

CLIVAR SCIENTIFIC STEERING GROUP
REPORT OF SEVENTH SESSION

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CLIVAR SSG 7 ACTION ITEMS AND RECOMMENDATIONS

1. ENSO

1.1 CLIVAR to produce a summary report on the 97/98 ENSO, based on SSG7 presentations and additional input, which will appear in *Exchanges* and also serve as input to the UN-sponsored retrospective activities. (K. Trenberth, lead) UPDATE: article has appeared in *Exchanges* Vol. 3, No. 2/3.

1.2 SSG nominates K. Trenberth as CLIVAR representative on UN ENSO retrospective scientific organizing committee. [UN Retrospective Conference held in Guayaquil, Ecuador 9-13 November 1998 - resolution supporting research and CLIVAR in particular, see Appendix C.]

1.3 SSG calls on NEG-1 to analyse generic failure of ENSO prediction models to correctly characterize the full intensity of SST warming associated with the recent event.

1.4 SSG suggests that the AA Monsoon Panel, Africa Study Group and NEG-1 work together to determine to what extent Indian Ocean SSTs were responsible for heavy rains in late 1997 over East Africa and what, if any, link exists to the ENSO.

2. VAMOS

2.1 SSG encourages VAMOS Panel to pursue recommendations and actions from their recent meeting and supports the phased approach proposed for project implementation. SSG Chairs to write to VAMOS Panel Chair to this effect, also encouraging Panel members to work within their own countries and regions to prepare for the CLIVAR Conference.

2.2 ICPO to assist VAMOS in implementing the first phase observing system, particularly upper air observations in low-level jet region of South America.

3. AA MONSOON

3.1 SSG encourages AA Monsoon Panel to move towards implementation, following

recommendations and action items from their recent meeting. SSG Chairs to write to AA Monsoon Panel Chair to this effect, and encouraging Panel members to work within their own countries and regions to prepare for the CLIVAR Conference.

3.2 SSG recommends that there be at least one common member on the AA Monsoon Panel and NEG-1 to ensure that the relevant modelling issues are addressed. (UPDATE: I.S. Kang to join NEG-1 (WGSIP) as of 1999.) ENSO/monsoon interactions should be addressed by both groups.

3.3 SSG Chairs, in consultation with the AA Monsoon Panel, to write to appropriate Indonesian official acknowledging Indonesian initiative to open its waters to researchers and asking how CLIVAR can take advantage of this opportunity.

3.4 Five page summary of JASMINE to be distributed to SSG for information and comment.

4. COARE

In reference to the request from R. Lukas to establish a CLIVAR boundary layer group, SSG Chairs to write to R. Lukas noting that although the SSG recognizes the central importance of the boundary layer problem, the Group considers that it must wait for the final report of the JSC-SCOR WG on Air Sea Fluxes before recommending any further action.

5. OCEAN OBSERVATIONS

5.1 Recognizing the need for coordination of the various ocean-observing components of CLIVAR, the SSG calls for the formation of three task groups to consider the role of eventual CLIVAR panels concentrating on the Atlantic, Pacific and Southern Oceans. The task groups would be charged to recommend terms of reference and membership, including representatives from the atmospheric as well as the oceanographic communities.

5.2 UOP to continue under current terms of reference until end of 1999, by which time its role should have been reviewed in context of action 5.1 (above).

5.3 SSG requests that the UOP consider requirements for CLIVAR global ocean products.

6. PALEO

6.1 SSG reconfirms strong need for joint CLIVAR/PAGES Working Group to meet and encourage development and dissemination of products useful to the CLIVAR community.

6.2 SSG to nominate representatives of the paleo community to various panels which deal with ENSO, monsoons, DecCen and ACC.

6.3 J. Jouzel to prepare *Exchanges* article on need for CLIVAR to understand rapid climate change.

7. IPCC

7.1 The SSG identified the following critical areas where CLIVAR could contribute to the next IPCC assessment and encourages the appropriate groups to take action:

- *Climate sensitivity.* CLIVAR should encourage more work on water vapour and cloud feedbacks, and encourage proactive links between WGCM and GEWEX.
- *Thermohaline circulation.* A CMIP project should be Initiated to assess the response of the thermohaline circulation in CMIP2.
- *Natural modes of variability:* CLIVAR should accelerate work on model validation and diagnosis, and properties of dominant modes of natural variability. This could be achieved by extending AMIP and CMIP subprojects. Paleoclimatic data over the last six centuries should be analyzed for estimates of natural variability.
- *Climate change attribution and detection:* CLIVAR should foster work to refine estimates of indirect sulphate aerosol effects which are the largest source of uncertainty in historical forcing.

7.2 The SSG strongly endorses the JSC position that the role of natural climate variability should be more central to the IPCC process.

8. CLIVAR/CCI WG on Climate Change Detection (CCD)

8.1 The SSG recommends that the joint CLIVAR/CCI WG on CCD undertake studies of informal detection techniques (WGCM to do formal fingerprint detection work) (N. Nicholls to draft letter).

8.2 The SSG recommends that the joint WG on CCD should look at robustness of SST climatologies based on different statistical methods.

9. MODELLING

9.1 The CLIVAR SSG recommends that the membership of the WGCM be modified to be better able to assess the ability of climate models to simulate modes of natural variability on all the timescale within the remit of CLIVAR, and to address, in particular, the impact of anthropogenic forcing on these modes.

9.2 The SSG recommends that NEG-1 increasingly focuses on the seasonal to interannual prediction problem and interacts more closely with the UOP, particularly in the specification of initial conditions for seasonal prediction.

9.3 In view of the report of NEG-1, the SSG recommends that WGCM consider, prior to its next meeting, taking responsibility for some of the activities of NEG-1 (such as ENSIP).

9.4 SSG recommends that NEG-1 and WGCM coordinate on a more structured CMIP3, e.g., agree on standards for data exchange, save full range of diagnostics.

10. DATA MANAGEMENT

A Task Team on Data Management to be formed to develop a CLIVAR plan, taking into full account the existing data structures; preliminary outline to be prepared prior to the CLIVAR Conference.

11. IMPLEMENTATION PLAN

11.1 SSG endorses Implementation Plan for publication, with modifications to introductory sections 4, 5 and 12, as discussed, and with other comments and suggestions incorporated.

11.2 ICPO should aim to have Implementation Plan ready for distribution by first week in June.

12. PRINCIPLES FOR IMPLEMENTATION

The SSG developed the following guiding principles for CLIVAR implementation:

- i. International coordination is the essence of CLIVAR implementation and is the primary responsibility of the International CLIVAR Project Office (ICPO).
- The CLIVAR panels should focus primarily on implementation issues, based on what is in the Plan and on the outcomes of the December Conference, with the SSG providing overall scientific guidance and coordination between panels.
 - Implementation of CLIVAR reaches across timescales since many observing systems will provide data that is essential for several principal research areas (PRAs) within GOALS, DecCen and ACC. In contrast, many aspects of implementation are regional; therefore formation of regional oversight panels should be considered.
 - The SSG should encourage, and the ICPO should help coordinate, international and multinational process studies. The SSG should regularly invite reports from these projects to enable effective coordination.
 - Background sustained observing systems should be recommended and encouraged by CLIVAR, but implemented through programmes such as GCOS and GOOS.

13. COORDINATION ISSUES

13.1 SSG to work with WOCE SSG to develop objectives of a workshop on the representativeness of the WOCE data sets.

13.2 Coordination with GEWEX should be increased in the following areas:

- i. study of stratus (VAMOS to work with GCSS group)
- ii. land processes (VAMOS with LBA, AA Monsoon with GAME)
- iii. WGCM, NEG-1 and radiation and cloud panels of GEWEX.

13.3 D. Martinson to represent CLIVAR on the JSC task group concerning WCRP and the cryosphere.

13.4 SSG nominates J. Mitchell to work with M. Geller on solar forcing report to JSC.

14. CLIVAR CONFERENCE

14.1 SSG recommends that Conference Organizing Committee be reformulated to include representatives of the funding community.

14.2 ICPO to prepare special letter of invitation targeted at potential major CLIVAR funders.

14.3 Organizing committee should be urged to develop a programme which would include speakers with appeal to the broad audience anticipated. (Final programme in Appendix D.)

14.4 D/WCRP to seek additional funding for Conference, in particular requesting IGFA to consider the CLIVAR Conference at its next meeting. [UPDATE: US\$18,000 secured from WMO to support participation from developing countries, in addition to the US \$40,000 foreseen in the JCRF]

14.5 ICPO to develop document outlining resources required to implement CLIVAR.

15. NEXT MEETING

15.1 Next full meeting of SSG scheduled for week of 10 May at ECMWF or SOC [SOC has been selected].

15.2 SSG members and Panel Chairs present at CLIVAR Conference to meet at UNESCO on Friday directly after the Conference closing.

15.3 SSG "Executive" and ICPO to explore possibility of meeting with all Panel Chairs the week of 8 February to analyze Conference outcome with respect to implementation of the individual PRAs and the overall programme.

REPORT OF THE SESSION

1. OPENING

The CLIVAR Scientific Steering Group (SSG) held its seventh session in Santiago, Chile at the headquarters of the Chilean National Science Foundation. This was the first SSG meeting to be held south of the equator, and the venue was selected to highlight the role of Latin American science and scientists in CLIVAR, and particularly VAMOS (the CLIVAR study of the Variability of the American Monsoon Systems).

Allyn Clarke opened the meeting, thanking the local host, Dr Fuenzalida of the University of Chile, for the excellent arrangements. On behalf of the SSG he welcomed new members Drs Hanawa, Palmer and Willebrand (who was unable to attend) and expressed his deep appreciation

to members whose terms had expired in December 1997, Profs Sumi, Schott and Webster, whose contributions since the beginning of CLIVAR had been fundamental. He noted with regret that his co-Chair, Kevin Trenberth, had been detained in Miami and would arrive only the next day. Some rearrangement of the agenda was agreed, as reflected in Appendix A.

In his opening remarks, Professor Grassl, Director of the WCRP, predicted that CLIVAR would soon become the biggest WCRP project, but that its success depended on the success of other WCRP efforts, most notably GEWEX, and on the ability to effectively coordinate and merge the scientific outcomes of these two projects. He observed that the co-location of the WOCE and CLIVAR Project offices would also assist in co-ordination and produce cost savings.

Dr Clarke welcomed Dr Gould as the new Director of the International CLIVAR Project Office and invited him to give a brief outline of his vision of how the Office might operate. Dr Gould listed four main functions for the ICPO:

- communications hub, for scientists and national agencies
- executive arm of the SSG and CLIVAR panels and WGs
- enquiry desk, for the scientists and general public
- as a generator and co-ordinator of publicity

A more detailed report can be found in section 11.

Professor Gates, Chair of the Joint Scientific Committee for the WCRP, emphasized the importance JSC attaches to CLIVAR, noting that this was the first time the two fundamental objectives of the World Climate Research Programme were being tackled in one project. He reported that the JSC had reviewed CLIVAR favourably at its nineteenth session in March. Comments on the Implementation Plan had focussed on the need to articulate an overall vision for the project and to make the programme appear more as a whole than just a collection of Principal Research Areas (PRAs). Allyn Clarke reviewed in more detail the JSC discussions of relevance to CLIVAR. He mentioned the START end-to-end projects and the need for CLIVAR PRAs to link with these efforts. Climate monitoring had been discussed at some length at JSC, and the CLIVAR SSG shared JSC concern that neither national nor international institutional arrangements were in place to implement long term measurements of the type called for by CLIVAR, GCOS, COP4, etc.

A. Clarke briefly reviewed CLIVAR events since the last SSG meeting in Washington, DC. He noted with regret the departure in August 1997 of Dr Michael Coughlan as Director of the ICPO and expressed his appreciation, on behalf of the SSG, to Prof. Lennart Bengtsson of Max Planck Institut fur Meteorologie for making available the services of Dr L. Dumenil to serve as interim Director. Clarke lauded Dr Dumenil for her smooth running of the office and her efforts to initiate preparations for the International CLIVAR Conference. After an extensive search and review, Dr W.J. Gould had been selected to fill the post of Director, ICPO. Dr Gould accepted on the condition that the office move to Southampton, UK, and be co-located with the WOCE Project Office, of which he was also Director. A transition agreement was made by which Andreas Villwock and Anne Stephan would continue as ICPO staff at MPI at least until the end of 1998, and that the functions of the office would transfer fully to the Southampton site in 1999. The position of Senior Scientist in the ICPO had also been advertized, and it was hoped to fill this post by the end of 1998.

2. IMPLEMENTATION PLAN

2.1 Final review

Prior to the meeting SSG members had all received a copy of the final draft Implementation Plan which reflected reviewer comments and input. After a brief discussion during which some minor suggestions for changes were made (see also item 2.2 below), it was agreed to proceed with the intended publication schedule by which the document should be ready for community distribution in early June.

2.2 Status of implementation and discussion of priorities

The co-Chairs had distributed a white paper entitled "Assessment of the status of CLIVAR: establishing priorities" to SSG members for comment prior to the meeting. The document proposed a phased approach for implementing different research foci, while sustaining some effort in all areas. It discussed factors which might be involved in developing an implementation sequence. A similar document had also been submitted to the JSC in March. The JSC had recommended that the proposed "priorities" be modified to be less exclusive, and recast as an assessment of status, or feasibility and readiness, and that it should then be incorporated into the main body of the IIP Plan.

Considerable discussion took place at the SSG meeting concerning the use of the terms "priorities" and "readiness", and also on the order of listing of the individual PRAs. D. Martinson reported significant unease or displeasure within the scientific community concerning the perceived prioritization of PRAs. J. Jouzel pointed out that by prioritizing only the PRAs, it appeared that the global integrating elements, such as global observing systems or paleontological studies, were less important. E. Sarachik suggested that prioritization was not appropriate at the international level, but that it would be done by nations in the context of their own plans. It was generally felt that the approach to the CLIVAR implementation leading up to the International Conference should be inclusive rather than exclusive in order to entrain the maximum number of nations and scientists in the CLIVAR enterprise. Hence it was concluded that the sections of the Implementation Plan referring to priorities and readiness be modified so as to accommodate national priorities and interests. The SSG recommended that the ICPO co-ordinate a post-Conference assessment of what was already committed and where significant gaps existing with regards to the overall Implementation Plan. This assessment would then serve to guide SSG and ICPO efforts to fully implement the Plan.

2.3 Basic principles

The SSG discussed how best to oversee and coordinate a programme as ambitious and diverse as CLIVAR (sometimes referred to as ten TOGAs). The SSG preference was for minimizing the number of formal committees and using workshops and ad hoc working group meetings to develop and refine implementation of various aspects of the programme. The SSG was also looking to maximize the synergy with other related programmes, through shared resources and committees.

Some basic principles for CLIVAR implementation were agreed:

- i. International coordination is the essence of CLIVAR implementation and is the

- primary responsibility of the International CLIVAR Project Office (ICPO).
- ii. The CLIVAR panels should focus primarily on implementation issues, based on what is in the Plan and on the outcomes of the December Conference, with the SSG providing overall scientific guidance and coordination between panels.
 - iii. Implementation of CLIVAR reaches across timescales since many observing systems will provide data that is essential for several principal research areas (PRAs) within GOALS, DecCen and ACC. In contrast, many aspects of implementation are regional; therefore formation of regional oversight panels should be considered.
 - iv. The SSG should encourage, and the ICPO should help coordinate, international and multi-national process studies. The SSG should regularly invite reports from these projects to enable effective coordination.
 - v. Background sustained observing systems should be recommended and encouraged by CLIVAR, but implemented through programmes such as GCOS and GOOS.
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3. THE 1997-98 EL NIÑO EVENT

The SSG had decided to use this meeting to make a preliminary assessment of how well the 97/98 ENSO event, and its impacts around the globe, had been observed, modelled and predicted. This review would serve as an initial contribution to the retrospective on the event being prepared by WMO for a UN system-wide review in response to the recent UN resolution calling for a strategy for the prevention, mitigation and rehabilitation of the damage caused by El Niño. Reports were heard of experiences from within the various nations and institutions represented at the meeting and on lessons learned which might be help guide CLIVAR research.

K. Trenberth lead the session with a brief review of the 97/98 event. He remarked that the development of the 1997-98 El Niño event into, by some measures, the biggest on record in over a century had given the CLIVAR community a wonderful opportunity to exploit an experiment mounted for us by nature. This event would be the best observed ever and the worth of the TAO moored buoy system in the equatorial Pacific has been clearly demonstrated. The TAO data showed the evolution of subsurface temperature anomalies exceeding 10°C at about 100 m depth, which developed into sea surface temperature anomalies exceeding 5°C, and subsequently into a cooling of over 5°C that progressed eastward; these data were also used for initializing models which successfully predicted future evolution.

Dr Trenberth noted that "El Niño" is now in the public vernacular. All kinds of things have been blamed on El Niño when sometimes there is at best a tenuous link. A new aspect of this event is that it was predicted by CLIVAR scientists well in advance, and forecasts were widely disseminated. But how good were the forecasts? Were the expressions of uncertainty appropriate? Were the forecasts used? And were they misused? Clearly, this event demands a careful, in-depth analysis of its many aspects and has lessons for CLIVAR. A summary of Dr Trenberth's presentation follows.

The onset of the 1997/98 El Niño

Onset was predicted by several dynamical models beginning about November 1996, these included the Scripps, NCEP, COLA, and ECMWF dynamical model predictions. There were also some notable failures (LDEO/Cane-Zebiak). Operationally, none captured the strength. However, ECMWF did very well forecasting for May from December, but this forecast was not in real time.

Despite claims of success, the statistical/inverse models did not seem to show skill of value.

Time series of the subsurface temperature and temperature anomaly evolution from the TAO buoys and TOPEX data documented the evolution and revealed that the event was traceable to September 1996 on the equator. Especially revealing are the longitude-time sequences along the equator of the westerly wind anomalies, SSTs and depth of the 20°C isotherm (which represents the centre of the thermocline). 40-50 day Madden-Julian Oscillation (MJO) waves were very prominent in the westerly wind anomalies in the far western Pacific, with westerly bursts in December 1996, February, May, August, October and November 1997, and each one is traceable as down-welling Kelvin waves propagating rapidly eastwards (across the Pacific in about three months) in the thermocline, as seen in the 20°C isotherm anomalies. Thus within the overall envelope of the eastward developing subsurface temperature anomalies, there is important structure associated with the MJOs. Key questions then arise:

- Were these waves a key in triggering and amplifying the event?
- Was their role minimal, as El Niño occurs in intermediate models that do not have MJOs?, i.e., are they merely "embroidery"?
- Was their continual presence a reason for the magnitude of this event?
- No GCMs reproduce MJO waves very well. If MJOs are important, this has implications for predictability and highlights the need to improve models.

The role of MJOs in the 1997/98 ENSO is a key question that can and should be explored with diagnostic and numerical experimentation studies.

As well as the onset of the event, dynamical model-based forecasts of the evolution of tropical SSTs continued to be made throughout the event and appeared to show considerable skill for several months in advance, including the timing of the peak in SST anomalies in December.

CLIVAR should analyze how well the event was forecast throughout, both for SST forecasts and the weather regimes around the world (coastal erosion, precipitation, temperature, storminess, flooding, drought, fires, etc).

SSTs in other regions

Clearly, a careful analysis and assessment of the impacts of the event are needed. A superficial assessment indicates that some effects fit the classical model (as given by previous events), but many did not.

Very notable has been the heavy rains in Kenya and the horn of Africa region which were surely linked to very high SSTs in equatorial Indian Ocean (above 95 percentile, above 29°C) after about September 1997. Major convection in this area clearly had an impact on the divergent atmospheric circulation and there is good reason to believe it altered teleconnections. These aspects need to be established more firmly. It is likely that these changes had impacts on Australia, India, Southern Asia - all regions where conditions were not as dry as expected from past events - and elsewhere, but again these need to be confirmed.

SSTs were also abnormally high in the tropical Atlantic. One consequence of the high SSTs throughout the tropical oceans may be a tendency for a more zonal (less wavy) response so that the drought in the western tropical Pacific was more confined to Indonesia.

SST anomalies also developed in the extratropical Pacific of both hemispheres, as is expected (notably cold anomalies about 40°N and 40°S just east of the dateline).

There is a need for numerical experimentation to test effects of high SSTs in other tropical oceans: Indian and Atlantic, to sort out what might be attributed to the tropical Pacific SSTs, and whether the extratropical SST anomalies played a role. Of course, warming in the tropical Indian Ocean usually accompanies El Niño events, so these other SST anomalies also may not be independent of those in the Pacific.

The 1997/98 El Niño impacts

Many questions arise here.

- What was caused by El Niño, what can be attributed to it?
- Where were the substantial and tenuous influences?
- What impacts were positive?
- Atlantic hurricane suppression
- Warm conditions, less heating, less coal, oil and natural gas use and lower heating bills for consumers.
- What impacts were negative?
- Layoffs in natural gas industry
- Coastal damage, flooding, drought, fires, etc.
- Tornadoes in Florida

No attempt is made here to compile a list. Instead, it is clear that lists do need to be compiled and the task will not be easy nor solely one for CLIVAR. It is apparent that for just about every positive impact, there were negative impacts elsewhere. For instance, while it may be possible to attribute the tornadoes in Florida to the active and southward-displaced storm track, thereby favouring the outbreak in that location, it is possible that tornadoes may have simply occurred elsewhere, such as in Georgia. Similarly, other examples above are the benefits of warm conditions on consumers but not on the heating companies, and the shift in hurricane activity from one ocean basin to another. These highlight the need to separate the positive and negative effects or else one might conclude that the effects of El Niño economically were zero because of cancellation between huge positive and huge negative impacts.

There is a need for data base development of various kinds and careful analysis.

The 1997/98 El Niño; Possible activities

The following lists some initial suggestions for activities, it is not intended to be comprehensive.

On the physical climate side:

- description of event: gathering requisite datasets
- diagnosis of processes, empirical studies
- verification of numerical predictions, forecasts
- forecast verification techniques
- implications for the observing system
- implications for model development
- numerical experimentation

- the role of global warming (all of tropics were warm)
- attribution of local and regional climate anomalies to the event,
- any process studies that should follow?

On human dimensions and applications side:

- proliferation of "information" (e.g. on the www), improvement of quality
- attribution of unusual events to El Niño
- impacts of El Niño
- costs/damage of El Niño
- assessment of information
- actions taken because of forecasts
- impacts of actions not taken
- impacts of failed forecasts
- utility of information
- communication, dissemination of information
- benefits of forecasts (mitigating losses etc).

In that CLIVAR is investigating the physical climate aspects, these activities should be coordinated with work on the human dimensions and applications side. The UN General Assembly passed a resolution in December 1997 on International Cooperation to Reduce the Impact of the El Niño Phenomenon. The resolution, which was coordinated under the framework of the International Decade for Natural Disaster Reduction (IDNDR), has led to the establishment of an El Niño "Task Force" encompassing several UN agencies and programmes. The WMO, for example, has been asked to take the lead in coordinating the provision of scientific and technical advice on El Niño, other agencies will coordinate the socioeconomic impacts and response aspects.

The SSG felt that CLIVAR should take the lead on the physical aspects by sponsoring workshops and conferences, and activating panels and working groups to promote such things as numerical experimentation, forecast evaluations, assessment of associated weather events and attribution, and so on. (see further discussion under item 5). A comprehensive report on the 97/98 event, based on the SSG presentations, was to be compiled by K. Trenberth and submitted as a CLIVAR contribution to the United Nations 97/98 ENSO Retrospective which is being organized under the auspices of several UN agencies. A summary would appear in the next issue of *Exchanges*.

4. REPORTS FROM CLIVAR PANELS

Three of the GOALS PRAs are already served by planning and oversight panels. The VAMOS Panel had met four weeks earlier, and Prof. CR Mechoso, Chair of the Panel, provided a full report to the SSG in person. The Asian-Australian Monsoon Panel had met just the week before the SSG meeting in Korea, and Dr Wm. Lau, Co-chair of the Panel, sent a report via fax. The CLIVAR African Climate Study Group was to meet for the first time the week directly following the SSG meeting in Abidjan, Cote d'Ivoire. A provisional agenda for the meeting is included here in Appendix E. The CLIVAR Upper Ocean Panel was meeting concurrently with the SSG in Toulouse, France. They provided a brief summary of their activities to the SSG via electronic mail late in the week. The PAGES-CLIVAR Panel had not met since the last SSG meeting, but J. Jouzel reported on some community activities. Although there is no longer a COARE oversight committee, the COARE community remains active. The SSG considered a proposal by Roger

Lukas for a new boundary layer working group.

4.1 VAMOS

Professor C.R. Mechoso, Chair of the VAMOS Panel, gave an overview of VAMOS plans. The VAMOS Panel had held its first session in Sao Paulo, Brazil, 29 March - 3 April, in conjunction with a VAMOS/PACS Workshop on Field Programmes. PACS is the Pan American Climate Study, a US contribution to VAMOS. Prof. Mechoso outlined the intersection between VAMOS and other climate research activities over and adjacent to the American continent, such as the GEWEX basin scale experiments and the Pilot Research Moored Array in the Tropical Atlantic (PIRATA). He explained that, in recognition of these activities and given an assessment of resources available, the Panel recommended a phased approach to implementing VAMOS, and in particular proposed field programmes.

Prof. Mechoso briefly reviewed what was known about the North and South American monsoons. He noted that the onset of the North American monsoon, centred around Arizona, always came abruptly in mid-June and that the associated level of precipitation seemed to be inversely linked to the amount of rainfall during the previous winter. Less was known about the South American monsoon, but a climatology had been recently compiled using the NCEP reanalysis data. Work was ongoing to compare this with ECMWF analyses results; there appeared to be considerable discrepancies between the two. The low level jet, a very strong feature associated with the South American monsoon, was as yet mostly unstudied.

One of the first concerns of the VAMOS Panel meeting was observing systems. For instance, no radiosonde data is reported in the region of the low level jet which is centred on Bolivia.

Another major focus of VAMOS was to investigate the role of the adjacent oceans in determining Latin American climate variability. A US-led effort called EPIC, the Eastern Pacific Investigation of Climate, was launching a field programme focussed on the low level stratus deck. VAMOS endorsed EPIC and agreed to establish links with Latin American countries which wanted to cooperate with this effort. The SSG noted that GEWEX had a working group on global stratus issues and encouraged VAMOS to work more closely with this group.

The VAMOS Panel was in the process of creating five ad hoc working groups to cover:

1. South American monsoon system
2. processes
3. stratus
4. sustained measurements, and
5. data, including data archaeology.

These working groups were to carry out most of their work via email or at meetings of opportunity. The Panel also established two long- term goals:

1. To develop an integrated field programme on the South American monsoon system, which includes field programmes on the South American low-level jet and on the Altiplano heat source.
2. To develop a tropical observing system to cover the tropics from the Pacific to the Atlantic including the South American continent. This implies, for instance, an extension in time of PIRATA.

Prof. Mechoso noted that these proposed efforts have an important capacity building component, which includes the installation of upper-air observing stations and the creation of databases. A close collaboration with WMO would be required. Mechoso elaborated on the need for international resources to support these programmes. The notions of a VAMOS International Project Office and of an intergovernmental board to administer the funds were discussed. The SSG felt that recommendations of this nature should arise from the CLIVAR Conference in December. It was agreed that the SSG Chairs would write to Prof. Mechoso as Chair of the VAMOS Panel, recognizing the start of VAMOS as a CLIVAR project and endorsing the phased approach to implementation. The letter should also encourage Panel members and the participants at the recent workshop to work within their countries over the next six months to identify national interests in VAMOS in preparation for the CLIVAR Conference.

4.2 AA Monsoon

The CLIVAR Asian-Australian Monsoon Panel held its second meeting in Kyongju, Korea, the week before the SSG meeting in Santiago. The Panel provided the following written report to the SSG via fax.

"Opening" of Indonesian Seas for Research, by President Soeharto

The CLIVAR Monsoon Panel was asked by Dr Arnold Gordon to host a working group to develop a co-ordinated programme of oceanographic and meteorological research and monitoring, to take advantage of the opportunity offered by the "opening" of Indonesian seas for research by the President of Indonesia. The Panel agreed that this was a significant development for monsoon science, and that CLIVAR should take strong action to capitalize on this opportunity.

The Panel strongly recommends that the CLIVAR SSG write to the President of Indonesia, thanking him for his initiative in "opening" Indonesian seas for climate research. The SSG should instruct all CLIVAR Panels to consider possible modifications to their Implementation Plans, in light of this very welcome development; and they should inform the Indonesia authority of any action plan involving Indonesia.

JASMINE (Joint Air-Sea Monsoon Interaction Experiment)

JASMINE is a proposed programme of modelling and data analysis of the Asian-Australian monsoon system, built around an Indian Ocean field project. Plans for a pilot phase of JASMINE, to be conducted in the Bay of Bengal in May-September 1999, are well advanced. The Panel strongly endorses the 1999 JASMINE Pilot Project and encourages all interested individuals and science agencies to contribute to the success of this project.

Modelling initiatives

The anomalous conditions of the AA-monsoon during 1997-98 were discussed. One unusual feature of 1997 was that, for the first time since 1961 (which was not an El Niño year), the SST off equatorial east Africa was substantially warmer than off Sumatra for several consecutive months. As in 1961, this SST pattern was accompanied by very heavy anomalous rain near east Africa, in October-November, and by drought over Indonesia. In 1997-98 the Indian monsoon as a whole was near normal, however, the East Asian monsoon was highly abnormal with excessive rainfall in the south and record drought in north China. Intraseasonal events were unusually active throughout the AA-monsoon region.

In view of this unusual development in the Indian Ocean and the strength of intraseasonal oscillations, and their potential impact on the AA-monsoon, the Panel proposes to establish:

- an atmospheric modelling working group to carry out atmospheric GCM intercomparison studies focusing on the 1997-98 AA-monsoon using a select group of AGCMs (Co-ordinators: Kang, Shukla, Goswami);
- a parallel working group on OGCM, focusing on intercomparison studies of the 1997-98 Indian Ocean anomaly (Co-ordinators: Godfrey, Murtugudde, McCreary).

The above initiatives should be co-ordinated with NEG-1 and the Upper Ocean Panel.

Long-term monitoring (LTM)

Long-term Monitoring of monsoon-related parameters, e.g., SST, salinity, ocean surface wind, precipitation, land surface temperature, soil moisture, snow cover, vegetation and tropospheric wind, temperature and humidity fields should be maintained both by ground based and satellite observations. These include continued operations and maintenance of:

- GAME-AAN, including Tibetan Plateau, Central Asia up to the 2005 time frame.
- Buoy arrays and AWS in SCSMEX also need to be continued.
- Japanese ship observations in the western Pacific by JEXAM.
- Expansion of ATLAS/TRITON buoys to the equatorial East Indian Ocean to co-ordinate with JASMINE.

Data quality and observational network

The WCRP/GCOS observing system for climate is identified in the CLIVAR Implementation Plan as an integral part of the CLIVAR observing system. However, this network is inadequate for monitoring the detailed structure and variability of the monsoon. For example, the GCOS Upper Air Network has no sounding stations in the Indian subcontinent. Operational sounding stations do exist within this region, but they have been declining in number in recent years and data quality is frequently poor. Therefore, supplemental elements of a sustained CLIVAR system need to be identified that are relevant to the AA Monsoon Programme scientific objectives.

Recommendations

- Relatively sparse observation network of GCOS over the Indian Ocean basin needs to be enhanced. Of particular importance is the upper air sounding wind profiling over Gan Island.
- Establishment of an ad hoc working group to define the elements of an atmospheric and land surface observing system necessary to meet the scientific needs of the AA monsoon programme.
- Facilitate and promote networking within present international monsoon groups/individuals in forming a data inventory catalogue of monsoon rainfall data and other related atmospheric and oceanic data.
- CLIVAR SSG to establish international data centres to meet the data requirements of all the panels. Free data exchange/access is paramount.

The SSG welcomed this report. The co-chairs would write to the appropriate authorities in Indonesia concerning the recent announcement on research access to the adjacent seas, but asked that the Panel provide more details of what might be required. The SSG also requested more

information about the proposed JASMINE effort.

Concerning the modelling activities, the SSG wanted to see these better coordinated with parallel activities of NEG—1 and WGCM. They recommended that there be at least one common member on the AA Monsoon Panel and NEG-1 to ensure that the relevant modelling issues are addressed. ENSO/monsoon interactions should be addressed by both groups.

The SSG expressed its regret that no representative from the Project Office nor the SSG had been able to attend the recent Panel meeting. The Group agreed that there should be stronger communication between the CLIVAR SSG and the Panel and asked the Project Office to keep the Panel well informed and to ensure that a representative of the Office was available to attend the next meeting.

In general, the SSG encouraged the AA Monsoon Panel to move towards implementation, following the recommendations and action items from their recent meeting. As for VAMOS, the SSG encouraged Panel members to work within their own countries and regions to prepare for the CLIVAR Conference.

4.3 UOP

The CLIVAR Upper Ocean Panel (UOP) held its third session in Toulouse, France, 27-29 April. Andreas Villwock represented the ICPO at the meeting and was able to send the following summary report to the SSG via electronic mail on Thursday 30 April.

The meeting focussed mainly on the development of a basic observing system for sea level, $S(z)$ and $T(z)$ for the purposes of CLIVAR research. For almost all Principal Research Areas of CLIVAR (e.g., G1 (Salinity important for ENSO forecasting), G2 (E-P), D5 (Thermohaline circulation), A1/2 (long term trends)...) a regular systematic sampling of temperature and salinity of the upper ocean is necessary to achieve the goals of CLIVAR. This will be especially true for the understanding decadal variability and processes in areas where deep convection is important.

Based on the proposals for an Array for Real-time Geostrophic Oceanography (ARGO) and for a Global Ocean Salinity Monitoring (GOSAMOR) focussing on global observations for $T(z)$ and $S(z)$, the UOP came to the following conclusions:

During the last two years there has been significant progress made in the technical development of the salinity sensors and float equipment that enable a global coverage (about 3,000 floats) with these instruments at feasible costs (about US \$12m). Additionally, salinity measurements from merchant ships, moorings, drifting buoys and stations will become more common in the near future. Hence, the UOP recommended that CLIVAR implement a global programme of routine salinity sampling using various techniques.

Although the systematic errors of the different observational methods could be reduced substantially, there is a need for a combination of the different methods to reduce the errors to a level that allows the detection of decadal and long term climate variability in the upper ocean. The UOP will work towards an integrated global observing system for CLIVAR to detect natural climate variability on different timescales (seasonal to decadal) to:

- monitor long term climate trends (naturally or anthropogenically caused)
- deliver products needed to calibrate and validate satellite measurements
- provide observational data for validation of models resp. assimilation into these models

(e.g., for purposes of climate forecasting).

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Additionally to the proposed global float array, special attention is needed along the boundaries and in narrow channels. Furthermore, this proposed measurement system will provide measurements up to a depth of about 2,000 meters at present time. Deep ocean measurements, needed for the monitoring of long term trends, cannot be covered by this network.

For the implementation of the proposed global array as a multinational effort, the UOP recommended to organize a workshop within six months. This would enable CLIVAR to present a detailed plan for the main basic upper ocean observational network in time for the CLIVAR conference in December. It was proposed to hold the meeting in conjunction with the first GODAE steering group meeting beginning in July in Tokyo.

Other UOP business

The UOP discussed in depth the future of the panel. It was felt that the UOP will be needed in future to act as a scientific advisory and oversight committee for CLIVAR and the OOPC. In contrast, the OOPC is mostly concerned with the implementation aspects of an operational ocean observing system. Therefore, it was felt that dissolving or merging the UOP with the OOPC would not be the correct way forward.

The implementation of the proposed monitoring arrays during the next year will be one of the main tasks of the panel. Additional efforts are required to work towards a fully integrated observing system for the purposes of CLIVAR.

The UOP has existed now for three years and it was felt that the panel should start to rotate membership. The current chair, Dr Ants Leetmaa, would like to step down from his chairmanship by the end of this year. He would like to stay on the panel for another year and rotate off thereafter. Dr Chet Koblinsky has been proposed as his successor. Other suggestions for membership were made.

The SSG welcomed the report from the UOP and concurred with the Panel's findings. In addition the SSG requested that the UOP, in preparation for the CLIVAR Conference and in support of the UN El Niño Task Team review, assess how well the upper ocean was monitored via in situ and remotely-sensed observations during the 1997-98 ENSO. It asked the UOP to document the anomalous conditions that occurred in the global upper ocean during this event, and identify gaps in the present suite of observations which limit our knowledge and understanding of what caused these anomalies. To the extent feasible, this activity should be coordinated with the related NEG-1 assessment of the numerical predictions of the 1997-98 ENSO.

4.4 PAGES/CLIVAR Panel

J. Jouzel reviewed the history of the joint PAGES/CLIVAR Panel. He recalled that the first meeting was held in Venice in November 1994 and that the outcomes of this session are reflected in the Implementation Plan. A second meeting was held in Villefranche in October 1996, in conjunction with the CLIVAR Ocean Workshop. Although the Panel had not met since then, a lot of activity was taking place at the national and multinational level. The recent IPCC meeting on nonlinear rapid climate change had involved numerous members of the paleo community; also, a lot of new work of interest to CLIVAR had been presented at the open PAGES meeting held the

week before the SSG.

The SSG discussed the strong need for the joint Panel, for instance to assess progress towards the development of high quality, high resolution paleo data sets and historical temperature data sets as proposed in the Implementation Plan, and also to generate products and distribute them widely to CLIVAR researchers. The SSG Chairs would write to the Chairs of the PAGES/CLIVAR Panel urging them to call a meeting and to encourage the paleo community to consider CLIVAR's needs. J. Jouzel agreed to write an article for Exchanges on this topic.

4.5 COARE

At the sixth session of the CLIVAR SSG in April 1997, Dr R. Lukas raised the idea of a working group to address various issues of air-sea coupling to advance CLIVAR modelling of ocean-atmosphere interaction. A particular motivation was the formal ending of funding for TOGA COARE, which orphans the very productive flux working group. The SSG asked Dr Lukas to propose terms of reference and an initial membership for such a group for consideration at the next SSG meeting. Below are the proposed terms of reference for a CLIVAR Coupled Ocean - Atmosphere Boundary Layer (COABL) Working Group which Dr Lukas put to the Group this year.

Proposed Terms of Reference

- Develop awareness of the critical role of boundary-layer processes and interactions in coupling ocean and atmosphere within the global climate system.
- Lead community efforts to identify crucial problems of boundary layer parameterization that must be solved to achieve accurate coupled-model representation of air-sea fluxes of heat, freshwater, momentum and gases on time and space scales relevant to CLIVAR.
- Support the development of improved boundary layer formulations in models of the ocean and atmosphere.
- Foster effective use of existing observations to develop improved parameterizations and to test models
- Identify the need for new observations to improve understanding and modelling of the coupling between ocean and atmospheric boundary layers.
- Forge interactions between oceanographers and meteorologists, and between modellers, theoreticians and observers to bring research results into applications.
- Liaise with CLIVAR NEG-1, NEG-2, Upper Ocean Panel and the mesoscale modelling effort of GEWEX to cooperate fully in model diagnosis and development efforts.
- Advise the CLIVAR SSG on matters which relate to the role of the coupled ocean-atmosphere boundary layer in climate variability and predictability.

There was considerable discussion at the SSG meeting concerning the appropriateness of forming such a group at this time. The SSG recognized that this was a very important problem for CLIVAR and saw the need for the activities which had been carried out by the COARE flux working group to continue. However, it felt that it must wait for the report of the WCRP/SCOR ad hoc Working Group on Air Sea Fluxes before taking a decision about whether and how to formulate another group. The possibility that this might be a WCRP-wide activity was also considered. The SSG Chairs would write to Dr Lukas thanking him for his proposal and suggesting that the rationale and concepts therein be further developed, perhaps at the upcoming COARE 98 Workshop in July.

5. MODELLING

N. Smith, co-Chair of CLIVAR NEG-1 provided a comprehensive written summary of the second meeting of the Group which was held in Hamburg in May 1997. This is included here in Appendix F since the full report of the meeting has not yet been published. Main topics were status reports on the various NEG-1 projects, interaction with the broad range of panels and committees now in existence whose work impinges on the agenda of NEG-1, including AA Monsoon, UOP and the proposed IRI working group on modelling. Several areas for new activities were also discussed.

T. Palmer reported on progress in several NEG-1 areas, including the success of ensemble forecasts. He noted that an area of great interest to both the NEG-1 and UOP was how to improve data assimilation techniques for seasonal forecasting to make the best possible use of observational data. There was some concern on the part of NEG-1 that the question of how anthropogenic forcing might effect natural modes of variability, e.g., ENSO, was not being adequately addressed by the current modelling structure.

J. Mitchell reported on recent progress in WGCM activities. He noted that there had been considerable improvement in the runs using model fluxes without adjustment. Some members of the SSG remarked that there was no intercomparison of how well these model reproduce large scale climate patterns such as NAO. The SSG recommended that NEG-1 and WGCM coordinate on a more structured follow-on Climate Model Intercomparison Project (CMIP) by agreeing on standards for data exchange and saving a full range of diagnostics.

J. Mitchell led a discussion on downscaling. The SSG recognized this as an important area for CLIVAR, but there was some disagreement as to whether CLIVAR should address the problem of regional modelling immediately or wait until global models improved. It was noted that downscaling is being done daily by numerical weather forecasters and that WGNE dealt with this problem to some extent already. K. Trenberth recalled that at SSG-6, after hearing a presentation on ongoing downscaling activities under the Project to Intercompare Regional Climate Simulations (PIRCS), it was concluded that CLIVAR should not initiate a separate project, but that downscaling should be folded into individual PRAs as appropriate. The Group agreed to this approach.

The organization of modelling efforts in support of CLIVAR research formed a central point of discussion at the meeting. It was recommended that the CLIVAR Numerical Experimentation Group (NEG-1) increasingly focus on the seasonal to interannual prediction problem and interact more closely with the UOP, particularly in the specification of observations required for initializing models. The SSG would request that the Working Group on Coupled Modelling (WGCM) take responsibility for those activities of NEG-1, such as the El Niño Simulation Intercomparison Project (ENSIP), that involve improving the ability of coupled climate models to simulate seasonal to interannual climate variability as contained in the global models. The WGCM was urged to fully assess the ability of climate models to simulate modes of natural variability on all the timescale within the remit of CLIVAR, and to address in particular the impact of anthropogenic forcing on these modes. The SSG also agreed to work with the WOCE SSG to ensure that issues related to the improvement of ocean models were adequately addressed within the WCRP modelling programme.

6. ACC

6.1 IPCC matters relating to CLIVAR

The third conference of the parties (COP3) on the Framework Convention on Climate Change took place in Kyoto in December 1997, and the fourth COP will take place in Buenos Aires in November 1998. The sources and sinks of greenhouse gases are the main scientific issue for the 1998 meeting which is primarily intended for reaching agreement on emission controls.

Dr Mitchell presented a provisional timetable for producing the Third Assessment Report (TAR) of Working Group I. A scoping meeting to finalize lead authors has been arranged for late June 1998. The first drafting meeting is planned for October 1999, followed by a peer review, a further drafting meeting, a government review leading to a final drafting meeting in the second half of 2000. Formal approval by Working Group I Plenary is expected in early 2001.

Dr Mitchell raised several areas where CLIVAR could help IPCC:

1. *Climate sensitivity*. This is a major issue for IPCC, and little new work was available for the Second Assessment. In particular, CLIVAR could encourage more work on water vapour and cloud feedbacks, and encourage proactive links between WGCM and GEWEX.
2. *The thermohaline circulation*. This was the major focus of the recent IPCC workshop which made a large number of recommendations. In particular, models provide a wide range of response to increasing greenhouse gases - a CMIP project to assess the response of the thermohaline circulation in CMIP2 would be particularly timely.
3. Anthropogenic climate change may first manifest itself as a change in the frequency of the *main modes of natural variability*. CLIVAR could accelerate work on model validation and diagnosis and properties of dominant modes in general. This could be achieved by extending AMIP and CMIP subprojects
4. *Climate change attribution and detection* are likely to remain one of the more contentious areas in the next report. CLIVAR should foster work to refine estimates of indirect sulphate aerosol effects which are the largest source of uncertainty in historical forcing. There are large differences in the estimates of the amplitudes of the main modes of natural variability in the current generation of coupled models which lead to uncertainties in climate change detection. Again CLIVAR can help by accelerating work in this area through DecCen. An appraisal of a recent estimate of natural variability using palaeoclimatic data over the last six centuries would also strengthen the IPCC report.

6.2 Joint CLIVAR/CCL Working Group on Climate Change Detection

The Twelfth session of the WMO Commission on Climatology (CCI), in consultation with the CLIVAR SSG, agreed that the Commission's Working Group on Climate Change Detection (WG CCD) would become a joint body with CLIVAR. The rationale was to bring together those doing research into climate change detection techniques (primarily CLIVAR) with those concerned with producing data sets (primarily WG CCD). Both the CLIVAR SSG and the CCI nominated new members to the Working Group to cover its expanded remit (see Terms of Reference in Appendix G). The Working Group itself has not met in its newly constituted form (normally it would meet only once every four years), but it has appointed two task groups which have recently sponsored workshops on the topics of interest. N. Nicholls reported on the Workshop on Indices and Indicators for Climate Extremes held in Asheville, North Carolina USA in June 1997, jointly

sponsored by CCI (WMO and CLIVAR) and GCOS. This Workshop was designed to encourage the development of data sets and analysis techniques to determine whether extreme climate events were becoming more extreme or variable. Over 100 participants from 23 countries, including representatives from 15 insurance and reinsurance companies participated. The following recommendations were made:

- A small group of climate extremes indices should be selected, to simplify the analysis and presentations of climate extreme trends. These indices would be selected by the chairs of the breakout group.
- Regional rapporteurs were selected to encourage improved access to data and co-ordination of analyses, and the development of time-series of the selected climate extreme indices.
- A small task group should be established to facilitate inter-regional consistency of analyses and to improve data access and liaison with the insurance industry.
- The regional rapporteurs and the task group would decide on improved methods for archiving global climate extremes data.
- Global and regional bodies would be approached to encourage regional projects to develop data sets and analyses of climate extremes.
- A further Workshop would be held in approximately two years to determine progress and any impediments to determining whether the global climate was becoming more extreme or variable.

7. DECCEN

A. Busalacchi reported on various DecCen-related activities that were in the process of being implemented or planned. The Pilot Research Moored Array in the Tropical Atlantic (PIRATA) now had five moorings deployed and was reporting data in real time. The effort was currently joint between the USA, Brazil and France, the latter two providing shiptime. The surface met data was reaching the GTS; T. Palmer noted that were the subsurface thermal data to be on the GTS, as well, they would be assimilated into the ECMWF analyses. The ICPO volunteered to check into the status and take action as required.

A major meeting had been held in February of this year in the USA to better define US Atlantic plans, partly in preparation for the EuroCLIVAR Atlantic Workshop which was to take place in May. A draft science plan, for an Atlantic Climate Variability Experiment (ACVE) was circulating for review. The workshop had been organized around three geographic subdivisions: mid-latitude, high latitudes and subtropics and tropics. At the meeting it became apparent that, at least at present, the tropics gave the most promising indications of coupled modes. T. Palmer noted that the investigation into whether or not these modes were predictable should form an important focus for CLIVAR. C. R. Mechoso reported on some recent AGCM experiments which showed the North Atlantic Oscillation (NAO) to be associated with sea-surface temperature (SST) anomalies in the Southern and tropical Atlantic. He emphasized the need for coordinating CLIVAR efforts in the Atlantic with VAMOS.

Another US-led effort was being organized to investigate climate variability in the Pacific. Known as Pacific Basin-wide Extended Climate Study (BECS), the region being considered covered approximately 20S to the Bering Sea. Discussions about joint projects with Japan and Australia were being initiated. Both observationalists and modellers were involved in the planning, and, although the problem was recognized as a coupled one, the emphasis was on oceanography.

J. Gould reported on WOCE activities. He noted that although the WOCE field programme formally ended in 1997, some important observations were continuing, including some hydrography and current meter measurements, particularly in the North Atlantic. Profiling ALACE floats were demonstrating their ability to observe remote areas. Analysis of the WOCE data collected worldwide was now a major preoccupation. Workshops were being organized to bring together modellers and observationalists to stimulate the analysis, interpretation and synthesis of the data. Workshops on the Pacific, S. Atlantic and Southern Ocean had already been held, as well one on data assimilation, sponsored jointly with GODAE. This summer a major CLIVAR/WOCE ocean modelling workshop would be held in Boulder CO, USA. Workshops on the Indian Ocean, tracers and the North Atlantic were scheduled to be held in the next 18 months. Dr. Gould presented the objectives of a workshop to address WOCE goal two, assessing the representativeness of the WOCE data set. He invited the CLIVAR SSG to comment and participate in the organization of this workshop, tentatively scheduled for the year 2000.

A. Clarke initiated a discussion on whether CLIVAR should encourage resurveying some of the WOCE hydrographic sections. He noted that the North Atlantic was likely to continue to receive a lot of attention, due to the many people interested in working there and its relative small size and accessibility, but that if CLIVAR wanted other oceans to be surveyed, concerted action would be needed. J. Gould raised the desirability of quantifying error bars on oceanic estimates of air-sea fluxes and comparing these with model estimates in order to better determine where ocean observations were needed for climate studies. T. Palmer suggested that current model estimates might not be sufficiently advanced to drive ocean observations. J. Mitchell remarked that atmospheric model flux estimates are within the errors bars of observations, implying that improved observations would be needed. There was a general consensus that CLIVAR would have to wait until WOCE makes a judgement on the representativeness of the WOCE data before making extensive plans for repeat hydrography. It was noted, however, that repeating a small set of sections such as those recommended at the Villefranche Ocean Workshop in October 1996 (WCRP report no 15/1997) would undoubtedly be wise.

A discussion followed on how best to manage the five DecCen PRAs, each of which had a strong oceanographic component tied to regional and global atmospheric circulation issues and, in some, cases, to sea ice and land surface processes, as well. The group concluded that the three Atlantic PRAs would benefit from cross-fertilization and coordination under a single oversight Panel. Draft terms of reference were drawn up as follows:

- to oversee, facilitate and co-ordinate the implementation of CLIVAR observations in the respective ocean basins so that the PRAs may be progressed;
- to ensure that the observations address the requirement to understand the coupled ocean-atmosphere system both through observations alone and through model development and through the development of products;
- to work with other basin panels to consider matters relating to inter-basin exchanges and processes
- to work with the CLIVAR UOP to identify the level of commitment to global observations
- where appropriate to cooperate with the VAMOS, AA Monsoon and such other regional panels as may be established
- to identify shortfalls in observational resources, technology and infrastructure, to initiate actions to alleviate these shortfalls and alter the SSG to any action required.

A task group was to be appointed to consider these draft terms of reference and recommend membership. Similar proposals were put forward for a Southern Ocean group and one for the

Pacific. The Indian Ocean was being actively considered by the AA Monsoon Panel and the SSG felt that this Panel should currently remain the focal point for CLIVAR requirements in this area. The formation of all these groups should be coordinated with the Ocean Observing Panel for Climate (OOPC) and the various existing CLIVAR panels to ensure that the requirements of each are taken into account and to avoid duplication of effort. The SSG recognized that there would probably be a need to revisit the terms of reference of the CLIVAR Upper Ocean Panel (UOP) once these panels had been established.

8. DATA MANAGEMENT

The SSG agreed as a first principle that CLIVAR would rely on the existing IOC, WMO and ICSU data management structure to deal with its data. In addition it would encourage initiatives such as that of the Joint Data Implementation and Management Panel (JDIMP) of GCOS, to formulate a data information centre which would track what data was collected, where it resides, and how it is available. However, the SSG recognized that certain data problems, particularly those related to data collected primarily for research purposes, would require CLIVAR oversight. WOCE had proposed that its Data Products Committee could evolve to a joint CLIVAR/WOCE group to deal at least with oceanographic data. The SSG welcomed this proposal and agreed that as a first step the next meeting of the group should begin to consider which aspects of the WOCE (and TOGA) data system would be needed for CLIVAR and what additional actions were likely to be needed in the near future to assure that these systems stayed in place.

There was full agreement that any CLIVAR data centre should adhere to a real-time delivery standard where the data was required in real time for improving and analyzing climate forecasts. There was also recognition that some CLIVAR data sets would not be available in real time, such as hydrographic and paleoclimate data. J. Jouzel noted that the US National Geophysical Data Center in Boulder CO could serve CLIVAR, both for raw paleo data sets and data products. Dr Mechoso emphasized that CLIVAR had a responsibility to provide data for applications, and that providing data on-line in formats suitable for applications work should be a goal of the programme.

There was some discussion as to whether CLIVAR should sponsor the assembly of a CD ROM to complement the first TOGA CDROM which had been produced by the NASA Jet Propulsion Lab (JPL) and which covered the first five years of the ten-year TOGA period. The value of such a product to developing countries to aid in the study of ENSO or in the development of a prediction system was recognized. However, it was generally felt that CLIVAR should encourage the use of the reanalysis data sets which were already being issued on CD-ROM.

The SSG decided that, with so many issues to consider, it would be wise to form an ad hoc data management task team which would be charged to develop a preliminary outline of a data management structure for CLIVAR. The CLIVAR Project Office was to develop draft terms of reference and a suggestion for membership as soon as possible.

9. NATIONAL AND MULTINATIONAL REPORTS

The SSG recognized that most of the initiatives for CLIVAR research would come from individual investigators and groups of researchers. These efforts would first be organized at a national or multinational level before becoming part of the overall CLIVAR programme. Therefore it listened

with great interest to the presentations by representatives from the seven nations and two multinational groups represented at the meeting on their CLIVAR activities and plans.

Dr Fuenzalida had invited two members of the University of Chile staff to present different aspects of CLIVAR research being carried out in Chile. Dr Aceituno gave an introduction to climate predictions in Chile. He presented an overview of the general climate of Chile, with its strong north-south variations, and which is strongly linked to the presence of a semi-permanent subtropical cyclone present in summer and winter. Changes in the latter result in important variations in rainfall; clear links are seen to El Niño. During the last three to four years, seasonal forecasts of winter rainfall have been issued through the University. This effort was initiated after training at the IRI (see below). Dr Rutland presented preliminary results from a field experiment to study climate dynamics of the Antofagasta region on the arid west coast of north-central Chile. He noted the importance of understanding the physical mechanisms acting for key issues like environmental protection and assessment of climate change scenarios arising from global warming.

Ib Troen outlined the impressive scope and size of the European Commissions (EC) Environment and Climate Programme. Projects funded under this umbrella are cost-shared with national agencies and must involve participants from several European Union countries. Major projects covering all aspects of CLIVAR research are currently being funded. This five-year programme will expire at the end of 1998, and efforts are underway to ensure its continuation. Other complementary EC programmes covering climate change impacts, climate processes, water resources, natural hazards and marine science also sponsor CLIVAR-related research.

The EuroCLIVAR initiative is also an EC project. It has been funded to organize community workshops aimed at determining how EC funds reserved for CLIVAR-related research should be spent. Eight workshops have been or will be held before the end of the year. Full reports of these meetings and their recommendations are published and are available from G. Komen, EuroCLIVAR coordinator.

A. Moura, Director of the International Research Institute for Seasonal to Interannual Prediction (IRI), made an in depth presentation of his institute and its activities during discussions of the 97/98 ENSO event. He reviewed the end-to-end approach of the IRI, which included research, issuing forecasts, making assessments of impacts, downscaling and applications. He explained that many lessons had been learned as a result of the recent ENSO event. He noted that disseminating useful information requires considerably more effort than simply issuing SST predictions and that more institutional arrangements were needed to cascade information down in an appropriate way.

M. Patterson reported on recent advances in US planning for CLIVAR. Four relevant reports from the National Research Council had been published or were in advanced stages of preparation, namely the GOALS Science Plan, GOALS Implementation Strategy, DecCen Science Plan and the Pathways report from the US Global Change Committee. An Interagency Group had been established to coordinate climate programmes sponsored by NSF, NOAA, DOE and NASA. The Group was chaired by the Director of the US Global Change Research Programme (USGCRP) office, currently Dr. Dave Goodrich, who would also serve as a single point of contact for the ICPO on behalf of the US agencies.

Input for implementation plans within the US was being solicited from the community through workshops, reports and science working groups. Patterson noted that a lot of TOGA-related work was continuing, including observations, prediction efforts, COARE data analysis and regional

assessments. A consensus on the focus for new efforts was emerging which involved investigating phenomena cutting across timescales from intraseasonal to interdecadal and organized initially around four regions: Pan America, Pacific, Atlantic and Asia-Australia. Patterson reported that planning for the Pan American effort was the most advanced, particularly as part of the PanAmerican Climate Study (PACS). Basin-wide extended climate studies (BECS) were being planned for the Atlantic and Pacific, and an Asian-Australian Monsoon Workshop would be held in July 1998. Members of the SSG noted the lack of mention of ACC and paleo activities. Patterson said that although there was considerable activity in this area, notably the computing initiative by the Department of Energy, coordination of related efforts within the US deserved further attention.

K. Hanawa reported on ongoing and planned projects in Japan contributing to CLIVAR. These include oceanographic investigations such as SAGE (XBT project in the North Pacific), NEAR GOOS (the North East Asian Regional GOOS which is a multinational effort with Korea, China and Russia), and KNOT, the Kyodo North Pacific Ocean Time Series. A major focus for Japan has been the Asian monsoon experiment (ASIMON and JEXAM) and planning is underway for a further ten years of study under ASIMON II. Y. Hishida reported on the extensive CLIVAR-related programmes sponsored by JAMSTEC. Four deployments of TRITON moorings had been made in March along 156 E; two deployments were planned for the Indian Ocean. Investigations into the air-sea interaction in the warm pool region of the western equatorial Pacific had been carried out using the large new research vessel, Mira.

JAMSTEC and the Japanese space agency, NASDA, together are funding the major Frontier Research Programme for Global Change. Research interests include climate variability, the hydrological cycle, global warming and modelling. The 1997 Fiscal Year budget is approximately 14 million US dollars and this is expected to double in FY98. Several research institutes have been established, including the International Pacific Research Center in Hawaii, which has recently advertised five tenure track research positions.

N. Nicholls briefly reported on plans to coordinate implementation of CLIVAR efforts in Australia. A national CLIVAR committee has been formed and a science and implementation plan is in preparation. Contributions are expected in all CLIVAR areas, with a particular emphasis on the Indian Ocean.

10. CLIVAR CONFERENCE

The SSG noted that the CLIVAR Conference to be held at UNESCO headquarters in Paris 1-4 December 1998 presented a major opportunity to advertise CLIVAR to programme managers and decision makers interested in climate science. It should also allow nations to publicize their plans for CLIVAR activities and to make some initial steps towards coordination with activities of other nations. The SSG asked the ICPO to ensure that as many nations as possible came prepared with national statements regarding their interests in and commitments to CLIVAR. After the conference, the SSG would analyze the various national reports and oral presentations to take stock of what aspects of the Implementation Plan were in place and where major gaps remained. The SSG Chairs would call a meeting of CLIVAR Panel chairs shortly after the Conference to assess the status of individual PRAs and other programme elements and to plan further actions to foster implementation.

The SSG made some suggestions to the Conference Organizing Committee concerning the

formulation of the Conference programme. In particular it wanted the agenda to place emphasis on user requirements and the application of CLIVAR research for socio-economic benefit. The SSG asked the Director, WCRP, to slightly restructure the Conference Organizing Committee in order to get stronger advice from nations on how the Conference could best serve their needs as well as CLIVAR's. The SSG asked that the Organizing Committee, with the assistance of the ICPO, develop in the very near future an appropriate agenda and selection of speakers.

11. REPORT FROM THE ICPO

John Gould, who had only very recently stepped in as Director of the ICPO, gave his vision of how the office might be organized. As noted earlier, he envisaged four major functions for the office: communications hub, executive arm of the SSG and its panels, enquiry desk and publicity. The main office tools would be good rapid-response communications, high quality publications and a well trained expert staff. He noted that there was still a requirement for staff recruitment and funding for the office, as well as development of national CLIVAR infrastructures. The Office's highest priorities for the moment were publication of the Implementation Plan and preparations for the Conference.

Dr Gould emphasized that although the WOCE and CLIVAR offices were now co-located, they would remain two separate offices. The WOCE structure would remain basically unchanged. The two offices would share a Director and some secretariat functions. Efforts were currently underway to recruit a CLIVAR senior scientist to work in the ICPO. The SSG expressed its desire that the person selected broaden the scientific expertise of the Office staff.

12. CLOSING

The Co-Chairs thanked Dr Fuenzalida and his staff for the excellent local arrangements and the Chilean National Science Foundation for providing the meeting facilities. The SSG agreed to meet again approximately one year hence in the United Kingdom, preferably the week of 10 May, and asked the ICPO to investigate appropriate sites.

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