

***Interactive comment on “Carbon allocation to biomass production of leaves, fruits and woody organs at seasonal and annual scale in a deciduous- and evergreen temperate forest” by M. Campioli et al.***

**Anonymous Referee #1**

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**General comments**

With this paper, Campioli and co-workers explore through data analysis a somewhat overlooked theme in studies related to C budget. They present and compare seasonal and interannual patterns of productivity at the organ level for both a young Beech and a mature temperate Pine stands.

The paper is overall clear, concisely and well written. It presents an original dataset of primary interest for ecophysiologicals and should be useful for modellers interested

C3959

in simulating growth processes. Yet, I expect several precisions / modifications to the current text in the final version. I therefore recommend this paper to be published after major revisions. The main points of concern to date are: (1) Most seasonal data (LAI, circumference increment) are expressed as ratios, and no absolute values are given by the authors. I would like the authors to add a figure illustrating the seasonal evolution of LAI and DBH / CBH data in absolute numbers (not only a value of leaf and stem NPP as in figure 4). (2) The methodology section is quite elliptic. I would like to have more precisions regarding the allometric equations employed to calculate biomasses and increment from CBH data. How was height increment considered? (3) Provide more details regarding the calculations of LAI and leaf biomass data. (4) I'm surprised by the seasonal dynamics of wood growth in Pine. Please address this question by making a figure reporting the measured CBH data (maybe on a relative scale to illustrate different trees), and compare your data to already published patterns (Schmitt et al., 2004; Makinen et al., 2008 and, more relevant for temperate pines, Zweifel et al., 2006) (5) The authors completely overlook the question of data uncertainty and argue that errors on NPP are too many to be computed. I disagree with this argument. One can at least assess the error introduced by the use of allometric equations (given known uncertainties on the parameter values). One additional source of uncertainty is, at least for Pines, interannual variations in wood density, which is usually very important and not that easy to link with variations in late/early wood proportions (as suggested by the authors). I therefore expect the authors to precise this point. (6) Do not overstate the few results originating from published papers (Granier et al., 2000 and Janssens, 2002) to draw strong conclusions about fine roots. This compartment is indeed extremely difficult to monitor and is still an important source of uncertainty in C budgets. (7) One conclusion of the paper is wrong and should therefore be corrected. The authors state that the C sequestration capacity of the Beech stand is higher than that of the Pine stand on the basis of an incomplete C budget, based on leaf and woody compartment, but completely ignoring fine roots and soil organic matter.

I would like to see the revised version of the paper before publication.

C3960

## Specific comments

Title: correct "at seasonal and annual scales"

L2 P7576: "because tree organs have different construction and maintenance costs, life span..."

L1 p7577: no estimate of autotrophic respiration is (or can be, considered the data) given in the paper

L22 p7578: change "Thornely" to "Thornley"

P7580: the authors do not document the influence of storm Lothar (December 26th, 2009) on stands' structures. It damaged a number of forest stands, notably in Northern France and Belgium. Should moreover precise if height and DBH should be understood as "mean" or "dominant".

P7581: indicate that eddy covariance device was changed following the storm Lothar in Hesse (cf Granier et al., 2009 AFS). Change "Euroflux" to "CarboEurope". L26 p7581: Change "biased" to "biases".

P7581: the cited reference (Nagy et al.) does not include a comparison of GPP calculated with / without footprint corrections. Please state the numbers and briefly remind the reader of the methodology used to compute both estimates.

P7582: the 2-step procedure for annual biomass calculations in Pine should be precised. Cite the allometric equations used. It is formally not possible to compute interannual variations in woody growth (i.e. including stems, branches and coarse roots) from weighted averages based on CBH dynamics (you need to do so 2 more hypotheses not cited in the text: (a) that the ratios of branch and coarse root biomass to total woody biomass are equal from year to year and (b) that wood density does not vary from year to year).

P7582: Eleven trees is a low number for CBH sampling given the inter-tree variability

C3961

(even within a given social class)...

P7583: cite Granier et al. 2009 illustrating CBH dynamics for some years at Hesse

P7583: i'm concerned with the data used by the authors. Three trees are not sufficient to correctly sample the seasonal dynamics of CBH (consider for instance the strong inter-tree variability of extractable water linked to soil properties spatial variability). More I would like to have details regarding the computation of 3-week interval growth increment from automatic dendrometer which typically provide 1 measurement per half-hour/day. Make these data apparent in a new figure.

P7584: I acknowledge the effort of the authors to consider wood density variability. It is still extremely difficult to infer from year to year, particularly for Pine. I have the impression that the early/latewood transition was fixed from year to year in this study (and ring density calculated thereafter). Considered the very strong wood density difference between early and late wood, I would expect the transition date to be determined more precisely. It is, at least in the ring-porous Pine data, easily feasible on the basis of stem core data.

P7585: please provide details regarding the calculation of seasonal LAI from hemispherical photographs (+ frequency of acquisition). The authors carefully detail the use of CH reserves for the formation of Beech leaves in spring. What about Pines? The authors seem not to even consider the possibility of needle construction depending (at least partly) on CH reserves (the construction cost of needles stay important and it is not sure that photosynthates provided by previous year needles are enough to make the new cohort).

P7586: it is not clear at all what the different NPPi components refer to. Please state it clearly. I also remind the authors that stand total NPP can not be computed unless one can assess the NPP of CH reserves and fine roots compartments. So NPPT should definitely be renamed.

C3962

P7586: see the “general comments” regarding error assessment.

L24 p7586: replace “annul” by “annual”

P7586: cite absolute ranges of variations, they are much more easy to interpret than CV.

P7586: I'm surprised by the high NPP values attributed to coarse roots for Beech. Considered that NPP<sub>stem</sub> is 55% of NPP<sub>w</sub>, NPP<sub>branches</sub> is 15% of NPP<sub>w</sub> and that NPP<sub>coarse roots</sub> is 30% of NPP<sub>w</sub>, one can compute a rootshoot ratio of investment of  $NPP_{cr}/NPP_{(st+br)}=30/70=42\%$  which is much higher than the biomass rootshoot of 20% showed by Genet et al. (2009, Tree physiol) for Beech. Two possible reasons for that : (a) the coarse root biomass estimates are wrong (from allometries) or (b) the life span of coarse roots and wood are very different (i have no reference for that, sorry). The authors should detail and conclude on this point.

P7587: calculated Pine productivities are low but realistic when compared to yield tables (see e.g. Class 3 of productivity for *Pinus sylvestris* in Decourt, 1965, Annals of forest science. Le Pin Sylvestre et le Pin Laricio de Corse en Sologne: tables de production provisoires et méthodes utilisées pour les construire. Readily downloadable from scholar.google.com). Please mention this (or make reference to an other yield table)

P7587: present results of the stats analysis in a Table. Regarding correlation with climate variables, why not using a multiple regression model (df problem ?).

P7588: for GPP seasonality the beginning and end of season follow increasing / decreasing temporal trend can not be said to be “exponential”

P7588: i'm quite surprised by the seasonal dynamics of wood growth in Pine (fig. 4). I would expect most of the growth to occur in May-June, as commonly observed in Scots pine, either in boreal (Schmitt et al., 2004; Makinen et al., 2008) or temperate (Zweifel et al., 2006 + my personal data) environment. I'm wandering about possible biases in

C3963

auto-dendrometer data (see Makinen et al., 2008 for an extensive quantification of the biases). Please show your CBH data and discuss the possibility of a bias affecting the seasonal dynamics.

P7589: you compare the NPPT/GPP ratio with the one published by De Lucia et al. (2007). Please rename your NPPT estimate (i remind that it does not include fine roots). Do De Lucia et al. included fine roots NPP in their estimation (in a word aren't you comparing apples and pears?).

L10-15 p7590: in the case of a diversion of photosynthates towards cone production, one should also observe a negative correlation with NPP<sub>w</sub> and NPP<sub>f</sub>. This would be much more informative than the comparison of CV proposed by the authors.

L22-24 p7590: how were Rauto and its uncertainty estimated in both cited studies (Nagy, Granier)?

L24-26 p7590: considered that, for Pine, NPPT (stems + branches + fruits + coarse roots) is 17% of GPP and Ra 45% of GPP one expect an investment in fine roots+exsudates of  $[1-(0.17+0.45)] * GPP = 0.38 * GPP$ . Please mention this, and give NUMBERS more than ratios of GPP which are less easily interpretable from an eco-physiological viewpoint.

L9 p7591: refer to Jarosz et al. (AFM) for GPP numbers of understory in Pine stands (*Pinus pinaster*...).

P7591: I'm sorry but the data presented do not allow the author to conclude that the C sequestration in Pine stand is lower than in Beech. We have no idea of the investment to fine roots and exsudates (even if the author give rough estimates from Granier et al. and Janssens et al.) and know nothing about C sequestration in soil organic matter. Hence you should moderate the statement.

L3 p7592: Mis-citation of Hobbie (2006). The Hobbie paper refers to juvenile trees (not “plants” in general as stated by the authors). In *Pinus sylvestris*, allocation towards

C3964

ectomycorrhiza is estimated to be at most 14-15% of NPP. No information for Beech.

L8-9: This sentence is wrong. Remember that leaves grow early in the season, when most annual GPP has NOT been fixed... and i also remind the author that they cite earlier the work of Deckmyn et al. showing for Beech that current leaves are at least partly built on CH reserves accumulated on past year(s).

L26-29 p7592: Remember that Granier et al. (2009 AFS) find the contrary when including year 2004 (following year 2003). For that year, following a particularly strong drought + heat stress, the spring resumption of cambial growth was slowed, probably due to a low level of CH reserves. Please cite this counter-example in case of strong drought

L26 p7593: replace "at whole" by "at all"

L2 p7594: replace "aboveground and woody organs" by "wood, leaves and fruits"

L16 p7594: formation of new leaves followed by vessel production is only observed in diffuse-porous species (e.g. beech). In ring-porous species (e.g. sessile oak), vessel formation precedes leaves formation (see Breda et al., 1996).

#### Literature cited

Bréda, N. & Granier, A. (1996) Intra- and interannual variations of transpiration, leaf area index and radial growth of a sessile oak stand (*Quercus petraea*). *Annales Des Sciences Forestieres*, 53, 521-536.

Décourt, N., Michaux, F., Tisserand, A. & Simon, R. (1965) Le Pin sylvestre et le Pin Laricio de Corse en Sologne. Tables de production provisoires méthodes utilisées pour les construire. *Annales Des Sciences Forestieres*, 257-318.

Genet, H., Breda, N. & Dufrene, E. (2010) Age-related variation in carbon allocation at tree and stand scales in beech (*Fagus sylvatica* L.) and sessile oak (*Quercus petraea* (Matt.) Liebl.) using a chronosequence approach. *Tree Physiology*, 30, 177-192.

C3965

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Makinen, H., Seo, J. W., Nojd, P., Schmitt, U. & Jalkanen, R. (2008) Seasonal dynamics of wood formation: a comparison between pinning, microcoring and dendrometer measurements. *European Journal of Forest Research*, 127, 235-245.

Schmitt, U., Jalkanen, R. & Eckstein, D. (2004) Cambium dynamics of *Pinus sylvestris* and *Betula* spp. in the northern boreal forest in Finland. *Silva Fennica*, 38, 167-178.

Zweifel, R., Zimmermann, L., Zeugin, F. & Newbery, D. M. (2006) Intra-annual radial growth and water relations of trees: implications towards a growth mechanism. *Journal of Experimental Botany*, 57, 1445-1459.

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C3966