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On the significance of surface active polysaccharides in the high Arctic open lead surface Microlayer in summer

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The air-sea interface, known as surface microlayer (SML, operationally defined as the uppermost 1 μm), represents a unique community of which the physical and chemical characteristics may differ considerably from those of the underlying subsurface seawater. Emerging evidence suggests that marine microcolloids or gels derived from microbes in seawater as a result of extracellular excretion can be accumulated at the SML due to their high surface affinities. It has been proposed that the bio-derived microcolloids accumulated at the SML can be ejected into the atmosphere through bubble bursting and provide a substantial fraction of aerosol particles over remote marine areas. This airborne surface active organic matter may enhance the number concentration of cloud droplets and consequently modify cloud microphysics.

Marine colloids are quite abundant in surface seawater (about 106-107 particles per milliliter). They are complex aggregates of organic macromolecules containing predominantly polysaccharides with a minor fraction of proteins and lipids. The large fraction of colloidal polysaccharides in seawater provides a solid–liquid interface for the occurrence of adsorption, polymerization and coagulation. Although some studies have been carried out on assessing the bulk concentration of total dissolved and particulate carbohydrate in the SML, there is little data available on the molecular composition of marine polysaccharides.

In this study, samples were collected in 2008 during the Arctic Summer Cloud Ocean Study (ASCOS; www.ascos.se) from both the lead SML and subsurface waters. Colloidal polysaccharides were isolated from bulk seawater by ultrafiltration. Monosaccharide composition of acid-hydrolyzable polysaccharides was analyzed by liquid chromatography coupled with tandem mass spectrometry.

Our results indicate that polysaccharides were enriched in the SML compared to the subsurface waters. The enrichments were non-uniform and polysaccharides in the microcolloidal phase were scavenged preferentially into the SML. Variation of monosaccharide spectra suggested that dynamic chemical processes occurred at the air-sea interface. It implies that the highly enriched colloidal polysaccharides in the SML may provide major components of the abundant organic matter found in the high Arctic airborne aerosol, providing a link between the high Arctic low-level clouds and marine biological activity.