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Mechanisms behind climate oscillations in last glacial maximum simulations

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Millennial-scale variability has been extensively observed across the last glacial period records (115 to 12 thousand years ago) but reproducing it on general circulation models remains a challenge. In recent years, a growing number of climate models have reported simulations with oscillating behaviours comparable to typical abrupt climate changes, although often relying on unrealistic forcing fields and/or boundary conditions. This may become an issue when trying to review the mechanisms at stake because of glacial climates' sensitivity to these parameters, notably ice sheets geometry and greenhouse gases concentration.

With the addition of snapshots of the early last deglaciation meltwater history over a last glacial maximum (~21 thousand years ago) equilibrium simulation, we obtained different regimes of climate variability, including oscillations that provides the perfect framework for studying abrupt climate changes dynamics in a glacial background. The oscillations consist of shifts between cold modes with a weak to almost collapsed Atlantic Meridional Ocean Circulation (AMOC) and warmer and stronger AMOC modes, with large reorganisation of the deep-water formation sites, surface ocean and atmospheric circulations. The phenomenon has a periodicity of roughly every 1500 years and can be linked to changes of about 10°C in Greenland. This new set of simulation suggests an intricate large-scale coupling between ice, ocean, and atmosphere in the North Atlantic when meltwater is discharged to the North Atlantic.

Most attempts at theorising millennial-scale variability have involved vast transfers of salt between the subtropical and subpolar gyres, often referred to as the salt oscillator mechanism, that in turn controlled the intensity of the north Atlantic current. We believe that the salt oscillator is in fact part of a larger harmonic motion spanning through all components of the climate system and that can enter into resonance under the specific boundary conditions and/or forcing. Illustrated by the mapping of the main salinity and heat fluxes on the oscillating simulations, we propose a new interpretation of the salt oscillator that includes the stochastic resonance phenomenon as well as the effect of meltwater forcing.