Benthic Nitrogen Cycling and N_2O Fluxes under Changing Environmental Conditions

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Biogeochemical interactions at the ocean floor are complex, and especially in coastal areas benthic processes are influenced by many factors, including tidal dynamics, and are impacted directly by environmental changes, such as variations in temperature, oxygen concentrations and nutrient input. Sediments are particularly important sites for complex microbially-driven and often coupled transformations of nitrogen. Key nitrogen transformations often occur associated with steep gradients found at oxic-anoxic interfaces in sediment environments, with close interactions between aerobic and anaerobic metabolisms. Sediment-dwelling macrofauna organisms create and maintain burrows that are flushed with oxygen-rich water, thus extending the oxic-anoxic interface and enhancing biogeochemical reactions. Despite their importance of harboring a complex network of nitrogen tranformations, coastal sediments remain understudied, especially in terms of the response of nitrogen-cycling microbial communities to changes in environmental conditions.

I will report on our studies investigating the benthic nitrogen cycle, and how it is impacted by bioturbation activity, tidal dynamics and changing environmental conditions, with a focus on nitrous oxide (N_2O), one of the most important greenhouse gases, which is produced through both oxidative and reductive processes. Although the main pathways of N_2O transformations are understood, the exact mechanisms of N_2O emission and their regulation in complex ecosystems, such as coastal and shelf sediments, are still poorly understood. The potential role for sediment hosted N_2O production and flux to the overlying water may play an increasingly important role in the oceanic and atmospheric N_2O inventory. One of the key questions is whether sediments represent sinks or sources of N_2O, and how coastal dynamics and changing environmental conditions are impacting N_2O production. We used a suite of approaches to investigate and to simulate the processes impacting benthic nitrogen cycling, and to illustrate and quantify the impact of biological and physical factors on sediment oxygen dynamics and N_2O fluxes.