Swell impact on wind stress and atmospheric mixing in a regional coupled atmosphere-wave model

Over the ocean, the atmospheric turbulence can be significantly affected by swell waves. Change in the atmospheric turbulence affects the wind stress and atmospheric mixing over swell waves. In this study, the influence of swell on atmospheric mixing and wind stress is introduced into an atmosphere-wave-coupled regional climate model, separately and combined. The swell influence on atmospheric mixing is introduced into the atmospheric mixing length formula by adding a swell-induced contribution to the mixing. The swell influence on the wind stress under wind-following swell, moderate-range wind, and near-neutral and unstable stratification conditions is introduced by changing the roughness length. Five year simulation results indicate that adding the swell influence on atmospheric mixing has limited influence, only slightly increasing the near-surface wind speed; in contrast, adding the swell influence on wind stress reduces the near-surface wind speed. Introducing the wave influence roughness length has a larger influence than does adding the swell influence on mixing. Compared with measurements, adding the swell influence on both atmospheric mixing and wind stress gives the best model performance for the wind speed. The influence varies with wave characteristics for different sea basins. Swell occurs infrequently in the studied area, and one could expect more influence in high-swell-frequency areas (i.e., low-latitude ocean). We conclude that the influence of swell on atmospheric mixing and wind stress should be considered when developing climate models.

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