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

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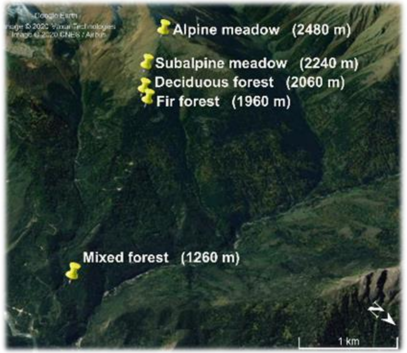
1. MOTIVATION

Mountains cover almost 25% of the world's land surface, so their contribution to the global C cycle can be significant. However, the C fluxes, in particular soil respiration (R_S), of these remote areas remain poorly understood. This study focused on estimating the spatial variability of R_S along the altitudinal gradient as a possible function of changes in vegetation and soil characteristics.

2. STUDY AREA



Location: Northwest Caucasus Mount.; Russia; 43°40´N / 40°47´E

Slope:
- northeastern exposure
- 1.2 km altitudinal gradient
- 5 vegetation belts (ecosystems)

Climate: MAT → from 3.5 °C to 5.9 °C
MAP → from 800 to 1850 mm

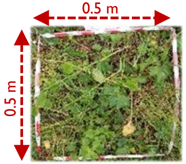
Soils: Cambisols, Umbrisols, Leptosols

3. DESIGN and METHODS

Each ecosystem → 12 randomly distributed plots (totally *n*=60)

Simultaneously measurement on 11 August 2018:

- R_S with closed chamber technique (SBA-5, PP system, USA)
- Vegetation survey (projective cover, richness, Shannon-Wiener index, graminoids, forbs)
- Soil physicochemical (temperature, moisture, C and N contents, C:N ratio, pH)
- Soil microbial (biomass, activities of β-glucosidase, chitinase, leucine aminopeptidase)



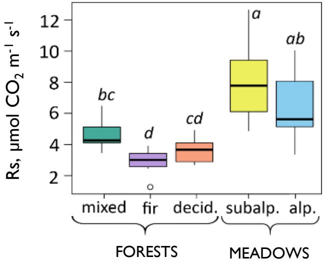
Plot's size

} 0-10 cm soil layer

4. RESULTS

R_S rate for forests and meadows

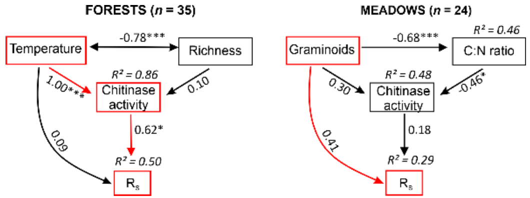
- A higher spatial variability of R_S was found in meadows than in forests.
- On average, R_S was twice as high in meadows as in forests, reaching 7.3 and 3.7 μmol CO_2 m^{-1} s^{-1}, respectively.



Drivers of R_S spatial variability

(1) The best predictors based on stepwise regression analysis:
forests → soil temperature, chitinase activity, species richness (29–50% explained variation)
meadows → chitinase activity and graminoid abundance (19 and 27% explained variation)

(2) Direct/indirect predictor effects tested by path analysis:



forests →
soil temperature (indirect),
chitinase (direct)

meadows →
graminoid abundance (direct)

5. CONCLUSIONS

The results showed principal differences in the main drivers of R_S spatial variability in forests and meadows. The chitinase dependence of R_S in forests may be related to soil N limitation. This was confirmed by low N content and high C:N ratio compared to meadow soils. The greater sensitivity of meadow R_S to vegetation structure may be related to the essential root C allocation for some grasses. Thus, the crucial role of soil microbial activity in forests and vegetation structure in meadows as drivers of R_S spatial variability has been demonstrated.

Photography encouraged

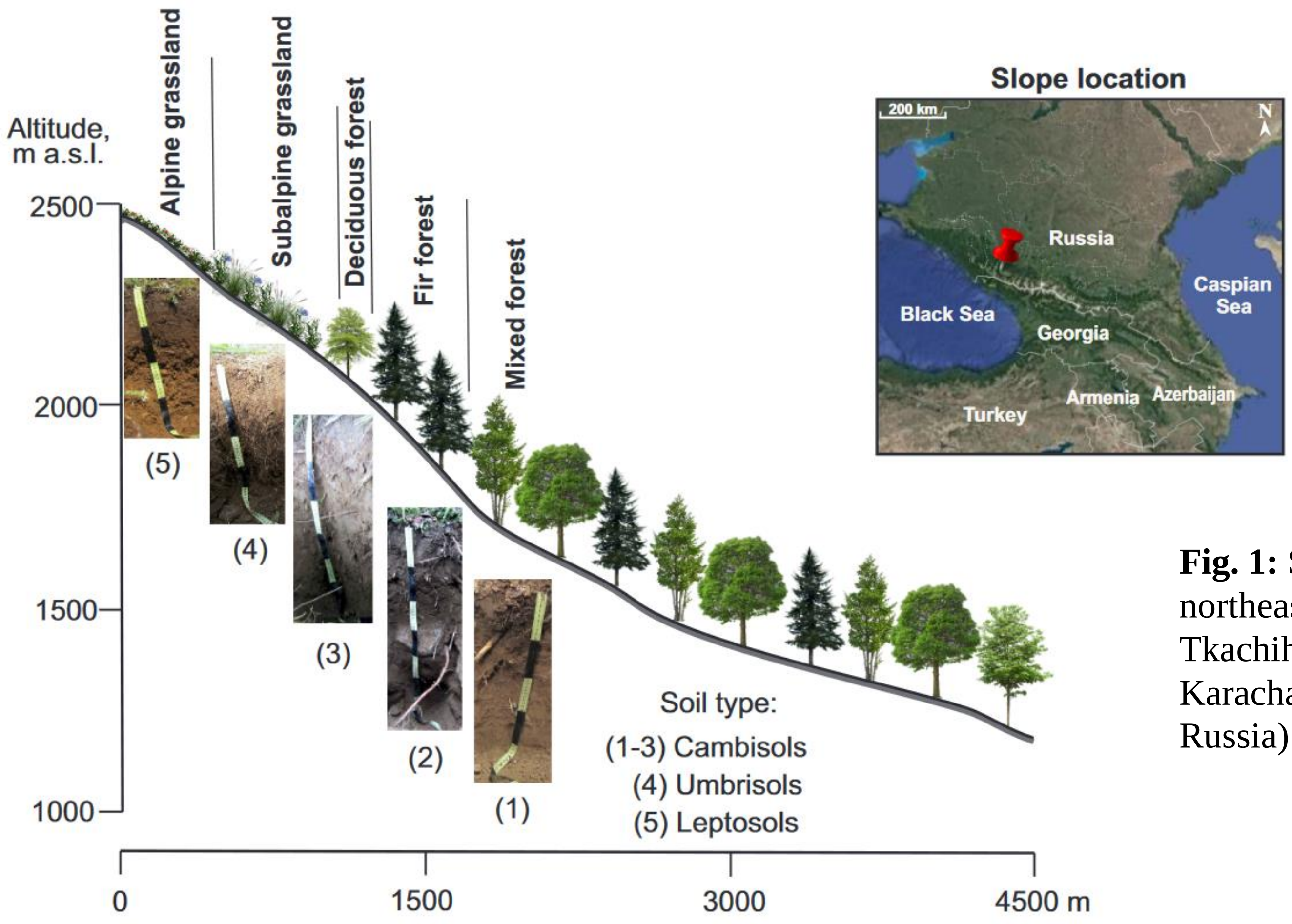


Fig. 1: Scheme of the northeastern slope of Mt. Tkachiha (Northwest Caucasus, Karachay-Cherkess, Republic of Russia)

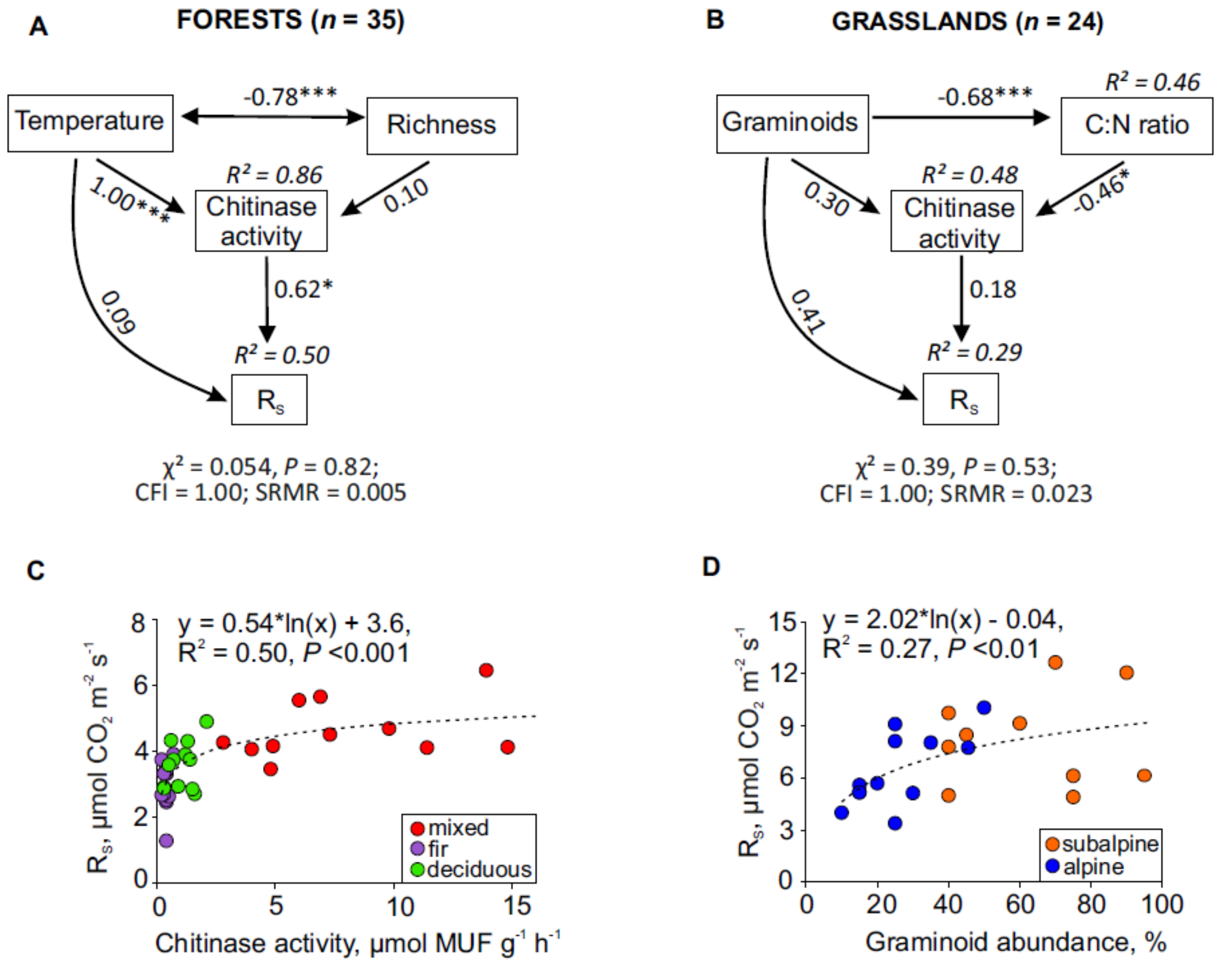


Fig. 2: Path models and simple regression revealed the effects of soil (temperature, chitinase activity, C:N ratio) and vegetation factors (species richness, graminoid abundance) on R_S spatial variability in mountain forests (A, C) and grasslands (B, D).

In the path model, numbers within double-headed arrows are correlation coefficients between variables, numbers within one-way arrows are standardized path coefficients indicating the size effect of the causal relationship among variables (**P* ≤0.05; **0.01; ***0.001); CFI, comparative fit index; SRMR, standardized root mean square residual.