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HONO fluxes from soil surfaces: an overview

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Gaseous nitrous acid (HONO) contributes up to 80% of atmospheric hydroxyl (OH) radicals and is also linked to health risks through reactions with tobacco smoke forming carcinogens. Field and modeling results suggested a large unknown HONO source in the troposphere during daytime. By measuring near ground HONO mixing ratio, up to 30% of HONO can be released from forest, rural and urban ground as well as snow surfaces. This source has been proposed to heterogeneous reactions of nitrogen dioxide (NO_2) on humic acid surfaces or nitric acid photolysis. Laboratory studies showed that HONO emissions from bulk soil samples can reach 258 ng m^{-2} s^{-1} (in term of nitrogen), which corresponding to 1.1 $\times$ 10^{12} molecules cm^{-2} $s^{-1}$and $\sim$ 100 times higher than most of the field studies, as measured by a dynamic chamber system. The potential mechanisms for soil HONO emissions include chemical equilibrium of acid-base reaction and gas-liquid partitioning between soil nitrite and HONO, but the positive correlation of HONO fluxes with pH (largest at neutral and slightly alkaline) points to the dominance of the formation process by ammonia-oxidizing bacteria (AOB). In general soil surface acidity, nitrite concentration and abundance of ammonia-oxidizing bacteria mainly regulate the HONO release from soil. A recent study showed that biological soil crusts in drylands can also emit large quantities of HONO and NO, corresponding to $\sim$20% of global nitrogen oxide emissions from soils under natural vegetation. Due to large concentrations of microorganisms in biological soil crusts, particularly high HONO and NO emissions were measured after wetting events. Considering large areas of arid and arable lands as well as peatlands, up to 70% of global soils are able to emitting HONO. However, the discrepancy between large soil HONO emissions measured in lab and low contributions of HONO flux from ground surfaces in field as well as the role of microorganisms should be further investigated.