Newsletter of the Climate Variability and Predictability Programme (CLIVAR)

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South American Low Level Jet Experiment SALLJEX

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This issue been sponsored by the China Meteorological Administration through the Chinese Academy of Meteorological Sciences.

CLIVAR is an international research programme dealing with climate variability and predictability on time-scales from months to centuries.

CLIVAR is a component of the World Climate Research Programme (WCRP).

Call for Contributions

We would like to invite the CLIVAR community to submit papers to CLIVAR Exchanges for issue 31. The overarching topic will be on **North Atlantic Predictability.** The deadline for articles for this issue is 30th July 2004. See CLIVAR webpage (see below) for full details.

Guidelines for the submission of papers for CLIVAR Exchanges can be found under: http://www.clivar.org/publications/exchanges/guidel.htm

Editorial

The South American Low-level Jet (SALLJ) along the lee of the Andes Mountains is a key feature of the continent's climate. At the initiation of the Variability of the American Monsoon (VAMOS) programme in 1997 there was consensus that the SALLJ was directly relevant to the strong mesoscale features that develop around its exit region in central South America. It was also thought that the jet played a key role in the regional hydrology and in the water exchanges between the Amazon Basin in the tropics and the La Plata Basin to the south. The SALLJ, however, flows above some of the poorest regions in South America and the available data sets were simply not adequate to attempt a meaningful quantitative validation of the hypotheses being put forward. The emerging VAMOS programme also brought to light that many leading scientists from the region, and beyond, were eager and ready to investigate and study the SALLJ.

The combination of an exciting, unexplored atmospheric phenomenon with the potential for important interactions with the underlying land surface, and the readiness of the scientific community to tackle it, put the SALLJ study high on the VAMOS agenda. In that context, the CLIVAR Scientific Steering Group requested that a SALLJ project be developed, firmly rooted in a climate framework. This was helped by the timely publication of studies that suggested associations between the SALLJ and the major modes of South American climate variability, including links with sea-surface-temperature anomalies in both the Pacific and Atlantic Oceans. Once the scientific stage was set, the SALLJ research programme quickly took shape. In particular, a field campaign, the South American Low-level Jet Experiment (SALLJEX), was proposed that would enhance rain gauge networks, launch pilot balloons and radiosondes several times a day, and fly instrumented research aircraft to probe the associated mesoscale convective systems. This was an international collaborative venture from the beginning, and remains such.

SALLJEX represents an important start to the proper study and better understanding of the SALLJ and its role in shaping the climatic characteristics of South America, and further afield. But to answer several important questions will require mounting further field campaigns, such as SALLJEX, perhaps several times. SALLJEX and its associated research agenda have, however, already revealed a number of important issues. The following articles highlight those of a scientific nature. However, we also wish to acknowledge SALLJEX for the effectiveness of its international collaboration based on clear scientific goals, as well as the enthusiasm and unselfishness of the participants. We congratulate SALLJEX scientists on their achievements to date, which have contributed to the scientific aims of VAMOS and CLIVAR, and therefore also to those of the World Climate Research Programme.

David Carson Roberto Mechoso

I have been pleased indeed to act as the editor of this special edition of Exchanges featuring the South American Low Level Jet Experiment (SALLJEX). Like David Carson and Roberto Mechoso I congratulate all those involved in SALLJEX on their achievements. The papers here present early results of the analysis of SALLJEX datasets and show promise of a rich harvest when analyses are complete and full results are published in the refereed literature in due course.

One of the key topics which the ICPO is tackling is the issue of CLIVAR Data and Information Management. This topic was highlighted at the end of March by the first CLIVAR Data Planning Meeting, held at Scripps Institution of Oceanography. The meeting focussed on ocean observations and brought together the CLIVAR Data Assembly Centres (DACs) (formerly the WOCE DACs, that have agreed to continue their activities for CLIVAR) and representatives of CLIVAR's Ocean Basin Panels. The meeting was chaired by David Legler (Director of US CLIVAR) and Dean Roemmich, hosted by Jim Swift and organised by Katy Hill of the ICPO. Thanks to Katy's encouragement participants prepared a range of position papers beforehand and these and the presentations helped to stimulate and encourage a wide range of discussion. Two of the key outcomes of the meeting were mechanisms to further develop the interactions between CLIVAR's panels and those responsible for data management and actions to stimulate the identification of key datasets and archiving and quality control requirements for them.

The 1st International CLIVAR Science Conference is fast approaching and David Legler and his team are working hard to ensure smooth and effective local organisation. Over 700 poster abstracts were received and registration is well underway. Further details of the Conference can be seen on page 25 and you can register at:

www.clivar2004.org

Howard Cattle

Introduction to the South American Low–Level Jet Experiment (SALLJEX)

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1. Overall Goal and strategy

VAMOS has implemented the South American Low-Level Jet (SALLJ) program, an internationally coordinated effort to improve short and long term predictions through the following strategy: i) obtain an improved description of the temporal and spatial structure of the SALLJ based on expanded monitoring activities and special field experiments; ii) evaluate the veracity of numerical representation (forecasts and analyses) of SALLJ against special observations and; iii) determine improvements to initial state representation and model parameterizations required to improve prediction.

The SALLJ field campaign (SALLJEX) was performed with great success between 15 Nov 2002 and 15 Feb 2003 in Bolivia, Paraguay, central and northern Argentina, western Brazil, and Peru. SALLJEX aimed at describing many aspects of the SALLJ and was a blend of many observing systems. Scientists, collaborators, students, National Water Service personnel and local volunteers from Argentina, Brazil, Bolivia, Paraguay, Chile, Uruguay, Peru and the USA participated in SALLJEX activities in an unprecedented way. SALLJEX was the first WCRP/CLIVAR international campaign in South America.

2. SALLJEX Components

2.1 SALLJEX upper-air sounding network

Accurate upper-air observations were needed over a large region currently without a dense sounding network to a) quantify the variability of the LLJ over different spatial scales; b) describe the spatial variability of the diurnal cycle of the lower and middle tropospheric wind field; and c) describe the Chaco heat low, its variability in space and time and the basic processes responsible for its variability. The observations were also essential for validation of numerical simulation sensitivity studies that attempt to reproduce the structure of the jet and its variability.

The basic observation period (BOP) of this component covered the 3-month duration of the experiment and it consisted in one radiosonde observation (RAOBS) at 06UTC and two pibal observation (PAOBS) at 06 and 21UTC. Within this interval, during a Special Observing Period (SOP) of one month duration (approximately Jan 6-Feb 15) RAOBS were made 2 times daily (06 and 21UTC) while PAOBS were made 4 times daily in Argentina, Bolivia and Paraguay and 4-time daily RAOBS were made in Brazilian SALLJEX stations (Fig. 1 page 15). Finally, intensive-observing periods (IOP's) when up to 3-4 RAOBS and/or 8 pilot balloon observations per day were made at selected sites along the LLJ axis.

2.2 NOAA/WP-3D missions

The main objective of the aircraft missions was to provide a detailed representation of the structure and variability of the LLJ east of the Andes. The WP-3D flights were used to address secondary scientific objectives as well, such as: 1) a description of the heat low over the Chaco and northwestern Argentina; 2) the relationship between mesoscale convective systems over northern Argentina or western Paraguay and the LLJ; 3) the structure of cold frontal surges near the eastern slopes of the Andes and 4) the description of mesoscale wind and moisture variability over the Altiplano. P-3 deployment went as planned, with 13 research missions flown between 11 January and 8 February, for a total of 99 research hours.

2.3 SALLJEX raingauge network

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

SALLJEX installed approximately 1200 raingauges, which were read daily, in Argentina, Paraguay, Bolivia, and Peru (Fig. 2 page 15). The installation of around 250 gauges was largely successful in Argentina, where it was merged with the existing network (around 1500 stations) from which rainfall measurements are not easily available. In Paraguay, the SALLJEX installation activities (around 300 gauges) discovered many additional raingauges operated by the agricultural sector and this offers hope of greatly extending future observations (around 250 stations). In Bolivia there were some difficulties with the raingauge installation but around 260 gauges were installed. In Peru, the installation was split among the Instituto Geofisico del Peru and Servicio Nacional de Meteorologia e Hidrologia del Peru and was fully successful. SALLJEX activities in Brazil were concentrated on the installation of two dense raingauge networks around Rio Branco (20 raingauges) and Ji Paraná (40 raingauges) respectively, that provided rainfall data of very high temporal resolution.

Future efforts will be made to promote the continuation of such an integrated raingauge network which is extremely useful for long-term monitoring in the region as well as for other VAMOS activities like PLATIN, a research program on the climatology and hydrology of La Plata Basin .

2.4 Modeling activities

During the experiment, the SALLJEX modeling group provided a diversity of forecast products from several numerical models running not only at operational centers but also at the research institutions involved in SALLJEX.

SALLJEX observations provide a unique opportunity for numerical model validation and sensitivity studies that attempt to reproduce the structure of the jet and its variability as well as the related precipitation. Such validation as well as data assimilation experiments are currently underway. Preliminary results are presented in this special issue.

2.5 Other SALLJEX activities:

Data Management: Current information about SALLJEX products and about reports of the activities is available at the SALLJEX field catalog (http://www.joss.ucar.edu/salljex/catalog/). An interactive SALLJEX data catalog is under development at JOSS (http://www.joss.ucar.edu/salljex/dm).

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

3. Final considerations and introduction to the special issue

A SALLJEX data Workshop was held in Buenos Aires, Argentina between 10 and 12 December of 2003 in order to: a) assess what progress has been made on SALLJEX objectives; b) strengthen and arrange collaborations among the participants in SALLJEX, c) broaden participation and expand the analysis and modeling use of SALLJEX data by other scientists and their students and d) determine future activities. This special issue illustrates several of the works presented at the Workshop, providing a good picture of the considerable interest in SALLJ related issues and the wide-ranging studies that are currently taking place.

Full information about SALLJEX is available at:

SALLJEX-JOSS site: http://www.joss.ucar.edu/salljex

SALLJEX-UBA site: http://www.salljex.at.fcen.uba.ar

SALLJEX-NSSL site: http://www.nssl.noaa.gov/projects/pacs/web/html/salljex.html

Acknowledgments

On behalf of the SALLJ SWG and the VAMOS Panel, it is a pleasure to acknowledge the excellent work performed by the SALLJEX scientists, students, collaborators and local volunteers. Very special thanks are also due to Gus Emanuel (JOSS), Carlos Ereño (ICPO) and Jose Meitin (NOAA) of the SALLJEX project office, for their excellent support. Funds were mainly provided by NOAA/OGP, NSF, FAPESP (Brazil), ANPCyT (Argentina).

The South American Low Level Jet Experiment (SALLJEX) Multinational Logistics, Coordination, and the Implementation of the Daily Operations

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The VAMOS Programs Project Office was established within the Joint Office for Science Support (JOSS) / UCAR. Its goal is to provide scientific, technical and administrative support services to the VAMOS programs for the purpose of organizing, coordinating and implementing the VAMOS field campaigns, including the data collection, archiving and dissemination functions.

In addition, the office provides specialized logistics support relevant to the field campaign requirements, and supports workshops, training sessions, and educational outreach programs.

Nearly a year ago (January-February, 2003), the Project Office completed the field phase of the South American Low Level Jet Experiment (SALLJEX). It established a base of operations in Santa Cruz de la Sierra, Bolivia, where the NOAA WP-3D aircraft was also based carrying out its research missions from Viru Viru International Airport.

The primary participating countries during the SALLJEX field phase were Argentina, Chile, Bolivia, Brazil, Paraguay, and the US. All countries, except the US, supported the data collection requirements as specified in the SALLJEX Science Implementation Plan with radiosonde and pibal launchings, rain gauge arrays, and standard meteorological surface data at a number of meteorological sites. These sites were identified in advance by the SALLJEX Science Working Group. The US data collection activities during SALLJEX were supported by the meteorological research aircraft capabilities, including the two on board radars (doppler, C-band).

It is important to note that these multi-national field experiments require a variety of complex arrangements that must be made months to years in advance. Each country's laws dealing with Customs, Immigration, frequency allocation permits, importation and exportation of equipment, importation of expendables and associated hazardous gases, must be observed in their entirety and the necessary permits be secured well in advance of the field phase. To satisfy the operational requirements for SALLJEX, the Project Office implemented Memoranda of Agreements with the relevant agencies of the governments of Argentina, Paraguay, and Bolivia. Similarly, the operation of the WP-3D research aircraft required the necessary flight permits to execute research flights in support of the SALLJEX scientific objectives. Consequently, permits were secured for flights over Bolivia, Paraguay, Argentina, and Chile.

The Project Office established an Operations Center in Santa Cruz de la Sierra, Bolivia. Most of the principal investigators participating in SALLJEX were present during a six week period when the intensive observations were made over the SALLJEX domain. In addition, the Project Office established a local area network and telecommunications capabilities of adequate bandwidth to support the activities of the participants.

Daily meetings were conducted during the entire period; the meetings started at 1400 hours (local time), with a decision for the next day's operations accomplished no later than 1600 hours. This was necessary in order to give the flight crews adequate rest time should there have being a requirement to conduct a research flight the next day. The meeting's agenda consisted of a presentation of the forecast for the next 24-48 hours as well as other meteorological products, model outputs and analyses, and satellite imagery. In addition there were status reports pertaining to aircraft research systems, land meteorological sites, etc. After these discussions, the attending Science Working Group members and other investigators deliberated the potential mode of operations for the next 24 hours, sometimes considering the 48-72 hour period as well.

At the Operations Center, the Project Office maintained the JOSS "SALLJEX Field Data Catalog", an archive where all the daily activities and data collected were deposited for immediate perusal by interested parties. Further information can be found at: *http://www.joss.ucar.edu/salljex/*

CLIVAR Calendar

2004	*Meeting*	*Location*	*Attendance*
May 10-12	The Ocean in a High CO_2 World	Paris, France	Open
May 17-21	AGU 2004 Spring Meeting	Montreal, Canada	Open
May 17-19	ESF Workshop on Mediterranean Climate Variability and Predictability	Rome, Italy	Invite
May 23-28	Challenges in the Climate Sciences	Chateau de Blois, France	Open
May 24-29	4th International Symposium on Asian Monsoon System (ISAM4)	Kunming-City, China	Open
May 25-28	9th International Meeting on Statistical Climatology	Cape Town, S.Africa	Open
May 31- June 4	II Brazilian Oceanography Symposium	Sao Paulo, Brazil	Open
May 31- June 3	38th Congress of the Canadian Meteorological and Oceanographic Society	Edmonton, Alberta, Canada	Open
May 31 - June 4	Southern Africa Workshop on Climate Extremes	Cape Town, S. Africa	Open
June 7-9	Tropical Atlantic Workshop	De Bilt, The Netherlands	Limited
June 7-10	OOPC-9	Southampton, UK	Invite
June 15-19	5th WGOMD Meeting	Princeton, USA	Invite
June 16-18	Ocean Climate Model Workshop	Princeton, USA	Limited
June 20	6th CLIVAR Atlantic Panel Meeting	Baltimore, USA	Invite
June 21-25	1st International CLIVAR Science Conference	Baltimore, USA	Open
June 27-29	CLIVAR SSG 13th Session	Baltimore, USA	Invite

Check our our Calendar under: http://www.clivar.org/calandar/index.htm for additional information

South American Low Level Jet Diurnal cycle and Three Dimensional Structure

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The South American Low-level jet (SALLJ) is a wind maximum within the lower troposphere just east of the Andes. It often produces a large transport of atmospheric water vapor from tropical to extratropical latitudes and consequently modulates the spring and summer rainfall events over the La Plata river basin. The SALLJEX Field Experiment, conducted under CLIVAR's VAMOS programme was an internationally coordinated effort aimed to monitor, quantify and analyze the low-level circulation over a region enclosing the SALLJ domain. This field experiment featured an enhanced sounding network within which pibals and radiosondes were launched during the Austral summer of 2002-2003, and about 100 hours of research flight missions from the NOAA WP-3D aircraft.

An overview of past observational studies showed the diurnal wind cycle (particularly the nocturnal phase) and the three-dimensional structure of the SALLJ to be inadequately resolved. This contribution briefly summarizes the improved description of the low-level circulation revealed by the increased spatial and temporal resolution in wind observations during SALLJEX and identifies some remaining gaps for further advances.

Previous to SALLJEX, there were available twice a day observations in Santa Cruz, Bolivia that hardly depicted the diurnal cycle of the jet. Studies based on the four-times-a-day available NCEP reanalysis (Marengo et al., 2004) and ERA reanalysis (Salio et al., 2002), suggested that SALLJs are more frequent and intense between 0600 and 1200 UTC for the warm season north of 20°S near the core of the jet, while at the region downstream the maximum (around 30°S) is detected between 0000 and 0600 UTC. Saulo et al. (2000) and Nicolini et al. (2002) found a maximum between 0000 and 0600 UTC using 40 km-resolution ETA forecast products during the 1997-1998 warm season. These findings can be corroborated with the more frequent upper-air observations during SALLJEX field experiment.

Observations made during the NOAA WP-3D flight mission on February 06, 2003 show the horizontal (Fig. 1a at 800 hPa, near the level of maximum wind) and vertical structure of the low-level flow (Fig. 1b given by the series of ascents and descents along the vertical cross section depicted in Fig. 1a, across the jet). This is a case of a moderately intense SALLJ over southern Bolivia and western Paraguay. A maximum wind speed of about 25 ms^{-1} in the 800-700 hPa layer is located over northwestern Paraguay. A secondary maximum was observed near Santa Cruz, Bolivia before landing. SALLJEX data provide unique information for the evaluation of three-dimensional fields supplied by advanced modeling tools. Fig. 1c and 1d show the Regional Atmospheric Modeling System (RAMS, version 4.3) 20-km nested grid wind field. Comparison between aircraft measurements and model derived wind fields is satisfactory in describing the general NW flow and the position of the maximum but the intensity is underestimated.

Figure 2 (page 16) shows the mean SALLJEX period vertical wind profiles (both pilots and raobs included) at Mariscal Estigarribia (Paraguay) every 3-hours (wind speed and zonal and meridional wind components). This figure which also includes the number of observations at each time, on the right side of the corresponding panel, denotes the variation of number of available observations between times and altitudes. Less than 10 observations for the whole experiment have been done at 00, 03 and 15 UTC times included in Intensive Observation Periods (IOP), while 06, 12, 18 and 21 UTC have more than 50 and 09 UTC around 30 observations close to the surface. It is important to remember that Mariscal Estigarribia operated as a radiosounding station at 06 and 18 UTC while other stations only launched pibals during IOPs with a consequently reduced number of nocturnal observations (see data inventory in PACS-SONET web page: http://www.nssl.noaa.gov/projects/pacs/html_files/invehour.html for more detailed information about the whole network). From Fig. 2 the presence of the maximum speed both in the wind and in the northerly component is confidently evident during the 06 to 12 UTC period as well as the absence at 18 and 21 UTC.

The few upper-air observations available since 1998 have localized the maximum of the wind between 1000-1600 m asl st Santa Cruz. During SALLJEX, the altitude of the speed maximum is most often between 500 and 1500 m asl. It can be as low as 500 m and as high as 3 km within the domain with a tendency to rise during daytime hours, consistent with mixed layer growth (not shown).

Hodographs at most SALLJEX sites reveal an oscillation in direction over the diurnal cycle with transitions between different time intervals instead of a regular progression. The observed behavior is consistent with a simple theoretical model that includes inertial oscillation, a

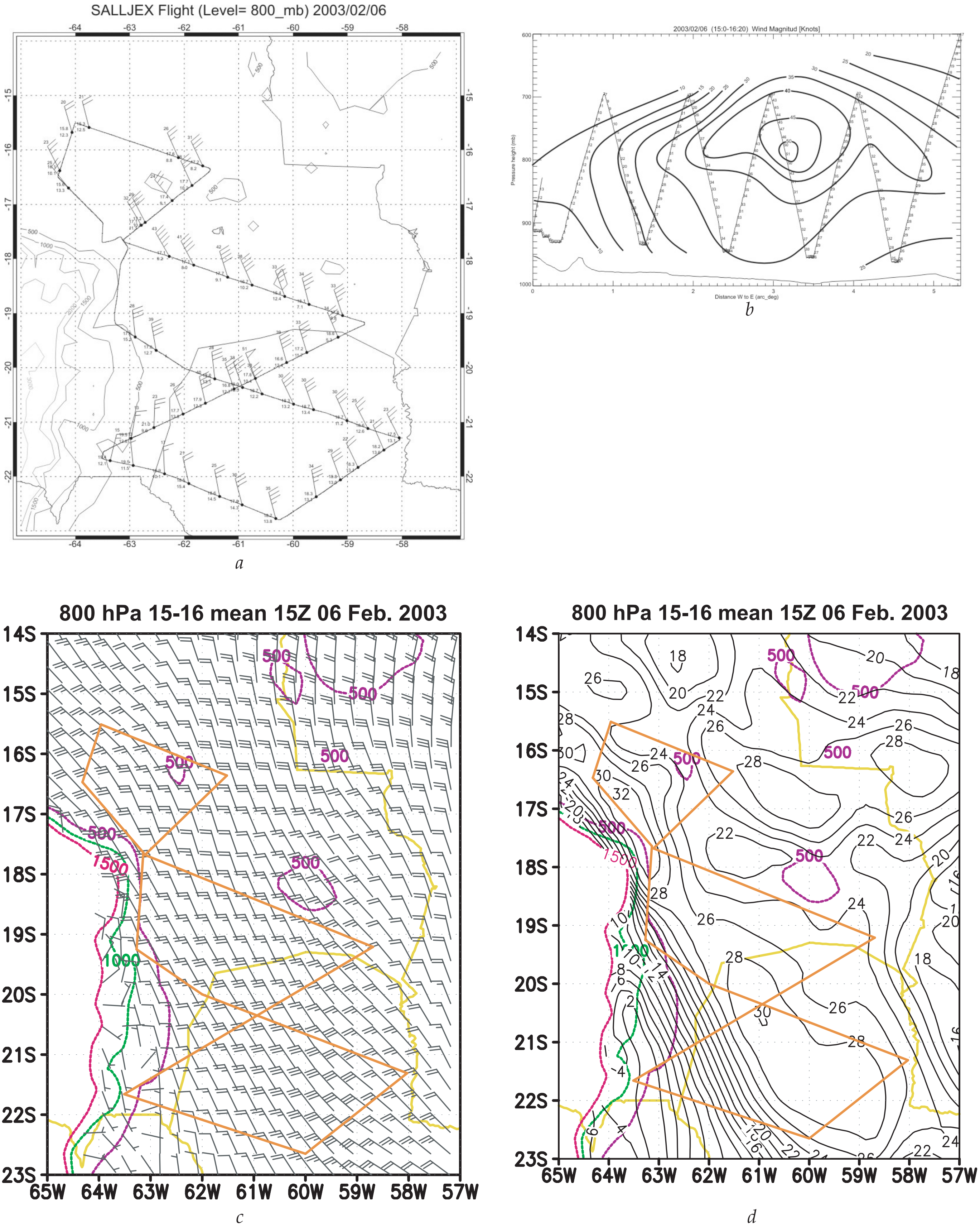

Figure 1: Observational and model simulation wind field on February 06, 2003, a) NOAA WP-3D flight trajectory and wind field (one full wind barb=10 kt) plotted at 800 hPa, b) isotach analysis (kt) in vertical cross section along NE-SW transect (that goes from 19.2S, 58.7W to 21.5S, 63.5W) and aircraft ascents and descents in the 1500 to 1620 UTC time interval, c) and d) RAMS (1500-1600 mean) wind field and isotach analysis (kt) respectively, at 800 hPa.

subsynoptic pressure gradient related to mountain-valley differential diurnal heating/cooling and the interaction of a dominant meridional northerly component with the subsynoptic circulation. Figure 3 (page 16) shows an example of this behavior at Asunción at 1000 m asl. Diurnal rotation is weaker in the northern part of the network increasing toward the south where synoptic variability is stronger. This evidence is in agreement with the behavior described by Saulo et al. (2000).

The SALLJEX days have been divided into three different samples using the NCEP operational analyses: days without evidence of SALLJ (NSALLJ), days characterized by SALLJ occurrence penetrating to subtropical latitudes (Chaco-SALLJ, denoted CJE) and non-Chaco SALLJ days (NCJE). Figure 4 (page 16) shows the wind data composites at 1000 asl, to look for signals in the diurnal cycle. An analysis of this figure and of vertical profiles of zonal and meridional wind components also composited for the three samples (for more levels, stations and hours refer to http://www.joss.ucar.edu/salljex/workshop/presentations/SALLJ_diurnalcycle.pdf) provides the following characteristics. At northern sites within the network the jet profile signal is very weak but it becomes stronger during both CJEs and NCJEs. At Santa Cruz, Bolivia, the wind speed vertical profile shows a strong (~15 m/s) and high maximum present at all the available hours (except 21 UTC) during NCJEs. This signal is still stronger during CJEs. The mean summer wind profile shows no signal at 12 UTC and during NSALLJ the maximum is much shallower. Over Paraguay the strongest jets (>20 m/s) are detected (a few observations earlier) from 06 to 12 UTC and the maximum amplitude in diurnal oscillation occurs during CJEs. Near the mountains over Argentina another shallow LLJ is present during NSALLJ cases while eastward (at Resistencia) a jet is evident only during CJEs. More to the south the SALLJ'signal weakens determining its southern limit.

The mean seasonal wind vector gyre typically behaves as follows. During night time the wind accelerates and turns anticlockwise (mostly from 03 to 12 UTC) consistent with an enhanced rate of rotation as the inertial oscillation is in the same direction of the two other components. After sunrise the wind direction stays almost uniform through the morning (up to 15 UTC). During the afternoon the wind slows down and the sense of rotation of the wind anomaly with respect to the daily mean wind vector is more variable and also more uncertain because of the reduced number of observations. At the sites near the mountains this turning is consistent with a "valley breeze" component toward the west. Before and after sunset (mostly before 03 UTC) the rate of rotation is reduced by the large-scale (dominated by a northerly flow) and subsynoptic (mountain breeze) components that oppose the inertial oscillation.

The presence of a meridional variability in the time of wind speed maximum is not clear from this preliminary analysis of available observations in SALLJEX. Despite the improvement in temporal resolution, and the effort made to document the nocturnal part of the wind cycle, the limitation in number of observations makes it still difficult to clearly define this and to determine if the maximum occurs before or after 06 UTC.

Acknowledgments

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References:

Marengo, J, W. Soares, C. Saulo, M. Nicolini 2004: Climatology of the LLJ east of the Andes as derived from the NCEP reanalyses. Accepted, Journal of Climate.

Nicolini, M., A. C. Saulo, J. C. Torres, and P. Salio, 2002: Enhanced precipitation over southeastern South America related to strong low-level jet events during austral warm season. Meteorologica, Special Issue for the South American Monsoon System, 27, 59-69.

Salio P., M. Nicolini and A.C. Saulo, 2002: Chaco Low-level jet events characterization during the austral summer season. J. Geo. Res., 107,

Saulo, A. C., M. Nicolini and S. C. Chou, 2000: Model characterization of the South American low-level flow during 1997-1998 spring-summer season. Climate Dynamics, 16, 867-881.

Description of the Thermal Low Characteristics using SALLJEX Special Observations

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Introduction

A low pressure system is commonly observed over Northwestern Argentina near the Andean slopes, with a center located approximately at 67ºW: 30ºS. This system is locally known as the Northwestern Argentinean Low (NAL) but usually referred to as the Chaco low, mainly because it is located at the southern portion of the Chaco low itself, resembling an appendix of this thermal system.

Previous studies characterized the NAL as a thermal-orographic system, being much more frequent during summer than in winter (Lichtenstein, 1980). Contrasting with the Chaco low, the NAL exhibits an intermittent behavior, with a mean duration typical of a midlatitude synoptic wave. Through modeling studies, Seluchi et al. (2003) showed that the summer NAL has a significant diurnal cycle and its existence is mostly explained by the sustained surface warming that results from the previous day's circulation, characterized by clear skies that favour the positive radiative surface balance over the region.

Since no upper air-data are available over the region of the NAL, the Seluchi et al (2003) work does not have an observational basis. On the other hand, several studies related to the South American Low level Jet (SALLJ), identified the relationship between the deepening of this low pressure system and the intensification of the northerly low level jet. For this reason, special attention was given to this thermal low during SALLJEX, with a NOAA-P3 flight mission (February 1st, 2003) dedicated to the observation of this feature. This work compiles all the data provided through the enhanced upper air observations and the NOAA-P3 profiles, in order to describe the three dimensional structure of the NAL episode that started by January 29, 2003 and ended by February 4, 2003.

Mean circulation and significant phenomena during this NAL event

As mentioned earlier, the NAL events last around a week, so this case is probably representative of the mean behavior. During its development stages, a strong heat wave episode affected Central Argentina, where many stations reported record maximum surface temperatures on January 30 (e.g. Mendoza -32º 53' S; 68º 49' W- reached 44.4ºC). The system reached its minimum surface pressure between February 1st and February 2nd. In the following days, mesoscale convective systems were reported at the exit region of the low level jet. By February 4th the system entered its decay phase.

In agreement with the Seluchi et al. (2003) results, the evolution of this NAL is mostly controlled by processes in the 900/500 layer, as indicated by the time evolution of the area average geopotential heights within the NAL region (Fig. 1).

Cerne et al. (work in progress), have analyzed the circulation during the 3 pentads previous to the one associated to this NAL event, and distinguished a dominant subsidence motion over the region south of 20ºS which also favoured the sustained warming that leads to the formation of the NAL. The signature of this subsidence is seen in the special radiosonde observation at Santiago del Estero for 1 February 2003, (Fig 2 page 10) which is very close to the low pressure center, and is also detected in several soundings from January 25 onwards (not shown).

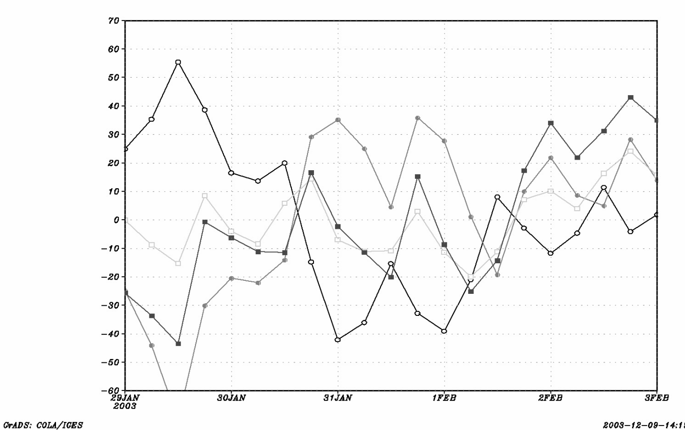

Figure 1: Area average temporal evolution (over the NAL region) of the 500–900-hPa thickness (full circles), and the geopotential heights at the 500-hPa (full squares), the 300-hPa (open squares), and the 900-hPa (open circles) levels. Magnitudes (in gpm) are relative to a reference value for each level/variable.

Description of the February 1st NAL as derived from special observations: preliminary results.

Fig. 2 shows a strong surface warming (reaching above 40ºC at 3 PM local time) and a very deep mixed layer, reaching up to 700 hPa, where the subsidence inversion avoids further penetration of the mixing. Northerly winds dominate the circulation at Santiago del Estero on February 1 st. Fig. 3 shows the NOAA P3 flight tracks, and Figs. 4a, and b (page 17) show soundings obtained

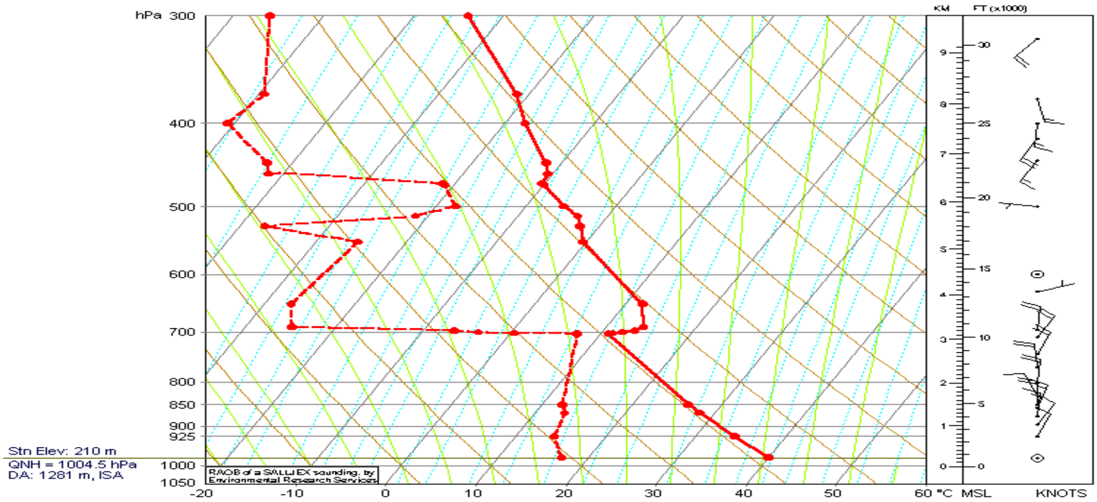

Figure 2: Skew-T diagram at Santiago del Estero, Argentina (27º 48'S; 64º 16'W) corresponding to February 1st, 18:00 UTC

from the aircraft while flying legs 2, 3, 4 and 5 (see captions for details). The vertical stratification indicates that this system is surrounded by very deep mixing layers that reach up to 670 hPa. over the warmer surfaces. The depth of the mixing layers shows an increase towards the low level pressure center. This rather unique stratification of the system has been identified for the first time and is in qualitative agreement with what was expected from previous studies, but more abrupt. Accordingly, with the strong mixing, very weak circulation is detected near the core, but over leg 2 and even at leg 3 northerlies were observed, with maximum wind intensities occurring at higher altitudes following the aircraft track. Another interesting finding is that from the circulation measured with the P3, it could be confirmed that the thermal low exhibits a closed circulation, even at 700 hPa. (Fig 5 page 17).

It is expected that after the quality controlled version of the data becomes available, a more detailed comparison between observations and Global Data Assimilation System (GDAS) analysis as well as model outputs will be carried out. The upcoming research will also contribute to one of SALLJEX objectives, that is to assess how well represented is this system by standard data sets, commonly used for the characterization of synoptic features in the region.

Acknowledgments

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References

Lichtenstein, E. R., 1980: La Depresión del Noroeste Argentino (The Northwestern Argentina Low). Ph.D. dissertation, University of Buenos Aires, 223 pp.

Seluchi, M., C. Saulo, M. Nicolini and P. Satyamuyty, 2003: The Northwestern Argentinean Low: a study of two typical

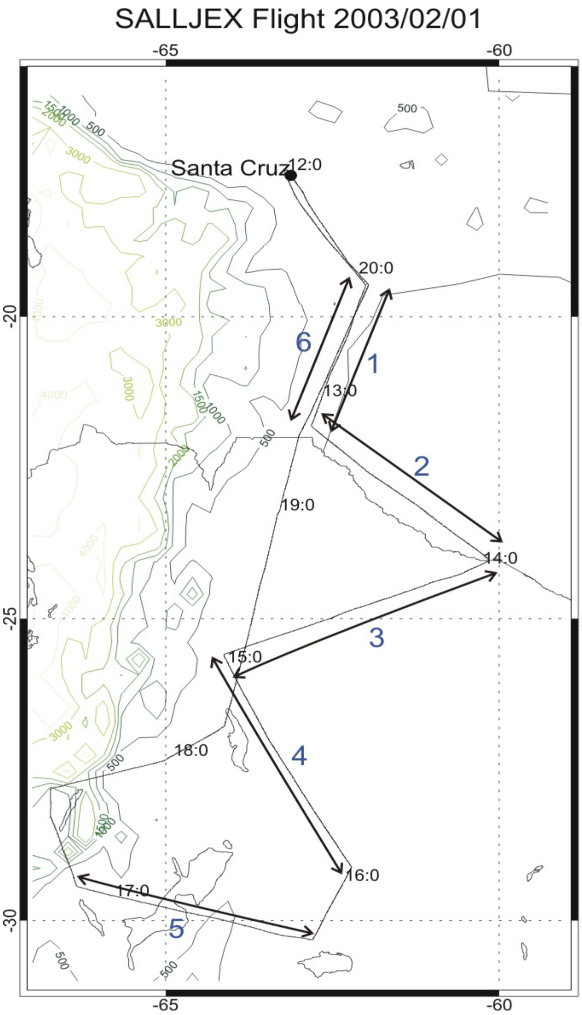

Figure 3: Map of the NOAA-P3 flight track including the trajectory of the aircraft indicated by a continuous line. The small black numbers along the track indicate the time (hh:m) giving an idea of the flight direction. Each leg (referred in the text) is indicated by a large black number.

Variability of Moisture and Convection over the Central Andes during SALLJEX

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Introduction

The South American Altiplano is a high altitude plateau situated between two mountain chains in the central Andes between 15°S and 22°S . A distinctive climatic feature of the region is the occurrence of vigorous afternoon convection between December and March, that contributes to more than 90% of the annual precipitation (Aceituno, 1997). During this time the Altiplano generally experiences alternating dry and wet conditions, each lasting about a week (eg., Lenters and Cook 1999), whose occurrence is thought to be largely controlled by the availability of surface moisture, which exhibits a matching variability (Garreaud 2000). The intra seasonal moisture variation is coherent across the whole Altiplano and in turn related to synoptic scale variability of the mid and upper level flow (Garreaud 1999). Moist periods occur when easterly winds favor the transport of humid air west of the mountain range to the Altiplano. The numerical studies of Garreaud (1999) indicated that the importance of the large scale flow was to intensify afternoon moisture transport on the eastern slopes of the Andes, allowing moisture from the Bolivian low-lands to reach the Altiplano and initiate afternoon convection. The mid-level flow itself was considered to dry to account for the levels of moisture observed over the Altiplano during wet events.

In this communication we present a preliminary examination of the characteristics of moisture and convective variability over the central Andes during the austral summer of 2002 – 2003, making use of data collected during SALLJEX. We find that the ideas summarized above are applicable over a large area including the western and southern Altiplano. However a different convection regime appears to operate in the northeastern Altiplano (Lake Titicaca basin and mountains to the north). Here convective activity is both temporally uncorrelated with other parts of the Altiplano and is not related to intra seasonal moisture variability.

Data

In this study we make use of infrared satellite images, surface reports and radiosonde observations, all data being provided by the SALLJEX data management system. The surface and radiosonde stations are shown in figure 1a. All surface stations are regular synoptic stations that transmit surface weather reports over the GTS, except for the Chungara site, which was specially deployed by the University of Chile during the SALLJEX observing period. The three radiosondes were also temporary SALLJEX instruments.

Afternoon (16:39 LST and 19:39 LST) GOES-8 channel 4 infrared imagery, originally at 4 x 4 km resolution, were processed to yield daily gridded fields of equivalent black body temperature (T_{bb}) with 12 km spacing. In this study T_{bb} is used as a simple proxy for convective activity. Low values of T_{bb} (i.e. < 235K) are assumed indicative of high (cold) convective cloudiness, while high T_{bb} signifies low clouds or cloud free areas. The GOES-8 dataset spans the period 11 November 2002 until 15 February 2003, and yielded a total of 92 complete afternoon images (along with 4 days of missing data).

Results

Figure 1b shows a spatial map of the frequency of afternoon convection during the SALLJEX season based on the T_{bb} imagery. Convective cloudiness occurs mainly within an elongated band extending northwest to southeast, covering all of the northern Altiplano and reaching the eastern slopes of the southern Altiplano. Convection is most frequent in the mountainous regions of the north, and all but absent in the southwest. A local minimum can also be observed over the Lake Titicaca basin, presumably a result of reduced daytime heating over the surface of the lake. The spatial distribution of convective activity shown here shows a strong resemblance to those presented in the coarser, but longer term, studies of Lenters (1995) and Garreaud and Wallace (1997).

The specific humidity (q_{V}) is plotted in figure 2 for the station at Chungara, situated on the western edge of the central Altiplano (figure 1a). As noted in past studies, q_V alternates between distinct dry and moist periods, during which it has values of roughly 2 g kg^{-1} and 6 g kg^{-1} respectively. Examination of upper level wind data from NCEP-NCAR Reanalysis (Kalnay et al., 1996) clearly indicates that moist periods occur when there is a mid-level flow (i.e., 500 hPa) directed towards the mountain range from the east (not shown). Also shown in figure 2 are radiosonde q_V measurements at the same height as Chungara (4200 m) from three selected SALLJEX radiosonde stations (figure 1a). During moist periods, there is little difference between the moisture content at the surface of the (western) Altiplano and that at similar altitudes at locations over the moisture source region. Thus direct *advection* of mid-level air masses across the Altiplano during periods of synoptic scale easterly flow appears sufficient to explain the observed intra seasonal moisture variability.

Figure 2 also shows the T_{bb} evaluated at the grid point nearest to Chungara. There is a clear correspondence

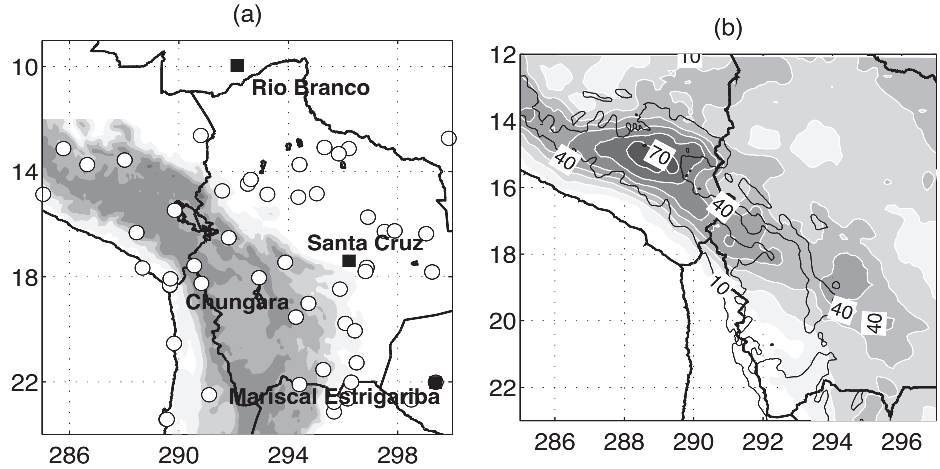

Figure 1: a) Topography of the central Andes. Shaded contours show the topography of the Central Andes at 1000 m intervals from 1000 m (lightest) to 4000 m (darkest). Open circles show the locations of surface synoptic stations in the area. Squares show the locations of SALLJEX radiosonde sites. b) Contours show the frequency of convection over the central Andes, measured as the percentage of days with Tbb < 235 K (a standard threshold for convective cloudiness). Thick and thin lines denote political boundaries and the 4000 m topographic contour respectively

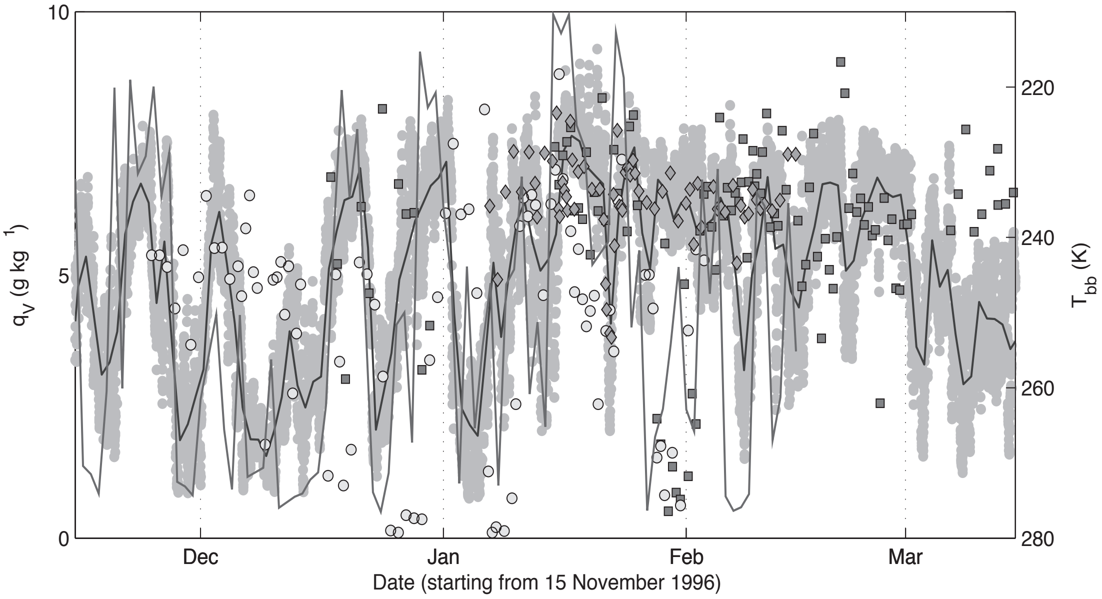

Figure 2: a) Specific humidity qV at Chungara: gray dots show all values and the light grey line shows the daily mean. The dark grey line is Tbb at the same location (data until Feb 15 only). Also shown are values of qV at 3 the three radiosonde sites shown in figure 1a: Mariscal Estigarribia (circles), Santa Cruz (squares) and Rio Branco (diamonds).

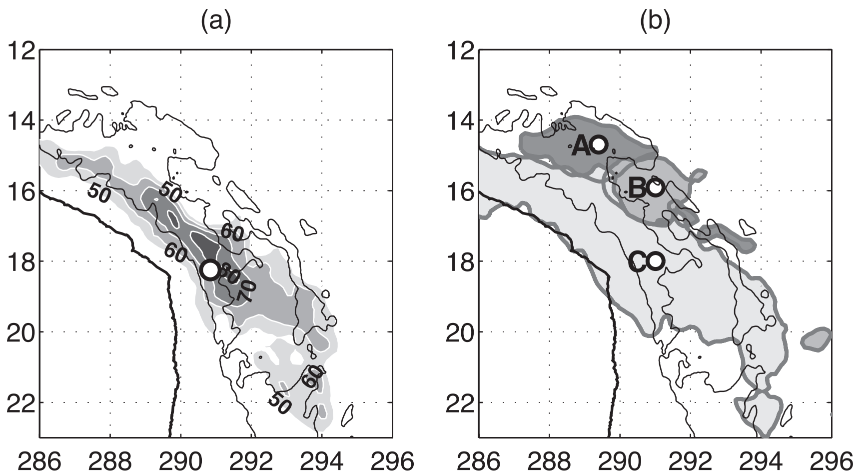

Figure 3: a) Correlation coefficient (%) of specific humidity at Chungara with -Tbb. Only significant coefficients (> 50%) are plotted. b) Regions in which Tbb is significantly (r > 0.5) correlated with Tbb at points A (dark, 14.7°S, 70.6°E), B (medium, 15.9°S, 69°E) and C (light, 18°S, 69°E). In both plots thin lines indicate the 4000 m topography contour

between the two variables,which exhibit a linear correlation coefficient (r) of 0.78. To examine the spatial extent of this relationship, the correlation coefficient of -T_{bb} and q_V at Chungara was calculated at every grid point in the T_{bb} data[1] . The resulting map, plotted in figure 3a, shows a large region of significant correlation extending along the western mountain ranges and occupying most of the Southern Altiplano. This demonstrates that afternoon convection may be quantitatively linked to synoptically driven moisture variability over this part of the Altiplano. However it is noteworthy that this region does not include the northeastern Altiplano, i.e., the geographical region which includes the lake Titicaca basin and mountains to the north. The same correlation analyses were performed using data from other surface stations in the region (all stations shown in figure 1a). It was found that at *no* location was there a significant correlation of q_V with -T_{bb} in the northeastern Altiplano. While our analysis is limited by the rather sparse distribution of surface stations, the result strongly suggests that water vapor is not a key factor guiding the day to day variation of convection in this area.

Figure 3b provides further evidence of the existence of a different convection regime in the northeastern Altiplano. The plot shows the regions within which T_{bb} is significantly correlated ($r > 0.5$) with the T_{bb} at three specific locations (labeled A, B and C). Overall these regions encompass almost the entire Altiplano, and exhibit very little over lap, indicating that the Altiplano may be divided into three regions, each possessing distinct (uncorrelated) modes of convective variability. This convenient division of convective activity over the Altiplano is in part a result of a rather arbitrary choice of locations for points A, B and C. However the same centers of activity were also revealed, somewhat more rigorously, in a principal component analysis of the T_{bb} data (not included here for the sake of brevity).

The largest region, C is readily interpreted from the previous results as that in which the variability of convective cloudiness is largely governed by the availability of moisture. In regions A and B, which occupy the north eastern Altiplano, convection is both more localized (owing to the smaller size of the regions) and apparently unrelated to intra seasonal moisture fluctuations. The distinct climate observed in region B should not come as a surprise, as it encompasses the lake Titicaca basin and hence the surface heating required for afternoon convection is largely absent. The reasons for the localization of convection in the mountains to the north of Lake Titicaca are not yet clearly understood. Convective cloudiness occurs more frequently and exhibits a higher day to day variability here than in other parts of the Altiplano. A more detailed study of convection in this area is a possible avenue for future investigation.

An important factor limiting the applicability of these results is the short time period that has been studied. Although the 92 afternoons used was enough to adequately infer the statistical significance of the relationships tested, it is unclear whether the same relationships with be observed if evaluated over longer time periods (i.e., over multiple seasons). For the present, our results may only be considered to be *indicative* of possible climatological features of the central Andes. A definitive confirmation will require a longer term study.

[1]*The quantity -Tbb is used so that high values of qv are positively correlated with low Tbb. All correlation coefficients, r, quoted in this communication have been calculated from 3-point moving average versions of the original daily time series. In calculating the statistical significance of r, an effective number of independent daily samples of 18 (as opposed to the original 92) was assumed, based on the auto-regressive characteristics of the smoothed time series. In general, correlation coefficients > 0.5 are significant at the 96% confidence level*

References

Aceituno, P., 1997: Climate elements of the South American Altiplano. Rev. Geofis., 44, 37-55

Garreaud, R. D., and J. M. Wallace, 1997: The diurnal march of convective cloudiness over the Americas. Mon. Wea. Rev., 127, 901 – 921

Garreaud, R. D., 1999: Multi scale analysis of the summertime precipitation over the Central Andes. Mon. Wea. Rev., 127, 901 – 921.

Garreaud, R. D., 2000: Intra seasonal variability of moisture and rainfall over the South American Altiplano. Mon. Wea. Rev., 128, 3337 – 3345.

Kalnay, E., and Coauthors, 1996: The NCEP-NCAR 40-Year Re-analysis Project. Bull. Amer. Meteor. Soc., 77, 437-472

Lenters, J. D., and K. H. Cook, 1995: Simulation and diagnosis of the regional summertime precipitation climatology of South America. J. Climate., 8, 2298 - 3005

Lenters, J. D., and K. H. Cook, 1999: Summertime precipitation variability over South America: Role of the large-scale circulation. Mon. Wea. Rev., 125, 279-291

Mesoscale Convective Systems activity during SALLJEX and the relationship with SALLJ

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1. Data and Methodology

IR brightness temperature data every half an hour available with 4km horizontal resolution at http://lake.nascom.nasa.gov/ are used to determine the position and stage of every mesoscale convective system (MCS) during the SALLJEX period. More description about the dataset can be found in Janowiak et. al (2001).

MCS is defined following similar criteria to those of Maddox (1980) and Torres (2003). The MCS initiation stage occurs when the -55 C isotherm area is greater than 50,000 km^2, the mature stage is the moment when the -55 C isotherm area is at a maximum, and the dissipation stage is the moment when the -55 C isotherm area is less than 50,000 km^2. Systems that are involved in complex merger or split with another MCS, having a double growth/decay cycle are not included in the sample.

The FORTRACC program (Machado et al, 1998) determines the position of any cluster that verifies against the MCS criterion. This program follows the different systems through their life cycle assuming an areal overlap between an image and the previous one higher than 15%. We present only the results over the Southeastern South America (SESA, 20-40 S and 45-65 W) in this study, to better analyze the relationship between the low level jet and the presence of MCSs.

Operational model analysis GDAS and SALLJEX pibal and radiosonde wind data are used in this study to analyze the synoptic and meso-alpha environment structure.

2. Results

SALLJEX had a total of 112 MCS cases over SESA. Only 7% of these cases have their maximum extent over the Atlantic Ocean. 42% of the cases have their maximum extent located in the subregion between 20-30 S and 45-55 W. There are thus a high number of cases over the South American Convergence Zone (SACZ) region. The average MCS lifetime is 11 hours, but the modal value is 6 hours (figure not shown). The life cycle is similar to that shown by Velasco and Fritch (1987). 73% of the cases have lifetimes between 3 and 13.5 hours, the rest have a longer life over a wide range of hours.

The mature stage of the systems peaks at two principal times, one very well defined maximum in the afternoon and the other during night and early morning (figure 1). The nighttime maximum mostly occurs westward of 55 W, while the afternoon maximum is over the SACZ area. These results are consistent with previous findings by Nesbitt and Zipser (2003) using TRMM data, who show that rainfall from MCSs peaks at night. Nicolini et al (2004) in this issue confirm the nocturnal – early morning structure of the low level jet using SALLJEX data. Chaco jet events (CJEs, defined as SALLJ cases extending southward into Argentina; see Nicolini and Saulo, 2000) produce an efficient moisture transport into central Argentina and Uruguay from tropical latitudes.

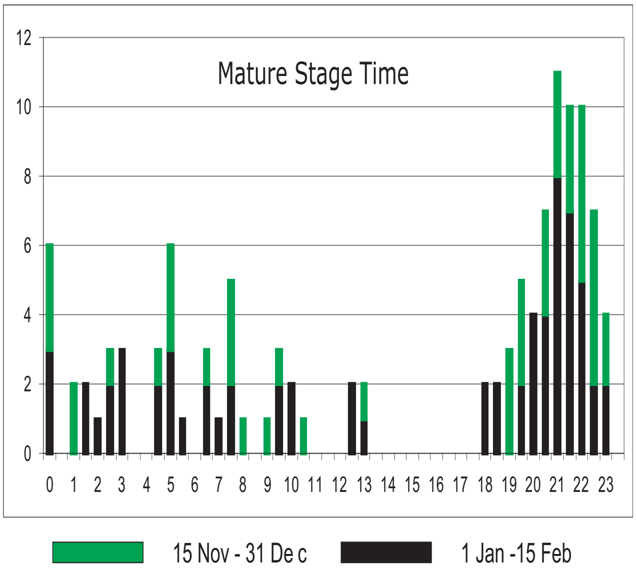


Figure 1: Mature stage time occurrence frequency during SALLJEX. Bars in green represent the period November 15 to December 31, in black January 1 to February 15.

The nighttime maximum of MCSs is found mostly in the same region that the SALLJ is found. Since the greatest wind speed in the SALLJ also occurs at night, it is natural to ask whether these facts are connected. In order to address this we select a particular MCS subset: those cases that have a nocturnal – early morning maximum (0130UTC- 1030UTC) and are located between 20-30 S and 55-64 W. Figure 2 (page 17) shows the position of the mature stage of the 13 cases that compose the sample, at 3 different night hours.

The structure of the wind at 06 UTC at Mariscal Estigarribia (Fig. 3, page 18, right side) that is located on the northern side of the systems shows the presence of a weak low level jet on the day of occurrence of the systems. On other hand, the previous day shows a stronger and well defined low level jet (Fig. 3 left side).

Low-level wind analysis on the day before the MCSs,

continued on page 19

From Vera: Introduction to the South American Low Level Jet Expeirment (SALLJEX) (page 3)

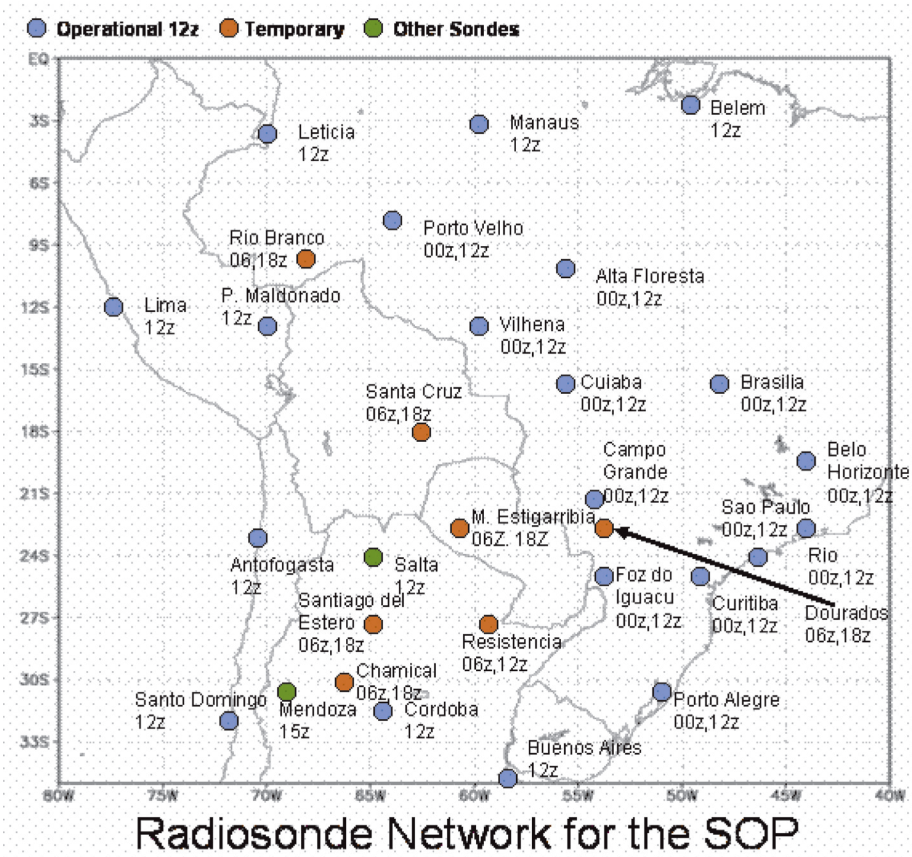
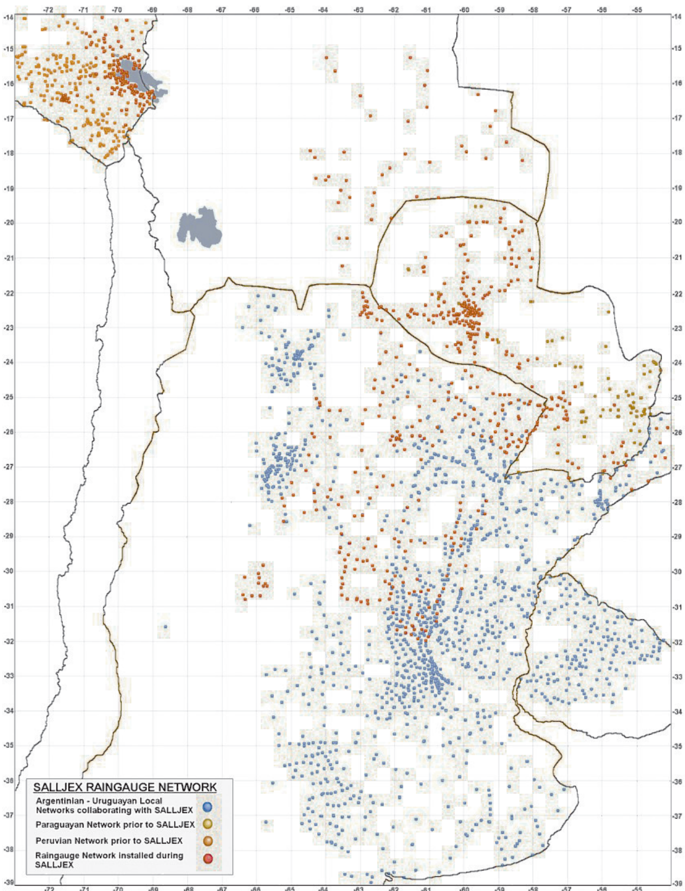


Figure 1 : SALLJEX radiosonde network during the SOP. (blue) operational sites, (red) SALLJEX sites, (green) others.

Figure 2: SALLJEX raingauge network



From Nicolini et al: South American Low Level Jet Diurnal cycle and Three Dimensional Structure (page 6)

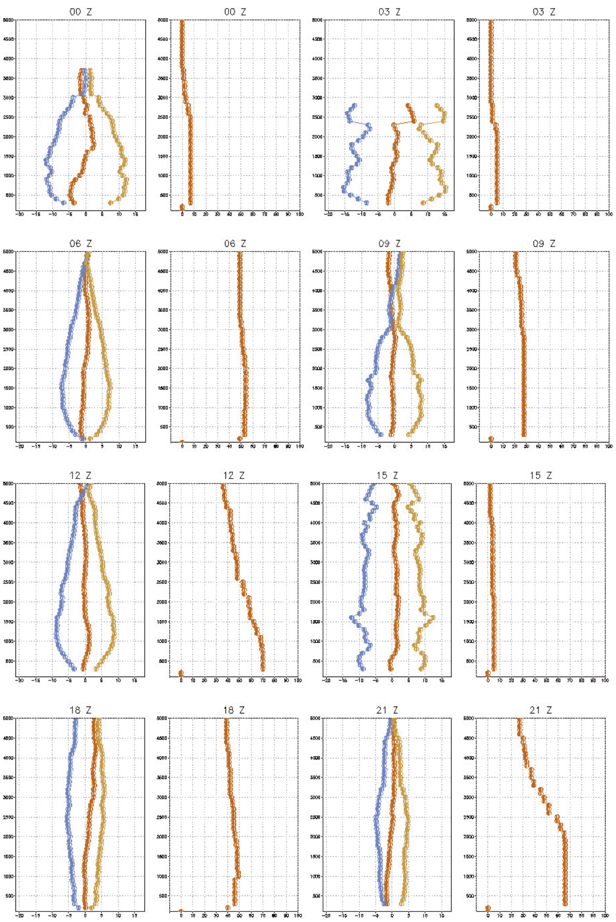


Figure 2: Mean summer vertical wind speed (yellow), zonal (red) and meridional (blue) wind components (left in m/s) and number of observations as function of height (right) at Mariscal Estigarribia. Each panel corresponds to a different time (as indicated).

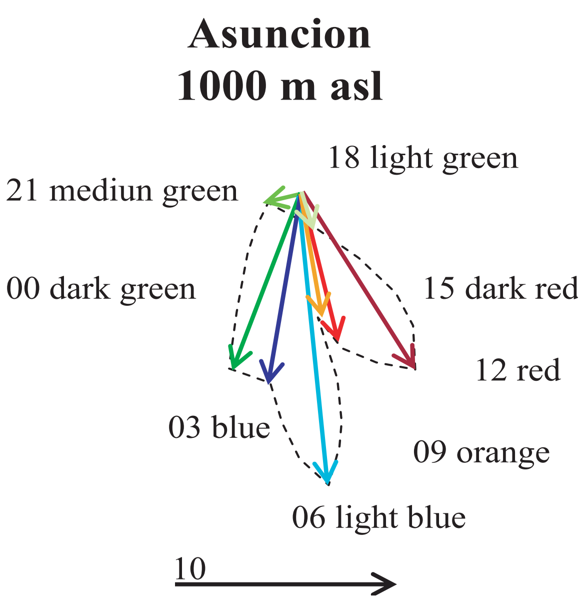


Figure 3: Mean summer diurnal wind gyre (m/s) at Asunción (Paraguay) at 1000 m asl. UTC times.

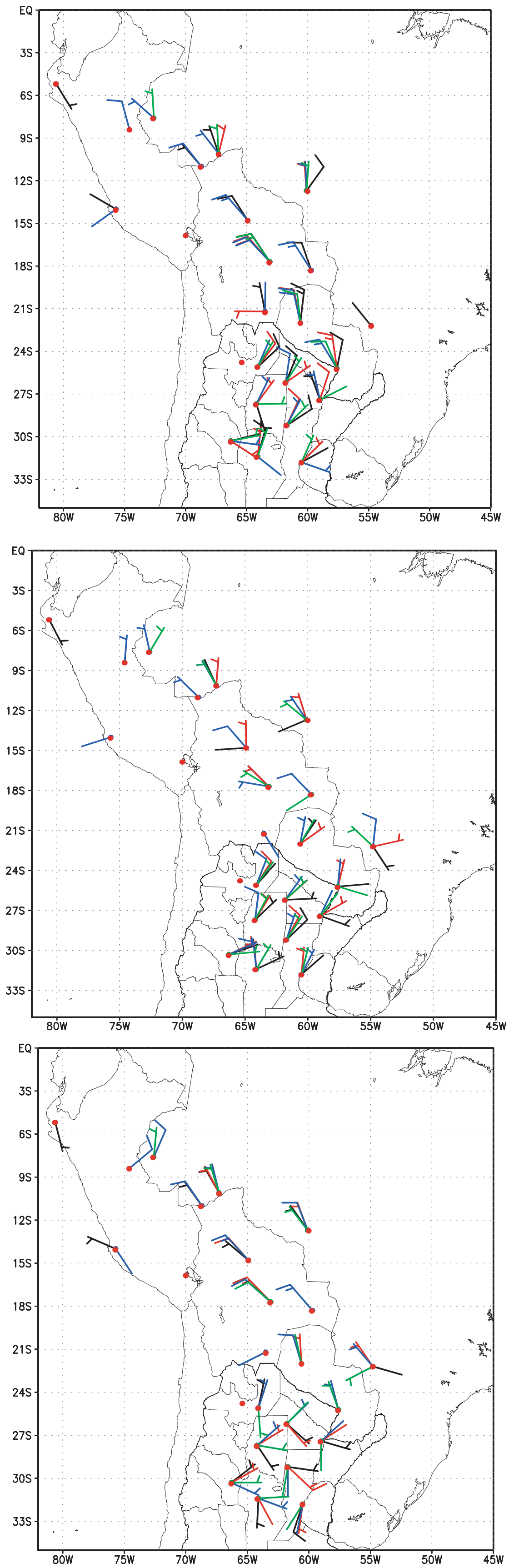


Figure 4: Mean CJE, NSALLJ and NCJE (respectively from top to bottom) observed wind fields at 1000 m asl, including 00 (black), 06 (red), 12(blue) and 18 (green) UTC wind barbs (full barb=10 m/s) at each station.

From Saulo et al: Description of the Thermal Low characteristics using SALLJEX Special Observations (page 9)

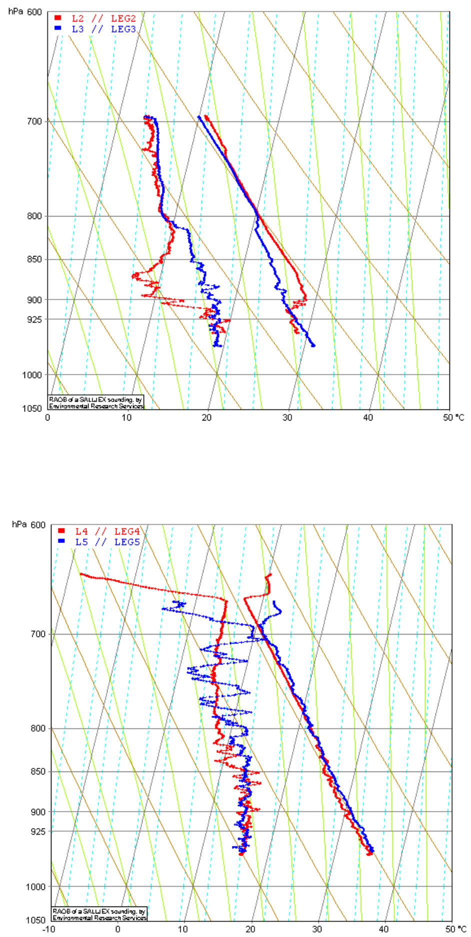


Figure 4: a) Skew-T diagram derived from NOAA-P3 soundings at selected points over legs 2 (red) and 3 (blue); b) same as Fig. 4a but for legs 4 (red) and 5 (blue).

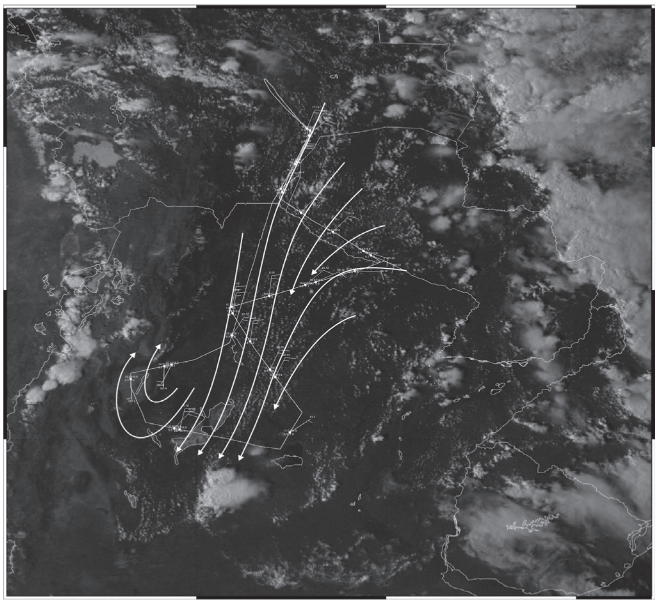


Figure 5: 700 hPa streamlines derived from NOAA-P3 soundings plotted over the visible GOES image corresponding to 19:45 UTC

From Zipser: Mesocscale Convective systems Activity during SALLJEX and the Relationship with SALJJ Events (page 14)

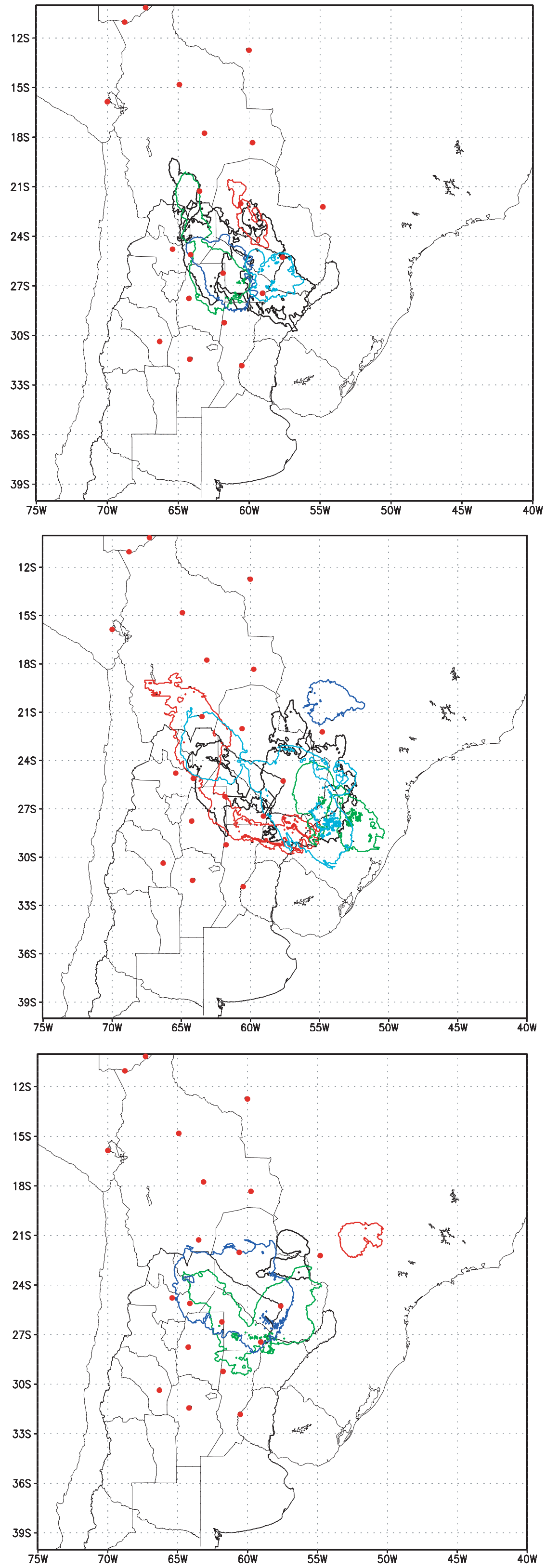


Figure 2: -55° Isotherm for every MCS that has its mature stage between 1:30UTC to 4:30UTC top panel, 4:30 to 7:30 central panel and 7:30 to 10:30 bottom panel. SALLJEX stations are plotted with red dots.

From Zipser: Mesocscale Convective systems Activity during SALLJEX and the Relationship with SALJJ Events (page 14)

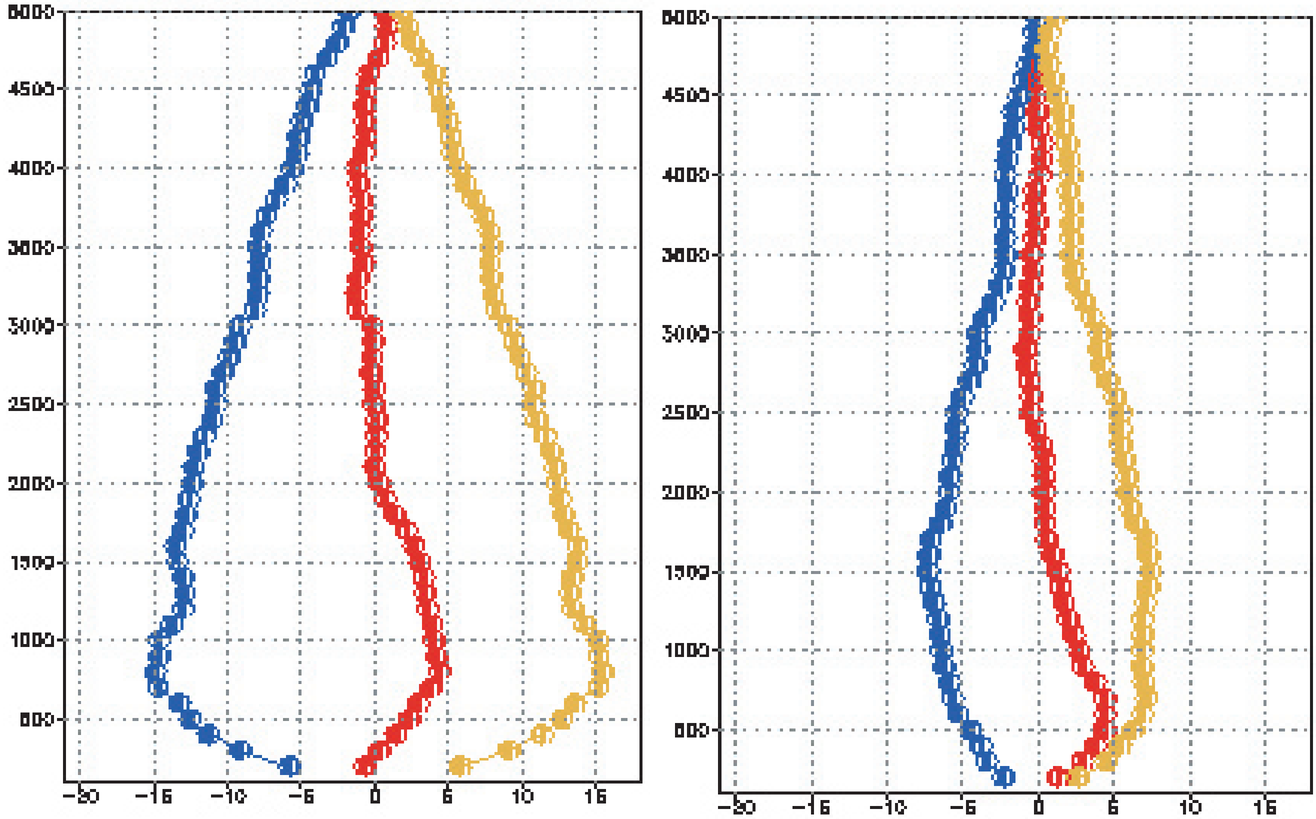


Figure 3: Vertical wind profile at Mariscal Estigarribia (Paraguay) at 06 UTC for MCS composition, meridional component in blue, zonal component in red and wind speed in orange. The magnitude of the variables are in m s-1. The day of the occurrence of the MCS is on the right panel, and the day before is on the left panel.

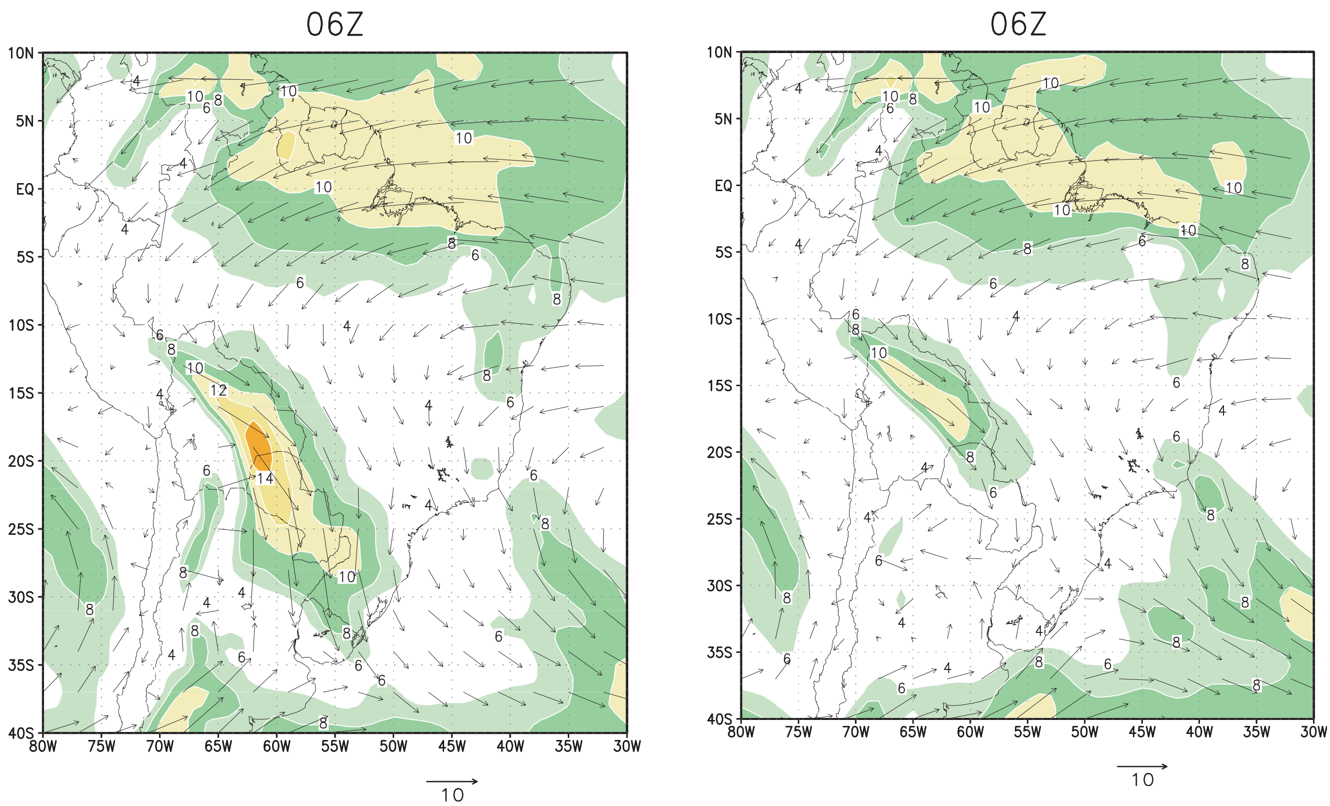


Figure 4: GDAS wind vector at 850 hPa at 06 UTC for MCS composition. Wind speed is shaded every 4 ms^{-1} from 4 ms^{-1}. The day of the occurrence of the MCS is on the right panel, and the day before is on the left panel.

continued from page 14

using GDAS and SALLJEX data verify the criteria for a CJE on 9 of the 13 days while the rest of them are classified as SALLJ-no CJE. The horizontal wind composite at 850 hPa for the day before the MCS (Fig. 4, page 18) shows the presence of a strong CJE on these days at 06 UTC. The CJE thermodynamic and wind field structure enhances the convective instability by transporting heat and moisture over the whole region. All individual cases described within this composite have an MCS or at least disorganized convection over the exit region of the low level jet southward of the selected subdomain.

As an upper-level trough moves to the north (not shown), the convection starts to develop on the MCS day in the selected region located over northeastern Argentina and Paraguay, and the low level jet in that area attains its maximum at the same time as the MCS's mature stage, in agreement with Torres (2003).

A particularly interesting MCS occurred during a SALLJ day (22 January) in the experiment period. The observations of this case were almost ideally located in space and time to describe the explosively growing and mature stage of this large and intense MCS. To do this, SALLJEX was blessed with combination of a good forecast, good organization and planning and some luck.

The early stages were dominated by supercells, well documented by the Doppler radar data on the NOAA-WP3 (Fig. 5). The cells reached at least 19 km ASL, had vertical velocities well in excess of 30 ms-1, and were rotating. A few hours later, the scattered supercells evolved into a bow-echo shaped squall line with mostly trailing anvil. A GOES satellite IR movie loop demonstrated the rapid growth of the cold cloud mass and propagation of the system, originally centered near 25 S 60 W, toward the north into Paraguay as it spread and then weakened.

The radar data suggest that during the early and mature stages, the precipitation efficiency may have been rather low, but that remains to be investigated further.

Additional research is in progress analyzing the relationship between SALLJ and MCSs located in other sub-domains, and with non-nocturnal mature stage.

Acknowlegments

This research is supported by UBA grant TX30 (Argentina), ANCyT grant PICT Nº 07 – 06671 (Argentina), PACS-SONET network, FAPESP grant 01/13816-1 (Brazil), NSF ATM0106776, NASA NAG5-9717 NOAA PID-2207021 and NA03OAR4310096. Thanks to Daniel Vila for his valuable assistance with the FORTRACC program.

References

Janowiak J., R. Joyce, and Y. Yarosh, 2001: A real time global half hourly pixel resolution infrared dataset and its applications. Bull. Amer. Meteor. Soc., 82, N 2.

Machado L.A.T., W.B. Rossow, R.L. Guedes and A.W. Walker, 1998: Life cycle variations of mesoscale convective systems over the Americas. Mon. Wea. Rev., 126, 1630 – 1654.

Maddox, R.A., 1980: Mesoscale convective complexes. Bull. Amer. Meteor. Soc., 61, 1374-1387.

Nesbitt S. and E. J. Zipser, 2003: The diurnal cycle of rainfall and convective intensity according the three years of TRMM measurements. J. of Clim., 16, 1456 – 1475.

Nicolini M. and A.C. Saulo, 2000: ETA characterization of the 1997-1998 warm season Chaco jet cases. 6th International Conference on Southern Hemisphere Meteorology and Oceanography. 3-7 April, Santiago, Chile, 336 – 337.

Torres J.C., 2003: High precipitationg mesoscale convetive complex on Northern and Central Argentina, in Spanish, Univ. of Buenos Aires, Ph D dissertation (132pp).

Velasco I. y J.M. Fritsch,1987: Mesoscale convective complexes in the Americas. J. Geophys. Res., 92, 9591-9613.

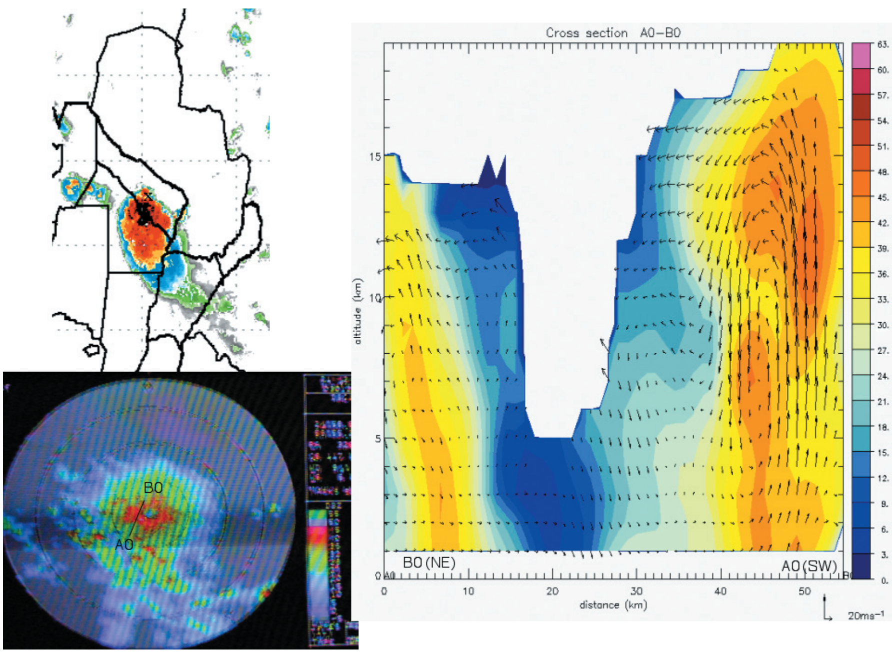


Figure 5: Infrared satellite image at 22 Jan 03, 2130 UTC, with the location of the aircraft at 2145 UTC given by the X on the north edge of the system (upper left). Plan view (belly) radar image (lower left) from the P3 at 2145 showing scattered strong echoes from individual storms (embedded in extensive surface clutter). The cross-section from A0 - B0 from the P3 (tail) Doppler radar (right) goes through one of the rotating storms with updrafts in excess of 30 m/s and 35 dBZ echoes extending above 18 km, or 4 km above the tropopause. The Doppler wind analysis is preliminary.

Modeling Studies Related to SALLJEX

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Introduction

Prediction of weather and short-range climate evolution over South America is characterized by different observational problems compared to those found in North America. One SALLJEX project focus was upon special problems posed by observational gaps in the Southern Hemisphere. In addition to observation issues, the steep Andes orography and the low latitude of most of the continent provide new concerns relative to forecast problems for North America. Remote sensing is particularly important in the South American networks, where the forecast skill now approaches levels found in the Northern Hemisphere. This has been accomplished through better and more efficient use of vast amounts of satellite data, primarily over the oceans. The impact of an enhanced observing network in the SALLJEX area is a major challenge that may lead to improvement of models, data assimilation procedures, and better use of remote sensing products over continents.

There remains a question whether data-deficient regions of the oceans or of the continents most strongly limit the southern observing system. This is being addressed within CPTEC, INPE, and the University of Sao Paulo in Brazil, in the University of Buenos Aires, CIMA, and the Servicio Meteorologico in Argentina, at the University of Chile, and also by investigators in North America using SALLJEX observations to study the value of regional surface-based observations. The field experiment was supported by regional, real-time model simulations provided by researchers within these organizations. Real-time comparison between model results and observations was routinely made at the operations center of SALLJEX in Santa Cruz de la Sierra in Bolivia. Model forecasts were used for guidance in planning special observing and intensive observing periods, and were at times found to be quite accurate for planning purposes, but were less adequate at other times, and the experiment has led to systematic intercomparisons of models designed to prioritize observational and modeling enhancements required for improved numerical guidance.

Dynamical perspectives

Past research by Silva Dias and collaborators has shown that basic features of low-level summer circulations in tropical regions are often well-described by linear models that include the effect of observed heat sources. These and other studies also point out significant discrepancies over South America that cannot be resolved in models lacking the topographic effect. A number of studies confirm that the lower tropospheric flow is most affected by the steep mountains, while the upper level flow is barely influenced.

While most past studies have emphasized topographic modifications of Amazon Basin wind systems and the effect of heating east of the Andes, some investigators emphasize correlation of the East Andes LLJ with El Nino events of the Pacific Ocean, and with the strength of the upper westerlies. Cyclonic circulation surrounds the Andes in the lower-troposphere in both summer and winter, and this supports a poleward east Andes LLJ in both seasons. This contrasts with observations for the Great Plains LLJ of North America, which reverses from winter to summer. Lau and collaborators suggest that the South American monsoon system has more similarities with the South Asian monsoon.

Regional models

The inability of global models to capture important details of regional circulations has prompted many regional model simulations over South America. Only a sample of recent studies focused upon the SALLJEX domain is summarized here. Silva Dias and collaborators have demonstrated that the structure of the simulated LLJ is highly dependent upon horizontal resolution, and suggest that accurate moisture transport along the eastern slopes of the Andes may require grid sizes as small as 20 km. Nicolini and collaborators demonstrate the important role of initial surface conditions for prediction of rainfall associated with Chaco jet events (particular cases of the LLJ characterized by augmented southward penetration of the jet, and associated with enhanced precipitation over the La Plata basin.) The long memory of surface conditions reflects the prominent role of land surface processes in South American rainforests.

Berbery and collaborators have used the Eta model to downscale the lower resolution analyses available over the region and to thereby obtain a higher resolution representation of the low-level flow that allows study of the processes that modulate the diurnal cycle.

A systematic intercomparison of regional models for a particularly active mesoscale convective system (MCS) has been initiated by Saulo and collaborators (http://www.salljex.at.fcen.uba.ar). This intercomparison is coordinated at the University of Buenos Aires, but includes participation by groups based at CPTEC, The University of Sao Paulo, the University of Chile, and the Universities of Maryland and of Utah in North America. The tested models include versions of the Eta, RAMS, MM5 models as well as the global CPTEC model.

A key aspect of the research is to assess the degree of dispersion of forecasts generated with identical initial and lateral boundary conditions, and very similar domain and horizontal resolution. Since a central forecast problem in this part of the world concerns mesoscale convective systems (MCSs) that are not routinely predicted by the operational global models, the research has thus far focused upon one such event that occurred during SALLJEX (Fig 1). There are several hypothesized reasons for the poor model performance for this case, including inadequate boundary data, inadequate initial data, poor model parameterizations, and inherent predictability limits. Here we reproduce some of Saulo and collaborators' findings in regards to initial data quality and verification issues relevant to SALLJEX observations.

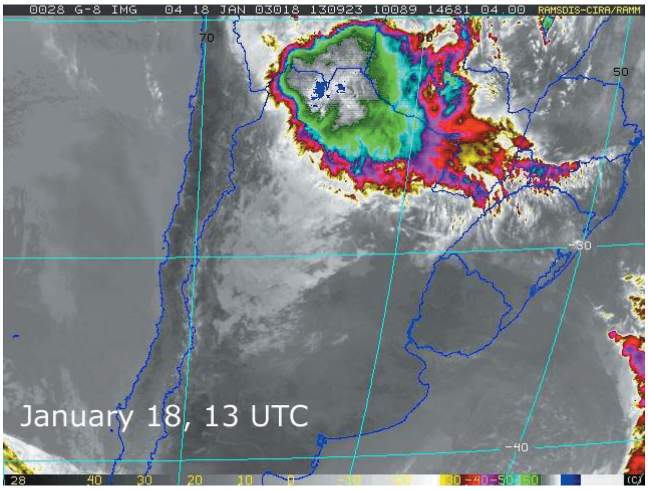


Figure 1 The 17-18 Jan. MCS. This was not well predicted by the mnodels.

At the highest resolution (about 20 km) the models predict large amounts of precipitation (Fig. 2), but most do not adequately reflect the precipitation associated with the MCS of Fig. 1, and individual forecasts display high variability in areas of large precipitation. It is likely that much of the forecast variation reflects variability in model physical parameterizations, since all models use the same initial and lateral boundary conditions. The poorly predicted MCS may also be due to errors of the initial state specification, which did not have the benefit of SALLJEX observations. Figure 3 illustrates differences between selected SALLJEX wind speed profiles and those obtained at the same locations from NCEP/NCAR Reanalysis gridded fields. The observed vertical wind shears are poorly represented by the Reanalysis.

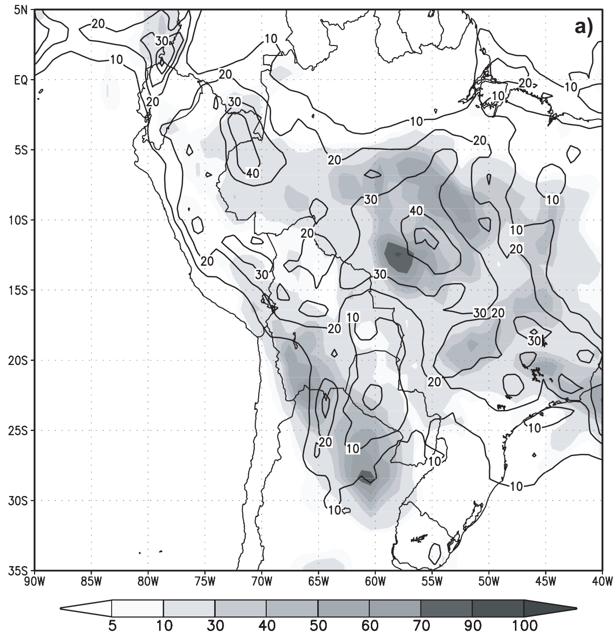


Figure 2a: 48 hs mean total precipitation between 17 January 00 UTC & 19 January 00 UTC and GPCP precipitation estimates (shaded)

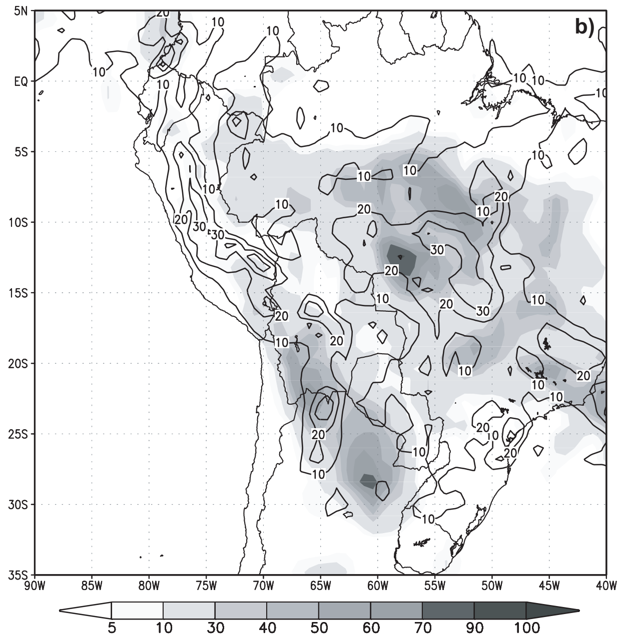
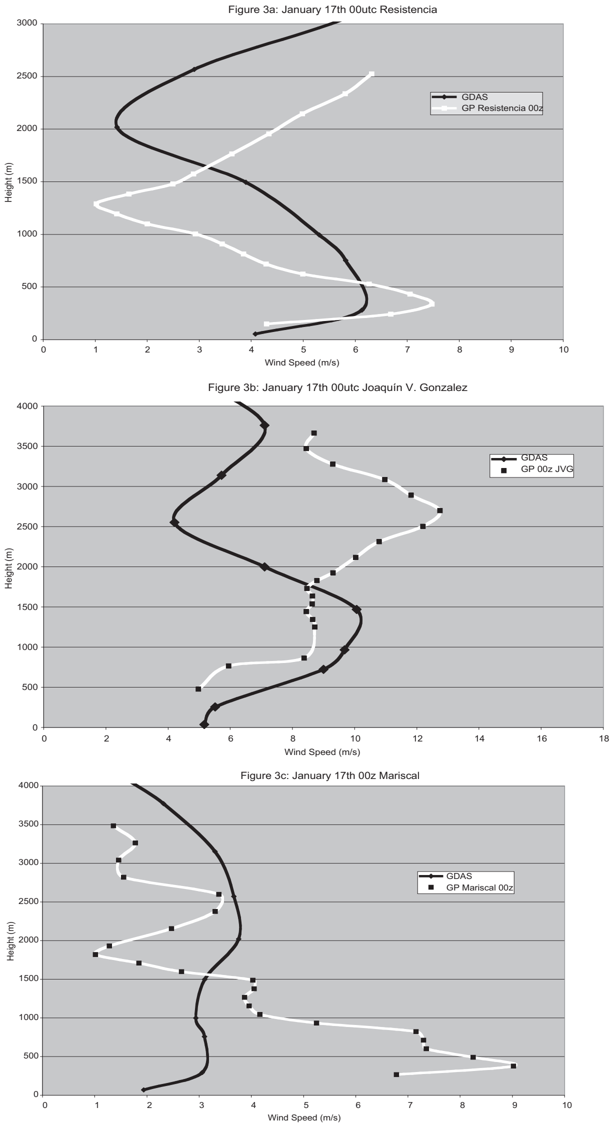


Figure 2b: 48hs total precipitation dispersion (contour) and GPCP precipitation estimates (shaded) January 19 00 UTC

Figure 4 displays predicted vertical profiles of wind speed at Resistencia. There is much inter-model variability, which is, however no larger than the difference between the SALLJEX radiosonde observation at this station and the Reanalysis estimate interpolated to the same point. Model initialization and validation in this case would clearly benefit from improved specification of the atmospheric state.

Figure 3: Initial wind speed observations (curves with squares) and analyses used for model initialization (curves with diamonds) at 00 UTC, 17 January for three selected sites in Paraguay and Northern Argentina



Future research

Future research will utilize the special SALLJEX observations in data assimilation systems. This effort has already begun at CPTEC and is planned in other research centers. Preliminary results indicate significant impact of SALLJEX observations upon a case study as well as improvement in the modelled precipitation structure of an MCS in Northern Argentina.

Model experiments will focus upon the origin and maintenance of the East Andes LLJ, and study a variety of mechanisms, including: topographic impact on trade winds; orographic effect in the absence of latent heating; impact of latent heat release upon the LLJ; impact of surface thermal heating relative to upper level forcing associated with transient perturbations of the westerlies; propagation of low-level wind bursts from the North Atlantic towards the Plata Basin; cold surges (southerly case); and synergism among the previous mechanisms. The studies will be carried out with a variety of model techniques, and SALLJEX observations will provide an important test for different model methods, for predictability studies, and for future observing systems.

Acknowledgements

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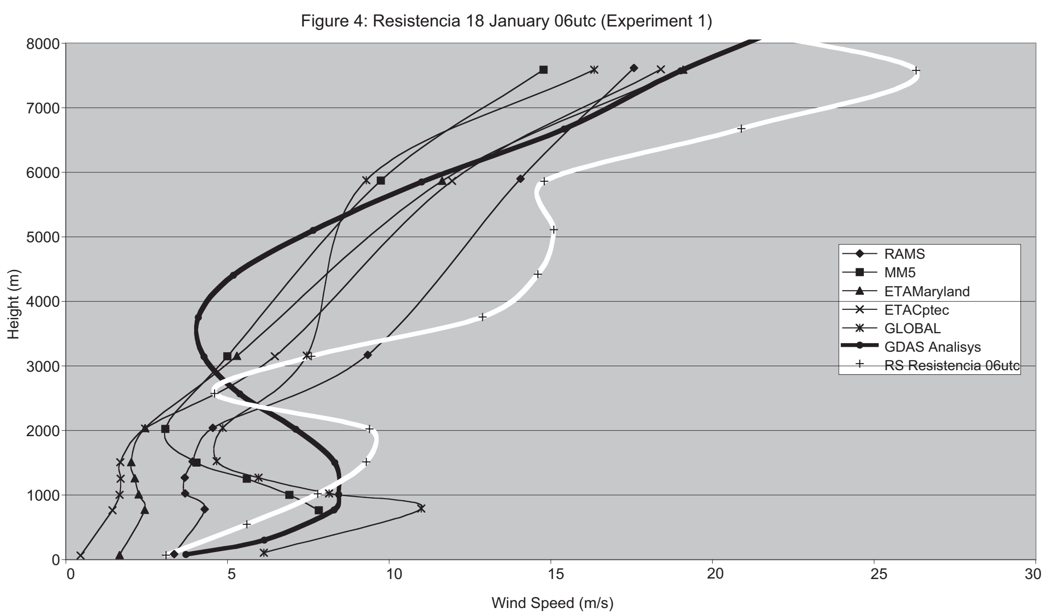
Figure 4: Model wind speed forecasts and verifying analyses at Resistencia, Argentina, valid at 06 UTC on 18 January.



Data Assimiliation Study using SALLJEX Data

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Introduction

A data assimilation study is being performed to assess the impact of observations on analyses over a usually data sparse region. The study uses radiosonde data taken during the South America Low-Level Jet Experiment (SALLJEX) (November 2002-February 2003), which focused on the region east of the Andes Mountains from western Brazil southward to central Argentina. This region has a high frequency of occurrence of a northwesterly Low-Level Jet (LLJ) and Mesoscale Convective Systems (MCS). A better understanding of the vertical and spatial atmospheric structures associated with these features is necessary in order to validate existing global and regional models, and ultimately to improve forecasts and simulations on a variety of time scales.

The additional SALLJEX soundings are included in the data assimilation system of CPTEC to prepare the initial conditions used to integrate the Atmospheric Global Circulation Model. One of the purposes of assimilating these data is to assess their impact on the initial conditions and on the forecasts for specific cases. Another objective is to provide a reanalysis set for the period of the experiment. The additional soundings were taken in areas where there is lack of conventional data; Rio Branco (Brazil), Dourados (Brazil), Santa Cruz (Bolivia), Resistência (Argentina), Santiago del Estero (Argentina) and Mariscal Estigarribia (Paraguay). These stations are indicated in Fig. 1, along with the locations of operational radiosonde stations in South America. The additional sites were chosen considering the entrance and exit regions of the LLJ. The assimilation of these data is expected to improve the LLJ analysis and forecasts.

The Data Assimilation System

The data assimilation scheme blends observations with a short term (6-hour) forecast, which is a first guess of the state of the atmosphere. The scheme implemented at CPTEC is the Physical-space Statistical Analysis System (PSAS), developed at the Global Model Assimilation Office (GMAO/ NASA) (Da Silva and Guo, 1996; Cohn et al., 1998). PSAS is a global analysis system with characteristics of 3D-Var and Optimal Interpolation, in which the minimization is performed in the physical space of the observations, rather than in a model space. PSAS solves the analysis equation globally rather than locally, similar to the global spectral variational analysis system (3D-Var) and it is fundamentally independent of the forecast model formulation. Therefore, it is a portable algorithm suitable for global and regional models.

The scheme runs with the spectral Atmospheric Global Circulation Model CPTEC/COLA, with T126 L28 resolution, which corresponds to 100 km in the horizontal with 28 levels in the vertical sigma coordinate. Details of this model can be found in Cavalcanti et al. 2002. The assimilation scheme has a regional version (RPSAS), which runs with the Regional Eta Model with a horizontal resolution of 40 km and 38 vertical layers (Seluchi et al, 2003).

The Global dataset used in the assimilation system is obtained from the Global Telecommunication System - GTS (T, P, u, v, q), ATOVS (temperature and humidity), QuikScat data (u and v over the ocean surface) and Total Precipitable Water (TPW). In addition, this study uses the radiosonde data taken from the SALLJEX (see SALLJEX stations shown in Fig. 1).

GTS sites - SALLJEX sites

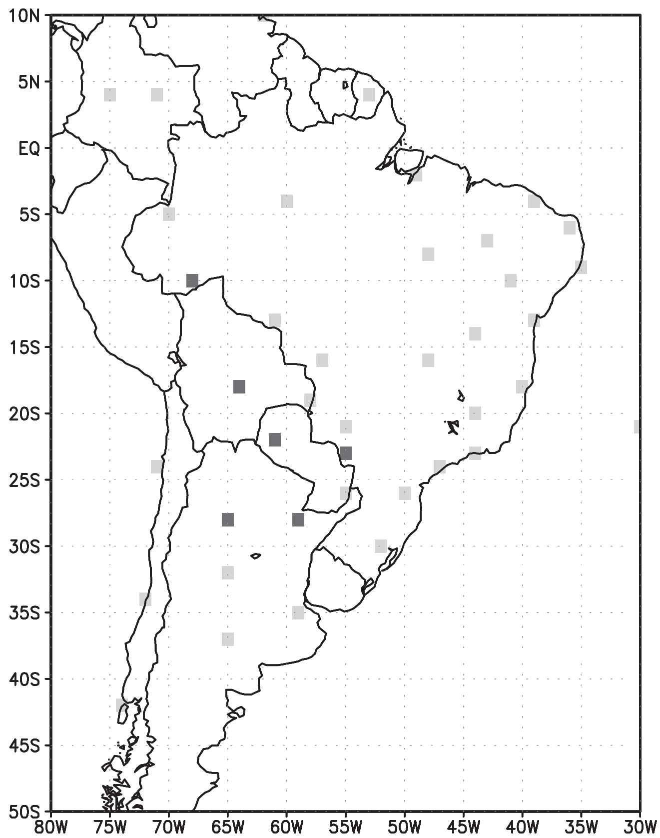

Fig. 1- Location of GTS data (light grey squares) and SALLJEX data (dark grey squares).

Preliminary results

As a pilot study, we selected the period 15-24 January 2003. On 21 January 2003 an intense MCS developed over northern Argentina and then propagated north-northeastward into Paraguay. Two experiments were performed, one without SALLJEX data (control), and another including the additional SALLJEX soundings.

The objective was to verify the impact of assimilating the additional data on the analyses and model forecasts. A time series of the vertical structure of meridional moisture flux, from the daily analysis taken at a grid point (18^0 S, 62^0 W) to the north of the MCS development shows a gradual increase in the intensity of northerly moisture flux reaching a maximum on 21 January. The moisture flux in the model results changed direction to southerly on 24 January. These results are consistent with the MCS development on 21 January and with the synoptic conditions observed in satellite images. Both experiments revealed similar features, but the intensity of the northerly moisture flux was larger in the experiment using the additional SALLJEX data (Fig. 2).

Another difference was found in the position of the maximum moisture flux on 21 January. In the experiment with the additional SALLJEX data, the maximum was slightly shifted to the west of the region of the LLJ. This shift and greater intensity occurred only within the longitude band of the LLJ, where additional SALLJEX soundings were taken. No difference was found at longitudes farther to the east, where there was another maximum of northerly moisture flux associated with the convergence and presence of a frontal system. The forecasts showed an increase in the intensity of the northerly flow and in the humidity over Bolivia when the additional SALLJEX data are included. Furthermore, the vertical structure of the meridional wind and humidity in the forecasts using the SALLJEX data are much closer to the observed radiosonde profiles than those produced in the control experiment (Fig. 3).

Ongoing and future activities

The data assimilation system at CPTEC is being used to reanalyze the entire period of the SALLJEX. This data set will be made available on the JOSS web site. During January 2003 several synoptic and mesoscale systems developed over South America, and there was considerable variability of the meridional wind in the LLJ region. The reanalysis dataset from the data assimilation system will be used to investigate this variability and to explore the details of atmospheric conditions in a region where there is generally a lack of meteorological observations. A detailed study of the synoptic and mesoscale conditions, mainly related to the moisture flux, LLJ and the South American monsoon variability, will be possible using the reanalysis data. The impact of assimilating the SALLJEX data will be assessed through these analyses and comparisons with control analyses, and also by studying the forecasts based on the two sets of initial conditions. Other investigations will include: sensitivity experiments using data from one station at each time, verification of the remote sensing data impact compared to the extra SALLJEX data impact and use of PSAS with the Regional Eta Model, considering the boundary conditions from the CPTEC AGCM reanalysis (including SALLJEX dataset).

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References

Cavalcanti, IFA, J.A.Marengo, P.Satyamurty, C.A Nobre, I. Trosnikov, J.P Bonatti, A O. Manzi, T. Tarasova, L.P. Pezzi, C. D'Almeida, G. Sampaio, C.C. Castro, M. B. Sanches, H.Camargo, 2002. Global climatological features in a simulation using CPTEC/COLA AGCM. Climate, 15, 2965-2988.

Cohn, S.E., A. Da Silva, J. Guo, M. Sienkiewicz, and D. Lamich, 1998: Assessing the Effects of Data Selection with the DAO Physical-space Statistical Analysis System. Mon. Wea. Rev., 126, 2913-2926.

Da Silva, A. and J. Guo, 1996: Documentation of the Physical-space Statistical Analysis System (PSAS) Part I: The Conjugate Gradient Solver Version PSAS-1.00. DAO Office Note 96-02, 66 pp. [Available from Data Assimilation Office, GSFC, Greenbelt, MD 20771, and online at http://dao.gsfc.nasa.gov/subpages/office-notes.html].

Seluchi , M., A.C. Saulo, M. Nicolini, and P. Satyamurty, 2003: The Northwestern Argentinean Low: A Study of Two Typical Events. Mon. Wea. Rev., 131, 2361-2378.

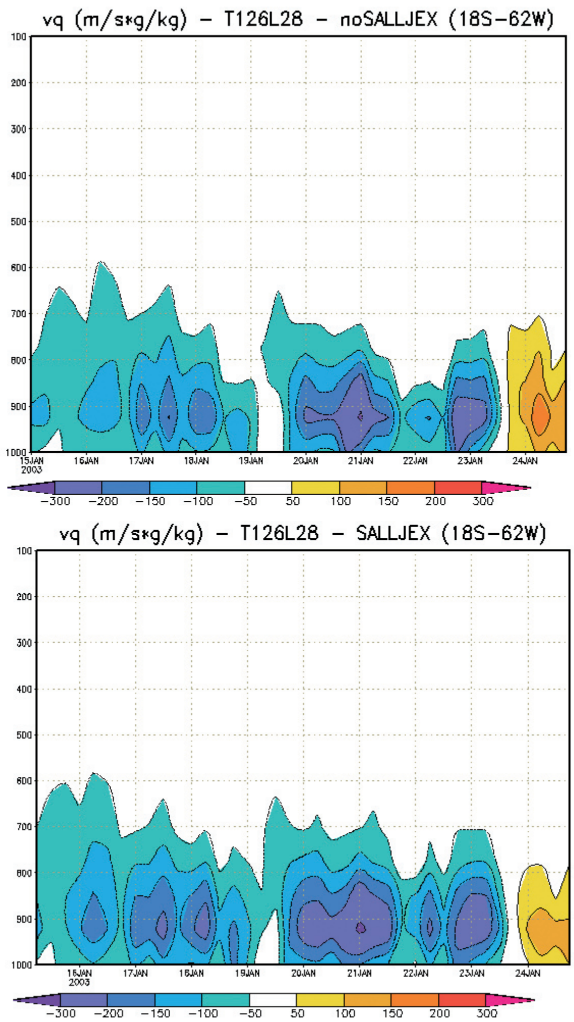

Fig. 2- Timeseries (15-24 January 2003) of moisture flux vertical section at 18^0S , 62^0W for (top) without SALLJEX data, (bottom) including SALLJEX data

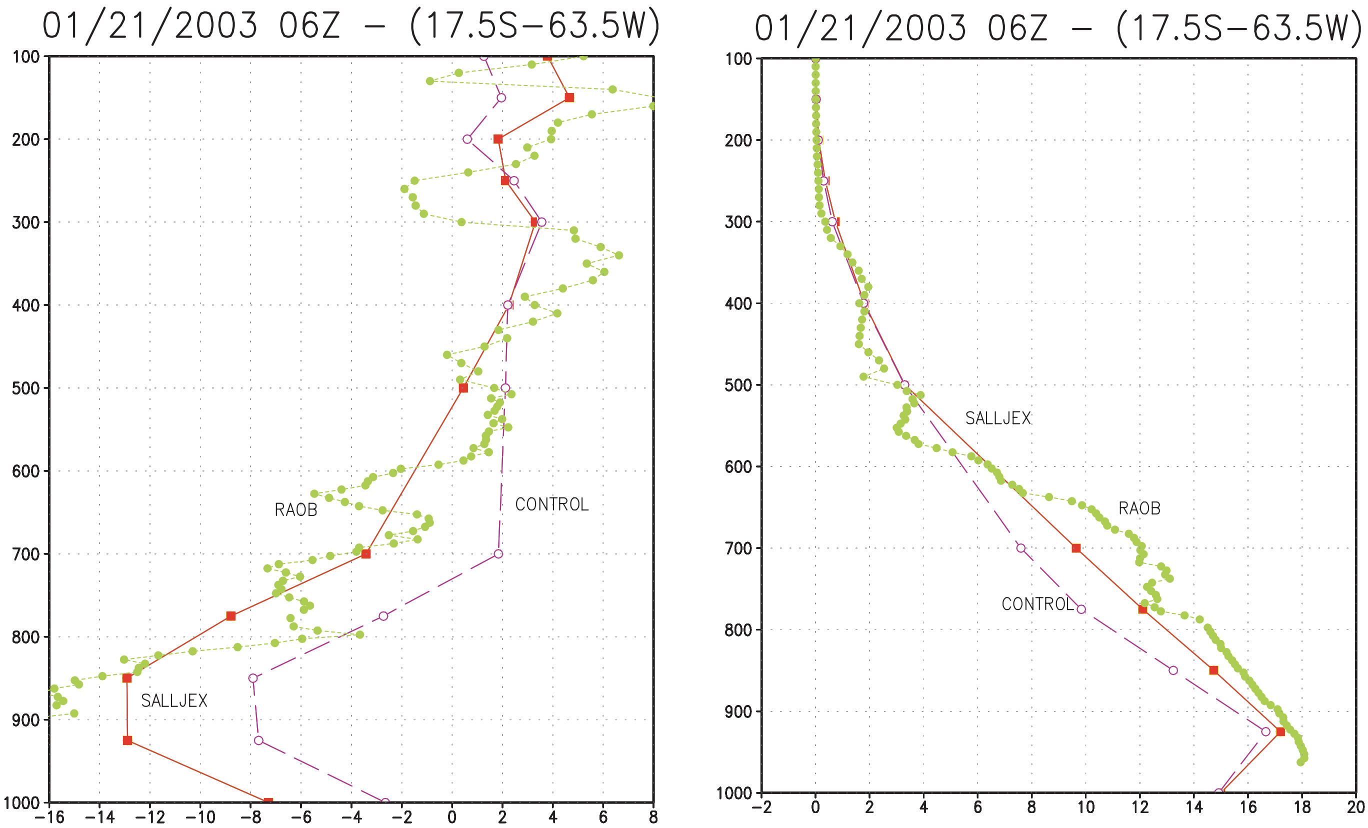

Fig.3- Vertical structure of (left) meridional wind, (right) humidity, on January, 21, from radiosonde data at Santa Cruz (17.50S, 63.50W) (RAOB), and forecast results using SALLJEX data and from the Control

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Low-Frequency Variability of the SALLJ

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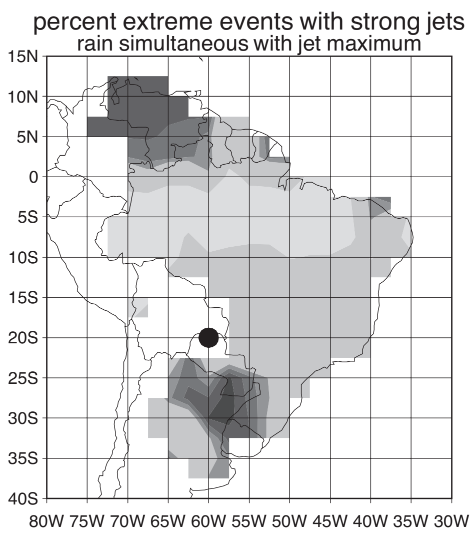
1. Introduction

Considerable attention has recently focused on low-frequency variability of precipitation over southeastern South America (Nogués-Paegle et al. 2002 and Barros et al. 2002). The temporal and spatial variability of the South American low-level jet east of the Andes (SALLJ) is still not well-understood, in part because the available limited upper-air observational network is not of adequate resolution to accurately describe it. Thus gridded reanalyses such as those from ECMWF and NCEP, have, by necessity, been used as an approximation to the true atmospheric state over South America. Recent work has shown that the frequency and intensity of the SALLJ events exhibit considerable variability on intraseasonal, interannual and even longer time scales (Marengo et al. 2004). A discussion of such variability is presented in this paper.

2. SALLJ variability

Intraseasonal variability: Recently Liebmann et al (2004) have explored the mean and intraseasonal variability of the relationship between SALLJ events and rainfall extreme events at the SALLJ exit region. Fig. 1 suggests that the percentage of daily extreme precipitation events (defined over the period 1976-1997 when daily precipitation equals at least 10% of its DJF climatology) show a good correspondence with the occurrence of the strongest SALLJ events (identified as those days on which the northwesterly NCEP reanalyses wind is at least one standard deviation above the DJF climatology). There is mounting evidence that when moisture flux into central South America by the SALLJ is strong, convection along the South American Convergence Zoner (SACZ) is weak, and vice-versa (Paegle et al. 2000), and this pattern is influenced by oscillatory modes with periods both of 22-28 and 36-40 days. Liebmann et al. (2004) explored the relationship between Madden-Julian Oscillation (MJO) phases and the occurrence of heavy rainfall events at the SALLJ downstream region. There is a preference for DJF extreme rainfall events to follow the MJO convective maximum by two days, while suppressed convection in the MJO region seems to precede rainfall by 26 days. Similar composites at the climatological center of the SACZ show a preference for rainfall enhancement 26 days prior to the MJO convective minimum. Those results are complementary to each other in that together they confirm the existence of a dipole in precipitation associated with the MJO between rainfall downstream of the jet and slightly southwest of the mean position of the SACZ. It might be that this dipole pattern is a consequence of the preferred phasing of synoptic waves due to variations of the planetary scale basic-state flow, which is at times associated with the MJO.

Figure 1 Percent of extreme precipitation events occurring when northwesterly component of 850 mb wind at 60° W, 20° S exceeds its average by 1 standard deviation (15.0% of days). An extreme is defined as occurring when 10% of December - February climatological total precipitation falls in 1 day.

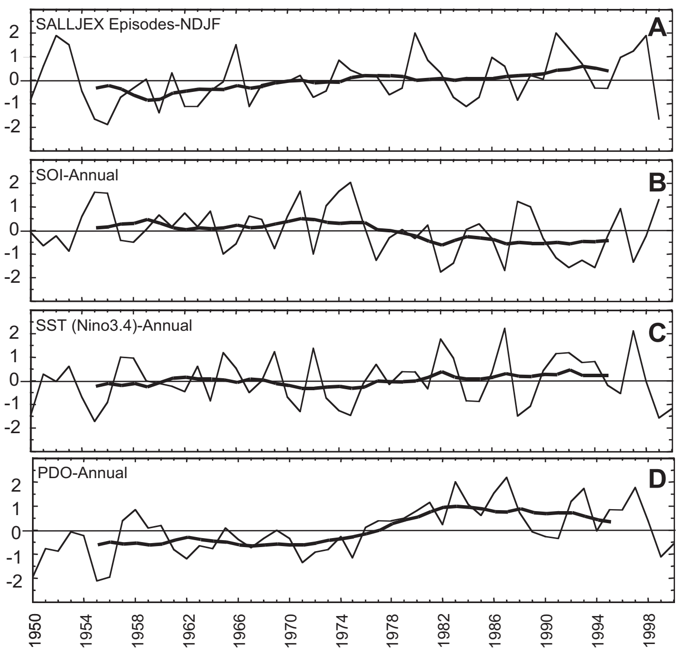


Interannual variability: Time series of the frequency of SALLJ episodes (as defined by applying the Bonner criteria [Marengo et al (2004)] to NCEP reanalysis wind fields) during 1950-2000 are shown in Fig. 2 (page 30) for Santa Cruz. There is no clear association between the occurrence of ENSO events and the number and intensity of SALLJ events. On the other hand, in the period with available Pan American Climate Studies Sounding Network (PACS-SONET) pilot balloons at Santa Cruz (since 1998), there were 29 SALLJ events during the strong El Niño of 1998, while during the La Niña of 1999 there were only 7 events. The intensity of the winds based on the average for the time with the maximum wind speed from the reanalyses (06-12Z) shows that the strongest events of record were observed during 1997-98, while the episodes during the El Niños of the middle 1980s and early 1990s were relatively weaker. Studies using the PACS-SONET upper air data have also suggested enhanced SALLJ activity during 1998 as compared to weak activity in 1999 (Douglas et al. 1999; Marengo et al. 2002). In Fig. 2, the reanalyses suggest fewer episodes of SALLJ in 1999 as compared to 1998, but the lack of observations during other ENSO events limit the possibility of a more firm conclusion about warm ENSO events related to more frequent SALLJ events during the warm season.

Decadal and longer term variability: Marengo (2004) explored the potential role of tropical SST and SALLJ activity on longer time scales. Statistically significant positive correlations between SALLJ frequency and SST anomalies are observed in the Pacific Ocean, while the correlations in the tropical Atlantic are quite weak. The correlations barely surpass 0.4, however, implying that less than 20% of the SALLJ variance can be explained by the SST anomalies in the tropical Pacific. Also, the magnitude of the correlations indicates a more important role of tropical Pacific SST anomalies during September. Marengo et al. (2004) suggest that warm SST anomalies in the tropical Pacific excited an anomalously east-west overturning with sinking motion and low-level easterlies in northern Brazil. These easterlies turn southwestward when encountering the Andes, enhancing SALLJ activity and increasing rainfall over southern subtropical South America, while weakening that over the SACZ region. Fig. 3 shows time series from 1950-2000 for the SALLJ occurrences during the warm season in Santa Cruz, together with indices that describe El Nino and El Nino-like conditions (Southern Oscillation, Nino 3.4 SST and the Pacific Decadal Oscillation (PDO) indexes). The climate shift that occurred in the Pacific around the late 1970s is evident in all the time series, which suggests a turning towards El Nino-like conditions after the middle 1970s (represented by systematic warming in the tropical and extratropical Pacific (NINO3.4 and PDO, consistent with negative tendency in the Southern Oscillation index) and consistent with increase of SALLJ activity.

SALLJ activity in future climate change scenarios: For climate change scenarios for the 21st Century, new developments in dynamic vegetation schemes and coupled climate-carbon models (Cox et al. 2000, Betts el al. 2004) have shown an effect named die-back of the Amazon forest, by which rising atmospheric CO_2 is found to contribute to a 20% rainfall reduction and to more than 30% of surface temperature increases in the Amazon basin, through the physiological forcing of stomatal closure. They also show an increase in rainfall in southern Brazil-northern Argentina. The observed small negative rainfall trends in northern Amazonia, and systematic increases in rainfall and runoff in southern Amazonia and the southeastern South America region since the middle 1970s (Marengo 2004) are consistent with the increase in the frequency of SALLJ events. Thus, following Betts' results from the HadCM3 model it could be hypothesized that after the middle 2050s, the drying of the Amazon basin and the humidification of the southern Brazil-northern Argentina region in an extended El Nino-mode produced by this model, could be explained by changes in the regional circulation, with an increase on the SALLJ frequency and/or intensity in a global warming world. The likelihood of this scenario, however, is still an open issue.

Figure 3 Normalised departures of SALLJ occurrences and indices of the Southern Oscillation (b-Annual SOI; and c-SST El Nino 3.4). The Pacific Decadal Oscillation (PDO) is shown in (d). Thick line represent the 11 year movng average.



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References

Barros, V., M. Doyle, M. González, I. Camilloni, R. Bejarán and R. Caffera, 2002: Climate variability over subtropical South America and the South American Monsoon System: A Review. Meteorologica, 27, 33-58.

Cox, P., Betts, R., Jones, C., Spall, S., Totterdell T, 2000: Acceleration of global warming due to carbon-cycle feedbacks in a couple climate model. Nature, 408, 184-187.

Douglas, M.W., M. Nicolini, and A.C. Saulo, 1999: The Low-level jet at Santa Cruz, Bolivia during January-March 1998, pilot balloon observations and model comparisons, in Extended Abstracts of the 10th Symposium on Global Change Studies, 10-15 January 1999, Dallas, Texas, pp. 223-226.

Liebmann, B., G.N. Kiladis, C.S. Vera, A.C. Saulo, and L.M.V. Carvalho, 2004: Subseasonal variations of rainfall in South America in the vicinity of the low-level jet east of the Andes and comparison to those in the South Atlantic convergence zone. J. Climate (in revision).

Marengo, JA, M. Douglas, and P., Silva Dias, 2002: The South American Low-Level Jet East of the Andes during the LBA-TRMM and WET AMC campaign of January-April 1999. J. Geophys. Res., 107, (D18)

Marengo, J, W. Soares, C. Saulo, M. Nicolini 2004: Climatology of the LLJ east of the Andes as derived from the NCEP reanalyses. In Press, Journal of Climate

Marengo, J.A., 2004: Interdecadal and long term rainfall variability in the Amazon basin. In press, Theoretical and Applied Climatology.

Nogués-Paegle, J., Mechoso C., Fu R., Berbery, H., Winston. C., Chao, T, Cook, K., Diaz, A., Enfield, D, R. Ferreira, Grimm, A., Kousky, V., Liebmann, B., Marengo, J. Mo, K., Neelin, D., Paegle, J., Robertson, A., Seth, A., Vera, C., Zhou,J., 2002: Progress in Pan American CLIVAR Research: Understanding the South American Monsoon. Meteorologica, 27, 3-30.

Paegle, J.N., L.A. Byerle, and K.C. Mo, 2000: Intraseasonal modulation of South American summer precipitation. Mon. Wea. Rev., 128, 837-850.

SALLJEX Data Management Activities

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The development and maintenance of a comprehensive and accurate data archive is a critical step in meeting the scientific objectives of the South American Low-Level Jet Experiment (SALLJEX). A series of data management activities are supported under the VAMOS Programs Project Office at University Corporation for Atmospheric Research (UCAR) Joint Office for Science Support (JOSS).

Data Management Philosophy

The overall guiding philosophy for SALLJEX data management is to make the completed data set available to the research community as soon as possible following the field campaign.

The time periods for which data are archived cover the period 1 November 2002 to 28 February 2003. SALLJEX data were collected from a variety of field activities led by individual researchers and groups of researchers. The archiving of SALLJEX data sets was done at one of the distributed SALLJEX Data Archive (SDA) centers. Creating harmonized SDA data formats is an essential element of the SALLJEX data policy in order to provide easy access to the data by the scientific community.

Performing high-quality measurements during the planned SALLJEX period, carrying out quality and error checking procedures and submitting data and related documentation to the appropriate SDA, required substantial coordination, financial and logistical efforts by the data providers. The necessary support for these activities originated from a variety of international, national and institutional sources. The SALLJEX data are available to the scientific community through a distributed archive coordinated by the Joint Office for Science Support (JOSS), in Boulder Colorado, USA. JOSS oversees the SALLJEX data management tasks in collaboration with the SALLJEX Science Working Group. The SALLJEX Data Management Plan describes the guiding data management policies, the strategy and functional description of the data management systems, and the implementation details of the SALLJEX data sets and the data management systems.

The SALLJEX data management archive activities fall into two major areas:

1. Development and implementation of a real-time data catalog to provide in-field support and project summaries /updates for the Principal Investigators (PIs) and insure optimum data collection; and

2. Establishment of a coordinated final archive system and providing data distribution/support for the investigators and the CLIVAR/VAMOS scientific community.

General guidance was provided by the SALLJEX Science Working Group. JOSS had primary responsibility for the in-field collection, compilation and access to all supporting operational data for the SALLJEX Field Phase. JOSS also performed quality control and reformatted select operational data (e.g. soundings) prior to access by the community. JOSS is responsible for coordinating and archiving other research data that were collected, processed and quality controlled by the SALLJEX investigators.

General information on the data activities on-going in SALLJEX (i.e. Data Management Plan, other documents and reports), instructions for submitting data sets to the archive, links to related VAMOS programs and projects (e.g. Pan American Climate Studies (PACS)), and direct data access to distributed archives of interest (i.e. in-situ [land, ocean], satellite, model output) are available via the Internet. Access to specific SALLJEX datasets (sorted by various data categories) is provided via a "one stop" linkable master list of all datasets (http://www.joss.ucar.edu/salljex/dm/data_access_frame.html). Currently, there are over 64 on-line datasets available to the SALLJEX scientific community.

The SALLJEX data policy (http://www.joss.ucar.edu/salljex/dm.html#policy) was adopted by the SALLJEX Science Working Group and is a good "model" for an overall VAMOS data policy. Details of the SALLJEX data policy/protocol are documented within the SALLJEX Data Management Plan.

Research Datasets

UCAR/JOSS provided support (operations, logistics and data management) for the SALLJEX field campaign. Data collected during SALLJEX included the NOAA P-3 aircraft flight level and airborne radar data binary/imagery), upper air data (RAOBS, PIBALS), satellite data (binary files and imagery), model output, and precipitation data. A "merged" GOES northern/southern hemisphere high resolution (30-min, 1-km visible) satellite sector was routinely produced and archived. During the field phase, a web-based field catalog for SALLJEX was populated with operational/research product imagery and various reports (daily operations, mission summary, and status). Following the field phase, contents of the field catalog were migrated to the archive.

Research-quality radiosonde data of the highest resolution available were processed and quality checked by JOSS.

These included operational National Weather Service sites and supplemental research SALLJEX sites.

Pilot balloon data were processed at the National Severe Storms Laboratory. The NSSL has maintained an enhanced monitoring network of pilot balloon observations since 1997. Data are given a preliminary quality control at the observing site, then a final check prior to submittal to the archives..

Final, quality-controlled data from the NOAA research aircraft are archived at JOSS. These data include flight-level measurements from various instruments; as well as data from the two onboard research radars. Additional processing of aircraft flight-level data included reformatting to NetCDF for ease-of-use by the investigators.

Precipitation data from the various SALLJEX networks plus existing cooperative networks have been processed by the individual countries and submitted to the University of Buenos Aires (UBA) Centro de Investigaciones del Mar y la Atmósfera (CIMA). CIMA investigators have done extensive work to digitize, quality-control, reformat and load into a relational database system a comprehensive archived dataset; copies will be submitted to the SALLJEX archive at JOSS. The precipitation archive can be accessed at: http://www.salljex.cima.fcen.uba.ar/salljexpl

The data sets residing at UCAR/JOSS are archived and distributed through an existing relational database management system (CODIAC). CODIAC offers scientists access to research and operational data. It provides the means to identify data sets of interest, facilities to view data and associated metadata, and the ability to automatically obtain data via internet file transfer. Some datasets can be browsed to preview selected data sets prior to retrieval. Data displays include time series plots for surface parameters, skew-T/log-P diagrams for soundings, and GIF images for model analysis and satellite imagery. CODIAC automatically includes associated documentation concerning the data itself, processing steps, and quality control procedures. All operational data sets (and imagery) that were collected during the field phase were processed and loaded to CODIAC.

A data workshop was held in December 2003 in Buenos Aires, Argentina. The general objectives were to: assess what progress has been made on SALLJEX objectives; strengthen and arrange collaborations among the partipants in SALLJEX; broaden participation in order to expand the analysis and modeling use of SALLJEX data by other scientists and their students and determine follow-up SALLJEX activities

Daily Rainfall Data over Argentina and Uruguay during SALLJEX

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South American orography, (large land mass surrounded by oceans and very high mountains to the west), favours the evolution of the monsoon system. During the summer months, an air mass with plentiful moisture supplied from the Atlantic Ocean is blocked by the mountains and forced to move to extratropical latitudes by the low level jet, resulting on abundant precipitation over different regions of South America. One of the goals of Variability of American Monsoon System (VAMOS) is to improve the understanding of the monsoon system.

Although SALLJEX was only held during one austral summer (2002-2003), it has been very useful because the observations collected give a unique opportunity for validation of numerical simulation sensitivity studies that attempt to reproduce the structure of the jet and its variability, as well as the related precipitation.

The climate observing system over South America exhibits serious deficiencies in spatial and temporal resolution. In that sense, one of the main objectives of the CLIVAR/VAMOS/South American Low Level Jet Experiment (SALLJEX) was the enhancement of the current daily rainfall network over southeastern South America. This internationally coordinated effort took place between 15 November 2002 and 15 February 2003.

In order to determine wet and dry periods during the experiment and their relationship with South American Low Level Jet events in different geographical regions, an enhancement of the daily raingauge network was made. In particular, 300 raingauges were installed in Argentina. Figure 1 (left) shows the current daily raingauge network in Argentina and Uruguay, which depends on the National Weather Services and Instituto Nacional de Tecnología Agropecuaria (INTA). Researchers at the Departamento de Ciencias de la Atmósfera y los Océanos (DCAO) and Centro de Investigación del Mar y la Atmósfera (CIMA) coordinated the installation of and data collection from of the enhancement to the rainfall network in Argentina and Uruguay.

From June 2002 onwards, different institutions and local cooperatives, with their own raingauge networks, were invited to participate in the experiment (Table 1). As a result of this effort, the experiment could count on approximately 1700 raingauges with daily information. This improved considerably the spatial resolution that would otherwise be available (Figure 1, right). The local institutions also collaborated with raingauge installation. During August and September 2002, students of DCAO visited different institutions. They installed new raingauges, checked the old ones, and gave instruction on how to measure the rain if necessary (Figure 2).

In addition, the participants in the SALLJEX raingauge enterprise developed different documents to support raingauge installation as well as the making of daily rainfall observations. For example, the accuracy of raingauge deployed by SALLJEX was evaluated by researchers of the Centro de Informaciones Meteorológica in Santa Fe Province. A SALLJEX raingauge was installed very close to a standard raingauge (Figure 3) and the amounts of the rain of both raingauges were analyzed for different atmospheric systems (Table 2).

During the experiment the collection of the daily precipitation dataset was performed, on a daily, weekly or monthly basis depending on how the information was sent (by e-mail or post-mail). Some work was dedicated to checking the data and constructing the database.

The data quality control was performed by researchers at CIMA/DCAO and NOAA/CDC . This task consisted of the temporal and spatial analysis of the daily rainfall information. Daily rainfall was class-posted by province, institution or region and compared with GOES images (each half hour). For stations that were very close to each other a daily rainfall time series was analyzed. These studies allowed evaluation of the accuracy of the zero and heavy rainfalls as well as the station that never sent rainfall data.

Although SALLJEX was only held during one austral summer (2002-2003), it has been very useful because the observations collected give a unique opportunity for validation of numerical simulation sensitivity studies that attempt to reproduce the structure of the jet and its variability, as well as the related precipitation.

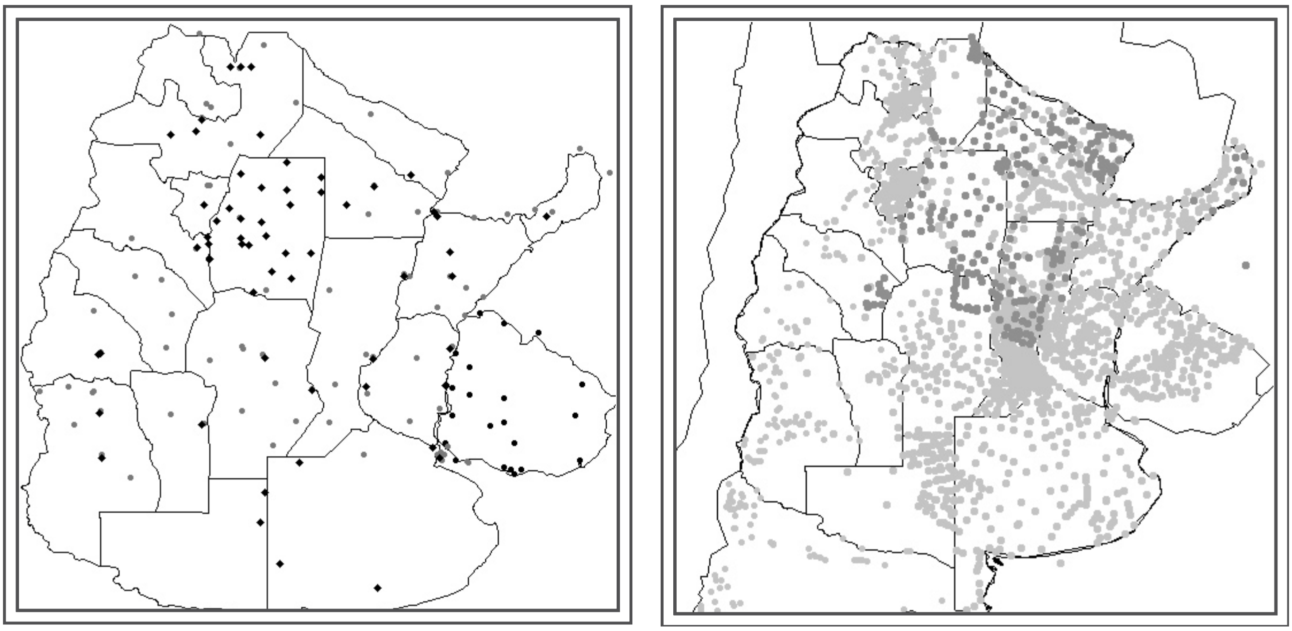

Figure 1. Left: Daily raingauge network of the National Wether Services (Argentina and Uruguay) and Instituto Nacional de Tecnología Agropecuaria (Argentina). Right: Stations of local institutions collaborating with SALLJEX (light dots) and stations checked and installed by SALLJEX (dark dots).

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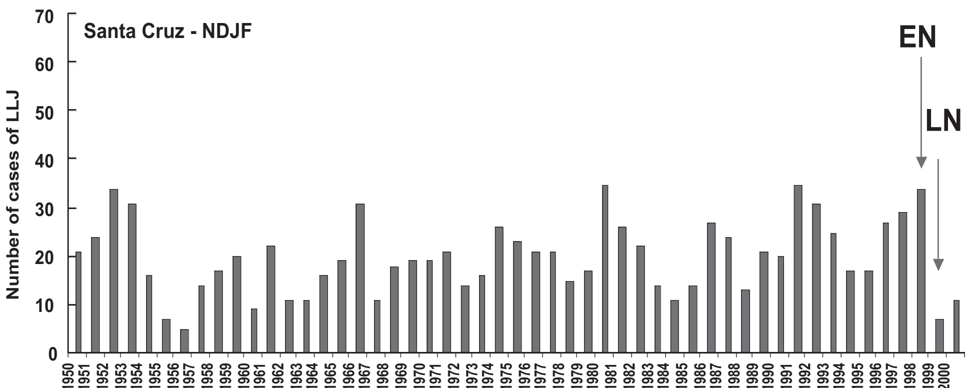

Figure 2 Interannual variability of SALLJ episodes during NDJF in Santa Cruz during 1950-2000. The El Nino (EN) 1998 and La Nina (LN) 1999 are indicated by arrows.

Figure 2. Students of DCAO visiting local institutions and installing SALLJEX raingauges

Figure 3. A SALLJEX raingauge (to the right) installed very close to a standard raingauge (to the left) to evaluate the accuracy of the SALLJEX gauge, in the Centro de Informaciones Meteorológica in Santa Fé province.

National Institutions	**ARGENTINA** Servicio Meteorológico Nacional (S.M.N.) Sec. Agricultura, Ganadería, Pesca y Alimentación Acopiadores Instituto Nac. de Tecnología Agropecuaria (INTA) Entidad Binacional Yacyretá Recursos Hídricos de la Nación
	URUGUAY Ad. Nac. Usinas y Transmisiones Eléctricas (UTE)
	ARGENTINA - URUGUAY Comisión Técnica Mixta de Salto Grande
Provincial Institurions	**SANTIAGO DEL ESTERO** Recursos Hídricos Universidad Nacional Santiago del Estero Pampa de los Guanacos (Krapovicas)
	SANTA FE Centro Informaciones Meteorológicas – UNL
	SALTA Wichis Joaquín V González Estación Exp. Agropecuaria - INTA
	MISIONES Estación Exp. Cerro Azul - INTA
	LA RIOJA Universidad Nacional de La Rioja (Chamical)
	LA PAMPA Estación Exp. Agropecuaria - INTA Universidad Nacional de La Pampa
	TUCUMAN Est. Exp. Agroindustrial "Obispo Colombres"
	CORDOBA Universidad de Cordoba – Mar Chiquita

Table 1. National and provincial institutions who collaborated in the experiment.

Date	B Raingauge (mm)	SALLJEX Raingauge (mm)	Observations
11/15/2002	20.0	19.5	Strom – hail – wind:40 km/h
11/18/2002	0.4	0.0	Drizzle – wind: 50 km/h
11/19/2002	21.5	21.0	Rain – drizzle
11/25/2002	110.0	108.0	Thunderstorm – wind: 110 km/h
11/30/2002	41.5	42.0	Storm

Table 2. Example of rainfall amounts collected in two raingauges, close to each other, (B and SALLJEX) during differents atmospheric situations on November 2002.

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