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Short-term variations of methane and methanotrophic activity in a coastal inlet (Eckernförde Bay, Germany)

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Large quantities of the greenhouse gas methane are produced in anoxic sediments of continental margins and may be liberated into the overlying water column and, potentially, into the atmosphere where it further contributes to global warming. The ocean input to the atmospheric methane budget is mitigated by a sequence of microbially mediated methane oxidation pathways in sediments and the water column. In anoxic sediments, specialised microbes can oxidise methane anaerobically. In addition, aerobic bacteria at the sediment surface and in the water column have the potential to consume methane (aerobic oxidation of methane - MOx) that has bypassed oxidation in sediments. The MOx microbial filter in the water column is consequently the final sink for methane before its release to the atmosphere. Nevertheless, spatiotemporal aspects of MOx activity in (aerobic) marine waters, particularly the controlling physical, chemical and biological factors are not well constrained. Here we show results from our investigations on methane dynamics on very short time scales of hours to days in the Eckernförde Bay (E-Bay), a costal inlet of the Baltic Sea in northern Germany featuring seasonal bottom water hypoxia/anoxia. During a storm in autumn 2014, we observed high spatiotemporal variations in water column methane content and MOx activity: Anoxic bottom waters in a trough in the northern part of the bay contained extremely high methane concentrations of up to 800 nM, which sharply decreased at the midwater redox interface (methane remained supersaturated with respect to the atmospheric equilibrium throughout the water column at all times). This decrease was related to highly active MOx communities consuming methane under microoxic conditions at rates of up to 40 nM/d at the redox interface. About 12 hours later, the methane content and the extend of bottom water anoxia was much lower, and MOx activity was highly reduced in the northern part, but strongly elevated in the southern part of the bay. A few days later, bottom water anoxia, methane loading and MOx activity was partially re-established. In this contribution, we will show that partial mixing and re-stratification related to storms and (tidal) currents are key forcing mechanisms leading to the observed dynamics.