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Report of CLIVAR SSG-14

Development of a CLIVAR Roadmap

1. INTRODUCTION

1.1. Welcome, introductions and local arrangements

CLIVAR SSG-14, held at the Hotel Colon, Buenos Aires, Argentina, was opened by the CLIVAR SSG co-chairs Dr Antonio Busalacchi and Dr Tim Palmer at 08.30 on Wednesday 19th April 2006. Attendees (Annex A) introduced themselves and Dr Carlos Ereño (International CLIVAR Project Office, ICPO, University of Buenos Aires, and local host) outlined a number of local arrangements for the meeting. During the meeting, the SSG heard two lectures by local scientists, namely:

Wednesday 19 April: Science lecture: The GEF project for the la Plata basin by Vincente Barros and Jorge Rucks.

Friday 21 April: Science lecture: "Regional Ocean Science Activities: Ocean fronts, primary production and ocean-atmosphere CO₂ fluxes in the western South Atlantic" by Alberto Piola, Department Oceanografía – SHN & Department of Atmospheric. & Ocean Sciences – UBA.

1.2 Introduction to CLIVAR SSG-14 including metrics for CLIVAR

Dr Busalacchi provided an introduction to CLIVAR SSG-14, emphasising the outcomes of the recent meeting of the Joint Scientific Committee for WCRP (JSC-27, Pune, India, 6-10 March 2006) that sought new directions for WCRP. In doing so he outlined a current exercise across WCRP to identify where WCRP lies in terms of a Road Mapping matrix focused on where we are now; future physical climate science, future seamless prediction goals; future Earth System science and WCRP delivery of benefits to others.

Action 46: SSG members, panel and working group chairs to provide input to the ICPO on the WCRP Road Mapping matrix activity.

A particular request by the JSC had been for a set of key metrics for each WCRP Core Project. Those proposed for CLIVAR had been as follows and were subject to SSG ratification:

- New resources enabled by leveraging off of CLIVAR efforts, (e.g. \$15M GEF funding of LPB, ESF MedCLIVAR, Climate Process Teams, AR4 analyses)
- Improvements in:
 - The spectral character (i.e. spectral power, frequency) and
 - Predictability of ISO, seasonal, interannual, and decadal variability in coupled models
- Number of global ocean observation deployments and the transition of process study and research observations to operational status (e.g.TAO).
- Reduction of uncertainty in climate models, bias reduction, and the number of new parameterizations incorporated into operational models (e.g. CPT on marine stratus, VOCALS)
- Metric tracking capacity building within and incorporation of developing nations into CLIVAR activities (e.g. efforts within VAMOS, VACS, AAMP)
- Global and regional data products enabled by CLIVAR (e.g., global ocean data reanalyses, African Climate Atlas)

Following discussion during the meeting, the SSG agreed:

Recommendation 1: Adopt CLIVAR metrics.

Dr Busalacchi emphasised the need for the SSG to build on the outcomes of the 1st International CLIVAR Science Conference and the Assessment of progress with CLIVAR carried out by 13th meeting of the CLIVAR Scientific Steering Group (SSG-13 – Baltimore, 27-29 June 2004). So that CLIVAR can identify where it lies in terms of the WCRP Road Mapping exercise he proposed that CLIVAR SSG-14 (Buenos Aires, 19-22 April 2006) develop a CLIVAR Road Map against the key CLIVAR cross cutting science themes identified at SSG-13, namely:

- ENSO and other models of tropical variability (TV)
- Monsoons
- Decadal variability and the thermohaline circulation (THC)
- Anthropogenic climate change (ACC)

Together with:

- The role of the oceans in climate
- Global modelling and prediction
- Initial consideration of the CLIVAR legacy when CLIVAR comes to its sunset date of the end of 2013.

These reflected

- CLIVAR's responsibility for study of the role of the oceans in climate under WCRP, including those for ocean observations
- It's key role in global climate modelling and prediction in WCRP; CLIVAR's Working Group on Seasonal to Interannual Prediction (WGSIP), its Working Group on Ocean Model Development (WGOMD) and the joint JSC/CLIVAR Working Group on Coupled Modelling (WGCM) represent WCRP's primary efforts in global modelling and prediction.
- The need for CLIVAR to continue its efforts to develop links to applications of its science and to consider what legacy it will leave both in terms of science and delivery to applications.

Dr Busalacchi emphasised that the agenda for SSG-14 (Annex 2) had been designed to facilitate development of the Road Map through a series of mini assessments of the current status of CLIVAR activity. For each theme area these comprised:

- Theme Lead Overview: state of science, current status, science directions, needs, provided both as written papers & presentations (these can be found at: <http://www.clivar.org/organization/ssg/ssg14/ssg14.php>)
- Roundtable contributions from Panel and Working Group chairs as appropriate: How is CLIVAR addressing this theme? Aspects of these will be found in the individual Panel and Working Group reports at the above webpage
- Theme Assessor report: Developing the Road Map, path ahead. Synthesis. Gap analysis, redundancies. What will we do by 2007, 2010, 2013? Where will we be at these milestone dates?

In addition a background of sponsor/context setting would be provided, by presentations from representatives of IOC, WMO and IGBP by the Director, JPS for WCRP (Section 2 of this report).

Production of elements of the Road Map for each science area would then be carried out by small task teams of experts during the meeting (with refinement of some in the weeks following). Those identified for each area in turn are summarised in Annex 4 with reference to the total input from all the presentations and discussions at the SSG:

2. Sponsor and other programme/project input

2.1 Future directions for WCRP

Dr Ann Henderson Sellers, the newly appointed Director of WCRP, identified a number of issues and challenges for WCRP, namely who we are, how does WCRP build from national and individual contributions and regional projects to global research projects, issues of funding and how to improve the overall visibility of WCRP. She identified a number of key science questions for WCRP, including whether climate past the point of no return; why the range of predicted temperature rise for doubled CO₂ hasn't changed over the period of IPCC Assessment Reports 1-4; whether climate warnings are understood; the impacts of ocean acidification; just what is a safe level of climate change and "is climate research honest". She emphasised the role of WCRP in facilitating and helping to prioritize world-important research but also raised the issue of who we deliver to ("who are WCRP end users?") and how WCRP can help the less fortunate in the least developed countries, 33 of which are in Africa. In discussion, Dr Palmer asked if CLIVAR should focus more on human impacts on climate whilst Dr Washington commented that aid agencies, concerned with "now", want to know what is happening on much shorter, seasonal timescales.

2.2 IOC programme needs as a WCRP sponsor

Dr Roger Dargaville (IOC) introduced IOC's programme needs based around a recent IOC discussion document on "Climate Impacts on the Marine Environment", developed by a group which included the JSC Chair, John Church. He identified a number of questions of interest to the general public and the needs of IOC member states for advice for better management, adaptation, or mitigation. He also identified a number of areas where international programmes and projects could contribute, namely:

- Ocean and Coastal Circulation Patterns (*CLIVAR, CLiC*)
- Sea Level Rise and Coastal Erosion (*CLIVAR, CLiC, LOICZ*)
- Natural Hazards (*CLIVAR, GCOS*)
- Carbon Sources and Sinks (*GCP, CLIVAR, SOLAS, IMBER*)
- Ocean Acidification (*SOLAS, IMBER*)
- Fisheries and Ecosystems (*GLOBEC, IMBER*)
- Biodiversity (*Diversitas, GLOBEC, IMBER*)

"Special focus issues" were also identified as follows: impacts on Arctic / Antarctic systems, impacts on small islands, impacts on coral reef ecosystems. He encouraged the research programs and their sponsors to initiate a scoping activity on climate impacts on the marine environment to determine how to develop a more comprehensive and coordinated approach to addressing these issues and communicating them to the general public and decision makers. In addition he noted that IOC and regional intergovernmental organizations PICES (North Pacific) and ICES (North Atlantic) are co-hosting an international symposium in May 2008 entitled "Effects of Climate Change on the World's Oceans", adding that IOC would like to invite the research programmes to participate fully in this symposium and its development, and to use this opportunity to examine ways for better coordination and communication in addressing climate impacts on the marine environment.

In discussion of this item, the SSG agreed:

Action 32: Formulate a response based on comments to the ICPO from SSG members and others to the IOC document on "Climate Impacts on the Marine Environment" (Action ICPO and W Hazeleger)

2.3 WMO and Working Group on Numerical Experimentation (WGNE) activities relevant to CLIVAR

Dr Pedro Silva Dias provided a short report on these activities, covering, in particular NWP performance including various verification studies (e.g. precipitation, Tropical Cyclones); WGNE-related projects such as AMIP, transpose AMIP (CAPT) and a WGNE aqua planet experiment; a WGNE push for climate model metrics (as for NWP); reanalyses; THORPEX and the need for high resolution in climate modelling and for a concerted effort on convection. He also advertised the upcoming WGNE-sponsored Workshop on Model Systematic Errors (San Francisco, 12-16 February 2007).

2.4 IGBP/WCRP links

Background to IGBP activities was provided by the Chair of the IGBP Scientific Committee Professor Carlos Nobre. He covered examples of what comprises global change; key findings from IGBP Synthesis Reports; the new questions and structure for IGBP that have been developed and which focus on biogeochemical sciences with relevance to issues of societal concern and interdisciplinarity and integration in an Earth System context; and the IGBP network. He then identified a number of IGBP areas of collaboration with CLIVAR including: CLIVAR/PAGES, emphasising the PAGES/CLIVAR vision document developed at the last PAGES/CLIVAR meeting; the Surface Ocean-Lower Atmosphere Study (SOLAS) activities, including SOLAS-VAMOS (VOCALS) collaboration; the IGBP Integrated Marine Biogeochemistry & Ecosystem Research Project (IMBER) activities and efforts under IGBP AIMES (Analysis, Integration and Modeling of the Earth System, which WGCM interfaces with) on the interactions between humans and the environment. In particular he described a new AIMES activity entitled IHOPE – Integrated History of the Peoples of the Earth. Finally, Professor Nobre outlined the nature of the Earth System Science Partnership, which both IGBP and WCRP are engaged in together with IHDP and Diversitas, and in particular the ESSP Integrated Regional Studies. He closed by emphasising IGBP's wish to encourage collaborations between the groups in CLIVAR and the IGBP Integrated Land Ecosystem - Atmosphere Processes Study (iLEAPS) and its Global Land Project (GLP) which are working on dynamic global vegetation models, suggesting a joint workshop on this topic.

3. Reports against CLIVAR Science Themes and development of the CLIVAR Road Map

3.1 ENSO and other modes of tropical variability

3.1.1 Current Status and science directions and needs

Dr Rienecker's overview paper and presentation brought to the fore the still fundamental gaps in our knowledge of the coupled atmosphere-land-ocean system responsible for the dominant modes of tropical variability. These gaps partly arise from lack of appropriate observational datasets but also because of the complex scale interactions between the atmosphere, biosphere and hydrosphere. Current research includes attention to multi-scale interactions amongst these dominant modes of climate variability. She emphasized that as a complement to observations, models are key to our understanding. However, coupled models, which are the repository of our knowledge about the dynamics of the climate system, have significant systematic errors that are a sign that our knowledge is still inadequate. Dr Rienecker summarized the status of ENSO forecasts to be as follows:

- i) Probabilistic seasonal forecasts with dynamical models are now performed by operational centres around the world.
- ii) A multi-model forecast (i.e. an ensemble across prediction systems) is more skillful than the single prediction system (with equal number of ensemble members) [e.g., Hagedorn et al., 2005].
- iii) Seasonal forecasting has led the way in the multi-model ensemble activities (e.g., DEMETER, see Palmer et al., 2004; Hagedorn et al., 2005) which are now operational in some places (EUROSIP at ECMWF)

- iv) ENSO prediction with a multi-model ensemble usually yields reliable forecasts but it is usually at the expense of large ensemble spread. Increasing the forecast resolution is still a challenge, and it will probably be achieved only by increasing the quality of individual prediction systems. [Resolution describes the ability of a forecast system to discriminate between situations that lead to different events in the future. The greater the difference between the correctly assigned forecast probability and the climatological probability of a particular event, the better is the resolution of the forecast system.]
- v) Both statistical and dynamical models produce useful tropical SSTA forecasts for the peak phase of ENSO up to two seasons in advance.
- vi) The spring predictability barrier is not as marked in the dynamical models as in the standard statistical models based on SST, probably because of the former include subsurface information [van Oldenborgh et al., 2005].
- vii) The periods of retrospective forecasting are too short in terms of distinguishing between the skill scores of the various prediction systems.
- viii) Models predict the sign of extreme events well, but too often predict warm or cold events when the observations call for normal conditions.
- ix) Consistency among forecasts initialized one month apart is not a good *a priori* measure of forecast

3.1.2 How is CLIVAR is addressing this theme?

Chaired by Dr Rienecker, inputs here were provided in particular by the written reports of the Atlantic and Pacific Panels (see <http://www.clivar.org/organization/ssg/ssg14/ssg14.php>) and panel presentations by Drs Hazeleger (Atlantic Panel Chair) and Timmermann (Pacific Panel chair) which also included a number of wider issues (see below). These fed into the discussion which followed.

Particular issues arising from Dr Hazeleger's presentation requiring SSG decision were as follows:

- (a) Co-sponsorship by CLIVAR of the CliC Arctic Climate Panel (ACP).

Action 4: CLIVAR agrees to co-sponsor the Arctic Climate Panel with CliC and encourages cross membership with the CLIVAR Atlantic Panel. The ACP should be asked to report to the next SSG meeting on progress toward developing a climate observing system in the Arctic. There is a need to clarify financial implications which should match those for the CLIVAR/CliC/SCAR Southern Ocean Region Panel. (V Detemmerman, ICPO)

- (b) Endorsement of TACE, the Tropical Atlantic Climate Experiment

Action 5: CLIVAR endorses TACE as a CLIVAR process study. It also encourages development of extension to the western Atlantic (WAVES). TACE is to report to the Atlantic and VACS Panels (Hazeleger lead, with ICPO)

3.1.3 Discussion: Developing the Road Map: the ENSO/TV theme within CLIVAR

This was led by Dr Timmermann who subsequently chaired a small group to develop the Road Map in this area, the outcomes of which were presented to the SSG later in the meeting (item 9) by Dr Rienecker and are summarised in the relevant section of Annex 4

3.2 Monsoons

3.2.1 Current status and science directions and needs

Professor Bin Wang's paper "Monsoons-current status, science directions and needs: An AAMP perspective" summarized a number of key issues for monsoons. Cutting across nearly all monsoon sectors are requests to have better understanding and model representations of the **diurnal cycle**, tropical **intraseasonal variability** and tropical **mean** state. With regard to the diurnal cycle, addressing the shortcomings in this area – particularly in global climate/weather models – is thought to be a tractable way and potentially necessary means to address more generalized convective/cloud parameterization issues and their rectification from short to longer time scales, including the mean. Intraseasonal variability is an intrinsic and fundamentally important mode of variability in the A-A sector with important remote impacts - and in some cases plausibly intrinsic modes - in the American and African sectors. The shortcomings in our model representations of the mean are thought to both negatively impact and derive from the poor representation of these higher frequency variabilities. These items, along with a number of others were identified as key priorities at the 1st pan-WCRP Monsoon Modelling Workshop (Irvine, Ca, USA, 15-17 June 2005).

3.2.2 Summary of outcomes of the pan-WCRP modelling workshop and JSC responses

Dr Howard Catle addressed this item. The overall near-term recommendation from the workshop was to seek to improve the simulation of the diurnal cycle of precipitation and convection in global models by making use of regional climate models and cloud resolving models that have more comprehensive physics. A range of other detailed recommendations were also made and a number of key datasets identified, details of which can be found in the workshop report at: http://eprints.soton.ac.uk/19335/01/icpo_pub_103.pdf.

JSC-27 comments on the report had included the need for CLIVAR & GEWEX to work more closely on monsoons. In particular GEWEX & CLIVAR (with CliC & SPARC) were asked to establish monsoon "focal points" (individuals) with a JSC representative. to define how to bring more coordinated programme on monsoons for discussion at JSC-28. The WCRP Modelling Panel was also asked to coordinate modelling parts of the monsoon components of the two projects (including CEOP).

A strong request was made to WGNE & THORPEX to participate, especially in the focus on the diurnal cycle.

3.2.3 Developments in GEWEX and GEWEX monsoon activities

Professor Soroosh Sorooshian outlined developments in GEWEX starting with the GEWEX Phase II objectives to produce consistent quality datasets; enhance understanding of energy and water cycle processes and feedbacks; improve parametrizations to provide better seasonal prediction of water and energy cycle variability and undertake joint activities with hydrometeorological services and programmes to demonstrate value. He outlined the structure of GEWEX, including the development of a phase II of the Coordinated Enhanced Observing Period (CEOP) activity and efforts to develop a GEWEX Road Map. Areas of mutual interest between CLIVAR and GEWEX included air-sea fluxes, with GEWEX efforts over both land and ocean; issues of precipitation and clouds and radiation and the monsoons which were the area of most recent CLIVAR/GEWEX collaboration, in particular:

- The La Plata Basin CSE initially promoted by CLIVAR/VAMOS represents a great example of joint interaction with GEWEX that continues to move forward very well.
- Good progress is being made with AMMA (Recently approved as a GEWEX CSE).
- The joint CLIVAR-GEWEX Pan-Monsoon workshop, in June 2005, reported above.

And for the future:

- Development of the Monsoon Asian Hydro-Atmosphere Scientific Research and prediction Initiative (MAHASRI) as the GAME follow-on.

Dr Sorooshian noted that in it's review of GEWEX, JSC-27 had considered the MAHASRI proposal and recommended that GEWEX request CLIVAR to review it. In response to this request the SSG agreed:

Action 9: AAMP to review the MAHASRI plan and report to the CLIVAR SSG (AAMP co-chairs)

The SSG also agreed:

Action 10: All CLIVAR monsoon panels to review the CEOP-II plan (Monsoon Panel co-chairs)

In addition to the above, Dr Sorooshian further reminded the SSG of the CEOP Inter-Monsoon Studies (CIMS) activity, aimed at both providing better understanding of fundamental physical processes (diurnal cycle, annual cycle, intraseasonal oscillations) in monsoon regions around the world and at demonstrating the synergy and utility of CEOP data in providing a pathway for model physics evaluation and improvement. On a wider front he noted that of all the WCRP projects, CLIVAR and GEWEX have the greatest affinity and intersection; that collaborative efforts until recently have been ad hoc, but successful and that GEWEX and CLIVAR would benefit from a "practical" meeting, jointly organized to attack the truly global water cycle issues.

In discussion of the GEWEX surface flux activities, the SSG agreed, in particular, of the need for the WCRP Working Group on Surface Fluxes (WGSF) to extend it's efforts to include the land surface:

Action 6: Pass message to the WGSF to work with GEWEX to develop flux products that cover both land and ocean. (V Detemmermann)

3.2.4 How is CLIVAR addressing this theme?

Chaired by Professor Bin Wang, inputs here were provided in particular by the written reports of the VACS, VAMOS and AAMP Panels and presentations by Dr Richard Washington (VACS co-chair), Drs Carolina Vera VAMOS-MESA) and Dr Wayne Higgins (VAMOS-NAME), Professor Bin Wang (AAMP co-chair) and Dr Mike McPhaden for the CLIVAR/GOOS Indian Ocean Panel (IOP), currently a sub-panel of AAMP.

A particular action arising from VACS presentations was as follows:

Action 38: ICPO to follow up with VACS and George Philander to develop possible collaborations with the African Centre for Mathematical Sciences (ICPO)

Particular issues arising from VAMOS presentations were as follows:

(a) VAMOS modelling plan (see section 3.2.5 below)

Action 12: SSG to review the VAMOS modelling plan; VAMOS to invite GEWEX to review it as well; SSG to submit the plan to the WCRP Modelling Panel for further review after iteration with VAMOS (VAMOS co-chairs)

(b) VOCALS links with the GEWEX Cloud System Study (GCSS)

Action 13: Encourage VOCALS to continue to develop active links with GCSS (VAMOS co-chairs)

And (c) following mention that several complimentary comments had been received on the VAMOS Newsletter

Action 40: Compile comments/feedback on latest VAMOS Newsletter for WCRP JPS (C Ereño).

Issues arising from the AAMP/IOP presentations were as follows:

(a) Status of the IOP.

Action 14: It was agreed to continue the IOP as an independent basin panel; revisit ToRs, in particular with regard to links with AAMP and other CLIVAR panels (IOP chair, IPCO)

Action 42: Engage in discussion with IOP and AAMP to define relative roles and collaborations (SSG co-chairs, ICPO)

(b) Request from Dr Siegfried Schubert for SSG endorsement of a proposal on hurricane's and typhoons.

Action 15: Ask AAMP and other appropriate panels to review Sieg Schubert's proposal on hurricanes and typhoons and make recommendation to SSG about endorsement by 15 June 2007 (ICPO).

(c) US CLIVAR MJO Working Group

Action 11: CLIVAR will support a limited number of international participants in the US CLIVAR sub-seasonal variation/MJO working group (V Detemmermann)

3.2.5 Discussion: Developing the Road Map: the Monsoon theme within CLIVAR and WCRP more widely

This was led by Dr Duane Waliser who subsequently chaired a small group to develop the Road Map in this area, the outcomes of which were presented to the SSG later in the meeting (item 9) and are reflected in the relevant section of Annex 4. In introducing the discussion, Dr Waliser appraised the SSG of a recommendation by the THORPEX/WCRP/ICTP Workshop on Organisation and Maintenance of Tropical Convection and the MJO, held in Trieste, Italy, in March 2006 to develop a "year of coordinated observation, modeling and forecasting addressing the challenge of organized tropical convection". If implemented in 2008, this initiative could be a WCRP contribution to the UN Year of Planet Earth* and compliment the International Polar Year (IPY). Following discussion, the SSG agreed:

Action 8: CLIVAR is supportive of the proposal for WCRP/THORPEX year of coordinated observing, modelling and forecasting of the tropics – D Waliser to take lead in further developing plans for this in cooperation with AAMP, WOAP, WMP, GEWEX, THORPEX and other relevant groups. Plan for 2008 as

a WCRP contribution to UN Year of Planet Earth; complement to IPY. (D Waliser, lead).

3.3 Decadal variability and the thermohaline circulation (THC)

3.3.1 Current status and science directions and needs

Professor Marotske's overview paper identified a number of key research needs and CLIVAR's potential role within them. These covered: firstly, the issue of MOC timeseries for which the number one priority is the continuation of the single MOC time series at 26.5°N in the Atlantic, augmented by time series at other locations. CLIVAR's role in this area should be to coordinate a discussion about (i) observing locations complementary to 26.5°N; (ii) alternative observing systems; (iii) development of cheaper technologies and (iv) transfer to operational agencies. Secondly the need for development of MOC proxies. This is because the technical challenge and expense of directly measuring the MOC motivates discussion of the need for efficient proxies for the MOC, enabling us to extend the time series backward in time, prior to 2004. CLIVAR can have a role in coordinating the systematic development of MOC proxies. Thirdly, the issue of decadal predictability and prediction which CLIVAR can and should take the lead on within WCRP by coordinating a discussion about MOC predictability and end-to-end prototype prediction systems. Fourthly, the fact that studies of mechanisms of decadal-interdecadal MOC or THC variability are a thriving enterprise, and it is less clear that CLIVAR is needed. The possible exception might be an initiative to expose, systematically, the proponent models of competing mechanisms to long term observations.

A particular action arising from Dr Marotske's presentation was:

Action 24: CLIVAR to coordinate systematic development of proxies (observations and modelling) for the meridional overturning circulation (Atlantic Panel)

3.3.2 How is CLIVAR addressing this theme

Chaired by Dr Marotske, inputs here were provided in particular from the Atlantic, Pacific and Southern Ocean Region Panels, the last presented by Dr Doug Martinson, and from the written inputs from the panels at: <http://www.clivar.org/organization/ssg/ssg14/ssg14.php>

3.2.5 Discussion: Developing the Road Map: the decadal variability and the THC theme within CLIVAR

This was led by Dr Hazeleger who subsequently chaired a small group to develop the Road Map in this area, the outcomes of which were presented to the SSG later in the meeting (item 9) and can be found in the relevant section of Annex 4.

3.4 Anthropogenic Climate Change

3.4.1 Current status, science directions and needs

Dr McAveney's paper, presented by Dr Tokioka, addressed almost exclusively the future needs for ACC in terms of directions for Earth System modelling. The paper emphasized the need for CLIVAR to more actively participate in ESSP activities, anticipating a rapid convergence of ACC modelling activities within the programmes of the IGBP and WCRP framework over the coming 5 years. However the timescale for incorporating wider Earth System science into any future IPCC assessment may be short; for example modelling groups preparing potential modelling input for an IPCC assessment in 2012 will only have until about 2008 to configure their climate models. He emphasized that new understanding of aerosol effects, carbon cycle dynamics and cryospheric changes is pushing the consensus projected temperature increase towards the upper end of the IPCC range. However there remain many uncertainties associated with these amplifying effects and major challenge will be to determine how important these amplifying effects are. Thus a more systematic, and

more complete approach to studying the role of feedbacks in the climate systems should be fostered. In conjunction with this effort there is a need for enhanced studies of the predictability of climate change, especially in climate extremes.

3.4.2 How is CLIVAR addressing this theme?

Chaired by Dr Tokioka, this session provided the following reports:

(i) WGCM

Dr Meehl (WGCM co-chair) presented a view of how CLIVAR is addressing the ACC theme through the activities of WGCM (jointly sponsored through CLIVAR and the JSC for WCRP), suggesting that CLIVAR could sponsor a regular ACC climate model analysis workshop. Major ACC issues and activities addressed by WGCM include:

1. *Climate sensitivity and climate system response* - a major uncertainty in climate sensitivity is magnitude of feedbacks, and cloud feedbacks are crucial. CFMIP was set up by WGCM to address cloud feedbacks. In cooperation with AIMES, C4MIP studied carbon cycle feedback.
2. *Effects of model systematic errors on climate change projections* - CMIP analysis projects have shed considerable light on the type and effect of systematic errors (e.g. double ITCZ, over-extensive cold tongue, flux adjustment) on future climate change projections.
3. *How do modes of natural variability (ENSO, NAO, decadal) affect our understanding of ACC* - the multi-model analysis effort organized and run by WGCM (see below) has produced numerous papers regarding changes of ENSO, NAO, SAM, and other modes of natural variability compared to observations of the 20th century and involving future climate change.
4. *What scenarios are appropriate to produce future climate change projections for IPCC* – With the help of PCMDI for data archiving, WGCM took ownership of the process to perform a coordinated set of future climate change scenario experiments for the IPCC AR4 that involved “low, medium and high” emissions scenarios (B1, A1B and A2), as well as three climate change commitment scenarios. WGCM coordinated these experiments across 15 modeling groups from 11 countries and 23 state-of-the-art AOGCMs, and then organized analyses of the simulations.
5. *Reduce systematic errors in coupled models* – WGCM is helping to organize the 3rd WGNE Workshop on systematic errors in Climate & NWP Models.
6. *Analyze and understand seasonal, interannual and decadal variability* - WGCM has CMIP Coordinated Experiments to address aspects of variability, the first on meridional overturning circulation in the Atlantic (water hosing experiments).
7. *Probabilistic climate change with AOGCMs* - the multi-model archive has made possible the first analyses of global/regional probabilistic climate change.

(ii) Expert Team on Climate Change Detection, Monitoring and Indices (ETCCDMI) activities

In addition to WGCM activities and individual efforts within CLIVAR Panels and Working Groups to analyses the AR4 archive (item 4 above) CLIVAR's contributions to the ACC theme also come through the activities of the joint CCI/CLIVAR Expert Team on Climate Change Detection, Monitoring and Indices (ETCCDMI). Dr Francis Zwiers (ETCCDI Chair) summarised the activities of this Team to the ACC theme through its 5 regional capacity building climate change workshops which had focussed on analysis of extremes, input to a

number of peer-reviewed papers and a global extremes indices paper, completed in time for IPCC AR4. The activity had also resulted in production of user-friendly workshop software for data analysis. Much of the work of ETCCDMI has focussed on indices of extremes with a view towards detection of external influence on extremes, evidence for which is now beginning to emerge. For the future, sponsors of the Expert Team would be joined by JCOMM and with a change of title to ETCCDI, the financial arrangements for which need to be clarified. Potential future areas of activity include:

- Robust indices for detection
 - Properties of “simple indices”
 - Surface air temperatures
 - Precipitation
 - Circulation related indices
 - Marine surface climate indices
 - Ocean indices (including ocean heat content, water mass properties indicators)
- Dissemination, maintenance and upgrade of indices
- Continued model/obs assessment
 - Extremes - Scales, phenomena, underlying physics
- Maintaining broader overview of detection and attribution science with good links to modelling, observational and detection communities.

Action 7: Determine CCI and JCOMM support for ETCCDI (V Detemmermann)

(iii) CLIVAR/PAGES (IGBP Past Global Changes)

On behalf of the CLIVAR/PAGES co-chairs, Dr Gavin Schmidt provided an outline of the new vision for CLIVAR/PAGES which had been developed at its meeting in late 2004. Key scientific foci include climate variability over the last few millennia; MOC/abrupt climate change; hydrologic, biospheric, land-surface interactions and tropical-extratropical links including ocean and atmospheric teleconnections. The key focus is on decadal to centennial climate variability. Dr Schmidt drew attention in particular to two upcoming CLIVAR/PAGES workshops on “Past Millennia Climate Variability – Proxy-based reconstructions, modelling and methodology” (Wengen, Switzerland, 7-10 June 2006) and “Rapid Climate Changes and the 8.2ka Event” (Birmingham, UK, October 2006)

3.4.3 Discussion: Developing the Road Map: ACC theme within CLIVAR

This was led by Dr Palmer who subsequently led a small group to develop the Road Map in this area, the outcomes of which were presented to the SSG later in the meeting (item 9) and are summarized in the relevant section of Annex 4. Two particular actions arose from the discussion (reflected also in Annex 4):

Action 16: Write pan-CLIVAR review paper on assessment of anthropogenic forcing on natural modes of variability (ENSO, etc) based on AR4 integrations and atmosphere/ocean data analyses. Plan CLIVAR ACC workshop for 2007 (Palmer coordinator); publish report for 2008 Year of Planet Earth. (T Palmer, lead)

Action 17: All Panels and working groups to nominate contributors to the review paper on anthropogenic forcing on natural modes of variability. (T Palmer lead, with ICPO)

4. CLIMATE MODELLING

4.1-4.3 Current status and science needs

Building on the climate modelling issues raised under ACC in particular, this session

provided overviews in development of ocean models by Dr S Griffies, chair, of WGOMD and the current status of seasonal prediction and how WGSIP/the JSC Task Force on Seasonal Prediction (TFSP) is addressing these. Particular attention was given in the WGSIP presentation to the current status of its Seasonal Model Intercomparison Project (SMIP) and the proposed TFSP Seasonal Modelling Experiment aimed at testing the hypothesis that there is currently untapped predictability in the various components of the coupled climate system, and the associated workshop to be held in Barcelona in June 2007. A past WGSIP issue which had recently re-emerged was that of the definition of ENSO which WGSIP had made a particular recommendation to the community on (see Appendix D of http://eprints.soton.ac.uk/28974/01/068_wgsip7.pdf). The WMO Commission for Climatology was now proposing to set up a group to look again at this issue and it would be important for WGSIP to provide input.

As an outcome of the discussion of these presentations, the SSG agreed the following actions:

Action 18: Change TOR for WGOMD from mid/high latitude to global and to report solely to CLIVAR and CLIVAR co-chair of WGCM. (ICPO)

Action 19: Continue to encourage CLIVAR panels to analyze SMIP data sets for their regions and feed back to WGSIP; WGSIP to identify members to liaise with panels on this. (WGSIP co-chairs)

Action 20: SSG to write to all CLIVAR panels and WGs asking them to develop sessions for the June 2007 Seasonal prediction workshop. (relate to above). (SSG co-chairs, ICPO)

Action 21: Invite ex officio members from other WCRP projects to join WGSIP to enable effective transition of TFSP to WGSIP while maintaining cross-WCRP links (WGSIP co-chairs, ICPO).

Action 22: WGSIP to raise issue of future of AMIP type activities with WGNE, noting desirability of more coupled activities for the prediction problem (WGSIP co-chairs)

Action 23: WGSIP and WGCM to identify or provide input on what climate processes should be better observed, and provide this input to the regional panels for consideration of future experimental observation activities. (WGSIP, WGCM)

Action 39: Follow up on CLIVAR involvement in CCI ENSO definition (ICPO)

4.4 Developing the Road map: modelling activities within CLIVAR including global/regional linkages

Discussion on this item was led by Dr P Silva Dias and led to the Road Map items in the relevant section of Annex 4:

5. THE OCEAN'S ROLE IN CLIMATE

5.1 Current status of the global observing system including the CLIVAR role

Dr Ed Harrison provided an overview of the global ocean observing system and products. He provided information on a number of ocean anomalies in 2005/6, ocean system planning and status; ocean system status for winter 2005/6; some examples of decadal variability and

some major roadmap issues and CLIVAR issues for progress. He emphasised that CLIVAR needs a sustained global ocean observing system and related products:

- To describe oceanic variability on climate space and time scales,
- To identify long term oceanic trends
- To support exploration of the roles of the ocean in climate including relationships with surface climate anomalies

Dr Harrison also noted that CLIVAR scientists and national activities have been integral to:

- Design of the initial global system
- Implementation of the present system
- Improvements in coverage
- Development of climate information-papers, products including indices and reanalyses.

They are also the primary customer of system.

Dr Harrison then outlined the status of planning embodied in the following documents:

- IGOS-P Ocean Theme (2001)
- GCOS 2nd Report on Adequacy of Global Observing Systems for Climate (2004)
- GCOS Implementation Plan for 2AR (2005) (GCOS-92)
- GCOS/CEOS Satellite Observing Requirements for Climate (open review 5/06)

The overall strategy of the GCOS-92 plan was aimed at being feasible, using proven technology and leveraging off existing efforts; attaining and sustaining global coverage; and inclusive of real time data transmission for system status, operational oceanography & NWP and data management and evaluation and evolution processes. The plan also recognized the need for more variables, science and technology R&D and pilot projects. Its present status is that it has been accepted by other co-sponsors WCRP & GOOS and by UNFCCC, with a call for Parties to implement ocean system & make annual reports. It was also part of the G8 Gleneagles declaration and has been incorporated into the GEOSS 10-year Implementation Plan.

The present status of the observing system (winter 2005/6) is that it is ~60% complete against plan with very good progress in some components but losing ground in some others. There is progress in real time data transmission and metadata and in analysis and reanalysis. There are a number of system status issues: little of what is now present can be counted on for the future; there are concerns about the continuity of ocean satellite sensors & adherence to "GCOS Satellite Climate Monitoring Principles" for future missions; there are also few national actions toward sustained funding. In terms of a Road Map some issues are:

- How to complete and sustain the system
- How to get more users and advocacy
- How to get feedback & advocacy from forecasting & assessment communities
- The need to explain significance of decadal variability and implications.
- Ocean information product development and delivery in infancy.
- The need for ecosystem & biogeochemical components.

Finally Dr Harrison noted some issues for CLIVAR as follows:

- Maintaining global coverage requires research community help for deployment, & infrastructure; an OOS Center is needed.
- Ocean data system needs further effort & full participation by researchers, including archiving.
- "Climate QC" is still to be agreed
- The need for development of 'reference data sets' including appropriate climatologies & statistics.

In discussion of Dr Harrison's presentation, the SSG agreed the following actions:

Action 25: Lend CLIVAR support to the campaign to create an Ocean Observation System Centre (to be expanded in discussion of roadmap) (SSG co-chairs, ICPO)

Action 26: Remind CLIVAR researchers of the need to submit all data in real time for model evaluation, etc. (via Exchanges) (ICPO)

Action 27: GSOP to identify and coordinate development of CLIVAR reference data sets, including error bars where possible, and develop ideas on how to make them widely accessible. (GSOP)

5.2 Report on GSOP activities

A report on GSOP activities was provided by Dr Detlef Stammer, GSOP co-chair. With regard to ocean synthesis activities, GSOP has finalised guidelines for a joint CLIVAR/GODAE Global Synthesis/Reanalysis Evaluation effort, with the intention to evaluate the existing reanalysis products against observations to identify reanalysis efforts suitable to meet CLIVAR needs. It has also requested and received from CLIVAR Basin Panels a list of climate indices that should be computed routinely by reanalysis efforts in support of the CLIVAR community. In addition GSOP has identified the need for CLIVAR reference datasets to be used not only for evaluation of the reanalysis and WGOMD products but also as input for reanalysis. Dr Stammer illustrated current progress in ocean synthesis in a number of areas and outlined plans for a GSOP/GODAE Synthesis Evaluation Workshop to be held at ECMWF, Reading, UK from 31 August to 1 September 2006. The workshop is aimed at evaluating the quality and skill of available global synthesis products, at identifying the common strength and weaknesses of current ocean synthesis systems and defining and testing climate-relevant indices. Dr Stammer also noted the need for CLIVAR reference data sets and their error fields for (1) the analysis of climate processes; (2) for the evaluation of assimilation and WGOMD simulations and (3) as data constraints input to global synthesis.

A GSOP-related activity was the IOCCP/CLIVAR International Repeat Hydrography Workshop, held in Japan in November 2005 to discuss the global priorities for ship based hydrography to fulfil the specific science aims of CLIVAR and the ocean carbon and tracer community, and in light of the existence and needs of the Argo program. The three main outcomes of the workshop were the creation of a small oversight group on repeat hydrography (outlined also in a presentation by Dr Dargaville), identification of the need to develop synthesis activities and to develop the data management component of hydrography further. One proposal was for a co-sponsored synthesis workshop of hydrography data for the North Atlantic region which GSOP would need to work very closely with the Atlantic Panel on.

Following discussion of Dr Stammer's presentation, the SSG agreed the following actions:

Action 27: GSOP to identify and coordinate development of CLIVAR reference data sets, including error bars where possible, and develop ideas on how to make them widely accessible. (GSOP)

Action 28: GSOP to work with Atlantic Panel on Atlantic synthesis in cooperation with IOCCP. (Request D Stammer to refine)

Action 30: Establish need for a hydrography planning and oversight group with reference to outputs from recent Hydrography workshop (ICPO to

coordinate with Weller and Hood). ICPO to continue its support to the international hydrography and carbon research community. (ICPO).

Action 31: Ask basin panels and other working groups to analyses ocean synthesis products and feed back to GSOP (GSOP)

Action 41: ICPO to ask GCOS for GCOS-CEOS satellite requirements document and liaise with GSOP on any CLIVAR response. (ICPO)

5.3 CLIVAR's ocean observational needs

This topic was introduced by Dr David Legler who saw CLIVAR's role the development of the sustained ocean observing system as:

1. Identifying scientific requirements for future observations and observation systems (and assessing impact of degrading systems)
2. Assessing adequacy of observation systems to deliver data and products
3. Encouraging and coordinating current (e.g. hydrography) and emerging observational activities carried out by the research community
4. Developing, coordinating, and utilizing syntheses of these observations for climate purposes (e.g. monitoring, model and forecast initialization, indices, understanding, etc)

Under items 1 and 2, and coordinating with OOPC, Dr Legler identified the need for CLIVAR to continue assessing the scientific adequacy of system elements; array design and deployment and system delivery of data and products (also coordinating with JCOMM). He also suggested a new activity, namely a follow-up to the OceanObs'99 conference in, say, 2009 or 2010. Under item 3, CLIVAR should continue to advocate and encourage the research community to continue their observational activities but should also spin up new activities to address specific shortcomings that need to be addressed, including International planning; data flow; best practices for data management and QC; provision of products. He supported the establishment of the Hydrography Advisory Group (see above) and identified the need for an Ocean Transport Workshop within the next two years. Syntheses and ocean metrics (item 4) are already a key activity of GSOP and need to be continued. For observations over relatively limited time periods and regions aimed at specific processes or climate features (e.g. NAME-2004 (atmosphere), KESS) Dr Legler also identified the need for recommended "best practices" for collection, distribution, and long-term archival and for consideration to be given to continuation of these observations for monitoring and modeling input purposes. He also identified the need for consideration of observations from experimental and/or emerging technologies (e.g. ocean gliders, GPS occultation data, etc.). Finally he made some recommendations for Road Map items, incorporated into the relevant section of Annex 4.

In consideration of Dr Legler's input, the SSG agreed:

Action 27: Develop plans for an "OceanObs 2008" and consult potential sponsors regarding sponsorship. To be seen as part of CLIVAR annual workshop devoted to the Oceans' role in climate; include issues such as Ocean Observations Data Centre, measurement of ocean currents and transports, etc. (GSOP)

5.4 Developments in IGBP IMBER (Integrated marine Biogeochemistry and Ecosystem Research)

Dr Hazeleger, as a member if the IMBER SSC presented the present status of IMBER, the goal of which is to "investigate the sensitivity of marine biogeochemical cycles and

ecosystems to global change, on time scales ranging from years to decades". IMBER operates under the following themes:

Theme 1. Interactions between biogeochemical cycles and marine food webs

Theme 2. Sensitivity to Global Change

Theme 3. Feedbacks to the Earth System

Theme 4: Responses of Society

IMBER has a number of regional activities with GLOBEC and SOLAS in the areas of food webs and carbon respectively. These are carried out through identified groups and there are clear links to CLIVAR through carbon representatives on ocean basin panels. Key issues in terms of observations include: repeat hydrography (ensuring carbon measurements on CLIVAR lines and strategy on replacement CLIVAR lines); maintaining and extending time series stations (oceanSITES) and promoting Argo float technology (with O₂, CO₂ sensors), ensuring good coverage. Dr Hazeleger also suggested the need for a hydrography strategy workshop which SOLAS/IMBER are willing to take the lead on and the need for basin synthesis workshops similar to those identified at the recent hydrography workshop in Japan (see above). He also identified the need to provide ocean re-analysis products and models suitable for biogeochemical hindcasts (e.g. without spurious diapycnal diffusion by assimilation) and suggested exploring possible linkage between the CLIVAR and IMBER (GLOBEC) data management systems. In this context, he also outlined the GLOBEC questions to CLIVAR raised through the Atlantic Panel, in response to which the SSG agreed:

Action 2: Form an organizing committee for a workshop on climate impacts and the marine environment – with GLOBEC and IMBER; use the opportunity of SCOR coordination meeting in London, UK, December 2006 to advance coordination (Hazeleger lead)

5.5 Discussion: Developing the Road map: the role of the oceans in climate

Discussion of this item was led by Dr Weller, emphasizing the need to better quantify the ocean's exchanges with the atmosphere; heat, salt and CO₂ storage and the mean and eddy transports of these around the ocean. In terms of exchange with the atmosphere, he suggested CLIVAR partner with GEWEX on this issue to help fully address the global water cycle. He also felt there is a need to more critically examine priorities given to process studies to ensure a return in terms of modelling and synthesis on the investment they require. He raised the need to better identify what the CLIVAR's legacy will be suggesting the need to choose a few foci crafted around the ocean's role in climate and to start to build the foundations of the CLIVAR legacy over the 2007/10 timescale in terms of :

- Data management
- Data synthesis
- Assertion of the role of research in sustained observation of the coupled climate system
- CLIVAR outreach to IOOS, GEOSS
- CLIVAR outreach to governments, intergovernmental organizations
- The next generation of people

on the 2013 timescale Dr Weller also identified the need to consider what might be the focus post-CLIVAR, advocating in particular development of a CLIVAR synthesis programme for the 2013 – 2023 timeframe.

In consideration of Dr Weller's presentation and previous presentations, the SSG agreed the need to start to consider CLIVAR legacy issues now, in addition to the Road Map for CLIVAR's focus on the role of the oceans in climate. Discussion and further inputs by a small

group led to the Road Map items in the relevant section of Annex 4.

5. The role of the ICPO and programme visibility and outreach

5.1 CLIVAR outreach: summary review

In opening this item, Dr Heidi Cullen emphasized the need for CLIVAR to be “Responsive/Reactive & Proactive” in dealing with it’s outreach. She suggested the need for the Website to include position statements (e.g. on natural variability & global warming; tipping points/climate commitment; weather extremes, hurricanes. She also encouraged outreach to local TV meteorologists on topics such as probabilistic forecasting ensuring connections of weather to climate and communicating on climate change. She outlined various media opportunities, including “Forecast Earth” (www.weather.com), a ½ hour show covering science and policy topics and the Broadband Channel (www.weather.tv/onedegree).

In the discussion which followed, the following action items were suggested:

Action 33: All CLIVAR panels and working groups to send Heidi Cullen any available videos, blogs or other information for posting on new Weather Channel broadband (web) station. (All)

Action 34: ICPO to post Palmer explication of probabilistic forecasting on CLIVAR web pages with other links (from Heidi Cullen). (ICPO)

Action 34: ICPO to work with NOC public relations office to raise visibility of CLIVAR; include “CLIVAR in the news” on the website. Highlight new publications on web, eg Med CLIVAR book, Journal of Climate issue. ICPO)

5.2 ICPO Report

Dr Cattle, as Director of the ICPO introduced this item, outlining the functions of the ICPO, an providing a summary of outline its activities, publications, meetings supported and attended and it’s current funding support since SSG-13 (June 2004). With respect to the last of these, the UK Natural Environment Research Council renewed renewed it’s funding for a further 3 years from 1 April 2005 with further extension for additional 2 years from 1 April 2008 subject to review. The Office is also substantially supported by NOAA, NASA & NSF funding through US CLIVAR on an annually renewed contract with UCAR. Additional support had also been received from the CSIRO Division of Marine Research during 2005/6 and support had been received from the Chinese Academy of Sciences through CMA for publication of Exchanges in 2005. The ICPO is currently hosted in the UK by the James Rennell Division (JRD), National Oceanography Centre, Southampton (NOCS), UK). However 2 staff were also hosted at Vigo, Spain/Villefranche sur Mer, France and University of Buenos Aries over the period of the report. Within NOCS, ICPO is expected transition from JRD to National Marine Coordination Office, National Marine Facilities Division during 2006 but without implications for funding or function. Dr Cattle expressed his thanks to those who have funded the ICPO a sentiment strongly supported by the SSG.

2005/6 had seen some staff changes in the ICPO: Katy Hill left in April 2005 to do a PhD in Hobart; Nico Caltabiano joined as replacement in April 2005; Zhongwei Yan (50% FTE) left at the end of July; Carlos Ereno’s time was reduced to 25% FTE during 2005 but increased to 50% for 2006; Roberta Boscolo’s time increased from 50% to 100% with effect from 1 Jan 2006; Mike Sparrow’s time for CLIVAR increased (in phases) from 30% to 90% FTE over 2005/6.

One of the functions of the ICPO is to implement CLIVAR data and information management under the guidance of GSOP. In response to earlier discussion, Dr Cattle outlined the present status of this area as follows: (a) the CLIVAR data policy had been finalized and published (web and Exchanges 33, April 2005); (b) a data information web page had been set up on the web site – all are encouraged input links to CLIVAR and/or CLIVAR-related data; (c) the ICPO has continued to develop and encourage input to hydrography and carbon web pages for notification of cruise plans in collaboration with IOCCP, working with IOCCP to support the Hydrography Workshop reported earlier; for VAMOS data substantial success had been achieved through data management through UCAR/JOSS; links had been maintained with the CLIVAR (formally WOCE) DACS with an article on the DACS published in Exchanges 33 drawing attention to their role.

Finally, in terms of outreach, a new CLIVAR website with a new look and feel had been developed 'in house' by Nico Caltabiano and had been well received. A particular feature is its ease of updating. It rationalises the previous website which had become too large and cumbersome. The baseline site went 'live' on the web in mid-March. Much work needs to be done by ICPO staff members to fully populate the individual pages.

In discussion, the SSG raised the following actions:

Action 43: ICPO to survey list of CLIVAR data assembly centres concerning their status. Review their mandates. (ICPO)

Action 44: ICPO to add links to data pages on CLIVAR website as a matter of priority. (ICPO)

Action 45: In term of outreach, print extra copies of October issue of Exchanges (Indian Ocean) to include in ESSP OSC registration package; also consider including information sheets produced for Baltimore Conference. (ICPO)

7. Briefing on US CLIVAR reorganization

Dr Legler briefed the SSG on the new organization for US CLIVAR. In summary, US CLIVAR now has a structure encompassing 3 panels as follows:

- Process Studies and Model Improvement (PSMI)
- Predictability, Predictions and Applications Interface (PPAI)
- Phenomenology, Observations and Synthesis (POS)

As well as these panels, provision has also been made to support short term focussed Working Groups arising from the panels and the community. Working Groups on Salinity, the MJO and Drought were underway/proposed. The Panel and Working Group structure is overseen by an overarching US CLIVAR Committee and managed through the US CLIVAR Office with involvement of the US CLIVAR Interagency Group (program managers and administrators). For further information see www.usclivar.org.

8. Presentation on MedCLIVAR and the CLIVAR Programme of the Netherlands

Dr Piero Lionello outlined progress with MedCLIVAR (Mediterranean Climate Variability and Predictability) which is supported through the European Science Foundation. MedCLIVAR coordinates and promotes research on the Mediterranean climate. The main goals include reconstruction of past climate evolution, description of patterns and mechanisms characterizing climate space-time variability, and identification of the forcing responsible for the observed changes. Emphasis is being put on identification of trends, present in

observational records as well as on climate prediction under future emission scenarios. The study of the occurrence of extreme events and of climate change impacts is also included in MedCLIVAR.

MedCLIVAR is moving ahead on a variety of fronts:

- 1) Analysis of past climate;
- 2) Systematic observations of the present climate;
- 3) Understanding climate processes at regional scale;
- 4) Simulation of future climate scenarios;
- 5) Dissemination of MedCLIVAR objectives and results

A key achievement is the publication of a MedCLIVAR book "Mediterranean Climate Variability". A number of workshops are currently in the planning phase and future activities include a young scientist exchange programme and provision for two summer schools in 2008 and 2010. An open meeting is also being planned to introduce MedCLIVAR to a wider community.

Dr Hazeleger next provided information on the CLIVAR programme of The Netherlands. In discussion of which, and as an additional response to the earlier outreach discussion, the SSG requested:

Action 35: Encourage SSG members to organize national reports on CLIVAR activities to raise programme visibility. (SSG co-chairs, ICPO).

9. Revisit of Road Map

Through a series of short presentations by leaders of ad hoc "road map development groups" established during the meeting, the SSG agreed the key elements of the Road Map and requested:

Action 37: Continue development of CLIVAR Road Map activities post SSG (ICPO to lead, SSG and Panel and Working Group Chairs).

This eventually led to the version of the Road Map at Annex 4

10. Review of action items; revisit of science issues as needed

This item led to the list of action items at Annex 3 the background to which is outlined in this report.

11. SSG and other membership issues

The SSG agreed to take these issues "offline". However the group also agreed:

Action 3: Review all Panel and Working Group mandates in 2009, taking into consideration Road Map milestones (ICPO, SSG, Panel & Working Group Chairs).

12. Date and place of next meeting

The group agreed that they would seek to meet next from 10-13 April 2007, starting lunchtime on 10th) at the WMO Headquarters, Geneva, Switzerland. These dates were later changed to 11-14 September 2007.

Action 47: Date and place of next meeting tentatively agreed as April 10-13, starting lunchtime on 10th) in Geneva. (V Detemmermann, ICPO)

13. Closure of the meeting

In closing the meeting, the SSG co-chairs expressed their thanks to the Secretary of Science, Technology and Productive Innovation, Ing. Tulio Abe Del Bono and to the Director of International Relations, Ing. Agr. Agueda Menvielle, for local financial support of the meeting. They also expressed thanks to Dr Carlos Ereno and his assistants for their work to ensure the smooth running of the meeting. This being Dr Busalacchi's last SSG meeting as chair, Dr Palmer made a presentation to him on behalf of the group to mark his time with CLIVAR and the SSG with grateful thanks for all his many contributions to CLIVAR.

Annex 1

SSG-14 Attendees

Name	Capacity in which attending
Tony Busalacchi	SSG Co-Chair
Tim Palmer	SSG Co-Chair
Heidi Cullen	SSG member
Pedro Silva Dias	SSG member
Jochem Marotzke	SSG member
Michelle Reinecker	SSG member
Tatshushi Tokioka	SSG member
Duane Waliser	SSG member
Bin Wang	SSG member/AAMP co-chair
Bob Weller	SSG member
Renhe Zhang	SSG member
Jerry Meehl	WGCM CLIVAR Vice Chair
Ben Kirtman	WGSIP Co-Chair
Stephen Griffies	WGOMD Chair
Detlef Stammer	GSOP Co-Chair
Gavin Schmidt	CLIVAR/PAGES representative
Wilco Hazeleger	Atlantic Panel Co-Chair
Axel Timmermann	Pacific Panel Chair
Doug Martinson	Southern Ocean Panel representative
Carolina Vera	VAMOS Co-Chair
Wayne Higgins	VAMOS Co-Chair
Richard Washington	VACS representative
Francis Zwiers	ETCCD Co-Chair (CLIVAR)
Mike McPhaden	TIP Chair
Soroosh Sorooshian	GEWEX SSG Chair
Ed Harrison	OOPC Chair
Roger Dargaville	IOC
Piero Lionello	MedCLIVAR
Phil Arkin	Interested scientist
Ann Henderson-Sellers	JPS for WCRP
Valery Detemmerman	JPS for WCRP
Howard Cattle	ICPO
Carlos Ereno	ICPO, local organiser
David Legler	US CLIVAR
Carlos Nobre	IGBP
Jim Todd	US Funder – NOAA
Jin Huang	US Funder - NOAA

Annex 2

CLIVAR SSG-14

Hotel Colon, Buenos Aries, Argentina

19-22 April 2006

AGENDA & TIMETABLE

WEDNESDAY 19 APRIL

			Chairs/leads*	Speakers/ contributors
	1.	Introduction		
0830-0845	1.1	Welcome, introductions, local arrangements	A Busalacchi/ T Palmer	
0845-0930	1.2	Introduction to CLIVAR SSG-14, including metrics for CLIVAR and strawman road map		A Busalacchi
0930-0945	1.2 cont	Discussion	A Busalacchi/ T Palmer*	All
	2.	WCRP & sponsor input		
0945-1030	2.1	Future directions for WCRP; JSC-27 recommendations for CLIVAR; JPS; WCRP funding	A Busalacchi/ T Palmer	A Henderson-Sellers
1030-1050		Coffee/tea		
1050-1105	2.2	IOC programme needs as a WCRP sponsor	A Busalacchi/ T Palmer	R Dargaville
1105-1120	2.3	WMO & WGNE activities relevant to CLIVAR	A Busalacchi/ T Palmer	P Silva Dias
	3.	Reports against CLIVAR science themes		
	3.1	<i>ENSO and other modes of tropical variability</i>		
1120-1150	3.1.1	Current status and science directions and needs	A Busalacchi/ T Palmer	M Rienecker
1150-1230	3.1.2	How is CLIVAR addressing this theme? Round table contributions from chairs/ reps of the Atlantic and Pacific Panels, AAMP & WGSIP and other Panels & Working Group chairs/ reps	M Rienecker	Panel & Working Group chairs/ reps.
1230-1400		Lunch		
1400-1430	3.1.3	Discussion Developing the road map: the ENSO/TV theme within CLIVAR	A Timmermann*	All
1430-		Science lecture: The GEF project for	A Busalacchi/	V Barros & J

1515		the La Plata Basin	T Palmer	<i>Rucks</i>
1515-1535		<i>Coffe/tea</i>		
	3.2	<i>Monsoons</i>		
1535-1605	3.2.1	Current status and science directions and needs	A Busalacchi/ T Palmer	B Wang
1605-1615	3.2.2	Summary of outcomes of pan-WCRP Modelling Workshop & JSC responses	A Busalacchi/ T Palmer	H Cattle
1615-1630	3.2.3	Developments in GEWEX & GEWEX monsoon activities	A Busalacchi/ T Palmer	S Sorooshian
1630-1745	3.2.4 part1	How is CLIVAR addressing this theme? Reports from, VACS+AMMA (30 mins) VAMOS, & AAMP & IOP, (20 mins each) & round table contributions from other Panel & Working Group chairs/ participants.	B Wang	Panel & Working Group chairs/ reps
1745		END OF DAY 1		
		THURSDAY 20 APRIL		
0830-0915	3.2.4 cont	How is CLIVAR addressing this theme? Reports from, VACS+AMMA (30 mins) VAMOS, & AAMP & IOP, (20 mins each) & round table contributions from other Panel & Working Group chairs/ participants; discussion on IOP status	B Wang	Panel & Working Group chairs/ reps
0915-1000	3.2.5	Discussion: Developing the roadmap: The Monsoon theme within CLIVAR and WCRP more widely.	D Waliser*	All
1000-1015	2.4	IGBP/WCRP links	A Busalacchi/ T Palmer	C Nobre
1015-1035		Coffee/tea		
	3.3	<i>Decadal variability and the thc</i>		
1035-1105	3.3.1	Current status and science directions and needs	A Busalacchi/ T Palmer	J Marotzke
1105-1155	3.3.2	How is CLIVAR addressing this theme? Round table contributions from chairs/ reps of Atlantic, Pacific, Indian and Southern Ocean basins panels & WGCM plus other Panel &	J Marotske	Panel & Working Group Chairs/ reps

		Working Group chairs/ reps		
1155-1205	3.3.3	Plans for a CLIVAR Workshop on Multi-decadal Variability	A Busalacchi/ T Palmer	A Timmermann
1205-1235	3.3.4	Discussion: Developing the road map: The decadal variability and the theme within CLIVAR.	W Hazeleger*	All
1235-1400		Lunch		
	3.4	<i>Anthropogenic climate change</i>		
1400-1430	3.4.1	Current status, science directions and needs	A Busalacchi/ T Palmer	T Tokioka for B McAveney
1430-1530	3.4.2 part1	How is CLIVAR addressing this theme? Reports on WGCM including AR4 runs (30 mins), ETCCD & CLIVAR/PAGES (15 mins each). Round table contributions from other Panel & Working Group chairs/ reps.	T Tokioka	Panel & Working Group Chairs/ reps
1530-1550		Coffee/tea		
1550-1630	3.4.2 cont	How is CLIVAR addressing this theme? Reports on WGCM including AR4 runs (30 mins), ETCCD & CLIVAR/PAGES (15 mins each). Round table contributions from other Panel & Working Group chairs/ reps.	T Tokioka	Panel & Working Group Chairs/ reps
1630-1700	3.4.3	Discussion: Developing the roadmap: The ACC theme within CLIVAR	T Palmer	All
1700-1720	6.1	CLIVAR outreach: Summary review.	A Busalacchi/ T Palmer	H Cullen
1720		END OF DAY 2		
		FRIDAY 21 APRIL		
	4.	GLOBAL modelling activities and regional/global modelling panel links (cont)		
0830-0900	4.1	Current status of coupled modelling and science needs and how WGCM is addressing these	A Busalacchi/ T Palmer	G Meehl
0900-0930	4.2	Current status of global ocean model development and science needs and how WGOMD is addressing these	A Busalacchi/ T Palmer	S Griffies
0930-	4.3	Current status of seasonal	A Busalacchi/	B Kirtman

1000		prediction and science needs and how WGSIP/TFSP is addressing these	T Palmer	
1000-1020		Coffee/Tea		
1020-1050-	4.4	Discussion (lead): Developing the roadmap: modelling activities within CLIVAR, including global/regional linkages, links with GEWEX etc	P Silva Dias	All
	5.	The ocean's role in climate		
1050-1115	5.1	Current status of the global ocean observing system, including PIRATA review and CLIVAR's role	A Busalacchi/ T Palmer	E Harrison
1115-1145	5.2	Report on GSOP activities including current status of reanalysis activities, science directions and needs and CLIVAR data management	A Busalacchi/ T Palmer	D Stammer
1145-1230		Discussion: CLIVAR's ocean observational needs, ocean reanalysis & CLIVAR data management	D Legler	All
1230-1400		Lunch		
1400-1540	5.4	Basin Panel observing system and synthesis issues and science issues not covered previously. Reports from Atlantic (including TACE & ACP) (30 mins), Pacific, and Southern Ocean Basin Panels (20 minutes each), TIP (10mins); TACE & ACP discussion	R Weller	Panel & Working Group Chairs/ reps
1540-1600		Tea/coffee		
1600-1645		<i>Science lecture: Regional ocean science activities</i>		A Piola
1645-1705	5.5	Developments in IGBP IMBER	A Busalacchi/ T Palmer	W Hazeleger
1705-1750	5.6	Discussion: Developing the roadmap: the role of the oceans in climate. How do we best address CLIVAR's ocean observational and synthesis needs and their links to wider activities; how can we best respond to IOC needs? Scope of an SSG workshop on the 'Role of	R Weller*	

the Oceans in Climate'.

1750

END OF DAY 3

SATURDAY 22 APRIL

6. Role of the ICPO; programme visibility and outreach (including web page, publications etc)

0830-0950

6.2 ICPO report, including recap of outreach review and discussion

A Busalacchi/
T Palmer

H Cattle

7. National activities

0900-0910

7.1 Summary of Netherlands' Report

A Busalacchi/
T Palmer

W Hazeleger

0910-0930

7.2 Briefing on US CLIVAR reorganisation

A Busalacchi/
T Palmer

D Legler

0930-0950

8. Presentation on MedCLIVAR

A Busalacchi/
T Palmer

P Lionello

0950-1030

9. Revisit of roadmap/plans for the coming year

A Busalacchi/
T Palmer*

All

1030-1050

Coffee/tea

1050-1140

10. Review of action items; revisit of issues as needed

A Busalacchi/
T Palmer

All

1140-1210

11. Panel & Working Group membership issues

A
Busalacchi/T
Palmer*

Panel &
Working
Group
chairs/ reps

1210-1220

12. Date and place of next meeting

A
Busalacchi/T
Palmer*

All

1220-1230

13. Close

A Busalacchi/
T Palmer

END OF SSG-14

Annex 3

CLIVAR SSG 14 RECOMMENDATIONS AND ACTIONS

GENERAL

1. Adopt CLIVAR metrics
2. Form an organizing committee for a workshop on climate impacts and the marine environment – with GLOBEC and IMBER; use opportunity of SCOR high level coordination meeting in London, Dec 06 to advance coordination; (Hazeleger lead).
3. Review all Panel and Working Group mandates in 2009, taking into consideration roadmap milestones (ICPO, SSG, Panel & WG chairs)
4. CLIVAR agrees to co-sponsor Arctic Climate Panel and encourages continued cross membership with the CLIVAR Atlantic Panel. Ask ACP to report to next SSG meeting on progress towards developing a climate observing system in the Arctic. There is a need to clarify the financial implications which should match those for the CLIVAR/CliC/SCAR Southern Ocean Panel. (V Detemmermann, ICPO)
5. CLIVAR endorses TACE as a CLIVAR process study. It also encourages development of extension to western Atlantic (WAVES). TACE is to report to Atlantic and VACs panels. W Hazeleger Lead, with ICPO).
6. Pass message to WCRP WG on Surface Fluxes to work with GEWEX to develop flux products which cover land and ocean (V Detemmermann)
7. Determine CCI and JCOMM support for ETCCDI (V Detemmermann)

MONSOONS/ TROPICS

8. CLIVAR is supportive of the proposal for WCRP/THORPEX year of coordinated observing, modeling and forecasting of the tropics – D Waliser to take lead in further developing plans for this in cooperation with AAMP, WOAP, WMP, GEWEX, THORPEX and other relevant groups. Plan for 2008 as a WCRP contribution to UN Year of Planet Earth; complement to IPY. (D Waliser, lead)
9. AAMP to review MAHASRI plan and report to CLIVAR SSG. (AAMP co-chairs)
10. All monsoon panels are to review CEOP II plan. (Monsoon Panel co-chairs)
11. CLIVAR will support a limited number of international participants in the US CLIVAR Subseasonal variation /MJO working group. (V Detemmermann)
12. SSG to review VAMOS modeling plan; VAMOS to invite GEWEX to review it as well; SSG to submit plan to WMP for review after iteration with the VAMOS (VAMOS co-chairs)
13. Encourage VOCALS to continue to develop active links with GEWEX Cloud System Study (GCSS). (VAMOS co-chairs)
14. Agreed to continue Indian Ocean Panel as an independent basin panel; revisit TORS, in particular with regards to links to AAMP and other CLIVAR panels. (IOP chair, ICPO)
15. Ask AAMP and other appropriate panels to review Sieg Schubert's proposal on hurricanes and typhoons and make recommendation to SSG about endorsement by 15 June. (ICPO)

ACC

16. Write pan-CLIVAR review paper on assessment of anthropogenic forcing on natural modes of variability (ENSO, etc) based on AR4 integrations and atmosphere/ocean data analyses. Plan CLIVAR ACC workshop for 2007 (Palmer coordinator); publish report for 2008 Year of Planet Earth. (T Palmer, lead)
17. All Panels and working groups to nominate contributors to the review paper on anthropogenic forcing on natural modes of variability. (T Palmer lead, with ICPO)

MODELLING

18. Change TOR for WGOMD from mid/high latitude to global and to report solely to CLIVAR and CLIVAR co-chair of WGCM. (ICPO)
19. Continue to encourage CLIVAR panels to analyze SMIP data sets for their regions and feed back to WGSIP; WGSIP to identify members to liaise with panels on this. (WGSIP co-chairs)
20. SSG to write to all CLIVAR panels and WGs asking them to develop sessions for the June 2007 Seasonal prediction workshop. (relate to above). (SSG co-chairs, ICPO)
21. Invite ex officio members from other WCRP projects to join WGSIP to enable effective transition of TFSP to WGSIP while maintaining cross-WCRP links (WGSIP co-chairs, ICPO).
22. WGSIP to raise issue of future of AMIP type activities with WGNE, noting desirability of more coupled activities for the prediction problem (WGSIP co-chairs)
23. WGSIP and WGCM to identify or provide input on what climate processes should be better observed, and provide this input to the regional panels for consideration of future experimental observation activities. (WGSIP, WGCM)

DECEN/ THC

24. CLIVAR to coordinate systematic development of proxies (obs and modeling) for the meridional overturning circulation (Atlantic Panel)

OCEANS

25. Lend CLIVAR support to the campaign to create an Ocean Observation System Centre (to be expanded in discussion of roadmap) (SSG co-chairs, ICPO)
26. Remind CLIVAR researchers of the need to submit all data in real time for model evaluation, etc. (via Exchanges) (ICPO)
27. GSOP to identify and coordinate development of CLIVAR reference data sets, including error bars where possible, and develop ideas on how to make them widely accessible. (GSOP)
28. GSOP to work with Atlantic Panel on Atlantic synthesis in cooperation with IOCCP. (Request D Stammer to refine)
29. Develop plans for an "OceanObs 2008" and consult potential sponsors regarding sponsorship. To be seen as part of CLIVAR annual workshop devoted to the Oceans' role in climate; include issues such as Ocean Obs Data Centre, measurement of ocean currents and transports, etc. (GSOP)
30. Establish need for a hydrography planning and oversight group with reference to outputs from recent Hydrography workshop (ICPO to coordinate with Weller and Hood). ICPO to continue its support to the international hydrography and carbon research community. (ICPO)
31. Ask Basin panels and other working groups to analyse ocean synthesis products and feed back to GSOP. (GSOP)
32. W Hazeleger to formulate response to IOC doc based on comments from SSG members and others on IOC discussion document on Climate Impacts on the Marine Environment to ICPO by 15 May (CLIVAR SSG 14 Doc 2.2). (W Hazeleger)

OUTREACH

33. All CLIVAR panels and working groups to send Heidi Cullen any available videos, blogs or other information for posting on new Weather Channel broadband (web) station. (All)
34. ICPO to post Palmer explication of probabilistic forecasting on CLIVAR web pages with other links (from Heidi Cullen). (ICPO)

35. ICPO to work with NOC public relations office to raise visibility of CLIVAR; include "CLIVAR in the news" on the website. Highlight new publications on web, eg Med CLIVAR book, Journal of Climate issue. (ICPO)
36. Encourage SSG members to organize national reports on CLIVAR activities to raise programme visibility. (SSG co-chairs, ICPO)

ROADMAP

37. Continue development of CLIVAR roadmap activities post SSG (ICPO to lead, SSG and Panel and Working Group Chairs)

ICPO

38. ICPO to follow up with VACS and George Philander to develop possible collaborations with African Centre for Mathematical Sciences. (ICPO)
39. Follow up on CLIVAR involvement in CCI ENSO definition. (ICPO)
40. Compile comments/ feedback on latest VAMOS newsletter for WCRP JPS. (C Ereno)
41. ICPO to ask GCOS for GCOS-CEOS satellite requirements document and liaise with GSOP on any CLIVAR response. (ICPO)
42. Engage in discussion with IOP and AAMP to define relative roles and collaborations. (SSG co-chairs, ICPO)
43. ICPO to survey list of CLIVAR data assembly centres concerning their status. Review their mandates. (ICPO)
44. ICPO to add links to data pages on CLIVAR website as a matter of priority. (ICPO)
45. Print extra copies of October issue of Exchanges (Indian Ocean) to include in ESSP OSC registration package; also consider including information sheets which were produced for Baltimore Conference. (ICPO)
46. SSG members and panel, wg chairs, to provide input to ICPO on space time diagram. (All)

DATE AND PLACE OF NEXT MEETING

47. Tentatively agreed as April 10-13, starting lunchtime on 10th) in Geneva. (V Detemmermann, ICPO)

Annex 4: CLIVAR SSG-14

Development of a CLIVAR Road Map/Forward Look

Annex 4: CLIVAR SSG-14

Development of a CLIVAR Road Map/Forward Look

1. BACKGROUND

Building on the outcomes of the 1st International CLIVAR Science Conference and the Assessment of progress with CLIVAR carried out by 13th meeting of the CLIVAR Scientific Steering Group (SSG-13 – Baltimore, 27-29 June 2004), CLIVAR SSG-14 (Buenos Aires, 19-22 April 2006) sought development of a CLIVAR Forward Look against the key CLIVAR cross cutting science themes. These were identified by SSG-13 to be:

- ENSO and other models of tropical variability (TV)
- Monsoons
- Decadal variability and the thermohaline circulation (THC)
- Anthropogenic climate change (ACC)

SSG-13 also re-emphasized:

- CLIVAR's responsibility for study of the role of the oceans in climate under WCRP, including those for ocean observations
- CLIVAR's key role in climate modelling and prediction in WCRP, notably CLIVAR's Working Group on Seasonal to Interannual Prediction (WGSIP), its Working Group on Ocean Model Development (WGOMD) and the joint JSC/CLIVAR Working Group on Coupled Modelling (WGCM) represent WCRP's primary efforts in global modelling and prediction.
- The need for CLIVAR to continue its efforts to develop links to applications of its science.

SSG-14 sought development of the Forward Look against various science themes identified above, namely ENSO/TV; Monsoons; Decadal variability/THC; ACC; the role of the oceans in climate and global modelling and prediction; in addition attention was given to initial thoughts on the CLIVAR legacy when CLIVAR comes to its sunset date of the end of 2013. Applications were not specifically addressed as part of the Forward Look exercise per se. This remains a topic to be included in the future.

Development of the Forward Look was organized around a series of mini assessments of the current status of CLIVAR activity. For each theme area these comprised:

- Theme Lead Overview: State of science, current status, science directions, needs, provided both as written papers & presentations

- Roundtable contributions from Panel and Working Group chairs as appropriate: How is CLIVAR addressing this theme? Panel & Working Group contributions to crosscut theme
- Theme Assessor report: Developing the Forward Look, path ahead. Synthesis. Gap analysis, redundancies. What will we do by 2007, 2010, 2013? Where will we be at these milestone dates?

In addition a background of sponsor/context setting was provided, by presentations from representatives of IOC, WMO and IGBP by the Director, JPS for WCRP.

Production of elements of the Forward Look for each science area was carried out by small task teams of experts during the meeting (with refinement of some in the weeks following). We summarize those identified for each area in turn below with reference to the total input from all the presentations at the SSG in the pages which follow.

CLIVAR Forward Look – ENSO AND OTHER MODES OF TROPICAL VARIABILITY

OVERALL AIMS BY 2013:

- Improved representation of ENSO and other modes of tropical variability and their global teleconnections in coupled models
- Improved understanding of intraseasonal variability and predictability leading to improved representations in coupled models
- Improved initialization procedures and predictions across the tropics
- Initiate operational decadal thermocline anomaly predictions

Priority path ENSO & TAV	Immediate	2010	2013
Enhancement of ocean observing system in the tropics	Continue to develop/ sustain tropical ocean observing network. Build Indian Ocean observing system	Continue, with national agencies & CLIVAR GSOP + OOPC/GOOS/GCOS/GEOSS	Sustained array
Implementation of process studies/outputs	Tropical field study activity (TACE, PUMP, VOCALS...	Continue/evaluate (e.g. tropical Atlantic heat budget & subsurface heat content)	Assess impact of feed into modeling.
Improve understanding of the representation of tropical modes of variability in models	Establish connections between modes in AR4 models (MJO <-> IOZCM and ENSO; IOZDM -> WWB -> ENSO -> IOZDM	Make evaluation of the predictability of TAV, Indian Ocean modes, both weak & strong events in the Pacific & connection with monsoons. Make evaluation of the mechanisms of tropical mode variability and global connections of patterns of variability (ENSO, SAM, WAM, TAV, AMO, IOZDM, MJO)	Improved representations in coupled models leading to improved seasonal predictions
Assess representation of tropical modes in IPCC-class models	Evaluate AR4 and 20th C coupled model runs; Use ocean/atmosphere reanalysis to quantify climate variability and associated uncertainty	Establish robustness of TV mechanisms and global teleconnections in IPCC-class models.	Assessment of tropical mode variability and teleconnections in AR5 models (Pan CLIVAR paper?)
Improve tropical representation in predictive models	Coordinate experiments to address causes/robustness of model biases (cols/warm biases; extent of SST anomalies; double ITCZ; Atlantic	Seek to reduce model biases: Make assessment of robustness of mechanisms and global teleconnections in models (those in AR4 as well as operational	Reduced model biases in operational predictions

	ITCZ & SST; ENSO); identify key indices/metrics for model evaluation	forecast models; comparisons with observations.	
Participation in TFSP seasonal prediction experiment	Spin up of TFSP seasonal prediction experiment	Continue, including global and regional analysis of operational/TFSP models to assess predictability/prediction.	Feed into operational systems
Improve initialization of predictive models and related observational needs	Evaluate OSE/OSSE feasibility for coupled systems	Develop improved coupled initialisation for seasonal prediction; evaluate OSE/OSSEs; feedback to observing system considerations	Improved initialisation procedures & operational observational networks.
Decadal prediction for the tropics		Develop experimental decadal prediction for tropics	Operational decadal thermocline anomaly predictions
Paleoclimate		Spin up coordinated experiments to assess the sensitivity of ENSO to past climate change using coupled models	Assess the sensitivity of ENSO to past climate change using coupled models. Assess the sensitivity of ENSO to past climate change using paleoclimate proxies (e.g. corals, lake sediments... and others).

CLIVAR Forward Look – MONSOONS

OVERALL AIMS BY 2013:

To have progressed along the monsoon prediction Forward Look set out below

a. The diurnal timescale

While the diurnal cycle may appear to be the least tangibly relevant to climate time scales, it is felt that the improving/fixing its model representation offers a very tractable route towards improving models' variability at a wide range of time scales, including the mean state. Immediate needs are to join with GEWEX to facilitate progress and to progress this element of the VAMOS modelling strategy (see below)

b. Subseasonal variability

A primary objective of the AAMP modeling and prediction strategy is to make progress on subseasonal variability. This involves:

Improving the model fidelity in representing such variability (e.g., MJO)

and in parallel:

Developing the prediction and operational frameworks (i.e. 2 wk to 2 mo) for delivering these predictions.

c. Seasonal timescale

d. VAMOS modelling strategy

The modeling strategy is organized into four science themes: (A) modeling and predicting SST variability in the Pan-American Seas, (B) predicting and describing the pan-American monsoon onset, maturation and demise, (C) improving the prediction of droughts and floods and (D) simulating, understanding and predicting the diurnal cycle. The principal cross-cuts among these themes include improving prediction made with global models, multi-scale interactions, data assimilation, and analysis and model improvements. Each science theme includes a comprehensive assessment of how well the models simulate and predict the relevant phenomena on multiple space and time scales. This assessment necessarily requires the identification of indices and metrics for model evaluations and prediction verification. The assessment also involves collaboration within CLIVAR (e.g., WGSIP, WGCM) and with operational forecast providers (NCEP, IRI, CPTEC, ECMWF) in terms of access to coupled predictions and simulation data.

e. African monsoon modelling studies and their applications

VACS will seek to capitalize on AMMA field observations and process studies for improved simulations and predictability of WAM particularly on SIP, multi-decadal to centennial time scales.

In eastern and southern Africa, VACS aims to encourage and partly facilitate modeling efforts and model post-processing appropriate to the complex gradients of rainfall, topography and land cover of both regions.

Evaluation of additional predictability derived from Benguela Ninos, the IOD and other recently revealed atmosphere-ocean modes important to climate variability will be encouraged by VACS through regional modeling as will ongoing efforts with ENSO and Indian Ocean modes.

VACS sees the integration of climate information, particularly that relating to interannual variability, in health, food security and water management as a prime requirement for sustainable climate science (including observations) in Africa.

f. Monsoon-related field/process studies

VOCALS is recognized as the leading candidate for the next field/process study for VAMOS, an ocean-atmosphere campaign planned for the 2008 time frame. The already underway AMMA program is the principal field campaign for VACS which focuses on the west Africa monsoon. The Atlantic Panel's TACE effort is likely to have tangible benefits to VACS. A future focus for VACS will be on planning an east Africa campaign. In addition, efforts to reverse the decaying climate observing system in Africa through GCOS, G8 and COP processes have been and will continue to be an important contribution of VACS. The principal AAMP-related field effort is the development and implementation of the Indian Ocean Observing System (IOOS). Future more focused field campaigns are likely to focus on air-sea interaction processes in the equatorial Indian Ocean, in part to better observe and understand the development and amplification region of the MJO/ISO, although this is likely to not be before 2010. Past and future specific contributions to the target phenomena discussed above are as follows:

Diurnal Cycle: NAME, SALJEX, MESA, VOCALS, AMMA, GEWEX/CEOP, JEPP

MJO/ISO: Genesis/Active regions: IOOS, JEPP, CIRENE, JEEP.

MJO/ISO: Remote effects: NAME, MESA, AMMA.

Mean State: Combined VAMOS efforts, AMMA, TACE, IOOS

2007

Monsoon Prediction Matrix	Empirical Atm or Hydrol	GCM	RM Hydrology	RM or GCM Earth System
MJO	S			
Subseasonal<->Synoptic*				
Seasonal/Interannual	S**	S**	S**	
Decadal				

2010

Monsoon Prediction Matrix	Empirical Atm or Hydrol	GCM	RM Hydrology	RM or GCM Earth System
MJO	SA	S		
Subseasonal<->Synoptic*				
Seasonal/Interannual	SA**	SA**		
Decadal				

2013

Monsoon Prediction Matrix	Empirical Atm or Hydrol	GCM	RM Hydrology	RM or GCM Earth System
MJO	SA	SA	SA	
Subseasonal<->Synoptic*				
Seasonal/Interannual	SA**	SA**	SA**	
Decadal				

* Multi-scale interactions, modulation of hurricanes/typhoons, higher-order wave interactions

** Some skill under strong ENSO conditions, strongly dependent on monsoon region.

Prediction Activity / Fidelity	
Virtually None	
Research	
Experimental	
Operational	
With Skill	S
With Applications	A

g. Response of the monsoons to ACC

In terms of environmental and economic impacts, the societies in monsoon areas tend to be particularly vulnerable to the potential deleterious impacts from ACC. Emphasis on analysis of the AR4 model output is important in the 2007 to 2010 time frame with analysis of the expected AR5 effort in the 2013 time frame.

CLIVAR Forward Look – DECADEAL VARIABILITY AND THE THC/MOC

Overall aims by 2013

The overall aims by 2013 are to have:

To have appropriate MOC observing system components recognized as part of the sustained global observing system

To have improved understanding of patterns of variability and to have improved their representations in IPCC-class models, including MOC changes.

In terms of decadal prediction, to have improved confidence on the extent to which decadal prediction is possible, to have sustained syntheses and product generation, to have established the viability of practical (pre-operational) decadal prediction systems and to be applying coupled data assimilation and synthesis systems within them.

To have an assessment of the feasibility of downscaling global-scale climate change predictions on decadal timescales for applications on the regional scale.

Priority paths	Immediate	2010	2013
Decadal & THC/MOC			

Maintain and sustain the MOC monitoring arrays and the global ocean observing system	Continuation of monitoring arrays to observe the THC; Develop/ sustain global ocean observing network. Establish proxies for the MOC	Continue, with national agencies & CLIVAR GSOP + OOPC/GOOS/GCOS/GEOS	Sustained arrays
Evaluate decadal variability in coupled models	Evaluate 20th C runs of coupled models against observations; establish changes in patterns of decadal variability in AR4 models	Continue to assess model performance. Seek to improve representation of decadal variability in AR5 models	Assessment of decadal variability in AR5 models
Increase understanding of mechanisms of decadal variability and global connections to patterns of variability	Make progress in terms of the NAO/NAM, PDO, SAM, TAV and AMO through projections of hypothesis/models onto observations and vice versa	Continue; increased understanding of ocean heat content & sea level variability	Synthesis of understanding (Pan-CLIVAR paper?)
Explore the potential for decadal prediction	Decadal predictability studies; assess the potential for developing decadal prediction systems; develop coupled data assimilation & synthesis systems	Establish the extent of decadal predictability; experimental decadal prediction trials & assessment, including downscaling	Apply coupled data assimilation systems to perform experimental decadal predictions on global scales with regional downscaling

CLIVAR Forward Look – ANTHROPOGENIC CLIMATE CHANGE (ACC)

Overall aims by 2013:

For CLIVAR and WCRP to have provided key input to any future IPCC assessment through climate modelling and climate change detection studies

Priority paths ACC	Immediate	2010	2013
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Further develop complex Earth System Models	Continue GCM and IGBP GAIM collaboration in this area	Earth System Models for use in AR5	Analyses of runs in AR5
Develop understanding of feedbacks induced by new model components	Understand feedbacks introduced by new components and reduce uncertainties in their magnitude/operation/representation	Continue with feed into Earth System models for AR5	Analysis of runs in AR5
Carry out assessment of the impact of anthropogenic forcing on natural modes of variability (ENSO, THC, Monsoons etc)	"Climate change - The CLIVAR perspective". Pan-CLIVAR review paper on assessment of anthropogenic forcing on natural modes of variability, based on AR4 integrations & atmosphere/ocean data analysis, to be developed through CLIVAR ACC Workshop		As 2007 but based on IPCC AR5 (Earth System Model) integrations, seamless predictions on decadal/seasonal/weather forecasts and atmosphere/ocean data analyses
To identify the optimal path for ACC research post-CLIVAR		Pan-CLIVAR assessment of the merits of the WCRP seamless prediction strategy (weather to long term climate change) Viewpoint on best way of organizing ACC research post-CLIVAR	
Climate change detection and extremes	Develop Climate Change Detection and Monitoring Studies with key effort on ocean indices	Inputs to AR5	Synthesis of Climate Change Detection and Monitoring indices as part of CLIVAR legacy

CLIVAR Forward Look – Modelling

Priority areas Modelling	Immediate	2010	2013
Earth System modelling	WGCM lead in Earth System Model development with IGBP	Realisation in AR5 runs	Analyses of AR5 outputs from CLIVAR perspective (Pan-CLIVAR paper)
Seasonal Prediction experiment	TFSP seasonal prediction runs “There is currently untapped seasonal predictability due to interactions (& memory) among all the elements of the climate system.”	Analysis of outcomes; improved prospects for seasonal prediction. Continued experimentation.	Realisation in operational centres
Coordinated ocean reference experiments	Coordinated Ocean Reference Experiments; Ocean model development activities	Analysis of outcomes; Input to AR5	State of the art ocean models
Ocean reanalysis	Development of ocean reanalyses + coupled reanalysis concept (with WOAP) including d/a aspects	Realization of multiple model reanalyses; input to AR5 development of coupled reanalyses	Syntheses as part of “CLIVAR legacy; initial coupled reanalyses
Model intercomparisons	Various MIPS/numerical experiments (e.g. CFMIP, GLACE etc). Spin off to AR5 models.	Various MIPS/numerical experiments (e.g. CFMIP, GLACE etc). Spin off to AR5 models.	Inputs to operational centres
Seamless prediction	CLIVAR role in development of WCRP “seamless prediction” concept (through WMP)	CLIVAR role in development of WCRP “seamless prediction” concept (through WMP)	Realisation in operational centres

CLIVAR Forward Look- OCEAN OBSERVATIONS

Priority areas	Immediate	2010	2013
Global ocean observation system	Continue close cooperation with OOPC and others	International activity to evaluate current state and development vector of global ocean observation system	Identify further needs for permanent and global observation system?
Ocean synthesis/reanalysis	CLIVAR/GODAE Synthesis Evaluation Workshop (complete). Publish experimental ocean indices on GSOP.CLIVAR web pages Establish Hydrography Planning/Oversight Group (2 yr life)	Completion and validation of multiple global reanalyses. Feed into AR5.	First global description of subsurface ocean variability?

CLIVAR Forward Look – CLIVAR LEGACY

Immediate	2010	2013
<p>Subgroup of SSG works on 2013 vision/legacy & develops data management requirements</p> <p>Choose a few foci crafted around the ocean's role in climate:</p> <p>e.g.</p> <ul style="list-style-type: none"> - exchange (with atmosphere) - storage (heat/salt/CO2) - transports <p>and utilise new observing capabilities</p> <p>Assess process study activities</p>	<p>Joint global flux project (with GEWEX) focussed around water cycle</p> <p>Common climate indices for models/observations</p> <p>Pilot data syntheses/data collection</p> <p>Develop concept of post CLIVAR activity (with GEWEX/IGBP?)</p>	<p>Datasets for CLIVAR legacy</p> <p>Indices/indicators</p> <p>Start post CLIVAR data synthesis decade?</p>