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Interactive comment on "Tree size and age induced stem carbon content variations cause an uncertainty in forest carbon stock estimation" *by* Suhui Ma et al.

Anonymous Referee #1

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Ma et al compiled a meta-database of carbon concentrations of different tree organs and analyzed that database for (1) correlations among the carbon concentration of the different organs, (2) relationships between carbon concentrations and tree diameter and age, as well as (3) the error coming from using either a fixed carbon concentration of 50% or the observed carbon concentration of the stem wood when calculating the carbon content of a tree. Although the study contains some interesting elements, the analyses and discussion lack the depth expected from a paper in Biogeosciences.

Some general issue that need to be addressed: (1) The observations of carbon concentration are treated as if they come without a measurement error. This is of course

not the case. Which methods were used to determine carbon content? What is their precision in the range of the observations? Did the laboratories that performed the analyses run a quality control and quality assurance program? If so, what was the reproducibility of their control samples? If not, what is the typical measurement error of the different methods? Do the results hold when measurement errors are accounted for?

(2) The heterogeneity of the organs itself is neither accounted for nor mentioned. How much does the carbon concentration varies within a single stem? And how much variation is there between different individuals of the same species in a single stand? Do the results hold when these heterogeneities are accounted for?

(3) Where were the samples taken? Which biomes and species are represented in the database? How were the samples taken? Which roots were samples; fine or coarse? Which leaves were sampled; sun or shade, top or bottom of the canopy? If there is heterogeneity with in canopy, stem or root system the sample location doesn't matter but if there is heterogeneity it should be confirmed that samples from different studies can be jointly analyzed.

(4) The values reported in table 1 may be significantly different but the standard deviation suggests that the differences are marginal. From this respect I think it would be more honest to report the results in terms of "tendency for lower/higher C concentrations" than in terms of "different" carbon concentrations. A statistical significant difference should not be confused with a meaningful difference.

(5) Given the absence of a benchmark – in this case a tree for which the carbon concentration was determined in its entirety rather than through sampling – the error estimates are not validated and thus also based on a set of assumptions (i.e., homogeneous radial carbon density within a stem and along the height). These assumption should be made explicit and it should be discussed how likely they are. In other words, how sure are you that the single observation of carbon concentration of, for example the stem,

represents the whole stem? How many samples of carbon concentration does one needs to take from a single stem to obtain the a good estimate of its true value?

(6) It is fine to focus a study on a single (very) detailed aspect of the C cycle, in this case the impact of using an exact carbon concentration but in the discussion the scope should be broadened again. The abstract and discussion should report this finding within a comprehensive uncertainty analysis. What are the sources of uncertainty when determining the C content of a tree and forest. What are the expected errors of each error/uncertainty source? Such a framework would enable the authors to conclude that determining the carbon concentration is (very) important or not important at all given the overall uncertainty. Given my understanding of our current ability to quantify the carbon content of a tree, allometric relationships and wood density would rank much higher than carbon concentration. When studying the carbon content of a forest, uncertainties from processing remote sensing images and below ground carbon are likely to overrule the uncertainties from the carbon concentration of different plant organs. If the authors can use formal uncertainty analysis to demonstrate that my understanding is wrong, the study could be of interest to the readership of Biogeosciences.

(7) In plantation forest and more natural even-aged forest, diameter and age are strongly related to each other. Diameter increases with increasing tree growth. If carbon concentration increases for one, it could be expected to increase for the other as well. Along the same lines, carbon content is likely to increase with increasing tree height, increasing basal area and increasing wood volume.

(8) The discussion is superficial and fails to shed a new light on the results. Some related studies are listed but the discussion does a poor job in presenting a couple of (competing) hypothesis as for why carbon concentration increases with increasing diameter? The sapwood/heartwood hypothesis could easily be tested by back of the envelope calculations.

(9) Check the difference meaning (in biogeochemistry) between “content” and “concentration” and use accordingly

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