*Author responses reviewer comments, ESCO-S-16-00245R1, “Quantifying seagrass light requirements using an algorithm to spatially resolve depth of colonization”. Line numbers in our responses refer to the revised manuscript. All author responses are in italics. Note that the second reviewer used* CAPS *for new comments and* () *for old comments.*

Reviewer #1: Authors have positively responded to my previous comments and I find the manuscript ready for publication, I have just three comments.

1. All figures are a bit fuzzy, might just be the conversion to PDF, but hard to see axis.

*The figures are automatically downgraded during PDF conversion. High quality originals are provided with the submission.*

1. Can authors add location labels to maps in Fig 4 just to help reader remember which area is which.

*Yes, these are added.*

3) Changes in %SI over time could be due to water temperature, as increasing respiration would drive seagrasses to require a higher light environment.

*Yes, we have previously mentioned the potential effect of water temperature on seagrass light requirements (line 121). We have added an additional sentence to clarify the precise relationship (line 122): ‘For example, long-term or seasonal increases in water temperature could increase estimates of light requirements due to increased metabolic rates (Masini and Manning 1997).’*

Reviewer #2: NEW COMMENTS ON CAPITAL LETTERS FOLLOWING PREVIOUS REVIEW AND RESPONSE BY AUTHORS IN PARENTHESES

(Also concerning is the lack of information about satellite imagery processing and results including number of pixels used, masks, errors, mean vs median values for outliers, etc. This combined with my previous point, gives the impression of a lack of familiarity or knowledge with remote sensing processing. A great addition to this work could be to include modeled Kd values from radiative transfer simulations, expanding future predictions of light availability (from in situ or remote sensing measurements) and seagrass distribution.

We agree that there is not extensive methodological detail regarding remote sensing. In our paper we were seeking to demonstrate an application of existing remote sensing methods. In this regard, our processing was standard, in keeping with previous work. Co-author C. Le is very familiar with remote sensing processing and has previously published papers specifically addressing many of the detailed topics. To keep the focus of the paper on seagrass, we have referred to published material describing our remote sensing methods as much as possible to avoid excessive information in our paper.)

AGREED THIS IS NOT A REMOTE SENSING PAPER PER SE, BUT IT IS THE FOCUS OF A SUBSTANTIAL PART OF THE RESEARCH, AND INCLUDES VALIDATIONS MADE BY THE AUTHORS AND NOT BY PREVIOUS STUDIES. AT THIS POINT I STILL WOULD LIKE TO SEE SOME MORE INFORMATION REGARDING THE IN SITU / MODIS VALIDATION (AS THE AUTHORS STATED FOR THE PREVIOUS COMMENT, THIS WAS A "CRITICAL ISSUE"). E.G. ARE TEN IN SITU POINTS CORRELATED TO A SINGLE (1 KM?) PIXEL? OR A 3X3 AREA? WHAT ABOUT AREAS TOO CLOSE TO SHORE? DID YOU APPLIED A LAND MASK? IF SO, CAN THIS MASK FLAG CLOSE-TO-SHORE WATER PIXELS WHERE SEAGRASS (AND/OR IN SITU VALIDATION POINTS) ARE LOCATED? BOTTOM ALBEDO? REMOTE SENSING IS ACTUALLY ONE OF THE MANUSCRIPT'S 'KEY WORDS'.

*The locations of in situ data for Choctawhatchee Bay were located along the primary axis from the eastern portion to the outflow with the Gulf of Mexico. Pixels in shallow waters were not used to correct the data, as seen in Figure S1 (new addition). Note that the pixel that appears relatively close to the shoreline is actually located at the pass that exchanges with the Gulf of Mexico. Using bathymetry maps, we calculated that the average depth of sampling locations was 7.2 m and the shallowest location was 3.5 m. Comparing these with our in situ estimates of Kd, optical depths at these locations were 1.9 to 3.7, indicating that these station are optically “deep.”*

*We added content that describes the validation process in more detail, including Figure S1 and description of the regressions used to correct the estimates.*

*Lines 205 – 215:‘…Monthly field measurements of Kd obtained in 2010 at ten optically deep locations in Choctawhatchee Bay were used to correct annual means of the un-validated satellite values (Kd, MODIS) to match annual means of in situ measurements (Figure S1a). The satellite estimates of Kd were corrected by comparing regression curves of in situ data and satellite estimates from corresponding pixels versus cumulative frequency of each type of measurement (Cumulative Freq = -0.34 + 1.75 ∙ Kd, r2 = 0.93 for in situ model; Cumulative Freq = -0.35 + 1.15 ∙ Kd, MODIS, r2 = 0.95 for satellite model). For any uncorrected satellite estimate (Figure S1b), the corresponding frequency estimate on the regression curve from the satellite data was identified, matched with the corresponding frequency for the in situ data, and then related to the associated in situ Kd value to yield the corrected satellite estimate…’*

(We are not clear what the reviewer is suggesting about "predicting light availability." Predicting light availability is not our objective. Rather we want to know, how changes in water clarity might relate to the distribution of seagrasses.)

THIS WAS JUST A SUGGESTION. YET, FUTURE APPLICABILITY OF THIS WORK CAN BE UNDERMINED IF THERE ARE NO FULL SETS OF NEW DATA. MODELED LIGHT AVAILABILITY MAY BE USEFUL TO ESTIMATE Zc.

*We understand the value of improving our quantitative description of optics in these waters, and agree that in the future, if there is even less data, it could be useful to have that to support use of remote sensing (i.e., if we didn’t have any in situ observations at all). In other work (e.g., Le et al. 2015 L&O 60: 920), we describe some research we’ve done on optical properties in these estuaries. Fortunately, for this paper, we do have these measurements of Kd.*

(Ln 181-184: Satellite images from the Tampa and Choctawhatchee Bays may and will also be affected by bottom reflectance. How did you deal with this for these two areas, since it is stated that only for Indian River Lagoon was an issue?

To estimate attenuation without excessive effect from bottom reflectance, it's necessary to have deeper areas within the study area. Indian River Lagoon does not have a deeper central basin where bottom reflectance is not a major issue. It is also very narrow, so that image resolution is a problem. Most pixels are contaminated by shorelines. Please see our response to the first reviewer regarding use of attenuation estimates in deeper water adjacent to seagrass beds.)

THEN I GO BACK TO A PREVIOUS COMMENT ABOUT SATELLITE IMAGERY PROCESSING. PIXELS CLOSE TO SHORELINES WILL BE CONTAMINATED WHETHER THE WHOLE BAY GETS DEEPER OR NOT. HOW DID YOU DEAL WITH THIS FOR YOUR CHOCTAWHATCHEE BAY PROCESSING? LAND MASK? BATHYMETRY CONTOURS?

*We thank the reviewer for challenging us on this again. Looking at the issue again, we realized that there was a need to address this further, which we have done. Specifically, we recognized that while we validated our Kd estimates in optically deep water, there is the potential that we are using pixels in optically shallow water and that this could affect those estimates of Kd and therefore estimated % PAR on the bottom at these locations. The effect of bottom reflection in shallow water is evident in nearshore pixels in Figure S1 (new).*

*We can confirm that land pixels were screened out with a land mask, but we have added an additional step to ensure that we do not use affected pixels in our estimates of %PAR at the depth of colonization. All estimates of Kd that were used were for locations where we also estimated the seagrass depth of colonization in the vicinity of that location. We compared the water depth at each location with the estimated depth of colonization and screened out all the observations where the water depth was less. The effect is that we ended up comparing remotely sensed Kd for pixels located offshore and in slightly deeper water than the seagrass with which they were compared. Conversely, pixels located within a seagrass bed, at shallower depth than the deep-edge, or inshore of seagrass in shallower water were not used. Given that most estimates of the light requirements for seagrasses are in the range of 20-40%, the effect is that we screened out Kd estimates for waters with an optical depth less than approximately 1 to 1.6, without actually using the (potentially wrong) remotely sensed Kd values to determine the optical depth.*

*We recalculated all of our affected results using this additional screen, and found that only minor changes occurred and that these did not affect our conclusions. Ten percent of the locations in Choctawhatchee Bay and 13% in Tampa Bay were screened out. We changed all the affected values. These are reflected in Table 3 where there are now separate columns for the sample size (n) for the depth of colonization locations and associated estimates of light requirements, where the latter had locations removed if Zc > depth. The following was added in the text to make this clear:*

*Line 345: ‘Surface irradiance at the seagrass edge was not estimated from remote sensing data if the associated depth of colonization estimate exceeded the actual bottom depth. These locations were removed to reduce potential bias from bottom reflectance in shallow waters (10% of locations in Choctawhatchee Bay, 13% in Tampa Bay).’*

ALSO, YOU STATED THAT IT IS A "COMMON ASSUMPTION" THAT DEEPER AND ADJACENT SEAGRASS AREAS WILL HAVE SIMILAR LIGHT ATTENUATION (FROM YOUR RESPONSE TO FIRST REVIEWER AND THE DOCUMENT). IF SO, CAN YOU ADD SOME REFERENCES SUPPORTING THIS?

*We added references from several locations in Florida, North Carolina and Chesapeake Bay where this assumption is evident in the work. We noticed that it was fairly easy to find papers where it is apparent that this assumption was made (i.e., all the monitoring locations are in open water, and they are looking at seagrass on the fringe of the estuary) but that authors didn’t necessarily go out of their way to make it clear that they had made this assumption not did they necessarily present data to support the assumption. As examples, monitoring programs in Charlotte Harbor used largely open water monitoring in relation to seagrass (e.g., Corbett 2004, Corbett and Hale, 2006). A similar approach was used to evaluate light requirements of seagrass in Chesapeake Bay using water clarity data from monitoring sites that are overwhelmingly located in open water (http://www.chesapeakebay.net/documents/3676/map\_of\_mainstem\_and\_tributary\_monitoring\_stations.pdf). Biber et al. 2005 (Ch 13 in Estuarine Indicators, Fig. 13.2) evaluated water quality with respect to Seagrass in Pamlico Sound, North Carolina utilizing data from 9 stations in open water. These references were added to the manuscript (see below, Kemp et al. 2004 was previously cited). We have ourselves collected data (not for these estuaries) in some cases showing little difference, while also seeing anecdotally situations where there was quite obviously a difference, generally due to wind-driven sediment resuspension. However, we felt that a detailed examination of the assumption would not improve the manuscript, in part because like a lot of other people we don’t have the data, because it’s hard to measure.*

(Table 3: Superscripts for mean Zc and %light are confusing. A proper table showing statistical results (used analysis, significance levels, p-values, errors etc when appropriate) can be better.

We have modified the table and caption to simplify the information but we have not added additional tables because this method of presenting comparisons is not uncommon.)

STILL NOT CLEAR WHAT THE SUPERSCRIPTS FOR "Zc, med" MEAN. a STANDS FOR SEGMENT, THEN WHAT ARE a, ab, b AND SO ON?

*To make the table easier to understand, we eliminated superscripts related to footnotes, as these were unnecessary. We retained superscripts as commonly used to illustrate the results of multiple comparison tests. To aid in interpretation, we added additional clarifying text in the caption:*

*“Superscripts for mean Zc,med denote significant differences in segment means. Segments with the same superscript are not significantly different. Multiple comparison tests are only within estuaries, not between estuaries.”*

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ADDITIONAL NEW COMMENTS:

Ln 47-48: Abstract: No need to mention "R", since you are not providing a new package, but just using existing ones. Same way you do not really mention SeaDAS for example.

*This was removed from the abstract.*

Ln 224-227: References

*Added to line 239: ‘Many studies have used open-water estimates to infer water clarity in adjacent seagrass beds (e.g., Kemp et al. 2004; Biber et al. 2005; Corbett and Hale 2006).’*

Ln 248-249 and Fig 1: outflow of the Steinhatchee River not labeled.

*This is now labelled.*

Ln 454: Which Bay? Maybe better to state the whole Tampa Bay, or, the studied areas of Tampa Bay.

*Changed*.

Fig. S1: What do numbers represent?

*The numbers are the sampling station designation. The caption was modified to clarify.*