Modelling climate and vegetation during glacial MIS 20 and interglacial MIS 19 periods using an Earth system Model of Intermediate Complexity

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Description:

During the Quaternary (i.e., the last 2.6 million years), the Earth's climate has been marked by gradual cooling and our planet entered into a succession of glacial and interglacial episodes. We are currently in the Holocene which is an interglacial that has lasted for 11,700 years already. The previous glacial period started more than 100,000 years ago and culminated 21,000 years ago during the last glacial maximum. The temperature or the ice volume during past periods is recorded by the oxygen isotopic abundance ($^{18}O/^{16}O$) in the calcite or aragonite shells of marine organisms that are deposited in marine sediments. The higher the $^{18}O/^{16}O$ ratio, the colder the climate (or equivalently the larger the ice volume) at the time the shell has been deposited. So, it is common to refer to glacial and interglacial periods of the Quaternary as marine ($^{18}O/^{16}O$) isotopic stages (MIS). The Holocene corresponds to MIS 1, which is the last minimum in the marine isotopic ratio, while the last glacial maximum, the last isotopic maximum, corresponds to MIS 2. These two isotopic stages have been widely studied with 3-dimensional climate and vegetation models, but earlier glacials and interglacials remain largely understudied from a modelling point of view.

In this master thesis, we propose to model MIS 20 and MIS 19, a succession of a glacial and an interglacial that happened approximately between 810,000 and 760,000 years ago. This time span includes the early to the middle Pleistocene transition (EMPT), when a shift in the astronomical periodicities of the climate signal has been recorded in the marine sediments. Indeed, before the EMPT, the dominant periodicity in the climate signal was the 40,000 year period of the obliquity, while later the dominant periodicity was the 100,000 year period of the eccentricity. The time span also includes the last reversal of the Earth's magnetic field, the Matuyama-Brunhes transition. Finally, MIS 19 has been recognized as the interglacial which is closest, from an astronomical (or insolation) point of view, to the Holocene. It can thus contain clues regarding to the stability of the current interglacial period. Some pollen data covering MIS 20 and MIS 19 have been published recently from a site (Montalbano Jonico section) in southern Italy.

The objective of the master thesis will be to simulate MIS 20 and MIS 19 with the Earth system model of intermediate complexity iLOVECLIM that has been recently coupled to the CARAIB dynamic vegetation model developed by our laboratory. This coupling is undertaken within a collaboration between our laboratory and the Laboratoire des Sciences du Climat et de l'Environnement (LSCE) in Gif-sur-Yvette, France. The results of the model over southern Europe will be compared to the pollen data of the Montalbano Jonico section.

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