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Boundary layer flow of granular sea ice

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The flow of sea ice in the marginal ice zone (MIZ) is considered theoretically. The sea ice is treated as a granular plastic and a composite rheology is presented which is a weighted linear sum of a viscous-plastic rheology [Hibler 1979] and a collision-based rheology [Shen et al 1987]. The collision-based rheology depends upon granular temperature, which is a measure of the kinetic energy in the pertubation velocity of the floes. The flow of sea ice is determined by the momentum balance across and along the MIZ and the perturbation energy conservation equation, which determines the granular temperature. The model takes the form of a boundary layer problem consisting of three nonlinear, coupled ODEs. The physical relevance of the model equations is discussed. Analytical and numerical results describing the boundary layer flow are presented. The results have relevance to descriptions of the MIZ in models of sea ice dynamics and boundary conditions used in GCM calculations.