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Controls on soil solution nitrogen along an altitudinal gradient in the Scottish uplands

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Nitrogen (N) deposition continues to threaten upland ecosystems, contributing to acidification, eutrophication and biodiversity loss. We present results from a monitoring study aimed at investigating the fate of this deposited N within a relatively pristine catchment in the Cairngorm Mountains (Scotland). Six sites were established along an elevation gradient (486 – 908 m) spanning the key habitats of temperate maritime uplands. Bulk deposition chemistry, soil carbon content, soil solution chemistry, soil temperature and soil moisture content were monitored over a 5 year period, making this the first study of its kind in a maritime Alpine environment. Results were used to assess spatial variability in soil solution N and to investigate the factors and processes driving this variability.

Highest soil solution inorganic N concentrations were found in the alpine soils at the top of the hillslope. Soil carbon stock, dissolved organic carbon concentration and factors representing site hydrology were the best predictors of nitrate concentration. These factors act as proxies for changing net biological uptake and soil/water contact time, and support the hypothesis that spatial variations in soil solution nitrate are controlled by habitat N retention capacity. Soil percent carbon was a better predictor of soil solution N concentration than mass of carbon. Ammonium was less affected by soil hydrology than nitrate and showed the effects of net mineralization inputs, particularly at Racomitrium heath and peaty sites. We hypothesize that high ammonium concentrations at the Racomitrium heath are related to the mineralization of microbial cell tissue during times of stress, largely in the absence of plant uptake. Due to the spatial heterogeneity in N leaching potential, a fine-scale approach to assessing surface water vulnerability to N leaching is recommended over the broad scale, critical loads approach currently in use, particularly for sensitive areas.