Psychrophiles at the Seafloor: Temperature Response of the Microbial N Cycle in Arctic Fjord Sediments

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The response of the microbial N cycle in polar environments to climate change will depend on the metabolic potential of microbial communities. This research addresses the temperature response of nitrate/nitrite respiration activity and the coupling of the C and N cycles in Arctic fjord (Svalbard) sediments at two sites, Kongsfjorden and Smeerenbergfjorden, with contrasting organic carbon contents of 0.3% and 1.45%, respectively. Rates of denitrification and anammox were determined in anaerobic slurries from -1°C to 40°C with and without the addition of organic carbon substrates. Kongsfjorden sediments showed a lower temperature optimum for anammox (10-20°C) than denitrification (25°C). Smeerenbergfjorden showed similar potential rates of denitrification across a temperature range from 5°C to 30°C, and anammox rates were highest at 26°C. A long term (weeks) temperature shift experiment was performed with Kongsfjorden sediment at 4°C and 25°C to determine structure-function relationships of the microbial communities. Sediments maintained at 4°C exhibited decreased rates of denitrification and increased anammox rates. Sediments exposed to warming (25°C) showed a shift in the optimal denitrification rate to 35°C, a loss of anammox activity, and a change in microbial community composition. Cold sediments amended with carbon substrates maintained the same temperature optima for NO_3^- respiration but showed a pronounced increase in microbial community diversity. Our results indicate a tight interaction between temperature and organic carbon in controlling rates of microbial N cycling that is linked to shifts in microbial community structure in permanently cold environments.

^{17}O anomaly of tropospheric CO_2 fluxes from soil, leaf and ocean

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^{17}O anomaly, a new potential tracer, may supply additional information about the sources and sinks of CO_2. Previous works focused on troposphere-stratosphere CO_2 exchange, which were resulted from the limited understanding of ^{17}O anomaly mechanisms and the lack of precise analytical methods. Recently, a new analytical technique can precisely determine $\Delta^{17}O$ of CO_2,[1] which may change the scenario of this field. It has been expected for a long time that the study of ^{17}O anomaly of CO_2 can be just like those of small ^{17}O anomaly of meteoric waters.(eg, [2]) In this work, we will present theoretical estimates of $\Delta^{17}O$ of CO_2 fluxes from soil, leaf and ocean.

To estimate $\Delta^{17}O$ of CO_2 fluxes from soil and leaf, previous models are used.([3], [4]) Equilibrium theta value (i.e., $\ln^{17}\alpha/\ln^{18}\alpha$) for CO_2-H_2O exchange is taken from [5]. Kinetic theta value for the CO_2 diffusion process is calculated from kinetic theory of gases.(e.g., [6]) CO_2 flux from ocean is assumed to be in equilibrium. The results show that $\Delta^{17}O$ of CO_2 fluxes from different sources are different and the differences are on the order of 0.1 per mil, in the scope that recent techniques can precisely distinguish. Using $\Delta^{17}O$ of tropospheric CO_2, a lot of information could be obtained. The ^{17}O anomalies are temperature and other properties dependent, which could be used to refine or re-check previous models, providing new chance to build more reasonable CO_2 flux models.

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