DIURNAL SOIL CO_2 EFFLUX VARIATIONS IN MATURE SCOT PINE (*PINUS SYLVESTRIS*) STANDS

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Introduction

Various processes taking place in forest soil have a big role in in the forest carbon cycle and contributing a lot to soil CO_2 efflux and soil respiration (SR). Soil respiration is a process when symbiosis is formed between soil microorganisms metabolism and plant roots respiration. This process includes various activities of microorganisms, the organic matter and plant‘s residues disintegration, which uses oxygen and produce carbon dioxide to the atmosphere. About half of the soil respiration is happening from the roots of the plant. In this way, plants have their own carbon dioxide resources, since 50 % of carbon dioxide, required for photosynthesis, comes from soil. In order to understand and determinate sources and sinks of C we have to have more knowledge of the local variability of carbon. For this reason diurnal carbon efflux rates were measured in Lithuanian Scot Pines (*Pinus sylvestris*) forests to determinate CO_2 efflux rates and the relative importance of various climatic factors. The aim was to investigate the variation in diurnal CO_2 efflux caused by soil temperature (Ts) and above ground air temperature (Ta) P. sylvestris forests. Overall CO_2 efflux and SR rates were strongly correlated with the temperature during day and night. These variations were related to micro environmental activities below soil surface.

Study area

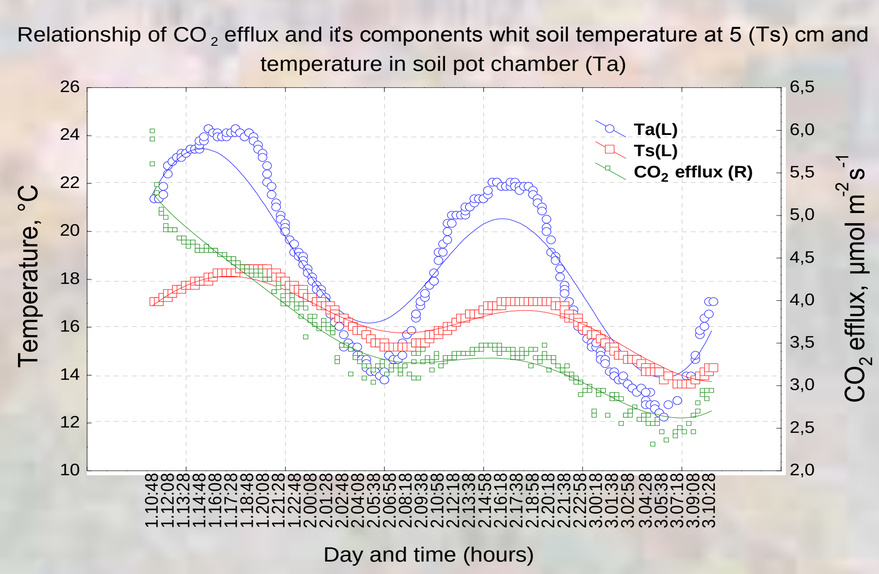
This study was conducted in central Lithuania at a mature Scots pine stands. Study site is located near city of Kaunas approximately 10km North East (54°57’31”N, 24°0’3”E) from city in Pilėnų forest. Site is consists of mature trees. Average age is 100 years, average high 29 meters. The vegetation at the study sites is manly dominated by Scots Pine (*Pinus sylvestris*). Underwood mostly consist from small oaks tree’s and hazelnut shrubs. The forest floor consists of a variety of small grasses, mosses, and trees litter. The soil is classified as sandy soil (Arenosols).

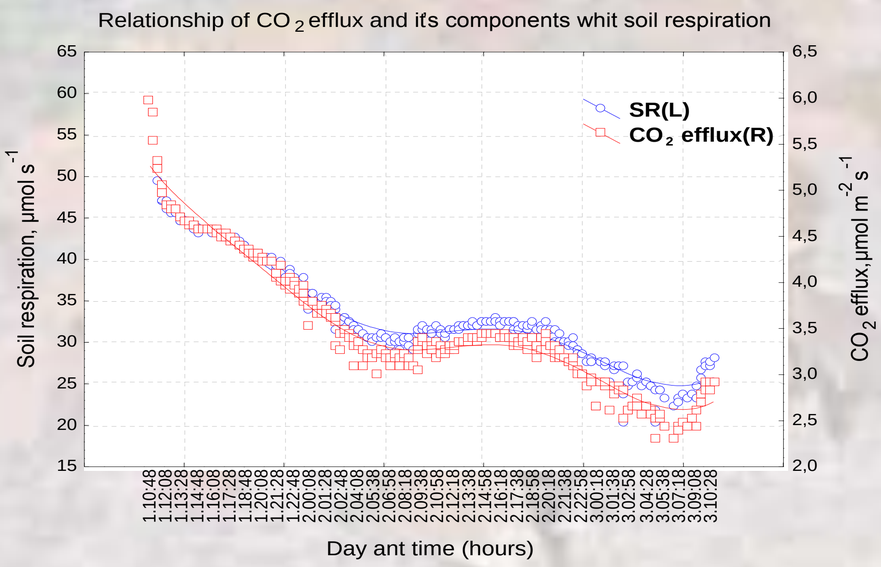
Material and Methods

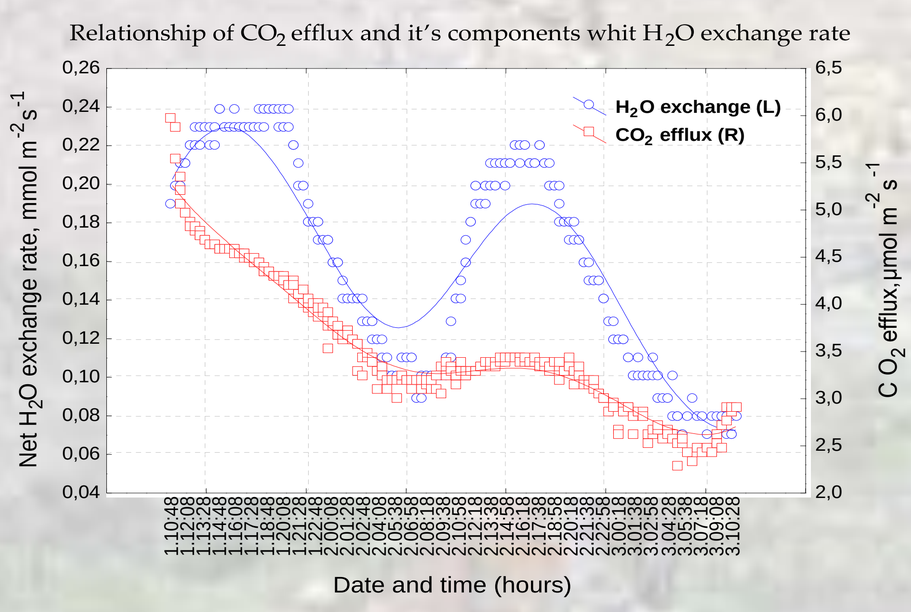
For continuous measurements of SR and CO_2 efflux an ADC BioScientific LCpro+ and soil respiration analysis system was used. Once the measurement location has been selected, the programming console is connected to the soil pot chamber. A metal ring, 10 cm in diameter, is inserted into the selected location and a soil pot chamber is attached to it. The ring is inserted perpendicular to the soil and left. Ring installed approximately 10 cm to the soil. For diurnal study a sampling time was set every minute in the soil pot chamber and after measuring ten minutes average were calculated to avoid measuring device deviations and inaccurate measurements. Measurements are performed without stopping for several days depending on whether conditions. There was one set of samples taken in 2020 11-13 of August. The main parameters that were measured are CO_2 efflux (µmol $m^{-2}s^{-1}$), soil respiration (µmol s^{-1}), air temperature (Ta) (°C) in the chamber, soil temperature (°C) at 5 cm depth and net water evaporation rate (mmol $m^{-2}s^{-1}$).
The collected data was analyzed using EXCEL program and the STATISTICA statistical analysis package. The data was processed with a multiple regression analysis. Correlation and relationships between data was tested using multiple comparison tests (ANOVA). Data were used to interpret simple effects associated with significant interactions between date, day and night effects. Significance tests used Fisher’s unrestricted least significant difference (LSD) test. Reliability factor p ($p<0.05$) were applied.

Portable CO_2 analyser ADC BioScientific LCpro+ System

Results







Conclusions

P. Sylvestris forest stands showed significant diurnal variations in they hourly mean Ta (in soil plot chamber) and Ts (at 5 cm depth) values. The diurnal Ta and Ts patterns were similar throughout the entire experimental period. During the measurements Ts changed less and stay more constant then Ta but correlated whit one another r=0.87, p<0.05. Most significant correlation was between efflux and Ts. Ta correlation in most cases was significant but less significant then Ts. Soil temperature could explain more than 80% variations in the CO_2 efflux in the forest stands. Average rate of all study was 3,47 µmol $m^{-2}s^{-1}$. Higest recorded values was after noon from 12:00 to 16:00. lowest values recorded in early morning from 5:00 to 6:00. Soil respiration correlation between temperatures also significant and are very similar to CO_2 efflux correlation whit temperature. The results of ANOVA test showed that most of the time correlation between CO2 efflux and SR is almost perfect throughout the entire experimental periods. Average correlation between these two parameters is r=0.97 (p<0.05). The variations of H_2O exchange rates was significant also. Although the weather had significant impact on water evaporation rates. The H_2O exchange rate increased during day light and peaking around same time as Ta, Ts and other properties that were measured. Correlation whit Ta r<0.88 and whit Ts r<0.82 (correlations are significant at p<0.05). Relationship between water evaporation and CO2 efflux was less significant. Average coloration r=0.67 (p<0.05).