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Biogeosciences Discussions

Interactive comment on "Stable isotopic constraints on global soil organic carbon turnover" *by* Chao Wang et al.

Anonymous Referee #1

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The manuscript "Stable isotopic constraints on global soil organic carbon turnover" by Wang et al. presents an interesting approach of deriving information about SOC decomposition kinetics from stable carbon isotope information along the soil profile. For this, they derive a slope "beta" from the relationship of δ13C values and SOC content of soil profiles across the globe, and then relate these "beta" values to calculated decomposition kinetic constants "k" (or more precisely their log-transformed negative values). They state that the highly significant linear relationship of the log-transformed variables can be used to derive SOC decomposition kinetics from δ13C profiles of SOC. Furthermore, they relate these ln(-beta) values to four different parameters, i.e. MAT, MAP, soil clay and nitrogen content. For all four parameters they find significant relationships with ln(-beta). This approach is interesting and might be promising if proven to be reliable.

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The weak part is the calculation of the kinetic decomposition constants with several secondary data sources and a fixed relationship between heterotrophic and total soil respiration, which might be too much of a simplification for this global approach, given the large range of ratios between heterotrophic and autotrophic respiration found for different ecosystems and conditions.

More specifically, the concerns are the following:

1) The kinetic decomposition constants k for the different soil profiles have been calculated by assuming steady-state conditions, i.e. SOC input and output are in equilibrium. While this assumption might hold true for many of the sites, there is no evidence provided that this really is the case.

2) The SOC stocks, which represent the denominator in equation 1, were extracted from the Global Organic Soil Carbon and Nitrogen (Zinke et al. 1998). There is no mention whether there was an exact match between the soil profiles used in the present study, or whether spatial approximations were made, and if yes, which criteria were used for these spatial approximations.

3) Heterotrophic soil respiration was calculated from total soil respiration by a fixed linear relationship adopted from Bond-Lamberty et al. (2004). Given the large variability of the fraction of Rh to total soil respiration (varying between 10% and 90% in vegetated ecosystems), this approach is highly questionable.

4) Also total soil respiration was not measured, but derived from a climate-driven regression model (Raich et al. 2002).

5) And finally, climate data were derived from WorldClim as a function of latitude and longitude (what about altitude?), whenever climate data were not available in the literature tapped in this study. Again, there is no mention whether there was an exact match between the locations of the present study, or whether spatial approximations were made, and if yes, which criteria were used for these spatial approximations.

Given all above-mentioned uncertainties concerning the calculation of the key variable of the study, i.e., the SOC decomposition rate constant k – which by the way is an apparent constant, as it is a composite of the decomposition of several SOC pools with different decomposability/recalcitrance – the reader would expect an extensive uncertainty analysis. However, not a single attempt was made to quantify those uncertainties, which certainly will amount to a large relative error due to multiple convolutions of single functions and error propagation. Also no mention is made of this crucial point in the discussion, and how this might affect the far-reaching conclusions drawn.

Therefore, I would have great concerns recommending acceptance of the paper in Biogeosciences, even after major revisions, as those concerns are aroused by the intrinsic weaknesses of the data sources, i.e. the dearth of own measured data of key components of the assessment presented here, which cannot be healed by a major revision.

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