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A Campaign Study of Sea Spray Aerosol Properties in the Bay of Aarhus

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The oceans of the world are a dominant source of atmospheric aerosol. Together with mineral dust, sea spray aerosols (SSA) constitute the largest mass flux of particulate matter in the atmosphere (Andreae and Rosenfeld, 2008). Due to their effects on the global radiative budget – both directly as scatterers and absorbers of solar and terrestrial radiation, and indirectly as cloud condensation nuclei (CCN), SSA are considered an important component of the climate system.

The sea-surface microlayer (SML) is an ultra-thin boundary layer between the ocean and the atmosphere. The high concentration of surface-active organic compounds in the SML, compared to that of the underlying water column, creates rigid film-like layer over the surface of the ocean. The SML is believed to play an important role in the formation and composition of SSA. However, current knowledge on the SML and its impacts on SSA remain limited.

To characterize the SML of natural seawater and examine its impacts on aerosol properties, a field campaign was conducted in the bay of Aarhus, Denmark, during spring 2015. Bulk seawater was collected 1-2 times every week along with selective sampling of the SML. Characterization of the sea water and SML included a wide range of measurements, including surface tension, water activity, dissolved organic matter, and chemical composition analysis by liquid chromatography/electrospray ionization high-resolution quadrupole time-of-flight mass spectrometry (UPLC/ESI-HR-Q-TOFMS).

SSA was generated from sampled sea water by diffusion of air bubbles through a 10L seawater sample situated in a sea spray tank. Particle number concentration and CCN measurements were conducted along with measurements of the organic share in the aerosol phase as indicated by volatility measurements. To investigate the effect of the SML, spiking of the seawater samples with additional SML was performed and measurements repeated for comparison.

Preliminary results show that the SML samples only displayed slightly lower surface tension compared to subsurface seawater. A number of overlapping masses were observed in dissolved organic matter extracted from SML and slick samples, which requires further identification. Spiking bulk seawater with SML seems to lead to a small increase in organic share in the aerosol phase as indicated by volatility measurements, while the trend is unclear in CCN measurements.

Andreae, M. O., and Rosenfeld, D.: Aerosol-cloud-precipitation interactions. Part 1. The nature and sources of cloud-active aerosols, Earth-Sci Rev, 89, 13-41, 2008.