

Author responses to review of Referee #1 of Biogeosciences manuscript bg-2019-70 "Dissolved Organic Matter at the Fluvial-Marine Transition in the Laptev Sea Using in situ Data and Ocean Color Remote Sensing "

by Bennet Juhls, Pier Paul Overduin, Jens Hölemann, Martin Hieronymi, Atsushi Matsuoka, Birgit Heim, Jürgen Fischer

We are very grateful to the anonymous reviewer for the detailed and valuable comments on our manuscript. We are confident that the constructive review and suggestions have contributed to improve the paper during our revisions.

Reviewer comments and our responses are presented below.

Reviewer comments are given in *italic font*, our response in **blue regular font** and the resulting change in the manuscript in *blue italic*.

Anonymous Referee #1,

GENERAL COMMENTS:

"The manuscript addresses a relevant scientific issue: sources of dissolved organic matter and carbon cycle in the fluvial-marine transition zone of the Arctic Ocean. The database collected in situ is robust and collaborates to expand knowledge of the sources and processes that occur in the study region, as well as to expand the database. The tests of the various ocean color algorithms show the possibilities of method application and point to certain deficiencies that arise from the available atmospheric correction algorithms dedicated to the satellite image processing.

The estimation of the dissolved organic carbon using satellites images and the empirical algorithm developed by the authors significantly increases the possibility of exploration of ocean color data in the study area, giving the manuscript a substantial contribution to scientific progress within the scope of Biogeosciences.

The method used for DOC estimation was correctly addressed and the results were discussed in an appropriate manner, with figures, tables and graphs presented in a clear, concise and well structured manner. The results are sufficient to support the interpretations and conclusions. The manuscript has the desired scientific quality and follows unrestricted, except minor issues pointed out below."

We are very glad about these positive comments on our manuscript. We revised our manuscript according to the specific comments below.

SPECIFIC COMMENTS:

"Page 1 Line 15: inset point "." after "Laptev Sea" "

This has been changed accordingly in the text.

"Page 1 Line 16: change "DOM" to "dissolved organic matter (DOM)" "

This has been changed accordingly in the text.

"Page 2 Line 2: change "dissolved organic matter (DOM)" to "DOM" "

This has been changed accordingly in the text.

"Page 2 Line 10: change "dissolved organic carbon (DOC)" to "DOC" "

This has been changed accordingly in the text.

"Page 2 Line 24: change "Ocean Color Remote Sensing (OCRS)" to "OCRS" "

This has been changed accordingly in the text.

"Page 3 Line 31: the first table to be quoted in the paper is table 2, instead of being table 1, please rename the tables so that the first table to be quoted is table 1. "

Thank you for this comment, the table number 1 and 2 has been changed and all references have been changed accordingly.

“Page 4 Line 9: please, see observation above (Page 3 – Line 31)”

This has been changed (see above).

“Page 4 Line 31: please inform whether the cuvette is quartz or not”

We used quartz cuvettes for our absorbance measurements. We changed the text in the manuscript accordingly:

“The quartz cuvette length varied depending on the expected absorption in the sampled water”

“Page 5 Line 3: please, insert a bibliographical reference that contextualizes the equation 2: “fitting the following equation (bibliographic reference):” “

We inserted two references (Jerlov 1968; Bricaud et al. 1981):

“Spectral slopes of $a_{CDOM}(\lambda)$ were calculated by non-linearly fitting the following equation (Jerlov, 1969; Bricaud et al., 1981)”

“Page 5 Line 7: change “ $a^*_{CDOM}(440)=a_{CDOM}(440)/DOC$.” To

“ $a^*_{CDOM}(440)=a_{CDOM}(440)/DOC$.” “

This has been changed accordingly in the text.

“Page 5 Line 12: after “high spectral resolution and spectroradiometric quality” insert a bibliographical reference”

We inserted Delwart et al. (2007) as a reference:

“For this study, we chose the Medium Resolution Imaging Spectrometer (MERIS) because of its high spectral resolution and spectroradiometric quality (Delwart et al., 2007)”

“Page 5 Line 13: Why was not used MERIS Full resolution images (300 m)???”

We used MERIS reduced resolution (RR) data because the signal to noise ratio (SNR) of MERIS RR is higher than that of MERIS full resolution (FR) and, thus, the use of RR data for water applications is recommended (Hu et al., 2012). Figure 1 (of this response letter) shows the comparison of MERIS FR (Fig. 1a) and MERIS RR (Fig. 1b) for the region of interest in this study. MERIS FR scene is characterized by a higher noise and thus the risk of extracting noisy pixel is high.

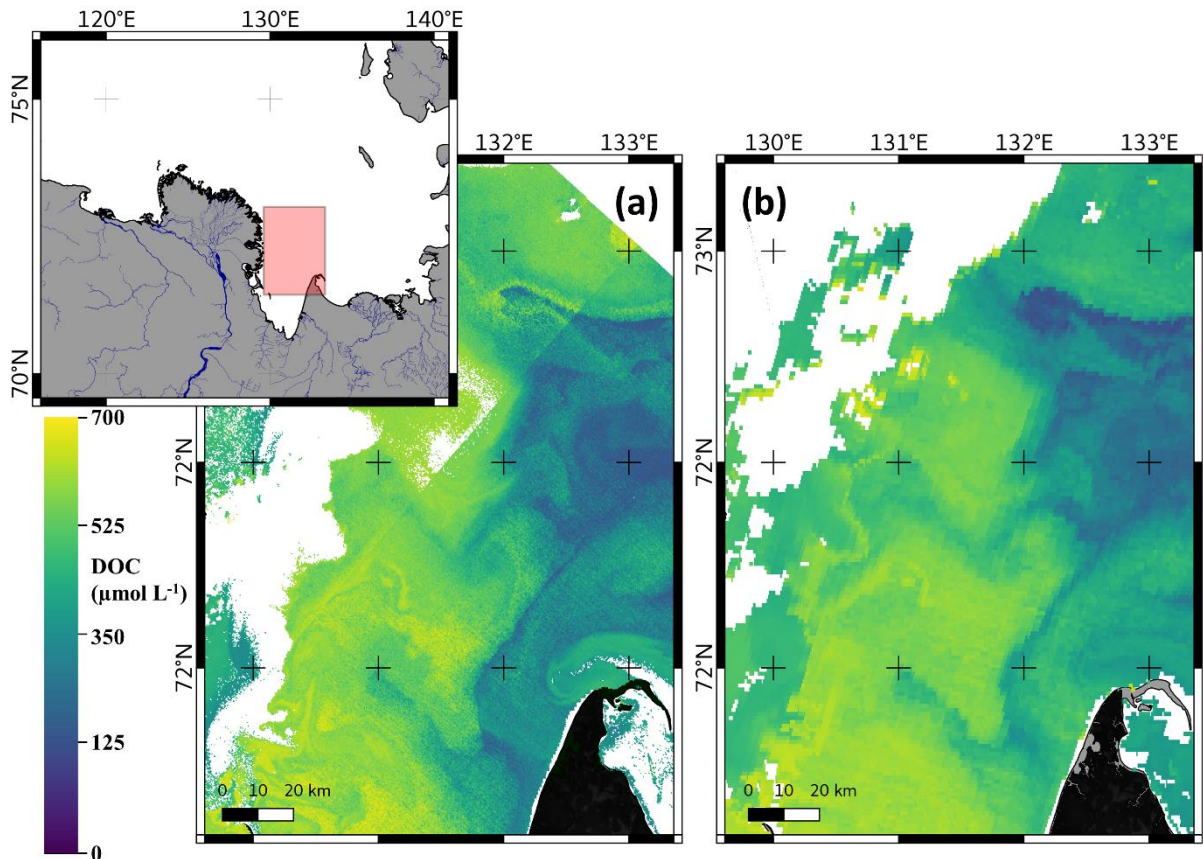


Figure 1: (a) DOC concentration retrieved from MERIS FR scene from 3rd August 2010 and (b) from MERIS RR scene.

Furthermore, our study investigates large areas (Laptev Sea shelf) and large-scale features as the Lena River plume (> 300 km). Since no small-scale features are of special interest in this study, we preferred to use the RR data because of its larger coverage and higher quality compared to MERIS FR. The relationship between in situ DOC and ONNS-derived DOC using FR data was slightly stronger ($r^2=0.68$) compared to RR data ($r^2=0.53$).

We added the following explanation to the manuscript:

“Scenes with reduced resolution were chosen because of their larger extent and thus better coverage of the in situ data stations. Furthermore, Hu et al., (2012) reported a better signal to noise ratio of MERIS reduced resolution compared to MERIS full resolution data and recommended the use of MERIS reduced resolution data.”

We added following information to section 3.5.1:

“The use of MERIS full resolution data revealed a slightly better performance ($r^2=0.68$, slope=0.77). However, we preferred the use of reduced resolution data due to the reported better quality (Hu et al., 2012).”

“Page 5 Line 20: please, explain what was the extraction window dimension (for instance, window of 3×3 pixels centered at the sampling points for Rrs median value)”

Thank you for pointing out this missing information. We indeed extracted 3 by 3 pixels of each OCS product following e.g. Müller et al., 2015 and used the median value for the comparison in chapter 3.4 and 3.5.1. We inserted an additional sentence, which provides this information:

“To compare in situ with satellite data, we used the median of 3 by 3 extracted pixel values from each single processed OCS image”

“Page 7 Line 6: change “and 1.17 to 7.91 m^{-1} aCDOM(443)” to “and 1.17 to 7.91 m^{-1} ” “

This has been changed accordingly in the text.

“Page 7 Line 9: change “from to 0.077” to “from 0.077” “

This has been changed accordingly in the text.

“Page 7 Line 18: change “from river to offshore.” to “from river to offshore (Fig. 2).” “
This has been changed accordingly in the text.

“Page 7 Line 25: please, inform what type of correlation (Pearson or Spearman or ...) was used. It may be better to insert in the paragraph "2.3.1 Functions for satellite retrieval evaluation" a paragraph mentioning the type of correlation used in the statistical analyzes. “

In this line we used the coefficient of determination (r^2) to show the goodness of the presented linear fit (red dashed line, Fig. 3). We added this information to the manuscript:

“As in other river-influenced waters, there was a strong linear relationship between $a_{CDOM}(443)$ and salinity ($r^2=0.87$, $n=283$) (Fig. 3), suggesting that physical mixing prevails and plays a role in near-conservative behavior of $a_{CDOM}(\lambda)$.”

Page 8 Line 2: the same situation as Line 25, Page 7. Please, see the above comment.

In cases where we wanted to show the correlation between two variables without fitting a model, we used Pearson correlation coefficient (r) (e.g. Fig 4). We edited the text accordingly:

“The strongest correlation was observed between $a_{CDOM}(443)$ and the UV slope $S_{275-295}$ (Fig. 4a, Pearson correlation coefficient (r) = -0.84).”

Page 8 Line 8: change “Nelson and Siegel, (2002) indicating...” to “Nelson and Siegel (2002), dashed lines in Figure 4c, indicating...”

This has been changed accordingly in the text.

Page 8 Line 9: please, insert bibliographic reference after “higher aromaticity (bibliographic reference)”

The a^*_{CDOM} (DOC normalized absorption) is a parameter similar to SUVA (DOC normalized absorbance). We added references, which use the slope (Granskog et al., 2012; Helms et al., 2008) as well as references, which use SUVA (Weishaar et al., 2003) as an indicator of aromaticity:

*“Most samples from this study are located below the $a^*_{CDOM}(440)$ limits of oceanic water reported by Nelson and Siegel (2002), dashed lines in Figure 4c, indicating that water samples from this study are primarily river influenced with higher aromaticity (Granskog et al., 2012; Helms et al., 2008; Weishaar et al., 2003)”*

Page 8 Line 10: change “from (Matsuoka et al., 2012) deviates...” to “from (Matsuoka et al., 2012), solid line in Figure 4c, deviates...”

This has been changed accordingly in the text.

Page 9 Line 18: I didn't find “Fig.11, A2”

Thank you for pointing out this mistake. The text has been changed to Fig. B1.

Page 10 Line 7: change “...DOC concentrations using...” to “...DOC concentrations (Fig. 8) using...”

This has been changed accordingly in the text.

Page 10 Line 8: change “...the presented DOC- $a_{CDOM}(\lambda)$ model (Fig.8) and...” to “...the presented DOC- $a_{CDOM}(\lambda)$ model (Eq. 7) and...”

This has been changed accordingly in the text.

Page 10 Line 24: change “...function of salinity, indicating....” To “...function of salinity (Fig 3), indicating...”

This has been changed accordingly in the text.

Page 10 Line 25: delete “(Fig. 3)”

This has been changed accordingly in the text.

Page 11 Line 12: please, insert a bibliographic reference here “... which is often used in the OCRS community (bibliographic reference),...”

We added bibliographic references from Babin et al. (2003) and Matsuoka et al. (2011, 2012):
“Here we use S350-500, which is often used in the OCRS community (Babin et al., 2003; Matsuoka et al., 2011, 2012), instead of S350-400, which is the wavelength range suggested by Helms et al. (2008).”

Page 13 Line 14: this acronym was quoted for the first time “TSM” ??? Please, write out the full text
“total suspended matter (TSM) ...”

The acronym was now introduced in section 2.3.

Page 13 Line 17: I didn't find “Fig. 11b”

Has been changed to “9b”

Page 14 Line 2: change “low” to “lower”

This has been changed accordingly in the text.

Page 14 Line 13: I didn't find “Fig 12b”

Has been changed to “Fig. 10”