Spectral broadening of free surface gravity waves as a consequence of resonance and quasi-resonance cascade under influence of wind

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The influence of wind on the four-wave interaction of surface gravity waves is investigated using a coupled air-water Reynolds Averaged Navier-Stokes model. The air and water domains are discretized in a surface following coordinate where the interfacial grid points are dynamically adjusted in an Averaged Lagrangian-Eulerian scheme. The k-omega SST scheme is used as a turbulent closure model. The model is solved in a horizontally periodic domain with free-slip bottom. Starting with three waves propagating at an angle, the forth wave grows as a result of four-wave resonance when the four waves satisfy the resonance condition. Initial growth of the fourth wave agrees with theoretical estimation based on discretized Zakharov's equation (with Krasitskii's coefficient used). After about 80 cycles or so, substantial energy was transferred to numerous spectral peaks due to dynamical cascade among quasi-resonant free waves. Under the influence of wind, the spectral broadening was enhanced. At about 40 cycles or so, the wave energy spread rapidly repeating the quasi-resonant cascade as much as four times. We conjecture that the wind energy pumping to the newly generated waves expedites the dynamical cascade. In the talk, effect of normal stress and tangential stress at the interface will be discussed in terms of modified dispersion relationship and resonance detuning.