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Estimating global sea-spray emissions using satellite data

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Sea-spray aerosol influences the climate considerably through both direct and indirect aerosol effects. Climate models contain a sea-spray source function, the generation of sea spray per unit surface area and per unit time over the world oceans, which is currently parameterized in terms of wind speed and sometimes sea surface temperature. The uncertainty associated with the calculated emission fluxes for sea-spray aerosol is a factor of 3-5. Another uncertainty is the fraction of organic material in sea-spray aerosol.
Organic material substantially contributes to the composition of sub-micron sea-spray aerosols, especially in biologically active regions, where small (r80, the radius at 80% relative humidity, smaller than about 0,25 micrometer) sea-spray particles have been observed to contain substantial amount of organic matter (OM) which decreases as particle size increases. OM occurs in the active CCN size range and a change in composition may thus affect cloud droplet formation. A first attempt to include the organic fraction in a sea-spray source function was presented by O'Dowd et al. (2008). These authors proposed to use remotely sensed chlorophyll concentration data as a proxy for oceanic biological activity. An organics-chlorophyll relationship was determined by correlating chlorophyll satellite data and in-situ measurements of organic mass. This information was used together with the sea-spray source function to determine the surface flux of the combined inorganic/organic sea-spray particles (O'Dowd et al., 2008; Vignati et al., 2010; Albert et al., 2010). By introducing this methodology, one inevitably introduces uncertainties due to the choice of a certain satellite instrument to obtain information on the chlorophyll concentrations and the choice of the resolution and compositing period of the data. Other uncertainties are due to the handling of the satellite data and the fit that is used in the organics-chlorophyll correlation. The organic fraction estimate can additionally be affected by the time period that is studied and the source function that is used to calculate the total sea-spray emission. Based on a first estimate of the global emission of the sub-micron organic matter fraction of sea spray, we have performed a sensitivity analysis regarding the above mentioned uncertainties. We found a variability of up to 50% depending on the chosen parameterizations. Specifically, different source functions and the fit that was used in the organics-chlorophyll correlation were found to cause large deviations from our first estimate. Conventional sea-spray source functions are expected to be improved by including factors, complementary to wind speed, which better account for the effects of a suite of meteorological and oceanographic factors.
In this study we explore the use of satellite retrieved whitecap coverage data (Anguelova et al., 2006). We are currently extending our study by incorporating global whitecap coverage data, derived from satellite measurements of changes of ocean surface emissivity at microwave frequencies, in our sea-spray generation model, and we will discuss the progress of this work at the meeting.

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