EGU21-831
https://doi.org/10.5194/egusphere-egu21-831
EGU General Assembly 2021

Spatial and temporal variability of soil N_2O and CH_4 fluxes along a degradation gradient in a palm swamp peat forest in the Peruvian Amazon

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Mauritia flexuosa palm swamp, the prevailing Peruvian Amazon peatland ecosystem, is extensively threatened by degradation. The unsustainable practice of cutting whole palms for fruit extraction modifies forest's structure and composition and eventually alters peat-derived greenhouse gas (GHG) emissions. We evaluated the spatio-temporal variability of soil N_2O and CH_4 fluxes and environmental controls along a palm swamp degradation gradient formed by one undegraded site (Intact), one moderately degraded site (mDeg) and one heavily degraded site (hDeg). Microscale variability differentiated hummocks supporting live or cut palms from surrounding hollows. Macroscale analysis considered structural changes in vegetation and soil microtopography as impacted by degradation. Variables were monitored monthly over 3 years to evaluate intra- and inter-annual variability. Degradation induced microscale changes in N_2O and CH_4 emission trends and controls. Site-scale average annual CH_4 emissions were similar along the degradation gradient (225.6 ± 50.7, 160.5 ± 65.9 and 169.4 ± 20.7 kg C ha^{-1} $year^{-1}$ at the Intact, mDeg and hDeg sites, respectively). Site-scale average annual N_2O emissions (kg N ha^{-1} $year^{-1}$) were lower at the mDeg site (0.5 ± 0.1) than at the Intact (1.3 ± 0.6) and hDeg sites (1.1 ± 0.4), but the difference seemed linked to heterogeneous fluctuations

in soil water-filled pore space (WFPS) along the forest complex rather than to degradation. Monthly and annual emissions were mainly controlled by variations in WFPS, water table level (WT) and net nitrification for N_2O; WT, air temperature and net nitrification for CH_4. Site-scale N_2O emissions remained steady over years, whereas CH_4 emissions rose exponentially with increased precipitation. While the minor impact of degradation on palm swamp peatland N_2O and CH_4 fluxes should be tested elsewhere, the evidenced large and variable CH_4 emissions and significant N_2O emissions call for improved modeling of GHG dynamics in tropical peatlands to test their response to climate changes.