Methane Emissions from Upland Trees

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Most work on methane (CH_4) emissions from natural ecosystems has focused on wetlands and wetland soils because they are predictable emitters and relatively simple to quantify. Less attention has been directed toward upland ecosystems that cover far larger areas, but are assumed to be too dry to emit CH_4. There is abundant evidence that upland ecosystems emit small amounts of CH_4 during hot moments that collectively constitute a significant source in the global budget of this potent greenhouse gas. Almost no attention has been given to trees and woody plants as significant sources of CH_4 in upland forests. Plant root systems integrate far larger range of soil conditions than are typically measured at the surface. Trees' roots can extend to soil depths and moistures where abundant anoxic microsites can develop. These sites can produce CH_4 that could enter woody plant tissue. To address these facts established a plot of upland trees in a research forest near Annapolis, Maryland. Both tree and soil CH_4 fluxes were measured using chamber methods with cavity ring down spectrometer. Each tree chamber was custom fit to the stem near the base. Near the plot, we also established an automated stem flux measurement system, allowing us to make high frequency measurements of fluxes at different heights and determine the drivers.

With one exception, all trees that were emitting CH_4 from the stems, were growing in soils that were net consumers of CH_4. Upland emissions from the tree stems averaged +25 ug CH_4 m^{-2} hr^{-1} while the average soil uptake was -72 ug CH_4 m^{-2} hr^{-1}. Some stem emissions were over +200 ug CH4 m_{-2} hr_{-1}. Factors controlling CH_4 emissions were soil moisture and Julian day.

The automated system showed fluxes followed a clear diurnal pattern and the magnitude of the fluxes decreased with height. These diurnal patterns peaked at midday and seem to be driven by transpiration. In addition, different species had similar magnitude of fluxes but the amplitude of diurnal patterns differed, indicating that species morphology may play a large role as a driver. Future CH_4 budgets and climate models will need to include tree fluxes and their drivers for accurate accounting and predictions.