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Influence of water droplet size variations on propagation of the pressure wave above water surface

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Problem of the wave-induced pressure on the atmospheric side of the ocean interface is fundamental to the topic of wind-wave interactions and thus of energy/momentum exchanges across the surface. In extreme conditions, that is at wind speeds exceeding 30m/s, this boundary layer close to the surface is filled or even saturated with the water droplets (spume) which is believed to essentially affect or even alter the air-sea interactions. The present paper is dedicated to one of possible mechanisms for the pressure-wave propagation in presence of such droplets. This work outlines a mathematical model of the pressure wave propagation in the gas media containing a spectrum of different liquid or solid particles such as water droplets or other spherical particles and offers a method to estimate the influence of the energy exchange between phases on the evolution of the wave under different conditions of interphase interactions. Conservation equations describing the propagation and structure of finite amplitude perturbations in such a medium, with correction for heat transfer and momentum exchange between the phases, have been employed to obtain the evolution of the wave profile during the pressure-wave propagation. These equations are taking in account difference in the sizes of particles. The media containing these particles is dispersive due to the finite rate of the above-mentioned exchange processes. The resultant equations in general incorporate integral terms containing the amplitude of the perturbation, heat and momentum exchange terms. The derived equations are capable of describing the evolution of waves at any ratio between time of the internal process and the characteristic period of the pressure wave. The solutions can be used to determine the dissipation of energy of a wave passing through a medium containing liquid droplets of different size. The proposed approach neglects the effect of droplets' or particle's temperature influence on the gas bulk. Two extreme cases have been considered, one for long-wave and the other one for short-wave interaction. The resultant equation is comprehensive and quite complex in the case of large difference in the size of droplets due to different interphase exchange mechanism. Final results show that there are analytical solutions for some of the specific cases of the interaction between phases. The finding could be used for estimation of wave dissipation in a medium containing different particles.