Sensitivity of the Atlantic Thermohaline Circulation to Global Freshwater Fluxes

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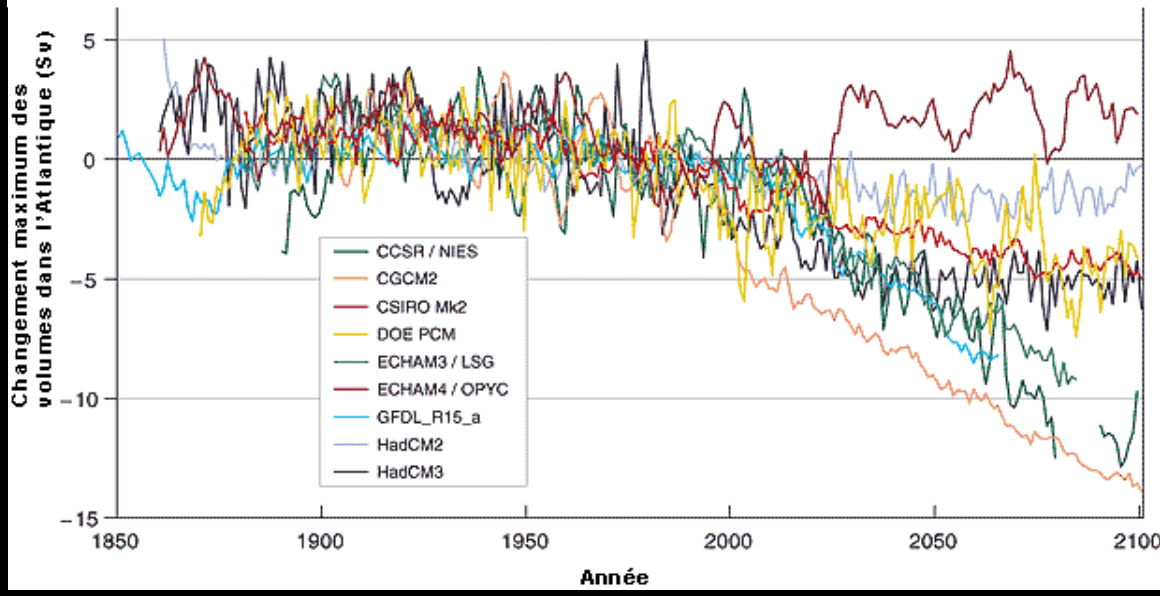
Background

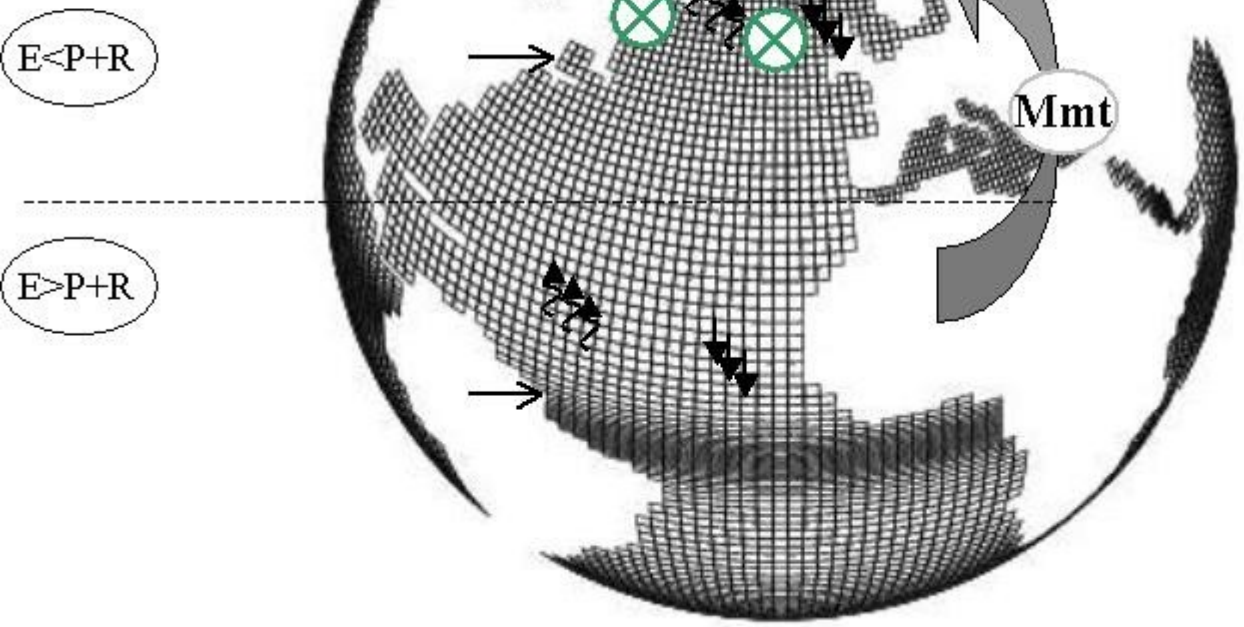
IPCC THC Index (max meridional stream fonction)



Background

Ssa: Southward salt advection

Nsa: Nortward salt advection



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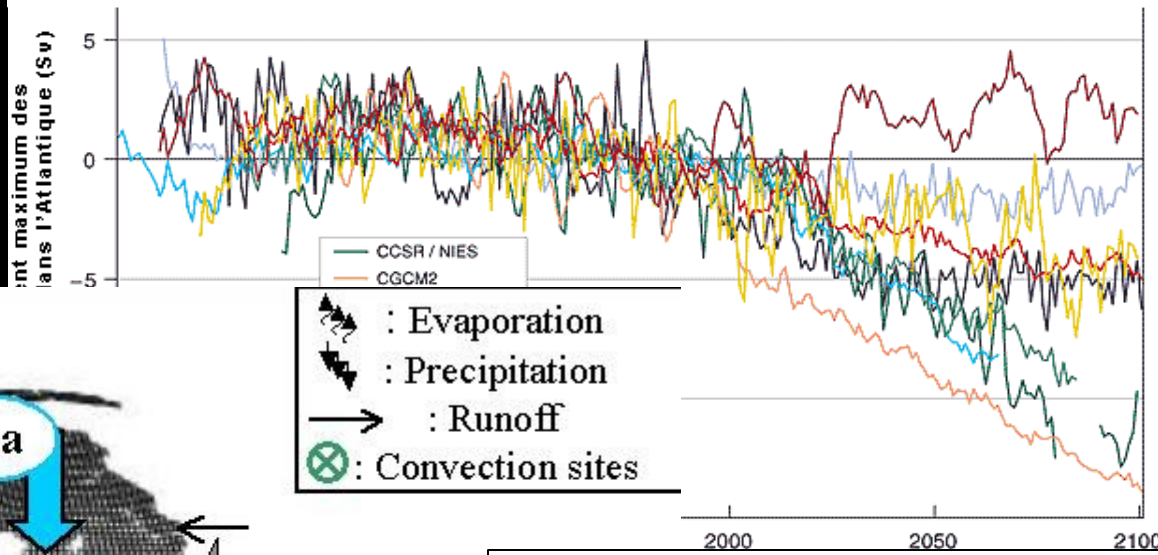

- IPCC scénarii display a wide range of behaviors for the future of THC
- Differences are due to the intensified hydrological cycle, with ambivalent consequences
- Ex : Dixon (1999)

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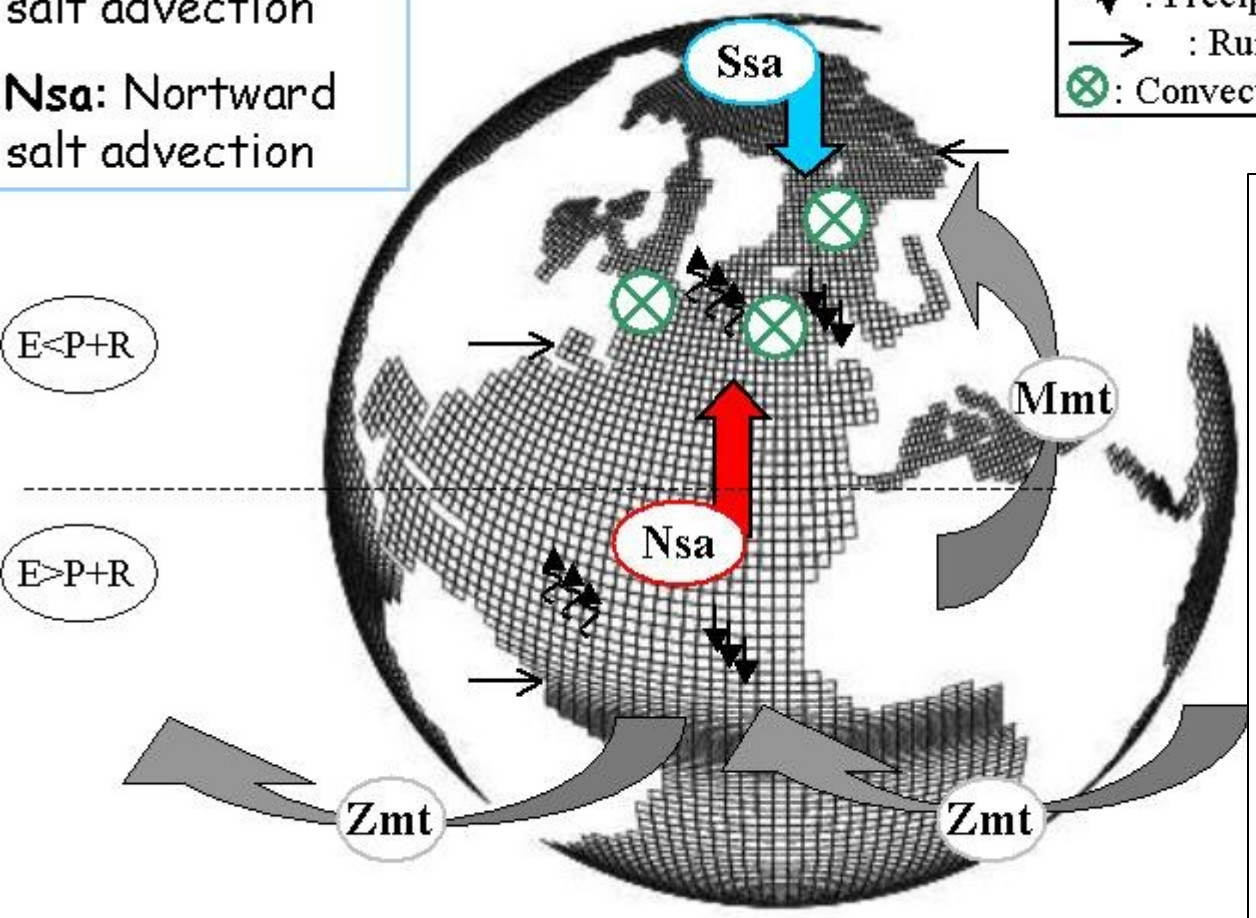

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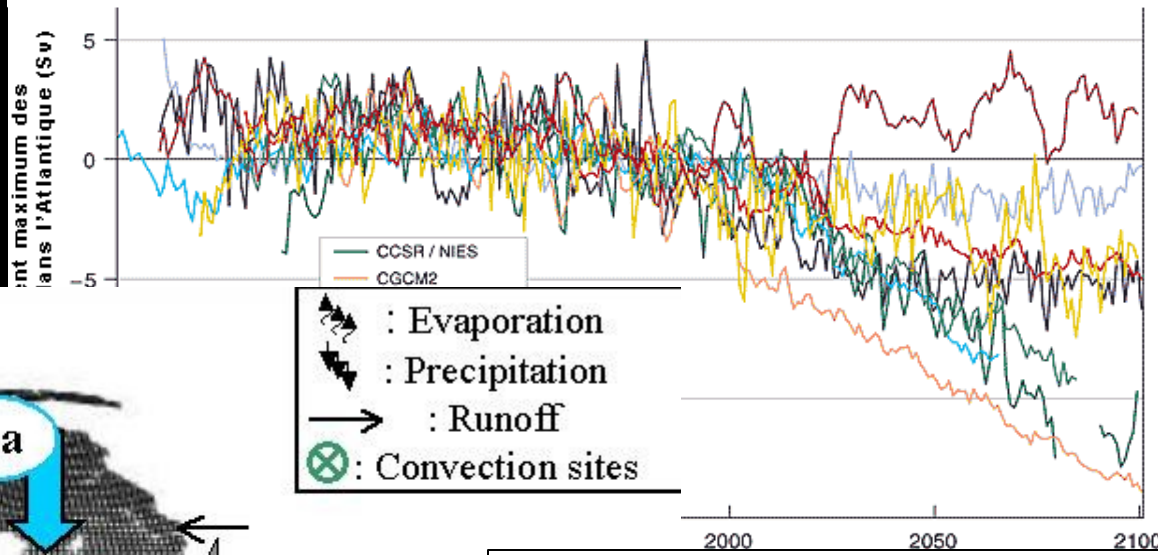


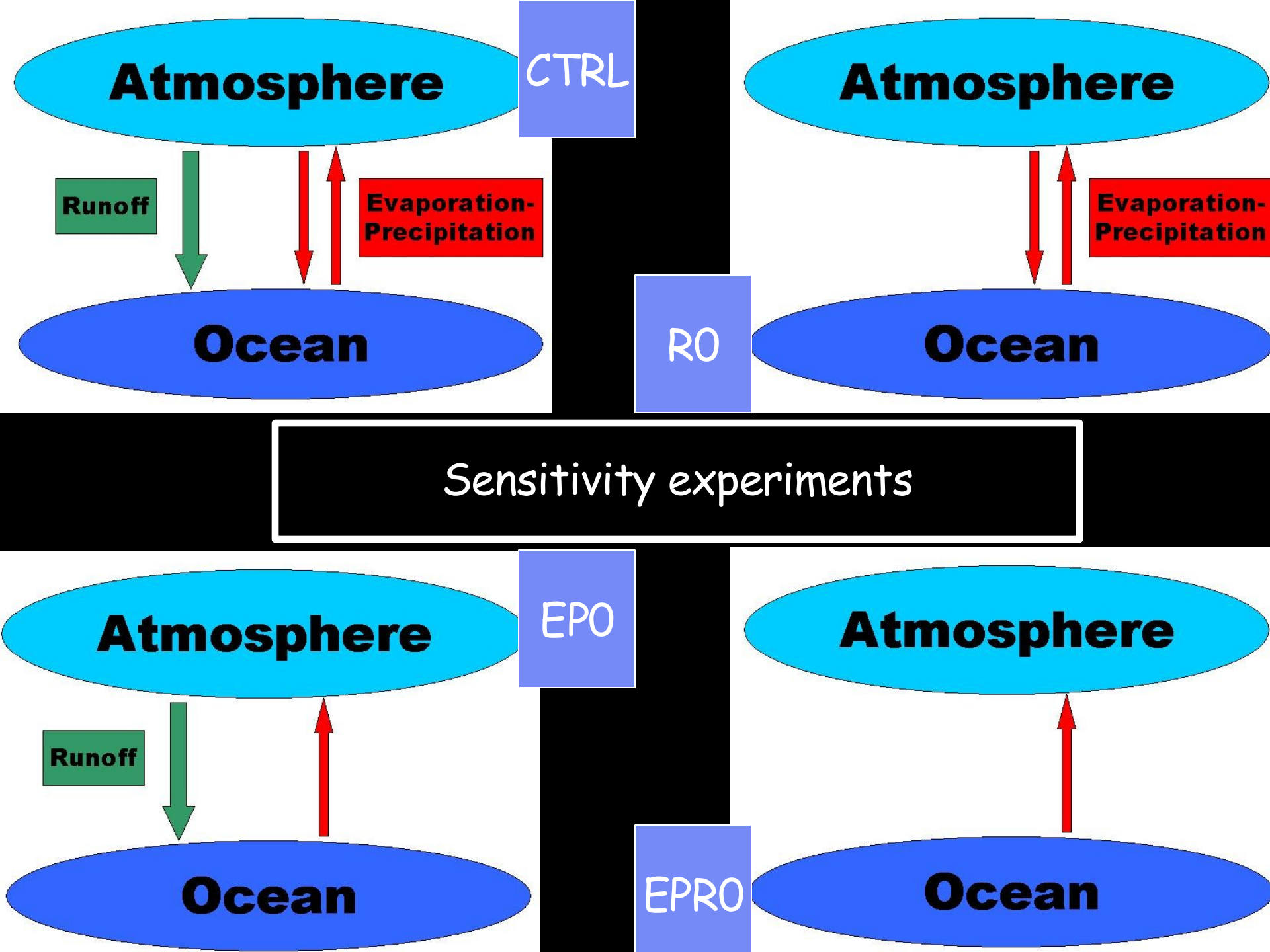
- IPCC scénarii display a wide range of behaviors for the future of THC
- Differences are due to the intensified hydrological cycle, with ambivalent consequences
- Ex : Dixon (1999) vs Latif (2000)

This study:

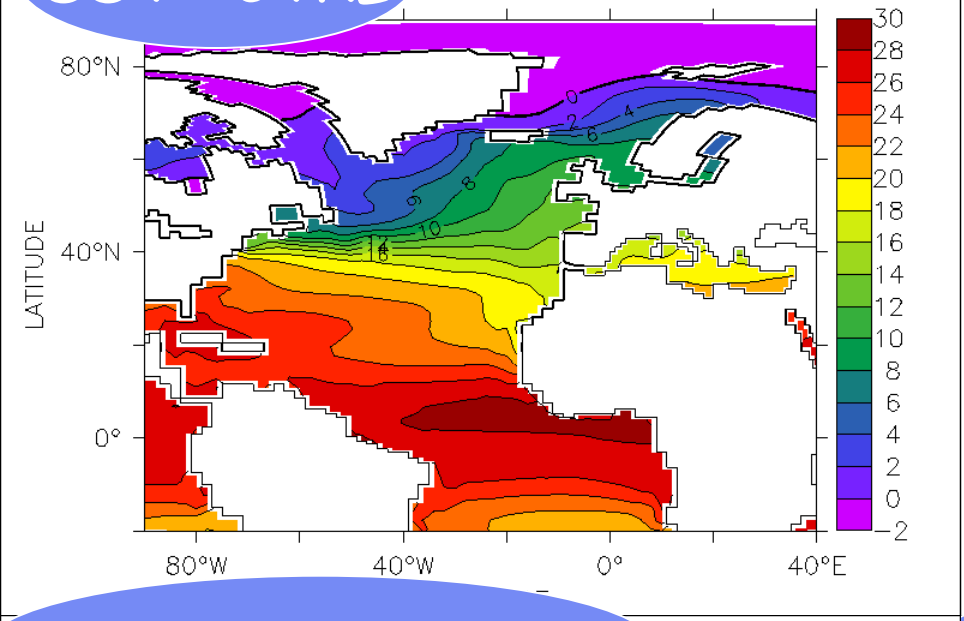
- Aims: Quantify the impact of global freshwater forcing on the THC, illustrating for each process:

  Time Scales and Magnitude

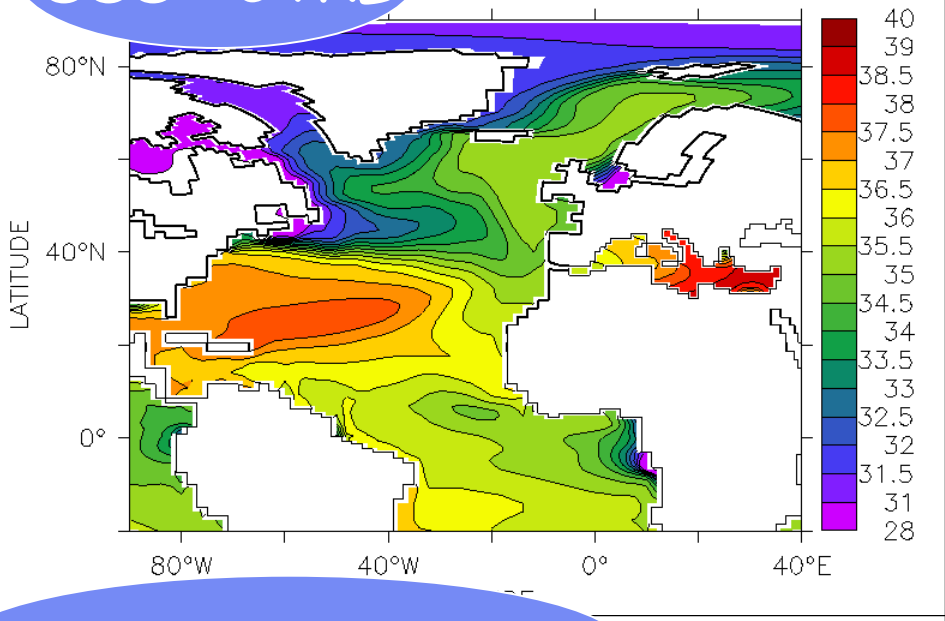
- Tool: IPSL-CM4 coupled model


Atmosphere
CTRL
Runoff
Evaporation-
Precipitation
Ocean
Atmosphere
Evaporation-
Precipitation
RO
Ocean
Sensitivity experiments
Atmosphere
EPO
Runoff
Ocean
Atmosphere
EPRO
Ocean

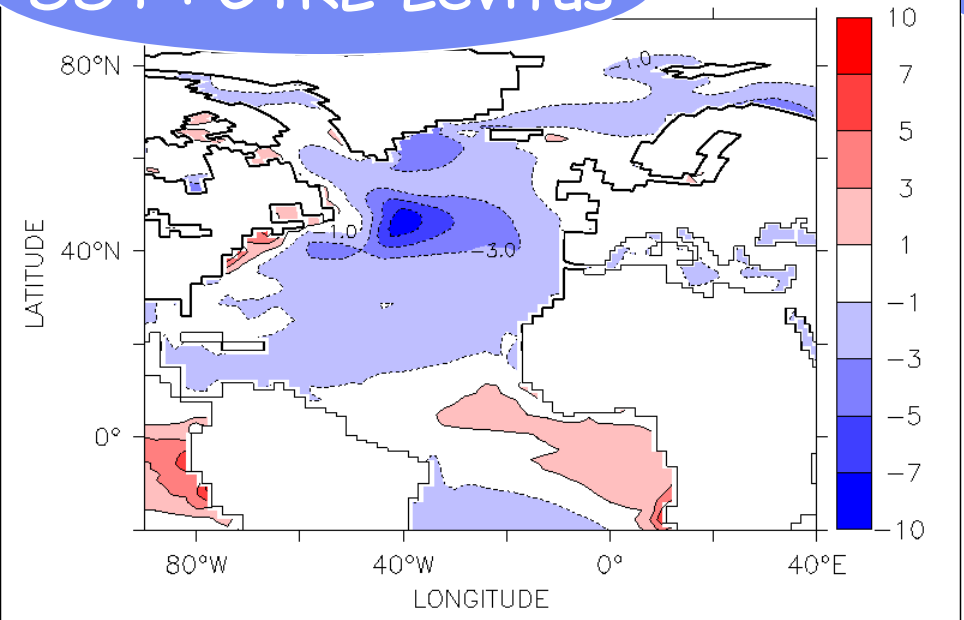
SST : CTRL



SSS : CTRL



SST : CTRL-Levitus



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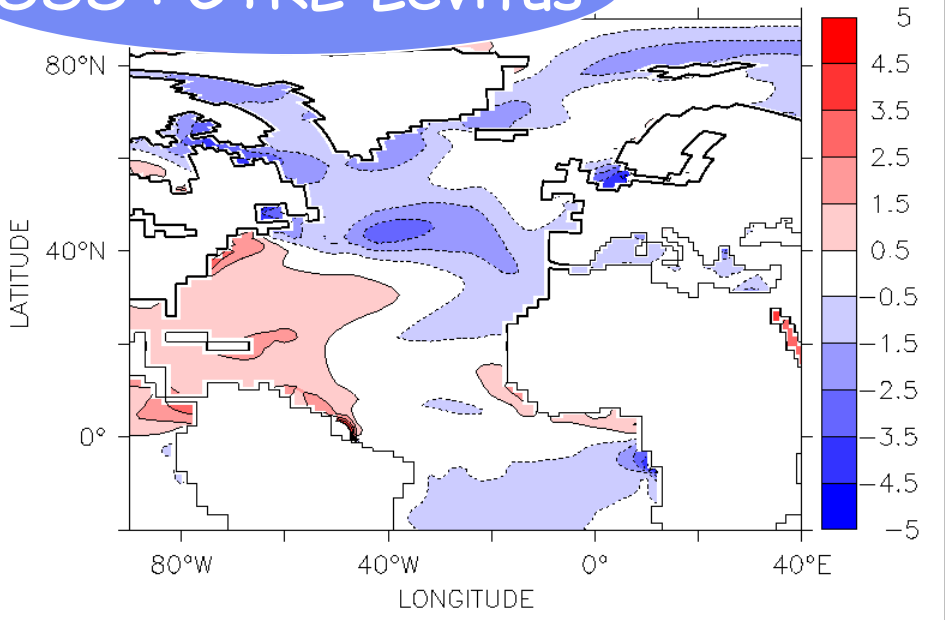
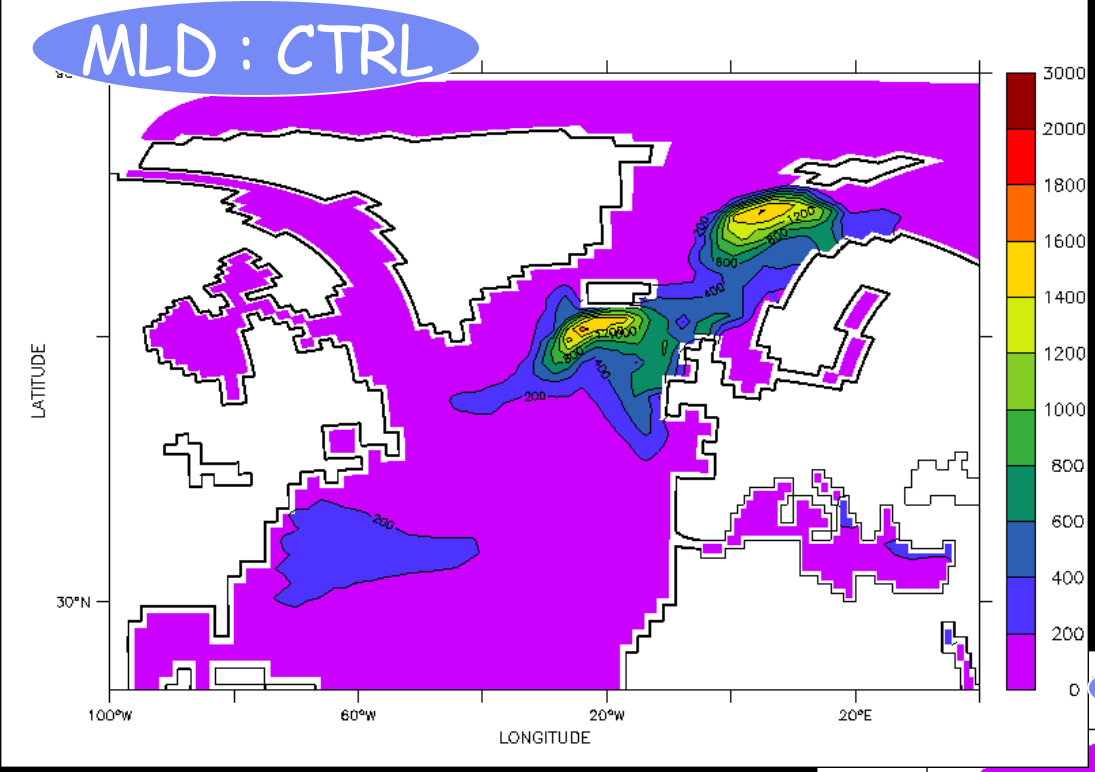
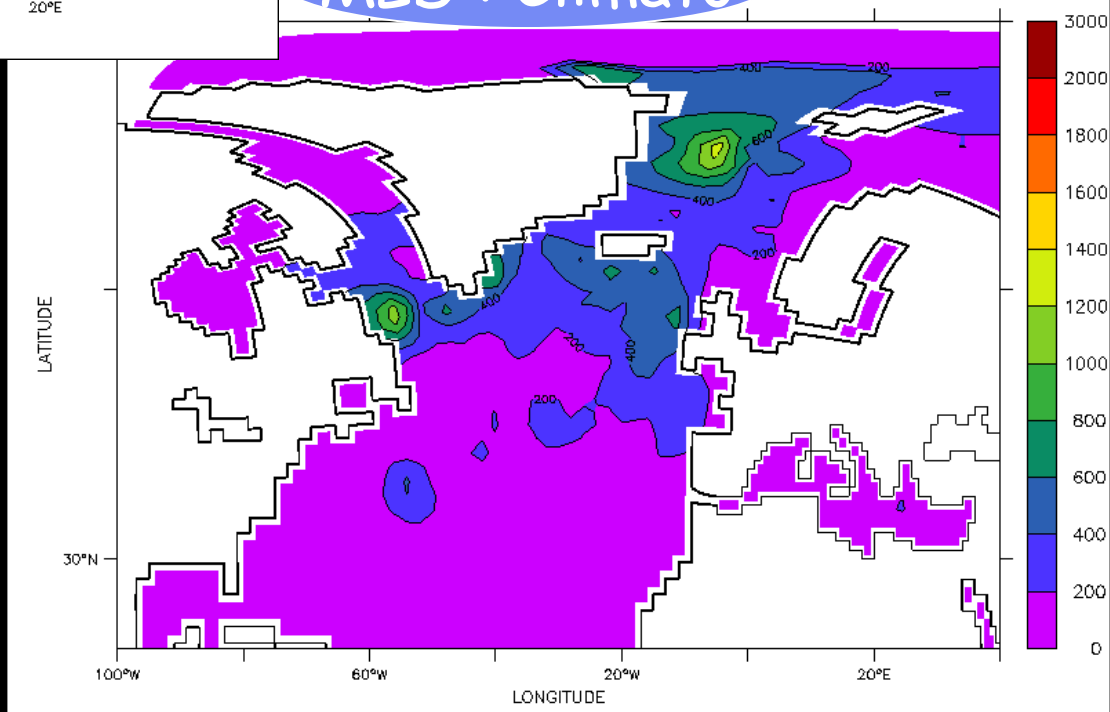


MLD : CTRL



- Profile based climatology by de Boyer (2004)
- No convection in the Labrador Sea in CTRL
- Other sites are correct

MLD : Climato



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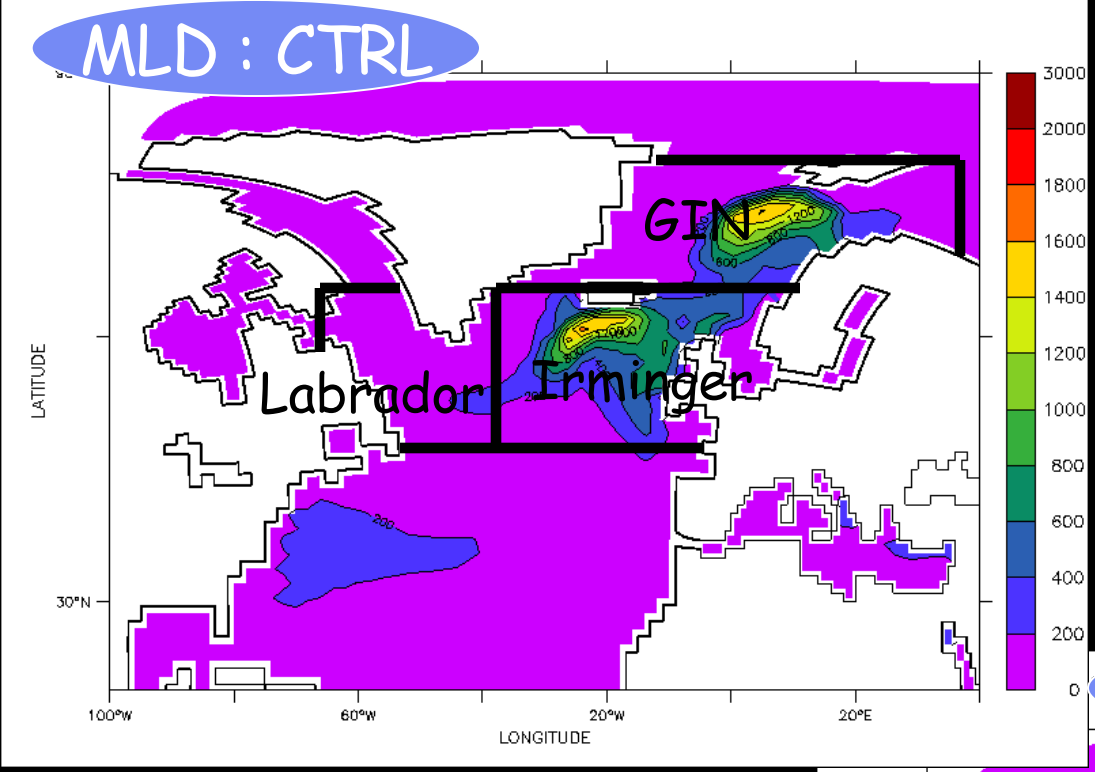

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- 3 boxes are defined for the remainder of the study

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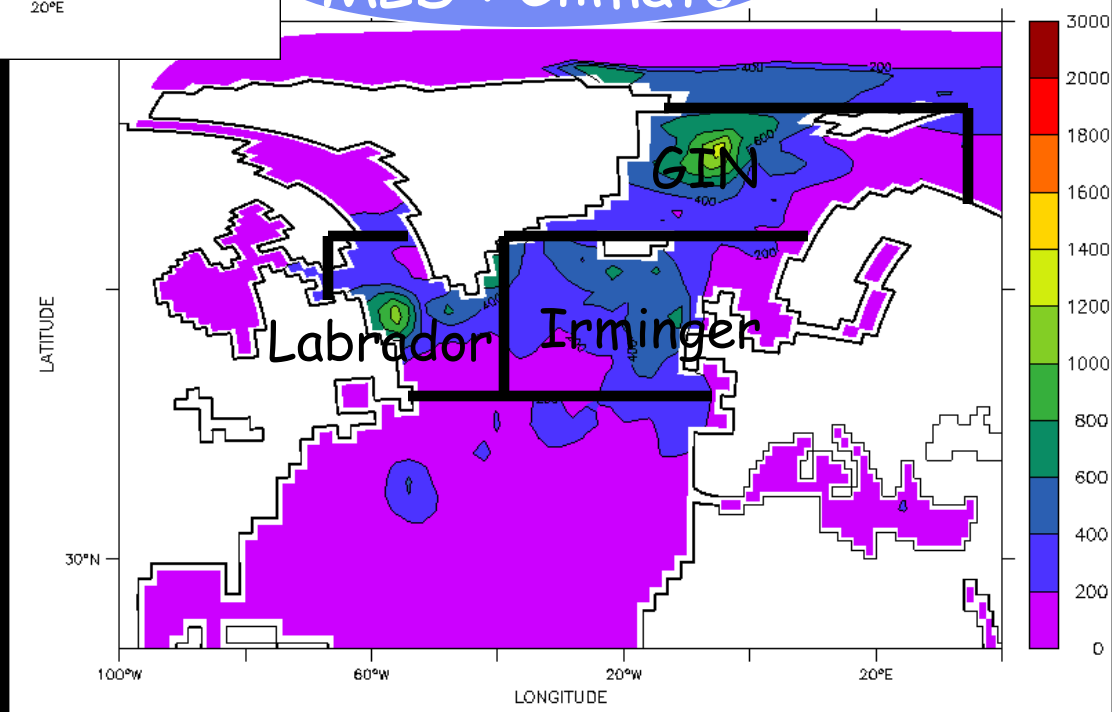
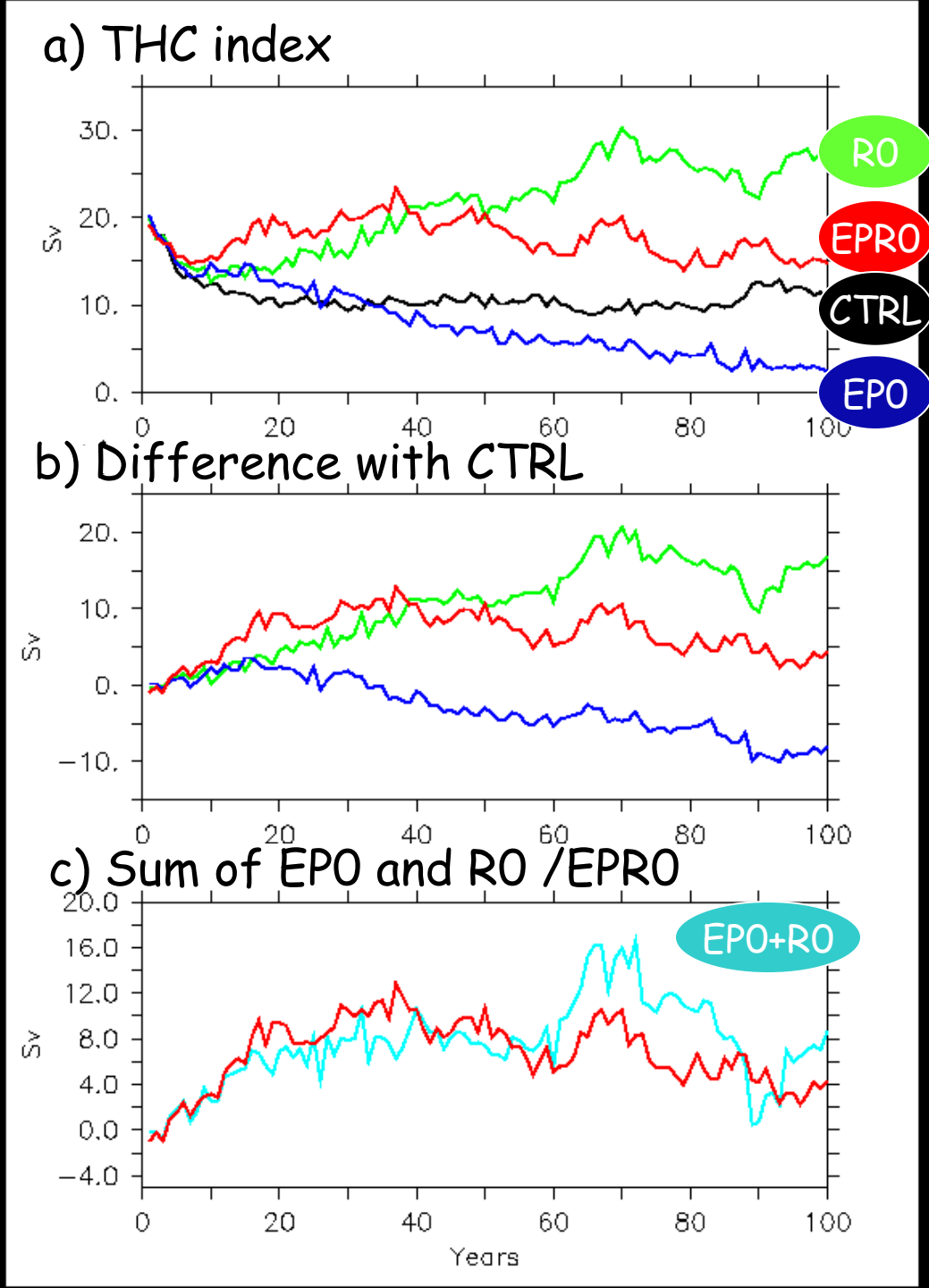


THC response over 100 years

- EPO decreases down to 3Sv
- RO increases up to 30 Sv
- EPRO is nearly the sum of EPO and RO over 60 years = Linearity on this time scale

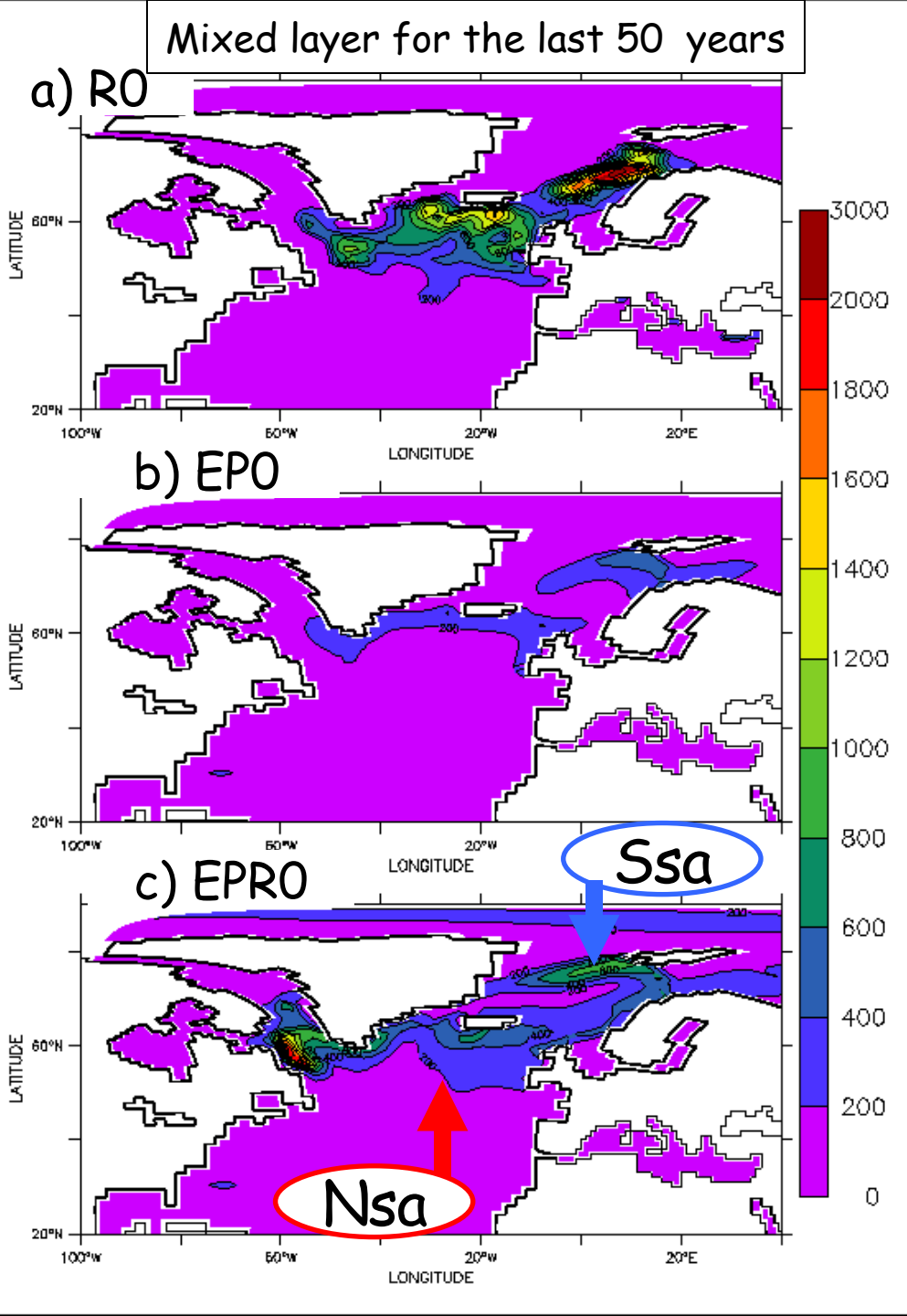
→ EPRO = EPO + RO



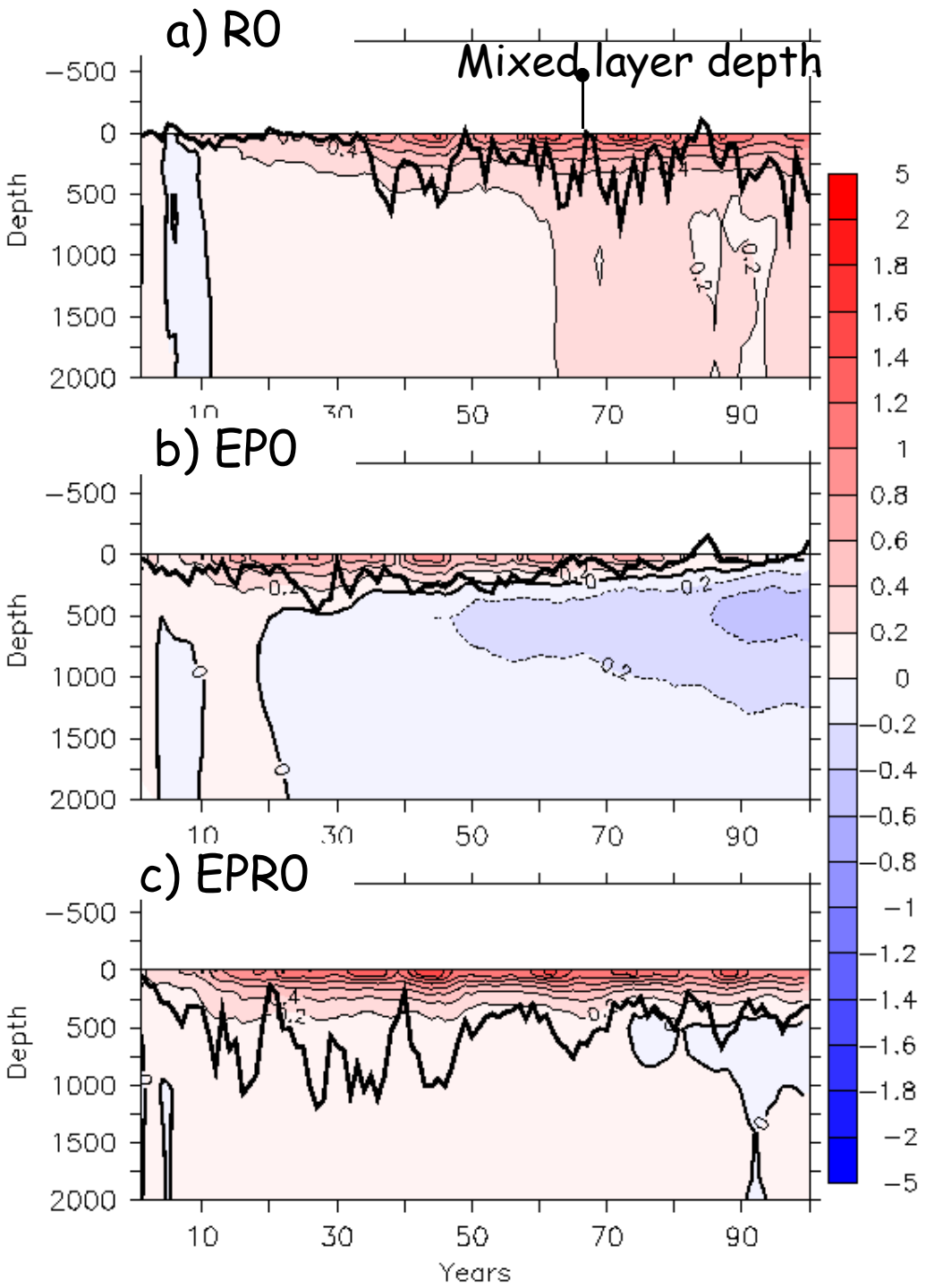
Convection sites changes

- Convection is enhanced in R0
- Convection vanishes in EP0
- Convection sites shift in EPR0: Labrador <-> Irminger

Different impact of Nsa and Ssa on the stratification of the convection sites

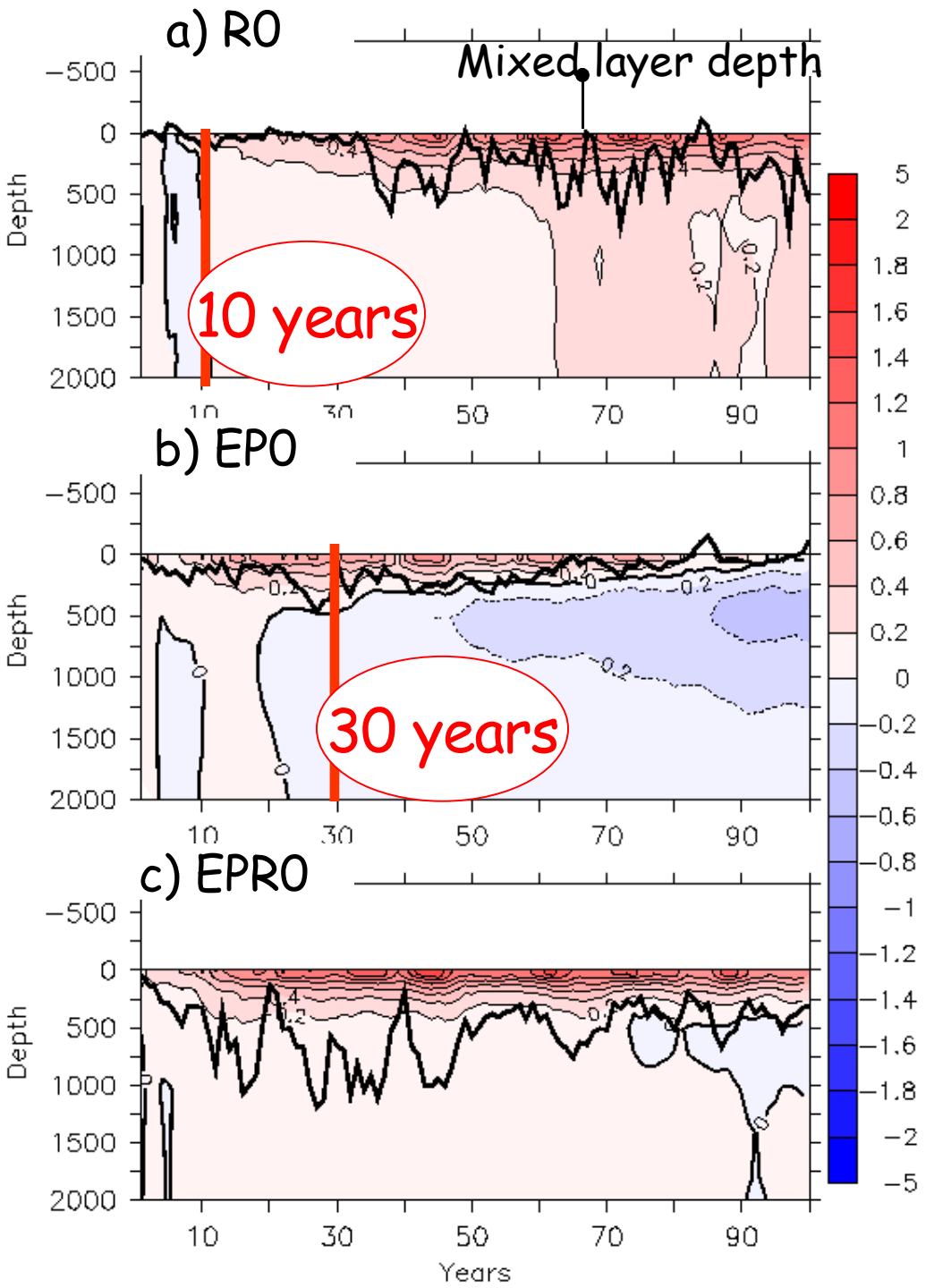


Stratification changes compared to CTRL in the Labrador Sea



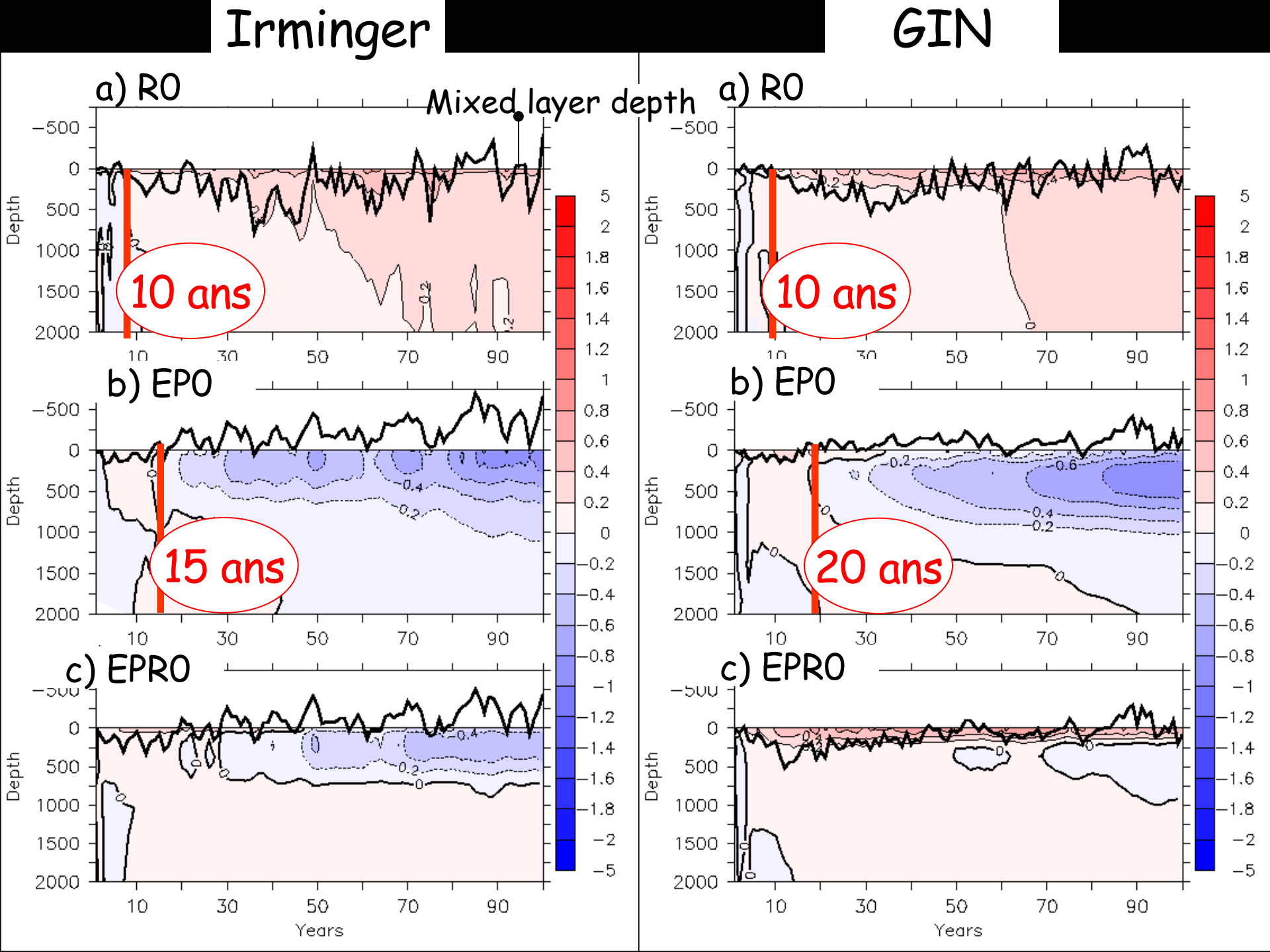
Stratification changes compared to CTRL in the Labrador Sea

- Ssa decrease => positive impact in 10 years
- Nsa decrease => negative impact in 30 years
- Labrador Sea mostly sensitive to Ssa and local forcing



Irminger

GIN



Summary of the convection sites sensitivity

	Labrador Sea	Irminger Sea	GIN Seas
Nsa	+ (30 years)	+ (15 years)	+ (20 years)
Ssa	- (10 years)	- (10 years)	- (10 years)
Global	-	+	/

+: enhances convection

-: limits convection

/: Neutral impact, processes balance each other

Conclusions

- Convection sites are sensitive to differents components of the hydrological cycle: Labrador / Irminger; (Wood 1999). 10 to 40 years time scales coherent with Vellinga (2002)

- Global freshwater forcing *damps* the THC, i.e. local freshwater forcing dominates over a time frame of 100 years i.e during transient response (Saenko, 2003)

- Model dependent results, but gives a framework for analysing THC spread due to changes in the freshwater forcing in IPCC scenarii.

Thank you

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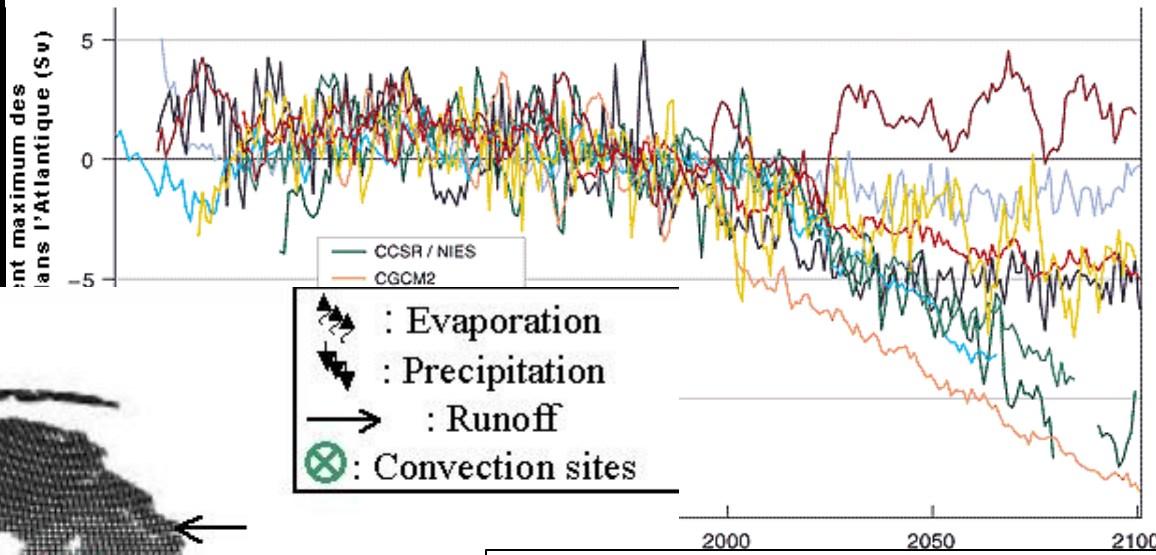

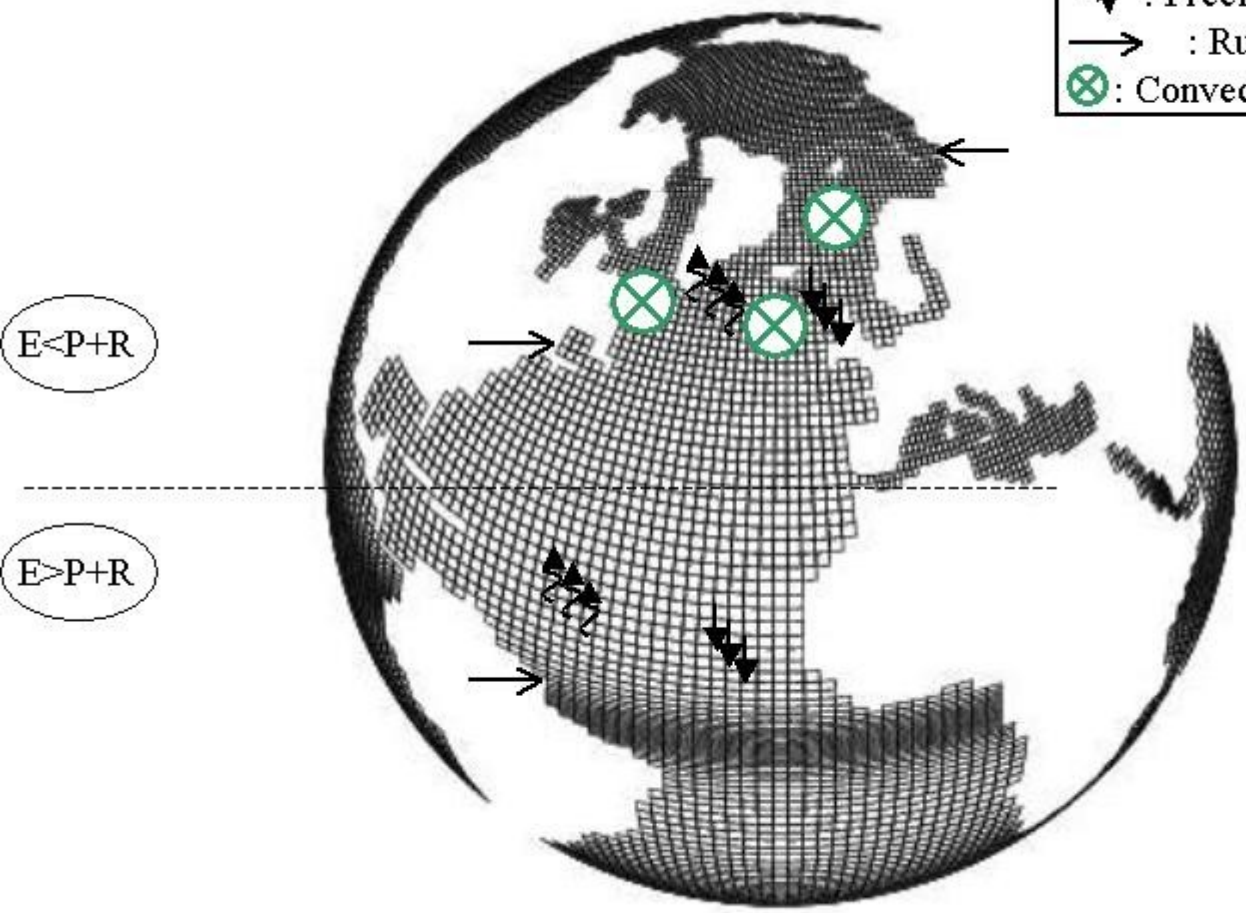

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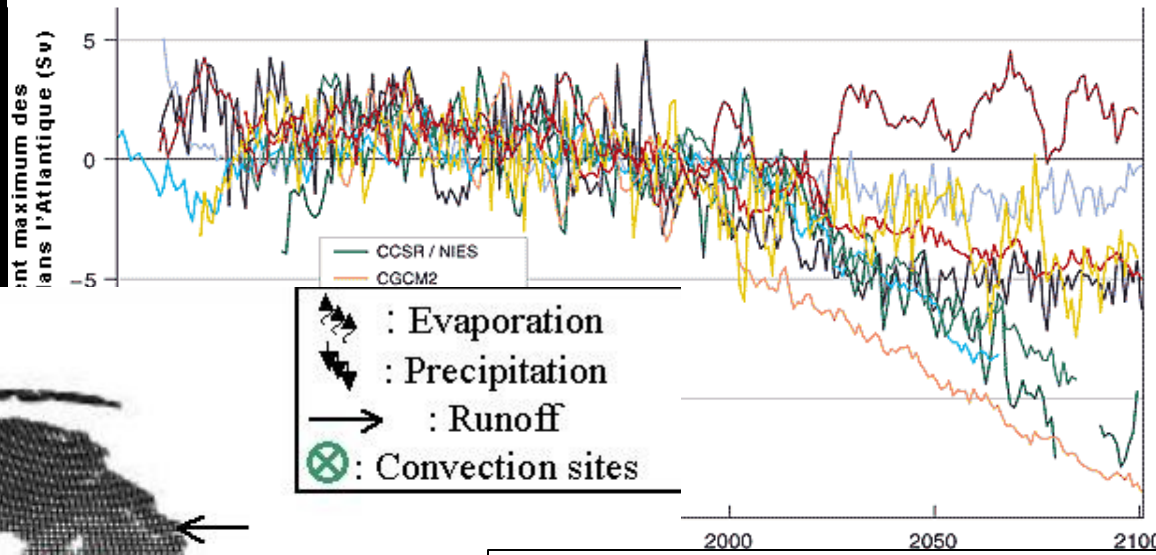

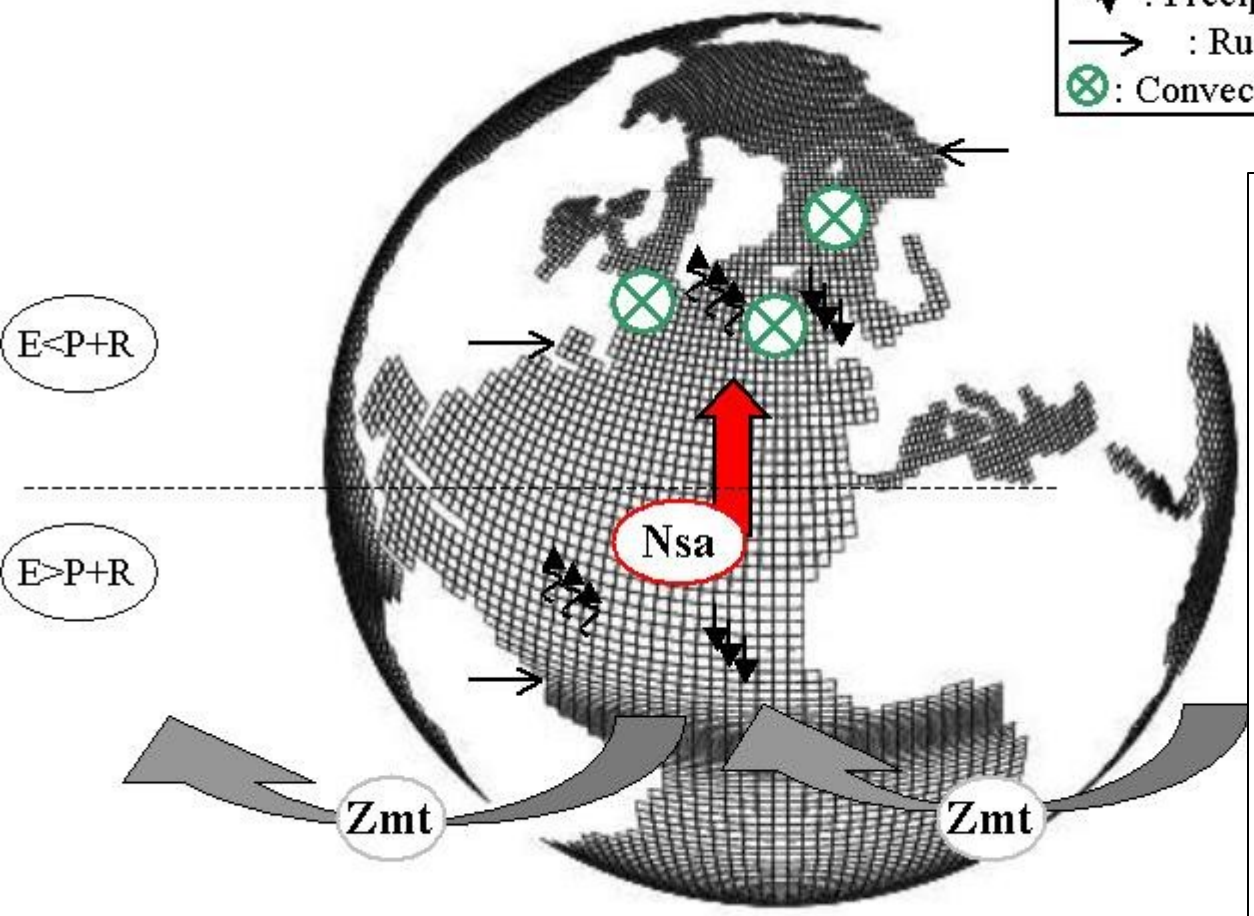

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