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## Recrystallization of ice enhances the creep and vulnerability to fracture of ice shelves

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The initiation and propagation of fractures in floating regions of Antarctica has the potential to destabilize large regions of the ice sheet, leading to significant sea-level rise. While observations have shown rapid, localized deformation and damage in the margins of fast-flowing glaciers, there remain gaps in our understanding of how rapid deformation affects the creep and toughness of ice. Here we derive a model for dynamic recrystallization in ice and other rocks that includes a novel representation of migration recrystallization, which is absent from existing models but is likely to be dominant in warm areas undergoing rapid deformation within the ice sheet. We show that, in regions of elevated strain rate, grain sizes in ice may be larger than expected (~15 mm) due to migration recrystallization, a significant deviation from solid earth studies which find fine-grained rock in shear zones. This may imply that ice in shear margins deforms primarily by dislocation creep, suggesting a flow-law exponent of  $n=4$  in these regions. Further, we find from existing models that this increase in grain size results in a decrease in tensile strength of ice by ~75% in the margins of glaciers. Thus, we expect that this increase in grain size makes the margins of fast-flowing glaciers less viscous and more vulnerable to fracture than we may suppose from standard model parameters.