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Upstream flow effects revealed in the EastGRIP ice-core using a Monte Carlo inversion of a 2D ice-flow model

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The North East Greenland ice-stream (NEGIS) is the largest active ice-stream on the Greenland ice-sheet and is a crucial contributor to the ice-sheet mass balance. To investigate the ice-stream dynamics and to gain information about the past climate, a deep ice-core is drilled in the upstream part of the NEGIS, termed the East Greenland ice-core project (EastGRIP). Upstream flow effects introduce non-climatic bias in ice-cores and are particularly strong at EastGRIP due to high ice-flow velocities and the location in an ice-stream on the eastern flank of the Greenland ice-sheet. Understanding and ultimately correcting for such effects requires information on the source area and the local atmospheric conditions at the time of ice deposition. We use a two-dimensional Dansgaard-Johnsen model to simulate ice-flow along three approximated flow-lines between the summit of the ice-sheet and EastGRIP. Model parameters are determined using a Monte Carlo inversion by minimizing the misfit between modeled isochrones and isochrones observed in radio-echo-sounding images. We calculate backward-in-time particle trajectories to determine the source area of ice found in the EastGRIP core today and present estimates of surface elevation and past accumulation-rates at the deposition site. The thinning function and accumulated strain obtained from the modeled velocity field provide useful information on the deformation history in the EastGRIP ice. Our results indicate that increased accumulation in the upstream area is predominantly responsible for the constant annual layer thickness observed in the upper part of the ice column at EastGRIP. Inverted model parameters suggest that the imprint of basal melting and sliding is present in large parts along the flow profiles and that most internal ice deformation happens close to the bedrock. The results of this study can act as a basis for applying upstream corrections to a variety of ice-core measurements, and the model parameters can be useful constraints for more sophisticated modeling approaches in the future.