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Biogenic nitric oxide emission from a spruce forest soil in mountainous terrain

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The process-based spatial simulation model SVAT-CN was used to estimate biogenic nitric oxide (NO) emission by soils of a Norway spruce forest (Weidenbrunnen) in the Fichtelgebirge, Germany. SVAT-CN core is a combination of a multiple-layer soil water balance model and a multi-layered canopy gas exchange model. The soil modules comprise a flexible hybrid between a layered bucket model and classical basic liquid flow theory. Further soil processes include: heat transport, distribution of transpiration demand proportionally to soil resistance, reduction of leaf physiological parameters with limiting soil moisture.

Spruce forest soils usually are characterized by a thick organic layer (raw humus), with the topmost centimetres being the location where most of the biogenic NO is produced. Within individual spruce forest stands the understory might be composed of patches characterized by different species (e.g. Vaccinium myrtillus, Picea abies, Deschampsia caespitosa), and NO production potentials. The effect of soil physical and chemical parameters and understory types on NO emission from the organic layer was investigated in laboratory incubation and fumigation experiments on soils sampled below the various understory covers found at the Weidenbrunnen site. Results from the laboratory experiments were used to parameterize multi-factorial regression models of soil NO emission with respect to its response to soil temperature and moisture. Parameterization of the spatial model SVAT-CN includes horizontal heterogeneity of over- and understory PAI, understory species distribution, soil texture, bulk density, thickness of organic layer.

Simulations are run for intensive observations periods of 2007 and 2008 of the EGER (ExchanGE processes in mountainous Regions) project, a late summer/fall and an early summer period, providing estimates for different understory types (young spruce, blueberry, grass, and moss/litter patches). Validation of the model is being carried out at point scale, by comparison with measured soil moisture and temperature data at 12 locations at the Weidenbrunnen site. In addition model output is compared to soil NO emission data from dynamic chambers. Understory type was found to have a strong influence on the magnitude of soil NO emissions, with emissions from blueberry and young spruce one order of magnitude larger than those from grass or moss/litter patches.