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Comparison between vertical shear mixing and non-breaking surface wave-induced mixing in the upper ocean

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Most parameterizations of vertical mixing are associated with local shear instability, which does not explicitly include the effects of surface waves. Here, we compared the performance of vertical mixing induced by vertical shear of the mean current and that by non-breaking surface waves in the upper ocean through three numerical experiments. The vertical mixing from vertical shear alone was too weak especially and failed to produce a reasonable mixed layer depth and seasonal thermocline, which resulted in a large cold bias and an unrealistic seasonal cycle in the subsurface. Surface waves can enhance the vertical mixing in the upper ocean, and induce vertical mixing to sustain a reasonable upper-ocean temperature structure. Both the temperature structure and seasonal cycle were significantly improved by including the non-breaking surface wave-induced vertical mixing, no matter whether shear effect was included or not. These results indicate that the vertical mixing from surface waves is more important than that associated with velocity shear of the mean current for the upper ocean.