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Soil-atmosphere exchange of carbon dioxide, methane and nitrous oxide from a typical karst region under different land use in southwest China

J.Z. Cheng, X.Q. Lee, and H. Zhou

State Key Laboratory of Environmental Geochemistry, Institute of Geochemistry, Chinese Academy of Science, Guiyang, China

In recent years, the eco-environmental problems characterized with the lost of soil nutrition elements in the southwest karst area of China are severe due to the increasing conflict between land and population. The changes of land use would have a great impact on the pools of soil carbon and nitrogen and change the exchanges of greenhouse gas (GHG) between soil and atmosphere. Fluxes of GHG from different land use patterns (matured forest, secondary forest, grassland and cropland) were measured directly with a vented enclosed chamber technique and gas chromatography method in a subtropical karst region of Guizhou province, southwest China. Soils under different land use in karst region acted as the sources of CO_2, N_2O and the sinks of CH_4. The average fluxes of soil CO_2 ranged from 35.5±91.4 to 134.1±78.8 (mean ± SD) mgC·m^{-2}·h^{-1}, ranking order: matured forest, secondary forest, cropland, grassland. The average uptakes of soil CH_4 ranged from 51.5±74.7 to 93.0±32.5 ugC·m^{-2}·h^{-1}, the order of soil CH_4 absorption was in accord with that of CO_2 release. The average emissions of soil N_2O ranged from 16.0±13.0 to 21.8±8.5 ugN·m^{-2}·h^{-1}, and soil N_2O emission was highest in the cropland, but no significant differences ($p>0.05$) were observed between different land use. Converting from the matured forest to secondary forest tended to increase annual emissions of N_2O (from 1.40 to 1.65 kg N ha^{-1} yr^{-1}), while changing land use from the secondary forest to grassland tended to decrease slightly (from 1.65 to 1.45 kg N ha^{-1} yr^{-1}). Moreover, the seasonal variations of soil CO_2 fluxes under different land use were very distinct, they increased from spring to summer and decreased from autumn to winter in response to changes of temperature and precipitation in this region. In contrast, seasonal patterns of CH_4 and N_2O fluxes were not clear, although higher CH_4 uptake rates were often observed in autumn and higher N_2O emission rates were often observed in spring. In the matured forest, there was a significant correlation between CH_4 flux and NH_4^+-N (r^2 = 0.39, $p<0.05$) and soil inorganic N (r^2= 0.48, $p<0.05$), but no significant correlation was found between CH_4 flux and NO_3^--N. Furthermore, a significant negative logarithmic correlation between N_2O flux and soil NO_3^--N concentration (r^2= 0.41, $p<0.05$) was found, this also applies to the relationship between CO_2 emission and soil inorganic N content (r^2= 0.35, $p<0.05$). Anyway, fluxes of soil CO_2 under different land use were significantly positively correlated with air and soil temperatures. Moreover, soil moisture influenced CO_2 fluxes to some extent, but there were no significant correlations between them under different land use. These results suggested that soil temperature and mineral N dynamics largely affect the temporal GHG exchanges between soil and atmosphere in the karst region.

Key words: Karst, Greenhouse gas, Flux, Land use, Temporal variation.