

WELCOME WORDS

CIN, the Centro de Ingeniería de la Innovación associated to CECS (Centro de Estudios Científicos), is a regional centre of science and technology established under the auspices of CONICYT, the Chilean science funding agency, and by the Gobierno Regional de Los Ríos. CIN harbours biologists, physicists and glaciologists. The involvement of CIN in glaciology aims at improving our knowledge of climate change and its effect on society, the economy and the ecosystems. CIN has ongoing regional monitoring programmes for glaciers and ice-capped volcanic cones that it considers of great potential in providing important information for our regional authorities.

Under the premise that we have to know the past to reach a reasonable prediction of the future, we are delighted to host the PAGES International Symposium "Reconstructing Climate Variations in South America and the Antarctic Peninsula over the last 2000 years", organized by CIN and Universidad Austral de Chile. The meeting aims at enhancing the interactions between scientists of diverse research areas along the tropical, extratropical and subantarctic latitudes and the Antarctic within the late Holocene. This effort is a continuation of the previous meeting organized by the PAGES Iniative in Malargüe-Argentina 2006 as well as preparatory for further PAGES symposia in forthcoming years.

It is a great privilege for us to welcome to Valdivia scientists working in different fields in climate dynamics, paleoclimatology and glaciology, in order to review current knowledge and discuss new data sets to reconstruct the history of climate in South America and the Antarctic Peninsula. Subjects as varied as the study of tree-rings, lake and marine sediments, glaciology, ice cores, historical documents, speleothems and other paleoclimate archives, will all be called to help to accomplish this task. We expect climatologists working on models of present climate of South America and the Antarctic Peninsula to provide a dynamically meaningful and physically plausible framework for the interpretation of past environmental records.

We thank you all for coming and let the science do the talking now

Varguel

Francisco Sepúlveda Director CIN

Valdivia , October 2010



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MAP OF DOWNTOWN VADIVIA







ABSTRACTS





International² Symposium

ABSTRACT #111. Poster Presentation



THE LAST 1500 YEARS OF HUMAN-CLIMATE INTERAC-TIONS IN AISÉN: AN OVERVIEW ON REGIONAL INFORMATION

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Keywords: human-climate dynamics, late hunter-gatherers, western Patagonia.

The image of hunter-gatherers in Patagonia is built on the observations in chronicles and documents not extending further than the last 500 years. Nonetheless, these "late hunter-gatherers" are rooted in earlier peoples who can be traced archaeologically. In Aisén region (~44° to 49°S, western Patagonia) despite having dated human presence since the Pleistocene/Holocene transition, late hunter gatherer archaeological record may be assessed for the last 1500 years. In this paper, we synthesize available archaeological and palaeoenvironmental data for this period in order to discuss human-climate interactions. We use ¹⁴C dates, archaeological site distribution and site function, geochemical analyses on obsidian artifacts and bioanthropological information. This data is compared to available pollen and charcoal records. Results show two major separate groups peopling the West and East of Aisén, respectively, with no signal of cultural interaction. The presence of a biogeographical barrier such as the evergreen forest/ice field/Andean cordillera modeled human distribution differently than other areas in Patagonia (i.e. Atlantic coast, Magallanes), where contacts between maritime and continental hunter gatherers were common. Around 3100 cal yr. BP., an abrupt change in vegetation shown in Shaman pollen record is suggestive of relative drier and cooler conditions and precedes an steppe-peoples East-West exploration of the western forests dated around 2750 cal yr. BP. Forest re-expansion around 1500 cal yr. BP., as shown in Shaman and other palaeoenvironmental records, allowed steppe groups to limit their mobility not further from forest/steppe ecotone. Our data suggests that it is within the last 1500 years, with the onset of current climatic conditions, when human distribution was established in western and eastern Aisén, as reflected historically. Acknowledgments: FONDECYT#1090027.



BOTTOM WATER OXYGENATION VARIABILITY OFF NOR-THERN CHILE DURING THE LAST TWO CENTURIES

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Keywords: Oxygenation, paleoproductivity, ENSO-like variability, northern Chile.

The Peru Chile Current ecosystem is characterized by high biological productivity and important fishery resources. Although this system is likely to be severely affected by climate change, its response to current global warming is still uncertain. In this study we analyzed 166 year old sediments in two cores collected in Mejillones Bay, an anoxic sedimentary setting favorable for preservation of proxies. We used proxies of bottom water oxygenation (Mo, V, S, and the (lycopane+n-C₃₅)/n-C₃₁) ratio) and surface water productivity (biogenic opal, counts of diatom valves, biogenic Ba, organic carbon and chlorins) to reconstruct environmental variations in Mejillones Bay. The results show that at decadal scales, and during the last two centuries, a shift in the coastal marine ecosystem off northern Chile took place which was characterized by intense ENSO-like activity and large fluctuations in biological export productivity, in bottom water oxygenation, and increased eolic activity (inferred from Ti/Al and Zr/Al). Superimposed on this short-term variability, a gradual increase of sulfidic conditions has occurred, being even more intensified since the early 1960s.

ABSTRACT #113. Poster Presentation



SILICEOUS MICROORGANISMS IN THE UPWELLING CENTER OFF CONCEPCIÓN, CHILE (36° S): PRESERVATION IN SURFA-CE SEDIMENTS AND DOWNCORE FLUCTUATIONS DURING THE PAST ~150 YEARS

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Keywords: diatoms, upwelling, seasonal variation, sediments, organic carbon

The coastal system off Concepción, Chile, is characterized by strong seasonal upwelling with intensive events taking place in austral spring and summer along a relatively wide continental shelf interrupted by submarine canyons. The area receives contributions from two major rivers (Itata and Bíobío). We analyzed the temporal pattern of siliceous microorganisms in the water column and their representation in the underlying surface sediments between September 2002 and November 2005, at a fixed station on the shelf (Station 18, 36º30.80' S and 73º07.75' W), connecting our results to instrumental records of temperature, salinity, coastal upwelling, and freshwater input. Diatom abundance data integrated over a water column depth of 40 m ranged between 1×10⁶ and 4×10¹⁰ cells m⁻²; in the surface sediments, their overall abundance fluctuated between 7×10^5 and $\sim 2 \times 10^8$ values g⁻¹. In both settings, maxima of the key diatom genera Chaetoceros and Skeletonema coincided with the spring-summer upwelling period. For the autumn-winter non-upwelling period, significant plankton-sediment discrepancies were observed, with enrichment of moderately/robust taxa in the sediments and an absence of delicate species, as well freshwater diatoms and phytoliths tracing the increased winter river discharges. A 30-cm core collected at the same site and spanning the last ~150 years of sedimentation was also studied. A marked decrease in total diatom accumulation rates was accompanied by increasing concentrations of lithogenic particles and freshwater diatoms, suggesting higher continental input of material from river discharges since the late 19th and throughout the 20th century. Along with the increased decadal to interdecadal scale variability of alkenone concentrations, upwelling, and warm water diatoms that accompanied this sedimentary change, these signals suggest an intensified influence of ENSO-like variability in the ocean-climate system off subtropical western South America. An alkenone-based sea surface temperature reconstruction of the past 150 years and instrumental data show that these changes occurred concomitantly with a general trend of increasing temperatures in the upwelling area off Concepción.



FOSSIL DIATOM EVIDENCE FOR HOLOCENE CHANGES IN THE WIND-DRIVEN MIXING REGIME AND HUMAN IMPACTS IN LAGO VILLARRICA, SOUTH CENTRAL CHILE

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Keywords: diatoms, paleolimnology, westerly winds.

A low-resolution Holocene diatom stratigraphy from a 14m long sediment core from Lago Villarrica (39°15'S, 72°02'W) was combined with sedimentological proxies in order to infer paleoenvironmental and paleoclimate changes in Northern Patagonia. We could identify three periods with marked changes in the diatom record over the past 7574 years. Between 5370 and 4646 cal yr BP and between 1881 and 658 cal yr BP stronger wind strengths could be inferred based upon the notable co-occurrence and high abundances of Aulacoseira granulata spp., A. granulata var. angustissima and Urosole*nia eriensis*. These species favor a highly mixed water column and relatively high nutrient levels, which are most likely related to changes in the prevailing Southern Westerlies and/or frequency of El Niño events. The recent period is characterized by a marked shift in the diatom community composition, with a sudden increase of Asterionella formosa, indicating increased nutrient levels, likely related to human activities in the lake and its catchment area. We conclude that diatoms are a powerful proxy to reconstruct past changes in the wind-driven mixing regime in North Patagonian lakes and recent human impacts on these ecosystems. Microscopic analyses of thin sections from diatom rich varved sediments from these lakes may even allow us to reconstruct climate related and anthropogenically induced paleolimnological variability at yearly intervals.

ABSTRACT #115. Oral Presentation



LATE HOLOCENE RIA LAKES FROM NORTHERN COLOMBIA: NEW HIGH-RESOLUTION TARGETS FOR PALEOCLIMATE RESEARCH

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Keywords: ria lakes, northern Colombia, laminated sediments.

The Cauca paleolake (Santa Fé-Sopetrán basin) in the middle Cauca Valley, and its modern ria analogues in the middle Magdalena Valley, do contain laminated sediments deposited under high sedimentary rates of ~600 cm/ka during the last 3.5 ka. This sedimentary succession contains the late Holocene paleoenvironmental history of the northern Andes, in which seasonal flood pulses of the braided middle Cauca River, triggered by the path and strength of the ITCZ and ENSO dynamics, resulted in a highly dynamic sedimentological, hydrological and biological connectivity with, - and damming of -, its small tributaries. We have fully documented the tectonic setting of the Santa Fé-Sopetrán pull-apart basin, together with the sedimentological, palynofacies, diatom, and geochemical records of the 20 m thick, laminated, fluvio-lacustrine terraces of the Cauca paleolake. A dual control, tectonic and hydrological, in these ria paleolake deposits became apparent as well as the transition from a igapo (black water) to a varzea (white water) depositional setting. For the first time a ria lake facies model is described. Simultaneously, we are currently documenting limnological and paleolimnological conditions at present ria lakes in the middle Magdalena Valley, where fluvial dynamics seem to be dominant. Our contribution, therefore, demonstrates the high potential of these hitherto undervalued deposits for the reconstruction of the paleohydrological history of the northern Andes of Colombia for the late Holocene.





HOLOCENE PALEOCLIMATE RECONSTRUCTION BASED ON STRATIGRAPHY AND STABLE ISOTOPES OF SPELEOTHEMS FROM NORTHEAST AND SOUTHERN BRAZIL

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Keywords: Speleothems, stable isotopes, southern Brazil.

This research aims to investigate the paleoclimate changes that occurred at two different sites in Northeast and Southern Brazil. The study is based on high-resolution records of oxygen and carbon isotope ratios from speleothems, and also includes measurements of layer thickness and frequency within the same samples, precisely dated by U/Th method. The variations in the oxygen isotope ratio are indicative of increased and decreased rainfall in the study area, and the carbon isotope ratio correlates with the local paleovegetation. Differences in layer thickness of speleothems might be indicative of changes in the volume of recharge into the karst aquifer resulting from precipitation variations. Time-series analyses were used to interpret high frequency climatic cycles from isotopic and microstratigraphic proxies of speleothems. The records from different cave sites in Brazil are used to discuss the intensity and variability of the rainfall associated with the South American Summer monsoon System (SASM) on a regional scale. It might be possible to link them with climatic features originating in the Atlantic or Pacific oceans such as El Niño-Southem Oscillation (ENSO), North Atlantic Oscillation (NAO) and Pacific Multidecadal Oscillation (PDO) and with the humidity that propagates from the Amazon Basin to surrounding areas as well as to study the impact of events such as the Medieval Climate Anomaly and the Little Ice Age on the SASM precipitation over Brazil.

ABSTRACT #117. Oral Presentation



CLIMATE AND STREAMFLOW VARIABILITY IN THE SUB-AN-TARCTIC REGION OF SOUTH AMERICA (45[°] - 56[°] S) DURING THE LAST 500 YEARS: INTEGRATING TREE-RINGS, INSTRU-MENTAL RECORDS AND HYDRO-CLIMATIC MODELING

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Keywords: dendrochronology, climate reconstructions, climate change.

The sub-Antarctic region of South America is the only continental area where trees grow south of 47° S worldwide, providing proxy climatic records for the last centuries. This emphasizes the uniqueness of the sub-Antarctic region and its relevance to improve our understanding of global climate change. Limitations in the available instrumental climatic records in this region regarding their length, quality and geographic distribution, severely hampers progress in the understanding of climate and its relationship to oceanatmospheric forcings. This work presents the results up to date of a research grant in progress that looks for the understanding of climate change and streamflow variability in the sub-Antarctic region. The main objectives of this research are: 1) To enhance the network of precipitation and/or temperature sensitive tree-ring chronologies in the sub-Antarctic region of Chile. 2) To reconstruct precipitation, streamflow, temperature, and climatic indices such as the Antarctic Oscillation Index (AAO), using the new tree-ring chronologies and the more than 200 available tree-ring records in Chile and Argentina. 3) To develop streamflow annual or seasonal estimations for the last 200 years using innovative hydrological models, largely depending on tree-ring records. The new knowledge about climate change provided by this study is highly relevant from a global perspective and for long-term planning and decisionmaking regarding productive activities as well as the provision of ecosystem services in these territories that have remained for the most part pristine. Acknowledgements: Fondecyt Grant Nº 1090479 and CRN II 2047 of the Interamerican Institute for Global Change Research (IAI), supported by the US NSF Grant GEO-0452325.





PALEOCLIMATIC VARIATIONS IN THE CORDOBA HILLS (AR-GENTINA). OPAL PHYTOLITHS ANALYSIS FROM ARCHAEO-LOGICAL SITE EL ALTO 3. FIRST APPROACHES

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π π - ν

Keywords: Cordoba Hills, Paleoclimate, Opal Phytoliths.

The paleoclimatic tendencies during the Middle and Late Holocene are shown by means of opal phytoliths analysis in the Cordoba Hills, Argentina. Soil samples from the archaeological site El Alto 3 (1650 meters above sea level) from present to ca. 7100 BP were analyzed and identified into three Poaceae subfamiliy grasses (Pooideae, Panicoideae and Chloroideae) that are climatic indicators. Both temperature and humidity indices were taken from relative percentages of opal phytoliths according to international criteria and temperature and precipitation indices were calibrated in the study region by considering the current subfamilies grass/climate relationships obtained from 437 floristic samples. The correlation between the international and regional indices was strong and reinforced the reliability of the results obtained. At ca. 7100 BP the regional climate was colder and drier than current conditions but it was changing to a more humid condition towards ca. 6000 BP. After this moment, the climate began to warm and humidity continued increasing until at ca.4000 BP it was a warm and wet climate. At ca. 2000 BP the climate began to be cold and dry but at ca. 1500 BP temperature increased and conditions became warm and dry. From ca. 1000 BP to the present the climate has been changing progressively towards current wet and warm conditions.

ABSTRACT #119. Poster Presentation



THE 900-YR SEDIMENTARY RECORD OF LAGO THOMPSON, NORTHERN CHILEAN PATAGONIA

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Keywords: Lake sediments, Northern Chilean Patagonia, Little Ice Age.

We evaluate the climate and environmental variability of Northern Chilean Patagonia during the Last Millennium, using a multi-proxy analysis of a sediment core from Lago Thompson (area 1km²; 750 masl; 45°S, 71°W). The present-day climate conditions around the lake are relatively dry (annual precipitation ~500 mm), and the local vegetation is dominated by pasturelands and remnants of the native Subantarctic Nothofagus forest. In 2008, we surveyed the lake bathymetry with an echo-sounder and we collected several 1m- long sediment cores with an Uwitec gravity corer. The sediment cores, which are composed of light brown organic-rich clayey silt, were analyzed for sedimentology, mineralogy and geochemistry. The radiocarbon ages, measured on bulk sediment and macro-remains, demonstrate that the core covers the last 900 years. Visual descriptions and X-ray radiographies show that the sediment record is relatively undisturbed. The lower part of the core is finely laminated whereas the upper part appears more homogeneous. Magnetic susceptibility highlights the presence of two tephra layers. The biogenic silica content of the sediment is high (40 to 80%), in relation to the small catchment to lake surface ratio, which limits the supply of terrestrial particles to the lake. By comparison, the inorganic content of the sediment is very low. Some clay minerals, quartz and feldspars were identified by X-ray diffraction. The high organic matter content (mean 15%) and its low C/N ratio (8) throughout the core, evidence that the lake productivity remained high over the last 900 years. Higher concentrations in biogenic silica and organic matter between 1550 and 1800 AD could be interpreted as drier climate conditions in Northern Patagonia during the Little Ice Age. Further research will focus on biological proxies. This research is funded by Chilean and Belgian projects (Fondecyt project number 1070508, and FNRS "crédits au chercheur" 1360 2007-2010, respectively).



A 500-YR RECORD OF NORTHERN PATAGONIAN ENVIRON-MENTAL CHANGES: LAGO PLOMO AND LAGO BERTRAND

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Keywords: lacustrine sediments, Northern Chilean Patagonia.

We study the sedimentary records of two interconnected lakes from Chilean Patagonia (46.5°S 72.5°W). Lake Betrand is adjacent to the pro-glacial lake, Lake Plomo. The connection between both lakes is limited by a morainic barrier. The coring sites were selected after a bathymetric survey using an echo-sounder. Short cores were retrieved in 2009 using a gravity corer. For Lake Plomo radiocarbon, ²¹⁰Pb and ¹³⁷Cs data are consistent with a constant accumulation range of 2 mm/yr. ²¹⁰Pb data support a lower sedimentation rate for Lake Betrand. To reconstruct past climate changes, we conduct a multiproxy study combining sedimentology and geochemistry. Lake Plomo sediments are made by light brown silts with 20% of clay but no sand. X-ray radiographies demonstrate that the sediment is finely laminated, rich in organic macro-remains. The C/N ratio is stable, the average value of 15 supports the important terrestrial supply to the lake. The organic content of the sediment, calculated from 550°C loss of ignition, represent a few percents. The biogenic silica content of the sediment, estimated by atomic absorption after NaOH leaching, is very low (<5%). Microscopic slides reveal the sparse occurrence of small 6 to 10 µm diatoms. The Plomo sedimentary record contrasts with the adjacant lacustrine record, Lake Betrand. The sediment is made by homogeneous silts with some clays (< 20%) and 5 to 10% of sand. Lake Betrand is characterized by lower C/N ratio (10) supporting a more important aquatic productivity. Diatoms are abundant and larger in size (50-100 µm). The biogenic silica profile evidences two peaks (Si bio>30%) above a 5% background level. They probably record a major climate change in North Patagonian Andes. Even further sedimentological and geochemical analyses are in progress our observations evidence the potential of such lacustrine records to reconstruct the Last Millennium climate changes in North Patagonia. This research is funded by Chilean Fondecyt project number 1070508 and Belgian projects (FNRS proposal 1360 2007-2010, ULg CFRA 1060 2009-2010).

ABSTRACT #121. Poster Presentation



EMPIRICAL-STATISTICAL DOWNSCALING OF REANALYSIS DATA TO HIGH-RESOLUTION AIR TEMPERATURE AND SPE-CIFIC HUMIDITY ABOVE A GLACIER SURFACE (CORDILLERA BLANCA, PERU)

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Keywords: statistical downscaling, tropical glaciers.

Recently initiated observation networks in the Cordillera Blanca (Peru) provide temporally high-resolution, yet short-term, atmospheric data. The aim of this study is to extend the existing time series into the past. We present an empirical-statistical downscaling (ESD) model that links 6-hourly National Centers for Environmental Prediction (NCEP)/National Center for Atmospheric Research (NCAR) reanalysis data to air temperature and specific humidity, measured at the tropical glacier Artesonraju (northern Cordillera Blanca). The ESD modeling procedure includes combined empirical orthogonal function and multiple regression analyses and a double cross-validation scheme for model evaluation. Apart from the selection of predictor fields, the modeling procedure is automated and does not include subjective choices. We assess the ESD model sensitivity to the predictor choice using both single-field and mixed-field predictors. Statistical transfer functions are derived individually for different months and times of day. The forecast skill largely depends on month and time of day, ranging from 0 to 0.8. The mixed-field predictors perform better than the single-field predictors. The ESD model shows added value, at all time scales, against simpler reference models (e.g., the direct use of reanalysis grid point values). The ESD model forecast 1960-2008 clearly reflects interannual variability related to the El Niño/Southern Oscillation but is sensitive to the chosen predictor type.



WETLAND PALYNOLOGICAL FLORA OF THE CORDOBA AND CESAR DEPARTMENTS (COLOMBIAN CARIBBEAN) AND THEIR IMPLICATIONS IN THE PALEOECOLOGICAL RECONS-TRUCTIONS

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Keywords: palynological characterization, aquatic vegetation, Colombian Caribbean.

The palynological characterization of 213 species that settle down in aquatic and swamp environments, and in the flood plain of wetland complexes in the Colombian Caribbean, (Zapatosa, Cesar department and Arcial-Cintura, Cordoba department) allowed the differentiation of stenopalynological families like Cyperaceae with pollen grains inaperturates or pseudoaperturates, scabrates and tectates; Mimosaceae, inaperturates or tetracolporates, psilates, striates or reticulates, tectates or semitectates; Onagraceae with grains triporates, psilates or scabrates and tectates; Poaceae with grains monoporates, scabrates, psilate-scabrates, verrucates and tectates. In other families of the current vegetation and the sediments like Fabaceae, are presented grains tricolporates, psilates, scabrates and tectates; Lamiaceae with grains pericolpates, syncolpates, tricolporates, reticulates and semitectates. In floodplain euripalynological families like Apocynaceae predominate, with pollen grains stephanoporates or tricolporates, psilates, granulates, psilate-striates or psilate-scabrates and tectates and Polygonaceae with pollen grains periporates or tricolporates, reticulates, regulates or granulates, semitectates or tectates. In comparison with the traditional approach level (genera or family) that has been pursued in paleoecological works in Colombia, the availability of this palynological flora has allowed to recognize dominant elements with ecological relevance in the paleoecological reconstructions like *Phyllanthus elsiae* (Euphorbiaceae), Symmeria paniculata or Ruprechtia ramiflora (Polygonaceae), typical elements of the flood plain; species of *Cyperus* sp. (Cyperaceae), common in swamp environments and species of the genus Sagittaria sp. (Alismataceae), Utricularia sp. (Lentibulariaceae), Eichhornia sp. (Pontederiaceae), typical of aquatic vegetation. This atlas will facilitate the understanding of historical changes in the vegetation (for example the last 5000 years) in the Colombian Caribbean.

ABSTRACT #124. Oral Presentation



VARVED SEDIMENTS OF LAGO PLOMO (46°59 S / 72°52 W) AS A PALEOCLIMATE ARCHIVE AD 1572 – 2009

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Keywords: Climate reconstruction, varved lake sediment.

High-resolution climate reconstructions from a variety of natural archives across the world are needed to place climate change into a broader perspective. For the Southern Hemisphere Meteorological data only reach back until ca. AD 1900 and only few quantitative high-resolution reconstructions (mainly tree ring data) exist for the past Millennium. In this context South America plays a crucial role, because it is the largest land mass extending to the south. Lago Plomo (46°59S / 72°52W / 203 m a.s.l.) a Late-Glacial and Holocene proglacial lake east of the Northern Patagonian Ice field is one of the exceptional lakes that provides clastic sediments with annually resolved laminations. Three short cores up to 122 cm lengths were collected at 28.9 m water depth about 50m west of a Late-Glacial moraine that separates the lake from Lago Bertrand. ²¹0Pb and ¹³7Cs activity profiles and a calibrated ¹⁴C AMS date of a wood fragment at 41 cm sediment depth (~ AD 1850) are consistent with laminae counts confirming the annual nature of the laminae (classified as graded clastic varves). The mm-scale sediment laminae were analyzed for varve thickness, mass accumulation rate, scanning micro X-ray fluorescence spectroscopy and scanning reflectance spectroscopy 380-730 nm (VIS-RS). We compared Mass Accumulation Rates to meteorological data of the CRUTS 3 dataset (0.5°x0.5°) and found negative correlation for annual temperature (calibration period: 1901-2006) and positive correlation with summer precipitation (calibration period: 1930 - 2006). We also found that multi-decadal-scale variability of the Mass Accumulation Rate record AD 1572-2009 is related to the activity of the Glacier Soler (S 46°55', W 73°09') of the Northern Patagonian Ice field. Higher Mass Accumulation Rates in the sediments from AD 1572 to ~ AD 1700 are consistent with the Little Ice Age (LIA) maximum advance of Soler glacier which, according to (Masiokas 2009), occurred around AD 1650. Coring of longer sediment cores is scheduled for February 2011 to produce a Holocene record.



SCANNING REFLECTANCE SPECTROSCOPY 380-730 NM (VIS-RS) AS A NOVEL TOOL FOR HIGH-RESOLUTION CLIMA-TE RECONSTRUCTIONS FROM LAKE SEDIMENTS IN SOUTH CENTRAL CHILE

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Keywords: reflectance spectroscopy, reconstruction

Quantitative high-resolution climate reconstructions derived from lake sediments help to understand long-term climate variability and change. Scanning methods (XRF, near-infrared NIR and visible light VIS reflectance) are important, because they allow for very rapid, cost-effective and non-destructive acquisition of large multivariate data sets. In-situ (logging directly on the split sediment half-core) reflectance spectroscopy in the visible spectrum (380-730 nm: VIS-RS) is a novel, non-destructive scanning technique for the acquisition of high-resolution (2 mm) data from lake sediments. Von Gunten et al (2009) were able to reconstruct high-resolution (five years), quantitative austral summer (DJF) temperatures back to AD 850 from absorption characteristics between 660-670 nm (indicative of sedimentary photopigments) in organic lake sediments of eutrophic Laguna Aculeo in Central Chile. The method also works in minerogenic sediments: Trachsel et al (in press) developed a quantitative summer temperature reconstruction back to AD 1177 based on several reflectance-dependent variables that indicate the mineralogical composition (mainly clay minerals) of the clastic sediments. To explore the potential and limitations of the VIS-RS method we systematically tested intra-site, intra-lake and within-core variability for scanning in-situ VIS-RS data with cores from lakes of different size, origin and limnological and sediment properties in different geological and ecological settings across Chile (34-45°S). We compared the VIS-RS data with standard 'conventional' analytical techniques (Corg, C/N, loss on ignition, biogenic silica, and photospectrometric/ HPLC pigment determinations). Additionally we tested the method for effects of oxidation and water content. First results for sediments from several cores of Laguna Puyehue show that the method is highly reproducible and robust within a core and between different coring sites in the same lake, suggesting that VIS-RS may serve as a precise, rapid and low-cost tool for stratigraphic core correlations. We recommend that VIS-RS measurements should be done immediately after core opening because changing water content and oxidation of the fresh core surface influences individual spectra-derived parameters (mainly those indicative of organic compounds and maybe iron minerals) while other parameters of the spectra remain unaltered and robust.

ABSTRACT #126. Oral Presentation



LARGE-SCALE CONTROL ON THE CLIMATE OF PATAGONIA: CLUES FOR PAST AND FUTURE CHANGES

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Keywords: Patagonia, climate change, modelling.

The climate results from the interaction of the atmospheric (and, sometimes, oceanic) large-scale circulation with the regional geography (mountains ranges, coastline geometry, presence of lakes, etc). Accordingly, a significant fraction of climate variability and climate change is caused by variations in the large-scale circulation, although the functional relationship can be quite complex. In this work we investigate the large-scale factors that control the climate variability of Patagonia in southern South America. The region is embedded in the circumpolar belt of westerly flow and the storm track of the Southern Hemisphere, and divided by the Andes cordillera leading to a marked precipitation gradient between the hyper-humid conditions in the Pacific side and dry conditions to the east of the mountains. Previous studies have shown that year-to-year changes in zonal flow (U) are strongly and positively (negatively) correlated with annual-mean precipitation (R) changes to the west (east) of the Andes. We now extend this analysis to seasonal averages of precipitation and surface air temperature (SAT), and augmented the poor observational records by using results from a regional (25 km horizontal resolution) climate model (PRECIS) integrated between 1960 and 1990. The recalculated U-R relationship is quite stable year round and mostly similar to the previous (observational) result. In contrast, the new U-SAT relationship exhibits significant seasonal and geographical dependence. For instance, years with stronger than normal westerly flow are associated with milder than normal winters in western Patagonia but colder than normal summers in eastern Patagonia. The variations in SAT are interpreted in terms of the windmediated changes in temperature advection and surface energy balance. As a relevant application, we use the U-SAT and U-P relationships to obtain the changes in temperature and precipitation over Patagonia that are congruent with changes in the zonal wind during the second half of the XX century.





MULTIPROXY RECONSTRUCTION OF HYDROLOGICAL CHAN-GES DURING THE LATE HOLOCENE IN LAGUNA CHÁLTEL (SOUTHERN PATAGONIA, ARGENTINA)

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Keywords: Paleolimnology, multiproxy approach, Southern Patagonia.

Laguna Cháltel (49° 57' S- 71° 06' W) is a crater lake located in the semiarid steppe of Patagonia. Several cores obtained by the South Argentinean Lake Sediment Archives and Modelling international research project were analyzed using a multi-proxy approach to reconstruct the paleoenvironmental history of the lake. Changes in diatom, chironomid and ostracod assemblages and detailed geochemical analysis provided information about past lake water level fluctuations and hydrological changes in the watershed. Between 4500 and 3900 cal. BP, relatively moist conditions can be inferred from ostracods. From 3900 to 3150 cal. BP, there is geochemical evidence of allochthonous input and a shift to saline conditions implied by marked changes in ostracods. Both indicate low water level by that time. Between 3150 and 2400 cal. BP, conditions became moister with a concurrent lake level rise. Moderate salinities and the presence of abundant marginal vegetation are inferred from ostracods and diatoms. At 2400 cal. BP changes in diatom and ostracod assemblages suggests that the lake level rose markedly. These conditions may have triggered lower salinities, and higher productivity. A noticeable increase in diatoms may have been enhanced by expansion of littoral habitats. The high lake level may point to a less arid climate or less evaporation due to higher relative humidity, less wind or seasonal ice cover. A new shift to cooler/moister conditions took place at around 1400 cal. BP, when modern lake conditions were established. The presence of littoral and semiterrestrial chironomid species confirms diatom interpretation of expansion of littoral habitats. The present work, which was partially financed by the Southern Patagonia Interdisciplinary Project (PIPA) (PICTR 2006 - 2338) and includes neolimnological information obtained by its members, enhances the understanding of spatial patterns of past hydrological changes in Southern Patagonia steppe, indicating further hydrological variations during the late Holocene.

ABSTRACT #129. Oral Presentation



PRECIPITATION AS THE MAIN DRIVER OF NORTHERN PA-TAGONIAN GLACIER VARIABILITY DURING THE LAST 5400 YEARS: EVIDENCE FROM CHILEAN FJORD SEDIMENTS

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Keywords: Northern Patagonia, Fjord, Neoglaciation.

The Northern Patagonian Ice Field (NPI, Chile, 47°S) is one of the largest lowlatitude ice masses in the world. It covers an area of 4200 km² and it receives annual precipitation of 6000-8000 mm. Here, we reconstruct the mid- and Late Holocene variability of Gualas Glacier, one of the northernmost outlet glaciers of the NPI, using a multi-proxy sedimentological and geochemical analysis of a 15 m long sediment core from Golfo Elefantes. We then compare our proxy record with regional precipitation and sea surface temperature (SST) reconstructions to assess the origin of NPI glacier variability during the last 5400 years. Between 5400 and 3700 cal. yr. BP and from 750 cal. yr. BP to the present, sedimentation in Golfo Elefantes was characterized by the rapid deposition (~10 mm/yr) of fine silt, most likely transported by fluvio-glacial processes. In contrast, the geochemistry and grain-size of the sediment deposited between 3700 and 750 cal. yr. BP indicates slow sub-glacial sedimentation, most likely resulting from a major advance of Gualas glacier during the Neoglaciation. Our sediment record also provides evidence for minor glacier advances during the Little Ice Age, in agreement with historical data from Gualas and San Rafael glaciers. Regional paleoclimate and paleoceanographic records suggest that the Neoglacial advance of Gualas glacier was caused by a combination of low temperature and high precipitation. However, its retreat at the end of the Medieval Climate Anomaly seems related to a decrease in precipitation, rather than an increase in temperature. Similarly, the minor Little Ice Age re-advances correspond to increased precipitation. These results therefore suggest that NPI glacier variability is mainly driven by precipitation in the Andes, which is in turn controlled by the strength and latitudinal position of the Southern Westerlies. Additional high-resolution precipitation records are however needed to confirm this hypothesis.





PUTTING THE RISE OF THE INCA EMPIRE WITHIN A CLIMA-TIC AND LAND MANAGEMENT CONTEXT

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Keywords: climate, history, Inca.

The rapid expansion of the Inca from the Cuzco area of highland Peru (ca. AD 1400-1532) produced the largest empire in the New World. Although this meteoric growth may in part be due to the adoption of innovative societal strategies, supported by a large labour force and a standing army, we argue that it would not have been possible without increased crop productivity, which was linked to more favourable climatic conditions. A multi-proxy, highresolution 1200-year lake sediment record was analysed at Marcacocha, 12 km north of Ollantaytambo, in the heartland of the Inca Empire. This record reveals a period of sustained aridity that began from AD 880, followed by increased warming from AD 1100 that lasted beyond the arrival of the Spanish in AD 1532. These increasingly warmer conditions allowed the Inca and their immediate predecessors the opportunity to exploit higher altitudes (post-AD 1150) by constructing agricultural terraces that employed glacial-fed irrigation, in combination with deliberate agroforestry techniques. There may be some important lessons to be learnt today from these strategies for sustainable rural development in the Andes in the light of future climate uncertainty.

ABSTRACT #131. Oral Presentation



RECONSTRUCTING WINTER SNOW ACCUMULATION SINCE AD 1150 IN THE ANDES (30°-37°S) USING TREE RINGS, HIS-TORICAL DOCUMENTS AND INSTRUMENTAL RECORDS

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Keywords: Andean snowpack reconstruction, tree rings, historical records, time series analysis.

The Andean snowpack between 30°-37°S is the main water source in the adjacent Chilean and Argentinean lowlands and has affected communication and transportation between these regions since at least Spanish colonial times. Here we present a series of sequential reconstructions of a regionallyaveraged snowpack record based on different proxies with varying explanatory power and temporal coverage. First, the 1951-2010 snowpack record is extended back to 1909 using a strongly correlated regional streamflow series. Instrumental values for winter precipitation in central Chile, also strongly related to snow accumulation levels in the adjacent Andes, are then used to reconstruct regional snowpack variations since 1866. These reconstruction models explain over 80% of the variance in the snowpack series. Snow accumulation levels are then extended back to AD 1535 using two selected treering width chronologies from drought-sensitive Austrocedrus chilensis trees plus historical and instrumental information on extreme wet years in central Chile. In this case 71% of the predictand's variance is accounted for by the model. Finally, a very simple tree-ring based model that explains almost 50% of the variance over the 1951-2000 calibration period is used to reconstruct winter snowpack variations back to AD 1150. Additional information on mountain snow accumulation since the 18th century has recently been compiled from historical reports and could also be incorporated into future models to provide better estimates of past snowpack changes in this portion of the Andes. This is the first attempt to reconstruct Andean snowpack variations from different proxies with different inherent limitations (e.g. tree rings are more capable of recording below-average snowpack conditions, historical documents focus mainly on extreme wet/snowy years), and the approach appears quite promising. An innovative combination of time series analysis techniques will be used to identify the main intra- to multi-decadal patterns in the snowpack reconstructions. Such analyses will allow the objective evaluation of the variations observed in the instrumental series within a multicentury perspective.



MULTI-PROXY TEMPERATURE AND PRECIPITATION FIELD RECONSTRUCTIONS FOR SOUTHERN SOUTH AMERICA OVER THE PAST CENTURIES

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Keywords: multi-proxy, field reconstructions.

We present the methods and results of the first attempt to integrate the currently available proxy records of southern South America (SSA) to derive seasonally-resolved regional climate field reconstructions. Under the umbrella of the PAGES LOTRED-SA initiative, annually-resolved records from natural archives (tree rings, ice cores, corals, lake and marine sediments) and documentary evidence were collected, screened and optimized for climate field reconstructions. Out of the 144 records sensitive to SSA climate, four independent subsets were selected to reconstruct temperature and precipitation fields in 0.5°x0.5° spatial resolution for austral summer (DJF) and winter (JJA). Various reconstruction methodologies and predictor combinations were applied to validate the robustness of the reconstructed climate variations. The available proxy evidence allowed reconstructions of summer (winter) temperature back to AD 900 (1706) and precipitation back to AD 1498 (1590). The reconstructions reveal distinct seasonal variations in the multi-centennial evolution of both temperature and precipitation. The results also allow identification of regional differences in trends, variability, extremes and amplitude within the reconstructed fields. In some areas, particularly in eastern SSA, the uncertainties of the reconstructions are still high, due to the relatively sparse coverage with both proxy and instrumental data. This underlines the need for more high resolution proxy records in order to improve forthcoming SSA climate reconstructions in both the spatial and temporal domains.

ABSTRACT #133. Poster Presentation



SOUTHERN HEMISPHERE ATMOSPHERIC CIRCULATION VARIABILITY OVER THE PAST MILLENNIUM: A NEW MULTI-PROXY RECONSTRUCTION PROJECT

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Keywords: multi-proxy, field reconstructions, Southern Hemisphere.

Currently, large scale climate variability in the Southern Hemisphere (SH) can only be quantified for the short instrumental period starting as early as AD 1871, but more reliably from around 1948. To understand the processes driving SH climate variations needed to improve future predictions of SH climate, it is essential to analyze spatio-temporally highly resolved paleoclimate data. This project aims to statistically reconstruct coherent modes of SH atmospheric circulation, expressed as sea level pressure (SLP) variability over Australasia, the South Pacific and South America for the past 400–1000 years using natural and documentary proxy data, early instrumental measurements and data from ship log books. These reconstructions, together with outputs from climate model simulations, will help to interpret the multi-centennial regional temperature and precipitation variations reconstructed within the PAGES initiatives Aus2k (Australasia) and LOTRED-SA (South America). Here, we present an overview of the currently available circum-Pacific proxy network and discuss its potential for SH SLP reconstructions.



REGIONAL TEMPERATURE RECONSTRUCTION FROM ILLI-MANI ICE CORE

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Keywords: ice core, Illimani, ammonium.

High resolution ice core records may provide good proxies for past climate and atmospheric parameters, a kind of information especially valuable for the Southern Hemisphere, where instrumental data are sparse. Stable isotope data from high-elevation ice cores have been interpreted with respect to past temperature variability. However, calibration attempts and modeling studies for tropical South America point to a dominant sensitivity to precipitation at least on annual and decadal timescales. We propose instead the ammonium concentration as a new proxy for tropical South American temperatures. This proxy was developed using a highly resolved and carefully dated ammonium record from an ice core that was drilled in 1999 on Nevado Illimani in the eastern Bolivian Andes (16°37'S, 67°46'W, 6300 m). The reconstruction reveals that Medieval Warm Period and Little Ice Age type episodes are distinguishable in tropical South America, adding evidence that these climate phenomena were not confined to the Northern Hemisphere. For the time period from about 1050 to 1300 AD, relatively warm conditions prevailed that were followed by cooler conditions from the 15th to the 18th century, when temperatures dropped by up to 0.6°C below the 1961–1990 average. The last decades of the past millennium are characterized by warm temperatures that seem to be unprecedented in the last ~1600 years.

ABSTRACT #135. Oral Presentation



ACCUMULATION RATES DERIVED FROM PIO XI ICE CORE, SOUTHERN PATAGONIAN ICEFIELD

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Keywords: ice core, accumulation rates

The Southern Patagonia Icefield (SPI) is the largest ice body of the Southern Hemisphere outside Antarctica with an area of 13,000 km² and 48 major glaciers. Pio XI, the largest glacier of the SPI, reached its neoglacial maximum extent in 1994 and is one of the few glaciers in that area, which is not retreating. In view of the recent warming it is important to understand glacier responses to climate changes. However, no systematic mass balance studies have been performed on this glacier, due its remoteness and the harsh conditions in Patagonia. In this study we derived net accumulation rates from a 50 m firn core collected in the accumulation area of Pio XI (2600 m a.s.l., 49°16'S, 73°21'W). Borehole temperatures indicate temperate ice, but records of stable isotopes and biological markers are well preserved and were used for identification of annual layers. Accumulation rates range from 4.4 to 7.1 m weq, with an average of 5.8 m w. eq., comparable to precipitation amounts at the Chilean coast, but not as high as expected for the Icefield. Ice core stable isotope data agree reasonably well with upper air temperatures. Assuming well-preserved records in the deeper part and simple Nye-type glacier flow, the 170 m thick Pio XI glacier may contain 100 to 200 years of past climate history.



ENSO-RELATED ACCUMULATION VARIABILITY DERIVED FROM MERCEDARIO ICE CORE

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Keywords: ice core, accumulation rates, ENSO.

The climate of South America is irregularly altered by ENSO, which is a climate phenomenon of the tropical Pacific having important consequences on climate and weather around the globe. In subtropical South America, between 28 and 35°S, El Niño events are associated with increased precipitation, which is probably due to a less pronounced anticyclone that allows the Westerlies to move further north. In 2005, a 104 m ice core was recovered from Glaciar La Ollada on Cerro Mercedario (31°58'S, 70°07'W, 6100 m a.s.l.), covering 92 years (1913-2004). Accumulation at Cerro Mercedario varies between 0.3 and 1.8 m weq, with a mean accumulation of 0.91 m weq. This is high compared to Santiago de Chile (0.32 m, Central Valley), but the amount of precipitation in the high elevation Andes can usually be of the order of three or four times the amount over the Central Valley at the same latitude. Nevertheless, the year-to-year fluctuation agrees well and years with high accumulation generally correspond to El Niño events. Mass balance data from Piloto Glacier at Cajón del Rubio (32°S, 4500 m a.s.l.) support the observed accumulation rate on Cerro Mercedario. There, mean total accumulation was 0.96 m weg yr⁻¹ for the time period 1979-2002. Echaurren Norte (33°S, 3800 m a.s.l.), a glacier 50 km east of Santiago de Chile, shows even higher accumulation rates of 2.7 m weg yr⁻¹ in the period 1975-2009. Both glaciers have high ablation rates as they are located at a lower altitude. Similar to Santiago the year to year fluctuation agrees well (Piloto Glacier: r=0.41), Echaurren Norte: r=0.33). In addition, Piloto Glacier and Mercedario show a decreasing trend since the mid 1980s, which is unincisive in the Santiago record.

ABSTRACT #137. Oral Presentation



CLIMATIC RECONSTRUCTIONS FROM HIGH-ALPINE LAGU-NA CHEPICAL, CENTRAL CHILEAN ANDES, SINCE AD 1880: TESTING SEASONALLY RESOLVED PROXIES

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Keywords: seasonal climate reconstructions, chrysophyte stomatocysts.

Climate in the central Chilean Andes is characterized by strong seasonal and interannual variability. In summer, dry conditions dominate, related to a strong South Pacific Anticyclone. In winter, however, weakening of the anticyclone allows for the northward progression of the westerly wind belt, controlling temperature, wind and precipitation patterns between ca. 32-65 °S. Therefore, seasonally resolved proxy records are required to reconstruct past climate variability and mechanisms in this region. This study aims to test the strength and seasonal representation of novel and established proxies derived from lake sediments by comparison to meteorological and reanalysis data. These proxies can then be applied to provide seasonally resolved reconstructions further back in time. A sediment core from Laguna Chepical, a high-alpine lake in the central Chilean Andes (32.16 °S, 70.30 °W, 3050 m. a.s.l.) was analysed for C/N, total biogenic Silica (bSi) and total organic carbon (TOC) from AD 1880 to present at 2 mm resolution. In addition, scanning reflectance spectroscopy (380-730 nm; VIS-RS) was used to infer past summer temperatures; previous work from the Chilean lowlands has shown a strong correlation between VIS-RS based proxies and summer temperature. Similarly, bSi and TOC may reflect summer - autumn temperature. To determine the timing and influence of human impact, long-term pollen analysis was included in the project. The chronology of the core was based on detailed ²¹⁰Pb dating, constrained by spheroidal carbonaceous particle counts and a clear ¹³⁵Cs peak. Detailed chrysophyte stomatocyst analysis was also carried out. Chrysophyte stomatocysts (siliceous 'cysts' produced by golden-brown algae; Synurophyceae and Chrysophyceae) are known to be sensitive indicators of cold-season temperatures and are common in alpine lakes. In the sediments from L. Chepical, cysts were abundant and diverse. The calibration-in-time approach was used to i) determine the season reflected by each of the proxies and ii) test the performance of each proxy. The promising results obtained so far indicate that several of these methods may be used to generate long-term, season-specific climatic reconstructions from a region for which currently few – in particular cold-season temperature – reconstructions are available.



EVALUATING SYNTHETIC RAINFALL DATA AND ITS DISTRI-BUTION GENERATED FOR FUTURE CLIMATE PROJECTIONS THROUGH HYDROLOGICAL MODELS IN CATALONIA

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Keywords: climate change, rainfall distribution, soil moisture accounting models.

According to the General Circulation Models (GCMs) projections for the western Mediterranean region indicate a decrease of precipitation and increase of temperature and precipitation variability in a time horizon of 100 years. But the question arises about the consequences on water resources. To verify this point, a general hydrological model will be used, verified over three selected Mediterranean catchments, to assess the influence of precipitation / temperature variation on the water resources. Twenty-five years with temperature, precipitation and flow discharge, from 1984 to 2008, will be used to verify an HMS model, with the Soil Moisture Accounting loss model selected for long term simulations. Because the quantification of water availability for future scenarios represents one of the goals to be achieved, the hydrological model needs to address this issue. Rainfall and temperature simulations for future scenarios of climate change due to greenhouse-gas emissions were obtained from the ECHAM model (Max Planck Institute). Estimated greenhouse effects for the A2/B1 scenarios were considered. As the coarse GCM outputs are not suitable for hydrologic studies in small catchments, GCM outputs were considered for downscaling, based on stochastic weather generators. Stochastic methods applied were Markov chains and Weibull distribution for precipitation and ARMA models for temperature. Several tests have been carried out with synthetically generated data in different catchments and subcatchments to evaluate changes in production of water. On the other hand different distributions of rainfall by months and years have been tested and it has been observed that rainfall distribution has a high sensitivity in the hydrological cycle, since the whole hydrological system reacts different with intensity, duration and distribution of the rainfall. Thus it has to be included in further test and studies how this effect may have an impact in the production of water, especially in semi-arid zones.

ABSTRACT #139. Oral Presentation



CLIMATE, MAIZE AGRICULTURE AND HUMAN DIET IN SOUTH AMERICA MID LATITUDE: STABLE ISOTOPES IN HUMAN BONES

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Keywords: maize, mid latitude, human strategies, first farmers

The human paleoecological perspective can provide information about simple societies in pre Hispanic times. In this sense we can try to understand some aspect of the human strategies and the relationship with environmental and climatic change from this record. This paper explores the development, significance and variation of maize consumption between human societies in arid environments at different altitudinal levels during the last 2000 years. Bone collagen and bone apatite stable isotope signatures covary with reliance on maize, facilitating useful reconstructions of past diet. Stable isotopes in archaeological human bones (δ^{13} C, δ^{15} N and δ^{18} O) from mid latitude west South America (30°- 40° SL) is presented in order to characterize the diet. The results show meaningful temporal and spatial variation on maize consumption significance during the late Holocene. The relationship between these variations in human diet with paleoclimate trends is discussed. The paleoenvironmental records from late Holocene suggest environmental variations in the Andes and in eastern lowlands. Evidence of re-advanced glaciers show climate variability in the region. In order to understand the landscape evolution and the relationship between human strategies and climate this case is a good opportunity to understand the development of maize farming and its variability in arid-semiarid landscape. The region is a pre Hispanic boundary of maize record and in this sense it is a case to understand the way to incorporate or not maize in the human diet. The case is compared with information from the Great Basin (North America) in order to explore a more general pattern about the maize consumption and climate during the Holocene.

ABSTRACT #140. Poster Presentation



ISOTOPIC AND CHEMICAL SIGNATURES OF SURFACE SEDI-MENTS FROM THE PUNA-ALTIPLANO AREA

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Keywords: Puna-Altiplano Plateau, South America, Paleoclimatic records.

The Puna-Altiplano plateau (PAP) is considered, together with Patagonia, an important source of aeolian materials to surrounding areas such as the Pampean region, the Southern Ocean, and the Antarctic continent. The climatic condition of the PAP is closely associated with the upper air circulation. Easterly zonal flow from May to October is related to moisture conditions (<5% of the time), whereas westerly flow prevails during dry conditions. At the latitude of ~25°S, the Puna is crossed by the subtropical jet stream (tropospheric westerly). The jet stream reaches its maximum intensity during winter and early spring, allowing the development of huge storms which deflate large amounts of sediments. We present here preliminary data on chemical and isotopic composition of sediments susceptible to be deflated from the PAP area. Surface sediment samples were taken in a N-S transect from Uyuni (19°39' S, 68°11' W , Bolivia) to Campo Carachi (27° S, 66°18' W, Catamarca, Argentina) including different geomorphologic environments: ephemeral lakes, lowland areas, edges of salt flats, alluvial fans, and dunes. In order to define the geochemical signature from different areas of the PAP, chemical and isotopic sediment compositions were compared with geochemical data from different lithologies present in the study area. We noted that the "macro-regional" signature along the N-S transect is heterogeneous, enabling the identification of different PAP areas in sediment provenance studies from different paleoclimatic records. Furthermore, we present evidence that in addition to the Patagonian region, the PAP area could be another source of aeolian material in southern South America contributing to the Pampean loess accumulation and its transport to Antarctica.
ABSTRACT #141. Oral Presentation



PALEOCEANOGRAPHIC STUDIES FROM THE CHILEAN FJORDS

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Keywords: Patagonia, Fjord, sediments

The Chilean fjords, located between 41° and 56° S, cover an area of roughly 241,000 km² characterized by an extensive coast line composed by a large number of islands, fjords, sounds, basins and gulfs which were formed by glacial erosion during the Quaternary and tectonic sinking of the central Chilean valley. The fjord region lies mostly under the influence of the main Southern Hemisphere atmospheric circulation pattern, the Southern Westerlies, which in turn, are closely linked to changes within the tropical climate system and climate conditions in coastal Antarctica. High annual rainfall in the fjord region (1,000-7,000 mm year⁻¹) and high mean annual river discharges (~2,500-3,500 m3 s⁻¹) greatly enhance the supply of terrigenous sediment which leaves its mark in the sedimentary record. The sediments in the fjord region accumulate at high sedimentation rates (up to 0.8 cm yr⁻¹, at the sediment surface). The terrigenous organic matter content in the sediments increases from the oceanic area to the heads of the fjords due to local river discharges. Sediments influenced by glaciers have very low organic matter due to dilution by the large amounts of inorganic matter contributed by glaciers. Both freshwater and marine microfossils are abundant in sediment cores, allowing assessment of variability in freshwater input through time which in turn is tied to precipitation on land and river runoff into the fjords. I will present data from ongoing collaborative research by UDEC students and researchers with colleagues from AWI, MARUM, JAMSTEC, MIT, Univ. Trier in the Chilean fjords and adjacent oceanic area, addressing the following themes: 1) Surface sediments as mirrors of surface marine productivity and continental influence; 2) Short-term fluctuations in sea surface temperature, productivity, and the continental signal over the past 200 years; and 3) Holocene sea surface temperature evolution from high-resolution marine sediment cores from Southern Patagonia and the Strait of Magellan.





LATEGLACIAL /EARLY HOLOCENE CLIMATIC RECONSTRUC-TION FROM LAKE MASCARDI (PATAGONIA, ARGENTINA) USING A MULTIBIOPROXY APPROACH

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Keywords: multibioproxy study, climate reconstruction, Patagonia.

Despite the recent increase of paleoproxy work from both marine and terrestrial archives in the Southern Hemisphere, the relationships between glacialinterglacial climate changes in the Northern and Southern Hemispheres remain clouded by uncertainties in the absolute timing and magnitude of the events recorded in both hemispheres. In southern South America, the debate is primarily focused on the existence of a ACR-like, a YD-like, or a mixture of both cooling events at the end of the LGM. In this paper we explore climate changes occurred during the Late Glacial/ Early Holocene transition (between 15,000 and 11,000 cal yr BP) in Lake Mascardi, a glacial lake located eastern of the Andes in Argentinean Patagonia at 41º S. This multiproxy study provides high-resolution postglacial chironomid, cladoceran and diatom records which, combined with detailed radiocarbon dating and geochemical analysis, revealed the suitability of these bioproxy data in helping to pinpoint timing and magnitude of cold/warm dry/wet episodes and to produce more robust interpretations of climate change in southern South America. This paper, along with previously published records from the southern midlatitudes suggests a more complex relationship in temperature trends between the polar hemispheres than the widespread notion of in-phase versus climatic anti-phase during the Last Glacial-Interglacial Transition.

ABSTRACT #143. Oral Presentation



TOWARDS A POLE-TO-POLE PALEOCLIMATE RECONSTRUCTION IN THE AMERICAS

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Keywords: lake sediments, databases, paleoclimate reconstruction methods, palynology.

Pollen analyses from lake sediments can produce paleoclimate records of at least century-scale resolution, as documented using both high-resolution analyses and regional reconstructions. In North America, progress in this area was greatly enhanced due to a publically-available database of modern calibration data, including both modern pollen and environmental data derived from gridded datasets. Recent regional and continental-scale paleoclimate reconstructions have clearly shown millennial-scale climate variability, including the Little Ice Age and Medieval Warm Period, and have quantified these temperature variations of the past 2ka, but also extended the records further back in time. Comparison these pollen-based reconstructions with those derived from tree-rings or other sources show a close correspondence, suggesting that a combined reconstruction can provide improved multi-scale paleoclimate estimates. These multi-proxy records are essential to derive accurate records with multi-scale variability, as any one type of proxy record may alias or truncate certain frequencies of climate variability. Using regional reconstructions and time-space diagrams, we have shown the spatial and temporal evolution of the climate across North America. These have indicated a slight time-transgressive behavior to the initiation and termination of the Little Ice Age and Medieval Warm Period from west to east across North America. A similar methodology could be applied to derive a pole-to-pole quantitative reconstruction that could answer critical questions in paleoclimatology.



CUSHION PEATLANDS ("BOFEDALES") IN THE HIGH ANDES AS A NEW GEOARCHIVE IN THE CONTEXT OF MULTIDISCI-PLINARY STUDIES

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Keywords: cushion peatlands, bofedales, palaeoecology.

The function of high-altitude cushion peatlands as climate archives is becoming more and more important for paleoclimatological research in the Andes. Our current research work demonstrates that they are well-suited for high-resolution paleoecological studies. These unique ecosystems, dominated by juncaceous, peat-forming cushion plants, can develop astonishing accumulation rates, depending on the topography and a permanent and balanced water input. They form below spring outlets on slopes or in valley bottoms at altitudes ranging from 4000-5000 m a.s.l. We present first results of multi-proxy studies on peat cores from cushion peatlands in the western cordillera of southern Peru (Lucanas province) and in the eastern cordillera of northwestern Argentina (Jujuy province). We compare peat accumulation characteristics in the different Andean regions and discuss the impact of anthropogenic activities on peatland formation. Pollen, charred particles and plant macrofossil records provide continuous high-resolution chronologies over the last 2000 years, verified by geochemical analysis (CNS, humification, XRF scanning). Results show that drier conditions are attended by a significant increase in shrub pollen (mostly Asteraceae). During humid phases, grasslands expanded and provided fuel to burn. The recorded environmental changes during the last millennia coincide well with pre-Columbian history and, furthermore, offer a more exact timing for comparison with continentalscale records. Our findings show that in both study areas, the strength of convective tropical summer precipitation mainly controlled the humidity conditions. Their intensity might be regionally controlled by temporal variabilities in the formation and the position of the Bolivian High.

ABSTRACT #145. Poster Presentation



A SEVEN-YEAR SYNOPTIC CLIMATOLOGY OF HEAVY ORO-GRAPHIC PRECIPITATION EVENTS OVER THE SUBTROPICAL CENTRAL ANDES (30^o-37^oS)

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Keywords: heavy precipitation, subtropical central Andes, atmospheric rivers.

This study investigates the synoptic conditions during the 46 heaviest winter (Apr-Sep) orographic precipitation events from 1970 to 1976 over the Central Andes (30° - 37° S). Four to five heavy events account for most (~70%) of the winter total precipitation, which in turn represents more than 90% of the total annual precipitation. Consequently, heavy orographic precipitation events play a crucial role in the regional water cycle on central Chile and central-western Argentina, supplying water to adjacent regions and generating in some cases floods, avalanches and road blockings. Based on the ERA-40 reanalysis and rawinsonde data, the dominant and key pattern for these events was a long (>2000km) and narrow (<1000km) plume of large Integrated Water Vapor (IWV) with strong low-level northwesterly winds, along the cold-front surface in the warm sector of extratropical cyclones moving eastward over the Pacific Ocean. These IWV plumes, called "atmospheric river" in previous studies on the western coast of North America, made landfall on south-western South America discharging large water vapor amounts as precipitation over the Andes by orographic lifting mechanisms. Moisture flux and IWV fields of two sub-groups of 46 heavy precipitation events revealed that extreme (i.e., daily precipitation into the 95%-100% percentile) and intense events (i.e., into the 75%-95% percentile) were associated with atmospheric rivers in 91% and 75% of the cases, respectively. Consistently, anomalous low-level northwesterly winds predominated in heavy events, exceeding 2σ from winter climatology in 70% of the 46 cases. Deeper cyclones and stronger atmospheric rivers against the Andes occurred with extreme than intense events, suggesting more accentuated upslope moisture flux raining out over the mountains. The results of this study indicate that atmospheric rivers greatly modulate winter precipitations over the subtropical central Andes.



CENTENNIAL-SCALE CHANGES IN CLIMATE, VEGETATION AND FIRE REGIMES IN NW PATAGONIA OVER THE LAST 2000 YEARS

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Keywords: Westerly precipitation, Medieval Climate Anomaly, Little Ice Age.

Few paleoecological studies throughout Patagonia have the required detail and sensitivity to decipher centennial-scale environmental changes over the last 2000 years. This time frame offers the opportunity to examine the sensitivity and vulnerability of terrestrial plant communities and fire regimes to historical and pre-Hispanic disturbance, and allows testing for the regional occurrence of climate anomalies during the so-called Little Ice Age (~700-100 cal yr BP), Medieval Climate Anomaly (~1200-700 cal yr BP), and several warm/cold oscillations that preceded them. In this study we present results of precisely dated high-resolution sedimentary records from small, closedbasin lakes from the lowlands of NW Patagonia. Among the similarities in our palynological and paleofire records we stress a conspicuous warm/relatively dry interval between 1200 and 800-600 cal yr BP. These conditions terminated abruptly at ~800 or 600 cal yr BP with an increase in hygrophilous trees that persisted until ~480 cal yr BP. Forest taxa indicative of warm/relatively dry conditions reexpanded at that age until the onset of intermediate- or large-scale disturbance by fires set by Europeans sometime between ~390-290 cal yr BP, depending on site location. Intersite heterogeneities/divergences indicate strong spatial heterogeneities in vegetation and susceptibility to fire occurrence, suggesting that the magnitude of climate forcing during some of these intervals was rather subtle, and/or there were significant spatial variations in fire occurrence. One implication of our results is that climate and disturbance agents have affected the composition and dynamics of the natural vegetation repeated times over the last 2000 years in the study area. Apparently, fire regimes have accelerated the transitions between states at times of declining precipitation of westerly origin. The regional and global implications of these findings will be discussed during the presentation. Acknowledgements: ICM P05-002, PFB-23, Fondecyt 1070991.

ABSTRACT #147. Oral Presentation



PRECIPITATION AND RIVER DISCHARGE IN SUBTROPICAL SOUTH AMERICA: A LONG-TERM PERSPECTIVE FROM TREE RINGS

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Keywords: Subtropical northwestern Argentina, dendrochronology, rainfall and streamflow reconstructions

The sustainable management of water resources is an increasingly demanding topic in view of future climatic and human water-consumption projections. The disruption of the northeasterly humid-air flow by the Sub-Andean mountain ranges generates a latitudinal-band of enhanced orographic precipitation in subtropical northwestern Argentina (SNWA). These Sub-Andean mountain areas are the major sources of water for the river systems in NWA. It has been shown that tree-ring variations from the montane forests in SNWA are sensitive to annual or even seasonal variations in precipitation. Consequently, they provide a unique opportunity to evaluate the long-term variability in precipitation and streamflow across the region. Principal component analysis was applied to a network of Juglans australis chronologies in SNWA to determine the common patterns of variance among records. Correlation and multiple regression techniques were used to determine the relationships between the tree-ring dominant patterns and monthly rainfall variations. Based on the strongest correlations between precipitation and tree growth, transfer functions were developed to estimate past variations in precipitation during the past 2-3 centuries using tree-ring records as predictors. Our results indicate that variations in growth are related to late spring-summer rainfalls, the season of the year recording the largest precipitation, and consequently, the maximum runoffs in SNWA. According to our reconstructions, precipitation variability has increased since early 1990s leading to years of extremely-wet followed by very-dry events. Reconstructions of seasonal precipitation and streamflow may provide an important framework to evaluate the current hydroclimatic changes in the subtropical regions in South America influenced by the summer monsoon system.





PRECIPITATION VARIABILITY IN THE ALTIPLANO DURING THE PAST 700 YEARS: INTEGRATING INSTRUMENTAL, TREE-RING AND HISTORICAL RECORDS

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Keywords: Polylepis tarapacana, precipitation reconstruction, documentary data.

Precipitation variations in the Altiplano have direct human and environmental impacts, often being associated with droughts and floods. Instrumental records of climate in the tropics are short, fragmentary and heterogeneous. In this study we present a multi-century perspective of past precipitation variations in the Altiplano estimated from historical documents and a precipitation reconstruction based on *Polylepis tarapacana* tree-rings. The atmospheric circulation patterns associated with precipitation variations over the region were also analyzed. Previous dendrochronological studies have demonstrated the high skill of P. tarapacana as a proxy for precipitation. The radial growth of this tree species is strongly influenced by moisture availability, representing an excellent proxy for past precipitation. The tree-ring reconstruction covers the past 700 years, and captures 54% of the instrumental precipitation variance. Spectral analysis of the tree-ring reconstruction reveals significant peaks at interannual, decadal and interdecadal scales which are in agreement with the main oscillatory modes recorded in instrumental records, and the Niño3.4 and PDO indices. In agreement with previous studies, analysis of the main ocean-atmospheric circulation patterns associated with reconstruction show the strong influence of the tropical Pacific on determining dry and wet events across the Altiplano. As water runoff was used to power the silver mills of Potosi, the Spaniards consistently recorded the occurrence of wet/ dry years during the 1585-1807 period in Bolivia. This valuable past hidroclimatic archive show a remarkable similarity with the tree-ring reconstruction. The significant relationship between these records adds confidence on both proxies as reliable sources of precipitation variations across the Bolivian Altiplano and provides a unique opportunity to better understand climate variability in this region during the past centuries.

ABSTRACT #149. Oral Presentation



A MILLENNIAL TREE-RING CHRONOLOGY FROM PILGERO-DENDRON UVIFERUM AT AYSÉN REGION, SOUTHERN CHILE

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Keywords: Pilgerodendron uviferum, subfossil wood, tree rings.

Pilgerodendron uviferum (D. Don) Florin is the southernmost conifer tree species in South America. Its geographic range extends over 1,600 km north to south, from around 40°S to 55°S, and it has been successfully used to reconstruct climate variations for the last 500 years in southern South America. We developed a tree ring-width chronology from buried subfossil wood of Pilgerodendron collected at the valley of Puerto Aysén (45º23'S, 72º40'W) and from living-trees samples of two localities of the same region, Laguna Leal (48º02'S, 73º07'W) and Río Pascua (48º11'S, 73º09'W). Subfossil wood came from stumps buried around 100 cm depth associated with a very clear layer of fluvioglacial sand and gravel extended along the entire Río Aysén valley. This layer has an age of 980 ± 90^{14} C years BP. Below the *Pilgerodendron* level at around 170 cm depth a buried forest of angiosperm trees have ages up to 3150 ± 130 ¹⁴C years BP. The resulting 1520-years long chronology covers the period AD 484 to AD 1620 from the subfossil material, and AD 1357 to AD 2003 from a compound set of living trees samples of Laguna Leal and Río Pascua localities, providing an adequate overlapping common period for crossdating purposes. These results represent an interesting opportunity to produce highly resolved series of millennial climatic reconstruction, and to interpretate vegetation dynamics and natural catastrophic events during the past few thousand years. Acknowledgements: Fondecyt 1080320.



HOLOCENE PEAT-CARBON ACCUMULATION PATTERNS IN PATAGONIA: RATES, TIMING, AND CLIMATIC CONTROLS

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Keywords: peat bogs, ecosystem dynamics, carbon cycle.

Patagonian peatlands have sequestered about 15 Gt of organic carbon (C) since the Last Glacial Maximum (Yu et al., 2010, GRL) as a result of a positive balance between plant productivity and peat decomposition. In these ecosystems, century- and millennial-scale changes in peat-C accumulation rates (PCAR) are largely controlled by regional climate and climatic seasonality. Here, we present radiocarbon-dated peat profiles for Patagonian sites located south of 50°S to infer peat-C response to past climatic changes. Results indicate that the highest PCAR at Cerro Negro Bog (52°04'19"S, 72°02'17"W) occurred during the mid-Holocene (4.5-2.8 ka, 1ka = 1000 cal. BP), a period that was regionally characterized by high summer temperatures due to strong insolation, and by an increase in summer moisture induced by a poleward westerly position. This peatland was sequestrating up to 70 gC/m²/yr during this period, 80% higher than its mean PCAR. Lowest PCAR (1-8 gC/m²/yr) were reached at 8.2-5 ka and have possibly been induced by dry conditions, as supported by high grass pollen in published regional records, and enhanced peat decay at our site. Following the climatic optimum, low PCAR of 7-11 gC/m²/yr at 2.8-1.5 ka are, instead, probably attributable to an increase in effective moisture and/or a cool climate that led to a change in the bog's plant community. Our ongoing plant macrofossil analysis effectively indicates an increase in wet plant species (low resistance to decay) during this time interval. Another wet species increase was recorded at 0.8-0.4 ka, a period known to have been regionally wetter due to stronger westerlies. Similar results have been recorded at our southernmost sites (~54°S, 67°W) for this time interval, suggesting a regional climatic signal. To provide new insights on past hydroclimatic trends and fluctuations, water table depth along peat profiles are also being reconstructed using testate amoebae assemblages.

ABSTRACT #152. Poster Presentation



EMBEDDING RECONSTRUCTION METHODOLOGY FOR TIME SERIES: APPLICATION TO LARGE EL NIÑO EVENTS

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Keywords: embedding method, SOI.

We propose an alternative approach for the embedding space reconstruction method using time series. An *m*-dimensional embedding space is reconstructed with a set of time delays including the relevant time scales characterizing the local dynamical properties of the system. By using a maximal predictability criterion, a *d*-dimensional subspace is selected with its associated set of time delays, in which a local blind forecasting prediction performs the best reconstruction of a particular phenomenon. A locally unfolded *d*-dimensional embedding space is then obtained with a local embedding dimension. When applied to the Southern Oscillation Index (SOI), associated with the El Niño-Southern Oscillation phenomena, an optimal set of embedding parameters allows reconstructing the main characteristics of the El Niño 1982-83 and 1997-1998 events, directly from measurements up to 3 to 4 years in advance.



INFLUENCE OF NATURAL FORCINGS ON SOUTHEASTERN BRAZILIAN CLIMATE DURING THE PAST TWO THOUSAND YEARS

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Keywords: Natural climate forcings, Monsoon precipitation related data, empirical mode decomposition.

The scientific community has recently been discussing the possible influences of solar activity, galactic cosmic ray flux and geomagnetic field on the Earth's climate. In this work we use the Empirical Mode Decomposition and Moving Window Average Smoothing methods in order to identify the influences of these natural climatic forcings on precipitation over southeastern Brazil. We use Monsoon precipitation related data based on high-resolution records of oxygen isotope ratios from speleothem in Iporanga, São Paulo State (24.5°S,48.7°W). The data of galactic cosmic ray production rate, modulated by Solar and the Earth's Magnetic Field, were obtained from INTCAL04 calibration curve. Our results indicate that the solar modulation of climate variability is significant and persistent throughout the investigated period.

ABSTRACT #154. Oral Presentation



RECONSTRUCTION OF CENTENNIAL-SCALE CLIMATE VA-RIABILITY IN THE ATACAMA DESERT (16º-26ºS) OVER THE LAST 2 KA

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Keywords: central Andes, ENSO-like variability, MCA.

Multiple millennial-scale changes in hydroclimatic conditions have been previously documented along the dry central Andes throughout the latest Pleistocene that have been linked to ENSO-induced changes on the Tropical Pacific SST gradients. Sub-millennial rainfall anomalies have been also detected in diverse records from the hyperarid Atacama Desert during the latest Holocene. The timing, magnitude and causes of these fluctuations, however, have remained poorly defined. Here, we reconstruct rainfall patterns in the Atacama (16º-26ºS) over the last 2 ka, encompassing the Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA). Our dataset compromises 232 records of hydrological change such as rodent midden abundance, paleowetlands deposits and radiocarbon density from inland archeological sites. Between 2-1 ka, low rodent midden abundance suggests that the first stage of the MCA was in general unproductive. Short-lived wet pulses at 1.7-1 ka, however, are suggested by paleowetlands and increased human activities. Significant increase in midden abundance, paleowetlands and human settlements by the late MCA stage (1.05-0.6 ka) indicate a sustained rainfall event. Starting at ~0.55 ka, total lack of paleowetland deposits, reduced midden abundance and human settlements, imply prevailing arid conditions. This widespread dry interval was interrupted by a brief rainfall event during the LIA as indicated by elevated midden abundance and a slight recover in human populations at ~ 0.2 ka. Our results point to important precipitation variability on centennial timescales across the Atacama Desert over the past two millennia. Marine records from the eastern Tropical Pacific suggest negative (positive) SST anomalies during MCA (LIA). This implies that positive (negative) precipitation anomalies during the latest Holocene were likely related to periods of sustained La Niña-like (El Niño-like) conditions. We conclude that Pacific SST gradients during the MCA and LIA drove an alternation of wetter and arid conditions throughout the Atacama. Acknowledgments: FONDECYT-1070140, IEB, CA-SEB.



ARCHAEOLOGY AND PALAEOECOLOGY IN NORTHERN PATAGONIA: RESEARCH DESIGN AND SUPRA-REGIONAL INTEGRATION

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Keywords: Human-climate Interaction, archaeology, Northern Patagonia.

Within the context of the current knowledge on the Holocene human peopling of South America, archaeological information from northern Neuquén, Patagonia, Argentina is comparatively scarce. The project presented here is intended to fill this gap by contributing archaeological and palaeoecological data for the Late Pleistocene - Late Holocene period. We will produce chronological records for characterizing diachronic patterns of human presence, and palaecological information from rodent middens and cave deposits to analyze the climatic fluctuations at a local scale. Then, at a supra-regional level, these results will be integrated with palaeoclimatic archives from both sides of the Andes, including northwestern Neuquén (Mallín Vaca Lauquen), southern Mendoza (Laguna El Sosneado, fluvial stratigraphic sequences), and Central Chile (i.e., Laguna de Tagua Tagua, Laguna Aculeo, marine cores). Archaeological evidences indicate that human populations living east and west of the Andes were socially articulated, with important temporal and behavioral variation. Given that these spaces operated in association with different climatic regimes, and may eventually acted in a decoupled fashion, it is necessary to produce palaeoclimatic reconstructions at equivalent spatial scales. On this basis, a comprehensive evaluation of the Holocene climate-human dynamics can be achieved.

ABSTRACT #156. Poster Presentation



CHRONOLOGY AND HYDRO-STATIGRAPHY OF SEDIMENTS FROM THE LLANO GRANDE PEAT BOG, FRONTINO PÁRAMO-REGION, ANTIOQUIA-COLOMBIA

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Keywords: Chronology and hydro-statigraphy, palaeoecology, Colombia.

The Llano Grande peat bog in the páramo of Frontino (6°29'00"N, 76°6'00" W), Antioquia, Colombia, is one of the best dated sites among the páramos of Colombia. It has 38 radiometric records along a depth of 12.5 m and has one of the most complete records from the Tardiglacial-Holocene periods with an estimated age at the bottom of 14500 C14years. Water is the dominant phase in natural sediments from Llano Grande cores accounting for 87% of its dry weight. Organic matter accounts only for 7%; remaining phase correspond to mineral matter. This large reserve of fossil water is ecologically important for lacustrine environments and the páramos ecosystems, allowing us to establish a hydrostratigraphy along the sediment cores. From the Tardiglacial to the lower Holocene (9300 14C years BP) the sediments contain low amounts of fossil water whereas during the remaining of the Holocene they are hydrated to fully-hydrated by fossil water.



A 2000-YEAR HIGH-RESOLUTION POLLEN, SPORE AND CHARCOAL RECORD FROM LAGUNA SAN PEDRO, SECTOR LONQUIMAY, REGIÓN DE LA ARAUCANÍA, CENTRAL CHILE (38°26'S, 71°19"W)

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Keywords: Araucanía, Medieval Climate Anomaly, Little Ice Age.

We present a high-resolution 2000-year record of vegetation and fire change from near the forest-steppe ecotone in Región de la Araucanía, Chile, a region that constitutes an interesting study area in which cultural and biological interfaces have developed in the context of highly dynamic climatic and volcanic scenarios, yet one that has received surprisingly little attention from palaeoclimatologists. The region is host to the iconic tree species, Araucaria araucana, an important economic and social focus for the original inhabitants of Chile, a key resource that supported European colonisation and a species synonymous with Chilean identity. A long history of dendrochronological studies from Northern Patagonia have revealed decadal to centennial scale climate changes over the last 1000 years that were apparently coeval with the northern hemisphere Little Ice Age (LIA) and Medieval Climate Anomaly (MCA). We analysed pollen, spore, charcoal and physical characteristics of lake sediments from Laguna San Pedro (38°26'S, 71°19"W), located close to Longuimay, an area within the Andes rain-shadow where continentally results in extreme weather conditions, in an attempt to discern between volcanic, human and climatic drivers of environmental change and to test whether lake-sediments from this region have potential as palaeoclimate indicators. We use gradient analysis to objectively extract the main gradients of change, revealing a highly dynamic forest-steppe ecotone over the last 2000 years. We identify phases that are remarkably consistent in direction of change and timing of the MCA and LIA in this part of southern South America, corroborating tree-ring analyses and giving us confidence in palaeoclimatic potential of this site. We identify multi-decadal to centennial scale phases through the last 2000 years that represent substantial deviations from the long-term mean climate state and that extend beyond the current limits of tree-ring analyses in this region, providing a testable framework for future palaeoclimate studies.

ABSTRACT #158. Poster Presentation



INVENTORY AND RECENT FRONTAL VARIATIONS OF GLA-CIERS IN THE NORTHERN CHILEAN VOLCANOES (17°30' TO 21°S)

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Keywords: Northern Chile glaciers, area reduction

Glaciers in the northern Arid region of Chile were preliminary inventoried by Garín (1985), who used aerial photographs acquired between 1955 and 1980. Since this work, very little glaciological studies have been done in the region in spite of increased concern on the effects of climate change on glaciers along the Andes. By analysing remotely sensed satellite imagery (Landsat TM), a complete glacier inventory of the Chilean glaciers between the border with Perú and 21°S was developed. Most of the detected ice bodies are located on top or at the flanks of active volcanoes, being the glacier located at Volcan Parinacota the largest with a total area of 1,5 km² of ice in year 2009. According to Garín (1985), this glacier had in 1979 an area of 13,13 km², yielding a total reduction of almost 90% since that year. This figure, however, is hiding a serious problem with the preliminary identification of glaciers, where snowfields were included as ice, resulting in an overestimation of the total glacier area. By compiling satellite scenes from different dates, frontal variations were recorded using the most accurate and recent satellite image scenes. The methods are described together with the analysis of the results, which in turn are compared to similar studies carried out in the glaciers at the Bolivian side of the Andes. This abstract was partially funded by FONDECYT N° 1090387.





PALEOECOLOGICAL RECONSTRUCTION OF THE LAST 4000 YEARS IN LURUACO'S SWAMP (CARIBBEAN COAST, COLOM-BIA): HUMAN ADAPTATION PROCESSES AND ENVIRONMEN-TAL CHANGES

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Keywords: Palinology, Palaeoecology, Colombia.

Based on palynological analysis of sediments from the Ciénaga de Luruaco swamp, located on the Caribbean coast, Colombia (10° 36' 26.90" N and 75° 09' 29.27" W and 25 m above sea level), changes of vegetation and climate during the last 4000 years were reconstructed. Results were compared with previous research on sea level changes along the Caribbean coast of Colombia and human adaptation processes of pre-Hispanic cultures inhabiting the region. Two wet periods, between 3600 and 3500 years BP, and from 450 years BP to the present were identified. A dry period was recorded between 1700 and 800 years BP. At a first stage, the swamp was covered by flooded forests with Sabal palm surrounded by land-based forests. At a later stage, the extent of flooded area was significantly reduced showing an increase in the representation of vegetation from land-based forests with species of Melastomataceae, Myrtaceae and Sapindaceae. More recently, it turns into forest vegetation due to the recent human impact in the vicinity of the wetland. The presence of Spirogyra and Botryococcus throughout the entire sediment column indicates open water and good oxygenation, which implies that during the late Holocene the swamp of Luruaco was always a lacustrine environment.

ABSTRACT #160. Poster Presentation



CONTRASTING HYDROCLIMATIC CONDITIONS IN THE AR-GENTINEAN PAMPEAN PLAINS: THE PALEOLIMNOLOGICAL RECORD OF THE LITTLE ICE AGE AND THE 20TH CENTURY

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Keywords: Pampean plains, Little Ice Age, 20th Century.

Limnogeological reconstructions, in addition to historical data, indicate two recent contrasting hydroclimatic phases overall the Pampean Plains: A cold and dry period ascribed to the Little Ice Age (LIA) and a hyper-humid stage after the decade of 1970s. Throughout the late Holocene, different shallow lakes in the central plains of South Eastern South America (SESA) have registered synchronous behavior in their paleohydrological balance triggered by changes in the Precipitation-Evaporation ratio. In Laguna Mar Chiquita (30°54'S-62°51'W), limnogeological reconstructions suggest very dry conditions during the LIA. In agreement with this record, historical evidences from Laguna Melincué (33°43'S-61°28'W), located further south in the same region, show pervasive arid conditions during the last part of the 18th century. For instance, chronicles of 1796 reveal that Laguna Melincué was separated in two minor water bodies denoting extremely low water-levels. Paleolimnological and instrumental records from Laguna Melincué suggest important water level fluctuations throughout the 20th century. The first decades are recorded by low lake level facies, indicating an arid period, which is followed by alternating humid/dry phases. A shift to a comparatively wetter scenario (registered on both, sedimentary and instrumental records) started in the Pampean plains during the decade of 1970 and it is still present. The observed contrasting hydrological situations during the LIA and 20th century on Pampean lakes indicate important climatic variations over the region and validate the hypothesis of the South America Monsoon like-system as the common mechanism controlling hydroclimatic variability in SESA, at least since late Holocene.



ABSTRACT #161. Poster Presentation

LANDSCAPE IMPACTS IN THE AYSEN RIVER BASIN (PATAGO-NIA): IMPLICATIONS FOR UNDERSTANDING PAST HUMAN ACTIVITIES

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Keywords: forest fires, archaeology, livestock.

Archaeological materials and other sources to reconstruct the human past, as data to deliver environmental information, are constantly subjected to a variety of changes and stimuli from being deposited in a matrix, until they are subsequently recovered for study (taphonomy / post depositional processes). Some of them are natural, while others have their genesis in the anthropogenic changes to landscapes that have and continue to affect these registers. In the case of the Aysen River basin (Central Patagonia), forest fires, agricultural and livestock activities, coupled with natural agents, subject to this register to a dynamic such that it can alter the conservation of proxies, reading of the palaeoenvironments and important parts of our conception of the past.

ABSTRACT #162. Poster Presentation



RECONSTRUCTION OF PLANT SUCCESSION IN THE ESTUA-RINE ENVIRONMENT OF THE CISPATÁ BAY, CARIBBEAN COAST, COLOMBIA

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Keywords: Caribbean coast, Palynology, Rhizophora.

The dynamics of the Sinú river at its mouth has generated changes in the establishment, extension and floristic composition of different vegetation types on the landscapes influenced by the river and the sea. Based on pollen analysis of sediment cores from two meters deep in a swamp from the Ostional Cispatá Bay (9 ° 23'53 .1 "N, 75 ° 53'5 .1" W), the major changes in vegetation during the Late Holocene were reconstructed. The lower part of the sediment column reflects the dominance of a marshy area, characterized by vegetation types such as *Ambrosia* flats (playones), herbs formation with species of Acrostichum, Cyperaceae, Poaceae, Polynonaceae, Typha and mixed palmettos forest of Iriartea. On the alluvial zones, inundation low forests whit species of Myrtaceae Cecropia, Miconia/Terminalia, Leguminosae, Rubiaceae were established. The floristic composition of this phase is similar to that observed in wetlands from the Caribbean region and can be associated with the old mouth of the Sinú River in the seventeenth century. At the mid-nineteenth century, when the river mouth changed, salinization of the soil increased and the landscape changed dramatically as shown in the upper parts of the sediment column. The pollen spectrum was dominated by estuarine species as Rhizophora mangle, Laguncularia racemosa, Avicenia germinans and their plant-associations. The typical elements of the wetland (aquatic and marshy elements) and dry forests reduced their representations in the pollen spectrum.



SOL-CLIMATE RELATIONSHIP FROM CROSS-WAVLET ANALYSIS IN TREE-RING FROM BRAZIL

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Keywords: Tree Ring Data, Sol-Climate Relationship, Cross-Wavelet Analysis.

The tree-ring width date from Brazil, were studied by cross-wavelet analysis technique, which permits the identification of non-steady features in the tree ring data, southern hemisphere temperature and sunspot number. It was found that evidences of the 11 and 22-yr. solar cycle. The 11 yr solar cycle in the tree-ring width data is present only during the epochs the maximum solar activity, to 1940-1970 interval time. The Hale solar cycle in the tree-ring width data is present only to 1890-1915 and 1940-1970 interval time. The cross-wavelet map between tree-ring width and sunspot number show the results identical for the 11 and 22-yr. solar cycle, found in tree-ring width wavelet map. ABSTRACT #164. Poster Presentation



INFLUENCES OF PAST CLIMATE VARIATIONS ON TREE ES-TABLISHMENT AND MORTALITY IN PATAGONIA

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Keywords: drought, dendrochronology, ecotone.

Instrumental and proxy records indicate that some regions in Patagonia are likely experiencing the warmest interval of the past millennium. Concurrent with warmer conditions, precipitation has experience a reduction during the past decades. Present climatic conditions could be affecting the structure of the Patagonian forests through direct effects on tree demography. We evaluated the effect of climate variations on the establishment and mortality of tree species along the Argentinean Patagonian Andes using dendrochronological techniques. The dynamics of Austrocedrus chilensis in the forest-steppe ecotone responds to dry-wet climatic events. Decades with a predominance of cool-wet summers favor the establishment of the Austrocedrus while mortality events are associated with extreme drought events during one or two consecutive dry-warm summers. Similarly, periodic mortality in mesic and dense A. chilensis forests is related to particularly dry and warm climatic conditions in northern Patagonia. For the Nothofagus dombeyi populations at the eastern sector of its distribution range, tree mortality follows droughts. After mortality, resources released by dead trees concurrent with wet periods favor tree establishment, showing the dependence of successful tree recruitment on favorable wet periods for growth and survival of seedlings. Based on the negative impact of recent extreme droughts on N. dombeyi populations at its eastern range, changes in this species distribution as a consequence of future climate change are expected. The recent increase in temperatures in southern Patagonia, in combination with extended growing seasons, has facilitated the establishment of individuals of Nothofagus pumilio above the present upper treeline. Moreover, an increase in tree mortality rates has been recorded during the past three decades at the lower-elevation stands of this species. The increase in water deficit during the last decades has lead to abundant tree mortality from the forest-steppe ecotones to mid-elevation forests, whereas warmer summers have facilitated the forest expansion at the upper, relatively-humid treelines

ABSTRACT #165. Poster Presentation



INFLUENCES OF PAST CLIMATE VARIATIONS ON FOREST DISTURBANCE IN PATAGONIA

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Keywords: avalanches, insect outbreaks, fire history.

Climate influences ecosystems by modulating the frequency, magnitude, and spatial scales of natural disturbances. Many studies have documented the importance of disturbances in the dynamics of Patagonian forests. We report the influence of climatic variations on three types of disturbances (avalanches, insect outbreaks and fires) affecting the Nothofagus pumilio and Araucaria araucana forests in Patagonia, Argentina. Tree-ring based avalanche chronologies from nine avalanche tracks adjacent to Lago del Desierto, Santa Cruz, southern Patagonia, indicate that years with large avalanche activity are significantly correlated with abundant precipitation from May to October. These winter seasons show features typically observed during the cold phase of El Niño-Southern Oscillation. In the same region, defoliators outbreaks have been documented for 1998-1999, 2002-2003 and 2004-2005 growing seasons. Tree-ring chronologies from the forests affected by Ormiscodes amphimone showed abrupt growth reductions the years following the insect attacks. The reductions in tree growth related to these outbreaks are the most severe recorded during the past 100 years. Increases in outbreak frequency and intensity may be associated with unprecedented warm temperatures in the recent decades in the context of the past 400 years. During the past three centuries, years of fire occurrence recorded in ten fire chronologies from A. araucana in northern Patagonia were concurrent with years of reduced tree growth in this species. However, fire years are not significantly correlated with temperature variations from long-term climate reconstructions in the area, suggesting that in addition to climate, humans strongly influence fire regimes in the A. araucana forests. Based on our observations, we concluded that climate changes play a major role in modulating forest disturbance regimes across Patagonia.

ABSTRACT #166. Poster Presentation



INFLUENCES OF PAST CLIMATE VARIATIONS ON FOREST DYNAMICS IN PATAGONIA

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Keywords: tree rings, forest decline, crown dieback

It is widely accepted that forest decline is a complex phenomena involving diverse processes such as tree vigor loss, crown dieback, branch mortality, cambial disruption, and the consequent mortality of trees. Drought is one of the most important environmental factors predisposing forest decline. In Patagonia, forest decline has been reported since the second half of the last century. We related external tree-vigor characteristics with patterns of radial growth in Austrocedrus chilensis and Nothofagus pumilio forests in Patagonia, Argentina. In mesic A. chilensis forests visually affected by decline, the onset of radial growth differentiation between declining and non-declining trees was significantly related to negative PDSI anomalies during the year prior to growth. Furthermore, the radial-growth decline at the tree level was related to the occurrence of droughts and/or extended periods of unfavorable growth conditions. Similarly, different patterns of tree growth were observed at the stand and regional level on N. pumilio forests showing external evidences of tree decline. Whereas some trees show a steady reduction on tree growth, others increase radial growth after some decades of negative or uniform trends in growth. For the northern populations of N. pumilio, drought was the major factor determining these changes in tree-growth patterns. For southern Patagonia, the increase in temperature during the last decades appears to be the climate forcing related to forest decline. Based on future climatic predictions suggesting increasing trends in temperature and in the frequency and intensity of drought events in Patagonia, a gradual increase in the number of stands affected by decline along the twenty-first century is likely expected.



AN EXPERIMENTAL APPROACH TO IMPROVE THE FOSSIL RODENT MIDDEN POLLEN ANALYSIS IN NORTHERN ARID AND SEMIARID AREAS OF CHILE

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Keywords: pollen analysis, rodent middens, northern arid and semiarid Chile.

Fossil rodent middens are a valuable source of palaeoecological and palaeoclimate information in the northern arid and semiarid areas of Chile where other paleoenvironmental archives are scarce. The vegetation dynamics during the last 50,000 yrs has been inferred mainly from the combined analysis of pollen and plant macrofossils from fossil rodent middens. The fossil pollen rodent midden records have been interpreted using modern surface pollen assemblages. However, whether these samples are adequate modern analogues or not is not fully clear given the different pollen deposition processes that could have affected both kinds of samples. Therefore, the present study aims at determining the actual potential of surface pollen assemblages to be used as modern analogues of rodent middens pollen record by analysing the relationships between modern surface and middens (faeces and sedimentary matrix) pollen assemblages from northern arid and semiarid areas of Chile. Although results are still preliminary we conclude that (1) the pollen surface assemblages along four west-east altitudinal transects (located at 23°, 25°, 27° and 29°S) ranging from 700 to 4650 masl reflect the different vegetation units (Adesmia scrub, Pre Puna, Puna and high Andean steppe) at the local and regional scales; (2) the modern pollen rodent midden assemblages located between 22° and 32°S reflect the vegetation communities from the surroundings, although, (3) some differences arise between the faeces and the sedimentary matrix pollen assemblages that might be related to taphonomic processes that need to be deeply investigated. Our results show the potential of surface pollen assemblages as modern analogues of the fossil pollen rodent midden records to interpret past vegetation changes in northern Chilean arid and semiarid areas. The present study was funded by FONDECYT#1080458; 1100916.

ABSTRACT #169. Oral Presentation



ENVIRONMENTAL RECONSTRUCTION OF SEMIARID REGION OF CHILE DURING THE LATE HOLOCENE

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Keywords: Pollen analysis, semiarid region of Chile, Westerlies.

Given that the semiarid region of Chile (32°S) lies in the interaction zone between the Subtropical High and the northern zone of influence of the Southern Westerlies Wind Belt (SWWB), it is a key zone to record the past interactions between both systems. Furthermore, modern dendrocronological and water stable isotopes analysis pointed out that the development of the Myrtaceae swamp forests shows a strong correlation with local rainfall (winter precipitation) directly associated to the SWWB system. Then, pollen and charcoal analysis from two swamp forests (Palo Colorado and Santa Julia) and other indicators such as stable isotopes analysis in shells from archaeological sites were used to reconstruct the climatic and environmental history at the northern limit of SWWB in the semiarid region of Chile during the last 3000 cal yrs BP. Pollen record from the swamp forests show relatively arid conditions between 3000 and 2000 cal yr BP followed by an increase in moisture until 1400 cal yr BP probably associated to a higher frequency of and/or intensified El Niño events. The expansion of swamp forest taxa such as Myrtaceae and Drimys between 1000 and 600 cal yr BP suggests a moisture increase whereas the later decline of these taxa around 300 cal yr BP could be explained by either the establishment of relatively arid conditions or increased anthropogenic activity affecting forest dynamics. In fact, the simultaneous increase in charcoal accumulation and the European settlement in the area suggest anthropic clearance and logging of the swamp forests supporting the second hypothesis. Acknowledgements: FONDECYT: 11070016





FLUCTUATIONS OF SIERRA VELLUDA GLACIERS (37.5°S) AND REGIONAL TREE-RING VARIABILITY SINCE 1961 IN SOUTH- CENTRAL CHILE

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Keywords: Glacier fluctuations, Tree-rings, Principal Component Analysis.

Mountain environments of south-central Chile (35º-40ºS) contain a variety of natural proxies for past climate variability including glaciers, tree-rings and lakes sediments. But only few studies have utilized a multiproxy approach to unveil past hydroclimate variability in this region. In this context, we present a comparison between the Sierra Velluda glacier fluctuations and tree-rings patterns from 1961 onwards to test correspondence between these proxies and to determine their response to climate variability. We mapped glacier changes from aerial photographs and satellite images (cover four to six periods between 1961 to 2007; the 1970's are particuraly well represented) and analize tree-ring chronologies of A. chilensis and A. araucana using Principal Component Analysis (PCA). The results show that, for both species, the PC2 of tree-growth (>20%) have the best match with the frontal changes of glaciers during the 1970's. These PCs were correlated positively with winterspring and annual precipitation in instrumental records. After the year 1975, the series of both PC2 show a negative trend similar to the Sierra Velluda glaciers, suggesting that they responded to similar climatic factors. Indeed, in this period more than 70% of the glaciers show frontal retreat with maxima of -25 m/yr, and more than 60% have area lost ranging from 47% to 29%. These preliminary results demostrate the suitability to combine glacier fluctuations and tree-ring studies in south-central Chile to get a better insight of the regional hydroclimate variability. At present new images are being collected to obtain a more continuous time-series of frontal glacier changes.

ABSTRACT #172. Poster Presentation



THE GREAT DROUGHTS OF 1924-25 AND 1968-69 IN THE ARGENTINEAN CENTRAL ANDES: SOCIO-ECONOMIC IM-PACTS AND RESPONSES

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Keywords: Andes cordillera, extreme drought, socio-economic impacts.

The increased frequency of extreme droughts in the Andes Cordillera over the past 100 years has been concurrent with a large increase in regional population, and consequently, with a greater demand of water for domestic use, irrigation and energy production on both sides of the Central Andes. In addition, the extraordinary recession of glaciers over this period has also reduced the ice-mass capacity for regulation of Andean streamflows in times of shortage. The present work studies the extreme drought events of 1924-25 and 1968-69 in the Argentinean Central Andes using historical documentation, tree rings and meteorological records. This case study demonstrates the significant impacts of water shortages during the spring-summer period for a province such as Mendoza, Argentina, in which agricultural, economic and daily life depends on the flow of rivers originating from the eastern flanks of the Andes Cordillera. Although both drought events were relatively similar in magnitude, the socio-economic scenarios during these two dry events were significantly different: A small population largely distributed across rural areas in 1924-25 contrast with a larger (more than double), urban-concentrated population in 1968-69. Thus, whereas the social unrest, as reported by the local newspapers, was mainly associated with the lack of water for irrigation during the 1924-25 drought, the reduction in hydro-power generation for the urban populations was the major concern during the dry 1968-69 event. The results of this study could be useful in establishing guidelines for political actions to prevent or at least, alleviate the effects of similar future droughts. The significant population increase in Mendoza since the 1968-69 drought and the present infrastructure problems related to usage of the water resource would further exacerbate these drought detrimental effects.





CLIMATIC VARIATIONS IN THE CORDILLERA DE LOS ANDES AND THEIR CONSEQUENCES ON THE ENVIRONMENTAL PROCESSES IN NORTHERN OF MENDOZA . 16th to 20th CENTURIES

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Keywords: Climatic variations, environmental processes, Mendoza.

The wrong management of watering in the highest zones of the Mendoza northern oasis, the topography of the terrain and the deficient drainage, together with neotectonics phenomena, but mostly a dramatic and progressive increase of the Río Mendoza flow volume originated the expansion of the wetlands area at the NE of the city of Mendoza at the turn of the 18th century, while in previous centuries it had retracted to a minimum. The area grew until reaching the dimension of large wetlands in the lowest oasis zones, resulting from a larger runoff and soil saturation by the rise of the phreatic layers. This situation remained throughout the 19th century, affecting the extension and use of the available land for human activity. The purpose of this study was to research this process that culminated in 1930 with the partial desiccation of the area. We have given particular importance to the influence of the climatic fluctuations in the Cordillera de los Andes and to the consequent variations of the Rio Mendoza flow volume in this process. For the analysis we used snowfall series at the cordillera and flow volume of the Rio Mendoza, built by Prieto (2009) with documental data. We analyzed which were the mediate and immediate consequences of the growth and later desiccation of the wetlands over the environment and its present repercussion on the ecosystem (salinization, poor soil drainage, soil alkalinization, sedimentation). In addition, we have also worked over georeferenced historic charts that partially reflect the behavior of the Cienaga del Bermejo during the 18th, 19th and 20th centuries. This behavior characterized by "growth pulses" and retraction moments is reflected in the analyzed charts, where those moments of major growth coincide with cycles of bigger snowstorms and larger flow volume in the Rio Mendoza.

ABSTRACT #174. Oral Presentation



CLIMATIC CHANGES BETWEEN THE LATE 20TH CEN-TURY AND PRE-INDUSTRIAL TIMES OVER CENTRAL AND SOUTHERN SOUTH AMERICA IN REGIONAL CLIMATE MO-DEL SIMULATIONS

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Keywords: Regional climate modeling, Southern Westerlies, Pre-industrial Climate.

The present study analyses two simulations carried out with the regional climate model CCLM with a horizontal resolution of 0.44° x 0.44°. The simulations are driven with boundary conditions of the global climate model ECHO-G for present-day (1990 AD) and pre-industrial conditions (1750 AD). The differences in the external forcings pertain to a changed greenhouse gas content of the atmosphere, being higher in the present-day simulation. The present-day simulation is compared with the pre-industrial simulation for atmospheric fields of near-surface temperatures, precipitation and zonal wind. The differences present-day minus pre-industrial for near-surface temperatures during southern summer (DJF) show positive anomalies over entire South America, mostly pronounced over the southern region of the Andes Mountains and the Parana basin. During southern winter (IJA) also positive temperature anomalies prevail over the entire continent, but with highest temperature anomalies shifted further to the central Andes Mountains and the Amazonian basin. Precipitation differences show a more heterogeneous pattern, especially over tropical regions. This might be explained by changes in convective processes acting on small scales. During DJF positive anomalies are evident over the Amazonian and Parana basin. Positive anomalies can be seen over Patagonia. For JJA a dipole pattern along the Andes Mountains with positive anomalies over the southern parts and negative anomalies over the central parts is evident. This pattern can be explained by changes in largescale circulation related to latitudinal changes of the extratropical southern hemispheric westerlies. The simulations can be used to compare results with recent proxy data in order to test hypothesis related to large and local scale atmospheric forcing.





ASSESSMENT OF THE XX CENTURY CLIMATE SIMULA-TIONS OVER SOUTH AMERICA SIMULATED BY THE CMIP3 COUPLED CLIMATE MODELS

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Keywords: Climate Change, CMIP3 dataset and uncertainties on climate change.

South America is vulnerable to current climate extremes and can be deeply affected in a global warming scenario. Although recent studies derived from global and regional climate models have contributed to our understanding on possible causes and future impacts of climate change over this region, uncertainties present on the current climate representation and future climate projection still continue to be high. Among other things, this is due to a poor model representation of the relevant climate processes and feedbacks and also to the future emission scenarios used on these projections. Due to these difficulties, rigorous model evaluations of the current climate and projections are needed. Therefore, from the twentieth century climate simulations produced by more than 20 global models available in the third phase of the Coupled Model Intercomparison Project (CMIP3) dataset, this study evaluate the performance of these models in representing the observed climatology over South America and adjacent oceans. Monthly values of precipitation, temperature, sea level pressure (SLP) and wind field were analyzed in an annual and seasonal time scale. Results show that the ensemble is able to reproduce the main features of the temperature, SLP and circulation field with a reasonable agreement among all the models. However, almost all models are not able to reproduce correctly the precipitation associated with the Intertropical Convergence Zone (ITCZ) over the Equatorial Atlantic Ocean and produce erroneous double ITCZ over the Equatorial Pacific Ocean. Models also fail to represent the extension and intensity of the South Atlantic Convergence Zone and the spatial distribution of rainfall related to the South American Monsoon activity. Once the reliability of climate change projections is based mainly in the accuracy of models in representing the present climate, results presented in this study emphasize the importance in treating the projections more carefully and in a probabilistic way.

ABSTRACT #176. Oral Presentation



SOUTHERN HEMISPHERE ATMOSPHERIC CIRCULATION: IMPACTS ON ANTARCTIC CLIMATE AND RECONSTRUCTIONS FROM ANTARCTIC ICE CORE DATA

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Keywords: palaeoclimatology, climate dynamics, Antarctic Peninsula.

The atmospheric circulation patterns in the Southern Hemisphere have had a significant impact on the climate of the Antarctic. There is much evidence that these circulation patterns have changed in the recent past. This change is thought to have contributed to the warming trend observed at the Antarctic Peninsula over the last 50 years - one of the largest trends observed in this period on the planet. The trends associated with the continental Antarctic climate are less clear but are likely to be impacted less directly by atmospheric circulation changes. The circulation changes can be put into the context of longer timescales by considering atmospheric circulation reconstructions that have been performed using data from Antarctic ice cores. In this review paper we look at the main body of work examining: Antarctic climate trends; the understanding and impact of atmospheric circulation of the mid- to highlatitudes of the Southern Hemisphere; and the usefulness and reliability of atmospheric circulation reconstructions from Antarctic ice core data. A series of papers by the authors, focusing on the Eastern Antarctic Peninsula, will also be presented to show a specific example of this methodology. Finally, beyond several of the more quantitative reconstructions, it is deemed that an assessment of their consistency is not possible due to the variety of circulation characteristics that the various reconstructions consider.





GLACIAL INVENTORY OF THE ICE-CAPPED VOLCANOES OF THE SOUTHERNMOST PART OF THE ANDEAN SOUTHERN VOLCANIC ZONE (SVZ): METHODS AND RECENT GLACIER CHANGES

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Keywords: Ice-capped volcanoes, glacier change, remote sensing.

Several glacier inventories have been recently compiled in central and southern Chile. However, some areas close to the Patagonian Ice Fields, especially on top of active volcanoes, are still lacking detailed data of recent glacier variations, ice dynamics and glacier-volcano interactions. By means of band ratio techniques applied to several Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite images, we delineated the glacier extents of six active ice-capped volcanoes located between 43°S and 46°S, all of them associated to the Liquiñe-Ofqui mega fault system (LOFS). These extents were compared to former glacier areas derived from Multispectral Scanner System (MSS) and Thematic Mapper (TM) satellite images acquired since late 1970s, to assess area and length changes. A total area for year 2007 of 148.6 km² of glaciers larger than 0.1 km² was detected. Volcán Melimoyu (44º4'31" S, 72º51'39" W; 2405 m asl) exhibits the greatest ice-cap area (57.03 km²). Between 1979 and 2007 a glacier area change of -18% was detected at Volcán Melimoyu, whilst Volcán Mentolat (44º41'45" S, 73º4'32"W; 1607 m asl) experienced the largest area reduction (-39.5%) during the same period of time. As a consequence of the generalized glacier retreat, several proglacial lakes have appeared in the areas where glaciers are receding. This results in higher risks for outburst floods in the case if future volcanic events reach these glaciers and the proglacial lakes. In order to assess these volcanic risks, ASTER thermal bands acquired during night passes have been analyzed. The present research is funded by FONDECYT project 1090387.

ABSTRACT #179. Poster Presentation



RECENT VARIATIONS OF PIO XI GLACIER AND ASSOCIATED PROGLACIAL GREVE LAKE, SOUTHERN PATAGONIA ICE-FIELD

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Keywords: Outburst flood, Greve Lake, Pío XI glacier.

Greve Lake is a proglacial lake located in Southern Patagonia Icefield (73°57'42"W - 49°01'49"S, 150 m. a.s.l.). This lake was generated when a lateral glacier-free valley was blocked by the advance of Pío XI glacier. The historical records of glacier fluctuations have been reconstructed for the last 180 years, showing an anomalous behavior when compared to most of the glaciers in Patagonia. In the first map of the area (1830), the area now occupied by Greve Lake seems to be ice/lake free, in a similar shape as observed in the 1920s, when the first advance of Pío XI was recorded to have dammed the valley. In 1945 however, the valley was again free of ice/lake when the first aerial photographs were acquired, showing evidences of past obstructions. Since then, the glacier has been advancing, damming the valley since 1963. At present, the valley is fully blocked by the glacier, totalizing an inundated area of 213,6 km² in year 2009, and the lake outlet is at the northwestern edge, where a river is leaving the lake through the margin of the Occidental glacier until reaching the Témpanos fjord (by the Kaweshkar river). In order to evaluate a possible outburst flood from this proglacial lake, a simple model was generated, including the research on the behavior of nearby glaciers (Occidental, Greve, HPS8, Lautaro and Pío XI). The conditions and probability of occurrence of this event are studied under different climate change scenarios. This research is part of FONDECYT N° 1080320.



RECENT FLUCTUATIONS AND GLACIER INVENTORY OF MONTE SAN LORENZO AND ADJACENT MOUNTAINS IN PATAGONIA

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Keywords: San Lorenzo, inventory, fluctuations.

Monte San Lorenzo (47º 30' S, 72º 30' W) on the border of Chile and Argentina is one of the highest peaks in Patagonia (3706 m a.s.l.). The massif is covered by several glaciers which have been poorly studied. We present an ASTER-derived glacier inventory for Monte San Lorenzo and some of the adjacent mountains, utilizing multi-spectral classification methods for mapping clean ice and manual digitialization for mapping debris covered ice and areas of deep shadows. SRTM DEM data are used to determinate ice basins and 3D glacier parameters. Several satellite images acquired between 1979 and 2010 (Landsat MSS, TM, ETM+ and ASTER), historical records (Alberto de Agostini first ascent in 1943) and aerial photographs are used to estimate the frontal variations of some glaciers. The total area of Monte San Lorenzo glaciers yielded 142 km² for the year 2007, one of the biggest areas after the Northern and Southern Patagonian Ice Fields. Other smaller mountains located near Monte San Lorenzo, add another area of approximately 234 km². A general glacier retreat has been observed with the strongest rates at Monte San Lorenzo main glaciers (Calluqueo and Río Tranquilo), totalizing to a retreat rate of 40 and 31 m a⁻¹ respectively between 1979 and 2007. This trend has been slowing down in recent years, as many glaciers have shown more stable fronts. The resulting glacier fluctuations are analyzed in combination to climate data collected at Cochrane (47º 23' S, 72º 55' W). In a couple of glacier case studies, non-climatic responses have been detected, mainly related to the calving activity of the lower part of glaciers Calluqueo and Río Tranquilo. These climatic and non-climatic related factors are discussed to support some explanations for the ongoing changes. This research is funded by FONDECYT 1080320.
ABSTRACT #181. Poster Presentation



LITTLE ICE AGE SCENARIOS BY GODDARD INSTITUTE FOR SPACE STUDIES GENERAL CIRCULATION MODEL II AND PROXY DATA

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Keywords: Little Ice Age, Maunder Minimum, Paleoclimate, EdGCM model simulations, Irradiance, Carbon Dioxide.

The Little Ice Age (LIA) was a cold period extended from the XIVth until the XIXth centuries. The decrease of solar activity, the increase of volcanic activity and changes in Carbon Dioxide concentrations were the main forcing driven the three pulses of low temperature occurred during these periods. In this paper, we studied the pulse of the period between the years 1645 to 1715, designated as Maunder Minimum (MM), and its impacts on the Southern Hemisphere. We used the General Circulation Model GISS Model II to obtain different responses to changes in solar irradiance and CO2 during the MM. The anomalies between the XXth century and the MM revealed by the model agree qualitatively and quantitatively, with proxy data values for various regions of the Southern Hemisphere. In the cold semester of the MM the temperature and atmospheric circulation shows intense anomalies and a pattern of wave number 2 and wave number 4 at middle and high latitudes.



TOTAL SOLAR IRRADIANCE RELATIONSHIP BETWEEN SE-CULAR VARIATIONS IN EL NIÑO AND THE PACIFIC DECADAL OSCILLATION

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Keywords: Total Solar Irradiance, Pacific Decadal Oscillation, El Niño Southern Oscillation.

Several recent papers have pointed out discrepancies in the assessment of the relation between the Total Solar Irradiance, the Sea Surface Temperature (SST), El Niño Southern Oscillation (ENSO) and the Decadal Pacific Oscillation (PDO). The aim of this paper is to study some of these discrepancies using the wavelet transform and the Global Coherence Wavelet Spectrum to find regions in the time frequency space where the study time series have strong connections. The time series used were the historical sunspot number (1700 - 2007) and the reconstructed Total Solar Irradiance (TSI) based on the variations of cosmogenic isotopes; the SSTs indexes for El Niño (1871 - 2007); the tree-ring based reconstructions of El Niño and the Pinus flexilis tree rings reconstructions of the PDO. Our results shown the complex nature of the response between signals with no linear coupling, in particular, it is not obvious why the signals change from direct to inverse significant relationships. They also raise doubts on any proposed mechanisms to explain solar influence on climate based on ENSO-like atmosphere ocean coupling and changes in the Walker cell, in a context where ENSO variability plays a crucial role.

ABSTRACT #184. Oral Presentation



SOLAR SIGNAL IN SANTIAGO DE CHILE RECONSTRUCTED PRECIPITATION

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Keywords: Santiago precipitation reconstruction, solar activity, coherence wavelet.

The aim of this work is to present new results supporting the hypothesis that solar activity has influence in Santiago de Chile annual precipitation variability. Santiago de Chile (33°26' S; 70°41' W, 520 m asl) has a continuous record of monthly mean precipitation beginning in 1866 and it is the longest and most reliable record in the area. A tree-ring based multivariate model was developed to reconstruct Santiago precipitation between 1288 and 1999, using three standard tree-ring chronologies derived from Austrocedrus chilensis as predictors. This series is used as an extended proxy of Santiago precipitation, while Berilio 10 (¹⁰Be) time series, from NOAA Paleoclimatology Data Centre is used as a measured of solar variability. Wavelet (WT) and wavelet-squared coherency (WTC) methods were used to analyze local variations of power and co-varying frequency bands within the study time series. The coherence signal/noise between the ¹⁰Be and Precipitation shows that the 5.5 yr, 11 yr, 20 yr, 40 yr, 100 yr & 240 yr peaks are on or above the red noise level; however the 5.5 yr, 11 yr, 20 yr, 40 yr and 100 yr peaks are not consistent neither in time nor in phase. In contrast, the 240 yr periodicity is strongly in phase and coincides with the secular cycle of Sun motion around the centre of mass of the solar system. These results describe how complex and non-linear are the physical processes linking the solar activity with Santiago precipitation.



FIRE HISTORY AND SOIL LOSS IN NORTHERN PATAGONIA: EVALUATING THE 20TH CENTURY EARLY SETTLEMENT IN THE AYSEN REGION, CHILE

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Keywords: erosion, charcoal, sediment records.

Chilean Patagonia is considered one of the world's most pristine environments. However, during the arrival of the first settlers to this land, at the beginning of the 20th century, devastating fires were generated for the initial forest clearance, that destroyed more than 3million of hectares. Erosion was one of the most important impacts that these fire generates, whose consequences have not been evaluated yet. The aim of this work was to determinate the effect of forest fires on erosion in the lacustrine basin of lake Burgos, Northern Patagonia. It was achieved through the study of sedimentary record properties that includes magnetic susceptibility, organic matter (LOI) and charcoal. The fire events were estimated identifying the macrocharcoal peaks in the sediment, while erosion was obtained from the sedimentation rates and other sedimentological parameters. The charcoal record shows low concentrations in the deepest part of the profile, which would correspond to the background levels, while since 1963AD, an increasing trend in charcoal concentration is identified that continues up to today. Magnetic susceptibility also shows a gradually increment since 1963AD, with a concurrent increase in the erosion rates and a decrease of LOI in recent times. The increase in the erosion rates between 1963AD and 1985AD was approximately of 20% from the background levels; while among 1991-1999AD, the increase would have been about 116%. Currently, erosion decreased to 30% above the background levels, which is consistent with decreasing charcoal concentrations. The historical evidence suggests higher fire occurrence between 1930 and 1950. This doesn't agree with the sediment record of lake Burgos, which provides evidence that fires would have occurred in this basin since 1963AD, and they really increased the erosion rates and magnetic susceptibility while decreased the organic matter concentration (LOI), surely affecting the lacustrine ecosystem. These impacts will be evaluated later. This research was funded by projects Fondecyt 1070508 and 11080158.

ABSTRACT #188. Oral Presentation



LATE HOLOCENE PATAGONIAN PALAEOCLIMATE VARIABILTY FROM RAISED PEAT SEDIMENTS

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Keywords: Sphagnum bog, Patagonia, moisture balance.

Raised peat bog sediments provide excellent archives of variations in late Holocene palaeoclimate. Modern wiggle-match dating techniques aligned with a tephrachronological framework allow for the age of sediments to be precisely determined (Mauquoy et al. 2004; Langdon & Barber 2004). Modern palaeoecological and geochemical techniques can provide continuous (sub-) decadal resolution records of variations in near-surface atmospheric moisture balance that typically extend back to the early to mid- Holocene, that are continuous and are not subject to any forms of bioturbation (Barber & Charman 2003). Analysis of the cellulose in preserved sub-fossil Sphagnum remains has recently been demonstrated to provide reconstructions of the past isotopic composition of precipitation (Daley et al. 2009; Daley et al. 2010). The bogs in Patagonia are particularly well suited to isotopic analysis of Sphagnum cellulose by virtue of the dominance of a single species throughout much of their depth (Pendall et al. 2001; Chambers et al. 2007). Suitable bogs are geographically constrained to the southern and south-western limits of South America and the offshore South Atlantic islands, where the balance between precipitation amount and temperature-driven evaporation is favourable (Mauquoy et al. 2004; White et al. 1994). The records provided by those sequences have provided detailed data on the climate variability of the late Holocene, indicating changes in the strength of the prevailing atmospheric westerlies associated with northern hemisphere terrestrial and oceanic variability on timescales commensurate with solar variability. Whilst temporal linkage is observed, the direction of changes in the northern and southern hemispheres are opposite (Chambers et al. 2007). Association with variations in meridional overturning circulation in the North Atlantic (Bianchi & McCave 1999; Hall et al. 2004) has raised questions over the occurrence of a Holocene bipolar see-saw mechanism (Ljung et al. 2006; Ljung & Björck 2007).



WATER LEVEL AND TEMPERATURE RECONSTRUCTION OF TWO LAKES AT TORRES DEL PAINE, SOUTHERN CHILE

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Keywords: paleoclimate, climate change, isotopes, carbonate, thrombolites, stromatolites.

Lago Sarmiento and Laguna Amarga are located within the orographic rain shadow formed to the east of the Southern Patagonian Ice Field in the Andes Range, in the Torres del Paine Chilean National Park. Major thrombolite colonies are present in Lago Sarmiento and widespread stromatolites occur in Laguna Amarga. Based on the characterization of the hydrologic system of these two lakes, together with an estimation of the isotopic balance and an analysis of the equilibrium conditions between the water and biologically induced carbonates, it is concluded that the microbialites of Lago Sarmiento are better suited as paleotemperature indicators than those of Laguna Amarga. Sarmiento Lake thrombolites indicate that at 1215 cal yr Bp the level of the lake was at 85 m a.s.l with a temperature close to 9.3°C, was at 82 m a.s.l. at 600 cal yr Bp with a temperature close to 8.5°C. This coincides with the timing of the Northern Hemisphere Medieval Warming Period. At 183 cal yr Bp the level of the lake was at 80 m a.s.l with a cooler temperature close to 7.7°C, representing a colder period coinciding with the timing of the Little Ice Age (LIA).

ABSTRACT #190. Poster Presentation



A PALAEOLIMNOLOGICAL RECONSTRUCTION OF MID AND LATE HOLOCENE CLIMATE CHANGE IN SOUTH GEORGIA

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Keywords: palaeoclimatology, South Georgia, Holocene

South Georgia is located at the barrier between Antarctica and the mid-latitudes which makes it a key location to determine the main drivers of past and present-day climate variability and to assess whether the climate in the South Atlantic was synchronous with Antarctica or South America. Here we performed a sedimentological, high resolution (ITRAX) geochemical, and fossil diatom and pigment analysis of a 5.41 m long, ca. 8000 cal yr BP, sediment core from Fan Lake, Annenkov Island, South Georgia (54°29'0"S, 37°5'0"W) in an attempt to separate the influence of Holocene palaeoclimatic variability from changes in catchment stability and glacier activity. While radiocarbon ages of events in the top 250 cm (c. 4 ka) of this core appear to be broadly in line with some other studies on South Georgia, the chronology of the lower half still poses several questions. The main lithological division in the profile is marked by the establishment of finely laminated sedimentation at c. 250 cm (4000 yrs BP) and is also picked out by the diatom and pigment analysis. This change is characterized by a reduction to low stable magnetic susceptibility values and a step-change increase in organic matter, and is most likely related to deglaciation of the lake catchment during the 'Mid Holocene Hypsithermal'. Although the diatom composition is dominated by a single species (i.e., *Cyclotella stelligera*), relatively minor, but sometimes significant, fluctuations in other diatom species occur in the top 250 cm (mid-late Holocene). Interestingly, the most remarkable change in the diatom record occurs at c. 100 cm (1000 cal yr BP) and coincides with an increase in general lake productivity. We link these changes to increased catchment disturbance at c. 1000 cal yr BP, which is possibly associated with deglaciation following one of four relatively minor 'post-cooling events' during the late Holocene.





20TH CENTURY STRONG RETREAT OF GLACIAR JORGE MONTT, UNBURIED MORE THAN 250 YEARS OLD TREES DESTROYED DURING THE LITTLE ICE AGE

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Keywords: Southern Patagonian Icefield, tidewater calving retreat, Little Ice Age

Glacier Jorge Montt is one of the largest tidewater glaciers of the Southern Patagonia Icefield. The glacier front, first mapped in 1900, was 17 km north of the 2010 frontal position, yielding the greatest historically recorded glacier retreat in South America. The 1900 position of the glacier is marked by a prominent sub aqueous pushing moraine as detected by a subbottom profiler and echosounder survey carried out in February, 2010. The bathymetry of the abandoned fjord shows another prominent moraine that marks a 6.2 km retreat that occurred between 1900 and 1944/45. As seen in 1944/45 aerial photographs this area was covered by ice until the highest local peaks. Between 1945 and 1990, the glacier continued to retreat at relative small rates (100-200 m/y), however between 1990 and year 2000, the glacier retreated 7.8 km, leaving a 370 m deep fjord, suggesting that the retreat was a dynamic response to near flotation conditions of the glacier tongue. Since 2000, the glacier has been retreating at rates between 100-400 m/y. This huge historical recession exposed dead trees in an area that was covered by ice until 2009. These dead trees are located only 50-100 metres from the February, 2010 position of the glacier. Samples were collected from the outer part of the tree trunks for C14 analysis by Beta Analytic Inc. The age of one sample is 250 years BP and the other, 460 years BP. These trees must have been destroyed in the last glacier advance during the Little Ice Age, LIA. There are no trees growing at higher altitude in this area. The present position of the glacier was reached during the last interglacial time and is therefore not unique. Just before the LIA, the glacier must have been even smaller than today. Research partially funded by FONDECYT 1080320.

ABSTRACT #192. Poster Presentation



FINE-RESOLUTION POLLEN AND CHARCOAL RECORDS FROM NW PATAGONIA (41^e) REVEAL CENTENNIAL-SCALE CLIMATIC ANOMALIES DURING THE LAST 2000 YEARS

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Keywords: Climatic anomalies, NW Patagonia, Southern westerly winds.

Some studies developed in the Northern Hemisphere spanning the past 2000 years describe centennial-scale climatic anomalies termed as the "Little Ice Age" (LIA \sim 600 to 100 cal yr BP) and the "Medieval Warm Period" (MWP \sim 1200 to 600 cal yr BP). Their global character, origin, and associated circulation changes, however, are imprecisely understood. Paleoclimatic records from the Southern Hemisphere mid-latitudes offer the opportunity to monitor not only past temperature changes during this interval, but also the response of the Southern Westerly Winds (SWW). Here we present high-resolution pollen and charcoal records from Lago Campanario, a small closed-basin lake located in the Seno Reloncaví sector of NW Patagonia (41ºS), to determine the timing and direction of climate changes in NW Patagonia during the last 2000 years, and their temporal relationship with LIA and MWP. The data show centennial-scale alternations between Nothofagus dombeyi-type and the thermophilous trees Eucryphia/Caldcluvia and Aextoxicon punctatum, in conjunction with increases in paleofire occurrence. We observe cool-wet conditions between 2000-1200 cal yr BP with the absence of fire, and between 700 -500 cal yr BP with an abrupt decrease in local fire events at 600 cal yr BP. We detect a conspicuous warm-dry anomaly between 1200-700 cal yr BP and intense fire activity. Our results show a chronological correspondence between dry conditions associated with diminished SWW influence and the MWP, an increase in rainfall during the early part of the LIA, and a decline in precipitation that persists until today.

Acknowledgements: ICM P05-002, PFB-23, Fondecyt 1070991.





OPTIMIZATION OF HOMOGENEOUS LIQUID-LIQUID EX-TRACTION (HLLE) OF POLICYCLIC AROMATIC HIDROCAR-BONS (PAHS) FROM AQUEOUS SAMPLES

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Keywords: PAHs, HLLE, Ice core samples.

Polycyclic aromatic hydrocarbons, known as indicators of anthropogenic or natural fossil fuel combustion and biomass burning, can be traced to pristine areas in the world such as polar environments. They reflect combustion activities, for example fluoranthene for coal combustion, phenanthrene for fuel oil and pyrene, and chrysene for biomass burning. In Antarctica they can be present as a result of human presence and/or possible long-range atmospheric transport from sources in South America. As can be expected, ice core and snow samples from Antarctica contain these organic compounds in very low concentrations. Consequently effective pre-concentration methods tailored for low sample volumes and allowing the lowest limits of detection (LOD) and quantification (LOQ) through instrumental analysis have to be available. HLLE is a promising and powerful method of pre-concentration for this kind of samples. This method extracts the solutes from a homogeneous solution into a very small sedimented phase formed by the phase separation phenomenon. In this work a ternary component solvent system water-methanol-chloroform was optimized for the simultaneous extraction of 15 PAHs from water samples: naphthalene, phenanthrene, anthracene, acenaphthylene, fluorene, fluoranthene, benzo[k]fluoranthene, benzo[b]fluoranthene benzo[a]pyrene, acenaphthene, benzo[g,h,i]perylene, chrysene, pyrene, dibenzo[a,h]anthracene, and indeno [1,2,3-c,d]pyrene). The analytical determination was carried out through HPLC coupled to diode array detection. Factors optimized were methanol and chloroform volumes, and NaCl concentration. Optimum volumes were 1.2 mL for methanol, 120 µL for the extracting solvent (chloroform) at a 10 % w/v concentration of NaCl for a sample volume of 3.5 mL. Optimum conditions allowed obtaining an enrichment factor between 44 and 52. LODs and LOQs were between 0.30 - 1.81 ng mL⁻¹ and 1-6 ng mL⁻¹, respectively. Recoveries were higher than 80% for all compounds. The optimized method will be applied in ice core samples from Antarctica but coupled to more sensitive techniques than that employed in this work to obtain lower LOD and LOQ values.

ABSTRACT #194. Oral Presentation



TILLANDSIA DUNES FROM NORTHERN CHILE: A POTEN-TIAL PALEOCLIMATE SENSOR OF PAST VARIATIONS IN FOG INTENSITY DURING THE LATE HOLOCENE

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Keywords: advective fog; Atacama desert; Tillandsia.

The bromeliad Tillandsia landbeckii grows along the coastal scarp of the hyperarid Atacama Desert, one of the most extreme environments of the planet. A series of specialized adaptations such as unique trichomes, CAM metabolism and foliar morphology enable this plant to survive off scarce amounts of coastal fog that blow in from the ocean. By forming bands or "dunes", these plants form complex ecosystems known as tillandsiales. Layered remains of these fog-specialist plants are often found buried and preserved within these dunes attesting to the establishment of these ecosystems over several millennia. In fact, the largest of these dunes have organic layers dated to >3200 cal yr BP (calibrated years before present). Here, we use stratigraphy, geochronology, stable isotopes (δ^{13} C, δ^{15} N), and biomass nutrient stoichiometry (C, N y P) from five different *tillandsiales* along a ~215 km fog gradient to establish how these dunes form and accumulate over time. We thus: a) establish a chronology of past dune establishment, b) propose an explanation for how these dunes accumulate, c) relate gradient changes in δ^{15} N to present variations in fog intensity, and d) discuss variations in nutrient ratios over time. Across our gradient, modern tillandsiales evince a negative correlation between $\delta^{15}N$ and fog intensity. We studied a dead Tillandsia dune system located along the southern margin of our gradient. Radiocarbon dates indicate that it "died" sometime shortly after 1200 cal yr BP. The low δ^{15} N values compared to nearby living stands indicate that it lived under considerably greater fog input than today. These systems thus have the unique potential for studying regional variations in advective fog in northern Chile over the late Holocene.



RECENT CLIMATE VARIABILITY AND HUMAN IMPACT FROM LACUSTRINE CORES IN CENTRAL CHILE

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Keywords: lakes, central Chile, geochemistry.

We present a multidisciplinary study based on short cores from four lakes along a transect spanning coastal sites (Bucalemito and Colejuda) to Central Valley (Batuco) and Cordillera de la Costa (Name) in Chile. We use sedimentological and high resolution geochemical analyses performed with an AVA-ATECH X-Ray Fluorescence Core Scanner and a chronology based on AMS ¹⁴C dates and ²¹⁰Pb dating to investigate recent environmental and paleohydrological changes. Silicate - related elements (Al, Si, K, Fe, Ti, Zr, Rb) are used as proxies for sediment delivery whereas Ca and Sr are indicative of carbonate productivity, commonly associated with increased water chemical concentration. Mn, S and Fe reflect changes in redox conditions. Cu/Zr and Cu/Rb ratios are used as proxies for excess atmospheric Cu deposition. Excess copper deposition in the uppermost sediments occurred in the four of the studied sites, particularly in coastal lakes, since the beginning of the 20th century, when the first industrial smelters were commissioned. Laguna Colejuda records the transition from a more humid period, possibly the Little Ice Age, to more arid conditions during the 20th century. Laguna Grande de Bucalemito reflects important environmental variability over the last 50 years, with deeper depositional conditions during the 1980s and 1990s decades. The Ciénaga del Name sequence shows higher detrital input at the base, a transition to lower sediment delivery and likely lower fluvial connectivity, and a return towards higher clastic deposition in recent times along with greater fluvial input. At the Batuco wetlands, sedimentological and geochemical evidence also point to recent increases in lake level. These preliminary results show a high sedimentary variability that seems to reflect a rapid dynamics in the lake ecosystems in response to both human and climate -induced changes during the last decades and centuries.

ABSTRACT #196. Oral Presentation



PRECIPITATION PATTERNS IN THE CORDILLERA VILCANOTA, PERU

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Keywords: Cordillera Vilcanota, precipitation, meteorology.

The Cordillera Vilcanota in southern Peru has been the site of significant research focused on paleoclimatic reconstructions from ice cores (Quelccaya), past glaciations, climate-glacier interactions, and ecological and human responses to climate change. Although precipitation variability is a fundamental control on observed past and current changes in the Vilcanota, there remains considerable uncertainty on the timing, intensity, and spatial extent of precipitation events in the region. In this paper we analyze precipitation patterns in the Cordillera Vilcanota from 2004 to 2010 using twice daily precipitation observations from five regional climate stations and hourly observations of precipitation intensity and other meteorological parameters from nearby Cusco International Airport. We also analyze outgoing long-wave radiation (OLR) data and atmospheric fields of temperature, wind, and moisture at 500 hPa from the NCEP/NCAR (National Centers for Environmental Prediction/ National Center for Atmospheric Research) Reanalysis dataset and create 72hour antecedent upstream air trajectories for each precipitation event using the NOAA (National Oceanic and Atmospheric Administration) Hysplit Trajectory tool. Results indicate that the major portion of annual precipitation across the cordilleras and intermontane valleys alike occurs from nocturnal, regionally coherent stratiform rainfall events generated as a byproduct from deep moist convection over the Andes or adjacent Amazon lowlands. Lowlevel moisture (as inferred from the antecedent upstream air trajectories) for precipitation events can be supplied from a number of different regions, including from the northwest and west. These results are of particular value in understanding atmospheric signals registered in ice cores, and point the way towards obtaining greater climatological inference from parameters preserved in annual ice stratigraphy.





CORDILLERA VILCANOTA, PERU PRECIPITATION STUDIES: EXPLICIT SIMULATIONS OF OXYGEN ISOTOPE RATIO PROFI-LES IN SEASONAL SNOWFALL

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Keywords: oxygen isotope ratios, ice cores, Cordillera Vilcanota.

The Cordillera Vilcanota in southern Peru features the second greatest ice coverage of any tropical range and the largest single ice field, the Quelccaya Ice Cap. Glaciological investigations culminating in the first deep low-latitude ice cores for paleoclimatic research were performed atop Quelccaya between 1974-1983, yielding a rich legacy of published work that has brought forth many important insights into the tropical Andean climate systems. Yet despite many advances, these studies have been hindered by uncertainty over the climatological significance of the oxygen stable isotope ratio (δ^{18} O), the principal paleoclimatic indicator preserved in glacial stratigraphy. While δ^{18} O has been utilized in polar studies to infer temperature conditions over hundreds of thousand of years, the δ^{18} O-temperature relationship fails to apply in the tropics due to dissimilar climatology and precipitation delivery mechanisms. We have addressed this long-standing conundrum by identifying empirical relationships relating meteorological conditions during individual precipitation events to the δ^{18} O signatures preserved in sequential snow layers. These findings were used to develop a model that utilizes data from regional climate stations to simulate depth profiles of δ^{18} O variations in seasonal snow pack. We will present examples of annual layer simulations compared to actual snow pit δ^{18} O profile measurements that demonstrate the model's capability to capture both high- and low-frequency signals present in the stratigraphy, and how the smoothing of the high-frequency signals in the model can mimic the diffusive mixing of δ^{18} O observed during firnification. By analyzing δ^{18} O patterns recorded within annual layers through this approach, continuous histories of several key climatic parameters (precipitation, boundary layer moisture and temperature) at seasonal resolution extending back for more than 1,000 years could potentially be decoded from the Quelccaya ice cores; the methodology could likewise be applied for other Andean ice core data series with similar meteorological characteristics (i.e. Coropuna, Illimani, Huascarán).

ABSTRACT #198. Poster Presentation



SPATIAL AND TEMPORAL DISTRIBUTION OF RODENT MIDDENS RECORDS IN NORTH-CHILE

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Keywords: Middens, Quaternary Climate, North Chile.

In this work we show some general patterns inferred from a rodent middens database that has been established in northern Chile. Most of these deposits are formed by Abrocoma (chinchilla rat) and Phyllotis (leaf-eared mouse) rodents. We review methods and approximations currently in use for paleoclimate reconstruction based on this biotic record of past environmental change. We include also the recent advances in paleoclimate reconstruction in the North of country. Since 1996, a total of 1025 middens have been collected in the Regions I to IV of Chile, of which 308 are dated by radiocarbon. For this analysis we classify the collection according to the biomes: 61% correspond to the Prepuna, 9% to the Puna, 7% to Semiarid and High-Andean, while 3% belong to the Coastal Mountains. Regarding the temporal distribution, 50% of middens are dated between 0-6 ka (ka = 10³ cal year BP), while 11% range between 6-9 ka, 30 % between 9-14 ka, 5% between 14-19 ka; 3% correspond to 19-25 ka and 0,3% are >25 ka old. With regard to the forming agent, 43% are Abrocoma, Phyllotis is 32% and 20% are middens formed by more than one species. About 17% of these samples are undetermined. Diverse approaches for paleoclimatic reconstructions are currently used in the analysis of middens; the analysis of the composition and richness of plant macroremains as well as cuticles and pollen allow us to visualize the qualitative and quantitative changes on the seasonality and changes in precipitation. Among the most innovative approaches, direct measurements on Abrocoma feces allow for the assessment of quantitative variations in rainfall. Finally, we propose a meta-analysis project for the last 20 ka for the north of Chile using these samples to develop regional paleoclimate reconstructions. A potential application of this metadata is the analysis of niche conservatism through the niche modeling applications.



MASS BALANCE OF MOCHO-CHOSHUENCO GLACIER, SOUTHERN CHILE, IN THE PERIOD 2003-2010

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Keywords: mass balance, glacier retreat, climate change.

In May of 2003 CECS began a mass balance monitoring programme on the south-eastern glacier of Mocho-Choshuenco volcano, southern Chile (39° 56' S, 72° 02' W). The glacier is the largest ice body within the "Región de los Ríos", with an area of 16.9 km² in 2003. The glacier has been retreating at a rate of 0.4 km²/y (1976-2003). Glacier retreat is predominant in southern Chile, in response to a combination of climate warming and precipitation decrease. Mocho-Chosuenco constitutes the only glacier site in the region which is currently monitored for mass balance, and one of the few mass balance sites in Chile. The last volcanic eruption at Mocho-Choshuenco occurred in 1864, and the volcano is regarded as a dormant complex. Mass balance is monitored in the southeastern glacier basin of 5.1 km² (Glacier Mocho) where data are collected on a monthly or bi-monthly basis. Measurements include monitoring of 13 stakes distributed between the front of the northern tongue at an elevation of 1713 m a.s.l. and the summit cone (2416 m a.s.l.). Stake positions and glacier surface elevation are also determined at each epoch with dual-frequency differential GPS method, as well as snow stratigraphy and density at shallow (1m) snow pits. The net mass balance is largely controlled by the variability in winter precipitation, which results in a winter snow accumulation ranging from 5 m to 15 m over the glacier. Here we present an updated mass balance series of Glacier Mocho for the period 2003-2010. In addition to evaluating the present glacier status in the region, the mass balance series is useful for calibrating recent firn core records obtained at Mocho-Choshuenco volcano.

ABSTRACT #201. Oral Presentation



CLIMATOLOGICAL AND GLACIOLOGICAL CHANGES IN THE SOUTH OF THE ANTARCTIC PENINSULA: A CASE STUDY AT FLEMING GLACIER, WORDIE BAY

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Keywords: Antarctic Peninsula, Climatology, Glaciology.

The collapse and retreat of ice shelves along the Antarctic Peninsula (AP) during recent decades has been attributed to changes in atmospheric and oceanic temperatures. While atmospheric warming leads to a prolonged melt season and increased melt ponding, oceanic warming increases bottom melting eroding ice shelves from below. Glaciers feeding into these ice shelves are known to accelerate because of the loss of the buttressing force the ice shelf exerted. We investigate the case of Wordie Ice Shelf and its tributary Fleming Glacier, describing the climatological setting, changes in the ice shelf geometry and consequential changes in glacier dynamics. Data from an automatic weather station deployed at Fleming Glacier (1057 masl) show high daily correlations with surrounding stations revealing that its climate is defined by the overall synoptic and subsynoptic scale perturbations that affect the western side of the AP. Wordie Ice Shelf experienced a continued retreat during most of the second half of the 20th century. Currently there are only two small floating ice tongues left comprising an area of less than 100 km², while the largest glacier Fleming terminates at its 1996 grounding line position. GPS measurements conducted in 2008/2009 about 40 km upstream of the grounding line reveal an increase in ice flow velocity compared to measurements from the 1970s. A detailed analysis of 10 month of continuous GPS data reveals acceleration even within this short time period. To analyze the effect of the accelerated ice discharge on surface topography, different airborne laser scanning campaigns from 2002 to 2008 were used. There is a clear decrease in surface elevation all along the surveyed profile with maximum change rates of about 4 m yr⁻¹ at the ice front. These data indicate that Fleming Glacier has not come to a new equilibrium and is still losing mass due to enhanced ice flow.



POLLEN AND CLIMATE DATA FROM SOUTHERN PATAGO-NIA: WEAKNESSES AND STRENGTHS FOR QUANTITATIVE PALAEOCLIMATIC RECONSTRUCTIONS

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Keywords: pollen climate datasets; quantitative palaeoclimatic reconstructions, southern Patagonia.

One of the important advances in pollen-based climate reconstructions has been the increase of efforts to improve the statistical precision of pollenbased reconstruction models. In this sense, pollen and climate dataset evaluations are presented for southern Patagonia. The original pollen dataset consisted of 221 georeferenced surface soil samples uniformly distributed between 46°-52°S and 67°-73°W and included 81 pollen types. Manual procedures and graphical tools were used to identify duplicate samples and/or to evaluate taxonomic consistency in the pollen identifications. This quality assessment led to the bestPollen dataset (bPD) that includes 155 samples and 57 pollen types. A further selection consisted of eliminating samples from over-represented vegetation units, generating a minimalPollen dataset (mPD) of 87 samples and 43 pollen types. Climate data were compared between instrumental data and different Global Climate databases in order to accurately represent modern climatic features. Some data overestimated precipitation values (50-240 mm) at locations close the Andes, while underestimated values (50-100 mm) are registered at coastal stations. Temperature estimations did not reveal significant differences between databases, and generally showed good agreement with the instrumental data. Calibration models for annual precipitation (P_{ann}) as well as annual (T_{ann}) , July (T^{jul}) and January (T_{im}) temperature were elaborated based on *b*PD and *m*PD, applying a transfer function (WA-PLS) and the Modern Analog Technique (MAT). The results of cross-validation (r², RMSEP, MaxBias) demonstrated that MAT models performed slightly better than WA-PLS models although there were no significant differences based on using bPD or mPD. The models presented a good inference power to estimate P_{ann} and T_{ian}, but moderate and poor success at estimating T_{ann} and T_{iuv} respectively. In order to validate the calibration models potential, P_{ann} and T_{ian} were reconstructed from two fossil pollen records of the Late Holocene, providing therefore key information on past regional climate variability at southern Patagonia.

ABSTRACT #204. Poster Presentation



MODERN POLLEN RAIN, VEGETATION AND CLIMATE IN THE BOLIVIAN ECOREGIONS

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Keywords: Pollen rain, Bolivia, ecoregions, tropics, calibration, climate, biomes, PFTs.

We aim to contribute to global vegetation mapping and reconstruction through improved knowledge of the relationship between modern pollen dispersal, vegetation and climate in Bolivia. Nine ecoregions were investigated: southern Puna, northern Puna, Yungas, pre-Puna, Gran Chaco, Chaco Serrano, Tucuman-Bolivia forest, inter-Andean dry forest, and flooded savanna. Forty soil surface samples were collected between October 2006 and April 2007, along an elevational transect from 4588 m down to 160 m from 16 types of vegetation cover. The vegetation cover was described in each sampling plot and statistical analyses were performed on the pollen data. From the nine ecoregions, our pollen data allowed us to identify seven groups of pollen assemblages. The two Punas were grouped in one group and the dry forests were in one group. Statistical regressions between pollen indicators and elevation, precipitation, and temperature were computed. These data revealed a strong opposition between Asteraceae (high elevation, low precipitation and low temperature) and Arecaceae (low elevation high precipitation and high temperature). Using the results of statistical analysis, our knowledge of the taxa, and published data, we were able to assign our pollen assemblages to 16 plant functional types and to characterize seven biomes in Bolivia.





COMPARISON BETWEEN HILBERT-HUANG AND WAVELET COSPECTRUM FOR STUDIES OF SUN-EARTH-CLIMATE RELA-TIONSHIP

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Keywords: Solar Activity, Hilbert-Huang Transform, Wavelets.

Despite the scientific works supporting the point of view that meteorological phenomena must respond to variations of solar activity, this subject is far from being settled. Several of the record analyses are fraught with problems in the methods considered, for example: bias in data selection, or questionable statistical significance of the reported correlations. Consequently, developments of new mathematical tools are needed to overcome such difficulties and restrictions. A novel, data driven approach, called Empirical Mode Decomposition (EMD) has been introduced in recent years by Huang et al. (1998). It consists in obtaining Intrinsic Mode Functions (IMF) through an adaptive/iterative procedure based on envelope averages without a priori assuming any previously defined signal form. Huang's EMD has been successfully used in analyzing nonlinear and nonstationary data. Furthermore, each IMF is defined in such a way that the Hilbert transform can be used to obtain instantaneous frequencies. The combination of both Hilbert spectral analysis and Huang's method is now known as the Hilbert-Huang Transform. In this study we introduce a new method based on the Hilbert-Huang Transform as a way to obtain instantaneous cospectra and coherence, applicable to climate time series. Examples of the proposed method are shown and a comparison with well-known wavelet methods is performed using centennial rainfall and sunspot records (1912-2010). While the EMD alone has a remarkable feature of identifying natural trends in time series, the Hilbert-Huang Cospectrum analysis proposed here eliminates spurious correlations and allows a more precise identification of the scales present in the data.

ABSTRACT #206. Poster Presentation



LATE HOLOCENE ENVIRONMENTS IN ARID AND SEMIARID REGIONS OF CENTRAL-WESTERN ARGENTINA (30° - 35°S): POLLEN RECORDS AND PALEOCLIMATIC INFERENCES

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Keywords: pollen analysis, vegetation history, general circulation models.

In arid and semiarid regions from central-western Argentina (30°-35°S), sparse vegetation with poor pollen production, in combination with high deposition rates of clastic sediments with abundant carbonate and sulfate cements, hamper the production of continuous, well-dated, high-resolution paleoenvironmental archives to reconstruct past changes in regional vegetation. Paleoecological and paleoclimatic records are scarce, non-continuous and of low-temporal resolution. In order to contribute to the regional paleoclimatology, a multidisciplinary study is currently in progress to reconstruct past environmental changes for the late Quaternary in central-western Argentina. In the framework of this investigation, two pollen records from the Piedmont and the plain at 33°-34°S were studied to reconstruct the vegetation history of the region during the Holocene. Our results show changes in hydrophytic plant communities during the late Holocene, attributed to the hydrological dynamics of local basins. In the La Estacada creek (33º27'S/69º03'W), two intervals with higher water availability at ca. 4000-3000 yrs BP and ca. 500 yrs BP were related to hydrophytic communities in the flood plain. In the Salinas del Bebedero (33º20'S/66º45'W) shallow lake, minor water level fluctuations during the last ca. 3400 yrs BP are associated with the presence of halophytic communities. These hydrologic variations at the La Estacada and Salinas del Bebedero basins are compared with additional paleoenvironmental proxies in the area to assess the local (fluvial dynamics) or regional (climate) nature of these humid events. Paleoclimatic scenarios are proposed for subtropical central-western Argentina during the late Holocene according to the current knowledge of past vegetation and paleoclimate indicators. These scenarios are compared with paleoclimatic reconstructions from the nearby regions of Central Chile, Pampa Bonaerense and Northern Patagonia. Finally, the paleoclimatic inferences from subtropical South America are contrasted with the results from general circulation models available for the region.



SOLAR FORCING OF RAINFALL VARIABILITY OVER SOUTHERN BRAZIL: A COMPARATIVE STUDY BETWEEN LITORAL AND CONTINENTAL SITES

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Keywords: Solar activity, rainfall, Southern Brazil.

The possible influence of solar activity on climate is a theme of intense debate. The relationship between solar activity and climate is very complicated and varies with time and probably also with geographic position. Consequently, a regional approach may allow one to recognize specific forms of solar forcing and where and when the solar contribution is important. For South America, few studies on this issue have been reported. Southern Brazil is a region of special interest because it is strongly influenced by the South Atlantic Magnetic Anomaly, and hence a possible direct or indirect climatic effect associated to electrically charged particle flux could be particularly relevant. In order to study a possible geographical dependence in the sun-rainfall relationship, the present work analyzed the influence of solar activity on long-term variability of rainfall over southern Brazil. For this purpose, the annual sunspot number (Rz) was cross-correlated with annual rainfall records (1912-2010) from a littoral site (Pelotas - 31°46'S, 52°20'W) and a continental site (Santa Maria -29°41'S, 53°48'W). Strong solar signals at 11 and 22 years in the cross-wavelet spectrum between rainfall and sunspots were found. The cross-wavelets indicate that the effects of the 22-year Hale cycle on rainfall variability may be stronger than the effects of the 11-year Schwabe cycle. Furthermore, the sunrainfall relationship was more evident for Pelotas, seashore city, probably due to the ocean's stabilizing effect. For Santa Maria, 350 km inland from the Atlantic Ocean, regional climatic peculiarities may be more significant. These results suggest that the solar forcing on climate may present geographical dependence from littoral to continental regions.

ABSTRACT #208. Poster Presentation



AGE-DEPENDENT TREE-RING GROWTH RESPONSES OF ARAUCARIA ARAUCANA TO CLIMATE IN ARGENTINA

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Keywords: Araucaria araucana, Tree-ring growth, age-classes.

Dendrochronology generally operates under the assumption that climategrowth relationships are age independent. However, several studies have demonstrated that tree physiology undergoes changes with age. The agerelated climate-growth relationship might potentially improve the veracity of past climate reconstructions. In this work we present three chronologies of tree-ring width of A. araucaria. Tree-ring width chronologies were generated from A. araucana cores taken in northwest Patagonia, Argentina, and were grouped into tree age classes (<120 years, 121-300 years and >301 years). Were analyzed age-dependent growth-climate response relationships. The tree-ring width chronologies extend to more than 700 years ago. Tree-ring statistics showed significant changes between tree-ring width chronologies and between age classes. The mean ring-width values show that A. araucana has a biological-geometrical trend deceasing with age. Ring widths of A. araucana are positively correlated with rainfall, but negatively with temperature. Preliminary analysis of age-classes suggests that different age-dependent climatic response relationships existed with respect to radial growth. These results suggested the importance of incorporating trees of all ages into the chronology of A. araucana.



INSTRUMENTAL CLIMATIC VARIABILITY IN VALDIVIA SINCE THE MID XIX CENTURY

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Keywords: Valdivia, seasonal shifts, AAO, ENSO.

In Chile, long instrumental climate records are exceptional, but very necessary for understanding climatic trends. The present work explores one of the longest precipitation records in Southern Chile, generated in Valdivia. This record begins in AD 1853, and includes temperature data AD since 1960. In this study, we analyzed these records with regard to their annual and seasonal trends, periodicities, and relation to the Antarctic Oscillation (AAO) and El Niño Southern Oscillation (ENSO). Since 1853 annual rainfall shows a decreasing trend, and mean annual temperature has been increasing since 1960. The autumn-winter precipitation shows the largest reductions, and spring-summer temperature reflects important increases. Multi-annual series of precipitation and temperature shows strong periodical signals between 3-5 years. Strong relations were observed between the winter-spring precipitation, summer-autumn temperature and ENSO activity in the last 45 years. Higher and positive correlations occurred between the AAO index and summer rainfall, also with autumn temperature. Preliminary results indicate that the most pronounced seasonal changes are during autumn-winter for the case of precipitation and during spring-summer for temperature. Comparison of these records with other long instrumental records is required to increase the understanding of large-scale climate variability in South-central Chile.

ABSTRACT #210. Poster Presentation



RECONSTRUCTING AND ANALYZING THE FLUCTUATIONS OF GLACIER ESPERANZA NORTE, WET ANDES, ARGENTINA, SINCE THE LITTLE ICE AGE

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Keywords: Little Ice Age, Glacier reconstruction, Wet Andes.

Glacier Esperanza Norte (also known as Glacier Túnel, 42°15'S, 72°10'W) is one of the largest glaciers in the north Patagonian Andes of Argentina and one of the very few glaciers with information about frontal fluctuations for the last centuries. This valley glacier is part of the Esperanza/Universo icefield and had in 2007 an area of 10.5 km², a mean altitude of 1844 m, and a length of 4.94 km. The glacier is formed in a compound basin and has a landterminating, clean ice tongue. The longitudinal profile of the glacier is characterized by a relatively flat accumulation area and a steep ice fall in which the ablation area is currently located. Although basic data for this glacier has been included in the World Glacier Inventory, this information is presently inadequate for reconstructing the Equilibrium Line Altitude (ELA), length or areal variations. Here we present a reconstruction of glacier geometry and mass balance/glacier flux response for the past 400 years using an inverse glaciological approach based on dendrochronology data, historic photos, satellite images and a new geomorphology map made from field work and remote sensing data. Preliminary results indicate that the Little Ice Age maximum extent occurred in the early 17th century and has been followed by at least 20 glacier readvances or standstills embedded within an overall retreat. An analysis of the glacier's response to changes in mass balance/glacier flux is performed in order to explain changes in the glacier's geometry and the characteristics of the frontal moraines. This hypothesis is further explored with different ELA reconstruction methods in combination with climate reconstructions from other proxies.



REGIONAL CLIMATE RECONSTRUCTIONS IN SOUTH AMERI-CA: A CONTRIBUTION FROM THE LOTRED-SA INITIATIVE

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Keywords: regional climate variations, Bolivian Altiplano, subtropical Andes, Patagonian Andes, tropical-extratropical climatic interactions.

Recent reviews in the LOTRED-SA Special Issue (Palaeo 3, 2009) show that there is a wealth of data sets available from a large variety of high-resolution archives across the Andes of South America. Based on this information, we provide regional syntheses of climate variations for the southern tropics (Altiplano), subtropical Andes (Central Chile and Argentina), and the northern and southern sectors of the Patagonian Andes during the last four centuries. Consistency among different proxy records provide confidence about the major climate changes recorded at regional scales. Humid conditions in the Bolivian Altiplano and the subtropical Andes inferred from tree rings during the 17th and 19th centuries are consistent with glacier advances in both regions during the Little Ice Age (LIA, ca. AD 1600-1850). Across Patagonia, most glaciers also reached their peak LIA advances between the 17th and 19th centuries followed by an accelerated loss of ice during the past century. Glacier retreat has been particularly pronounced in the northern Patagonian Andes since the mid-1970s, where tree-ring based temperature estimates have been the warmest of the past 400 years. This warming has been concurrent with a marked negative trend in regional precipitation. Comparisons of long-term climate variations in the four selected Andean regions suggest the existence of coupled interactions between tropical and extratropical modes of climate variability. The wet periods in the southern tropics and the subtropical Andes around AD 1650 and AD 1820 could be dynamically associated with a weakening of the Hadley Cell and a northward shift of the Westerlies, respectively. Northward locations of the Westerlies during the same intervals migth have enhanced Antarctic influences across Patagonia, consistent with the two coldest periods reconstructed for the north and south Patagonian Andes during the past four centuries.

ABSTRACT #212. Poster Presentation



TREE-GROWTH IN THE ATACAMA DESERT IS RELATED TO THE CENTRAL ANDES MONSOON VARIABILITY

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Keywords: Tree-rings, Groundwater, Altiplano precipitation.

The Atacama Desert is one of the driest places on earth where the development of plant species face extreme harsh conditions being almost completely absent form the landscape. In the northern part of Atacama, where annual precipitation is normally zero, a unique forest ecosystem is composed by the drought adapted tree species *Prosopis tamarugo*. These forests are located over the groundwater aquifer of the "Pampa del Tamarugal". This water reservoir is mainly comprised of fossil water with an annual underground recharge by percolation of precipitation from the Altiplano in the high Central Andes. Precipitation in this high-elevation intramontane plateau is closely related to variability of the South American monsoon. It occurs mainly during the austral summer, is of convective origin and has its moisture source in the eastern lowlands and the Amazon Basin. P. tamarugo have a pivotal root system which allows a phreatophyte water uptake strategy, thus tree growth would be modulated by the groundwater level and finally by precipitation occurring in the Altiplano. To test this hypothesis and evaluate if tree-growth in the Atacama Desert is related to the Central Andes monsoon variability, we examined the potential to develop an exactly dated annual tree-ring chronology and performed climate-tree growth time series comparisons. Tree-ring width is positively correlated with Altiplano precipitation during summer. Spatial correlation analysis shows that tree-growth is negatively correlated with surface pressure over the Amazon basin, and pressure patterns over the Pacific Ocean indicates that *P. tamarugo* growth is positively related to La Niña-like conditions.



CLIMATE OF THE ANTARCTIC AND SOUTHERN AMERICA (CASA) PROJECT: STATUS AND PRELIMINARY RESULTS

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Keywords: climate warming, ice coring, climate variability.

Although the scientific evidence of global warming is widely regarded as indisputable, the prediction of regional impacts has proved more problematic. The Southern Hemisphere climate record is particularly sparse and particularly true in the Antarctic Peninsula where there is a gap in ice core records. Long records are needed to reconstruct changes in atmospheric circulation and major climate regimes in order to understand past, present and future climate changes. During the past three years a joint effort between Brazil, Chile and the United States has focused on the recovery of a ca. 500 m length ice core record from a site located at 2000 m a.s.l. in the Detroit Plateau, Antarctic Peninsula (64°05'S, 59°40'W), that will potentially covers a period of at least 2000+ years. Up to now we have recovered a 133 m long, together with few other shallow ice cores; measuring dD, d180 stable water isotopes, IC for Na+, K+, Mg2+, Ca2+, Cl-, NO3-, SO42-; Cd, Pb, Ba, V, Fe, Mn, Zn, Cr, Co, Al, Ca, S,Ti, Cu, U, Cs, rare earths and microbes presence. Results from data analysis are promising and confirm the recovering of a well preserved ice core record. This international program of scientific collaboration and shared logistics provides an efficient way to investigate climate change and glaciology along the Antarctic Peninsula. Our joint goal is to fill the gap of longer-term, highresolution climate observations over the Antarctic Peninsula, that will extend past, pre instrumental climate record for the region and to allow the study of the Antarctic Peninsula/South America climatic connections. Future plans to collect another ice core down to the bedrock will be summarized.

ABSTRACT #215. Oral Presentation



SURFACE AIR-TEMPERATURE VARIATIONS ON ANTARCTIC PENINSULA OVER THE LAST 100 YEARS

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Keywords: temperature series, Antarctic Peninsula, Atmospheric warming.

We present the analysis of long-term instrumental surface air-temperature series of stations located on both sides of the Antarctic Peninsula (AP). The earliest instrumental data extending back for more than 100 years come from Orcadas Station, located on South Orkney Islands. The Orcadas temperature series, the longest instrumental record available in Antarctica, reveal that the past three decades were the warmest of the century, with the last one being the absolute warmest of the record. This decade was also the global warmest since the instrumental measurements begun in 1880's. The available longterm temperature records show an unequivocal pattern of pronounced atmospheric warming on AP which extends back for several decades. During this time interval the mean annual air-temperature on AP has increased several times the global average. According to our analyses the mean annual temperatures have increased since the initiation of measurements at each station at a rate of 0.02 °C a⁻¹ at Orcadas, 0.03 °C a⁻¹ at Esperanza on the northern tip of AP, 0.049 °C a⁻¹ at Marambio on south-east AP, 0.054 °C a⁻¹ at Faraday-Verndsky on the western coast, and 0.08 °C a-1 at San Martín, the south-westernmost weather station on AP. In addition, the mean annual temperature series show that warming trend increases from north to south, and that the largest warming on north-eastern AP takes place in autumn and summer seasons while on the south-western part occurs in winter. The pronounced atmospheric warming in recent decades, particularly during summers, has been largely responsible for the observed drastic retreat and negative glacier mass-balance, triggering also the disintegration of large ice shelf sections in this region.





VEGETATION CHANGES IN THE ANDEAN SECTOR OF CEN-TRAL PATAGONIA OVER THE LAST 2300 YR REVEALED BY THE LAGO EDITA RECORD (47°S)

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Keywords: vegetation, Central Patagonia, Lago Edita.

Here we present a high resolution pollen and charcoal record from Lago Edita (47°S, 72°25'W, 570 m elevation), a small closed-basin lake located near the modern forest-steppe ecotone on the eastern slopes of the Andes in Central Patagonia. We examine: i) the relationship between vegetation, fire, and climate change over the last 2300 cal yr BP, and ii) the impacts of the arrival of Europeans settlers to this area. The record shows the continuous dominance of Nothofagus during the interval, punctuated by increases in Poaceae and the microalgae Pediastrum at 2300-2000, 1550-1400 and 1200-700 cal yr BP suggesting decreased precipitation and warm conditions during these phases. An increase in *Rumex* and Cyperaceae, fire occurrence and a sustained decline in *Nothofagus* and Poaceae suggest the onset of European disturbance under warm/drier climate conditions. These vegetation changes start at 700 cal yr BP and were amplified by European disturbance, thus accounting for the modern patchiness of forest in the Andean region of Central Patagonia. Our results suggest that precipitation variations revealed by the Lago Edita record probably reflect changes in the strength and/or position of the core region of Southern westerly winds.

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ABSTRACT #217. Poster Presentation



CHANGES IN CLIMATE, VEGETATION AND FIRE REGIMES IN SW MENDOZA, ARGENTINA OVER THE LAST 6400 CAL-YR-BP: THE LAGUNA EL SOSNEADO RECORD

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Keywords: Holocene, vegetation, fire.

A new Holocene record from Laguna El Sosneado, in the upper Atuel River basin (34°47'S, 69°52'W; 2000 m asl), provides information on the environmental history of a region where little paleoenvironmental data is available and offers a comparison with other published records. Between 6400 and 1900 cal-yr-BP the pollen record shows the development of Andean-Patagonian shrub steppes dominated by Poaceae, Chenopodiaceae, Mulinum, Chuquiraga, Adesmia, Berberis, Asteraceae, Ephedra and Schinus that characterize the vegetation growing above 2200 m asl, suggesting wetter (~700 mm annual precipitation) and colder (~7.5°C annual temperature) than present conditions. During this interval, the high-resolution charcoal record suggests that fires were frequent. The highest fire activity between 2500 and 1900 cal-yr-BP is explained by a greater abundance of fine fuels as implied by the high values of grass/total charcoal proportions. In addition, an increment of Poaceae and Mulinum indicate a period of greater effective moisture. An abrupt change at 1900 cal-yr-BP towards more sparse vegetation similar to the lower belts of Patagonia-Monte steppes dominated by Neosparton, Asteraceae, Poaceae, Larrea, Prosopis, Prosopidastrum and Junellia indicate drier (~500 mm) and warmer (~9.5°C) than present conditions. Fire shows low frequency and low magnitude due to a lack of fuel presumably caused by the abrupt decrease of Mulinum, a fire-adapted cushion shrub, and Poaceae. The last 700 cal-yr-BP mark the development of the modern Patagonian steppes and semi-arid conditions (~600 mm and ~8°C) with the almost total absence of fire except for three events correlated with the LIA. Evidence of wet conditions in the Andean foothills during the middle Holocene contrasts with postulated arid conditions, especially in the western side of the Andes (37°-22°S). Our reconstructions agree with the onset of dry-wet periods recorded in northern-Patagonia, south-central Chile, and neoglacial advances documented in the area from 5500-4400 and 2500-2000 cal-yr-BP showing a strong relationship with the westerly dynamics.



TWO APPLICATIONS OF SELF-ORGANIZING MAPS IN CLIMA-TE SCIENCES

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Keywords: Self-organizing Maps, Sea Surface Temperature, Precipitation.

Self-organizing Maps (SOM) are a type of Neural Network, which use an unsupervised learning algorithm to map a data set onto a 2-dimensional grid. SOM are widely used for clustering, visualization and abstraction of multidimensional data. This method has two relevant features: (1) the SOM preserve topological relationships among input data, allowing to explore relationships and patterns between variables; and (2) it is possible to combine different variables in a single training data set. Those, and other features, make the SOM a suitable tool to explore patterns and relationships in climatological data. In order to present the potential of SOM, we show two applications. The first application explores the association between Sea Surface Temperature (SST) fields and precipitation in Central Chile, and associated climatic modes, showing the clustering capabilities of the SOM. The second application uses the SOM to forecast monthly precipitation in Central Chile based on SST fields. Additionally, we discuss some technical issues regarding the proper application of the SOM, like the number of neurons, size of the training data set, normalization of variables, and visualization tools. The method can be easily tailored towards other applications, and is based on a deep exploratory phase to define relevant variables to construct the training data set.

ABSTRACT #220. Oral Presentation



HIGH RESOLUTION PALEORECORD FROM THE GALÁPAGOS ISLANDS

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Keywords: High resolution, pollen, Galápagos, ENSO.

We retrieved a record of decadal and subdecadal climate variability for the last 2.5 K years in the Galapagos Islands. The pollen record of El Junco Cater Lake consisted of taxa not restricted to the crater, nor even to the Galápagos Islands. Andean elements in the record i.e. Alnus and Myrica are assumed as indicators of increased convection associated with warm sea surface temperature (SST) in the entire region of the Eastern Equatorial Pacific (EEP). The incidence of increased rainfall during extreme or prolonged El Niño events turns out into differential species responses. Lowland elements i.e. Bursera, Chamaesyce, and Hippomane respond increasing blossom. However, not all the taxa respond the same to climate variability over the late Holocene including the two main periods Little Ice Age (LIA) and Medieval Warm Anomaly (MWA). Not all taxa recorded display a positive correspondence to the Thycoplanktonic diatoms indicators of high lake level. The system at El Junco elevation, 670 m asl, is light limited due to garúa dominance most of the year. Misty conditions prevail during La Niña events that seem to be enhanced normal conditions in the EEP. We inferred dominance of La Nina conditions during the MWA, previously suggested by Rein (2005) in the Peruvian Coast. But conversely to previous records in the central tropical pacific (Cobb 2003), we inferred an erratic pattern of El Niño and the Southern Oscillation (ENSO) during LIA. Although the Galapagos ecosystem has been regarded as pristine, we report c. 1930 AD as a turning point of intense degradation leading towards a novel environment.



ABSTRACT #221. Poster Presentation

ENVIRONMENTAL CHANGES OF THE COLONIZATION IN THE CHACABUCO RIVER WATERSHED (SEPTENTRIONAL PATA-GONIA) DURING THE LAST CENTURIES THROUGH PALYNO-LOGICAL, CHARCOAL AND HISTORICAL RECORDS

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Keywords: human impact, lake sediments, historical records.

During the last two hundred years Patagonian ecosystems have been widely affected by human activities as a result of the settlement proccess and the concurrent population increase. During the 20th century the intervention was characterized by vast forest fires which lasted more than twenty years, producing a 50% reduction of the original vegetation, and affecting mainly the forest-steppe ecotone. In order to reconstruct and assess the human impacts of the last centuries in this ecosystem, a sediment core of 175 cm length was retrieved from the deepest part of Cisnes Lake (47°-8'S; 73°-24'E). The results of palynomorphs and charcoal analyses were expressed as relative abundance (%) and total concentration respectively. CONISS analysis identified three zones: a) Zone Ci-I (90–55 cm): dominated by Poaceae (70%) and the aquatic taxa of Cyperaceae and Pediastrum, followed by tree taxa Ericaceae (7%) and Podocarpus (4%). Among the herbs Acaena, Asteraceae sub. Asteroidae, Cariophylaceae (5% each) and Umbelliferae (3%) were the more conspicuous, while charcoal showed high concentrations; b) Zone Ci-II (45-20 cm), was characterized by the increase of Umbelliferae (7%), Acaena (7%) and aquatic taxa (20% each), Charcoal levels were maintained and showed two peaks; c) Zone Ci-III (20-0 cm), an increase of *Pediastrum* (35%) and *Podocarpus* (9%) is evidenced at the beginning of the zone, while at the end of this Berberis increased (30%) and charcoal concentration decreased noticeably. These results are discussed in relation to historical records. Research funded by Fondecyt Nº1070508 and DIUC Semilla Patagonia 208.310.054-1sp.

ABSTRACT #222. Poster Presentation



VOLCAN HUDSON GLACIER VARIATIONS AND THERMAL ANOMALIES FROM SATELLITE IMAGE ANALYSIS

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Keywords: Thermal monitoring, Remote Sensing, glacier thinning and retreat.

Hudson Volcano (45° 54'S, 72° 58'W) is the southernmost active volcano of the South Andes Volcanic Zone. It is characterized by a 10 km diameter caldera partially filled by ice. In the northeastern sector of the caldera, the ash/debris covered Huemules glacier is flowing out of the inner caldera. The last eruption of Hudson volcano began on 8th August 1991 yielding a vast destruction all along the Aysén region due to the ejection of a large volume of pyroclastic material. In order to identify thermal anomalies nearby the caldera, and by these means detecting possible precursors of volcanic activity, multispectral analysis methods were applied, based upon ASTER satellite imagery. Several ASTER and Landsat satellite images have been compiled and analyzed to characterize glacier behaviour since 1985. The comparison of Digital Elevation models (DEM) acquired at different dates, were used to identify an important ice thinning and glacier retreat in recent decades. The evolution of the main thermal anomalies and the characterization of features within the caldera are described. This investigation is part of the FONDECYT N^o 1090387 project.





FLUVIAL WETLAND EXPANSION DURING THE LAST 2000 YR BP IN SOUTH PUNA, ARGENTINA, 27°S

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Keywords: perennial river expansion, Puna, Argentina.

In this study we present Late Holocene stratigraphy records form five nonglacial valleys in the southern Puna Desert (Argentina, 27ºS, 67ºW). Approximately 13 AMS ¹⁴C dates on carbonized plant fragments and organic mats constrain the age of these deposits. The age of perennial streams deposits are similar in different valleys and developed during >2000-1500 yr, 700-600 yr and 300-150 yr BP. The corresponding deposits are mostly fine-grained diatom rich sediments and organic detritus with interbedded gravel channels and paleopeat layers. They were interpreted as a result of perennial groundwater discharges with low frequency non-stormy precipitation in an alluvial plain. During 1500-700 yr, 600-300 yr and in the last 150 yr BP aeolian and debris flow deposits with several erosional phases developed within all streams. These geological features are interpreted as a result of low frequency strong rainfall deposits in braided channels. The environmental evolution and geomorphic response of wetlands has important implications for assessing the relation between climate, humans and ecological change in the South Puna desert area.
ABSTRACT #225. Poster Presentation



CLIMATE CHANGE PROJECTED DATABASE FOR CHILE BA-SED ON HADCM3-PRECIS AND METEOROLOGICAL RECORDS

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Keywords: PRECIS, high resolution, Chile.

The first aim of this presentation is to present insights and results regarding the construction of a homogeneous and high-resolution climatic database along Chile. In addition seasonal climatologies for the different climatic conditions (ENSO and others) will be presented. Thirdly we will show results regarding a comparison with the baseline simulation (between 1961 and 1991) of the dynamic downscaling projection results obtained from HadCM3-PRE-CIS (Fuenzalida et al., 2006) under different emission scenarios. Taking into account the differences found between the in situ data and the dynamically downscaled climatology, we will correct the projected dynamically downscaled climatologies for the future A2 and B2 climate change scenarios and discuss the results.



EFFECT OF CIRCULATION INDICES ON FLOOD LIKELIHOOD ALONG CHILE

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Keywords: Floods events, climatic indices.

Floods are the most frequent natural disaster claiming loss of life and property compared to any other natural disaster. Worldwide about one-third of all losses due to nature's fury are attributed to floods. On average, worldwide, floods lead to more than 50 billion Euros in damage and 40000 victims per year in the last decades of the twentieth century. In South America, of the total number of Natural Hazards events registered between 1900 and 1998, 66 % were weather- or climate-related: 34 % due to floods, 5 % due to droughts, 2 % wildfires and 25 % wind related. There are many causes of floods, which include primarily structural causes (inadequate capacity of riverbanks to contain high flows, landslide obstruction, drainage congestion, snowmelt, glaciers and dam break flow, etc.) and causes most probably related with climatic anomalies. There are many ways to mitigate and manage floods, some of which are structural and some non-structural. For the second approach, constructing a correct Flood Hazard Model which may include a hydrologic-hydraulic approach, remote sensing, GIS, flood frequency and rating curve analysis is probably one of the main steps. The first step, however, is identifying the flood events, and their relationship with climatic variability. Thus, although there is yet no proof that the extreme flood events that struck Europe, North America, Middle East and Asia in recent decades (and precisely during the ongoing year) are a direct consequence of climate change, they may give an indication of what can be expected. Therefore, identifying such events in the historic record, and investigate the statistical significance of their relationship with climatic variability is a necessity. Precisely, this is our main purpose. In this work, after identifying the main historic flood events, we use a logit model to statistically analyze the probability of flood occurrence, dependent on climatic events. By applying this method we reveal patterns of the flood-precipitation occurrence variability as explained (a probability) by each of the climatic indices and their interactions.

ABSTRACT #227. Oral Presentation



CLIMATE VARIABILITY AND CHANGE IN THE NORTHERN TIP OF THE ANTARCTIC PENINSULA IN RESPONSE TO AT-MOSPHERIC CIRCULATION

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Keywords: regional warming, Antarctic Peninsula.

Series of precipitation, atmospheric pressure and extreme temperature registered at the Chilean Antarctic stations Eduardo Frei, Arturo Prat and Bernardo O'Higgins during 1970-2008; were analyzed, along with atmospheric data from surrounding weather stations. The lineal tendency analysis applied to the extreme temperature shows that the largest warming occurs in the minimum temperature with an increment of 0.1 and 0.5°C per decade, and a decrease in the frequency of cold night, which corresponds to the extreme values within the 10 percentile. While, the maximum temperature shows a negative trend (cooling) mainly associated with the decrease of extreme warm events (above 90 percentile) during spring and summer seasons. The analysis of the 10% percentile of the minimum temperature indicates that a decrease rate of extreme cold days of 7 days per decade. Decadal changes in the distribution of minimum and maximum temperatures are also significant. It has been observed a shift toward the right of the distribution curve which it is an indication of a decrease of extreme cold days. Compose analysis of warmer and colder years reveals two distinct large-scale circulation patterns, in the first case negative anomalies in the pressure field surrounding the Antarctic continent (intensification of the circumpolar trough) are shown, while in the other case, a positive anomaly region appears in the southeastern sector of the Pacific Ocean centered just north of Amundsen Sea. Analysis of the extremes changes during the recent past and the associated atmospheric circulation changes can help to predicted future environment in the Antarctic Peninsula. This study was supported by Proyecto Anillo ARTG02-2006.





MODIFICATION OF THE ENSO TELECONNECTION IN THE SOUTHERN HEMISPHERE: IMPACT ON THE RAINFALL REGI-ME AT MID-LATITUDES

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Keywords: El Niño event, precipitation impact.

A recent work has shown that El Niño is experiencing significant changes of its characteristics over the last decades. In particular, El Niño tends to develop more in the central Pacific in recent years (this peculiar El Niño pattern is called Modoki El Niño). Such evolution of El Niño is to be taken into account in the analysis of the regional climate response because the teleconnection pattern is different for both types of El Niño (i.e. Modoki El Niño versus the so-called Cold Tongue El Niño). Teleconnection patterns in the South Pacific region are documented for contrasting periods of Cold Tongue El Niño and Modoki El Niño events. It is shown that both types of El Niño have a distinctive signature on the pathways, intensity and seasonal cycle of the extra-tropical disturbances which modify the "normal" rainfall pattern at mid-latitudes in South America. ABSTRACT #229. Poster Presentation



MASS BALANCE ESTIMATION OF A SMALL GLACIER, IN THE GREENWICH ISLAND, ANTARCTIC PENINSULA

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Keywords: Antarctic Peninsula, glacier mass balance.

The Quito (Traub) glacier located at the Greenwich Island was selected for a new mass balance monitoring program in the Antarctic Peninsula. A network of stakes was deployed during the last austral summer at the ablation part of the glacier, and next summer more stakes will be deployed at the accumulation zone, in order to account for the annual mass balance of the glacier. This program will be undertaken at least for three years, including the positioning of the glacier front and its variations, hoping to characterize the recent behavior of this part of the Antarctic Peninsula undergoing significant atmospheric, oceanic and glacier changes.



ABSTRACT #230. Oral Presentation

EVOLUTION OF ECUADORIAN GLACIERS SINCE THE LITLLE ICE AGE, UPDATED ECUADORIAN GLACIER INVENTORY AND EVIDENCE OF CLIMATE CHANGE ON TROPICAL GLACIERS

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Keywords: Tropical glaciers, inventory, area changes.

In Ecuador, glacial extension during the Little Ice Age (LIA) was documented using lichen measurements on the moraines of 15 glaciers. The main results showed that the maximum LIA for high altitude glaciers > 5700 masl (Chimborazo, Antisana) ended by 1730 \pm 16, whilst low altitude glaciers < 5400 masl (Carihuayrazo) ended around 1830 ± 14 . After reaching that maximum length, both group of glaciers had been retreating continuously with a short periods of advances. Both type of glaciers showed a synchronous advance and retreat cycles, although the low altitude glacier retreated faster. The last glacier inventory of the Ecuadorian glaciers yielded a total area of 97.21 km² for year 1997. Between 1997 and 2009 the year when the inventory was updated, a reduction of 37.66% of the covered area was determined, yielding a reduction of 36.31 km².

ABSTRACT #232. Poster Presentation



DROUGHT VARIABILITY ACROSS THE ANDES DURING THE LAST MILLENNIA AND ITS LINKAGES TO PACIFIC OCEAN CLIMATE VARIABILITY

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Keywords: Drought, Andes Cordillera, Tree-rings.

Since the second half of the 20th century the Andes Cordillera has experienced a positive warming trend, an increase in elevation of the 0°C isotherm, rapid melting of ice caps, and a sustained shrinkage of glaciers. These climate and environmental changes have occurred in conjunction with a growing demand for hydrological resources as a result of population increases and industrial development. Given the short span of instrumental hidroclimate records for this region, longer records are needed to understand the nature of climate variability and how the dominant interannual modes of climate variability have evolved under changes in long-term background conditions. We develop a field reconstruction of summer Palmer Drought Severity Index (PDSI) since AD 1200 from 10°S to 40°S latitude based on a multi species network of treering chronologies from both flanks of the Andes. Our results show two dominant spatio-temporal modes, the first centered in the Altiplano region and the second in the Central Andes of Chile and Argentina (CCha). Both modes show an intermittent anti-phase relationship among themselves at high spectral frequencies and an increase in interannual variability within the ENSO band since the late XIX century. Sea surface temperatures from the central Pacific Ocean results negatively (positive) correlated with Altiplano (CChA) summer PDSL



THE GLACIAL RETREAT OF CORDILLERA CASTILLO (46°S) SINCE THE LITTLE ICE AGE: ESTIMATING THE EFFECT OF GLOBAL WARMING ON THE EASTERN FLANK OF THE PATA-GONIAN ANDES

Torrejón, F.¹, Araneda, A.¹, Aguayo, M.¹, Mardones, M.², Jana, P.1, Bizama, G.¹, Vargas, P.¹ & Urrutia, R.¹

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Keywords: climate change, historical records, settlement process.

Southern Chile is an excelent place for studying recent climate change because is one of the few sites in the world with extratropical glaciers. Our study area is located in the Aysen region (46° 3'28.18"S; 72°10'39.01"W) in a small icefield of ~20 km², called Cordillera Castillo where it is possible to recognize ancient morraines that define a clear treeline border and some glacier fronts that are clearly retreating as a result of current global warming. Considering that the Westerlies determine precipitation in the Northern Patagonia, glaciers located in the eastern flank of the Andes will receive less precipitation than in the western flank. Therefore, this area is more sensitive to temperature increases during the last century, resulting in an earlier and faster retreat. Using oral and historical documentary records - including aerial photographs- of the 20th century, the glacier behavior of Cordillera Castillo was reconstructed since its last maximum which has been reached supposedly during the ocurrence of the Little Ice Age in Patagonia. Finally a tree-ring study is being conducted in order to complement the historical data. Funding for this research has been provided by the research projects DIUC Semilla Patagonia 210.310.056-1sp. and Fondecyt 1070508.

ABSTRACT #234. Poster Presentation



SPATIAL VARIABILITY OF SUB-FOSSIL CHIRONOMID AS-SEMBLAGES IN THE SURFACE SEDIMENTS OF LAKES: A TOOL FOR DEVELOPING A QUANTITATIVE TEMPERATURE RECONSTRUCTION FOR SOUTHERN CHILE

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Keywords: training-set, sediment records, past climate.

Temperature reconstructions are an important key for understanding the climate system functioning. Especially important is the climate reconstruction of the last millennium because the magnitude of such changes is comparable to the current global warming, and the reconstructions are useful to evaluate climate models that predict future climate change. Among several climate proxies, subfossil remains of chironomid larvae (Insecta: Diptera) have proven to be a powerful tool for quantitatively inferring temperature, though its application is constrained to places where a calibration-set is available. Since Southern Chile lacks a training set for calibration, all the applications of subfossil chironomids have been mainly qualitative. Thus the aim of this research is to develop a chironomid training set for southern Chile in order to generate a quantitative reconstruction of temperature at first, for the last millennium. Until now 25 lakes have been sampled measuring chemical and physical parameters in the sediment and in the water column, including pH, Ca, Mg, Na, Cl, SO4, Fe, P, N and organic carbon. Due to scarce meteorological data available and the sinuosity of the country, air as well as water temperature loggers were deployed in some of the lakes studied. The lakes analyzed until now comprise a temperature range from 7.96 to 22.0 °C. The physicochemical data indicate that water temperature will be one of the most important variables to determine chironomid taxa variability, even more important than air temperature, followed by trophic status and water depth, respectively. However such preliminary results should be confirmed with a larger number of sampled lakes. Funding for this research was provided by Fondecyt 11080158.



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Torres R.R.	#175
Travassos J.	#213
Urrutia R.	# 117 - #119 - #120 - #124 - #125 - #186 - #211 - #221 - #233 - #234
Valenzuela M.A.	#192
Valero-Garcés B.	#195
Van der Hammen T.	#156
Van de Vyver E. †	#114
Van Nieuwenhuyze W.	#190
Vargas G	#112 - #113
Vargas P.	#221 - #233
Velasco V.M.	#182 - #184
Velez M.I.	#115
Verleyen E.	#114 - #190
Viale M.	#145
Videla J.	#146
Villa-Martínez R.	#216
Villafanez Y.	#115
Villalba R.	# 117 - #131 - #133 - #147 - #148 - #164 - #165 - #166 - #172 - #206 - #210 - #211 - #232
Villegas P.M.	#198
Vivero S.	#177



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Von Gunten L.	#125 - #137
Vyverman W.	#114 - #190
Wagner S.	#174
Wartenburger R.	#124 - #125
Welter G.S.	#153 - #205 - #207
Wendt A.	#201
Wendt J.†	#201
Whitlock C.	#217
Yokoyama Y.	#115
Yu Z.	#150
Zamora R.	#201






































