

Interactive comment on “Carbon allocation and carbon isotope fluxes in the plant-soil-atmosphere continuum: a review” by N. Brüggemann et al.

Anonymous Referee #1

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Carbon allocation and carbon isotope fluxes in the plant-soil-atmosphere continuum: a review. Submitted by Brüggemann et al.

This paper presents a very comprehensive review on the multiple physical and biogeochemical processes influencing the isotopic characteristics of carbon during its transformation in the feedback processes between atmosphere, plants and soil as well as during internal turnover. The manuscript is divided into four major scientific topics, i.e. fractionation processes in plants, carbon allocation in the plant-soil system, below-ground carbon turnover and physical interactions in soil-atmosphere CO₂ exchange. This organization provides an apparent and logical introduction to this rather complex topic, in which many turnover and transformation processes are involved. A brief introductory section introduces general characteristics on ¹³CO₂ and ¹²CO₂ isotopo-

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logues. For the completeness of the review, it is suggested that this section is extended with a brief general introduction to the concept of the delta unit / atom% and reference materials; in this context it is also important to stress the difference between the ‘little’ delta expressing $^{13}\text{C}/^{12}\text{C}$ ratios, and the ‘large’ delta expressing isotopic fractionation during transformations (mentioned in 2.1). The section 2 deals with carbon fractionation in plants. It is suggested that this section is elaborated a bit further to include an overview of the discrepancies among different photosynthetic systems (C3-C4-CAM), which has different impacts of the ^{13}C of assimilated C. Section 3.1 could be reduced in length. It is stated above (Page3632/line27) that phloem transport probably does not change the isotopic composition of carbon compounds. Hence, a long description of phloem transport is not really needed in this context, although scientifically interesting. In section 3.3, plant losses via respiration and BVOC emissions, there’s no mentioning of the use of stable isotopes associated to works on the emissions of BVOC. It would be very interesting to the reader to include some knowledge and perspectives on this topic. Page3646/line24. . It is suggested to make this a separate section on SI methodologies and elaborate somewhat more on the content including e.g. specific characteristics of the “new cutting-edge technologies” as compared to conventional IRMS. Some mentioning of new technologies in the Conclusions and outlook (P3663/line17..) could be merged into this section. In section 4.3 on fractionation due to microbial metabolism there’s no mentioning of the potential role of autotrophic microorganisms in the context of SMC C-13 signals. Fractionation in autotrophic bacteria has been reported to be interestingly high, see eg. Cowie et al., 2009, Organic Geochemistry. The text reads easy in many places, but in others it is characterized by relatively long sentence constructions. Please, consult once again for linguistic corrections to polish and make more fluent.

Specific comments P3623/line9 vs. line20: The terms ‘global change’ and ‘climate change’ are often used synonymously in the literature, and also here. However, increasing atm. CO_2 is (supposedly) a driver of climate change, and not a climatic variable undergoing changes and needs to be considered as an element in global change.

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P3624/line13: Insert “atmosphere-plant-soil” interactions P3626/line1: Must be a “simplified model of Eq. (1)” P3627/line16: Was this a Northern hemisphere study so that June and July refer to summer; please, specify. P3632/line3: It is unclear what is meant by “respired CO₂” in the discussion on isotopic signatures in different plant organs. Is it respiration from the organs? Please, specify. P3645/line15: Do the finding imply that time lags decreased with increasing or decreasing plant height? Please, specify. P3645/section3.6: It is suggested to swap the two sections 3.6 and 3.7 for continuity of description of C transport processes. P3650/line22: It would be very useful to the less experienced reader to include the Rayleigh distillation equation in the text with some additional explanations (e.g. as for the photosynthesis discrimination equation given in section 2.1) P3651/line20: Fig. 5 should read Fig. 3. P3653/line10: What is meant by carbon fixation by heterotrophs? The term carbon fixation is commonly used for CO₂ fixation in autotrophic bacteria. Please, explain. P3656/line17: Presumably this section deals with aboveground litter, but dying roots should also be considered as litter belowground. Please, specify. Page3656/line24: The differential C-13 signals of heterotrophic vs. autotrophic plant organs (described section 2) and their possible differential turnover times might potentially also affect the isotopic composition of the litter layer. This could be further discussed in this section. P3658/line18: Please, give some more details on “stable isotope probing”. P3659/line10: A small 1-2 sentence summary of section 4.5 emphasizing formulation of open research questions could be added, as for previous sections. Fig. 2: There’s no reference to Fig. 2 in the text. Please, insert. Fig. 3: This figure summarizes interesting information, but is difficult to understand. The figure text needs further elaboration in order to identify the respiration processes involved in data compilation. Plant respiration, ecosystem respiration or soil respiration. Fig. 4: This is a nice figure. To compile current knowledge even further, it is suggested to insert some typical fractionation factors in the grey boxes to illustrate the importance.

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