Geophysical Research Abstracts
Vol. 21, EGU2019-5008-1, 2019
EGU General Assembly 2019

What drives ecosystem nitrous oxide (N_2O) greenhouse gas fluxes in a mature commercial oil palm plantation?

Christian Stiegler (1), Ashehad Ashween Ali (1), Tania June (2), and Alexander Knohl (1)

(1) Bioclimatology, University of Goettingen, Goettingen, Germany, (2) Department of Geophysics and Meteorology, Bogor Agricultural University, Bogor, Indonesia

Global atmospheric concentration of nitrous oxide (N_2O), a powerful greenhouse gas with high global warming potential and long atmospheric life span, has been increasing in the past decades. Agriculture and related application of nitrogen-based fertilizers is the main anthropogenic source of N_2O, thus, there is worldwide concern over potential long-term impact of agricultural land-use practices on climate. During the past decade, oil palm (*Elaeis guineensis* Jacq.) emerged to an important cash crop, with Indonesia and Malaysia being the world's biggest producers of palm oil. Despite the growing areal extent and increasing economic importance of oil palm, only little is known about the overall N_2O balance of oil palm plantations at the ecosystem scale. This study investigates N_2O greenhouse gas fluxes in a mature commercial oil palm plantation in tropical lowland Sumatra (Jambi province, Indonesia). We use the eddy covariance technique, based on a fast-response and high-precision gas analyser and sonic anemometer, combined with ancillary micrometeorological measurements to identify atmospheric and environmental drivers of N_2O fluxes. Measurements of N_2O have been ongoing since August 2017. Preliminary results show that the oil palm plantation is a source of N_2O, with average flux of 66.2 μg N-N_2O m^{-2} h^{-1}. The observed annual N_2O flux, based on mean diel cycle from 30-minute average values, equals to 5.6 kg ha^{-1} yr^{-1} of N-N_2O emission and a global warming potential of 232 g CO_2-equivalent m^{-2} yr^{-1} (63.3 g carbon-equivalent $m^{-2}yr^{-1}$). Our eddy covariance-based ecosystem-level N_2O emissions are relatively high compared to chamber-based measurements from previous studies in the area, suggesting that chamber measurements might underestimate the true N_2O flux due to exclusion of possible N_2O root assimilation and leaf flux, possible N_2O production in the plants, and canopy soil N_2O emissions. Diurnal N_2O fluxes are negative (N_2O uptake) during the night, with average night time N_2O flux of -27.9 $\pm$ 10.0 μg N-N_2O m^{-2} h^{-1}, and positive (N_2O emission) during the day, with average day time fluxes of 123.7 $\pm$ 96.7 μg N-N_2O m^{-2} h^{-1} and peak fluxes in the early afternoon. N_2O fluxes showed no correlation with soil temperature and soil moisture (R^2=0, respectively), but N_2O generally increased with increasing air temperature (R^2=0.37), increasing atmospheric vapor pressure deficit (R^2=0.38), increasing incoming solar radiation (R^2=0.44) and increasing photosynthetically active radiation (R^2=0.51). Negative N_2O fluxes (N_2O uptake) during the night might be related to microbial activity and anaerobic denitrification or possible sensor detection limits. The increase in N_2O flux during the day might be related to light-dependent plant internal gas transport through N_2O-root assimilation and leaf transpiration and light-dependent plant internal N_2O production.