*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 estimated average depth of sampling locations was 7.2 m and the shallowest location was 3.5 m.*

*We have added content that describes the validation process in more detail, including Figure S1 and regression models used to correct the estimates.*

*Lines 205 – 214:‘…Monthly field measurements of Kd obtained in 2010 at ten 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 are confident that the addition in response to the previous comment addresses the concern regarding data availability and the ability of others to use our methods for further work.*

(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?

*The sampling locations for the in situ data for Choctawhatchee Bay were located in water sufficiently deep to avoid bottom reflection. The pixel size is sufficiently small that pixels associated with our stations are entirely un-contaminated, whereas the effect of bottom reflection in shallow water is evident in nearshore pixels, as shown in Figure S1 (new).*

*To better evaluate a potential effect of contaminated pixels on our estimates of light requirements (derived from the validation datasets), we removed satellite estimates at several points in Choctawhatchee Bay and Tampa Bay. We assumed that locations with likely contamination from bottom reflectance were those where depth of colonization estimates were deeper than the observed depth. That is, our methods could infer an expected maximum or median depth of seagrass growth at these locations from the empirical data, but the associated satellite estimates of light attenuation are potentially inaccurate given the shallow depth. Re-analysis of these data showed only minor changes in the results, which did not affect our conclusions. We include these results to maintain continuity with the possibility that nearshore pixels are potentially inaccurate. As noted below, the assumption that open water estimates of water clarity are similarly used to estimate clarity in seagrass beds is a related but separate issue.*

*These changes are reflected in Table 3 where there are 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 341: ‘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 recognize that there could be differences in water clarity between shallow habitats and nearby open waters. However, there are several reasons that we feel justified in inferring water clarity near seagrass from water clarity in nearby open waters. First, tidal mixing could reduce lateral gradients in water quality over short distances, as long as the constituents are changing slowly relative to time scales for tidal mixing. Water quality constituents like CDOM and algae that dominate light attenuation can be expected to mix when tidal excursions are much longer than the lateral distances from open water to the deep-edge of seagrass. Only wind driven sediment resuspension is likely to exhibit strong gradients, and these are limited to periods with wind-waves impinging on lee shores with resuspendable sediments. Some personal experience with both continuous underway sampling and paired deployments of continuous instrumentation have indicated that such inshore-offshore differences were minor relative to longitudinal estuarine gradients.*

*As we suggested, this thinking isn’t uncommon in the scientific community 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).*

*As we suggested initially, this is not to say that it’s not worthwhile to measure light attenuation in shallower water or that differences wouldn’t be expected. However, significant practical limitations make measuring this much less common, and limit applications to management. For example, Secchi depth cannot be measured in water where the disk is visible, PAR profiles are less accurate than in deeper waters, and boat operation on lee shores with shallow waters is generally avoided. In situ instrumentation would be preferred for this purpose, but suitable instruments and the data they can generate are relatively uncommon. The citations above suggest that measurements in open-water are more commonly used for these reasons.*

(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 234: ‘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.*