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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 numbers, sizes and associated birth parameters such as ejection speed and trajectory 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. The existence of 'secondary' droplets generated by the impacts of 'primary' film drops has now been established. So, it becomes important 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 the droplets produced by the bursting of 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, magnesium oxide coated surfaces, and water dyes.

## WORK COMPLETED

The FY97 the measurements of film drop production by individual bubbles and the theoretical framework explaining these results lead to a prediction that primary film drops would create secondary droplets by splashing when the primaries impacted the water's surface. This prediction has been verified, and, during FY98, the numbers and sizes of these secondary droplets have been measured as a function of bubble size. In addition progress has been made in determining the effect of water temperature on jet drop size distributions.

## RESULTS

The numbers and sizes of the secondary droplets created when film drops impact the water's surface have been determined as a function of bubble size. This was accomplished by having the bubbles rise in a narrowly confined column filled with ordinary sea water which was surrounded by, but isolated from, sea water which had been dyed red by the addition of food coloring. Filter paper forming a concentric shell surrounding, and just above, these water columns was used to detect and size any secondary droplets which, of necessity, left red stains.

## IMPACT

Previous work had lead to a substantial understanding of the generation by individual bubbles of film droplets. It became clear that from the sizes of these droplets, their high speed, and angle of ejection that few would be entrained and that, instead, they would impact the surface near the parent bubble. A strong inference was drawn that these impacts by 'primary' film drops would give rise to 'secondary' drops by splashing in a manner analogous to the generation of droplets when rain drops impact the surface. This was a wholly new concept which showed that the question of 'film' drop production was far more complex than previously thought. As a result of work this year, their existence is now confirmed and progress has been made in establishing the role they play in bubble mediated air-sea exchanges. The importance of these air-sea exchanges to the Navy is evident . Thus, the demonstration of a an altogether new exchange mechanism is a milestone.

## 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.

## PUBLICATIONS

Spiel, D.E., On the births of film drops from bubbles bursting on seawater surfaces, J. Geophys. Res., **103**, C11, 24907-24918, 1998

Spiel D.E., The droplets produced by individual bubbles bursting on a sea water surface, Chapter 18, in: "Air-sea fluxes of momentum, heat, and chemicals" to be published by Kluwer, Dordrecht, The Netherlands, 1998

## IN-HOUSE/OUT-OF-HOUSE RATIOS

100% of the work was performed in-house.