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Nitrification by archaea fuels high nitrous oxide emissions from arctic peatlands

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Bare peat surfaces located on permafrost peatlands and created by frost and wind erosion are the only known areas in subarctic and arctic ecosystems showing high nitrous oxide (N_2O) emissions. With global warming, emissions of this highly potent greenhouse gas are likely to increase from arctic permafrost peatlands. In natural unamended soils with low atmospheric nitrogen deposition, nitrification is the main source of nitrite and nitrateand thus directly or indirectly a key driver of N_2O production. Here, we studied nitrification and N_2O production in both vegetated and bare permafrost peat soils at four distant arctic locations. Through a combination of molecular studies and specific inhibitors we show that ammonia oxidation, the first step in nitrification, is mainly performed by ammonia-oxidizing archaea (AOA). All the high N_2O emitting bare peat as well as low emitting vegetated peat soils contained only two AOA phylotypes, including an organism closely related to *Ca*. Nitrosocosmicus spp.. This indicates that high N_2O emissions from these ecosystems are primarily fueled through ammonia oxidation by very few archaeal keystone species. Any changes in archaeal nitrification induced by global warming will have a key role for future N_2O emissions from the arctic ecosystems.