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Whitecaps, sea-salt aerosols, and climate

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ABSTRACT

Oceanic whitecaps are the major source of sea-salt aerosols. Sea-salt aerosols are the dominant natural aerosols in remote marine air and contribute to radiative and chemical processes affecting climate. The inclusion of the effects of sea-salt aerosols improves the predictions of climate models. The generation of sea-salt aerosols is the first of many processes that must be modeled. Modeling the production of sea-salt aerosols usually needs whitecap coverage, W, and its dependence on wind speed, U_{10}. Various measurements of sea-salt production, however, do not constrain well the predictions of the sea-salt generation function using the relation $W(U_{10})$ alone. Other variables, beside wind, affect the formation of whitecaps and production of sea-salt aerosols. In addition, the sea-salt generation function needs extension of its applicability toward smaller sea-salt aerosol sizes.

In my dissertation I propose modifications to make the sea-salt generation function currently used in climate models more relevant for studies of aerosol effects on climate. To implement the modifications, I have developed a new method for estimating whitecap coverage from satellite-measured brightness temperature of the ocean surface. Whitecap coverage evaluated with this method incorporates the effects of sea-surface temperature, salinity, wind fetch, wind duration, and amount of surface-active material. An extensive database of whitecap coverage has been compiled with the new method and used to derive spatial and temporal characteristics of oceanic whitecaps and sea-salt fluxes.

I will shortly describe the various processes through which sea-salt aerosols affect climate. I will show how sea-salt aerosols form from sea spray and how sea spray production is modeled. I will present the concept of a new method for estimating whitecap coverage and discuss the global spatial distribution of oceanic whitecaps. Finally, I will illustrate implications of the new estimates of whitecap coverage by evaluating global sea-salt aerosol flux, CO2 exchange, and ocean albedo in the presence of whitecaps.