Abstract Submitted
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A new exact solution of the Boussinesq equations S.J.S. MORRIS, U.C. Berkeley — We give a solution of the coupled nonlinear equations describing horizontal flow in a layer of viscous but thermally non–conducting fluid with uniform internal heating. The shear stress and heat flux both vanish at the top and bottom of the layer; the flow is driven purely by the small–amplitude long–wave baroclinicity due to internal heating, and heat generated internally is removed by the purely horizontal flow. This solution models flow near the centre of a long convection cell, like that occurring beneath the Pacific plate. (There, heat generated internally is transported horizontally over the cell length, then removed at the cell end by mixing of hot matter with the cold plume, i.e. the subducted slab. Our solution models only the first of those processes.) Though it is estimated that 50–80% of earth's heat loss is generated internally within the mantle, our conceptual picture of mantle flow is based on simplified boundary layer models for bottom heated convection, in which the temperature is adiabatic outside thin boundary layers, and the flow is driven purely by the excess mass of cold plumes. By contrast, our solution does not contain a cold plume and predicts that the small–amplitude long–wave density field due to internal heating can, by itself, generate velocities close to those observed. Simplified mantle flow models that assume the motion to be driven purely by density differences across slabs may be ignoring an essential part of the forcing.
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