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A MODEL OF MARINE AEROSOL GENERATION VIA WHITECAPS AND WAVE DISRUPTION

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1. Introduction

We have, over the past several years, as one element in the development of a time-dependent model of the aerosol population of the marine atmospheric boundary layer, attempted to define, in terms of aerosol droplet radius (r) and 10m-elevation wind speed (U), a model of open-ocean sea-surface aerosol generation. This source function is represented by the expression $dF(r, U)/dr$, which states the rate of production of marine aerosol droplets, per unit area of the sea surface, per increment of droplet radius. In the initial modeling efforts only the indirect aerosol production mechanisms associated with the bursting of whitecap bubbles (see Figure 1) were considered. The model for sea surface aerosol generation by the indirect mechanisms, first introduced in our Canberra SSAG-1 (Monahan, et al, 1979) and Manchester SSAG-2 (Monahan, 1980) papers, is given by Equation 1, where W is the

$$dF_0/dr = W \tau^{-1} \, dE/dr \tag{1}$$

instantaneous fraction of the sea surface covered by whitecaps, τ is the time constant characterizing the exponential whitecap decay (measured in seconds), and dE/dr is the differential whitecap aerosol productivity, i.e. the number of droplets per increment droplet radius produced during the decay of a unit area of whitecap (expressed in $m^{-2}\ \mu m^{-1}$). The necessary expression for W(U) was obtained from shipboard photographic observations of whitecaps (Monahan, 1971; Toba and Chaen, 1973),

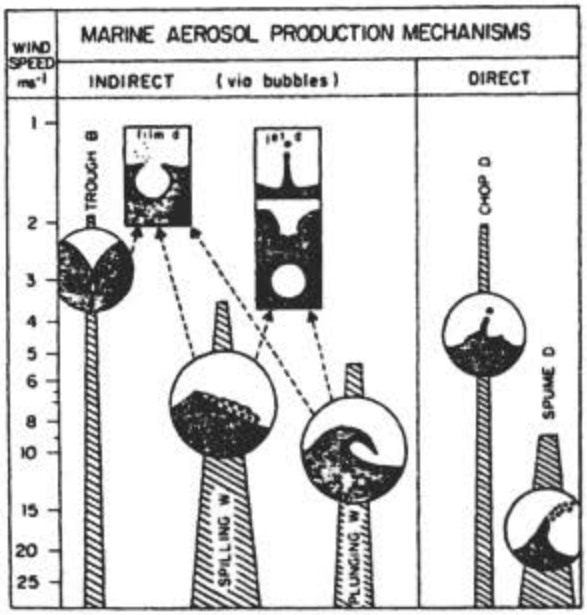

Fig. 1. Schematic representation of the relative importance of various marine aerosol production mechanisms. The relative widths of the shaded columns, at any particular wind speed, are meant to indicate the relative significance of the direct and indirect aerosol production mechanisms represented by the various columns. Note that spilling and plunging waves both form whitecaps.

while values for τ and dE/dr were derived from measurements made using the University College, Galway, whitecap simulation tank.

The specific expression for W(U) used in the latest model of dF_0/dr, SSAG-3 (Monahan, et al, 1982), and given in Equation 2, was extracted

$$W(U) = 3.84 \times 10^{-6} \, U^{3.41} \tag{2}$$

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