



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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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

Main Outline

Model Setup

Response to Sealevel Change

Conclusions

- 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**

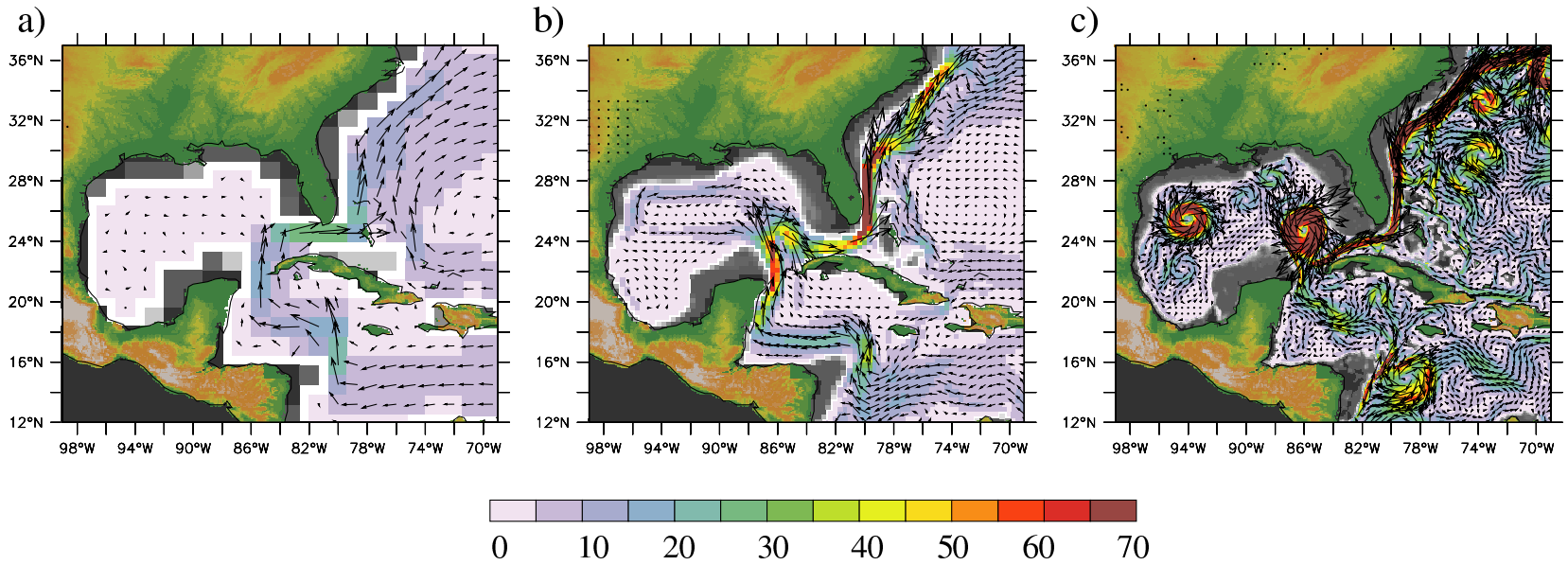
 - (ii) changes in **surface forcing** over the North Atlantic
(focus on windstress as the major contributor)

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



- FLAME = 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° (~ 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

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





- Response of Flame-4/3^o-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*")



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

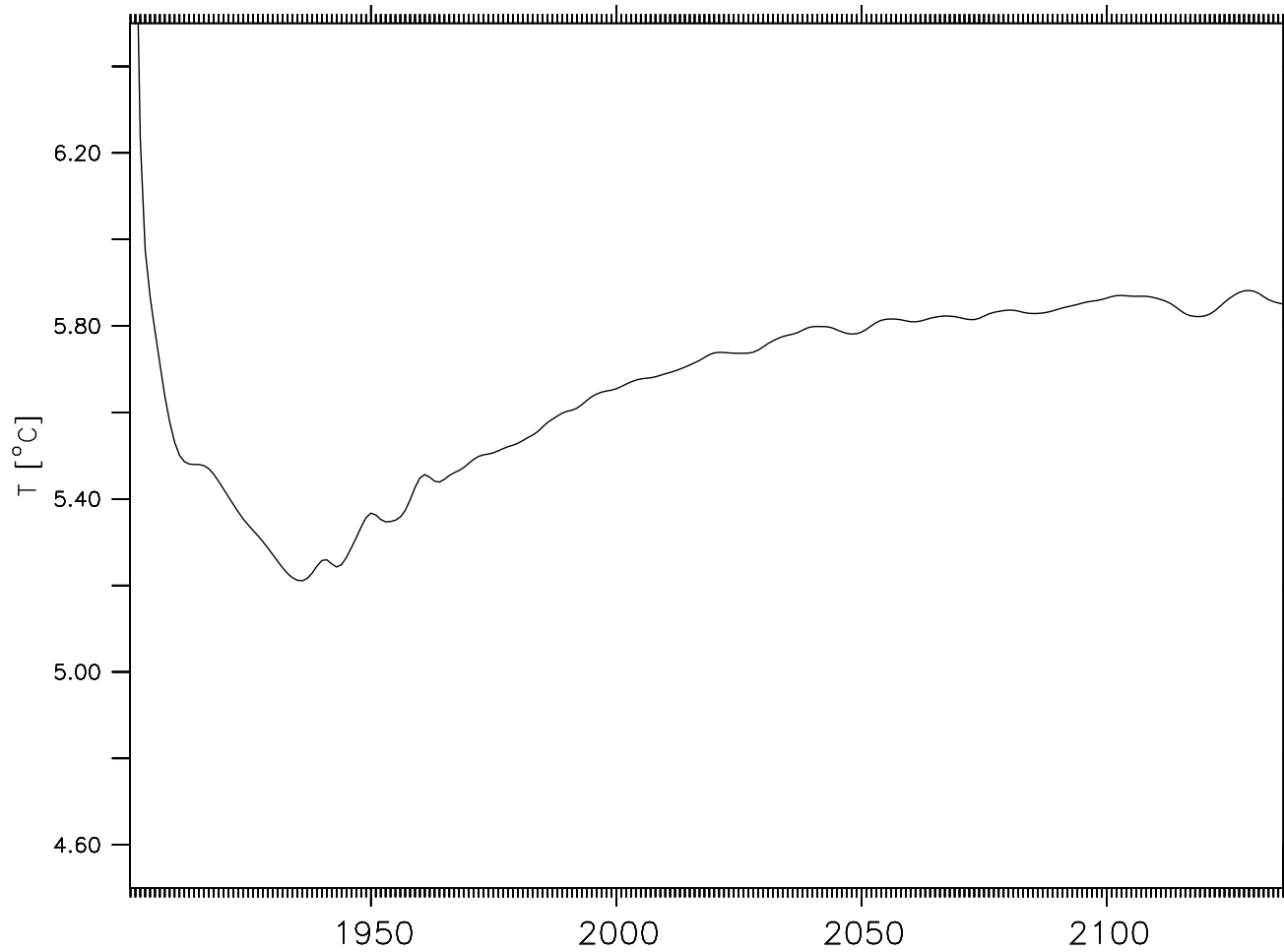
Late Holocene (~ 3 kyrs BP) - 1m

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



Model Spin-Up

Temperature spin-up at 70W / 35N / 1000m depth





Volume Transport

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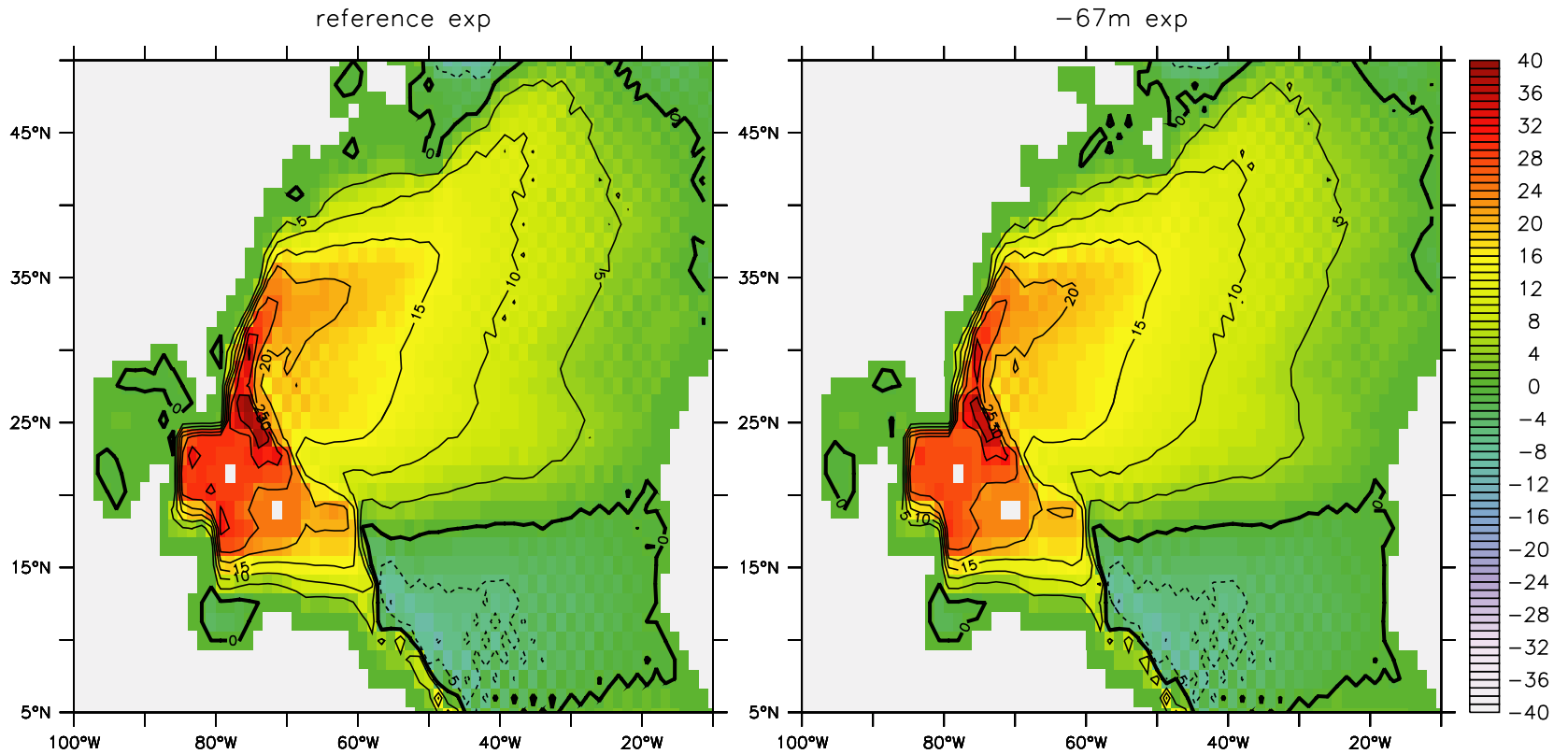
Main Outline

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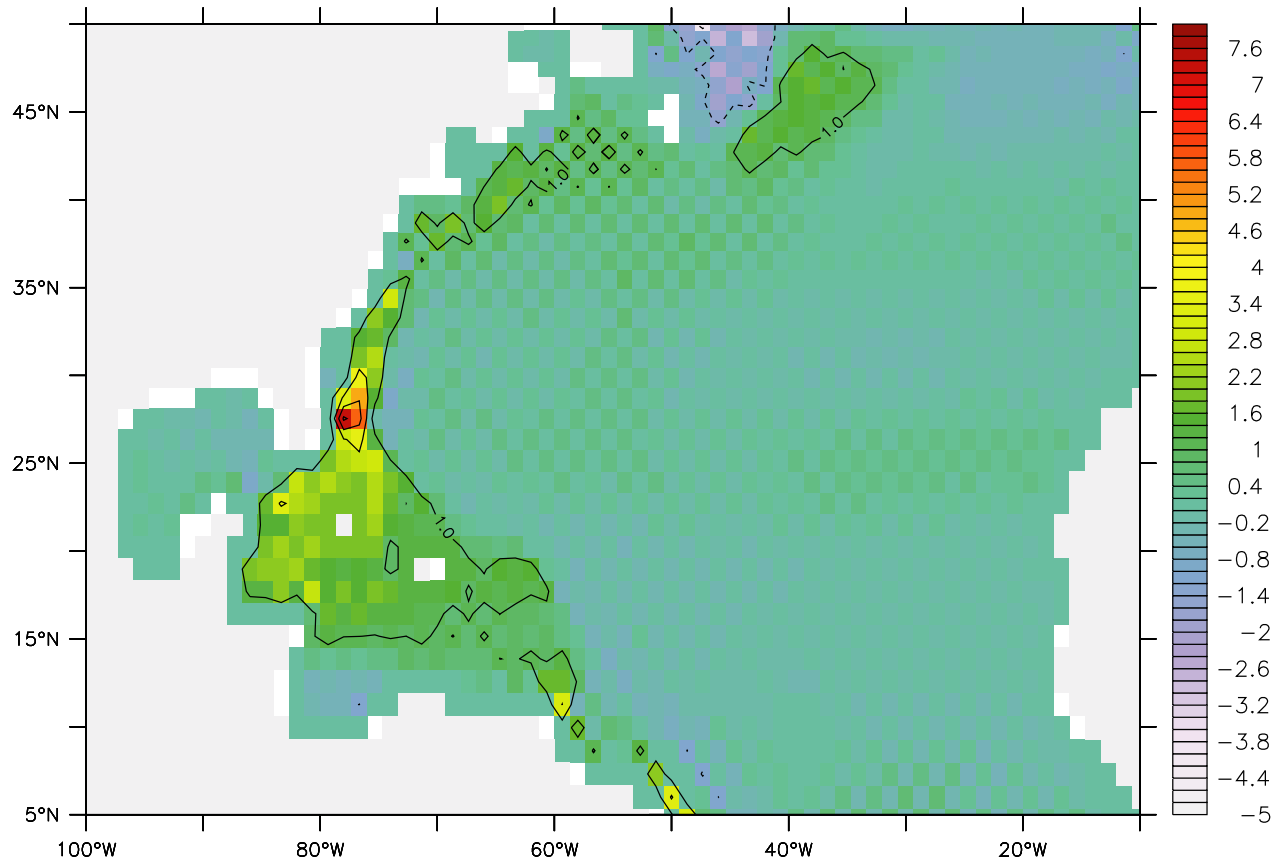
Response to Sealevel Change

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Streamfunction [Sv] after 200 yrs spin-up



Difference in Streamfunction [Sv] after 200 yrs spin-up



- ↪ **minor differences in the ocean interior**
- ↪ **major reduction at the boundary layers (e.g. Florida Strait: ~ 3 Sv)**



- 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

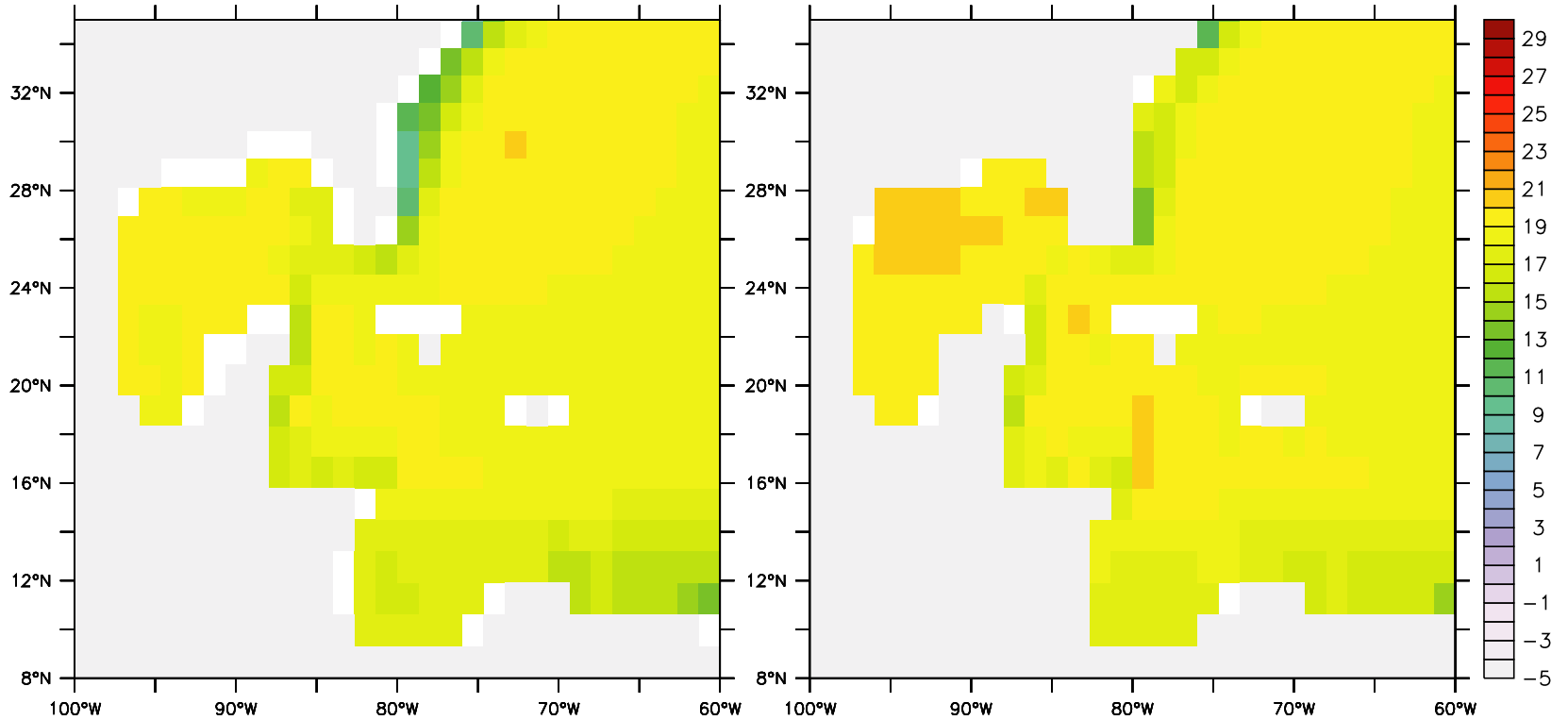


Temperature

Ann. mean temperature [$^{\circ}\text{C}$] after 200 yrs spin-up at 200m depth

reference exp

-67m exp



↪ **small differences in the heat budget**

At this stage...

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

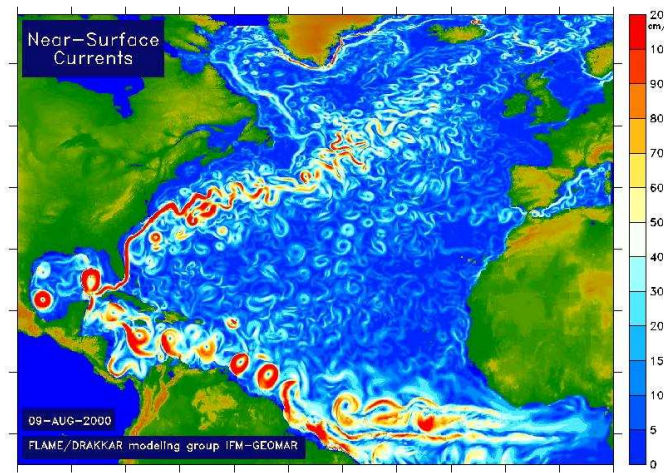
Main Outline

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



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Main Outline

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Thank you for listening...