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# Nitrous oxide fluxes from tree stems of temperate forests

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Although trees are recognized as conduits of soil-generated N2O, little is known about N2O fluxes from mature trees under field conditions and thier contributions to total forest N2O fluxes. Here, we quantified in situ stem N2O fluxes from mature alder trees on poorly-drained soil and mature beech and spruce trees on well-drained soils in Solling, Germany from March to October 2015. Soil N2O fluxes, soil N2O concentrations at 40-cm depth, and soil and climatic variables known to influence N2O fluxes were also measured concurrently with the stem N2O fluxes. Alder, beech and spruce consistently emitted N2O via stems and all displayed higher emission rates in summer than in spring and in autumn. Stem N2O fluxes from alder stand were higher than those from beech and spruce stands ($P < 0.01$), which was attributed to the presence of aerenchyma and lenticels as well as higher soil water content and soil C and N availability in the alder stand ($P < 0.01$-$0.05$). The correlations of stem N2O fluxes from alder with soil N2O fluxes, soil N2O concentrations, soil and air temperature and vapor pressure deficit ($R = 0.60$ - $0.90$, $P < 0.01$-$0.05$) suggest that N2O transport in alder was facilitated by a combination of passive gas diffusion through aerenchyma and active transport of dissolved N2O through sap flow. In the beech and spruce stands, correlations of stem N2O fluxes with soil and air temperature and vapor pressure deficit ($R = 0.57$ - $0.78$, $P < 0.01$-$0.07$) suggest that active transport of dissolved N2O via xylem sap was the major mechanism for stem N2O emissions in upland trees. Stem N2O fluxes represented 8-11% of the total (soil + stem) N2O fluxes in the spruce and beech stands whereas in the alder stand, with its large soil N2O emission, stem emission contributed only 1% of the total flux. Our results suggest that the relative contribution of tree-mediated N2O fluxes is more important in upland trees than in wetland trees.