Up-rooting surface-atmosphere exchange models: How mycorrhizal associations may affect soil emission profiles

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Volatile organic compounds (VOCs) impact ecological interactions and atmospheric chemistry, but our understanding of the sources of and controls over VOCs from terrestrial ecosystems remains incomplete. Despite the potential for soil to be a significant source of VOCs, most emission models do not consider processes occurring at or below the soil surface. 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 VOC emissions. The primary aim of our project is to describe the mechanisms controlling soil VOC emissions within the context of plant-microbe interactions, forest nutrient cycling, and physical resistances to VOC transport to improve current mathematical descriptions of atmospheric photochemistry.

Using plots established across a mycorrhizal gradient within the Morgan Monroe State Forest, we are currently quantifying the magnitude, timing, and ecological and environmental controls of VOC emissions from forest soils. Once a month, samples are collected from chambers established within plots containing >90% AM or ECM-associated tree species (n=4). Air samples are collected using dynamic headspace techniques and compounds with m/z 21 to 140 are analyzed using proton transfer reaction-mass spectrometry (PTR-MS). Temperature and relative water content data and soil cores for enzymatic assays are also collected from soil + litter collars and collars where the litter has been removed.

Preliminary results from November 2013 show methanol to dominate emissions from both soil and litter (~20-30%), with the exception of acetaldehyde dominating litter VOCs in AM plots (~43%). Litter appears to be the primary source of fluxes observed late in the season and proportional differences of compounds to the total profile suggest that variation in litter type and microbial associations between ECM and AM plots are potentially translated into differences in VOC quality and quantity. We will continue to measure soil VOC emissions over time and look to correlate our findings with the abiotic and biotic factors being measured concurrently. We are also using state-of-the-art metabolomic techniques to explain the biochemical controls of observed soil VOCs and parse out sources of emissions within the rhizosphere. Our continued work will allow us to elucidate the unknown temporal variation of soil VOC fluxes in the context of environmental and biogeochemical conditions and gain valuable insight into biochemical controls over emissions and their potential role in atmospheric models.