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Evaluation of quasi-geostrophic turbulent closures in a two-layer model with barotropic structure

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This study assesses the validity of the quasi-geostrophic turbulent closure of Larichev and Held in an inhomogeneous forced-dissipative two-layer model. We describe the sensitivity of the diffusivty on the model's criticality when perturbing the main external parameters: the width and baroclinicity of the radiative-equilibrium profile, the stratification, the environmental PV gradient β, and the diabatic and frictional time scales for the zonal-mean flow. It is found that the empirical results agree well with the theoretical prediction, with two exceptions. When the width of the baroclinic zone or the frictional time scale are changed, the theoretical closure fails because the equilibration is dominated by changes in the meridional structure. Nevertheless, agreement with the theory is recovered if the criticality is generalized by including the environmental relative vorticity in the definition of β. When this is done, the agreement with the theory holds locally over the full eddy generation region.