



## **More evidence that anaerobic oxidation of methane is prevalent in soils: Is it time to upgrade our models?**

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Estimating future fluxes of CH<sub>4</sub> between land and atmosphere requires well-conceived process-based biogeochemical models. Current models do not represent the anaerobic oxidation of methane (AOM) in land surface soils, in spite of increasing evidence that this process is widespread. Our objective was to determine whether AOM, or potential AOM, commonly occurs in 20 hydromorphic soils spanning a wide range of chemical properties. Bulk soil samples were collected under shallow water near the shoreline of 15 recently drained fish ponds in southern Bohemia (Czech Republic), as well as from below the water table at 3 peatland locations in northeast Scotland and 2 acid sulfate soils on the southern coast of Finland. Each soil slurry was incubated under both oxic and anoxic conditions, with or without the addition of alternative electron acceptors (SO<sub>4</sub><sup>2-</sup> and NO<sub>3</sub><sup>-</sup>) or H<sub>2</sub>PO<sub>4</sub><sup>-</sup>. Here, “oxic” and “anoxic” conditions refer to anoxic soil respectively incubated in the presence of air or argon. Using the isotope dilution method, we determined the gross production and oxidation rates of CH<sub>4</sub> after 2 days incubation under oxic conditions, and after 2, 21 and 60 days incubation under anoxic conditions. Large differences in net CH<sub>4</sub> fluxes were observed between soil types and between incubation conditions. AOM was detected in each of the 20 bulk soil samples, which spanned >6 pH units and 2 orders of magnitude in organic C content. Significant positive relationships were found between AOM and gross CH<sub>4</sub> production rates under anoxic conditions, resulting in AOM rates that were sometimes higher than CH<sub>4</sub> oxidation rates under oxic conditions. There was no relationship between net and gross CH<sub>4</sub> production rates, such that 2 soil types could display similar low net rates, yet conceal very large differences in gross rates. The effects of alternative electron acceptors on AOM were idiosyncratic and resulted in no net trend. We did find, however, a negative effect of SO<sub>4</sub><sup>2-</sup> and H<sub>2</sub>PO<sub>4</sub><sup>-</sup> on gross CH<sub>4</sub> production rates under anoxic and oxic conditions respectively. Under oxic conditions, CH<sub>4</sub> oxidation was related to soil organic C content. Taken collectively, our results suggest that AOM, or potential AOM, is prevalent over a wide range of soil types, that AOM may contribute substantially to CH<sub>4</sub> oxidation in soils, and that AOM in soils should be integrated to current process-based CH<sub>4</sub> cycling models.