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Report of the Second Session of the CLIVAR / CliC Southern Ocean Panel

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CLIVAR is a component of the World Climate Research Programme (WCRP), which was established by WMO and ICSU, and is carried out in association with IOC and SCOR. The scientific planning and development of CLIVAR is under the guidance of the JSC Scientific Steering Group for CLIVAR assisted by the CLIVAR International Project Office. The Joint Scientific Committee (JSC) is the main body of WMO-ICSU-IOC formulating overall WCRP scientific concepts.

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1. ACTION ITEMS

Action items are grouped into the following categories:

1. Progress in implementation
2. Cross panel and project cooperation
3. Regional integration
4. Carbon issues
5. Data issues
6. International Polar Year
7. Other relevant issues

1. Progress in implementation

1:1. A white paper on sustained observations and process studies needed in the Sea Ice Zone to be completed. Arnold Gordon to coordinate contributions *(Arnold Gordon)*.

1:2. Several countries are now carrying out sections across the Drake Passage. It would be useful to have this work summarised *(Stuart Cunningham)*

2. Cross panel and project cooperation

2:1. Panel to produce a list of climate indices based on Southern Ocean phenomena for the OOPC. Of particular interest are indices that rely on *in situ* observations, to help demonstrate their value. *(various, coordinated by Kevin Speer)*.

2:2. At the request of the OOPC, the Panel is to produce a white paper for time series sites in the Southern Ocean, including science justification, summary of funded and proposed work, and rationale for oceanographic use of observatories deployed by other programs (e.g. DEOS sites). *(Initial draft from Steve Rintoul, subtropical; Rosemary Morrow, Kerguelen; Kevin Speers, SE Pacific; comments and input from panel)*

2:3. Now that the WCRP Working Group on Surface Fluxes has been formed, former action item 12 (The panel supports the formation of an air-sea flux group and seeks advice from them on the correct mix of SO observations that the Panel should advocate) can be carried over. Steve to ask Chris Faroe; Mark Bourassa *(Steve Rintoul)*

2:4. Chad Dick to distribute CliC implementation strategy document with the CliC Project Area descriptions when available, for comment and discussion by the panel. *(Chad Dick)*

3. Regional integration

3:1. There was concern from the panel that the newly formed Indian Ocean panel should be able to cover circulation issues in mid latitudes, CO_2 issues etc. The panel recommend appointing someone to the panel who has an interest in these matters *(Chairs to write to SSG and Gary Meyers)*

4. Carbon issues

4:1. No standards or protocols have been specified for carbon measurements conducted on CLIVAR cruises. The panel suggests that the International Ocean Carbon Coordination Project (IOCCP) prepare recommendations to be circulated among the CLIVAR basin panels and SSG and distributed to PI's. *(Chris Sabine)*

4:2. The panel identified a need for more international coordination of carbon measurements (e.g. carbon groups were not always aware of cruise opportunities where collaboration might fill gaps in the global array of carbon measurements). The panel recommends that individual PIs and national reps let Katy

Hill (who is the CLIVAR Carbon staffer) (klh@soc.soton.ac.uk) and Maria Hood (m.hood@unesco.org) know of their plans. (*Mike Sparrow, Katy Hill)*

4:3. Chris Sabine to contact Nicolas Metzl about the possibility of including deep carbon stations on some OISO cruises. *(Chris Sabine)*

4:4. Chairs to write to US funding agencies iterating the importance of Carbon measurements in the Southern Ocean *(chairs and Chris Sabine)*

5. Data issues

5:1. Check that Southern Ocean XBT data collected regularly by several nations (e.g. China, Japan) is being submitted to data centres. *(Shigeru Aoki)*

5:2. Arnold Gordon to contact Raytheon to encourage submission of underway data collected on US ships (e.g. thermosalinograph) to Coriolis Data Centre *(Arnold Gordon).*

5:3. Panel to enquire how much of the SO TSG data is being submitted to the Coriolis data centre *(national reps headed by Rosemary Morrow).*

5.4 Need to ensure integration of CLIVAR and CliC data systems, in particular to ensure easy access to integrated data sets by users. Stuart Cunningham to coordinate with CLIVAR and CliC data management efforts. Stuart and Shigeru Aoki to draft recommendations for the CLIVAR data management system and contribute to the planned workshop. *(Stuart Cunningham and Shigeru Aoki)*

6. International Polar Year

6:1. The International Polar Year. The panel will submit a statement of intent with suggestions for a focus for the IPY. *(coordinated by Steve Rintoul).*

7. Other relevant issues

7:1. Add relevant links and text to SO panel web site to underscore importance of carbon, paleo-oceanography, atmospheric circulation and modelling (areas with insufficient attention in original implementation plan). *(Chris Sabine, Philip Froelich, Ian Simmonds, Gurvan Madec, coordinated by Mike Sparrow)*

7:2. Stuart Cunningham to circulate the South Atlantic (SACOS) meeting report to the panel when available. *(Stuart Cunningham)*

7:3 Mike Sparrow to chase up national reports for e.g. Spain, other Latin American countries and ensure that the present reports are kept updated. *(Mike Sparrow)*

7:4 Chairs to write a letter to SCOR endorsing iAnzone's contribution to Southern Ocean research *(chairs)*

7:5. The importance of IPAB to SLP, SST measurements in the Southern Ocean should be made clear. Chairs to write to SCAR. (*Steve Rintoul, Eberhard Fahrbach and Enrico Zambianchi)*

2. INTRODUCTION

The Southern Ocean (SO) CLIVAR/CliC panel is charged with refining and implementing the science plans of CLIVAR and CliC in the SO Sector. The panel was formed as the result of a recommendation from a SO workshop held in Perth, Australia, in November 2000 and held its first meeting in Hobart, Australia in March 2002.

The terms of references (TORs) of the panel are:

1 To design a strategy to assess climate variability and predictability of the coupled ocean-atmosphere-ice system in the Southern Ocean region.
2 To develop and refine an implementation plan for the Southern Ocean region that defines the process studies, sustained observations, and model experiments needed to meet the objectives of CLIVAR and CliC.
3 To work in concert with relevant CLIVAR panels (e.g. regional panels, numerical experimentation groups), ACSYS/CliC Panels (DMIP, OPP, NEG) and other groups (e.g. Ocean Observation Panel for Climate, Argo Science Team) to integrate SO observations with those in neighbouring regions to ensure the objectives of CLIVAR/CliC are met and resources are used efficiently.
4 To enhance interaction between the meteorology, oceanography, cryosphere, biogeochemistry and paleoclimate communities with an interest in the climate variability of the SO region.
5 To serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the SO region
6 To work with the CLIVAR and CliC data systems on issues related to distribution and archiving of SO observations.
7 To advise the CLIVAR and ACSYS/CliC SSGs on progress achieved towards implementation.

For further details see: http://www.clivar.org/organization/southern/

The current members (at the time of the meeting) of the SO CLIVAR/CliC Panel are:

S. Rintoul - co-chair	CSIRO, Hobart, Australia
E. Fahrbach - co-chair	Alfred-Wegener-Institut für Polar und Meeresforschung, Bremerhaven, Germany
S. Aoki	National Institute for Polar Research, Tokyo, Japan
I. Allison	Antarctic CRC, Hobart, Australia
S. Cunningham	Southampton Oceanography Centre, Southampton, UK
P. Froelich	Florida State University, Talahassee, USA
A. Gordon	Lamont Doherty Earth Observatory, Palisades, USA
G. Madec	LODYC, Paris, France
D. Martinson	Lamont Doherty Earth Observatory, Palisades, USA
R. Morrow	LEGOS, Toulouse, France
C. Sabine	NOAA/PMEL, Seattle, USA
I. Simmonds	University of Melbourne, Melbourne, Australia
K. Speer	Florida State University, Talahassee, USA
M. Sparrow	International CLIVAR Project Office (ICPO), Southampton Oceanography Centre, Southampton, UK
C. Ereño	ICPO South American representative, University of Buenos Aires, Buenos Aires, Argentina

There are also several national representatives (see Appendix 4) who keep the panel – and SO community as a whole – up to date with their country's work in the SO region.

Unfortunately Ian Allison, Phillip Froelich, Gurvan Madec and Ian Simmonds were unable to make this second meeting. However, by making use of invited experts a good cross section of the Southern Ocean Science community was represented. A full list of the attendees is given in Appendix 1.

This report is a summary of progress made by the end of the second meeting. For a more recent update of the panel's activities please see http://www.clivar.org/organization/southern/ or email Mike Sparrow (m.sparrow@soc.soton.ac.uk).

3. WELCOME AND PURPOSE OF MEETING

The second meeting of the CLIVAR/CliC Southern Ocean Panel was held at the Alfred-Wegener Institute (AWI) in Bremerhaven, Germany in the context of a "Southern Ocean Science Week" held on the 5-12 of September 2003.

The Southern Ocean Science Week was designed to facilitate interaction between a number of groups with responsibility for aspects of Southern Ocean research, including:

- The WCRP International Programme for Antarctic Buoys (IPAB),
  Contact: Enrico Zambianchi (enrico.zambianchi@uninav.it)
- The Climate Variability and Predictability (CLIVAR) and the Climate and Cryosphere (CliC) Southern Ocean panel,
  Contact: Mike Sparrow (m.sparrow@soc.soton.ac.uk)
- The International Antarctic Zone (iAnZone) SCOR affiliated programme,
  Contact: Karen Heywood (K.Heywood@uea.ac.uk)
- The Antarctic Sea-Ice Processes and Climate project (ASPeCt) within the SCAR Global Change Programme
  Contact: Steve Ackley (sackley@pol.net)
- The participants of the cruise of the Polarstern to the Weddell Sea ANT XXII/2 from 6 November 2004 to 24 January 2005: Ice Station POLarstern (ISPOL)
  Contact: Hartmut Hellmer (hhellmer@awi-bremerhaven.de)
- The participants of the GOODHOPE project
  Contact: Sabrina Speich (Sabrina.Speich@univ-brest.fr)

A day of science talks mid-week provided an excellent overview of the status of Southern Ocean research relevant to each of the groups meeting during the Southern Ocean Science Week. Copies of presentations given at the CLIVAR/CliC panel meeting can be downloaded from: http://www.clivar.org/organization/southern/so2_talks.html

4. OVERVIEW AND STATUS OF CLIVAR

The meeting continued with a talk prepared by Howard Cattle and given by Mike Sparrow on the status of CLIVAR. Mike started by giving an overview of CLIVAR and CliCs' sister projects in WCRP such as the Global Water and Energy Experiment (GEWEX) and Stratospheric Processes and Climate (SPARC), before discussing CLIVAR.

The objectives of CLIVAR are:

- To describe and understand the physical processes responsible for climate variability and predictability on seasonal, interannual, decadal, and centennial time-scales, through the collection and analysis of observations and the development and application of models of the coupled climate system, in co-operation with other relevant climate research and observing programmes.
- To extend the record of climate variability over the time-scales of interest through the assembly of quality-controlled paleoclimatic and instrumental data sets.
- To extend the range and accuracy of seasonal to interannual climate prediction through the development of global coupled predictive models.
- To understand and predict the response of the climate system to increases of radiatively active gases and aerosols and to compare these predictions to the observed climate record in order to detect the anthropogenic modification of the natural climate signal.

CLIVAR implementation, and the role of the International CLIVAR Project Office (ICPO) were discussed. The panel were reminded of the first International CLIVAR Science Conference to be held in June 2004 in Baltimore, USA.

Issues of relevance to the SO panel arising from the last meetings of the Joint Steering Committee (JSC) and Scientific Steering Group (SSG) were highlighted. These included:

- Nominate CLIVAR contacts to work with CliC Project Office on International Polar Year (IPY) Plans
  (The IPY was a major focus of discussion for the SO panel. See Section 18.)
- Concept of Indian Ocean Basin Panel with limited lifetime endorsed…
  (Recommendations on the makeup of the new Indian Ocean panel are found in Section 9.)
- Develop terms of reference (TOR) and suggested membership for a new Panel to replace COOP which would include responsibilities for ocean, atmosphere and coupled reanalysis, surface fluxes, data management, links with atmospheric research community, WMO bodies, GCOS, GTOS and AOPC; Name: CLIVAR Global Synthesis and Observations Panel (GSOP)
  (Input on membership and TOR was provided prior to the panel meeting by email.)
- Accept IOC recommendations for joint carbon cycle reps on basin panels and joint website effort.
  (The SO panel has always had a carbon representative (Chris Sabine), which has worked very well. The panel was pleased to see that the other basin panels were being encouraged to do the same.)
- All CLIVAR Panels to provide a brief summary of what they have accomplished relative to what they set out to do and what they think they can achieve by a given sunset date of 2013
  (A summary will be provided to the SSG by their next meeting.)
- Develop goals of a data management workshop and charge to a data consultant.
- Hold workshop in next 9 months to develop an overall data strategy for CLIVAR

The status of data issues in CLIVAR remains an issue of concern to the panel. The panel agreed to the strategy proposed by SSG and nominated the data contacts for the panel (Stuart Cunningham and Shigeru Aoki) to take this forward (see Section 22).

5. OVERVIEW AND STATUS OF CliC

Vladimir Ryabinin gave an overview on the status of the CliC (Climate and Cryosphere) and ACSYS (Arctic Climate System Study) projects. The principal goal of CliC is to "Assess and quantify the impacts of climatic variability and change on components of the cryosphere and their consequences for the climate system, and determine the stability of the global cryosphere." CliC also has several supporting objectives, which include remit to:

- Enhance the observation and monitoring of the cryosphere in support of process studies, model evaluation and change detection
- Improve understanding of the physical processes and feedbacks through which the cryosphere interacts within the climate system
- Improve the representation of cryospheric processes in models to reduce uncertainties in simulation of climate and predictions of climate change

Vladimir described the major themes of relevance to CliC, and gave several detailed science examples, for example the glacier surge after the collapse of the Larsen Ice Shelf. Satellite missions of relevance to CliC goals such as ICESat and CryoSat were discussed. Finally Vladimir announced that the first CliC Science Conference "A changing cryosphere and its interaction with global climate" would be held at the beginning of 2005.

CliC has nominated four project areas:

- Terrestrial cryosphere
- Oceans and the marine cryosphere
- Glaciers and sea-level rise
- Cryosphere and global climate

To date, no coordinators have been nominated for these theme areas. Ocean – ice shelf interactions were described as on the CliC "wish list" but is not an active project area at present. This may be an area where the joint CLIVAR/CliC panel can play a role.

CliC is preparing an "implementation strategy" document to be available in the first half of 2004.

ACTION: Chad Dick to distribute CliC implementation strategy document with the CliC Project Area descriptions to panel members for comment. (Chad Dick).

6. REVIEW OF ACTION ITEMS FROM LAST MEETING

Mike Sparrow reiterated that the discussion sessions in the meeting agenda (see Appendix 2) each had action items from the last meeting associated with them. Therefore these were mainly dealt with throughout the week. All the action items from the last meeting and the actions taken to deal with them are summarised in Appendix 3.

7. STATUS OF IMPLEMENTATION PLAN

At the last meeting it was thought to be a good idea to produce an evolving version of the implementation plan on the web in order to update the original (see WCRP report WCRP-103 "CLIVAR Initial Implementation Plan" and previous Action Item (23), Appendix 3). Steve Rintoul put to the panel that it was perhaps not worth pursuing this as the panel's efforts were better spent in addressing themes such as the IPY and producing white papers for specific topics (e.g. the sea ice zone).

Most of the panel agreed with this sentiment. Chris Sabine suggested that although the implementation plan doesn't necessarily require a re-write, some statement from the panel that Carbon issues are of relevance to CLIVAR would be advantageous.

Chad Dick and others in the panel thought that it might be a good idea to include a statement as to why each of the 'missing' parts (Carbon, paleo, atmosphere and models) of the implementation plan are important and have pointers to relevant pages.

ACTION: Add relevant links and text to SO panel web site to underscore importance of carbon, paleo-oceanography, atmospheric circulation and modelling (areas with insufficient attention in original implementation plan). (Chris Sabine, Philip Froelich, Ian Simmonds, Gurvan Madec, coordinated by Mike Sparrow)

8. OOPC (OCEAN OBSERVATIONS PANEL FOR CLIMATE)

The OOPC now invites representatives from the CLIVAR basin panels, a move that the SO panel strongly supports. Kevin Speer, as the SO panel representative, attended the last OOPC meeting, held shortly before the SO panel meeting.

The OOPC is sponsored by three groups: GOOS (Global Ocean Observing System), GCOS (Global Climate Observing System, and WCRP. It provides recommendations for the enhancement, or missing elements, of the climate observing system with an emphasis on sustained observations.

Following his overview of OOPC activities, Kevin went on to summarise the sparse observing system in the SO region. The basic message was that *in situ* (Argo, Expendable Bathythermograph (XBT), etc) data are far from adequately sampling the ocean because, e.g. of daily, seasonal, and regional biases. Better sampling is needed to correct biases for data-based analyses and to aid the interpretation and calibration of satellite data. The sort of enhancements required to the observing system are:

Drifters and floats

- Argo spatial coverage, especially the SE Pacific sector; also extension to the seasonal sea-ice zone to gain truly global coverage
- Surface drifters - wind slip calibrations, high wind conditions – in particular to extend tests of these to the Southern Ocean.

Surface Meteorology

- Enhance IMET coverage. *In situ* sampling of the diurnal cycle of SST (sea surface temperature) and wind will help with interpretation of sun synchronous satellite observations.
- Meteorological buoys in the seasonal sea-ice zone (T_air, wind…).
- Automated Weather Stations (AWS) on subantarctic islands.
- Surface Time-series stations in SE Indian (high mean wind conditions - some technological buoy development required) and Pacific-AA (synoptic variability) sectors.

Subsurface Oceanography

- Subsurface Time-series stations/arrays in the Ross Sea, Weddell Seas, and Princess Elizabeth Trough. The need is for *in-situ* monitoring since sea-ice zone boundary conditions so poorly known.
- XBT (sampling on Drake, Tasman, African, 32°S)

Sea-Ice

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

The OOPC has asked the SO panel to produce a list of climate indices for the Southern Ocean region. The OOPC has also asked for quantitative arguments for the justification of elements of the observing system. An initial discussion at the meeting identified a number of candidates, and individuals were nominated to take these forward:

Sea ice – extent, thickness at key sites, drift divergence, key coastal polynyas etc. (Ian Allison along with ASPeCt)

Ocean circulation – e.g. ACC (Antarctic Circumpolar Current) transport, bottom pressure, baroclinic flow through key locations from PIES (pressure inverted echo sounders), front position and variability, SST, coastal ice-core based indices (Rosemary Morrow, Stuart Cunningham, Shigeru Aoki)

Water mass properties - Bottom Water outflow from Weddell, Ross Sea shelf water, SAMW, Carbon etc. (Eberhard Fahrbach, Chris Sabine)

Atmosphere – SAT (surface air temperature), SLP (sea level pressure), Paleo, cyclone numbers and depth etc. (Ian Simmonds)

Other –

AABW (Antarctic Bottom Water), AAIW (Antarctic Intermediate Water), SAMW (Subantarctic Mode Water) formation rates, strength of overturning circulation in each basin, ACC absolute transport, sea ice volume (Steve Rintoul)

Number of icebergs, export from Weddell Sea..? (Eberhard Fahrbach)

ACTION: Panel to produce list of climate indices based on Southern Ocean phenomena, for OOPC (various, coordinated by Kevin Speer)

A general message from the OOPC was that evaluations of the ocean observing system are few and more effort is need to demonstrate the impact of various observations, to justify their continued support (this is not just directed at the Southern Ocean case).

A number of other items were discussed:

The lack of regular temperature observations from XBTs is a long-standing problem in the Southern Ocean. The problem perhaps looks even worse because it is not clear that data from some regularly occupied lines are reaching the relevant data centres.

ACTION: Check that Southern Ocean XBT data collected regularly by several nations (e.g. China, Japan) is being submitted to data centres. (Shigeru Aoki)

There is a great need for subsurface float data in the Sea Ice Zone. At present there are several groups working on this problem. Olaf Boebel has developed some ice-avoidance software that is now available on floats manufactured by Webb. By avoiding surfacing when the mixed layer is at the freezing point, the floats can survive the winter season. A capability to store the winter profiles and download the following summer should be available soon. Several groups are testing approaches to acoustically track floats under the ice, which is needed to determine the position of under-ice profiles (e.g. Fahrbach, Boebel, Riser, Speer).

ACTION: At request of OOPC, Panel to produce a white paper for time series sites in the Southern Ocean, including science justification, summary of funded and proposed work, and rationale for oceanographic use of observatories deployed by other programs (e.g. DEOS sites). (Initial draft from Steve R, subtropical; Rosemary M, Kerguelen; Kevin S, SE Pacific; comments and input from panel)

The panel suspects that much of the thermosalinograph (TSG) data collected on a regular basis in parts of the Southern Ocean is not getting on the GTS (Global Telecommunication System) and is not being submitted in delayed mode to data centres. TSG data would be very useful for studies of the seasonal cycle of the upper ocean and air-sea interaction (recognizing that surface salinity requires careful calibration and quality control). Surface fCO_2 measurements also may not be reaching data centres.

ACTION: Arnold to contact Raytheon to encourage submission of underway data collected on US ships (e.g. thermosalinograph) to Coriolis data centre (Arnold Gordon).

ACTION: Panel to enquire how much of the SO TSG data is being submitted to the Coriolis data centre (national reps headed by Rosemary Morrow).

9. THE INDIAN OCEAN

At the last meeting the SO panel expressed its concern that the Indian Ocean sector falling between the remit of the SO panel and the Asian-Australian Monsoon Panel (AAMP) would be likely to be overlooked. It therefore pushed for the formation of a separate Indian Ocean panel. Since such a panel is now in the process of being formed the SO panel felt it should be discussed at this meeting.

Steve Rintoul started the discussion by listing those issues of relevance to both panels. These may include:

- That the Indian Ocean is open to exchange with the Southern Ocean
- The importance to the meridional overturning circulation
- That the southern Indian Ocean is an important formation region of SAMW
- The upper branch of overturning circulation
- Impacts of carbon storage
- Impact of SST (e.g. Indian Ocean dipole, equator?)
- Impact of south Indian Ocean SST on regional climate?
- The subtropical cell

There were several hydrography/data issues of relevance to both the Indian Ocean and SO panels:

- Argo in south Indian Ocean: commitments sufficient?
- 30°S XBT line
- Future repeat hydrography/carbon
- Plans for moorings/monitoring of the Agulhas Current
- Time series sites in the south Indian Ocean (DEOS and others)

Chris Reason also gave a brief talk on Indian Ocean issues. The significance of various interannual SST anomaly patterns in the subtropical and mid-latitude South Indian Ocean for southern African and Australian rainfall variability was mentioned. There seems to be a linkage between mid-latitude SST anomalies in the SW Indian Ocean with those in the SW Atlantic (such that the latter lead by about 1 month) and a wavenumber 3 or 4 pattern in the Southern Hemisphere atmospheric circulation.

The deficiencies of NCEP and ECMWF operational models in representing the latent and sensible heat exchange over the Agulhas Current region was also discussed. Heat exchange here influences both South African and Australian rainfall. Flux measurements taken over the northern part of the planned GOODHOPE cruises may help provide better information to improve operational models.

ACTION: There was concern from the panel that the newly formed Indian Ocean panel should be able to cover circulation issues in mid latitudes, CO_2 issues etc. The panel recommend appointing someone to the panel who has an interest in these matters (Chairs to write to SSG and Gary Meyers)

10. THE SOUTH ATLANTIC

Stuart Cunningham reported on the CLIVAR workshop on the South Atlantic Climate Observing System (SACOS) held in February 2003. The motivation behind this workshop was "to foster participation of South Atlantic countries in the formulation of a research strategy which will contribute to the development of a South Atlantic Climate Observing System".

It was obvious from the workshop that there is a diversity of opinions of what the important physical mechanisms associated with South Atlantic climate variability on all timescales were. However, it was agreed that a key problem in the South Atlantic was the need to make better estimates of circulation and fluxes, for example:

- What is the meridional heat flux through the South Atlantic?
- What factors determine and can induce variability in the meridional heat flux?

Several ideas were proposed at the workshop to try to resolve these issues:

- A section at 24°S (motivated by the reduced eddy activity at this latitude compared to 30°S and to observe flux of NADW through a gap in the Mid Atlantic Ridge (MAR))
- Repeat hydrographic sections in different seasons to understand upper ocean variability
- Moorings at the boundaries and on the MAR
- A zonal section is needed to close the box of the Southern Ocean meridional sections associated with GOODHOPE and Drake Passage
- UK will propose a section for sometime between 2005 and 2009

The panel were encouraged by progress made at the SACOS meeting.

ACTION: Stuart Cunningham to circulate the South Atlantic (SACOS) meeting report to the panel when available. (Stuart Cunningham)

11. CARBON-CLIVAR INTERACTIONS AND SOUTHERN OCEAN CARBON STUDIES

Chris Sabine started by introducing the panel to the International Ocean Carbon Coordination Project (IOCCP). The IOCCP is working with national, regional, and international programmes and data centres to provide a global view of ocean carbon by:

- Developing a compilation and synthesis of ocean carbon activities and plans;
- Working with international research programmes to fully integrate carbon studies into planning activities;
- Standardising data formats;
- Ensuring the continued development and use of certified reference materials;
- Supporting regional synthesis groups and creating regional databases.

Chris then discussed planned and funded sections of importance for carbon measurements including the Japanese "around the world" 32°S cruise, -the Australian sections such as I9S, a large multi-European project called Carbo-Ocean, and the US CLIVAR/Carbon repeat hydrography programme.

Chris pointed out that currently both the UK and Spain want to occupy Drake Passage (SR1) in 2005 and 2008 (amongst others). The Russians have proposed to occupy A16, SR1, and SR2 in the 2003-2005 time frame.

ACTION: The panel identified a need for more international coordination of carbon measurements (e.g. carbon groups were not always aware of cruise opportunities where collaboration might fill gaps in the global array of carbon measurements). The panel recommends that individual PIs and national reps let Katy Hill know (klh@soc.soton.ac.uk) of their plans. (Mike Sparrow and Katy Hill)

ACTION: No standards or protocols have been specified for carbon measurements conducted on CLIVAR cruises. The panel suggests that the International Ocean Carbon Coordination Project (IOCCP) prepare recommendations to be circulated among the CLIVAR basin panels and SSG and distributed to PI's. (Chris Sabine)

ACTION: Chris Sabine to contact Nicolas Metzl about the possibility of including deep carbon stations on some OISO cruises. (Chris Sabine)

ACTION: Chairs to write to US funding agencies iterating the importance of carbon measurements in the Southern Ocean (chairs and Chris Sabine*)*

12. GLOBAL AND HEMISPHERIC CLIMATE VARIATIONS AFFECTING THE SOUTHERN OCEAN

Steve Rintoul gave a talk on global and hemispheric climate variations affecting the Southern Ocean using a presentation supplied by Ian Simmonds. This covered the following topics:

- Survey of large scale influences on the Southern Ocean
- Modes of atmospheric variability
- Role of cyclones in Southern Hemisphere (SH) climate
- Atmosphere-Southern Ocean fluxes of kinetic energy and moisture
- Recent behaviour of the 'Southern Annular Mode'

First and second modes of SH atmospheric variability are the

- Southern Annular Mode (SAM)
- Pacific-South American pattern (PSA)

The polarity of these strongly influences conditions in the SO (changes in the westerlies, impact on sea ice extent, etc.). The SAM has moved progressively into a more positive phase over last few decades. Is this typical or atypical behaviour? This could explain, in part, the absence of sea ice retreat over the period (cf Arctic ice). It may also explain some of the warming over the western Antarctic Peninsula (see Figure 1).

Other large scale modes which influence the Southern Ocean area are the Semi-annual Oscillation (SAO) and the Antarctic Circumpolar Wave (ACW).

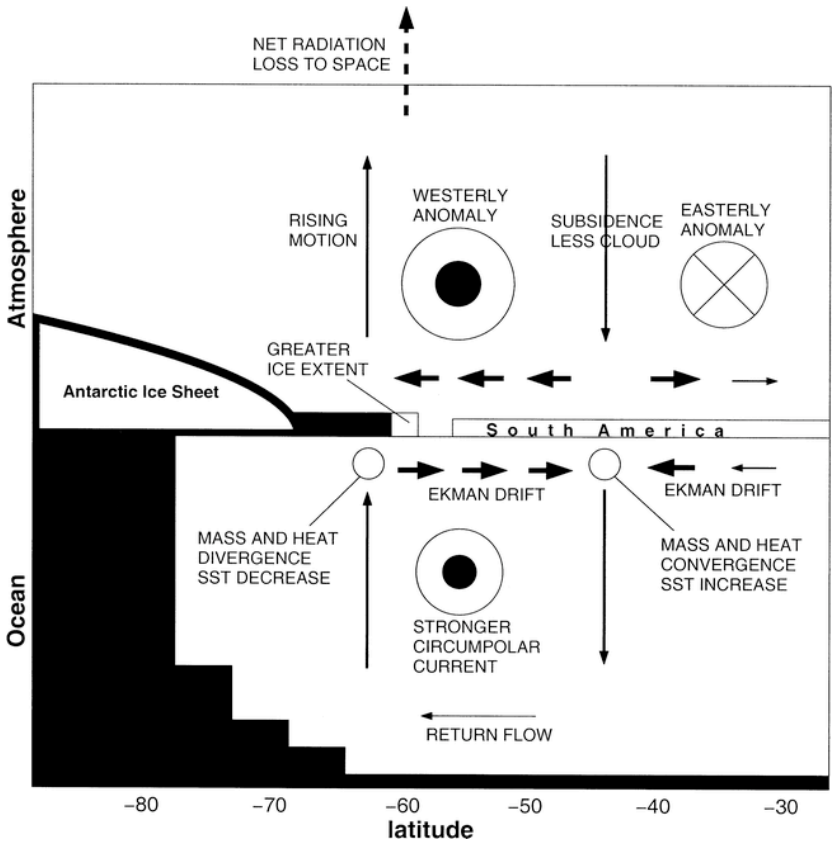


Figure 1 – Schematic of the changes in the atmosphere and ocean that occur when the SAM index is positive (from Hall and Visbeck, 2002, Journal of Climate, Vol15, No21, 3043-3057). A poleward movement and strengthening of the westerlies drives changes in Ekman transport, which in turn drive changes in the overturning circulation, sea ice extent, and a weak increase in the strength of the ACC.

Chris Reason also gave a talk on the relationship between SST and climate variations in southern Hemisphere countries. There appear to be statistical relationships between the Antarctic Oscillation and winter rainfall in both southern Australia and south-western South Africa. The latter region may also be modulated by the Pacific South America pattern whose influence appears to extend well into the South Atlantic region. Further investigation of the influence of these modes on subtropical to mid-latitude SST and rainfall in the neighbouring Southern Hemisphere landmasses is needed.

Several issues of relevance to the SO panel came out from the discussion:

- Is there evidence for the influence of mid or high lat SST on regional climate?
- Are the SST changes predictable?
- What are the changes in the nature of the ACW and what are its impacts?
- Impact of change in cyclones?

A general discussion on air-sea fluxes then followed. Several points were raised:

- There is a need for justification of enhanced met observations (e.g. IMET on supply ships, on Antarctic continent and Subantarctic islands) to e.g. validate satellite data, models etc.
- Do drifters with sea level pressure sensors make any difference to reanalysis products? How many do we need?

ACTION: Now that the WCRP Working Group on Surface Fluxes has been formed, former action item 12 (The panel supports the formation of an air-sea flux group and seeks advice from them on the correct mix of SO observations that the Panel should advocate) can be carried over. Steve Rintoul to ask Chris Faroe; Mark Bourassa (Steve Rintoul).

13. SUMMARY OF OBSERVATIONS AND NATIONAL PROGRAMMES

We now have national reports from fourteen countries (a list of the SO panel national representatives is given in Appendix 4). This is excellent, but there is a need to get input from other countries that have not yet contributed. There is also a need to keep the national reports updated.

ACTION: Mike to chase up national reports for e.g. Spain, other Latin American countries and ensure that the present reports are kept updated. (Mike Sparrow)

Mike went on to show figures from the new 'Observing system in the SO region' webpage. CLIVAR and CliC activities in the Southern Ocean region will benefit greatly from coordination among the various countries and investigators involved. The SO observations webpage contains a comprehensive inventory of ongoing and planned observational efforts in the Southern Ocean region (see Figures 2 and 3). The panel felt that this was an important effort and should be maintained and kept continually updated. See: http://www.clivar.org/ organization/southern/CLIVAR_CliC_Obs.html

ACTION: Several countries are now doing sections across the Drake Passage. It would be useful to have this work summarised (Stuart C)

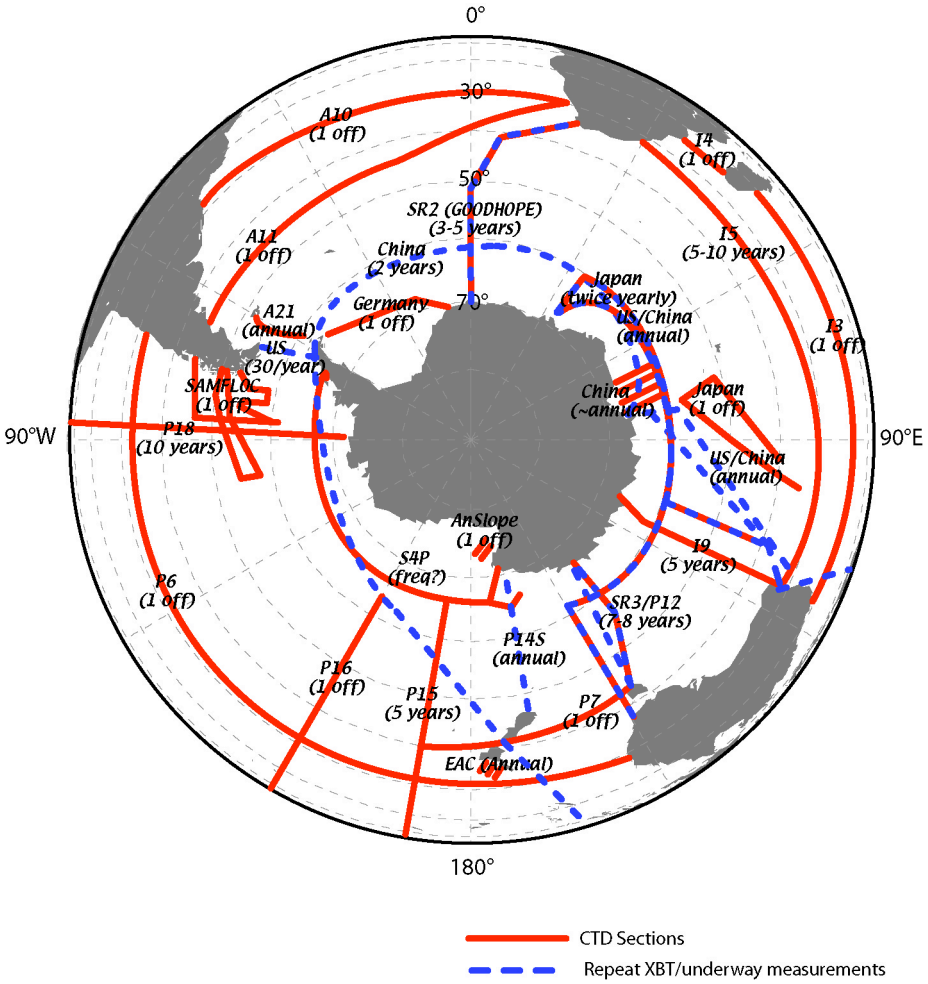
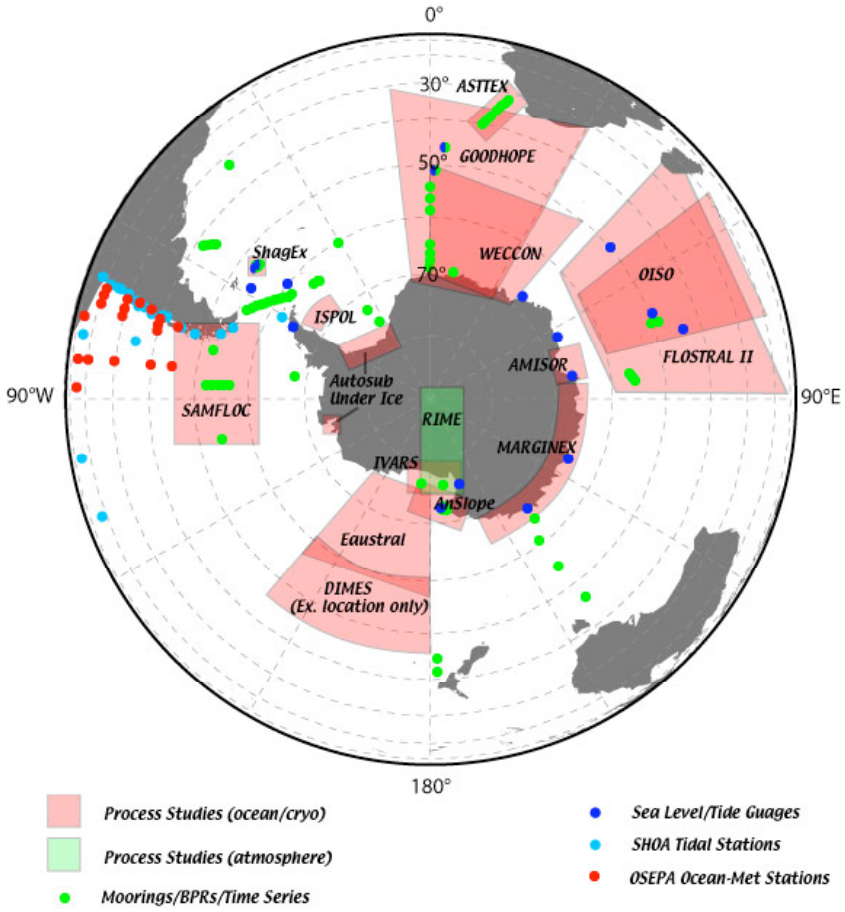


Figure 2 – Schematic of planned or ongoing hydrographic, XBT and underway measurements. Numbers in brackets refer to the frequency of measurements. For further details see: http://www.clivar.org/organization/ southern/CLIVAR_CliC_Obs.html. Please email any additions or corrections to m.sparrow@soc.soton.ac.uk.



Project Name		Main Contact	
AMISOR	(Amery Ice Shelf Ocean Response Experiment)	N. Bindoff	n.bindoff@utas.edu.au
AnSlope	(Cross-Slope Exchanges at the Antarctic Slope Front)	A. Gordon	agordon@ldeo.columbia.edu
ARGUA		D. Ruiz-Pino	ruiz@oceanar.mil.ar
ASTTEX	(Agulhas-South Atlantic Transport Experiment)	D. Byrne	dbyrne@umeoce.maine.edu
Autosub Under Ice		J. Copley	jtc@mail.soc.soton.ac.uk
CLIMA		G. Spezie	spezie@uninav.it
DIMES	(Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean)	J. Ledwell	jledwell@whoi.edu
Eaustral		K.Speer	kspeer@ocean.ocean.fsu.edu
FLOSTRAL II		R. Morrow	rosemary.morrow@cnes.fr
GASEX	(Southern Ocean air-sea CO2 exchange study)	W. McGillis	wmcgillis@whoi.edu
GOODHOPE		S. Speich	Sabrina.Speich@univ-brest.fr
ISPOL	(Ice Station POLarstern)	G. S. Dieckmann	gdieckmann@awi-bremerhaven.de
IVARS	(Interannual Variations in the Ross Sea)	Unknown	Unknown
MARGINEX		N. Bindoff	n.bindoff@utas.edu.au
OISO	(Ocean Indien Service d'Observations)	N. Metzl	metzl@ccr.jussieu.fr
RIME	(Ross Island Meteorology Experiment)	D. Bromwich	bromwich@polarmet1.mps.ohio-state.edu

SAMFLOC	(Subantarctic Mixed Layers, Fluxes and Overturning Circulation)	L. Talley	lynne@gyre.ucsd.edu
ShagEx	(the North Scotia Ridge Overflow Project)	D. Stevens	D. Stevens@uea.ac.uk
WECCON	(Weddell Sea Convection Control)	E. Fahrbach	efahrbach@awi-bremerhaven.de

Figure 3 – Schematic of planned or ongoing process studies, moorings and tide series stations, sea level and tide gauges, and met stations. For further details see: http://www.clivar.org/organization/southern/CLIVAR_CliC_Obs.html. Please email any additions or corrections to m.sparrow@soc.soton.ac.uk.

14. SUSTAINED OBSERVATIONS AND PROCESS STUDIES IN THE SEA-ICE ZONE

As a prelude to producing a white paper on the sea-ice zone, Arnold Gordon summarised a number of items that should be considered:

- Atmosphere observations: Improvement of met data over the Antarctic continent, ocean and sea ice is needed.
- Sea Ice: The sea ice cover varies seasonally, interanually and at longer time scales. Models suggest that the global temperature is sensitive to how sea ice is represented in climate models - albedo feedback is a key process.
- Atmospheric/upper ocean Boundary Layer at margins and over broken sea ice cover: Very cold stratified Antarctic air meets the coastal polynyas and broken fields of sea ice (5% leads).
- Glacial Ice: For example, the melting of glacial ice [at the base of ice shelves] through ocean contact is not only important to ice sheet budget and stability, but also fosters margin deep-reaching plumes. Are basal melting and iceberg calving rates changing?
- CLIVAR Repeat Sections: E.g. extending CLIVAR repeat sections to Antarctica is needed to better observe the changing nature of deep/bottom reaching ventilation, resolved at the regional scale): Is AABW formation rate slowing?
- Time Series: E.g. monitoring of outflow of newly formed deep and bottom water at select sites around Antarctica: Are the properties and magnitude of deep/bottom ventilation changing? Weddell outflow is monitored; add Ross and other sites along east Antarctica…
- Satellites: Remote sensing is key to southern polar region climate research. There is a need to vigorously encourage future satellite coverage and algorithm development, particularly for sea ice and snow data, for the southern polar region.
- Models: E.g. ocean models disagree from each other and from reality in how they portray the Southern Ocean. Improvements are needed if the southern polar region is to be properly represented in climate models.
- New or updated equipment: Vertical fluxes under sea ice? Buoys with water column sensors? Under-ice Argo floats etc.?

During the subsequent discussion several other important suggestions were made:

- Under ice Argo – importance on working on technology in order to keep under ice profiles (with present ice avoidance systems only the last profile is kept).
- More surface/ice drifters are required to measure SST, SLP etc. for e.g. satellite validation. This is also true of radiosondes.
- The need for more satellites in near polar orbits.
- Improvements in models. The SO/ice system needs to be properly represented in climate models. Small scales are important.
- The concept of ice-flooding, where snow causes sea ice to sink causing flooding and formation of new ice on the surface of the flow, is important – also significant for CO_2 flux?
- Leads contain around 10% of the open water fraction, something that satellites are hard pressed to catch. These leads are likely to be important in the total CO_2 flux.

ACTION: White paper on sustained observations and process studies needed in the Sea Ice Zone to be completed. Arnold Gordon to coordinate contributions from the following people:
Enrico Zambianchi/ Steve Ackley – IPAB/Sea Ice
Jouko Launiainen - Radiosondes.
(Arnold to find volunteer) - Atmospheric boundary layer correct e.g. katabatic winds.
Chris – CO_2 in sea ice zone
Kevin and Eberhard – under ice Argo
Arnold - outflow monitoring

15. US SOUTHERN OCEAN CLIVAR

Arnold Gordon updated the panel on the progress of the relatively recently formed US CLIVAR SO and Climate Working group. The terms of reference of this group are to:

- Develop and advise the US Scientific Steering Committee (SSC) on field, empirical and model studies in the Southern Ocean sector as needed to achieve CLIVAR goals;
- Suggest to the SSC appropriate mechanisms for implementation of such studies;
- Coordinate US activities with international studies of the Southern Ocean and climate, and relevant national programs;

Arnold updated the panel on the progress of various US SO process studies such as SAMFLOC, DIMES, GASEX etc. For further info see: http://www.clivar.org/organization/southern/CLIVAR_CliC_Obs.html

Only the hydrographic component of SAMFLOC has been funded so far. The panel felt that funding at least the major portion of the SAMFLOC moorings should be a priority for funding agencies.

Recommendations:

- Future 'oceanographic' programmes should include atmospheric and cryospheric components and involve scientists from these disciplines.
- The Weddell Sea is relatively well serviced with time series stations, but the Ross Sea and other sites along east Antarctica are not well covered.
- The use of XCTD, hull mounted ADCP and underway pCO_2 are recommended on all research ships.
- XBT/XCTD lines along 30°S across each ocean basin is suggested.

16. PALEOCEANOGRAPHY

Andreas Mackensen kindly stepped in to lead the paleoceanography discussion. He brought the panel up to date with the PAGES-IMAGES coring plans. The aims of IMAGES are to:

- Quantify climatic and chemical ocean variability on decadal, centennial and millennial time scales
- Detect the history of the ocean variability on internal/external forcing over the last 50 kyr
- Diagnose the role of ocean variability in controlling atmospheric CO_2

Sediment rates in the PAGES-IMAGES areas of interest are between 10 cm and 1m/kyr. The cores taken for IMAGES are roughly 60-80 m in length, 11 cm diameter. This provides sufficient sediment volume to support multi-proxy investigation at sub-centimeter resolution. These continuous large diameter cores offer improved recovery up to the sediment surface and avoid uncertainties associated with core breaks, but can only presently be taken from one ship, the Marion-Dufresne. This is a problem for IMAGES as the funding agency involved (IODP) have a policy of not allowing projects to specify a ship.

17. GOODHOPE

The so called 'choke point' sections south of South America and Australia are relatively well sampled, but the section south of Africa is not so. GOODHOPE is an international cooperative project strongly endorsed by the SO CLIVAR/CliC panel to fill this gap in the observing system (see Figure 4). Its main aims are to:

- Study the mass, heat and salt fluxes along the GOODHOPE section and their correlation with the Atlantic NADW export and import of cold, warm and cool waters
- Examine how the ACC is modified in the Atlantic sector, in terms of transport and water mass content
- Estimate the mass, heat, freshwater, and biogeochemical budgets of the Southern Ocean and S. Atlantic
- Study the impact of interocean exchanges on the local air-sea heat exchanges and their role on the local climate of the African continent and on the global heat budget

In order to carry out GOODHOPE many institutes from around the world will pool resources. The chokepoint monitoring will be done using a combination of the following observational tools: Altimetry, high density XBTs, XCTDs, profiling floats, subsurface floats, drifters, thermosalinographs; oxygen, nutrients, and chlorophyll samples. Complete CTD sections (hydrography and biogeochemistry) will be carried out every 2 to 5 years.

The nature of this proposal is thus to routinely survey the SR2 line with a high resolution XBT line using the SA Agulhas as a monitoring platform during its contracted "ferry service". In addition, underway surface samples will be collected at 15' intervals. A number of drifters, floats and profiling floats aimed at capturing regional dynamics and the large-scale thermohaline structure of the upper 2000 m of the water column will be deployed during each transit.

The intended line will also take full advantage of WECCON and ASTTEX observations. In addition a full depth CTD section will be undertaken every three to five years and is not expected to interfere with the "ferry service". In particular, the related INTAS-NIS Interocean Exchange project will undertake (if approved) the first SR2 CTD section at the end of 2004*)*. Lastly, the position of the selected transect will permit full advantage of available satellite altimetry coverage. Further details can be obtained from the CLIVAR/CliC panel website.

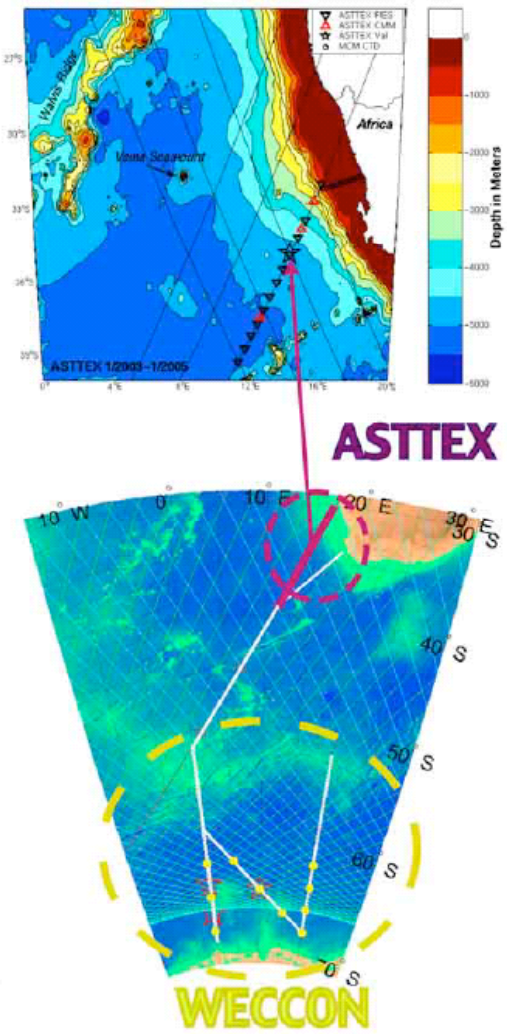


Figure 4 – Location of the WECCON moorings and the ASTTEX array.

18. THE INTERNATIONAL POLAR YEAR

Cynan Ellis-Evans started the discussion by introducing the panel to some of the IGBP relevant programmes such as SO GLOBEC, SO IMBER and ICCED that are mainly ecosystem studies, but have connections to climate variability. The importance of interactions with SO CLIVAR was emphasised.

The discussion then moved to the proposed International Polar Year (IPY) in 2007/8. The IPY was originally advocated by the US Polar Research Board, the European Polar Board, SCAR, and the International Council of Science (ICSU). WCRP are also now having discussions with ICSU in order to coordinate efforts. The CliC International Project Office, under Chad Dick, will coordinate IPY activities for WCRP.

There are many reasons for having an IPY since polar regions:

- Are integral components of the Earth system
- Are variable over wide range of timescales – non-linear
- Respond to, amplify and drive changes elsewhere in the system
- Are the only component of climate system capable of producing rapid change
- Are a repository of information on past states of planet
- Are incompletely explored
- Have specific scientific policy-relevant issues that need to be resolved

- Have existing programmes that would benefit from such a burst of energy and coordination

In addition:
- Previous IPYs and IGY provide reference data for change detection and evaluation
- New satellite assets provide an opportunity for advance
- New intensive campaigns of observations will lay foundations for future reference

ICSU have set a deadline of the beginning of 2004 for IPY plans.

As far as ICSU are concerned, activities for the IPY should have the following characteristics. They should:
- Provide scale - activities that would not otherwise be possible
- Be truly bipolar and to include summer and winter
- Be multidisciplinary (including arts / humanities)
- Be truly international and fully inclusive
- Push frontiers / accept some risk of failure
- Be easily understood – selling to public, funders, etc.
- Have tangible outcomes
- Be challenging but achievable

Chad Dick presented the WCRP's vision for an IPY. The WCRP see the IPY's main theme as being polar aspects of global environmental change (GEC) and how these relate to global climate. The aims are to initiate a step change in our ability to observe, understand and predict the polar environment and its interactions with GEC and to educate and stimulate a new generation of polar scientists.

WCRP proposals for the IPY should have the following objectives:
- Must have some achievable goals (but perhaps some that will not be achieved – aim high)
- Must be truly international
- Must be bipolar
- Must be globally relevant
- Must be science driven

Chad suggested that what the panel needed to do during the meeting was to:
- Identify the big science issues for a CliC and CLIVAR (or WCRP) IPY effort
- Confirm bi-polar links and global relevance
- Discuss and note broadscale logistical requirements
- Specify technological requirements
- Identify other pre-IPY activities (data, models etc.)
- Specify outputs – the selling points (how do we match ICSU ideas)
- Identify those who will take this forward

Enrico Zambianchi pointed out that the IPAB (International Programme for Antarctic Buoys) were going to suggest an initiative to have 100 buoys measuring SST, SLP etc. in the Southern Ocean for IPY (the usual number is around 20). This will be extremely important for satellite verification. The panel thought this was an excellent idea and merited their full support.

The panel agreed the following essentials for a WCRP effort:
- It should be a comprehensive observational programme that includes atmosphere, sea ice, ocean and shelf ice.
- It needs quasi-simultaneous circumpolar observations of the Southern Ocean region because short term variations such as the annual cycle and the interannual variability are of such an intensity that non synoptic measurements can lead to large uncertainties in the estimate of large scale properties as heat transports across the SO.
- The scientific focus should be on the study of the freshwater cycle. This is timely since it is expected to intensify with global warming. Indications of change are seen in the Antarctic Intermediate and Mode Waters. Further, freshwater transports are the links between glacial, sea ice and oceanic processes, changes in the freshwater cycle and will affect the interactions between the different components of the SO climate system.

- It should be a bi-hemispheric programme: significant changes in the freshwater cycle are observed in both hemispheres.

The panel will produce a white paper to address the envisaged components

ACTION: The International Polar Year. The panel will produce a white paper with suggestions for a focus for the IPY. (coordinated by Steve Rintoul).

19. SEA ICE AND ASPECT

Steve Ackley was invited to the SO panel meeting to talk about sea ice and ASPeCt. ASPeCt is a programme of multidisciplinary Antarctic sea ice zone research within the Scientific Committee on Antarctic Research (SCAR). It was formed to address key deficiencies in our understanding of the Antarctic sea ice zone.

The aim of ASPeCt is to build on existing and proposed research programmes, and the shipping activities of national Antarctic operators, to collect the necessary data to address key scientific questions. ASPeCt also includes a component of "data rescue" of valuable historical sea ice zone information. The sort of key scientific questions that ASPect is attempting to answer are:

- What are the broad-scale time-varying distributions of the ice and snow-cover thickness, ice composition and other physical characteristics in the Antarctic sea ice zone?
- What are the dominant processes of ice formation, modification, decay and transport that influence and determine ice-thickness, composition and distribution?
- What is the role of coastal polynyas in determining total ice production, heat, salt and biogeochemical fluxes, and water mass modification?
- What are the processes that control the ice-water interactions at the ice-edge, and their seasonal changes?

There is a CD "Observing Antarctic Sea Ice" available from ASPeCt for ice observers (see http://www.antcrc.utas.edu.au/aspect). Using these sort of observations sea ice thickness distributions are produced. Although these are extremely useful they are not sufficient on their own. More exact measures from e.g. upward looking sonar, Autosub etc. are also essential.

20. THE ROLE OF IANZONE:

Robert Munch talked to the panel about the International Antarctic Zone (iAnZone) Programme. iAnZone is an affiliated Program of the Scientific Council for Ocean Research (SCOR). It consists of a group of specialists focussed on climate related physical processes in the Antarctic Zone of the Southern Ocean and therefore has a large overlap with the interests of the SO CLIVAR/CliC panel.

A discussion followed of the role of iAnZone in Southern Ocean research, given the existence of several other panels. The panel agreed that iAnZone continues to play a very significant role. In particular, iAnZone has been a primary driver of focused process studies at high southern latitudes. The fact that the membership of iAnZone is primarily made up of principal investigators involved in specific joint experiments makes it a very effective mechanism for coordination of implementation and planning.

ACTION: Chairs to write a letter to SCOR endorsing iAnzone's contribution to Southern Ocean research (chairs).

21. THE INTERNATIONAL PROGRAMME FOR ANTARCTIC BUOYS

The role of the International Programme for Antarctic Buoys (IPAB) was summarised by Enrico Zambianchi, the chair of the programme. IPAB is a self-sustaining project of the WMO/ICSU/IOC World Climate Research Programme (WCRP) and an Action Group of the WMO/IOC Data Buoy Co-operation

Panel. It was started in 1995 to coordinate drifter deployments in the Antarctic sea ice zone, to optimize buoy distribution over this region and to create a central archive of Antarctic buoy data.

The type of measurements made by IPAB platforms vary, but typically they might include:

- atmospheric pressure
- air temperature
- sea surface temperature
- wind speed and direction
- buoy heading
- ice temperature
- wave height and spectrum

Besides the obvious importance of the gathered data within individual projects and in the framework of climate studies, the data are of importance to force models and/or to apply corrections in order to retrieve other kinds of information. As an example, one important application is in the validation of satellite data (see Figure 5).

ACTION: The importance of IPAB to SLP, SST measurements in the Southern Ocean should be made clear. Chairs to write to SCAR. *(*Steve Rintoul, Eberhard Fahrbach and Enrico Zambianchi).

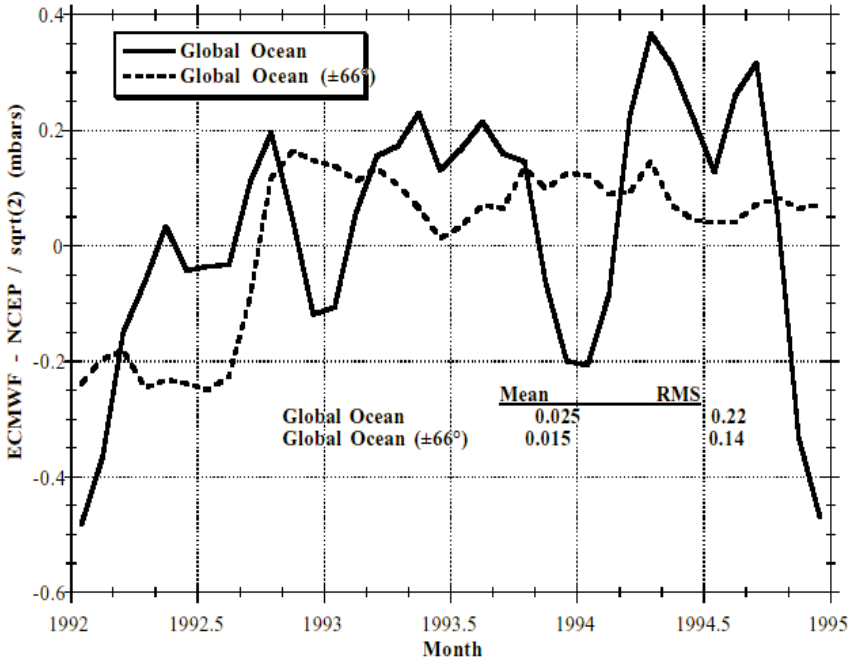


Figure 5 - Global mean differences of the ECMWF and NCEP pressure fields (divided by the square root of 2) over the ocean using a 550 km averaging radius. Significant benefits to be gained, mostly in Southern Ocean - from improved SLP. The IPAB - SLP Argos drifters are of paramount importance. Periodic deployment of a GTS reporting SLP device on Peter I island in Bellingshausen Sea is desirable.

22. DATA MANAGEMENT ISSUES

CLIVAR data policy was a major issue of concern to the panel during the last meeting, so the decision was made to include this as a major topic of discussion during this meeting. Howard Cattle attended the final day of the meeting in order to update the panel on CLIVAR data issues. Howard explained that although CLIVAR was still feeling its way with regards to data, significant progress had been made. Recent developments include:

- Development of a CLIVAR portal within the NOAA Global Master Change Directory
- The opening of the VAMOS Project Office and VAMOS data archiving through JOSS

- Web pages for notification of cruise plans for hydrography and carbon which will be further developed with IOC and submissions to which need continual encouragement
- Requests and mandates to WOCE DACs (Data Assembly Centres) to act for CLIVAR as CLIVAR DACs. However there is:
  - Uncertainty amongst the DACs on how to act for and interact with CLIVAR
  - A need to engage DACs with Basin Panels more and vice versa
  - A for the DACs to be seen in the context of an overall plan

It is essential that the basin panels interact and work with the DACS on issues of data archiving and assembly through the activities of the panel data liaison members.

- Work on a set of global data pages to provide a data information system, as opposed to a data management and archiving system

In terms of developing CLIVAR's data management structure further, the proposal is to build around a distributed network of data centres and DACS for atmosphere, ocean, the land surface (through GEWEX and others) and cryosphere (through CliC, and a corresponding CLIVAR Data Interface (CDI).

A CLIVAR data management and information workshop will be held over the coming months, The format is under discussion with identified SSG members (K Trenberth, R Weller, M Visbeck, D Legler). The workshop will bring together panel data liaison members, data managers, DACs, and other WCRP components.

The role of the data liason members (Stuart Cunningham and Shigeru Aoki) is to stimulate the CLIVAR panels and working groups to identify the specific data or data sets which they:
(a) require to be managed or
(b) are required to meet the data needs of the Panel or Working Group in carrying out its work.

This includes working within the panels and working groups to help:
- Identify the data needs for their activities and the centres where the data are archived and distributed to assist the ICPO in developing a comprehensive data information system for CLIVAR.
- Identify the kinds of data and data sets that will be collected under panel activities, the data centres where the data will be assembled and archived and any specific data management actions that need to be undertaken.
- Identify the amounts of the various types of data that will need to be assembled, distributed or archived as a result of Panel and Working Group activities.
- Identify any special approaches needed for the assembly, archiving and distribution of data.

ACTION: Need to ensure integration of CLIVAR and CliC data systems, in particular to ensure easy access to integrated data sets by users. Stuart Cunningham to coordinate with CLIVAR and CliC data management efforts. Stuart and Shigeru Aoki to draft recommendations for the CLIVAR data management system and contribute to the planned workshop. (Stuart Cunningham and Shigeru Aoki)

In the discussion that followed, Steve Rintoul asked what updates and new information will the DACs need following on from WOCE? What about data collected between the end of WOCE and the beginning of CLIVAR? Efforts should be made to ensure this is not lost.

Stuart Cunningham asked how will DACs interact with the CLIVAR data interface. He pointed out that we need more of a steady flux of data to data centres, rather than 'last ditch' effort after WOCE. More people need to be able to access data sets. The data interface needs to enable as many people to get access to data and do good research as possible. Streamlining of data access is required.

The panel were concerned that the CLIVAR and CliC data systems be closely linked (people should not have to submit data to both).

The panel were reminded that data issues have to be taken on by panel as a whole, not just by the data liason officers.

The panel recommended that in future the national reports should include statements on data availability

23 MEMBERSHIP

Member name	Term
S. Rintoul	Jan 2001- Dec 2004*
E. Fahrbach	" "
S. Aoki	" "
A. Gordon	" "
R. Morrow	" "
C. Sabine	" "
K. Speer	" "
S. Cunningham	" "
P. Froelich	" "
G. Madec	" "
D. Martinson	" "
I. Simmonds	" "
I Allison	" "

* Or after the 3rd meeting, whichever is later. Some panel members may rotate off before this date, other may be asked to stay for a further single two-year term. This is to ensure some continuity in the panel membership.

Eberhard Fahrbach has asked to rotate off as co-chair at the next panel meeting. The panel is very grateful for all his hard work and glad that he will be remaining on the panel.

24 NEXT MEETING

The venue for the next meeting was left open. South America, South Africa, the USA and the UK were suggested as possible venues. The next meeting is likely to be held in April 2005.

APPENDIX 1. LIST OF ATTENDEES

S. Ackley	ASPeCT/SCAR, San Antonio, U.S.A.	sackley@pol.net
S. Aoki	National Institute for Polar Research, Tokyo, Japan	shigeru@nipr.ac.jp
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C. Dick	ACSYS-CliC Project Office, Tromso, Norway	chad.dick@npolar.no
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E. Fahrbach	Alfred-Wegener Institut für Polar und Meeresforschung (AWI), Bremerhaven, Germany	efahrbach@awi-bremerhaven.de
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A. Mackensen	Alfred-Wegener Institut für Polar und Meeresforschung (AWI), Bremerhaven, Germany	amackensen@awi-bremerhaven.de
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R. Muench	Earth & Space Research, Seattle, U.S.A.	rmuench@esr.org
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C. Reason	University of Cape Town, Rondebosch, South Africa	cjr@egs.uct.ac.za
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V. Ryabinin	Joint Planning Staff for World Climate Research Programme, WMO Secretariat , Geneva, Switzerland	Ryabinin_V@gateway.wmo.ch
C. Sabine	NOAA/PMEL, Seattle, USA	chris.sabine@noaa.gov
A. Sokov	Russian Academy of Sciences, Moscow, Russia	sokov@sio.rssi.ru
M. Sparrow	International CLIVAR Project Office (ICPO), Southampton Oceanography Centre, Southampton, UK	mdsp@soc.soton.ac.uk
K. Speer	Florida State University, Talahassee, USA	kspeer@ocean.ocean.fsu.edu
S. Speich	University of Bretagne Occidentale - UFR Sciences, Brest, France	sabrina.speich@univ-brest.fr

M. Wakatsuchi	Hokkaido Unviersity, Sapporo, Japan	masaakiw@lowtem.hokudai.ac.jp
M. Williams	National Institute of Water and Atmospheric Research (NIWA), ,Wellington, New Zealand.	m.williams@niwa.co.nz
E. Zambianchi	Universita de Napoli "Parthenope" Instituto di Meteorologia e Oceanografia, Napoli, Italy	enrico.zambianchi@uninav.it

APPENDIX 2. INITIAL MEETING AGENDA
(note that changes were made during the meeting)

Monday, September 08, 2003

No AI		
1	0900-0915	Welcome and purpose of the meeting (Fahrbach, Rintoul)
2	0915-0945	Overview and status of CLIVAR (Sparrow, Cattle)
3, 1	0945-1015	Overview and status of CliC (Ryabinin)
	1015-1045	Coffee break
4, 15, 34	1045-1115	Review action items from last meeting (Sparrow)
5, 23	1115-1200	Status of implementation plan (Rintoul)
6, 4	1200-1230	OOPC (Speer)
	1230-1345	Lunch
7, 29	1345-1430	Indian Ocean (Rintoul)
8, 6, 7, 26	1430-1515	Carbon uptake and storage in the Southern Ocean (Sabine)
	1515-1545	Coffee break
9, 24, 32	1545-1615	Meteorology, air-sea coupling and surface fluxes (Rintoul, Simmonds)
10, 2, 31	1615-1645	Modelling (Madec)
11, 12	1645-1715	SO Argo (Speer)
12, 13, 14	1715-1730	Time series stations (Rintoul, Speer)

Tuesday, September 09, 2003

13, 9, 10	0900-0945	Summary of observation and national programmes (Sparrow)
14, 3	0945-1015	Sustained observations/Process studies (Gordon, Fahrbach)
15	1015-1045	US Southern Ocean CLIVAR (Arnold Gordon)
	1045-1115	Coffee break
16, 8, 25	1115-1145	GOODHOPE (Speich, Fahrbach, Klepikov, Reason)
17, 11, 27, 28, 35		
	1145-1215	South Atlantic (Cunningham, Rintoul, Fahrbach, Gordon)
18 22, 30	1215-1245	Paleoceanography discussion (Mackensen, Froelich)
	1245-1345	Lunch
19	1345-1445	International Polar Year IPY (Dick)
20	1445-1530	European Polar Board, EU FP6/7 & IPY (Evans-Ellis)
	1530-1600	Coffee break
21, 5	1600-1630	Sea ice and Aspect (Ackley, Klepikov, Allison)
22	1630-1700	The Role of iAnzone (Muench, Hellmer)
23	1700-1730	IPAB (Zambianchi)
	2000	Dinner

Wednesday 10 Sept: Science day

Thursday 11 September

24, 16, 17, 18, 19, 20, 21		
	0900-0945	Data management issues (Aoki, Cunningham, Cattle)
25 33	0945-1015	SO panel interaction with other basin panels etc. Rintoul, Fahrbach, Sparrow)
	1015-1045	Coffee break
26	1045-1100	Upcoming meetings and participation (Rintoul, Fahrbach, Sparrow)
27	1100-1230	Review action items, writing assignments, plans for next meeting, membership (Rintoul, Fahrbach, Sparrow)
28	1230-1245	Closing (Rintoul, Fahrbach)

APPENDIX 3. ACTION ITEMS FROM PREVIOUS MEETING

1. Draft implementation plan of CliC to be distributed for comment by rest of panel. (Ian Allison and Eberhard Fahrbach)

Report was distributed and comments sent to Chad Dick.

2. Gurvan Madec to coordinate with CliC NEG on issues of ocean and ice model development of common interest to CLIVAR and CliC. (Gurvan Madec)

Ongoing item. Gurvan should stay in contact with the NEG to be sure that SO issues are taken into account.

3. Arnold Gordon and Eberhard Fahrbach to prepare a brief white paper outlining a strategy for sustained and process observations in the sea ice zone. (Arnold Gordon and Eberhard Fahrbach, with input form rest of panel, Karen Heywood and Nathen Bindoff)

This has been carried over to this meeting's action items.

4. The panel should investigate the possibility of including an oceanographic component to the meteorological RIME experiment in the Ross Sea. (Kevin Speer)

Kevin reported that D. Bromwich, the RIME coordinator said that RIME would have welcomed an oceanographic component that did not compromise the goals of the primarily atmospheric experiment. Proposal details were circulated for the June 2002 deadline (see the OSU web site (http://www-bprc.mps.ohio-state.edu/RIME-01/RIME.html).

5. Is there the potential for getting ice thickness and other relevant variables from Russian historical data? (Alexander Klepikov).

Alexander commented that they have ice thickness and other relevant historical data from the cruises of Russian vessels in the Antarctic waters. The current form of the data (notebooks) needs to be digitized in standard formats compatible with current analysis techniques. They plan to digitize the notebook data and to develop the ship-borne sea ice digital database. They need people and funds for that, which Alexander is trying to find.

6. A plan to box in the Adelie Land source with repeat hydrography, in coordination with the US Carbon sections, needs to be negotiated between the US, Australia and any other nations likely to be able to make a contribution to this work. (Steve Rintoul, Chris Sabine)

Negotiations were initiated between the US (joint CLIVAR/CARBON group) and Australia (Tilbrook). This has now been agreed on and will be covered.

7. Steve Rintoul and Chris Sabine to discuss who to contact about recommending a reoccupation of 43S in the Pacific.(Steve Rintoul and Chris Sabine)

Chris proposed the idea of a 43S line in the Pacific at the IOC/SCOR CO_2 advisory panel held an International Ocean Carbon Coordination Workshop in Paris (http://ioc.unesco.org/ioccp/), but there was quite a bit of resistance to this suggestion since historically this line has not had carbon measurements and the Japanese are committed to occupying the 32S line in all of the oceans.

8. The "choke point" section south of Africa remains somewhat of a gap. Germany, Russia and South Africa are encouraged to merge resources (and perhaps those of other collaborators like the USA) to see if more frequent hydrography or XBTs can be obtained to complement the present German efforts. (Eberhard Fahrbach, Alexander Klepikov, Chris Reason)

There is a new initiative (GOODHOPE) by Sabrina Speich and others to address this very issue. See Section 17 of this report.

9. Mike Sparrow to chase up national reports from other (e.g. Scandinavian) countries. (Mike Sparrow)

We have the Scandinavian report now. Mike has been chasing up reports from other countries.

10. Individuals to keep national reports updated annually. Mike Sparrow to send reminders. (National representatives and Mike Sparrow)

Mike sent reminders. Several updates were received.

11. Chair to write to Atlantic Panel and Edmo Campos emphasising the importance of the South Atlantic to CLIVAR science issues, supporting the planned South Atlantic Workshop, and NOAA efforts to establish an observing system at 30ºS. (Steve Rintoul and Eberhard Fahrbach)

South Atlantic Workshop has taken place (Workshop on the South Atlantic Climate Observing System (SACOS)) in Angra dos Reis, RJ Brazil February 06 - 08, 2003. See http://tucupi.cptec.inpe.br/pirata. Also Section 10 of this report.

12. Kevin Speer is to be the Argo contact point for the SO Panel, and coordinate the writing of a white paper for SO Argo. The paper will include contacts, schedules, and cruise tracks for Antarctic vessels capable of deploying floats. (Kevin Speer and rest of panel)

Kevin has produced a webpage for SO Argo showing the above information - see http://argo.ocean.fsu.edu. Please note that this is still under construction. Send any comments to Kevin, cc'ing to ebryer@ocean.fsu.edu.
Kevin has also been in contact with the ARGO Science group and will work on this.

13. SO Panel to update the white paper prepared for the Time Series Science Team (TSST) by requesting contributions from the panel members. For each site, a one page description of the scientific rationale, measurements proposed, investigators, and readiness is required. (Steve Rintoul to coordinate.)

Action item partially carried over

14. TSST website will be up and running soon. ICPO to contact Uwe Send to ensure that details are posted on the SO website. (Mike Sparrow) [Sent 9/4/03]

Website now running (www.oceantimeseries.org) which can be accessed via the SO CLIVAR/CliC website.

15. The SO panel endorses the GHRSST project. The use of multiple sensors will be particularly useful in the cloudy Southern Ocean. The panel seeks guidance on the right mix of in situ measurements needed to complement and remove biases from satellite measurements in order to ensure the GHRSST goals are met in the SO. (Steve, Eberhard or Mike to write to Neville Smith)

Mike wrote to Neville Smith. His reply is as follows:

"Michael,

Thanks for the query. It would be wise if I passed your question off to experts (Harrison, Reynolds, for in situ requirements; Donlon for the GHRSST).

To my knowledge the in situ requirements for the Southern Ocean remain much as they have been for the last x years though, because of related requirements (particularly MSLP) we are I think trying to squeeze even more sampling out of the sparse in situ system. The old requirements were for several samples per week per 500 km square; I think the new requirements are roughly double the demand in time and space. It is not yet clear what role Argo might play - it might satisfy part or all of this extra demand if fully implemented and whether the microwave instruments will change the basic requirement.

The other key area is of course near the ice zone where the whole definition of "SST" yet again becomes fuzzy. This is also an area of current research (Reynolds and others) and area where our climate products have not always measured up to the standards as we would like.

Neville S"

16. Once specific guidelines on data management are provided by ICPO, the Panel will communicate these guidelines to Principal Investigators to make sure they understand their responsibilities. (Stuart Cunningham, Shigeru Aoki)

ICPO has a staff scientist (Katy Hill - klh@soc.soton.ac.uk) who is responsible for data issues along with Howard Cattle. There are still several issues to be resolved with regards to data. Stuart and Shigeru are on Katy's email list so they can be kept informed of any future developments. See Section 22 for further comments on data issues.

17. Panel needs to identify data sets that have been collected since WOCE that should be archived as part of CLIVAR. (All panel, headed by Stuart Cunningham)

Ongoing action item. WHPO are also doing this to a certain extend (Mike to also help coordinate).

18. Katherine Bouton's draft CLIVAR data policy to be circulated to the rest of the panel for comment. (Mike Sparrow)

Done.

19. National representatives should assemble information on collection and availability of data sets resulting from the national programmes and forward to Stuart Cunningham and Shigeru Aoki. (All national representatives, Stuart Cunningham and Shigeru Aoki)

Ongoing item. Discussed further in Section 13.

20. The SO Panel should liase with the CliC DMIP with regards data issues. (Stuart Cunningham and Shigeru Aoki)

Ongoing action item.

21. The panel needs to let ICPO and the CLIVAR SSG know of any data concerns, in particular any difficulty in accessing data sets (All panel, headed by Stuart Cunningham and Shigeru Aoki)

Ongoing action item.

22. The Panel should review the SO coring sites proposed by IMAGES/PAGES and provide guidance, if needed, on their oceanographic relevance. (Philip Froelich)

Philip writes "The sites make sense from a paleo perspective - surface water biological parameters TS Nuts etc. across the fronts. Need to have someone with a dynamic perspective take a look, e.g., Jean Lynch (Lamont) and a phys oceaner for BW flow-line characteristics. There is always a disconnect between paleo goals (static points and distributions in time and space, which is about all our paleoproxies provide) vs. paleo dynamics (which is what we'd really like to know - heat, water and salt fluxes). The only person I know who approaches paleocean with dynamic tools is Jean Lynch (paleo geostrophic flow via thermal wind equation from horizontal density structure). For the ACC, the problem of barotrophic vs. baroclinic and basal steering would require a multi-proxy approach. Don't know if Jean has thought about this. Much of the Southern Ocean doesn't have good continuous sediment drifts to play with - too many "holes" in the stratigraphic record - so sometimes the paleo game is played from where the sediments exist." See also Section 16.

23. SO Panel to produce an evolving version on the web of the Implementation plan. To start with this should include a two or three page statement on the atmosphere (Ian Simmonds), carbon issues (Chris Sabine), paleo issues (Philip Froelich) and models (Gurvan Madec). (Ian Simmonds, Chris Sabine, Philip Froelich, Gurvan Madec and rest of panel)

The panel felt that spending the time to update the implementation plan was not a good use of peoples' time. Instead the panel have diverted their efforts into other areas.

24. The panel supports the formation of an air-sea flux group and seeks advice from them on the correct mix of SO observations that the Panel should advocate. (Steve Rintoul)

This was reported by Steve to the JSC and by Eberhard to the CliC SSG. Since the group has now been formed the panel should contact them (new action item)

25. Chris Reason and Alexander Klepikov to provide maps summarising the cruise tracks of the South African and Russian vessels and investigate whether logistical support exists in South Africa for enhanced observations south of Africa. This information will then be forwarded to the SOOP. (Chris Reason, Alexander Klepikov)

Chris has mentioned that it may be possible to get the SA Agulhas to make deviations from its normal cruise tracks if required.

26. The panel felt it would be useful to make the distinction on the CLIVAR hydrography/Carbon website between sections that are sustained commitments to multiple repeats and those that are one-off reoccupations. (Mike Sparrow)

Mike talked to Katherine Bouton about this – in fact since the occupations/reoccupations are listed I don't think it's a problem. Sandy Grapes (icpo@soc.soton.ac.uk) is now looking after this site.

27. Chairs to write to Atlantic panel strongly endorsing plans for a 30S observing system, and seeking clarification of present proposed and funded efforts. (Steve Rintoul and Eberhard Fahrbach)

This was included in the panel's input to the South Atlantic Workshop.

28. Arnold Gordon to summarise arguments for re-occupation of WOCE lines in the South Atlantic, to forward to Atlantic panel. (Arnold Gordon)

This was included in the panel's input to the South Atlantic Workshop.

29. Chairs to write to AAMP to propose a "division of labour" between the two panels: The AAMP to cover the top-to-bottom circulation north of 20S, while the SO panel extends its domain north to 20S. (Steve Rintoul and Eberhard Fahrbach)

A new Indian Ocean panel has now been formed – see Section 9 for further discussion.

30. Explore with PAGES the possibility of a joint Southern Ocean workshop. (Philip Froelich)

Philip Foelich has been in contact with Chris Charles (Scripps) about this. He will keep us updated.

31. The SO panel needs to think about indices that provide useful benchmarks for models (e.g. transport of ACC, overturning cell, rate of bottom water formation, gyre circulation etc). It was suggested that modelling issues be a subtheme for the next panel meeting. (Gurvan Madec and rest of panel)

This has been carried as an action item to this meeting

32. Chairs to write to Judy Curry and Paul Stackhouse expressing the strong support of the panel for SEAFLUX and SRB and asking for suggestions as to how the panel might be of help. (Steve Rintoul and Eberhard Fahrbach)

From Paul Stackhouse:

"GEWEX SRB has just completed processing and making public 12 years of SW and LW surface fluxes at the 1x1 degree resolution. Both the monthly and daily averages of these quantities are now available. Also, monthly averaged 3-hourly and the full 3 hourly data sets will be available in a couple more months.Validation is still being pursued but overall agreement with BSRN measurements over land sites is showing monthly averaged bias differences less than +/- 5 Wm^{-2} and RMS of 20 – 23 W m^{-2} in the SW and about 15 W m^{-2} in the LW. Intercomparisons with other data sets are being pursued. Documentation and publications relating to the data set are being developed."

No contact from SEAFLUX as yet.

33. The SO Panel webpage should be kept updated with information about other projects and panels. (Mike Sparrow)

Continuous action required.

Mike has now included a page of Southern Ocean relevant observations. All the panel should try to ensure this is kept up-to-date.

34. A list of scientific highlights, important and submitted papers to be included on the SO panel webpage. Details to be forwarded to Mike Sparrow. (All panel and Mike Sparrow)

Done – needs Mike and rest of panel to keep it updated (submitted papers now longer updated due to lack of resources).

35. At least one representative from the panel should attend the South Atlantic Workshop (see Edmo Campos for details). (Steve Rintoul to seek a volunteer nominate)

Stuart Cunningham attended the workshop. A draft of the report is now available.

APPENDIX 4. LIST OF SO PANEL NATIONAL REPRESENTATIVE*S*

Argentina	Alejandro Bianchi	abianchi@hidro.gov.ar
Australia	Steve Rintoul	Steve.Rintoul@csiro.au
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New Zealand	Mike Williams	m.williams@niwa.co.nz
Russia	Alexander Klepikov	klep@aari.nw.ru
South Africa	Chris Reason	cjr@egs.uct.ac.za
United Kingdom	Stuart Cunningham	scu@soc.soton.ac.uk
USA	Arnold Gordon	agordon@ldeo.columbia.edu

Other national reps are required to keep the panel and community as a whole abreast of SO work in their countries. Please email m.sparrow@soc.soton.ac.uk if you are interested.

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