Geophysical Research Abstracts
Vol. 14, EGU2012-13891, 2012
EGU General Assembly 2012

Strong indications of nitrogen limited methane uptake in tropical forest soils

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Tropical forest soils contribute an estimated 6.2 Tg yr^{-1} (27%) to global methane (CH_4) uptake, which is large enough to alter the CH_4 accumulation in the atmosphere if significant changes would occur to this sink. Elevated deposition of inorganic nitrogen (N) to temperate forest ecosystems has shown to reduce CH_4 fluxes from forest soils, but almost no information exists from tropical forest soils even though projections show that N deposition will increase substantially in tropical regions. Here we report the results of a long-term, ecosystem scale experiment in which we assess the impact of chronic N addition on soil CH_4 fluxes from two old-growth tropical forests in Panama: a lowland forest on a deeply weathered soil with control and 9-12-yr N addition, and a montane forest on a less-developed volcanic soil with control and 1-4-yr N addition. CH_4 fluxes from the lowland forest control plots (-21.47 $\pm$ 1.57 μg CH_4-C m^{-2} h^{-1}) and the montane forest control plots (-3.99 $\pm$ 3.40 μg CH_4-C m^{-2} h^{-1}) did not significantly differ from their respective N-addition plots. In the lowland forest, chronic N addition did not lead to inhibition of CH_4 uptake; in contrast, a negative correlation of NO_3^- with CH_4 fluxes in these plots suggests that higher NO_3^- availability may have stimulated CH_4 consumption and/or reduced CH_4 production. Also in the montane forest, we detected negative correlation of CH_4 fluxes with NH_4^+ both in the organic layer and mineral soil, which we interpret as evidence that CH_4 consumption may have been N limited. That chronic N addition did not lead to higher CH_4 uptake at any of these sites was probably caused by the large spatial variability of CH_4 fluxes which may have rendered treatment effect not statistically significant. Furthermore, in the lowland forest soil CH_4 uptake was limited by diffusion of CH_4 from the atmosphere into the soil, which was not alleviated by N addition. We conclude that in these extremely different tropical forest ecosystems, there were strong indications of N limitation on CH_4 uptake and that based on these results it is unlikely that elevated N deposition on tropical forests will lead to widespread inhibition of CH_4 uptake.