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Reconstructing surface mass balance from the Greenland ice sheet stratigraphy.

Alexios Theofilopoulos and Andreas Born
University of Bergen, Faculty of Mathematics and Natural Sciences, Department of Earth Science, Bergen, Norway (atheofi@yahoo.gr)

Our knowledge of the past surface mass balance on Greenland depends on scarce paleoclimate reconstructions and uncertain climate simulations. However, reconstructions of the internal layering of the ice sheet can provide an independent dataset of accumulation. The thickness of isochronal layers is directly affected by accumulation, but modified over time by the flow of ice. Existing methods can disentangle these two effects only near the ice divide where assumptions of stationarity may be justified. To solve this problem and to obtain a spatially comprehensive reconstruction of accumulation, we use an ice sheet model with an isochronal grid. Thinning rates are calculated prognostically by the model and can be used to define an inverse problem that can be solved iteratively. The only input data is the final layer thickness of the target, e.g., reconstructed radio echo layers from the Greenland ice sheet. To test this method and its limitations, we reconstruct the accumulation histories from the stratigraphies of simulations for which the idealized accumulation time series and spatial distributions are known. These simulations represent a two-dimensional cross section of the Greenland ice sheet. The results are robust to a wide range of realistic variations in accumulation for all but the layers closest to the bedrock where the deformation by the flow is most severe.