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Greenland Ice sheet during the Pliocene climate optimum: a sensitivity study to CO_2 level and orbital configuration

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The extent of the Greenland Ice Sheet (GrIS) during the late Pliocene (3.3 to 3 Ma) remains largely unconstrained. It was fixed to 50% of its present-day volume for simulations of the late Pliocene climate (Dowsett et al., 1999; Hill et al., 2007) based on sea level estimates and vegetation data. The first major pulse of ice-rafted debris on Greenland continental margin is observed at 3.3 Ma, correlated with oxygen isotope signal, suggesting the first expansion in Greenland ice volume, with later increase occurring from 3 Ma (Kleiven et al., 2002). Reconstructed pCO_2 for this period vary during the time interval and among reconstructions. Seki et al. (2010) suggest values between 330 to 400 ppm, and Bartoli et al. (2011) propose minimal CO_2 estimates of 245 ppm. Through a series of simulations with the IPSL-CM5A-LR coupled model used to force the GRISLI ice sheet model, we investigate the possibility of growing or maintaining an ice sheet on Greenland during the late Pliocene. Sensitivity studies to both CO_2 levels of 405, 360 and 280 ppm and varying orbital configuration around 3 Ma are carried out starting from ice-free conditions on Greenland. Using this set of simulations, we will answer the following questions: in favorable conditions (low summer insolation), which CO_2 level triggers glaciation? On the other hand, if an ice-sheet exists, can it be maintained during warmer periods of high summer insolation and higher CO_2?