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Elucidating the mechasnisms responsible for the ocean carbon budget changes between the onset (125ka) and offset (115ka) of the Eemian

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The Last interglacial (LIG, or Eemian) is composed of a warm onset around 125ka known as a warmer Earth climate than present (+2˚C) and a colder offset around 115ka (-1˚C). Many evidences from land, ice, and ocean records put this early period as the most intense global warming of the last 200 000 years (Turney and Jones, 2010; NEEM 2013; Carpon et al., 2014) mainly caused by changes in the orbital configurations. This contrasting climate has also led to hypothesis that the AMOC structure and strength changes considerably between these two periods. Future warmer state is expected toward the end of the 21^{st} century in response to anthropogenic carbon emissions and thereby rising the Earth radiative imbalance. For this reason, the Eemian is often referred as an analog for future warmer climate. Few studies have examined the carbon cycle dynamics from this period (Schurgers et al., 2006; Brovkin et al., 2016; Kleinen et al., 2016) with a particular focus on the ability of models to simulate the changes in atmospheric CO_2 concentration, which remained relatively stable around 270-280 ppm without displaying any trends (Lourantou et al., 2010; Schneider et al., 2013; Brovkin et al., 2016). However, the role of the ocean in regulating the Earth's carbon budget in previous studies, is still not well defined and the carbon cycling dynamics within this period are still not well understood.

In this study, we analyze the ocean carbon dynamic between these two opposite states from the last interglacial period: the early and warm Eemian onset (125ka) versus the cooler and late Eemian (115ka). Using a state-of-the-art Earth System model with prescribed atmospheric CO_2, the model simulated a strong decrease of dissolved inorganic carbon (DIC) under warm climate conditions (i.e. 125ka) with a drop of -200 Pg C in the global carbon inventory compared to 115ka. The Atlantic Ocean accounts for 20% of the total loss of DIC and is predominantly due to shorter residence time of the watermasses and lower bio-remineralization at depth. The AABW (Antarctic Bottom Water) is highlighted to retreat southward in the deep ocean in favor of the NADW (North Atlantic Deep water) reaching down to 40˚S on the western border in 125ka. Changes in the carbon budget of the Ocean is likely to occur through the century and quantifying this changes of natural ocean carbon sinks and sources during the Eemian and their feedbacks on the biogeochemistry are essential to constrain future climate projections. Our result is consistent with the expected positive climate carbon cycle feeback such that the ocean capacity to store carbon is reduced in warmer climate.