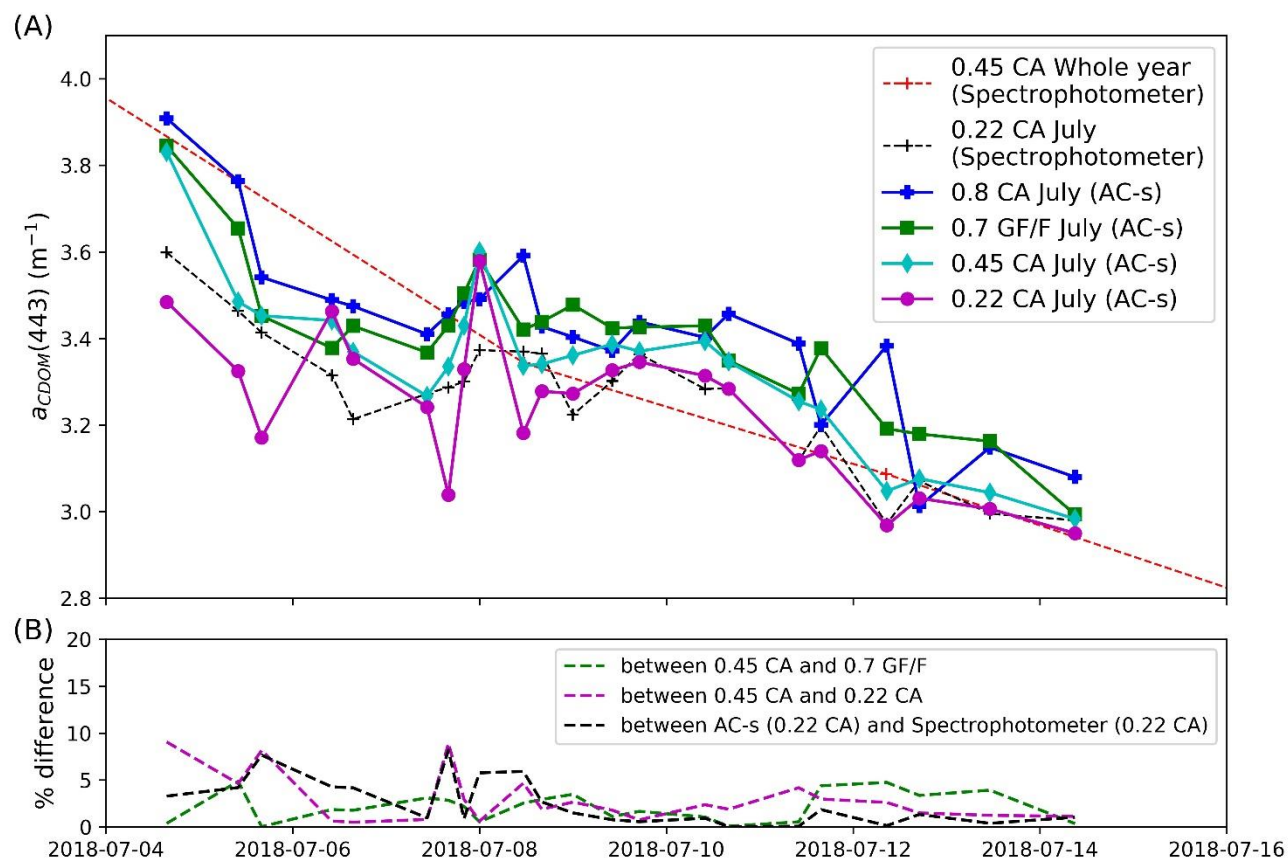


Supplementary Material

1.1 Difference in DOC and a_{CDOM} using different instruments, filter types and pore sizes

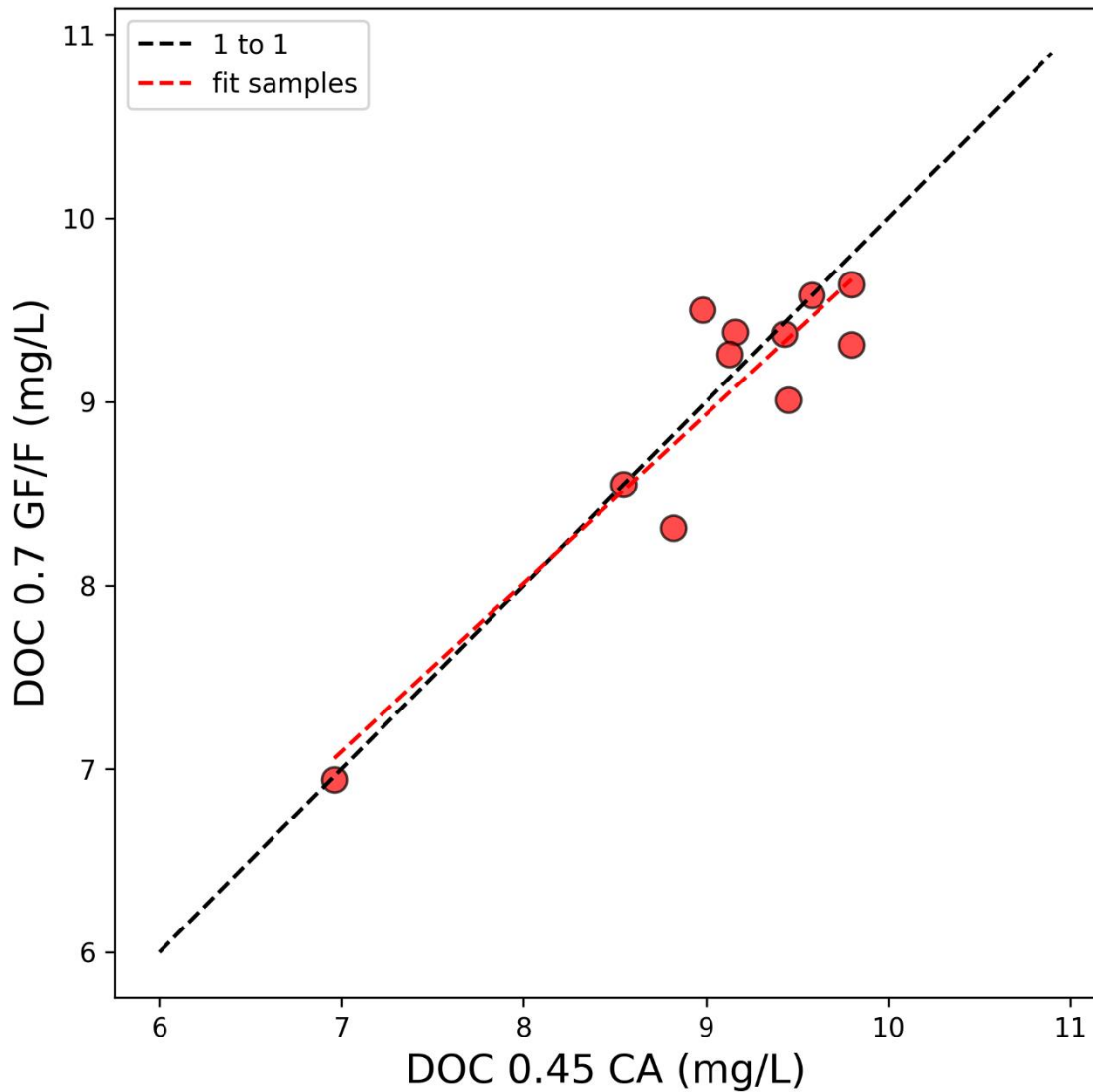
During the additional sampling program in July 2018, DOC and CDOM absorption (a_{CDOM}) samples were filtered through 4 different filter types and filter pore sizes: (1) 0.22 μm CA, (2) 0.45 μm CA, (3) 0.7 μm GF/F and (4) 0.8 μm CA. CDOM absorbance was measured at OSL (SPECORD 200 spectrophotometer, Analytik Jena) and additionally measured right after filtration on Samoylov Island using a AC-s (WET Labs).

There are a number of protocols for measuring a_{CDOM} in inland water with high DOM concentrations and high particulate load. For instance, different filter types and pore sizes are used to separate the dissolved organic matter fraction from the total organic matter including absorbing particles and pigments. Too small filter pore sizes trend to clog too fast and filtration of enough volume is difficult. Thus, for the monitoring program, we chose a 0.45 μm Cellulose Acetate (CA) filter. To evaluate differences between different filter pore sizes and their materials, we used four different filter for each sample during the high frequency sampling period in July (Table 1). The results show consistent but small differences in $a_{\text{CDOM}(443)}$ (Supplementary Figure 1). The mean difference between 0.45 μm CA filter and 0.22 μm CA was 2.98 % for the 22 samples. Between 0.45 μm CA and 0.7 GF/F we observed a mean difference of 2.16 %. Between the a_{CDOM} measurements using a AC-s and 0.22 μm CA filter and a spectrophotometer (Specord) and also 0.22 μm CA filter we observed a mean difference of 2.56 %.



Supplementary Figure 1. (A) Comparison of $a_{CDOM}(443)$ measured with different instruments, filter types and pore sizes. (B) Percentage differences.

In addition to filter tests for $a_{CDOM}(443)$, we also tested the difference for DOC concentration between 0.45 μm CA filter (which we use in the whole-year sampling) and 0.7 μm GF/F filter (Supplementary Figure 2). The mean absolute difference between DOC concentrations of both tested filters is 0.232 $mg L^{-1}$ (2.51 %).



Supplementary Figure 2. Comparison between DOC concentration using two different filter type and pore sizes.

1.2 Principal Component Analysis (PCA) of biogeochemical parameter

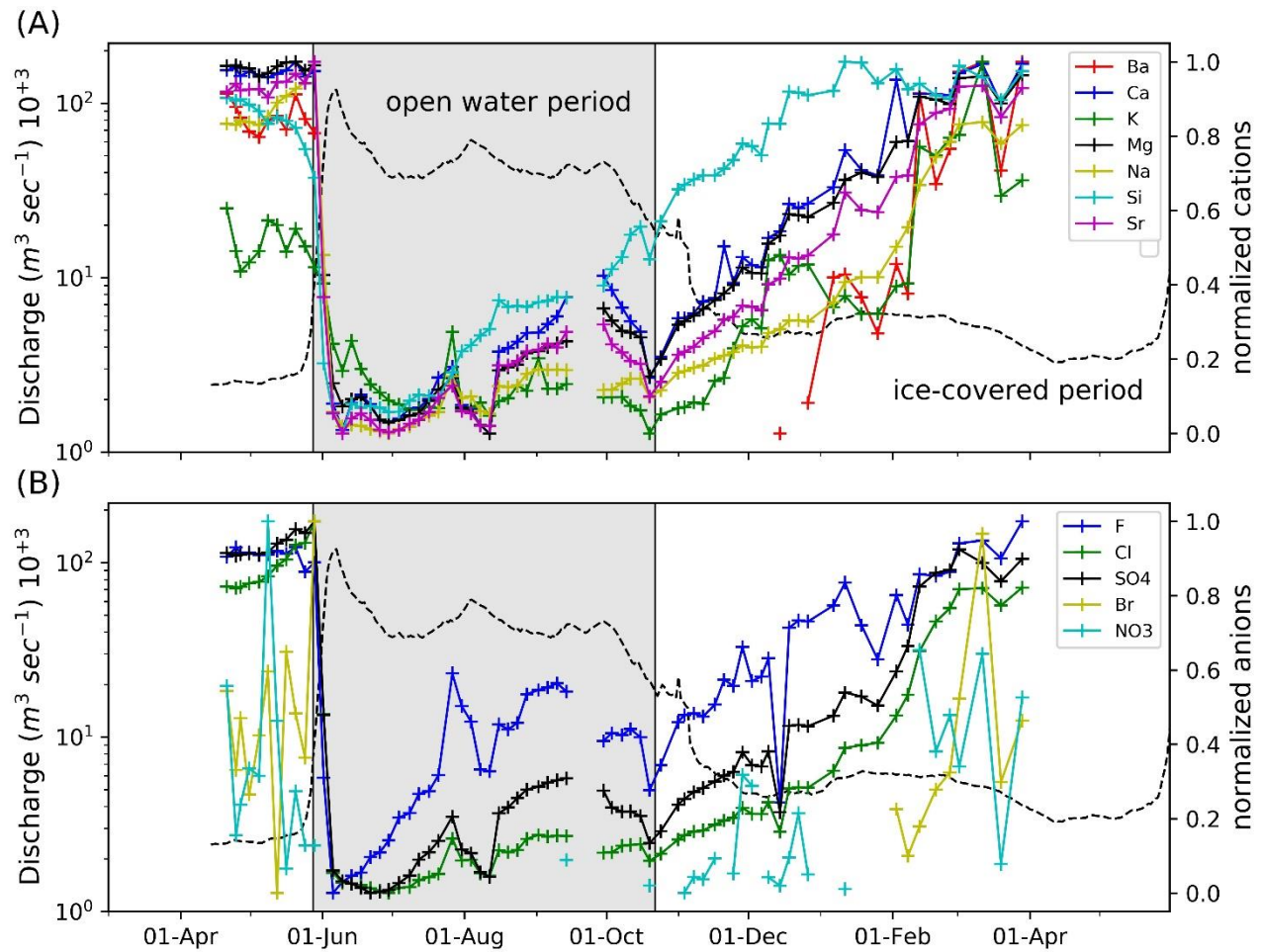
Supplementary Table 1. Percentage of variability that is explained by each component

Component	% of variability explained
Component 1	97.97545
Component 2	1.809842
Component 3	0.185318
Component 4	0.019407
Component 5	0.003892
Component 6	0.002956
Component 7	0.001691

Component 8	0.000701
Component 9	0.000398
Component 10	0.000175
Component 11	0.000113
Component 12	4.24E-05
Component 13	1.06E-05
Component 14	2.97E-08

1.3 Major ions

Major dissolved species concentrations in the Lena River vary seasonally. Supplementary Figure 4 shows concentrations normalized to the annual range of concentrations. Missing data points are samples with concentrations below the detection limit, except for the data break in all parameters in the beginning of October, when sampling was interrupted. Some anion concentrations (F^- , Cl^- , SO_4^{2-}) dip strongly for one sample only, which probably results from sampling problems, since this change in concentration is not reflected in other measured parameters; these values should be discarded.

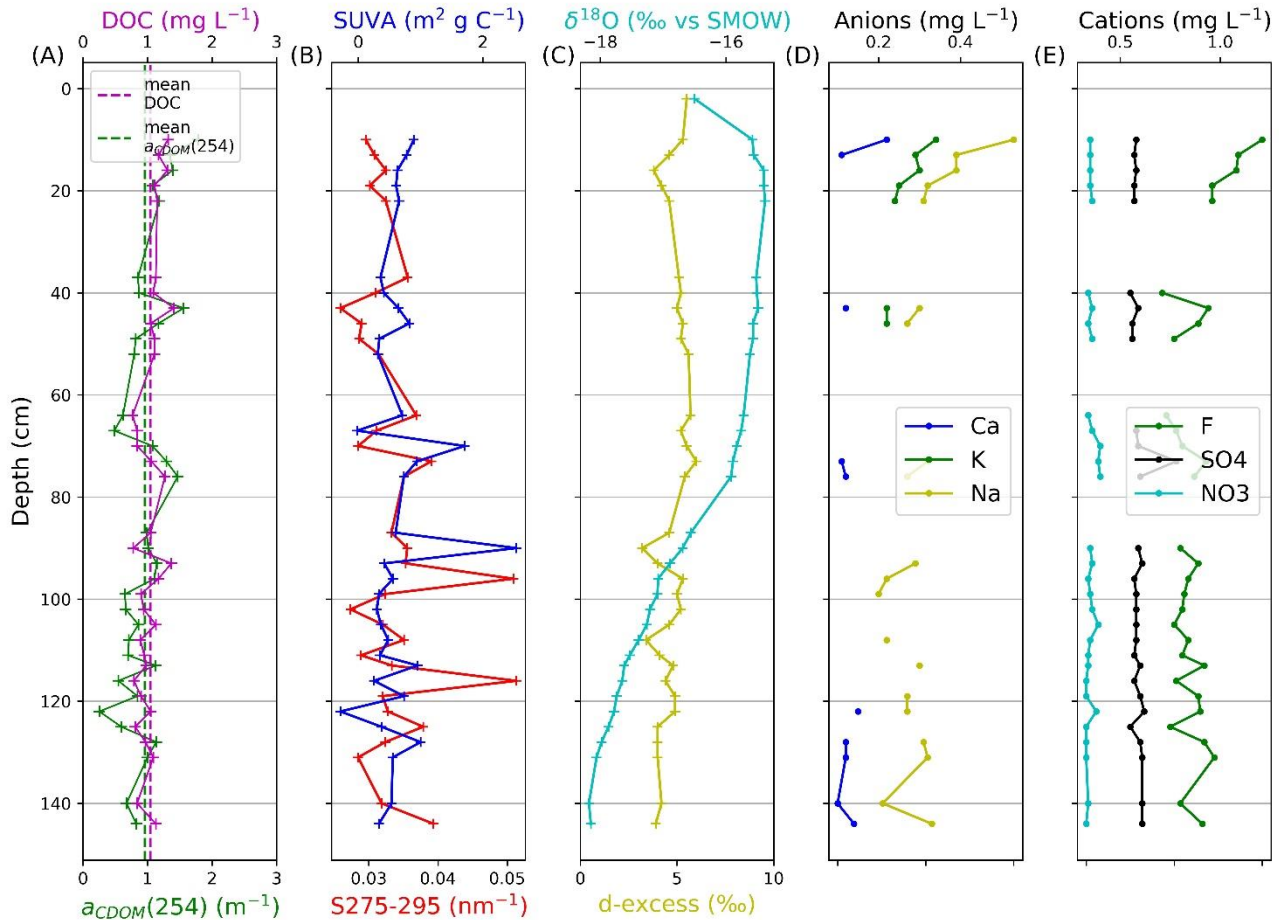


Supplementary Figure 3. Normalized major ions concentration. Al (<100 $\mu\text{g/L}$), Fe (<100 $\mu\text{g/L}$), Mn (<20 $\mu\text{g/L}$) and P (<0.1 mg/L) are below detection limit.

1.4 Biogeochemistry of Lena River ice

To get an insight about how much DOM is stored in the river ice during winter, we drilled an ice core in the end of winter 2018 (4 May 2018). The total ice thickness was 144 cm and the snow cover was 36 cm. Lena River water EC below ice was 453 $\mu\text{S}/\text{cm}$. The ice core consisted of 5 pieces. At each end, we removed one samples due to signs of contamination (peaks of DOM and high EC).

Generally, DOC and $a_{\text{CDOM}}(254)$ in the ice core is low. Mean DOC concentration is 1.04 mg L^{-1} and mean $a_{\text{CDOM}}(254)$ is 0.96 m^{-1} . No clear trend from top to bottom could be observed.

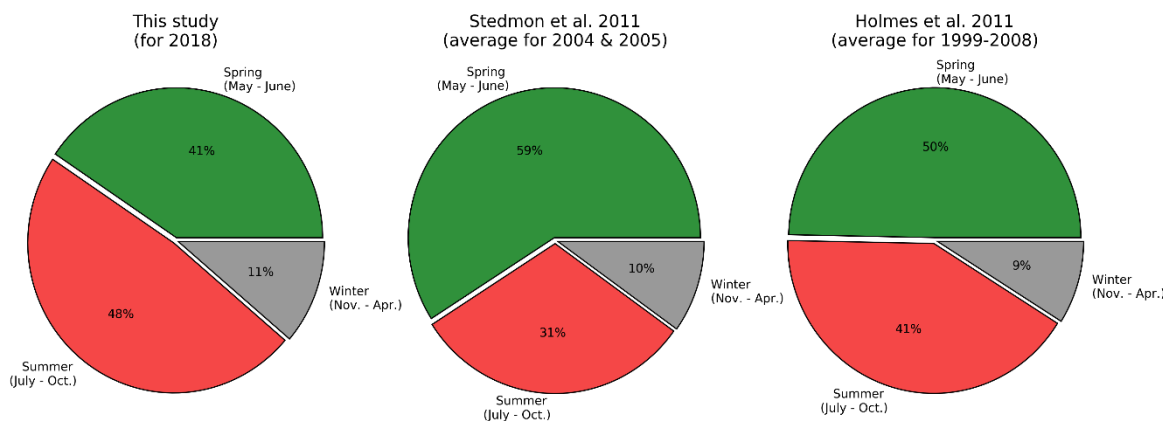


Supplementary Figure 4. Ice Core taken in May 2018 showing in (A) DOC, $a_{\text{CDOM}}(254)$, optical DOM properties (B), stable water isotopes (C), and major ions (D, E).

1.5 Seasonal DOC flux comparisons

Following Raymond et al. (2007), percent spring thaw DOC flux is defined here as the 2-month period preceding the point on the hydrograph when 50 % of maximum flow is hit (2. June 2018 to 2 August 2018). The percent spring thaw DOC flux of 53.2 % (3.62 Tg C) for 2018 is low compared to 54 % (2.84 Tg C) in 2004 and 70 % (4.47 Tg C) in 2005. When divide the year into spring (May to June, 2 month), summer (July to Oct.) and winter (Nov. to April), we see a dominant flux in during summer (48 %) compared to spring (41 %) and winter (11 %) (Supplementary Figure 5). The percentage flux of spring and summer as well as the percent spring DOC flux is very variable between different years. Both, Raymond et al. (2007) and Stedmon et al. (2011) report a dominant

flux in spring rather than during summer as observed in this study. Reasons for the variability of seasonal fluxes between years can be changing discharge and DOC concentrations but also timing of spring ice break-up and duration of the peak discharge can contribute to the variations. Another factor is the potential error of daily DOC concentration calculated by statistical models connecting the discharge and DOC concentration as used in many studies (i.e. Holmes et al., 2012; Raymond et al., 2007; Stedmon et al., 2011). These models are applied to overcome the lack of measurements throughout the whole year. The winter flux varies only between 9 and 11 % when comparing different studies.



Supplementary Figure 5. Percentage season fluxes (spring, summer and winter) of this study (for year 2018) compared to reported averaged values for 2004 to 2005 (Stedmon et al., 2011) and 1999 to 2008 (Holmes et al., 2012).

References of Supplementary Material

- Holmes, R. M., McClelland, J. W., Peterson, B. J., Tank, S. E., Bulygina, E., Eglinton, T. I., et al. (2012). Seasonal and Annual Fluxes of Nutrients and Organic Matter from Large Rivers to the Arctic Ocean and Surrounding Seas. *Estuaries and Coasts* 35, 369–382. doi:10.1007/s12237-011-9386-6.
- Raymond, P. A., McClelland, J. W., Holmes, R. M., Zhulidov, A. V., Mull, K., Peterson, B. J., et al. (2007). Flux and age of dissolved organic carbon exported to the Arctic Ocean: A carbon isotopic study of the five largest arctic rivers. *Global Biogeochem. Cycles* 21. doi:10.1029/2007GB002934.
- Stedmon, C. A., Amon, R. M. W., Rinehart, A. J., and Walker, S. A. (2011). The supply and characteristics of colored dissolved organic matter (CDOM) in the Arctic Ocean: Pan Arctic trends and differences. *Mar. Chem.* 124, 108–118. doi:10.1016/J.MARCHEM.2010.12.007.