MASTER'S PROJECT ON
SIMULATING NOBLE GASES TO RECONSTRUCT MEAN OCEAN TEMPERATURE OF THE PAST

Context: The ocean, with a heat capacity three orders of magnitude larger than the atmosphere, plays an important role in modulating Earth's surface temperature. Since the industrial revolution, the global ocean has absorbed over 90% of the excess heat in the Earth. Ocean heat uptake also accounts for approximately half of the total planetary energy gain during the transition from the last ice age into the current warm period. Yet, constraining changes in ocean heat content and thus Mean Ocean Temperature (MOT) remains a significant challenge. To address this limitation, a MOT proxy has been developed using polar ice cores. This proxy is based on the temperature-dependent solubilities of quasi-inert gases (noble gases), which partition their globally conserved inventories between the atmosphere and ocean on orbital to millennial time scales.

This Master's project aims to investigate the processes governing the partitioning of noble gases between the ocean and atmosphere to better constrain past variations of MOT inferred from atmospheric noble gas ratios. This will be achieved by utilizing the Bern3D Earth system model of intermediate complexity, a highly efficient model that includes noble gas tracers. Initial results indicate that temperature-independent effects also contribute to changes in noble gas ratios. However, their contributions remain unknown during periods of rapid climate change, such as the last deglaciation. The project will focus on investigating these processes by performing model simulations, analyzing the results, and comparing the output to reconstructed atmospheric noble gas ratios from Antarctic ice cores measured in-house at our division.

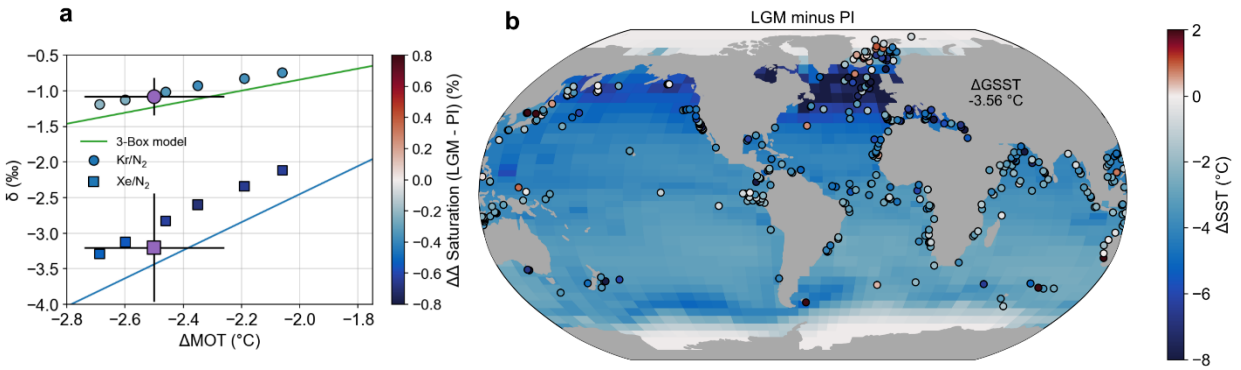

Figure 1: *(a) Relationship between Mean Ocean Temperature (MOT) and noble gas ratios of $\delta Kr/N_2$ and $\delta Kr/N_2$. (b) Simulated sea-surface temperature (SST) difference between the last glacial maximum (LGM) and Pre-industrial (PI) compared to reconstructions.*

Project tasks:

- Getting familiar with software and computational facilities (linux, fortran, computing cluster) and the Bern3D model.
- Performing model simulations with the Bern3D model including noble gas tracers.

- Identifying processes that lead to changes in noble gas partitioning between the ocean and atmosphere independent of temperature (e.g., ocean circulation, sea-ice, winds, …).
- Comparison to reconstructed noble gas ratios from Antarctic ice cores.

Duration of project: Ideally for 1 year (60 credits).

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References:

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