Oxygen isotope constraints on the abyssal circulation of the modern and glacial Pacific Ocean, and its role in regulating atmospheric CO_2

Supervisors: William Gray (LSCE), Casimir de Lavergne (LOCEAN), Didier Roche (LSCE)

Contact: william.gray@lsce.ipsl.fr, cdllod@locean-ipsl.upmc.fr, didier.roche@lsce.ipsl.fr

Although the Pacific Ocean plays a fundamental role in global climate and carbon cycling, the circulation of the deep Pacific is poorly understood in both the modern day and under differing climate states. In the classical view of ocean circulation, mixing within the Pacific Ocean helps close to the 'global conveyor belt'. However, a new view is emerging which suggests large volumes of the mid-depth Pacific are excluded from the global overturning circulation. These two models of circulation have vastly different implications for our understanding of how heat and carbon (and other nutrients) are distributed and cycled through the ocean, and thus how the climate and carbon cycle are likely to respond to climate changes. Changes in the circulation of the Pacific Ocean are thought to play a key role in driving the ~80 ppm changes in atmospheric CO_2 observed over Glacial–Interglacial cycles, however strong constraints on changes in the circulation during glacial times are lacking. Furthermore, as mixing is poorly represented in current numerical simulations of the glacial climates, the impact of circulation changes on the carbon cycle is likely to be underestimated.

The primary aim of this project is to constrain the circulation of the deep Pacific in both the modern ocean and the Last Glacial Maximum (LGM, ~20,000 years ago) using oxygen isotopes ($\delta^{18}O$) in seawater and benthic foraminifera as a conservative circulation tracer, and to understand the implications of changes in circulation on the carbon cycle using an oxygen isotope enabled intermediate complexity earth system model (iLOVECLIM). The student will generate new benthic foraminiferal $\delta^{18}O$ data from sediment cores in the Pacific Ocean spanning the LGM, and perform numerical simulations with iLOVECLIM under differing oceanic mixing regimes. The student will combine these new simulations of ocean circulation and carbon cycling with the $\delta^{18}O$ data to constrain the circulation of both the modern and glacial Pacific, and understand the implications of changes in circulation for carbon cycling and atmospheric CO_2. The student will learn data analysis and climate modelling skills, as well as geochemical analysis of foraminifera; there are likely to be sea-going opportunities.

The student will start in will start in October 2021 and be based at the Laboratoire des Science du Climat et de l'Environnement (LSCE) on the Saclay science campus located to the south of Paris. Upon completion, the PhD will be awarded by the Université Paris-Saclay.

To apply, please send a CV and cover letter to william.gray@lsce.ipsl.fr or didier.roche@lsce.ipsl.fr by 07/05/2021. Please feel free get in touch with any questions you may have.

Further reading

de Lavergne et al. (2017) *Nature*, **Rae** et al. (2020*) Science Advances,* **Gray** et al. (2018*) Nature Geoscience*, **Keigwin** (1998) *Paleoceanography,* **Sigman and Boyle** (20000) *Nature,* **Talley** (2013) *Oceanography*