



High resolution mapping of methane concentrations measured by membrane inlet mass spectrometry around pockmarks in Lake Constance, in the North Sea and in the North Atlantic west of Svalbard

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Atmospheric methane is the most abundant organic compound in the atmosphere and an important greenhouse gas at least 20 times more potent than carbon dioxide. By application of online membrane inlet mass spectrometry, we investigated in situ the 3D concentration field of dissolved methane in the water column around pockmarks in Lake Constance/Germany, the North Sea, as well as in the North Atlantic west of Svalbard, to describe the pathway of methane from the seafloor to the atmosphere.

In lakes as well as in marine environments pockmarks (morphological depressions at the seafloor) or gas flares (ebullition of methane enriched gas bubbles from sediments) are observed worldwide. Around pockmarks and gas flares high methane concentrations in sediments and in the water column were reported for marine as well as for limnic environments. At several pockmarks, intense ebullition of gas from sediments were observed. Around these pockmarks strong concentration gradients were measured. Methane concentrations close to pockmarks or gas flares were up to four times higher than measured within a distance of less than 50 m or 200 m aside. For shallow water pockmarks and gas flares enhanced CH₄ concentrations were observed in surface waters. Compared to the atmospheric equilibrium concentration of CH₄ over-saturation ratios of more than 5 were derived. These areas contribute significantly to the export of CH₄ from surface waters into the atmosphere. For gas flares released from deeper water depths only low methane concentrations in surface waters were observed. This supports model results suggesting the release of methane from the gaseous phase within the gas bubble into the dissolved phase of the water column. High resolution 3D mapping of gas concentrations around gas flares allows identification of transport pathways as well as computation of mass budgets.