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Quantifying N2 losses via denitrification from different terrestrial ecosystems using of a gas-flow core method

K. Butterbach-Bahl (1), M. Dannenmann (1), C. Scheer (1), G. Willibald (1), R. Wang (2), and X. Zheng ()

(1) Institute for Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU), Garmisch-Partenkirchen, Germany (klaus.butterbach@imk.fzk.de), (2) State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029, PR China

Microbial respiratory reduction of nitrous oxide (N_2O)to dinitrogen (N_2)via denitrification plays a key role within the global N-cycle since it is the most important process for converting reactive nitrogen back into inert molecular N_2. However, due to methodological constraints, we still lack a comprehensive, quantitative understanding of denitrification rates and controlling factors across various ecosystems. In order to quantify N_2-emissions from terrestrial ecosystems we developed and applied a measuring system that allows to simultaneously determine N_2- and N_2O-emissions from intact soil cores with high accuracy (detection limit approx. 10 μg N m^{-2} h^{-1} for N_2 and <1 μg for N_2O). The measuring technique is based on a gas-flow core method and soil air as well as headspace air are replaced with an artificial atmosphere in which N_2 is substituted by He (Butterbach-Bahl et al., 2002). This system was used in a series of studies, e.g. beech forest soils at Tuttlingen, Germany (Dannenmann et al., 2008), soils from irrigated cotton fields, Aral Sea Basin, Usbekistan (Scheer et al., 2008), or rice paddy soils from Jiangdu province, China (unpublished data). The N_2 fluxes observed are often huge, exceeding N_2O emissions by a factor of 2-200. Annual N_2 losses for the investigated sites were 7-14 kg N_2-N ha^{-1} yr^{-1} at the Höglwald Forest, Germany (spruce and beech) (Butterbach-Bahl et al., 2008), 2-10 kg for pine forests in lowlands of North Germany, 14-24 kg N_2-N ha^{-1} yr^{-1} for a beech forest on limestone (thinned plots up to 94 kg N_2-N ha^{-1} yr^{-1}) at Tuttlingen, Germany, or 24- 175 kg N_2-N ha^{-1} yr^{-1} for irrigated and heavily fertilised cotton in Usbekistan. Overall the results of this study show that the N_2:N_2O ratio is crucial in the regulation of N_2O fluxes of the investigated soil and that reliable estimates of N_2 are an indispensable prerequisite for accurately calculating N balances for the investigated ecosystem and very likely for many other terrestrial upland ecosystems as well.

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