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Modeling of suspended sediment concentrations under combined wave-current flow over rippled bed

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Under the joint effect of waves and currents, ripples appear and disappear dynamically on coastal bed. The bottom stress can significantly be enhanced when ripples appear, and then the sediment transport will be influenced by the ripple-enhanced stress. However, ripples' impact on sediment suspension is seldom discussed. In this study, a bedform (ripples) module based on combined wave and current flow is coupled with a bottom boundary layer (BBL) model, and the coupling is based on the exchange of roughness and wave coupled shear velocity. This BBL model outputs our improved bottom shear stress (BSS) to the sediment model (UNSW-sed) to generate sediment movements. Model results in Jervis Bay show that the simulated suspended sediment concentration (SSC) is significantly improved by considering ripples rather than setting a uniform roughness (K_b).The ripples can lead to a higher resuspension near the bottom under the influence of waves. However, the SSC of an abrupt rising is still underestimated by using previous schemes. Differently from the previous estimation of ripple-enhanced shear velocity U_{*cwe}, noted as U_{*cwe_NL}, we introduce the shear velocity $U_{*cwe_K_b}$improved by calculating through ripple-enhanced K_b. Simulation shows that $U_{*cwe\_K_b}$ produces significantly increased SSC under high wave conditions. This abrupt rising of SSC results in reasonable agreements with the measurements. The wave friction factor f_w is shown to play a crucial role in causing the difference between$U_{*cwe_K_b}$ and U_{*cwe_NL}.

Key words: ripples; sediment transport; roughness; bottom shear velocity; combined wave-current stress; Jervis Bay