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Coupled ice sheet - climate simulations of the last glacial inception and last glacial maximum with a model of intermediate complexity that includes a dynamical downscaling of heat and moisture

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Comprehensive fully coupled ice sheet - climate models allowing for multi-millenia transient simulations are becoming available. They represent powerful tools to investigate ice sheet - climate interactions during the repeated retreats and advances of continental ice sheets of the Pleistocene. However, in such models, most of the time, the spatial resolution of the ice sheet model is one order of magnitude lower than the one of the atmospheric model. As such, orography-induced precipitation is only poorly represented.

In this work, we briefly present the most recent improvements of the ice sheet - climate coupling within the model of intermediate complexity iLOVECLIM. On the one hand, from the native atmospheric resolution (T21), we have included a dynamical downscaling of heat and moisture at the ice sheet model resolution (40 km x 40 km). This downscaling accounts for feedbacks of sub-grid precipitation on large scale energy and water budgets. From the sub-grid atmospheric variables, we compute an ice sheet surface mass balance required by the ice sheet model. On the other hand, we also explicitly use oceanic temperatures to compute sub-shelf melting at a given depth.

Based on palaeo evidences for rate of change of eustatic sea level, we discuss the capability of our new model to correctly simulate the last glacial inception (∼116 kaBP) and the ice volume of the last glacial maximum (∼21 kaBP). We show that the model performs well in certain areas (e.g. Canadian archipelago) but some model biases are consistent over time periods (e.g. Kara-Barents sector). We explore various model sensitivities (e.g. initial state, vegetation, albedo) and we discuss the importance of the downscaling of precipitation for ice nucleation over elevated area and for the surface mass balance of larger ice sheets.