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Long waves through emergent coastal vegetation

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We study the effects of emergent coastal forests on the propagation of long surface waves of small amplitudes. The forest is idealized by a tight array of vertical cylinders. Simple models are employed to represent bed friction and to simulate turbulence generated by flow through the tree trunks. A multi-scale (homogenization) analysis similar to that for seepage flows is carried out to deduce the effective equation on the macro-scale. The effective coefficients are calculated by numerically solving the micro-scale problem in a unit cell surrounding one or several cylinders. Analytical and numerical solutions for wave attenuation on the macro-scale for different bathimetries are presented. For a transient incident wave, analytical results are discussed for the damping of a leading tsunami. For comparison a series of laboratory data for periodic waves simulating wind waves, as well as transient incident waves simulating tsunamis, are also presented. Good agreement is found between data and predictions even though some of the measured waves are short or nonlinear.
The asymptotic technique of homogenization can be extended to solute dispersion in waves through coastal forests.