Isotopic composition of water vapour in strong convective updrafts

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The isotopic composition of water is a tracer of interest for understanding convective processes, and the last decade has seen a surge of modelling and observational studies in that field. Yet, the physics of convective clouds governing the transformation of water across its different phases is potentially very complex and the exact dependence of isotopic compositions upon it is not well known nor has been extensively documented since the pioneering work of Jouzel *et al*. [1]. Important processes to consider include kinetic effects that arise from super-/subsaturated conditions due to liquid-ice disequilibrium in mixed phase zones and to lengthy phase adjustment over ice; isotopic re-equilibration between vapour and a variable reservoir of cloud liquid water; and different routes to cloud glaciation (freezing vs. the Wegener-Bergeron-Findeisen process). Using a simplified adiabatic model, we clarify the role of those processes in altering the isotopic composition of water vapour in strong convective updrafts.

We find that the deuterium-excess, which is the conventionally used metric of the joint distribution of deuterium and oxygen 18, is highly sensitive to cloud physics at low temperatures (< -30°C), with a complicated structure of variability resulting from multiple factors. We propose new metrics that relate deuterium and oxygen 18 isotopic ratios at cloud base and cloud top and that are better related to the structure of evolution of those isotopic ratios [2]. We show that, in a statistical sense, those metrics are respectively informative on the level of supersaturation reached by the cloud upon the completion of glaciation (which removes the control of saturation by liquid water); and on the temperature at which cloud glaciation is effective. The retrieved information can serve as a probe of the physics of deep convective clouds.

[1] Jouzel, Merlivat & Roth (1975), *J. Geophys. Res.* **80 (36)**, 5015-5030. [2] Bolot, Legras & Moyer (2012), *Atmos. Chem. Phys. Discuss.* **12**, 22451-22533.

Early Eocene Climatic Optimum: numerical modelling of the impact of the Neo-tethys closure.

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The Early Eocene Climate Optimum (EECO, 53-50 Ma) was the warmest interval of Cenozoic time. This warm climatic interval was induced by a high atmospheric pCO_2. Several mechanisms have been proposed to explain this climatic anomaly (e.g. LIP of North Atlantic). However one of them seems to be the most convincing in term of carbon fluxes degassing: the Neotethys closure, resulting in large amounts of pelagic carbonates recycled as CO_2 in arc volcanoes during the subduction process. Hoareau *et al*. (submitted) [1] have modelled the volume of subducted sediments and the related amount of CO_2 and CH_4 emitted at active arc volcanoes along the northern Tethys margin. The volume of hemipelagic carbonates and the Indian continental margin carbonate sediments subducted, can produced a maximum of $3.7x10^{18}$ $molCO_2$/Ma during the EECO, corresponding to a maximum of 85% of the modern CO_2 outgassing rate. A numerical modelling has been performed to test the impact of these carbon fluxes on the climate using a model of biogeochemical cycles of carbon (COMBINE) coupled with a general circulation model (FOAM). Different parameters, as the size of Greater India continental margin and the timing of the continental subduction, have been tested in order to reconstruct the potential scenarii which could occurred during this interval.

[1] Hoareau G., Carry N., Marquer D., van Hinsbergen D.J.J., Vrielynck B. & Walter-Simonnet A. (submitted) *Did Neotethys subduction rates contribute to the Early Eocene Climatic Optimum?* Submitted to EPSL.

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