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Soil greenhouse gas pulses from a Tropical Dry Forest

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Tropical Dry Forest are an important global carbon sink, with fundamental ecological functions of capture, regulation, and supply of water resources. However, due to the seasonality with prolonged dry season water is the most limiting resource for growth. Even though Tropical Dry Forest represents 42% of all tropical forests, studies dealing with their carbon and greenhouse gas (GHG) exchange are still scarce. The aim of this study was to evaluate the seasonal variations of soil CO_2, N_2O and CH_4 fluxes in a Tropical Dry Forest. We evaluated three different land covers in the Tropical Dry Forest Santa Rosa National Park in Costa Rica i.e. advanced forest succession, early succession, and pasture: At each site soil GHG exchange was measured by replicated (n=6) dark static chamber technique. Measurements were taken between 8:00 and 9:00 am twice a week at each site during the period of dry/wet transition season (May-June) and monthly during the rainy season (July-December) in the year 2018. Over the same period, the NEE (net ecosystem exchange) at the late stage forest site was measured using an Eddy covariance flux tower. Our results show that in the dry season soil fluxes remain low and with the start of the first rain events, we see large pulse emissions at all sites caused by the “Birch effect." Moreover, these high pulses were lower in the pasture (CO_2 24.50 $\pm$ 18.29 mg C m^{-2} h^{-1}, N_2O1.58 $\pm$ 1.88 μg N m^{-2} h^{-1}, and CH_4-4.86 $\pm$ 8.10 μg C m^{-2} h^{-1}), followed by the late forest succession (CO_2 38.38 $\pm$ 21.78 mg C m^{-2} h^{-1}, N_2O17.39 $\pm$ 21.48 μg N m^{-2} h^{-1}, and CH_4-24.57 $\pm$ 10.52 μg C m^{-2} h^{-1}) and the early succession (CO_2 50.67 $\pm$ 20.7 mg C m^{-2} h^{-1}, N_2O21.37 $\pm$ 34.02 μg N m^{-2} h^{-1}, and CH_4-3.23 $\pm$ 16.77 μg C m^{-2} h^{-1}). The early stage forest had the highest soil fluxes, probably due to the higher accumulation of organic matter and dieback of microbial biomass in the soil during the dry season. The ecosystem NEE measured with the eddy covariance tower at the beginning of the rainy season was of 4154.01 $\pm$ 2782.68 mg C m^{-2} d^{-1}reaching maximum values of 8184.98 mg C m^{-2} d^{-1}. The total GHG exchange from the soil varies for all sites going from $\sim$2 kg CO_2-C equiv $ha^{-1}d^{-1}$ in the dry season, to $>$15 kg CO_2-C equiv $ha^{-1}d^{-1}$ in the transition season and $>$5 kg CO_2-C equiv $ha^{-1}d^{-1}$ in the rainy season. Soil moisture is the main driver for soil respiration and soil greenhouse gasses in this ecosystem, however, the current and historic land use and stage of forest succession also affects differently the accumulation and release dynamics of soil greenhouse gasses to the atmosphere in tropical dry forest soils.