

Report of the 5th CLIVAR Asian-Australian Monsoon Panel Meeting

25-27 February 2003

New Environmental Science and Technology Building
Georgia Institute of Technology, Atlanta, USA

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Action 1: To summarize the panel's comments on the WCRP Banner as input for the JSC24 meeting. – ICPO, Co-Chairs

Action 2: To maintain and update the AAMP data list on the web as a part of the CLIVAR Data and Information System. – ICPO, with input from the Panel

Action 3: To prepare the AAMP Prospectus, with a draft version available as soon as possible for discussion within the Panel and the CLIVAR-SSG - Slingo, ICPO, with input from the Panel

Action 4: To assure funds to publish the Prospectus, in form of a 6-8-page pamphlet, available for distribution before the First CLIVAR Science Conference (June 2004) – Webster, ICPO

Action 5: To build links with and influence the program of the Pacific Panel, with regard to strong impact of the Pacific on the AA monsoon system. – Co-Chairs, ICPO

Action 6: To write a letter to Dr. David Carson regarding support for a 2-3-day planning workshop with interested groups, in order to develop an overall coordination strategy for the monsoon modeling within WCRP. – D/ICPO to discuss with CLIVAR SSG Co-Chairs and D/JPS for WCRP

Action 7: To ensure full involvement of CLIVAR/AAMP in the development of CEOP/CIMS (including participation of AAMP Co-Chairs in relevant workshops) - Lau, Slingo and D/ICPO to open with Sam Benedict

Action 8: To develop a grand plan of AAMP monsoon modeling, prediction and application, as suggested by Prof. Shukla, with initial draft ready for the CLIVAR SSG meeting (May 2003). - Co-Chairs

Action 9: To ensure linking the list of model inter-comparison projects (the MIPs Catalogue initiated by WGCM through Dr. Meehl) to the AAMP web. - ICPO

Action 10: To develop the link to applications and endorse Climate Forecasting Applications in Bangladesh (CFAB) as an example project to demonstrate monsoon prediction and how the forecasts can be well applied to society.

Action 11: To investigate getting ocean data into CEOP (IO and more widely). - D/ICPO

Action 12: To inform CEOP and ICPO of a list of in-situ ocean data available from India, Japan and other contributors to IOGOOS. – Sengupta, Lau, Kuroda, Meyers

Action 13: To establish an organizing group for a joint workshop with VACS in 2004, focused on 'Impacts of Indian Ocean Variability on Regional Climate', in order to identify dates, venue, funding issues and scientific themes, available for discussion at the CLIVAR SSG meeting (May 2003). Thorncroft, Meyers, Co-Chairs

Action 14: To endorse and provide inputs to VACS/AMMA and send AAMP representative(s) to the next VACS meeting (Kenya, January 2004) – Co-Chairs, Meyers, Thorncroft

Action 15: To seek for sponsorship for a conference in India for MONEX retrospective and way ahead. – Webster, Sengupta

Action 16: To examine the latest proposal of I-MAP (Indian Ocean Moored Array Project) and inform Mark Jury and the TIP group of the discussion at AAMP5 in order to coordinate the implementation of the Indian Ocean Observing System. – Webster, Meyers, Thorncroft

Action 17: To write a letter to Argo group summarizing the Panel's ongoing effort to develop recommendations of how to deploy the floats in order to efficiently monitor intra-seasonal oscillation in the tropical oceans. – Schiller, Webster

Action 18: To write a letter to JAMSTEC to express appreciation of Japanese ongoing efforts in deploying moorings in the Indian Ocean and to encourage further support for a sustained Indian Ocean Observing System. – Co-Chairs, with input from Kuroda

Action 19: To write a letter to the relevant Indian organizations to acknowledge the significance of the Indian Buoy Network for monsoon studies and appreciation of Indian support for a sustained Indian Ocean Observing System. – Co-Chairs, with input from Sengupta

Action 20: To write a detailed proposal for establishing a joint CLIVAR/IOC(or GOOS) Indian Ocean Panel, including rationale, functions, structure and possible membership and funding issues, available for discussion at the CLIVAR SSG meeting (May 2003). – Meyers, Webster, Thorncroft

Action 21: To write a letter to Dr. Kolli's Institute to express appreciation of the effort in maintaining the web of Monsoon on Line. – Slingo

Action 22: To carry messages from CLIVAR/AAMP to the START IRS Monsoon Asia meeting (Bangkok, 22-24 March 2003) and report back to the Panel for further decision on representation if appropriate - Yan

Action 23: To write a short paper for CLIVAR Exchanges upon the unusual monsoon conditions in 2002/03. - Kolli

Action 24: To consider membership changes, taking into account the possible establishment of an Indian Ocean Panel and better representation of the community of monsoon studies. - Co-Chairs

Action 25: To prepare a proposal for the next panel meeting in India, while keeping the possibility of Beijing and Honolulu open, with special consideration of the meeting dates relevant to the annual CLIVAR-SSG and JSC meetings. – Kolli, Sengupta, Co-Chairs

Background

The CLIVAR Asian-Australian Monsoon Panel is a part of the CLIVAR organisation. It plays a primary role in the development of CLIVAR's research programme for monsoons in the Asian-Australian sector extending from the western Pacific Ocean to Africa. The programme includes investigations of the annual monsoon cycle, and intraseasonal through interannual to longer-term variability of the entire monsoon system. Its terms of reference are:

- Evolve a strategy to assess climate variability and predictability of the coupled ocean-atmosphere-land system in the Asian-Australia-Africa monsoon region;
- Design and implement a programme to investigate the mechanisms of ENSO-monsoon interactions;
- Determine a monitoring strategy for the Indian Ocean, Western Pacific and surrounding marginal seas and land regions necessary for investigating the structure and variability of the monsoon;
- Co-ordinate and promote interactions among meteorologists, oceanographers and hydrologists from interested nations;
- Develop an implementation plan for monsoon research in the region, that recognises the need for a well co-ordinated and optimised set of process studies; and

- Work in co-operation with other existing and planned regional and multinational programs directed at improving our understanding of the monsoon system, which include investigations on regional weather forecasting, seasonal climate prediction and impacts on human activities.

The history of the panel and its activities are recorded in [previous meeting reports \(http://www.clivar.org/organization/aamon/index.htm\)](http://www.clivar.org/organization/aamon/index.htm). The current panel members are

J. Slingo	Co-Chair, University of Reading, Reading, UK
P. Webster	Co-Chair, Georgia Institute of Technology, Atlanta, USA
I.-S. Kang	Seoul National University, Seoul, Korea
R. Kawamura	Toyama University, Toyama, Japan
R. Kumar Kolli	Indian Institute of Tropical Meteorology, Pune, India
W. K.-M. Lau	NASA/GSFC, Greenbelt, USA
J. McCreary	IPRC, Honolulu, USA
G. Meyers	CSIRO, Hobart, Australia
N. Nicholls	BMRC, Melbourne, Australia
D. Sengupta	Indian Institute of Science, Bangalore, India
J. Shuttleworth	University of Arizona, Tucson, USA
H. Wang	Institute of Atmospheric Physics, Beijing, China
The ICPO contact for the Panel is	
Z.-W. Yan	Southampton Oceanography Centre, Southampton, UK

The aims of the 5th AAMP Meeting were:

- *to review progress in observing, understanding and predicting the AA monsoon system, and to identify research and infrastructure priorities for the near future;*
- *to develop a long-term strategy for model evaluation and improvement, building on the GEWEX/CEOP initiative and in collaboration with other CLIVAR panels, GEWEX, and the WCRP modeling working groups (WGNE, WGCM);*
- *to discuss the observation network for the Indian Ocean and surrounding seas in the light of Mauritius IGOOS meeting and to consider the need for an Indian Ocean Panel; and*
- *to discuss the status of CLIVAR-AAMP implementation plan and consider its future development.*

1. Introductory Remarks

The fifth CLIVAR Asian-Australian Monsoon Panel meeting was held at the School of Earth and Atmospheric Sciences, Georgia Institute of Technology. Prof. P. Webster (Co-Chair of the Panel) opened the 2.5-day meeting at 8:30 am, 25 February 2003. Prof. J. Curry (Chair of the host institution) welcomed the Panel and experts to Atlanta and kindly offered logistic support for the meeting. Prof. J. Slingo (Co-Chair of the Panel) forwarded apologies from Profs. H. Wang and G. Wu, who could not attend the meeting because the US Embassy in Beijing did not issue visas in time. Dr. T. Sribimawati from Indonesia and Dr. D. Halpern from the US were unable to attend. Contact details of the 18 attendees are in Appendix 1.

The Co-Chairs introduced the meeting objectives and perceived outcome. They stressed that discussion at this meeting would be focused on development of a CLIVAR AAMP Prospectus, implementation of a sustained observing system for the Indian Ocean (including proposing for establishing an Indian Ocean Panel) and a strategy for monsoon modeling. The meeting agenda is at Appendix 2 and also available online at CLIVAR's web site (http://www.clivar.org/organization/aamon/aamp5_agenda.htm).

Dr. H. Cattle, Director of the International CLIVAR Project Office (ICPO), also welcomed all participants to the meeting and wished the meeting a success with fruitful outcome regarding progress with the Indian Ocean observing system and global monsoon modeling. Relevant CLIVAR and ICPO activities were then briefed on by Dr. Z. Yan and discussed by the panel. Main points raised (other than those in later sections) were as follows.

WCRP banner – As Prof. J. Shukla explained, a new version of the banner proposals would be available soon from the Banner Task Force led by Prof. B. Hoskins. The panel supported the notion of a WCRP Banner project upon predictability and prediction of climate system. However, as Prof. Slingo commented, the timescales for prediction should be focused on a range from intra-seasonal to interannual, based on current scientific knowledge. It was questioned whether prediction of decadal climate variations was reasonable and foreseeable for the near-term, while study of predictability was necessary. Prof. Webster emphasized the application of climate prediction as an important aspect of the banner project. He appealed to WCRP to make effort in developing infrastructures in monsoon countries for applying climate prediction in relation to adaptation to climate change.

Ocean carbon - With regard to a recently established project for a Global Carbon Study co-sponsored by IGBP, WCRP and IHDP, CLIVAR basin panels had been asked to appoint an expert to provide liaison to the carbon community. It was noted that the carbon issue related to the Indian Ocean needed attention, though it was currently not highly prioritized by AAMP. The Panel was informed that Katy Hill was appointed at ICPO as a contact point for the carbon issue.

CLIVAR Data and Information System – An initiative at ICPO is to establish a list of web sites, so that users can find a one-stop site identifying current, on-going and planned CLIVAR data sets and information. It would be essential that panels and working groups input the needed information to the ICPO. A 'call for input' was circulated to attendees and collection of inputs requested both during and after the meeting.

First International CLIVAR Science Conference – The panel was reminded that the conference dates are 21-25 June 2004 at Baltimore, USA. Details are online at <http://www.clivar2004.org/>. It will serve as a window for the Panel to exhibit the implementation process. The CLIVAR AAMP Prospectus, which would result from AAMP5, was expected to be available in form of a concise pamphlet for distribution at the conference.

Action 1: To summarize the panel's comments on the WCRP Banner as input for the JSC24 meeting. – ICPO, Co-Chairs

Action 2: To maintain and update the AAMP data list on the web as a part of the CLIVAR Data and Information System. – ICPO, with input from the Panel

2. Development of the CLIVAR AAMP Prospectus

Prof. Slingo explained why the Co-Chairs had suggested the development of a prospectus rather than updating in detail the existing Implementation Plan. The main consideration was that a detailed Implementation Plan would be very time-consuming to prepare. While the meeting reports and many relevant materials available online serve to archive the current status and implementation processes, it was questionable whether the Implementation Plan would be widely used and if it was worthwhile to update it. The proposed CLIVAR/AAMP Prospectus could be in form of a concise pamphlet. It should include short statements on the current status of AA monsoon science and identify key areas for development in the near-term (e.g., 5 years). Prof. Slingo asked the Panel to consider key questions for each of the 5 parts (describing, observing, simulating, predicting the AA monsoon system and applications) as addressed in the agenda.

The Panel agreed with the idea in principle and discussed the contents of the Prospectus. During the discussion, Dr. W. K.-M. Lau questioned if there were sound scientific reasons for the Panel not to go with the existing Implementation Plan and if a brief pamphlet without in-depth scientific contents would be meaningful to the community. Dr. Cattle took GEWEX and CliC as examples of different approaches to implementation. Some panel members suggested that the prospectus could address the Panel's coordinating function in international cooperation and links to other international activities such as IPCC reports in order to get recognized within wider community. Dr. Y. Kuroda commented that scientific debates were important for scientific development but a concise pamphlet might be suitable for wider community. However, he suspected that applications were a side issue for CLIVAR. Prof. Webster stressed that applications should be an important aspect of the monsoon studies and the only way to explore resources for scientific development especially in developing countries. He suggested the Panel endorse the recently established Climate Forecast Applications in Bangladesh (CFAB) as an example project to show how to make and apply predictions of monsoons to society.

It was noted that the contents of the prospectus might depend on the possible establishment of the Indian Ocean Panel. Nevertheless, the Panel proposed the following potential items for the prospectus, including:

- Describing the AA monsoon: key processes and phenomena, e.g., Intraseasonal Oscillation / MJO, Tropical Biennial Oscillation, ENSO, Indian Ocean variability including the Dipole (zonal mode) and Indonesian Through Flow;
- Observing the AA monsoon: field studies, satellite data, and in particular a sustained Indian Ocean Observing System for long-term observations;
- Simulating the AA monsoon: evaluation and improvement of global and regional models, with emphasis on key physical processes that are currently not well represented in models, e.g., diurnal cycles and the ISO;

- Predicting the AA monsoon: methodology, empirical methods, dynamical model forecasts, with emphasis on intraseasonal to interannual timescales;
- Applications of AA monsoon prediction to food, water availability and health issues, with regard to impact of global warming on monsoon variability; and
- Coordination of international activities, including regional and multi-national monsoon experiments, and collaboration with other international organizations upon the monsoon studies.

A complete Prospectus would be prepared after the meeting with contributions from all members.

Action 3: To prepare the AAMP Prospectus, with a draft version available as soon as possible for discussion within the Panel and the CLIVAR-SSG - Slingo, ICPO, with input from the Panel

Action 4: To assure funds to publish the Prospectus, in form of a 6-8-page pamphlet, available for distribution before the First CLIVAR Science Conference (June 2004) – Webster, ICPO

3. Current Status of AA Monsoon Simulation, Predictability and Prediction

The Panel was briefed on the following international projects dealing with monsoon simulation and prediction endorsed by or related to AAMP.

AAMP AGCM Inter-comparison Project – The project, endorsed by AAMP, aimed at assessing the ability of AGCMs to simulate the monsoon. The project had been finished and major results were reported at the 4th AAMP meeting (2001 in Reading). As Prof. I.-S. Kang described, 11 models were applied in the inter-comparison project. In the past few years, 5 subjects had been well studied, including Global Atmospheric Anomalies and Asian-Australian Monsoon Anomalies during 97/98 El Niño, the Climatology of the Asian Summer Monsoon, forced and free Intra-seasonal Variability in the Monsoon Region, and Intra-seasonal Variability Associated with the Asian Summer Monsoon. Further studies of monsoon climatology, monsoon anomalies and the relationship between monsoons and ISOs were going on at NOAA, NASA, IPRC and National Taiwan University.

WGSIP SMIP2/HFP project – The seasonal prediction model inter-comparison project (SMIP) initiated by Shukla about 10 years ago was designed to assess potential seasonal predictability (with observed sea surface temperature). At the initial stage, the project comprised only 4 annual cases (for winter and summer respectively). SMIP II was an extension endorsed by CLIVAR's Working Group on Seasonal-Interannual Prediction (WGSIP). Five models from USA, Canada, Japan and Korea were used to produce 10 ensemble members for 4 seasons during 21 years (1979-1999). The results showed good correlation between observed and modeled precipitation for the tropics, but negative correlation for some monsoon regions. A statistical downscaling technique was developed, which helped to enhance the correlation between the observed and modeled fields. Recently, SMIP/HFP has been designed to assess actual predictability (with predicted SSTs or coupled GCMs), by carrying out 4-month ensemble integrations using 5 atmospheric GCMs with observed initial conditions. All data produced would be available at PCMDI's website (<http://www-pcmdi.llnl.gov/s mip/smip2.html>).

Prof. Slingo guided the panel to consider what priority for future research could be expected from the model comparison projects. Prof. Kang pointed out that besides the Indian monsoon region, the Western Pacific Warm Pool also showed poor predictability. Dr. A. Schiller questioned if parameterization of cloud processes could be a key issue. Dr. Lau commented that one issue should be to improve model physics with proper data. Further development of coupled models in these areas and verifications against observed data was encouraged.

AMIP/CMIP MJO studies – The AAMP had identified the Madden-Julian Oscillation as one of the key physical processes in the tropical climate system, which was not well simulated in current models. Dr. K. Sperber summarized the results from 19 AMIP models and 4 CGCMs integrated for 10-20 years compared with NCEP reanalysis data. All data had been filtered to retain 30-70-day band variability and principal component analysis was adopted to assess the transient ISO signals during the boreal winters. Most atmosphere-only models underestimate the amplitude of MJO convection by a factor of two. All atmosphere-only models produced less organized propagation of the MJO convection from the Indian Ocean to the west Pacific Ocean than observed. Some models were even dominated with westward propagation. However, the coupled models having AMIP runs with the same atmospheric model version exhibited improved propagating features of the MJO convection compared with their atmosphere-only counterparts.

Dr. Lau commented that projecting to observed EOFs might be misleading, if models did not produce the signal. Prof. Webster questioned the 30-70-day timescale for ISO and why only the boreal winter was

studied. Dr. Sperber explained that the boreal winter was the season when the MJO appeared strongest in a year with longer timescales than during other seasons. The present analysis approach was simply for easier handling of model output. It was clearly more difficult to simulate the ISO in summer monsoon season.

Monsoon simulation by coupled models – Dr. G. Meehl introduced results of monsoon-related simulations from coupled models. He took the Parallel Climate Model (PCM, with T42 & 18 level CCM3 atmosphere) as an example of a coupled model. For the summer monsoon precipitation within (5-40N, 60-100E), he noted that AMIP2 models simulated a value of 6.9 mm/day, while PCM produced 4.7 mm/day, closer to the observed 5.3 mm/day. PCM did not produce right intra-seasonal variability and was also characterized by the systematic error of the double ITCZ in the Pacific. Nonetheless, the coupled model produced a better pattern of correlation between the Southern Oscillation Index and summer rainfall, while the AGCM failed to simulate the observed high correlation zone in the western Pacific. The strong annual variability in the main rainfall belt would deserve future model study with comparison with AGCM results.

Dr. H. Hendon noted that the cold SST anomaly zone in PCM could cause the lower simulated rainfall. The SST as simulated might be too cold in the monsoon region (1-2deg colder than the observed). Prof. Slingo questioned if the wind stress was wrongly represented, which appeared a common problem for coupled models. Dr. J. McCreary suspected that the air-sea fluxes were misrepresented in some regions.

Dr. Meehl also briefed the Panel on the simulation of the Tropical Biennial Oscillation (TBO) with the NCAR CSM coupled model. There were still systematic errors in the SST field as a major source of error for the spatial patterns of monsoon rainfall, but the ENSO-related pattern and interannual variability were well simulated. Some processes and features of the TBO were better in the coupled model than in the atmosphere-only model. Problems existed with the boundary layer conditions and seasonal variation, which were to be assessed in near future.

Empirical prediction of AA monsoon rainfall – Prof. Webster presented a physics-based empirical method for predicting intraseasonal monsoon rainfall, which had been applied in the Climate Forecast Applications in Bangladesh (CFAB) project. As he pointed out, application of the traditional forecast of all-India summer rainfall was limited because interannual variations were relatively small, while intraseasonal variability and spatial variations dominated. The traditional annual forecast was also limited by the moderate and changing relationships between monsoon and global circulation features such as ENSO. He suggested that it would be most useful to local societies to forecast intraseasonal rainfall variations. Combining principal components and wavelet analysis of a number of variable fields, the method resulted in good skill predicting turning points and amplitudes of intraseasonal rainfall variations in regions such as Ganges Plain and Rajasthan.

However, as Prof. Kang and Dr. Lau commented, the statistical method will have adopted training data during a certain period and therefore hardly be versatile for different regions and times. Dr. Hendon questioned whether the area where average rainfall was predicted by the method was appropriately large for capturing the ISO. Nevertheless, the results were encouraging, in the sense that ISOs might be predicted as long as the correct physics was grasped.

Applications of climate prediction – Dr. Hendon described the case in Australia. Climate variations could cause 20% increase/decrease in annual agricultural productivity in Australia, implying great potential for application of climate prediction. Traditional studies had revealed close relationships between climate conditions (e.g., the Southern Oscillation Index and rainfall) and varying agriculture conditions. A recent study at CSIRO showed that the real key to seasonal climate prediction related to farming application would be ocean temperature. For Australian farming, the Pacific Ocean temperature was of the greatest influence. The newly developed forecasting system demonstrated considerable benefits for farmers (e.g., an increase of USD 25 000 in annual cash flow for a simulated grazing enterprise).

These presentations and discussions would be useful for developing the AAMP Prospectus. Moreover, Dr. Cattle noted that considering the strong impact of the Pacific Ocean conditions on the AA monsoon system demonstrated by Dr. Meehl, it would be important for the Panel to set up links to the recently established Pacific Panel.

Action 5: To build links with and influence the program of the Pacific Panel, with regard to strong impact of the Pacific on the AA monsoon system. – Co-Chairs, ICPO

4. A Modeling Strategy for AAMP.

Before the Panel was briefed on future developments of individual projects, Prof. Shukla presented general comments on the study of monsoon predictability and prediction. He noted that billions of people suffered from serious floods and droughts due to monsoon variability. He called for consideration for what scientists could deliver to the society.

In general, as Prof. Shukla mentioned, climate variations of timescales from weekly to decadal all impact on the monsoon system. However, a critical fact was global warming, which appeared to have an influence on the Indian Ocean and should influence monsoon variability. Climate change is a major issue for the region's societies and attracts many scientists (e.g., in India and China) as well as resources. Currently, dynamic models still could not provide correct predictions of the monsoon. Empirical methods helped in some cases. AAMP could play a role in coordinating international and regional research activities and guide the community to efficiently approach a better understanding of the monsoon, Indian Ocean dynamics, the ISO and its role in the monsoon system, etc., particularly in the context of global warming. Prof. Shukla suggested the Panel to develop a grand plan of AAMP monsoon modeling, prediction and application.

In later discussion, Prof. Shukla gave more details of his thoughts about how to organize AAMP's coordinating efforts in monsoon studies and to promote a 'grand monsoon climate experiment'. The target for 2010-2020 should be to produce weekly to yearly predictions by incorporating model, observation, application and policy strategy studies in the context of supporting sustainable development. He stressed starting this now. There were many scientific questions relevant to monsoons, e.g., as Prof. Shukla challenged the Panel, where the maximum latent heating source in the atmosphere linked to the maximum rainfall center was located.

The Panel discussed what key questions should be addressed. Prof. Webster noted the need for capacity building to make use of climate prediction products and hoped to see more national involvements at some stage. He mentioned a number of key process studies including air-sea interaction in relation to the ISO, Indonesian Through-Flow and land surface processes over the Tibetan Plateau. Prof. Kang suggested making an effort to push SMIP further forward. Dr. McCreary suggested making efforts in developing an ocean model for the Indian Ocean, in particular with regard to the circulation in the region of Sumatra. Prof. Slingo agreed by commenting that current coupled models had serious problems off Sumatra. She also pointed out some key processes which are poorly simulated in current coupled models such as diurnal cycle and sea breezes. Dr. Meehl proposed that a key question was why the ISO signal was particularly strong in the Indian Ocean.

Prof. Webster emphasized the importance of monsoon studies, reminding the Panel that there could be 75% of the world population in the monsoon area by 2050. He informed the Panel of that UNEDP might fund the CFAB project in Bangladesh, focusing on forecasting ISO scale variations. For applications, he asked if it was necessary to wait until models and observations became perfect. Dr. Lau added that application studies with regional models could be encouraged. Dr. D. Sengupta commented that application studies were a serious issue, as any recommendation to policy-makers without qualified science would be dangerous.

Prof. Slingo guided the Panel by recalling the proposal for a pan-WCRP workshop on modeling monsoon environments. She suggested that the basic idea discussed at the last meeting be revised, in the light of the new CEOP/CIMS initiative. She asked the Panel to consider how to develop CIMS to a global monsoon modeling project, how to take the suggested workshop forward, and what to do as a panel, taking into account future development of other relevant international modeling projects.

CIMS – Dr. Lau briefed the Panel on the Coordinated Enhanced Observing Period (CEOP) Inter-monsoon Model Study (CIMS). CEOP identified monsoon system study as one of its major objectives, with a working group led by Dr. Lau and Prof. Yasunari. The group would make efforts, through both observation and modeling, in diagnostics, validation, inter-comparison, and predictability studies on the Asian-Australian monsoon, North and South American monsoons, and the West African monsoon. To quantify the controls of the water and energy cycles in the monsoon system, data for moisture convergence and surface fluxes were required with spatial resolutions of 100 -10 km globally and regionally and timescales of hours to years.

The CEOP Monsoon Systems Working Group had proposed the initial definition of CIMS, as a GEWEX/CLIVAR joint effort, and had the first planning meeting on 10-11 September 2002. The objectives of CIMS were

- to provide better understanding of fundamental physical processes underpinning the diurnal and annual cycles, and intraseasonal oscillations in monsoon land and adjacent oceanic regions of Asia, Australia, North America, South America and Africa; and

- to demonstrate the synergy and utility of CEOP integrated satellite data, *in situ* observations and assimilated data in providing a new pathway for model physics evaluation and improvement.

CIMS would initially focus on issues relevant to model physics improvement, via simulations, and cross-validation of model outputs with detailed observations. The synergistic use of global data, in conjunction with high-resolution space and time observations from field sites would be critical. A major task would be to define the data requirements and modeling strategy for validating model physics. Validation data would be derived from CEOP reference sites, including GEWEX continental scale experiments (CSEs) and planned CLIVAR field campaign sites, e.g. NAME, CAMP, MESA and AMMA. Numerical experiments would be designed using, where appropriate, combinations of AGCMs, CGCMs, regional climate models, as well as cloud resolving models to target the simulation of fundamental physical processes in monsoon regions, leading to identification of model errors and pathways for improvement.

Regarding the fact that the AAMP co-chairs were not invited to participate in the first planning meeting, Dr. Lau assured them that they would be invited to the next meeting and explained that some basic ideas developed within CLIVAR AAMP had been adopted by the group. Prof. Slingo stated that a sound mechanism for AAMP to be appropriately involved was certainly needed. Dr. McCreary noted that the current plan did not consider much of the oceanic aspects of the monsoon systems. Prof. Slingo summarized the discussions by emphasizing that the project needed to incorporate more oceanic aspects, including how to integrate the *in situ* Argo observations and CLIVAR oceanic data such as those from JASMINE. She suggested that a special workshop be organized, involving all interested WCRP groups, in order to develop the grand experiment as suggested by Shukla. As this activity is at a pan-WCRP level, an action was placed on Dr. Cattle to communicate with Dr. Carson (Director, JPS for WCRP) on this matter.

WGCM CMIP future development – Dr. Meehl outlined the Coupled Model Inter-comparison Project. CMIP1 (the first phase of the project) was to simulate present-day climate and CMIP2 to make control runs and sensitivity experiments with CO₂ increasing by 1% per year, with limited output fields and monthly time series. The goals of CMIP2 were to

- document the mean response of the coupled climate system to a transient increase of CO₂ in the models near the time of CO₂ doubling;
- quantify the effects of flux adjustment on climate sensitivity in the coupled climate simulations; and
- document features of the simulated time-evolving climate system response to gradually increasing CO₂.

CMIP2plus was an extension of CMIP2, making the same experiments but with all output fields and some daily data including ocean data. The project would allow investigators to be able to analyze all fields and daily data from models and address the reasons for models' differing responses.

CMIP had accepted 23 experiments on different subjects, up to early 2003. The output of the coupled models would be useful for studies of climate change detection and attribution, model validation, decadal variability and downscaling for local climate analysis. Currently, there were 5 monsoon-related sub-projects, covering the East Asian monsoon, West African monsoon, Australian monsoon, ISO and Indian monsoon prediction. Dr. Meehl noted that there was potential for more monsoon subprojects and possibility for formulation of monsoon CMIP coordinated experiments.

Prof. Slingo suggested that there could be a focus on seasonal and interannual variability in the Indian Ocean, which might serve as a link point between the CGCM and monsoon studies. Dr. Meehl mentioned that the ocean model inter-comparison (OMIP) was also going on as well as AMIP for atmosphere models. To help make the AA monsoon community aware of the advances in the model inter-comparison projects, Dr. Cattle suggested that the ICPO set a link on the CLIVAR AAMP website to the MIPs catalogue maintained by Dr. Meehl.

GEWEX land surface and cloud modeling plans – Prof. J. Shuttleworth briefed the Panel on the GEWEX projects GLASS and GCSS, with input from the group chairs (Drs. Polcher and Krueger). GLASS (Global Land-Atmosphere System Study) is a project of the GEWEX Modeling and Prediction Panel (GMPP). Previous GLASS studies (PILPS) had focused on validating physical land-surface process modeling of semi-arid areas, dealing with monsoon influence. GLASS was currently carrying out the PILPS-C1, a local off-line study incorporating biogeochemistry and the first experiment to evaluate the ability of land-surface models to simulate local carbon fluxes, with validating data from the Euroflux site at Loobos in the Netherlands. More local studies would be carried out in the San Pedro Basin (US) and would contribute to the VAMOS North American Monsoon Experiment. A global scale off-line action (GSWP-2 experiments) was also on the way. A further step was planned at a workshop at KNMI in April 2002 to incorporate some atmospheric feedback

into the local models. A global coupled action (GLACE) was also planned based on the experiment of Koster et al (2002). The group was seeking for possible collaboration with i-LEAPS of IGBP, with regard to the Global Soil Wetness Project (GSWP) providing global 1x1Deg 2-D arrays of data for land surface models.

GCSS (GEWEX Cloud System Study) is another project of the GEWEX GMPP, with 5 working groups for different regional and types of clouds. A revised science plan is available online at <http://www.gewex.com/gcss.html>. The main tool of GCSS is the Cloud Resolving Model (CRM). Many model intercomparison projects for clouds have been carried out and are planned in order to evaluate the participating CRMs. Results are available at <http://gcss-dime.giss.nasa.gov>. A significant issue deserving new effort in the future would be the parameterization of ice microphysics. Prof. Shuttleworth noted that the GSCC results had been increasingly used in GCM simulations and evaluations. Some studies revealed that current models tended to underestimate cloud cover, overestimate cloud thickness and miss thin layer clouds.

Asian-Pacific Climate Network (APCN) – Prof. Kang briefed on this newly established APEC intergovernmental organization for climate study, with input from Chung-Kyu Park of the APCN Secretariat at Korea Meteorological Administration. The network was proposed at the 3rd APEC Ministers Conference on Regional Science and Technology Cooperation in October 1998, Mexico City, and approved at another APEC meeting in August 1999, Seattle. The first Steering Committee meeting was held in June 2002, Seoul. APCN was aimed at realizing the APEC vision of regional prosperity by

- Producing real-time operational seasonal forecast information based on well-validated multi-model ensemble systems;
- Sharing high-cost climate data and information;
- Enhancing capacity-building in the monitoring and prediction of unusual weather and climate in the Asia-Pacific region; and
- Assisting the management of climate risks in the Asia-Pacific region.

A core project is the APCN Multi-Model Ensemble System (MMES), which is aimed at developing the ideas of CLIVAR SMIP to establish infrastructures for generating real-time forecasts and disseminating climate monitoring and forecast information for regional scale applications. The APCN had requested that WMO designate a World Climate Center (WCC), where global climate predictions would be processed and optimized forecast information disseminated to Regional Climate Centers (RCCs) for further downscaling to regional applications. Prof. Kang informed the Panel of the first APCN International Symposium on MMES for Climate Prediction, 14-17 October 2003, Jeju, Korea. Details are available at <http://www.apcn21.net>.

Action 6: To write a letter to Dr. David Carson regarding support for a 2-3-day planning workshop with interested groups, in order to develop an overall coordination strategy for the monsoon modeling within WCRP. – D/ICPO to discuss with CLIVAR SSG Co-Chairs and D/JPS for WCRP

Action 7: To ensure full involvement of CLIVAR/AAMP in the development of CEOP/CIMS (including participation of AAMP Co-Chairs in relevant workshops) - Lau, Slingo and D/ICPO to open with Sam Benedict

Action 8: To develop a grand plan of AAMP monsoon modeling, prediction and application, as suggested by Prof. Shukla, with initial draft ready for the CLIVAR SSG meeting (May 2003). - Co-Chairs

Action 9: To ensure linking the list of model inter-comparison projects (the MIPs Catalogue initiated by WGCM through Dr. Meehl) to the AAMP web. - ICPO

Action 10: To develop the link to applications and endorse Climate Forecasting Applications in Bangladesh (CFAB) as an example project to demonstrate monsoon prediction and how the forecasts can be well applied to society.

5. AA Monsoon Process Studies

The Panel was updated on current and planned field experiments dealing with monsoon studies.

CEOP – As Dr. Lau described, the Coordinated Enhanced Observing Period was originated in GEWEX, but later developed into a WCRP-level project. The Scientific Steering Committee included Prof. R. Mechoso as a member representing CLIVAR. CEOP seeks to establish an integrated observing system for the water cycle, which responds to both scientific and social needs (including relevant WCRP groups dealing with

water and energy cycle study and climate prediction). Currently, the project promotes observations mainly over land particularly through the concept of reference sites. Dr. Lau noted the need for incorporating more oceanic aspects of the climate system with possible support from NOAA. All data collected within CEOP should be freely available to research communities, including model outputs archived at Max-Planck Institute (<http://www.mpg.de>), in-situ data from 33 CEOP reference sites collected at UCAR (<http://www.ucar.edu>), land data at NASA (<http://ldas.gsfc.nasa.gov>), satellite data and the data integrating and plotting system at University of Tokyo (<http://monsoon.t.u-tokyo.ac.jp/ceop>). Dr. Lau noted that GEWEX had made efforts in collecting and disseminating its data. The CEOP data system could, in future, be similar to that of NCEP with data and image transferring facilities through FTP and web interfaces.

The Panel discussed the data issue in relation to the CEOP system and noted the potential for CLIVAR to contribute with regard to Indian Ocean monitoring, AAMP field experiments such as JASMINE, VAMOS projects such as NAME, MESA and SALLJ, VACS projects such as AMMA and the international Argo program. CLIVAR itself is currently defining its data management structure. Dr. Cattle mentioned that, with the end of WOCE, the WOCE Data Assembly Centers (DACs) had been mandated as CLIVAR DACs for an initial 3-year period. An action item was put on Dr. Cattle, as Director of ICPO, to investigate routes for getting ocean data into CEOP system.

Dr. Meyers noted that there had been many individual ocean projects producing abundant data and coordination was very much necessary. In particular, Drs. Sengupta and Lau were asked to provide CEOP and ICPO with a list of ocean observations maintained by Indian institutes. In response to a question raised by Dr. McCreary, Dr. Lau further explained that CEOP were trying to push the process by obtaining national commitments for supporting the CEOP data system.

JASMINE II – The 1st phase of this field experiment on air-sea interaction in the Bay of Bengal was carried out in 1999 with fruitful results (<http://paos.colorado.edu/~jasmine/index.html>). The panel had endorsed a 2nd phase during the last panel meeting (Reading, August 2001). However, as Prof. Webster explained, JASMINE II had not moved forward yet, due to lack of local contact and funding support. He asked what kind of field experiments were needed and suggested having a small group with Prof. Shukla and Dr. Meyers to discuss how to move the process forward. He mentioned the possibility of having an international conference (a MONEX retrospective) in India during 2004, which was aimed at summarizing the various monsoon experiments to date and finding a way ahead to deploy further field experiments.

BOBMEX and ARMEX – Dr. Sengupta outlined the research progress resulting from the Bay of Bengal Monsoon Experiment during the summer of 1999 and the Arabian Sea Monsoon Experiment during 2002. It was demonstrated that sea salt contributed 61% to the aerosol optical depth in the area. Aerosol caused negative radiative forcing at the top of atmosphere (-18 to -8 W/m²) and the surface (-29 to -21 W/m²), but positive at the aerosol layer (3 to 19 W/m²). The buoy-measured variables were compared with other data sets such as CLIM and TMI. With daily details, the field measurements clearly showed the pre-monsoon-seasonal sudden sub-surface warming since late March. New cruise tracks were proposed for ARMEX II, taking into account the fact that there was no rain in the region during the 1st phase.

The Panel discussed what AAMP-sponsored process studies should be aimed at. Prof. Webster pointed out that one target was to provide guidance for designing long-term monitoring observations. Dr. Meyers agreed, emphasizing that the monitoring community usually did not know much about how to develop the monitoring system with regard to research requirements. He suggested that the Panel should endorse the combining of process studies with long-term observing system design, as panel business. Prof. Slingo added that process studies were needed also for improving understanding of physical processes, and in particular for future process studies, and studies of biosphere processes in the system. Dr. Lau suggested involving modelers to fully use the experimental data. In particular, Prof. Slingo addressed the need for validating coupled modeling. Dr. Schiller suggested that an additional aim of field experiments be to calibrate satellite observations, which had widely been incorporated in long-term monitoring systems.

INSTANT – During a later discussion, Dr. Meyers briefed the panel on a new project named International Nusantrara Stratification and Transport Experiment. The project will directly measure the velocity, temperature and salinity of the Indonesian Through-Flow (ITF), using simultaneous, three-year mooring deployments in both the inflow and outflow passages of the Indonesian Seas. INSTANT is a cooperative investigation involving Australia, France, Indonesia, the Netherlands, and the United States. The measurements would operate over a three-year period commencing December 2003.

The ITF is a critical choke point in the global climate system affecting the oceanic transport of heat and freshwater, and ultimately the global thermohaline circulation. Variability of the ITF and associated changes in subsurface oceanic structure also has a direct impact on the climate of the maritime continent. The goals

of INSTANT are to measure the ITF and its property-transport, to understand the dynamics of its variability (e.g. relationship to local and remote forcing) and to identify proxy-indicators of its strength that can be maintained for decades.

East Asia Monsoon Experiment – Due to the absence of Chinese representatives at the meeting, the panel missed the planned talk about monsoon experiments in China. However, in a document received from Prof. Wu with input from Prof. W. Li of the National Climate Center in Beijing, the Panel was advised that China had led a multi-national project, the South China Sea Monsoon Experiment (SCSMEX, <http://climate.gsfc.nasa.gov/~kim/relacs/campaign/index.html>). A series of new experiments were now being proposed as an integrated East Asia Monsoon project, with major experimental sites including the South China Sea, the Huai River Basin and the Tibetan Plateau. The project will be mainly a China-Japan cooperative, but more national involvements are welcomed. AAMP was expected to play a role in coordinating the regional activities.

VACS – Dr. C. Thorncroft presented the relevant ideas from CLIVAR VACS panel. On the ocean – climate relation for Africa, he stressed 3 phenomena: the Indian Ocean SST pattern, which greatly influenced droughts in southern Africa, and Tropical Dipole and ENSO, which influenced east African climate. Analyses of the relationships between SST and African climate variables showed potential for 3-month-long-lead forecasts. However, caveats arose from the fact that the statistical relationship could break down sometimes. VACS therefore strongly supported establishment of new observation systems for the Indian Ocean, in order to improve understanding of African climate variability and predictability.

On a proposed AAMP-VACS joint workshop, Dr. Thorncroft suggested a subject of common interest: the impact of the Indian Ocean on climate variability and predictability over all surrounding land areas. He informed the Panel of that the next VACS meeting would be in Kisumu (Kenya) in January 2004, which could provide an opportunity for the joint workshop.

Dr. Thorncroft also briefed the Panel on the VACS AMMA project. AMMA has been designed as a multi-disciplinary study upon African climate variability, including monsoon dynamics, and the impact of climate change in the region. Regional modeling would be a key tool, as global models failed to produce correct climate simulation in the region. However, he noted that in the local research communities, global modeling scenarios were simply taken to force regional models. He stated that this was an area where CLIVAR needs to make special effort in coordination. AMMA plans to launch a west African monsoon experiment, of which one task will be to make special ground observations along a transect during 2004-2006. The Panel was invited to provide input to the AMMA project. In addition, Dr. Thorncroft mentioned the new I-MAP proposal and asked support from AAMP.

Action 11: To investigate getting ocean data into CEOP (IO and more widely). - D/ICPO

Action 12: To inform CEOP and ICPO of a list of in-situ ocean data available from India, Japan and other contributors to IOGOOS. – Sengupta, Lau, Kuroda, Meyers

Action 13: To establish an organizing group for a joint workshop with VACS in 2004, focused on 'Impacts of Indian Ocean Variability on Regional Climate', in order to identify dates, venue, funding issues and scientific themes, available for discussion at the CLIVAR SSG meeting (May 2003). Thorncroft, Meyers, Co-Chairs

Action 14: To endorse and provide inputs to VACS/AMMA and send AAMP representative(s) to the next VACS meeting (Kenya, January 2004) – Co-Chairs, Meyers, Thorncroft

Action 15: To seek for sponsorship for a conference in India for MONEX retrospective and way ahead. – Webster, Sengupta

6. Indian Ocean Observing System and Indian Ocean Panel

The panel was briefed on recent progress towards an integrated Indian Ocean Observing System (IOOS). A milestone event was the IOGOOS Mauritius conference. Dr. Meyers, who played a role in organizing the event, introduced some key results.

IOGOOS Conference - The First Indian Ocean GOOS Conference was held in Mauritius on 1-9 November 2002. 158 participants from 22 nations and 5 intergovernmental agencies attended. The highlight of the conference was the signing of the IOGOOS MOU by 19 organizations from 10 countries affirming interest in creating a regional alliance to develop GOOS. In addition to six overview presentations on the need and

status of IOGOOS, the Conference included Workshops on Ocean Dynamics and Climate, Coastal Ocean Observations, Data Management and Satellite Applications. The Conference Report can be obtained from Intergovernmental Oceanographic Commission Regional Program Office, Perth, PO Box 1370, Perth WA 6872, Australia.

Dr. Meyers noted that while satellite data remained fundamental in the observing system, in-situ moorings, drifters and shipping observations also required huge and sustained support from nations. For maintaining the observing system, social and scientific applications would be critical. Due to this consideration, the Mauritius conference facilitated the bringing of coastal communities including fishery and biogeochemistry into the system's development. Currently, national commitments were time-limited. Meyers pointed out that previous AAMP meetings played key roles in developing the idea of a sustained IOOS, but effort in identifying key research issues based on the IOOS was still needed. He suggested working with GOOS to develop a CLIVAR/GOOS joint implementation plan.

The AAMP noted and encouraged progress and plans for Sustained Observations of Climate in the Indian Ocean (SOCIO) that emerged from the Mauritius Conference. Japan and India have established six, multiyear, near-equatorial mooring sites for measurement of upper ocean currents and/or temperature/salinity; and India had planned an ambitious mooring program for the Bay of Bengal and Arabian Sea. The initial data from pilot moorings were providing new insights on the role of oceanic processes in the Intraseasonal Oscillation. The Panel strongly recommended that plans be completed for a multi-national effort to sustain a coordinated array. The ad-hoc panel of mooring experts formed at the Conference should meet again as soon as possible to achieve this goal.

The Panel also discussed the possible research issues, for which an IOOS might be of special importance. Dr. Meyers listed a few items such as air-sea heat / fresh water fluxes, Indonesian Through-Flow and Southern Ocean MOC. Dr. Lau commented that for surface fluxes, relevant atmospheric variables should well be considered in the observing system. Dr. McCreary noted that Argo floats might not be sufficient for monitoring circulations in coastal regions, like Somalia and Sumatra/Java. Dr. Sengupta informed the panel of that the Indian Oceanography Administration maintained 40 floats in the Indian Ocean, motivated mainly towards monitoring and forecasting tropical cyclones and partly for monsoons as well.

Argo and sampling – Dr. Schiller briefed on progress in Argo and reported on sampling experiments in the Indian Ocean. As a part of the IOOS, the Argo float program had progressed in the Indian Ocean, with >70 floats sending temperature/salinity profiles every 10 days at the present time. Resources had been committed to bring the deployment up to 170 in 2003 and 450 in 2005, aiming at full coverage of the tropical Indian Ocean at the standard Argo sampling density (~1 float in each 300 km square) and substantial coverage in the subtropical and sub-Antarctic zones. The AAMP encouraged development of the Argo program throughout the Indian Ocean and noted the importance of completing coverage at its higher latitudes.

The fast upper ocean variability of the tropical Indian Ocean requires a special approach to Argo sampling. The ad hoc group for Observing System Simulation Experiments formed in Mauritius was encouraged to complete their work aimed at developing a sampling strategy for Argo in the Indian Ocean. As Dr. Schiller reported, model experiments with an OGCM had been performed to assess sampling strategies for ARGO floats on intraseasonal-to-seasonal timescales. The preliminary results suggested that a minimum requirement for resolving ISOs in the ocean was given by their spatial scales, i.e. about 300km in the zonal and about 100km in the meridional direction. Frequent temporal sampling becomes particularly important in dynamically active areas such as the western boundary current regime and the equatorial wave-guide. High frequency sampling was required in these areas to maintain an acceptable signal-to-noise ratio on intraseasonal timescales. A first model-based estimate on the required minimum sampling interval to capture ISOs in the upper ocean was about 6 days or less. However, these preliminary results were based on a single OGCM and subject to model errors. Researches with various models were being carried out by Harrison, Vecchi (PMEL), Lee (JPL), Schiller, Wijffels and Meyers (CSIRO) and the results were to be applied to assess and to minimize the impact of individual model errors on sampling strategies.

The Panel appreciated Dr. Schiller's contribution and the group's effort in strategy studies for Argo deployment. Based on the preliminary results presented at the meeting, the Panel agreed to write to the Argo group summarizing its ongoing effort to develop recommendations of how to deploy the floats in order to efficiently monitor intra-seasonal oscillation in the tropical oceans.

TRITON and ADCP – Dr. Kuroda described Japanese activities, with input from Yukio Matsumoto of the Frontier Research System for Global Change (FRSGC). The FRSGC and Japan Meteorological Agency (JMA) have continued their investigation of atmosphere-ocean circulation and variability associated with

Asian-Australian monsoons using both observations and models. The main targets of the study includes intraseasonal variability in the tropical Indo-Pacific area, seasonal variations in Asian-Australian monsoon regions, and interannual variations associated with the ENSO and the Indian Ocean Dipole Mode. A major effort of the Frontier Observational Research System for Global Change (FORSGC) was to conduct intensive field observations in Eurasian regions and the Indian and Pacific oceans to investigate the atmosphere-ocean-land interactions associated with climate variability in the Indo-Pacific sector. Currently the atmospheric observations include,

- deployments of an in-situ automatic flux measurement network in the Eurasian continent;
- a wind profiler system and radiosonde observations in Palau, and drop-sonde measurements using an aircraft over the Pacific warm pool region harmonized with atmospheric measurements using R/V Mirai; and
- a comprehensive network of radiosonde observations, GPS water vapor measurements, and stable isotope hydrological measurements in the Asia/Pacific monsoon region.

The ocean observations include

- ADCP sub-surface mooring at 90E on the equator from November 2000;
- up to 15 Argo floats to be deployed in Japanese-FY2003 in the southern Indian Ocean during a WHP type R/V Mirai cruise and more in the Pacific; and
- several surface drifter deployments.

In addition, the FORSGC, JMA and Japan Fishery Agency jointly maintain three VOS XBT/XCTD lines in the Indian Ocean and the western tropical Pacific Ocean as well as several other XBT observations in the Indian Ocean by voluntary ships. JAMSTEC had completed the originally planned TRITON buoy array of 18 sites in the western tropical Pacific Ocean and eastern Indian Ocean in August 2002. The two TRITON buoys had been deployed in the eastern Indian Ocean since October 2001. In addition, the R/V Mirai of JAMSTEC goes to the eastern Indian Ocean once a year. These FORSGC and FORSGC projects were carried out with cooperation with university scientists.

Dr. Kuroda also briefed on some results of the mooring data, which were expected to be applicable to the study of winds and surface fluxes dealing with the ISOs in the tropical oceans.

The Panel was appreciative of the Japanese contribution to the Indian Ocean observing system. As Prof. Webster commented, the moorings provide invaluable data sets for the studies of the Indian Ocean and monsoon system. The Panel supported Dr. Kuroda's proposal to maintain the TRITON moorings in the equatorial Indian Ocean as a part of the pilot study of the IOOS. The Panel agreed with Dr. Cattle's suggestion to write a letter to JAMSTEC (corresponding to Dr. Hajimu Kinoshita, Executive Director, Japan Marine Science and Technology Center, 2-15 Natsushima, Yokosuka, 237-0061, Japan; cc Dr. Takatoshi Takizawa, Director of Ocean Observation and Research Department) expressing appreciation and addressing the importance of the long-term observations in the equatorial Indian Ocean.

Subsurface current meter mooring – Dr. Sengupta briefed on results from an Indian mooring at 93E 0N installed by the National Institute of Oceanography (NIO) under the Ocean Observing Systems Program, which measures oceanic currents and their variability. He introduced the dynamics of equatorial zonal jets using a model simulation. The meridional currents from the mooring and model showed biweekly variability with the structure of mixed Rossby-Gravity (MRG) waves, associated with strong fluctuating upwelling and downwelling on either side of the equator and forced by intraseasonal wind stress variability. On a recent (November 2002) multidisciplinary cruise in the central equatorial Indian ocean, NIO scientists may have found the first evidence that the upwelling associated with the biweekly MRG wave has an influence on the chemistry and biology in the upper ocean. He pointed out that the common use of NCEP wind data to force models might be problematic with regard to the simulated oceanic response.

The Panel appreciated the Indian activities for developing IOOS and agreed to endorse Indian mooring deployment. A letter would be sent to relevant leaders in India (Mr. K. Premkumar, Programme Director, National Data Buoy Programme, National Institute of Ocean Technology, Department of Ocean Development, NIOT Campus, Velachery-Tambaram Main Road, Pallikaranai, Chennai 601 302, India; cc Dr. K. Radhakrishnan, Director, Indian National Centre for Ocean Information Services, Department of Ocean Development, Plot No. 3, Nandagiri Hills, Jubilee Hills, Hyderabad 500 033, India; and Director, National Institute of Oceanography, Dona Paula, Goa 403 004, India).

Indian Ocean Panel – The idea to form an Indian Ocean Panel was raised at the 4th AAMP meeting (August 2001). It has become increasingly feasible and necessary as requirements from scientific communities and the IOOS merged. Prof. Webster introduced the issue by emphasizing that many countries would be

involved in the development of the IOOS, which deserved a panel to make special effort in coordination. He noted that AAMP could hardly get full representation from all relevant nations but a separate Indian Ocean Panel would likely be acceptable. During discussion, Prof. Webster pointed out that the IOOS was a big challenge to scientific community, as it should deal with not only the ocean, but also atmospheric and biological aspects, so that it could serve to support many kinds of scientific applications.

The Panel discussed the rationale for establishing a new panel. Prof. Slingo noted that Indian Ocean observations were under-represented currently by AAMP. She suggested that the new panel should work closely with AAMP and pay special attention to the coupled system of the Asian-Australian monsoon. By having a new panel, AAMP could focus more on the study of monsoon predictability, prediction and applications. Prof. Kang pointed out that the scope of AAMP was wider than Indian monsoon and hoped that the establishment of an IOP would provide AAMP with a chance to develop a more complete context of monsoon study. Dr. Meyers commented that an IOP would help to address more marine science and applications. He noted that, as an example, AAMP had not considered the typical shallow meridional overturning circulation in the Indian Ocean at all. Drs. Sengupta and Kuroda commented that an IOP with links to both CLIVAR and GOOS would promote national ocean observation networks. With regard to the funding issues, Dr. Cattle suggested that funding would probably be more feasible by putting the new panel under CLIVAR and an oceanic organization such as GOOS or IOC. He also agreed that the IOP should promote both ocean and atmosphere observations in the Indian Ocean.

Dr. Meyers summarized the motivations for consideration of an Indian Ocean Panel. The idea was initially motivated by comments from several leading oceanographers with a broad range of interests in the Indian Ocean indicating that important Indian Ocean processes were being overlooked when the focus of AAMP was sharply on monsoons. It was also motivated by the larger amount of resources for observations that would be available during the next few years, much coming from the operational oceanography community outside of CLIVAR. AAMP recognized that coordination of the deployment of these resources was necessary. At the same time research on ocean dynamics was an essential business for AAMP, and the Panel's interests must in due course expand into longer time scales and a broader perspective on Indian Ocean processes. In view of these considerations, the Panel recommended establishing a joint CLIVAR/IOC (or GOOS) Indian Ocean Panel whose primary task would initially be implementation of an Indian Ocean observing system. The Panel would prepare a detailed proposal for the CLIVAR SSG meeting (May 2003).

Action 16: To examine the latest proposal of I-MAP (Indian Ocean Moored Array Project) and inform Mark Jury and the TIP group of the discussion at AAMP5 in order to coordinate the implementation of the Indian Ocean Observing System. – Webster, Meyers, Thorncroft

Action 17: To write a letter to the Argo group summarizing the Panel's ongoing effort to develop recommendations of how to deploy the floats in order to efficiently monitor intra-seasonal oscillation in the tropical oceans. – Schiller, Webster

Action 18: To write a letter to JAMSTEC to express appreciation of Japanese ongoing efforts in deploying moorings in the Indian Ocean and to encourage further support for a sustained Indian Ocean Observing System. – Co-Chairs, with input from Kuroda

Action 19: To write a letter to the relevant Indian organizations to acknowledge the significance of the Indian Buoy Network for monsoon studies and express appreciation of Indian support for a sustained Indian Ocean Observing System. – Co-Chairs, with input from Sengupta

Action 20: To write a detailed proposal for establishing a joint CLIVAR/IOC (or GOOS) Indian Ocean Panel, including rationale, functions, structure and possible membership and funding issues, available for discussion at the CLIVAR SSG meeting (May 2003). – Meyers, Webster, Thorncroft

7. Special Session

Talks about some recent developments in regional monsoon and related studies were presented at this special session.

US AAMWG – As the group leader, Dr. Lau outlined recent activities of the US AA Monsoon Working Group. A prospectus was developed in May 2001. The US group identified the tropical intra-seasonal oscillation (TISO) as a key physical process, in comparison with the ISO in the monsoon system. The group planned a few streams of activities including: TISO; MIPs in TISO; predictability of TISO; and new and sustained AA monsoon ocean-atmosphere observations. Dr. Lau informed the Panel of that a workshop of the TISO experiments would be held later in 2003.

Prof. Webster noted that monsoon studies had not been identified as a key research issue in some US funding schemes. He pointed out that the huge population and global warming impacts in Southeast Asia would be not only a local problem, but also one with serious consequences to the development and stability of the world and the US.

START Integrated Regional Study Monsoon Asia – Dr. Yan outlined this new regional initiative of monsoon and global change study under the umbrella of the Earth System Study Partnership (ESSP) including IGBP, WCRP, IHDP and DIVERSITAS. The issue was raised during early this year, when Dr. Carson (Director JPS for WCRP) received a request from Prof. Roland Fuchs (Director START) to have WCRP representatives involved in the development of an IRS for Monsoon Asia, and confirmed that he would welcome WCRP's involvement. The START IRS was designed as a regional approach to the multi-disciplinary study of the Earth system. It was aimed at questions such as what the region would be like in 50 years (2050) and what would be the consequences of the regional change for the Earth system. The IRS should comprise both natural and social sciences in order to provide not only new results for the Earth system study, but also science-based recommendations for policy makers. The IRS should be developed and led by scientists in the region, but collaboration with scientists from other regions would be essential. A scientific steering committee should include membership from each of the sponsoring international global change research programs (the ESSP).

The Panel welcomed a START IRS for Monsoon Asia and appreciated START's effort in linking science and sustainable development of human society. It was expected to establish a concrete link between CLIVAR/AAMP and the regional project. The Panel endorsed Dr. Yan's participation on behalf of CLIVAR in the first planning meeting for the 10-year IRS Monsoon Asia Project in Bangkok, 22-24 March 2003. Details of the meeting would be available shortly at the web site of START (global change SysTEM for Analysis Research and Training): <http://www.start.org>.

Review of the 2002 monsoons - The 2002 Asian summer monsoon was notable for the highly deficient rainfall over India, with a prolonged break in the monsoon in July. As Dr. Rupa Kumar Kolli highlighted, the all-India summer rainfall showed an anomaly of -19% and in July the rainfall amounted to an unprecedented -51%. Most of the seasonal predictions, empirical as well as dynamical, failed to foresee such an extreme deficit. Though a few models at some stages provided reasonable forecasts, there had been no indication of the record deficit in July. Dr. Kolli noted that there seemed to be no perceptible precursors for this anomalous behavior of the monsoon. For example, the Eurasian winter snow cover in 2002 was below normal, which was in fact favorable for a good monsoon. Another notable feature of the 2002 monsoon was the total lack of monsoon depressions which usually give rise to large-scale precipitation over India. It appears that the association of the monsoon with global circulation features in 2002 was beyond the range of past associations used to train the empirical models, which possibly resulted in their gross failure. However, there was strong evidence suggesting that the tropical ISO triggered enhanced convection in the Pacific, leading to adverse circulation anomalies over India. Dr. Kolli suggested that there was a need to monitor/predict the ISO over the Asia-Pacific sector and to have better understanding of its role in modulating Indian summer monsoon rainfall.

Dr. Hendon briefed the panel on Australian monsoon rainfall in 2002/2003 and its relation with ENSO, noting that there were strong ISOs in mid-May propagating to the dateline.

The Panel was very interested in the presentations for the last monsoon season. It was recommended that Dr. Kolli prepare a short paper for the CLIVAR Exchanges to summarize the case in 2002 and foci for future research. The Panel also appreciated the effort of the Indian colleagues in maintaining the web site of Monsoon on Line, which was deemed to have benefited the worldwide community of monsoon studies and applications.

Action 21: To write a letter to Dr. Kolli's Institute to express appreciation of the effort in maintaining the web of Monsoon on Line. – Slingo

Action 22: To carry messages from CLIVAR/AAMP to the START IRS Monsoon Asia meeting (Bangkok, 22-24 March 2003) and report back to the Panel for further decision on representation if appropriate - Yan

Action 23: To write a short paper for CLIVAR Exchanges upon the unusual monsoon conditions in 2002/03. - Kolli

8. Membership and Next Meeting

Some members had already indicated to the Co-Chairs their willingness to renew their membership before the meeting. The Panel discussed how to get fuller representation of the monsoon study community. The Co-Chairs would consider the issues in due time, with regard to the possible establishment of the Indian Ocean Panel.

The Panel discussed the time and venue of the next meeting, taking into account the timings of other annual meetings such as those of CLIVAR-SSG and WCRP-JPS. Before the meeting, Dr. McCreary had proposed that the next AAMP meeting be hosted by IPRC, Honolulu in February 2004 in combination with AMIP East Asian Climate Subproject and the IPRC Regional Climate Modeling Workshop. Prof. Wang also proposed to host a panel meeting in Beijing. The Panel appreciated the kind offers, but recommended that the next panel meeting be at the monsoon 'heart' in India. Drs. Kolli and Sengupta were charged to prepare a proposal and report back to the Co-Chairs about the feasibility of a meeting in India. The possibility of Beijing and Honolulu remained open, anyway.

Action 24: To consider membership changes, taking into account the possible establishment of an Indian Ocean Panel and better representation of the community of monsoon studies. - Co-Chairs

Action 25: To prepare a proposal for the next panel meeting in India, while keeping the possibility of Beijing and Honolulu open, with special consideration of the meeting dates relevant to the annual CLIVAR-SSG and JSC meetings. – Kolli, Sengupta, Co-Chairs

Appendix 1: Attendee List

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Appendix 2: Agenda

Meeting Aims:

To review progress in observing, understanding and predicting the AA monsoon system, and to identify research and infrastructure priorities for the near future;

To develop a long-term strategy for model evaluation and improvement, building on the GEWEX/CEOP initiative, and in collaboration with other CLIVAR panels, GEWEX, and the WCRP modelling working groups (WGNE, WGCM);

To discuss the observation network for the Indian Ocean and surrounding seas in the light of Mauritius IOGOOS meeting and to consider the need for an Indian Ocean Panel;

To discuss the status of CLIVAR-AAMP implementation plan and consider its future development.

Tuesday 25 Feb 2003

8:30 – 9:00

1. Introductory Remarks

Welcome and introduction of panel members and experts (Co-Chairs)

Briefing on relevant CLIVAR SSG and ICPO activities (ICPO)

Discussion of agenda led by Co-Chairs, with perceived outcome of this panel meeting.

9:00 – 10:00

2. Development of the CLIVAR AAMP Prospectus.

Co-Chairs have suggested that a detailed 'implementation' plan is very time-consuming to prepare and that the meeting reports act as a record of the current status and plans. It is not clear whom the Implementation Plan is aimed at and whether it would be widely read and used. They propose instead that an AAMP Prospectus be prepared which includes short statements on the current status of AAM science, and in which key areas for development in the next 5 years are identified. Potential items for the prospectus include:

- Describing the AA monsoon system: Processes and phenomena
- Observing the AA monsoon system: Field studies, satellite data, Indian Ocean Observing System
- Simulating the AA monsoon system: Evaluation and improvement of global and regional models
- Predicting the AA monsoon on intraseasonal to interannual timescales
- Applications of AA monsoon prediction to food, water availability and health issues

Note that the development and content of the prospectus depends on the decision regarding the formation of an Indian Ocean Panel. The panel is asked to discuss the above proposal and to agree a strategy to develop the prospectus with assistance from the ICPO.

10:00 – 10:30

Tea break

10:30 – 12:00

3. Current status of AA monsoon simulation, predictability and prediction

Formal presentations (12-15 mins for each):

Shukla: General comments on monsoon predictability and prediction

Kang: Update on the AAMP intercomparison and WGSIP SMIP2/HFP projects

Sperber: Update on WGSIP, and AMIP/CMIP MJO studies

Meehl: Briefing on coupled model simulations

Webster: Empirical intraseasonal prediction of AA monsoon rainfall

Hendon: Applications of monsoon prediction in Australia

12:00 – 12:30

The panel is asked to discuss the status of monsoon prediction and to consider priorities for future activities.

12:30 – 14:00

Lunch

14:00 – 15:00

4. A modelling strategy for AAMP.

The proposal for a pan-WCRP Workshop on Modelling Monsoon Environments, discussed at the last meeting is to be revised, with regard to the CEOP/CIMS initiative. It is proposed that a workshop be held in late 2003 with CLIVAR monsoon panels, GEWEX, WGSIP, WGCM and WGNE involved.

The AAMP will be briefed on the following (10-12 mins for each):

Lau: CIMS

Sperber: WGNE AMIP future development

Meehl: WGCM CMIP future development

Shuttleworth: GEWEX land surface and cloud modelling plans (GMPP, GLASS, GCSS with input from Polcher, Krueger)

Kang: Asian-Pacific Climate Network (APCN)

15:00 – 15:30

The panel is asked to nominate an organizing committee for the workshop and to discuss how CIMS can be evolved to provide a longer-term strategy for model evaluation and improvement which engages CLIVAR and wider WCRP interest

15:30 – 16:00

Tea break

16:00 – 17:30

Discussion and outstanding issues

End of Tuesday sessions

Wednesday 26 Feb 2003

9:00 – 10:00

5. AA Monsoon Process Studies

Updates on current and planned field experiments (10-12 mins for each):

Lau: CEOP and AAMP data needs

Webster: JASMINE II

Wu: East Asian Monsoon Experiment

Sengupta: ARMEX II

The panel is asked to note these activities with regard to AAMP data needs from field experiments such as CEOP and to provide endorsement where appropriate.

10:00 – 10:30

Tea break

Group photo

10:30 – 12:30

6. Indian Ocean Observing System and Indian Ocean Panel

The panel will be briefed on recent progress towards an integrated Indian Ocean Observing System (15 mins per presentation):

Webster: IOGOOS Mauritius meeting

Meyers: Sustained observations of climate in the Indian Ocean

Schiller: ARGO sampling experiments in the Indian Ocean

Kuroda: JAMSTEC activities, TRITON and subsurface ADCP moorings

Sengupta: Equatorial variability from the subsurface current meter moorings

Thorncroft: Brief of VACS report

The panel is asked to discuss the activities and to provide feedback. The availability of data to the research community should be considered.

12:30 – 14:00

Lunch

14:00 – 15:30

6. Indian Ocean Observing System and Indian Ocean Panel (continued)

Peter Webster and ICPO will brief the panel on the proposal to form a CLIVAR Indian Ocean Panel to further the development of the Indian Ocean Observing System

The panel is asked to make a recommendation regarding the formation of an Indian Ocean Panel and to discuss the implications for the remit of the AAMP. In addition, the CLIVAR SSG has recommended that a joint panel meeting (or a workshop) be held with VACS, with regard to the common interest in the Indian Ocean and East African Climate. The panel is asked to discuss this recommendation and to identify a lead contact who will work up a workshop proposal with VACS.

15:30 – 16:00

Tea break

16:00 – 17:30

7. Special session 1: discussions on regional activities including

Brief on US AAMWG activities (Lau: 15 mins)

Link to START Integrated Regional Study Monsoon Asia (ICPO and panel: 30 mins)

End of Wednesday sessions

Thursday 27 Feb 2003

9:00 – 10:30

7. Special Session 2: on the 2002 Asian Summer Monsoon and the outlook for the 2002/03 Austral Monsoon

The 2002 Asian Summer Monsoon was notable for the highly deficient rainfall over India, a prolonged break in the monsoon in July and the developing El Nino in the Pacific. Rupa Kumar Kolli will lead a discussion of the 2002/03 monsoon season, how it developed and whether it was predicted, with contributions from panel members / experts from

Australia (Hendon)

China (Wang)

Korea (Kang)

Indonesia (Sribimawati)

Japan (Kuroda)

Contributions from others are welcome

10:30 – 11:00

Tea break

11:00 – 12:00

8. Future Meetings and AOB

Action items review

Jay McCreary has proposed that the next AAMP meeting be hosted by IPRC, Honolulu in February 2004 in combination with AMIP East Asian Climate Subproject and the IPRC Regional Climate Modelling Workshop. The panel is asked to consider this proposal and to recommend the venue and timing for the next AAMP meeting.