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Unexpectedly small N_2O emissions from alpine permafrost rivers on the East Qinghai-Tibet Plateau

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Streams and rivers emit substantial amounts of nitrous oxide (N_2O) and are therefore an essential component of global nitrogen (N) cycle. Permafrost soils store a large reservoir of dormant N that, upon thawing, can enter fluvial networks and partly degrade to N_2O, yet the role of waterborne release of N_2O in permafrost regions is unclear. Here we report N_2O concentrations and fluxes during different seasons between 2016 and 2018 in four watersheds on the East Qinghai-Tibet Plateau. Thawing permafrost soils are known to emit N_2O at a high rate, but permafrost rivers draining the East Qinghai-Tibet Plateau behave as unexpectedly minor sources of atmospheric N_2O. Such low N_2O fluxes are associated with low riverine dissolved inorganic N (DIN) after terrestrial plant uptake, unfavorable conditions for N_2O generation via denitrification, and low N_2O yield due to a small ratio of nitrite reductase: nitrous oxide reductase in these rivers. We estimate fluvial N_2O emissions of 0.432−0.463 Gg N_2O-N yr^{-1} from permafrost landscapes on the entire Qinghai-Tibet Plateau, which is marginal (~0.15%) given their areal contribution to global streams and rivers (0.7%). However, we suggest that these permafrost-affected rivers can shift from minor sources to strong emitters in the warmer future, likely giving rise to the permafrost non-carbon feedback that intensifies warming.