The sub-antarctic atmospheric circulation between 15º W and 90º W and its effects on the climates of the Antarctic Peninsula and southern South America

Francisco Eliseu Aquino[1,2,3], Alberto Setzer[2], Jefferson Cardia Simões[3]

francisco.aquino@ufrgs.br, asetzer@cptec.inpe.br, jefferson.simoes@ufrgs.br

[1] Programa de Pós-Graduação em Geociências, Universidade Federal do Rio Grande do Sul - UFRGS
[2] Centro de Previsão de Tempo e Estudos Climáticos - CPTEC, Instituto Nacional de Pesquisas Espaciais – INPE , São José dos Campos, SP - Brazil
[3] Núcleo de Pesquisas Antárticas e Climáticas - NUPAC, Departamento de Geografia - UFRGS, Porto Alegre, RS - Brazil

INTRODUCTION

The Antarctic and sub-Antarctic regions have a greater degree of climatic interannual variability than observed at lower latitudes. This enhanced variability is due to a number of feedbacks that result from complex interactions between atmospheric circulation, oceans and cryosphere. Surface air temperatures increases of up to 3ºC in the last 50 years have been recorded in the western coast of the Antarctic Peninsula (AP). Following world-wide tendencies, temperatures in continental South America have also increased in the same period, but to a much smaller extend.

OBJECTIVES

The interaction of the Antarctic and sub-Antarctic climates with South America is still a very unexplored subject. In this study we investigated the meridional wind flow at surface level in the sub-Antarctic sector of 15ºW to 90ºW (Weddell and Bellingshausen seas) and its effects in the eastern coast of South America and in the AP, from 1970 to 2005, using NCEP/NCAR Reanalysis data.

DATA AND METODOLOGY

The study used the following monthly reanalysis data obtained from NOAA-CIRES-CDC NCEP/NCAR online web facility (NOAA-CDC, 2006; Kalnay et al., 2001) for the level of 925 hPa in the period of 1970 to 2005: meridional wind averaged for the sector of 40ºS to 65ºS and 30ºW to 55ºW; monthly air temperature averaged for the sector of 30ºS to 32,5ºS and 50ºW to 52ºW, off the coast of south Brazil (CSB), and; air temperature and wind vector anomalies for 20ºS to 80ºS, all longitudes. Daily fields of air temperature and wind vector were also used to analyze specific circulation events. The data were processed using the GRADS package and electronic spreadsheets. Summer and winter months in the time series with anomalous low mean air temperatures at CSB were identified; the thresholds used were 18ºC and 10ºC, respectively. For the specific months selected, the corresponding monthly anomaly of meridional flow and their daily circulation in the 15ºW to 90ºW sector was analyzed. This study follows the ongoing monthly analyses of Antarctica-South America presented regularly at Climanálise (2006).

RESULTS AND DISCUSSION

The meridional flow in the sector of 40ºS to 65ºS and 30ºW to 55ºW varies significantly in the summer and winter, as shown by the anomalies presented in figures 1 and 2. Analysis of the data showed that without exception, all anomalous cold months in the coastal regions of south and southeast Brazil (red arrows, figures 3 and 4) resulted from corresponding anomalous northward

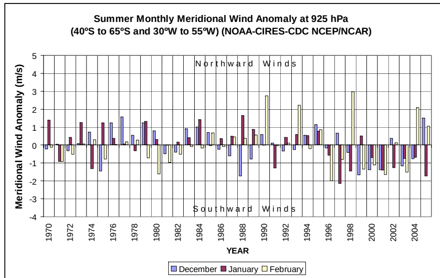

Figure 1: Summer monthly meridional wind anomaly (December, January and February)

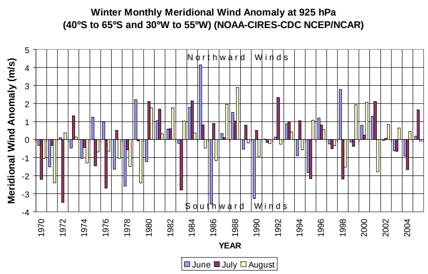

Figure 2: Winter monthly meridional wind anomaly (June, July and August).

penetration of cold air masses originating from the Weddell sea. Incidentally, these same months registered anomalous warm temperatures in the Antarctic Peninsula, which resulted from the southward advection of warm air at other longitudes.

Figures 3a, 3b, 3c, 4a, 4b and 4c show the effect of the sub-Antarctic air masses in SBC air temperatures for the summer months of January/1979, February/1988 and February/1995, and for the winters months of August/1984, July/1990 and July/2000, when the monthly averages were some 3ºC below normal. The specific number of days in these six months with northward flow from the Weddell sea region was 7, 7, 6, 10, 5 and 7. As seen in these same six figures, the temperatures in the AP region were above the average.

Figures 3d, 3e, 3f, 4d, 4e and 4f show the wind vector anomalies for the same months with low temperature anomalies at SBC, where one can identify the unusual flow from sub-Antarctic latitudes. Conversely, the southward flow to PA is also evident at more western latitudes.

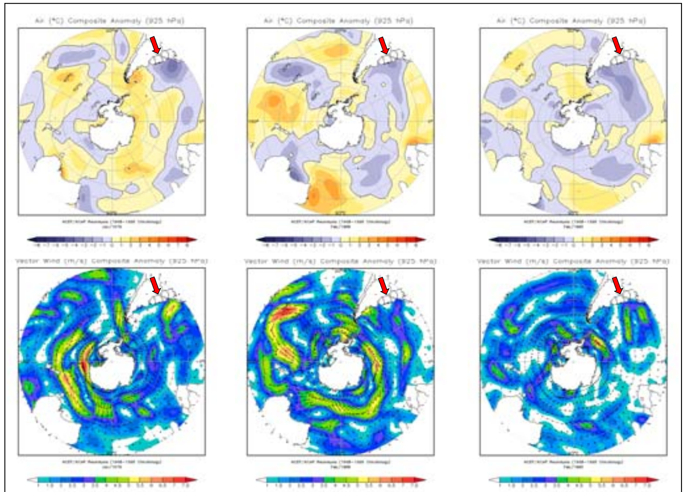

Figure 3: Summer months with negative air temperatures anomalies (a, b and c) in SCB and the meridional south wind anomaly (d, e and f) that contribute in decrease of air temperatures over southeast South Brazil (read arrow)

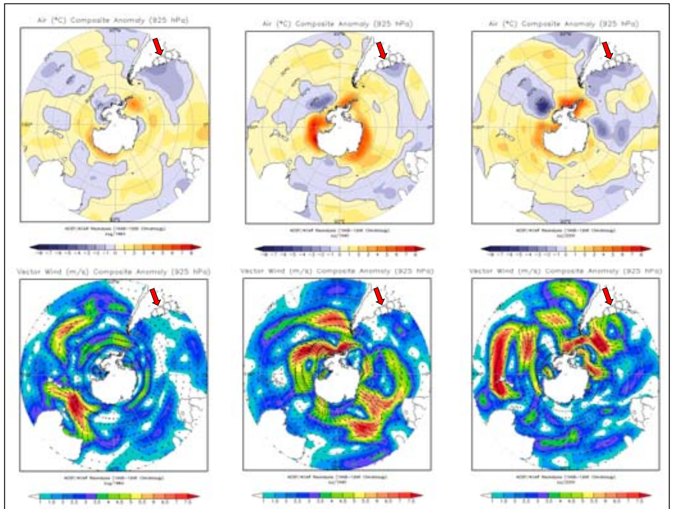

Figure 4: Winter months with negative air temperatures anomalies (a, b and c) in SCB and the meridional south wind anomaly (d, e and f) that contribute in decrease of air temperatures over southeast South Brazil (read arrow).

CONCLUSIONS

Climatic interactions between sub-Antarctic latitudes and southern South America occur with exchange of air masses at the lower troposphere, causing variations of a few degrees in monthly average air temperatures at these regions. Therefore, changes in temperature time series at these regions can result also from variations in the advection and circulation from thousands of km away, and not necessarily from a regional warming. Cold sub-Antarctic surges lasting just a few days each will significantly drop the average monthly temperature in the southeast coast of South America by a few degrees.

References

CDC, 2006, http://www.cdc.noaa.gov/cposites/
CDC, 2006, http://www.cdc.noaa.gov/composites/day/
Climanálise, 2004-2006, http://www.cptec.inpe.br/products/climanalise/
Connolley, W. M., Variability in annual mean circulation in southern high latitudes, *Clim. Dyn.*, **13**, 745-756, 1997.
Gong, D. and Wang, S., Definition of Antarctic Oscilation Index, *Geophys. Res. Lett.*, **26**, 459-462,1999.
Kalnay, E. and Coauthors, The NCEP/NCAR Reanalysis 40-year Project. *Bull. Amer. Meteor. Soc.*, **77**, 437-431, 1996.
Marshall, G. J., Stott, P. A., Turner, J., Connolley, W. M., King, J., and Lachlan-Cope, T. A., Causes of exceptional atmospheric circulation changes in the Southern Hemisphere, *Geophys. Res. Lett.*, **31**, L14205, doi:10.1029/2004GL019952, 2004.
Simmonds, I., and Keay, K., Mean Southern Hemisphere extratropical cyclone behavior in the 40-year NECP-NCAR Reanalysis, *J. Clim.*, **13**, 873-885, 2000.
Thompson, D. W. J., and Solomon, S., Interpretation of recent Southern Hemisphere climate change, *Science*, **296**, 895-899, 2002.

Aknowledgments

Fundings for this investigation was provided by the Brazilian Antarctic Programe (PROANTAR), through the Brazilian National for Scientific and Tecnological Development (CNPq). Also thanks to Clóvis Sansigolo, Denilson Ribeiro Viana, João Gerd and Marcelo Oliveira Romão.

www.cptec.inpe.br/antartica www.ufrgs.br/antartica