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Aerobic methane oxidation in a coastal environment with seasonal hypoxia - a time series study

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In the coastal ocean, methane is generally produced in anoxic sediments from where it can migrate through the water column to the atmosphere. A significant amount of methane is consumed along this passage by a series of microbial filter systems. Over the last 15 years, researchers focused on the first filter in marine sediments, the anaerobic oxidation of methane (AOM). Comparably little is known about the second filter, the aerobic methane oxidation (MOx), which is mediated by bacteria and takes place in the oxic water column. MOx is particularly important in shallow coastal environments that account for more than 75 % of the global oceanic methane emissions. Key environmental factors possibly controlling MOx in these systems are subjected to strong temporal variations since coastal regions are highly dynamic systems. We will present results from a time-series study on methane cycling in the water column of a coastal inlet in the southwestern Baltic Sea (Eckernförde Bay, Boknis Eck Time Series Station, 54°31.823 N, 10°02.764 E, 28m water depth; www.bokniseck.de). Results from monthly samplings for the last 8 years revealed year-round methane seepage from the seafloor and methane supersaturation (with respect to the atmospheric equilibrium) of surface waters. Seasonal stratification during the summer months leads to intermittent oxygen depletion (hypoxic to anoxic) in bottom waters in late summer to early fall. The frequency of these low-oxygen events increased over the last 20 years. In addition to oxygen fluctuations, bottom water salinity can vary strongly (17-24 psu) due to regular inflows of salty North Sea water through the Kattegat. Over the course of one and a half years, we investigated MOx rates, the methanotrophic community, methane concentrations and physicochemical parameters of the water column on a quarterly basis. Albeit methane concentrations were high throughout the water column (20-120 nM), methane turnover showed a clear spatial pattern. That is, MOx rates were very low in surface waters and strongly increased below the pycnocline, with highest rates in bottom waters (1-5 nM/day). Oxygen concentrations below detection limit ($< 1\ \mu$M) did not inhibit MOx. In fact, we measured highest methane oxidation rates under these microoxic conditions. In ongoing experiments, we further investigate the relationship between water column oxygen concentration and MOx activity in order to better understand the impact of hypoxia and anoxia on methane oxidation in coastal systems.