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THE OCEAN'S AEROSOL SOURCE FUNCTION

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LONG TERM GOALS

The major long term goal of this work is to determine the fundamentals of the ocean aerosol source function.

OBJECTIVES

The objective of this work is to determine the mechanisms by which ocean droplets are generated. For each of these mechanisms the objective becomes the measurement of the number, size and associated birth parameters such as ejection speed, angle, time and height of the droplets. The two best known and studied mechanisms of ocean droplet production are the jet and film drops from bursting bubbles. Less well known and almost completely unstudied are the droplets generated by the surface impacts of other droplets. There is now, for example, very strong evidence that 'primary' film drops generate 'secondary' film drops when they impact the surface, at high speed, immediately adjacent to their parent bubbles. Another objective, then, is to determine the birth parameters of these secondary droplets. This work is supported by ONR Marine Meteorology.

APPROACH

The basic approach in this research has been to study individual bubbles. Droplet sizes and birth parameters have been measured using acoustic and capacitance sensors in conjunction with Particle Measuring System's Optical Array Probe, fast video cameras and magnesium oxide coated surfaces.

WORK COMPLETED

In FY97 the measurements of film drop production by individual bubbles ranging in size from 2 to 14.6 mm-diameter were completed and a theoretical framework explaining the results constructed.

RESULTS

The parameters of the births of film droplets originating from bubbles bursting on sea water surfaces were determined for bubbles of 2 to 14.6 mm-diameter. It was shown, contrary to earlier reports, that the films of all these bubbles burst in an orderly manner in which a hole appears at a well defined location, usually the film's edge, and propagates from there gathering up the film's mass into a toroidal ring as it progresses. It was also shown that, for bubbles larger than 2.4 mm-diameter, film droplets are generated by centrifugal forces and that this begins when the film has rolled up through an angle of about 31^{o} independent of both bubble size and (theoretically) surface tension. Film drop spray patterns recorded on MgO coated cylindrical shells surrounding the burst bubbles yielded film drop numbers and trajectories. In addition, film drop size distributions, their speed of launch and the speed at which the film opens were determined as a function of bubble size.

IMPACT

As a result of the work this year, there is now a substantial understanding of the generation by individual bubbles of film droplets. It is clear that from the sizes of these droplets, their high speed, and angle of ejection that few will be entrained. They will, instead, impact the surface. A strong inference can be drawn that these impacts by 'primary' film drops will give rise to 'secondary' film drops by splashing in a manner analogous to the generation of droplets when rain drops impact the surface. Perhaps it would be better to call them 'splash' droplets. This is a wholly new concept suggesting that the question of 'film' drop production is more complex than previously thought. As a result, the necessity of studying high speed, shallow angle impacts of droplets with water surfaces is apparent. The predictions of net water vapor flux and near-surface electromagnetic propagation, which are important to the Navy, depend significantly on the outcomes of such measurements.

TRANSISTIONS

The data generated by these measurements are important inputs to the models developed by such workers as P.G. Mestayer, A.M.J. Van Eijk, B. Tranchant, E. Monahan and E. Andreas.