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Modeling fabric development using coupled non-parametric orientation and lattice strain-energy distribution functions

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As polycrystalline ice undergoes ductile deformation, the c-axis fabric develops and the effective, macroscopic physical properties of ice become anisotropic. Modeling the flow of anisotropic ice therefore necessitates modeling the evolution of c-axes, too. We propose a non-parametric spectral model to account for the co-evolution of c-axis orientation distributions and stored lattice strain-energy distributions, which in principle allows any distribution shape to be represented. The coupled evolution provides the means to (statistically) model nucleation and migration recrystallization in an energy consistent way as nonuniform decay processes that depend on the accumulated cold work experienced by a given parcel of ice. The free model parameters determine the relative importance of grain rotation versus dynamic recrystallization processes given the local ice temperature, stress- and strain-rate states. We argue that the free parameters may be constrained by consulting the ice-core literature and present tentative simulations of the GRIP ice-core fabric.

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