The oceanic Thermohaline Circulations and the Climate

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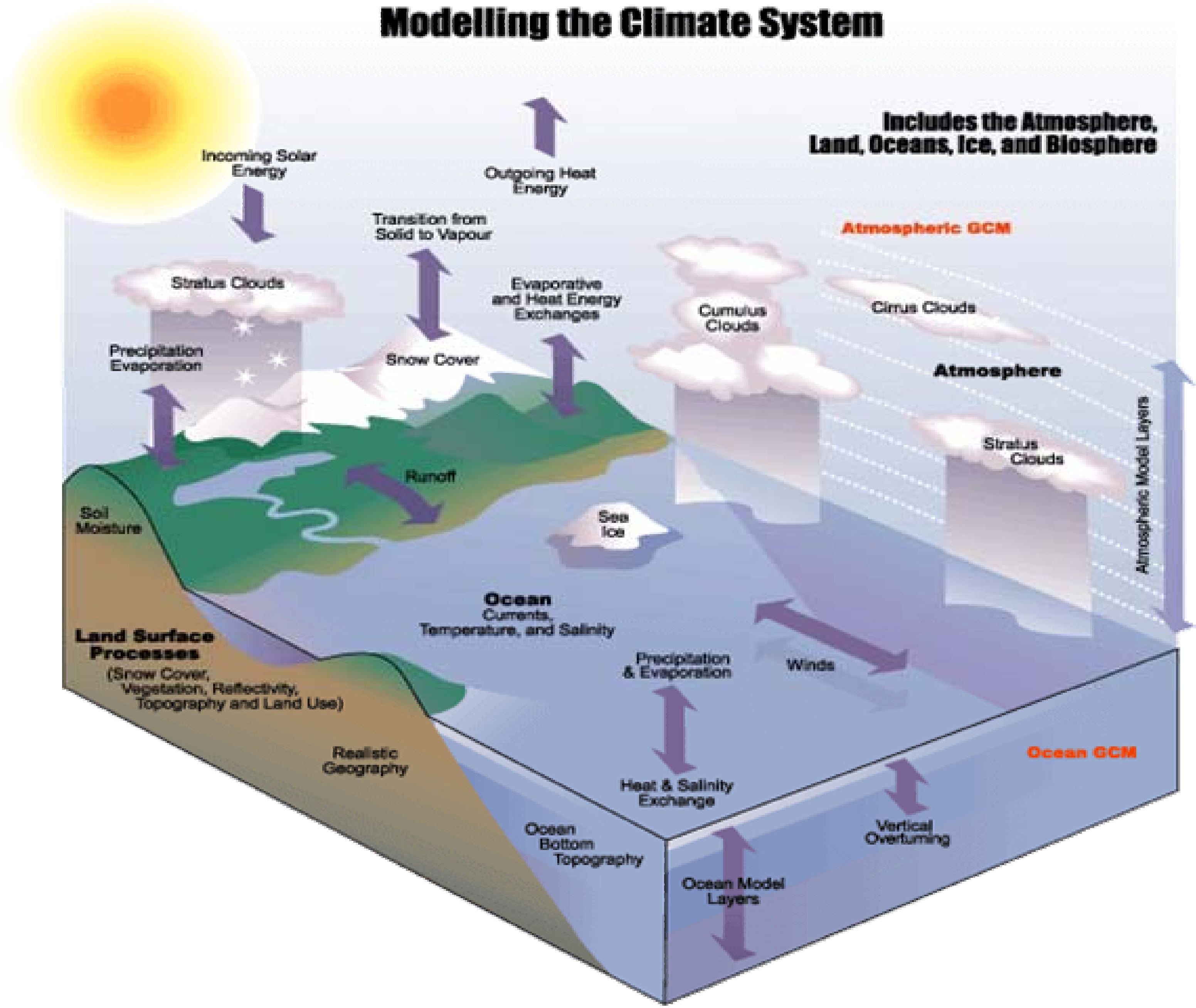
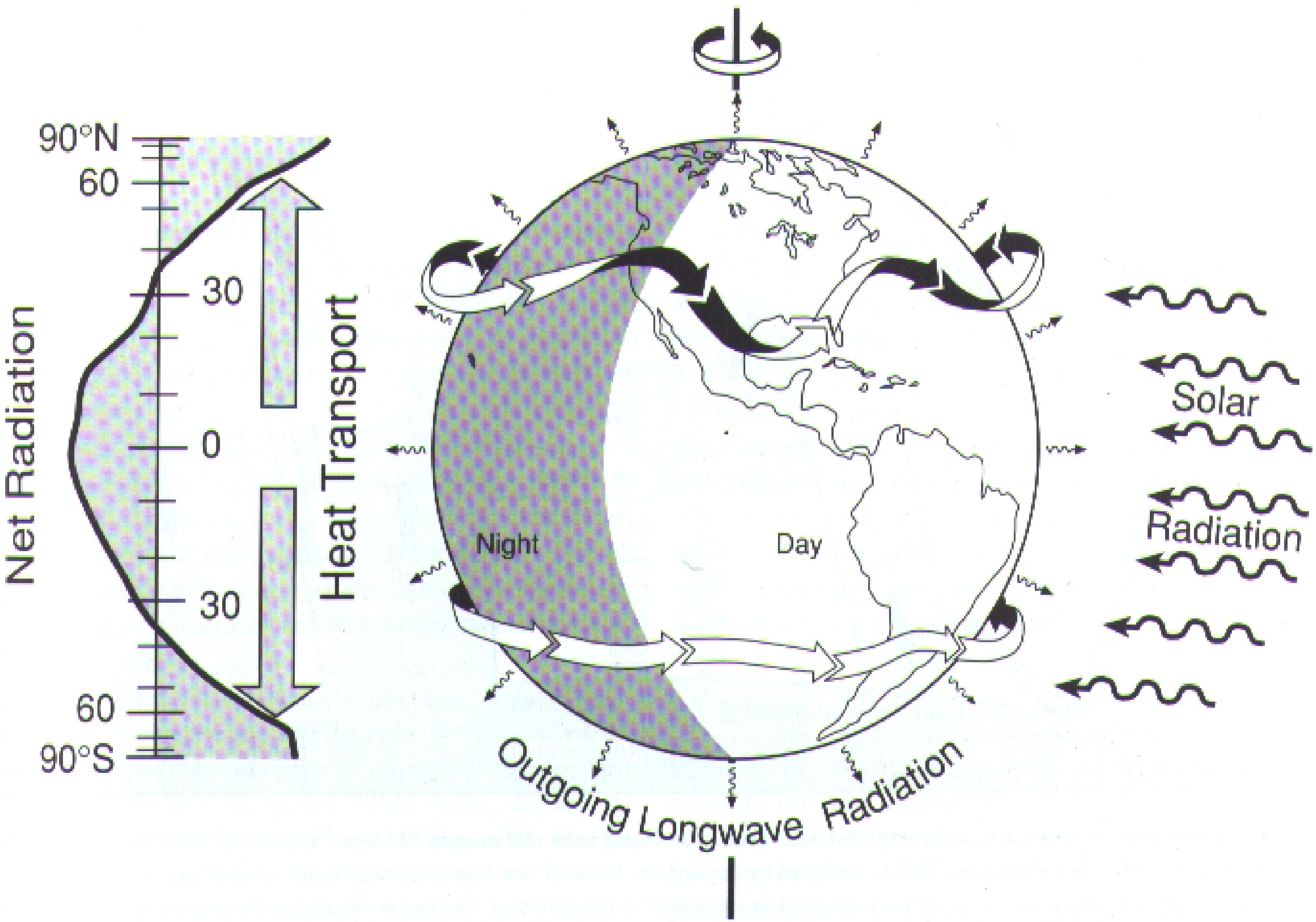
Modelling the Climate System

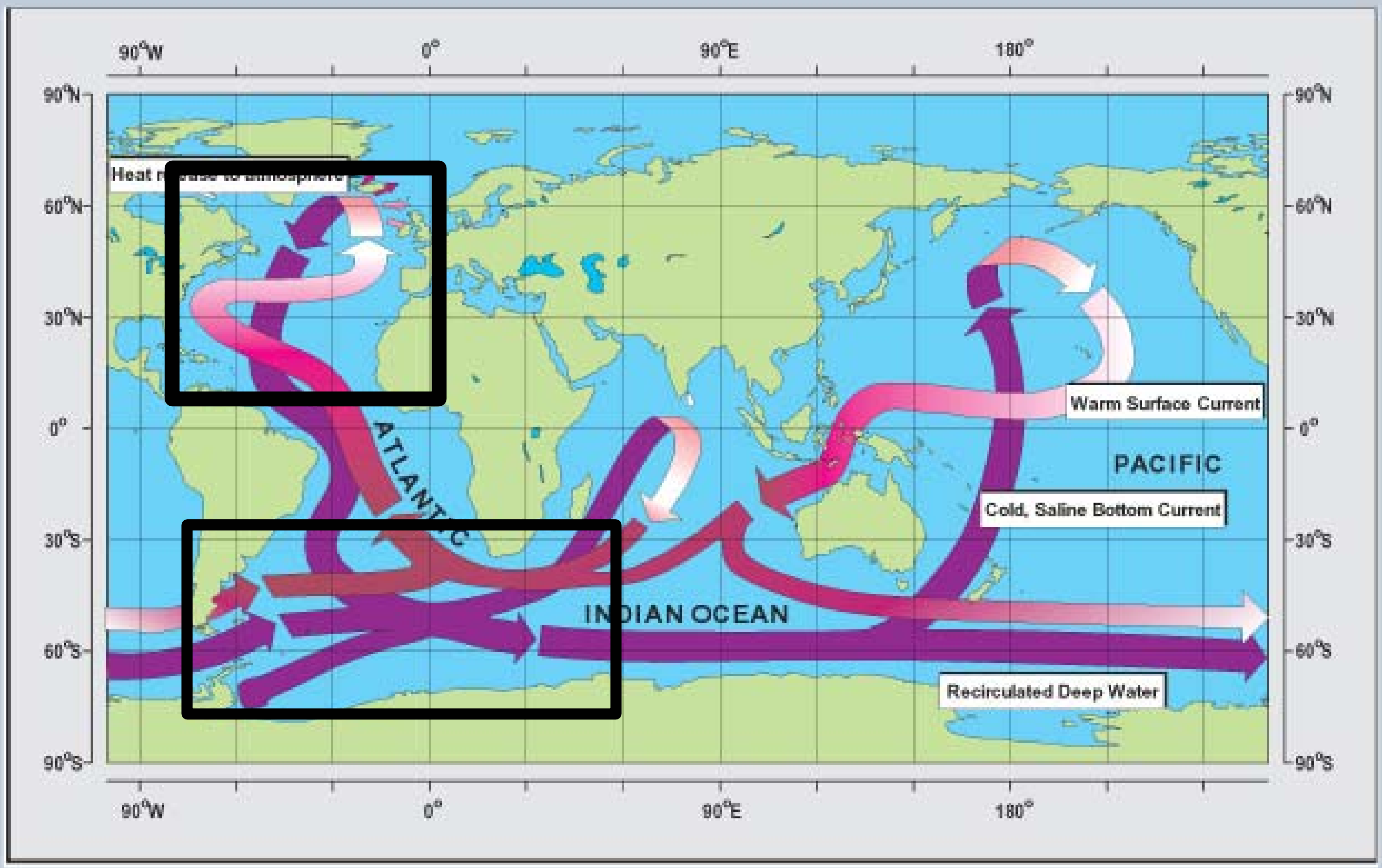




90°N
60
30
0
30
60
90°S
Net Radiation
Heat Transport
Night
Day
Solar
Radiation
Outgoing Longwave Radiation

The Atlantic Thermohaline Circulation

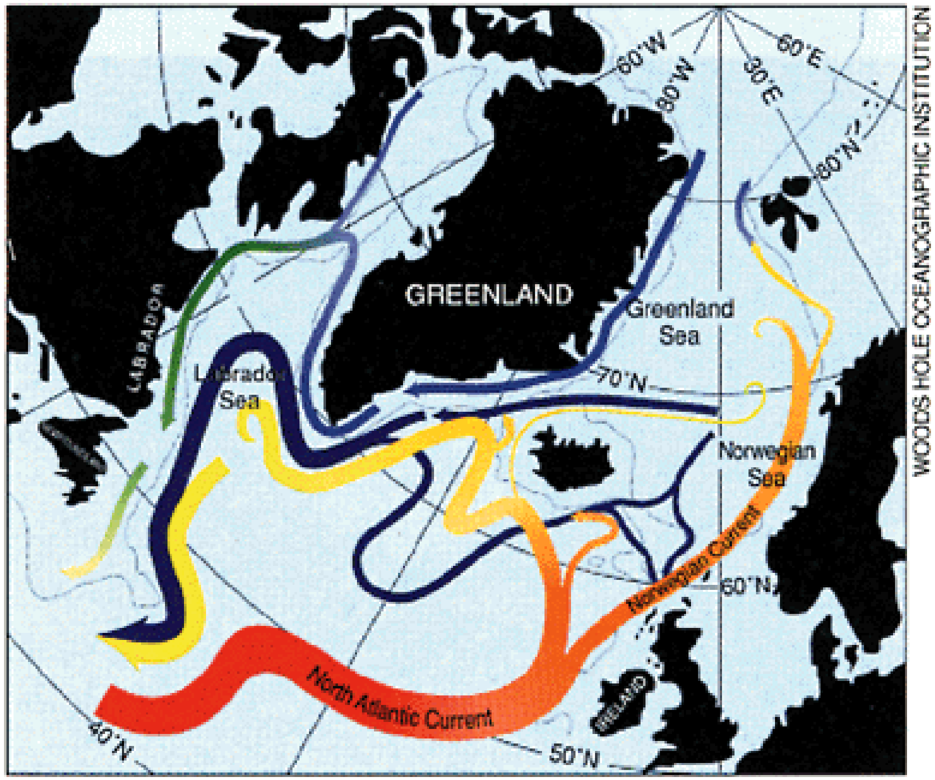
- A key Element of the Global Oceanic Circulation -



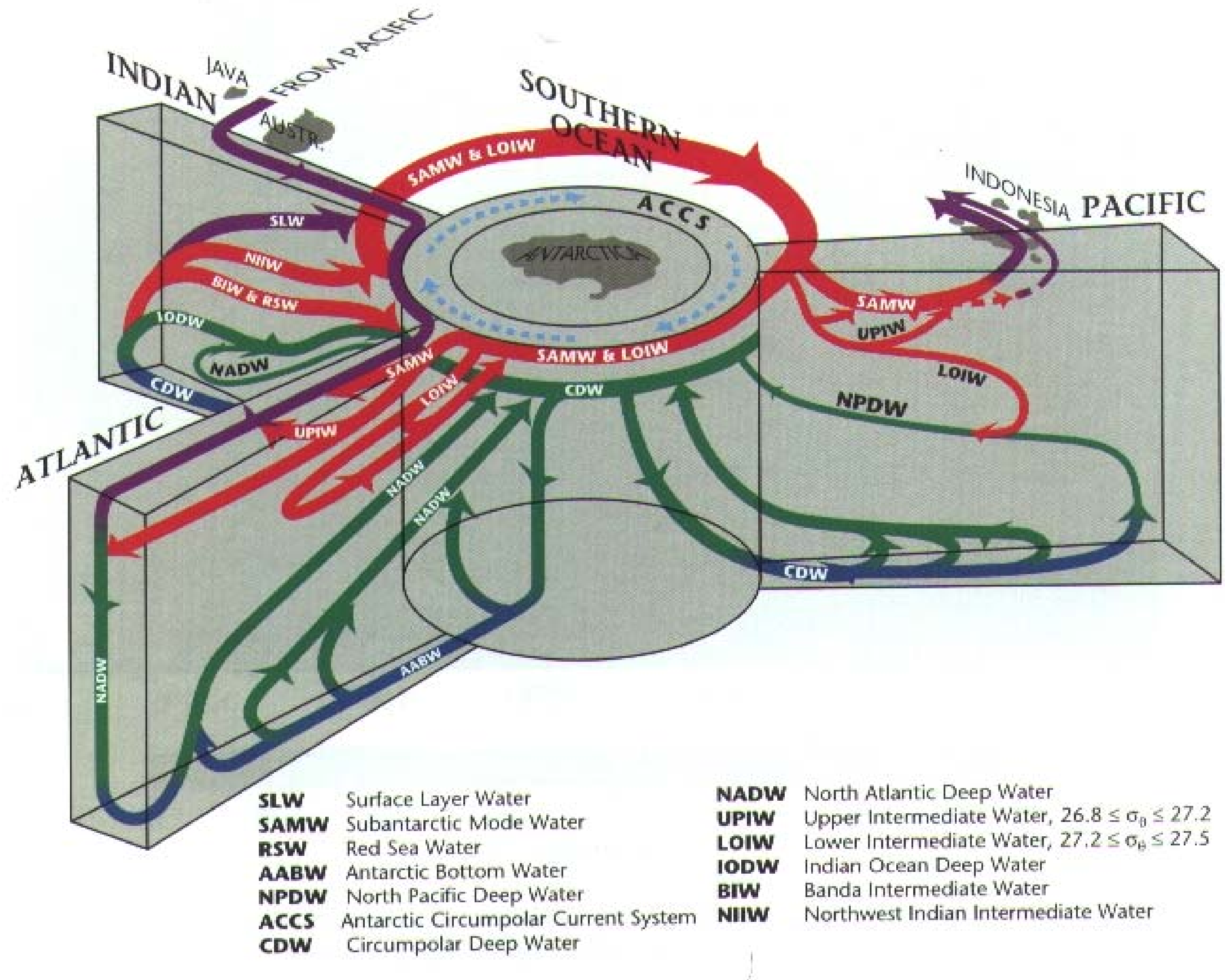
Schematic diagram of the global ocean circulation pathways, the 'conveyer' belt (after W. Broecker, modified by E. Maier-Reimer).

AV/D3/99-2

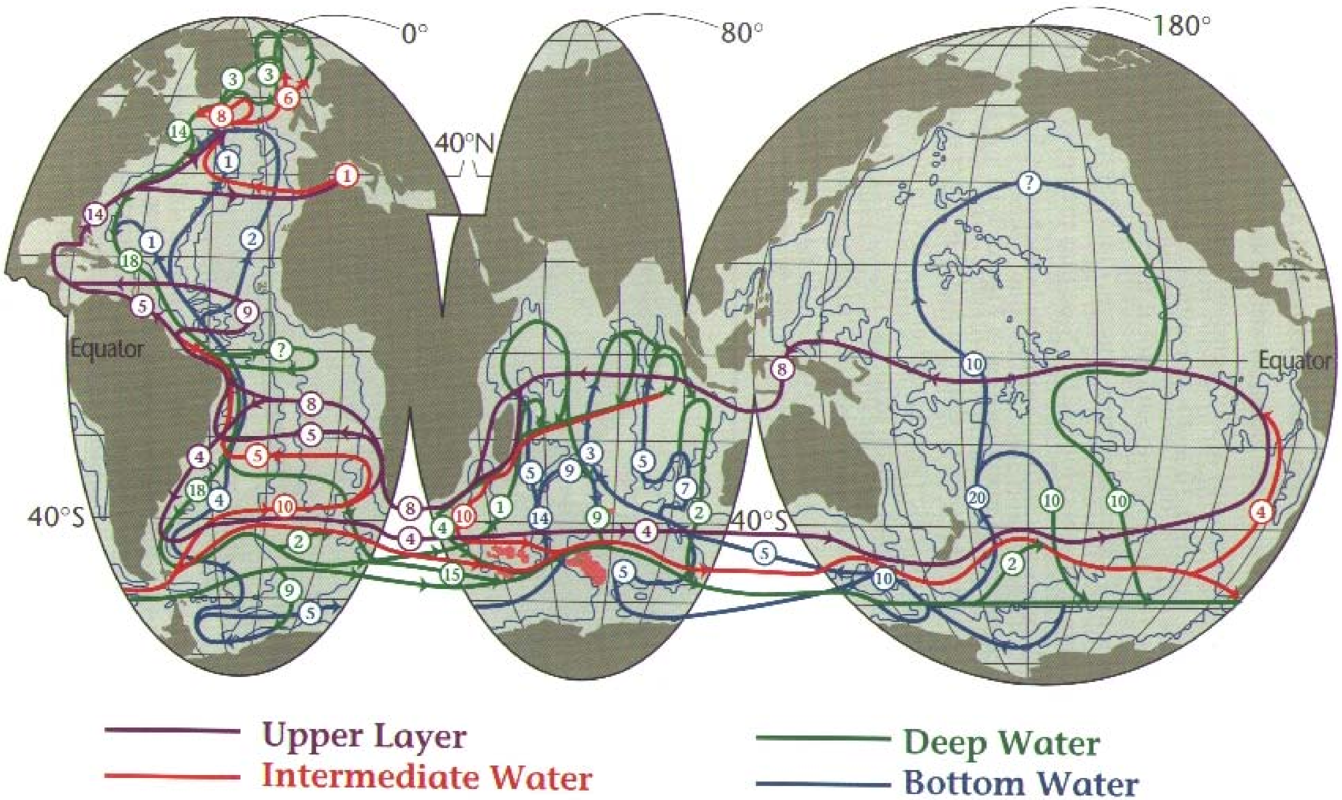
No Atlântico Norte, após ceder calor para a atmosfera, as águas de maior salinidade vindas de sul afundam, dando origem ao ramo profundo da circulação termohalina.



Water masses and the global THC

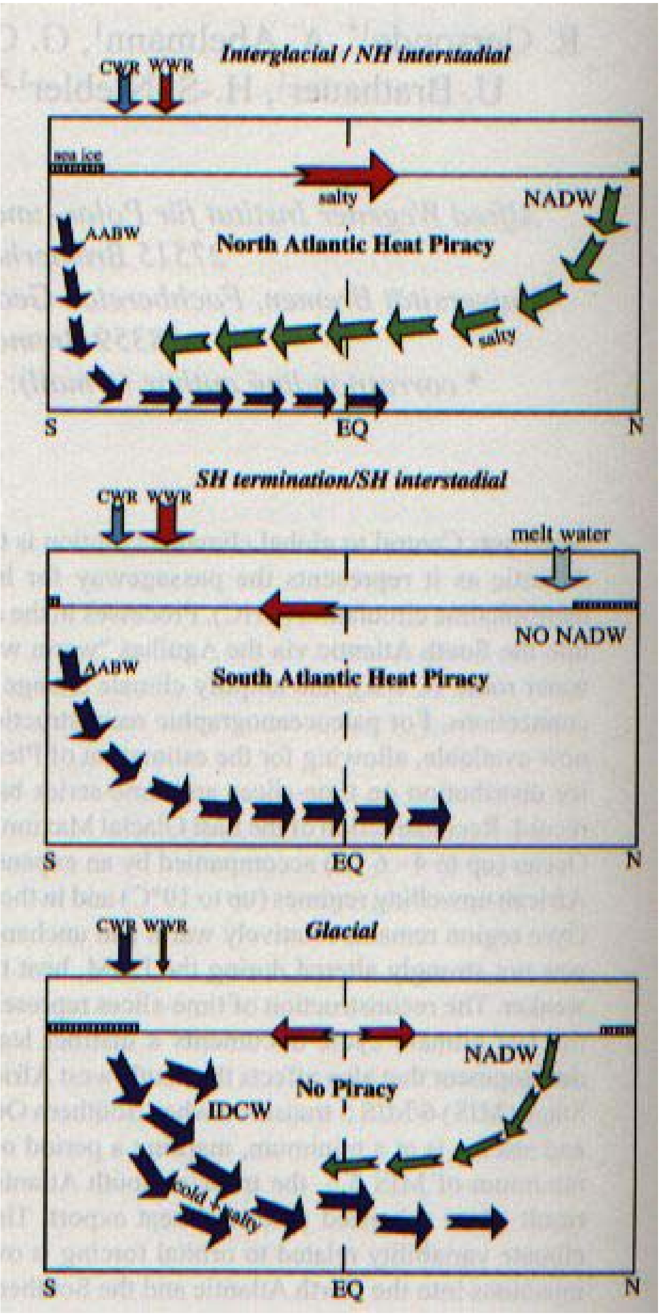


Circulação Termohalina em 4 camadas

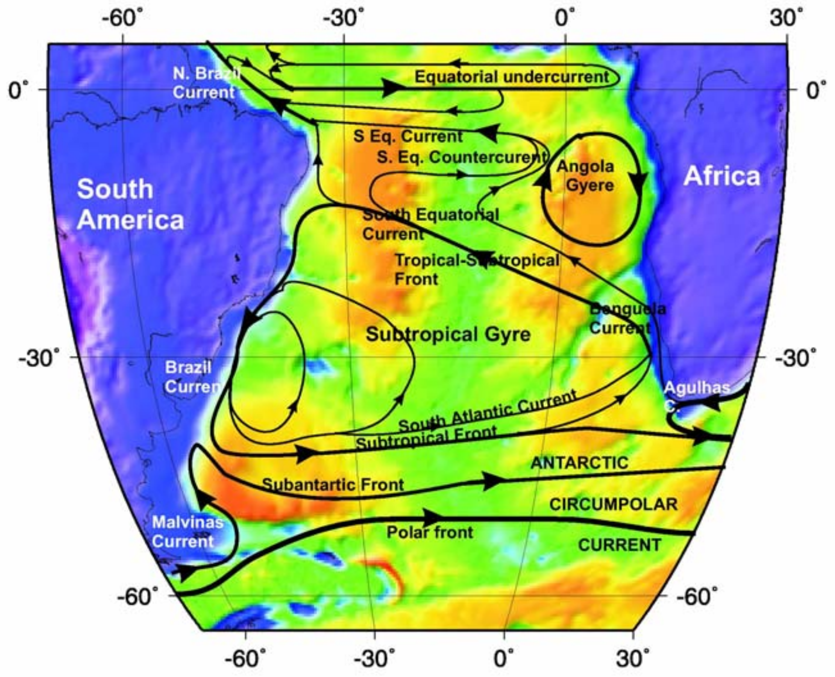


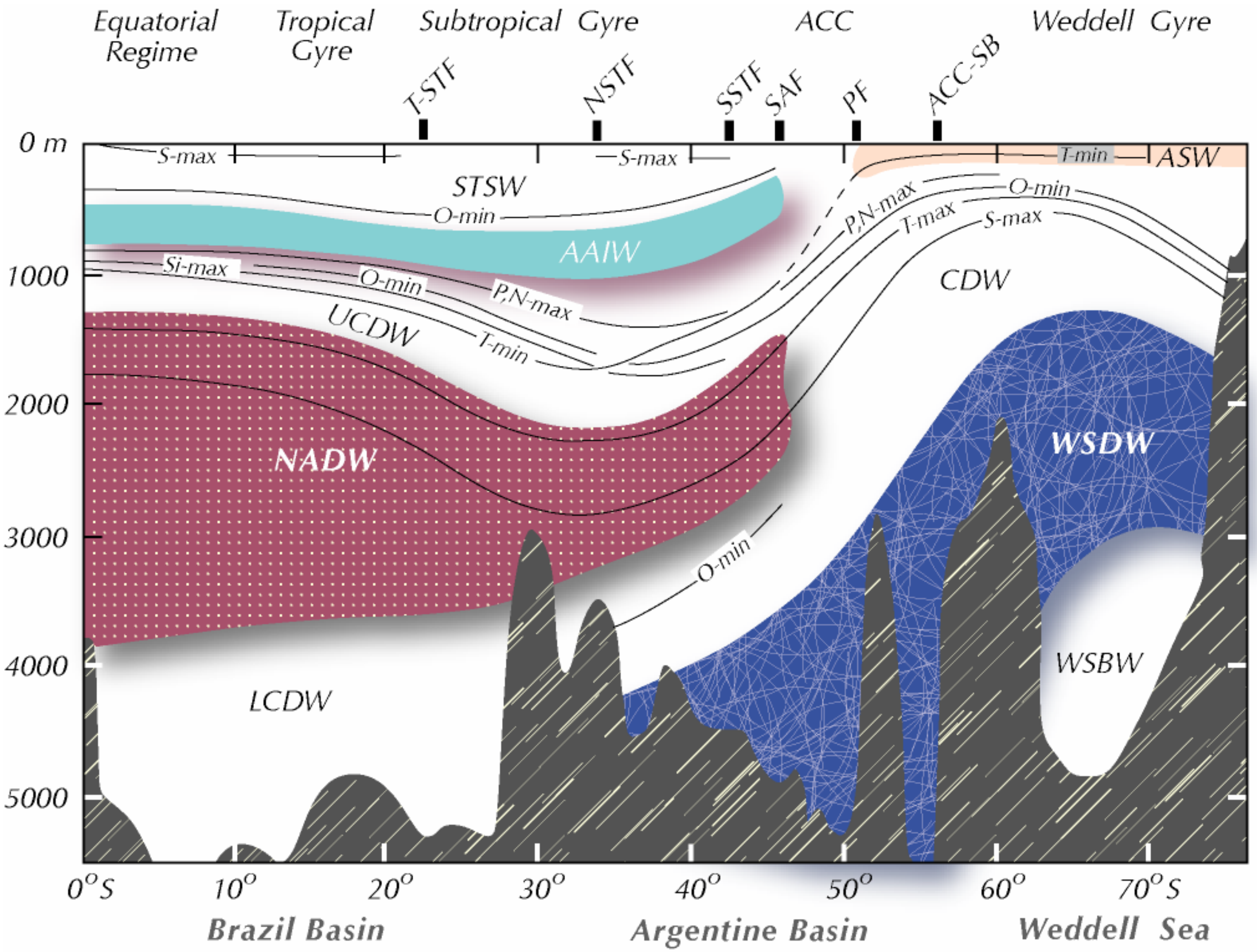
Representação esquemática da Circulação Termohalina Global em quatro camadas. Púrpura: Camada superior; Vermelho: Água Intermediária; Verde: Água Profunda; Azul: Água de de Fundo. O números em círculos indicam o Transporte (em Sverdrups).

The THC and heat piracy in the Atlantic Basin in different climatic conditions



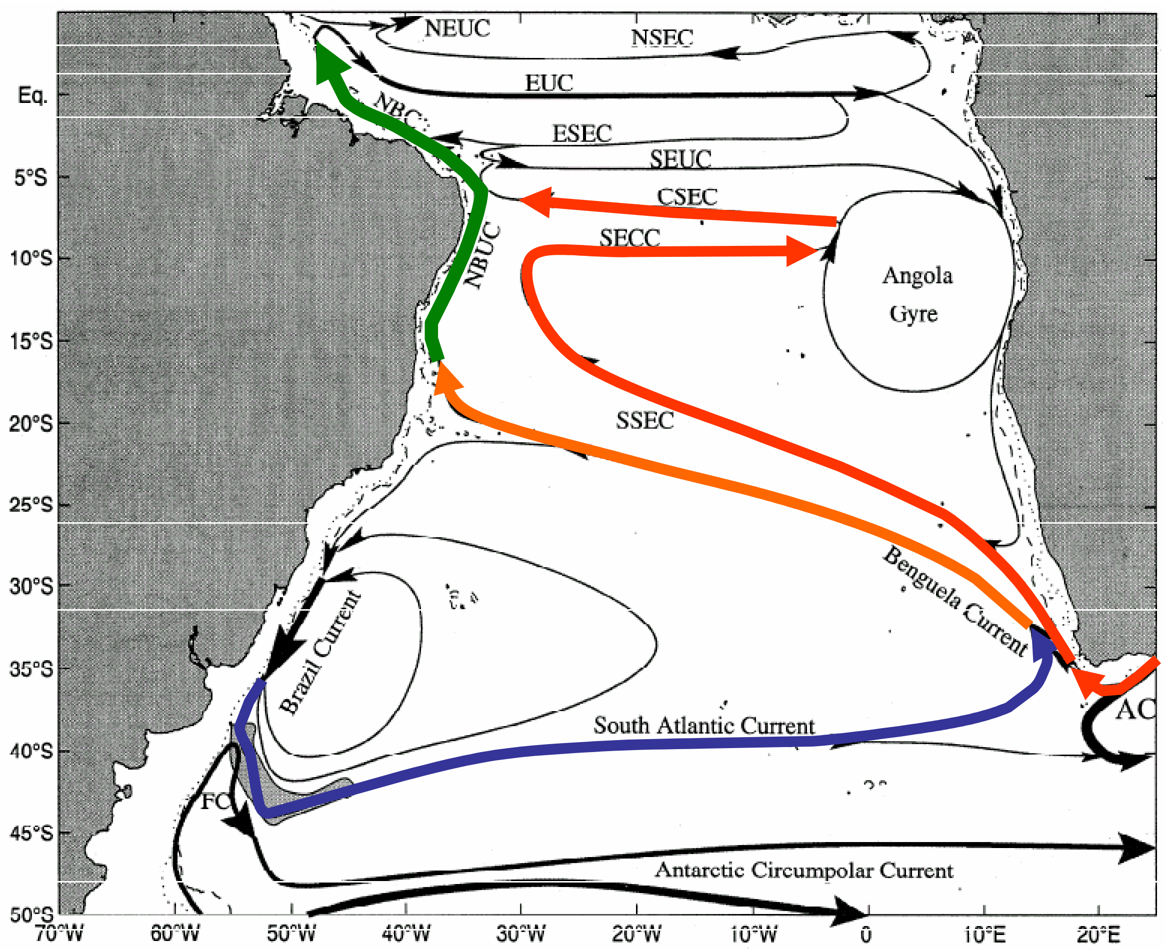
Does the South Atlantic matter to the Global Climate System ???





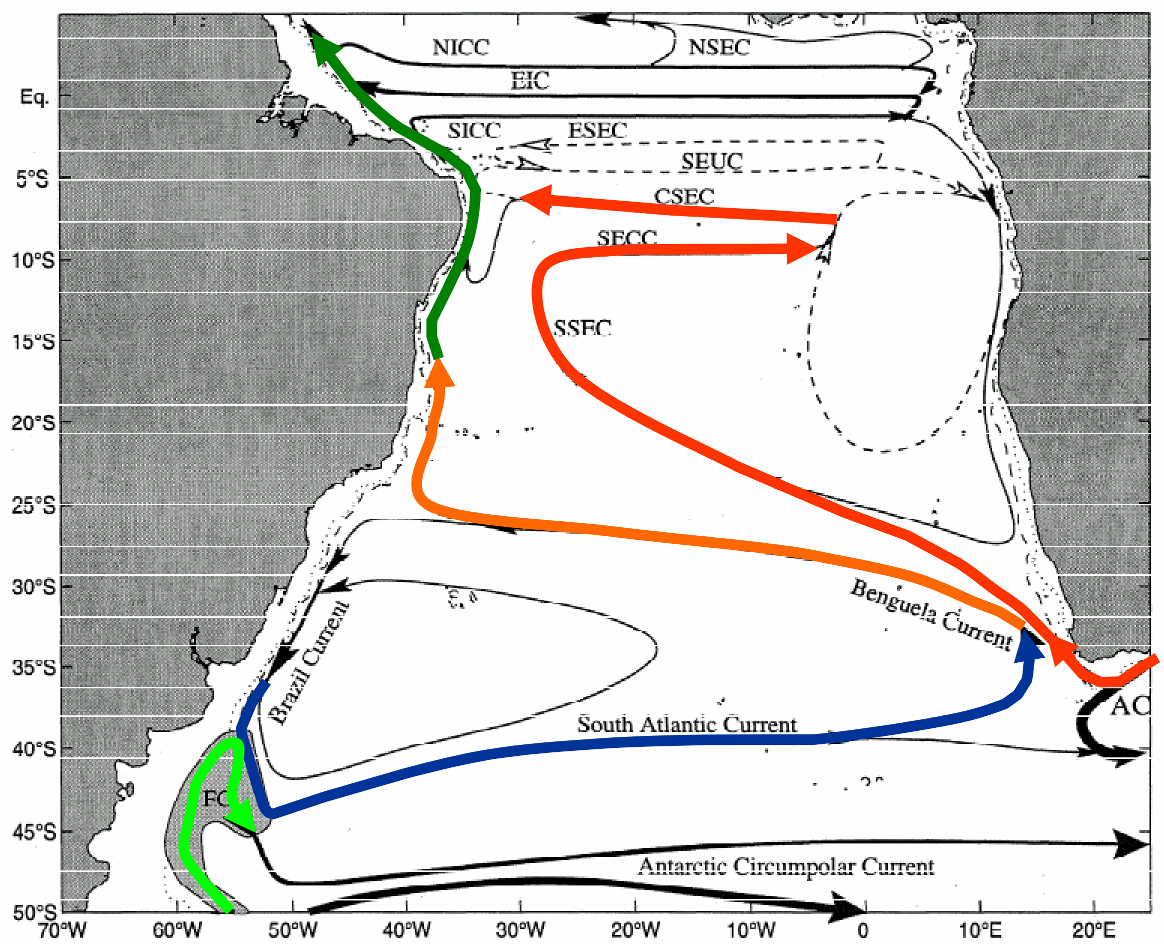
After Ray Peterson

South Atlantic Central Water (SACW)



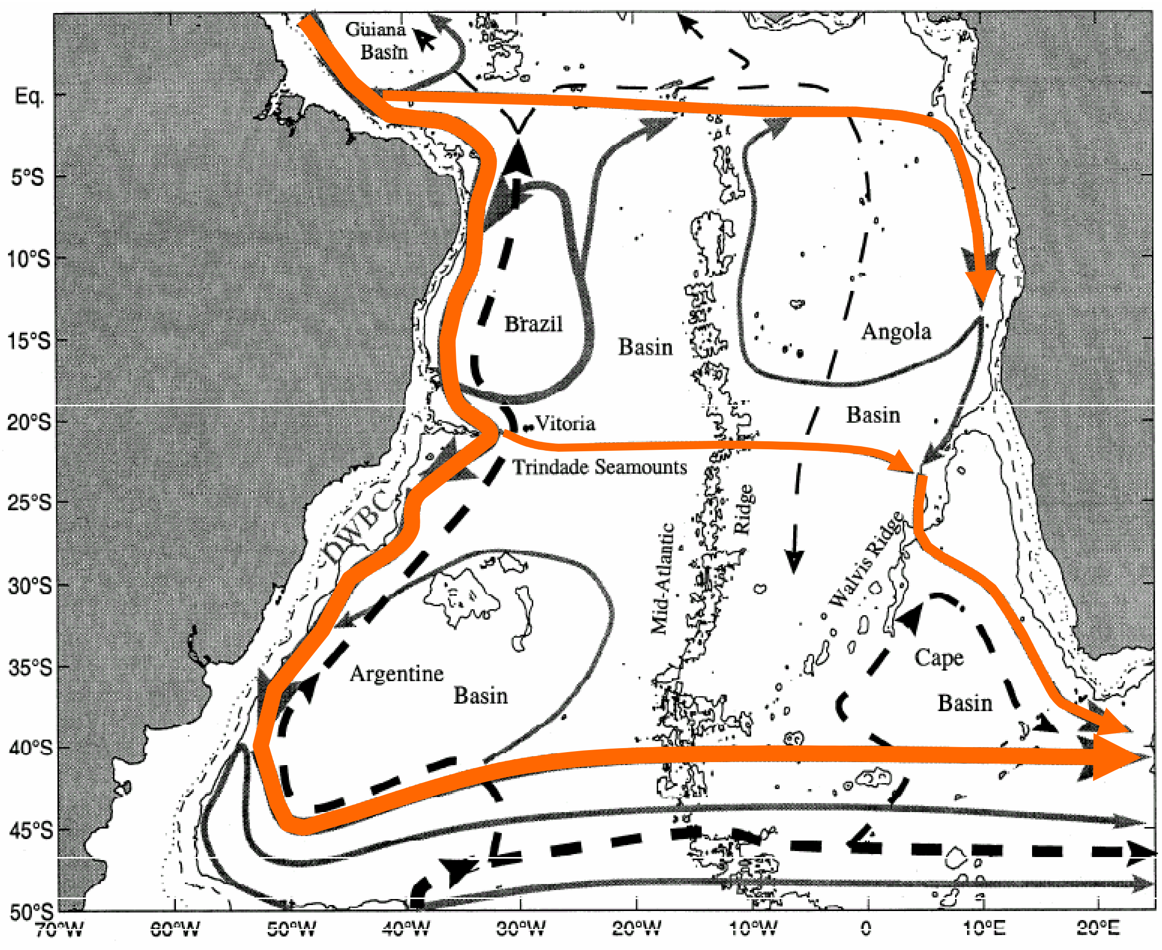
Stramma & England 1999

Antarctic Intermediate Water (AAIW)



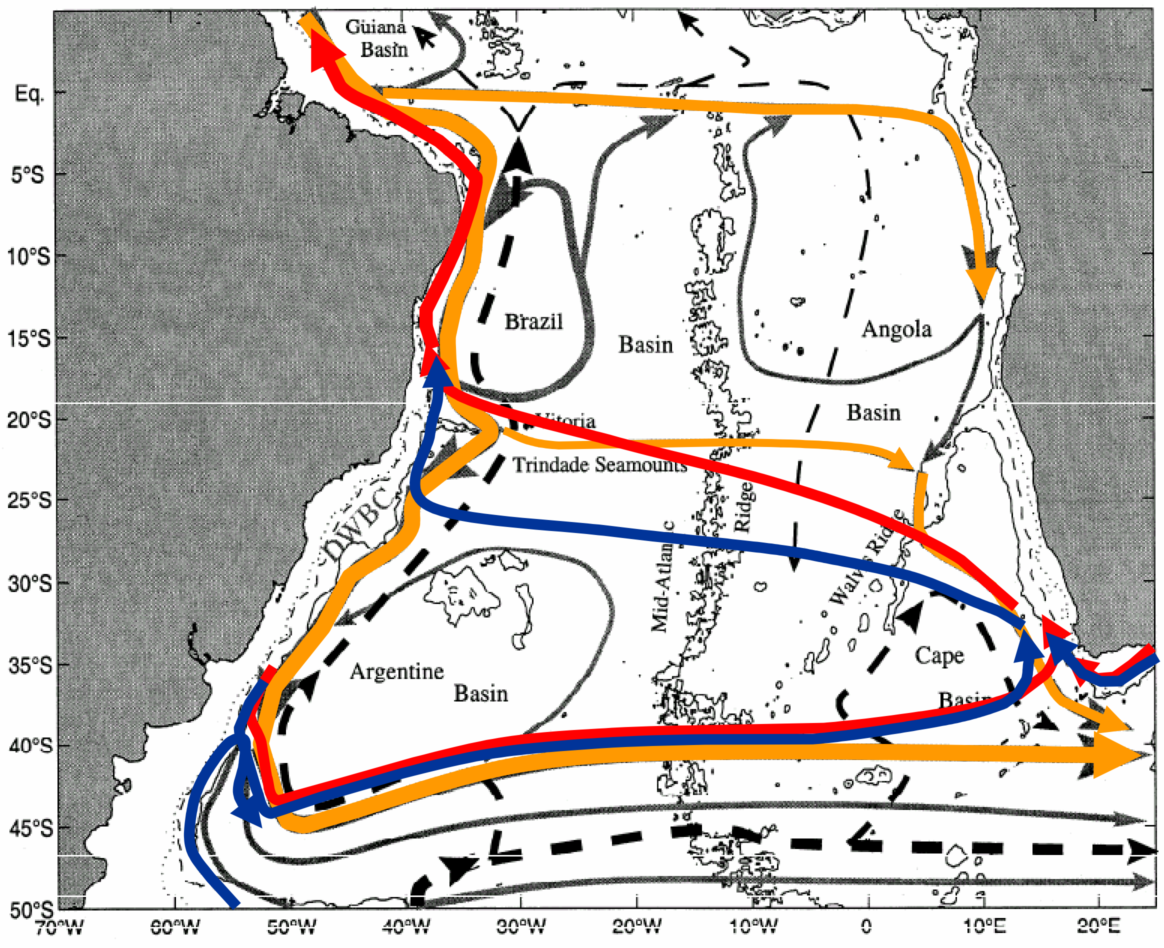
Stramma & England 1999

South Atlantic deep water circulation



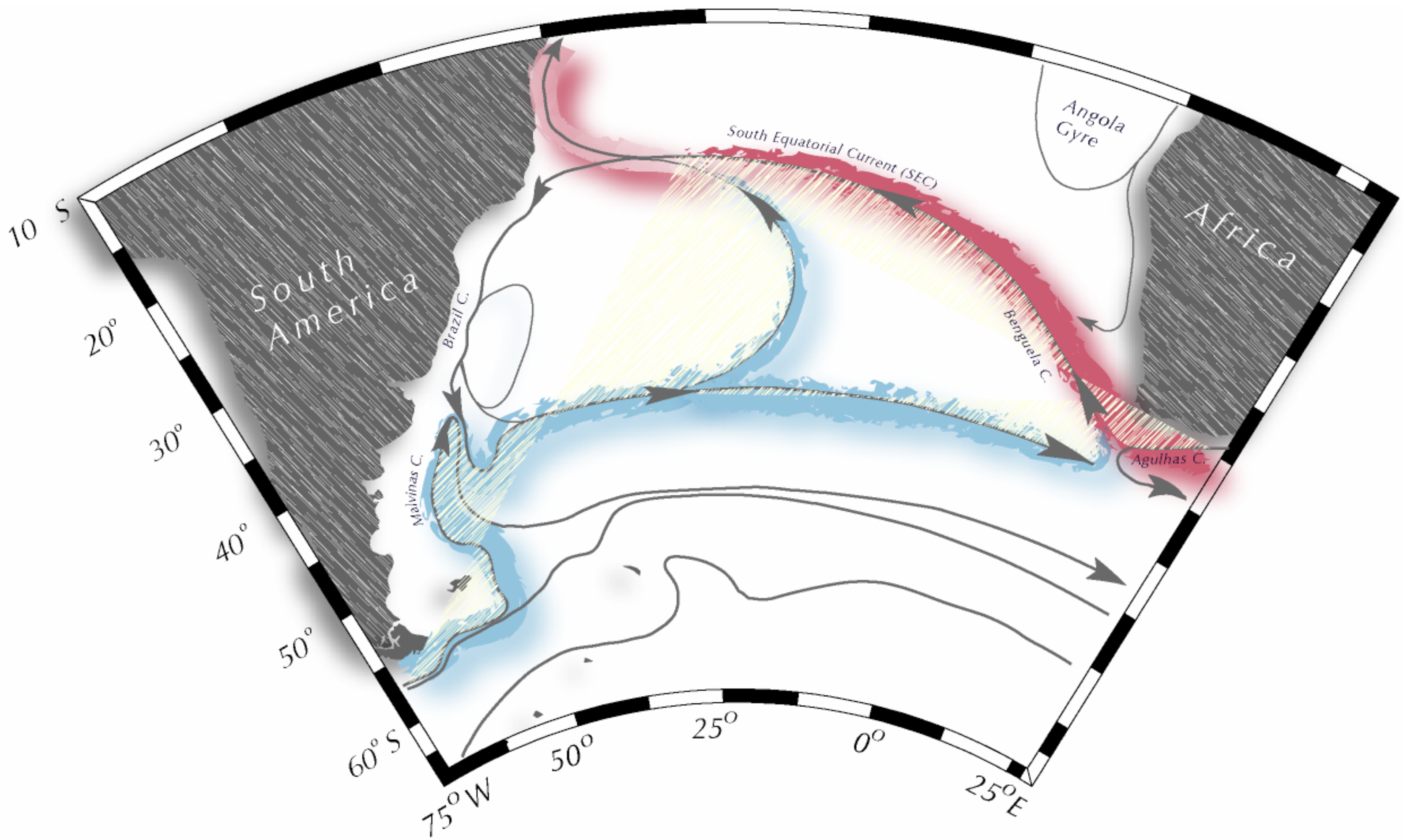
Stramma & England 1999

The compensating meridional flows



Stramma & England 1999

The bifurcation region: Where all comes together



A Confluência Brasil-Malvinas

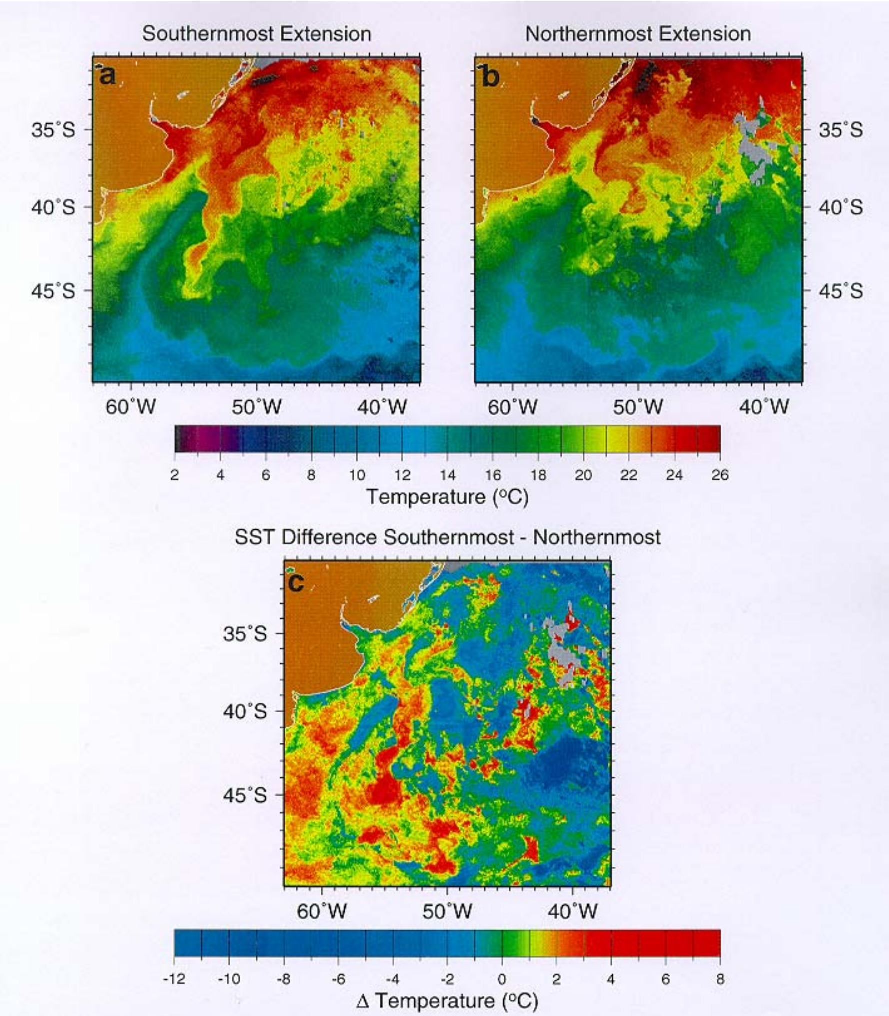
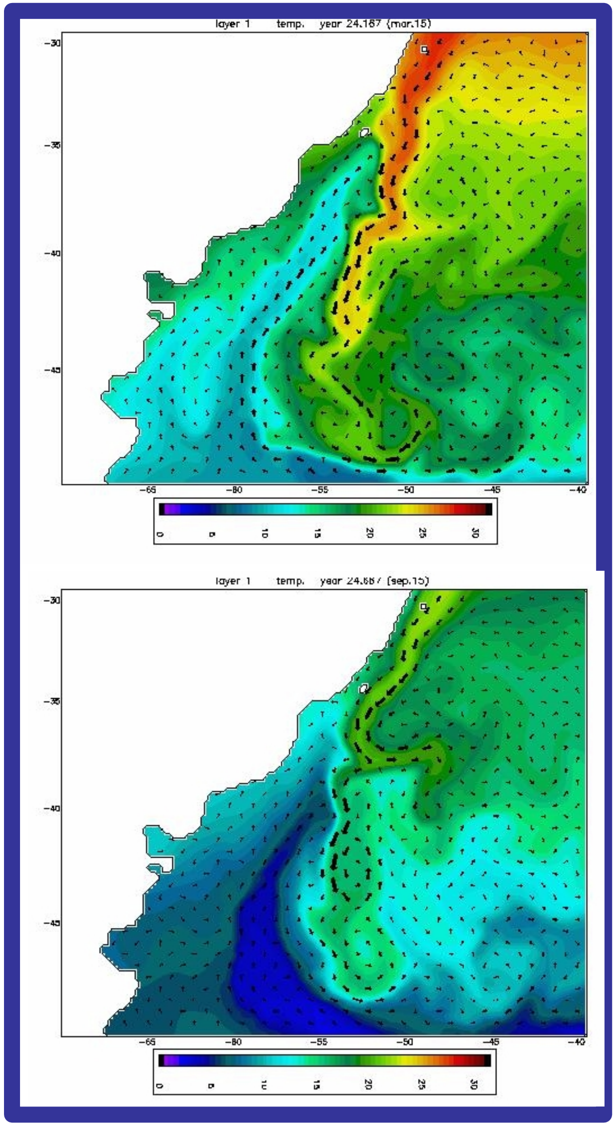


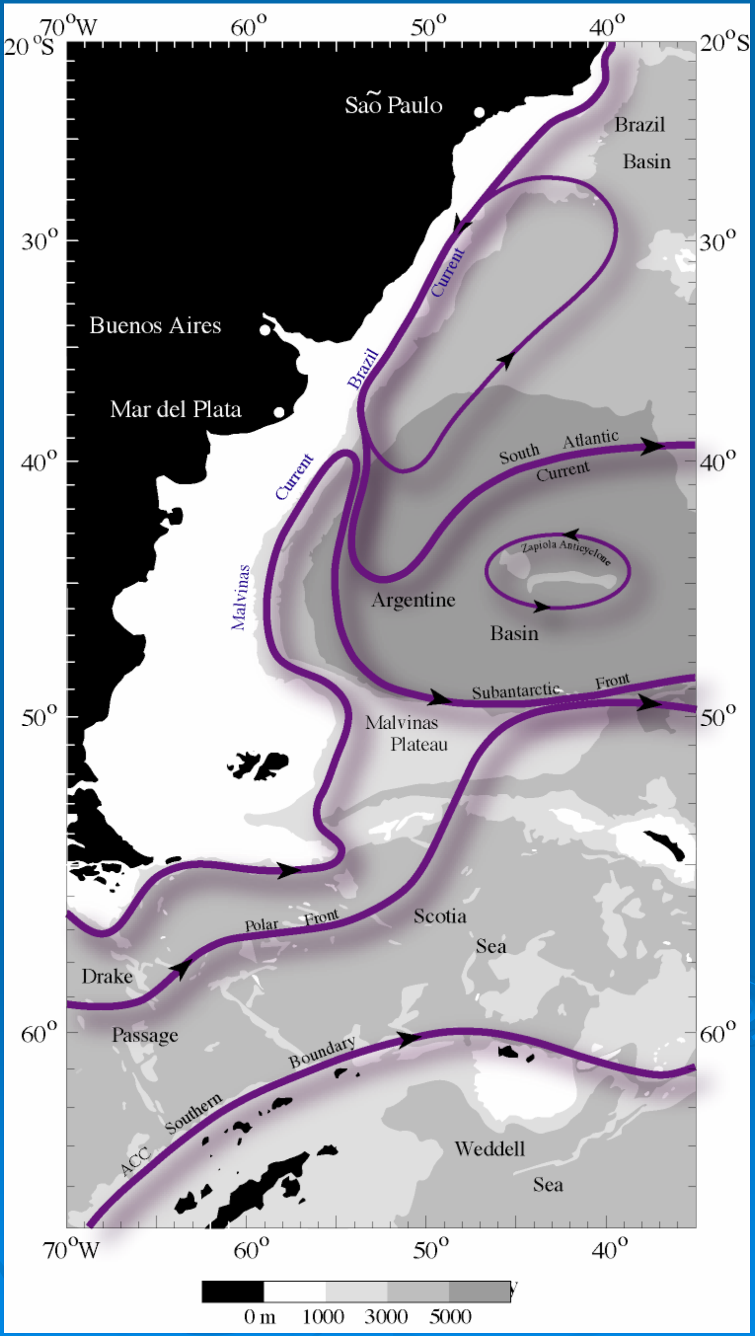
Figure 2. SST distribution in the WSA during February (a) 1998 and (b) 1999. (c) Interannual differences.



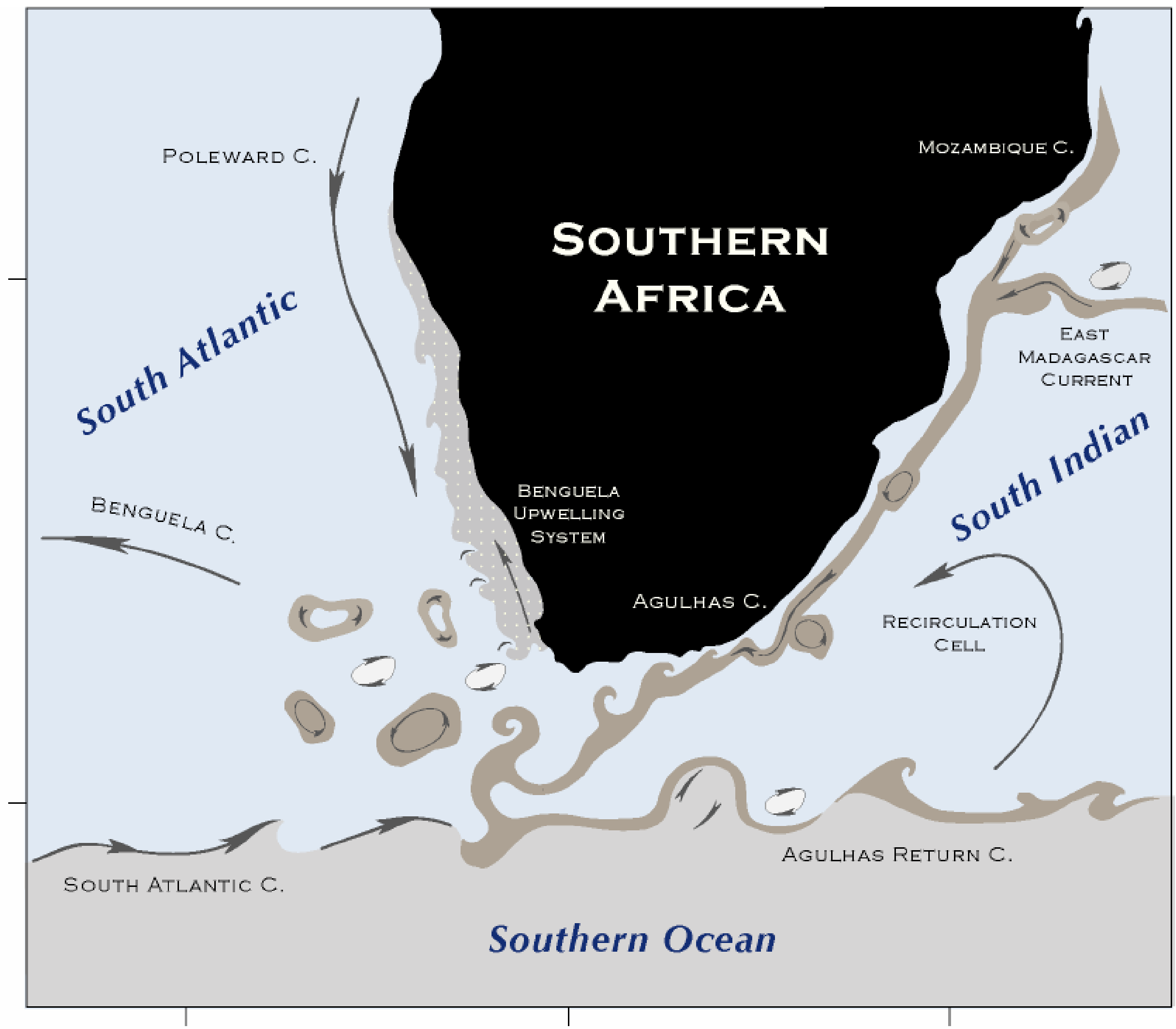
The Southwestern Atlantic

Question

Is there any linkage between the variabilities of the ACC and the Malvinas Current?



The Agulhas Current



After J. Lutjeharms

Coupled modes of variability in the South Atlantic. A comparison of model results with observations

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[2] Royal Netherlands Meteorological Institute (KNMI)
[3] Los Alamos National Laboratory, U.S.A.

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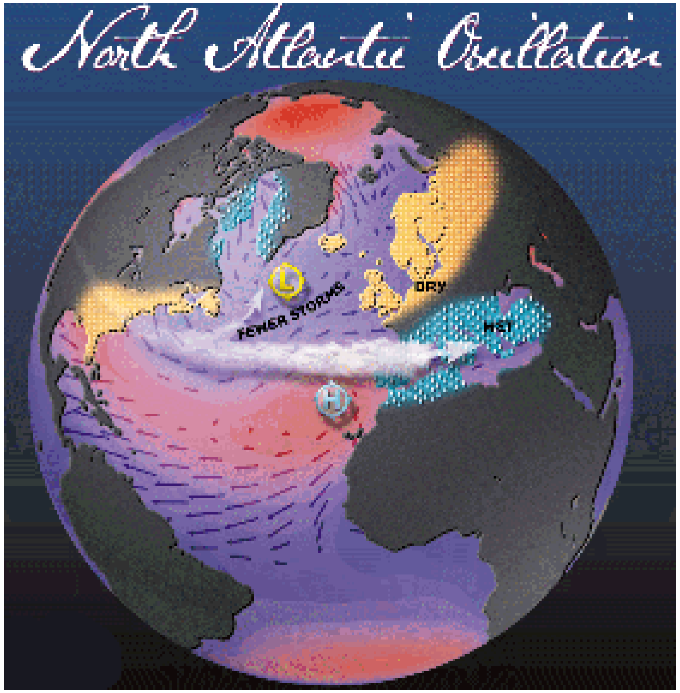
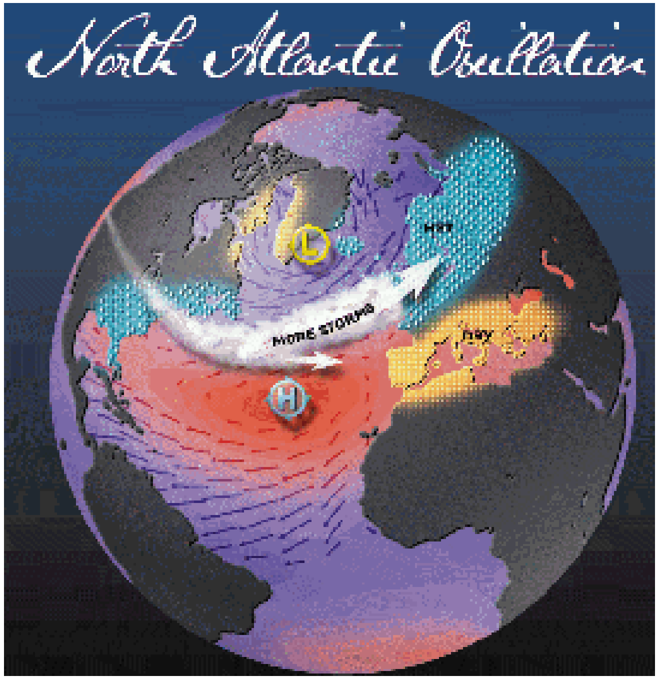
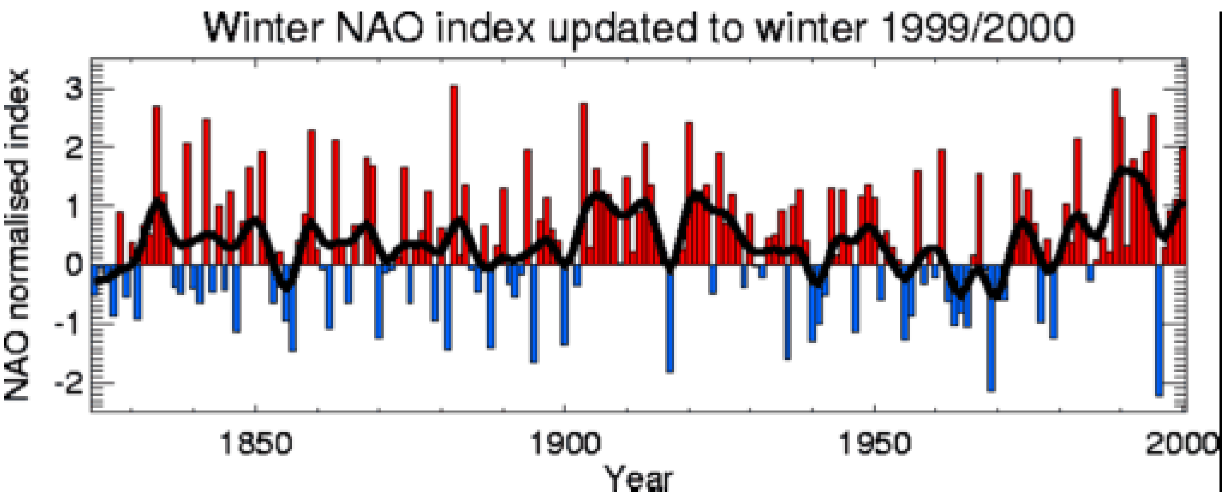
Motivation and Objective

Recently, Cheng and Bleck have identified coupled modes of low-frequency variabilities in the N. Atlantic, in a MICOM-CCM3 run.

Motivated by that, we started a search for such variabilities in the South Atlantic using the same MICOM-CCM3 output, and to compare the results with observations.


North Atlantic Oscillation
L
FEWER STORMS
DRY
H


North Atlantic Oscillation
L
MORE STORMS
H

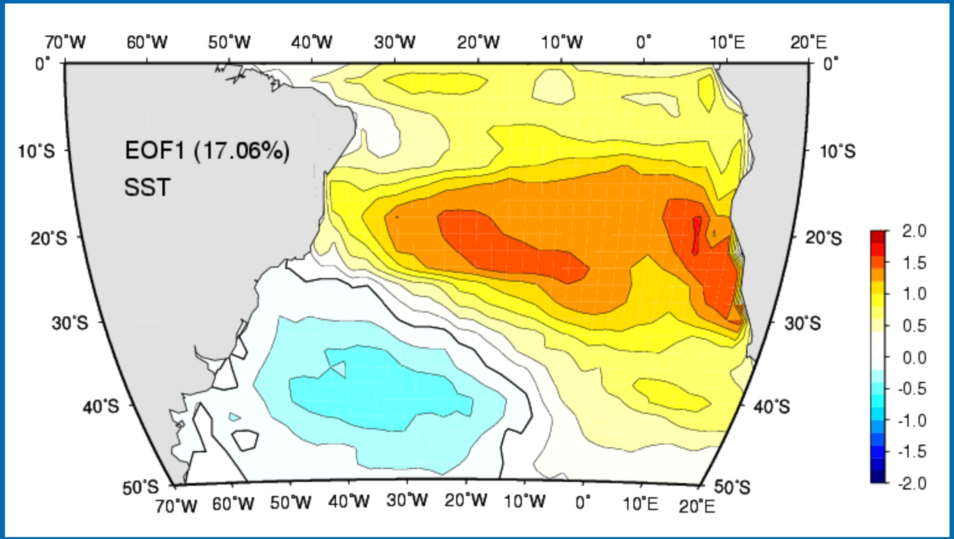


Winter NAO index updated to winter 1999/2000
NAO normalised index
3
2
1
0
-1
-2
1850
1900
1950
2000
Year

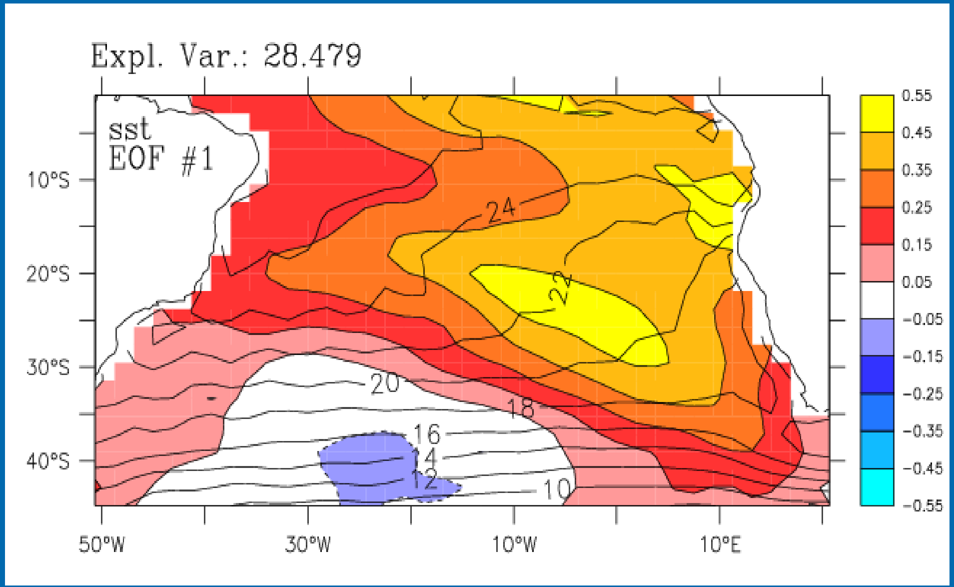
Empirical Orthogonal Function (EOF) Analysis. 1st mode of Sea Surface Temperature (SST) variability

- **EOF analysis was conducted on the Sea Surface Temperature (SST) and Sea Level Pressure (SLP) fields**
- **Results from year 25 to 80 of the simulations were analyzed**
- **Coupled run EOF shows a great resemblance with NCEP-NCAR reanalysis data (Sterl and Hazeleger, 2003)**

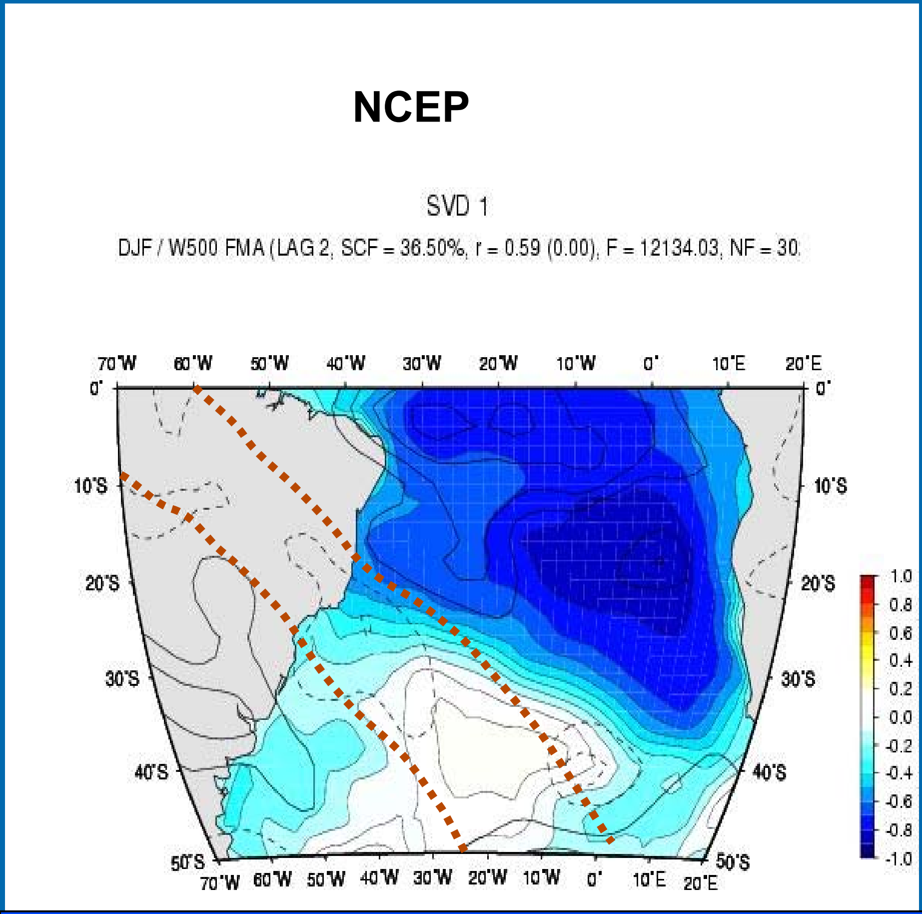
EOF 1 SST from MICOM-CCM3

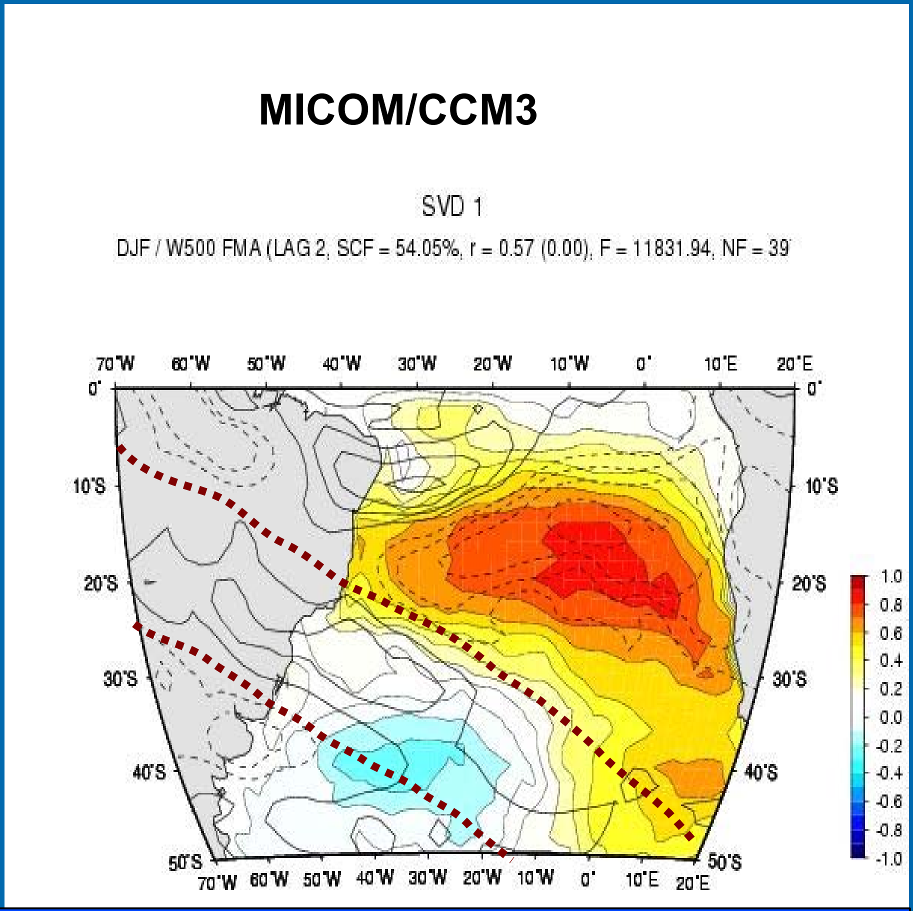


EOF1 SST from NCEP Sterl and Hazeleger, 2003



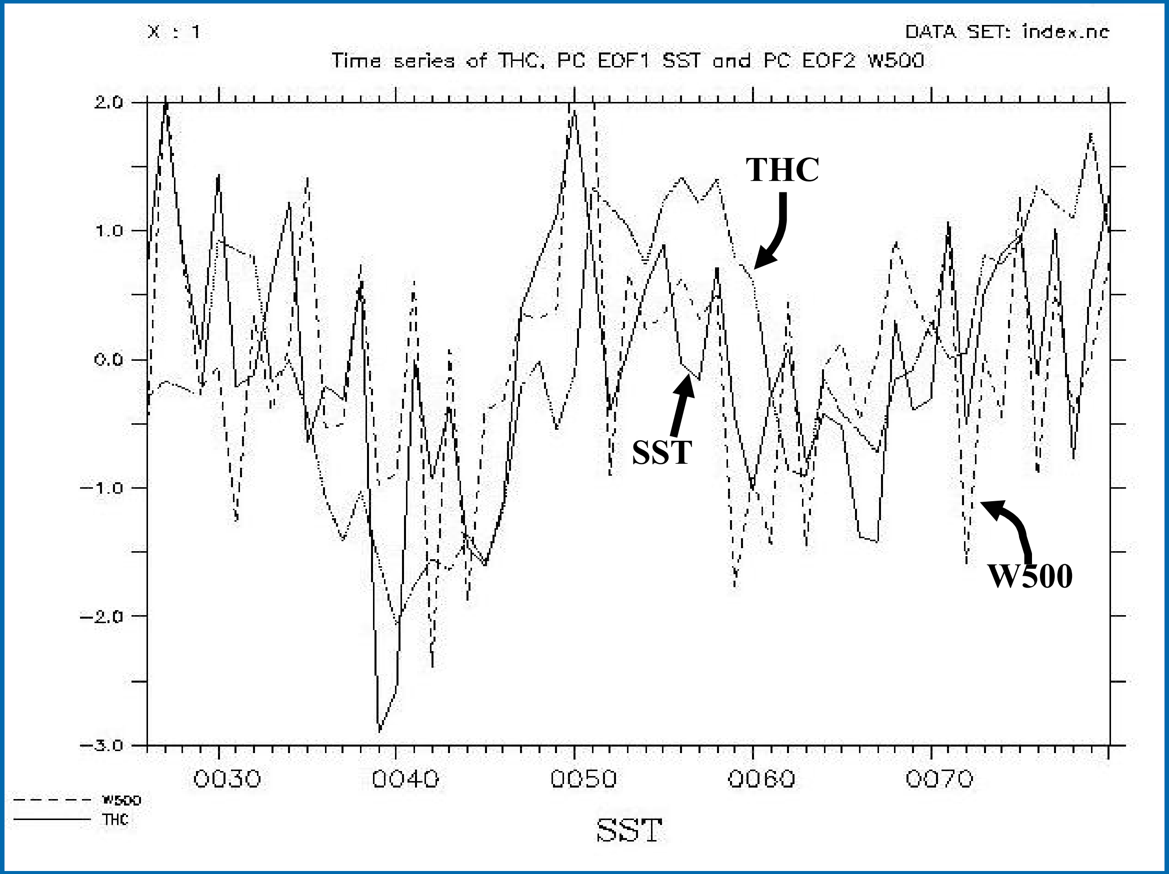
MCA of SST and vertical velocity (ω) at 500 hPa





MCA between ω (FMA) and SST (DJF), both from NCEP data (left panel) and model (right) indicate an intensified SACZ (area between red dashed lines) in late summer, as a response to SST anomalies two months earlier.

Time series of THC, PC of EOF1 of South Atlantic SST and PC of EOF2 of South Atlantic W500.

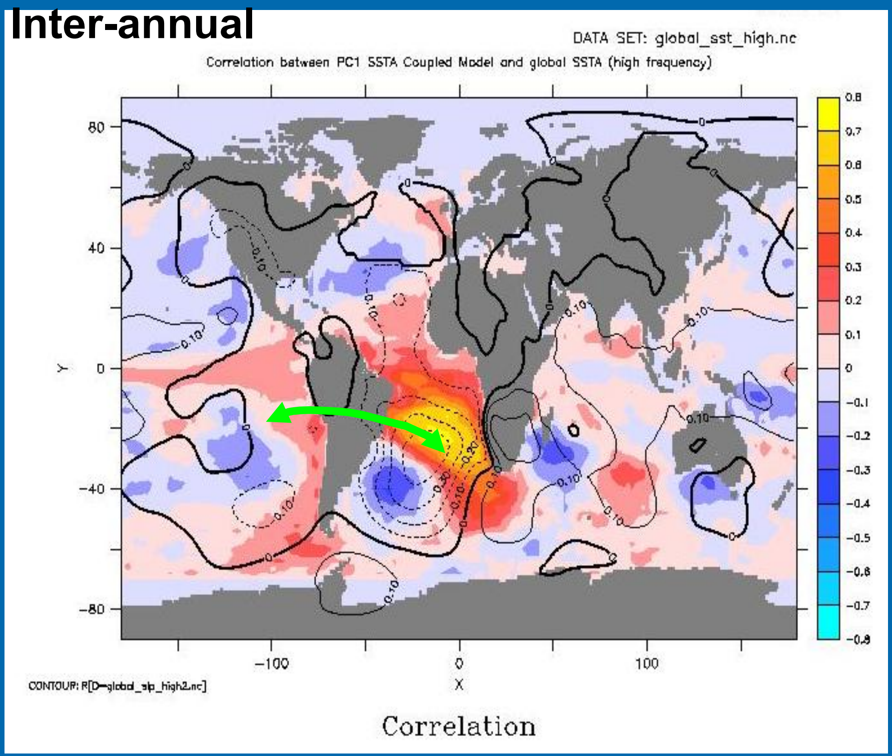


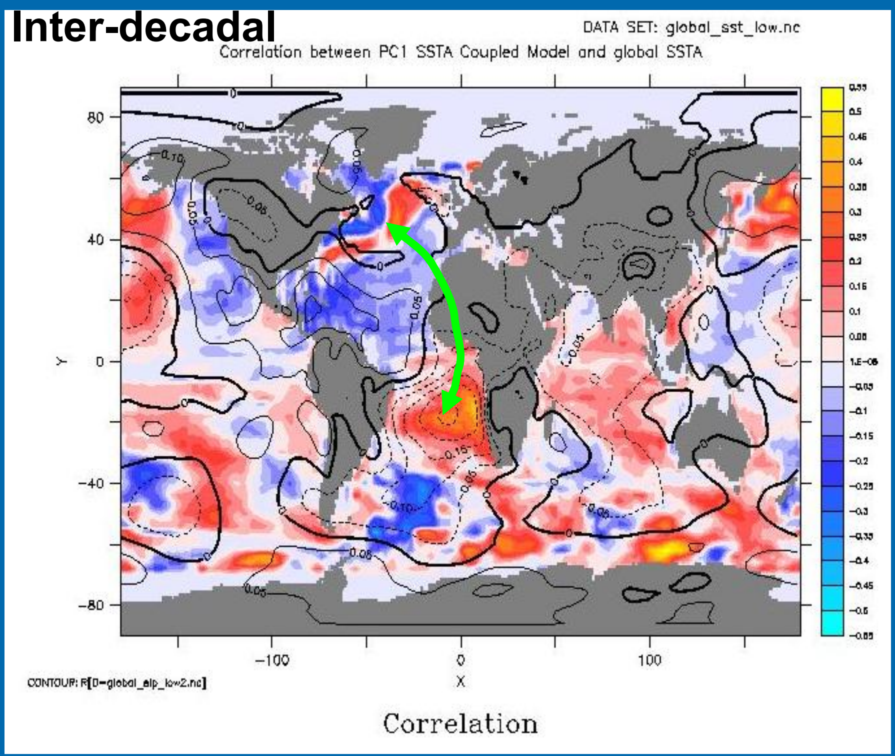
Cheng et al. (2004) found a dominant 25-30 year time scale in the model's termo-haline circulation (THC)variability.

At low frequency, the time-series of the Cheng et al.'s THC index and the principal components of the South Atlantic SSTA EOF1 and W500 EOF2 are almost synchronous.

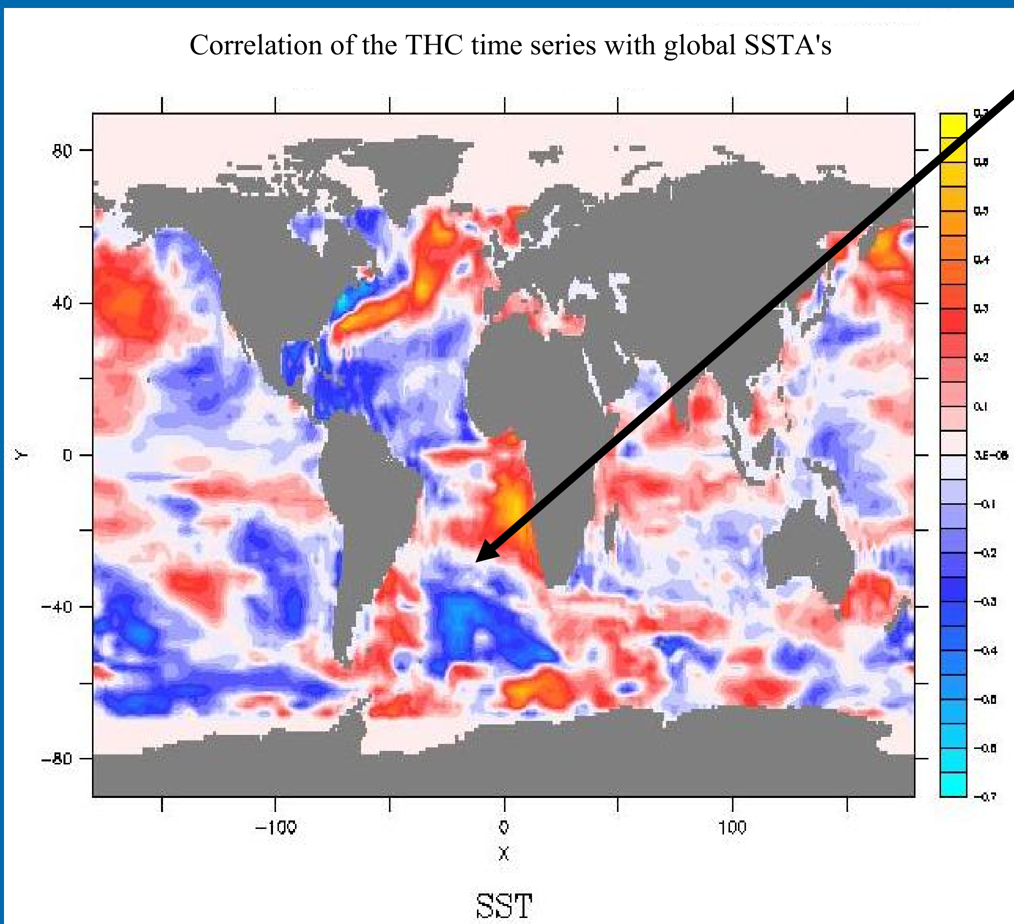
Correlation between the 1st EOF mode of the South Atlantic with global SST and MSLP, for inter-annual and inter-decadal time scales

On Inter-annual time scales (left) a South Atlantic (SA) monopole in MSLP is situated over the SA SST dipole. This is similar to the SVD pattern and suggests an oceanic response to the atmosphere. On inter-decadal time scale (right), the monopole is over the northern SST pole. This indicates an atmospheric response to SA SST dipole.

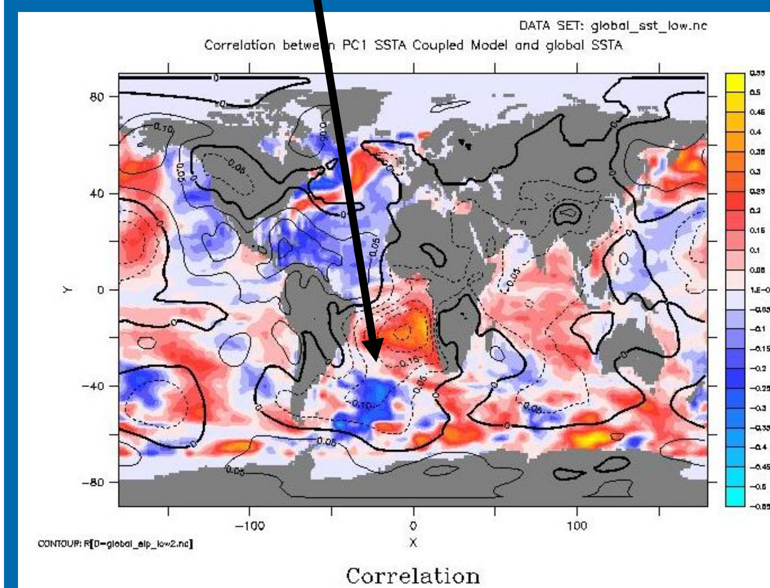




Correlation of THC index with global SST's



A correlation of the THC index with the global SSTA's reveals a dipole pattern in the South Atlantic that is very similar to the South Atlantic dipolar SST pattern obtaining in the correlation between the PC1 SSTA and global SSTA.



Summary and Conclusions

- ➢The coupling between MICOM and CCM3 can successfully reproduce SST and SLP patterns of variability observed in COADS and NCEP-NCAR reanalysis data for the South Atlantic
- ➢The SST variabilities in the South Atlantic can not be explained only as a passive response of the ocean to the atmospheric forcing
- ➢Lead-lag MCA indicates the existence of two modes of variability of the atmospheric South Atlantic Convergence Zone (SACZ).
- ➢One of these modes is a result of remote forcing while the other is a local response to the oceanic forcing.
- ➢The model shows significant modes of SST variability at inter-annual and inter-decadal time scales.
- ➢The inter-annual mode is apparently correlated with ENSO while the inter-decadal is linked to variability of the model's thermohaline circulation.