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Temporal variability in methane fluxes from tropical peatlands within the Peruvian Amazon

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Tropical peatlands are one of the largest soil carbon (C) reservoirs globally and play a significant role in modulating fluxes of C between the tropical biosphere and atmosphere. These C fluxes are of global importance because tropical wetlands are the single largest natural source of atmospheric methane (CH4); while land-use change and biomass burning also contribute to the growing global atmospheric carbon dioxide (CO_2) burden. Amazonian peatlands play a potentially important role in regional and global atmospheric budgets of C because of their large extent. These ecosystems cover an estimated 150,000km2, which is roughly three-quarters the size of Indonesian peatlands; the world's most extensive and well-studied tropical peatlands.

Here we report CH4 fluxes from a lowland tropical peatland in the Pastaza-Maranon foreland basin in Peru, one of the largest peatland complexes in the lowland Amazon Basin. Strong prolonged seasonal rainfall events and the annual Amazon River flood-pulse may lead to pronounced temporal variability in biogeochemical cycling and trace gas fluxes, and this study explored how CH4 fluxes varied among wet and dry season periods in a number of key vegetation types in this region. Sampling was concentrated in 3 of the most numerically-dominant vegetation types: Forested Swamp, Mixed Palm Swamp and Mauritia flexuosa-dominated Palm Swamp, with data collection occurring in both wet and dry seasons over a 2 year period from 2012-2014 (4 field campaigns in total).

Overall mean CH4 fluxes from the Forested Swamp, Mixed Palm Swamp and Mauritia flexuosa-dominated Palm Swamp for the entire sampling period were 31.06 $\pm$ 3.42 mg CH4 – C m-2 d-1, 52.03 $\pm$ 16.05 mg CH4 – C m-2 d-1 and 36.68 $\pm$ 4.32 mg CH4 – C m-2 d-1. CH4 emissions, when averaged across the entire dataset, did not differ significantly among habitats. However, when CH4 emissions were aggregated by season, the Mixed Palm Swamp showed a significantly different emissions from all other habitats (Fischers LSD, P<0.0001). All of the vegetation types showed pronounced seasonality in CH4 fluxes. Mean dry and wet season fluxes for the Forested Swamp were 18.82 $\pm$ 2.61 mg CH4 – C m-2 d-1 and 60.42 $\pm$ 9.11 mg CH4 – C m-2 d-1; 85.51 $\pm$ 26.36 mg CH4 – C m-2 d-1 and 5.15 $\pm$ 2.73 mg CH4 – C m-2 d-1 for the Mixed Palm Swamp; and 25.54 $\pm$ 2.9 mg CH4 – C m-2 d-1 and 53.36 $\pm$ 9.78 mg CH4 – C m-2 d-1 for the Mauritia flexuosa-dominated Palm Swamp. Dry season fluxes did not differ from each other between years. In contrast, wet season fluxes showed significant differences between years, with CH4 emissions in the 2012 wet season more than double the emissions from the 2014 year. These observed differences in CH4 emissions during different seasons suggest that seasonal variability in water availability and flooding is a key control on CH4 emissions from Amazonian peatlands.