First we would like to thank the reviewer for their comments. Their time spent in critiquing the manuscript is appreciated. We believe that addressing the reviewer's concerns has led to improvements in the document. We hope the reviewer and editor agree.

Endmember mixing:

The reviewer notes that using the numbers presented in Tables 1 and 2 indicates that a conservative mixing model would provide a better fit to measured AQYs than indicated in the paper.

The reviewer's calculations are correct. However, the data in Table 1 is the annually averaged data for the Tyne estuary, whereas the conservative mixing model was applied for the day on which the samples for AQY determination were collected – i.e. 9^{th} April 2001. If the reviewer / editor wish, the absorbance and salinity data for this specific day can be added to the paper or supplemental information.

The reviewer indicates that Equation 3 is incorrect and to compare with a similar equation in Belanger et al. 2008.

Equation 3 in our reviewed manuscript is as follows:

 $\sum_{\text{Station Area}} \int_{280}^{800} (\text{irradiance} \times \text{attenuation}_{1+2} \times A_{\text{CDOM}} / A_{\text{Total}} \times [1-10^{-A_{\text{CDOM}}}] \times \text{CO} AQY)_{\lambda}$

The reviewer is correct. The term $1-10^{-ACDOM}$ is not required when integrating over the entire water column as the term A_{CDOM} tends toward infinity.

The reviewer notes that a term for irradiance reflectance is required. The reflectance due to the albedo of the water's surface is already included in the attenuation term.

This error in equation 3 was a typo caused by using an equation for a depth integrated study. We thank the reviewer for catching this. The following correctly represents the equation used to generate the rates reported in the manuscript.



The reviewer notes that: ATotal should be the summation of ACDOM, particle absorption (AP), and water absorption. Ap is an important light absorption term in estuaries. The manuscript, however, lacks methodology of Ap measurement. To my knowledge, this is part of the first author's doctoral thesis. According to the thesis, only was light attention (absorption plus scattering) measured but not Ap. Scattering is important for particles. The authors should explicitly point out this approximation and the associated uncertainties in their CO photoproduction estimates (both for CDOM and CDOM plus particles).

Edits have been made as suggested by the reviewers. Text has also been added to make it clear that the CDOM only estimate represents a lower limit for CO photoproduction and the CDOM+particles photoproduction is an upper limit.

Temperature sensitivity of CO AQYs:

The reviewer is thanked for raising the issue of CO AQYs temperature sensitivity.

An appraisal of field notes from the sampling campaigns of the current study and for others spanning the last 10 years in the Tyne estuary show that: average temperatures at the head of the estuary are ~7 degrees centigrade in winter, around 10 in spring and autumn and up to 15 degrees C summer. For the purposes of constraining the predicted photochemical rates these numbers seem adequately robust.

Using these temperatures an estimation of the influence of the difference between in estuary temperature and the temperature at which the irradiations were conducted has been added to the relevant portion of the manuscript (end of Section 3.4). As the in situ temperatures were lower than those in the lab (25 degrees C), the predicted rates needed to be downscaled. A minimum estimate of CO production was produced assuming the Tyne CDOM to exhibit the highest level of temperature sensitivity reported by Zhang et al. 2006. This is now used to produce a conservative estimate, constraining the low end of estimate CO production and DOC photo-mineralization in the Tyne estuary. This new lower estimate is 28% lower than without the temperature correction applied. The upper limit for CO production is still calculated as before, without temperature correction. The new range, containing the major uncertainties we can identify, which now include the imprecise calculation of particulate absorbance as well as temperature sensitivity, remains relatively small and does not alter the conclusions of the study that CO production and total DOC mineralization are minor terms with respect to the quantitative cycling of C in the Tyne estuary.

Minor points:

Some recently published papers are very relevant to this study and should be referenced (e.g., White et al. 2010, Mar Chem 118, 11-21; Fichot and Miller 2010, Remote Sensing of Environ,

114, 1363-1377; Xie et al. 2009, L&O 54, 234-249).
P7424, line 12, please add Fichot and Miller (2010).
P7424, line 3, please add White et al. (2010) and Xie et al. (2009).
P7424, line 16-20, please acknowledge that similar approaches have been employed by Fichot and Miller (2010) and Xie et al. (2009).

The above references are acknowledged in the relevant sections.

P7425, line 8, 0.5-0.7 or 5-7 m? – *Edited* (0.7-5.0m)

P7426, line 26-27, Tygon tubing is notorious for CO contamination (Teflon tubing is much better). Please report pre-irradiation CO concentrations in the irradiation cells.

Tygon did not appear to contaminate samples, perhaps due to considerable cleaning. Reference is made to the use of Tygon and the possibility of contamination, along with the inclusion of CO concentrations for blanks filled with the same tubing as the irradiation cells.

P7428, line 21-24, please also compare with White et al. (2010) and Xie et al. (2009).

Refs cited.

P7429, line 26-27, Fig. 6, however, does indicate additional input of CDOM at salinity>20.

Fig. 6 shows some addition of CDOM between salinity 12 and 17 around the Howdon wastewater treatment plant. This is now noted in the text.

P7430, line 16-17, Fig. 6 does not indicate significant photobleaching across the freshwater-salty water transition zone if there was no additional input of CDOM as suggested by the authors.

CDOM data in Fig. 6 is seasonally averaged data and so not suitable for the determination of variations from conservative mixing. Individual transects are a more reliable method for this. In the current study we choose not to present numerous daily estuarine profiles as numerous transects of Tyne CDOM mixing have been presented previously (Uher et al. 2001), in this previous publication it was shown that CDOM is generally lost in the Tyne estuary. As stated in the current document, it is not known what fraction of this CDOM is lost due to various processes. It should be noted however that CO AQYs bleach much more rapidly than does CDOM absorbance (Zhang et al. 2006), so that minimal CDOM photobleaching results in significant reductions in CO AQYs. In estuary photobleaching would not therefore need to have a quantitatively significant effect upon CDOM absorbance to significantly reduce CDOM photoreactivity.

P7431, line 5-7. In fact, Xie et al. (2009) did already report a significant correlation between CO AQY and aCDOM(412) and discuss its implication for space-based evaluation of CDOM photochemistry.

This point has been added to the manuscript.

Table 1. Define surface areas and volumes. Their meanings are unclear. $10 \ge 6 \le 10^{6} \le 10$

Text edited as suggested.

Fig. 1. Add station numbers.

Added

Fig. 6. How did you measure particle absorption coefficients (see major comments above).

Addressed above.

Fig. 3. Where is the modeled AQY for the North Sea seawater (salinity 32.4)? Is this point hidden by the filled squared symbol? If so, please change filled symbols to non-filled ones.

The freshwater and saline endmembers for the conservative mixing model are not included in the model's appraisal. To do so would introduce two perfect false positives. The CO AQYs of the endmembers are not predicted by the model, they are the drivers of the model.