Response to Reviewer 1

Reviewer comments in *italic*.

Overall, the paper discusses a highly important alternative to determining longwave irradiance if an obstruction is present. This change will help improve data collection at environmental monitoring stations, both current and that may be in use in the future. I recommend this article for publication, following some minor revisions outlined below.

Hello, thank you for taking the time to review this paper, recommending the article for publication and for your suggestions. We believe this has made the paper stronger and more detailed. To respond to your suggestions:

Line 28: Please remove the acronym definition of NASA from Line 32 to Line 28. This is the first place it is mentioned.

We made the change from Line 32 to 29 (former line 28).

Equation 2: Is this a derived equation? Or created by the authors as a model for collected data? A reader would benefit from having some background on the established relationships and source of all equations, not just Equation 2.

Thank you for pointing this out as we did not make this clear. That equation is a LW energy balance equation that is similar to the one presented by Lee et al. (2010), (page 24), but we also include the emissivity of air. We have re-written the introduction to Eq 3 (formerly Eq 2) to aid readers:

> "The air temperature and skin temperature of the water within the small field of view of the down-looking measurements at COVE are very likely isothermal, so the upwelling radiation at COVE is isotropic (Stephens, 1994, Section 7.1). Since the air temperature and water skin temperature are horizontally homogeneous, we can assume that they are both gray bodies and use the Stefan-Boltzmann law to relate Planck's function to broadband irradiance. Hence, we can use an energy balance (e.g., Lee et al., 2010) to express $LW^{\uparrow}_{f=0}$ as a component sum of measurements that do not require a pyrgeometer and are not influenced by the lighthouse:"

We also added Appendix C, which breaks down Equation 3 (formerly Eq. 2) to assist the reader in understanding the contributions of each term.

A review of the equations were conducted and sourced where needed. We explained how to compute the fraction of blocked upwelling (f) in a new Appendix A. This will hopefully provide enough background information for the reader.

Line 260—262, related to Figures 6 and 7: is the expectation that the LWcs is to be pretty consistent and not impacted by air temperatures? Mentioning that the adjusted data matches expectations (and why) could help emphasize the validity of the new measurement technique.

Yes. The expectation for Fig. 5 and 6; Lines 266-268(formerly Fig. 6 and 7; former Line 262-264) is that LWcs is dominated by the water temperature. This is because the terms in Equations 3 that involve air temperature are small compared to the water emission. We did not emphasize this enough in the paper, so we've added the following paragraph to the beginning of Section 5.2 (Former section 5.3):

> "In this section we analyze four single-day scenarios in winter and summer and in clear and overcast conditions to help understand the physics driving the biases in Figures 3 and 4. Since the water emission term in Equation 3 ($\varepsilon_w \sigma T^4$) dominates the radiative flux (see Appendix C), we expect the true upwelling flux to track the IRT measurements throughout the day (albeit with a high bias) and only minor perturbations associated with the air temperature. In the following paragraphs, though, we see that the pyrgeometer measurements can be significantly affected by changes in air temperature and/or solar heating of the lighthouse structure."

Line 280: How is FOV found/calculated? This explanation may help readers trying to apply this to their own situation.

Thank-you for bringing this up – Reviewer 2 also mentioned this, so we use similar text for both responses.

The parameter f is the fraction of flux that is blocked by the lighthouse, and it was first introduced after Eq 1. This was not stated clearly in the original draft, so we have modified the text after Equation 1 to state:

"...where f is the fraction of the upwelling irradiance that is blocked by the structure, $LW^{\uparrow}_{f=0}$ is the upwelling longwave flux in the absence of the structure, and $LW^{\uparrow}_{twr}$ is the upwelling longwave flux emitted by the structure."

We have also added Appendix A to describe the physical basis for computing flux in the presence of an obstruction with a simple shape (a rectangular cuboid). The appendix concludes with some text about how we use ImageJ software to estimate f for the complex shape of the lighthouse, and we acknowledge that our f value is our best estimate:

> "The geometry of the Chesapeake Lighthouse is more complicated than a rectangular cuboid, so we used imaging software to obtain $f \simeq 0.15 \pm 0.05$ for the lighthouse. Note that f is not needed for the component summation technique (Section 4.1, Equations 3). However, f is helpful for estimating the radiation perturbation caused by obstructions at other sites (Section 6.1)"

Finally, we added text to the beginning of Section 6.1 that describes briefly describes how we use the ImageJ software and our estimated accuracy of f.

> "Thus far, we have presented results specific to the geometry of the COVE platform, which obstructs about 15% of the pyrgeometer upwelling measurement (i.e., $f \simeq 0.15$). The obstruction percentage was calculated using a software package called ImageJ (https://imagej.net/ij/), which provides area and pixel value calculations within manually selected regions. In our application, we used ImageJ to distinguish the structure from the water surface and to estimate the percentage of the upwelling occupied by the structure. We conservatively estimate the accuracy of f as ± 0.05 because the camera used for Figure 2 is not precisely positioned at the pyrgeometer location and it may not be exactly level. Additional discussion about how f is affected by an obstruction's geometry is provided in Appendix A."

Figure 8: The x-axis should have a lower-case F to match the variable in Equation 11.

Thank you for catching this detail. The Fig. 8 plot was changed to match the variable in Eq. 11 and to match lower case f throughout the article.

References

Lee, H.-T., Laszlo, I., and Gruber, A.: ABI Earth Radiation Budget Upward Longwave Radiation: Surface (ULR) ATBD, Tech. Rep. Version 2.0, NOAA NESDIS Center for Satellite Applications and Research, 2010.