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Drivers of spatial variability of soil respiration along altitudinal gradient in Northwest Caucasus Mountains

Olga Gavrichkova[1], Sofia Sushko[2,3], Lilit Ovsepyan[4], Ilya Yevdokimov[3], Alexandra Komarova[3], Anna Zhuravleva[3], Sergey Blagodatsky[5], and Kristina Ivashchenko[3]

[1]Institute of Research on Terrestrial Ecosystems, National Research Council , Porano, Italy (olga.gavrichkova@cnr.it)
[2]Agrophysical Research Institute, Saint Petersburg, Russia (rogovaja7@mail.ru)
[3]Institute of Physicochemical and Biological Problems in Soil Science, Pushchino, Russia (ilyaevd@yahoo.com; alexandra_seleznyova@mail.ru; zhuravlevaai@rambler.ru; ivashchenko.kv@gmail.com)
[4]University of Tyumen, Tyumen, Russia (lill.ovsepyan@gmail.com)
[5]Terrestrial Ecology Group, Institute of Zoology, University of Cologne, Cologne, Germany (sblagoda@uni-koeln.de)

Mountains occupy almost a quarter of the land area and store significant pools of soil organic matter (SOM), which is a potential source of atmospheric CO_2 under warming climate. However, carbon fluxes in mountain areas with high environmental heterogeneity remain poorly understood, in particular regarding the spatial variability of soil respiration (R_S). The study was conducted on the northeastern slope of the Northwest Caucasus Mountains (1260-2480 m a.s.l.; Russia) that crossed five vegetation belts (i.e., mixed, fir and deciduous forests, subalpine and alpine meadows). R_S was measured simultaneously (at 10 a.m. on 11 August 2018) across five vegetation belts (at 12 randomly distributed points per belt; totally n = 60) using the closed static chamber technique. As potential drivers of R_S spatial variability, soil physico-chemical (temperature, moisture, total and dissolved C and N contents, C:N ratio, pH), soil microbial (microbial biomass C content, basal respiration, enzymatic activities: β-glucosidase, chitinase and leucine aminopeptidase) and vegetation properties (grasses projective cover, its species richness, Shannon-Wiener diversity index, abundance of graminoids and forbs) were assessed. The R_S rate ranged from 1.3-12.7 µmol CO_2 m^{-1} s^{-1}, with average values of 3.7 and 7.3 µmol CO_2 m^{-1} s^{-1} for forests and grasslands respectively. Stepwise regression and subsequent path analysis showed that key driver of R_S spatial variability in forests was temperature-sensitive soil chitinase activity (explained variance 50%), while in grasslands it was graminoid abundance (explained variance 27%). The forest soils are mostly limited in N, therefore R_S variability depends largely on SOM-derived CO_2 sources, i.e. activity of the N-acquiring enzyme. In the grasslands, extensive network of fine roots and the associated considerable contribution of root-derived respiration to Rs, makes the flux more sensitive to vegetation composition and associated phenology and C allocation patterns. Thus, soil N availability and differences in plant cover play a crucial role in regulation of R_S spatial patterns in mountains ecosystems.

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