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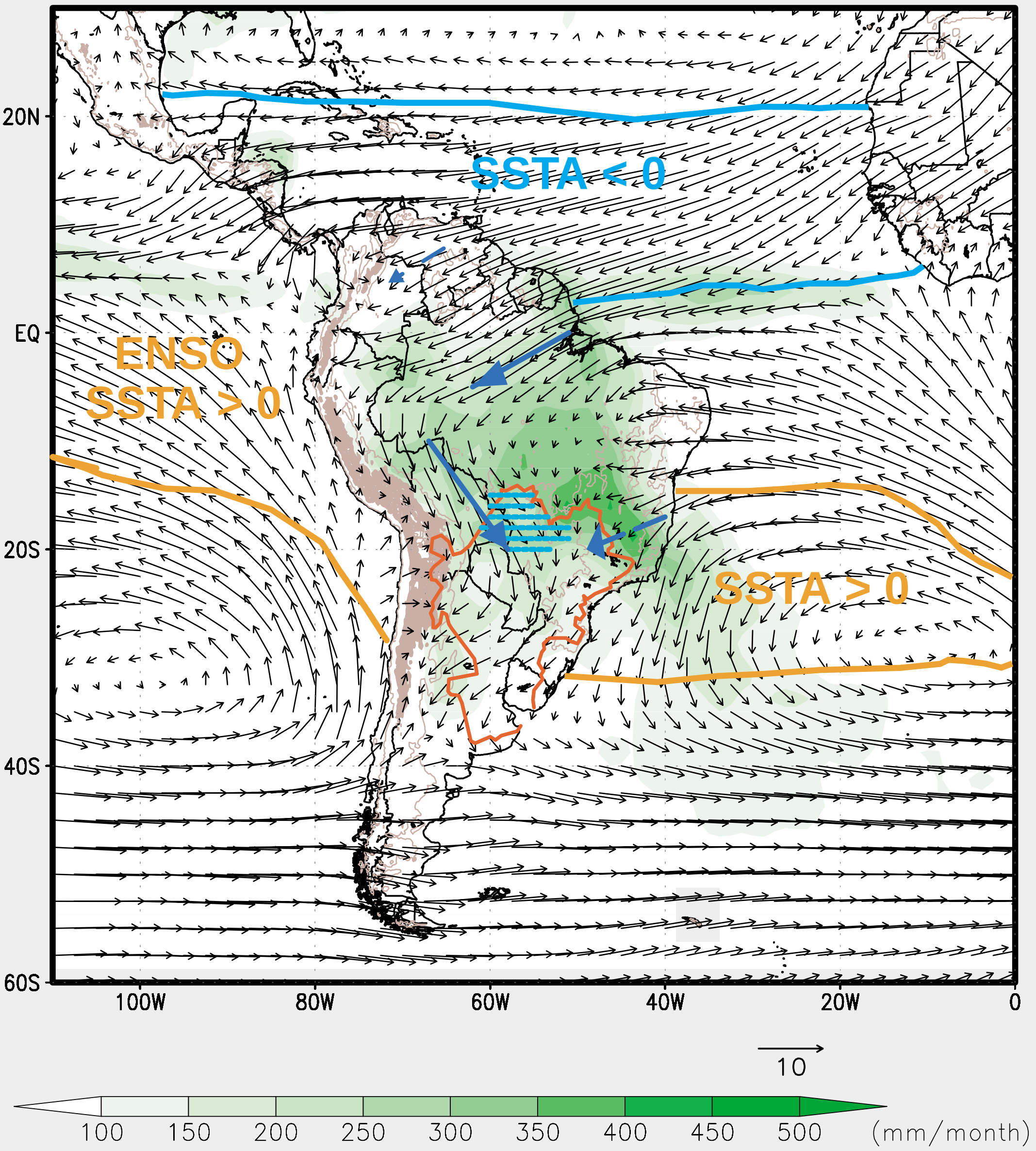
Exchanges No. 16 - Special issue featuring VAMOS -



South American Monsoon Modulation by SST Anomalies

Links between climate variability in the Rio de la Plata basin (area encircled by the red curve) and SST anomalies for the southern warm season (December-February). Green shading corresponds to precipitation (mm/month), black arrows to 925 hPa winds, thick blue arrows to maxima in vertically integrated moisture transport, and the blue hatched region to the Pantanal. The configuration of SST anomalies corresponds to enhanced precipitation in the basin (see article by C.R. Mechoso, page 5).

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Editorial

In this issue of Exchanges we feature one of CLIVAR's Principal Research Areas: "Variability of the American Monsoon Systems" (VAMOS). VAMOS focuses on the complex issues raised by the need for better understanding and prediction of the second largest monsoon system on Earth. VAMOS also aims to improve the human and logistical capabilities required to address those complex issues and to enhance awareness of the societal impacts of the variability of monsoonal circulations over the Americas.

The VAMOS panel has held a series of planning meetings with the scientific community active in this field of research, and is now entering the implementation phase of an ambitious project that will last through the end of CLIVAR in 2010. The planning of the initial field experiments is practically completed and the first field observations are expected to take place towards the end of 2002 in central South America and southwestern North America.

VAMOS strategy is based on encouraging partnerships between interested scientists and organisations in different countries of the Americas. Two major international programmes on the American climate, the Land-Biosphere-Atmosphere in Amazonia (LBA) and the Pilot Research Array in the Tropical Atlantic (PIRATA) have been contributing to VAMOS since the very beginning. The Pan American Climate Studies (PACS) and Eastern Pacific Investigation of Climate (EPIC) of the USA are two national programmes represented in the VAMOS panel; other national programmes may come on board as they develop. The Inter American Institute (IAI) and International Research Institute for Climate Prediction (IRI), both international institutions crucial to multi-national efforts in the Americas, are represented in the panel. VAMOS has established close ties with another major WCRP effort: GEWEX. These ties are formalised by the representation of GCIP in the panel and will be tightened by the planned work on the Rio de La Plata basin of South America.

Overall, the VAMOS project is expected to be one of the keys to CLIVAR's success. We certainly have to acknowledge Carlos Roberto Mechoso for his enormous efforts and enthusiasm as VAMOS panel Chair. The high degree of readiness of VAMOS could not have been achieved without his leadership in scientific and organisational aspects, as well as without the outstanding commitment of the other panel members.

Although VAMOS is the main overarching theme of this issue much more has been happening. The SSG co-chairs Anthony Busalacchi and Jürgen Willebrand summarise this in their report based on the discussions at the CLIVAR Scientific Steering Group that met recently in Hawaii.

Then, the VAMOS section starts off with an overview of the VAMOS project by C. R. Mechoso. This is followed by descriptions of selected project components, which are illustrated with recent scientific findings.

An important article in the general section of the newsletter is that by John Gould about the CLIVAR 'Tracking Project': an initiative to provide comprehensive, up-to-date information about the programme to the community.

After 5 years we feel that it is time to renovate the layout of Exchanges and we started with some modest modifications in this issue. We hope that you will enjoy it and encourage you not only to read but also to contribute to Exchanges with short and interesting scientific highlight of research relevant to CLIVAR.

For the next issue, that will appear in late summer we would like to highlight the synthesis of climate research: bringing observations and simulations together, e.g. through advanced assimilation techniques, intercomparisons, or detection and attribution. We strongly encourage you to submit your contribution to the editor of CLIVAR Exchanges (andreas.villwock@clivar.dkrz.de) not later than July 31.

Andreas Villwock

The CLIVAR Web-site has moved to Southampton !

Since beginning of May the main CLIVAR Web-site is now located in Southampton accessible under:

http://www.clivar.org/

Please update your bookmarks. The old site at DKRZ in Hamburg will not be updated anymore and will be phased out soon. The mirror site at UCAR is not affected by this change.

CLIVAR SSG activities

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The ninth meeting of the CLIVAR SSG was hosted by the International Pacific Research Center at the East-West Center on the University of Hawaii Campus, May 2-5, 2000. The SSG wishes to express its sincere appreciation for the fine meeting support from the IPRC, and it was pleased to see the progress that has been made in the development of this new research center with research goals very much in line and supportive of CLIVAR.

The SSG was briefed on a number of significant accomplishments over the past year and plans for the coming year with respect to CLIVAR implementation of monsoon studies, ocean observations, and coupled model studies. When considering the fact that the International CLIVAR Conference was held only 18 months ago in Paris, considerable progress has been made at the international level and within various countries under the auspices of CLIVAR. CLIVAR has developed recently a tracking system to monitor these various international contributions, and more information on this resource can be found on page 23. This ninth meeting of the CLIVAR SSG was one of the first SSG meetings in which a majority of the chairmen of the CLIVAR working groups and panels were in attendance. In view of the broad scope of CLIVAR, there was considerable discussion of plans to further strengthen the links and communication among the various elements across the programme. The presence of the SSG panel chairs contributed greatly to the deliberations of the SSG and the overall approach to CLIVAR implementation.

Among the highlights of the past year was the CLIVAR co-sponsorship of Ocean Observing System for Climate Conference (a.k.a. Oceanobs '99) in Saint Raphael, France. Under the leadership of Neville Smith and Chet Koblinsky, a consensus was developed regarding the approach to sustained ocean observations in support of operational and CLIVAR research requirements. With respect to these CLIVAR requirements, and as a means of consolidating a number of the CLIVAR principal research areas, CLIVAR is proceeding with implementation via ocean sector or basin panels that consider the range of observations, modelling, and process studies needed to address CLIVAR goals and objectives. On April 13 and 14, the first meeting of the CLIVAR Atlantic Panel was held in Natal, Brazil (see also article on page 23). The panel discussed the extent of activities within the Atlantic bearing on studies of the North Atlantic Oscillation, the Atlantic thermohaline circulation, and the tropical Atlantic variability. From the perspective of CLIVAR implementation, it is important not to consider these principal research areas as separate areas onto themselves, but rather to consider the context of the multiple factors or processes that determine the major modes and signals of climate variability and prospects for predictability within the region. In view of the prospects for predictability at low latitudes in the region, CLIVAR is encouraging interested countries to develop a coordinated approach to implementing a tropical Atlantic observing system building on the success of the PIRATA programme and the report of the COSTA meeting, chaired by Sylvia Garzoli, in May 1999.

At the SSG meeting, Bob Weller reported on a planning meeting held just prior to the SSG for the purpose of the development of a Pacific Implementation Workshop to be held in Hawaii in early 2001. Similarly, Doug Martinson is also in the process of planning an implementation meeting for the Southern Ocean to be held in Perth, Australia, in November 2000. Against this backdrop of the Ocean Obs'99 Conference and the ocean sector implementation panels, the SSG agreed that the present CLIVAR Upper Ocean Panel should become the CLIVAR Ocean Observations Panel. The new panel would be charged to oversee implementation of sustained and near sustained ocean observations in support of CLIVAR research. This would include oversight for research purposes of the ENSO observing system, for example. It was decided that increased emphasis should be placed on ocean assimilation and air-sea fluxes.

Over the past year CLIVAR has seen significant progress made by a number of its monsoon related elements. This is just one aspect of CLIVAR that intersects with other elements of the World Climate Research Programme. The CLIVAR monsoon initiatives have much to offer and are also in a position to gain much from the Global Energy and Water Experiment (GEWEX). The CLIVAR SSG was very pleased that Soroosh Sorooshian, the GEWEX Chairman and Ron Weaver of the GEWEX SSG were able to attend the SSG meeting. At the SSG meeting Bill Lau, Stuart Godfrey, and Peter Webster reported on the AA Monsoon Panel meeting held this past December and the strategy that is being developed for a sustained monsoon observing system. The SSG welcomed the progress made by AA Monsoon Panel and encouraged the group to develop further their plans in conjunction with GEWEX and the Coordinated and Enhanced Observing Period (CEOP). The SSG also saw a potential need for a process study to resolve some of the outstanding questions concerning intraseasonal oscillations associated with the AA monsoon system with a particular view to improving atmospheric model performance. The SSG encouraged the AA Monsoon Panel to develop an implementation plan in this regard and take advantage of the November meeting in Perth of regional Indian Ocean laboratory directors.

Roberto Mechoso reported on the implementation progress that VAMOS has made with respect to a three-tiered implementation strategy for studying the warm season precipitation within the Americas. As reported later in this issue, this will include process studies under the stratus deck off the west coast of South America, field studies of the South American low level jet, all culminating with a coordinated study of the climatology and hydrology of the Rio de la Plata basin.

With respect to Africa, the CLIVAR Africa Study group published its report on African climate variability in 1999. Subsequently a CLIVAR African task team was established to develop an initial implementation plan for achieving CLIVAR's objectives with regard to Africa. A draft of the task team report was reviewed by the SSG, which decided that upon completion of the plan, a formal CLIVAR African Climate Panel would be established to foster and oversee implementation. One of the early tasks for this Panel would be the compilation of an inventory of data sources relevant to achieving those objectives stated in the plan

The modelling groups within CLIVAR continue to be very active, and this past year has seen considerable amount of effort in support of the IPCC process. An important aspect of this process are issues of attribution and detection of climate change which were reported on by the Working Group on Climate Change Detection which is jointly sponsored by CLIVAR and the WMO Commission for Climatology. This past year, the Working Group on Seasonal-to-Interannual Prediction evaluated various predictions of 1997-98 El Niño/La Niña sequence and the role that intraseasonal oscillations may have played in the timing and amplitude of this extreme event. During the course of the SSG, there was discussion that certain aspects of CLIVAR science, with respect to the fundamental basic research and modelling activities, have matured to the point that CLIVAR should broaden and deepen its interactions with the applications sector. A step in this direction was taken at this meeting by way of the discussions regarding the UNESCO programme on Hydrology for the Environment, Life, and Policy (HELP) which was represented by Jim Shuttleworth. The SSG saw a need to strengthen its links with programmes such as HELP and with organisations such as the IRI, IAI, CLIMAG, Food and Fibre, and CLIPS. Interactions of this nature would naturally lead to recommendations for joint projects with the CLIVAR modelling working groups such as predictability case studies for the recent floods in Mozambique on the short time scale, and the Sahel rainfall on the longer decadal time scale. It was decided that the SSG will devote a full session to this general topic at one of its next meetings.

In summary, implementation of CLIVAR is well underway. In the 18 months since the CLIVAR Conference, the CLIVAR approach to implementation through the monsoon panels, ocean sector panels, and modelling working groups has been providing the framework for the scientific community to proceed with a number of exciting research opportunities, and overall has resulted in substantial progress on CLIVAR objectives. As mentioned above with respect to links with GEWEX, CLIVAR is striving to strengthen cooperation across the full range of the WCRP activities. At the present time, CLIVAR is coordinating with CLIC for the implementation in the Southern Ocean. Moreover, CLIVAR, particularly through the co-location of the project offices, is working closely with WOCE to ensure a successful conclusion of WOCE (e.g. the joint Variability Workshop to be held in Japan this autumn) and a smooth transition where appropriate of such aspects as WOCE data centres. Lastly, a programme such as CLIVAR benefits from an appropriate injection of new ideas and energy together with the stability provided by overlapping committee membership. We wish to acknowledge the efforts of Allyn Clarke and Chongyin Li, who contributed so much over the past several years as members of the SSG, and take this opportunity to welcome Francis Zwiers and Guoxiong Wu as new members of the SSG.

Introduction to VAMOS

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1. Overall goals and strategy

The goal of VAMOS in the Americas is to improve the 1) understanding of the monsoons in the context of the global climate system, 2) capacity for seasonal to interannual climate predictions, and 3) assessment of anthropogenic climate change impacts. The VAMOS Panel's strategy to achieve these goals is based on the 1) identification of scientifically important climate phenomena with demonstrated potential for predictable components, 2) encouragement of partnerships between scientists in interested countries and contributions to the development of national and international research plans, and 3) promotion of broad participation in field programmes, both to bring local expertise to an international setting and to enhance scientific exchange and capacity building.

2. The American monsoon experiments

The Panel has focused on the definition of key problems within the framework of VAMOS goals, and on the formulation of hypotheses for guidance of future empirical and modelling research as well as on the design of field experiments. A unifying view has started to emerge as similarities and differences between North and South American monsoon systems have been further clarified.

The current plans are centred on two internationally coordinated efforts to improve prediction of warm season precipitation over South and North America:

a) Monsoon Experiment South America (MESA), and

b) North American Monsoon Experiment (NAME).

The principal objectives of MESA and NAME are

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.

MESA and NAME are both organised in three stages or tiers. The latter experiment is described by W. Higgins in this issue of Exchanges. We will concentrate on MESA in this report.

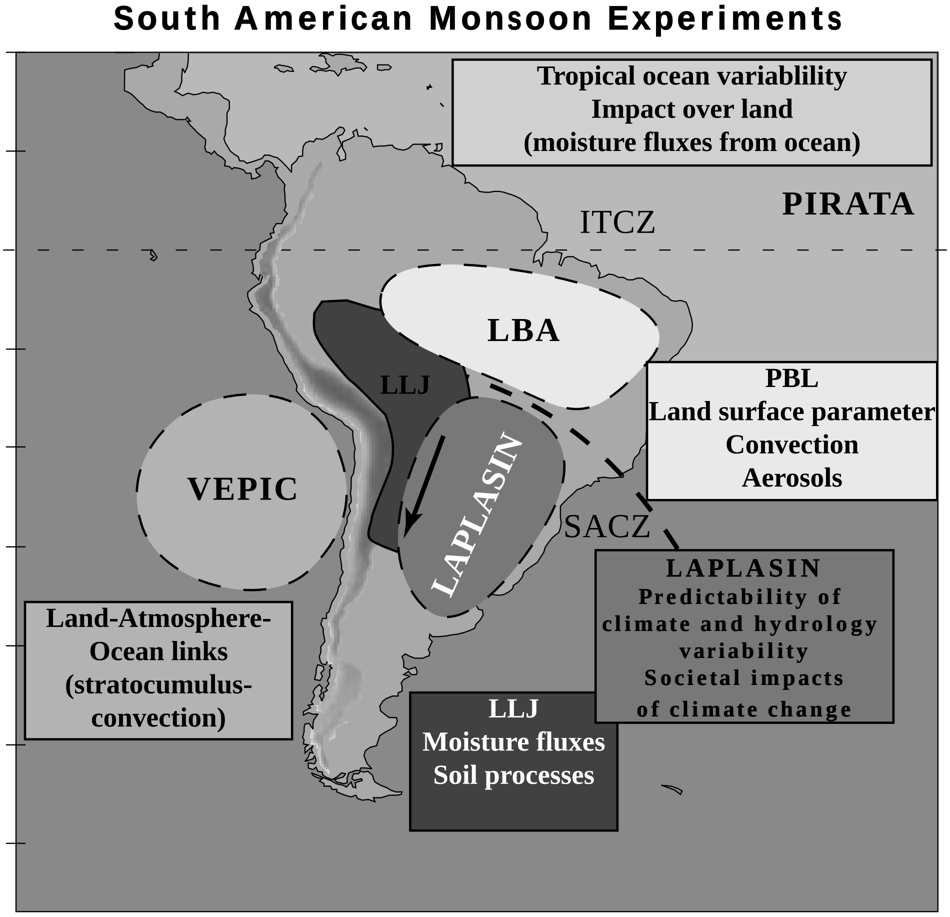

Fig. 2: Schematic of VAMOS programmes during MESA Stage 2.

3. MESA

Over South America, the summer circulation is dominated by the monsoon system. Important geographical factors determining the evolution of this system are the large land mass bisected by the equator, very high mountains to the west that effectively block air transport in the zonal direction, and surface cover that varies from tropical forests in Amazonia to high altitude deserts in the Bolivian Altiplano. Plentiful moisture supply from the Atlantic maintains a precipitation maximum over central Brazil. A major seasonal feature of the monsoonal circulation over South America is the South Atlantic Convergence Zone along the northeastern boundary of the La Plata Basin. A low-level northerly/northeasterly jet that flows east of the Andes (SALLJ) is described in the papers by J. N. Paegle and E. H. Berbery, and Nicolini and Saulo.

An important component of MESA's Stage 1 focuses on the SALLJ and the moisture corridor between the Andes and the Brazilian Altiplano. The main objective of this component is to better understand the role of the SALLJ on the moisture transports, their variability and links to remote and local climate anomalies. Stage 1 also comprises VEPIC (VAMOS-EPIC: Eastern Pacific Investigation of Climate Processes in the Coupled Ocean-Atmosphere System), which targets the links between continental convection and marine stratocumulus along the chilean coast.

MESA's Stage 2 will be a study of the hydroclimatology of the La Plata River Basin, whose importance is emphasised in the paper by E. H. Berbery and C. R. Mechoso. The current consensus is that climate variability in the La Plata Basin has remote influences (see the paper by A. Grimm). Positive precipitation anomalies in the basin tend to correspond to warm events in the tropical Pacific, warm sea surface temperature (SST) anomalies in the western South Atlantic, and cold SST anomalies in the north tropical Atlantic (see Fig. 1, cover page). The current consensus also states that, at least during the monsoon season, the major contribution to the moisture flux into the basin comes through a "moisture corridor east of the Andes". There is also evidence that precipitation in the basin is inversely correlated with the intensity of the SACZ. Understanding the mechanisms at work for these connections is a principal goal of MESA. Figure 2 is a schematic of MESA Stage 2. Stage 3, towards the end of the decade, will link the Rio de La Plata basin project (PLATIN) to the climate monitoring efforts under development by the South American countries along the Pacific coast. Data gathered in these programmes will be made available in a VAMOS database.

4. VAMOS and GEWEX

MESA and NAME will provide an important linkage between CLIVAR and GEWEX. The GEWEX Continental-scale International Project (GCIP) has promoted much research into aspects of the North American monsoon system, which will continue and expand under the new GEWEX Americas Prediction Project (GAPP). Similarly, the GEWEX Coordinated Enhanced Observing Period (CEOP) will coincide with the first MESA field programmes. Finally, PLATIN will be the first large-scale, international project to be jointly sponsored and developed by CLIVAR and GEWEX. As a result of such collaborations, the MESA and NAME will contribute decisively to establish a long-term climate and hydrology monitoring capability throughout the Americas by the end of the decade.

5. Acknowledgement

On behalf of the VAMOS panel, it is a pleasure to acknowledge the excellent support provided by the ICPO representative, Andreas Villwock, and the encouragement received from John Gould and Valery Detemermann.

Low-level Jets over the Americas

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1. Introduction

Warm-season precipitation processes over North and South America are strongly modulated by Low-level Jets (LLJ's). The LLJ structure is particularly important since this wind system transports moisture rapidly over large distances, e.g., east of the Rockies and Andes mountains. This moisture often condenses and precipitates in the region of low-level convergence situated downstream of the LLJ core. Here, explosive mesoscale convective complexes (MCCs) occur preferentially at night.

Although both North and South American observations display extensive areas of nocturnal convection during the spring and summer seasons over vast agriculturally productive plains east of the mountains, general circulation models have been unable to reproduce the nocturnal precipitation maxima (Ghan et al., 1996). Consequently, models used for climate simulation, as well as for generation of global gridded data sets, systematically misrepresent this basic element of summer precipitation. It is plausible that the deficiency constrains accuracy of longer-term climate simulations, as several observational studies have suggested a correlation of longer-term rainfall fluctuations with areas of strong diurnal convection cycles. Limited area models (LAMs) and variable resolution global models have reported greater success in short-to-medium term simulations of diurnal convective cycles. It is not yet clear whether this is simply due to their better resolution of atmospheric dynamics or to more detailed depiction of surface characteristics such as topography. It is also plausible that accurate simulations of nocturnal convection depend upon accurate simulations of the LLJ and its strong diurnal cycle.

The extensive observational network and special field programmes over North America have made possible to gain some insight into the spatial and temporal structure of the Great Plains LLJ. In contrast, over South America, the more extensive LLJ is located in one of the largest observational data gaps over the Americas: the region that comprises Bolivia, Paraguay and northeastern Argentina. VAMOS has recognised the critical importance of advancing the knowledge of this LLJ and has given priority to the development of a programme on the South American LLJ. This includes empirical studies, modelling and field experiments. We will review here some recent results that indicate the potential long-term predictability of LLJ currents over South America and associated rainfall patterns (Section 2), inferred mesoscale structure from model simulations (Section 3) and current plans for a field component designed to better describe the South American LLJ structure and its role in climate (Section 4).

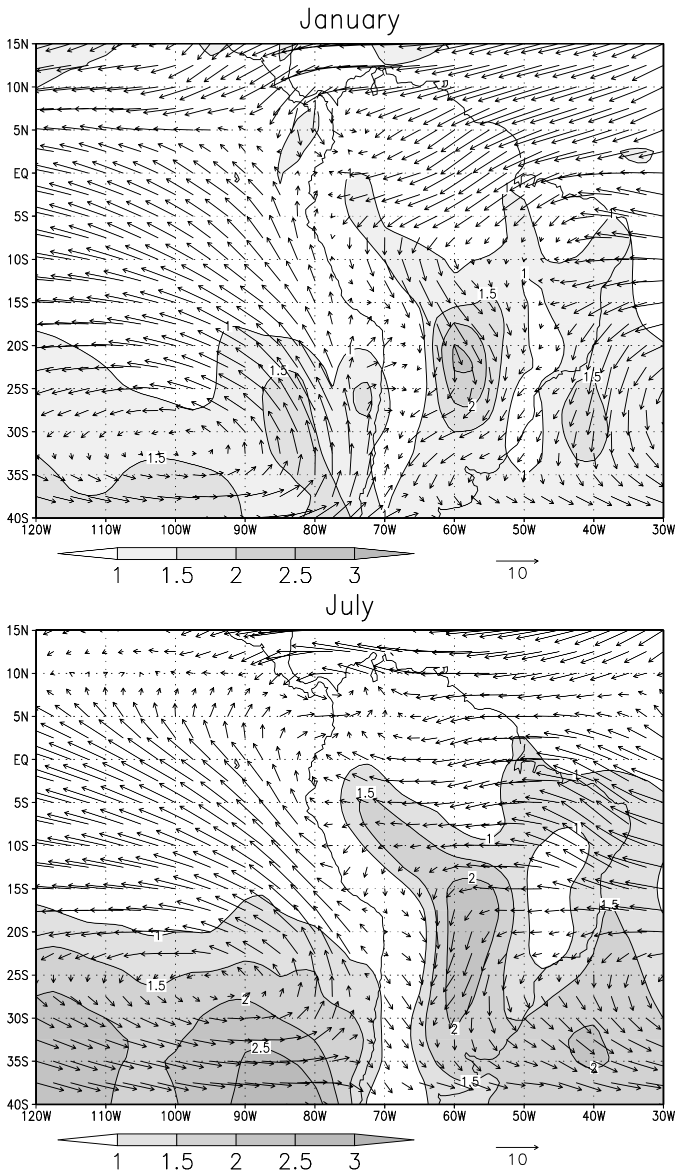

Fig. 1: Mean wind field (arrows) and its monthly standard deviation (shades) at 950 hPa, estimated from 1957-1996 NCEP/NCAR reanalyses.

2. Long Term Variability

Figure 1 depicts the January and July 950 hPa wind average and its monthly standard deviation obtained from 40 years of NCEP/NCAR reanalysis. The maximum variability of the meridional wind is found in close proximity to the region of maximum northerlies east of the Bolivian plateau and represents about 50% of the average value. This indicates a high potential predictability of the January low-level flow (and associated rainfall patterns). However, for this potential to be realised it is necessary to determine the source of such variability, both with regards to possible remote influences and regional forcings. The latter includes the blocking effects of the Andes mountains and Brazilian Altiplano as well as land-atmosphere interactions.

Figure 1 shows easterly flow over South America from the Atlantic Ocean into tropical South America, channelled southward by the Andes. The trade winds merge with the northern branch of the Atlantic subtropical high, which brings moist air into the South American coast. Changes in the position and intensity of the north-easterlies and the Atlantic high have profound impact on the LLJ. For example, as the Atlantic high shifts westward in summer, the LLJ east of the Bolivian plateau shifts southward and is often associated with increased precipitation over the lower La Plata river basin.

In interdecadal time scales there is evidence for increased precipitation over tropical South America with the warm (positive) phase of the North-Atlantic Oscillation. During this phase, the trade winds increase bringing additional Atlantic moisture over the continent. Over the southern oceans there is a tendency for a southward shift of the subtropical highs (Burnett and McNicoll, 1999) and a concomitant impact on the circulation over the perimeters of continents. Significant interdecadal variations in rainfall have also been detected in several regions of South America. For example, CastaZeda and Barros (1994) disclosed long term variations in rainfall over northern Argentina. Robertson and Mechoso (1998) showed long-term variations and trends in streamflows of rivers in the La Plata basin. Grimm et al. (1998) discussed significant shifts in the precipitation over southern and southeastern Brazil in the 70's. The period and region of maximum variation suggest an ENSO-like impact on longer time scales.

In interannual time scales, the LLJ is influenced both by Pacific and Atlantic sea surface temperatures (SST). Warming of the equatorial Pacific (warm ENSO event) results in a eastward displacement of the Walker circulation. The South America rainfall pattern during a warm ENSO event (Ropelewski and Halpert, 1987) depicts a dipole with dry conditions over northeast Brasil and wet conditions over the lower La Plata basin. In contrast, south Atlantic SST anomalies (10^{o}S) modulate the South Atlantic Convergence Zone convection, such that warm SSTs are associated with a weakened SACZ and strengthened LLJ east of the Bolivian plateau (Robertson and Mechoso, 2000).

Nogues-Paegle and Mo (1997) describe an oscillation between the LLJ and the SACZ in intraseasonal time scales and point out some basic differences between the low-level jet over the United States Great Plains and that over South America. The moisture source of the former is a water mass (the Gulf of Mexico), while over South America the moisture corridor has strong interaction with the Amazon Basin that is traversed en-route to the La-Plata Basin. In addition, the Great Plains low-level jet has a marked annual cycle, with the jet developing during the warm season while the South American LLJ is present most of the year (Figure 1 and see also http://www.met.utah.edu/jnpaegle/research/miami_report.html).

3. Mesoscale aspects

The regional forcings that may affect the long term variability are of mesoscale nature. Similarly, one of the most remarkable aspects of the LLJs is their mesoscale nature. While their extent is typically of the order of 2000 km, their width is only about 500 km. Moreover, they have a large diurnal cycle that affects the downstream convergence of moisture flux and precipitation. Figure 2 (page 16) presents the diurnal cycle of convective cloud frequency (Garreaud and Wallace, 1997), which reveals a nocturnal maximum mainly over northeastern Argentina. Mesoscale model studies for summer have shown that the LLJ east of the Andes is strongest during night-time; however, as indicated earlier, no observations are available to verify that this is the case. On the other hand, if the model simulations realistically reproduce the night-time maximum of precipitation (e.g., Berbery and Collini, 2000), it is conceivable that other modelled aspects, including the night-time maximum in the LLJ intensity and its related convergence, are all part of a same physical evolution.

The hydrological cycle is of great interest in predictability studies, since it relates to the water resources for vast populations. Adequate resolution of LLJs in numerical models is a necessary condition to compute the moisture flux convergence as part of the hydrological cycle, but results from global reanalyses have exposed their limitation to achieve water balances for given regions (e.g., Higgins et al., 1996). Part of the problem has been attributed to uncertainties in wind analyses (Wang and Paegle, 1996), but an additional limitation is lack of resolution of the diurnal cycle and of mesoscale features (Berbery and Rasmusson, 1999).

4. Field programme

This programme consists of a Phase I buildup programme and a Phase II special observing period, as described below. The programme is designed to obtain an improved description of the LLJ and to delineate its dynamic and thermodynamic origins. It will provide high-quality data sets to evaluate gridded analyses and numerical models.

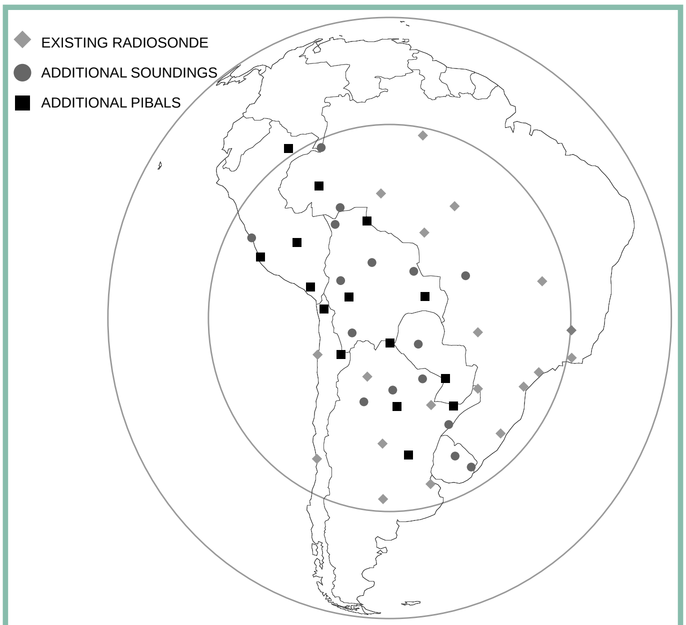

Fig. 3: Enhanced sounding network for South American LLJ field programme.

Phase I. Build-Up phase.

i) Compile and analyse special South American soundings of 1998, 1999 (Douglas et al., 1998, 1999) and those planned for the next three years as an extension of the PACS/SONET network over Bolivia and Paraguay. The latter effort is possible through the continued financial endorsement from NOAA's Office of Global Programs. This monitoring programme is essential to quantify intra-seasonal, seasonal, and inter-annual variability of South American LLJs, and thereby validate, calibrate, and tune assimilation systems.

ii) Improve rainfall measurements in the region through improvement of the network of recording rain gauges over tropical and subtropical South America.

Phase II: Field Experiment Special Observing Periods (SOPs)

At least two SOPs (two to three months long) are currently planned to account for interannual variability (field campaigns of 2002-2003 and 2003-2004). The SOP's would start in November to coincide with the climatological time of maximum late spring MCC activity to the lee of the Andes. The regular radiosonde network would be augmented during this period to two times per day as shown in Fig. 3 and an array of three 915 MHz wind profilers will be potentially deployed over Bolivia and the Bolivian-Brazilian border. Intensive observing periods (IOP, 3-7 days long) would be selected within the observing periods. Upper level soundings would be increased to 4 times per day during the IOP's and the NOAA P-3 aircraft will be flown out of Santa Cruz, Bolivia. This latter platform will measure horizontal gradients associated with LLJ near the Andes (from a few km from foothills to about 400 km) with better resolution than can be provided by the sounding network.

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The Hydrologic Cycle of the Rio de la Plata basin

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The Rio de la Plata basin (La Plata basin) in South America comprises the Paraná, Paraguay and Uruguay rivers. It covers about 3.6 10^6 km^2 and spreads over five countries, where about 50% of their combined population lives. Approximately 46% of the basin's surface is in Brazil, 30% in Argentina, 13% in Paraguay, 7% in Bolivia, and 4% in Uruguay. The basin is important in different ways for the regional economies; about 70 of the total GNP of the five countries combined is produced within the basin. Firstly, harvests and livestock are among the region's most important resources. Secondly, the rivers are natural waterways and ground transportation has greatly increased in recent years due to the integration of regional economies. Thirdly, several hydroelectric plants provide energy to the region, and, in fact, 92% of the energy produced by Brazil depends on hydroelectric resources. Finally, the rivers of the basin are the water resource for one of the most densely populated regions of South America.

The VAMOS implementation plan for the Monsoon Experiment in South America (MESA) has a particular interest in the water cycle and regional water resources. Within MESA, the study of the South American Low-level Jet (LLJ) seeks to understand its role in moisture transports and associated hydrological processes (Mechoso, 2000 in this issue). In a second stage, MESA will target the climatology and hydrology of the La Plata basin.

This note discusses basic features of the La Plata river discharge, and contrast them with those of the Mississippi River. Such a comparison is of interest in view of the intense research that has been devoted to the latter; both basins are about the same size and it is expected that the experience gained in studies of the Mississippi's hydrologic cycle could greatly help to better understand La Plata's. The same reasoning motivates the American Low-level Jets (ALLS) project, since the two basins have an important inflow of moisture from the tropics/subtropics through poleward LLJs east of a mountain barrier (the Rockies for the Mississippi River basin and the Andes for the La Plata basin). On the other hand, it is also important to identify differences that will require special research. For instance, despite the overall similarities, the Great Plains LLJ has marked differences with its South American counterpart, both in structure and seasonal cycle (see, e.g., Nogués-Paegle and Mo, 1997; Berbery and Collini, 2000). Further details are discussed in Nogués-Paegle and Berbery (2000) in this issue. Concerning river discharge, it is crucial to investigate the main contributors to its seasonal cycle and variability.

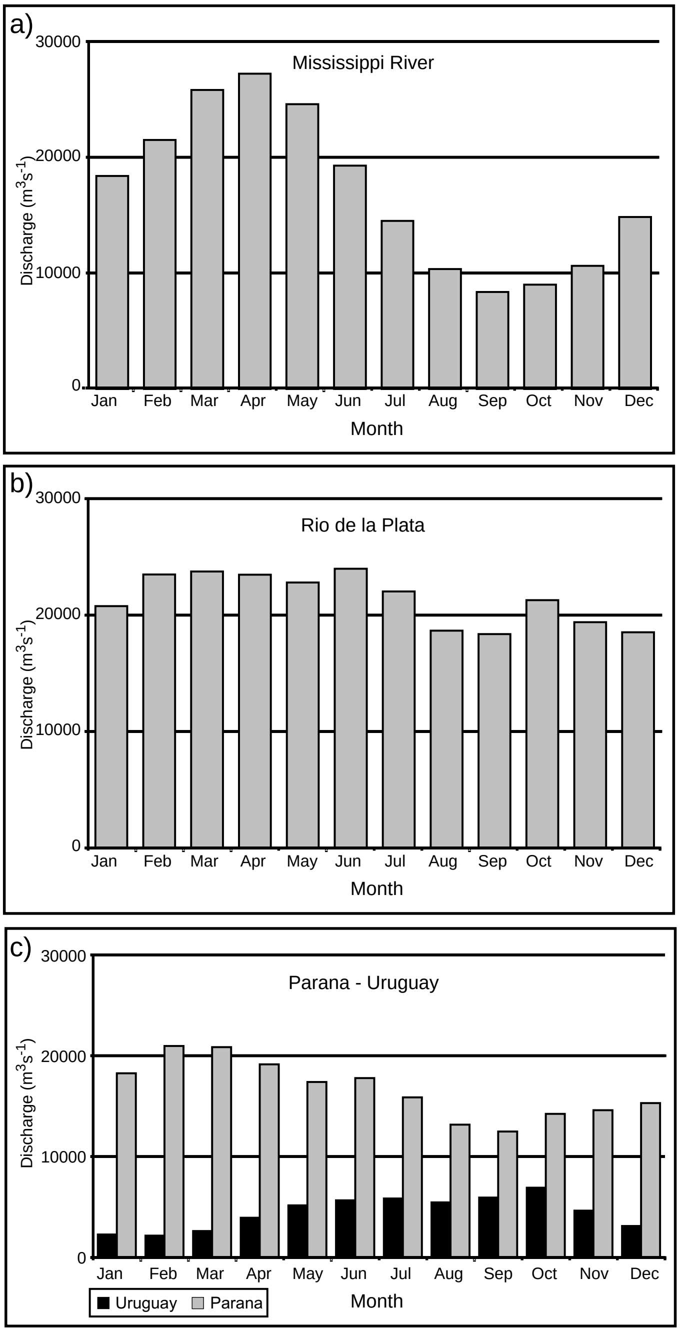

Fig. 1: Seasonal cycle of river discharge for a) the Mississippi, b) the Rio de la Plata and c) the Paraná and Uruguay river, respectively.

The Mississippi River discharge (Figure 1a) has a well defined seasonal cycle with a maximum of about 25,000 m^3 s^{-1} during spring (March-April-May); this maximum is the result of snow melting in the northern parts of the basin, with an additional contribution by springtime precipitation associated with convective activity that develops over the Great Plains. The minimum river discharge (of about 8,000 m^3 s^{-1}) occurs towards the end of the boreal summer and autumn, when the contribution from ice melt-

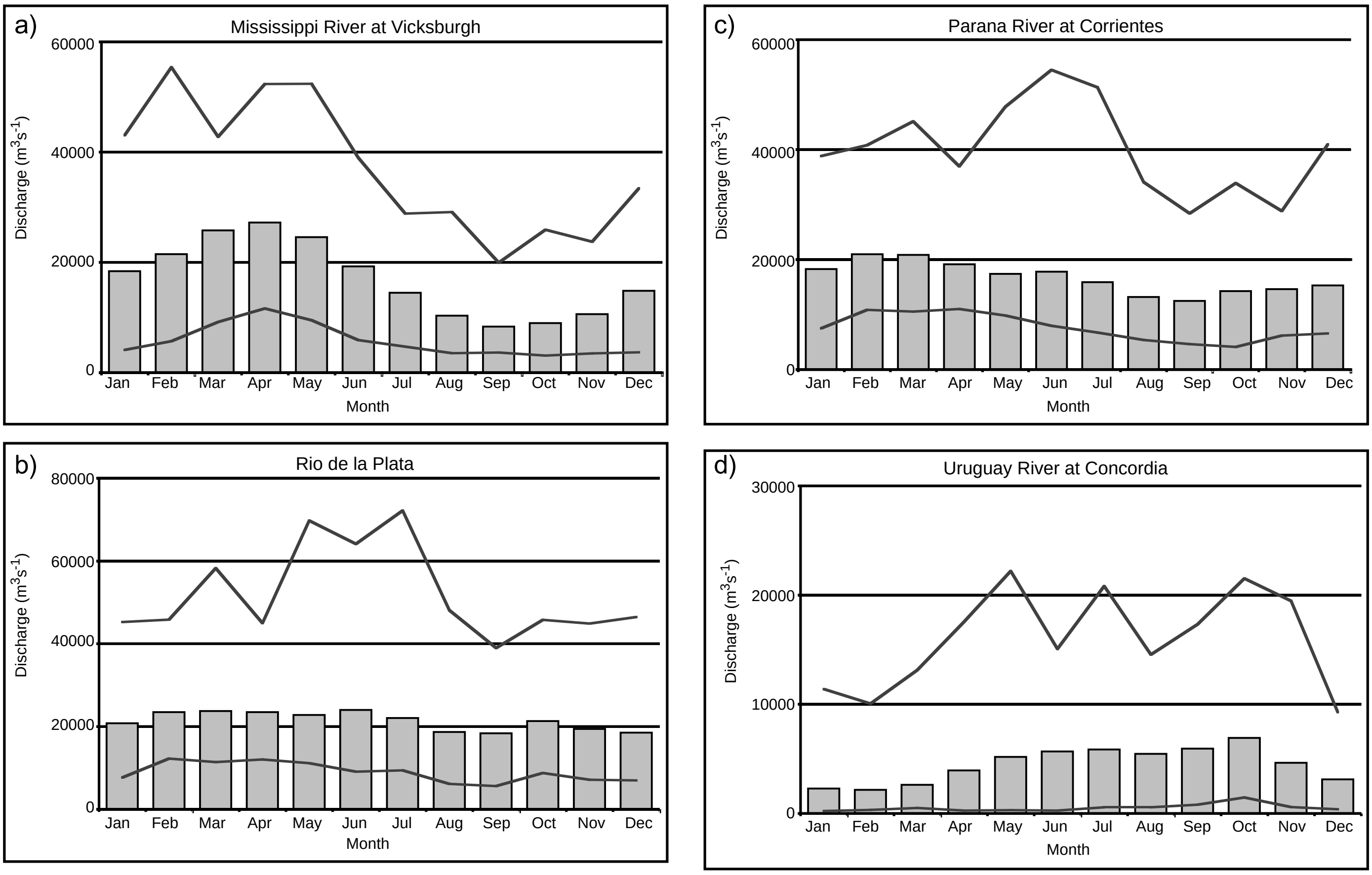

Fig. 2: Mean seasonal cycle of river discharge and the historical maximum and minimum for each month for a) Mississippi, b) Rio de la Plata, c) Paraná, and d) Uruguay river.

ing has decreased significantly. An additional factor for the reduced river discharge may be the result of the development of the North American monsoon system: when precipitation over northwestern Mexico increases (usually at the beginning of July) that over the Great Plains decreases (Douglas and Englehart, 1996; Higgins et al., 1997; Barlow et al., 1998).

The La Plata River discharge (the combined discharge of the Paraná/Paraguay and Uruguay rivers) presented in Fig. 1b is fairly uniform around the year, with typical values of about 20,000 $m^3\ s^{-1}$. There is a slight discharge increase from February to July (late austral summer and autumn). However, the analysis of the discharge for each of the subbasins (Fig. 1c) shows that in fact the Paraná and Uruguay rivers each have well defined seasonal cycles, but that their peaks are out of phase: the Paraná river has a maximum in late austral summer while the Uruguay river has largest discharge (although of smaller magnitude) between June and November.

Figure 2 presents the mean seasonal cycle of river discharge and the historical maximum and minimum for each month (based on monthly time series during 1932-1998 for the Mississippi River and 1904–1993 for the La Plata River). The potential for flooding of the Mississippi

Table 1

	Mississippi River	**La Plata River**
Area	3.1 10^6 km^2	3.6 10^6 km^2
Mean annual discharge	17,100 m^3 sec^{-1}	21,400 m^3 sec^{-1}
Maximum river discharge/ Time of year	27,200 m^3 sec^{-1} April	23,970 m^3 sec^{-1} June (and several other months)
Minimum river discharge/ Time of year	8,350 m^3 sec^{-1} September	18,350 m^3 sec^{-1} September
Historical Maximum/ Timing	55,000 m^3 sec^{-1} Spring	72,000 m^3 sec^{-1} Winter

basin (Fig. 2a) as revealed from these historical maxima is during the first half of the year, concurrent with the mean maximum of the annual cycle. On the other hand, Fig. 2b shows that flooding in the La Plata basin may occur at any time of the year, with largest values during austral winter. Although not shown here winter maxima tend to be associated with El Niño episodes, as those during 1982/1983 and 1997/1998. The Uruguay River discharge, while usually small in comparison to the Paraná river, can in some cases achieve values that are as high as the Paraná mean discharge.

The main aspects of the river discharge are summarised in Table 1: The La Plata River has a large mean annual discharge (larger than the Mississippi River), and its potential for flooding is present at any time of the year (with a maximum in winter). Moreover, floods can cover large areas due to the flat terrain that characterises the region. These remarkable features strongly suggest the need for more detailed studies of the La Plata basin. Indeed, the new challenge ahead is to increase our understanding of the regional climate and hydrology, in order to develop the capability to perform seasonal to interannual forecasts that include the water resources.

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Implications of strong low level jets east of the Andes for enhanced precipitation over subtropical South America

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Previous studies have been devoted to study the low-level circulation over South America (Rasmusson and Mo (1996) and Nogués-Paegle and Mo (1997), among others). Particularly, Saulo et al (2000) have characterised the low-level flow and water vapour flux during the September 1997- February 1998 warm season using ETA regional model operational forecasts provided by CPTEC (Centro de Previsao de Tempo e Estudos Climaticos, Brazil), and identified low-level jet events (SALLJ) immersed in a northerly current that originates in northerly tradewinds deflected by the tropical Andes range. One of the main findings of these studies is the presence of a maximum moisture flux dominated by a northerly and stationary component east of the Andes. Moisture convergence downstream of this maximum is detected over subtropical and mid-latitude Argentina, Uruguay and southern Brazil. Nogués-Paegle and Mo (1997) have identified episodes of strong moisture flux into subtropics corresponding to the weak SACZ phase and positive anomalies in OLR of a seesaw pattern. Garraud and Wallace (1998) studied equatorward incursions of midlatitude air into subtropics and tropics during austral summer and characterised the days –2 and –1 before the onset of these incursions by the presence of a stronger than normal low-level northerly flow with an area of enhanced convection over the region of interest. These two previous works have focused in SACZ or in cold air incursions during summer. Other evidences emphasised the relationship between moisture flux convergence maximum downwind low-level jets and the triggering of convection within mesoscale convective systems over this region (Velasco and Fritsch, 1987; Torres and Nicolini, 1999). Present study poses a hypothesis with implications in the occurrence of enhanced precipitation in continental latitudes between 25 and 40ºS. This hypothesis is that the relationship between moisture flux convergence in the exit region of the low-level jet and extreme precipitation depends primarily on the incidence of events that penetrate farther south from the mean maximum.

The relevance of this hypothesis in terms of the impact of low-level jets in severe weather outbreaks during the warm season has motivated the selection of a subensemble of SALLJ cases more strongly related to precipitation in the mentioned area. These particularly strong jets are denoted Chaco jets because they flow over the biogeographical province called Chaco. These cases may be related to a secondary maximum described by Sugahara and da Rocha (1996).

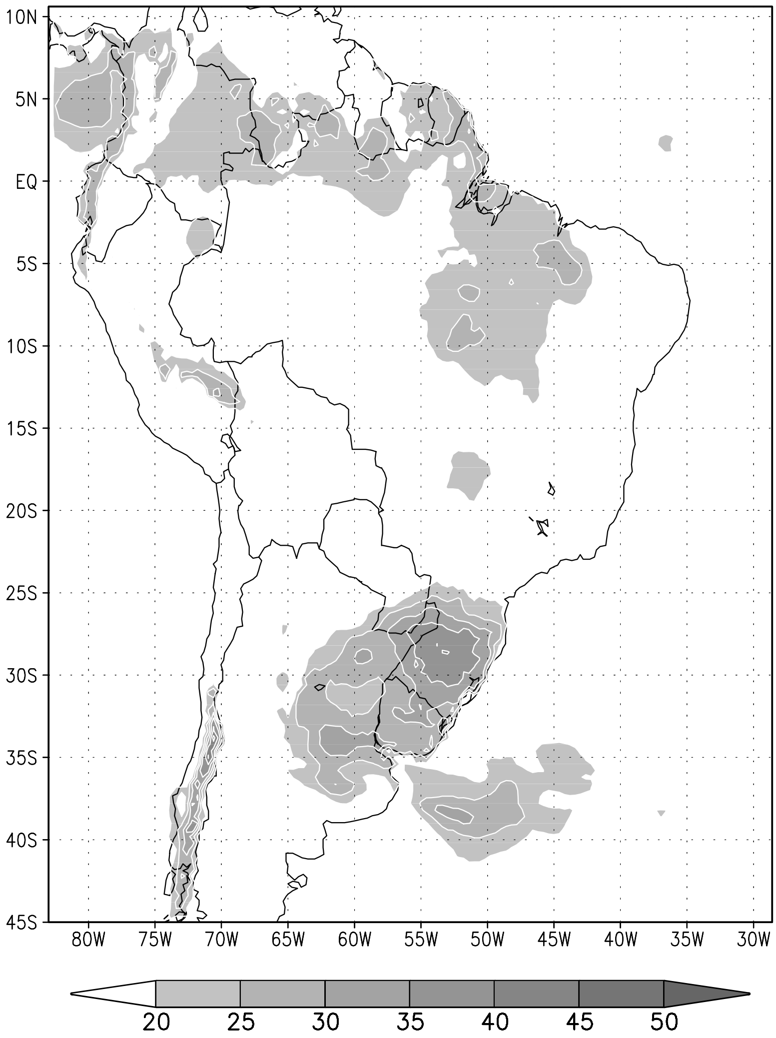

Fig. 1: Percentage of warm season accumulated precipitation due to Chaco jet events

For this study ETA model forecast products with an horizontal resolution of 40 km and 35 levels are used. Criterion defined to identify days with occurrence of Chaco jets requires the three conditions similar to Bonner Criterion 1 (1968) and adds the requirement that the isotach of 12 m/s extends farther south, at least up to 25^{o}S. Bonner's criterion assures the presence of a jet-like profile in the local low-level wind vertical structure, as a more mesoscale feature and is more frequently verified near Santa Cruz de la Sierra in Bolivia, downwind of the Central Andes. This criterion has been used daily for the whole period and the days with Chaco jet cases have been identified. Only around 40% of the SALLJ cases, verify the selected criterion and consequently penetrate to subtropical latitudes. Composite anomalies have been calculated as the difference between the composites and the warm seasonal mean. Based on this pool of episodes an analysis of both the intensity and characteristics of the Chaco jet circulation and the related moisture meridional transport has been done. A relevant result is that in these cases the wind speed is stronger than the summer mean.

A center of positive specific humidity anomaly at 850 hPa is co-located with the area of moisture flux convergence for Chaco jet events. This area of maximum moisture convergence is also coincident with the area where the contribution of the Chaco cases to the seasonal accumulated precipitation is maximum (around 40%, see Fig. 1). This amount of enhanced precipitation for this particular warm season gives support to the mentioned hypothesis. However, a longer time period analysis is necessary to substantiate these preliminary results.

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Intraseasonal Variations of the South American Summer Rainfall

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Austral summer is the rainy season over most of South America. The analysis of the summertime circulation and rainfall over this region indicates the existence of a regional summer monsoon regime. The maximum of precipitation during summer exhibits a large intraseasonal variability, revealed by the analysis of outgoing longwave radiation (OLR), which has been used as a proxy for rainfall (e.g., Paegle and Mo, 1997; Liebmann et al., 1999; Paegle et al., 2000). These studies emphasise the intraseasonal variations of the South Atlantic Convergence Zone (SACZ). Paegle and Mo (1997) and Paegle et al. (2000), using OLR anomalies for November through April for a 20-years period, filtered to retain scales from 10 to 90 days, performed EOF analysis for a domain including South America and the adjacent area. They focused on the 5th rotated EOF, a dipole pattern of OLR depicting a well-marked SACZ accompanied by opposite anomalies in the subtropical plains of South America. Paegle et al. (2000) showed that this dipole convection pattern is modulated dominantly by modes with periods of 36-40 days and 22-28 days.

The present study examines the intraseasonal variability of the observed summer precipitation (for November through March) in a region including the maximum intraseasonal variance of OLR over South America during the austral summer (Liebmann et al., 1999). The data base includes daily rainfall data spanning the period 1965-1990, from 516 stations distributed over a region extending from Patagonia to the southern part of Northeast Brazil. The spectral analysis of these data shows that stations with significant spectral peaks in each one of the ranges 7-20 days, 21-35 days or 36-70 days have different spatial distributions over the analysed area. EOF analysis was therefore performed on daily precipitation data filtered to retain periods in the ranges of 10-100, 20-30 and 30-70 days, to obtain the modes that most contribute to the variability in each of these ranges. The results show some similarities and some interesting differences when compared to OLR-based results.

The EOF analysis with varimax rotation discloses a mode of variability with strong anomalies concentrated over the SACZ area (Fig. 1A, page 17), as in the 5th EOF of OLR in Paegle and Mo (1997) and Paegle et al. (2000). It is the leading mode for the 10-100 day filtered data (explaining 9.1 % of the variance), and the second one for the other two ranges. The principal component series of that 1st REOF shows a spectral peak around 26 days and some peaks in the high-frequency end of the spectrum (16, 13 and 11 days), but there are not significant peaks in the range 30-60 days. Although the anomalies are of opposite signs in the SACZ region and in the subtropical plains, this mode is not really dipole-like for the anomalies are far stronger (almost one order of magnitude) over the SACZ region. Composites of rainfall for extreme opposite phases of this mode confirm this feature. It indicates that the mechanisms that lead to excess rainfall in the SACZ region are not the main mechanisms that lead to periods of severe drought in the subtropical plains during summer. The 4th rotated mode (explaining 6.7 % of the variance) shows strong anomalies over the subtropical plains and very weak opposite ones over the SACZ area (this is the first mode in the 20-30 days range). It is worth mentioning that the composites of OLR anomalies for the extreme opposite phases of the 1st REOF show opposite anomalies of more comparable magnitudes, hence a much better defined dipole-like pattern, as in Paegle et al. (2000).

The principal component series of the 1st precipitation REOF and of the 5th OLR REOF (Paegle et al., 2000) show a good agreement concerning the location of extreme values (Fig. 1B, page 17). The OLR mode leads the rainfall mode by two or three days, which would be expected. The agreement is not perfect, though, especially during 1986.

There is a better defined dipole-like intraseasonal mode of precipitation, but its northern centre is displaced northward, by about 7^{o}, em relation to that of the 1st REOF. Its southern centre is over South Brazil. It is the 3rd REOF for the 10-100 day filtered data (explaining 7.7% of the variance), and the 1st REOF in the 30-70 days range. Its principal component series presents spectral peaks around 60, 32-22, 16 and 13 days. The anomalies in the northern centre of the dipole are stronger than those in the southern centre (but not as much as in the 1st REOF), and are located in the region where usually OLR anomalies associated with the 30-60 day oscillation are located over South America. Extreme values of the principal component series of that 3rd REOF sometimes coincide with those of the 1st REOF (and of the 5th REOF of Paegle et al. (2000)), but they are not the same mode.

In summary, results from this work, which is still in progress, indicate that the 1st REOF of rainfall during summer in South America describes rainfall oscillations over the SACZ area. Although anomalies over the surrounding areas are of opposite sign, a dipole-like structure of rainfall with a second centre over the subtropical plains is not characterised since the magnitude of the anomalies there is far weaker. The 30-60 day oscillation does not seem to modulate this mode significantly, but spectral peaks around 26, 16, 13 and 11 days are present. On the other hand, the 3rd REOF presents a more dipole-like pattern, but its centers are displaced northward. Eventually, extremes of these modes coincide in time, and then the SACZ shows a broader cloud (and rainfall) band compared to when only the first mode is more active. The 3rd REOF is modulated by the 30-60 day oscillation, but spectral peaks in the 32-22 days range and around 16 and 13 days are also important.

Although OLR is a reasonable proxy for rainfall, the comparison of the rainfall-based results with OLR-based results shows that differences between them, concerning their variability and spatial distribution, could make difficult the separation of rainfall modes with neighbour centres and higher frequency, when using OLR.

Acknowledgments

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CIMAR-5 Cruise off Northern Chile at 27°S (Caldera to Easter Island): 15-29 October 1999

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1. Introduction

A multi-disciplinary programme has been set up by the Chilean National Oceanographic Committee (CONA) to promote marine research using the R/V Vidal Gormaz. For the period 1999-2000 the programme has considered research in the Chilean oceanic islands: Easter and Sala and Gomez islands in 1999 and the Robinson Crusoe, Alexander Selkirk, San Felix and San Ambrosio islands in 2000.

An important component of the 1999 cruise was the oceanographic and meteorological east-west transect at 27°S (Caldera to Easter island) carried out in the second half of October.

The meteorological component of the programme aimed at the study of the marine boundary layer (MBL) structure and its space variability, including the marine stratocumulus cloud deck and the subsidence inversion. Another objective was to assess the skill of reanalysed data in representing the actual troposphere within a largely in-situ data void area.

The study area encompasses a coastal strip subject to year-round upwelling processes under the quasi-permanent action of the SE Pacific subtropical anticyclone as well as the open ocean MBL capped by stratocumulus clouds and its transition to trade wind cumuli. The study period matched approximately the maximum in sea-level pressure and low-cloud cover extension of the seasonal cycle and the cold extreme of the ENSO interannual cycle.

2. Scientific, Environmental and Socio-economic Issues

On the local to regional scales, the coastal strip supports coastal wind-driven upwelling processes responsible for a wealth of economic resources as pelagic fisheries, fresh water from coastal stratus and tourism. Besides the large-scale forcing of the coastal winds, several ocean-atmosphere coupling mechanisms control the regional component of the winds associated with the land-ocean thermal contrast along the coast and other factors as the height step change of the subsidence inversion associated with the upwelling front (SST steepest east-west gradient).

The alongshore equatorward winds driving upwelling of cold, nutrient rich and CO_2 saturated waters are modulated by atmospheric coastally-trapped disturbances (CDT's; e.g. coastal lows). These CDT's, that drift southwards at phase speeds of 10-20 ms^{-1} produce, on a quasi-weekly periodicity, strong alongshore gradients in the windstress, sea-level pressure, inversion base height and cloudiness. Besides the typical signal in the low clouds (clear areas adjacent to a thick stratus wedges to the north) in the satellite pictures, little is known about the offshore extension of such disturbances.

On the continental scale the deep convection over the South American Altiplano during the austral summer forces a strong diurnal signal that could be in some way related to the diurnal cycle of the stratocumuli albedo (thickness, liquid water content, droplet spectra and concentrations) over the tropical-subtropical SE Pacific. This fact should influence the diurnal cycle of the surface energy budget at the ocean surface, with consequences on climate simulation (cloud parameterisations and feedbacks).

3. Meteorological Measurements

Three types of observations were made on board: (1) 15 min-averages of air temperature and relative humidity, global solar radiation (PAR), atmospheric pressure and wind speed/direction, scanned every 15 seconds by means of a Campbell AWS; (2) 15-min averages of cloud base

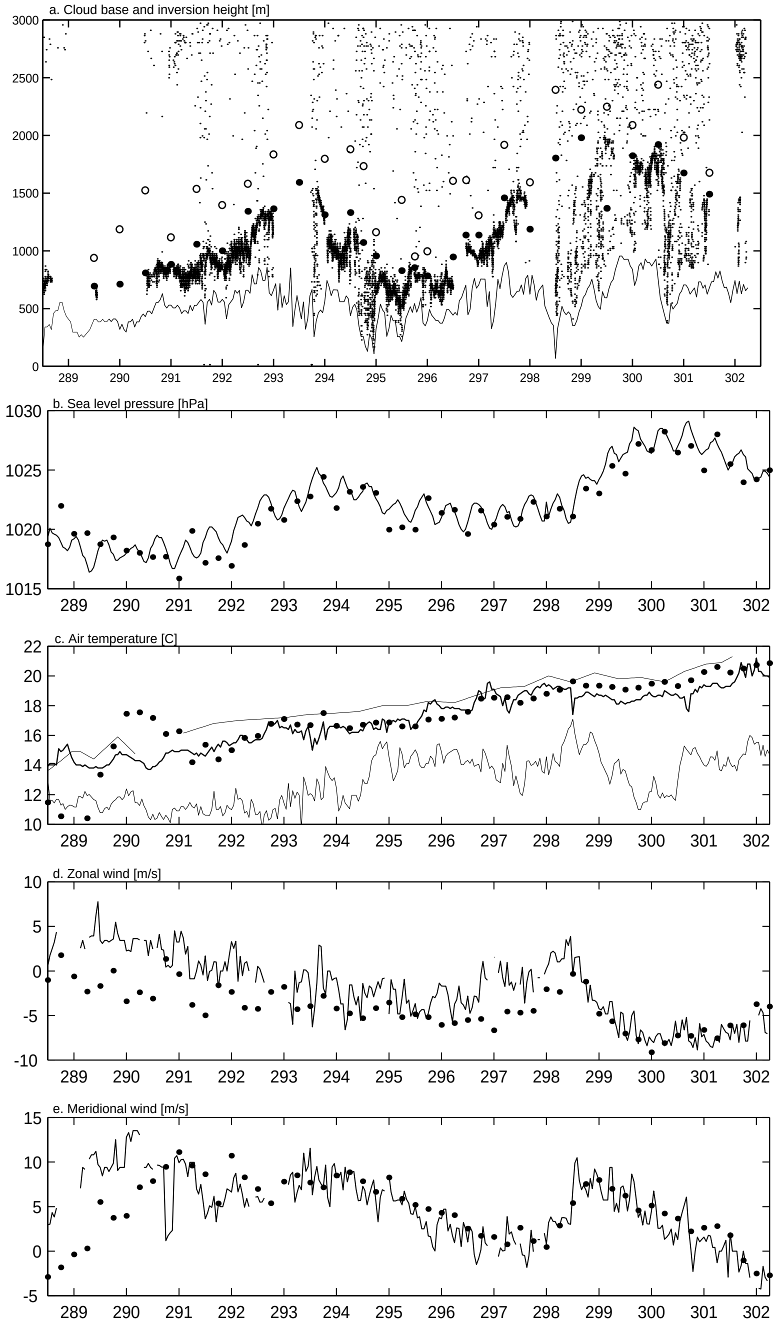

Fig. 1. MBL cloudiness, trade inversion and surface variables during CIMAR-5.
(a) Cloud base height (small dots) from 30 min laser ceilometer. Also shown are the top (solid circles) and base (open circles) of the trade inversion derived from twice-a-day rawinsoundings, and the lifting condensation level (solid line) from 30 min near-surface observations.
(b) 30-min average of sea level pressure (solid line). Filled circles are the 6-hr NCEP/NCAR reanalysis data interpolated to the ship location.
(c) As (b) but for air temperature. Upper thin line is SST. Lower thin line is dew point temperature.
(d) As (b) but for zonal wind.
(e) As (b) but for meridional wind.

height and reflectivity profiles up to 4000 m height with a Vaisala laser ceilometer; and (3) twice-a-day Vaisala GPS rawinsonde launchings at 00:00 and 12:00 UTC. Standard on board surface meteorological and sea state observations together with satellite imagery and the NCEP/NCAR Reanalysis data were also collected for the cruise period.

4. A few synthetic results

Figure 1 depicts the 27ºS east-west cross section (longitude and date) of the following: a) height of the inversion base and top and low-cloud base, b) SLP, c) air temperature d) zonal and e) meridional wind components. It can be readily seen that the general westward increase in the MBL depth, T_{air} and SLP, was interrupted by a synoptic-scale disturbance that came across the ship track centred on days 22 to 25, bringing a consistent signal in all measured variables.

Other relevant results include a westward transition at about 95ºW from a thin layer of stratocumuli capping a fully coupled MBL to cumulus clouds rising into patchy and thin stratus within a decoupled MBL reaching up to 1700 m depth near Easter island. Also wind directions in the first 200-km off the coast show onshore and northward departures from the NCEP/NCAR reanalysis ones, in agreement with results reported elsewhere.

5. Acknowledgements

We want to thank the effort in organisation and funding provided by the Chilean National Oceanographic Committee (CONA), the efficiency of the R/V Vidal Gormaz crew and the dedication of the technician from the National Weather Service (DMC) Mr. José Nuñez in maintaining the equipment on board. The laser ceilometer was kindly provided by Dr. Bruce Albrecht from the University of Miami. Credit is also due to the Program in Atmospheric Dynamics and Climate (PRODAC) and to the Department of Geophysics (DGF), both at the Universidad de Chile and to the DMC for facilities and additional funding.

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Project Co-PI's René Garreaud (DGF) and Juan Quintana (DMC).

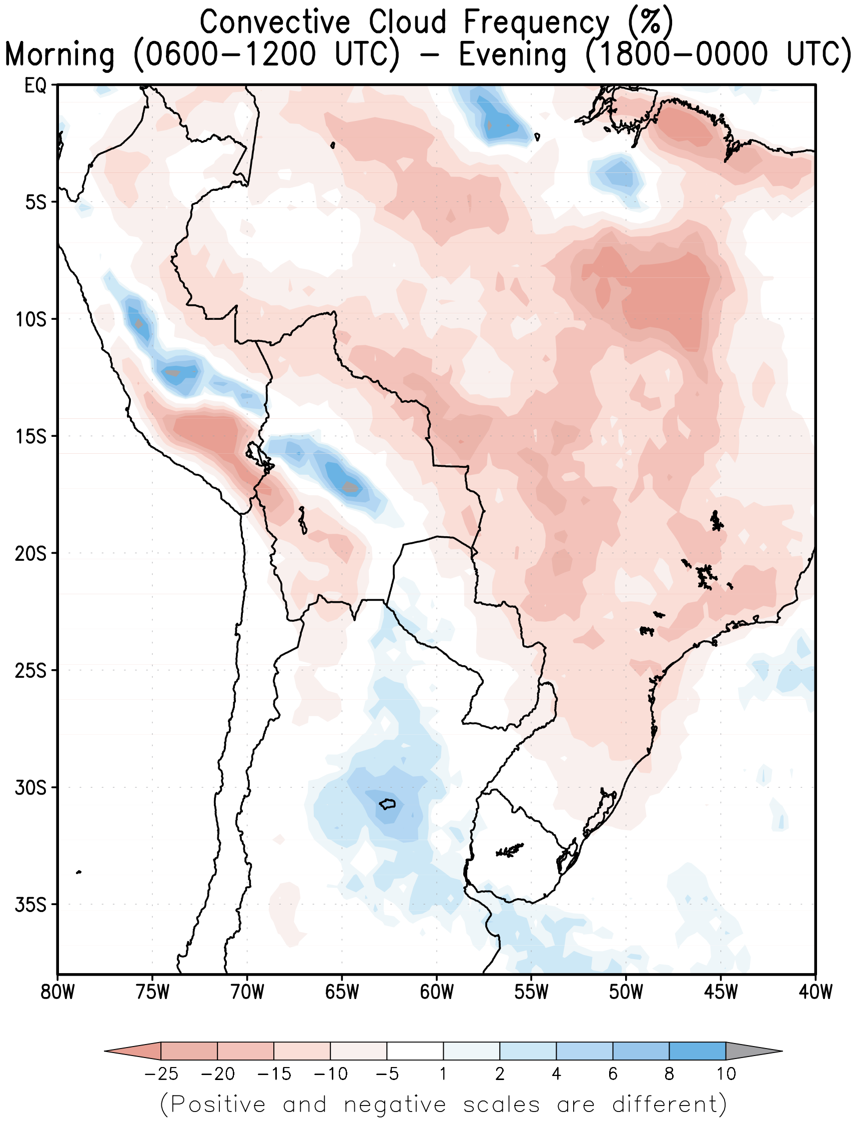


Fig. 2 (from Paegle and Berbery, pages 6-8): Amplitude of the diurnal cycle of convective cloudiness estimated from geostationary satellites for DJF 1985-1991. [Thanks to Rene Garreaud for providing the data.]

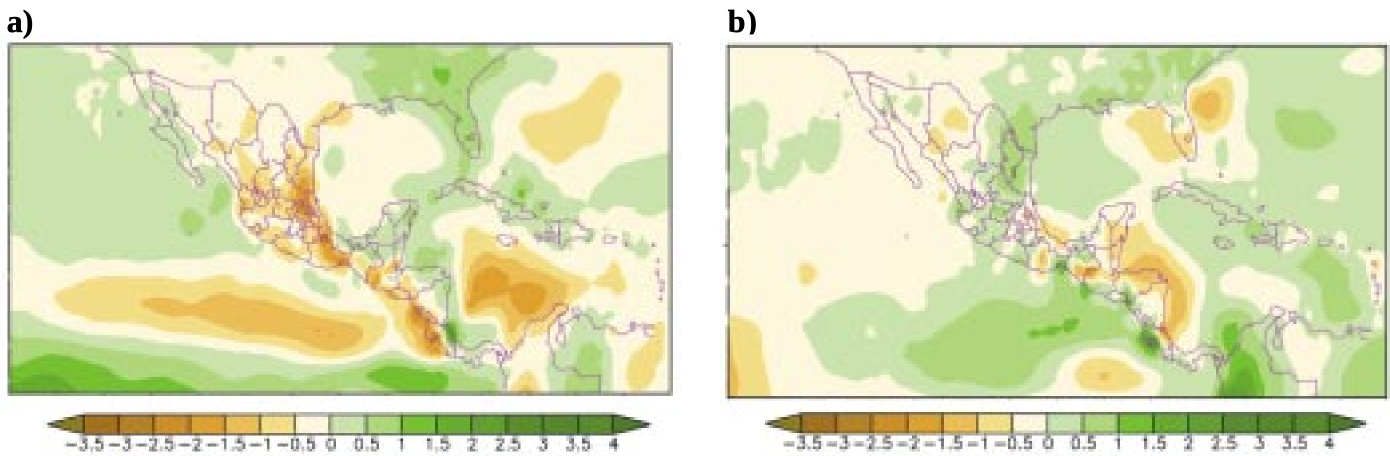
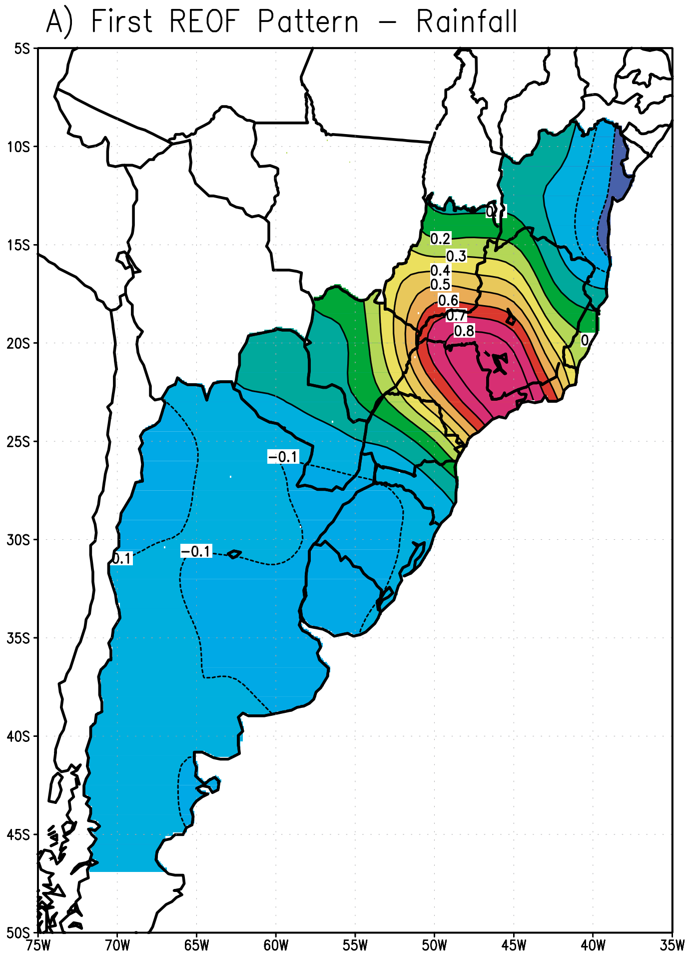
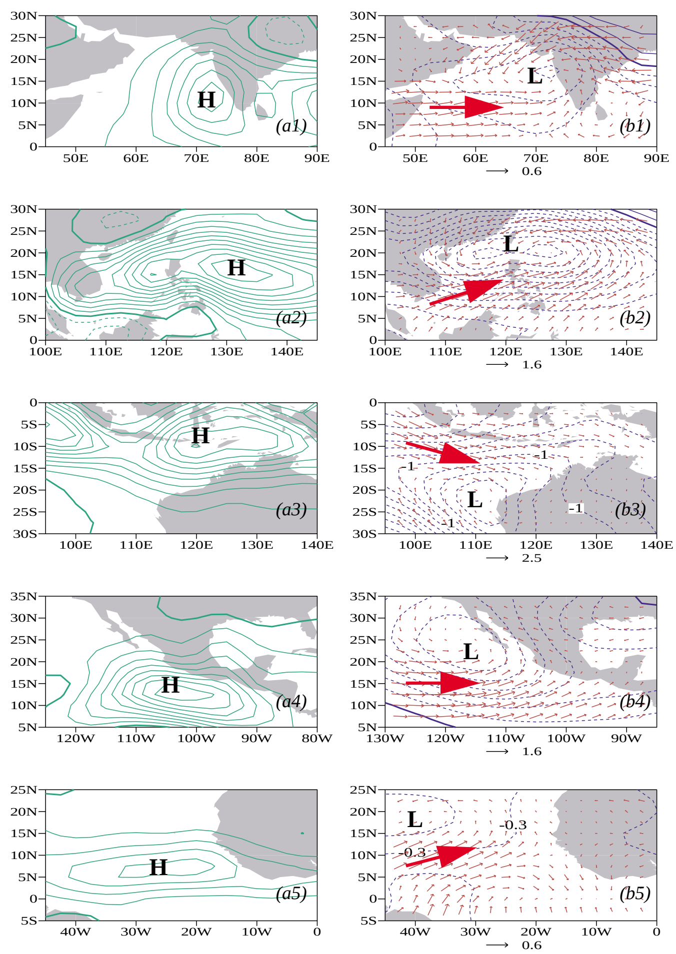


Fig. 1 (from Magaña, page 19): Composite of precipitation anomalies (mm/day) during a) five El Niño (1965,1972, 1982, 1986, 1991, 1997), and b) La Niña (1964, 1970, 1973, 1975, 1988, 1998) summers (Jun-Jul-Aug-Sep).





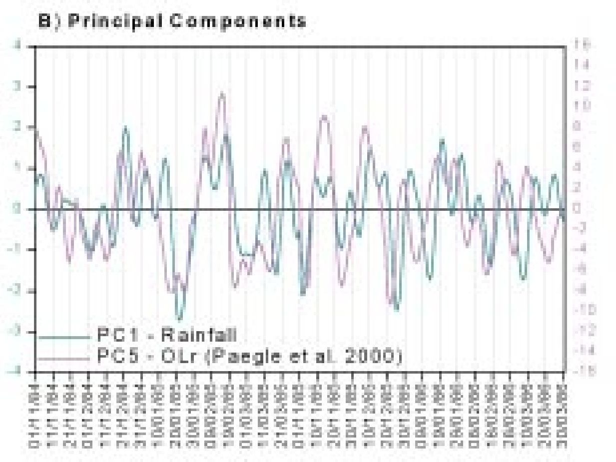


Fig. 1 (Yu and Wallace, page 20-21):
a1: Regression of monthly mean precipitation for the Indian monsoon region, based on the Xie and Arkin dataset for the period 1979-97, upon the standardised PC1 of precipitation anomalies from the same dataset for the domain included within the figure. Contour intervals: 0.4 m/ day per standard deviation of the standardised PC1 time series (psd). b1: Regression patterns of SLP and surface wind for the Indian monsoon region, based on NCEP Reanalysis for the period 1979-97, upon the standardised PC1 time series. Contour intervals: 0.1 hPa psd. The zero contour is thickened and negative contours are dashed.
a2(b2), a3(b3), a4(b4), and a5(b5) are as in a1(b1), but for the East Asian, the Australian, the North American, and the African monsoon regions, respectively.

Fig. 1 (from Grimm et al., page 13-14):
(A) First Rotated Empirical Orthogonal Function (1st REOF) pattern for the 10-100 day filtered daily rainfall.
(B) Principal component of 1st REOF for rainfall and of 5th REOF for OLR (from Paegle et al., 2000).

North American Monsoon Experiment (NAME)

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State-of-the-art climate models do not accurately represent the spatial distribution and temporal variability of warm season precipitation over southwestern North America. The North American Monsoon Experiment (NAME) is an internationally coordinated effort to improve the prediction of warm season precipitation over that region on seasonal time scales. NAME objectives will be achieved by a symbiotic mix of diagnostic and modelling studies, together with enhanced monitoring. The integrated thrust of NAME can be broadly characterised as improving warm season precipitation prediction over North America.

NAME is designed to link CLIVAR/VAMOS, which has an emphasis on ocean-atmosphere interactions and GEWEX/GAPP, which has an emphasis on land-atmosphere interactions in order to determine the relative importance of the coupled interactions between the ocean, land and atmosphere as they relate to the monsoon. NAME will benefit from linkages to other ongoing projects within GEWEX/GAPP, including the CEOP, LDAS and the NCEP Regional Reanalysis and from linkages to other field programmes within CLIVAR/PACS and CLIVAR/VAMOS, such as the American Low-level Jets (ALLS) and EPIC.

Some anticipated benefits from NAME include (i) a better understanding of the key components of the North American Monsoon System (NAMS) and their variability; (ii) a better understanding of the role of the NAMS in the global water cycle; (iii) improved observational data sets and (iv) improved simulation and monthly-to-seasonal prediction of the monsoon and regional water resources.

NAME is designed using a 3 tiered approach involving different spatial scales (Figure 1). Each tier has a scientific focus aimed at improved warm season precipitation prediction, and activities related to each tier will proceed concurrently. NAME studies presume that the general nature of the warm season evolution of the atmospheric circulation and precipitation regimes over North America is reasonably well known from previous studies.

Tier I focuses on mesoscale-features in the core mon-

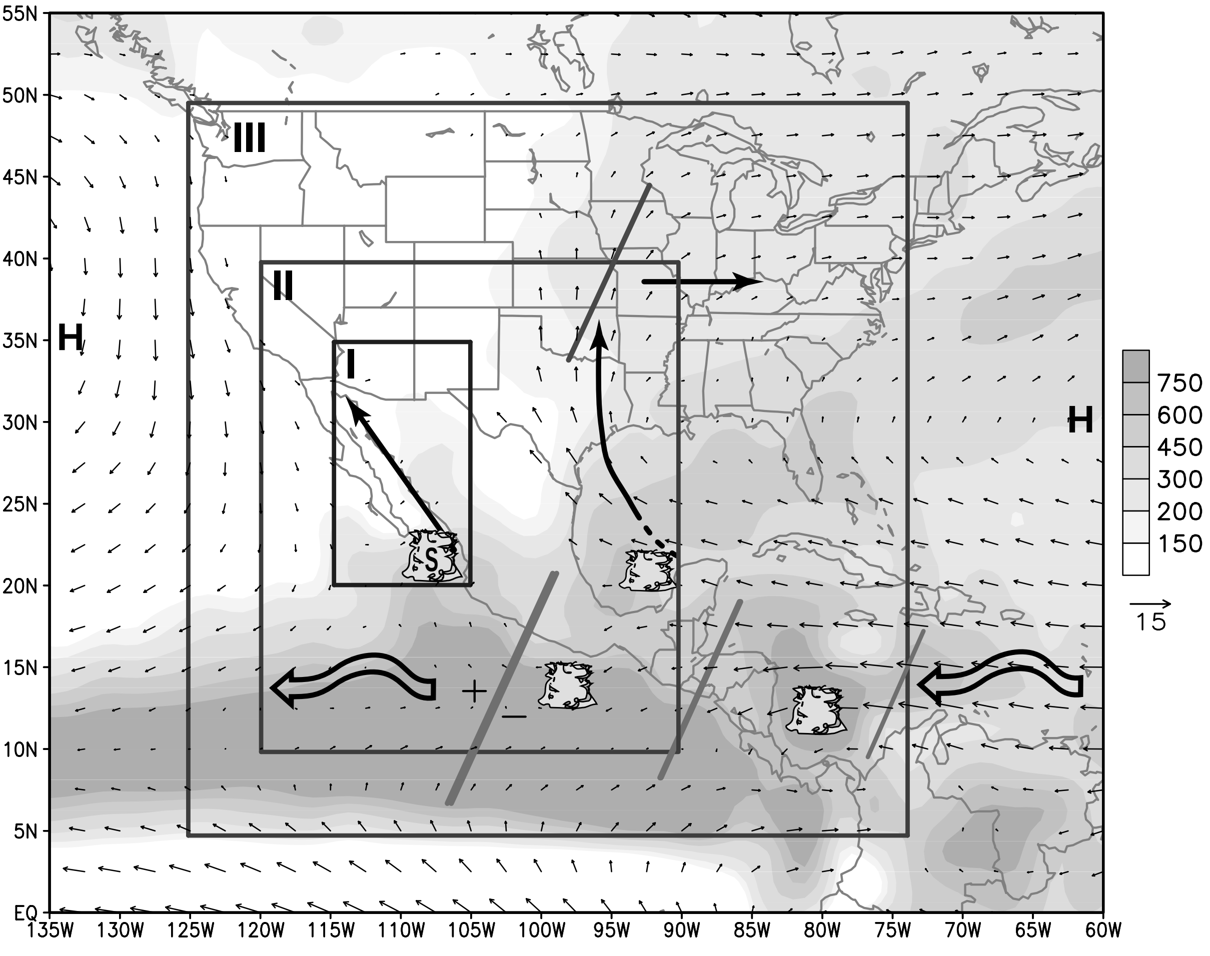

Fig. 1: Schematic illustrating the multi-tiered approach of the North American Monsoon Experiment (NAME). The schematic also shows mean (July-September 1979-1995) 925-hPa vector wind and merged satellite estimates and station observations of precipitation (shading) in millimeters. Circulation data are taken from the NCEP/NCAR Reanalysis archive.

soon region over southwestern North America. The goal of activities in this region is to improve the monitoring and modelling of the diurnal heating cycle and its influence on convection as a necessary step towards improved warm season precipitation prediction. Of primary interest are relationships between the low-level circulation features (including the land breeze/sea breeze circulation and Gulf of California (GC) low-level jet) and the diurnal cycle of convection. Enhanced observations will be required to validate models and analyses, including sea-surface temperatures along the Gulf of California, transects from the Gulf of California to the Sierra Madre Occidental (wind, surface temperature, sea-level pressure, and precipitation from automated weather stations), pilot balloons and possibly NOAA-P3 flights. Regional mesoscale models and the Eta Model Data Assimilation System (EDAS) will be used to guide the enhanced monitoring activities.

Tier II focuses on regional-scale features over southwestern North America and the warm pool region to the southwest of Mexico. The goal of activities in this region is an improved description and understanding of intraseasonal aspects of the monsoon. A key question concerns the importance of interactions between Tropical Easterly Waves (TEWs) and GC moisture surges in the prediction of monsoon precipitation. Related questions include: (1) What fraction of TEWs produce GC surge events?; (2) What is the physical setting for the pronounced double peak structure in monsoon precipitation?; (3) How strong are relationships between the Madden-Julian Oscillation, tropical cyclone activity, and monsoon precipitation?; and (4) What role do energy sources over the InterAmerica Sea/Gulf of Mexico play in Great Plains low-level jet (GPLLJ) variability? These activities will benefit from linkages to EPIC, which emphasises variability in the ITCZ-cold tongue complex of the eastern tropical Pacific.

Tier III focuses on aspects of the continental-scale monsoon circulation. Here the goal is an improved description and understanding of spatial/temporal linkages between warm season precipitation, circulation parameters and the dominant boundary forcing parameters. Among the questions that will be addressed by NAME are the following: (1) How is the evolution of the warm season precipitation regime over North America related to the seasonal evolution of the boundary conditions?; (2) What are the interrelationships between year-to-year variations in the boundary conditions, the atmospheric circulation and the continental hydrologic regime?; (3) Can coupled models reproduce the observed summer precipitation in average years and years with ENSO/PDO influence?; (4) What is the relative importance of tropical cyclones and extratropical systems for warm season precipitation over the continent? These studies will be carried out in tandem with land surface model experiments and land data assimilation experiments, and will benefit from multi-year regional reanalyses and retrospective soil moisture analyses.

NAME activities include planning, preparation, data collection and principal research phases. NAME planning will include the development of a NAME Science and Implementation plan and a CLIVAR/GEWEX Planning Workshop to consider the plan. NAME preparations will include a build-up phase leading to a two-summer Enhanced Observing Period (EOP). A two-year period (possibly 2003-2004) has been identified as providing an excellent opportunity to carry out NAME data collection activities because (i) a new generation of remote sensing satellites will be available to provide unprecedented enhancement of observing capabilities to quantify critical atmospheric, surface, hydrologic and oceanographic parameters; (ii) several NWP centres (e.g. NCEP, ECMWF) are able to run their coupled modelling system to provide dynamically consistent datasets over the NAMS domain, and (iii) other GEWEX/GAPP and CLIVAR/VAMOS field experiments are planned during this period. The components and scope of the observational effort will be closely linked to the magnitude of the overall effort. The NAME principal research phase will continue for several years following the data collection phase, culminating in a NAME Research Conference. A timetable for NAME activities is being developed for the NAME Science and Implementation Plan.

Interannual Climate Variability in the Mexico, Central America, and Carribean Region

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The Mexico, Central America and Caribbean Region exhibits what may be considered a monsoonal climate, with an intense rainy season during summer months, and a relatively dry season during winter. There are various forms of variability related to a rich spectrum of meteorological phenomena such as: Northerlies during winter and hurricanes during summer. However, it has not been until recently that the dynamical mechanisms that control interannual climate variability in the region have begun to be analysed. The intense signal of El Niño in the region has led a number of scientists to explore various prognostic schemes to predict the characteristics of the summer rainy season.

When summer climate variability over the region is studied, the presence of two warm pools, one over the northeastern Pacific (off the coast of Mexico) and one over the Intra Americas Seas (IAS) should be considered. In the former, convective activity is intense, constituting the Inter Tropical Convergence Zone (ITCZ). In the latter, tropical convection is relatively weak due to intense subsidence. The relatively low precipitation over the IAS may be considered abnormal for a warm pool region. The other important element that determines the characteristics of precipitation is the interaction of the topography with the trade winds, which leads to differentiated precipitation patterns in the Caribbean and Pacific coasts of Central America.

One of the peculiarities of the annual cycle of precipitation in this region is the relative minimum in precipitation in the middle of the summer rainy season. The Mid-Summer Drought (MSD) or Canicula, is observed over southern Mexico and Central America. It appears to be related to the fluctuations in sea surface temperature (SST) over the northeastern tropical Pacific, which are in turn modulated by the effects of incoming solar radiation, low-level winds and precipitation. During the MSD (July and August), the trade winds intensify generating intense precipitation along the Caribbean coast of Central America. Actually, the intensification of the trade winds over the Caribbean is related to an enhancement of the low-level jet over the Caribbean. This barotropically unstable low-level jet has been suggested as responsible for the amplification of some circulation anomalies that result in tropical cyclones over the eastern Pacific.

El Niño summers usually result in negative precipitation anomalies over most of Mexico and Central America (Fig. 1a, page 16). The mechanisms that produce such precipitation deficit include: a southward shift (2^o – 3^o) in the ITCZ over the eastern Pacific; enhanced subsidence over northern Mexico; and a stronger low-level jet over the Caribbean, which in turn results in a more intense wind shear over the IAS and fewer tropical cyclones than normal. The intense low-level jet intensifies the coastal upwelling over the northern coast of South America leading to negative SST anomalies over the eastern Caribbean. Therefore, the Caribbean low-level jet acts as a link between the eastern Pacific and the IAS.

On the other hand, during La Niña summers (Fig. 1b, page 16), precipitation returns to normal or is even above the climatological mean as a result of: an ITCZ around 10^oN, weaker trade winds over the IAS, weaker subsidence over northern Mexico, and a recovery in the number of hurricanes in the Atlantic. There are some regions though, that appear to be relatively insensitive to the occurrence of La Niña. For instance, northwestern Mexico may exhibit precipitation deficit during El Niño or La Niña years. In fact, this regions shows low or null predictability based on SSTs only.

Since the signal of El Niño or La Niña will be relatively weak during the summer of the 2000, the effects of SST anomalies over the Atlantic, or over the warm pools around the region will become more important. The dynamical mechanisms that relate SST anomalies in the Atlantic or in the warm pool off the coast of Mexico with precipitation are just being explored. Further research will be necessary to find the elements that will result in more predictability over the region, particularly over the Mexican monsoon region. The CLIVAR - Variability of the American Monsoon Systems (VAMOS) Programme will address these issues in the near future. A better understanding of the interannual climate variability in the region will have profound impacts on seasonal climate predictions and the planning of socioeconomic activities.

The Principal Mode of the Interannual Variability of the Tropical Monsoon

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Monsoons are an integral part of the summer general circulation and over the tropical and subtropical continents. The most common definition of monsoons uses the characteristics of the annual variation of both rainfall and wind. By these criteria, almost all of the eastern hemisphere of the tropics is included (Ramage, 1971). The southwestern part of North America is also regarded as having a monsoon climate with a strong summer rainfall maximum over the southwest US and northwest Mexico (Webster, 1987). The principal mode of the interannual variability of the North American Monsoon System (NAMS) has been studied in our recent paper (Yu and Wallace, 2000). In this short contribution, first of all, we will briefly introduce the principal mode of the three dimensional atmospheric variability of the NAMS, and then show that similar patterns are found in the other tropical monsoon regions.

In Yu and Wallace (2000), the "NAMS domain" is defined as encompassing, not only the continental regions with pronounced summertime precipitation maxima, but also the adjacent ocean waters to the south of Mexico and central America (i.e., Fig. 1.a4, page 17). We determined the mode of variability of the NAMS that captures as much as possible of the variance of summertime (June-September) precipitation over the entire monsoon domain, by means of principal component analysis. The leading principal component (PC1) is relatively robust with respect to changes in the domain boundaries. It was thus regarded as a simple index of the intensity of the NAMS precipitation: a spatially integrated precipitation index (IPI).

The IPI is highly correlated with summer rainfall averaged over this broadly defined NAMS domain, and is also well correlated with hurricane activity over the tropical and subtropical northeast Pacific. In its positive polarity, the IPI is characterised by an intensification and northward expansion of the ITCZ toward the Mexico coast. It has a well defined sea-level pressure and surface wind signature, with negative sea-level pressure anomalies to the northwest of the region of enhanced rainfall and westerly wind anomalies converging into the region from the west along 10^o-20^oN (Figs. 1. a4 and b4, page 17). These tropical features extend upward to the 500hPa level and are overlaid by weak anomalies of opposing sign in the upper troposphere, whereas poleward of 30^oN, the structure of the circulation anomalies is equivalent barotropic, amplifying with height. The IPI is only weakly correlated with summer rainfall over the southwestern US, with ENSO, and with sea surface temperature anomalies within the NAMS domain.

Following the research approach we used above, Figure 1 (page 17) shows the regression patterns of the monthly mean precipitation, sea-level pressure and surface wind upon the corresponding principal component of the precipitation anomalies over the domain included within the figures. The patterns for the Indian (IDM), East Asian (EAM), Australian (AUM), North American (NAM), and African (AFM) monsoons are given from the top to the bottom panels. The PC1s account for 25%, 31%, 41%, 28% and 29% of the total variances for these regions, respectively, and are all well separated from the subsequent PCs based on the criterion of North et al. (1982). It is interesting to see that wet years are characterised by negative SLP anomalies located poleward of the precipitation centers of action with anomalous westerly flow in the tropical latitudes, converging into the belt of the enhanced precipitation. These phenomena resemble the patterns we reported for the NAMS, although the intensity of the monsoonal variability varies from region to region. The structure of the circulation anomalies tends to be equivalent baroclinic, with the anomalous features extending upward to the 500hPa level, with the exception of the AFM, which is a comparatively shallow system in the lower troposphere. In all cases, the vertical structure is barotropic in the extratropics.

Table 1:

PC1s of the interannual variability of the tropical monsoons: Their relations to ENSO and persistence

	IDM	EAM	AUM	NAM	AFM
Correlation with ENSO	-0.31	-0.30	0.27	-0.24	-0.37
Lag-1 Auto-correlation	0.11	-0.40	0.05	-0.07	0.54

The principal modes of the interannual variability of the precipitation anomalies over the five monsoon domains are all weakly correlated with ENSO. The correlation coefficients between the June-December mean Cold Tongue index and the individual summertime seasonal mean PC1 time series are low (Table 1). Some significant relationships may be detected between ENSO indices and the subsequent PCs of summer precipitation, such as the second PC in the NAMS case. The autocorrelation of the individual PC1 at a lag of one month is remarkably low for the IDM, the AUM and the NAM (Table 1). This is likely due to modulation of these PC'S by the Madden-Julian Oscillation (Maloney and Hartmann, 2000; Higgins and Shi, 1999), for which the autocorrelation at a lag of one month is likely to be small or perhaps even negative. The lag-1 autocorrelations over the EAM and the AFM regions are somewhat stronger, presumably because they are less strongly influenced by the MJO.

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Features of the East Asian Monsoon during El Niño Episode

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The Asian monsoon system is one of the most important circulation system in the general circulation of the global atmosphere (Krishnamurti, 1971; Krishnamurti et al., 1973). As reviewed by Lau and Li (1984) and by Tao and Chen (1987), the Asian monsoon can be divided into East Asian and Indian monsoons. The East Asian monsoon is distinct from the Indian monsoon in both their large-scale structures and constituent subsystems. Nitta (1987) and Huang and Wu (1989) studied the influence of El Niño on the summer climate over the East Asia. They found that a teleconnection between the western tropical Pacific and the East Asian region has significant impact on the East Asian summer climate. In most of the El Niño years, cold SST anomalies around the Philippine Islands appeared and the convection there was inactive, which, through this teleconnection, can affect summer precipitation and temperature in the mid-latitude East Asia. Zhang et al. (1996) diagnosed East Asian monsoon flow during '86/87 and '91/92 El Niño events. They found that the El Niño has significant impact on the East Asian monsoon flow in its mature phase. When the mature phase is in boreal summer, the East Asian summer monsoon flow is intensified. On the contrary, when boreal winter is within the mature phase, the East Asian winter monsoon flow is weakened. By examining the precipitation anomalies in China, Zhang et al. (1999) pointed out that in northern winter, spring and autumn positive anomalies appear in South China in the El Niño mature phase. In northern summer positive anomalies exist in East China around the lower reaches of Yangtze River and Huai River valley, but they are not statistically significant. It is inferred that the poor Indian monsoon accompanied with an El Niño transports less water vapour to the East Asian region, which weakens the positive precipitation anomalies.

The effect of an El Niño on the atmosphere is mainly through the anomalous latent heat releasing to the tropical atmosphere by means of convection, which then causes the atmospheric variations in the extra-tropics through teleconnection. In order to investigate the physical process by which the El Niño affects the East Asian monsoon, we made the composites of the outgoing long-wave radiation (OLR) anomalies and the wind anomalies at 850hPa in the El Niño mature phase during northern winter, spring and autumn, which are shown in Figure 1. The datasets used are the NCEP/NCAR monthly reanalysis data from 1949 to 1998 and the NOAA OLR data from 1974 to 1998. The El Niño mature phase is defined in terms of the seasonal sea surface temperature anomalies (SSTA) averaged over an area called NINO3 (5°S-5°N, 90°W-150°W). For the strong El Niño events, the seasons when seasonal NINO3 SSTA is greater than 1.0°C are taken to be the mature phase of these El Niños. For the weak El Niño events with seasonal NINO3 SSTA less than 1.0°C, we then choose the season with the highest NINO3 SSTA to be the El Niño mature phase.

It can be seen from Fig.1 that the El Niño mature phase is characterised by a prominent dipolar distribution of the OLR anomalies in the tropics, which is distinct from the composite in the other phases. Stronger convection is in the central and eastern tropical Pacific and weaker convection in the western tropical Pacific over the maritime continent. In contrast to the strong convective heating of the atmosphere over the central and eastern tropical Pacific, there exist remarkable convective cooling anomaly around the maritime continent. Fig. 1 also shows that to the north and to the south of the anomalous cooling area, there exists a pair of anticyclone anomalies in the lower troposphere with their centres located around north Australia and the Philippine Islands, respectively. According to Gill (1980), it is tempting to explain this pair of anticyclone anomalies to be the Rossby wave response of the tropical atmosphere to the convective cooling anomaly around maritime continent.

The anticyclone anomaly to the north of the maritime continent stretches to the southeastern coast of East Asia, where the monsoon flow can be affected by the southwesterly anomalies. By examining the moisture circulation over East Asia during the El Niño mature phase (Zhang and Sumi, 2000), it is found that the southwesterly anomalies associated with this anticyclone anomaly transport more water vapor to the area around the southeastern coast of East Asia, where the moisture converges and more precipitation appears.

The East Asian monsoon is mainly maintained by the huge contrast between the heating of the atmosphere over land and that over its surrounding oceans. It seems that the East Asian monsoon can be significantly modulated by an El Niño at its mature phase when significant change happens in the heating field over western tropical Pacific.

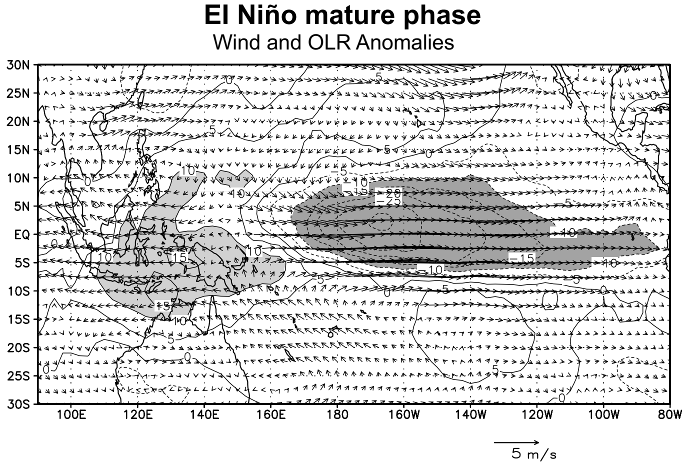

Fig.1: Composites of OLR anomalies (contours; Unit: W/m²) and wind anomalies at 850hPa (vectors) in the El Niño mature phase for northern winter, spring and autumn. The contour interval is 5 W/m². Heavy shadings and light shadings indicate OLR Anomalies less than -10 W/m² and greater than 10 W/m², respectively.

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CLIVAR Atlantic Implementation Panel

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The CLIVAR Atlantic Implementation Panel held its First Meeting, April 13-14, 2000 in Natal, Brazil. This meeting followed PIRATA 7; a number of participants in PIRATA 7 also participated in the CLIVAR Atlantic discussions.

The meeting was attended by seven panel members: Antonio Busalacchi, Allyn Clarke, James Hurrell, Peter Koltermann, Yochanan Kushnir, Mike McCartney and Rowan Sutton. Five panel members were absent: Tom Delworth, Bob Dickson, Alberto Piola, Gilles Reverdin and Fritz Schott.

Tropical Atlantic

Since the meeting was held in conjunction with PIRATA 7, we began by discussing the tropical Atlantic. PIRATA will complete its pilot phase in 2001 and they are working on securing resources from their sponsoring agencies in Brazil, France and the US for an extended consolidation phase 2001-2006. Vandalism and equipment failures has resulted in poor data return. The poor data return from several key sites makes it difficult to examine the development of events along the equator. The PIRATA community is considering replacing frequently vandalised surface moorings with subsurface moorings although this would reduce the range of processes that could be studied. A more frequent mooring service schedule for other sites would improve the overall data return but would also increase the cost of the programme.

Other agencies are seeking to extend the PIRATA array geographically within the tropical Atlantic. An extension to the SE could focus on the development of SST anomalies offshore of the Congo. An extension to the NE could examine coastal upwelling and its link to local fisheries issues. An extension to the west would provide data that will contribute to seasonal and hydrological forecasts for the tropical Americas. PIRATA is encouraging these extensions but will ensure that full funding is available for these extensions before they are implemented.

There is growing evidence that SST signals from the tropical Atlantic affect the extratropical atmospheric circulation over the North Atlantic. Equatorial SST variations can arise through a variety of mechanisms. Variations in winds can lead to variations in equatorial upwelling. Changes in the cross equatorial exchanges could also lead to SST variations as would changes in the air-sea fluxes. PIRATA is just part of the observational system needed to study this part of the Atlantic.

Other observations are made in this region. The US and Germany are planning a current meter array across the western boundary current at 17°N. IFM Kiel is planning a similar western boundary current array at 10°S. There will also be drifter and profiling float deployments, hydrographic sections and XBT lines. These issues are discussed with the US COSTA report.

The panel explored the idea that PIRATA take a broader coordination role for the tropical Atlantic. At present, PIRATA exclusively deals with its own implementation issues. The Tropical Atlantic needs a forum where people from around the basin can discuss and perhaps debate science results, plans and ideas. The panel will ask PIRATA whether they will consider taking this role during their consolidation phase.

South Atlantic

The issue of climate variability over the Atlantic involves SST variability which is related to upper ocean heat storage, air-sea fluxes and circulation changes. The upper ocean waters of the Atlantic flow from south to north. In order to evaluate the role of oceanic advection of temperature variability in the Atlantic, we have to understand the circulation of the South as well as the North Atlantic. The panel would like to extend our region south to include the inflows of upper and intermediate waters around both Cape Horn and the Cape of Good Hope.

North Atlantic Oscillation

The NAO appears to be mostly an internal atmospheric mode of variability. The tropical Atlantic SST variability appears to play a role in its development and structure as does interactions with the troposphere. The NAO has considerable impact on a wide variety of atmospheric and oceanographic signals such as SST, sea ice and the meridional overturning circulation. The ocean appears to be able to carry information forward from the late winter of one year to the fall of the following year through deep winter mixed layers.

Meridional Overturning Circulation

The deeper layers of the ocean respond to climate forcing as a low pass filter. The deeper one goes, the lower the filter period. Within the sub surface ocean, temperature anomalies can arise from both changes in air-sea fluxes and changes in the transport. If you look at the potential energy differences between the Labrador Sea and Bermuda over the past 40 years, you see implied changes in the baroclinic transport of the gyres of 20 sverdrups. Monitoring the temperature and salinity profiles of the water column at a few key locations around the gyres, we will be able to describe these large changes in gyre circulation. Much of what we think we know about variations in the meridional overturning circulation comes from observations that are very sparsely sampled in time. The few well sampled and well place time series stations would allow use to see how these large scale changes in gyre circulation evolve with time.

The way forward

- There needs to be more studies of how poleward heat transport arises and varies within couple climate models. Such studies should examine how the coupled system adjusts and varies as compared to how ocean or atmospheric models adjust and change.
- Need to look more at the small perturbations on the meridional overturning circulation in models rather than the large perturbations and the collapse of the meridional overturning circulation.
- While these studies are looking at processes with an Atlantic focus, they need to be done with a global model.
- We need to understand the limitations of our estimate of air-sea fluxes and why they appear to fail over particular parts of the North Atlantic. Need more air-sea flux buoy measurements.

Membership

The panel would like to strengthen our Southern Hemisphere representation. We would like to add a Brazilian with interest in the role the western boundary current plays in the upper ocean heat and salt budgets. We would also like to add a South African who is interested in the connections between the Atlantic and the climate of Africa.

Next Meeting

The panel would like to hold its next meeting in conjunction with a planned Chapman Conference on the NAO in Orense (northern Spain) . The Chapman Conference will be 3.5 days, Nov 28 – Dec 1, the panel meeting 1.5 days, Dec 1-2.

Climate Change Detection: What can a small Working Group do about It?

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It is hard to pick up newspaper nowadays without reading something about global warming. It's also hard to pick up a professional climate journal without realizing that some of the best scientific minds in the world are working on climate change detection and its attribution. So what in the world can a small Working Group on Climate Change Detection contribute to this major endeavour? This is the question the Chairman asked himself when he accepted, in April 1999, the Chair of the joint WMO Commission for Climatology/CLIVAR Working Group on Climate Change Detection.

Basically, the Climate Change Detection Working Group sits at the intersection of observational data and models, though with more of a foot in the observational camp. The CLIVAR-nominated members are Gabi Hegerl (US), Phil Jones (UK), David Karoly (Australia), and John Mitchell (UK). From the Commission for Climatology we have Svetlana Dolgikh (Kazakstan), Chris Folland (vice-chair, UK), Chet Ropelewski (US), and Anjian Sun (China). In addition, Chris is working with four nominated Commission for Climatology Rapporteurs on Climate Change Detection Methodologies and Indices: George Gruza (Russia), Bill Hogg (Canada) Ibrahim Mokssit (Morocco) and Neil Plummer (Canada) Together with a variety of collaborators around the world, we are trying to address questions such as: What observational data are needed for climate change detection? What analyses of these data can provide information useful for climate change detection? And what international coordination on data issues would improve climate change detection? We are putting particular emphasis on daily data for the analysis of extremes.

At our meeting in Geneva in November 1999, we agreed to focus on two main activities. The first is analysis of indices derived from daily meteorological data. There are several good long-term global data sets of monthly data available to the climate community. But up until now there is no comparable set of daily data. Yet we know that monthly means filter out important information. Long-term daily data allows for analyses of a wide variety of extreme events such as heat waves and flood producing rains that are of great interest to the general public as well as derived parameters that would be of interest to modellers. The indices work started in September 1998 when Chris Folland organised a meeting of a special task group on indices under the banner of the joint Working Group on Climate

Change Detection. This included all the additional CCl Rapporteurs and a report is available from the WMO Secretariat. The indices work has continued to build momentum and recently Gabi Hegerl has begun a study to determine which indices are relevant to climate models. Chris Folland and his colleagues at the Hadley Centre have also reviewed the accuracy and availability of climate data. Their conclusions were delivered in a lecture delivered to WMO Congress in 1999, and published in the January WMO Bulletin.

Povl Frich (UK) as current leader of the task group is preparing a full report on the indices analyses to date, and some of the results will find their way into the IPCC Third Assessment Report. A description of the indices and the exact way each should be calculated can be found at the web site prepared by Albert Klein Tank (The Netherlands; http://www.knmi.nl/samenw/eca/indicator_descriptions). Multi-national participation has been greatly facilitated by focusing in on derived indices: we've been pleased to find that many countries which would not exchange their long-term daily data are often willing to exchange long-term time series of indices derived from these data. This fact led us to develop our next thrust.

The second focus of the Working Group's activities is to foster regional workshops to increase the number of countries participating in the calculation and analyses of these indices. The model for these was the very successful Asia-Pacific Network meetings that Mike Manton (Australia) organised. These workshops will involve training on quality control and homogeneity adjustments, processing and analyses of data that participants bring with them and regional climate discussions. The set of indices produced for the region will be matched up with our other indices work and should fill in another piece of the global climate puzzle. We are currently making plans for several regional workshops. First up will pobably be one in the Caribbean organised by Michael Taylor (Jamaica) with the Chairman's assistance followed hopefully by one in North Africa organised by Abdalah Mokssit (Morocco) with Povl Frich's assistance. Down the road, Louis Molion (Brazil) may hold one in northern or southern South America and Johan (Chris) Koch (South Africa) is interested in organising one for Southern Africa.

A developing focus is to compare modelled and observed extremes, initially in atmospheric general circulation models simulating the climate of the twentieth century. Dmitri Kiktev, one of George Gruza's colleagues, is shortly to spend a period working on this in the Hadley Centre.

If you are interested in this concept of regional workshops, please contact Valery Detemmerman (detemmerman_v@gateway.wmo.ch) or Peter Scholefield (scholefield_p@gateway.wmo.ch) at the WMO Secretariat who are putting together a regional climate change workshop "recipe" that will be updated as additional experience is gained.

How should we collect and disseminate information about the CLIVAR project?

John Gould, Director ICPO
Southampton Oceanography Centre, Southampton, UK
John.Gould@soc.soton.ac.uk

CLIVAR is by any measure a very large and diverse project. One of the challenges for those involved in its scientific oversight is to know what is going on and what is planned. This information is needed by the panels which oversee implementation of specific aspects of CLIVAR and by the SSG to ensure that the appropriate coordination amongst the diverse programme elements is taking place. The information required concerns observations, modelling and synthesis activities and information about the location and availability of important data sets and products.

At the meeting of the CLIVAR SSG in 1999 it was agreed that in preparation for the 2000 meeting (see report by the co-chairmen), countries should be approached by the ICPO and asked to provide a report on their CLIVAR-related activities. (Generally these would be an update on material prepared for the 1998 International CLIVAR Conference). In response to this request, several countries provided new information. Many countries however found it impossible to respond because no central mechanism was available to provide an integrated summary that reflected a balanced view of the activities of the atmospheric, oceanographic, modelling and observational communities. During the coming year the ICPO will work hard to forge improved links with all the countries that are carrying out CLIVAR research and to encourage and aid the compilation of national reports.

So, when we have the information, what will we do with it? How can we make it accessible to anyone interested in the project and how can we provide useful syntheses of information for the SSG and the CLIVAR WGs?

During the past year staff in the ICPO and in the WCRP Joint Planning Staff in Geneva have developed what we refer to as the CLIVAR tracking project. It is a searchable data base containing information on CLIVAR activities. It allows the enquirer to search for information

1) by activity and region e.g. observations in the Atlantic sector
2) by CLIVAR Principal Research Area or Panel (e.g. PRA G1 on ENSO prediction or activities falling under the remit of the Australian-Asian Monsoon panel)
3) by country
4) by project acronym (e.g. Triton, Jasmine, ENSIP)

The tracking project can be accessed at

http://clivar-search.cms.udel.edu/

Besides being essential for the internal management of CLIVAR, it is hoped that the site would be useful to other climate programmes and might foster greater cooperation and minimise overlap. National planning and funding offices, individual researchers, research groups and implementing bodies alike should find the information available through the tracking project useful in planning and carrying out their own activities. Ultimately the site could serve to link the applications and impacts communities directly with the scientists doing basic research.

We encourage all our readers to visit the site and to tell us whether you found it useful and how it could be improved. The most obvious way to achieve an improvement is for us to have more high quality, useful information to input. We encourage you to make use of the form under
http://clivar-search.cms.udel.edu/projects/project-entries.asp
to send in information about your own projects - The data requested is minimal and shouldn't take long to fill in. We also hope that we will greatly increase the information available through our improved contacts with national programmes.

You will also find at the same location as the tracking project a detailed calendar of coming events and a prototype CLIVAR bibliography. The bibliography is based on the monthly accessions to the UK Meteorological Office library. Those that fall in the area of CLIVAR science are extracted and the ICPO then adds to each article a set of appropriate CLIVAR key words. The bibliography can then be searched on these key words or by author.

There is, as yet, only a small number of entries but again we ask you to try to use the bibliography and to provide the ICPO with feedback on its usefulness.

To see how another project has used this approach you can go to
http://oceanic.cms.udel.edu/woce/biblio/
where you can look at a much larger bibliography that has been compiled since 1990 for the World Ocean Circulation Experiment (WOCE). In this bibliography there are two types of entry. The majority are publications that are relevant to WOCE science and can be used by researchers when preparing their own publications. A search under the key word AIMS (Analysis, Interpretation Modelling and Synthesis) lists almost 1100 papers in the refereed literature that are believed to be a result of WOCE research i.e. they are an output measure of the project.

Finally in the coming year we will undertake to improve the accessibility of information on the CLIVAR WWW site by
- modifying its structure,
- by the CLIVAR Panels and WGs providing new images and text for the gallery of CLIVAR viewgraphs
http://www.clivar.org/clivar_transp.html
- by adding a general introduction to the science that falls in CLIVAR's remit.

The information that we seek and that we will distribute is for the benefit of everyone. Please help us to collect accurate information and make it available to you in a user-friendly manner.

HELP: Hydrology for the Environment, Life, and Policy

Jim Shuttleworth
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The UNESCO International Hydrology Programme (IHP) and the WMO Hydrology and Water Resource Programme (HWRP) act as joint stewards of international hydrology within the United Nations system, with IHP primarily responsible for scientific aspects and HWRP mainly responsible for in operational aspects of hydrology. In February 1999, the 5th Joint UNESCO/WMO Conference on International Hydrology unanimously endorsed a new global initiative, entitled HELP (Hydrology for the Environment, Life, and Policy), which will establish a global network of catchments to improve the links between hydrology and the needs of society.

The overarching purpose of HELP is to deliver social, economic, and environmental benefit to stakeholders through the sustainable and appropriate use of water by deploying hydrological science in support of improved integrated catchment management. Because the catchment is the natural unit of hydrology, HELP is specifically catchment-based. However, HELP is people and environment centred, problem-driven and demand–responsive: it takes questions of environment, life and policy as the starting point and hydrology as a vehicle for their solution. HELP therefore undertakes new interdisciplinary studies at a range of appropriate scales that foster integrated solutions to a range of water related environment, life, and policy problems. From the outset of the programme, HELP has involved physical and social scientists from the operational and research communities, water policy experts, mangers and users. Where expertise is lacking, HELP will endeavour to create it through education and capacity building. It addresses the following six global freshwater policy issues: (a) water and food; (b) water quality and human health; (c) water and the environment; (d) water and climate; (e) water and conflicts; and (f) communication between hydrologists and society.

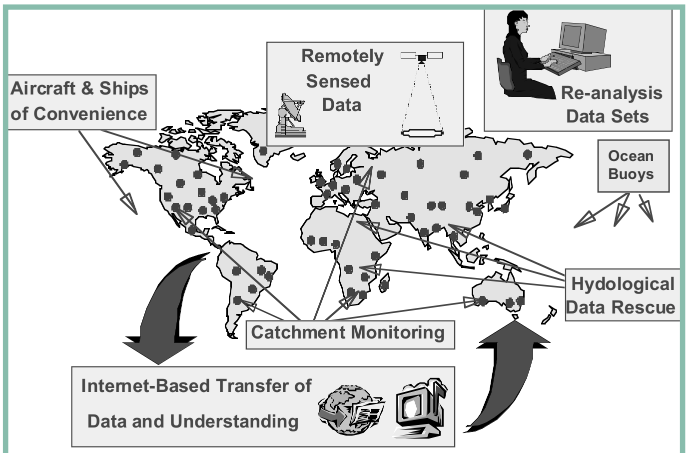
At the global level, HELP is guided by a Steering Committee of international experts on water-related policy, management, and science and representatives of partner organizations (e.g. WMO, IAEA, IGBP, GEWEX, CLIVAR, IAHS, NGOs). The structure of HELP Regional Coordinating Units (RCUs) is necessarily flexible to accord with local institutional arrangements, most likely established in existing national or regional institutions. Fundamentally, HELP is a global network of catchments that benefit from communication between hydrologists and stakeholders within and between participating basins. Benefits include knowledge of new technologies of data acquisition and analysis and shared expertise, and the opportunity to address existing and emerging conflicts through access to external expertise and experience in conflict management, and by learning from the experience and body of knowledge from other HELP basins. To contribute to the HELP programme, some catchment attributes are deemed essential. HELP catchments must provide an opportunity to study a water policy or water management issue for which hydrological process studies are needed, relevant national and local agencies must agree to cooperate in the execution of HELP, there must be adequate local capacity to participate in the programme as a full partner. In addition, a minimum range of key variables and parameters must be monitored, data, information and technological expertise must be shared openly, and HELP data standards, quality assurance and quality control must be adhered to.

The policy issue addressed in HELP that relates most directly to CLIVAR is that which concerns the policy and management implications of the interrelationship between water and climate. For conciseness, hereafter this component of HELP is referred to as "Global-HELP". The overarching question that motivates Global-HELP is:

"How can knowledge, understanding, and predictive modelling of the influence of global variability and change on hydrological variables and remotely sensed data be used to improve the management and design of water resource, agro-hydrologic and eco-hydrologic systems?"

Subsidiary questions relate to defining the strength of the influence of global phenomena in catchments, and to the potential for using remotely sensed data and global knowledge and prediction at a range of time scales in water management and design. Specifically:

- How significant is the relationship between the statistics of hydrological variables and observable global phenomena, and how does this change with location?
- How can remote data capture, and advanced information transfer technologies best be applied to improve the management and design of water systems?
- How can predictions of seasonal-to-interannual variations be used to improve the management of water?
- How significant are multi-decadal fluctuations in climate, and how can knowledge of such fluctuations be used to improve the design of water systems?
- What is the hydrological significance of potential anthropogenic climate change, and how can predictions of such change best be used to improve design of water systems?



The HELP programme will establish a global network of hydrological catchments in which hydrological monitoring and data rescue will be carried out to parallel the documentation of global processes and global modelling that will be done by WCRP programmes such as CLIVAR.

Global-HELP seeks to collaborate with CLIVAR and to use the results of the research carried out by CLIVAR to address all of the above questions. In the case of questions 1, 2, and 3, the relationship will involve an at least equal level of simultaneous collaboration with GEWEX. In the next decade, HELP anticipates that:

- CLIVAR-GOALS will develop new, predictable, oceanic "indexes" which have statistical linkages to the hydrological variables in individual HELP catchments that can be used to benefit water management;
- CLIVAR-DecCen will provide new definition and understanding of the nature, range, and geographical extent of longer-term climatic variations that can be used to refine the design criteria for water systems;
- CLIVAR-ACC will provide more credible and accurate predictions of long-term anthropogenic change in the climate system that can be used to assess the vulnerability of current or proposed water systems;
- Ultimately, CLIVAR, in collaboration with GEWEX, will develop a realistic, global-scale, coupled, ocean-atmosphere-land model, with a meso-scale grid mesh, that can be run in ensemble mode to provide seasonal-to-interannual predictions that have demonstrated utility in water resource applications at the scale of HELP catchments.

The HELP programme anticipates that collaboration with CLIVAR will take the form of joint research initiatives in which CLIVAR will focus on providing new understanding and predictive products while HELP will focus on exploring their potential use in water systems at catchment scale. In addition, HELP foresees potential for collaboration with CLIVAR through the exchange of data, by jointly organising scientific meetings, and in the context of relevant training and capacity building in developing countries.

More information about HELP can be obtained under

http://www.unesco.org/science/help

Workshop Announcements

Workshop on "Decadal Climate Predictability", 4-6 October 2000, Scripps Institution of Oceanography, La Jolla, California, USA

The workshop is organised under the auspices of the CLIVAR Working Groups on Global Coupled Modelling (JSC/CLIVAR-WGCM) and Seasonal and Interannual Predictability (CLIVAR-WGSIP). It precedes a WGCM meeting the following week also in La Jolla.

The organising committee

The members of the organising committee are: T. Barnett (SIO), G. Boer (CCC), M. Latif (MPI) and M. McCartney (WHIO).

Objectives

The workshop will address all aspects of observation-based and model-based decadal climate predictability studies. Both oceanic and atmospheric studies are welcome. The main focus of the workshop is expected to be the investigation of the decadal predictability by means of complex models. The goal of the workshop is an assessment of the state-of-the-art in the field of decadal climate predictability and the identification of future research topics for international cooperation.

If you are interested in participating in the workshop please contact G. Boer or M. Latif (george.boer@ec.gc.ca, latif@dkrz.de).

Logistics:

Hotel rooms have been reserved at Hotel La Jolla. The rates are $135 for garden view and $155 for ocean view. Reservations were made also at the Andrea Villa Hotel. Rates for the Andrea Villa are $90 (plus tax). It is expected that reservations will be made by the participants themselves.

CLIVAR Workshop on "Shallow Tropical-subtropical Overturning Cells (STC) and their Interaction with the Atmosphere" 9-12 October 2000, Venice, Italy

Motivation:

The Meridional Overturning Circulations (MOC's), in particular the Atlantic Ocean MOC, have been the object of numerous investigations during the last decade. Much less attention has been given to observational and modelling studies of the shallow subtropical/tropical overturning cells (STC's) that can act as a mechanism for transferring mass, heat and salt between the subtropical and equatorial gyres.

Through their effect on the Sea Surface Temperature (SST) the STC's have been proposed as the oceanic component of coupled models of air-sea variability that influence atmospheric climate on decadal time scales.

Herein, we propose to convene a workshop under the CLIVAR banner to bring together modelers and observationalists to assess our present understanding of the structure of these cells and of their influence on the atmosphere. This assessment will be used to develop strategies for future observational and modelling studies. A final document will be produced as a CLIVAR report.

Relationship to CLIVAR

Understanding and quantifying the role of STC's in the climate system are relevant to the major objectives of the CLIVAR programme. Specifically, STCs are important in relation to research objectives of CLIVAR-DecCen programme D2 (WCRP, 1998). To our knowledge, no meeting, workshopor symposium has ever been held on this subject. There are several programmes proposed under the CLIVAR umbrella that provide a larger scale framework applicable to the STC's: Pacific Basin-wide Extended Study (BECS), Tropical Atlantic Variability (TAV) and COSTA among others. However, the dynamics of the STC's are common potentially to all the oceans. A goal of this workshop is to design an effort dedicated to observing and modelling the STC's globally.

Objectives

Overall objective: to assess the present understanding of the structure and dynamics of the shallow tropical-subtropical overturning cells in the tropics and their interaction with the atmosphere and to develop strategies for future observational and modelling studies.

Specific objectives:

I) Compare model results and observations of the mean and time dependent STC's to address the following issues:

1) What are the sources for and what determines the rate of subduction of subtropical waters that contribute to the shallow cells?
2) What are the pathways and time scales from the subtropics to tropical upwelling areas (e.g., western boundary currents and/or interior ventilation)?
3) What processes determine the intensity of equatorial upwelling (e.g., local winds, remote forcing)?
4) What are the pathways for the return of upwelled waters to the subtropical subduction region?
5) What is the role of the global thermohaline circulation in influencing the STC structure and intensity?
6) What processes control the effect on the atmosphere of SST variability induced by STC's?

II) Based on the understanding of the above issues, propose a strategy for:

1) An air-sea network to observe the STC's and their effect on the atmosphere.

2) Numerical modelling activities to increase the understanding of the STC's.

Contact: Prof. Dr. F. Schott, Institut für Meereskunde, Kiel, Germany, e-mail: fschott@ifm.uni-kiel.de

First Latin American School in Ocean and Climate Modelling
16-27 October 2000, Concepción, Chile

The Program for Regional Studies in Physical Oceanography and Climate (PROFC) at University of Concepcion announces the First Latin American School in Ocean and Climate Modelling to be held in Concepcion, Chile, during 16-27 October 2000. This school is organised by Dr. Joachim Ribbe. The event is supported by the Intergovernmental Oceanographic Commission, the Scientific Committee on Oceanic Research, the Inter-American Institute for Global Climate Research, the US Global Climate Change Program, and the Department of Oceanography at the University of Concepcion, and receives endorsement from the International Association for the Physical Sciences of the Oceans.

The workshop will bring together internationally leading experts in ocean and climate modelling and Latin American based graduate students, young researchers, and other professionals. Travel support, food and lodging are available for Latin American participants. This course is fee exempt.

Further information about the school and the application procedure can be found at

http://www.profc.udec.cl/school2000

or via e-mail to: Joachim.Ribbe@profc.udec.cl.

The WOCE/CLIVAR Representativeness and Variability Workshop
17–20 October 2000, Fukuoka, Japan

The organising committee

T. Joyce, Co-chairman; S. Imawaki, Co-chairman; D. Roemmich; N. Bindoff; W. Large; P.-Y. Le Traon; D. Webb; K. Hanawa; P. Koltermann

The objectives

- To review information gained on seasonal to interannual variability during WOCE
- To assess information gained on decadal variability from comparison of WOCE and pre-WOCE data
- To estimate the impact of this variability on the representativeness of the WOCE (particularly WHP) data sets and derived quantities (e.g. heat and freshwater fluxes)
- To review the ability of models to represent seasonal and longer-term ocean variability and the variation in water mass properties, volumes and formation rates
- To identify, and take steps to initiate, data analysis and modelling research needed to better assess the representativeness of WOCE data sets and derived quantities
- To identify the principal mechanisms (e.g. local or remote air-sea exchange, advection, propagation coupled air-sea processes) behind the oceanic signals of climate variability as measured in WOCE
- To make recommendations based on the workshop conclusions for the design of future research (CLIVAR) and operational (GOOS) observing systems.

The provisional timetable

Tuesday, 17 October
Introductory remarks [Joyce and Imawaki]
Plenary session 1: global views of WOCE variability: data and models
Introduction of posters and poster session
Plenary session 2: principal mechanisms for variability
Introduction of posters and poster session

Wednesday, 18 October
Plenary session 3: model/data comparisons, where are we?
Introduction of posters and poster session
Plenary session 4: Pacific/Indian variability
Introduction of posters and poster session

Thursday, 19 October
Plenary session 5: Atlantic variability
Introduction of posters and poster session
Focus groups discussions

Friday, 20 October
Plenary session 6: Southern Ocean and Arctic variability
Introduction of posters and poster session
Focus groups discussions
Plenary session 7: focus groups presentations, workshop summaries

Posters

Abstracts of posters should be sent to the WOCE IPO (woceipo@soc.soton.ac.uk) by 31 July 2000. The decisions on which posters to accept will be made before 31 August when lead authors will be informed of the decision by e-mail. At the same time copies of the accepted abstracts will be linked to the workshop web page:
http://www.soc.soton.ac.uk/OTHERS/woceipo/varbwk
Printed and bound copies of the abstracts will be available at the workshop.

Registration

Pre-registration for the workshop, accommodation and payment for the workshop dinner are being handled by a travel agency in Fukuoka. Once details are agreed the

workshop web page
http://www.soc.soton.ac.uk/OTHERS/woceipo/varbwk
will link to a workshop web page maintained by the travel agency. The registration fee for the workshop will be $US100 or 10,000 Japanese Yen. For students the fee will be $US50 or 5,000 Yen. The deadline for pre-registration will be 31 August.

Local information

Fukuoka City is situated on the northern coast of Kyushu, the third largest and south-western most of the four main islands of Japan. The climate is rather mild with the annual mean temperature of about 17°C and is similar to that of the south-eastern coast of the US. Fukuoka Airport is located fifteen to twenty-five minute by car from Hakata Station and the Tenjin downtown area. If you travel by subway the trip takes less than ten minutes. Fukuoka train station, Hakata, is well connected with Hiroshima, Osaka, Kyoto, Nagoya and Tokyo by the Shinkansen bullet train. The train to Tokyo takes about 6 hours, connections to Narita Airport taking a further 1 to 2 hours.

The workshop will be held at the Takakura Hotel, Fukuoka. A special rate will be available for attendees.

25th Climate Diagnostics and Prediction Workshop
23-27 October 2000, International Research Institute, Palisades, NY, USA

Two special sessions are being organised for the 25th Climate Diagnostics and Prediction Workshop (CDPW) during the week of October 23-27, 2000.

The first is a special session on the North American Monsoon Experiment (NAME) (described below). The second is a special session) on Land Processes and Seasonal Predictability (also described below). Both events will be held at the International Research Institute (IRI) during the latter part of the week. These special sessions are important for GAPP (GEWEX America Prediction Project), PACS (Pan American Climate Studies) and VAMOS (Variability of the American Monsoons) as discussed below.

Participants are encouraged to submit abstracts to the 25th CDPW by July 3rd, 2000. Details are available at:
http://yao.ncep.noaa.gov:2000/monsoon/25thCDPW.htm

Special Session I.
North American Monsoon Experiment (NAME):

Previous research has demonstrated potential for the prediction of warm season precipitation over North America. Recent advances in the monitoring and modelling of ENSO-precipitation relationships and in the diagnosis and understanding of the role of coupled ocean-atmosphere-land surface interactions in the continental hydrologic cycle have promoted the idea that there is a deterministic element in the year-to-year variability of precipitation, particularly during the cold season. To date, however, the climate community has not been very successful in extending our understanding of these broad precipitation relationships to improved prediction of warm season precipitation. The North American Monsoon Experiment (NAME) is an internationally coordinated effort aimed at determining the sources and limits of predictability of warm season precipitation over North America, with emphasis on time scales ranging up to seasonal and annual.

The NAME special session will provide an opportunity for participants to exchange information, ideas, and opinions on a variety of topics related to the North American monsoon. Papers dedicated to the diagnosis and prediction of the North American Monsoon (including regional monsoon characteristics and associated teleconnections on intraseasonal, interannual and interdecadal timescales) are sought for this session. These topics are critical for the implementation of NAME in GAPP, PACS and VAMOS, consequently it is anticipated that presentations in this session could be helpful in identifying priorities for its implementation. Invited talks on progress in developing NAME will also be presented. An important objective of the NAME special session is to review the working draft of the NAME Science Plan and Implementation Strategy which is available at
http://yao.wwb.noaa.gov:2000/monsoon/index.html

Participants are encouraged to review the working draft before the meeting. Questions about this special session should be addressed to Wayne Higgins at whiggins@ncep.noaa.gov

Special Session II.
Land Processes and Seasonal Predictability

During the past decade there has been a growing recognition that land surfaces can have a significant influence on the predictability of precipitation on time scales of months and seasons. This influence is most clearly seen during the summer when the role of sea surface temperatures (SSTs) in forcing large scale circulation patterns is a minimum and convective activity is a maximum. Papers are sought for this session that will describe the role of land surface, boundary layer and convective processes in controlling precipitation on time scales of months and seasons. In particular, papers dealing with the influences of soil moisture, vegetation, snow cover, land-ocean interactions, and mountains on seasonal precipitation patterns are solicited. Papers dealing with the feedbacks between precipitation, runoff, soil moisture and vegetation, and their impacts on regional water budgets, are also encouraged. These topics are critical for the implementation of the new GEWEX America Prediction Project (GAPP), consequently it is anticipated that presentations in this session could be helpful in identifying priorities for its implementation.

NASA-IPRC Workshop on Decadal Climate Variability
8-12 January, 2001, East-West Center, U. Hawaii, Honolulu, USA

Organising Committee:

V. Mehta, J. McCreary, D. Battisti, A. Busalacchi, T. Delworth, C. Koblinsky, W. Lau, E. Lindstrom, M. Mann, D. Martinson, J. Meehl, E. Smith, M. Visbeck, T. Yamagata

Purpose:

1. To bring together researchers active in Decadal Climate Variability
2. To provide inputs to NASA's Earth Science programme from this community
3. To continue to develop an integrated framework of research in the observation, description, physics, prediction, and societal applications of Decadal Climate Variability and its interaction with seasonal-to-interannual and anthropogenic climate phenomena

Agenda:

1. Analysis, modelling, and predictability of decadal-multidecadal climate variability
2. Decadal-multidecadal climate variability as seen via paleoclimate data
3. High-latitude ocean-ice-atmosphere processes that lead to decadal-multidecadal climate variability
4. Interaction between decadal-multidecadal and interannual climate variabilities
5. Interaction between natural decadal-multidecadal climate variability and anthropogenic climate change
6. Observing and data assimilation systems for decadal-multidecadal climate variability
7. Assessment of societal impacts of decadal-multidecadal climate variability

The need for this Workshop

1. This is a nascent but rapidly-growing area of research. More than two years between this Workshop and the previous such Workshop
2. Recent results suggest a much more important role of decadal-multidecadal variability in seasonal rainfall anomalies over North and South America, South and East Asia, Australia, and West and South Africa than hitherto known; this adds an urgency to observe, understand, and predict these slowly-varying climate anomalies
3. Need to provide further inputs to NASA's evolving Earth Science Vision 2025 and to ocean observing and data assimilation systems being planned
4. Need to assess societal impacts of decadal-multidecadal climate variability
5. Becoming increasingly obvious that these "central" timescales interact with both shorter (interannual) and longer (climate change) timescales, and influence their predictability.

Contact: Vikram Metha, mehta@climate.gsfc.nasa.gov

CLIVAR Calendar

2000/2001	Meeting	Location	Attendance
July 10-14	Meteorology at the Millennium	Cambridge, UK	Open
October 4 - 6	WGCM Workshop on Decadal Predictability	La Jolla, USA	Open
October 9-11	JSC/CLIVAR Working Group on Coupled Modelling	La Jolla, USA	Invitation
October 9-12	Workshop on "Shallow Tropical-subtropical Overturning Cells and their Interaction with the Atmosphere"	Venice, Italy	Open
October 17-20	WOCE/CLIVAR Representativeness and Variability Workshop	Fukuoka, Japan	Open
October 23-27	25th Climate Diagnostics and Prediction Workshop	Palisades, USA	Open
October 23-27	CAS/JSC WG on Numerical Experimentation	Melbourne, Australia	Invitation
November 1-3	CLIVAR Working Group on Seasonal to Interannual Prediction	Mar del Plata, Argentina	Invitation
November 12-14	CLIVAR Ocean Observing Panel	Perth, Australia	Invitation
November 16-17	TAO Implementation Panel, 9th Session	Perth, Australia	Invitation
November 16-18	CLIVAR Southern Ocean Workshop	Perth, Australia	Invitation
November 28-December 1	Chapman Conference on the North Atlantic Oscillation	Orense, Spain	Open
December 15-19	AGU Fall Meeting	San Francisco, USA	Open
January 8-12	NASA/IPRC Workshop on Decadal Climate Variability	Honolulu, USA	Open

Contents

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