MEASUREMENT AND ANALYSIS OF THE CARBON SEQUESTRATION BY A MIXED FOREST DURING THREE CONSECUTIVE YEARS

Marc AUBINET

Unit of Physics, Faculté des Sciences Agronomiques de Gembloux, 5030 Gembloux, Belgium

The importance of the role played by forested areas in the global carbon cycle actuated the scientific community to foster experimental measurements of the CO_2 exchanges between forests and the atmosphere. The protocol of Kyoto strengthened the interest in such measurements and revealed their immediate policy relevance. Such measurements are performed since August 1996 at the Vielsalm experimental site (Belgian Ardennes) in the frame of the EU funded EUROFLUX network. They are still continuing.

The site is a mixed forest, constituted by deciduous (*Fagus sylvatica*, L.) and coniferous (*Pseudotsuga Menziesii* (Mirb.) Franco) species that form distinct sub-plots allocated around the measurement site. Fluxes of heat, water vapour and CO_2 were measured continuously on a half hour basis using the eddy covariance method. The system was placed at 40 m above the forest floor. It was completed by a meteorological station that records every half hour the air and soil temperatures and humidities, the radiation, the precipitation and the atmospheric pressure. The leaf area index (LAI) and the soil respiration are also periodically measured.

A first aim of these measurements is to infer the flux response to the meteorological variables in order to predict their reaction to a possible climate change. In particular, the responses of the day CO_2 flux to the radiation and of the night CO_2 flux to the temperature were stressed and analysed. The first was found sensitive to the air saturation deficit and to the temperature; the second, to the soil water content. However the impact of this latter variable is limited as its variation range is narrow (0.2 - 0.3 m^3m^{-3}) due to frequent and regular rains.

A second aim is to quantify the annual carbon sequestration (ACS) by the ecosystems and its inter-annual variation. In order to do this, before to be summed, the fluxes must be corrected and data gaps must be filled in. The impact of these procedures on the ACS is analysed. Due to a dense data coverage (more than 86% of the time covered by the measurements), the impact of the data gap filling procedure remains small. On the other hand, a "night time correction" must be applied in order to overcome the inability of the eddy covariance method to measure the real flux during quiet nights. Its impact on the ACS amounts to 10 to 20% according to the years.

The ACS were, respectively, 0.45, 0.38 and 0.52 $kgCm^{-2}$ for the beech in 1996-97, 1997-98 and 1998-99 (from August 1st to July 31st). They were 0.77, 0.56 and 0.68 $kgCm^{-2}$ for the coniferous on the same periods. The higher carbon absorption in the coniferous sub-plot is explained by the longer vegetation season (8 months against $5^{1/2}$ months for the beech) but also by a higher absorption efficiency during the vegetation season. The measurements don't allow to determine yet if this is due to a higher leaf assimilation efficiency or to a lower soil and branch respiration rate.

The ACS inter-annual variability may be explained by climatic (essentially radiation) differences but also by changes in LAI in the beech sub-plot : in particular a more precocious leaf initiation (5 days earlier) was observed in 1999 as well as a more precocious leaf fall (about 8 days earlier) in 1998. In addition, the LAI was found about 0.7m^2m^{-2} higher in 1998 than in 1997. As each of these factors was exerted alone, it could induce a relative ACS variation of about 10%. In fact, they partially compensate during the year. If it was not the case, a larger inter-annual variability could be expected.