Response to review comments on “DOM and its optical characteristics in the Laptev and East Siberian seas: Spatial distribution and inter-annual variability (2003–2011)” by Svetlana P. Pugach et al.

Anonymous Referee #1

General Comments:

In the manuscript entitled “DOM and its optical characteristics in the Laptev and East Siberian seas: Spatial distribution and inter-annual variability (2003-2011)” the authors describe the dominant factors which control the distribution of dissolved organic matter (DOM) in the Siberian shelf seas. On the basis of a data set of several years the authors also try to explain the reason for the observed year-to-year variability of the DOM distribution. A further focus of the work is on the estimation of the utility of in situ fluorescence measurement.

Basically, the article describes phenomena that have been already investigated and published by other authors, i.e.: - The atmospheric forcing of the Lena freshwater plume - and thus the associated high content of terrestrial DOM (for example: Dmitrenko et al., 2005, Wind-driven surface hydrography of the eastern Siberian shelf, doi:10.1029/2005GL023022).-

- The geochemical behavior of DOM on the Laptev and East Siberian Seas (for example: Alling et al., 2010, cited in the manuscript) – The usefulness of in situ fluorescence measurements for the investigation of DOM in the East Siberian and Laptev Seas (Belzile et al., 2004; cited in the manuscript). Actually, some of the co-authors of this manuscript were also co-authors of the study published by Belzile. Because both studies are based on samples from the same region and the same year, the question is whether it is the same set of samples? What is the main difference to the work of Belzile et al.?

***SP**: Thank you for your careful consideration of our results. Indeed, N. Shakhova and I. Semiletov co-authored paper by Belzile et al. (2006) which is based on a very limited data set (14 stations, number of samples = 23) obtained on one single cruise in 2004 in a limited nearshore zone of the East Siberian Sea. In contrast, the current paper is based on four much longer expeditions, with orders of magnitude more observations over much greater spatial scales, and using more techniques/parameters. Belzile et al. (2006) show that good estimates of dissolved absorption can be obtained from DOM-FL measured in situ on unfiltered samples, but this work don’t study relationship between DOC and CDOM concentrations.*

The current paper contributes much novel data relative to Belize et al., Dmitrenko et al. (no optical data at all), and Alling et al. (very limited optical data used only as ancillary information). For instance, the utility of high-resolution DOM-FL (> 1750 measurements made only in 2008) and at 286 different stations for biogeochemical studies is assessed by in situ multi-year data obtained in the two very different regimes of the East Siberian Sea, and the Laptev Sea. The spectral characteristics of CDOM and salinity in different East Siberian Arctic Shelf (ESAS) areas (obtained during the 2004, 2005, and 2011 surveys) were used to separate the ESAS into western and eastern biogeochemical provinces (Table 2). Moreover, based on approach described by Weishaar et al., (2003): specific UV absorbance (SUVA) - defined as the UV absorbance of a water sample at 254 nm normalized for DOC concentration, was used to estimate the degree of aromaticity in bulk CDOM. For the first time, CDOM/DOC interannual variability in connection with atmospheric pressure fields and dynamics/wind-driven water circulation is considered in our paper. Taken together, the current paper, relative to earlier studies focusing on hydrology and bulk DOC distribution, focus on DOM dynamics and its optical properties which provides new insight in biogeochemical processes in the ESAS – the broadest and shallowest shelf in the World Ocean.

In general, it is hard for me to recognize on which data set the analysis is based on. According to Table 1, CDOM (for absorbance measurement) was sampled on 245 stations, but in Table 2 (statistics) the number of samples (N) is 90. Also Figure 2a and 5 give no explanation because the gridded maps do not show the sampling locations for CDOM. Figure 9 (DOC) only shows ~19 sampling locations. This makes it difficult to follow the study's line of argumentation - at least for me. In my opinion, the presentation of the data has to be revised.

***SP**: We agree and will revise accordingly. We will give detailed explanation on which data set each analysis is based on. Table 2 will be edited accordingly. The sampling locations for CDOM also will be given in Figures 2a and 5. In the current Figure 9 we did show only 19 sampling locations because at these sites salinity was < 24.5 psu; in areas with higher salinity correlation between CDOM and DOC is going down. Figure 9 will be redrawn showing all sites. Finally, the presentation of the data will be revised.*

The authors distinguish a western biogeochemical province from an eastern province and state that the CDOM concentration is high near the Lena Delta and low in the eastern East Siberian Sea, a region that is less influenced by riverine freshwater. They also found a strong negative correlation between the CDOM absorption and the salinity and concluded that the CDOM is mainly of terrestrial origin. For the Arctic Ocean, this is a well-documented hypothesis (see the work of R. Amon, C. Stedmon; M. Granskog and many others). Unfortunately, no figures were presented to show the correlation between salinity and CDOM. In my opinion, we are not dealing here with different biogeochemical regimes but with differences in the hydrography and spatial expansion of the region of freshwater influence (ROFI) driven by atmospheric forcing. The conclusion that "the atmospheric circulation regime is the dominant factor controlling CDOM spatial distribution" is therefore somewhat misleading. Are the geochemical processes fundamentally different within and outside of the ROFI? This point needs to be discussed in much greater detail.

***SP:** Thank you for this comment, which helps to improve our manuscript. In this paper, we don't pretend to be the first who predicted a strong negative correlation between the CDOM absorption and the salinity and concluded that the CDOM is mainly of terrestrial origin. Our objective is to deliver to scientific community our unique multi-year CDOM data sets obtained in the poorly explored shallow ESAS. As requested, a new figure will be presented to show the correlation between salinity and CDOM.*

Concerning the comment: "we are not dealing here with different biogeochemical regimes but with differences in the hydrography and spatial expansion of the region of freshwater influence (ROFI) driven by atmospheric forcing", we will give our explanation showing that there are no contradiction between reviewer's 1 and our understanding for such a matter. We use an approach described by Semiletov et al., 2005 and Pipko et al., 2005, which shows that based on distribution of the hydrological (and hydrochemical data), two biogeochemical provinces (areas) were identified in the shallow ESAS: a western area (heterotrophic biogeochemical province) that is influenced strongly by freshwater flux and particulate material transport of the coastal eroded material enriched by organic carbon (oxidized to CO_2, Semiletov et al., 2016, and other publications cited in this paper), and an eastern area (autotrophic) which is under the influence of highly productive Pacific-derived waters. From year to year, depending from dominated wind-regimes, the longitudinal shift of the boundary (frontal zone) between western and eastern areas may reach 10 degrees and more. In this paper, in addition to hydrological and hydrochemical data, the CDOM and its spectral characteristics were applied to identify different biogeochemical provinces in the surveyed area. We will rewrite our *conclusion in this sense as following: "The atmospheric circulation regime is the dominant factor controlling hydrography and spatial expansion of the western area of freshwater influence which determines CDOM/DOM spatial distribution on the ESAS. A western and an eastern regime of ESAS, separated around 165-170° E, were reflected with distinctly different DOM optical properties".*

Specific and technical comments:

- Are the DOM data accessible? - Please indicate the sampling locations in the figures.

***SP:** The sampling locations will be shown in the figures. DOM and all data will be made publicly available at the open-access Stockholm University Bolin Centre Database (http://bolin.su.se/data/), once the manuscript is published.*

- I guess you used the DIVA tool (ODV) for the spatial gridding. I believe the interpretation of data can be misleading if a spatial interpolation that is based on 17 sampling locations covers an area of approx. 500.000 square kilometers (Figure 9.). The DIVA interpolation gives DOC and CDOM concentrations ~400 km north of the last sampling location. I would like to suggest to redraw all figures and to show the original data (e.g. as colored dots) instead of the interpolated data.

***SP**: Thank you, we agree. To avoid any misinterpretation, the Figure 9 was redrawn as shown below. In the upper row-left, original DOC data are presented as colored dots, in the upper row-right, calculated DOC values are shown as colored dots. In the lower row, the same values, but used ODV for the spatial gridding, are presented. We can find a good visual agreement between interpolated original and calculated DOC distribution.*

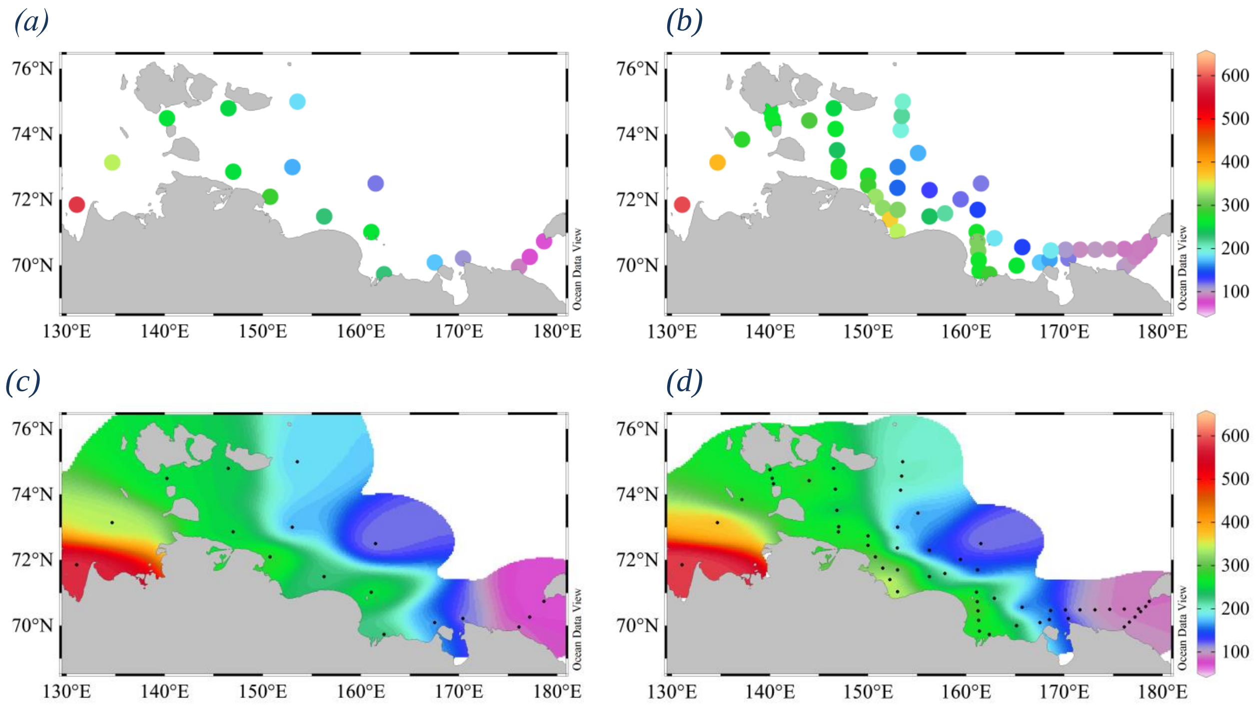

Figure 9. DOC distribution in the ESAS surface waters in September 2004. Upper panels, data presented as colored dots: (a) measured DOC data, (b) DOC data, calculated from DOM-FL. Low panels, interpolated data: (c) measured DOC data, (d) DOC data, calculated from DOM-FL.

- Samples were taken from a “seawater intake system” that pumped the water into a 300 l barrel. Have you measured the salinity directly in the sample, or did you use the salinity data from the Seabird CTD?

The inlet of the ship was at 4m water depth. If you have taken the salinity data from the CTD, which depth have you chosen?

***SP**: We have measured the salinity directly in the barrel using the CTD Seabird 19+ equipped with the WetStar CDOM sensor. “In-barrel” salinity data agreed well with the salinity data measured at stations at depth ~4m. This information will be explicitly added to the revised ms.*

- Please do not use acronyms in the heading of the manuscript

***SP**: Agree. Fixed.*

- Page 3 line 147: I guess 0.7 µm is the correct nominal pore size of the filters.

***SP**: Thank you. It was our typo. This sentence was rewritten as following: “Water samples for CDOM underwent filtration through 0,7 µm GF/F filters (Whatman, Inc.)”.*

- Is figure 3 really necessary? What does it tell about the CDOM distribution?

***SP**: We think that for the scientific community and further investigations it would be useful to represent in Figure 3 the surface CDOM absorption coefficient spectra a (λ) obtained for three distinct sites located in contrasting hydrological and biogeochemical conditions.*

- Figure 4: Wouldn’t it be better to show the relation between aromaticity and salinity instead of longitude?

***SP:** Agree. The relation between aromaticity and salinity is added in a new Figure 4.*

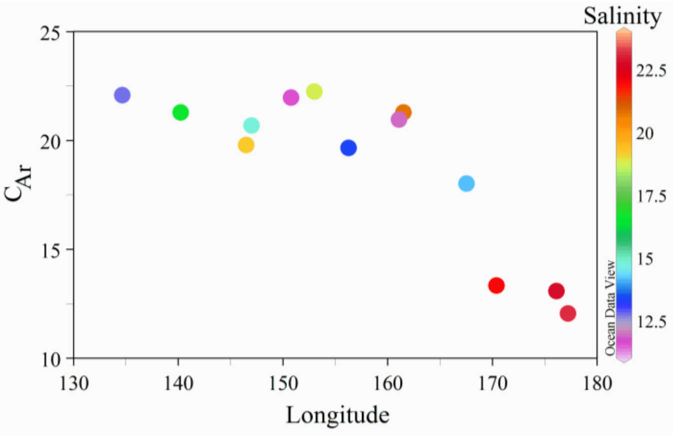

***Figure 4.** The relationship between the aromatic carbon content (C_{Ar}, %) and salinity in the ESAS surface waters, September 2004.*

- English is not my first language, but I believe the text needs a linguistic revision.

***SP:** Agree. The final version of our manuscript will be edited by professional English native editor.*