We would like to gratefully thank the anonymous referee 2 for your very positive and constructive comments.
RC = Referee's comments; AR = Authors' Response

Specific Comments
Abstract: it may be interesting to add a reference after "the northward shift of the ecosystem structure in the Chukchi Sea and Bering Sea shelf region" or refries this sentence.
AR: We agree and Grebmeier et al. (2006b) has been added as a reference in the sentence.

RC:
Equation (2)- I would not recommend to use this data set.
AR:
We had committed a mistake that Equation 2 is conversion method of Chl-$a_{>5\mu m}$ to Chl-a_{total} ratio (Chl-$a_{>5\mu m}$/Chl-a_{total}) to Chl-$a_{>10\mu m}$ to Chl-a_{total} ratio (Chl-$a_{>10\mu m}$/Chl-a_{total}), not the chlorophyll concentration itself.
We believe that this data is needed. Because all high values of in situ F_L (>75%) belong to this data, we cannot validate SDM accuracy in wider F_L range without the data. Additionally, since the data is used just as the SDM validation, we also believe that there are fewer problems than uses of the data for model development.

RC:
A number of previous works relating phytoplankton cell size and the backscattering coefficient need to be cited and incorporated in the discussion.
AR:
We agree. We have now referred several additional works such as Loisel et al. (2006), Kostadinov et al. (2009) and Kostadinov et al. (2010) that described application study to satellite remote sensing and Reynolds et al. (2001), and Wozniak and Stramski (2004) that described relationship between γ and suspended particles at the field study.

RC:

Legends of all Figures need to be more detailed.

AR:

We have restructured the figure captions as follows:

Fig. 1. Location of 75 stations where in situ data were obtained for this study. Data for SDM development were sampled during the OS180 (red circles) and those for SDM validation were sampled during the OS190 (pink circles), KH09-4 (purple circles) and MR10-05 (blue circles). Bathymetry contours indicated are 50- and 200-m intervals.

Fig. 2. Variation of in situ F_L as a function of (a) in situ $a_{ph}(443)/a_{ph}(667)$, (b) in situ $a_{ph}(488)/a_{ph}(555)$ and (c) in situ γ. Colors in each plot correspond to fraction of diatom calculated by HPLC pigment composition (Aiken et al., 2007). Dashed circles indicate samples whose diatom fraction is relatively high in spite of their relatively low F_L values. Solid lines indicate regression lines and their slope and intercept values are described in Table 3.

Fig. 3. Comparison of SDM-derived F_L and in situ F_L ($r^2 = 0.45$, $p < 0.0001$, RMSE = 22.7, $N = 55$) when $a_{ph}(488)/a_{ph}(555)$ and γ were used as SDM inputs . Solid red line represents the regression line (slope = 0.63, intercept = 8.46), the solid black line indicates the 1:1 line, and the dashed lines indicate the +/-20% F_L range with respect to the 1:1 line. 38 out of 55 validated data (success rate of 69%) are correctly derived within +/-20% F_L range.

Fig. 4. Satellite-retrieved map of monthly composited F_L in the study region for (a) August 2006 and (b) August 2007. Shaded parts by gray color indicate the invalid pixels according to the presence of clouds or sea ice. Frames located at 60–72°N, 166–172°W indicate the area for which statistical analysis was performed (Table 5, Fig. 5) for F_L, chl-*a* and SST. Bathymetry contours indicated are 50- and 200-m intervals.

Fig. 5. Histograms of (a) F_L, (b) log-transformed chl-*a* and (c) SST in the area defined in the shelf region (Fig. 4). Blue and red lines indicate the

observations of August 2006 and of August 2007, respectively. Cloud and sea ice covered and other invalid pixels are ignored. Valid pixels in the area are account for 91% of the total pixels for both years. Statistical differences of F_L, chl-*a* and SST are provided in Table 5.

RC:

Analyses and validations must be improved to access the central scientific question proposed.

AR:

Our understanding of the problem of the manuscript is that our analyses and validations are not enough for answering the question, that is, whether SDM can be used to improve biogeochemical knowledge or not. In addition, F_L derived by SDM is not totally independent from chl-*a* because of its calculation steps, uses of same reflectance ratio as an input.

Actually, after the re-composite of monthly F_L and Chl-*a* from daily-calculated ones that anonymous referee #1 had pointed it out, we found significant differences between 2006 and 2007 for the all satellite products, F_L, SST and also in chl-*a*. We had made a mistake. To improve the analyses, however, we simply analyzed inter-annual and seasonal trend of F_L, chl-*a*, $a_{ph}(488)/a_{ph}(555)$, γ and SST (Figure A and Figure B attached) in the same area as the manuscript (60–72°N,166–172°W). Data of 2007 were used to demonstrate the seasonal variability (Figure A) and inter-annual trend of August was investigated from 2003 to 2010 (Figure B).

There is highly significant correlation between seasonal variability of F_L and chl-*a* (r=0.92). F_L almost co-varies with chl-*a* and its seasonal pattern in spring and summer is consistent with in situ study (Hill et al., 2005). Hill described that large assemblages released from light limitation increase both their proportion and biomass in the ice-melt season in the Chukchi sea shelf. During summer, on the contrary, smaller groups increase because of the depletion of nutrients according to the strong stratification. Unfortunately there is little knowledge about autumn phytoplankton species distribution in the region, though SDM could represent seasonal and spatial pattern of phytoplankton size structure consistence with in situ study at least during spring and summer.

On the other hand, there is relatively low correlation between inter-annual variability of $\boldsymbol{F_L}$ and chl-*a* (r=0.69) in August from 2003 to 2010. Although $\boldsymbol{F_L}$ and $a_{ph}(488)/a_{ph}(555)$ exhibit gradual decrease from 2003 to 2010 (p-value < 0.05), chl-*a* does not show such significant changes. Liu et al. (2009) showed that proportion of small phytoplankton assemblage is increasing according to the deepening of nutricline due to recent freshening in the Beaufort gyre, Canada Basin. In the case of this study region, there have not been proposed any evidence of phytoplankton size structure change but several studies indicate a significant warming and freshening at the Bering Strait (e.g., Woodgate and Aagaard, 2005, Woodgate et al., 2006, Mizobata et al., 2010, Woodgate et al., 2010), which can be easily assumed that stratification is enhanced also in the region. Since the warming and freshening is attributed to Alaska Coastal Current, which is known as nutrient poor water and spread widely in the surface layer, we suggest that the limitation of nutrient supply from below is one of the reason why $\boldsymbol{F_\mathrm{L}}$ gradually decrease significantly along with the time series (Figure B).

In addition, we would like to answer a problem that chl-*a* and F_L is not totally independent. According to the estimation of SDM parameters from common R_{rs} ratio with chl-*a*, F_L cannot be independent totally, indeed. Especially, γ is derived by $R_{rs}(488)/R_{rs}(555)$ which is often same as chl-*a* derived by arctic-OC4L. However, the use of $a_{ph}(488)/a_{ph}(555)$ as another model input can trust SDM derived F_L "semi-independent", we believe. It is because F_L and $a_{ph}(488)/a_{ph}(555)$ exhibit gradual decrease from 2003 to 2010 (p-value < 0.05), though chl-*a* does not show such significant changes (Figure B). $a_{ph}(488)/a_{ph}(555)$ is rather correlated with F_L than gamma, r=-0.92 and r=-0.38, respectively. The semi-independent between F_L and chl-*a* is coming from its calculation step of QAA that the subtraction of $a_{dg}(\lambda)$ from $a_t(\lambda)$ (Lee et al. 2002, table 3).

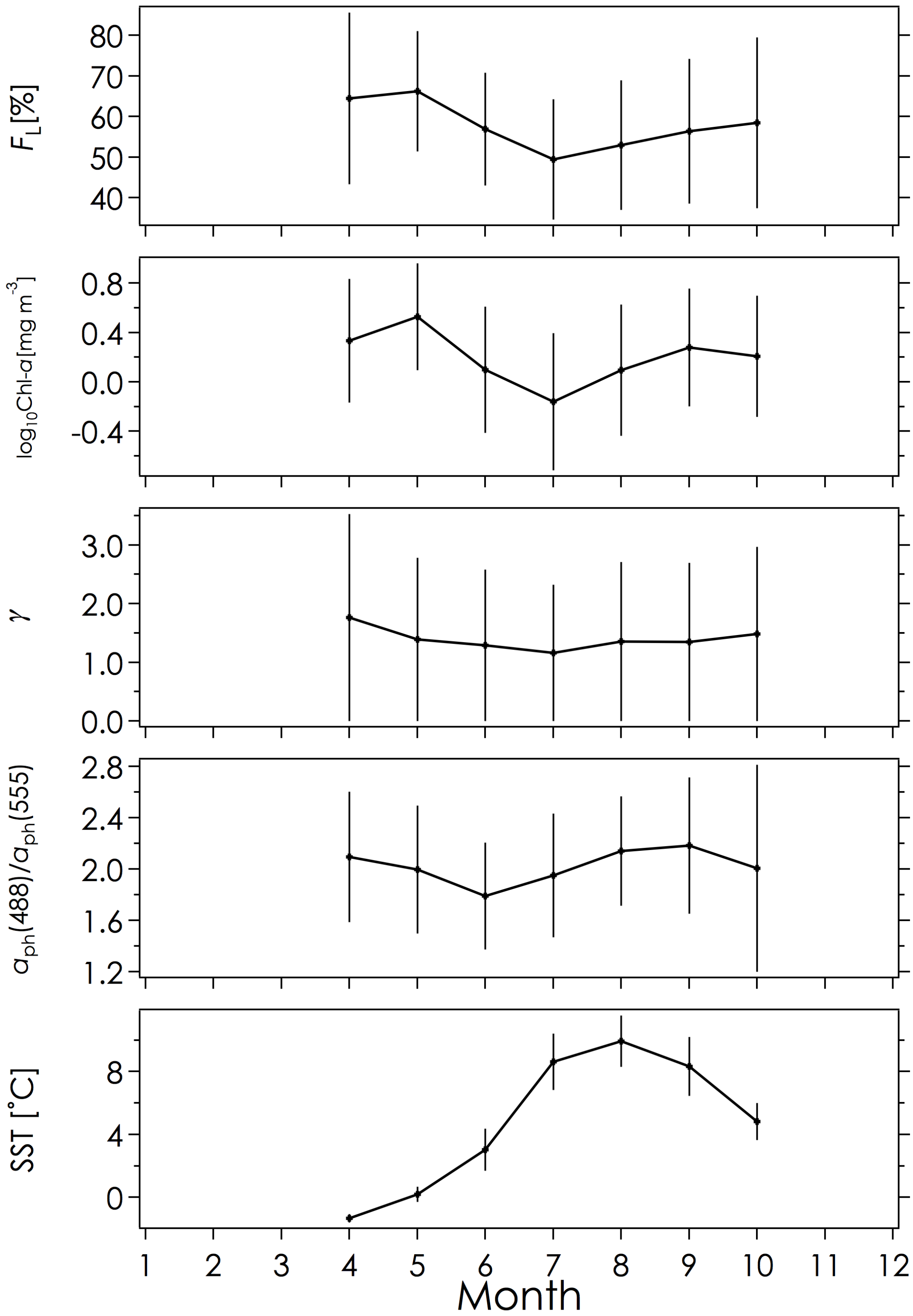

Figure A. Seasonal variability of F_L, chl-a, γ, $a_{ph}(488)/a_{ph}(555)$ and SST in the box-averaged area (60–72°N, 166–172°W) in 2007. Error bars indicate the standard deviation for each month.

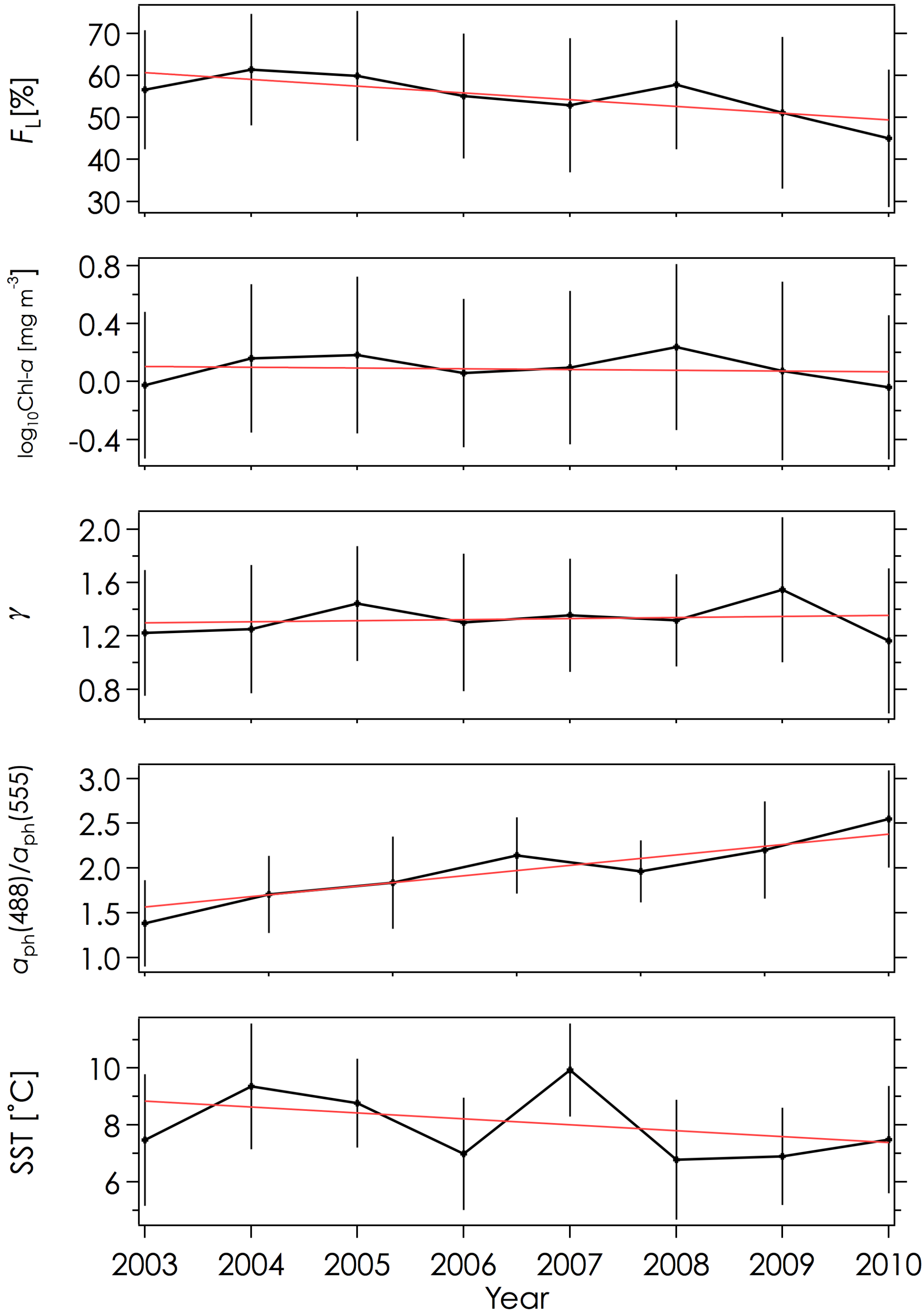

Figure B. Inter-annual variability of F_L, chl-a, γ, $a_{ph}(488)/a_{ph}(555)$ and SST in the box-averaged area (60–72˚N, 166–172˚W) of August from 2003 to 2010. Error bars indicate the standard deviation for each year. Red solid lines indicate regression line for the time series. F_L (r = -0.78, p-value < 0.05) and $a_{ph}(488)/a_{ph}(555)$ (r = 0.93, p-value < 0.001) show significant decrease and increase along with the time series, respectively.