Scratching the surface of belowground volatile emissions A mechanistic and VOCational analysis

TES program
PI: Amy M. Trowbridge
Authors: Paul C. Stoy, Philip Stevens, Richard P. Phillips
Affiliation: Indiana University Department of Biology
Email: amtrowbr@indiana.edu

Much research has detailed the ways in which biogenic volatile organic compounds (bVOCs) present in the atmosphere influence both ecological interactions and tropospheric chemistry. However, our understanding of the sources of and controls over VOCs from terrestrial ecosystems remains incomplete, namely the relative source/sink strength of deciduous forest soils. In temperate hardwood forests, nearly all fine roots are colonized by either arbuscular mycorrhizae (AM) or ectomycorrhizae (ECM), which respond uniquely to environmental variability and have differential effects on soil organic matter decomposition with likely consequences for bVOC emissions. The primary aim of our project is to 1) quantify differences in soil bVOC uptake and/or emissions between AM and ECM dominated forest stands 2) identify the biotic, abiotic, and biogeochemical processes responsible for driving these fluxes from leaf-out to leaf senescence, and 3) consider processes occurring at or below the soil surface to potentially improve models aimed at describing atmospheric photochemistry, particularly OH reactivity.

In a temperate deciduous forest in southern Indiana, we are currently quantifying the magnitude, timing, and ecological and environmental controls of bVOC emissions from soils *in situ*. Once a month, air samples are collected from chambers established within plots containing >90% AM or ECM-associated tree species (n=4) and analyzed using proton transfer reaction-mass spectrometry (PTR-MS). Preliminary results from the 2014 growing season show total bVOC emissions are higher in ECM forests than in AM forests. Furthermore, AM forests shift from bVOC sources to VOC sinks as the growing season progresses. However, these general patterns are not reflected for individual compounds. Together, these data suggest that variation in litter type and microbial associations between ECM and AM plots are potentially translated into differences in bVOC quality and quantity.

We will continue to measure soil bVOC emissions over time and look to correlate our findings with the environmental, biogeochemical, and biotic factors we are concurrently measuring. To tackle questions regarding sources of soil bVOCs, we have initiated a greenhouse experiment to follow the fate of stable isotopes into belowground emissions and assess associated root enzyme activity. Finally, we are using existing Ameriflux infrastructure to create a series of bVOC profiles, both within the soil and the forest canopy, in conjunction with OH reactivity measurements in order to model VOC transport through the forest and address unknown source/sink dynamics for soils themselves and their potential to affect the oxidative capacity of the troposphere.