Glacial/Interglacial simulations with an Earth System model of intermediate complexity

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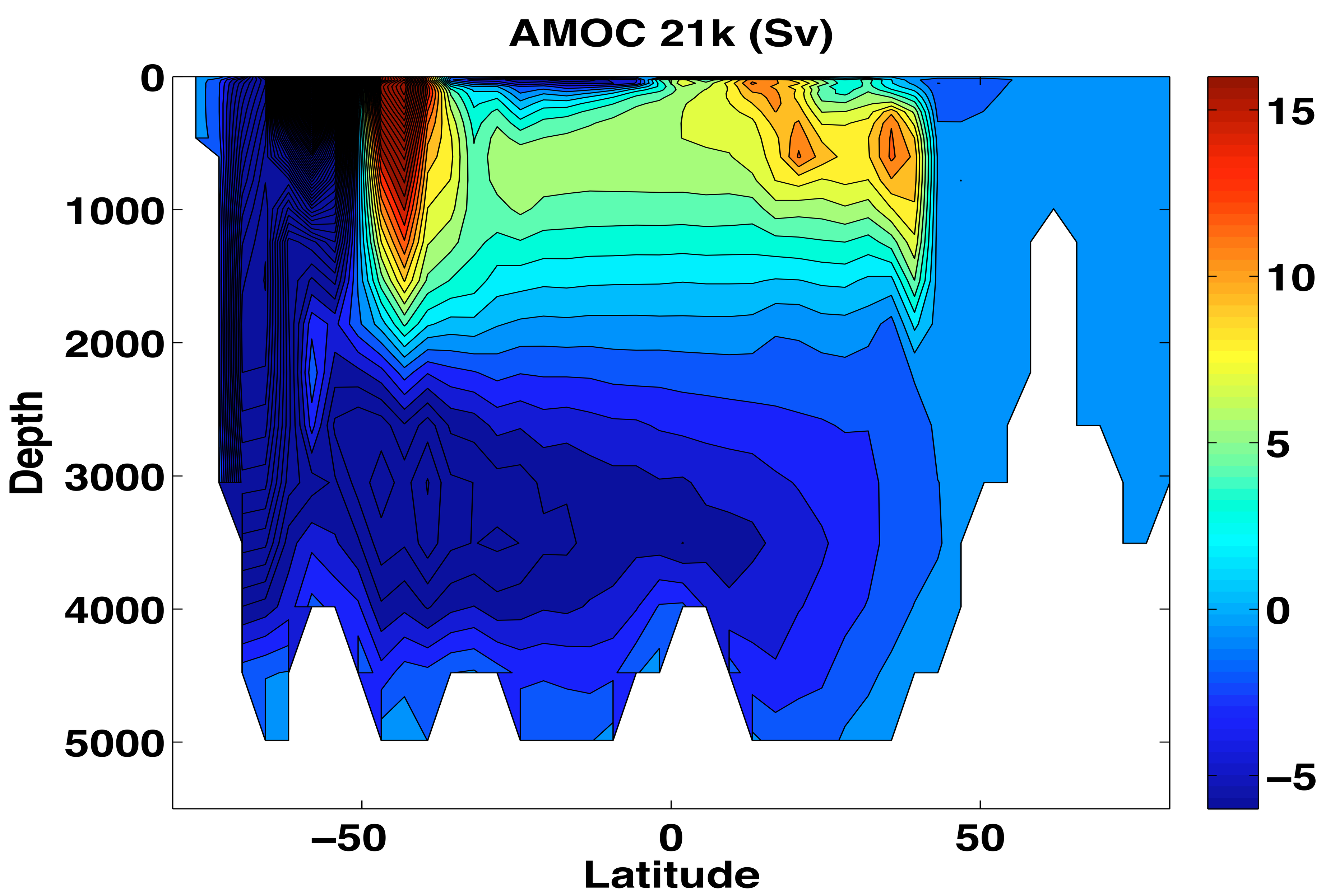
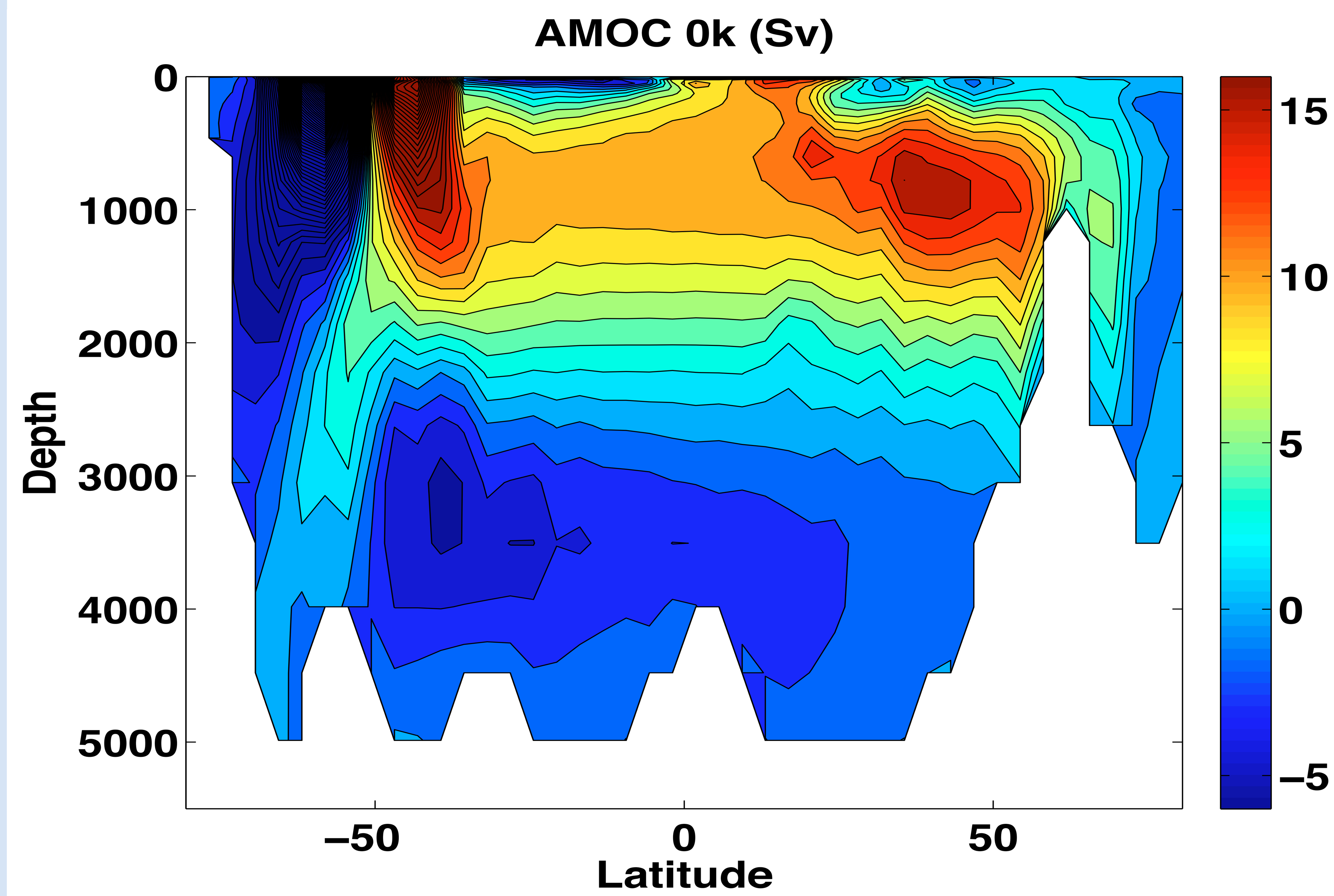
Aim of our work

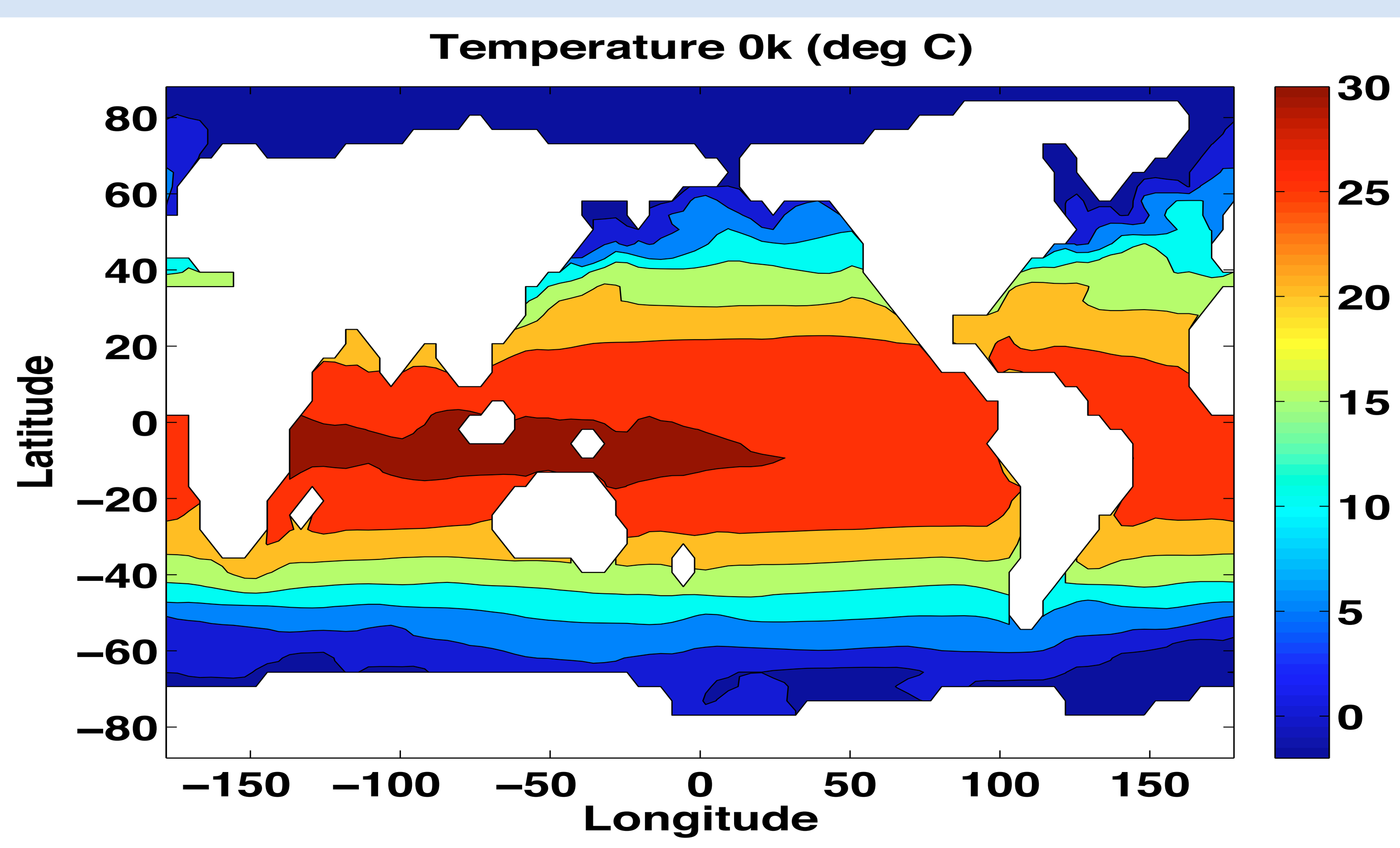
To study the variation of the global ice volume between the Last Glacial Maximum (LGM, ca. 21 kyr before present (BP)) and present time (0 kyr) using a combination of simulations with the CLIMBER-3α climate model (*Montoya et al., 2005*) and the GRISLI three-dimensional ice-sheet model (*Ritz et al., 2001*)

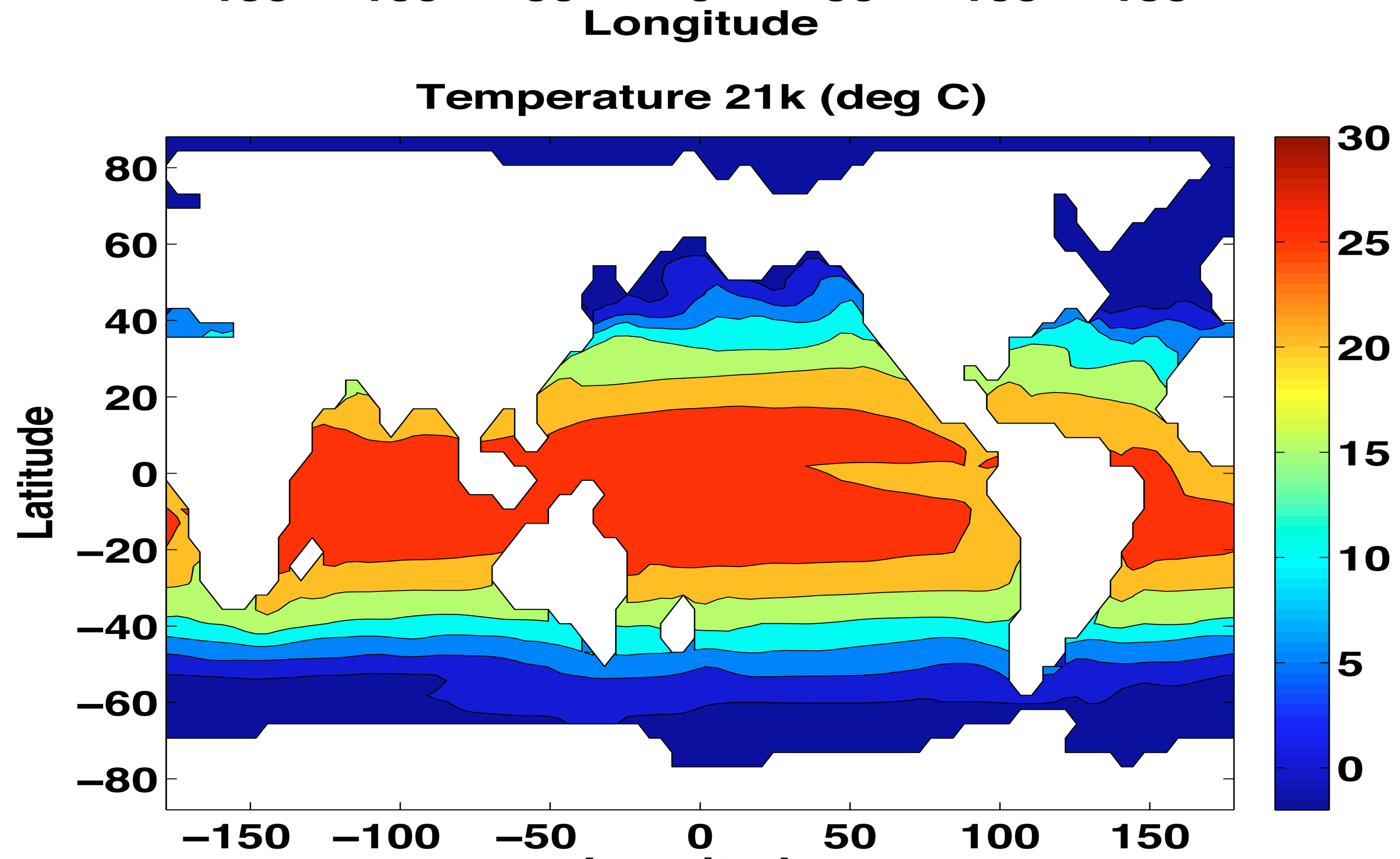
Experimental Design

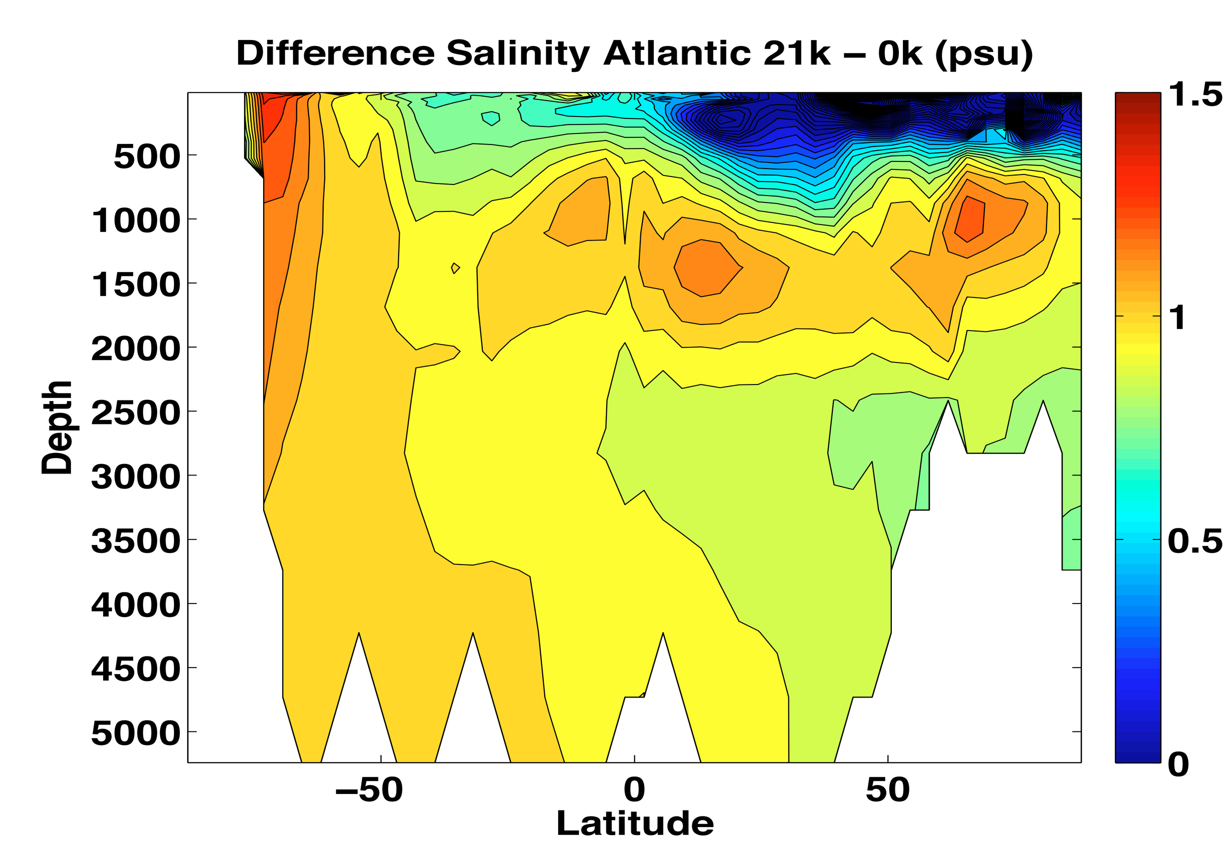
Using CLIMBER-3α, two reference states have been simulated: a glacial state corresponding to the LGM, in which forcing and boundary conditions follow the specifications of the Paleoclimate Modelling Intercomparison Project Phase III (*PMIP3 http://pmip3.lsce.ipsl.fr/*), and an interglacial state correspondig to present conditions. The climatological surface wind-stress vector field has been scaled by a globally constant factor and changes in the formation of brines give us a range of climatic and oceanographic states. Using these climatic fields for LGM and present conditions, GRISLI can be forced throughout the last glacial cycle to obtain a phase space for the Northern and Antarctic ice volume.

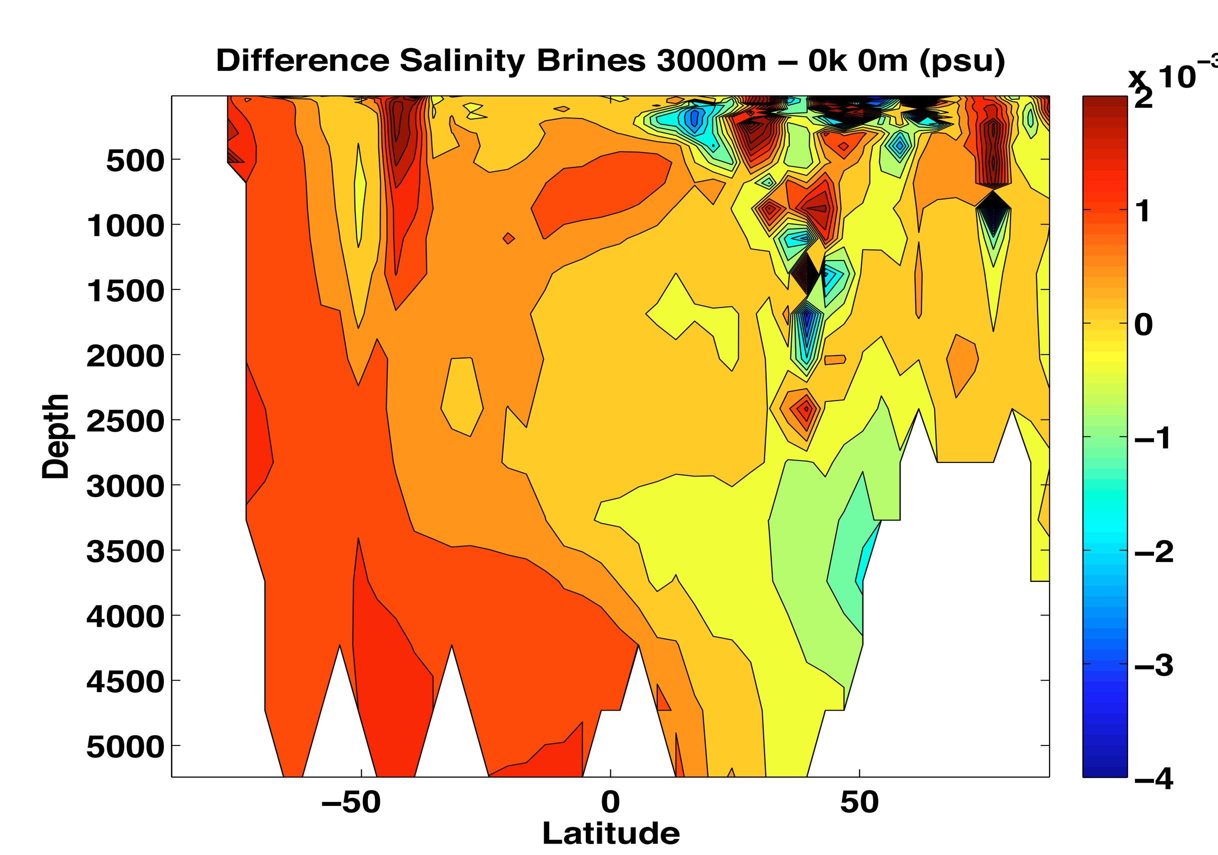












Sinking of Brines

Brines are small pockets of very salty water rejected by sea ice formation as sea ice is mainly formed of fresh water. In CLIMBER-3α, the flux of salt rejected to the ocean is mixed in the surface oceanic cell instead of rapidly sink to the deep ocean, due to their high salt content. To avoid such effect, the sinking of brines to the deep ocean has been parameterized, imposing the depth at which the salt rejected by sea ice formation dilutes.

Imposing this effect at 3000m for present conditions, results in increased salinity in the South Atlantic, specially in Antarctic deep waters, showing a more realistic behaviour.

Results

The LGM and the present climate have been simulated with CLIMBER-3α. Oceanic temperatures are also different, being higher in 0k especially in the equatorial zone and in the North Atlantic. An increased salinity can be observed at LGM state which may be related to Antarctic Bottom Water filling a larger ocean volume, even in the Northern hemisphere. Finally, comparison of the AMOC clearly shows distinct deep water formation, a more heightened Deacon cell in 0k, and an intensification of the meridional overturning at 0k. LGM shows a more intense Antarctic deep cell accompanied by a weakening of the NAMOC. All of this leads us to assume that the model is correctly representing the fundamental mechanisms in each climate state. This climatic fields will be used to force GRISLI throughout the last glacial cycle to investigate the evolution of the Antarctic and the Northern Hemisphere ice sheets.

References

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