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A geophysical scale model of turbulent natural convection next to a vertical isothermal surface ANDREW WELLS, M. GRAE WORSTER, Institute of Theoretical Geophysics, DAMTP, University of Cambridge — Modelling of many geophysical systems requires accurate prediction of heat transfer from large vertical surfaces. For example, the melt rate of a polar ice shelf submerged several hundred metres into the ocean is controlled in part by the convective heat flux to its surface. We use scaling ideas to develop a model of a vertical natural convection boundary layer with an inner laminar layer coupled to an outer turbulent region. Two distinct dynamical regimes are observed. At small heights the laminar layer is buoyancy driven resulting in a Nusselt number-Rayleigh number correlation of $Nu \propto Ra_x^{1/3}$ consistent with laboratory experiment. At larger heights the dominant buoyant forcing is in the outer turbulent region, which exerts a shear to drive the laminar sublayer. This regime is likely to be the one relevant to most geophysical situations, and yields $Nu \propto Ra_x^{1/2}$. Our scaling analyses are consistent with the ideas that the width of the laminar sublayer is determined by a buoyancy-driven instability in the first regime but by a shear-driven instability in the second.

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