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Impact of Surface Waves on Ocean Surface Currents

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An approximate steady solution is obtained for a wave-modified Ekman model resulting from the Stokes drift, wave-breaking dissipation and reduction of wind stress due to wave generation for the vertical eddy viscosity formulated by the K-Profile Parameterization scheme by using the WKB method. Based on the satellite remote sensing data and WAVEWATCH III outputs, the solution presented is used to calculate ocean surface ageostrophic current. The results are compared with those of the other two existed models. One of the two models is the classical Ekman model without considering the wave effect, and the other is a simple wave-affect Ekman model that only considered the effect of Stokes drift. Both the classical Ekman model and the simple wave-affect Ekman model use a constant eddy viscosity coefficient. Ocean surface currents are then estimated by considering the contributions the geostrophic current and Stokes drift. The estimated surface currents are validated by the in situ Argo drifter observations. The results shown that the currents calculated by the wave-modified Ekman model presented in this research are more consistent with the drifter observations than those of the other two models. Compared with the classical Ekman model, the averaged correlation coefficients (root mean square error) of the wave-modified Ekman model have increased (decreased) both for the zonal currents and for the meridional currents if a constant eddy viscosity coefficient is used. The average contribution ratios of wave-modified terms induced by the Stokes drift, wave-breaking dissipation and reduction of wind stress due to wave generation to the Lagrangian current are estimated both for the zonal component and for the meridional component. The average relative deviation of the surface current calculated by the proposed model using a depth independent eddy viscosity and that obtained by the K-Profile Parameterization scheme are also compared. The research shown that the wave-breaking dissipation, reduction of wind stress due to wave generation and the parameterization of eddy viscosity also have significant influence on the estimation of the ocean surface current in addition to the wave effect of the Stokes drift.