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Interactive comment on "Particulate organic matter composition and organic carbon flux in Arctic valley glaciers: examples from the Bayelva River and adjacent Kongsfjorden" *by* Z.-Y. Zhu et al.

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We appreciate the reviewer's help.

Reply to major points:

1. there is a lack of discussion. . .. . .

Yes, and previously there are lots of work that has been done for the Bayelva river glacier basin, and other glaciers in Svalbard. As was suggested by the reviewer, the

proglacial environments and ice margins are important zones that modifies the glacier melt water content (e.g., nutrients and organic carbon concentration), as was proved by hydrochemical data in glacier melt water (Hodson et al., 2002). Also, the high arctic glaciers are different from temperature glaciers, and the glaciers in Svalbard do not lack of sediment source throughout the melt season, so the total suspended matter concentration in glacier melt water can maintained at a high level all the time during melt season (Hodson et al., 1998). The thermo regime of glacier is very important as the manners of the melt water flow through the glaciers can differ from each other, and this would influence the glacier meltwater quality (Wadham et al., 1998).

Stick to the organic matter theme of the present study, there are also some aspects in our work that reflect the previous findings obtained via former hydrochemical approach. For example, we found that D form of amino acids in the glacier meltwater indicates the presence of bacteria (e.g., Fig. 4). We noticed that in previous work, the presence of nitrification bacteria was suggested by glacier meltwater hydrochemical data (e.g., NO3-/Cl-) (Hodson et al., 2002) and in cryoconite holes in Svalbard (Telling et al., 2011). Also, there is a clear decrease of organic carbon concentration from the glacier terminus to the lower reaches (e.g., DOC decreased from 167 μM at the glacier terminus to 73 μM at NVE stn). The POC data of the Bayelva river, also decreased from around 100 μM at the glacier terminus to 56 μM at NVE stn (Table 1); and the TSM decreased from 741 mg/L at the glacier terminus to 214 mg/L at NVE stn (Table 1). The TSM and POC decrease trend along Bayelva river agrees well with the previous findings that the proglacial sandur is a major net suspended sediment sink throughout most of the remaining melt season (Hodson et al., 1998). As DOC also decreased along the Bayelva river, we further suggest that, in addition to suspended particles and dissolved inorganic chemicals (Hodson et al., 2002), the proglacial region also has a great removal impact on dissolved organic carbon. We think these above points can be added into the manuscript.

2. the difference in area-weighted carbon fluxes among glaciers is unlikely. . .

We agree with the idea that the thermal regimes would have an important effect on carbon flux, and that the comparison of discharge-weighted carbon flux among glaciers will be more helpful. The discharge-weighted POC flux was calculated as the total OC flux divided by the glacier runoff of Svalbard, and we also derived and/or cited the other two glaciers discharge-weighted organic carbon flux from literatures (table R1).

Table R1. (due to format reason, please see supplement pdf file for this table.)

The difference in discharge-weighted flux is much smaller between Greenland ice sheet and the other two glacier systems (Table R1). Both as valley glaciers, Svalbard glaciers has a much higher discharge-weighted DOC flux (compared to glaciers in Gulf of Alaska; namely 0.86 vs. 0.31), but its area-weighted DOC flux is less than half of that for glaciers in Gulf of Alaska (i.e., 0.55 vs. 1.3) (Table R1). We did a quantitative calculation, and suggested that this is explained by the higher meltwater discharge per unit area that yielded by glaciers in Gulf of Alaska ($\sim$ 61 °N), relative to glaciers in Svalbard (further north and colder: 76 °N $\sim$ 80 °N). Namely, the area-weighted runoff for the glaciers in the Gulf of Alaska is 0.0042 km/year (=320 km3/year/75300 km2) (Hood et al., 2009), and the area-weighted runoff for the glaciers in Svalbard is only 0.00068 km/year (=25 km3/year/36600 km2). In per unit area, Glaciers in Gulf of Alaska yield 6.2 times higher meltwater discharge when compared to glaciers in Svalbard (i.e., 0.0042 vs. 0.00068), and this 6.2 times multiple relationship is very close to the multiple relationship between the area-weighted DOC flux and discharge-weighted DOC flux for the two glaciers, which is (0.86/0.31)*(1.3/0.55) = 6.6 times (Table R1). In another word, higher discharge-weighted DOC flux suggests that Svalbard glaciers have a higher efficiency in generating DOC (or higher in DOC concentration) when compared to other glacier systems like the Greenland Ice Sheet and glaciers in Gulf of Alaska (Table R1).

We think these new findings based on discharge-weighted flux is helpful in improving the original manuscript.

Reply to minor points:

P15657 L15…(explain source of POC in glacial meltwaters)

The main sources of POC in glacial meltwater include bed rock and paleosoil at the bottom of glaciers and subglacial microbial activity (Sharp et al., 1999), the proglacial/ice margin (e.g., soils) (Hodson et al., 1998), and the cryoconite and supraglacial microbial contribution (Anesio et al., 2010).

P16657 L23-24…(note the work on microbial aspect)

Thanks for reminding. Yes, lots of microbial process work has been done in Svalbard, like those literatures related to Svalbard cited in a latest review work (Boetius et al., 2015). In this particular context at L23-24 in the manuscript, we noticed that some previous microbial work is also closely related to carbon (and other nutrient elements) flux. For example, Irvine-Fynn et al., (2012) calculated the total fluvial export of cells and further estimated the corresponding carbon flux. This will be considered in the revised version.

P15670 L1…(change the term to 'glacial meltwater production')

We agree. Thanks. This will be revised in the revised version.

P15670 L10-12…(not convinced due to too small number and short period)

Yes, our DOC data was only based on Bayelva river alone, and the sampling period only covered three weeks, and so the opinion that DOC in the glacier meltwater was high in concentration is not convinced. But we further cited other people's work to support this idea. Namely, as was described in latter words in the paragraph (see P15670 L15-L18), previous investigations covered the whole melt season also showed that DOC concentration in the meltwater is high throughout the melt season (our [DOC]: 73 μM, theirs: all >165 μM)(Tye and Heaton, 2007). So the reported DOC concentration and hence high discharge-weighted DOC flux in Svalbard in this work (relative to glaciers in Gulf of Alaska and Greenland ice sheet) can be considered as a conservative estimate, and if based on previous work (Tye and Heaton, 2007), the DOC concentration and flux will be even higher.

P15670 L18-20…(the difference is due to the area of meltwater production)

Right. Greenland ice sheet is much greater in area than Svalbard glaciers and this is a very important reason for its lower area-weighted flux. We think there are at least two reasons for the lower area-weighted DOC flux in Greenland ice sheet relative to Svalbard glaciers: 1. The area of Greenland ice sheet is much bigger, 2. The discharge-weighted DOC flux in Greenland ice sheet is also much lower than Svalbard (i.e., 0.32 mg/L vs. 0.86 mg/L; Table 5). In the revised version, we will revise this sentence and further add discharge-weighted flux discussion as was suggested.

Table 1…(indicate the time of sampling)

The time is 20:20 for date 8th, 10:07 for date 12th, 20:15 for date 13th, 18:30 for date 16th, 16:25 for date 19th. And it can be added into table 1.

Table 2…(indicate which sample were used for the data)

This table means to describe the nutrients endmembers in this study, as a basic information for further organic matter discussion in latter section.

For Bayelva river, we used all the samples that collected in the river, namely from the glacier terminus to NVE station. The salinity of these samples were all 0.

For floating ices: we collected floating ices in the fjord and those samples were determined for nutrients.

For fjord waters (surface): all the surface samples collected in the fjord were used, including the estuary samples. All samples were salinity >0.

For fjord waters (near-bottom): the deep water samples in the fjord. Samples were all from the bottom layer, with depth deeper than 170 m (max.: 320 m). they are usually 15 m above the seabed.

Figure 1a…(show all glaciers in the map)

Fine. All glaciers will be added into this plot.

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Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/12/C7942/2015/bgd-12-C7942-2015-supplement.pdf

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