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Formation of methane and nitrous oxide in plants

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Methane, the second important anthropogenic greenhouse gas after carbon dioxide, is the most abundant reduced organic compound in the atmosphere and plays a central role in atmospheric chemistry. The global atmospheric methane budget is determined by many natural and anthropogenic terrestrial and aquatic surface sources, balanced primarily by one major sink (hydroxyl radicals) in the atmosphere. Natural sources of atmospheric methane in the biosphere have until recently been attributed to originate solely from strictly anaerobic microbial processes in wetland soils and rice paddies, the intestines of termites and ruminants, human and agricultural waste, and from biomass burning, fossil fuel mining and geological sources including mud volcanoes and seeps. However, recent studies suggested that terrestrial vegetation, fungi and mammals may also produce methane without the help of methanogens and under aerobic conditions (e.g. Keppler et al. 2009, Wang et al. 2013). These novel sources have been termed “aerobic methane production” to distinguish them from the well-known anaerobic methane production pathway.

Nitrous oxide is another important greenhouse gas and major source of ozone-depleting nitric oxide. About two thirds of nitrous oxide emissions are considered to originate from anthropogenic and natural terrestrial sources, and are almost exclusively related to microbial processes in soils and sediments. However, the global nitrous oxide budget still has major uncertainties since it is unclear if all major sources have been identified but also the emission estimates of the know sources and stratospheric sink are afflicted with high uncertainties. Plants contribute, although not yet quantified, to nitrous oxide emissions either indirectly as conduits of soil derived nitrous oxide (Pihlatie et al. 2005), or directly via generation of nitrous oxide in leaves (Dean & Harper 1986) or on the leaf surface induced by UV irradiation (Bruhn et al. 2014). Moreover, lichens and mosses, so called cryptogamic covers, were recently identified to release substantial amounts of nitrous oxide (Lenhart et al. 2015).

In this presentation we will give a brief overview of recent observations of aerobic methane formation and nitrous oxide emissions from terrestrial vegetation. Furthermore, we will present new results from laboratory incubation experiments that provide further insights into the formation of methane and nitrous oxide from plants.

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