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5th Session of the CLIVAR VAMOS Panel

San José, Costa Rica, March 13-16, 2002

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Executive Summary

The Fifth Annual Meeting of the WCRP/CLIVAR VAMOS panel (VPM5) convened at the Centre for Geophysical Research of the University of Costa Rica, in San José, Costa Rica, March 13-16, 2002. Approximately sixty participants received a warm welcome from the Minister of Science the Technology of Costa Rica, representatives of the University and National Meteorological Service of Costa Rica, representative of WMO in Costa Rica, CLIVAR SSG and VAMOS chairs, representative of CLIVAR International Project Office (ICPO) in VAMOS, and the principal local organiser.

After a review of CLIVAR and VAMOS activities, the meeting started with a report on the VAMOS Conference on the South American Low Level Jet, held in Santa Cruz, Bolivia, February 5-7, 2002 (see Appendix 3). The event attracted more than 60 scientists from all countries in the SALLJ region (Bolivia, Argentina, Uruguay, Brazil, and Paraguay), as well as scientists from U.S.A. and Chile. Next there was a report on the progress achieved in US CLIVAR and the Eastern Pacific Investigation of Climate (EPIC). The framework for US CLIVAR process studies in the Pan American region is EPIC (also a VAMOS programme), and the VAMOS North American Monsoon Experiment (NAME) and South American Monsoon Experiment (MESA). EPIC has completed a very successful field phase in the eastern Pacific (EPIC 2001). A report on the VAMOS Data Base described ongoing data collection and archival activities for support of VAMOS programmes. A VAMOS Project office has been established to support the different field campaigns to be developed under the programme.

VPM5 featured two major VAMOS programmes: NAME and the VAMOS Eastern Pacific Investigation of Climate (VEPIC). The chairs of the corresponding science working groups (SWGs) reported on recent progress of their programmes. NAME's objectives are to promote a better understanding and more realistic simulation of the North American monsoon evolution and variability, the response of the warm season circulation and precipitation patterns over North America to slowly varying boundary conditions (e.g. SST, soil moisture), and intraseasonal variability of the monsoon. VEPIC strives to a better understanding and simulation of how eastern Pacific cloud systems interact with the coupled atmosphere-ocean-land system on diurnal to interannual time scales. As for all CLIVAR/VAMOS programs, the goal is to improve predictions of climate variability over the Americas. Thereafter the VPM5 branched out into two activities: 1) NAME Workshop, and 2) meeting of the VEPIC SWG meeting.

The NAME Workshop was organised into seven sessions dealing with international partnerships, field campaign, modelling and diagnostic studies, links with other programs, human dimensions, and education and training. The workshop provided an excellent opportunity to accelerate the plans for a NAME field Campaign in 2004, and to establish international partnerships. The Workshop also contributed to the definition of research topics in the area of modelling and diagnostics.

The VEPIC SWG meeting reviewed recent progress on the better understanding and modelling of the Eastern Pacific climate. The group identified topics of research in reference to stratocumulus decks and their variability in a broad range of time scales Strategies for research on these topics were suggested, including model evaluation, sensitivity and improvement, as well as enhancement of relevant datasets.

The VAMOS panel met after the NAME Workshop and VEPIC SWG meeting. The panel reviewed the status of all VAMOS programmes and expressed a number of opinions.

- C. Vera and organisers of the VAMOS/SALLJ Conference in Santa Cruz, Bolivia, were congratulated for their successful work.
- PLATIN plans to develop a research programme on the modelling of the hydroclimatology of the Plata basin were endorsed.
- NAME was praised as a model of international partnership. A sharper definition of NAMAP was recommended.
- The accomplishments of EPIC 2001 were acknowledged and the desirability of extended funding to allow for a through analysis of data gathered was emphasised.
- The VEPIC workshop greatly helped to define the scientific objectives of a program that follows EPIC in the eastern tropical Pacific. The VEPIC SWG should continue with its efforts on implementation plan in coordination with other CLIVAR programmes in the Pacific.
- The appropriateness of a SALLJ focus on moisture transports and tropical-extratropical connections was supported.
- Actions to increase participation in VAMOS of European scientists and funding sources were encouraged.
- The links with CLIVAR programmes for the other major monsoons and the oceans adjacent to the American continent were confirmed as the highest priority for VAMOS.
- The participation of VAMOS in a CLIVAR workshop on monsoon modelling was endorsed.
- The support of VAMOS to a CLIVAR initiative on a programme for the South Atlantic climate was confirmed.
- VPM6 will feature VEPIC and will be held in Perú or Ecuador.

C. Roberto Mechoso
VAMOS Panel Chair

1. Introduction

The Centre for Geophysical Research (CIGEFI) of the University of Costa Rica, in San José, Costa Rica, provided a stimulating environment for the Fifth Annual Meeting of the WCRP/CLIVAR VAMOS panel (VPM5).

Professor Jorge Amador (U. Costa Rica) and principal local organiser, welcomed more than 70 participants from various countries. The panel for the opening ceremony included Dr. Guy de Taeramond, Minister of Science and Technology of Costa Rica, Dr. Yamileth Gonzalez, Vice-Rector of Research representing the Rector of the University of Costa Rica, Dr. Eladio Zarate, Director, Instituto Meteorologico Nacional of Costa Rica and Representative of Costa Rica to WMO, and Dr. Oscar Arango, Director, WMO Subregional Office in San José, Costa Rica. Professor Tony Busalacchi, co-Chair, Scientific Steering Group, and Professor C. Roberto Mechoso, Chair, VAMOS panel, represented CLIVAR. Professor Carlos Ereño represented the International CLIVAR Project Office.

After a brief report on the progress of CLIVAR during the last year by Professor Ereño with special emphasis on VAMOS related items, Professor Mechoso described the objectives and goals of the VAMOS programme. He stated that VAMOS has completed a science study phase and selected its first targets for research, and is now entering an implementation phase. This phase is organised as two internationally coordinated efforts: Monsoon Experiment South America (MESA) and North American Monsoon Experiment (NAME). MESA and NAME both target important aspects of climate research within the Americas and the adjacent oceans.

Dr. Gonzalez, on behalf of the Rector of the University of Costa Rica, emphasised the importance of climate research and its benefits to the countries economies. She expressed the University’s great pleasure in hosting a VAMOS meeting, and welcomed the large group of visiting scientists from varied institutions.

Dr. Taeramond, Minister of Science and Technology, gave a presentation on the Project for Establishing an Advanced Internet Network. The project is aimed at providing Costa Rica with state-of-the-art technology tools by allowing generalised access to communication and information networks. Dr. Taeramond indicated that Costa Rica is ideally suited for providing a node for communication between Central American countries, the Caribbean and other networks throughout the world.

2. Scientific presentations

2.1 CLIVAR Activities

Professor Busalacchi (U. Maryland) provided an overview of the CLIVAR Programme and its goals. He emphasised the added value of international programmes to national research, as they:

- Provide a framework for identifying gaps in the program and priority setting through an internationally agreed upon agenda
- Provide framework efficient, effective, and coordinated allocation of resources
- Stimulate scientific networking
- Develop common methodologies and experimental protocols

- Organize model experiments, data collection and standardization
- Synthesize and integrate national research project results

He described the progress of the different CLIVAR panels, in particular the basin panels. CLIVAR has formed a panel for the Atlantic and is about to form oversight panels for the Southern Ocean and for the Pacific. The Indian Ocean sector is covered in CLIVAR by the Asian-Australian Monsoon panel and by the CLIVAR Panel on Variability of the Africa Climate System (VACS). The CLIVAR Upper Ocean Panel will become the CLIVAR Ocean Observations Panel (COOP). The new Panel will be charged to oversee implementation of sustained and near-sustained ocean observations in support of CLIVAR research. This would include oversight, for research purposes, of the ENSO observing system, for example. Increased emphasis will be placed on ocean assimilation and surface fluxes. The TAO Implementation Panel (TIP) will become a technical advisory committee concerned solely with the logistical and technical aspects of implementation of mooring arrays in all three tropical ocean basins.

Professor Busalacchi also presented a summary of the 21st meeting of the Joint Scientific Committee (JSC) for WCRP, which was held in Boulder, CO, March 19-21, 2001. The progress report on the WCRP was well received by the fifty-second Session of the WMO Executive Council (Geneva, May 2000). In particular the Council was encouraged by the steps taken towards implementation of a number of specific regional CLIVAR activities, namely: VAMOS, the Asian-Australian monsoon system, and, African climate variability. Bearing in mind the considerable potential socio-economic benefits of progress in those activities, the Council urged all Members in the Regions concerned to participate to the limit of available resources. Other specific supportive comments included: the importance of PIRATA in CLIVAR studies.

The El Niño Outlook produced by WMO in collaboration with the International Research Institute for Climate Prediction (IRI), February 2002, was discussed:

- Warm water was developing at the surface in the eastern Equatorial Pacific
- Unusually warm waters over a large area were present near the dateline and were influencing tropical convection
- Different computer models vary on whether the situation will develop further into what is commonly referred to as an El Niño event
- The potential for the onset of El Niño events in the past has generally been cleared towards the end of the first quarter of the year.

The presentation finished with a summary of highlights and issues for the JSC.

2.2 VAMOS Chair Report

Professor Mechoso (U. California Los Angeles) reviewed the goals and strategy of the VAMOS programme and presented the VAMOS Implementation Plan. A overview of the current status of VAMOS can be found in Appendix 3.

The VAMOS Implementation Plan is based on three internationally coordinated efforts:

- Investigation of American Monsoon Systems: North American Monsoon Experiment (NAME), Monsoon Experiment South America (MESA), VAMOS Eastern Pacific Investigation of Climate (VEPIC)

- Development of the VAMOS database and research programs on the Tropical Cyclones and Bolivian Altiplano.
- Establishment of long-term climate monitoring capability spanning the monsoon regions in the Americas and the tropical Pacific and Atlantic.

The South American Low-Level Jet (SALLJ) program, a component of MESA, will have a field campaign in December 2002-February 2003. NAME is developing actively, and some of its subprojects have already started. There are several activities leading to the establishment of a research programme on the climatology and hydrology of the Plata Basin in South America (MESA/PLATIN). VAMOS will contribute to CEOP (Co-ordinated Enhanced Observing Period). CEOP is a GEWEX element that aims to provide a unique hydroclimatological dataset combining information from *in situ* stations, special and operational satellites, and model output that focuses on two annual cycles (2003-2004). CEOP will have a major Data Management activity and two science objectives: 1) water and energy cycle simulation and prediction, and 2) monsoon system studies.

Professor Mechoso finished his presentation with the reminder that the VAMOS panel requires that its component projects actively seek to create a legacy including a project data base, education and training for regional scientists, observational systems that may have been proven to be of value for improved climate and hydrological prediction, implemented upgrades to the operational systems used by interested stakeholders and published records of progress that reflect the international framework of the project.

2.3 VAMOS/CLIVAR/WCRP Conference on the South American Low Level Jet (SALLJ)

Professor Carolina Vera (U. Buenos Aires) presented a report on the VAMOS Conference on the South American Low Level Jet, which was held in Santa Cruz, Bolivia from February 5-7, 2002 (see Appendix 3). More than 60 scientists from countries in the SALLJ region (Bolivia, Argentina, Uruguay, Brazil, and Paraguay) as well as scientists from U.S.A and Chile attended the meeting. The Conference had several specific objectives:

1. To review the current scientific knowledge about the SALLJ
2. To bring together researchers interested in the SALLJ and related aspects of SAMS
3. To stimulate discussion on the current knowledge of the SALLJ and its role in moisture and energy exchange between tropics and extratropics, and related aspects of regional hydrology, climate and climate variability
4. To promote the integration of scientists, especially in the countries of South America along the SALLJ, and consider the need for any other internationally coordinated initiative

A list of extended abstracts of the papers presented at the Conference can be found at http://www-cima.at.fcen.uba.ar/sallj/sallj_conf_extabs.html

The publication of a SALLJ Conference volume is tentatively planned for the second semester of 2002 and it will be announced at CLIVAR web site.

SALLJEX will involve a great part of South America, including, partially or completely, the following countries: Argentina, Bolivia, Brazil, Chile, Paraguay, Peru, and Uruguay. Further information on this experiment can be found at the following web sites:

American Low Level Jets (ALLS) implementation plan:
http://www.met.utah.edu/jnpaegle/research/ALLS.html

Exchanges special issue featuring VAMOS:
http://www.clivar.org/publications/exchanges/ex16/exchv5n2p1.htm

2.4 US-CLIVAR and the Eastern Pacific Investigation of Climate Program (EPIC)

Professor Steven Esbensen (Oregon State U.) reviewed progress achieved in US CLIVAR and the Eastern Pacific Investigation of Climate (EPIC) programme.

The US CLIVAR Scientific Steering Committee (SSC) will be considering process study plans for the Pacific, Pan American and Atlantic regions at its 16-18 July 2002 meeting in Boulder, Colorado. Each of the US CLIVAR regional implementation panels, including the Pan American Panel, was asked to present a prioritized list of process studies with timelines and costs. The SSC will evaluate the proposed activities on the basis of the short and long-term goals of US CLIVAR, readiness and overall financial constraints. The SSC will then present the overall process study priorities of the US CLIVAR science community to the interagency group of US funding agencies interested in CLIVAR.

The Pan American Panel will continue to collaborate with the VAMOS Panel in preparing a process study timeline for the US CLIVAR SSC meeting in July.

The framework for US CLIVAR process studies in the Pan American region is EPIC, NAME and MESA.

In September and October 2001, investigators from the United States, México and Ecuador carried out the field phase of EPIC 2001 in the eastern Pacific. The objectives of EPIC 2001 were to understand and improve simulation of coupled ocean-atmosphere process in the eastern Pacific cold-tongue / ITCZ complex and to explore stratocumulus cloud properties in the south-eastern Pacific.

EPIC investigators carried out over 30 missions with the NCAR C130 and NOAA P3 aircraft, 4 weeks of observations by research vessels Ron Brown and New Horizon, augmented TAO mooring observations, and enhanced Galapagos upper air observations. EPIC 2001 investigators scheduled a meeting in Seattle on 25-26 March to discuss preliminary results and data quality issues, and to begin the synthesis of data sets with models. Highlights of preliminary results to date include the documentation of a surprisingly large diurnal cycle, the stratocumulus top heights and cloud properties in the south-eastern Pacific. This suggests strong remote mechanical forcing of the stratocumulus cloud decks, possibly from atmospheric heating over South America. The successful EPIC 2001 stratocumulus pilot cruise is already playing an important role in the planning of the VEPIC process study.

US CLIVAR is developing the concept of Climate Process Modelling and Sciences Teams (CPTs) to encourage interactions between observation-oriented scientists, process modellers and developers of climate models. Each team would make a long-term commitment to focus on a key problem such as parameterization of stratocumulus clouds in the atmosphere, or diapycnal mixing in the ocean. The funding agencies would commit to long-term funding of team activities. The team would be expected to deliver such things as documented observations from field programs, demonstrate improvements in parameterizations, plans for field programs and observing requirements. It is expected that CPTs will accelerate progress in improving coupled climate model components.

2.5 VAMOS Data Base

Drs. José Meitín and Steve Williams (NOAA National Severe Storms Laboratory, NSSL, and UCAR Joint Office for Science Support, JOSS) described the current status of the VAMOS Database and data management activities within the CLIVAR Data Task Team. The presentation included a description of the ongoing data collection and archival activities at UCAR JOSS and NOAA NSSL in support of the Pan American Climate Studies (PACS) programme over the past year.

The VAMOS Data Information Server (DIS) is located at UCAR (http://www.joss.ucar.edu/vamos/) with a "mirrored" server, for the southern hemisphere, located at IAI (http://www.iai.int/vamos/). These DIS contain links to data sets of interest and to various related VAMOS programmes. JOSS has been supporting VAMOS-related field projects and workshops in the areas of scientific planning, data management, and logistics. A recent example was EPIC, where JOSS provided support (http://www.joss.ucar.edu/epic/) in all these areas including the development and maintenance of an on-line field catalog. Such a catalog contained operational daily summaries, status and aircraft mission reports, preliminary data products, and other supporting information to assist in operational decisions and document the project activities. Other VAMOS supporting data activities currently underway at JOSS include automated ingest and archival of hourly GOES satellite imagery/data (including 1-km visible sectors) in regions of interest for the upcoming VEPIC, SALLJ, PLATIN projects. JOSS is also coordinating data management support for the PACS (http://www.joss.ucar.edu/pacs/) and GAPP (http://www.joss.ucar.edu/gapp/) projects; under the auspices of CLIVAR and GEWEX programs. A NAME WWW "home" page has recently been added at: http://www.joss.ucar.edu/name/ which contains links to project activities (i.e. meetings and workshops), documentation, background data, and other relevant sites and related projects.

JOSS provides field project data management services in the areas of: data questionnaires, data management plans, real-time operations and data ingest, field catalog data, quality control and data set development, interactive data archive and distribution, and development and publishing of special media products (i.e. CD ROMs). An example of a questionnaire was an on-line model intercomparison questionnaire prepared and distributed for the NAMAP initiative (see subsection 4.4.4). VAMOS data sets are archived using a distributed architecture; those data sets at JOSS are archived and distributed using the JOSS interactive Data Management System (CODIAC). CODIAC provides the means to identify data sets of interest, facilities to view data and associated metadata, and the ability to automatically obtain data via internet file transfer or magnetic media. Nearly 300 GB of on-line data have been distributed via CODIAC since 1995.

JOSS staff will continue to work with VAMOS scientists in the coordination of future data management activities.

2.6 VAMOS Investigation of the Eastern Pacific Climate (VEPIC)

Professor Chris Bretherton (U. Washington) reviewed the motivation, goals, and current status of the VEPIC project. VEPIC-related research has made progress on several fronts since The Fourth Annual Meeting of the VAMOS Panel (VPM4), Montevideo, 2001. Two very successful field projects were carried out. DYCOMS-II (July 2001) took airborne measurements to study entrainment, aerosol processing, and drizzle processes in nocturnal stratocumulus-capped mixed layers in the NE Pacific. EPIC 2001 (October 2001) included a two-week exploratory cruise under the Southeastern Pacific stratocumulus regime using radar and lidar based remote sensing, soundings, and in-situ flux measurements. A deep, surprisingly well-mixed boundary layer was found, with substantial early morning drizzle. A pronounced regular diurnal cycle of inversion height and cloud thickness seems to be due to large diurnal variations in the subsidence rate, perhaps driven by heating over South America. Upcoming field experiments are being planned to study coastally trapped waves in the atmosphere and ocean west of Chile (2003), and to look at shallow trade cumulus cloud regimes near Puerto Rico (2004).

In addition, there has been progress on parameterizing the East Pacific stratocumulus regimes. Realistic cloud distributions have now been obtained from a mesoscale model using a coupled shallow convection scheme and entraining moist convective turbulence parameterization, and from general circulation model (GCM) simulations in which the PBL is treated as a separate model layer. GCM simulations have also been used to demonstrate the sensitivity of the global Hadley circulation to the radiative effects of eastern Pacific stratocumulus clouds. Mesoscale models have also shown good skill at representing coastally trapped waves in the marine boundary layer along the Chilean coast associated with the passage of synoptic disturbances.

The VEPIC scientific plan will focus on promoting additional measurements on NOAA research ships and selected enhancements at coastal locations, offshore at San Felix Island, combined with international sharing of ongoing data (e.g. from buoys, coastal soundings) and scientific findings, and synthesis of satellite data.

2.7 North American Monsoon Experiment (NAME)

Dr. Wayne Higgins (Climate Prediction Center - NCEP/NWS/NOAA) introduced NAME as an internationally coordinated, joint CLIVAR-GEWEX process study aimed at determining the sources and limits of predictability of warm season precipitation over North America. It hypothesizes that the NAMS provides a physical basis for determining the degree of predictability of warm season precipitation over the region. NAME's objectives are to promote a better understanding and more realistic simulation of monsoon evolution and variability, the response of the warm season circulation and precipitation patterns to slowly varying boundary conditions (e.g. SST, soil moisture), the diurnal heating cycle and its relation to the seasonally varying mean climate, and intraseasonal variability of the monsoon. NAME employs a multi-scale (tiered) approach with focused monitoring, diagnostic and modeling activities in the core monsoon region, on the regional-scale and on the continental-scale. The NAME programme has strong links between the VAMOS element of International CLIVAR, US CLIVAR Pan American research, and the GEWEX America Prediction Project (GAPP). A field campaign is planned for the summer of 2004. An online version of the

NAME Science and Implementation Plan is available at:

http://www.cpc.ncep.noaa.gov/products/precip/monsoon/NAME.html.

2.8 Project Office for VAMOS Programmes

Dr. Gus E Emmanuel (UCAR/JOSS) presented the VAMOS Project Office. This will support the different field programs to be developed under VAMOS, starting with the planning and field implementation of NAME and SALLJ. In order to implement the field phase of a particular research programme, the VAMOS Project Office must put in place a rather expansive and diverse network of research systems and platforms; it must also put in place a communications network that meets the data gathering requirements, internet accessibility, meet product delivery, etc.

The VAMOS Project Office will initially support both the NAME and SALLJ Science Working Groups (SWG) with the planning and field implementation of their experiments and also by coordinating, managing, and implementing all activities such as meetings, workshops, outreach programs, training, etc. The Project Office will address all facets of data management, including data collection, validation, quality control, and archiving, i.e. it will support the efforts of the SWG Data Management Sub-Group. The Office will be responsible for all operational aspects of the experiments under the guidance of the corresponding SWGs and of the Program Manager(s) of funding agencies. Among the functions of the Office are the establishing of International Project Support Teams, and the preparation of "Field Operation Plans".

Dr. Emmanuel finished his presentation by emphasizing that the SWGs of the different experiments have the responsibility to ensure that all project scientific objectives are met during the field phase of the corresponding projects.

3. Review of Climate Research in Costa Rica

Dr. Jorge A. Amador (U. Costa Rica) convened the special session dedicated to presentations by researchers of the host country. He gave a description of selected aspects of the regional climate in Costa Rica. Next, the Dr. Eladio Zárate (Instituto Meteorológica Nacional, Costa Rica, IMN), described the activities related to climate research that are carried out at the Institute of which he is Director. The following presentation was made by Dr. Jorge Gutierrez, who described the modelling activities at the University of Costa Rica. Next, Dr. Eric Alfaro talked about applications of multivariate statistical methods to research in Central America. Dr. Walter Fernández presented the education and training plans of the University of Costa Rica. Dr. Edwin Campos (Instituto Oceanografico) concluded the session with a talk on measurements of raindrop size distribution in Costa Rica.

The VPM5 participants were very impressed by the high level of climate research in Costa Rica. Appendix 3 gives summaries of the presentations.

4. NAME Workshop

NAME held a very successful workshop in the framework of VPM5. Considerable progress was made on the planning of 2004 field campaign, modeling and diagnostic studies, and international partnerships. A summary of each session from the NAME Workshop follows. NAME Science and Implementation Plan, which is available on the web at: http://www.cpc.ncep.noaa.gov/products/precip/monsoon/NAME.html

Session 1. Name International Partnerships (*Chair: C. Vera*)

4.1.1. Servicio Meteorologico Nacional (SMN), Mexico, participation in NAME (*M. Cortez , Servicio Meteorológico Nacional, México*)

The SMN plans for the next three years are centred on the following activities:

1. Digitise historical data from traditional climatological stations (daily and monthly), as well as hourly data from the synoptic stations (2002-03). Maintenance and calibration (as needed) of the meteorological observation networks (2002-03). Calibration of the radars (2002-03). Modernization of data acquisition systems and data management.
2. Increase the number of the climatological automatic stations (15 during 2002).
3. Maintenance of the upper-air sounding network. Operate twice daily observations May-Oct at eight sites (2002). Unify operation time to once-daily (1200Z) at all stations.

The SMN has several expectations for NAME:

1. To exchange climatologícal data and products.
2. Common products for the North American Sector (e.g. drought monitoring).
3. Support for radar calibration.
4. Opportunities for education and personnel training.
5. A better understanding of the dynamics of summer precipitation over the North American sector and its interannual variability.
6. More accurate climate predictions from coupled models.

4.1.2. IMTA participation in NAME; promotion of NAME within Mexico (*R. Lobato, IMTA*)

The principal function of the Hydrometeorological Group at the Instituto Mexicanó de Tecnología del Agua (IMTA) is to assist the SMN, Mexico.

1. Due to a recent change in regulations, all IMTA research projects must be funded in some way. Therefore, whatever involvement IMTA has on the NAME project, it must be officially acknowledged.
2. NAME was presented to the scientific community of Mexico in several meetings: Mexican Geophysical Union in early November of 2001 (researchers from UNAM); Mexican Congress of Meteorology in late November (students and Marine and Ministry of Transport and Communications); University of Veracruz; new Coordinator of the Mexican Weather Service.

4.1.3. CICESE participation in NAME (*T. Cavazos, CICESE*)

The Centro de Investigación Científica y de Educación Superior (CICESE) has a strong group working on oceanographic and atmospheric aspects of climate over Mexico and surrounding oceans. The presentation showed that the mature phase of the monsoon is associated with two distinct intraseasonal (>10 days) wet monsoon modes. The signature of the wettest monsoon mode is a zonal three-cell mid-tropospheric height anomaly pattern over the North Pacific-North American sector, suggesting a large-scale dynamical mechanism, possibly linked to SST anomalies in the North Pacific. This zonal mode, which is most common in July and August, is characterized by an enhanced and north-eastward-displaced monsoon ridge, large amounts of mid-tropospheric moisture over the study area, and an out of phase relationship between precipitation in the Southwest United States and precipitation in the Great Plains of the United States. The zonal mode has been recognized in longer data sets and it is the most typical mode that characterizes the mature phase of the monsoon in the Southwest United States. On the regional scale, the zonal wet mode is also characterized by a latitudinal gradient of SST anomalies between Baja California and southern Mexico and reversed low-level flow over the Gulf of California. An examination of the extreme wet monsoons outside of the study period (e.g., 1955, 1959, 1999) indicated no consistent SST pattern along the Pacific coast of Baja California. These results indicate that interactions between local and remote forcing mechanisms over the study area are likely to be complex during extreme events.

4.1.4. University of Guadalajara participation in NAME (*A. Meulenert Peña, U. Guadalajara*)

1 The Institute of Astronomy and Meteorology (IAM) of the University of Guadalajara is a Center for research and teaching in the atmospheric sciences, ocean, sciences, astronomy, and astrophysics.

2 The researchers in IAM's Meteorology group carry out several projects:
   a. Study of the formation and evolution of tropical cyclones in the Eastern Pacific.
   b. Study of the impact of El Niño and La Niña in the state of Jalisco.
   c. Climatology of the state of Jalisco.
   d. Study of the impact of drought in the state of Jalisco.
   e. Study of the contamination of the Metropolitan Zone of Guadalajara.
   f. Study of Lake Chapala.

3 The IAM has a suitable infrastructure and in some areas, such as the Fluid Dynamics Laboratory a high-level of technology. IAM has modern sounding equipment for temperature and ocean currents, in real time, to different depths; as well as a number of portable automatic weather stations and geopositioning equipment.

4 The IAM has a database of digitised meteorological data for the city of Guadalajara from the year 1881 until the present.

5 Projects that could be carried out by IAM during NAME:
   a. Role of the monsoon flow in the formation and evolution of tropical cyclones in the Eastern Pacific.
   b. Experimental modelling of the oceanic circulation during the monsoon flow in the Eastern Pacific.
   c. Interaction of the Americam Monsoon with the rainfall regime of west - central Mexico
   d. Active participation in the collection and processing of information for the NAME experiment.

6. All the equipment, databases, means of transportation and specialized personnel of the IAM will be available to the NAME experiment.

4.1.5. Central America collaborative interests (*J. Amador, U. Costa Rica*)

1. During the last few years, some private and public organizations have been promoting scientific and technical collaboration to improve the understanding of the physical causes of natural disasters in Central America.
2. This important contribution to supporting collaboration between national institutions in Central America in different aspects related to climate, among other disciplines, has lead to the development and strengthening of research groups interested in both the scientific and the human dimension components of the problem.
3. Camilo Acosta presented CRUSA, a Costa Rica-USA, private, independent, non-profit, Foundation for Cooperation that is dedicated to achieving the sustainable development of Costa Rica. As a bilateral organization, CRUSA supports projects that provide technical cooperation, facilitate technology transfer, and build human potential. The discussion provided useful information on likely future interactions among some participating institutions such as the University of Costa Rica (CIGEFI), the National University (School of Chemistry) and the National Meteorological Institute.
4. Potential USA partners for collaboration were identified and some ideas about the preparation of a joint proposal about modelling activities and atmospheric pollution in Costa Rica were discussed.

4.1.6. Historical data archives in Mexico (*A. Douglas, Creighton, U.*)

1. An important aspect of the NAME ramp up strategy is the establishment of climatologies for the region. Specifically, the mean general circulation of Tier 2 needs to be defined and the diurnal cycle in Tier 1 needs to be addressed in fine detail.
2. Synoptic 3 hourly observations for 77 Mexican observatories have been collected and placed on CD by the Servicio Meteorológico Nacional (SMN) (data coverage 1973-present). Variables include: temperature, dew point, rainfall, pressure, wind speed and direction, and observed weather parameters (e.g. thunderstorm, fog, hail, frost).
3. A second CD of great interest to NAME has been created by the SMN, which contains daily raob data for Mexico, 1948-present. These two CDs can form an important data set for developing regional climatologies for Tier 1 and 2. Both CDs can be obtained from the SMN in Tacubaya, Mexico.
4. In the past year NCEP and Mexico began daily data exchanges of 24hr rainfall totals for approximately 1000 stations in Mexico. This operational data set is supported by an archive that extends back to 1989 for approximately 600 of these stations. Art Douglas collected a long-term set of 24 hour rainfall data for 300+ stations to serve as the long-term climatology for the operational data grid. This station data set has been transformed to a 1x1 grid system. These data sets have been sent to JOSS for NAME and PACS researchers to access.
5. IMTA, the Mexican research agency, has developed two other CDs, which are of interest to NAME. The first CD, named ERIC II: all available climate data from approximately 5,500 stations in Mexico only from 1961-1998, with large data gaps from 1986-present. A second CD created at IMTA but available through the SMN contains long term data sets of 322 stations includes temperature (maximum and minimum), 24 hour total

precipitation (reported at 8:00LST), pan evaporation data, and observed weather in the past 24hrs. Art Douglas also developed a long term data set of monthly precipitation for 128 equally spaced stations in mainland Mexico from the mid 1920s-1998 with less than 1% of the data missing. A series of monthly rainfall maps for 1924-1998 have been constructed from the data set and this map series has been updated through 2001 using the operational rainfall grid.

6. Gloria Herrera of the SMN has indicated that the SMN office in Tacubaya could become a hub for data handling during NAME. Specifically, the SMN would maintain an archive of standard hourly observatory reports from the observatory system and the 3 hourly synoptic reports from these observatories. The SMN computer would also become a depository site for the Mexican raob data.
7. It must be stressed that the hourly observatory data frequently does not enter the GTS system due to data delays in regional collection centres in Mexico. Likewise, the raob data frequently does not enter the GTS due to delays in QC analysis in Tacubaya. Consequently, an SMN data hub for accessing these data sets would be valuable to enhancing the NAME related observation network in Tier 1 and Tier 2.
8. An analysis of the 128 station grid (1928-1998) indicates that the summer monsoon shows considerable spatial and temporal variability that may be difficult to anticipate for the NAME experiment in 2004. Monsoon variability is greatest east of the Tier 1 region and there is reason to believe that this variability is related to variability in moisture transport from the Gulf of Mexico. The historical data set implies the need for *in situ* data enhancement east of the Sierra Madre Occidental in Chihuahua and Durango. Gulf of California SSTs (mouth of the Gulf) seems to be positively related with June rainfall in Tier 1 while they seem to be negatively correlated with regional precipitation in eastern and southern Mexico in July and August. This critical teleconnection should be emphasised in future promotions of the NAME campaign in Mexico.

SESSION 2. NAME FIELD CAMPAIGN (*Chair: M. Silva Dias, U. Sao Paulo*)

4.2.1. NAME ramp-up strategy (*M. Douglas, NOAA SSL*)

This talk outlined some basic aspects of ramping up to the NAME field phase in 2004. Main points were that science questions need to drive observing system design, and not enough thought has been yet put into network justification.

Several needs were identified:

1. Evaluate status of current network. How does this extrapolate to the future?
2. Different observing strategies: “gap-filling”, specific phenomena networks, logistical restrictions…
3. Educational needs mentioned – need for involving Mexican Weather Service in
4. substantial manner.
5. Translation of NAME web site into Spanish.

4.2.2. Precipitation network design and estimation of retrospective precipitation (*D. Lettenmaier, U. Washington*)

This presentation gave some general considerations in precipitation gage network design, and in the production of gridded precipitation fields from retrospective gauge observations. The NAME domain is a region in which the historic and existing rain gauge networks are extremely sparse by comparison with, for instance, the continental U.S. A major issue that NAME is facing is how best to augment the existing precipitation gauge network in such a way as to obtain maximum additional information over the term of the experiment. There are, however, auxiliary concerns, and opportunities, associated with the long-term implications of supplementation of the rain gauge network. For comparison purposes, the historical precipitation network (recording and non-recording) within the NAME network has a gauge network density that is about 1/10 that of the continental U.S. climatology network. It seems likely that the ratio is roughly the same for the reporting (e.g., via the GTS) network.

In any network design problem, the first, and most important, issue that must be addressed is to determine the objective of the network. Inevitably, precipitation networks must address multiple objectives, a consideration that complicates design decisions. Among the possible objectives are:

1. estimate storm time-space evolution (difficult from station data);
2. estimate storm depth-area-duration; and/or spatial structure of storm depth;
3. estimate rainfall accumulation spatial structure;
4. estimate spatial structure of mean rainfall;
5. estimation of other rainfall characteristics (e.g., diurnal variability).

When one considers the space-time structure of precipitation events, it is immediately apparent, aside from very high density networks over small (order of a few km^2) areas, that it is not possible to provide estimates of space-time storm evolution from gauge networks– this is a problem more appropriate to (and perhaps only addressable by) radar. The type of objectives that precipitation gauge networks are best able to meet have to do with estimation of precipitation characteristics that vary slowly in space, and that allow observation over time at a (relatively) small number of fixed locations to substitute for spatial density. Therefore, for instance, storm depth-duration statistics can be extracted from long-term gauge records (although storm area information is dependent on gauge network density). Likewise, gauge networks are well suited to providing information about regional variations in the diurnal frequency of occurrence of precipitation. The proposed NAME supplemental recording gauge network will utilize transects of recording gauges, and should provide valuable information about variations in the diurnal cycle of precipitation regionally, and with elevation. Gauge networks are also well suited to providing information about precipitation climatologies, which usually vary relatively slowly in space, at least in areas with low topographic relief.

Among the key considerations in rain gage network design are:

1. Station location
2. Recording (e.g. sub daily) vs. non-recording
3. Relocation strategies
4. Gage measurement error characteristics

Generally, station location in a network supplementation context comes down to "filling in the holes" – depending of course on specific objectives of the network, and the general under-representation of high elevation areas in topographically complex regions. Tradeoffs between recording vs. non-recording gauges (data from the latter are often transmitted by "low tech" methods such as the monthly summary sheets used by the U.S. cooperative observer network) may offer the opportunity to increase network density substantially at very low cost. As a point of reference, the climatological precipitation network in Mexico north of latitude 25 N is about 1/10 that of the cooperative observer network in the U.S. Relocation strategies for high cost equipment (e.g., automated mesonet stations) are not often employed, but may be considered in the context of multi-year observation programs.

Precipitation gauge measurement errors are perhaps not given enough attention. Generally, a good quality precipitation gauge in an unexposed location should be expected to have long-term errors (e.g., in seasonal accumulations) less than about 10 percent for liquid precipitation (errors are generally much larger, and strongly dependent on specifics of the gauges, for solid precipitation). However, recent work by M. Steiner and S.J. Burges at the Goodwin Creek USDA experimental watershed in Mississippi comparing various rain gauges with buried installations indicates that errors can be considerable, and many gauges, especially those with moving parts, can yield large errors especially on a storm-by-storm basis. The message from their work seems to be that a) recording gauges should always be accompanied by non-recording precipitation accumulation measurements; and b) where possible, gauge replication (multiple gauges at the same location) is desirable. The latter is generally feasible when non-recording gauges are used.

Gridded precipitation fields are of interest for water balance studies, large scale hydrological modelling, evaluation of coupled land-atmosphere models, and more recently, for data assimilation. Although there is the hope that eventually precipitation radars may provide the primary data source for gridded precipitation data sets estimation of climate quality gridded precipitation over large areas from precipitation radars remains a research problem. Data sets like the Higgins data set for the continental U.S. and Mexico, and the retrospective LDAS (Land Data Assimilation System) gridded data set over the same domain are based on gage data. The main problem that complicates gridding of gage precipitation is mismatch between the desired spatial resolution of the gridded product and the mean distance between gauges. Typically, the desired spatial resolution of gridded precipitation fields is similar to that of regional coupled models, which now is approaching 10 km. Even in the continental U.S. the average station separation distance for cooperative observer stations exceeds 25 km (and is much larger for recording rain gauges). Therefore, the gridding process, which amounts to taking a weighed average of station data, has the effect of imposing considerable smoothing on the gridded fields. The amount of artificial smoothing imposed increases as the time step decreases. Clearly, it also depends on the decorrelation distance of the precipitation process ("true" fields). For instance, artificial smoothing is much more significant in summer, when correlation distances tend to be small, than in winter, when they are much longer.

A second critical problem in the development of gridded precipitation fields is to reflect the effects of orography accurately. In the western U.S. (and presumably over much of the NAME domain) the land surface branch of the hydrologic cycle is dominated by precipitation at high elevations. On the other hand, most U.S. precipitation gauges (especially those in the cooperative observer network) are located in inhabited areas, mostly at (relatively) low elevations. Methods have been developed by Daly and others at Oregon State University to estimate the seasonal climatology of precipitation as it is affected by elevation (essentially more accurate maps of precipitation climatology in areas of complex terrain. The method, termed PRISM (precipitation regressions on independent slopes method) utilizes all available precipitation information, especially from the SNOTEL snow and precipitation observation system over the western U.S. Gridded precipitation fields for the U.S. LDAS (Land Data Assimilation System) retrospective data set, and more recently the Higgins data set, utilize the PRISM fields via methods that adjust their climatologies to match those of PRISM. This method works quite well, and in any event represents a vast improvement over data sets, like GPCC, that have no orographic correction. The complication for NAME will be that the station archive needed to produce something analogous to PRISM fields, even if relatively short-term observations were used probably does not exist. If an initiative is forthcoming to augment the Mexican climate network (for which stations similar to those used within the U.S. Cooperative Observer network would be more than adequate), consideration should be given to selection of some subset of sites at intermediate and high elevations. The objective of these stations would be to provide the basis for construction of orographically adjusted precipitation climate fields, which in turn could be used to produce more accurate time-sequenced gridded precipitation fields.

4.2.3. The TRMM/NAME connection (*S. Curtis, NASA Goddard Space Flight Center*)

TRMM was launched in November 1997 and orbits at a 35° inclination resulting in four years of tropical precipitation measurements. The first space radar and radiometer observations have led to improvements in characterizing tropical precipitation features, monitoring ENSO variations and defining the diurnal cycle. Many of the TRMM goals overlap with the objectives of NAME, including providing rain and latent heating distributions for improved climate modelling and hydrological applications. It is likely that TRMM will be operational during the NAME Enhanced Observing Period of 2004. All the sensors are working nominally and the power supply is in excellent shape. Some preliminary applications of TRMM data to the North American Monsoon region (Tier 2) were presented.

The focus of this talk was on TRMM seasonal climatologies and intraseasonal variability in the context of longer term satellite data sets of the Global Precipitation Climatology Project (GPCP). The TRMM microwave imager (TMI) and precipitation radar (PR) both define similar areas of monsoonal rainfall, on the west coast of Mexico and extending into the Pacific. However, the June-September averages of the PR and TMI show substantial differences. Overall, TMI is higher than PR by about 1 $mm.day^{-1}$. It was shown after removing this bias, that TMI is higher at the coast and PR is higher over the Sierra Madre Occidental. However, both estimates have their peaks over the western mountain slopes. TRMM and GPCP gridded data are also useful for studies of intraseasonal variability and the diurnal cycle, especially since they extend the precipitation map off shore. An example was presented quantifying the mid-summer drought (MSD) of Central America. In the GPCP and TRMM climatologies the MSD is strongest over the Pacific side of the continent. Finally, past field campaigns were listed as examples for NAME. Non-rainfall measurements from TRMM, namely lightning and SST, were offered as additional useful data sets for this experiment.

4.2.4. Measuring and modeling topography dependent precipitation: the NAME raingauge network (*C. Watts, IMAEDES; J. Garatuza, Instituto Tecnológico de Sonora; D. Gochis, U. Arizona; and J. Shuttleworth, U. Arizona***)**

Ninety tipping-bucket raingauges with event loggers will be installed in the Tier 1 region in coordination with the National Water Comission (CNA) regional offices in Hermosillo and Caliacán. All these gauges will be deployed before the IOP in 2004 and around 30% will be collocated with manual gauges operated by CNA. This is done so that the response of tipping-bucket gauges will be deployed along transects on the western slopes of the SMO between Mazatlan and Moctezuma. The enhanced network will provide data for the diurnal behaviour of rainfall as well as improving the information about its spatial distribution. All the data will be available on a web page together with the daily data from the CAN gauges. We also intend to operate a cooperative network in coordination with local associations of cattle ranchers.

4.2.5. The NAME wind profiler / radar network (*R. Carbone, UCAR; and S. Rutledge, Colorado State U.***)**

The principal rationale for a dense network of profilers and radars in Tier 1, together with soundings and rain gauges, is to describe and understand the diurnal cycle of precipitation and the structure of precipitation in the core region of the NAMS and to better understand regimes associated with intra-seasonal variability, including the effects of surges, jets, and topographic blocking.

Objectives (to which radar and profiler observations will contribute)

1. Observe and describe statistically the daily evolution of "ordinary" convective rainfall over the high Sierra Madre Occidental, the western and eastern slopes, the Gulf of California coastal plain, and the southern Gulf.
2. Clarify the relationship of convection on east and west slopes of the Sierra Madre Occidental and water vapour transport from the Gulf of Mexico and the Gulf of California.
3. Observe and describe statistically the location and amplitude of organized meso-scale rainfall systems within the diurnal cycle.
4. Observe and diagnose the principal mechanisms that force or maintain meso-scale rainfall systems so that the effects of these may be adequately represented in models (e.g. convectively-generated cold pools, sea and land breeze fronts, microphysics, other diurnally-varying and/or topographically-influenced aspects).
5. Assist in the identification of local properties and processes associated with variability in the precipitation (e.g. anomalous surface latent or sensible heat fluxes, quasi-permanent convergence zones)
6. Observe the development and propagation of southerly surges and associated low-level jets in the Gulf of California in the broader regional context of easterly wave and westerly trough passages.
7. Clarify the relationship of southerly surges/jets to the forcing, organization and northward propagation of convectively-generated precipitation.

The plan is to maximize use of observing systems currently operated by the SMN and to augment these with research systems currently maintained by U.S. agencies. There are five SMN sounding sites in Tier 1 – Obregon, Mazatlan, Torreon, Chihuahua, and La Paz. There are four 5 cm Doppler radars in Tier 1: Obregon, Gusave, Cabo San Lucas, and Palmito. The sounding sites are presumed to be fully functional, so experimental design constraints mainly concern the frequency and scheduling of soundings and the provision of expendables as may be required. All of the radars are operational, however, none currently meet standards for systematic recording of calibrated 3-D data suitable for research.

Several types of sites are planned, in order of increasing complexity:

UHF wind profilers (some with Radio-Acoustic Sounding System (RASS) capabilities)
Virtual Integrated Sounding Systems, VISS (co-located SMN sounding + UHF profiler)
NCAR Integrated Sounding Systems, ISS, (UHF profiler + RASS + rawinsonde)
SMN 5 cm Doppler radars
10cm Doppler-polarimetric radars (NASA N-POL, NCAR S-POL)
The Ron Brown shipboard platform (VISS, 5 cm Doppler radar)

4.2.6. Participation of the R/V Ron Brown and ETL during NAME (*W. Peterson, Colorado State U.; C. Fairall, NOAA/ETL; R. Cifelli, U. of Colorado; M. J. Post; NOAA/ETL; and S. Rutledge, Colorado State U.*)

The NOAA R/V Ronald H. Brown is being requested for participation in the NAME IOP during July-August 2004. The ship should be viewed as an integrated research platform that includes instruments such as:

1. Radar for quantifying precipitation and convective structure and also the diurnal cycle.
2. Sounding system for quantifying tropospheric wind and thermodynamic structure.
3. Flux/radiometer instruments for measuring surface sensible, latent and radiative heat fluxes.
4. Oceanographic instrumentation (ADCP/CTB) for coupling ocean characteristics to the atmosphere.

5. We propose to operate the R/V Ron Brown at a quasi-fixed location near the southern end of the Gulf of California. In this location the platform can be effectively used to study the coupling between easterly waves, moisture surges and Gulf of California low level jet.

A formal request has been made to NOAA for use of the ship for a maximum of 55 days and a minimum of 45 days during the NAME field campaign mid July through August of 2004. The requested ship time includes transit time to the NAME area from a US port, probably on the east coast (e.g. Miami).

4.2.7. SUOMINET and other GPS applications during NAME (*A. Hahmann, U. of Arizona; R. Kursinsky, C. Minjarez Sosa, C. Watts, IMADES*)

SuomiNet (http://www.unidata.ucar.edu/suominet) is a university-based, real-time, national Global Positioning System (GPS) network. The atmosphere is constantly illuminated with 1.6 and 1.2 GHz signals transmitted by the 24 GPS satellites. The lower and upper atmosphere induce GPS signal phase path delays that can be measured with high precision (sub millimeter). In the lower atmosphere, dry air, water vapor, and hydrometeors (with relatively small effect) induce delays in GPS signals. Water vapor - integrated along each GPS signal path - can be inferred if observed or estimated surface pressure is available (to subtract ``dry-air'' contribution to path delay).

Some of the advantages of GPS PW estimates over other satellite and conventional measurement techniques are:

1. High temporal resolution (up to about 5 minutes including oversampling)
2. Can be operated continuously without severe contamination from clouds and/or hydrometeors
3. Low cost compared to other conventional techniques (GPS receiver provided by UCAR / Met station \$ 3--5 K)
4. Besides PW, 4-D characterization of moisture field using slant delays; amplitude data useful in studies of atmospheric turbulence

The disadvantages of GPS PW estimates include:

1. Requires power and internet connection to be integrated to SuomiNet network (this can be solved by collaboration with Mexican universities and research groups)
2. Requires conventional meteorological surface parameters (not a real problem because these are useful anyway)
3. Possible contamination when precipitation is occurring at measurement site (contaminated observations could be removed if collocated rain gauge exists)

Three Mexican institutions have already registered with SuomiNet. It remains to be seen to what level their participation will develop. In terms of NAME, we propose to collaborate with US and Mexican institutions in the NAME region to develop a GPS-based network of integrated water vapor IWV). Also, we are looking into the possibility of establishing a IWV cross section provide high-resolution integrated water vapor estimates along a west-east section of the Gulf of California. Restricted by the maximum distance ``visible' from an emitter located at high altitude (about 200 km for an emitter located at an elevation of 2800 meters). Observations near the 22.21 GHz water vapor line will be used to measure absorption from the Baja ridge to the Puerto Peñasco site.

4.2.8. XBT's in the gulf of California (*S. Miranda, IMTA*)

It is proposed to take advantage of the daily ferry-boat cruises from La Paz-Mazatlan, La Paz-Topolobampo and Santa Rosalia-Guaymas to perform low cost ocean and atmosphere Ship Measurements during NAME. It is allowed to make any type of meteorological and atmospheric measurements as long as no interference with the cruise takes place. The launching of radiosondes and XBT is suggested. A XBT program has been going on for the last ten years with only six launches in the summer and six in the winter. A more intensive program is proposed for NAME.

The ocean and atmospheric data will be used for the development of an operational short and medium range forecast for NW Mexico by means of a regional atmospheric numerical model (MM5) and an ocean model (POM) for the Gulf of California and nearby waters.

Session 3. NAME Work Session (*Chairs: M. Douglas, NOAA/NSSL; and A. Douglas, Creighton U.*)

Plans for the VAMOS NAME Field Campaign were discussed extensively in the afternoon plenary session. Ninety event logging raingauges (funded) will be installed in transects from the GOC to the western slopes of the SMO. Proposed ideas for enhancements to the simple raingauge network were discussed. Hypotheses and objectives for the NAME in situ sounding / wind profiler / radar network were discussed, and the details of the network are currently under discussion. Specific sites will be chosen based on network objectives. An updated Timeline for the NAME Field Campaign and NAME meetings was developed. A NAME special session and NAME SWG meeting will be held in conjunction with the 27th CDPW at George Mason University (N. VA) in October 2002.

Session 4. NAME Modelling and Diagnostic Studies (*Chair: J. Shuttleworth, U. Arizona*)

Overview

This session had three goals, specifically, (i) to define priority research topics in the area of modelling and diagnostics to be addressed in the North American Monsoon Experiment (NAME), (ii) to help specify a ramp-up strategy for addressing these topics, and (iii) to provide guidance on the needs and priorities for observations under NAME relevant to modelling and diagnostics. All of these goals were successfully addressed through a session that comprised invited talks covering a range of subjects. Below, these talks are separately reported in the form of short abstracts. Overall, the most important feature of this session was that it set a precedent for applying the important organizing principle that will be used by NAME, i.e., using modelling needs for the improved prediction of climate to identify and set priority for observations.

The talks in this session had three broad themes. The first theme was a series talks by Jae Schemm, Chet Ropelewski, Sig Schubert, and Andrea Hahmann that reported modelling and diagnostic studies at global scale. These talks together demonstrated that global models have some worthwhile descriptive and predictive capability in the core North American Monsoon (NAM) region, but that they currently have very significant shortcomings when modelling the NAM system in general.

In terms of required observations during NAME, global models require improved documentation of the basic climatology within the NAME study region--especially of precipitation--at relevant time and space scales, better to specify shortcomings in the models. Global models would also benefit from observations that would provide guidance on weaknesses in model parameterization that are diagnosed by any shortcomings in performance, measurements made by radar and radiosonde systems, for instance. To propagate continued operation of the organizing principle of using models to define required observations, it was proposed that NAME should participate in the model diagnostics working group established to interface between process studies and representatives from GFDL, NSIPP, CDC, NCEP, and COLA.

The second theme in this session was a series of talks by Dave Gutzler, Ray Arrit, Hugo Berbery, Kingste Mo, and Walt Peterson (speaking on behalf of the Colorado State RAMS group) that described modelling and diagnostic studies at the meso-scale. On the basis of the results presented, it was clear that meso-scale models already have a significant capability to describe and predict the NAMS system when operating in predictive mode, and that such models had a more substantial capability to document the NAM when operating in analysis mode.

There was a clear consensus that, in the case of meso-scale models, the priority topic for study in NAME is improved representation of convective precipitation processes in general, and its improved representations in regions of complex terrain, in particular. Consistent with this, the priority observational needs are for improved precipitation observations, both from rain gauges and remote sensing, that include focus on defining the diurnal cycle and topographic influences on precipitation, but which also include a broader sampling of precipitation using simple, inexpensive gauges capable of provided time-integrated observations. There is also a need to investigate the topography-induced circulations that influence precipitation processes using radar systems, and to document the low level wind fields that control vapour flow in the core region of the NAM system using strategically placed radiosondes that are released at least four times, and preferably six times, each day. To propagate continued operation of the organizing principle of using models to define required observations it was proposed that NAME should create a working group involving both meso-scale modellers, scientists interested in improved representation of processes in models, and observational scientists. The activity of this working group would be focused on assessing models relative to field data and seeking improved parameterizations in them. The North American Monsoon Assessment Project (NAMAP) is a strategy for integrating the NAME modelling community into the planning for the NAME observational efforts.

This session included two talks by Phil Arkin and Chidong Zhang that highlighted additional issues and opportunities. They reminded participants of the need for NAME to take the opportunity to exploit and improve remotely sensed estimates of precipitation, and not to forget the bigger (Tier 3) context of the experiment during upcoming studies in the core monsoon region. The fact that NAME represents an important, TRMM- and GPM-relevant opportunity to study the topographic influence on satellite retrievals of precipitation emerged in discussion. To exploit this opportunity, NAME should include measurements that adequately sample the orographic influences on precipitation, and also radar-based estimates of precipitation over the Gulf of California and over the nearby areas of the Pacific Ocean.

The session did not include any talks on the hydrological modelling and water resource issues that are of interest to GAPP, and this omission was recognized. In discussion it was agreed that hydrological modelling is an important component and should be encouraged among the modelling and diagnostic studies of NAME. Hydrological modelling would be aided by a widely distributed network of inexpensive integrating rain gauges. Preliminary studies have shown that surface runoff is not merely related to monthly-average precipitation; rather it is strongly dependent on the intensity and duration of the rain storms. GAPP-related hydrological modelling activity in NAME therefore requires observations of the statistical properties of precipitation to allow calculation of surface runoff and to ensure the statistical properties of rainfall are being adequately simulated by meso-scale hydro-meteorological models.

Abstracts

4.4.1. Features of the NAM Depicted in CPC's Seasonal Prediction GCM Runs (*J. Schemm, NOAA/NW; W. Higgins, NCEP/NWS/NOAA; and Y. Zhou*).

This talk focused on climatological features of the North American Monsoon depicted in the NCEP seasonal prediction GCM runs in terms of warm season circulation patterns and precipitation. The GCM runs used for this purpose were initialised in early May for the period 1979 to 1999 and comprised 10-member ensembles for each year, integrated for the subsequent seven months. To investigate the impact of initial soil moisture on warm season predictions, comparisons between two sets of GCM runs were presented, one initialised with climatological soil moisture (CSM) conditions, and one initialised with analysed soil moisture (ISM) from the NCEP Reanalysis 2.

In terms of circulation patterns, the CSM runs were not able to capture the upper level anticyclone over the Gulf of California because they gave an eastward shift to the Gulf of Mexico, whereas the ISM runs modelled the anticyclone at roughly the correct location. However, in both sets of runs the low-level easterly winds that prevail throughout Central America extended too far north into northern Mexico. Over the subtropical Pacific sector, westerly winds were modelled in the GCM runs rather than the observed weak easterlies.

These errors in the low-level winds have a large impact on the modelled precipitation distribution in the NAM region. There was a northward migration of precipitation in Mexico and the south-western U.S. in the GCM runs relative to observations, with excessive amounts of precipitation in northern Mexico. The onset, break, and decay of the monsoon cycle during the season were fairly well simulated, but with much better amplitude in the case of the ISM runs.

4.4.2. The Skill of Warm Season Model Rainfall Predictions in the NAME Region (*C. Ropelewski, IRI*).

This presentation examined the correlation skill for precipitation forecasts in the NAME region for the four numerical models used by the IRI in its multi-model ensemble seasonal prediction, namely the CCM3, NCEP, ECHAM3, and NSIPP models. For the June-August season, all of the models showed some very modest skill (with correlations of 0.4) in some parts of the NAM domain, most noticeably in the core monsoon region.

Time series of warm season rainfall "hindcasts" for the June-August season averaged over northwest Mexico and the southwest United States, made using specified sea surface temperatures, also suggest some skill over the NAM domain. This modest but model consistent predictive skill suggests that there is a real potential for seasonal predictability over the region that merits investigation in NAME.

4.4.3. Global Modelling Activities and NAME (*S. Schubert, NASA/GSFC*)

Global models are important for understanding and predicting the impact of remote forcing on regional climates. However, AGCMs currently simulate warm season continental climates poorly, making them of limited value for setting the context for regional predictions. Simply increasing horizontal resolution does not seem to help greatly, implying that the most significant errors are likely in model physics, i.e. in the parameterization of convection and clouds, the Planetary Boundary Layer (PBL), and the description of the land surface. Ensemble model results suggest that there is potential predictability associated with SST and soil moisture in different parts of the NAME region, but this is not yet realized as skill.

This presentation also addressed the role that NAME could play in addressing the current weaknesses in global model performance. Clearly the experiment should provide validation data that document the basic climatology of the NAME study region. In this respect, better specification of mean rainfall patterns (including the diurnal cycle), of the low-level jet and upslope flow surges in the Gulf of California, and of storm systems and their associated humidity fluxes will all help the global modelling community. Providing improved specification of sea surface temperature (SST), especially local SST, and soil moisture (perhaps derived off-line by data assimilation) will be valuable, as will observed or reliable remotely sensed fields of radiation and information on atmospheric heating profiles and three-dimensional cloud fields.

The need to develop stronger links between NAME researchers and modelling was emphasized and, in particular, the value of building links to an existing model diagnostics working group that includes representation from GFDL, NSIPP, CDC, NCEP, and COLA.

4.4.4. North American Monsoon Assessment Project (NAMAP) (*D. Gutzler, U. New Mexico*)

NAMAP is proposed as part of a strategy to integrate the modelling community into the planning for the NAME observational efforts. The NAME Science Plan calls for simulations of the North American Monsoon System that, at minimum, adequately represent the location, spatial structure, and diurnal cycle of precipitation. Studies to date suggest that current models do not satisfy this requirement. Generally speaking, coarse-resolution GCMs tend to underestimate precipitation while high-resolution regional models tend to overestimate precipitation.

NAMAP Phase I intends to document the current status of models by stimulating simulations of precipitation and boundary layer variables for a single warm season (1990) across the NAME Tier 1 study area and, in the case of large-scale fields, the NAME Tier II domain. This will provide a reference for future NAME modelling efforts. The general protocol for NAMAP Phase I (i.e. choice of year and domain) was defined during 2001 and this has lead to a registration page, which is now hosted by JOSS through the VAMOS Project Office at URL http://www.joss.ucar.edu/name/namip.

NAMAP is currently unfunded and voluntary. The nominal deadline for completing the numerical simulations is May 2002. In the very near future, a number of time series (precipitation, moisture flux, etc.) at a set of specified locations will be defined, and NAMAP participants have been asked to develop time series of these from their simulations over the 1990 summer season. Initial results will be presented at the NAME SWG meeting during the Climate Diagnostics Workshop in October 2002, with a view to guiding more detailed planning for the NAME special observing period in the subsequent year.

4.4.5. PIRCS 1C: A Multi-model Simulation of the North American Monsoon (*R. Arritt, Iowa State U.; C. Anderson, Z. Pan, W. Gutowski, Jr. and E. Takle***)**

This presentation overviewed the Project to Intercompare Regional Climate Simulations (PIRCS), which was originally designed to provide a common framework for evaluating the strengths and weaknesses of dynamical models for regional climate. PIRCS has now extended its mission to include evaluations of ensemble approaches for simulating regional climate. Previous results for short-term NWP ensembles and longer-term global model ensembles do not necessarily apply to nested regional climate models because such models are strongly constrained by continually providing large-scale information at their lateral boundaries.

PIRCS Experiment 1c will focus on simulation of the North American Monsoon system. The model domains include the continental U.S. and most of Mexico. The minimal simulation period will be 1987 to 1991, with participants strongly encouraged to extend their runs through to the present time. Preliminary tests indicate the importance of incorporating high-resolution sea surface temperature information for the Gulf of California into the lower boundary conditions for regional climate models. In the context of NAME, observational needs for PIRCS 1c include documentation of the temporal and spatial variability of precipitation, especially in regions that usually are currently poorly sampled such as over complex terrain. Data to support the diagnosis of precipitation processes, especially low-level wind and moisture fields, are also needed.

4.4.6. Diagnosis and Simulation of the North American Monsoon Using NCEP's ETA Model, EDAS, and Regional Reanalysis (*H. Berbery, U. Maryland; Y. Luo, U. Maryland; K. Mitchell, and R. Yang***).**

This presentation reviewed the contributions that Eta model-based studies have made to our understanding of the NAM system. The talk addressed three main topics. First, data from the Eta Data Assimilation System (EDAS), i.e. model-calculated data that may have been influenced by model changes, were used to investigate how the diurnal cycle of moisture flux over the Gulf of California influences development of precipitation over the slopes of the Sierra Madre Occidental and south-western U.S. The character of the low-level jet and moisture surges along the Gulf of California that transport moisture northwards over the US were also discussed.

The recent initiative to develop a regional reanalysis data set on a 32 km grid mesh for studies that involve not only meso-scale, but also lower frequency (beyond intraseasonal) variability was then described. So far, several pilot runs at 80 km grid spacing have been performed and the results were shown to be promising, particularly in respect to diagnosing processes that involve moisture transport and precipitation, two key components of the monsoon system.

Finally, the initial results were given for experiments in which the present version of the Eta model (which is essentially identical to that used in the regional reanalysis) was used to make seasonal simulations of the North American monsoon. Indications are that an ensemble approach is needed to describe the uncertainties related to the monsoon development. Uncertainties related to the lower boundary conditions driving the model were also highlighted.

4.4.7. Influence of SST's Over the Gulf of California for the NAM (*K. Mo, CPC/NCEP/NWS/NOAA***)**

This paper investigated the influence of sea surface temperatures in the Gulf of California on the North American monsoon rainfall using observational data and the regional model experiments. Weekly SST analyses from 1983 to 1999 indicate that there is no connection between SSTs in the Gulf and the monsoon onset dates, and their impact on the total seasonal precipitation over the south-western United States and the northern Mexico is also very small.

Regional model experiments were performed using the NCEP Regional Spectral Model (RSM) operating during 1997 and 1992, with a grid mesh of 50-km over the U.S. and northern Mexico and nested in Reanalysis 2 boundary conditions. These years were selected because during July-September in 1997, the SST in the Gulf of California were at their warmest while, during this period in 1992, they were at their coldest. The model was able to capture the major features of monsoon rainfall and the diurnal cycle. The primary deficiency of the model was a too dry atmosphere over western Arizona. The model did, however, captures the rainfall differences between July and September.

The experiments were repeated using the same initial and boundary conditions but using the climatological average SST. The largest impact of Gulf of California SST's on rainfall is over the western slopes of the Sierra Madre Occidental (SMO), with warm SST being associated with greater rainfall. However, the large-scale flow has more influence on rainfall than SST in the Gulf of California because changes in SST's are not strong enough to modify the low level flow significantly and, in this way, influence rainfall. Similar experiments with the model using a 30-km grid mesh gave essentially the same results.

4.4.8. RAMS Investigations of the North American Monsoon: Overview and Recommendations (*S. Rutledge, W. Cotton, R. Pielke, G. E. Liston, S. Saleeby, C. Castro, presented by W. Petersen, Colorado State U.***)**

This paper demonstrated that, when used in a regional domain and seasonal weather prediction mode, RAMS is a practical tool to investigate the climatology and interannual variability of NAMS features, such as low-level jets, the diurnal cycle of moisture flux and convergence, the evolution of the monsoon ridge, differences in low and upper level divergence, moisture transport, and daily precipitation associated with pre- and post-onset periods in different years. Pending and future work includes continued investigation of the relationship between NAMS and SSTs, both local (Gulf of California) and remote (tropical and North Pacific), and the impact of land-surface parameters (soil moisture, vegetation, snow cover) on the NAMS, together with quantification of the relative contribution of moisture transport from various sources (e.g. the Gulf of California and Gulf of Mexico), and the refinement of convection schemes to improve their performance in areas of high and steeply sloping terrain, such as the Sierra Madre.

Recommendations were made on NAME measurement strategies. There are discrepancies between meso-scale models with respect to their simulation of the diurnal cycle, position, and strength of the low-level jet. To resolve these, a dense network of rawinsonde and aircraft measurements are required, located in and around the Gulf of California, to capture the structure and evolution of the jet, both diurnally and seasonally, with measurements targeting gulf surge events. The upper air network should also be large and dense enough to ascertain the relative roles of the Gulf of California and Gulf of Mexico in supplying NAMS moisture. Mesoscale model research also suggests that the evolution and impact of the NAMS depends on antecedent precipitation and the soil moisture. It would therefore be valuable if an east-west array of surface stations were to be installed across the Mexican Plateau, to measure soil moisture, precipitation, temperature, humidity, and wind speed and direction. These stations should sample altitude and climate regimes, with measurements made for six months prior to and then through the monsoon period. Gauged and radar estimates of precipitation are also required over broad regions to evaluate model skill.

Pacific SST and associated teleconnection patterns appear to affect monsoon onset and the frequency of low-level jet events, with La Niña and a low phase of the North Pacific Oscillation more likely to have enhanced easterly wave activity in the tropics and more frequent gulf surge events in late June and early July. Consequently, the NAME field campaign should ideally encompass two seasons with different large-scale, Pacific SST conditions.

4.4.9. Role of the Satellite Observing System in NAME / Potential NAME Role in TRMM/GPM (*P. Arkin, ESSIC*)

This paper made the point that satellite observations are essential to ensure that NAME will have the precipitation data sets required to achieve its scientific objectives. Gauges and radar systems alone will not provide the spatial coverage to allow spatially and temporally complete precipitation analyses. In addition, the temporal sampling of the satellite sensors is essential to complete documentation of the diurnal cycle across the NAME domain.

Estimates of precipitation can be made from satellite observations in several ways, each with its own strengths and weaknesses. Estimates made from geostationary infrared observations have excellent spatial and temporal sampling and coverage but have a poor physical basis, i.e. the indirect relationship between cloud top temperature and precipitation. Estimates made from microwave data have a better physical basis over oceans because they directly measure radiation from raindrops. Over land, detection is from scattering by ice-phase precipitation in deep convective systems. However microwave-based estimates have poor sampling because they use polar orbiting satellites that give only two snapshots per day per satellite, and they have mediocre (25-50 km) resolution. Estimates made with the TRMM Precipitation Radar have a reliable physical basis but very poor sampling, between 35°N and 35°S, from a precessing polar orbiter with a narrow swath.

Existing data sets available (or potentially available) for NAME include precipitation analyses at various scales, resolutions, and for different periods of record. Global products include the GPCP and CMAP data, in each case available from 1979 to present time on a 2.5° pentad. Both are based on a combination of infrared and microwave observations and gauges, and include estimates of error. Production of equivalent 1° daily products began in 1997, again primarily based on infrared and microwave observations. The diurnal climatology of infrared radiation are available as histograms from 1986 to present day at 3 hourly intervals and 2.5° pentad. These have already been used for coarse (but useful) analyses and may allow description of the intra-seasonal and interannual variability of the diurnal cycle in precipitation over the NAME domain. Combining these with microwave and gauge data may arguably allow a more accurate product from 1987, while a similar product with higher resolution (0.5°, 30 minutes) is also feasible from 1999.

A new analysis could be made for NAME with 30 km and 30 minute resolution, based on infrared and microwave (and perhaps TRMM PR) observations, gauges, and surface radar, when available, using an adaptation of CMAP algorithm as implemented in CPC African/South Asian analyses. This would require an excellent, diurnally resolved, gauge analysis to correct for the phase lag between precipitation and cloud cover. Such a product will benefit from improvements in the estimation of orographic precipitation. The use of infrared data is essential to good resolution of the diurnal cycle, but correction for the cloud-precipitation phase lag requires a network of diurnally resolving gauges. Accurate estimation of orographic precipitation is critical in the NAME region, but existing algorithms are poor in this respect. Corrections to existing algorithms and/or the development of new algorithms will require high quality gauge and radar measurements in regions of orographic precipitation. Existing algorithms and analyses are also poorly validated over water, so radar observations over the Gulf of California and over the nearby areas of the Pacific Ocean will be necessary to define accurate error bounds.

The suite of observing systems and scientists already committed to NAME means the experiment is an outstanding opportunity for NASA to use it as a "campaign of opportunity" for TRMM and GPM validation. TRMM may well still be flying during the NAME intensive observation period and GPM will be building toward launch. The NAME domain provides an example of a domain with orographically influenced convective precipitation so far unstudied TRMM validation campaigns. NAME will have many observing systems and scientists in place and therefore provides an extraordinary opportunity to leverage on assets to enable the execution of a combined TRMM validation and GPM proof of concept project.

4.4.10. Moisture budget of the Inter Americas Sea, its transport, and their roles in warm season precipitation (*C. Zhang, RSMAS*)

The so-called Inter Americas Seas (IAS), which comprise the Gulf of Mexico and the Caribbean Sea, serve as the main moisture reservoir for warm season precipitation in the central U.S. Moisture transport by the southerly low-level jet (LLJ) from the Gulf of Mexico is critical to warm season precipitation on a broad spectrum of timescales (synoptic to interannual). Roughly 20% of total moisture into the continental US comes from the Gulf of Mexico via the LLJ, while about 80% of total moisture exported from the Gulf of Mexico enters the central U.S. Of total moisture imported into the Gulf of Mexico, about 50% is from the Caribbean Sea. Local evaporation is a substantial moisture source for the IAS, it provides 25-40% of atmospheric moisture for the Gulf of Mexico and 20-25% for the Caribbean Sea.

The mechanisms that control variability in the atmospheric moisture budget and transport in the IAS are not known. Unresolved questions include, what controls the intensity of the LLJ and local evaporation, what role do the oceans of the IAS play, how much does evaporated moisture from the IAS contribute to precipitation in the Central US, and what are the uncertainties in the current global and regional model analysis and reanalysis products?

These questions can partially be addressed by (1) quantifying the errors in the analysis and reanalysis products using observations using the existing sounding network, (2) including tracer diagnoses in model simulations, and (3) global and meso-scale modelling, in general. Studying the moisture budget and transport in the IAS is clearly relevant to other climate research programs: it serves as a bridge between CLIVAR-Pacific and CLIVAR-Atlantic, and between CLIVAR/PACS/GAPP, CLIVAR/VAMOS, and LBA.

Session 5. CLIVAR/PACS and GEWEX/GAPP (*Chair: C. Zhang, RSMAS*)

4.5.1. CLIVAR-PACS NAME plans (*M. Patterson, NOAA, OGP*)

The PACS objectives are improving the prediction skill over the Americas on subseasonal to interdecadal timescales. Its topical emphases are the monsoons, the ITCZs, and the storm tracks, and its regional emphases are NAME, MESA, and EPIC. PACS interest in NAME, in particular, consists of improving the skill of summertime prediction over North America, gaining a better understanding/simulation of the North American monsoon system and its connection with the leading patterns of climate variability (ENSO, MJO), developing a partnership between observational and modelling activities, developing the climate observing system in the south-western US, Mexico, and Central America, and fostering collaborations with climate assessment activities. The joint effort of CLIVAR/PACS and GEWEX/GAPP would combine the expertise in air-sea coupled modelling from CLIVAR with the expertise in land-air coupling from GEWEX. This joint effort in the North American Warm Season Precipitation Project will lead to establishment and development of climate observing, monitoring, and modelling systems, investigations on major influences on the monsoon (land surface in the south.western and central US, the InterAmericas Sea). The NAME field observation program may include a variety of instruments. International collaborations are supported by PACS through meetings, observation system operation, training and travel. PACS NAME funding plan and timeline are given. The NAME legacy would be in better understanding and modelling of the monsoon system, observational infrastructure, climate assessment, and international collaboration.

NOAA/OGP announced several funding opportunities during FY03 of interest to the NAME Community. First, an Announcement of Opportunity (AO) for the FY03 PACS/GAPP Warm Season Precipitation Initiative (primarily modelling and analysis) is due out in March 2002. A NAME AO (observations) will be announced in the fall of 2002 and a NAME AO (analysis) will follow in the spring of 2003.

4.5.2. GEWEX-GAPP-NAME Plans (*R. Lawford,; J. Huang, NOAA/OGP*)

The GEWEX Americas Prediction Project has two objectives: to improve monthly/seasonal predictions of precipitation and hydrological variables and to apply climate predictions to water resource management. GAPP study areas include the Mississippi River Basin, the Northwest US, and the North American Monsoon region. The GAPP NAME goal is to study the predictability of warm season precipitation over North America, with emphasis on the role of land surface. GAPP NAME strategy is a mix of diagnostic and modelling studies, field experiments, and data development.

GAPP expects NAME to determine the role of land in the monsoon system and low-level jets and the role of the monsoon system in water and energy budget and GAPP prediction studies. NAME can benefit from GAPP in its land surface modelling expertise, land and precipitation data sets, and the linkage with NOAA operations.

Session 6. NAME and Human Dimensions (*Chair: C. Zhang, RSMAS*)

NAME and human dimensions (*A. Ray, NOAA/CDC***)**

A workshop on climate and society interaction (CSI) held in 18-22 June, Tucson, Arizona, was summarized. There exist many CSI activities in the monsoon region, which cover a broad range of topics and are funded by different US agencies. NAME can contribute to CSI through integration of science and societal needs, climate services, promote general interest in the science and knowledge transfer. Workshop participants were from government (both US and Mexico) and research institutes. The workshop recommended four themes for research, application, and assessment activities in NAME: fire and climate, ecosystem management, dryland/rainfed systems, and integrated water management. The workshop also recommended a monsoon regional observations and data system and regional climate service infrastructures in both north-western Mexico and south-western US.

Session 7. NAME Education and Training (*Chair: C. Zhang*)

4.7.1. Central American training course (*M. Douglas, NOAA/NSSL*)

A training workshop was held in Panamá July 2001 to improve use of PACS-SONET data. The workshop consisted of three components: 1) lectures on climate, weather, forecasting, and observations, 2) group work on designing regional meteorological/climate services, and 3) a field observation program. Participants came from all types of weather and climate activities in 12 countries. The workshop met several challenges, such as diverse backgrounds of the participants, selection of motivated individuals who have the potential to be leaders later, and maintenance of follow-on communications.

4.7.2. A strawman for the educational component of NAME (*R. Lobato, IMTA*)

There are possibly six institutions from northern and north-western Mexico that can potentially be involved in NAME. Many issues remain to be addressed in regard to participation in NAME by Mexican weather operational staff and students, such as They include: selection, training, and compensation. NAME should provide opportunities for Mexican students to gain experience in the field operation and data analyses and to be motivated to pursue careers in the atmospheric sciences. To have more Mexican participants in NAME can help with logistic problems, and would be an important contribution to NAME's legacy.

5. VEPIC Science Working Group Report (*B. Stevens, UCLA*)

Professor Bjorn Stevens presented a summary of the discussions and inclusions from the VEPIC SWG meeting

5.1 Prologue

In the past decades subtropical stratocumulus have been the topic of intense investigation. Because of their effect on the mean radiative balance, and their potential role as an important cloud feedback in climate change scenarios, investigators have struggled to understand how this cloud type works. For the most part the studies of the past decades have been at the process level, with observational studies, single column model studies and large-eddy simulation all focused on how the delicate interplay between cloud microphysics, radiation and turbulence determine the local evolution of the cloud layer. These studies have made important contributions to our understanding, particularly as pertains to processes such as entrainment, diurnal decoupling, drizzle, and varied mechanism for effecting a transition from stratocumulus to trade cumulus. What these studies have not been able to evaluate is how clouds interact with their large-scale chemical, thermodynamic and dynamic environment on time-scales much larger than the timescale of turbulence.

The hope of course is that process level studies can be scaled up to yield insight on longer time-scales and larger spatial scales. As ultimately cloudiness on these time and space scales interacts most strongly with the Earth's climate. Observationally, the increasing coverage and sophistication of space-borne remote sensing combined with the limited but critical data from buoys, ships of opportunity, and coastal or near coastal observational network provide an excellent tool for evaluating the patterns of behaviour of clouds on these time and space scales. What these observations often lack however is sufficient context. For instance, data collected from Weather Ship N in the north east pacific probably is still our most important source of data on long-term variability of cloud statistics as a function of the vertical structure of the atmosphere, and detailed measurements of its interaction with the underlying surface. While observations such as those taken at weather ship N could help us learn to better use the satellite record, their temporal coverage is restricted to the pre-satellite era. Thus one of the challenges in addressing hypotheses related to the long-time and large-spatial scale variability of cloud systems is learning how to most effectively use existing, particularly satellite, data. So doing requires the development of new research programs which incorporate targeted observations and careful integration of simulation and observational studies.

5.2 The Goal of VEPIC

The goal of VEPIC is to address these issues by striving to better understand and simulate how Eastern Pacific Cloud Systems interact with the Coupled Ocean-Atmosphere-Land System on Diurnal to Interannual Timescales. Toward this end we have identified four issues:

1. On what time and space scales does continental heating and mechanical forcing significantly modulate boundary layer cloud radiative forcing?
2. How sensitive is the overall tropical circulation and ENSO to variations of Eastern Pacific cloud topped boundary layer properties and what processes determine this sensitivity?

3. What are the dominant feedbacks among stratocumulus clouds, surface winds, up-welling, coastal currents and SST in the South East Pacific on seasonal and interannual time-scales?
4. To what extent do variations in the natural and anthropogenic aerosol modulate East Pacific cloud radiative forcing?

The focus on the East Pacific is motivated in part by the role of this part of the world in the global climate system, and also by the developing infrastructure in this region. Not only have recent field studies (e.g., CIMAR and EPIC) helped describe the climatology of cloudiness in the region, but field studies in similar cloud regimes in other regions (e.g., DYCOMS, FIRE, ASTEX, ACE-II, DYCOMS-II) have helped advanced our understanding at the process level so that new field initiatives can focus on other questions. In addition the Eastern Pacific has seen a tremendous enhancement in its regional and instrumental infrastructure. Groups in both Chile and Peru are actively involved in studies to understand these cloud systems and their relationship to the larger-scale environment, and their studies are augmented by expanding coastal networks, national buoy networks, and the presence of a new, IMET buoy in the heart of the Eastern Pacific stratocumulus regime. This combined with the lack or regional bias in space-borne remote sensing make the Eastern Pacific a natural laboratory for investigating how Eastern Pacific Cloud Systems interact with the Coupled Ocean-Atmosphere-Land System on Diurnal to Interannual Timescales.

The switch toward looking at longer timescales is in part motivated by progress on the small time-scale front, but also by the increasing number of concrete scientific hypotheses resulting from empirical studies and investigations with theoretical and numerical models. Lastly the additional scope, whereby we also address the relationship of cloudiness to the evolution of its chemical environment is a direct response to the increasing interest and concern as to the role of the atmospheric aerosol --- as for instance evidenced by the birth of national initiatives in this direction.

5.3 VEPIC Strategies

Toward these ends VEPIC has identified five strategies:

1. Model evaluation and improvement (e.g parameterization development) using multi-scale data sets.
2. Model sensitivity studies to refine hypotheses and target observations.
3. Synthesis and enhancement of existing data sets, through targeted instrument procurement, algorithm evaluation and development and enhanced observation periods.
4. Better co-ordination with aerosol and oceanographic communities.
5. Development and use of "climate process team" concept.

To begin implementing these strategies the VEPIC panel of VAMOS also recommends the following five eight action items:

1. Augment San Felix Island instrumentation through the deployment of ceilometer, wind profiler and aerosol sampler.
2. Co-ordinate with ECMWF, NCEP and CPTEC to provide high resolution column data over selected VEPIC study areas.
3. Develop a VEPIC data set through a distributed data archive maintained by JOSS, in co-ordination with CEOP.

4. Support of "climate process teams" to evaluate existing observations and simulations in the VEPIC region, perform model sensitivity studies, develop retrieval algorithms and physical parameterizations.
5. Improve cloud/aerosol instrumentation on the R/V Ronald Brown (cloud radar and aerosol sampling) as part of her standard equipment package.
6. Organize a special VEPIC cruise and flights to co-ordinate, evaluate and synthesize the long-term sampling from buoys, drifting floats, coastal and island stations and satellites.
7. Support a radiosonde observation period at San Felix or Juan Fernandez Islands in co-ordination with the VAMOS/SALLJ field campaign.
8. Include VEPIC as an activity on VAMOS project office for meeting co-ordination, data management and field operations.

6. Discussion on NAME and VEPIC

Professor Mechoso moderated a plenary discussion on the NAME Workshop and VEPIC SWG Meeting. He started by saying that VAMOS is a CLIVAR programme that addresses regional climate problems of the Americas, but places those problems in a global context. All VAMOS programmes, therefore, are expected to develop a “Climate Scenario” and formulate “Guiding Hypotheses”. Ideally a VAMOS programme would consist of the following building blocks: (1) Guiding Hypotheses, (2) Field Campaigns, (3) Empirical Studies, and (4) Modelling Studies. Activities in each one of those categories strongly interact among one another.

The NAME Workshop has demonstrated that the experiment has considered activities in all categories. It was felt that interactions between (1) and (4) might be strengthened. Namely, the use of models in hypothesis testing/ development could be enhanced.

Concerning VEPIC, this has also outlined activities in all categories. There is still some uncertainty on the uniqueness of VEPIC contribution to the better understanding and prediction of the tropical climate. Plans for VEPIC will be affected by the outcome of EPIC.

7. VAMOS panel session

The VAMOS panel season started with a warm welcome to four new members: Jorge Amador (U. Costa Rica), Kingtse Mo (CPC/NCEP/NWS/NOAA), Maria Assunçao Silva Dias (U. Sao Paulo), Dennis Lettenmaier (U. Washington), and Andrew Robertson (International Research Institute - IRI). Three founding panel members rotated off: Julia Paegle (U. UTAH), Jim Shuttleworth (U. Arizona), and Antonio Divino Moura (IRI).

7.1 Status of VAMOS programmes

7.1.1 SALLJ

The SALLJ Conference in Santa Cruz, Bolivia, was a very successful meeting. The panel was greatly pleased with the outcome of the meeting and warmly congratulated C. Vera and the organizing committee. The conference also started the process of preparation for the field experiment (SALLEX). In this regard, the panel was very encouraged by the enthusiasm of several young scientists who participated in the training course for SALLJEX that was held following the conference.

Potential problems for the implementation of SALLJEX were reviewed. Installation of the multi-national radiosonde network depends on funding from several countries. Proposals that include in their budget the enhancement of radiosondes, wind profilers, and pilot balloons during the experiment have been funded in Argentina, Brazil and the US. The need to be alert for possible delays or any other difficulties with the funding in any one country was emphasized, and preparation for the adoption of remedial actions was encouraged. There is still some uncertainty on the availability of the NOAA P3 aircraft for SALLJEX.

The panel encouraged the realization of an international workshop focused on the analysis and applications of data gathered by SALLJEX as soon as possible after completion of the experiment.

7.1.2 PLATIN

PLATIN is a joint VAMOS/GEWEX programme. The PLATIN SWG, which is co-chaired R. Mechoso (VAMOS) and P. Silva Diaz (GEWEX) scheduled a meeting in Buenos Aires, Argentina, by early April 2000. The panel was informed that PLATIN has targeted the formation of a research programme on the modelling of the hydroclimatology of large river basins, with emphasis on La Plata basin. In this case, the SWG will be expanded to include hydrologists such as Carlos Tucci and Alexander Guetter. These two individuals, in particular, will be specially invited to attend the Buenos Aires meeting.

The panel was informed that PLATIN has joined other initiatives in the preparation of a proposal to the Global Environmental Facility (GEF). The American Association for the Advancement of Science (AAAS) leads one of these initiatives. This AAAS programme, Ecosystem Dynamics and Essential Human Needs (EDEHN), and aims to develop a multidisciplinary research agenda in the Plata Basin. PLATIN and EDEHN complement each other very well, since the former emphasizes the science aspects of climate and hydrology while the latter places a greater stress on applications and human dimensions. The United Nations Environment Program (UNEP) would be The Proposing Agency to GEF, and the Organization of American States (OAS) would be the Executing Agency.

7.1.3 NAME

The NAME Program was praised as a model of international partnership. A substantial financial commitment has already been obtained from funding agencies. A workshop will be planned for 2003 to bring together operational forecasters, staff personnel of Meteorological, and specialists in the human dimension component. The NAME field campaign will be coordinated by the VAMOS Project Office. Proposals for enhancement of raingauge networks, and deployment of wind profilers have been submitted in Mexico and the US.

7.1.4 VEPIC

The panel praised the accomplishments of EPIC 2001, which is a VAMOS program. S. Esbensen indicated that EPIC PIs are expecting funding from NOAA and NSF for a two-three year period. NOAA support for enhanced monitoring will end in 2004, almost simultaneously with the NSF funding. It was agreed that an extension of support would be desirable in order to allow for a through analysis of data gathered during the campaign.

In reference to VEPIC, the panel recommended consideration of both regional and global aspects. The latter would include the planetary response to the variability of stratocumulus decks. The panel was pleased with the results of the VEPIC workshop. This clearly helped to better identify future scientific and observational activities, as well as organizations with specific commitments to carry out field campaigns. In addition, scientific issues have been successfully reformulated.

The participation in VEPIC of Chile and Perú were highlighted. Chile is organizing a cruise in 2004, which will be a collaboration between the Navy and the Met Service. Peru is operating a set of buoys that provide a unique dataset on the eastern subtropical Pacific.

7.2 Science issues of the programs

R. Mechoso opened a discussion on the progress made as far on the understanding of the SALLJ in the context of CLIVAR. It was agreed that SALLEX could help to clarify several key scientific issues on the SALLJ. The emerging consensus is that the enhanced low-level flow east of the Andes results from a combination of dynamical orographic effects to the north and thermal effects to the south. Observational data are required to validate simulations of the intensity and diurnal cycle of the jet. It was agreed that an appropriate framework for CLIVAR would be based on the role of the SALLJ on moisture transports and tropical-extratropical connections.

The panel discussed the proposed North American Monsoon Assessment Project (NAMAP). It was agreed that a sharper definition of objectives is required. One strong opinion was that the project should not be limited to a simple inter-comparison between model outputs. NAMAP should aim to bring together specialists in modelling and analyses of empirical data, as well as those who gather the data in the field and address specific deficiencies of models and their parameterizations. This format would be similar to a Climate Process Modelling and Science Team (see subsection 2.4).

H. Le Treut expressed his willingness to start actions in order to increase participation in

VAMOS programmes of scientists involved in European-lead initiatives. European funding agencies have already provided support to several science activities in Latin America, mainly to satellite-related projects. There are also several European sponsored cruises in the southern Pacific, which have produced datasets of interest to VEPIC. LeTreut indicated that scientific issues such as those involved in the modelling of climate in the subtropical and extratropical South America are of a very broad interest. It might be possible put together a group of specialist in global and regional modelling in order to submit a proposal for funding to the European Union. The panel strongly encouraged LeTreut to proceed in that direction. The first step would be the preparation of a short "letter of interest" outlining the goals of the proposed activity and identifying potential participants for presentation to the European Union.

7.3 Data and Policy of Data Issues

The discussion on data primarily centred around the needs of the SALLJ programme. The panel members that are directly involved in SALLJEX argued for the need of historical data from the national Meteorological Services of the region. It was suggested that the World Meteorological Organization could greatly facilitate access to these data by contributing to disseminate information on SALLJEX among operational centres. It was stated that daily historical precipitation observations archived at the different national weather services of the region have not been organized in a single dataset yet. There is a general agreement by SALLJ Project scientists that availability of such dataset is crucial for the achievement of program goals, namely the better understanding and simulation of precipitation variations.

SALLJEX will provide an exceptional opportunity to develop, implement and test a data policy for VAMOS. The data obtained in a field program can be broadly classified into three broad categories:

1. free available when observations are made
2. released after a period (for scientists involved in the experiment by using pass-word)
3. data that will be never released, for example daily precipitation data.

SALLJEX is the first field program in South America for VAMOS and also for CLIVAR. It is therefore important for both VAMOS and CLIVAR to proceed with caution in setting up policies for data distribution. An important issue is that data should not be released without a thorough quality control. That is the reason for planning a workshop immediately after the experiment to discuss data policies as well as ancillary data to be received from other sources. An expected outcome of the workshop would be the development of a standard data policy for VAMOS field programs.

7.4 Calendar of VAMOS Activities

The timeline of VAMOS meetings was reviewed. In addition to SALLJEX and the PLATIN SSG meeting in Buenos Aires, NAME plans to meet in the fall of 2003. VEPIC plans a special observing period during SALLJ EX.

The Seventh AMS Conference on Southern Hemisphere Meteorology and Oceanography will New Zealand on March 2003. K. Mo, past chair of the AMS Committee that organizes the conference, was encouraged to propose a session on the South American Monsoon System.

7.5 Topics for VPM6 and venue for the meeting

It was decided that the Sixth Annual Meeting of the VAMOS panel (VPM6) will highlight VEPIC. Two highly appropriate venues for VPM6 are Perú and Ecuador. These countries host number of well-known national and international organizations that might sponsor the event. Examples of such organizations are Estudio Regional del Fenómeno de El Niño (ERFEN), Instituto del Mar del Perú (IMARPE), Instituto Geofisico del Peru (IGP).

7.6 Links with other CLIVAR panels

Discussions held at the Tenth Annual Meeting of the CLIVAR Scientific Steering Group (SSG, Toulouse, France 15-18 May 2001) and the fourth meeting of the CLIVAR Asian Australian Monsoon Panel (AAMP, Reading, England, August 29-31, 2001). Diurnal and seasonal cycles, in the tropics, for example, are often poorly simulated in models. Special challenges arise from the need to model phenomena in a wide variety of space and time scales, such as convective precipitation, low-level jets, synoptic disturbances and continental or even planetary scale structures. There is also a need to evaluate simulations of specific processes and phenomena in climate models. This means confronting models with observational data, including those from field experiments, at a higher level than is currently done.

A proposal for a cross-CLIVAR Workshop on monsoon modelling of monsoon systems is under monsoon panel. The proposal will be presented at the coming meeting of the CLIVAR SSG (SSG 12).

It was also acknowledged that the establishment of close links with the activities of CLIVAR panels for the oceans adjacent to the Americas is one of the highest priorities for VAMOS. VEPIC must coordinate with Pacific Ocean panels. VAMOS endorses the development of a research programme on the climate of the Southern Ocean in collaboration with the Atlantic Ocean panel.

7.7 Executive session

C. Vera was unanimously nominated as panel’s Vice-Chair, and R. Mechoso was nominated to remain as panel’s chair until 2004. These nominations will be presented at the CLIVAR SSG meeting in May 2002.

R. Mechoso encouraged the panel members to consider the contributions that VAMOS might make to the CLIVAR Science Conference in 2004. In closing, the panel thanked Dr. Jorge Amador and his collaborators at the University of Costa Rica for the excellent organization of VPM5

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Appendix 2: Agenda

WCRP/CLIVAR
Fifth Annual Meeting of the VAMOS Panel
San José, Costa Rica, 13-16 March 2002

Wednesday, March 13, Morning Session, Plenary
Chair: Jorge A. Amador

8:50 am Opening of VPM5
- *Carlos Ereño, International CLIVAR Project Office*
- *Anthony Busalacchi, CLIVAR Scientific Steering Group Co-Chair*
- *C. Roberto Mechoso, VAMOS Chair*
- *Eladio Zarate, Director Instituto Meteorologico Nacional y Representante de Costa Rica ante OMM*
- *Oscar Arango, Director Oficina Subregional de OMM en San José*
- *Yamileth Gonzalez, Vicerrectora de Investigacion y Representante del Rector, Universidad de Costa Rica*
- *Guy de Teramond, Ministro de Ciencia y Tecnología*

9:30 am Short Break
9:40 am CLIVAR Report – *Tony Bussalachi (CLIVAR Co-Chair)*
10:05 am VAMOS Chair's Report – *C. Roberto Mechoso (VAMOS Chair)*
10:30 am Break
11:00am The VAMOS/CLIVAR/WCRP Conference on the South American Low Level Jet – February 5-7 2002, Santa Cruz Bolivia – *Carolina Vera*
11:30am US CLIVAR and the Eastern Pacific Investigation of Climate Program (EPIC) – *Steven Esbensen*
12:00am The VAMOS Database – *José Meitin, Steve Williams*
12:30pm Break

Wednesday, March 13, Afternoon Session – First Part, Plenary
Chair: C. Roberto Mechoso

2:00pm The VAMOS Investigation of the Eastern Pacific Climate (VEPIC) – *Chris Bretherton*
The EPIC2001 stratocumulus cruise
Large-scale modeling activities
Upcoming field activities (FONDECYT, CHOC, RICO)
2:30pm The North American Monsoon Experiment (NAME) – *Wayne Higgins*
3:00pm Project Office for VAMOS Programmes - *Gus Emmanuel*

Wednesday, March 13, Afternoon Session – Second Part

Parallel Session 1: NAME WORKSHOP
Session 1: NAME International Partnerships
Chair: Carolina Vera

4:00pm SMN Participation in NAME - *Miguel Cortez*

4:20pm IMTA Participation in NAME; Promotion of *NAME* within Mexico; *University of Vera Cruz participants*; other linkages - *Rene Lobato*

4:40pm CICESE Participation in NAME - *Maria T. Cavazos*

5:00pm University of Guadalajara participation in NAME - *A. Meulenert Pena*

5:20pm Central American Collaborative Interests - *Jorge Amador*

5:40pm Historical Data Archives In Mexico - *Art Douglas*

6:00pm Break

Parallel Session 2: VEPIC Working Group
Session 1: Participant update talks
Chair: Chris Bretherton

4:00pm The DYCOMS-II nocturnal *stratocumulus* study (July 2001) - *Bjorn Stevens*

4:20pm A new boundary layer and shallow cumulus parameterization in the MM5 mesoscale model and application to NE and SE Pacific cloud-topped boundary layers. - *Chris Bretherton*

4:40pm High-frequency variability in the marine boundary layer off the Chilean coast, including plans for the FONDECYT and CHOC field studies. - *Jose Ruttland and Rene Garreaud*

5:00pm GOES retrievals of cloud properties over the SE Pacific - *Bruce Albrecht*

5:20pm"The Andes and the Peruvian stratocumulus" and "A positive feedback between marine stratocumulus and the tropical circulation in the UCLA-AGCM" - *Rafael Terra*

5:40pm Shipboard remote sensing of boundary layer fluxes and cloud during NOAA research ship operations as a form of extended monitoring. - *Chris Fairall*

6:00pm Break

Thursday, March 14, Morning Session

Parallel Session 1: NAME WORKSHOP
Session 2. NAME Field Campaign
Chair: Maria A. Silva Dias

8:30am Some ideas for a NAME "ramp-up" strategy - *Mike Douglas*

8:50am Problems with the precipitation network and estimation of retrospective precipitation - *Dennis Lettenmaier*

9:10am The NAME/TRMM connection - *Scott Curtis*

9:30am Measuring and Modeling Topography Dependent Precipitation: the NAME

Parallel Session 2: VEPIC Working Group
Chair: Chris Bretherton

8:30am Continuation of participant talks (as needed). Otherwise move to implementation plan discussion.

Raingauge Network – *Chris Watts, Jaime Garatuza, Dave Gochis and Jim Shuttleworth*

9:50am The NAME Wind Profiler / Radar Network - *Rit Carbone, Steve Rutledge*

10:10am Break

10:30am NOAA Research Vessel Ron Brown / ETL Participation in NAME - *W. Peterson, Chris Fairall, Rob Cifelli, M. J. Post*

10:50am Simple raingauge network / Flux measurements for NAME - *Rene Lobato*

11:10am SuomiNET: Real-time National GPS Network - *Andrea Hahmann*

11:30am XBT's in the Gulf of California - *Saul Miranda*

11:50am Charge to the NAME Work Session - *Wayne Higgins*

12:30pm Break

10:10am Break

Discussion of science/implementation plan. The VEPIC science plan from VPM4 is posted at http://www.atmos.washington.edu/~breth/VEPIC/VEPIC_Science_Plan.pdf

Summary of issues:

- Coordinated data analysis
- Modelling
- Extended monitoring esp. San Felix
- Intensive field observations - EPIC Phase II?

12:30pm Break

Thursday March 14, Afternoon Session – First Part

Parallel Session 1: NAME WORKSHOP
Session 3. NAME Work Session
Chair: Art Douglas

2:00pm NAME Ramp-up Strategy, and Design/Integration of the Observing System – *M. Douglas*

3:30pm Break

Parallel Session 2: VEPIC Working Group
Chair: Chris Bretherton

2:00pm Continued from Morning Session, and Revision of implementation plan.

Preparation of VEPIC WG summary for plenary

3:30pm Break

Thursday, March 14, Afternoon Session – Second Part, Plenary
Chair: Jorge A. Amador

Presentations by Participants from Host Country

4:00pm Some aspects of regional climate – *Jorge A. Amador*
4:20pm Activities of the IMN in relation to climate research– *Eladio Zárate*
4:40pm Modeling Activities at the University of Costa Rica – *Jorge Gutiérrez, Jorge A. Amador, and Omar G. Lizano*
5:00pm Multivariate Statistical Methods, Applications in Central America – *Eric J. Alfaro and F. Javier Soley*
5:20pm Education and Training at the University of Costa Rica – *Walter Fernández and Vilma Castro*

5:40pm Measurements of raindrop size distribution in Costa Rica – *Edwin Campos and Walter Fernández*

6:00pm Break

Friday, March 15, Morning Session

Parallel Session 1: NAME WORKSHOP
Session 4. NAME Modeling and Diagnostic Studies
Chair: Jim Shuttleworth

8:30am NAMIP - *Dave Gutzler*

8:50am Global Modeling Activities and NAME - *Siegfried Schubert*

9:10am Features of the NAM depicted in CPC's Seasonal Prediction GCM Runs - *Jae Schemm*

9:30am IRI Warm Season Forecasts – *Chet Ropelewski*

9:50am Mesoscale Modeling Activities for NAME - *Dave Stensrud*

10:10am Influence of SST over the Gulf of California for the NAM - *Kingtse Mo*

10:30am Break

10:50am Simulation of the NAM with Eta / EDAS; NCEP Regional Reanalysis - *Hugo Berbery*

11:10am The Diurnal Cycle of Cold Cloud and Precipitation over the NAME Region, 1985-2000 -*Phil Arkin*

11:30am Moisture Budget of the IAS, Its Transport and Their Roles in Warm Season Precipitation - *Chidon Zhang*

11:50am PIRCS Activity -*Ray Arritt*

12:10am CSU Simulations of the North American Monsoon: Overview and Recommendations - *S. Rutledge, C. Castro, William Cotton and Roger Pielke*

12:30pm Break

Parallel Session 2: VEPIC Working Group
Chair: Chris Bretherton

8:30am Continuation of VEPIC group discussions

10:30am Break

10:50am Continuation of VEPIC group discussions

12:30pm Break

Friday March 15, Afternoon Session – First Part

Parallel Session 1: NAME WORKSHOP
Session 5. CLIVAR/ PACS, GEWEX/GAPP and NAME
Chair: Chidong Zhang

2:00pm CLIVAR-PACS NAME Plans - *Mike*

Parallel Session 2: VEPIC Working Group
Chair: Chris Bretherton

2:00pm Continuation of VEPIC group

Patterson

2:20pm GEWEX-GAPP-NAME Plans - *Rick Lawford, J. Huang*

Session 6. NAME and Human Dimensions

2:40pm NAME and Human Dimensions - *Andrea Ray*

Session 7. NAME Education and Training

3:00pm A strawman for the Educational Component of NAME / Student Observers in NAME - *Jorge Amador, Rene Lobato*

3:20pm Central American Training Course – *Mike Douglas*

3:30pm Break

discussions (if needed)

3:30pm Break

Friday March 15, Afternoon Session – Second Part, Closing Plenary

Chair: C. Roberto Mechoso

4:00pm Reports on NAME WORKSHOP – *Wayne Higgins*

4:45pm Report on VEPIC Working Group Meeting – *Chris Bretherton*

5:30pm General Discussion - *C. Roberto Mechoso*

6:00pm End of VPM5

Saturday March 16 – Panel Session

9:00am CLIVAR Executive Session

12:30pm End of Panel Session

Appendix 3: Extended Abstracts

Status of VAMOS

The following report by C. Roberto Mechoso was prepared for the annual meeting of the Joint Scientific Committee (JSC) of WCRP in May 2002.

VAMOS Report for SSG11 – April 2002

C. Roberto Mechoso, Chair

VAMOS has completed a science-study phase emphasising the climatology and variability of the American monsoon systems. During this phase, VAMOS contributed to motivate and coordinate the Eastern Pacific Investigation of Climate (EPIC). An EPIC field campaign (EPIC 2001) took place between September 1 and October 15 of 2001 in Huatulco, Mexico and San Cristóbal, Galápagos Islands, Ecuador. Further information on EPIC can be found at http://www.joss.ucar.edu/epic/.

The current implementation of the VAMOS science plan is based on three international coordinated efforts:

- Investigation of American Monsoon Systems: Monsoon Experiment South America (MESA) and North American Monsoon Experiment (NAME). MESA and NAME both target important aspects of climate research within the Americas and the adjacent oceans.
- Development of the VAMOS database and research programs on the Tropical Cyclones and Bolivian Altiplano.
- Establishment of long-term climate monitoring capability spanning the monsoon regions in the Americas and the tropical Pacific and Atlantic

The MESA process study to be developed first targets the South American Low-Level Jet (SALLJ). SALLJ will be the second WCRP-sponsored programme in South America. A special observations period (SALLJEX) will take place in December 2002-February 2003. In preparation for SALLJEX, a WCRP/CLIVAR/VAMOS conference on the South American Low Level Jet was held in Santa Cruz, Bolivia, February 5-7, 2002. More than 60 scientists from all countries in the SALLJ region (Bolivia, Argentina, Uruguay, Brazil, and Paraguay), as well as scientists from the US and Chile, participated in the conference. The deliberations concentrated on integrating different results and conclusions in a unified conceptual model of the SALLJ. A training course for SALLEX participants was also held in Bolivia immediately following the conference. A SALLJ workshop is planned immediately after the experiment to discuss policies of use of the information gathered as well as ancillary data to be received from other sources. A draft of SALLJ science document can be found at fttp://www.met.utah.edu/jnpaegle/research/ALLS.html.

MESA also includes the VEPIC programme, which focuses on the climate of the eastern Pacific Ocean. The annual panel meeting in 2003 will highlight the implementation of this programme. Several field campaigns led by Chileans scientists will be conducted in the VEPIC framework. A draft of the VEPIC science plan can be found at ftp://www.eos.atmos.washington.edu/pub/breth/VEPIC_science_plan.pdf.

NAME as an internationally coordinated, joint CLIVAR-GEWEX process study aimed at determining the sources and limits of predictability of warm season precipitation over North America. NAME is developing very rapidly, and some of its component subprojects have already started their implementation phases. A version of the NAME Science and Implementation Plan is available at: http://www.cpc.ncep.noaa.gov/products/precip/monsoon/NAME.html.

There are several activities leading to the establishment of a research programme on the climatology and hydrology of the Plata Basin in South America (PLATIN). A joint CLIVAR/GEWEX PLATIN group is working towards the establishment of an international group on modelling the climatology and hydrology of large river basins.

The VAMOS Database and data management activities are organised within the CLIVAR Data Task Team. There is an ongoing data collection and archival activities at UCAR Joint Office for Science Support and NOAA National Severe Storms Laboratory in support of the Pan American Climate Studies (PACS) programme, which contributes to VAMOS. More information is available at http://www.joss.ucar.edu.

A VAMOS Project Office (VPO) has been established to support the different field programs to be developed under VAMOS, starting with the planning and field implementation of NAME and MESA/SALLJ. The VPO will address all facets of data management, including data collection, validation, quality control, and archiving. It will also support the efforts of the Data Management Sub-Group and individual Project Supports Teams, which assess the scientific requirements for field-specific site surveys, and interface with relevant countries/specific locations to secure the necessary clearance and permits for ground-based research sites, aircraft flight tracks, etc.

VAMOS will contribute to CEOP (Co-ordinated Enhanced Observing Period). CEOP is a WCRP element that aims to provide a unique hydro-climatological dataset combining information from *in situ* stations, special and operational satellites, and model output that focuses on two annual cycles (2003-2004). CEOP will have a major Data Management activity and two science objectives: 1) water and energy cycle simulation and prediction, and monsoon system studies.

The VAMOS panel requires that its component projects actively seek to create a legacy. This includes a project data base, education and training for regional scientists and observational systems that may have been proven to be of value for improved climate and hydrological prediction. It also includes implemented upgrades to the operational systems used by interested stakeholders and published records of progress that reflect the international framework of the project.

Issues and limitations to future progress

8. As process studies over the continents get underway, the need for coordination with regional National Weather Services (NWS) becomes more evident. For example, a daily precipitation dataset is absolutely crucial to VAMOS scientists involved in the SALLJ Project. NWSs, however, have been generally reluctant to freely provide those data to scientists even from their own countries. The VAMOS panel has found that several NWSs are willing and even eager to collaborate with the research community. The panel is of the opinion that a major effort must be made to bring together the operational and

research communities. NWS must be better informed about WCRP activities and encouraged to become active partners in its programmes, as well as to be the first users of research findings in their operational decisions.

9. An extraordinary spirit of cooperation has developed among scientists of different countries interested in VAMOS programmes. Funding of these efforts, nevertheless, can only be allocated at the national level.

10. The strong probability that a GEF funded project will occur with a key participation of a CLIVAR/GEWEX group (PLATIN) may require a negotiating power beyond the VAMOS panel.

Panel issues

The panel requests SSG endorsement for panel membership of Dennis Lettermaier (U. Washington, USA), Kingtse Mo (NCEP, USA), Andrew P. Robertson (IRI, USA), and María A. Silva-Dias (U. Sao Paulo, Brazil). They replace, respectively, James Shuttleworth (GAPP), Julia Paegle, Antonio D. Moura (IRI), and Pedro Silva-Dias (LBA). The panel also requests SSG endorsement of Carolina Vera (U. Buenos Aires, Argentina) as the panel's Vice-Chair. It is proposed that C. Roberto Mechoso (UCLA, USA) continue as panel's chair until 2004.

Acknowledgements

The VAMOS panel acknowledges the exceptional performance of Carlos Ereño in his capacity as ICPO contact, and the friendly help of Andreas Villwock. Jorge Amador, of the University of Costa Rica, was an excellent organiser of the 2002 annual panel meeting.

VAMOS/CLIVAR/WCRP Conference on South American low-level jet.
Santa Cruz de la Sierra, Bolivia, 5-7 February 2002.

Carolina Vera
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Introduction

The VAMOS Programme is organizing a field program on the South American Low-Level Jet (SALLJ) that flows southward along the eastern flank of the Andes mountains. The field campaign (SALLJEX) is currently planned for three months (Nov 15 2002 - Feb 15 2003) with two (one-month each) special observing periods. The data gathered will allow for a better understanding of several important issues related with the tropical-extratropical moisture transport over central and subtropical South America. As a preceding activity, the VAMOS/CLIVAR/WCRP Conference on the South American low-level jet took place at the Royal Lodge Hotel in Santa Cruz de la Sierra, Bolivia, from 5-7 February 2002.

There were over 60 scientists from all the countries on the SALLJ region (Bolivia, Argentina, Uruguay, Brazil, Paraguay) and also from the U.S.A and Chile. The Conference consisted of around 50 presentations grouped in 4 main sessions. By the end of each session plenary discussions were held mostly concentrated on integrating the different results and conclusions in a single conceptual model of the SAMS.

The different elements acting on the moisture transport between the tropics and extra-tropics over South America are presented in figure 1. On a large scale, easterly trade winds transport moisture from the equatorial Atlantic into the continent. The Amazon region and the south-western Atlantic ocean are considered as additional moisture sources. Moisture is then mainly advected along the eastern slope of the Andes to the south and near the Andes “elbow” a maxima of the low-level winds are observed in all seasons with frequent LLJ episodes. Although the LLJ definition is related with the meso-scale characteristics of the flow intensity and shear, this name has been extended by the VAMOS community to identify, from a large-scale perspective, the moisture corridor flowing to subtropical and middle latitudes. Poleward moisture penetration is strongly modulated on synoptic, intraseasonal and even interannual timescales. Moisture convergence occurs over la Plata basin and enhanced precipitation is observed mostly due to meso-scale convective system activity.

SALLJ Characterization and Variability

The observed east-Andes low level jet (LLJ) is modulated by an orographically-bound, lower-tropospheric cyclonic circulation in both winter and summer. The LLJ and cyclone both tend to accelerate in the presence of enhanced cross-Andes westerly winds. Certain aspects of these observations may be explained in terms of simple, adiabatic models in which orography provides only mechanical, rather than heating modifications of the zonally averaged circulation. More complete model studies probe the mechanical effects of South American orography with more detailed diagnoses of LLJ phase and response to ambient circulation and to baroclinically evolving Rossby waves. Superposition of a baroclinic wave train upon realistic southern hemisphere circulation, allows favourable conditions for southward LLJ penetration in the presence of an evolving cyclonic perturbation over South America. This appears to be a dominant mechanism in stronger jet cases. Also, highly resolved regional models show that in some cases the LLJ tends to be progressively more confined to the immediate slopes of the Andes as the horizontal model resolution increases to 4km grid spacing. Because the jet narrows with increasing resolution, attendant moisture fluxes become smaller as model resolution increases. This carries important implications for possibly over-estimated LLJ fluxes in crude reanalyses. The result also indicates the need for high-resolution cross-jet aircraft observations in field campaigns. Regional simulations also point out diurnal signatures in pressure oscillations as well as in wind fields, and show phase variation with latitude. The maximum jet lags minimum surface pressure by approximately 2 hours, and LLJ initiation often starts around 18°S, and then spreads toward 30°S in strong LLJ cases (usually called Chaco cases).

Statistics of Chaco jet events in reanalyses indicate typical periods between 1-5 days, extending at times up to 10 days. Comparisons of reanalyses against surface-based wind soundings show some qualitative agreement in scatter plots of analysed and measured winds for Santa Cruz, Bolivia, located on the slopes of the Andes at the mean maximum wind area. Larger scatter of observed/analysed winds characterizes a site further removed from the orography, at Rondonia, Brazil. The fact that local processes over that area are not well reproduced by numerical models could explain such result.

There were some discussions on the validity of the Bonner criterion to detect a LLJ. This criterion was developed for LLJ in North America with radiosonde observations with higher resolution in time, and may need some sort of adjustment to make it suitable for South America in order to adequately account for the apparently deeper character of the SALLJ. A revision of the Bonner criteria for SALLJ was suggested using SALLJEX data.

The SALLJ and precipitation development

The relationship between SALLJ events and meso-scale convective system (MCS) activity over South America was also discussed at the Conference. The two primary regions for MCS formation are the central United States and central South America. In both of these regions the MCSs appear to be maintained by the advection of warm moist tropical air via the low-level jets found in the two regions. Evidence was presented showing that the SALLJ was present prior to the onset of convection, with 80% of the MCSs occurring during periods with intense northerly low-level flow. The LLJ seems to provide maximum moisture flux convergence that intensifies the MCS, becoming its primary moisture source. The observed diurnal cycle of MCS activity includes an onset period between 1500-2100 LT, a mature phase at night and a dissipation phase in the morning. The diurnal cycle as identified with observed rainfall and TRMM products in southern South America (south of 15°S) shows a nocturnal maximum consistent with that of the MCS activity. In contrast, over most of the Amazon rainfall exhibits a maximum in early afternoon. There is a need for more observations of rainfall in order to validate TRMM and other satellite-derived precipitation products.

Analyses suggest that above 45 % percent of austral summer precipitation over la Plata Basin can be explained by the occurrence of LLJ events. The large-scale circulation features detected over South America, associated with SALLJ events, include: 1) an alternating pattern of anticyclonic and cyclonic circulation anomalies (wave train) from the central South Pacific to the region of South America, 2) mid- and upper-tropospheric trough over southern South America, 3) mid- and upper-tropospheric ridge near the coast of southern Brazil, 4) below-normal sea level pressure over Argentina and the southwest South Atlantic, 5) above-normal temperatures over southern Brazil, Paraguay, Uruguay and northeastern Argentina, 6) below-normal temperatures over central and southern Argentina, 7) intensified baroclinic zone over central Argentina, 8) heavier-than-normal rainfall over southern Brazil, Uruguay, southern Paraguay and northeastern Argentina, 9) drier-than-normal conditions over northern and central Brazil, and 10) lack of a significant SACZ.

The presence of a LLJ is related to a large-scale wave pattern at upper-levels, that extends from the central Pacific eastward to South America. This pattern has also been linked in previous studies to the modulation of the position of the South Atlantic Convergence Zone (SACZ) during austral summer. The connection between SACZ and LLJ episodes was extensively discussed with the intensification of the LLJ related to an inactive SACZ, and vice versa. This impacts the precipitation in southern Brazil-northern Argentina, the South American monsoon region, and the region of the SACZ. In the specific cases of JFM 1998 and 1999, 1998 (El Niño year) showed strongest LLJ and more MCS and rainfall in subtropical South America, and a less active SACZ. On the other hand, 1999 presented more than six times the number of MCS and large precipitation in the tropics, an active SACZ and fewer LLJ episodes.

Analyses of the circulation anomalies accompanying anomalous warm and cold surface waters in the western subtropical South Atlantic on interannual timescales, show that during austral summer, warm conditions are associated with a strong advection of moist air from the Amazon basin toward SE South America. These features explain enhanced southward moisture flow and above normal precipitation over la Plata Basin. At the same time, easterly wind anomalies prevail over the SACZ, where convection is relatively weak. Moreover, circulation differences between wet and dry periods in the south-eastern Amazon, during the wet season, show a close relationship to changes in the orientation and strength of the LLJ. Similar circulation changes were also found to occur during the onset and demise stages of the wet season.

SAMS numerical simulations

Regional and global models were shown to successfully simulate the synoptic variability associated with LLJ events. However, different models have similar problems reproducing correct amounts of seasonal precipitation over Amazonia and the Altiplano while they reproduce SACZ stronger than normal. The fact that most models underestimate MCS precipitation promoted the discussion about the importance of improving cumulus parameterizations in models. Also, meso-scale structure (dynamic and thermodynamic) needs further observations and studies to relate MCSs to LLJ and baroclinic influences and thus improve numerical simulations of precipitation.

Another main conclusion of the Conference was the need to have a historical daily precipitation dataset available at the VAMOS dataset site for the SALLJ Project scientists. The main problem is that daily historical precipitation observations archived at the different national weather services of the region have not yet been gathered in a single dataset. The those data to scientists even from their own countries. As a consequence scientists have been using in their investigations partial datasets just of their own countries and in general with specific restrictions not to transfer them to others. SALLJ Conference participants are convinced that the availability of such datasets is crucial to better understand and simulate precipitation variations over tropical and subtropical South America from synoptic to interannual timescales and also to describe the role of the SALLJ on precipitation development. In an effort to remedy this situation, a letter formally requesting the historical daily precipitation dataset was sent to the NWS of the SALLJ region. Although the wisdom of this approach has been generally acknowledged within the region, difficulties have been experienced in expeditiously resolving this issue.

The Conference was chaired by C. Vera (CIMA/UBA, Argentina). C. Ereño (ICPO), Ramiro Villarpando (UMSA, Bolivia) and Carlos Diaz (SENAMHI, Bolivia) were members of the organizing committee. Members of the program committee were: Patricio Aceituno (Univ. of Chile, Chile), Pedro Silva Dias (IAG/USP, Brazil), Jan Paegle and Julia Paegle (Univ. of Utah, USA), Matilde Nicolini (CIMA/UBA, Argentina), Vernon Kousky (NOAA/CPC, USA), Jose Marengo (INPE/CPTEC, Brazil), Alice Grimm (UFPR, Brazil) and Rong Fu (EAS, USA).

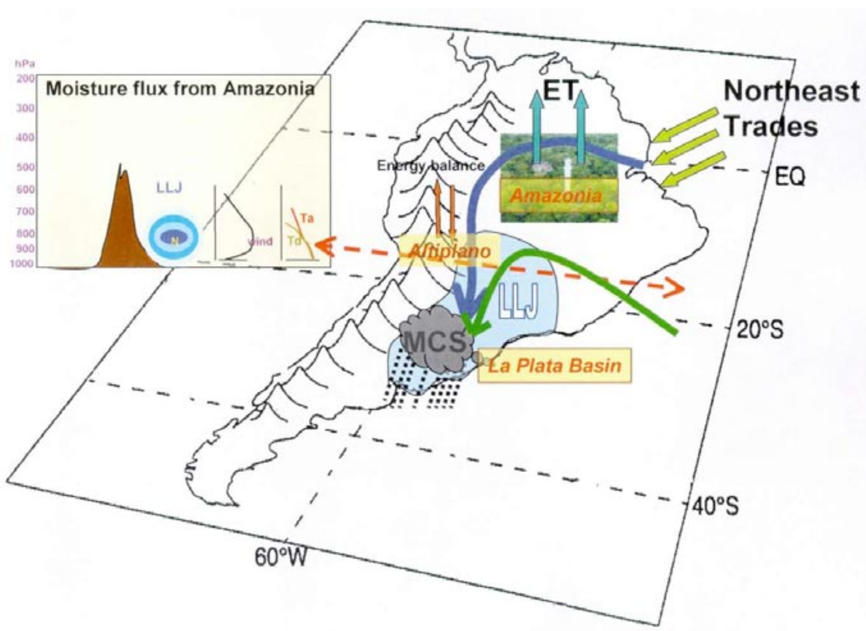

Figure 1: Schematic diagram of elements relevant to poleward moisture transport over South America (courtesy Jose Marengo, CPTEC/INPE, Brazil)

Summary of Presentations by Participants from Host Country

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Presentations by participants from the host country addressed the current status of several components and activities of climate research in Costa Rica. Institutions such as the Universidad de Costa Rica (Centro de Investigaciones Geofísicas (CIGEFI), and Laboratorio de Investigaciones Atmosféricas y Planetarias (LIAP), School of Physics), the Instituto Meteorológico Nacional (IMN) and the Instituto Costarricense de Electricidad (ICE) have been working in close collaboration in different areas of climate and climate variability research in the region. Most of the research has been carried out with grants from local institutions, IAI, NOAA/OGP, Pan American Institute of Geography and History (PIGH), among others.

Jorge A. Amador presented a review of the current knowledge on regional climate systems ant its relationship with the precipitation distribution, both in space and time, in Central America. One of the most striking features of climate in the region is related to the seasonal precipitation distribution on the Pacific side of Central America as opposed to that of the Caribbean slope. On the Pacific side, a bimodal precipitation pattern predominates, with maxima in May-June and September-October. A clear reduction in precipitation is observed during July-August, a feature that is locally known as the “veranillo” or mid-summer drought. Over the Caribbean slope, July is the month with maximum precipitation, and no evidence of any dry spell is observed. The Caribbean Low-Level Jet (CALLEJ) constitutes the most important atmospheric circulation during the summer months. Although its origin is still unclear, its barotropically unstable nature suggests a close relationship with transients (easterly waves). On inter-annual time scales the strength of the low level jet varies, following ENSO cycles, such that, during El Niño (La Niña) events, the low level jet is more (less) intense and transient activity in the eastern Pacific increases (decreases). Its intensity is closely related to tropical convective activity, not only on seasonal, but also, on inter-annual time scales. Low-level jet changes in intensity modulate the wind shear amplitude and therefore, the conditions for tropical cyclone activity. The CALLEJ may even constitute the dynamical mechanism through which the Caribbean and eastern Pacific SST anomalies are related. Using NCEP/NCAR data, Fig 1. presents the long term mean (1958-1998) of the 925 hPa wind (m/s) for July showing the core of the jet near 15ºN 75ºW.

Jorge A. Amador also examined the efforts that are being carried out to improve, within the context of a regional IAI project (CRN073), the understanding of the summer rains in Mexico, Central America and the Caribbean as a process involving air sea interactions. The ultimate goal of this project is to provide more accurate and adequate climate predictions to fulfill some of the needs of climate information of particular socioeconomic sectors. To achieve this goal, the Climate Experiment in the Americas Warm Pools (ECAC) brought together all CRN–73 and PESCA–05 participants, to work on data acquisition on board of the National Autonomous University of Mexico (UNAM) oceanographic vessels. ECAC included three campaigns in the Pacific and one in the Caribbean. Field work included meteorological, oceanographic, biological and chemical observations on board and in various continental locations of the region of interest. The ECAC field activities concluded on September 8, 2001. After that, data organization, data quality checking and data analyses have been conducted among CRN participants. Some preliminary results have been obtained and are being prepared for publication in scientific journals. Undergraduate and graduate students currently conduct their thesis work based on the analysis of ECAC data. During ECAC-3 (6-26 July 2001) one of the goals was to document and gathered additional information about the CALLEJ and study air sea interaction processes. Radiosonde data provided information for Fig. 2, which presents the vertical profile of the wind speed during ECAC-3 on 13 July 2001 at 12Z near 19ºN 81ºW. As can be seen from Fig 2., the observed wind exhibits, on the one hand, a clear jet-like structure, and helps to validate, on the other, NCEP/NCAR Reanalysis data over this part of the Caribbean during the summer months.

Modelling activities at the UCR were presented by Jorge Gutierrez, Omar Lizano and Jorge A. Amador. The main interest of Jorge Gutierrez is the study of orographic flows. He has worked on the dynamics of flow past isolated mountains as well as flow past mountain ranges in different regimes, i.e., low Froude-number-flows and high Froude number-flows.

Gutierrez showed some results, using the MM5 model, about the orographic generation and enhancement of rain and discussed potential applications of these results on weather forecasting, in particular over mountainous regions. Omar Lizano does his research on hurricane wave simulation in the Caribbean coast of Central America using third generation models. He stressed the importance of this type of work for the region in order to learn more about the coastal impact of hurricanes such as Mitch, which caused a damage in all Central America that was calculated in $6535 millions. In Costa Rica the implementation of numerical wave forecasting techniques began after the regional impact of hurricane Joan in October, 1988. An integrated one layer hurricane wind model was used as input to a second deep-water wave generation model to simulate the wave distribution for this particular case. As a result of academic exchange between the Centro de Investigación Científica y de Educación Superior (CICESE) de Ensenada, Baja California, Mexico, and CIGEFI, wave models of the type of the Third Wave Generation: SWAN and WAM, have been updated. These models are ready to forecast the wind and wave distribution from deep to shallow water for specific places in the Caribbean coast of Central America under hurricane conditions. Also, operational forecasting has been implemented for tourist beaches, and ports in Costa Rica, where the wave information is important to support the marine activities. Jorge A. Amador described a research initiative, funded by NOAA/OGP, that is aimed at the development of a regional climate modelling system for Central America by a group at CIGEFI and LIAP, in collaboration with scientists from the UNAM. The project lies within the tasks to be performed by regional institutions such as CRRH (Comite Regional de Recursos Hidraulicos) and CEPREDENAC (Centro de Prevencion de Desastres Naturales de America Central), and contributes to strengthen actions and previous support by WCRP/CLIVAR/VAMOS, NOAA-Mitch and Regional Climate Forum Programs. The intended result is a modelling system of regional extent with higher spatial resolution than that of GCM's (General Circulations Models), and driven by time dependent boundary conditions provided by models such as the CCM3 and ECHAM4. It is expected that this approach should significantly improve the prediction skill of climate systems, the regional scientific infrastructure and will provide an unique opportunity to enhance regional collaboration among National Weather and Hydrological Services and other regional institutions.Eladio Zárate reported on several of the climate operational and research activities of the IMN. He mentioned the different types of networks that the IMN operates, including a radiosonde observing system, one global atmospheric watch station, a satellite earth station to receive automated weather stations and meteorological satellite images, and others. Of great importance resulted the participation of the IMN in the Advance National Network for Research using internet 2. This network includes the four main public universities of the country and other institutions for research. Water concession process and activities and integrated water management in the IMN were highlighted. The presentation included aspects on weather forecasting and climate prediction relevant to the Panel meeting. Climate variability has a special site in the activities of IMN, generating products in relation to ENSO, monthly bulletins, seasonal outlooks and others. During the last years, the demand for this type of products has increased enormously, not only in Costa Rica, but also in Central America. The ozone and the climate change programs were mentioned, where IMN acts as the focal point with both, the Montreal Protocol and the IPCC, scientific body for the United Nations Framework for the Climate Change Convention. Zárate showed in this respect some of the activities developed, the current status of the programs and the future steps to fulfill the goals imposed by the country and the world society.

Eric Alfaro, and F. J. Soley, presented some results by the use of multivariate methods at LIAP and CIGEFI, such as Principal Components Analysis, Singular Value Decomposition and Canonical Correlation Analysis, which have proved to be a valuable tool in the study of climate variability. Vector Auto Regressive-Moving Average models besides identifying causes of variability are also useful in forecasting. These methods are being applied to the precipitation and temperature anomaly fields in Central America and the principles on which they are based are also used in academic activities. Some applications were presented. In the first one, a cluster analysis technique was used. This model showed that the Tropical North Atlantic Sea Surface Temperature Anomalies (SSTA) have the largest influence over the region when compared to that of other indices; having positive correlation with all the rainfall EOF's. The Niño 3, instead, was found to have lower correlation with the rainfall of the region, influencing only the Pacific related clusters. In the second one, a Transfer Function Model was fixed to SSTA of the Gulf of Tehuantepec, Papagayo, Panama and Quepos time series. This model showed that El Niño 3.4 has the most important influence over the region when compared with the influence of the other indices; having positive correlation with all the SSTA series.

Dr. Walter Fernández described the activities in atmospheric sciences at the UCR. He mentioned that the Department of Atmospheric, Oceanic, and Planetary Physics (DFAOP) of the UCR is today one of the main centres of meteorological education of Latin America, which offers degrees in the atmospheric sciences with emphasis on physical, chemical, and dynamical problems of the tropical regions. The DFAOP is part of the School of Physics. Since 1968, the UCR has been recognized by the World Meteorological Organization (WMO) as a “Regional Meteorological Training Center”. This has allowed a continuous collaboration of the WMO. The UCR offers the following programs of study: (a) Program for Meteorological Technicians, (b) Bachelor of Meteorology, (c) Licenciate of Meteorology, (d) Postgraduate course of specialization in Applied Meteorology and Operational Hydrology, and (f) Master Program (degree of Magister Scientiae) in Atmospheric Sciences. In the undergraduate programs, students from the following countries have graduated: Brazil, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, and Venezuela. From the Program for Meteorological Technicians students from the following countries have graduated: Brazil, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Netherland Antilles, Nicaragua, Panama, and Paraguay. In addition, from the postgraduate programs, students from Costa

Rica, El Salvador, Honduras, Nicaragua, Panama, and Mexico have successfully finished their degrees. In parallel to the activities in atmospheric sciences, other teaching and research activities in several branches of the geophysical sciences have been developed, particularly in physical oceanography, planetary science and remote sensing. Joint research is conducted at LIAP and CIGEFI. The current research topics of LIAP are: Applications of meteorological satellites, climate variability and global change, solar radiation and planetary radiation, structure and dynamics of clouds and storms, meso-scale and synoptic scale processes, numerical modelling, micrometeorology, atmospheric chemistry, atmosphere-ocean interaction, and planetary science. The research programs of CIGEFI cover all the geophysical sciences, but are orientated mainly to: remote sensing applied to natural resources, climate variability and regional climate modelling, prevention of natural disasters, structure and dynamics of geophysical systems, and physical oceanography. The teaching programs of the DFAOP and the research programs of LIAP and CIGEFI are strongly interrelated. As part of this joint effort, Edwin Campos finally described a research project related to field measurements of raindrop size distribution in Costa Rica.

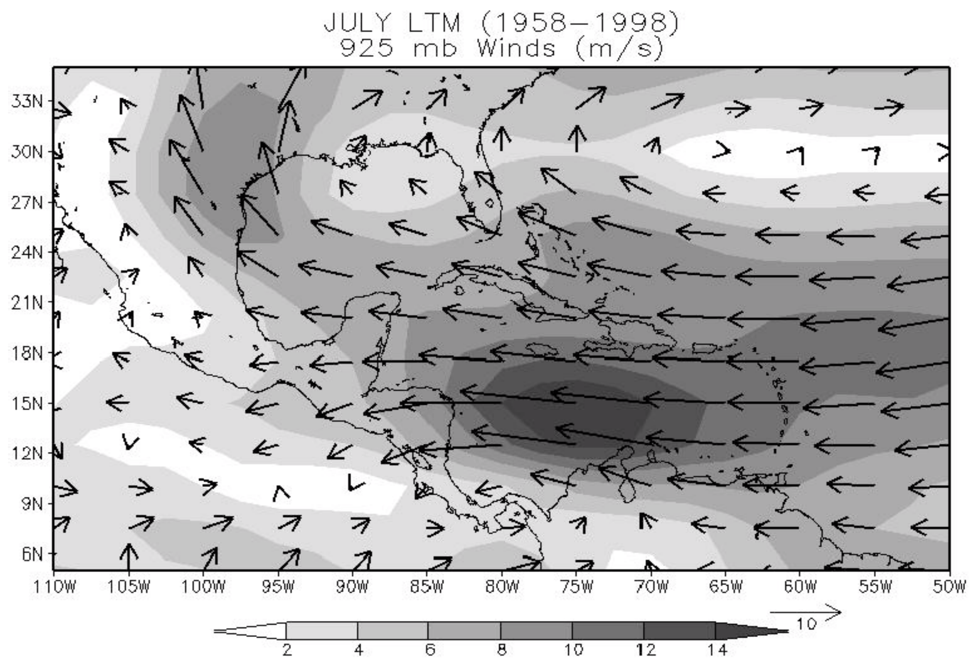

Fig. 1. Long term mean (1958-1998) of the 925 hPa wind (m/s) for July showing the core of the Caribbean Low Level Jet (CALLEJ) near 15ºN 75ºW, using NCEP/NCAR data.

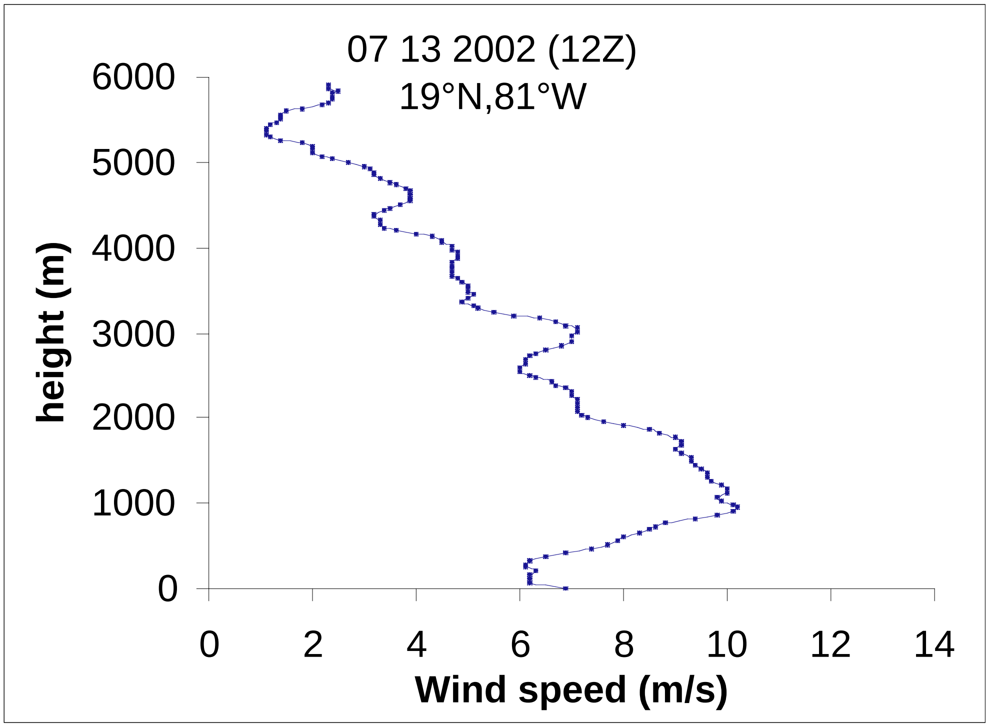

Fig.2. Observed vertical profile of the wind speed during ECAC-3 on 13 July 2001 at 12Z near 19ºN 81ºW (see text for details).