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Global biosphere productivity changes during Heinrich Stadial 4: Preliminary results from the triple isotope composition of air oxygen and numerical simulation using a coupled climate model

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The slowdown of Atlantic meridional overturning circulation (AMOC) caused by accelerated climate change is one of the major concerns as it would have severe impacts at global scale (e.g., Rahmstorf, 1995; Ditlevsen and Ditlevsen, 2023). However, our knowledge on the potential impact of such an event on the global biosphere productivity is still limited, despite its important role in the global carbon cycle. The reasons for this lack of knowledge is mainly two folds: on the one hand, it is challenging to estimate the global biosphere productivity based on local reconstructions as they are often based on qualitative- and indirect micropaleontological or geochemical tracers and are characterized by large spatial heterogeneities (e.g., Averyt and Paytan, 2004; Kohfeld et al., 2005), and on the other hand, numerical experiments using Earth System Models (e.g., Mariotti et al., 2012; Reutenauer et al., 2015) have yet failed to capture the response of global biosphere productivity in its entirety as they do not take into account important forcing factors such as changes in CO_2, dust deposition or vegetation cover.

To address these issues, we present here a preliminary reconstruction of the global biosphere productivity using the triple isotopic composition of air oxygen ($\Delta^{17}O$-O_2) trapped in NEEM (North Greenland Eemian Ice Drilling) ice core samples over 42 to 37 ka covering Heinrich Stadial (HS) 4, a period marked by the weak intensity of the AMOC. Local reconstructions such as European pollen assemblages (e.g., Sánchez Goñi et al., 2020), Antarctic ice-core non-sea-salt Na and Ca (e.g., Fischer et al., 2007), or marine sediment core opal flux records from sub-Antarctic zone of Southern Ocean (Gottschalk et al., 2016) and previous model studies (e.g., Mariotti et al., 2012; Reutenauer et al., 2015) indicate a weak global biosphere productivity during HS4. However, our preliminary result from ice-core $\Delta^{17}O$-O_2 measurements shows little evidence of reduced global biosphere productivity during HS 4. Idealized Heinrich-like freshwater hosing experiments using IPSL-CM5A2-VLR Earth System Model support our findings. In this presentation, the potential role of different forcing factors in regulating the global biosphere productivity will be discussed.