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Water column methanotrophy controlled by a rapid oceanographic switch

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Large amounts of the greenhouse gas methane are released from the seabed to the water column where it may be consumed by aerobic methanotrophic bacteria. This microbial filter is consequently the last marine sink for methane before its liberation into the atmosphere. The size and activity of methanotrophic communities, which determine the capacity of the water column methane filter, are thought to be mainly controlled by nutrient and redox dynamics, but little is known about the effects of ocean currents. Here we show that cold bottom water at methane seeps west of Svalbard, containing a large number of aerobic methanotrophs, was rapidly displaced by warmer water with a considerably smaller methanotrophic community. This community replacement led to a reduction of methane oxidation rates of 60 % and was independent of methane input. Measurements of temperature and salinity, combined with the output of a high-resolution ocean/sea-ice simulation model (VIKING20) showed that this water mass exchange was caused by short-term variations of the West Spitsbergen Current (WSC), which is characterized by two principal modes: The warm core of the WSC either flows along the continental shelf break and thus above the methane seeps (nearshore mode), or it meanders offshore thereby entraining colder shelf water, which then flows over the seeps (offshore mode). We could link the larger community to the colder shelf water during the offshore mode, and the smaller community and lower methane oxidation rates to the presence of the warmer WSC water above the seeps. As a result, the meandering of the WSC can be considered as an oceanographic switch severely reducing methanotrophic activity in the water column. Output from the ORCA12 model showed that strong and fluctuating bottom currents are common features at methane seep systems. We thus argue that the variability of physical water mass transport is a globally important control on the distribution and abundance of methanotrophs and, as a consequence, on the efficiency to oxidize methane above point sources.