STRATIFIED MULTIFRACTAL MANTLE CONVECTION AND SURFACE GRAVITY FIELDS

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The recent publication of the geoid up to 360th order shows that over the range in scales of roughly 200 to 3000 km, the gravity spectrum falls off remarkably slowly with wavenumber k; it is roughly of the scaling form $E(k) \spadesuit k^{-\beta}$ with $\beta \spadesuit 0.5$. Hence that power in the density spectrum *increases* with k. In order to understand this, we consider the problem of high Rayleigh and Prandtl number convection far from boundaries. By assuming uniform fluid properties and constant vertical heat flux, and using dimensional analysis based on the equations of fluid dynamics we show that unique quantities of dimension length, time and temperature are obtained. We also obtain anisotropic scaling laws for the density, temperature and velocity fluctuations; the inner scale of these laws corresponds to the sphero-scale (where typical convective structures are roundish); at this scale (of the order of 20km), the Peclet number is 1 so that the convection is stopped. We show that this turbulent like high Rayleigh number regime does indeed give a surface gravity exponent close to that observed: we predict bª1. Finally, we show how to make multifractal simulations of mantle convection which include random plumes traversing much of the mantle but only a hundred kilometers or so across. We discuss the implications for mantle modelling.