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Variable depth of the sulfate-methane transition zone (SMTZ) in Aarhus Bay (Denmark): Local sediment heterogeneity versus seasonal variability

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Anaerobic oxidation of methane (AOM) is a widespread microbially-mediated process in marine sediments and represents a globally-important sink for methane. The rate of AOM is primarily controlled by the diffusive flux of sulfate (down) and methane (up) into the sulfate-methane transition zone (SMTZ) where AOM takes place. Experimental evidence from one station in Aarhus Bay (Denmark) indicates that the SMTZ depth varies by up to 50 cm (between 150 and 250 cmbsf) on seasonal time scales. However, it is unclear whether the depth fluctuations are due to local heterogeneity of the sediment at this station, or to seasonal changes in environmental forcings. We use a reaction-transport model incorporating a comprehensive reaction network for carbon degradation and AOM to determine whether seasonal variability in sediment temperature and organic carbon flux to the sediment-water interface are sufficient to explain the observed SMTZ depth variability, or whether local sediment heterogeneity at the sampling site must be involved. This work forms part of the EU-project METROL (Methane Flux Control in Ocean Margin Sediments).