



DMS and DMSP dynamics in Antarctic early spring sea ice (Bellingshausen Sea, September-October 2007)

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The ocean is an important source of biologically mediated atmospheric sulphur through the production of large amounts of dimethylsulfide (DMS), a known precursor of climatically active aerosols. Few studies have addressed the question of the role of the sea ice in the production of DMS and dimethylsulphoniopropionate (DMSP) although the sea ice environment provides favourable conditions to the production of the latter at concentrations which are several orders of magnitude higher than in the water column. This study presents the evolution of the concentrations of DMS and DMSP in the early spring sea ice and underlying water from two sites of the Ice Station 'Belgica'. The latter took place for about one month in the Bellingshausen Sea in the framework of the SIMBA cruise ('Antarctic Sea Ice in IPY' program, Bellingshausen Sea, September-October 2007 – Chief scientist: S.F. Ackley) onboard the RV/IB Nathaniel B. Palmer. The two sites were chosen for their contrasted ice and snow conditions (mostly columnar thin ice and thin snow cover at 'Brussels site' vs. mostly granular thick ice and thick snow cover at 'Liège site') and the homogeneity of the surface properties (level ice, uniform snow thickness). The sites were visited at regular time lapses during the experiment. Ice core samples were processed and the DMS/P concentrations measured at high resolution directly after sampling onboard the ship, in order to minimize the bias related to delayed measurement of the DMS.

This compound was extracted from the ice samples using a dry-crushing technique at low temperature which has been specifically designed to avoid a partial artificial conversion of DMSP into DMS on melting. The concentration of the DMS (and DMSP after reaction with excess NaOH) in the gas sample was then measured with a GC according to a usual 'purge and trap' procedure. We had the opportunity, during the study period, to capture a complete cooling and warming cycle which has induced major thermodynamic shifts within the sea ice cover. As attested by the main physical parameters (texture, temperature, bulk and brines salinity, relative brine volume), the resulting 'flood-freeze' cycle has strongly influenced the whole ice cover at the Brussels site but only the upper half of the ice cover at the Liège site. The ice showed (surprisingly for that period of the year) obvious signs of degradation and large tubes of descending refrozen brines have frequently been observed. Increasing DMSP and DMS production was observed during the cooling phase especially in the upper part of the ice cover at the Brussels site. This process led to the highest DMS (up to 3000 nmol kg⁻¹ ice) and DMSP (up to 5400 nmol kg⁻¹ ice) concentrations ever observed in sea ice. Astonishingly high concentrations (never reported before) of DMS (up to 120 nmol l⁻¹) and DMSP (up to 80 nmol l⁻¹) were also measured in the underlying water (at 0m, 1m and 30m depth). These observations confirm the existence of an active brine release process to the seawater below and strongly support a thermodynamic control of the system.