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Long-term responses of anaerobic carbon mineralization during bacterial sulfate reduction to induced temperature shifts in Arctic and temperate marine sediments

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The study of the oceanic carbon cycle is crucial for the understanding of global climate change. In the Arctic Ocean, some of the most pronounced effects of climatic temperature increases are expected. On continental shelves, a large fraction of the organic matter produced by primary production is exported from the photic zone to the seafloor and is oxidized by anaerobic benthic sulfate-reducing bacteria into CO_2 and nutrients. A temperature increase, at the scale of predicted climate change, affects the stability of microbial communities and the benthic metabolic pathways, and therefore, the magnitude of the mineralization of organic matter. Hence, the net flux of CO_2 between the oceans and the atmosphere might also be affected. To assess long-term effects of a climate-scale temperature increase, sediment collected from two different habitats, a permanently cold (Svalbard) and a seasonally changing environment (North Sea), was incubated shifting the in-situ temperature (0˚C and 10˚C respectively) to 0˚C, 4˚C, 10˚C and 20˚C. Time-course experiments entailed short-term ^{35}S-sulfate tracer incubations in temperature gradient blocks (-3.5˚C to 40˚C) to establish temperature optima of activity and apparent activation energies for bacterial sulfate reduction as well as time series for microbial community analysis. In permanently cold sediments, the apparent activation energy decreased with incubation time and temperature. The data indicate that a temperature shift of 4˚C is sufficient to induce a pronounced change in the sulfate reducing bacterial community. Decreasing absolute prokaryotic cell numbers in the 20˚C upshift incubations reflect the gradual disappearance of a psychrophilic community not capable of tolerating these elevated temperatures. Specific 16S-rRNA targeted probes indicated that the cell numbers of psychrophilic sulfate-

reducing bacteria decreased in the incubation at 20˚C, whereas numbers of psychrotolerant sulfate-reducing bacteria increased. Incubation experiments with temperate sediment showed little change in response to increasing or decreasing temperatures and suggest a broad temperature adaptation of the active bacterial community.