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Dense bottom gravity currents and their impact on pelagic methanotrophy at oxic/anoxic transition zones

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Interfaces between oxic and anoxic water bodies represent distinct zones in which the activity of specially adapted microbes often controls biogeochemical transformations. Anoxic basins as the Black Sea, the Cariaco Basin, and the Baltic Sea represent ideal locations to examine these processes, the involved microorganisms, and the influence of their metabolism on the turnover of different substances. Taking the Baltic Sea as an example, it is shown here that turbulent mixing of sulfidic and oxic waters may have a strong impact on microbially-mediated transformations. Direct evidence for these processes was derived from observations of methane oxidizing bacteria (MOB), their activity, and turbulence inside a sharp redox interface, freshly generated by a large-scale intrusion of oxic waters into the sulfidic deep layers of the central Baltic Sea (Gotland Basin). Based on detailed turbulence measurements, different mixing regimes along the basin slope were defined in our study to characterize the effect of turbulent mixing on MOB abundances and methanotrophic activities. We found that methane oxidation rates inside the oxic/anoxic transition zone at the shallow entrance of the basin were five times higher compared to the weakly turbulent redoxcline region in the deep interior of the basin. We propose that high mixing rates in the entrance and the close vicinity of two oxic/anoxic transition zones increased the flux of oxygen and methane into the transition zone, and consequently stimulated the growth of the MOB population and their activity. In contrast, low mixing rates in the stagnant interior of the basin reduced the flux of these gases into the transition zone, explaining the relatively small MOB population size and low methane turnover rates observed in the center of the basin.