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Spatial variability in tree stem CH4 fluxes suggests that uptake dominates over emission across temperate and tropical upland forests.

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Forests play an important role in the exchange of radiatively important gases with the atmosphere. Previous studies have shown that in both temperate and tropical wetland forests tree stems are significant sources of methane (CH4), yet little is known about trace greenhouse gas dynamics in 'upland' free-draining soils that dominate global forested areas. We examined trace gas (CH4 and N2O) fluxes from both soils and tree stems in lowland tropical forest on free-draining soils in Panama, Central America (Barro Colorado Nature Monument), in the Amazon (Cunia) and from a deciduous woodland in the United Kingdom (Wytham, Oxfordshire). In Panama, fluxes were sampled over the dry to wet season transition (March-August) in 2014 and November 2015. In Cunia, we measured mature and young tree fluxes in a single campaign during 2013 from two 20 x 30 m plots. CH4 and N2O flux was measured from the stem between 20 and 140 cm above the forest floor. Soil fluxes were measured 1 m away from each tree under investigation. Temperate fluxes were sampled at Wytham Woods, Oxfordshire, over 12 months from February 2015 to January 2016. Tree stem samples were collected via syringe from temporary chambers strapped to the trees and soil fluxes were sampled from installed collars. We found that trees behaved as both sources (near the tree base) and sinks (higher up the tree stem) of methane across Panamanian and UK sites, however, this pattern was only apparent in a subset of trees in the Amazon where the dominant process was stem CH4 uptake for the majority of trees. We synthesise these results and those of our N2O measurements and report the consequences for ecosystem budgets of these gases.