Geophysical Research Abstracts, Vol. 9, 07907, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-07907

Towards a new Conceptual Model of Climate Change Impacts on Peatland CH_4 Emissions

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As natural sources of methane (CH_4), peatlands play an important role in the global carbon cycle. The position of the water table within a peatland can have a large effect on CH_4 emissions. With climate models predicting enhanced evapotranspiration under a 2 x CO_2 scenario, and therefore a lower water-table position, it has been suggested that wetland CH_4emissions will decrease in the coming decades. This commonly accepted conceptual model has been proposed despite the expectation that CH_4 production will increase with warmer peat soils because it assumes that increased CH_4oxidation, due to a lower water table, will exceed production increases. This Fickian diffusion centric view of CH_4 flux is overly simple and does not consider the effects of plant transport and permafrost degradation on CH_4 flux. While several studies have recently considered these factors, we suggest it is also important to consider the effects of changing peat structure (bulk density, peat composition), temperature and, indeed, synoptic climatology on the generation, trapping and release of CH_4 gas bubbles within and from peatlands. While some models of CH_4 production within, and emission from, peatlands have attempted to account for biogenic gas bubble formation and movement, they almost certainly treat the processes too simply and do not consider the importance of climate change on bubble dynamics. Over the last five years our research has examined the importance of ebullition of biogenic gas bubbles as a mechanism for the transport of CH_4 to the atmosphere. Here we present a new conceptual model on how changes in temperature, atmospheric pressure and peat structure (the last due to water-table decline or permafrost degradation) will likely affect CH_4 bubble storage and release. We suggest that many peatlands may experience a (much) higher CH_4 flux under warmer and drier conditions due to increased CH_4 ebullition despite a decrease in CH_4 flux via diffusion.