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Investigation of turbulent entrainment in ocean thermocline using large eddy simulation

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Large eddy simulation is used to investigate how the turbulence erodes the linear stratified ocean thermocline. Simulations initialize with different one-dimensional vertical potential temperature profile. The initial profile consists a well-mixed upper layer, followed by a tilt thermocline, then a deep layer where the temperature slowly drops with depth. All the experiments are imposed with constant momentum/heat flux. The results are agree with the common response to surface wind stress and cooling. The deepening of the mixed layer presents two stages: an early fast deepening and then reach to a quasi-steady state. At the mixed layer depth, the gradient Richardson number remains approximately constant. There is a strong shear appearing at the base of mixed layer, which is due to the stable thermal stratification dampens momentum and buoyancy flux across the thermocline, and it results in the enhance of local instabilities and turbulence intensity. Different background stratification bring small disturbances to entrainment characteristics. The comparison suggests stronger stratification in thermocline limits the downward strength of turbulent mixed layer penetration, nevertheless, the vertical structure of velocity variance and momentum/heat flux are maintain the same shape. Furthermore, the influence of external forcing on mixing and turbulence kinetic energy budget terms also display through a group of sensitivity experiment.