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Ice sheets, insolation and CO_2 during the interglacial MIS-13

Qiuzhen Yin (1), Andre Berger (1), Andrey Ganopolski (2), Heiko Goelzer (3), Zhengtang Guo (4), and Philippe Huybrechts (3)

(1) George Lemaitre Centre for Earth and Climate Research, Earth and Life Institute, Université Catholique de Louvain, Louvain-la-Neuve, Belgium (qiuzhen.yin@uclouvain.be), (2) Potsdam Institute for Climate Impact Research, Potsdam, Germany, (3) Earth System Sciences & Departement Geografie, Vrije Universiteit Brussel, Brussels, Belgium, (4) Key Laboratory of Cenozoic Geology and Environment, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China

Marine Isotope Stage (MIS) 13, an interglacial about 500,000 years ago, has been seen as the coolest interglacial of the past 800,000 years in proxy records of the Southern Ocean and Antarctica. Its CO_2 concentration is also lower than that of other interglacials and is about 40 ppmv lower than at pre-industrial time. It is also an obviously weak interglacial in marine oxygen isotope records. Its sea level could be 20 m lower than today if the benthic δ18O is assumed to be a signal of only ice volume. All these let assume that ice sheets other than Greenland might have existed in the Northern Hemisphere (NH) during MIS-13. However, this is questioned by the fact that diverse proxy records from the NH suggest that MIS-13 was as warm as or even warmer than other interglacials.

Here we investigate the NH ice sheet configuration during MIS-13 through a modeling approach involving two climate models and two ice sheets models. An offline NH ice sheet model (NHISM) is forced by precipitation and temperature fields provided by transient simulations made with the climate model LOVECLIM. These 50,000-year long transient simulations cover the whole peak of MIS-13.1 (including the two peaks MIS-13.11, -13.13 and the stadial MIS-13.12) and take into account changes in CO_2 concentration, insolation and ice sheets which are provided by simulations of a climate-ice sheet coupled model (CLIMBER-SICOPOLIS). LOVECLIM-NHISM and CLIMBER-SICOPOLIS give similar results although small differences exist. Interestingly, both pairs of models simulate no significant additional ice sheets in the NH at the two peaks MIS-13.11 and -13.13. This means that the effect of a 40ppmv lower CO_2 concentration is counterbalanced by higher summer insolation when NH summer occurs at perihelion. However, a non-negligible Scandinavian ice sheet is simulated during the stadial MIS-13.12. This time, in the framework of a NH summer occurring at aphelion (like today), the lower CO_2 concentration can initiate an additional ice sheets in the NH. More information about how climate and ice sheets respond to different forcings will be further discussed.