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Implementing the Pa/Th proxy computation in iLOVECLIM intermediate complexity climate model: a step towards forward multi-proxy modeling and marine core data comparison

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The Atlantic Meridional Overturning Circulation (AMOC) is a major component of the climate system through its impact on low to high latitude heat transport and CO_2 air sea exchange. Despite numerous studies, its role in abrupt climate changes of the last glacial period is still poorly constrained. In the past decades, the sedimentary ($^{231}Pa_{xs,0}$/$^{230}Th_{xs,0}$) (hereafter Pa/Th) has been widely used as a kinematic proxy to reconstruct AMOC export changes over the last glacial period. However, translating the Pa/Th records into AMOC strength is not straightforward. Indeed, some local processes or features, not directly related to circulation (such as boundary scavenging or nepheloids layers), can affect Pa/Th records. Moreover the sedimentary Pa/Th alone can only provide a qualitative indicator of relative changes in overturning rate. Thus modeling work is needed to better constrain AMOC changes over the last glacial period through model-data comparison.

We have implemented the Pa/Th computation in the isotope-enabled version of the LOVECLIM Earth System model (iLOVECLIM). In its current version, iLOVECLIM allows to generate multi-millenial and multi-proxy simulations – in particular Pa/Th, $\Delta^{14}C$ and $\delta^{13}C$ – within a relatively short computation time ($\sim$1000 years per 24 hours on current clusters). The ocean biogeochemistry model incorporated in iLOVECLIM simulates at the moment calcium carbonate and particulate organic carbon but does not include an explicit computation of biogenic opal, thought to play also an important role in Pa and Th scavenging. Here we present our model development and evaluate its performance relative to observations and especially the GEOTRACES intermediate data product 2017. We analyze the simulated evolution of the different circulation proxies available in iLOVECLIM (Pa/Th, $\Delta^{14}C$ and $\delta^{13}C$) in response to imposed abrupt circulation changes.