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Wind stress distribution above complex sea states

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A Laboratory experiment was conducted to investigate the surface wind stress distribution above wind generated waves perturbed by longer mechanical waves. A systematic change was observed in the wind stress in response to increasing the steepness of the long waves, independent of variations of mean wind forcing and long wave frequency. With increasing paddle wave steepness, the short wind wave energy density reduces with a corresponding attenuation of up 20 % in the wind stress. Further significant increases in long wave mean steepness resulted in rapid increases in the wind stress up to 190% enhancement. Similar behaviour of the aerodynamic roughness length zo was also observed. Re-examining Jeffreys (1925) theoretical approach to the determination of the wave-induced stress, we obtain robust estimates of form drag and tangential stresses. Using a wind speed referenced to a single height, above the level of wave influence, provided a good collapse of the entire dataset with a single sheltering coefficient. Estimates of tangential stresses are consistent with previous direct measurements (Banner and Peirson 1998, Giovanangeli et al 1999).

The same methodology was applied to open field data obtained during the FETCH campaign (Hauser et al 2003) yielding similar trends, high correlation between measured and estimated stresses, consistent tangential stresses values and similar sheltering coefficient.

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