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Spatial-temporal variability of the microbial respiration at the regional scale: comparison of field and laboratory approaches

Viacheslav Vasenev (1,2), Jetse Stoorvogel (2), Nadezhda D. Ananyeva (1,3), and Riccardo Valentini (1)

(1) Laboratory of Agroecological Monitoring, Ecosystem Prediction and Projecting, Russian State Agricultural University, 127550, Timiryazevskaya, 49, Moscow, Russia, vasenyov@mail.ru, (2) Soil Geography and Landscape Group, Wageningen University, P.O. Box 47, 6700 AA, Wageningen, The Netherlands, (3) Laboratory of soil C and N cycles, Institute of physico-chemical and biological problems in soil science, RAS, 142290 Pushchino, Moscow region, Russia

Regional carbon assessments are increasingly important. Soil respiration is a predominant carbon efflux of terrestrial ecosystems. The total carbon efflux from soils includes autotrophic respiration of root systems and heterotrophic microbial respiration (MR). MR usually refers to 60-80% of the total efflux and thus plays a key role in regional carbon balance. Quite a few studies report high sensitivity of MR to climate conditions and land-use. Different approaches to analyze MR exist. The methods differ in the procedures to consider space and time variability. We evaluated two approaches to assess MR variability. One approach uses field measurements on a limited number of locations with chambers. The other approach samples more intensively and derives basal respiration (BR) from measurements under standard conditions in the laboratory.

The chamber approach includes periodic measurements at a limited number of sites. As such, the methodology provides appropriate information on temporal dynamics. Spatial variability although, is underrepresented .. In our case chambers were mounted in forest, cropland and urban sites (n=48) located in the north of Moscow city. Roots were removed and geotextile (1 micron mesh) bags were inserted in soil to segregate MR. The flux was measured weekly by Li-6400-XT from July till September 2012.

In contrast, standardized BR techniques minimize the diversity of initial conditions. This allows to increase the number of observations considerably. However, the temporal variance is avoided. BR was analyzed in mixed topsoil (0-10 cm) and subsoil (10-150 cm) samples (n=182) collected in forest, cropland and urban sites from different bioclimatic zones of Moscow region. After preincubation (T=22°C, 55% water content, 7 days) soil MR (in μg O_2- g-1) was measured after incubating 2g soil with 0.2 μl distilled water as the rate of O_2 production (22° , 24 h) by gas chromatography.

Both approaches can be used to describe MR variability in the region. The chamber approach focuses on temporal dynamics whilst description of the spatial variability is limited to a confined local site. The BR approach provides a dataset suitable for a regional spatial analysis although temporal dynamics is not included.

Surprisingly, similar variability was shown for both approaches. Coefficients of variance (CV) obtained were 63% for the chambers and 61% for the topsoil (67% for the subsoil) based on the BR. The CV obtained by chambers includes both temporal and spatial components (although for a confined area), whereas the one derived from BR referred only to the spatial variation. In order to split these components CV was estimated on the bases of average values per location and per week separately. The spatial CV (45%) was considerably higher than the temporal CV (17%). An ANOVA also demonstrated that “location” factor had significant influence on MR variance (36%, $p<0.01$), whilst “week” factor was not significant (6%, $p= 0.37$). The BR database provided higher spatial variability results than chamber approach, whereas the covered by the chambers was considerably smaller than one BR approach enables to analyze. It may be concluded that chamber approach is more convenient when high temporal variability is expected, although standardized BR technique provides more explicit results when spatial variability dominates.