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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 $Bu^{?1}$ 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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