Project: **975**

Project title: **OCTANT**

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Report period: **2020-11-01 to 2021-08-31**

1 Project Overview

The main objective of OCTANT is investigating to what extent the temporal evolution of the ocean circulation during abrupt events may be inferred from deep-sea cores. In that purpose we implemented in MPIOM isotopic ratios commonly measured in sediment cores as well as several age tracers allowing tracking water masses and their role in ventilation. By means of transient simulations from the end of the last glacial maximum (LGM) to the present day we investigate the relevance of radiocarbon as a proxy for deep ocean ventilation changes. In parallel we develop tracer methods aimed at assessing water mass fractions and ventilation pathways.

2 Report on work performed

During 2021 we analyzed the available transient experiments and devoted time to paper redaction. The computing time was used for sensitivity experiments and post processing.

The work performed includes

1. Revision of the paper "Deep ocean ventilation as depicted by radiocarbon" by Mouchet A., Mikolajewicz, U., and Deleersnijder, E. submitted to Earth and Planetary Sciences Letters. This paper examines the use and limitation of radiocarbon as a proxy for the ventilation of the deep ocean.
2. Development of a method for calibrating the modeled deep radiocarbon ages and assessing the uncertainties of the associated calibrated ages over the deglaciation.
   The uncertainties are evaluated by taking advantage of available realizations of the transition from the LGM as different ice-sheets formulations (reconstructions ICE-6G_C and GLAC-1D; interactive) and model configurations (addressing vertical mixing, bathymetry and land-sea mask) provide a range of ocean responses. The impact of planktonic foraminifer species-specific habitat [1] is also considered. In combination with the suite of model states this allows obtaining a range of reservoir ages over time.
   The calibration step [2] then provides a time resolution [3] for each deep ocean conventional radiocarbon age. The time resolution of the calibrated dates are then computed over the whole deglaciation transition. Such study is of relevance for model assessment against reconstructed fields as well as for assimilation procedures which are being developed (e.g., PAGES-CVAS initiative).
3. Redaction of a paper "Diagnosing deep ocean ventilation pathways by means of partial ages" by Mouchet A., Deleersnijder, E, Delhez E., and Six K.
   Partial ages [4] allow investigating where water masses spend most of their time in the deep ocean. These locations (where age is built) do not coincide with those where oldest water are found (where age is stored).
   Additionally, dividing the partial age relative to a specific region by the average time spent in that region allows obtaining a 'return' coefficient, i.e., a measure of the probability for the water to transit again through that region.
   These concepts are applied to the global ocean and to the Pacific Ocean where a throughout investigation of the impact of model resolution is performed.

References

[1] Roche, D. M., Waelbroeck, C., Metcalfe, B., Caley, T. FAME (v1.0): a simple module to simulate the effect of planktonic foraminifer species-specific habitat on their oxygen isotopic content, Geosci. Model Dev., 11, 3587–3603, https://doi.org/10.5194/gmd-11-3587-2018, 2018.

[2] Cook, M. S., and Keigwin, L. D. Radiocarbon profiles of the NW Pacific from the LGM and deglaciation: Evaluating ventilation metrics and the effect of uncertain surface reservoir ages. Paleoceanography, 30, 174–195. doi: 10.1002/2014PA002649, 2015.
[3] Svetlik, I., et al. The Best possible Time resolution: How precise could a Radiocarbon dating method be? Radiocarbon, 61(6), 1729-1740. doi:10.1017/RDC.2019.134. 2019.
[4] Mouchet, A., Cornaton, F., Deleersnijder, E., Delhez E. Partial ages: diagnosing transport processes by means of multiple clocks. *Ocean Dynamics* **66,** 367–386, doi: 10.1007/s10236-016-0922-6, 2016.