

Diurnal variations of $\delta^{13}\text{C}$ and concentration of atmospheric and soil carbon dioxide in a meadow site

Janina Szaran¹, Andrzej Dudziak², Andrzej Trembaczowski¹, Halina Niezgoda¹, Stanisław Halas¹

¹Institute of Physics, Maria Curie-Skłodowska University, Plac M. Curie-Skłodowskiej 1, 20-031 Lublin, Poland, e-mail: halas@tytan.umcs.lublin.pl

²Department of Physics, Lublin University of Technology, 20-618 Lublin, Poland

Diurnal (24-hours) variations of carbon isotopic composition and carbon concentration in the air over a meadow and also in the soil were investigated during late Spring (11 – 12 June 2003). As the study site we have chosen a flat meadow covered with high grass, before mowing. It was located in the Bystrzyca river valley, on the left side of the river, 100 m from the waterside trees, 600 m from the road and 500 m from the nearest farm buildings of the Żabia Wola village, near Lublin. The sampling site was situated in the grass, the height of which was about 0.7 m, in the middle of rectangular meadow (200 m x 50 m). The atmospheric conditions during sampling were steady; almost cloudless and windless, the atmospheric pressure was 100 kPa at 203 m above sea level. The air and soil temperature varied from 9 to 25 °C and from 14 to 17 °C, respectively. The soil was dry; no rain falls were recorded over three weeks prior to observation. The samples of atmospheric air were sucked into evacuated ampoules from three horizons: near the soil (0.05 m), between the grass (0.5 m) and above the meadow (2 m) every two hours. At the same time samples of soil air were collected from two horizons: -0.1 m and -0.5 m. Soil air was slowly sucked into 50 ml syringes. During sampling the temperature of air above the ground and of the soil were measured too. The samples were immediately delivered to the laboratory, where the CO₂ was extracted and analysed mass-spectrometrically (Dudziak, and Hałas, 1996; Szaran, 1998; Szaran et al., 2002). The results are presented in figures.

Results for atmospheric air

1. The isotopic composition is a very sensitive indicator of biogenic activity, more sensitive than CO₂ concentration.

2. After the twilight the CO₂ concentration increases and the amount of ¹²C increases too, tending to amount of ¹²C in the soil air (the maximum is reached before a dawn). After the dawn the CO₂ concentration decreases and the amount of ¹²C decreases too, and δ¹³C tends to the value -8‰.
3. The maximum values of CO₂ concentration in the atmospheric air were noticed near the soil, also the concentration of ¹²C near the ground was the highest.
4. The lowest contents of ¹²C and the lowest CO₂ concentration were noticed in the air within the grass at 0.5 m level above the ground. Also the variation of the CO₂ concentration were the smallest on this level.
5. The largest variation of the CO₂ concentration was noticed in the air near the ground.
6. A very good correlation was noticed between δ¹³C and 1/CO₂ concentration at the horizon of 2 m above the ground (R²=0.984) and near the ground (R²=0.932), whereas within the grass the correlation was rather weak (R²=0.47).

Results for soil air

1. CO₂ concentration in soil air and ¹²C contents at the depth of 0.5 m were higher than at the horizon of 0.1 m and in the atmospheric air.
2. The relative variation as well as the CO₂ concentration and ¹²C contents were insignificant in the soil air.
3. The correlation between δ¹³C and 1/CO₂ concentration in the soil air was very weak. The squared correlation coefficients were R²=0.30 and 0.02 at depths 0.1 m and 0.5 m, respectively.

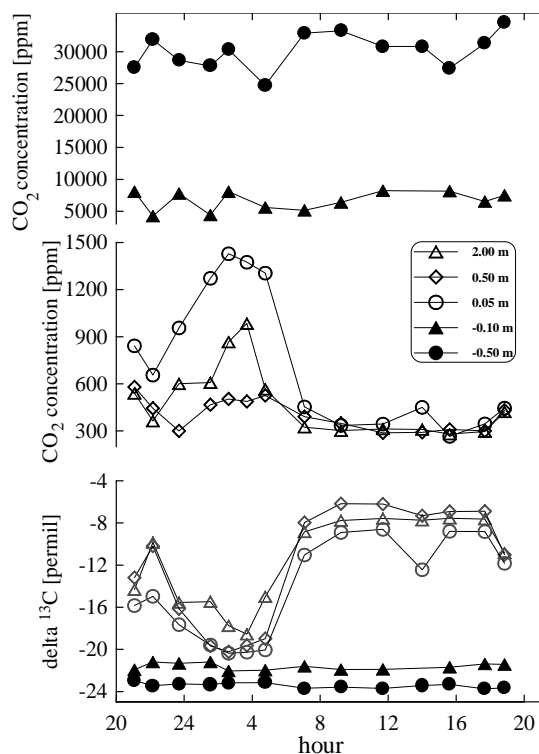


Fig. 1. Diurnal variations of concentration and carbon isotopic composition in soil and atmospheric carbon dioxide at various horizons, see legend.

Conclusion

The strong diurnal variations and the correlation between $\delta^{13}\text{C}$ and CO_2 concentration in the atmospheric air indicate a mixing line, from which $\delta^{13}\text{C}$ of the biogenic CO_2 may be inferred. The extrapolation of the straight line to zero value of the $1/(\text{CO}_2 \text{ concentration})$ yields $\delta^{13}\text{C} = -23.0 \text{ ‰}$. Rather small diurnal variations are characteristic for a dry soil, thereby $\delta^{13}\text{C}$ is weakly correlated with CO_2 concentration.

References

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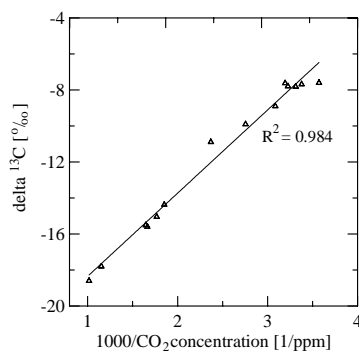


Fig. 2. Correlation between carbon isotopic composition and reciprocal concentration in atmospheric air (2 m).

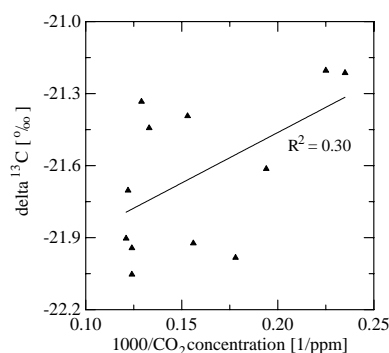


Fig. 3. Correlation between carbon isotopic composition and reciprocal concentration in soil air (-0.1 m).

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Autor(en)/Author(s): Szaran Janina, Dudziak Andrzej, Trembaczowski Andrzej, Niezgoda Halina, Halas Stanislaw

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