Stratosphere-Troposphere Coupling Studies at High Southern Latitudes and Antarctic Historic Data Analysis

Work in progress

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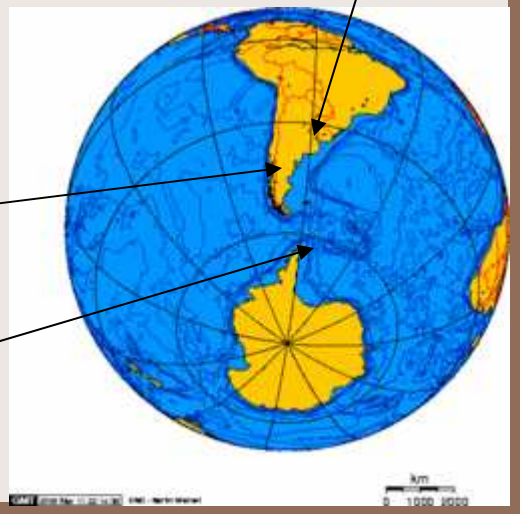
Current research activities at PEPACG linked to IPY

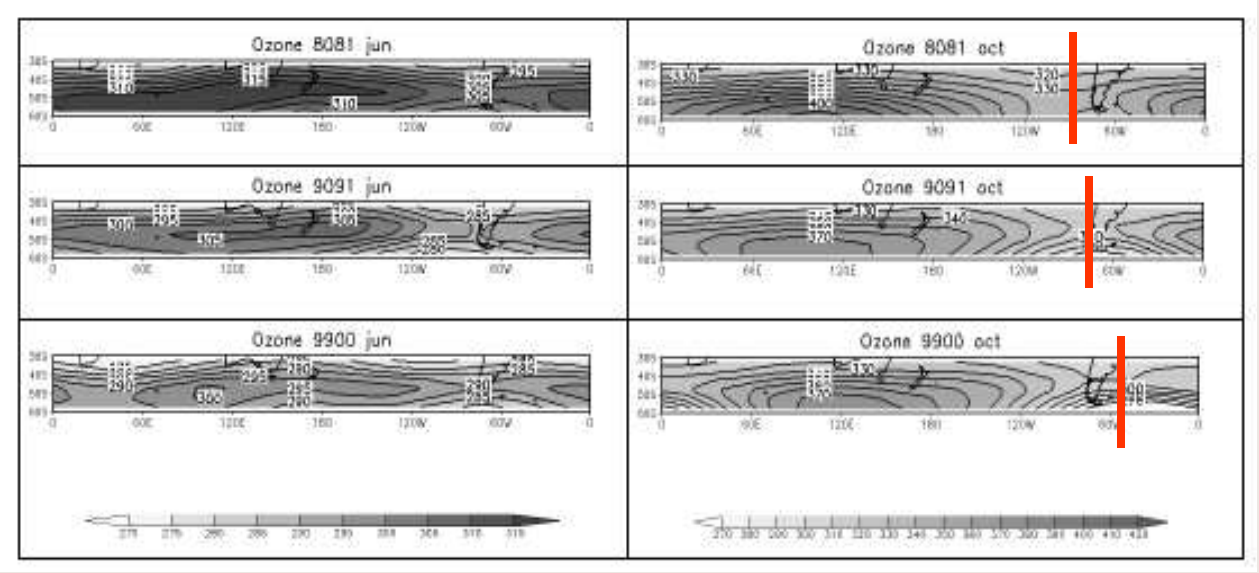
1. Stratosphere-troposphere coupling at mid and high southern latitudes.
2. Tropopause characteristics/behaviour and STE over the Southern Hemisphere.
3. Recovery and analysis of historical data in Patagonia and Antarctica.
4. Climate variability and change in Patagonia.



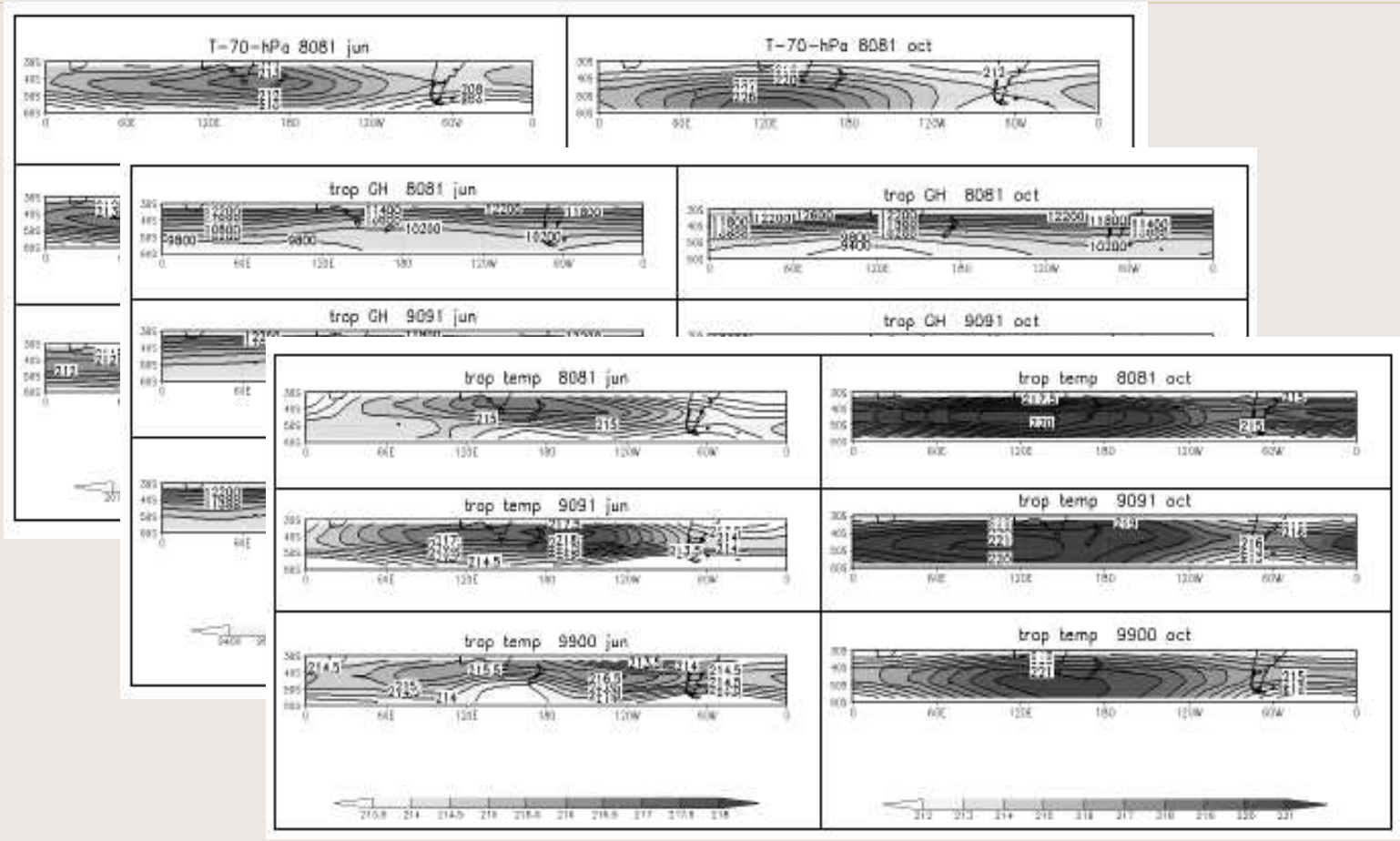
Some Results....

1. UT/LS decadal interactions at southern midlatitudes

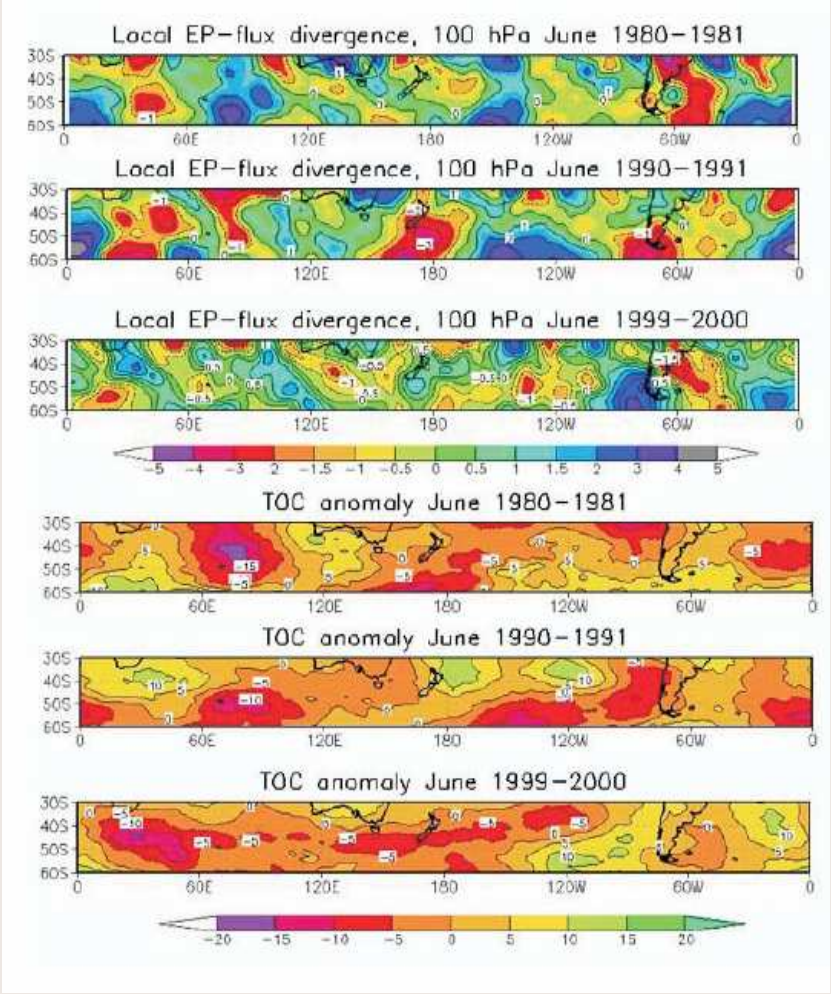
Total Ozone



Such changes are observed in the tropopause and the lower stratosphere



A comparison between local EP-Flux divergence (according to Trenberth, 1986) at 100hPa and TOMS anomalies:



June

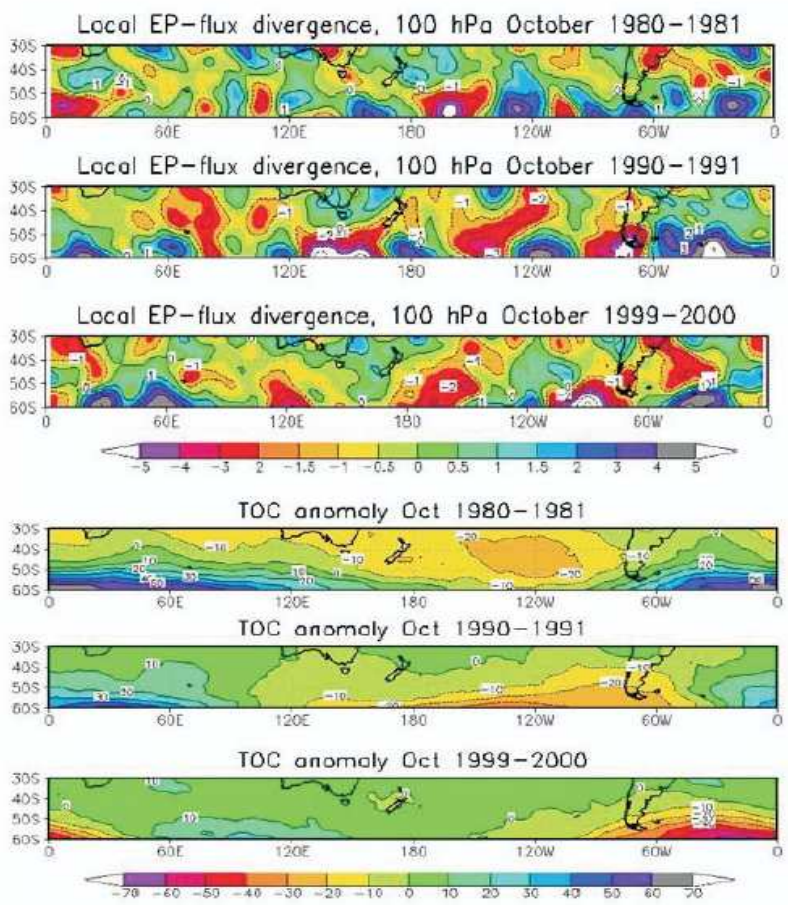


Figure 7

October

The TOMS ozone, temperatures at 400hPa, tropopause and 70hPa, PV at 340K and geopotential at 70 hPa fields and fields of decadal differeces were statistically compared. The results of the comparison was:

1) TOMS ozone decadal in June appears to respond to changes in the upper troposphere. Other stratospheric variables are not linked in all cases with upper troposheric variability

2) TOMS changes in October and the comparison with changes observed in the tropopause and lower stratospheric variables shows a decoupling between the tropospheric and stratospheric decadal evolution

Remember that the SAM couples the southern troposphere and stratosphere later in the austral spring.

This however does not help us explain what has caused the longitudinal displacement of the polar vortex main axis as well as of the high ozone region surrounding it...

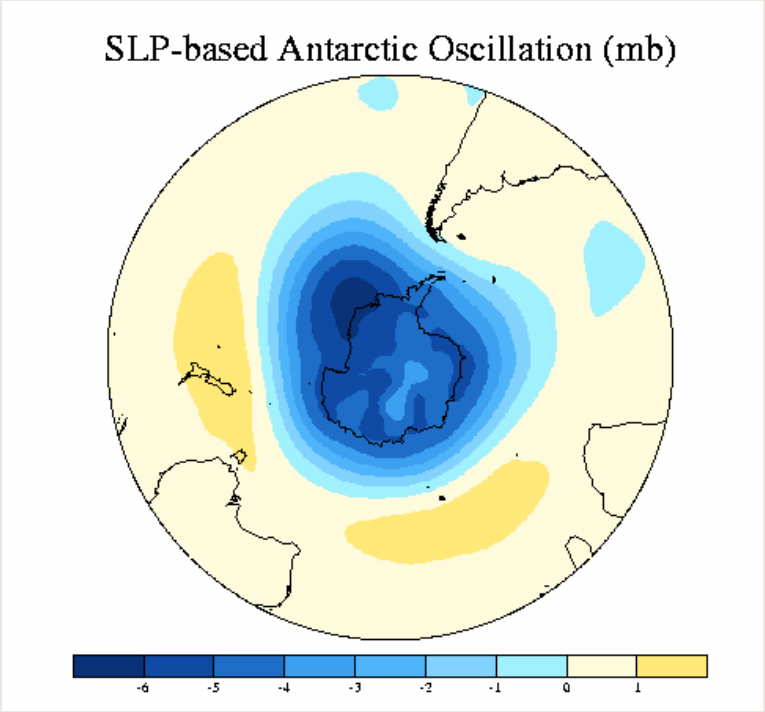
So, could there be some sort of spatial variability in SAM?

Has this EOF pattern

slowly rotated

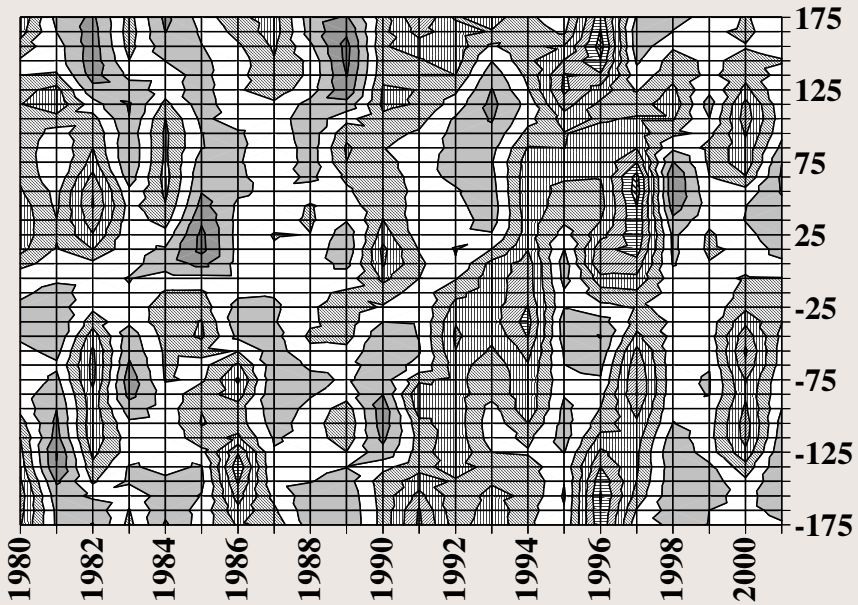
over the years

for example?



From JISAO website

Following Marshall´s SAM index calculation using surface observations we estimated the spatial variability of the SAM index at 400hPa and 70 hPa using ERA-40 geopotential data products: at 10°longitude intervals the index was calculated and plotted as a Hovmoller diagram to detect such a possibility:



October

The idea of SAM spatial variability does not appear to apply....

So... We need a new idea!

More abut possible UTLS interactions during the AGU Chapman conference in a few weeks...

3 Historic data analysis in Patagonia and Antarctica

Understanding climate variability and change, including ozone depletion and change effects as well as SAM contributions requires the analysis of real observations since there are limits to what can be done with reanalysis products in such a data-sparse region.

The approach taken in our activities is to recover and rebuild consistent historic data sets in the region. This is particularly relevant for Antarctica, where there are few but valuable observations starting after the Second World War.

Of particular interest is the oldest record belonging to the Base Antarctica Orcadas, established by Argentina on Laurie Isalnd back in 1903, as a result of the efforts carried out by the Argentine authorities to rescue the Swedish Nordjenskold Expedition that was stranded in Antarctica.

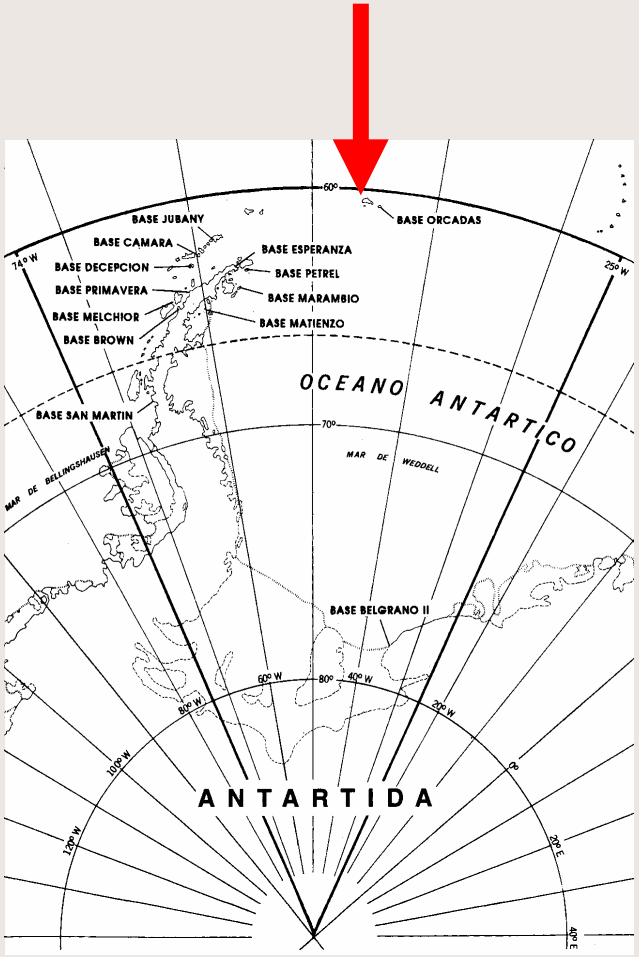
The observatory provides a reasonably good data set as far as temperature is concerned from 1903 and rainfall from 1908 to early 1980s.

The following are results obtained from the analysis we are carrying out with this dataset.

Base Antarctica Argentina Orcadas

In operations since 1903

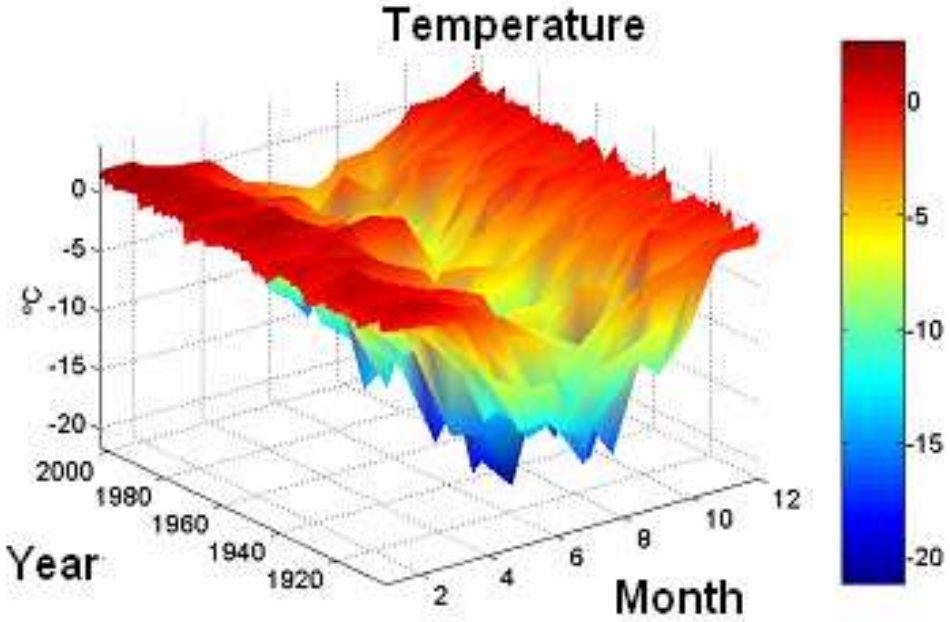
60º 45'S 44º 43'W

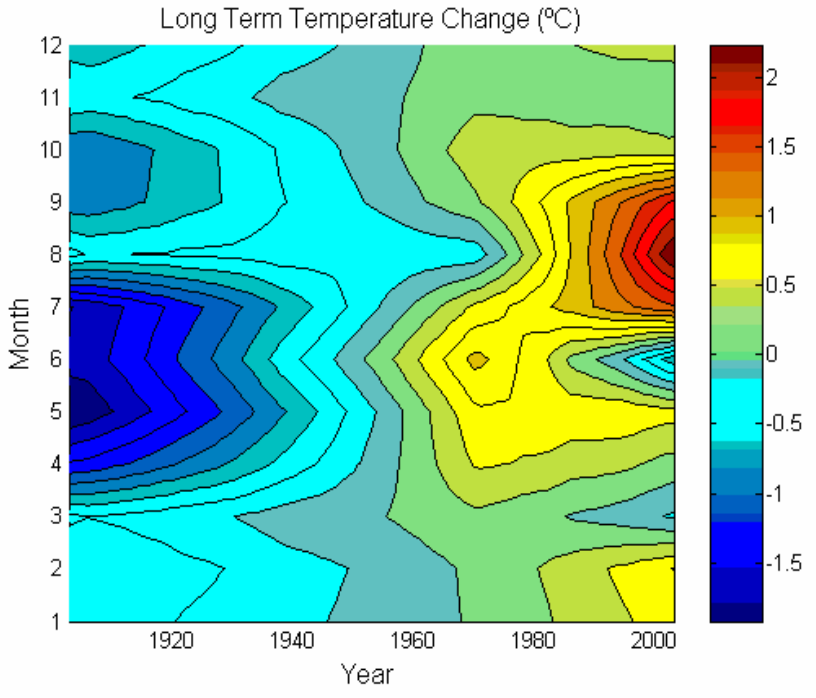


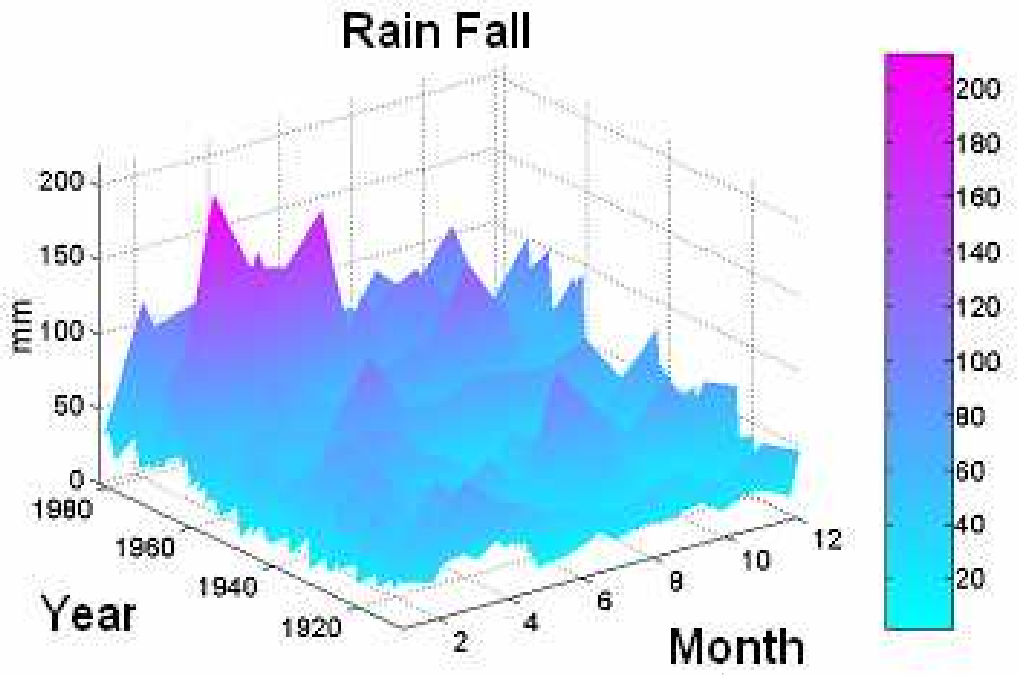
After the data set was made consistent, the monthly mean temperature time series, for surface temperature and precipitation was analysed using wavelet analysis.

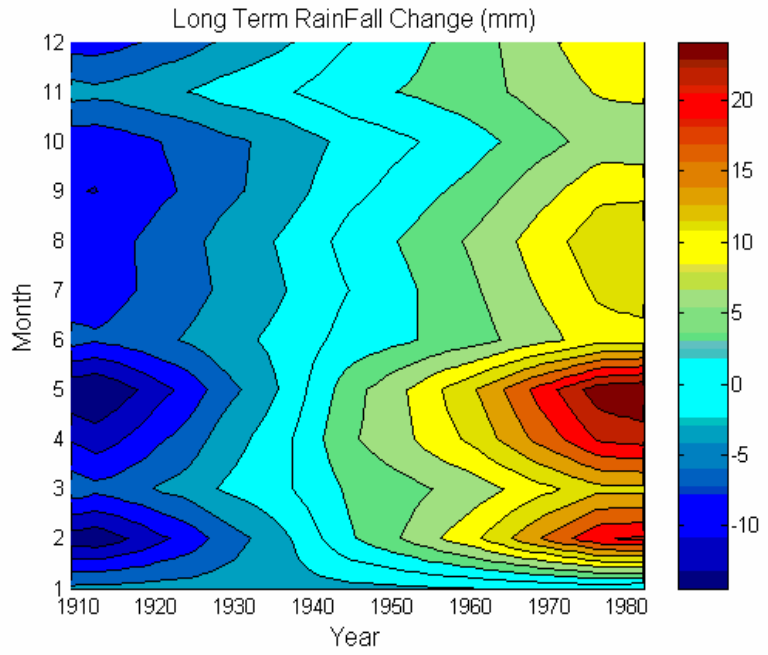
The aim of this work is to determine not just the linear trends but also trend breaking points and variability.

The following plots show the temporal evolution of the deseasonalized variables.


Temperature
0
-5
-10
-15
-20
°C
2000
1980
1960
1940
1920
Year
2
4
6
8
10
12
Month
0
-5
-10
-15
-20


Long Term Temperature Change (ºC)
12
11
10
9
8
7
6
5
4
3
2
1
Month
1920
1940
1960
1980
2000
Year
2
1.5
1
0.5
0
-0.5
-1
-1.5


Rain Fall
mm
200
150
100
50
0
1980
1960
1940
1920
Year
2
4
6
8
10
12
Month
200
180
160
140
120
100
80
60
40
20


Long Term RainFall Change (mm)
Month
12
11
10
9
8
7
6
5
4
3
2
1
1910
1920
1930
1940
1950
1960
1970
1980
Year
20
15
10
5
0
-5
-10

During IPY 2007 - 2009

The stratosphere-troposphere coupling research will be continued using satellite observations from 1979 to present and reanalysis

Base Antarctica Argentina Orcadas

- The rainfall data from 1980 to present at will be recovered
- Temperature data (from 1903) and rainfall data (from 1908) to present will be archived at SPARC data center

THANKS!

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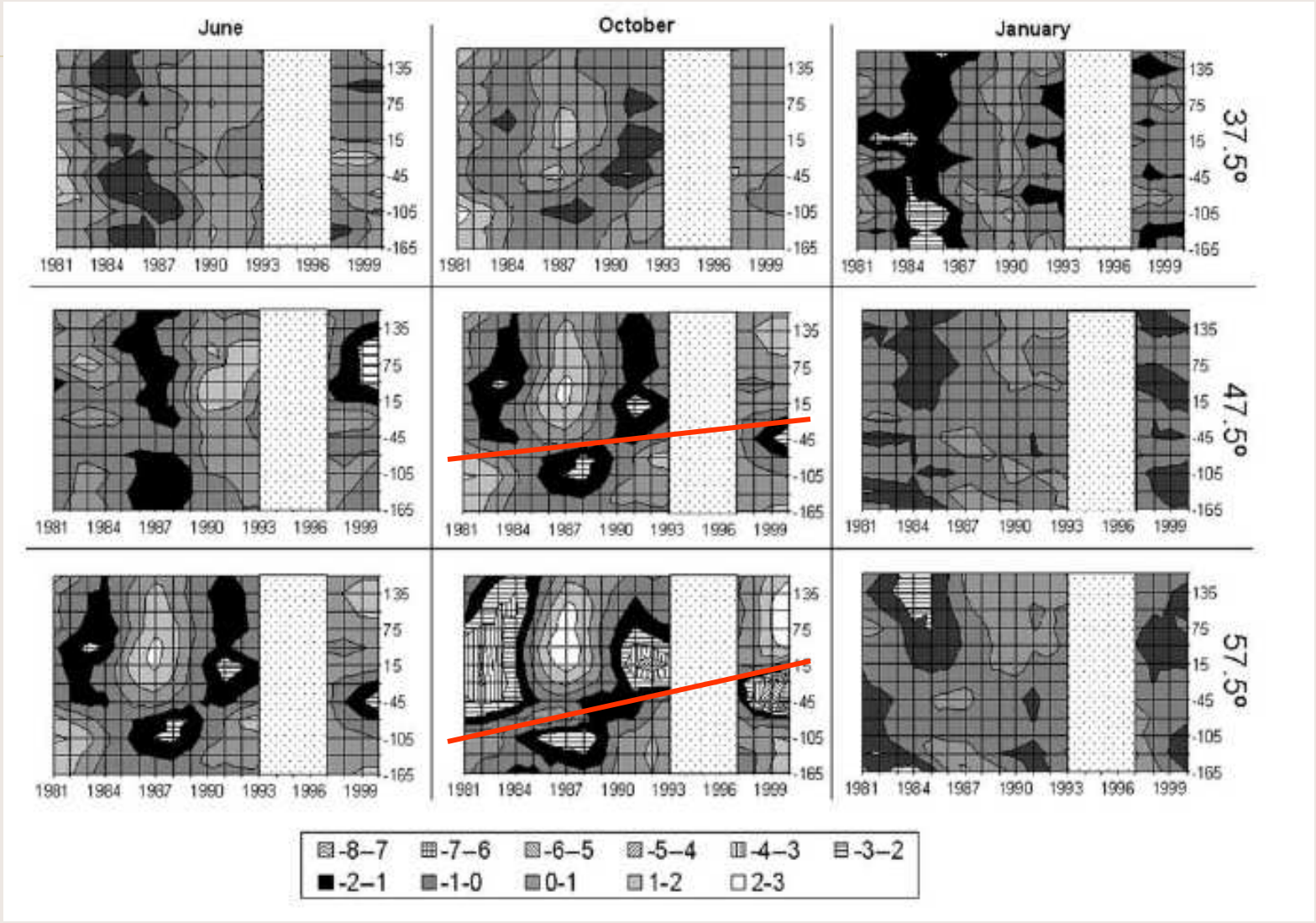
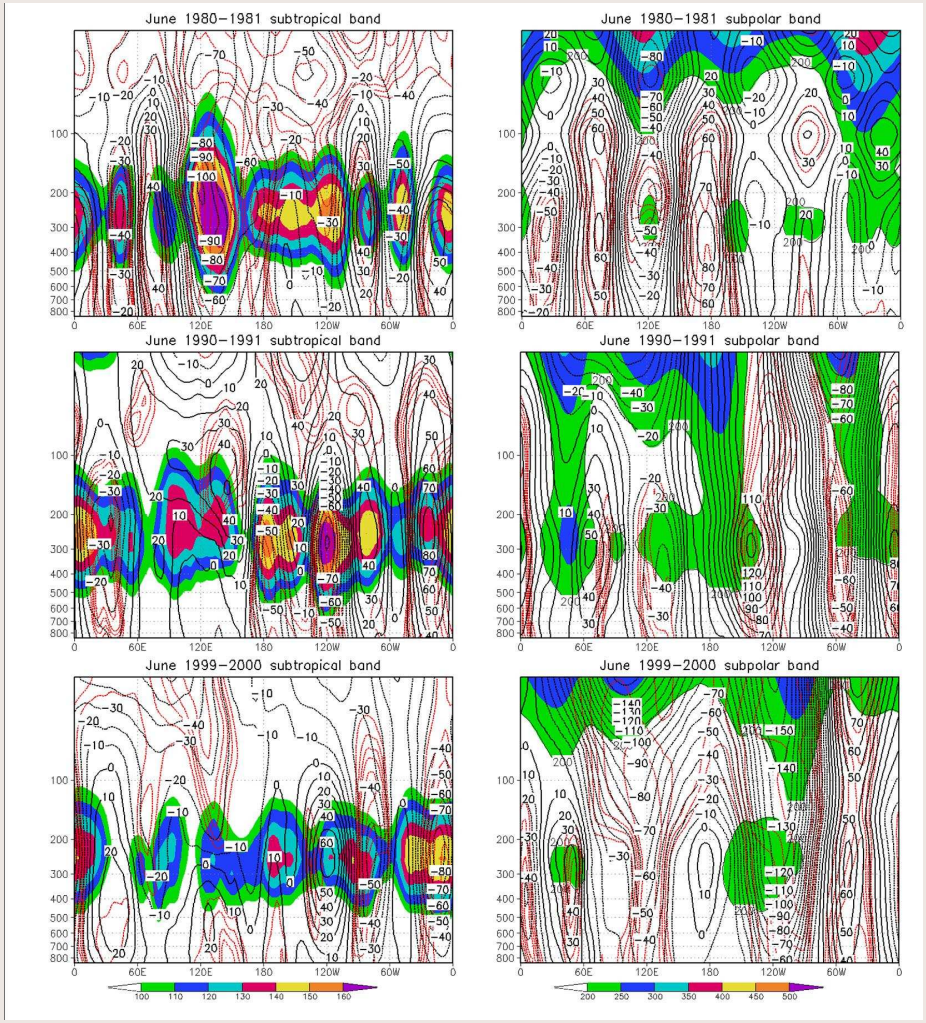
Website: www.uca.edu.ar/pepacg

Special thanks for Ellie for being so patient and helpful.

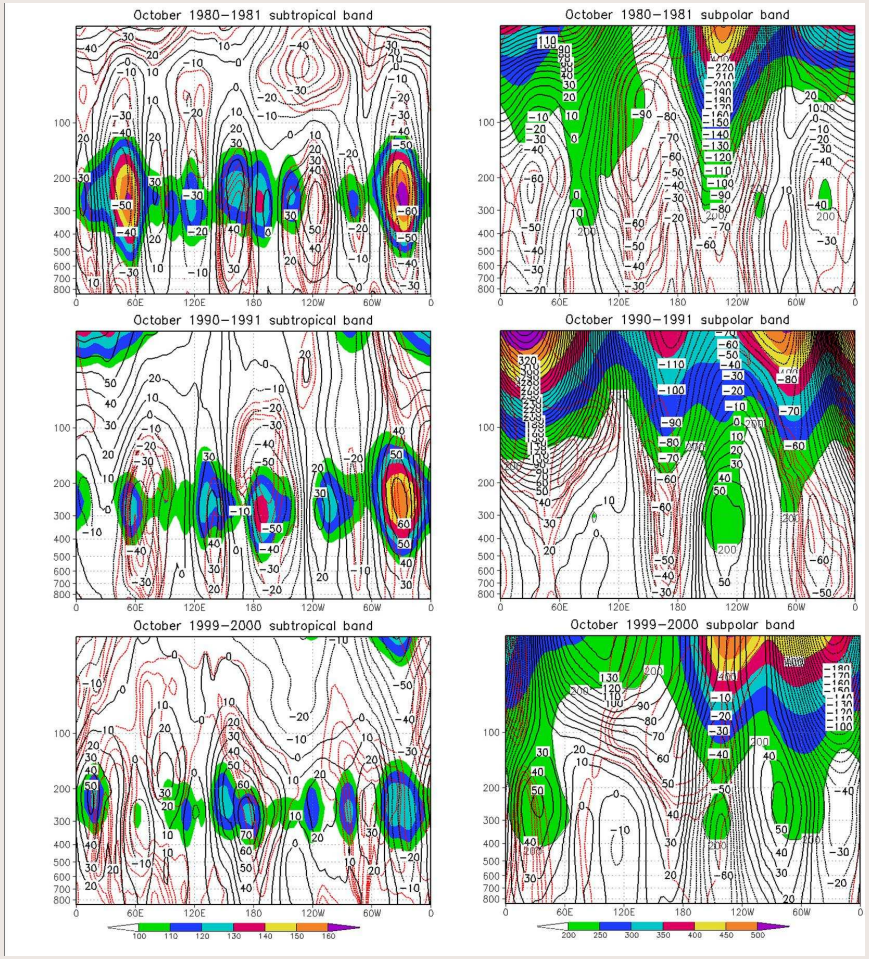
The latitudinal evolution of the ozone change as a function of latitude between 1980 and 2000 in the interannual Total ozone percentage change



Transient wave activity and geopotential anomalies during June and October can shed some light on this:

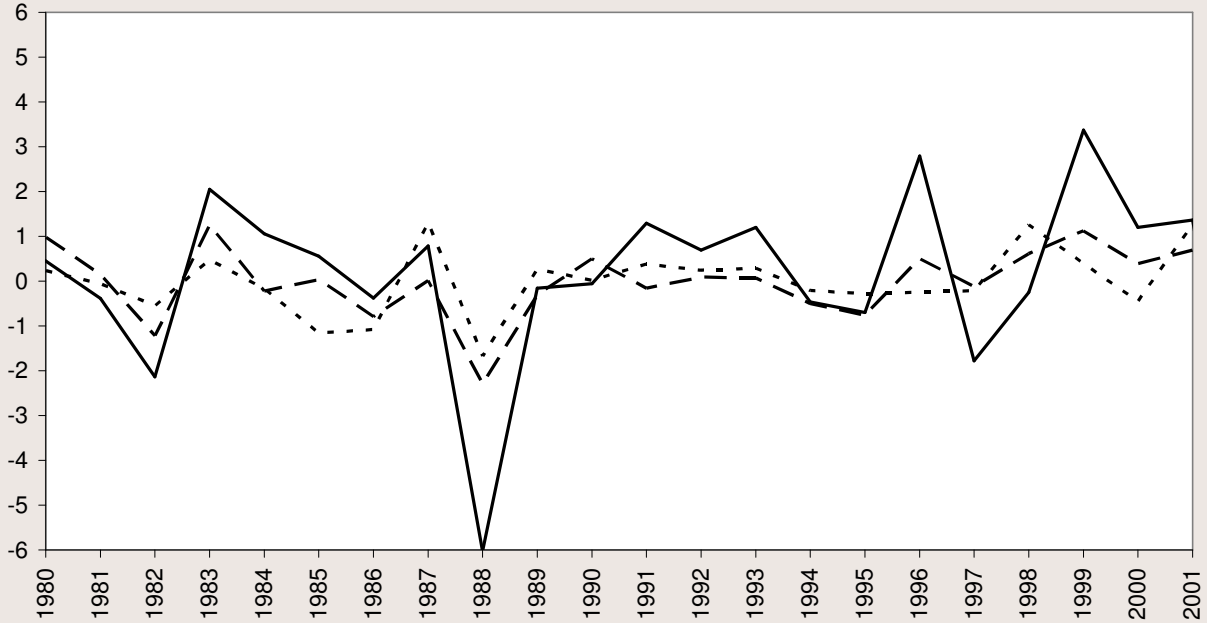


June


October 1980–1981 subtropical band
October 1980–1981 subpolar band
October 1990–1991 subtropical band
October 1990–1991 subpolar band
October 1999–2000 subtropical band
October 1999–2000 subpolar band

October

In case you do not believe us, this is the zonal mean time series of our longitudinal SAM indeces at 400 and 70 hPa (dashed and dotted lines respectively) compared with Marshall's SLP SAM index (solid line) for the period 1980-2001....



Not too bad considering the differences between reanalysis and observations over the SH as well as the height differences

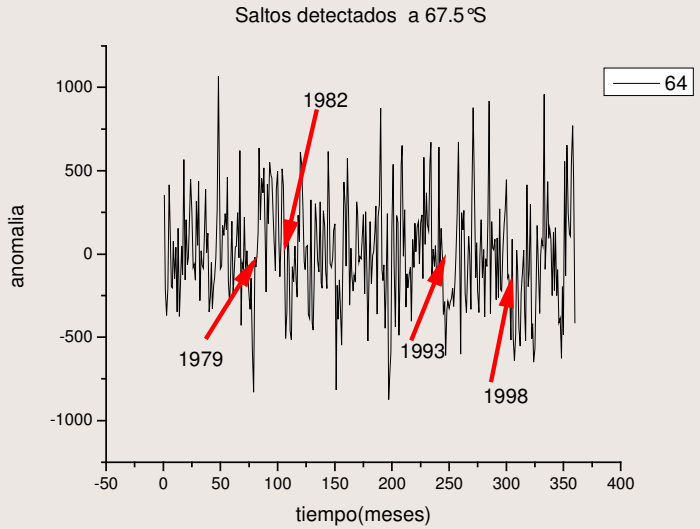
2. Abrupt disturbances in the Southern Troposphere-Stratosphere

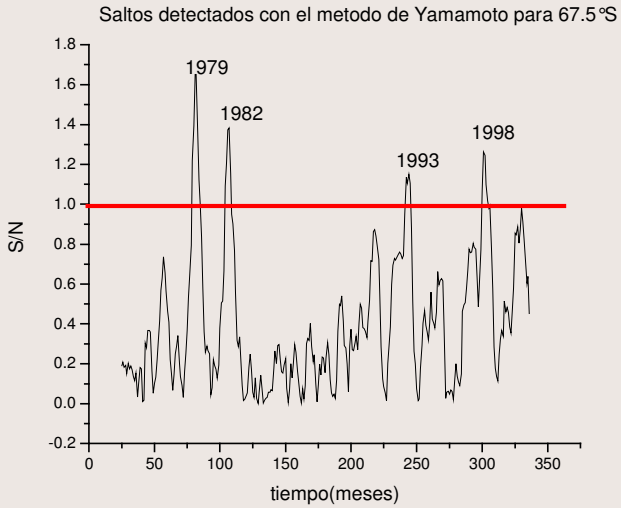
Abrupt changes can take place in the atmosphere. The 1976/1977 climatic jump is an example. There are abrupt process which may not necessarily be as long lasting as that process but could result from pulsed or high frequency perturbation sources that affect the atmosphere and thus the troposphere-stratosphere interactions

One way to detect such abrupt processes as climatic jumps or shorter lived climatic disturbances has been Yamamoto´s method (Yamamoto et al. 1986) used by many authors to study the 19876/1977 jump.

We have adapted Yamamoto´s method so that it can be used to detect disturbances in monthly mean anomalies.

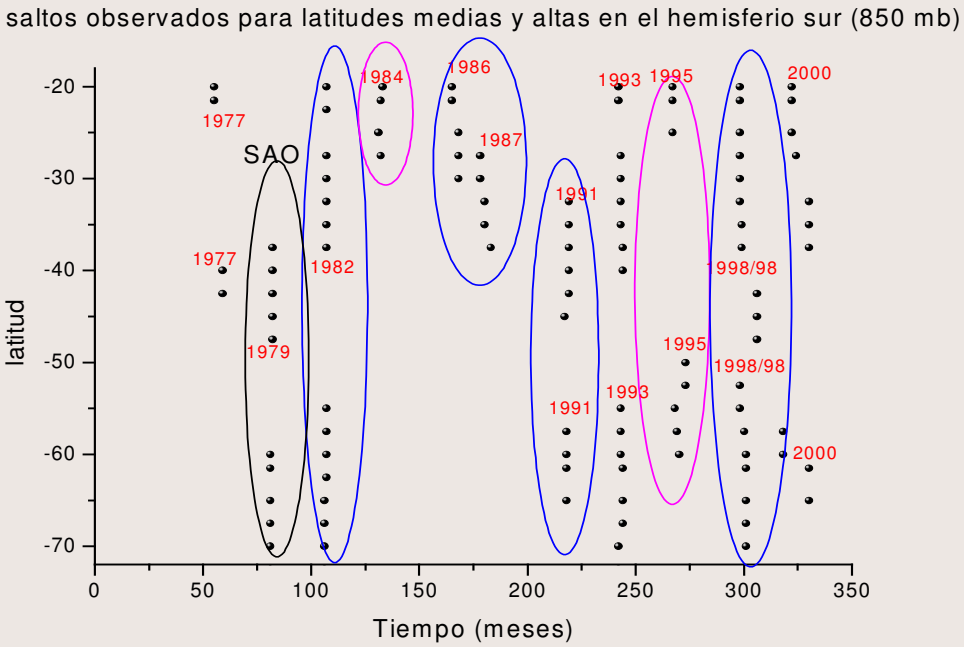
Some examples follow using ERA-40 reanalysis geopotential fo the period 1973-2002.





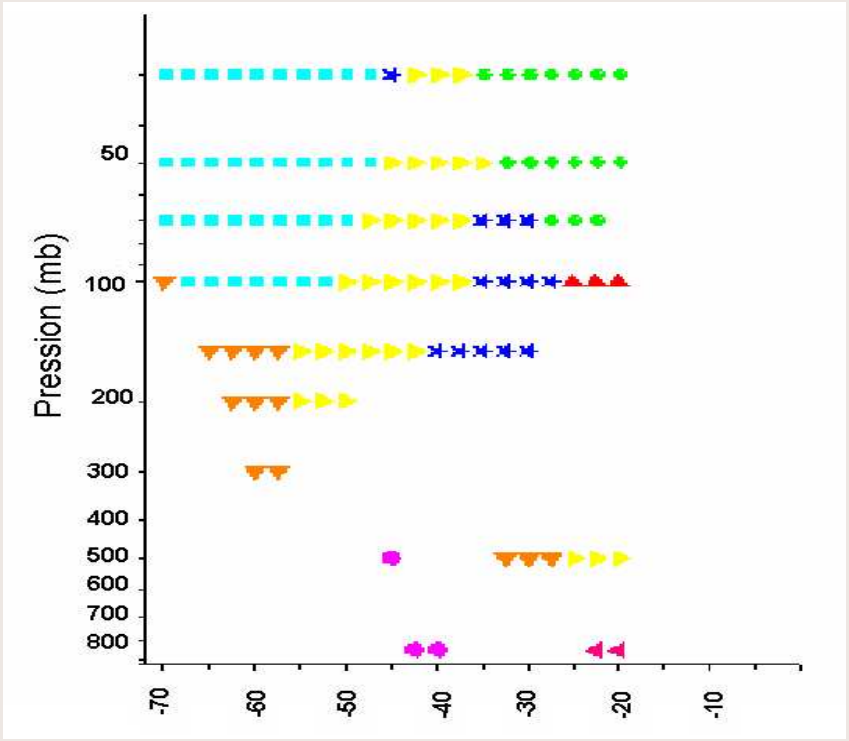
Disturbances are detected when the S/N ratio is greater than 1.

Disturbances detected at 850 hPa in the range 20°-75°S

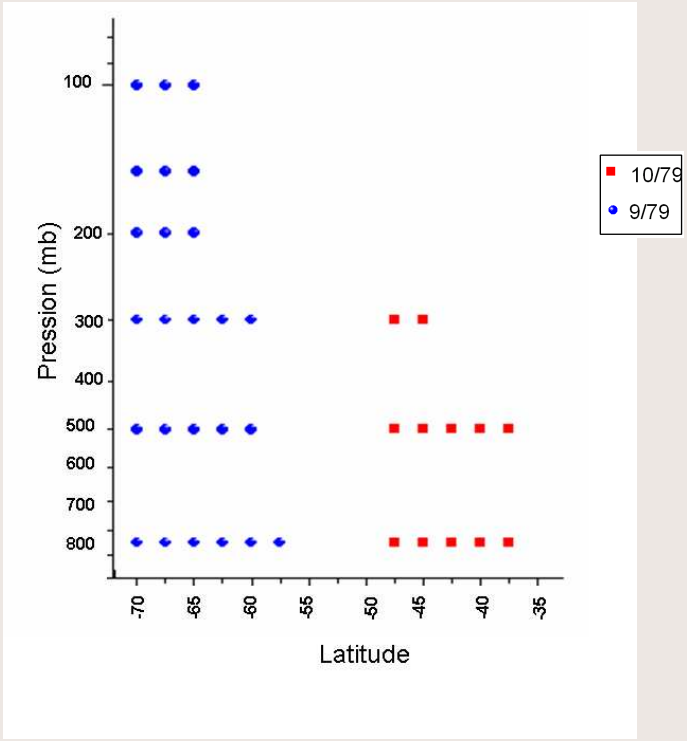


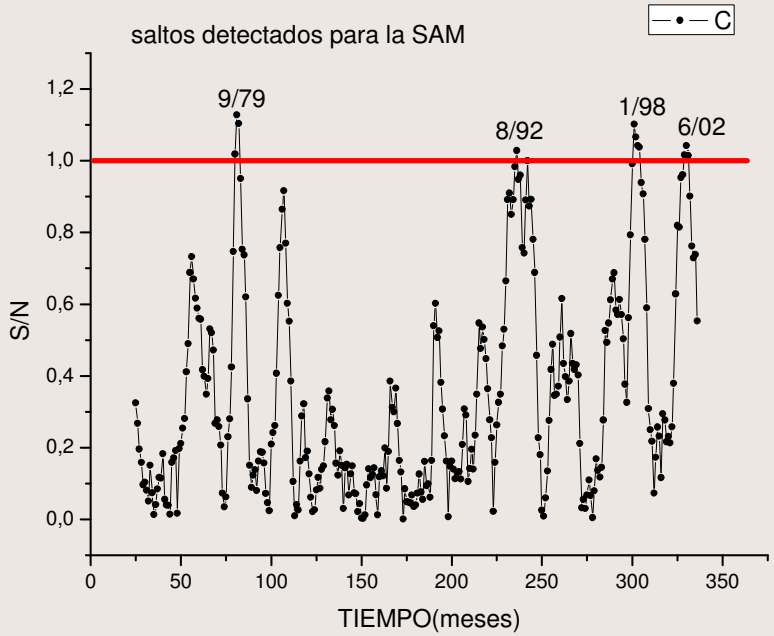
This and the following example correspond to preliminary studies using zonal mean as monthly anomalies.

The 1976/1977 Climate Jump

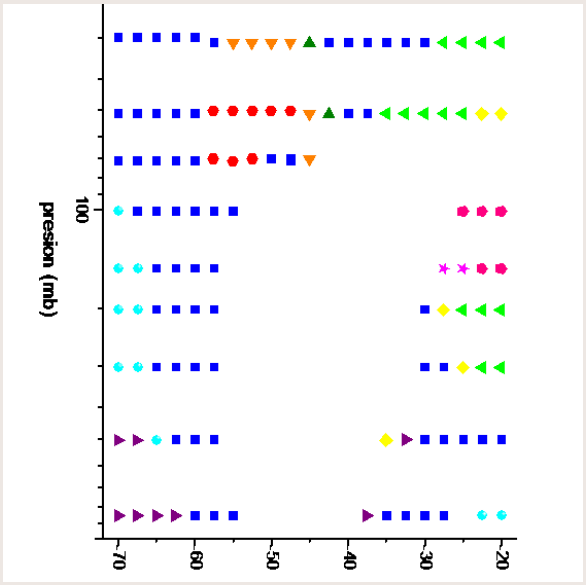


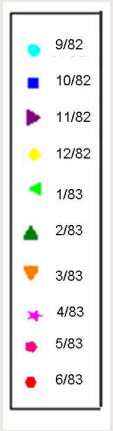
The Semi Annual Oscillation Change in 1979

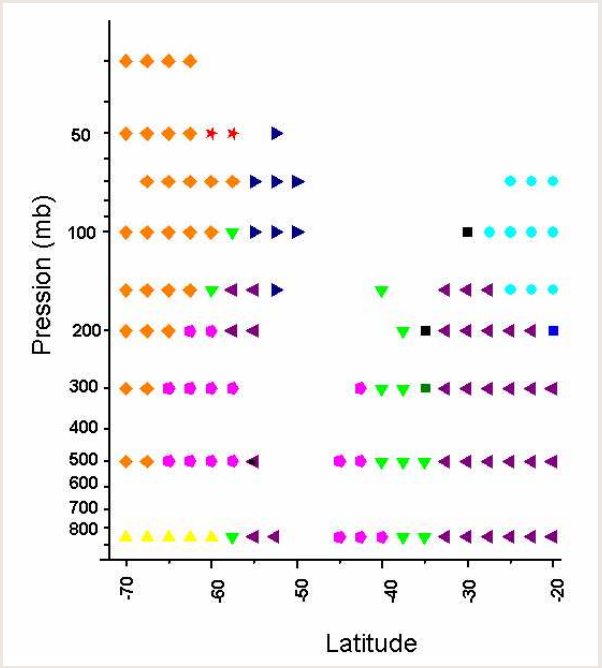


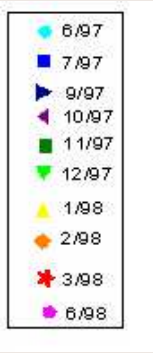


Examples of ENSO events: the strong 1982/1983 and 1997/1998 El Niño events.









The modified Yamamoto´s test was cxapable of detecting climatic disturbances that could be associated with:

1) The 1976/1977 climatic shift
2) The SAO change in 1979
3) All Niño events in the peiod sampled. Only one La Niña event was strong enough to be detected with this method.
4) Disturbances probably associated with he Benguela El Niño , which are linmmited to the troposphere near the tropic of Capricorn were also detected.