Spatial patterns of ammonia oxidizing bacteria and archaea at field scale relate to soil ecosystem functioning

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Characterization of spatial patterns of microbial communities aids in understanding not only the mechanisms driving their distribution, but also the processes shaping their structure. Focusing on spatial patterns of functional microbial communities could facilitate the understanding of the relationships between the ecology of microbial communities, the biogeochemical processes they performed and the corresponding ecosystem functions. For ammonia oxidation there are two known microbial groups that carry out this reaction, the ammonia oxidizing bacteria (AOB) and archaea (AOA), respectively. Because of their role in the cycling of nitrogen, greenhouse gas fluxes and nitrate leaching, understanding the spatial distribution of the AOA and AOB in relation to soil properties is of importance. We explored the spatial distribution of these communities by measuring the activity, abundance and community structure across a 44 ha large farm divided into an organic and an integrated farming system. The spatial patterns were mapped by geostatistical modelling and correlations to nitrate leaching and soil properties were studied. All measured community components, activity, abundance and community structure, for both AOB and AOA exhibited spatial patterns. Soil properties were differently related to the AOB and AOA communities, with clay content, soil organic carbon and total nitrogen correlating positively to the AOB abundance while clay content showed a negative correlation to the AOA abundance. Interestingly, the substrate induced ammonia oxidation rates correlated to the AOB abundance, whereas the amount of leached nitrate had a strong correlation to the AOA abundance at the field site. This indicates that the AOB and AOA may occupy different niches in agroecosystems. Findings in this study are part of a first step in identifying the "meta-habitat" of ammonia oxidizing communities at a scale compatible with management strategies.