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# Inferring histories of accumulation rate, ice thickness, and ice flow from ice-sheet internal layers

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The spatial and temporal histories of accumulation and ice-sheet flow are necessary to recreate ice-volume and sea-level histories, and are important to correctly interpret ice-core chemistry. Internal layers preserve information about how the ice sheet responded to past spatial and temporal changes in accumulation rate and ice flow, and present-day internal-layer shapes observed by radar are an accessible remaining record of this information. We solve an inverse problem on a spatially limited flowband domain to infer transients in accumulation rate, ice-sheet thickness, and ice flow from the shapes of deep internal layers and other available ice-sheet data. In our approach, we limit our model domain to the extent of data coverage near the divide. We relate changes in the ice-sheet interior with changes originating near the margin by solving for externally forced changes in ice flux across the edge of our model domain.

The solution to this inverse problem depends on the data available, on the ability of the ice-flow model to generate realistic realizations of the data, and on the constraints used in the inverse algorithm in order to stably find a unique solution. To assess the capability of our new algorithm to infer histories of accumulation rate and ice flow, we first solve the inverse problem using synthetic data. Comparing the inferred parameter values to the known parameter values allows us to assess how well we can recover each parameter value for a given test. We solve inverse problems to infer spatial and temporal variations in accumulation rate at different temporal resolutions over the past tens of thousands of years. While variations in the spatial pattern of accumulation can drive divide migration, we expect that externally forced changes in ice flux at the boundaries of our limited domain (e.g. from changes in sea level or in ice-stream activity) will be the primary control on longer-term variations in ice-divide position. Therefore, we solve inverse problems to simultaneously infer both spatial and temporal variations in accumulation rate and temporal variations in ice flux at the domain boundaries.

This general approach is well-suited to data in the vicinity of ice divides. For example, we will eventually apply this approach to data near the West Antarctic Ice Sheet-Divide ice core. The solution is better defined if the internal layers are dated by an intersecting ice core. In addition, shallow internal layers are important to constrain the recent history of accumulation. If few layers are available, a prior expectation of past spatial or temporal variability in accumulation may be necessary to constrain the solution.