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THE INFLUENCE OF WATER TABLE AND BURNING ON GREENHOUSE GAS EMISSIONS FROM SOUTH AFRICAN SOILS

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ZUSAMMENFASSUNG

Moore sind ein bedeutender Kohlenstoffspeicher im globalen Kohlenstoffkreislauf. Treibhausgase wie Kohlenstoffdioxid, Methan und Lachgas werden dabei von Böden emittiert oder aufgenommen, wobei der Wasserstand die Flüsse zwischen Boden und Atmosphäre vornehmlich reguliert. Hierzu haben wir ein Inkubationsexperiment mit vier unterschiedlichen Böden aus den Drakensbergen, Südafrika durchgeführt. Unter denselben Bedingungen haben die Böden unterschiedlich auf eine Anhebung des Wasserstandes reagiert. Nicht-Moorböden zeigen dabei signifikant höhere CO_2 Emissionen im Vergleich zu den Moorböden. Mit steigendem Wasserstand sinken die CO_2 Emissionen und sind weniger stark unterschiedlich. Methanflüsse waren gering und zeigen keinen signifikanten Einfluss durch den Wasserstand in diesem Experiment. Lachgasflüsse zeigten eine hohe Variabilität und korrelieren mit den NO_3 Konzentrationen im Bodenwasser. Kurz vor der Probenentnahme wurde die Vegetation gebrannt und dieses hatte einen Einfluss auf die Treibhausgasflüsse, insbesondere auf die CO_2 und N_2O Flüsse. Die erwartete schnelle Reaktion von hohen Methan- und Lachgasemissionen auf die Wiedervernässung konnte in diesem Experiment nicht gemessen werden. In einer Variante führt die Wasserzugabe zu erhöhten N_2O Emissionen, wobei eine totale Flutung des Bodens diese reduziert. Generell konnte gezeigt werden, dass die gesamten Treibhausgasemissionen am niedrigsten bei dem höchsten Wasserstand sind. Des Weiteren können die nicht-Moorböden einen erheblichen Beitrag zu dem regionalen Treibhausgasbudget beitragen.

Schlüsselworte: Treibhausgasemissionen, Moore, Experiment, Grundwasserstand, Brennen, Kohlenstoffdioxid, Lachgas, Methan, Drakensberge, Südafrika

SUMMARY

Wetland soils are an important pool in the global carbon cycle. The greenhouse gases carbon dioxide, methane and nitrous oxide exchange between the atmosphere and wetland soils and are highly controlled by the water table. We performed a soil incubation experiment with four different soils from the Drakensberg, South Africa. Under same conditions in the laboratory these soils react different to water table rising. Non-wetland soils show

significant higher CO_2 emission compared to wetland soils during all water table depths. With rising water table the CO_2 emissions decrease and were less different. Methane fluxes were low and showed no significant influence by the water table in this experiment. N_2O fluxes of these soils showed a high variability and were correlated to the NO_3 concentrations in the soil water. Recent burning of the vegetation had influenced the greenhouse gas emissions particularly the CO_2 and N_2O fluxes. The expected quick response of high nitrous oxide and methane emissions to water table rising, like these soils did during field measurements, could not be measured in the experiment. At one variant (MRW wetland) the water addition enhanced the N_2O emissions while a total flooding of the soil reduces them. In general the greenhouse gas emissions from these soils are lowest at highest water table. Nevertheless, also non-wetland soils could contribute significantly to the regional greenhouse gas budget.

Keywords: Greenhouse gas emissions, wetlands, experiment, water table, burning, carbon dioxide, nitrous oxide, methane, Drakensberg, South Africa

1 INTRODUCTION

The increased concentrations of atmospheric greenhouse gases, carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) are the main reasons for global warming (IPCC 2007). These gases are cycling between the atmosphere, the ocean and the terrestrial ecosystems. In this context soils are a large pool of carbon (more than 1500 Pg) and nitrogen (140 Pg) (Batjes 1996) and store more C than is presented in the atmosphere (Davidson & Janssens 2006). Wetland soils are mainly situated in the northern hemisphere and store approximately 600 Pg carbon (Yu et al. 2011, Jungkunst et al. 2012) in their soils and are important components in the carbon and nitrogen cycle. For instance wetlands contribute approximately 20 % to the global methane emissions (Reddy & DeLaune 2008) and are the largest single source of methane (Denman et al. 2007). Beside methane (bare) wetlands could also emit large amounts of nitrous oxide (Repo et al. 2009, Marushchack et al. 2011) mainly during drying and rewetting events.

A large proportion of the research is located in the northern or tropical latitudes because most of the wetlands are located in these regions. Nevertheless, wetlands occur in the southern hemisphere for instance in southern Africa. Additional there are other carbon rich soils, beside wetlands soils, which contribute a significant amount to the global soil carbon pool and should not be underestimated (Jungkunst et al. 2012).

The water table as well as burning of the vegetation affects the greenhouse gas (GHG) exchange between soils and the atmosphere (Castaldi et al. 2010). In general dry soils (aerobic