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Strong sesquiterpene emissions from Amazonian soils as product of microbial activity

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The Amazon rainforest is the world's largest source of reactive volatile isoprenoids to the atmosphere. It is generally assumed that these emissions are products of photosynthetically driven secondary metabolism and released from the rainforest canopy from where they influence the oxidative capacity through reaction with hydroxyl radicals (OH) and ozone (O_3). However, recent volatile organic compound (VOC) budgeting experiments (based on OH reactivity) show that further important sources remain to be discovered. Here we show that soil microorganisms are a strong, unaccounted source of highly reactive and previously unreported sesquiterpenes (C15H24; SQT). The emission rate and chemical speciation of soil SQTs were determined as a function of water and oxygen in the laboratory from soil samples. Based on these results a model was developed to predict soil-atmosphere SQT fluxes including emissions from the surface soil to 50 cm depth, spanning oxic to anoxic conditions. Simulated results compared closely with SQT flux measurements in the field, so a two-year period (2014-2015) was modelled based on in-situ rainfall and soil moisture measurements. It was found that SQT emissions from a Terra Firme soil in the dry season were in comparable magnitude to current global model canopy emissions and that soil emissions dominated O_3 reactivity on the forest floor. SQT release and microbial activity were shown to be linked through 16S- and 18S- rRNA transcript abundances as a function of moisture in soils from a long-term forest fire experiment. Natural forest soil produces reproducible, strong emissions of SQTs, accompanied with a simultaneous increase in 16S-rRNA transcripts. In contrast, the burned forest soil generates minor SQT emissions accompanied by reduced microbial activity, establishing an important ecological connection between soil microbes and atmospherically relevant SQTs.