

Abstract Submitted
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Boundary layer convection in a radiatively cooled porous medium

JOSEPH HITCHEN, ANDREW WELLS, University of Oxford — In the polar winter, porous sea ice grows by losing heat to the atmosphere through radiative cooling. Sea ice is a reactive, porous medium so cooling causes solidification and creates density gradients in the ice pore space. Previous studies of mushy-layer convection have used highly-conducting boundary conditions with fixed temperatures but we consider the impact of surface radiative cooling using a mixed boundary condition where the heat flux is linked to the evolving boundary temperature. To build initial insight, we consider convective instability in a deep porous layer cooled from above. Using the Biot number to characterise the relative strengths of thermal conduction in the ice and atmospheric heat exchange, we use an energy stability method to determine the critical Rayleigh number, wavenumber and time for convection to occur, driven by density gradients in a transiently growing boundary layer. In the highly conducting limit, we find similar behaviour to previous studies, but a new regime is identified for lower conductivities with a transition region between the two. Calculations suggest that the Biot number for Arctic sea ice may fall in the transitional regime, and therefore the effects of radiative cooling may be important for ice growth.

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