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Biogeosciences
Discussions

Interactive comment on "Estimating absorption coefficients of colored dissolved organic matter (CDOM) using a semi-analytical algorithm for Southern Beaufort Sea (Canadian Arctic) waters: application to deriving concentrations of dissolved organic carbon from space" *by* A. Matsuoka et al.

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Dear Reviewer #2, In response to your comments, the text has been revised. Please find below our detailed response to their comments and suggestions.

::: Reviewer #2 (Comments) : ::: General

comments: The manuscript entitled "Estimating absorption coefficients of colored dissolved organic matter (CDOM) using a semi-analytical algorithm for Southern Beaufort Sea (Canadian Arctic) waters: application to deriving concentrations of dissolved organic carbon from space." by Matsuoka et al. presents a semi-analytical algorithm for the remote detection of the CDOM absorption coefficient at 443 nm (aCDOM(443)) from ocean color. The algorithm is designed specifically for use in the Western Arctic Ocean. Although it is similar in concept to the GSM algorithm, this new algorithm includes new parameterizations that help distinguish CDOM absorption from that of non-algal parti- cles. The algorithm was developed using data from field measurements made in the Chuckchi Sea and along the Northern Alaskan slope, and was validated using data collected during the Malina study (vicinity of the Mackenzie River). The algorithm was applied to MODIS Aqua data to derive aCDOM(443) in surface waters of the South eastern Beaufort Sea during August 2009 (year of the Malina field sampling). A published relationship between aCDOM(443) and DOC (Matsuoka et al., 2012) derived from data acquired during Malina was applied to estimate corresponding surface DOC concentrations. Overall, the manuscript is logically organized, written in proper English, and is within the scope of Biogeosciences. The manuscript deals strictly with the development and validation of a CDOM semi-analytical algorithm, but the methodology used appears sound. The CDOM algorithm itself represents a worthwhile addition to the Malina special issue, although I would have liked to see more application of the algorithm. The DOC results represent a weak aspect of the manuscript.

This study focuses on development of a robust semi-analytical CDOM algorithm and its application for estimating DOC concentration. We present results of DOC estimates using ocean color since this estimation is an important step to understand modification of carbon cycle in the context of increasing river discharge and climate warming of the Arctic Ocean. Application of both CDOM and DOC algorithms developed here will be presented with their evaluation in the following papers that we are preparing now.

Below are some specific comments (major comments followed by minor comments) that, I think, need to be addressed before publication. I believe they would improve the overall quality of the manuscript.

Please find below our detailed response to your comments and suggestions.

Specific comments The following are major comments: 1) The semi-analytical algorithm presented here is less straightforward to apply than an empirical algorithm. The need for this level of complexity could be better justified. A simple way to do this would be to compare the performance of the proposed semianalytical algorithm to that of a simple empirical algorithm (one that uses a simple band ratio Rrs412/Rrs555 for example). The empirical algorithm would be developed and validated using the same data sets used to develop and validate the semi-analytical algorithm. The two algorithms could be compared side by side.

We evaluated three empirical algorithms for estimating aCDOM(443) using SBI spr and SBI sum datasets (MR dataset was not used because of lack of Rrs(555) data). There were almost no correlations between aCDOM(443) and each Rrs(λ) ratio (see Table A2). Thus, these relationships cannot be used for estimating aCDOM(443) in our study area. This description was added in the text (New lines 255-258, Table A2).

2) It is very important for potential users of this algorithm to be able to easily reproduce this algorithm. Currently, a lot of the information necessary to reproduce the algorithm is scattered throughout the manuscript. The diagrams (Fig. 2 and 7) are useful to describe the algorithm, but I think a step-by-step description of how the algorithm is to be applied would be very helpful to potential users. A clear, step-by-step "recipe" could be added in the appendix and would follow the diagrams of Figure 2 and Figure 7 (or one diagram that combines both). It would provide all the equations and parameters necessary to implement the algorithm in one single location.

We agree with the reviewer that it is important for a potential user to apply our algorithm easily. The original code of GSM (called GSM01) is now freely available on the ocean color website

(http://oceancolor.gsfc.nasa.gov/DOCS/MSL12/master_prodlist.html/#prod15). Old Figures 2 and 7 (New figures 2 and 6) are indeed designed to be used for the modification; a user can easily modify the code (very minor modification) based on these figures. To avoid redundancy, we did not add another flow chart. Instead, we added the coefficients and the regression used for our algorithm in the appendix to facilitate this modification (see Table A1 in the text).

3) The results on DOC represent a weak aspect of the manuscript. The relationship between aCDOM(443) and DOC is already published, and no validation nor interesting application of the retrieved DOC is provided. The manuscript is often misleading with regards to how DOC data are used and presented in this study. For example: Abstract: Line 13-14. The sentence makes it sound like it is a result of this study. In fact the relationship was established in Matsuoka et al. 2012. Please rewrite accordingly.

Regarding our results of DOC, please find our answer to the general comments. Abstract and section 3.3 are corrected (New lines 62-63 and 305).

Materials and Methods: I do not see the necessity of describing the DOC data in the materials and methods because the algorithm relies entirely on a published relationship between CDOM and DOC. Nothing new is actually done with DOC data. Section 2.2: Section is entitled "Datasets for evaluating the CDOM absorption and DOC concentration algorithms" but the DOC product is never evaluated.

We think it is useful to keep a very brief description of the methodology used for DOC measurements, to keep the paper self-sufficient. The title of section 2.2 has been corrected (New line 152).

4) I find the description of the k-means clustering a little confusing. The authors explain that an optimum number of clusters is 4 (based on the Calinski–Harabasz index), but they end up mentioning that defining only 2 clusters is enough for CDOM absorption. Please provide a better justification for the choice of cluster numbers.

For classifying an object, a number of classes needs to be set objectively. This was first performed in this study, and an optimum number of cluster (CN) was found to be equal to 4 in terms of statistics. However, a CN of 4 is not necessary for applying our CDOM and DOC algorithms (i.e., a CN of 2 is enough for this purpose; see flow chart in Figure 6). To avoid the confusion, we modified sentences (New lines 237-240).

5) Overall, the writing style is OK but I would encourage the authors to go through the manuscript again and try improve some of the wordy sentences used. Two examples are the sentences on Lines 6-11 on page 13746, and Lines 9-12 on page 13754. This would improve the overall readability of the manuscript. The following are minor comments:

An english-speaking person went throught the text and corrected sentences.

Title: I would consider making the title shorter.

Corrected.

Figure 1: I would suggest using only the 200-m and 2000-m isobaths to delineate the shelf and Canada Basin, respectively. The 500 and 1000-m isobaths do not add any useful information and interferes with the locations of some stations. In the caption, please mention that the SBI and MR data are used to develop the algorithm, and the Malina data are used to evaluate its performance.

This figure 1 was modified according to the reviewer's comment. In addition, the description, "Note that the SBI_spr, SBI_sum, and MR_aut datasets were used to develop our CDOM absorption algorithm. The MALINA dataset was used to evaluate the performance of the algorithm", was added in the figure caption (New lines 499-500).

Figure 4: You could add the word "oceanic" to plot (a) and (c) and "turbid' to plot (b) and (d) to make it immediately obvious to the reader. Also, why are the +/- 50% lines only shown in plot (d). The terms coastal and turbid seem to be used interchangeably. Please stay consistent with the terms used.

This figure 4 was modified according to the reviewer's comments. Also, the term "coastal" was used throughout the text.

Figure 5 and 6: I would suggest combining these two figures into a single one. If sea ice "concentration" is shown, then a scale of values should also be added.

Corrected.

Table 2: The average error associated with the retrievals (+/- ?? %) would be a useful addition to this table.

Added (see Table 2).

Interactive comment on Biogeosciences Discuss., 9, 13743, 2012.

Table A1. Summary of the relationships used for developing our CDOM algorithm for Arctic waters.

Equation	Function	Block number in Figure 2	Reference
$a^*_\varphi(\lambda)$	$A_\varphi(\lambda)[chl]^{-B\varphi(\lambda)}$	1	Matsuoka et al. [2011]
	$A_\varphi(\lambda)$ = (0.0273, 0.0298, 0.0192, 0.0138, 0.006, 0.0127)		
	$B_\varphi(\lambda)$ = (0.3443, 0.3480, 0.3604, 0.3487, 0.3428, 0.2867)		
	λ = (412, 443, 488, 531, 555, 667)		
S_{CDM}	0.0185	2	This study
η	Equation 1 when class 2. Otherwise, 1.0 is applied.	2	This study
$a_{NAP}(443)$	$b_{bp}(555)/0.2393$	4	Matsuoka et al. [2007]

Fig. 1.

Table A2. Relationship between $a_{CDOM}(443)$ and $R_{rs}(\lambda)$ band ratio using SBI spr and SBI sum datasets.

Relationship	r^2	N
$a_{CDOM}(443)$ vs. $R_{rs}412/R_{rs}555$	0.19	92
$a_{CDOM}(443)$ vs. $R_{rs}490/R_{rs}555$	0.05	92
$a_{CDOM}(443)$ vs. $R_{rs}531/R_{rs}555$	0.02	92