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Biogeosciences Discussions

Interactive comment on "Annual net primary productivity of a cyanobacteria dominated biological soil crust in the Gulf savanna, Queensland, Australia" *by* Burkhard Büdel et al.

Anonymous Referee #2

Received and published: 11 October 2017

GENERAL COMMENTS This is a very nice study providing some data on a topic for which data is quite scarce: a high-temporal-resolution examination of isolated biocrust C exchange on an annual time scale in natural conditions. My main recommendation is to work on the framing of the study and improving the context of the results. These could be more compelling in a couple ways. First, the setting up at the beginning of a "mystery" that some crusts take up C and others don't does not work for the structure of this paper. I already knew the answer before seeing the results that it was a difference in methods among the studies (isolated crusts vs. whole soil column) so the results did not resolve this part of the narrative.

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Instead of taking this 'source vs. sink' approach to framing the study, I recommend more directly addressing the contribution of isololated crusts vs. other components of the ecosystem, which though not measured here, are measured much more often than isolated crusts in other studies. This brings me to the context of the results. The order of magnitude of one of the main results here, the 1.72 g m-2 is quite interesting (a very significant finding for which it is hard to come by data). It would be worth putting this in the context of eddy flux tower-measured NEE values, which tend to be on the order of 10s to 100s of g C m-2. For example, a recent study of drylands showed NEP varying from 350 to +330 g C m-2 (Biederman et al. 2017 http://dx.doi.org/10.1111/gcb.13686). Furthermore, the other cited studies that do not isolate crusts report values on the order of 50 g C m-2 losses, and these losses likely come from plant roots (which the authors should discuss).

The results in this study suggest that net exchange from these biocrusts are 1-2 orders of magnitude below the flux magnitudes of plants, possibly suggesting they are not a huge part of the total ecosystem C budgets. The Elbert et al review claims global NPP by cryptogamic covers to be 7% globally but that seems hard to reconcile with this type of result. Regardless of whether the authors totally agree with my reasoning here, this kind of context is worthy of more exploration in lieu of the source vs. sink issue. The true strength of this study, the knowledge gap it fills, is in helping to understand the annual fluxes of an isolated crust into our overall understanding of ecosystem C exchange in systems that contain biocrusts. For that, it is a great study and certainly worthy of publication. The exploration of seasonality and environmental effects on flux rates are also quite nice and well done.

SPECIFIC COMMENTS abstract: "Of the metabolic active period, 48.6% were net photosynthesis and 51.4% dark respiration." 48.6% of what? measurement timepoints? typo: "above a relative humidity above 42%"

Abstract: "This must be taken into consideration for future analyses and modelling of carbon balances in comparable biocrust ecosystems." I think a much more solid

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conclusion can be given here. It's not clear what comparable biocrust systems are being referred to and "it might be helpful for modeling" is never very compelling. I would end with direct and clear answers to the questions and what the results mean to the larger study of biocrust C exchange.

Take a look at the significant digits throughout the manuscript. eg 31.66 nmol feels unrealistically and unnecessarily precise. This will make it easier to read too.

P6 L5: missing close parenthesis?

I'm not wild about the reporting of WC as mm precip equivalent. Wouldn't moisture levels depend on both precip in as well as evapotransipiration and drainage out? Why not report as something intuitive such as g water g-1 wet soil (ie % water by mass)? If kept, include an explanation of why this approach was used.

I like figures 1 and 2. I wish more papers would include nice methods photos like this.

Figure 3 caption needs to define what the codes on the horizontal axis (x axis?) mean. I think it should say x axis and it says sample signature, which I didn't understand. Does that mean an individually collected sample? I counted them and see 21 so I am guessing that's what it means. The codes are a bit cryptic.

P2 L 23. what is meant by "carbon deposition"

P2. L25. Part of the issue here is that studies are being mixed in which the biocrusts are by themselves or sitting on top of intact soil in which other fluxes like sub-crust respiration and root respiration contribute. This study uniquely looks at an isolated crust with very high temporal resolution. It is quite interesting that net uptake is on the order of 1g m-2 year. This is quite meaningful when comparing with eddy flux values from drylands and many ecosystems that show NEE values on the order of 10s or 100s of g C m-2 year. This suggests that cyano crusts alone are not huge contributors to C uptake, even in dryland ecosystems. (Note: I jotted this paragraph down before reading the results and discussion)

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I'd phrase the crucial question part of the intro more clearly and flag them as such with numbers and questions marks. Something like: This led us to two questions: (1) How do Boodjamulla biocrusts respond to the pronounced seasonality of water availability? and (2) Are they sources or sinks for carbon at the annual timescale?

"So far, it is unclear what is triggering a biocrust as either a sink or a source of C." I'm not sure this is conceptually accurate. If the biocrust itself, isolated as you have done here" is a persistent source, it dies. If it's a sink, it is growing or at least building SOM. I think what's unclear is the role of the crusts in the larger ecosystem and THAT'S what this study shows probably better than any previous study.

P8 L10. A key point here though is that that top soil chamber still includes plants because there are plant roots below those crusts. The same is true for all the chamber approaches, and is one of the key reasons studies of isolated crusts like this one is valuable and needed. Those numbers (48.8 and 62) are likely large because they are catching the flip side of plant photosynthesis via roor respiration, which is a lot higher than what the crusts are doing. Chamber depth is more or less irrelevant because they are not closed on the bottom. Any root or microbe from anywhere below the measurement area would contribute to surface fluxes.

In conclusion, some key take-homes from this study I'd like to see emphasized more are that the cyano crust alone is capable of being a small but consistent sink of carbon as it grows and possibly contributes a bit to SOM. However, it's clear also from the magnitude of the values that we are not seeing C fluxes that are anywhere close to what the plant community can do. A more complete discussion of these quantities would greatly improve the presentation of this excellent data set.

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