Simulating the combined response of climate, carbon cycle and marine biodiversity through a LIP degassing

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Carbon isotopes display huge fluctuations over the course of Earth history, especially during major disruptions of the surficial environment, like the onset of Large Igenous Provinces. The amplitude and the direction of the fluctuations are quite variable, some events being characterized by strong positive excursions in sedimentary carbonates and organic carbon record, while others display a negative excursion.

In this contribution, we explore the origins of the isotopic carbon variations through numerical modelling. We are thus using the coupled climate-carbon model GEOCLIM [1,2]. To investigate the role of the oceanic biological productivity on the isotopic carbon record, we developed an ecosystem module. This module simulates the dynamics of ecosystems in the photic zone of past oceans. The first trophic level is represented by plankton functional types (PFTs) [3]. Three higher trophic levels include the consumers feeding on the lower levels. Each PFT productivity and biomass depend on its sensitivity to environmental parameters (nutrient, temperature, pH) and on its links with other PFTs (competition). The characteristics of the PFTs are stochastically fixed at the beginning of each simulation, generating a different response of the coupled climate-carbon-biodiversity model to environmental disruptions.

As a test, we generate a climatic disruption by adding large amount of CO_2 in a degassing scenario of the Siberian Traps. The model outputs suggest that the response of the Earh system to the same disruption varies considerably, depending on the ecosystem structure and characteristics.

[1] Goddéris and Joachimski (2004) Palaeogeography, Palaeoclimatology, Palaeoecology 202, 309–329. [2] Donnadieu et al. (2006) Geochemistry, Geophysics, Geosystems 7, 1-21. [3] Le Quéré et al. (2005) Global Change Biology 11, 2016-2040.