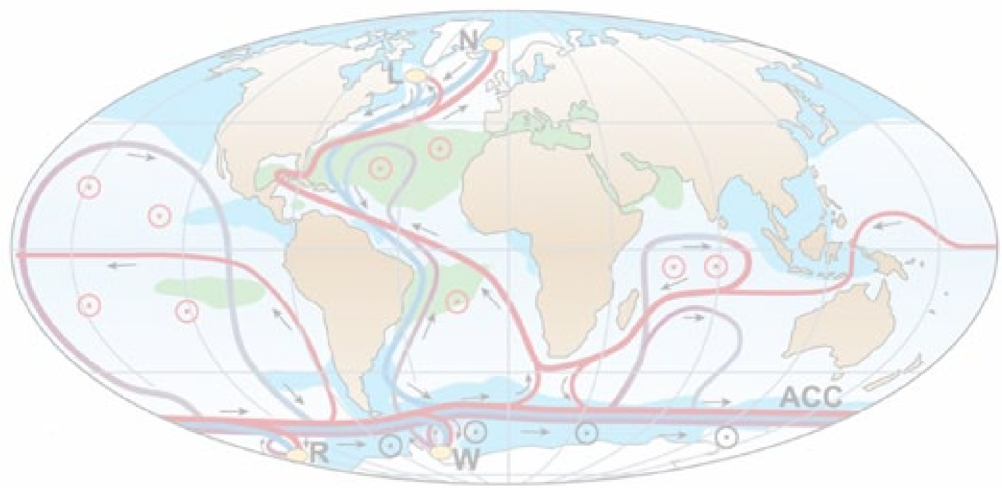
THE AMOC IN MILLENNIAL ECHO-G CLIMATE SIMULATIONS AND FUTURE CLIMATE CHANGE SCENARIOS



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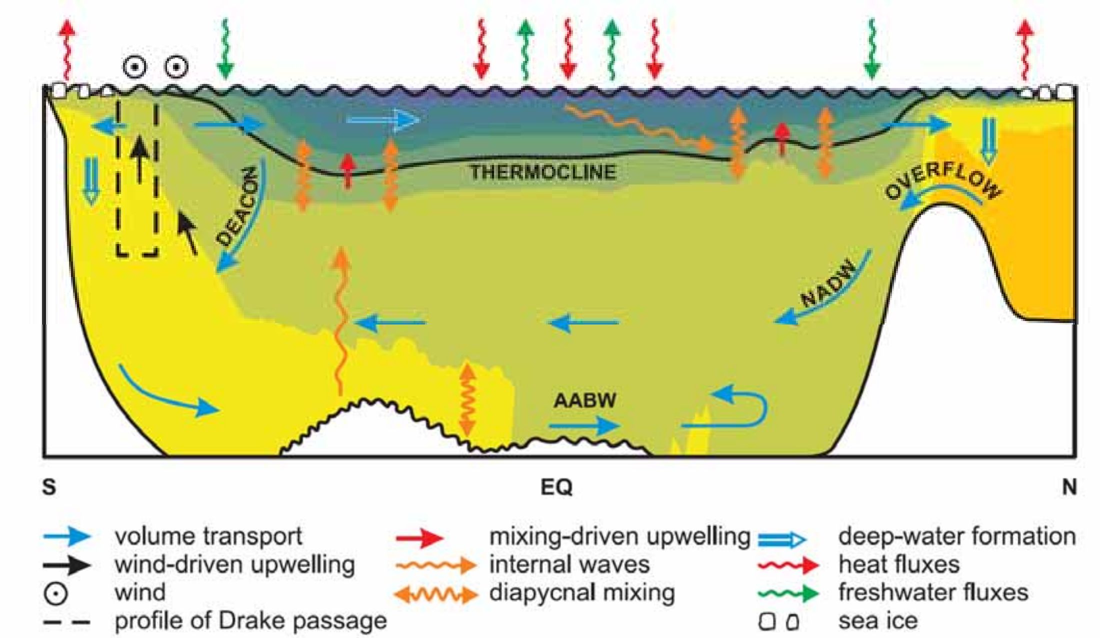
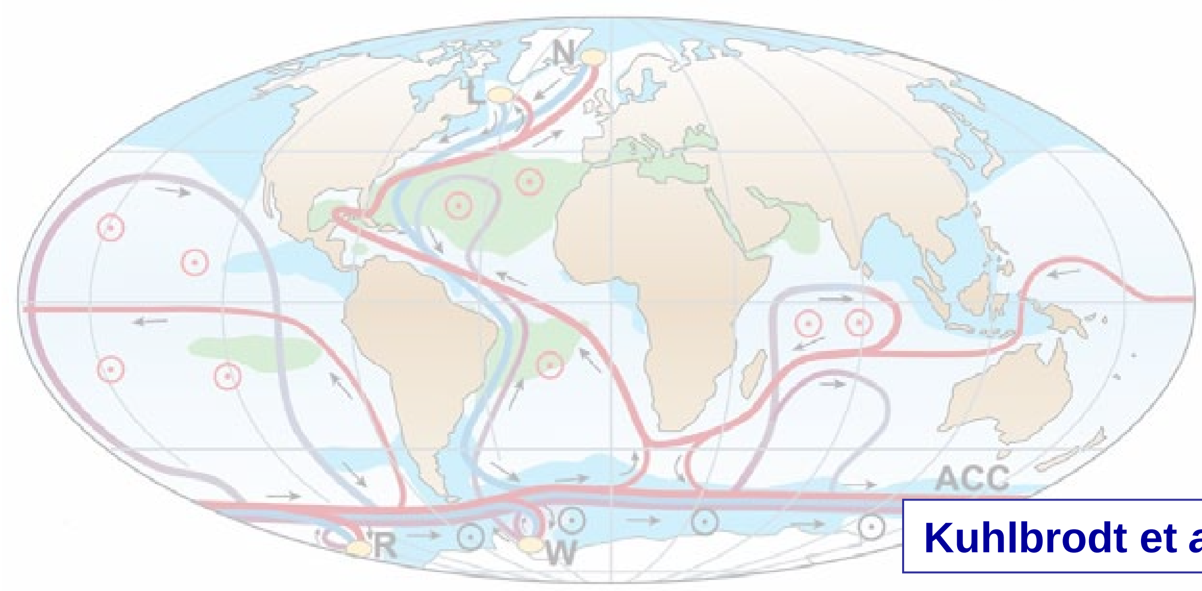
Universidad Complutense de Madrid

INTRODUCTION I

Conveyor belt model



Kuhlbrodt et *al*. (2007)

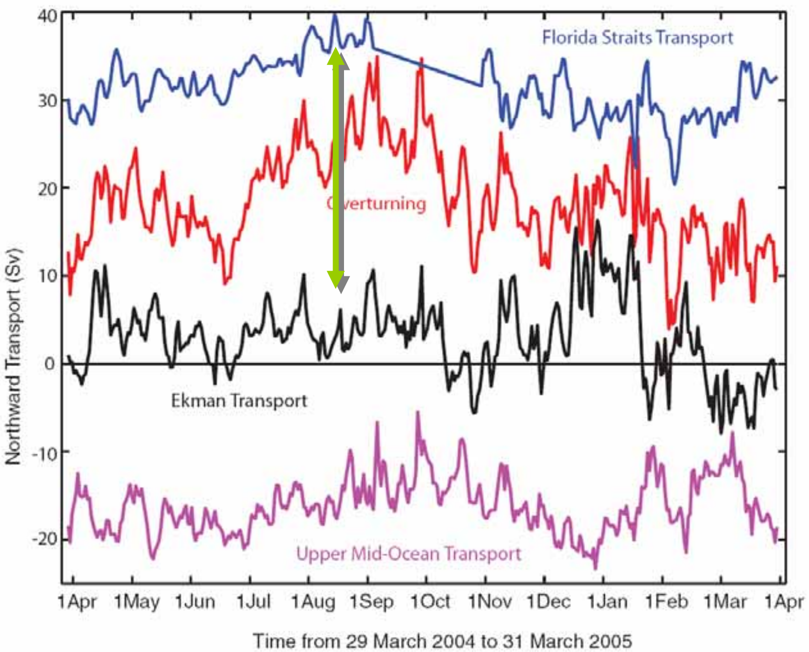


Kuhlbrodt et *al*. (2007)

INTRODUCTION II

In situ measurements at 26.5º N since March 2004

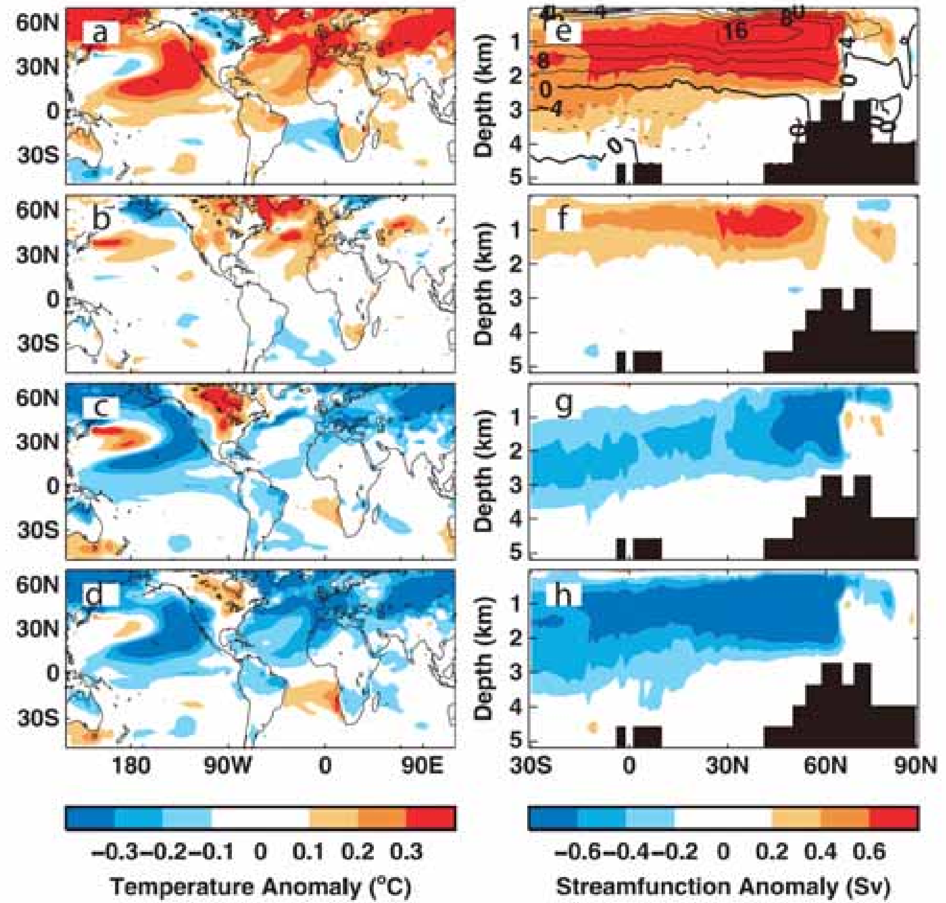
Cunningham et *al*. (2007)



Anual average: 18.7±5.6 Sv

Intra-annual range: 4.0 to 34.9 Sv

Control simulations explore AMOC long-term variability



Knight et *al*. (2005) identify an oscillatory mode where the Atlantic Multidecadal Oscillation is driven by changes in the overturning circulation

MODEL AND EXPERIMENTS I

THE ECHO-G MODEL

⟶ **Atmospheric Component ECHAM4**:

T30 resolution (3.75º x 3.75º), 19 vertical levels

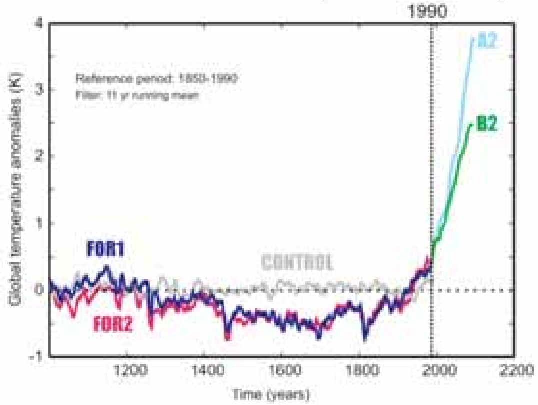
⟶ **Oceanic Component HOPE-G**:

T42 resolution (2.8º x 2.8º), 20 levels in depth

THE SIMULATIONS

- **CTRL →** 1000 yr control simulation
- **FOR1, FOR2 →** Forced simulations of the last millenium
- **A2, B2 →** IPCC scenario simulations

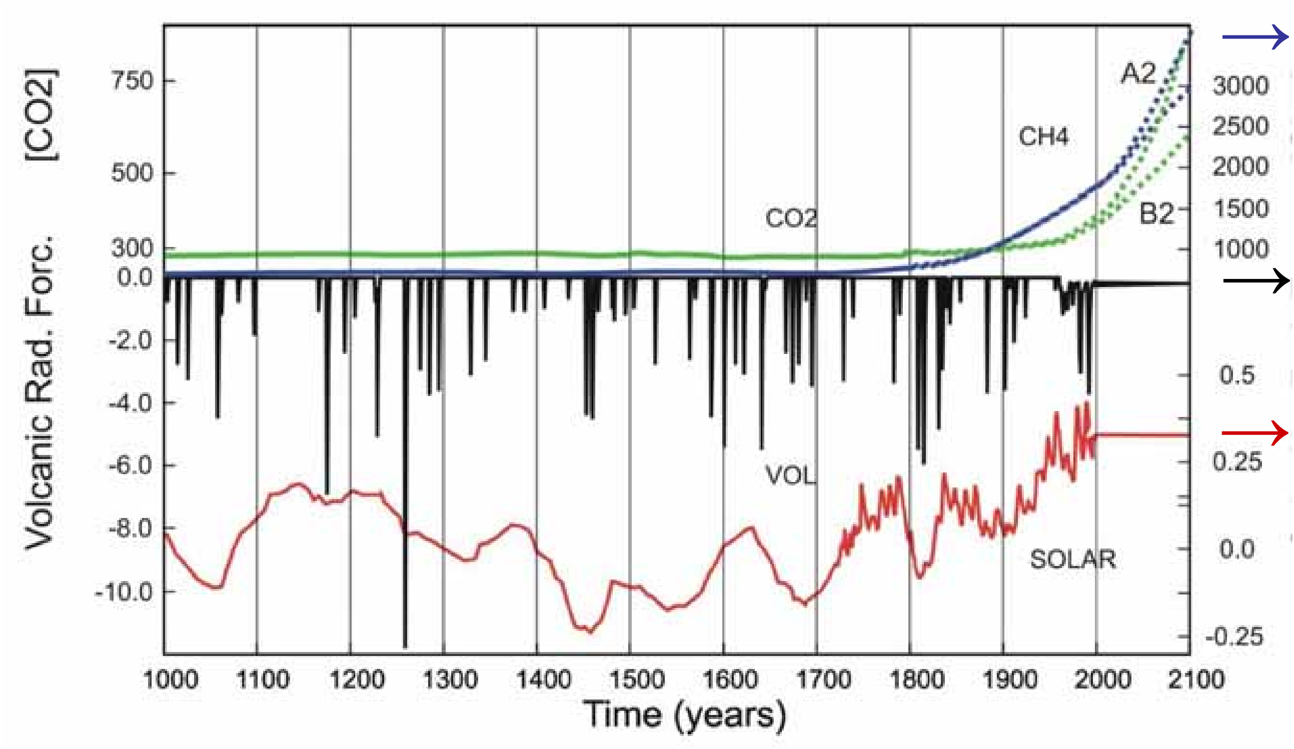
Global mean temperature (2m)



The simulations in literature: **González-Rouco et *al*. (2003,2006); Zorita et *al*. (2003,2005); von Storch et *al*. (2004); Beltrami et *al*. (2006); Gouirand et *al.* (2007); Stevens et *al*. (2007)**

MODEL AND EXPERIMENTS II

THE FORCING FACTORS



→ **Greenhouse gas concentrations**

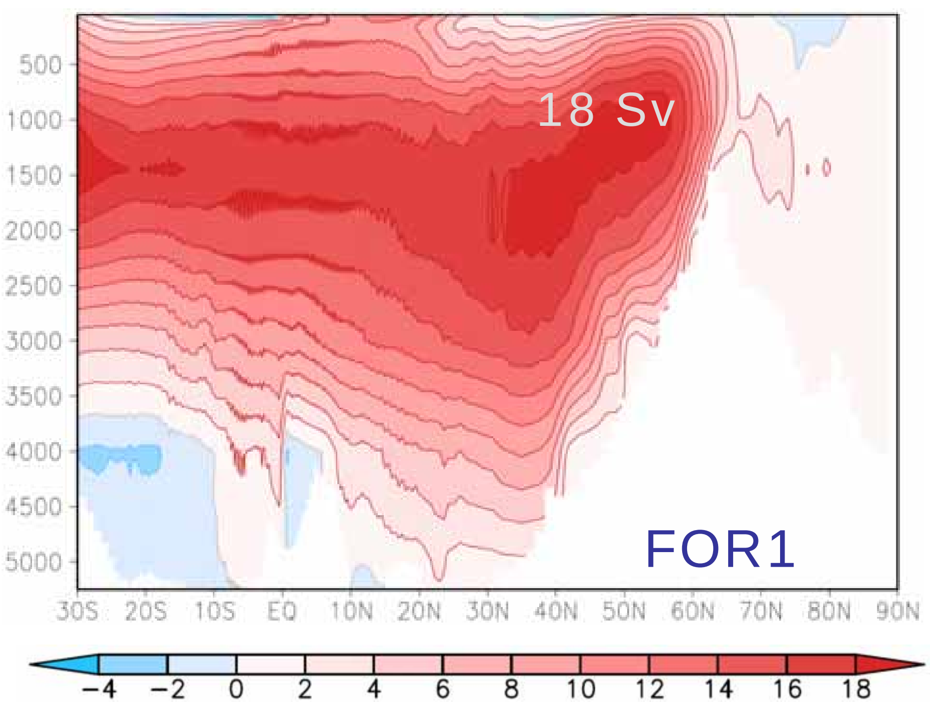
→ **Radiative effect of volcanic aerosols**

→ **Solar Irradiance**

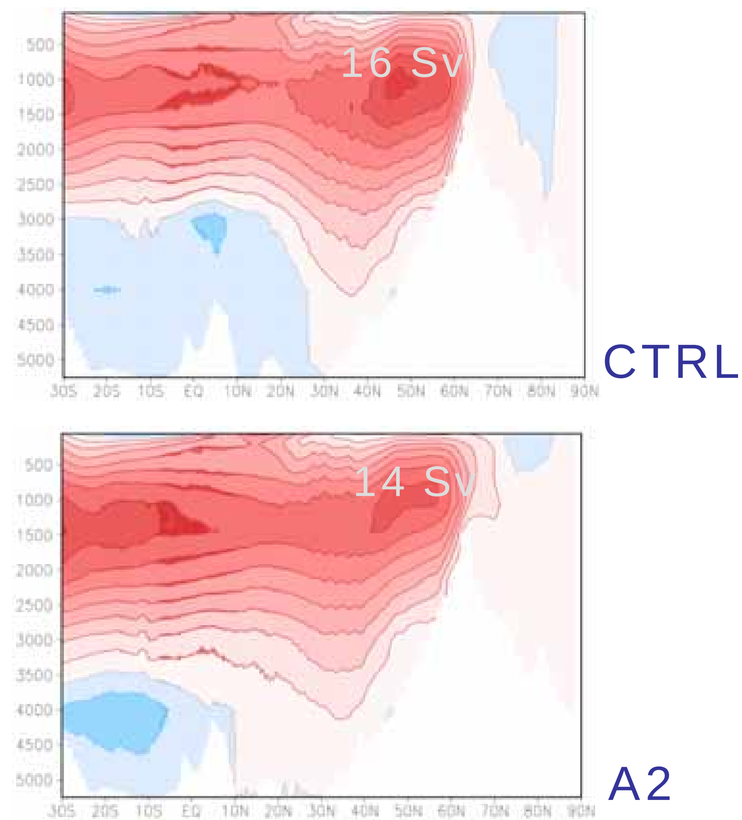
Crowley (2000)

AMOC CLIMATOLOGY AND TEMPORAL EVOLUTION I

THE AMOC MEAN STATE



Long-term mean AMOC streamfunction

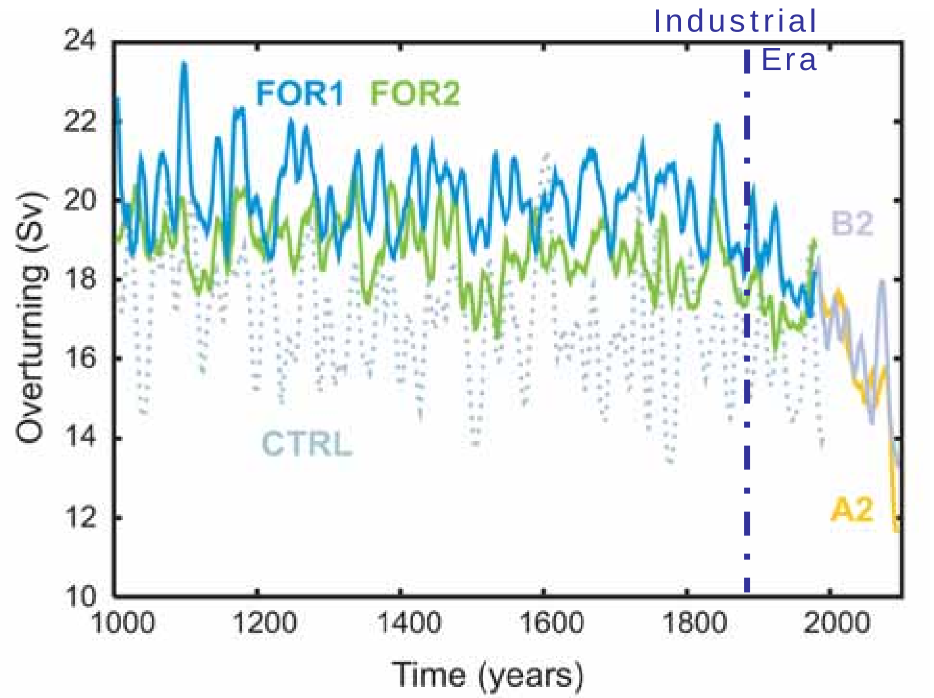


The circulation is realistic and close to estimates by Ganachaud & Wunsch (2000); 15±2 Sv

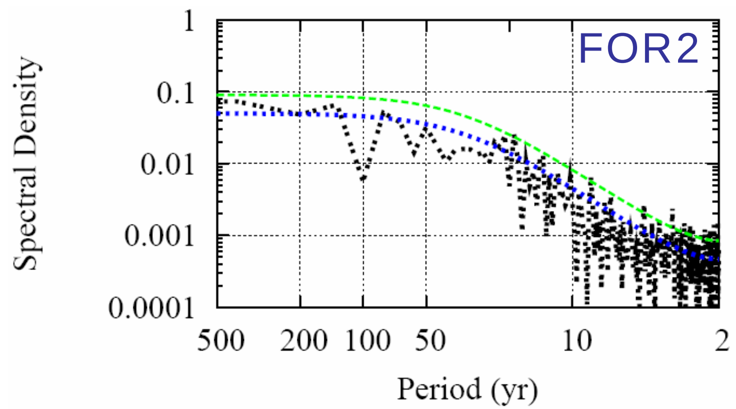
$1Sv = 10^6 m^3/s$

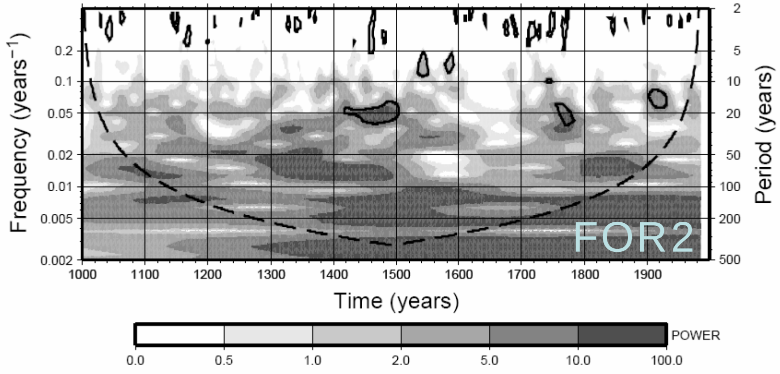
AMOC CLIMATOLOGY AND TEMPORAL EVOLUTION II

The meridional overturning index (MOI)



Fourier and Wavelet spectrums



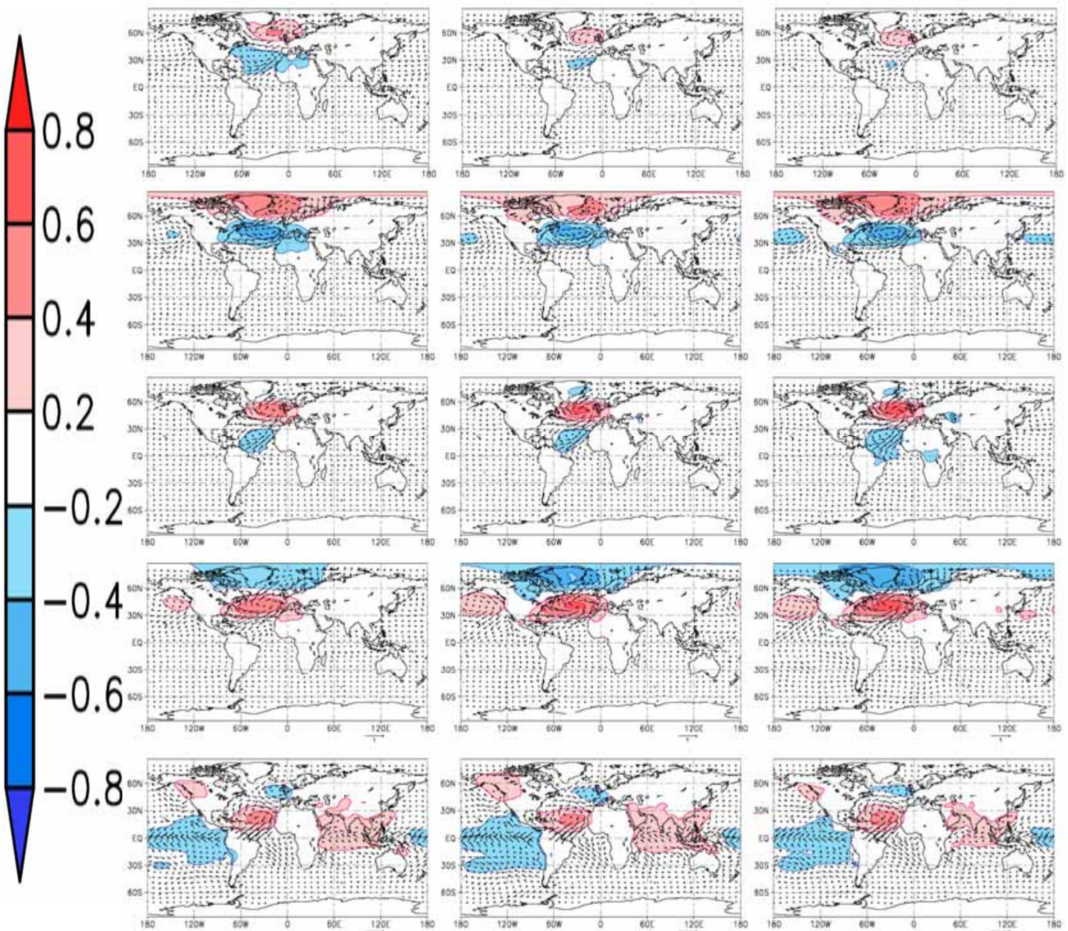


The AMOC exhibits a weakening beginning in the industrial era, and intensifying in the future change scenarios

MODES IN HIGH-FREQUENCY I

Correlation maps MOIs – SLP and wind stress

CTRL FOR1 FOR2



MOI

MOI-1

MOI-2

MOI-3

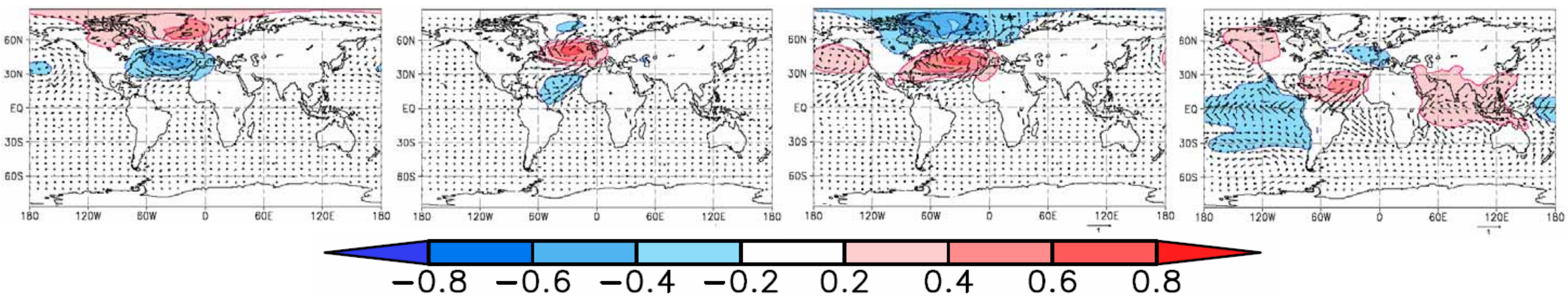
MOI-4

The patterns are common to the three millennial simulations

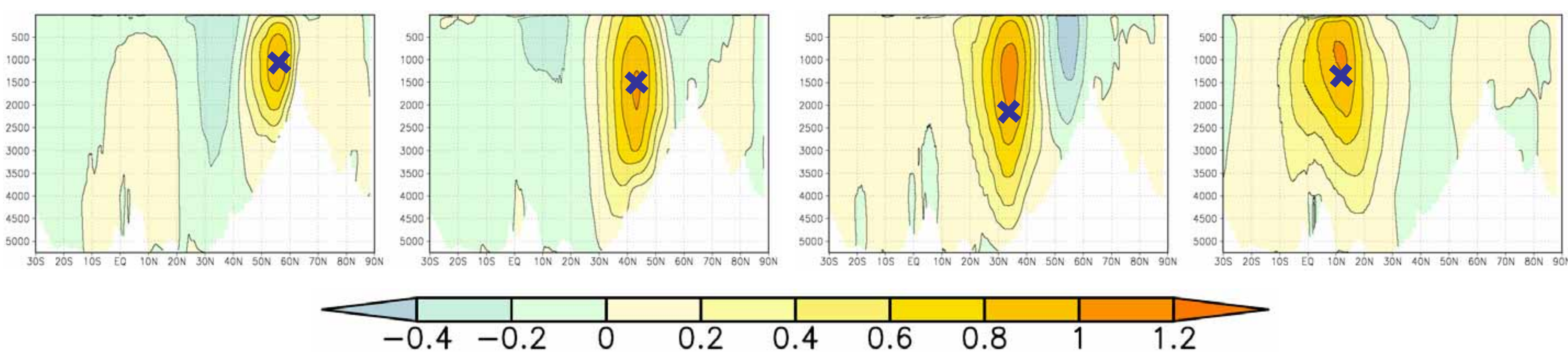
MODES IN HIGH-FREQUENCY II

Correlation maps MOIs – SLP and wind stress (FOR1)

MOI-1 MOI-2 MOI-3 MOI-4



Regression patterns MOIs – Streamfunction (FOR1)



MODES IN LOW-FREQUENCY I

- **In the low frequency it is identified a propagating mode that differs in some extent from CTRL to the forced runs.**

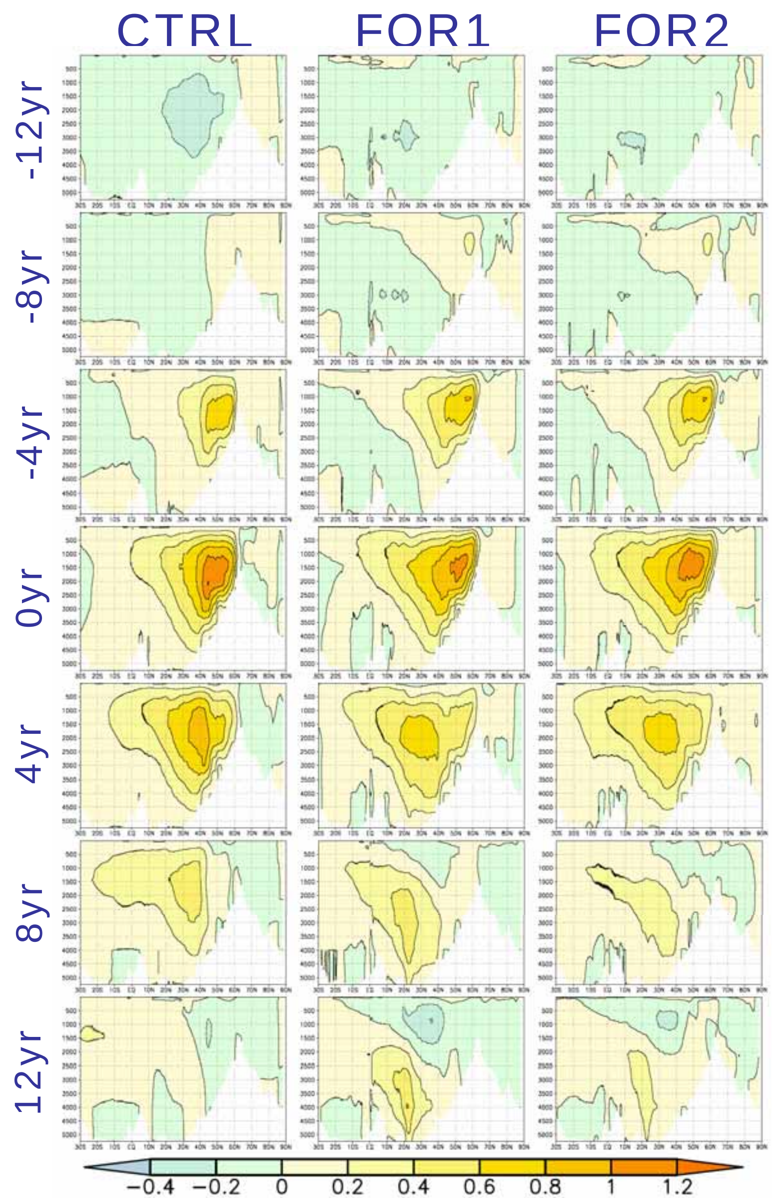
- **Positive overturning anomalies appear in the sinking regions of the North Atlantic several years before a MOI maximum (7-8 yr).**

- **When the lag is 0 the overturning reaches its maximum anomalies and extension.**

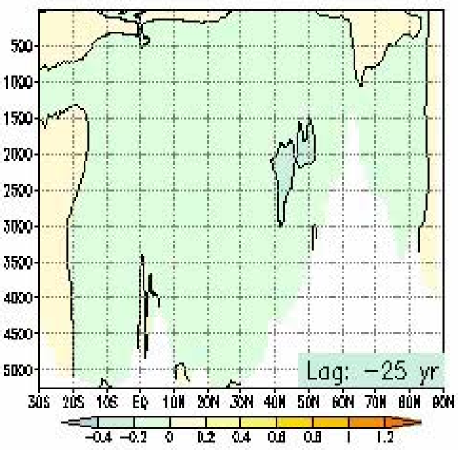
- **About 8 years after the maximum the overturning in the sinking region becomes negative.**

- **The positive anomalies move southwards in latitude in CTRL, while in the forced runs they are confined to the deep ocean.**

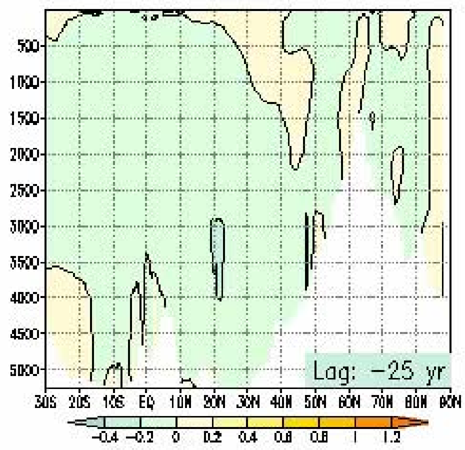
Regression patterns MOI-Streamfunction



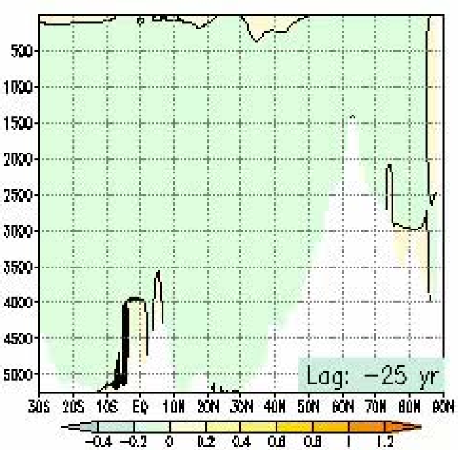
MODES IN LOW-FREQUENCY I



FOR1

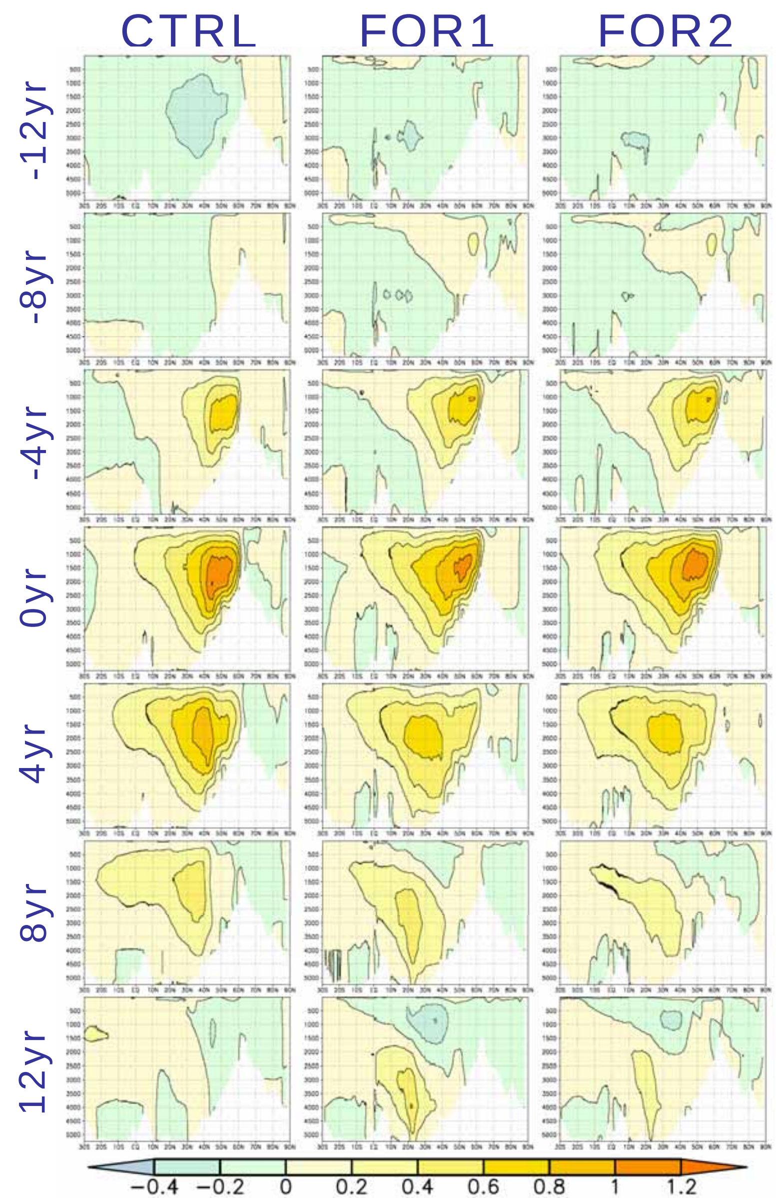


FOR2



CTRL

Regression patterns MOI-Streamfunction

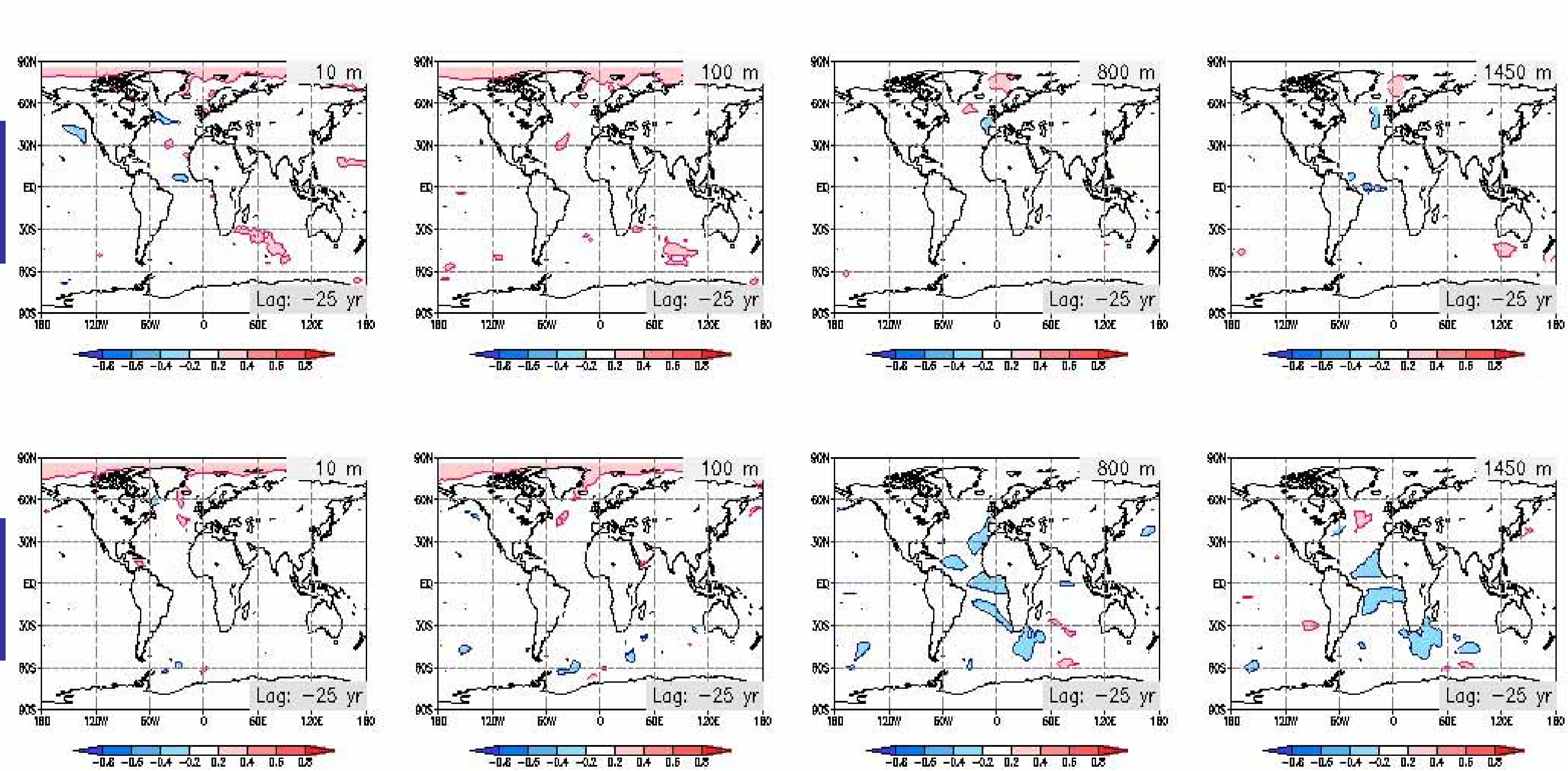


MODES IN LOW-FREQUENCY II

Correlation maps MOI – Density anomalies

CTRL

FOR1



SUMMARY AND CONCLUSIONS

I. All simulations show a realistic AMOC, with maximum values close to estimates.

II. During the industrial era the forced runs exhibit a weakening in the AMOC that is intensified in the future scenario simulations.

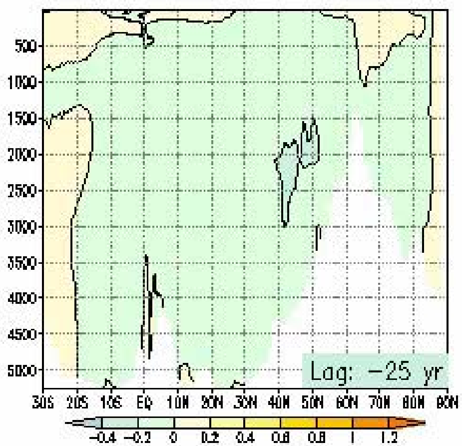
III. The high-frequency modes are common to the three simulations and forced by various wind regimes.

IV. In the low-frequency two propagating modes are identified, one in the forced runs and the other in CTRL. Both are related to the irruption of density anomalies in the North Atlantic sinking region several years before the MOI maximum.

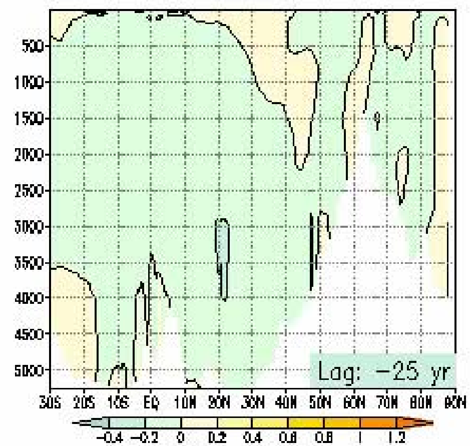
THE END

¡¡¡Thanks for your attention!!!

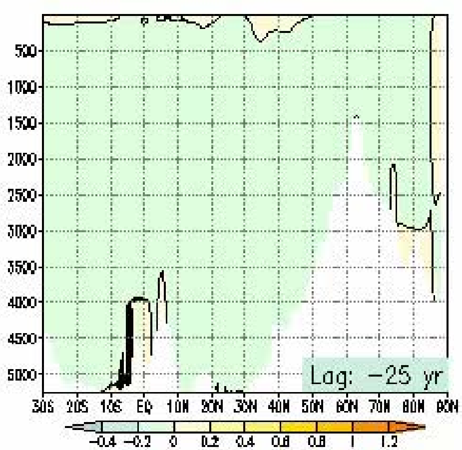
MODES IN LOW-FREQUENCY I



FOR1



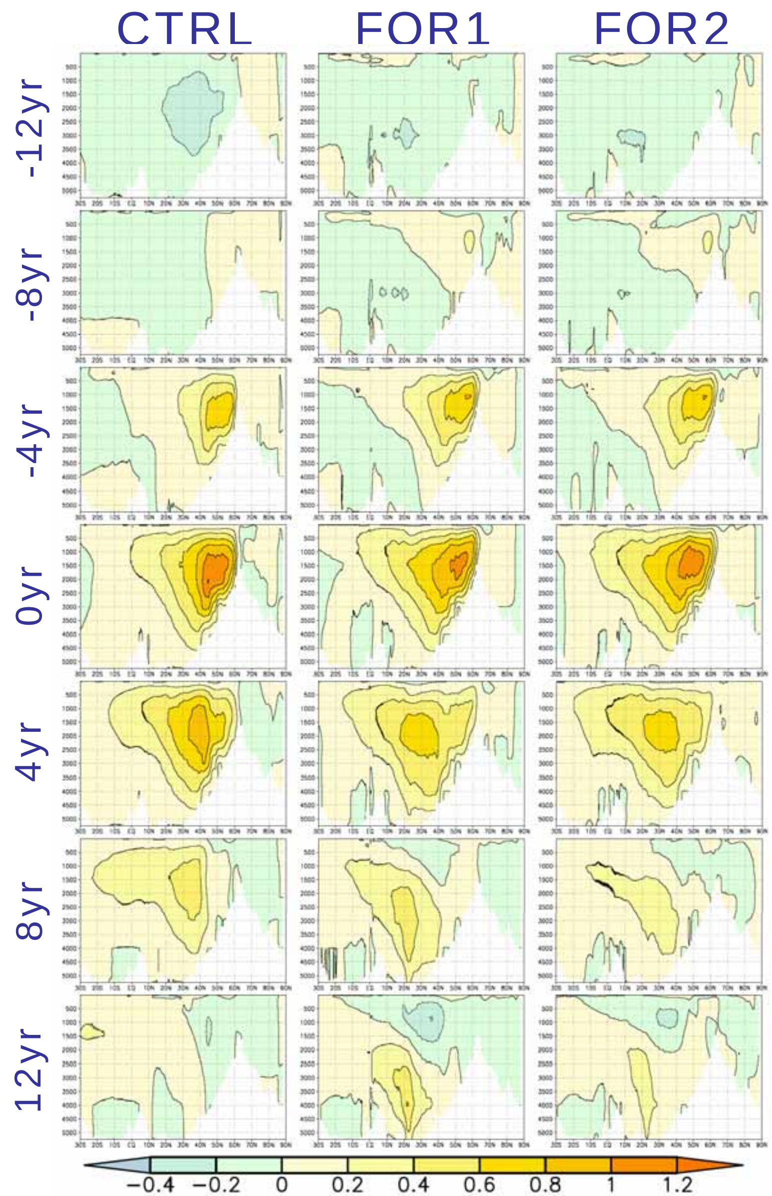
FOR2



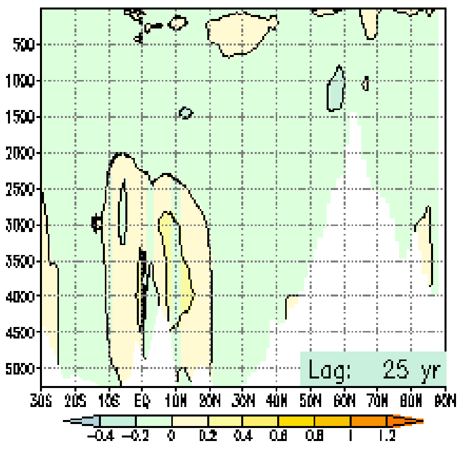
CTRL

The propagating mode in CTRL differs in some extent from the forced ones. The main differences occur in the deep ocean, where the forced runs exhibit higher variability.

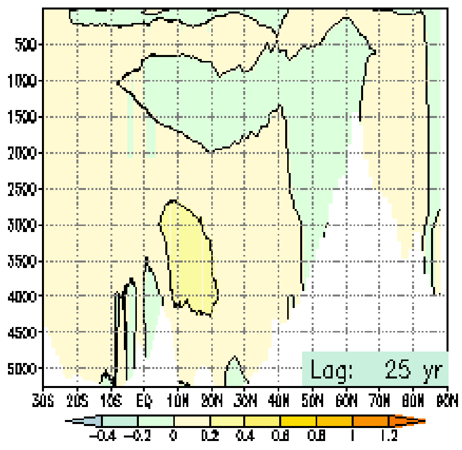
Regression patterns MOI-Streamfunction



MODES IN LOW-FREQUENCY



FOR1



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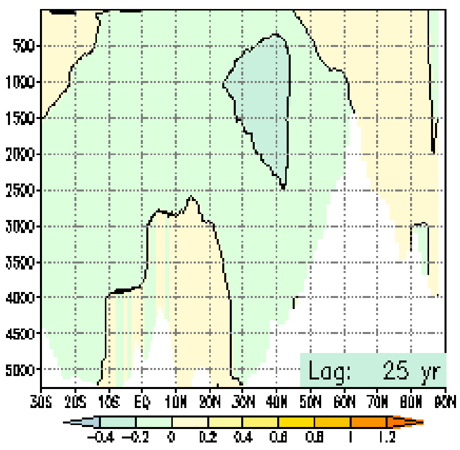
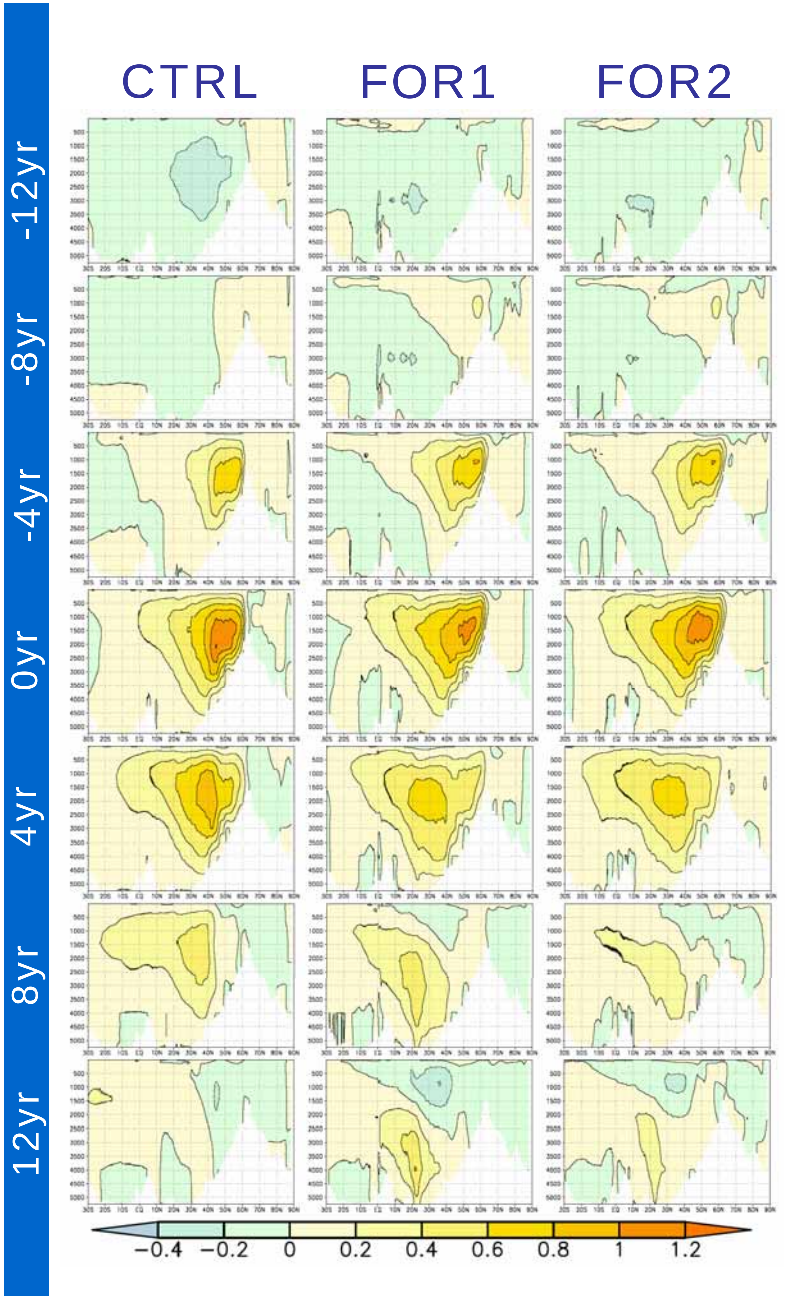
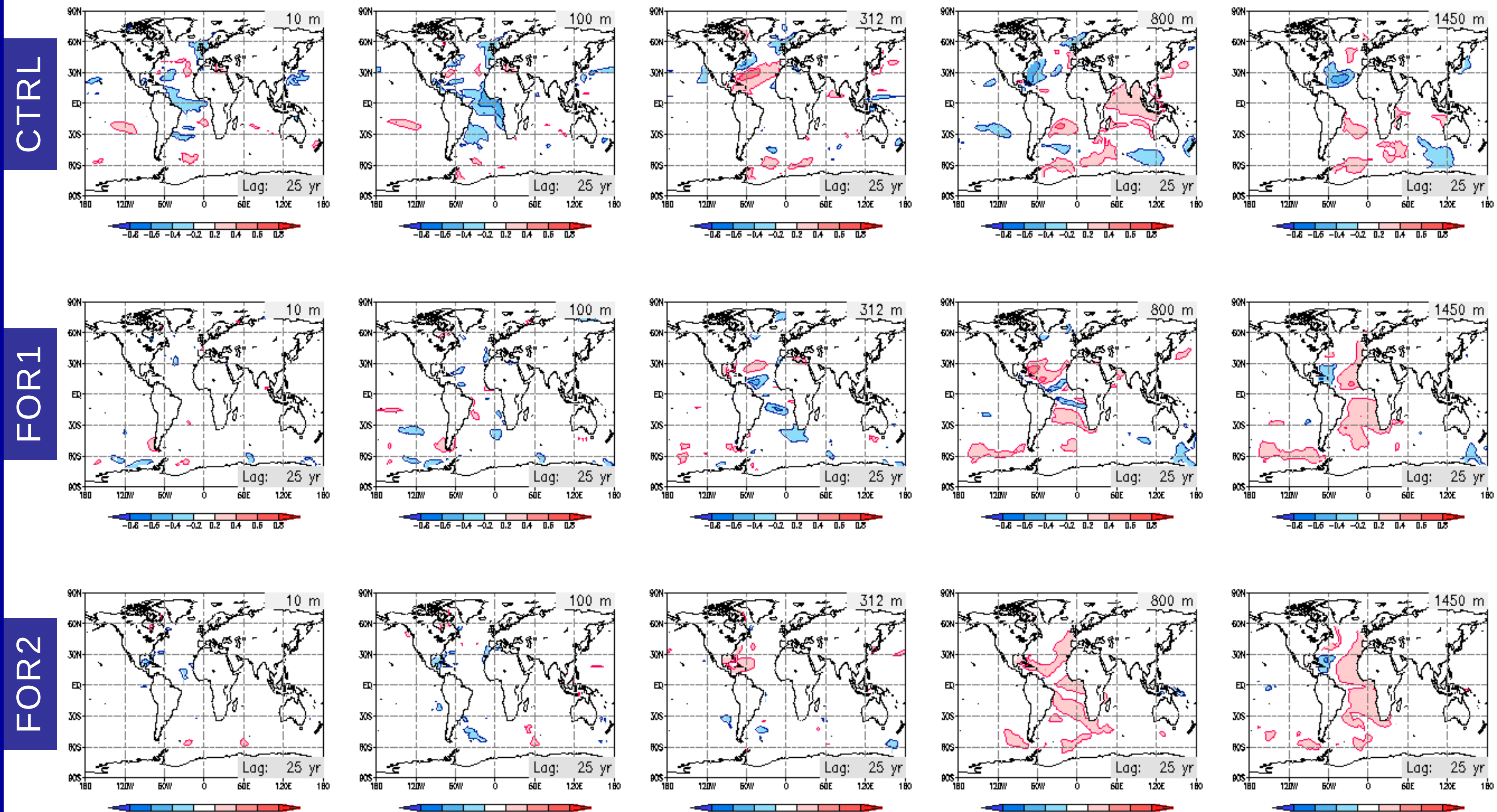


CTRL



MODES IN LOW-FREQUENCY II

Density anomalies

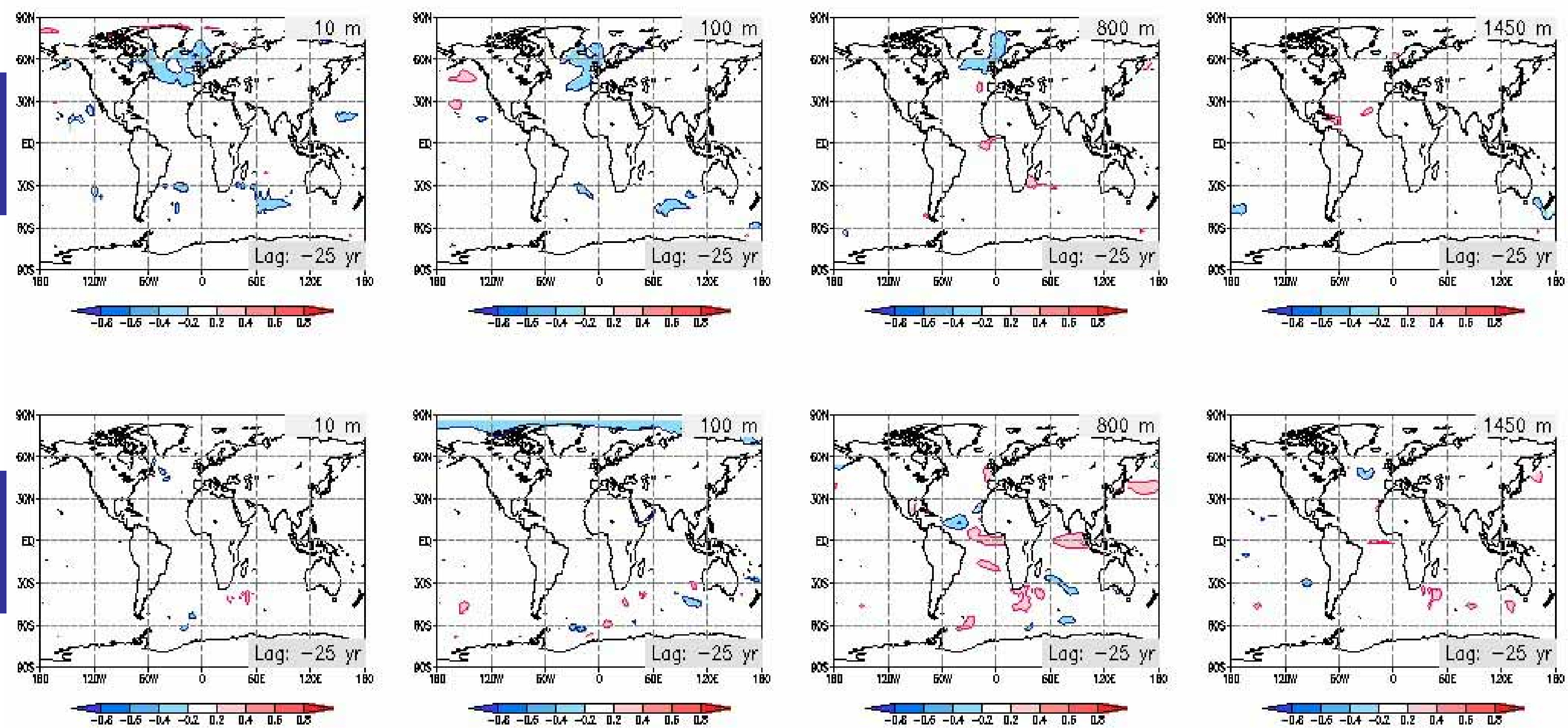


MODES IN LOW-FREQUENCY III

Temperature anomalies

CTRL

FOR1

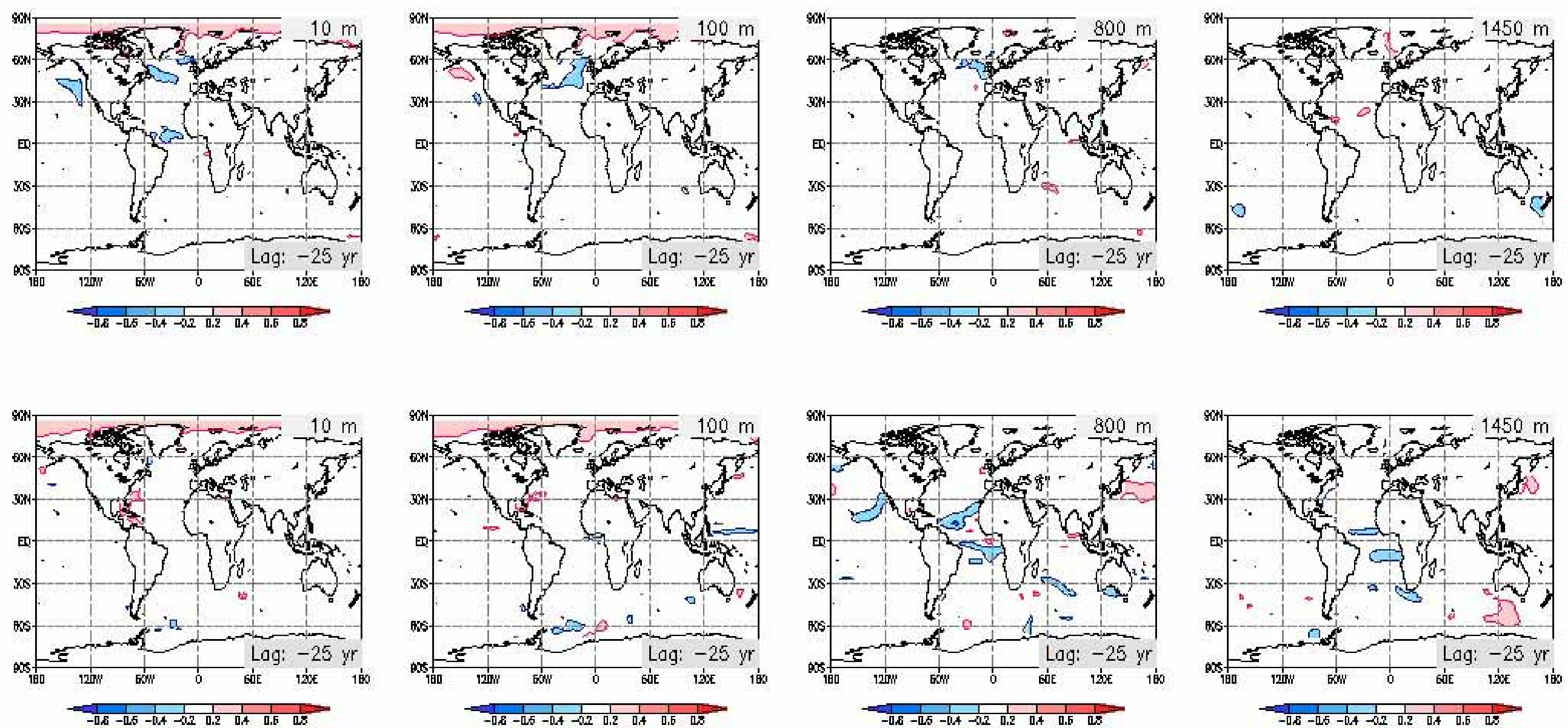


MODES IN LOW-FREQUENCY IV

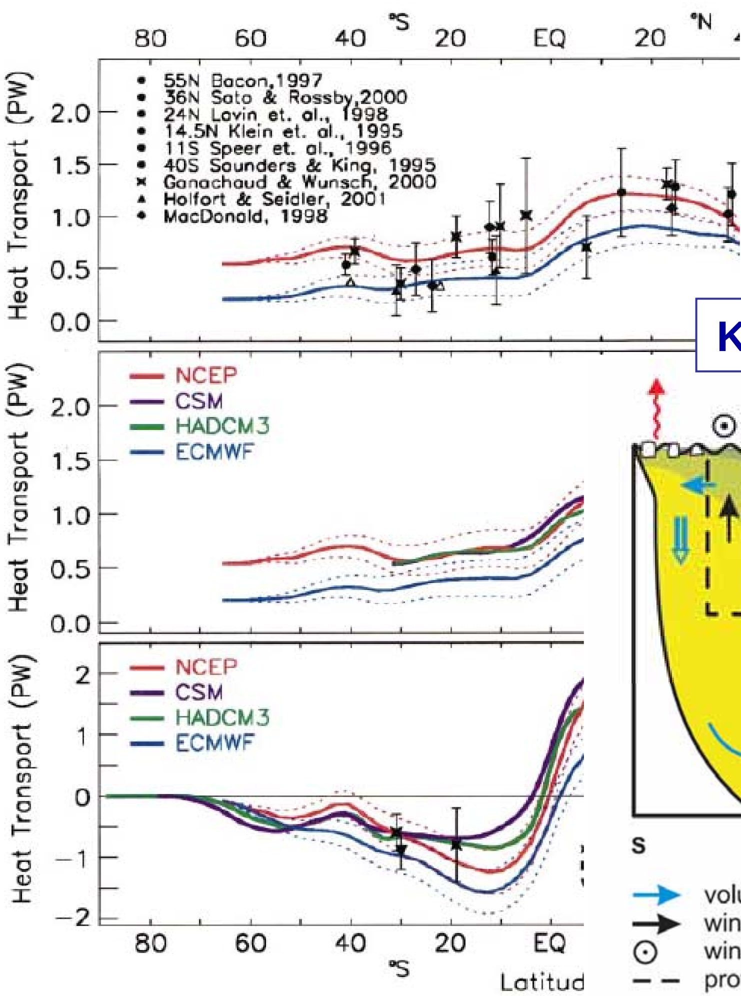
Salinity anomalies

CTRL

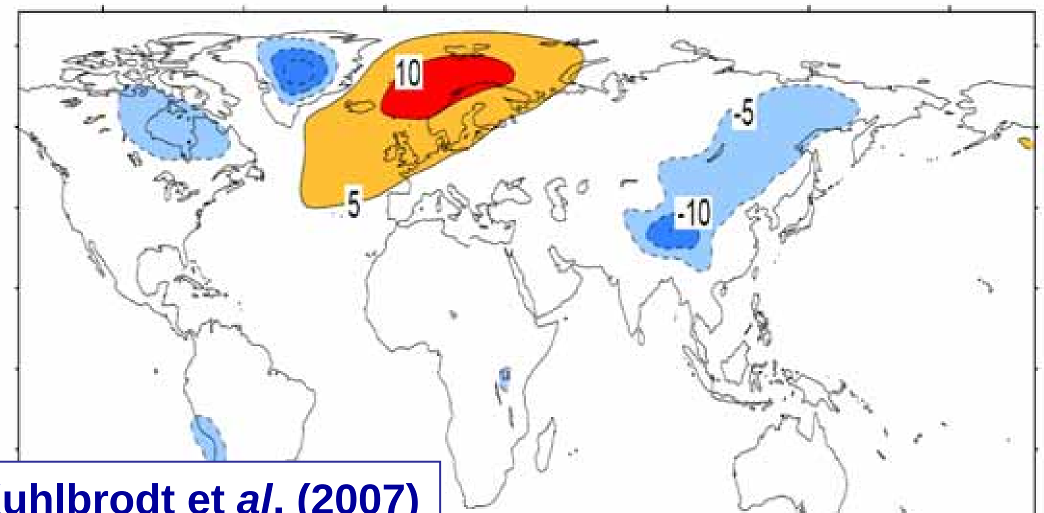
FOR1



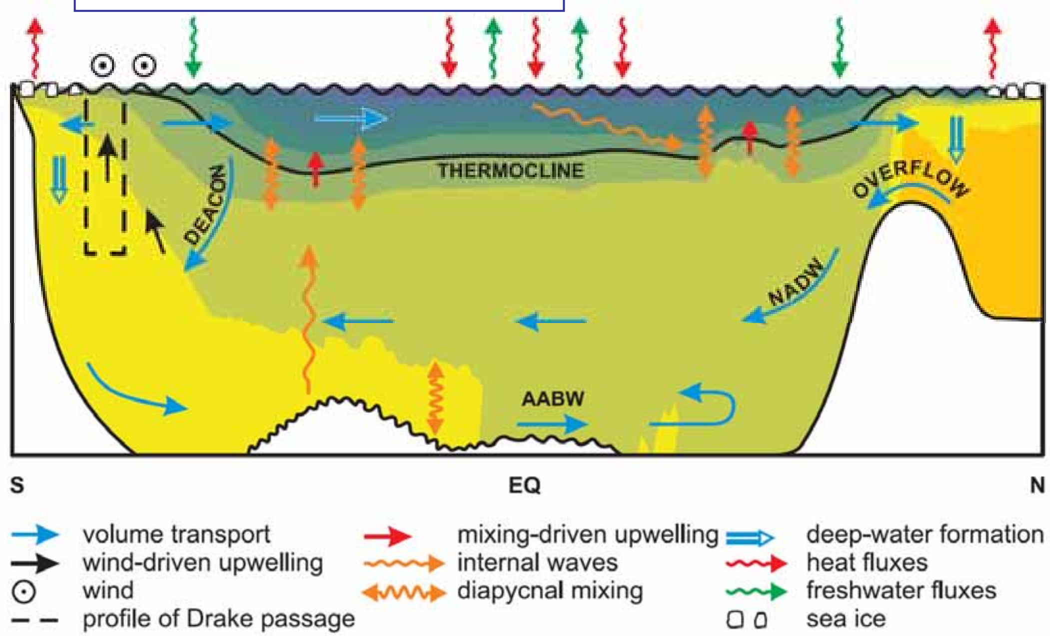
MOTIVATION



T(K) anomaly respect to zonal mean



Kuhlbrodt et *al*. (2007)



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OUTLINE

I. Introduction

II. Model and Experiments

III. AMOC climatology and temporal evolution

IV. Modes in high-frequency

V. Modes in low-frequency

VI. Summary and conclusions