Geophysical Research Abstracts
Vol. 18, EGU2016-10506-1, 2016
EGU General Assembly 2016

Wavemaker theories for acoustic-gravity waves over a finite depth

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Acoustic-gravity waves (hereafter AGWs) in ocean have received much interest recently, mainly with respect to early detection of tsunamis as they travel at near the speed of sound in water which makes them ideal candidates for early detection of tsunamis. While the generation mechanisms of AGWs have been studied from the perspective of vertical oscillations of seafloor (Yamamoto, 1982; Stiassnie, 2010) and triad wave-wave interaction (Longuet-Higgins 1950; Kadri and Stiassnie 2013; Kadri and Akylas 2016), in the current study we are interested in their generation by wave-structure interaction with possible application to the energy sector.

Here, we develop two wavemaker theories to analyze different wave modes generated by impermeable (the classic Havelock's theory) and porous (porous wavemaker theory) plates in weakly compressible fluids. Slight modification has been made to the porous theory so that, unlike the previous theory (Chwang, 1983), the new solution depends on the geometry of the plate. The expressions for three different types of plates (piston, flap, delta-function) are introduced. Analytical solutions are also derived for the potential amplitude of the gravity, evanescent, and acoustic-gravity waves, as well as the surface elevation, velocity distribution, and pressure for AGWs. Both theories reduce to previous results for incompressible flow when the compressibility is negligible. We also show numerical examples for AGW generated in a wave flume as well as in deep ocean. Our current study sets the theoretical background towards remote sensing by AGWs, for optimized deep ocean wave-power harnessing, among others.

References

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