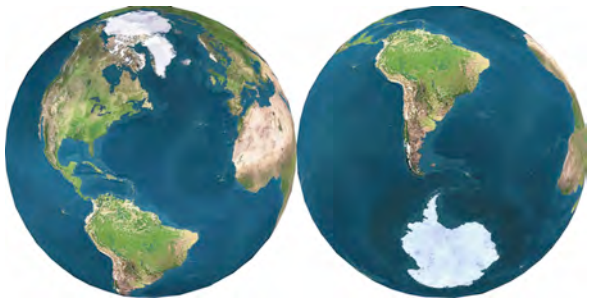
Activity Report
2010



BRAZILIAN NATIONAL INSTITUTE
OF CRYOSPHERIC SCIENCE AND TECHNOLOGY

Simões, J.C.
Brazilian National Institute of Cryospheric Science and Technology - Acitivity Report 2010 / Jefferson C. Simões (ed.), Carlos E.G.R. Schaefer, Heitor Evangelista, Jandyr M. Travassos, Maurício M. Mata, Ilana Wainer, Ronald B. de Souza, Jorge Arigony-Neto, 2010, 42 p.

Brazilian National Institute of Cryospheric Science and Technology

A joint research centre with headquarters at the

Polar and Climatic Centre - CPC
Institute of Geosciences
Federal University of Rio Grande do Sul - UFRGS
Porto Alegre, RS

and laboratories at the

Institute of Oceanography
Federal University of Rio Grande (FURG)
Rio Grande, RS

Southern Regional Centre for Space Research (CRS)
National Institute for Space Research (INPE)
Santa Maria, RS

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University of São Paulo (USP)
São Paulo, SP

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University of the Rio de Janeiro State (UERJ)
Rio de Janeiro, RJ

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Rio de Janeiro, RJ

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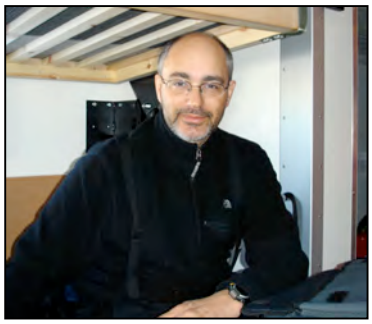
Brazilian Antarctic Program - PROANTAR
Secretary of the Interministerial Commission for the Resources of the Sea- SECIRM

Our mission

To deliver an international-class scientific research programme that investigates the role of the cryospheric processes on the South American environment, thus advancing our knowledge of the connections between the polar and Brazilian climates.

From the General Coordinator



It is a great pleasure to present the first annual report of the *Instituto Nacional de Ciência e Tecnologia da Criosfera* (INCT da Criosfera) - the Brazilian National Institute of Cryosphere Science and Technology, a pioneering initiative in many ways: it is the first time that a group of Brazilian scientists organizes and executes an integrated research plan on the cryosphere; it marks a new stage for the Brazilian Antarctic Program, which now has expanded its geographic range, into the interior of that continent; and, fostering investigations on the role of the Andean ice on the Amazon environment. Hopefully, in the near future, the institute will also allow us to carry out investigations in the Arctic.

At a first glance it may seem unusual to have a cryospheric research programme in a country that is set, mainly, between the two tropics. But, on the other hand, it reflects the growth of our understanding on the importance of the Polar Regions in the environmental system, which is highlighted by three observations: 1) The vast polar ice masses are the main energy sinks of the ocean-atmosphere general circulation; 2) These ice masses are some of the main controls of the mean sea level, where even small changes in the ice stored in glaciers, ice caps and ice sheets will have great impact in our coastlines; 3) The science of ice cores has provided one of the best records on the natural climatic variability as well as offering the history of anthropogenic impact preserved in past atmospheric composition. As it is to be expected, there are strong links between the Polar Regions and the tropics. Our Institute seeks to obtain a deeper understanding of these processes through the study of the ice masses that nowadays cover 10% of the Earth's surface.

Prof. Jefferson C. Simões
General Coordinator
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SCIENCE

POLAR RESEARCH FROM A SOUTH AMERICAN PERSPECTIVE

The Brazilian National Institute of Cryospheric Science and Technology is a partnership composed of seven institutions to investigate the role of the planetary ice masses in the environmental system. Actions are focused on Antarctica and the Andes, involving research on the impacts of climate changes on glaciers and its consequences on the mean sea level, paleoclimatic reconstruction from ice cores studies, the role of sea ice and ice shelves in the atmospheric and oceanic circulations, the permafrost response to climate change and connections between the Polar Regions and the South American environment. The latter topic includes research on the ocean-atmosphere interaction processes between the South Atlantic and the Southern Ocean, making it possible to improve weather forecasting and climate studies for South America, and particularly for southern and south-eastern Brazil.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

This Institute's first year was devoted to several expeditions to Antarctica, the Southern Ocean and the Bolivian Andes. Among which, the first national scientific expedition to the interior of Antarctica to collect ice cores, allowing us to retrieve a set of ice cores holding the climatic history of the last 300 years. Initial results point to signs of biomass burning patterns of South American. Over the next three years, teleconnections between the Antarctic and South American climates will be intensively investigated based on these ice cores. One new international programme was established, CASA (Climate of Antarctica and South America, http://www.polartropical.org/casa/), a join initiative with the Climate Change Institute, University of Maine, USA. Along with these endeavours, to understand water resources issues related to the cryosphere, we are monitoring, in the Bolivian Andes, glaciers that form the headwaters of the Madeira River drainage basin.

This institute has established one of the largest networks to monitor permafrost areas and associated ice-free ecosystems in Maritime Antarctica and Antarctic Peninsula sites; these studies will be expanded to the Andes and the Arctic in the near future. Our oceanographic groups conducted several expeditions to the Southern Ocean, mainly near the Antarctic Peninsula, to investigate the temporal variability of hydrological parameters. Oceanic bottom waters freshing is observed in the region, possibly resulting from the Antarctic Peninsula continental ice masses losses. This institute research groups have carried out observations in the Southwest Atlantic Ocean, mainly to study the confluence of the Brazilian and Falklands (Malvinas) currents, essential to understand the connections between Antarctica-Southern Ocean and south-southeastern Brazilian coastal and oceanic processes.

ICE AND ATMOSPHERIC CHEMISTRY

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Instituto de Biologia Roberto Alcântara Gomes
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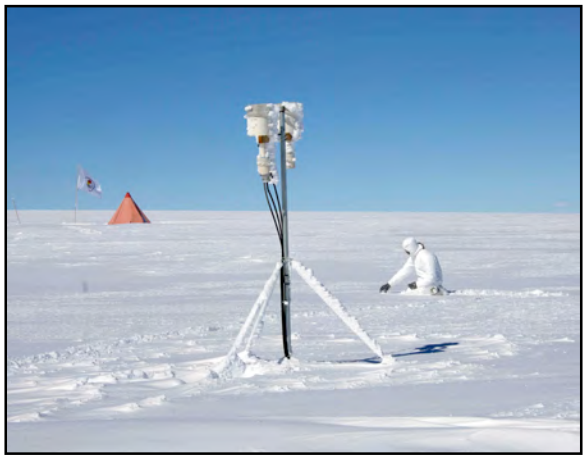
Rio de Janeiro, RJ - Brazil

http://www.biologia.uerj.br/dbb/paginas/labramg.htm

A better understanding of the Antarctic climate system, its atmospheric circulation patterns and associated biogeochemical processes would bring significant contributions for the understanding of the Southern Hemisphere recent climate and its trends. This programme investigates the role of microparticles, organic compounds, bio-indicators and trace gases as "markers" of environmental changes in South America and West Antarctica, their role as atmospheric and climate tracers, and implications for the regional biogeochemical cycles and environmental variability. Existing databases allow us to distinguish oceanic, biogenic, terrigenous, and anthropogenic aerosols sources in the subtropical-subpolar lower atmosphere domain, enclosing the South America and West Antarctica. Herein, we focus on the biogeochemical relations existing among the atmosphere, the ocean, the sea ice and the Antarctic continental ice masses, using data on the composition of atmospheric aerosols, volatile organic compounds, microorganisms and trace gases, and snow and ice cores from Antarctica and the Southern Andes.



Atmospheric sampling (suction pumps in the foreground) and snow (researcher working with ultra-clean clothes to prevent contamination) at the top of the Antarctic Peninsula.

Potential source regions of biogenic aerosol number concentration apportioning at King George Island, Antarctic Peninsula

Alexandre S. Alencar[1], Heitor Evangelista[1], Elaine A. dos Santos[1], Sérgio M. Correa[1], Myriam Khodri[2], Virgínia M.T. Garcia[3], Carlos A.E. Garcia[3], Enio B. Pereira[4], Alberto R. Piola[5] and Israel Felzenszwalb[1]

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Abstract Nowadays it is well accepted that background aerosols in the boundary layer over remote oceans are of marine origin and not aged continental. Particularly in the Atlantic sector of the Southern Ocean at least four main important regions exhibit significant ocean primary productivity. They are the Bellingshausen–Amundsen Sea, the Weddell Sea, the southern Argentinean shelf and the southern Chilean coast. In this work, we have combined ground-based continuous atmospheric sampling of aerosol number concentration (ANC), over-sea dimethyl sulphide (DMS) measurements, chlorophyll *a* (chl *a*) concentration provided by Sea-viewing Wide Field-of-view Sensor (SeaWiFS) satellite images, *in situ* meteorological data and monthly regional NCEPNCAR re-analysis wind fields in order to investigate the relative contribution of each of the above regions to the apportionment of the ANC at King George Island (KGI), South Shetland Islands. Our results suggest that, at least during the period from September 1998–December 1999, the southern Argentinean shelf acted as the main contributor to the ANC measured in KGI.

Conclusions Herein we have explored the understanding of ANC interanual variability on KGI and its association with marine productivity that may result in DMS oxidation products, marine primary organic matter (*e.g.* microcolloid aggregates) and secondary organic aerosols, all potential components of ANC. In this sense we suggest that chl *variability* is the major process controlling the summer ANC seasonal peak, despite the inorganic compounds of terrigenous and marine sources. Our interpretations were based on the averaged monthly ANC data, which covered a period long enough to include secondary processes from chl a blooming to aerosol formation. A contribution of dust micro-particles eroded from the Argentine Patagonian semi-desert to the ANC, although not discarded, is probably of lesser importance to the annual variability since the flux of dust into the southern latitudes is episodic (Evangelista *et al*. 2010). In this work, we employed a dataset of meteorological and environmental parameters in order to identify the main source regions of aerosol arriving at the northern tip of the Antarctic Peninsula (KGI), from September 1997–December 1998. From averaged SeaWiFS chl *a* images we selected four main potential source areas: the Bellingshausen– Amundsen Sea, the Weddell Sea, the southern Argentinean shelf and the southern Chilean coast. Correlations and associations among NCEP/NCAR regional wind pattern, local AWS wind data, monthly chl *a* concentration and aerosol number concentration allowed us to conclude that the southern Argentinean shelf region is more likely the main contributor of ANC (presumably through S particles) at KGI, despite the proximity of this island to Antarctic productive regions. We attribute the high correlation found to a combination of two factors: 1) the favourable regional surface wind circulation, and 2) the high occurrence of diatoms and the Coccolithophorid species like *Emiliania huxleyii*, which are known to be associated with high DMS emissions in the Southern Ocean.

Full reference

ALENCAR, A.S., EVANGELISTA, H., DOS SANTOS, E.A., CORREA, S.M., KHODRI, M., GARCIA, V.M.T., GARCIA, C.A.E., PEREIRA, E.B., PIOLA, A.R., FELZENSZWALB, I. Potential source regions of biogenic aerosol number. *Antarctic Science*, **22**(5): 580–588, 2010. doi:10.1017/S0954102010000398

Inferring episodic atmospheric iron fluxes in the Western South Atlantic

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[1]*Laboratório de Radioecologia e Mudanças Globais, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil*
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Abstract Iron (Fe) and other trace elements such as Zn, Mn, Ni and Cu are known as key-factors in marine biogeochemical cycles. It is believed that ocean primary productivity blooms in iron deficient regions can be triggered by iron in aeolian dust. Up to now, scarce aerosol elemental composition, based on measurements over sea at the Western South Atlantic (WSA), exists. An association between the Patagonian semi-desert dust/Fe and chlorophyll-a variability at the Argentinean continental shelf is essentially inferred from models. We present here experimental data of Fe enriched aerosols over the WSA between latitudes 22°S–62°S, during 4 oceanographic campaigns between 2002 and 2005. These data allowed inferring the atmospheric Fe flux onto different latitudinal bands, which varied from 30.4 to 1688 nmolFe m^{-2} day^{-1} (October 29th–November 15th, 2003); 5.83–1586 nmolFe m^{-2} day^{-1} (February 15th–March 6th, 2004) and 4.73–586 nmolFe m^{-2} day^{-1}(October 21–November 5th, 2005).

Conclusions In this work, we present results of measurements of atmospheric Fe at the coastal region of the WSA. Aerosol samplings were carried out underway, during four oceanographic cruises from the Southeastern Brazil (22°S) to King George Island (62°S), during spring and summer periods from 2002 to 2005. Data was analyzed in conjunction with modelled air mass back-trajectories attempting to identify potential dust/Fe source region. Shipboard measurements exhibited important episodically high atmospheric Fe concentrations during 2004 and 2005 cruises, varying from 38 ng m^{-3} in 2005–80 ngm^{-3} in 2004 at latitudes between 25°S and 38°S, which could not be related with anthropogenic activities. These relatively high values were explained by the back-trajectory analysis of regional air masses that apparently transport Fe enriched aerosols from the Patagonian semi-desert region to lower latitudes in the South Atlantic Ocean. These results suggest that Fe from the Patagonian desert can travel long distances and be deposited over ocean areas very far from the source. Particularly in summer 2004, calcium carbonate was measurable in the atmosphere between 32°S and 42°S, a vicinity region where coccolithophorids have been previously detected by remote sensing techniques. Fe fluxes calculated for the WSA margin varied from 4.73 nmolFe m^{-2} day^{-1} to 1688 nmolFe m^{-2} day^{-1}.

Full reference

EVANGELISTA, H., MALDONADO, J., DOS SANTOS, E.A., GODOI, R.H.M., GARCIA, C.A.E., GARCIA, V.M.T., JONHSON, E., DIAS DA CUNHA, K., LEITE, C.B., VAN GRIEKEN, R. Inferring episodic atmospheric iron fluxes in the Western South Atlantic. *Atmospheric Environment*, **44**: 703–712, 2010.

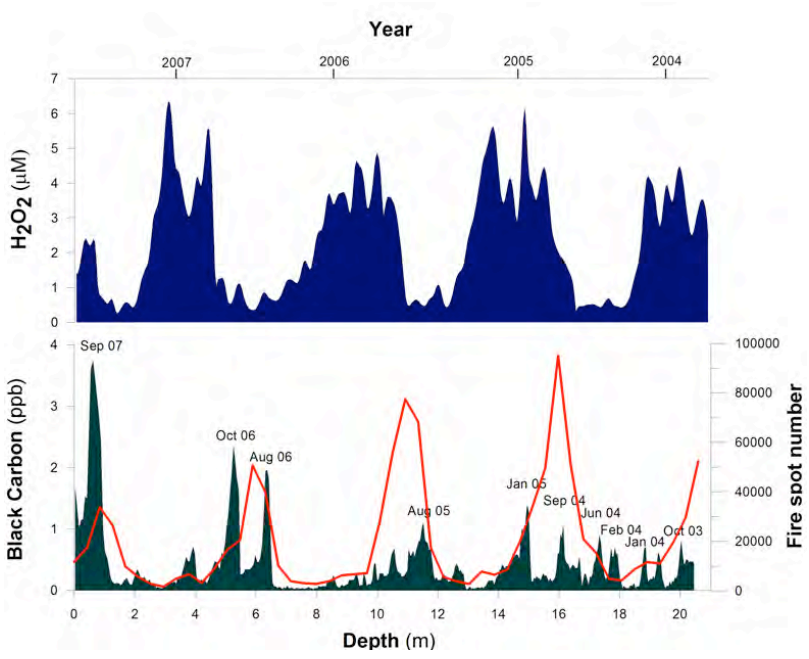
Atmospheric sampling in the Antarctic Peninsula under ultra-clean conditions

Black carbon on snow and ice: the impact of the South American biomass burning on Antarctica

Heitor Evangelista[1], Alexandre S. Alencar[1] and Jefferson C. Simões[2]

[1]*Laboratório de Radioecologia e Mudanças Globais, Universidade do Estado do Rio de Janeiro, Brazil*
[2]*Centro Polar e Climático, Universidade Federal do Rio Grande do Sl, Porto Alegre, Brazil*

Abstract The Intergovernmental Panel on Climate Change (IPCC) estimates that the black carbon (BC) aerosol accounts for 0.8 ± 0.4 W m^{-2} of the global rise in atmospheric temperature. Because of the short lifetime of BC in the atmosphere, it is more closely related to the effects on a regional climate scale than on a global scale. The geographical extent of the impact of atmospheric BC, and its biogeochemical consequences, still requires a more accurate description. We measured BC in a firn core from a site with a high snow precipitation rate (Plateau Detroit, Antarctic Peninsula) allowing interanual observations. In this case, the BC peaks predominantly coincide with the peak number of fire outbreaks in Brazil, concentrations ranged from ~ 0.1 to 3.0 ppb. We also developed an atmospheric transport simulation on a continental scale, GISS GCM BC, isolating biomass burning and petrogenic emissions from South America, and from that infer the BC flow over the geographical area of interest. The model estimates a BC flow to the Antarctic Peninsula from 5 to 10 pg (BC) m^{-2}s due to biomass burning.



Black carbon concentration in a firn core from the Detroit Plateau (Antarctic Peninsula) and number of fire outbreaks in South America from to 2003 to 2007. The H_2O_2 seasonal variation is used to date the core.

ICE CORES AND PAST CLIMATES

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Leading research group:

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The study of the chemical record in snow and ice cores is one of the best paleoclimatic methods; it provides detailed information about the air chemical composition and climatic changes. The dozens of measured variables give information, for example, on the past variability of the surface temperature, precipitation origin, terrestrial and marine biological activity, pollution, oxidizing capacity of the atmosphere, solar activity, volcanism, influx of extraterrestrial material, and global desertification. The great temporal resolution of these natural archives (sometimes even semi-seasonal), allows for a detailed investigation on the glacial-interglacial cycles, clearly showing a climatic system with rapid oscillations and abrupt changes, sometimes within a human generation. As for the last 10,000 years, ice cores provide the most detailed record about the anthropogenic impact in the atmospheric chemistry.

This programme aims to produce an integrated interpretation of environmental time series derived indirectly (by proxy) from several snow and firn cores obtained from the geographic South Pole (90°S) to the northernmost part (63°S) of the Antarctic Peninsula by our Brazilian team, and covering the last 1,000 to 2,000 years. To complement our records, two international drilling operations are planned for the summers of 2011/2012 and 2013/2014, to obtain a 10,000 years core from the north Antarctic Peninsula.

Shallow snow and ice core-drilling operations in Antarctica.

Climate of Antarctica and South America (CASA) Project: Present State and Preliminary Results

Ricardo Jaña[1,2], P. Mayewski[3], J.C. Simões[4], A. Kurbatov[3], F.E. Aquino[4], L.F. Reis[4], H. Passos[5], A. Alencar[6], J. Travassos[7], M. Potocki[3], S. Kraus[1], M.A. Godoy[8], M. Arevalo[8], G. Casassa[9] and A. y Rivera[9]

[1]*Instituto Antartico Chileno, Chile*
[2]*Fundacion Centro de Estudios del Cuaternario, Chile*
[3]*Climate Change Institute, University of Maine, USA*
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Abstract Since the beginning of the 20th century, the global mean surface temperature has risen approx. 0.74°C (IPCC, 2007). In the Antarctic Peninsula area, a dramatic rise of the superficial temperatures of ca. 3 degrees has been reported for the last 50 years. This main driving force working together with other processes has resulted in the collapse of several ice shelves in the region and is linked to nearby ocean warming and intensification of the circumpolar westerlies. Glaciers are retreating on the Peninsula, in Patagonia, on the sub-Antarctic islands, and in West Antarctica adjacent to the Peninsula (Mayewski and others, 2009). Although the scientific evidence for global warming is meanwhile overwhelming, the prediction of regional impacts proves to be much more problematic. Considering the lack of a longer climatic data record it is desirable to extend this information in order to understand the contribution of several other factors that feedback the mechanisms. During the last two years, a joint international effort undertaken by Brazil, Chile and the USA focused on the recovery of an ice core at Detroit Plateau (northern Antarctic Peninsula, 64°05'S/59°40'W). Besides being located in an area so far not covered by Antarctic ice coring, this site is situated below the -10°C isotherm, avoiding the problem of water inclusions that contaminates the isotopic signal of ice beneath. Moreover, airborne radar measurements showed that the bedrock forms a basin with a maximum depth of 560 m, giving the possibility that comparatively old ice could have been trapped at this location. Following a brief and promising pre-scouting landing in February 2007 the first field campaign at Detroit Plateau was carried out in November 2007. As a main result a medium-deep ice core (133 m) was drilled in a site located at 1,940 m a.s.l.. Additionally, numerous other measurements were compiled.

This work included snow sampling for isotopic analysis, radio eco-sounding, investigations on ice dynamics and snow accumulation, DGPS measurements using Leica SR9500 equipment, installation of AWSs', meteorological observations and atmospheric aerosol measurements. The 133 m ice core is still being processed, including analyses of about 50 trace elements at ppt resolutions, moreover stable isotopes. The November 2008 field campaign stated extraordinary high snow accumulation rates (about 4 m) for the preceding winter.

Snow core sampling in the Antarctic ice sheet.

An important step in reconstructing the time frame

for paleoclimatic events is to calibrate climate archives like ice or sediment cores. One option is to establish time markers that allow comparison of climate signals from different regions based on relative stratigraphy. Volcanic ash layers are among those proven time markers but a crucial pre-requisite for their use as a calibration tool is the existence of data on possible source volcanoes in order to identify their origin. This data is largely missing in the Antarctic Peninsula area. The final drilling to get the long ice core it is planned for 2013.

Full reference

JAÑA, R., MAYEWSKI, P. A., SIMÕES, J. C., KURBATOV, A. V., AQUINO, F. E., REIS, L.M.F., PASSOS, H. R., ALENCAR, A.S., TRAVASSOS, J. M., POTOCKI, M., KRAUS, S., GODOY, R., AREVALO, M., CASASSA, G. Climate of Antarctica and South America (CASA) Project: Present State and Preliminary Results In: IPCC workshop on Sea Level Rise and Ice Sheet Instabilities, 2010, Kuala Lumpur, Malaysia. **Workshop Report: IPCC workshop on Sea Level Rise and Ice Sheet Instabilities**. Bern, Switzerland: Intergovernmental Panel on Climate Change, **1**: 109–110, 2010.

Site CASA project http://www.polartropical.org/casa/

The Brazilian-Chilean-USA ice drilling team at the Detroit Plateau, Antarctic Peninsula.

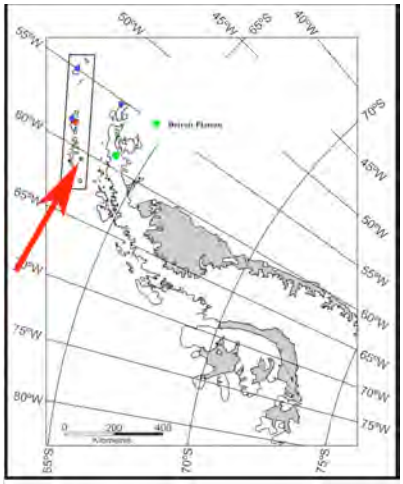
Tephra beds from Deception Island glaciers as a tool to ice core correlation

Luciano Marquetto, Norberto Dani and Jefferson C. Simões

Centro Polar e Climático, Universidade Federal do Rio Grande do Sul, Brazil

Abstract The last Deception Island eruptions, in 1969 and 1970, were restricted to its eastern part in a glacier-covered zone at Goddard Hill (62°55'00,7"S /60°37'40,3" W). In the summer of 2002, a Brazilian Antarctic Program glaciological expedition investigated a small (diameter <400 m) crater formed in those events. One of its walls bisected the glacier, resulting in a 60 m vertical section that exposes the annual snow and ice accumulation layers intercalated by several tephras beds from former eruptions. Their geochemical identification may be a useful tool for many research themes, especially to ice stratigraphy and paleoenvironmental reconstructions using tephras horizons found in ice cores. We sampled the 15 most expressive tephras beds, which are nonconsolidated pyroclastic ejecta, well preserved and not affected by strong alteration or erosional processes. Our first aim is to characterize each tephra layer by detailed mineralogical, petrographic and geochemical studies looking for peculiarities of each eruption. In addition, specific grain composition of plagioclases, ferromagnesian assemblages and glass fragments were determined by microprobe analysis to help differentiating eruptions. This work compares the tephra beds considering their petrography associated geochemistry using major, trace and rare earth elements concentrations and individual mineral properties (composition, specimen, homogeneity). This set of information may characterize the signature of each eruption helping to fingerprint ash layers found in ice cores elsewhere in Antarctica. The association of seawater and glaciers in the Deception Island volcanic environment favour phreatomagmatic eruption events that increase largely the production and dispersal of pyroclastic material.

Tephras layers in a glacier ice front, Deception Island, South Shetland Islands, Antarctic. Those are the layers sampled for this study.



Red arrow points to Deception Island off the Antarctic Peninsula.

Full reference

MARQUETTO, L., DANI, N., SIMÕES, J.C. Tephra beds from Deception Island glaciers as a tool to ice core correlation In: 4th SCAR Open Science Conference: Witness to the Past and Guide to the Future, 2010, Buenos Aires. *4th. Open Science Conference CD-ROM*. Buenos Aires: Instituto Antártico Argentino, 2010. v.1. p.481–481.

Chemical analysis of Antarctic ice cores

Jefferson C. Simões[1], Daiane F. Hammes[1], Ronaldo T. Bernardo[1] and Gino Casassa[2]

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[2]Centro de Estudios Científicos, Valdivia, Chile

Abstract Studies on variations in the stable-isotope and ionic composition of snow, firn and ice are some of the main tools in paleoclimatology, providing information on climatic and air chemistry conditions at different time scales. This project analyses 6 shallow core and 105 surface samples from an Antarctic ice sheet traverse. Up to now, 2 cores, IC-5 (82°30.5'S, 79°28'W, 950 m a.s.l.; 42.5 m) and IC-6 (81°03'S, 79°51'W, 750 m a.s.l.; 36 m) were collected as part of the 2004/2005 Chilean (with Brazilian collaboration) ITASE (International Trans-Antarctic Scientific Expeditions) traverse from Patriot Hills (Ellsworth Mountains) to the South Pole. Mean accumulation rates in water equivalent calculated for the upper 10 m at the IC5 site is 0.37 m a^{-1} and 0.33 m a^{-1} at the site IC6. Coregistered samples (1595 for IC5 and 1368 for IC6) were obtained using a discrete continuous melter system with a pure nickel melt head at the Climate Change Institute under class 100 clean room conditions. Ionic chromatography (IC), inductively coupled plasma field mass spectrometry (ICP-MS), and stable isotope ratio mass spectrometry (IRMS) are used for core analyses. Preliminary results for IC6 show mean concentrations, determined by a Dionex chromatographer of IC6 (Na^{+}= 66.92±2.32 µg L^{-1}, K+= 3.31±0.18 µg L^{-1}, Mg^{+2} = 10.07±0.25 µg L^{-1}, Ca^{+2} = 16.93±0.38 µg L^{-1}, Cl^{-} = 155.74±4.40 µg L^{-1}, NO_3^{-} = 56.01±0.80 µg L^{-1}, SO_4^{-2} = 55.65±1.36 µg $L^{-1}$and methylsulfonate (MS^{-}) = 14.11±1.19 µg L^{-1}). The Na^{+}, Mg^{+2}, Ca^{+2}, Cl^{-}, SO_4^{-2} concentrations and Cl^{-}/Na^{+} ratio (2.32) agree with the Antarctic spatial distribution determined previously by other authors. A mean net accumulation rate (in water equivalent) of 0.36 m a^{-1} is considered representative for the core. The deepest layer was deposited in 1938 (a dating error of ± 4 years is estimated). To date the core, we used Na^{+}, SO_4^{2-}, Cl^{-}, and Mg seasonal variations.

In 2010, other 4 cores were subsampled and analysed at the Climate Change Institute by a team of the Centro Polar e Climático (CPC). Totally more than 18.000 samples are ready from the following cores collected previously by CPC field missions: IC2 (88°01'S, 82°04'W; 2.611 m a.s.l.; 43 m), IC3 (86°00'S, 81°35'W; 1.620 m a.s.l.; 46 m), IC4 (83°59'S, 80°07'W; 1.295 m a.s.l., 22 m), Detroit Plateau (64°05'S, 59°39'W; 1.937 m a.s.l.; 133 m), Mount Johns (79°55'S, 94°23'W; 2.100 m a.s.l.; 95 m).

Cutting an ice core section in a cold room at -25°C.

Melting and sampling a firn core section continuously (sampling length of 3 cm).

REMOTE SENSING OF THE CRYOSPHERE

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During the last two decades, drastic changes were detected in the cryosphere, comprising disintegration of ice shelves, glacier acceleration and thinning, changes in accumulation and ablation patterns, glacier fronts retreat, variations in glacier zones and seasonal snow coverage, reduction in the sea ice extent, etc. However, consistent systematic observations in the polar and mountainous areas are still lacking. On the other hand, images acquired by radar sensors allow covering large regions in Antarctica and the Andes, generating statistically representative information on those changes.

This research programme develops automatic methods for monitoring snow and ice masses in Antarctica and the Andes by using satellite imagery acquired by several sensors; estimating the influence of meteorological and topographic parameters on variations of snow and ice masses; and developing remote sensing products for use in climate-, hydrological-and cryospheric models. Further, we develop algorithms and automatic routines of image processing for the extraction of cryospheric parameters that are indicators of climatic changes (*e.g.*, limits between snow and ice superficial zones; estimations of accumulation and ablation rates; glacier velocity; seasonal sea ice extent variations; dynamics of ice shelves calving) using data from radar sensors (*i.e.*, ERS-1/2 SAR, Envisat ASAR, Radarsat, SMMR, SSM/I), optical sensors (*i.e.*, CBERS CCD/HRC, Terra ASTER, Landsat TM/ETM+, Terra/Acqua MODIS), and altimeters (*i.e.*, Cryosat, Icesat GLAS), storing results in a geospatial database (*i.e.,* PostgreSQL/PostGIS), and generating digital elevation models (DEMs). Our projects cover glaciers in the Antarctic Peninsula and in the Bolivian Andes (where it contributes to glacio-hydrological modelling of glaciers that flow to the Amazon basin).

Spatial and temporal changes in dry-snow line altitude on the Antarctic Peninsula

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Abstract Drastic changes were detected in glacial systems of the Antarctic Peninsula in the last decades. The observed phenomena comprise the disintegration of ice shelves, acceleration and thinning of glaciers, and retreat of glacier fronts. However, due to the lack of consistent systematic observations in particular of the higher parts of the glacial systems, it is difficult to predict further responses of the Antarctic Peninsula glaciers to climatic change. The present paper analyses spatial and temporal variations of changes in the dry-snow line altitude on the Antarctic Peninsula as extracted from a time series (1992–2005) of ERS-1/2 SAR and Envisat ASAR data. Upward changes in dry-snow line altitude were observed in general, and are attributed to extreme high-temperature events impacting the central plateaus of the Antarctic Peninsula and the increasing duration of warming periods. A mean decrease in dry-snow line altitude was detected on the west side of the peninsula and is identified as a response to recorded increase in precipitation and accumulation. These results validate the capability of SAR data for deriving superficial parameters of glaciers to be used as indicators of climatic changes in high-latitude regions where operational restrictions limit conventional meteorological observations.

Conclusions Automatic analyses of multi-temporal ERS-1/2 SAR and Envisat ASAR datasets enabled the record of different patterns of spatial and temporal changes in DSLA for the AP north of 70°S. These patterns vary within the covered time period of the study (1992–2005), showing that in contrast to the Antarctic ice sheet, variations in climatological and glaciological conditions on a relatively short time scale are typical for this region. The upward changes in DSLA observed almost overall after the balance year 1996/97 are attributed to extreme high-temperature events impacting the central plateaus of the AP and the increasing duration of warm periods. The mean decrease in DSLA detected on the west side of the peninsula was identified as a response to the recorded increase in precipitation and snow accumulation. These results validate the capability of SAR data to derive superficial parameters of glaciers to be used as indicators of climatic changes in high-latitude regions where operational restrictions limit conventional meteorological observations. A first comparison of the detected changes in DSLA with results from the NCEP/NCAR reanalysis model shows similarities between the satellite derived variations in DSLA and the occurrence of extreme events of geopotential height at 850 hPa or periods of high accumulated precipitation, for conditions of upward or downward changes in DSLA respectively. It demonstrates the potential of the developed method to be used for validation of reanalysis or climate models.

Full Reference

ARIGONY-NETO, J., SAURER, H., SIMÕES, J.C., RAU, F., JAÑA, R., VOGT, S., GOSSMANN, H. Spatial and temporal changes in dry-snow line altitude on the Antarctic Peninsula. *Climatic Change*, **94**: 19 - 33, 2009. DOI 10.1007/s10584-009-9550-1.

Using ERS SAR images for the monitoring of glacier facies on the northeastern Antarctic Peninsula

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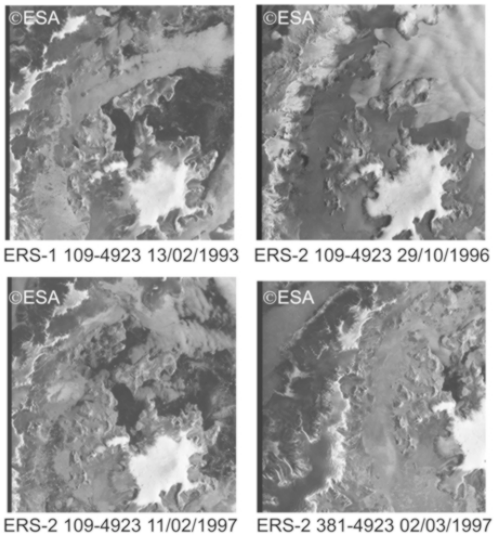
Abstract ERS SAR images acquired in the austral summer 1993 and 1996-97 and spring 1996 and 2000 were used for analyses of spatial-temporal variations of glacier facies (GF, *i.e.*, dry-snow zone, percolation zone, wet-snow zone and glacier ice) on the northeastern Antarctic Peninsula (AP). The study area includes James Ross, Vega, Eagle and Corry islands and the northern region of the Trinity Peninsula. Algorithms based on decision rules were developed to the GF discrimination in ERS SAR images. Rock and coastline data from the Antarctic Digital Database were used to mask outcropping rocks and seawater, respectively. Total areas and maximum values of GF altitudes were calculated and images of variations and frequency of these zones were generated by using GIS spatial analysis tools. Furthermore, the GF dynamics were compared with mean daily surface air temperatures measured by meteorological stations. Significant changes were observed in GF on the AP from 1993 to 2000. The GF dynamics showed good correlations with interanual and seasonal variations of the surface air temperatures. The spatial-temporal variations were interpreted as responses of the different glaciers to the climatic, oceanographic and topographic parameters. The highest variations in GF were detected on the east side of the Trinity Peninsula, northwestern region of James Ross Island, eastern tip of Vega Island and western part of Eagle Island.

Conclusions Significant changes occurred in the study area, mainly at lower altitudes, where melting processes were more intense. The extent and location of these glacier facies (GF) vary with time, responding to changes in mass and energy balances of glaciers and thus is sensitive indicators of weather conditions and local glaciology. The dynamics of the GF is related to the large seasonal and interanual climate variability in northeastern Antarctic Peninsula. Variations of the areas of GF were highly correlated with average temperatures of surface air. For the variations of maximum altitude of GF, there was no significant correlation with these temperature data.

The total number of images used is not a major factor for detecting GF changes and selected images should have low spatial correlation. ERS SAR images have spatial, radiometric and temporal resolutions suitable for GF dynamics analysis. The low spectral resolution of these images and the ambiguity between the GF backscatter and rocky areas restrict the use of non-supervised and supervised classifiers. More complex and intelligent classifiers, based on neural networks or even the recognition of textural/or morphological patterns and characteristics, could be applied to detect GF in SAR images.

Full reference

MENDES JÚNIOR, C.W., ARIGONY-NETO, J., RIBEIRO, R.R., SIMÕES, J.C. Uso de imagens ERS SAR no monitoramento de zonas superficiais de neve e gelo da região nordeste da Península Antártica [Using ERS SAR images for monitoring snow and ice surface zones on the northeastern Antarctic Peninsula region]. *Pesquisas em Geociências*, **36**(2): 65–84, 2009.



SAR images from the Antarctic Peninsula showing variations in glacier facies from 1993 to 1997.

A new topographic map for Keller Peninsula, King George Island, South Shetlands, Antarctica

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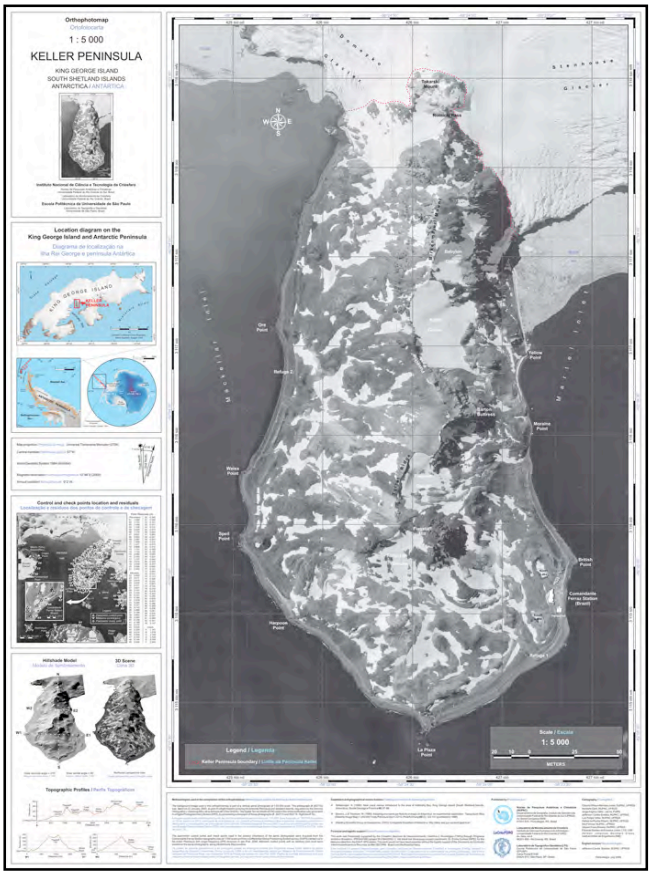

The Keller Peninsula map. This and other maps produced by the Institute can be download at http://www.ufrgs.br/antartica/.

Abstract The Keller Peninsula (KP), on the King George Island, shelters the Brazilian Comandante Ferraz Station (EACF) and it has been the site from several international research projects. However, this area has not yet been mapped in detail, except for the area around the EACF, which is mapped at 1:500. Aiming to overcome the lack of a detailed and accurate map for the entire KP, this work proposes the use of photogrammetric and GIS techniques for the compilation of a new topographic map at a scale of 1:5,000. The elaboration of this map was based on interior and exterior orientation of aerial photographs, generation and edition of a Digital Terrain Model (DTM), derivation of contour lines from the created DTM and accuracy assessment of the results. Verification of horizontal position and elevation data of the resulting map showed a good correlation with data from other maps, mainly in the area around the EACF and at Flagstaff Hill.

Full reference

MENDES JUNIOR, C.W., DANI, N., ARIGONY-NETO, J., SIMÕES, J.C., VELHO, L.F., RIBEIRO, R.R., PARNOW, I., FONSECA JUNIOR, E.S., ERWES, H.J.B. A new topographic map for Keller Peninsula, King George Island, Antarctica. *Pesquisa Antártica Brasileira*, Brazilian Academy of Sciences, **5**, 2010 (*in press*).

ICE GEOPHYSICS

Laboratório Geofísica de Geleiras-ON

Programme leader: **Dr. Jandyr M. Travassos** jandyr@on.br

Leading research group: Laboratório de Geofísica de Geleiras
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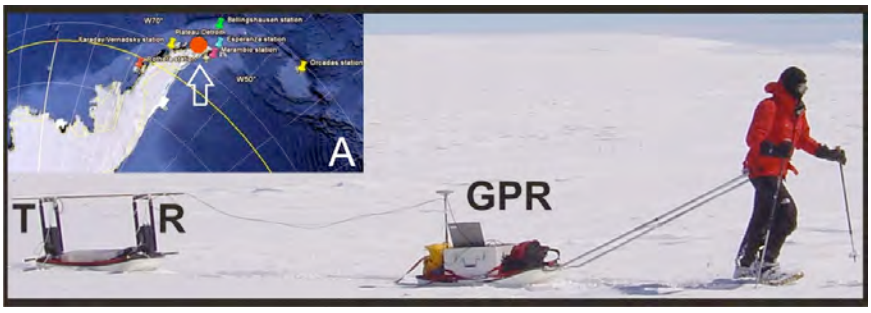
The most used geophysical techniques to study ice are the Ground Penetrating Radar (GPR) and the Radio Echo-Sounding (RES), which use active remote sensing electromagnetic (EM) sensors based on the transmission and reflection of an EM pulse at inhomogenities. The analysis of the reflected signals provides information on the physical and chemical properties of ice, and bedrock. GPR and RES surveys are sometimes complemented by the reflection seismic method, which may provide an alternative way for obtaining the bed topography under the glacier.

This programme aims to develop the use of these geophysical techniques in Brazil, supporting other research groups with information such as the thickness, the internal structure and bedding of ice masses, essential data for glacier dynamic models. It also assess physical processes that leads to radar reflections, and that my help ice core interpretation (as the identification of high acidity ice layers due volcanic ash).



A GPR survey at the Detroit Plateau, Antarctic Peninsula. The resulting profile shows the snow stratigraphy (note the vertical scale to the left, about 30 m).

GPR signatures of temperate and cold land ice

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Abstract The excellent penetration of the electromagnetic field in ice favours the radar and the radio-echo sounding methods for the study of ice masses laying on Earth's surface. In particular the ground penetrating radar has proved to be very effective for surface-based studies of land and sea ice. The most ubiquitous radar signatures are reflections from the internal structure of ice, the so-called stratigraphic layers, or from the bedrock. In most cases those are useful reflections, but some of them can be detrimental to the interpretative effort, either masking useful data or yielding false estimates. In that case they are generally labelled as artefacts and discarded on the spot. Some others provide useful information on the studied ice mass albeit bearing no direct relation to stratigraphy. In this paper we concentrate on some reflection phenomena other than on ice stratigraphy. The first two of those phenomena are the glacial inclusions and the englacial channels that scatter radar energy in temperate ice, either in a detrimental or a useful way, respectively. The former is both an impediment to penetration and a source of error in trace-derived quantities, as are free water contents estimates. The latter is a geophysical signature of the existence and positioning of the englacial channel itself. Isochrones multiples are artefacts that are used here to distinguish an echo-free zone, caused by crystal orientation in a preferred angular distribution, from a zone simply beyond signal penetration. Anomalous crystal growth and coalescence in cold ice can also scatter radar energy in a way that resembles the scattering by the temperate ice glacial inclusions. In this paper we use the scattering to estimate the depositional chronology, with the aid of independent albeit remote temperature data. The last case discussed here is the case where radar energy gets partially trapped in a surficial waveguide, a result of a more refringent/dense surficial snow layer over a less refringent/dense snow below.

Full reference

TRAVASSOS, J.M., SIMÕES, J.C. Geophysical signatures of temperate and cold ice. *Pesquisa Antártica Brasileira*, Brazilian Academy of Sciences, **5**, 2010 (*in press*).

High-resolution radar mapping of the Cierva Peninsula

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[3]Universidade do Estado de Rio de Janeiro, Rio de Janeiro, Brazil

Abstract The excellent penetration of the electromagnetic field in ice favours the radar and the radio-echo sounding methods for the study of ice masses laying on Earth's surface. In particular the ground penetrating radar has proved to be very effective for surface-based studies of land and sea ice. The most ubiquitous radar signatures are reflections from the internal structure of ice, the so-called stratigraphic layers, or from the bedrock. In this paper we concentrate on some reflection phenomena other than on ice stratigraphy revealed on the ice cover of the Cierva Point, Antarctic Peninsula. We acquired 25 SW-NE and NE-SE profiles in an area of 140 x 175 m^2 with an acquisition train of 2 Nansen sledges dragged by a snowmobile. Radar sections revealed internal reflection horizons are caused by changes in dielectric properties as well as density fluctuations and preferred crystal orientation fabric.

Full reference

TRAVASSOS, J. M., MUSA, J.E.C., PECHE, L.A. High-Resolution Radar Mapping of the Cierva Peninsula, *Revista Brasileira de Geofísica*, **28**(2): 223–228, 2010.

ICE AND SOILS: PERMAFROST AND CRYOSOLS

Programme leader: **Dr. Carlos E.G.R Schaefer** reyschaefer@yahoo.com.br

Leading research group: Centro TERRANTAR
Centro de Ciências Agrárias
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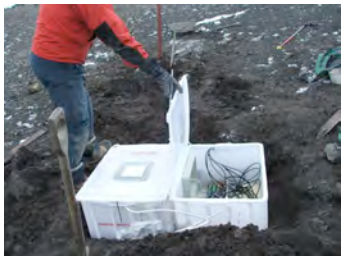
Cryogenic soils are typical of polar and subpolar regions and have as a marking characteristic the presence of permafrost. Antarctic permafrost forms an integral part of the terrestrial cryosphere, yet information on its distribution, thickness, age, and physical and geochemical properties is highly fragmented and absent for large sectors of this region. At the same time, active layer and permafrost conditions are increasingly recognized to be highly sensitive to climate change. Such changes can create important responses in regional hydrology, ecosystems functioning, and landscape stability. At the same time, Antarctic permafrost and soils archive high-resolution long-term (million years) records of past environmental change and biological activity.

The general objective of this programme is to characterize polar and sub-polar terrestrial ecosystems, implementing a long-term system for monitoring permafrost and soils in the main ice-free areas of maritime and peninsular Antarctica. Emphasis is being given to permafrost temperatures, as currently there is no global Antarctic database that defines the thermal state of soils and permafrost for a specific time period. Our dataset will serve as a baseline to assess permafrost changes in Maritime Antarctica and will improve our understanding on permafrost dynamics.



Installing sensors for monitoring permafrost in King George Island, South Shetlands, Antarctica.

Impact of expected global warming on C mineralization in maritime Antarctic soils: results of laboratory experiments

Juliana V. de S. Carvalho[1], Eduardo de Sá Mendonça[2], Rui T. Barbosa[1], Efran L. Reis[1], Paulo N. Seabra[3] and Carlos Ernesto G.R. Schaefer[3]

[1]*Universidade Federal de Viçosa, Viçosa, Brazil*
[2]*Universidade Federal do Espírito Santo, Alegre, Brazil*
[3]*CENPES-Petrobras, Rio de Janeiro, Brazil*

Abstract This study concerned the fragility of maritime Antarctic soils under increasing temperature, using the C dynamics and structural characteristics of humic substances as indicators. Working with four representative soils from King George Island (Lithic Thiomorphic Cryosol (LTC1 and LTC2), Ornithogenic Cryosol (OG) and Gelic Organosol (ORG)) we evaluated the total organic C and nitrogen contents, the oxidizable C and humic substances. Soil samples were incubated to assess the amount of C potentially mineralizable at temperatures typical of an Antarctic summer (5–14°C). Humic acids showed a higher aliphatic character and a smaller number of condensed aromatic groups, which suggests that these molecules from Antarctic soils are generally less resistant to microbial degradation than humic acids molecules from other regions. Based on ^{13}C NMR spectra of MAS and CP/MAS, samples of soil humic acids of mineral soils (LTC1 and LTC2) have a higher content of aliphatic C, and heteroatom C, with lower levels of carbonyl and aromatic C, when compared with organic matter-rich soils (OG and ORG). Increasing incubation temperature led to a higher rate of mineralizable C in all soils. A sequence of soil fragility was suggested - LTC1 and LTC2.OG.ORG, which showed a correlation with the Q10 coefficient and the ratio of labile and recalcitrant C fractions of soil organic matter ($R^2 = 0.83$).

Conclusions Humic substances in maritime Antarctic soils, mainly the humic acid, have a greater aliphatic character and lower number of condensed aromatic groups when compared with humic substances from other terrestrial environments. Such characteristics suggest that the molecules of humic acid from maritime Antarctic soils are generally less resistant to microbial degradation than the soils from other regions. An increase in temperature produced a significant increase in the C mineralization of these soils, demonstrating their likely response to global change. The sequence of soil fragility is Lithic Thiomorphic Cryosol>Ornithogenic Cryosol>Gelic Organosol, which correlates with the $C_{lab/recalc}$ ratio and the Q10 coefficient of soil organic matter. It is important to map the extent of these soils in the Antarctic to estimate accurately their contribution in terms of CO_2 emission. These results indicate that structural components of HAs molecule may be used as indicators to interpret the potential of soil C-CO_2 evolution with environmental change

Full Reference

DE SOUZA CARVALHO, J.V., DE SÁ MENDONÇA, E., BARBOSA, R.T., REIS, E.L., SEABRA, P.N., SCHAEFER, C.E.G.R. Impact of expected global warming on C mineralization in maritime Antarctic soils: results of laboratory experiments. *Antarctic Science*, **22** (5): 485-493, 2010.

Spatial and temporal variability in soil CO_2 – C emissions and relation to soil temperature at King George Island, maritime Antarctica

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[1]*Universidade Estadual Paulista, Jaboticabal, Brazil*
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Abstract Few studies have examined the effects of temperature on spatial and temporal trends in soil CO_2–C emissions in Antarctica. In this work, we present in situ measurements of CO_2–C emissions and assess their relation with soil temperature, using dynamic chambers. We found an exponential relation between CO_2 emissions and soil temperature, with the value of Q_{10} being close to 2.1. Mean emission rates were as low as 0.026 and 0.072 g of CO_2–C m^{-2} h^{-1} for bare soil and soil covered with moss, respectively, and as high as 0.162 g of CO_2–C m^{-2} h^{-1} for soil covered with grass, *Deschampsia antarctica* Desv. (Poaceae). A spatial variability analysis conducted using a 60-point grid, for an area with mosses (*Sannionia uncianata*) and D. *antarctica*, yielded a spherical semivariogram model for CO2eC emissions with a range of 1 m. The results suggest that soil temperature is a controlling factor on temporal variations in soil CO_2–C emissions, although spatial variations appear to be more strongly related to the distribution of vegetation types.

Conclusions In a maritime Antarctica soil, we found the highest mean CO_2–C emission rate at a site with *D. antarctica*, compared with sites with moss carpet and bare soil, indicating the effect of soil respiration by the root system. We found an exponential relation between CO_2 emissions and soil temperature. The highest sensitivity of emissions to soil temperature was found for bare soil, indicating the emission of C present in the soil, independent of vegetation. The results of a spatial variability analysis suggest that the type of vegetation, rather than soil temperature, controls the spatial variability model, because no relation was observed between soil CO_2–C emission and soil temperature, either by linear correlation or by comparing the spatial variability models and maps.

Full reference

LA SCALA JÚNIOR, N., SÁ MENDOÇA, E., SOUZA, J.V., PANOSO, A.L., SIMAS, F.N.B. and SCHAEFER, C.E.G.R. Spatial and temporal variability in soil CO_2-C emissions and relation to soil temperature at King George Island, maritime Antarctica. *Polar Science*, **4**(3): 479–487, (2010), doi:10.1016/j.polar.2010.07.001.

POLAR OCEANS: ICE AND CIRCULATION

Programme leader: **Dr. Maurício M. Mata** mauricio.mata@furg.br

Leading research group:

Grupo de Oceanografia de Altas Latitudes (GOAL)
Institute de Oceanografia
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The polar seas are some of the most susceptible areas of the planet to climate changes. At the same time, those regions host key physical and biogeochemical processes, which deeply influence the planet's climatic system from local to planetary scales. Despite the importance of those processes, they are still poorly understood. This programme aims to improve our understanding on coastal and oceanic processes associated to the Antarctic sea ice decay and melting, specially near the Antarctic Peninsula where a significant loss of continental ice occurred during the last two decades, freshing the surrounding waters. Our field investigations are carried out by re-occupying sampling sites and analyzing oceanographic time series (hydrography, currents and icebergs drift), which were originally obtained by the High Latitude Oceanography Group, of this same University.

Tagging an iceberg with an ARGOS transmission buoy, work in the vicinity of James Ross Island. Logistics supported by the Brazilian Navy.

Volume transport variability in the northwestern Weddell Sea seen in a global ocean model (OCCAM)

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Abstract The *Synoptic Antarctic Shelf-Slope Interactions Study* (SASSI) project has conducted multidisciplinary studies on the continental shelf and slope at Antarctic margins during the *International Polar Year* (IPY-2007/09). In summary, during the IPY several countries contributed to SASSI project with short synoptic transects that were undertaken circumpolarly and radiated outwards across the Antarctic continental shelf and slope. One of those is the high sampled WOCE SR4 hydrographic section starting near the tip of the Antarctic Peninsula across the Weddell Sea, which is one of the main areas of Antarctic Bottom Water (AABW) export to the global oceans. As part of the SASSI project and because of the high spatial-temporal resolution available, we have chosen to analyze the 1/12° simulation obtained with the *Ocean Circulation and Climate Advanced Modelling* (OCCAM) model to investigate the temporal variability of AABW (i.e. Weddell Sea varieties) volume transport in the northwestern Weddell Sea (NWS).

The mean total full depth cumulative volume transport obtained was respectively 28.6 ± 8 Sv (1 Sv = 106 m^3s^{-1}) and 28.7 ± 10 for section 1 (i.e. the western part of the WOCE SR4 section) and section 2, this is somewhat lower than the transport (i.e. 46 ± 8 Sv) obtained during the summer 2007 cruise of the *Antarctic Drift Experiment Link to Isobaths and Ecosystems* (ADELIE) project. On the other hand, this is the mean volume transport considering all the simulated years (i.e. 1988-2004). It is not unexpected that the bottom layer volume transport is also underestimated by the model (*i.e.* 11.6 ± 4 Sv –and 10.7 ± 4 Sv). The same is true for the volume transport obtained only for the main currents and fronts (i.e. Antarctic Coastal Current – CC; Antarctic Slope Front – ASF; and Weddell Front – WF) present in the NWS. This could be probably associated with the weaker current velocity representation by OCCAM model in the Weddell Gyre. The monthly variability of the total volume transport, considering both the entire section and only the γn layers >28.26 kg m^{-3}, shows the maximum (minimum) transport occurring in June (January). The monthly variability of the total volume transport in the model is in phase with sea ice fraction monthly average (not shown) in the Antarctic Peninsula sector. The annual variability of the total volume transport of section 1 is not in phase with the sea ice parameters (not shown). In contrast, the annual average of the bottom volume transport is ~2 years lagged with both the sea ice fraction and the sea ice thickness variability. Other parameters (as the wind patterns) are under investigation to try to explain these findings.

Full reference

KERR, R., HEYWOOD, K.J., MATA, M.M., GARCIA, C.A.E. Volume transport variability in the northwestern Weddell Sea seen in a global ocean model (OCCAM). In: *OceanObs'09 - List of Community Paper and Additional Abstracts,* p. 41-42, 2009.

Energetics from drifting buoys in the southwestern Atlantic Ocean

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[2]Servicio de Hidrografía Naval and Universidad de Buenos Aires, Buenos Aires, Argentina

Abstract The Southwestern Atlantic mean surface circulation, its associated variability and energetics are studied through the analysis of 16 years (1993-2008) of surface drifter data from the NOAA. The highest Mean Kinetic Energy (MKE) values are found along the path of the Western Boundary Currents in the area, particularly in the Malvinas Current (MC) north of 45ºS, where values approaching 2500 cm^2 s^{-2} where computed. The Eddy Kinetic Energy (EKE) field is normally associated with mesoscale activity. On the Brazil Current (BC), the barotropic conversion (BT) goes from MKE to eddy kinetic energy. Conversely, on the MC the term BT in the most of the path is negative, i.e., conversion of the EKE to MKE. The anticyclonic branch of the BC includes the region of its recirculation cell. In the great part of this region the eddies lose kinetic energy to the mean flow but the reverse energy flow is also possible.

The results unveil that the barotropic conversion fluxes are present in the Brazil Current (BC), Malvinas Current (MC) and the Brazil-Malvinas Confluence (BMC). The highest Mean Kinetic Energy (MKE) values are found along the path of the WBCs, particularly in the MC north of 45ºS, where values approaching 2500 cm^2 s^{-2} where computed. The Eddy Kinetic Energy (EKE) field is normally associated with mesoscale activity. The highest EKE was found in the vicinity of the BMC, where values approach 3000 cm^2 s^{-2}. High EKE in the BMC has been attributed to the frequent observation of mesoscale eddies and meanders. The EKE distribution over the BMC is comparable to the most energetic regions in the global ocean. Furthermore, our EKE estimates in the BMC show higher values than previous estimates based on coarser resolution grids and substantially fewer number of velocity estimates. For example, using ship drift data found values of around 1000 cm^2 s^{-2}. All previous studies found relatively high EKE in the BMC, however, due to the limited spatial resolution and poor data coverage, they consistently underestimated the EKE in this region. Our results, based on a substantial increase in the number of drifters available after 2000, allowed an improved resolution and hence more robust estimates of EKE, MKE and associated fields. Moreover, the similar values of MKE and EKE found in the BMC suggest strong interactions between the mean flow and eddies. When compared to the BC, the MC current displays lower values of EKE (<265 cm^2 s^{-2}) indicating that the eddy activity is lower in the latter. Indeed, when comparing the EKE with the MKE, the MC displays a clear dominance of the mean flow over the eddy variability. The conversion of MKE to EKE is given by the BT term and can be used as an indicator for barotropic instability. Wherever this term is positive, MKE is being converted to EKE through the work of the Reynolds stresses on the mean shear. However, there is a dynamic distinction between those currents, which was identified by the barotropic (BT). On the CB, the BT conversion goes from MKE to eddy kinetic energy. Conversely, on the MC the term BT in the most path is negative, i.e., conversion of the EKE to MKE. The term production of mean kinetic Energy (PKE) by eddies indicates that they are producing mean kinetic energy in the most of the path of MC [4]. However, with BC is an inverse scenario. The net exchange between mean and eddy kinetic energy is characterized by the term BT – PKE, so the mean flow loses kinetic energy to the eddies in the Brazil Current, but the situation is again inverse with Malvinas Current. The more offshore branch of the BC includes the region of its recirculation cell. In the most of this region eddies lose kinetic energy to the mean flow but the inverse energy flow is also possible. On the cyclonic branch of the MC the mean flow loses energy to eddies. These results supporting old investigations, which suggest that different energetic systems can exist in the cyclonic and anticyclonic branches of the western boundary currents. The estimate of the baroclinic conversion term and the relative importance between baroclinic and barotropic energy conversion mechanisms in this energetic region should be further investigated, for instance, with the aid of numerical models and in-situ observations.

Full reference

OLIVEIRA, L.R., MATA, M.M., PIOLA, A.R., SOARES, I.D. Energetics from drifting buoys in the southwestern Atlantic Ocean. In: *OceanObs'09 - List of Community Paper and Additional Abstracts,* p. 46–47, 2009.

Tracking icebergs through SAR images and ARGOS Buoys in NW Weddell Sea

Lorena L. Collares, Maurício M. Mata, Jorge Arigony-Neto, Carlos A. E. Garcia,

Universidade Federal do Rio Grande, Rio Grande, Brazil

Abstract Icebergs play an important role in climate through the transfer of freshwater, heat, dissolved and particulate material between ice sheets and the oceans. Small and medium icebergs form by calving from the outer margins of the Antarctic Ice Sheet, and by the fracturing of larger icebergs into two or more smaller icebergs. They are dispersed by the ocean currents, and decay by progressive fracturing, melting and erosion of their borders under waves action. In February 2009 three icebergs were tagged with ARGOS transmission buoys in the vicinity of James Ross Island. From the positions provided by Argos buoys was possible to identify these icebergs in Advanced Synthetic Aperture Radar (ASAR) images. The objective this work is to monitor the icebergs that were tagged with ARGOS transmission buoys, using Advanced Synthetic Aperture Radar (ASAR) images. This works contributes to the Collaborative Research into Antarctic Calving and Iceberg Evolution (CRAC-ICE). Tracking icebergs through ASAR images seem to be revealed as an efficient and robust method, owing to its high resolution and capacity to acquire images in Polar Regions, frequently covered by clouds. Icebergs smaller than 1000 m, have presented identification problems because of the large number of others with similar sizes and shapes. Icebergs larger than 1000 m have been easily detected and recognized. The probable cause of the reduction of icebergs free-drifting in the beginning of the austral winter is the seasonal sea-ice formation.

Full reference

COLLARES, L.L., MATA, M.M., ARIGONY-NETO, J., GARCIA. C.A.E. Tracking icebergs through SAR images and ARGOS Buoys in NW Weddell Sea. In: 4th SCAR Open Science Conference: Witness to the Past and Guide to the Future, 2010, Buenos Aires. *4th. Open Science Conference CD-ROM*. Buenos Aires: Instituto Antártico Argentino, 2010.

The two Brazilian Navy polar ships that support the activities of this institute: the Oceanographic Support Ship Ary Rongel (right) and the Polar Ship Admiral Maximiano. Two of our associated laboratories (Grupo de Oceanografia de Altas Latitudes (GOAL) and Centro Regional Sul de Pesquisas Espaciais) carry out all Antarctic fieldwork using these vessels as sampling platforms.

ANTARCTICA–SOUTHWESTERN ATLANTIC CONNECTIONS

Programme leader: **Dr. Ronald Buss de Souza** ronald@dsr.inpe.br

Leading research group:

Centro Regional Sul de Pesquisas Espaciais
Instituto Nacional de Pesquisas Espaciais (INPE)
Campus da UFSM, Camobi
Santa Maria, RS - Brazil

http://www.inpe.br/crs/

This programme investigates climatic processes linking the Southern Ocean to the Southwestern Atlantic Ocean (SWA). The effects of these processes on the South American weather and climate are still not well understood, especially over the coastal regions off the south and southeastern Brazil. The SWA is characterized by the formation and passage of storms (cold fronts, storm surges, and cyclones), a better understanding of the oceanic-atmospheric-cryospheric processes occurring from Antarctica to the SWA region will improve weather and climate forecast for South-American countries. Four major themes of research deserve attention: (1) Synoptic, simultaneous observations of the ocean-atmosphere system; (2) Spatial and temporal variability of the sea surface temperature, and sea level response to wind fields, estimated from remote sensing data; (3) Assimilation of satellite and in situ data into weather and climate models; (4) the development and integration of meteorological and oceanographic instrumentation.

A team of our Institute launching weather balloons to collect data using radiosondes.

Atmospheric boundary layer adjustment to the synoptic cycle at the Brazil-Malvinas Confluence, South Atlantic Ocean

Otávio C. Acevedo[1], Luciano P. Pezzi[2], Ronald B. Souza[3], Vagner Anabor[1] and Gervásio A. Degrazia[1]

[1]*Universidade Federal de Santa Maria, Santa Maria, Brazil*
[2]*Instituto Nacional de Pesquisas Espaciais, São José dos Campos, Brazil*
[3]*Centro Regional Sul, Instituto Nacional de Pesquisas Espaciais, Santa Maria, Brazil.*

Abstract This study analyzes and discusses atmospheric boundary layer vertical profiles of potential temperature, specific humidity, and wind speed at each of the sides of the Brazil-Malvinas Confluence in the southwestern Atlantic Ocean. Such confluence is characterized by the meeting of water masses with very different characteristics: the southern waters of the Malvinas current can be several degrees colder and appreciably less salty than the northern Brazil current waters. At the same time, a synoptic cycle can be identified at the region, marked by the successive passages of frontal systems and extratropical cyclones. The different phases of the synoptic cycle lead to different thermal advections at the confluence, causing respective different patterns of atmospheric boundary layer adjustment to the surface heterogeneity induced by the confluence. In the present study, this adjustment along the synoptic cycle is analyzed using data from five experiments performed across the confluence from 2003 to 2008. In each of the campaigns a number of soundings were launched from a ship at both sides of the confluence. A climatological analysis with respect to the closest frontal passage is presented, and it suggests that the observations collected at each of the years analyzed are referent to a different day of the synoptic cycle. The average profiles at each side of the confluence are in agreement with previous modelling studies of warm and cold thermal advection patterns over an oceanic front. Furthermore, our study shows that peculiar transitional characteristics are also observed between the conditions of well-established warm and cold advection. At many phases of the synoptic cycle a strongly stratified boundary layer occurs at one or both sides of the confluence. Some of the observed characteristics, such as a large moisture accumulation near the surface, suggest that existing sensible and latent heat fluxes parameterizations fail under very strong stratifications, and the consequences of this deficiency are analyzed.

Conclusions The marine atmospheric boundary layer adjustment to the surface heterogeneity imposed by the intense SST gradients of distinct water masses at the Brazil-Malvinas Confluence region follows a well-defined cycle. Warm and cold air advection, characteristic of prefrontal and post-frontal conditions, respectively, induce large differences on the thermodynamic and dynamic structure of the atmosphere at both (warm and cold) sides of the confluence. Besides that, transitional conditions also have their own, peculiar characteristics as a consequence of shorter relaxation times over a region dominated by shear-generated turbulence. Turbulent heat fluxes over the region are also modulated by both the SST gradients and the synoptic cycle of the region. In many phases of the cycle, a strongly stratified boundary layer occurs at the cold side, or even at the warm side. As a consequence of this, the schemes commonly used to estimate heat fluxes tend to fail. Meteorologists working in southeastern South America frequently observe that numerical weather forecast models tend to underestimate moisture content, especially at postfrontal conditions when the airflows from the oceanic portions near the BMC. In such case, clear sky conditions may be predicted when overcast or even rainy situations actually occur. We believe that the inadequacy of latent heat flux representations at the BMC region is the most important responsible for these discrepancies. Russo [2009] showed that numerical weather simulations are sensitive to the inclusion of the observed data at the BMC region by means of radiosonde data assimilation. When comparing (*in situ*) observed profiles of relative humidity and (zonal, meridional) wind components of the MABL with simulated profiles, Russo [2009] found that using the assimilation method the MABL is better represented than when no assimilation is used. The present study represents a key contribution toward a better understanding of the surface processes occurring at the BMC region. In the future, this knowledge can be used to improve turbulent fluxes representation in the models and, as a consequence, the forecast quality. Before that can be possible, however, it is necessary to quantify the fluxes with higher accuracy than is nowadays possible with the available parameterization schemes. To address that issue, in situ flux measurements using the eddy covariance method are planned to be performed in the following field campaigns. It is also important to say that the higher latitudes of the South Atlantic Ocean are acknowledged as one of the most important carbon

sinking regions of the World Ocean. Our future knowledge on the annual balance and variability of the CO_2 fluxes between the ocean and the atmosphere along the Subtropical Front and on the Southwestern Atlantic Ocean is dependent on a better understanding of the local variability of the water masses, phytoplankton concentration and turbulent fluxes at the ocean-atmosphere interface.

Full reference

ACEVEDO, O. C., PEZZI, L. P., SOUZA, R. B., ANABOR, V. and DEGRAZIA, G.A. Atmospheric boundary layer adjustment to the synoptic cycle at the Brazil-Malvinas Confluence, South Atlantic Ocean, *Journal of Geophysical Research*, **115**, D22107, doi:10.1029/2009JD013785.

Multiyear measurements of the oceanic and atmospheric boundary layers at the Brazil-Malvinas confluence region

Luciano P. Pezzi[1], Ronald Buss de Souza[2], Otávio Acevedo[3], Ilana Wainer[4], Mauricio M. Mata[5], Carlos A. E. Garcia[5] and Ricardo de Camargo[6]

[1]*Instituto Nacional de Pesquisas Espaciais, São José dos Campos, Brazil*
[2] *Centro Regional Sul, Instituto Nacional de Pesquisas Espaciais, Santa Maria, Brazil.*
[3]*Universidade Federal de Santa Maria, Santa Maria, Brazil*
[4]*Instituto Oceanográfico, Universidade de São Paulo, Brazil*
[5]*Instituto de Oceanografia, Universidade do Rio Grande, Rio Grande, Brazil*
[6]*Institute de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, Brazil.*

Abstract This study analyzes and discusses data taken from oceanic and atmospheric measurements performed simultaneously at the Brazil-Malvinas Confluence (BMC) region in the southwestern Atlantic Ocean. This area is one of the most dynamical frontal regions of the world ocean. Data were collected during four research cruises in the region once a year in consecutive years between 2004 and 2007. Very few studies have addressed the importance of studying the air-sea coupling at the BMC region. Lateral temperature gradients at the study region were as high as 0.3°C km^{-1} at the surface and subsurface. In the oceanic boundary layer, the vertical temperature gradient reached 0.08°C m^{-1} at 500 m depth. Our results show that the marine atmospheric boundary layer (MABL) at the BMC region is modulated by the strong sea surface temperature (SST) gradients present at the sea surface. The mean MABL structure is thicker over the warm side of the BMC where Brazil Current (BC) waters predominate. The opposite occurs over the cold side of the confluence where waters from the Malvinas (Falkland) Current (MC) are found. The warm side of the confluence presented systematically higher MABL top height compared to the cold side. This type of modulation at the synoptic scale is consistent to what happens in other frontal regions of the world ocean, where the MABL adjusts itself to modifications along the SST gradients. Over warm waters at the BMC region, the MABL static instability and turbulence were increased while winds at the lower portion of the MABL were strong. Over the cold side of the BC/MC front an opposite behaviour is found: the MABL is thinner and more stable. Our results suggest that the sea-level pressure (SLP) was also modulated locally, together with static stability vertical mixing mechanism, by the surface condition during all cruises. SST gradients at the BMC region modulate the synoptic atmospheric pressure gradient. Postfrontal and prefrontal conditions produce opposite thermal advections in the MABL that lead to different pressure intensification patterns across the confluence.

Full reference

PEZZI, L. P., DE SOUZA, R.B., ACEVEDO, O., WAINER, I., MATA, M.M., GARCIA, C.A.E., CAMARGO, R. Multiyear measurements of the oceanic and atmospheric boundary layers at the Brazil-Malvinas confluence region, *Journal Geophysical Research*, **114** (D19103), 2009, doi:10.1029/2008JD011379.

MODELLING OCEANIC-CRYOSPHERIC INTERACTIONS

Programme leader: **Dr. Ilana Wainer** wainer@usp.br

Leading research group: Laboratório de Oceanografia, Clima e Criosfera OC^2
Instituto Oceanográfico - Universidade de São Paulo (USP)
São Paulo, SP - Brazil

http://oc2.io.usp.br/

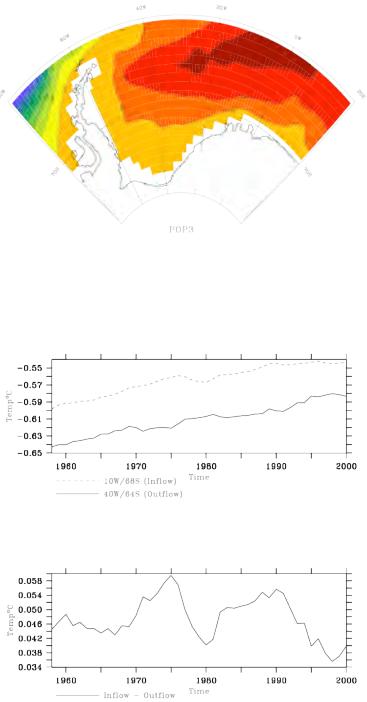
The Southern Ocean is very important to climatic studies, because this is where energy, heat and mass exchanges take place among between the three ocean basins. These exchanges play essential roles on the climate system. Besides that, the sea ice seasonal and annual variability modify processes in water masses, especially in the Weddell and Ross Seas. In these key regions, ice formation and melting affect the upper ocean stability due to salinity variations. This mechanism directly affects water mass formation and, thus, the Thermohaline Circulation. In short, sea ice is important to global climates because it modifies radiation, energy balance and mass exchange processes. It reduces the sea surface temperature, redirects surface currents and modifies down welling rates in Antarctic latitudes. The programme, aims to: a) develop models on the sea ice role in ocean-atmospheric interactions at high latitudes; b) develop models to assess the impact of sea ice extent changes on the cryosphere "as a whole", on the Atlantic southern ocean circulation and on the South American climate; considering the present climate scenario and that one where CO_2 concentrations increases 1% per year until it reaches twice pre-industrial values.

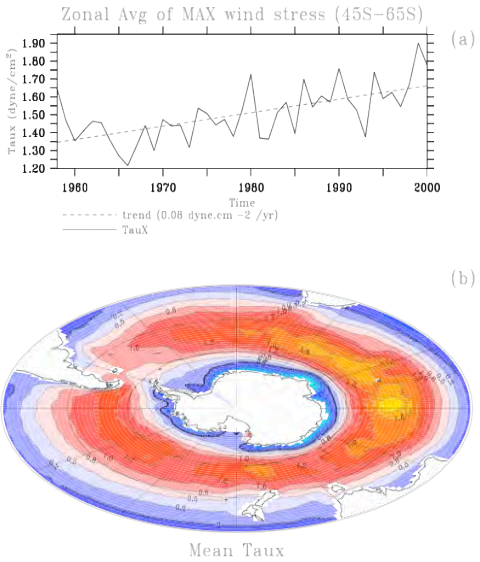
Weddell Sea warming in the Ocean Component of NCAR-CCSM

Ilana Wainer[1] and Maurício M.Mata[2]

[1]*Instituto Oceanográfico, Universidade de São Paulo, Brazil*
[2]*Universidade Federal do Rio Grande, Rio Grande, Brazil*

Abstract In order to evaluate the temporal variability, warming trends, as well as the processes responsible for the changes observed in the Weddell Sea an ocean only simulation of the NCAR Ocean model forced by NCEP/NCAR fluxes are examined. Temperature and Salinity evolution through the 43 years of model simulation are examined along a transect roughly equivalent to the WOCE section SR4 which connects Kapp Norvegia and Joinville Island, on the tip of Antarctic Peninsula. The focus is on changes in the dense waters both at the inflow and outflow regions of the Weddell Sea. So far, most of the research concerned with the warming of the oceans has focused on the upper 1000m. What happens to the deep ocean in particular remains a challenge. The results here show that the minimum temperature for the 1000–5000m layer is slowly increasing linearly (0.001383 year^{-1}) from 1957 to 2000. The overall increase in deep temperature is approximately 0.1 deg. This trend is the same for both outflow and inflow regions. This brings up the question of which is the controlling mechanism: ocean dynamics, ocean-ice-atmosphere exchanges or both? The observed cooling in the 1970's (Weddell Polynia) and in the late 1990's (recurrence of the polynia) is well registered in this model simulation.





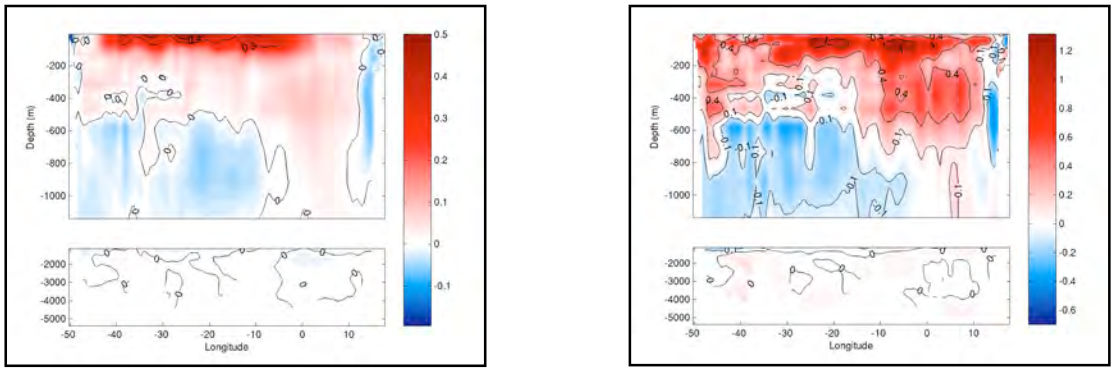
Variations in the inflow of CDW which can be induced by changes in the zonal wind, affects the WDW which is a combination of CDW with mixing and cooling within the Weddell Sea. As the WDW is a precursor of both WSBW and WSDW, any anomalies are likely to be carried along the transformation processes.

Antarctic Intermediate Water & Climate

Ilana Wainer[1], Natalia Signorelli[1] and Maurício M.Mata[2]

[1]*Instituto Oceanográfico, Universidade de São Paulo, Brazil*
[2]*Universidade Federal do Rio Grande, Rio Grande, Brazil*

Abstract Propagation of the Salinity Minimum Associated with the Atlantic Ocean Intermediate Waters from Ocean Reanalysis – Ocean reanalysis from the Simple Ocean Data Assimilation System (SODA) from 1958 to 2007 are used to understand the propagation and freshening of the salinity minimum associated with the Antarctic Intermediate layers in the Atlantic Ocean. Results show that the zonal salinity changes across the Atlantic basin are related to changes in the maximum zonal wind stress at the eastern boundary. Changes in the wind trigger westward propagating Rossby waves. These carry fresher waters from the east into the salty western part of the basin producing decadal changes associated with the freshening of the subtropical eastern Atlantic and saltiness of its western counterpart.



Differences between the vertical profiles of salinity (a) temperature (b) for the 1960's (average for 1960-69) and 1990' s (average 1990-99). Above 400 m there is an evident warming with some regions reaching 1C differences. There is also distinct increase in salinity with maximum values (up to 0.4 psu) confined to the surface layer and centred near 25S. Below that, at intermediate layers, there is cooling and freshening south of 10°S.

MANANGING AND INFRASTRUCTURE

HEADQUARTERS

Centro Polar e Climático, Instituto de Geociências
Universidade Federal do Rio Grande do Sul - UFRGS
Av. Bento Gonçalves 9500
91501-970 - Porto Alegre, RS

Currently, our main facilities, including administrative and logistic staffs, operate within CPC office and laboratory spaces, Instituto de Geociências, at the Universidade Federal do Rio Grande do Sul (UFRGS) in Porto Alegre, Rio Grande do Sul.

The construction of a new 4 floor building (2025.92 m^2) for the CPC will begin in 2011, and will house our Institute headquarters. These facilities will include glaciological cold rooms, ultra-clean chemical laboratories, polar gear, garage for snowmobiles), lecture rooms, museum, library and administrative staff office. Necessarily, to reduce our carbon footprint these facilities will meet the LEED certification (*Leadership in Energy and Environmental Design*) criteria.

The new headquarters building of the Institute at the *Centro Polar e Climático* (Polar and Climatic Centre) at the Universidade Federal do Rio Grande do Sul, Porto Alegre. It's construction will begin in 2011.

ASSOCIATED LABORATORIES

Grupo de Oceanografia de Altas Latitudes (GOAL)
Instituto de Oceanografia, Universidade Federal do Rio Grande (FURG)
Rio Grande, RS

Centro de Estudos de Interações Oceano-Atmosfera-Criosfera
Centro Regional Sul de Pesquisas Espaciais, Instituto Nacional de Pesquisas Espaciais (INPE)
Santa Maria, RS

Laboratório de Oceanografia, Clima e Criosfera OC^2
Instituto Oceanográfico, Universidade de São Paulo (USP)
São Paulo, SP

Centro de Biogeoquímica Polar e Sub-tropical (CBPS)
Laboratório de Radioecologia e Mudanças Globais - LARAMG
Departamento de Biofísica e Biometria, Instituto de Biologia Roberto Alcântara Gomes
Universidade do Estado do Rio de Janeiro (UERJ)

Laboratório de Geofísica de Geleiras
Observatório Nacional (ON)
Rio de Janeiro, RJ

Centro TERRANTAR: Permafrost-Criossolos-Ecossistemas Terrestres e mudanças climáticas na Antártica
Universidade Federal de Viçosa (UFV)
Viçosa, MG

STEERING COMMITTEE

Jefferson Cardia Simões (General coordinator)	Universidade Federal do Rio Grande do Sul (UFRGS) Brazilian alternate delegate to the Scientific Committee on Antarctic Research (SCAR/ICSU) Brazilian representative to the International Association of Cryospheric Sciences (IACS/ICSU) Member of the steering committee of the International Partnerships in Ice Core Sciences (IPICS) Member of the steering committee of the International Trans-Antarctic Expeditions (ITASE) Member of the Brazilian National Committee on Antarctic Research (CONAPA)
Carlos E.G.R. Schaefer	Universidade Federal de Viçosa (UFV) Brazilian member of the SCAR Antarctic Permafrost project (ANTPAS/SCAR)
Ilana E.C. Wainer	Universidade de São Paulo Vice-president of the Scientific Committee on Oceanic Research (SCOR/ICSU) Member of the steering committee of the World Climate Research Program (WCRP) Member of the Brazilian National Committee on Marine Sciences
Heitor Evangelista da Silva	Universidade do Estado do Rio de Janeiro (UERJ) Member of the Brazilian Panel on Climate Change Member of the Brazilian-French International Program PALEOTRACE
Maurício M. Mata (Deputy General Coordinator)	Universidade Federal do Rio Grande (FURG) Brazilian representative to the Scientific Committee on Oceanic Research (SCOR/ICSU) Member of the Brazilian National Committee on Marine Sciences Member of the Climate Variability and Predictability - Atlantic Implementation Panel (CLIVAR/AIP)

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ANTARCTIC AND ANDEAN EXPEDITIONS

In the summer of 2009/2010, several of our research groups participated in the XXVIII Brazilian Antarctic Operation in the Southern Ocean. Our field investigations also included atmospheric, snow and sediment sampling on the King George Island (South Shetland Islands).

A cruise in the vicinity of the Antarctic Peninsula produced 49 oceanographic stations where our scientists collected information on temperature, conductivity, pressure, dissolved oxygen, fluorescence and transmittance (660 nm) using a CTD (Conductivity, Temperature and Depth) system. Collected water samples, using the Niskin bottle, which will be analyzed to determine the concentration of chlorophyll-a, nutrients, alkalinity, pH, phytoplankton counting, and other sea water properties. Continuous sampling of pCO_2 (air and water), surface temperature and salinity were also carried out during the entire cruise.

One of our researchers participated in an Bolivian expedition to the Cordilheira Tres Cruces (67°22'–67°32'W e 16°47'–16°09'S), collecting data on the retreat of Andean glaciers ice fronts.

IMPACT

INTERNATIONAL COLLABORATION

Sound polar research requires intense international cooperation that can share logistics and analytical costs, also assuring high safety standards for our scientific teams. Our Institute cooperates with 22 international scientific institutions, including: Climate Change Institute, University of Maine, USA; Alfred Wegener Institute for Polar and Marine Research, Germany; Jet Propulsion Laboratory/NASA, USA; British Antarctic Survey, U.K.; Instituto Antártico Chileno, Chile; Institut für Physische Geographie, Universität Freiburg, Germany; Laboratoire des Sciences du Climat et l'Environnement, CEA, France; National Oceanography Centre, Southampton, U.K.

EVENTS

A great part of our investigations occurs under the umbrella of the Scientific Committee on Antarctic Research (SCAR) of the International Council for Sciences (ICSU). In 2010 our researchers and students participated intensively in 2 important events supported by SCAR: the *International Polar Year Oslo Science Conference* (http://ipy-osc.no/) and the *4th SCAR Open Science Conference* (http://www.dna.gov.ar/scar2010/) in Buenos Aires, Argentina. In all, our Team presented 30 articles in these 2 meetings and members of our steering committee convened two sections in the Buenos Aires meeting (*Antarctic & South America climate: linking the past & present record*, Jefferson C. Simões; *Southern Ocean circulation and the global climate system,* Maurício M. Mata). One of our *Ph.D.* students (Natália T. Signorelli, USP) won an award for best poster (*Propagation of the salinity minimum associated with the Atlantic Antarctic intermediate water form ocean reanalysis).*

We should also highlight the role of our institute in the *62nd Annual Meeting of the Brazilian Society for the Advancement of Science* - SBPC, held in Natal, Rio Grande do Norte, from 25th to 30th July 2010. We organized and coordinated the symposium "Beyond the myth of the tropical country: the influence of the Antarctic environment in Brazil", Simões) and the round-table "Brazil in Antarctica: time for progress and change". Further, JC Simões and Carlos Schaefer gave conferences: "Glaciers, climate variability and sea level" and "Soils and terrestrial ecosystems of the Brazilian oceanic islands and Antarctica: interfaces with the South Atlantic", respectively.

Finally, C. Schaefer presented a conference at the International Congress of Soil Science in Brisbane, Australia: “Soils, Permafrost Carbon and maritime studies in Antarctica”.

Professor Jefferson C. Simões talking with Prince Albert II of Monaco about recent changes in the Antarctic ice sheet. Our general coordinator gave a special lecture for Prince Albert and his entourage while their visit to the interior of the continent.

SCIENCE IN SOCIETY: EDUCATION AND OUTREACH

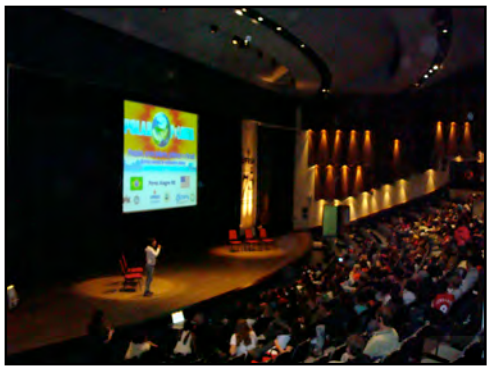
Education

To this date, we maintain the only lecture course in Brazil about the Geography of the Polar Regions; teached to undergraduate students at the Universidade Federal do Rio Grande do Sul (UFRGS). At the Universidade do Rio Grande (FURG) we are developing resources on oceans and global changes., for middle school students.

Our institute supports outreach activities to a wide range of students, professionals and the general public, bringing the polar experience to the classrooms, and other audiences. In the 2009-2010 period the main actions included:

Polar-Palooza Brasil (http://passporttoknowledge.com/polar-palooza//brasil/)

We brought to Brazil the US POLAR-PALOOZA, an outreach project supported by the *National Science Foundation*. Three American scientists and three Brazilian Antarctic Program researchers gave interactive presentations on their work to public schools students in Porto Alegre and Rio de Janeiro. This action also included writing the Portuguese version lyrics for a musical clip on climate change and the Polar Regions.



Polar Palooza in Porto Alegre, 1.200 middle school students packed an auditorium at UFRGS to hear about the Polar Regions and climate change.

Norwegian Polar Exposition - The White Adventure

This was a travelling exhibition on the Norwegian presence in both Polar Regions, sponsored by the Royal Norwegian Embassy in Brasília; our Institute sponsored the venues in Porto Alegre and Rio Grande (RS).

A última fronteira (The last frontier)

It is an interactive site (www.ultimafronteira.com.br), maintained by our Institute, and aimed at middle school students. This resource documents, the first Brazilian mission to the interior of the Antarctic ice sheet.

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FACTS AND FIGURES 2009-2010

Staff		
	Researchers	**87 (includes 25 international collaborators)**
	Technical support	**36**
	Administrative	**2**
Students		
	PhD	**45**
	MSc	**35**
	Undergraduate	**53**
Published articles		
	International	**12 (+ 5 *in press*)**
	National	**1 (+9 *in press*)**
	Map	**1**
Institutions		
	Associated	**7**
	Collaborating	
	Brazilian	**17**
	International	**20**

Financial support (2010-2014)

Budget	**(millions of R$)**	
	Direct funding by CNPq	**4.79**
	Brazilian Antarctic Program	**5.30***
	Other sources (CNPq PROSUL)	**0.08**
	Total	**10.17**

* This is the total amount allocated by the Brazilian Antarctic Program (PROANTAR) to 5 of our 7 institutions, in the next 3 years, to carry out field and laboratory investigations.

South America and Antarctica: Red points mark terrestrial areas where researchers from the Brazilian National Institute of Cryospheric Science and Technology conduct research. Oceanographic missions are carried out from the southern Brazilian coast to the Southern Ocean.

Further information

Instituto Nacional de Ciência e Tecnologia da Criosfera
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