

Participants

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Figure 1. Sampling sites in Himmerfjärden.

Table 1. Askö June 2011 Campaign Stations:

ID	N	E	(m)
H6	59°04.08 N	017° 40.63 E	41
		017°42.2949 E	
SIVAB	59°028.500 N	E	25
H5	59° 02.19 N	017° 43.40 E	25
Frinsö	59°03.2517 N	017°43.5766 E	25
H4	58°59.07 N	017°43.60 E	30
H3	58° 56.04 N	017°43.81 E	50
H2	58° 50.40 N	017° 47.42 E	30
B1	58° 48.19 N	017° 37.52 E	42
Tvären 1	58°47.6144N	017°23.0774E	4.5
Tvären 2	58°47.5819N	017°23.1475E	6

Tvären 3	58°47.4308N	017°23.1475E	9
Tvären 4	58°47.2445N	017°23.7467E	15
Tvären 5	58°46.9461N	017°24.7404E	30
Tvären 6	58°46.3630N	017°25.5309E	75
Hållsviken 1	58°53.3074 N	017°27.7051 E	3.2
Hållsviken 2	58°53.1319 N	017°27.9611 E	8
Hållsviken 3	58°52.0386 N	017°29.2492 E	18

From June 10 to June 16, 2011, three BONUS scientists, one PhD candidate and one B.Sc. students from Stockholm University, Sweden participated in the third field campaign in Himmerfjärden to determine methane concentrations in the water column and to determine methane fluxes to the water column using floating chambers.

Water column methane work

Stations B1, H2, H3, H5, and H6, and two stations near the outflow of the SYVAB sewage treatment plant were selected for flux experiments in Himmerfjärden. In addition, 6 stations were selected in the coastal basin of Tvären, which develops late summer/fall bottom water anoxia. As the third transect, we selected 4 stations in Hållsviken (Fig.1). For the experiments, thermally insulated round plastic chambers with a volume of 7.5 L and a surface area of 0.08 m² were connected via plastic tubing to a LGR ICOS CO₂-CH₄-H₂O analyzer so that gas was circulated in a closed loop through the analyzer and chamber. The floating chamber was set out about 5 m from the ship. Two chamber deployments were performed per station. Methane fluxes were determined from the change in concentration in the chamber over time and recalculated to a methane flux in mmol m⁻² d⁻¹ using the total volume and surface area of the chamber. In parallel, duplicate water samples for the determination of dissolved methane were determined from the surface water. 40 ml water samples were equilibrated with 20 ml air headspace and directly analyzed with the LGR analyzer. Wind speed and air pressure were recorded for every station. At station 6 in Tvären, a water column profile of dissolved methane was obtained using Hydrobios water samplers.

Benthic methane fluxes

Benthic methane fluxes were determined by ex-situ incubations of intact multicores by circulating the water overlying the core through an INSPEC 200 mass spectrometer. Fluxes were calculated from the volume of water overlying the core and surface area of the sediment core.

Results

Water column fluxes

All stations had positive fluxes of methane ranging from 0.01 mmol m⁻² d⁻¹ to 0.12 mmol m⁻² d⁻¹. On average fluxes were 0.066 mmol m⁻² d⁻¹. All surface water oversaturated with respect to the expected concentration of methane in equilibrium with the atmosphere. Methane fluxes were highest in very shallow water of Hållsviken (4 m) and in the surrounding of the SYVAB sewage treatment plant suggesting that sewage discharge significantly contributes to methane budget of the water column. Fluxes decrease offshore and were lowest at the open water station B1 and Tvären 6. Water depth was weakly negatively correlated with methane flux. Bottom

water anoxia and high bottom water methane concentrations had little effect on the effective methane flux to the atmosphere.

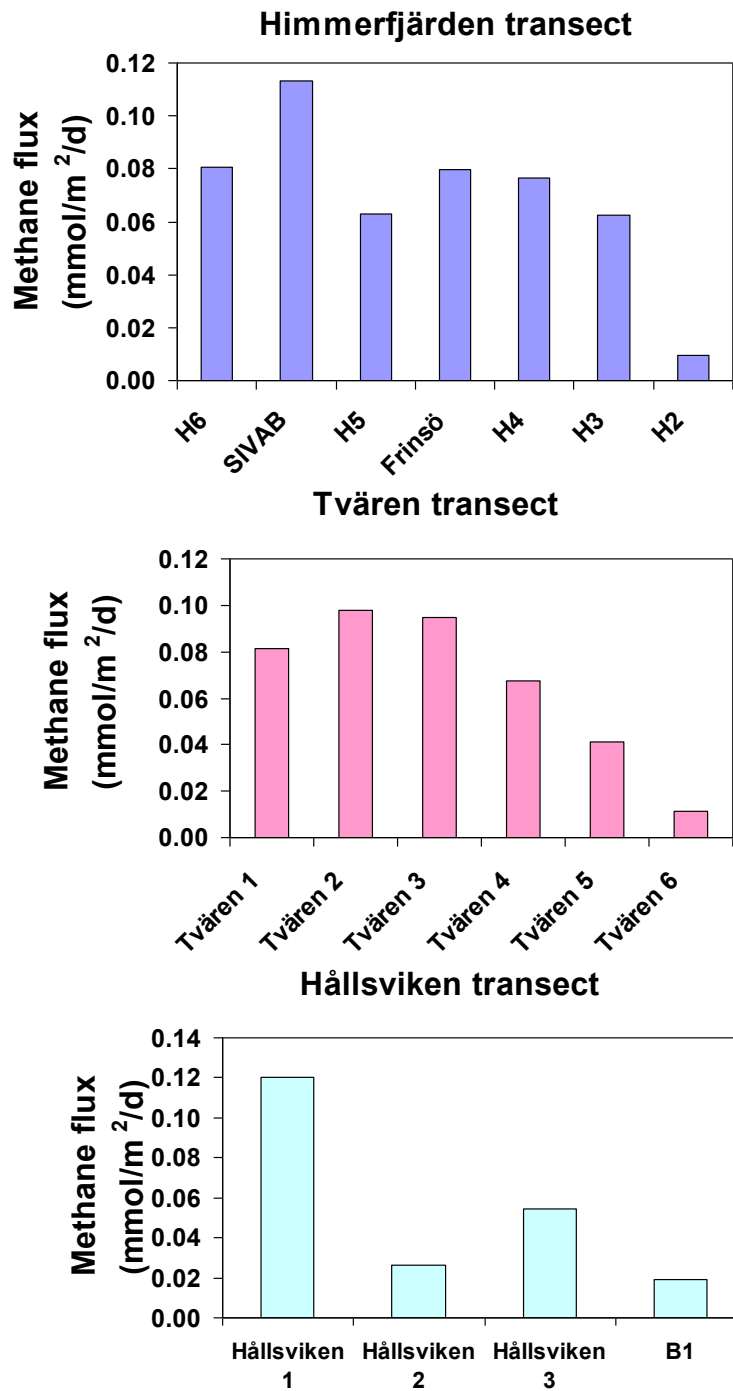


Figure 2. Methane fluxes determined in chamber experiments in Himmerfjärden, Tvären, and Hållsviken.

Benthic fluxes

Benthic fluxes were determined at Station H2, H3, and H5 in Himmerfjärden. Rates ranged from 0.3 mmol m⁻² d⁻¹ at Station H2, 0.4 mmol m⁻² d⁻¹ at Station H3, and 1.0 mmol m⁻² d⁻¹ at

Station H5. These numbers are in accordance with methane fluxes determined porewater gradients of dissolved methane.

We would like to thank the Askö Marine Station staff for support during sampling.