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Long-Term Climate Implications of Persistent Loss of Tropical Peat Carbon Following Land Use Conversion

Steve Frolking (1), René Dommain (2,5), Aurich Jeltsch-Thömmes (3), Fortunat Joos (3), and Paul Glaser (4)

(1) University of New Hampshire, EOS Institute, Durham, NH United States (steve.frolking@unh.edu), (2) Institute of Earth and Environmental Science University of Potsdam, Germany, (3) Climate and Environmental Physics, Physics Institute and Oeschger Centre for Climate Change Research, University of Bern, Switzerland., (4) Department of Earth Sciences, University of Minnesota, Minneapolis, MN United States, (5) Smithsonian Institution, Washington DC United States

The climate mitigation potential of tropical peatlands has gained increased attention as Southeast Asian tropical peat swamp forests are being deforested, drained and burned at very high rates, causing globally significant carbon dioxide emissions to the atmosphere. We used a simple force-restore model to represent the perturbation to the atmospheric carbon dioxide and methane burdens, and net radiative forcing, resulting from long-term conversion of tropical peat swamp forests to oil palm or acacia plantations. Drainage ditches are installed in land-use conversion to both oil palm and acacia, leading to a persistent change in the system greenhouse gas balance with the atmosphere. Drainage causes the net carbon dioxide exchange to switch from a weak sink (removal from the atmosphere) in the accumulating peat of a swamp forest to a relatively strong source as the peat is oxidized. Methane emissions increase due to relatively high emissions from the ditches themselves. For these systems, persistent carbon dioxide fluxes have a much stronger impact on atmospheric radiative forcing than do the methane fluxes. Prior to conversion, slow peat accumulation (net carbon dioxide uptake) for millennia establishes a slowly increasing net radiative cooling perturbation to the atmosphere. Upon conversion, carbon dioxide loss rates are 16-32 times higher than pre-conversion uptake rates. Rapid loss rates cause the net radiative forcing perturbation to quickly (decades) become a net warming, which can persist for centuries after the peat has all been oxidized.