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Laboratory incubation experiments assessing the factor interactions affecting urine-derived nitrous oxide emissions from spatially and temporally variable upland pastures

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Urine patches deposited to soils by grazing animals represent hot-spots of nitrous oxide (N2O) emissions (Hargreaves et al., 2015), a powerful greenhouse gas (GHG) and precursor of ozone depletion in the stratosphere. Urine N2O emissions are produced via nitrification of ureolysis-derived ammonium (NH4+) and/or subsequent nitrite (NO_2-) and nitrate (NO_3-) denitrification (Kool et al., 2006). The dominant process and the N2O fluxes generated depend on interactions between urine characteristics (e.g. nitrogen [N] concentration and volume), soil characteristics (e.g. carbon [C] availability and pH) and preceding and prevailing environmental conditions (e.g. soil moisture and temperature; Bergstermann et al., 2011; Butterbach-Bahl et al., 2013; Dijkstra et al., 2013). The spatial and temporal variability of these interactions in grazing systems is potentially large and greatly increases the uncertainty associated with N2O emission estimates from such systems. In particular, the contribution of extensively managed upland agroecosystems, which occupy ca. 5.5 million hectares in the UK and provide the bulk of land for sheep farming (Pollott & Stone, 2004), to UK GHG emissions is poorly defined.

Improving understanding of the interactions between the wide range of factors affecting urine-derived N2O production and emission from pasture soils and considering this in the context of the spatial and temporal variability of the grazing environment could therefore be extremely valuable in improving the accuracy of N2O emission estimates from such systems. The factorial laboratory incubation experiments presented have been designed to assess the interactive effects of factors such as urine N concentration, volume and soil moisture affecting soil N2O (and nitric oxide [NO], nitrogen gas [N2] and carbon dioxide [CO_2]) production and emissions (García-Marco et al., 2014) using the state-of-the-art Denitrification Incubation System (DENIS). This work forms part of a wider project aimed at improving understanding of the spatial and temporal interactions between sheep grazing behaviour, forage selection, urine composition and edaphic factors to increase the accuracy of direct N2O emission estimates from extensive upland systems. Two upland pastures at Henfaes Research Centre (Bangor University) are being used for field measurements and the laboratory incubation experiments have been designed to reflect these systems. This includes using soils sampled by non-hierarchical clustering to accurately represent the sites, re-packed in layers (to field-measured bulk density) and selecting factors and levels based on data from field experiments. The relationships between N2O fluxes and the N2O:N2 mole fraction resulting from factor interactions will be used in a pasture-scale model of upland N2O emissions which integrates the spatial and temporal variability of sheep diet and behaviour, urine deposition characteristics, topography and soil physico-chemical measurements. The approach will generate more accurate N2O emission estimates from extensive grazing systems. The improved process-level understanding gained will aid the development of appropriate mitigation strategies.

Bergstermann (2011) SBB 43, 240-250.
Butterbach-Bahl (2013) Phil. T. R. Soc. B 368, DOI:10.1098/rstb.2013.0122.
Dijkstra (2013) Animal 7, 292-302.
García-Marco (2014) EJSS 65, 573-583.
Hargreaves (2015) Environ. & Nat. Res. Res. 5, DOI:10.5539/enrr.v5n4p1.
Kool (2006) SBB 38, 1757-1763.
Pollott & Stone (2004) The Breeding Structure of the British Sheep Industry 2003, Defra, UK.