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Long term carbon dioxide exchange above a mixed forest in the Belgian Ardennes: evaluation of different approaches to deduce total ecosystem respiration from Eddy covariance measurements

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Abstract

The general aim of this research is to analyze inter annual variability of carbon dioxide (CO2) fluxes exchanged by a mixed forest located at the Vielsalm experimental site in Belgium. At this site, CO2 flux measurements started in 1996 and are still going on. Thirteen complete years of measurements are thus available.
Net Ecosystem Exchange (NEE) inter annual variability may be driven by gross primary productivity (GPP) or Total Ecosystem Respiration (TER), which should thus be both quantified. Using flux partitioning methods, TER is deduced from NEE measurements. GPP is then obtained by subtracting TER from NEE. Initially, a robust estimation of TER is required.
This work seeks to compare two independent approaches to assess TER in order to quantify the implications on inter-annual variability. The comparison was performed on twelve complete years.
TER estimates can be deduced by extrapolating to the whole day NEE measurements taken during selected night or day periods. In both case, the extrapolation is performed by using a respiration response to temperature.
The first approach, referred as the night-time approach, consisted in calculating TER using a temperature response function derived from night-time data sets (Reichstein et al., 2005). The second approach, referred as the daytime approach, consisted in assessing TER from the intercept of the NEE/Photosynthetically Photon Flux Density (PPFD) response (Wohlfahrt et al., 2005). For each approach, different modalities were compared: the use of long term (annual) or short term (15 days) data sets for the night-time approach and the use of different types of regression for the daytime approach. In addition, the impact of the temperature choice was studied for each of the approaches.
For the night-time approach, main results showed that air temperature sensitivity of ecosystem respiration derived from annual data did not reflect the short-term air temperature sensitivity. Vielsalm is a summer active ecosystem (annual temperature sensitivity larger than short-term temperature sensitivity). Results suggested also that, for both approaches, regressions based on soil temperature gave more robust results than those based on air temperature. Furthermore, the comparison showed that the night-time and the daytime approaches give disagreeing pictures of TER inter annual variability which suggested that the choice of the approach is critical in order to correctly depict TER inter annual variability. Finally, at this stage, TER inter annual variability cannot be explained by variability of climatic conditions.

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