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Ensemble simulations of the minimum configuration of the Greenland ice sheet during the Last Interglacial constrained by ice-core data

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The Last Interglacial (LIG) between ca. 130 and 115 ky BP is probably the best analogue for future climate change for which increasingly better proxy data are becoming available. The volume of the Greenland ice sheet during this period is of particular interest to better assess how much and how fast sea-level can rise in a future Earth undergoing gradual climatic warming. Sea-level during the Last Interglacial is inferred to have been up to 8 meter higher than today and a substantial fraction of that must have come from melting of the Greenland ice sheet. Various ice-sheet modeling studies have come up with a very broad range of the LIG volume loss to between 1 and 6 m of equivalent sea-level rise. This wide range is mainly due to the sensitivity of Greenland ice sheet models to the imposed climatic conditions and to poor knowledge of the LIG climate itself, both in terms of the magnitude and precise timing of the maximum warming, as in terms of spatial and annual patterns. Here we take another approach to constrain the minimum LIG configuration of the GIS. Using a three-dimensional thermomechanical ice-sheet model, we produced an ensemble of 210 possible LIG configurations by varying only three key parameters for temperature, precipitation rate, and surface melting within realistic bounds. The result is a variety of glaciologically consistent GIS geometries corresponding to a wide range of possible "climates", thereby avoiding the complications of having to prescribe the details of the LIG climate itself. To constrain the ensemble of GIS geometries, we used data inferred from 5 Greenland ice cores such as the presence or absence of LIG ice, borehole temperature and isotopic composition. Lagrangian backtracing of particles was used to establish ice-core chronologies and to take into account biases introduced by horizontal advection and local elevation changes. Comparison of model-generated ice-core characteristics with the observed data enabled to narrow down the ensemble to a preferred bound on the GIS contribution to the LIG sea-level rise of between 4 and 5 m.