High CH_4 and N_2O emissions from soil and stems of disturbed swamp forests in Peruvian Amazon

Jaan Pärn[1], Kaido Soosaar[1], Thomas Schindler[1], Kateřina Macháčová[2], Waldemar Alegría Muñoz[3], Lizardo Manuel Fachín Malaverri[4], José Luis Jibaja Aspajo[3], Robinson Negron-Juarez[5], Jhon Ever Rengifo Marin[4], Rodil Tello Espinoza[3], Segundo Cordova Horna[3], Tedi Pacheco Gómez[3], Jose David Urquiza Muñoz[3], and Ülo Mander[1]

[1] Department of Geography, Institute of Ecology and Earth Sciences, University of Tartu, Estonia (jaan.parn@ut.ee)

[2] Department of Ecosystem Trace Gas Exchange, Global Change Research Institute of the Czech Academy of Sciences, Brno, Czech Republic

[3] School of Forestry, National University of the Peruvian Amazon (UNAP), Iquitos, Peru

[4] Peruvian Amazon Research Institute (IIAP), Iquitos, Peru

[5] Lawrence Berkeley National Laboratory, Berkeley, CA, USA

Photo: Uno Andreas Tavast

Introduction

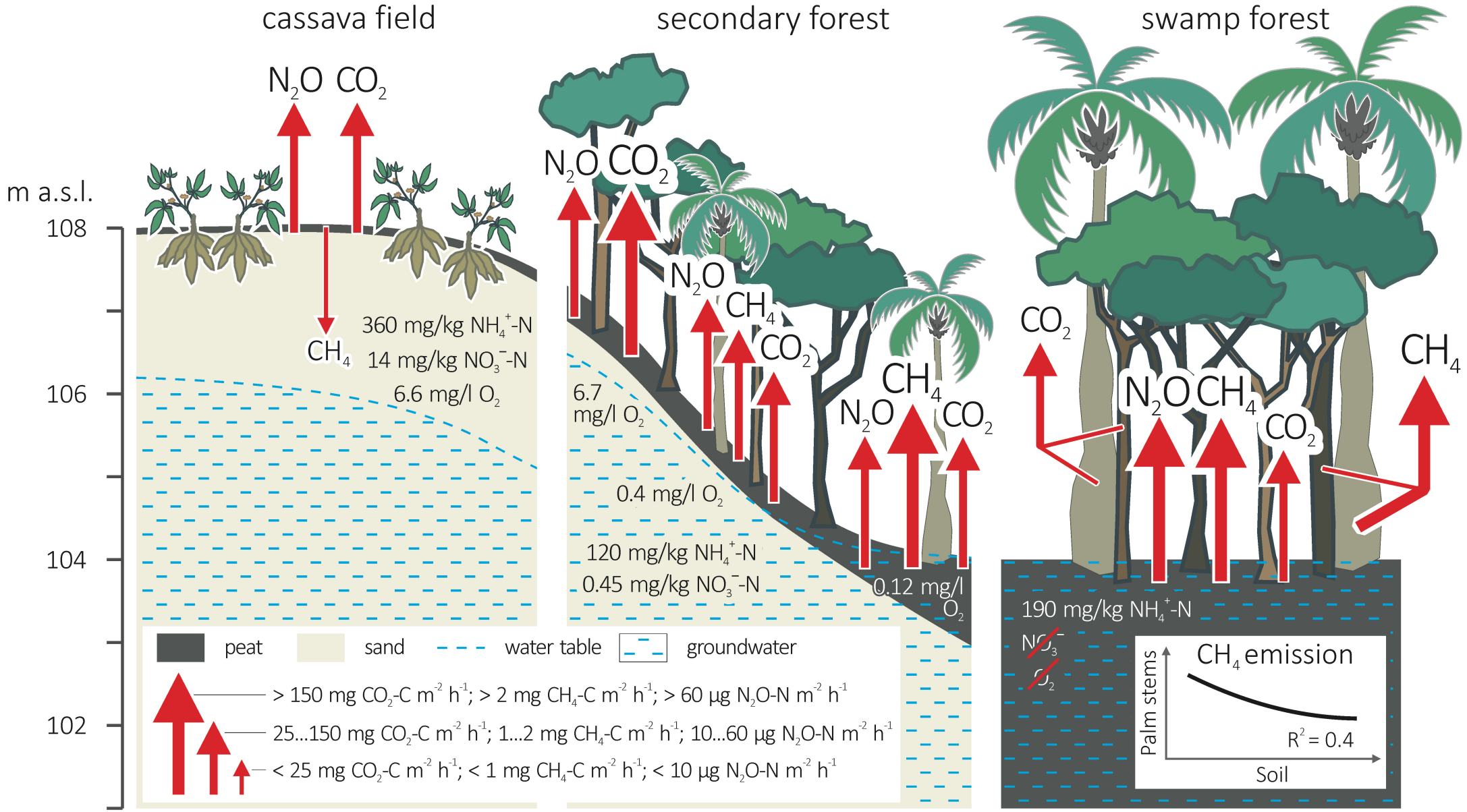
- Amazon swamp forests sequester carbon into trees and peat.
- Respiration from them may outweigh it under disturbance.
- Anaerobic decomposition of the tree biomass and peat yields methane (CH_4).
- Suboxic processes release nitrous oxide (N_2O).
- Drought is a quickly increasing disturbance in Amazonia which may shorten the growth period and impose tree decline (IPCC, 2019). The short-lived warming events increase ecosystem respiration and may be further enhanced by a positive feedback on soil microbes.
- The role of Amazonian trees, and stem cryptogams and saptrotrophs in the greenhouse gas (GHG) fluxes is poorly understood.

Material and methods

- With an objective to clarify the GHG budget of Amazon swamp forests, the University of Tartu in collaboration with CzechGlobe, UNAP and IIAP held a measurement campaign in Iquitos, Peru from September 2019 to March 2020.

- We observed CO_2, CH_4 and N_2O fluxes in the soil and tree stems using opaque chambers, and potential environmental factors in three sites with various disturbance histories:
  a) *Mauritia flexuosa* palm dominated swamp forest; 3°50'03.9"S, 73°19'08.1"W,
  b) secondary swamp forest grown on fallow pasture and banana plantation in 12 years 3°50'10.7"S, 73°21'45.0"W, and
  c) slash-and-burn cassava field 3°51'00.0"S, 73°22'45.8"W.

Results along the schematic profile of study sites



Highlights

- Soil respiration was positively related to water table depth. Thus, the secondary swamp forest respired large amounts of CO_2.
- CO_2 efflux from the palm (*Mauritia flexuosa*) and boarwood (*Symphonia globulifera*) **stems equalled ¼ of soil respiration**.
- The wet swamp forest sites, especially palm stems, emitted large amounts of CH_4. The dry slash-and-burn cassava field consumed CH_4.
- Session-average soil and palm-stem CH_4 emissions were reversely correlated between each other, implying dynamic competition between the pathways.
- **Anaerobic swamp peat** produced a session average of up to **420 µg N_2O-N m^{-2} h^{-1} from the 190 mg kg^{-1} soil NH_4^+-N**. The secondary swamp forest floor and slash-and-burn cassava field emitted a considerable 12…55 µg N_2O-N m^{-2} h^{-1}.
- Most of the observed relationships are novel for and unexplained by current literature.

Mobilitas+

European Union
European Regional
Development Fund

Investing
in your future

The study was supported by the Estonian Research Council (PRG352 and MOBERC-20 grants) and the EU through the European Regional Development Fund (ENVIRON and EcolChange Centres of Excellence, Estonia and the MOBTP101 returning researcher grant) and the European Social Fund (Doctoral School of Earth Sciences and Ecology).