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Convection in sea ice forced by an external shear flow

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Shear flow within the sub-ice boundary layer is shown theoretically to interact with hydraulic roughness on the ice-ocean interface to produce a Bernoulli pressure perturbation which drives convection within the sea ice. This convection leads to a spatiotemporal variation of the porosity of the ice matrix in addition to driving salt and heat fluxes. We investigate the system using a sea ice analogue: the controlled solidification of an ammonium chloride solution in a laboratory flume. We find a threshold speed above which a spatiotemporal variation of the permeability of the layer appears with a planform wherein the long axis is transverse to the flow direction. Upon removal of the flow, the material returns to a uniform state. The growth of the pattern is compared with a stability analysis which incorporates dissolution of the solid matrix. We describe the systematics of the instability and its importance to the formation of sea ice and associated salt fluxes.