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Biogeosciences Discussions

Interactive comment on "Dissolved organic matter composition and bioavailability reflect ecosystem productivity in the Western Arctic Ocean" *by* Y. Shen et al.

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We thank reviewer #2 for the thorough review and valuable comments. Please see our replies to comments below.

General comments:

1. Chlorophyll and inorganic nutrient data were measured by other groups and were reported by the following studies: Hill and Cota, 2005; Codispoti et al., 2009; Kirchman et al., 2009; Ortega-Retuerta et al., 2012.

2. A significant positive correlation ($r = 0.87$, $p < 0.001$) between concentrations of

TDAA and chlorophyll has been observed in the Chukchi Sea in a previous study (Davis and Benner, 2005).

3. We don't have DIN concentrations for all samples and therefore cannot calculate DON. The DI is based on the molecular compositions of protein amino acids and its calculation does not rely on DON.

4. We did not observe an accumulation of DOC as found in these papers. We observed higher concentrations and yields of amino acids, not DOC. Thingstad et al. (1997) provides insight into the processes that control the bacterial activity and their study was cited in the revised manuscript.

5. The amino acid compositions were used to calculate the degradation index, which revealed compositional variations of DOM in the systems.

Detailed comments:

1). Revised. We further clarified our use of the terms "labile" and "bioavailable" in our response to reviewer #4.

2). Page 9574, line 17: The sentence in lines 17-18 was removed.

3). Page 9575, line 15: Revised.

4). Page 9575, line 16: The bottles were soaked in 0.5 mol L-1 hydrochloric acid for 24 h and rinsed with Milli-Q UV-Plus water.

5). Page 9575, line 17: The DOC samples were filtered and frozen without adding acid.

6). Page 9575, line 27: In these regions the Chl max is often in the 50-70 m depth range.

7). Page 9576, line 5-8: Reference standards were obtained from the University of Miami. Blanks were negligible and values for reference standards were within 5% of reported values.

8). Page 9576, line 16-20: The coefficient of variation between measurements of a given sample was typically less than 5%. The amino acid compositional data were used to calculate the degradation index, which indicated changes in DOM composition.

9). Page 9576, line 21: DOC-normalized yields of TDAA were calculated by dividing the concentrations of carbon in protein amino acids by the concentrations of DOC and were reported as the percentage of DOC (%DOC).

10). Page 9576, line 21-26: Please refer to Dauwe et al. (1999) and Kaiser and Benner (2009) for the calculation of degradation index (DI). The DI is a diagenetic indicator derived from a principal component analysis of protein amino acid compositions (Dauwe and Middelburg, 1998). In general, positive DI values indicate recently produced DOM and negative values indicate more diagenetically altered DOM (Davis et al., 2009). This information was added in lines 21-26.

11). Page 9577, line 1: Revised. Please refer to our response to reviewer #4.

12). Page 9578, line 14: TDAA concentrations showed a more heterogeneous distribution than DOC concentrations (Fig. 3 vs. Fig. 4). Concentrations of TDAA varied by over a factor of 14, whereas concentrations of DOC varied by a factor of 5. TDAA concentrations are not in carbon units.

13). Page 9578, line 25-26: The average TDAA yields $\pm$ standard deviations (SD) were reported in Tables 1 and 3.

14). Page 9579, line 10: The calculation of the DI was based on the composition of amino acids. Variations in DI values reflected changes in amino acid compositions.

15). Page 9579, line 10-15: Revised. Please refer to our response to reviewer #1, no. 5.

16). Page 9579, line 16: Combing data from different sampling years created a wider range of values that were in fact more representative of the region. In addition, statistical analyses were performed to indicate the statistical differences between the two

systems.

17). Please refer to our response to reviewer #1, no. 5.

18). Page 9581, line 1-3: We don't have primary production data to perform statistical correlation analyses between PP and DOC/TDAA. A previous study found significant positive correlations between chlorophyll and concentrations of DOC and TDAA (Davis and Benner, 2005).

19). Page 9581, line 8-10: The sentence in lines 7-11 was rewritten as: DOC-normalized yields of TDAA displayed minor spatial variations in shelf and slope-basin surface waters. The yields ($\sim$1.6% DOC) were more than 2-fold greater than those in refractory DOM (0.70% DOC; Davis and Benner, 2007), indicating a substantial supply of bioavailable DOM in surface waters of the Chukchi Sea.

20). Page 9582, line 12-14: Major biological and physical processes include primary production, microbial utilization, grazing, sorption, eddy transport, etc.

21). Page 9582, line 20: The sentence in lines 20-22 was removed.

22). Page 9584, line 1-2: Data used for comparing the Cape Bathurst polynya with the rest of the Beaufort Sea were collected in the two different years (2008 vs. 2009). Given the temporal variability of DOM, different sampling times probably influenced the differences in DOM between the two regions.

23). Page 9584, line 23: "It is interesting to consider" was replaced by "It is important to explore".

24). Page 9585, line 8: Revised.

25). Page 9585, line 14: It's true for both systems that primary production (PP) produces DOM that is rich in amino acids. But the Chukchi Sea has substantially higher PP than the Beaufort Sea, leading to higher concentrations of amino acids in the Chukchi region.

26). Page 9585, line 18: “is clearly imprinted” was replaced by “appears to be reflected”.

27). Page 9585, line 27: We added “direct release from plankton”, “grazing”, and the following reference in lines 27-28 (Strom et al., 1997).

28). Page 9585, line 29: “indicators” referred to significantly higher concentrations and yields of TDAA.

29). Page 9586, line 8-22: “for the added substrates” in line 19 was removed. Lines 12-14 were rewritten as: Temperature, availability of labile substrates and nutrient concentrations play important roles in regulating bacterial growth and the functioning of the microbial loop (Pomeroy and Deibel, 1986; Thingstad et al., 1997; Kirchman et al., 2009b; Ortega-Retuerta et al., 2012).

30). Table 1: Please see our response to general comments, no. 3.

31). Figure 2a: This figure was revised to include a line and equation for the R2 value (see below).

Additional references:

Codispoti, L. A., Flagg, C. N., and Swift, J. H.: Hydrographic conditions during the 2004 SBI process experiments, Deep-Sea Res. Part II Top. Stud. Oceanogr., 56, 1144-1163, doi:10.1016/j.dsr2.2008.10.013, 2009.

Ortega-Retuerta, E., Jeffrey, W., Babin, M., Bélanger, S., Benner, R., Marie, D., Matsuoka, A., Raimbault, P., and Joux, F.: Carbon fluxes in the Canadian Arctic: patterns and drivers of bacterial abundance, production and respiration on the Beaufort Sea margin, Biogeosciences, 9, 3679-3692, 2012.

Strom, S. L., Benner, R., Ziegler, S., and Dagg, M. J.: Planktonic grazers are a potentially important source of marine dissolved organic carbon, Limnol. Oceanogr., 42, 1364-1374, 1997.

Thingstad, T. F., Hagstrom, A., and Rassoulzadegan, F.: Accumulation of degradable DOC in surface waters: Is it caused by a malfunctioning microbial loop?, Limnol. Oceanogr., 42, 398-404, 1997.

Interactive comment on Biogeosciences Discuss., 9, 9571, 2012.

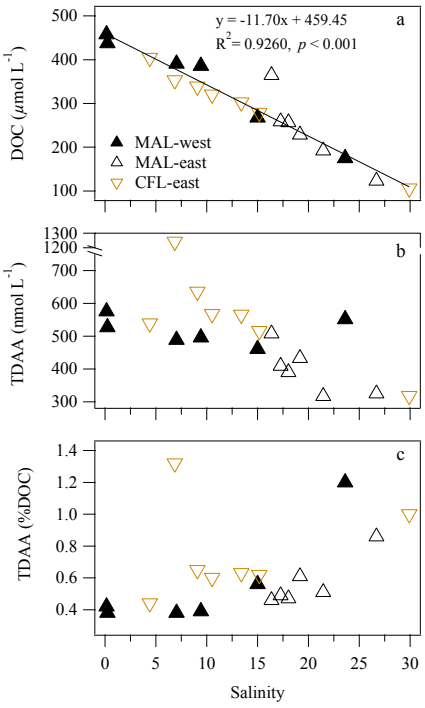
y = -11.70x + 459.45
R2= 0.9260, p < 0.001
a
MAL-west
MAL-east
CFL-east
DOC (μmol L-1)
b
TDAA (nmol L-1)
c
TDAA (%DOC)
Salinity

Fig. 1.