Reply

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Kantha (2005) correctly states that the numerical solutions obtained by Mellor (2002, henceforth M02), interpreted as the ratio of apparent roughness to actual roughness, differ from data obtained in wave tanks. Because the solutions using a turbulence closure model, simplified for zero stratification, correspond well to data for pure current flow and to pure oscillatory flow and because the model has been shown to be applicable for other turbulent flows, there is every reason to expect that the model should apply to combined current–oscillatory flow. The M02 solutions were for oscillatory flow with no variation in the stream direction, however, and thus correspond to a wavenumber k equal to 0. For nonzero wavenumber, one must contend with so-called streaming flow (Longuet-Higgins 1953; Phillips 1977), in which the bottom boundary layer induces a nonzero correlation between vertical and horizontal wave velocities and which, for laminar flow, appears to be surprisingly important in modifying the near-bottom flow and stress. Therefore, one should add another parameter to Kantha's Eq. (1): kA_b. One hopes that the M02-type turbulence analysis can be extended to $k > 0$ to supply the missing information. Note that a finding in M02 is that an alteration in the effective kappa in the law of the wall more nearly represents the flow change than does altering the effective roughness. Whether this finding will apply to $kA_b > 0$ is a question in need of an answer.

Some minor quibbles: it is the logarithm of the ratio of apparent roughness to actual roughness that is most relevant so that the zero-k M02 solutions are not as different from the wave-tank data as Kantha implies. Also, his modification of the Grant–Madsen results (Grant and Madsen 1979, 1986) may be a significant improvement but it is very hard to see this improvement from his plots.

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