# Evaluation of the Mediterranean Outflow variability in HYCOM

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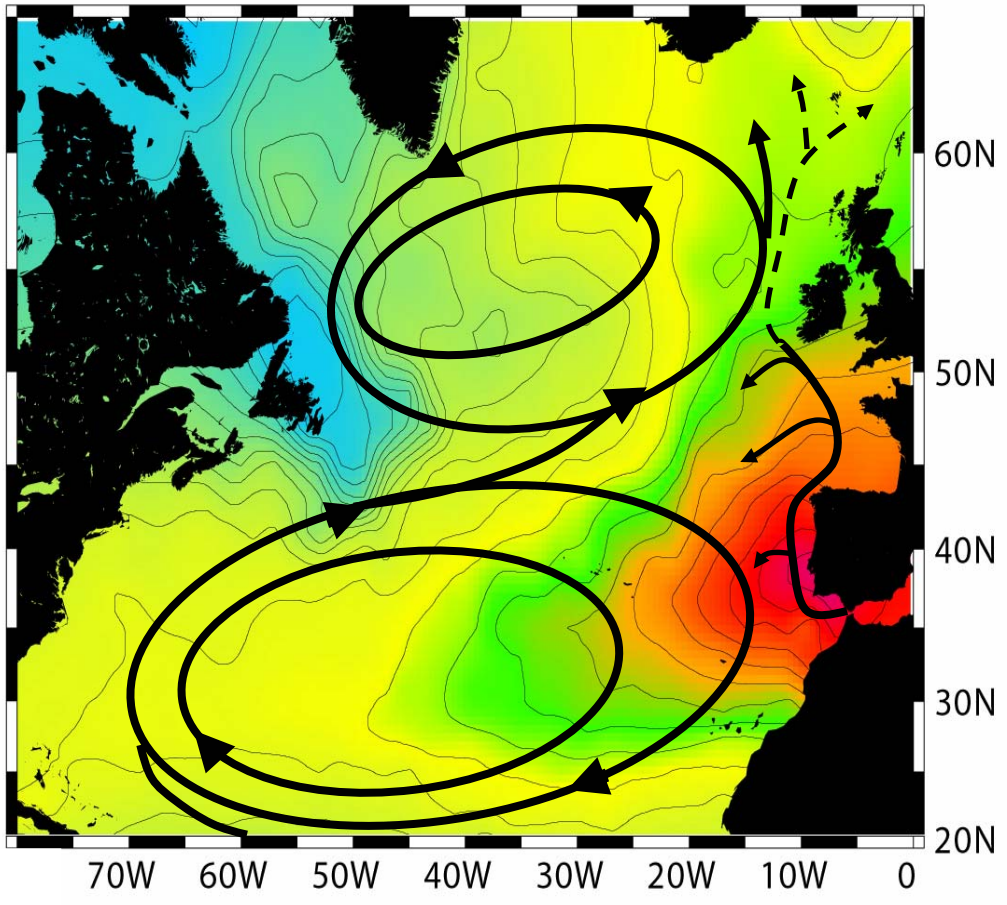
# Outline

- Background
- The Mediterranean outflow in HYCOM 1/3°
  - Validation
  - Analysis of the variability in a 50 year interannual simulation
  - Variability due to the NAO?
- Conclusions
- Ongoing work

# Mediterranean Outflow Water

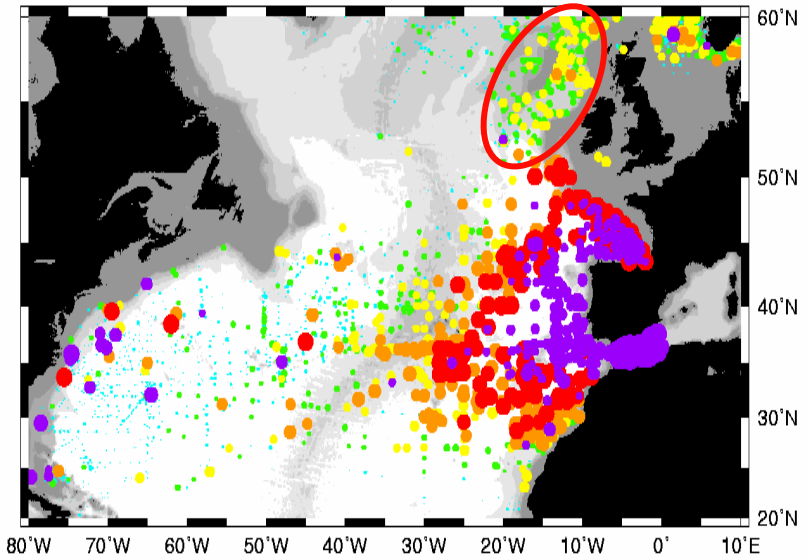



*From Lozier and Stewart, 2006*

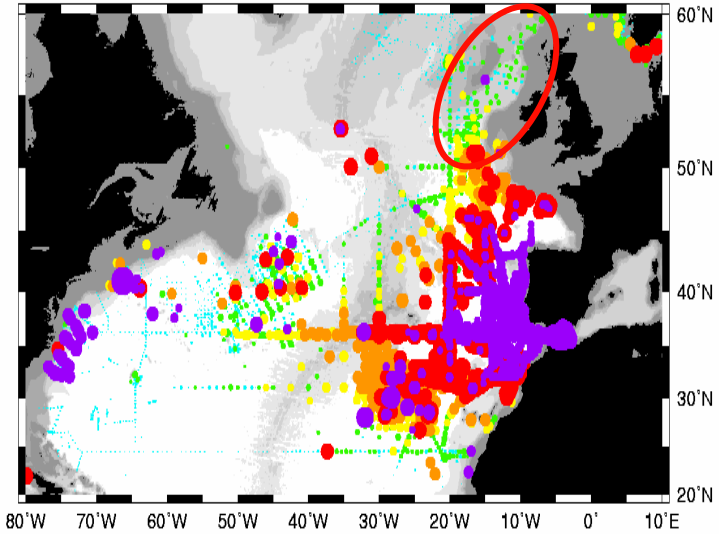
# Mediterranean Outflow Water

On $\sigma_1$= 32.10; at MOW core

**NAO- 1960-1969**




**NAO+ 1985-1994**




**Increasing salinity anomaly**

Negative correlation between NAO and salinity

*Lozier and Stewart, 2006*

# The 1/3° configuration: ATLn0.32

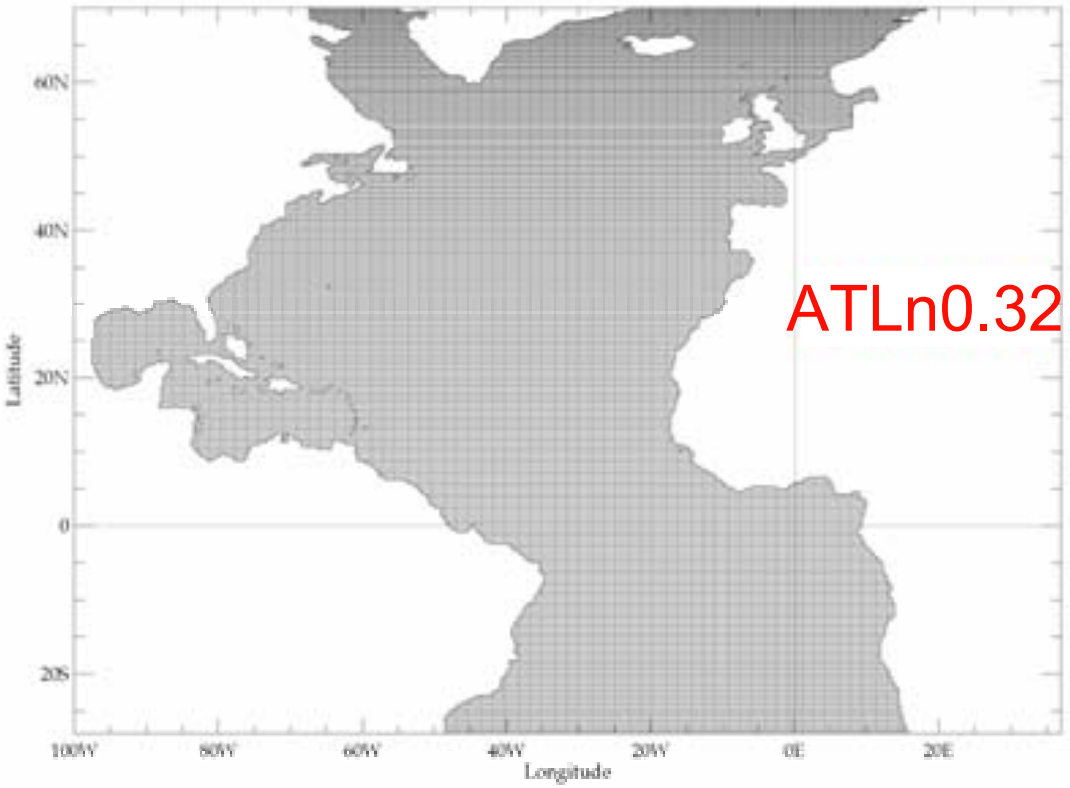
- Initial state from GDEM3
- 20 years of Spinup (expt SPIN)
- 55 years of interannual run (exp INTER)

- Use Price and Yang box model as boundary condition for the Mediterranean outflow

- NCEP forcing from 1948 to 2003

wind stress anomalies, wind speed, airtemp, radiation, water vapor

- Rivers




*Simulations performed by Zulema Garraffo*

# Price and Yang Box model

The Price and Yang model (Price and Yang, 1998) is used as a boundary condition to prescribe the outflow in the **HYCOM ocean model**.

Specified parameters are :

Med. Surf. Fluxes (prescribed)

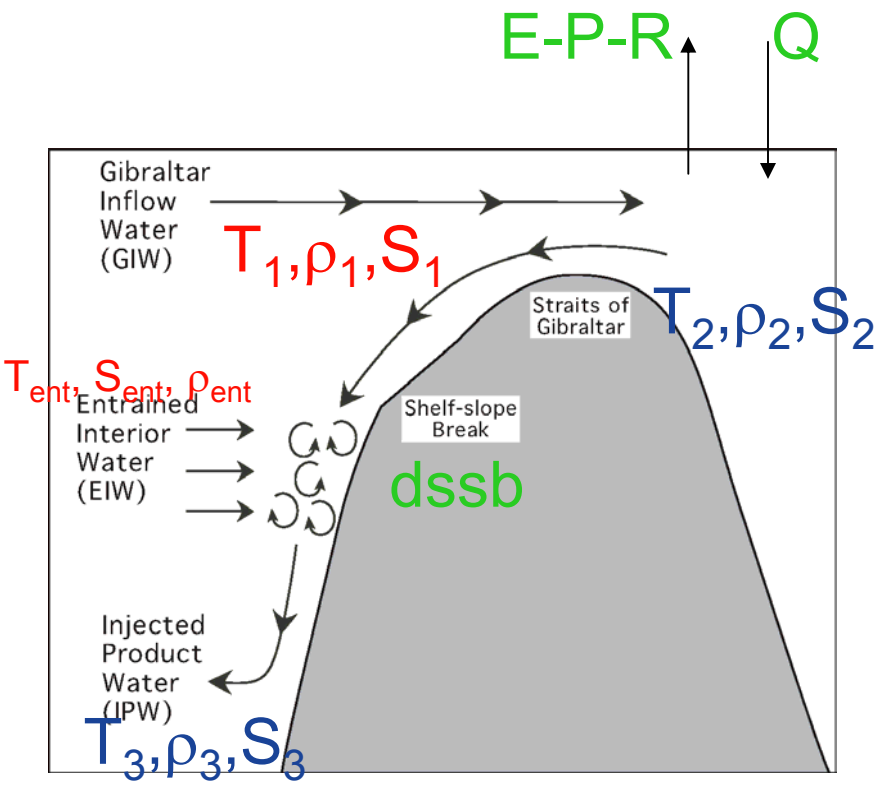
- E-P-R over Mediterranean
- Q Net Heat flux over Mediterranean
- dssb Depth of the entrained water

Specified Atlantic Ocean Water Properties(HYCOM)

- $T_1$,$S_1$, $\rho_1$ of Gibraltar inflow water
- $T_{ent}$, $S_{ent}$, $\rho_{ent}$ of entrained interior water at shelf-slope break

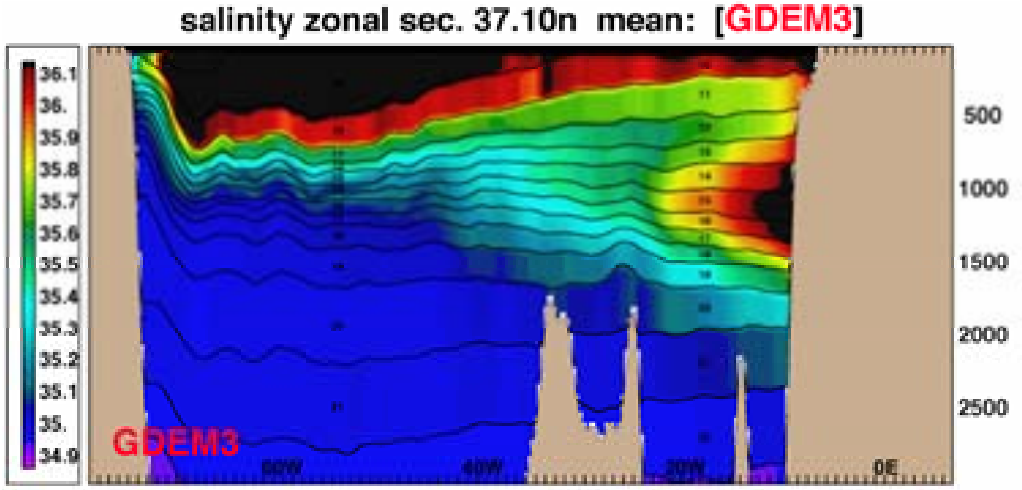
P-Y Model Output

- Gibraltar outflow $\rho_2$, $S_2$, $T_2$
- Entrained interior water transport
- Final product water $\rho_3$, $S_3$, $T_3$, depth, transport

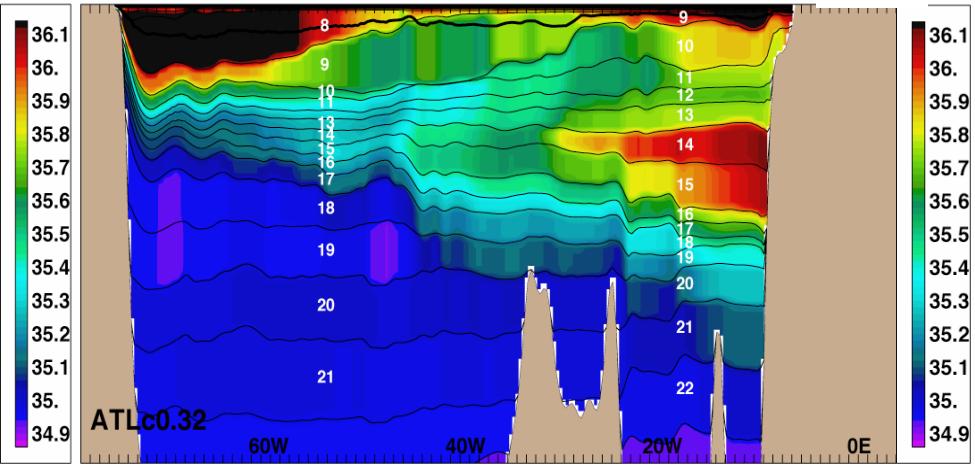


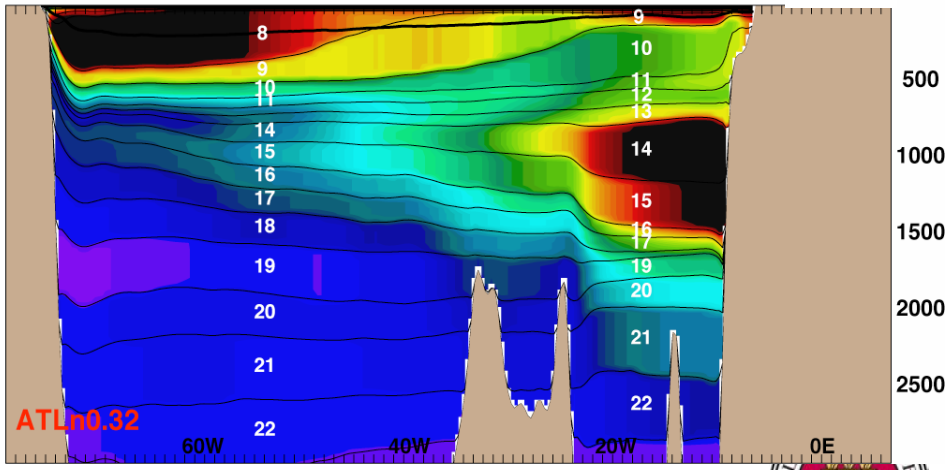

*(implemented in HYCOM by George Halliwell)*

# Representation of the outflow in ATL13








ATL13 SPINUP

ATL13 INTERANNUAL

# OUTFLOW properties:SPIN/INTER

- Transport at the sill: **0.83 Sv /0.83 Sv**

*(Observations, Hopkins,1999: 0.8Sv)*

- Temperature/Salinity at the sill: **10.69°C/38.28psu / 11.07°C/38.22psu**

*(Observations, Baringer and Price,1997 : 13°C/ 38.4psu)*

- Transport of the outflow: **4.05Sv / 3.8 Sv**

*(Observations, Rhein and Hinrichsen,1993: 3.7 Sv)*

- Temperature/Salinity of the outflow: **10.9°C/36.22psu / 11.03°C/36.22psu**

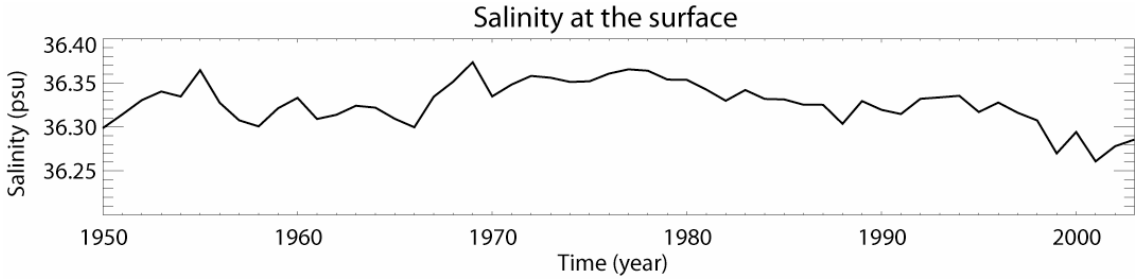
*(Observations, GDEM3: 11°C/ 36.2psu)*

- Central Depth of the outflow:**~1200m / ~1100m**

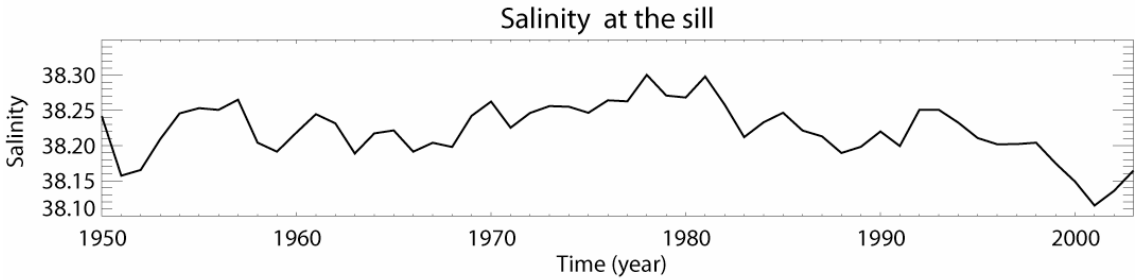
*(Observations, Baringer and Price, 1999: ~1100m)*

# Salinity of the outflow

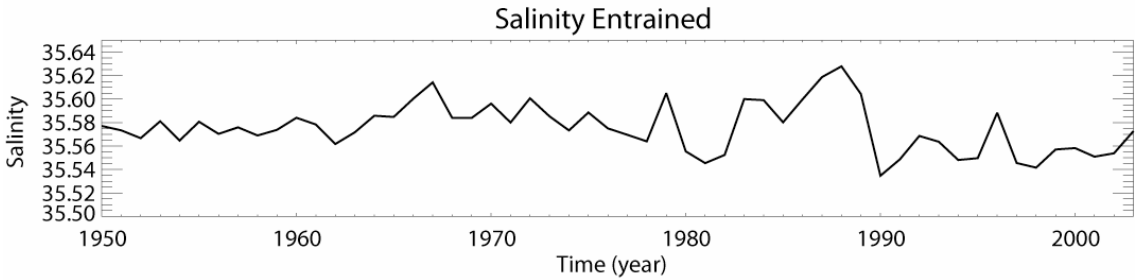
given by HYCOM

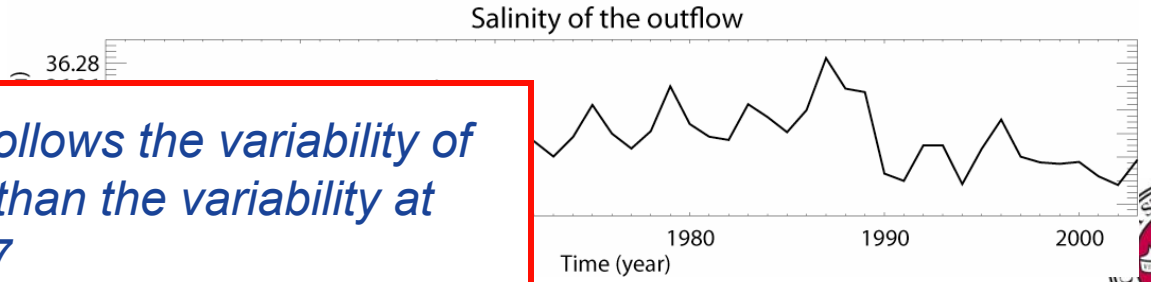



computed by PY



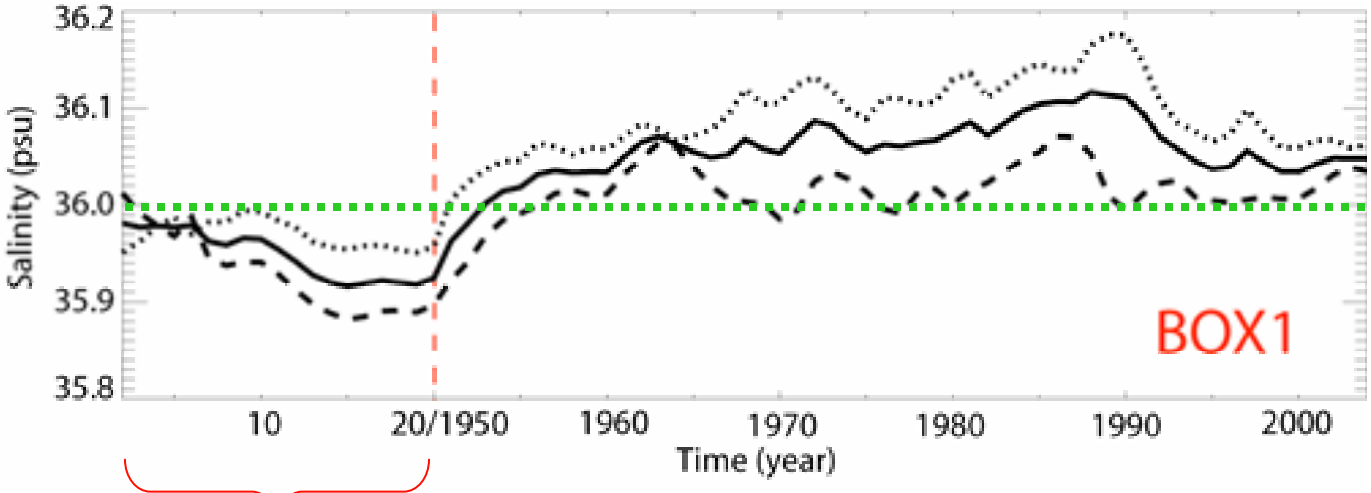

given by HYCOM



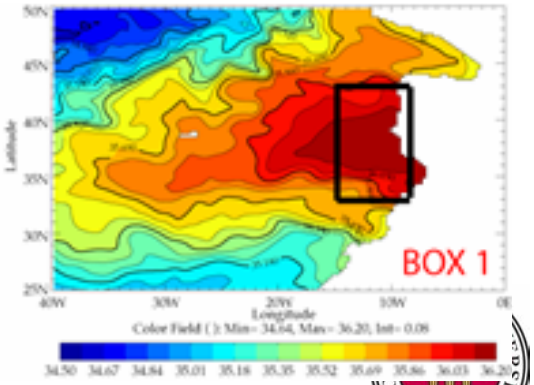

- *Variability of the Outflow follows the variability of the Entrained Water more than the variability at the Sill as in Xu et al. 2007*

# Evolution of salinity

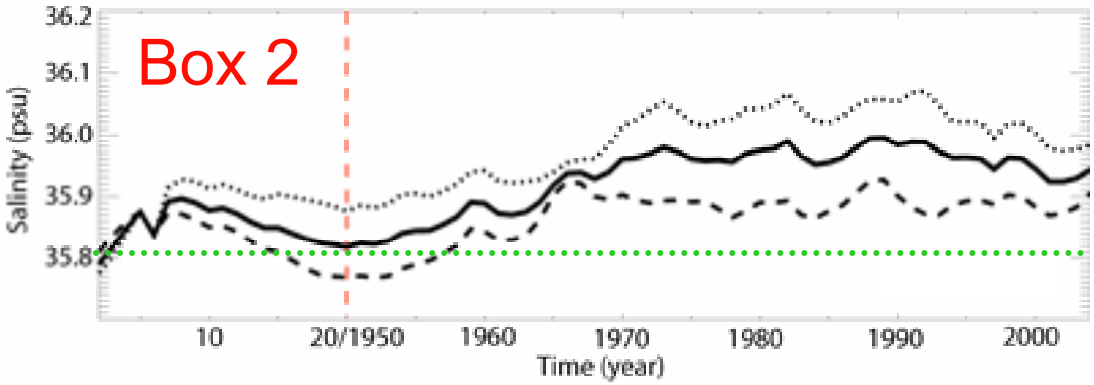


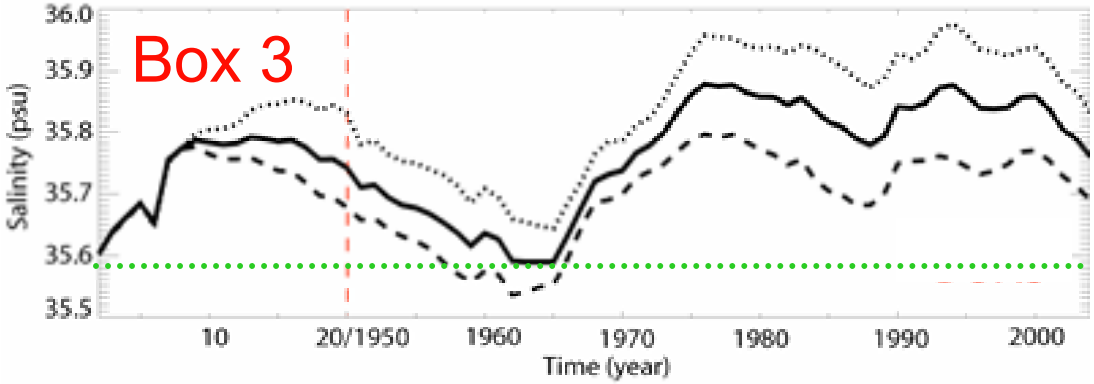

SPINUP

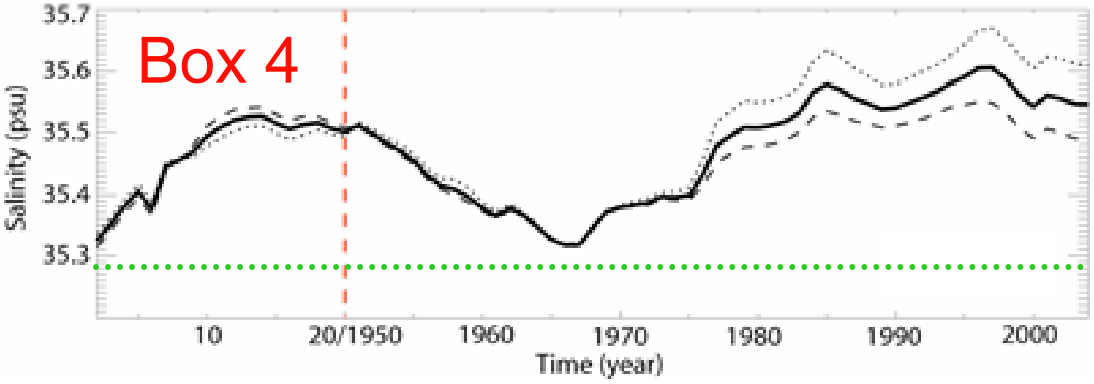
GDEM3 : 36.0psu

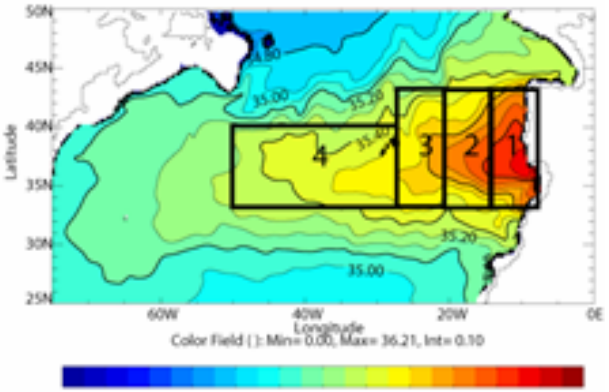


# Evolution of the salinity




**GDEM3 : 35.8psu**

**GDEM3 : 35.57psu**

**GDEM3 : 35.27psu**

# Variability in HYCOM: INTER

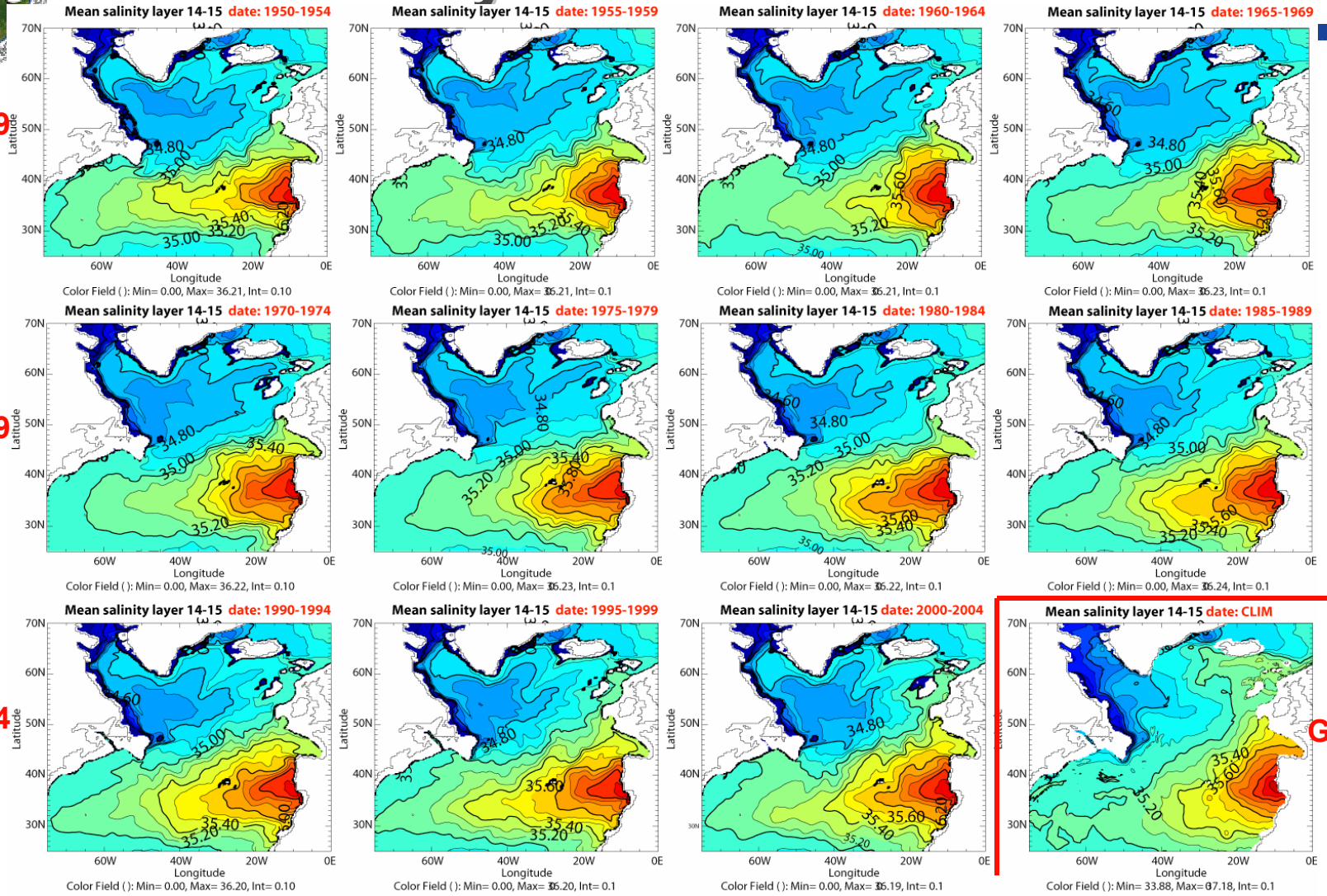
5y mean map

1950-1969

1970-1989

1990-2004

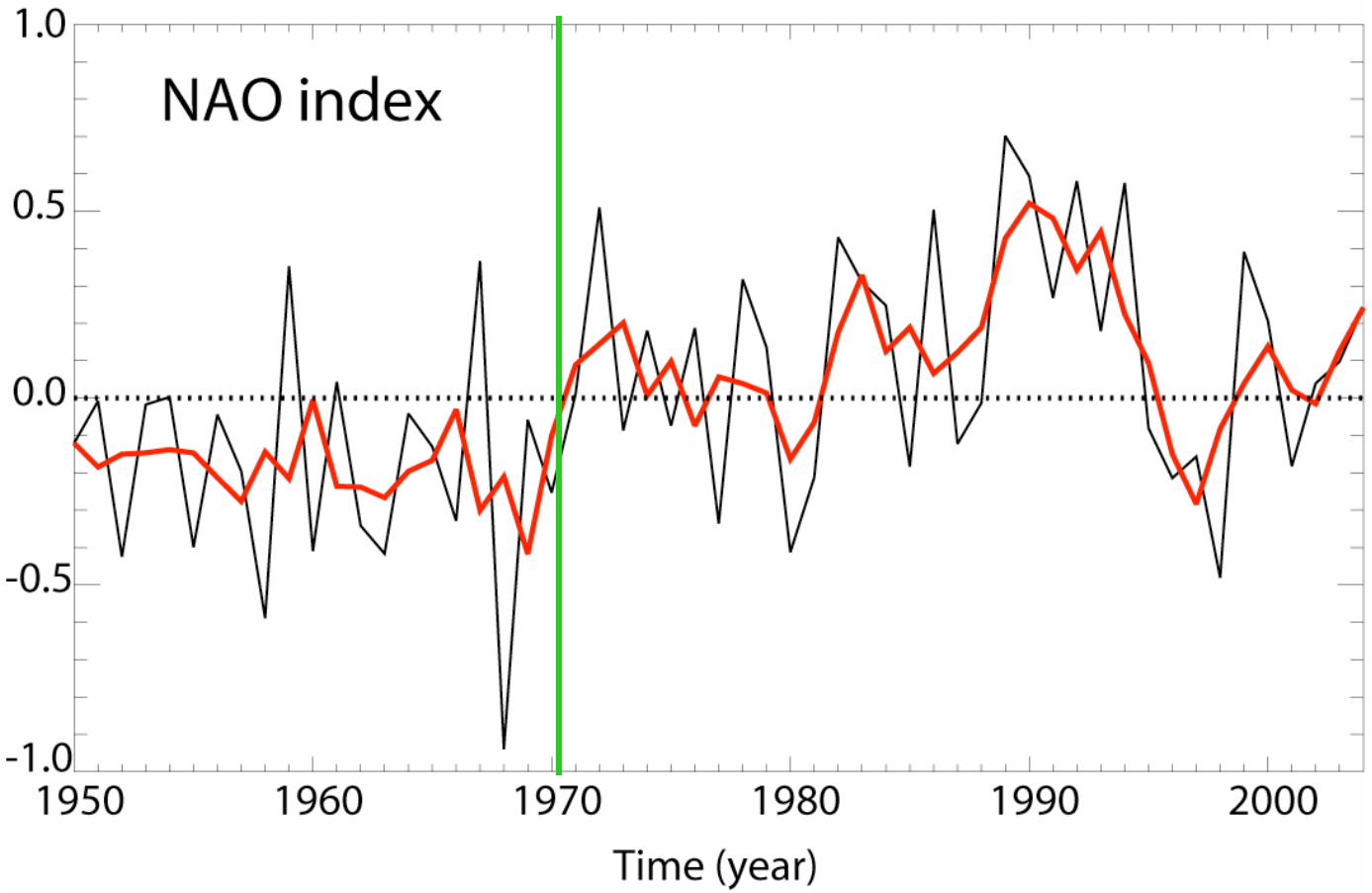
GDEM3




34.00 34.20 34.40 34.60 34.80 35.00 35.20 35.40 35.60 35.80 36.00 36.20 36.40

MEAN SALINITY LAYER 14-15

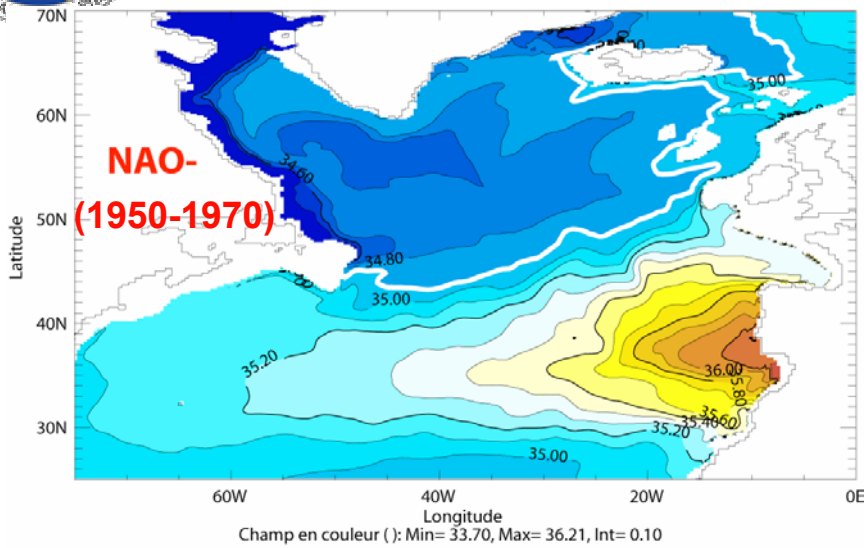
# NAO index

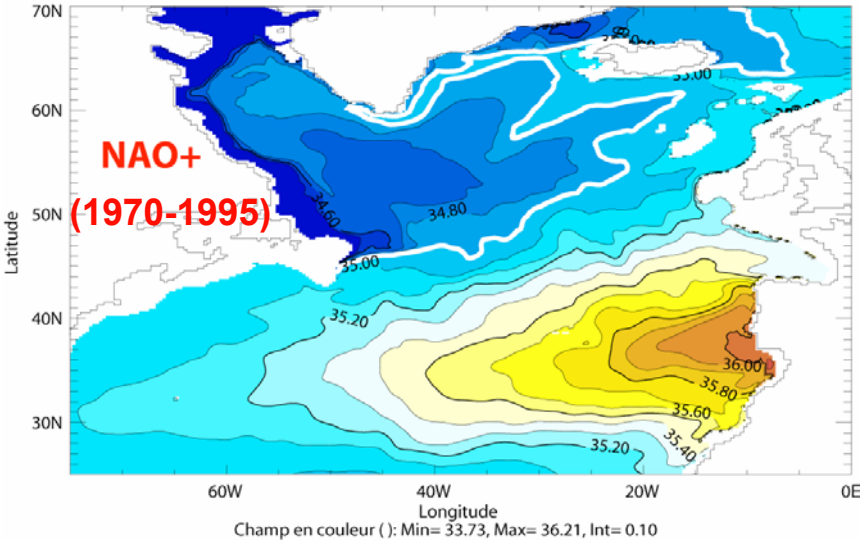


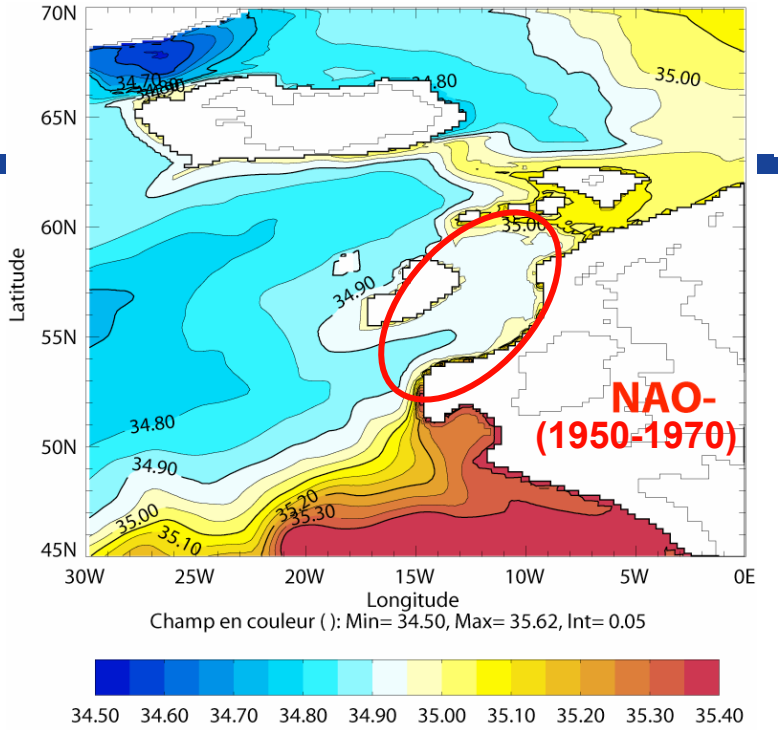

1 year average

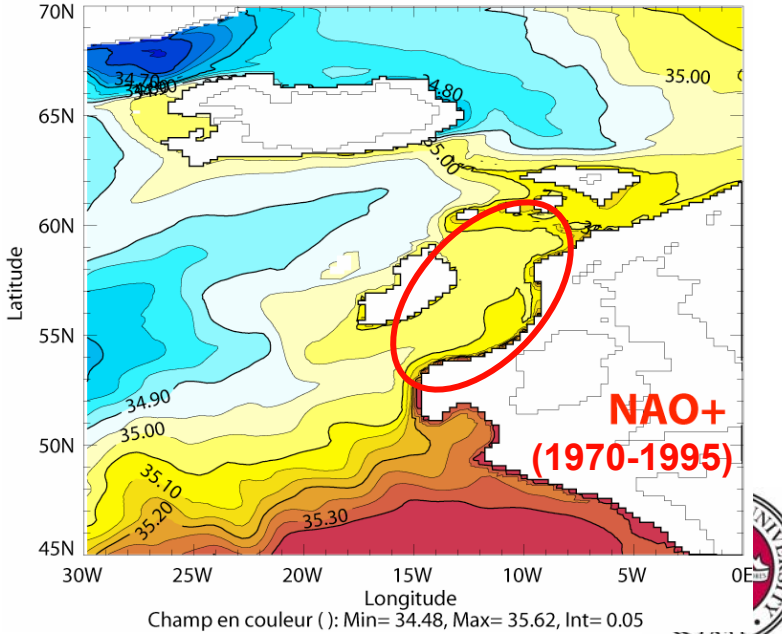
3 year average

# NAO variability?

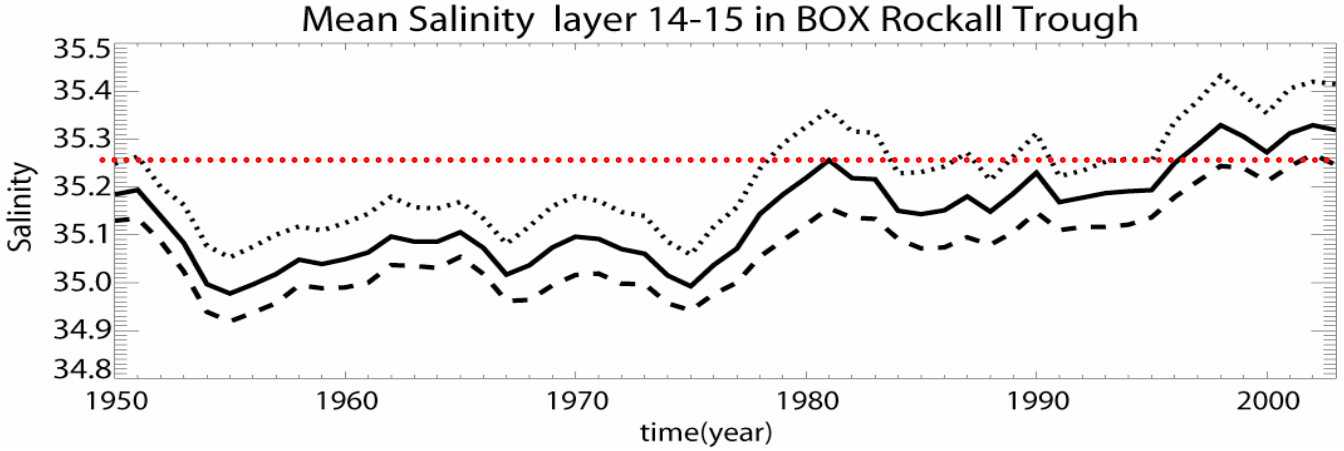


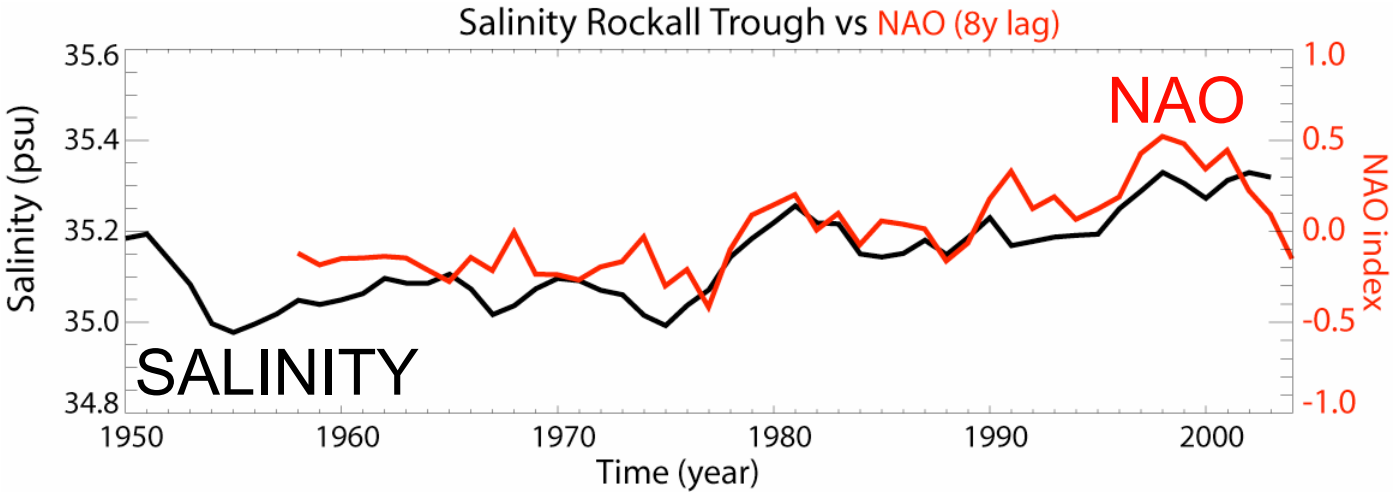



# NAO vs Salinity Rockall Trough




**GDEM3**
**35.25psu**




**Positive**
Correlation with NAO =>
R =0.48 at lag 8-9 years

# Conclusions

- The outflow is well-represented in HYCOM 1/3° in terms of depth, temperature, salinity and shape.

- Expansion/contraction of the Mediterranean tongue but seems not correlated to the NAO.

- Positive correlation between NAO and salinity in Rockall Trough in contradiction with results of *Lozier and Stewart, 2006*

# Ongoing work

- Continue the analysis of the 1/3° simulation

- Set up several sensitivity experiments on the outflow :
    - for the 1/3° configuration
    - for a 1° Atlantic configuration

Next step:

- Introduce the variability of the Mediterranean Sea in the system.