Melt pond biogeochemistry in central Arctic: first insights from MOSAiC campaign

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We undertook a melt pond survey during the international drift campaign MOSAiC Leg 5 (from 22 August to 18 September 2020) to understand variations in climate gases (CO_2, CH_4, N_2O and DMS) and nutrients in melt ponds during the open water and freezing periods, and to study the interactions with atmospheric and ecological parameters (Figure 1a). Inside those melt ponds with a darker color, we found significant quantities of floating organic material within the pond water, along with significant further organic material settled at the bottom of the pond and frozen into the ice (Figure 1b). These floating and sedimented materials were both white and green/brown; the green/brown material was mainly composed of phytoplankton "*Melosira arctica*", while the white material was composed of re-mineralized organic matter during degradation (including the remains of krill and other zooplankton). There were strong vertical gradients in physical parameters from the surface to the bottom of the melt pond (within 1 m depth): from +0.2°C to –1.5°C for temperature, from 0 to 29 psu for salinity, and 9.2 to 13.5 mg L^{-1} for dissolved oxygen (DO). The DO minimum layer (below 9 mg L^{-1}) corresponded with a salinity of 25 psu, which generally occurred at approximately 0.6 m depth, and it increased to over 13 mg L^{-1} at the atmospheric interface. At the end of Leg 5 (mid-September 2020), these strong gradients disappeared, likely due to the mixing events during the cooling and freezing periods. Prior to and during the freezing period, CO_2 flux was measured periodically within the melt pond with a floating chamber system. Because measured in situ CO_2 concentration at the melt pond surface (top 10 cm) was low (321 ppm) compared to the atmosphere (approximately 400 ppm), air–to-melt pond CO_2 flux was negative (melt pond was acting as a sink for atmospheric CO_2) around –3.9 mmol m^{-2} day^{-1}. Therefore, the melt pond water absorbs significant amounts of CO_2 from the atmosphere. We also found extremely low CO_2 concentrations (170 ppm) at the freshwater/seawater interface (0.6 m depth) corresponding to the same depth as the DO minimum. Therefore, we expected that if melt pond water is mixed vertically by the wind, cooling, crack formation, and ice movement, the melt pond could become an even stronger sink for atmospheric CO_2. Ice cores collected from the bottom of the melt pond were porous at the top 0.50 m, and contain large quantities of organic material similar to that identified floating in the water column This accumulation of material and ongoing degradation processes over the pond bottom ice would contribute significantly to the turnover of carbon, sulphur and nitrogen containing gases cycles within melt pond water and thereby gas exchange process with the atmosphere.

a

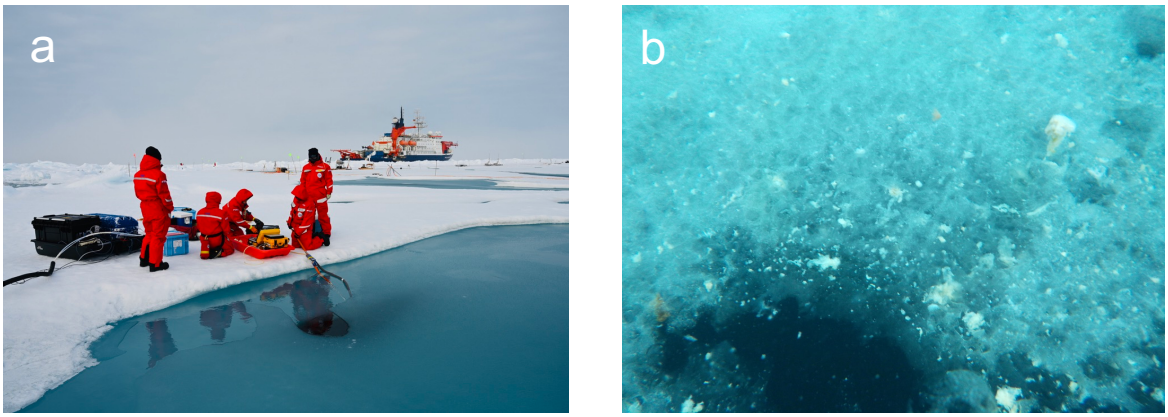

Figure 1. Pictures of the melt pond water sampling (a) and the organic layer at the bottom of the melt pond (b) at St. MP4 during the international drift campaign MOSAiC Leg 5.