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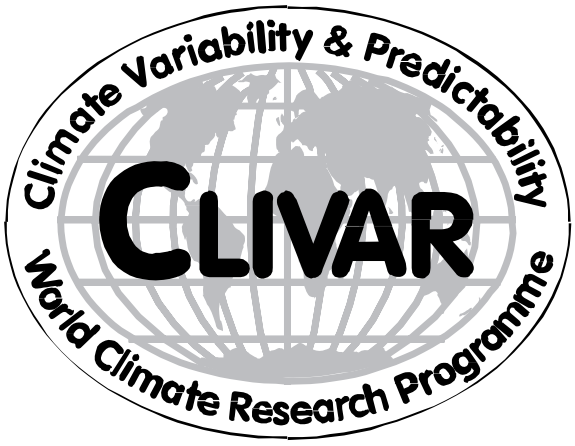

6th Session of the CLIVAR VAMOS Panel

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

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Executive Summary

The sixth session of the WCRP/CLIVAR VAMOS Panel (VPM6) was held in Miami, Florida, USA, from 23–26 April 2003. Hosts were the Rosenstiel School of Marine & Atmospheric Science (RSMAS), of the University of Miami, and the Atlantic Oceanographic and Meteorological Laboratory (AOML) of the US National Oceanic and Atmospheric Administration (NOAA). The event was attended by 55 participants from 11 countries. VPM6 had three principal objectives:

- Define an implementation strategy for the initiative known at the time as VEPIC (VAMOS Eastern Pacific Implementation of Climate).
- Discuss the desirability of restructuring VAMOS into more unified components.
- Define a climate modeling component for VAMOS.

The plenary session was opened by Dr. Kristina Katsaros, Director of AOML, Mrs. Valery Detemmerman, member of the Joint Planning Staff for the WCRP responsible for CLIVAR, and attending on behalf of Dr. David Carson, Director of WCRP, and Prof. C. Roberto Mechoso, UCLA and Chair of the VAMOS panel.

The starting presentations gave overviews of International and US CLIVAR. The first was given by Prof. Antonio Busalacchi, U. Maryland, who is co-Chair of CLIVAR's Scientific Steering Group (SSG). He summarized discussions held in CLIVAR on a WCRP Banner activity, and commented on proposed changes in the WCRP structure, particularly the establishment of modeling and observational councils. He also reported on the state of preparations for the First International CLIVAR Science Conference, which will take place in Baltimore, USA, on June 21- 25, 2004. The second presentation was given by Dr. Robert Weller, Woods Hole Oceanographic Institution, who is co-Chair of US CLIVAR. He highlighted the Eastern Pacific Investigation of Climate (EPIC), the first US CLIVAR enhanced monitoring project and process study. He also pointed out that US CLIVAR includes a Pan American component that contributes to the North American Monsoon Experiment and South America Low-Level Jet programme (NAME and SALLJ, respectively). Dr. Weller informed the meeting that US CLIVAR proposed the formation of Climate Process Teams (CPTs) in order to bring together scientists involved in field process, empirical, and modeling studies. He concluded by emphasizing the synergy between US CLIVAR and VAMOS programmes.

In his annual report on the progress of VAMOS, Prof. Mechoso expressed satisfaction with the programme's accomplishments since VPM5 in March 2002. He highlighted the establishment of the VAMOS International Project Office; execution of the South American Low-Level Jet Experiment (SALLJEX); and preparations for the NAME 2004 field campaign. SALLJEX was the first VAMOS field campaign. He also alluded to VAMOS activities relevant to applications. Prof. Mechoso noted that PLATIN scientists are participating in the Coordinated Enhance Observing Period (CEOP), and in the development of a framework programme on La Plata Basin, for which funding will be requested to the Global Environmental Facility (GEF). He indicated that VAMOS would benefit from a closer similarity in the structure of its two major components: NAME and the Monsoon Experiment in South America (MESA), and emphasized the importance of climate issues addressed by the VAMOS extension of EPIC (VEPIC). Prof. Mechoso ended his presentation by stating the VPM6 objectives and reviewing the format of the meeting.

There were three presentations on activities peripheral to VAMOS, but of special relevance to the programme. Prof. Carlos Ereño, the International CLIVAR Project Office (ICPO) staff member responsible for VAMOS, brought news from the ICPO. After a general overview of the present structure of CLIVAR and the objectives and specific tasks of ICPO, he mentioned staff changes during the past year. He then commented on technical improvements and updates in the CLIVAR web site. Dr. Silvia Garzoli, NOAA AOML, reviewed the Workshop on the South Atlantic Climate Observing System (SACOS). This was held on 6-8 February 2003, in Angra dos Reis, Brazil, under the sponsorship of CLIVAR, the Ocean Observations Panel for Climate (OOPC), and the Inter-American Institute for Global Change Research (IAI). SACOS recommended the design and implementation of a sustained monitoring system for the South Atlantic. Dr. Rafael Terra, U. de la Republica, Uruguay, introduced the project "Climate Variability and its Societal Impacts in South America" (CLARIS). This is a joint effort between European and South-American climate and applications scientists. A proposal for funding of CLARIS was submitted to the European Union with Dr. Jean-Phillipe Boulanger from the Laboratoire de Meteorologie Dynamique as Principal Investigator. VAMOS provided support to the proposal through a letter from the panel's chair.

A VAMOS Field Program Office has been established and Dr. Gus Emmanuel, UCAR-JOSS, is its director. He reviewed the office participation in SALLJEX, during which the NOAA WP-3D research aircraft (operating for the first time South America) supported the data gathering by making 13 flights for a total of 99 hours. Dr. Emmanuel reported that SALLJEX field operations hosted one high school teacher from Argentina and one from the US under the sponsorship of the NOAA OGP "Teacher-in-the-Field" program. The office is currently engaged in providing support to NAME activities.

The VAMOS database is an important asset for research programmes. Dr. Steve Williams and José Meitín, UCAR-JOSS and NOAA National Severe Storm Laboratory, presented an update on the database. The VAMOS Data Information Server is located at UCAR/Joint Office for Science Support (JOSS) with a "mirrored" server for the Southern Hemisphere, located at the IAI.

The following presentations were dedicated to the three major VAMOS components, and were given by their chairs. In the first, Dr. Carolina Vera, U. Buenos Aires and Vice-Chair of VAMOS, focused on MESA. She reported that SALLJEX was carried out with great success between 15 November 2002 and 15 February 2003 in Bolivia, Paraguay, central and northern Argentina, and western Brazil. Scientists, students and local volunteers from Argentina, Brazil, Bolivia, Paraguay, Chile, Uruguay and the US enthusiastically participated in the experiment. SALLJEX had three major components: 1) enhanced upper air observations, 2) enhanced raingauge daily observations, and 3) NOAA/P-3 aircraft missions. Detailed information on the experiment is available at http://www.salljex.at.fcen.uba.ar/. In the following presentation, Dr. Chris Bretherton, U. Washington, evaluated VEPIC related progress in atmosphere–ocean feedback in the eastern Pacific, including the diurnal cycle of subsidence over stratocumulus clouds and importance of cloud/drizzle/aerosols coupling. He described efforts on model/reanalysis validation, enhancements in monitoring, and other relevant field experiments such as the Dynamics and Chemistry of Marine Stratocumulus - Phase II: Entrainment Studies (DYCOMS-II). Dr. Wayne Higgins, Climate Prediction Center, NOAA/NWS/NCEP, gave a report on the status and plans of NAME emphasizing the programme's scientific rationale, linkages (to agencies and other programmes), modeling and data assimilation activities, and the NAME 2004 field campaign.

Three working groups concentrated on SALLJ, PLATIN and VEPIC. The level of activity in these working groups was very intense. The following paragraphs summarize the major outcomes, which were presented in plenary sessions.

- The SALLJ Working Group reviewed matters relevant to the SALLJEX data management, distribution and analysis. The realization of a workshop on SALLJEX was planned. The group agreed that the merging of SALLJ and PLATIN would provide a more adequate MESA structure for the comprehensive understanding of the different elements in the South American Monsoon System and its variability. The group found that the initiative to establish a climate modeling component for VAMOS had several merits.
- The VEPIC Working Group decided to rename VEPIC as VOCAL (VAMOS Ocean – Cloud – Atmosphere – Land study). A set of recommendations on diagnostic, sensitivity, and parameterizations studies to be encouraged by VOCAL was drafted. Coordination of activities with the US CLIVAR CPTs to feed into coupled model development was also recommended.
- The major outcome of the PLATIN working group was the conceptual design of a PLATIN Field experiment (PLATEX). A strategy based on the study of catchments with increased complexity and geographical extent was proposed.

A discussion on climate modelling in VAMOS was held in plenary. There was general agreement that VAMOS can provide unique contributions to climate model development in the areas of Land Surface Processes (NAME and MESA) and Boundary Layer Clouds (VOCAL). VAMOS can also provide important contributions to the improvement of model performance in diverse areas of North and South America, such as the lee of the Rocky and Andes Mountains.

The panel session reviewed the status of all VAMOS programmes and recommendations from the working groups.

VAMOS reorganization: It was decided to organize VAMOS in three components: NAME, MESA (encompassing SALLJ and PLATIN), and VOCAL. Component chairs will be W. Higgins, C. Vera, and C. Bretherton, respectively. A PLATIN group will continue working on the proposed framework project for La Plata Basin with Profs. Mechoso and P. Silva-Dias as co-Chairs.

VAMOS modeling. It was decided to convene an *ad hoc* working group to review the status of modeling relevant to VAMOS research, and to organize a special session at VPM7 on monsoon modeling. Prof. Mechoso and Dr. Ben Kirtman (COLA) will act as chair and vice-chair, respectively, and will request nominations from NAME, MESA, and VOCAL.

Relations with National Weather Services. Several Met Services in the region made significant contributions to SALLJEX but there were some cases where greater cooperation would have been beneficial. The matter will be brought up to the attention of the CLIVAR SSG.

SALLJEX Workshop. The panel warmly endorsed the realization in late 2003 of a workshop on SALLJEX data and follow-up activities.

GEWEX and PLATIN. It was decided to renew the VAMOS request for "Continental Scale Experiment" status for La Plata Basin to the GEWEX Hydrometeorology Panel (GHP).

Panel membership. Panel membership remains the same in 2003. The panel members were asked to vote by e-mail for the replacements of both the chair and vice-chair after VPM7.

Next panel meeting. VPM7 will meet in March 2004. The panel decided to accept an invitation formulated at the plenary session by Dr. P. Cornejo Escuela, Superior Politécnica del Litoral (ESPOL), and to meet at her institution in Guayaquil, Ecuador.

VPM7 demonstrated that VAMOS has reached maturity. Scientific objectives have been clearly stated, one major process study was successfully completed, another is well advanced in its design stage, and another has identified its scientific objectives. There is a potential for major international funding of initiatives, as well as international collaborations involving the realization of meetings and exchange of researchers.

Dr. Bruce Albrecht and Dr. David Enfield coordinated an excellent local organization for VPM6. Thanks were given to RSMAS and AOML for their support. WCRP and NOAA's Office of Global Programs generously provided funds. The key contributions of V. Detemmerman (WCRP) and M. Patterson (NOAA OGP) to the panel since its formation were warmly acknowledged. Carlos Ereño has provided an exceptional level of support to VAMOS activities. Andreas Villwock has also provided technical support to the panel.

C. Roberto Mechoso, Chair
WCRP/CLIVAR/VAMOS

1. Welcome and Opening Remarks

The Sixth Annual Meeting of the WCRP/CLIVAR VAMOS panel (VPM6) was held at the Rosenstiel School of Marine and Atmospheric Science (RSMAS), University of Miami, Miami, Florida, USA, 23-26 April 2003. Dr. Bruce Albrecht from RSMAS and Dr. David Enfield from the National Oceanic and Atmospheric Administration (NOAA) Atlantic Oceanographic and Meteorological Laboratory (AOML) were the local meeting hosts.

Dr. Kristina Katsaros, Director of AOML, opened the meeting by welcoming all participants (see list in Appendix 1) and saying that AOML and RSMAS were pleased to host a VAMOS meeting. She then gave an overview of the ongoing activities at AOML, one of NOAA's research facilities.

Mrs. Valery Detemmerman, the member of the WCRP Joint Planning Staff responsible for CLIVAR, said she was very pleased to attend a VAMOS panel meeting for the first time and greeted the participants on behalf of Dr. David Carson, Director of WCRP.

Prof. C. Roberto Mechoso, U. California Los Angeles and Chair of the VAMOS panel, also welcomed the participants and thanked the sponsoring organizations: WCRP, US CLIVAR, NOAA Office of Global Programs, RSMAS and NOAA AOML.

2. Reports and Scientific Presentations

2.1 International CLIVAR Report

Prof. Antonio Busalacchi, U. Maryland and co-Chair of CLIVAR's Scientific Steering Group (SSG) as well as member of the VAMOS panel, started the scientific program of VPM6 by providing an overview of the CLIVAR Programme, its goals and structure. He reported that the Executive Council of the World Meteorological Organization (WMO) at its fifty-fourth session held in Geneva, June 2002, noted the progress in WCRP core activities. Of particular interest to the Council were the regional studies being undertaken in CLIVAR by its components focused on the American monsoon systems (VAMOS), African climate variability, and Asian-Australian monsoon. The Council stressed that attention should also be given to the applications and applicability of CLIVAR scientific results.

Prof. Busalacchi summarized discussions held on a WCRP Banner, which included an *in depth* review of the scientific direction and structure of WCRP and the role of its Joint Scientific Committee (JSC). He emphasised the task WCRP was entrusted with:

- To assess the nature and predictability of seasonal to interdecadal variations of the climate system at global and regional scales, and provide the basis for operational predictions of these variations for use in climate services in support of sustainable development.
- To detect climate change and attribute causes, and to project the magnitude and rate of human-induced climate change, regional variations, and related sea level rise.

To recognise the renewed emphasis of WCRP on its prediction aims and the observational activity that is needed to fulfill them, the whole activity was proposed to be named Climate System Observational and Prediction Experiment (COPE). The initial time-frame for COPE is the period up to 2015.

Prof. Busalacchi explained that the JSC will establish Modelling and Observational Councils. The Modelling Council would coordinate modelling activities across WCRP and facilitate collaborations where appropriate. It would focus on the prediction and projection aspects of COPE, and oversee data management in WCRP modelling activities. COPE's Observational Council would coordinate observational activities across WCRP, focus on the observational aspects of COPE, and act as the contact point with GCOS and satellite agencies developing the WCRP observational requirement. This council would also link with IPCC on observational aspects of the detection and attribution problems, and oversee data management in WCRP observational activities. He also mentioned that the activity of both Councils would overlap in the areas of data management, climate system data assimilation, and model initialization.

At the end of his presentation, Prof. Busalacchi referred to the First International CLIVAR Science Conference to be held in Baltimore, USA, on 21-25 June 2004. The participants were informed of the Conference format and the draft agenda.

2.2 US CLIVAR Report

Dr Robert Weller, Woods Hole Oceanographic Institution (WHOI) and co-Chair of US CLIVAR, reported on the progress of this research programme. US CLIVAR has several major goals:

- To identify and understand the major patterns of climate variability on seasonal, decadal, and longer time scales and evaluate their predictability;
- To expand the capacity in short term (seasonal to interannual) climate predictability and search for ways to predict decadal variability;
- To better document the record of rapid climate changes and the mechanisms for these events, and evaluate the potential for abrupt climate changes in the future; and
- To evaluate and enhance the models used to project climate change due to human activity, including anthropogenically induced changes in atmospheric composition.

Dr. Weller explained that the Eastern Pacific Investigation of Climate Processes (EPIC) was the first US CLIVAR enhanced monitoring project process study. VARIATIONS, the US CLIVAR newsletter, highlights the analysis of data collected by EPIC 2001 (see http://www.usclivar.org/Newsletter/Variations_V1N1.pdf). He then pointed out that the Pan American component of US CLIVAR evolved from the Pan American Climate Studies (PACS) program. Other process studies considered by US CLIVAR are the North American Monsoon Experiment (NAME), South American Low Level Jet (SALLJ), and Kuroshio Extension System Study (KESS).

A new approach to research proposed by US CLIVAR, the Climate Process Teams (CPTs), has garnered a tremendous amount of attention in both the scientific and programmatic communities. The approach seeks to more effectively link the process-oriented research to coupled climate model development. A CPT has three main objectives: (1) speed up the transfer of theoretical and practical process understanding into improved treatment of processes in climate model systems (e.g. coupled models and their component models, assimilation and prediction systems), and demonstrate, through testing and diagnostics, the impacts of these improvements; (2) identify process study activities necessary to further refine climate model fidelity; and (3) develop sustained observational requirements for climate model systems.

US CLIVAR believes that the community is ready to proceed with the implementation of CPTs as a pilot-phase activity. In the pilot phase, CPTs will be initially organized around the issues of climate feedback processes and climate sensitivity for understanding and reducing uncertainties in climate model predictions and projections, and improving the treatment of mixing in ocean circulation models. Under the first topic, a CPT approach has the potential for accelerating progress in the areas of deep convection, and water vapor and cloud (e.g. boundary-layer clouds) processes. In regard to ocean mixing, it is apparent that it is the most uncertain component of modern ocean general circulation models (GCMs).

The pilot phase of the CPT initiative envisions the formation of 2-4 teams to demonstrate the effectiveness of the concept in making progress rapidly and leading the way to an effective long-term strategy in improving climate models.

Dr. Weller informed the meeting about the upcoming workshops and activities of US CLIVAR. He finished his presentation by commenting on the desirability that VAMOS plans beyond 2006 be made in accordance with the global objectives formulated by CLIVAR and other WCRP programmes.

2.3 VAMOS Chair Report

In the annual chair's report, Prof. Mechoso started by highlighting the significant accomplishments made in the implementation of VAMOS:

- A VAMOS International Project Office was established for support of field programs.
- The SALLJEX field campaign was performed with great success between 15 November 2002 and 15 February 2003 in Bolivia, Paraguay, central and northern Argentina and western Brazil. SALLJEX

stands as the first WCRP/CLIVAR international campaign in South America. Proposals and plans have also been developed for the NAME 2004 field campaign, Enhanced Observations and NAME, Modeling and Diagnostic Studies

- A NAME Forecast Operations Center (FOC) was established jointly by the US and Mexican National Weather Services for support of NAME 2004 and longer term efforts.The WHOI buoy at 20S, 85W completed a second successful year of data gathering for VEPIC related research.
- PLATIN established a Science Working Group on the Climatology and Hydrology of large river basins.
- A request for $0.7 M was made to the Global Environmental Facility (GEF) by the Program of the United Nations for Development, Organisation of American States (OAS) and Intergovernmental Committee for La Plata Basin (CIC) for funding of a framework program on the climate and hydrology of the basin, including its impacts on the economies and populations. PLATIN has been identified as having responsiblity for the science component. If successful, the next step will be the design of a $25 M project.

The presentation continued with a review of major issues and challenges facing VAMOS:

- In preparation for SALLJEX, the WMO sent a letter in 2002 to the National Weather Services of the region requesting logistical and data support for the experiment. Several Met Services in the region made significant contributions to SALLJEX but there were some cases where greater cooperation would have been beneficial.
- VEPIC has not yet focused on an intensive new short-term field program. The definition of such a program and entrainment of interested oceanographers have proved challenging.
- VAMOS is starting a modeling component addressing basic issues such as orographic effects and land-atmosphere interactions. This effort could be part of a broader pan-CLIVAR monsoon modeling activity. Although VAMOS is conceived as a unified project, there is a large discrepancy in the means of communicating needs and obtaining funding sources for the plans of its North American component (NAME) and the South American component (MESA). The programme can split if a special effort is not made to keep these components together.

The presentation also listed ongoing VAMOS initiatives:

- An international SALLJEX workshop is planned for the second half of 2003 to carry out a preliminary evaluation of the experiment.
- A ceilometer was installed at San Felix Is. (26º S, 77º W). A profiler will be installed on the island to detect precipitation from stratocumulus clouds.
- Plans are underway to carry out routine ship-based cloud remote sensing and turbulence measurements on a variety of buoy maintenance cruises in the Pacific.
- An effort on VAMOS modeling has started and concrete actions and plans had to be reviewed during the panel meeting.

Prof. Mechoso then reported on some activities with direct relevance to applications:

- One elementary and one high-school teacher (from the US and Argentina) participated in SALLJEX through the NOAA OGP "Teachers in the Field" program. The program promotes awareness of the need to understand and protect the world's environment. On March 13, 2003, the teachers and SALLJEX scientists attended a reception at Capitol Hill and talked to members of US Congress as well as NSF and NOAA administrators. The applications community has been participating in NAME meetings. An announcement of opportunity on NAME applications is anticipated during 2004 to foster collaborations aimed at developing new climate information products for stakeholders.
- The request to GEF in which PLATIN is participating includes a large application component, specifically in the areas of the protection and integrated management of La Plata Basin's basic resources and adaptation to climate change and variability.

The presentation focused next on the structure of the VAMOS programme. Prof. Mechoso emphasized that VAMOS is conceived as a unified project, in which NAME and MESA complement each other by performing modeling and empirical studies of two monsoon systems, while enhancing the climate monitoring infrastructure in the Americas through multinational scientific collaboration. The deliverables of both NAME and MESA include fine resolution precipitation products, as well as an improved understanding of orographic and land surface processes, and of regional water budgets. Nevertheless, NAME is organized as a centralized effort while MESA has three components (SALLJ, PLATIN and VEPIC). A minimization of

such differences in organization might enhance the efficiency of the entire programme. Prof. Mechoso pointed out the importance of the developments in the VAMOS Data Information Server located at UCAR/Joint Office for Science Support (JOSS). He then reminded participants that the VAMOS legacy will include a long-term climate monitoring capability spanning the monsoon regions in the Americas and the tropical Pacific and Atlantic Oceans.

The three major objectives of VPM6 were presented as follows:

1) To define an implementation strategy for VEPIC

This would encompass commitments to science objectives, methodologies for research, timeline of field programs, and relationships with other CLIVAR components.

2) To discuss a restructuring of MESA

MESA was originally designed as an aggregate of three components (SALLJ, PLATIN, VEPIC). A more unified structure of MESA would make it a closer counterpart of NAME. In this case:

- A MESA Science Working Group (SWG) must be appointed.
- MESA will continue the research on SALLJ, including new process studies addressing intraseasonal and interannual variability.
- MESA will take the initiative for a research programme on La Plata Basin.
- PLATIN will become the link between VAMOS and GEF.
- VEPIC will become a separate program, perhaps under a different name.

3) To define a modeling component for VAMOS

The establishment of a modeling component in VAMOS could be highly beneficial to the programme. It would, for example,

- Provide a unifying element for NAME and MESA.
- Contribute to the WCRP banner activity and prepare VAMOS for future WCRP directions.
- Facilitate links with modeling efforts in other CLIVAR and GEWEX panels.
- Contribute to the WCRP/CEOP monsoon modeling initiative (CIMS).
- Facilitate the examination of model systematic errors in the simulation of the American climate, and the extent to which those errors limit confidence in predictions of climate change.
- Promote a better understanding of the extent to which data collected by WCRP process studies can contribute to enhance climate predictability in the Americas.

Another topic suggested for discussion was the identification of possible new themes for VAMOS. Several possibilities were mentioned: a program on isotopes in climate, an activity centered in the tropics, a critical assessment of the adequacy of observational systems for climate monitoring in the Americas, and a joint activity with the Atlantic panel on the climate of the South Atlantic.

2.4 ICPO Report

Prof. Ereño reviewed the general objectives and activities of the International CLIVAR Project Office (ICPO) and relevant developments within CLIVAR during the last year. His presentation started with a general overview of the current structure of CLIVAR, and of the objectives and specific tasks of ICPO. He reported that Dr. John Gould retired from his post as ICPO director in August 2002. His successor is Dr. Howard Cattle, who came from the Met. Office in Bracknell. Dr. Daniela Turk, formerly responsible for the Pacific Panel, left the ICPO in June 2002. Her successor is Katy Hill who took up her post in November 2002. Dr. Mike Sparrow, responsible for the CLIVAR Southern Ocean Panel, has temporarily moved to Beijing. Dr. Katherine Bouton, who was responsible for data management activities, completed her appointment with ICPO in December 2002.

The CLIVAR web site has been updated to incorporate a number of services. There is now a literature reference section, which includes relevant publications by journals, publications by CLIVAR topic of regional focus, and links to other journals. Selected research papers from Exchanges can be downloaded.

Prof. Ereño also referred to the First International CLIVAR Science Conference, to be held in Baltimore, USA, on 21-25 June 2004. The Conference is seeking contributions on research topics that include, but are not limited to:

- Advances in understanding elements of the climate system (seasonal-to-interannual variability, especially ENSO, monsoon systems, decadal and longer variability, and anthropogenic climate change)

- Looking into the past (analysis of paleoclimate records; reanalysis)
- New approaches to climate predictions (modeling, data assimilation, and validation)
- Improvement to the observing system
- Climate applications (Who are CLIVAR's customers? What products and information do they need?)

Further information on the CLIVAR Conference can be found at http://www.clivar2004.org

2.5 VAMOS Project Office Report

The Project Office Director, C .B. Emmanuel, UCAR-JOSS, presented a report of activities.

2.5.1 EPIC

The Project Office provided support for EPIC's activities. The EPIC Scientific Working Group is considering holding a meeting to discuss future activities. The meeting may take place in the August-September period, and the Project Office will contribute to its realization.

2.5.2 SALLJEX

The field preparations for SALLJEX were presented during VPM5 in San Jose, Costa Rica. The field phase was carried out as planned, and the base of operations was set in Santa Cruz, Bolivia. During January-February 2003, the NOAA WP-3D research aircraft supported the data gathering requirements of SALLJEX by making 13 flights for a total of 99 hours. Nearly all the participants present in Santa Cruz were given the opportunity to take part in one or more flights.

Some adjustments in the GPS radiosonde allocation among Santa Cruz, Mariscal Estigarribia, and Resistencia were necessary as the gas supplies during the experiment became somewhat erratic.

During the field operations in Santa Cruz, the VAMOS Field Programs Office was pleased to host participants in NOAA's OGP "Teacher-in-the-Field" program. Two teachers, one from Argentina and one from the US took part in the SALLJEX activities, including one or more research flights. The Project Office looks forward to having such participants in upcoming experiments. Similarly, the Project Office would assume the responsibility to organize and implement a SALLJEX Data Workshop once the venue and dates are selected.

2.5.3 NAME

The VAMOS Project Office is currently responding to field requirements that need to be implemented for the intensive observations period planned for 2004. With the consent of the NAME SWG, the Project Office has established an International NAME Project Support Team [INPST] to address the specific logistics requirements. The first meeting of the NAME INPST is scheduled for May 13 and 14 in Mexico City at the facilities of the National Meteorological Service (SMN). At this time the Project Office will also explore the Mexican Government requirements for programmatic clearances to conduct research activities from their domain, as well as customs requirements for the importation/exportation of equipment and expendables.

2.5.4 Other VAMOS programs

The Project Office stands ready to support the activities as determined by the corresponding SWGs.

2.6 VAMOS Database Report

The VAMOS database provides key support to research and field programs. J. Meitín and S. Williams, NOAA National Severe Storm Laboratory and UCAR-JOSS are in charge of the VAMOS Data Information Server, which is located at UCAR/Joint Office for Science Support (JOSS) (http://www.joss.ucar.edu/vamos/) with a "mirrored" server for the southern hemisphere at IAI (http://vamos.iai.int/). These distributed information systems contain links to various related VAMOS programmes and to datasets of interest (*i.e.* in-situ [land, ocean], satellite, model output). As of VPM6, over 180,000 files (comprising over 28 GB of data) are available on-line to the scientific community. The VAMOS Data Working Group, charged with coordinating data access for both national and local data sets, continued their activities during the past year. This group involves members in different countries in the Americas making contributions to VAMOS.

A brief summary of the various VAMOS-related project activities this past year is as follows:

Pan American Climate Studies (PACS) - Long-term enhanced climate monitoring and archival continues to include data from Intensive Observational Periods (IOPs), such as the TEPPS cruise (1997) and VAMOS-related field projects (e.g. SALLJEX, EPIC). The PACS database provides stability and continuity using common formats, a data portal, and ease of data access. The satellite climatology consists of various high-resolution sectors that are routinely produced and archived by UCAR/JOSS (2000 to present). Further details can be found at the PACS data management page: http://www.joss.ucar.edu/pacs/.

EPIC - Approximately 150 data sets are expected to be submitted to the EPIC database (100 of these are currently available or in the process of being loaded). The NOAA P-3 aircraft data are being reformatted to a common format with the NSF C-130 aircraft. An upper air sounding "composite" was generated using all available rawinsondes and dropsondes converted to a common format and analyzed using uniform quality control procedures. A complete high-resolution satellite data archive (GOES/POES) was collected and is available. Off-line data sets (such as aircraft radar data on tape) are being loaded on-line. Further details can be found at the EPIC data management page located at: http://www.joss.ucar.edu/epic/dm/.

SALLJEX - UCAR/JOSS provided data management support for the SALLJEX field project. A SALLJEX data policy was adopted by the SALLJEX SWG and should be a good paradigm for an overall VAMOS data policy. Data collected included the NOAA P-3 aircraft and airborne radar data (binary/imagery), upper air data (raobs, pibals), satellite (binary files and imagery), model output, and precipitation data. During the field phase, a web-based field catalog for SALLJEX was populated with operational/research product imagery and various reports (daily operations, mission summary, and status). A "merged" GOES northern/southern hemisphere high-resolution (30-min, 1-km visible) satellite sector was routinely produced and archived. Details of the SALLJEX data policy are documented in the SALLJEX Data Management Plan. All SALLJEX data management information, activities, and data access are located at a new data management page that can be found at: http://www.joss.ucar.edu/salljex/dm/.

NAME - The NAME data management strategy is currently under development (i.e. data policy, plan, etc.) and work has begun with surveying (and working with) available data sources such as the new special raingauge network in Mexico. Extensive work has been accomplished in preparing an on-line database of model output (and upper air verification data) from the summer 1990 to support the NAME Model Assessment Project (NAMAP). Further details are available from a new NAME data management page located at: http://www.joss.ucar.edu/name/dm/.

CEOP - Data management activities for CEOP that might be beneficial for VAMOS include the development of a "prototype" in-situ data set (July-September 2001) from 18 Reference Sites distributed globally. This data set consists of an hourly "composite" of designated upper air, surface, and sub-surface parameters all converted to a common format and analyzed using uniform quality control procedures. All Reference Site data are being archived (and available) at UCAR/JOSS. The CEOP model outputs (from 8 numerical weather prediction centers) are being archived at the Max Planck Institute (Germany), and satellite data are being archived at the University of Tokyo (Japan). Further details are available from the CEOP data management page: http://www.joss.ucar.edu/ghp/ceopdm/.

JOSS staff will continue to work with VAMOS scientists to coordinate future data management activities.

2.7 SACOS Report

Dr. Silvia Garzoli (AOML) was invited to present a report on the Workshop on the South Atlantic Climate Observing System (SACOS), held on 6-8 February 2003, in Angra dos Reis, Brazil. Dr. Edmo Campos (INPE, Brazil) and Dr. Alberto Piola (SHN, Argentina) were co-Chairs of that meeting, which was sponsored by CLIVAR, the Ocean Observations Panel for Climate (OOPC), and the Inter-American Institute for Global Change Research (IAI).

SACOS had two major objectives:

1. To provide an overview of the scientific understanding of the influence of the South Atlantic Ocean on the regional and global climate. To discuss existing elements of the South Atlantic observing system, and identify additional elements as required for a more complete understanding of the regional climate system and its link with the global climate.To encourage integration of the region's diagnostic, modeling

and observational communities, and the development of joint actions and principles for a long-term observing strategy. To identify potential funding sources and associated operational partners. SACOS started with seven presentations that reviewed key aspects of the role of the South Atlantic in the regional and global climate. The meeting then split into three working groups, which were asked to focus on the following topics:

- Links between the upper South Atlantic, the deeper ocean and the other ocean basins.
- South Atlantic links with and impacts on the regional and global climate.
- Modeling of the coupled ocean/atmosphere system.

The working group reports emphasized that the South Atlantic influences the variability of the upper layer interbasin exchange and meridional heat and freshwater fluxes, and contributes to intense water mass transformations and shortcircuits in the meridional overturning circulation. It was also highlighted that ocean-atmosphere interactions and subsurface, oceanic pathways, play important roles in shaping the sea surface temperature (SST) gradients in the South Atlantic, which themselves affect the behavior of the Intertropical Convergence Zone (ITCZ). SST variability in the southeastern (southwestern) South Atlantic has a direct impact on precipitation over Africa (South America), and a better understanding of coupled ocean-atmosphere modes at work for those impacts requires further investigation. It appears that SST anomalies in the South Atlantic on several timescales have predictable components.

In order to organize the discussion on enhancements of observing systems in the South Atlantic, a division into sub regions was adopted according to outstanding climate features:

- Southwestern subtropical Atlantic, where diagnostic studies point to a significant role of land-surface processes, and possibly ocean-atmosphere interactions, in the sub-seasonal and interannual variations of the South Atlantic Convergence Zone (SACZ);
- Brazil-Malvinas confluence region, where SST anomalies seem to influence cyclogenesis, rainfall and temperature variability over southeastern South America and southwestern Africa;
- Gulf of Guinea, which is a major source of moisture for the West African monsoon;
- Tropical South Atlantic, where rainfall over northeastern Brazil is better correlated with SST anomalies (roughly between 20W-5E, 20S-5S) than with TNA anomalies in the preceding seasons.
- Southeastern Atlantic, where warm and cold events originating as equatorial Kelvin waves forced by trade wind anomalies in the western Atlantic have a significant impact on regional fisheries and southern Africa rainfall.
- Sub-polar south Atlantic: Recent studies show a relationship between the activity of the Southern Hemisphere mode and changes in the Antarctic Circumpolar Current. The mechanisms of air-sea interaction in the polar regions need to be better understood.

Summary of required observations

1) The southeast and southwest regions of the South Atlantic are the gateways for entertainment of upper layer water from neighboring oceans and for their modification through mixing and water mass conversions. Time series transport measurements and regional modeling are necessary in these regions.
2) To better understand the role of the South Atlantic on the meridional overturning circulation, it is necessary to reduce the uncertainty in the meridional heat flux through the subtropical band.
3) To establish the origin of the decadal signal observed in SST in the subtropical gyre of the South Atlantic Ocean it is necessary to monitor the variability of SST and the subtropical gyre.
4) Though the tropical Atlantic is covered by the PIRATA array, additional observations in the tropical-subtropical region appear to be necessary in order to monitor the area of extra-tropical upwelling and the bifurcation of the SEC. These regions are the strongest links between tropical SST variability and the largely undersampled subtropical South Atlantic. Measurements of the heat storage in the upper water column and the air-sea fluxes of heat, mass and momentum are necessary to improve the understanding of SST variability in the subtropical South Atlantic.

- SACOS concluded that there is sufficient evidence that the South Atlantic plays an important role in shaping the SST gradients through surface ocean atmosphere interactions and subsurface, oceanic pathways. To a large extent improved understanding of the South Atlantic impact on climate is limited by the sparse observations. There are ongoing long-term observation efforts in planning for the South

Atlantic. It is important to coordinate them with the existing ones in the Tropical Atlantic. Design and implementation of a sustained monitoring system for the South Atlantic, which could be maintained in by South Atlantic countries in cooperation with North American and European counterparts.

2.8 SALLJ: Status and Plans

C. Vera, U. Buenos Aires and Vice-Chair of the VAMOS panel, and J. Nogues-Paegle, U. Utah, reported on SALLJEX. This was performed with great success between 15 Nov 2002 and 15 Feb 2003 in Bolivia, Paraguay, central and northern Argentina and western Brazil. Scientists, collaborators, students and local volunteers from Argentina, Brazil, Bolivia, Paraguay, Chile, Uruguay and USA participated in SALLJEX activities in an unprecedented way. SALLJEX was mainly funded by NOAA OGP with additional contributions from NSF and funding agencies from Brazil and Argentina. The experiment had three major components:

1) *Enhanced upper air observations*. The main objective of this component was to reduce the uncertainty in estimates of the daily (and longer time scales) intensity and other characteristics of the tropospheric flow over a large region which currently has a sparse sounding network. The basic observation period (BOP) of this component extended over the entire duration of the experiment, and consisted of one radiosonde observation (RAOBS) at 06UTC and two pibal observations (PAOBS) at 06 and 21UTC. Within the BOP there was a special Observing Period (SOP) of one month duration (approximately January 6-February 15), during which RAOBS were made twice daily (06 and 21UTC) and PAOBS were made 4 times a day in the Argentina, Bolivia and Paraguay; in the Brazilian SALLJEX stations RAOBS were made 4 times a day. Also, there were intensive-observing periods (IOP's) with up to 3-4 RAOBS and/or 8 pilot balloon observations per day at selected sites along the LLJ axis.

2) *Enhanced raingauge daily observations*. SALLJEX raingauge network activities over Argentina, Bolivia, Paraguay, Peru and Uruguay aimed at improving the very sparse operational network. The SALLJEX network included not only the raingauge stations set up by the experiment itself, but also raingauge networks owned by local cooperatives and institutions that kindly accepted to participate in the experiment. Efforts continue to be made for a continuation of such an integrated raingauge network. This will be extremely useful for long-term monitoring of the region's climate, as well as for other VAMOS activities such as PLATIN.

3) *NOAA/P-3 aircraft missions*. The main objective of the aircraft missions was to provide a detailed representation of the structure and variability of the LLJ east of the Andes, and of the relationship between mesoscale convective complexes over northern Argentina and western Paraguay and the LLJ. Around 120 flight hours were available for SALLJEX during the period between 6 January through 15 February 2003. A science group with participants from local countries and the USA was specially established in the operation center in Santa Cruz de la Sierra, Bolivia.

For the duration, SALLJEX numerical modeling groups provided a diversity of forecast products from several numerical models running at participating operational centers and research institutions. Information on all these products as well as about the reports of the several activities and preliminary results of the data collection efforts is available at the SALLJEX field catalog (http://www.joss.ucar.edu/salljex/catalog/). Full information on SALLJEX is available at http://www.salljex.at.fcen.uba.ar/

The observations gathered by SALLJEX provide a unique opportunity for validation of numerical simulation and sensitivity studies that attempt to reproduce the structure of the South American low-level jet and its variability, as well as the associated precipitation. Such validations as well as data assimilation experiments are currently under way. A SALLJEX data Workshop will be held in Buenos Aires, Argentina between 10 and 12 December 2003 in order to: a) assess the progress made in achieving SALLJEX objectives; b) strengthen and arrange collaborations among the participants in SALLJEX; c) broaden participation in order to expand the analysis and modeling use of SALLJEX data by other scientists and their students; and d) determine follow-up SALLJEX activities. SALLJEX is the first WCRP/CLIVAR international campaign in South America.

The experience of organizing and carrying out a large activity such as SALLJEX experience has been used to improve classroom instruction. One elementary and one high school teacher (from the US and Argentina,

respectively) participated in SALLJEX through the NOAA program "Teachers in the Field". The program promotes awareness of the need to understand and protect the world's environment. The teachers and SALLJEX scientists attended a reception on Capitol Hill, where they presented VAMOS to members of US Congress as well as NSF and NOAA administrators.

2.9 VEPIC: Status and Plans

Dr. Chris Bretherton, U. Washington, gave an update on VEPIC. This included a review of goals and methods, targeted extended time observations, and developments during EPIC/DYCOMS-II (Dynamics and Chemistry of Marine Stratocumulus - Phase II: Entrainment Studies). The theme of VEPIC is to better understand and simulate how cloud systems over the eastern Pacific interact with the coupled ocean-atmosphere-land system on diurnal to interannual timescales.

At the Fifth VAMOS panel meeting (VPM5) the following scientific questions relevant to VEPIC were formulated:

- On what time and space scales does continental heating/mechanical forcing impact boundary layer cloud/radiative forcing?
- How sensitive is the overall tropical circulation and ENSO to variations of Eastern Pacific cloud topped boundary layer properties and why?
- What are the dominant seasonal-to-interannual feedbacks among stratocumulus clouds, surface winds, upwelling, coastal currents and SST in the eastern Pacific?
- Does natural and anthropogenic aerosol variability significantly modulate the stratocumulus decks?

The eastern Pacific is an ideal testbed for model evaluation and improvement (e.g. parameterization development) using multiscale data sets. The following strategies for VEPIC were discussed and agreed on for the region:

- Model sensitivity studies to refine hypotheses and target observations.
- Synthesis and enhancement of existing data sets, through targeted instrument procurement, algorithm evaluation and development, and enhanced observation periods.
- Co-ordination with oceanographic, aerosol, cloud process communities, including US CLIVAR CPTs.

The results of EPIC 2001 (East Pacific Investigation of Climate Processes field phase, 1 September to 15 October 2001) are providing VEPIC with valuable information. Two articles on EPIC have been submitted to the Bulletin of the American Meteorological Society (BAMS), and there was a special session at the Fall 2003 Assembly of the American Geophysical Union.

The TAO-EPIC project (http://www.pmel.noaa.gov/tao/epic/) as part of the EPIC has gathered a multiyear dataset that includes precipitation and other ocean data in the South Eastern Pacific 'ITCZ'.

A number of scientific issues connected to VEPIC in the southeastern Pacific were presented:

- Buoy measurements show large net heat flux into ocean balancing eddy cooling, and ocean altimetry also shows an energetic eddy field.
- The University of Chile has installed a ceilometer and surface met station at San Felix Island.
- The diurnal cycle at 20º S, 85º W shows a daytime subsidence maximum.
- Diurnal variation of horizontal surface wind divergence. The hypothesis here is that subsidence driven by diurnal heating cycle over the Andes reaches the buoy at noon. MM5 simulations also show late afternoon convergence at the coast and midnight ascent at the buoy.
- Remotely-sensed cloud microphysics has been obtained from EPIC 2001.

One example of related initiatives that could enrich VEPIC activities is the Rain In Cumulus over the Ocean (RICO). This experiment focused on the shallow, maritime cumulus convection in the trade wind zone (http://rico.atmos.uiuc.edu/).The CPT proposed on tropical cloud feedbacks on climate sensitivity includes several US members of VEPIC.

Dr. Bretherton finished his presentation evaluating the VEPIC related progress in:

- Atmosphere-ocean feedbacks in the eastern Pacific
- South America and southeastern Pacific diurnal cycle of subsidence, clouds
- Importance of cloud/drizzle/aerosol coupling to eastern Pacific stratocumulus

- Model/reanalysis validation using both existing data synthesis, targeted enhancements (WHOI buoy, SFI), field experiments (EPIC2001/DYCOMS-II), and coordinated modeling.

2.10 NAME: Status and Plans

Dr. Wayne Higgins, Climate Prediction Center and NOAA/NWS/NCEP, gave a comprehensive report on NAME Status and Plans emphasizing the NAME scientific rationale, linkages (programs and agencies), modeling and data assimilation activities and the NAME 2004 field campaign.

2.10.1 **Scientific Rationale**

NAME is 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 recognizes that global and regional models do not accurately simulate or predict warm season precipitation, especially in tropical / subtropical land-ocean interaction regions. Thus, NAME seeks improved understanding of the key physical processes that must be parameterized for improved simulations and predictions with coupled models. A fundamental first step towards improved prediction is the clear documentation of the major elements of the NAMS (North American Monsoon System) and their variability within the context of the evolving annual cycle of the ocean-atmosphere-land system.

NAME hypothesizes that the NAMS provides a physical basis for determining the degree of predictability of warm season precipitation over the region. NAME has a multi-scale tiered approach with focused activities in the core monsoon region (Tier I), on the regional scale (Tier II) and on the continental scale (Tier III). Key objectives are tied to these Tiers and include a better understanding and simulation of warm season convective processes in complex terrain (Tier I); intraseasonal variability of the monsoon (Tier II); response of warm season circulation and precipitation patterns to slowly varying oceanic and continental boundary conditions (Tier III); and monsoon evolution and variability (Tiers I-III). In order to achieve its objectives NAME is implementing empirical and modeling studies that carry forward the joint PACS/GAPP Warm Season Precipitation Initiative (2000 onward), and the NAME Field Campaign (June-September 2004) including build-up, field, analysis, and modeling phases.

The NAME Science and Implementation Plan (Higgins et al. 2001) can be found at http:// www.joss.ucar.edu/name for details.

2.10.2 **Linkages**

NAME is the North American Implementation of the WCRP/ CLIVAR VAMOS Program. It is endorsed by the US CLIVAR SSC as a warm season process study of the North American monsoon under the U S CLIVAR Pan American Panel. US CLIVAR's interests in NAME were listed in its June 2001 meeting report.

NAME has also been directly responsive to GEWEX Science Goals. The Experiment is included in the GEWEX/GAPP Science and Implementation Plan, with emphasis on topographic influences on precipitation, hydrology and water resources, and land-surface memory processes. NAME Contributions to GAPP include fine resolution precipitation products (e.g. for LDAS and regional reanalysis), and improved understanding of summer orographic precipitation processes, role of land processes during the monsoon and role of the North American Monsoon System (NAMS) in the water budget over the region. GAPP contributions to NAME include improved land surface models and coupled land-atmosphere models, LDAS in Tiers 1 and 2, CEOP, and regional reanalysis. NAME is contributing to GEWEX's Cloud System Study (GCSS) by bringing a focus on the effects of complex coastal terrain on precipitating convection into the agenda of GCSS Working Group 4 (Precipitating Convective Cloud Systems).

Dr. Higgins listed some recent NAME activities that illustrate NAME's responsiveness to the broad objectives of CLIVAR and GEWEX:

Ocean Processes:
–Ocean Component of NAME Workshop (Ensenada, April 21-22, 2003)

Land Surface Processes:
–Soil Moisture Field Campaign (NASA Terrestrial Hydrology Program)

–NAME Hydrometeorology Working Group (quarterly newsletter)

Modeling:
–NAME Modeling - Observations Team: "White Paper"
–NAME "Workshop" on Multi-scale Modeling, Data Assimilation, and Prediction R&D (College Park, MD, June 6, 2003)

NAME 2004 Enhanced Observing Period:
–NAME 2004 Solicitation (April 2003; NOAA PACS/GAPP)
–NAME International Project Support Team (timeline, data management plan)
–NAME Forecast Operations Center (NWS-SMN-NAME Project Office)
–NSF Tier 1 Observations Briefing (Arlington, VA, March 2003)
–R/V Ron Brown Request
–NOAA P-3 request and NASA P3-B Request

Agency programs providing support and/or most likely to provide additional support for NAME 2004 include:
–NOAA PACS/GAPP NAME 2004 Solicitation (spring 03; observations)
–NOAA PACS/GAPP Warm Season Precipitation Initiative (annual since 2000)
–NASA Terrestrial Hydrology Program (Tier I Soil Moisture Field Campaign)
–NSF GEO/ATM, Hydro (Tier I network and related modeling/diagnostics)
–NCAR/ATD (Tier I network)–NOAA ETL and NOAA/AL (Tier I network)
–DOE (Mobile Research Facilities)

2.10.3 NAME Modeling and Data Assimilation Activities

The NAME Modeling - Observations Team has the following charge: (i) to provide guidance on needs and priorities for NAME 2004 field observations; (ii) to identify the path to improved warm season precipitation prediction and (iii) to identify additional process studies necessary to reduce uncertainties in coupled models.

Activities during the past year included the NAMS Assessment Project, which was undertaken to identify and describe inter-model consistencies and differences (both global and regional models), and provide measurement targets for the NAME 2004 field campaign. A technical report summarizing the results of this activity will appear shortly on the NAME web page.

The NAME Modeling-Observations Team has also been compiling a "White Paper" on NAME Modeling and Data Assimilation Research and Development. The paper is intended to provide a roadmap for NAME modeling activities through the remainder of the program. NAME modeling activities presume that the leading factors that limit precipitation forecast skill in both global and regional models during the warm season are deficiencies in how we model "local" processes that modulate deep convection. In order to achieve the desired improvements, NAME will focus on the diurnal cycle of convection in the core monsoon region of NW Mexico, a region of complex terrain and land/sea contrasts.
NAME 2004 will provide improved estimates of the 3-d structure of the monsoon and its variability on diurnal to monthly time scales. The objectives of NAME data assimilation and analysis activities are to better understand and simulate the various components of the NAMS (e.g. moisture surge – precipitation relationships; tropical easterly wave – midlatitude (westerly) wave relationships; components of the moisture budget and sources of moisture; basic seasonal evolution (life cycle) of the monsoon); to quantify the impact of the NAME 2004 observations; and to identify model errors and attribute them to the underlying model deficiencies. The objectives of NAME predictability and forecast skill activities are to examine the predictability of warm season precipitation over the NAM region; to quantify error growth due to model errors versus that due to uncertainties in analyses and boundary conditions; and to assess the value of NAME observations for prediction. These activities will allow us to address some of the key questions (ultimately critical for climate prediction) such as: How is the life cycle of the monsoon related to the evolution of oceanic and continental boundary conditions? Or, can models reproduce the observed summertime precipitation in average years and years with ENSO influence? These activities will be discussed in more detail at a NAME Modeling and Data Assimilation planning meeting in College Park, MD on June 6th, 2003.

The NAME modeling strategy recognizes three distinct roles that NAME 2004 observations will play in model development: (1) to guide model development by providing constraints on model simulations at the process level (e.g. convection, land/atmosphere and ocean/ atmosphere interactions); (2) to help assess the veracity of model simulations of the various key NAMS phenomena (e.g. low level jets, land/sea breezes, tropical storms) and the linkages to regional / larger-scale climate variability; and (3) to provide initial and boundary conditions, and verification data, for model predictions.

2.10.4 **NAME 2004 Field Campaign**

NAME Field Networks for the 2004 campaign include the following:

Tier I Instrumentation:
–UHF wind profiler (1)
–VISS (5) (SMN sounding+UHF-RASS profiler)
–NCAR ISS (4) (UHF-RASS profiler+sounding +sfc)
–SMN 5cm Doppler radars (4) (3 Enterprise; 1 Eriksson)
–10cm Doppler-polarimetric radar (NCAR S-POL)
–Ron Brown shipboard platform (VISS, 5cm Doppler radar, sfc fluxes)
–NOAA/ETL shipboard flux system (on UNAM/PUMA)
–Advanced Lightning Direction Finder (5)
–Raingauges (100 event logging; 1600 simple)
–Research Aircraft (NOAA P-3, NASA P-3B)
–Soil Moisture Sensors

Tier II and III Instrumentation:
–Radiosonde
–PIBAL

Details on each field network can be found in the NAME Science and Implementation Plan (Higgins et al. 2001) and in a NAME Science Overview document (Carbone et al. 2002).

Latest developments for NAME 2004 include:

(i) Establishment of the NAME Forecast Operations Center jointly between the US NWS and Mexico SMN (exchange visits between NWS and SMN during summers of 2003 and 2004; joint US/Mexico weather discussions; daily weather briefings for NAME 2004; arrange airport logistics from TIA, etc.), and the NAME International Project Support Team (NAME implementation and data management).

(ii) A soil Moisture Field Campaign (funded by the NASA Terrestrial Hydrology Program) that includes temporary in-situ soil moisture networks (between Tucson and Hermosillo), aircraft (NASA P3-B) and satellite (AMSR and TMI) mapping and intensive sampling concurrent with the aircraft mission.

(iii) Possible DOD observational involvement and support during NAME 2004, including military units that take upper-air soundings (Yuma AZ - Army; Edwards AFB; Ft. Huachuca- Army; White Sands - USAF/Army), USAF PIBALS (Gila Bend AZ), wind profilers (most sites above operate from 1 to 3 profilers BUT most of these data are not available to the FSL real-time access URL) and surface data (Ft. Huachuca and White Sands operate surface mesonets).

2.11 The CLARIS project

Dr. Rafael Terra, U. Republica, Uruguay, introduced the project “Climate Variability and its Societal Impacts in South America” (CLARIS). This is a cooperative effort between European and South American scientists. Climate modelling is carried out in a variety of European institutes. An international initiative called PRISM is presently financed by the European Commission in order to strengthen the links between those institutes in terms of software: couplers between the different modules (ocean/atmosphere/atmospheric chemistry/ocean biochemistry), data formats, result analysis. Another project, ENSEMBLES, has been proposed to organize the European strategy in terms of climate change simulations and related model developments.

There have been scientific exchanges on modelling issues between European and South American countries for a long time in a variety of contexts. The European Commission financed two modelling projects during the 1990s, with the participation of the CIMA (Argentina) and the CPTEC (Brazil). The CIMA is currently using the LMD atmospheric GCM as part of its modelling tools as a result of those projects (see related publications on the CIMA webpage)

The CLARIS project aims at renewing and strengthening collaboration between European and South American climate scientists. Its goal is to provide some European participation to CLIVAR-VAMOS, and to reinforce IAI projects such as PROSUR. It will be focused on the subtropical region of South America and will proceed through a multi-scale integrated approach (continental-regional-local).

First, CLARIS will encourage the transfer of knowledge and expertise on Earth System Models, their different components and coupling procedures. Moreover, it will facilitate the access to large sets of simulation results. Most of these results have been obtained in the context of past, present or future European projects, although some additional numerical experiments will be necessary for the sake of consistency.

Second, CLARIS will provide a common framework to European and South American scientists involved in regional climate modelling in order to compare and exchange their methodologies (dynamical and/or statistical). Complementary to that modelling aspect, a major goal for CLARIS is to set up a high-quality, daily climate database for temperature and precipitation.

Finally, at a local scale, CLARIS will promote pilot actions designed to integrate multi-disciplinary components and to demonstrate the potential and feasibility of using climate information in the decision-making process in three major areas: agriculture, health and pollution.

The European member of the VAMOS panel, Prof. Herve le Treut, was key in the project conception. A proposal for funding of CLARIS activities was sent to the European Union with Dr. Jean-Phillipe Boulanger from the Laboratoire de Meteorologie Dynamique as Principal Investigator.

3. SALLJ Working Group Report

The working group chair, C. Vera, stated that the first objective of this working group was to evaluate and prepare a report of SALLJEX field experiment including a summary of the observations collected in the field as well as preliminary evaluations of data quality. Discussions about the SALLJEX data analysis, the organization of the Workshop on SALLJEX data, and follow-up activities such as the interaction and integration with PLATIN activities, were also made by the SALLJ/WG at VPM6. The full version of the SALLJEX report of activities including the conclusions of the SALLJ/WG meeting is in Appendix 3.

The working group also discussed the reorganization of MESA. The specific objectives of MESA include: 1) a better understanding of the key components of the American monsoon systems and their variability, 2) a better understanding of the role of those systems in the global water cycle, 3) improved observational data sets, and 4) improved simulation and monthly-to-seasonal prediction of the monsoon and regional water resources.

There was agreement in the working group that the basic objectives for MESA reorganization should be: i) to include the scientific issues currently being implemented under VAMOS (specifically in SALLJEX, PLATIN and VOCAL), in the integrated context of South American Monsoon System (SAMS) and its variability, and ii) to identify the relevant scientific questions that need to be answered in South American regions not studied under VAMOS yet.

A unified vision of the different programs of MESA is necessary in order to a get more comprehensive understanding of the different components of SAMS and its variations. In particular, the SALLJEX contribution to PLATIN was discussed as well as the implementation of a new field experiment to study climate variability and its impact on La Plata Basin hydrology.

A number of additional themes that deserve more attention from MESA were also identified:

- Distinctive features of SAMS: i) Most of the rainfall is convective in nature, ii) Large continental area in the equatorial region that impacts the length of the rainy season, iii) The associated heating source is located closer to the Equator than in NAME. These features imply a marked different atmospheric response to the heating source than in other monsoonal circulation.
- Monsoon life-cycle, its inter-hemispheric impact and links with subtropical and extratropical regions.
- South American see-saw pattern of precipitation anomalies.
- Rainfall and temperature extreme events. Climate and weather linkages.
- Low-Frequency modulation of the SAMS elements: i) Intraseasonal variability: MJO and other IOS and Interannual variability, ii) Relative roles of internal vs. forced variability, iii) Land surface forcing, iv) Role of remote and local SSTs.

The implementation of the MESA modeling component was discussed. The goal of such component is to improve seasonal and intraseasonal climate and hydrological predictions. The strategy is to focus on: (1) Testing of hypothesis with models, (2) Detecting deficiencies in the models and improving their performance and, (3) Developing new parameterizations and model components. Models currently available in the MESA Community include: Regional & Mesoscale Models, Global Coupled Atmosphere Land Ocean models, Global Atmospheric Model, Regional Climate models, Simple Conceptual Models, Single Column Models, Hydrological Models. Parameterization development has been identified, mainly focused on soil processes. The processes that would need modeling activities in MESA were also discussed as well as the different strategies that can be followed considering the community's current modeling capacity. Examples of those processes with the corresponding modeling strategies are: Intraseasonal oscillation, Interannual and decadal, onset/end of the rainy season, Understanding the equilibrium state of the monsoon system, MCS, Transient kinetic energy, Radiation- aerosol-climate interactions, Impacts of complex topography: numerical, mechanical, thermal, surface processes, Diurnal cycle, Transition from shallow to deep convection, Interhemispheric effects, and Water budget: precipitation, evaporation, storage.

4. VEPIC Working Group Report

C. Bretherton was Chair of this working group, which decided to rename the initiative, previously known as VEPIC, VOCAL (VAMOS Ocean – Cloud – Atmosphere -Land study). The group reviewed the scientific issues and strategies for VOCAL.

The theme of VOCAL is to better understand and simulate how marine boundary layer cloud systems surrounding the Americas interact with the coupled ocean-atmosphere-land system on diurnal to interannual timescales.
The major VOCAL themes were reviewed by the working group:
- On what time and space scales does continental heating/mechanical forcing impact boundary layer cloud/radiative forcing?
- How sensitive is the overall tropical circulation and ENSO to variations of Eastern Pacific cloud topped boundary layer properties and why?
- What are dominant seasonal-to-interannual feedbacks among stratocumulus clouds, surface winds, upwelling, coastal currents and SST in the eastern Pacific?
- Does natural and anthropogenic aerosol variability significantly modulate the stratocumulus decks?

The group reached agreement on the following VOCAL strategies:
- Global and mesoscale model evaluation and improvement (e.g. parameterization development) using multiscale data sets.
- Model sensitivity studies to refine hypotheses and target observations.
- Science by synthesis/use of existing data sets, enhancement through targeted instrument procurement, algorithm evaluation and development, and enhanced observation periods.
- Co-ordination with oceanographic, aerosol, cloud process communities, including CLIVAR CPT, CLOUDSAT, etc.

The group examined the progress of hypothesis generation related to the following processes:
- Cloud microphysics/drizzle (polynyas)
- Diurnal cycle (role of continental convection on stratocumulus dynamics)
- Role of Andes/flow blocking in influencing stratocumulus in the southeastern Pacific.
- WHOI buoy/ocean energy budget

- Interest in coastal oceanography of region, including ocean-atmosphere interactions through trapped coastal (e.g. Kelvin) waves.
- Implementation of plans formulated in VPM5.

A set of recommendations was drafted during the working group:
- Major continuing efforts in diagnostic, sensitivity, parameterization studies of southeastern Pacific stratocumulus decks and their variability, based on past field studies, satellite/model products, and observational enhancements.
- Add an ocean diagnostic study component based on ARGO/ODA, cruises, WHOI buoy aimed at better understanding of ocean upwelling/lateral heat transport processes and their relation to atmospheric variability.
- Global atmosphere/coupled, mesoscale atmosphere, and regional ocean modeling.
- VOCAL 'radiator fin' coupled ocean-atmosphere-land experiment, possibly in October 2006.
- Augment San Felix Island instrumentation with wind profiler, radiation, microwave LWP, and aerosol sampler.
- NOAA/ETL surface/remote sensing instrumentation on Pacific and Atlantic buoy maintenance cruises, as well as in RICO.
- Develop a VOCAL data set through a distributed satellite/model/in situ data archive maintained by JOSS. Archive ECMWF and NCEP hi-resolution column data at WHOI buoy, SFI in co-ordination with CEOP.
- Coordinate with proposed US CLIVAR cloud-climate sensitivity "climate process team" to feed into coupled model development.

The working group updated the timeline for VOCAL

2003-2010 - Diagnostic/modeling work
2003 ETL - Enhanced cruises, SFI profiler, VEPIC data archive
2004/11 - Cloudsat
2005/11 - RICO
2006/10 - Radiator experiment

A number of scientific issues were put forward as a result of the discussion within the group:

Cloud/drizzle/aerosol interactions
Further offshore, the radius of cloud drops is usually larger.
- Why? Are there more aerosols near the coast? Is it because of pollution, ocean productivity, DNS, Salt/wind?
- How does this feedback on mean stratocumulus albedo? What is the vertical PBL structure like?

Ocean
- Ekman vs. eddy heat transport to the west vs. air-sea interaction
- Vertical mixing at buoy: role of "sagging trades", comparison with ocean GCMs
- Horizontal extent of nutrients and relation to offshore transport mechanisms
- Space/time nature of eddy heat transport offshore
- Vertical ocean (and atmosphere) cross-section along selected latitude lines
- Regional ocean modeling of 1500 km nearest South American coast
- Coastal wind jet and relation with coastal upwelling and clouds

Cloud-PBL Dynamics
- Space/time nature of eddy heat transport offshore
- Vertical ocean (and atmosphere) cross-section along a latitude line
- Regional ocean modeling of 1500 km nearest South American coast
- Coastal wind jet and relation with coastal upwelling and clouds

Coupled IssuesSeasonal cycle of SST
- Continental influence on long timescales
- Cloud feedbacks on ENSO

Finally, the group presented details on the implementation of different VOCAL aspects, including the names of the researchers involved in each of them as well as the most relevant activities:

- San Felix (Rene Garreaud, Bruce Albrecht, Bob Weller):
  - Installed: Met., ceilometer (funded 1,5years), SST
  - Planned: Drizzle detection, sonic
  - Need: Profile ($20K+), radiation, aerosols, cloud radar (?)
- RH Brown (or other US ship, Chris Fairall)
  - Covered already by PACS/other NOAA ($250K per year)
  - Student for analysis (Bretherton/Student, $100K)
- RICO/trade cumulii: (Graciela Raga, aerosol)
- Satellite observations
  - JOSS: Coordinate satellite observations for the RICO site
  - Diagnostic studies, analysis, post-processing
- SCM/LES of diurnal cycle/drizzle in stratocumulus decks.
- Mesoscale modeling: UCH (Rene Garreaud et al.), synoptic scale/diurnal variability, parameterization, and connection to the Andes heating.
- Global modeling: UCLA/UR-Uruguay: mean circulation, ENSO feedbacks, interaction with orography on seasonal timescale. CAM-UW: PBL
- Ocean diagnostic studies:
  - Ken Takahashi, Bob Weller, Ted Strub, Pilar Cornejo
  - Oscar Pizarro, Art Miller
  - Ocean data assimilation, ECCO vs. buoy
  - Horizontal heat transport via eddies
- Ocean regional modeling
  - Patrick M. (France), coastal E.P, Bibliography
  - Oscar Pizarro's colleagues at U. Concepcion
  -Pablo Lagos (Princeton ocean model)
  -Art Miller
- CPT on cloud processes
- Field Experiment "SE Pacific Radiator" (October 2006)

5. NAME Primer

Although NAME was not featured in break-out sessions during VPM6, NAME was critically reviewed by representatives of International CLIVAR, U.S. CLIVAR and GEWEX/GAPP at the meeting. One important recommendation was that NAME should clearly articulate how its activities are organized according to the multi-scale tiered structure, especially for Tiers II and III. In response to this, NAME SWG members prepared a NAME PRIMER and presented it at the Friday afternoon plenary session. A brief review of this presentation is given. The complete Powerpoint presentation is found on the NAME webpage (http://www.joss.ucar.edu/name) under "Presentations". Those interested in a thorough discussion of NAME activities in each Tier should refer to the NAME Science and Implementation Plan, which is also found on the NAME webpage.

5.1 NAME 2004 Field Campaign

NAME Field Observations include instrumentation in each of the Tiers:

Tier I Instrumentation

–UHF wind profiler (1)
–VISS (5) (SMN sounding+UHF-RASS profiler)
–NCAR ISS (4) (UHF-RASS profiler+sounding +sfc)
–SMN 5cm Doppler radars (4) (3 Enterprise; 1 Eriksson)
–10cm Doppler-polarimetric radar (NCAR S-POL)
–Ron Brown shipboard platform (VISS, 5cm Doppler radar, Sfc fluxes)
–Mexican Research Vessels
–Buoys (ASIS)
–NOAA/ETL shipboard flux system (on UNAM/PUMA)
–Advanced Lightning Direction Finder (5)

–Raingauges (100 event logging; 1600 simple)
–Research Aircraft (NOAA P-3, NASA P-3B)
–Soil Moisture Sensors

Tiers II and III Instrumentation
–Radiosonde
–PIBAL

A NAME Overview Document describes much of the NAME Tier I instrumentation (especially that relating to an NSF Facilities request); this document is found on the NAME webpage. Documentation on the radiosonde and PIBAL networks for Tiers II and III appears in several presentations on the NAME webpage. Most recently NAME has organized an oceanographic component that includes requests for the R/V Ron Brown (radar, surface fluxes), an ASIS buoy (central GOC) and Mexican Research Vessels.

5.2 NAME Scientific Questions
Scientific questions that NAME will address using the NAME 2004 field observations in conjunction with NAME modeling activities include:

NAME Tier I Scientific Questions:
1. How are low-level circulations along the Gulf of California / west slopes of the Sierra Madre Occidental related to the diurnal cycle of moisture and convection? ***(low-level circulation)***
2. What is the relationship between moisture transport and rainfall variability (e.g. forcing of surge events; onset of monsoon details)? ***(moisture transport and budget)***
3. What is the typical life cycle of diurnal convective rainfall? Where along the western slope of the Sierra Madre Occidental is convective development preferred? ***(diurnal cycle)***
4. What are the fluxes of water (and energy) from the land surface to the atmosphere across the monsoon region, and how do these fluxes evolve in time during the warm season? ***(role of land surface)***

NAME Tier II Scientific Questions:
1. What is the nature of the relationship between the MJO, tropical cyclone activity and monsoon precipitation? ***(role of the MJO)***
2. How important are interactions between tropical easterly waves and mid-latitude westerly waves in the prediction of monsoon precipitation? ***(dynamical linkages)***
3. What is the physical setting for the bimodal distribution (i.e. wet-dry-wet) in warm season precipitation over Mexico and Central America and what factors influence its interannual variability? ***(double peak structure)***
4. What are the dominant sources of precipitable moisture for monsoon precipitation over southwestern North America? ***(moisture sources, GOC-vs-GOM)***

NAME Tier III Scientific Questions
1. What are the relative roles of local (e.g. Gulf of California) and remote (e.g. tropical Pacific) SST's on the predictability of the NAMS? ***(role of SST's, simultaneous and antecedent)***
2. Can numerical models reproduce the observed summer precipitation in average years and years with ENSO influence? ***(role of ENSO)***
3. What are the influences of the core monsoon region on the larger scales (e.g. relationship between precipitation variability in the SW and Great Plains)? ***(dynamical linkages)***
4. What are the relationships between extreme weather events (e.g. floods, droughts, heat waves, hurricanes), climate variability and long-term trends? ***(extreme events)***.

See the NAME Science and Implementation Plan (http://www.joss.ucar.edu/name for more details).

5.3 NAME Modeling Strategy
NAME's Modeling and Data Assimilation activities were described in the "NAME Status and Plans" report presented in plenary session (earlier in this document). This report emphasized how NAME modeling and data assimilation activities are tied to the Tiers.
The NAME Modeling-Observations Team recently drafted a "White Paper" on NAME Modeling and Data Assimilation R&D activities. The paper is intended to provide a roadmap for NAME modeling activities

through the remainder of the program. The paper will be distributed to the SWG and the broader community for additional input. Subsequently the Team will hold a one day workshop (June 6, 2003 in College Park, Maryland) to discuss the white paper in detail. An important objective of this meeting is to develop the timeline of specific modeling and data assimilation activities.

6. PLATIN Working Group Report

The major outcome of this working group was the agreement for a "straw man" conceptual design for a PLATIN Field experiment (PLATEX). Professor Carlos Tucci, U. Sao Paulo and working group Chair, provided several compeling motivations for PLATEX:

- Strong interannual and interdecadal climate and streamflow variations and trends
- Combined effects on the basin's climate and hydrology of land use change: deforestation, intensive agriculture trends and urbanization.
- Unknown effects of aerosols advection from biomass burning from tropical areas
- Strong role of mesoscale convective processes (MCS) in total precipitation

A number of other reasons in support of a PLATIN field experiment were also presented:

- La Plata Basin is the fifth largest in the world and houses about 100 million people.
- The climate and hydrology of the Basin, in addition to their intrinsic variability, are sensitive to the variability of remote climates.
- The physical links that determine this sensitivity vary with time and region.
- A better understanding of those links, and of their local modulations can result in improved climate predictions.
- Skillful climate predictions are key input to Decision Support Systems.

A conceptual design for PLATEX based on three tiers was proposed:

- ***Tier 1***: selected paired catchments (minimum two) with contrasting agriculture and natural forest land use (Tier 1 domain area ~10 – 50,000 km^2; individual catchments probably (1000 km^2)
- ***Tier 2****:* regional scale 200,000 km^2 (middle Parana and Uruguay River basins)
- ***Tier 3****:* entire La Plata basin (3,000,000 km^2)

The group worked out details on the PLATEX conceptual design:

- Multi-year observations throughout Tiers 1-2, but focused on Tier 1. These observations would include a supplement in the rain gauge network and streamgauges, flux towers, in-situ soil moisture, wind profilers and other micrometeorology, and ideally a permanent precipitation radar coverage in Tier 1.
- At least 2 IOPs of about 2 months each, one each preferably in spring and fall. Observations would include cloud microphysics (aircraft), additional ground-based atmospheric measurements (radar? lidar?), precipitation, and other surface observations; radiosonde enhancement, aircraft soil moisture, aerosol, and energy flux. The project would start in 2005 with its first IOP in 2006.
- Other potential linkages – satellite missions in the proposed period – GPM (potential for PLATEX as verification site), SMOS (possibly), EOS/Terra and Aqua, others?
- Possible justification (and beneficiary) of enhancements in surface observation network (especially precipitation radar).

The group also analyzed the practical issues, implications and justifications for the suggested location of PLATEX.

Practical Issues and Implications:

- Flood impacts on cities and huge flood plains, with associated economic impacts
- Hydropower production sensitivity to streamflow variations
- Navigation sensitivity to stream discharge variations

A location for Tier 1 of PLATEX was identified for the mid-Paraná:

- The location is in the path of the average of low level moisture flow, as well as aerosols; it is also an area of maximum (mean and extreme) precipitation
- Mid-Paraná basin is the major source of runoff in the largest floods

- There are strong contrasts in land use change (extensive land conversion from forest to agriculture in the Brazilian part of the domain; Argentinean portion is closer to natural condition).

7. Plenary discussion on climate modelling in VAMOS

The VAMOS need for a centralized climate modeling activity, one of the most important issues of VPM6, was discussed in plenary first and at the panel session on the following day. Such a centralized activity would contribute to coordinate diverse modeling efforts in NAME, MESA, VOCAL, as well as other groups outside VAMOS and operational centers. The activity would also help VAMOS to benefit from the work of GEWEX modeling groups focused on processes, encourage the application of datasets generated by VAMOS field programs to improvement in predictability and predictions, contribute to engagement climate modelers along with observationalists and diagnosticians in VAMOS process studies, and facilitate the building of scientific infrastructure in countries of the VAMOS region without a tradition in climate modeling.

It was agreed that VAMOS can, and should, provide unique contributions to climate model development in the areas of Land Surface Processes (NAME and MESA) and Boundary Layer Clouds (VOCAL). The input of VAMOS can also be important to the improvement of model performance in diverse areas of North and South America. There was no agreement, however, on the precise format for a VAMOS climate modeling activity additional to that already present in the different programmes, and there were several opinions in favor of starting the process with a pilot phase.

8. VAMOS panel session

8.1 VAMOS reorganization

The panel started by reviewing the programme's structure. It was decided to reorganize VAMOS in three components: NAME, MESA and VOCAL, with MESA absorbing SALLJ and PLATIN. Components chairs will be W. Higgins, C. Vera, and C. Bretherton, respectively. A PLATIN group will continue acting as the link between VAMOS and the GEF framework project with Professors Mechoso and P. Silva-Dias as co-Chairs.

8.2 VAMOS modeling

The panel discussed in depth the modeling strategy for VAMOS. It was argued that a group focused on modeling would have several important objectives:

- To review and synthesize the current status of seasonal-to-interannual weather and climate forecasting over the Americas
- To foster communication with operational centers on simulation and prediction issues in weather and climate variability for the Americas
- To enhance the synergy between studies of the North and South American monsoon systems
- To help coordinate the science issues addressed by VEPIC, MESA and NAME
- To identify topics for model development (e.g. land surface processes, boundary clouds, resolution-or multiscaling) from the points of view of model users, evaluators, and developers.

Some issues on modeling relevant to VAMOS were mentioned:

1) Importance of exploiting the overlap with GEWEX modeling programmes.
2) Importance of mesoscale models for monsoon studies. Benefits from the coordination between global and mesoscale modeling. Verification of parameterizations and strategies in models with different scales.
3) Identification of gaps and duplication of efforts.
4) Interactions with forecasting centers (e.g. CPTEC, NCEP, ECMWF). Need to invite operational groups to learn about numerical modeling aspects they have identified as roadblocks to successful weather and climate predictions. Need to be inclusive of operational centers and appeal to interests of modeling centers within the region. Importance of outreach activities.

An active modeling group would also contribute to an enhanced cooperation between modelers, observationalists and diagnosticians, and the formulation of clear research objectives on numerical modeling

The panel decided to appoint an *ad hoc* group and charged it with the following tasks:

- review the status of numerical modeling relevant to VAMOS research;
- organize a session at VPM7 dedicated to increase exposure of ongoing research on numerical modeling to the VAMOS community. It would be helpful to receive a full update on how current models perform in simulation/forecasts of the monsoon system.
- develop terms of reference for a possible standing group on VAMOS modeling.

Prof. Mechoso and Dr. Ben Kirtman (COLA) will chair this ad hoc group. They will invite VAMOS components to nominate members and look for support from other groups and programmes.

8.3 NAME review

Several aspects of NAME plans were reviewed. The programme was encouraged to:

- Articulate the plans for tiers 2 and 3 in closer agreement with the overall goals of WCRP and CLIVAR.
- Strengthen the oceanographic component.
- Broaden the international participation in NAME programmes.
- Encourage the participation of hydrologic modelers in NAME activities.

8.4 MESA review

The impressive achievements of SALLJEX were reviewed. Several proposals that will use the SALJJEX data and research are in preparation. The panel warmly endorsed the realization of a SALLJEX data workshop and follow-up activities in late 2003.

8.5 PLATIN review

The science goals of PLATIN are within the framework of MESA. One important factor is that the GEF-PLATIN proposal, which has already received the funding for the first block and the approval of the second block proposal by all the Plata Basin countries, is a program with all its scientific aspects well-connected, in particular the hydrological ones and the governments in the region are interested in it. It was decided to renew the VAMOS request presentation for "Continental Scale Experiment" status for the activities in La Plata Basin at the coming meeting of GEWEX Hydrometeorology Panel (GHP). Prof. Mechoso will attend the GHP session in Lülenbec, Germany, 25-26 September 2003, and will make the presentation.

8.6 VEPIC /VOCAL review

The panel accepted the suggestion made by the VEPIC working group to rename the program as VOCAL (VAMOS Ocean–Cloud–Atmosphere–Land Study). It was mentioned that VOCAL could be perceived wrongly as concentrated on processes with small space and short temporal scales. The highly regional character of an observational campaign based on island stations and a few upper-air soundings may contribute to the perception. The panel is aware, however, that a major outcome of VOCAL would be the improvements of global climate models.

Although VOCAL becomes a separate VAMOS component, its goals are strongly linked to those of NAME and MESA. In particular, a major theme of VOCAL is the possibility of links between convection over the continents and variability of stratocumulus cloud decks.

8.7 Relationships with National Weather Services

Several Met Services in the region made significant contributions to SALLJEX but there were some cases where greater cooperation would have been beneficial. The matter will be brought up to the attention of the CLIVAR SSG.

8.8 Panel membership

No changes in panel membership were decided at VPM6. It was noted that several panel members will rotate off in 2004, including the chair and vice-chair. The panel members were asked to vote by e-mail for their replacements either as chair/vice-chair or as co-chairs. The panel will vote on the nominations in executive session at VPM7.

8.9 **Topics and venue for VPM7**

VPM7 will feature the VOCAL programme. In preparation for this important meeting, VOCAL was encouraged to carry out a workshop in one of the South American countries along the Pacific coast in order to enhance involvement of regional scientists.

The panel decided to accept the kind invitation formulated at the plenary session by Dr. P. Cornejo, Escuela Superior Politécnica del Litoral (ESPOL), and to hold VPM7 in late March 2004 at her institution in Guayaquil, Ecuador.

9. Acknowledgements

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Appendix 2: Agenda

WCRP/CLIVAR Sixth Annual Meeting of theVAMOS Panel, Miami, Florida, USA, 23-26 April 2003

Wednesday, April 23, Morning Session, Plenary, Chair: Bruce Albrecht

8:50am	Opening of VPM6 – David Enfield/Bruce Albrecht (Organizing Committee)
9:00am	Welcome
	– Dr. Kristina Katsaros (AOML)
	– Valery Detemmerman
	– C. Roberto Mechoso
9:30am	SALLJEX (Carolina Vera/Julia Paegle)
10:00am	VAMOS Project Office (Gus Emmanuel)
10:15am	CLIVAR ICPO (Carlos Ereño)
10:30am	Break
11:00am	US CLIVAR Report – Bob Weller (US CLIVAR co-Chair)
11:30am	VAMOS Chair's Report – C. Roberto Mechoso (VAMOS Chair)
12:00am	The VAMOS Investigation of the Eastern Pacific Climate (VEPIC) – Chris Bretherton CLIVAR SSG Report –
12:30pm	Break

Wednesday, April 23, Afternoon Session – First Part, Plenary, Chair: C. Roberto Mechoso

1:30pm	Tony Busalacchi (CLIVAR co-Chair)
2:00pm	VAMOS Database – José Meitin, Steve Williams
2:30pm	SACOS Report – Silvia Garzoli
3:00pm	Charge to the Workshop – C. Roberto Mechoso
3:30pm Break	

Wednesday, April 23, Afternoon Session – Second Part, WGs meet

4:00pm	Break – out: WGs meet: VEPIC, SALLJ, PLATIN
6:00pm	Break
8:00pm	Reception at the RSMAS Dining Commons

Thursday, April 24, Morning Session – First Part, Plenary, Chair:

8:30am	The North American Monsoon Experiment (NAME) – Wayne Higgins
9:00am	Oceanographic Component of NAME – Francisco O'Campo Torres

Thursday, April 24, Morning Session – Second Part, WGs meet

9:15am	Break – out: WGs meet: VEPIC, SALLJ, PLATIN
10:10am	Break
10:30am	Break – out: WGs meet: VEPIC, SALLJ, PLATIN
12:30pm	Break

Thursday April 24, Afternoon Session – First Part, Plenary

1:30pm	VAMOS Modeling Discussion – C. R. Mechoso

Thursday, April 24, Afternoon Session – Second Part, WGs meet

2:00pm Break – out: WGs meet: VEPIC, SALLJ, PLATIN
3:30pm Break
4:00pm Break – out: WGs meet: VEPIC, SALLJ, PLATIN
5:30pm Break

Friday, April 25, Morning Session – First Part, Plenary

8:30am Other Directions (Tropics?, South Atlantic?)
9:00am Cooperation between Europe and South-America concerning climate modelling – Rafael Terra

Friday, April 25, Morning Session – Second Part, WGs meet

9:20 am Break – out WGs meet: VEPIC, PLATIN, Modeling?
10:10am Break
10:30am Break – out WG meet: VEPIC, PLATIN, Modeling?
12:30noon Break

Friday, April 25, Afternoon Session – First Part, WGs meet

1:30pm Break – out: WGs meet: VEPIC, PLATIN, Modeling?
3:30pm Break

Friday April 25, Afternoon Session – Second Part, Plenary

4:00pm VEPIC Field Program report –
4:30pm PLATIN Strategy report –
5:00pm Modeling report –
5:30pm General overview – C. Roberto Mechoso
6:00pm Break

Saturday April 26 – Panel Session

8:30am VAMOS Executive Session: Panel membership, next meeting.
10:10am End of Panel Session
10:30am Panel, Working-Group Chair and Agency Representatives meet
12:30pm End of VPM6

Appendix 3: Group Reports

SALLJEX
Preliminary Report of Activities
(Compiled and discussed at the 6th VAMOS Panel Meeting, Miami, 23-26 April 2003)
(*C. Vera, U. Buenos Aires)*

1. Introduction

The South American low-level jet (SALLJ) program, a component of the CLIVAR/VAMOS program, is an internationally coordinated effort to contribute to the understanding of the role of the SALLJ in moisture and energy exchange between the tropics and extratropics and related aspects of regional hydrology, climate and climate variability. SALLJ is part of the first stage of the VAMOS/Monsoon Experiment on South America (MESA).

The ultimate goal of SALLJ is to improve short and long term predictions through the following strategy: i) obtain an improved description of the temporal and spatial structure of the SALLJ based on expanded monitoring activities and special field experiments; ii) evaluate the veracity of numerical representation (forecasts and analyses) of SALLJ against special observations and; iii) determine improvements of initial state representation and model parameterizations required to improve prediction.

A full description of the scientific implementation plan for the South American low-level jet (SALLJ) is included in the document on the American low-level jet study (ALLS) which is available at http://www.clivar.org/organization/vamos/

The SALLJ field campaign (SALLJEX) was performed with great success between 15 Nov 2002 and 15 Feb 2003 in Bolivia, Paraguay, central and northern Argentina and western Brazil. SALLJEX aimed at describing many aspects of the SALLJ, will be a blend of many observing systems. Scientists, collaborators, students and local volunteers from Argentina, Brazil, Bolivia, Paraguay, Chile, Uruguay, Perú and USA participated in SALLJEX activities in an unprecedented way. SALLJEX has been mainly funded by NOAA/OGP with additional contributions from NSF and funding agencies from Brazil and Argentina. SALLJEX is the first WCRP/CLIVAR international campaign in South America. Further information is available at: http://www.salljex.at.fcen.uba.ar.

2. SALLJEX Components

2.1 SALLJEX upper-air sounding network
The main objective of this component is to reduce the uncertainty in estimating the daily (and longer time scale) intensity and other characteristics of the tropospheric flow over a large region currently without a dense sounding network. Accurate atmospheric estimates are needed to a) quantify the variability of the LLJ over different spatial scales; b) describe the spatial variability of the diurnal cycle of the lower and middle tropospheric wind field; and to c) describe the Chaco heat low, its variability in space and time and the basic processes responsible for its variability. The observations are also essential for validation of numerical simulation sensitivity studies that attempt to reproduce the structure of the jet and its variability.

The basic observation period (BOP) of this component covered the 3-month duration of the experiment and it consisted in one radiosonde observation (RAOBS) at 06UTC and two pibal observation (PAOBS) at 06 and 21UTC. Within this interval, during an special Observing Period (SOP) of one month duration (approximately Jan 6-Feb 15) RAOBS were made 2 times daily (06 and 21UTC) while PAOBS were made 4 times daily in Argentina, Bolivia and Paraguay while 4-time daily RAOBS will be made in Brazilian SALLJEX stations. Finally, intensive-observing periods

(IOP's) when up to 3-4 RAOBS and/or 8 pilot balloon observations per day were made at selected sites along the LLJ axis.

	Argentina		Bolivia		Brazil		Paraguay		Peru	TOTALS		
Hr	PB	RS	PB	RS	PB		PB	RS	PB	PB	RS	All
0:0	75	17	33	3	24	66	12		98	242	86	328
3:0	90		18		35		10			153		153
6:0	72	168	10	32	27	14	9	54		118	268	386
9:3	237		3		78		61			379		379
12:	458	21	368	4	122	35	153		273	1374	60	1434
15:	109		29		71		11			220		220
18:	190	73	14	37	69	15	41	45		314	170	484
21:	599		267		129	15	151		272	1418	15	1433
	1830	279	742	76	555	145	448	99	643	4218	599	4817

Table 1: Total number of pibal and radiosonde observations collected during SALLJEX.

Table 1 displays a first estimation of the pibal and radiosonde observations collected at each country during SALLJEX. The summary for Argentina includes information from the following stations: Santiago and Resistencia (radiosondes) and Pilot balloons for Resistencia, Chamical, Parana, Tostado, Joaquin V. Gonzalez (no data during February), Pampa de los Guanacos (no data during February), Cordoba and Santiago. The summary for Pilot Balloons at Bolivia, Brazil and Peru includes observations from the following stations: Santa Cruz, Cobija, Trinidad, La Paz, Robore, Uyuni and Villamontes (Bolivia), Cruzeiro do Sul, Dourados, Rio Branco and Vilhena (Brazil), Piura, Pucallpa, Ica, Puno and Arequipa (Peru). The summary for radiosondes at Bolivia corresponds to Viru-Viru station while those in Brazil to Dourados and Rio Branco. Figures 1 and 2 display the SALLJEX radiosonde and pibal observation networks respectively.

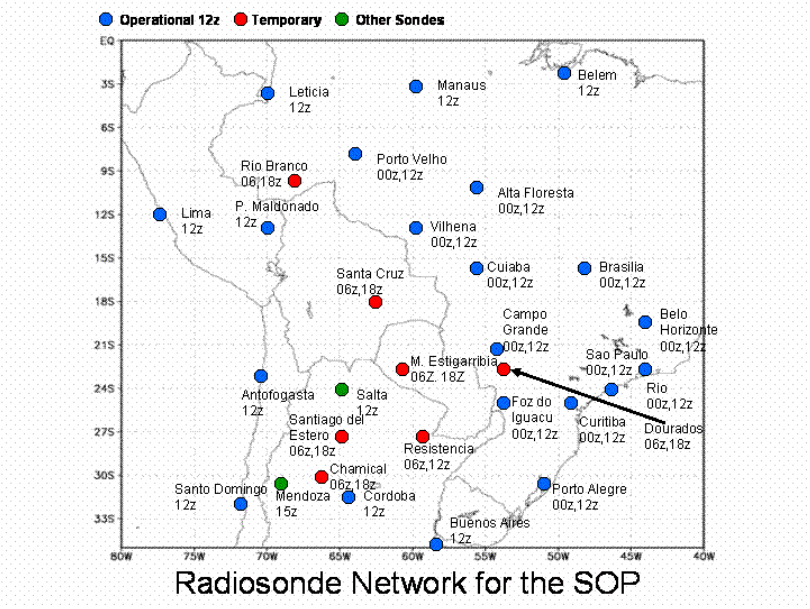

Figure 1: SALLJEX radiosonde network

Some problems that the SALLJEX upper-air sounding networks suffered during the campaign were occasional shortage of gas, cloud skies prevented sounding at high levels, rain storms prevented soundings. Particularly in Paraguay the shortage of hydrogen affected the number of radiosonde observations collected while in Bolivia some operational problems occurred at Viru-Viru station. In Argentina, Santiago del Estero station had antenna problems until December 5 while RS sensor was incompatible with received at Chamical, problem that was solved by December 29.

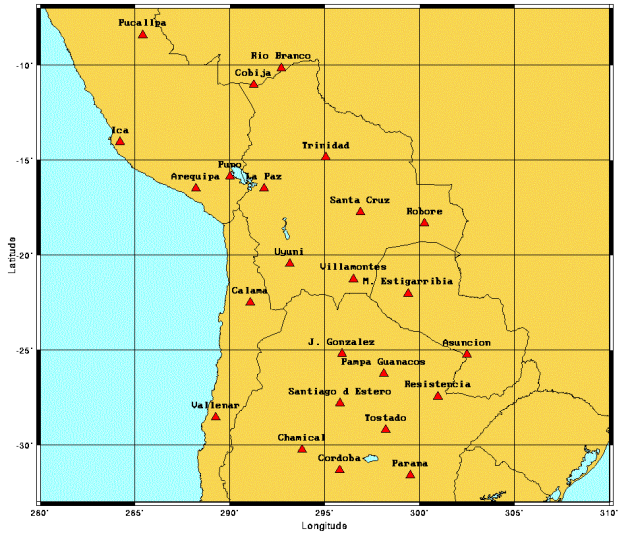

Figure 2: SALLJEX pibal observation network

2.2 NOAA/WP-3D missions

The main objective of the aircraft missions is to provide a detailed representation of the structure and variability of the LLJ east of the Andes. Also, the WP-3D flights have been used to address secondary scientific objectives as well, like: 1) a description of the heat low over the Chaco and northwestern Argentina; 2) the relationship between mesoscale convective complexes over northern Argentina or

western Paraguay and the LLJ; 3) the structure of cold frontal surges near the eastern slopes of the Andes and 4) the description of mesoscale wind and moisture variability over the Altiplano.

P-3 deployment went as planned, with 13 research missions flown between 11 January and 8 February, for a total of 99 research hours. No problems were encountered which seriously compromised any aspect of the deployment, which was carried out about as planned and about on budget. Cooperation from many individuals, agencies and nations is acknowledged. Table 2 summarizes the SALLJEX flights as well as their motivations. There were only minor deviations from the planned allocation of flights to the various objectives, as forced by the weather. In addition to 8 flights for low level jet, there was one complete MCS mission and two partial MCS missions, one southerly (cold front) jet, one Chaco Low (or northwest Argentina low) mission, and one mission to the east Pacific which also sampled an undisturbed day on the Altiplano, covering similar tracks about 5 hours apart.

Flight dates	Flight type
Jan 11	LLJ Flight
Jan 15	LLJ Flight
Jan 17	LLJ Flight. 840-hPa Flight close to the Andes Mountains
Jan 18	Cold Front Flight
Jan 21	LLJ Flight
Jan 22	LLJ Flight. MCS event
Jan 24	Cold Surge Flight
Jan 28	Altiplano & South Pacific Flight
Feb 1	Chaco Low Flight
Feb 4	LLJ Flight
Feb 6	LLJ Flight
Feb 7	LLJ Flight
Feb 8	LLJ Flight. Dissipating MCS

Table 2: List of NOAA/P-3 flights during SALLJEX

The majority of the low level jet flights were carried out in the "porpoising" mode, almost continuously ascending and descending between 300 m AGL and about 3000 m, occasionally to 4-5000 m. This mode was judged to have been successful in mapping out both the essential features of the horizontal and vertical structure of the low level jet. On at least two days, a strong jet was sampled, reaching 30 m/s near 850 mb. Also, the individual flight that was most successful in mapping a strong and rapidly growing MCS, which reached large MCC status was that during the night of 22-23 January. The combination of an excellent forecast from SALLJEX operation center, timely permission to enter Argentine air space, and good luck, enabled close sampling of the radar echoes and the environment of the system. This mission should be the basis of an excellent case study of this type of system.

2.3 SALLJEX raingauge network

An enhancement of the current daily rainfall network was performed in SALLJEX. The objectives of this component are to: i) determinate wet and dry periods during the experiment and their relationship with SALLJ events in different geographical regions (eastern Bolivia, Chaco); ii) provide ground truth estimates for comparison with a hierarchy of numerical simulations of rainfall in the region and iii) determine the accuracy of satellite-rainfall estimates over the region.

SALLJEX installed approximately 1200 raingauges, which were read daily, in Argentina, Paraguay, Bolivia, and Peru (Fig. 3). The installation of around 250 gauges was largely successful in Argentina, where it was merged with already installed, but not easily available rainfall measurements (around

1500 stations). In Paraguay the SALLJEX installation activities (around 300 gauges) discovered many additional raingauges operated by the agricultural sector and this offers hope of greatly extending future observations (around 250 stations). In Bolivia there was some coordination difficulties with the raingauge installation and there were transport strikes and road closures, but it appears that more than 220 gauges have been installed in military outposts and another 40 in the Department of Santa Cruz. However, an additional 32 sites will provide rainfall data from AASANA airports and another unspecified number of SENAMHI climatological sites will provide their rainfall measurements. In Peru, the installation was split among the IGP and SENAMHI and was fully successful. Despite the success in installing the raingauges, only when the data are collected will the extent of reliable observations become known.

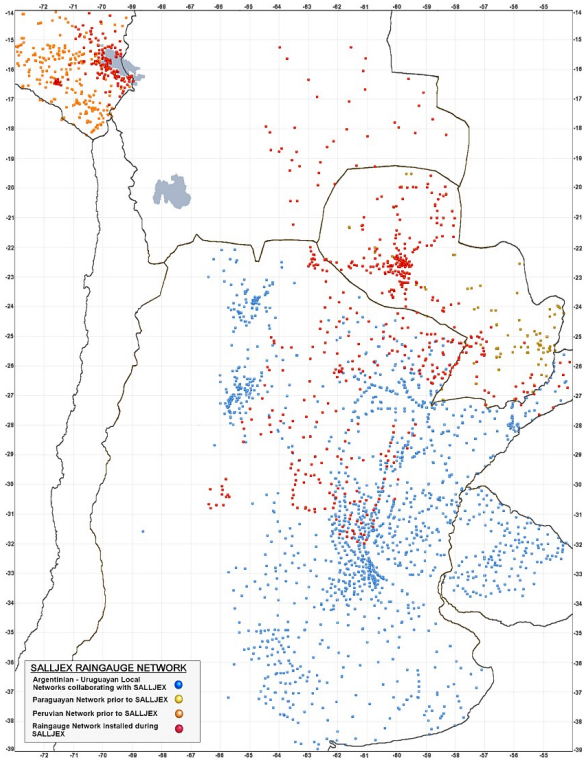

Figure 3: SALLJEX raingauge network

Future efforts will be made in order to promote the continuation of such integrated raingauge network extremely useful for long-term monitoring in the region as well as for other VAMOS activities like PLATIN.

SALLJEX activities in Brazil were concentrated on the installation of two dense raingauge networks around Río Branco (20 raingauges) and Ji Paraná (40 raingauges) respectively. Those networks provided rainfall data of very high temporal resolution, which were complemented by daily rainfall data provided by several operational networks available in Brazil.

2.4 Modeling activities

During the experiment the SALLJEX modeling group provided a diversity of forecast products from several numerical models running at operational centers and research institutions involved in SALLJEX. These products were used in the decision making process for the P3 missions and other IOP activities. The SALLJEX Catalog has products from the following models:

- NOGAPS model Analysis
- University of Utah Model Analysis
- ETA/CPTEC 40 km res., 00 and 12 UTC Forecast Cycle (FC)

- ETA/CPTEC 20 km res., 12 UTC FC
- ETA/UMD 80 km res., 00 UTC FC
- LAHM/CIMA 60 km res., 00 UTC FC
- NCEP/AVN 100 km res., 00 UTC FC
- RAMS/UBA 20 km res., 00 UTC FC
- RAMS/USP 25 km res., 00 and 12 UTC FC
- U of Chile MM5 30 km res., 12 UTC FC

From a preliminary assessment of model performance evaluation, the following forecast issues arose:

- Surface processes: strong variability of surface characteristics that are not well represented even at 20-km grid spacing.
- Initialization/Assimilation: sometimes the analysis does not represent local forcing adequately. The "rejection" problem in the assimilation techniques.
- 24 and 48 hr-forecasts had problems to correctly represent frontal displacements, particularly when fronts remained quasi-stationary (this was very common during November)
- Mayor challenges: to forecast weather "very near" the Andes and to forecast MCS occurrence and location, particularly when large scale forcing is not so evident
- The LLJ-like circulation pattern and the SACZ-like circulation pattern were reasonably well captured even 5 or more days in advance, with strong coherence between models to reproduce the 850 hPa mean flow. Certain tendency to underestimate wind intensity at low levels has been detected.

2.5 Other SALLJEX activities:

Radar observations were implemented at 6 sites located in southern and southeastern Brazil. The LLJ and convection on these regions were observed in combination with the SALLJEX pibal and radiosonde network operatations. Such database will permit the detailed aircraft data to be placed in proper context on aircraft case study days, as well as provide priceless information about the relationships between the environmental fields and the precipitation systems. Data stored: Radar reflectivity: corrected (Z) and uncorrected (UZ), Doppler velocity (V) and spectral width (W). The volumetric sweeps were stored in polar coordinates, and will be used later for precipitation analyses and in the integration to the other weather radars operating during the experiment. Volumetric data will be integrated using all meteorological radars in order to create a consistent 3D radar reflectivity and Doppler velocity database. Simultaneously, rain gauge data measured from various meteorological networks will be gathered to compute an optimal radar reflectivity (Z) and rainfall rate (R) relationship. Moreover, this task will produce a map of the spatial distribution of precipitation in the region.

Teachers in the Field: Application of SALLJEX experience has already been made in the classroom. One elementary and one high school teacher (from the US and Argentina) participated in SALLJEX through the NOAA program "Teachers in the Field". The program promotes awareness of the need to understand and protect the world's environment. Further information about this program available at http://www.ogp.noaa.gov/salljex/index.htm

3. Data Management

Current information about SALLJEX products and about reports of the activities is available at the SALLJEX field catalog (http://www.joss.ucar.edu/salljex/catalog/). An interactive SALLJEX data catalog is under development at JOSS (http://www.joss.ucar.edu/salljex/dm). Radiosonde and Pibal data will be available at JOSS that will also store and distribute precipitation and model archives. All upper-level data will flow to JOSS by June 2003 and will be released by JOSS by August 2003. Argentina and Brazil will quality control the digital version of the Pilot balloons before sending these to JOSS. NSSL will do the same for Peru, Bolivia and Paraguay. Questionable data will be flagged by JOSS before they are released. JOSS will also make available GTS and non-GTS data obtained in delayed mode over South America during the experiment. Efforts should be made in order to make

available global TOVS during SALLJEX that are necessary to test data impact on different assimilation systems.

Regarding the SALLJEX daily rainfall information, data digitalization and data format compatibility is currently being made. Part of the SALLJEX rainfall database (raw version) will be accessible through the SALLJEX web page at UBA by August 2003 while the quality controlled version will be ready by the end of 2003. JOSS will store and distribute the final version of the SALLJEX rainfall database. NCEP would be willing to produce a high resolution (.5 by .5 degree) analysis of the daily rainfall data during SALLJEX with their operational rainfall analysis system.

Horizontal plan views of the SALLJEX flight tracks with wind barbs and preliminary wind analyses at several levels are available for most of the flights on the web site http://www.nssl.noaa.gov/ projects/pacs/salljex/p3/ . The Official data set will be release in a *CDF* format by Joint Office for Science Support (JOSS) and after that they will be posted in that site using an *ASCII* and Binary format. Radar data tapes have been copied, and the University of Utah will take the lead in processing and analysis of those data.

4. Follow-up activities

A SALLJEX data Workshop will be held in Buenos Aires, Argentina between 10 and 12 December of 2003 in order to: a) assess what progress have been made on SALLJEX objectives. b) strength and arrange collaborations among the partipants in SALLJEX. c) broaden participation in order to expand the analysis and modeling use of SALLJEX data by other scientists and their students determine follow-up SALLJEX activities

Several phenomena were observed during the SALLJEX and there is a need to organize the several initiatives of diagnostic and modeling. The charge between VPM6 and the SALLJEX Data Workshop is to have a consolidated list of foci to be presented. A number of phenomena and process studies were mentioned during VPM6:

- Strong NW LLJ - 21 January - horizontal structure (narrow/wide, double structure: narrow, close to the mountain slope; wider, farther east, larger scale)
- Well developed MCS - 22-23 January
- Northerly surges from the Northern Hemisphere interacting with the Andes, strong LLJ in Acre (19 January)
- Heat Low - 1 February
- Cold surge - 23 - 28 January
- Turbulence structure, size of the eddies for low level flights
- Meridional extent of LLJ – Acre, N. Argentina; Acre, SACZ region (S, SE Brazil).
- Diurnal variability of LLJ and convection in the Andean slopes, relationship with Amazon convection

SALLJEX observations provide a unique opportunity for validation of numerical simulation sensitivity studies that attempt to reproduce the structure of the jet and its variability as well as the related precipitation. Such validations as well as data assimilation experiments are currently undergoing and some of those efforts are listed below:

- Study of model performance during SALLJEX (CPTEC, U. Chile)
- Data assimilation impact (NCEP, CPTEC, U. Sao Paulo)
- Sensitivity studies to:
  - different model resolution and domain (CPTEC)
  - soil and topography contrasts (USP)
- Case studies: mainly related to NOAA P3 flights (CPTEC, FURG, U. Chile, U. Buenos Aires).
- Studies related to large-scale features like:
  - Intraseasonal variability during this period (CPTEC)
  - Impact of ambient flow upon the LLJ (U. Utah)

- Feedback of local forcing upon larger scale flow (U. Utah)

A coordinated analysis of model performance during SALLJEX is being planned. Specifically, verification of the simulations by regional models during the December 17-18 mesoscale convective system development using the same initial and boundary conditions is being planned by several institutions. The results of this analysis will be shown during the SALLJEX data Workshop.

Some Unique Features of Rainfall in South America

Edward Zipser, U. Utah

New and unique observations over the past 5 years have led to some insights on the physical processes responsible for rainfall over the tropics in general and over South America in particular. These include more than 5 years of satellite data from the multi-platform Tropical Rain Measuring Mission (TRMM) satellite, and a series of field programs in Amazonia (mainly associated with LBA), and most recently the SALLJEX.

There is now little doubt that most rainfall in most of South America in convective in nature. A new and startling finding is that convective systems in Amazonia are relatively modest in intensity, compared with tropical Africa and other continental regions. It is common to refer to the Amazon as the 'green ocean' because its convective systems are almost as weak as those over the ocean. In stark contrast, the Parana Basin from 25 - 35 S has a higher fraction (~80 percent) of its rainfall contributed by strong, organized mesoscale convective systems (MCSs) than any other region on earth, equaling or exceeding the percentage in the southern great plains of the United States. In addition, by any measure, those subtropical South American MCSs are as strong or stronger than those anywhere, including the central U.S. Therefore, understanding South American rainfall is a challenge that requires understanding of the physics of convection, not only where rising motion takes place on a large scale.

Convective rainfall requires significant amounts of convective available potential energy (CAPE) as a necessary but not sufficient condition. In South America east of the Andes, the water vapor is imported mostly from the South Atlantic Ocean, a notably cool ocean and the only one never to have experienced a tropical cyclone. The (moist static energy)(moist enthalpy)(theta-e)(take your pick) of the low level air coming off the south Atlantic, even on the equator, is too low to support deep convection under normal circumstances. That makes South America unique among the continents in requiring the additional moisture to come from the land surface. It is quite clear that the typical values of theta-e for air entering Brazil between 0 and 10 S are not nearly high enough to account for the observed intense convection over the Parana Basin; this additional latent energy is supplied (with assistance from solar radiation and vegetation) from the land surface during the several days the air spends traveling over Amazonia. (N.B., Air entering the North American monsoon circulation from the tropical Pacific, Gulf of California or Gulf of Mexico comes from a 28-30C ocean; air entering India and SE Asia during the summer monsoon comes from 28-30C ocean; air entering Africa from the tropical Atlantic/Gulf of Guinea comes from an ocean initially >28C in June, although the equatorial oceans cool between June and August, so some of the African rainfall also depends upon evaporation from the land surface.)

A few recent references:

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