Bubble-mediated transport of benthic microorganisms into the water column and its implication on pelagic methane oxidation capacity at the blowout site in the North Sea

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Gas releasing seep sites represent hot spots of seabed-derived methane emissions to the water column, where physical and biological barriers regulate transport of methane to the atmosphere. Pelagic methane oxidation is the final sink for seabed-derived methane before its release into the atmosphere. Especially at gas vent sites, where large amounts of methane bypass the sedimentary microbial methane sinks, the role of pelagic methane oxidation in reducing the methane emission from the ocean becomes even more important. Pelagic methane turnover at highly active seeps is controlled by environmental factors such as methane availability, differential circulation patterns, and redox conditions. In our study at the blowout site in the North Sea (decommissioned well site 22/4b), we investigated how the bentho-pelagic transport of methanotrophic bacteria affects pelagic methane turnover. In our studies, we proved the dislocation of microorganisms from the sediment into the water column via gas bubbles released from the seabed, and showed that the transport efficiency is dependent on the gas flux intensity from the gas-releasing vent site. Furthermore, our investigations showed, that the dislocation of benthic methanotrophs into the water column can spontaneously boost the methane oxidation capacity within the dispersing methane plume. This transport mechanism becomes even more critical at seep sites characterized by water residence times that are too short to allow the relatively slow-growing methanotrophic community to establish a resilient methane sink. However, for a comprehensive understanding of methane dynamics in a dispersing plume we propose further studies to investigate the survival, potential growth and activity change of benthic MOB in the aging plume waters and trace shifts in the microbial community composition. Even though the impact of environmental factors on MOB abundance and activity may vary between seep locations, we contend that the bentho-pelagic transportation of methanotrophs creates a positive feedback on the pelagic methane sink through the reduction of methane turnover time and atmospheric flux.

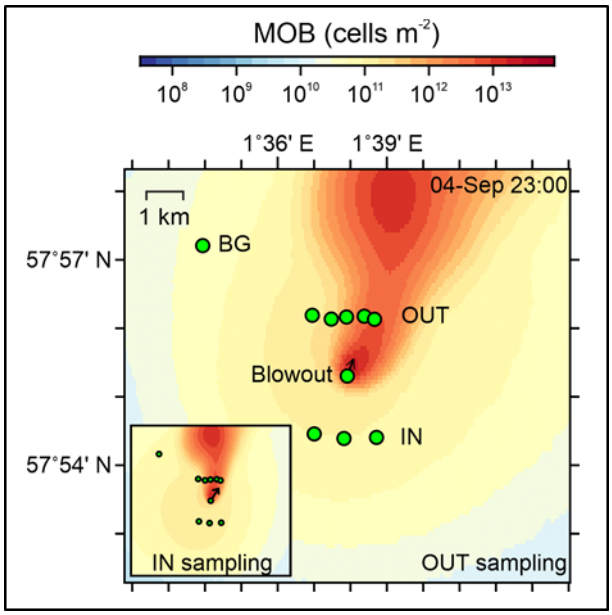

Figure 1. Snapshots of the modeled methane-oxidizing bacteria (MOB) spatial distributions at the blowout site in the North Sea (decommissioned well site 22/4b). The color-coding indicates the MOB cell concentration integrated over the respective depth range (Jordan et al. 2021).

References

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