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A Scale-Aware Parameterization of Restratification Effect of Turbulent Thermal Wind Balance

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Journal of Physical Oceanography

Supplementary material for

A Scale-aware Parameterization of Restratification Effect of Turbulent Thermal Wind Balance

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Text S1 and Figure S1-S3

Introduction

Text S1 describes the configuration of the 0.3 km simulation (KE0.3). Figure S1 compares the front intensity and the vertical buoyancy flux (VBF) induced by the TTW balance $\langle B_f^{\text{TTW}} \rangle$ in KE0.3 and KE1. Figure S2 shows the ratio of the maximum turbulent vertical viscosity (K_m) in the surface boundary layer to K_m at five times of the surface boundary layer depth. Figure S3 shows that the offline computation of VBF induced by mixed layer instability $\langle B_f^{\text{MLI}} \rangle$ increases as the model resolution becomes coarser.

Text S1. To demonstrate whether the 1-km simulation can resolve the frontal width and $\langle B_f^{TTW} \rangle$, a 0.3 km-resolution simulation (KE0.3) is configured over 34.5°N-40°N, 155°E-162°E nested within the KE1 region. A biharmonic horizontal Smagorinsky-like mixing scheme for momentum and no horizontal mixing is used for tracers in KE0.3 simulations. The KE0.3 is initialized on 1 December 2003 and integrated for 80 days with the initial condition and boundary conditions obtained from KE1. The mixed layer averaged front intensity $(\overline{\nabla_H b^z})^2$ and $\langle B_f^{TTW} \rangle$ in KE0.3 and KE1 over 34.6°N-39.9°N, 155.1°E-161.9°E from 15 December 2003 to 15 February 2004 is compared in Fig. S1.

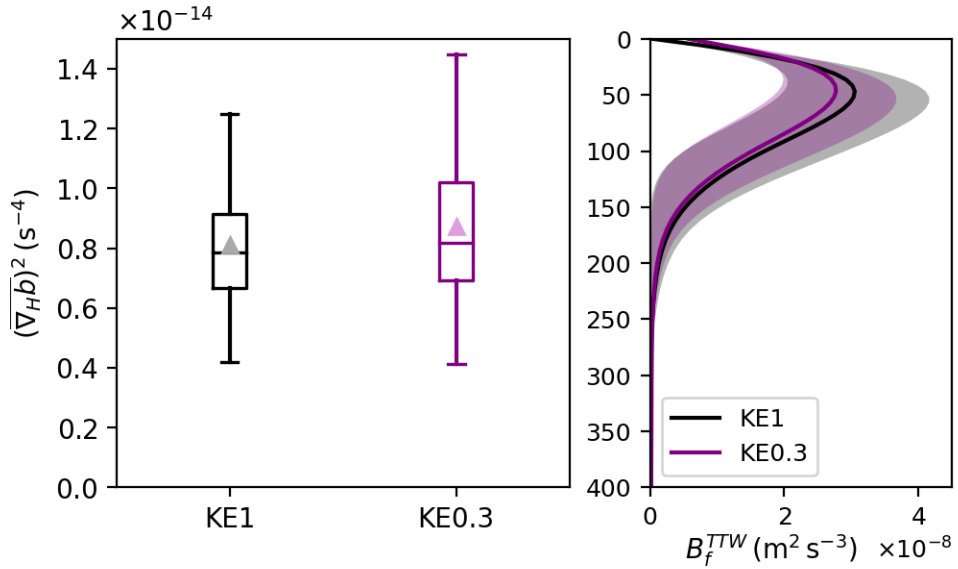


Figure S1. (a) Boxplots for horizontal mean front intensity $(\overline{\nabla_H b^z})^2$ in KE1 (black) and KE0.3 (purple) with their temporal mean values indicated by triangles. (b) Vertical profiles of horizontal and temporal mean B_f^{TTW} in the KE1 (black) and KE0.3 (purple) with the standard deviation over time shown in shadings.

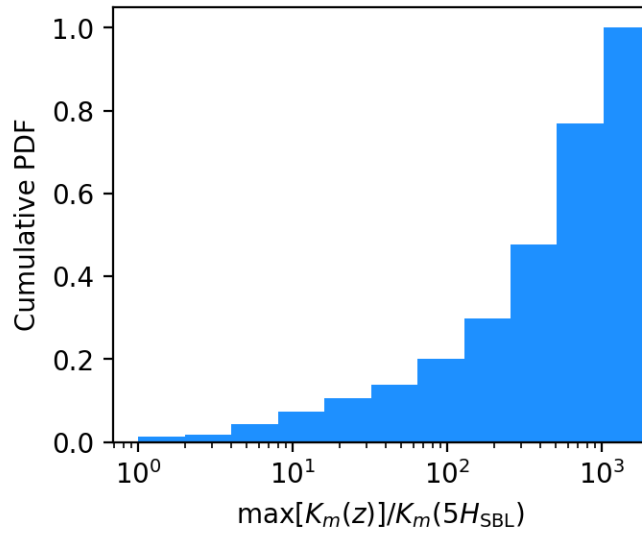


Figure S2. The cumulated probability density function of the ratio of the maximum K_m in the surface boundary to K_m at five times of the surface boundary layer depth.

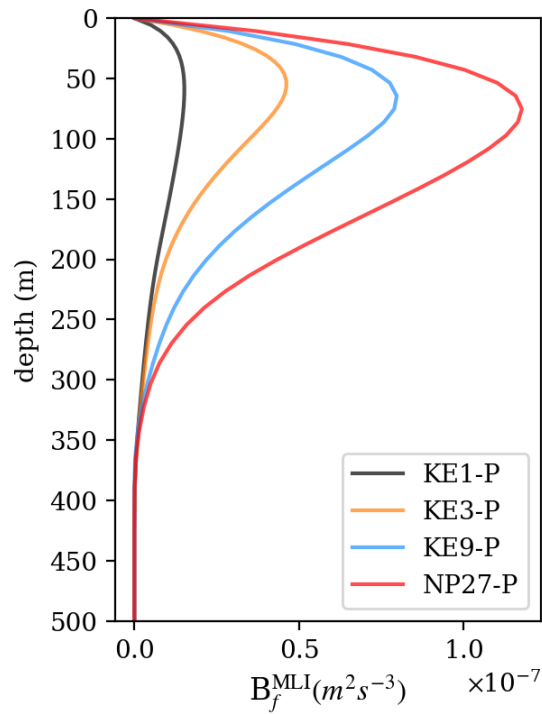


Figure S3. The offline computation of the vertical buoyancy flux $\langle B_f^{\text{MLI}} \rangle$ induced by mixed layer instability averaged over averaged over 150°E–166°E, 33°N–42°N from 1 December 2003 to 31 March 2004 in the NP27-P (red), KE9-P (blue), KE3-P (orange), and KE1-P (black).