IFM-GEOMAR
Leibniz-Institut für Meereswissenschaften
an der Universität Kiel

LOOP Current variability – its relation to meridional overturning circulation and the impact of Mississippi discharge

A Preliminary Outline

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RD1 / Theory and Modelling

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Key Objectives

Interprete paleo-records found in the Gulf of Mexiko (GOM) aiming at a better understanding of the circulation changes in this region.

↷ for the interpretation of these records we will focus on

- the role of **Loop Current strength** and **eddy shedding**
- **freshwater discharge events** from the Mississippi

↷ under **different climatic boundary conditions**

- cold-deglacial
- warm-deglacial
- interglacial

The Modelling Strategy

- Use present day regional model of the North Atlantic (FLAME) with different setups with increasing **resolution from 100 km up to 10 km**

- in particular **eddy resolving** resolution (5-10 km) will be used to analyze ocean dynamics on smaller length scales

- simulate the response of the circulation in the GOM to

  (i) decreased **sea level**

  (ii) changes in **surface forcing** over the North Atlantic
  (focus on windstress as the major contributor)

  (iii) Mississippi point-source **freshwater influx** at different rates

FLAME

- FLAME = Family of Linked Atlantic Model Experiments
- “eddy-resolving” circulation model, which predicts and simulates velocity, temperature, and salinity
- **Model code**: extended and revised version of the MOM2-Code (http://www.ifm-geomar.de/index.php?id=spflame)
- **Model area**: 20°S - 70°N
- **Horizontal (grid-) resolution**: 4/3°, 1/3° and 1/12° ($\sim$ 8 km in the GOM)
- **Vertical resolution**: 45 vertical layers (10 m at the surface up to 250 m at depth)
- **Forcing**: thermohaline forcing (heat-, freshwater fluxes), wind stress

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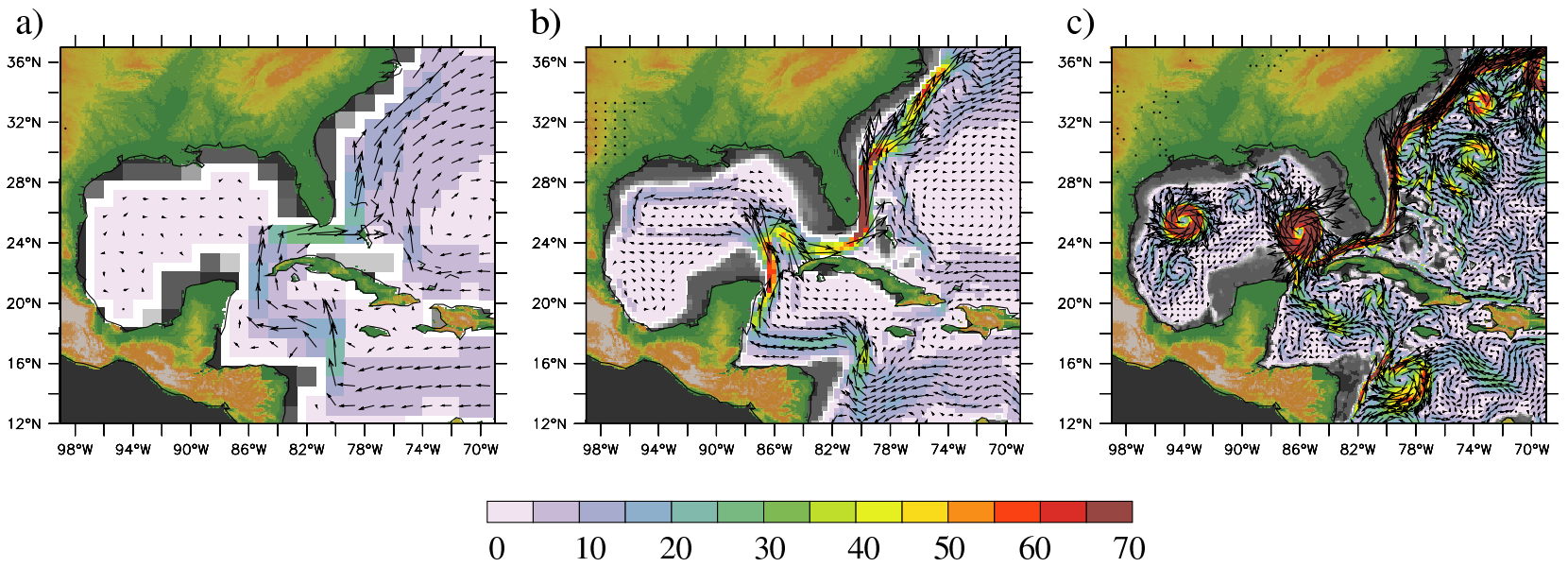
Model Resolution

Numerical Simulation of the instantaneous velocities in the GOM at 200m depth with horizontal resolution of (a) $4/3°$ (b) $1/3°$ (c) $1/12°$



Outline

- Response of Flame-4/3°-model to lowered sea level as **a first step**
- using **present day climatological forcing data** (windstress, heat flux)
- **two experiments**:

  (1) Reference experiment without change in sea level (*"reference exp"*)

  (2) Experiment with 67m lower sea level (*"-67m exp"*)

Outline

Cold-deglacial

Heinrich I (∼ 16 kyrs BP)	-	110m
Younger Dryas (∼ 12 kyrs BP)	-	67m

Warm-deglacial

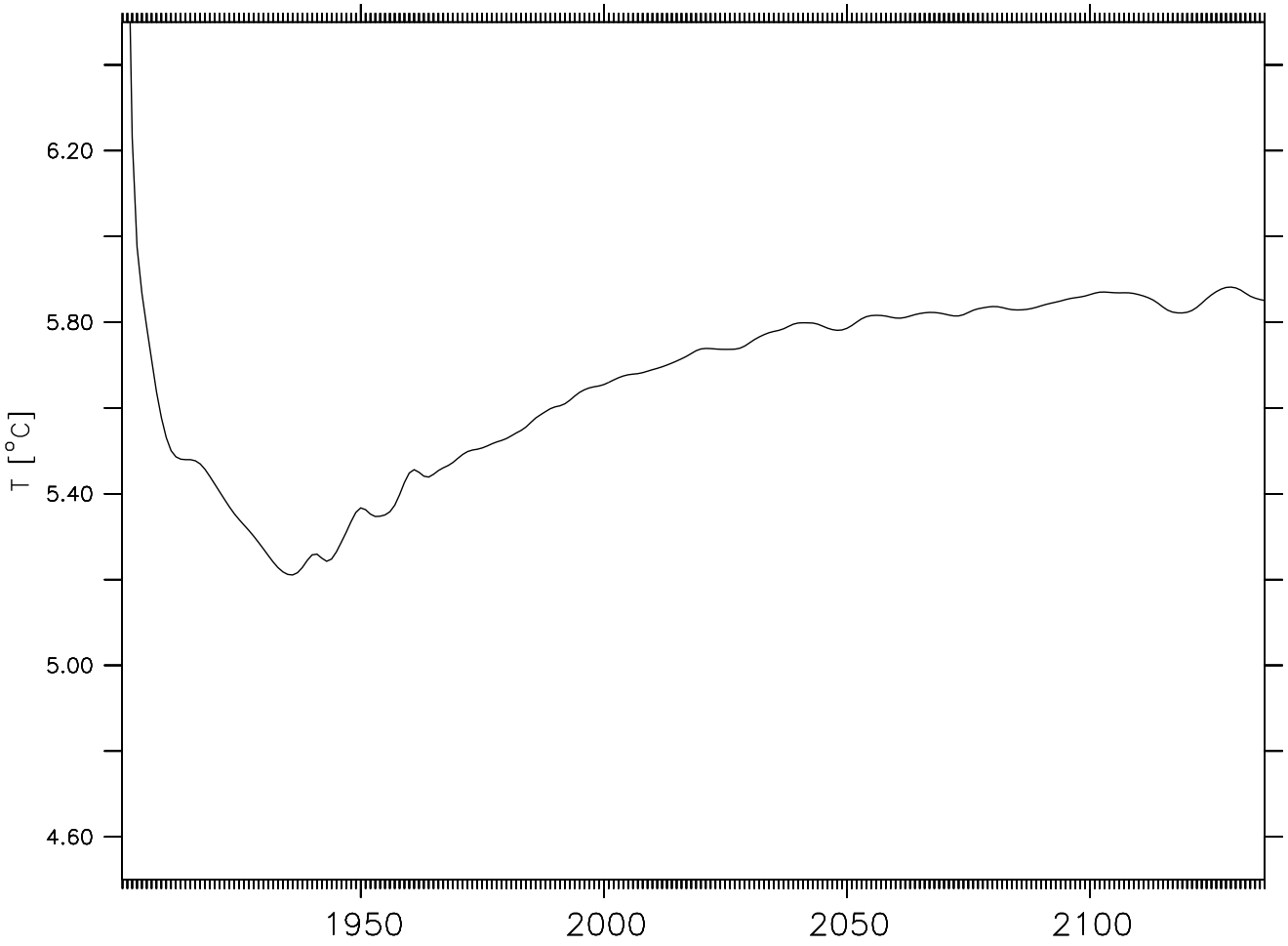
Bølling/Allerød (∼ 14 kyrs BP)	-	89 m

Interglacial

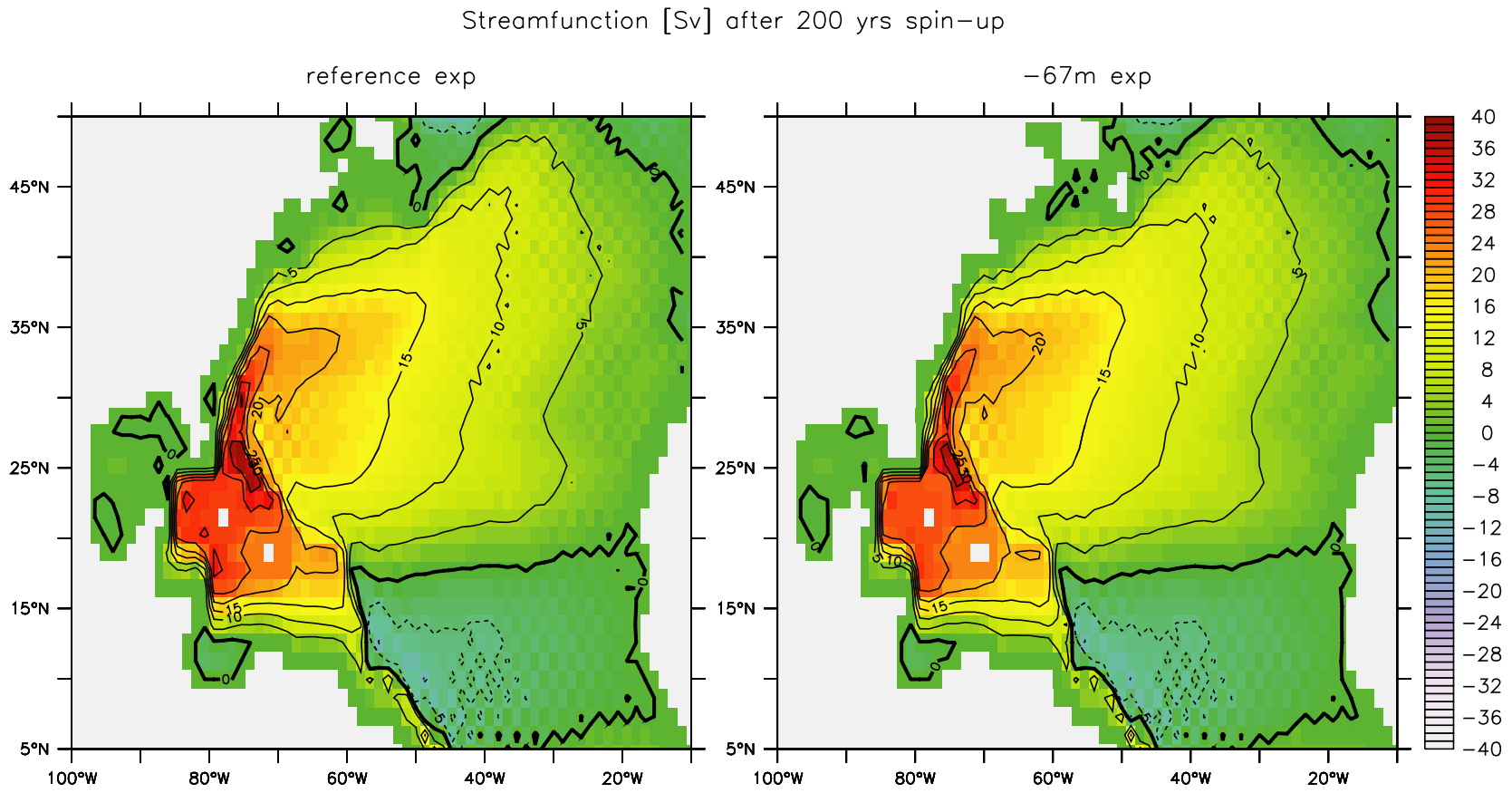
Early Holocene (∼ 9 kyrs BP)	-	24m
Late Holocene (∼ 3 kyrs BP)	-	1m

(Waelbroeck et al., 2002, Quaternary Science Reviews 21(1-3): 295-305)

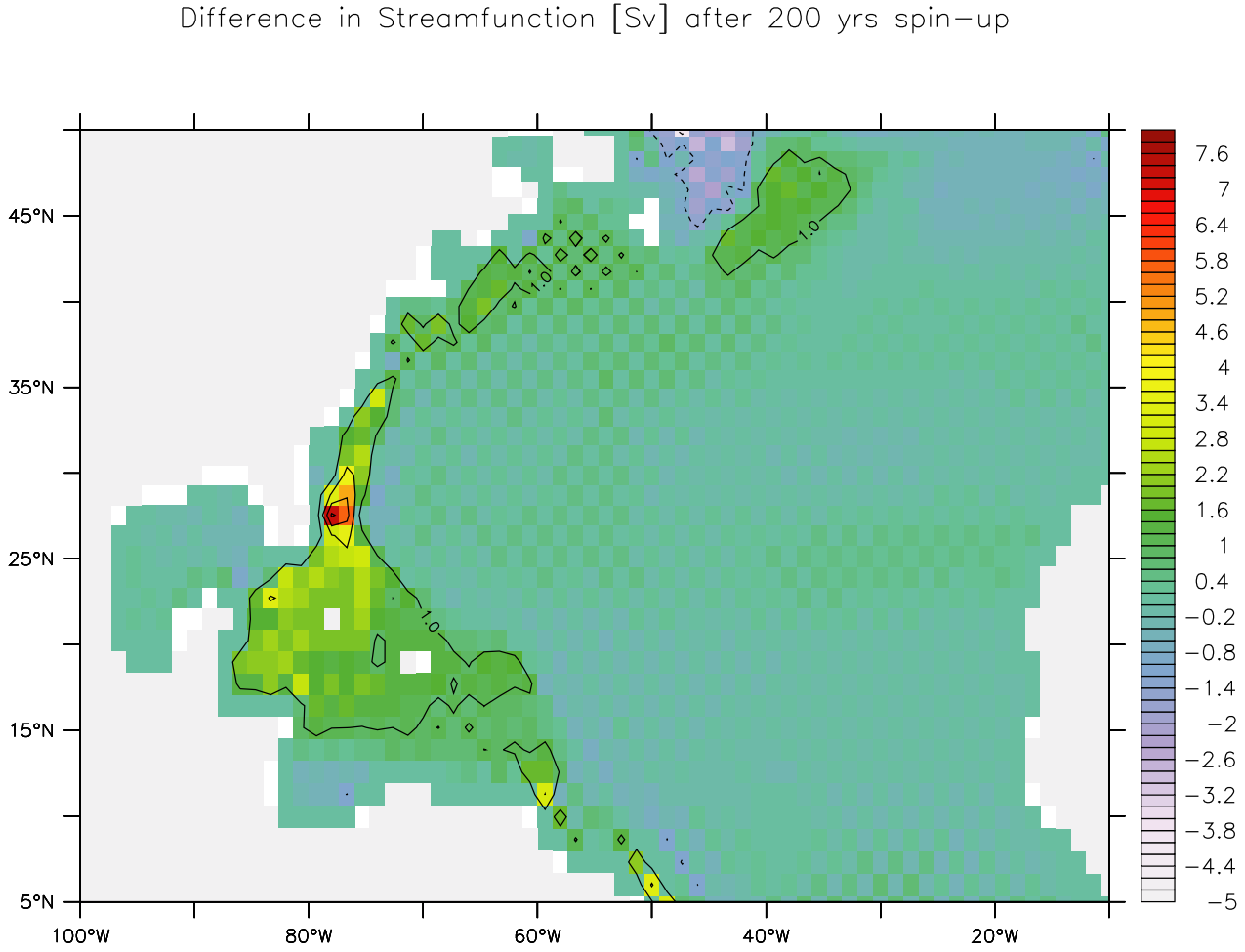
Model Spin-Up



Volume Transport



Volume Transport



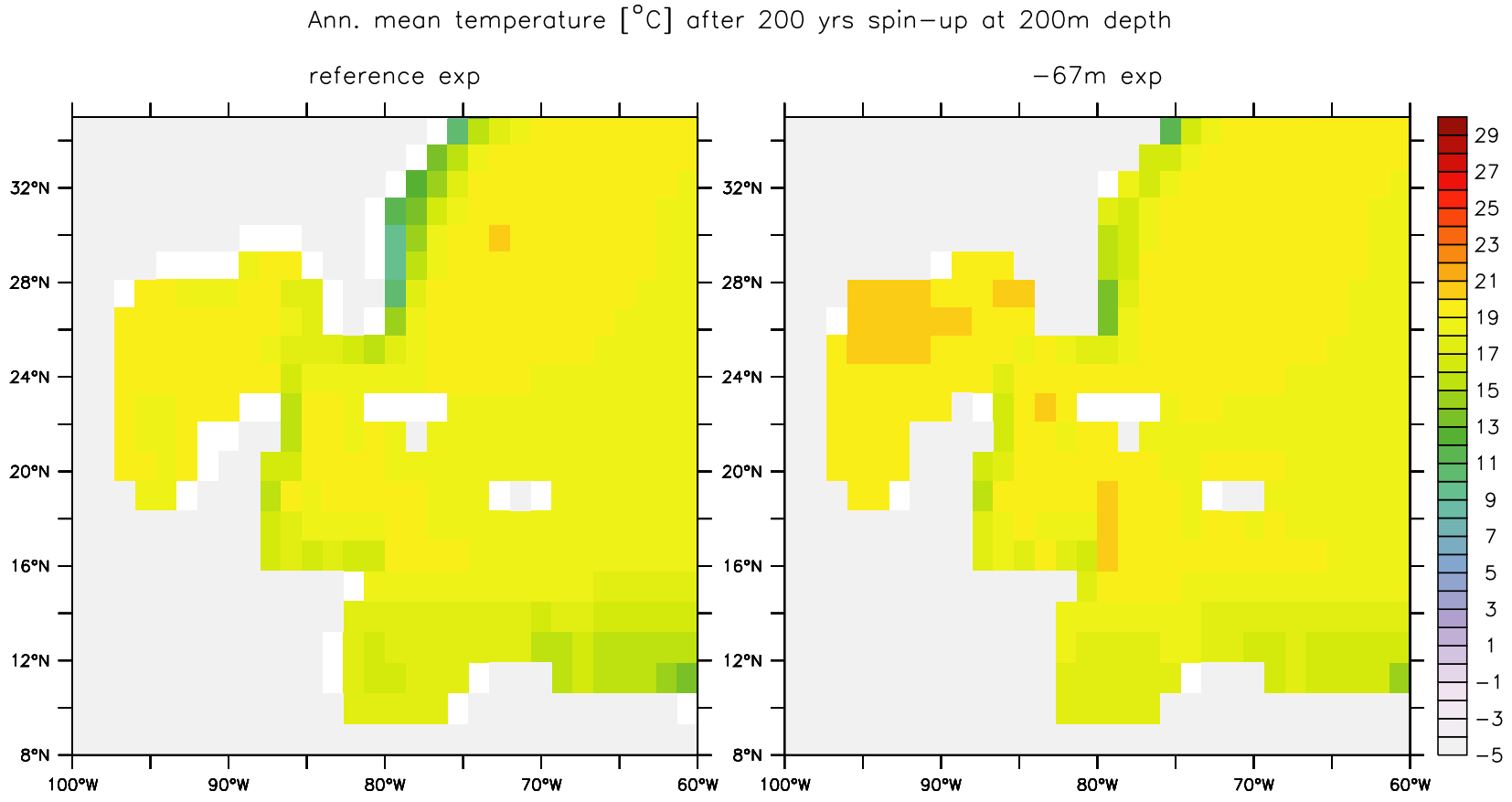
↷ **minor differences in the ocean interior**

↷ **major reduction at the boundary layers** (e.g. Florida Strait: $\sim$ 3 Sv)

Volume Transport

- away from the boundary layers
  - ↷ **flat-bottom Sverdrup relation** – independent of depth
- near the coastal boundaries
  - ↷ Florida Strait: reduction in the cross-section between Florida and Cuba
  - ↷ other processes might affect the transport (**JEBAR**...?!)
  - ↷ further analysis needed
- change in **volume transport** might affect **eddy-shedding** and also the **heat-budget** in the GOM, thus influencing the paleo-records

Temperature



↷ **small differences in the heat budget**

At this stage...

- reponse can provide **only preliminary** but still can some qualitative information

- **higher resolution is needed** to provide more accurate results on smaller (eddy resolving) scales

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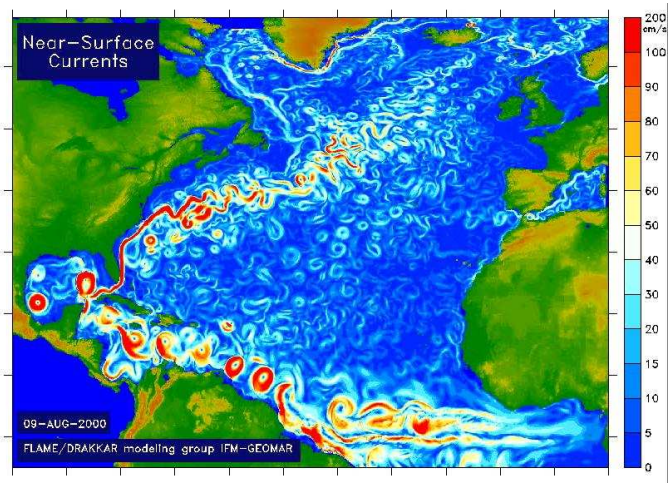

Thank you for listening...