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Towards Greenland Glaciation: cumulative or abrupt transition?

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During the mid-Pliocene warming period (3-3.3 Ma BP), global annual mean temperature is warmer by 2-3 degree than pre-industrial. Greenland ice sheet volume is supposed to be a 50% reduction compared to nowadays [Haywood et al. 2010]. Around 2.7-2.6 Ma BP, just $\sim$ 500 kyr after the warming peak of mid-Pliocene, there is already full Greenland Glaciation [Lunt et al. 2008]. How does Greenland ice sheet evolve from a half size to a glaciation level during 3 Ma – 2.5 Ma?

Data show that there is a decreasing trend of atmospheric CO_2 concentration from 3 Ma to 2.5 Ma [Seki et al.2010; Bartoli et al. 2011; Martinez et al. 2015]. However, a recent study [Contoux et al. 2015] suggests that a lowering of CO_2 is not sufficient to initiate a perennial glaciation on Greenland and must be combined to low summer insolation, to preserve the ice sheet during insolation maximum, suggesting a cumulative process.

In order to diagnose whether the ice sheet build-up is an abrupt event or a cumulative process, we carry on, for the first time, a transient simulation of climate and ice sheet evolutions from 3 Ma to 2.5 Ma. This strategy enables to investigate waxing and waning of the ice sheet during several orbital cycles. To reach this goal, we use a tri-dimensional interpolation method designed by Ladant et al. (2014) which combines the evolution of CO_2 concentration, orbital parameters and Greenland ice sheet sizes in an off-line way by interpolating snapshots simulations. Thanks to this new method, we can build a transient like simulation through asynchronous coupling between GCM and ice sheet model. With this method, we may consistently answer the question of the build-up of Greenland: abrupt or cumulative process.