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

:::::::::::::::::::::::::::::::::::: Reviewer #1 (Comments) : ::::::::::::::::::::::::::::::::::::

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General comments: Matsuoka et al modified the eigenvectors used in a spectral optimization algorithm, so that improved retrievals of the inherent optical properties (in particular the absorption coefficient of the colored dissolved organic matter, aCDOM) could be obtained from spectral remote sensing reflectance. Further, based on field-measured data in the Southern Beaufort Sea waters, an empirical link between aCDOM and concentration of DOC was established, thus made it possible to estimate DOC concentration in the surface waters via satellite-ocean color remote sensing. The authors further applied the modified/updated processing routine to MODIS data over this region and obtained reasonable estimates for this wide area. I found the manuscript is well written and fits BGD very well.

Specific comments: p.13750, lines 1 – 11, Rrs calculation. It is not clear what "The above-water global solar irradiance . . . evolution in the incident light field." means here. Profiles of Lu(z) and Ed(z) were obtained, Lu(0-) was obtained through linear regression, then Rrs is calculated as 0.54 Lu(0-)/Es. Note that, more or less, Lu(z) suffers from wave focusing, but not Es. it might be more robust if Lu(z)/Ed(z) is calculated first (as both are affected by wave focusing), then propagate to 0- and then above surface. A depth range used for the regression would be helpful.

The initial term, " global solar irradiance" is correct and adheres to the NASA Ocean Optics Protocols [Mueller et al., 2003, Ocean Optics Protocols For Satellite Ocean Color Sensor Validation, Revision 4, Volume III: Radiometric Measurements and Data Analysis Protocols, NASA/TM-2003-21621/Rev-Vol III]; the solar irradiance has two components, direct and diffuse, which are referred to as the global solar irradiance when measured together with a hemispherical cosine diffuser (as we do). We thus keep this term as it is.

To examine wave effect, we evaluated the difference between $Rrs(\lambda)$ ($1Rrs(\lambda)$) calculated as $0.54*Lu(\lambda, 0-)/Es(\lambda)$ and $Rrs(\lambda)$ ($2Rrs(\lambda)$) calculated as $(0.54*0.96)*Lu(\lambda,0-)/Ed(\lambda,0-)$. In this analysis, the unbiased percent difference (UPD) is defined as $200*(1Rrs(\lambda)-2Rrs(\lambda))/(1Rrs(\lambda)+2Rrs(\lambda))$. The overall average of these differences

should be within the uncertainty of our ability to make the observations in a homogeneous layer of water, which is about 5% [see Hooker et al., in this issue]. So any UPDs above 5% reveals a bias. As seen in Table S1, the bias (denoted by the *) is less than 1% (i.e., 0.44 %). This result suggests that 1Rrs(λ) is not significantly affected by wave effects, and therefore neglecting this effect does not influence our analyses in this study.

p.13750, line 21. The units for S_CDM should be nm-1; and no units for η.

Corrected (New line 195).

p.13750, line 28, there is no "0.754188" as a correction factor in Maritorena et al (2002).

We apologize for the inappropriate expression. While the factor 0.754188 is not clearly described in Maritorena et al.[2002], an equivalent expression, "After correction for a small offset (0.197 in log space)...", is found in p2712, lines 4-7 of Maritorena et al. [2002]. This bias, 0.197 is actually wrong, and the right value is 0.1225 [Maritorena, personal communication, 2011], which is equivalent to 0.754188. This factor is indeed included in the original code [Maritorena, personal communication, 2011]. To avoid misunderstanding, this description was deleted.

p.13751, line 7, MODIS has listed the '551 nm' band ad '547 nm'.

We don't understand what the reviewer means. If we understood correctly, he/she says that not Rrs(551) but Rrs(547) is available for MODIS.However, Rrs(551) is obtained using MODIS (IOCCG, 1997; Esaias et al., 1998; http://oceancolor.gsfc.nasa.gov/DOCS/MODISA_processing.html). This band is equivalent to that from the previous sensors (e.g., 555 nm for SeaWiFS, CZCS). Nonetheless, we produced Rrs(547) values for the same study area during the same time period. The difference between Rrs(547) and Rrs(551) was small enough (RMSE = 0.0004, r2 = 0.997, slope = 1.009, intercept = 0.0003, N = 95,443). Thus, if Rrs(547) instead of Rrs(551) is used for estimating CDOM absorption, this does not influence

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our results.

p.13755, line 26, ". . . this is the first semi-analytical algorithm for estimating CDOM absorption. . ." This could be true for Arctic waters. Using bbp as an index for a_NAP, Zhu et al (2011) and Lee (1994) demonstrated the potential for waters in the Gulf of Mexico. Lee, Z.P., Visible-infrared Remote-sensing Model and Applications for Ocean Waters, in Department of Marine Science. 1994, The University of South Florida: St. Petersburg. p. 160. Zhu, W., et al., Estimation of chromophoric dissolved organic matter in the Mississippi and Atchafalaya river plume regions using above-surface hyperspectral remote sensing. Journal of Geophysical Research-Oceans, 2011. 116.

To avoid misunderstanding, we corrected this description: "this is the first semi-analytical algorithm for estimating CDOM absorption for Arctic waters" (New lines 325-326). We also cited the paper by Zhu et al.[2011] (New lines 117-118, 325).

p.13767. Fig.3 shows there are Rrs of extremely turbid waters (e.g. Cluster 4). It is curious what was the depth range used for the calculation of Lu(0-) (then Rrs) for such waters.

For extremely turbid waters (i.e., Cluster 4), the top and the bottom of the extrapolation interval were, on average, 0.15 m and 1.58 m, respectively. For all dataset, they were on average 0.12 m and 1.96 m, respectively. The latter description was added in the section 2.2.2 (New lines 181-182).

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

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Table S1. Summary of analysis for the unbiased percent difference (UPD) at selected wavelength.

Wavelength (nm)	412	443	490*	510	532	555	670
UPD	2.09	-0.36	-5.44	2.11	3.67	3.02	4.31

* bias of 0.44 %