Action 14	GSC requests the OOPC to undertake the following actions: (i) to foster development of an ongoing observing system evaluation and evolution activity, in recognition that much will be learned, as the initial global ocean climate observing system provides more complete information than has been available previously, and that specific observing system activities should be adjusted in reaction to new knowledge and to new technology; (ii) to update the 1998 OOPC/CLIVAR review of global sea level to refine *in situ* requirements for climate sea level variability and change; (iii) to develop recommendations for an activity to ensure that operational flux fields will be stored and made available for comparison with each other and with high quality *in situ* observations; (iv) to carry out a review of the global surface drifting buoy programme and formulate recommendations to maximize the utility of this programme; (i) to expedite its efforts to develop a set of ocean climate indicators with associated observing system activity needs; (ii) to review the state of climate-related sea ice analysis capability, with appropriate specialist groups, and recommend any needed	E. Harrison	As appropriate	Will be discussed at OOPC-VIII

	actions for improvement; (iii) to review the trends in subsystem development with a view to developing a 10-year development profile for each as the basis for identifying priorities for investment.			
Action 15	GSC requests the OOPC and COOP to formulate a joint pilot project to make use of GODAE products and shared technology.	E. Harrison , T.Malone	As appropriate	Will be discussed at OOPC-VIII and COOP-V
Action 18	GSC requested OOPC to work with the JCOMM Observations Coordination Group (OCG) to develop a mechanism for coordinating observational data requirements with implementation mechanisms.	E. Harrison	Before OOPC-VIII	Harrison to SOT2 and GLOSS with requirements. Coordination with Johnson.
Action 19	GSC accepted the invitation to co-sponsor the JCOMM *ad hoc* Task Team on the Development of New Products and Services, and called for membership nominations from COOP and GODAE.	E. Harrison, N. Smith	ASAP	Harrison and Smith will participate
Action 23	GSC agreed to co-sponsor the Ocean Products Workshop, May 2004 (no financial implications), and requested OOPC and the GOOS Regional Forum to provide representatives on the organizing committee.	E. Harrison S. Vallerga	ASAP	Harrison and Vallerga to nominate people Who is organizing?
Action 25	GPO and Eric Lindstrom to work with OOPC, COOP, JCOMM and the GRAs to carry out the rolling review of Ocean Theme by year end 2003.	E. Lindstrom, Director GPO	December 2003	Linstrom and Summerhayes to do
Action 26	OOPC to work with International Time Series Science Team and JCOMM to develop a data and information plan.	E. Harrison	ASAP	Will be discussed at OOPC-VIII
Action 29	(i) The Working Group on Indicators to continue its work to finalize the present draft and present it to GSC-VII; (ii) GSC to aim to have a set of marine indicators ready for inclusion in UNEP's GEO-4 report; (iii) GPO and GSC Members to work together to develop a page of indicators that can be placed on the GOOS web site; (iv) Franciscus Colijn to provide Members and the GPO with copies of the recent Dutch study on marine indicators.	M. Sinclair M. Sinclair M. Sinclair Director GPO F. Colijn	By GSC-VII ?? By GSC-VII ASAP	Done Sinclair to do Sinclair to do

Action 31 (old action item GSC-V.32)	Tom Malone will identify a COOP representative to explore with PICES the possibility of developing a joint GOOS and PICES approach to ocean observations in the North Pacific, including the possibility of establishing a regional GOOS office for the North Pacific.	T. Malone	Before PICES meeting in Seoul Oct 10-18	Malone to do
Action 32	(i) The trends noted by Bert Thompson's review of national inputs need to be cross checked by the JCOMMOPS Center; (ii) JCOMMOPS should be providing regular statistics to JCOMM and GOOS on system performance.	E. Charpentier	ASAP	JCOMMOPS to do
Action 33	GSC requests JCOMMOPs to develop a method for demonstrating the volume flow of data over time.	E. Charpentier	ASAP	JCOMMOPS to do
Action 42	Create intersessional Working Group to develop GOOS inputs to JCOMM-II, and follow recommendations given in (i) through (iii) of GSC-VI 9.1 (a).	J. Baker	Advice on documents by January 2004; actual documents by fall 2004	To do (involving I-GOOS Board)
Action 44	To create an intersessional Working Group on Strategy, chaired by Worth Nowlin and comprising also Tom Malone, Ed Harrison, Nic Flemming, Tom Trull, Paula Etala and the Director GPO, to develop Version 2.0 of the Strategic Plan for GOOS, following the recommendations and timetable laid down in 9.1 b (ii) 1-8, above.	W. Nowlin et al.	ASAP	Nowlin to do: Include representation of I-GOOS Board; in I-GOOS Report (para 63). NOTE: eventually to take on board output of intersessional Assembly Working Group on GOOS Structure which reports to the IOC Executive Council in June 2004.

5.3 WORLD CLIMATE RESEARCH PROGRAM

The 24th meeting of the Joint Steering Committee endorsed the “Next Step” recommendations, noting its strong agreement with the view that successful evolution of the initial observing system will depend on successful ongoing interaction with the climate research community. That community is needed to develop improved observational technology, to evaluate the effectiveness of existing observing efforts, to develop new scientific insights that can lead to indices and the applicability to society of index and other information products, and, in many cases, to continue to make climate quality observations a part of the initial system.

The feasibility of establishing a new surface flux working group (to include land–air, ice–air and water–air fluxes) will be explored. OOPC will be invited to participate in any new group.

The importance of improved ocean analysis and reanalysis capability was noted. GODAE progress was noted, and the importance of analysis and reanalysis leading to ocean products suitable for climate science and climate applications was emphasized.

The importance of knowledge of ocean surface conditions for most WCRP modeling work was noted. Uncertainty estimates of surface analyses and reconstructions of surface conditions will be important as WCRP undertakes multidecadal hindcast studies such as the proposed “climate of the 20th century”. Continued data archaeology efforts should be made, so that the historical data base may be as complete as possible. The importance of the coming CLIMAR-II conference for estimates of marine surface condition uncertainty was noted.

5.3.1 **Climate Variability and Predictability Study (CLIVAR) Overview**

The Chair noted that CLIVAR has been well represented in OOPC since the beginning of OOPC, through shared panel members, and again welcomed the CLIVAR Basin Panel representatives Their experience and wisdom will benefit greatly the ongoing development of plans for sustained observations.

As will be discussed more extensively by Weller in a later section, under the new CLIVAR oversight structure, the CLIVAR SSG concluded that the existing CLIVAR Ocean Observations Panel should be replaced by an activity that was more focused on analysis, diagnostics, assimilation and reanalysis. The new group might be called the Global Synthesis and Observations Panel. There was considerable discussion of ways to move ocean climate analysis forward. It was noted that many ocean data assimilation workshops are taking place in 2003 and 2004, and that coordination of so many activities posed a significant challenge. Every effort will be made to coordinate GODAE and CLIVAR ocean data assimilation activities.

International CLIVAR. Weller reported on the activities of international CLIVAR, going through topics that came up at the CLIVAR international SSG meeting in Victoria, B.C. (5-9 May 2003). Progress on the development of CLIVAR in Africa was noted, with the VACS (Variability of the African Climate System) Panel now active and discussing possible links between the AMMA (African Monsoon Multiscale Analyses) project being discussed among several nations and the Atlantic ITCZ research being discussed in the Atlantic CLIVAR panel. The VAMOS (Variability of the American Monsoon Systems) element of CLIVAR has had active programs including EPIC (Eastern Pacific Investigation of Climate) and MESA (a

South American monsoon experiment), will soon start a North American Monsoon Experiment (NAME), and is planning further work off the west coast of South America under the name of VOCALS (VAMOS Ocean Cloud Atmosphere Land Study).

At the last CLIVAR SSG the development of definitions for El Niño was discussed and action was taken to set up an Indian Ocean Panel. This reflects recent international planning for basin-scale observations in the Indian Ocean and the desire of the CLIVAR Asian–Australian Monsoon Panel for another formal group to be charged with a basin-scale perspective. Plans for the CLIVAR 2004 conference in Baltimore were reviewed. It was noted that CLIVAR is very interested in ocean reanalysis and ocean data assimilation. That interest is reflected both in CLIVAR’s sponsorship of an upcoming workshop on ocean reanalyses/data assimilation (planned for February 2004 but now believed to be on hold because other similar workshops have been scheduled). CLIVAR’s interest in ocean data assimilation and reanalysis is reflected also in the action taken at the last SSG to develop new term of reference and a new name for the CLIVAR Ocean Observations Panel (COOP). The new name will be Global Synthesis and Observations Panel; the terms of reference are being developed now.

CLIVAR is interested in developing its relationship with global carbon programs and is planning to add carbon representatives to its panels. It will also have Basin Panel representatives attend OOPC meetings, a practice which began at OOPC-VIII. There was also discussion at the SSG of collaboration and cooperation with GEWEX (Global Energy and Water Cycle Experiment) and with SOLAS (a program of the IGP, Surface Ocean Lower Atmosphere Study). CLIVAR and SOLAS interest in air–sea fluxes are high, and WCRP is formulating a new air–sea flux working group with both CLIVAR and SOLAS representation. It was mentioned that WCRP also expressed at the CLIVAR SSG interest in defining a future Climate Observation and Prediction Experiment (COPE), had a discussion on redefining its modeling programs, and wanted to define a sunset date for CLIVAR which would likely be 2013.

Atlantic Ocean. M. Visbeck presented an update on CLIVAR Atlantic Observations and projects. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/. He presented the Terms of Reference for the Implementation Panel, and discussed the major ocean climate phenomena being addressed in the Atlantic, including the North Atlantic Oscillation, Tropical Atlantic Variability, and Meridional Overturning Circulation, with a particular emphasis on the interactions between these events and other climate processes. He then outlined the CLIVAR Atlantic Strategy, including observations, modeling and theory, and data synthesis, and the links between these activities and those of other groups. He outlined the observing system in the Atlantic and briefly mentioned several ocean-climate research programs currently operating in the Atlantic with connections to CLIVAR.

Visbeck stated that there were several issues currently facing CLIVAR that are being discussed. The Panel supports strongly the CLIVAR-wide strategy for model-based synthesis and using the results as feedback on observing-system optimization. The Panel believed that the data should also be made available for other, more empirical, studies. For data management, Visbeck noted that the CLIVAR strategy is piecemeal at best and that they were in need of some new ideas. He questioned whether we could build upon an emerging data center in support of “operational” oceanography and meteorology. Visbeck also outlined several issues that needed joint attention by CLIVAR and the OOPC. The first issue is how to maintain the existing networks. CLIVAR is one of the scientific users of the existing networks, but all users should speak with one voice when it comes to defending observing systems. Will the OOPC be the voice, with input from CLIVAR when needed? Another issue is how to evaluate the overall usefulness of a particular array in the context of other data and a variety of users. A major issue for the OOPC is how to make the transition from pilot efforts to sustained operation. CLIVAR has pilot projects in the water that, if proven useful, should be sustained. How will we accomplish that? Visbeck also mentioned that there is a rich mixture of data types (state, flux, shallow, deep) and there is a question of how to achieve global and regional synthesis and how to manage the data for this.

Visbeck provided the following list of potential joint action items by the OOPC and CLIVAR Atlantic:

- Panel identified need for a Greenland–Scotland VOS XBT line
- Check the status of the 30°S Atlantic high-resolution XTB line
- Atlantic Panel to submit white paper for enhanced tropical observations (PIRATA plus) to OOPC for review October–November 2003
- Jointly work with CliC to develop a strategy for Arctic Ocean sustained observations
- Ensure full ARGO float deployment in tropical and south Atlantic.

Indian Ocean. The Chair noted that an IOC-CLIVAR Indian Ocean Panel was still being developed. It was hoped that the Panel would be in place and would send a representative to OOPC-IX

McPhaden and Harrison participated in the First IOGOOS Workshop in Mauritius in November 2002, at which an Indian Ocean GOOS Regional Alliance was established. They reported on the various discussions that took place at that Workshop. New linkages between Indian Ocean SST anomalies and monsoon rainfall have been published recently, emphasizing the importance of understanding how the ocean contributes to these anomalies. The impressive results from the Japanese Triton moorings in the eastern equatorial Indian Ocean were noted. There is much variability to be observed.

It was noted that the "Next Steps" call for a wide range of sustained observations to be made inthe Indian Ocean, and that these will support CLIVAR, GOOS and GCOS objectives for the region, if they can be implemented. It is hoped that the new IOGOOS Regional Alliance will be effective in advancing such implementation. Proposed new Indian initiatives in the northern Indian Ocean would greatly increase the number of time-series observations in these waters.

Pacific Ocean. The CLIVAR Pacific Panel representative , B. Weller, reviewed discussions at the CLIVAR Pacific Panel meeting in Yokohoma (14-16 July 2003), recent activities in CLIVAR Pacific, the status of basin-scale observations, ongoing process studies, development of science foci, and concerns of the Panel relevant to OOPC. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/. Among the activities in the last year were a Pacific Decadal Variability workshop, Pacific CLIVAR sessions at the EGS–AGU–EUG meeting in Nice in April and sessions at the IUGG in Sapparo in June–July 2003. Upcoming are a PACS/EPIC workshop in Boulder, Colorado, in September and a workshop on low-frequency modulation of ENSO to be held in Toulouse in September.

The international CLIVAR Project Office and the staffer for the Pacific Panel, Katy Hill, maintain a map and listing of Pacific Basin observations, which was shown to OOPC. The Pacific Panel relies on OOPC to support and campaign for implementation of Argo floats and surface drifters over the Pacific basin, for full implementation of the Pacific high-density XBT/IMET lines, repeat hydrographic/carbon transects, and for satellite SST, winds, and altimetry. The Pacific Panel is working to develop plans to address decadal variability in the Pacific, and sustained observations are a critical component of research into decadal variability. Air–sea exchanges and ocean storage and transport of heat and fresh water must be documented in the Pacific Basin. Of concern to the Pacific Panel are areas that are now undersampled, including the southeast Pacific and the northwest Pacific, and areas that may require higher-density sampling, such as the equatorial Pacific and areas where subduction will be studied.

Several studies now under discussion, including an equatorial upwelling experiment (PUMP), work along the west coast of South America (VOCALS), a Pacific subduction/subtropical mixing experiment, were outlined briefly to bring OOPC up to date on Pacific Panel plans. Interest in addressing decadal variability and low-latitude western boundary currents were also noted. Projects now underway, including KESS (Kuroshio Extension System Study) and EPIC, were reported on.

The presentation ended with a reminder that the Pacific Panel relied on OOPC for work on basin-scale coverage in the Pacific, flux reference stations, repeat transects, and joint effort to address regions along the boundaries of the basin; for example, to develop boundary-current monitoring systems.

Southern Ocean. Speer provided an overview of the status of all Southern Ocean CLIVAR-relevant projects. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/. Information about the CLIVAR-related projects in the Southern Ocean can be found at:
http://www.clivar.org/organization/southern/CLIVAR_CliC_Obs.html.

The basic message is that *in situ* (ARGO, XBT, etc) observations are far from adequately sampling the ocean; e.g., there is daily or seasonal bias, regional bias. Better sampling is needed to correct biases in data-based analyses and to aid the interpretation and calibration of satellite data. For winds (e.g., QuikSCAT), the coverage is nearly global (6:00 am and 6:00 pm). (US)-SeaWinds on ADEOS-II (10:30 am and 10:30 pm). For SST, infrared measurements are difficult to interpret in the Southern Ocean, except perhaps on monthly scales, because of clouds and diurnal cycle aliasing. Argo is ramping up to global coverage, with the largest gaps in the Pacific sector. New initiatives are extending Argo-like platforms with new sensors and into the sea-ice zone, a neglected region key to climate. High-resolution XBT lines are established in the S. Pacific, S. Atlantic (both nominally 30°S), Drake Passage and south of Tasmania, but require additional sampling. A new line south of Africa is likely. Air–sea flux observations require improved *in situ* measurements for calibration and process study boundary conditions. Subsurface sustained observational system elements are being defined and installed in locations relevant to climate change.

Suggested enhancements to the Southern Ocean sustained observations system include:

Drifters

- Argo spatial coverage, esp. SE Pacific sector; also extension to the seasonal sea-ice zone (cannot be global w/o ice zone).
- Surface drifters - wind slip calibrations, high wind conditions - extend these tests to the Southern Ocean.

Surface meteorology

- Enhance IMET coverage. *In situ* sampling of the diurnal cycle of SST and wind will help with interpretation of sun-synchronous satellite observations.
- Meteorological buoys in the seasonal sea-ice zone (air temperature, wind etc.).
- AWS on subantarctic islands.
- Surface time-series stations in SE Indian Ocean (high mean wind conditions, for which, some technological buoy development is required) and Pacific Ocean (synoptic variability) sectors of the Southern Ocean.

Subsurface oceanographySubsurface time-series stations/arrays in the Ross Sea, Weddell Sea, and Princess Elizabeth Trough. Need *in situ* monitoring, since sea-ice zone boundary conditions so poorly known.

- XBT (sampling on Drake, Tasman, African, 32°S)

Sea-ice

- Sea-ice thickness important for climate models (echo sounders) and Met buoys in the sea-ice zone for sea-ice dynamics.

Speer outlined some of the actions currently undertaken by the CLIVAR Southern Ocean Panel and suggested some possible action items for discussion with OOPC:

- SO Panel will prepare a white paper on the need for additional time-series reference stations at two locations near the Antarctic continent: Ross Sea (near US base) and Princess Elizabeth Trough (near Australian base); the justification for stations in the Indian μOcean sector and Pacific Ocean sectors will be updated. These should have the format of "mini-proposals", which should include words of relevance, feasibility.
- The SO Panel will prepare a white paper on missing elements of the sustained observing system; for instance, AWS on islands, etc.
- The SO Panel requests help in identifying gaps in the sustained observing network that have an impact on NWP products, particularly regarding buoy data that go into the GTS. (The presentation by Reynolds addresses the SST needs; it would be nice to have a similar study for the SLP).
- The Panel has a representative of the International Antarctic Buoy Program (about 30 buoys per year on drifting ice) and has recommended upgrading this system to 50 or so, but we are unsure of the impact of more high-latitude open-ocean SLP buoys on the NWP products. If OOPC knows of prepared maps of SST, SLP error in operational products, this would be useful.
- The SO Panel should upgrade its website table of observational projects to include maps of sustained observations. (Same format as Atlantic Panel, by Roberta Boscolo).
- The SO Panel will advise OOPC on a set of indices of climate and the observational system relevant to the Southern Ocean. Indices should be based on ocean data or instrumentation.

Discussion. The Panel noted that CLIVAR Panel representatives are uniquely placed to keep OOPC appraised of observational research activities that may be candidates for the sustained observing system, and requested the CLIVAR representatives to provide reports on any candidate systems at the next OOPC meeting, including information on the expected dates of termination of their present funding. The CLIVAR representatives should also solicit input on additional observational requirements outside the Next Steps.

5.4 JCOMM

5.4.1 **JCOMM Observations Coordination Group**

The Chairman of the JCOMM Observations Coordination Group, Mike Johnson, reported that the major challenges facing the OCG include extending the networks to achieve global coverage, developing system-wide monitoring and performance reporting, and maintaining funding to meet implementation targets. The GCOS Second Adequacy report to the UNFCCC has emphasized that "the ocean networks lack global coverage … without urgent action to address these findings, the Parties will lack the information necessary to effectively plan for and manage their response to climate changes." JCOMM has thus accepted as a fundamental requirement the need to proceed toward implementation of the sustained global system.

The capabilities required are: (1) global coverage by moored and drifting buoy arrays, profiling floats, tide-gauge stations, and repeat ship lines; (2) continuous satellite missions for sea-surface temperature, sea-surface height, and surface vector wind (OOPC noted that ocean color from satellites should be added to this list); (3) data and assimilation subsystems; (4) system management and product delivery. The initial system design is founded on the building blocks that have been put in place by the research program and on years of international planning; e.g., OCEANOBS'99. The composite system is about 40% complete at this time and could be completed over the next five years by using the international JCOMM implementation infrastructure working together with the satellite system agencies, given sufficient national resources.

Good progress has been made over the past year by JCOMMOPS in developing standard maps showing network coverage and subsets by country for the buoys arrays, profiling floats, tide gauges, and ships-of-opportunity lines. JCOMMOPS and the OCG have also implemented basic performance-monitoring tools for the sustained system.

Johnson requested the help of the OOPC in addressing three questions related to advancing the system:

(1) Consolidating the SOOP to the FRX and HRX lines, as recommended by the 1999 upper-ocean thermal workshop, depends on sufficient overlap with Argo for determining a transfer function; has there been sufficient overlap to move toward this consolidation?

(2) On the designed global network of 1,250 drifting buoys, how many barometers should be planned?

(3) The sustained observing system for monitoring thermohaline circulation, sea ice, and boundary currents still needs to be specified; what role should JCOMM be planning to play in these areas?

*Discussion***.** In response, the OOPC noted that:

(1) There has not been sufficient time yet to establish an overlap between Argo and the historic XBT sampling. But the JCOMM SOT has found that the present level of XBT

resources is not sufficient to achieve global coverage (about 22,000 per year versus 32,000 needed) so by default the XBTs are generally being deployed along the HRX and FRX lines as a top priority. OOPC endorsed this priority decision by the SOT. In the mean time OOPC will request that the Argo Science Team conduct an analysis as soon as possible to determine the transfer function between Argo and XBT sampling.

(2) OOPC will seek advice from CLIVAR and the operational centers regarding requirements for barometers on the global drifter array.

(3) OOPC recommended that development of a sustained system for monitoring thermohaline circulation and the boundary currents is still a research question and thus JCOMM cannot be charged with this work at present. A comprehensive sea-ice monitoring system is likewise still being developed by the research programs, but JCOMM in the mean time should continue the present International Arctic Buoy Program component of the DBCP.

In accordance with the OOPC and OCG strategy to promote routine delivery of ocean products, OCG suggested that OOPC and JCOMM might cooperate in sponsoring regular annual reports on variations and trends in mean sea level at the reference long-term-trends stations identified in the OOPC-CLIVAR 1998 International Sea Level Workshop Report. Sea-level trend analyses at tide-gauge stations are being produced today in non-standard, research mode, but not as a routine global product easily understood by non-scientists. Since sea-level rise is one of the most immediate impacts of climate change, such an annual report could be of significant interest and benefit to many management, engineering, and policy applications. OOPC will request that GLOSS consider development of regular annual reports on variations and trends in mean sea level

5.4.2 **JCOMM MAN II**

The Co-Chair of JCOMM, Savi Narayanan, reported on the JCOMM Management Committee. The JCOMM Management Committee at its last meeting recommended that JCOMM and OOPC interact on a regular basis to address the challenges in the implementation of the global observing system. As this is the first meeting of OOPC at which JCOMM was represented, Savi Narayanan provided an overview of JCOMM, with particular emphasis on the data-management program area. The observational PA was covered by Johnson and the activities of the ET on Wind Waves and Storm Surges of the Services Program Area were presented by Val Swail.

After highlighting the importance of data management in global programs, the new IOC policy framework for the oceanographic data exchange was discussed. This policy will be of direct relevance to OOPC and JCOMM, as it provides the basis on which to build the data-management elements of their programs. Since its establishment JCOMM has been collaborating with IODE to ensure better coordination of their activities. Of particular interest is the co-sponsoring of the relevant IODE and JCOMM working groups and the enhanced mandate of the IODE secretariat to support in part the JCOMM Data-Management Program Area.

IOC has also established a Task Team under the chairmanship of Neville Smith to develop an IOC Data Management Strategy. JCOMM has been contributing to this, and participated in the first meeting of this Task Team.

COOP has completed its design plan and is developing an implementation plan. JCOMM has been an active participant in the former and will continue to contribute to the latter.

These activities of JCOMM will not only contribute to the delimitation of the roles and responsibilities of IOC and COOP, but will result in a JCOMM data-management strategy that will be consistent with and complementary to those of IOC and WMO. In developing the JCOMM strategy, JCOMM will take advantage of the Future WMO Information Systems discussions and the US Data Management and Communication Plan.

The importance of developing and disseminating oceanographic data products was highlighted. To achieve this, the Services Program Area has established a Task Team that will hold a workshop in Toulouse in May 2004. Another opportunity to showcase the successes of GOOS and JCOMM will be at the scientific conference and the JCOMM-II, scheduled to take place in Halifax, in September 2005.

OOPC, through its pilot projects and participation in many fora, is in a position to influence the scientific community and the policy-makers on many fronts. Particular areas in which OOPC may be able to make a difference include:

- Bridging the gap between scientists and data managers, and service providers
- Creating incentives for scientists to submit their data to data centers for the benefit of the global community
- Establishing the peer-review process for data sets to ensure availability of known quality data
- Provide guidance to pilot projects.

5.5 OTHER ORGANIZATIONS

5.5.1 **Partnership for Observations of the Global Ocean**

On behalf of the POGO Executive Secretary, Shubha Sathyendranath, Bob Weller presented a summary of the activities of the Partnership over the last year. POGO is based on the oceanographic research institutions of the world and is a powerful agent for OOPC to coordinate and work with to define and develop the global ocean observing system. POGO initiatives that were mentioned include: the POGO-IOC-SCOR WSSD Type 2 Initiative for Intelligent Use and Management of the Oceans, to promote intelligent and sustainable use and management of the oceans, training courses and fellowships that POGO has sponsored, agreement among POGO members to work to increase observations in the southern hemisphere, the report from the recent POGO-sponsored Workshop on Biodiversity, POGO support of the Argo float program, POGO support of the Time-Series Science Team, POGO efforts to develop news and information resources, and POGO efforts to foster improved data archiving and sharing. The next POGO meeting (POGO-5) will be in Yokohama, Japan, in November 2003, and OOPC will participate.

5.5.2 **International Geosphere-Biosphere Program**

Dickey introduced this item and informed the Panel that the IGBP has projects focusing on the ocean–land interface (Land–Ocean Interactions in the Coastal Zone – LOICZ), the ocean–atmosphere interface (Surface Ocean–Lower Atmosphere Study – SOLAS) and the ocean interior (Integrated Marine Biogeochemistry and Ecosystem Research – IMBER). Both SOLAS and IMBER are relatively new and include programs relevant to ocean climate. Dickey reminded the Panel that the OOPC Terms of Reference state that the design of the observing system for climate should consider biogeochemical processes and the carbon cycle. While the carbon cycle is being addressed through OOPC links to the CO_2 Panel, other issues have yet to be considered. The IGBP provides a crucial link to the science needs and research-based observations for these topics.

The primary goal of IMBER is to understand the sensitivity of the ocean to global change within the context of the broader Earth System, focusing on biogeochemical cycles, marine food webs and their interactions. The overarching questions are:

- How does global change, represented by changes in natural climatic modalities and man-made forcings, impact marine biogeochemical cycles and ecosystem dynamics?
- How do these impacts mechanistically alter the relationship between elemental cycling and ecosystem dynamics?
- What are the feedback mechanisms to the Earth System from these changes?

Of particular interest for OOPC are the forcing and feedback links between marine ecosystems and climate variability. The IMBER program had its open science meeting in January 2003 and the science and implementation plans are being finalized.

The SOLAS program has more direct links to ocean climate through its focus on ocean−atmosphere interactions. With the ocean currently taking up 25-35% of the CO_2 put into the atmosphere resulting from fossil-fuel burning, policy-makers need to understand the regional, seasonal and interannual structure and variability of the ocean uptake, as well as how it may alter in the future as global conditions change. A specific item is how the lowering of seawater pH by about 0.3 units over the next 100 years due to rising atmospheric CO_2 levels will affect marine algae, particularly those with calcareous skeletons. Emission of trace gases from the ocean can have a profound effect on the properties of the atmosphere. For example, dimethyl sulphide (DMS), formed as a result of biological processes in the ocean, can affect the composition and number of cloud condensation nuclei in marine air, with resulting change in cloudiness and temperature. Recent coupled ocean-atmosphere modeling studies at the Hadley Center for Climate Prediction and Research show that even a relatively small change (factor of two) in marine emissions may have a significant impact on global temperatures (plus or minus about 1°C for a halving or doubling of DMS emissions, respectively). Evidence from ice cores and iron fertilization experiments shows that changes in DMS release at least as large as this have occurred in the past and may well occur under future global-change scenarios (e.g., altered inputs of N and Fe from the atmosphere). Additionally, organo-halogen gases emitted from the ocean or ice-covered surfaces are potent controls on the levels of atmospheric oxidants such as ozone. "Clouds" of BrO, a product of organo-halogen breakdown in air, can be seen by satellite over vast areas of both polar regions. (from SOLAS Science Highlights, written by the Scientific Steering Committee Chairman, Peter Liss, available at: http://www.uea.ac.uk/env/solas/scihigh/scihigh1.html)

The Ocean Implementation Plan of the US Carbon Cycle Science Program being finalized will represent the US participation in these two international programs. The European Community is developing a proposal called Carbo-Oceans that will be the framework for European contributions to these programs. Plans for the coordination and implementation of the carbon research in SOLAS (upper ocean pCO_2 and air−sea fluxes) and IMBER (biogeochemical cycling and ecosystem effects on carbon cycling) are being discussed, and may be coordinated through the SCOR−IOC Advisory Panel on Ocean CO_2 (whose Terms of Reference would be revised to reflect this new mandate). The IOCCP will keep track of observation programs and data synthesis being carried out under these programs, and will work to provide cross-cutting services, such as establishing international agreements on standards, best practices, and data management required to make basin- and global-scale data sets. The CO_2 Panel is co-sponsoring a SOLAS working group on air–sea fluxes of carbon, which is planning its first meeting for the end of 2003.

6. OBSERVATION PROGRAMS, EXPERIMENTS AND PROJECTS

OOPC has begun interactions with the observational subgroups of the Observations Coordination Group of the JCOMM, as requested by the GOOS SC. Each subgroup will be requested to review the existing documentary materials concerning the observing and metadata standards relevant to its activity. These reviews will provide a basis for updating, where necessary, international standards agreements. They will also assist ocean information technology infrastructure for metadata.

6.1 TAO/TRITON AND PIRATA MOORING ARRAYS

The Chairman of the Tropical Moored Buoy Implementation Panel (TIP), Michael McPhaden, briefed the panel on three topics: (1) the current successes of the TAO/TRITON partnership in maintaining the moored buoy array in the tropical Pacific; (2) recent scientific and organizational efforts that provide an international framework for developing a sustained ocean observing system, including moored buoys, in the Indian Ocean; (3) the recent request from the NOAA Executive Council (NEC) for a new plan to transfer operational responsibility for the TAO portion of the TAO/TRITON array from NOAA's Pacfic Marine Environmental Laboratory (PMEL) to the National Data Buoy Center (NDBC). Specific issues regarding TRITON were presented by Yukata Michida, and for and PIRATA, by Edmo Campos. These presentations are available for viewing at http://ioc.unesco.org/oopc/oopc8/.

The TAO/TRITON partnership continues to function well, providing a seamless real-time data stream for ENSO forecasting and analysis. During the recent 2000-2003 El Niño, TAO/TRITON data proved to be valuable for characterizing the evolution of the event and for coupled ocean–atmosphere model forecast initialization. The data are disseminated to the operational and research communities via the GTS and the World Wide Web. Between August 2002 and July 2003, 119,170 data files were downloaded from TAO/TRITON web sites at PMEL and JAMSTEC in 10,551 separate user requests. For August 2002-July 2003, real-time data return for the array was 86%.

Planning for an Indian Ocean moored buoy array has progressed over the past year. At the IOGOOS Workshop in Mauritius in November 2002, experts from several nations reviewed recent scientific progress, discussed array design and implementation, and produced a summary document on the status of Indian Ocean moored buoy activities. An informal working group of the TIP was formed at the end of the Workshop to continue the planning effort. Subsequently, the CLIVAR Asian Australian Monsoon Panel, in February 2003, recommended the establishment of a Indian Ocean Panel to guide the design and implementation of a sustained integrated ocean observing system in the region. This recommendation was endorsed at the CLIVAR Scientific Steering Group meeting in Victoria, B.C., in May 2003. Thus, a new Indian Ocean Panel is being established with sponsorship by CLIVAR, GOOS, and the IOC–WMO Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM). The TIP will work with this new panel (as well as other

CLIVAR and IOC–WMO panels) to advance the implementation of a moored buoy network in the context of other observing system elements in the Indian Ocean for climate purposes.

The NOAA Executive Council (NEC), which advises the Administrator of NOAA on management and policy issues, has requested submission of a new transition plan by 31 October 2003 to transfer responsibility for TAO array operations from PMEL and NDBC. Although at one level NOAA's management of the TAO array is an internal affair, the OOPC and other international bodies should be aware of impending changes in management practices because: (1) the TAO array was developed over a 20-year period, with intellectual, organizational, and financial support from the international community; (2) it is presently maintained as a contribution to GOOS, GCOS, and the WCRP through international partnerships; (3) it is universally recognized as a key element of the ENSO observing system. McPhaden briefed the OOPC on the history and status of TAO transition planning within NOAA and discussed some of the possible implications of how the array might be operated in the future.

Michida briefed the Panel on the status of the TRITON array. Presently, there are 16 TRITON buoys in the western Pacific and two in the eastern Indian Ocean. The array will be kept at the present level at least for the next two years, as specified in the report of the International Tropical Moored Buoy Workshop (Seattle, September 2001). However, one of the moorings along 130°E will be removed because of a shortage of maintenance resources, but otherwise the budgetary situation for TRITON is stable. Michida also reported on the cruise plans in FY2004 (April 2004–March 2005) for recovery and redeployment of the array. In the latter half of FY2003, there will not be regular cruises for TRITON, because JAMSTEC has been carrying out an extraordinary cruise to carry out circumpolar hydrographic sections on board the R/V Mirai. The rate of data return from the TRITON array has been improved to over 90% in the past year. Temperature and surface meteorological data collected from TRITON buoys have been available through the JAMSTEC and PMEL websites. Salinity, ocean currents, rainfall, and shortwave radiation will be freely available from the web in spring 2004.

Edmo Campos briefed the Panel on the PIRATA array and on the regional workshop on the South Atlantic Climate Observing System (SACOS). The GCOS–GOOS–WCRP Ocean Observing Panel for Climate (OOPC) and the CLIVAR, together with the Inter-American Institute for Global Change Research (IAI), sponsored a workshop to discuss the need for a South Atlantic Climate Observing System (SACOS). The workshop's aim was to assess the ongoing efforts and to discuss the scientific rationale for a climate observing system in the South Atlantic. The final product of the workshop includes a suggested design for observations and process studies that fit the brief of both OOPC and CLIVAR. The SACOS Workshop was conducted back-to-back with the PIRATA-9 Meeting, during the week of 3-8 February 2003, in Angra dos Reis, Brazil, hosted by the Instituto Oceanográfico da Universidade de São Paulo (IOUSP) and by the Instituto Nacional de Pesquisas Espaciais (INPE).

PIRATA-9 Final discussions and recommendations:

(1) Cruises: 2002/2003, Brazil and France maintain commitment

(2) Data return:

- Statistics show a still too low data return
- Vandalism again and again; technical failures were a problem in 2001-2003

- To continue with Java (0°N-10°W) and Soul (0°N-0°E) sites up to 2005 (end of consolidation phase)

Task: investigate alternative technologies that could decrease vandalism. PMEL is already working on the matter and will continue doing so.

(3) Training: need for speeding up the training of personnel for maintenance of mooring
Task: CPTEC should lead the actions to select and get appropriate funding to send Brazilian technicians/engineers to PMEL for training.

(4) Recommendation to comply with the following planning:

- Tide gauge at SPSP Rock
- Tide gauge at Atol das Rocas Meteorological buoy at 0°N-44°W *Task: this issue has not yet been resolved; a particular effort must be made by PIRATA-BR Committee.*

(5) Suggestion for the implementation of a PIRATA Data Analysis Workshop in 2004 with support of sponsoring organizations *Task: INPE/CPTEC and IOUSP should organize the event in Brazil.*

(6) A closer relationship with operational agencies that are users of PIRATA data; an effort should be made to ensure their participation in forthcoming meetings
Task: this is to be done by the Chairman of the SCC.

(7) PIRATA could benefit from the EU Framework Program VI, in which substantial funds are likely to be assigned to operational oceanography initiatives of developing nations that are partners with European countries *Task: J. Trotte will be the contact to verify the real possibility of this opportunity in PIRATA.*

(8) Action should be taken to stimulate the publication of papers based on the PIRATA data set.

(9) Extensions:

- NEE in stand-by
- SEE and SWE were presented and drafts of white papers were handed out during the plenary session.

(A guideline document was prepared by the SSC: all proposals for extensions to the original back-bone array should be evaluated according to these guide lines)

(10) The new composition of the SSC was presented:

- Paulo Nobre replaces Ilana Wainer
- Edmo Campos replaces Antonio D. Moura.

(11) PIRATA-10 meeting scheduled tentatively to be hosted by the University of Maryland in 2004, or in Cape Town (South Africa); decision will be taken later.

6.2 ARGO PROFILING FLOAT PROGRAM

Argo is making very good progress toward its designed initial global implementation. About 800 floats were working this week, and nearly 1,000 should be working by the end of 2003. A full array, of 3,000 floats, may be possible in 2006. Information on the status of the Argo array can be obtained from the Argo website (http://www-argo.ucsd.edu/) or the JCOMMOPS web site (http://argo.jcommops.org/). Near-real-time data can be downloaded from the GODAE data servers (US, Japan, France). Coverage of the southern hemisphere remains much more limited than that of the northern hemisphere; advocacy of global deployment should be maintained at every opportunity.

The development of the Argo data system is also proceeding well, and "science-quality" Argo profiles are hoped to be available by the end of 2003. More information on Argo data management will be presented later by Keeley.

The first Argo Science Conference will be held in Tokyo in November 2003, and should showcase some of the many interesting results obtained from Argo profiles to date. The meeting organizers were encouraged to expand the remit of the workshop to include all sources of recent upper-ocean thermal and salinity observations.

The OOPC Panel noted the progress in the implementation of the Argo array with satisfaction. The Argo community has made exceptional efforts to achieve this progress.

6.3 GODAE

2003 marks the beginning of the GODAE Demonstration Period (http://www.bom.gov.au/bmrc/ocean/GODAE/), which will continue for three years.

Progress is being made by each of the national and regional groups working to advance ocean-data assimilation in the generation of routine, useful ocean information products, including forecasts.

The GODAE High-Resolution SST Pilot Project (GHRSST, http://www.ghrsst-pp.org/) is also progressing well.

Comparisons for the evaluation of regional products are underway, with particular emphasis on the North Atlantic region at present.

Planning is well along for a GODAE Summer School in late summer 2004. Discussions concerning a Second GODAE Symposium, to be held probably in late-2004, have been initiated.

The need for reanalysis as well as near-real-time analysis and forecasts was discussed. It is important for GODAE reanalysis efforts to coordinate well with the new CLIVAR climate analysis group. The EU ENACT project (http://www.cls.fr/enact) has been funded and is advancing on each of its six work programmes.

Ocean data assimilation is also needed for seasonal-to-interannual forecasting. A workshop on coupled ocean-data assimilation for S-I forecasting was held in March 2003 in Portland, Oregon, and concluded that the absence of coupled DA in existing S-I forecast systems did not appear to be a primary factor limiting the skill of present forecasts. How best to initialize the ocean model components of these systems remains the object of significant effort. The NASA Seasonal-to-Interannual Prediction Project web site (http://nsipp.gsfc.nasa.gov) provides a sound perspective on the types of work ongoing.

6.4 VOLUNTARY OBSERVING SHIP (VOS) DATA AND THE VOS CLIMATE PROJECT (VOSCLIM)

Elizabeth Kent, on behalf of Peter Taylor, provided an update on VOSClim. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/.

VOSClim status. The objective of the Voluntary Observing Ship (VOS) subset envisaged by the WMO VOS Climate project (VOSClim) is to provide a source of high-quality marine meteorological data and associated metadata, suitable for a number of applications, including global climate monitoring, research and prediction (for more detail see Section 4.4 in GCOS 2002). The VOSClim project held its fourth meeting in London in July 2003. Almost 100 ships have been recruited to the project and commitments made at the meeting to extend ship recruitment could mean that the target of a 200-ship minimum contribution will soon be met. The operational side of VOSClim is beginning to work well, with many Port Meteorological Officers (PMOs) recruiting ships, training the officers on the importance of VOSClim and how to make the additional observations, collecting metadata, photographing the ship and instrument sites and making repeat visits where possible. VOSClim data have recently become available from the project website http://www.ncdc.noaa.gov/oa/climate/vosclim/vosclim.html. Analysis of the data is now possible and some preliminary results were presented at VOSClim-IV.

Metadata. The success of VOSClim depends heavily on the availability of good-quality metadata. VOSClim has adopted the normal VOS route for metadata delivery, through the WMO Marine Program Publication No. 47 (List of Selected, Supplementary and Auxiliary Ships). The metadata in Publication No. 47 have in the past been made available in electronic format and has been used both operationally (for example, enabling PMOs to efficiently service foreign VOS visiting their ports) and for climate research (for example, allowing the height correction of marine air temperatures). Electronic files are available for the period 1973 to 1998 and the first quarter of 1999. Since then, only one file has been made available (the last quarter of 2001). In 2002 an extended metadata format was introduced and later adopted by the VOSClim project as its metadata standard. Unfortunately, the WMO has not yet been able to provide electronic data in this new format. The importance of historical VOS metadata to the climate community is demonstrated by a pending project to digitize Publication No. 47 for the period 1954 to 1972 to allow its wider dissemination and use by climate researchers. The lack of current and recent historical metadata is a serious problem, operationally, for VOS and VOSClim and for climate research.

Operational support. VOSClim requires a healthy VOS system for successful operation; the support systems for both are the same. The second meeting of the WMO Ship Observations Team (SOT-II) heard consistent reports of pressure on ship operations within National Meteorological Agencies running the VOS program. An example was the recent reduction by two-thirds in the number of UK PMOs. There is also an increasing demand on their time for support for other functions, such as the drifting-buoy program. Experience has shown that the enthusiasm of ships' officers participating in the VOS program (and hence the quality and frequency of their observations) depends crucially on frequent visits from PMOs providing links to the National Meteorological Agencies.

VOSClim analysis. The VOSClim dataset is a valuable resource for climate researchers. Its wide use must be encouraged. There are three distinct phases in the scientific analysis for VOSClim. Firstly, the data collected must be thoroughly assessed, using the metadata to determine bias and scatter in the observations and how they depend on observational practice and environmental conditions. The second phase will use this information to develop a strategy for the production of a high-quality dataset from the data collected by the VOSClim ships and promote good practice amongst the VOS by feeding back the results to the VOS operators. Only then can the third stage, the use of high-quality data for climate science, begin. At present, the only scientific input has come from the VOSClim Scientific Advisors at the UK Southampton Oceanography Center. It is desirable that a wider range of scientists have input at each stage. Expanding the user base should be actively encouraged to promote a diversity of research and ensure that this dataset is used to its full potential. It is also desirable to promote the wider analysis of error and bias in historical VOS datasets, such as I-COADS .

VOS development. In recent years making observations has been made easier by the introduction of automated reporting software such as TurboWin, SEAS or OBSJMA. This has reduced the burden of coding reports on the ships officers and provides help with, for example, making cloud reports by having pictures of different types of cloud. This type of software should have reduced errors due to the incorrect calculation of true winds from ship-relative winds. However, as noted at OOPC-VII, Turbo+Win has resulted for the first time in the implementation of a WMO directive to correct winds to 10 meters height at source (Shearman and Zelenko, 1989). SOT-II recognized this as a problem, particularly for climate research, as there is no metadata to show which reports have been corrected to 10 meters and which have not. SOT-II has set in motion the process to revoke the WMO height-correction directive, and in the shorter term to ask the TurboWin developers to remove the height correction from the next version. An interim mechanism using footnotes in WMO Publication 47 should allow the identification of some of the reports that have been height-corrected at source from metadata. With pressure of time on ships' officers, there has been a move towards fully automated systems by some countries, notably Canada and France. A good-quality automated system, with the facility for manual input of some parameters, such as cloud types, could produce climate-quality reports. A further advantage is the reliable delivery of frequent observations in severe weather conditions. However, care needs to be taken that automatic systems are introduced in line with the GCOS Climate Monitoring Principles and ensure that enough ships still record the full range of variables required for surface flux calculation.

Convergence of VOS and VOSClim. Ideally all VOS observations would be of the quality aspired to by the VOSClim project. However, a significant minority of VOS observations are of poor quality and to some extent this undermines the usefulness of the remainder of the better-quality observations. For example, SST observations from VOS are assimilated into SST analyses with a relatively low weighting. This is partly because some VOS SST reports contain gross errors that could have a serious adverse effect on the analysis. Numerical Weather Prediction (NWP) centers therefore prefer to rely on SST reports from drifting buoys, which contain fewer gross errors but are prone to drift with time (potentially causing problems with large quantities of biased data in data-sparse regions). VOS reports are therefore given a low priority by NWP centers and there is little incentive to improve the quality as little use is made of the reports. Demand from the NWP community is therefore shifting from VOS to alternative data sources. As the NWP community funds the VOS program, resources for VOS are therefore declining. The importance of VOS for climate is that ships provide data on a wide range of parameters from which the four components of the heat budget can be calculated (long and shortwave radiation, sensible and latent heat flux). Whilst some moored buoys provide similar information, alternative systems typically provide a subset of the information required for climate studies, concentrating on the variables most important for NWP, such as pressure and SST and possibly winds and air temperature. Limited automatic systems have been installed on VOS providing similar information to that obtained from a drifting buoy. The needs of the NWP and climate researchers for VOS data appear to be diverging. However, both communities would be well served by a smaller number of reliably high-quality VOS providing data on a full range of meteorological variables. This would be supplemented for NWP by information from other systems, such as the buoy network, satellites and radiosondes. The VOSClim project, although much smaller, provides a possible model for a future transition to make the VOS a high-quality data system.

Dialogue between the NWP and climate communities is limited, especially when one considers that many National Meteorological Agencies have both NWP and climate responsibility. Improving this dialogue is essential if we are to move towards a system which can meet the required range of objectives.

We need to avoid the perception that VOSClim, with its minimum target of 200 ships, will replace the full functionality of the VOS. Monitoring the VOS from a climate perspective urgently needs to begin. The monitoring of VOS that is presently undertaken by NWP centers is designed to measure the quantity of observations and to identify gross errors in the data. Climate monitoring would require different information; for example, the number and distribution of reports containing the variables required to calculate the four components of the heat flux to good accuracy (compared to the output of NWP models). In the past it has been possible to identify errors in models using VOS fluxes. We need to ensure that, as models improve, the fluxes from VOS are of good enough quality for validation in regions away from dedicated surface-flux reference sites.

Discussion.**-** The OOPC Panel agreed that the VOS program, as well as VOSClim, was an important contribution to the global climate observing system. Concern was expressed at the failure of WMO to provide VOS metadata. The VOS metadata were thought to be a priority and WMO should be requested to make it available as soon as possible. If resources could not be made available at WMO to fulfill these requirements, then alternative methods of delivery should be considered. The Panel welcomed the decision of SOT to begin the process of reversing the decision to height-correct ship winds at source as being important for consistency of the climate record.

The Panel thought it vital that NWP centers operating VOS should consider climate requirements when assessing the observational networks. Dialogue was needed to ensure that the networks fulfill the needs of a wide range of users and not just those of short-term weather forecasting. Monitoring of the VOS data using climate criteria should be an important first step toward understanding the observing system and improving quality. However, it was thought likely that, even if particular VOS reports could be identified as high quality, the data-assimilation systems may still not make good use of the data, since other constraints on the model prediction systems were strong. This issue should also be addressed, perhaps initially through the use of different types of assimilation schemes for surface and upper-air products.

Action item. The OOPC Panel will strongly recommend that the WMO make the full historical record of VOS metadata available in electronic form as soon as possible to meet the requirements of climate researchers along with current metadata to support operators and forecasters.

Action item. The OOPC Panel will strongly encourage JCOMM to begin a dialogue with the operators of VOS fleets to ensure that the data collected continue to meet the requirements of the global climate observing system for high-quality data from which the ocean surface exchanges of heat, moisture and momentum can be calculated. It is necessary to build on current monitoring of VOS weather reports to include assessment of the requirements of the global climate observing system alongside the monitoring for numerical weather prediction. This monitoring for climate is the essential first step toward raising the number of VOS that make climate-quality observations.

6.5 TIME-SERIES STATIONS

Weller reported on work on establishing time-series stations as part of the integrated ocean observing system. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/. The report was in two parts, the first part providing an overview of the U.S. National Science Foundation's Ocean Observatory Initiative (NSF OOI), the second covering the activities of the International Time-Series Science Team.

The NSF OOI is of interest because it plans a 5-year program to develop observatory infrastructure, with the effort divided between coastal observatories, regional or plate-scale observatories, and open-ocean observatories. The open-ocean observatory plans have been developed to bring together the multidisciplinary interests that have been fostered by the Time-Series Science Team and those of seismologists who want ocean-bottom seismometers in locations more than 1,000 km from existing land-based seismometers. The convergence of these interests points to the likelihood of a joint effort to occupy some of the most challenging time-series sites, such as in the Southern Ocean, with moorings and buoys that could provide the power and bandwidth sought by those who want to run ocean-bottom seismometers and recover all the data in real time and those who want capable and viable surface moorings as long-term time-series sites in the same locations. There will be a workshop (called the Orion Workshop) in early January 2004 on the OOI (http://www.coreocean.org/deos/orion) which will be a venue for further development of collaboration leading toward ocean time-series stations.

The rest of the report brought OOPC Panel members up to date on the activities of the International Time-Series Science Team, which met in April 2003 in Nice. The rationale for and location of the time-series sites is well developed, and the group is working on a brochure, a white paper, and a website.

Discussion. There was discussion with CLIVAR Panel representatives, particularly with Speer of the Southern Ocean Panel, which suggested that the Time-Series Science Team should circulate present drafts of their material to the CLIVAR Panels to seek their input, advice, and confirmation of choice of sites. The discussion led to the point that the Time-Series Science Team should soon move beyond its maps and documentation showing the pilot phase of the most feasible and desirable sites to maps and text descriptions of all recommended time-series sites. There view that the Time-Series Science Team should become even more proactive in pushing for Time-Series was also discussed. One suggestion was for them to organize a special 1-day symposium in conjunction with the January Orion Workshop.

6.6 AIR-SEA FLUXES INCLUDING SURFA, VOS, TIME-SERIES

Dr. Bob Weller reported to OOPC-8 on behalf of Peter Taylor, himself, and others who have been working toward improved global air-sea flux fields with the support of OOPC. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/. Several topics were covered in the report and related discussions, including the plan by the WCRP to create a new WCRP working group on air-sea fluxes, efforts of the in-situ community to work with the model community under the SURFA effort, present discussions of climate reanalyses, and results from some of the surface flux reference sites now operating.

The WCRP had sponsored the WGASF (Working Group on Air-Sea Fluxes) which had led up to a meeting in Baltimore and accompanying report that did an excellent job of summarizing the state of the art of air-sea fluxes. The WCRP, looking to the future and to improving interaction between CLIVAR and SOLAS, who share interests in further improvements to knowledge about air-sea exchanges and capabilities to obtain new flux measurements. WCRP felt that SOLAS interests would include: biogeochemical fluxes, particle fluxes, deposition, and measurement technologies while CLIVAR's interests would include NWP fluxes, data assimilation, satellite fluxes, VOS fluxes, fluxes for ocean modeling, parameterizations, wind waves, fluxes over ice, surface flux variability, and flux observing systems. This group is now being set up and populated.

Weller briefly reviewed progress toward the global flux observing system that OOPC has recommended, which includes surface flux reference sites (time series moorings), meteorology and fluxes from ships (VOS, research ships, and high density XBT line VOS with IMET systems). Comparisons of observed net heat flux, wind stress, and heat flux component time series with the same quantities from NWP model reanalyses (NCEP1, NCEP2, and ERA15) were shown. The comparison points to large (50 to 100 W m^{-2}) biases in the model fluxes around the world. Flux fields are now being produced by several groups, including one at Woods Hole Oceanographic Institution (Lisan Yu) and Bill Large at NCAR. The strategy they use is to use the meteorology from the NWP models and make corrections to the data to reduce biases and other error and to bring in satellite data for radiation and precipitation fields. Their results are promising but are best validated by comparison to withheld data from the array of surface flux reference sites which it is hoped will continue to be implemented and maintained as a critical element of the strategy to develop improved flux fields.

Weller briefly summarized discussions at a recent workshop organized by Phil Arkin and Sig Schubert in Boulder, CO. The workshop discussed planning an effort to do a new reanalysis from a climate perspective. This stimulated great interest as it was seen possible in that reanalysis to address issues that lead operational NWP models to provide poor air-sea flux data and to reject accurate in-situ surface meteorological in their assimilations.

In recent years it had been hoped that a formal means for comparing high-quality in-situ fluxes from the surface reference stations with fluxes from NWP and climate models would develop under the SURFA project. In this project the in-situ data sets are provided to PCMDI, which does the Atmospheric Model Intercomparison Project (AMIP). Unfortunately, progress under SURFA has been extremely slow. In response to this OOPC discussed the need to again stress to WGNE the importance of this project and to examine other venues for facilitating comparison of NWP surface fields with surface reference station data and for allowing access to the NWP fields to stimulate more projects to develop improved global air-sea flux fields.

6.7 SEA SURFACE TEMPERATURE / SEA ICE WORKING GROUP

Dr. Richard Reynolds and Dr. Nick Rayner presented a status report on the Sea Ice SST working group. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/.

1. Use of Microwave SST Data in NOAA OI

Six different versions of the optimum interpolation (OI) were produced weekly from 10 December 1997 through 1 January 2003 using different combinations of Advanced Very High Resolution Radiometer (AVHRR) and Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) data. The results of the intercomparisons show that both AVHRR and TMI data have biases that must be corrected for climate studies. For the OI analyses with bias correction, it is difficult to clearly demonstrate that there is a significant advantage in adding TMI. The advantage of TMI data is clearly shown in the OI analyses without bias correction. Because IR and microwave satellite algorithms are affected by different sources of error, biases tend to be reduced when both TMI and AVHRR data are used in the OI. The use of both TMI and AVHRR data improves the OI analysis without bias correction and does not negatively impact the OI analyses with bias correction. A paper entitled "Impact of TRMM SSTs on a Climate-Scale SST Analysis" by Reynolds Gentemann and Wentz has been submitted to the Journal of Climate

2. Use of in situ SSTs from profile data in NOAA OI

A new project was started to use the NOAA OI to assess the importance of SSTs from ocean profile data (CTD, ARGO, XBT, etc.) for a one year period: 2002. The data were obtained from Bob Keeley, MEDS. The results showed that the analysis was not strongly impacted by the profile data because these data are so sparse relative to other surface marine in situ data.

3. Buoy Need Network

Considerable progress has been made on developing where additional buoys are needed to improve the accuracy of the SST analysis. Three SST errors were discussed: sampling, random and bias errors. Because of the present density of satellite data, sampling and random errors are small. Thus, additional buoy data are only needed to correct large-scale biases in the satellite data. A method was developed using random errors and spatial satellite bias errors to show that two buoys on a 10º spatial grid are needed for bias correction. Present SST distributions from January 2000 to December 2002 were examined and it was shown that additional 250 buoys were needed between 60ºS-60ºN.

4. GODAE High Resolution SST Pilot Project (GHRSST-PP)

Reynolds and Rayner attended the Third Workshop in Frascati, Italy, 2-4 December 2002 and will attend the Fourth Workshop in Pasadena, CA, 22-26 September 2003. In the third workshop there was considerable discussion of intermediate and final products. These products are complex because users' requirements vary among the different products. The purpose of the forth workshop is to discuss and approve the analysis document for GHRSST. This document is 171 pages and may be too detailed and over specified with too many acronyms. Reynolds plans to insist that large-scale satellite biases for each satellite dataset be monitored and that time series of biases should be available on the GHRSST web site. This is because satellite bias error can be expected to be the largest source of error in the final GHRSST product.

5. NCEP High-Resolution, Real-Time, Global SST (RTG_SST)

A brief review of the difference between the NOAA OI and the NCEP RTG_SST was presented. The RTG_SST uses the same in situ and satellite data but is analyzed daily instead of weekly with smaller spatial correlation scales. RTG_SST has higher spatial and temporal resolution than the NOAA OI but is noisier. NCEP uses the RTG_SST as a boundary condition with the NCEP regional model, but uses a daily version of the NOAA OI with the NCEP global model. Unfortunately, NCEP does not participate in GHRSST. Thus, information on new satellite SST data sets does not reach NCEP directly from GHRSST.

6. Historic SST Analyses

A monthly SST analysis was developed on a 2º grid from 1850 to present as discussed by Smith, T.M., and R.W. Reynolds, 2003: Extended Reconstruction of Global Sea Surface Temperatures Based on COADS Data (1854-1997). *J. Climate*, 16, 1495-1510. This analysis is now being modified to improve the variance in the western tropical Atlantic and Pacific and to add sea ice coverage with a new sea ice to SST conversion algorithm. The analyses are compared with the NOAA OI and UK Met Office products. A draft paper on the new analysis by Smith and Reynolds entitled "Improved Extended Reconstruction of SST (1854-1997)" has been sent to the Journal of Climate.

7. Sea Ice Improvement

Progress has been made to develop improved Along Track Scanning Radiometer (ATSR) SST data near the sea ice margin. A new study shows that standard screening products can mistakenly classify sea ice as water and that standard retrievals for SSTs are not adequate for marginal ice zones because of the wide range of atmospheric conditions. Improved screening and retrieval method were developed and tested. In addition a preliminary sea ice blended product for 1950-1998 was created on a 0.25º spatial grid using charts from many different sources.

8. Plans for Future Work

For sea ice, it is planned to develop a more homogeneous record of sea ice concentration. This will be done by continuing an objective assessment of passive microwave data from a climate perspective and by including more data (both digitized and undigitized) in the historical record. In addition, a complete assessment of an Arctic blended sea ice product will be examined for 1950-94 and extended to the Antarctic. Work will continue on sea ice to SST conversion algorithms using the new ATSR data to evaluate algorithms.

The SST working group will maintain a link with GODAE High Resolution SST Project since both Reynolds and Rayner are on the science team. They will help the high resolution SST project develop large scale satellite monitoring products to monitor the accuracies of intermediate products.

The working group will also continue to examine new SST data sets. In addition, new sets of satellite data will also be examined.

A final project has been planned to investigate the quality control (QC) and analysis procedures to help determine why SST analyses differ. Three agencies (JMA, UK Met Office and NOAA/NCDC) agreed to use common in situ input data and compare analyses. However, this project has not been started.

6.8 WIND WAVES AND STORM SURGES

Harrison introduced Dr. Val Swail, who discussed the JCOMM Expert Team on Wind Waves and Storm Surges. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/.

Dr. Swail, Chairman of the JCOMM Expert Team on Wind Waves and Storm Surges, began by pointing out that the Terms of Reference of the ETWS included an item to “ensure effective coordination and cooperation with appropriate GOOS bodies on requirements for, and implementation of, wind wave and storm surge products and services". He also noted that ETWS, which is part of the JCOMM Services Programme Area, already had strong linkages with other JCOMM groups, notably the Observations Coordination Group and its component bodies – the Ship Observations Team, the Data Buoy Cooperation Panel, and the Expert Team on Marine Climatology, part of the Data Management Coordination Group. ETWS is a co-organizer of the upcoming CLIMAR-II workshop in Brussels, with ETMC.

The second part of the presentation recalled the ETWS contribution to the OceanObs99 conference in St. Raphael, specifically the requirements and priorities for wind and wave information in the open ocean. These requirements basically addressed three different areas: (1) in situ and satellite data for assimilation into coupled atmosphere-ocean wave models for real-time forecasting activities, and subsequent verification; (2) in situ and satellite wind and wave observations to describe the ocean wave climate and its variability on seasonal to decadal time scales; (3) waves have an important role in the coupled ocean-atmosphere system, affecting winds, currents, turbulent mixing, fluxes, density structure and albedo; the dynamical consequences are reflected, for example, in improvements in ECMWF 10-day forecasts and model climatology using coupled atmosphere-ocean models. For GODAE, wind wave observations should be considered because of their effects on the forcing fields.

The first meeting of ETWS (ETWS-I, Halifax, June 2003) identified as a priority that the network of in situ wave observations from moored buoys be enhanced, particularly for offshore locations and in the tropics and southern ocean, in order to provide more balanced geographical coverage and therefore more representative statistics in the validation of wave model output and calibration of satellite sensors. Possibilities included adding wave sensors to the Surface Reference Sites time series moorings, or the Triton/TAO/PIRATA arrays. ETWS will provide an assessment of basic and enhanced requirements for additional wave measurements from moored buoys. Further work will be required on assessing the technical feasibility of adding wave measurements to existing mooring design, in terms of power budgets, transmission needs, mooring response and incremental cost. The times series group will consult with the ETWS, the Observations Coordination Group and other interested parties to investigate the feasibility of including wave observations on SRS moorings.

Discussion - Swail expressed interest in collaborating and liasing with international programs to come up with a better design and plan. An action item mentioned by Weller is to figure out the technology that would be required since a funding opportunity could become available in the future. He suggested that Swail involve other groups to get things rolling soon. Questions that arose are: what data are needed, what is the appropriate sampling rate, and what data do specialists want, from where, and how often? How should data be transmitted? Fixed locations are better than those that move. It is better to have a few good buoys than many more new ones. Harrison recommended that Swail ask for consensus from the expert team and submit needs to him.

Action Item: Swail to develop a group to assess the technical feasibility of adding wave measurements to existing mooring design, in terms of power budgets, transmission needs, mooring response and incremental cost. Other issues the group should address are: what data are needed, what is the appropriate sampling rate, and what data do specialists want, from where, and how often? How should data be transmitted?

6.9 OCEAN CARBON

Dr. Tommy Dickey introduced this item and referred the Panel to the CO2 Panel Progress Report June 2003 (http://ioc.unesco.org/oopc/oopc8/) provided by Dr. Maria Hood, the technical officer for the CO_2 Panel. In 2000, the IOC's CO_2 Panel began developing a comprehensive ocean carbon program to respond to international and intergovernmental needs for high-quality ocean carbon data for research, modelling and assessment activities. Program activities are addressing research coordination, observation program coordination, best practices and methods, standards and reference materials, training, data exchange policies and practices, and regional and global data syntheses. In early 2002, the CO_2 Panel joined with the IGBP-IHDP-WCRP Global Carbon Project to develop a joint pilot project called The International Ocean Carbon Coordination Project (IOCCP; http://www.ioccp.org). Dr. Hood is serving as the project officer for this pilot project at the IOC in Paris and at the Laboratoire d'Océanographie Dynamique et de Climatologie (LODYC), Université Paris 6. This is a collaborative project to (i) develop a compilation and synthesis of ocean carbon activities and plans, (ii) work with international research programs to fully integrate carbon studies into planning activities, (iii) standardize methods, qc/qa procedures, data formats, and use of certified reference materials, and (iv) support regional synthesis groups and create regional databases.

The first workshop of the IOCCP was held at the IOC-UNESCO Headquarters in Paris, France on 13-15 January 2003. This meeting brought together 56 participants from 17 countries to discuss activities and plans for carbon measurements from ships of opportunity and the repeat hydrographic sections of CLIVAR. The workshop documents and results, including maps and tables of the compiled information, are available on the IOCCP Web site or on Cd-rom from the project office. Dr. Chris Sabine, NOAA / PMEL, the scientific focal point for the GCP, and Dr. Hood have written an article about the IOCCP for the American Geophysical Union publication EOS, which appeared in the June 10 2003 issue. Figures 1 and 2 show the information compilations for repeat hydrography and underway measurements, respectively.

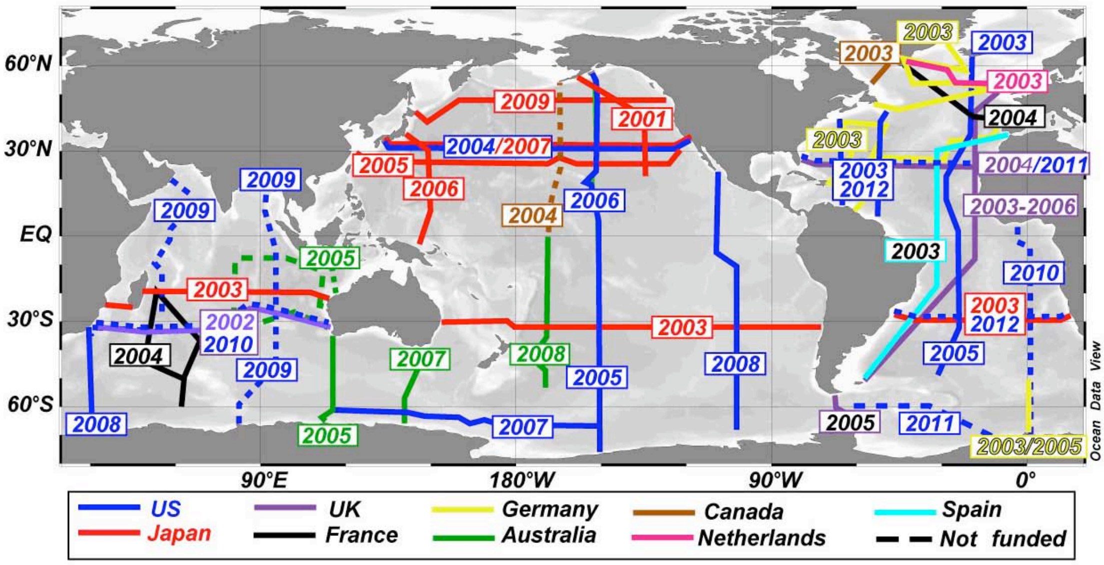


Figure 1. Global repeat hydrographic sections measuring carbon and tracers. For details, see http://www.ioccp.org.

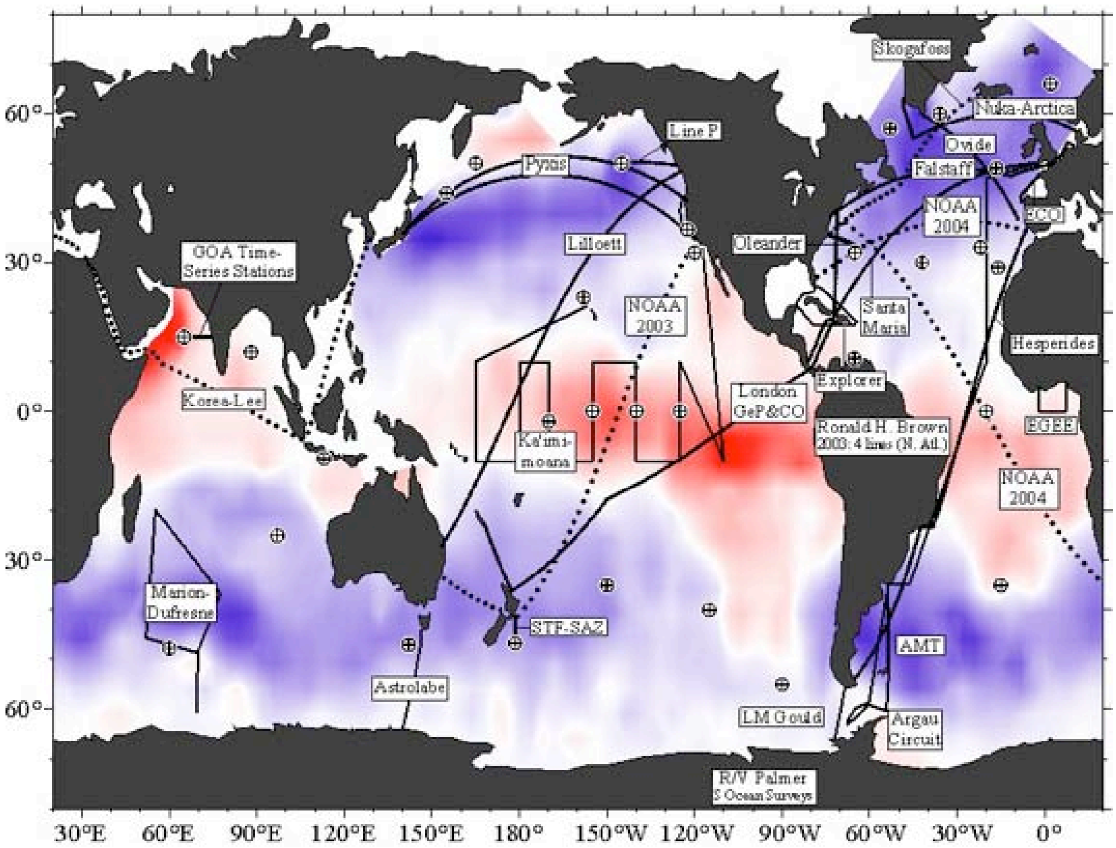


Figure 2. Global underway pCO2 measurement network (lines) with planned or operating time series stations measuring carbon variables (circles). For more information, see http://www.ioccp.org.

The Carbon Dioxide Information Analysis Center (CDIAC) Ocean CO_2 program, and the Global Hydrographic Project Office (formerly WOCE IHPO) have agreed to develop joint data management plans for the repeat section work. The CDIAC Ocean CO_2 program, the Carbon Dioxide in the Atlantic (CARINA) program, the World Data Center for Marine Environmental Data (WDC-MARE) and the PICES CO_2 Related data integration for the North Pacific (PICNIC) program are working together to develop regional and global data management plans for underway pCO_2 data. (See the IOCCP Web site for more information about these programs). The regional groups, along with new projects in the US and in Europe, will begin cooperative data synthesis projects in the next year (funding pending) to develop a 30 year global database for ocean carbon data. The IOCCP has been asked to aid in coordination of these activities to facilitate data sharing, appropriate acknowledgements for data use, and to minimize duplication of efforts.

As a result of this first workshop and the information published on the Web, plans for several national repeat hydrographic sections have been altered to avoid duplications with those of other nations, and a number of international discussions have about changing sampling plans or measurements on specific lines to better achieve the scientific goals of the whole community. The IOCCP is working with these groups to find appropriate funding sources and laboratories willing to make analyses for other groups where necessary.

A second workshop is planned for January 2004 in Tsukuba, Japan and will discuss the results of an intercomparison exercise for underway pCO_2 sensors that was held in March. The workshop will also focus on underway data formats and the development of a cooperative data management and exchange system for underway pCO_2 work. Data projects and centers in

Japan, the US, and Europe have agreed to work together on this, and will develop a joint strategy at the meeting. The IOCCP has been asked to host a 3rd workshop in early 2004 to develop international agreements on core and ancillary measurements for carbon and tracers from repeat sections. This priority list is needed to allow funding agencies to support particular sampling activities to be carried out on cruises of other countries. In November 2003, the IOCCP will begin discussions with POGO about biological and biogeochemical measurements, many of which can use the same or similar platforms as ocean carbon and could perhaps benefit from a similar coordination mechanism.

As mentioned in Section 5.5.2, the IGBP-SCOR global research programs SOLAS and IMBER is making plans to coordinate the research and implementation of their ocean carbon programs through the CO2 Panel, which will provide strong links to the observation information, cross-cutting services, and global observing system plans already carried out through the Panel programs.

6.10 GLOSS TIDE GAUGE NETWORK

Dr. Mike Johnson, Chair of JCOMM OCG, presented a briefing on the May 2003 *Report on the Status of the GLOSS Programme and a Proposal for Taking the Programme Forward* prepared by Philip Woodworth and Thorkild Aarup for the IOC. The presentation is available for viewing at http://ioc.unesco.org/oopc/oopc8/. The May 2003 report was produced at the request of the JCOMM Observations Coordination Group and because the GLOSS Group of Experts felt that a review of GLOSS status was required and the need for fresh investment had to be stated.

The tide gauges are used for several applications including altimeter calibration, backup incase of gaps in the altimeter records, mean sea level for climate change studies (e.g., for IPCC), tracking higher frequency climate variability (e.g., ENSO), ocean circulation, and many coastal applications. Over the past five years the main new GLOSS development has been the demand for “fast” delivery of tide gauge data. The term “fast” can be interpreted as two days for operational assimilation of data into deep ocean models, a few hours for assimilation into coastal models (e.g., storm surge), one week for altimeter calibration, and one day for tide gauge operators in order to detect faults in gauge sampling or reporting.

GLOSS is tracking the status of the global tide gauge network according four categories of reporting data to the global centers at PSMSL and UHSLC – Category 1 being good and Category being bad. Of the 290 station core network, 168 are Category 1, 69 are Category 2, 28 are Category 3, and 25 are Category 4. The GLOSS Fast Center at the University of Hawaii Sea Level Center now has 73 stations reporting in real time mode.

The May 2003 Report concluded that GLOSS progress in building the global network has been slower than desired and to make further progress there needs to be a centrally-coordinated development activity which will fill many of the gaps, especially in Africa. This is an opportune time to make a substantial investment in GLOSS given technological advances enabling modular tide gauge packages to be considered. The report contains a plan and proposal for investment of approximately $3.5 million USD over three years, half of this investment would be one-off costs for hardware and half would be required for annual costs over the three years and continuing into the future to maintain the system. The JCOMM OCG endorses this GLOSS proposal and will work with the GLOSS Group of Experts to encourage national investments for funding of the plan.

In accordance with the OOPC and OCG strategy to promote routine delivery of ocean products, Johnson suggest that OOPC and JCOMM might cooperate in sponsoring regular annual reports on variations and trends in mean sea level at the reference long-term-trends stations identified in the OOPC-CLIVAR 1998 International Sea Level Workshop Report. Sea level trend analyses at tide gauge stations are being produced today in non-standard, research mode, but not as a routine global product easily understood by non-scientists. Since sea level rise is one of the most immediate impacts of climate change, such an annual report could be of significant interest and benefit for many management, engineering, and policy applications.

Action Item: OOPC and JCOMM to discuss ways and means of sponsoring regular annual reports on variations and trends in mean sea level at the reference long-term-trends stations identified in the OOPC-CLIVAR 1998 International Sea Level Workshop Report.

6.11 SATELLITES

Johnny Johannesen represented OOPC at the WCRP satellite requirements workshop in Nov 2002. The meeting report calls for continuation of the key ocean satellite sensors identified in the 'Next Steps' – Topex/Poseidon class altimetry, SeaWifs class ocean color, TRMM class microwave SST and rainfall, QuikScat class surface vector winds.

Continued advocacy for ocean satellite missions is needed, as demonstrated by the efforts needed recently to ensure that the JASON-2 altimeter mission would go forward. How best to provide this advocacy is not clear to OOPC; its expertise is much more heavily with in situ observing system and analysis issues. It was noted that the first 'rolling review' of the IGOS-P Ocean Theme (see http://www.igospartners.org then go to Documents) is due, and it is hoped that this review will provide a framework to develop effective ongoing advocacy for the desired missions.

No complete overview of the state of commitments and planning for ocean satellites was available to the Panel. Such an overview will be sought for OOPC-9.

7. DATA

Mr. Bob Keeley briefed the Panel on the data and information management activities relevant to the OOPC.

7.1 OCEAN INFORMATION TECHNOLOGY PROJECT

This project was proposed by Neville Smith and dealt with modernizing the data management systems of the world. It partitioned the work in the following areas.

- Telemetry and communications
- Standards and protocols
- Datum and data set integrity
- Data circulation and service
- New functionality
- Product exchange and services
- Data assembly and quality control

Work in these areas is proceeding at different rates and at different levels of coordination. The progress for which some activity can be mentioned include the following.

The US has initiated a project called DMACS with the objective of improving data circulation and services as well as product exchange. The JCOMM has proposed a group to liaise with this effort.

- JCOMM has established a group to look at standards related to metadata
- JCOMM has established a group to look at data assembly and quality control standards.
- IODE/ICES has a group looking at how XML can facilitate exchange of both data and metadata, and help to standardize what information is preserved.
- JCOMM/IODE has moved forward to implement a unique data tagging scheme that will address data integrity. Initial tests will take place soon for profile data collected through the US SEAS program. Argo has also instituted a unique data tagging scheme

7.2 ARGO DATA SYSTEM AND PROGRESS TOWARDS IMPLEMENTATION

The Argo data system is progressing with its development. Much progress has been made in the past year. Present high priority activities include the following.

- Begin using the standard procedures developed by Wong et. al. to quality control the delayed mode data.
- Finalize a new version of the data format required for the results of the delayed mode QC procedures
- Assist DACs who need help getting their data to the global servers.
- Clarify the functions of the global servers relative to the long term archive
- Correct problems in getting timely distribution of data on the GTS
- Providing a facility for users to report problems encountered in the data system
- Encourage the development of the regional centers to carry out basin and instrument comparisons.
- Finalize an Argo CD
- develop a procedure for format change control

7.3 GLOBAL OCEAN SURFACE UNDERWAY DATA PROJECT (GOSUD)

This project has four goals:

- Build a comprehensive archive for ocean surface underway data and metadata.
- Provide data and information to users in a timely fashion.
- Work with data collectors to improve data acquisition systems and to provide feedback to data collectors about the data they provide
- Work with scientific organizations interested in surface data to provide products to a broad community

The project planning to this stage has been supported by 10 countries. The initial work was directed at managing thermosalinograph data, but other non-physical variables are also intended to be included. A co-chair of the GOSUD Project has started to make contacts with the underway pCO2 community to see what cooperation is possible.

The planned data system includes management of both real-time and delayed mode data and working with the data held in historical archives. Data and information distribution is expected to be similar to that used in the Argo project.

An implementation plan was presented to and endorsed by IODE in March, 2003. A meeting is planned for November, 2003 to begin the implementation by countries volunteering resources to tasks identified in the implementation plan.

More information about the project is available from http://www.ifremer.fr/sismer/program/gosud/

7.4 MEASURES OF DATA COLLECTION EFFECTIVENESS TO MEET GOALS

The OOSDP report on variables needed for climate studies provides a specification of time and space scale sampling that is the initial target. The precision of these specifications depends on the variable considered. At the last OOPC meeting Keeley had shown some initial products that used the space and time scale sampling requirements and the real-time data immediately available to him to illustrate one possible way to monitor the performance of the global observation program. At that time, his presentation showed results characterized by variable, but also by the code form in which the variable was reported in real-time. Comments suggested that a more effective presentation would be by instrument. He revised his figures, improved the display and presented some sample results for temperature profile data as well as SST. These maps show the real-time data contributions to the global observing system by instrument and then in composite. Again only those data immediately available were used so that for SST, for example, the contributions from the VOS are not included.

Discussion - OOPC will be assembling products that illustrate climate indices. It is important to have a place where such products can be made widely available. Although the OOPC web site may be suitable there are web facilities of JCOMM and IOC that may be more suitable and have the support to ensure that the products are maintained up-to-date. OOPC chair should ask JCOMM and IOC to see what help they may provide.

Dr. Michida led a brief discussion about establishing a data system for CLIVAR. He felt that it was the urgent business of OOPC to establish workable data system, particularly for CLIVAR. He noted that WOCE was over, that CLIVAR is already operating, that the IOC data exchange policy was adopted by IOC Assembly and a review of IODE will start shortly. He noted that the WOCE data system had a data policy with requirements for both data originators and data managers, a system of distributed data centers and a central hub for information, a system for continuous tracking of the data stream, and was guided by a steering group. Issues that still need to be dealt with include realtime exchange and delayed mode quality-controlled data / archive; design of data products; metadata and inventory directory; requirement of quality and timeliness; and access to both meteorological data and oceanographic data. Michida suggested that the next steps are to make data policy (data collection and exchange rules included); to establish a network of data centers; and to organize a committee to steer the data system.

Resources: OIT report by N. Smith http://ioc.unesco.org/goos/gsc6/B18.doc;
DMACs report http://dmac.ocean.us/dacsc/imp_plan.jsp

After discussion, it was decided that the OOPC technical officer would include Observing System monitoring results in ‘indices’ via OOPC web site, to provide a portal to climate index information and to information about the state of the observing system. Also, that Weller and Keeley should talk with CLIVAR leadership about DM progress and possibilities, and that the OIT project person should be encouraged to interact with US DMAC effort, where opportunities for sharing exist (real time and XML among others).

8. ADEQUACY, NEXT STEPS, AND STATUS FOR OCEAN CLIMATE

8.1 OCEAN PRODUCT EVALUATION PROCESS

At present these two activities are closely interconnected, since a key evaluation metric for the observing system is the quality of the products that can be derived from the data collected by it.

The most fundamental evaluation of the Observing System is the extent to which the initial system is deployed. A variety of metrics for implementation have been developed by OOPC, JCOMMOPS and others, and some have been exhibited this week. Others are in development, and are needed for proper system management of the observing system.

Development of processes to evaluate the product effectiveness of the initial observing system has begun. The SST and SLP working groups have identified persistent differences in analyses in regions of limited in situ data, and have made specific recommendations for additional observations in order to improve the quality of global SST and SLP analyses. These have been incorporated into the 'Next Steps' recommendations. Similar product comparison efforts could be carried out, for the other 'essential ocean climate variables' for which analyses are available, by specialist groups. The cost of a full suite of such groups would be substantial. Collaboration with research and pilot program efforts will be necessary.

Ocean subsurface analyses are just becoming routinely available, through the activities of GODAE and others. GODAE is encouraging the formation of Intercomparison Projects to look carefully at analyses of particular ocean basins and subregions of strong national interest. At present the North Atlantic comparison is furthest advanced.

Another evaluation approach is to examine the uncertainty in ocean climate indices, computed from different analysis products or via different ocean synthesis activities. This activity is furthest advanced for indices related to the El Niño-Southern Oscillation phenomenon. As agreement is reached on other ocean climate indices, such activities should be encouraged.

It is to be expected that our knowledge of global ocean variability will evolve as new information is developed from the developing observing system. The 'Next Steps' recommendations will need to be revisited, perhaps every five years via a Rolling Review process as is planned for the IGOS-P Ocean Theme.

8.2 SECOND ADEQUACY REPORT

8.2.1 **Next Steps**

The agreed Next Steps to be taken call for implementation of the initial surface observing network and subsurface network, enhanced ocean analysis and reanalysis efforts, improvement to the ocean data system, and developing strong connections between the sustained observing activity and the research community.

Each of the ocean networks is *composite*, in the sense that it makes best use of each of the available platforms able to collect information (satellite and in situ) and *integrated*, in the sense that all of the information collected is brought to bear to produce the best available fields of each variable of interest. Information products are the desired end products of the combined observing/analysis activity, and much developmental work is needed to estimate the uncertainty in products that can be based on existing information.

Research and development are needed for a number of reasons. The initial system is built around proven technology capable of global deployment. Because existing sensors for biogeochemical and ecosystem variables are not yet suitable for long term deployment, improvement is needed. The Next Steps call for platforms to be made available for the development, testing and pilot project use of new sensors.

Because so much of the ocean has not been sufficiently well observed for us to know its patterns of variability, research engagement is needed also to ensure that the sustained system evolves as more is learned about these patterns of variability. New scientific understanding will drive the evolution of the system, as it has provided the basis for the configuration of the initial system.

Research community involvement is also important for the implementation of the initial system. Much of the global ocean is not crossed by commercial shipping lanes or by aircraft capable of deploying sensors. Further, some of the variables of interest require research level attention to measurement in order to obtain the desiered level of accuracy. Determined effort by the research community is the most feasible path to implementation of an effective global system.

The specific observing actions called for in the Next Steps are enumerated in the ocean domain section of the Second Adequacy Report. The OOPC web site will contain the latest information on the specific implementation efforts needed, and summary of the present state of implementation.

In discussion, the CLIVAR basin panel representatives reaffirmed that the success of the CLIVAR program depends upon successful implementation and maintenance of the initial observing system.

Also discussed was whether a follow-on to the Ocean Obs 1999 symposium would be useful. It was felt that progress since OceanObs99 had been sufficiently modest that the Next Steps recommendations were unlikely to be modified in significant ways at this time. The importance of seeking long term commitments for ocean observations was again discussed; as before, national ocean research organizations are carrying out most of the observations at present. Such funding is typically confined in duration. It is hoped that the new GEO process and the interest that the UN Framework Convention on Climate Change has taken in global observations may lead to a higher level of visibility of the challenges ahead.

8.2.2 **Status Relative to Next Steps**

Mike Johnson summarized the status of implementation of the Next Steps. Overall, the system is roughly 50% implemented. No component of the system has the desired level of global coverage at present. The JCOMM Observations Coordination Group will make every effort to see that its observing subgroups do what they can to move toward full implementation of the initial global system. Details of the status of implementation of the global system will be available via the OOPC web site.

The initial surface system should sustain: a global array of surface drifters (SST and SLP) with 5x5 degree resolution (1250 if perfectly spaced) and reporting as often as feasible;

real time transmission of as much VOS surface data as possible, improvement of the quality of VOS data and participation of at least 200 ships in the VOSCLIM project; a global array of 29 time series reference site moorings; an 86 gauge subset of the GLOSS Core Network with real time data transmission and geocentric location; a global tropical network of (119) moorings; a global pilot project to collect air-sea pCO2 data. In addition continuing data from at least one Topex/Poseidon class altimeter, one SeaWifs class ocean color system, one QuikScat class surface vector wind system and one TRMM class surface microwave system are needed.

The intial subsurface system should sustain: a global array of Argo profiling floats with 3x3 degree resolution (3000 if perfectly spaced); a global network of repeat XBT sections along 44 different lines; a global network of full depth carbon/hydro sections repeated at least every ten years; subsurface instrumentation on the 29 reference site mooring network and on the 119 tropical moorings network. Information about ocean surface conditions is also essential for interpretation of the subsurface information.

After discussion it was noted that the efficiency of deployments could be enhanced if there was a clear implementation plan to achieve and maintain the planned global coverage and density of the Argo and surface drifting buoys, in preparation of future deployment possibilities.

9. SUMMARY OF ACTION ITEMS

Action Item	Report Ref	Action	Responsible	Date
1	4.3.2	to submit suggestions for ocean climate indices	all including guests	OOPC-9
2	4.3.2	to develop links on the OOPC web site to existing climate index time series	Secretariat	OOPC-9
3	4.3.2	to host experimental ocean climate index time series and provide process for feedback on the OOPC web site	Secretariat	OOPC-9
4	5.1	to support development of Implementation Plan for the Second Report on the Adequacy of the Global Climate Observing System	Chair, all	ongoing
5	5.1	to participate in GEO architecture and implementation process as feasible	As appropriate	ongoing
6	5.2.1	to continue collaboration with COOP, including the development of joint COOP / OOPC pilot projects.	Chair, Dickey, Hood	ongoing
7	5.3	to prepare a report from the SACOS workshop, including observational requirements	Campos, Visbeck	ASAP
8	5.3	to request the Southern Ocean Panel to provide suggestions for Southern Ocean sustained observing enhancements	Speer	
9	5.3	to prepare annual summaries of coming CLIVAR research observing activities and to provide the expected dates of	CLIVAR representatives	OOPC-9

		termination of their present funding		
10	5.3	to solicit input from the CLIVAR basin panels on additional observational requirements outside of the Next Steps	CLIVAR representatives	OOPC-9
11	5.3	to liaise with the CLIVAR Global Synthesis Observations Panel (GSOP)	as appropriate	ongoing
12	5.4.1	to request the Argo Science Team for analysis on how best to make the transfer from 'broadcast-mode' to 'line-mode' XBTs as Argo deployment proceeds	Chair	ASAP
13	5.4.1	to seek advice from CLIVAR and operational centers regarding barometer requirements on global drifter array	Chair, CLIVAR representatives	OOPC-9
14	5.4.1	to request that JCOMM consider development of regular annual reports on variations and trends in mean sea level	Chair	ASAP
15	6.4	to recommend (to JCOMM) that the WMO make the full historical record of VOS metadata available in electronic form as soon as possible (WMO Marine Program Publication No. 47)	Chair	ASAP
16	6.4	to strongly encourage JCOMM to stress with operators of VOS fleets that data collection should meet climate quality principles and standards	Chair	ASAP
17	6.6	to contact WGNE, requesting its help in coordinating establishment of an ongoing archive of operational marine surface fields and air-sea fluxes at the GODAE Server in Monterey to advance the SURFA and other projects	Chair	ASAP
18	6.8	to develop a group to assess the technical feasibility of adding wave measurements to existing mooring designs, and to develop requirements specifications	Swail	ASAP
19	6.11	to seek an overview of the state of commitments and planning for ocean satellites for report at OOPC-9	Chair, Johannessen, Secretariat	OOPC-9
20	7.3	to link observing system monitoring results to the OOPC web site	Secretariat	OOPC-9
21	7.4	to contact the CLIVAR SSG regarding the possibilities for data management for the time series stations	Weller, Keeley	OOPC-9
22	7.4	to encourage the Ocean Information Technology (OIT) project to interact with the US Data Management and Communications (DMAC) effort	Chair, Keeley	ASAP
23	8.1	to request GODAE and CLIVAR modeling groups to conduct observing system evaluation activities whenever feasible and	Chair	OOPC-9

		to report results to OOPC		
24	8.1	to request feedback from GODAE on the present and proposed initial observing system	Chair	OOPC-9
25	8.1	to initiate observing system evaluation via estimation of uncertainties in ocean climate index value estimates	all	OOPC-9
26	8.2.2	to request the JCOMM Observations Coordination Group to develop an implementation plan for achieving and maintaining global coverage and density for Argo and surface drifting buoys	Chair, Johnson	ASAP

10. DATE AND LOCATION OF NEXT SESSION

June 7-10, 2004, Southampton, England (decided in intersession).

ANNEX I
AGENDA

Wednesday, September 3rd	
0900 - 0945	**1. Opening and Welcome**
0945 – 1000	**2. Review and Adoption of the Agenda & OOPC-7 Report**
1000 - 1030	**3. OOPC Review 2002-2003 inc. Terms of Reference**
1030 – 1700 *coffee break* *1030 – 1045* *lunch break* *1230 – 1330* *coffee break* *1500-1515*	**4. The Next Steps Recommendations** (Harrison) 20min **5. SCIENCE** 5.1 Ocean climate 2002-2003 5.1.1 El Nino (McPhaden) (20min) 5.1.2 SST anomalies (Reynolds) (20min) 5.1.3 Other anomalies – (Harrison) (20min) 5.2 Invited Talks 5.2.1 Invited Talk #1: Open Ocean Waves, Swail (15 min) LUNCH 5.2.2Invited Talk #2: MOC, Clarke (45 min) 5.2.3 Invited Talk #3: Arctic Ocean, Morison (45 min) 5.3 Ocean climate indices (Discussion) 5.4 Ocean information for climate forecasting (Discussion)
Thursday, September 4th	
0900 – 1230 *coffee break* *1030 – 1045* *lunch break* *1230 – 1330*	**5. Sponsors Reports / Intersessional Activities** 5.1 Global Climate Observing System (GCOS) (Thomas) 10mins 5.1.1 Second Report on the Adequacy of the Global Climate Observing System Overview - (Harrison) 20min 5.1.2 GCOS Steering Committee (Harrison) 10min 5.1.3 GCOS Atmospheric Observations Panel for Climate (Harrison / Reynolds) 15min 5.2 Global Ocean Observing System (GOOS) 5.2.1 GOOS Coastal Ocean Observations Panel (Knap/Dickey) 30min 5.2.2 GOOS Steering Committee (Harrison) 15min 5.3 World Climate Research Program - JSC (Harrison) 10min 5.3.1 CLIVAR SC (Weller & CLIVAR Reps) 30min 5.4 JCOMM Observations Coordination Group (Johnson) 30min 5.5 JCOMM Co-President Comments (Naranyan) 15mins LUNCH 5.5 Other Organizations 5.5.1 Partnership for Observations of the Global Ocean (Weller) 10min 5.5.2 International Geosphere-Biosphere programs (Dickey) 30min 5.5.3 GMES report (Harrison for Johannessen) 15min
1330 - 1700 *coffee break* *1530-1545*	**6. Experiments, Programs, and Projects** 6.1 International Observation Activities 6.1.1 Status of TAO / TRITON and PIRATA Mooring Arrays (Michida/McPhaden/Campo) (40mins) 6.1.2 Argo profiling float program (Harrison) (10min) 6.1.3 GODAE (Harrison) (20min) 6.1.4 Volunteer Observing Ship Climate Project (Kent) (30min)

Friday, September 5th	
0900 – 1700 coffee break 1030 – 1045 lunch break 1230-1330 coffee break 1530-1545	6. Continued… 6.1.5 Time Series Stations (Weller) (30min) 6.1.6 Air-Sea Fluxes including WGASF (Weller) (20min) 6.1.7 Sea Surface Temperature / Sea Ice Working Group (Reynolds) (30min) 6.1.8 Ocean Carbon (Dickey) (30min) 6.1.9 GLOSS Tide Gauge Network (Johnson) (20min) 6.2 Basin Perspectives (including regional indices) 6.2.1 Atlantic (60min) (Campo, Visbeck, Clarke) 6.2.2 Pacific (60min) (Weller) 6.2.3 Indian (30min) (discussion) 6.2.4 Southern Ocean (30min) (Speer) 6.3 Satellites: 6.3.1 Status of missions - salinity, sea ice, microwave SST, surfac vector winds, sea surface height (Harrison for Johannessen) (30min) 6.3.2 WCRP Requirements meeting (Harrison, for Johannessen) (10min)
Saturday, September 6th	
0900-1230 coffee break 1030 – 1050	**6. Continued…** 6.4 Data (Keeley) 90 mins 6.4.1 Ocean Information Technology Project 6.4.2 Argo data system and progress towards implementation 6.4.3 Global Ocean Surface Underway Data Project (GOSUD) 6.4.4 Measures of data collection effectiveness to meet goals
	7. Adequacy, Next Steps, and Status for Ocean Climate 7.1 Observing system evaluation process (Harrison) 7.2 Ocean product evaluation process (Harrison)
lunch	**8. Summary of Action Items**
Close 1430	**9. Date and Location of Next Session**

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ANNEX III
LIST OF ACRONYMS

ACSYS	Arctic Climate System Study
ACVE	Atlantic Climate Variability Experiment
ADCP	Acoustic Doppler Current Profiler
ADEOS	Advanced Earth Observing Satellite (Japan)
ALACE	Autonomous Lagrangian Circulation Explorer
ANIMATE	Atlantic Network of Interdisciplinary Moorings and Time
AOML	Atlantic Oceanographic and Meteorological Lab (NOAA)
AOPC	Atmospheric Observing Panel for Climate
Argo	profiling fleet network (not an acronym)
ASCAT	Advanced Scatterometer
ATOC	Acoustic Thermometry of Ocean Climate
ATSR	Along Track Scanning Radiometer
AUV	Autonomous Underwater Vehicle
AVHRR	Advanced Very High Resolution Radiometer
BC	Boundary Current
BECS	Basin-Wide Extended Climate Study
BMRC	Bureau of Meteorology Research Center (Australia)
BODC	British Oceanographic Data Center
BSH	Bundesamt fur Seerschiffahrt and Hydrographie (Germany)
CAS	Commission for Atmospheric Sciences
CAVASOO	Carbon Variaibility Studies by Ships of Opportunity
CDS	Computerized Documentation System
CLIC	Climate and Cryosphere
CEOS	Committee for Earth Observation Satellites
CGOM	IOC Consultative Group on Ocean Mapping
CLIMAT	Report of Monthly Means and Totals from Land Stations
CLIVAR	Climate Variability and Predictability Program
CMR	Centre Meteorologico Regional
CNES	Centre National d'Etudes Spatiales (France)
CRYOSAT	Ice Observing Satellite (ESA)
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
CTD	Conductivity, Temperature, Depth
DAC	Data Assembly Centre
DM	Data Management
DODS	Distributed Ocean Data System
ECMWF	European Center for Medium-Range Weather Forecasting
EEZ	Exclusive Economic Zone
ENSO	El Nino Southern Oscillation
ENVISAT	Environmental Satellite
EOS	Earth Observation Satellite (US)
ERS	Earth Resources Satellite
ESA	European Space Agency
ESD	Earth Sciences Division
EUMETSAT	European Organization for Exploitation of Meteorological Satellites
FNMOC	Fleet Numerical Meteorology and Oceanography Center (US NAVY)
GCOS	Global Climate Observing System

GDACS	Global Data Assembly Centres
GEBCO	General Bathymetric Chart of the Oceans
GEF	Global Environmental Facility
GEO	Global Eulerian Observing System
GEOSAT	Geodetic Satellite (US)
GEWEX	Global Energy and Water Cycle Experiment
GLAS	Goddard Laboratory of Atmospheric Sciences (US)
GLI	Global Imager
GMT	Greenwich Mean Time
GOCE	Gravity field and steady state Ocean Circulation Experiment
GODAE	Global Ocean Data Assimilation Experiment
GOOS	Global Ocean Observing System
COP	Conference of the Parties (to the UN FCCC)
GOSIC	Global Observation System Information Center
GOSSP	Global Observing Systems Space Panel
GPCP	Global Precipitation Climate Project
GPO	GCOS Project Office
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment
GSC	GOOS Steering Committee
GTS	Global Telecommunications System
GTSPP	Global Temperature Salinity Profile Program
GUAN	Global Upper Air Network
G3OS	Shorthand for GOOS, GCOS, GTOS
HDX	High Density XBT Line
HOTO	Health of the Ocean Panel (of GOOS)
HOTS	Hawaii Ocean Time Series Station
IBCCA	International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
IBCEA	International Bathymetric Chart of the Central Atlantic
IBCM	Int'l Bathymetric Chart of the Mediterranean
IBCWIO	International Bathymetric Chart of the Western Indian Ocean
ICESAT	Ice Satellite (NASA)
ICPO	International CLIVAR Project Office
IGOS	Integrated Global Observing Strategy
IGOSS	Integrated Global Ocean Services System
IGST	International GODAE Science Team
IHB	International Hydrographic Bureau
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
IOCCG	International Ocean Color Coordinating Group
IOOS	Integrated Ocean Observing System (US)
IP	Implementation Plan
IPCC	Intergovernmental Panel on Climate Change
IR	Infrared
ISRO	Indian Satellite Research Organization
JAMSTEC	Japan Marine Science and Technology Centre
JCOMM	Joint Technical Commission On Oceanography and Marine Meteorology
JDIMP	Joint Data and Information Management Panel

JGOFS	Joint Global Ocean Fluxes Study
JMA	Japan Meteorological Agency
JSTC	Joint Scientific and Technical Committee
KERFIX	Kerguelan Time series Station
LMR	GOOS Living Marine Resources Panel
MERIS	Medium Resolution Imaging Spectrometer
METOP	Meteorological Operational Satellite
MJO	Madden-Julian Oscillation
MOC	Meridional Overturning Circulation
NAO	North Atlantic Oscillation
NASDA	National Japanese Space Development Agency
NCDC	National Climatic Data Centre
NCEP	National Center for Environmental Prediction (US)
NEG	Numerical Experimentation Group
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
NOAA	National Oceanic and Atmospheric Administration (US)
NPOESS	National Polar-Orbiting Operational Environmental Satellite System (US)
NPP	NPOESS Preparatory Program
NSCATT	NASA Scatterometer
NWP	Numerical Weather Prediction
OCTS	Ocean Color and Temperature Scanner
OGCM	Ocean General Circulation Model
OGP	Office of Global Programs (US)
OOP	Ocean Observations Panel
OOPC	GOOS-GCOS-WCRP Ocean Observations Panel for Climate
OOS	Ocean Observing System
OSSE	Observing System Simulation Experiment
PBECS	Pacific BECS
PICES	Pacific ICES
PDO	Pacific Decadal Oscillation
PIRATA	Pilot Research Array in the Tropical Atlantic
PMEL	Pacific Marine Environmental Laboratory (of NOAA)
PMO	Port Meteorological Officer
POGO	Partnership for Observations of the Global Oceans
PRA	Principle Research Area (of CLIVAR)
QC	Quality Control
QSCAT	Version of Scatterometer
RMS	Root Mean Square
SAFZ	Sub-Arctic Frontal Zone
SBSTA	Subsidiary Body for Scientific and Technological Advice {of the COP for the UNFCCC}
SCOR	Scientific Committee for Oceanic Research
SIO	Scripps Institution of Oceanography
SLP	Sea Level Pressure
SMOS	Soil Moisture Ocean Salinity Satellite (ESA)
SOC	Southampton Oceanography Centre
SOC	Specialized Oceanographic Centre
SOCIO	Sustained Observations for Climate of the Indian Ocean
SOCSA	Sustained Observations for Climate for the South Atlantic

SOOP	Ship-of-Opportunity Programme
SSIWG	Salinity - Sea Ice Working Group
SSS	Sea Surface Salinity
SST	Sea Surface Temperature
SURFA	Surface Reference Sites Project
TAO	Tropical Atmosphere - Ocean (buoy array)
TEMA	Training Education and Mutual Assistance
TRITON	Japanese Moored Buoy in TMBN
TRMM	Tropical Rainfall Measuring Mission
TS	Temperature Salinity
UKMO	UK Met Office
UNFCCC	United Nations Framework Convention on Climate Change
UOP	Upper Ocean Panel
UOT	Upper Ocean Thermal
VAMOS	Variability of the American Monsoon Systems
VIIRS	Visible and Infra-red Sensor (NPOESS Sensor)
VOS	Voluntary Observing Ship
WBC	Western Boundary Current
WCRP	World Climate Research Program
WDB	WMO Data Base
WGASF	Working Group on Air-Sea Fluxes
WGNE	Working Group on Numerical Experimentation
WGSIP	Working Group on Seasonal to Interannual Predication
WHOI	Woods Hole Oceanographic Institution
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WS	Workshop
XBT	Expendable Bathythermograph
XCTD	Expendable Conductivity Temperature Depth Instrument