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Microphytobenthic induced calcification – A modelling approach

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Benthic (de)calcification is a microbially driven process, which was thought to be affected by changes in the overlying water pH caused by ocean acidification. However, recent studies have revealed that benthic microorganisms in sediment and mats are rather resilient to pH changes, as they generate large local pH shifts due to photosynthesis and respiration. Microsensor studies showed pH variations between 7.5 and 9.5 due to microbial processes in diatom-dominated carbonate sediment from Bait Reef and Heron Island, Australia, as well as cyanobacterial biofilms from karst water creeks. The shift of pH from night to day seems to be consistent, although the settings differ. Moreover, pH-changes and calcification appear to be not necessarily tightly coupled to the day-night cycle of photosynthesis and respiration. In some systems pH remains elevated and calcification continues although oxygen profiles indicate the cessation of photosynthesis. The decoupling of photosynthesis and calcification might be due to diffusion.

This extensive data set of microsenor profiles is useful to investigate the complex relationship between microphytobenthic processes, transport, and pH-variability. Therefore, we constructed a 1D-model that calculates pH from the measured oxygen- and calcium-microsensor profiles. Acid-base reactions and diffusive transport of all chemical compounds involved in microphytobenthic and acid-base reactions allow calculation of pH assuming no temporal and environmentally changes (i.e. temperature and salinity changes). So far, our model indicates a better fit with measurements in the cyanobacterial biofilms from karst water creeks than with the observations in diatom-dominated carbonate sediment. Comparison of model simulations and data from karst water creeks most likely illustrate spatial heterogeneity whereas comparison of model results and data from carbonate sediments indicate larger differences possibly due to additional reactions (e.g. sulfate reduction) which are not included in the model.