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Three-dimensional flow influences on radar layer stratigraphy

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Current and past rates of accumulation are sparse on vast places such as East Antarctica, but are a basic necessity to understand more about past and future changes of the East Antarctic ice sheet. Radar-detectable englacial layers act as an archive and permit us to assess past variability in accumulation rates, with which to assess current variability and attribute it to natural and anthropogenic causes. However, we need to know how internal layers are affected by the ice sheet flow field, which is driven by spatially and temporally varying accumulation and basal melt fields. The better our understanding about the cause of isochrone deformation (e.g. bumps, troughs) the better our interpretation about the influences on the flow field. In this paper we show how the isochrones are affected by incorporating either changes in the flow mode or increased basal melting into three dimensional flow; Simulate the visualisation of radar lines that cross the flow direction; and consider the interaction of surface perturbations. We show that in the presence of lateral gradients we can reproduce bumps and troughs when viewed along transects perpendicular to the flow. The influences of flow convergence, melting and changes in flow mode, when coupled together, affect isochrones over the whole depth of the ice-sheet. Changes near the top cannot be solely attributed to spatial variation in the accumulation rate.