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Uncertainties in the determination of the organic fraction of global sea-spray emissions

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Sea-spray aerosol considerably affects the climate, both directly and indirectly. The emission rate of sea-spray droplets per unit area of the sea surface is implemented in climate models through a sea-spray source function. The uncertainty between existing formulations of the sea-spray source function that is parameterized in terms of wind speed and sea surface temperature is more than a factor of 2.

Organic material substantially contributes to the composition of sea-spray aerosols, especially in biological active regions. Small sea-spray particles may be mainly composed of organic carbon with a decreasing contribution as particle size increases. The sizes in which organic carbon occurs are in the active CCN range and a change in composition may thus have a substantial effect on cloud droplet formation. A first attempt to include the OC fraction of sea-spray 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 water insoluble organic compounds. 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., 2009; Albert et al., 2010). By introducing this methodology one inevitably introduces uncertainties due to the choice of a certain satellite instrument to obtain the chlorophyll data and the choice of the resolution and compositing period of the data. Other uncertainties that are introduced 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. We will first present a basis methodology to estimate the global emission of the submicron organic matter fraction of sea-spray. Starting from a first estimate of the annual global emission we have performed a sensitivity analysis regarding the above mentioned uncertainties. We found differences of up to at least 50% depending on the chosen parameterizations. Especially the choice of different source functions and the fit that was used in the organics-chlorophyll correlation were found to cause large deviations from our first estimate. From this we can conclude that the estimation of the fraction of organic matter in submicron sea-spray aerosol is still very uncertain.

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