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Simulations of dated radiostratigraphy for the Greenland ice sheet

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As layers of accumulated snow compact into ice and start to flow under its own weight, their deformations are recorded in the vertical structure of the glacier. Therefore, the isochronal stratigraphy of the Greenland ice sheet provides comprehensive dynamic constraints, which, with adequate methods, can be used to calibrate ice sheet models and greatly improve their accuracy.

We present the first three-dimensional ice sheet model that explicitly resolves isochrones. Individual layers of accumulation do not exchange mass with each other as the flow of ice deforms them, resembling the Lagrangian description of flow in the vertical dimension, while lateral flow within each layer is Eulerian. Direct comparison with dated radiostratigraphy is used to filter an ensemble of simulations of the Greenland ice sheet. The abundant information implied by the shape of the three-dimensional layering enables us to constrain a large number of degrees of freedom. The mismatch in the thickness of certain isochrones is used to calibrate the climate forcing of different periods of the last glacial cycle.