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Centro de Convenções Studio 5,

Av. Rodrigo Otávio, 3555 - Distrito Industrial

Fone: (092) 216-3555   Manaus/AM

Emissions of CO_2, CH_4, N_2O, and NO in a chronosequence of secondary forests in eastern Amazonia

FrançoiseYoko Ishida[1], Renata Tuma Sabá[2], Eric A. Davidson[3], Cláudio J. Reis de Carvalho[4], Ricardo de O. Figueiredo[1], Maria Tereza Primo dos Santos[1], Karina de Fátima Rodrigues Pantoja[2], and Georgia Silva Freire[2]

[1]Instituto de Pesquisa Ambiental da Amazônia
[2]Bolsista DTI, CNPQ/LBA
[3]The Woods Hole Research Center
[4]EMBRAPA Amazônia Oriental

Address of corresponding author:
FrançoiseYoko Ishida
Instituto de Pesquisa Ambiental da Amazônia
Av. Nazaré, n. 669
Belém-PA 66035-170 Brasil
Telephone: (91) 277-2515; (91) 241-5495 (FAX)
Email: yoko@cpatu.embrapa.br

Most studies of the effects of land use change on soil emissions of trace gases have focussed on forest-to-pasture or forest-to-cropland conversions. Here we examine soil fluxes from secondary forests regrowing after abandonment of traditional slash-and-burn agriculture. A chronosequence of secondary forests (3, 6, 10, 20, 40, and 70 years) was identified on highly weathered, acid, nutrient-poor soils in eastern Pará. An abandoned, intensively cultivated pepper field and a remnant mature forest were also studied. Three chamber flux measurements were made in each of 4 plots for each age class, 3 times in the wet season and 3 times in the dry season. As expected, CO_2 and N_2O emissions were highest during the wet season and soil consumption of atmospheric CH_4 was highest during the dry season. Consistent with other studies of deforested land, the abandoned pepper field had lower emissions of CO_2 and N_2O than the mature forest and was a net source of CH_4. Low fluxes were also observed in secondary forests, but wet season emissions of CO_2, N_2O, and NO and uptake of CH_4 increased with increasing forest age. Litter layer N concentration also increased with forest age, indicating that N gradually becomes less limiting during forest succession, thus permitting somewhat larger N gas losses in older forests. After 70 years of secondary succession, however, N_2O emissions were still only half those of the mature forest. These results show that deforestation has long-lasting effects on trace gas emissions and that recovery of N cycling processes may require many decades or centuries.