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Are termite mounds biofilters for methane? – Challenges and new approaches to quantify methane oxidation in termite mounds

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Methane emissions from termites contribute around 3% to global methane in the atmosphere, although the total source estimate for termites is the most uncertain among all sources. In tropical regions, the relative source contribution of termites can be far higher due to the high biomass and relative importance of termites in plant decomposition. Past research focused on net emission measurements and their variability, but little is known about underlying processes governing these emissions. In particular, microbial oxidation of methane (MOX) within termite mounds has rarely been investigated. In well-studied ecosystems featuring an oxic matrix above an anoxic methane-producing habitat (e.g. landfills or sediments), the fraction of oxidized methane (f_{ox}) can reach up to 90% of gross production. However, conventional mass-balance approaches to apportion production and consumption processes can be challenging to apply in the complex-structured and almost inaccessible environment of a termite mound. In effect, all field-based data on termite-mound MOX is based on one study that measured isotopic shifts in produced and emitted methane. In this study a closed-system isotope fractionation model was applied and estimated f_{ox} ranged from 10% to almost 100%. However, it is shown here that by applying an open-system isotope-pool model, the measured isotopic shifts can also be explained by physical transport of methane alone.

Different field-based methods to quantify MOX in termite mounds are proposed which do not rely on assumptions of physical gas transport. A simple approach is the use of specific inhibitors for MOX, e.g. difluoromethane (CH_2F_2), combined with chamber-based flux measurements before and after their application. Data is presented on the suitability of different inhibitors and first results of their application in the field. Alternatively, gas-tracer methods allow the quantification of methane oxidation and reaction kinetics without knowledge of physical gas transport. Two concepts of gas-tracer-test applications in termite mounds are presented, together with 3D photogrammetric approaches to estimate volume, surface area and internal gas volume of termite mounds that enables acuare scaling of methane production and consumption.

In a further phase of the project, the application of these methods in a comprehensive field survey in the Australian savanna ecosystem will give insights into major driving factors of MOX in termite mounds, a major driver of nutrient cycling in this extensive tropical ecosystem.