Seasonal variation of LAI in the footprint of a flux measurement tower

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Forests, throughout the year, undergo different phenological stages. These seasonal phenology patterns, in deciduous, coniferous and/or mixed forests, should be considered in modelling studies of carbon, water, energy and biogenic volatile organic compound fluxes. Estimates of leaf (needle) area are used to follow the phenological development of forest stands. Moreover, leaf area index is an important parameter for the integration and upscaling of different ecological processes. We performed a structural analysis of the forest canopy by using different non-destructive methods, namely hemispherical photography (HP), LAI-2200 and understory intercepted photosynthetically active radiation (PAR) measurements (Pontallier et al., 2003). The main objective of this study was to quantify temporal variability of LAI and to compare these three different methods.

LAI is defined as the leaf area (m^2) per unit of ground area (m^2) and it is known that it varies seasonally (Jonckheere et al., 2004). In literature different indices are used to study leaf area. Attention should be paid to which definition is used (Asner et al., 2003): plant area index (PAI) (Holst et al., 2004), leaf area index (LAI) (Mussche et al., 2004) or vegetation area index (VAI) (Fassnacht et al., 1994), being the most common indices. Measurements were done in the experimental forest of Vielsalm, located in the Belgian Ardennes (50°18'N, 6°00'E, altitude: 450m) described in detail in Aubinet et al. (2001). The footprint of the flux tower in this forest was divided into four transect subplots with five sampling points per transect. The distance between each point was 15 meters. In total 43 sampling points were divided and located using a GPS. The HP and LAI-2200 were carried out at nine dates on a monthly basis, while PAR measurements were logged automatically throughout the phenological year 2010.

During the course of one year, we observed a pronounced seasonal bell-shaped LAI variation for all three techniques used. Clearly, seasonal vegetation area index can be classified into three phenological periods: leaf production, leaf maturity and leaf senescence (Fig. 1). Interestingly, LAI-2200 showed a more rapid increase in spring compared to HP and intercepted PAR. LAI reached a maximum value in summer and a minimum value in winter for all techniques. Some explanations for the observed difference between the three techniques were brought forward and several fundamental questions were addressed. The seasonal evolution of the LAI will be discussed for the deciduous subplot, including strengths and weaknesses of each technique.

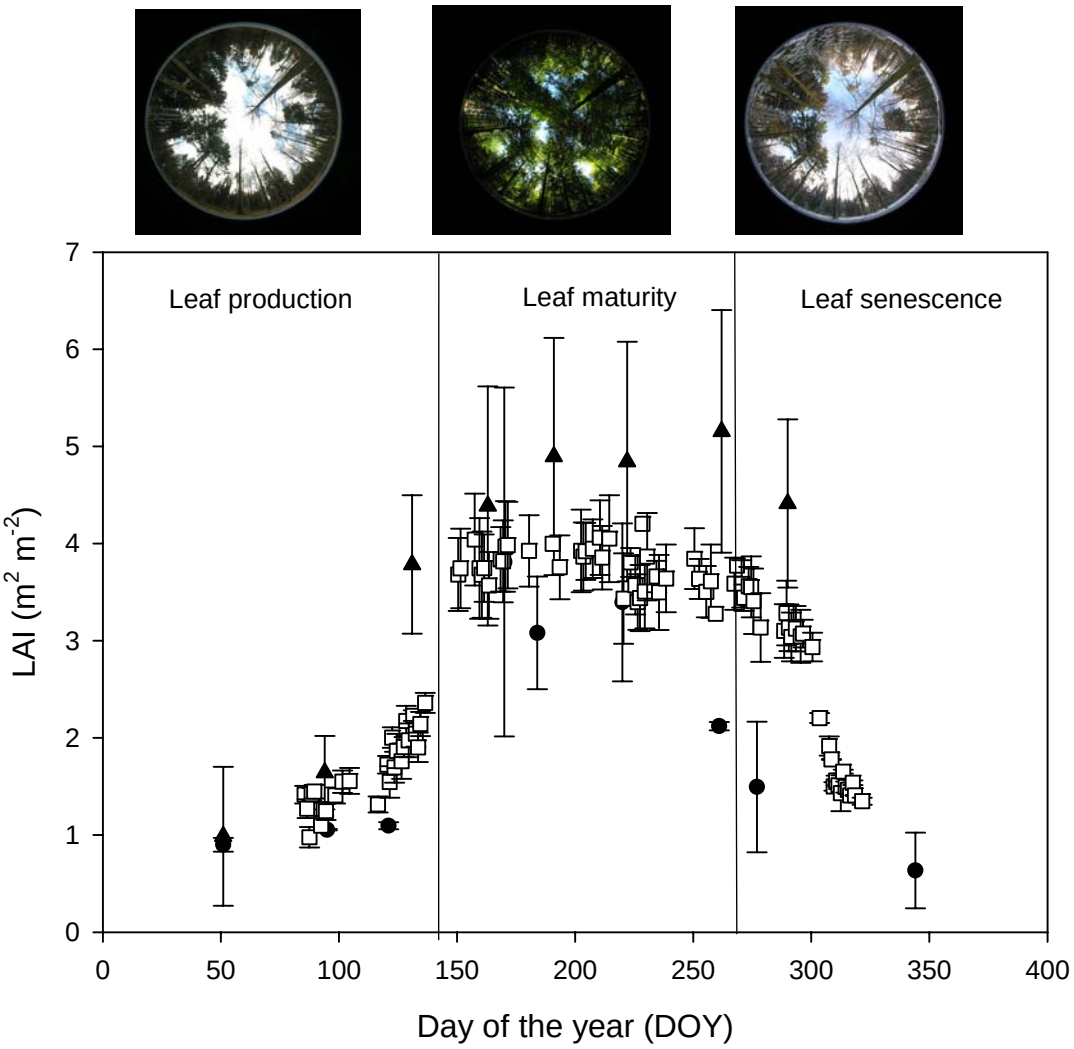

Figure 1: Leaf area index (LAI) of beech plot according to LAI-2000 (▲), hemispherical photography (●) and intercepted PAR (□) in Vielsalm forest (Wallonia, Belgium) during the phenological year of 2010.

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