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Radiogenic isotope evidence for cold spells in southern Greenland during the warm mid-Pliocene

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The warm mid-Pliocene (3.25-3.05 Ma) was the last time when Earth was warmer for a period longer than any Quaternary interglacial. According to recent studies, it was characterized by an atmospheric pCO_2 concentration close to 400 ppV and a mean global temperature about 3°C above the recent pre-industrial temperature. Most data published so far point to a later onset of the Northern Hemisphere Glaciation, at ~ 2.6 Ma, when carbon dioxide concentrations reached values as low as ~ 280 ppm. In the present study, we use the IODP site U1307 record to document changes in marine sediment sources during the mid-Pliocene. Site U1307 was drilled 200 km south of Greenland (58°30'N, 46°24'W, 2575 m water depth) and should thus provide direct information on erosional regimes inland during this critical interval. Sediment samples were collected with a time-resolution of ~ 10 ka over the ~ 3.2 to 2.9 Ma sequence. Grain size and mineralogical analyses were completed by radiogenic isotope measurements (Nd, Pb) on the sediment fraction <64 µm. Aside a few intervals with ice rafted debris (IRD, >150µm), Nd isotopes depict a general trend towards more radiogenic sources from the mid-Atlantic ridge ridge/Iceland area, which we associated with a strengthening of the Atlantic Meridional Overturning Circulation (AMOC). Over this trend, isotopic excursions with ENd values below -20 point to intervals with enhanced supplies from the unradiogenic bedrock of southern Greenland, with a mean 45 ka pacing, which we associate to ice advances. Subsequent intervals with relatively high IRD contents would support this interpretation. These findings first suggest that despite the relatively warm global conditions of the interval, the AMOC intensified, whereas ice was at least sporadically present over part of southern Greenland, prior to 2.6 Ma, in agreement with recent propositions [1].

[1] Bierman, P., Shakun, J., Corbett, L. *et al.* A persistent and dynamic East Greenland Ice Sheet over the past 7.5 million years. *Nature* **540**, 256–260 (2016). https://doi.org/10.1038/nature20147