Internal length scales in rotating and stratified Boussinesq flows
SUSAN KURIEN, New Mexico Consortium and Los Alamos National Laboratory, X.M. ZHAI, P.K. YEUNG, Georgia Tech — We study the characteristic length scales of the propagating (wave) and non-propagating (vortical) modes, in a suite of simulations of forced, rotating, stably stratified Boussinesq flows. We employ a pseudo-spectral code, periodic boundary conditions and grid resolutions ranging from $512^3$ to $2048^3$ on Blue Gene/Q (Argonne) under DOE’s INCITE program. The relative strength of rotation to stratification frequencies is given by the Burger number $Bu$. Integral length scales in the vertical and horizontal directions are chosen as the characteristic scales and their ratio defines an internal aspect ratio. Nominally quasi-geostrophic (QG) scaling of $Bu^{7/4}$ is recovered for the vortical scale aspect ratio in the stratification-dominated regime $Bu \gg 4$. Much weaker scaling in $Bu$ emerges for the vortical mode in the rotation-dominated regime $Bu \ll 1/4$. The aspect ratio of the wave modes in both regimes are only weakly dependent on $Bu$. Turbulence affects the wave modes in the strongly rotating case by increasing the aspect ratio systematically but has no impact on the weak $Bu$ dependence. It appears that for unit aspect ratio domains, QG scaling of the vortical mode holds only for stratification-dominated flows irrespective of the strength of rotation.

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