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CLIMATE RECONSTRUCTION FROM ICE CORE ISOTOPE ANALYSIS

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begindocument We present an overview of the title topic from the viewpoint of theoretical modelling and numerical computation. A number of drillsites are located at places where shearing is absent or very small. Each sample of an ice core gives us a wealth of information about the past climate through surface temperature, atmospheric CO2, CH4, etc., isotopic composition of air dust content, etc. To correlate these with the past climate, depth-age relationships are required. At the upper parts of an ice sheet depth-age relations can be inferred by stratigraphy, but at depth these must be based on the mathematical initial boundary value problem describing the flow of ice and the evolution of the entire ice sheet under consideration. Results inferred from these depend on external driving parameters: climate input, lithosphere-atmosphere response; on interior parameters: material parameters of isotropic/anisotropic polycrystalline ice, grain size, recrystallisation, impurities. All these are fraught with uncertainties/errors which affect the computational results.

The climate input consists of the prescription of the surface geometry, surface temperature and accumulation/ablation which is directly known only for the present time, but the latter must be parameterized for climate reconstructions and predictions. Boundary conditions from below involve bedrock models for the description of the ice-sheet-lithosphere-atmosphere interaction and allow direct validation only at the present time.

Glen-type constitutive relations, even when augmented by an enhancement factor, are inadequate and must be replaced by a flow law involving structure or alignment tensors whose values are determined by the orientation distribution of the crystals, recrystallisation, etc., as these evolve as the ice parcel moves through the ice sheet.

Finally, the governing equations are subject to mathematical simplifications via the application of the shallow ice approximation and its extension, and subsequent numerical discretisation with usually coarser grids than needed close to the bed and numerical diffusion may introduce further inaccuracies and falsify the age relation at large depth, close to the bed, to make inferences very difficult. Exemplarily, we demonstrate some results for Greenland. enddocument