

Interactive comment on “Radiocarbon isotopic evidence for assimilation of atmospheric CO₂ by the seagrass *Zostera marina*” by K. Watanabe and T. Kuwae

Anonymous Referee #1

Received and published: 11 June 2015

General comments:

This paper applies radiocarbon analysis to estimate C source of seagrass *Zostera marina* with simple dataset. The authors showed that *Z. marina* assimilates not only ¹⁴C-depleted DIC, but also ¹⁴C-enriched atmospheric CO₂. I basically agree with the authors' conclusion that ¹⁴C is a unique tool for this type of analysis because it is a fractionation-free value. However, I do not think that comparison with previous tool (i.e., ¹³C) is sufficient in current version of the manuscript. Furthermore, the authors did not take into account for contribution of terrestrial organic matter (¹⁴C-enriched) to the bulk seagrass biomass. Statistical approach (GLM) also needs more considerations. The authors should revise the manuscript especially focusing on my comments below.

C2731

Specific comments:

P.7600, L.25-26: “DIC source” should be “C source for their photosynthesis”? Can *Z. marina* also use bicarbonate and/or carbonate as photosynthetic substrates?

P.7601, L.8: “ratios” should be inserted after “stable carbon isotope”

P.7601, L.9-12: Needs more careful explanations. The difference of delta ¹³C values among chemical species in DIC is important in this context. Chemical species in DIC (relative abundance of CO₂ (aq), bicarbonate ion and carbonate ion) are controlled by in situ pH and water temperature. These species typically have distinctive delta ¹³C values under atmospheric equilibrium. The authors should check the following papers: “Plummer LN, Busenberg E. 1982. The solubilities of calcite, aragonite and vaterite in CO₂-H₂O solutions between 0 and 90°C, and an evaluation of the aqueous model for the system CaCO₃-CO₂-H₂O. *Geochimica et Cosmochimica Acta* 46(6):1011–40.”; “Zhang J, Quay PD, Wilbur DO. 1995. Carbon isotope fractionation during gas-water exchange and dissolution of CO₂. *Geochimica et Cosmochimica Acta* 59(1):107–14.”

P.7601, L.17-18: “As any ~ calculating Delta ¹⁴C” should follow “because it is internally corrected by delta ¹³C” and cite Stuiver and Polach (1977)

P.7601, L.19-20: “Furthermore ~ in ecosystems” Unnecessary sentence in this paper

P.7601, L.20: “The age of DIC” is confusing and not a good choice of words. “The ¹⁴C age of DIC” is more appropriate, but still unclear. I suggest the authors revise this sentence as “The Delta ¹⁴C value of DIC generally differs from that of atmospheric CO₂...”

P.7601, L.21: “long residence time in the ocean” should be replaced with “longer residence time of C in the aquatic environment than *** (reference)”

P.7601, L.22-24: “quantitative evidence of the assimilation of modern Cair by the seagrass, *Zostera marina*, by analyzing the Delta ¹⁴C values” should be revised as “quantitative evidence that the seagrass *Zostera marina* assimilates modern Cair, based on

C2732

the Delta 14C values”

P.7602, L.10: “screw-cap glass culture bottles” Was the hermeticity of the bottles ensured?

P.7602, L.13: Was the surface of *Z. marina* leaves washed? Did the authors see biofilm covering *Z. marina* surface? If it is the case, terrestrial organic matter might be attached to the *Z. marina* surface and provided 14C-enriched C to bulk *Z. marina* samples. Then, negative relationship between Delta 14C of (bulk) *Z. marina* and salinity can be also explained by the river transportation of terrestrial organic matter. That is, contribution of 14C-enriched terrestrial organic matter may be diluted along freshwater-seawater gradient

P.7602, L.18: “plant” should be inserted between “the samples”

P.7602, L.21: “ratios” instead of “ratio” and “concentrations” instead of “concentration”

P.7603, L.17-21: I did not understand why and how the authors used GLM. Why was the objective variable the difference between the Delta 14C values of the seagrass leaves and those of DIC? Why wasn't single regression used for each of DIC and seagrass independently?

P.7603, L.15: Were delta 13C values of plants measured by EAIRMS whereas delta 13C values of DIC measured by AMS? If so, provide a brief note that typical AMS is not optimized for delta 13C measurements. A great care should be taken to compare delta 13C values determined by EAIRMS and AMS. At least, the authors can check the difference between delta 13C values of plants measured by EAIRMS and those by AMS. How much different were they?

P.7603, L.24: “in each of four stations” should be inserted before “as follows”?

P.7604, L.1: The sentence “Delta 14C DIC was calculated from the best GLM (Table 1).” should be revised as “As DIC and *Z. marina* were not collected from the same stations, the Delta 14C DIC value as a C source of *Z. marina* in each station was estimated from

C2733

the best GLM (Table 1).”

P.7604, L.11: Insert space between “theDelta14C”

P.7604, L.16-18: “As mean ~ sampling sites” Unclear sentence

P.7605, L.1: “Nevertheless” should be replaced with “In any cases”

P.7605, L.5-6: “In particular ~ isotopic fractionation” Cite Stuiver and Polach (1977) here

P.7605, L.8-9: “As the ~ Cair (-8 permil)” These values are determined by a certain combination of delta 13C of atmospheric CO₂, pH and water temperature with assumption that DIC equilibrates with atmospheric CO₂. If pH and water temperature data are available, relative abundance and isotopic composition of each C species can be estimated. At least provide more detailed explanations with appropriate citations as I suggested in Introduction

P.7605, L.10: “seagrass with ~ isotopic signatures” Unclear sentence. Revise

Table 1: What is “Type (seagrass)”? Again, why was GLM used?

Fig. 1 (a): Provide regression formula for both DIC and seagrass

Fig. 1 (c): Was the relationship between delta 13C and salinity significant?

Interactive comment on Biogeosciences Discuss., 12, 7599, 2015.