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Drivers of spatial patterns of physiological and soil parameters at micro- and field scale in a Hungarian sandy grassland

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Plant physiological and soil parameters were sampled at two spatial scales on mowed and grazed sites of a semiarid sandy grassland in Hungary. Samples from 80×60 m grids of 10 m resolution with additional random points represented the field scale (78 positions), while measurements along every 20 cm of circular transects of 15 m length represented the micro-scale (75 positions). 22 transects were measured between 2004 and 2012 at micro-scale, and 6 grids in 2012-2013 at field scale. At the micro-scale, there was no apparent elevation (E) difference, nor any other spatial non-stationarity. Contrarily, apparent micro-relief and above-ground biomass (AGB) differences emerged at the field scale. Sampled variables were soil water content (SWC), soil temperature (T_s) and soil CO_2 efflux (R_s) at the micro-scale, and these were complemented with E and AGB at the field scale. N_2O was sampled spatially once at both sites, in autumn 2012.

Spatial patterns of the variables were investigated by variograms and cross-variograms. Autocorrelation lengths of the measured variables varied between 0-3.5 m at the micro scale. SWC was the main determinant of both the spatial variability and patch size of R_s, because dry conditions increased variability of the measured flux together with the characteristic patch size of R_s. Furthermore, optimal sample size and adequate sampling scheme could be estimated on the basis of actual SWC. T_s proved to negatively co-vary with SWC, which resulted in negative spatial dependency between T_s and R_s, contrary to the expectations. Effect of SWC was of two different sorts in this respect, in dry patches it directly limited R_s, while in wet patches it had a cooling effect, leading to the confounding response of R_s to T_s. These observations pointed to the relevance of SWC in model approaches.

At field scale, deviations in E and AGB produced a different setting for spatial correlation. In case of the mowed site, we found a coherent patch structure of about 20 m patch sizes of E, SWC, T_s, R_s and AGB at peak biomass, just before mowing. These spatial patterns were determined by E and surface micro-relief, creating wetter conditions and larger AGB in depressions and an opposite trend for elevated zones. This coherent spatial pattern became more or less masked in the 5 other field scale measurements. In the autumn datasets, a reverse pattern could be observed for both sites with larger AGB and/or R_s observed at swells than in depressions, due to higher T_s. We also hypothesized decoupling of AGB and R_s due to mowing. N_2O flux was governed by the same abiotic factors (SWC through E), but behaved differently in space than R_s. On the other hand, extensive grazing created a larger scale and less correlating spatial patterns of all of the investigated parameters, irrespective of the season. Mean autocorrelation lengths (considering all the measured variables) were 13 and 24 m on the mowed site, whereas values of 18 and 26 m were determined for the grazed site for direct and cross-variograms, respectively.