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Effects of Shear on Unstably Stratified Convection CURTIS HAMMAN, PARVIZ MOIN, Stanford University — Direct numerical simulations of plane channel flow heated from below are examined. At Richardson numbers of order unity ($|Ri| = Ra/PrRe^2$, $10^6 \leq Ra \leq 10^9$, $180 \leq Re_\tau \leq 590$ and $Pr = 1$), the production of wall-normal baroclinic vorticity is shown to have a substantial effect upon the mean momentum balance that leads to enhanced turbulent mixing, asymmetry, and turbulent heat transfer. These effects are neglected by traditional Boussinesq formulations, which generate zero baroclinic vorticity in the direction of gravity, accelerate negative and positive density fluctuations identically, and make no direct contribution to the streamwise mean momentum balance. Motivated by the work of Shirgaonkar and Lele (*Physics of Fluids*, 2006), a computationally efficient extension to the Boussinesq approximation is developed and shown to accurately capture these essentially incompressible interactions between shear and buoyancy as observed in variable-density turbulence. Applications to heat exchangers and other advanced energy systems, in which the effects of shear and buoyancy are comparable, are highlighted.

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