A model of icebergs and sea ice in a joint continuum framework

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The ice mélange, a mixture of sea ice and icebergs, often present in front of tidewater glaciers in Greenland or ice shelves in Antarctica, can have a profound effect on the dynamics of the ice-ocean system. The current inability to numerically model the ice mélange motivates a new modeling approach proposed here. A continuum sea-ice model is taken as a starting point and icebergs are represented as thick and compact pieces of sea ice held together by large tensile and shear strength selectively introduced into the sea ice rheology. In order to modify the rheology correctly, a semi-Lagrangian time stepping scheme is introduced and at each time step a Lagrangian grid is constructed such that iceberg shape is preserved exactly. With the proposed treatment, sea ice and icebergs are considered a single fluid with spatially varying rheological properties, mutual interactions are thus automatically included without the need of further parametrization. An important advantage of the presented framework for an ice mélange model is its potential to be easily included in existing climate models.