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Numerical modeling investigation of radiation stress in coastal wave-current coupling

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It is believed that the radiation stress is the main driving force for nearshore wave-induced currents. So far several theoretical formulas of radiation stress have been proposed, among which the vertical structures differ considerably. A numerical wave flume (NWF) have been established on the basis of the CFD software, and applied to simulate the wave motion in various shallow water topography with different incident waves. The results from the NWF is used to analyze the features of radiation stress. It is found, that the vertical integral of the radiation stress is agreeably consistent with the well-known classical result by Longuet-Higgins and Stewart (1964), while the vertical structure of the radiation stress is discontinuous at the surface where the maximum exists, which can be better characterized with the formula by Mellor (2008). The effects of radiation stress and wave roller are implemented in a coupled SWAN-POM model, so that the coupled model is able to simulate the wave setup and wave-induced current. The numerical modeling results have been verified by the field measurements. It is shown that the modelled wave setup corresponding to various radiation stress formulas is well in agreement with the field observation. This means the modeled wave setup is dependent on the vertical integral of radiation stress rather than the vertical structure of that. In comparison with the observed current velocity and direction data, it is shown that the modeled results with Mellor's radiation stress formula plus wave roller is able to be consistent with the filed measurement well. This indicates that the modeled wave-induced current is dependent on the vertical structure of radiation stress rather than the vertical integral of that.