Modelling the climate and vegetation changes induced by the Earth's orbital variations under decreasing CO_2 concentration across the Eocene-Oligocene transition

Delphine Tardif (1)*, Frédéric Fluteau (1), Yannick Donnadieu (2), Guillaume Le Hir (1), Jean-Baptiste Ladant (3), Agathe Toumoulin (2), Pierre Sepulchre (4), Nicolas Viovy (4)

(1) Institut de physique du globe de Paris (IPGP) – Univ. Paris VII-Paris Diderot CNRS: UMR7154 – Université de Paris, France
(2) Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement (CEREGE) – Aix en Provence, France
(3) Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, MI, USA
(4) Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, UMR 8212 CEA-CNRS-UVSQ, Université Paris-Saclay, Gif-sur-Yvette, France

*tardif@ipgp.fr

The shift from the Paleocene/Eocene warm and ice-free «greenhouse» (~ 65 - 33 Ma) to the colder and dryer Oligocene «icehouse» (~ 33 - 24 Ma) is usually referred to as Eocene-Oligocene Transition (EOT). It is marked by an important decrease in pCO_2 (from ~ 4 Preindustrial Atmospheric Levels – or PAL – to ~2 PAL), the inception of the Antarctic ice sheet and is coeval with important paleogeographic changes: notably the retreat of the Paratethys sea and the uplift of the Tibetan Plateau.

If the EOT is abruptly marked in the oceanic $\delta^{18}O$ record, its translation into contrasted biomes (assessed through pollens, fossil woods and leaves) over land is less straightforward. While some sites display important shifts in biomes (e.g. from tropical forest in the Eocene to temperate forest in the Oligocene), many regions present ambiguous signal (e.g. presence of tropical and temperate forest in nearby sites at the same period). This variability can have many origins: uncertainties in dating and paleo-location, preservation biases, or inappropriate calibrations methods.

The issue we aim at tackling here is the potential overprinting of a "short time noise" induced by the Earth's orbital variations (order of ~ 10^4 to 10^5 years) on the long trend climatic signal (~ 10^6 years). Using the IPSL-CM5A2 Earth System Model, and the dynamic vegetation ORCHIDEE model, we propose a reconstruction for each of the orbital parameters end-members (eccentricity, precession and obliquity). Our results highlight regions of high biome stability under contrasted orbital forcing and, on the contrary regions of extreme biome variability. The main outcomes are discussed.

Keyword: climatology