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Multiscaling analysis of buoyancy-driven turbulence in a differentially heated vertical channel TIE WEI, New Mexico Tech — A multiscaling analysis is presented for the turbulent flow and heat transfer in a differentially heated vertical channel (DHVC). Based on the characteristics of force balance, a three-layer structure is proposed for the mean momentum balance (MMB) equation. In Layer I, a viscous inner layer adjacent to the wall, the force balance is between the viscous force and the buoyancy force. In Layer III, the outer layer, the force balance is between the Reynolds shear force and the buoyancy force. A multiscaling analysis of the MMB equation is developed for the inner and outer layers. A proper scale for the Reynolds shear stress is found to be $u_\tau U_{\max}$ where u_τ is the friction velocity and $U_{\max}$ is the maximum streamwise velocity. The structure for the mean heat (MHB) equation equation can also be divided into three layers based on the characteristics of the diffusional and turbulent heat flux. The outer scaling of the MHB equation in a DHVC is similar to passive scalar transport in forced convection. However, the inner scaling for the thermal inner layer in a DHVC is distinctly different from that in forced convection. The multiscaling analysis of the MMB and MHB equations agree well with the direct numerical simulation data of DHVC.

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