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Nonlinear convection in a mushy layer: Chimney spacing and optimal brine fluxes ANDREW WELLS, STEVEN ORSZAG, JOHN WETTLAUFER, Yale University — The rapid solidification of any binary alloy leads to the formation of a chemically reactive porous medium, or mushy layer, comprised of a dendritic solid phase threaded by a concentrated fluid. An important geophysical example is sea ice, where solid ice crystals are separated by dense salty brine, the buoyancy-driven drainage of which has important implications for the ocean thermohaline circulation, and the long time bulk mechanical and electromagnetic properties of the sea ice matrix itself. It is known that convection and local dissolution lead to flow focusing in drainage channels devoid of solid, or chimneys. The spacing of chimneys and resulting brine fluxes evolve over time. We consider nonlinear convection within a mushy layer, applying a numerical model of directional solidification to investigate the spacing mechanism for fully developed chimneys. The resulting dynamics yields insight into the evolution of solute fluxes from growing mushy layers.

Andrew Wells
Yale University

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