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A variational principle for solute fluxes in mushy-layer convection

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— The utility of variational principles to describe nonlinear dissipative systems has been a topic of long-standing debate. We apply a variational principle to describe nonlinear convection in a *mushy layer*: a reactive porous medium formed during solidification of a binary alloy. Convection drives the formation of channels of zero solid fraction, or chimneys, which are the principle conduits through which solute drains from the mushy layer. By optimizing the rate of removal of stored potential energy, our numerical model predicts scalings for solute fluxes and chimney spacings consistent with previous simulations and laboratory experiments. This leads to predictions of solute fluxes from growing sea ice.

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