Reply to Anonymous Referee No.1

We are very grateful for the reviewer and appreciate your comment and suggestions. All responses or changes have been made below. The responses are marked blue.

Thank you very much

Kind regards,

Fangping Yan

(on behalf of the co-authors)

1. It is assumed that the strong relationship between Ca^{2+} and DOC (Fig. S3) reflects a primary source for Ca^{2+} and DOC from the same allochthonous source. Could not the DOC however be produced by later autochthonous or heterotrophic biological activity within the snowpack/ice surface, catalysed by nutrients associated with the dust? This should be at least discussed, and abstract and concluding statements adjusted accordingly.

Response: Thanks for the meaningful suggestion. Yes, DOC may also be produced by these activities. We discussed these potential sources in the section 3.2. The abstract and concluding statements were adjusted accordingly.

2. How was discharge measured? You give the discharge data in the supplementary info, but you need to either a) give details of methods used to discharge at the gauging station or b) cite a reference for this data.

Response: Thank you for your advice. The discharge measurement of LHG glacier has been discussed (Gao et al., 2014). In detail: The hydrological gauging site was setup at about 0.8 km downstream of the glacier terminus. It meets the requirements for a hydrological gauging site. Horizon walls were built on the both sides of the river, and an automatic barometric sensor (HOBO Water Level Logger, Onset, America) was installed in the wall to record water pressure every 10 minutes to calculate the water levels. There was a bridge across the river to facilitate the flow velocity measurement using propeller blade current meter (Model LS25-1, Huazheng Hydrometric Instrument Ltd). The river channel was divided into nine segments in which flow velocity and water depth were measured. Coupled with mean flow velocity, width of each segment and water depth, discharge at specific water level was obtained. By including maximum and minimum water level in a year, a discharge relationship with water levels was developed. Therefore, using the HOBO water lever record, discharge of all seasons was calculated. This part was added in the supplementary information. Below is the picture of the gauging station of the glacier.

3. Line 82 – be better to give numbers of different samples individually here, not just sum of total samples

Response: The sum of total samples has been changed to numbers of different individual samples.

4. Line 82 – how was ice sampled – using an ice axe? Shallow drill? To what depth? Were they also collected in the same plastic bottles after crushing?

Response: The 0-3 cm and 3-5 cm ice was sampled using a pre-cleaned ice axe and collected in the 125 mL pre-cleaned polycarbonate bottles after crushing similar with other samples, this information was added in section 2.2.

5. Line 115 – how were the plastic bottles cleaned?

Response：The plastic polycarbonate bottles were firstly cleaned by ultrapure water for three times, then soaked into 1 M HCl for 24 h (Spencer et al., 2009), after that washed for three times using ultrapure water, finally soaked into ultrapure water for over 24 h. This information was added into the method part 2.2.

6. Line 162 – I'd use pre-combusted or pre-baked rather than pre-burned.

Response "Pre-burned" has been changed to "pre-combusted" through the whole text.

7. Line 164 – I am unclear as to the methodology here. You state that the experimental samples are first filtered through 0.7um nominal filters, then incubated. But won't the filtration remove much of the biological activity? Plus isn't refrigerating the already filtered samples to act as controls effectively the same as the non control samples? Do you mean instead that samples were actually incubated prior to filtration, and then filtered at each time point then refrigerated? If so, please rewrite. And if so, please state the values of controls and place them on Fig 3. Note that you are unlikely to remove all microorganisms when filtering through the nominal 0.7um filters, so they shouldn't be expected to be sterile i.e. the initial samples may also have had some biological activity, hence the BDOC values should be seen as minimum values.

Response： Thanks for the suggestions. Although it might remove some part of the biological activity, this method was used in previous researches (e.g. Spencer et al., 2014). We adopted this method for the purpose of easy comparison with previous results. In detail, we filtered the samples, then started the experiment: firstly, refrigerated the two filtered original samples, other samples were put in the outside natural environment, and every 3 days 2 samples were put into the refrigerator to keep frozen till analysis. The control value was added on Figure 3. According to the other reviewer, Figure 3 was changed to Figure 4 as below.

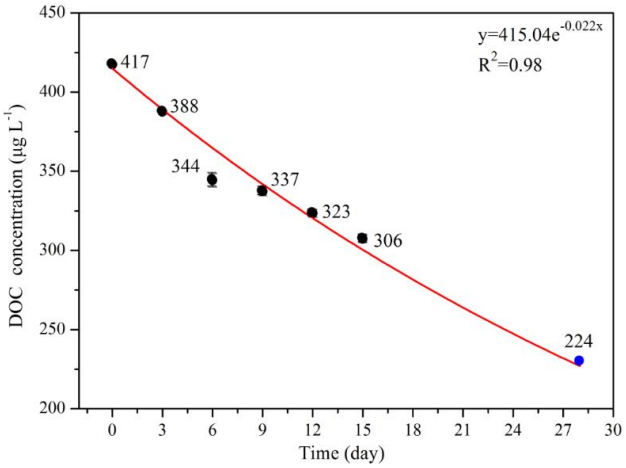

Figure 4 Exponential deceases in DOC concentrations during the biodegradation experiment. Note: The blue point is calculated using equations derived from the experimental data (black point). Mean values ± standard deviations of duplicate treated samples are presented.

8. Line 177 – DOC could also be influenced by microbial activity – see point 1 above.
Response：We agree that DOC was influenced not only by the mineral dust but also the microbial activities. “Microbial activity” has been added in the sentences.

9. Line 189 – again, should mention potential biological activity here
Response: We added the potential biological activity in the sentence.

10. Line 198 – you estimate from extrapolation that 43.2% DOC could be re-mineralized within 28 days. How does 28 days compare with the likely residence time of supraglacial runoff and river runoff, where will the water be in this time – still in a river, or lake, could the DOC survive long enough to impact additional downstream ecosystems?
Response：Supraglacial runoff of LHG glacier No. 12 is the headwater of Xiaochangma River, which disappears as underground water at the mouth of LHG valley and appears as the spring downstream, flowing into Shule River in the place of Changma. Therefore, DOC can survive long enough to impact the downstream ecosystem.

11. Line 205 – I don’t think Anesio et al 2009 looked at viruses. A good additional reference for viruses would be Bellas et al 2012 ‘Viral impacts on bacterial communi-ties in Arctic cryoconite’ Env Res Lett 8 http://iopscience.iop.org/article/10.1088/1748-9326/8/4/045021.
Response: Reference “Bellas et al., 2013” was added in the text, and the section of DOC sources was rewritten according to your point 1.

12. I found that the number of acronyms made it harder to read. For those used only a couple of times (e.g. BrC for brown carbon, WSOC for water soluble organic matter). I’d write them out in full each time simply to aid readability.
Response: These acronyms were rewritten in full name in the text.

13. There are too many decimal points e.g. in abstract 6,949.4 kg (line 27) should be rewritten

as 6,950 kg; 425.8 (line 26) should be rewritten as 426. And the same throughout the main text and supplementary information.

Response: Adjusted accordingly throughout the main text and supplementary information.

14. Figures:

1) Fig. 2. Add in error bars both ways, plus put n = x under each bar for sample numbers.

Response: Adjusted accordingly.

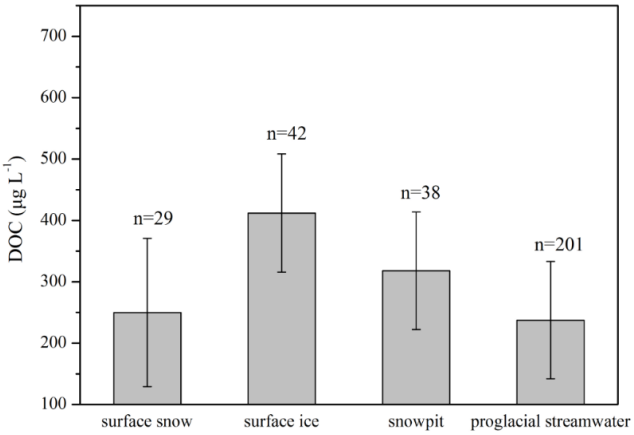

Figure 2 Average DOC concentrations of ice, snow and proglacial streamwater for LHG glacier.

2) Fig. 3. I would have thought that the relationship here could also be adequately described by a linear regression. Also, need to put control (refrigerated) values on here.

Response: The control values were added on the Figure 3. Yes, based on the data only, the linear regression could be adequate. However, according to the DOC bioavailablity, the exponential one can be more authentic (Spencer et al., 2015), because some DOC are bio-refractory, so that DOC cannot reach zero with long enough resident time. The modified figures are shown on Figure 3, and this Figure is now Figure 4 based on the other reviewer's comment as below.

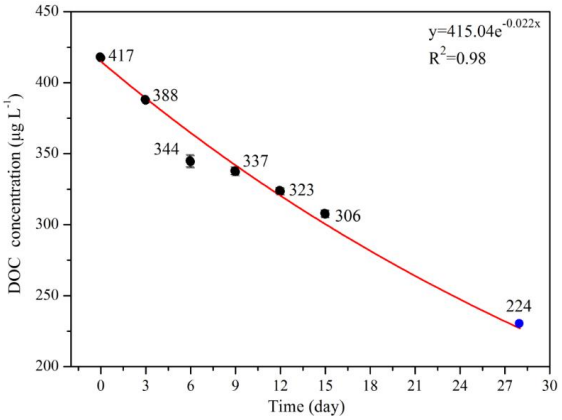

Figure 4 Exponential deceases in DOC concentrations during the biodegradation experiment. Note: The blue point is calculated using equations derived from the experimental data (black point). Mean values ± standard deviations of duplicate treated samples are presented.

3) Fig. 4. Would help to put some lines as dotted/dashed (when printing in black+white)

Response: Yes, the line types have been changed in Figure 4, and the spectrum of desert sand was deleted according to the other reviewer's comment. Figure 4 is now changed to Figure 5 in the main text as below.

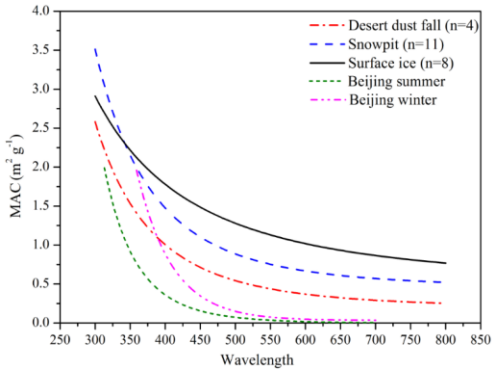

Figure 5 Absorption spectra for the DOC in snow and ice of LHG glacier and the dust and desert sand from surrounding areas.

4) Fig. 5. Again, be better to have one line dotted or dashed plus have different symbols to aid interpretation when printing in black + white.

Response: The line and symbol types have been changed, and this Figure is now changed to Figure 6 in the main text based on the other reviewer's comment.

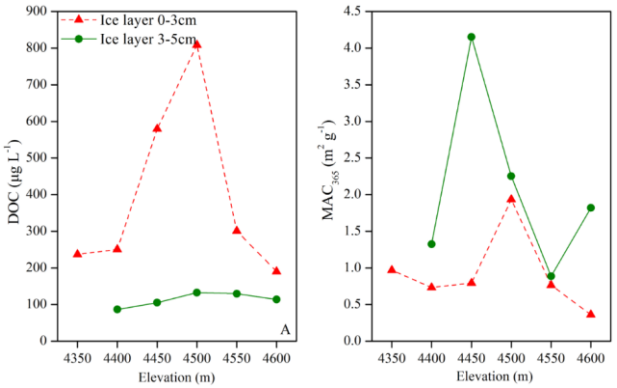

Figure 6 Comparison of DOC concentrations (A) and MAC365 (B) between surface and subsurface ice.

5) Fig. 6. How was discharge calculated and smoothed from raw data?

Response: By measuring water levels and flow velocity in different parts of the river channel in different seasons, a relationship between discharge and water levels was developed using the minimum, maximum and usual water levels. Coupled with HOBO water lever record, discharge of whole ablation period was calculated. Detained method was added in the supplementary information.

6) Fig. S2. Typo – should be elevation, not evelation

Response: Has been corrected.

7) Fig. S4 – use different symbols for ice and snow to aid readability.

Response: The symbols are changed to recognize easily in Figure S4, and now it is Figure S3 based on the other reviewer's comment as below.

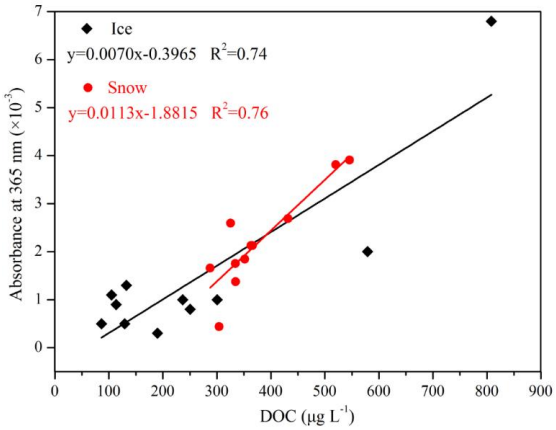

Figure S3 Relationship of the light absorbance at 365 nm and the DOC concentrations of snow and ice samples.

15. Tables:

1) Table 1. Use 3 sig figures throughout (e.g. 332.4 should be 332)

Response: Adjusted accordingly.

2) Table 2. Footnote unclear

Response: Very sorry for the mistake. The footnote was rewritten.

3) Table S1. Please clarify resolution – e.g. for snowpack I presume it is vertical resolution, for ice I presume horizontal distance on glacier, or is it calculated vertical distance?

Response: Yes, for snowpack it is vertical resolution, for surface ice and snow it is elevation interval (horizontal distance).

4) Table S2 BK2 (top line) is out of line. Plus would be better to replace BK numbers with date to show how they encompass the time of study. Could also include the mean+STDEV at bottom.

Response: BK numbers have been adjusted accordingly and the mean+STDEV was added at bottom.

References

Gao, X., Xie, X., Qin, X.: Analysis on a floor happened at the No. 12 glacier in Laohugou Valley, Qilian Mountain in June 2013, Journal of Northwest Normal University: Natural Science, 50, 88-91, 2014 (in Chinese with English abstract).

Spencer, R. G., Stubbins, A., Hernes, P. J., Baker, A., Mopper, K., Aufdenkampe, A. K., Dyda, R. Y., Mwamba, V. L., Mangangu, A. M., and Wabakanghanzi, J. N.: Photochemical degradation of dissolved organic matter and dissolved lignin phenols from the Congo River, J. Geophys. Res. Biogeosci., 114, doi:10.1002/2015GL063498, 2009.

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Cosmochim. Acta, 142, 64-74, 2014.

Spencer, R. G., Mann, P. J., Dittmar, T., Eglinton, T. I., McIntyre, C., Holmes, R. M., Zimov, N., and Stubbins, A.: Detecting the signature of permafrost thaw in Arctic rivers, Geophys. Res. Lett., 42, 2830-2835, 2015.